Geophysical Research Abstracts
Vol. 19, EGU2017-17971, 2017
EGU General Assembly 2017
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ERA*: An eddy-scale ocean forcing product

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High resolution satellite derived sea surface wind data, such as those from scatterometers, are increasingly required for operational monitoring and forecasting of the ocean. We present the development of ERA*, which keeps the time and space coverage of atmospheric model fields, but adds the accurately observed local mean and variability of wind scatterometers, to make these datasets suitable for, among others, high-resolution ocean model forcing.

Recent attempts of combining scatterometer data and numerical weather prediction (NWP) outputs, i.e. blended ocean forcing products, allows for an increased temporal resolution (e.g., daily) but generally only resolves NWP spatial scales of $\sim$200 km. Therefore, information on the wind-current interaction, the diurnal wind cycle and the wind variability in moist convection areas is lost in such products. Moreover, known systematic NWP model (parameterization) errors are in fact propagated at times and locations where no scatterometer winds are available. The alternative, direct forcing from NWP results in even more extensive physical drawbacks. We propose to maintain the increased temporal coverage in a gridded wind and stress product (ERA*), but also to maintain the most beneficial physical qualities of the scatterometer winds, i.e. 25-km spatial resolution, wind-current interaction, variability due to moist convection, etc., and, at the same time correct the large-scale NWP parameterization and dynamical errors. Additionally, we correct these winds for the effects of atmospheric stability and mass density, using stress equivalent 10 m winds, U10S.

In fact, collocations of scatterometer and global NWP winds show physical differences, where the local mean and variability of such differences are rather constant in time and thus could be added to the ERA-interim time record in order to better represent physical interaction processes and avoid NWP model errors. Correction of both wind vector biases and wind vector variability is expected to affect ocean forcing. Moreover, the collocation process provides the NWP winds sampled like a scatterometer and, therefore, provides information on the scatterometer wind sampling error.

Prior to merging different scatterometer data sources, a comprehensive characterization of the scatterometer corrections is required. Through a Monte Carlo simulation, we provide an assessment of the corrections and sampling errors (which depend on scatterometer sampling) for the tandem scatterometer data set ASCAT-A/B. The local NWP biases are reduced at the cost of a somewhat increased variance, and the total error mitigation is constrained to regions covered by the scatterometer at least 3 times over 5 days.

The new ERA* gridded ocean forcing product is validated against continuous 10-min moored buoy wind datasets and the Ku-band QuikSCAT scatterometer 25 km product. Globally, there is a 9% reduction of the vector root-mean-square error in ERA* w.r.t to ERA interim. Despite the limited sampling in the tropics, ERA* shows areas of increased wind variability, likely associated to moist convection. Furthermore, there is a remarkable improvement in the ERA* zonal wind component quality in the tropics.

In coastal areas, ERA* still shows slightly larger biases than ERA interim. This is most likely due to both the presence of increased wind variability and an inadequate scatterometer gridding. Future work will focus on the improvement of ERA* in coastal areas.