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A numerical study of radiative heating on melt ponds

Silvia Hirata, Enrico Calzavarini, and Stefano Berti
Université de Lille, France (silvia.hirata@univ-lille1.fr)

High-resolution numerical simulations and stability analysis are used to investigate the effects of external radiative heating on melt ponds. We focus on the small-scale process of convective heat transfer inside a sigle pond. The pond is modeled as an upside-down Rayleigh-Bénard cell with transparent boundaries, submitted to an external shortwave-radiation source. We study how the intensity of the radiative flux and its penetration-depth affect the overall temperature of the system and the global heat transport. In particular, simulations show that there is a value of the penetration depth which maximizes the average temperature inside the system. Radiation heating increases the heat flux but becomes negligible as turbulence increases.

Current Global Climate Models operate at a quite low resolution and the dynamics of melt ponds, when not neglected, is only accounted for by rather simple parametrizations. The present analysis can provide further insight on the small-scale mechanisms affecting the internal dynamics and evolution of ice-melt ponds during summer in the Arctic ocean. The small-scale results can then be used to improve the parametrizations of melt ponds in large scale models.