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On the Response of the Arctic Ocean Ice Thickness to External Forcing Perturbations

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The steady state ice thickness response to variations of the external forcing is investigated by a coupled atmosphere ice ocean column model. The main focus is on the thickness response to perturbations in the atmospheric heat advection and how the response characteristics are dependent on the surface albedo parameterization. The thickness response is investigated through a hierarchy of model cases in order to relate back to more idealized models and to show the effect of critical processes. The most simplified case (a slab ice model with constant albedo) gives the well known highly non-linear response (ice thickness – growth rate feedback) while including a thickness distribution and constant ice divergence gives a linear response. The most sophisticated case (standard case) using the CCSM3 albedo gives a much more complicated response with different distinct response regimes including a sharp transition between perennial and seasonal ice. The standard case albedo is then investigated in terms of internal parameters and the prescribed snowfall as well as being compared to other GCM albedo parameterizations. Finally we look at the relation between external forcing for solar radiation and atmospheric heat advection and notice a linear relation in a large part of the parameter space. The major outcome from this investigation is that the response of the ice cover to changes of the external forcing is very much dependent on the albedo parameterization. For the same set of forcing parameters: one parameterization might be very close to the perennial/seasonal transition and thus very sensitive to forcing perturbations while another parameterization can be far away from the transition and much less sensitive to perturbations.