Geophysical Research Abstracts, Vol. 7, 06238, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06238

Slip weakening model for arctic sea ice dynamics

P. Sammonds (1), D. Hatton (1), D. Feltham (2) and P. Taylor (2)

(1) CPOM, Earth Sciences, UCL (p.sammonds@ucl.ac.uk), (2) CPOM, Space & Climate Physics, UCL

We have studied slip-weakening behaviour in laboratory and ice tank experiments in ice. We propose that sea ice dynamics is dominated by tensile fracture and frictional slip. Further, stick-slip behaviour, which has only recently been recognised by us, we believe to be an important deformation mechanism. We proposed that the slip-weakening model can capture the essential mechanical properties of ice in shear, including the transition from brittle to ductile behaviour with increasing normal stress and temperature, and the transition from stable frictional sliding to stick-slip behaviour, necessary for modelling sea ice dynamics. In support of incorporating a slip-weakening model into geophysical-scale sea-ice models, we have undertaken double-direct-shear friction experiments, with floating ice sheets. Mostly, the sliding took a stick-slip form: sliding velocity and shear stress, at a given position on the fault, were episodically time-dependent, shear stress dropping as sliding accelerated. When we seek a local, instantaneous friction law, this militates in favour of proposed laws, in which the shear stress decreases with increasing speed, and against those, in which the shear-stress is velocity-independent or grows with increasing speed. We can test friction laws further by plotting the measurements, in combinations of variables, for which each proposed law predicts a simple graphical form. The velocity and shear stress are non-uniform in space as well as in time. Measurements of the same stick-slip cycle, at several positions along the fault, allow us to identify a nucleation zone, which begins to slip before the rest of the fault, and to relate this spatial variation of velocity and the temporal variation of shear stress; the slipping region, therefore, behaves like a wave-packet, propagating away from the nucleation zone.