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Plan de Recuperación,
Transformación y Resiliencia

IBERA
Main characteristics of the Iberian reanalysis

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6th All Staff Workshop
13-17 April 2026, Marrakech

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(2) Consejo Superior de Investigaciones Científicas (AEMET-CSIC)
(3) Tecnologías y Servicios Agrarios S.A. S.M.E M.P. (AEMET-TRAGSATEC)

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Motivation

The number of users for reanalysis are increasing in last years.

1. For climate studies.
2. For training Machine Learning models.
3. Other research fields were demanding high resolution reanalysis and also are interested on forecast fields.

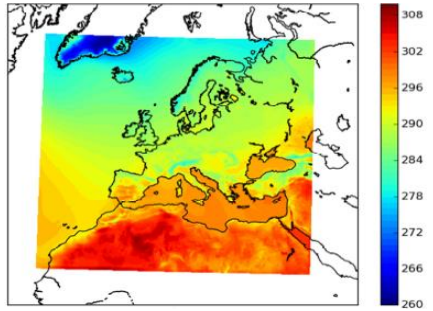
In this context IBERA was developed having two frameworks.

1. IBERA Harmonie. Based in Harmonie-Arome
2. IBERA Land.

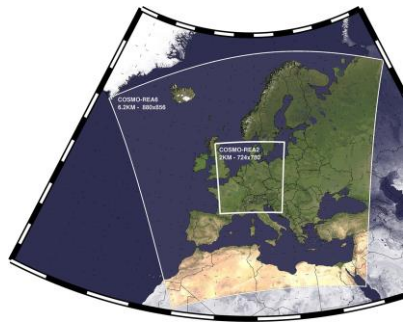
   External module for 24h precipitation analysis and extreme temperatures using optimal interpolation scheme.

A review of previous reanalysis over IBERIA and ISLAS CANARIAS.

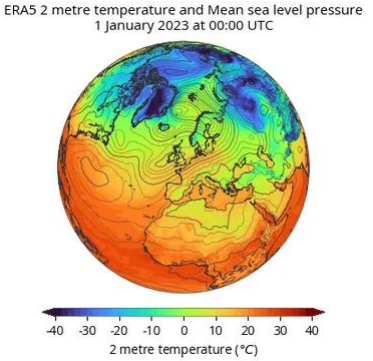
1. ERA5.
   - Global model of 31 km of horizontal resolution and 137 vertical levels.
   - From 1940 to nowadays.
   - Thanks to the 4D-VAR hourly analysis files are available.
2. UERRA.
   - Based in Harmonie-AROME cycle 38h1.1
   - From 1961 to the end of 2015.
   - 11 km of horizontal resolution and 65 vertical levels.
   - Provide analysis files each 6 hours.
3. CERRA.
   - Based in Harmonie-AROME cycle 40h1.2
   - From 1985 to nowadays.
   - 5,5 km of horizontal resolution and 106 vertical levels.
   - Provide analysis files each 3 hours
4. COSMO-REA6.
   - From 1995 to August 2019.
   - 6 km of horizontal resolution and 40 vertical levels.
   - CORDEX domain.
   - Uses a nudging technique of conventional observation.



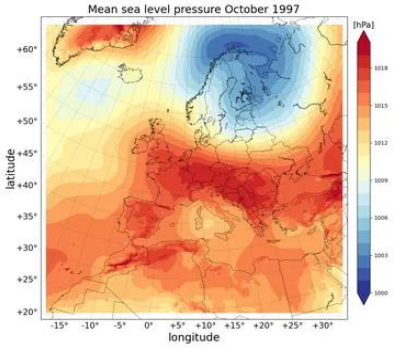
https://uerra.eu



https://reanalysis.meteo.uni-bonn.de/



https://cds.climate.copernicus.eu/datasets/reanalysis-era5-single-levels

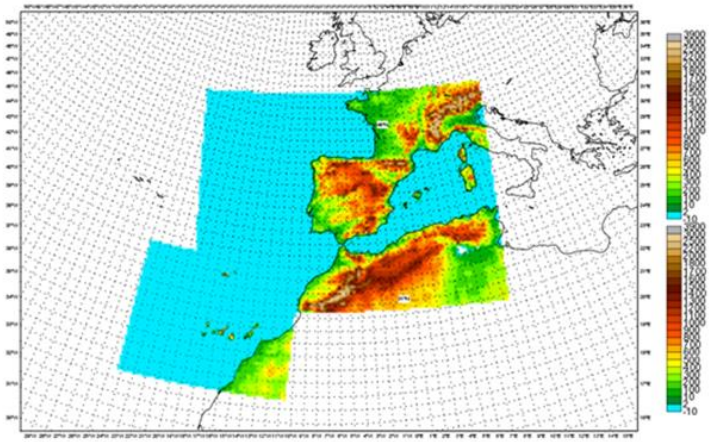


https://cds.climate.copernicus.eu/datasets/reanalysis-cerra-single-levels

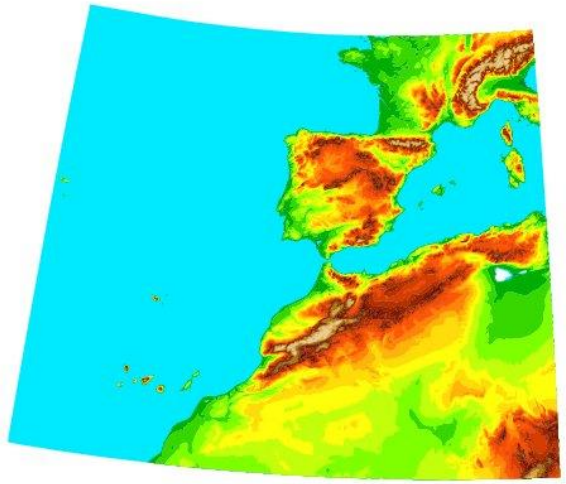
IBERA Harmonie

IBERA Harmonie is based in Harmonie-AROME cycle 46.

- IBERA spans from **1990 to nowadays**.
- Horizontal resolution of **2,5 km x 2,5 km**
- IBERA has a common domain for the Iberian Peninsula and the Canary Islands.



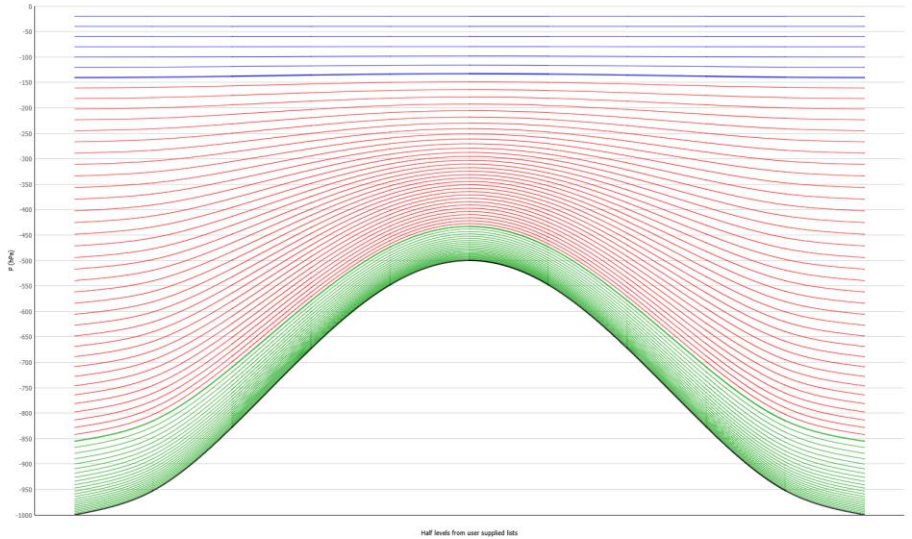
Operative domain of Harmonie in Aemet



IBERA

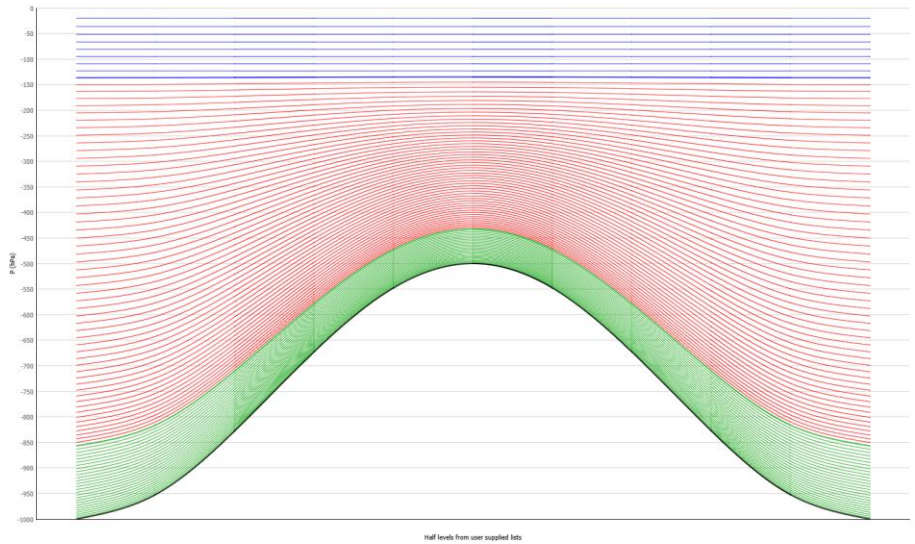
IBERA Harmonie

The number of levels of IBERA is higher than the operational suite.



Harmonie operational suite in Aemet

65 vertical levels



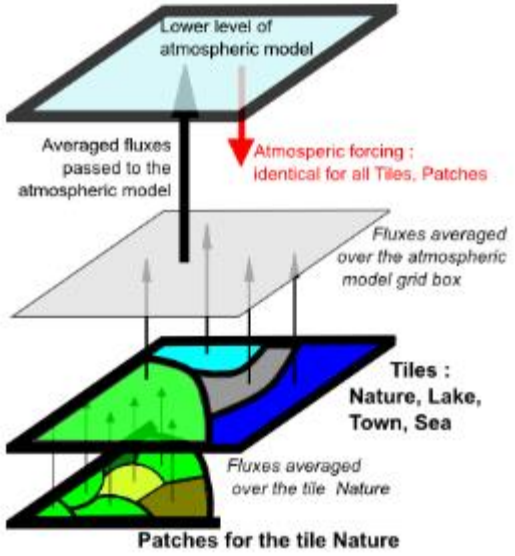
Levels of IBERA

90 vertical levels

IBERA Harmonie

Main characteristics of IBERA.

1. HARMONIE-AROME cycle 46h11.
2. Non-hydrostatic dynamics.
3. Boundary files from ERA5.
4. 3D-VAR for upper air assimilation.
5. Ecoclimap-SG for climate files.
6. Physical parametrizations.
   - OROTUR for the orography .
   - HARATU for turbulence.
   - SURFEX v8.1
     - 2 "patches" over the tile NATURE.
       - For forest and low vegetation.



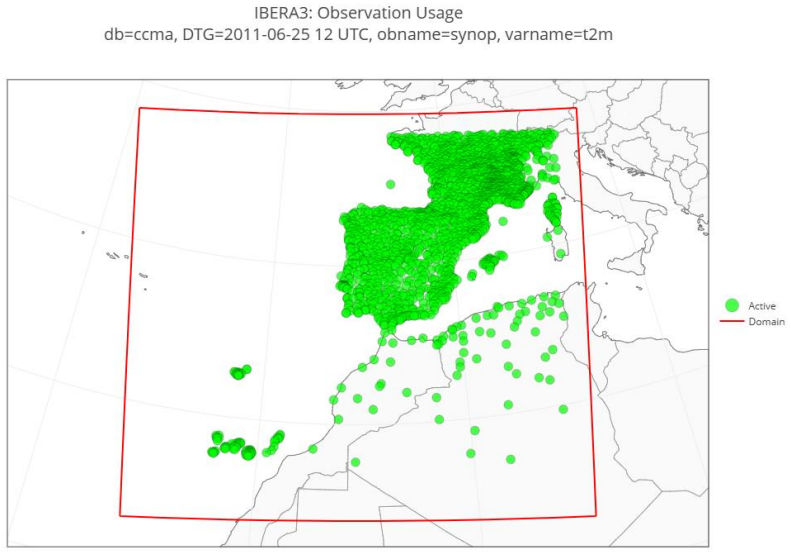
SURFEX tiling and coupling with an atmospheric model

IBERA Harmonie.
Use of observations

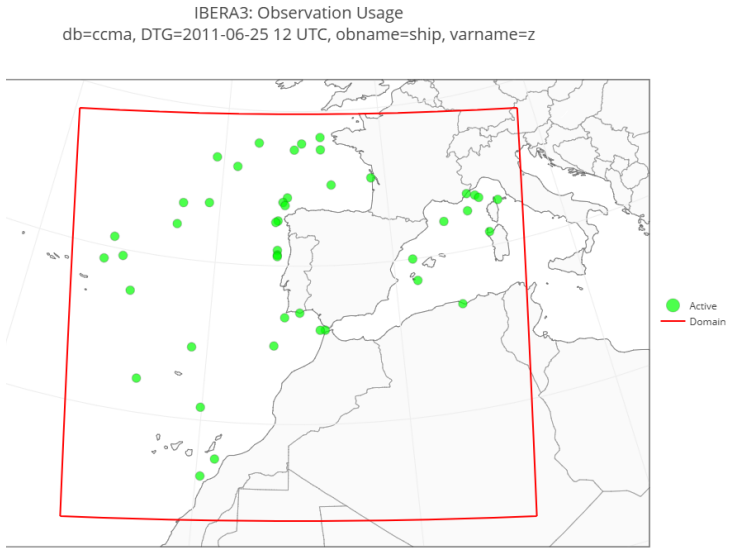
- Conventional observations.

  For Synop:

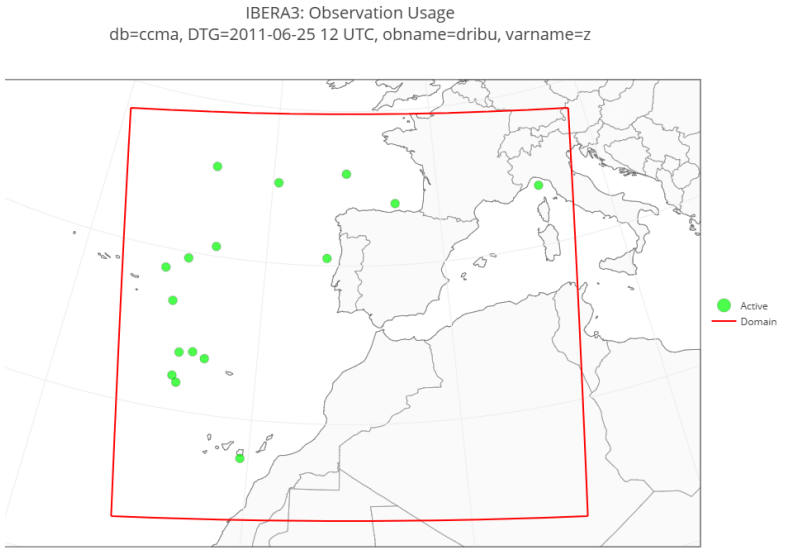
  MARS + local obs => Aemet + MeteoFrance + IPMA + DGM



synop



ship

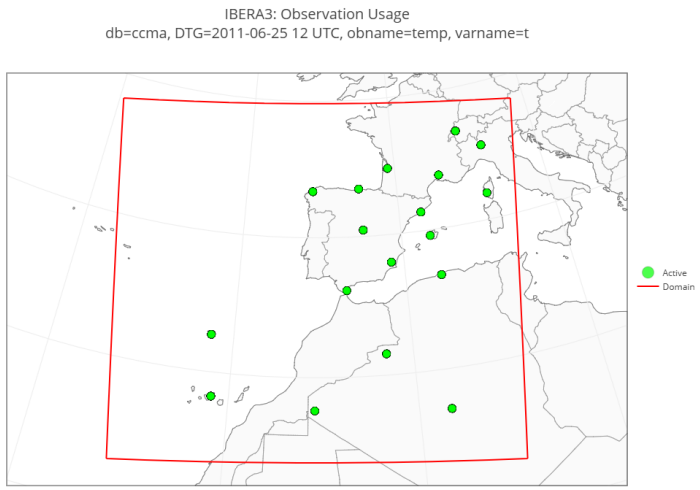


dribu

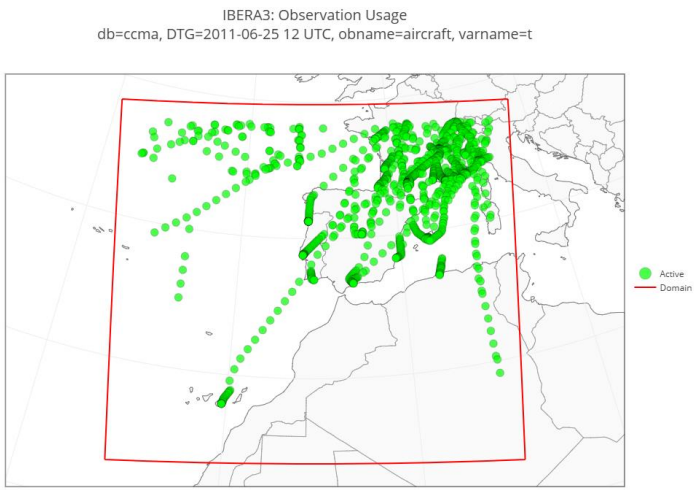
IBERA Harmonie.
Use of observations

For upper air:

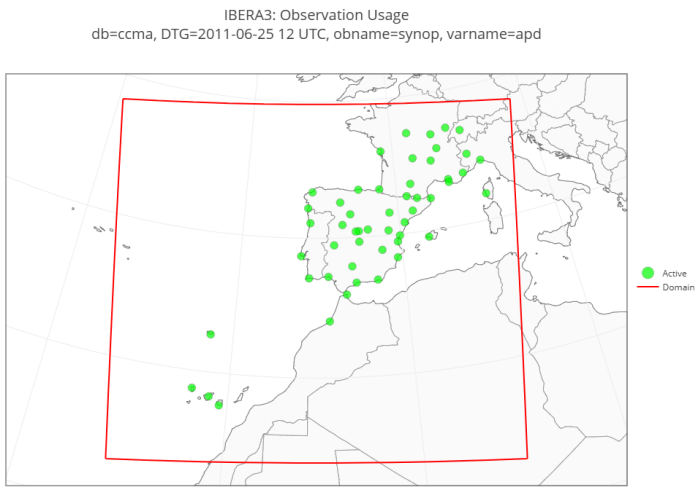
Radiosondes



Aircrafts



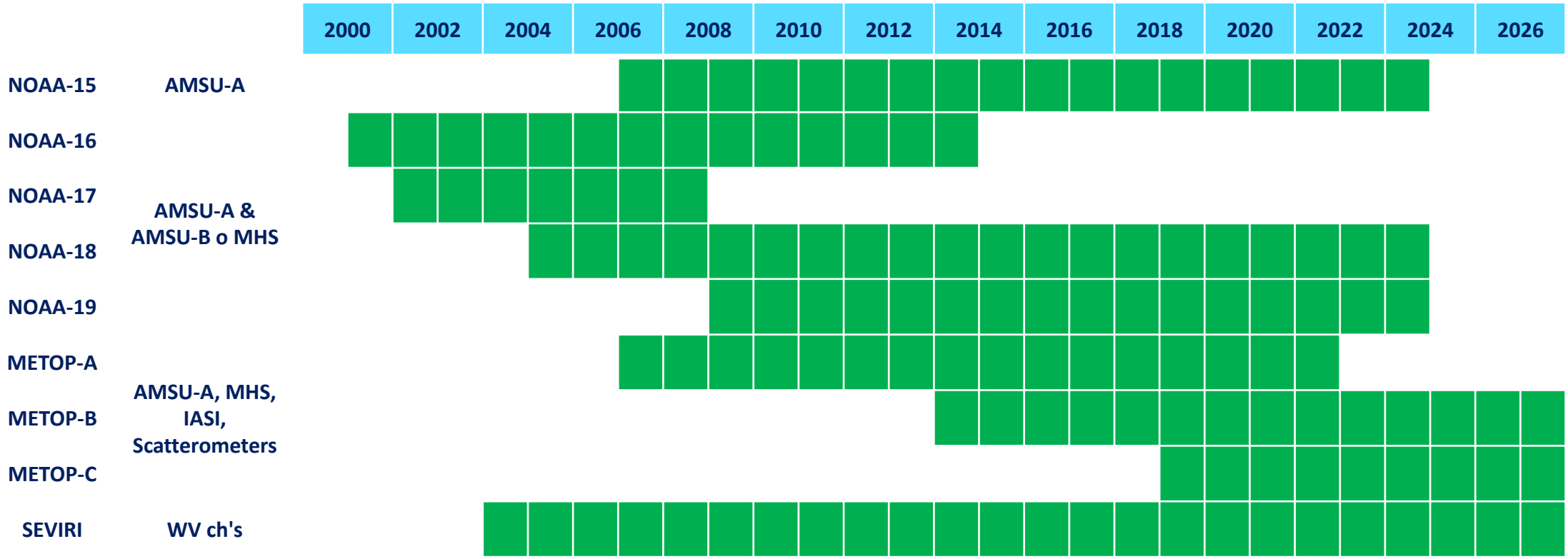
GNSS



IBERA Harmonie
Use of observations

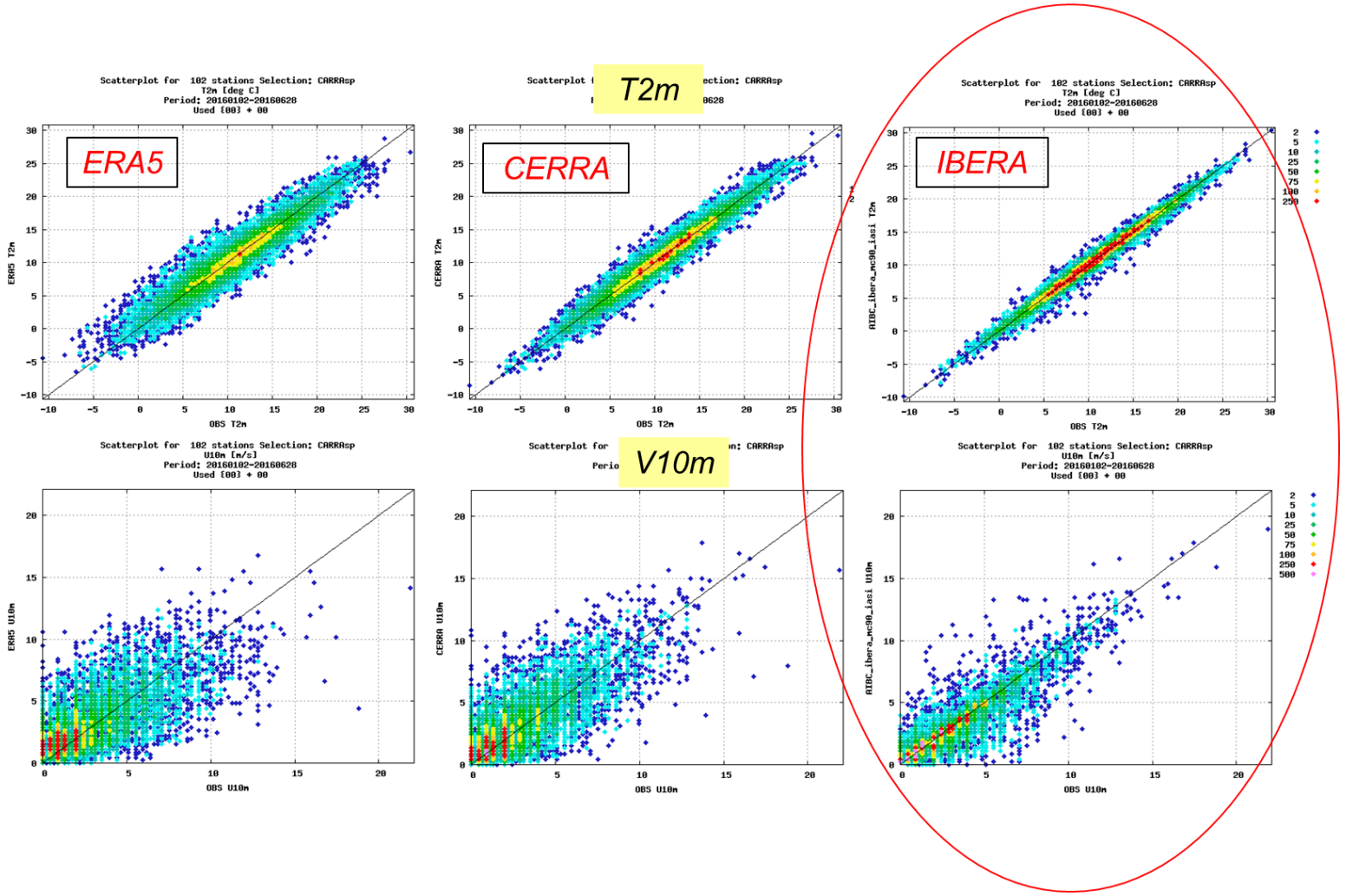
Satellite observations. Source of data **MARS** y **Eumetsat Data Store**

The monitoring of the satellite observations is one of the most delicate part.



IBERA Harmonie - Verification

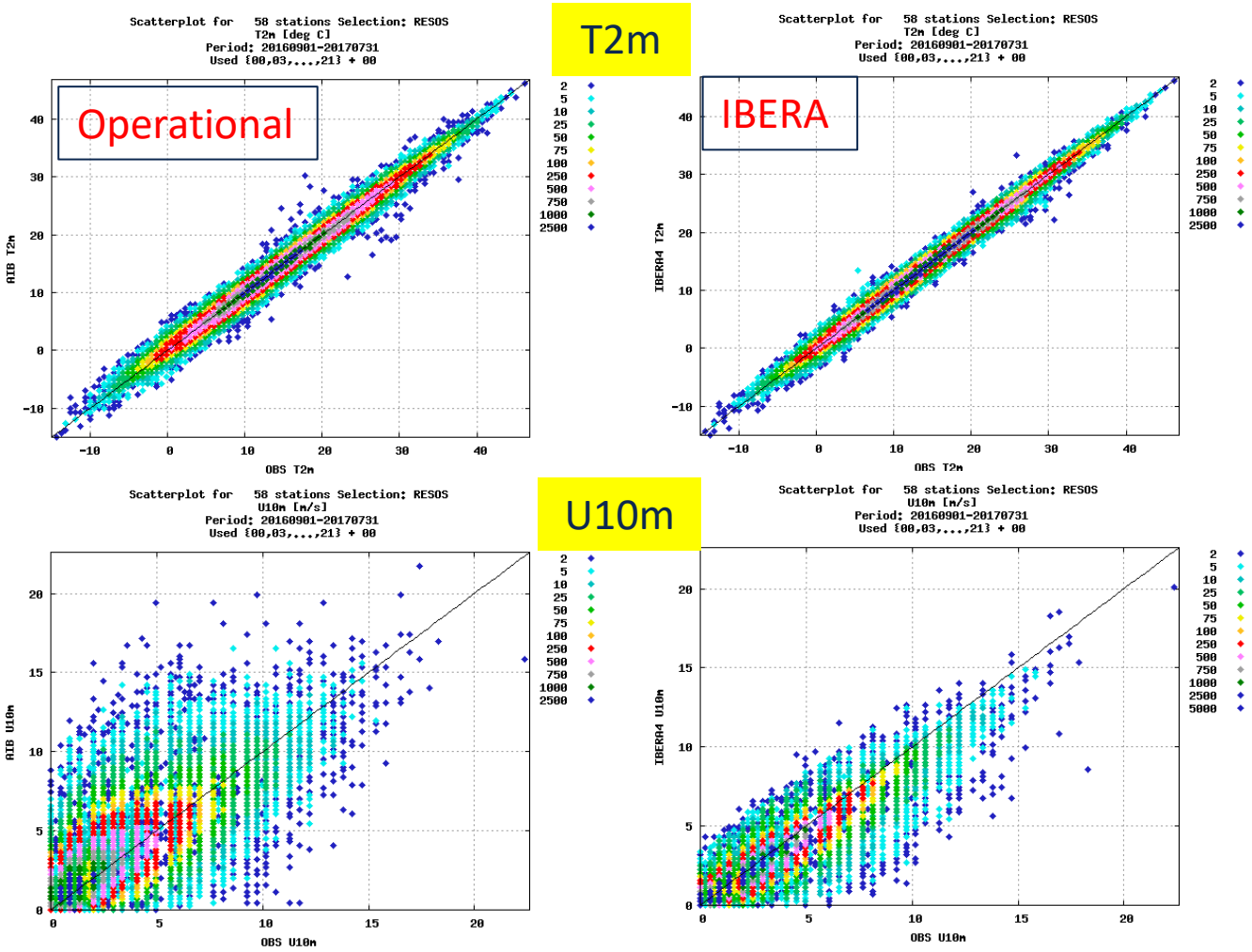
- IBERA has better verification scores for the analysis comparing ERA5 and CERRA.
- Objective verification of the analysis from January to June of 2016 (6 months)



IBERA Harmonie - Verification

- IBERA also shows better results for the analysis comparing with Harmonie-Arome operational suite in AEMET at 2017.

- Period of validation is from the 1st of September of 2016 to the 31st of July of 2017 (11 months)

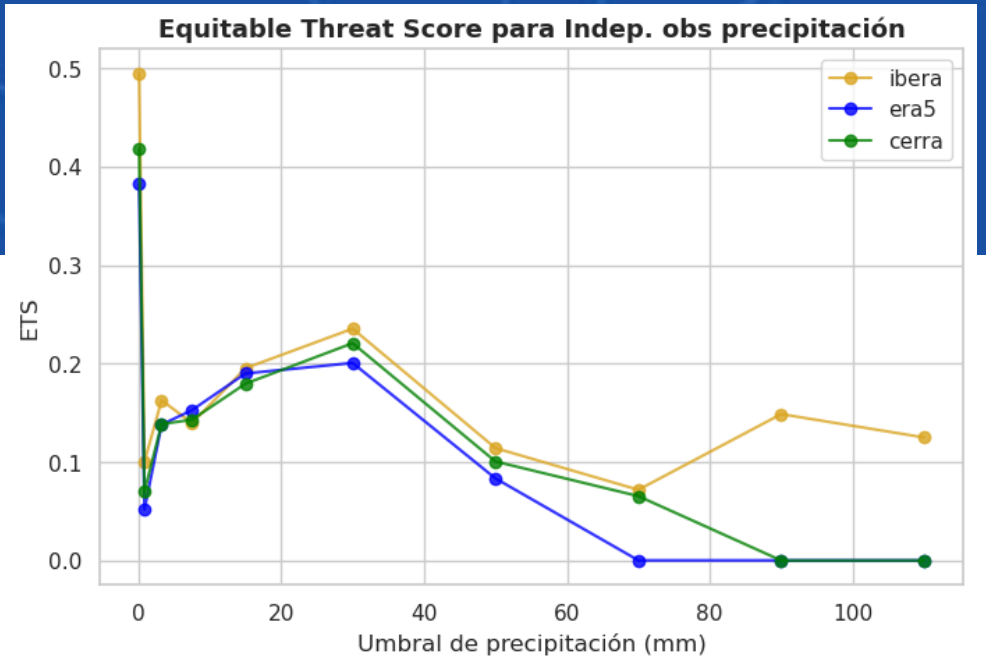


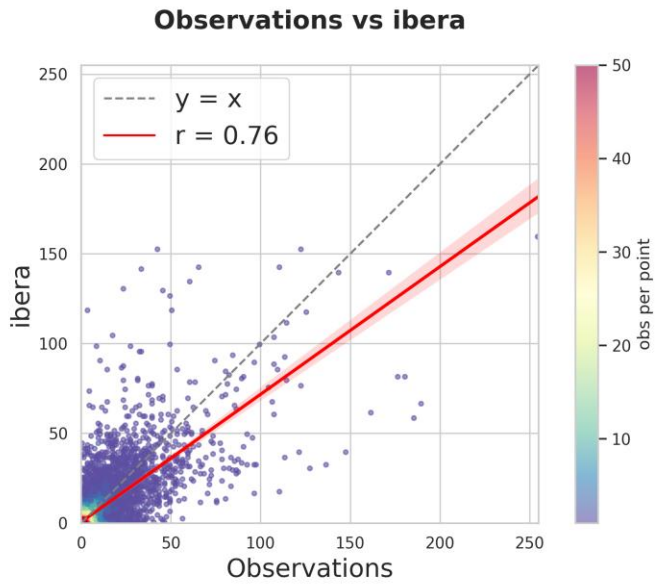
IBERA Harmonie - Verification

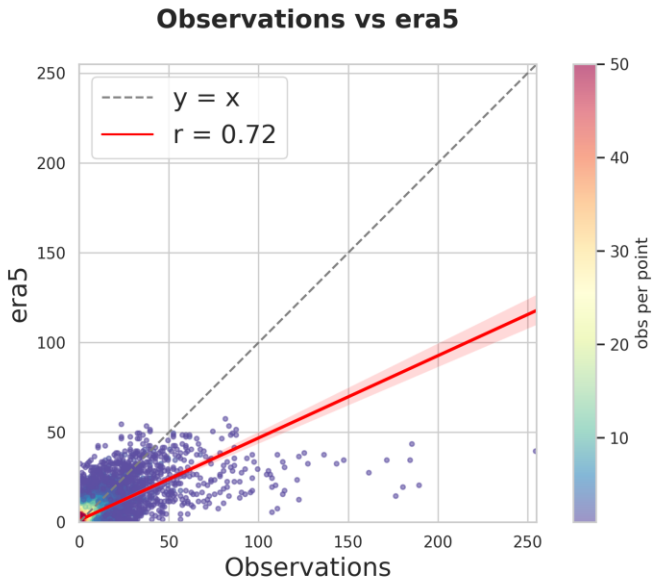
Verification of 2016 (Sep-Dec) for pcp24h.

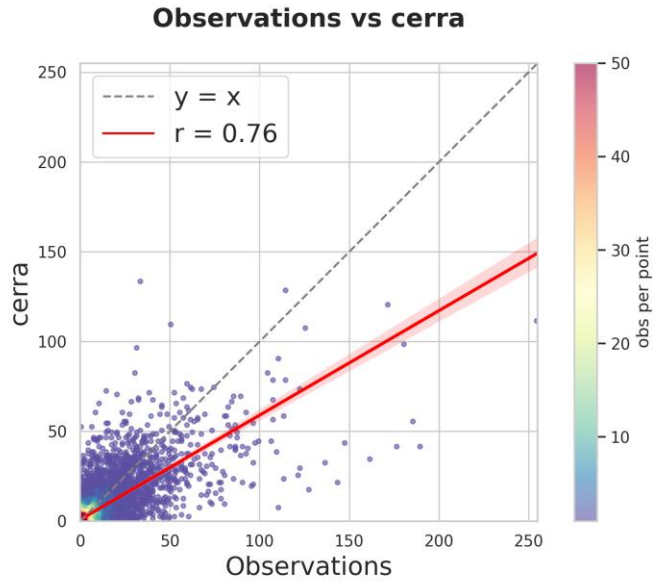
- Comparison of IBERA vs ERA5, CERRA for **forecasted 24h precipitation**.

- IBERA has better behaviour for all ranges, but it is more clear at high range precipitation events.
- IBERA and CERRA have the same correlation 0.76, while ERA5 is 0.72.







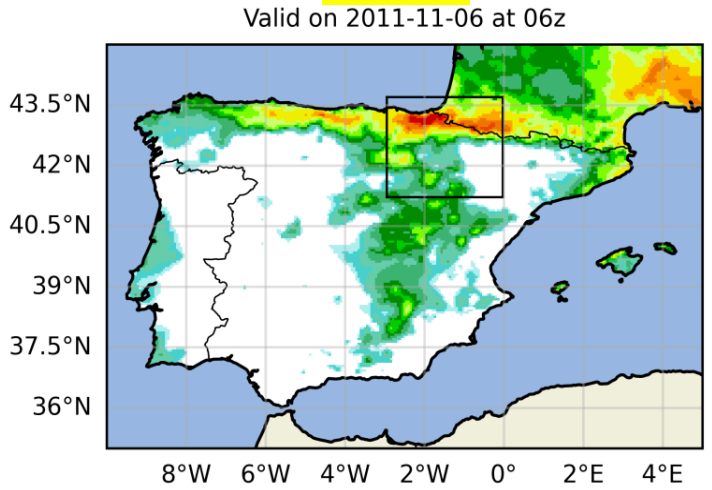


IBERA Harmonie - Verification

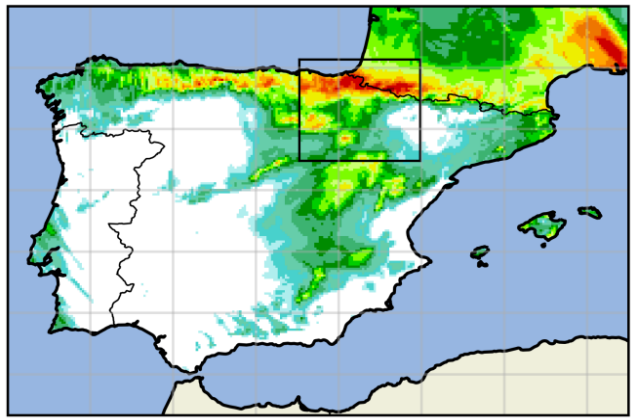
Case study: Intense rainfall in Navarra (northern Spain) in Nov 2011

- Spatial verification of 24-h accumulated pcp (forecast) of IBERA and CERRA using 5 km resolution kriging as a reference.
- High degree of agreement with the observations.
- Dry areas and extreme values are best represented in IBERA according FSS.

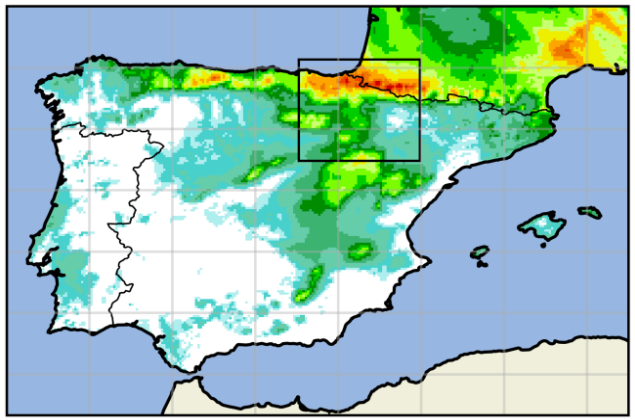
OBS

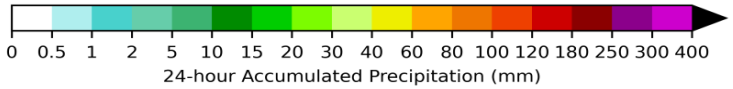


IBERA



CERRA





FSS values: IBERA Harmonie / CERRA (forecast)

2 mm	0.94 / 0.91	0.96 / 0.94	0.97 / 0.95
60 mm	0.83 / 0.84	0.92 / 0.92	0.95 / 0.95
120 mm	0.40 / 0.06	0.51 / 0.11	0.55 / 0.12
	5 km	**15 km**	**25 km**

Antonio Jiménez

IBERA Land

Off-line module that performs **24h precipitation** and **extreme temperatures analysis**. The assimilation scheme is **Optimal Interpolation**

- First guess files come from IBERA Harmonie forecast files.
- Structure functions, observations and first guess errors have been optimized.

Observation networks:

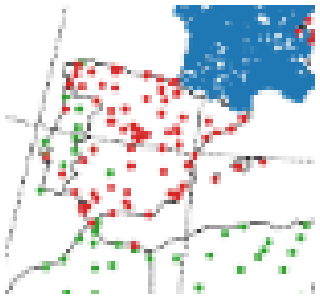
- AEMET climatological.
- Agriculture Ministry of Spain.
- Spanish hydrological departments.
- Other National Weather Services networks: IPMA, DGM and MeteoFrance
- National service for the information of hydric resources of Portugal (SNIRH)

IBERA Land

IBERA-Land uses more observations than CERRA over the Iberian Peninsula and Morocco.

For example: Observation of 24h precipitation used in **Spain**.

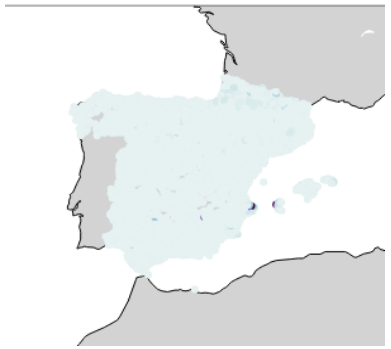
11/26/1991 at 07UTC



https://confluence.ecmwf.int/display/CKB/CERRA%3A+Strengths+and+weaknesses

CERRA

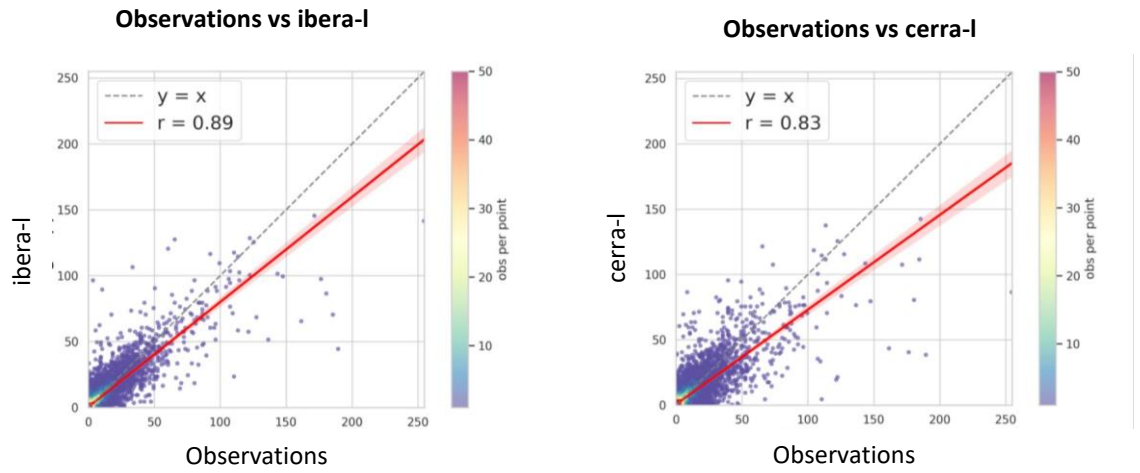
11/26/1991 at 07UTC

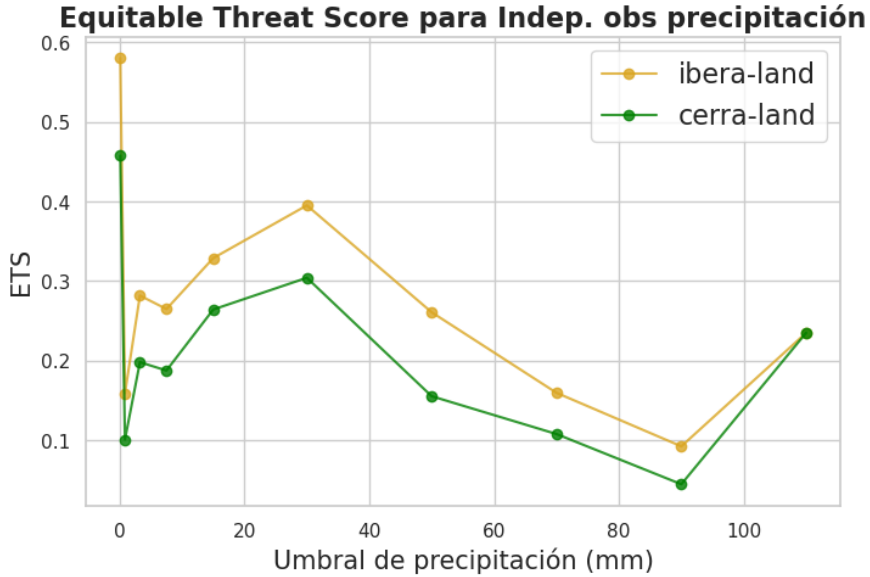


AEMET climatological observations

IBERA Land - Verification

- Preliminary results show good scores in all the ranges for 24h precipitation.
- Correlation in IBERA-L is slightly higher than in CERRA-L.





IBERA Production

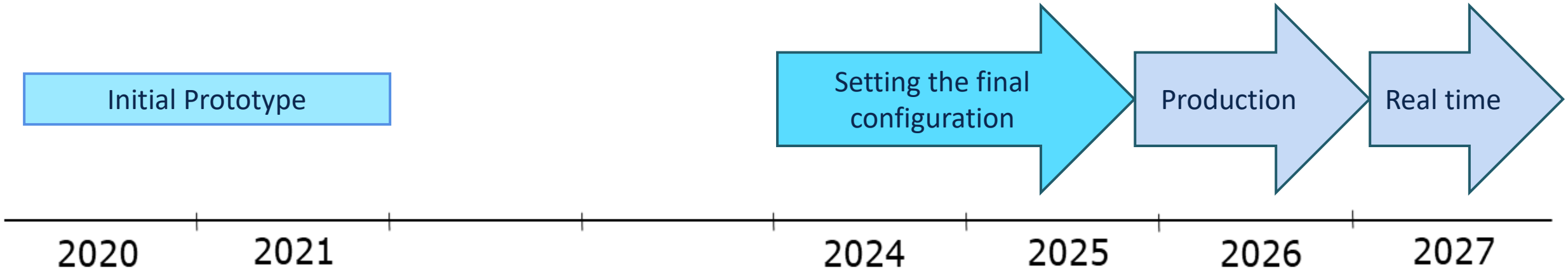
- Three hour cycles.

  For 00 cycle the forecast length will be 30h.

c\h	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	-30
00	A	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
03				A	F	F																			
06							A	F	F																
09										A	F	F													
12													A	F	F										
15																A	F	F							
18																			A	F	F				
21																						A	F	F	

- The output format will be **GRIB2** y **GRIB1** (only for some surface variables) and **ZARR** for a selection of variables.

IBERA Production



We plan to finish **30 years** of reanalysis at the beginning of 2027.

Execution is taking place on the local HPC of AEMET.

Conclusions

1. AEMET has developed a high resolution reanalysis based on HARMONIE-AROME over the new operational domain.
2. For this project, a collaboration between IPMA, DGM and AEMET has been started for sharing observations and verification purposes.
3. IBERA has two modules.
   - IBERA Harmonie, based in cycle 46h1.1 of HARMONIE-AROME.
   - IBERA Land, off-line module that performs analysis of 24 hours precipitation and extremes temperatures.
4. IBERA is right now at production phase.
5. We hope that the end of production will be at the beginning of 2027, updating the output at real time.
6. Output files will be available for users in ZARR format and GRIB (version 2 for most of the variables), on a platform yet to be decided.

Acknowledgments

1. To **Beatriz Navascués**, for starting the project in 2020.
2. CERRA y CARRA teams for their support and multiple conversations
   Eric Bazil, Xiahoua Yang, Martin Ridal, Per Dalghren, Swapan Mallic …
3. To **IPMA, DGM y MeteoFrance**, for sharing with the project their climatological networks.
4. A lot of **AEMET** colleagues of different departments.
5. To the **Spanish Ministry of Agriculture, Fisheries and Food** and **Ministry for Ecological Transition and the Demographic Challenge** for sharing their observations network with **AEMET**.
6. To the Portuguese **SNIRH** for sharing their observations freely.
7. This project has been partly financed with European Union Funds.

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Thank you

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5. **UERRA.** Project: 607193 UERRA. https://uerra.eu/



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DE ESPAÑA

VICEPRESIDENCIA
TERCERA DEL GOBIERNO

MINISTERIO
PARA LA TRANSICIÓN ECOLÓGICA
Y EL RETO DEMOGRÁFICO

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