The importance of large scale sea ice drift and ice type distribution on ice extent in the Weddell Sea

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FESOM Finite-Element Sea-ice Ocean Model

1. Introduction

The regular analysis of sea ice extent has become possible since the beginning of satellite observations. Ice extent changes are an indicator for changes in the atmosphere and the ocean. On the other hand sea ice extent variability modifies the exchange of heat, moisture and momentum between ocean and atmosphere. Therefore, an understanding of causes of its variability is required for an adequate simulation of those fluxes and thus for climate modeling.

During the last three decades mean annual ice extent in the Arctic has decreased by about 4.57% per decade while the ice cover in the Southern Hemisphere is increasing by about 2.09%. For understanding this contrary behavior it is necessary to determine the causes for the increase of sea ice extent in the Southern Ocean.

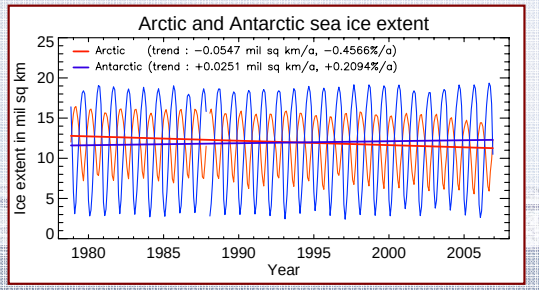

Fig. 1: Arctic and Antarctic sea ice extent and trends from November 1978 to December 2006. Data: Monthly mean ice extent from NSIDC

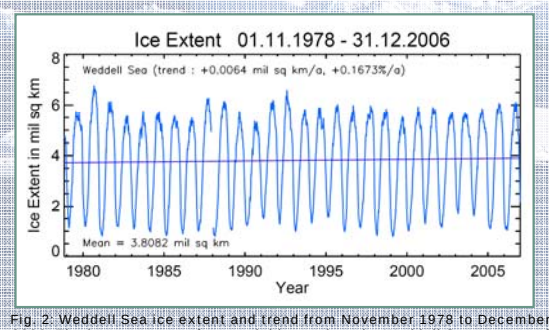

Fig. 2: Weddell Sea ice extent and trend from November 1978 to December 2006. The large amount of perennial ice makes the Weddell Sea an area of particular interest. Data: 2 day means of ice extent from NSIDC

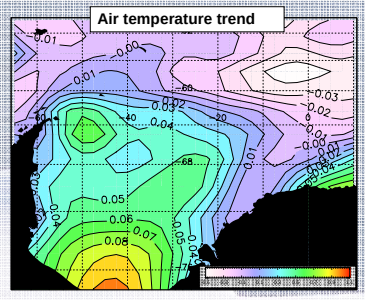

Fig. 3: Weddell Sea temperature trends from November 1978 to December 2006. Trends are mainly positive. Color bar shows corresponding trend in deg C per decade. Data: NCEP/NCAR Reanalysis Project

2. Drift and Wind speed

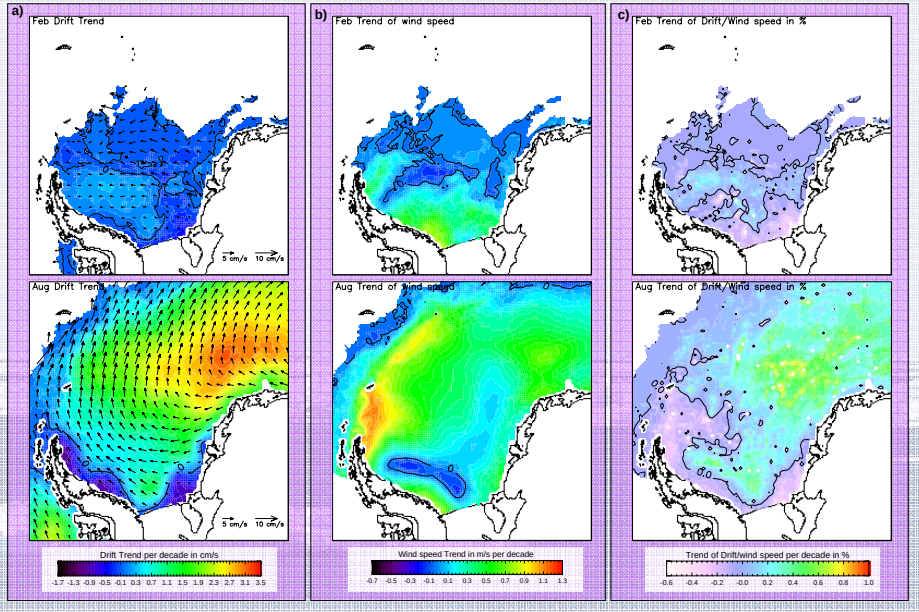

Fig. 4: a) Ice drift and b) wind speed trends for February (top) and August (bottom). Colored background indicates trend while arrows in a) show mean drift. Drift trends are low in spring and high in winter. c) Trend of ratio between Drift speed and wind speed for February (top) and August (bottom).

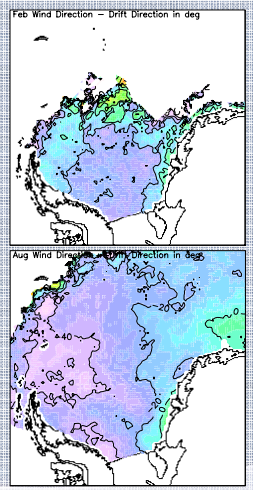

Fig. 5: Differences between wind and drift direction. Negative values mean that the drift is to the left of the wind.

5. Conclusion

- Ice drift velocity trends are low in summer and high in winter, showing increasing velocities in the eastern part of the Weddell sea. → Would explain an increase in winter ice extent.
- Along the Antarctic Peninsula drift speeds are decreasing in winter → higher consolidation of ice → could result in higher ice thicknesses and therefore for an increased summer ice extent
- Wind speeds also show mainly positive trends but not as strong as ice drift velocity does.
  → Which other parameters could be responsible for those ice drift changes?
- Ice drift is generally convergent in summer and also shows a trend to higher convergence. → Consolidation of ice in summer + less leads results in thicker ice and less summer heat flux from the ocean → would explain a higher ice extent in summer.
- In winter ice drift in the central Weddell Sea is divergent with a trend towards higher divergence. → Ice is pushed to the edges. → Would explain a higher ice extent in winter.
- Further investigations on seasonal and interannual behavior of sea ice properties are required!

6. Future plans

- Seasonal changes in ice extent for the Weddell Sea
- Seasonal analyzing of trends for
  - Ice concentration
  - Temperature
  - Modeled ice thickness distribution using the Finite Element Sea ice – Ocean Model (FESOM)
  - Long term ice type distribution, backward calculations from FESOM
- Comparison of drift regimes from NSIDC Data and FESOM and evaluation with IPAB buoy data
- Interannual variability

3. Divergence and Convergence

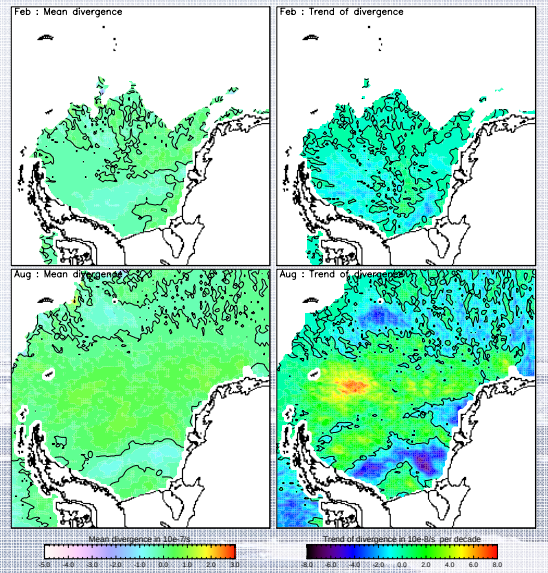

Fig. 6: Mean divergence (left) and trend of divergence (right) for February (top) and August (bottom). Ice drift is mainly convergent in summer with a trend to higher convergence. Divergent drift occurs in the central Weddell Sea in winter with a trend towards higher divergence.

4. Ice type distribution

Not only ice drift changes can modify ice extent but also ice type distribution (first and second year ice, FYI, SYI). Therefore the contribution of FYI and SYI in the Weddell Sea has been analyzed. Ice type distribution is estimated by using scatterometer data from the QuikSCAT satellite and SeaWinds sensor from January 2000 to December 2007 provided by the Department of Oceanography from Space, Institut Français pour l'Exploitation de la Mer (IFREMER).

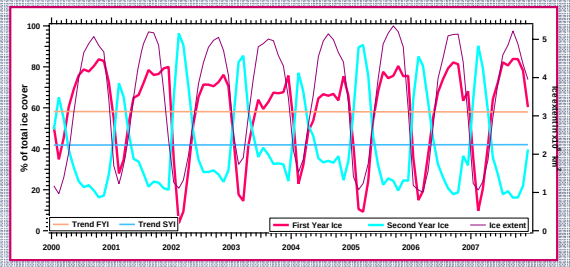

Fig. 7: Ice extent, ice type distribution and trend in the Weddell Sea from January 2000 to December 2007. There is nearly no trend in ice type distribution for these years. Data from QuikSCAT/ SeaWinds-Sensor

7. Literature

Fowler, C. 2003, updated 2007. *Polar Pathfinder Daily 25 km EASE-Grid Sea Ice Motion Vectors*, January 1979 - December 2006. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media. *NCEP Reanalysis data provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, http://www.esrl.noaa.gov/psd/*

Cavalieri, D., C. Parkinson, P. Gloersen, and H. J. Zwally. 1996, updated 2008. *Sea ice concentrations from Nimbus-7 SMMR and DMSP SSM/I passive microwave data*, November 1978 – December 2006. Boulder, Colorado USA: National Snow and Ice Data Center. Digital media.

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