Geophysical Research Abstracts, Vol. 9, 03731, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-03731

Sea ice drift assimilation in a finite element sea ice model using a Singular Evolutive Interpolated Kalman filter

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Assimilation of sea-ice drift into a finite element dynamic-thermodynamic sea-ice model of the entire Arctic using a Singular Evolutive Interpolated Kalman (SEIK) filter is presented. The SEIK filter is a powerful assimilation instrument that combines an ensemble of model forecasts and the observations including their errors with a computationally efficient algorithm. We use both sea-ice velocity measurements from drifting buoys and gridded drift fields derived from Quikscat and SSM/I data. The satellite datasets turn out to be more useful for assimilation because spatial coverage of buoy data is too sparse to improve large-scale model behaviour. However, the buoy data are used as an independent, "true" sea-ice drift field to verify results of the assimilation procedure. The problem in the assimilation of sea-ice drift so far has been that - compared to the ice thickness or concentration - the ice drift changes very frequently, depending on wind, ocean and internal ice stress. Since inertia of sea ice is small compared to the stresses, the system has very little memory beyond each assimilation step, making corrections by the filter very short-lived. Even a perfectly corrected drift field has very little effect on the model state in the next model integration step. However, ice-drift history is stored in the ice thickness and ice concentration distributions. By considering covariance of sea-ice thickness and drift as well as covariance of sea-ice concentration and drift, the SEIK filter enables us to modify the more conservative state variables "ice thickness" and "ice concentration" during the course of assimilation, which in turn leads to modifications of the larger-scale sea-ice distribution, transport and export.