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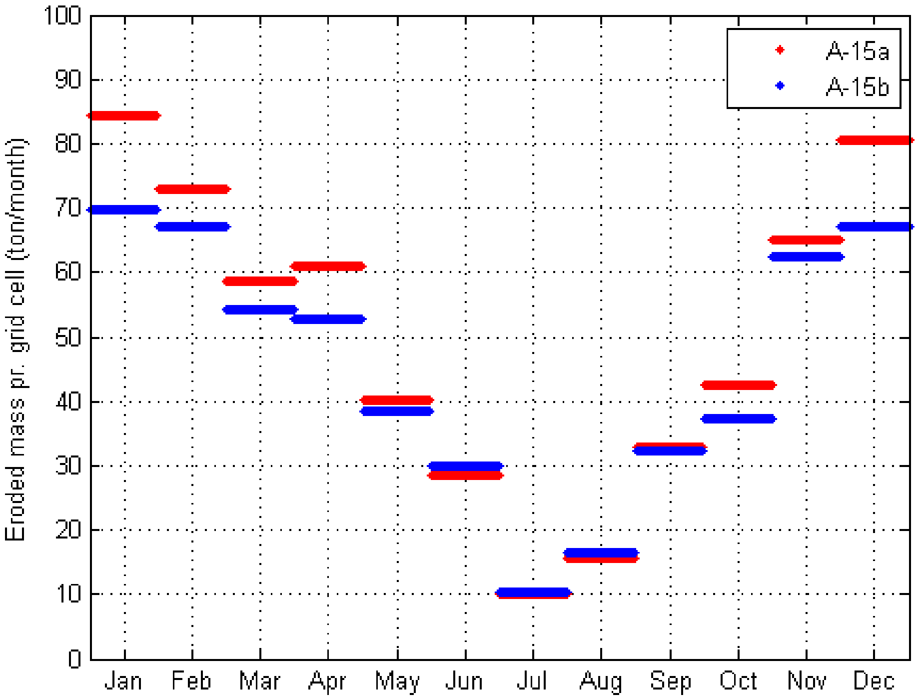

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Wave induced resuspension in fish farming areas of Suðuroy: an introductory model based investigation

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Abstract

Fish farming (net-pen aquaculture) generates substantial amounts of waste, which will affect the local ecology and well-being of the caged fish, if not transported out of the production area. In the Faroe Islands many fish farming areas are located in closed fjords where the tidal current is to weak to resuspend the settled waste.

In this report we investigate the role of wave generated resuspension in the fish farming areas of Suðuroy. Wave conditions measured offshore are transported into the fish farming areas by using a high resolution wave model. The amount of material eroded by the waves is calculated by using linear wave theory, parametric procedures and reported critical resuspension values of bottom shear stress.

Although the simulations are not validated against measurements, the main results are supported by local experience and some circumstantial evidence. The simulations indicate the following:

- Waves seem to be a dominating factor in the cleansing processes of the inner part of the fjords.
- Waves are most places strong enough to clean the fjords in the winter half of the year.
- Idealistic calculations suggest that waves alone are not strong enough to counteract waste accumulation in some areas in the summer months, if the fish density is high.
- The critical current strength for resuspending net-pen wastes suggested by Cromey et al. (2002) give realistic resuspension levels in the investigated sites, whereas the critical values suggested by Dudley et al. (2000) are clearly too high for this region.

Keywords:
resuspension, fish farming, net-pen aquaculture, waste, wave, model, SWAN.

Table of contents

Introduction

Fish farming (net-pen aquaculture) generates substantial amounts of waste, which will affect the local ecology and well-being of the caged fish, if not transported out of the production area. There is therefore a financial as well as an ecological incitement to investigate resuspension and waste transport mechanisms in fish farming areas.

Waste accumulation is counteracted by biological degeneration in the benthic layer and physical processes which resuspend and flush settled material. It can vary quite a bit from area to area which types of processes facilitate the transport of the waste. Many coastal areas are complex, and guidelines only based on minimum current speed and water depth do not represent the full picture of the hydrodynamic conditions in a fish farming areas. Several investigations suggest that wave induced resuspension is an important factor in many areas (Panchang et al., 1997; Dudley et al., 2000; Pizzamei et al., 2002).

In coastal areas of the Faroe Islands the tidal current is usually strong enough to do the waste transporting, but many fish farming areas are located in closed fjords where the tidal current is very weak. Some authors have found (Panchang et al., 1997; Dudley et al., 2000) that the current strength must be in excess of 0.4-0.6 m/s, one meter above the seabed to insure resuspension of fish farm waste. It becomes clear that the tidal current cannot be the sole resuspension agent in many Faroese fjords, when such threshold values are compared to modelled estimates of the maximum depthaveraged tidal current strength of the area (Figure 1). Meteorologically driven currents could help in facilitating waste transport, but such modelling is beyond the scope of the present investigation.

The aim of this report is to investigate if the oscillary movement of the water column, caused by surface waves, is an important factor in resuspending settled waste in some fish farming areas in the southern part of the Faroe Islands. We use the wave model SWAN to transport measured sea states into the respective near shore region and use linear wave theory and measured threshold values reported by other authors to estimate the importance of wave generated resuspension.

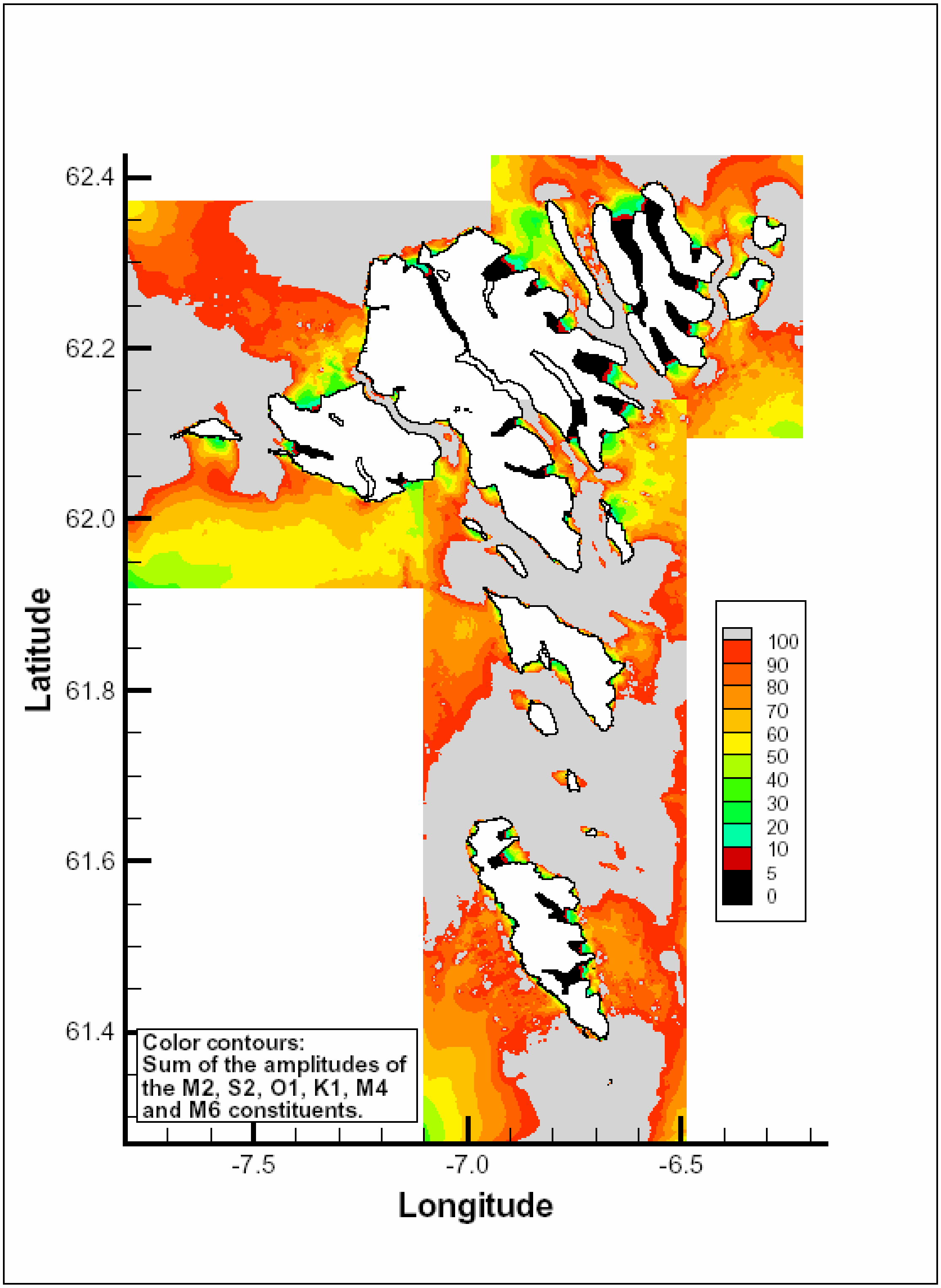

Figure 1
Estimation of the maximum current speed according to the simulations conducted in Simonsen and Gislason (2002), the picture is taken from Simonsen (2006).

The area

The Faroe Islands are located on a 'shallow' shelf in the middle of the deep Northern Atlantic Ocean and consist of 18 small islands. The hilly islands are roughly centred around 62° North and 7° West. The neighbouring countries are the United Kingdom to the south, Iceland to the Northwest and Norway to the East. The country has a total area of 1399 km^2, and spans in a straight line around 113 km from north to south and 75 km from east to west. The highest mountain on the islands reaches 882 m above sea level.

The surrounding banks and the large parts of the shelf, have a depth greater than 100 m (Figure 3), and the depth between the islands is most places more than 60 m (Figure 2).

There is an ongoing effort to improve the knowledge of the local bathymetry by utilizing data from ship echo sounders (Simonsen et al., 2002). The depth matrix used in this study can be seen in the Figure 2 below, and it is the same depth matrix used in the high resolution tidal model calculations reported in Simonsen and Gislason (2002).

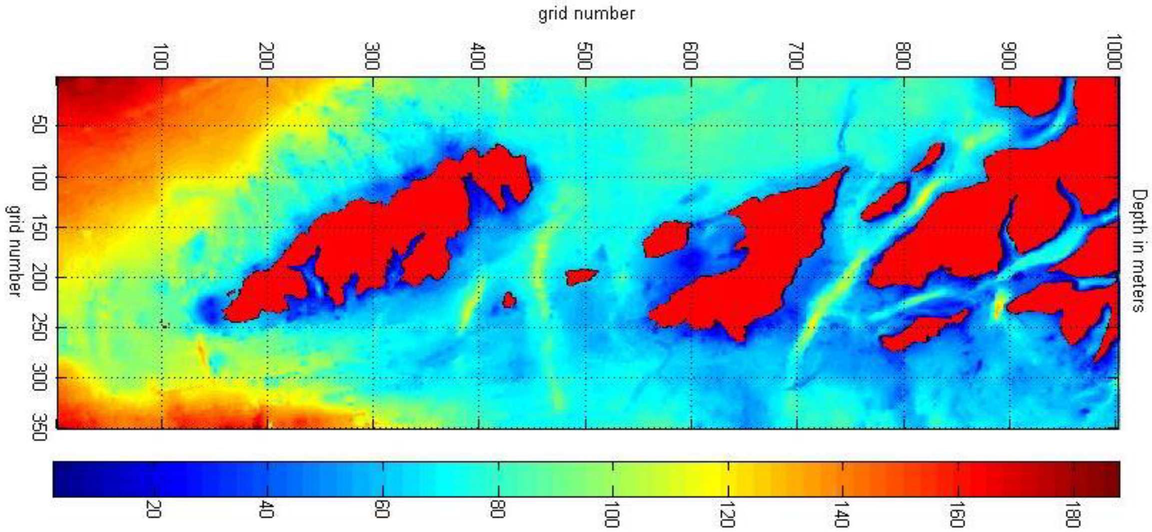

Figure 2
Depth matrix used in this study tilted 90° to the right (i.e. North on the figure is to the right). The colours indicate the depth in meters as given by the colourbar below.

Wave conditions

These investigations are based on a Datawell directional waverider deployed at station WVD-4 south of the Faroe Islands at 61°18´N 6°17´W at 240m depth (Figure 3). Here 17196 measurements in the interval from 10/2-1999 to 13/2-2004 are used. In this time period the storing rates (time interval between measurements) has varied somewhat due to different setup of the buoy. It is possible to interpolate between measurement times, in order to obtain a common sampling rate and thus an equal weight of the individual measurements. In this study, we will not go into such details, as the scope is merely to highlight average situations and not extreme values, which are more sensitive to such matters.

A general view of the wave climate in the region can be obtained from the information below. Table 1 contains the mean values and standard deviations of common wave parameters at WVD-4. Figure 4 displays the directional distribution of the incoming measured wave heights at WVD-4, and Figure 5 which shows the average value and standard deviation of the monthly wave height. More details concerning these measurements can be found in Heinesen (2004) and Niclasen and Simonsen (2007).

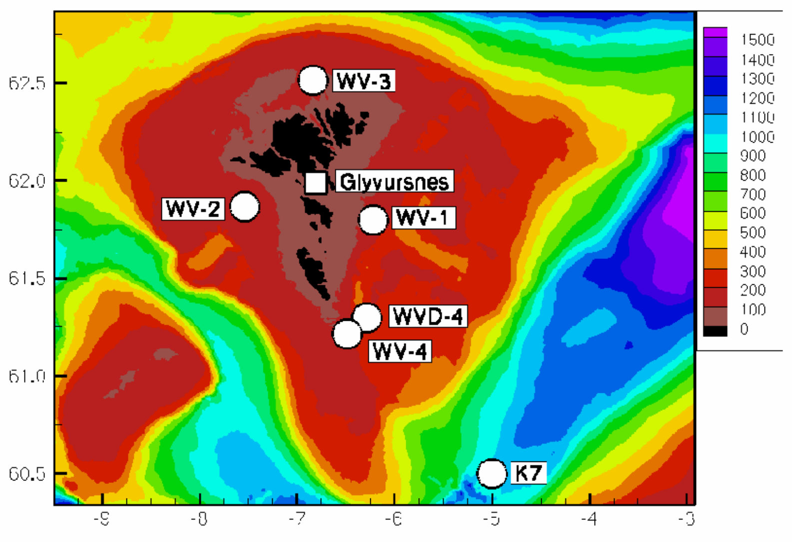

Figure 3
Operational wave buoy deployments around the Faroe Islands. The buoy used in this investigations is the one labelled WVD-4.

	Mean	Std	Max	Min
H_{m0} (m)	2.90	1.48	14.11	0.48
T_p (s)	10.59	2.51	22.22	3.33
T_{m-10} (s)	8.59	1.77	17.12	3.71
T_{m01} (s)	7.34	1.61	15.57	2.80
T_{m02} (s)	6.44	1.45	14.17	2.43

Table 1
Wave-parameter statistics from the deep-water buoy WVD-4 south of the Faroe Islands. Std gives the standard deviation of the parameter value, Max the largest recorded value and Min the smallest recorded value.

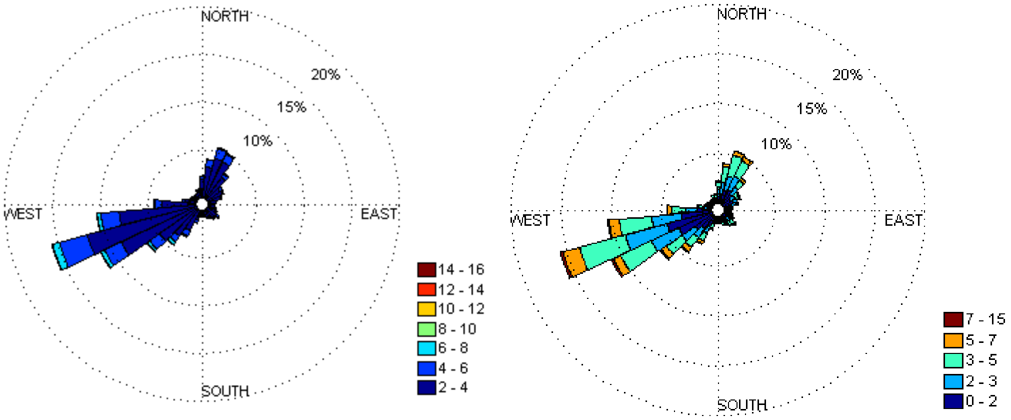

Figure 4
Two versions of the directional histogram of the measured wave heights subdivided into wave directions. Orientation gives direction, length from the centre gives occurrence rate and colours give wave height.

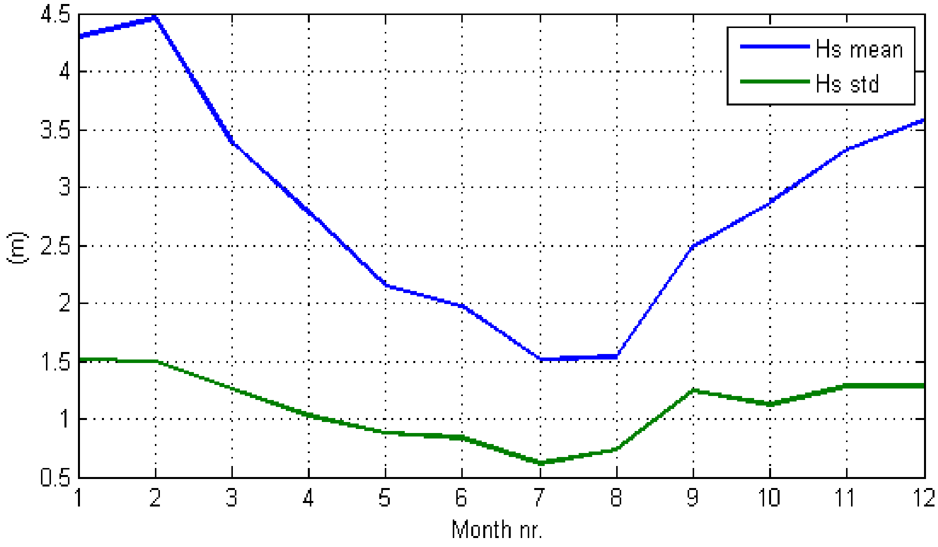

Figure 5
Monthly mean values of the H_{m0} recorded at WVD-4 (blue) and monthly standard deviation of the measured values (green). The months are represented by their number January is 1, February is 2 etc.

Theory

In order for organic matter from fish farms to accumulate and form sediments on the bottom, the current speed at the bottom must be lower than some settling threshold value. If such sedimented material is to be resuspended in the water column, the current speed at the bottom must be larger than some resuspension threshold value that usually is significantly larger than the settling threshold value connected to sedimentation.

Here we will review the basic terms and equations that describe the physical characteristics in relation to resuspension under fish farms.

Linear wave theory

According to linear wave theory, waves travelling in deep water give rise to an exponentially decaying circular orbital movement in the water column beneath the surface waves. If a wave travels in shallow water, the orbital movement beneath the wave will become increasingly oval with depth converging towards a purely horizontal movement near the seabed.

According to linear theory (e.g. Holthuijsen, 2007) the horizontal component of the velocity u_w beneath a monochromatic wave, is:

$$u_w = a\omega \frac{\cosh(kz)}{\sinh(kd)} \cos(kx - \omega t) \tag{1}$$

where a is the amplitude of the wave, $\omega=2\pi/T$ is the angular wave frequency (T is the period of the wave), z is the vertical coordinate ($z=0$ at the seabed), d is the water depth and $k=2\pi/L$ is wave number (L is the wavelength). The maximum velocity induced by the wave at the seabed, during one wave period, is therefore:

$$u_{w\max} = \frac{a\omega}{\sinh(kd)} = \frac{\pi H}{T\sinh(kd)} \tag{2}$$

where $H=2a$ is the height of the wave. The above equation can be used to estimate the movement that a wave induces at the seabed. The maximum monochromatic amplitude of the horizontal motion at the bottom given as:

$$a_{\max} = \frac{u_{w\max}}{\omega} \tag{3}$$

We will use recommended parameters combination by Wiberg and Sherwood (2008) and insert the peak period T_p for the period T, and root mean square wave height $H_{rms} = H_{m0}/\sqrt{2}$ for wave height H in the equation 2, in order to get an estimate of the wave induced movement at the seabed. This approach is strictly speaking an approximation, as different wave frequencies attenuate at different rates with depth etc., but it gives a good first impression of the seabed motions induced by the waves. The wave induced motion at the seabed is a function of depth, wave height, wave period and wave number. If the wave number is unknown it can be derived, from the dispersion relation for a linear wave:

$$\omega^2 = gk\tanh(kd), \tag{4}$$

given that the depth and wave period are known (here it is assumed that there are no currents that are affecting the wave). Due to its transcendental form of the dispersion relation, the wave number must be found by iterative methods or by some analytical approximation. Here we will use the Newton-Raphson method as implemented by Wiberg and Sherwood (2008).

The bottom boundary layer under a steady current

The interaction between the water column and seabed takes place in the bottom boundary layer, which is defined as the layer where the water flow is significantly affected by the seabed.

The steady current velocity profile is logarithmic (Nielsen 1992) in the boundary layer, and is given as:

$$u(z) = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_0}\right) \tag{5}$$

where u is current velocity, z is height above the sea bed, u_* is the frictional velocity, κ is the von Karman's constant (=0.40) and z_0 is the bed roughness length scale. It is possible to convert the frictional velocity into bed shear stress using the following formula:

$$\tau = \rho u_*^2 \tag{6}$$

where ρ is the density of sea water (≈1025 kg/m^3). If we combine Equations 5 and 6, and use a known roughness length we can express the shear stress τ as a function of the current speed $u(z)$ at a known height within the bottom boundary layer or visa versa,:

$$\tau = \rho\left(\frac{u(z)\kappa}{\ln(z/z_0)}\right)^2, \text{ or } \; u(z) = \frac{1}{\kappa}\sqrt{\frac{\tau}{\rho}} \ln\left(\frac{z}{z_0}\right) \tag{7}$$

Shear stress induced by a depth averaged current is:

$$\tau_c = \rho C_D u_m^2 \tag{8}$$

where τ_c is shear stress, ρ density, C_D is the drag coefficient and u_m is the mean current speed.

The bottom boundary layer under surface waves

Due to the oscillating motion beneath a wave field, where velocity and direction are constantly changing, the wave boundary layer is in the order of millimetres. A corresponding boundary layer due to a steady current of the same magnitude would be in the order of meters (Nielsen 1992). Using linear wave theory to estimate the orbital speeds at the sea bed is therefore a reasonable estimate of the orbital speeds above the wave boundary layer, as there is virtually no difference in depth. The oscillating value of the shear bed stress caused by a passing wave is given as:

$$\tau_w = 0.5\rho f_w u_w^2, \tag{9}$$

where f_w is the wave friction factor. The equations for wave induced and current induced shear stress at the sea bed are similar (equations 8 and 9), but the effect of wave and current velocities on shear stress at the seabed, is not directly compatible as the wave friction factor is one order of magnitude larger than the drag coefficient of a depth averaged current (e.g. Pizzamei et al., 2002).

If the bed is assumed to be smooth the friction factor is only dependent on flow regimes, and can be expressed as:

$$f_w = \begin{cases} \dfrac{2}{\sqrt{R}}, & \text{if } R \le 3\cdot 10^5 \\ 3.34\cdot 10^{-3} + 1.05\cdot 10^{-9} R, & \text{if } 3\cdot 10^5 < R \le 1\cdot 10^6 \\ 0.024 R^{-0.123}, & \text{if } 1\cdot 10^6 > R \end{cases} \tag{10}$$

where R is the Reynolds number:

$$R = \frac{u_{w\max} a_{w\max}}{\nu}, \tag{11}$$

and $\nu = 1.3\cdot 10^{-2}$ m/s is the kinematic viscosity (Jönsson, 2005). In the following we will assume that the bed in the fish farming areas is smooth and use $z_0 = 2\cdot 10^{-4}$ which corresponds to a muddy bottom. This assumption is thought to be realistic in areas with low resuspension rates, where fish farm waste most likely smooth out unevenness in the seabed.

A schematic diagram of how bottom wave stress depends on wave height, wave period and depth is given in Figure 6.

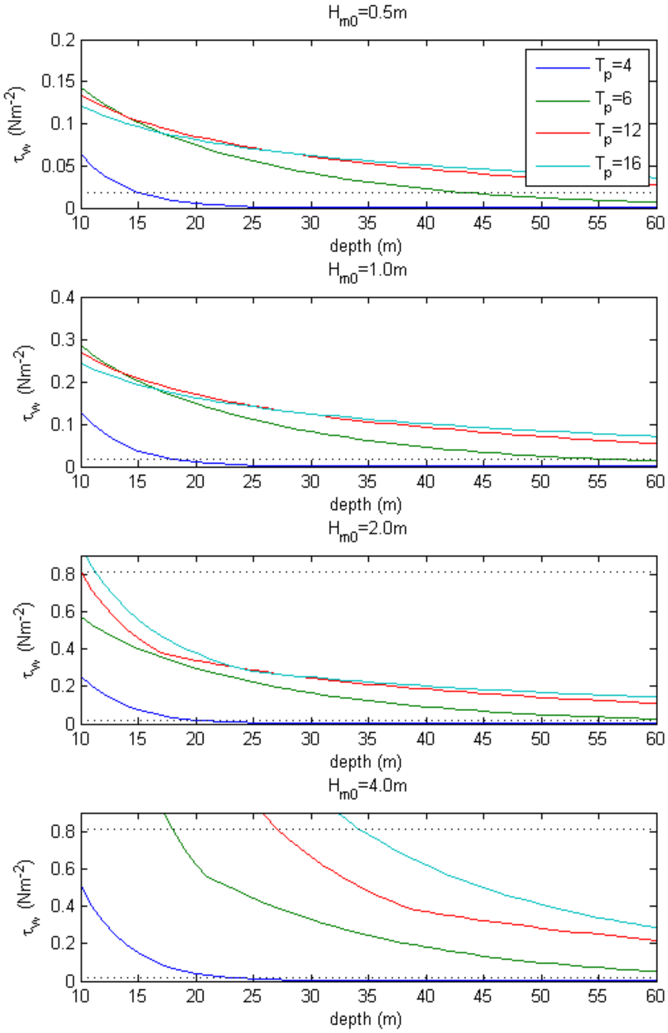

Figure 6 Calculated bottom stress (Eq. 9) for four different wave heights. Colour indicates the wave period, the horizontal axis is depth and the dashed black lines indicate the two resuspension limits used in this study (upper limit according to Dudley et al. (2000), lower limit according to Cromey et al. (2002)).

Resuspension

There have been some investigations of when waste materials from fish farms are resuspended into the water column. Panchang et al. (1997) suggests 0.15-0.20 m/s as a critical current speed (reference height not explicit in the text). This work was followed up[1] by Dudley et al. (2000) where a common value for critical resuspension current speed is estimated to be in the range from 0.40-0.60 m/s. These last speeds are at the high end as native material, and not only fish farm waste are resuspended at these speeds. In Dudley et al. (2000) it becomes clear that the used reference height of the critical current speed is 1 m. Current speeds 0.40-0.60 m/s at 1 m obove the sea bed correspond to shear stresses at the seabed between 0.362-0.814 Nm^{-2} (Eq. 7)

Cromey et al. (2002) contains a review of several resuspension threshold studies that are compatible to current velocities spanning from 0.07 m/s to somewhere in excess of 0.50 m/s. In their own study Cromey et al. (2002) found that critical erosion shear stress at the seabed equal to 0.018 Nm^{-2} gave the best model results. If this value is converted into a critical current speed at 1 m above the sea bed (Eq. 7), it gives 0.09 m/s. This is at the low end of reported values, and is therefore according to the authors best suited for freshly deposited material that has a low erosion threshold (Cromey et al., 2002). Based on sediment isotope inveastgations Yokoyama et al. (2006) came to a quite similar conclusion, that fish farming areas with neap- and spring-tide current speeds above 0.08 m/s (1m above the seabed) will not receive excessive accumulation of organic wastes.

In this investigation we will use an upper and a lower threshold value, as we do not have any local measurements that could be suited as guidance. The upper limit will be 0.60 m/s at 1 m above the sea bed and the lower limit will be 0.09 m/s. These values correspond to shear stress at the seabed of 0.814 Nm^{-2} and 0.018 Nm^{-2} respectively.

Bottom shear stress can be converted into an erosion rate, and here we will follow the method suggested in Cromey et al. (2002) and use following formula:

$$M_e = M\left(\frac{\tau_b}{\tau_{crit}} - 1\right) \tag{12}$$

where M is the erodibility constant, τ_b the bottom stress and τ_{crit} is the critical value of the bottom shear stress. In these investigations we will use $M = 7 \cdot 10^{-7}$ kg/(m^2 s) and $\tau_{crit} = 0.018$ Nm^{-2}, as suggested in Cromey et al. (2002).

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[1] There are three comments related to these two papers, that we must add. 1) These papers do not seem to distinguish between the resuspension effects of current velocities or orbital wave velocities, which is somewhat surprising as these quantities lead to bottom stresses that are one order of magnitude different. 2) In both papers it is unclear how to interpret wave height H and wave period T. 3) In both papers the equation for wave orbital velocities is mistyped as a factor 1/T is missing (but in tables with calculated examples it is used correctly).

Waste footprint

It is beyond the scope of the present investigation to conduct dynamic environmental modelling of fish farm wastes (generation-, settling-, consolidation-, decay-, resuspension by currents and waves, spatial transport etc.), but we need to introduce some simplified concepts which make it possible to quantify the results found later in the report. The first basic concept is the waste footprint of a fish cage.

Waste footprint is the size of the bottom area over which the waste material settles in average current conditions. This is not a static size by any means, and if realistic Here we will only make a rough estimate and assume: 1) that all the waste is released evenly over the bottom area of the fish cage 2) that the current speed is the same at all depths under the fish cage, 3) the current direction can rotate 360°. This leads to the following relation for the radius r of the footprint:

$$r = u\frac{h}{s} + r_c \tag{13}$$

where u is the current speed, h is the height of the cage-bottom over the sea bed, s is the sinking speed of the waste and r_c is the radius of the cage. This formula is quite similar to the one suggested in Gowen and Bradbury (1987). In the review article by Reid el al. (2009) a wide range of Atlantic salmon faeces settling rates are reported and here we will only use the most common value which is 3.2 cm/s. As food waste is very low, and presumably a large fraction of the food waste is eaten by wild fish, we will not discuss the footprint and resuspension of food waste in this investigation.

If we assume a circular footprint, the footprint area is given as:

$$Area = \pi\left(u\frac{h}{s} + r_c\right)^2 \tag{14}$$

For convenience some reference values of the footprint size are given in the tables below.

r_c = 15m	u = 20 cm/s	u = 10 cm/s	u = 5 cm/s
h = 5 m	6.7	2.9	1.6
h = 10 m	18.9	6.7	2.9
h = 15 m	37.2	12.0	4.6
h = 20 m	61.6	18.9	6.7
h = 30 m	128.8	37.2	12.0

Table 3 Area of footprint given in 10^3 m^2 for a cage with radius of 15m.

r_c = 20m	u = 20 cm/s	u = 10 cm/s	u = 5 cm/s
h = 5 m	8.2	4.0	2.4
h = 10 m	21.4	8.3	4.0
h = 15 m	40.6	14.1	5.9
h = 20 m	66.1	21.4	8.2
h = 30 m	135.3	40.6	14.1

Table 4 Area of footprint given in 10^3 m^2 for a cage with radius of 20m.

It should also be noted that here we have only looked at the footprint from one fish cage. In reality there will be several fish cages within the same area which thus can lead overlap of the footprints from the different cages i.e. reduction of the average footprint size. It must be stressed that equation 13 is based on crude simplifications and should therefore be used with this in mind. Some unresolved issues in the formulation of equation 13. The most important seem to be:

1. The real current speed under/around a cage is not stationary in time, space or depth, so what is the proper average value suitable to use in equation 13? or does such a value even exist?
2. Some part of the waste can exit the cage trough the side panels, and the present formulation does not account for this. Perhaps an assumption about a constant faeces production per volume would be better than constant distribution trough the bottom panel.
3. The settling rate can depend on several factors such as fish size, feed type etc. so using a standard value is at best an approximation.
4. Turbulent motion will most likely also have an important effect on the footprint radius, and turbulence is not incorporated into equation 13.
5. The current in a fjord is seldom purely circular, which indicates that the area calculated in equation 14 most likely is too large.
6. Finally and perhaps most importantly this type of stationary approximations to a non-stationary problem is only a crude first estimate.

Estimated waste from a fish farm

As mentioned above it is beyond the scope of the present investigation to venture into dynamic sediment modeling but, in order to put things into perspective, we need some reference estimate of the amount of wastes produced by one fish cage.

Aquaculture on the Faroe Islands is usually salmon farming done in circular net cages with a radius of 15-20m, and with a depth of 15m i.e. with volumes ranging from 11-$19 \cdot 10^3$ m^3. The highest allowed fish density is 25 kg/m^3, so these fish cages can contain up to 275t and 475t respectively depending on whether their radius is 15 or 20m.

The quantity of consumed food per day per kilo-fish varies with fish size and the season. Using the feeding tables that are derived from average fish food consumption per kg fish in the Faroe area (the table is divided into weight class and month of the year) gives between 3.2 and 7.5 g food per kg fish per day, given that the fish weigh more than 4 kg (Dam, 2009).

In their review paper Reid et al. (2009) estimate that the approximately 15% of the consumed feed becomes dry facial matter. This means that during the late summer months, when the fish consume roughly 7.0 g food per kg fish per day, an estimated maximum amount of facial waste per month is in the region of 9t or 15t depending on the cage radius (15 or 20m).

Wave modelling

There is a need to make some assumptions about the wave conditions in order to be able to transport realistic sea states into the fish farming areas. As mentioned above the effect of the tidal currents on the waves is not included in these investigations, as this would increase the computational load beyond the scope of this introductory investigation. In order to reduce the computational load the measured values were subdivided into discrete wave height and directional bins. As can be seen below there had to be at least 16 directions (each spanning 22.5°) to insure that the binned statistics resembled the real statistics (see the difference between Figure 7 and Figure 4)

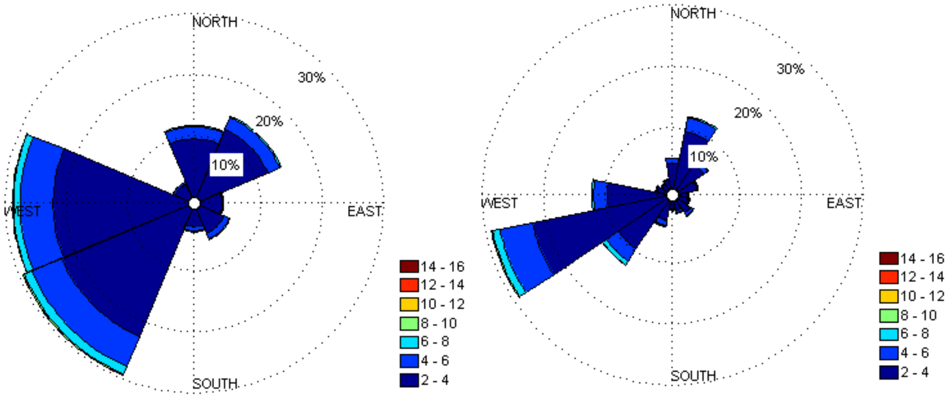


Figure 7
Binned directional wave statistics. To the right with eight directional bins, and to the left with sixteen directional bins.

The wave heights were binned into one meter bins, i.e. wave heights larger than 1.5m and less than 2.5m are approximated by a 2m wave height etc. from 1m up to 18m (lowest measurement is 0.5m and wave heights up to 18m were included as the design storm for the area is estimated to be in this range). All in all this means that 288 (16*18) idealized model runs had to be made.

In the following we use the binned equivalents of the measured wave height and peak wave direction at the WVD-4 buoy as forcing for the wave model. The model then supplies wave parameters at the fish farming sites, which then are converted into shear stress and erosion rates at the seabed using equation 9 and 12. In this manner we get a time series of the resuspension history at each of the fish farming sites that is as long as the measured series at WVD-4.

Wave model setup

In these investigations, we use the third generation wave model SWAN (Booij et al., 1999; Ris, 1997) version 40.41AB. The main features of the model setup are listed in the following table, and more details can be found in Appendix A.

Model version	40.41AB
Model domain	7.126°W - 6.462°W 61.250°N - 62.150°N
Run type	Stationary with no currents
Coordinates	Cartesian
Grid	100m by 100m 30 frequencies, 0.0345-0.5476Hz 180 directions
Physics	WAM3 with n=2 in the dissipation term *Additional source terms:* - Breaking - JONSWAP bottom friction - Diffraction

Table 2 Wave model setup

Introductory testing showed that high directional resolution was necessary in order to alleviate the numerically induced “Garden-Sprinkler effect”. The frequency resolution was set to be in the same range as that of the wave buoy used in the study. According to the experiences with running SWAN for the Faroese shelf (Niclasen, 2006), the WAM3 physics with altered dissipation source term was used. As no near-shore wave measurements have been available for validation studies, optional source terms that are important close to land have not been modified and are implemented with default setup.

Fish farming areas are typically situated close to land in sheltered regions (fjords) with weak local currents, so the direct local effect of the currents on the waves can therefore be expected to be negligible as seen in e.g. Niclasen and Simonsen (2005). The effect of the currents on the local wave field is expected to due to “up-wave” bending of the wave rays (propagation paths of the wave energy).

In each of these model runs the wave forcing at the model boundary is set to a fully developed sea state (Pierson-Moskowitz spectra) with the given wave height and direction. This means that the peak wave period is determined from the wave height and is not an independent parameter. The wind direction was set equal to the wave direction, and the wind velocity W_{PM} was determined from the parametric knowledge of fully developed sea states e.g. equation number 5-5-4 in (Tucker and Pitt, 2001):

$$W_{PM} = \sqrt{\frac{H_{m0}}{0.0246}} \tag{12}$$

It is known that running SWAN with WAM 3 physics and the given retuned dissipation source term, does not lead to an upper equilibrium with the wind (Rogers et al., 2003; Niclasen, 2006). In order to counteract further wave growth within the model domain the wind speed was set to 90% of the corresponding Pierson-Moekowitz value calculated from Eq. 12.

Output locations

The location of the fish farming sites was determined from the information given on the home page of Landsverk (www.landsverk.fo), the government agency administrating fish farming permits. The fish farming permit areas are shown below in Figure 8

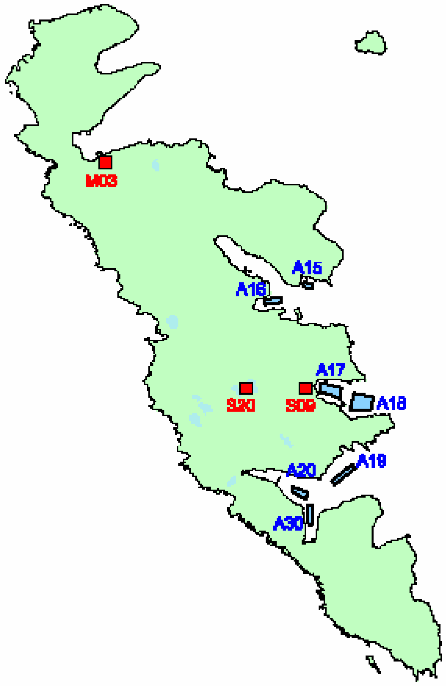


Figure 8
Fish farmin areas in Suðuroy. the picture is taken from the Landsverk web page http://landsverk.fo/dokumentir/Alioki.pdf

For each of these fish farming areas two diagonal corner locations were chosen as model output points. For each area the label ‘a’ is attached to the uttermost and more exposed corner, while ‘b’ labels the diagonal corner that is located further inside the fjord at a shallower and more sheltered location. The geographic locations and corresponding model locations can be seen in Table 3 and in Figure 9.

A conversion matrix was determined in for each of these locations, by extracting the site specific wave height and period from each of the 288 idealised model runs. These conversion matrices are listed in Appendix B.

By assuming that the measured waves at WVD-4 represent the incoming wave field, we can now use the site specific inversion matrix to transport measurements from WVD-4 to the given site.

The measured wave field at WVD-4 does not always represent the offshore wave field, due to refraction and sheltering, particularly when the waves come from North-westerly directions. On the other hand it can be said that waves coming from these directions would not penetrate the given fjords anyhow, so all in all WVD-4 is believed to be representative for the given locations.

Location	Lat (LV) Lat (Model) y-grid	Lon (LV) Lon (Model) x-grid	Depth m (Model)
A-15a	61.5407 61.5407 324	-6.7636 -6.7632 195	23.25
A-15b	61.5433 61.5434 327	-6.7701 -6.7707 191	17.59
A-16a	61.5380 61.5380 321	-6.7888 -6.7896 181	27.78
A-16b	61.5357 61.5353 318	-6.7884 -6.7877 182	19.15
A-17a	61.4984 61.4984 277	-6.7446 -6.7444 205	23.77
A-17b	61.5050 61.5047 284	-6.7597 -6.7595 197	14.98
A-18a	61.4989 61.4993 278	-6.7178 -6.7180 219	45.40
A-18b	61.4940 61.4939 272	-6.7370 -6.7368 209	25.80
A-19a	61.4720 61.4723 248	-6.7345 -6.7350 210	58.68
A-19b	61.4677 61.4678 243	-6.7534 -6.7538 200	22.91
A-20a	61.4633 61.4633 238	-6.7722 -6.7727 190	33.61
A-20b	61.4641 61.4642 239	-6.7854 -6.7859 183	20.73
A-30a	61.4585 61.4588 233	-6.7692 -6.7689 192	36.37
A-30b	61.4508 61.4507 224	-6.7729 -6.7727 190	21.59

Table 3 Corners of fish farming areas. The latitude and longitude values termed (LV) are from the information obtained from the Landsverk website, and the values termed (Model) are the corresponding positions of the closest model points. y and x-grid correspond to the representation of these locations within the model (grid numbers). The depth values are taken from the model bathymetry.

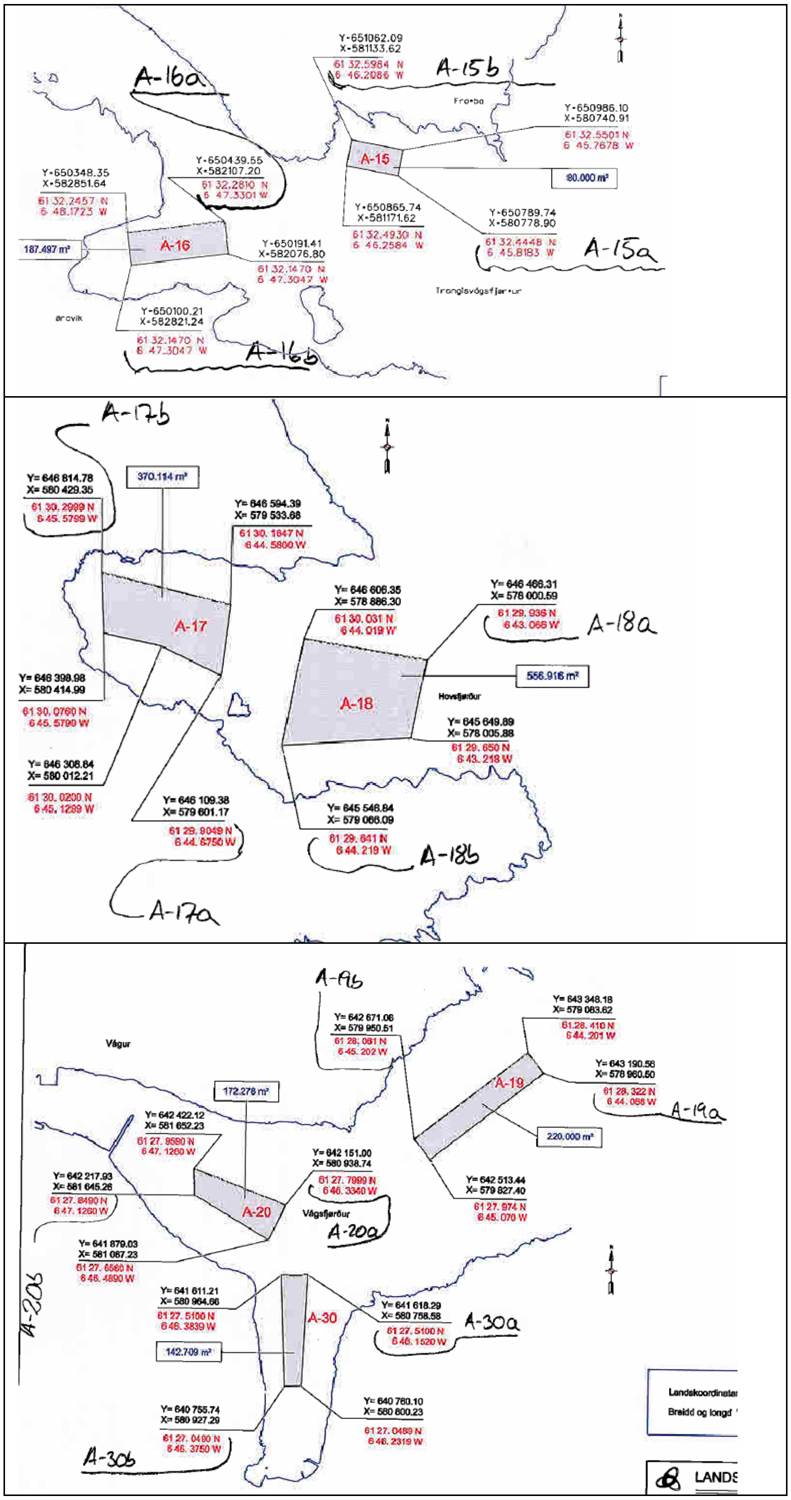


Figure 9 Fish farming areas of Suðuroy, with indications of which points are used as model output points. Images taken from http://landsverk.fo/.

Results

The 288 idealised wave model runs were made using the setup files and scripts listed in Appendix A. One such example with high waves coming from the west is given in Figure 10. Other examples can be found wave page on the university home page:

http://setur.fo/fo/natturuvisindadeild/gransking/verkaetlanir/sjostoedukunning/wave_simulations/
or
http://setur.fo/index.php?id=874

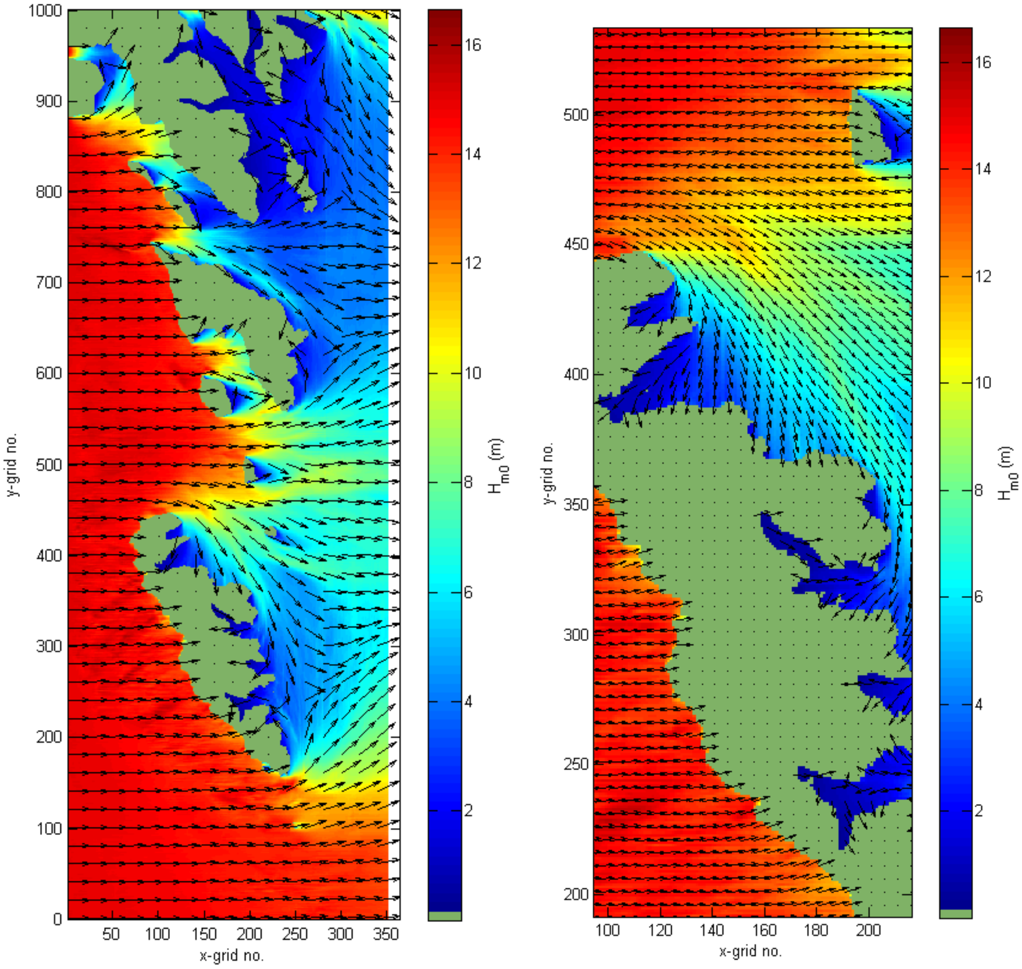


Figure 10 Modelled wave height and direction.

From each of these 288 idealised runs, the modelled wave height and period at the locations of interest (see Table 3, Figure 9) were stored in the respective inversion matrix (see Appendix B). Combining the measured wave height and direction at WVD-4 to the site specific inversion matrices, it is now possible to get an estimated time series of the wave conditions at the sites of interest. The estimated wave height and peak wave period at each site were then converted into wave induced bottom stress according and erosion rates by using Equations 9-12. One example of these time series is given in Figure 11. The black lines correspond to measured values at WVD-4 (wave height in the top plot and direction in the second plot). The red and blue lines correspond to the estimated values (wave height in the top plot, bottom shear stress in the third plot and erosion rate in the last plot) at the exposed and sheltered points of reference in the given fish farming area (see Table 3, Figure 9).

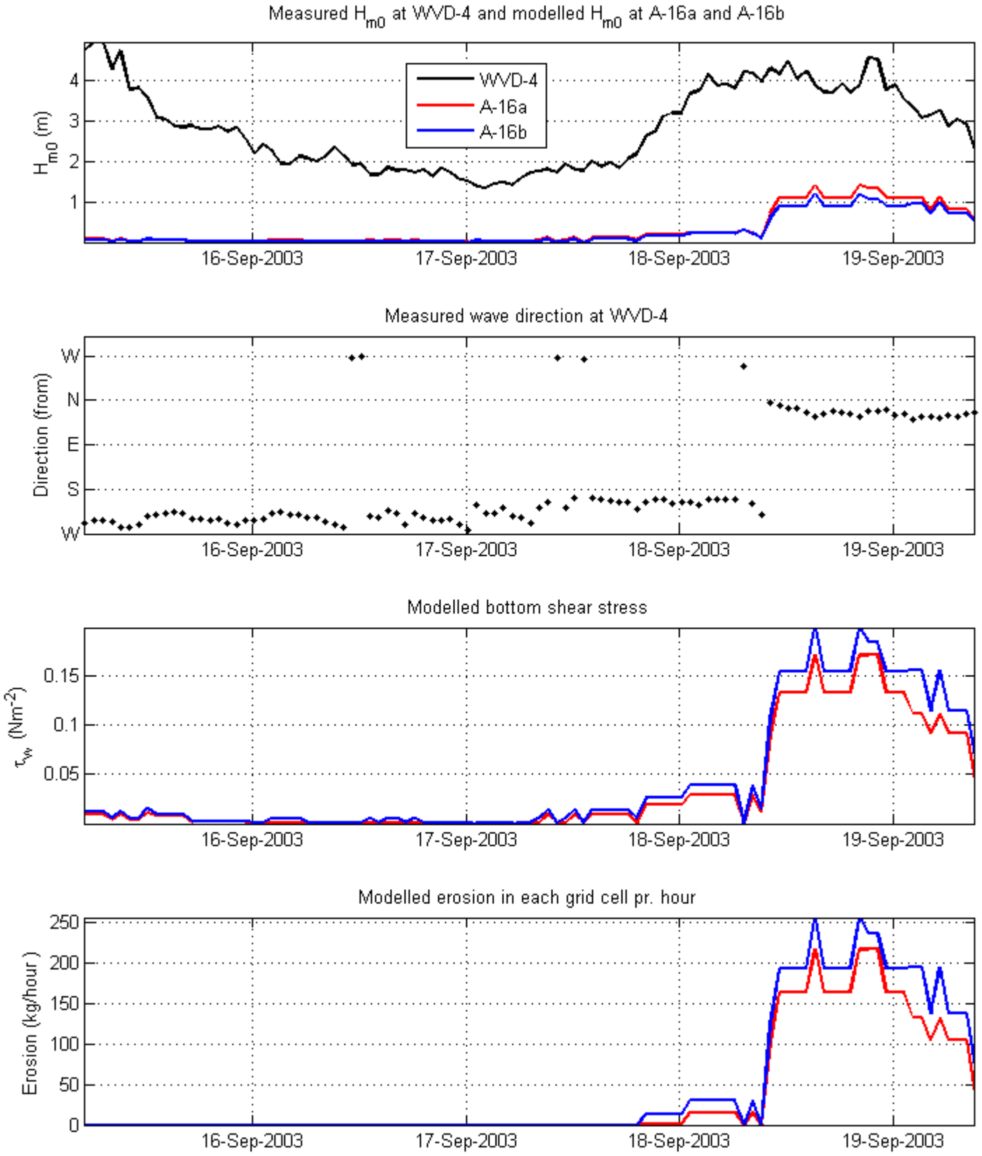


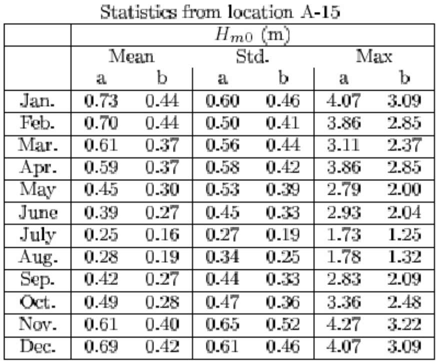
Figure 11 Part of the modelled time series in area A-16.

In Figure 11 we can observe that while the waves come from South-West the waves do not penetrate into the given fish farming area, and the local wave height and bottom shear stress are close to zero. When the wave direction changes to South-East, we see that the local wave height and bottom shear stress are higher and more directly correlated to the measurement at WVD-4, as the waves can partly enter the fjord from this direction. It is also apparent that the resuspension levels in this farming area does not vary so much with position, as the bottom shear stress and erosion rate (red and blue curves in the two last plots) are very similar. The threshold behaviour of resuspension i.e. erosion is also apparent in the two lowest plots, as erosion remains at zero until the bottom shear stress threshold is exceeded.

The time series for each location of interest have been converted into more accessible formats. Below the monthly statistics of the modelled wave height are given in Table 4, and monthly values of tabulated bottom shear stress are found in Appendix C. The abbreviations are Mean for mean value, Std for standard deviation, Max for maximum vale. In the Tables related to bottom shear stress (Appendix C) there are tree extra columns Int.1 , Int.2 and Int.3 that are give the percentage of the time the bottom shear stress values are below 0.018 Nm^{-2} (Int.1: no resuspension), between 0.018 and 0.814 Nm^{-2} (Int.2. resuspension) and above 0.814 Nm^{-2} (Int.3: all material can be resuspended).

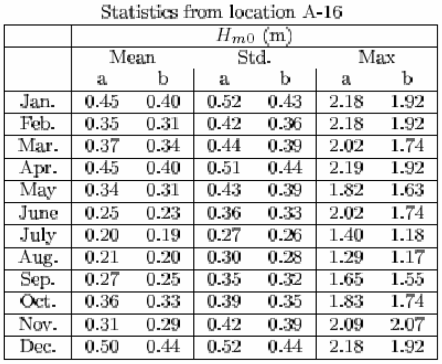
Monthly values of averaged total erosion rates have also been calculated and these are given in the following figures. These figures constitute the major results of this investigation, and some comments are given in the next section.

One important note in relation to using these figures directly is that the footprint is set to one numerical grid cell which is 100m by 100m. This means that the values given in these figures represent the amount of eroded material from an area of $10 \cdot 10^3$ m^2. If we want the amount of eroded material per square meter the values on the y-axis aught the multiplied by 10^{-4}, i.e. the unites per m^2 become in 100 g/month. Looking for example at the Eroded material at A-15 in July, the figure says that in average 10·100 g i.e. 1 kg is eroded per each m^2 due to the waves.



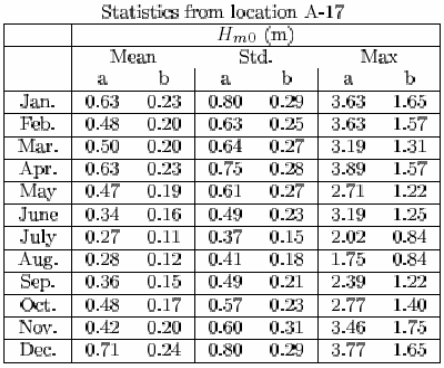
Statistics from location A-15

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.73	0.44	0.60	0.46	4.07	3.09
Feb.	0.70	0.44	0.50	0.41	3.86	2.85
Mar.	0.61	0.37	0.56	0.44	3.11	2.37
Apr.	0.59	0.37	0.58	0.42	3.86	2.85
May	0.45	0.30	0.53	0.39	2.79	2.00
June	0.39	0.27	0.45	0.33	2.93	2.04
July	0.25	0.16	0.27	0.19	1.73	1.25
Aug.	0.28	0.19	0.34	0.25	1.78	1.32
Sep.	0.42	0.27	0.44	0.33	2.83	2.09
Oct.	0.49	0.28	0.47	0.36	3.36	2.48
Nov.	0.61	0.40	0.65	0.52	4.27	3.22
Dec.	0.69	0.42	0.61	0.46	4.07	3.09



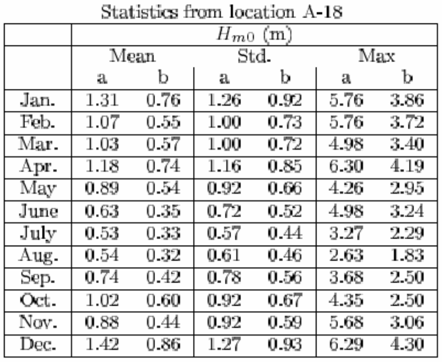
Statistics from location A-16

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.45	0.40	0.52	0.43	2.18	1.92
Feb.	0.35	0.31	0.42	0.36	2.18	1.92
Mar.	0.37	0.34	0.44	0.39	2.02	1.74
Apr.	0.45	0.40	0.51	0.44	2.19	1.92
May	0.34	0.31	0.43	0.39	1.82	1.63
June	0.25	0.23	0.36	0.33	2.02	1.74
July	0.20	0.19	0.27	0.26	1.40	1.18
Aug.	0.21	0.20	0.30	0.28	1.29	1.17
Sep.	0.27	0.25	0.35	0.32	1.65	1.55
Oct.	0.36	0.33	0.39	0.35	1.83	1.74
Nov.	0.31	0.29	0.42	0.39	2.09	2.07
Dec.	0.50	0.44	0.52	0.44	2.18	1.92



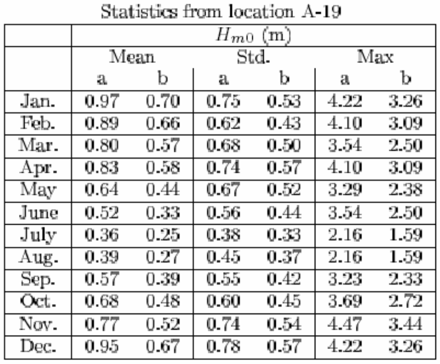
Statistics from location A-17

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.63	0.23	0.80	0.29	3.63	1.65
Feb.	0.48	0.20	0.63	0.25	3.63	1.57
Mar.	0.50	0.20	0.64	0.27	3.19	1.31
Apr.	0.63	0.23	0.75	0.28	3.89	1.57
May	0.47	0.19	0.61	0.27	2.71	1.22
June	0.34	0.16	0.49	0.23	3.19	1.25
July	0.27	0.11	0.37	0.15	2.02	0.84
Aug.	0.28	0.12	0.41	0.18	1.75	0.84
Sep.	0.36	0.15	0.49	0.21	2.39	1.22
Oct.	0.48	0.17	0.57	0.23	2.77	1.40
Nov.	0.42	0.20	0.60	0.31	3.46	1.75
Dec.	0.71	0.24	0.80	0.29	3.77	1.65



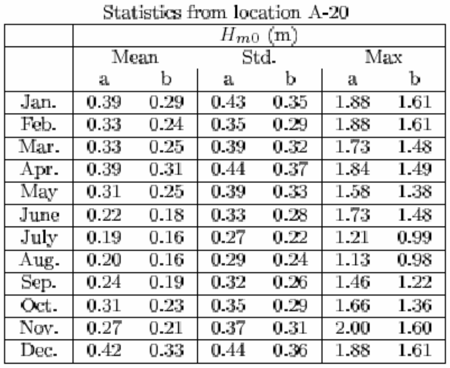
Statistics from location A-18

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	1.31	0.76	1.26	0.92	5.76	3.86
Feb.	1.07	0.55	1.00	0.73	5.76	3.72
Mar.	1.03	0.57	1.00	0.72	4.98	3.40
Apr.	1.18	0.74	1.16	0.85	6.30	4.19
May	0.89	0.54	0.92	0.66	4.26	2.95
June	0.63	0.35	0.72	0.52	4.98	3.24
July	0.53	0.33	0.57	0.44	3.27	2.29
Aug.	0.54	0.32	0.61	0.46	2.63	1.83
Sep.	0.74	0.42	0.78	0.56	3.68	2.50
Oct.	1.02	0.60	0.92	0.67	4.35	2.50
Nov.	0.88	0.44	0.92	0.59	5.68	3.06
Dec.	1.42	0.86	1.27	0.93	6.29	4.30



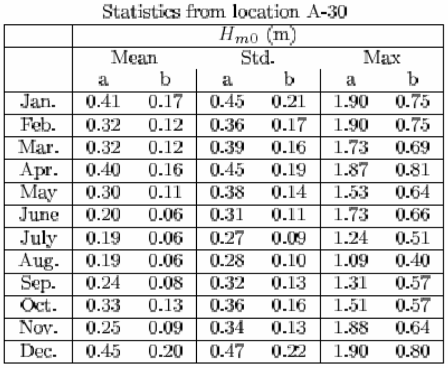
Statistics from location A-19

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.97	0.70	0.75	0.53	4.22	3.26
Feb.	0.89	0.66	0.62	0.43	4.10	3.09
Mar.	0.80	0.57	0.68	0.50	3.54	2.50
Apr.	0.83	0.58	0.74	0.57	4.10	3.09
May	0.64	0.44	0.67	0.52	3.29	2.38
June	0.52	0.33	0.56	0.44	3.54	2.50
July	0.36	0.25	0.38	0.33	2.16	1.59
Aug.	0.39	0.27	0.45	0.37	2.16	1.59
Sep.	0.57	0.39	0.55	0.42	3.23	2.33
Oct.	0.68	0.48	0.60	0.45	3.69	2.72
Nov.	0.77	0.52	0.74	0.54	4.47	3.44
Dec.	0.95	0.67	0.78	0.57	4.22	3.26



Statistics from location A-20

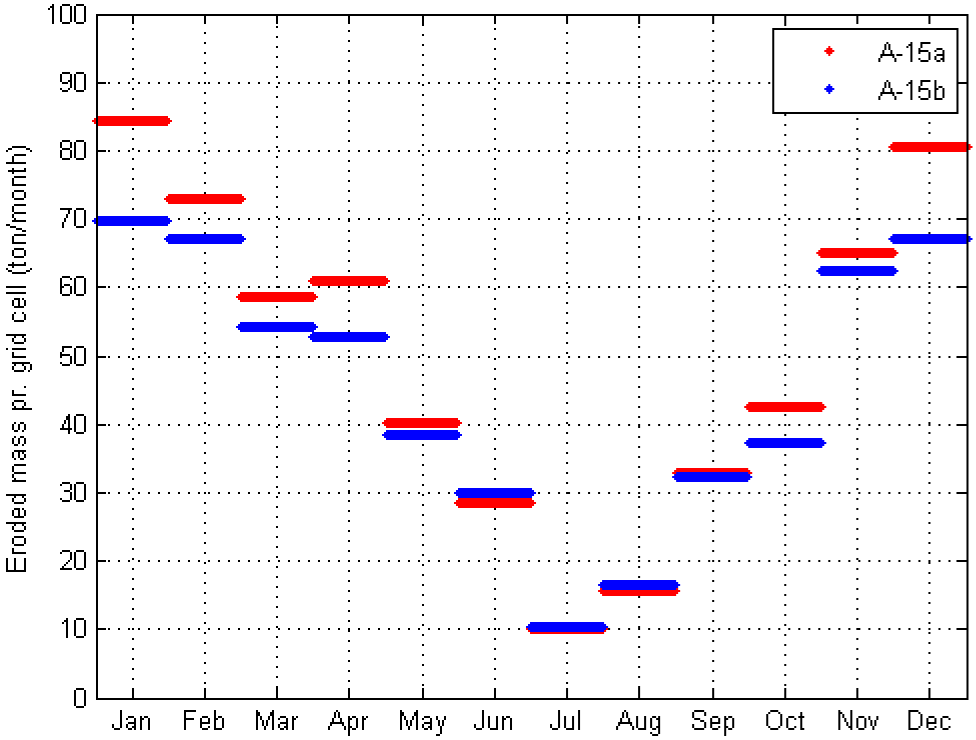
	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.39	0.29	0.43	0.35	1.88	1.61
Feb.	0.33	0.24	0.35	0.29	1.88	1.61
Mar.	0.33	0.25	0.39	0.32	1.73	1.48
Apr.	0.39	0.31	0.44	0.37	1.84	1.49
May	0.31	0.25	0.39	0.33	1.58	1.38
June	0.22	0.18	0.33	0.28	1.73	1.48
July	0.19	0.16	0.27	0.22	1.21	0.99
Aug.	0.20	0.16	0.29	0.24	1.13	0.98
Sep.	0.24	0.19	0.32	0.26	1.46	1.22
Oct.	0.31	0.23	0.35	0.29	1.66	1.36
Nov.	0.27	0.21	0.37	0.31	2.00	1.60
Dec.	0.42	0.33	0.44	0.36	1.88	1.61

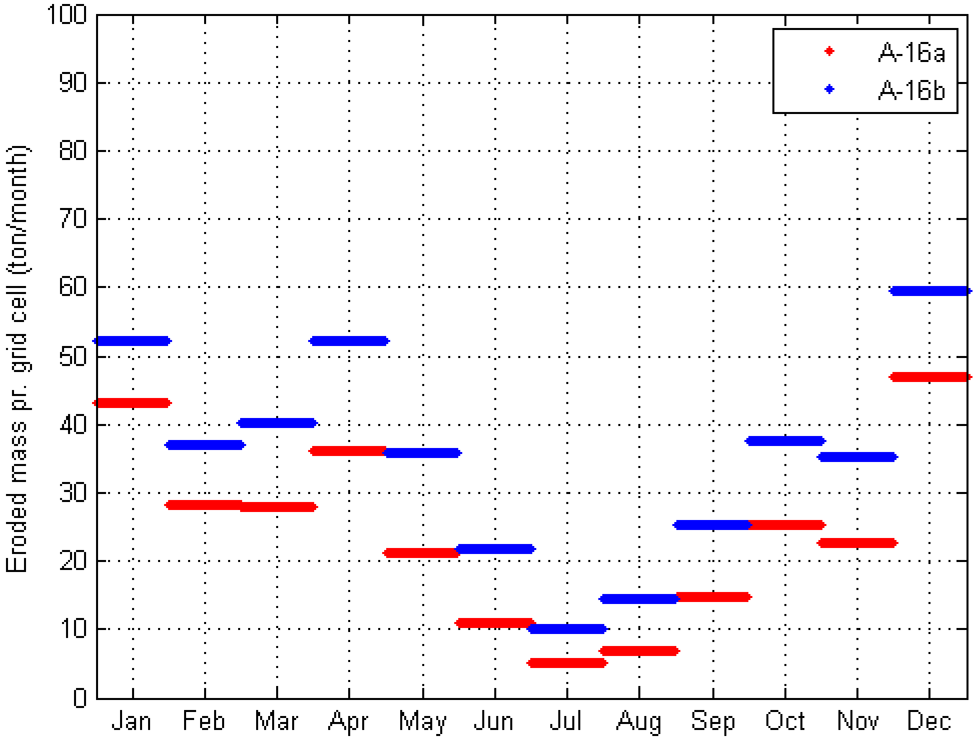


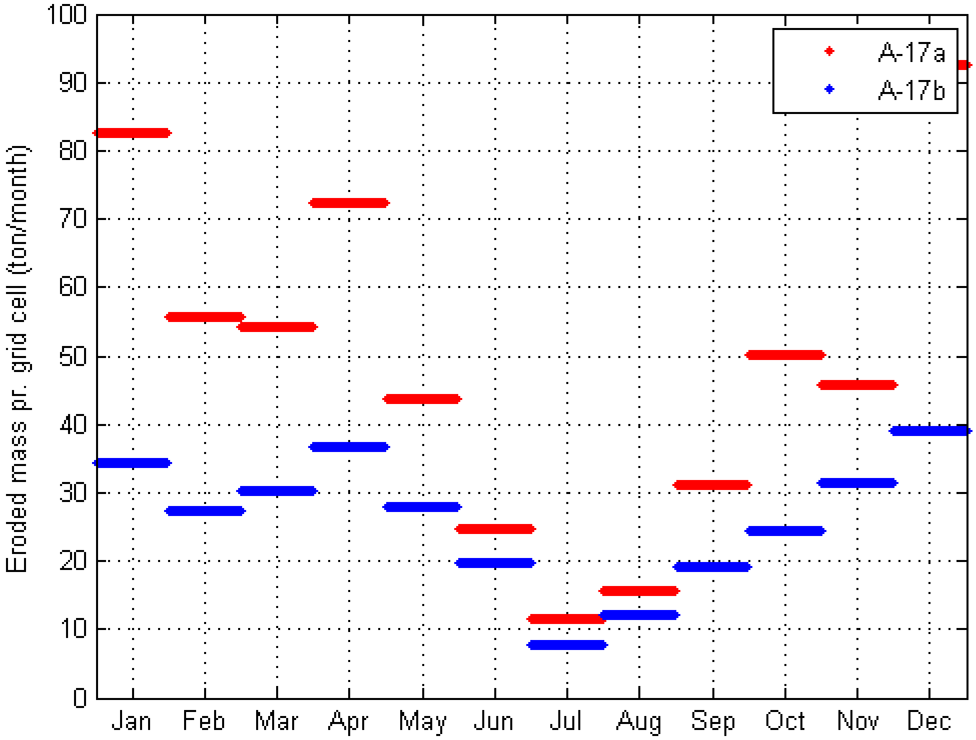
Statistics from location A-30

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.41	0.17	0.45	0.21	1.90	0.75
Feb.	0.32	0.12	0.36	0.17	1.90	0.75
Mar.	0.32	0.12	0.39	0.16	1.73	0.69
Apr.	0.40	0.16	0.45	0.19	1.87	0.81
May	0.30	0.11	0.38	0.14	1.53	0.64
June	0.20	0.06	0.31	0.11	1.73	0.66
July	0.19	0.06	0.27	0.09	1.24	0.51
Aug.	0.19	0.06	0.28	0.10	1.09	0.40
Sep.	0.24	0.08	0.32	0.13	1.31	0.57
Oct.	0.33	0.13	0.36	0.16	1.51	0.57
Nov.	0.25	0.09	0.34	0.13	1.88	0.64
Dec.	0.45	0.20	0.47	0.22	1.90	0.80

Table 4 Wave statistics from each of the fish farming areas.


Eroded mass pr. grid cell (ton/month)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
A-15a
A-15b


Eroded mass pr. grid cell (ton/month)
0
10
20
30
40
50
60
70
80
90
100
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
A-16a
A-16b


Eroded mass pr. grid cell (ton/month)
100
90
80
70
60
50
40
30
20
10
0
Jan
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May
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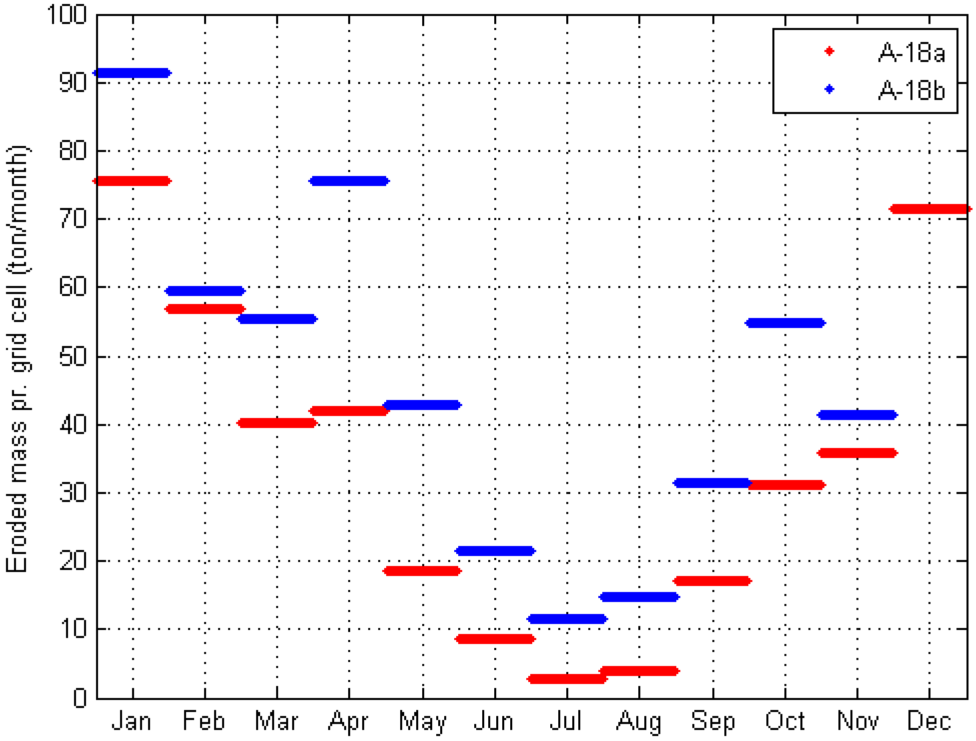
Jul
Aug
Sep
Oct
Nov
Dec
A-17a
A-17b


Eroded mass pr. grid cell (ton/month)
100
90
80
70
60
50
40
30
20
10
0
Jan
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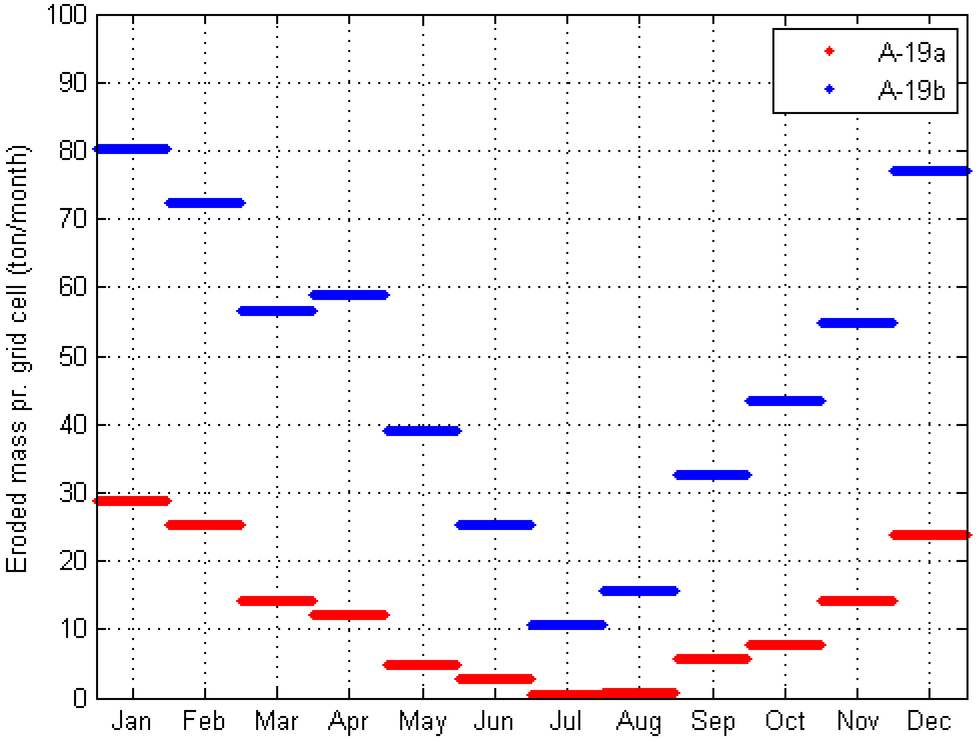
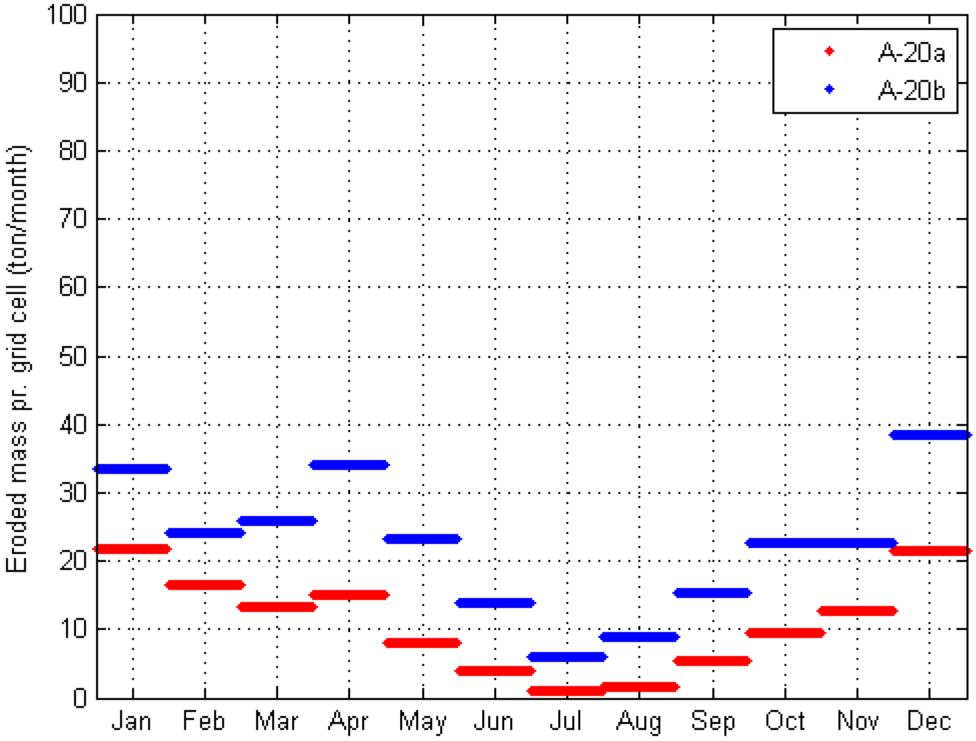
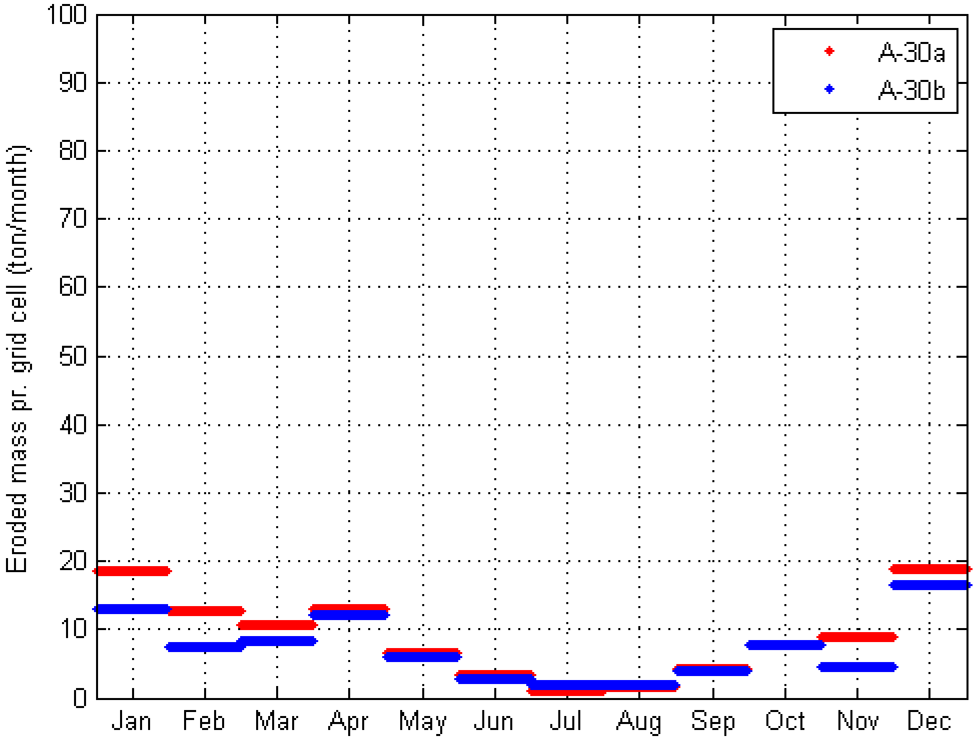
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
A-18a
A-18b



A-19a
A-19b
Eroded mass pr. grid cell (ton/month)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



A-20a
A-20b
Eroded mass pr. grid cell (ton/month)
100
90
80
70
60
50
40
30
20
10
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



100
90
80
70
60
50
40
30
20
10
0
Eroded mass pr. grid cell (ton/month)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
A-30a
A-30b

Discussion

Based on idealized wave model runs we can now say something about the wave induced resuspension conditions in fish farming areas of Suðuroy. As can be seen from the wave height tables (Table 4), some locations have quite rough conditions while others are more sheltered. In each site the statistics at the two output points a) and b) are also quite different, and although a) is the more exposed site this does not imply that there is more bottom shear stress at this site as the depth (see Table 3), also plays an important role according to equation 2.

In this investigation we have only looked at the wave factor, so it is not possible to come to a firm conclusion based on this investigation alone. What needs do be done in order to get a more reliable picture, useful e.g. for classification of fish farming areas, is discussed in the subsection "How do we get more answers". We can although make some general comments on the findings from the simulations.

General observations

- It seems unlikely that resuspension only can occur for wave induced bottom shear stresses above 0.814 Nm^{-2} (Interval 3 in the tables in Appendix C), for if this is the case most of the fish farming areas in Suðuroy would constantly have serious sediment accumulation problems.
- It seems clear that wave induced bottom shear stress plays an important role in the resuspension process in all the investigated sites.

Site specific comments based on idealistic assumptions

In order to be able to exemplify how the resuspension figures can be used, we do the following assumptions:

1. The fish cage is a circular, has a radius of 15m, and a depth of 15m.
2. We assume that equation 13 and 14 can be used to estimate the area of the waste footprint, in spite of the inherent simplifications and that uncertainty of the proper averaged current speed.
3. We assume that the maximum estimated tidal current speed seen in Figure 12, can be used in equations 13 and 14, as the averaged current speed.
4. The fish density is always the maximum allowed amount (25 kg/m^3), i.e. it is assumed that approximately 9 ton of waste exit the cage bottom per month.
5. The released waste distributes itself evenly over the footprint area.
6. If resuspended by the waves we assume that the waste is flushed out of the fjord.
7. Accumulation of wastes is only a problem if it lasts for more than two months.

It is now possible to do some practical estimates based on the resuspension figures. Using Figure 12 we get a crude estimate of the maximum current speed at the different reference points, and Table 3 gives the depth at the reference points. According to assumptions 1-3 it is now possible to estimate the footprint size. According to assumption

4 and 5 we get an estimate of the waste quantity per area (kg/m^2) by dividing the 9 ton of produced wastes by the estimated footprint size. The resuspension figure can now be used in connection with assumption 6, in order to see in how many months the resuspended amount is smaller than the produced amount of wastes, i.e. to see in how many months wastes accumulate.

Based on communication with people in the fish farming industry it is estimated that substantial accumulation of wastes is only a problem if it lasts more than three consecutive months (assumption 7). For example it takes in the region of three to six months before methane bubbles start to rise from the sediments under fish farms in Kaldbaksfjørður (pers. com. Gunnvør á Norði, Faroese Fisheries Laboratory), a fjord that is significantly more sheltered than the fjords investigated here. Based on the preceding assumptions we can now make some rough estimates of the largest recommended fish density in the respective areas. These calculations are given in tabular form in the following subsections.

It must be stressed that these calculations are highly speculative as they are based on the seven crude assumptions mentioned above, and do not take current induced resuspention into account. The tabulated results are therefore only displayed as an example of what type of site specific information could be achieved if this type of investigations (modelling and measurements) were continued.

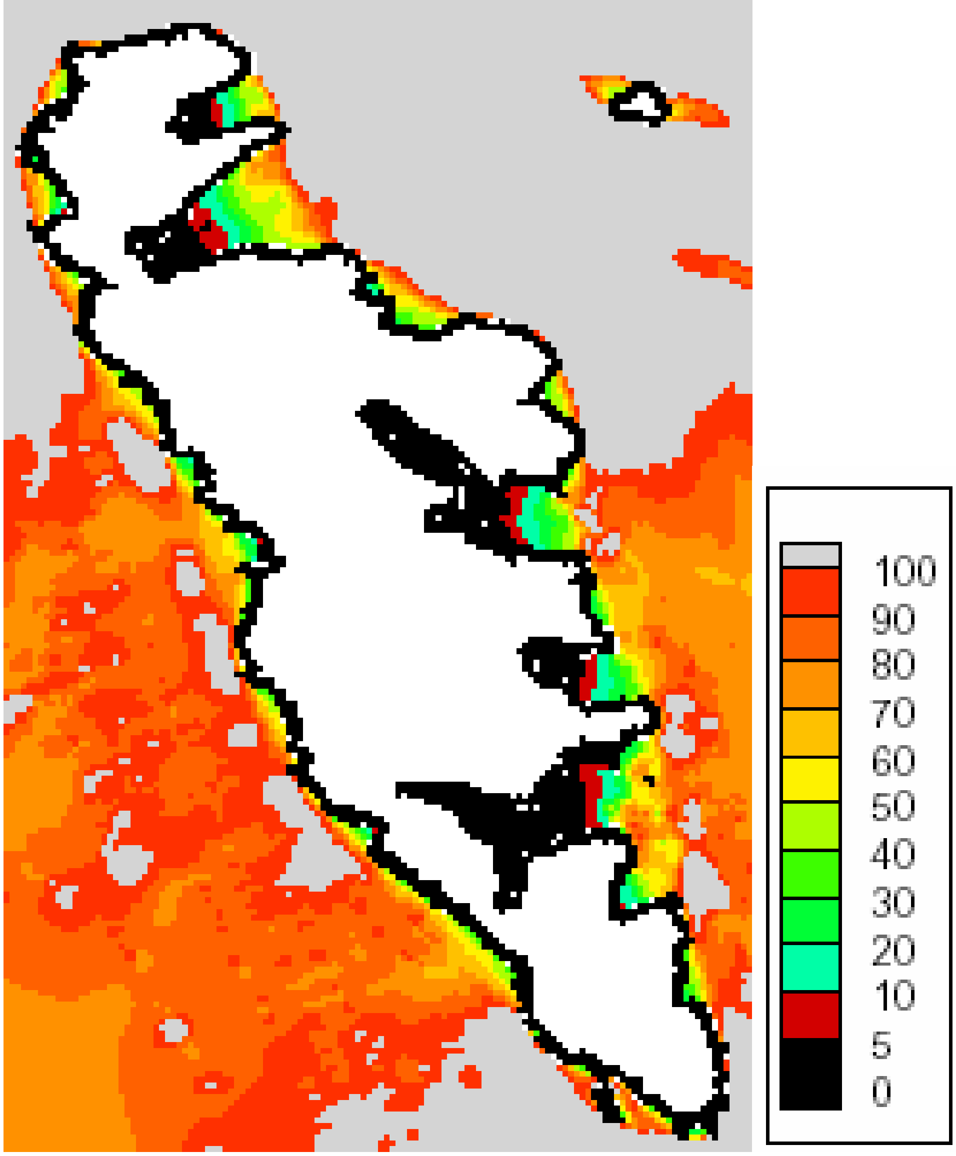


Figure 12 Maximum tidal current strength, zoom plot from Figure 1

A-15

This fish farming area is located in Trongisvágsfjørður, just outside Froðba. The depth in the area varies mostly between 25-30m according to the Landsverk-charts, and the depth of the reference cites are 23m at A15a and 18m at A15b (Table 3).

The maximum tidal current strength in part of the area is estimated to be 7.5 cm/s (see Figure 12), which is not enough to ensure regular resuspension of the wastes.

The average wave conditions at the two reference points are similar but the wave height is approximately one third less at b compared to the value at a. The largest estimated wave height during the investigated time period is 3-4 m.

Parameter	***Area A-15***	
Site	A-15a	A-15b
Depth (m)	23 (free height 8)	18 (free height 3)
Current speed u (cm/s)	7.5	7.5
Footprint radius (m)	34	22
Footprint area (m^2)	$3.5 \cdot 10^3$	$1.5 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is $25 kg/m^3$	2.5	5.9
Months with waste accumulation if fish density is $25 kg/m^3$	Some accumulation in: 2 months (Jul.-Aug.)	Accumulation in: 6 months May-Oct. Serious acc. 2-4 months
Comments:	None	Accumulation expected in summer months. Reduction in density advised
Recommended max. density: (kg/m^3)	25	25 * 40/59 ≈ 17 [*]

The big problem with A-15b is the shallow water depth compared to the assumed depth of the fish cage. In fact A-15b is to shallow to be suited representative reference point, as the depth in the area most places varies between 25 and 30m . If the fish cage had a depth of 10m instead of the 15m mentioned in the table, the footprint would be equal to that in A15a, and the recommended maximum fish density would then become 25 kg/m^3.

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes should not be a serious problem as long as there are more than 8m of free height beneath the fish cages.*

---

[*] The reduction factor 4/5.9 is determined as follows: 5.9 kg/m^2 (Monthly waste per area at A-15b) gives 59 ton per 100m*100m (the model grid cell size). By looking at resuspension figure for A-15 (blue colour represents location A-15b) we see that there would only be serious accumulation in two months (Jul-Aug) if the waste per month was reduced to 40 in stead of 59 ton/grid-cell. The corresponding decrease in fish density is therefore 40/59.

A-16

This site is located in Trongisvágjfjørður just outside Øravík. The depth in the area is most places between 20 and 25 m, and the depth at the reference points is 28 m at A-16a and 19 m at A-16b.

The estimated maximum current speed below 5 cm/s (Figure 12). This is below the current strength necessary for resuspending fish farm wastes.

The average wave conditions at A-16a and A-16b are almost identical with estimated maximum of approximately 2m in the modelled time series. As the wave conditions are quite similar the depth difference triggers stronger wave induced erosion at the shallower site (A-16b).

Parameter	***Area A-16***	
Site	A-16a	A-16b
Depth (m)	28 (free height 13)	19 (free height 4)
Current speed u (cm/s)	5.0	5.0
Footprint radius (m)	35	21
Footprint area (m^2)	$3.9 \cdot 10^3$	$1.4 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is $25kg/m^3$	2.3	6.3
Months with waste accumulation if fish density is $25kg/m^3$	Some accumulation in: 4 months (Jun-Sep)	Some accumulation all year. Serious accumulation in the summer months
Comment:	Accumulation expected in summer months. Reduction in density advised	Accumulation expected. Reduction in density advised
Recommended max. density: (kg/m^3)	$25 * 15/23 \approx 16$	$25 * 30/63 \approx 12$

There is slightly less wave induced erosion at A-16 compared to A-15, but this is only one factor that causes a reduction of the recommended maximum fish density at A-16 compared to A-15. The other and seemingly more important factor is the reduction in the estimated current speeds and the consequent reduction this inflicts on the estimated footprint. Taking A-16a as an example, a current speed of 7.5 cm/s would lead to a footprint size that was 67% larger, monthly waste per m^2 would reduce accordingly, and this would mean that there would be no cause for recommending a fish density that was less than the legislated upper value of 25 kg/m^3. The big difference between the density recommendations made for A-16a and A-16b is caused by the depth difference. The free height at A-16b is only 4m, if this was increased to 8m or more (e.g. by decreasing the depth of the fish cage) this would make the fish density recommendations at A-16a and A-16b compatible.

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes might be a problem in the summer months, and a reduction in maximum fish density is recommended. In the shallower parts of the area a free height of at least 8m is recommended beneath the fish cages.*

A-17

This site is the innermost of two fish farming areas in Hovsfjørður. The depth in the area is mostly in the region of 20m, and the depth of the reference points is 24m at A-17a and 15m at A-17b.

The estimated current speed is below 5 cm/s (Figure 12), and thus not strong enough to ensure resuspension of fish farm wastes.

The average wave conditions are quite different at the two reference points. The wave height at A-17b is usually less than half of the value at A-17a. The estimated maximum wave height in the investigation period is in the region of 4m and 2m respectively at A-17a and A-17b respectively.

The estimated wave induced erosion is stronger at A-17a compared to A-17b throughout the year, but only slightly in the summer months. The least erosion is in July where the estimated wave induced erosion is in the region of 1 kg/m^2 at both reference points.

Parameter	***Area A-17***	
Site	A-17a	A-17b
Depth (m)	24 (free height 9)	15 (free height 0)
Current speed u (cm/s)	5.0	5.0
Footprint radius (m)	29	15
Footprint area (m^2)	$2.6 \cdot 10^3$	$0.7 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is $25 kg/m^3$	3.4	12.7
Months with waste accumulation if fish density is $25 kg/m^3$	Some accumulation in: 3 months (Jun-Aug)	Serious accumulation all year
Comment:	Accumulation expected in summer months. Reduction in density advised	Accumulation expected. Reduction in density advised
Recommended max. density: (kg/m^3)	$25 * 30/34 \approx 22$	$25 * 25/127 \approx 5$

Once again the shallow depth of the more sheltered reference point causes a large difference in the recommended fish densities. As the depth in the region typically is 20m, a typical footprint would lead to a monthly waste per area in the region of 5.5 kg/m^2. According to the erosion figure this would lead to accumulation regardless of weather the location experiences wave erosion with the levels estimated at A-17a or A-17b. Using the estimated erosion levels at A-17a, the free height beneath the cage has to be 10m or more if the cage carries the maximum weight of fish per volume.

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes might be a problem. Insuring that enough of free height is beneath the fish cages is necessary.*

A-18

This site is the outermost of two fish farming areas in Hovsfjørður. The area is quite deep and exposed to the incoming waves. The depth in the area is mostly between 30 and 40m. The depth of the reference points is 45m at A-18a and 26m at A-18b.

The estimated current speed is between 10 and 30 cm/s (Figure 12), which most likely is strong enough to ensure resuspension of fish farm wastes with regular intervals.

The average wave conditions are quite different at the two reference points. The wave height at A-18b is usually half of the value at A-18a. The estimated maximum wave height in the investigation period is in the region of 6m and 4m respectively at A-18a and A-18b respectively. The depth difference counteracts the difference in wave conditions at the two locations, and the estimated wave erosion is stronger at A-18b compared to A-18a. Wave induced erosion has a minimum in July where the estimated values are 0.3 and 1.2 kg/m^2 respectively at A-18a and A-18b.

Parameter	***Area A-18***	
Site	A-18a	A-18b
Depth (m)	45 (free height 30)	26 (free height 11)
Current speed u (cm/s)	20.0	20.0
Footprint radius (m)	203	84
Footprint area (m^2)	$128.8 \cdot 10^3$	$22.0 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is 25kg/m^3	0.1	0.4
Months with waste accumulation if fish density is 25kg/m^3	None	None
Comment:	None	None
Recommended max. density: (kg/m^3)	25	25

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes is not a problem in this area. Both tidal currents and waves seem capable of flushing the site for wastes at regular intervals.*

A-19

This site is the outermost of three fish farming areas in Vágsfjørður. The area is quite deep and unsheltered to the incoming waves. The depth in the area is mostly between 35 and 60m. The depth of the reference points is 59m at A-19a and 23m at A-19b.

The estimated current speed is below 5 cm/s (Figure 12), which is not strong enough to ensure resuspension of fish farm wastes.

The average wave conditions are quite similar at the two reference points. The wave height at A-19b is usually 25% less than the value at A-19a. The estimated maximum wave height in the investigation period is in the region of 3-4m respectively. The depth difference has a large effect on the estimated wave erosion. The wave induced erosion at A-19a is almost nonexistent in the summer months while the erosion levels at A-19b are amongst the highest estimates of any site in this investigation. Wave induced erosion has a minimum in July where the estimated values are 0.05 and 1.0 kg/m^2 respectively at A-19a and A-19b.

Parameter	***Area A-19***	
Site	A-19a	A-19b
Depth (m)	59 (free height 44)	23 (free height 8)
Current speed u (cm/s)	5.0	5.0
Footprint radius (m)	84	28
Footprint area (m^2)	$22.0 \cdot 10^3$	$2.4 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is 25kg/m^3	0.4	3.8
Months with waste accumulation if fish density is 25kg/m^3	Some accumulation in 2 months (July-Aug)	Accumulation in: 2-3 months (Jun-Aug)
Comment:	None	None
Recommended max. density: (kg/m^3)	25	25

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes is not a serious problem.*

A-20

This site is one of three fish farming areas in Vágsfjørður. The area is located outside the harbour of Vágur. The area is located deep in the fjord and is quite sheltered from incoming waves. The depth in the area is mostly between 25 and 30m. The depth of the reference points is 34m at A-20a and 21m at A-20b.

The estimated current speed is below 5 cm/s (Figure 12), which is not strong enough to ensure resuspension of fish farm wastes.

The average wave conditions are quite similar at the two reference points. The wave height at A-20b is usually 20% less than the value at A-20a. The estimated maximum wave height in the investigation period is in the region of 2m. The depth difference has a significant effect on the estimated wave erosion. The wave induced erosion at A-20a is very low in the summer months while the higher erosion levels at A-20b are closer to values reported from other sites. Wave induced erosion has a minimum in July where the estimated values are 0.1 and 0.7 kg/m^2 respectively at A-20a and A-20b.

Parameter	***Area A-20***	
Site	A-20a	A-20b
Depth (m)	34 (free height 19)	21 (free height 6)
Current speed u (cm/s)	5.0	5.0
Footprint radius (m)	45	24
Footprint area (m^2)	$6.3 \cdot 10^3$	$1.8 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is 25kg/m^3	1.4	4.8
Months with waste accumulation if fish density is 25kg/m^3	Some accumulation in 6 months (May-Oct)	Accumulation all year
Comment:	Some accumulation in summer months. Reduction advised.	Accumulation all year. Reduction advised
Recommended max. density: (kg/m^3)	$25 * 9/14 \approx 16$	$25 * 18/48 \approx 9$

The shallow depth of A-20b is uncharacteristic for this area. If the depth was within the characteristic range e.g. 25m, the monthly waste per area would be 3.0 gk/m^2. This would in turn lead to a recommended maximum density of 13 kg/m^3 (same effect as using a 11m deep cage at A-20b instead of a 15m deep cage).

As the resuspension levels are quite steady over the year, it would only require some small amount of additional resuspension (e.g. coupled shear stress from waves and currents) to change the recommended density quite a lot in the positive direction.

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes seems to be a potential problem, especially in the summer months, and reduced density is recommended.*

A-30

This site is one of three fish farming areas in Vágsfjørður. The area is located outside the Lopra. The area is located deep in the fjord and is quite sheltered from incoming waves. The depth in the area is mostly between 25 and 30m. The depth of the reference points is 36m at A-30a and 22m at A-30b.

The estimated current speed is below 5 cm/s (Figure 12), which is not strong enough to ensure resuspension of fish farm wastes.

The average wave conditions are quite different at the two reference points. The wave height at A-20b is usually less than half the value at A-20a. The estimated maximum wave height in the investigation period is in the region of 2m at A-30a and 1m at A-30b. The depth difference has a significant effect on the estimated wave erosion. The wave induced erosion at A-30a and A-30b is very low throughout the year. Wave induced erosion has a minimum in July-August where the estimated values are in the range between 0.1 and 0.2 kg/m^2 at the two locations.

Parameter	***Area A-30***	
Site	A-30a	A-30b
Depth (m)	36 (free height 21)	22 (free height 7)
Current speed u (cm/s)	5.0	5.0
Footprint radius (m)	48	24
Footprint area (m^2)	$7.2 \cdot 10^3$	$2.6 \cdot 10^3$
Monthly waste per area (kg/m^2) if fish density is 25kg/m^3	1.3	3.4
Months with waste accumulation if fish density is 25kg/m^3	Some accumulation in 6 months (May-Oct)	Accumulation all year
Comment:	Some accumulation in summer months. Reduction advised.	Accumulation all year. Reduction advised
Recommended max. density: (kg/m^3)	$25 * 8/13 \approx 15$	$25 * 8/34 \approx 6$

The inner part of the area seems to be too sheltered from the incoming waves, so there is no increase in erosion with decreasing depth as it is found elsewhere.

As with area A-20, this area would only need a small amount of extra resuspension to cause a large increase in the recommended fish density.

A general comment that can be made about this area it therefore:

> *According to the assumptions and calculations made here, accumulation of wastes seems to be a potential problem, and reduced density is recommended.*

Feedback from fish farmers

The results from these investigations have been presented and discussed with the fish farmers that are active in Suðuroy. The main points in the feedback were:

- Local experience supports the modelled result in the sense that waves seem to be the main source of resuspension/cleansing of the fjords, and that this mainly occurs during winter storms.
- Local experience, and some circumstantial evidence supports the general trends in the site specific modelled results in Trongisvágsfjørður and Hovsfjørður.
- On the other hand local experience, and some circumstantial evidence, due not support the modelled results when it comes to the low resuspension levels reported at A-20 and A-30.
- Local experience suggests that higher levels of swells penetrate into Vágsfjørður than reported in the modelled results.
    - Subsequent investigation of the bathymetry used in the modeling, revealed that a reef in the outer part of the fjord was represented as land. This could explain part of this mismatch.
- Wave conditions at a specific locality can vary quite a lot from year to year, and this aught to be incorporated in the presentation of the results.
- It was also a problem that the modelled time period was too far in the past to be intercom pared with existing logbooks.
- The charts defining the fish farming areas have recently been adjusted, so some of the unfavourable reference locations used here, are now located outside the present fish farming areas.
- There would be a lot of interest in an event specific measurement/modelling campaign, which could reveal real sediment movement and clarify to which extent numerical models can be trusted.

How to get more answers

Here we have made some crude assumptions e.g. about the characteristic size of the waste footprint, and we have not discussed where the resuspended material is transported. In order to describe such problems with more confidence a different type of model needs to be run that resolves local sedimentation distributions rates, degeneration of settled material due benthic processes, resuspension due to waves and currents, and transport of resuspended material. This is outside the scope of the present project, but since the wave conditions now are better understood, and a tidal current model exists for the region, it is possible to take the next step closer to the general picture by applying the so called sediment models.

These types of models have several adjustable parameters and therefore need to be tested and validated against field data. Waves, currents and resuspension indicators have to be measured locally in order to validate and tune the model to a new environment.

Only when this is done can we generate the necessary statistics which can serve as a reliable guide for the local fish-farming industry.

Limitations of the present investigation

In the present investigation we have looked at wave induced bottom stress in fish farming areas by using a wave model to transport offshore wave measurements into the respective near shore sites. In order to reduce the computational burden of the investigation the measured wave situations are bind into an array of directional and wave height bins. The wave model was then only run for these idealised scenarios.

Assuming that the wave field always only consists of wind waves, as it is done here, is not accurate as the wave fields in the Faro Shelf typically contain swells. The difference between a wave field travelling in one main direction (peak direction in these investigations), and reality where different swell systems can be present, might quite possibly lead to different resuspension statistics in sheltered areas. It is therefore quite possible that the modelled resuspension rates at A-20 and A-30 would be higher if swells were modelled more accurately.

In these model runs, no reflections from land are included, and the shallow water source terms have been implemented in their default form, i.e. as long as there are no nearshore wave measurements to validate the model setup and assumptions used here, there is some uncertainty about the accuracy of the method.

For consistency with other authors orbital bottom speeds and period were calculated based on parametric approach using T_p and H_{m0} (Eq. 2 and 3). A more accurate approach, with less uncertainty of the estimated bottom orbital speeds and periods, could be achieved by basing the calculations on the full surface wave spectra (an output feature supported by newer versions of SWAN). It is also recommended that the full measurement series from WVD-4 is used to generate the local statistics and not only the four years used here.

Conclusion

In the present investigation we have looked at wave induced bottom stress in seven fish farming areas of Suðuroy, by using a wave model to transport offshore wave measurements into the respective near shore sites. Surface wave motion was converted into bottom motion based on wave height (H_{m0}) and peak period (T_p). The amount of wastes resuspended by the waves was estimated by using the critical erosion shear stress (0.018 N/m^2) and erodibility constant ($7 \cdot 10^{-7}$ kg m^{-2} s^{-1}) suggested by Cromey et al. (2002).

The main conclusions that can be made from this investigation are:

- The investigation has shown that wave induced resuspension seems to be the most important source of bottom cleansing in most of the investigated fish farming areas.
- The general level of wave induced cleansing, and the periods in which they occur, seem to be in accordance with local experience and circumstantial evidence in most of the investigated sites.
- In two of the sites the modelled resuspension seemed to be too low compared to local experience. This mismatch can either be caused by too simplistic approach when modelling the waves, or simply that other processes also ensure cleansing in at these locations.
- Taking this investigation as a showcase for a wave induced waste resuspension study, it is clear that the critical resuspension current speeds reported by Dudley et al. (2000) seem to be much too high (0.40-0.60 cm/s, 1m above the seabed). If they were accurate the wave induced resuspension would be insignificant at the sites investigated here, which is in contrast to local experience.

Now that local wave statistics are known as well as tidal current information, it is recommended to follow up these investigations by running local sedimentary models and simultaneously conduct a field campaign to verify the results. If this is done we have a usable tool to classify fish farming areas based on the biomass holding capacity of the respective areas.

Acknowledgements

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List of References

Booij, N., Ris, R. C. and Holthuijsen, L. H. 1999. A third-generation wave model for coastal regions - 1. Model description and validation. Journal of Geophysical Research-Oceans 104: 7649-7666.

Brown, J. M. Coastal area modelling: Sand transport and morphological change. 1-233. 2007. University of Wales, Bangor, UK.

Cromey, C. J., Nickell, T. D., Black, K. D., Provost, P. G. and Griffiths, C. R. 2002. Validation of a fish farm waste resuspension model by use of a particulate tracer discharged from a point source in a coastal environment. Estuaries 25: 916-929.

Dam, R. Framleiðsluhagtøl Føroysk Alivinna. 2009. Torshavn, Faroe Islands, House of Industry. Alirástevnan 2009.

Dudley, R. W., Panchang, V. G. and Newell, C. R. 2000. Application of a comprehensive modeling strategy for the management of net-pen aquaculture waste transport. Aquaculture 187: 319-349.

Gowen, R. J. and Bradbury, N. B. 1987. The Ecological Impact of Salmonid Farming in Coastal Waters - A Review. Oceanography and Marine Biology 25: 563-575.

Heinesen, S. P. FOIB Southwv project Final Data Q/A Report, Data Period 10'th February 1999-18'th February 2004. 1-27. 2004. Sp/f Data Quality.

Holthuijsen, L. H. 2007. Waves in oceanic and coastal waters. Cambridge, UK: Cambridge University Press.

Jönsson, A. Model studies of surface waves and sediment resuspension in the Baltic Sea. 1-49. 2005. Department of Water and Environmental Studies, Lindköping University, Sweeden.

Niclasen, B. A. An operational wave model for the Faroe Shelf. 1-127. 2006. University of the Faroe Islands.

Niclasen, B. A. and Simonsen, K. Current induced variations in measured wave parameters in data from the Faroe Islands. 2005:03. 2005. University of the Faroe Islands. NVD-rit.

Niclasen, B. A. and Simonsen, K. 2007. Note on wave parameters from moored wave buoys. Applied Ocean Research 29: 231-238.

Nielsen, P. 1992. Coastal bottom boundary layers and sediment transport. World Scientific Publishing.

Panchang, V., Cheng, G. and Newell, C. 1997. Modeling hydrodynamics and aquaculture waste transport in coastal Maine. Estuaries 20: 14-41.

Pizzamei, , M. and Gillibrand, P. A. Observation of wave conditions and sediment resuspension characteristics at Shetland fish farm sites. 06/02. 2002. Aberdeen, UK, Fisheries Research Services, Marine Laboratory.

Reid, G. K., Liutkus, M., Robinson, S. M. C., Chopin, T. R., Blair, T., Lander, T., Mullen, J., Page, F. and Moccia, R. D. 2009. A review of the biophysical properties of salmonid faeces: implications for aquaculture waste dispersal models and integrated multi-trophic aquaculture. Aquaculture Research 40: 257-273.

Ris, R. C. Spectral modelling of wind waves in coastal areas. 1-160. 1997. Delft University of Technology.

Rogers, W. E., Hwang, P. A. and Wang, D. W. 2003. Investigation of wave growth and decay in the SWAN model: Three regional-scale applications. Journal of Physical Oceanography 33: 366-389.

Simonsen, K. and Gislason, E. STREYMALD - an internet information system providing current, wave and depth around the Faroes. 2002. University if the Faroe Islands. NVD-rit 2002:05.

Simonsen, K. Sjóaling í Føroyum. 2006:13, 1-9. 2006. Faroe Islands, Faculty of Science and Technology, University of the Faroe Islands. NVD Rit.

Simonsen, K., Larsen, K. M. H., Mortensen, L. and Norbye, A. M. New Bathymetry for the Faroe Shelf. 2002:7, 1-9. 2002. Faroe Islands, Faculty of Science and Technology. NVD Rit.

Tucker, M. J. and Pitt, E. G. 2001. Waves in Ocean Engineering. Elsevier Science.
Wiberg, P. L. and Sherwood, C. R. 2008. Calculating wave-generated bottom orbital velocities from surface-wave parameters. Computers and Geosciences 34: 1243-1262.

Yokoyama, H., Abo, K. and Ishihi, Y. 2006. Quantifying aquaculture-derived organic matter in the sediment in and around a coastal fish farm using stable carbon and nitrogen isotope ratios. Aquaculture 254: 411-425.

Appendix A (Model setup)

This appendix gives technical information related to the model runs, which is not necessary in order to understand the main message of this report. This information is included so that it is possible to reproduce these runs, and the extra information also serves as argumentation for the given setup of the model that is used in these investigations.

A.1: The SWAN Input file - one example

```
$************************HEADING***********************
PROJ 'Rerun_fine' 'Cur'
$*******************MODEL INPUT************************
MODE STATIONARY
COORDINATES CARTesian
$
CGRID REGULAR xpc=0.0 ypc=0.0 alpc=0.0 xlenc=35000.0 ylenc=100000.0 mxc=350 myc=1000 &
CIRCLE mdc=180 flow=0.034523 fhigh=0.547637 msc=29
$
INPGRID BOTTOM REGULAR xpinp=0.0 ypinp=0.0 alpinp=0.0 &
mxinp=350 myinp=1000 dxinp=100.0 dyinp=100.0
$
$...Denne læs bundmatr. til fin scala model...
READINP BOTTOM 1.0 '/home/bardurn/Depth/depth_south.txt' 4 FREE
$
WIND  vel=15.0 dir=90.0
$
BOUNd SHAPespec PM PEAK DSPR POWer
$
BOUNdspec SIDE N CONstant PAR hs=10.0 per=15.8 dir=90.0 dd=2.0
BOUNdspec SIDE W CONstant PAR hs=10.0 per=15.8 dir=90.0 dd=2.0
BOUNdspec SIDE S CONstant PAR hs=10.0 per=15.8 dir=90.0 dd=2.0
BOUNdspec SIDE E CONstant PAR hs=10.0 per=15.8 dir=90.0 dd=2.0
$
INITIAL DEFAULT
$
GEN3 KOMEN
$
WCAP KOMEN delta=1
$
BREaking
$
FRICTION JONswap
$
DIFFRACtion
$
OFF BNDCHK
$
NUMeric ACCUR STAT mxitst=30
$
$.......OUTPUT FROM SWAN
$*************************************************************
$...MATLAB...whole area output...
BLOCK 'COMPGRID' NOHEAD 'D_out/Hs.mat' LAYOUT 3 HS
BLOCK 'COMPGRID' NOHEAD 'D_out/DIR.mat' LAYOUT 3 DIR
BLOCK 'COMPGRID' NOHEAD 'D_out/PDIR.mat' LAYOUT 3 PDIR
BLOCK 'COMPGRID' NOHEAD 'D_out/Tp.mat' LAYOUT 3 RTP
BLOCK 'COMPGRID' NOHEAD 'D_out/Tmm10.mat' LAYOUT 3 TMM10
BLOCK 'COMPGRID' NOHEAD 'D_out/Tm02.mat' LAYOUT 3 TM02
BLOCK 'COMPGRID' NOHEAD 'D_out/DEPTH.mat' LAYOUT 3 DEPTH
BLOCK 'COMPGRID' NOHEAD 'D_out/Wind.mat' LAYOUT 3 WIND
BLOCK 'COMPGRID' NOHEAD 'D_out/Dissip.mat' LAYOUT 3 DISSIP
BLOCK 'COMPGRID' NOHEAD 'D_out/Dissurf.mat' LAYOUT 3 DISSURF
BLOCK 'COMPGRID' NOHEAD 'D_out/Ubot.mat' LAYOUT 3 UBOT
BLOCK 'COMPGRID' NOHEAD 'D_out/Urms.mat' LAYOUT 3 URMS
BLOCK 'COMPGRID' NOHEAD 'D_out/Wlen.mat' LAYOUT 3 WLEN
$
TEST 1,0
$
COMPUTE STATionary
$
STOP
```

A.2: Keeping track of time in MPI SWAN run

SWAN does at times have problems with displaying the correct total time used on a given run. In order to ensure that I know the total time used (it is written to the file run.txt) and that the runs can be made while I'm logged of, the SWAN runs were imbedded in a bash script SWANRUN which content was:

```
nr_nodes=5
nr_threads=10
echo "BAN SWAN run" > run.txt
echo "number of nodes is $nr_nodes" >> run.txt
echo "number of threads is $nr_threads" >> run.txt
echo "the run starts at:" >> run.txt
date >> run.txt
mpdboot -n $nr_nodes -f machinefile -r ssh
nohup mpiexec -n $nr_threads -wdir `pwd`
/home/bardurn/swan4041AB/swan.exe >> run.txt
mpdAllexit
echo "the run ended at:" >> run.txt
date >> run.txt
```

A.3: Script for running swan for all 288 cases

A bash script was made so all the 288 cases could run without being started one at the time. The content was:

```
echo "All resusp SWAN runs" > run.txt
 date >> run.txt
 cd Dir_000_Hs_01
 chmod +x SWANRUN
 nohup ./SWANRUN
 cd ..
 date >> run.txt
 cd Dir_000_Hs_02
 chmod +x SWANRUN
 nohup ./SWANRUN
 cd ..   . . . and so on . . .
```

A.4: Matlab script for creating the 288 SWAN INPUT files

```matlab
function Gen_SWAN_resusp_DirAndFiles
% This function generates all the directories and files that are necesarry
% in order to run independant SWAN runs for the southern area
% INPUT ....................
Direc=[0:45:315];
% Direc=[22.5:45:315+22.5];
Hs=[1:1:18];
% OUTPUT....................
% length(Hs)*length(Direc) directories containing propper names and
% conatining SWAN INPUT files with appropriate values of vel, dir, hs and per
% Main Code---------
mkdir SWAN_Resusp
%
% User name settings
for Direc_index=1:length(Direc)
    disp(['direction is ',num2str(Direc(Direc_index))])
    % Generating propper names
    for Hs_index=1:length(Hs)
            disp(['Hs is ',num2str(Hs(Hs_index))])
        H_name=[num2str(Hs(Hs_index))];
        if length(H_name)<2
            H_name=['0' H_name];
        end
        D_name=[num2str(Direc(Direc_index))];
        if length(D_name)<2
           D_name=['00' D_name];
        elseif length(D_name)<3
            D_name=['0' D_name];
        end
        dirname=['SWAN_Resusp\Dir_' D_name '_Hs_' H_name];
        Dout_dirname=[dirname '\D_out'];
        eval(['mkdir ' dirname]);
        eval(['mkdir ' Dout_dirname]);
        dir=[num2str(Direc(Direc_index),'%1.1f')];
        hs=[num2str(Hs(Hs_index),'%1.1f')];;
        [per, vel]=Gen_PM_param(Hs(Hs_index));
        copyfile('Org_SWAN_files\machinefile',[dirname '\machinefile'])
        copyfile('Org_SWAN_files\SWANRUN',[dirname '\SWANRUN'])
        Gen_INPUT_file(vel,dir,hs,per)
        copyfile('INPUT',[dirname '\INPUT'])
    end
    %delete INPUT
end
% INTERNAL FUNCTIONS -----------------------------
function [per, vel]=Gen_PM_param(Hsig)
% this function calculates and generates Tp and wind vel names that
% correspont to a given Hsig. See p.100 in Tucken and Pitt, 2001
vel=(Hsig/0.0246)^0.5;
Tp=0.785*vel;
per=[num2str(Tp,'%1.1f')];
% NB this is done in order to conunteract induced wave growth due to n=2 effect in dissip
vel=0.9*vel;
vel=[num2str(vel,'%1.1f')];

function Gen_INPUT_file(vel,dir,hs,per)
% This function generates the INPUT file
file_id_write=fopen('INPUT','w');
file_id_read=fopen('Org_SWAN_files\INPUT','r');
Fil_eof=feof(file_id_read); % end of file status
line_nr=1;
while Fil_eof==0
    txt=fgetl(file_id_read); % data fra fil i tekstformat
    if length(txt)>4
        if txt(1:4)=='WIND'
            txt=['WIND vel=' vel ' dir=' dir ];
        end
    end
    if length(txt)>16
        if txt(1:16)=='BOUNdspec SIDE N'
            txt=['BOUNdspec SIDE N CONstant PAR hs=' hs ' per=' per ' dir=' dir ' dd=2.0'];
        elseif txt(1:16)=='BOUNdspec SIDE W'
            txt=['BOUNdspec SIDE W CONstant PAR hs=' hs ' per=' per ' dir=' dir ' dd=2.0'];
        elseif txt(1:16)=='BOUNdspec SIDE S'
            txt=['BOUNdspec SIDE S CONstant PAR hs=' hs ' per=' per ' dir=' dir ' dd=2.0'];
        elseif txt(1:16)=='BOUNdspec SIDE E'
            txt=['BOUNdspec SIDE E CONstant PAR hs=' hs ' per=' per ' dir=' dir ' dd=2.0'];
        end
    end
    fprintf(file_id_write,' %s \n', txt);
    Fil_eof=feof(file_id_read); % end of file status
    line_nr=line_nr+1;
end
fclose(file_id_read);
fclose(file_id_write);
```

Appendix B

B.1: Local conversion matrix for H_{m0}

Here the local conversion matrix for the 14 sites are listed in chronological order e.g. H_out(:,:,1) corresponds to the location A-15a, H_out(:,:,2) corresponds to the location A-15b. The rows correspond to H_{m0} at WVD-4 equal to 1-18m, the columns correspond to wave direction from 0° to 337.5° in 22.5° steps, see the example below (definition of the directions used here correspond to those used in the SWAN, see the SWAN manual):

H_out(:,:,1) = i.e. this is location A-15a

Dir=	*0*	*23*	*45*	*68*	*90*	*113*	*135*	*158*	*180*	*203*	*225*	*248*	*270*	*293*	*315*	*338*
Hm0=1	*0.0012*	*0.0556*	*0.1125*	*0.2064*	*0.3602*	*0.5006*	*0.5943*	*0.6294*	*0.5920*	*0.4934*	*0.3501*	*0.1891*	*0.0687*	*0.0176*	*0.0042*	*0.0008*
Hm0=2	*0.0132*	*0.0535*	*0.1770*	*0.3912*	*0.6703*	*0.9571*	*1.1466*	*1.2162*	*1.1701*	*0.9838*	*0.7131*	*0.4133*	*0.1783*	*0.0663*	*0.0331*	*0.0475*
Hm0=3	*0.3002*	*0.2387*	*0.2696*	*0.5920*	*0.9714*	*1.3663*	*1.6601*	*1.7836*	*1.7266*	*1.4831*	*1.1182*	*0.7041*	*0.3583*	*0.1780*	*0.2047*	*0.2862*
Hm0=4	*0.4271*	*0.4438*	*0.5084*	*0.7945*	*1.2715*	*1.7711*	*2.1543*	*2.3175*	*2.2675*	*1.9766*	*1.5279*	*1.0290*	*0.5833*	*0.3096*	*0.2916*	*0.4006*
Hm0=5	*0.5029*	*0.5484*	*0.6626*	*1.0875*	*1.5699*	*2.1683*	*2.6254*	*2.8349*	*2.7868*	*2.4633*	*1.9521*	*1.3646*	*0.8381*	*0.4622*	*0.3818*	*0.4790*
Hm0=6	*0.5624*	*0.6128*	*0.8384*	*1.3093*	*1.8770*	*2.5791*	*3.1111*	*3.3575*	*3.2996*	*2.9305*	*2.3672*	*1.7064*	*1.1050*	*0.6312*	*0.4895*	*0.5248*
Hm0=7	*0.6069*	*0.6748*	*0.9698*	*1.5051*	*2.1820*	*2.9765*	*3.5850*	*3.8556*	*3.7762*	*3.3632*	*2.7392*	*2.0191*	*1.3562*	*0.7968*	*0.5362*	*0.5765*
Hm0=8	*0.6735*	*0.7801*	*1.0856*	*1.7231*	*2.5000*	*3.3892*	*4.0717*	*4.2663*	*4.2614*	*3.7944*	*3.1174*	*2.3368*	*1.6155*	*0.9780*	*0.6453*	*0.6423*
Hm0=9	*0.7441*	*0.8699*	*1.2269*	*1.9459*	*2.8256*	*3.8040*	*4.5511*	*4.8351*	*4.6979*	*4.2037*	*3.4473*	*2.6218*	*1.8435*	*1.1438*	*0.7551*	*0.7183*
Hm0=10	*0.8365*	*0.9753*	*1.3937*	*2.1836*	*3.1581*	*4.2302*	*5.0082*	*5.1720*	*5.1043*	*4.5721*	*3.7708*	*2.8952*	*2.0635*	*1.3058*	*0.8682*	*0.7608*
Hm0=11	*0.9521*	*1.1082*	*1.5898*	*2.4402*	*3.5017*	*4.6546*	*5.4571*	*5.5866*	*5.4825*	*4.9118*	*4.0775*	*3.1820*	*2.3033*	*1.4646*	*0.9831*	*0.8589*
Hm0=12	*1.0759*	*1.2538*	*1.7914*	*2.6755*	*3.8517*	*5.0686*	*5.8187*	*5.9677*	*5.8227*	*5.2160*	*4.3291*	*3.4061*	*2.5042*	*1.6060*	*1.0892*	*0.9491*
Hm0=13	*1.2049*	*1.4064*	*2.0099*	*2.9597*	*4.2236*	*5.4691*	*6.2225*	*6.3595*	*6.1226*	*5.5144*	*4.5829*	*3.6492*	*2.7025*	*1.7420*	*1.1868*	*1.0350*
Hm0=14	*1.3389*	*1.5655*	*2.2395*	*3.2530*	*4.5777*	*5.8591*	*6.5925*	*6.6310*	*6.3790*	*5.7687*	*4.8191*	*3.8322*	*2.8733*	*1.8709*	*1.3325*	*1.1792*
Hm0=15	*1.4362*	*1.7343*	*2.4633*	*3.5493*	*4.9240*	*6.2093*	*6.9372*	*6.9121*	*6.6345*	*5.9933*	*5.0295*	*4.0251*	*3.0489*	*1.9970*	*1.4322*	*1.2702*
Hm0=16	*1.5519*	*1.8810*	*2.6913*	*3.8412*	*5.2587*	*6.5487*	*7.2564*	*7.1976*	*6.6423*	*6.1824*	*5.1585*	*4.1957*	*3.0534*	*2.1653*	*1.5218*	*1.3495*
Hm0=17	*1.5961*	*2.0226*	*2.9056*	*4.1285*	*5.5768*	*6.8657*	*7.5250*	*7.4304*	*6.8522*	*6.3205*	*5.3084*	*4.3005*	*3.1785*	*2.2776*	*1.6080*	*1.4256*
Hm0=18	*1.6329*	*2.1729*	*3.1134*	*4.4069*	*5.8982*	*7.1600*	*7.7632*	*7.6241*	*7.0496*	*6.4569*	*5.4400*	*4.4306*	*3.2945*	*2.3837*	*1.6853*	*1.4916*

```
H_out(:,:,1) =

    0.0012    0.0556    0.1125    0.2064    0.3602    0.5006    0.5943    0.6294    0.5920    0.4934    0.3501    0.1891    0.0687    0.0176    0.0042    0.0008
    0.0132    0.0535    0.1770    0.3912    0.6703    0.9571    1.1466    1.2162    1.1701    0.9838    0.7131    0.4133    0.1783    0.0663    0.0331    0.0475
    0.3002    0.2387    0.2696    0.5920    0.9714    1.3663    1.6601    1.7836    1.7266    1.4831    1.1182    0.7041    0.3583    0.1780    0.2047    0.2862
    0.4271    0.4438    0.5084    0.7945    1.2715    1.7711    2.1543    2.3175    2.2675    1.9766    1.5279    1.0290    0.5833    0.3096    0.2916    0.4006
    0.5029    0.5484    0.6626    1.0875    1.5699    2.1683    2.6254    2.8349    2.7868    2.4633    1.9521    1.3646    0.8381    0.4622    0.3818    0.4790
    0.5624    0.6128    0.8384    1.3093    1.8770    2.5791    3.1111    3.3575    3.2996    2.9305    2.3672    1.7064    1.1050    0.6312    0.4895    0.5248
    0.6069    0.6748    0.9698    1.5051    2.1820    2.9765    3.5850    3.8556    3.7762    3.3632    2.7392    2.0191    1.3562    0.7968    0.5362    0.5765
    0.6735    0.7801    1.0856    1.7231    2.5000    3.3892    4.0717    4.2663    4.2614    3.7944    3.1174    2.3368    1.6155    0.9780    0.6453    0.6423
    0.7441    0.8699    1.2269    1.9459    2.8256    3.8040    4.5511    4.8351    4.6979    4.2037    3.4473    2.6218    1.8435    1.1438    0.7551    0.7183
    0.8365    0.9753    1.3937    2.1836    3.1581    4.2302    5.0082    5.1720    5.1043    4.5721    3.7708    2.8952    2.0635    1.3058    0.8682    0.7608
    0.9521    1.1082    1.5898    2.4402    3.5017    4.6546    5.4571    5.5866    5.4825    4.9118    4.0775    3.1820    2.3033    1.4646    0.9831    0.8589
    1.0759    1.2538    1.7914    2.6755    3.8517    5.0686    5.8187    5.9677    5.8227    5.2160    4.3291    3.4061    2.5042    1.6060    1.0892    0.9491
    1.2049    1.4064    2.0099    2.9597    4.2236    5.4691    6.2225    6.3595    6.1226    5.5144    4.5829    3.6492    2.7025    1.7420    1.1868    1.0350
    1.3389    1.5655    2.2395    3.2530    4.5777    5.8591    6.5925    6.6310    6.3790    5.7687    4.8191    3.8322    2.8733    1.8709    1.3325    1.1792
    1.4362    1.7343    2.4633    3.5493    4.9240    6.2093    6.9372    6.9121    6.6345    5.9933    5.0295    4.0251    3.0489    1.9970    1.4322    1.2702
    1.5519    1.8810    2.6913    3.8412    5.2587    6.5487    7.2564    7.1976    6.6423    6.1824    5.1585    4.1957    3.0534    2.1653    1.5218    1.3495
    1.5961    2.0226    2.9056    4.1285    5.5768    6.8657    7.5250    7.4304    6.8522    6.3205    5.3084    4.3005    3.1785    2.2776    1.6080    1.4256
    1.6329    2.1729    3.1134    4.4069    5.8982    7.1600    7.7632    7.6241    7.0496    6.4569    5.4400    4.4306    3.2945    2.3837    1.6853    1.4916


H_out(:,:,2) =

    0.0009    0.0511    0.0999    0.1818    0.3118    0.4155    0.4730    0.4834    0.4347    0.3348    0.2015    0.0716    0.0139    0.0026    0.0006    0.0001
    0.0038    0.0447    0.1516    0.3366    0.5705    0.7802    0.8965    0.9174    0.8514    0.6641    0.4223    0.1926    0.0715    0.0295    0.0106    0.0027
    0.0488    0.0632    0.2170    0.5032    0.8137    1.1000    1.2825    1.3235    1.2468    1.0055    0.6822    0.3737    0.1866    0.0902    0.0402    0.0318
    0.1139    0.1788    0.3541    0.6892    1.0519    1.4141    1.6482    1.7100    1.6301    1.3507    0.9645    0.5924    0.3349    0.1736    0.0802    0.0701
    0.1738    0.2833    0.5063    0.9207    1.2836    1.7170    2.0044    2.0895    2.0014    1.6921    1.2660    0.8344    0.5085    0.2762    0.1334    0.1195
    0.2265    0.3623    0.6627    1.0757    1.5184    2.0340    2.3670    2.4751    2.3874    2.0354    1.5701    1.0882    0.6967    0.3909    0.1988    0.1640
    0.2692    0.4057    0.7553    1.2055    1.7512    2.3344    2.7195    2.8454    2.7599    2.3700    1.8460    1.3190    0.8804    0.5077    0.2688    0.2161
    0.3288    0.4676    0.8273    1.3672    1.9918    2.6472    3.0945    3.2165    3.1431    2.7131    2.1411    1.5565    1.0787    0.6377    0.3544    0.2884
    0.3938    0.5386    0.9164    1.5314    2.2398    2.9638    3.4510    3.5719    3.4940    3.0464    2.4028    1.7745    1.2561    0.7545    0.4373    0.3639
    0.4672    0.6230    1.0405    1.7088    2.4913    3.2817    3.7995    3.9024    3.8238    3.3485    2.6685    1.9906    1.4272    0.8673    0.5228    0.4237
    0.5519    0.7260    1.1843    1.9049    2.7523    3.6041    4.1435    4.2279    4.1333    3.6353    2.9252    2.2282    1.5950    0.9786    0.6069    0.4993
    0.6415    0.8384    1.3387    2.0858    3.0177    3.9315    4.4639    4.5302    4.4134    3.8904    3.1319    2.4008    1.7355    1.0772    0.6833    0.5646
    0.7388    0.9610    1.5040    2.2998    3.3013    4.2386    4.7864    4.8491    4.6630    4.1366    3.3409    2.5806    1.8830    1.1754    0.7557    0.6256
    0.8392    1.0890    1.6777    2.5215    3.5710    4.5382    5.0785    5.1033    4.8734    4.3433    3.5315    2.7227    1.9991    1.2686    0.8635    0.7332
    0.9238    1.2186    1.8546    2.7460    3.8344    4.8214    5.3470    5.3339    5.0767    4.5282    3.7022    2.8790    2.1336    1.3609    0.9372    0.7986
    1.0108    1.3399    2.0268    2.9667    4.0918    5.0894    5.5894    5.5399    5.0685    4.6826    3.8034    3.0159    2.1120    1.4928    1.0010    0.8541
    1.0564    1.4540    2.1951    3.1836    4.3364    5.3383    5.8012    5.7181    5.2265    4.7959    3.9276    3.0899    2.2123    1.5747    1.0633    0.9071
    1.0866    1.5695    2.3569    3.3946    4.5862    5.5647    5.9998    5.8734    5.3945    4.9112    4.0352    3.1909    2.3034    1.6555    1.1195    0.9524


H_out(:,:,3) =

    0.0001    0.0151    0.0341    0.0629    0.1697    0.3128    0.4437    0.5199    0.5325    0.4855    0.3837    0.2308    0.0849    0.0173    0.0038    0.0004
```

```
    0.0017    0.0091    0.0479    0.1151    0.3025    0.5552    0.7614    0.9012    0.9552    0.9084    0.7594    0.5115    0.2580    0.1041    0.0390    0.0081
    0.0302    0.0142    0.0685    0.1859    0.4152    0.7247    1.0050    1.1907    1.2907    1.2626    1.1012    0.8106    0.4812    0.3131    0.2652    0.1848
    0.1700    0.0300    0.0901    0.2356    0.5116    0.8733    1.2092    1.4400    1.5806    1.5642    1.3985    1.0893    0.7426    0.4700    0.3718    0.2985
    0.2547    0.0741    0.1172    0.2848    0.5953    1.0019    1.3673    1.6464    1.8169    1.8176    1.6569    1.3352    0.9792    0.6131    0.4612    0.3822
    0.3393    0.1626    0.1585    0.3401    0.6805    1.1156    1.5311    1.8272    2.0085    2.0223    1.8711    1.5699    1.1931    0.7621    0.5471    0.4602
    0.4406    0.3175    0.2190    0.4039    0.7659    1.2353    1.6761    1.9826    2.1585    2.1835    2.0421    1.7903    1.3848    0.8960    0.5749    0.5426
    0.5586    0.5070    0.4082    0.4910    0.8472    1.3437    1.7836    2.0886    2.2930    2.3185    2.1867    1.9640    1.5527    1.0304    0.6670    0.6043
    0.6668    0.5972    0.5316    0.6072    0.9380    1.4548    1.9200    2.2729    2.4109    2.4427    2.3294    2.1057    1.6917    1.1543    0.7583    0.6911
    0.7473    0.6721    0.6168    0.7532    1.0286    1.5651    2.0352    2.3532    2.5039    2.5442    2.4537    2.2153    1.8121    1.2763    0.8498    0.6950
    0.8297    0.7435    0.7009    0.8380    1.1214    1.6680    2.1481    2.4688    2.5897    2.6299    2.5673    2.3198    1.9251    1.3954    0.9415    0.7796
    0.8938    0.7987    0.7599    0.8667    1.2234    1.7770    2.2256    2.5692    2.6673    2.7071    2.6632    2.4381    2.0336    1.5044    1.0257    0.8537
    0.9709    0.8528    0.8245    0.9470    1.3483    1.8702    2.3089    2.6213    2.7345    2.7774    2.7373    2.5295    2.1355    1.6060    1.1020    0.9169
    1.0472    0.9097    0.8974    1.0266    1.4381    1.9612    2.4025    2.6895    2.7949    2.8434    2.7986    2.6204    2.2378    1.7011    1.2107    1.0310
    1.0956    0.9741    0.9520    1.1041    1.5226    2.0442    2.5011    2.7381    2.8552    2.8998    2.8587    2.6998    2.3247    1.7903    1.2890    1.0908
    1.1597    1.0276    1.0163    1.1798    1.6076    2.1419    2.5992    2.8272    2.9550    2.9522    2.9263    2.7716    2.4503    1.8634    1.3599    1.1448
    1.1668    1.0713    1.0686    1.2532    1.6856    2.2247    2.6824    2.9422    3.0063    2.9948    2.9701    2.8766    2.5267    1.9381    1.4216    1.1943
    1.1676    1.1248    1.1133    1.3224    1.7818    2.3009    2.7228    3.0011    2.9969    3.0351    3.0050    2.9313    2.5907    2.0078    1.4738    1.2354


H_out(:,:,4) =

    0.0001    0.0082    0.0196    0.0392    0.1254    0.2646    0.3977    0.4823    0.5104    0.4857    0.4038    0.2717    0.1303    0.0359    0.0069    0.0010
    0.0013    0.0053    0.0311    0.0865    0.2456    0.4890    0.6971    0.8332    0.8794    0.8422    0.7160    0.5042    0.2731    0.1113    0.0443    0.0084
    0.0258    0.0138    0.0553    0.1594    0.3733    0.6829    0.9503    1.1018    1.1692    1.1228    0.9667    0.7102    0.4298    0.3082    0.2751    0.1927
    0.1644    0.0318    0.0870    0.2246    0.4931    0.8544    1.1673    1.3406    1.4171    1.3544    1.1764    0.8895    0.6148    0.4138    0.3739    0.3017
    0.2451    0.0699    0.1261    0.2920    0.6041    1.0092    1.3414    1.5498    1.6290    1.5578    1.3591    1.0543    0.7730    0.5093    0.4491    0.3872
    0.3885    0.1431    0.1738    0.3624    0.7132    1.1574    1.5278    1.7431    1.8277    1.7442    1.5250    1.2495    0.9269    0.6060    0.5122    0.4772
    0.4937    0.2914    0.2216    0.4349    0.8230    1.3060    1.7003    1.9168    2.0077    1.9132    1.6841    1.4046    1.0692    0.6921    0.5070    0.5574
    0.5811    0.4248    0.2779    0.5168    0.9322    1.4489    1.8644    2.0742    2.1867    2.0793    1.8397    1.5277    1.1726    0.7760    0.5688    0.6105
    0.6370    0.5407    0.3627    0.6017    1.0475    1.5944    2.0291    2.2549    2.3600    2.2495    2.0003    1.6382    1.2513    0.8615    0.6302    0.6663
    0.6884    0.6112    0.4970    0.6884    1.1630    1.7375    2.1827    2.4005    2.5198    2.4040    2.1446    1.7491    1.3336    0.9470    0.6951    0.6173
    0.7353    0.6769    0.6133    0.7786    1.2798    1.8796    2.3404    2.5573    2.6759    2.5516    2.2748    1.8712    1.4228    1.0289    0.7653    0.6724
    0.7690    0.7222    0.6935    0.8651    1.3972    2.0294    2.4906    2.7045    2.8179    2.6887    2.3995    1.9787    1.5164    1.1058    0.8309    0.7263
    0.8172    0.7642    0.7724    0.9780    1.5156    2.1695    2.6550    2.8711    2.9523    2.8233    2.5098    2.0897    1.6088    1.1764    0.8896    0.7755
    0.8736    0.8076    0.8496    1.0852    1.6325    2.3097    2.8027    3.0068    3.0635    2.9509    2.6160    2.1880    1.6970    1.2454    0.9804    0.8550
    0.9015    0.8628    0.9178    1.1884    1.7472    2.4457    2.9452    3.1301    3.1806    3.0659    2.7166    2.2879    1.7859    1.3107    1.0375    0.8983
    0.9494    0.9066    0.9962    1.2905    1.8631    2.5773    3.0821    3.2475    3.1630    3.1704    2.7885    2.3845    1.8432    1.3996    1.0914    0.9409
    0.9504    0.9455    1.0654    1.3885    1.9757    2.7057    3.2044    3.3581    3.2479    3.2422    2.8645    2.4610    1.9192    1.4589    1.1383    0.9819
    0.9569    0.9949    1.1244    1.4824    2.0998    2.8246    3.3043    3.4458    3.3355    3.3154    2.9355    2.5392    1.9892    1.5121    1.1803    1.0170


H_out(:,:,5) =

    0.0026    0.0024    0.0146    0.0419    0.1400    0.3047    0.4728    0.5961    0.6471    0.6306    0.5446    0.3951    0.2321    0.0991    0.0327    0.0138
    0.0073    0.0108    0.0443    0.1210    0.3099    0.6208    0.9238    1.1444    1.2380    1.2080    1.0565    0.7862    0.4796    0.2264    0.0769    0.0231
    0.0233    0.0300    0.0933    0.2273    0.4932    0.9060    1.3133    1.5950    1.7527    1.7313    1.5353    1.1834    0.7666    0.3939    0.1551    0.0502
    0.0594    0.0643    0.1517    0.3347    0.6662    1.1637    1.6627    2.0089    2.2359    2.2292    2.0190    1.5974    1.0859    0.5990    0.2597    0.0999
    0.1138    0.1146    0.2191    0.4453    0.8340    1.4067    1.9659    2.3944    2.6826    2.7132    2.5031    2.0425    1.4347    0.8345    0.3853    0.1700
    0.1825    0.1778    0.3004    0.5626    1.0055    1.6481    2.2861    2.7693    3.1289    3.1864    2.9898    2.4912    1.8035    1.1000    0.5585    0.2767
    0.2768    0.2455    0.3838    0.6849    1.1829    1.8948    2.5880    3.1203    3.5439    3.6349    3.4408    2.9210    2.1870    1.3776    0.7378    0.4719
    0.4697    0.3308    0.4800    0.8211    1.3680    2.1410    2.8891    3.4649    3.9677    4.0763    3.8939    3.3558    2.6097    1.6632    0.9075    0.6011
    0.5909    0.4521    0.5794    0.9653    1.5540    2.3899    3.1867    3.8024    4.3535    4.4926    4.2893    3.7662    2.9879    1.9356    1.0636    0.7159
    0.6932    0.5832    0.6890    1.1239    1.7512    2.6416    3.4849    4.1335    4.7130    4.8524    4.6596    4.1631    3.3424    2.2008    1.2202    0.7318
    0.7809    0.7091    0.8089    1.2912    1.9558    2.9012    3.7873    4.4471    5.0360    5.1827    4.9993    4.5341    3.6819    2.4617    1.3805    0.8285
    0.8503    0.8071    0.9308    1.4467    2.1562    3.1648    4.0836    4.7446    5.3184    5.4617    5.2869    4.8250    3.9791    2.7125    1.5354    0.9201
    0.9421    0.8926    1.0618    1.6160    2.3765    3.4349    4.3987    5.0329    5.5720    5.7294    5.5472    5.1003    4.2724    2.9576    1.6892    1.0077
    1.0320    0.9892    1.2067    1.7866    2.5833    3.7152    4.6752    5.2968    5.7750    5.9469    5.7742    5.3375    4.5211    3.1946    1.8672    1.1274
    1.1062    1.0916    1.3403    1.9592    2.7875    3.9874    4.9302    5.5248    5.9822    6.1532    5.9825    5.5664    4.7627    3.4238    2.0209    1.2157
    1.1932    1.1843    1.4823    2.1283    2.9886    4.2641    5.1760    5.7368    6.0694    6.3222    6.1299    5.7618    4.8973    3.6853    2.1701    1.2995
    1.2421    1.2744    1.6143    2.2974    3.1757    4.5065    5.3891    5.9323    6.2567    6.4380    6.2808    5.9082    5.0867    3.8861    2.3148    1.3837
    1.2910    1.3690    1.7354    2.4665    3.4089    4.7356    5.5978    6.1109    6.3995    6.5606    6.4083    6.0544    5.2523    4.0709    2.4518    1.4613


H_out(:,:,6) =

    0.0000    0.0040    0.0206    0.0589    0.1532    0.2456    0.3212    0.3552    0.3442    0.2859    0.1986    0.0813    0.0156    0.0026    0.0003    0.0000
    0.0009    0.0109    0.0434    0.1082    0.2800    0.4600    0.5691    0.6211    0.6193    0.5226    0.3694    0.1763    0.0581    0.0192    0.0061    0.0015
    0.0056    0.0173    0.0638    0.1672    0.3958    0.6219    0.7726    0.8333    0.8415    0.7231    0.5315    0.2913    0.1397    0.0612    0.0219    0.0075
    0.0162    0.0325    0.0933    0.2235    0.5044    0.7765    0.9598    1.0322    1.0391    0.9069    0.6818    0.4243    0.2419    0.1212    0.0478    0.0190
    0.0336    0.0569    0.1287    0.2904    0.6073    0.9225    1.1319    1.2171    1.2209    1.0818    0.8362    0.5643    0.3691    0.1972    0.0833    0.0362
    0.0562    0.0892    0.1792    0.3840    0.7147    1.0634    1.3107    1.4008    1.4043    1.2502    0.9956    0.7195    0.4982    0.2852    0.1255    0.0574
    0.0806    0.1230    0.2289    0.4781    0.8275    1.2089    1.4811    1.5738    1.5759    1.4074    1.1337    0.8578    0.6306    0.3713    0.1627    0.0801
    0.1106    0.1669    0.2857    0.5892    0.9456    1.3561    1.6478    1.7516    1.7528    1.5603    1.2764    0.9974    0.7716    0.4591    0.2107    0.1065
    0.1398    0.2058    0.3474    0.7053    1.0704    1.5052    1.8185    1.9273    1.9204    1.7188    1.4023    1.1211    0.8986    0.5386    0.2558    0.1318
    0.1710    0.2487    0.4166    0.8087    1.1980    1.6588    1.9947    2.1037    2.0828    1.8559    1.5044    1.2382    1.0267    0.6169    0.3030    0.1501
    0.2037    0.2949    0.4947    0.9051    1.3324    1.8166    2.1757    2.2818    2.2412    1.9844    1.6072    1.3595    1.1256    0.6940    0.3518    0.1765
    0.2342    0.3386    0.5693    0.9774    1.4706    1.9669    2.3591    2.4577    2.4007    2.1141    1.6896    1.4269    1.1851    0.7617    0.3985    0.2018
    0.2653    0.3846    0.6535    1.0851    1.6085    2.1321    2.5316    2.6358    2.5591    2.2391    1.7805    1.5036    1.2732    0.8286    0.4455    0.2272
    0.2963    0.4325    0.7396    1.1956    1.7551    2.2998    2.7119    2.8073    2.6992    2.3658    1.8676    1.5404    1.3161    0.8859    0.5067    0.2581
    0.3248    0.4839    0.8267    1.3062    1.9022    2.4663    2.8832    2.9718    2.8459    2.4909    1.9573    1.5997    1.3863    0.9435    0.5541    0.2837
    0.3538    0.5314    0.9236    1.4160    2.0503    2.6241    3.0591    3.1221    2.8796    2.6053    2.0323    1.6548    1.2900    1.0400    0.5989    0.3073
    0.3772    0.5793    1.0229    1.5249    2.1956    2.8068    3.2118    3.2588    3.0033    2.7122    2.1154    1.6770    1.3219    1.0903    0.6434    0.3301
    0.3994    0.6292    1.0950    1.6322    2.3343    2.9574    3.3437    3.3847    3.1314    2.8020    2.1830    1.7238    1.3539    1.1384    0.6863    0.3522


H_out(:,:,7) =

    0.0827    0.0708    0.0914    0.2058    0.3576    0.5206    0.6694    0.7952    0.8739    0.9031    0.8718    0.7879    0.6650    0.5150    0.3664    0.2006
    0.2019    0.0790    0.2006    0.4109    0.7031    1.0402    1.3462    1.5922    1.7555    1.7973    1.7256    1.5301    1.2682    0.9584    0.6411    0.3685
    0.3400    0.1457    0.2807    0.6166    1.0319    1.5127    1.9689    2.3216    2.5687    2.6349    2.5089    2.2286    1.8343    1.3491    0.8831    0.5155
    0.5290    0.3784    0.3804    0.8107    1.3507    1.9671    2.5525    3.0104    3.3355    3.4210    3.2700    2.9079    2.3888    1.7510    1.1498    0.7451
    0.6899    0.5584    0.5793    1.0199    1.6713    2.4117    3.1114    3.6792    4.0797    4.1982    4.0083    3.5844    2.9435    2.1400    1.4125    0.9492
    0.8311    0.6945    0.8064    1.2671    2.0092    2.8640    3.6813    4.3520    4.8386    4.9847    4.7810    4.2564    3.4948    2.5367    1.6740    1.1171
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    0.9391    0.8074    1.0001    1.5600    2.3575    3.3134    4.2405    5.0133    5.5808    5.7614    5.5256    4.9238    4.0422    2.9200    1.8318    1.2915
    1.0904    0.9595    1.1905    1.8459    2.7299    3.7759    4.8086    5.6840    6.3393    6.5654    6.3021    5.6110    4.5891    3.3029    2.0726    1.4497
    1.2309    1.0930    1.3682    2.1210    3.1051    4.2413    5.3805    6.3456    7.1039    7.3692    7.0769    6.2901    5.1323    3.6856    2.3150    1.6125
    1.3849    1.2425    1.5695    2.4061    3.4888    4.7150    5.9548    7.0088    7.8785    8.1757    7.8512    6.9731    5.6777    4.0624    2.5493    1.6271
    1.5443    1.4061    1.7906    2.7111    3.8847    5.2011    6.5420    7.6766    8.6680    9.0016    8.6424    7.6791    6.2305    4.4449    2.7870    1.7937
    1.6897    1.5708    2.0072    2.9950    4.2840    5.6997    7.1282    8.3394    9.4549    9.8261    9.4305    8.3462    6.7773    4.8289    3.0246    1.9577
    1.8493    1.7412    2.2420    3.3175    4.7008    6.1960    7.7319    9.0512   10.2356   10.6501   10.2219    9.0305    7.3107    5.2063    3.2517    2.1215
    2.0112    1.9136    2.4915    3.6489    5.1169    6.7005    8.3239    9.7180   11.0000   11.4745   11.0160    9.7336    7.8366    5.5855    3.5241    2.3184
    2.1290    2.0982    2.7347    3.9861    5.5359    7.2036    8.9086   10.3759   11.7582   12.2847   11.7935   10.4120    8.3643    5.9535    3.7470    2.4762
    2.2793    2.2645    2.9832    4.3172    5.9517    7.6966    9.4850   11.0160   12.1749   13.0554   12.5181   11.0778    8.8580    6.3726    3.9716    2.6255
    2.3561    2.4209    3.2243    4.6467    6.3640    8.1864   10.0435   11.6339   12.8403   13.7636   13.2209   11.7094    9.3591    6.7249    4.1869    2.7699
    2.4479    2.5891    3.4574    4.9724    6.7787    8.6598   10.5889   12.2185   13.5541   14.4165   13.8673   12.3241    9.8390    7.0574    4.3904    2.9016


H_out(:,:,8) =

    0.0140    0.0027    0.0052    0.0147    0.0644    0.2056    0.3789    0.5434    0.6555    0.7049    0.6807    0.5824    0.4314    0.2648    0.1294    0.0586
    0.0341    0.0069    0.0256    0.0730    0.1915    0.4272    0.7327    1.0253    1.2279    1.3139    1.2796    1.1074    0.8333    0.5190    0.2410    0.0902
    0.0567    0.0283    0.0690    0.1645    0.3517    0.6581    1.0446    1.4081    1.6976    1.8339    1.7954    1.5817    1.2176    0.7672    0.3738    0.1354
    0.1077    0.0706    0.1269    0.2672    0.5112    0.8745    1.3312    1.7676    2.1316    2.3087    2.2894    2.0406    1.5985    1.0400    0.5404    0.2269
    0.1951    0.1339    0.1997    0.3820    0.6722    1.0878    1.5925    2.1119    2.5454    2.7752    2.7639    2.5016    1.9808    1.3223    0.7603    0.4376
    0.3698    0.2122    0.2860    0.5059    0.8442    1.2949    1.8588    2.4406    2.9551    3.2400    3.2526    2.9524    2.3793    1.6007    0.9491    0.5899
    0.5117    0.3078    0.3748    0.6348    1.0234    1.5039    2.1058    2.7512    3.3383    3.6857    3.7211    3.4027    2.7731    1.8735    1.0662    0.7171
    0.6278    0.4435    0.4782    0.7831    1.2193    1.6927    2.3181    3.0642    3.7189    4.1332    4.1941    3.8602    3.1596    2.1512    1.2429    0.8299
    0.7293    0.5616    0.5792    0.9330    1.3976    1.8674    2.5604    3.3852    4.1006    4.5719    4.6495    4.3035    3.5355    2.4264    1.4148    0.9444
    0.8319    0.6654    0.6887    1.0921    1.5561    2.0455    2.8086    3.7062    4.4786    5.0008    5.0947    4.7364    3.9107    2.7002    1.5808    0.9877
    0.9451    0.7650    0.8065    1.2540    1.7025    2.2347    3.0659    4.0306    4.8609    5.4313    5.5431    5.1671    4.2865    2.9780    1.7501    1.1024
    1.0538    0.8673    0.9225    1.3911    1.8432    2.4208    3.3251    4.3567    5.2455    5.8605    5.9880    5.5758    4.6517    3.2546    1.9201    1.2110
    1.1598    0.9752    1.0425    1.5228    1.9735    2.6202    3.5449    4.6434    5.6303    6.2858    6.4252    5.9836    5.0021    3.5277    2.0853    1.3227
    1.2692    1.0830    1.1625    1.6462    2.1139    2.8275    3.7990    4.9682    6.0257    6.7127    6.8620    6.3984    5.3448    3.7988    2.2823    1.4661
    1.3618    1.1898    1.2767    1.7680    2.2531    3.0278    4.0516    5.2895    6.4072    7.1319    7.2890    6.7947    5.6791    4.0603    2.4480    1.5778
    1.4641    1.2848    1.3829    1.8841    2.3875    3.1991    4.3007    5.6061    6.8235    7.5278    7.6946    7.1804    6.0020    4.3470    2.6090    1.6811
    1.5273    1.3736    1.4832    2.0044    2.5160    3.3921    4.5458    5.9144    7.1821    7.8995    8.0741    7.5482    6.3142    4.5897    2.7656    1.7822
    1.5906    1.4665    1.5769    2.1269    2.6362    3.5777    4.7414    6.1996    7.4813    8.2232    8.4142    7.8942    6.6106    4.8170    2.9139    1.8747


H_out(:,:,9) =

    0.0082    0.0110    0.0671    0.1884    0.3653    0.5325    0.6657    0.7496    0.7508    0.6820    0.5524    0.3872    0.2299    0.0985    0.0287    0.0135
    0.0720    0.1711    0.2393    0.4113    0.7358    1.0728    1.3382    1.4854    1.4961    1.3539    1.1057    0.7904    0.4851    0.2247    0.0687    0.0200
    0.3365    0.3981    0.5054    0.7803    1.1367    1.5851    1.9553    2.1481    2.1606    1.9673    1.6235    1.1993    0.7764    0.3948    0.1509    0.1866
    0.4266    0.5102    0.6545    1.0513    1.5134    2.0625    2.5057    2.7330    2.7556    2.5217    2.1203    1.6094    1.0893    0.5988    0.2808    0.3118
    0.5089    0.5757    0.7799    1.2808    1.8556    2.4950    2.9791    3.2325    3.2895    3.0415    2.5932    2.0271    1.4184    0.8256    0.4188    0.4157
    0.5895    0.6755    0.9508    1.5132    2.1814    2.9033    3.4192    3.6898    3.7947    3.5376    3.0621    2.4382    1.7524    1.0655    0.5677    0.5260
    0.6617    0.7938    1.1348    1.7521    2.4928    3.2846    3.8252    4.0989    4.2348    4.0004    3.5103    2.8441    2.0940    1.3058    0.7020    0.6379
    0.7776    0.9553    1.3346    2.0007    2.8017    3.6479    4.2153    4.4708    4.6279    4.4013    3.9396    3.2533    2.4449    1.5677    0.8785    0.7339
    0.8938    1.1135    1.5419    2.2447    3.1085    4.0075    4.5718    4.8149    4.9773    4.7897    4.3374    3.6572    2.8004    1.8208    1.0487    0.8347
    1.0257    1.2999    1.7629    2.4887    3.4128    4.3476    4.8918    5.1142    5.2789    5.1100    4.6881    4.0440    3.1417    2.0701    1.2061    0.8712
    1.1776    1.4939    1.9842    2.7416    3.7136    4.6680    5.1873    5.3882    5.5372    5.3832    4.9957    4.4215    3.4740    2.3213    1.3668    0.9957
    1.3243    1.6530    2.1847    2.9666    4.0105    4.9931    5.4573    5.6318    5.7489    5.6077    5.2581    4.7249    3.7950    2.5669    1.5214    1.1193
    1.4726    1.8114    2.3954    3.2205    4.3081    5.2626    5.7072    5.8452    5.9119    5.7930    5.4801    4.9892    4.1018    2.8097    1.6721    1.2406
    1.6178    1.9715    2.6068    3.4723    4.5753    5.4994    5.9002    6.0075    6.0297    5.9188    5.6511    5.1929    4.3884    3.0488    1.8538    1.3888
    1.7250    2.1429    2.8062    3.7141    4.8208    5.6995    6.0538    6.1424    6.1151    6.0136    5.7912    5.3658    4.6429    3.2805    2.0075    1.5090
    1.8566    2.2939    3.0113    3.9476    5.0519    5.8910    6.1911    6.2553    6.1810    6.0775    5.8680    5.5174    4.7844    3.5391    2.1547    1.6217
    1.9377    2.4300    3.1893    4.1660    5.2563    6.0360    6.2950    6.3426    6.2629    6.1188    5.9514    5.6177    4.9533    3.7564    2.2964    1.7299
    2.0206    2.5755    3.3535    4.3642    5.4306    6.1480    6.3592    6.4121    6.3011    6.1223    5.9999    5.7151    5.1000    3.9627    2.4324    1.8327


H_out(:,:,10) =

    0.0036    0.0015    0.0106    0.0397    0.1435    0.3001    0.4574    0.5701    0.6145    0.5965    0.5109    0.3617    0.1995    0.0733    0.0181    0.0082
    0.0052    0.0089    0.0386    0.1124    0.3045    0.6050    0.8861    1.0771    1.1455    1.0997    0.9413    0.6776    0.3912    0.1601    0.0443    0.0109
    0.2033    0.1629    0.2196    0.3204    0.5476    0.9402    1.3014    1.5146    1.5946    1.5121    1.2817    0.9382    0.5685    0.2565    0.0911    0.1424
    0.3815    0.4358    0.4820    0.5931    0.8274    1.2938    1.7056    1.9302    2.0016    1.8624    1.5790    1.1620    0.7316    0.3545    0.2092    0.3202
    0.4823    0.5608    0.6157    0.8046    1.1179    1.6532    2.0740    2.3295    2.3772    2.1883    1.8373    1.3653    0.8810    0.4507    0.3184    0.4080
    0.5537    0.6449    0.7689    1.0129    1.4234    2.0221    2.4709    2.7249    2.7452    2.5021    2.0884    1.5580    1.0284    0.5536    0.4085    0.4873
    0.6003    0.7264    0.9103    1.2239    1.7237    2.3861    2.8601    3.0935    3.0725    2.7836    2.3218    1.7466    1.1916    0.6703    0.4423    0.5405
    0.6746    0.8580    1.0851    1.4742    2.0471    2.7628    3.2598    3.4353    3.3642    3.0289    2.5337    1.9226    1.3326    0.7920    0.5173    0.5774
    0.7713    0.9858    1.2756    1.7331    2.3722    3.1334    3.6087    3.7348    3.6092    3.2466    2.7183    2.0932    1.4594    0.9001    0.5926    0.6287
    0.8854    1.1443    1.4887    2.0074    2.7068    3.4892    3.9174    4.0045    3.8076    3.4100    2.8760    2.2479    1.5880    1.0047    0.6679    0.6688
    1.0195    1.3179    1.7224    2.2948    3.0424    3.8178    4.2003    4.2621    3.9628    3.5363    3.0018    2.3972    1.7203    1.1123    0.7501    0.7617
    1.1514    1.4879    1.9519    2.5643    3.3537    4.1099    4.4587    4.5107    4.0822    3.6358    3.0943    2.5120    1.8525    1.2214    0.8393    0.8609
    1.2875    1.6650    2.1881    2.8524    3.6992    4.3576    4.6284    4.6264    4.1721    3.7074    3.1634    2.6084    1.9766    1.3309    0.9318    0.9573
    1.4250    1.8477    2.4302    3.1385    3.9775    4.5684    4.8116    4.8047    4.2491    3.7587    3.2130    2.6841    2.0842    1.4414    1.0507    1.0750
    1.5427    2.0354    2.6646    3.4120    4.2249    4.7443    4.9653    4.9556    4.3150    3.7957    3.2474    2.7420    2.1837    1.5469    1.1423    1.1753
    1.6711    2.2015    2.8895    3.6586    4.4314    4.8765    5.0923    5.0861    4.7364    3.8269    3.2676    2.7926    2.2397    1.6722    1.2307    1.2740
    1.7563    2.3583    3.0954    3.8836    4.6073    4.9860    5.1923    5.1898    4.8564    3.8437    3.2908    2.8103    2.3024    1.7635    1.3120    1.3696
    1.8385    2.5185    3.2886    4.0824    4.7617    5.0737    5.1680    5.2690    4.7942    3.8600    3.3037    2.8359    2.3495    1.8466    1.3883    1.4576


H_out(:,:,11) =

    0.0023    0.0000    0.0009    0.0084    0.0379    0.1636    0.3133    0.4284    0.4911    0.4978    0.4414    0.3261    0.1790    0.0604    0.0142    0.0065
    0.0013    0.0027    0.0127    0.0336    0.1061    0.3160    0.5720    0.7590    0.8527    0.8562    0.7711    0.5801    0.3294    0.1246    0.0334    0.0071
    0.0094    0.0163    0.0389    0.0953    0.2366    0.4943    0.8029    1.0054    1.1324    1.1258    0.9973    0.7637    0.4528    0.1829    0.0625    0.0182
    0.0983    0.0432    0.0856    0.2400    0.3908    0.6810    1.0185    1.2445    1.3768    1.3520    1.2055    0.9108    0.5513    0.2454    0.1800    0.1908
    0.2709    0.0864    0.1673    0.3849    0.5394    0.8578    1.2060    1.4581    1.5838    1.5493    1.3731    1.0422    0.6414    0.3483    0.3538    0.3667
    0.4090    0.2121    0.3118    0.5294    0.6835    1.0493    1.4004    1.6588    1.7878    1.7296    1.5348    1.1662    0.7270    0.4537    0.4294    0.4416
    0.4805    0.3556    0.4289    0.6475    0.8184    1.2217    1.5798    1.8396    1.9505    1.8761    1.6678    1.2827    0.8204    0.5307    0.4216    0.5120
    0.5592    0.4998    0.5501    0.7715    0.9533    1.3873    1.7694    1.9977    2.0879    1.9902    1.7742    1.3856    0.9497    0.5964    0.4688    0.5564
    0.5999    0.6204    0.6785    0.8763    1.0820    1.5458    1.9247    2.1421    2.1962    2.0898    1.8498    1.4806    1.0593    0.6638    0.5095    0.5797
    0.6405    0.7176    0.8179    0.9899    1.2128    1.6941    2.0602    2.2680    2.2748    2.1498    1.9103    1.5597    1.1532    0.7262    0.5446    0.5288
    0.6886    0.8220    0.9523    1.1161    1.3431    1.8292    2.1801    2.3812    2.3341    2.1906    1.9536    1.6475    1.2399    0.7902    0.5838    0.5725
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    0.7334    0.9058    1.0411    1.2003    1.4674    1.9719    2.2870    2.4834    2.3824    2.2267    1.9767    1.6916    1.2973    0.8544    0.6255    0.6166
    0.7879    0.9706    1.1381    1.3204    1.6283    2.0757    2.3657    2.5301    2.4180    2.2573    1.9985    1.7307    1.3595    0.9106    0.6695    0.6593
    0.8453    1.0364    1.2325    1.4370    1.7367    2.1645    2.4382    2.5962    2.4495    2.2781    2.0145    1.7399    1.4013    0.9645    0.7388    0.7272
    0.8869    1.1103    1.3266    1.5444    1.8297    2.2356    2.4951    2.6469    2.4722    2.2915    2.0241    1.7610    1.4446    1.0152    0.7894    0.7765
    0.9519    1.1682    1.4202    1.6441    1.9120    2.3123    2.5465    2.6963    2.6610    2.3069    2.0228    1.7828    1.4118    1.0999    0.8439    0.8276
    0.9794    1.2216    1.5002    1.7316    1.9814    2.3605    2.5863    2.7323    2.7057    2.3130    2.0328    1.7822    1.4408    1.1479    0.8957    0.8743
    1.0075    1.2850    1.5636    1.8086    2.0761    2.4005    2.5955    2.7588    2.6859    2.3218    2.0393    1.7923    1.4628    1.1907    0.9411    0.9151


H_out(:,:,12) =

    0.0009    0.0000    0.0010    0.0087    0.0392    0.1598    0.2844    0.3772    0.4286    0.4235    0.3556    0.2476    0.1175    0.0296    0.0067    0.0029
    0.0008    0.0026    0.0131    0.0349    0.1057    0.3089    0.5235    0.6661    0.7347    0.7171    0.6218    0.4338    0.2184    0.0718    0.0198    0.0033
    0.0065    0.0151    0.0374    0.0923    0.2057    0.4803    0.7369    0.8697    0.9829    0.9503    0.8091    0.5803    0.3035    0.1144    0.0384    0.0088
    0.0199    0.0392    0.0794    0.1636    0.3250    0.6449    0.9249    1.0544    1.1970    1.1520    0.9904    0.7005    0.3799    0.1524    0.0599    0.0187
    0.0424    0.0749    0.1346    0.2579    0.4541    0.7792    1.0177    1.2165    1.3776    1.3235    1.1365    0.8127    0.4518    0.1917    0.0798    0.0347
    0.0814    0.1202    0.2008    0.3704    0.5825    0.9590    1.1474    1.3632    1.5562    1.4803    1.2812    0.9177    0.5206    0.2541    0.1505    0.0911
    0.1614    0.1695    0.2739    0.4800    0.6978    1.0839    1.2627    1.4876    1.6951    1.6057    1.3932    1.0183    0.5940    0.3692    0.3144    0.2887
    0.2704    0.2359    0.3597    0.5919    0.8116    1.2057    1.4589    1.5965    1.8161    1.7017    1.4853    1.1097    0.6844    0.4421    0.3686    0.4083
    0.3624    0.3089    0.4442    0.6966    0.9177    1.3195    1.5651    1.6966    1.9067    1.7888    1.5503    1.1977    0.8230    0.5057    0.4194    0.4629
    0.4419    0.3932    0.5323    0.8066    1.0195    1.4246    1.6586    1.7877    1.9746    1.8446    1.6059    1.2899    0.9314    0.5649    0.4569    0.4136
    0.5099    0.4848    0.6198    0.9176    1.1171    1.5190    1.7484    1.8773    2.0327    1.8881    1.6507    1.3829    1.0204    0.6243    0.4959    0.4541
    0.5616    0.5603    0.7050    0.9752    1.2045    1.6757    1.8316    1.9601    2.0850    1.9307    1.6791    1.4200    1.0794    0.6860    0.5373    0.4948
    0.6194    0.6293    0.7948    1.0751    1.3877    1.7547    1.9613    2.0776    2.1253    1.9723    1.7127    1.4601    1.1365    0.7479    0.5765    0.5356
    0.6763    0.7047    0.8871    1.1733    1.4692    1.8282    2.0293    2.1466    2.1654    2.0034    1.7410    1.4701    1.1677    0.8029    0.6363    0.5999
    0.7009    0.7836    0.9773    1.2635    1.5371    1.8881    2.0843    2.2009    2.1994    2.0294    1.7629    1.4939    1.2068    0.8479    0.6716    0.6358
    0.7519    0.8521    1.0660    1.3465    1.5984    2.0045    2.1374    2.2589    2.2545    2.0587    1.7760    1.5194    1.1665    0.9222    0.7067    0.6712
    0.7705    0.9099    1.1446    1.4195    1.6496    2.0485    2.1822    2.3056    2.3050    2.0822    1.7981    1.5188    1.1928    0.9591    0.7378    0.7047
    0.7886    0.9732    1.2121    1.4840    1.7737    2.0812    2.2709    2.3417    2.3799    2.1060    1.8153    1.5329    1.2115    0.9905    0.7655    0.7351


H_out(:,:,13) =

    0.0058    0.0001    0.0002    0.0028    0.0138    0.0715    0.1986    0.3234    0.4116    0.4536    0.4310    0.3470    0.2321    0.1010    0.0268    0.0119
    0.0021    0.0020    0.0069    0.0210    0.0620    0.1844    0.4113    0.6270    0.7697    0.8190    0.7735    0.6404    0.4281    0.1934    0.0541    0.0156
    0.0095    0.0130    0.0295    0.0663    0.1515    0.3285    0.6172    0.8717    1.0474    1.0946    1.0263    0.8434    0.5794    0.2972    0.1419    0.0814
    0.1340    0.0357    0.0684    0.1357    0.2755    0.4874    0.8153    1.0975    1.2914    1.3246    1.2392    1.0117    0.7026    0.4434    0.3528    0.3155
    0.3079    0.0731    0.1225    0.2545    0.4190    0.6571    0.9989    1.3057    1.5079    1.5311    1.4193    1.1599    0.8406    0.5403    0.4317    0.4086
    0.3975    0.1726    0.2193    0.4345    0.5665    0.8372    1.1894    1.5106    1.7221    1.7268    1.5935    1.3040    0.9640    0.6195    0.5034    0.4651
    0.4565    0.2905    0.3939    0.5700    0.7006    1.0100    1.3795    1.7042    1.9057    1.8955    1.7389    1.4341    1.0793    0.6869    0.4846    0.5265
    0.5249    0.4056    0.5321    0.6840    0.8393    1.1854    1.5712    1.8819    2.0643    2.0370    1.8684    1.5534    1.1875    0.7460    0.5250    0.5448
    0.5729    0.4982    0.6328    0.7868    0.9721    1.3543    1.7500    2.0413    2.1976    2.1631    1.9696    1.6656    1.2817    0.8057    0.5686    0.5732
    0.6164    0.6546    0.7330    0.8899    1.1051    1.5190    1.9126    2.1794    2.2982    2.2468    2.0538    1.7586    1.3663    0.8614    0.6123    0.5241
    0.6605    0.7703    0.8369    0.9989    1.2388    1.6748    2.0541    2.3013    2.3738    2.3061    2.1170    1.8529    1.4454    0.9206    0.6620    0.5628
    0.6917    0.8380    0.9196    1.0887    1.3683    1.8284    2.1798    2.4099    2.4336    2.3536    2.1535    1.9042    1.5068    0.9859    0.7130    0.6042
    0.7347    0.8993    1.0106    1.2047    1.5135    1.9496    2.2784    2.4753    2.4766    2.3929    2.1855    1.9517    1.5761    1.0521    0.7603    0.6480
    0.7910    0.9558    1.1004    1.3193    1.6281    2.0557    2.3640    2.5470    2.5079    2.4179    2.2085    1.9724    1.6266    1.1201    0.8324    0.7103
    0.8512    1.0221    1.1883    1.4281    1.7293    2.1429    2.4308    2.6026    2.5308    2.4338    2.2225    1.9986    1.6812    1.1843    0.8804    0.7558
    0.9223    1.0756    1.2735    1.5295    1.8154    2.2278    2.4881    2.6526    2.6559    2.4499    2.2227    2.0262    1.6890    1.2820    0.9316    0.8016
    0.9481    1.1256    1.3498    1.6229    1.8903    2.2831    2.5332    2.6884    2.6909    2.4484    2.2329    2.0361    1.7320    1.3434    0.9825    0.8468
    0.9727    1.1863    1.4172    1.7055    1.9770    2.3283    2.5493    2.7137    2.6726    2.4550    2.2384    2.0523    1.7654    1.3991    1.0277    0.8937


H_out(:,:,14) =

    0.0043    0.0001    0.0000    0.0002    0.0014    0.0064    0.0290    0.0645    0.0996    0.1306    0.1359    0.1098    0.0775    0.0421    0.0139    0.0065
    0.0014    0.0006    0.0018    0.0052    0.0138    0.0359    0.0819    0.1469    0.2169    0.2637    0.2753    0.2481    0.1794    0.0833    0.0253    0.0094
    0.0029    0.0041    0.0089    0.0191    0.0410    0.0825    0.1470    0.2274    0.3151    0.3734    0.3968    0.3709    0.3380    0.2685    0.0511    0.0109
    0.0083    0.0116    0.0216    0.0405    0.0766    0.1362    0.2150    0.3049    0.4062    0.4809    0.5140    0.4822    0.4293    0.3660    0.2889    0.0955
    0.0477    0.0231    0.0392    0.0678    0.1182    0.1935    0.2834    0.3800    0.4903    0.5748    0.6040    0.5651    0.5146    0.4176    0.3653    0.2425
    0.1407    0.0383    0.0607    0.0988    0.1642    0.2519    0.3523    0.4555    0.5802    0.6631    0.6898    0.6378    0.5625    0.4665    0.4257    0.3086
    0.1873    0.0593    0.0836    0.1307    0.2106    0.3103    0.4205    0.5275    0.6558    0.7385    0.7520    0.6935    0.6055    0.4904    0.4186    0.3557
    0.2297    0.0969    0.1109    0.1676    0.2624    0.3727    0.4897    0.5966    0.7263    0.8042    0.8092    0.7487    0.6593    0.5058    0.4468    0.3957
    0.2599    0.1279    0.1378    0.2052    0.3160    0.4346    0.5544    0.6598    0.7883    0.8676    0.8577    0.8014    0.7069    0.5405    0.4701    0.4395
    0.2905    0.1560    0.1670    0.2483    0.3789    0.4995    0.6145    0.7160    0.8374    0.9088    0.9044    0.8527    0.7555    0.5749    0.4978    0.3875
    0.3278    0.1838    0.1984    0.3193    0.4521    0.5722    0.6697    0.7675    0.8785    0.9451    0.9480    0.9175    0.8102    0.6144    0.5232    0.4176
    0.3576    0.2026    0.2314    0.4019    0.5203    0.6460    0.7227    0.8156    0.9155    0.9782    0.9798    0.9576    0.8556    0.6623    0.5493    0.4445
    0.3883    0.2224    0.2684    0.4649    0.5874    0.7078    0.7775    0.8517    0.9462    1.0140    1.0180    1.0032    0.9095    0.7035    0.5756    0.4649
    0.4160    0.2465    0.3548    0.5215    0.6430    0.7625    0.8288    0.8931    0.9717    1.0458    1.0562    1.0343    0.9514    0.7450    0.6186    0.5064
    0.4277    0.2731    0.4301    0.5727    0.6925    0.8070    0.8711    0.9294    0.9936    1.0730    1.0892    1.0718    0.9995    0.7858    0.6463    0.5295
    0.4572    0.3023    0.5097    0.6237    0.7378    0.8586    0.9098    0.9674    1.0096    1.1040    1.1096    1.1139    1.0010    0.8457    0.6752    0.5566
    0.4587    0.3372    0.5572    0.6678    0.7766    0.8931    0.9448    0.9974    1.0341    1.1213    1.1401    1.1324    1.0383    0.8911    0.7013    0.5794
    0.4668    0.3784    0.5898    0.7062    0.8228    0.9205    0.9738    1.0217    1.0485    1.1454    1.1658    1.1623    1.0703    0.9274    0.7282    0.5985
```

B.2: Local conversion matrix for T_p

Here the local conversion matrix for the 14 sites are listed in chronological order e.g. T_out(:,:,1) corresponds to the location A-15a, T_out(:,:,2) corresponds to the location A-15b. The rows correspond to H_{m0} at WVD-4 equal to 1-18m, the columns correspond to wave direction from 0° to 337.5° in 22.5° steps.

```
T_out(:,:,1) =

    2.4304    2.0086    2.6735    4.7362    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.7308    6.3039    4.3057
    1.8260    2.9408    3.2349    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    7.6277    8.3905    8.3905    9.2296    1.8260
    1.8260    1.8260   10.1525    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296    9.2296    9.2296   10.1525   10.1525    1.8260    1.8260
    2.0086    2.0086   11.1678   10.1525   10.1525   10.1525   10.1525   10.1525   10.1525   10.1525   10.1525   11.1678   11.1678   11.1678   11.1678    2.0086
    2.2095    2.2095   12.2845   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845   12.2845   12.2845   13.5130    2.2095
    2.2095   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643
   16.3507   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507
   17.9858   17.9858   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843
   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628
   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390
   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390
   23.9390   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390


T_out(:,:,2) =

    2.4304    2.6735    2.6735    4.7362    4.7362    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    6.3039    6.9343    6.9343    7.6277
    2.9408    3.2349    3.2349    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    8.3905    8.3905    9.2296    9.2296   10.1525
    1.8260   11.1678   10.1525    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296    9.2296   10.1525   10.1525   10.1525   10.1525   11.1678
   12.2845   12.2845   11.1678   10.1525   10.1525   10.1525   10.1525   10.1525   10.1525   10.1525   11.1678   11.1678   11.1678   11.1678   12.2845   13.5130
   13.5130   13.5130   12.2845   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130
   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643
   16.3507   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507   14.8643   14.8643   16.3507   16.3507
   17.9858   17.9858   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   17.9858   17.9858   17.9858   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843
   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628
   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390
   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390
   23.9390   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390   23.9390   23.9390


T_out(:,:,3) =

    7.6277    2.6735    2.0086    2.2095    4.7362    4.7362    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.7308    6.3039    6.9343    6.9343
   10.1525    2.9408    3.9142    7.6277    6.9343    6.3039    6.3039    6.3039    6.9343    6.9343    6.9343    7.6277    7.6277    8.3905    8.3905    9.2296
   11.1678   11.1678   10.1525    8.3905    7.6277    7.6277    7.6277    7.6277    8.3905    8.3905    8.3905    9.2296    9.2296    9.2296    1.8260    1.8260
    1.8260   12.2845   11.1678   10.1525    9.2296    8.3905    8.3905    9.2296    9.2296    9.2296   10.1525   10.1525   10.1525   10.1525   11.1678    2.0086
   14.8643   14.8643   12.2845   11.1678   10.1525   10.1525   10.1525   10.1525   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845    2.0086
   14.8643   14.8643   14.8643   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   14.8643
   16.3507   16.3507   16.3507   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643
   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507
   17.9858   17.9858   17.9858   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507
   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858
   17.9858   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   16.3507   17.9858   17.9858   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858
   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628
   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   21.7628   19.7843   21.7628   19.7843   19.7843   19.7843   19.7843   21.7628   23.9390
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390
   23.9390   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390


T_out(:,:,4) =

    7.6277    2.6735    2.9408    2.2095    5.2099    4.7362    4.7362    4.7362    4.7362    4.7362    4.7362    4.7362    5.2099    5.7308    6.3039    6.9343
   10.1525   10.1525    9.2296    8.3905    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    7.6277    8.3905    9.2296
   12.2845   11.1678   10.1525    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296    1.8260    1.8260
    1.8260   12.2845   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296    9.2296    9.2296   10.1525   10.1525   10.1525    2.0086    2.0086
    2.0086   13.5130   12.2845   11.1678   11.1678   10.1525   10.1525   10.1525   10.1525   11.1678   11.1678   11.1678   11.1678   11.1678    2.2095    2.0086
    1.8260   14.8643   13.5130   12.2845   12.2845   11.1678   11.1678   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130    2.2095
    1.8260   16.3507   14.8643   13.5130   13.5130   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643
   16.3507   16.3507   16.3507   14.8643   14.8643   13.5130   13.5130   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507
   17.9858   17.9858   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
```

```
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858
   17.9858   19.7843   17.9858   17.9858   17.9858   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   19.7843
   19.7843   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628
   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   21.7628   21.7628   23.9390
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390
   23.9390   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   21.7628   21.7628   21.7628   23.9390   23.9390


T_out(:,:,5) =

    1.8260    2.6735    2.0086    6.3039    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.7308    1.8260
   10.1525    8.3905    8.3905    8.3905    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    7.6277    8.3905    9.2296
   11.1678   11.1678    9.2296    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296    9.2296    9.2296   10.1525   11.1678
   12.2845   12.2845   10.1525   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296   10.1525   10.1525   10.1525   10.1525   11.1678   11.1678   12.2845
   13.5130   13.5130   12.2845   11.1678   11.1678   11.1678   10.1525   10.1525   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845   12.2845   13.5130
   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130
   14.8643   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643
   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   16.3507   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   17.9858   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628


T_out(:,:,6) =

    6.9343    2.6735    2.0086    2.2095    4.7362    4.7362    4.7362    5.2099    4.7362    4.7362    4.7362    5.2099    6.9343    6.9343    7.6277    7.6277
   10.1525    8.3905    8.3905    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    8.3905    9.2296    9.2296   10.1525
   12.2845   11.1678    9.2296    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296   10.1525   10.1525   11.1678   11.1678
   13.5130   12.2845   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296    9.2296   10.1525   11.1678   11.1678   11.1678   12.2845   12.2845
   13.5130   13.5130   13.5130   12.2845   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130
   14.8643   14.8643   14.8643   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643
   14.8643   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643
   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   16.3507   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843
   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390   21.7628   21.7628
   23.9390   23.9390   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390   23.9390   21.7628   23.9390


T_out(:,:,7) =

    3.2349    2.9408    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    3.5584    3.2349
    2.2095    3.5584    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    3.2349
   11.1678   11.1678    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905   10.1525
   11.1678   12.2845   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296    9.2296    9.2296    9.2296   10.1525   10.1525   10.1525   11.1678
   12.2845   13.5130   12.2845   12.2845   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845
   13.5130   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845
   14.8643   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130
   14.8643   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   13.5130   14.8643
   16.3507   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643
   16.3507   16.3507   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   14.8643   16.3507
   16.3507   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   17.9858   17.9858   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   17.9858   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858
   19.7843   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628


T_out(:,:,8) =

    1.8260    2.9408    6.9343    6.9343    6.3039    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    4.7362    4.3057    2.0086
    2.0086    9.2296    8.3905    8.3905    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    2.9408
   11.1678   11.1678   10.1525    9.2296    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296    9.2296   11.1678
   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296    9.2296   10.1525   10.1525   10.1525   11.1678   12.2845
   13.5130   13.5130   12.2845   12.2845   11.1678   11.1678   11.1678   10.1525   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845
   13.5130   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130
   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130   13.5130
   14.8643   16.3507   16.3507   14.8643   14.8643   14.8643   13.5130   13.5130   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643
   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643
   16.3507   16.3507   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   17.9858   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843
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   19.7843   19.7843   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628


T_out(:,:,9) =

    1.8260    1.8260    2.0086    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    4.7362    4.3057    1.8260
    1.8260    1.8260    1.8260    7.6277    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    7.6277    8.3905    9.2296
    1.8260    2.0086   10.1525    9.2296    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    8.3905    9.2296    9.2296   10.1525    1.8260
    2.2095    2.2095   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296    9.2296   10.1525   10.1525   10.1525   11.1678   11.1678   12.2845
   13.5130   13.5130   12.2845   11.1678   11.1678   10.1525   10.1525   10.1525   10.1525   10.1525   11.1678   11.1678   11.1678   12.2845   12.2845   13.5130
   14.8643   13.5130   13.5130   12.2845   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845   12.2845   13.5130   13.5130   14.8643
   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   11.1678   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130   14.8643
   16.3507   16.3507   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643   16.3507
   16.3507   16.3507   16.3507   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507
   17.9858   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   17.9858
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858
   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858
   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628


T_out(:,:,10) =

    1.8260    1.8260    1.8260    5.7308    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    4.7362    1.8260    1.8260
   10.1525   10.1525    9.2296    8.3905    7.6277    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    6.9343    7.6277    8.3905    9.2296
    1.8260    1.8260   11.1678   10.1525    9.2296    9.2296    8.3905    8.3905    8.3905    8.3905    7.6277    7.6277    8.3905    9.2296   10.1525    1.8260
    2.0086    2.0086   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    9.2296    9.2296    9.2296   10.1525   11.1678    1.8260
    2.2095   13.5130   13.5130   12.2845   12.2845   11.1678   11.1678   11.1678   10.1525   10.1525   10.1525   10.1525   10.1525   11.1678   12.2845    2.0086
   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   12.2845    2.2095
   16.3507   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   16.3507
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   14.8643   13.5130   13.5130   14.8643   16.3507
   17.9858   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   17.9858
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843
   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390


T_out(:,:,11) =

    1.8260    7.6277    7.6277    6.9343    5.7308    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    4.7362    4.7362    4.7362    1.8260    1.8260
   10.1525   10.1525    9.2296    9.2296    8.3905    7.6277    6.3039    6.3039    6.3039    6.3039    6.3039    6.3039    6.3039    7.6277    8.3905    9.2296
   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    8.3905    8.3905    7.6277    7.6277    7.6277    7.6277    7.6277    8.3905    9.2296   10.1525
    1.8260   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    8.3905    8.3905    8.3905    9.2296    1.8260    1.8260
    1.8260   13.5130   13.5130   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525   10.1525    9.2296    8.3905    8.3905   10.1525    1.8260    1.8260
    2.0086   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   11.1678   11.1678   11.1678   11.1678   10.1525    9.2296   11.1678    2.0086    2.0086
    2.0086   14.8643   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130    2.0086    2.2095
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643   16.3507    2.2095    2.2095
   17.9858   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507   16.3507   17.9858    2.4304
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   14.8643   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628
   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390   23.9390   23.9390


T_out(:,:,12) =

    1.8260    8.3905    7.6277    2.4304    5.7308    4.7362    4.7362    4.7362    4.7362    4.7362    4.7362    4.7362    5.2099    5.7308    1.8260    1.8260
   10.1525   10.1525    9.2296    8.3905    8.3905    7.6277    6.9343    6.9343    6.9343    6.9343    6.3039    6.3039    6.3039    7.6277    8.3905    9.2296
   12.2845   11.1678   11.1678   10.1525    9.2296    8.3905    8.3905    8.3905    8.3905    8.3905    7.6277    7.6277    8.3905    9.2296    9.2296   11.1678
   13.5130   12.2845   12.2845   11.1678   10.1525   10.1525   10.1525   10.1525    9.2296    9.2296    9.2296    8.3905    9.2296   10.1525   10.1525   12.2845
   13.5130   13.5130   13.5130   12.2845   11.1678   11.1678   11.1678   11.1678   10.1525   10.1525   10.1525   10.1525   10.1525   10.1525   11.1678   13.5130
   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   13.5130   11.1678   11.1678   11.1678   11.1678   11.1678   11.1678   12.2845   14.8643
   16.3507   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   13.5130   13.5130   13.5130    1.8260    1.8260
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   13.5130   13.5130   14.8643   14.8643   14.8643   16.3507    1.8260    1.8260
   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   17.9858   17.9858   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   19.7843   19.7843   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390   23.9390
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390   23.9390   23.9390   23.9390   23.9390
```

```
T_out(:,:,13) =

    1.8260    2.2095    7.6277    6.9343    6.9343    5.7308    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    4.7362    4.7362    1.8260    1.8260
   10.1525   10.1525   10.1525    9.2296    8.3905    7.6277    6.9343    6.9343    6.9343    6.9343    6.9343    6.3039    6.3039    6.9343    8.3905    1.8260
   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    8.3905    8.3905    7.6277    7.6277    7.6277    7.6277    7.6277    8.3905    1.8260    1.8260
    1.8260   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    8.3905    8.3905    7.6277    9.2296    1.8260    1.8260
    1.8260   13.5130   13.5130   12.2845   12.2845   11.1678   11.1678   11.1678   10.1525   10.1525    9.2296    8.3905    8.3905    9.2296    2.0086    2.0086
    2.0086   14.8643   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296   10.1525    2.2095    2.0086
    2.0086   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   12.2845   12.2845    9.2296   12.2845    2.2095    2.2095
   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130   14.8643   14.8643   14.8643    2.2095    2.2095
   17.9858   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   16.3507   16.3507    2.4304    2.4304
   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858   17.9858   17.9858   17.9858   19.7843
   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843   19.7843   19.7843   19.7843
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628
   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   23.9390   23.9390


T_out(:,:,14) =

    1.8260    1.8260    7.6277    7.6277    6.9343    6.3039    5.7308    5.2099    5.2099    5.2099    5.2099    5.2099    5.2099    4.7362    4.3057    1.8260
    2.9408   10.1525   10.1525    9.2296    9.2296    8.3905    7.6277    7.6277    6.9343    6.9343    6.9343    6.9343    6.3039    6.3039    7.6277    1.8260
   11.1678   11.1678   11.1678   11.1678   10.1525   10.1525    9.2296    8.3905    8.3905    8.3905    8.3905    7.6277    7.6277    1.8260    9.2296   10.1525
   12.2845   12.2845   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525    9.2296    9.2296    9.2296    8.3905    2.2095    2.0086    1.8260    1.8260
   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   11.1678   11.1678   10.1525   10.1525   10.1525    9.2296    2.2095    2.0086    2.0086    2.2095
    1.8260   14.8643   14.8643   13.5130   13.5130   12.2845   12.2845   12.2845   11.1678   11.1678   11.1678   10.1525    2.4304    2.2095    2.0086    2.4304
    2.2095   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   12.2845   12.2845   12.2845   11.1678    2.4304    2.2095    2.2095    2.4304
    2.4304   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   13.5130   13.5130   13.5130   13.5130   13.5130    2.6735    2.4304    2.2095    2.4304
    2.4304   16.3507   16.3507   16.3507   16.3507   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643   14.8643    2.6735    2.4304    2.2095    2.6735
   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507   16.3507    2.6735    2.4304    2.2095    2.0086
   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   16.3507   16.3507   16.3507   16.3507   16.3507   17.9858    2.6735    2.6735    2.4304    2.2095
   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858    2.6735    2.4304    2.2095
   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   17.9858   19.7843    2.6735    2.4304    2.2095
   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   17.9858   19.7843   19.7843   19.7843   19.7843   19.7843    2.6735    2.6735    2.2095
   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843    2.6735    2.6735    2.4304
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   19.7843   19.7843   19.7843   19.7843   21.7628    2.9408    2.6735    2.4304
   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   19.7843   19.7843   21.7628   21.7628   21.7628   21.7628    2.9408    2.6735    2.4304
   23.9390   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628   21.7628    2.9408    2.6735   23.9390
```

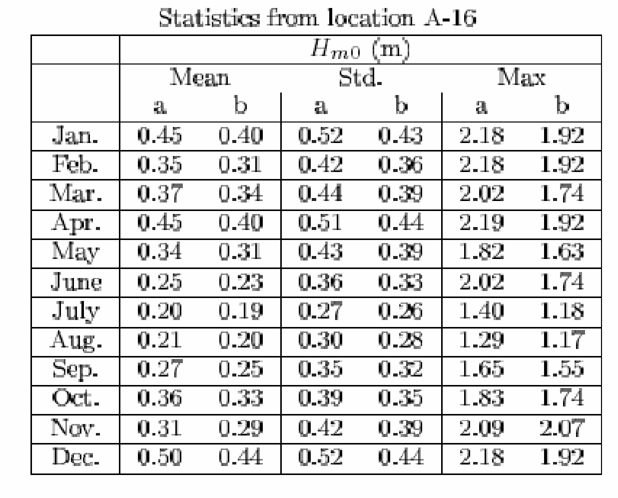
Appendix C Bottom stress statistics

Statistics from location A-15

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.73	0.44	0.60	0.46	4.07	3.09
Feb.	0.70	0.44	0.50	0.41	3.86	2.85
Mar.	0.61	0.37	0.56	0.44	3.11	2.37
Apr.	0.59	0.37	0.58	0.42	3.86	2.85
May	0.45	0.30	0.53	0.39	2.79	2.00
June	0.39	0.27	0.45	0.33	2.93	2.04
July	0.25	0.16	0.27	0.19	1.73	1.25
Aug.	0.28	0.19	0.34	0.25	1.78	1.32
Sep.	0.42	0.27	0.44	0.33	2.83	2.09
Oct.	0.49	0.28	0.47	0.36	3.36	2.48
Nov.	0.61	0.40	0.65	0.52	4.27	3.22
Dec.	0.69	0.42	0.61	0.46	4.07	3.09

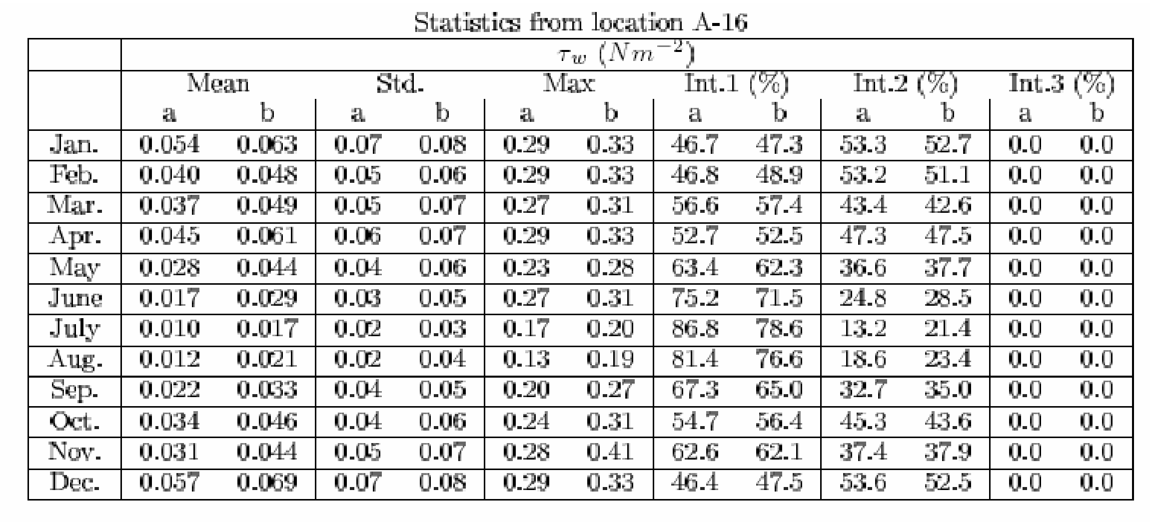
Statistics from location A-15

	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.093	0.084	0.13	0.10	1.50	1.19	38.9	22.1	60.6	77.6	0.5	0.3
Feb.	0.082	0.082	0.11	0.08	1.17	0.89	40.2	13.8	59.6	86.1	0.2	0.2
Mar.	0.066	0.066	0.10	0.08	0.63	0.54	51.5	36.3	48.5	63.7	0.0	0.0
Apr.	0.069	0.063	0.10	0.08	1.17	0.89	46.0	44.0	53.9	55.9	0.1	0.1
May	0.048	0.047	0.07	0.07	0.43	0.37	57.8	59.3	42.2	40.7	0.0	0.0
June	0.035	0.037	0.06	0.06	0.62	0.43	64.8	62.7	35.2	37.3	0.0	0.0
July	0.016	0.017	0.03	0.03	0.22	0.22	79.9	73.5	20.1	26.5	0.0	0.0
Aug.	0.021	0.023	0.04	0.04	0.23	0.23	76.3	70.9	23.7	29.1	0.0	0.0
Sep.	0.040	0.042	0.06	0.06	0.45	0.39	60.3	52.4	39.7	47.6	0.0	0.0
Oct.	0.050	0.048	0.08	0.07	0.75	0.59	52.6	46.2	47.4	53.8	0.0	0.0
Nov.	0.072	0.073	0.13	0.11	1.70	1.31	52.5	40.6	47.0	59.0	0.4	0.4
Dec.	0.089	0.079	0.13	0.11	1.50	1.19	42.5	31.4	56.7	68.3	0.8	0.3



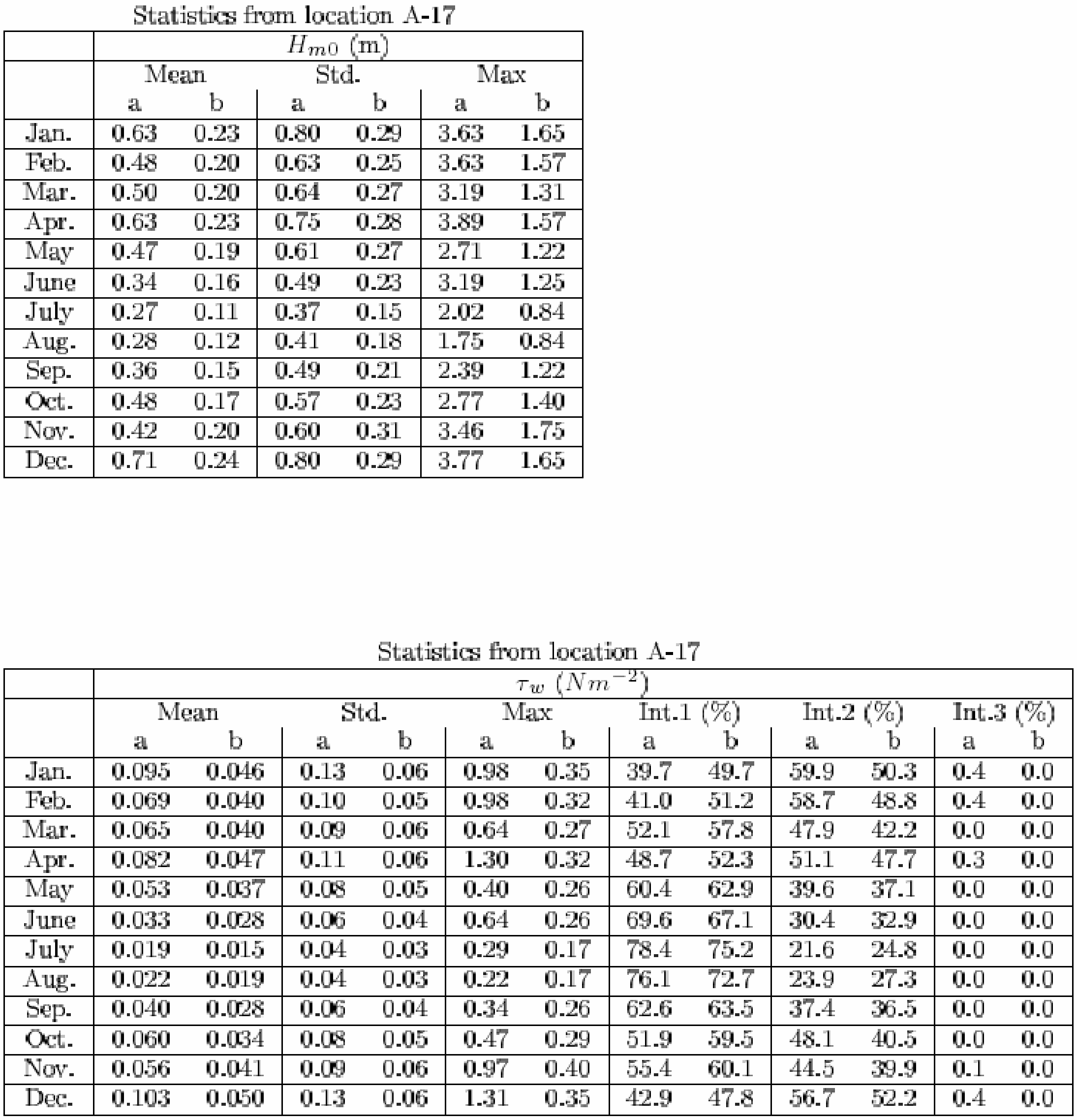
Statistics from location A-16

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.45	0.40	0.52	0.43	2.18	1.92
Feb.	0.35	0.31	0.42	0.36	2.18	1.92
Mar.	0.37	0.34	0.44	0.39	2.02	1.74
Apr.	0.45	0.40	0.51	0.44	2.19	1.92
May	0.34	0.31	0.43	0.39	1.82	1.63
June	0.25	0.23	0.36	0.33	2.02	1.74
July	0.20	0.19	0.27	0.26	1.40	1.18
Aug.	0.21	0.20	0.30	0.28	1.29	1.17
Sep.	0.27	0.25	0.35	0.32	1.65	1.55
Oct.	0.36	0.33	0.39	0.35	1.83	1.74
Nov.	0.31	0.29	0.42	0.39	2.09	2.07
Dec.	0.50	0.44	0.52	0.44	2.18	1.92



Statistics from location A-16

	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.054	0.063	0.07	0.08	0.29	0.33	46.7	47.3	53.3	52.7	0.0	0.0
Feb.	0.040	0.048	0.05	0.06	0.29	0.33	46.8	48.9	53.2	51.1	0.0	0.0
Mar.	0.037	0.049	0.05	0.07	0.27	0.31	56.6	57.4	43.4	42.6	0.0	0.0
Apr.	0.045	0.061	0.06	0.07	0.29	0.33	52.7	52.5	47.3	47.5	0.0	0.0
May	0.028	0.044	0.04	0.06	0.23	0.28	63.4	62.3	36.6	37.7	0.0	0.0
June	0.017	0.029	0.03	0.05	0.27	0.31	75.2	71.5	24.8	28.5	0.0	0.0
July	0.010	0.017	0.02	0.03	0.17	0.20	86.8	78.6	13.2	21.4	0.0	0.0
Aug.	0.012	0.021	0.02	0.04	0.13	0.19	81.4	76.6	18.6	23.4	0.0	0.0
Sep.	0.022	0.033	0.04	0.05	0.20	0.27	67.3	65.0	32.7	35.0	0.0	0.0
Oct.	0.034	0.046	0.04	0.06	0.24	0.31	54.7	56.4	45.3	43.6	0.0	0.0
Nov.	0.031	0.044	0.05	0.07	0.28	0.41	62.6	62.1	37.4	37.9	0.0	0.0
Dec.	0.057	0.069	0.07	0.08	0.29	0.33	46.4	47.5	53.6	52.5	0.0	0.0



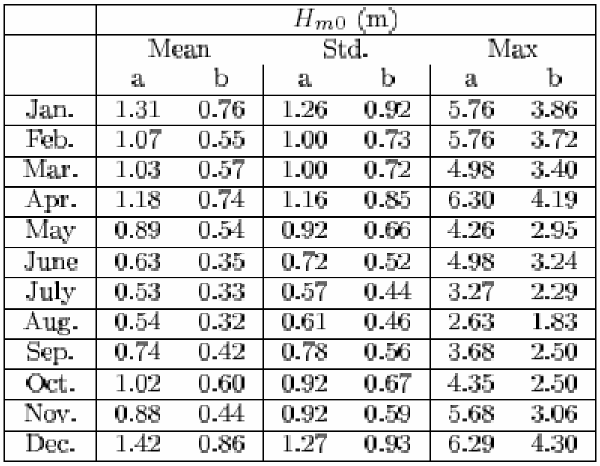
Statistics from location A-17

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.63	0.23	0.80	0.29	3.63	1.65
Feb.	0.48	0.20	0.63	0.25	3.63	1.57
Mar.	0.50	0.20	0.64	0.27	3.19	1.31
Apr.	0.63	0.23	0.75	0.28	3.89	1.57
May	0.47	0.19	0.61	0.27	2.71	1.22
June	0.34	0.16	0.49	0.23	3.19	1.25
July	0.27	0.11	0.37	0.15	2.02	0.84
Aug.	0.28	0.12	0.41	0.18	1.75	0.84
Sep.	0.36	0.15	0.49	0.21	2.39	1.22
Oct.	0.48	0.17	0.57	0.23	2.77	1.40
Nov.	0.42	0.20	0.60	0.31	3.46	1.75
Dec.	0.71	0.24	0.80	0.29	3.77	1.65

Statistics from location A-17

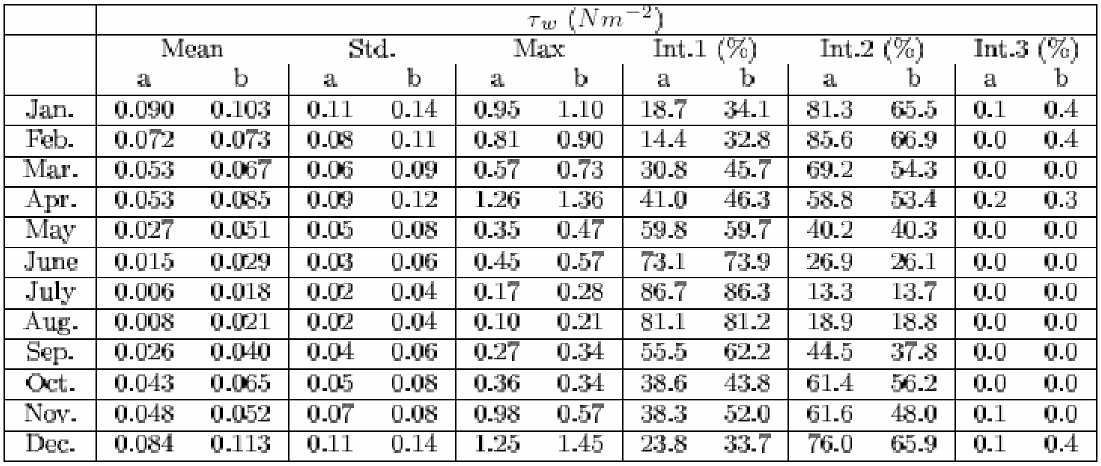
	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.095	0.046	0.13	0.06	0.98	0.35	39.7	49.7	59.9	50.3	0.4	0.0
Feb.	0.069	0.040	0.10	0.05	0.98	0.32	41.0	51.2	58.7	48.8	0.4	0.0
Mar.	0.065	0.040	0.09	0.06	0.64	0.27	52.1	57.8	47.9	42.2	0.0	0.0
Apr.	0.082	0.047	0.11	0.06	1.30	0.32	48.7	52.3	51.1	47.7	0.3	0.0
May	0.053	0.037	0.08	0.05	0.40	0.26	60.4	62.9	39.6	37.1	0.0	0.0
June	0.033	0.028	0.06	0.04	0.64	0.26	69.6	67.1	30.4	32.9	0.0	0.0
July	0.019	0.015	0.04	0.03	0.29	0.17	78.4	75.2	21.6	24.8	0.0	0.0
Aug.	0.022	0.019	0.04	0.03	0.22	0.17	76.1	72.7	23.9	27.3	0.0	0.0
Sep.	0.040	0.028	0.06	0.04	0.34	0.26	62.6	63.5	37.4	36.5	0.0	0.0
Oct.	0.060	0.034	0.08	0.05	0.47	0.29	51.9	59.5	48.1	40.5	0.0	0.0
Nov.	0.056	0.041	0.09	0.06	0.97	0.40	55.4	60.1	44.5	39.9	0.1	0.0
Dec.	0.103	0.050	0.13	0.06	1.31	0.35	42.9	47.8	56.7	52.2	0.4	0.0

Statistics from location A-18

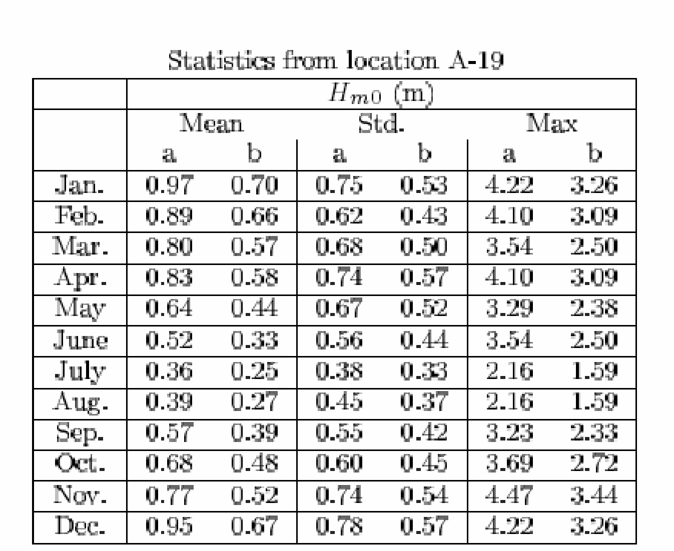


	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	1.31	0.76	1.26	0.92	5.76	3.86
Feb.	1.07	0.55	1.00	0.73	5.76	3.72
Mar.	1.03	0.57	1.00	0.72	4.98	3.40
Apr.	1.18	0.74	1.16	0.85	6.30	4.19
May	0.89	0.54	0.92	0.66	4.26	2.95
June	0.63	0.35	0.72	0.52	4.98	3.24
July	0.53	0.33	0.57	0.44	3.27	2.29
Aug.	0.54	0.32	0.61	0.46	2.63	1.83
Sep.	0.74	0.42	0.78	0.56	3.68	2.50
Oct.	1.02	0.60	0.92	0.67	4.35	2.50
Nov.	0.88	0.44	0.92	0.59	5.68	3.06
Dec.	1.42	0.86	1.27	0.93	6.29	4.30

Statistics from location A-18

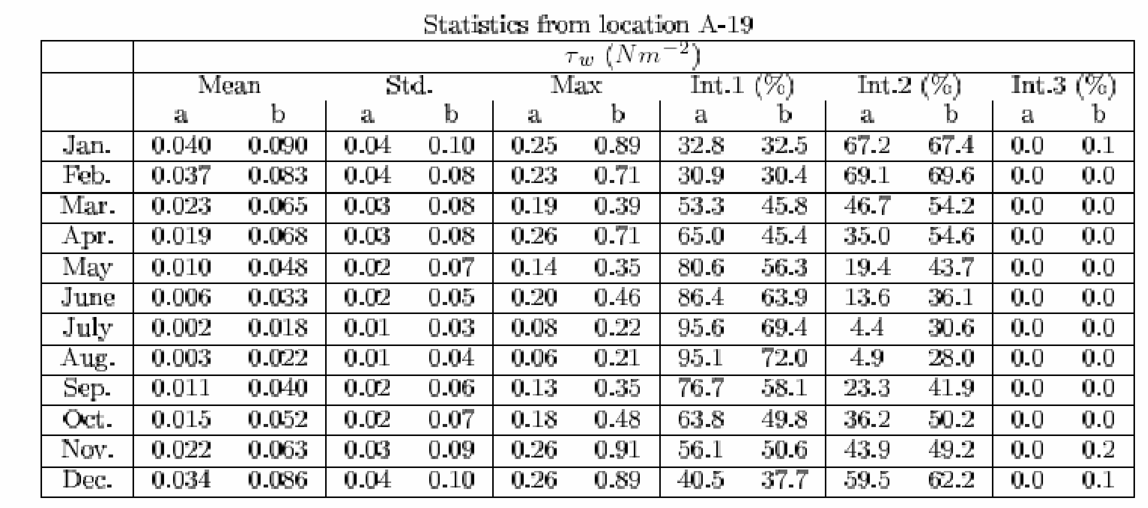


	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.090	0.103	0.11	0.14	0.95	1.10	18.7	34.1	81.3	65.5	0.1	0.4
Feb.	0.072	0.073	0.08	0.11	0.81	0.90	14.4	32.8	85.6	66.9	0.0	0.4
Mar.	0.053	0.067	0.06	0.09	0.57	0.73	30.8	45.7	69.2	54.3	0.0	0.0
Apr.	0.053	0.085	0.09	0.12	1.26	1.36	41.0	46.3	58.8	53.4	0.2	0.3
May	0.027	0.051	0.05	0.08	0.35	0.47	59.8	59.7	40.2	40.3	0.0	0.0
June	0.015	0.029	0.03	0.06	0.45	0.57	73.1	73.9	26.9	26.1	0.0	0.0
July	0.006	0.018	0.02	0.04	0.17	0.28	86.7	86.3	13.3	13.7	0.0	0.0
Aug.	0.008	0.021	0.02	0.04	0.10	0.21	81.1	81.2	18.9	18.8	0.0	0.0
Sep.	0.026	0.040	0.04	0.06	0.27	0.34	55.5	62.2	44.5	37.8	0.0	0.0
Oct.	0.043	0.065	0.05	0.08	0.36	0.34	38.6	43.8	61.4	56.2	0.0	0.0
Nov.	0.048	0.052	0.07	0.08	0.98	0.57	38.3	52.0	61.6	48.0	0.1	0.0
Dec.	0.084	0.113	0.11	0.14	1.25	1.45	23.8	33.7	76.0	65.9	0.1	0.4



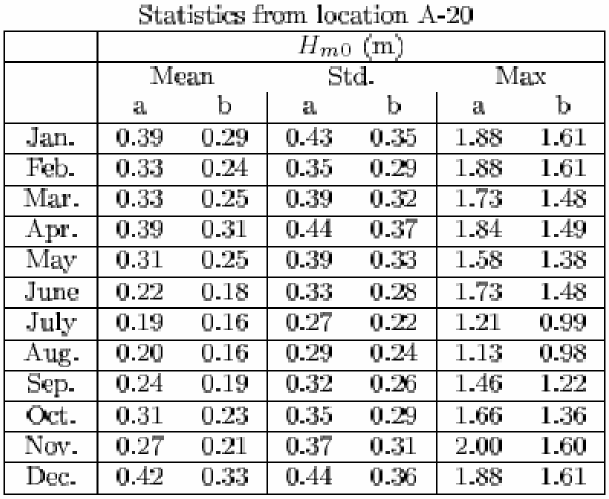
Statistics from location A-19

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.97	0.70	0.75	0.53	4.22	3.26
Feb.	0.89	0.66	0.62	0.43	4.10	3.09
Mar.	0.80	0.57	0.68	0.50	3.54	2.50
Apr.	0.83	0.58	0.74	0.57	4.10	3.09
May	0.64	0.44	0.67	0.52	3.29	2.38
June	0.52	0.33	0.56	0.44	3.54	2.50
July	0.36	0.25	0.38	0.33	2.16	1.59
Aug.	0.39	0.27	0.45	0.37	2.16	1.59
Sep.	0.57	0.39	0.55	0.42	3.23	2.33
Oct.	0.68	0.48	0.60	0.45	3.69	2.72
Nov.	0.77	0.52	0.74	0.54	4.47	3.44
Dec.	0.95	0.67	0.78	0.57	4.22	3.26



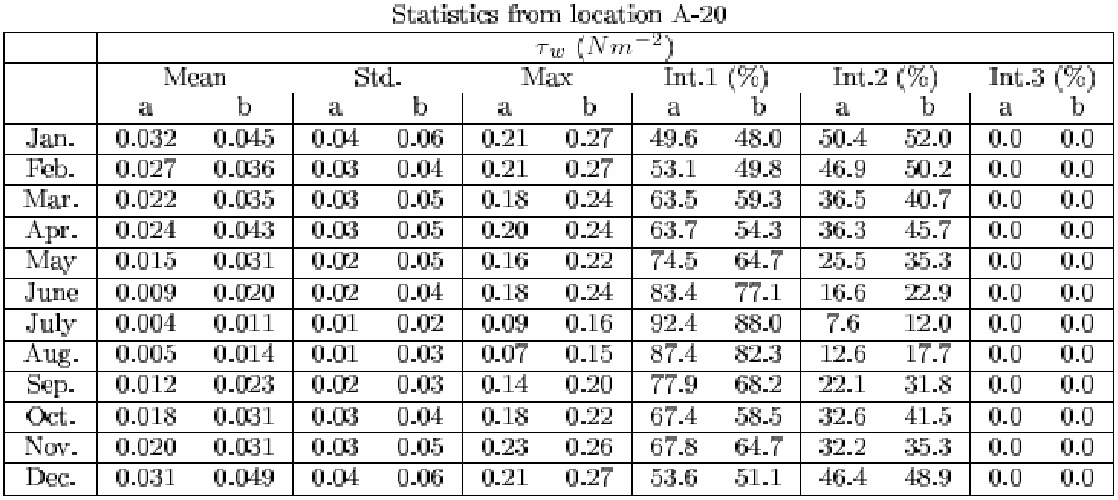
Statistics from location A-19

	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.040	0.090	0.04	0.10	0.25	0.89	32.8	32.5	67.2	67.4	0.0	0.1
Feb.	0.037	0.083	0.04	0.08	0.23	0.71	30.9	30.4	69.1	69.6	0.0	0.0
Mar.	0.023	0.065	0.03	0.08	0.19	0.39	53.3	45.8	46.7	54.2	0.0	0.0
Apr.	0.019	0.068	0.03	0.08	0.26	0.71	65.0	45.4	35.0	54.6	0.0	0.0
May	0.010	0.048	0.02	0.07	0.14	0.35	80.6	56.3	19.4	43.7	0.0	0.0
June	0.006	0.033	0.02	0.05	0.20	0.46	86.4	63.9	13.6	36.1	0.0	0.0
July	0.002	0.018	0.01	0.03	0.08	0.22	95.6	69.4	4.4	30.6	0.0	0.0
Aug.	0.003	0.022	0.01	0.04	0.06	0.21	95.1	72.0	4.9	28.0	0.0	0.0
Sep.	0.011	0.040	0.02	0.06	0.13	0.35	76.7	58.1	23.3	41.9	0.0	0.0
Oct.	0.015	0.052	0.02	0.07	0.18	0.48	63.8	49.8	36.2	50.2	0.0	0.0
Nov.	0.022	0.063	0.03	0.09	0.26	0.91	56.1	50.6	43.9	49.2	0.0	0.2
Dec.	0.034	0.086	0.04	0.10	0.26	0.89	40.5	37.7	59.5	62.2	0.0	0.1



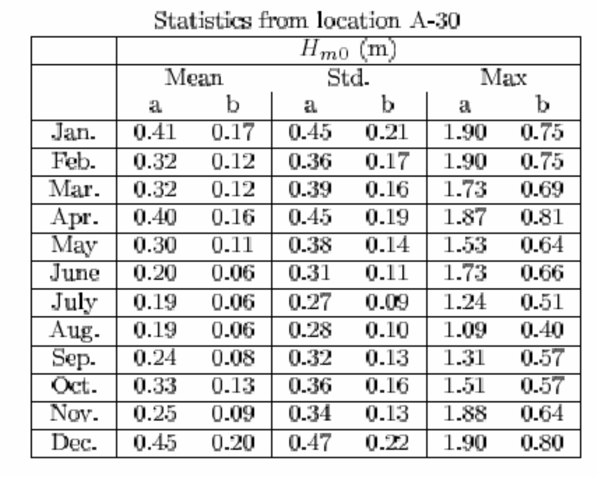
Statistics from location A-20

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.39	0.29	0.43	0.35	1.88	1.61
Feb.	0.33	0.24	0.35	0.29	1.88	1.61
Mar.	0.33	0.25	0.39	0.32	1.73	1.48
Apr.	0.39	0.31	0.44	0.37	1.84	1.49
May	0.31	0.25	0.39	0.33	1.58	1.38
June	0.22	0.18	0.33	0.28	1.73	1.48
July	0.19	0.16	0.27	0.22	1.21	0.99
Aug.	0.20	0.16	0.29	0.24	1.13	0.98
Sep.	0.24	0.19	0.32	0.26	1.46	1.22
Oct.	0.31	0.23	0.35	0.29	1.66	1.36
Nov.	0.27	0.21	0.37	0.31	2.00	1.60
Dec.	0.42	0.33	0.44	0.36	1.88	1.61



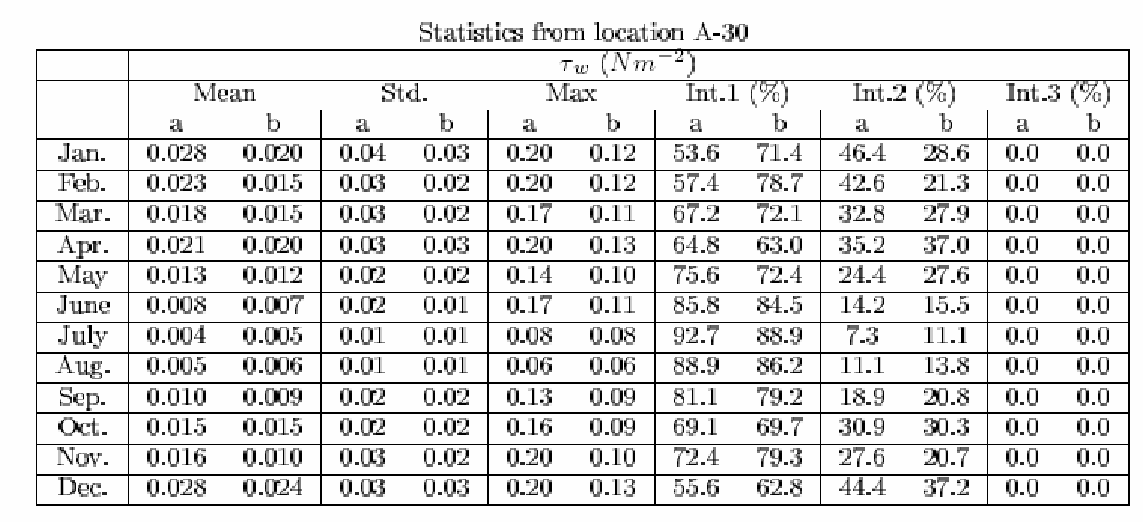
Statistics from location A-20

	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.032	0.045	0.04	0.06	0.21	0.27	49.6	48.0	50.4	52.0	0.0	0.0
Feb.	0.027	0.036	0.03	0.04	0.21	0.27	53.1	49.8	46.9	50.2	0.0	0.0
Mar.	0.022	0.035	0.03	0.05	0.18	0.24	63.5	59.3	36.5	40.7	0.0	0.0
Apr.	0.024	0.043	0.03	0.05	0.20	0.24	63.7	54.3	36.3	45.7	0.0	0.0
May	0.015	0.031	0.02	0.05	0.16	0.22	74.5	64.7	25.5	35.3	0.0	0.0
June	0.009	0.020	0.02	0.04	0.18	0.24	83.4	77.1	16.6	22.9	0.0	0.0
July	0.004	0.011	0.01	0.02	0.09	0.16	92.4	88.0	7.6	12.0	0.0	0.0
Aug.	0.005	0.014	0.01	0.03	0.07	0.15	87.4	82.3	12.6	17.7	0.0	0.0
Sep.	0.012	0.023	0.02	0.03	0.14	0.20	77.9	68.2	22.1	31.8	0.0	0.0
Oct.	0.018	0.031	0.03	0.04	0.18	0.22	67.4	58.5	32.6	41.5	0.0	0.0
Nov.	0.020	0.031	0.03	0.05	0.23	0.26	67.8	64.7	32.2	35.3	0.0	0.0
Dec.	0.031	0.049	0.04	0.06	0.21	0.27	53.6	51.1	46.4	48.9	0.0	0.0



Statistics from location A-30

	H_{m0} (m)					
	Mean		Std.		Max	
	a	b	a	b	a	b
Jan.	0.41	0.17	0.45	0.21	1.90	0.75
Feb.	0.32	0.12	0.36	0.17	1.90	0.75
Mar.	0.32	0.12	0.39	0.16	1.73	0.69
Apr.	0.40	0.16	0.45	0.19	1.87	0.81
May	0.30	0.11	0.38	0.14	1.53	0.64
June	0.20	0.06	0.31	0.11	1.73	0.66
July	0.19	0.06	0.27	0.09	1.24	0.51
Aug.	0.19	0.06	0.28	0.10	1.09	0.40
Sep.	0.24	0.08	0.32	0.13	1.31	0.57
Oct.	0.33	0.13	0.36	0.16	1.51	0.57
Nov.	0.25	0.09	0.34	0.13	1.88	0.64
Dec.	0.45	0.20	0.47	0.22	1.90	0.80



Statistics from location A-30

	τ_w (Nm^{-2})											
	Mean		Std.		Max		Int.1 (%)		Int.2 (%)		Int.3 (%)	
	a	b	a	b	a	b	a	b	a	b	a	b
Jan.	0.028	0.020	0.04	0.03	0.20	0.12	53.6	71.4	46.4	28.6	0.0	0.0
Feb.	0.023	0.015	0.03	0.02	0.20	0.12	57.4	78.7	42.6	21.3	0.0	0.0
Mar.	0.018	0.015	0.03	0.02	0.17	0.11	67.2	72.1	32.8	27.9	0.0	0.0
Apr.	0.021	0.020	0.03	0.03	0.20	0.13	64.8	63.0	35.2	37.0	0.0	0.0
May	0.013	0.012	0.02	0.02	0.14	0.10	75.6	72.4	24.4	27.6	0.0	0.0
June	0.008	0.007	0.02	0.01	0.17	0.11	85.8	84.5	14.2	15.5	0.0	0.0
July	0.004	0.005	0.01	0.01	0.08	0.08	92.7	88.9	7.3	11.1	0.0	0.0
Aug.	0.005	0.006	0.01	0.01	0.06	0.06	88.9	86.2	11.1	13.8	0.0	0.0
Sep.	0.010	0.009	0.02	0.02	0.13	0.09	81.1	79.2	18.9	20.8	0.0	0.0
Oct.	0.015	0.015	0.02	0.02	0.16	0.09	69.1	69.7	30.9	30.3	0.0	0.0
Nov.	0.016	0.010	0.03	0.02	0.20	0.10	72.4	79.3	27.6	20.7	0.0	0.0
Dec.	0.028	0.024	0.03	0.03	0.20	0.13	55.6	62.8	44.4	37.2	0.0	0.0