The WWRP Polar Prediction Project

Trond Iversen

Member of the WWRP Polar Prediction Project Steering Group

Norwegian Meteorological Institute / ECMWF

11th meeting, THORPEX GIFS-TIGGE, WG; June 2013

Background

Month	Milestones
Nov 2009	CAS recommends IPY legacy project
Oct 2010	WWRP and WCRP workshops in Norway
Oct 2010	EC-PORS formulates proposal for GIPPS
Sep 2011	Endorsement of PPP through THORPEX ICSC
Sep 2011	Formation of PPP steering group
Dec 2011	1st PPP steering group meeting (implementation plan)
Mar 2012	2nd PPP steering group meeting (implementation and science plan)
Jun 2012	Approval of PPP through WMO EC
Dec 2012	3rd PPP steering group meeting (YOPP etc.)
Jan 2013	Final version of the Implementation Plan

The WWRP-PPP Steering Group

SG3, Reading, 12-13. December 2012

- Thomas Jung (chair)
- Peter Bauer
- Chris Fairall
- David Bromwich
- Trond Iversen
- Marika Holland
- Brian Mills
- Pertti Nurmi
- Ian Renfrew
- Gregory Smith
- Gunilla Svensson
- Mikhail Tolstykh
- Paco Doblas Reyes (ex-officio)
- Peter Lemke (ex-officio)
- Neil Gordon (WMO consultant)

WWRP-PPP Implementation Plan

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Mission Statement

„Promote cooperative international research enabling development of improved weather and environmental prediction services for the polar regions, on time scales from hourly to seasonal“

An important addition:

„This constitutes the hourly to seasonal research component of the WMO Global Integrated Polar Prediction System (GIPPS)“

Short-term	Medium-term	Long-term
Hours to seasons	Years to decades	Centuries
WWRP	WCRP	WCRP

Research Areas

Service-oriented Research

- Societal and Economic Research Applications (SERA)
- Verification

Underpinning Research

- Predictability and Diagnostics
- Teleconnections

Forecasting System Research

- Observations
- Modelling
- Data Assimilation
- Ensemble Forecasting

THORPEX

WWRP

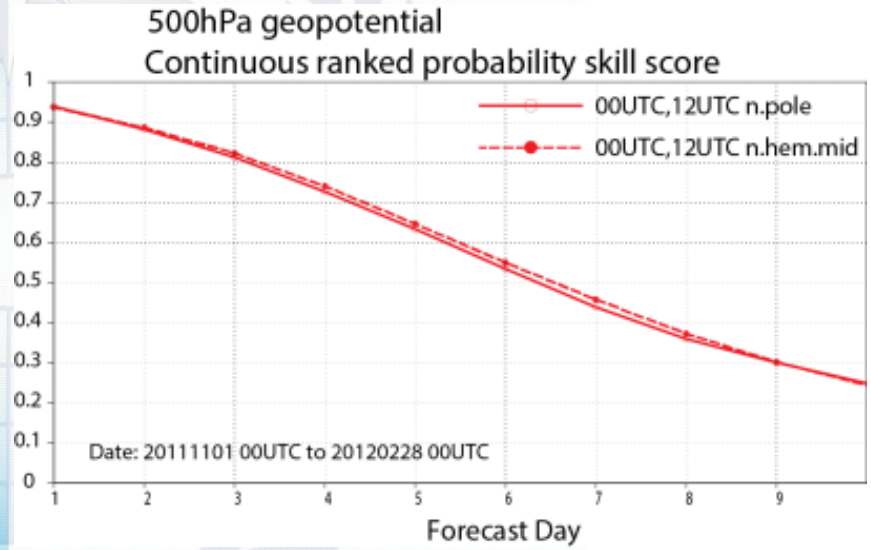
WMO OMM

Polar Verification

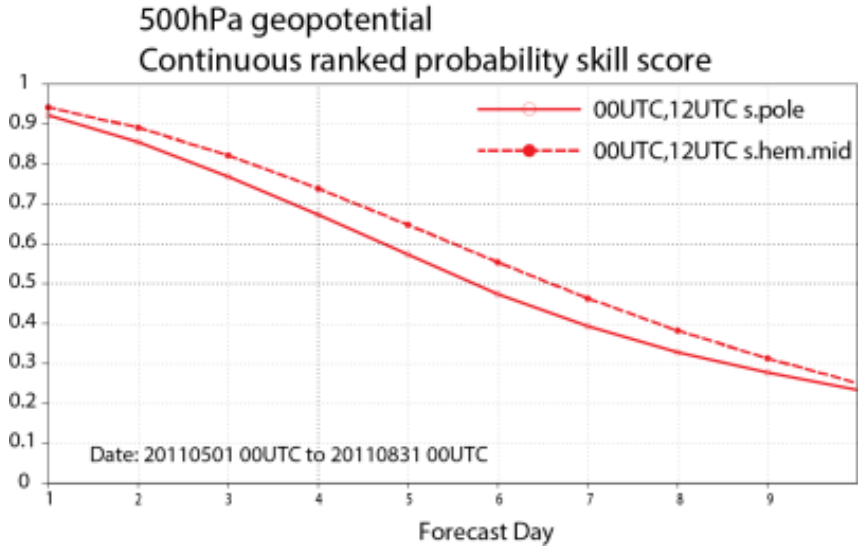
vs. Mid. latitudes

CRPSS, ECMWF EPS, Z_{500hPa}

2011-2012, NH Winter



2011, SH Winter



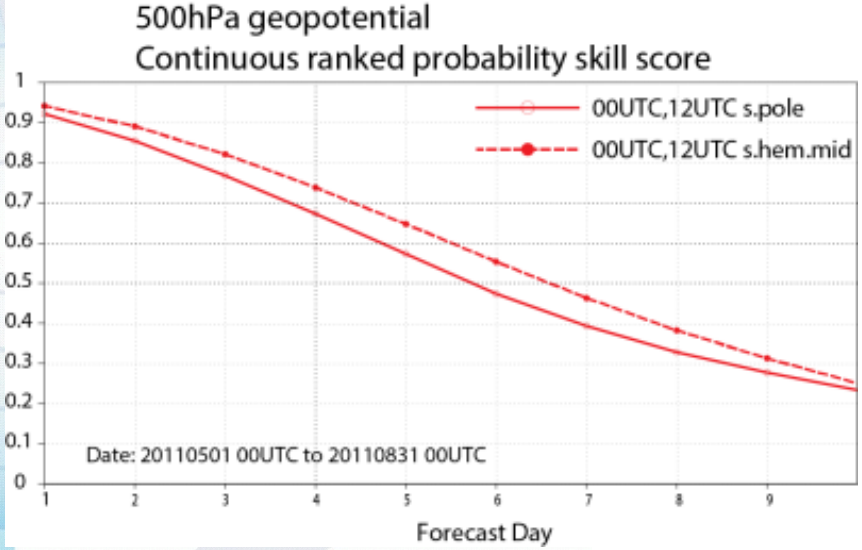
The continuous rank probability skill score (CRPSS) for the ECMWF probabilistic forecasts of 500 hPa geopotential height over extended 4-months winter periods. Left: November 2011 through February 2012 for the NH extratropics (dashed), and the area north of 65°N (continuous). Right: May through August 2011 for the SH extratropics (dashed), and south of 65°S (continuous). (Source: L. Magnusson, ECMWF).

Polar Verification

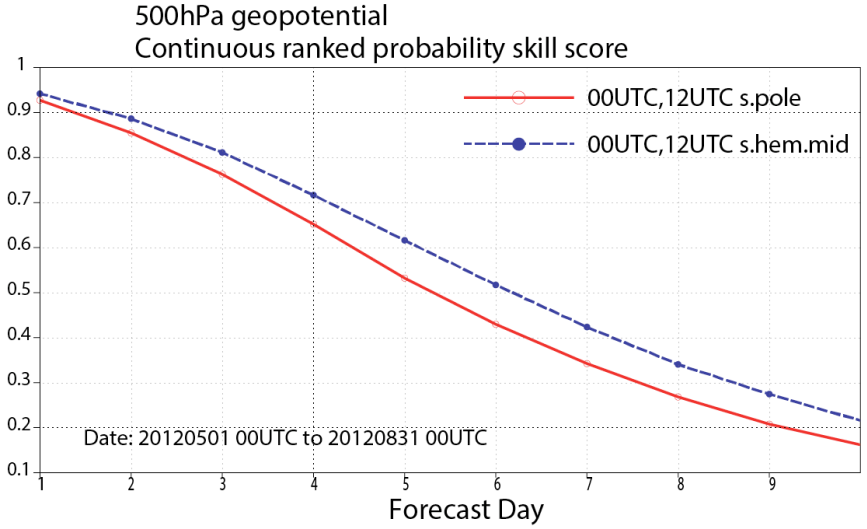
vs. Mid. latitudes

CRPSS, ECMWF EPS, Z_{500hPa}

2011, SH Winter



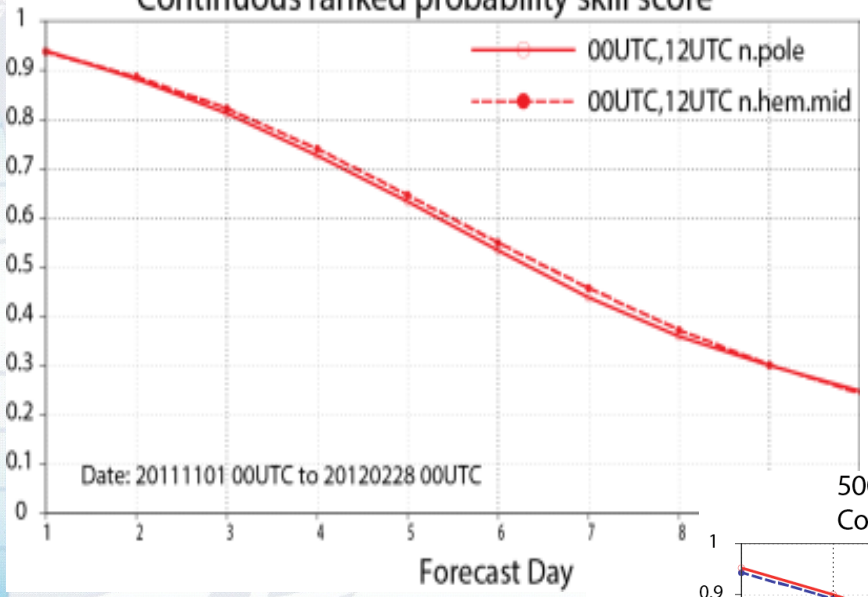
2012, SH Winter



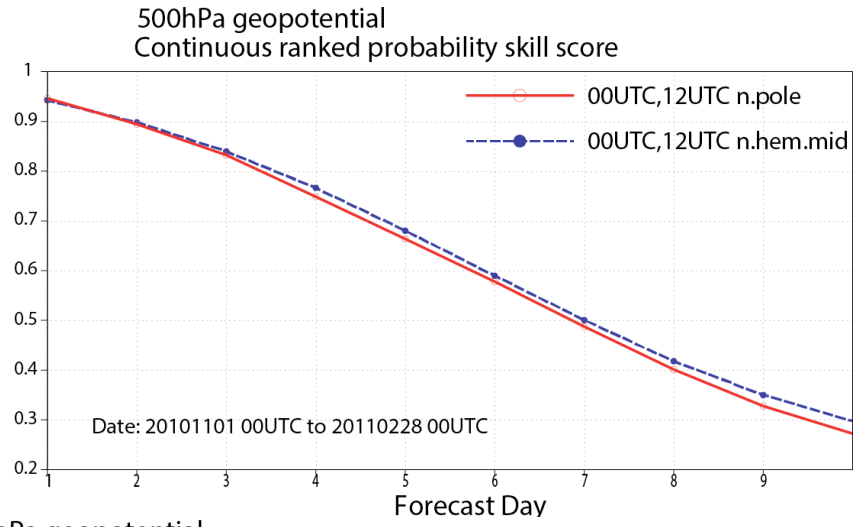
Polar Verifications vs. Mid. latitudes

CRPSS, ECMWF EPS, Z_{500hPa}

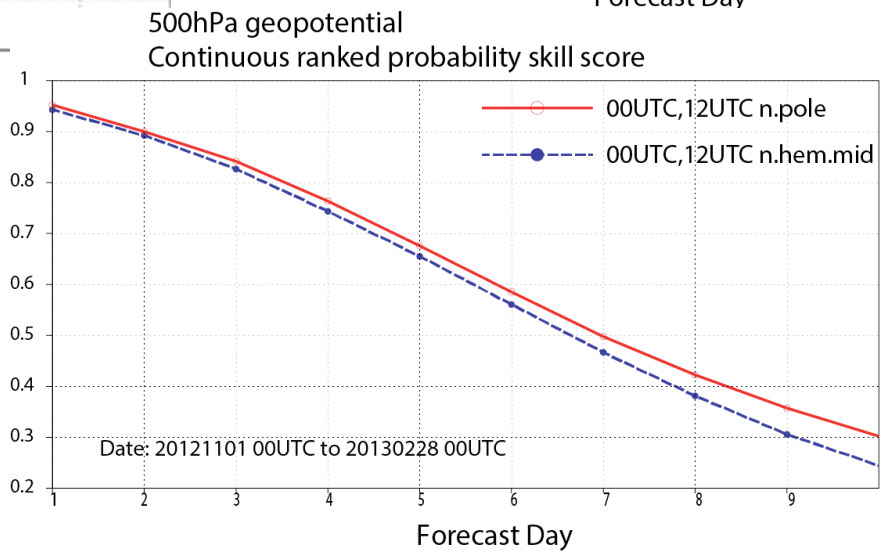
2011-2012, NH Winter



2010-2011, NH Winter



2012-2013, NH Winter

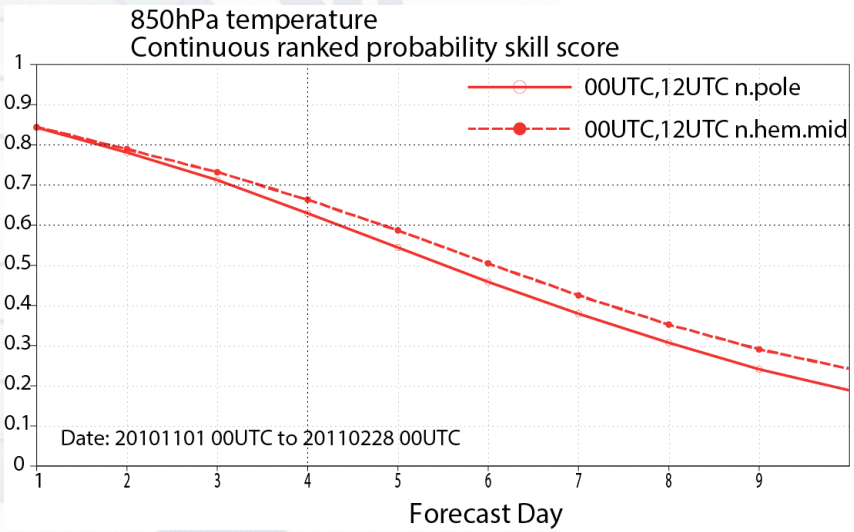


Polar Verification

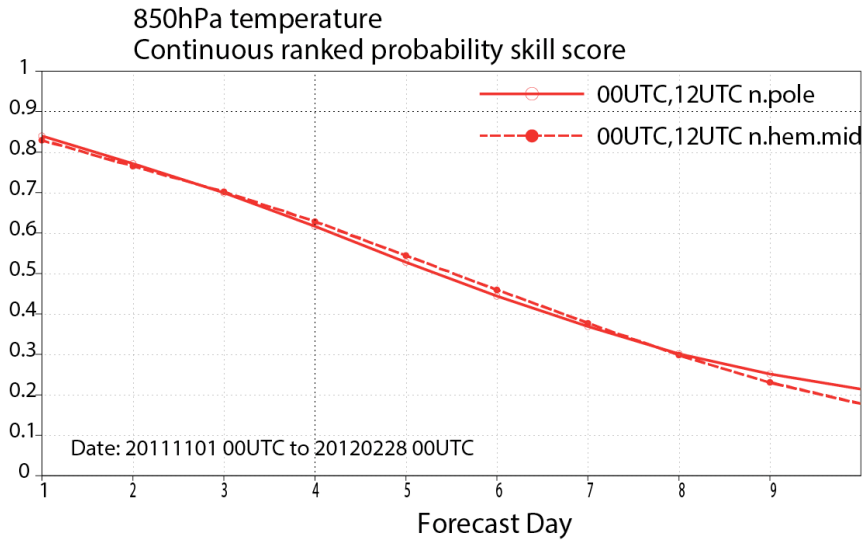
vs. Mid. latitudes

CRPSS, ECMWF EPS, T_{850hPa}

2010-2011, NH Winter



2011-2012, NH Winter

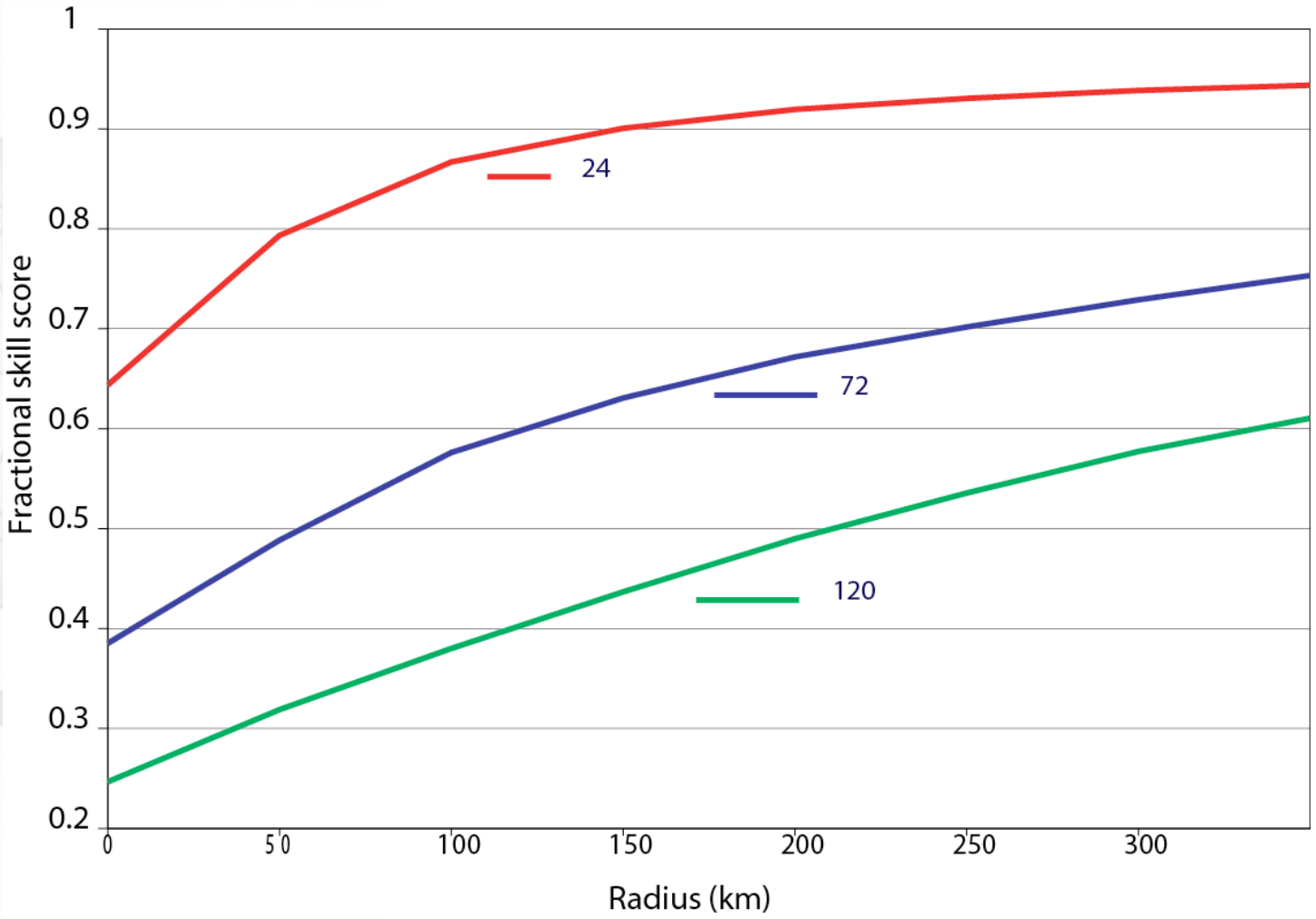


The continuous rank probability skill score (CRPSS) for the ECMWF probabilistic forecasts of 850 hPa temperature over extended 4-months winter periods. Left: November 2010 through February 2011, and Right: November 2011 through February 2012, both for the NH extratropics (dashed), and the area north of 65°N (continuous). (Source: L. Magnusson, ECMWF).

Impact-related Verification/Validation:

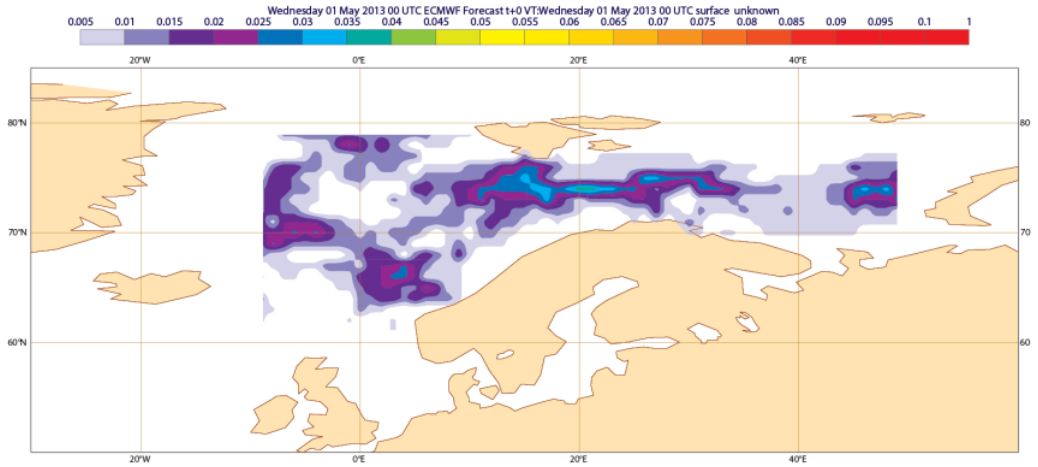
Fractions Skill Score for polar lows

EC deterministic, event = m>43C and ff10>15m/s



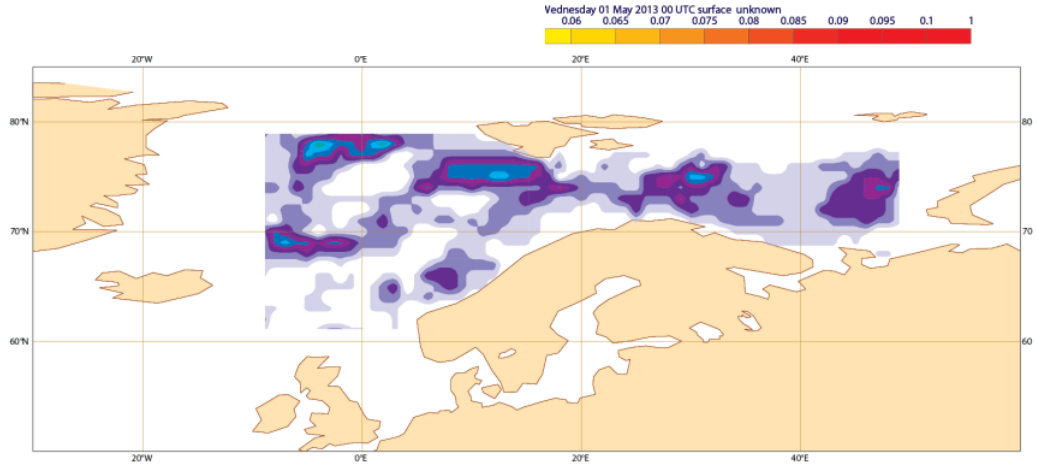
Courtesy: Linus Magnusson, ECMWF

Event «climatology», winter 2013



Analysis

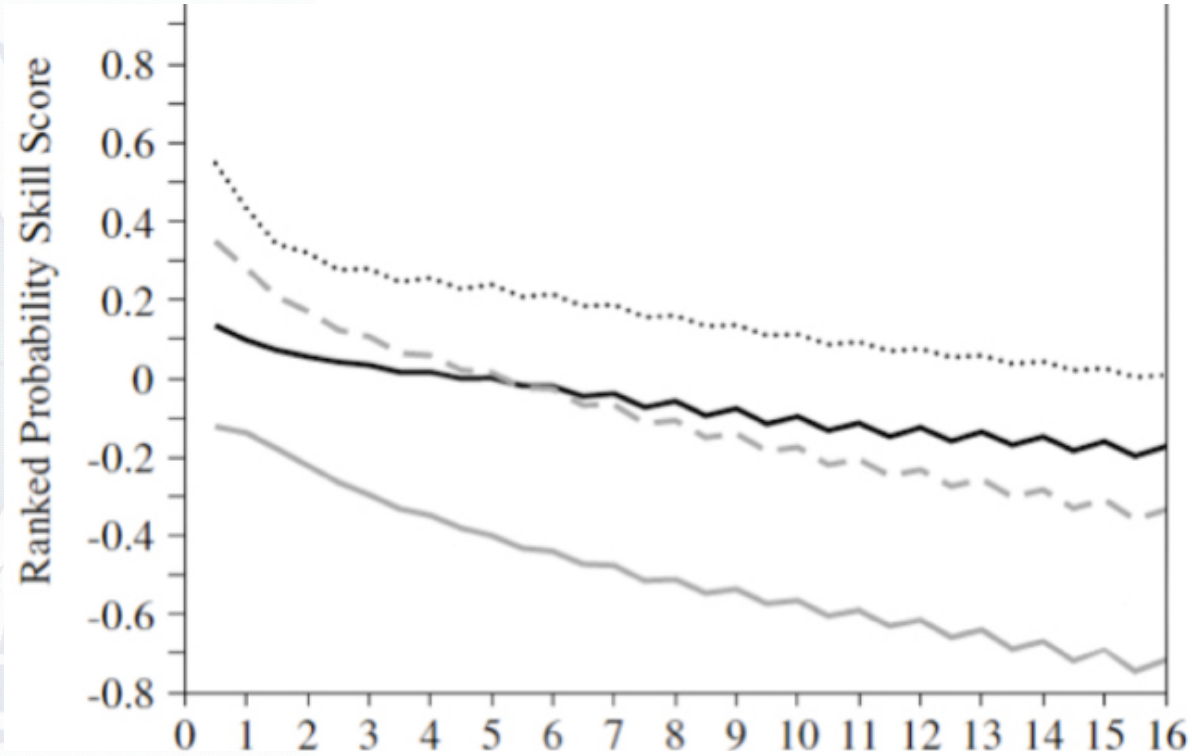
+3D Prog



Courtesy: Linus Magnusson, ECMWF

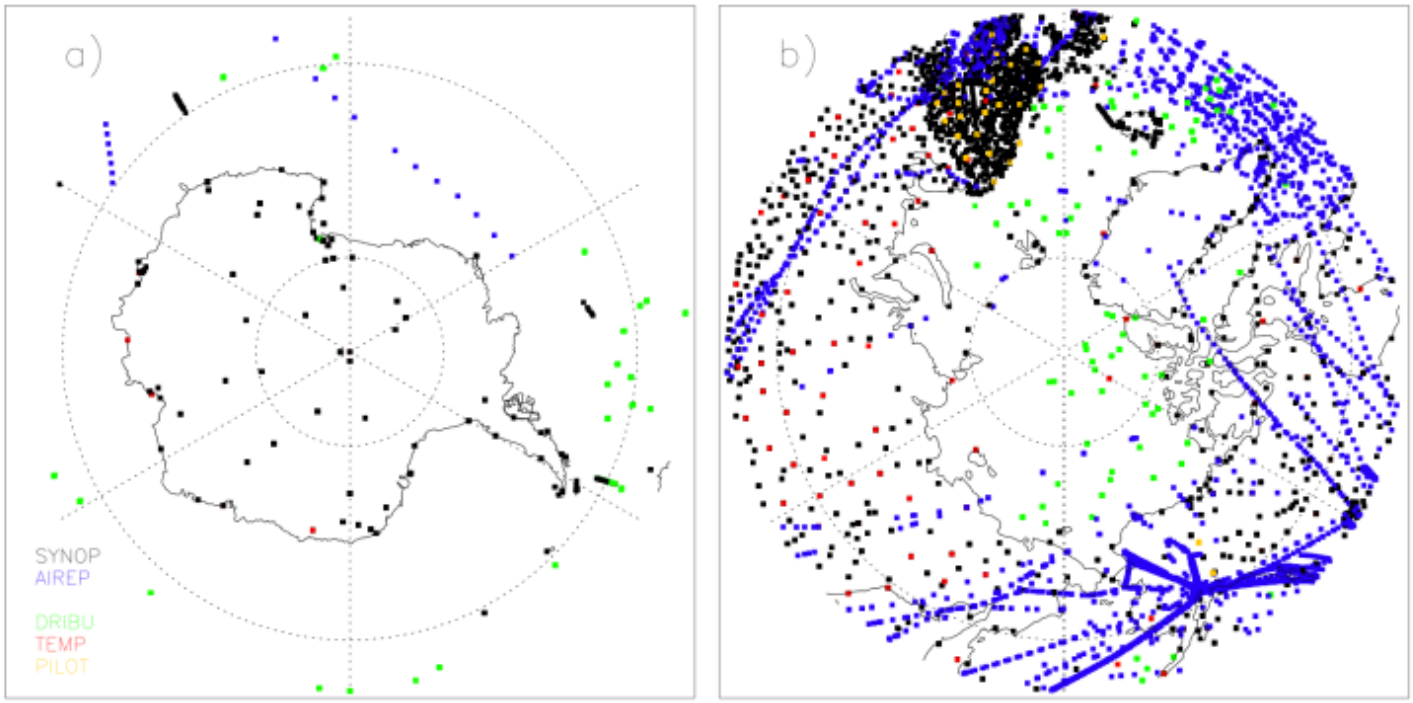
Verification Sensitivity

How to verify TIGGE predictions in polar regions?



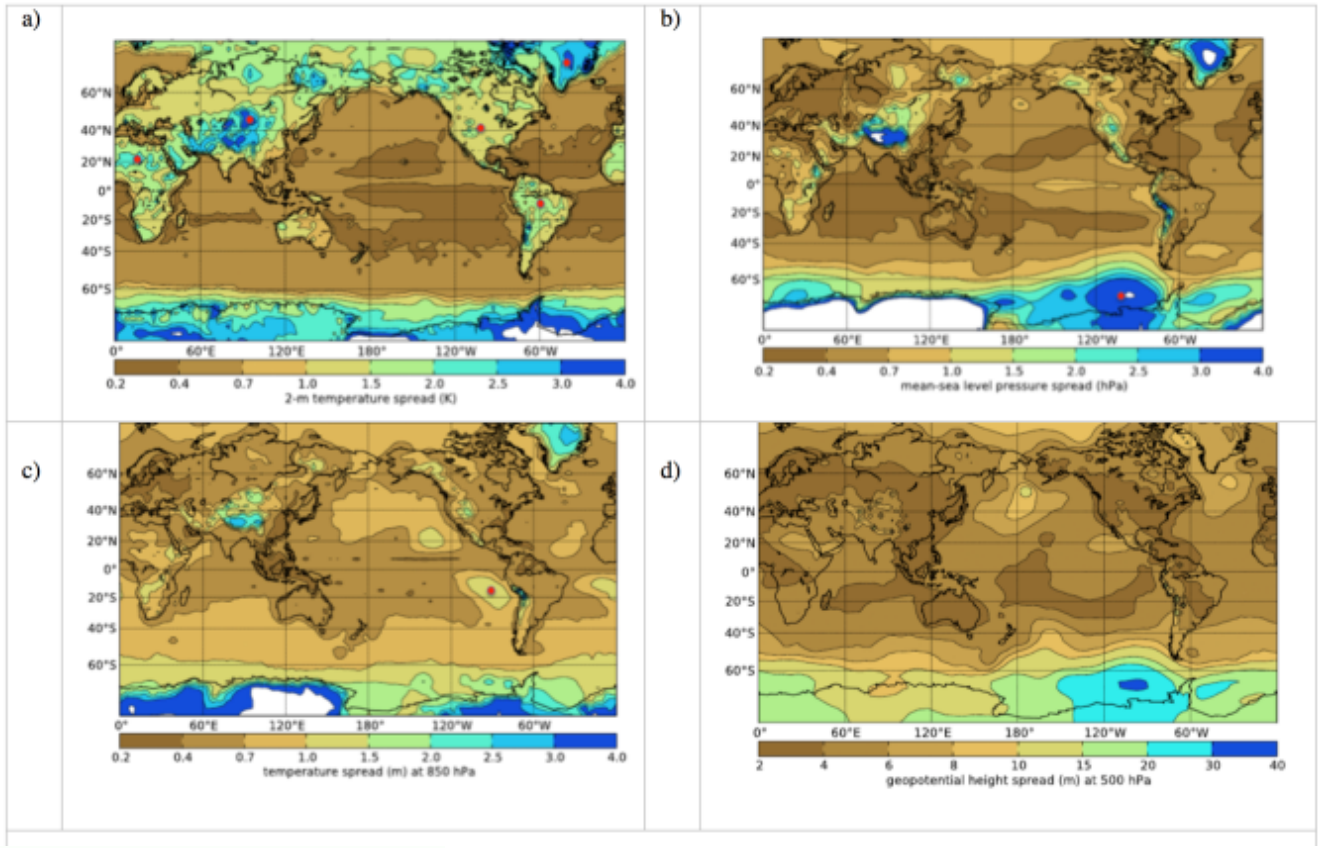
Sensitivity of probabilistic forecast skill to the analysis used for verification, showing the incestuous nature of using the same model for analysis and verification. Average Ranked Probability Skill Score (RPSS) for probabilistic forecasts of tropical temperature at 850 hPa with the NCEP ensemble prediction system using NCEP's own analyses (dotted), and ECMWF (solid-black), Met Office UK (solid-grey) as well as the multi-centre mean analysis (dashed-grey) for verification, for forecast periods out to 16 days. The larger the RPSS the more skilful the ensemble forecasts are. Based on Park et al. (2008).

Observations:
Polar Data Coverage



Polar data coverage of conventional observations in the ECMWF operational analysis at 00 UTC on 1 January 2012 (21-09 UTC window) for (a) southern polar region, and (b) northern polar region. SYNOPs are surface reports from land stations; AIREP are in-flight reports from aircraft; DRIBU are surface drifting buoys; TEMP are upper air balloon soundings; PILOT are upper air winds from tracked balloons.

Data Assimilation:
Analysis Differences in Polar Regions and High Terrain

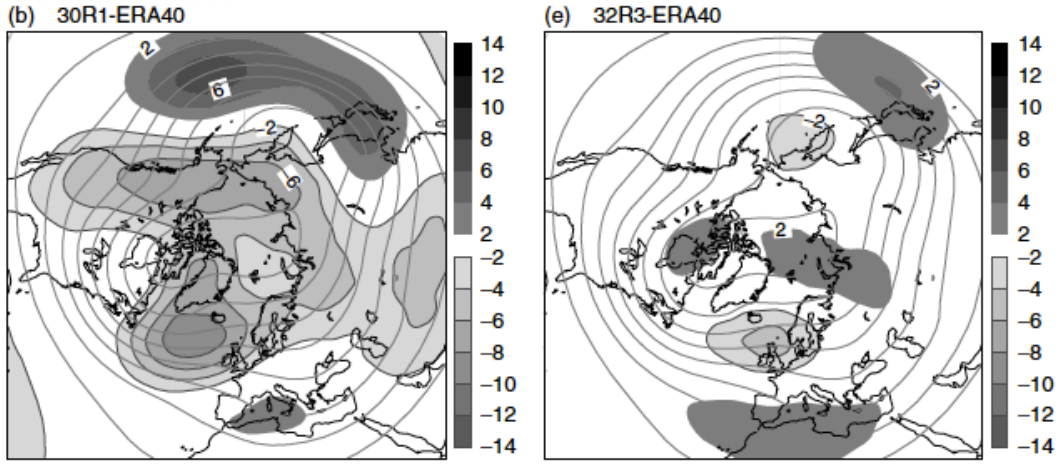


Spread of analysis mean for (a) 2-metre temperature, (b) mean sea-level pressure, (c) 850 hPa temperature, and (d) 500 hPa geopotential height from 5 operational TIGGE models (UKMO ECMWF, NCEP, CMC, CMA; 10/2010-11/2010) (Hamill 2012, pers. comm.).

Modelling development:

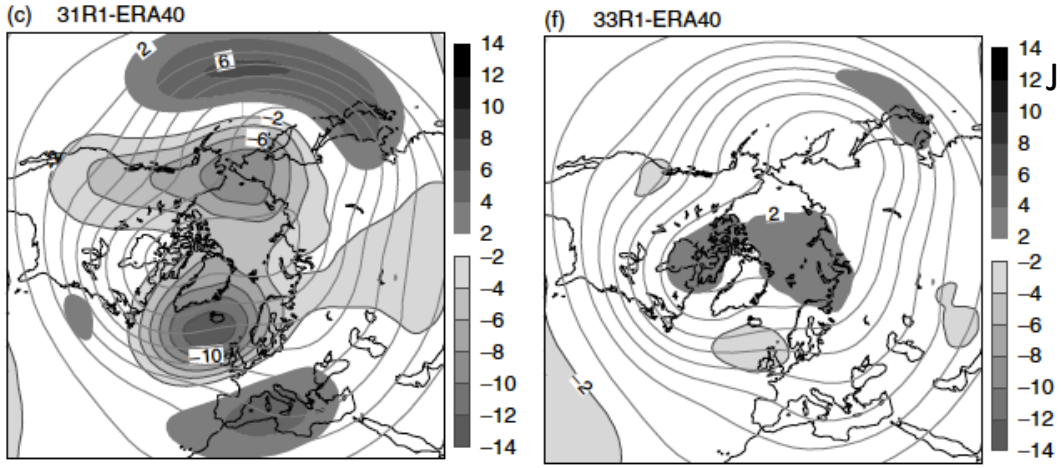
ECMWF Z_{500hPa}

Feb-Sep 2006



Nov2007-Jun2008

Sep2006-Jun2007



Jun2008-Nov2009

Mean systematic errors of $Z_{500\ hPa}$ (shades) for winters (Dec–Feb) 1962–2005 and various versions of the ECMWF NWP model. Also shown: mean $Z_{500\ hPa}$ (contours) from a combination of ERA-40 (1962–2001) and operational ECMWF analyses (2002–2005).

Jung et al., QJRMS, (2010)

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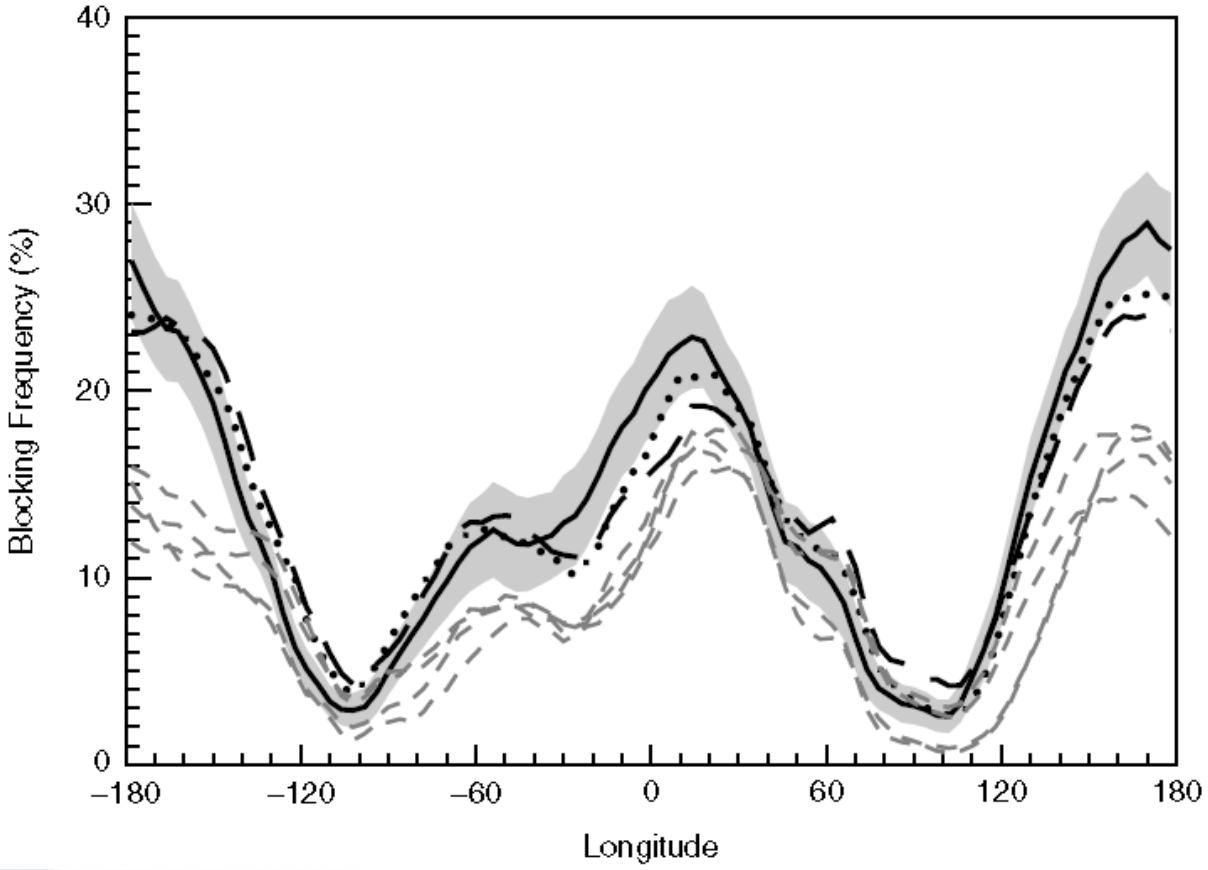
Model development:
ECMWF, NH Winter Blocking



Frequency of occurrence of wintertime Northern Hemisphere blocking events (December–February) for the period 1962–2005: ERA-40 (black solid), version 33R1 (black dotted), version 32R3 (black dashed) and versions 29R2 to 32R2 (grey thin dashed). Blocking frequencies have been determined using the methodology by Tibaldi and Molteni (1990). Also shown are 95% confidence intervals for ERA-40 data (grey shading).

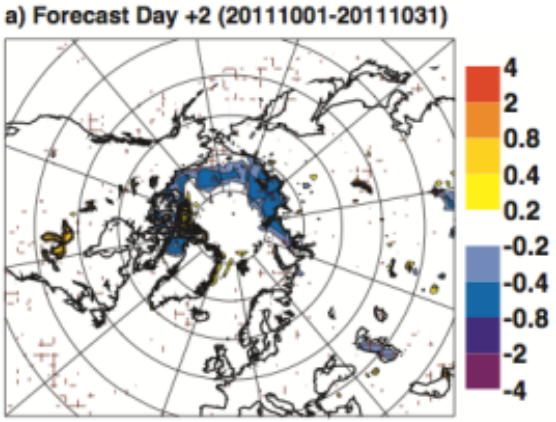
Jung et al., QJRMS, (2010)

Modelling / Diagnostics:

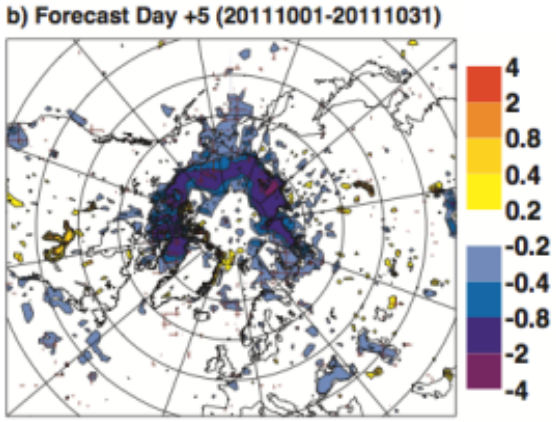
Sea Ice in Medium-Range Weather Forecasting: coupled models are needed for polar NWP

T2m Difference: Observed Minus Persisted Sea Ice

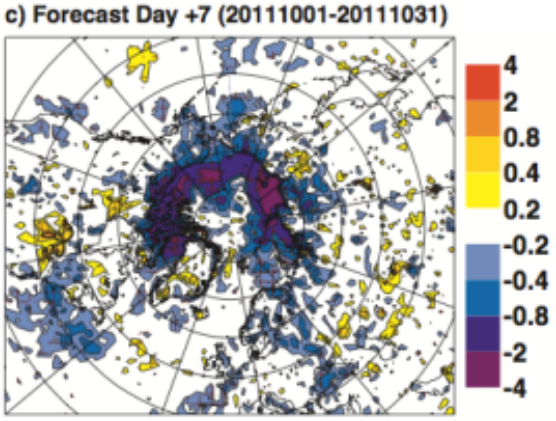
+2d



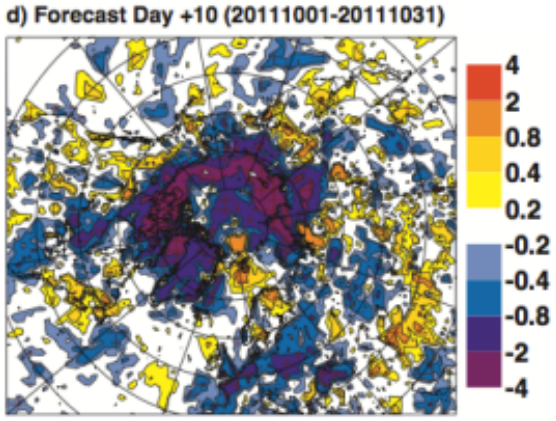
+5d



+7d



+10d



The mean difference for October 2011 in 2m temperature between hindcasts with observed SST and with persisted SST (operationally at ECMWF).
Growing sea ice has a noticable effect on T2m already after a few days forecasts.

P. Bauer (ECMWF & PPP SG)

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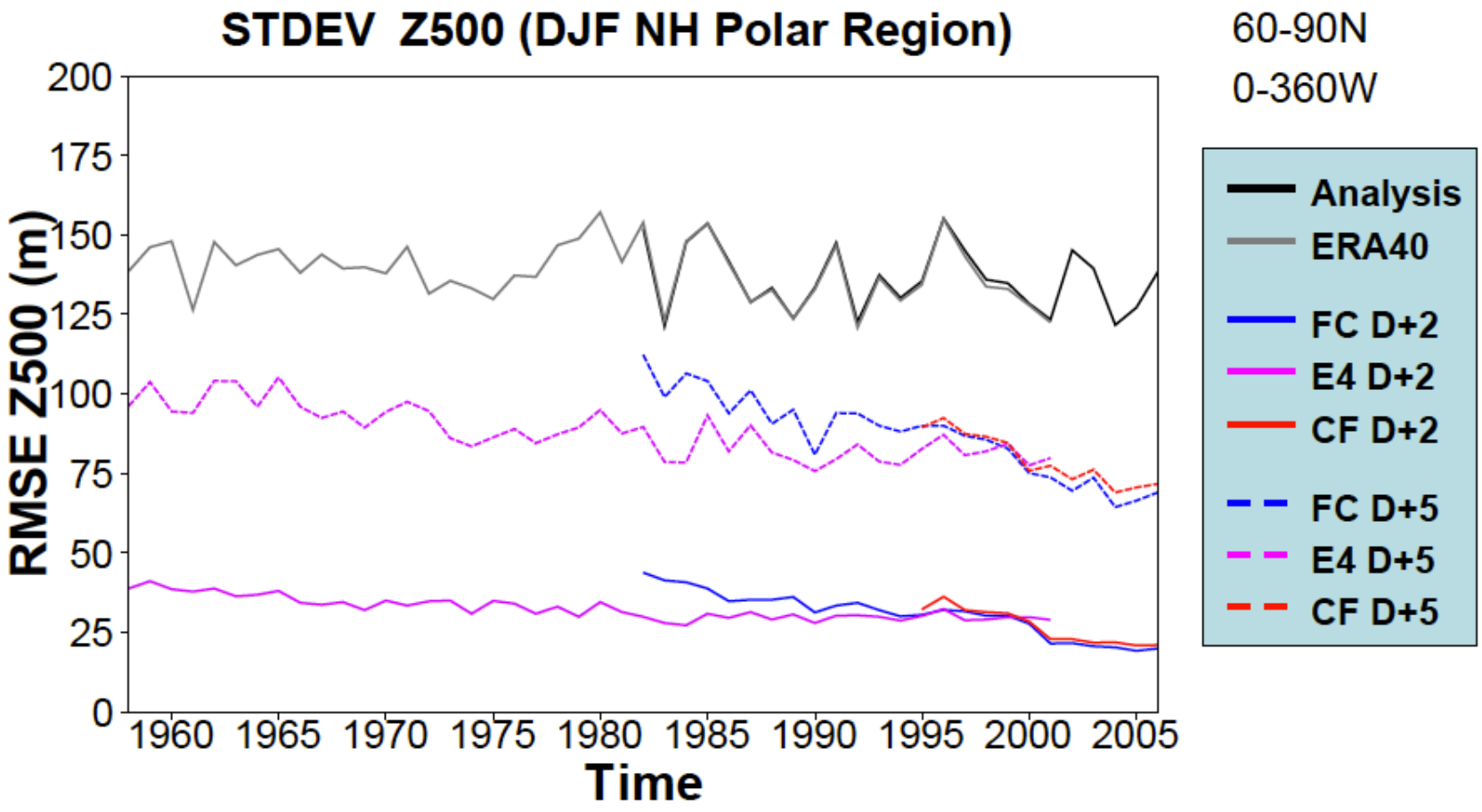
OMM

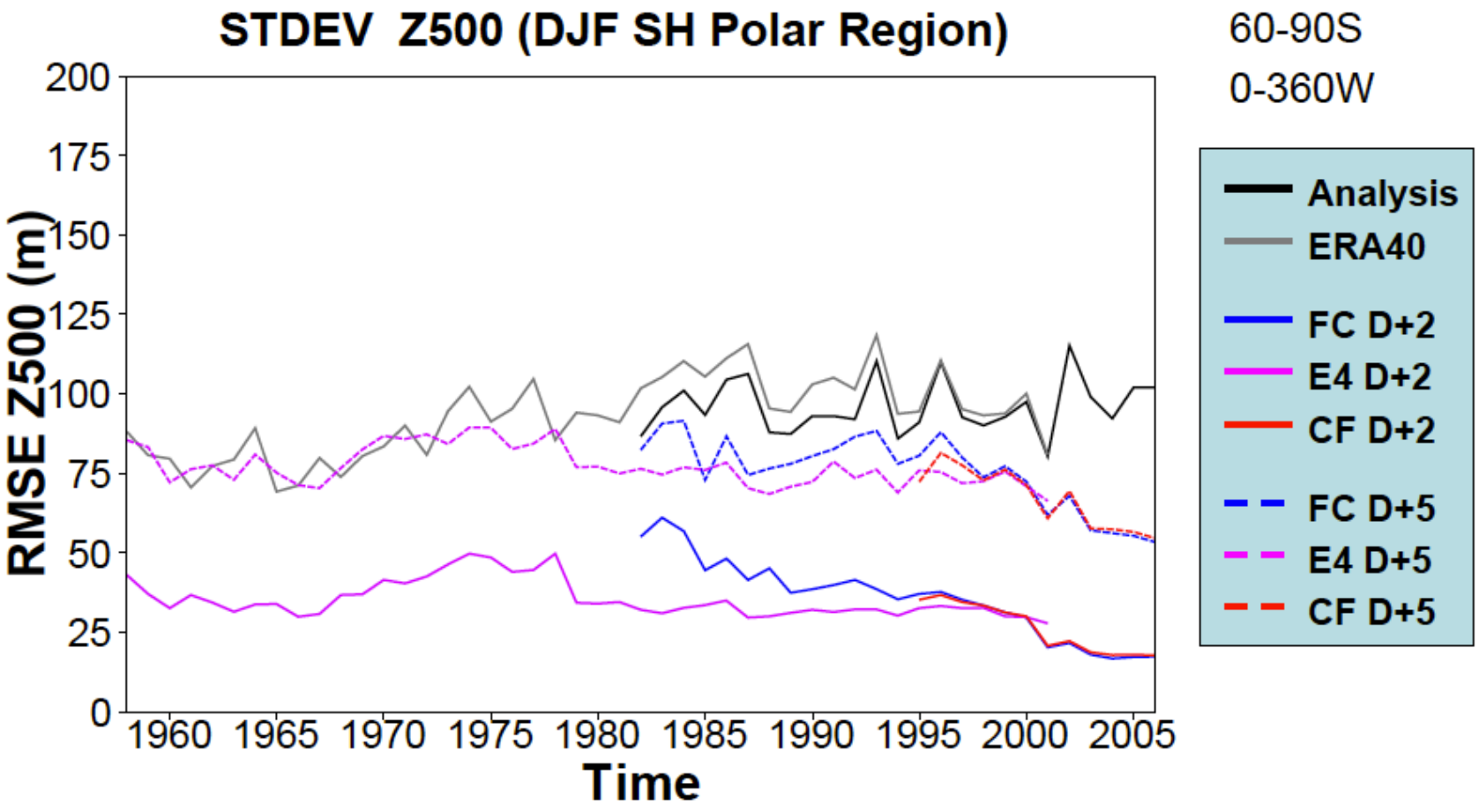
Importance of sea ice forecasts

Predictability:
Deterministic Skill: Z_{500} Arctic



Jung and Leutbecher (2007)

Predictability:
Deterministic Skill: Z_{500} Antarctic



Jung and Leutbecher (2007)

Scale dependent predictability

Spectra of mean-square 850hPa vorticity errors

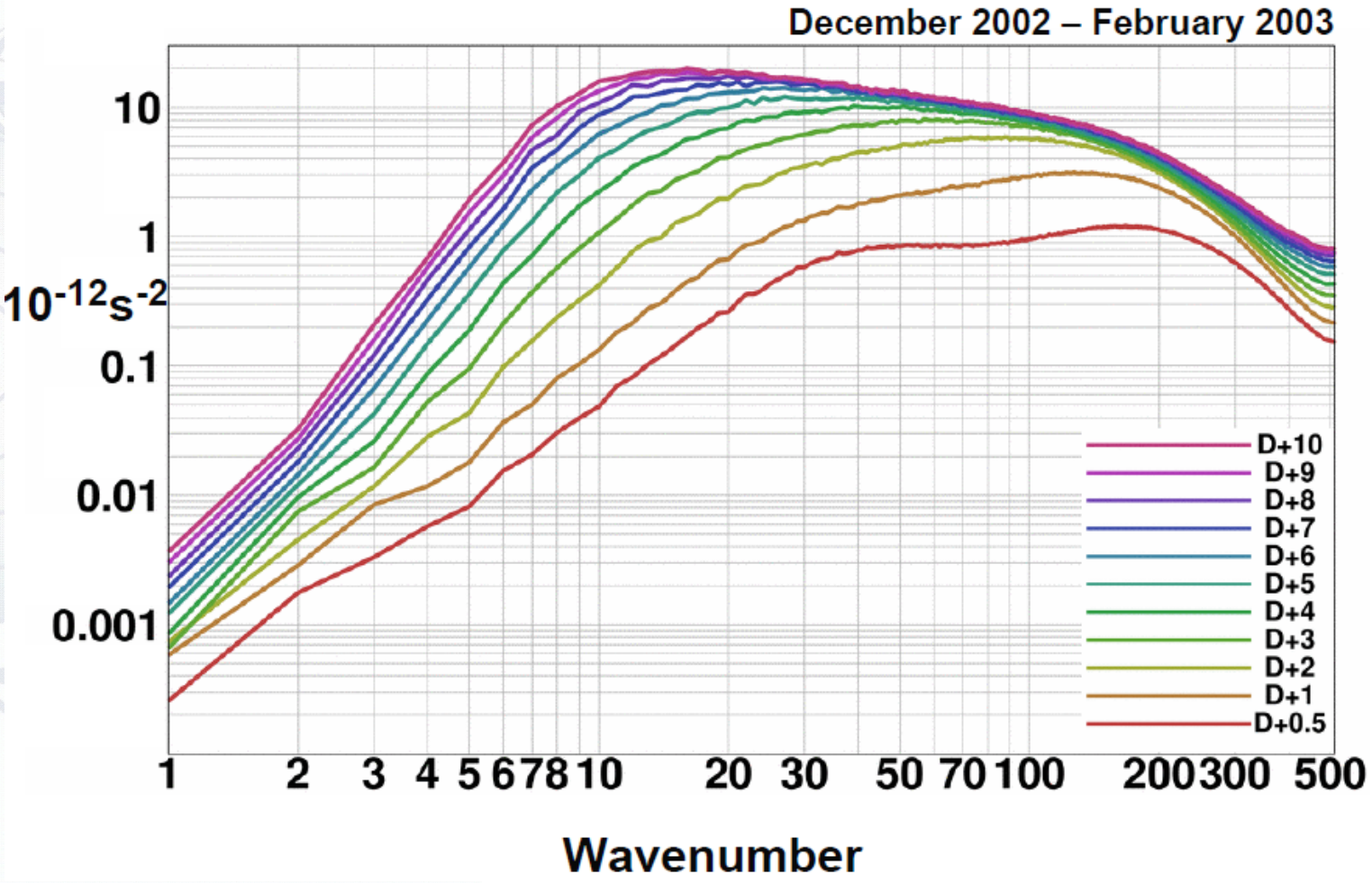
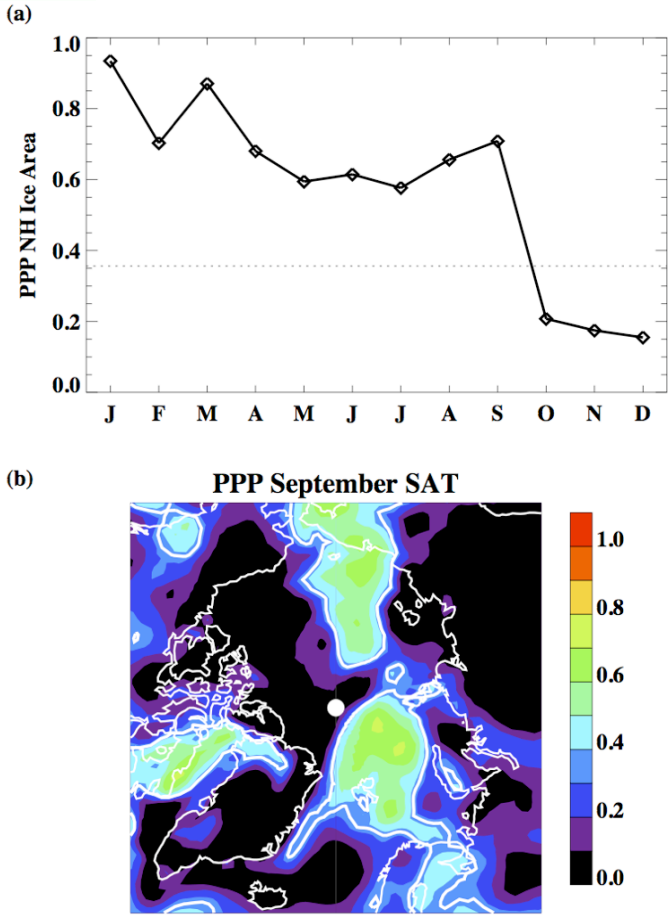


Figure courtesy of A. Simmons (ECMWF)

Potential Predictability



The prognostic potential predictability in (a) northern hemisphere sea ice area as a function of month and (b) September surface air temperature (SAT) for perfect model simulations initialized in January (see Holland et al. 2011). A value of 1 indicates perfect predictability, values above the dotted line in (a) and within the white contour in (b) indicate significant potential predictability. Note that significant potential predictability in SAT generally aligns with the sea ice edge indicating that the predictability resides in the sea ice and its influence on the overlying atmosphere.

Year of Polar Prediction (YOPP)

Aims:

- Intensive observational *and* modelling period to advance polar prediction capabilities.
- Research into forecast-stakeholder interaction
- Enhanced verification
- Education of students and early career scientists (APECS)

Important:

- Engagement of other committees
- Alignment with other (planned) activities such as MOSAiC

YOPP: Time line

TIGGE and its relationship with World Weather Research Programme (WWRP): *Polar Prediction Project (PPP)*

Challenges:

- Multi-model vs single-model ensembles
- Ensemble calibration in polar regions
- Resolution issues, paucity of LAM EPS in polar regions
- Can a potential next-phase TIGGE have enhanced attention on polar issues, for example:
  - Polar-mid latitude teleconnections, e.g. for various ice-cover regimes
  - Verification utilizing non-conventional data
  - The role of coupling from day 0, incl sea-ice and rivers
  - Polar-specific physics, e.g. stable boundary layers and extremely unstable boundary layers with strong influence on upper ocean mixing
- TIGGE during YOPP: a system for real-time production?