A statistical-dynamical operator for assimilating sea surface temperature observations in ocean models

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Abstract

The diurnal cycle of sea surface temperature (SST) is a fundamental signal of the climate system. Although vertical resolution in ocean general circulation models (OGCM) has been reduced to about a metre at the near surface most models do not properly resolve near-surface thermo-dynamical processes. In low wind and/or high insolation conditions the diurnal cycle in skin SST can be large, thus degrading the accuracy of the ocean surface analysis and prediction. Furthermore, this also presents challenges in assimilating satellite SST observations because infrared sensors (e.g. AVHRR, SEVIRI) measure the skin SST (10 μm depth) and microwave sensors (e.g. AMSR-2) measure a sub-skin temperature (1 mm depth). There is therefore a need for a dynamically-based observation operator for the assimilation of SST observations that can account for near-surface thermo-dynamical processes. In this paper an ocean column model that explicitly resolves the diurnal cycle of SST is used to estimate diurnal variability in SST over the Mediterranean Sea for 2013-2015. The modelled diurnal SSTs are validated against SEVIRI measurements. A canonical correlation analysis (CCA), which examines cross correlations between two datasets, is presented. Here we cross correlate high resolution profile data from the ocean column model with satellite skin SST measurements. The CCA is calculated in various categories of meteorological conditions. This analysis is then used to derive a statistical-dynamical observation operator. The operator can be used for assimilating SST observations, at appropriate depth and time, and is designed to be easily implemented in any OGCM data assimilation system. This approach to constructing the dynamically-based statistical observation operator may be applicable to wider applications in the Earth Sciences where poorly represented small scale thermo-dynamical processes have a large impact on relationships between observations and state quantities. [285 words]

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