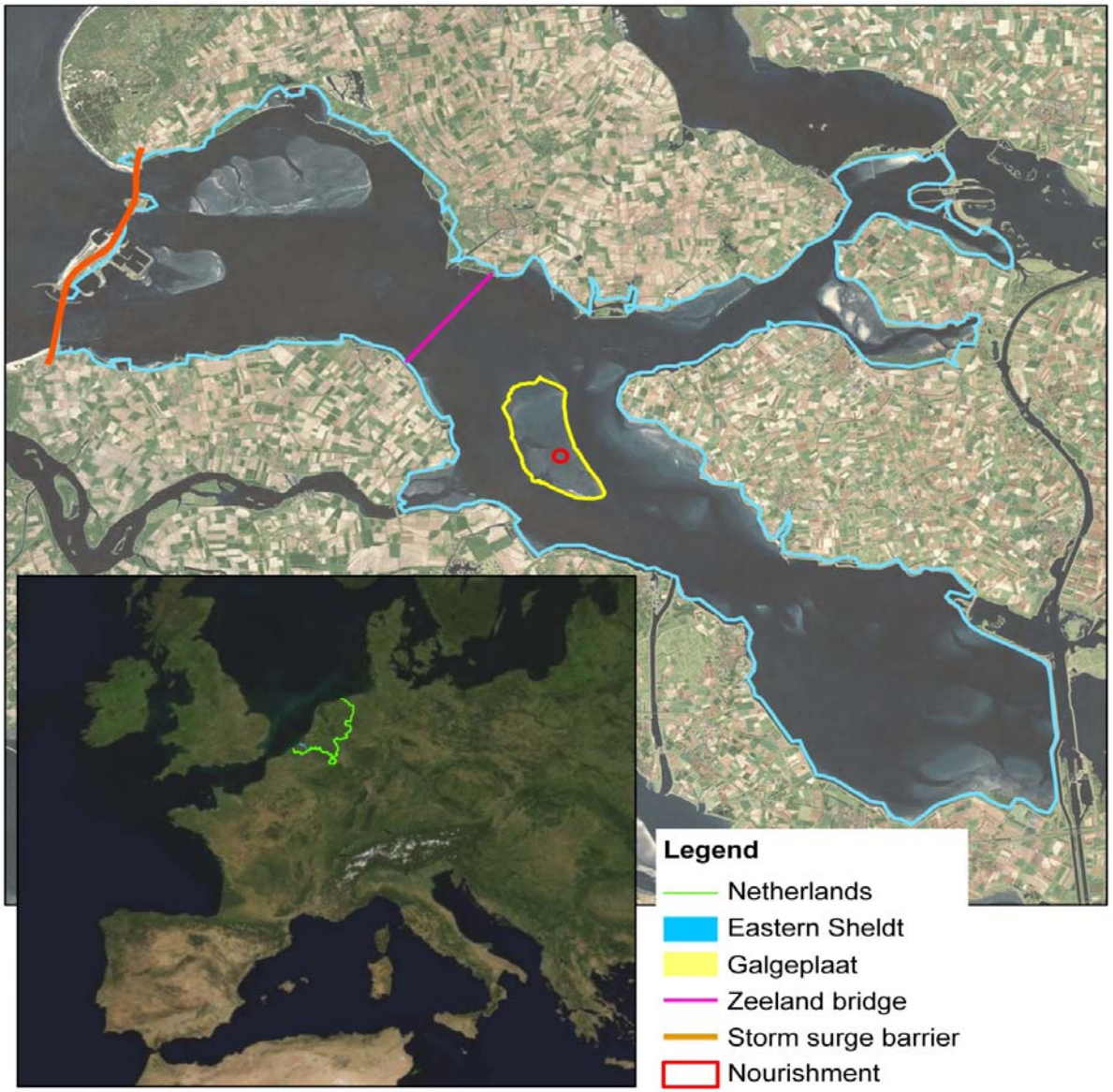
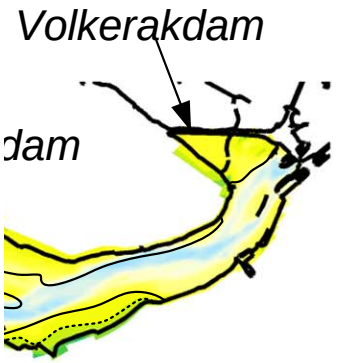
Deltares
Enabling Delta Life

Morphological modelling of an intertidal flat nourishment in the Eastern Scheldt, The Netherlands

Katherine Cronin (Deltares), Bas Borsje (Deltares), Harriëtte Holzhauer (Deltares), Ilse de Mesel (IMARES), Tom Ysebaert (IMARES) and Anneke Hibma (EcoShape)

Eastern Scheldt estuary





..... = Salt-marsh
——— = Mean low water line

Deltares

Main concerns:

Sediment starvation, Nature Conservation, Safety

Erosion --- barrier and compartment dams.

Drowning -- sea level rise

Total 1 - 3 Mm^3 per year lost

11,000 ha in 1986
10,000 ha now
4 -6,000 ha in 2060

Possible measures?

- Restore morphological equilibrium
- Dismantle barrier
- Dismantle barrier + compartment dams
- Natural transport of sand through the barrier
- Mitigate erosion

To investigate these solutions:

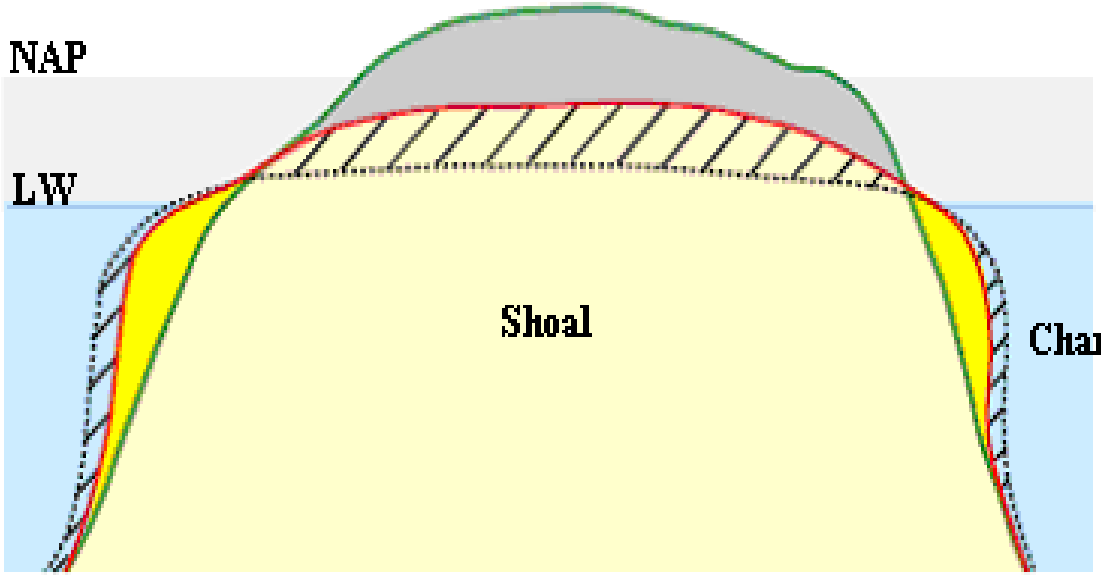
- EcoShape: Building with Nature:

Deltares investigating **ecodynamic** solutions to mitigate tidal flat degradation in the Eastern Scheldt with **Rijkswaterstaat**

- ANT project (Autonomous Downward Trend) commission by Rijkswaterstaat

Provide scientific knowledge on the feasibility and cost of reaching the **Natura 2000 targets** for the Eastern Scheldt Estuary

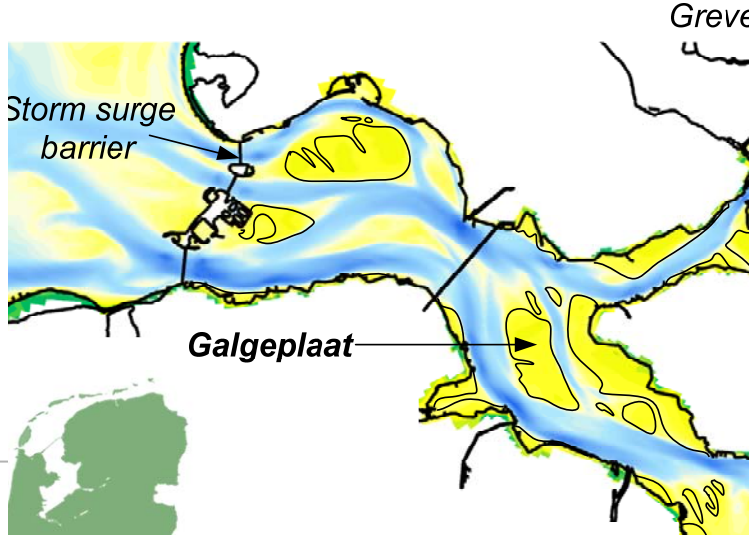
The Galgeplaat intertidal shoal



Cross-section shoal 1986
Cross-section shoal 2001
Prognosis 2015

Erosion
Sedimentation
Prognosis change 2001-2015

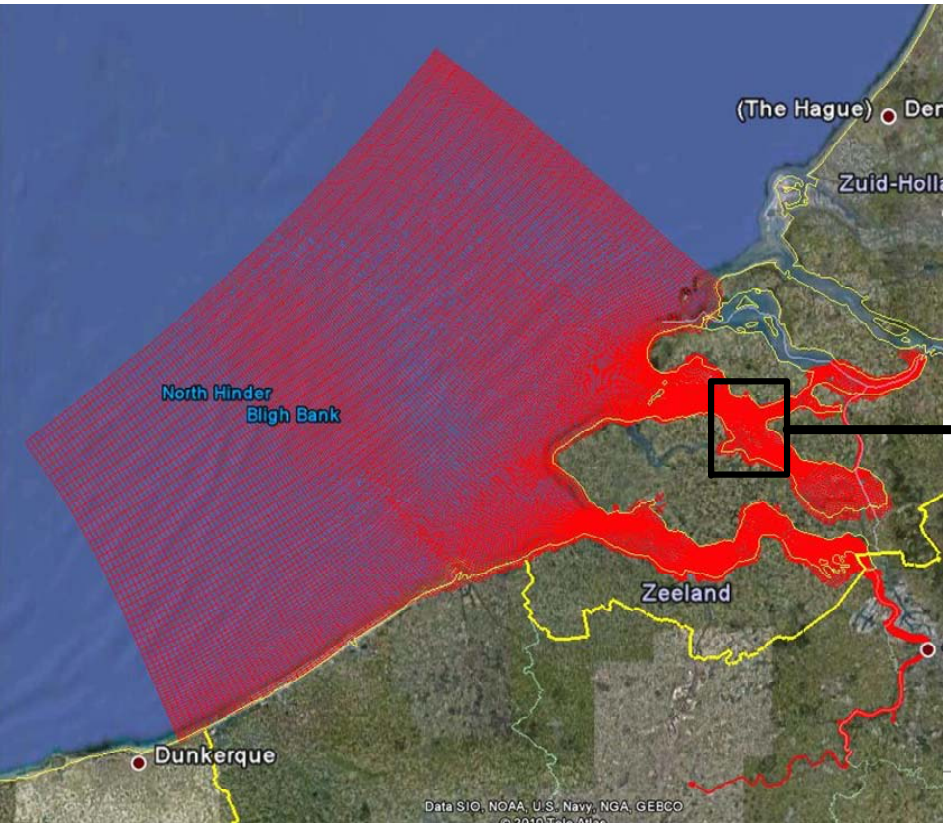
- Tidal flow at present does not allow shoal building
- Locally generated waves have a large impact on sediment transport and degradation of the intertidal areas
- Areas between +1 and -1 NAP eroding and higher areas flattening and spreading out



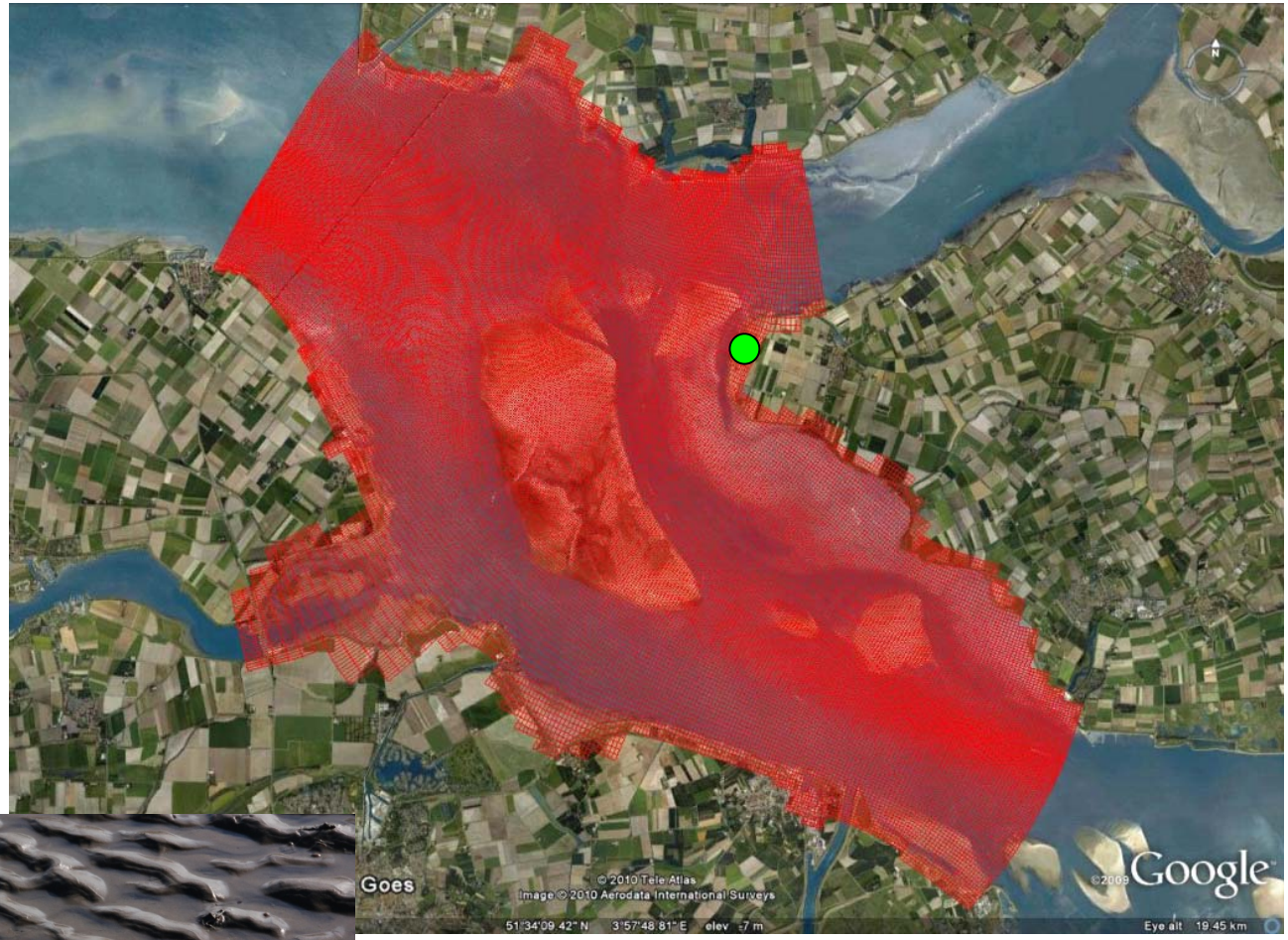
Intertidal flat nourishment

Delft3D-FLOW with online sediment transport

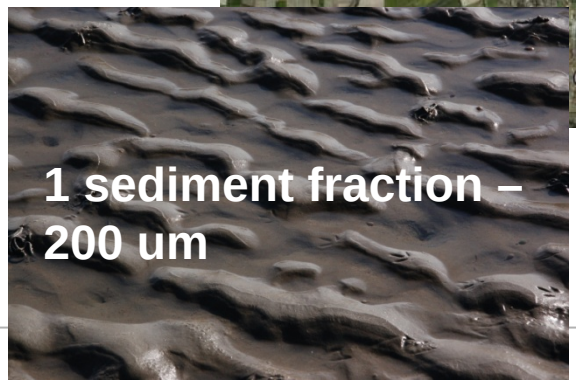
- 2DH hydrodynamic model of the Galgeplaat – 25-45m grid resolution
- Nested in the KustZuid model- simulates currents and waves of southern north sea
- Waves simulated using SWAN



Galgeplaat morphological model



0.5 minutes

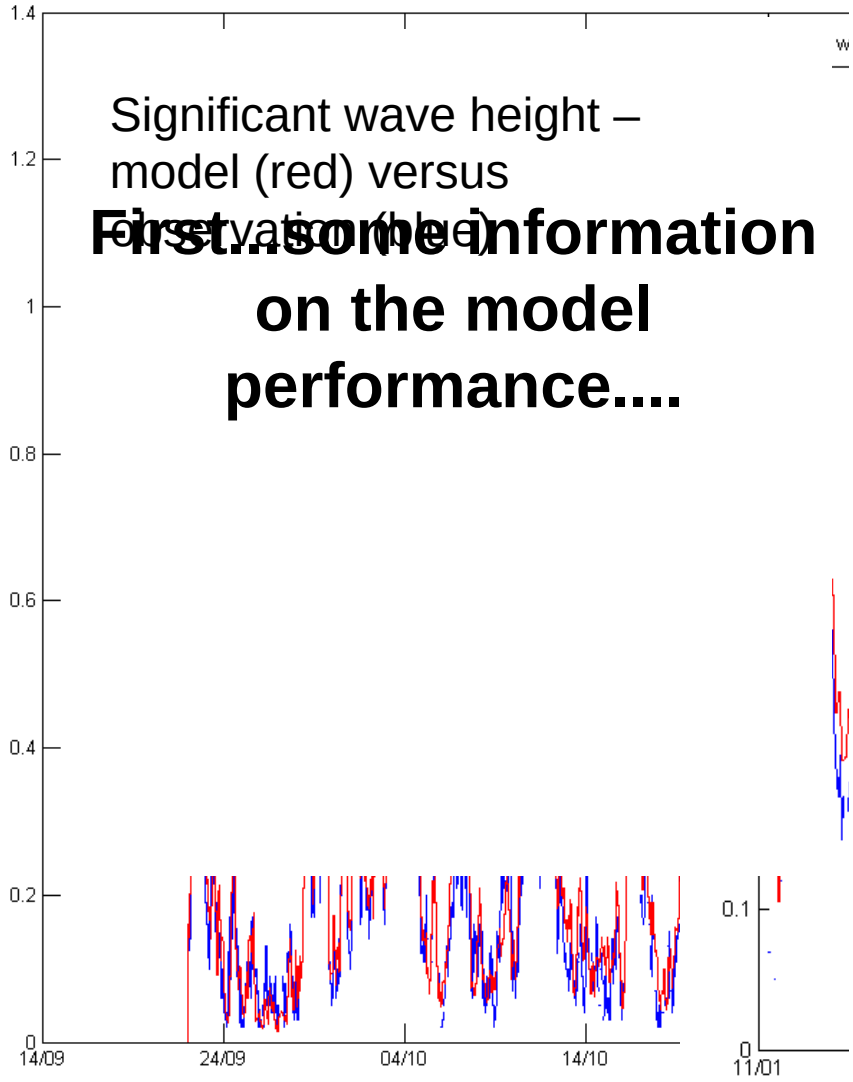


Chezy coefficient of 65

Morphological factor of 6

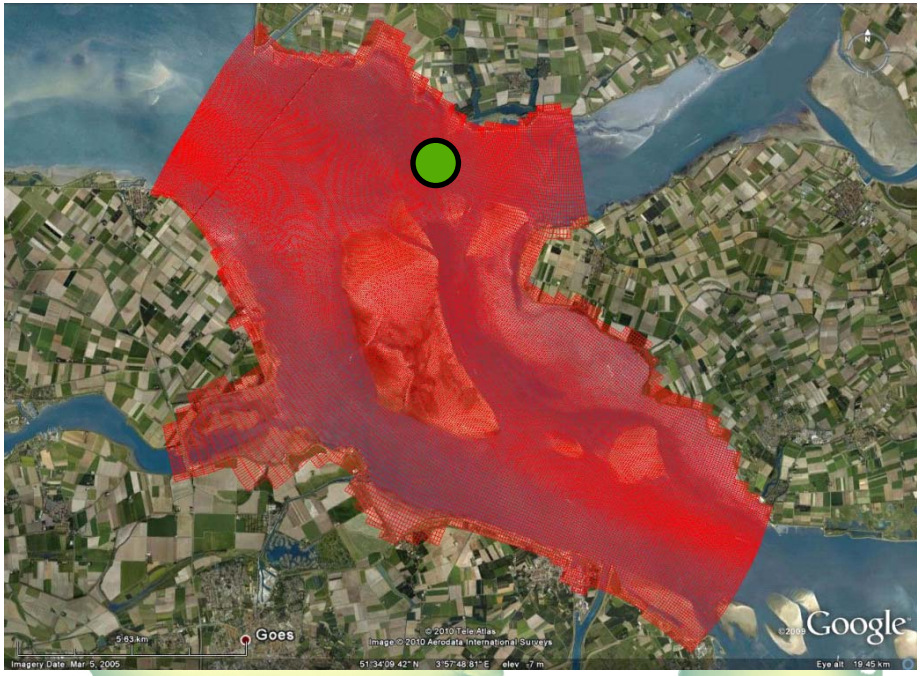
Deltares

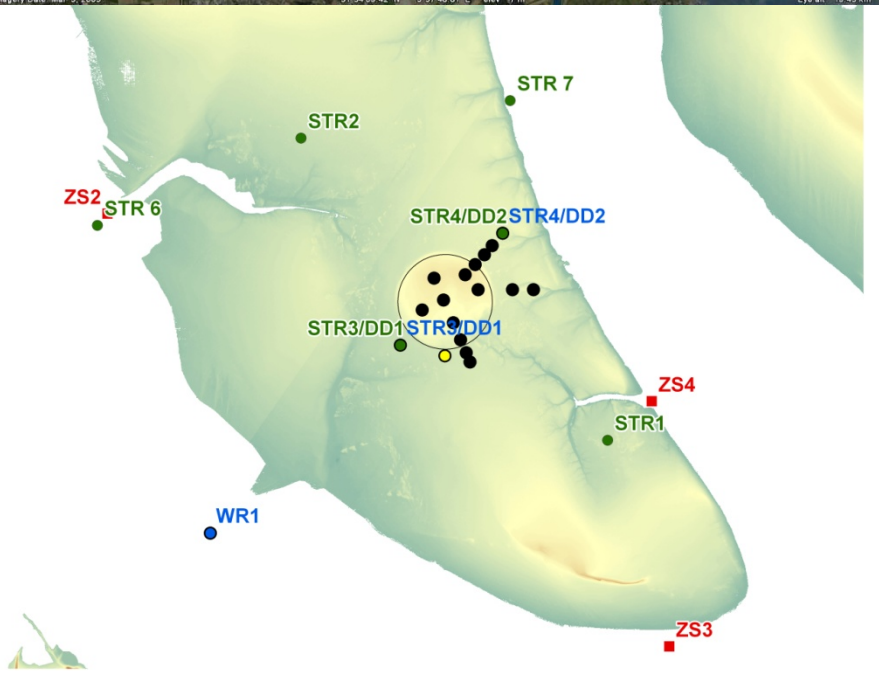
Waves – NE



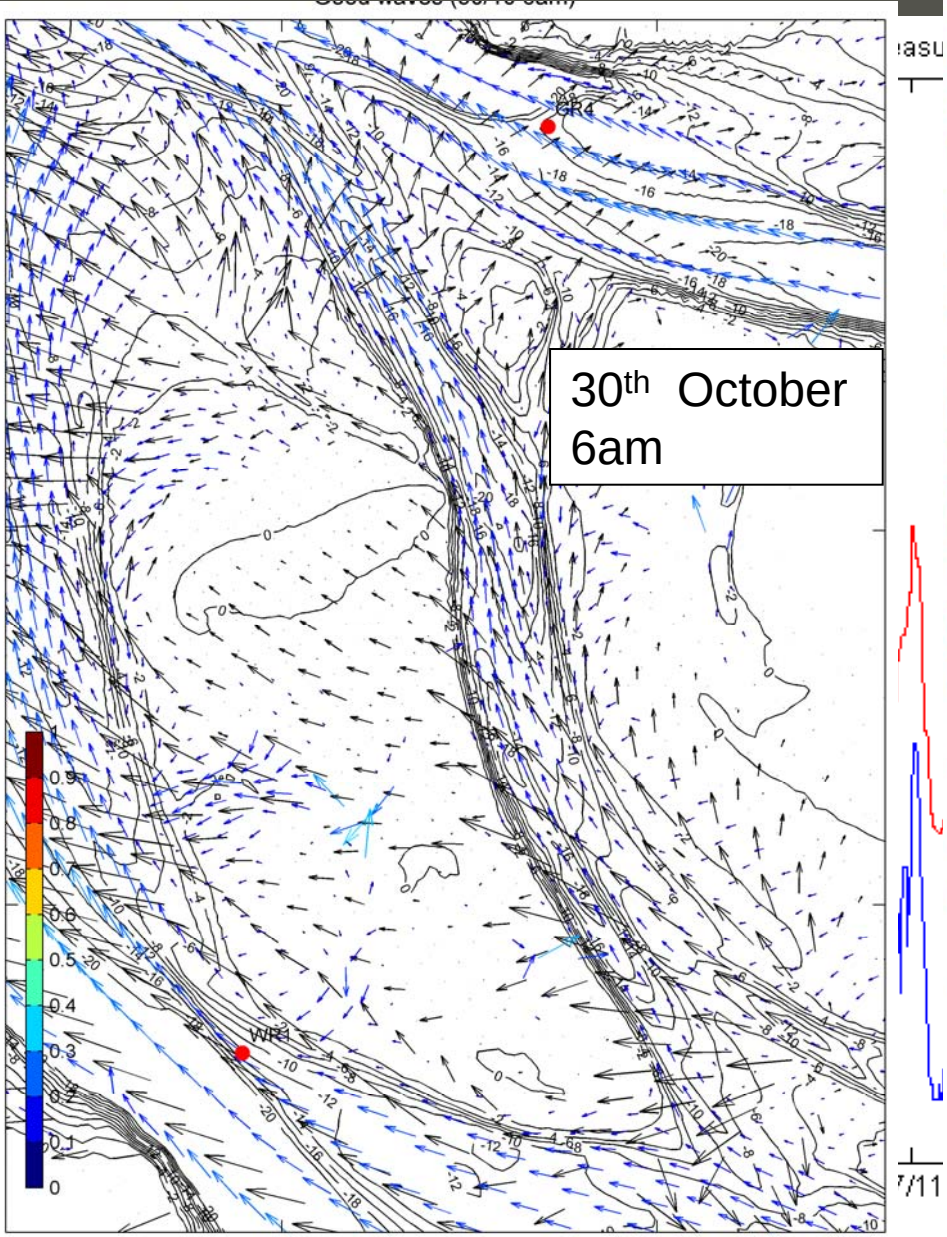
Significant wave height – model (red) versus observation (blue)

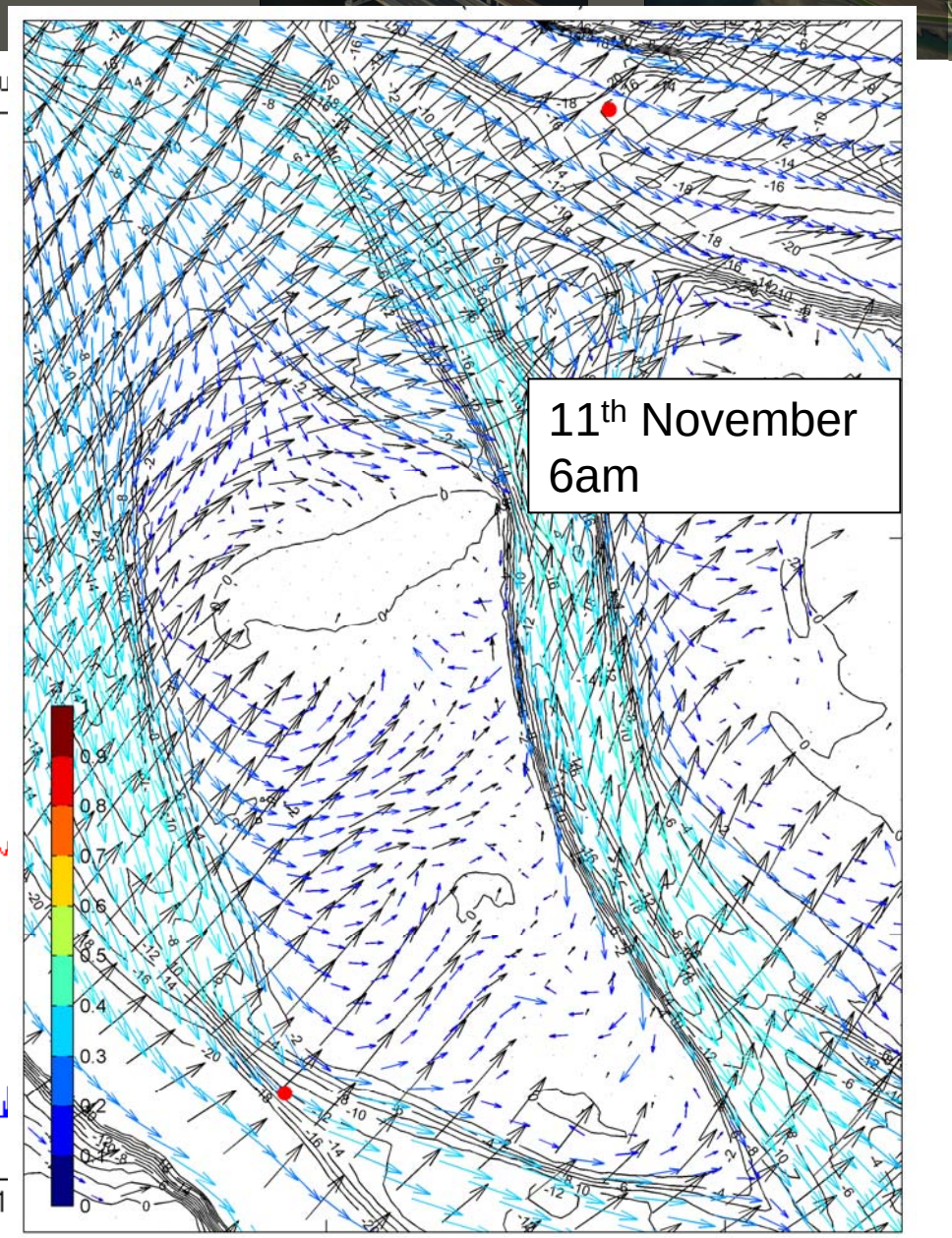
First some information on the model performance....



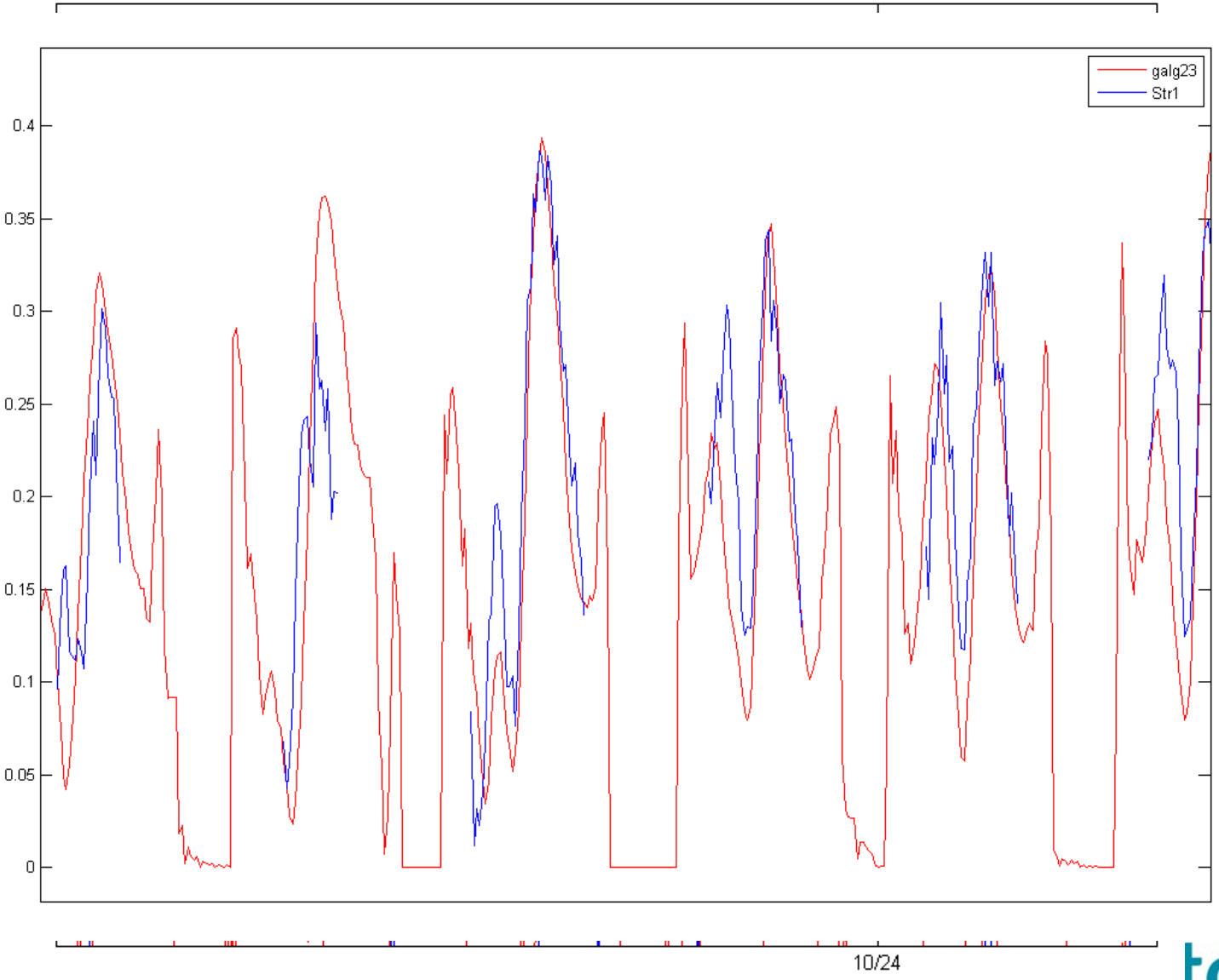


Waves SW

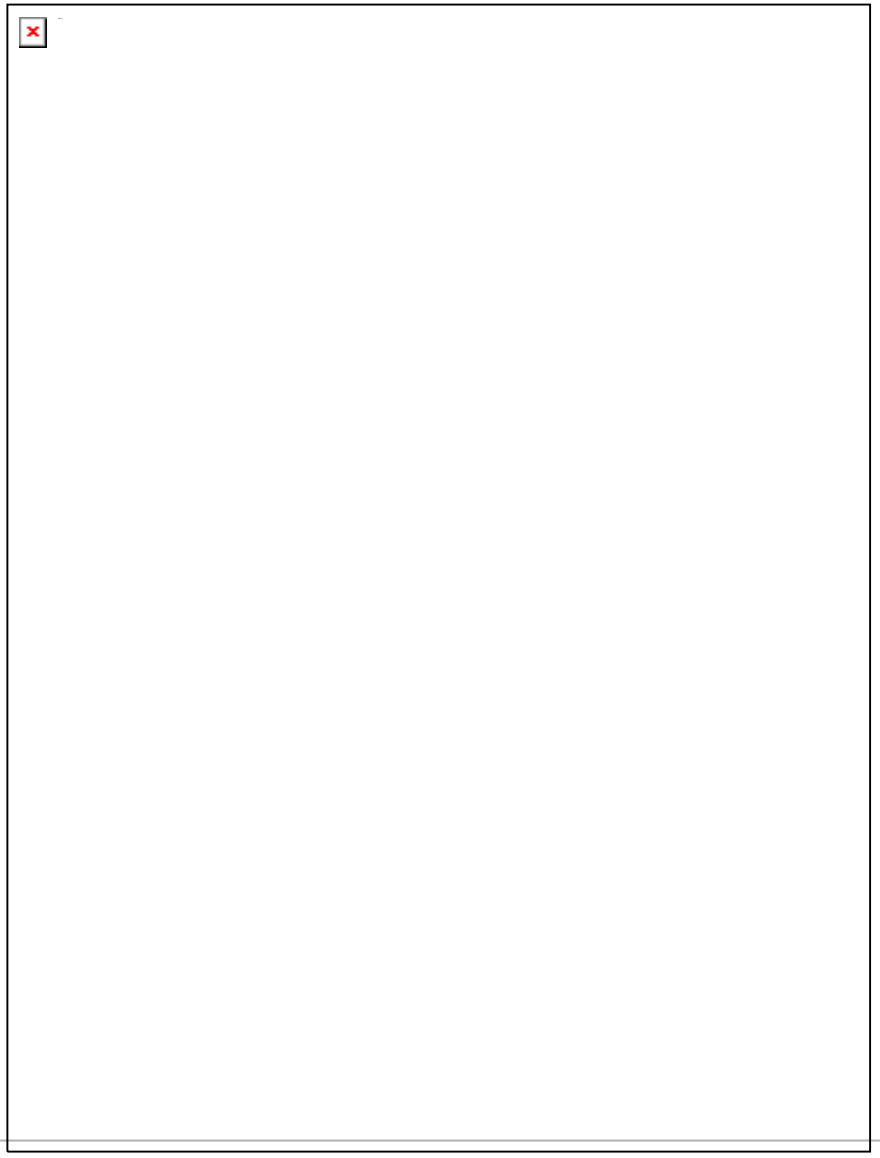


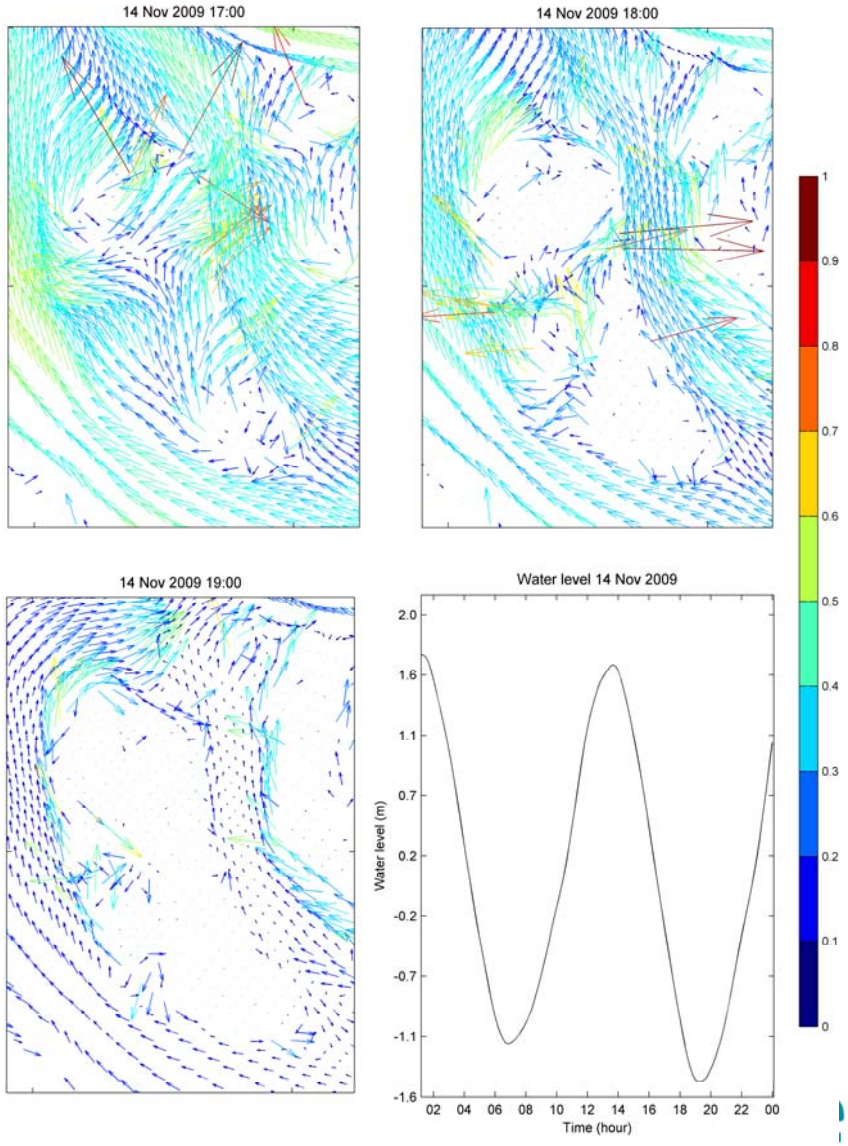


Currents (m/s -- blue observation, red model)



Flow fields



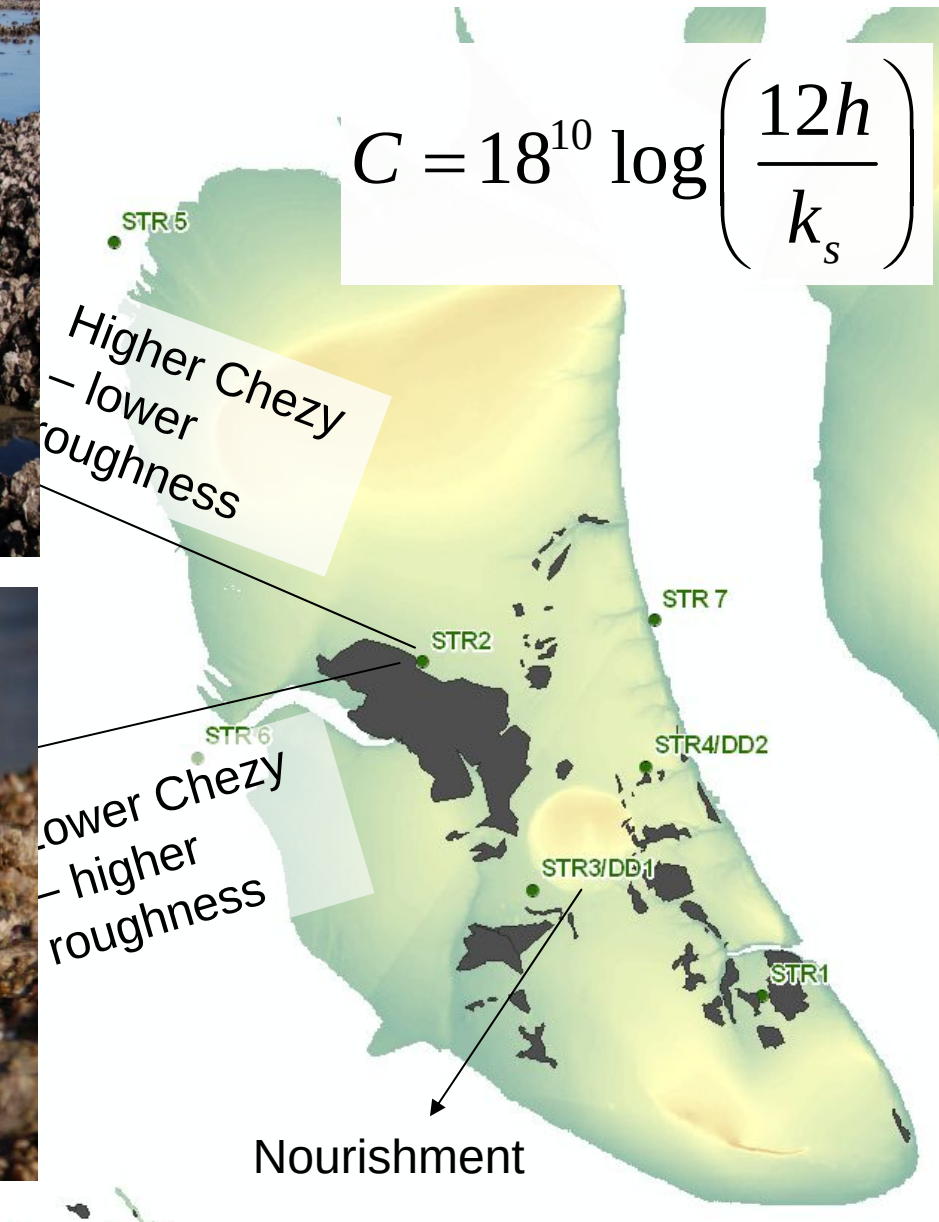

14 Nov 2009 17:00
14 Nov 2009 18:00
14 Nov 2009 19:00
Water level 14 Nov 2009
Water level (m)
Time (hour)
2.0
1.6
1.1
0.7
0.2
-0.2
-0.7
-1.1
-1.6
02 04 06 08 10 12 14 16 18 20 22 00
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Biological roughness effects

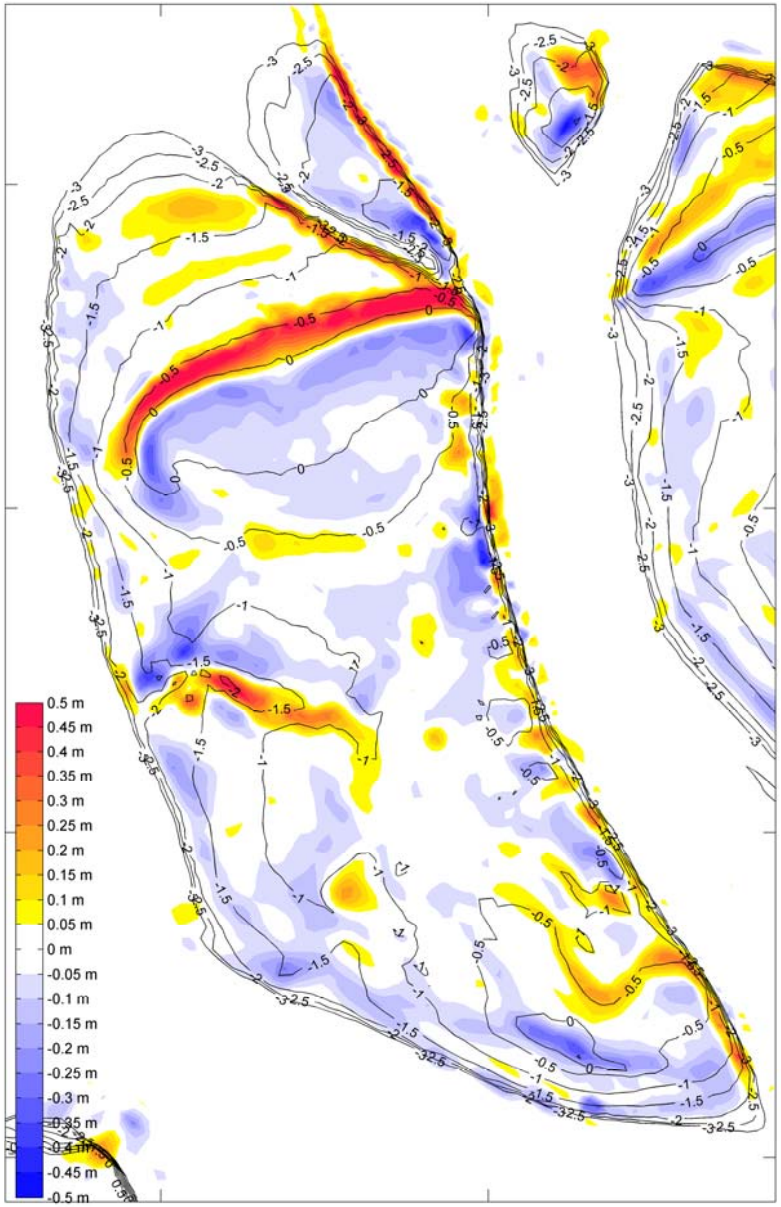
$$C = 18^{10} \log\left(\frac{12h}{k_s}\right)$$

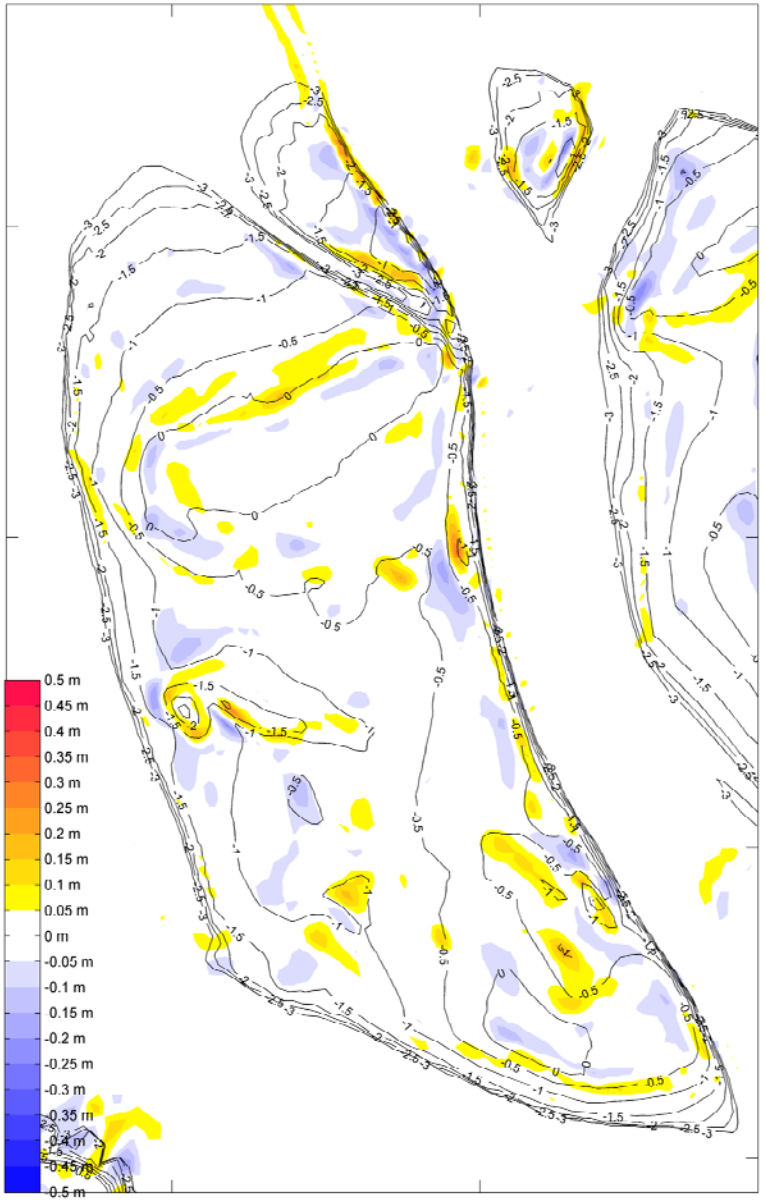
Higher Chezy
– lower
roughness

Lower Chezy
– higher
roughness

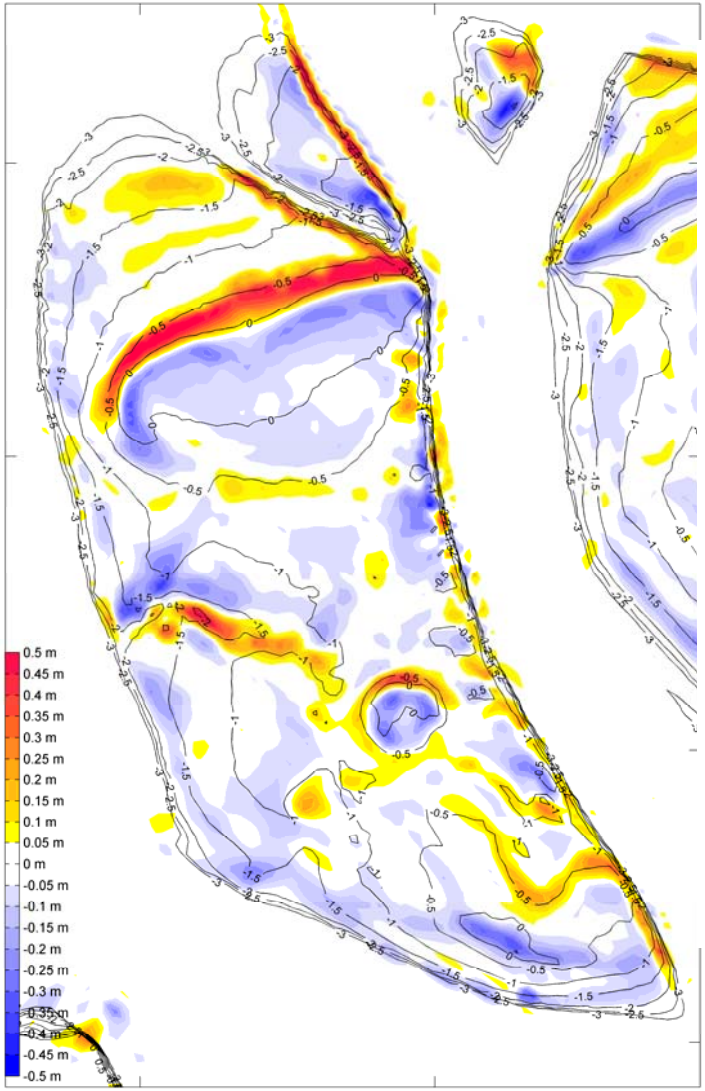


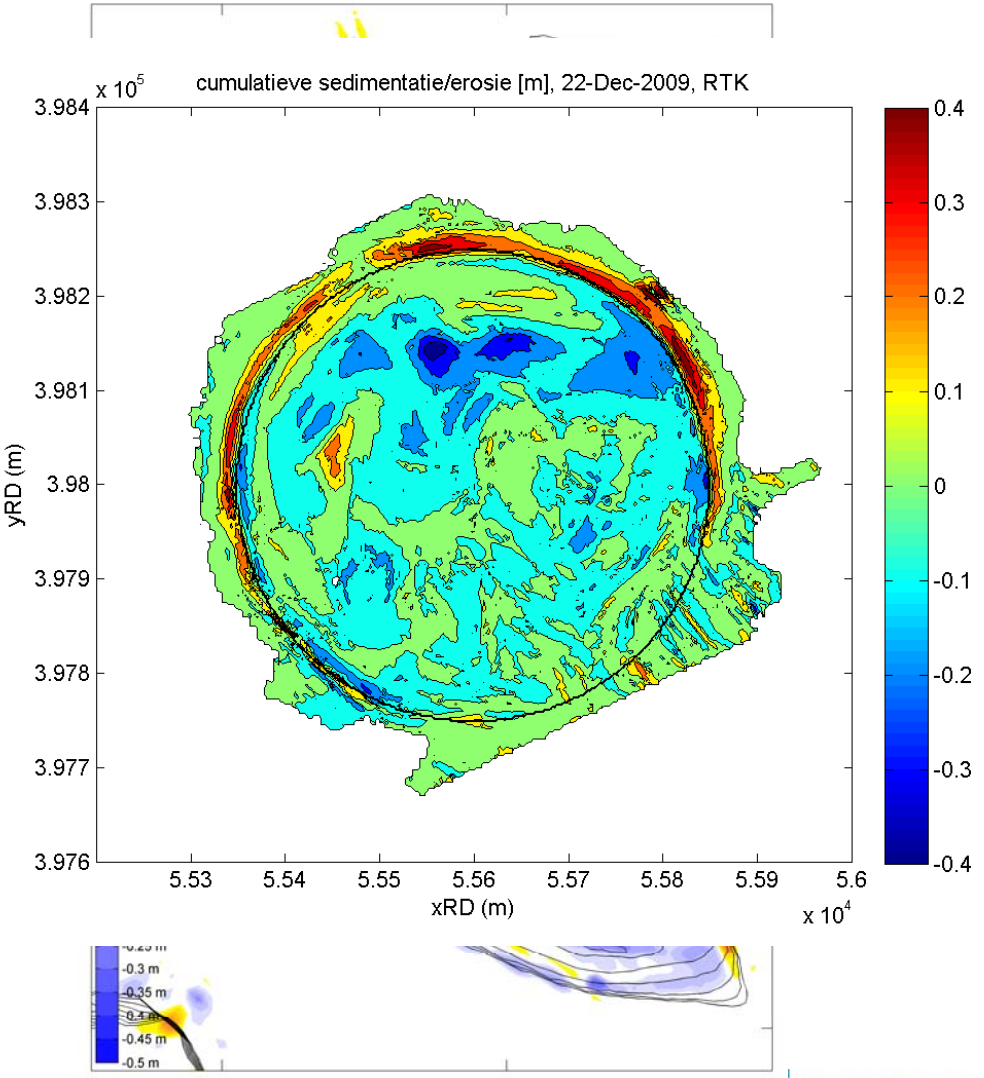
Simulations of morphological development



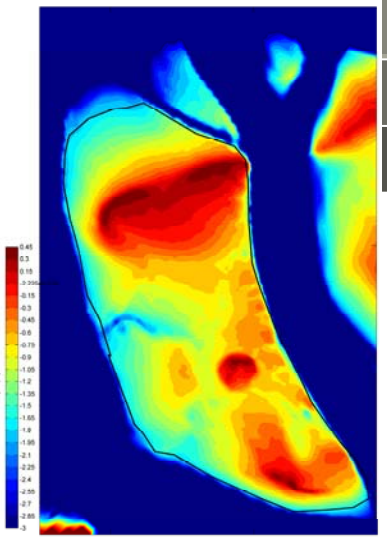


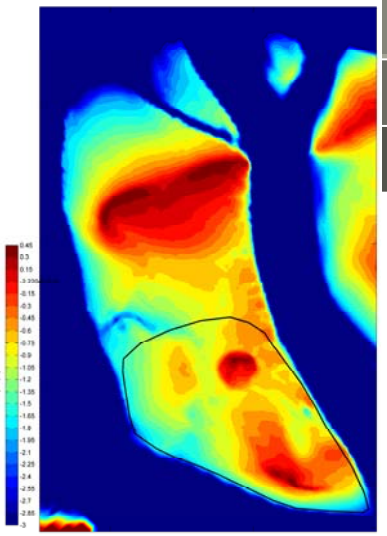
Nourishment scenarios



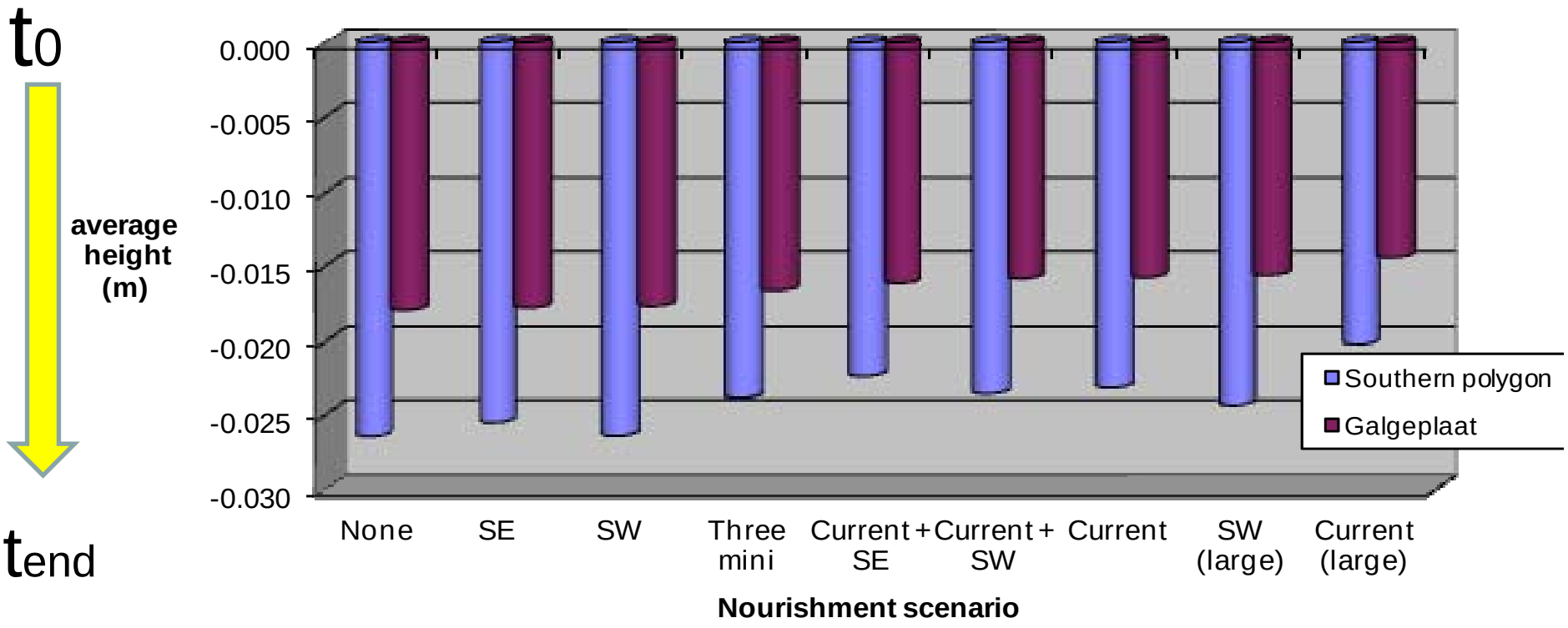


Deltares



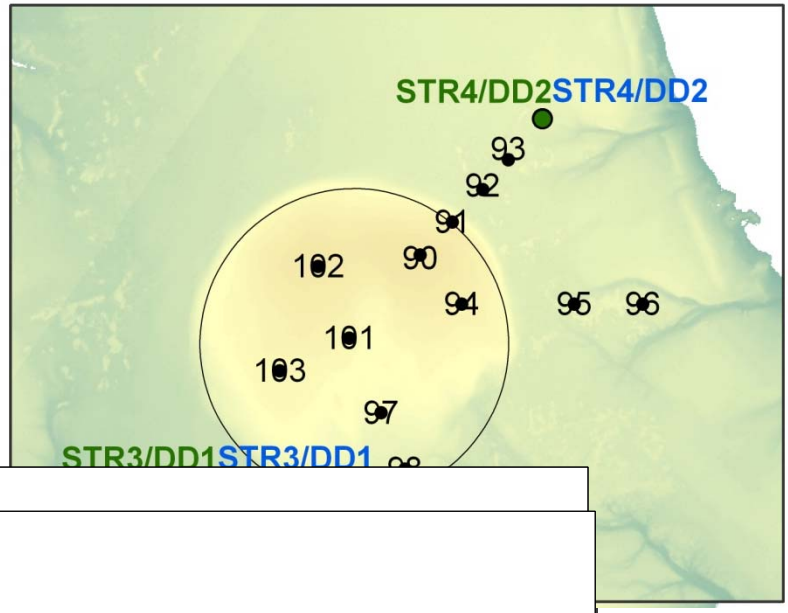


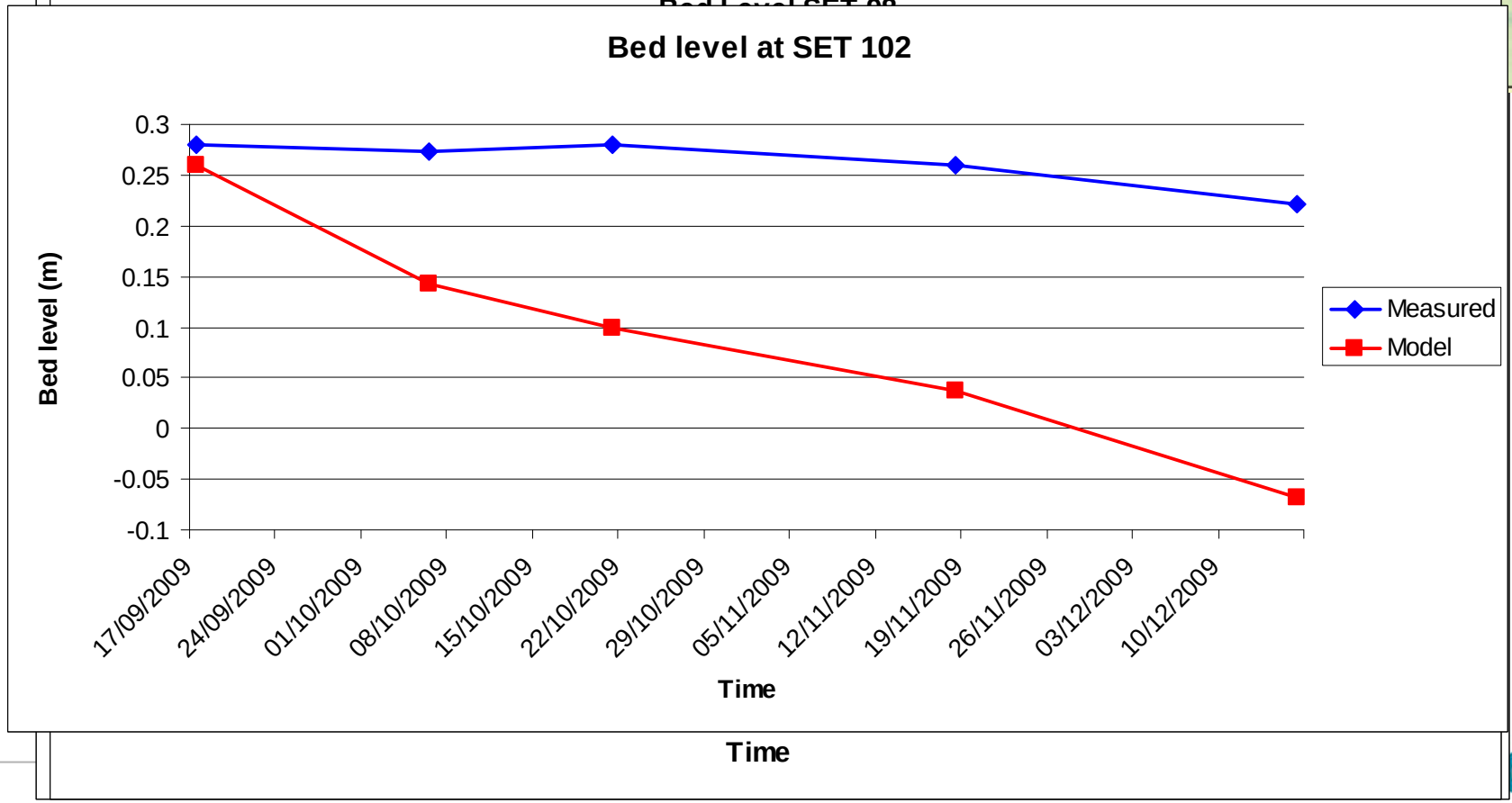
Nourishment scenarios



Comparison to measurements

SET = RTK measurements monthly





Summary and Conclusions...

• Both **wind and current direction** play a role in the correct simulation of significant wave heights on and around the Galgeplaat

• **Morphological patterns** are partly in agreement with observations that show western edge eroding and sediment building up on eastern edge of the flat

•Although the correct **order of magnitude of erosion** is simulated further work necessary to improve the results at specific locations

• Better implementation of **bio-geomorphological effects**

• Model is a **useful tool to test different nourishment strategies** and examine the **driving processes** of sediment distribution i.e. Suspended sediment transport patterns correlate with significant wave height → locally generated waves play important role

• Effectiveness of the nourishment influenced by both **location and bed level**

• Much more to improve – longer term behaviour, grain size variation etc etc....
.....to be continued.....

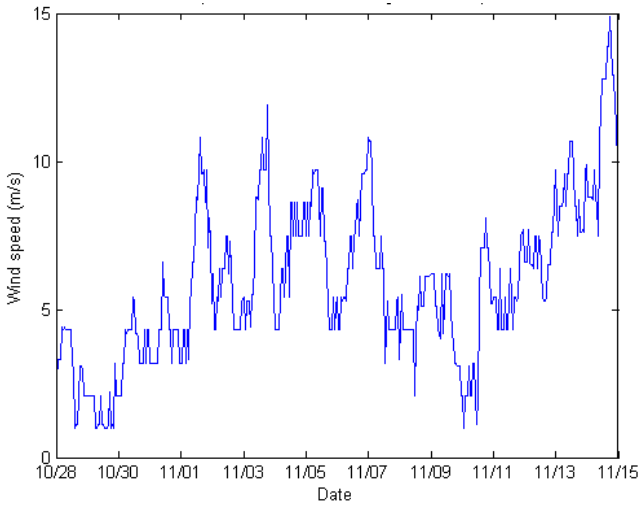
Deltares

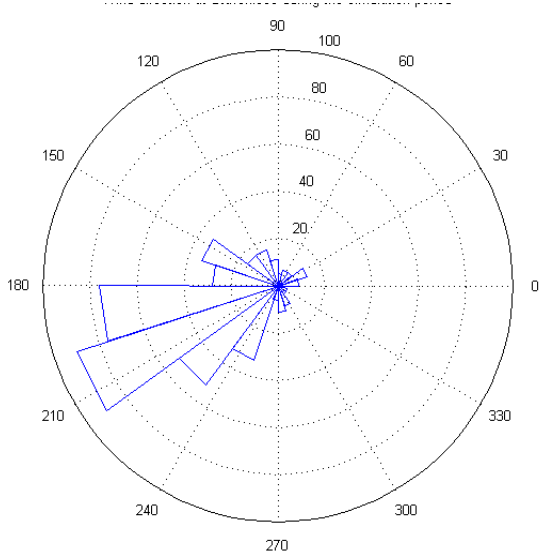
Thank You / Merci – Questions?

Deltares

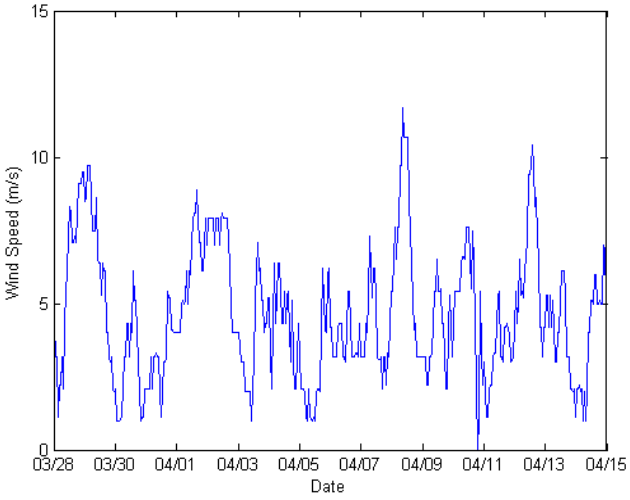
Wind and wave forcing

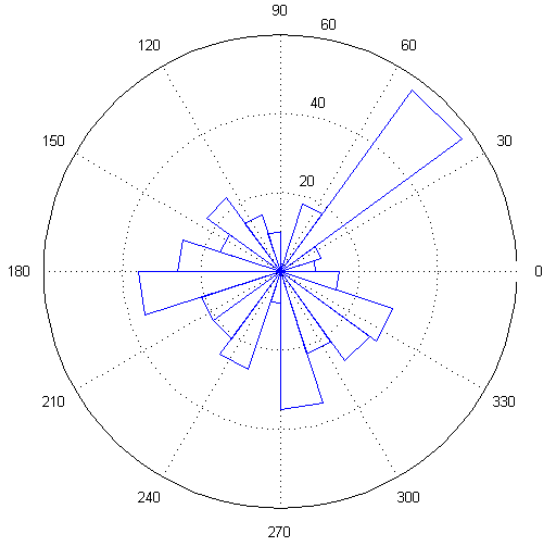
November





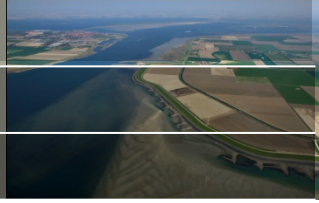
April





Deltares

Volume calculation

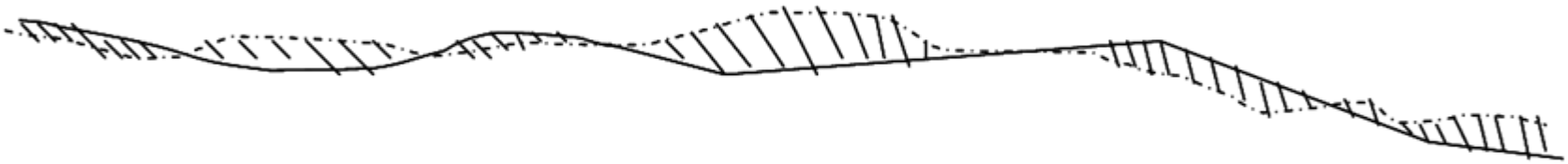


Surface at the beginning of the simulation

Surface at the end of the simulation

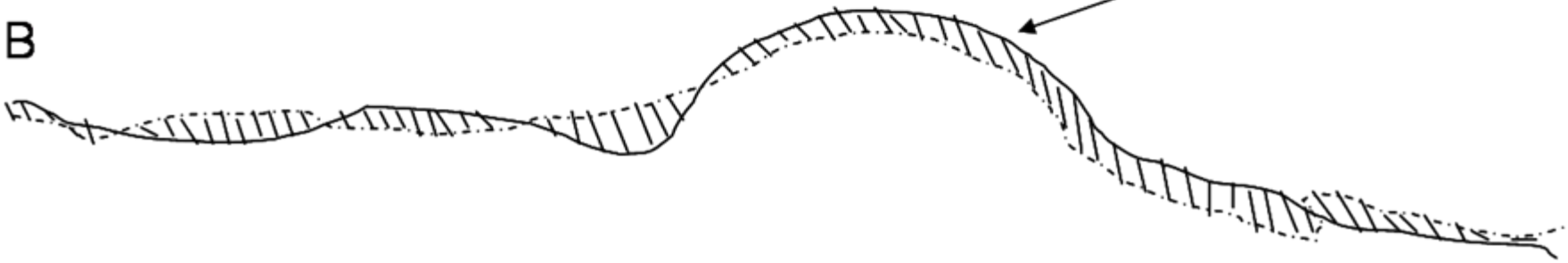
Volume change

A



Nourishment

B



Deltares