Geophysical Research Abstracts,
Vol. 10, EGU2008-A-00120, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-00120
EGU General Assembly 2008

How realistic are sea ice models in terms of sea ice dynamics and associated scaling properties?

L. Girard (1), J. Weiss (1), J. M. Molines (2)

(1) Laboratoire de Glaciologie et Géophysique de l'Environnement (CNRS/UJF), 54 rue Molière, 38400 St-Martin d'Hères, France, (2) Laboratoire des Ecoulements Géophysiques et Industriels (CNRS/UJF), BP53X, Grenoble (lucas.girard@lgge.obs.ujf-grenoble.fr)

The Arctic sea ice dynamics is characterized by a strong intermittency as well as highly heterogeneous deformation fields. This complexity is expressed by space and time scaling laws that are coupled together [Marsan et al. 2004; Rampal et al., 2007]. Such scaling properties imply that small scales cannot be arbitrarily disconnected from large scales, i.e. sub-grid scale physics matters. In addition, they clearly indicate that sea ice deformation is essentially accommodated by fracture and faulting at different scales, a vision at odds to the classical continuous, viscous-plastic modelling framework [Rampal et al., 2007; Weiss et al., 2007].

In this study, we evaluate to what extent this classical modelling framework could reproduce this complexity. The model is the 1/4° ORCA025 ocean/sea-ice global model configuration developed within the Drakkar project [Barnier et al., 2006] on the basis of the NEMO numerical code. Resolution in the Arctic is $\sim$12km, which is similar to the resolution of RGPS observations. It is driven from 1958 to 2004 with ERA40 6 hourly re-analysis [Drakkar group, 2007]. The sea-ice code is LIM2, based on a viscous-plastic (VP) rheology [Fichefet & Maqueda, 1997]. A dedicated run was performed for winter 1997, with outputs saved at 12h intervals.

The modelled ice velocity fields show good correlation with SSMI and RGPS data [Kwok, 1998] at high temporal and spatial scales (1 month, 100km) but the correlation decreases quickly towards finer scales. On the other hand, strain-rate fields are poorly represented, with no significant correlations between modelled and RGPS fields. Moreover, the structure of the modelled deformation fields is dramatically different from the observations. While highly heterogeneous strain patterns localised along linear kinematics features are expected, the modelled fields are smooth.

In order to evaluate the model performance on a statistical point of view, the strain-rate distributions were analysed. Modelled distributions substantially differ from observations. The divergence rate is particularly poorly represented, with expected consequences in terms of ice production estimates. The space and time scaling laws characterizing sea ice dynamics are not reproduced by the model. Instead, the modelled dynamics mimics the behaviour of a viscous fluid, without intermittency nor spatial heterogeneity. Therefore, our results emphasize that the VP rheology is unable model sea ice dynamics correctly. As an alternative, we believe that intermittency and strain localization arise from elastic long-range interactions. We are thus currently developing a new mechanics framework for sea ice based on progressive damage of an elastic plate.

References

Barnier B., Madec G., Penduff T., Molines J.M., Tréguier A.M., Beckmann A., Biastoch A., Boning C., Dengg J., Gulev S., Le Sommer J., Rémy E., Talandier C., Theetten S., Maltrud M., Mc Lean J. Impact of partial steps and momentum advection schemes in a global ocean circulation model at eddy permitting resolution. Ocean Dynamics, 56(5-6), 543-567, 2006.

Fichelet, T., and M.A. Morales Maqueda, Sensitivity of a global sea ice model to the treatment of ice thermodynamics and dynamics, J. Geophys. Res., 102 (C6), 12609-12646, 1997

Kwok, R., The RADARSAT geophysical processor system, in Analysis of SAR data of the polar oceans, edited by C. Tsatsoulis, and R. Kwok, pp. 235-257, Springer-Verlag, 1998

Marsan, D., H. Stern, R. Lindsay, and J. Weiss, Scale dependence and localization of the deformation of arctic sea ice, Phys. Rev. Lett., 93 (17), 178501, 2004

Rampal, P., J. Weiss, D. Marsan, R. Lindsay, and H. Stern, Scaling properties of sea ice deformation from buoy dispersion analyses, J. Geophys. Res., in press, 2007