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A continuum model for the coupled evolution of sea ice thickness and melt pond distribution

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Despite the acknowledged importance of the role played by melt water covering sea ice in the ice-albedo feedback mechanism [1-4], processes involving sea ice melt ponds are still, somehow, poorly understood. We will present a continuum model of sea ice, which includes an explicit description of melt pond evolution [5] and a miminal coupling with the atmosphere. Unlike models *à la Thorndike* [6], where the ice thickness distribution (ITD) $g(h; \mathbf{x}, t)$ is evolved, reflecting the obvious lack of detailed information below the scale of the mesh size of climatological interest, we study the evolution equations for the sea ice topography $h(\mathbf{x}, t)$ and the melt water depth field $w(\mathbf{x}, t)$, as in [7]. The two equations are mutually coupled via the thermodynamic driving (melting/freezing rate) and via the velocity field which encodes, explicitely, the horizontal transport of melt water down slopes of sea ice topography. Moreover, the proposed model features a coupling with the atmosphere through a wind shear (in the transport term) and a non-uniform seepage rate of water through sea ice. A source/sink term modelling possible transitions among thickness categories due to mechanical processes (ridging, rafting, etc) is also taken into account.

After providing a derivation of the model, based on phenomenological arguments, we will present numerical results from simulations of the summertime evolution of sea ice (i.e. only melting is considered, whereas water refreezing is disregarded). We will address the impact of the initial sea ice topography and of the presence/absence of melt ponds (through the dependence of the melting rate on w) on the final ITD (comparing with measurements [8] and theoretical predictions [9]), as well as the effect of winds on the morphology of melt pond configurations.

References

[1] D.K. Perovich and J.A. Richter-Menge, *Annu. Rev. Mar. Sci.* **1**, 417-441 (2009).

[2] H. Eicken, T.C. Grenfell, D.K. Perovich, J.A. Richter-Menge and K. Frey, *J. Geophys. Res.* **109**, C08007 (2004).

[3] D.K. Perovich, *J. Geophys. Res.* **110**, C03002 (2005).

[4] D. Flocco, D. Schroeder, D.L. Feltham and E.C. Hunke, *J. Geophys. Res.* **117**, C09032 (2012).

[5] D. Flocco and D.L. Feltham, *J. Geophys. Res.* **112**, C08016 (2007).

[6] A.S. Thorndike et al, *J. Geophys. Res.* **80**(33), 4501-4513 (1975).

[7] M. Lüthje, D.L. Feltham, P.D. Taylor and M.G. Worster, *J. Geophys. Res.* **111**, C02001 (2006).

[8] R. Kwok, G.F. Cunningham, M. Wensnahan, I. Rigor, H.J. Zwally and D. Yi, *J. Geophys. Res.* **114**, C07005 (2009).

[9] S. Toppaladoddi and J.S. Wettlaufer, *Phys. Rev. Lett.* **115**, 148501 (2015).