State Estimation in an Ocean-biogeochemical Model by Assimilation of Satellite Ocean Chlorophyll Data

Lars Nerger\textsuperscript{1,2} and Watson W. Gregg\textsuperscript{1}

\textsuperscript{1}(1): Global Modeling and Assimilation Office, NASA/Goddard Space Flight Center, Greenbelt, Maryland
\textsuperscript{2}(2): Goddard Earth Science and Technology Center, University of Maryland, Baltimore County
Contact: Nerger@gmao.gsfc.nasa.gov

\textbf{Introduction}

Chlorophyll data from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) is assimilated into the three-dimensional global NASA Ocean Biogeochemical Model (NOBM) for the period 1998-2004. The assimilation is performed by a multivariate configuration of the SEIK filter which is an ensemble-based Kalman filter scheme. The filter is simplified by the use of a static error covariance matrix. It operates with a localized analysis and is amended by an online bias correction scheme. The multivariate assimilation is applied to update the four phytoplankton groups of the model as well as the simulated nutrient fields. The chlorophyll estimates of the model can be improved by the assimilation such that they outperform the assimilated SeaWiFS data. However, the results are less clear for the nutrients where the bias estimation is required for stability but reduces the assimilation improvements.

\textbf{Experiments}

Experiments are performed using the SEIK filter \cite{1}, a particular variant of an ensemble-based Kalman filter. The analysis updates are performed locally on each single grid point using observations available within some influence radius. Observations are weighted, in addition to their variance, according to their distance from a grid point which is updated. The covariance matrix is kept constant. The assimilation is performed daily to alleviate sampling problems caused by data gaps. The filter is applied either univariately (UV) to update only surface chlorophyll, or multivariately (MV) updating also nitrate, ammonium, and N/C detritus. In addition, an online bias correction (OBC) algorithm is applied, which uses the same ensemble as the filter with a globally constant weight fraction. It is known that the distribution of chlorophyll concentration is log-normal. Also, other variables are likely log-normally distributed. Accordingly, the filter acts on logarithms of all variables.

\textbf{Conclusions}

- Complete state estimation in the model is superior to that of SeaWiFS. Regionally, the estimate is more accurate in most oceanic basins.
- Online bias estimation is effective in reducing bias in the state estimate. Better tuning of the bias estimation, e.g. by regional weights, is still required.
- Multivariate assimilation has only a small influence on the estimate of total chlorophyll. Regionally, the results can be improved or deteriorated.
- The multivariate assimilation is unstable without bias correction, as the estimated nitrate concentrations can become extremely high. Bias correction can improve the stability, but results in smaller improvements of non-observed fields. Overall, the stability of the multivariate assimilation is still an issue which needs more attention.

\textbf{References}