Geophysical Research Abstracts
Vol. 13, EGU2011-3456, 2011
EGU General Assembly 2011


# Implementation of a new anisotropic rheology into a GCM sea ice component

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In polar oceans, seawater freezes to form a layer of sea ice several metres thick that can cover up to 8% of the Earth's surface. This essentially two dimensional sea ice cover evolves under the combined effect of various forces dominated by oceanic and atmospheric drags and internal stresses to produce a complex spatio-temporal deformation pattern. Sea ice is observed to fracture along lines intersecting at preferred acute angles, delineating anisotropic diamond-shaped floes at length scales ranging from a metre to thousands of kilometres. The question has been recently raised (Kwok et al, 2008 and Girard et al, 2010), are current models of sea ice mechanics adequate for producing such patterns ? Sea ice rheologies in existing climate models make the simplifying assumption of isotropy, i.e. no account is taken of the observed orientation of leads or floes and locality, i.e. stress and strain rate are locally interdependent.

In this presentation we address the first assumption and in contrast to most current models of sea ice included in GCMs (Global Circulation Models) that use a variant of the visco-plastic rheology derived from Hibler (1979), we implement into the Los Alamos CICE sea ice model a new rheology (Wilchinsky and Feltham, 2006) that explicitly accounts for the local anisotropy of the sea ice cover. The model is simple, it contains one extra variable, the local structure tensor A, that quantifies the degree of anisotropy of the sea ice and three parameters that set the time scale of the reorientation and evolution of this local tensor. We present results of a "stand-alone" version of our model and show the influence of the new rheology routine on the dynamics both on a simple test geometry and at the Arctic basin scale. We use satellite observations including the high resolution SAR data from the GLOBICE ESA project to estimate the parameter values that appear in the evolution equation of the local order parameter A and show that with imposed simple flows (e.g. shear) or under realistic forcing sea ice quickly becomes highly anisotropic over large length scales, as is observed. We study how the effect of the anisotropy is coupled with the sea ice mechanical behaviour and compare the distribution of concentration, thickness, stresses and strain rates in the anisotropic and visco-plastic dynamics. We finally assess the influence of the new rheology on the spatial organisation of the deformation patterns and on its ability to reproduce more accurately the observed linear kinematic features of sea ice.