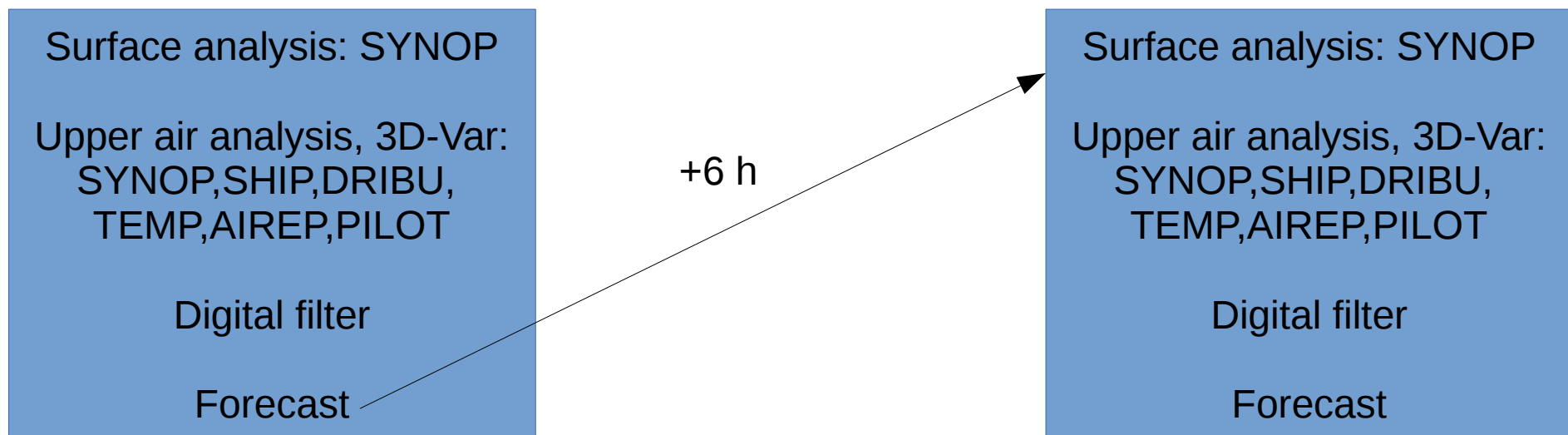


Upper air data-assimilation with 3D-Var and Large scale constraint choices

Per Dahlgren
SMHI

Aim: Run ALADIN and ALARO with a 6 hour data-assimilation cycle



Preparations for 3D-Var

+6 h forecast errors needs to be specified:
B matrix in 3D-Var cost function

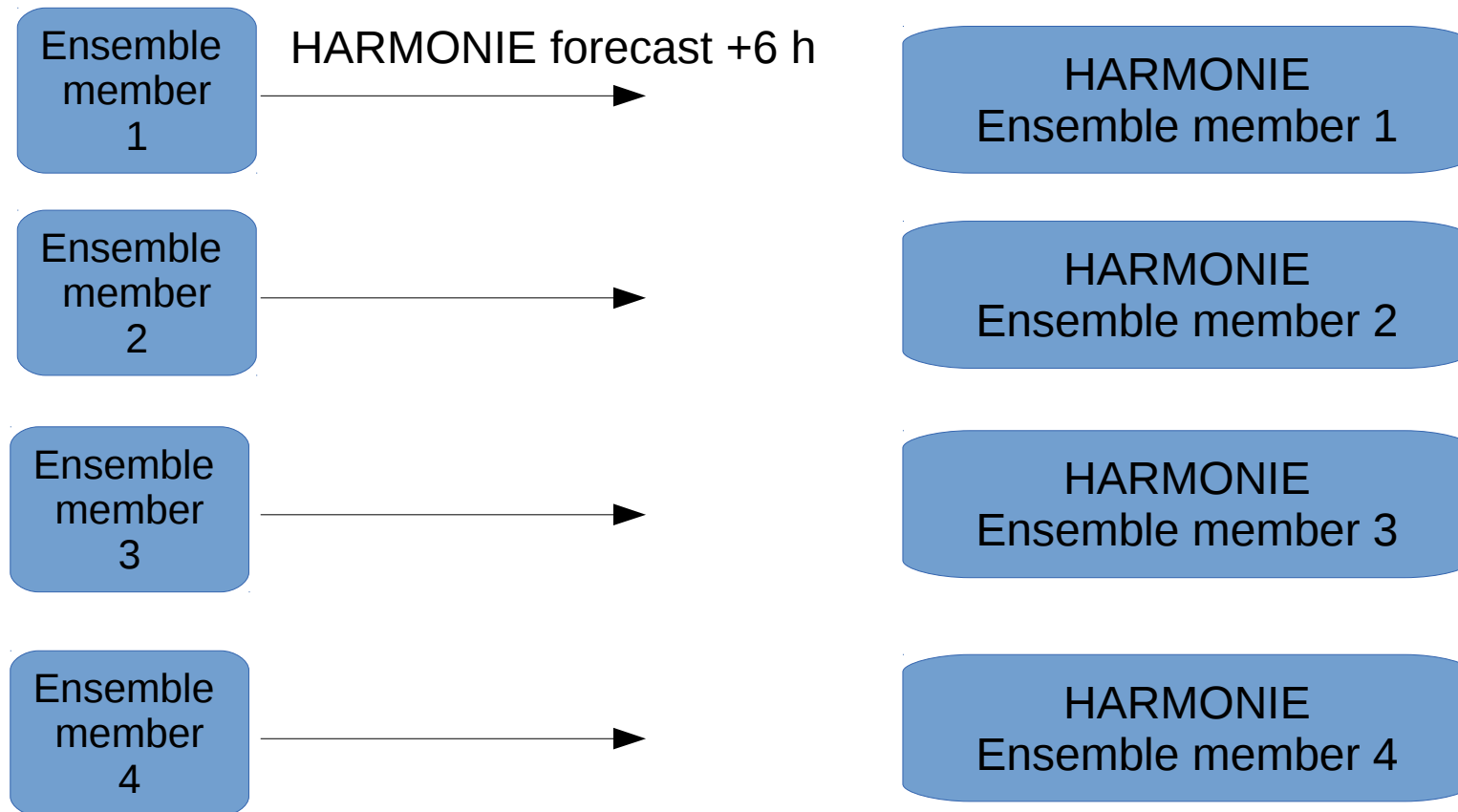
Needs to be calculated for each model setup
(geometry, physics settings etc) individually

B matrix covariances also called ***structure functions***
or ***background error covariances***

Generating structure functions

ECMWF
ensemble DA system (EDA)

HARMONIE ensemble



Generating structure functions

Calculate HARMONIE ensembles at 00 and 12 throughout Jan and Jul

HARMONIE
Ensemble member 1

HARMONIE
Ensemble member 2

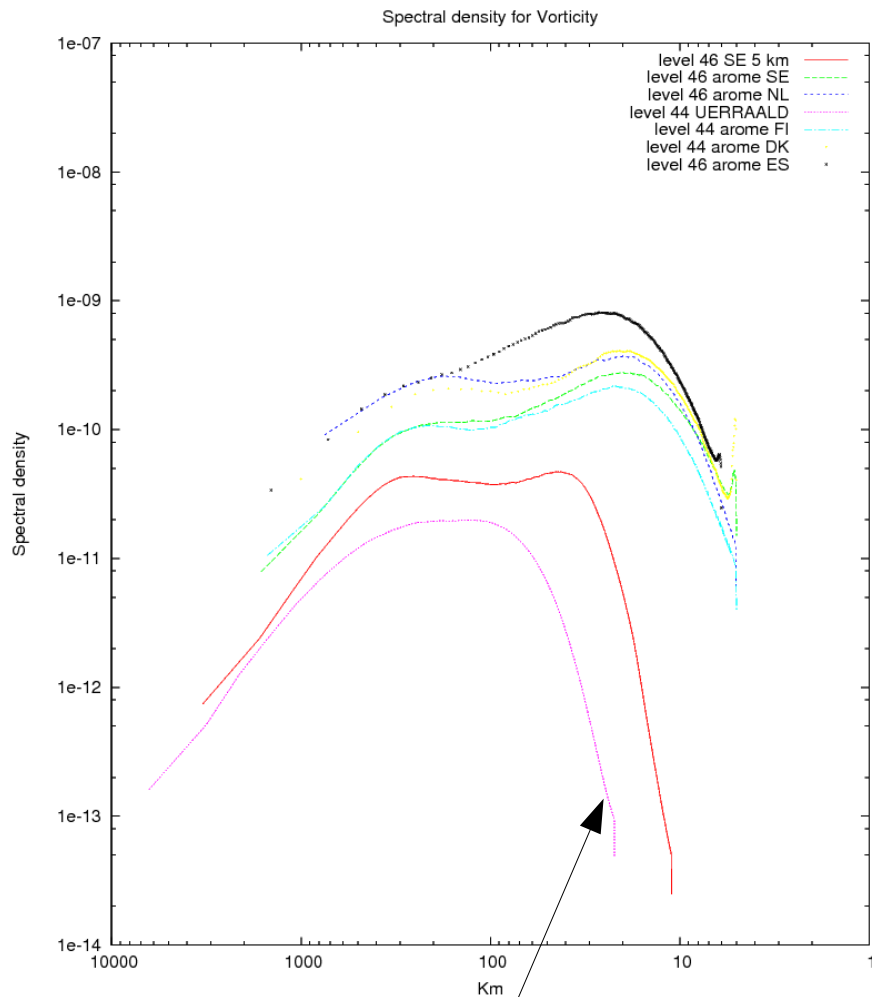
HARMONIE
Ensemble member 3

HARMONIE
Ensemble member 4

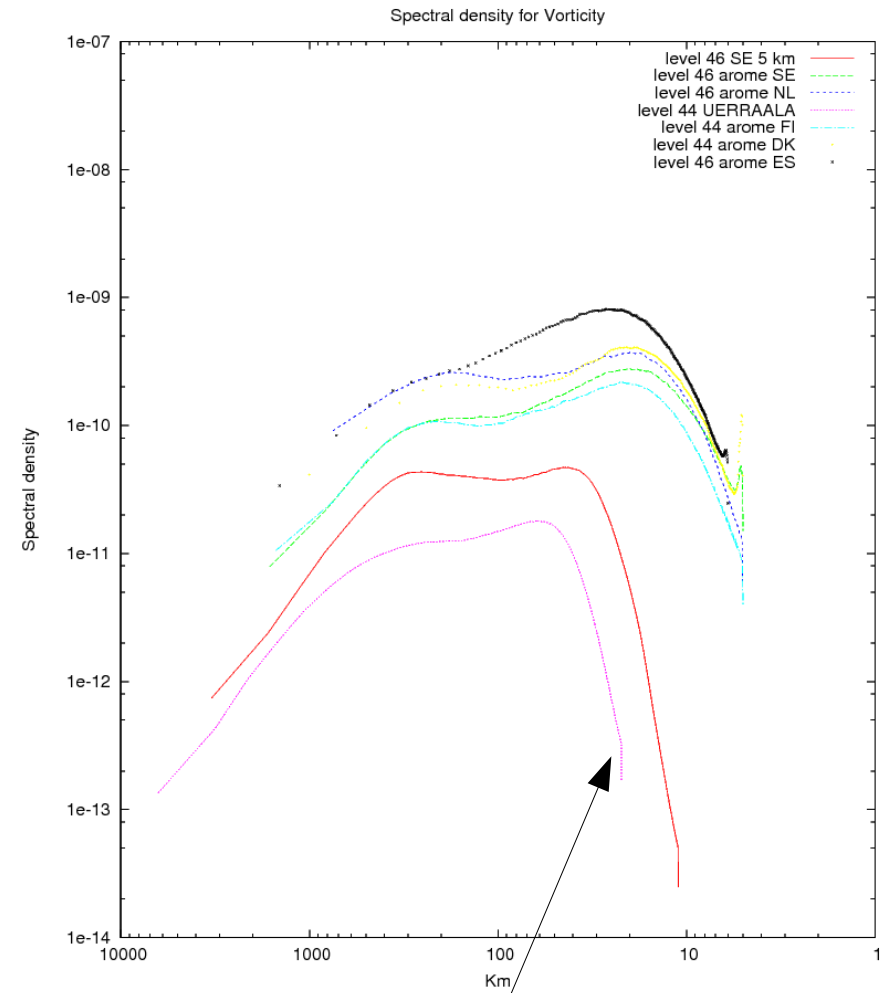
Differences between ens-members are used to
Calculate +6 h forecast errors in the **B** matrix

Structure functions, example

B matrix for ALADIN and ALARO quite similar



ALADIN



ALARO

Large scale constraint choices

Background:

To mix the large scales from ERA-Interim into the HARMONIE
initial state

(ERA-Interim analyses used at the lateral boundaries)

2 options available in HARMONIE:

LSMIXBC

Jk

Large scale constraint choices

Background:

To mix the large scales from ERA-Interim into the HARMONIE
initial state

(ERA-Interim analyses used at the lateral boundaries)

2 options available in HARMONIE:

LSMIXBC

Jk

... to be explained

LSMIXBC

xb = HARMONIE +6 h forecast
1:st guess (or background) for the analysis

xls = First boundary file; ERA-Interim analysis

xb and **xls** in spectral representation

LSMIXBC:

Large scales from **xls** + small scales from **xb**
==> Modified **xb**

Done **BEFORE** the 3D-Var analysis

Used operationally in Sweden+Norway (MetCoOp)

Jk

x_b = HARMONIE +6 h forecast
1:st guess (or background) for the analysis

x_{ls} = First boundary file; ERA-Interim analysis

y = observations

x_b and **x_{ls}** in spectral representation

Jk:

Add large scales from **x_{ls}** as an extra constraint in the 3D-Var cost function

Done **INSIDE** the 3D-Var analysis

Preparations for Jk

Cost function:

$$J(x) = J_b + J_o + \underbrace{(x - x_{ls})^T V^{-1} (x - x_{ls})}_{J_k}$$

V = Error covariances of ERA-Interim in the HARMONIE geometry

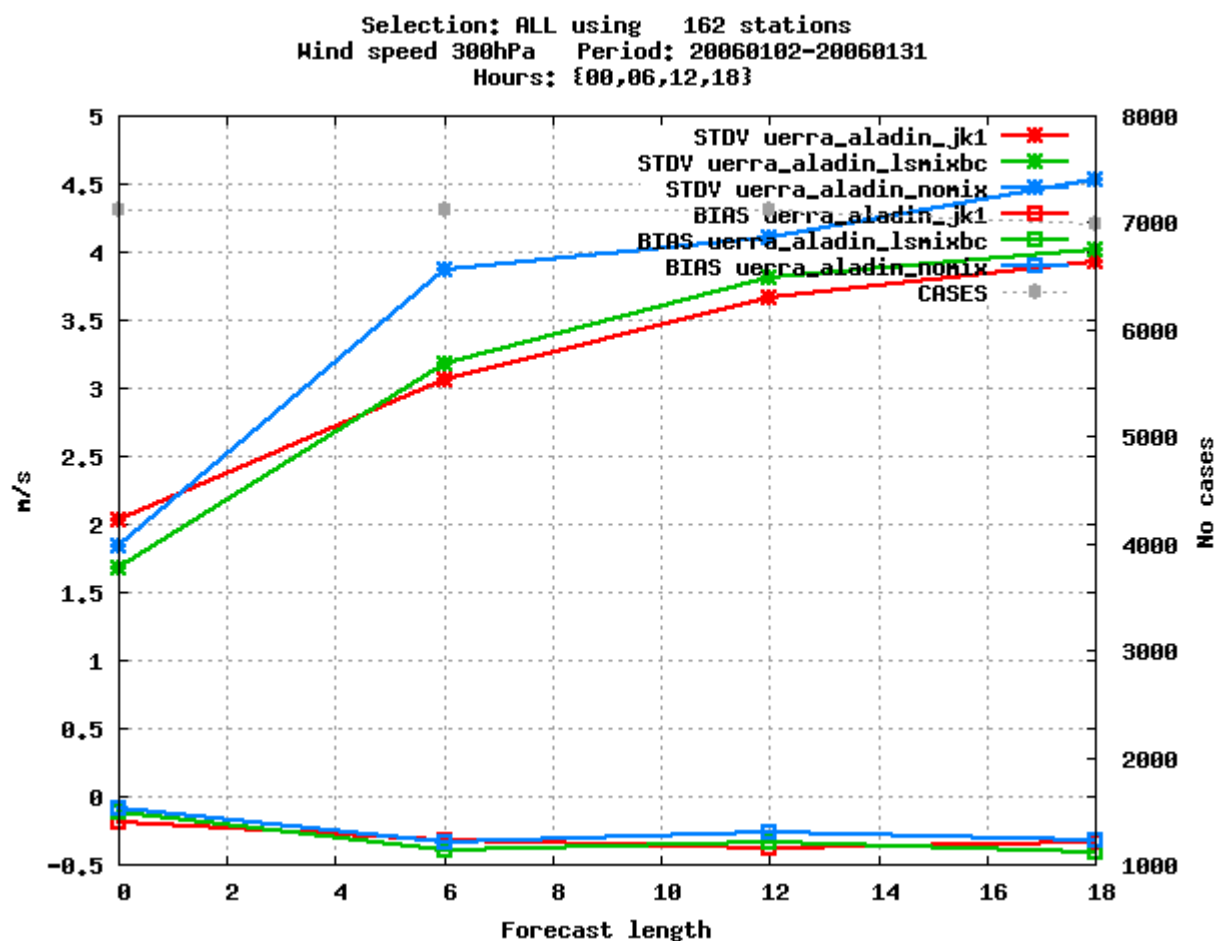
Need some ensemble statistics to determine V

How to determine the ERA-Interim error covariances?

Use ECMWF-EDA ensembles instead. Assume these errors are representative for ERA-Interim

Jk or LSMIXBC in UERRA runs?

Compared in a forecast experiment. Jan 2006



Wind speed compared to
Radiosondes at 300 hPa

Blue - no mix
Green - LSMIXBC
Red - Jk

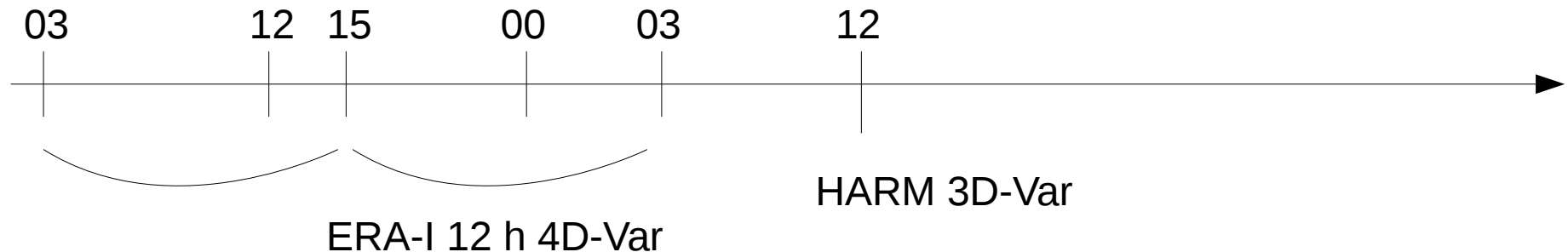
Scientific issues

Mixing an ERA-Interim analysis into the HARMONIE initial state:

Observations are used twice!

In operations, the first boundary file is a short ECMWF forecast

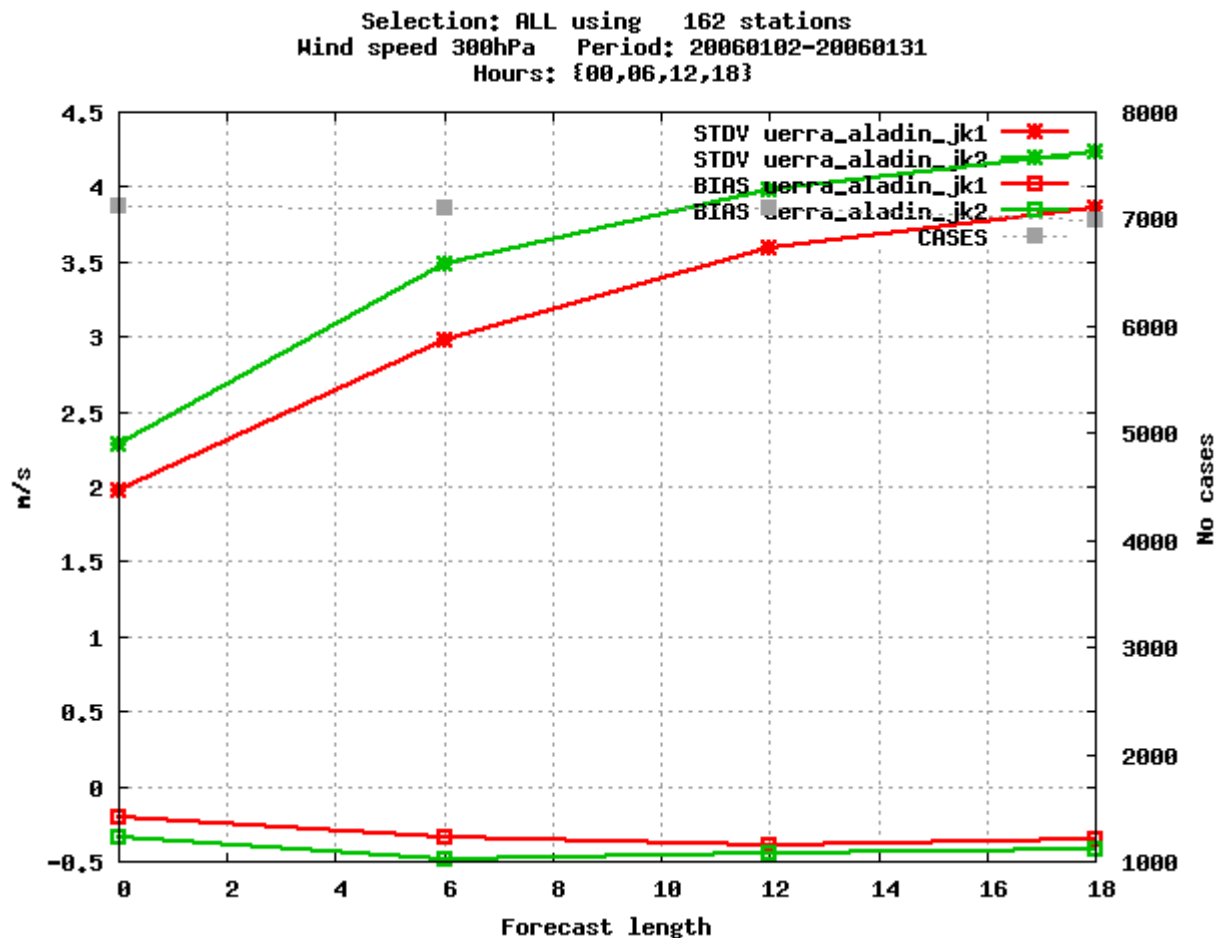
It is possible to use an ERA-Interim forecast



Easiest to test (technically) with Jk

Jk with ERA-I analysis or forecast

Compared in a forecast experiment. Jan 2006



Wind speed compared to
Radiosondes at 300 hPa

Green – Jk with ERA forecast
Red – Jk with ERA analysis

Summary

Background error covariances calculated for ALADIN and ALARO

Can now run UERRA experiments with 3D-Var

Host model mixing methods compared. Jk, LSMIXBC, no mix

Results not always as expected (ERA analysis vs ERA forecast in Jk)

5 year runs are using Jk with ERA-Interim analysis