

Arctic and Antarctic sea ice variability during 1955-2001: A model study

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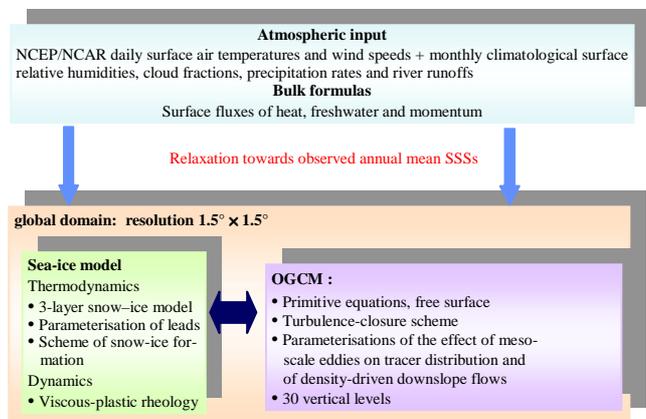
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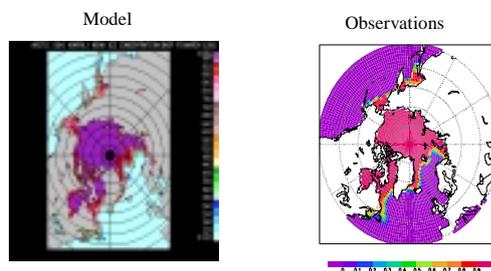
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A global, coarse resolution ice-ocean model is used to document the variability of the Arctic and Antarctic sea ice during the 47-year period 1955-2001. Daily data of surface air temperature and wind are utilised to produce the year-to-year variations of the ice packs. We focus on analysing the simulated variability of the ice area and volume in both hemispheres.

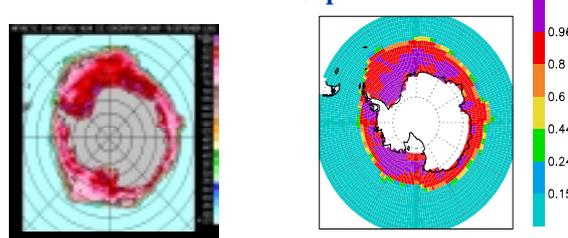
The Model



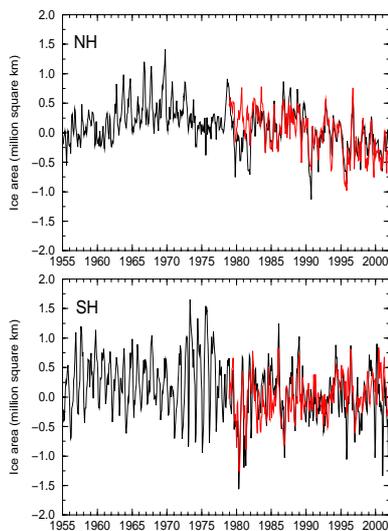
Ice concentration in March 1991



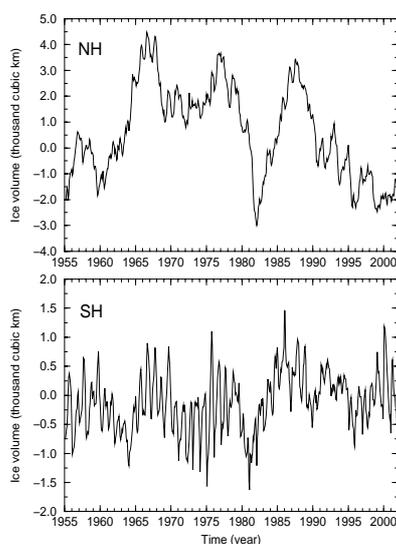
Ice concentration in September 1991



Ice extent in both hemispheres



Ice volume in both hemispheres



Discussion

1. The model simulates relatively well the observed time evolution of the ice extent. The correlation between the simulated and observed time series is 0.75 in the Northern Hemisphere (NH) and 0.56 in the SH.
2. A least squares regression analysis of the model results reveals a decrease of $13,650 \pm 2900 \text{ km}^2 \text{ year}^{-1}$ in Arctic ice area between November 1978 and September 2001. By contrast, no statistically significant trend in Antarctic ice area is detected.
3. Over the period 1955-2001, the simulated ice area decreases by $8300 \pm 1000 \text{ km}^2 \text{ year}^{-1}$ (0.8 % per decade) in the NH and by $9200 \pm 1500 \text{ km}^2 \text{ year}^{-1}$ (0.9% per decade) in the SH. Superimposed on these trends are pronounced decadal variations. In the SH, the overall negative trend is mainly due to an abrupt decline in ice area taking place during the second half of the 1970s and the beginning of the 1980s. Actually, the mean ice area from 1982 to 2001 (after the decline) is $0.3 \times 10^6 \text{ km}^2$ lower than that from 1955 to 1976 (before the decline).
4. Over the entire period, the ice volume in the NH has a decreasing trend of $40.0 \pm 5.2 \text{ km}^3 \text{ year}^{-1}$ (1.8% per decade). This figure must however be taken with caution because of the relative shortness of the time series and the high amplitude decadal fluctuations. The modeled Antarctic ice volume also exhibits decadal variability. However, the peak-to-trough changes are generally much weaker than the Arctic ones. In addition to these oscillations, there is an overall increase in ice volume of $10.5 \pm 1.5 \text{ km}^3 \text{ year}^{-1}$ (1.5% per decade).

Time series of monthly ice area anomaly as simulated by the model (black line) and as observed (red line) for the Northern Hemisphere (NH; top) and the Southern Hemisphere (SH; bottom).

Time series of monthly ice volume anomaly as simulated by the model for the NH (top) and the SH (bottom).