Sea ice variability and trends in the Weddell Sea for 1979 - 2006

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Outline

Background
Changes in sea ice extent & Sea ice concentration

Ice-atmosphere interactions
Temperature
Wind

Drift and deformation
Volume changes

Summary and Outlook
Summary of interactions
Outlook on further needs
Sea ice extent changes

Sea ice extent anomalies in the Arctic and Antarctic (Fetterer et al., 2002)

- Arctic: +1.36% per decade
- Antarctic: -4.31% per decade
The Weddell Sea

- Largest sea ice extent in the Southern Ocean
- Special sea ice drift regime due to the Antarctic Peninsula
- Occurrence of second year ice
- Areas of potential deep and bottom water formation
- High data coverage

Sea ice extent anomalies in the Weddell Sea.

NSIDC bootstrap sea ice concentration data (Comiso, 1999) vs. FESOM model simulation.

Seasonal trends in % per decade.
Sea ice concentration, 1979-2006

Mean SIC

SIC trend

Rel. signif. (95% lev.)

Data from NSIDC (Comiso, 1999).
Sea ice concentration, 1979-2006

Mean SIC

SIC trend

Rel. signif. (95% lev.)

Data from NSIDC (Comiso, 1999).
Monthly sea ice concentration trends


Sea ice concentration (SIC)

- decreases near the Antarctic Peninsula
- increases in the central and eastern marginal sea ice zone
What has been studied?

- Connection between air temperature/wind forcing and sea ice concentration variability and trends
- Do sea ice drift and deformation changes support connections?
- Impact on sea ice growth changes
- Impact on sea ice volume
Monthly correlation between detrended anomalies of bootstrap sea ice concentrations (SIC) and surface air temperatures (SAT) from NCEP, from 1979 to 2006.
SAT trends

Monthly correlation between detrended anomalies of bootstrap SIC and wind speeds from NCEP Reanalysis data, 1979 to 2006.
Wind speed trends

Mean wind field (in m/s, NCEP)

Trend of wind speed (in m/s per decade). Black arrows: statistically significant trends at the 95% level.
Sea ice drift

Data source: NSIDC, Polar Pathfinder sea ice motion vectors (Fowler, 2003)
Sea ice divergence

Data source: NSIDC, Polar Pathfinder sea ice motion vectors (Fowler, 2003)
Dynamical sea ice growth

- Sea ice thicknesses influenced by deformation at the Antarctic Peninsula
- Trends indicate increased sea ice growth by deformation in this region
• Reduced freeze rates in the north-western Weddell Sea
• Enhanced freezing in the south-western Weddell Sea
Sea ice volume

- Increase of modeled sea ice thickness by few cm per decade
- Overall increasing sea ice volume
- Highest trends occur in summer and fall
- High interannual variability
Summary

Wind speeds
- increase
- decrease
Outlook

- Sea ice thickness measurements are needed
  - In different seasons
  - In different regions
  - Continuation of ULS measurements in the central Weddell Sea
  - Planned sea ice thickness surveys in winter 2013

- Refinements of grid resolution in FESOM simulations
  - Deformation processes might be better resolved

- Comparison with model runs forced by ECMWF data
  - Higher resolution of atmospheric forcing