Prospects for subseasonal sea ice prediction at both poles

Workshop on Predictability, dynamics and applications research using the TIGGE and S2S ensembles
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Images from the YOPP Promotional Video
Focus on 6 S2S models

ECMWF  
UKMO  
KMA  

CMA  
Météo France  
NCEP

12 years of forecasts  
1999 - 2010

Forecasts cover the whole seasonal cycle

Characterization goes beyond specific events such as the September minimum
Design of the verification study

Spatial Probability Score

Lead Time [Days]
Design of the verification study

Spatial Probability Score

\[ SPS = \iint_A (p_{f[sic>15\%]} - p_{o[sic>15\%]})^2 \, dA \]

Design of the verification study

Spatial Probability Score vs. Lead Time [Days]

- Persistence Benchmark
- Climatological Benchmark
Design of the verification study

- Persistence
- Benchmark
- Forecast
- Climatological Benchmark

Spatial Probability Score vs. Lead Time [Days]

- Skillful Forecast
- Unskillful Forecast
Method Summary

Ensemble S2S sea-ice forecasts

Verification against satellite observations using the SPS

Compare forecast SPS to the benchmarks

Assessment of the forecast predictive skill

Indications about errors and biases
Arctic sea ice forecasts (1999-2010)

Antarctic sea ice forecasts (1999-2010)

![Graph showing Antarctic sea ice forecasts from 1999 to 2010 for various models including ECMWF, UKMO, KMA, NCEP, CMA (out of range), MF, and ECMWF Pres. with benchmarks. The graph plots SPS [10^6 km^2] against lead time in days.]
Seasonality of ECMWF skill

Arctic

Antarctic
Forecasting the 2007 minimum

The CMA has strong model bias and sea ice initialization issues. Forecasts based on climatological records systematically overestimate the sea ice edge. Too little ensemble spread after 30 days. Persistence provides a decent forecast at the end of the summer. Underestimation of the sea ice edge due to misrepresentation of thermodynamical processes.

The images show maps of sea ice probability for different models and benchmarks. The maps are color-coded to indicate the probability of sea ice presence, with red indicating higher probabilities. The models and benchmarks include ECMWF, UKMO, KMA, NCEP, CMA, MF, ECMWF Pres., Clim. Benchmark, and Pers. Benchmark. The dates range from Day 30 of 2007 to 2007.09.16, with some images also showing 15% sic OSI-SAF.
Summary

Big skill difference among different forecast systems.

Similar model ranking for the two hemispheres.

Evidences of skillful Arctic sea ice forecast up to 1½ months in advance.

Substantial errors associated with model biases and data assimilation procedure.

A (well formulated) dynamical sea ice model is beneficial to the forecast skills.
Thank you!
Improvements in ECMWF forecast system

- **NEW!**
- **OLD!**

Graph showing changes in SPS [10^6 km^2] over lead time [Days].

Legend:
- ECMWF
- ECMWF Pres.
- Climatology
# Model details

<table>
<thead>
<tr>
<th>Forecast System</th>
<th>Initialisation Freq.</th>
<th>Ensemble Size</th>
<th>Range</th>
<th>sea ice Model</th>
<th>SIC</th>
<th>Assimilated</th>
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<td>ECMWF</td>
<td>×2 weekly</td>
<td>10+1</td>
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<tr>
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<td>×4 monthly</td>
<td>6+1</td>
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<td>CICE 4.1</td>
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<tr>
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<td>×4 monthly</td>
<td>2+1</td>
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</tbody>
</table>
The sea ice edge position

Sea ice edge Observation

Sea ice edge Model

Overest.

Underest.
The Spatial Probability Score

Ensemble forecasts

Probabilistic verification metric required

Spatial Probability Score

\[ SPS = \iint_A \left( \mathcal{P}_f[sic>15\%] - \mathcal{P}_o[sic>15\%] \right)^2 \, dA \]
The S2S time scale

Long-range

2 month

Medium-range

2 week

S2S timescale

Short-range

Nowcasting

Climate Projection

Prediction forecast timescale

Image from the S2S Promotional Video