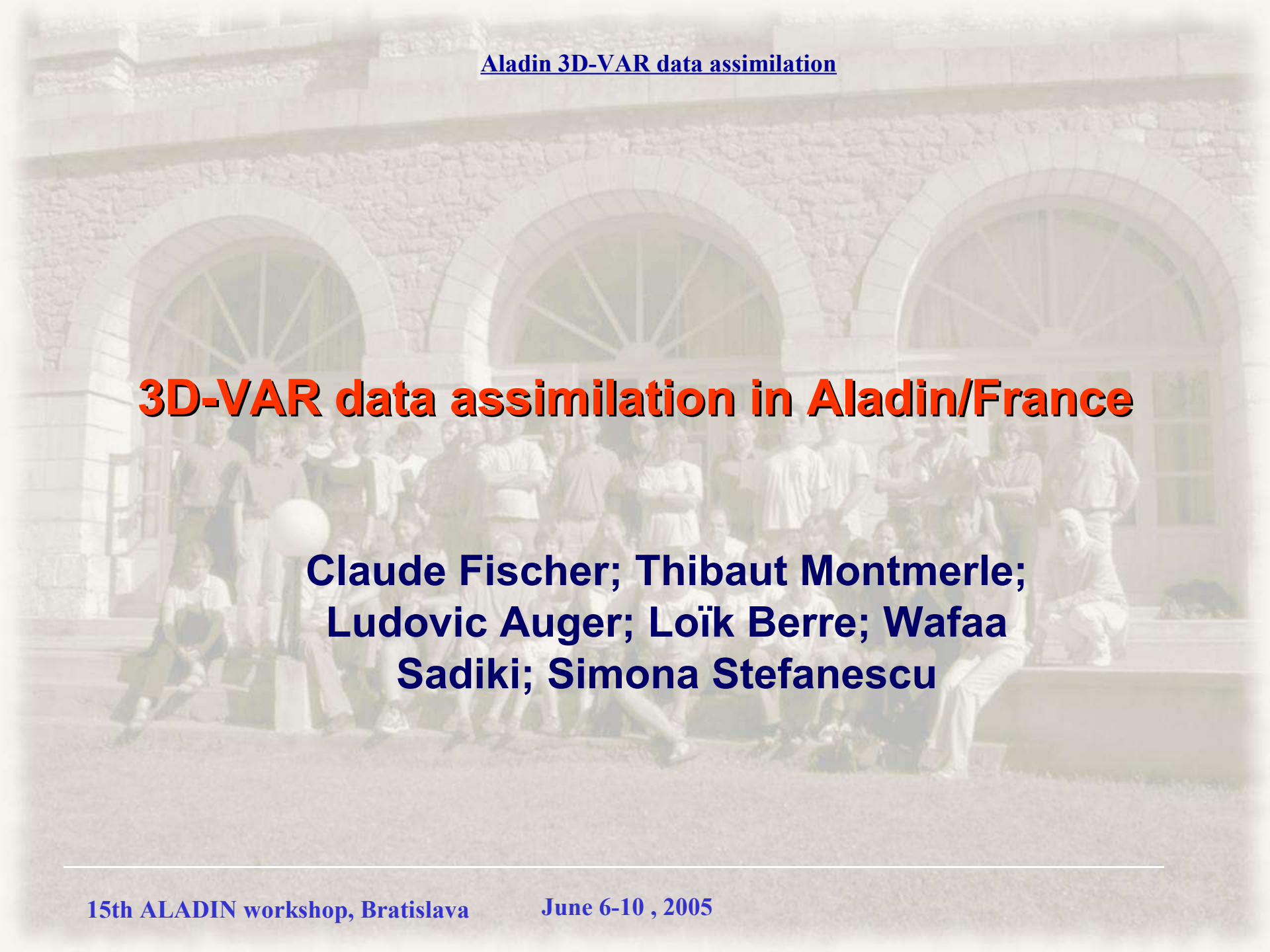


3D-VAR data assimilation in Aladin/France

Claude Fischer; Thibaut Montmerle;
Ludovic Auger; Loïk Berre; Wafaa
Sadiki; Simona Stefanescu

What is in it ?

- Incremental 3D-VAR, using 80-90 % of the common Arpège/IFS code
- Continuous assimilation cycle, 6 hour frequency, long cut-off assimilation cycle and short cut-off production, coupled with Arpège, Analysis=Model gridmesh=9.5 km
- Observations:
  - Surface pressure, SHIP winds, *synop T2m and RH2m*
  - Aircraft data
  - SATOB motion winds
  - Drifting buoys
  - Soundings (TEMP, PILOT)
  - Satellite radiances: AMSU-A, AMSU-B, HIRS, *Meteosat-8 SEVIRI*
  - *No QuikSCAT*

Ensemble B matrix

- Background error covariances are sampled from an ensemble of Aladin forecasts, with initial conditions from an ensemble of Arpège analyses: « ensemble Jb »
- Sample: over 48 days, two pairs of 6 hour forecasts are extracted from the ensemble, and their difference is computed => 96 elements in the sample
- Berre etal. (2005) and Stefanescu etal. (2005)
- Total error variance is calibrated a posteriori (empirically for the time being), later using the works of B. Chapnik and W. Sadiki (evaluation of *Tr(HK)*) => inflate background standard deviations by a factor of 1.8 *(1.5)*

Tuning of background and observation error variances

- **Desroziers and Ivanov, 2001:**

  (So, Sb) ? ➔

$$\begin{cases} S_o(s_o, s_b) = \dfrac{2E(J_o^{\min})}{Tr(I_p - HK)} \\ S_b(s_o, s_b) = \dfrac{2E(J_b^{\min})}{Tr(KH)} \end{cases}$$

  - **For a consistent system ⏭ So = Sb = 1**

- **For a LAM system:**

  Sadiki and Fischer, Tellus, 2005

  Chapnik etal., QJRMS, 2004

  - **How to compute the Trace ? -> Monte-Carlo method (Girard, 1987)**
  - **How to compute the statistical expectation ? -> use a time mean over a suitably long range**
  - **Samples of small size -> aggregate analysis times together**
  - *Applied to the NMC statistics*

Sensitivity experiments

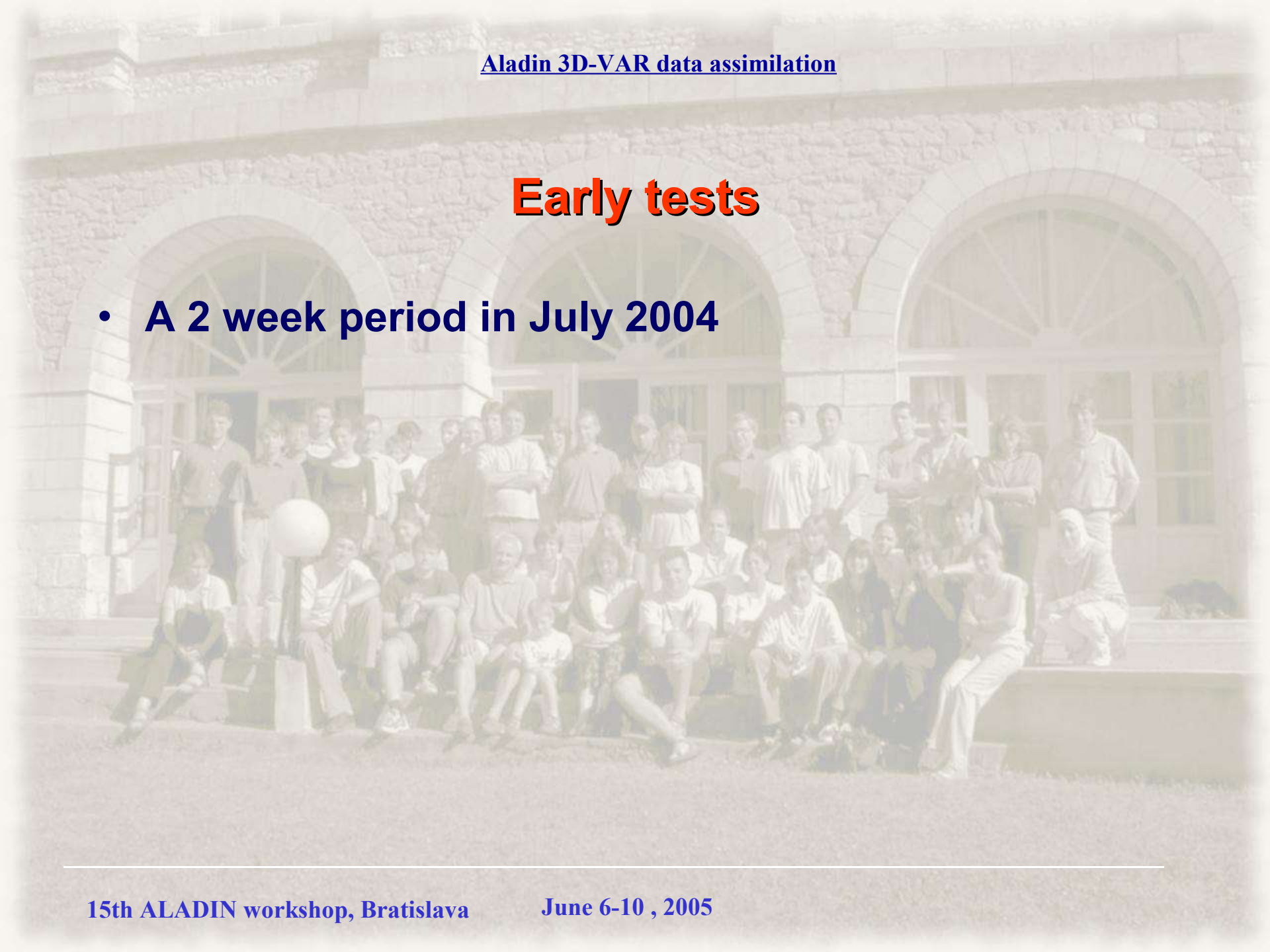
⇨ 3d-Var ARPEGE

$$S_o = 0.8 < 1$$

3d-Var ALADIN experiments over 1 month	S_o	S_b
NMC-lagged background=P06H	0.86 < 1	1.67 > 1
Standard NMC statistics	0.6	0.53
Ensemble statistics	---	1.44 (by comparison with NMC)

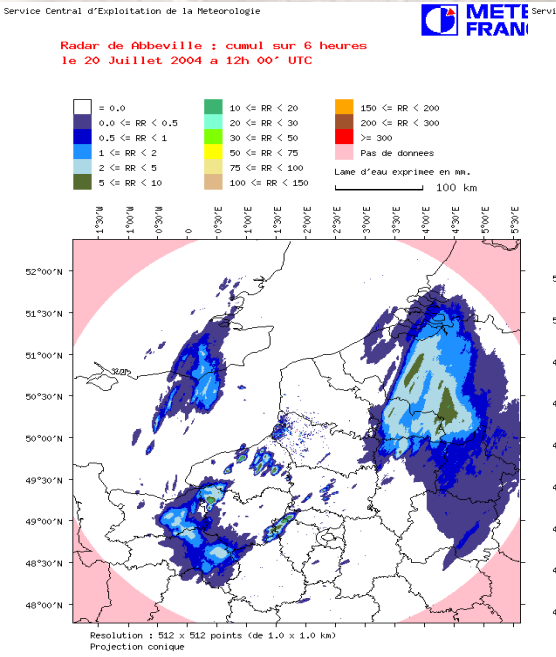
Early tests

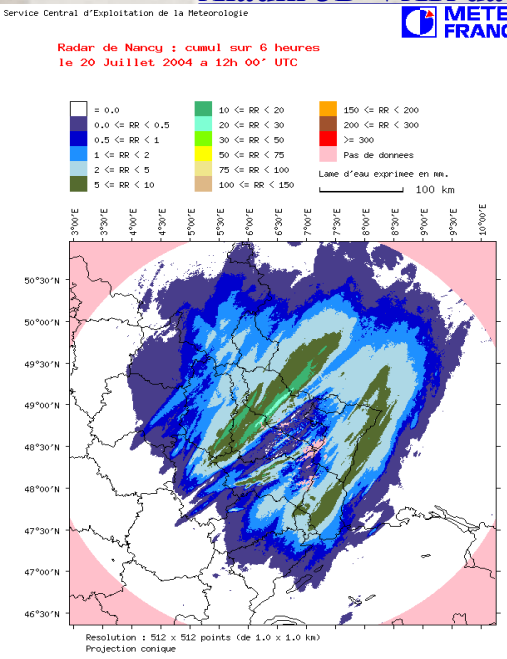
- A 2 week period in July 2004

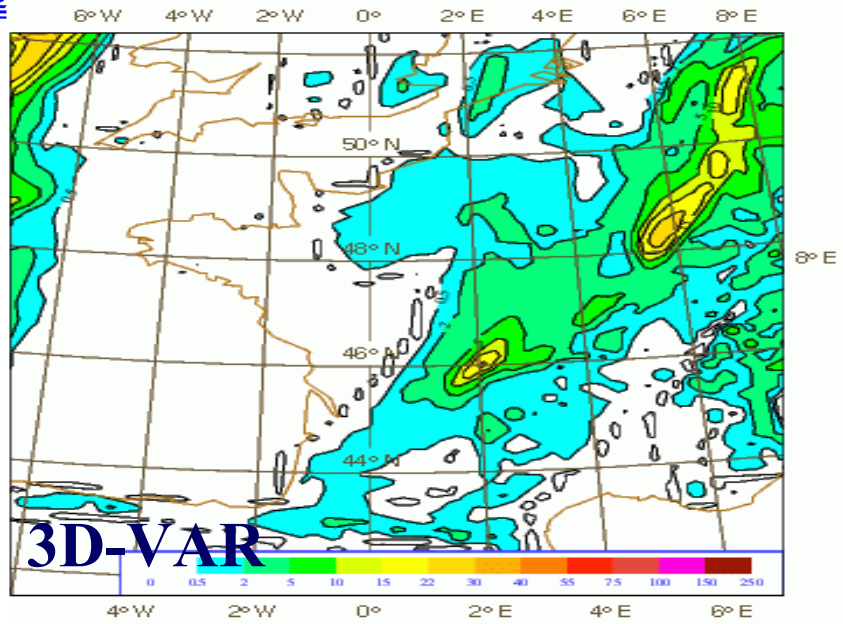


20/07/04 RR (P12-P6)

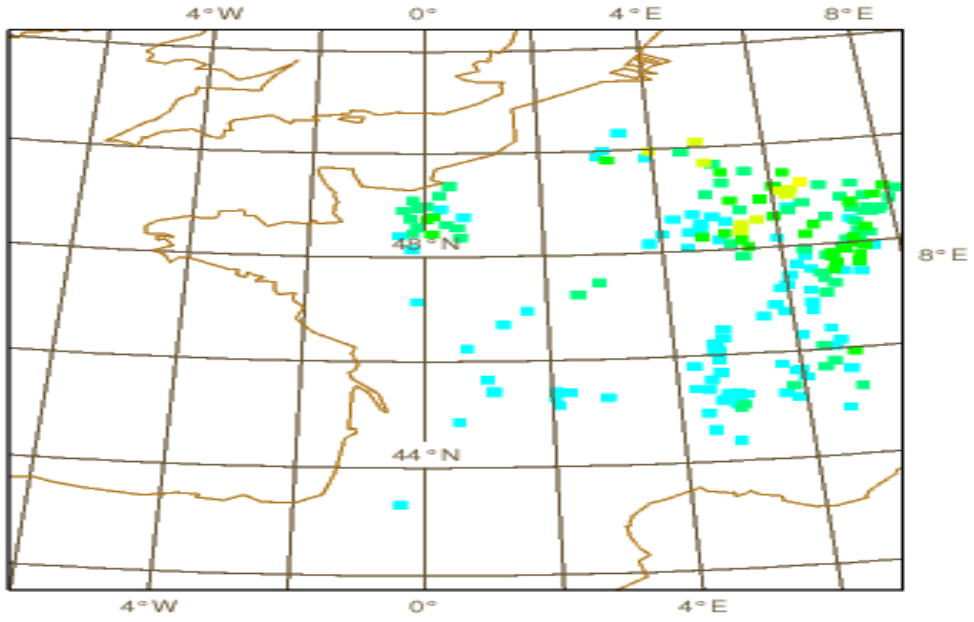
Aladin 3D-VAR data assimilation

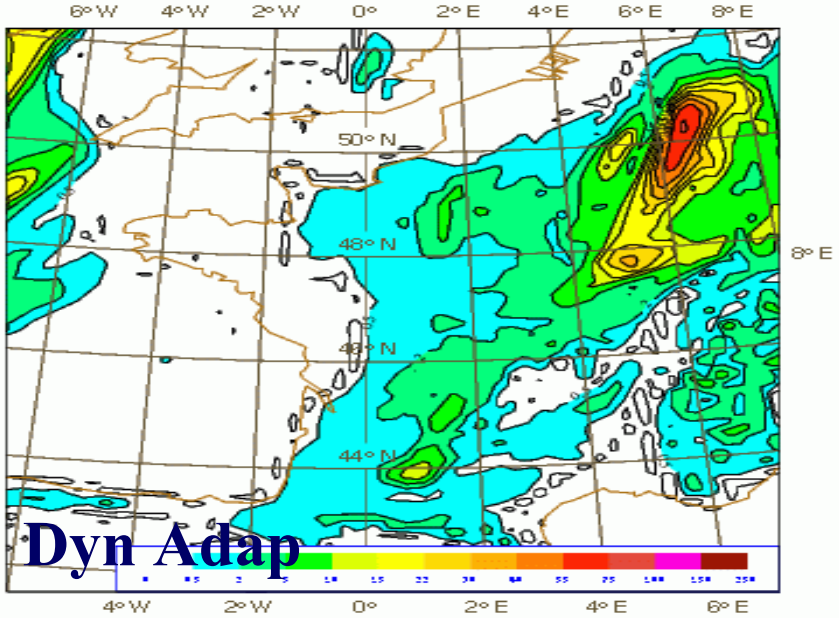






0 - 0.5 0.5 - 2 2 - 5 5 - 10 10 - 15





Lessons:

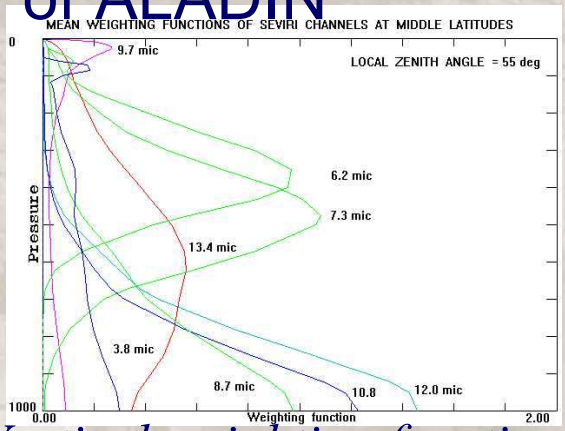
- **Precipitations:**
  - **[0,3h] => *caution* (impact of initialisation, of imbalances …);**
  - **[3,12h] => the assimilation cycle(s) produce their own solution, which compares competitively with dynamical adaptation (to be confirmed by ongoing E-suite!);**
  - **[12,24h] => a limit of predictability somewhere in this range ??**
  - **RMS(Dyn Adap – 3DVAR) for 6 hour precipitation (mm/6h), for three days of the test period:**

	07/07	08/07	22/07
P12-P6	2.32	2.08	1.75
P24-P18	1.37	1.44	1.10

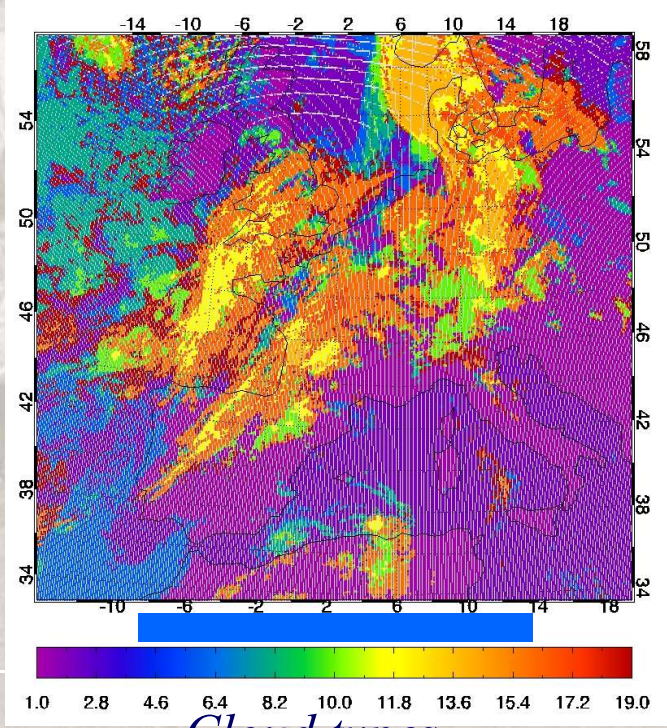
Use of Météosat-8/SEVIRI in the 3DVar of ALADIN

Data processing :

- 1 pixel out of 5 is extracted and thinning boxes of 70 km are applied
- IR 3.9 μ and ozone 9.7 μ are blacklisted, *as well as IR channels over land*
- constant, uniform bias correction applied to the other channels, *recently changed to a predictor, case-dependent b.c.*
- empirical σ_o are used
- first-guess quality control removes too large innovations
- CMS/Lannion cloud classification is used to keep IR 8.7 μ , 10.8 μ ,12 μ and 13.4 μ only in clear sky while the two WV channels are also kept over low clouds



Vertical weighting functions

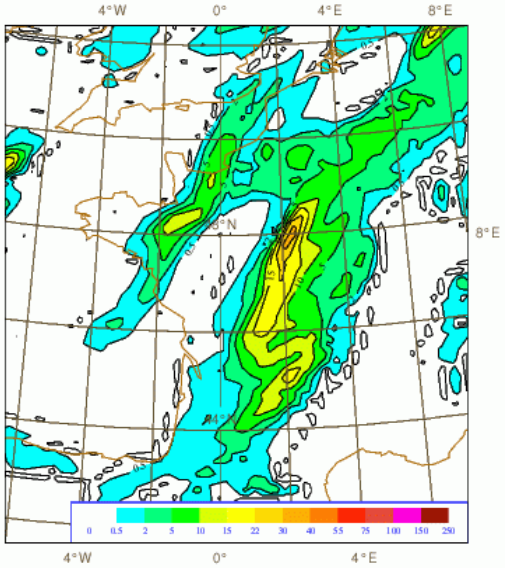


Cloud types

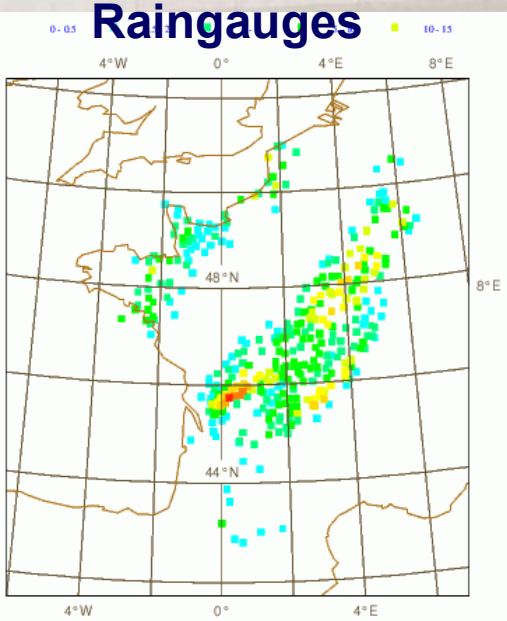
Impact study :
Precipitation forecast

2004/07/18 12UTC
RR P12 – P6

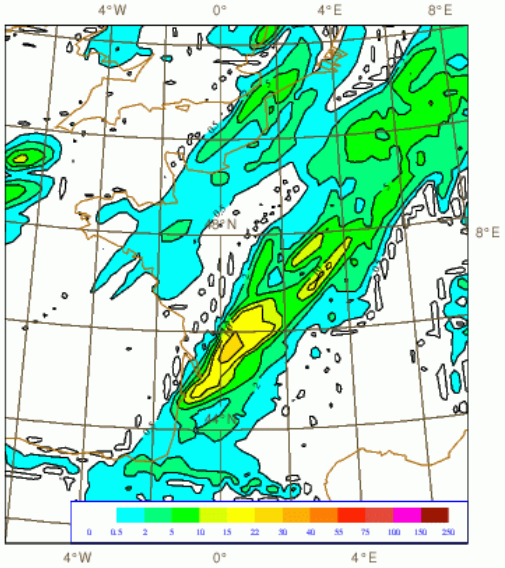
Dyn. Adapt.



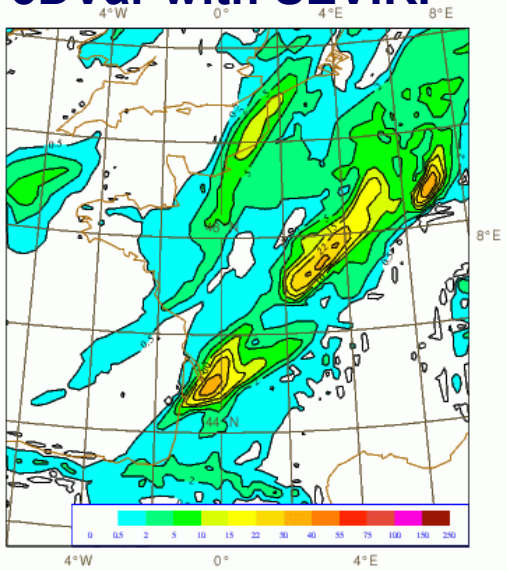
Raingauges



3DVar



3DVar with SEVIRI



E-suites: V1 and V2

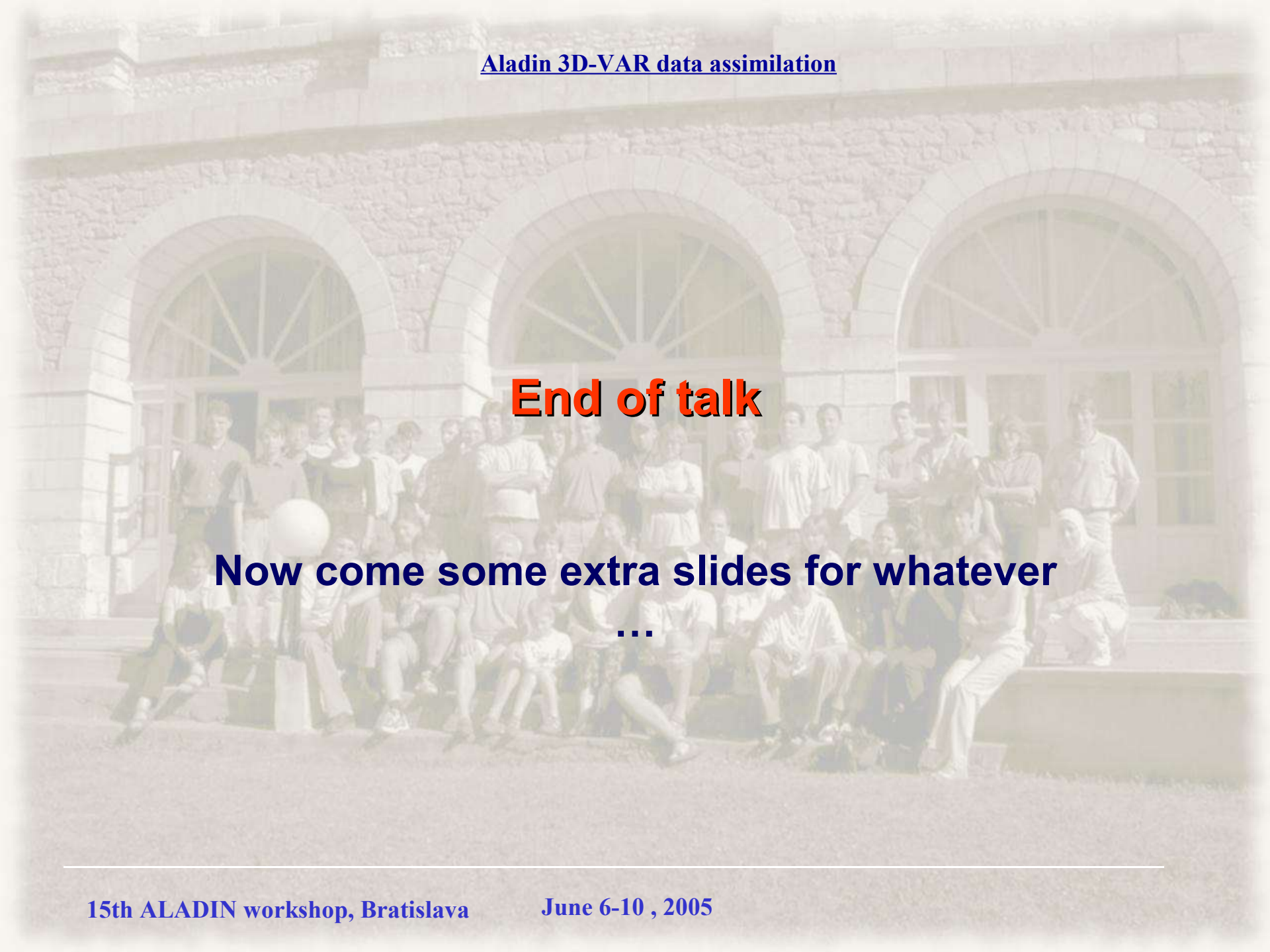
- V1: 23 March through 22 May, 2005 =>
  - Deteriorated MSLP bias and RMS by about 0.2 hPa
  - Too strong precipitation amounts at short range (6h, 12h), with significant spin-down
  - Analyses too wet compared to RS
  - No increase in the number of « Aladinades » (which is a relief, given the problems on humidity and RR)
- *V2*: started 2nd of June, scheduled for about 1.5 month
  - Improved SEVIRI bias correction, using a case/location-dependent b.c. (with 4 predictors)
  - Infrared channels over land blacklisted (problem of poor quality surface temperature)
  - Additional surface observations ready: T2m, RH2m => quite complementary with SEVIRI data
  - Digital filter initialization: back to settings from dynamical adaptation
  - Reduced weighting of Jo with respect to Jb: Sb decreased from 3.24 to 2.25

In the near future

- 3D-VAR FGAT
- non-linear balance, β-plane
- *Jk* extra cost function to fit towards the ARPEGE analysis
- « new » humidity control variable
- Better understand the intrication between digital filter initialization, coupling and B-matrix dynamical balances
- Innovating observations for the mesoscale: sampling of satellite data, QuikSCAT, V10m, radar reflectivity
- Applications in AMMA, Arome
- Code convergence with the Hirlam group: mesoscale multi-incremental 4D-VAR (?)
- Next 4 year mid-term Aladin scientific plan

Aladin collaboration

- Aladin-NORAF (Casablanca): internal E-suite runs daily
- Aladin-Hungary: operations since 17 May 2005
- Cross-border scientific activities:
  - LAM wavelets (A. Deckmyn & L. Berre)
  - LAM ensemble B statistics (S. Stefanescu & L. Berre)
  - AD model development (C. Soci, C. Fischer)

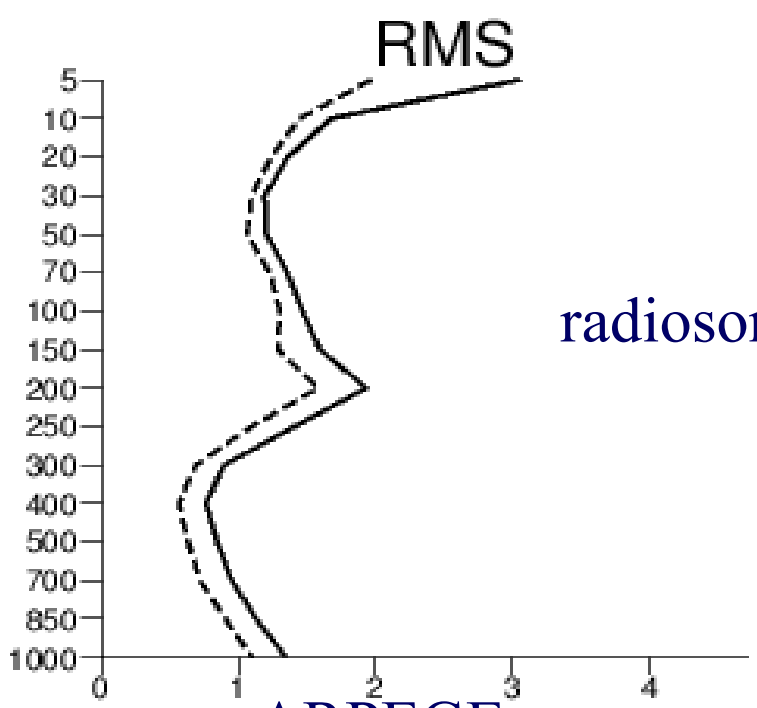


End of talk

Now come some extra slides for whatever …

Statistics in the space of observations

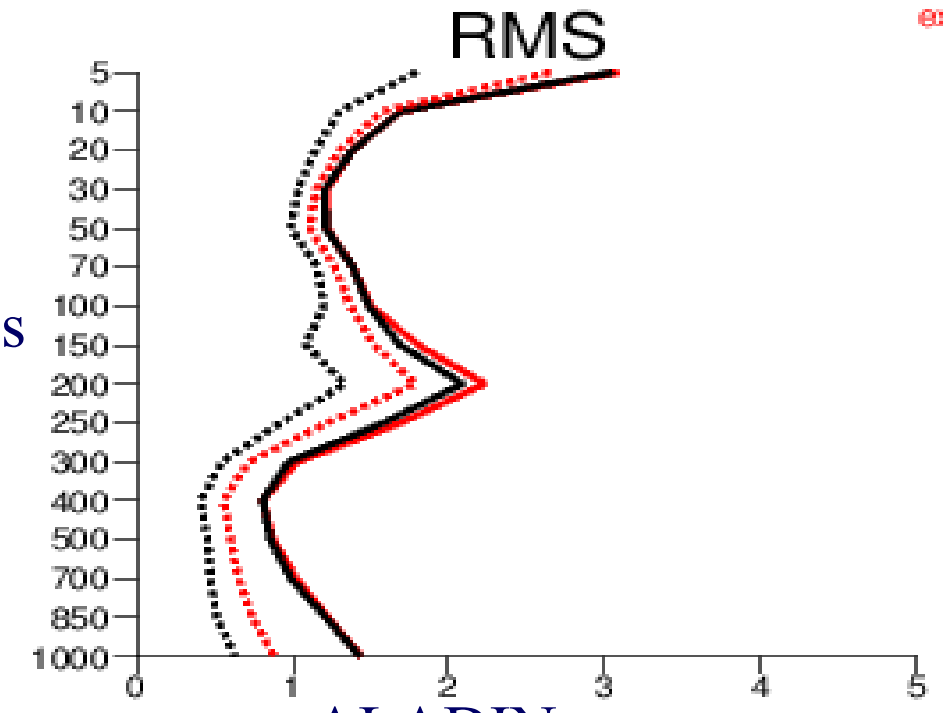
exp:OPER obstat 2004070600-200
RAOB-T Aladin
used T any instrument



ARPEGE
4D-VAR

radiosondes

exp:304l obstat / ref: 20WY 2004070600-
RAOB-T Aladin
used T



ALADIN
3D-VAR

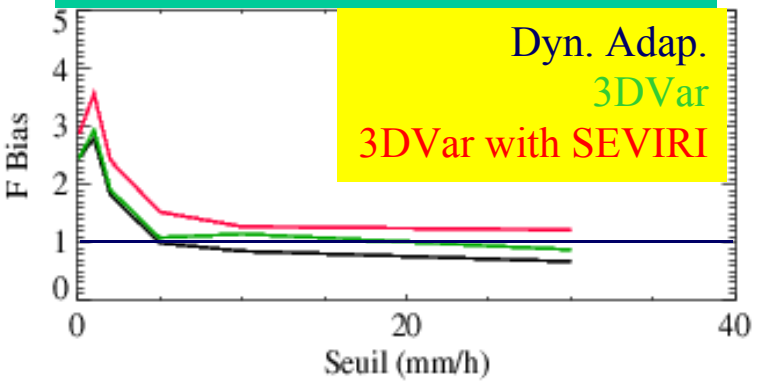
ATOVS channels

Scores QPF: raingauges ⇔P12-P6

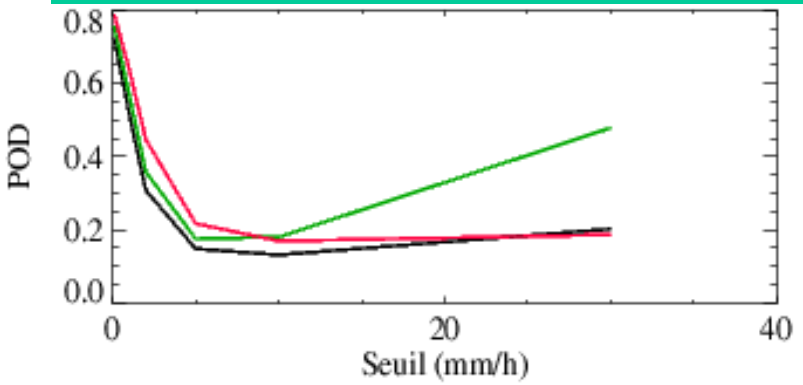
5 through 23 July 2004

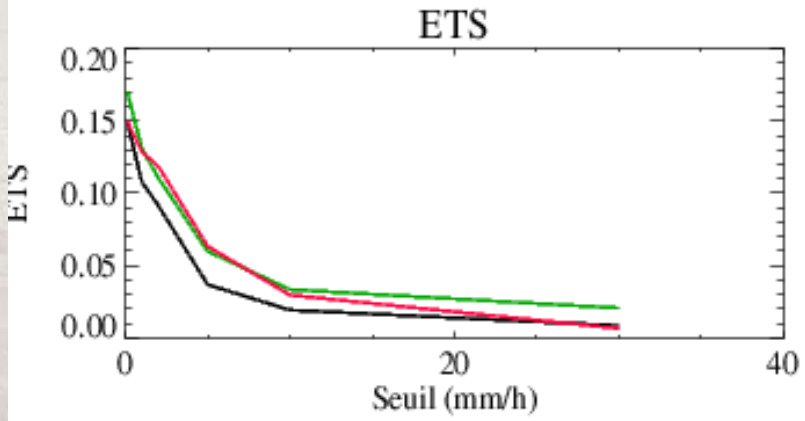
Aladin 3D-VAR data assimilation

Freq. Bias = (Nb simu >x) / (Nb Obs >x)

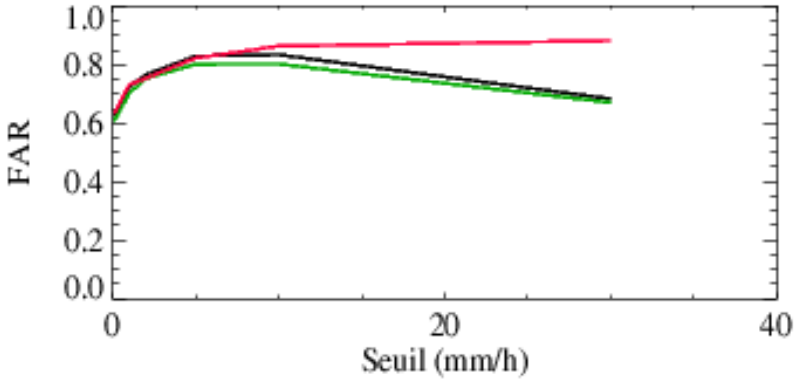


POD = (Nb simu >x & Nb Obs >x) / (Nb Obs >x)





FAR = (Nb simu surestimées) / (Nb simu >x)

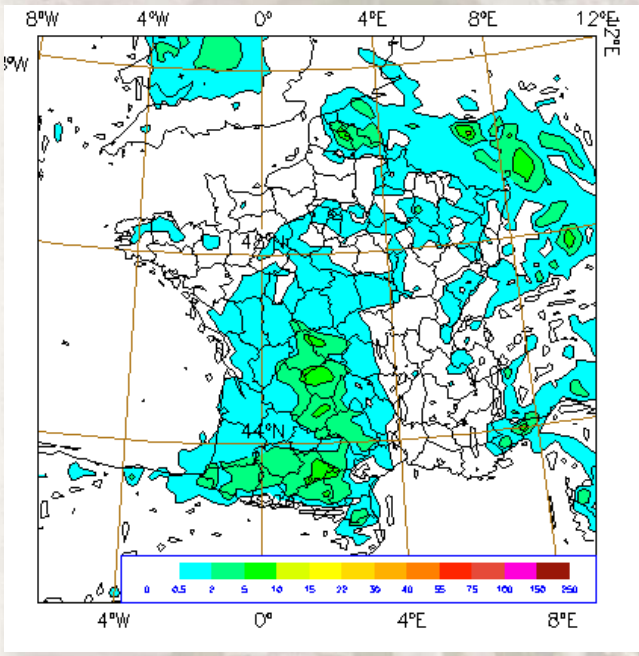


With SEVIRI : better POD and ETS, but bigger biases, especially for small thresholds

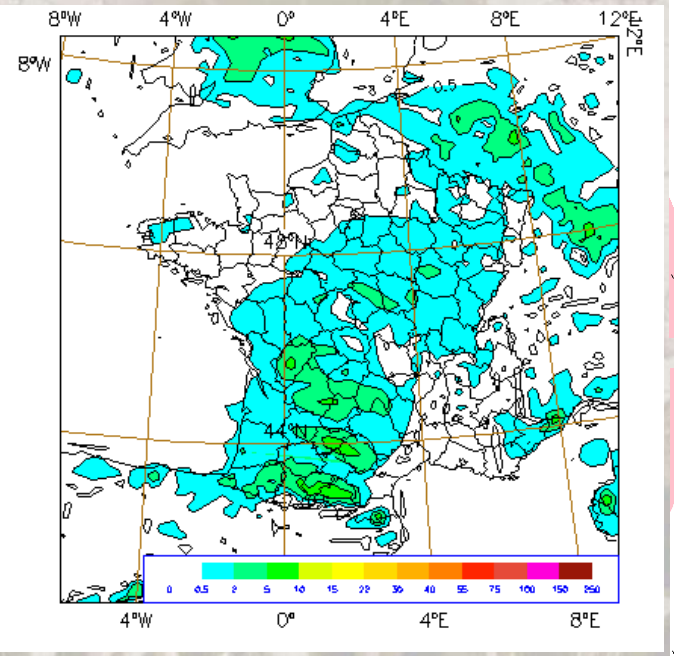
⇒ possibly due to vertical propagation of increments

⇒ Use surface data to counter this bias ?

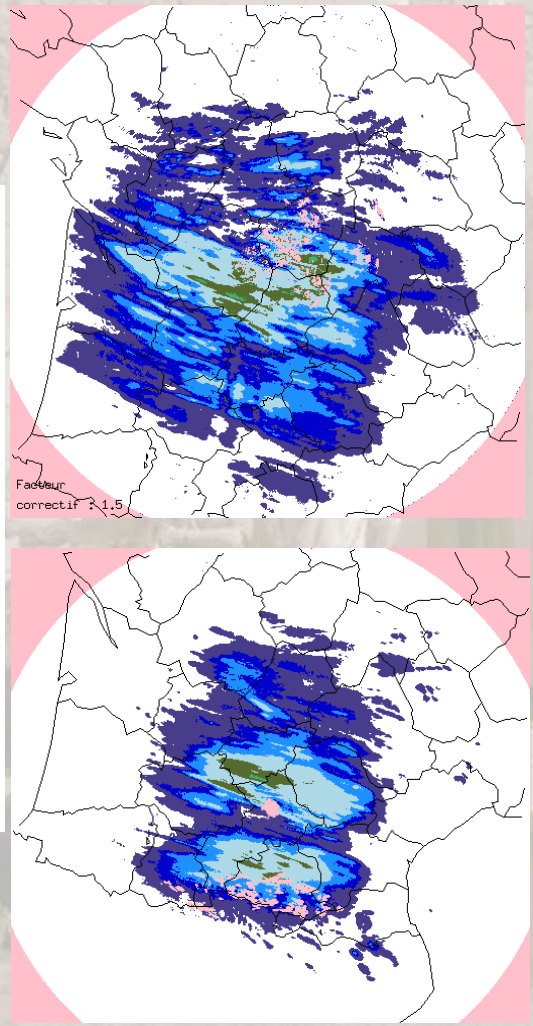
2005/03/30 12UTC
RR P12 – P9



ALD oper



ALD dbl



Radar cumulated RR