Diagnostics of the ensemble system for polar regions

Linus Magnusson
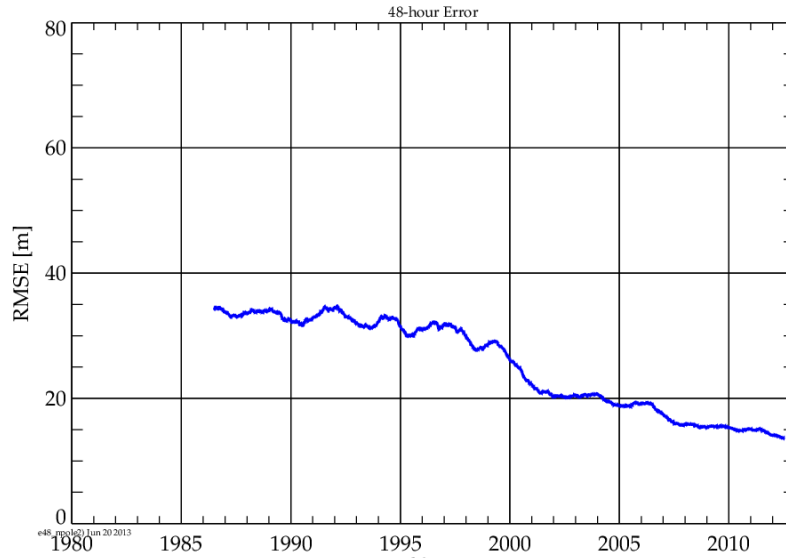
ECMWF

RMSE error (against ERA Interim reanalysis)
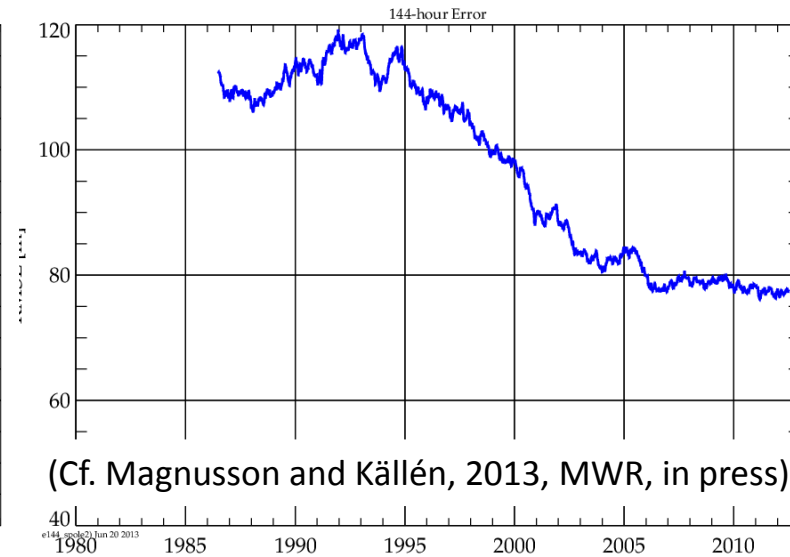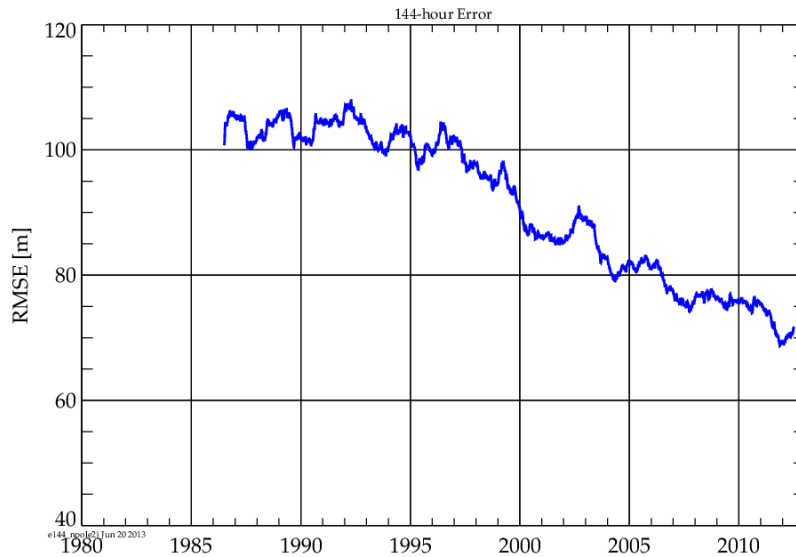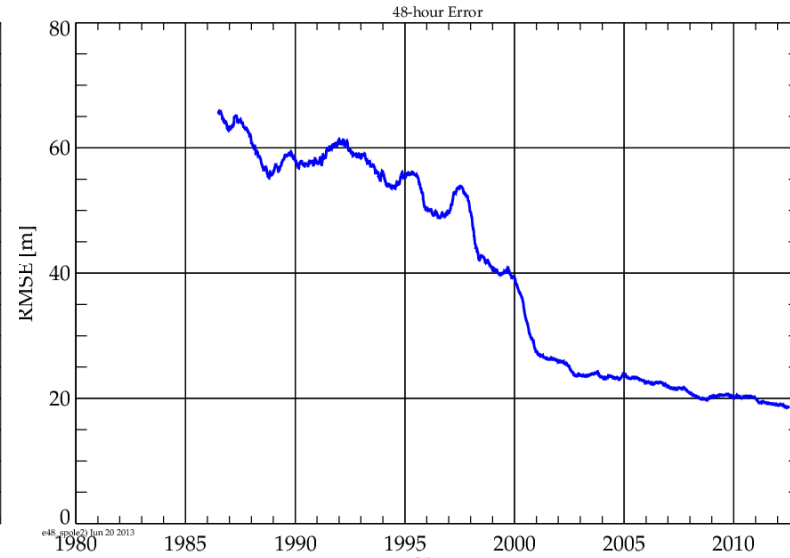
Arctic

Antarctic

2-day error

6-day error

(Cf. Magnusson and Källén, 2013, MWR, in press)

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ECMWF

Daily errors (2012, z500, 6-day forecasts)

Arctic

Antarctic

August 2012 over Antarctica

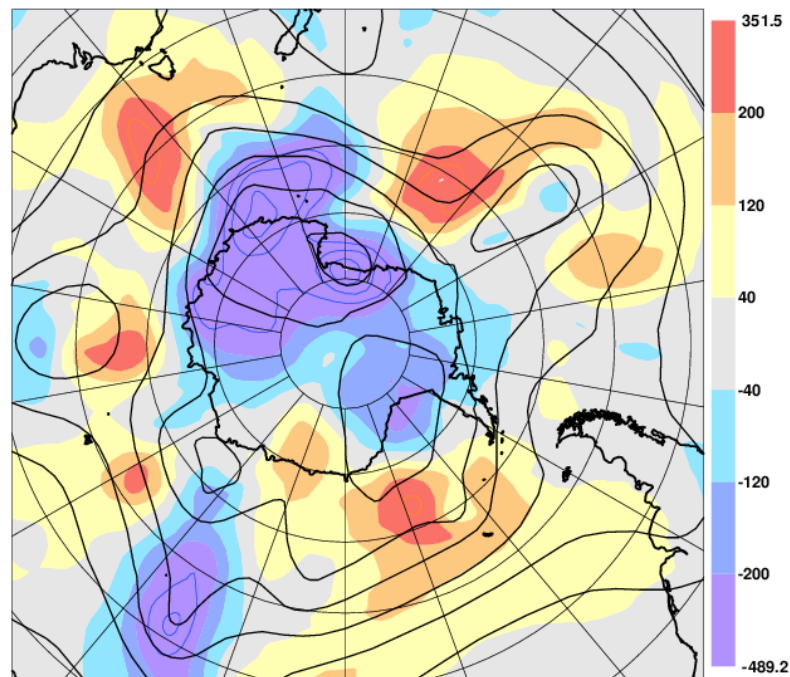500hPa geopotential
Root mean square error
S Pole (lat -90.0 to -65.0, lon -180.0 to 180.0)
T+144
oper_an od enfo 0001

● oper
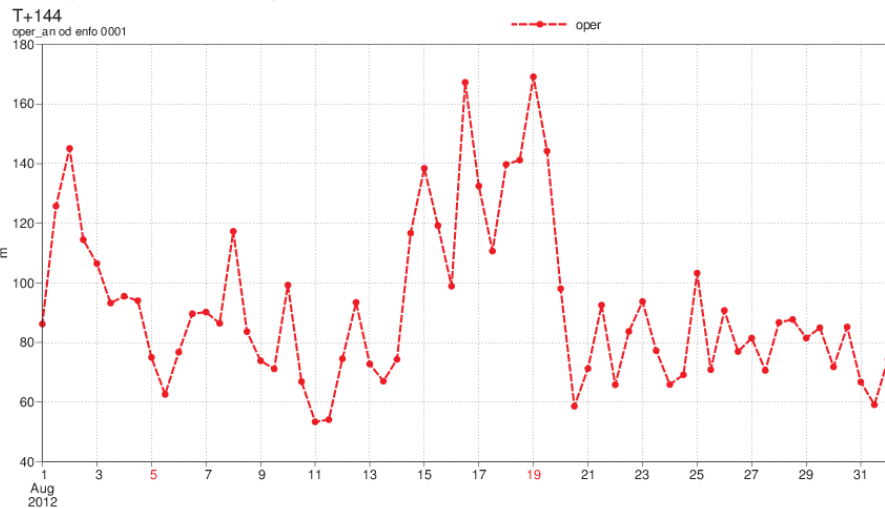
Forecast error ecmf 20120819, 0+144 mem:1
RMSE Error Arctic: 192 metres

ECMWF
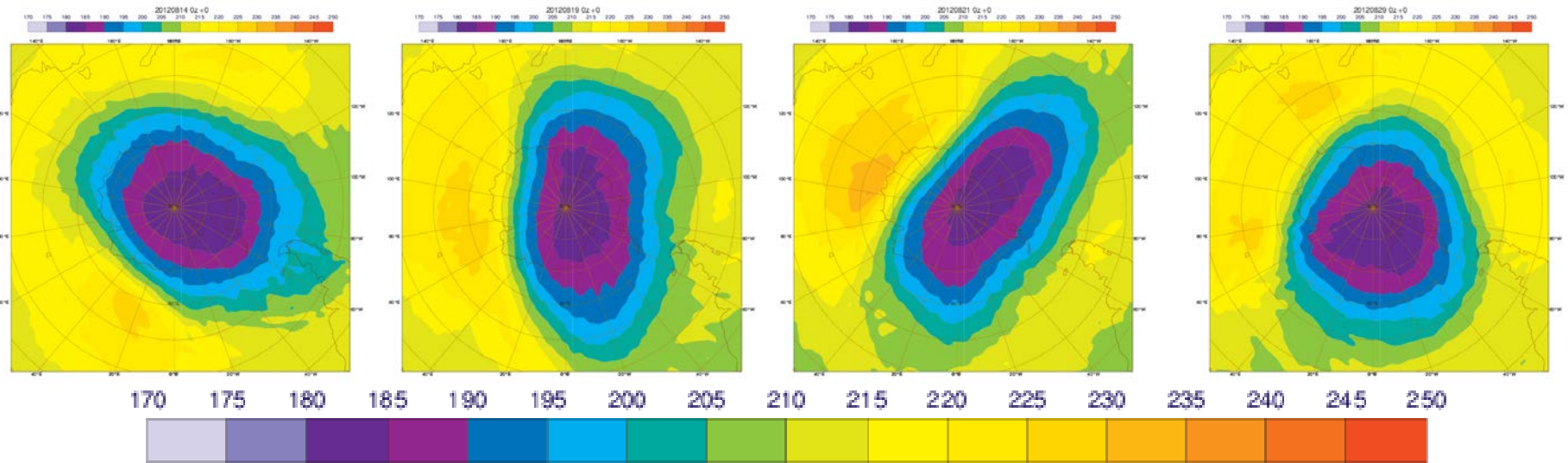
Temperature anomaly in the troposphere and stratosphere
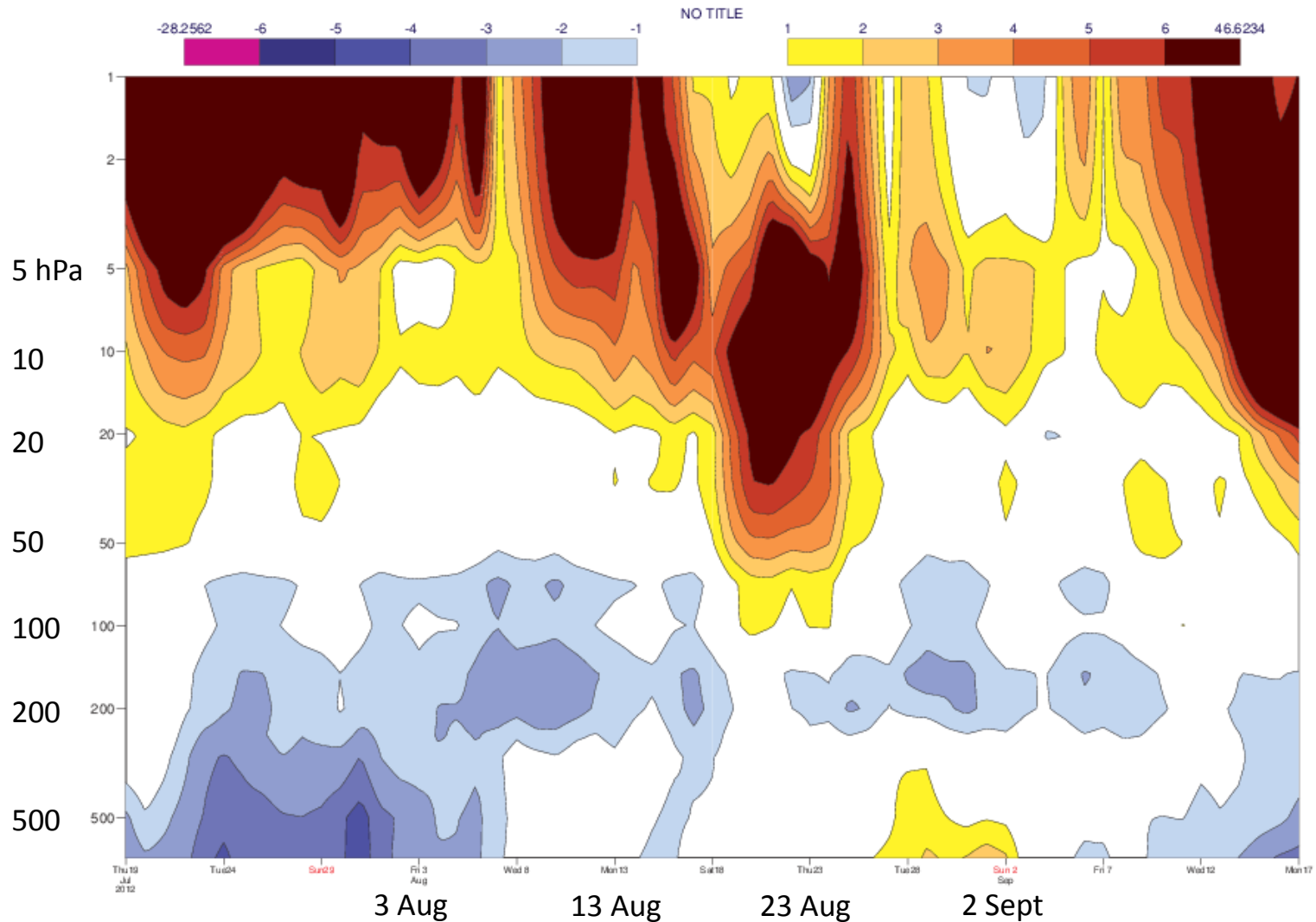
Temperature at 50 hPa

2012-08-14 **2012-08-19** **2012-08-21** **2012-08-29**

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Best and worst ensemble members

Z500 (70-90S)

T10 (70-90S)

14 19 24 29
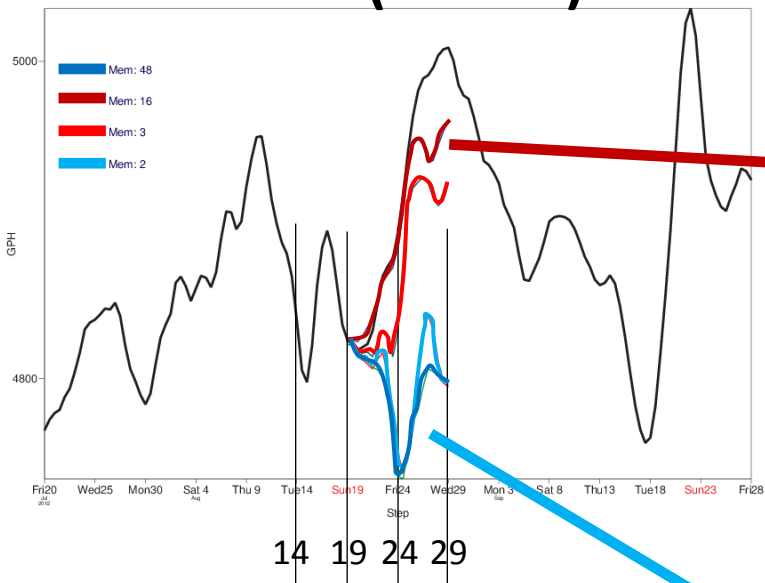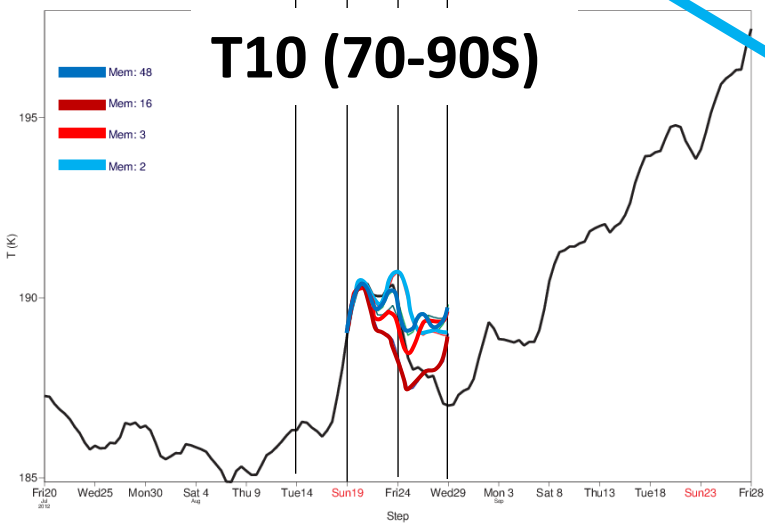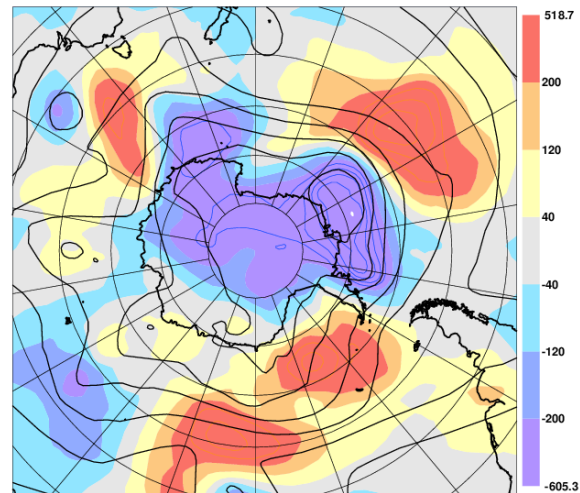
Forecast error ecmf 20120819, 0+144 mem:16
RMSE Error Arctic: 142 metres
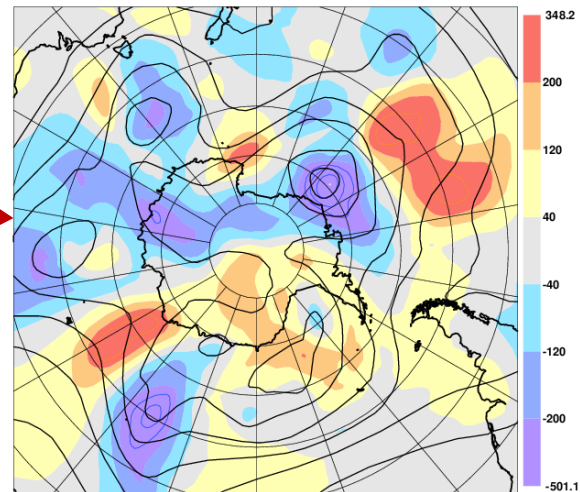
Forecast error ecmf 20120819, 0+144 mem:2
RMSE Error Arctic: 246 metres

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Concept behind ensemble forecasts

| Perturbed forecast	=	Optimal analysis	+	Initial Perturbations	+	Model Perturbations
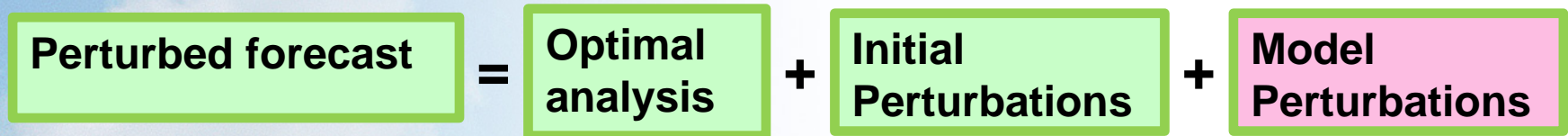
Aim: Simulate the uncertainties in the forecast

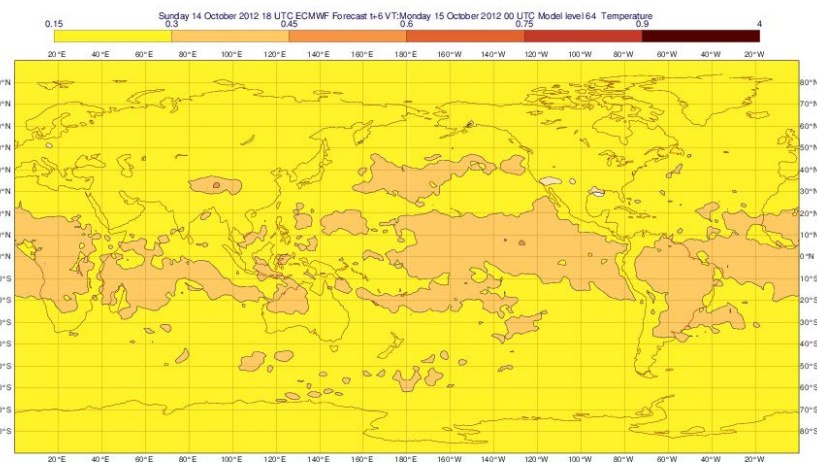**Needs all components of uncertainty to simulate the forecast uncertainty**

Standard deviation of the error = Standard deviation of the ensemble

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Ensemble of data assimilations – effect of polar orbiting satellites

Ensemble assimilation and prediction
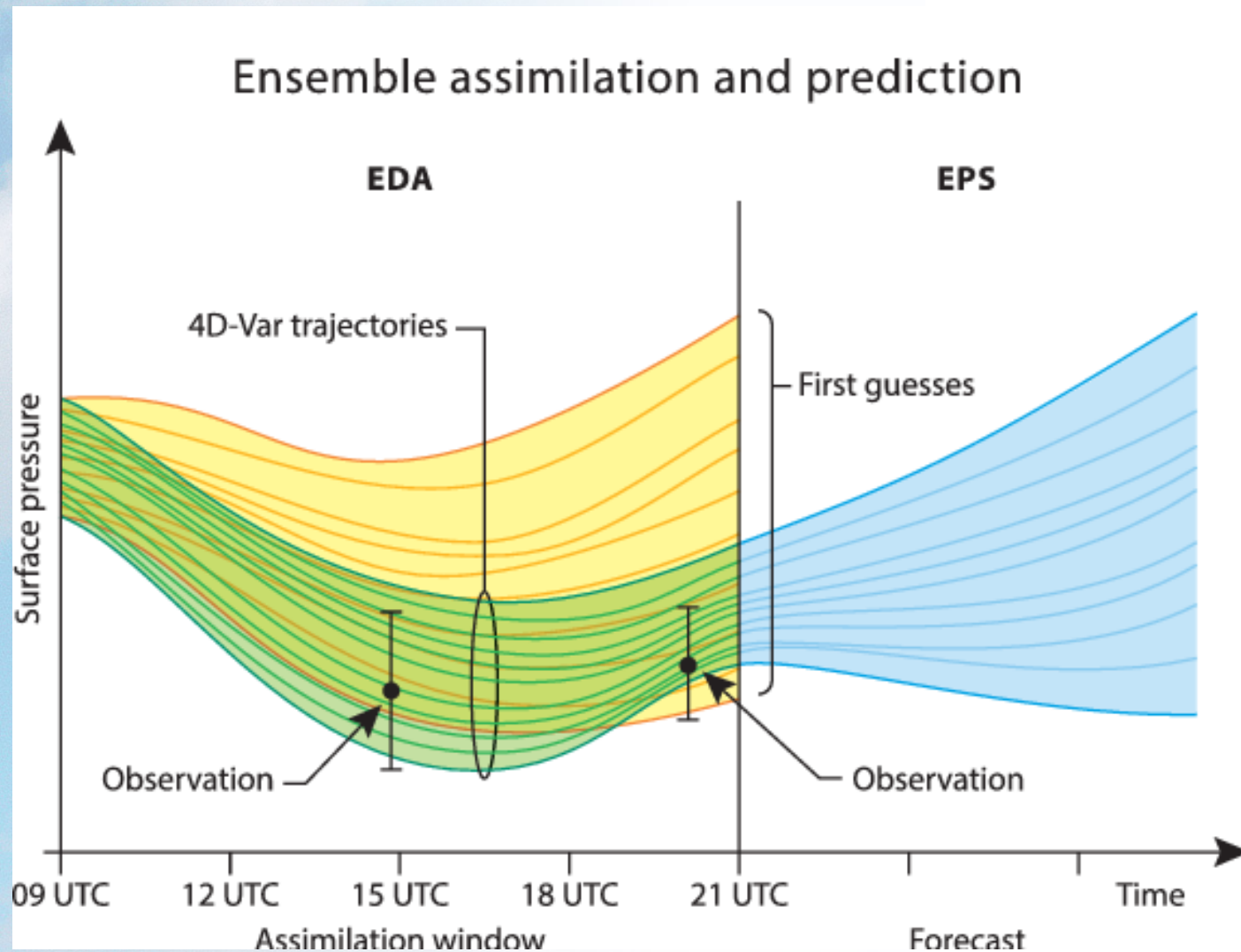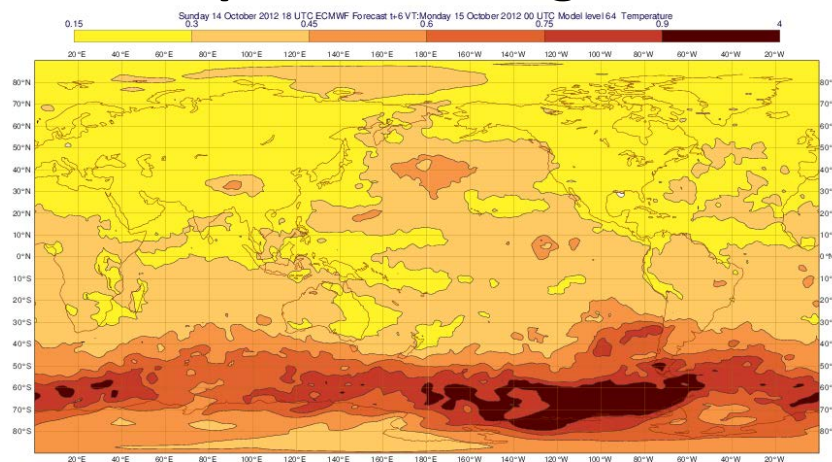
EDA standard deviation – T ~500 hPa
(15 Oct – 1 Nov, twice a day)

All observations   **No polar orbiting sat.**

0.15   0.30   0.45   0.6   0.75   0.9
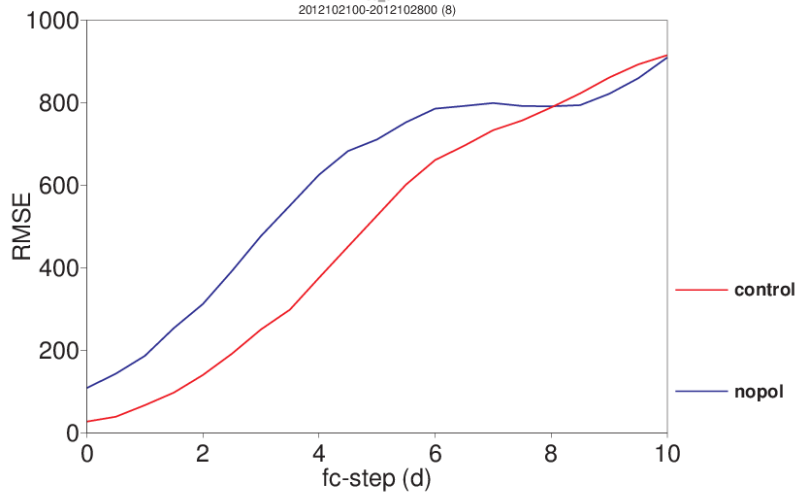
(Thanks to M. Bonavita)

ECMWF

Ensemble forecasts – Antarctic
(8 cases = small sample)
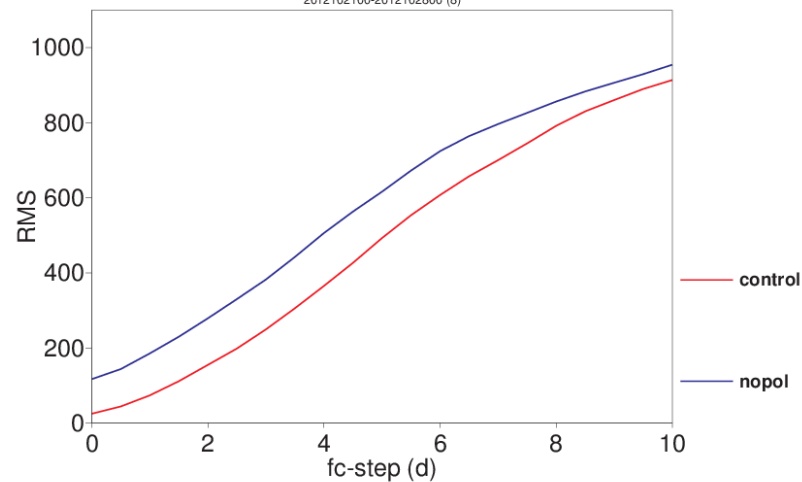
RMSE

z500hPa, Antarctic
rmse_em
2012102100-2012102800 (8)
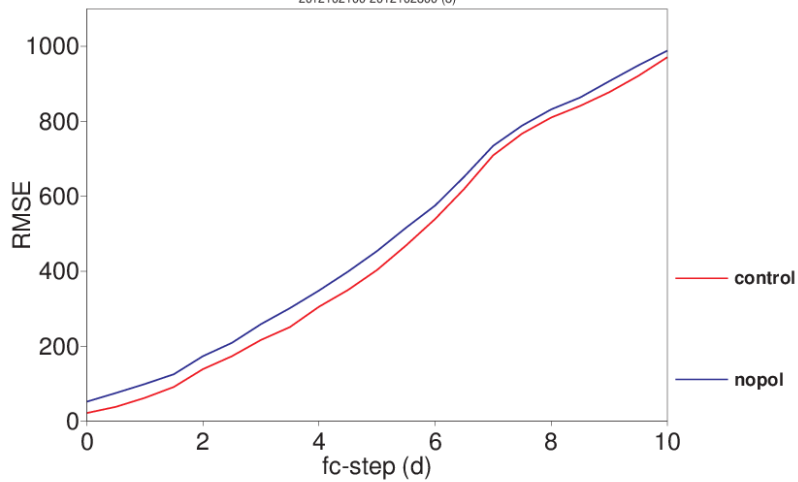
Ens. Stdev.

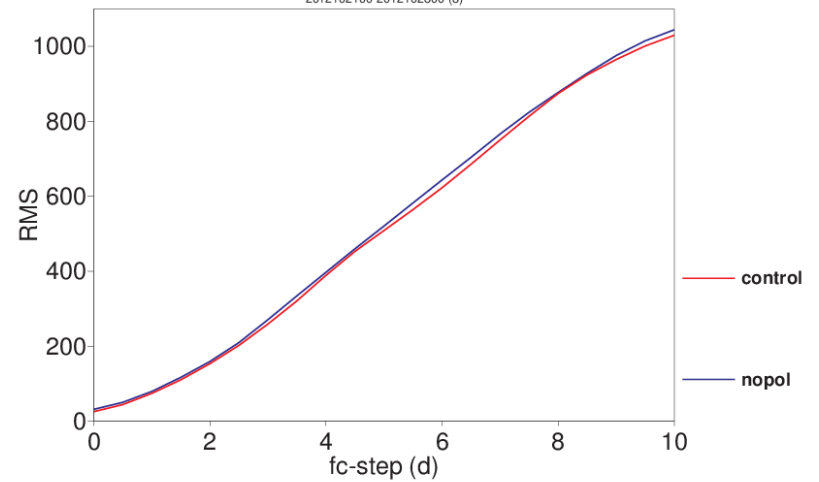z500hPa, Antarctic
spread_em
2012102100-2012102800 (8)

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Ensemble forecasts - Arctic

RMSE

Ens. Stdev.

Are the uncertainties from the ensemble system reliable in the Arctic?

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RMSE and Ens.Std for temperature at 500 hPa Arctic

t500hPa, Arctic
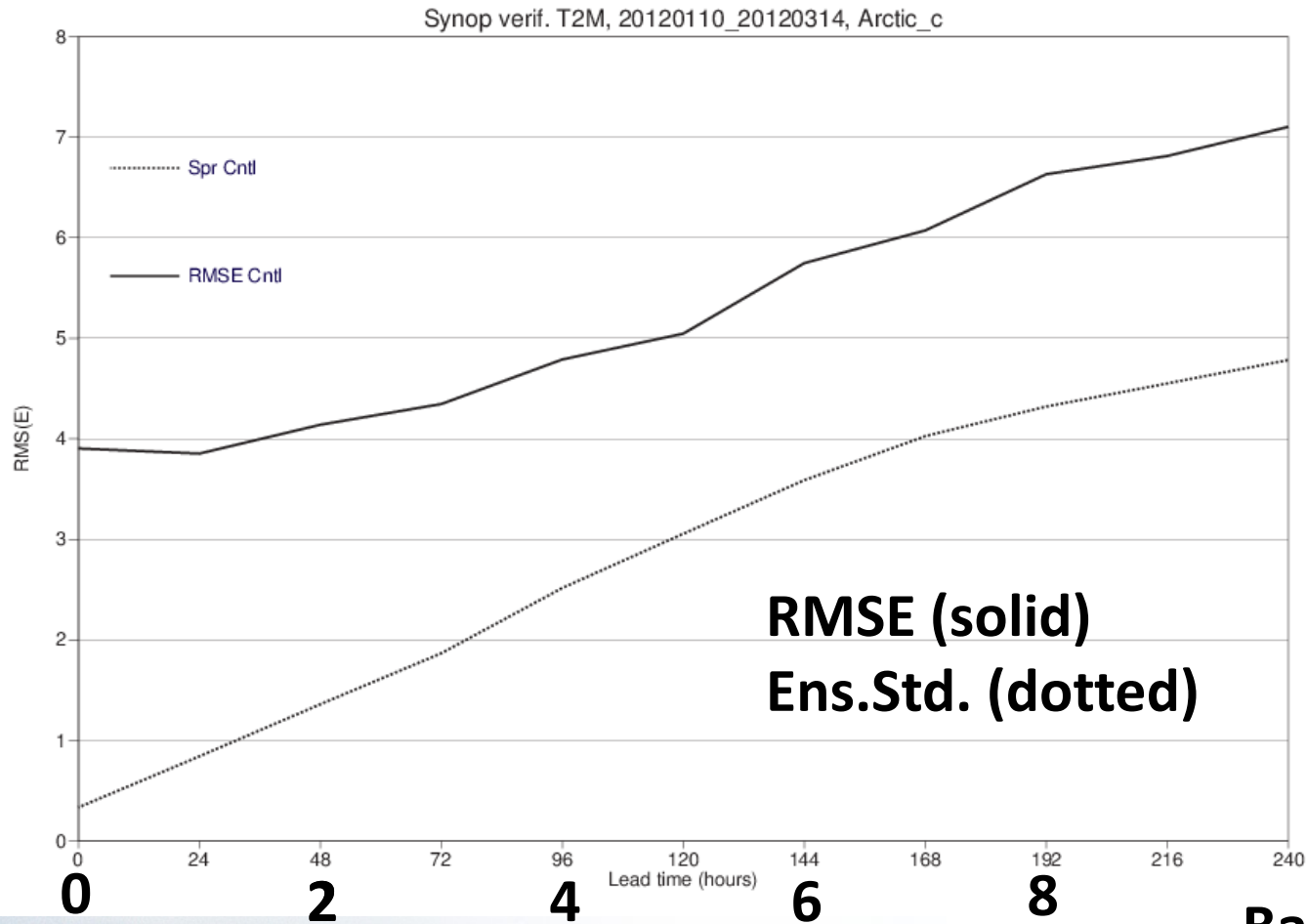spread_em, rmse_em
2012011000-2012031400 (17)

RMSE (solid)
Ens.Std. (dotted)

cy38r2

Good match!

© ECMWF

ECMWF
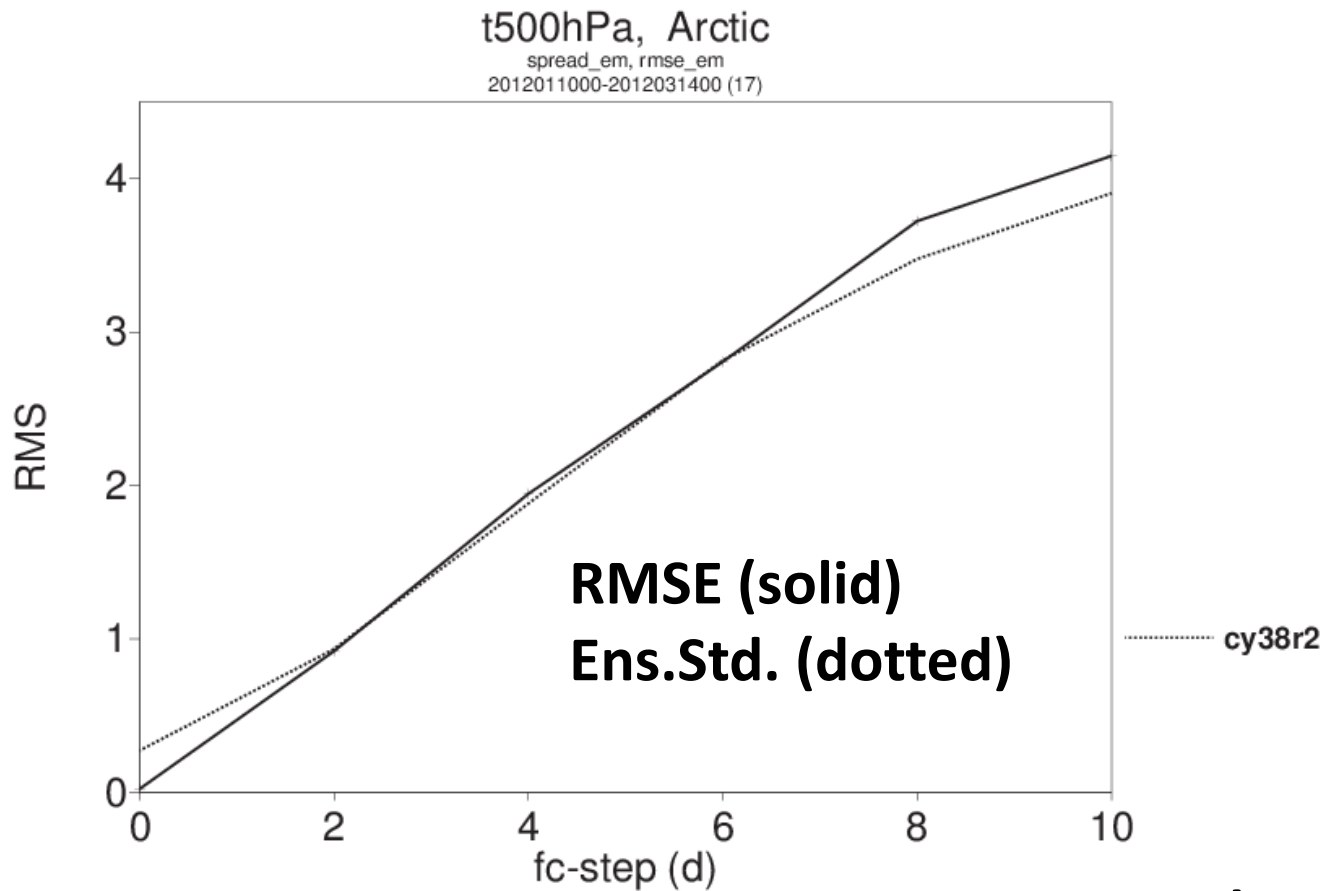
RMSE and Ens.Std for temperature at 850 hPa Arctic

t850hPa, Arctic
spread_em, rmse_em
2012011000-2012031400 (17)

RMSE (solid)
Ens.Std. (dotted)

cy38r2

Reasonable match.

© ECMWF
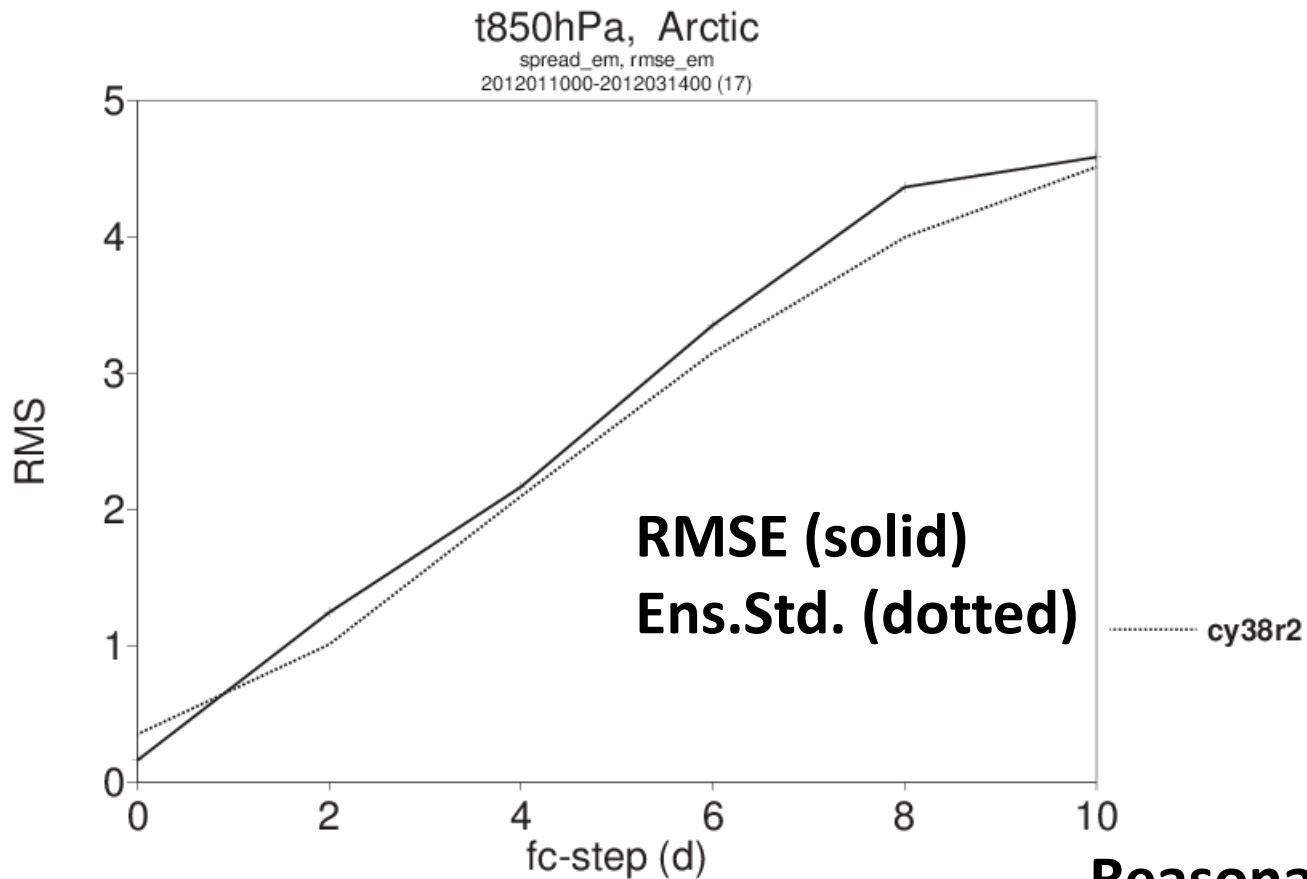
RMSE and Ens.Std for 2-metre temperature, Arctic (against SYNOP)

Synop verif. T2M, 20120110_20120314, Arctic_c
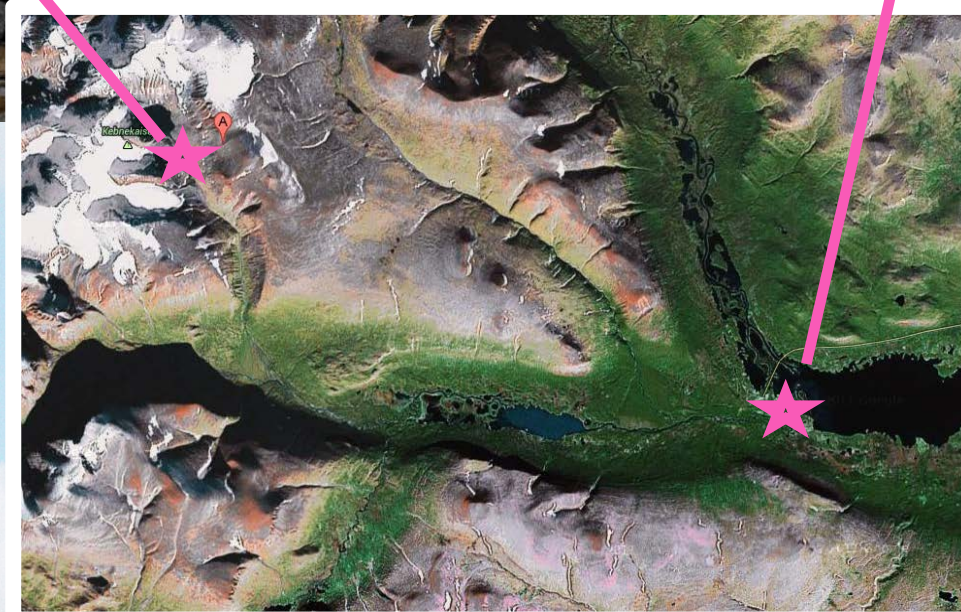
RMSE (solid)
Ens.Std. (dotted)

Bad match…

SYNOP stations north of 65N (6-day error of each station)
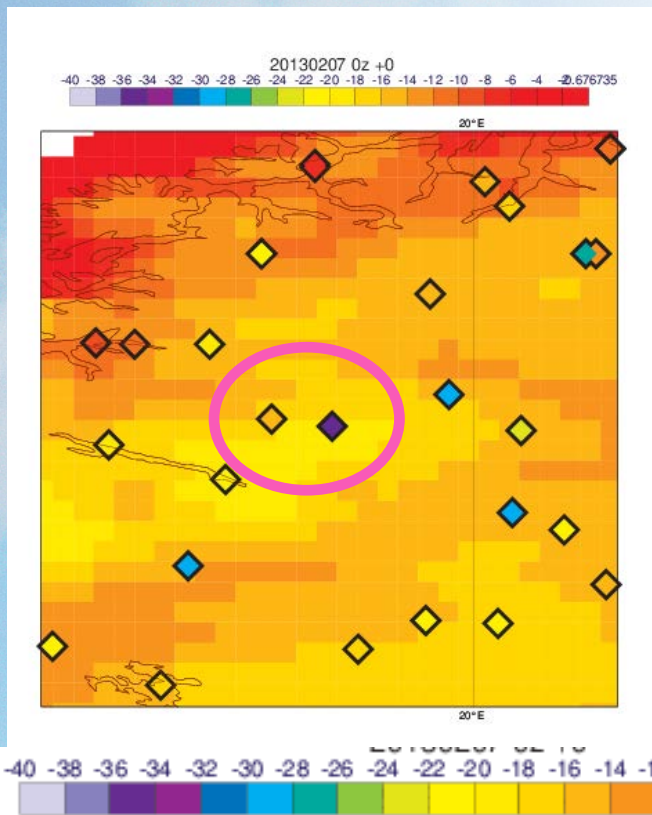
© ECMWF

ECMWF
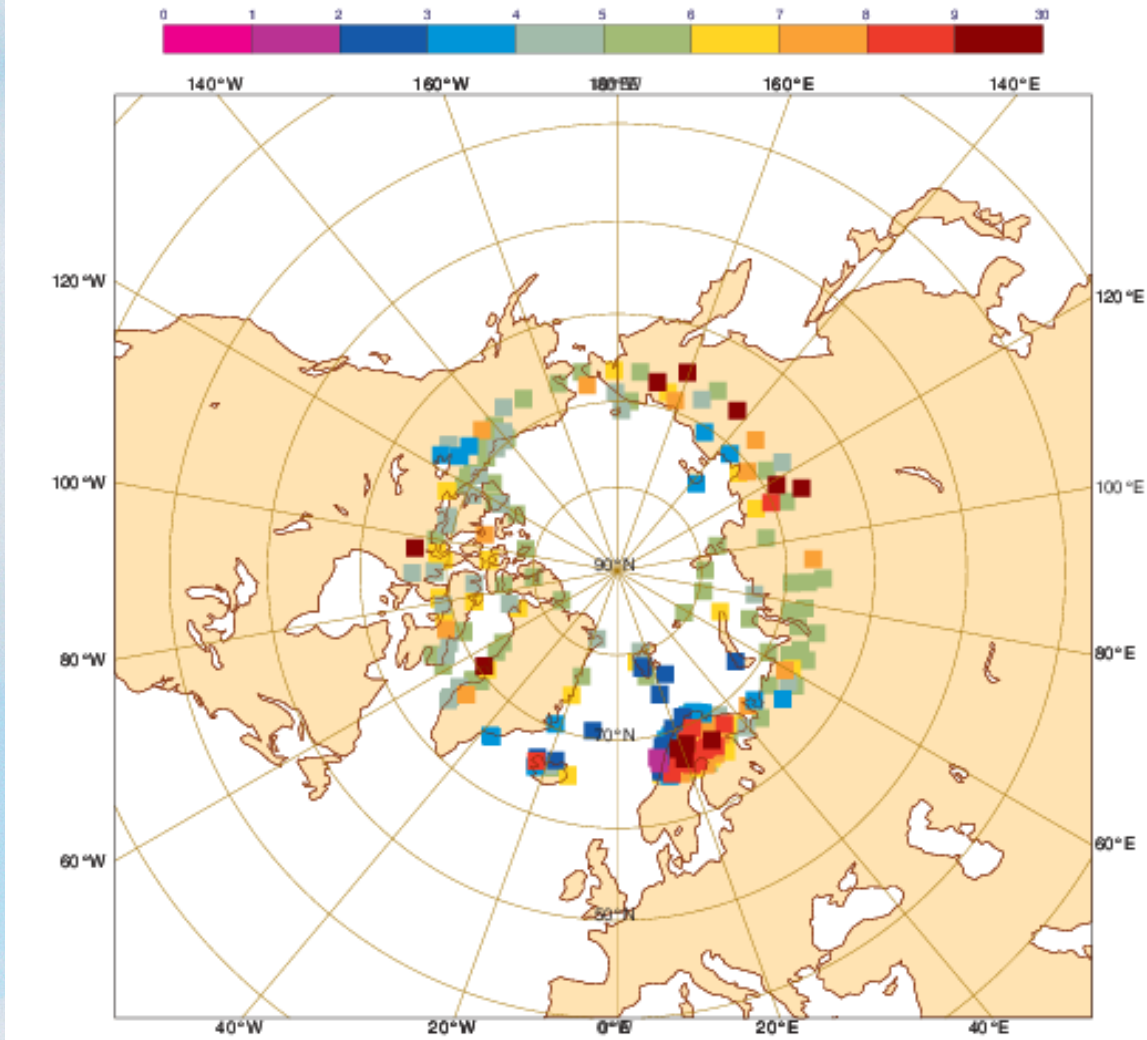
Tarfala

Nikkaloukta
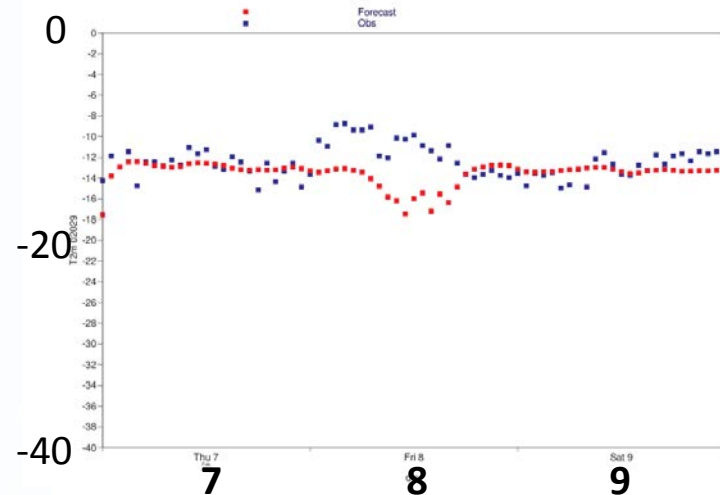

17 km between the stations, ENS resolution 32 km..

ECMWF

Observed and forecasted temperature 2013-02-07

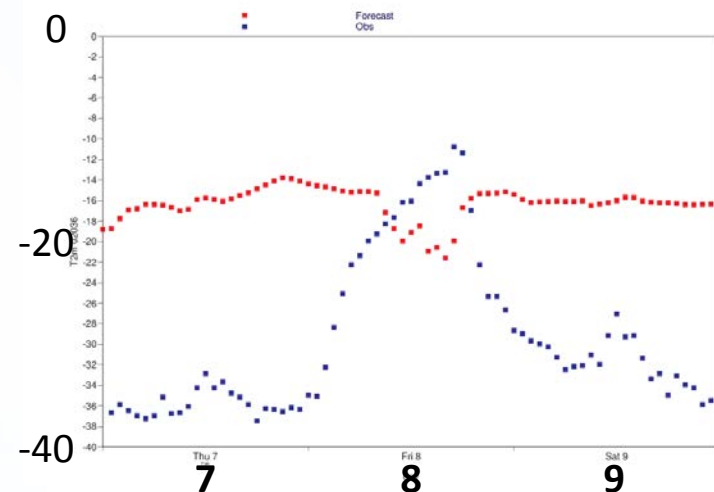## North-western Scandianavia

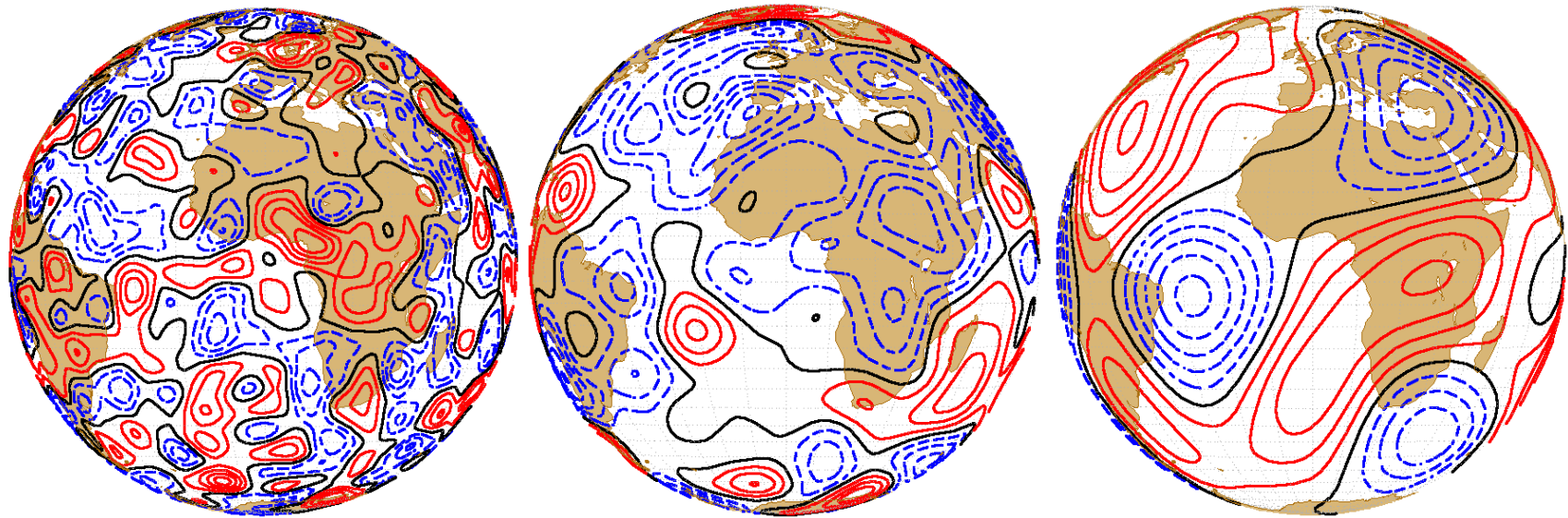20130207 0z +0

Analysis (shade)
Synop (diamonds)

Tarfala

Nikkaloukta

How to represent this difference in ENS?

Stochastic perturbed physical tendencies (SPPT)

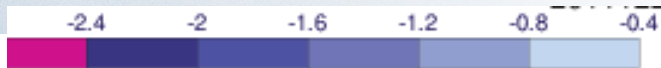dX/dt=Dynamical tend.+(1+r)Physical tend.(convection, radiation, cloud, diffusion, dissipation)

No perturbations in the boundary layer and the stratosphere
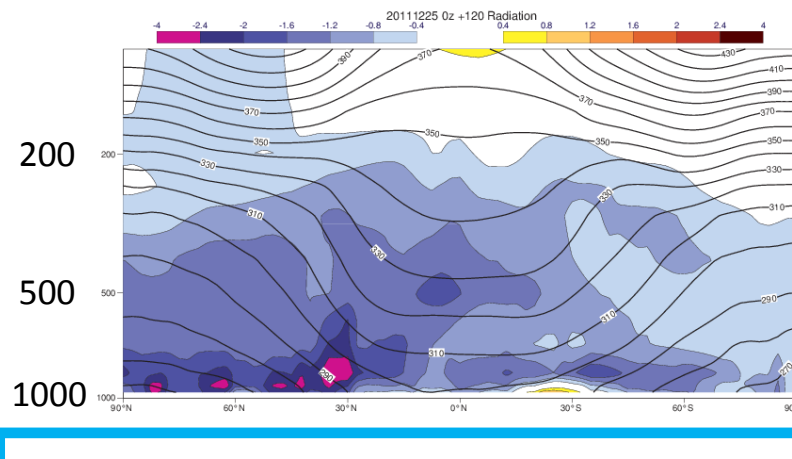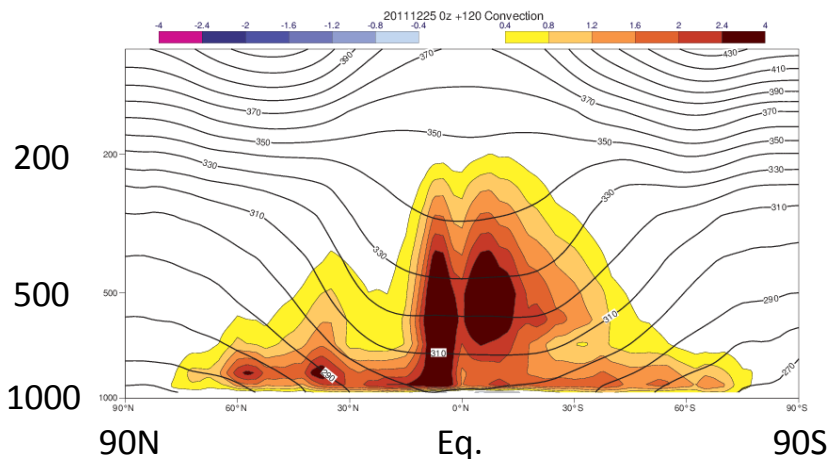
Palmer et al. (2009)

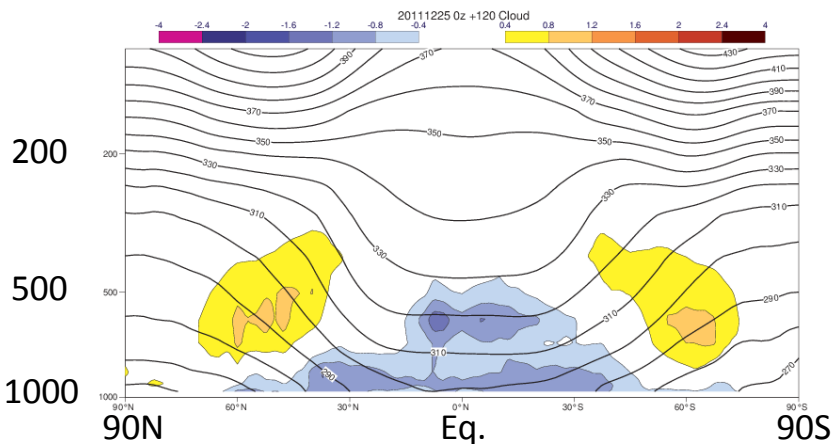# Mean tendencies for temperature (Dec-Jan)
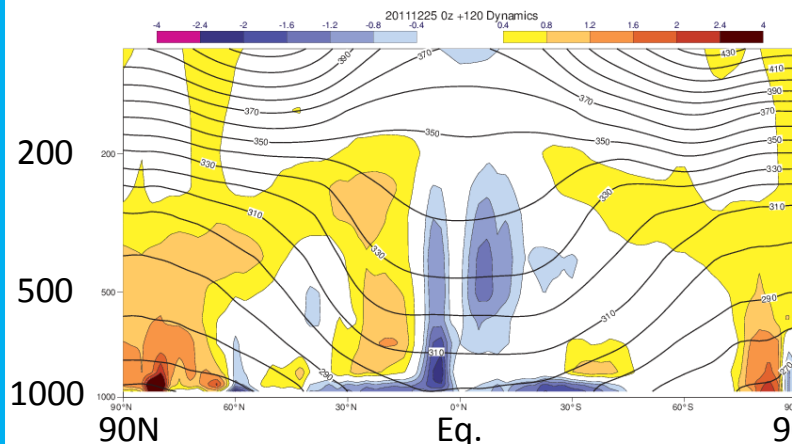

Convection scheme

Radiation scheme

Cloud scheme

Dynamics (advection)

Thanks to N. Wedi and S. Lang

Summary

- The forecasting system has improved over the years

- The ensemble system have to simulate the remaining errors

- Still many types of errors to solve or simulate (stratosphere-troposphere, surface, sea-ice, boundary layer)

- How to include sub-grid variability?

Synop verif. T2M, 20120110_20120314, Arctic_c

ECMWF

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