

IMPACT OF IASI WATER VAPOUR CHANNELS IN THE FRENCH NWP MODELS

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advancing the frontiers



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Content

Water vapour channels for assimilation

Impact in the global model forecast

- Forecast score
- Observation impact

Impact in the mesoscale AROME model

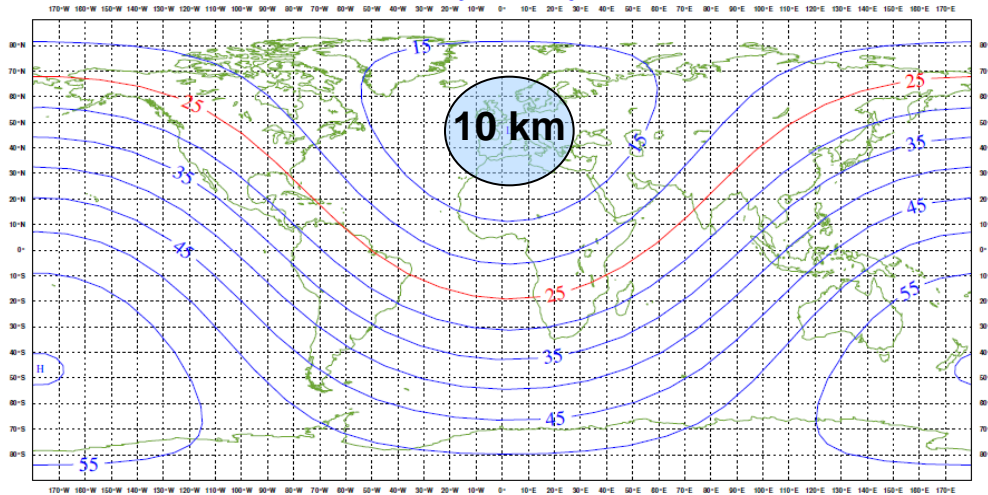
- Impact on the rain rate forecast

Conclusions and prospects

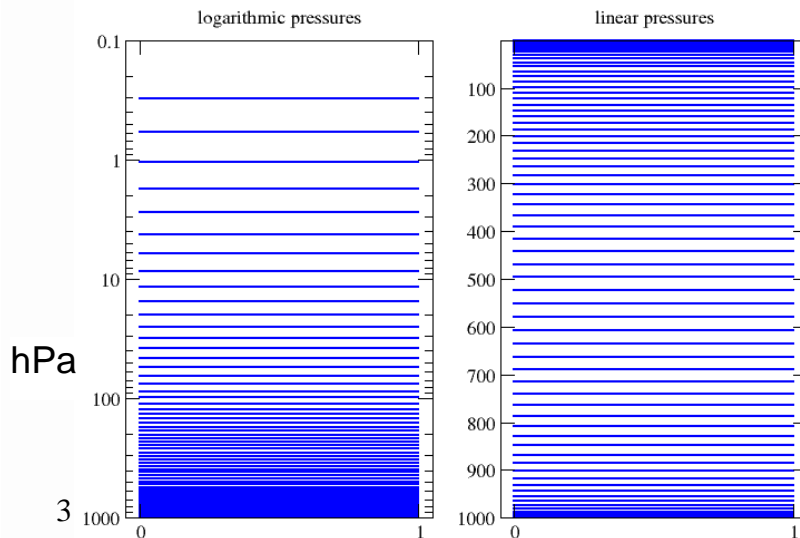
Description of the NWP global model at Météo-France

Global model ARPEGE

Horizontal resolution: between 10 and 60 km

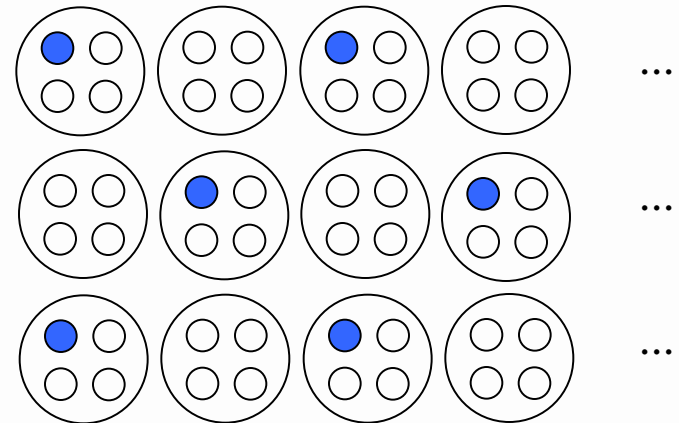


70 vertical levels



IASI pixels

Only detector #1, 1 FoR / 2

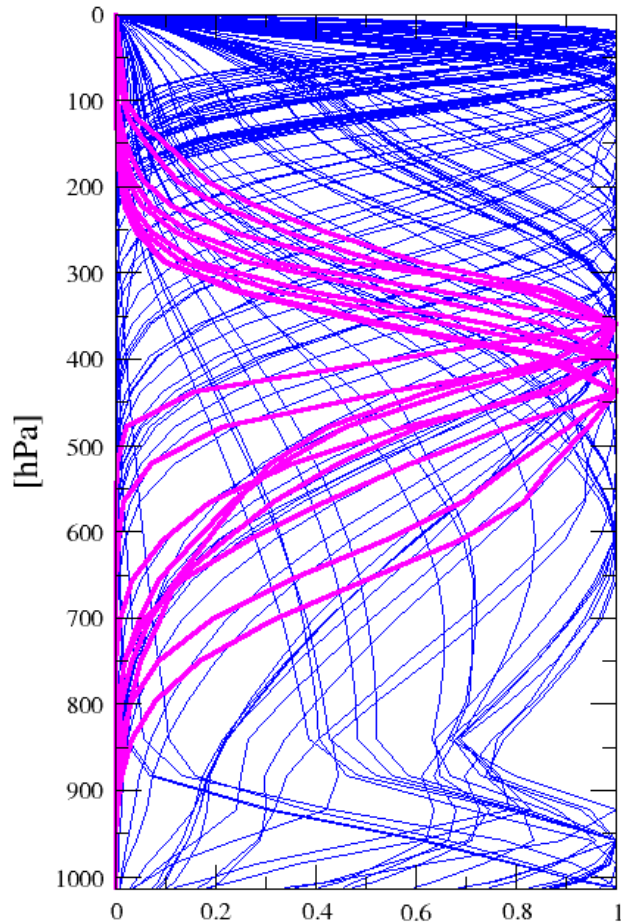


1 pixel in 125 km box in the assimilation

In operations (since 26 Sept. 2012)

Weighting function of assimilated IASI channels since 26 September 2012

101 T channels + 9 WV channels



Over land 78 T+ 9 WV channels

Over sea ice 60 T + 9 WV channels

Prescribed final observation error = 3.6 K
for the water vapour channels.

Assimilation of IASI over Sea

Towards assimilating more WV channels

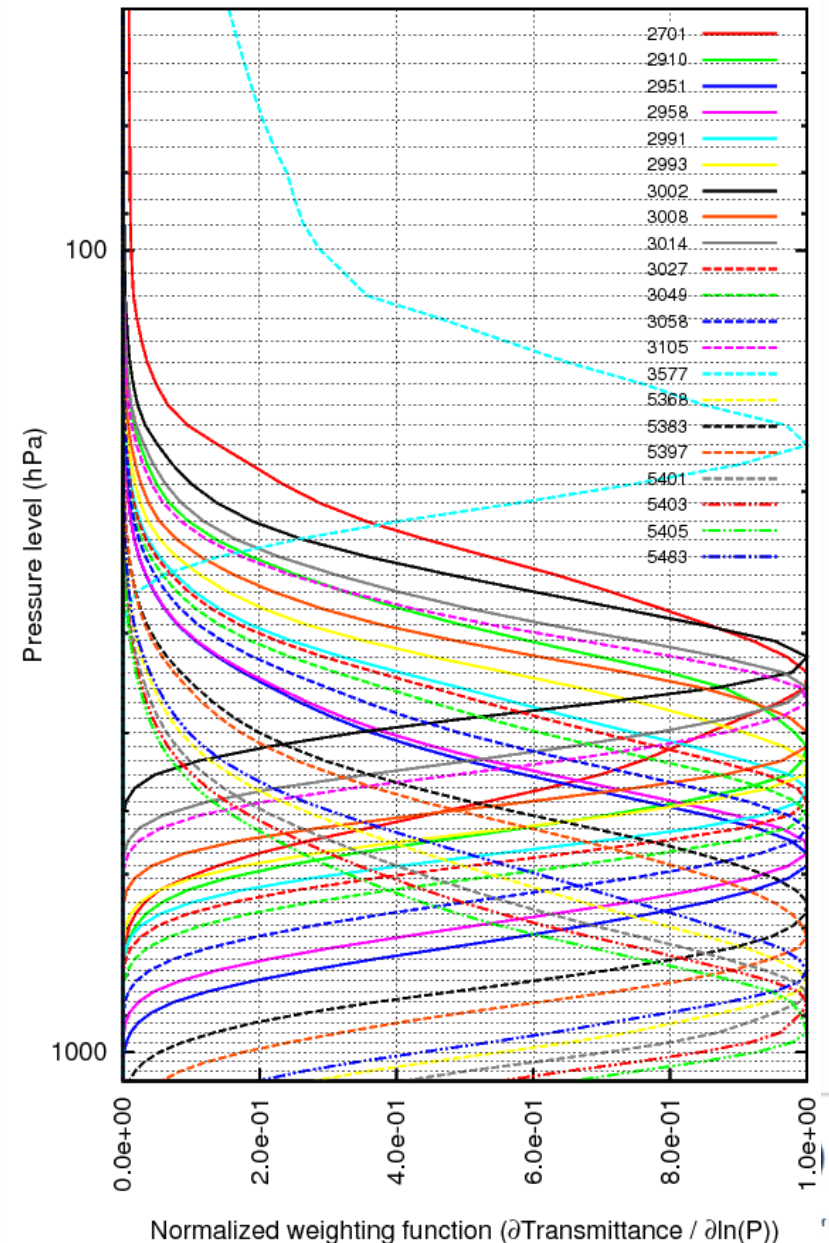
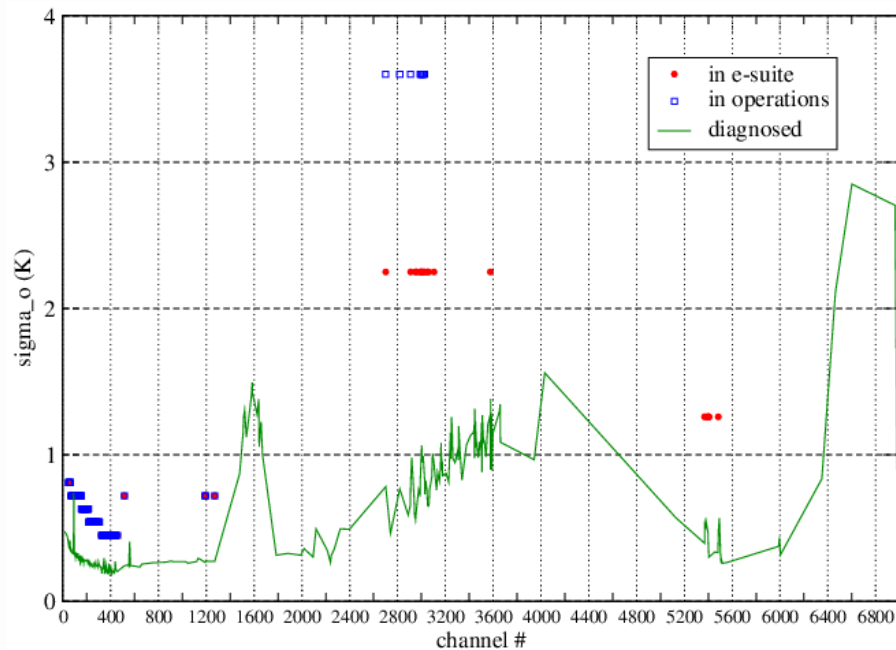
From 9 WV channels

To 21 WV channels only over sea

No inter-channel error
correlation is prescribed

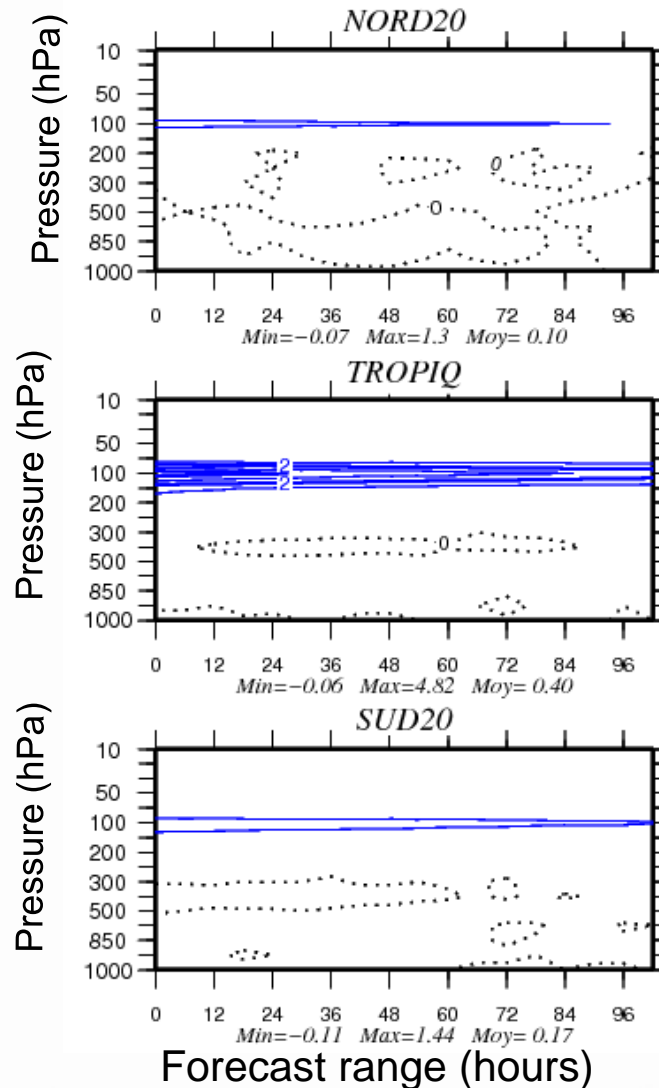
But observation error decreased

From 3.6 K to 2.25 K or 1.26 K



Towards assimilating more WV channels

Impact on forecasts – 41 cases (13/03/2012-23/04/2012)
Relative humidity wrt ECMWF analyses



Improvement of the forecast

RMSE of the humidity at
100 hPa at the 3 day
forecast range

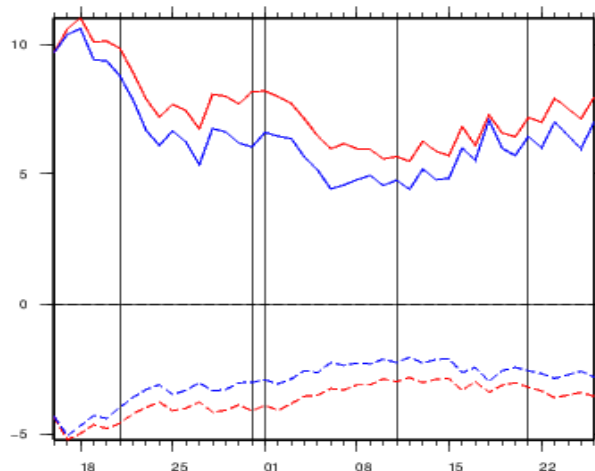
————— RMSE

- - - - - Bias

CONTROL

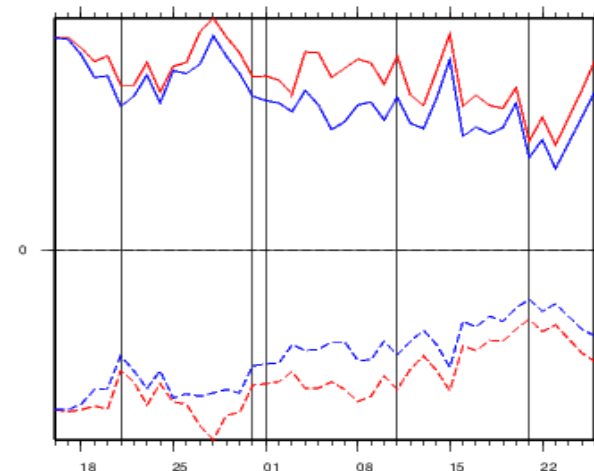
WV EXP

NORD20



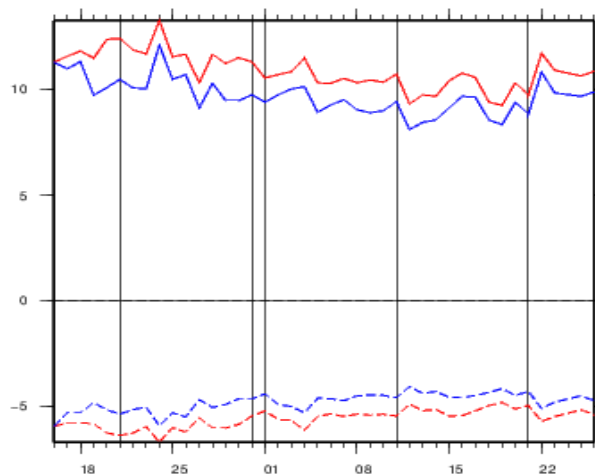
Moy Diff[Ref-Exp] : Bias = -0.70 Eqm = 1.04

EURATL



Moy Diff[Ref-Exp] : Bias = -0.28 Eqm = 0.29

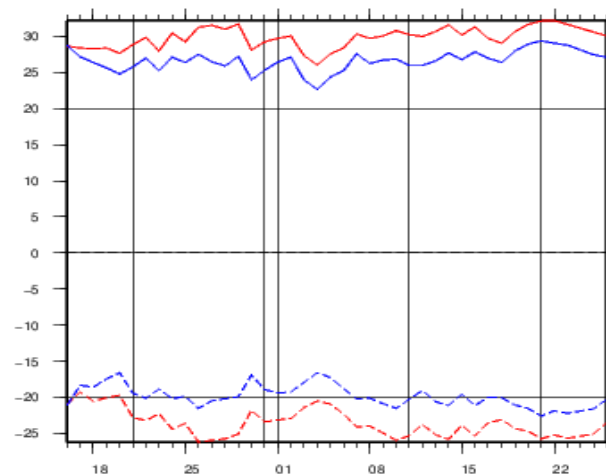
SUD20



15/03 26/3

Moy Diff[Ref-Exp] : Bias = -0.78 Eqm = 1.20

TROPIQ



Moy Diff[Ref-Exp] : Bias = -3.71 Eqm = 3.21

Time period

RMSE of Humidity at 24 and 96 hours

HUMIDITY forecast range: 24 Hours

(%)

41 simulations from 20120314 to 20120424

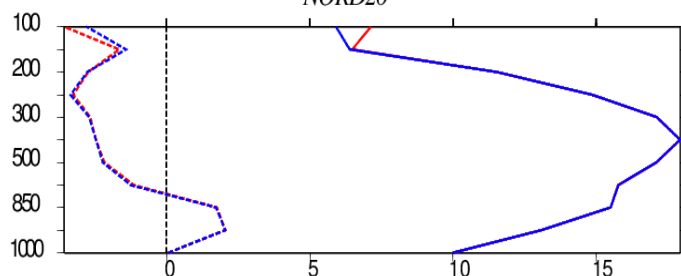
— RMSE CONTROL.r 00/AC

— RMSE EXP WV.r 00/AC

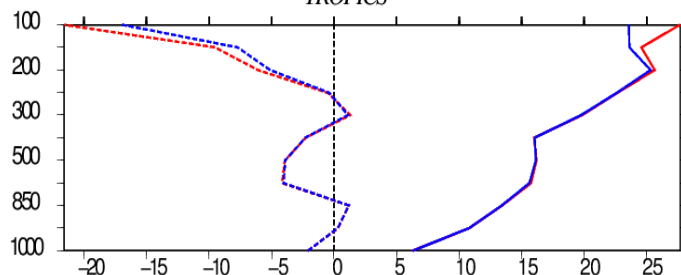
-- Bias CONTROL.r 00/AC

-- Bias EXP WV.r 00/AC

NORD20

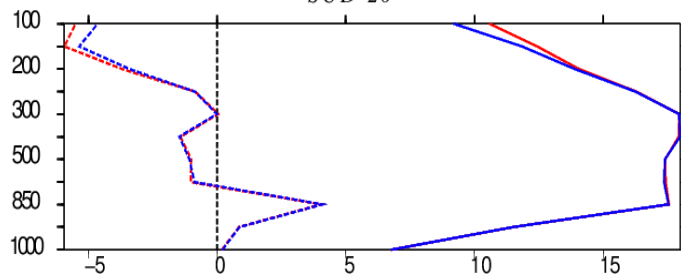


TROPICS



SUD 20

Pressure (hPa)



HUMIDITY 96 hour forecast range

(%)

41 simulations from 20120317 to 20120427

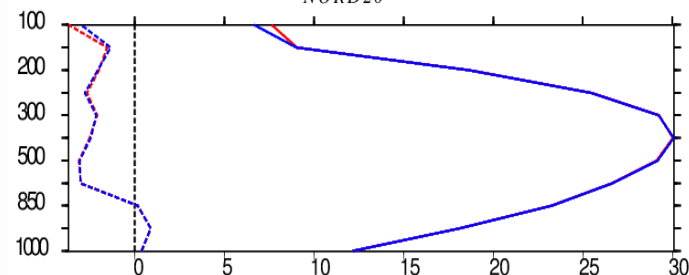
— RMSE CONTROL.r 00/AC

— RMSE EXP WV.r 00/AC

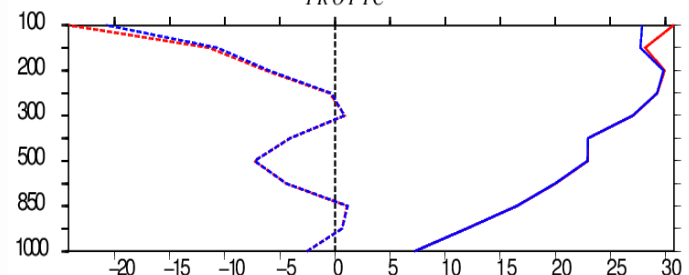
-- Bias CONTROL.r 00/AC

-- Bias EXP WV.r 00/AC

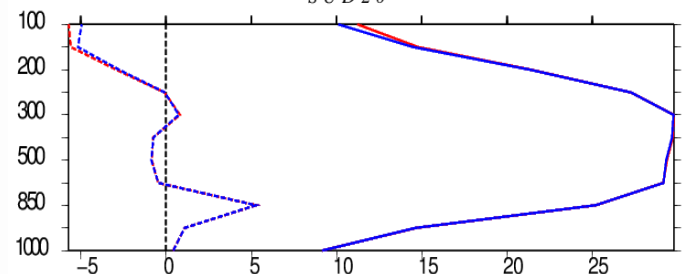
NORD20



TROPIC

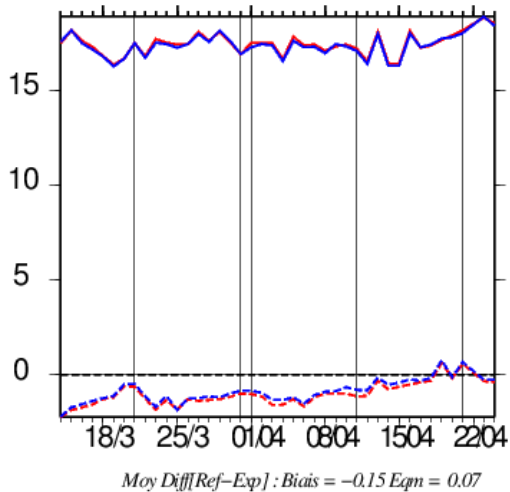


SUD 20

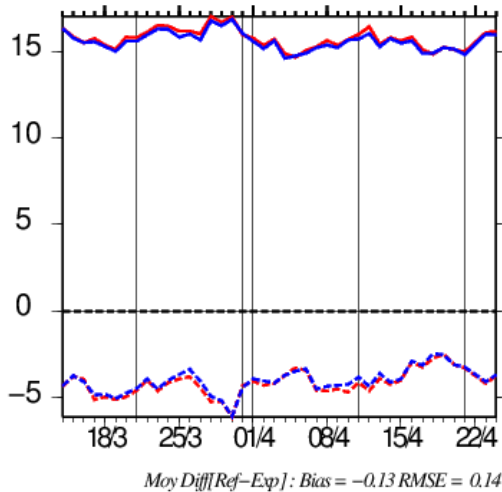


Humidity at 700hPa for the 24 hour forecast range wrt time

SUD 20



TROPICS



Smaller impact but still statistically significant

Information brought by microwave sounders

Bootstrap Statistical test

[illegible]

++ significant at 95% level

Error reduction from the observations: Introduction

Computation of the forecast sensitivity

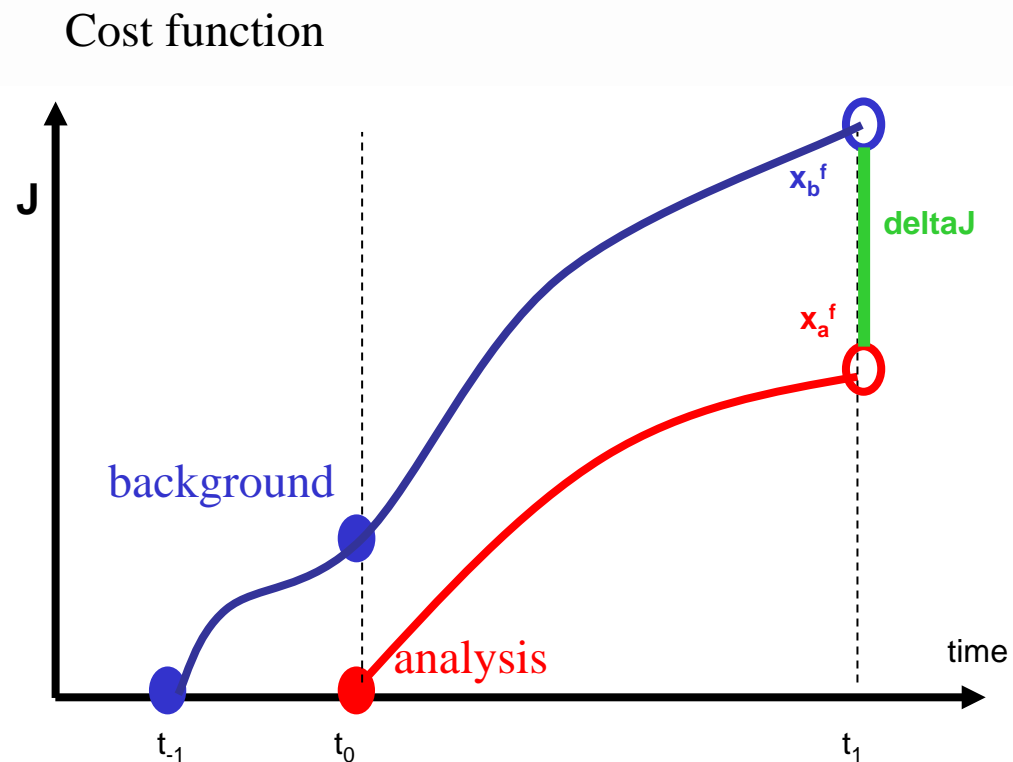
Implemented in IFS (ECMWF) by
C. Cardinali.

Use of the forecast model adjoint and
of the assimilation system adjoint

J : 3D dry total energy of the
difference between the 24 h forecast
and a reference (the analysis)

Observation impact:

$$\text{delta}J = \sum \left(\frac{dJ}{dy_i} \right) \times dy_i$$

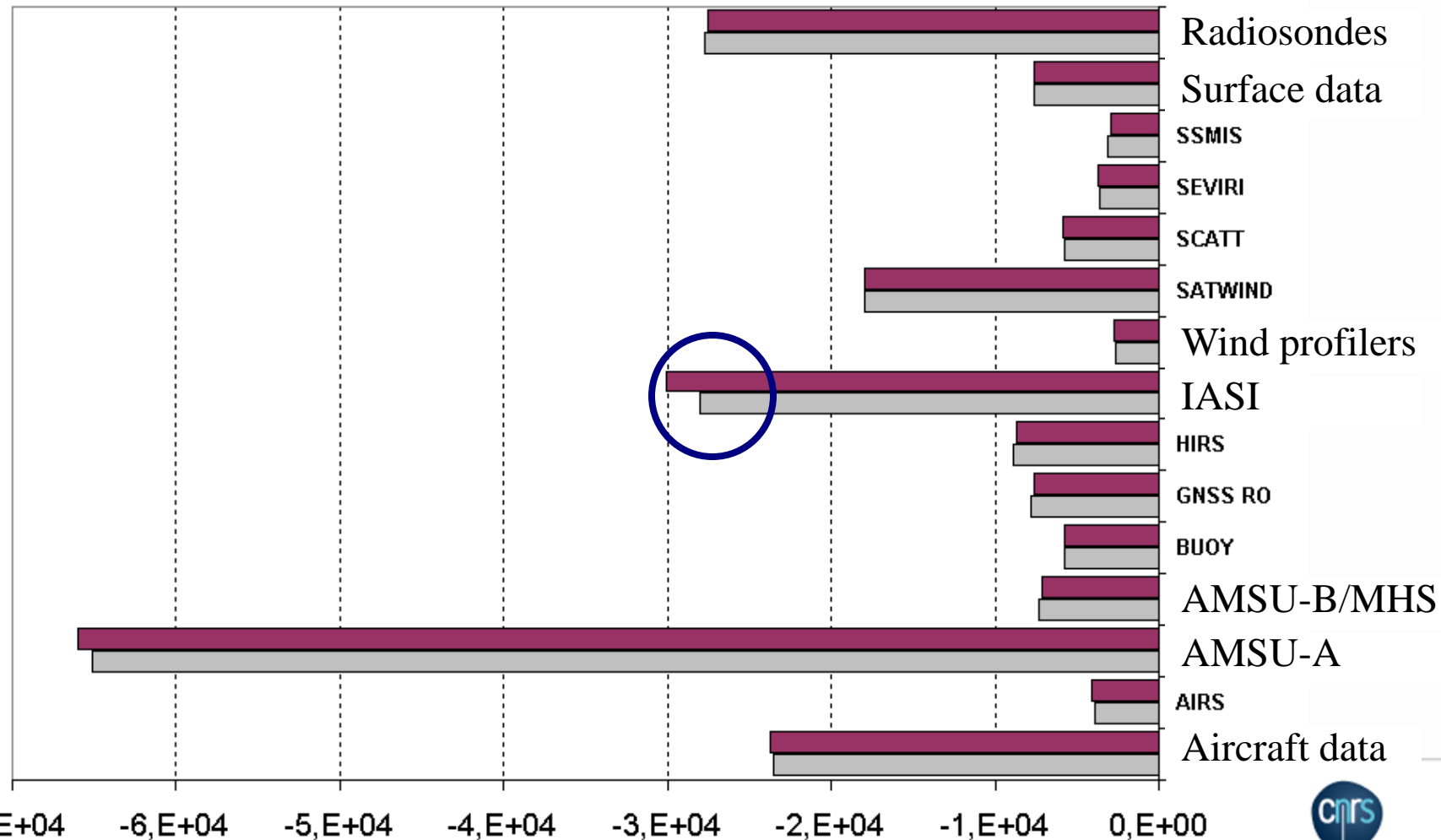


Error reduction from observations computed over a 3 week period

More WV IASI channels
CONTROL

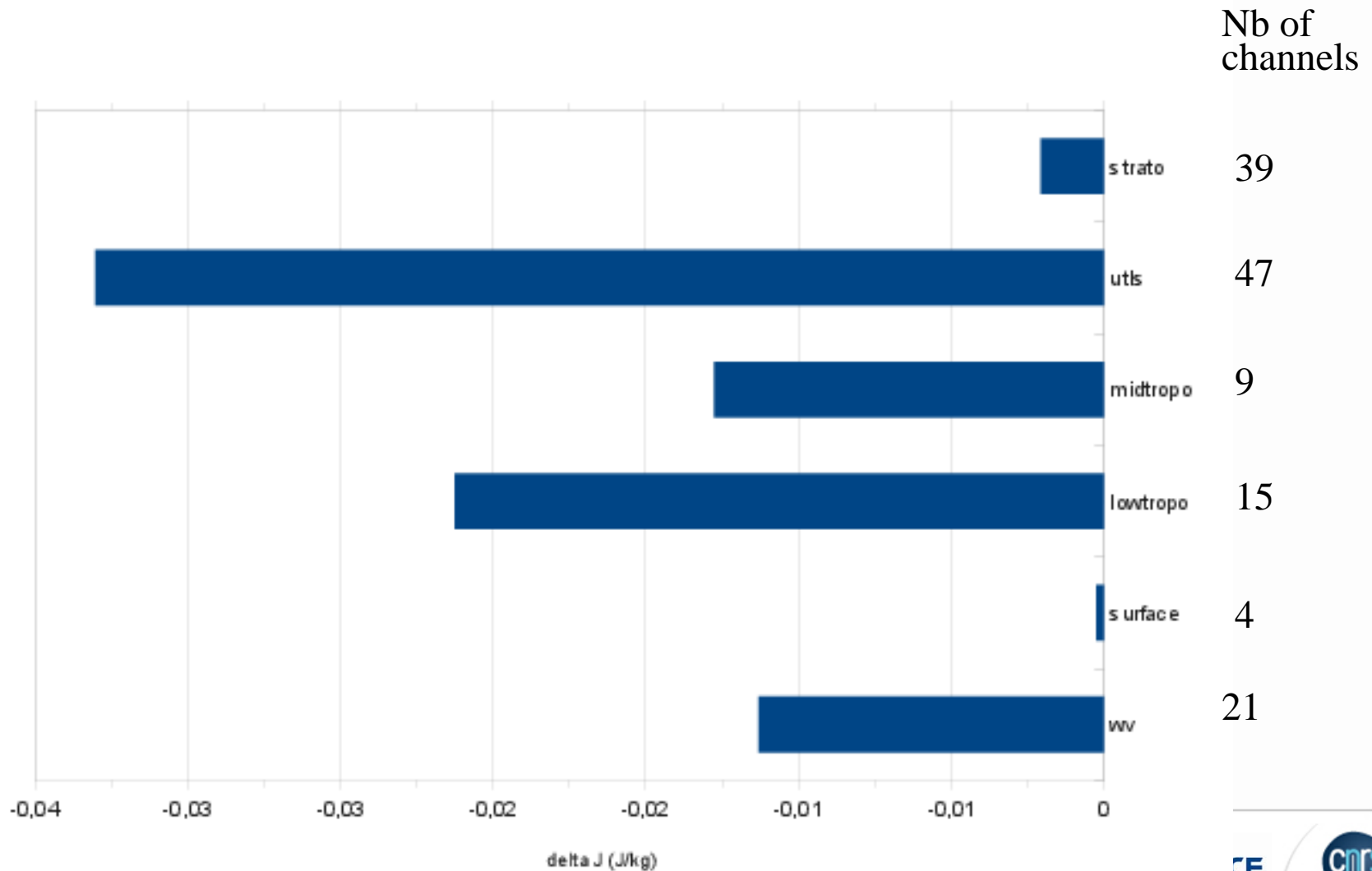
EXP
REF

B2KM : -221 kJ/kg
B2CR : -218 kJ/kg

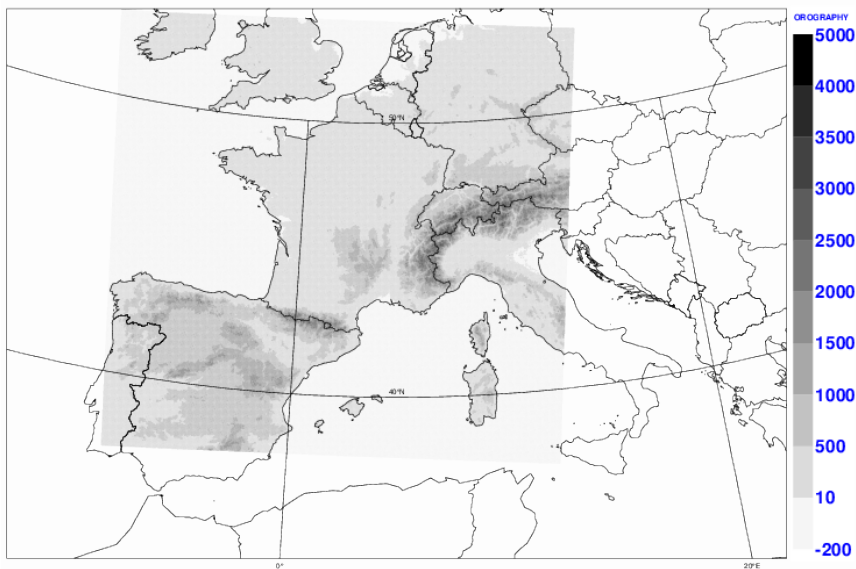


Error reduction from IASI observations computed over a 3 week period

Impact of IASI channels on the 24hour forecast error reduction

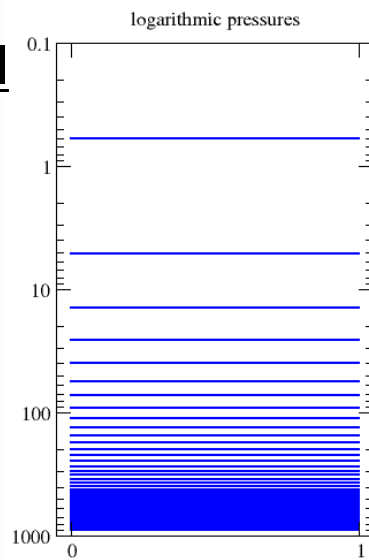


Assimilation of IASI in the convective scale AROME



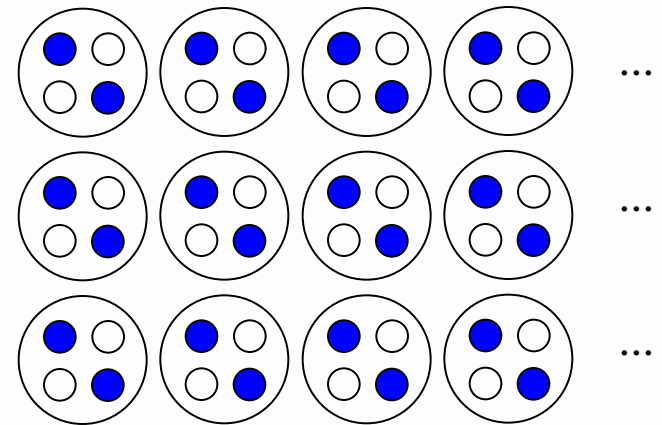
Limited area model AROME

2.5 km horizontal mesh
60 vertical levels



Limited area model AROME

Detectors #1 & #3, all FoR



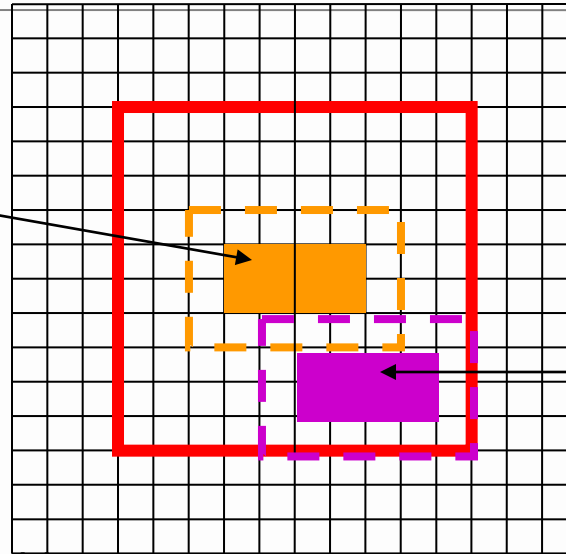
1 pixel in 80 km box

Similar channel selection
than ARPEGE

Brier Skill Score (with neighbouring distance)

Observation

Rain rate amount well
predicted but mislocated



Model

Example for a 10 mm rain threshold

$$BS_NO = \frac{1}{Nj} \sum_{j=1}^{Nj} \frac{1}{N_{obs}} \sum_{p=1}^{N_{obs}} \left(v_{prev}(rr > 10mm) - v_{obs}(rr > 10mm) \right)^2$$

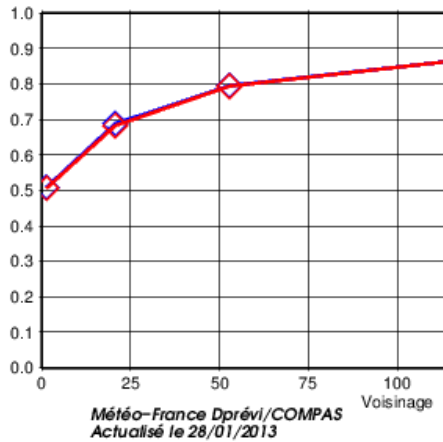
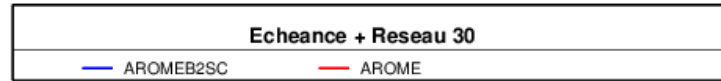
The Brier Score measures the quadratic difference between the predicted frequency and the observed frequency over a « neighbouring » area

$$BSS_NO = 1 - \frac{BS_NO}{BS_NO_{pers}}$$

Normalization with the persistence score => The inter-annual variability is taken into account

Impact on the 24h rain rate forecast Brier skill score

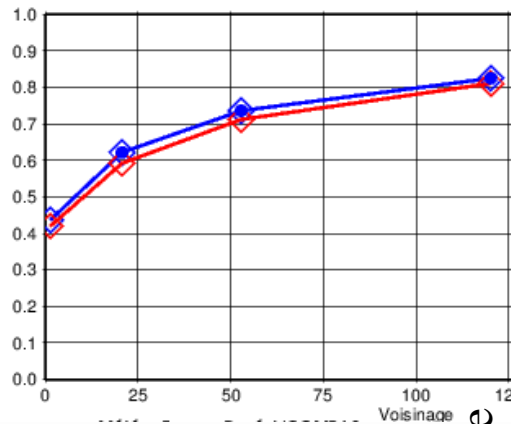
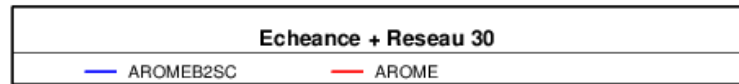
Threshold 5 mm/24 h



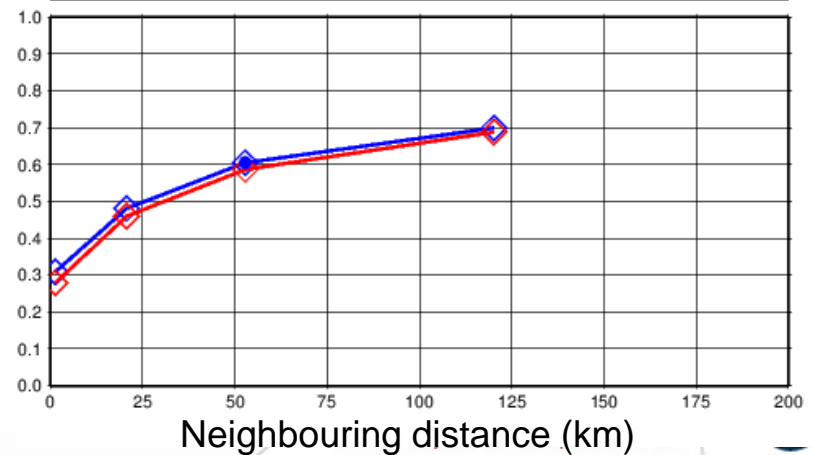
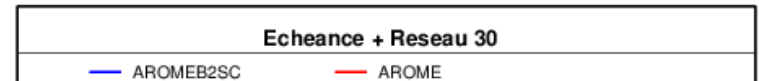
AROME WV

CONTROL

Threshold 10 mm/24 h



Threshold 20 mm/24 h



Brier Skill Score

Neighbouring distance (km)

Conclusions and further work

- Increase of number of assimilated WV IASI channels in the NWP models ARPEGE and AROME
- Large positive impact from a upper troposphere-lower stratosphere channel
- Positive impact of the IASI water vapour channels
 - In the global model up to 96 hour forecast range
 - Improvement of the humidity, temperature and geopotential height at around 100 hPa
 - Small positive impact at 700 hPa
 - In the convective scale model, positive impact in the rain rate forecast.
 - In the next e-suite

Study of the assimilation of the UTLS WV channel over land.

Humidity analysis increment cut at 100 hPa, to be further evaluated with information brought by IASI and other satellite sounders.

An aerial photograph of a mountain town, likely in the French Alps, is shown. The town is nestled in a valley, surrounded by steep, forested slopes. A dense layer of white clouds or fog fills the lower part of the image, partially obscuring the town and the surrounding landscape. Overlaid on the bottom left of the image is a white weather map. The map features contour lines with numerical values such as 1010, 1015, 1020, 1025, 1030, 1035, 1040, and 1045. It also includes symbols for wind direction and speed, represented by arrows and small circles. The background of the entire slide is a deep blue gradient.

Thank you for listening !



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