The Structure of the Background Errors in a Global Wave Model

A thesis submitted for the degree of
Doctor of Philosophy

by

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September 2003

Contents

One of the main limitations to current wave data assimilation systems is the lack of an accurate representation of the structure of the background errors. For example, the current operational wave data assimilation system at the Australian Bureau of Meteorology (BoM) prescribes globally uniform background error correlations of Gaussian shape with a length scale of 300 km and the error variance of both the background and observation errors is defined to be 0.25 m^2. This thesis describes an investigation into the determination of the background errors in a global wave model. There are two methods that are commonly used to determine background errors: the observational method and the 'NMC method'. The observational method is the main tool used in this thesis, although the 'NMC method' is considered also.

The observational method considers correlations of the differences between observations and the background, in this case, the modelled Significant Wave Height (SWH) field. The observations used are satellite altimter estimates of SWH. Before applying the method, the effect of the irregular satellite sampling pattern is examined. This is achieved by constructing a set of anomaly correlations from modelled wave fields. The modelled wave fields are then sampled at the locations of the altimeter observations and the anomaly correlations are recalculated from the simulated altimeter data. The results are compared to the original anomaly correlations. It is found that in general, the altimeter sampling pattern underpredicts the spatial scale of the anomaly correlation.

Observations of SWH from the ERS-2 altimeter are used in this thesis. To ensure that the observations used are of the highest quality possible, a validation of the European Remote Sensing Satellite - 2 (ERS-2) SWH observations is performed. The altimeter data are compared to waverider buoy observations over a time period of approximately 4.5 years. With a set of 2823 co-located SWH estimates, it is found that in general, the altimeter overestimates low SWH and underestimates high SWH. A two-branched linear correction to the altimeter data is found, which reduces the overall *rms* error in SWH to approximately 0.2 m.

Results from the previous sections are then used to calculate the background error correlations. Specifically, correlations of the differences between modelled SWH and the bias-corrected ERS-2 data are calculated. The irregular sampling pattern of the altimeter is accounted for by adjusting the correlation length scales according to latitude and the calculated length scale. The results show that the length scale of the background errors varies significantly over the globe, with the largest scales at low latitudes and shortest scales at high latitudes. Very little seasonal or year-to-year variability is detected. Conversely, the magnitude of the background

year variability. By separating the altimeter ground tracks into ascending and descending tracks, it is possible to examine, to a limited extent, whether any anisotropy exists in the background errors. Some of the areas on the globe that exhibit the most anisotropy are the Great Australian Bight and the North Atlantic Ocean.

The background error correlations are also briefly examined via the 'NMC method', i.e., by considering differences between SWH forecasts of different ranges valid at the same time. It is found that the global distribution of the length scale of the error correlation is similar to that found using the observational method. It is also shown that the size of the correlation length scale increases as the forecast period increases.

The new background error structure that has been developed is incorporated into a data assimilation system and evaluated over two month-long time periods. Compared to the current operational system at the BoM, it is found that this new structure improves the skill of the wave model by approximately 10%, with considerable geographical variability in the amount of improvement.