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Lecture: ***Issues in Ensemble Prediction and Data Assimilation Using a Lagrangian Model of Sea-Ice***

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Abstract:

In the first part of the talk, we will present a sensitivity analysis of a novel sea ice model. *neXtSIM* is a continuous Lagrangian numerical model that uses an elastobrittle rheology to simulate the ice response to external forces. The response of the model is evaluated in terms of simulated ice drift distances from its initial position and from the mean position of the ensemble. The simulated ice drift is decomposed into advective and diffusive parts that are characterized separately both spatially and temporally and compared to what is obtained with a *free-drift* model, i.e. when the ice rheology does not play any role. Overall the large-scale response of *neXtSIM* is correlated to the ice thickness and the wind velocity fields while the *free-drift* model response is mostly correlated to the wind velocity pattern only. The seasonal variability of the model sensitivity shows the role of the ice compactness and rheology at both local and Arctic scales. Indeed, the ice drift simulated by *neXtSIM* in summer is close to the *free-drift* model, while the more compact and solid ice pack is showing a significantly different mechanical and drift behavior in winter. In contrast of the *free-drift* model, *neXtSIM* reproduces the sea ice Lagrangian diffusion regimes as found from observed trajectories. The forecast capability of *neXtSIM* is also evaluated using a large set of real buoy's trajectories. We found that *neXtSIM* performs better in simulating sea ice drift, both in terms of forecast error and as a tool to assist search-and-rescue operations. Adaptive meshes, as the one used in *neXtSIM*, are used to model a wide variety of physical phenomena. Some of these models, in particular those of sea ice movement, use a remeshing process to remove and insert mesh points at various points in their evolution. This represents a challenge in developing compatible data assimilation schemes, as the dimension of the state space we wish to estimate can change over time when these remeshings occur.

In the second part of the talk, we highlight the challenges that such a modeling framework represents for data assimilation setup. We then describe a remeshing scheme for an adaptive mesh in one dimension. The development of advanced data assimilation methods that are appropriate for such a moving and remeshed grid is presented. Finally we discuss the extension of these techniques to two-dimensional models, like *neXtSIM*.