5 years Ensemble surface re-analysis with MESCAN

E. Bazile & R. Abida

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ECMWF, Reading, UK

Outline

- How to estimate uncertainties:
  - Observation network & perturbation
  - Model physics
- Ensemble system for 2006-2010
  - For precipitation
  - For 2m temperature & relative humidity
- Production status
- Conclusions

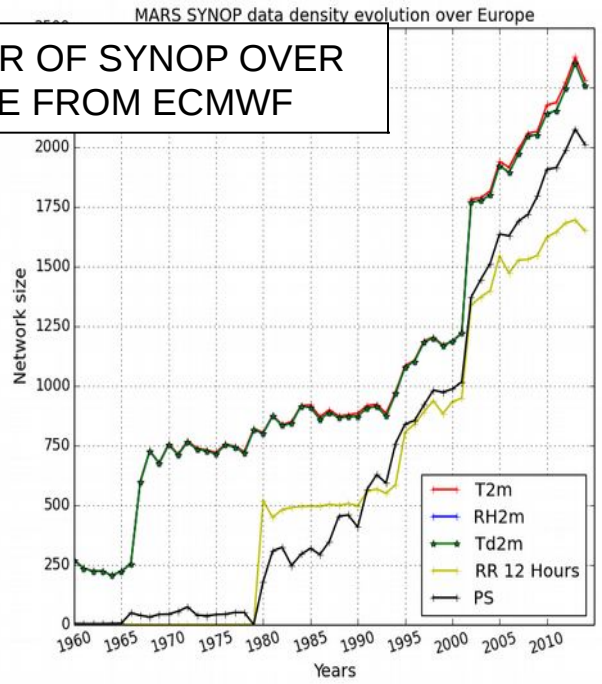
Surface observations T2m, Hu2m & RR24

- **Surface observation density is a critical factor,** without enough observations the reanalysis tends to drift towards the model climatology.
- A sharp increase in observation density might lead to misleading results. Particularly, for surface trend interpretation..
- T2m & RH2m are from GTS, while those for RR24 are from some national data base (MF and SMHI) & ECA&D.

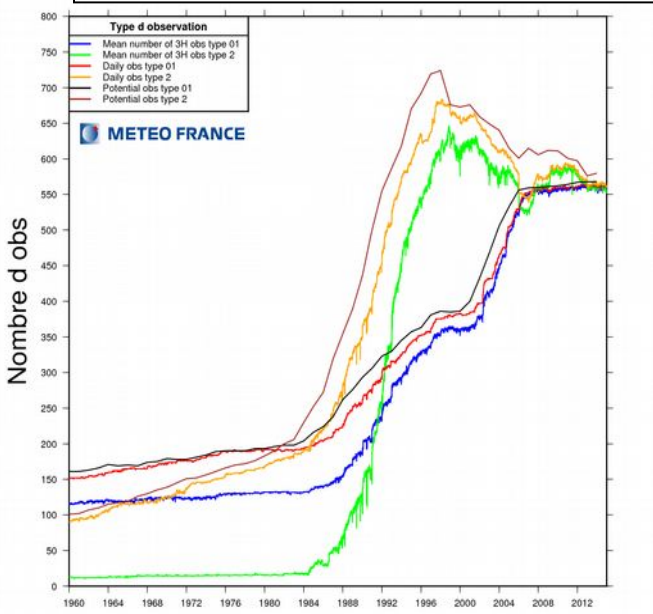
NUMBER OF SYNOP OVER EUROPE FROM ECMWF

x3

UE

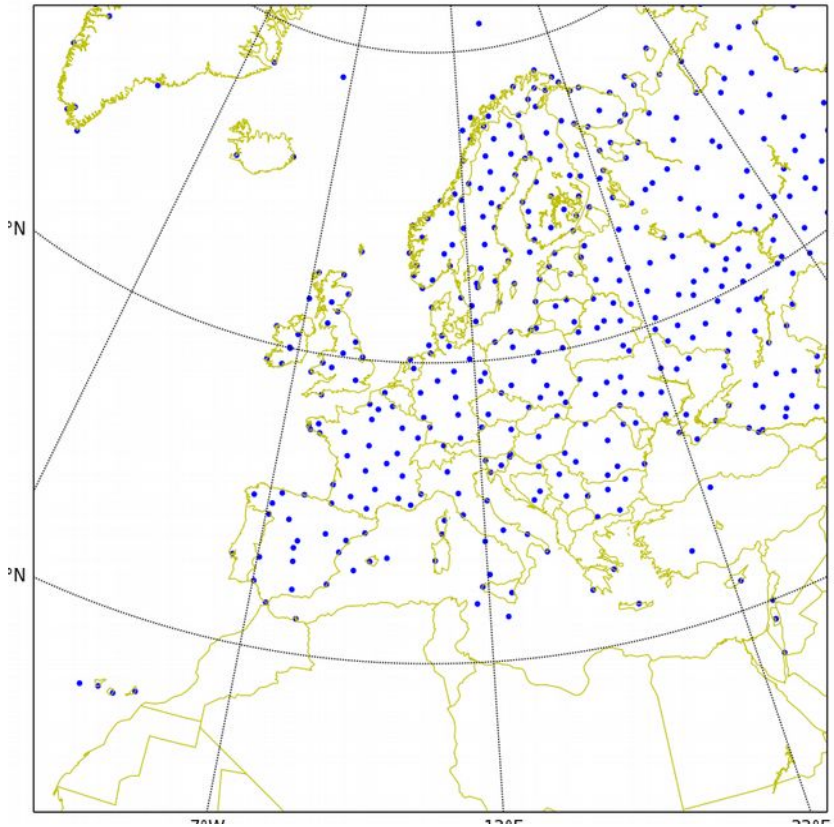


NUMBER OF SYNOP OVER FRANCE

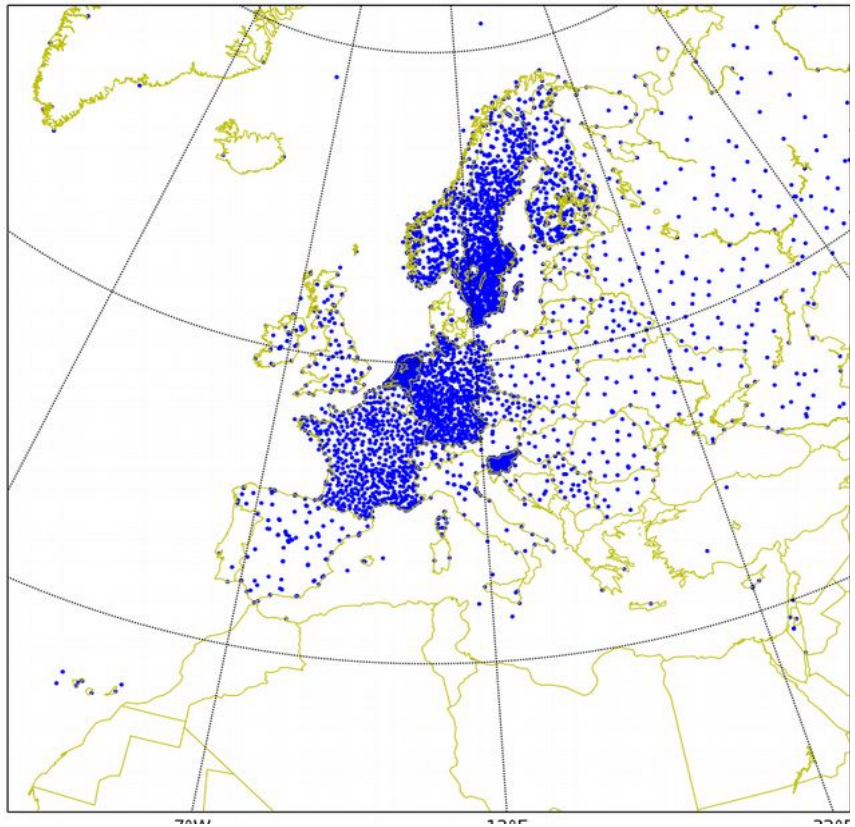


High & low surface observation density patterns for the test-bed period (2006-2010):RR24

Low density (~ 470 obs)

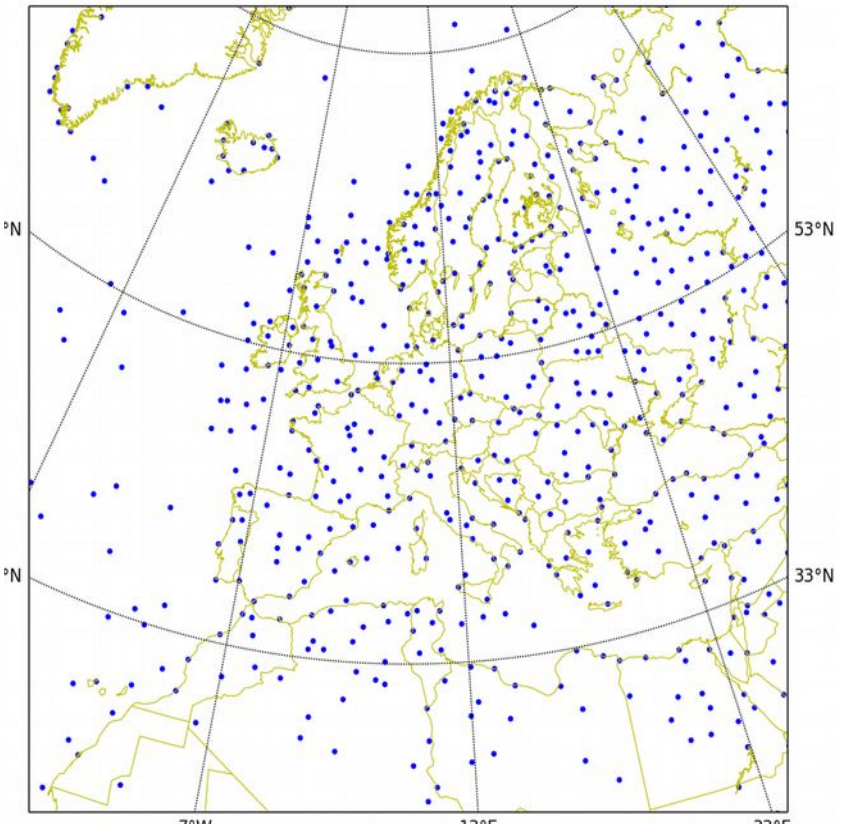


High density (~ 4540 obs)

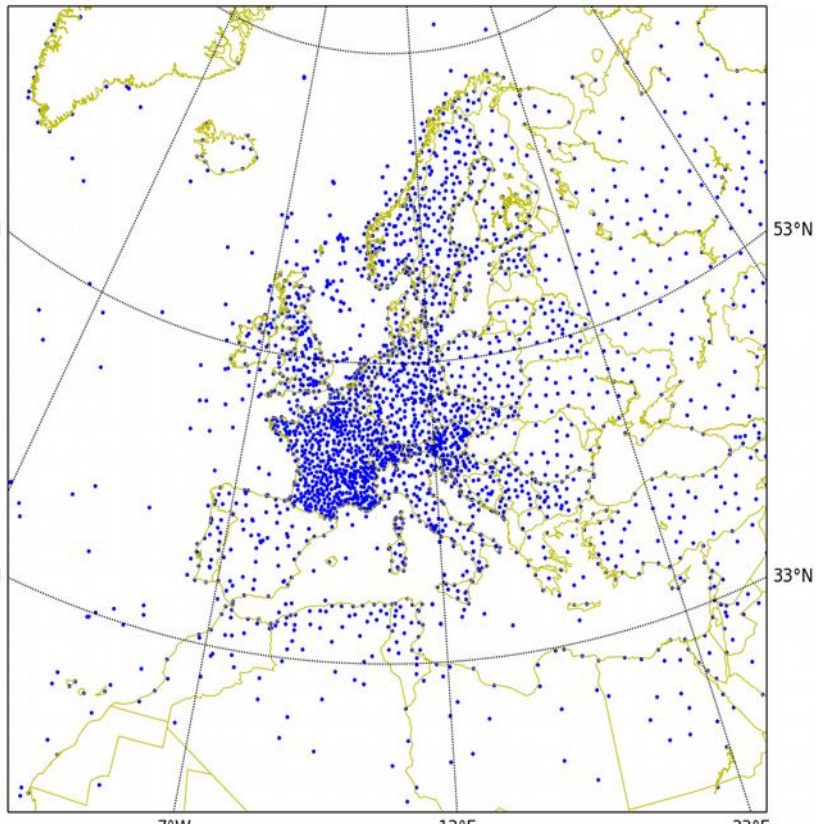


High & low surface observation density patterns for test-bed period (2006-2010): T2m & RH2m

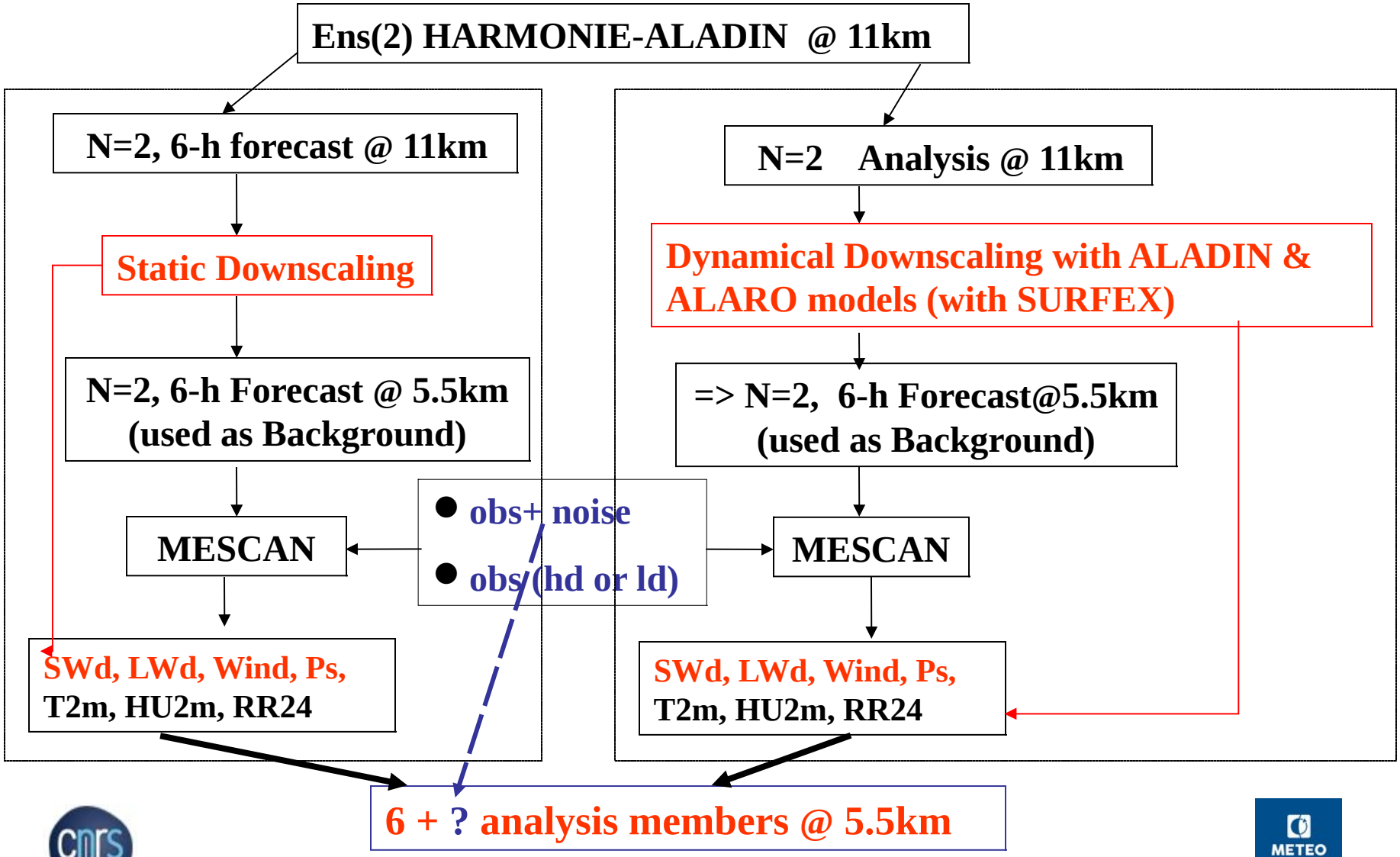
Low density (~830 obs)



High density (~ 3080 obs)



Ensemble of Surface analyses 2006-2010 (Test-bed)



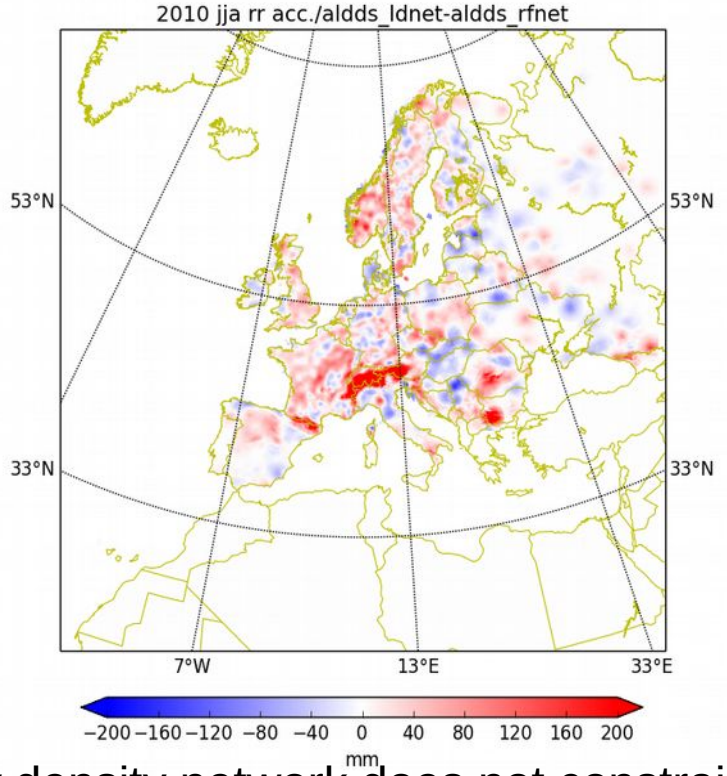
Setup for the Ensemble System at 5.5km for the 24h precipitation analysis

6 members :

- Two members from ALADIN & ALARO physics (with SURFEX) at 11km downscaled at 5.5km
- Two types of the observation network : low density and ‘all obs” .
- One ALADIN (with SURFEX) forecast at 5.5km :
  - better background for the surface analysis (vs the static downscaling)
  - necessary to have “fine scale structure” for the precipitation Soci et al. (2016)
  - BUT it is more expensive and is it necessary to :
    - improve the ensemble spread for the precipitation ?
    - improve the surface fluxes, the snow cover, the river discharge computed by SURFEX-TRIP driven by MESCAN ?

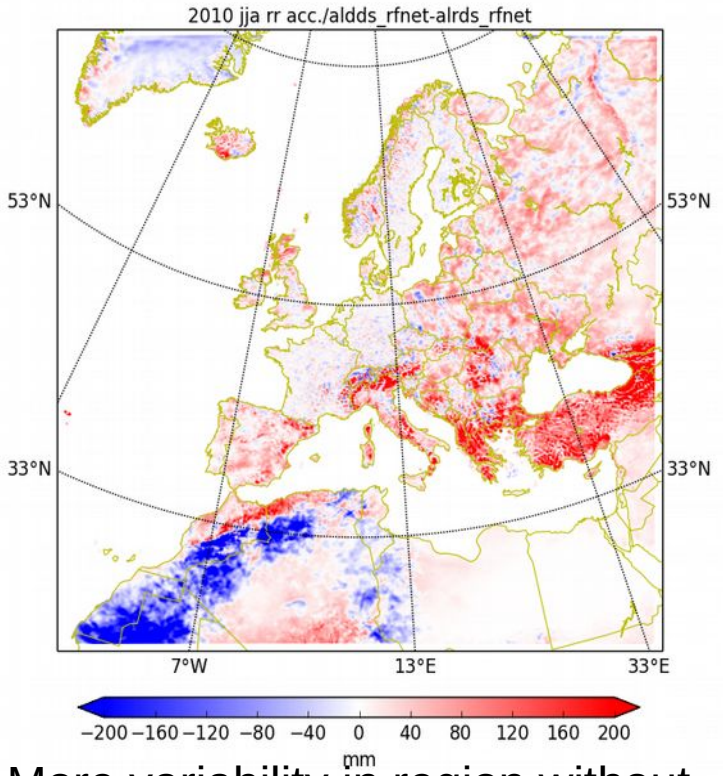
Effect of observation density and the physics on the RR surface reanalysis (JJA2010)

Impact of network density



Low density network does not constrain enough model precipitations particularly over mountain

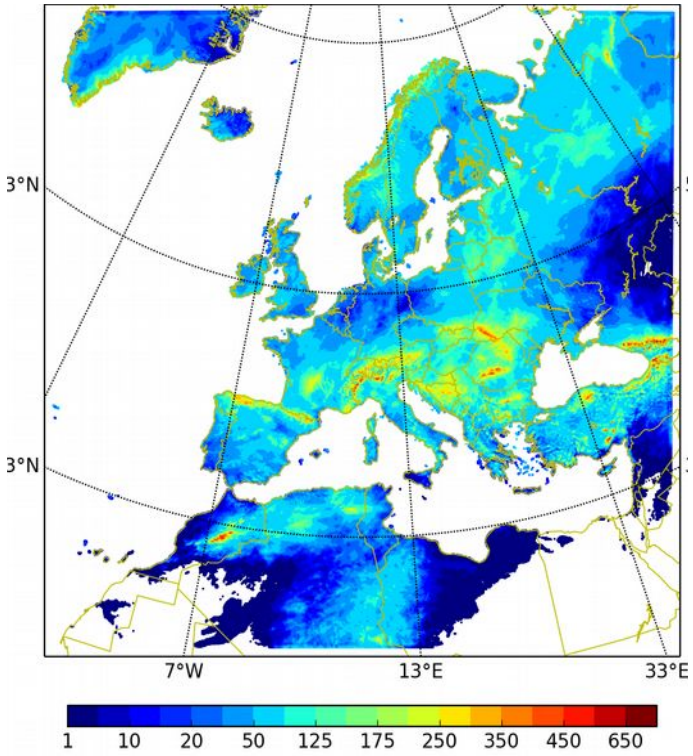
Impact of model physics



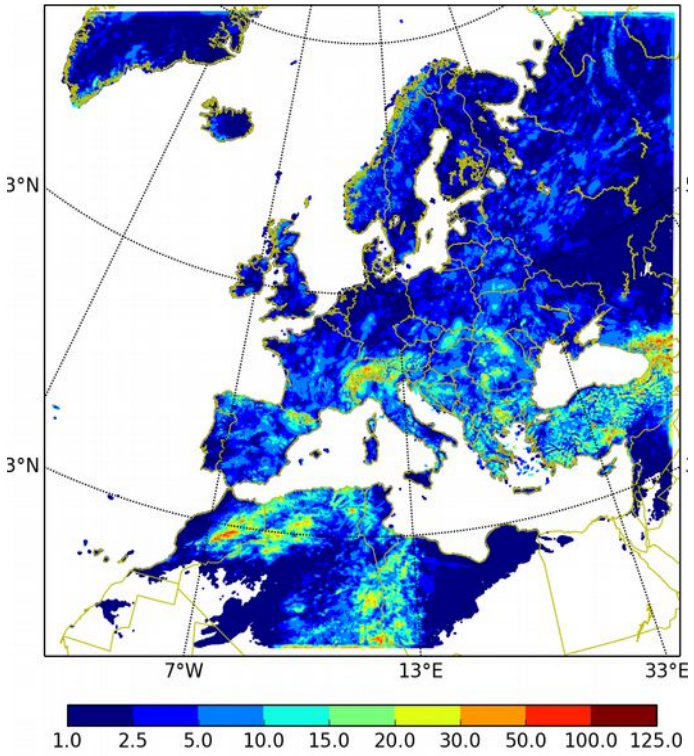
More variability in region without observations due to the physics in the model especially over North Africa and Turkey

Ensemble (6-members) MEAN and SD for RR24-h Precip Analysis (June 2010)

Ensemble Mean

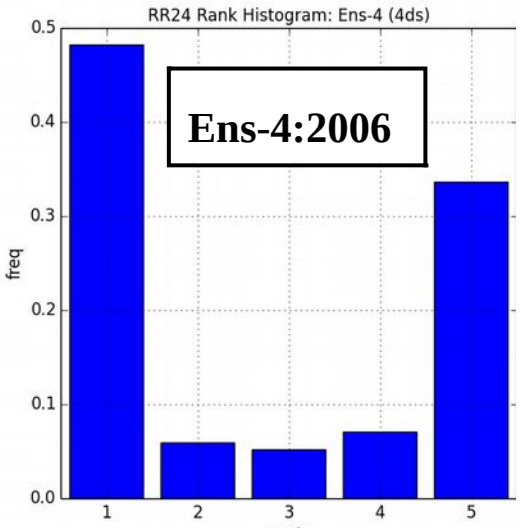


Ensemble Mean SD

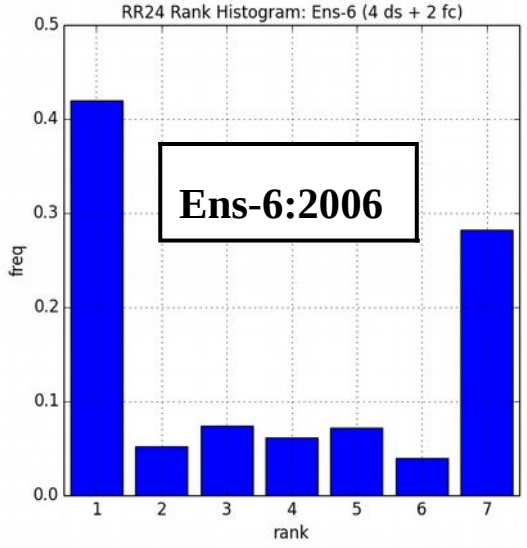


Higher uncertainties over mountains & regions lacking observation, preliminary due to the model physics : over Atlas coefficient of variation (CV) can reach 80%

Rank Histogram for RR24 January 2010 & 2006 over Europe



- **Ens-6 with ALADIN at 5.5km is slightly better than Ens-4, but still with under dispersion**



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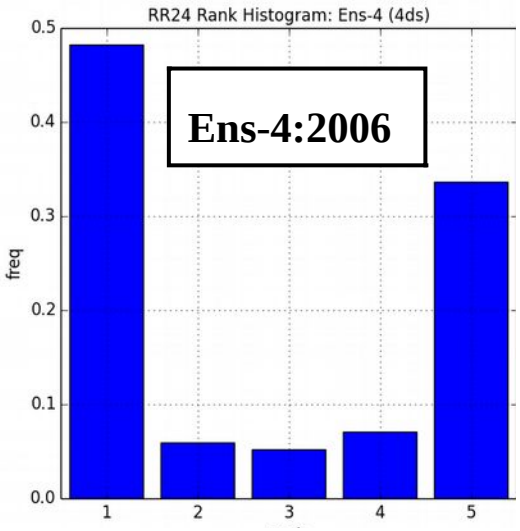

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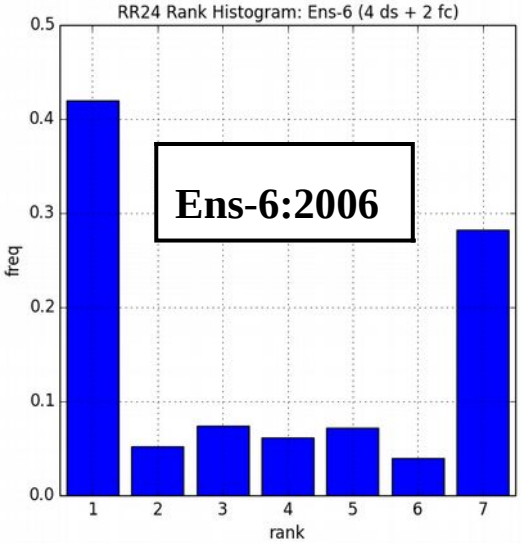

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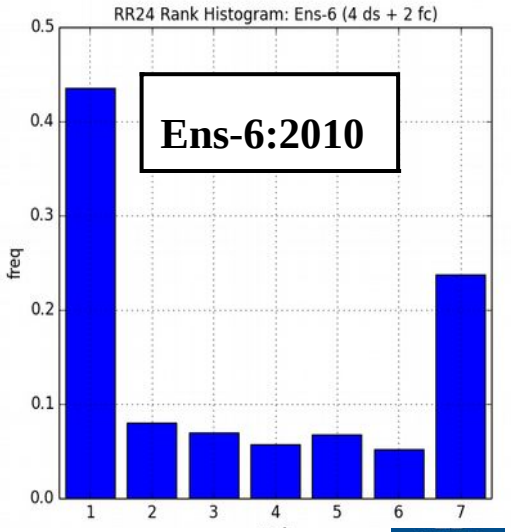

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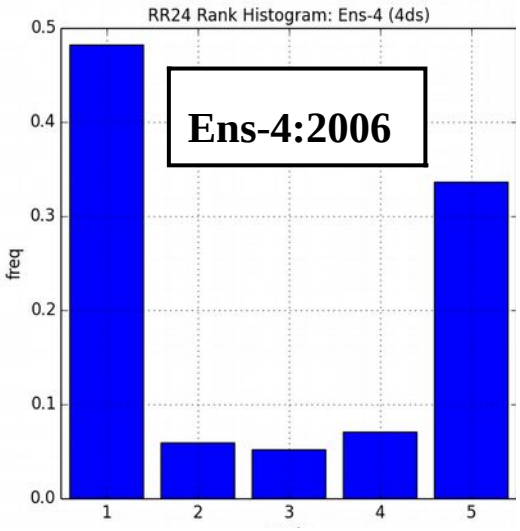

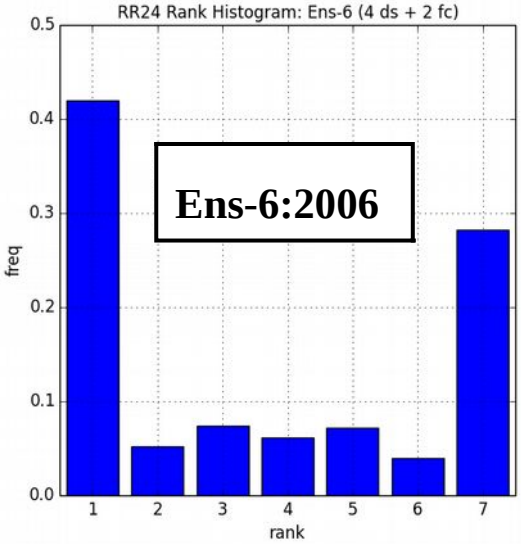

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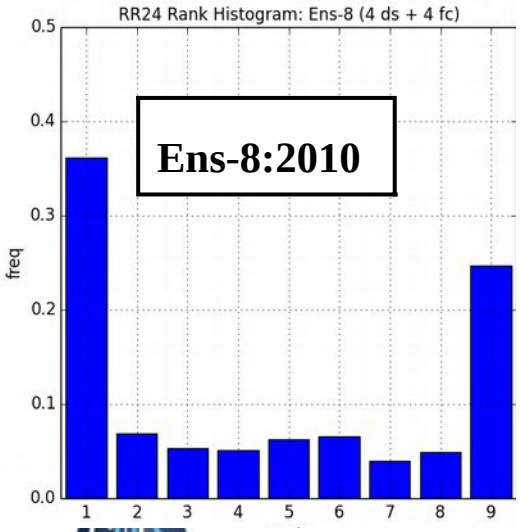

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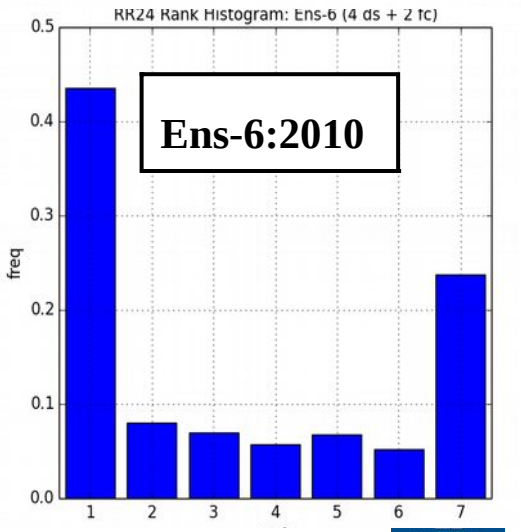

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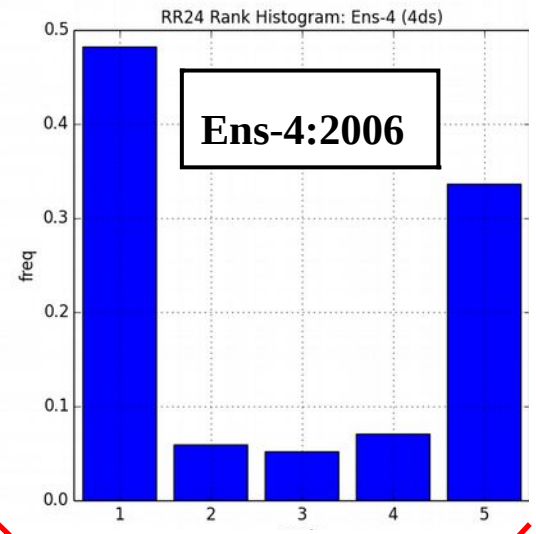

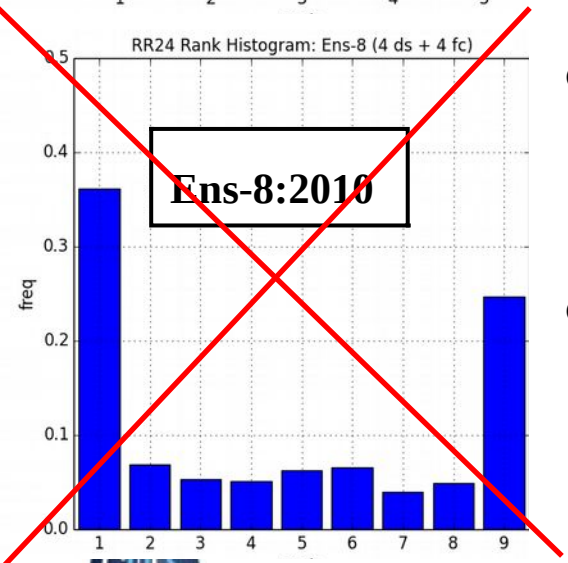

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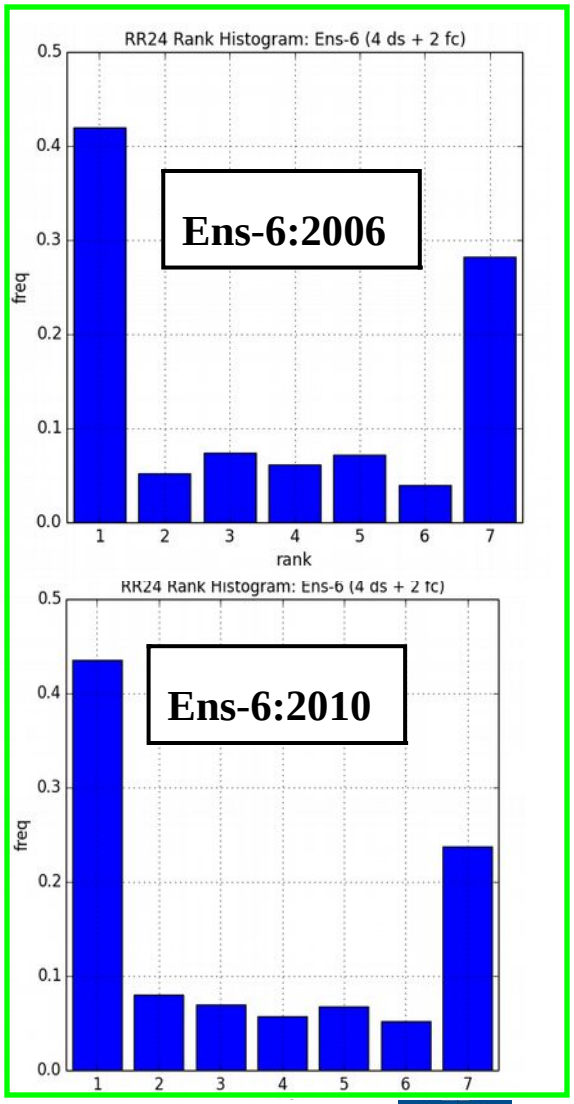

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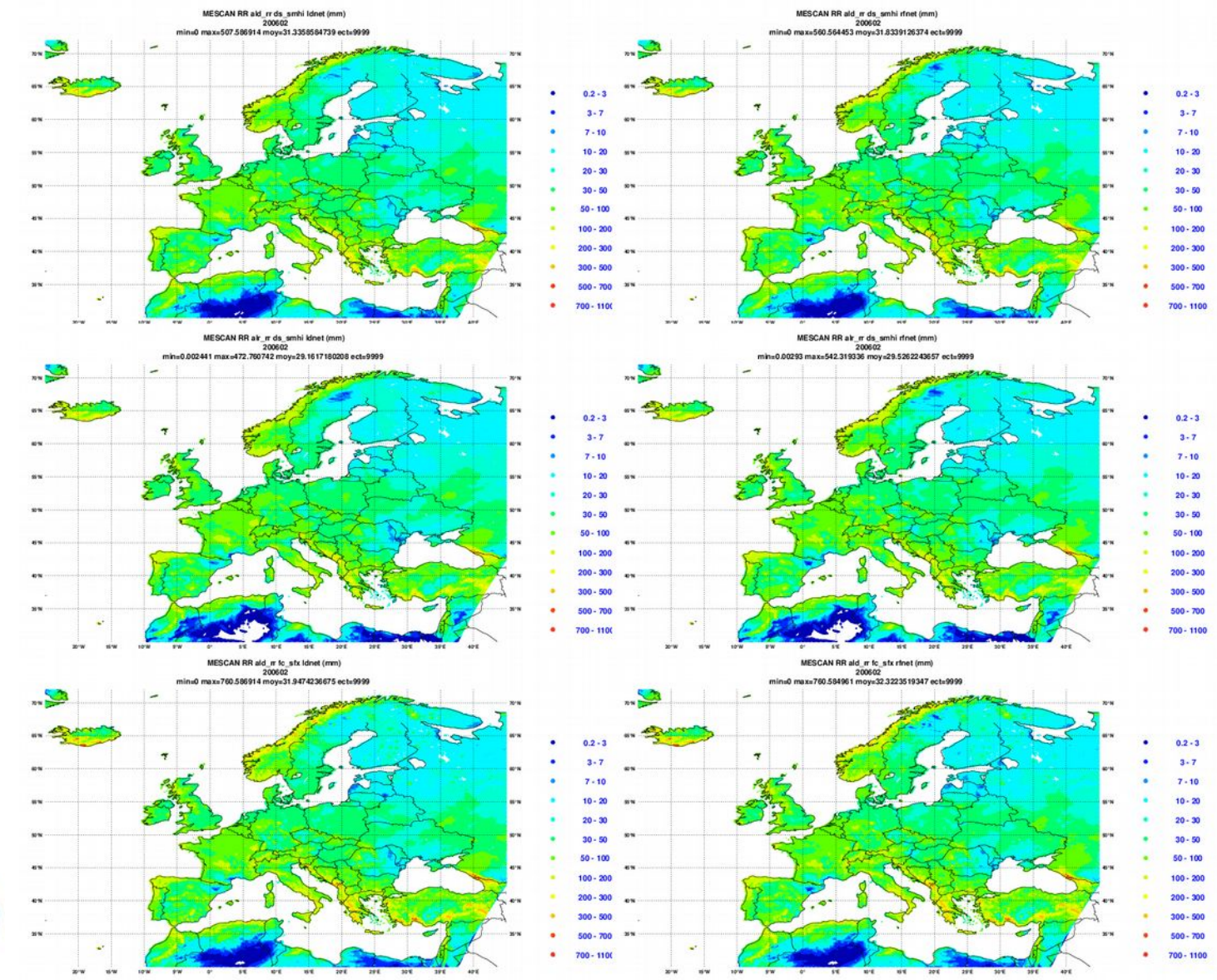

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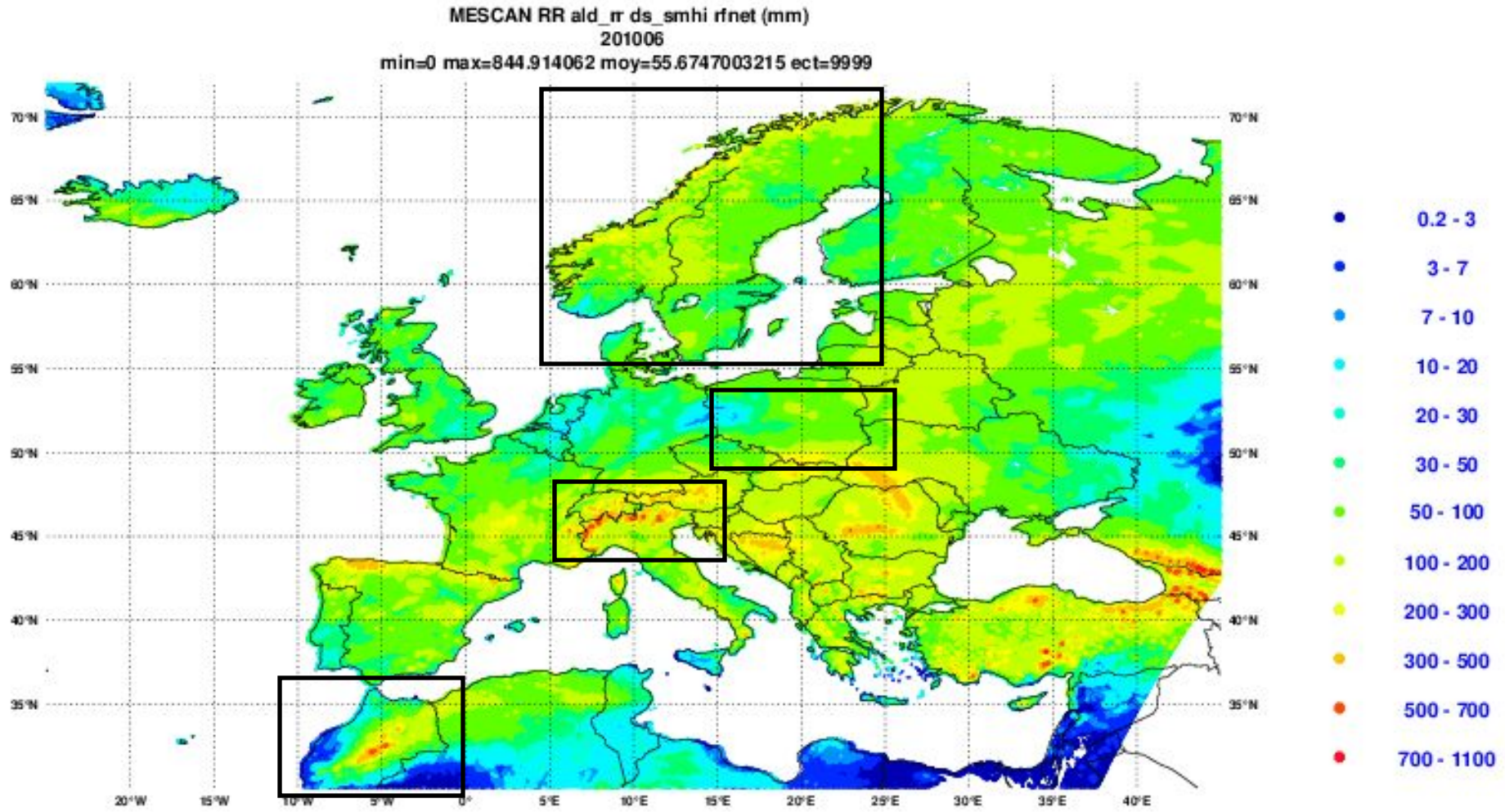

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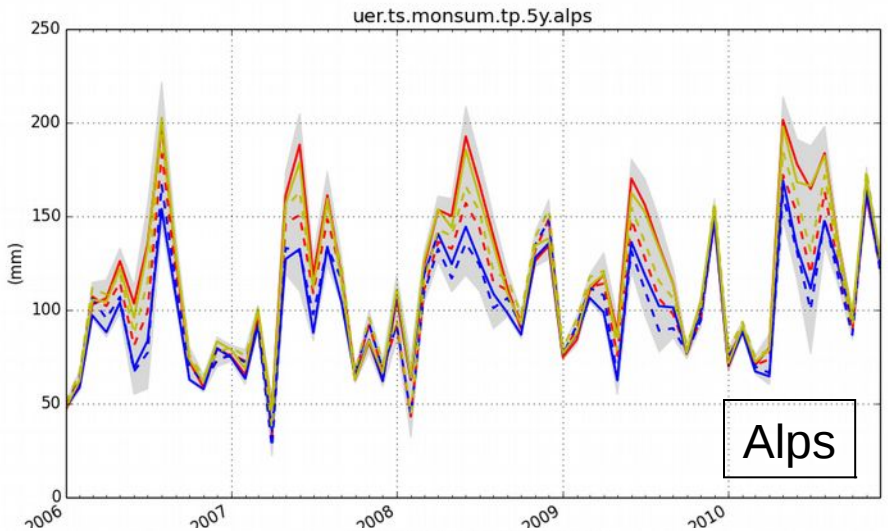

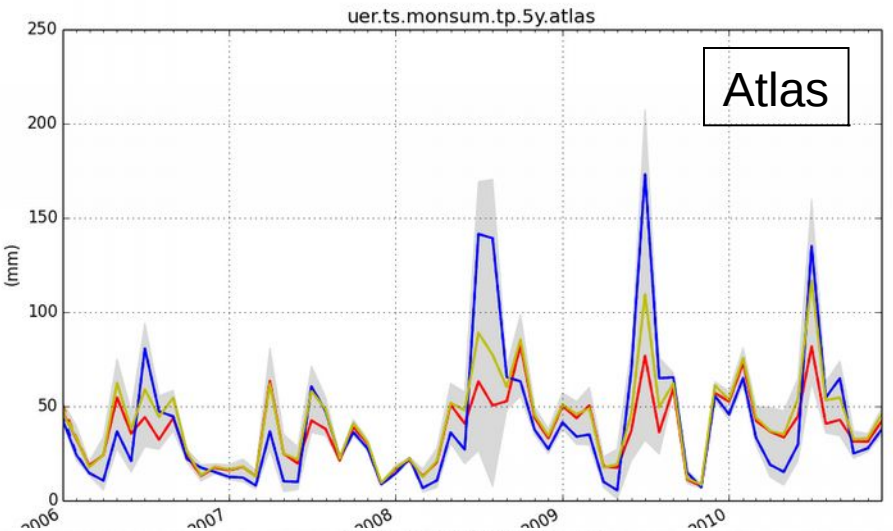

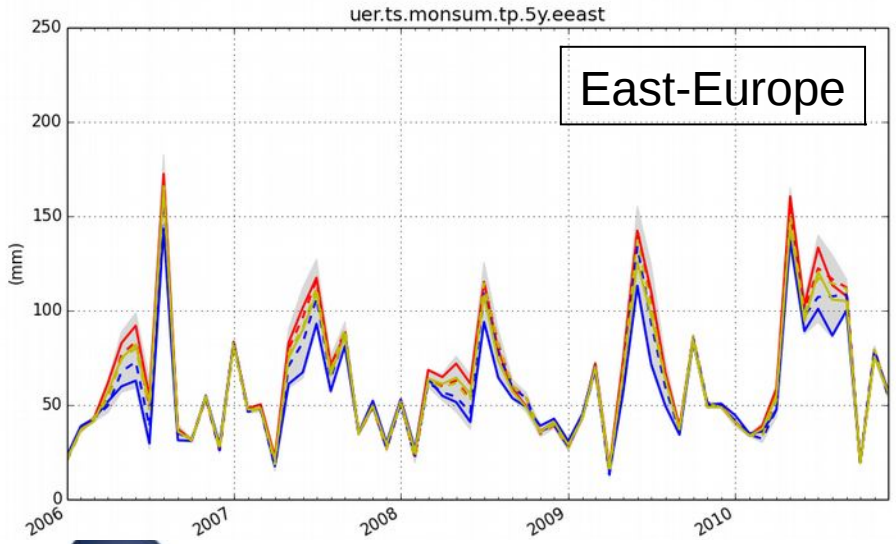

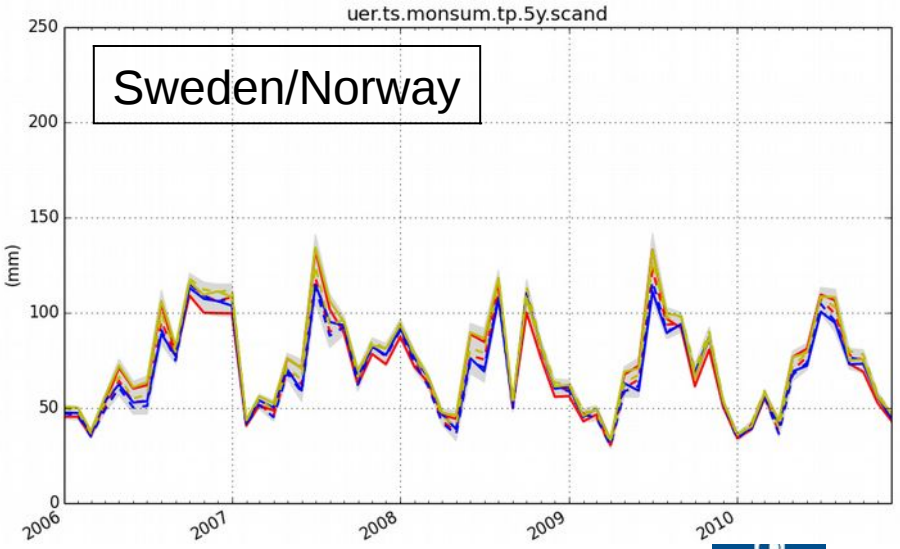

Setup for the Ensemble System at 5.5km for 2m-temperature & Rh

- Three background members @5.5km
  - Two members from ALADIN & ALARO models (with SURFEX) at 11km downscaled to 5.5km.
  - One member from ALADIN forecast (with SURFEX) at 5.5km
    - Background for T2M, Hu2m and Wind are improved with the model at 5.5km vs the downscaling of the 11km background (C. Soci et al, EMS2014)

- Two configurations of the observation network : low density and “all obs”
- Perturbed observation approach for 4 members (based on “all obs” network)

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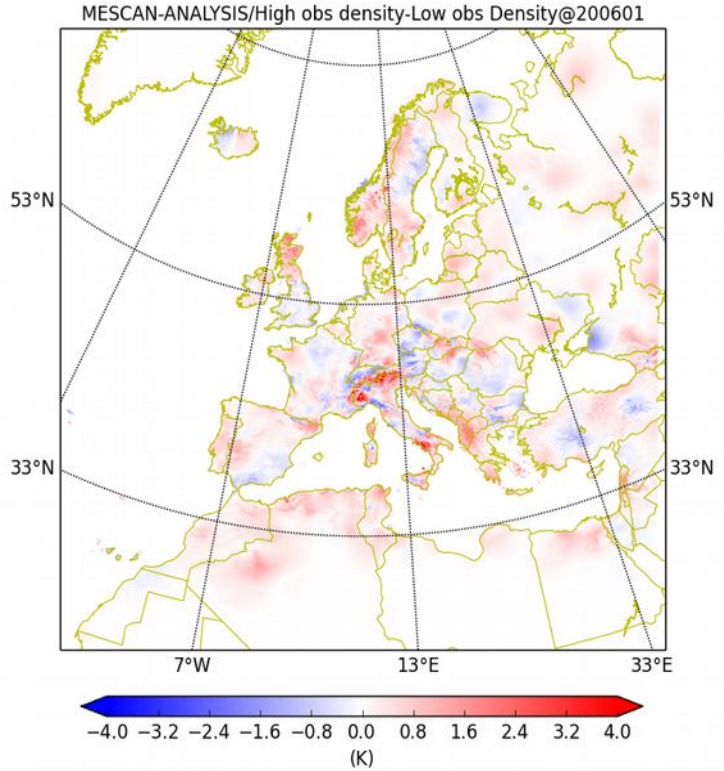
Two configurations of the observation network : low density and “all obs”

Perturbed observation approach for 4 members (based on “all obs” network)

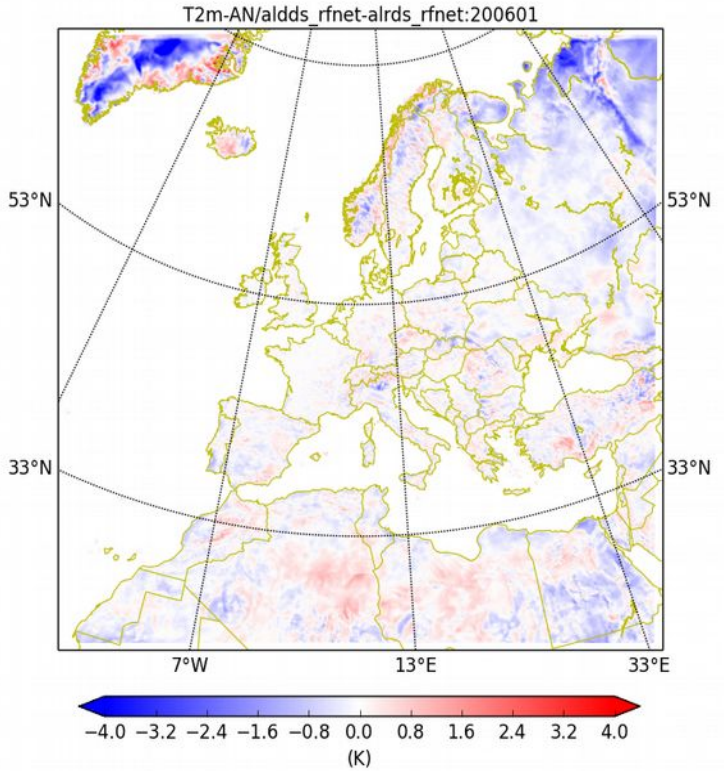
Effect of observation density and model physics on the T2m surface reanalysis (Jan 2006)

Impact of network density



More impact in mountainous area: fine scale, larger error with snow ...

Impact of model physics



More impact where observations are sparse !

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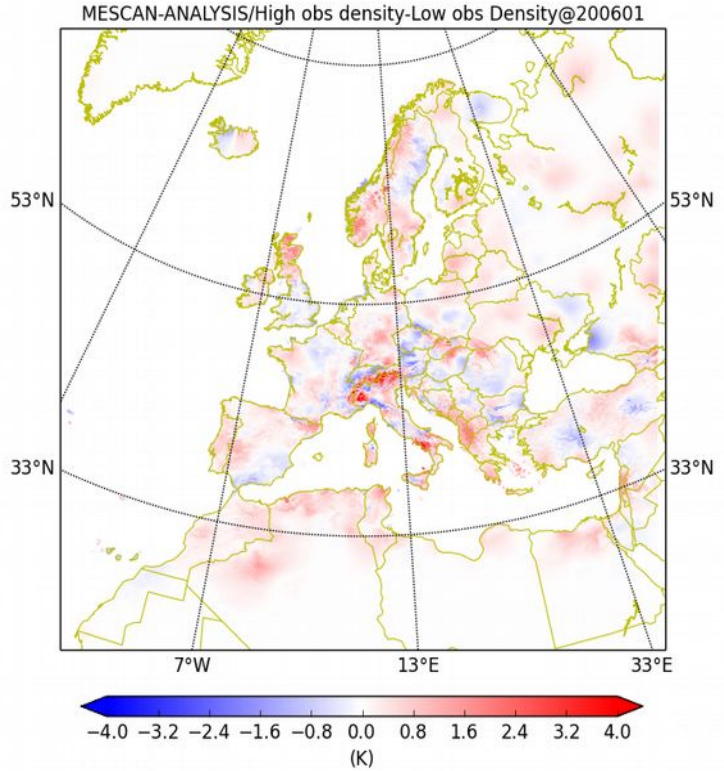

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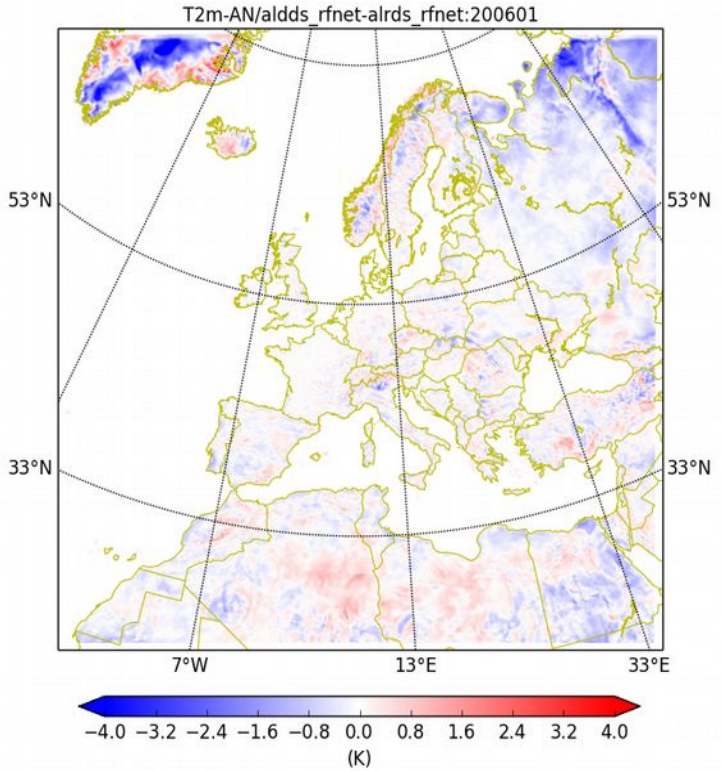

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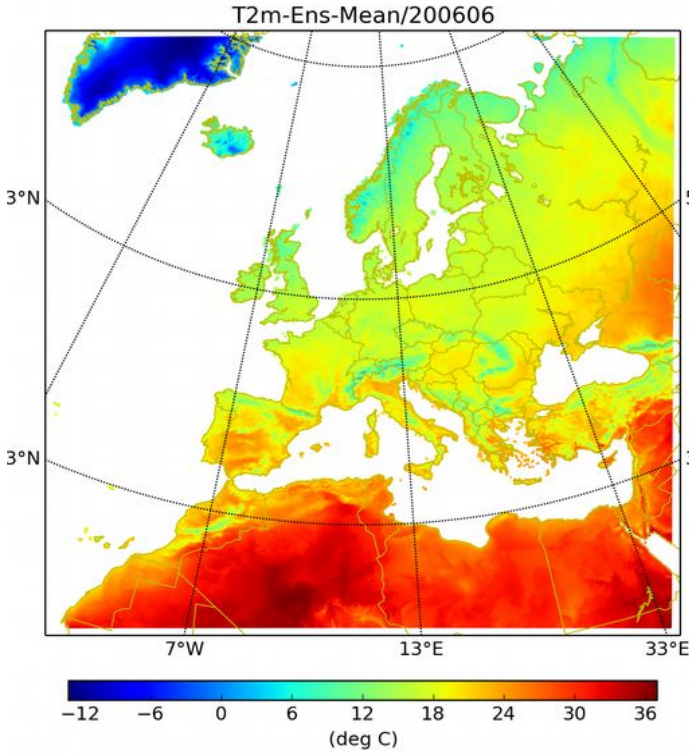
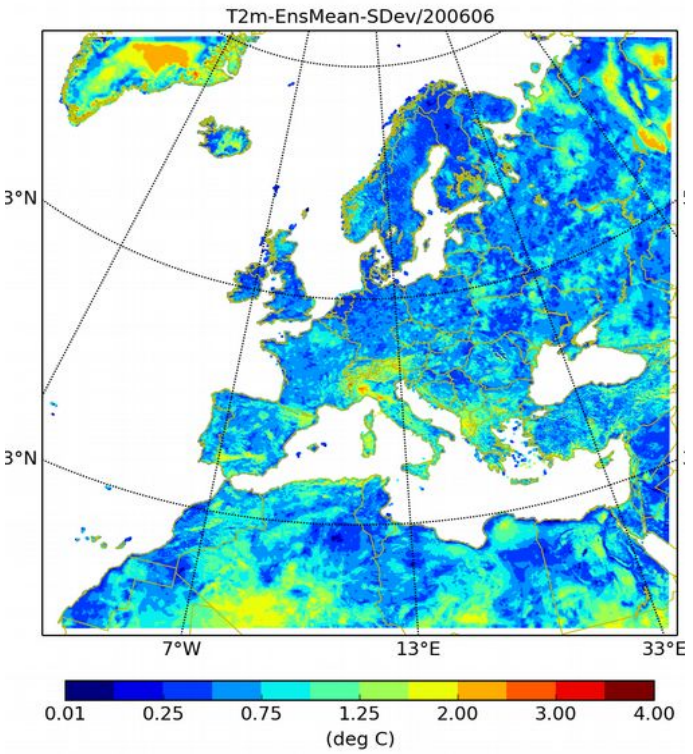
We need both approaches to estimate “correctly” the uncertainties in time and space

Ensemble (6-members) MEAN and SD of T2m Analysis (June 2006)

Ensemble Mean

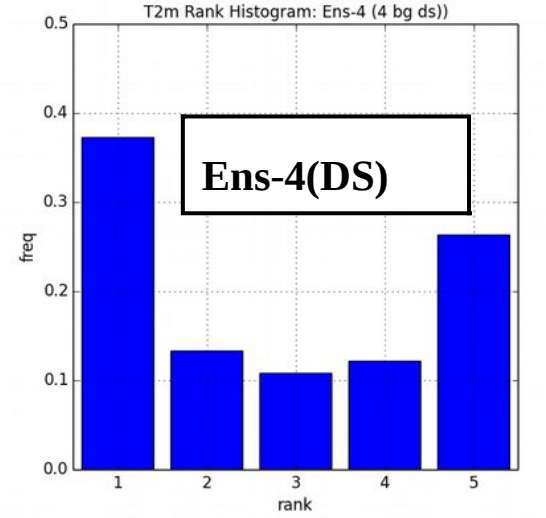


Ensemble Mean SD



SD is smaller (below < 1°) where observations are dense and in flat area.

Rank Histogram for T2m for June 2006 over Europe



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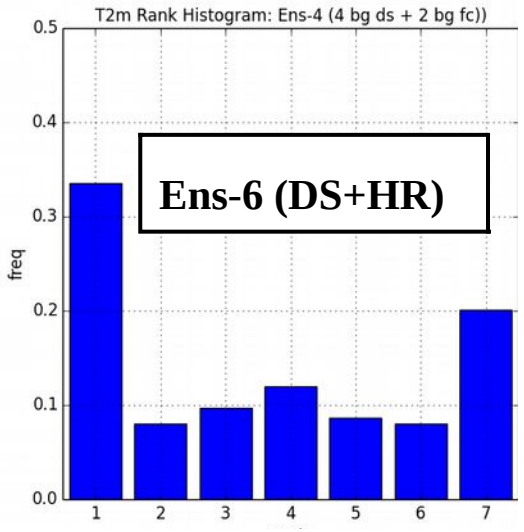

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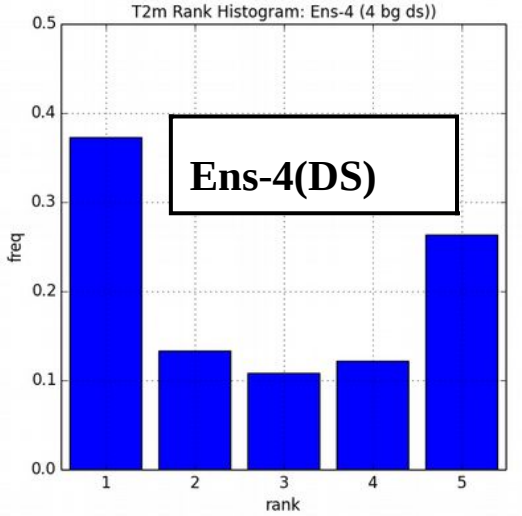

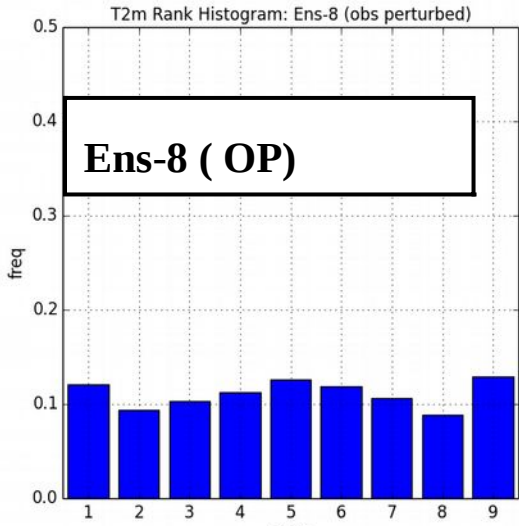

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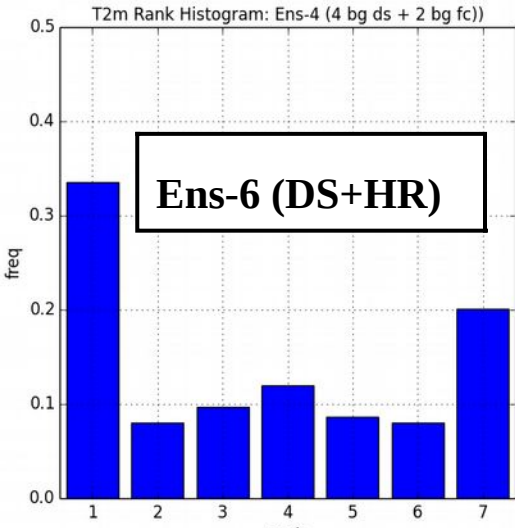

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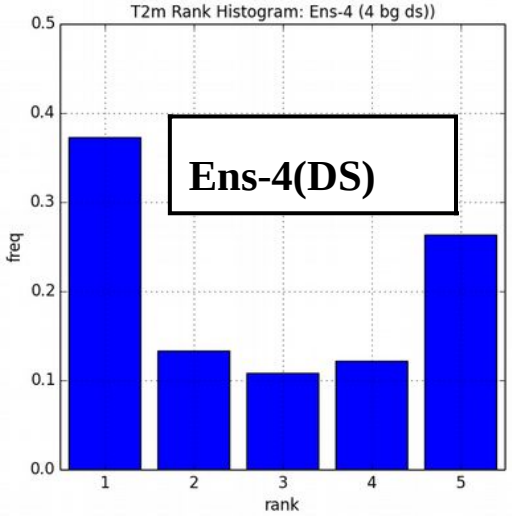

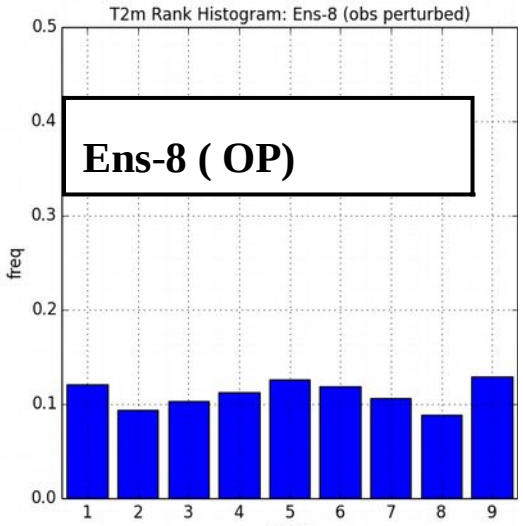

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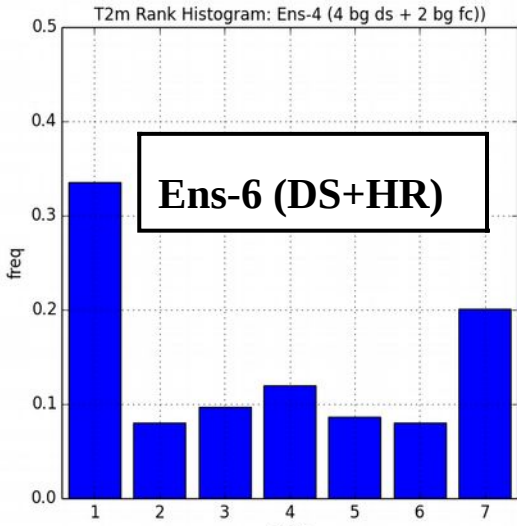
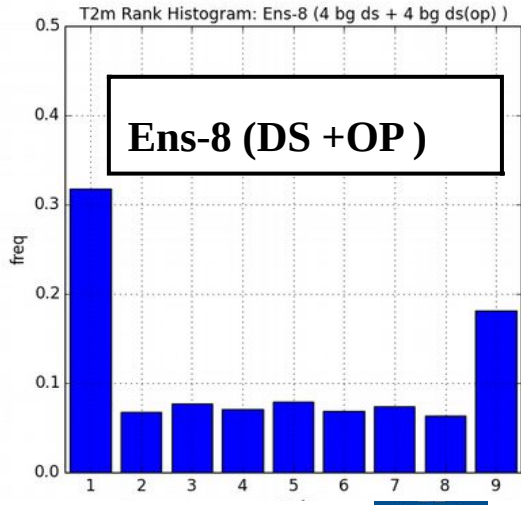
- **Ens-8 with ALADIN bg (DS) and perturbed obs. Shows a better spread but does not take into account the uncertainties coming from a lower density and the 2 model physics**
- **Ens-4(DS) with 4 members picked randomly from Ens-8 (OP) is better than Ens -4 and Ens-6**





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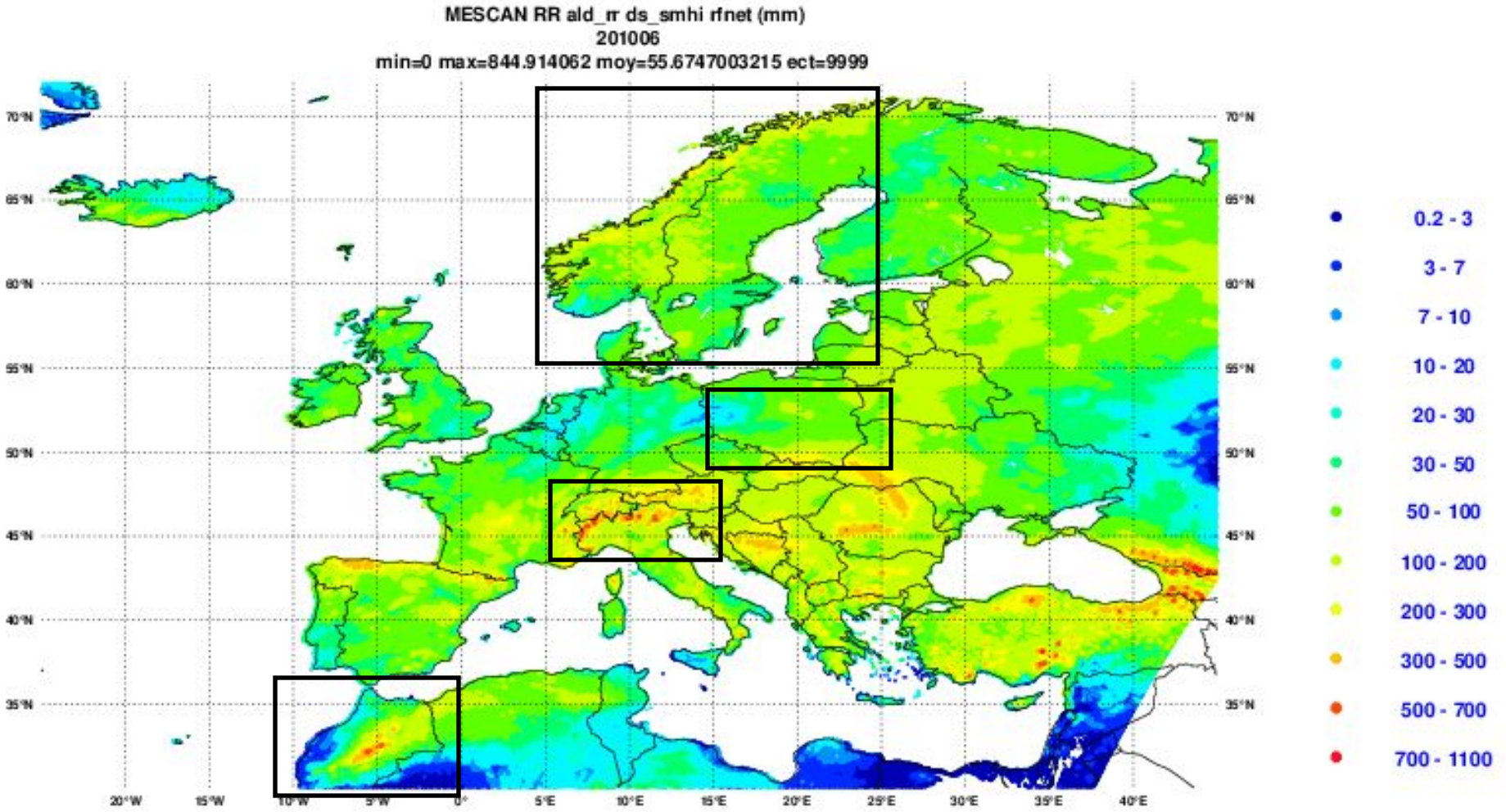
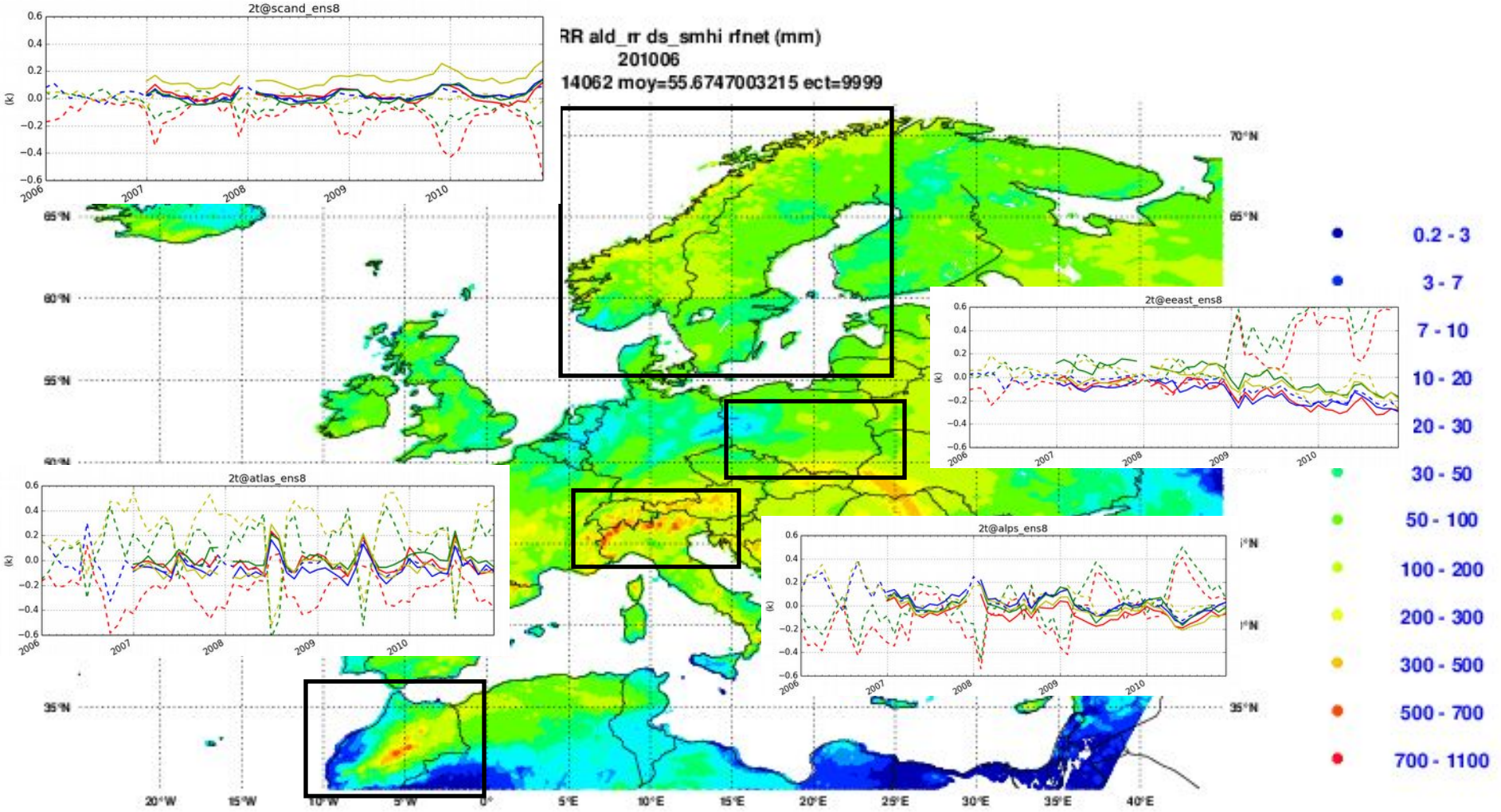


T2m : Ensemble members for 2006-2010 over Europe



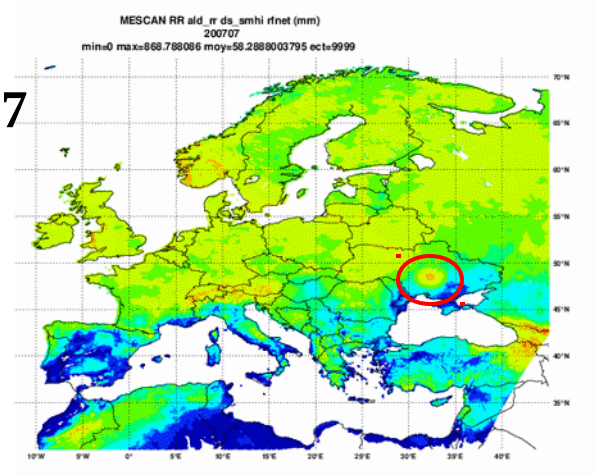
Production status

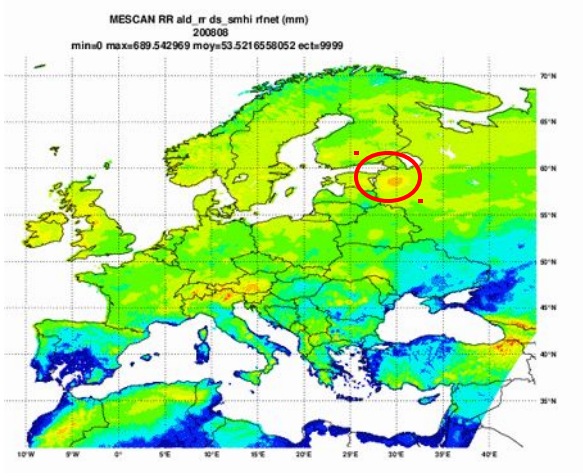
- **For the period 2006-2010**:
  - Ensemble is complete for the T2m/Hu2m with 8 members and for the 24H precipitation analysis with 6 members.
  - Grib1 file are available BUT not yet in GRIB2 and not available on Mars.
- **For the show case**: 2008 is available on Mars with analysis data and SURFEX output (special thanks to F. Besson, A. Verrelle & R. Mladek) but probably still some works is needed for some soil variables …
- **The reference production has started based on the new downscaled SMHI-3Dvar-ALADIN :**
  - First we need to downscale the SMHI-ALADIN background (T2m, Hu2M and precipitation) : one month in one day on (cca or ccb)
  - Period done: 1961-1964, 1970-1971, 1990-1993, 2000-2002, 2006-2012

Production status

- **The reference production has started based on the new downscaled SMHI-3Dvar-ALADIN :**
  - Precipitation analysis done for 2006-2010 : one year in 1.5 days BUT we will need probably to re-run some periods due to suspicious observations …

July 2007





Aug. 2008

- Temperature/Relative humidity done for 2008.
  - 2006 almost finished 15th November & 2007 29th july

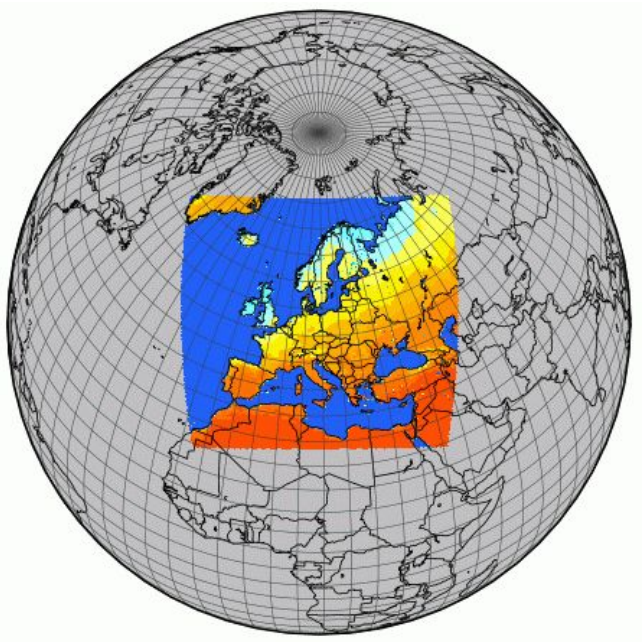
Conclusions :

- For the precipitation analysis, the differences in the physic model create uncertainties in area without observation (ex North Africa)
- Fine scale comes ONLY from the background at 5.5km especially for RR (Soci et al (2016))
- Large variability of the density network across Europe (partly due to the data policy) and along the 50 years
- Uncertainties come from the evolution of the observation network, observations errors AND model errors.

Conclusions & for the coming months :

1. Report on the surface ensemble re-analysis (re-run the ALADIN & ALARO model at 5.5km with the correct soil moisture for 2008) → 31 dec 2016
2. Surfex soil variable in GRIB2 on Mars & put the ensemble MESCAN.
3. Create observations file for the period 1961/1980 especially for the precipitation from several data bases (ECMWF, MF, SMHI, ECA&D)
4. Continue to downscale the SMHI background : follow the SMHI production
5. Sensitivity experiments with SURFEX-TRIP using MESCAN-ENSEMBLE impact on river discharge, snow, soil moisture etc …(P. Le Moigne Talks)

Thank you for your attention! Questions ?



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