ALTIMETRY AND SEA-STATE FORECASTING AT MÉTÉO-FRANCE

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Forecasting sea-state is part of the Météo-France mission to help protect life and property. A number of numerical wave forecasting models have been produced. The VAG model, developed in the mid-1980s, has been operational in the North Atlantic since 1988 and in the western Mediterranean since 1991.

These models provide a statistical description of the waves and can be used to characterise them from their energy density directional spectra. This, in turn, makes it possible to deduce the mean height, mean wavelength and mean wave train propagation direction.

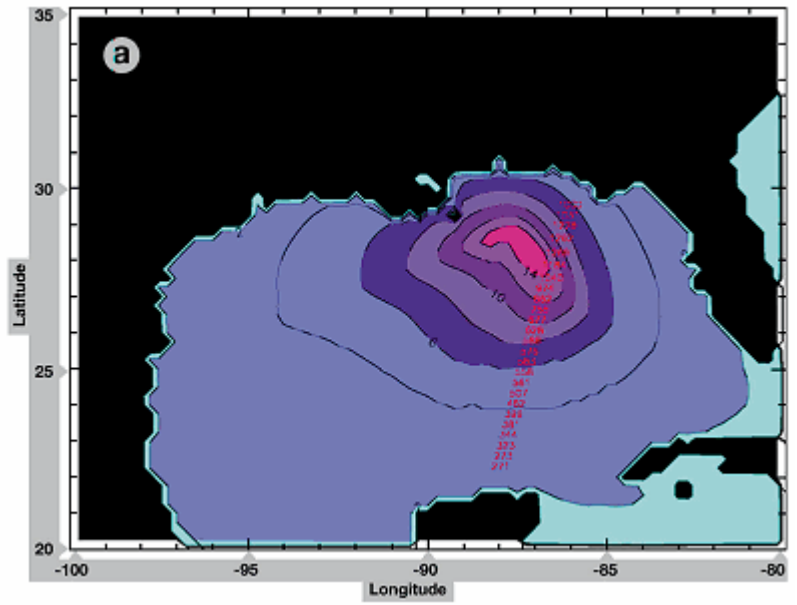
Introduction

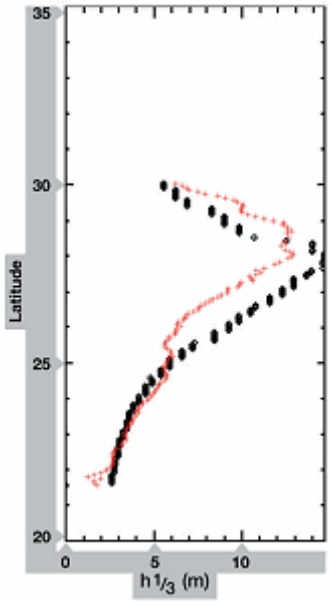
In the last decade, many researchers have joined together in the WAM group to improve the physical components of wave models. In 1991 the work led to the development of the operational WAM model at the European Centre for Medium-Term Weather Forecasts (ECMWF). Having been involved in the WAM group and contributed to the special ECMWF wave project, Météo-France now has worldwide WAM model forecasts, with 0.5° resolution.

Model-enhancing data

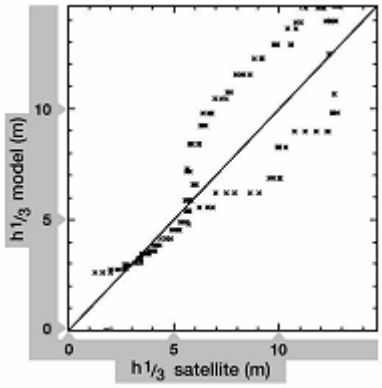
Météo-France also uses the WAM model for retrospective simulations. WAM 's behaviour has been studied and compared with that of the VAG model, which is simpler and uses less computer time. VAG performance was recently improved by jointly using SEMAPHORE experiment data [Eymard et al., 1994] and ERS and TOPEX/POSEIDON (T/P) altimeter data [Fradon et al., 1996].

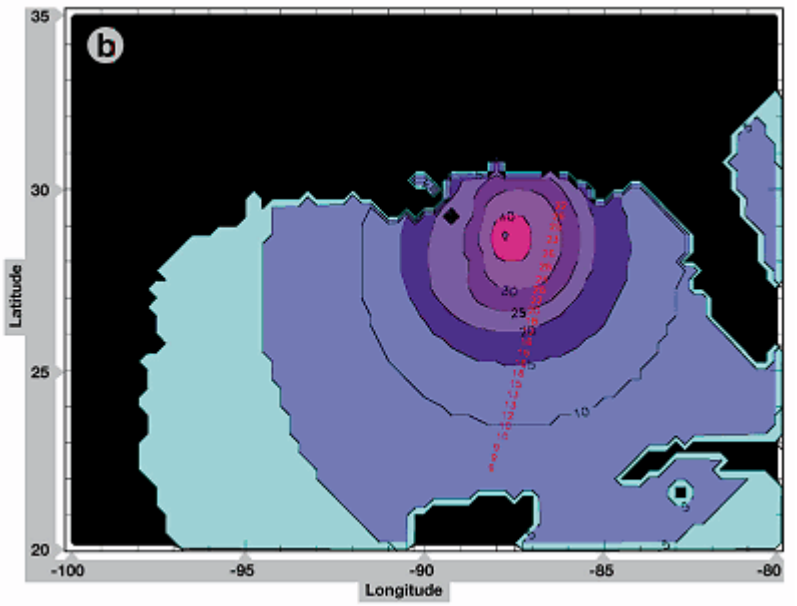
The altimetry wind/wave data were also useful for qualifying a hurricane swell forecasting system through joint use of a parametric hurricane wind model and a wave model. The wind model uses messages from the National Hurricane Center (NHC) in Miami. A version of the wave model enabling different nestings of grids is forced by the parametric model winds. A typical simulation is shown in Figure 1. Several dozen simulations were done, and the results compared with ERS and TOPEX/POSEIDON data, as well as with measurements from wave gauges moored off Guadeloupe and Martinique.

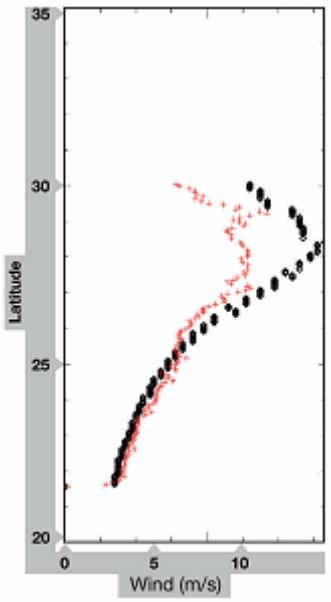




	mean	standard deviation	max value
satellite	6.78	3.28	12.89
model	7.27	3.80	14.64
difference	-0.49	1.87	







	mean	standard deviation	max value
satellite	16.65	6.21	28.40
model	19.50	9.80	36.50
difference	-2.75	4.16	

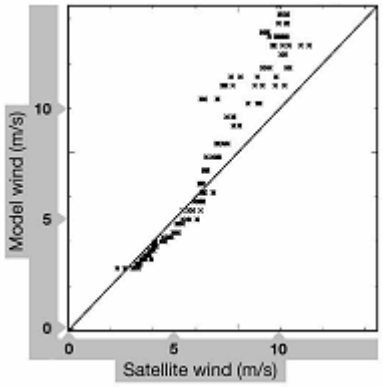


Figure 1

Typical simulation, for Opal cyclone (65 hours after its passage). The significant wave heights (a) in meters and wind velocity (b), in m/s, simulated by the model are shown, and compared with altimeter measurements (in red) along the satellite track.

Wave forecast-enhancing data

Research has also been done into the optimal use of satellite data. Until 1997, the VAG model did not use observations to readjust its analyses. Significant wave height data from the ERS-2 altimeter are now assimilated into a pre-operational global version of the wave model. The system for assimilating altimetry-derived wind velocities and wave heights into the VAG model [Le Meur et al., 1995] is an adaptation of the method used for WAM , operational at the ECMWF. The adaptations mainly concerned the replacement of wind sea and growth parametrisations for WAM by JONSWAP type data fundamental to VAG model physics. The optimal interpolation scheme was also enhanced by data selection as well as the empirical correlation distances taken from the altimeter-minus-model differences.

The importance of wind data quality for forcing models also led Météo-France to investigate the contribution of ERS scatterometer measurements to sea state forecasting. Studies at Météo-France's ocean forecasting unit [Le Meur et al., 1995, Lefèvre et al., 1995] showed and quantified the impact of such measurements on sea-state forecasting. A variational adjoint method for coherent assimilation of altimeter wave data and scatterometer wind data is now being developed.

Conclusion and prospects

The work should lead to a more efficient model, able to assimilate real-time altimeter products such as Jason OSDRs, by the year 2000. But it is also expected to provide more information-rich data such as wave directional data, from the Synthetic Aperture Radar (SAR) in wave mode or from future instruments.

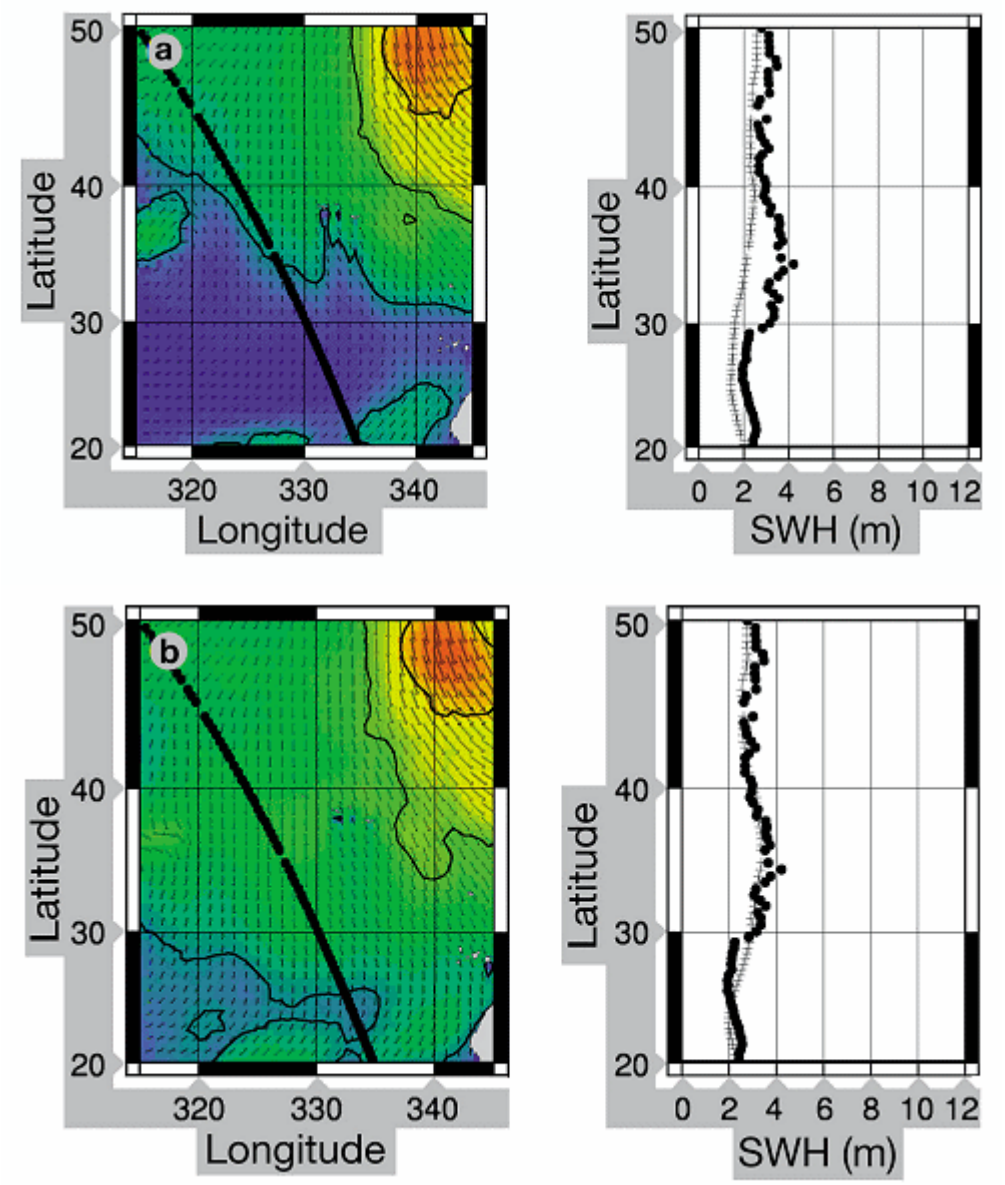


Figure 2

Effect of assimilating ERS wave heights to readjust the wave model. The T/P data are used to gauge the impact independently. (a), no observations were assimilated into the wave model. (b), the ERS data are assimilated. On the left, the significant wave height and mean direction of wave motion simulated by the model are shown with the T/P ground track. On the right are the heights simulated by the model (crosses) and observed by T/P (black dots) along the satellite track.

References :

- Lefèvre J.M, D. Le Meur, B. Fradon, and H. Roquet, 1995: Study of the impact of ERS-1 scatterometer wind data on numerical wave modelling, *Proceedings of the Second International Symposium on Assimilation of observations in Meteorology and Oceanolgraphy*, WMO/TD N° 651, March 13-17 1995: Tokyo, Japan.

- Le Meur D, J-M Lefèvre and H. Roquet, 1995: Apport des capteurs actifs micro-onde d'ERS-1 et de TOPEX/POSEIDON à la modelisation numérique des vagues. *Actes de l'Atelier de Modélisation de l'Atmosphère, 26-28 Novembre 1995, Toulouse, France.*
- Fradon B, D. Hauser and J-M Lefevre, 1996: Performance des modèles de prévision de l'état de la mer VAG et WAM pendant l'expérience SEMAPHORE, *Actes de l'Atelier de Modélisation de l'Atmosphère, 3-4 Décembre 1996, Toulouse, France.*
- Eymard L., S. Planton, P.Durand, C. Le Visage, P. Y. Le Traon, L. Prieur, A. Weill, D. Hauser, J. Rolland, J. Pelon, F. Baudin, B. Bénech, J. L. Brenguier, G. Caniaux, P. De Mey, E. Dombrowski, A. Druilhet, H. Dupuis, B. Ferret, C. Flamant, F. Hernandez, D. Jourdan, K Katsaros, D. Lambert, J.M. Lefèvre, P. Le Borgne, B. Le Squere, A. Marsoin, H. Roquet, J. Tournadre, V. Trouillet, A. Tychensky, B Zakardjian: 1996, Study of the air-sea interactions at the mesoscale: the SEMAPHORE experiment, *Ann, Geophysical, 14*, 986-1015.