

ARRA : Kilometric re-analysis over France with AROME (ARome Re-Analysis)

Eric Bazile¹, P. Le Moigne¹, Y. Selly¹, S. Van Hyfte², J-M Willemet², A. Verrelle¹

(1) CNRM, Université de Toulouse, Météo-France, CNRS, Toulouse, France

(2) Direction de la Climatologie et des Services Climatiques, Météo-France, Toulouse, France.

25th EMS

2-6 September 2024, Barcelona, Spain

- **ERA5 (1950 - RT)**

- Global re-analysis ECMWF, 31km
- ERA5-Land : ERA5 Downscaled at 9km to « drive » a surface module

- **UERRA (1961-2019)**

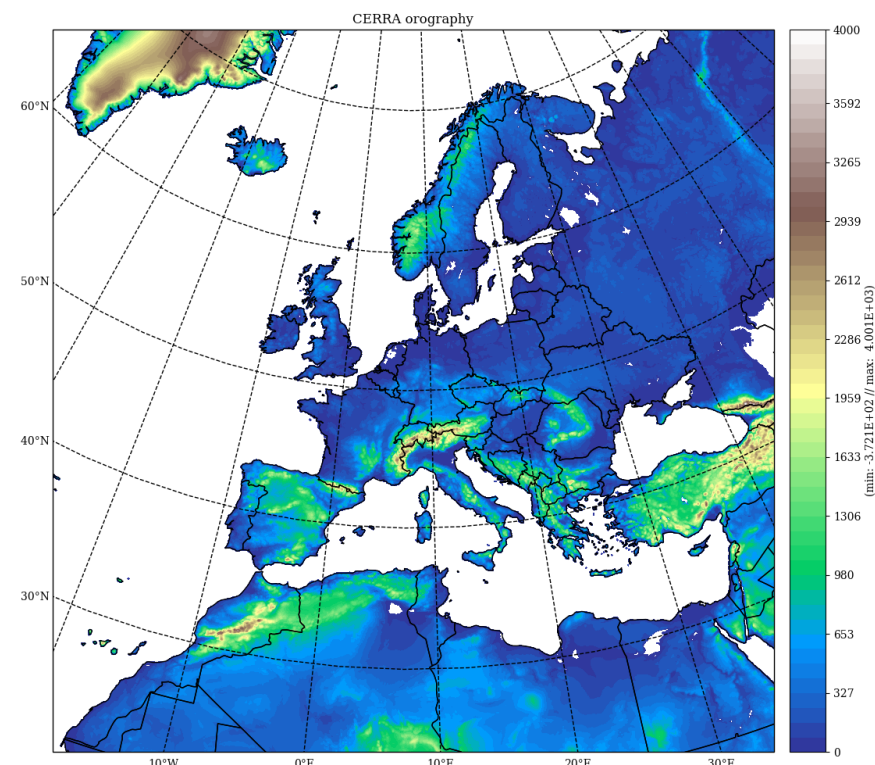
- European re-analysis, 3D-Var 11km
- **UERRA-MESCAN-SURFEX (1961-2019):**
- Downscaled at 5.5 km with a surface and precipitation analysis → « drive » SURFEX-offline

- **CERRA (1984-2021)**

- European re-analysis, 3D-Var 5.5 km
- **CERRA-Land (1984-2021):**
- precipitation analysis and SURFEX -Offline

- **CERRA-TU (2021-NRT) (ends 08/2027)**

- Production has re-started to catch up NRT
- Back extension for CERRA and CERRA-Land since 1961



- **ERA5 (1950 - RT)**

- Global re-analysis ECMWF, 31km
- ERA5-Land : ERA5 Downscaled at 9km to « drive » a surface module

- **UERRA (1961-2019)**

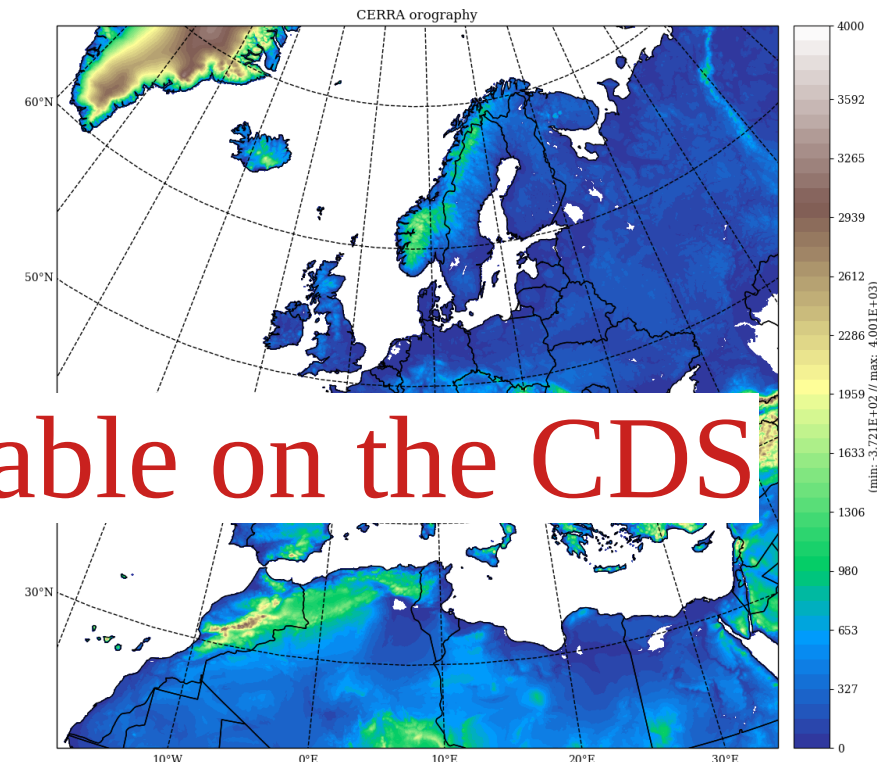
- European re-analysis, 3D-Var 11km
- **UERRA-MESCAN-SURFEX (1961-2019):**
- Downscaled at 5.5 km with a surface and precipitation analysis → « drive » SURFEX-offline

- **CERRA (1984-2021)**

- European re-analysis, 3D-Var 5.5 km
- **CERRA-Land (1984-2021):**
- precipitation analysis and SURFEX -Offline

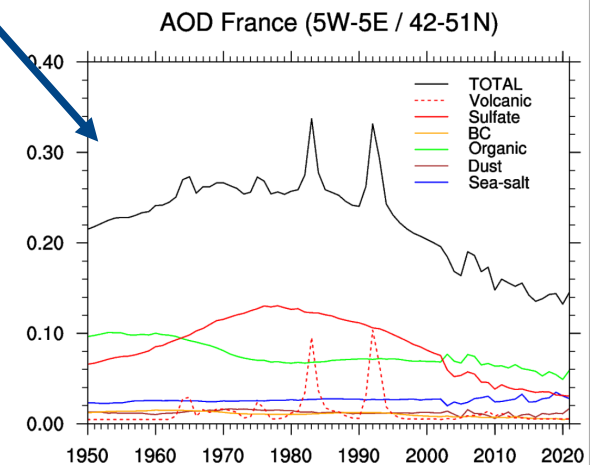
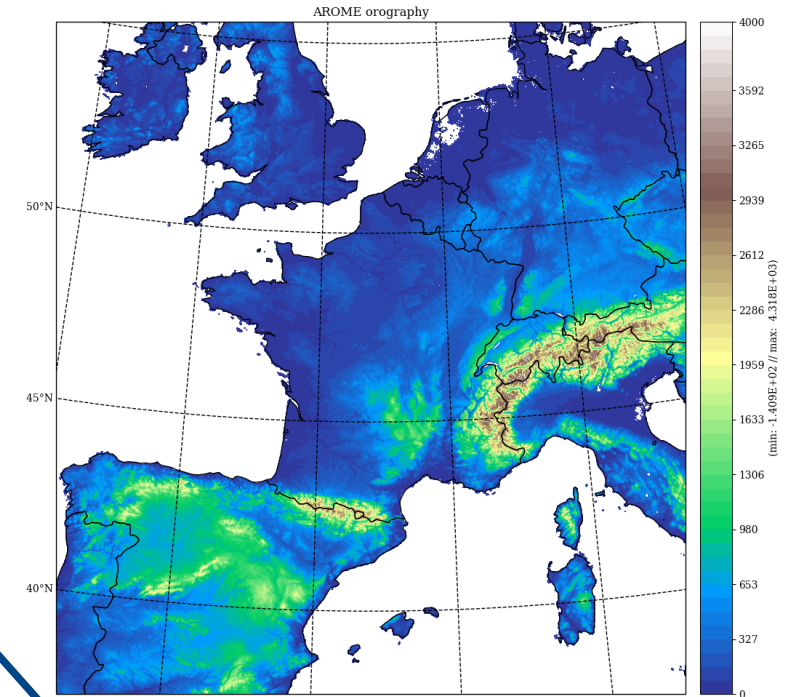
- **CERRA-TU (2021-NRT) (ends 08/2027)**

- Production has re-started to catch up NRT
- Back extension for CERRA and CERRA-Land since 1961



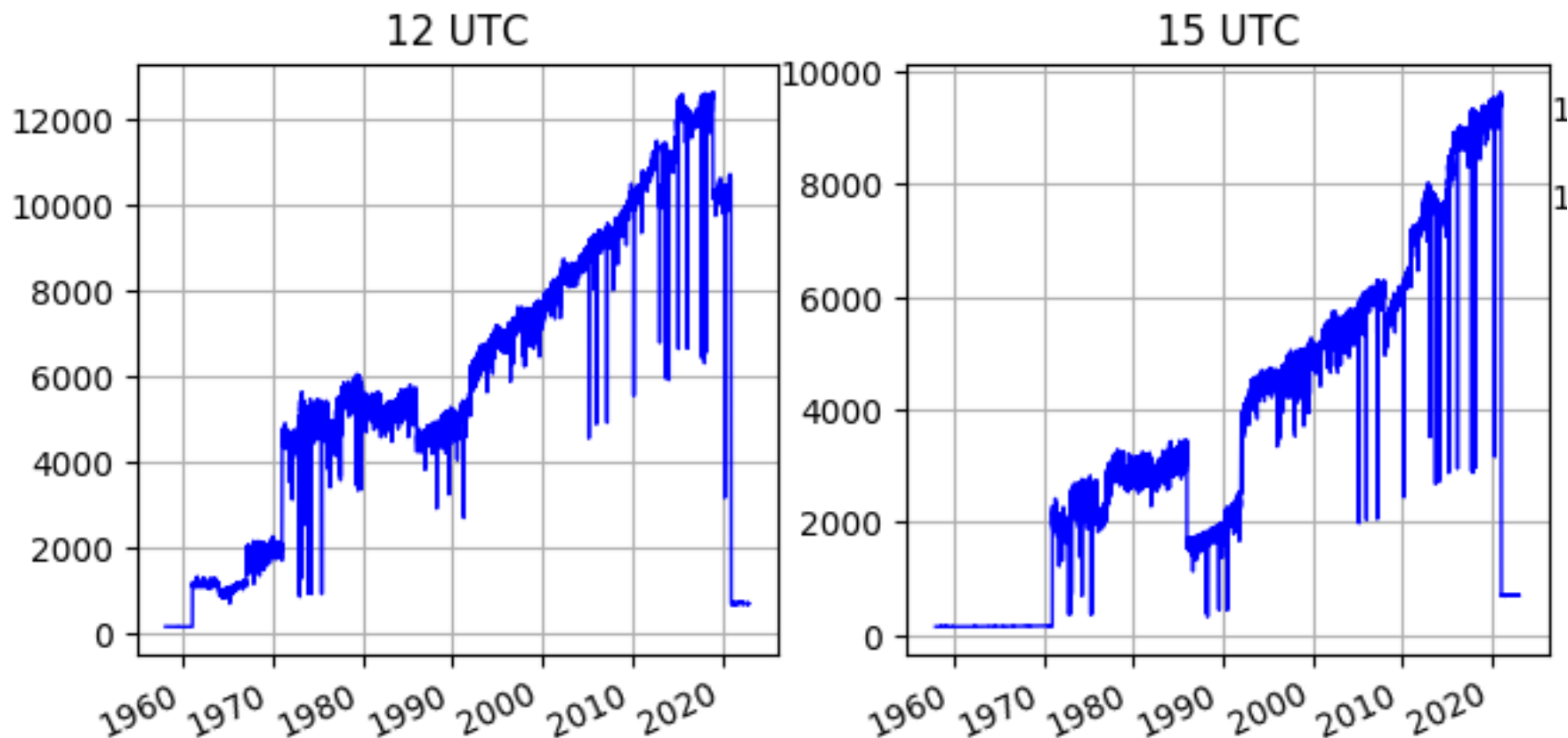
- Need to replace the operational system based on SAFRAN (8km) with a high resolution re-analysis (<2km) for a 50 year period and a near real time production
- Improve the small scale representation , precipitation, hydrology, wind and solar energy
- Use for impact study with AROME-Climat
- European Re-analysis : UERRA and CERRA (resp. 11km and 5.5km) are not available in near real time, too coarse resolution and do not use all the observations available in France.

- AROME-France configuration : 1.3km, L90, same domain, time-step, post-processing, code version (cy48t1op1) Seity et al. (2011), Brousseau et al. (2016)
- Specific changes :
 - No 3DVar only dynamical adaptation with surface assimilation every 3h, with IAU (Incremental Analysis Update) Bloom et al. (1996)
 - Use annual aerosols based on CAMS and TACTIC (P. Nabat) instead of a 30years climatology
 - LBC and IC for the upper air : UERRA before 1985 and CERRA after.
 - Daily precipitation analysis with MESCOAN (Soci et al. (2016))
 - Lake module (FLake) (Coll. A. Napoly)
 - Solar eclipse extended to the past (Coll. J.M. Piriou and P. Descamps (IMCCE))
- ARRA-Land : SURFEX-offline @ 1.3km with advanced soil and snow scheme forced by ARRA and MESCOAN precipitation analysis



Volume for 60 years : ~ 13Po
Production plan : 1 year in 1.3 month so with 6 streams of 10 years ~ 15 months

- Several input data BDCLim, Bdmonde, UERRA/CERRA and AEMET



Mean number of T2M obs : no observations available at 3,9,15 and 21UTC before 1971

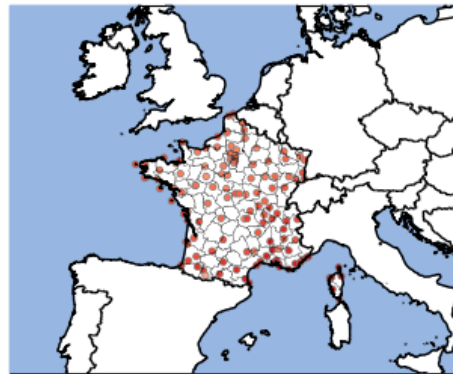
- Several input data BDCLim, Bdmonde, UERRA/CERRA and AEMET

(T2m) 28-06-1961

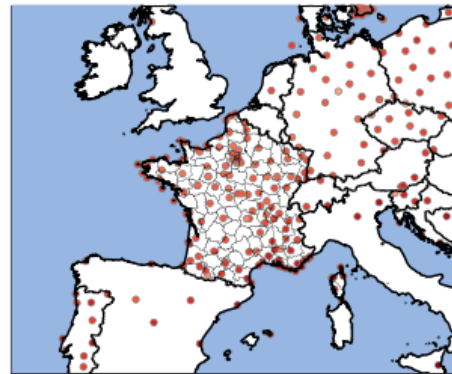
00 UTC



03 UTC



06 UTC

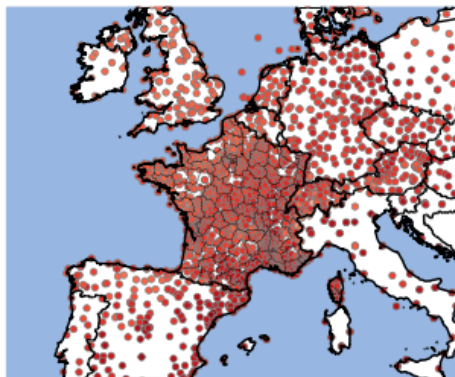


09 UTC

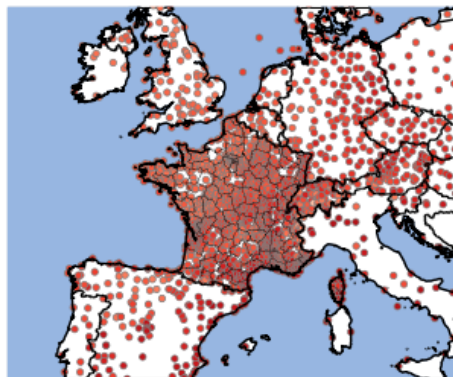


(T2m) 28-06-1998

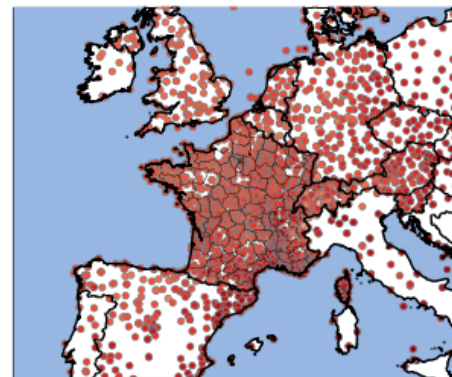
00 UTC



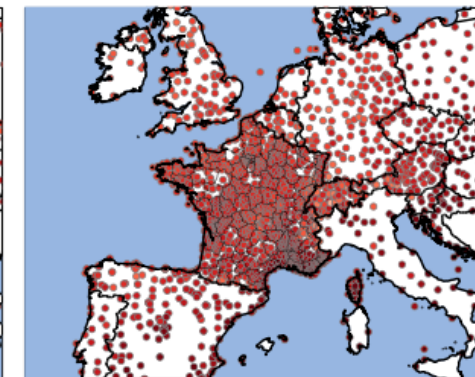
03 UTC



06 UTC



09 UTC



ARRA Dynamical Adaptation

CERRA 5.5km
Analysis (upper air)
Interpolated @1.3km

CERRA 5.5km
Analysis (upper air)
Interpolated @1.3km

Surface
analysis

Surface
analysis

AROME fc3h

AROME fc3h

AROME fc3h

Obs

T2m, Hu2m, Snow

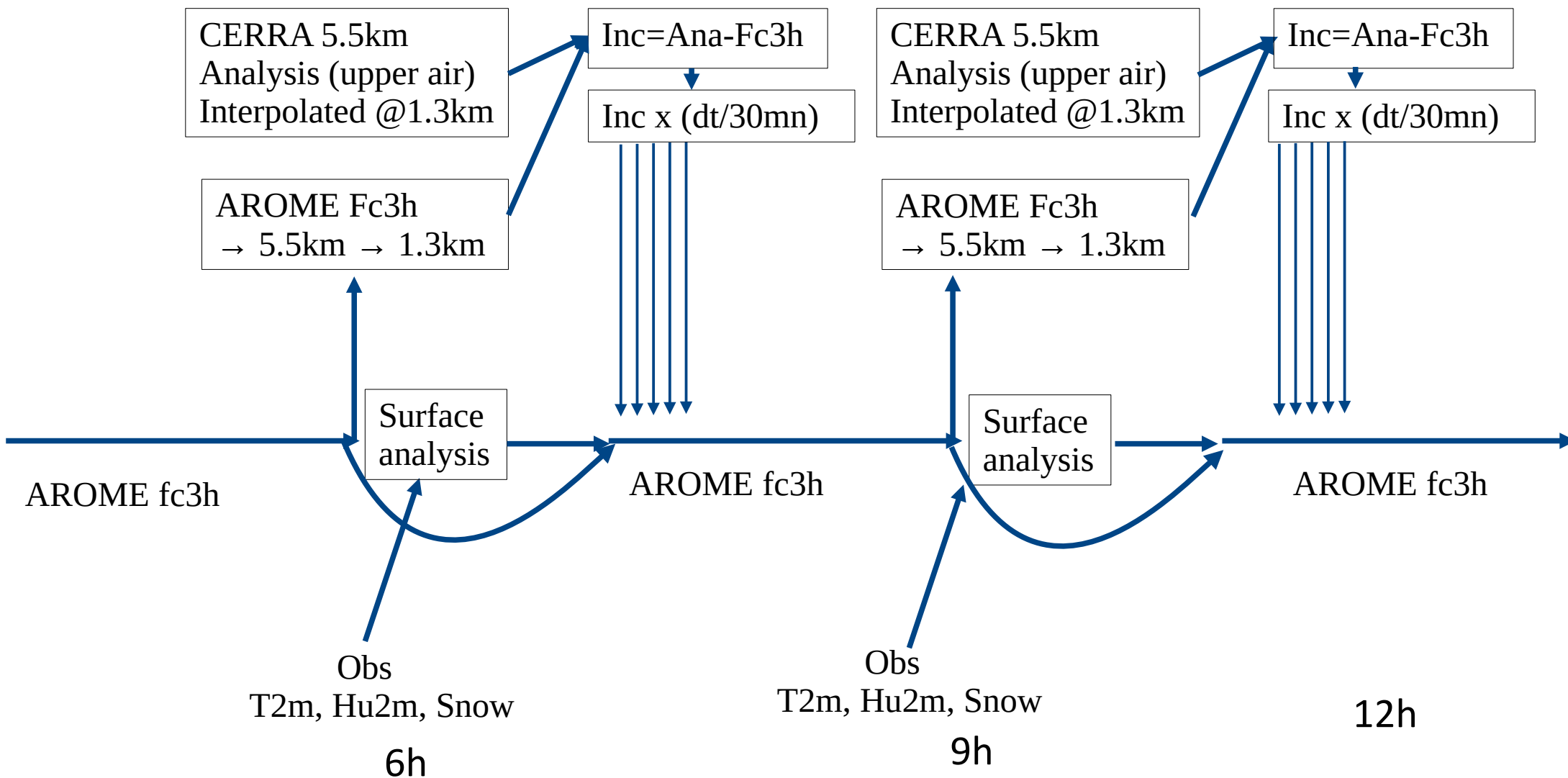
6h

Obs

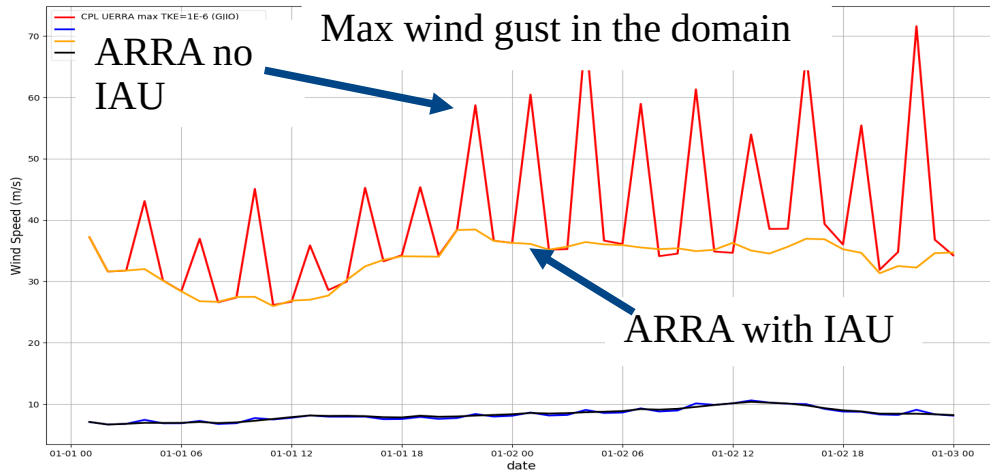
T2m, Hu2m, Snow

9h

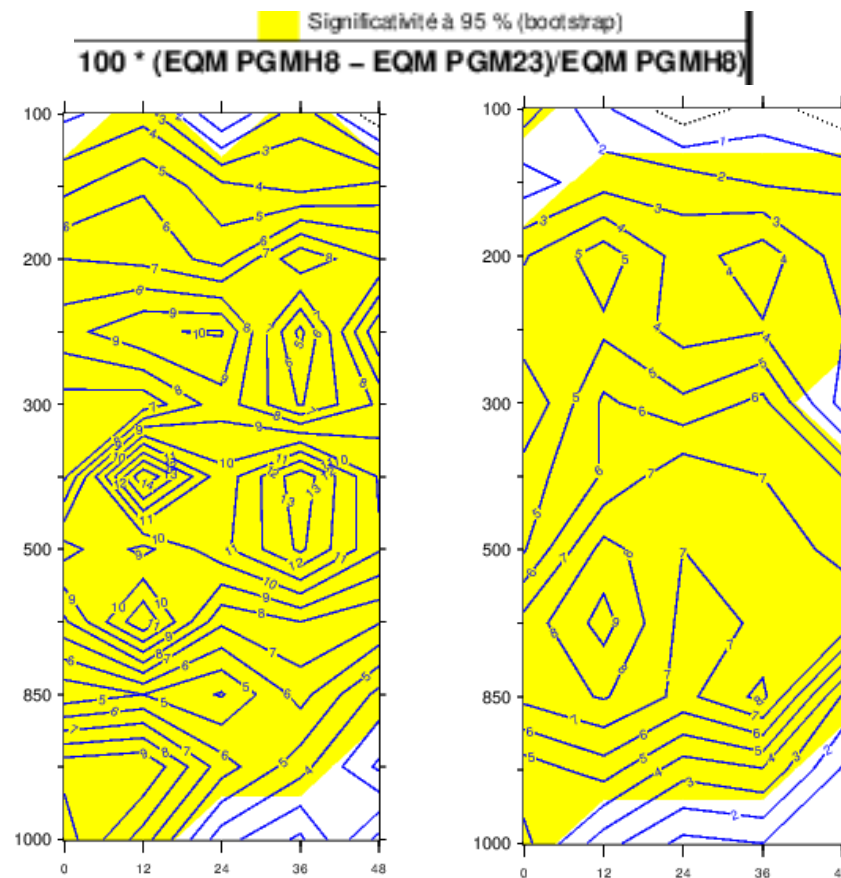
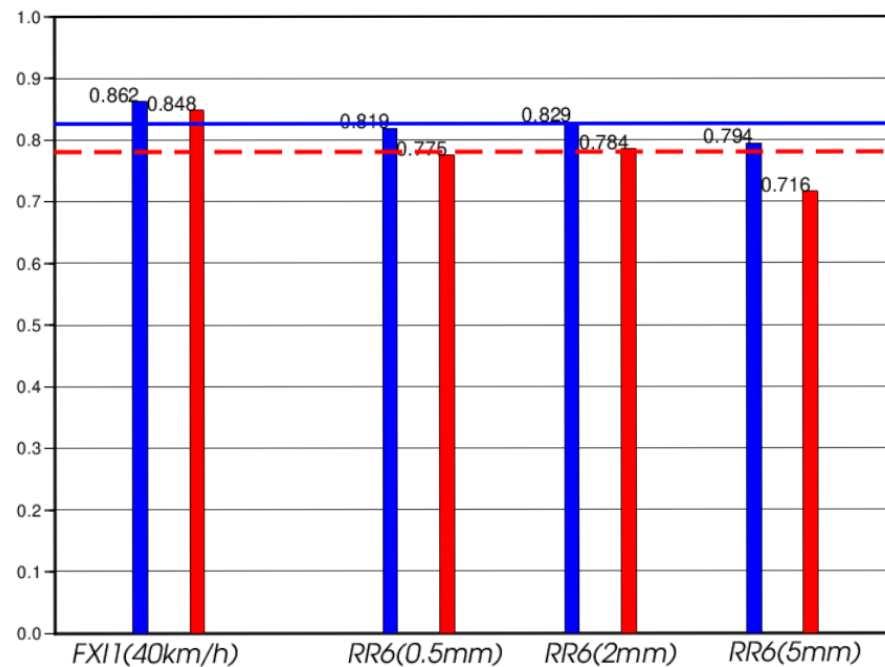
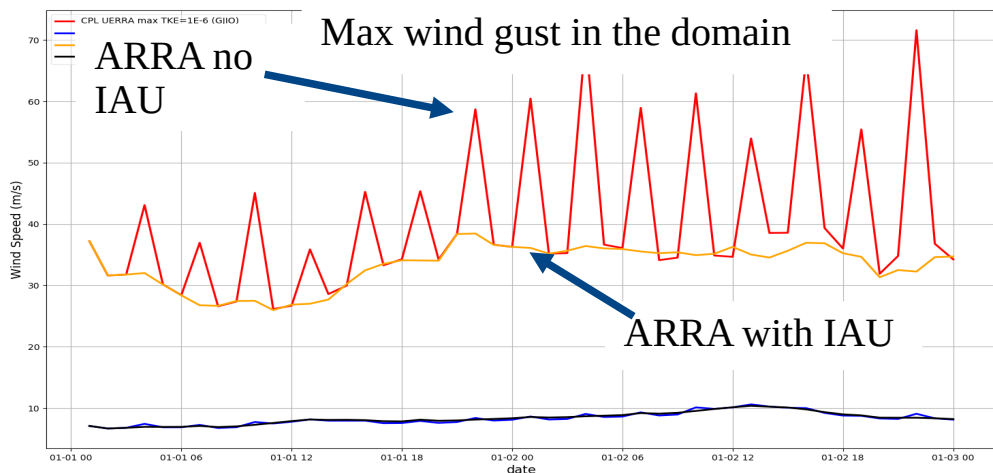
12h



IAU and LBC impact



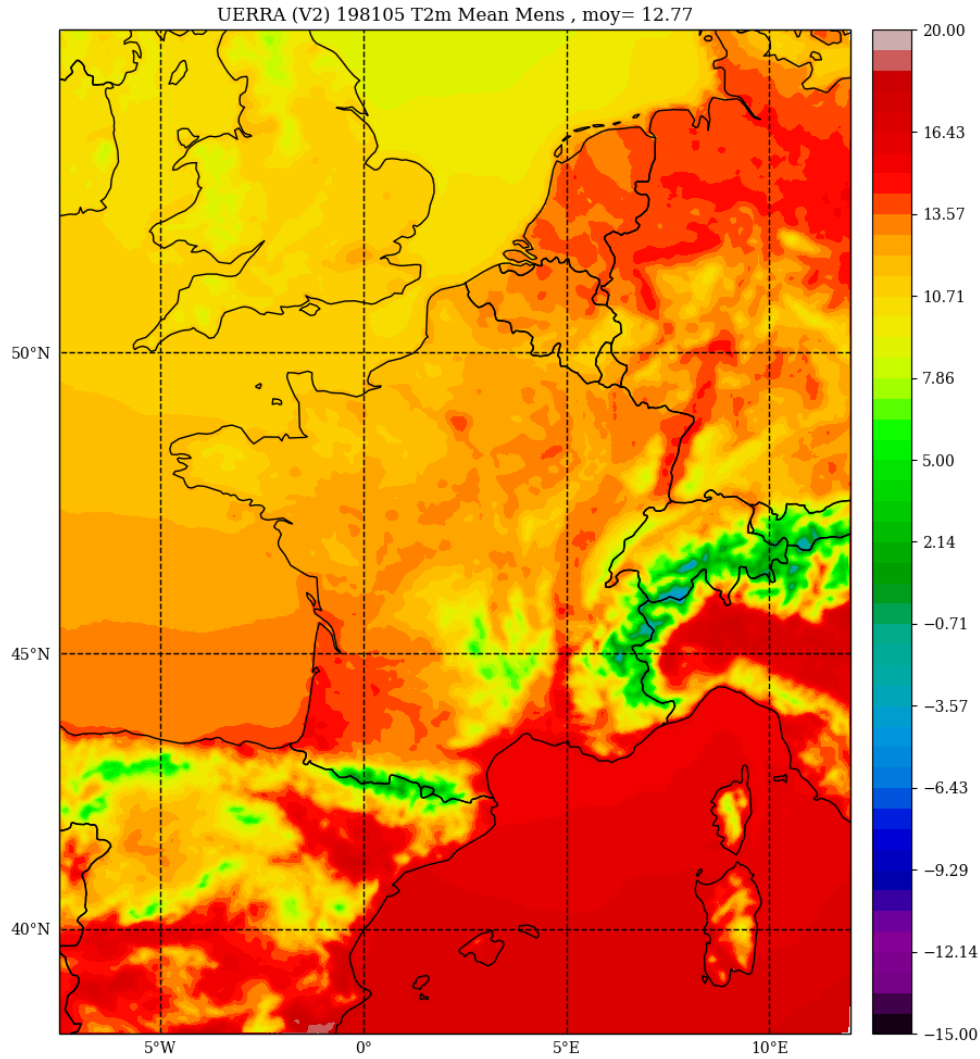
IAU and LBC impact



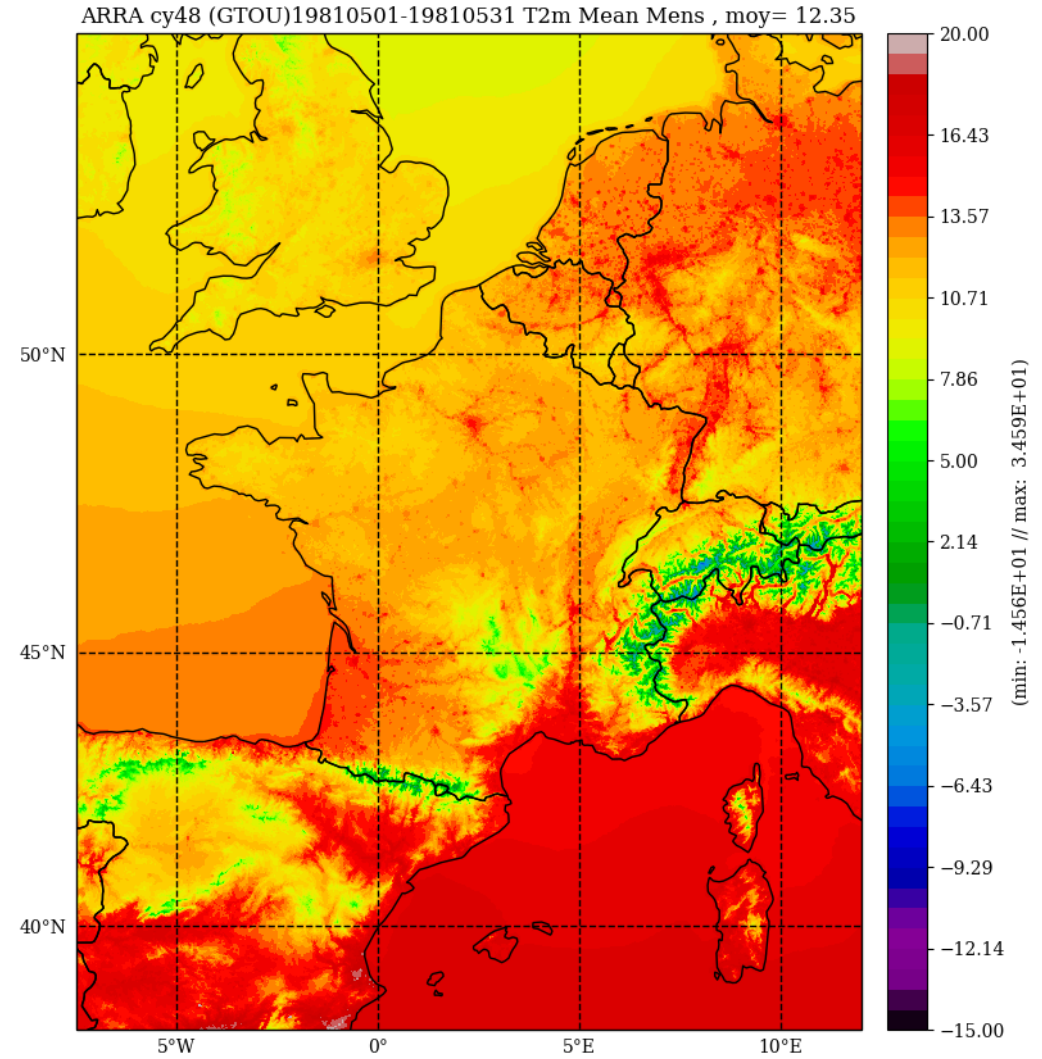
Temperature
Vent (module)
With UERRA init/LBC slightly worse

Jan-Feb 2019
ARRA coupled with CERRA Indic=0.826
ARRA coupled with UERRA Indic=0.781

T2m Monthly mean May 1981

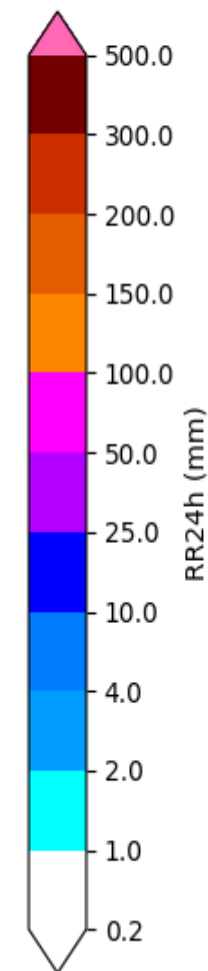
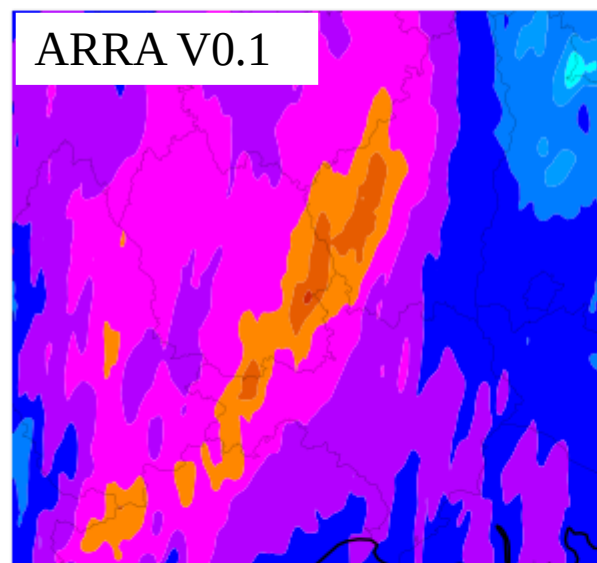
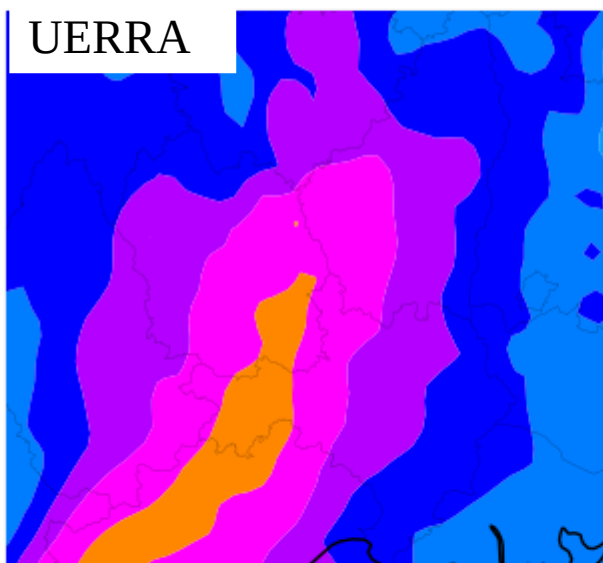
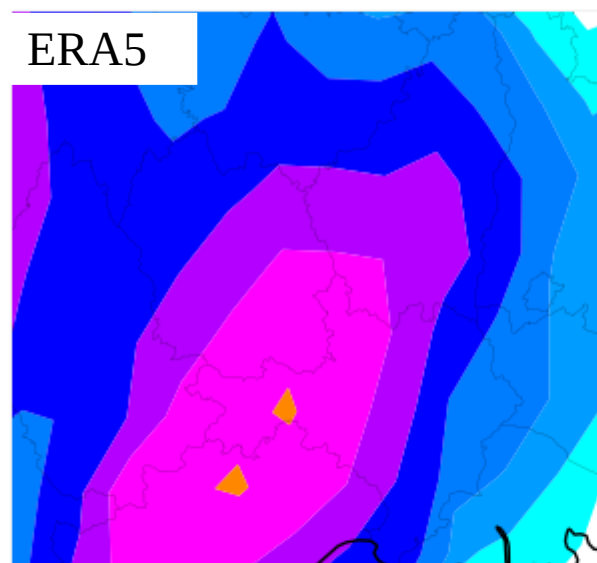
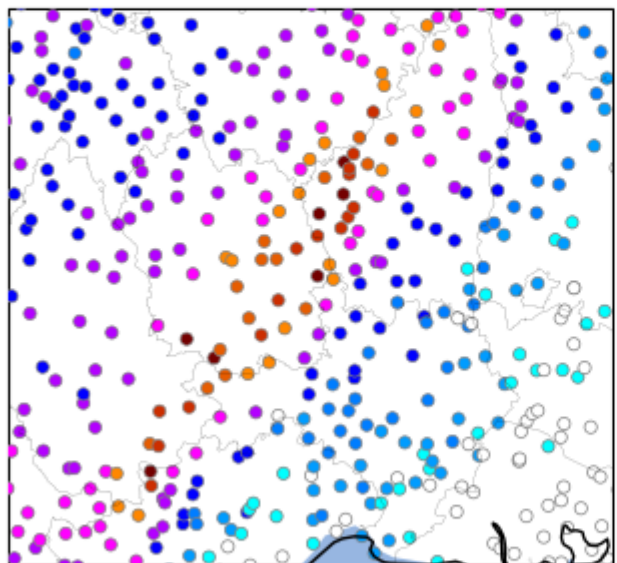


UERRA-MESCAN-SURFEX 5.5km

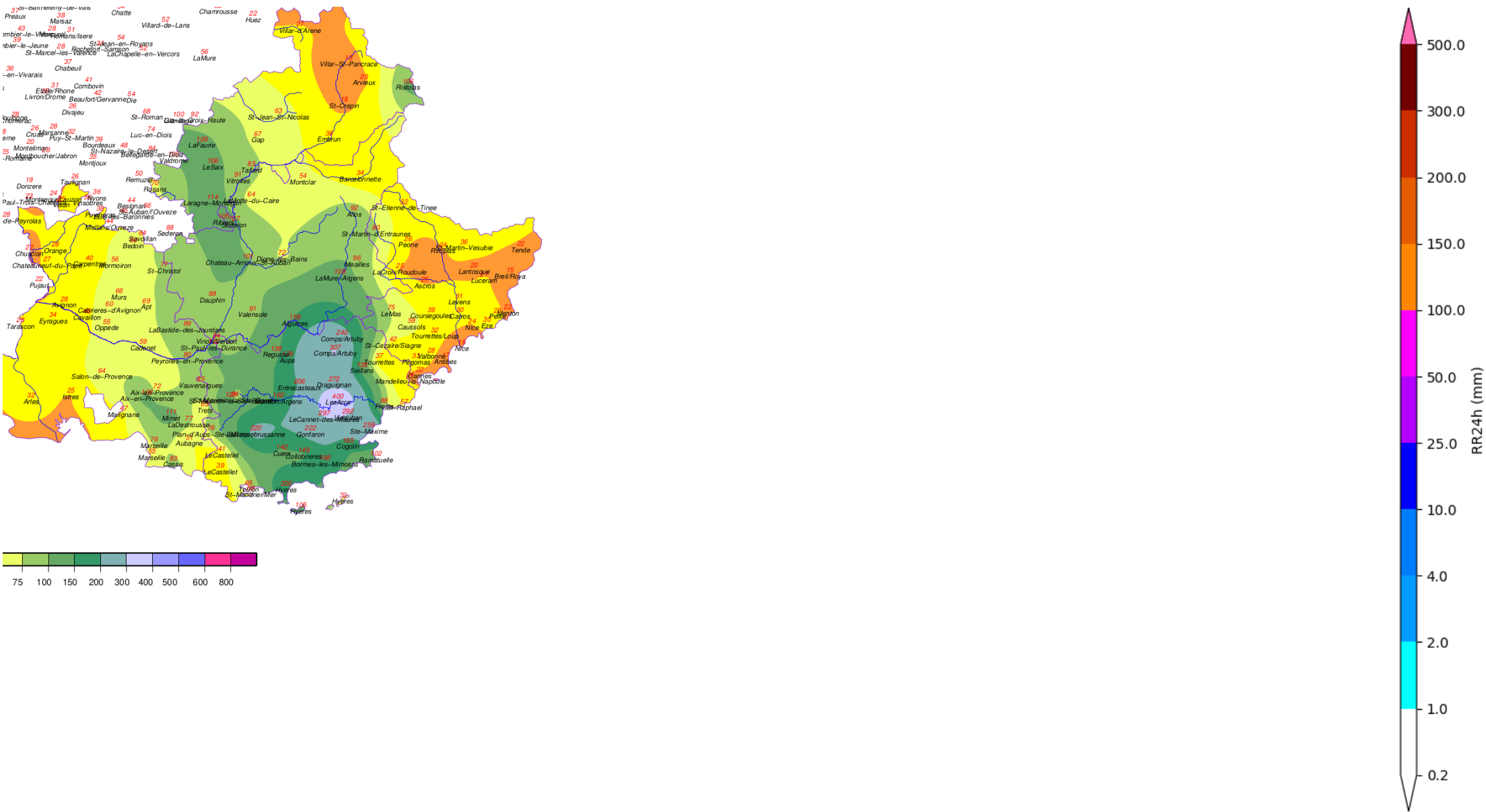


ARRA-V0.1 1.3km

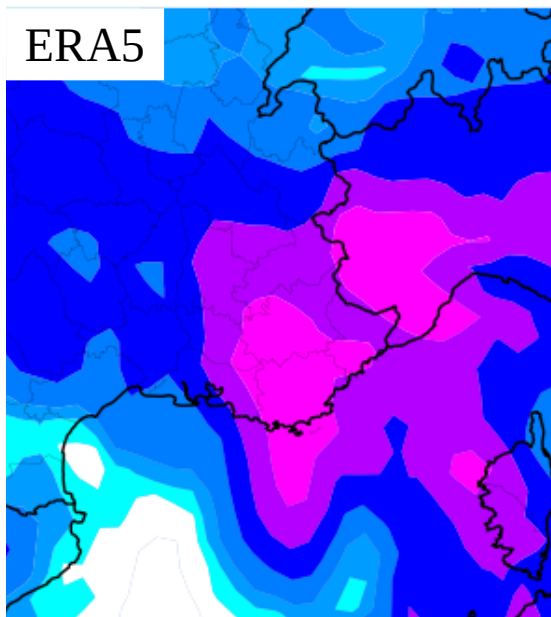
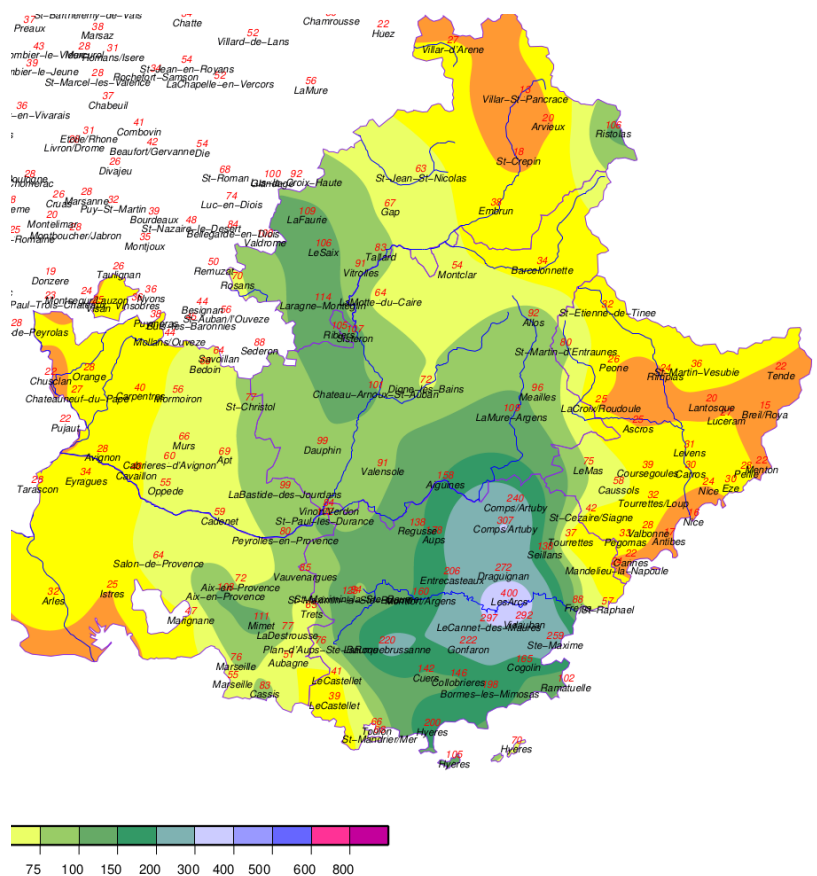
Extreme precipitation 24h accumulated 20/21 Sept 1980



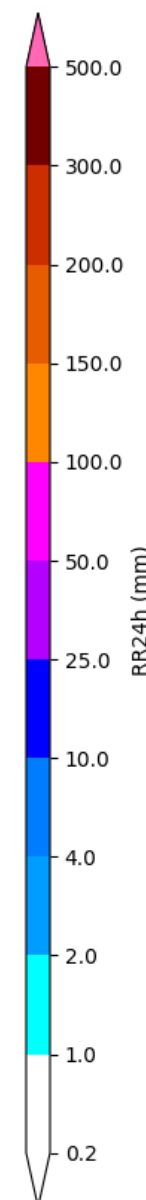
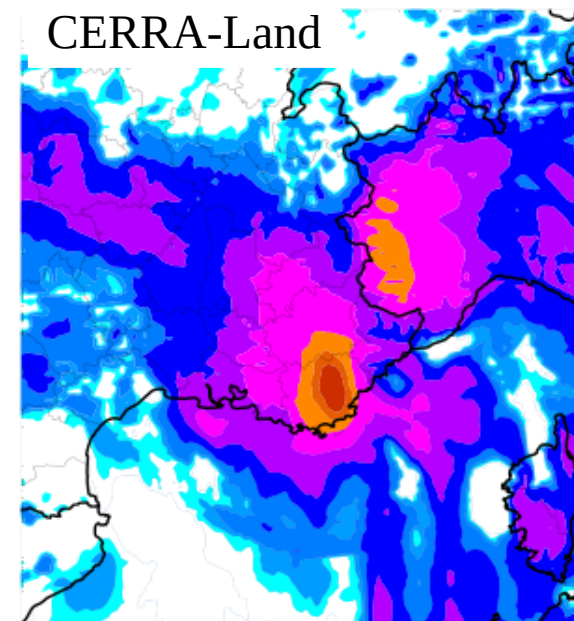
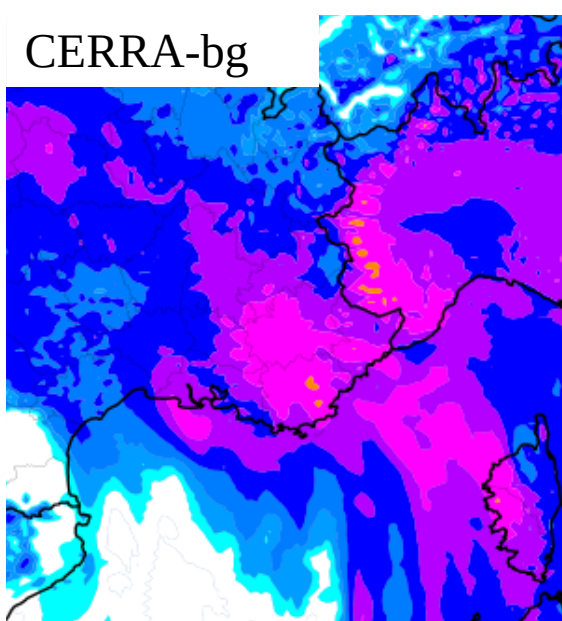
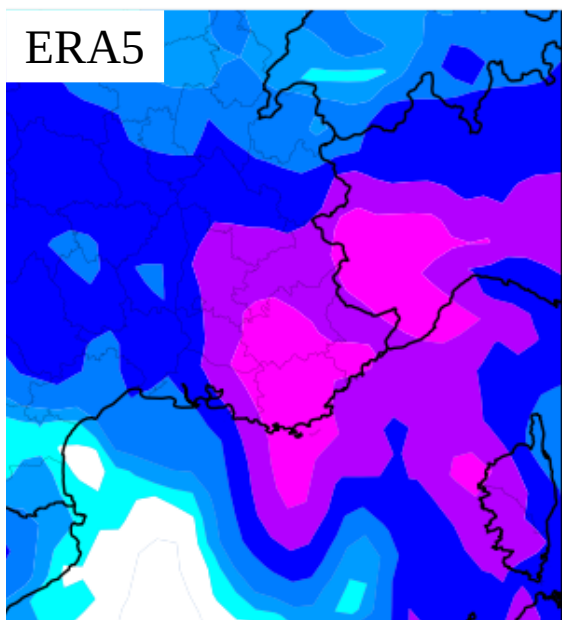
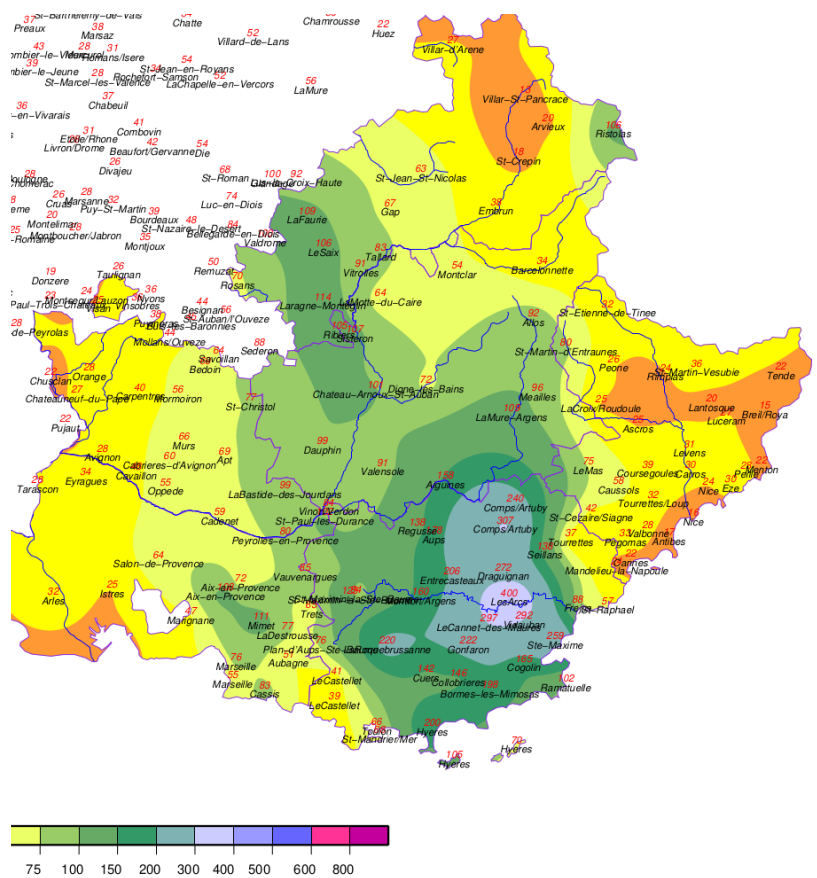
Extreme precipitation 24h accumulated 15 June 2010



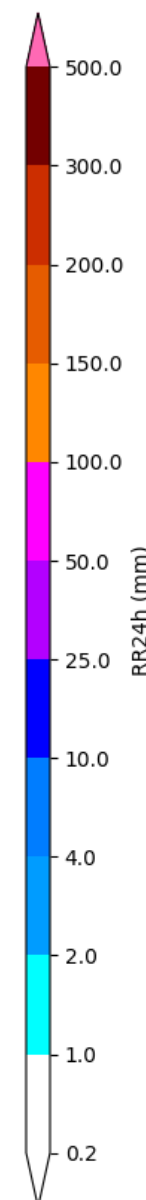
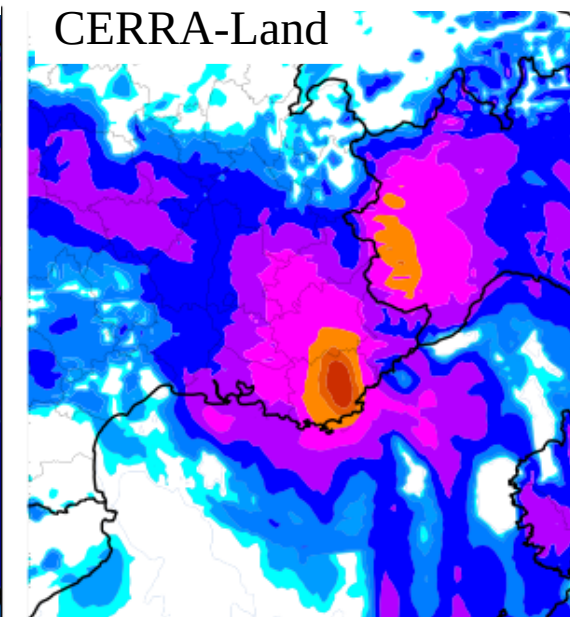
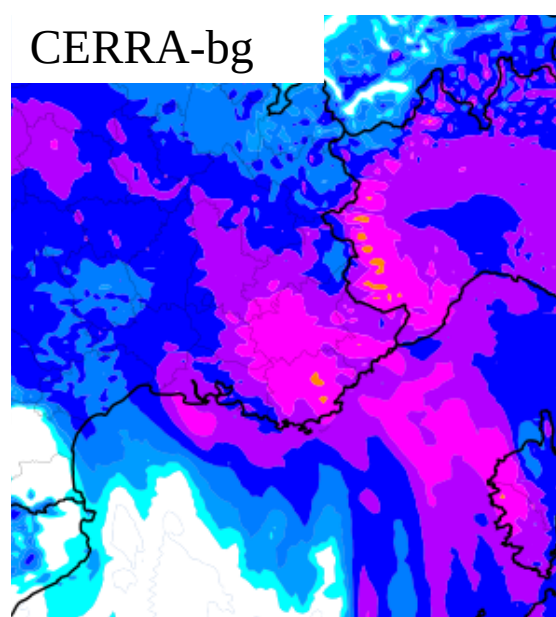
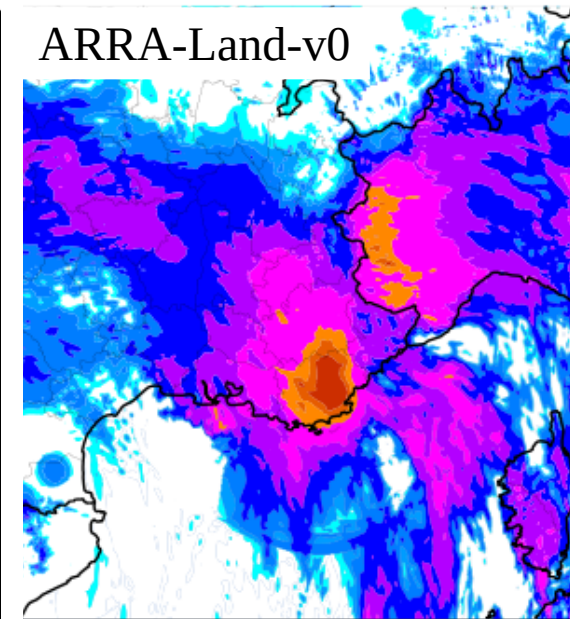
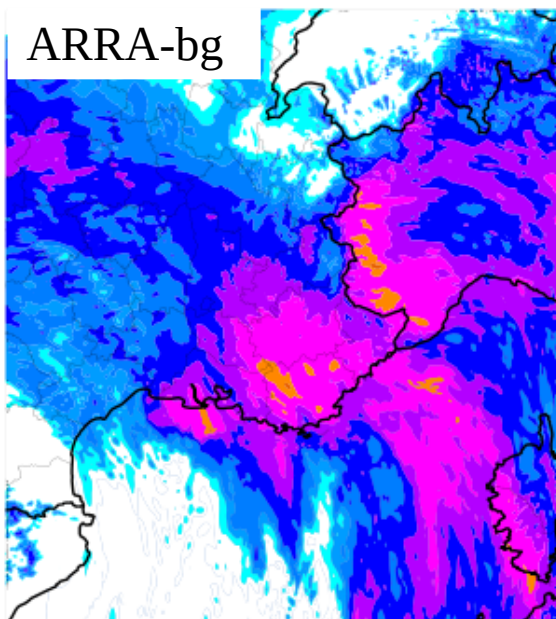
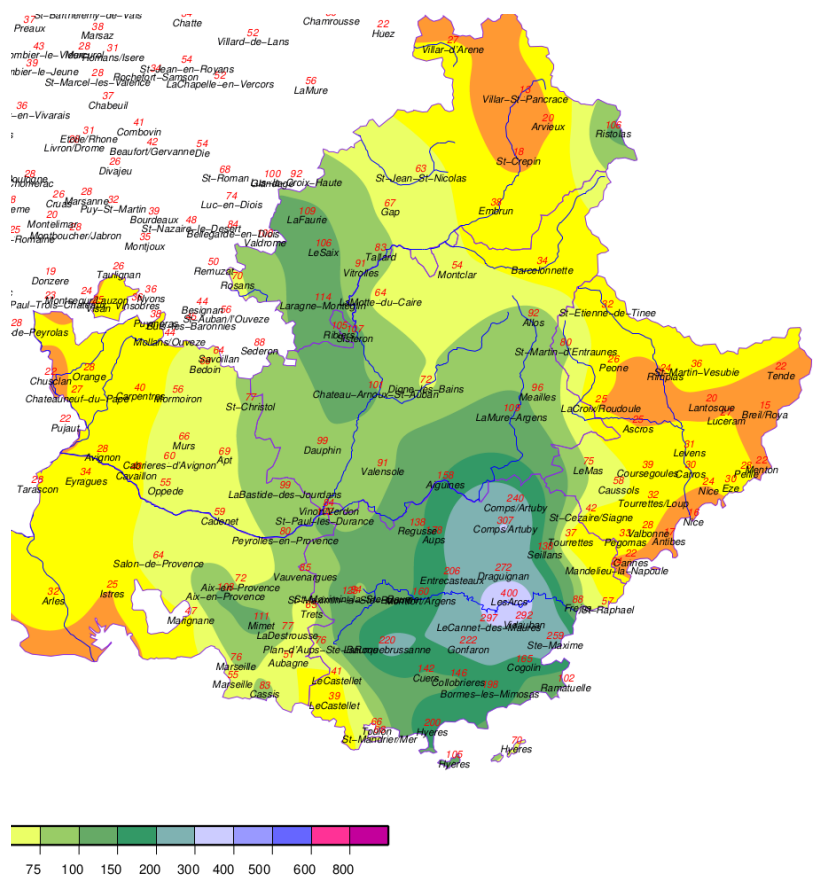
Extreme precipitation 24h accumulated 15 June 2010

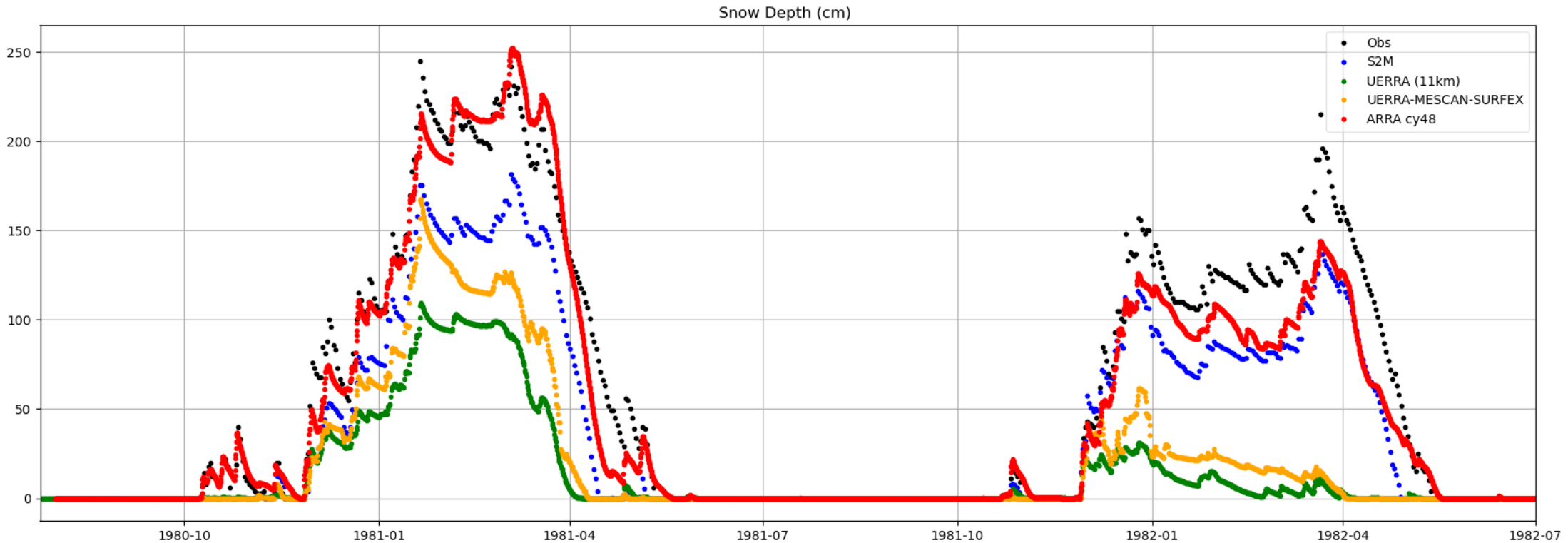


Extreme precipitation 24h accumulated 15 June 2010



Extreme precipitation 24h accumulated 15 June 2010





Encouraging preliminary result:

ARRA is better than UERRA-MESCAN-SURFEX and S2M (SAFRAN re-analysis) at Col de Porte (1325m)

We can expect better result with ARRA-Land with sophisticated soil and snow scheme, forced by precipitation analysis (MESCAN) instead of direct model output

Conclusions :

- The internal ARRA project has started in summer 2022
- Unexpected problem was to transfer the native file from UERRA/CERRA from Ecfs to MF_archive to compute LBC ; some missing files due to the “trip” to Bologna
- The preliminary results are promising, the IAU option was necessary to avoid spin-up problem due to the downscaling from UERRA/CERRA
- The ARRA configuration with some specific modification (new aerosols, FLake) is now in the final evaluation on the period 1980-1990 before “official production”
- Production should start end of 2024
- The ARRA-Land production with the daily precipitation analysis should start beginning of 2025
- The period 1961-2020 should be ready end of 2025 ! if no problem

