Construction of Perturbed Initial Conditions

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3. Ensemble prediction systems

Temperature

Temperature

fc_j

fc_0

PDF(t)

reality

PDF(0)

Forecast time
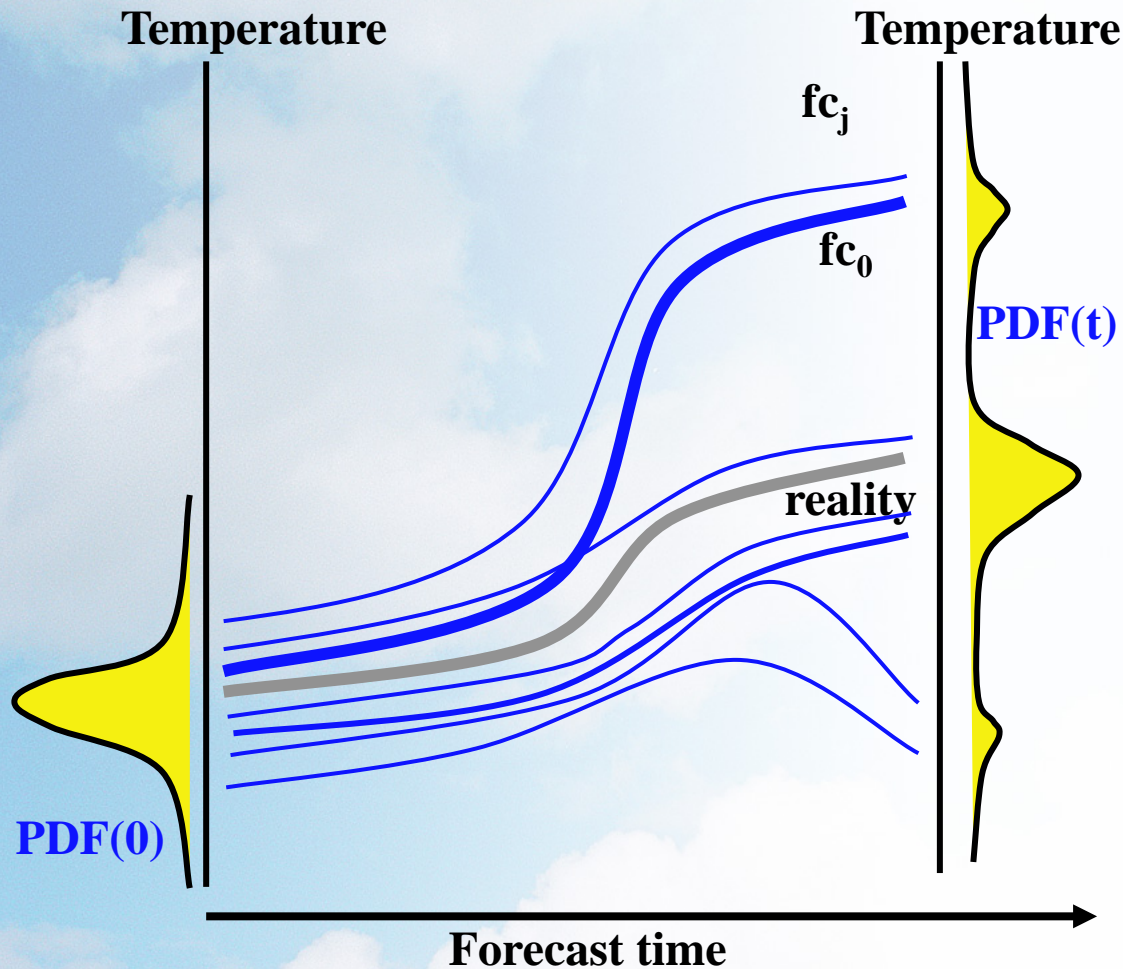
Sources of Uncertainty:

- **Initial Conditions**

- **Model Formulation**

from R. Buizza

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Ensemble assimilation and prediction

EDA

EPS

4D-Var trajectories

First guesses

Surface pressure

Observation

Observation

09Z   12Z   15Z   18Z   21Z   Time

Assimilation window

Forecast

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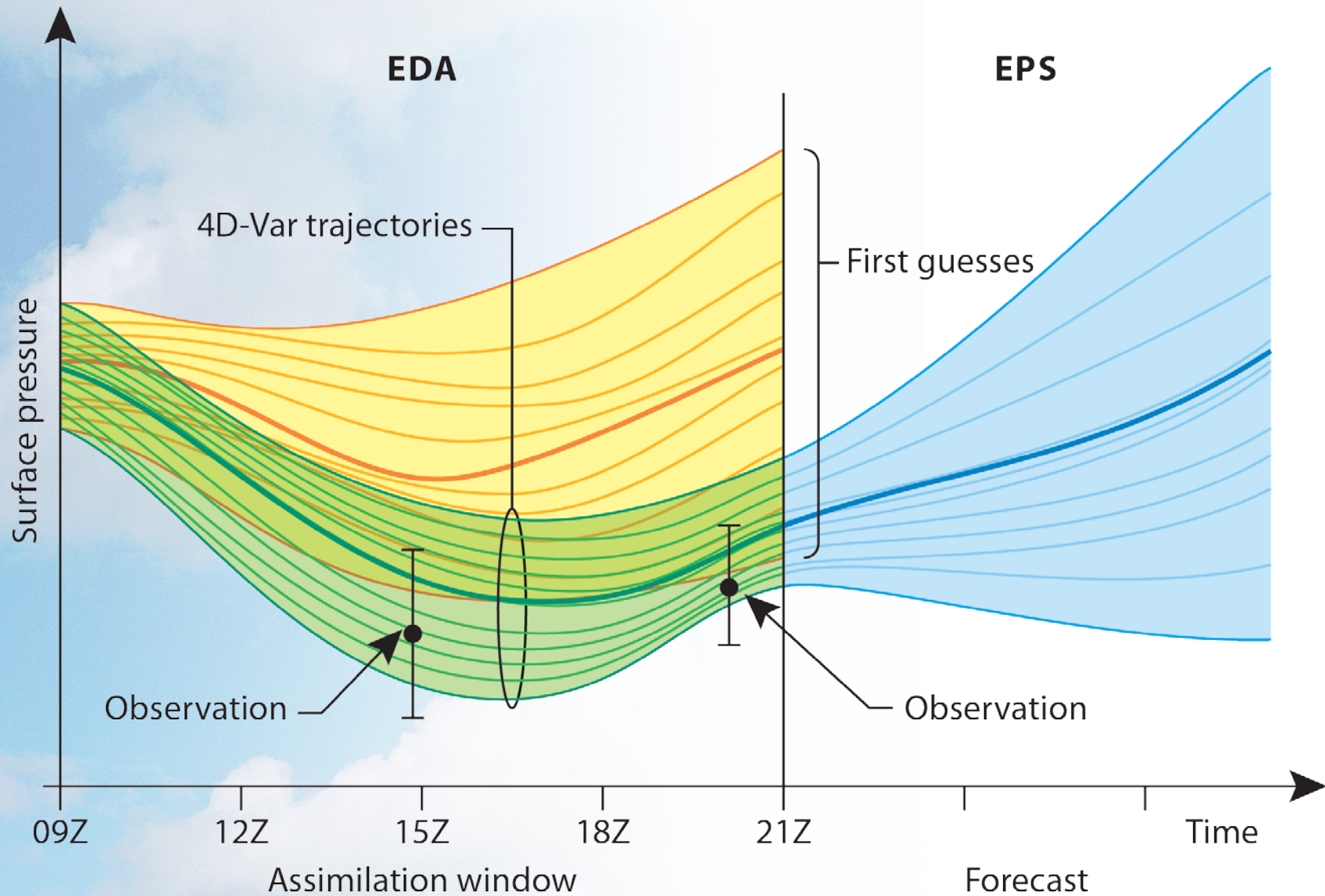
Generation of initial conditions for the ensemble:

$$AN_{pf} = AN_{Hres} \pm (EDA_i - \overline{EDA}) \pm SVPERT_j$$

$$i = 1..25$$
$$j = 1..25$$
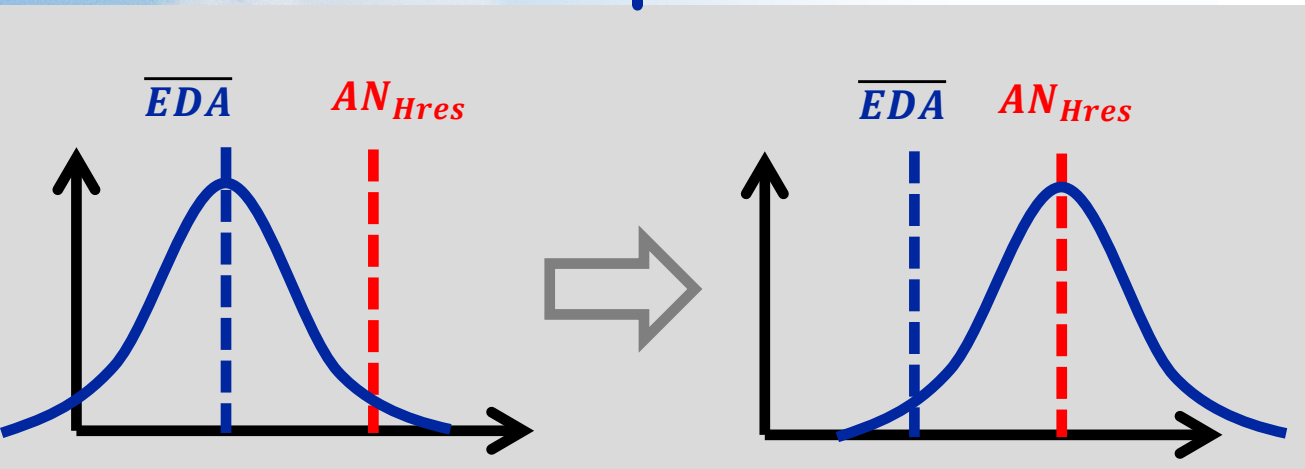
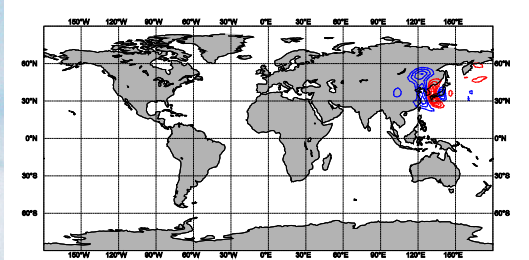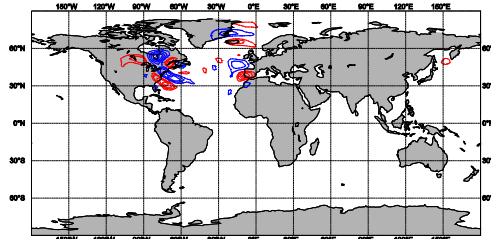**Re-centre EDA-Distribution on Hres-Analysis**

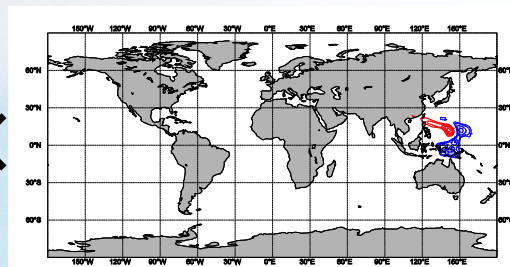$$SVPERT_j = \sum_l^{NSET} \sum_k^{NSV_l} \alpha_{lk} \, SV_{lk}$$

α **random number drawn from Truncated gaussian**
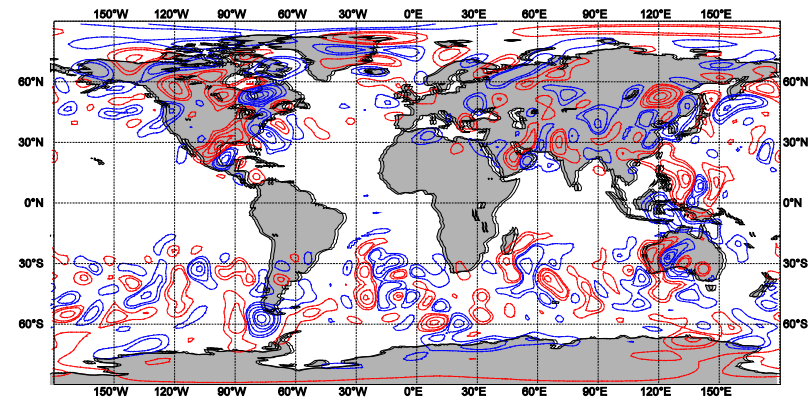
NSET : nhem, shem, TCs1-6
NSV   : 50 for nhem and shem, 5 for TCs

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Combine SVs to construct Perturbations:

SV$_1$

SV$_2$

SV$_{50}$

$$\alpha_1 \times \boxed{} + \alpha_2 \times \boxed{} + \cdots$$

SV$_{TC1}$

SV$_{TCn}$

$$+ \alpha_{TC1} \times \boxed{} + \cdots$$

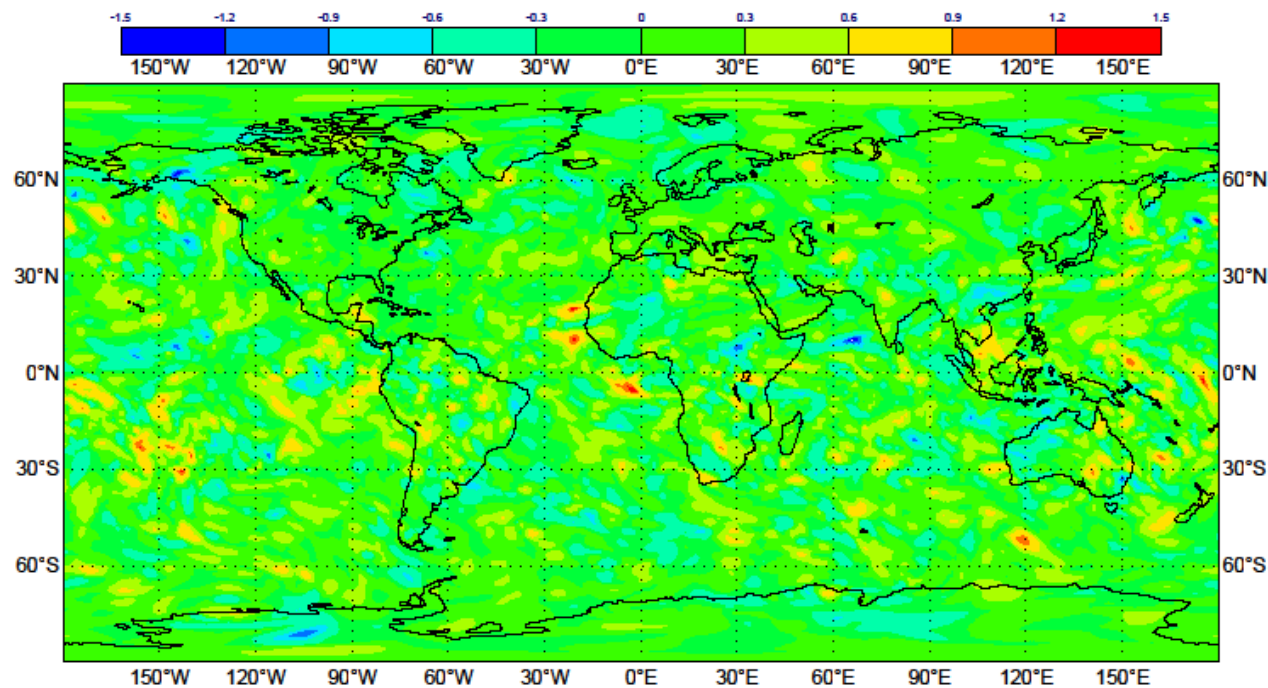**SVPERT 1**

$$=$$

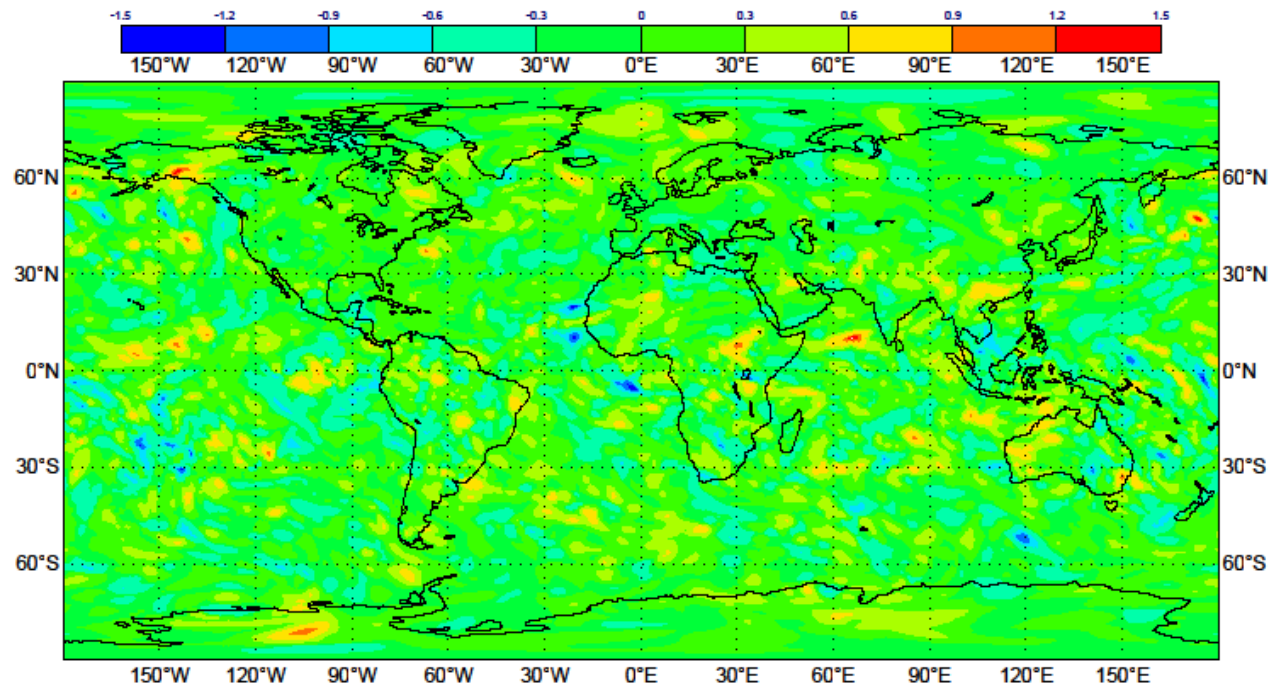**SVPERT 1**

SVPERT 2

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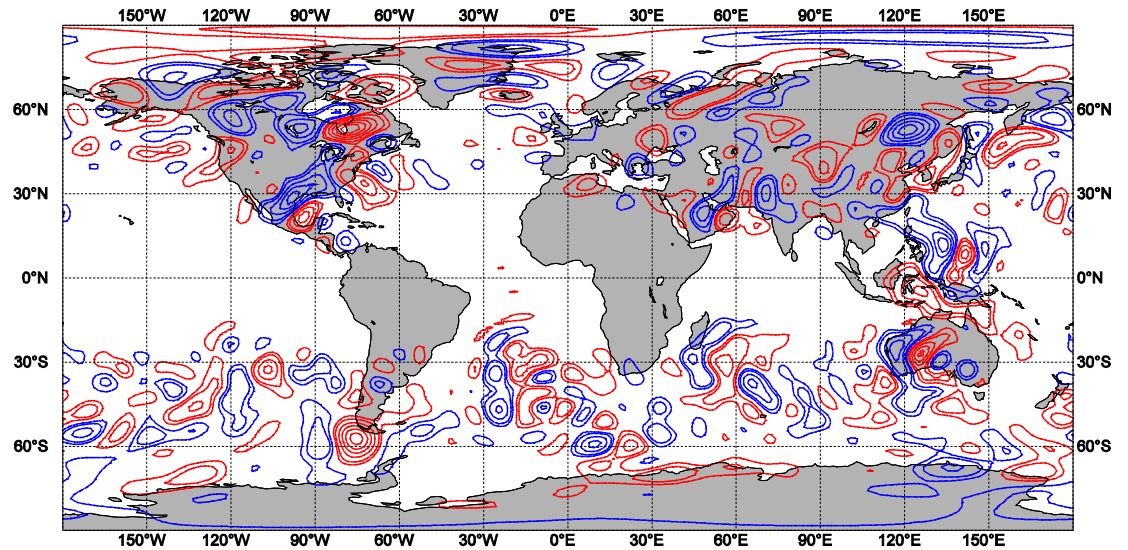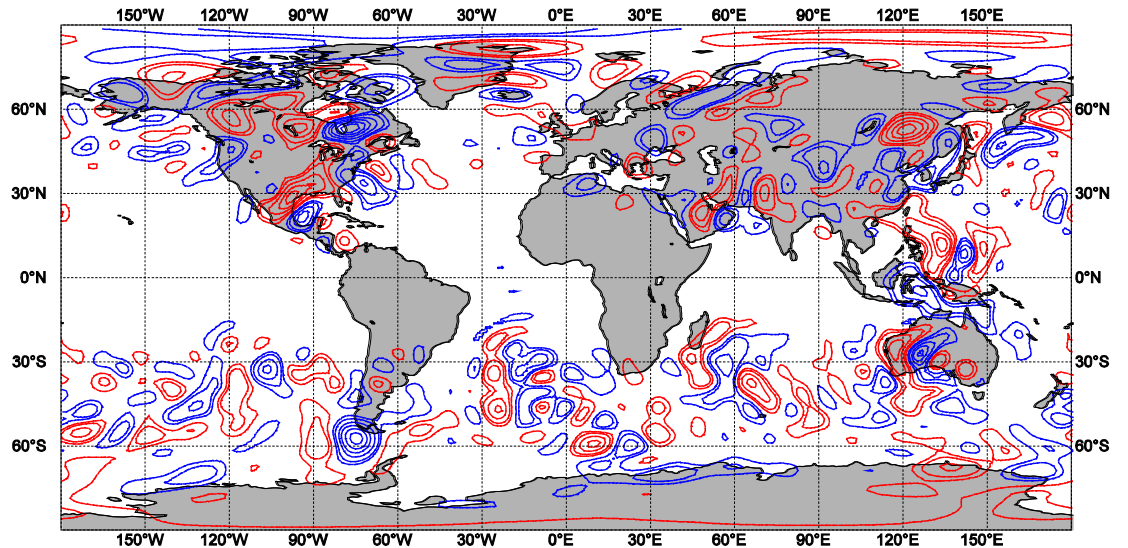
Example:
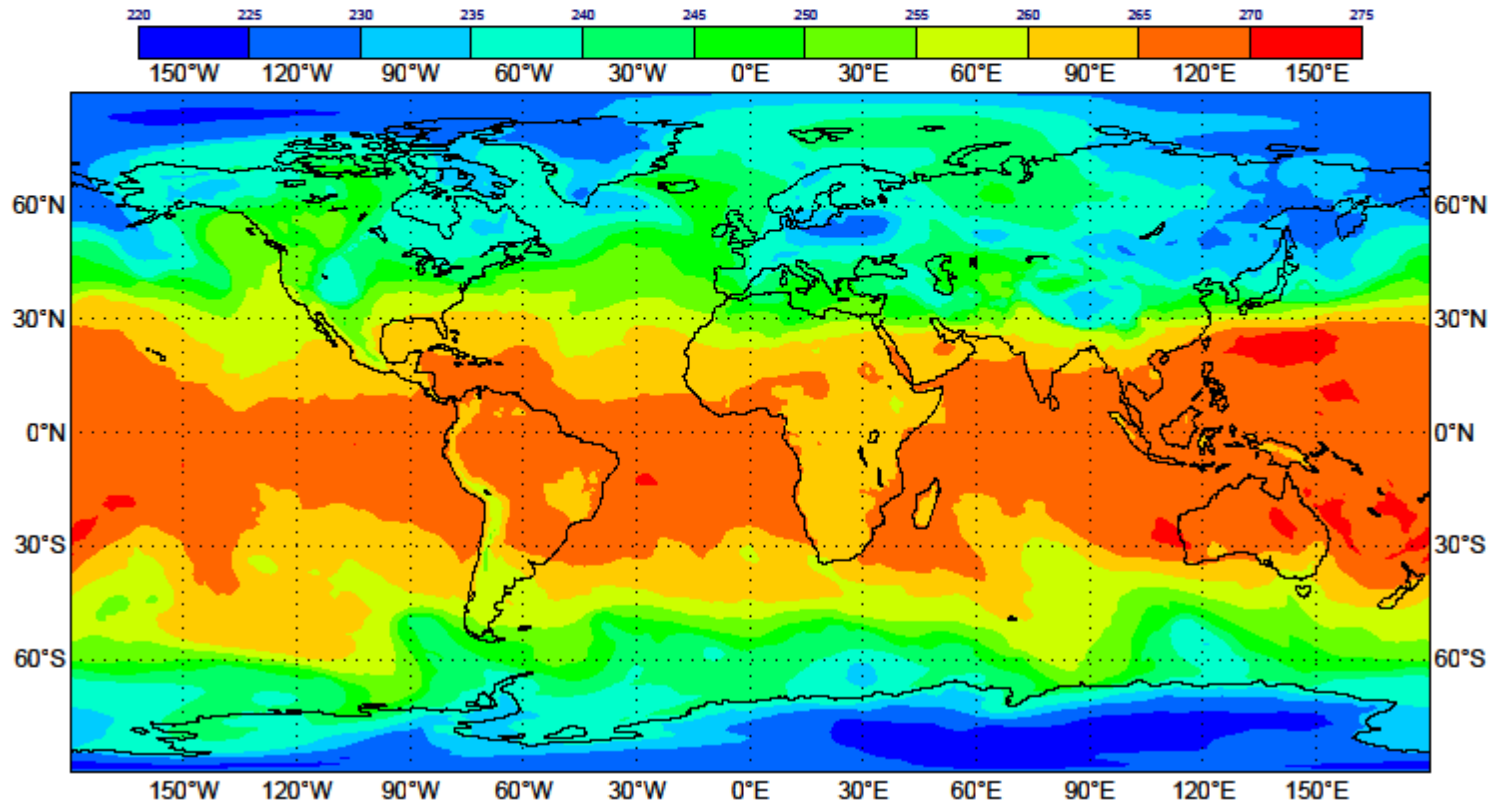
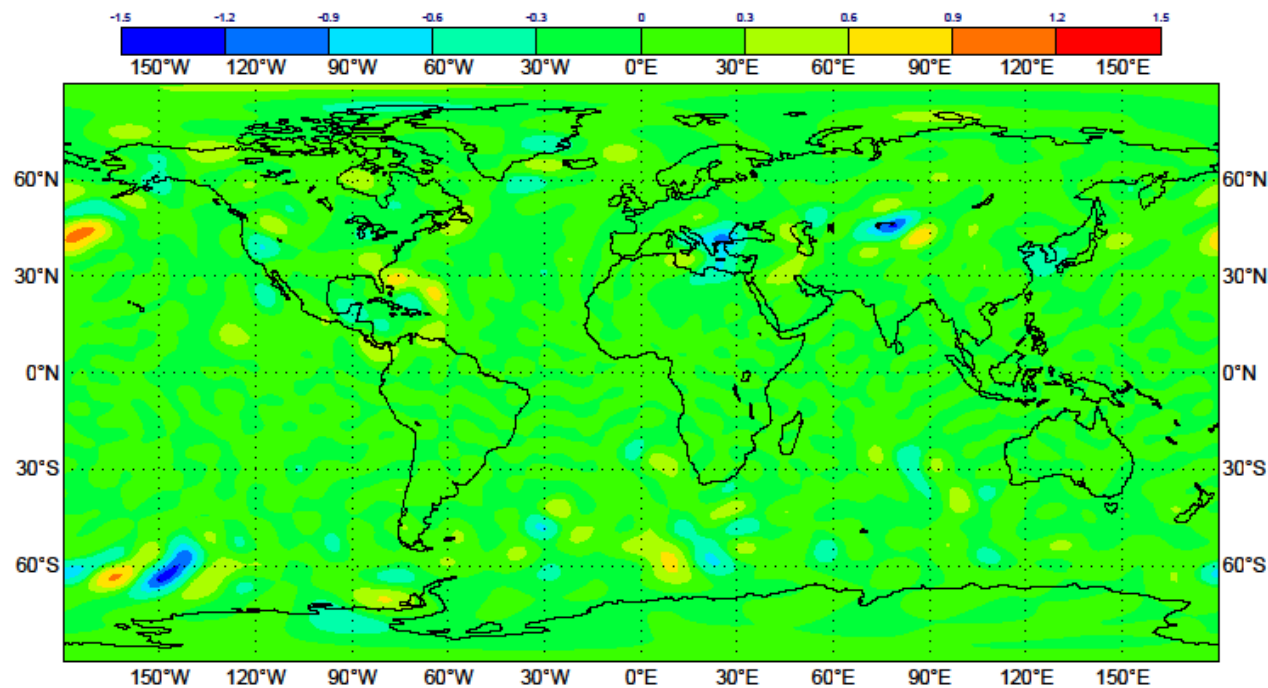**Hres Analysis Temperature 500hPa**

Member 1:

$$EDA_1 - \overline{EDA}$$

Member 2:

$$-(EDA_1 - \overline{EDA})$$

Member 1:

$$SVPERT_1$$
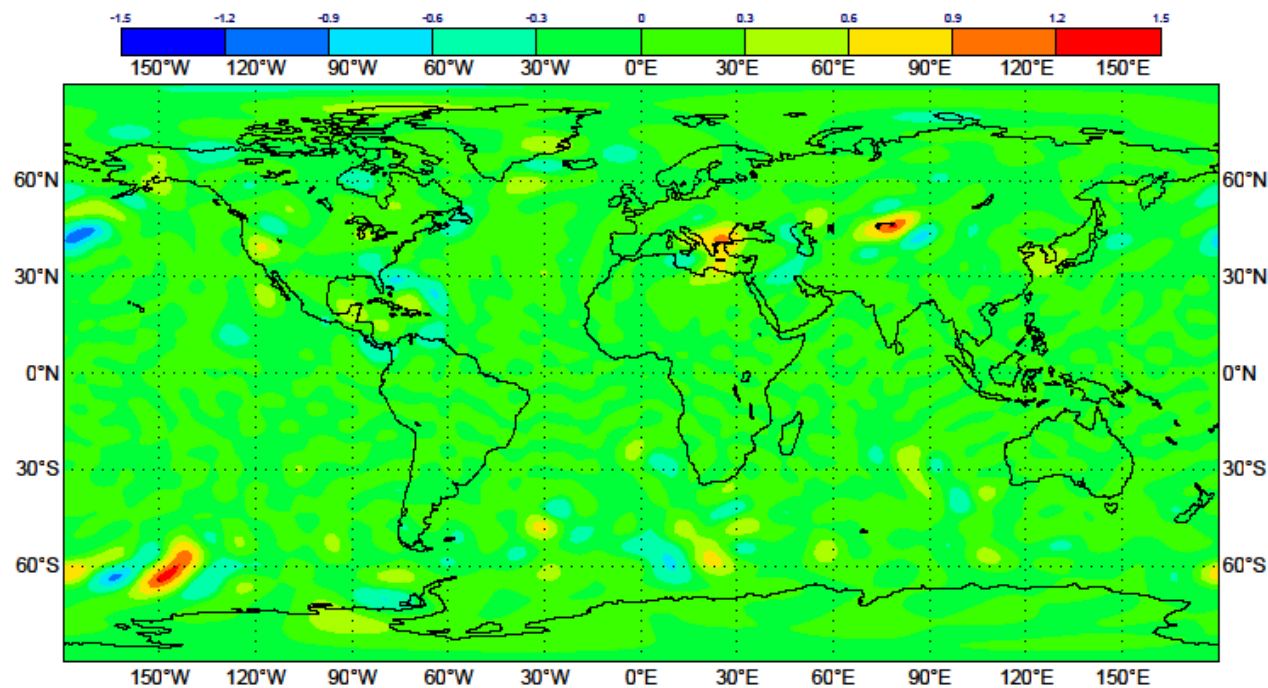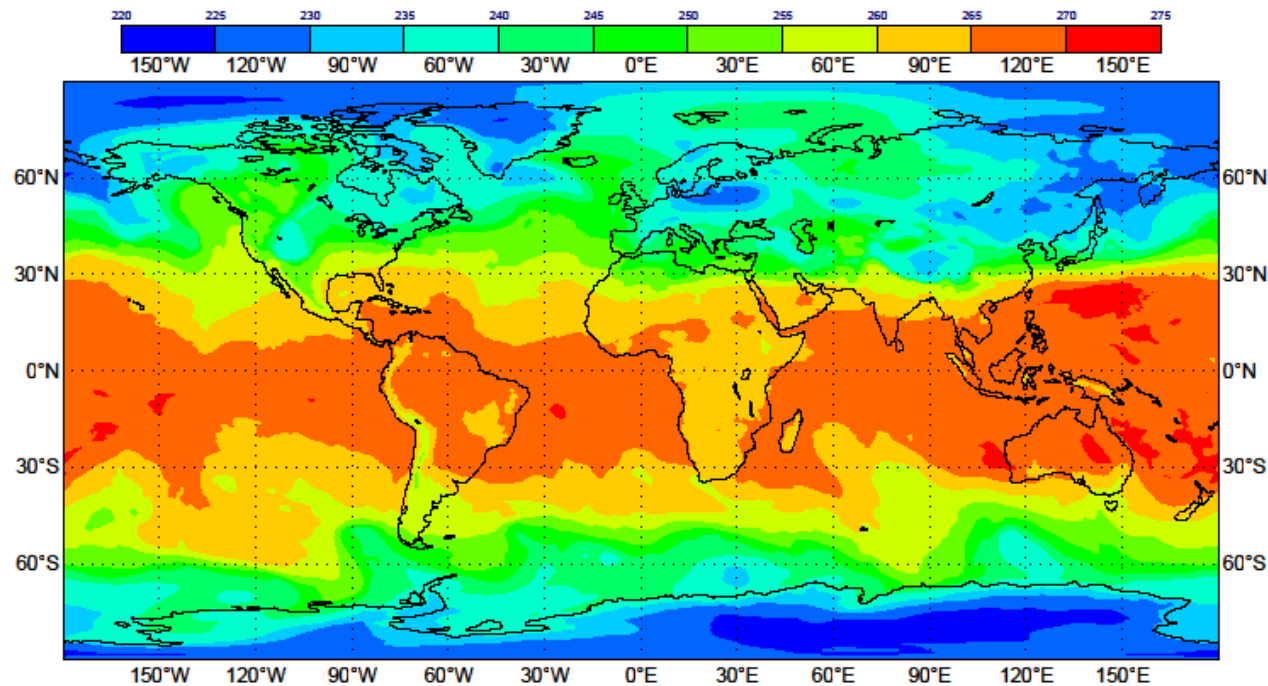
Member 2:

$$-SVPERT_1$$

Member 1:

AN_{pf1}
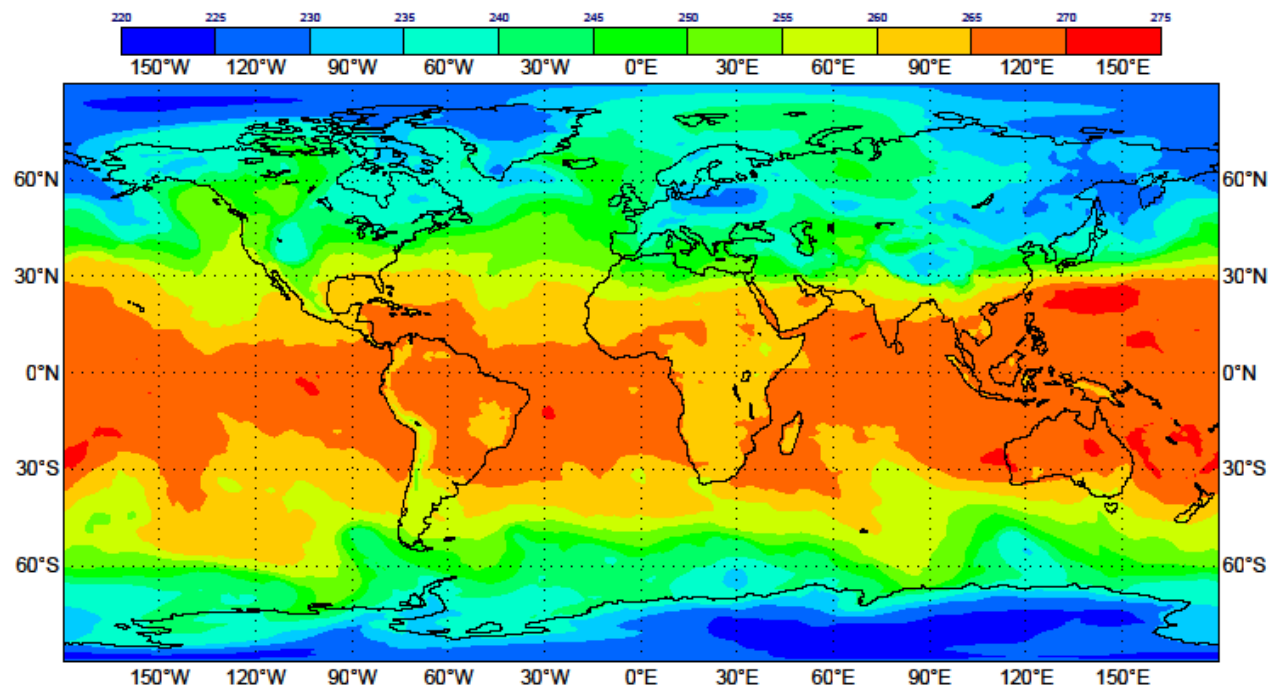
Member 2:

AN_{pf2}

Thank You!

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Chaos and weather prediction

The atmosphere is a chaotic system

- Small errors can grow to have major impact (butterfly effect)

- We can never perfectly measure the current state of the whole atmosphere

- This limits detailed weather prediction to a week or so ahead

Ensemble Forecasts

- Parallel set of forecasts from very slightly different initial conditions and model formulation

- Assess uncertainty of today's forecast

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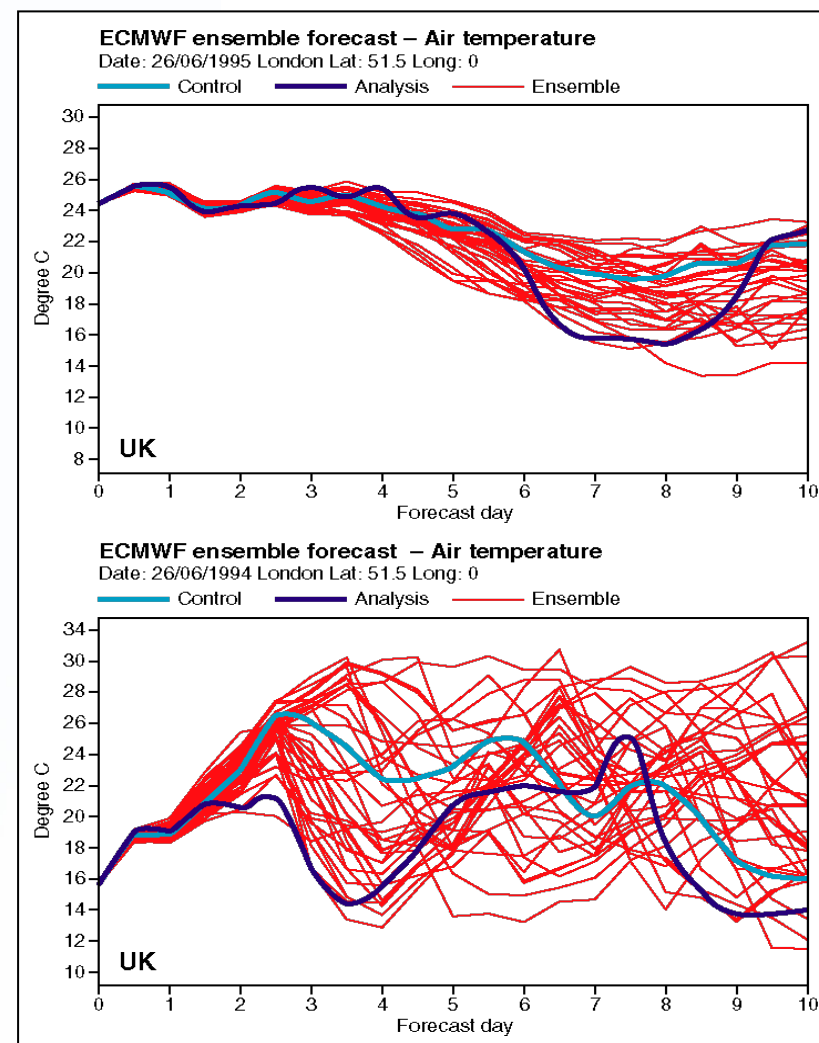
Starting the Medium-Range Forecast – the 'Analysis'
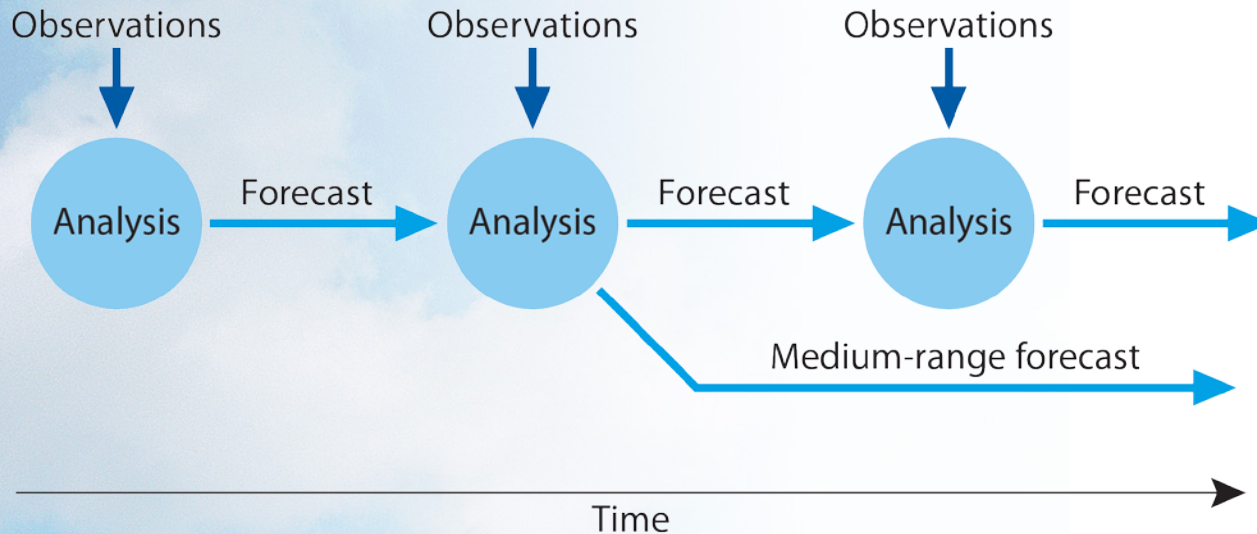
Analysis: 3 dimensional virtual image of the atmosphere at a given time.

- The short range forecast from the previous analysis is our 'first estimate' of the current state of the atmosphere.
- every 12 hours we process about 60 million observations
- Using 4-dimensional interpolation (space and time) temperature, wind and humidity observations are used to 'pull' the model state closer to reality
- This operation takes as much computer power as all the forecasts

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4D-Var assimilation
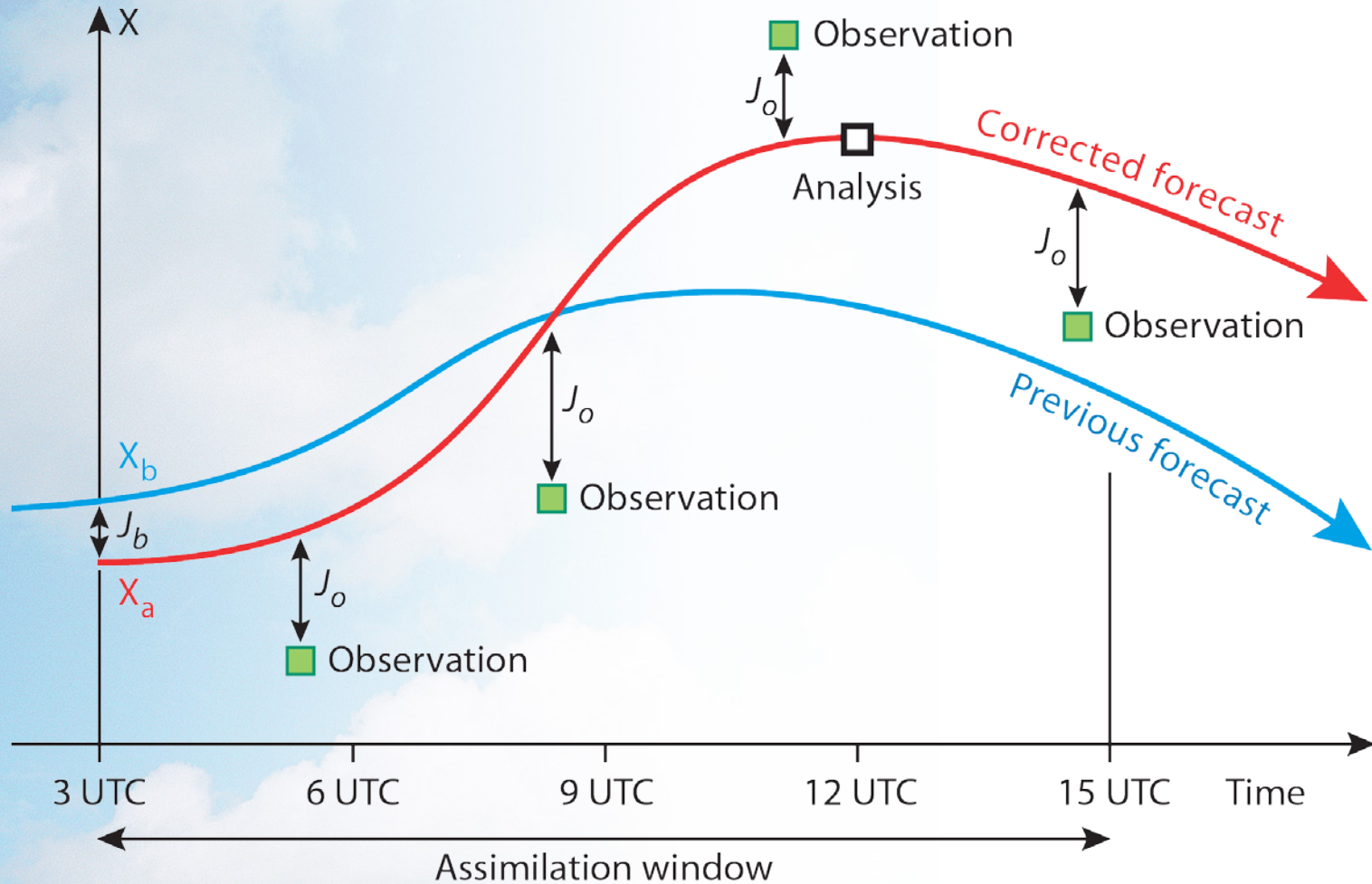
Operational schedule
Early delivery suite introduced June 2004

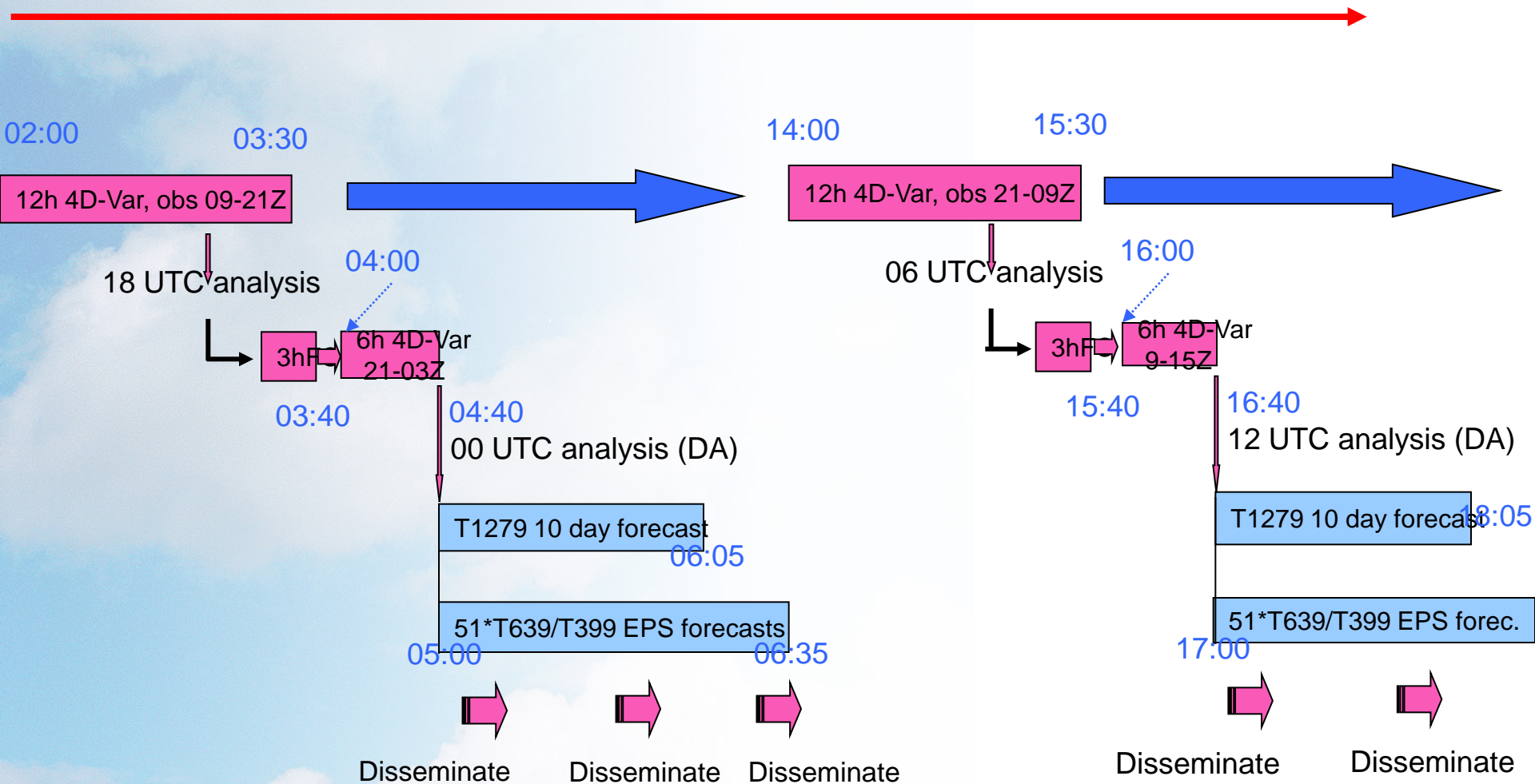**02:00**

03:30

12h 4D-Var, obs 09-21Z

18 UTC analysis

04:00

3hFG → 6h 4D-Var 21-03Z

03:40

04:40

00 UTC analysis (DA)

T1279 10 day forecast

06:05

51*T639/T399 EPS forecasts

05:00   **06:35**

Disseminate   Disseminate   Disseminate

14:00   **15:30**

12h 4D-Var, obs 21-09Z

06 UTC analysis

16:00

3hFG → 6h 4D-Var 9-15Z

15:40

16:40

12 UTC analysis (DA)

T1279 10 day forecast   **18:05**

51*T639/T399 EPS forec.

17:00

Disseminate   Disseminate

from L. Isaksen

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