



CoSMoS

an operational model system to simulate storm impacts along the Dutch Coast

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Acknowledgments



FloodControl 2015 - innovation programme funded by Dutch government aimed at improving operational flood protection around the world

MICORE – EU research project on morphological impacts and coastal risks during extreme storm events

USGS Coastal Marine Geology group in Santa Cruz (Patrick Barnard)

Motivation



Hinterland well protected by dikes and sandy dunes (1:10,000 year storm)



Motivation

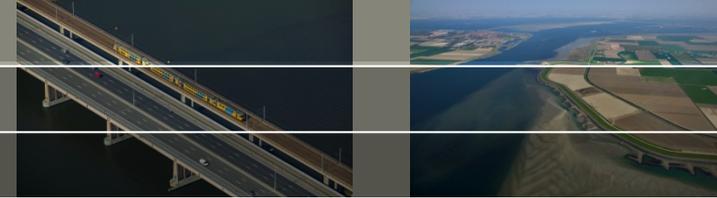


What about people and property on and seaward of dunes?
They risk flooding under more common than normative storm conditions.



© Rijkswaterstaat - 18 oktober 2005 - 11.47 uur

Summary

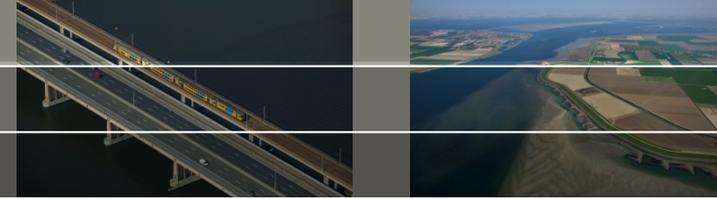


- Development of an operational wave and tide model system
 - Storm conditions (run-up and erosion)
 - Rip currents
 - Provide boundary conditions for BeachWizard data assimilation system
- Nested model approach
- WAVEWATCH III, coupled Delft3D-FLOW - SWAN and Xbeach
- Results presented on web interface with Google Earth plug-in
- Validation of system for 2009 and a number of large storm
- Up-to-date bathymetry from Argus camera system in combination with Beach Wizard at selected sites (not yet operational)

Conclusions

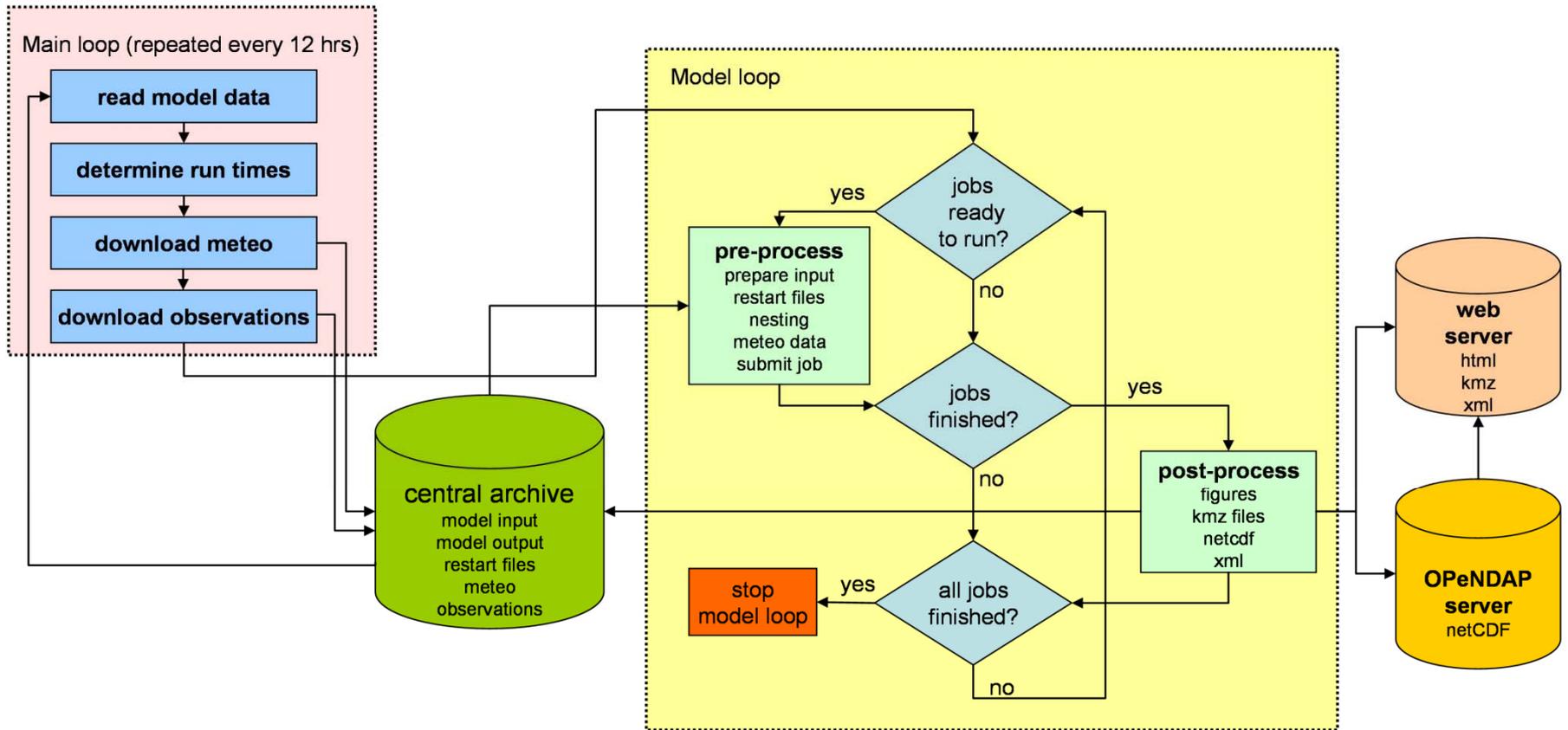


- Model does reasonably well with tides, waves and dune erosion
- More validation needed
 - Beach/dune erosion
 - Rip currents
 - BeachWizard

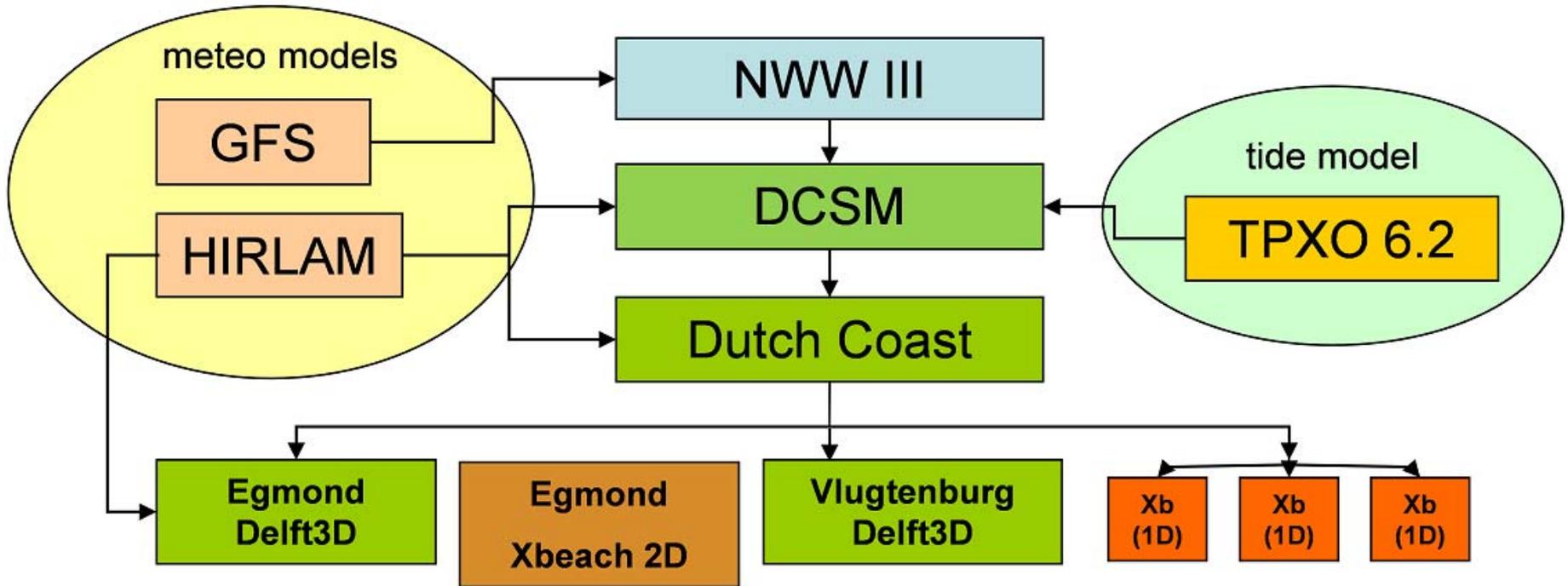


- Easily relocatable and easy to add new models
 - Dutch coast
 - California
 - Hawaiian Islands
 - Gulf of Mexico
- Easy to run in forecast mode or to study historic and future scenarios
- Automated nesting between different models
- Matlab
- System runs on Windows machine
- Simulations submitted to Linux cluster or Windows machine
- 48 hour forecasts (cycle every 12 hours)
- Deterministic approach

Work flow

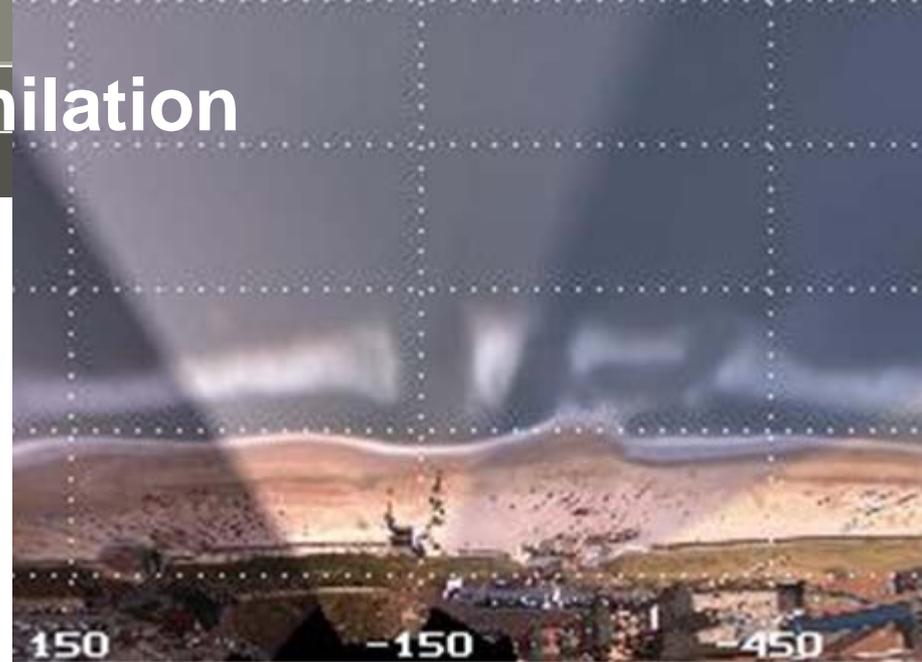


Models - CoSMoS Dutch Coast



BeachWizard data assimilation

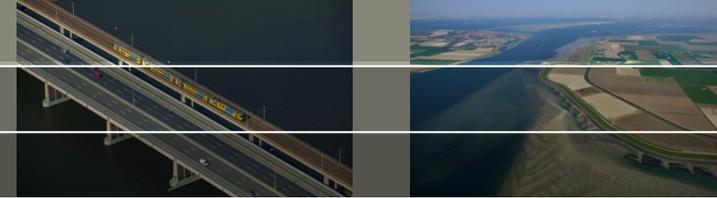
- We need up-to-date bathymetry
 - Beach-dune erosion and run-up
 - Timing, location of rip currents



Egmond aan zee, 26 August 2009

- Compares observed wave dissipation patterns from ARGUS video imagery with computed patterns
- Adjusts model bathymetry where differences are seen
- Uses relation between breaking intensity and local depth

WAVEWATCH III



Cosmos Coastal Storm Modelling System | **Rip Currents** DUTCH COAST | **Deltares** Flood Control 2015

Forecasts - NWW3 global 1x1.25 degr. Last update: 01 Nov 2011 08:19:23 (CET)

Navigation menu:

- Home
- About CoSMoS
- Rip currents
- Real-time forecasts
- Historical runs
- Field area
- Validation
- Useful links
- Contact

Map controls:

- Models: NWW3 global 1x1.25 degr. [Info]
- Stations: Select a station [View]
- Maps: Sea front wave height [View]
- Available Times in Map: Fri, 4 Nov 2011 00:00:00 UTC
- Animation Controls: Play, Delete
- Speed: Medium, Opacity: 100%

Models:

- WAVEWATCH II
- De IJSD
- XBeach

Stations:

- wave buoy
- tide station
- meteo station

Map legend: Models Stations Hazards Places

<http://cosmos.deltares.nl>

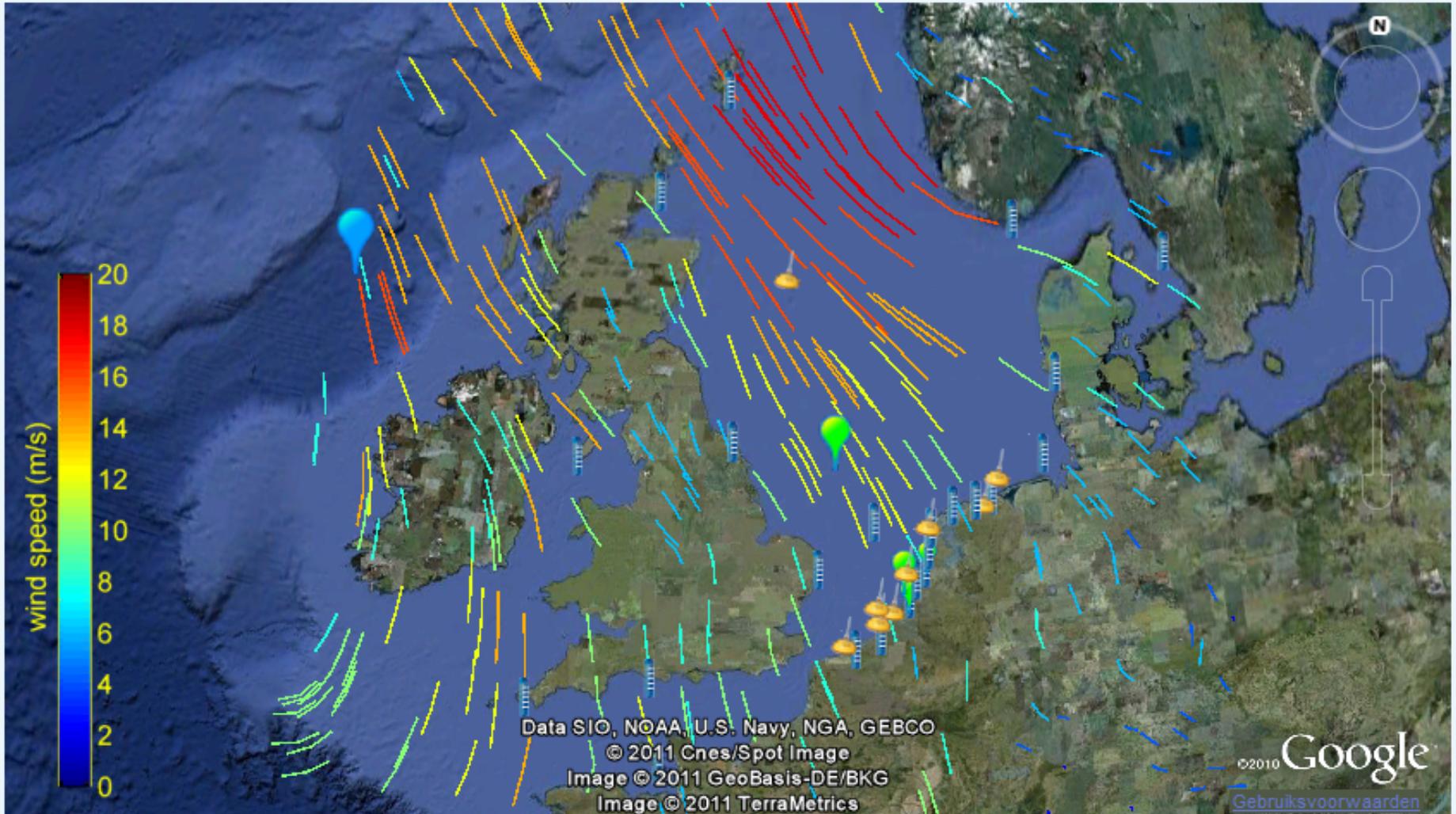
Deltares

Continental Shelf Model (DCSM)

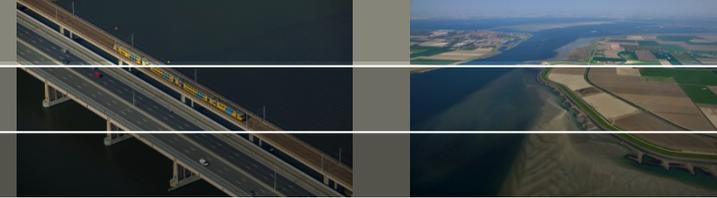


Forecasts - Dutch Continental Shelf Model

Last update : 04-Nov-2011 00:59:58 (CET)

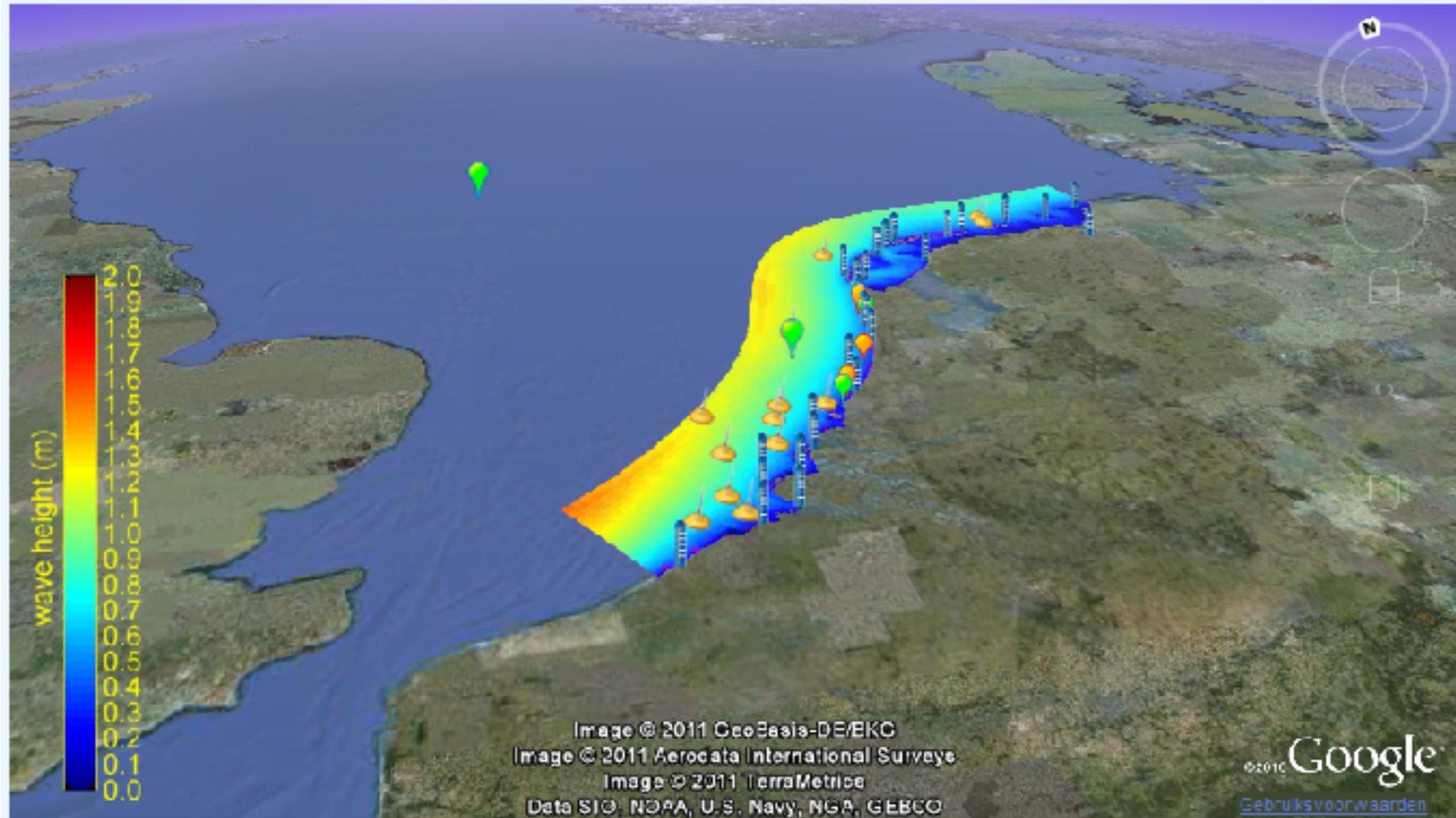


Dutch Coast Model



Forecasts - Kuststrook

Last update . 04 Nov 2011 03.14.11 (CET)



Models Stations Hazards Places

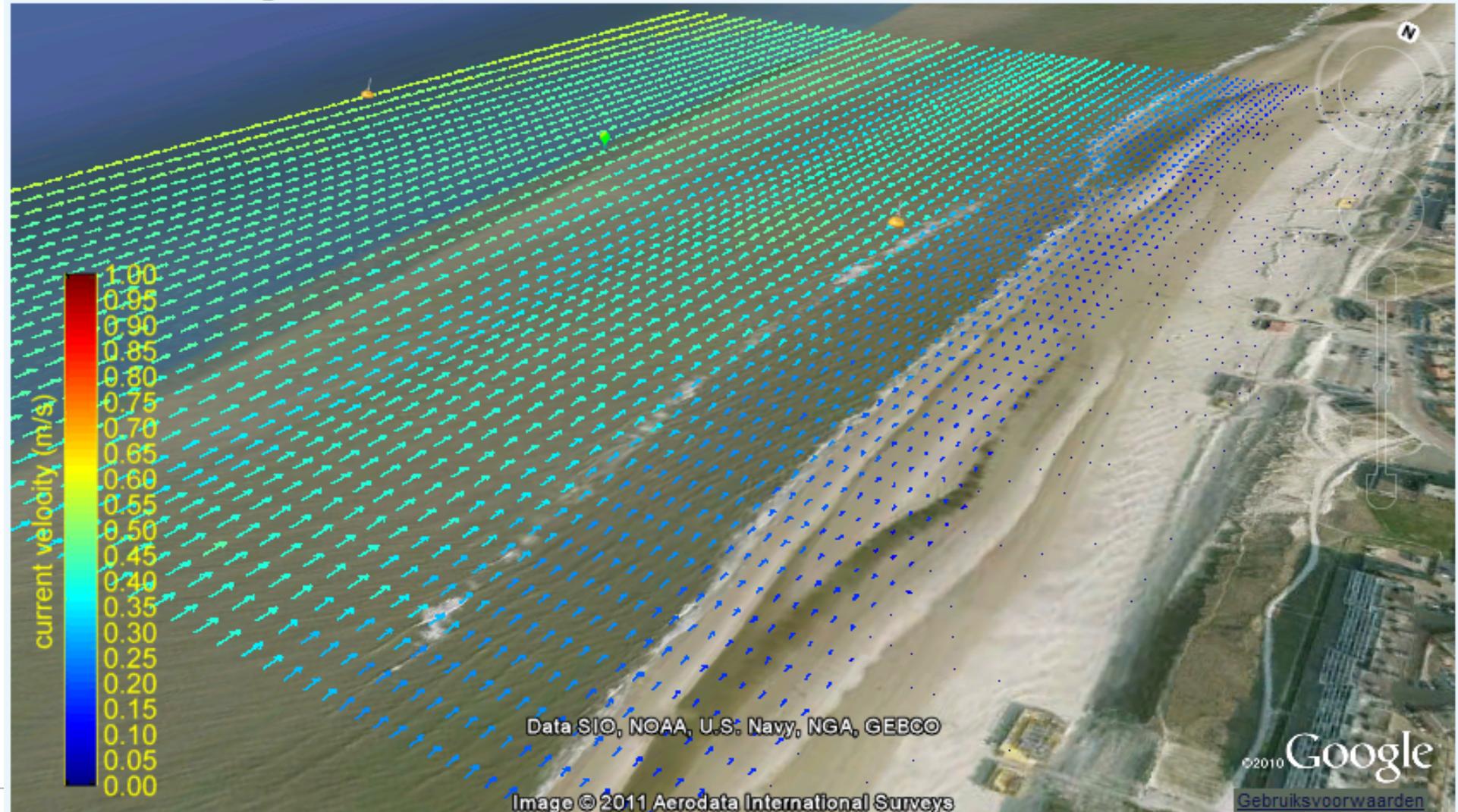
19 januari 2012

Egmond (Delft3D)



Forecasts - Egmond Delft3D

Last update : 04-Nov-2011 05:37:55 (CET)



current velocity (m/s)
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00

Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image © 2011 Aerodata International Surveys
19 januari 2012

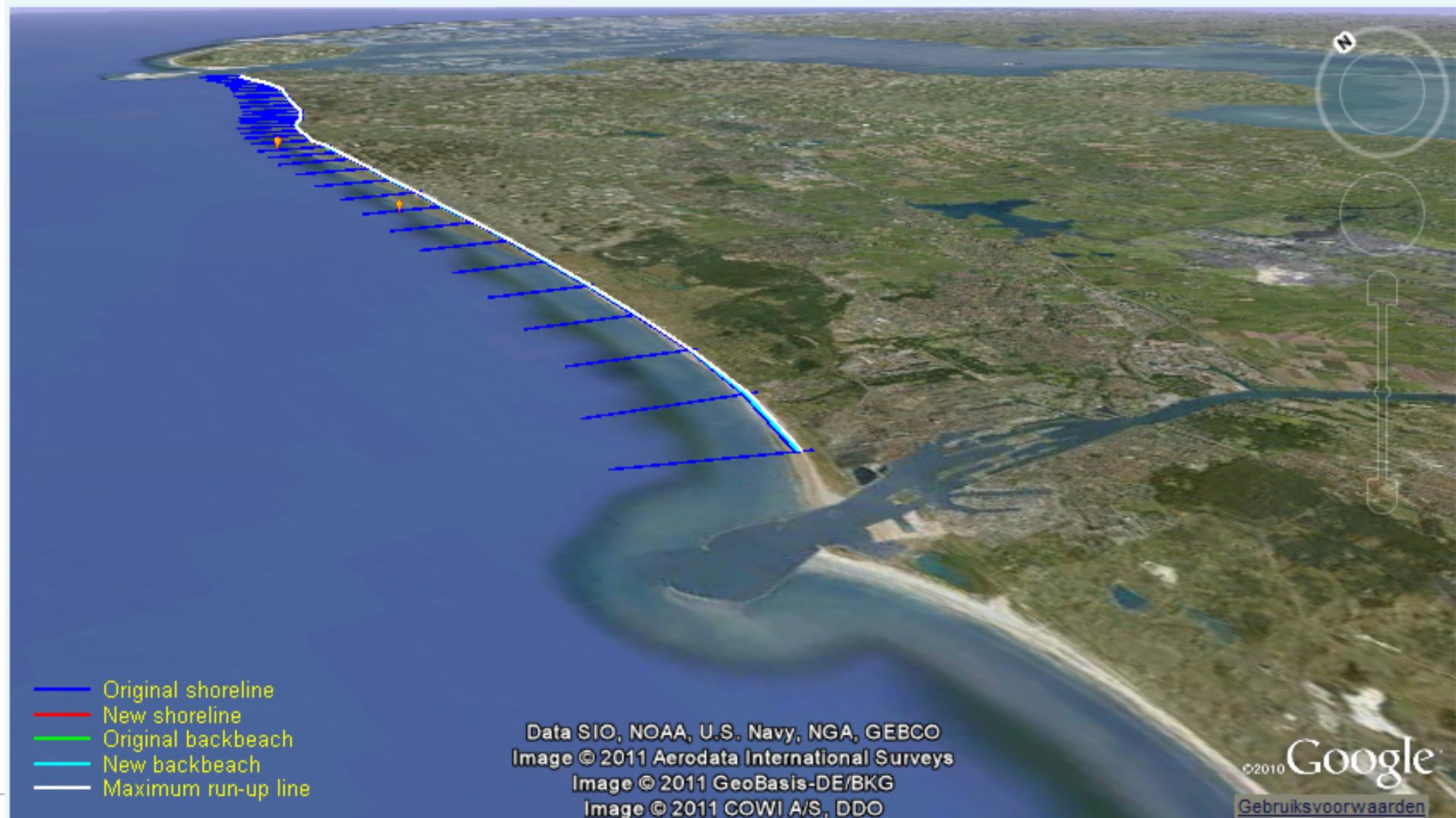
©2010 Google
Gebruiksvoorwaarden

Xbeach profile models

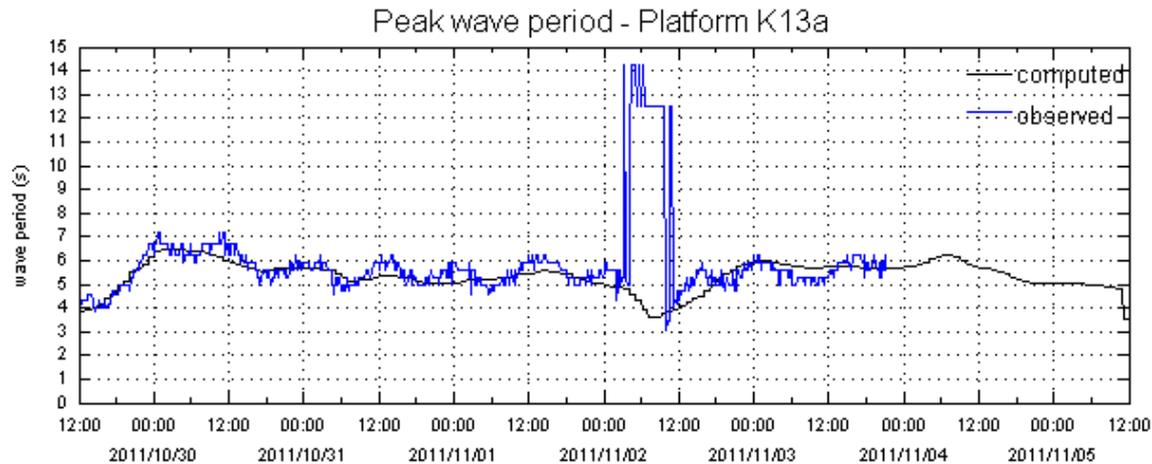
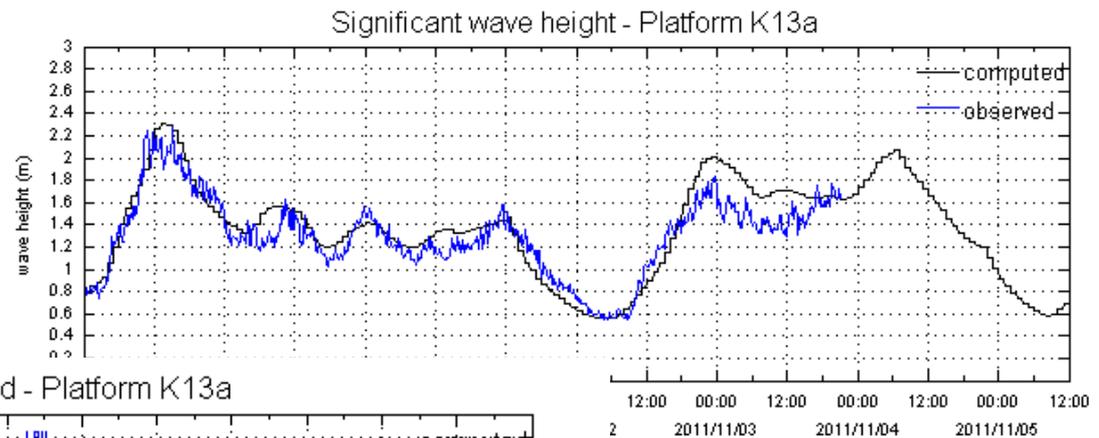
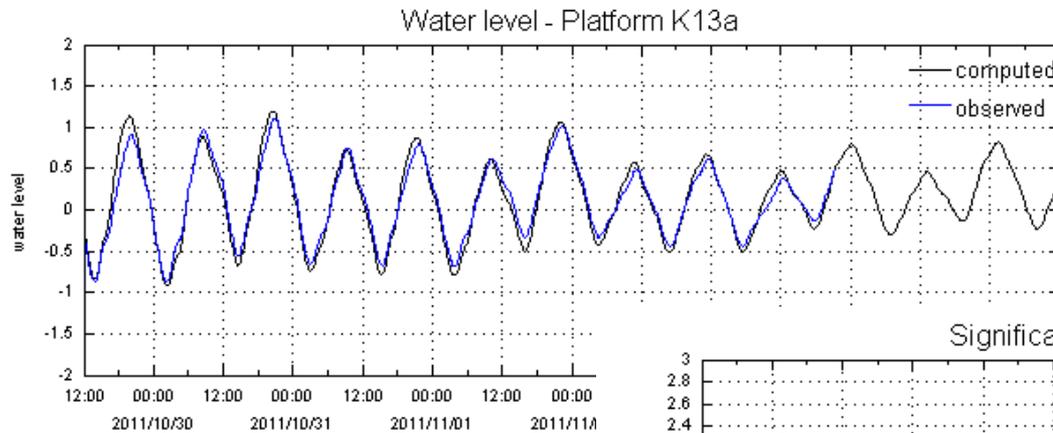
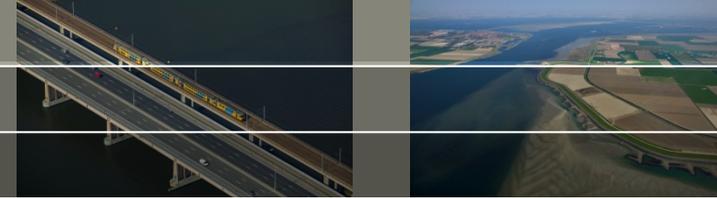


Storm 1953 - Noord-Holland X

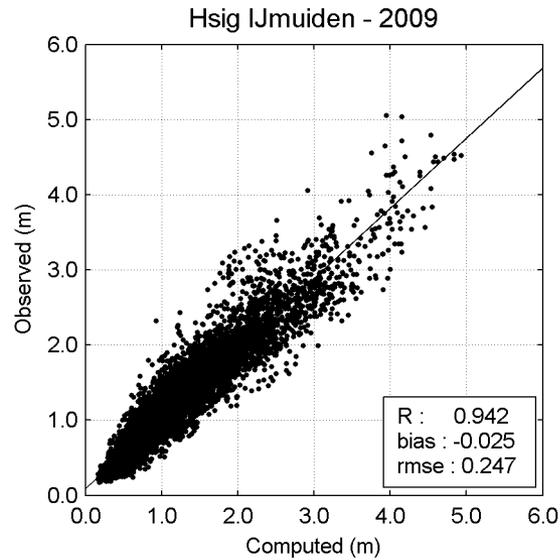
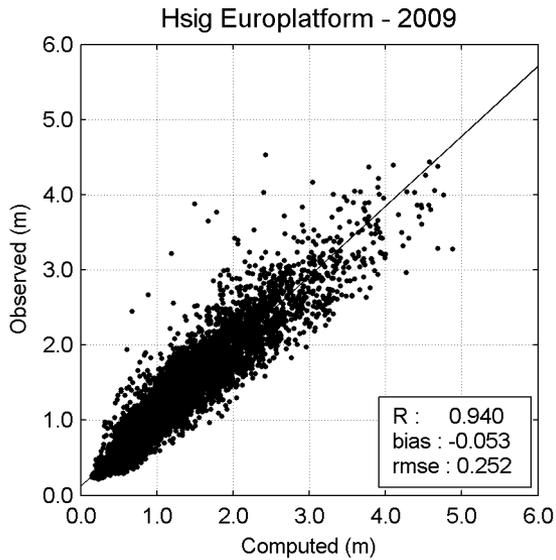
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Recent result Platform K13

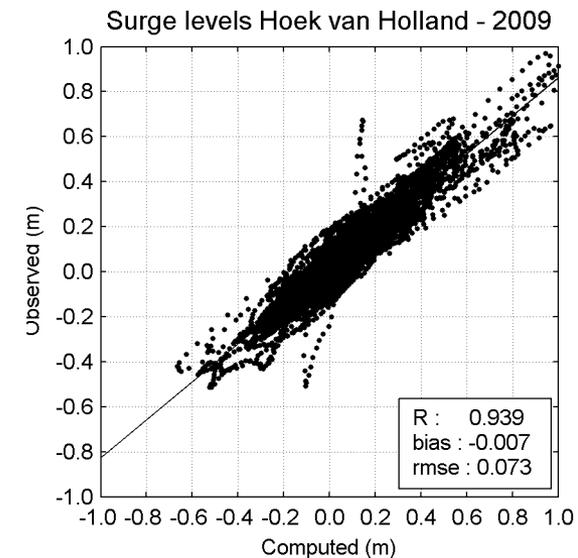
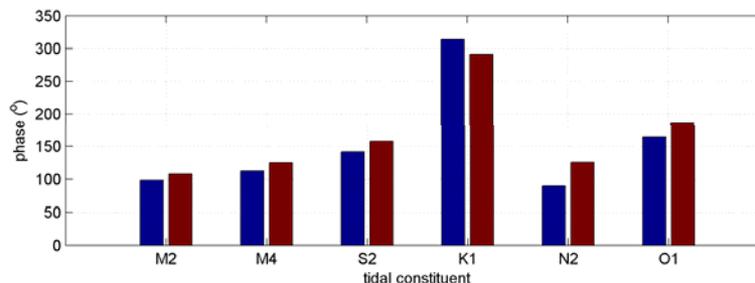
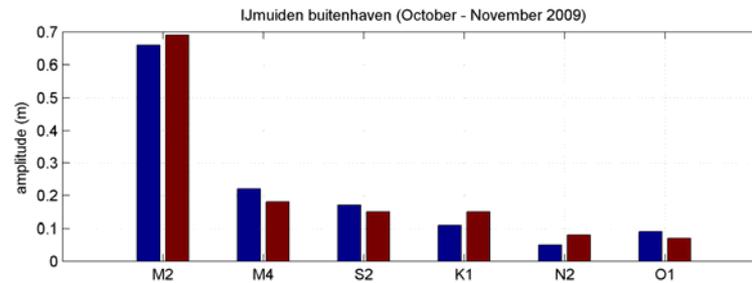


Hydrodynamic validation – 2009 hindcast

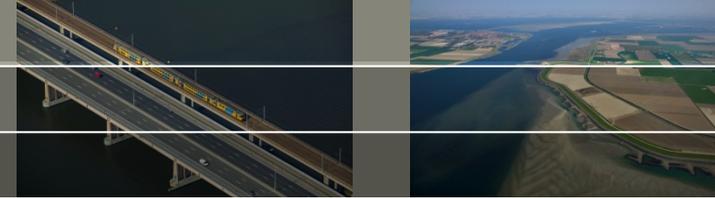


← Wave heights at Europlatform and IJmuiden

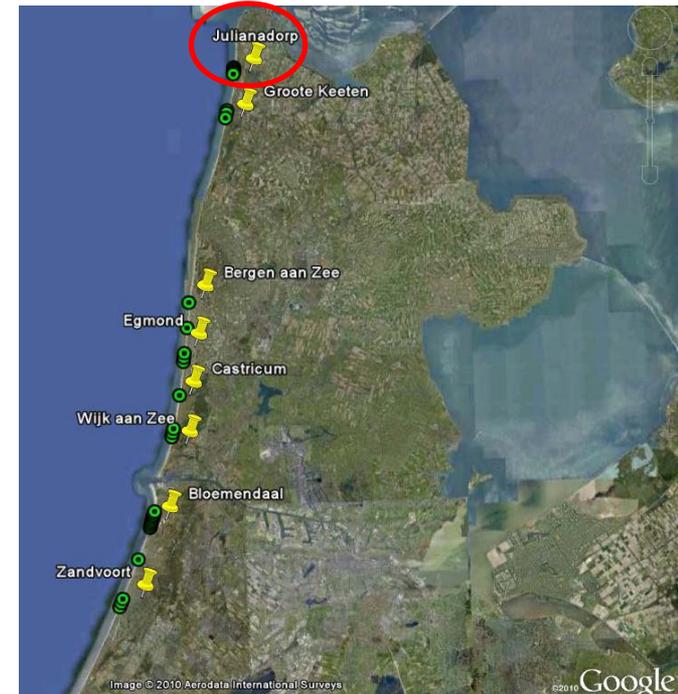
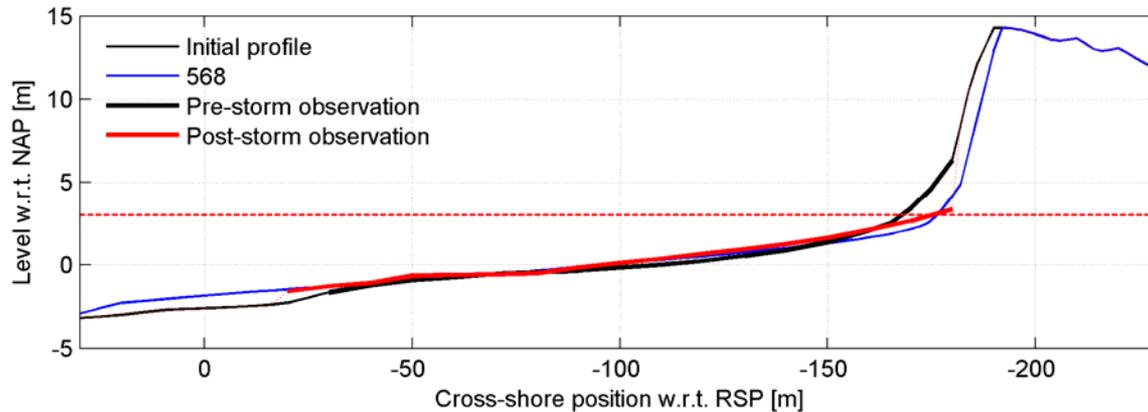
Water levels at Hook of Holland



Morphodynamic validation



Julianadorp (no. 568)



January 3rd 1976

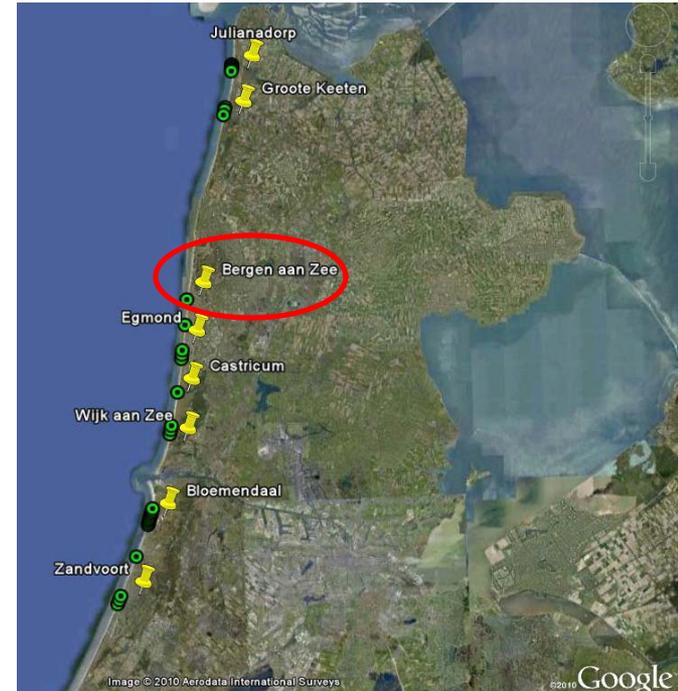
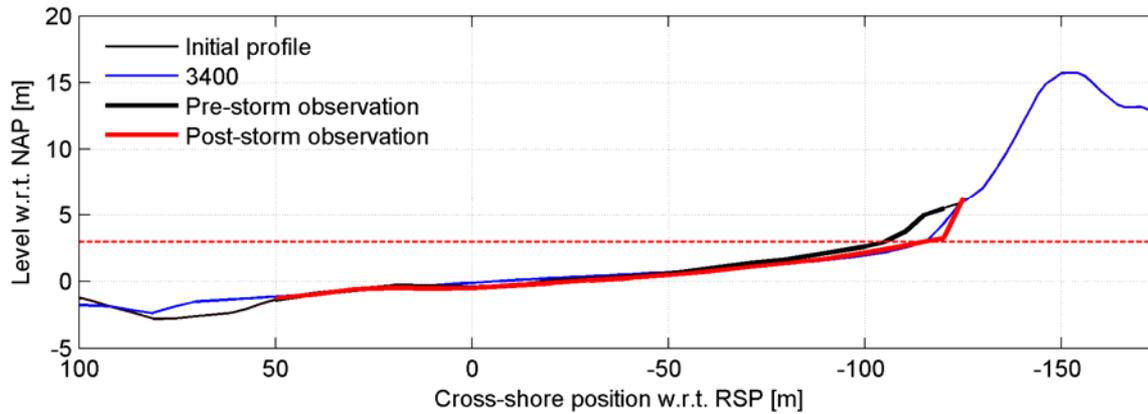
Largest storm since the 1953 storm disaster

Previously presented by Van der Werff at Coastal Sediments 2011

Morphodynamic validation



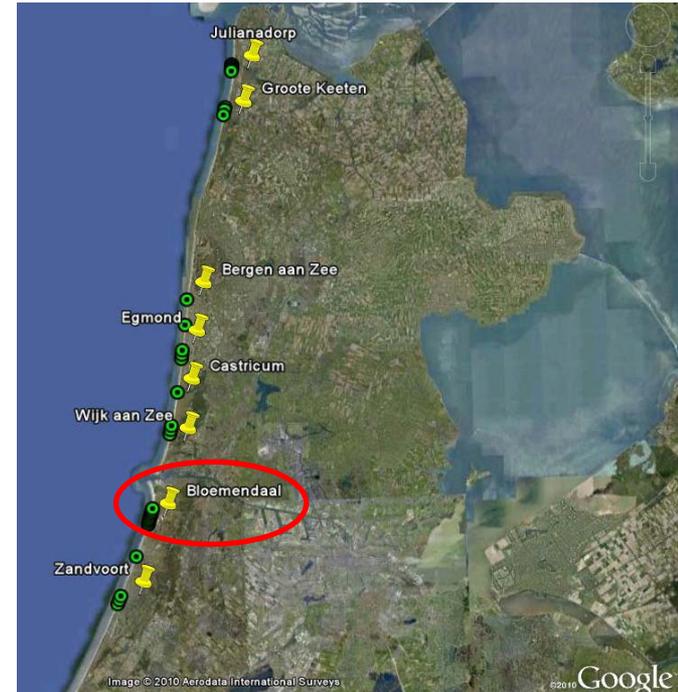
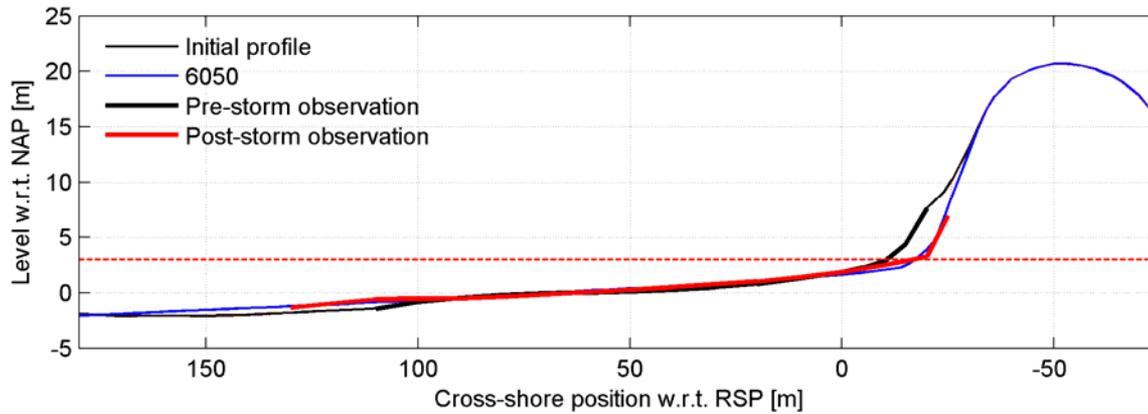
Bergen aan Zee (no. 3400)



Morphodynamic validation



Bloemendaal (no. 6050)



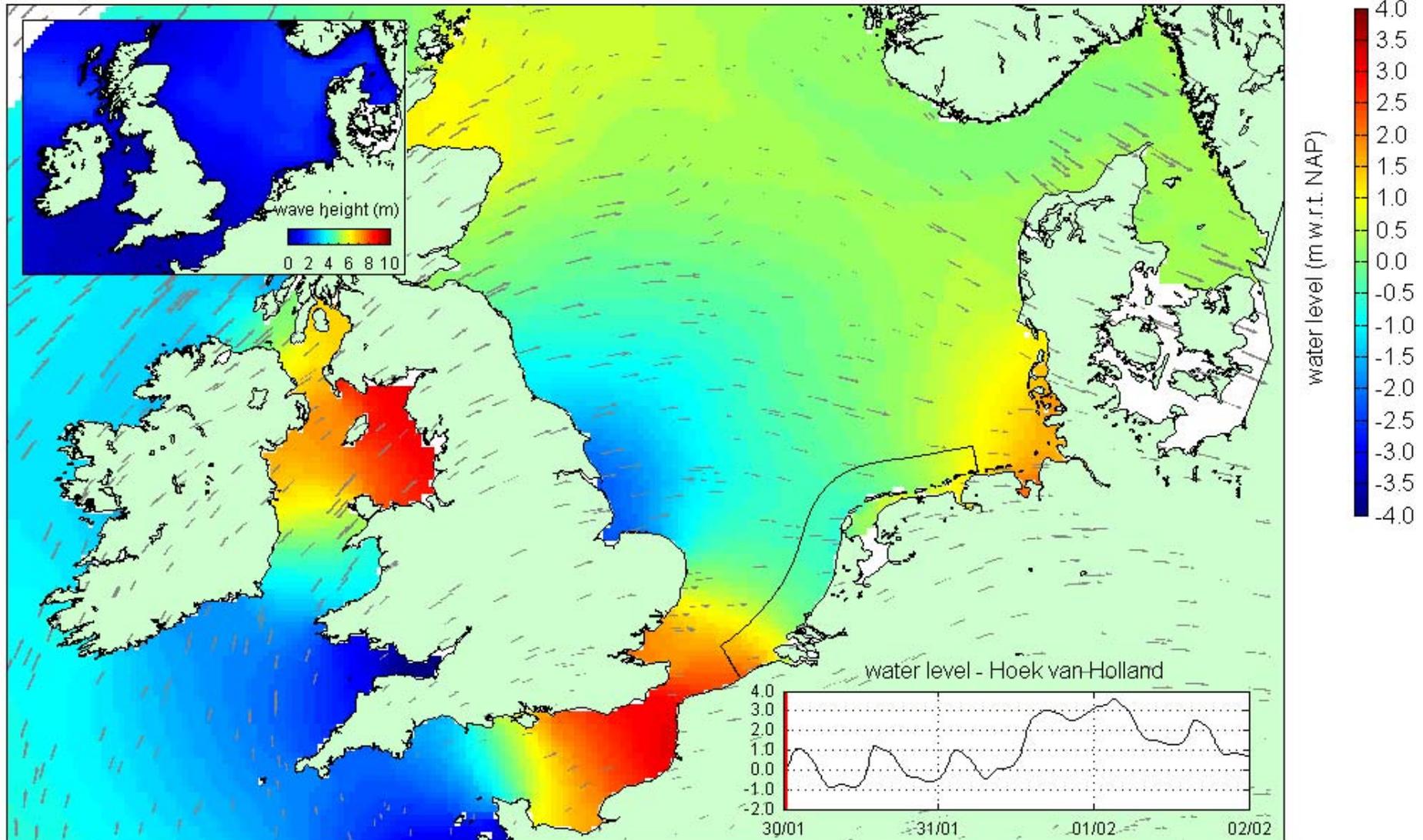
The 1953 storm



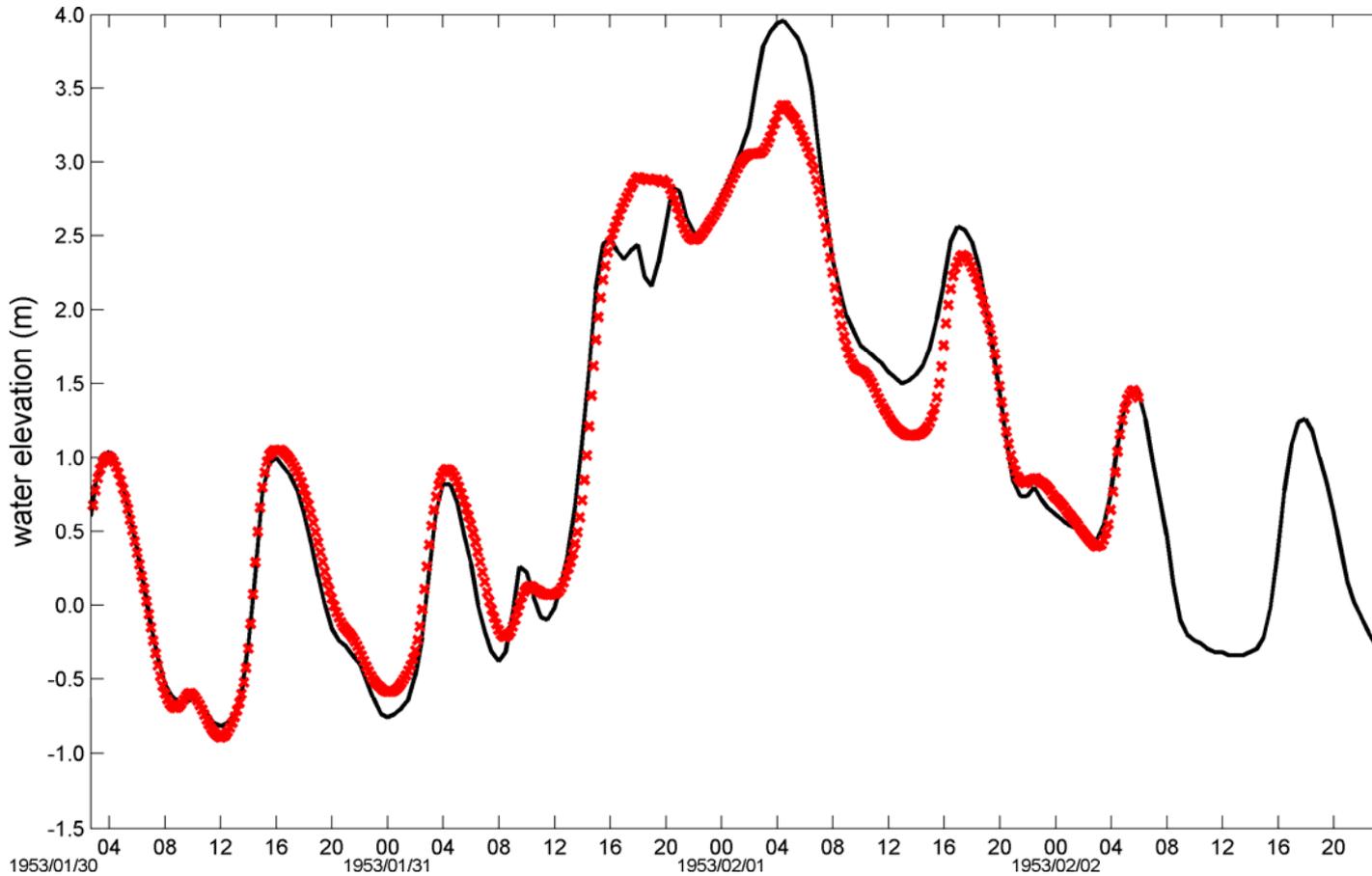
Killed 1800 people
100,000 people homeless

The 1953 storm

North Sea storm surge - January 1953

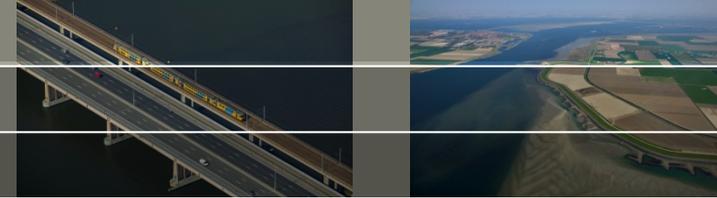


Water levels Hook of Holland 1953

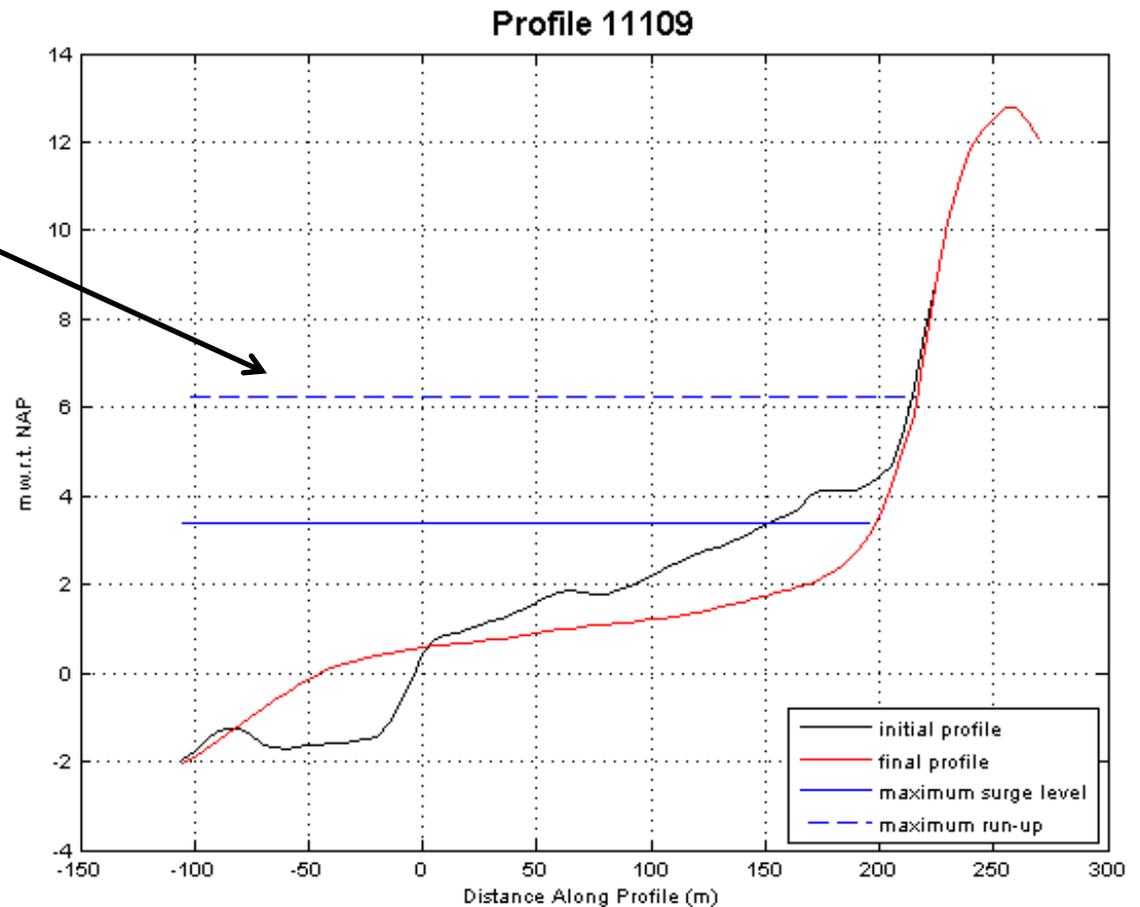
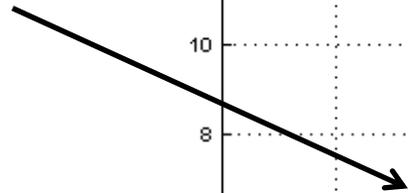


RED COMPUTED
BLACK OBSERVED

Erosion Delfland 1953



Infragravity run-up, not short wave



Observed dune erosion $\sim 90 \text{ m}^3/\text{m}$ along Delfland coast

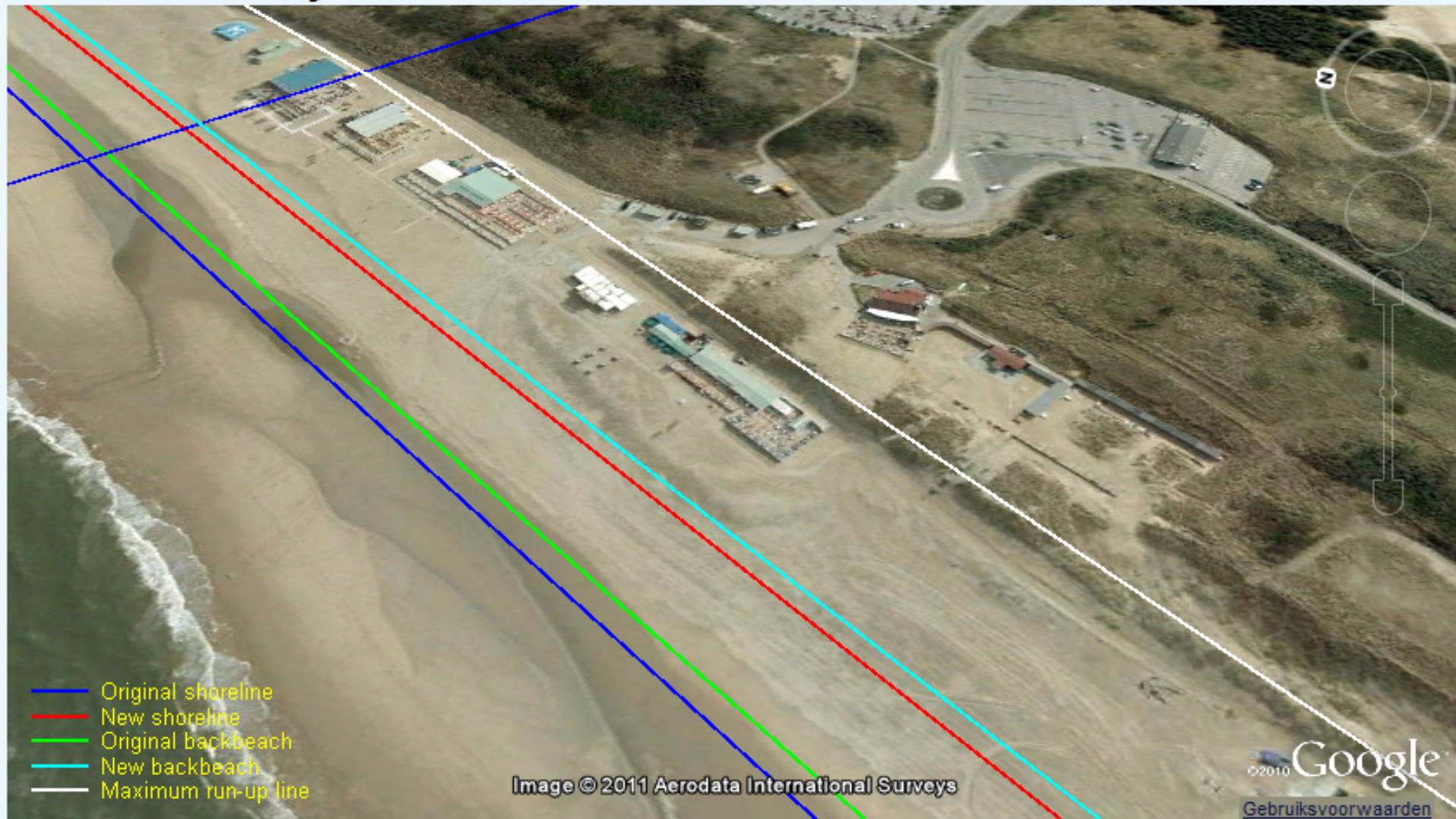
Computed dune erosion $\sim 60 \text{ m}^3/\text{m}$

Run-up and erosion



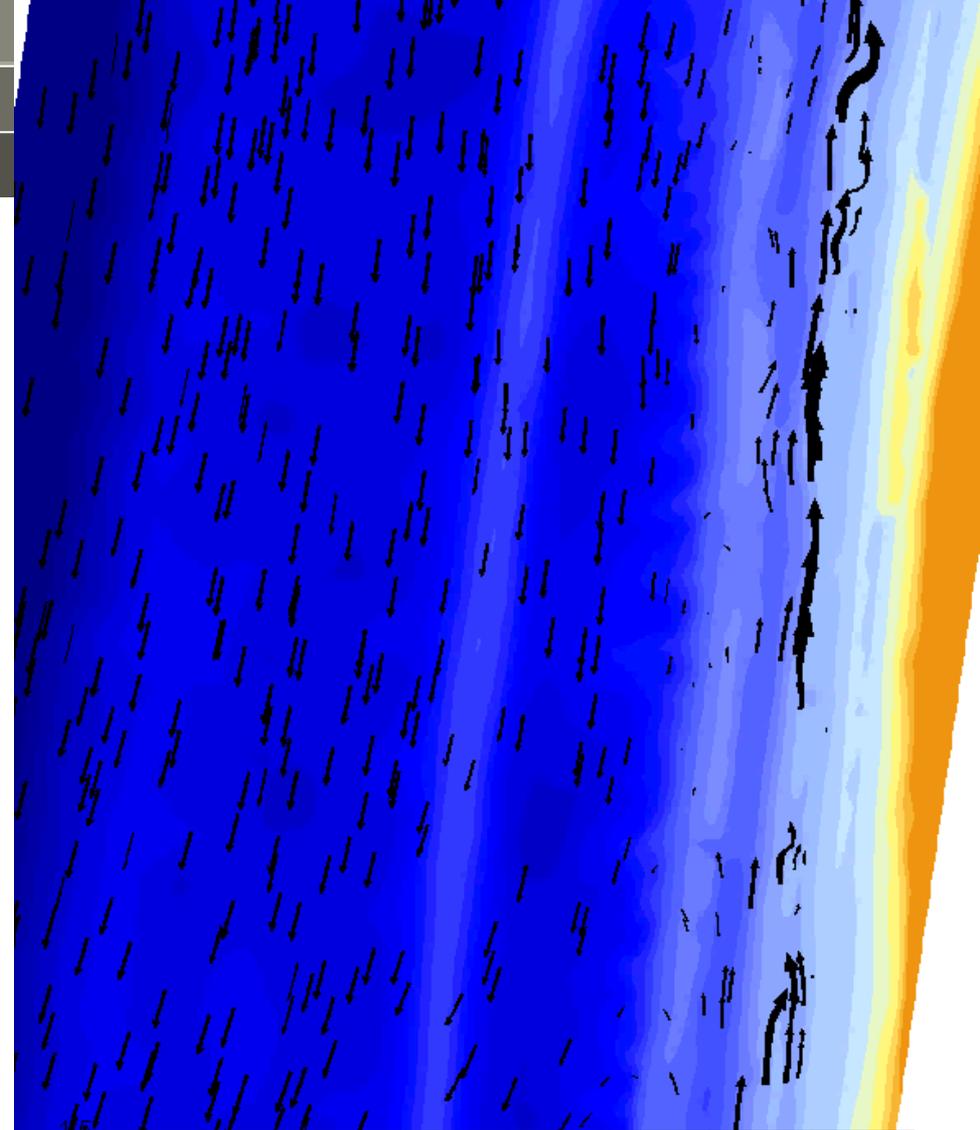
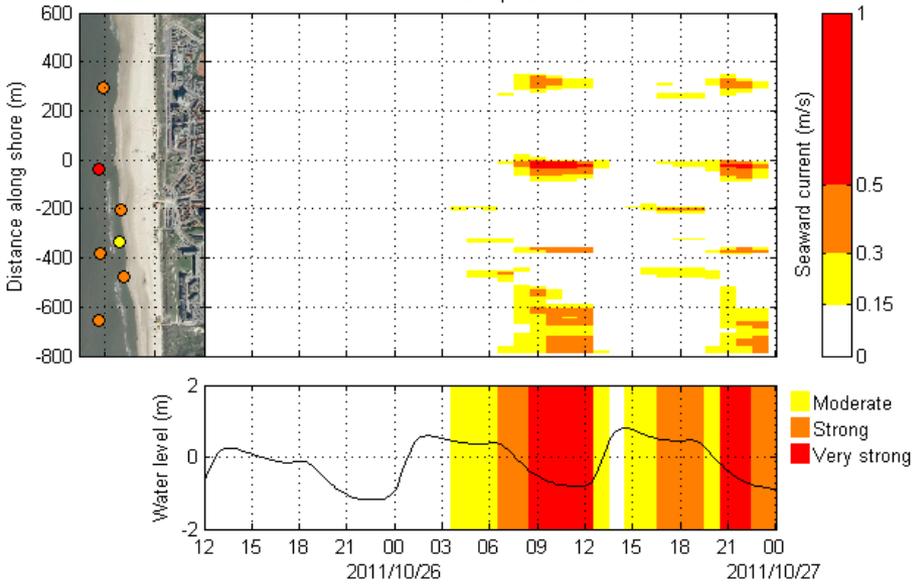
Storm 1953 - Rijnland X

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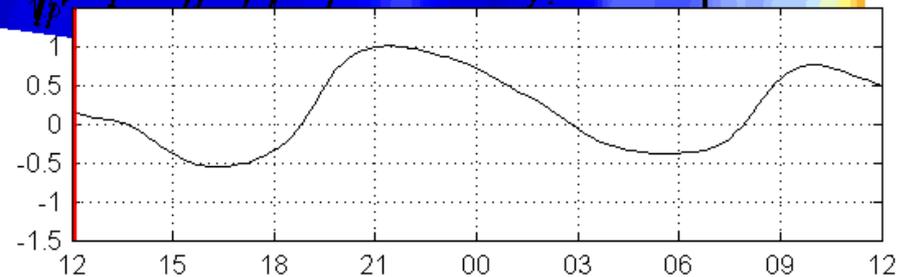


Rip currents Egmond

Time-stack rip currents



Latest bathymetry obtained from Argus/
BeachWizard



Conclusions



- Development of operational system
 - Open source: www.openearth.eu
- Model does reasonably well with tides and waves
- More validation needed
 - Beach/dune erosion
 - Rip currents
 - BeachWizard
- We are waiting for a storm. A big one preferably.