PROJECT AIM

Large scale numerical models are often used for prediction problems. These models however are however far from perfect. The model predictions can be improved by assimilating measurements into the model using a Kalman filter. A serious problem with this approach is that the standard filter algorithm imposes a very large burden on the computer. In order to obtain a computationally efficient filter, simplifications have to be introduced. Model reduction is a corner stone in developing sub-optimal scheme's. In this project new sub optimal algorithms to solve large scale Kalman filtering problems are developed: The Reduced Rank SQuare Root (RRSQRT) algorithm, the Partially Orthogonal Ensemble Kalman filter (POEnKF) and a number of variants. Both theoretical aspects (convergence theorem) as well as a number of practical applications (tidal flow prediction in coastal waters, air pollution prediction problems and reservoir engineering).

PROGRESS

We have applied the various new filter algorithms in the large scale atmospheric-chemistry transport model EUROS of RIVM to reconstruct the Ozone distribution in the atmosphere. We also developed a model reduction methodology for large scale numerical groundwater flow models in corporation with TNO. A new PhD project "Smart Wells" in corporation with the faculty CiTG, MIT and Shell has started. In this PhD project we will develop and apply model reduction and filtering techniques for assimilating data into multi-phase flow models in order to solve reservoir engineering problems.

DISSERTATIONS

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SCIENTIFIC PUBLICATIONS

1. Sumihar, JH, Verlaan, M & Heemink, AW (2008). Two-sample Kalman filter for steady-state data assimilation. Bulletin of the American meteorological society, 4503-4516. (TUD).
2. Altaf, MU & Heemink, AW (2007). The use of pod within variational data assimilation. In G Paltineanu, E Popescu & I Toma (eds.), Trends and challenges in applied mathematics (pp. 34-43). Bukarest: Matrix Rom. (TUD).
3. Lawniczak, W, Hanea, RG, Heemink, AW & McLaughin, D (2008). Multiscale ensemble filtering for reservoir engineering applications. Comp. geoscien., 1-10.(TUD).
4. Kaleta, MP, Hanea, RG, Jansen, JD & Heemink, AW (2008). Model-reduced variational data assimilation for reservoir model updating. In s.n. (Ed.), 11th European Conference on the Mathematics of Oil Recovery (pp.1). Houten, The Netherlands: EAGE. (TUD).
5. Zamani Foroushani, A, Solomatine, DP, Azimian, A & Heemink, AW (2008). Learning data for wind-wave forecasting. Journal of waterway port coastal and ocean engineering-asce, 35, 953-962. (TUD).
6. El Serafy, GY, Heemink, AW & Geer, FC van (2008). Identification of ground water flow patterns using particle models. Appl. mathem. modeling,32, 1208-1218.(TUD).
7. Lawniczak, W, Hanea, RG, Heemink, AW, McLaughin, D & Jansen, JD (2008). History matching using a multiscale ensemble Kalman filter. In s.n. (Ed.), 11th European Confernce on the Mathematics of Oil Recovery (pp.1-7). Houten, The Netherlands: EAGE. (TUD)
8. Sumihar, JH, Verlaan, M & Heemink, AW (2008). Analysis and prediction of time varying tidal components using Kalman filtering. In J Bruthans, K Kovar & Z Hrkal (Eds.), Predictions for hydrology, ecology, and water resources management: using data and models to benefit society (pp. 29-33). S.l.: Czech Association of Hydrogeologist. (TUD).

PROJECT LEADERS

AW Heemink

RESEARCH THEME

Mathematical and computational methods for fluid flow analysis

PARTICIPANTS

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COOPERATIONS

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Deltares, Shell, TNO, NWO
1st 20% 2nd 20% 3rd 60%

START OF THE PROJECT

2001

INFORMATION

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