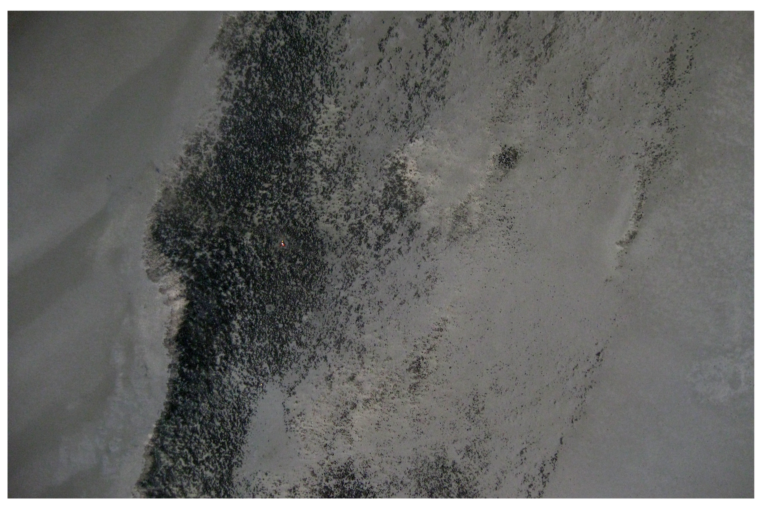
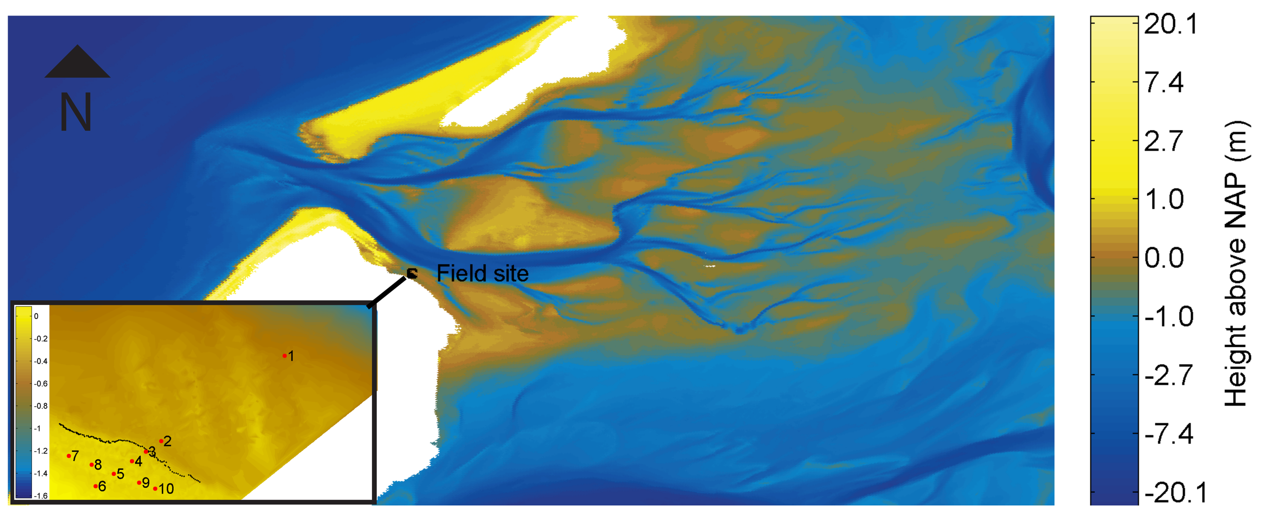
wave dissipation over a mussel bed

Jantien Rutten, Jasper Donker,
Maarten van der Vegt, Piet Hoekstra
Department of Physical Geography, Utrecht University

Introduction

The disappearance of mussel beds in the Wadden Sea in the sixties inspired a study to their stability. A mussel bed is considered stable after surviving one winter. To investigate the hydrodynamical forcing over the beds wave data was collected at the intertidal mussel bed north east of Texel in the Wadden Sea during the 48-day field campaign (2010).





Objectives

Hydrodynamical forcing on an intertidal mussel bed:
- estimation of wave dissipation
- estimation of friction coefficients

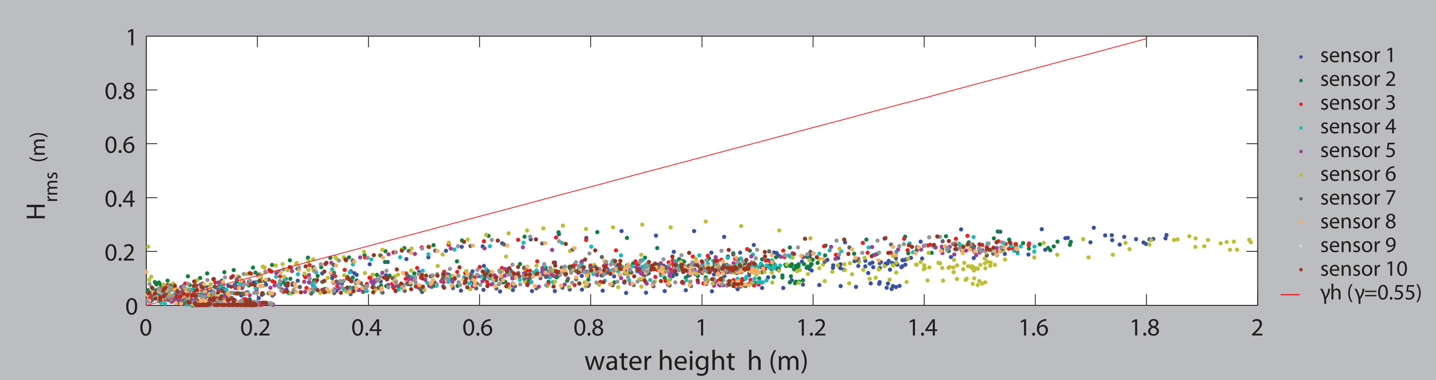
Method

- Surface elevation and velocity measurements at 10 locations (top-right figure)
- Selection of a few consecutive high energetic tides
- Determination of Root-Mean-Squared wave height H_{rms}
- Calculation of Wave energy flux F

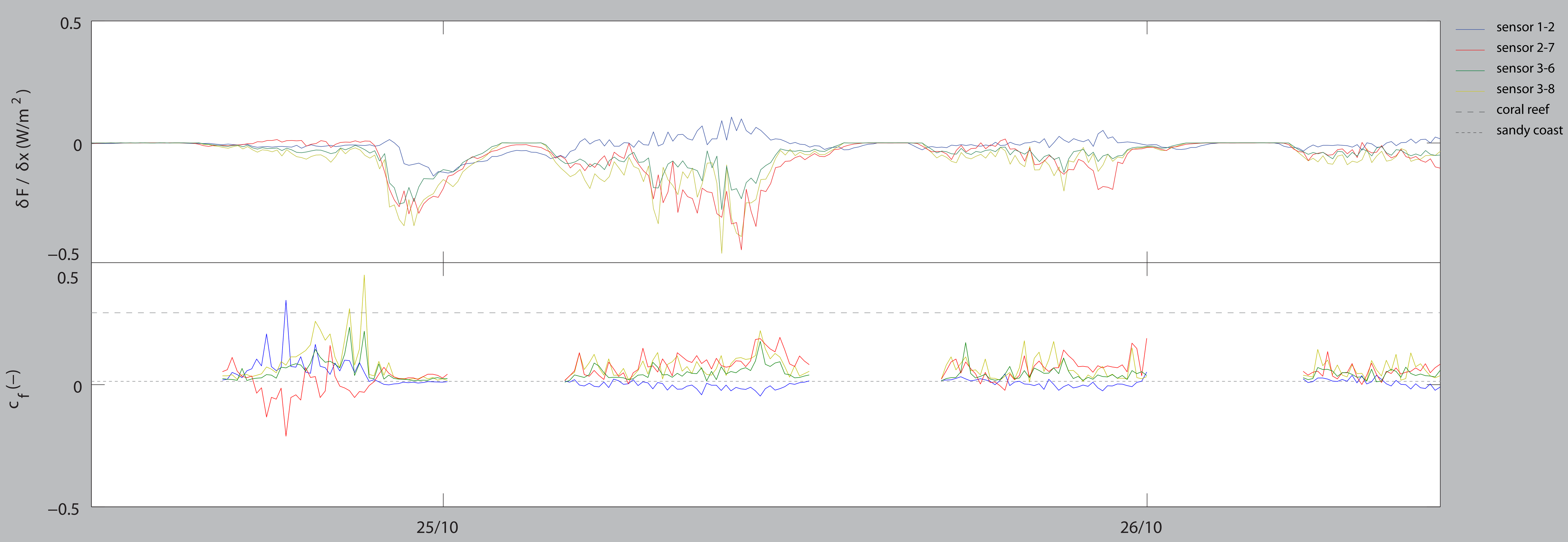
From the changes in the wave energy flux the following is estimated:
- Energy dissipated due to breaking e_b
- Energy dissipated by friction
- Friction coefficient c_f

$$c_f = \frac{16\sqrt{\pi}}{\rho}\left(\frac{\delta F}{\delta x} - \langle e_b \rangle\right)^{-1}\left(\frac{\sinh(\kappa h)}{2\pi f_p H_{rms}}\right)^3$$

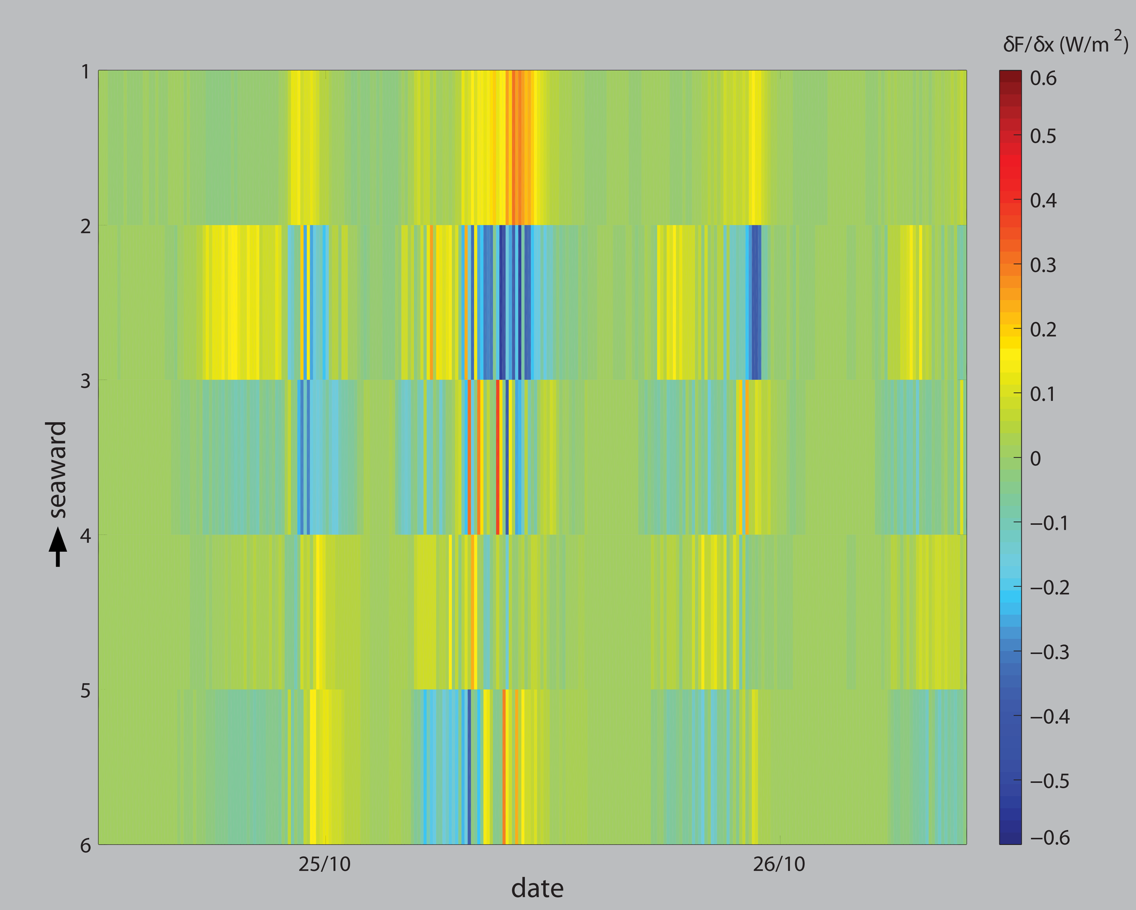
Results



Wave energy dissipates due to wave breaking or bottom friction, especially during high energetic conditions. The (high energetic) wave data is classified in non-breaking and breaking waves, based on the wave breaking threshold of γh with γ is 0.55 (red line).
So dissipation due to wave breaking is negligible, except for low energetic conditions (h<0.25m).



Friction coefficients cf (bottom) were derived from the spatially averaged rate of wave energy flux F (top) of several sensor transects. The sandy flat cf (blue) of approximately 0.02m can be referred to the Torrey Pines sandy beach cf (Thornton and Guza, 1983). The mussel bed cf (yellow, red and green) are about 0.11. The cf of 0.3 at the much rougher coral reef (Lowe et al., 2005) is used for reference.



Generally, the spatially averaged change in wave energy flux δF/δx (W/m²) is negative (energy decrease) landward (blue). The change in wave energy flux is negligible during low tide as can be noticed from the green coloured vertical bands.

Conclusions

- Wave energy flux decreases with 0.2-0.5 W/m² over the mussel bed during high energetic conditions.
- Energy dissipates predominantly by bed friction, rather than wave breaking.
- The sandy flat and mussel bed friction coefficient c_f are about 0.02 and 0.11 respectively.
- The wave energy flux and friction coefficients scatter due to small sensor transects and the random wave field.

Further research

- Verifying results by a larger data set.
- Relate erosion events to energy flux to consider mussel bed stability.
- Incorporate forcing of current over the mussel bed.

MOSSELWAD

Universiteit Utrecht

References **Thornton**, E.B., Guza, R.T., 1983: Transformation of wave height distribution. Journal of geophysical research 88, No. C10: 5925-5938.
Lowe, R.J., Falter, J.L., Bandet, M.D., Pawlak, G., Atkinson, M.J., Monismith, S.G., Koseff, J.R., 2005. Spectral wave dissipation over a barrier reef. Journal of geophysical research 110: C04001, doi: 10.11029/2004JC002711.

j.rutten2@students.uu.nl