Geophysical Research Abstracts,
Vol. 10, EGU2008-A-11369, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-11369
EGU General Assembly 2008

Has the Arctic ice-pack shifted to a high flow state

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Most speculation on the recent decline of arctic sea ice summer extent and thickness has emphasized either thermodynamic or wind forcing shifts in explaining the observed rapid changes. A more direct explanation of these shifts based on the constrained nature of arctic pack ice compared, say, to the Antarctic, is a slow weakening of the ice pack due to climate warming. This slow weakening has then caused a more precipitous shift of the ice pack to a high flow state whereby the Arctic ice pack flows out of the Arctic basin in a manner relatively unconstrained by sea ice mechanics.

Observationally, this view is supported by drifting station data obtained during the 1960's which showed extremely sluggish ice drift despite strong wind forcing. This slow drift for significant wind forcing is compared to current observations showing higher drift rates for similar wind speeds. In addition recent observations using SAR imagery of the Fram Strait outflow shows areal outflow to depend on ice strength and vary seasonally for the same wind forcing.

To demonstrate the theoretical basis for the shift to a high flow state and the possible presence of multiple equilibrium states thermodynamic forcing from paleoclimate simulations using 'pre-industrial' and 'present day' climatic forcing are with fixed seasonally varying daily wind forcing are used together with a non linear dynamic thermodynamic sea ice model to investigate the potential for either multiple equilibrium low and high flow states during the pre-industrial period or a single low flow state. Starting with a low flow state during the pre-industrial period the ice model is then forced with an interpolated thermodynamic forcing over the last 200 years to demonstrate the rapid shift to a high flow state sometime after the 1960's, with the results compared to a high flow state only over the same time period. The simulation

results together with observations demonstrate that melting of sea ice alone cannot explain the rapid decrease in summer ice extent.