Changes of sea ice drift and deformation in the Weddell Sea

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Outline

Introduction

Sea ice drift
Sea ice growth

Conclusion
Further needs
Introduction

- Polar Pathfinder sea ice motion vectors
- 25 km x 25 km grid
- Cross correlation method
- Interpolation onto grid cell with SIC ≥ 50%
- Monthly mean when ≥ 20 OI vectors available

<table>
<thead>
<tr>
<th>Sensor</th>
<th>Operation time</th>
<th>Temporal coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanning Multi-channel Microwave Radiometer</td>
<td>Oct 1978 – Aug 1987</td>
<td>every other day</td>
</tr>
<tr>
<td>(SMMR)</td>
<td></td>
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<tr>
<td>Special Sensor Microwave/Imager</td>
<td>Jul 1987 – Dec 2006</td>
<td>every day</td>
</tr>
<tr>
<td>(SSM/I)</td>
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<tr>
<td>Advanced Very High Resolution Radiometer</td>
<td>Jul 1981 – Dec 2000</td>
<td>4 satellite passages each day</td>
</tr>
<tr>
<td>(AVHRR)</td>
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</tbody>
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Fowler (2003), Data from NSIDC
Accuracy of drift data

- High data coverage since 1987
- Satellite and in situ data correlate well
- Summer months: lower data coverage/correlation

Adapted from Schwegmann et al. (2011)
Sea ice drift variability

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

- Decrease in sea ice drift velocities in the western Weddell Sea
- Increased sea ice drift in the eastern Weddell Sea
- Correlation coefficients of up to 0.7 in the central and marginal sea ice zone for zonal and meridional components
- Correlation of magnitudes does not exceed coefficients of 0.5
- Generally low correlation near the coasts
Wind variability

Data source: NCEP Reanalysis (Kalnay, 1996)

- Western Weddell Sea exhibits
  - increasing westerlies in the north
  - increasing offshore winds
- Trends in wind field are opposed to trends in sea ice drift
Divergence

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

- Tendency to reduced divergence in most parts of the Weddell Sea
- Redistribution of sea ice from the west to the east
Sea ice volume

- Thermodynamical sea ice growth
  - increases in Ronne polynya
  - decreases in north-western Weddell Sea

- Dynamical sea ice growth
  - increases in the south-western Weddell Sea
Conclusions

- Reasonable data quality since 1988
  - before 1988: low data coverage
  - since 1988: validation with buoy data possible

- Decrease of sea ice drift in the west certainly by increased deformation

- Higher ice production in Ronne polynya consistent with
  - increased off-shore wind
  - increased sea ice drift
Needs

• Sea ice thickness measurements
  ➢ frequent large-scale measurements from e.g. satellites
  ➢ in situ measurements for validation and case studies

• Updated large-scale sea ice drift product

• Ongoing in situ sea ice drift data, especially in arrays of at least 3 buoys
The Finite Element Sea ice-Ocean Model

Global resolution: 1.5° x 1.5°

Prognostic variables:
  - ice concentration, ice drift, mean ice and snow thickness

Forcing: NCEP wind, temperature, specific humidity, cloud cover and precipitation

Mean September sea ice thickness and sea ice drift vectors (1979 – 2006)

Timmermann et al. (2009)
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