Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07016, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07016
EGU General Assembly 2008

Arctic Predictability and Sensitivity in a coupled numerical Model

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SMHI has developed a regional coupled ocean-sea ice-atmosphere model of the Arctic. The modelling project aims at assessing the natural variability of the Arctic coupled system on timescales from years to decades. The tool to address this topic is Rossby Centre's coupled ocean-ice-atmosphere model RCAO, which is run over the ERA40 period 1959-2000. During the development phase, sensitivity studies with respect to snow and ice albedo and river runoff have been carried out. The resulting coupled model shows a realistic sea ice extent decrease in the 1980s and 1990s. The goal of the predictability study is to distinguish between the internal and external Arctic variability. The internal variability is that part of the total variability which is generated inside the Arctic model domain due to nonlinear interaction between ocean, ice and atmosphere components of the Arctic system. Knowledge on the internal variability is important for statistical attribution of climate change signals. RCAO has been set up for an ensemble experiment with several runs, only differing by slightly varying initial conditions. First results show strongest differences in the variability of sea ice extent on the 1-5 year timescale, while the longer scale variability is common to all coupled runs. The same statement can be applied to the mean sea ice thickness, which in addition shows biases on the 10-year timescale. A two-dimensional view on internal and external variance gives additional information. The internal variance is assessed by the mean internal variability among the ensemble members which is the considered noise, not predictable by providing lateral boundary conditions in sub-arctic regions. The external variance is given by the time-variance among the ensemble-averaged anomalies, which is interpreted as the variance due to external lateral forcing at the

outer boundaries of the regional model. Generally both external and internal variability show strongest amplitudes at the Arctic coasts. The internal part has a clear stronghold at the Siberian coasts. In coastal regions, the external amplitudes are up to two times stronger than the internal ones. Away from the coast, the external part is often larger by a factor of 1-1.4. Furthermore, the role of large scale atmospheric circulation patterns for the amplitude of Internal variability is examined. These results need to be substantiated by further ensemble member by partner institutions. It is hypothesised that this kind of variability and predictability analysis will be even more interesting for transient climate runs, were thinning sea ice possibly allows for stronger internal amplitudes.