Cyclone Xaver seen by Geodetic Observations

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Cyclone Xaver pounded the North Sea on 5-6 December 2013 and reached its maximum in the German Bight the second day. The radar altimeter on-board the SARAL/AltiKa satellite measured the largest storm surge signal captured by satellite altimetry to date, nearly 3 m, at the maximum. A local dense network of in-situ stations (tide gauges and GPS) monitored the event over several days. The combined geodetic measurements detect alongshore and cross-shelf surge variations and land subsidence.

The GPS network detects a maximum land subsidence at the GPS locations of 4-6 cm, in excellent agreement with the loading of the predicted surge by two forecast models in both measure and occurrence. The differences between the surge model predictions at the peak event are mainly caused by different wind forcing and reduce from 1 to 0.3 meters when the same wind forcing is used in both models.

Observations largely agree with model predictions on wind speed (Root-Mean-Square (RMS) of the differences is 4 m/s) and surge height (RMS 30 cm) and mostly differ on wave height (RMS 2 m).

The temporal and spatial characteristics of the surge and vertical displacement derived from the observations along the coast agree with the simulations. The water height indicates both a direct large scale forcing and a shelf wave dynamics with anticlockwise propagation of the surge. Instead, the temporal and spatial evolution of the vertical displacement appears to be mainly affected by this last component. After post-processing, the 1-minute sampling GPS time series monitor very well the propagation direction of the storm; the maximum subsidence is reached in the stations following the anticlockwise path of the surge. The along-track off-shore observations provided by satellite altimetry are valuable information to validate the simulations off-shore.

The results underline the importance of geodetic measurements in improving existing forecast approaches.

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