



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

Eric Bazile & Patrick Le Moigne

3rd ACCORD All Staff Workshop
27-31 March, Tallinn



- 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.

- **ERA5 (1950 - RT)**

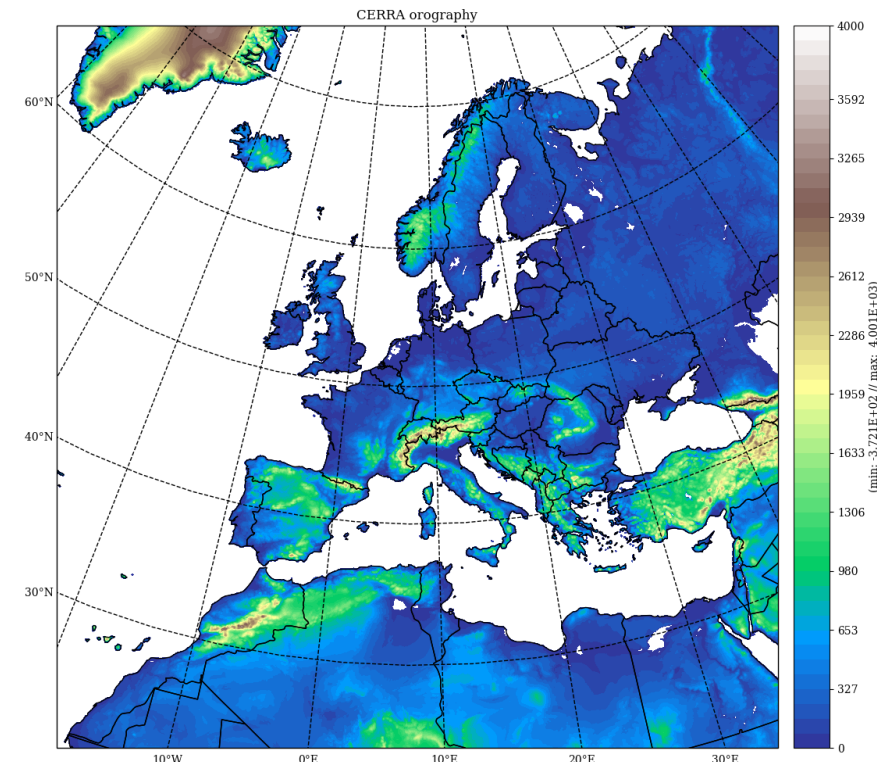
- Global re-analysis ECMWF, 31km
- ERA5-Land : ERA5 Downscaled at 9km to « drive » a surface module

- **UERRA (1961-2019)**

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

- **CERRA (1984-2021)**

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



- **ERA5 (1950 - RT)**

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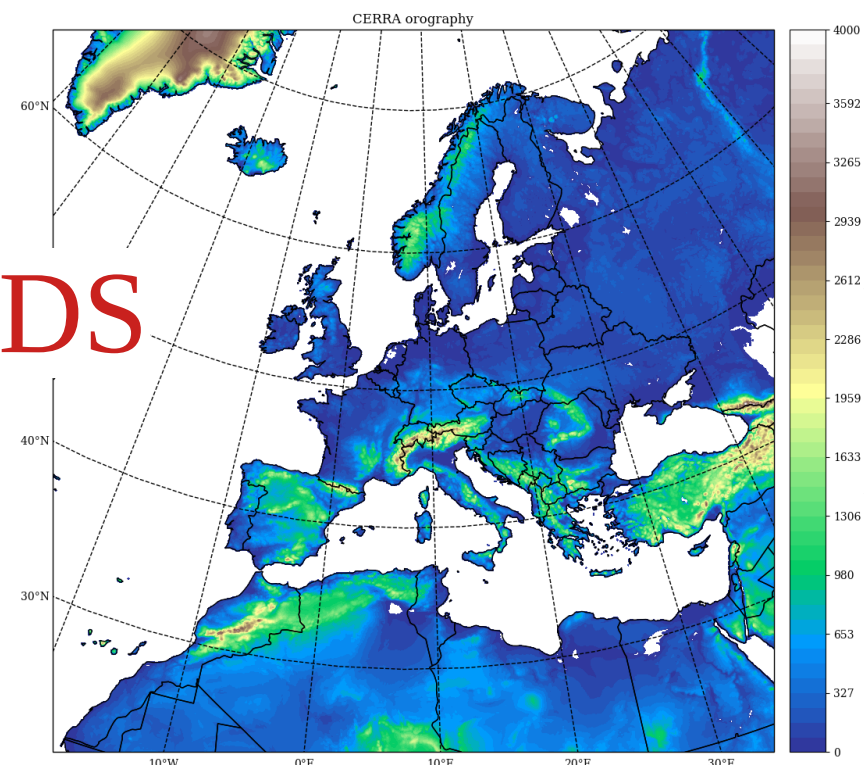
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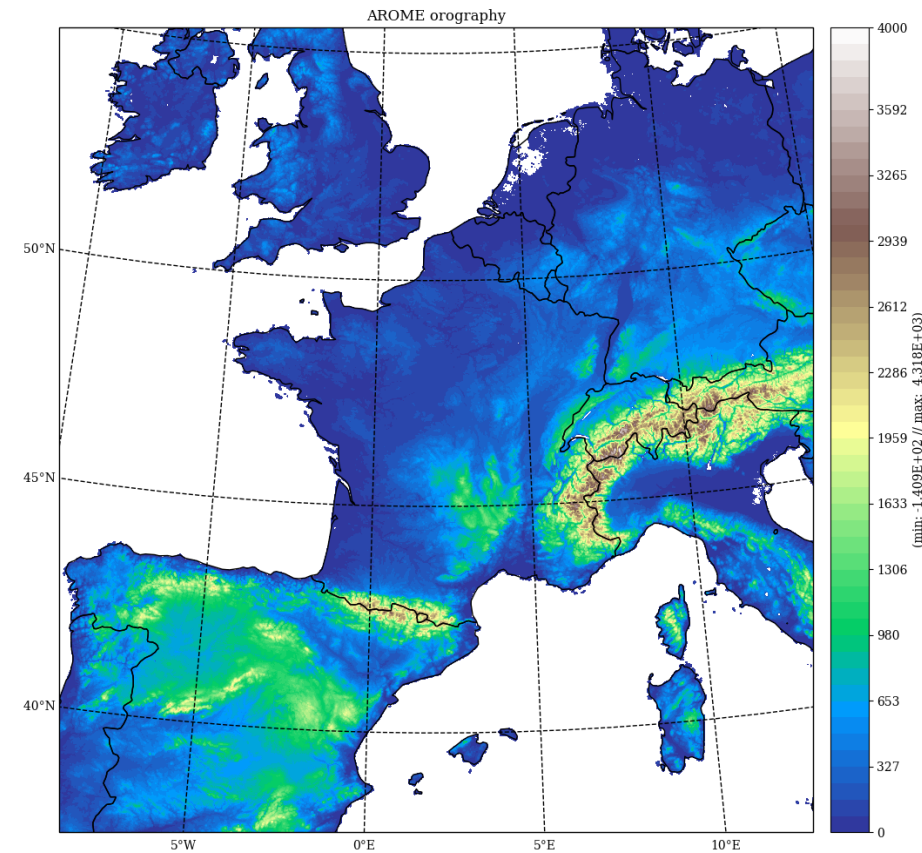
available on the CDS

- **CERRA (1984-2021)**

- European re-analysis, 3D-Var 5.5km
- CERRA-Land (1984-2021)
- Precipitation analysis and SURFEX-Offline at 5.5km



- AROME-France geometry 1.3km, L90, same domain, time-step, post-processing, oper cycle (probably cy48t1), under vortex
- Specific changes :
 - No 3dVar only dynamical adaptation with surface assimilation every 3h, IAU ?
 - Mixed precision
 - Daily precipitation analysis with MESCAN
 - LBC and IC for the upper air : UERRA before 1985 and CERRA after.
 - SURFEX-offline with Diff + ES (MEB ?) @ 1.3km



Volume for 50 years :

ARRA : hourly output + 1 fc 30h at 00utc ~8000 To + UERRA/CERRA LBC (1000 To)

ARRA-Land : Precipitation analysis + surfex output in GRIB2 and NetCdf (?) (1400 To)

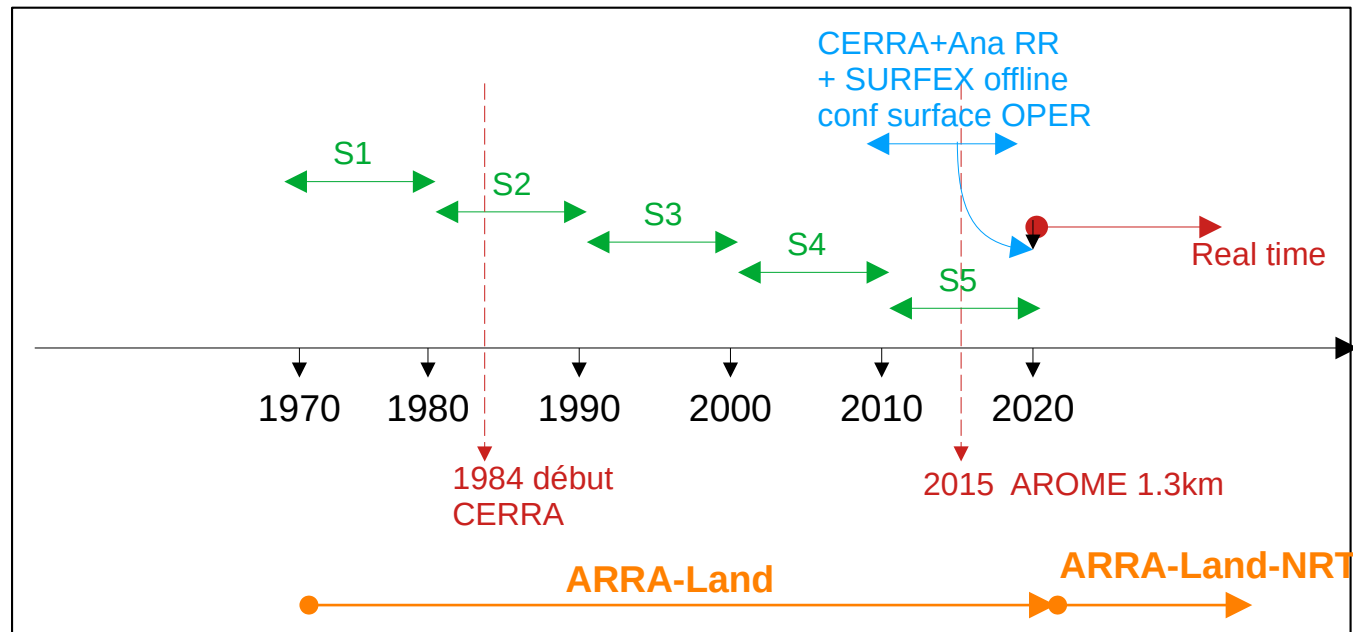
Total : 10400 To

ARRA project :

- **WP0** : Management E Bazile - P Le Moigne and N. Boullot (adm)
- **WP1** : Atmospheric production : **E. Bazile**
 - System configuration : LBC, IAU or not
 - Impact of the LBC between UERRA (11km, 6h) and CERRA (5.5km,3h)
 - Observation file (T2m, Hu2m, snow)
- **WP2** : real time system **P. Le Moigne, C. Birman**
 - MESCAN precipitation analysis in cy48
 - Precipitation analysis with AROME-MF oper background under Vortex
 - Off-line SURFEX under Vortex in real time
- **WP3** : Precipitation analysis and SURFEX offline **S. Van Hyfte**
 - Precipitation observation file with QC based on Météo-France database, CERRA and UERRA
 - Precipitation analysis and SURFEX off-line production for the 50 years (1970-2020)
- **WP4** : Evaluation and users **A. Drouin**
 - Evaluation compared to SAFRAN, CERRA and UERRA for ECV
 - Hydrology, snow, energy sector ...

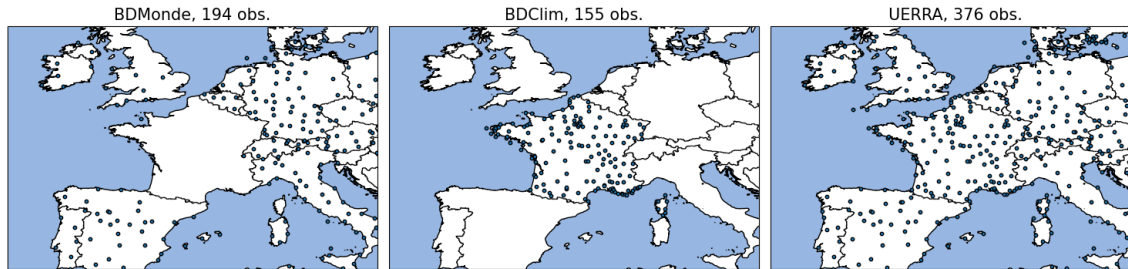
ARRA production plan

- Atmospheric : 50 years , 5 streams (10 years) with 1 year spin-up
- Off-line SURFEX 1 stream 1/1/1970 to 31/12/2020 = **ARRA-Land**
- **ARRA-Land-NRT** : Probably after 31/12/2020 SURFEX off line will continue driven by the operational AROME-FR and the daily MESCOAN precipitation analysis

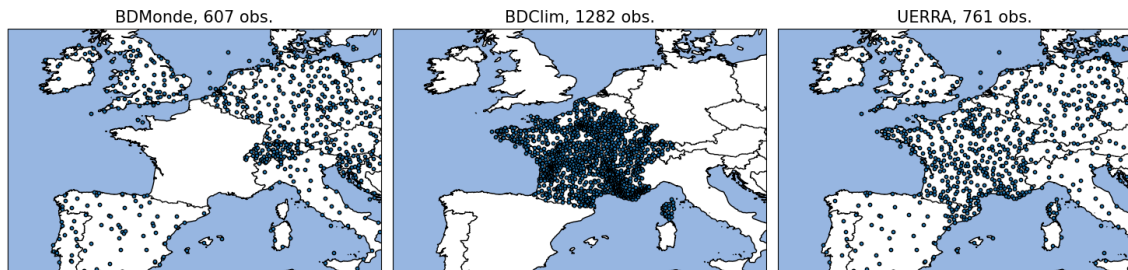


Several countries potentially interested by the ARRA data :

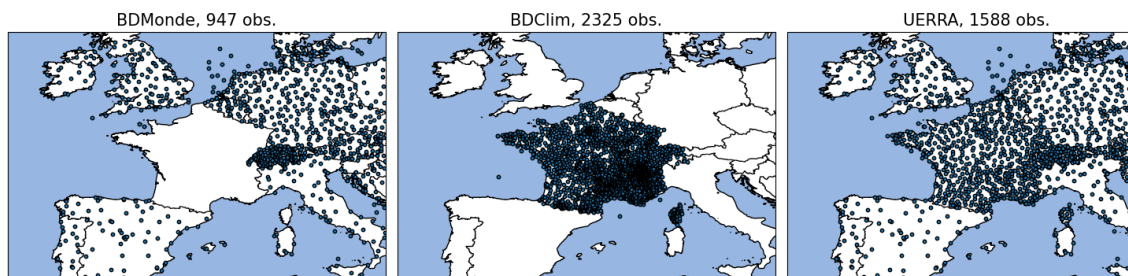
- Germany, Switzerland, **Belgium**, Luxembourg, **Netherlands**, Andorra
- Almost all of **Spain**, **Ireland**, **England**



2m Temperature
1st january 1971 6TU



2m Temperature
1st january 1998 6TU

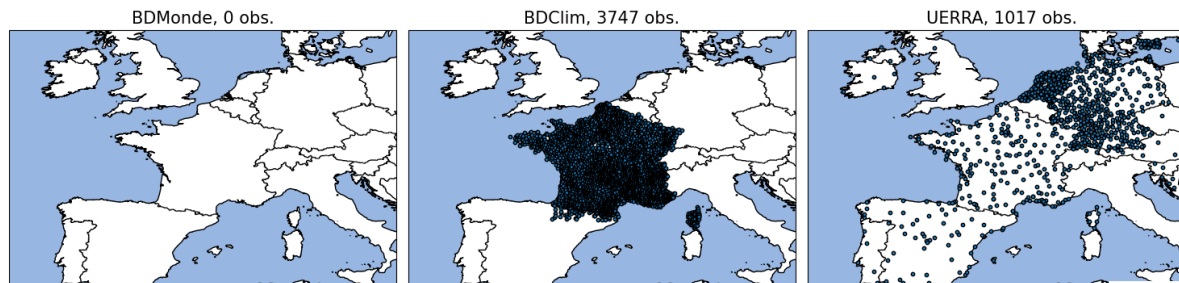


2m Temperature
1st january 2019 6TU

Courtesy Stephane Van Hyfte

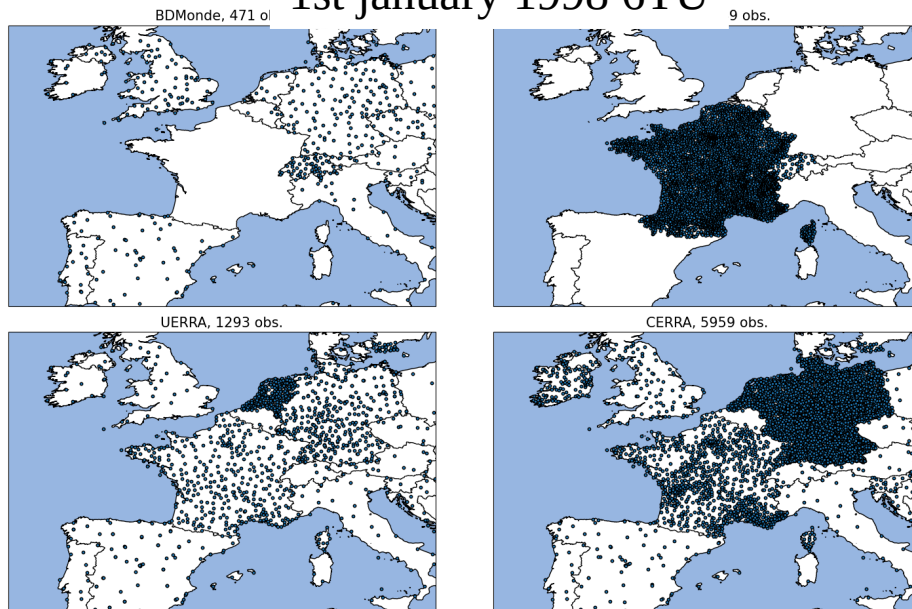
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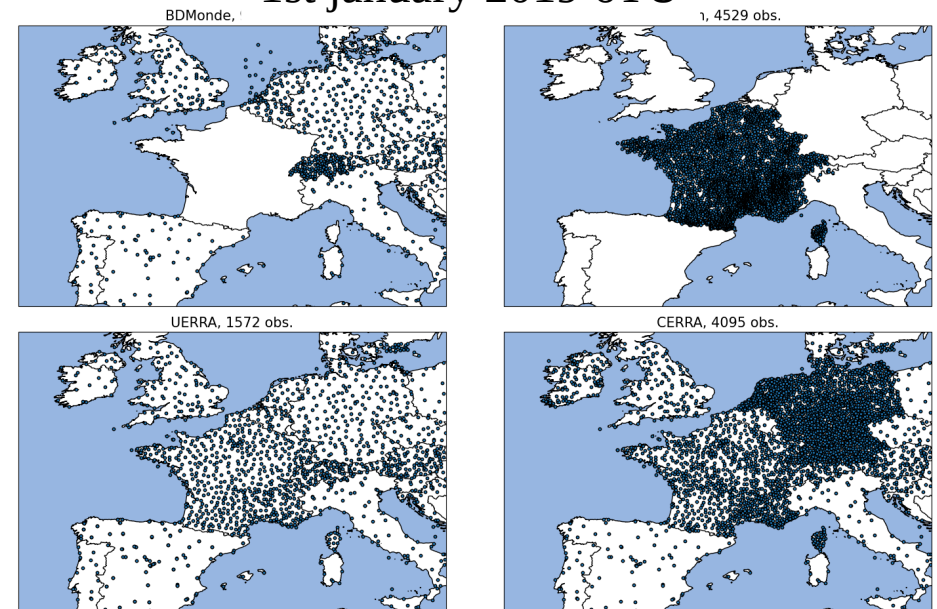


Courtesy Stephane Van Hyfte

Precipitation 24h
1st january 1998 6TU



Precipitation 24h
1st january 2019 6TU



ARRA configuration :

Two questions :

- Impact of the change of the init file and LBC in 1984 ?
 - 11km 65 levels to 5.5km, 106 levels ?
 - Analysis every 6h with UERRA
 - Analysis every 3h with CERRA
- in UERRA, the TKE field is not available in the UERRA file → spinup problem for the wind gust ? (seen in the UERRA data for the 1h lead time)
- Can IAU (Increment Analysis Update) help ?

TEMPERATURE CORRIGEE (K)

(K)

28 simulations de 48h valides du 20190102 au 20190131

AROME-France-oper

ARRA-AROME-FC-CERRA

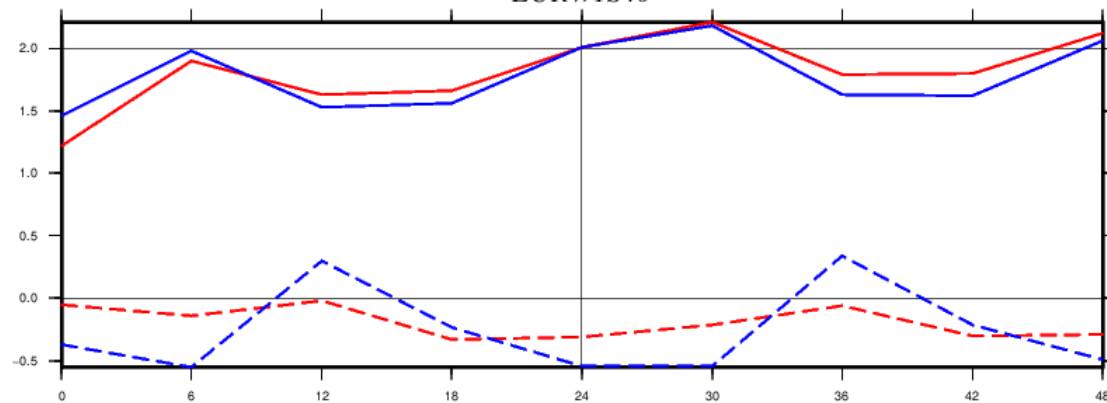
— Eqm PAROME.r 00/SYNOP

— Eqm PGJEW.r 00/SYNOP

-- BiaisPAROME.r 00/SYNOP

-- BiaisPGJEW.r 00/SYNOP

EURWIS40



With only surface assimilation and
init/LBC : **CERRA**

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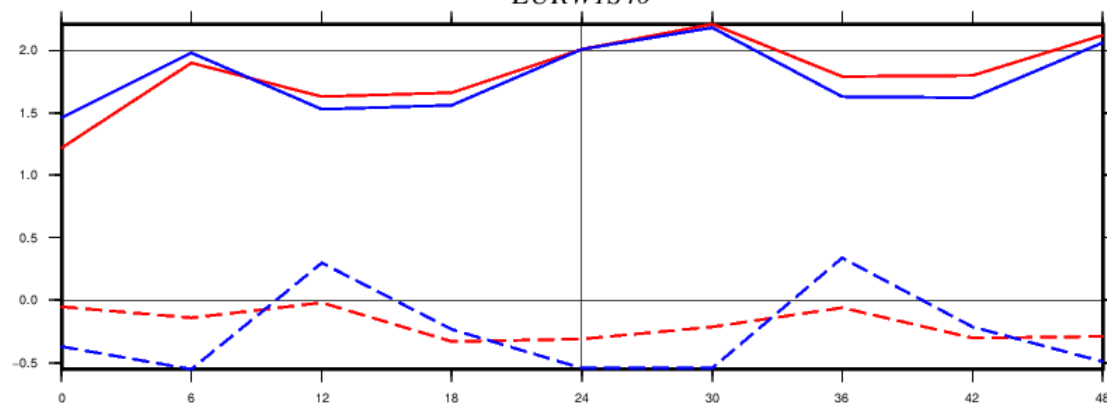
— Eqm PAROME.r 00/SYNOP

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init/LBC : CERRA

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LBC/INIT : UERRA/CERRA

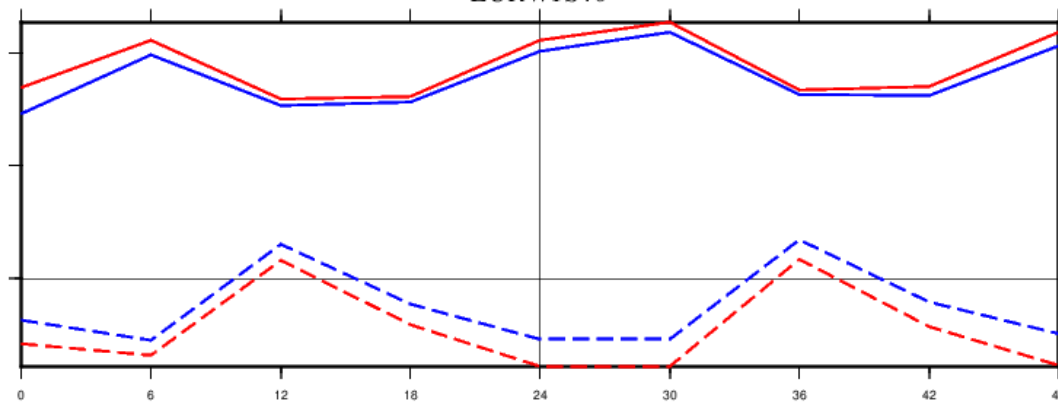
— Eqm PGJKB.r 00/SYNOP

— Eqm PGJEW.r 00/SYNOP

-- BiaisPGJKB.r 00/SYNOP

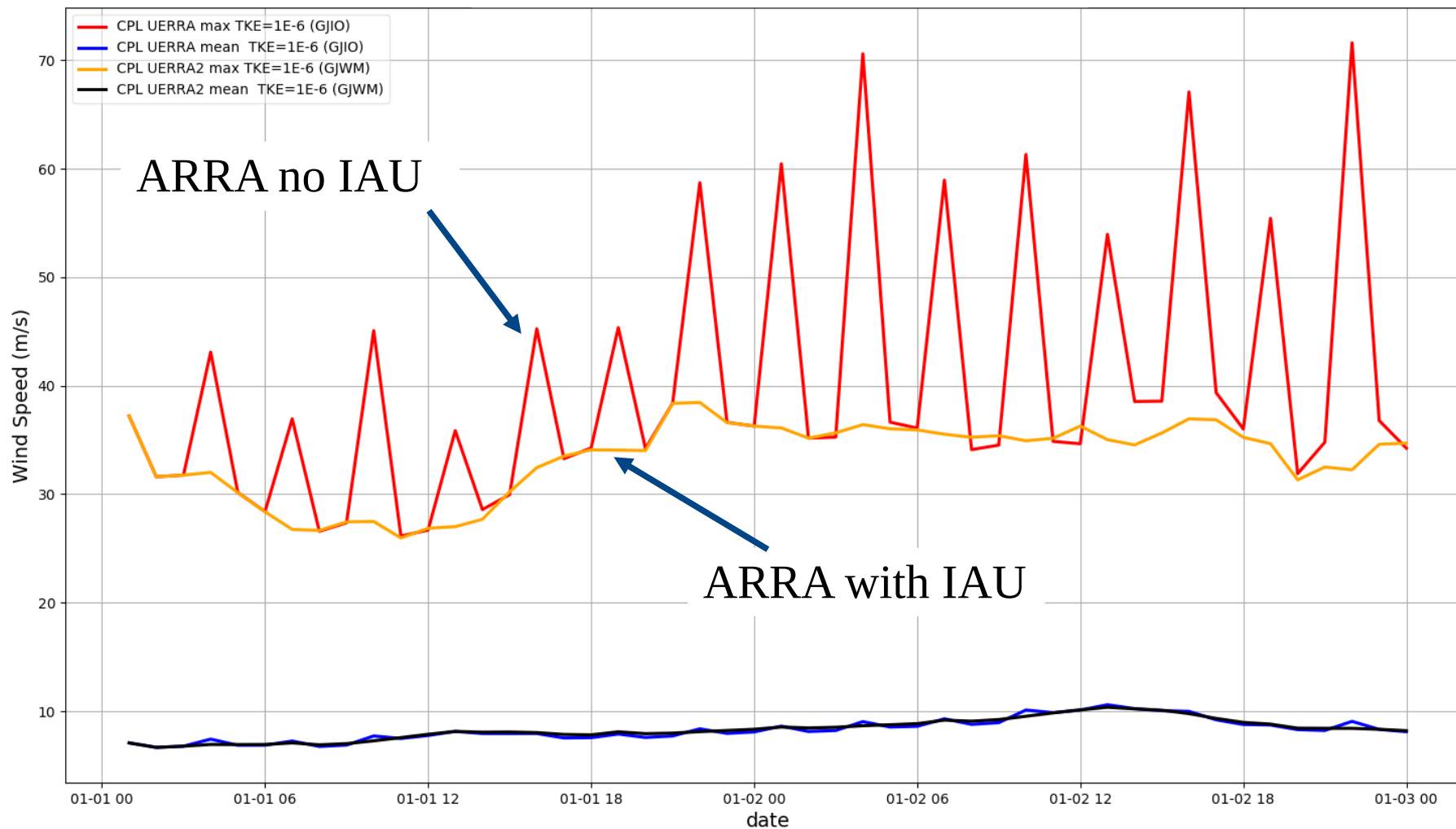
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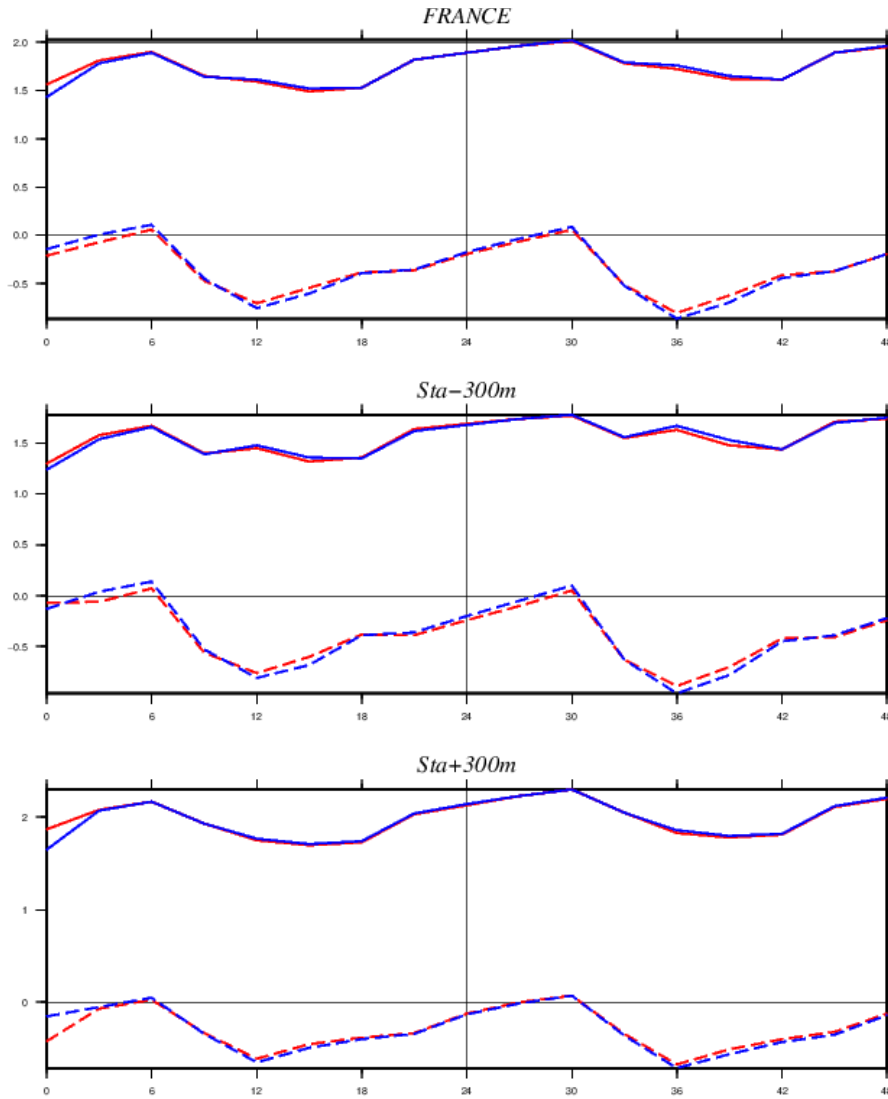
EURWIS40



With UERRA init/LBC slightly worse

Max wind gust in the domain





FC with IAU (GM23)
FC without IAU (GME9)

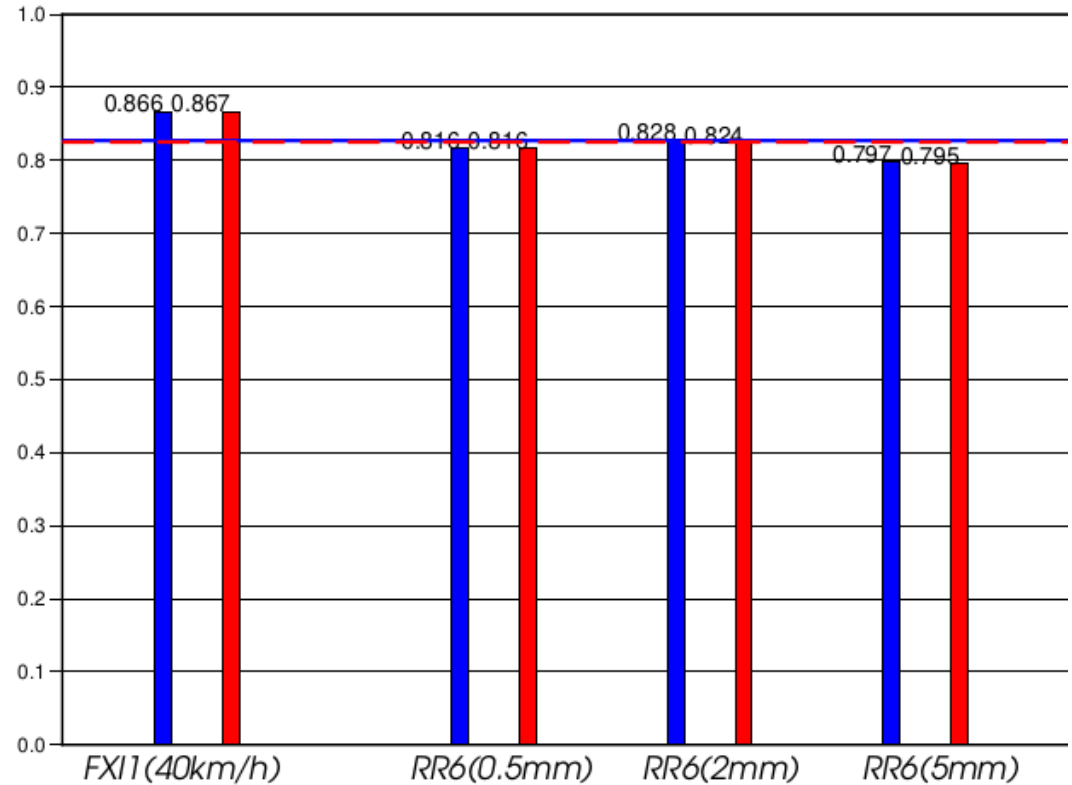
TEMPERATURE CORRIGEE (K)

(K)

52 simulations de 48h valides du 20190102 au 20190225

FC with IAU (GM23) Indic=0.827

FC without IAU (GME9) Indic=0.825



Météo-France DirOP/COMPAS
Actualisé le 24/03/2023

LBC impact UERRA/CERRA with IAU :

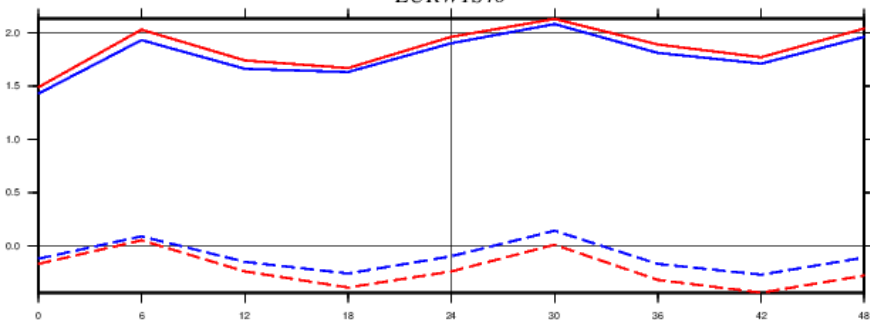
TEMPERATURE CORRIGEE (K)

(K)

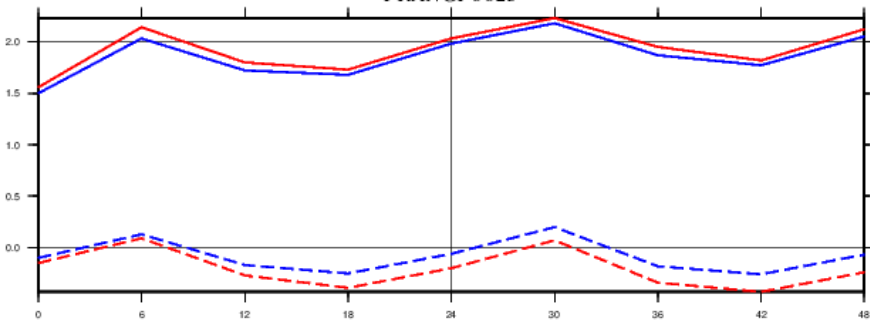
56 simulations de 48h valides du 20190102 au 20190301

— Eqm PGMH8.r 00/SYNOP — Eqm PGM23.r 00/SYNOP
- - BiaisPGMH8.r 00/SYNOP - - BiaisPGM23.r 00/SYNOP

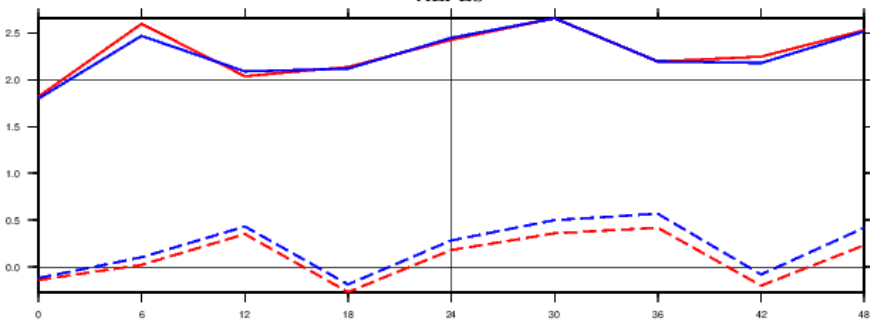
EURWIS40



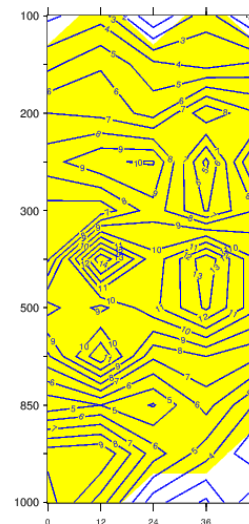
FRANGP0025



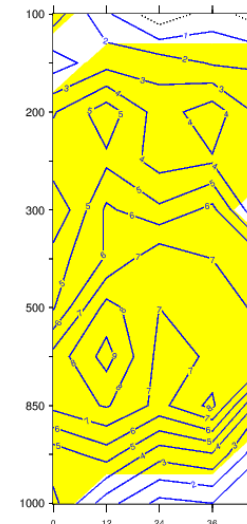
ALPES



Significativité à 95 % (bootstrap)
100 * (EQM PGMH8 - EQM PGM23)/EQM PGMH8

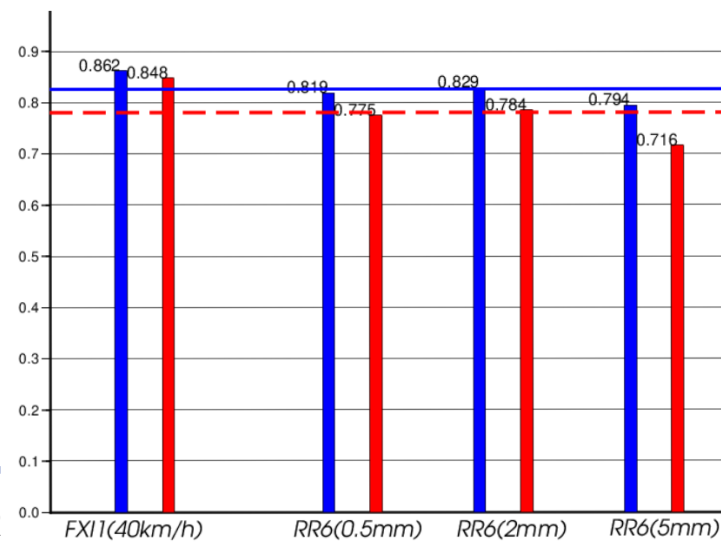


Temperature



Wind Speed

FC with IAU (GM23) CERRA Indic=0.826
FC with IAU (GMH8) UERRA Indic=0.781



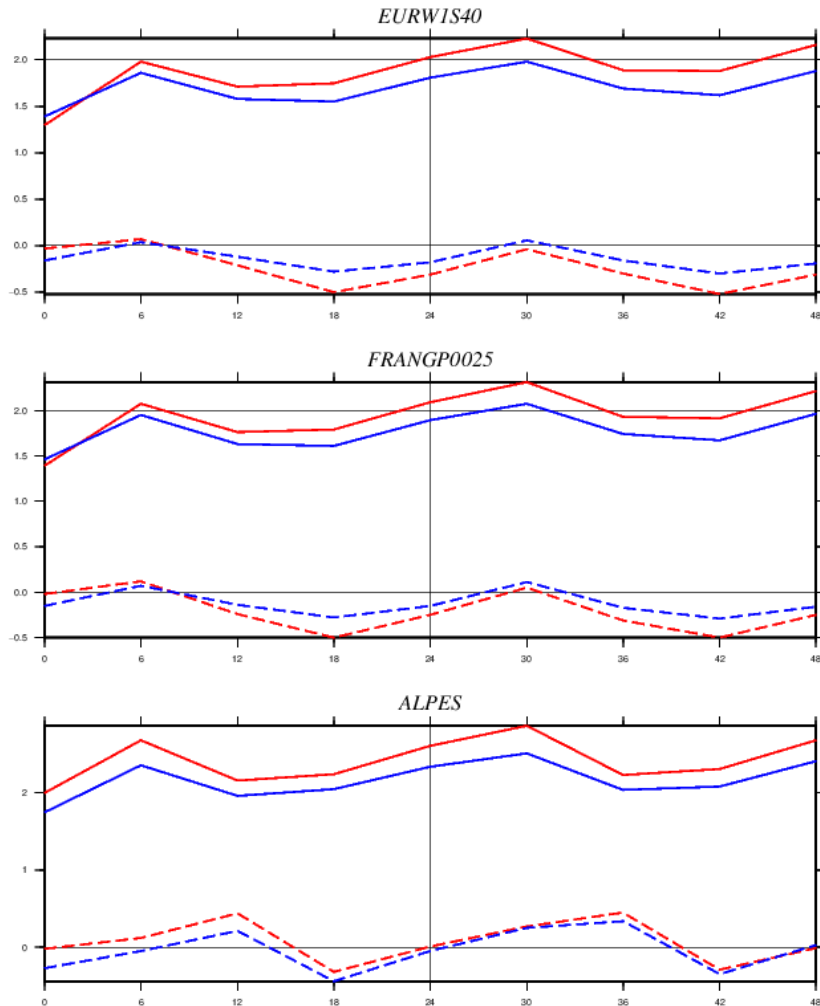
V2023 ACCOR

TEMPERATURE CORRIGEE (K)

(K)

81 simulations de 48h valides du 20190102 au 20190328

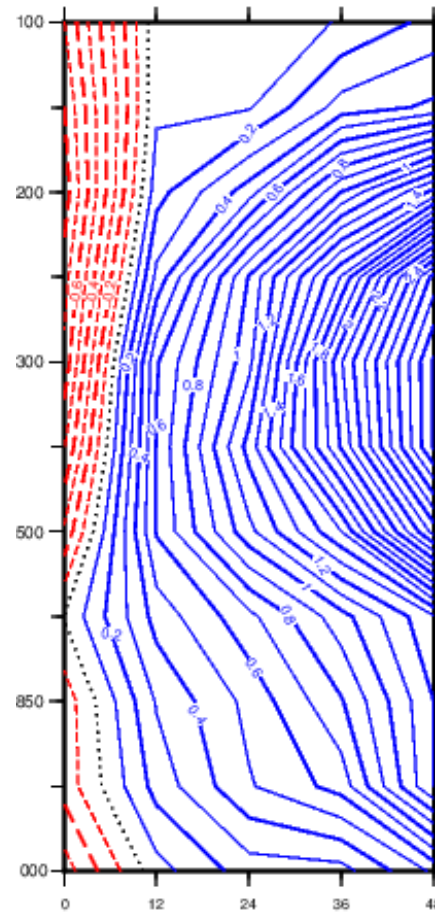
— Eqm PAROME.r 00/SYNOP — Eqm PGM23.r 00/SYNOP
-- BiaisPAROME.r 00/SYNOP -- BiaisPGM23.r 00/SYNOP



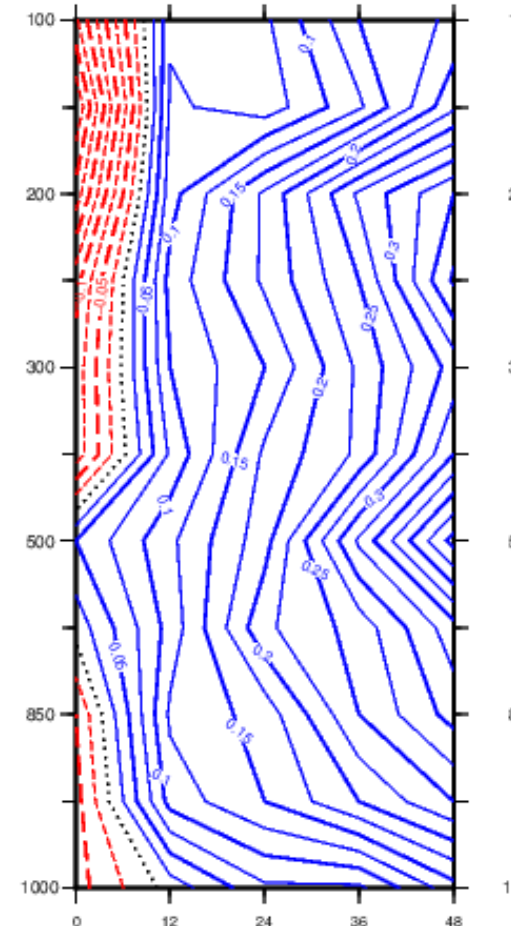
2days forecast with ARRA-IAU-CERRA vs AROME-FR

Wind Speed
Diff EQM

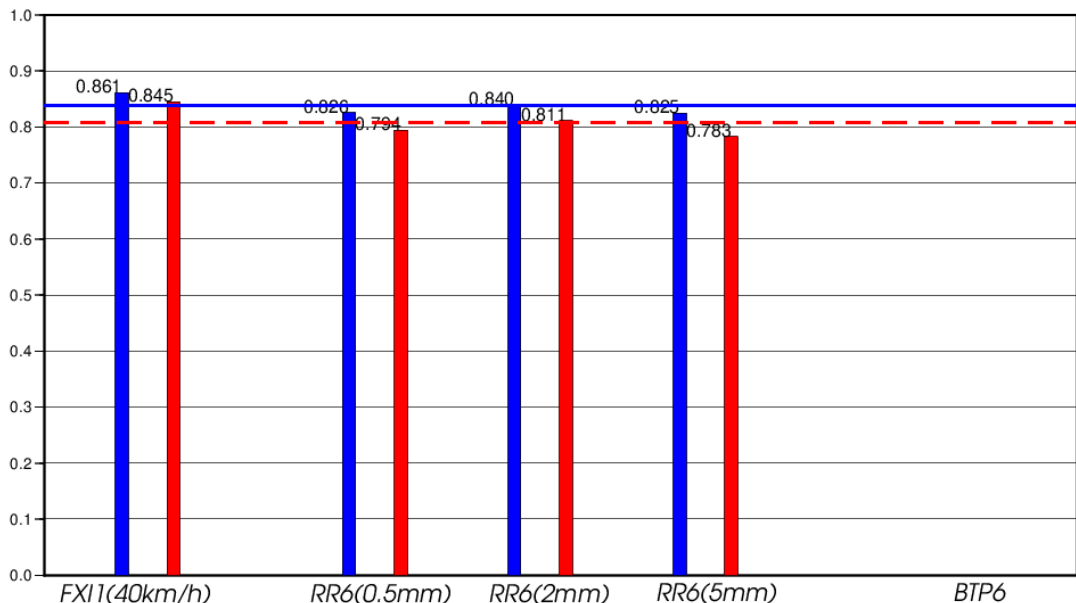
Temperature
Diff EQM



Mfn=-0.86 Max=2.92 Moy=0.61

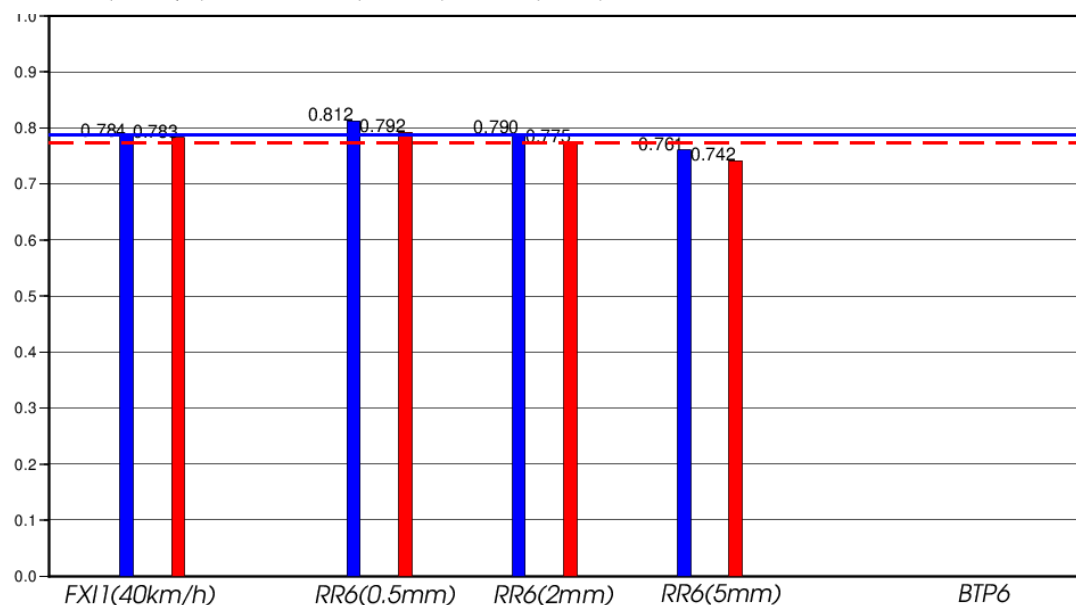


Mfn=-0.25 Max=0.46 Moy=0.13



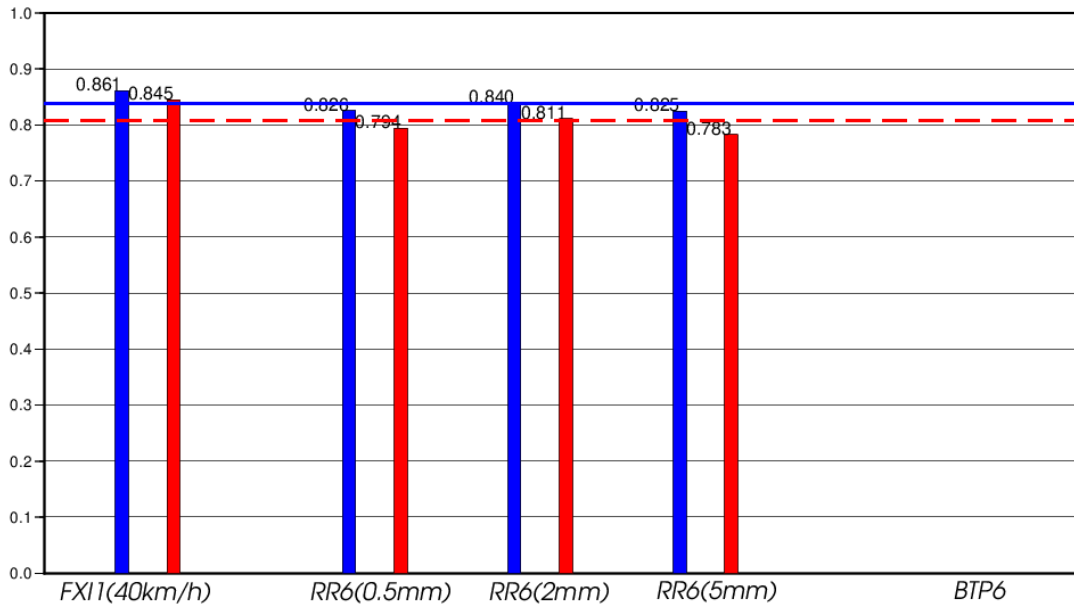
Jan-Feb-Mar 2019

- AROME-FR : Indic=0.808
- ARRA-IAU-CERRA : Indic=0.838



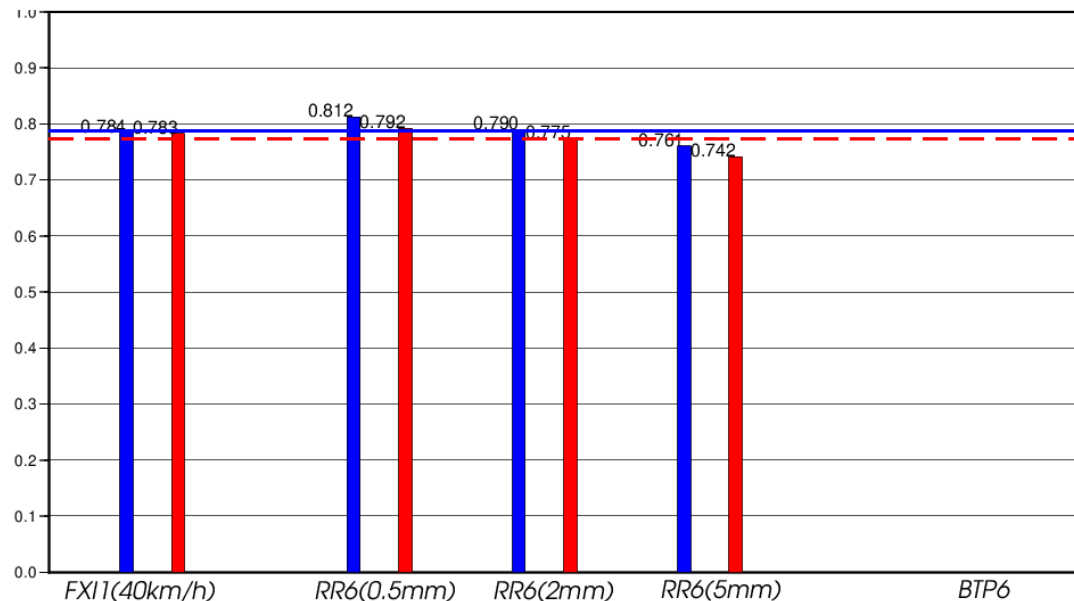
April → July 2019

- AROME-FR : Indic=0.773
- ARRA-IAU-CERRA : Indic=0.787



Jan-Feb-Mar 2019

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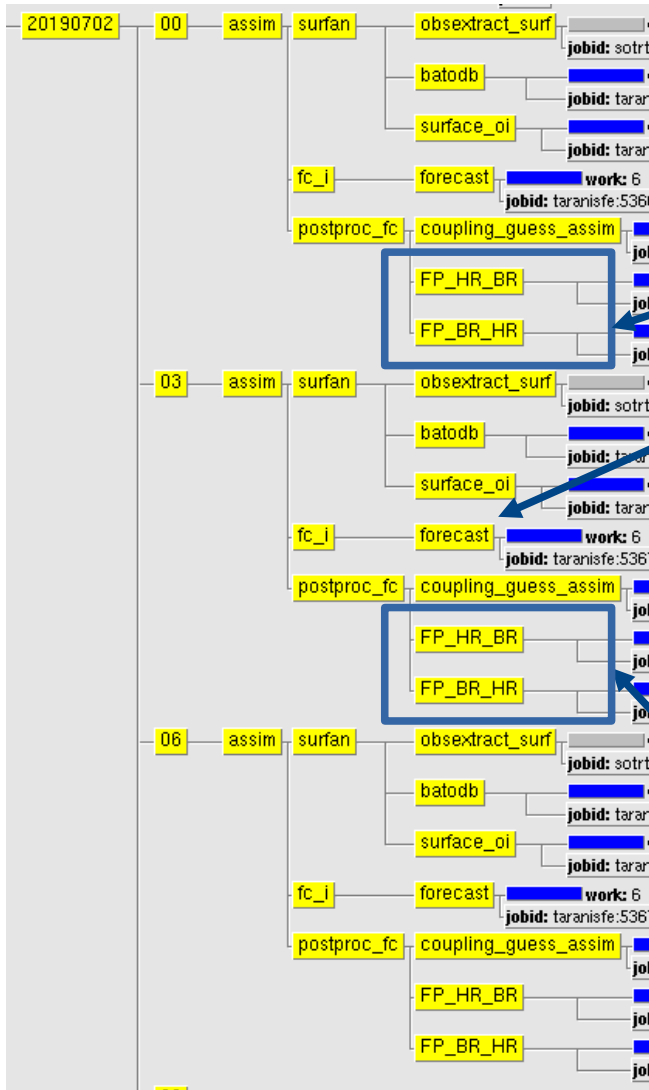
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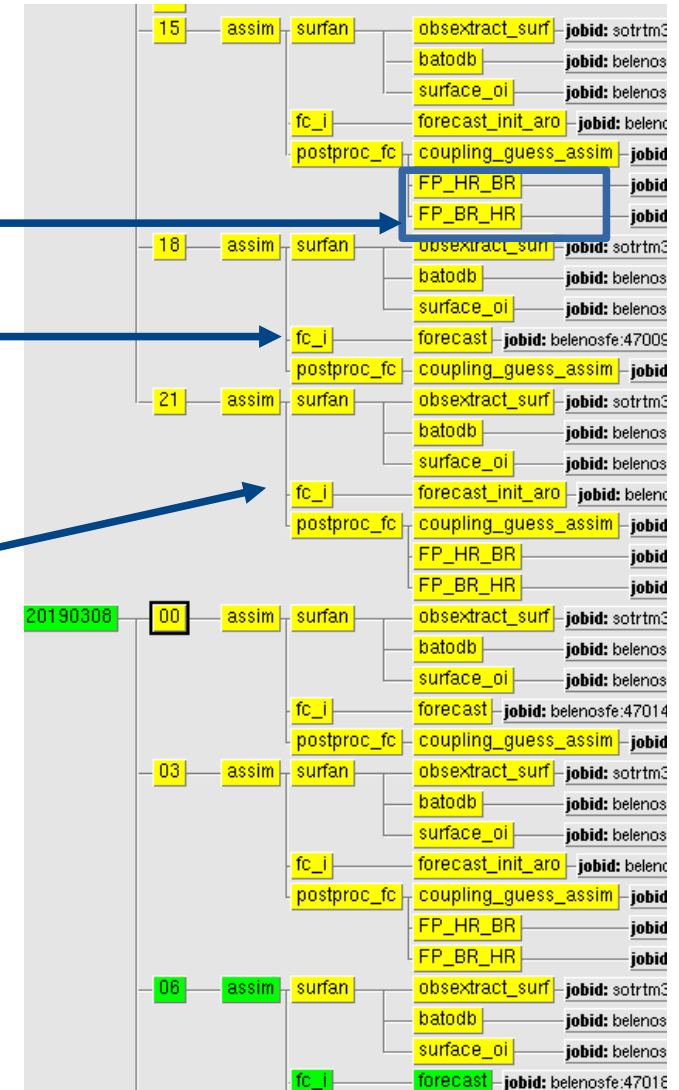
AROME-FC with IAU from ARRA same quality or even better than AROME-France due to the LBC (CERRA-analysis) instead of ARPEGE forecast

ARRA : Configuration IAU

ARRA IAU with CERRA



ARRA IAU with UERRA

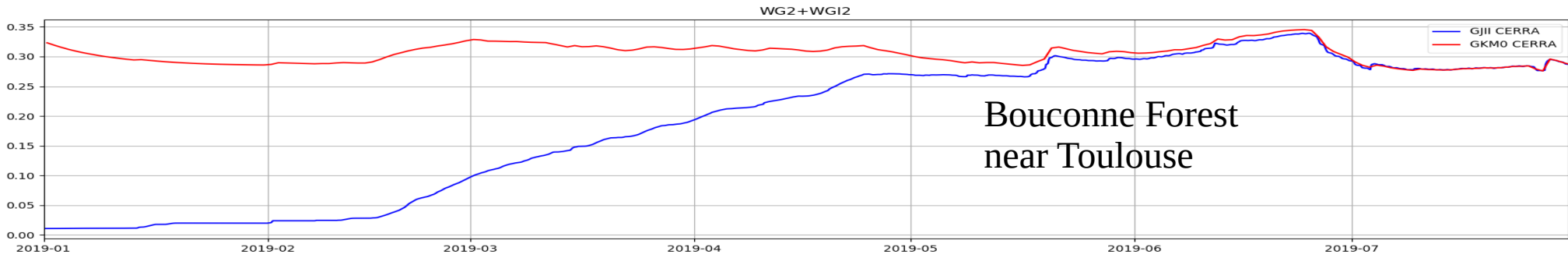


Filtered Guess at the UERRA or CERRA resolution used in the next forecast with IAU

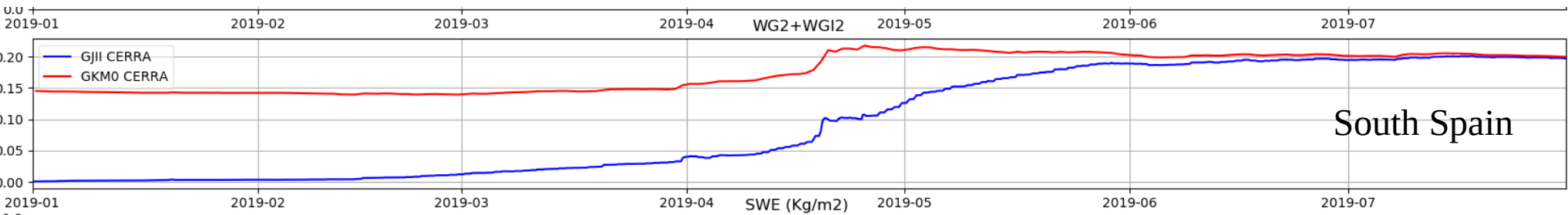
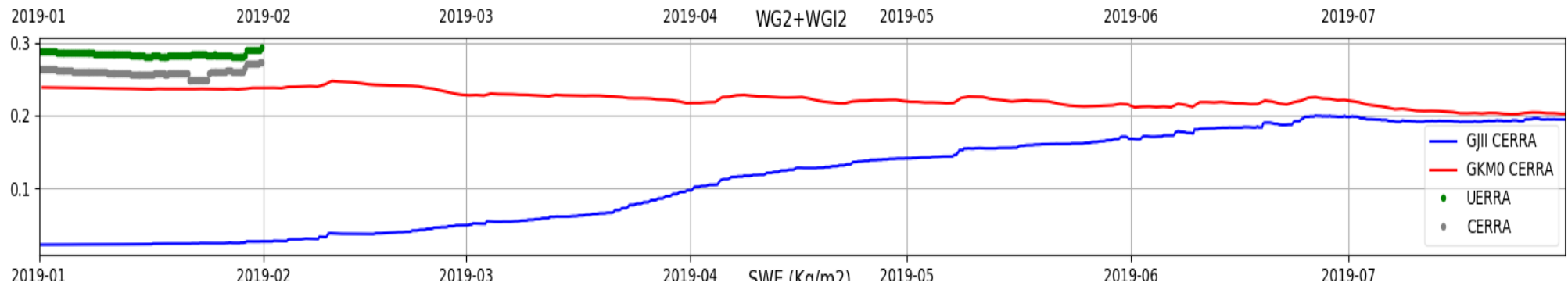
No IAU at 0, 6, 12 and 18 UTC with UERRA-LBC

With CERRA LBC IAU at 0, 3, 6, 9, 12, 15, 18, 21 UTC

Spinup in soil moisture ?



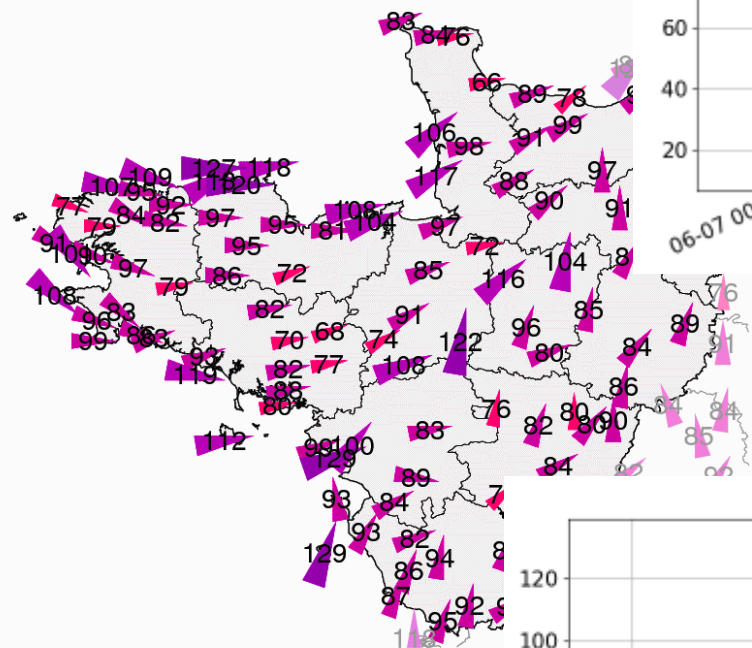
Forest point in Bretagne



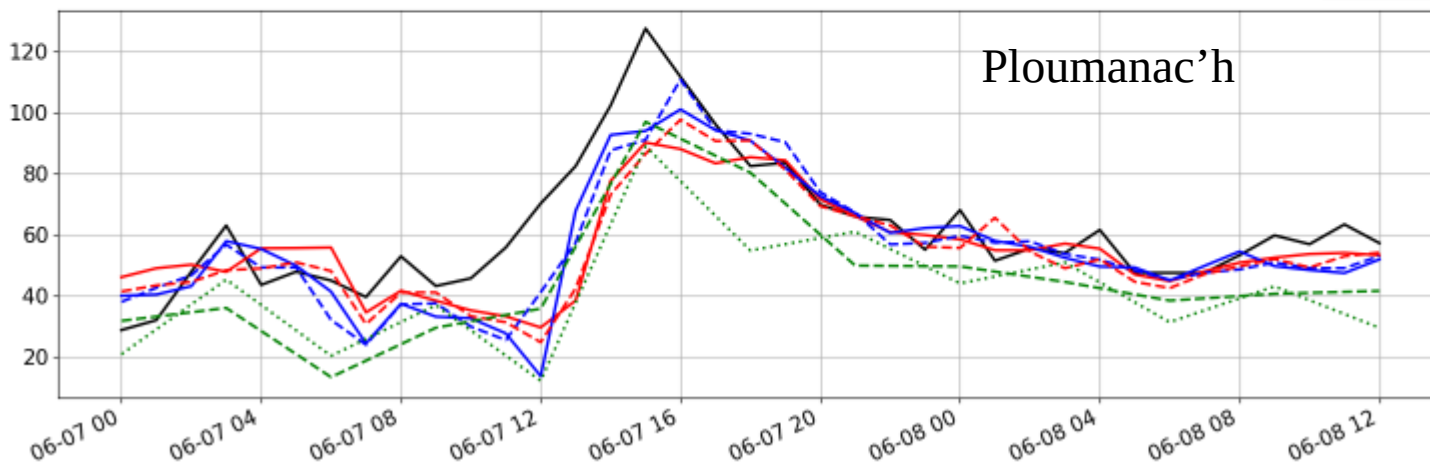
Miguel storm 7th June 2019

7 juin 2019

Max Wind gust



Edité le : 1

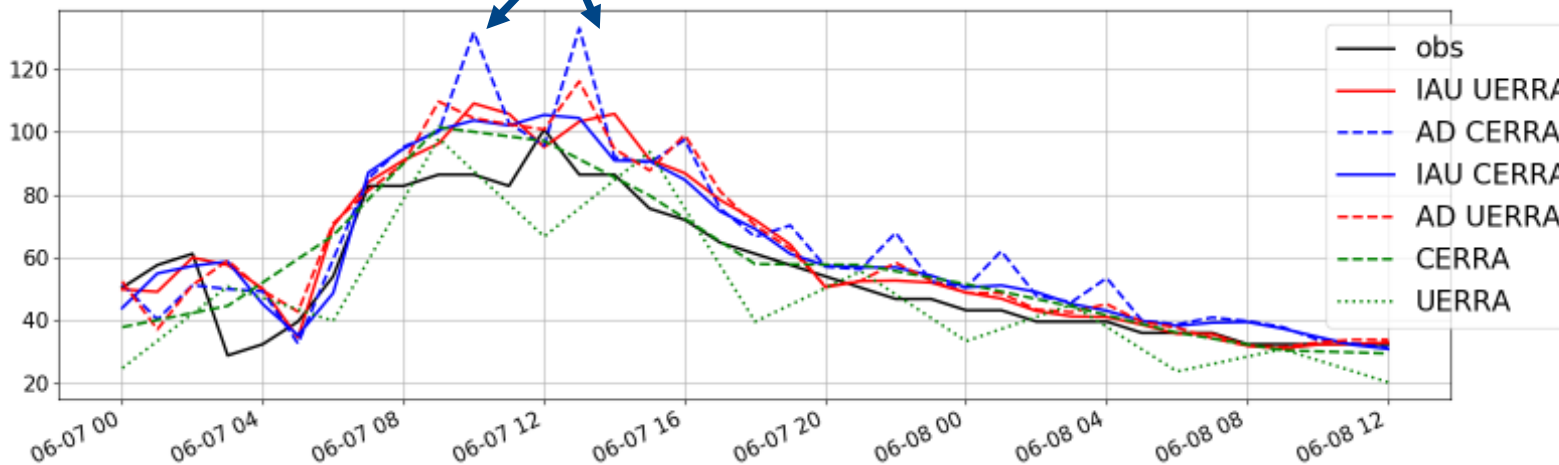


Ploumanac'h

Courtesy S. Van Hyfte

No IAU

Ile d'Oleron



Conclusions :

- IAU : reduces the differences between the UERRA and the CERRA Init/LBC
- ARRA configuration : Cycled surface analysis with IAU
- Preliminary results are encouraging for the ARRA quality compared to AROME-France
- In the next 6 months :
 - Transfer all the LBC (UERRA/CERRA) in Toulouse from Bologna
 - preparation of the observation files with additional “local” obs from the neighboring countries ?
 - Summer 2023:
 - Run a pre-version 1980-1990 with the change of the LBC in 1985
 - Run a pre-version for 1970-1980 (10 years in 20 months)
- October 2023 :
 - precipitation analysis 1970-1980
 - SURFEX-Offline ready under vortex

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 - SURFEX-Offline ready under vortex
- No later than T1 2024 : start the final production and

