DATA ASSIMILATION AND GEOSTATISTICS IN ECOLOGICAL MODELING

L. BERTINO, H. WACKERNAGEL
Centre de Géostatistique, Ecole des Mines de Paris, Fontainebleau, France
bertino@cg.ensmp.fr

AND

H. VON STORCH
Institute for Hydrophysics, GKSS, Geesthacht, Germany

Data assimilation (DA) can be defined as the incorporation of measurements into the numerical model of a physical system, to improve the forecasts of this model. Data assimilation has gained increasing popularity in the atmospheric and oceanographic communities over the last two decades. The random functions approach of geostatistics, its multivariate spatial modeling tools, its change-of-support models and the spatial simulation capabilities provide an attractive framework for performing data assimilation (Bertino et al., 2000).

The study of nutrients in estuaries from the Odra river in the EC funded PIONEER project allows combination of both techniques for forecasting the physical, biological and chemical state of the estuarine system (von Storch, 2000).

As a first step towards real applications a simple ecological model solving the differential equations of diffusion and biological interactions in a water column containing nutrients, phytoplankton and herbivores is used to test the assimilation techniques (Eknes and Evensen, 1999). A simple model run gives the reference solution. Artificial data are sampled from the three variables of the reference solution and a random noise is added. Then the reference solution is reproduced from an erroneous initial state and by assimilation of the perturbed data.

Since the dynamics of the system are non-linear, an extended Kalman Filter is used for the data assimilation. For efficient ecological monitoring of the Odra estuary the forecast has to be produced within limited computation time - local authorities should take action before incidents get

P. Monestiez et al. (eds.), geoENV III – Geostatistics for Environmental Applications, 501–502.

out of hand. To achieve this, different suboptimal schemes (SOS) based on eigendecomposition (the Reduced Rank Square Root (RRSQRT) Filter, Verlaan, 1998) and on Monte-Carlo methods (the Ensemble Kalman Filter, Eknes and Evensen, 1999) are compared. Geostatistical modeling ideas are discussed in the application of these algorithms.

An example of DA applied to a real estuary system is presented (see Figure 1) with the case of the Odra Lagoon. Water level data are assimilated in the TRIM3d hydrodynamical model (Bertino et al., 2000) and efficiently correct the erroneous initial conditions.

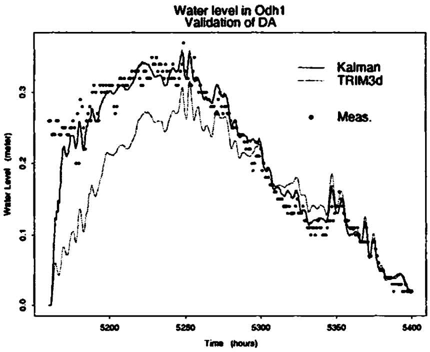

Figure 1. Water levels in pile station Oderhaffl, the points are measurements, the solid line is the estimate of the RRSQRT Kalman Filter - Oderhaffl measurements are not assimilated for validation - and the dotted line is the crude model output without DA. The influence of the initial state is remarkably reduced by use of DA.

Acknowledgments

This work was supported by the PIONEER project of the MAST III program of the European Community.

References

Bertino, L., Sénégas, J., Wackernagel, H., von Storch, H. (2000) *Data assimilation for hydrodynamical modeling of the Odra lagoon*, Presented at the Geostat2000 conference in Cape Town, South Africa.

Eknes, M., Evensen, G. (1999) *An Ensemble Kalman Filter with a 1-D Marine Ecosystem Model*, Submitted to the Journal of Marine Science.

Verlaan, M. (1998)*Efficient Kalman filtering algorithms for hydrodynamic models*, Doctoral thesis at TU Delft, The Netherlands.

von Storch, H., and the PIONEER consortium, (2000) : *The pioneer project as an example of operational coastal research.* Fourth Symposium on Integrated Observing Systems, American Meteorological Society, 215-220.