Medium-range prediction in the polar regions:
current status and future challenges

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Marine Prediction Section

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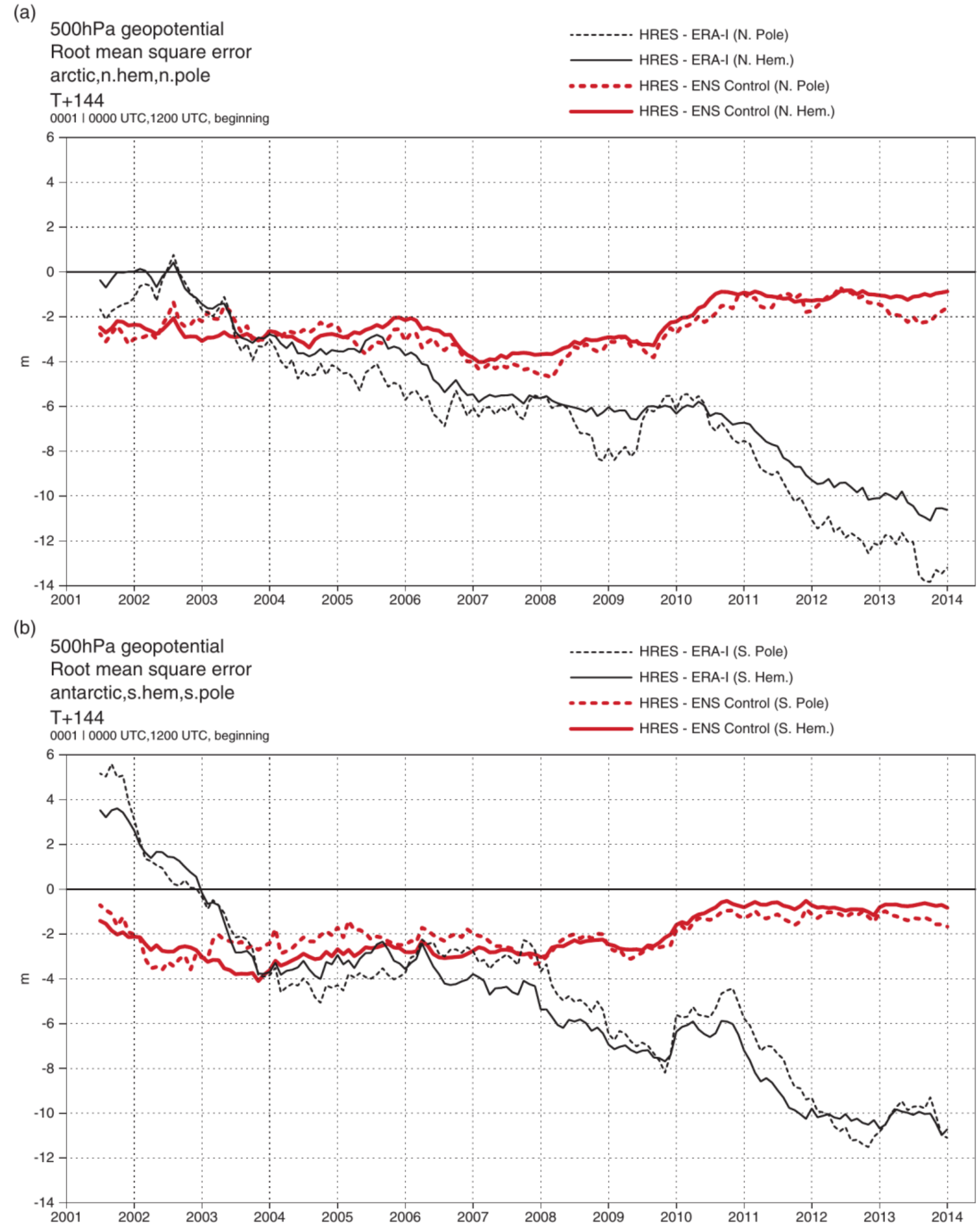
Polar Region Forecasts (Day 6)

General error reduction over the past decade

Improvements in model and data assimilation systems

Higher resolution does help to reduce some of the errors in the forecast.



Bauer et al. 2014

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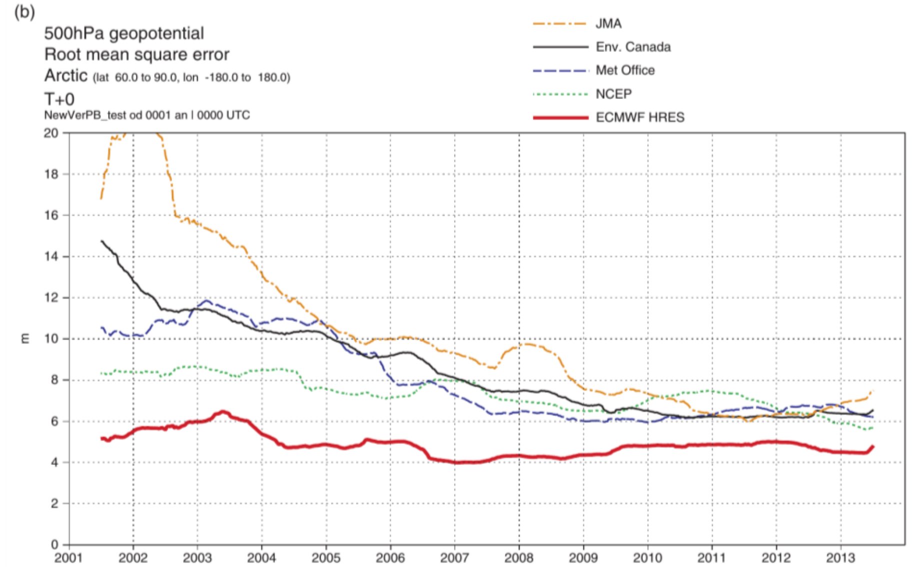
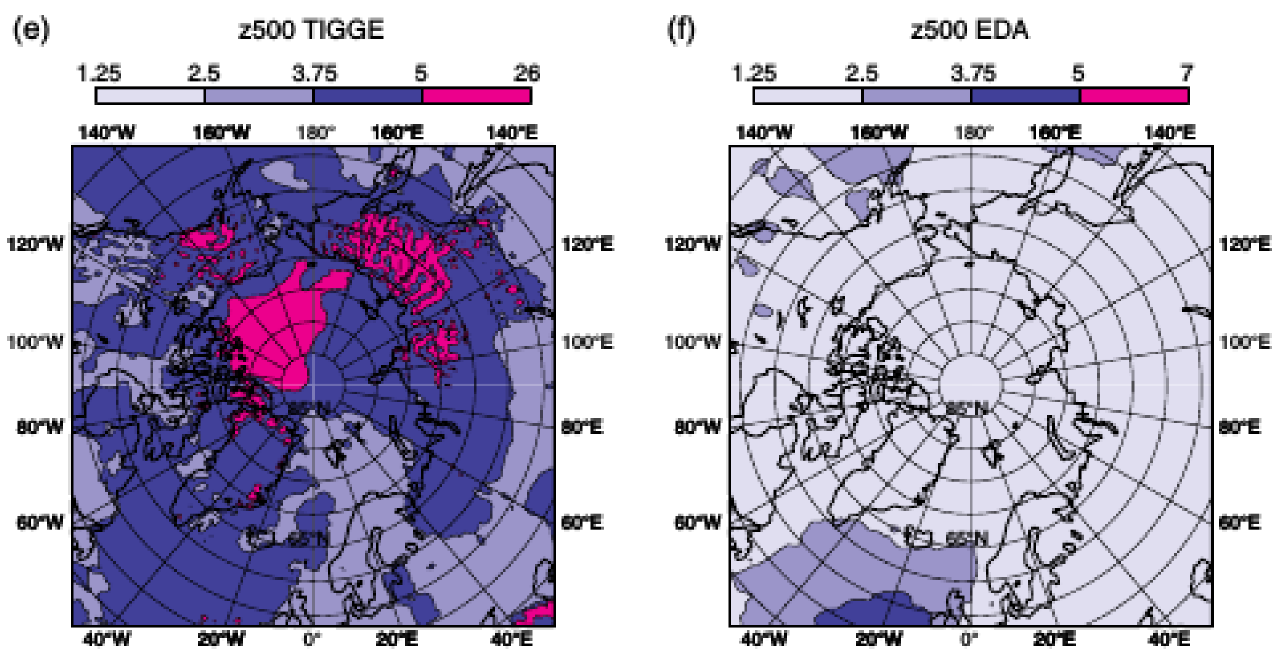
Skill of forecast systems

Over the last decade there has been an increased consistency in the analysis of the polar region.

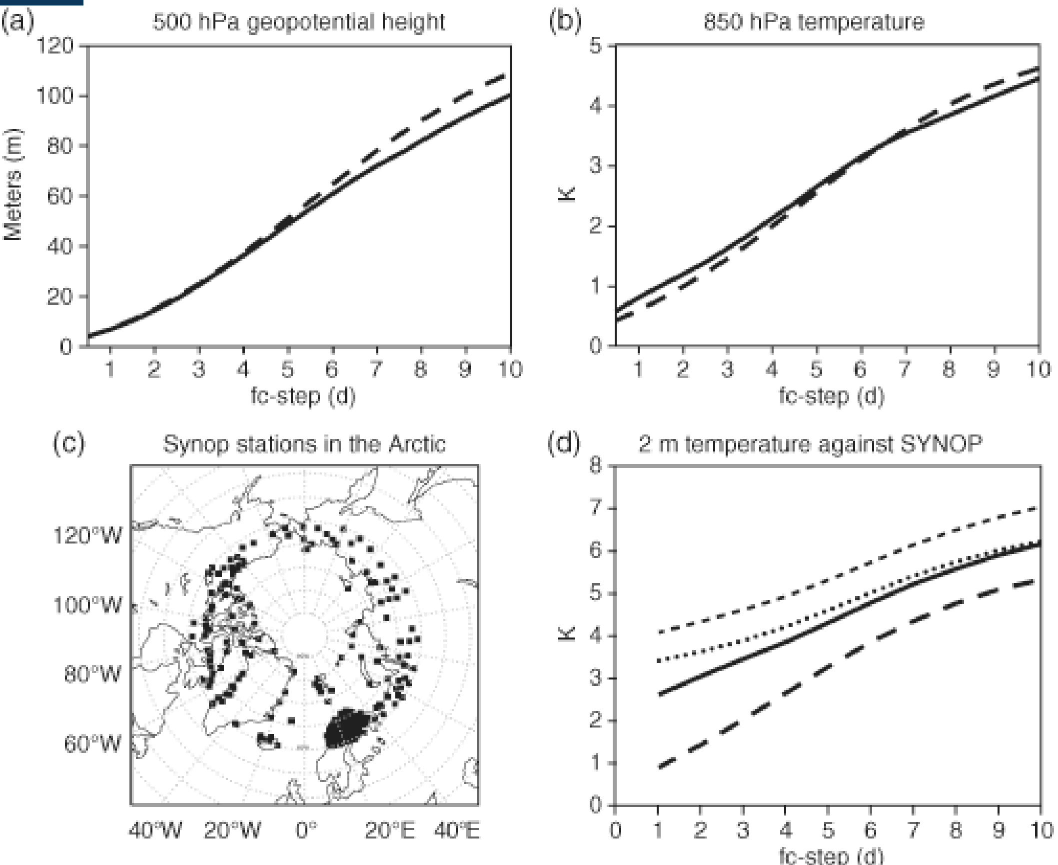
BUT still differences especially in the sea ice and snow covered regions.





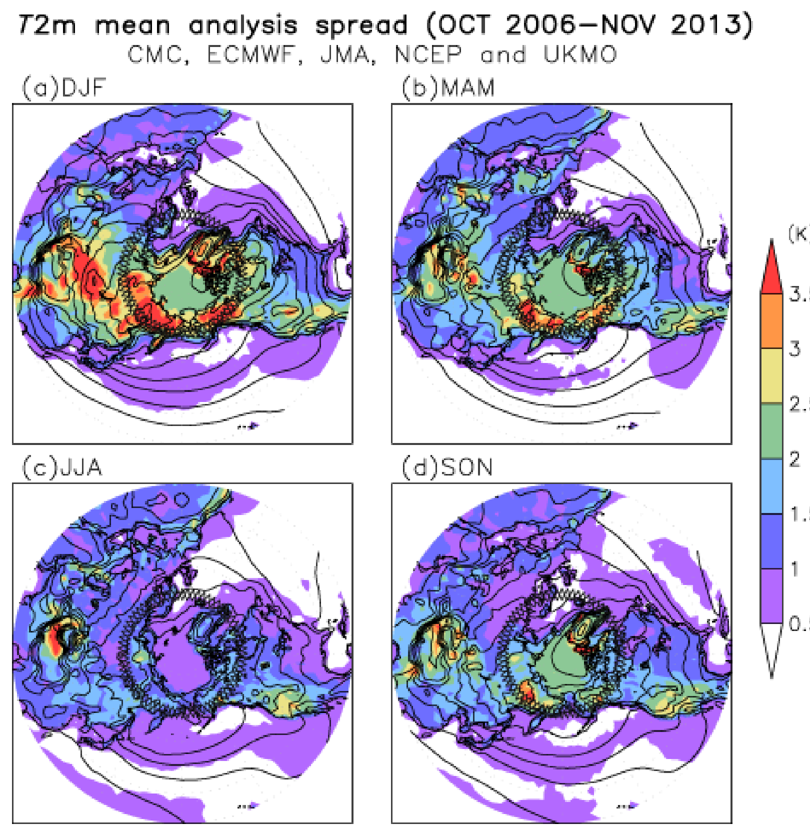
Bauer et al. 2014

And the surface?



Spread in the analysis of T2m throughout the seasons in regions of sea ice and snow – except summer when the ice surface temperature is closer to that of melting.

Jung et al. 2014



Bauer et al. 2014

Winter spread error relationship

Free troposphere good match

Nearer the surface model error and spread don’t match - errors in analysis/representative issues for SYNOP obsevations.

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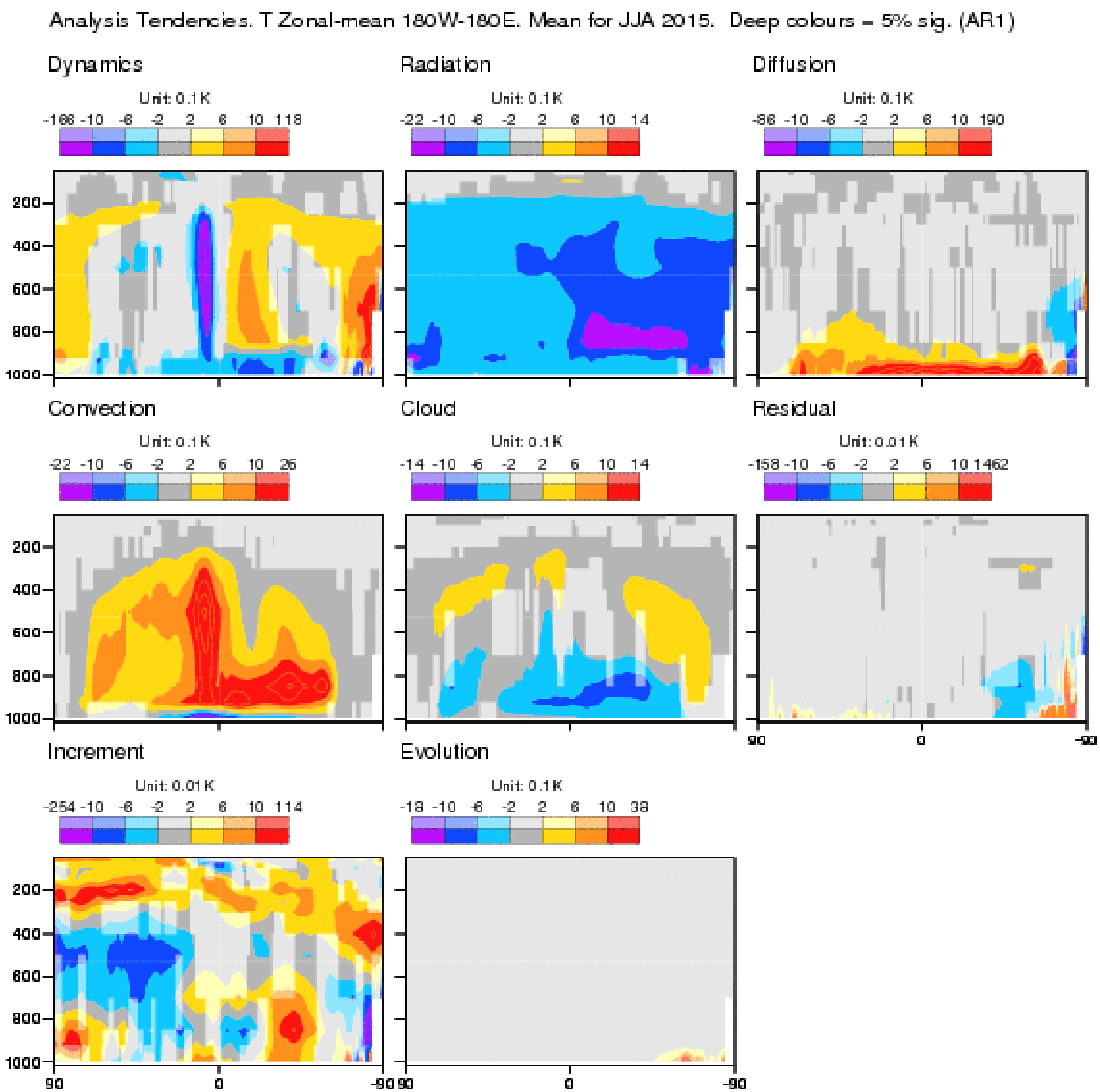
Diagnosing cause of model error

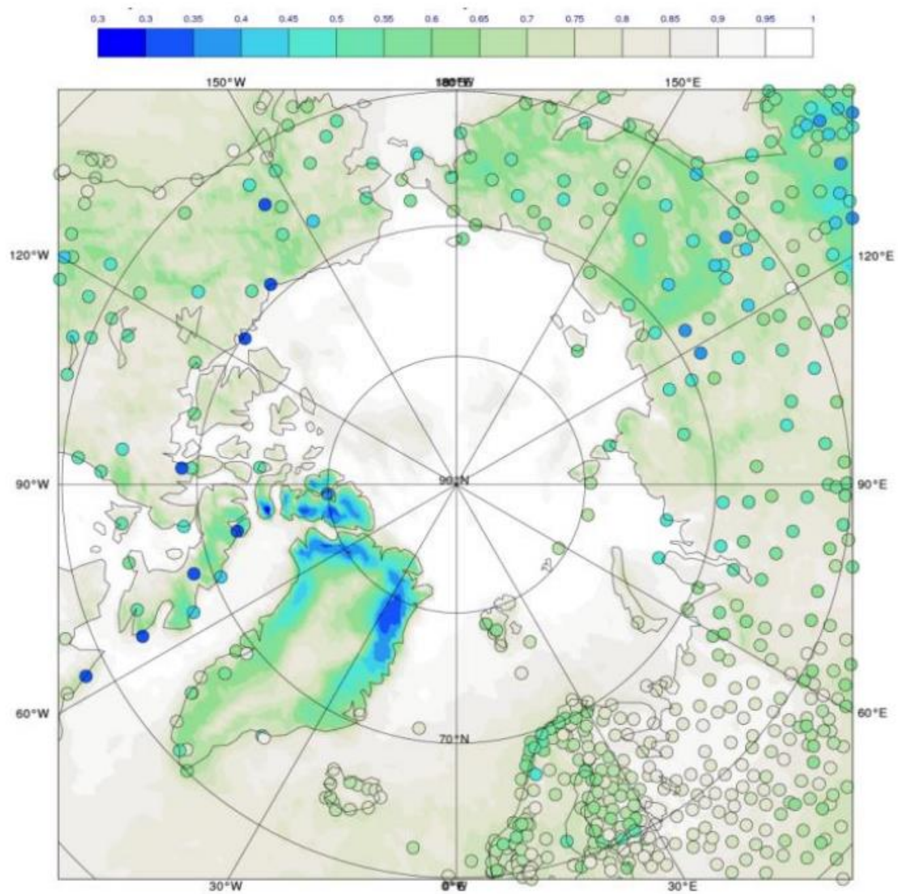


- Use analysis and short forecast to understand model errors.
- Breakdown of model tendencies in comparison to the analysis increment which corrects them

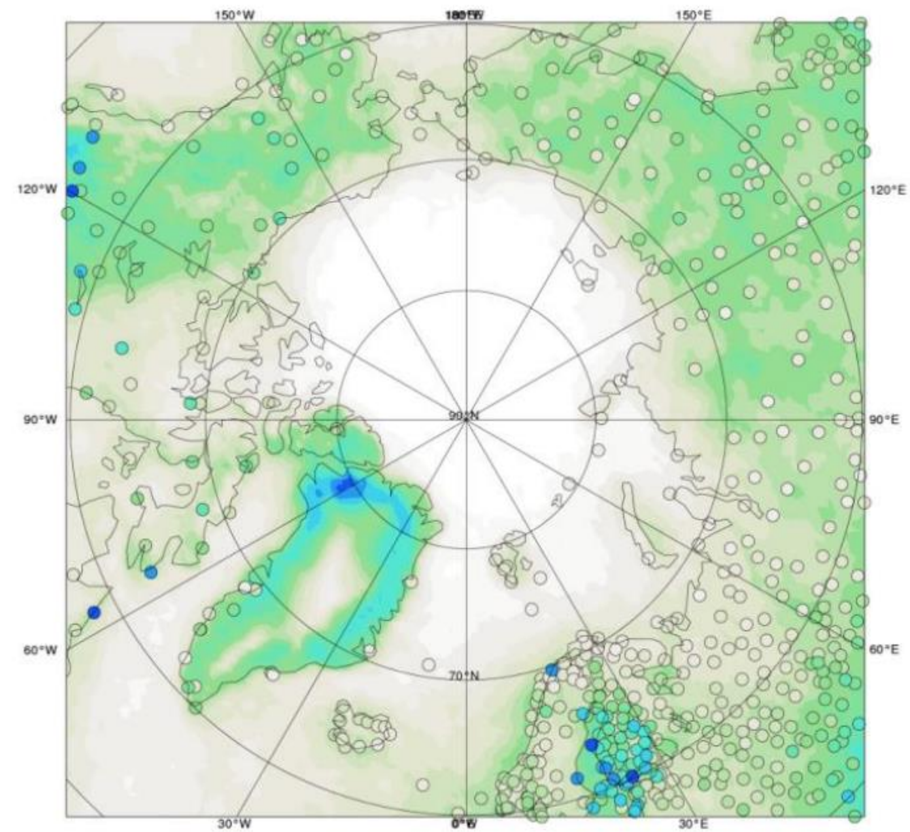
Slides from L. Magnusson

Examples of uncertainty in the model and observations

Model in background shading and observations within the rings.



Cloud cover winter



Cloud cover summer

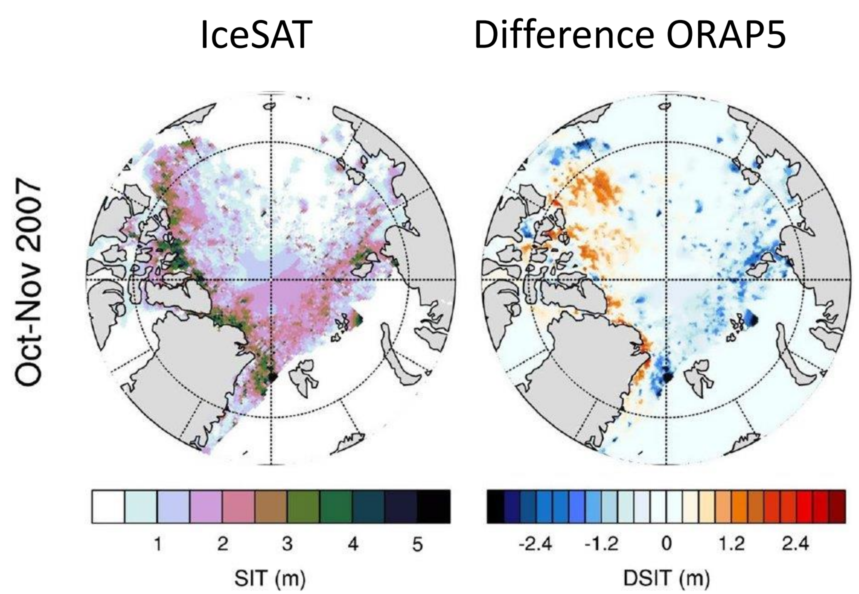
Figure courtesy of Thomas Haiden

Comparing models with observations

Sea ice thickness observations from altimeters

Thickness derived from freeboard

- IceSAT 2003 – 2008
- CryoSat 2010 – present
- IceSAT2 from 2017



Zuo et al., Clim. Dyn. (2015)
Tietsche et al., Clim. Dyn.(2015)

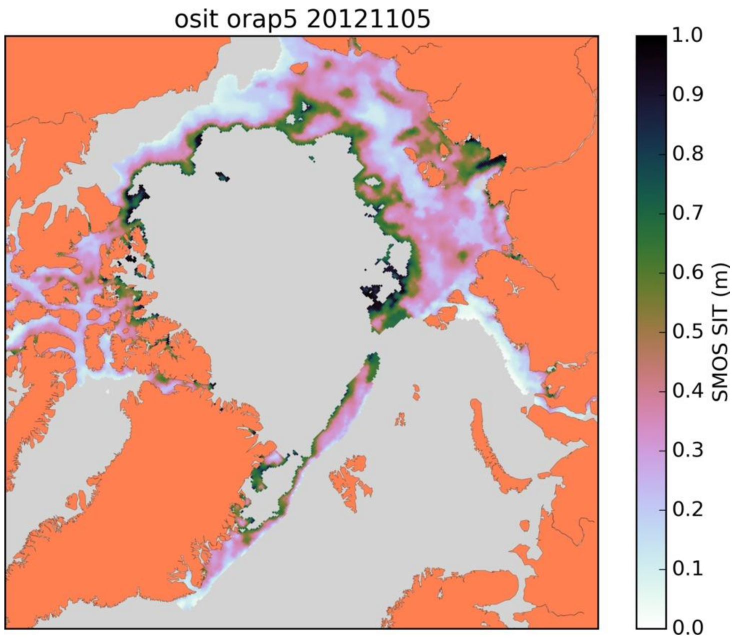
New observations and new reanalysis tools

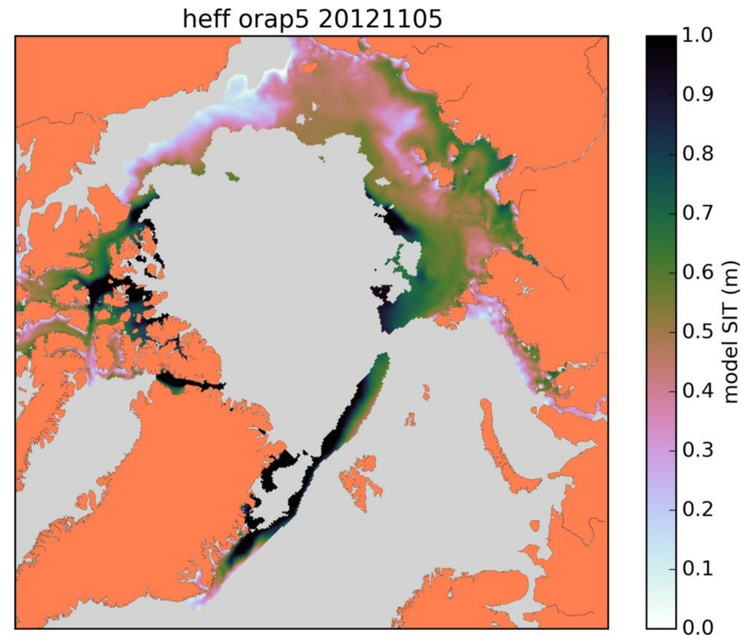
Maps of thin sea ice during freeze-up

SMOSIce observations

11 Nov 2012

ORAP5 ocean reanalysis

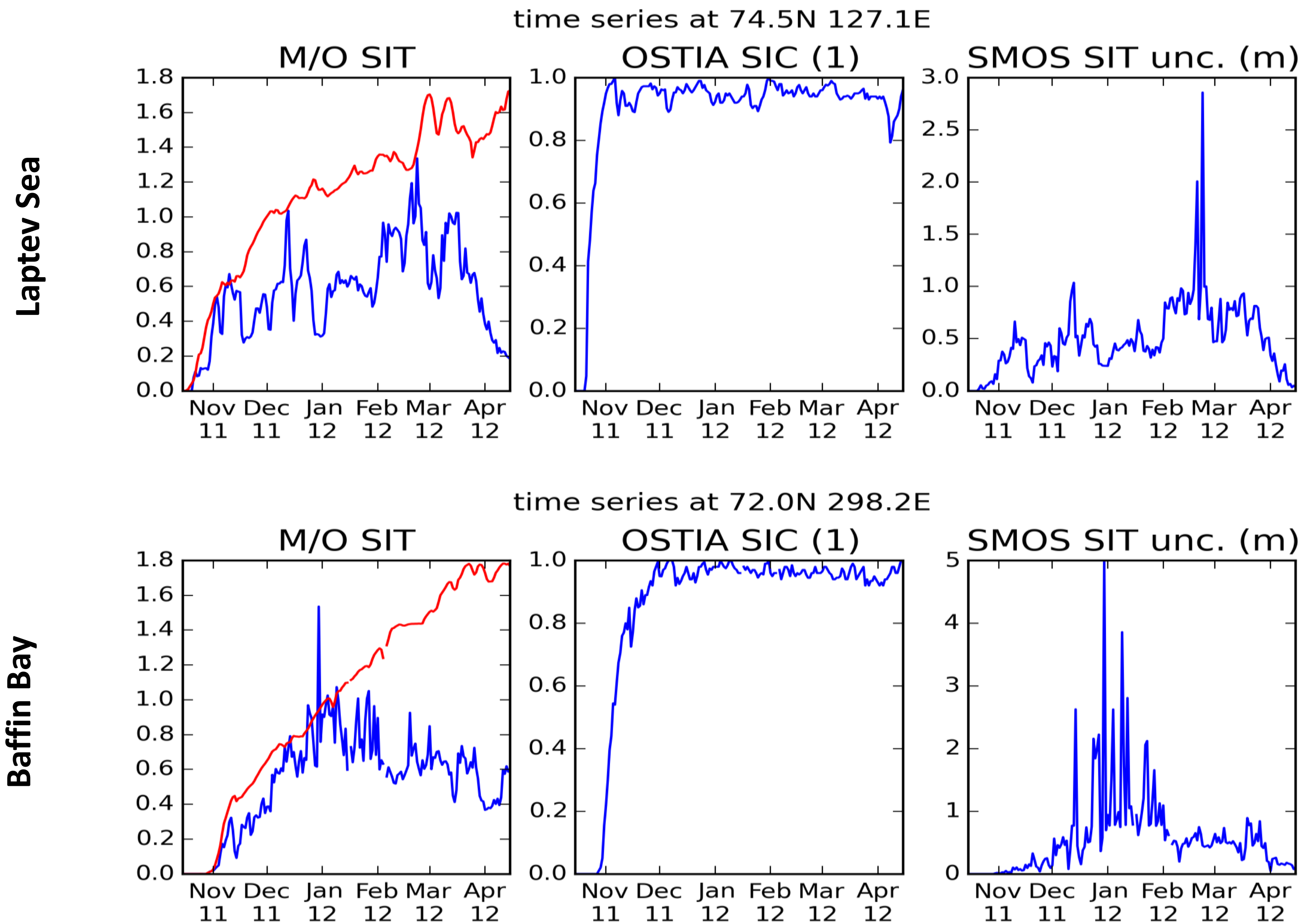




Thin new ice reliably detected, reasonably well simulated

Slides from S. Tietsche

Time series at fixed location



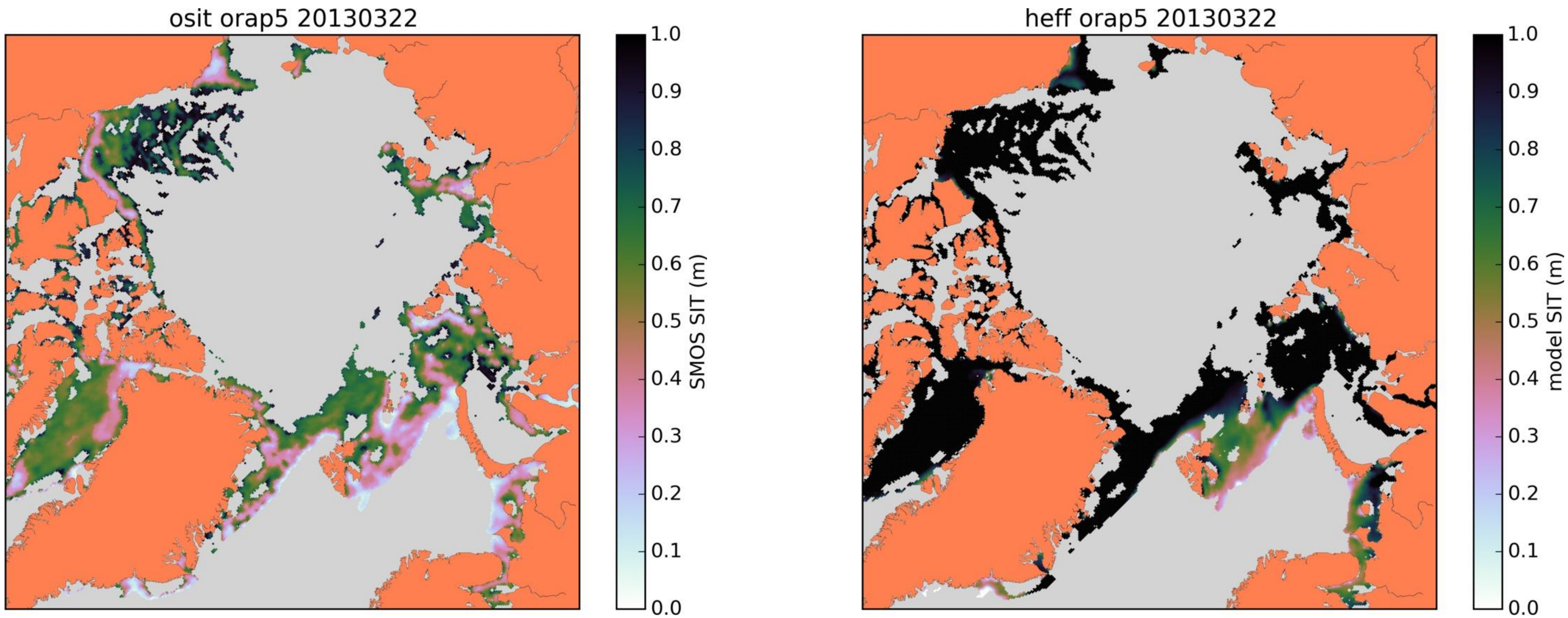
Slides from S. Tietsche

Maps of thin sea ice during late winter

22 Mar 2013

SMOSIce observations

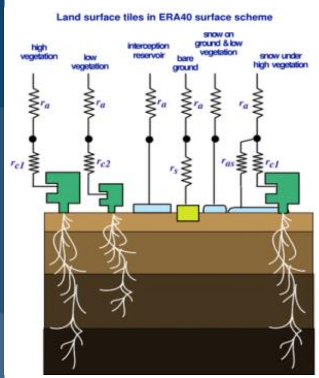
ORAP5 ocean reanalysis

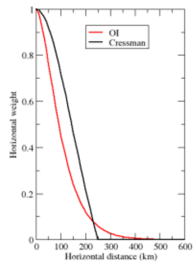


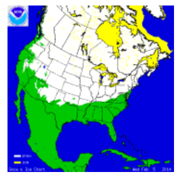
Modelled thickness much larger than SMOSIce (polynias, uncertain snow cover, ...)

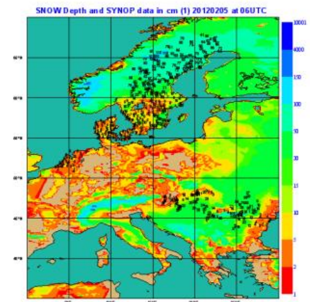
Snow in the ECMWF IFS

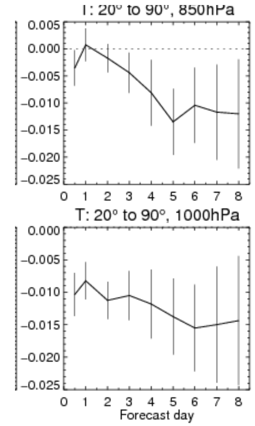
2009 2010 2011 2012 2013 2014 2015











Snow Model

. Liq. Water
. Density
. Albedo
. Fraction

Snow Obs and DA

. OI
. 4km IMS
. Obs preproc/QC
. IMS latency/acquisition

. Additional in situ obs
. New BUFR template
. WMO/SnowWatch action
. IMS data assimilation
. obs error revision

Ongoing

. BUFR SYNOP
. Snow COST action
. Snow Watch
. MultiLayer model

Future:
RT modelling

Dutra et al., JHM 2010
de Rosnay et al., Res Memo 2010, 2011
Brun et al., Snow Watch 2013
de Rosnay et al., Surv. Geophys 2014
de Rosnay et., ECMWF Newsletter 143, Spring 2015

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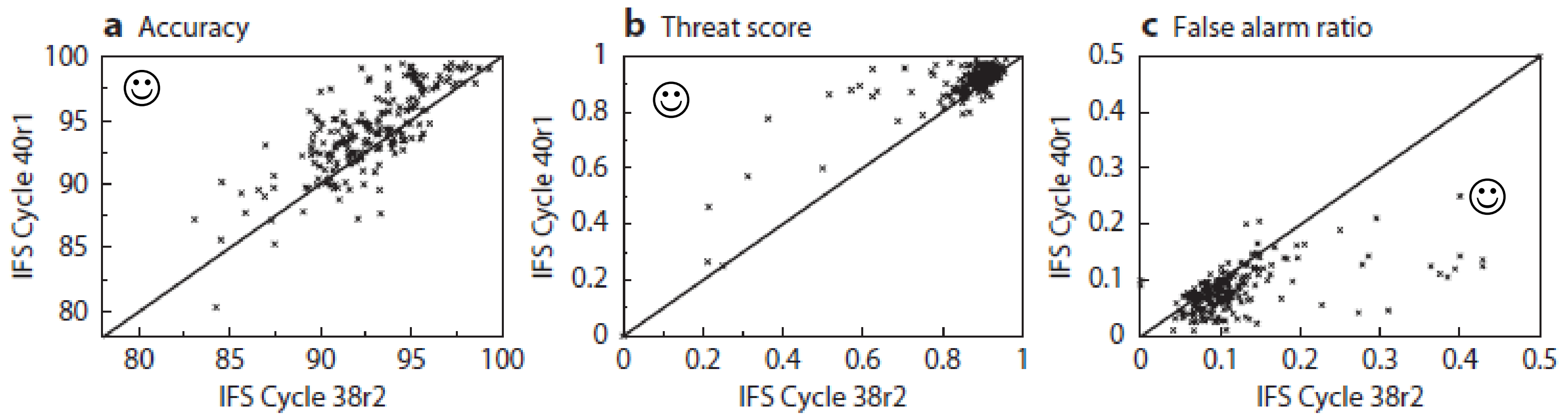
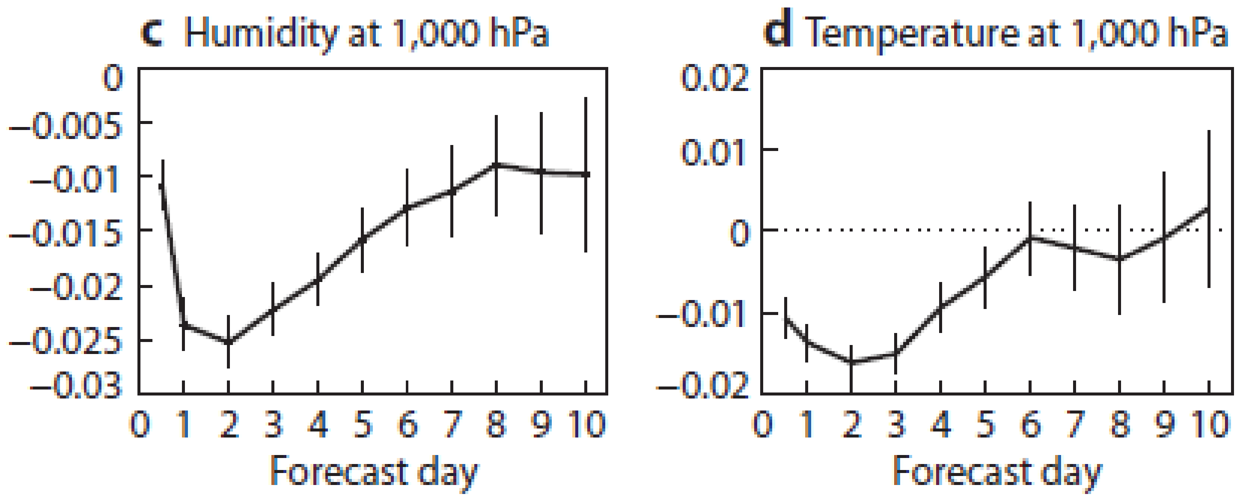
Slides from P. de Rosnay

Snow analysis: Forecast impact

Impact on snow October 2012 to April 2013
(using 251 independent observations)



Impact on atmospheric forecasts
October 2012 to April 2013 (RMSE new-old)

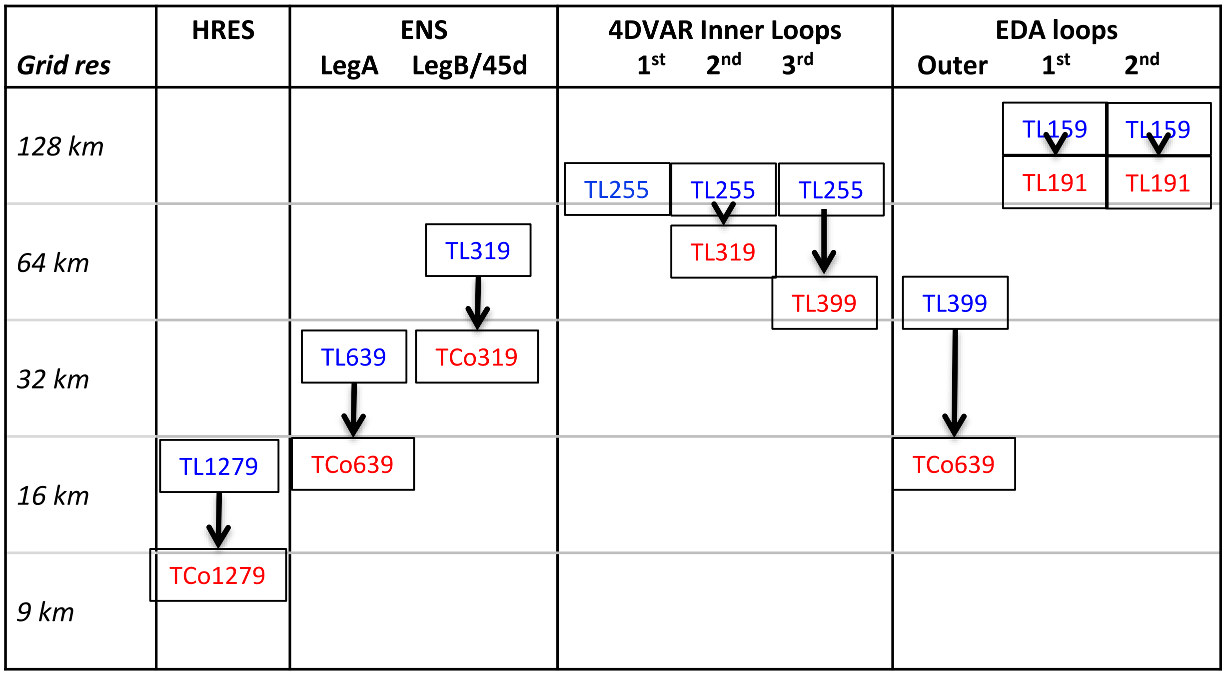


de Rosnay et al., ECMWF Newsletter 143, Spring 2015

Slides from P. de Rosnay

Changes to our forecast system

2016 atmos resolution upgrade: 41r1 → 41r2
from linear (L) grid to cubic octahedral (Co) grid



Ocean model Upgrade in 2016
(NEMO): from 1.0º /42 lev to 0.25º /75 lev
Add dynamic sea ice model

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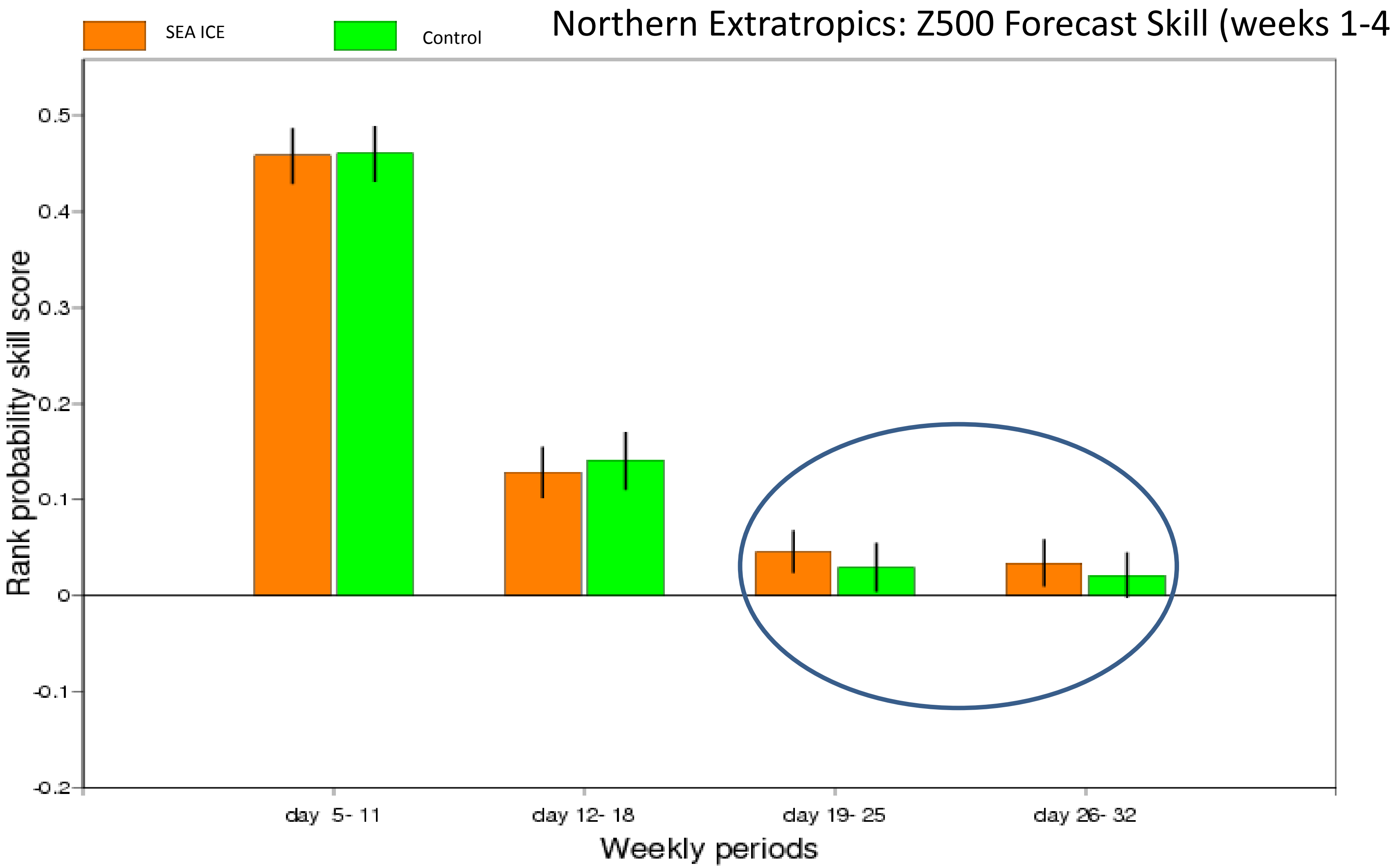
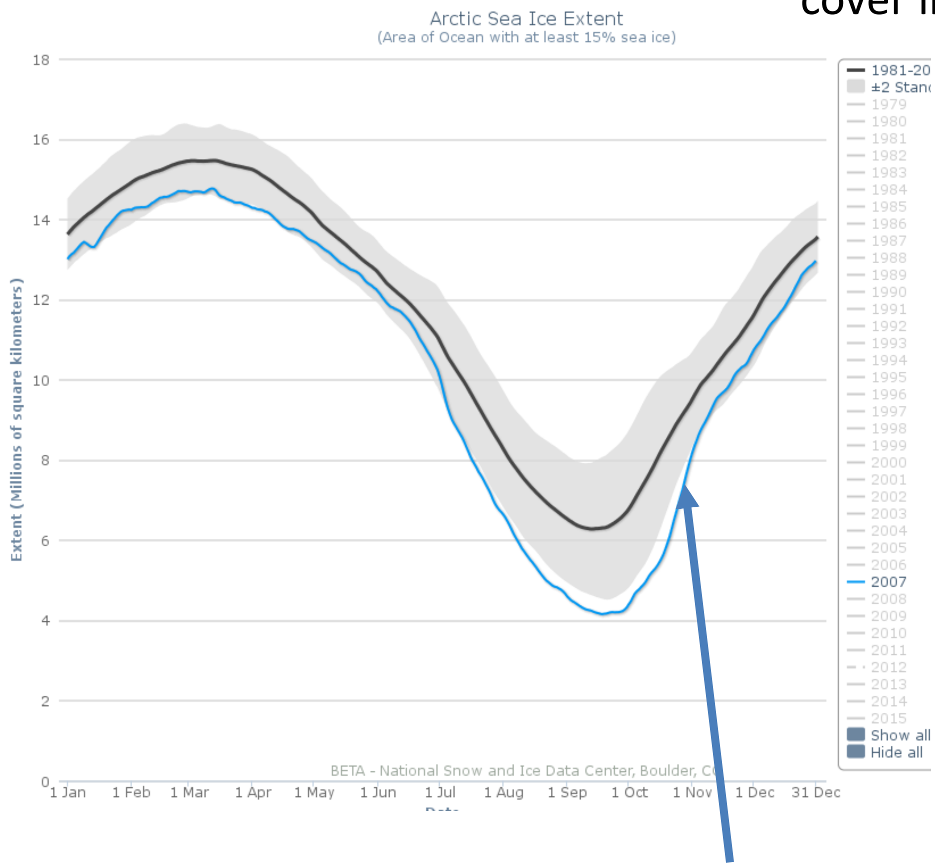
Impact of dynamic ice model in medium range

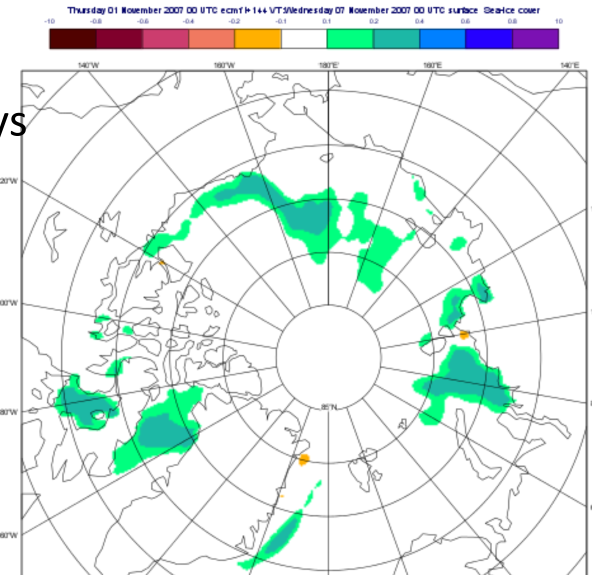


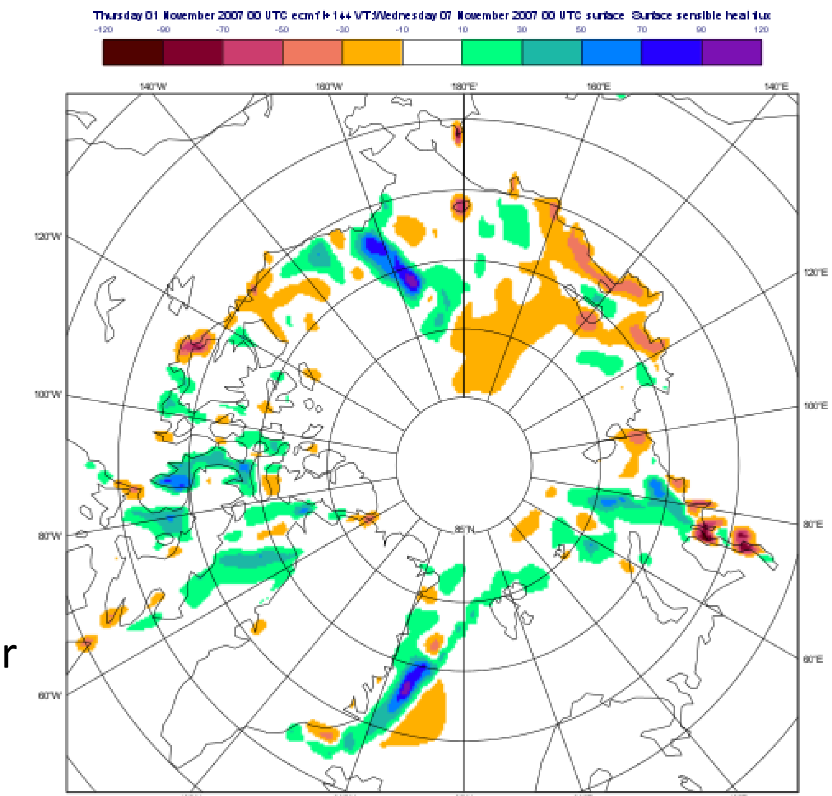
80 cases- all seasons – The vertical bars represent the 95% level of confidence

Impact of dynamic ice model in medium range



Change in ice cover in 6 days





Period of rapid freeze up

Average turbulent flux into atmosphere over first 6 days >50 W/m2 in some areas

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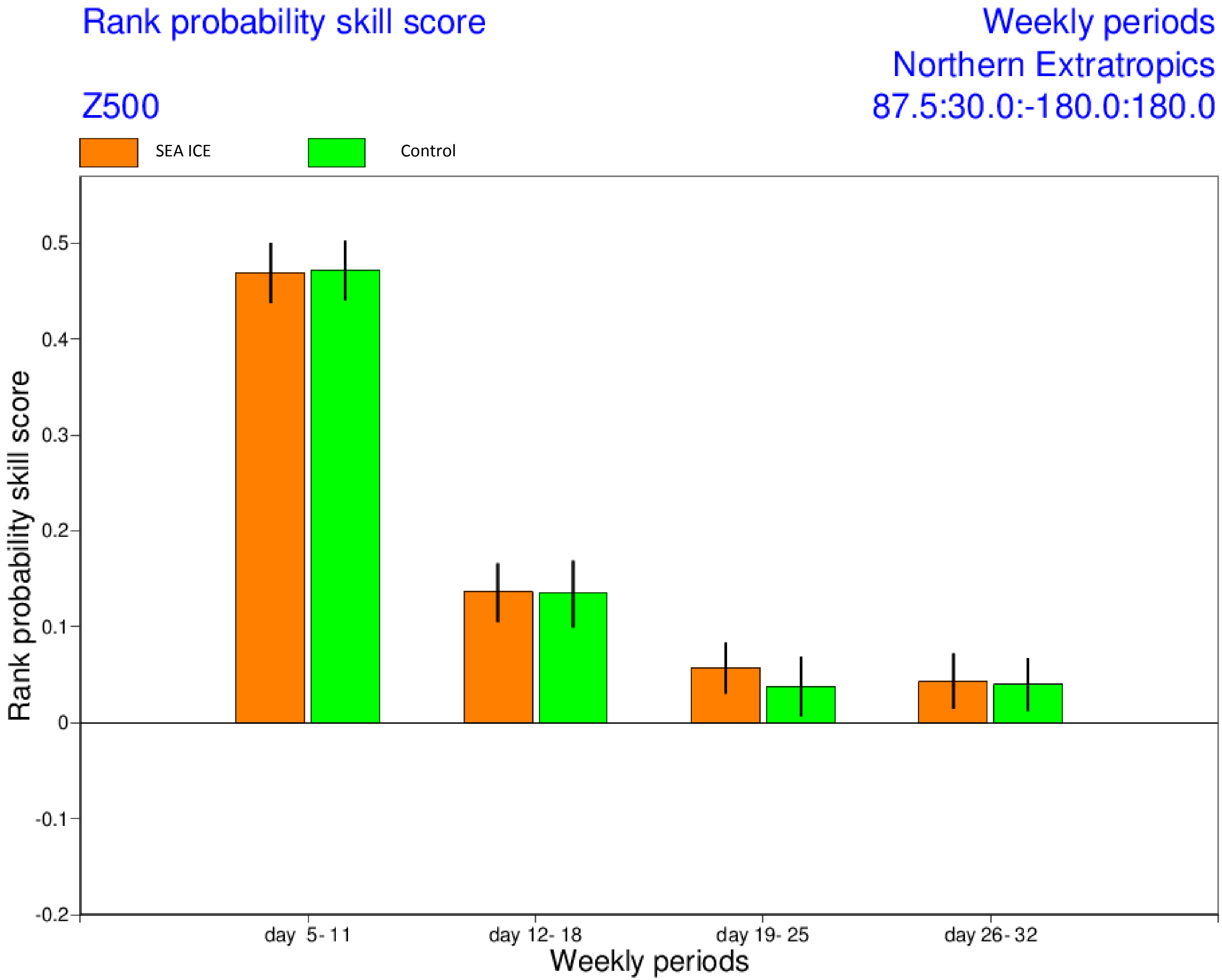
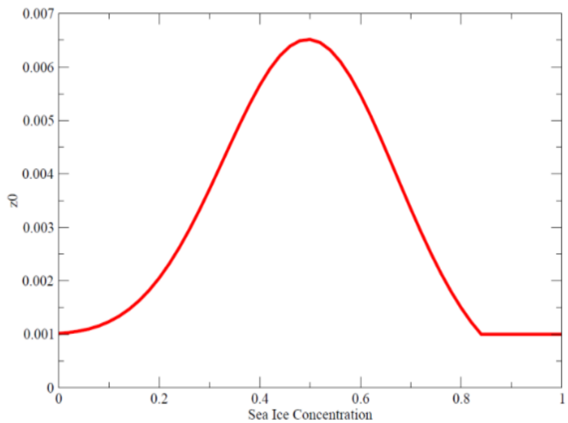
Autumn and Spring only

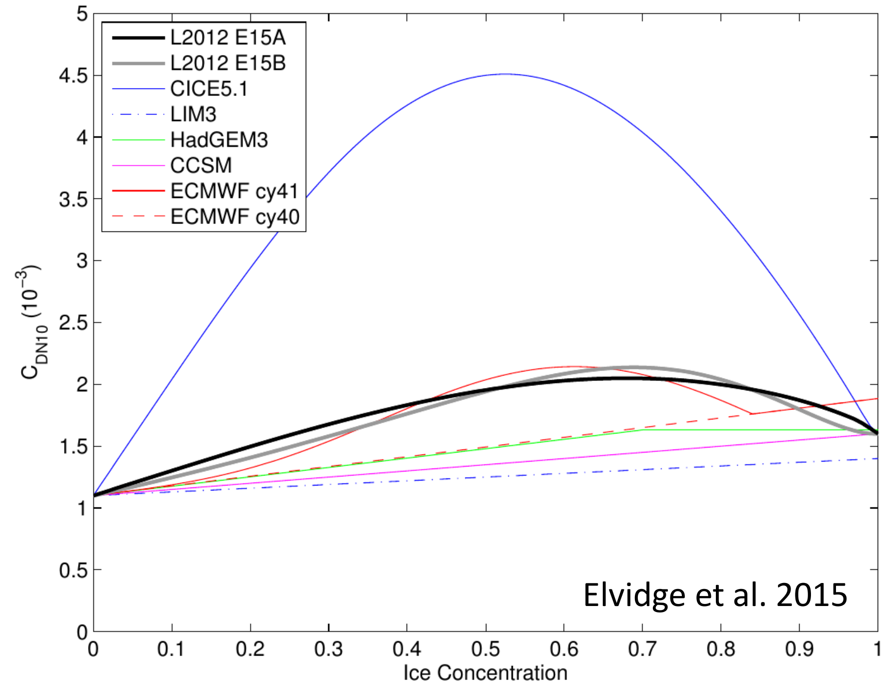


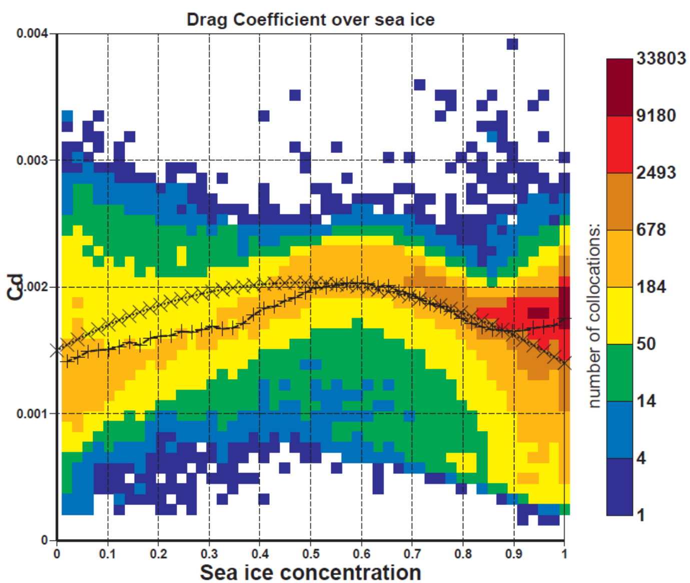
Impact of sea ice changes (Z_0) example of use of campaign data

In CY41R1: z_0



0.001





T1279 t+6,12,18,24 forecast
g2d3 from 20130901

Cd over sea ice
forecast from
2013-09-01, t+6,12,18,24
MPS contributions to CY41R1

rcimin=2%
z_0= max(z_0(ci), 0.001)
Charnock from WAM

Summary

Current status:

Forecasts at medium range timescale have skill out to about day 7 in terms of large scale flow

Limited observations make it difficult to diagnose model error sources; challenges remain with representation of the boundary layer, clouds and snow and ice covered surfaces.

Observation error large due to assumptions made about the state of the system

Future Challenges/ Opportunites:

Model provides tools for diagnosis and process understanding
Confronting models with observations – ground truth
Observational campaigns
Reanalysis tools available that perform well in polar regions
Higher resolution medium range coupled forecast systems running in YOPP.

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