WAVELETS IN THE FORECAST VERIFICATION OF AN ASSIMILATION EXPERIMENT IN THE LIGURIAN SEA.

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Abstract

The skill assessment of an assimilation experiment is presented. A 2D wavelet decomposition is used to decompose the model results and the observations into different spatial scales. This allows to establish the error between the model and the observations at those different spatial scales, and to identify the scale where the error is higher. At each scale, classical error measurements are applied, such as RMS. Special attention is paid to the land-sea boundaries, as they affect the wavelet analysis.

Keywords: Forecast Verification, Wavelets, Ligurian Sea.

The GHER 3D primitive equation model has been implemented in the Ligurian Sea in a two-way nested approach. A reduced order, optimal interpolation data assimilation scheme has been used for an assimilation experiment. Sea Surface Temperature (SST), Sea Surface Height (SSH) and CTD profiles are assimilated to realize the forecast [1]. This work presents the analysis of the results obtained by the model, in order to establish the benefits of the assimilation.

For the skill assessment of the model, a 2D wavelet decomposition is made [2, 3], in order to realize a multiresolution analysis of the results obtained. Wavelet Transforms are capable of localizing the signal variability simultaneously in both time and scale, something that Fourier Transforms, for example, are not able to do. The wavelet analysis allows to decompose the model and the observations into different spatial scales, ranging from ~1 km (the spatial scale of the model) to 128 km. At each scale, the model is compared to the observations, and the error is established. The scale where the highest errors are found can be identified, and studied in more detail, to find the causes of the error. The wavelet decomposition allows thus to make an analysis of the model results in a more detailed way. At each scale, the Root Mean Square (RMS) error and the Mean Square Skill Score (MSESS) are calculated. They can be derived from the Mean Square Error (MSE) [4]:

$$MSE = \frac{1}{M}\sum_{m=1}^{M}(X_f - X_o)^2 \qquad [1]$$

$$RMSE = \sqrt{MSE} \qquad [2]$$

$$MSESS = 1 - \frac{MSE}{MSE_{ref}} \qquad [3]$$

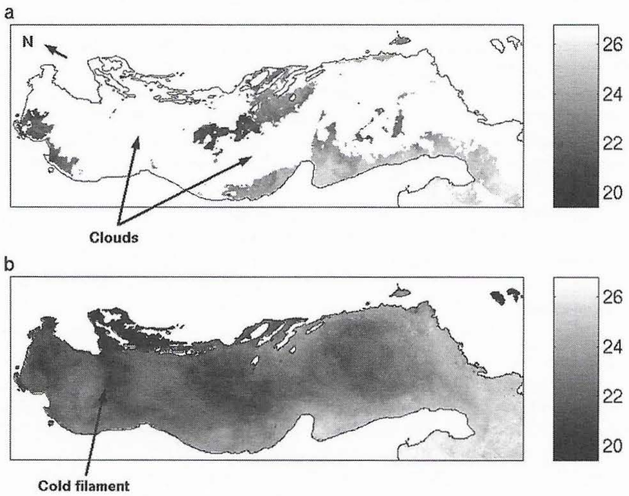
where *Xo* are the observations, *Xf* the model forecast at the observation points, and MSE_{ref} is the MSE calculated between the reference system and the observations. The RMS allows to establish the error between the model and the observations, and the MSESS measures the improvement of the model in relation to a reference system. There are several possibilities for the reference system, as climatology, the persistence forecast, or an output of an ancient version of the model. In this work we have used a free model run of the model to test its improvement.

The wavelet analysis presents a limitation when dealing with oceanographic data sets. They present often irregular land-sea boundaries. The wavelet will be affected by the boundaries and the result of the decomposition will show a high perturbation at the coast. This effect may be diminished by, first, a good choice of the mother wavelet, and second, a smooth passage between the sea and the earth.

The wavelet chosen for this work is the Haar wavelet, as its support width is 1, while the other wavelets have higher support width, as for example the Daubechies wavelet family, with a support width of 2N-1, with N the order of the wavelet. The small support of the Haar wavelet may help to reduce the effects at boundaries. High support wavelets "feel" the boundary earlier than small support wavelets.

The smooth passage between the land and the sea consists in a diffusion of the sea values towards the land values, such that the limit between them is less abrupt. This smoothing decreases the noise of the wavelet amplitudes at the boundaries.

The boundaries approach in the wavelet decomposition, as well as the analysis of the assimilation experiment results will be presented.



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