

Daily precipitation analysis by optimum interpolation using high-resolution background and rain gauge data

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Aladin-Hirlam All Staff Meeting, Bucharest, 7-10 Apr 2014



METEO FRANCE
Toujours un temps d'avance

Outline

- MESCOAN System
- Precipitation Analysis in MESCOAN
- System Validation
- Outlook



MESCAN/ CANARI system

MESCAN refers to the developments carried out under the framework of the EURO4M project (www.euro4m.eu) that concern:

- **MESan** error statistics and structure function for T2m and RH2m coded into **CANari** system.

More infos:

- Häggmark et al, 2000, Tellus, 52A
 - deliverable D2.6 of EURO4M
-
- Precipitation analysis in CANARI



Analysis of accumulated precipitation in 2 options

1) Analysis in physical space (MESCAN-RR)

Variable: RR

Hypothesis:

$$RR \sim N(0, \sigma)$$

Error statistics: $\sigma_o=5$, $\sigma_b=13$, $L=35\text{km}$
[as in SAFRAN]

2) Analysis in log-space (MESCAN-log)

Variable: $\ln(RR+1)$

Hypothesis:

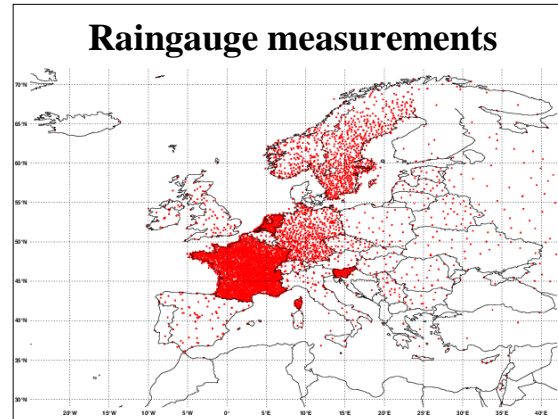
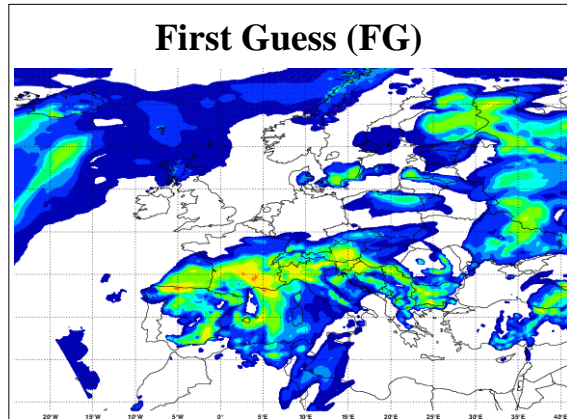
$$RR \sim LN(0, \sigma_1) \rightarrow \ln(RR) \sim N(0, \sigma_2)$$

Error statistics: $\sigma_o=0.6$, $\sigma_b=0.71$, $L=43\text{km}$
[after Mahfouf *et al.*, 2007]

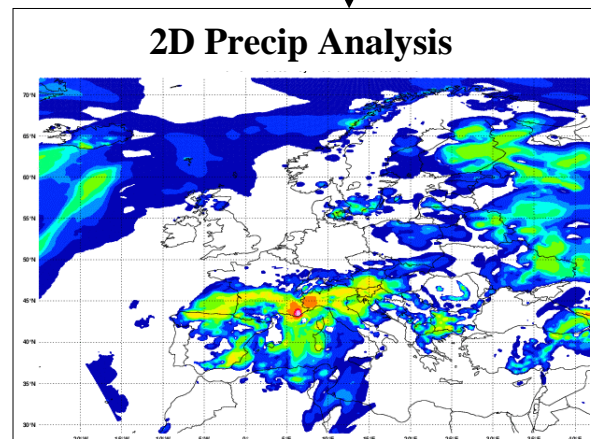
- **Correlation function, same for both options:**

$$Cor(r) = \left(1 + \frac{r}{L}\right) \cdot e^{-\frac{r}{L}}$$

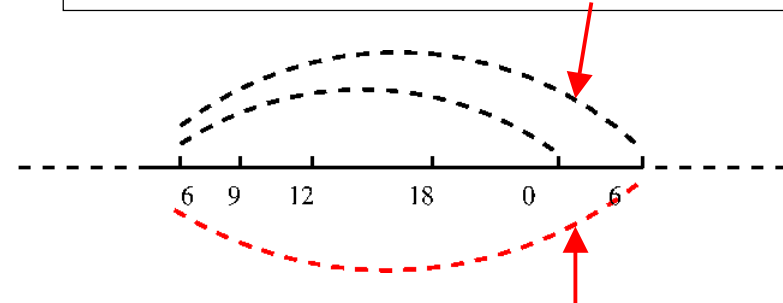
Sequence of steps in producing 2D precipitation analysis



**OI MESCAN
(CANARI) system**



NB: accumulated forecasted RR ...



**... and in-situ measured RR
must be on the same period**

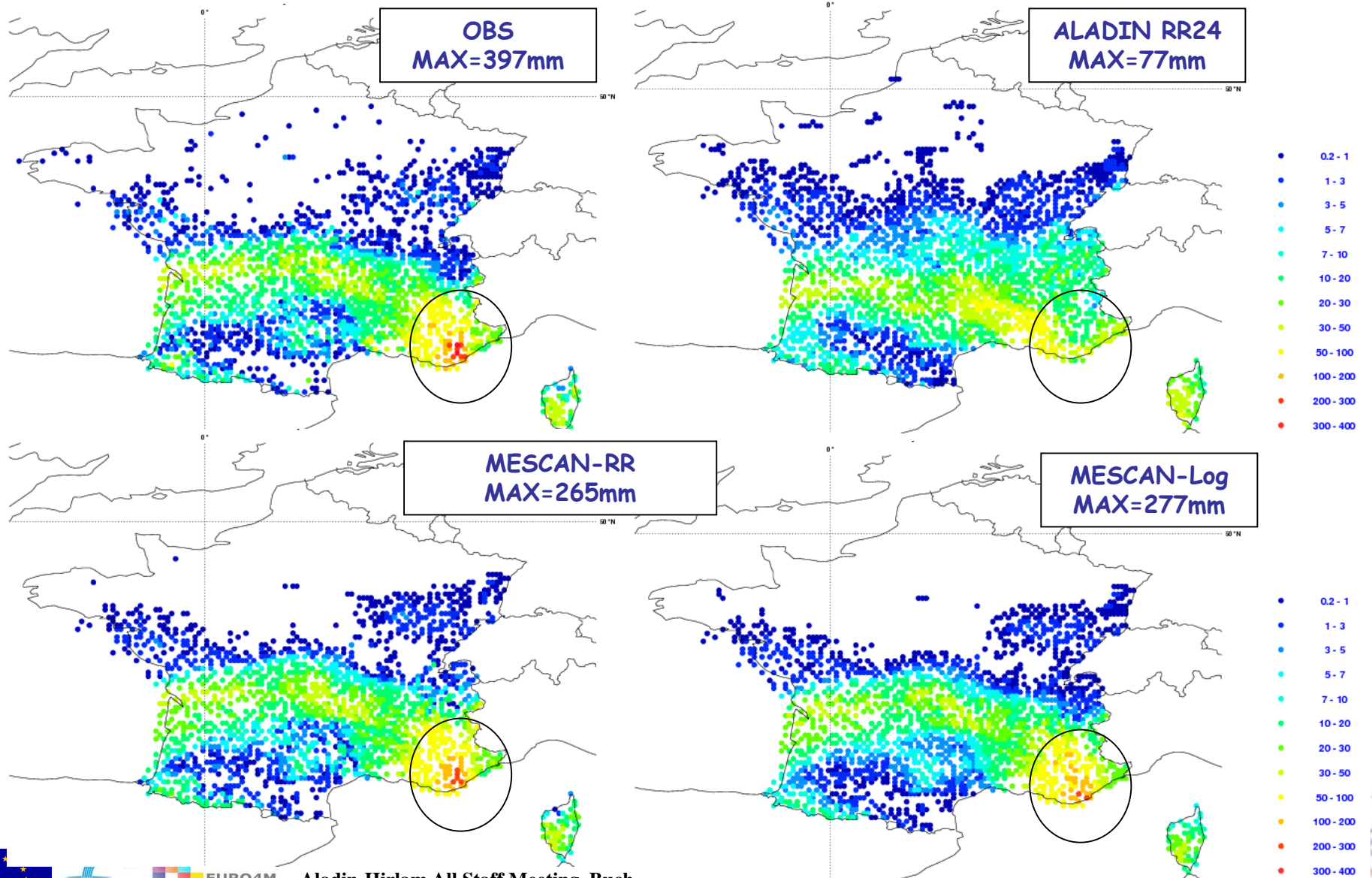


Validation of MESCOAN precipitation analysis over France

- **Period** : 01/09/2009 – 30/06/2010
- **Horizontal Domain**: 288x288 grid points, $\Delta x=5.5$ km
- **ALADIN first guess** :
 - 24-h ALADIN forecast from 3D-VAR reanalysis at 9km downscaled at 5.5 km, from run initiated at 06UTC
- **Observations**:
 - MF operational and climatic databases
 - Temporal resolution:
 - 24-h for RR24: ~1600 daily reports (from operational database);
~ 4200 daily reports (climate database)
- **Analyzed variable**: precip



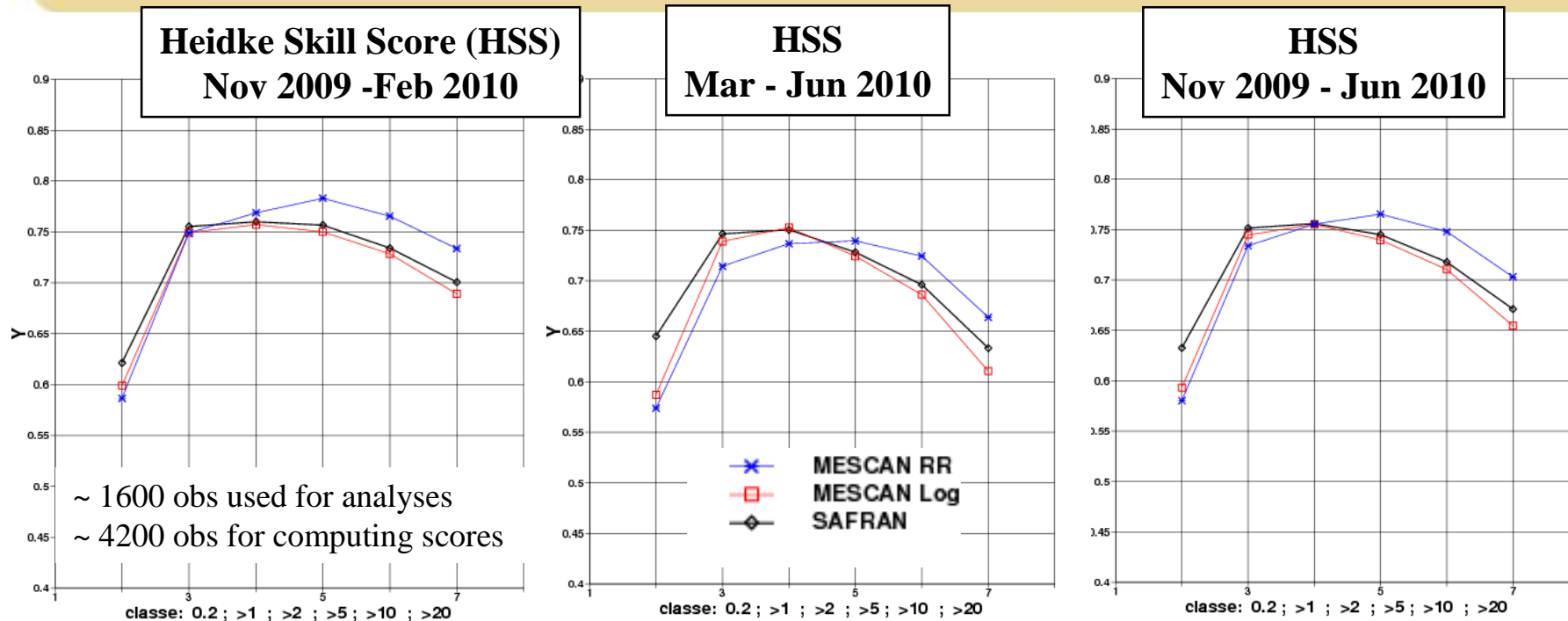
Extreme event: Var, 2010 (RR24h, Grid 0.1°)



EURO4M

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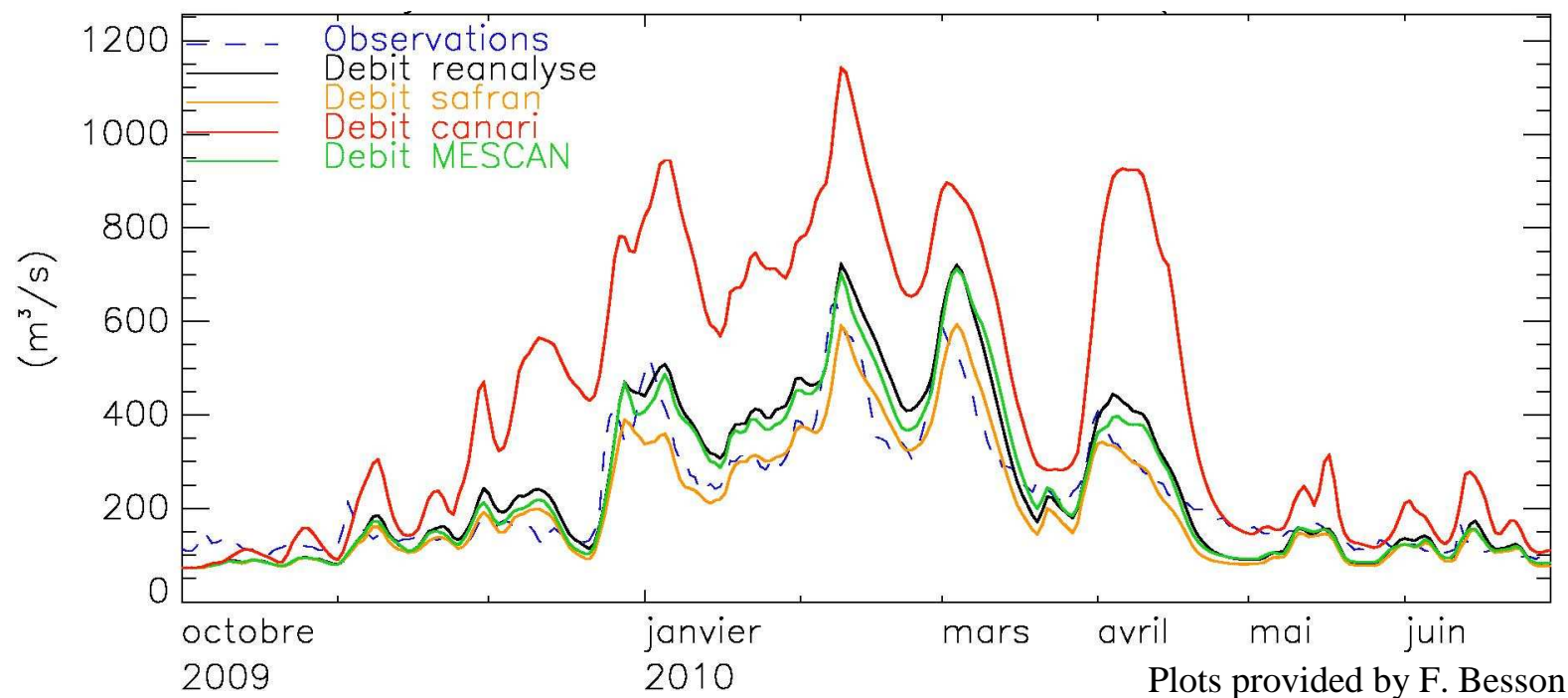
Validation of precipitation analysis vs SAFRAN over France



- MESCAN-RR (Φ -space) compared with SAFRAN and MESCAN-Log for spring (Mar-Jun):
 - improved skill for RR > 5mm/day, but not for RR < 2mm/day
- MESCAN-RR less biased than MESCAN-Log => more suitable for Hydrological purposes

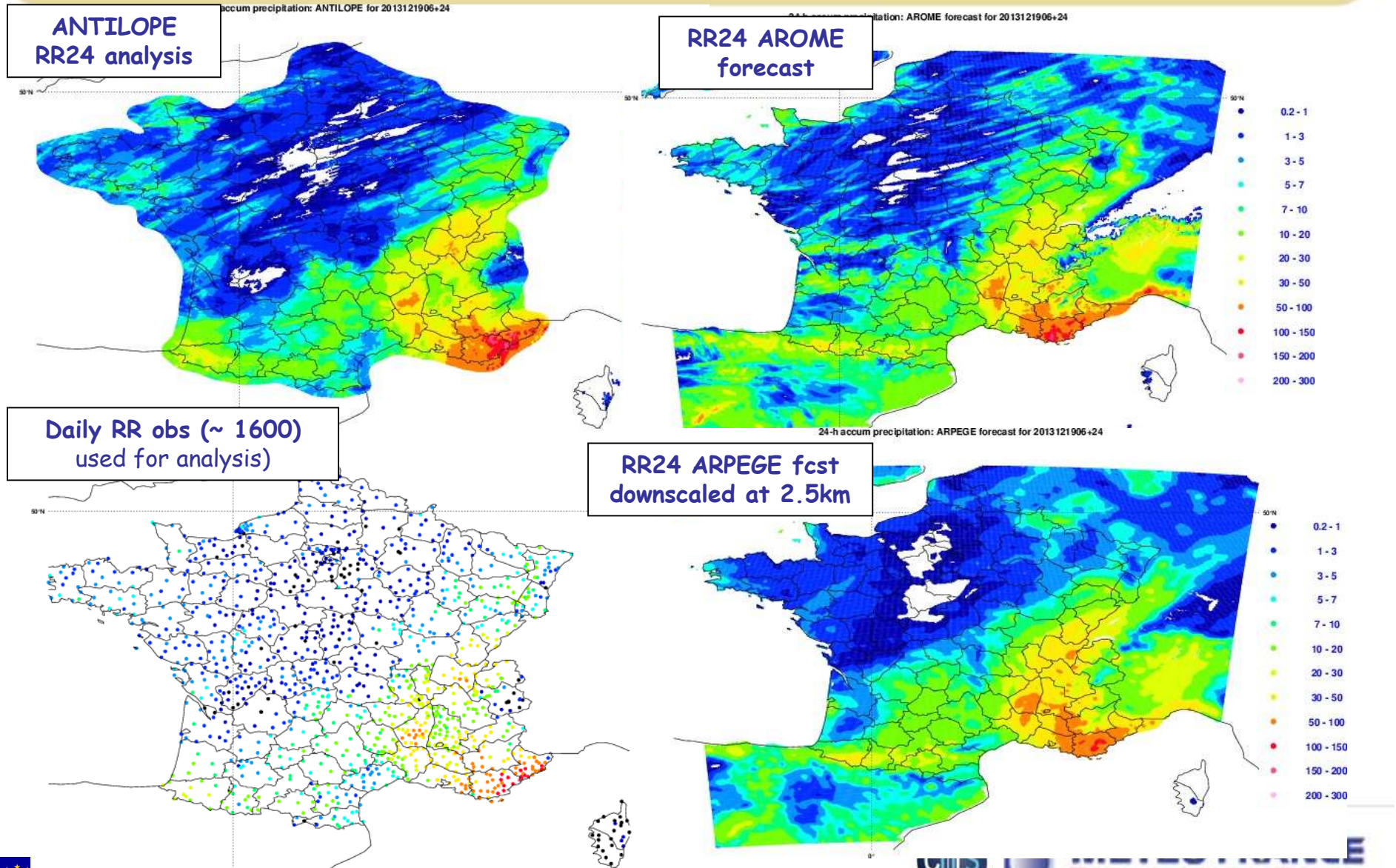
Impact of different types of forcing on the river flow for Oct 2009- Jun 2010

Daily river discharge for the Seine river at Paris



- The forcing provided by the MESCOAN-RR precipitation analysis is significantly improved in comparison to the one generated by the ALADIN precipitation.

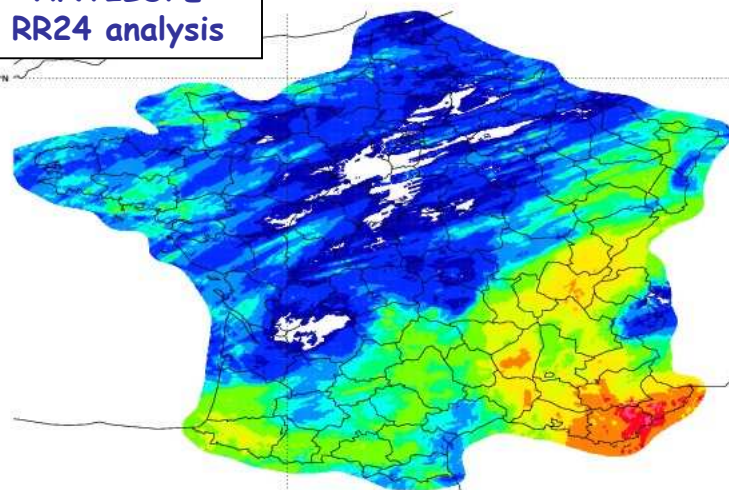
Recent tests at 2.5 km grid: comparison of MESCOAN-RR with ANTILOPE analysis



Comparison of RR analysis with ANTILOPE

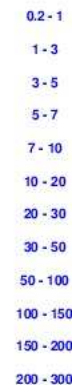
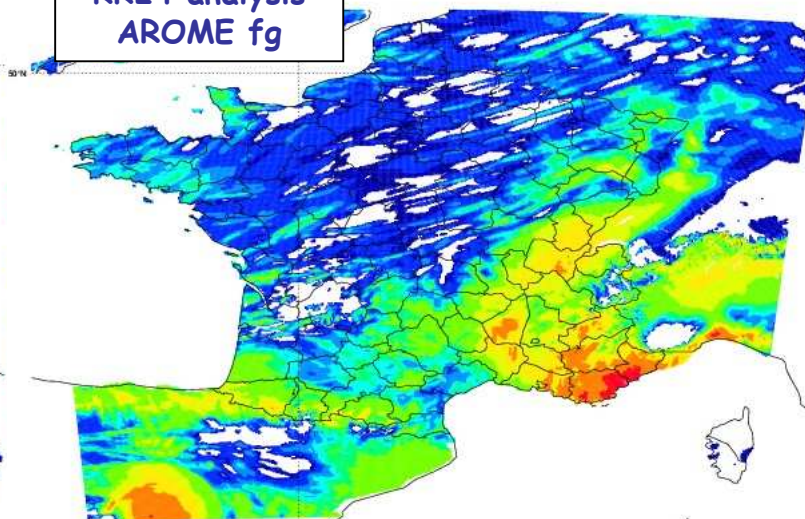
ANTILOPE
RR24 analysis

accum precipitation: ANTILOPE for 2013121906+24

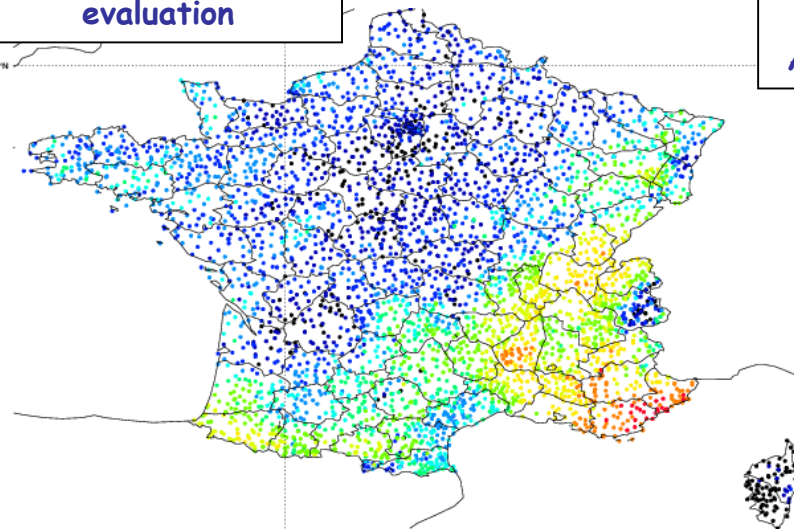


RR24 analysis
AROME fg

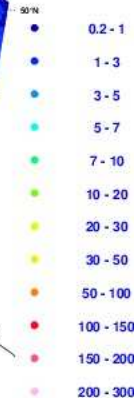
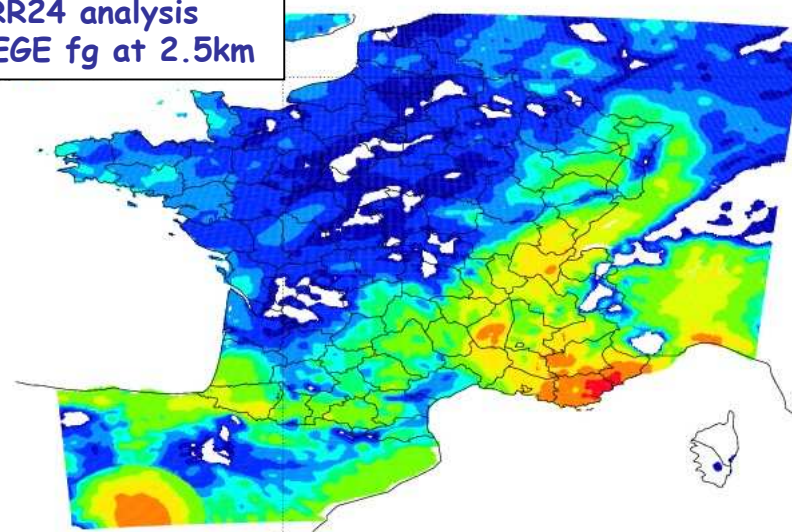
accum precipitation: analysis for 2013121906+24 (AROME guess)



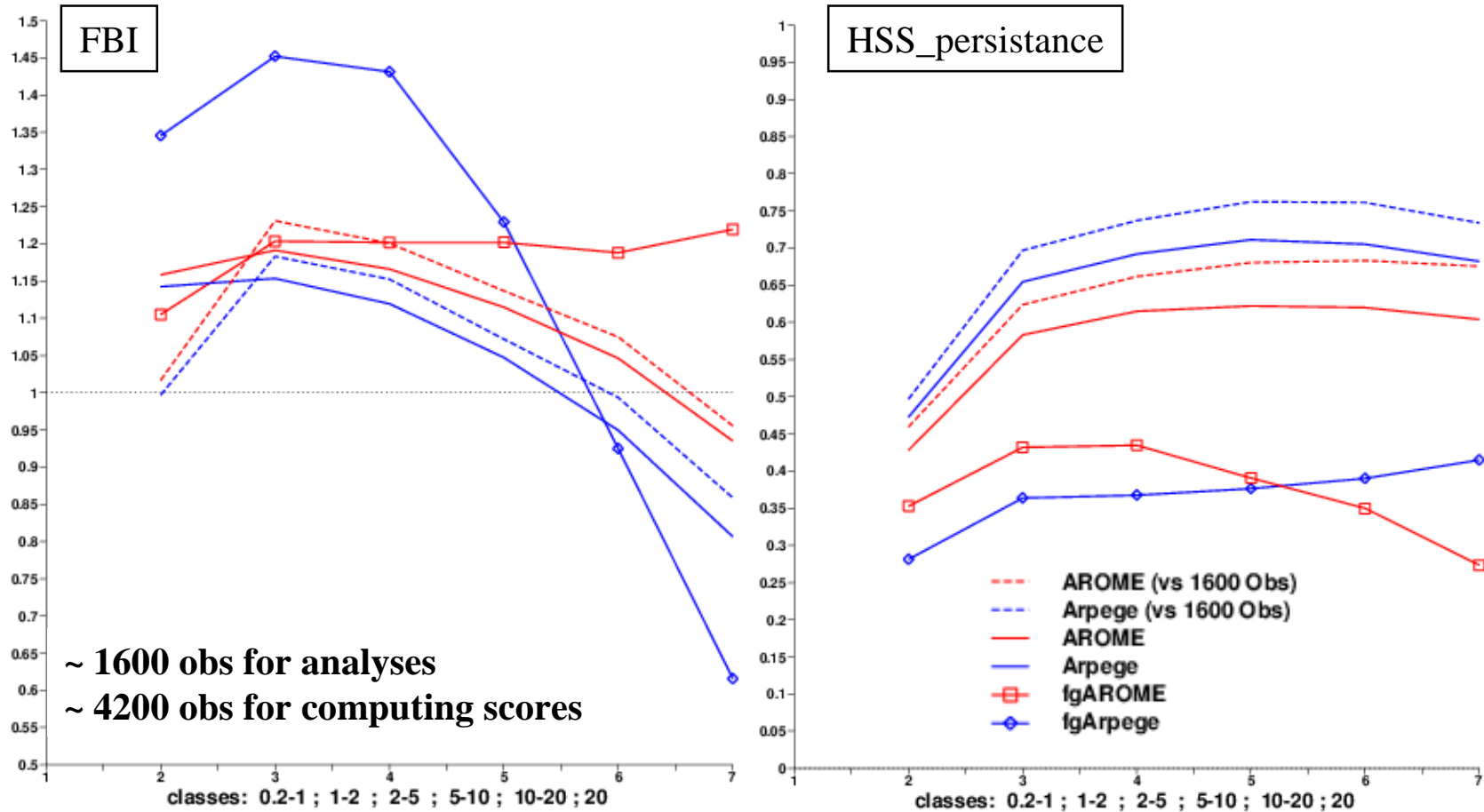
4200 Obs used for
evaluation



RR24 analysis
ARPEGE fg at 2.5km



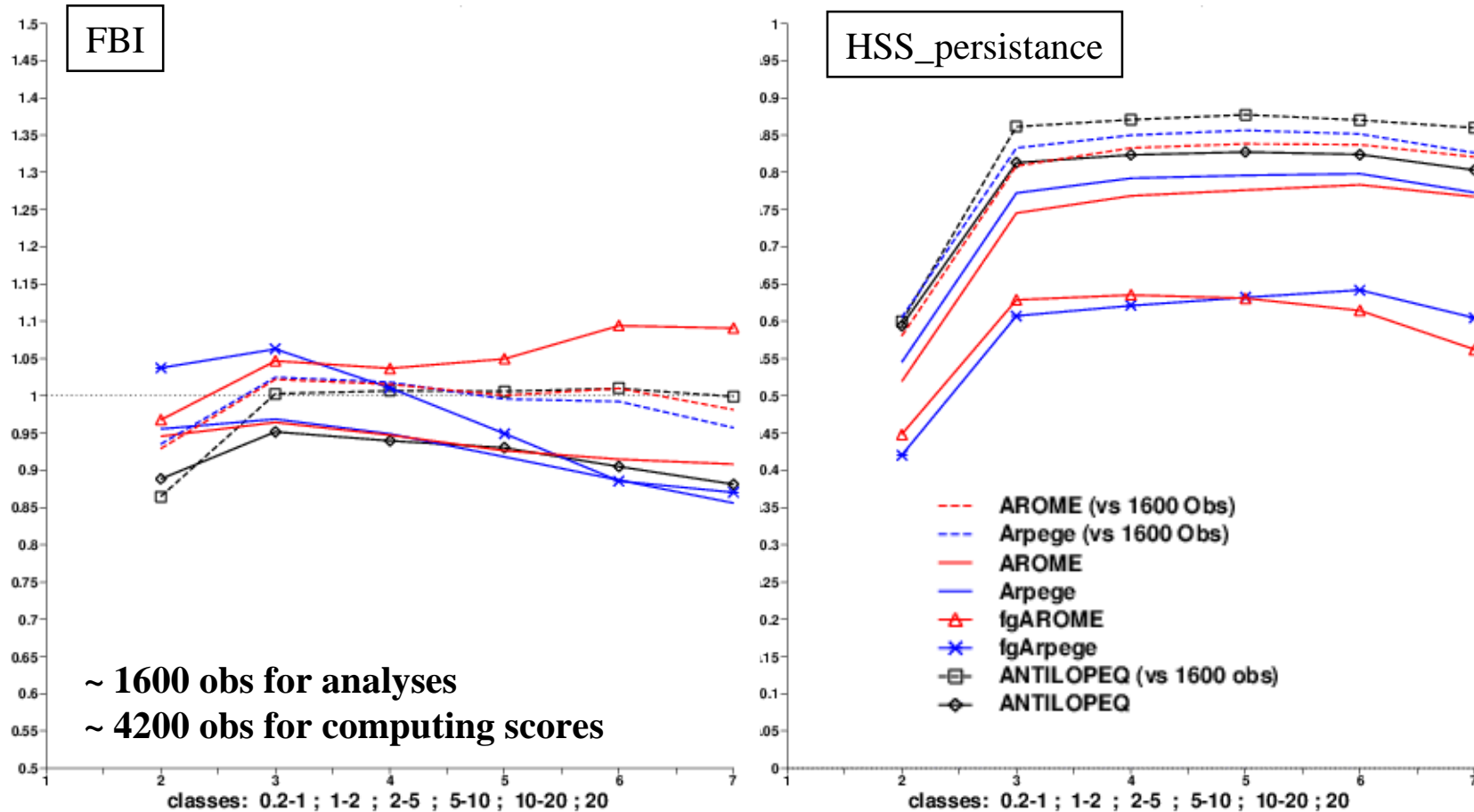
Validation of precipitation analysis over France for summer (JJA) 2013



- AROME FG has a systematic positive bias;
- AROME analysis likely penalized due to the small scales features ? More investigation needed.



Validation of precipitation analysis vs ANTILOPE over France for Dec 2013- Jan 2014



- RR analyses with ARPEGE FG better than those with AROME FG, so far.
- Verification vs 4200 obs shows that all the analyses are underestimated. Reason not clear => to be clarified



Outlook for RR analysis – first guess

- RR analysis coded in CY38T1 but not in the public release
 - to be phased to CY4x and made available to the HARMONIE community
- Additional work on MESCAN-Log is needed for bias removal
- Improvement of the analysis
 - Selection of the first guess chosen to minimize the spin-up effect
 - Work on the estimation of background and observation errors statistics, correlation length scale
- Worth to try a RR analysis under the hypothesis of a normal distributed FG and log-normally distributed observations ?
- RR analysis used to creates soil moisture increments ?



Outlook for RR analysis - observations

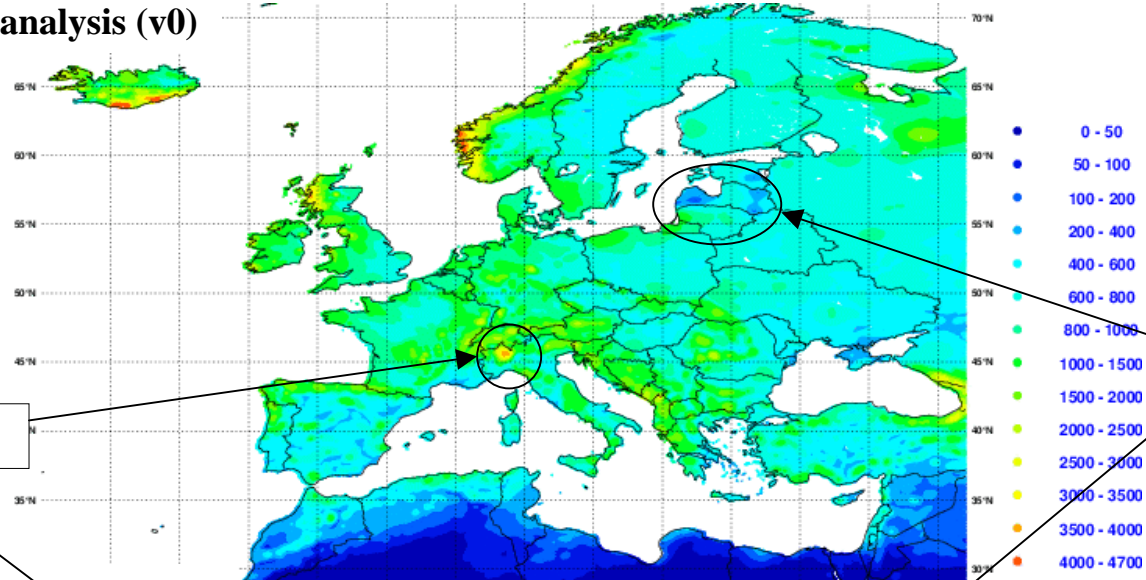
■ Observations:

- work on the QC of the real time raingauge measurements
 - misleading information provided by rain gauges in winter and early spring (heated/ non-heated rain gauges, 'zero' precip reports when it snows etc)
- bias correction of the rain gauge measurements for systematic errors (undercatch due to the wind, wetting and evaporation losses)
- using of radar data as observations (or as background) ?
- For reanalysis: how to deal with the outliers?



Correction of analysis due to the pre-processing of the precip observations (2007)

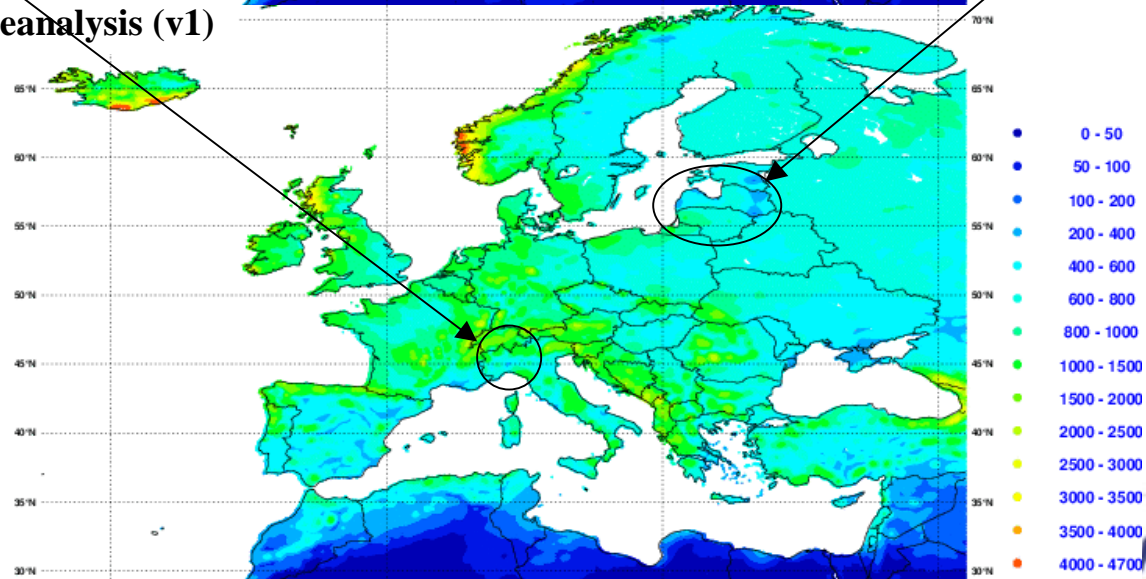
Initial reanalysis (v0)



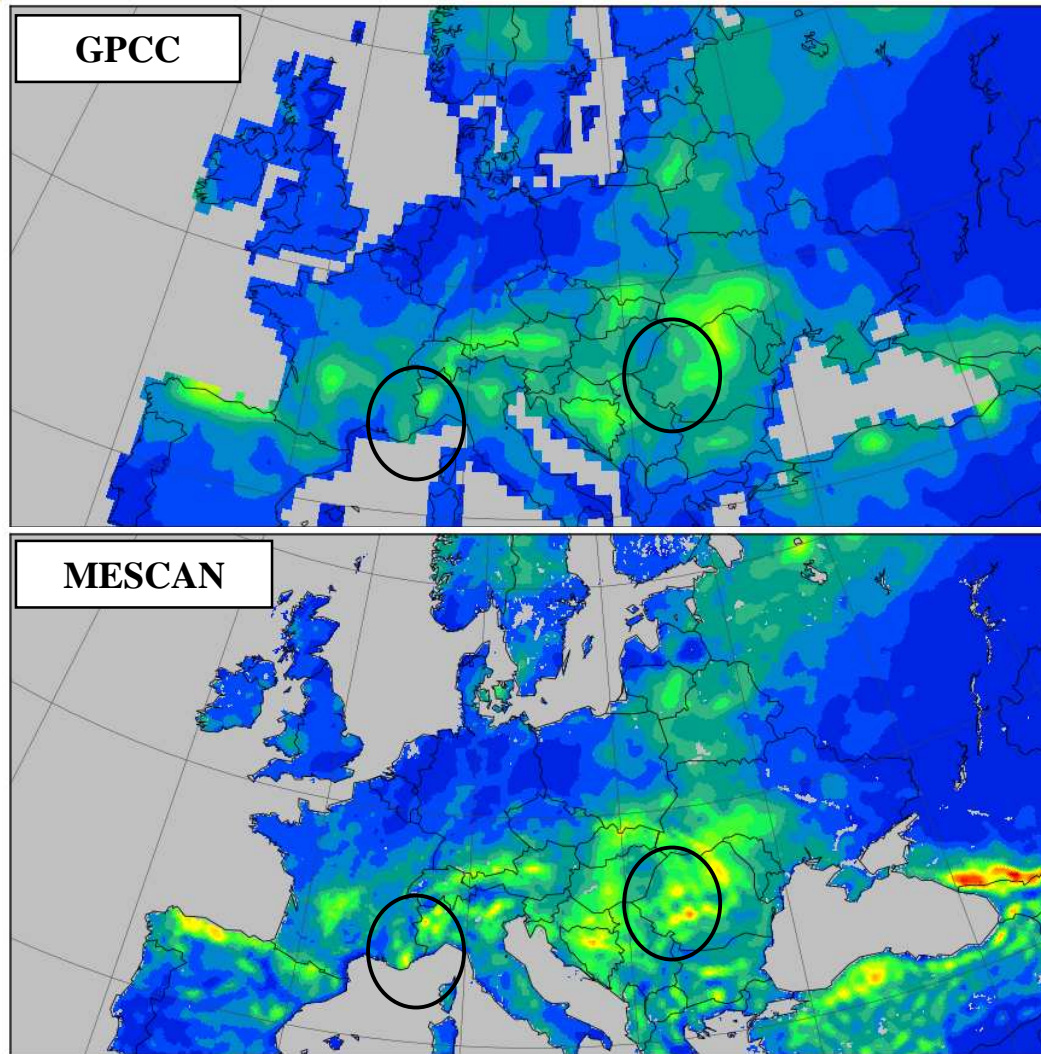
Too much rain

Too dry

Final reanalysis (v1)



Comparison of RR24 analysis for June 2010: MESCAN (0.05°) vs GPCC (0.5°)



- Rejecting outliers will not reflect the climatology of the region.
- Pre-processing of obs needed



EURO4M available products

(more info on www.euro4m.eu)

<ul style="list-style-type: none">▪ <u>Re-analyses:</u><ul style="list-style-type: none">▪ 6-h T2m and RH2m▪ 24-h precipitation	<ul style="list-style-type: none">▪ <u>Downscaled fields:</u><ul style="list-style-type: none">▪ 6-h SW, LW, U10m and V10m
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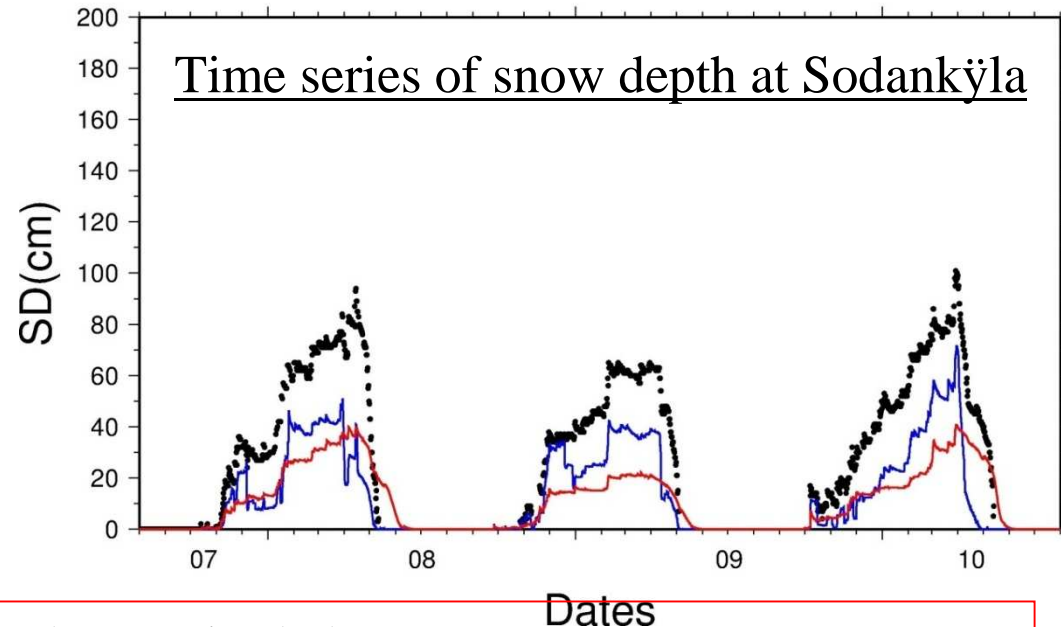
- **Period:** 01/01/2007 – 31/12/2010
- **Model domain:** Europe, 1080x1000 grid points, $\Delta x=5.5$ km, Lambert conformal proj.
- **First guess:** HIRLAM forecast from 3DVAR reanalysis at 22km downscaled at 5.5km
- **Observations:**
 - MF operational database for T2m and RH2m analyses
 - SMHI, MF, ECA&D (v6) merged by SMHI (T. Landelius) for RR24 analyses
- **ARCHIVE:** 4 netCDF files per day (00,06,12,18 utc); archive of about 212 GB



Example of using MESCAN re-analysis to force SURFEX (from M. Coustau)

Details in deliverable D2.11 of EURO4M

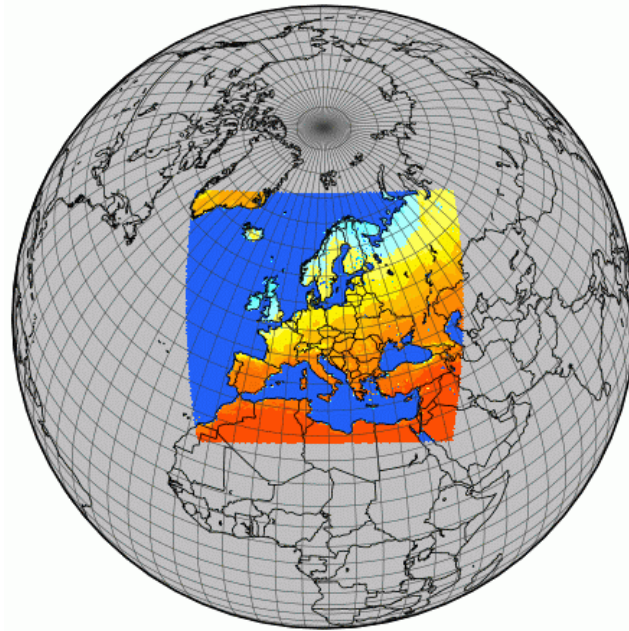
- Observations (M. Kangas)
- ERA-Interim-SURFEX
- MESCAN-SURFEX



Underestimation of snow depth magnitude but :

- Good representation of the snow depth duration
 - Good representation of the climatology (relative intensity of each winter)
 - Better results than the ERA-Interim reanalysis
- Added value of MESCAN / ERA-Interim

Thank you for your attention! Questions ?



Acknowledgements

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