Geophysical Research Abstracts
Vol. 14, EGU2012-2538, 2012
EGU General Assembly 2012

Multi-scale data fusion using Multiresolution Variational Analysis (MRVA)

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Geophysical data tend to be heterogeneous in measurement characteristics and irregularly sampled over space and time. For example, in satellite remote sensing of the sea surface temperature, the microwave (MW) sensors have typically coarser 25-km resolution than the infra-red (IR) sensors which can resolve down to a 1-km scale. However, the MW sensors are less prone to cloud contamination which affects the IR data and leads to data voids. Moreover, geostationary satellites have fine temporal resolutions but cover limited geographical regions, while orbiting satellites can have global coverages by compromising temporal sampling. To merge such data sets with drastically different spatial resolution and coverage into a coherent reconstruction of the geophysical field, the *multiresolution variational analysis* (MRVA) method has been used. MRVA is a hybrid of the variational interpolation technique used commonly in meteorology and oceanography and multiresolution analysis (MRA) technique known for wavelet-based orthonormal signal transformation. Apparent advantages of MRVA include: (1) the interpolation scale (correlation scale) can be optimized for each input data set; (2) inter-sensor bias corrections are facilitated; (3) the spectral characteristics (e.g., power law) of the output can be controlled to match a desired specification. These are demonstrated with remote sensing data for the sea surface temperature and wind.