COMBINING DATA ASSIMILATION AND MOVING MESHES FOR MOVING BOUNDARY PROCESSES: APPLICATION TO ICE SHEET MODELLING

B. Bonan[1], M. J. Baines[1] & N. K. Nichols[1]
[1]*School of Mathematical and Physical Sciences, University of Reading, Reading, United Kingdom*

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Numerous processes in geosciences (for example glacier melting or flooding) are governed by nonlinear time-dependent partial differential equations on domains with finite moving boundaries whose position depends on the solution of the problem itself. Predicting their evolution including tracking the trajectory of their moving boundaries can be challenging. Here we propose to combine a particular moving mesh method and data assimilation to overcome the issue. The moving mesh method based on the preservation of mass fractions is well-suited to tracking moving phenomena accurately [1]. In order to initialise our model, we apply advanced data assimilation techniques to the system. We develop particularly an Ensemble Kalman Filter approach in this context. The data assimilation procedure treats both the mesh node positions and physical variables at these locations as unknown state variables and updates both of these at each assimilation step. The advantage of the ensemble approach is that it enables the sensitivity of the system to be understood and, more importantly, provides information on the correlations between the state variables, in particular between the grid and the physical variables. We demonstrate the success of the technique, especially for estimating the position of the boundaries in the context of ice sheet modelling.

References

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