Assimilation of scatterometer winds in HARMONIE for wave and surge forecasting near the coast

Ad.Stoffelen@knmi.nl
Hans de Vries (KNMI)
Martin Verlaan (Deltares)

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Jan Kroos (SVSD)
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Martin Verlaan (Deltares)
That’s why we needed wellies in Venice!
Progress surge forecasts

- Maeslantkering requires $\sigma < 15 \text{ cm} (0.1 \text{ yr}^{-1})$
- Developments:
  - High resolution models (weather, surge)
  - Data assimilation water levels, incl. EO (Kalman filtering)
  - Improved interaction hydrologists and Meteorologists
- In 2007 standard deviation (RMSE) surge forecasts reached $\sigma < 15 \text{ cm}$
What’s next

Take away remaining uncertainties:

- Mesoscale wind forcing
- Air-sea interaction (momentum flux)
- Improving water-level representation inside estuaries and shallow seas (increased resolution)
- Data assimilation of heights and winds to increase predictive quality for the shorter lead times (<12 h)
- Steric effects (salinity, SST)
Mesoscale meteo oscillations

Convective cells

HOEK VAN HOLLAND

23 cm

22 cm

24 cm
Harmonie regional model

- Non-hydrostatic
- 800x800 grid
- 2.5 km grid size
- 3D-var assimilation
  - 8 times per day
  - 48-hour forecast
- ECMWF boundaries
- Available since 1/1/2012
- Oper. cycle: cy36h1.4
- Research: cy37h1.2, soon cy38h1.1
Harmonie experiments: verification

1. NoDA: No data assimilation
2. Conv: Assimilation of conventional observations (TEMP/Aircraft/SYNOP) only
3. Conv + ASCAT/QSCAT (default settings)
4. Conv + ASCAT – no thinning

Conclusions
- Assimilation of observations does not improve forecast skill
- ECMWF outperforms Harmonie
- Harmonie small-scale spatial structures do not verify
- Too much weight is given to observations
Maeslantkering closure

- Surface winds from HARMONIE model at 1.7 km grid
- HARMONIE shows mesoscale structures
Model wind averaging compares better to observations

Small scale model structures realistic but probably not real

Investigate realism
Mesoscale DA challenges

- Default: 3D-Var with 3-hr assimilation window
  - Time mis-match between asynoptic (satellite) observations and analysis time
  - Harmonie small-scale spatial structures look realistic but are not real, i.e., they do not verify with observations
  - Harmonie exaggerates strong winds

- New developments at KNMI
  - 4D-Var is running in experimental mode
  - 3D-Var Rapid Update Cycle (1-hr window)

- Collaborative/coordinated effort on mesoscale DA within Hirlam/Harmonie consortium and at IWW workshop

Optimal use of observations in meso-scale DA
“New” QuikSCAT reduces HARMONIE bias substantially

Closure Maeslantkering 9 November 2007 06 UTC

Surface wind speed

FC+03; first-guess

Analysis; old QuikSCAT

Re-processed QuikSCAT overpass 04:30 UTC

Analysis; re-processed QuikSCAT

FC+03; old QuikSCAT

HARMONIE bias substantially reduces
HARMONIE recovers bias in about 3 hours.
Next steps

- Period 4 (6/12/2011 – 6/1/2012)
  - ASCAT/OSCAT assimilation
  - Test error growth
  - 3D-Var Rapid Update Cycle (1-hr)

OSCAT (25-km product) assimilated in HARMONIE for the first time!