Comparing snow processes in different Iberian Mountains

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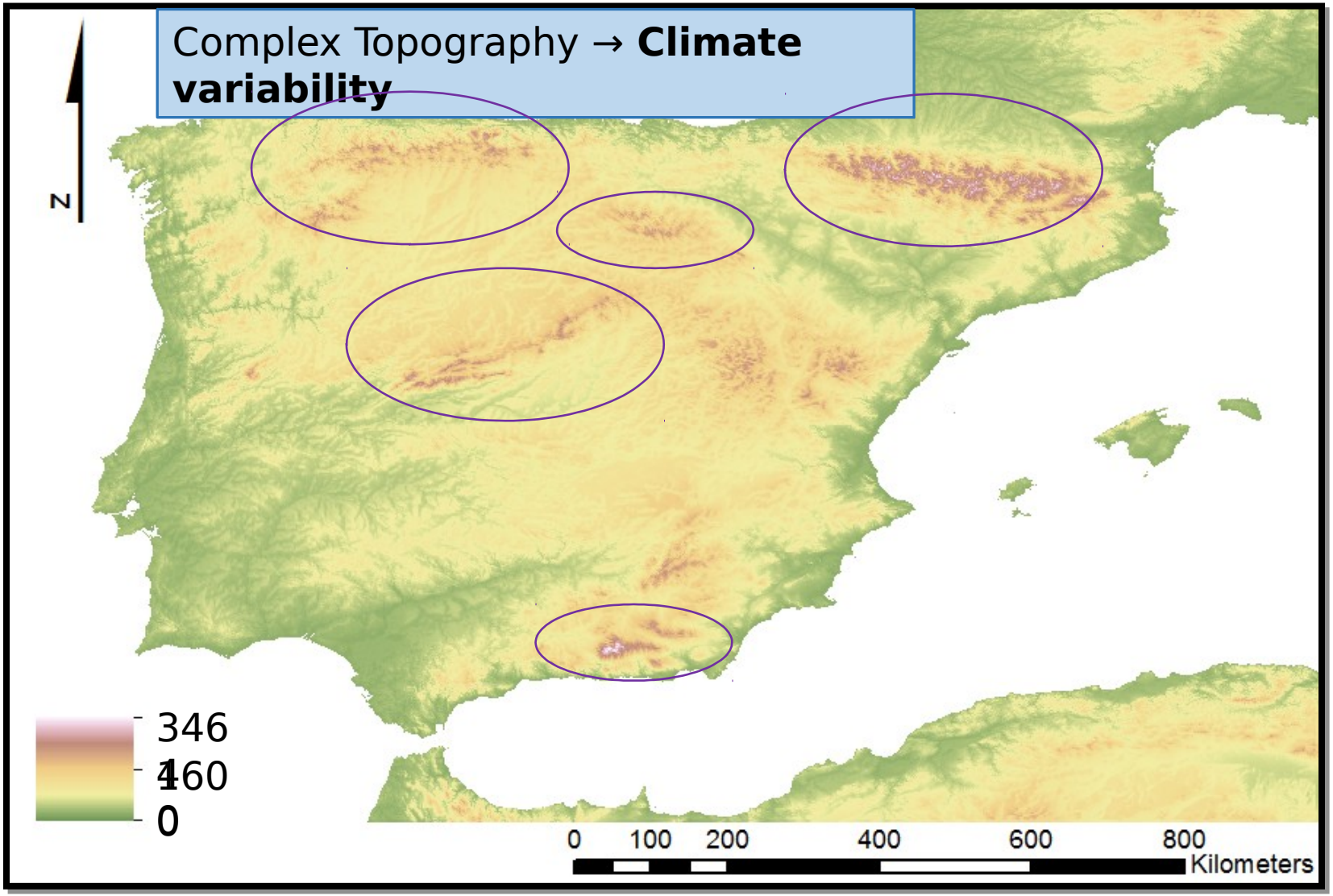
troduction: Iberian Peninsula climatology.



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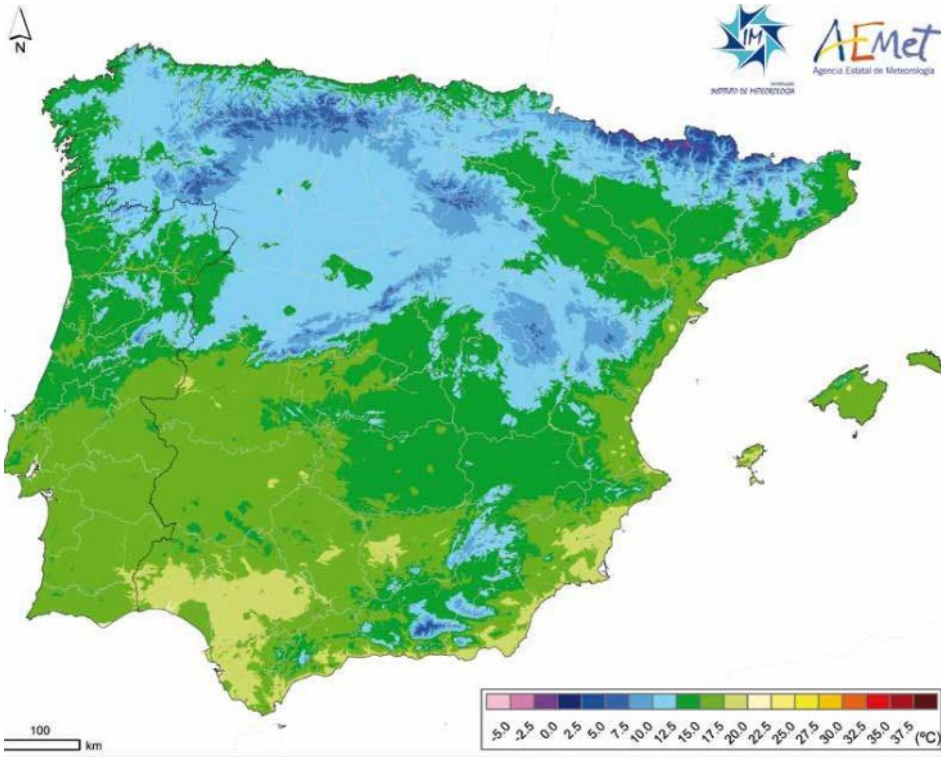
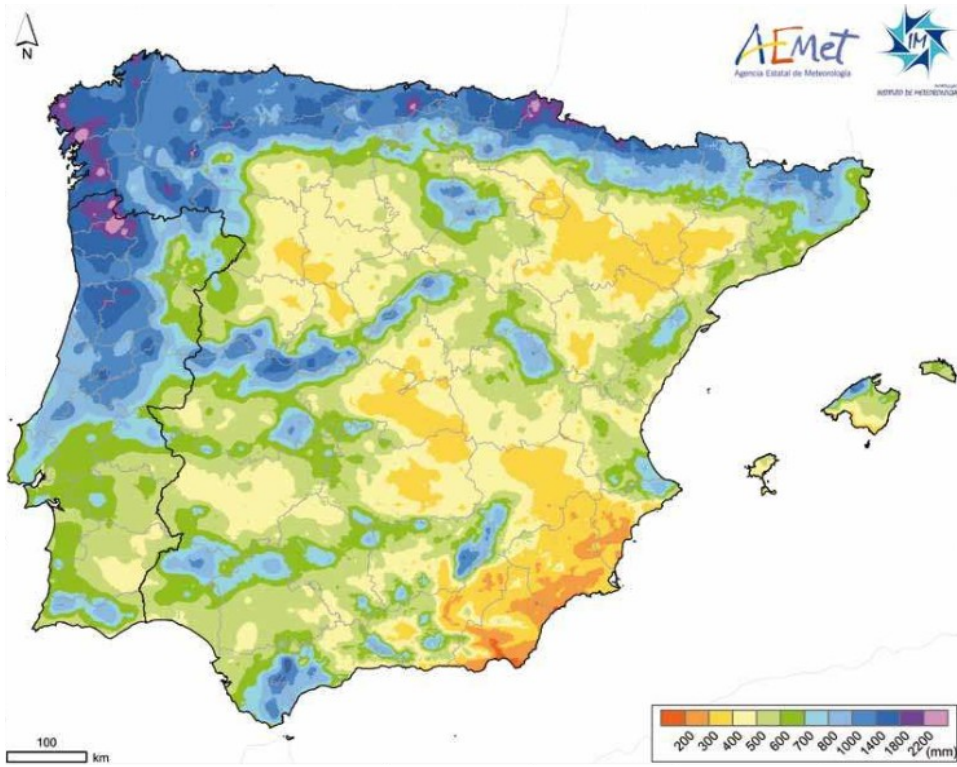




Average Temperature (Cº) **Average Precipitation (mm)**

Source: Iberian Climate Atlas, State Meteorological Agency of Spain(AEMET)

COST Action: ES1404 – HarmoSnow Granada 3/November/2016

Objetives

Main Objective:

- Study the particularities of the snowpack over different mountain ranges of Iberian Peninsula

ndary objectives:

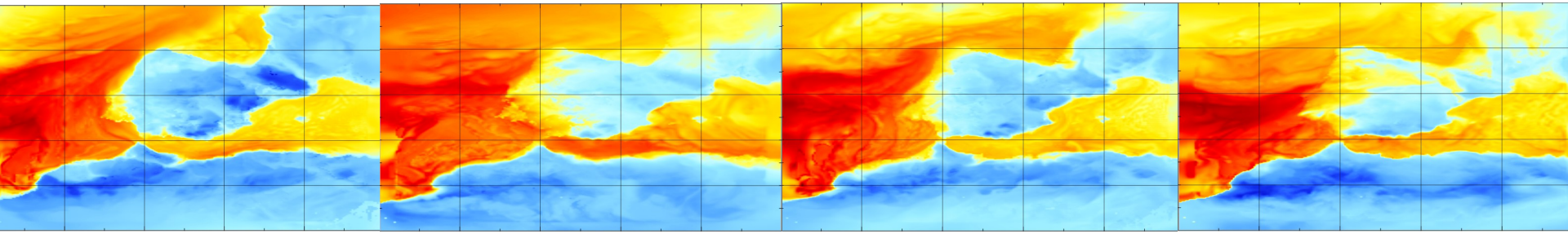
d a Daily MODIS database for every Principal Mountain Range in the Iberian Pen

d a Daily Snow Depth (SD) and Snow Water Equivalent database for Iberian Pen

WRF model (Wheather Reserach and Forecast)

Problem: There is not enough snow and high mountain meteorological data!

Solution: Modelled data



00:00 03:00 06:00

Format:

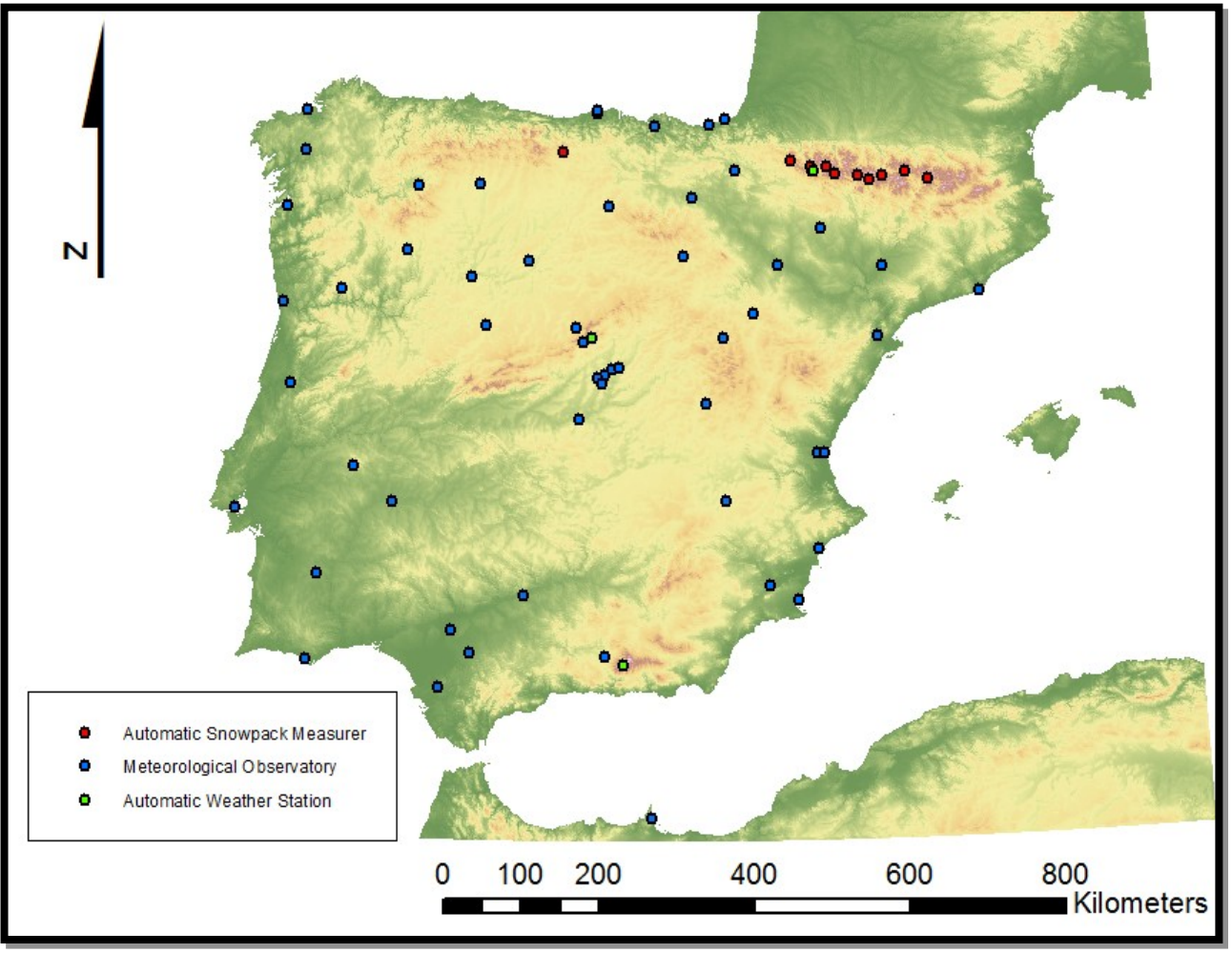
- **Spatial Resolution: 0.088º (~10km)**
- **Temporal Resolution: 3h**
- **Timeframe: 1/12/1979 -> 30/11/2014 (35 years)**

Variables:

- **Precipitation**
- **Pressure**
- **Specific humidity**
- **Temperature**
- **Short Wave Radiation**
- **Wind**

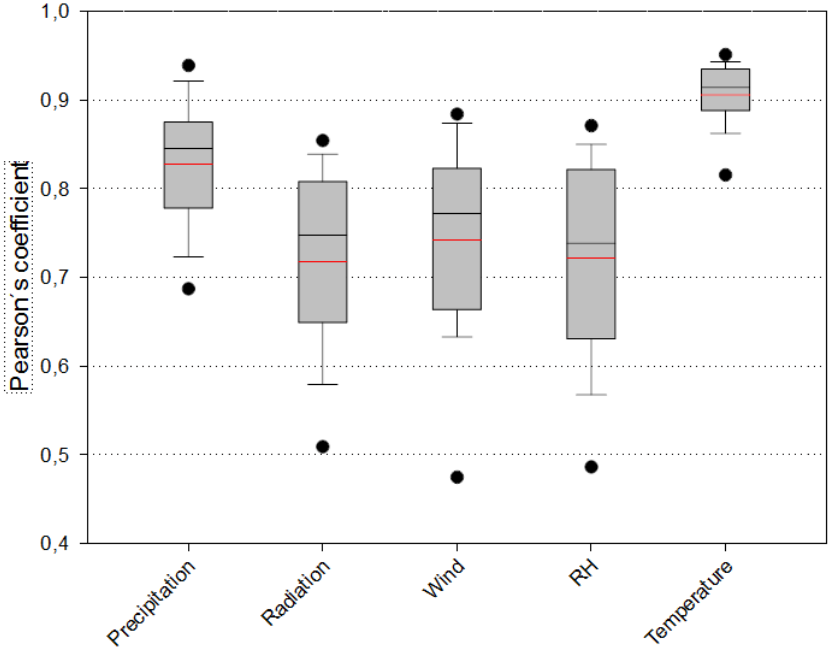
WRF validation

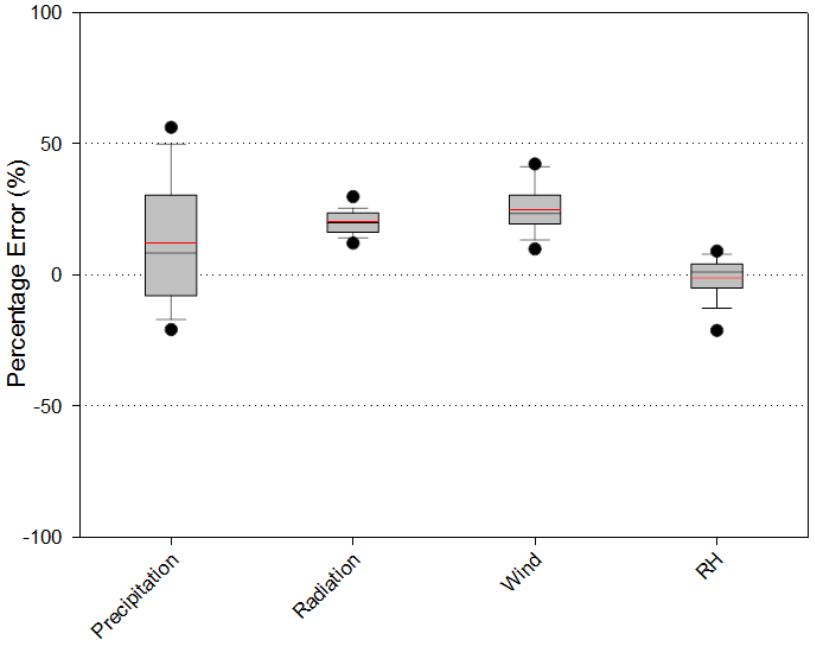
Extremely useful data, but it is not real… We have to validate it

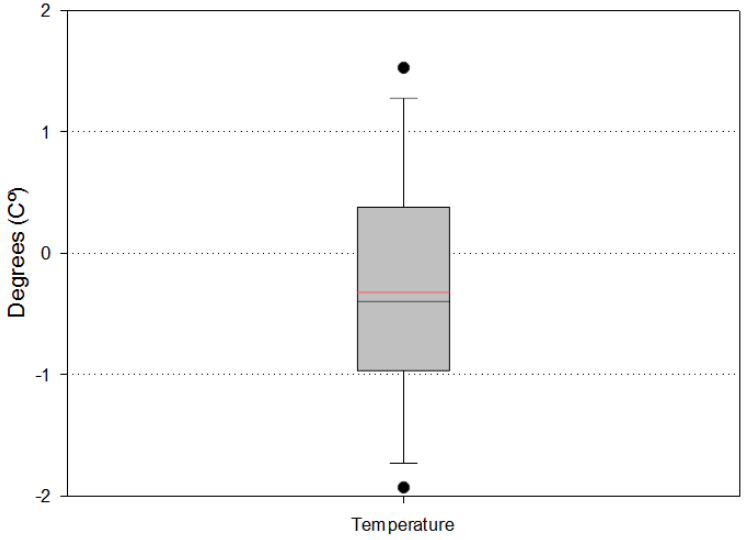


- Variables:
  - Temperature
  - Insolation
  - Precipitation
  - Relative Humidity
  - Wind
  - 53 Weather stations
- 53 Weather stations
- Dates (Winter validation):
  - From: January-1961
  - To: December-2011

WRF validation







Good Interannual variability

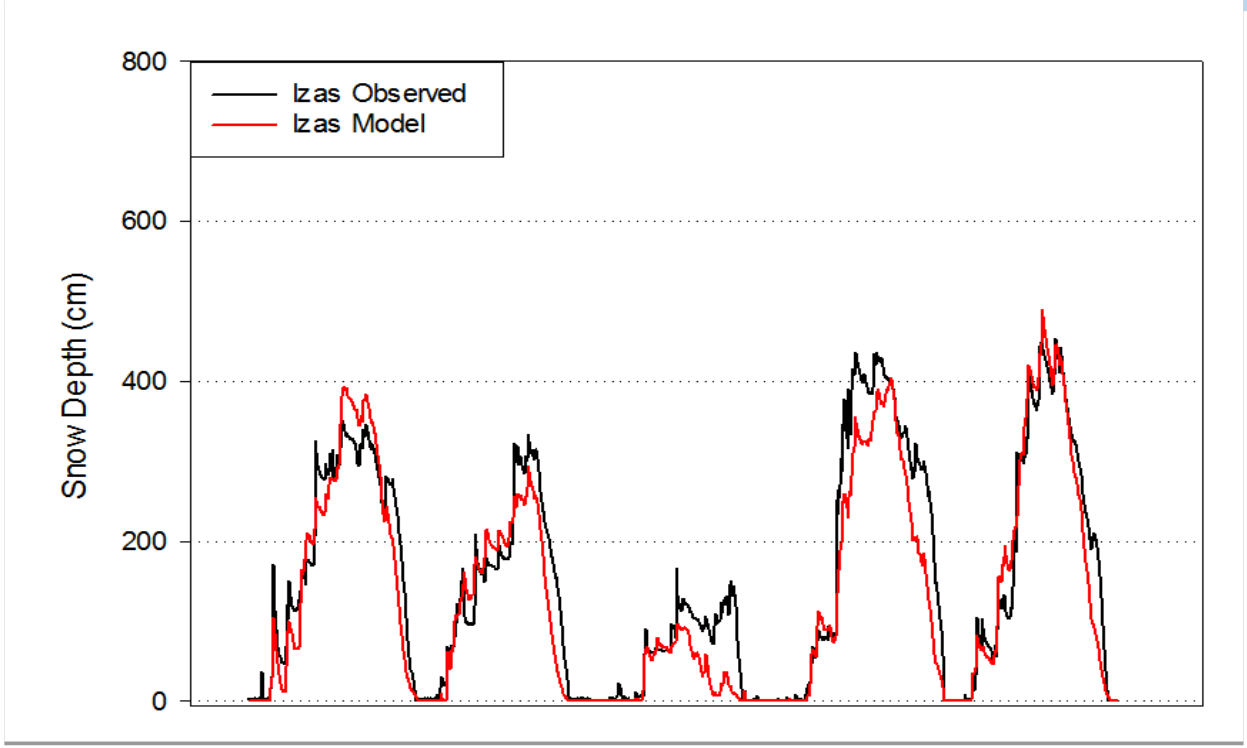
There are biases with no clear spatial pattern or elevation dependence.

FSM model (Factorial Snow Model 1.0) Essery (2015)

- Multi-physics energy balance model of accumulation and melt of snow on the ground

- 5 different Parametrizations (32 model configurations)

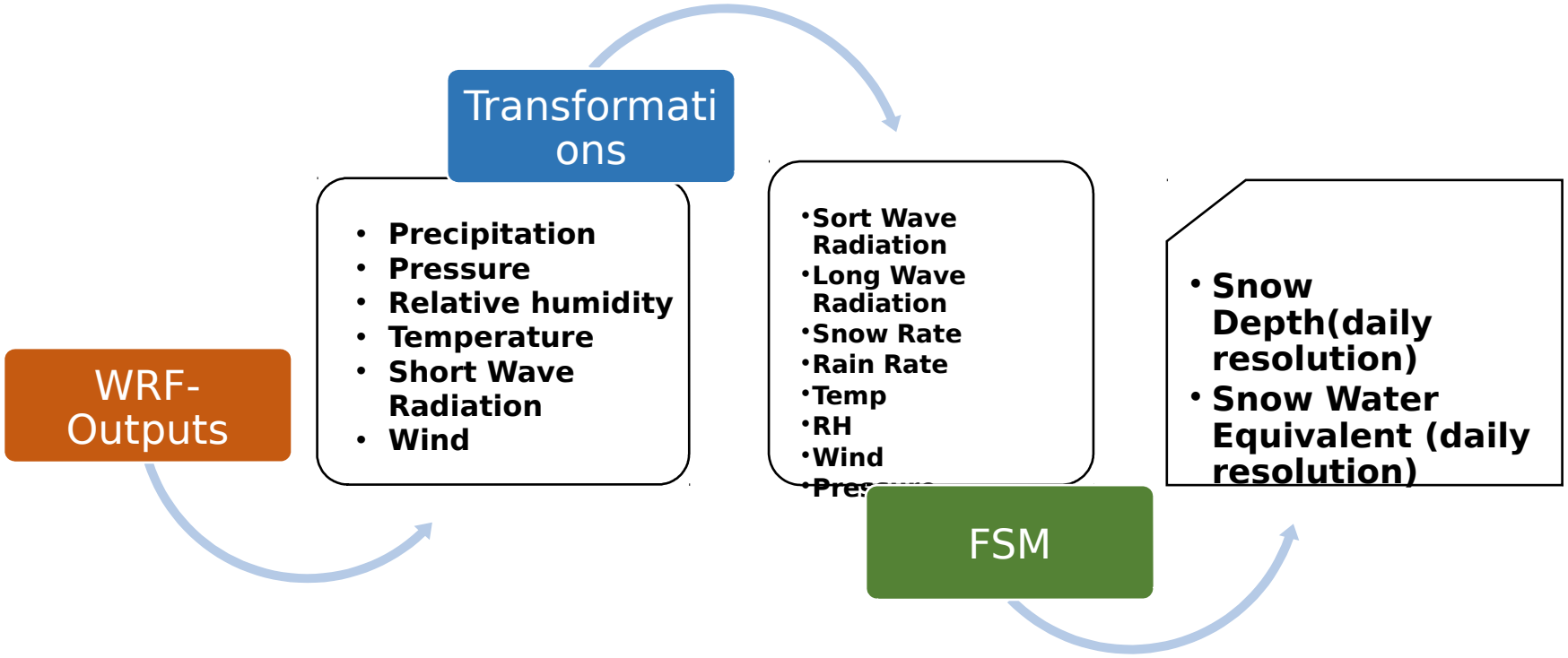
- *3 snow layers: First layer for snow depths up to 0.2 m,* second for depths from 0.2 to 0.5 m; and third layer for deeper depth



Advantages:
- Very Fast
- Open Source
- Possible to Automatize
- Different

Problem:
- Different inputs than WRF outputs

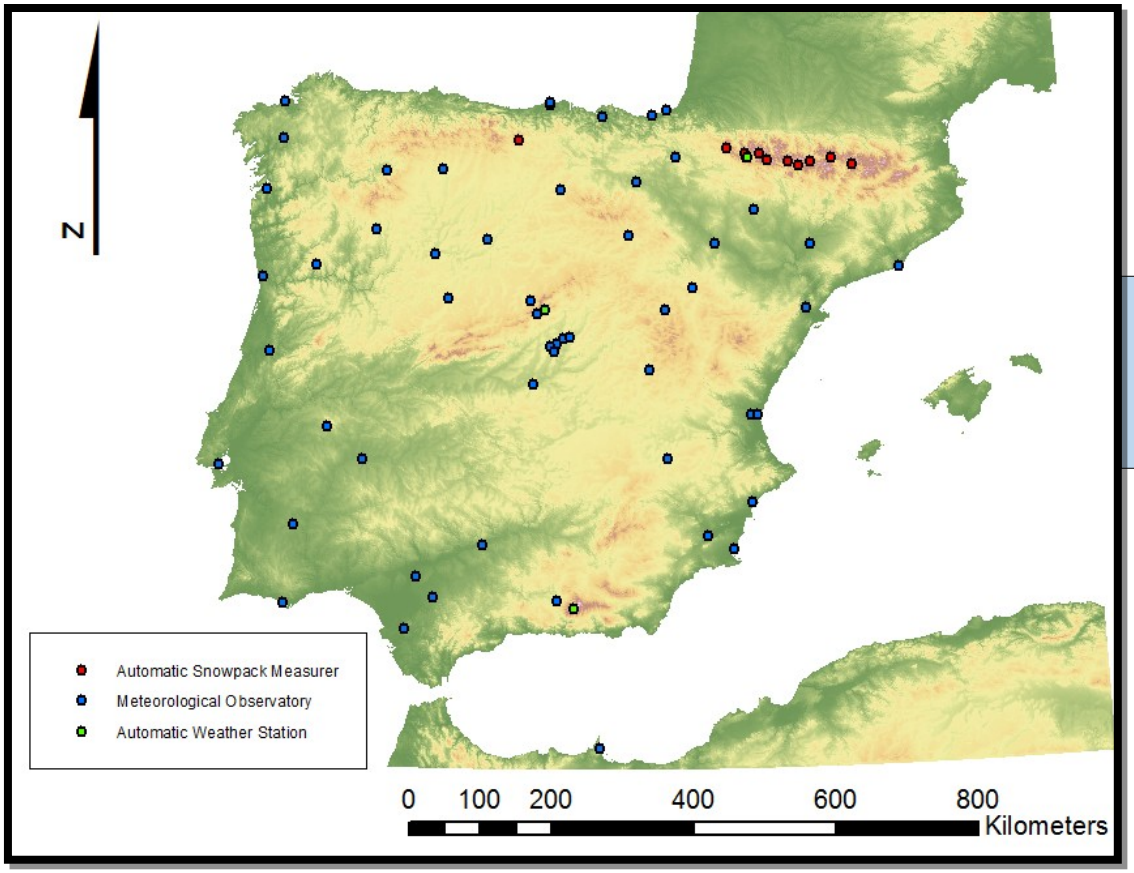
FSM model (Factorial Snow Model 1.0) Essery (2015)



This methodology allow us to develop an SD and SWE database for all Iberian Peninsula…

Now we already have data! But it is necessary to validate it

FSM 1.0 Validation: Automatic SWE sensors and Automatic Weather Stations

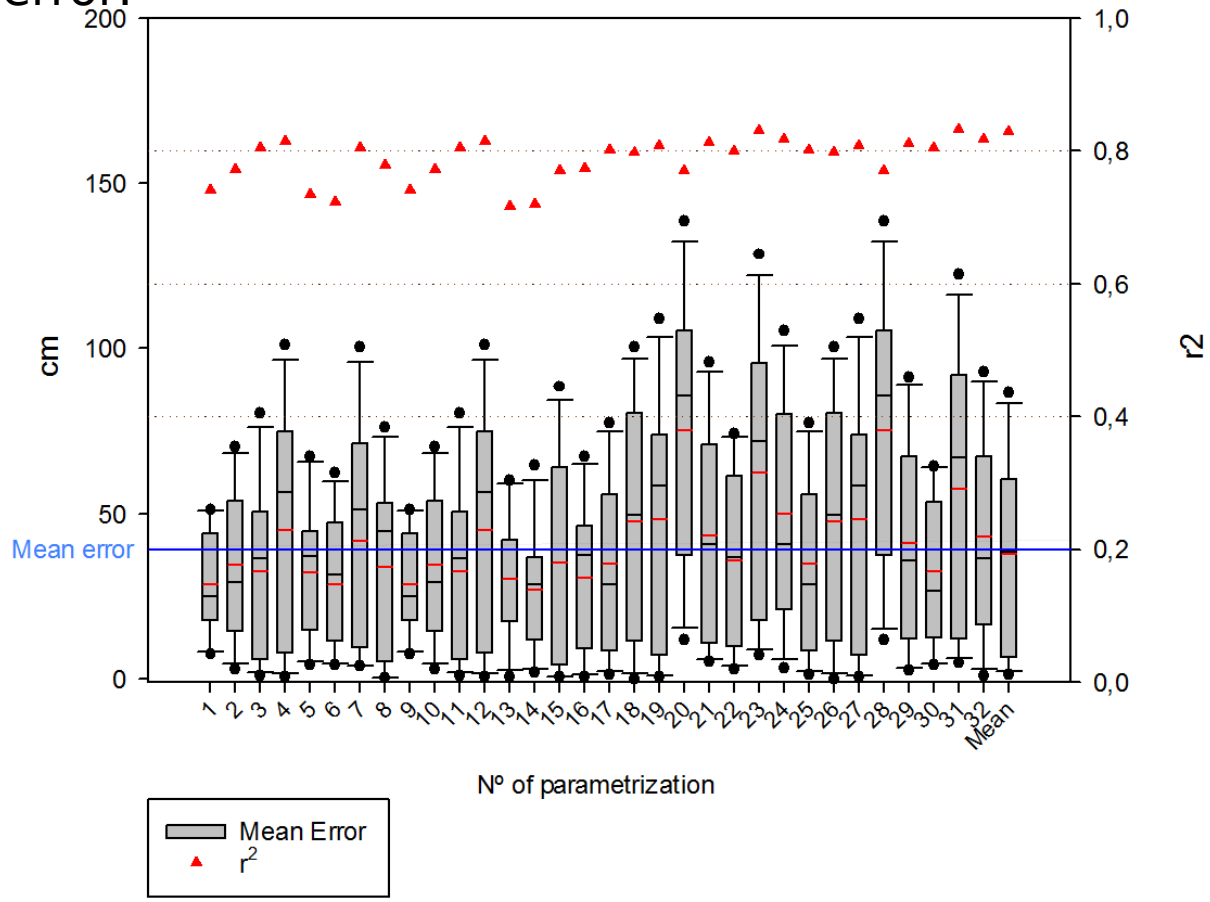


Mountain Weather Devices
- 11 SWE sensors (SAIH Ebro)
- 3 Automatic Stations

They are at different elevations than WRF model, we will also check the error projecting the data to different elevations

FSM 1.0 Validation: Automatic Snowpack sensors and Automatic Weather Stations

Ensemble of parametrizations estimation of error:



We compare the errors of each model configuration with the real data

Good interannual variability

Is not clear which configuration is the best

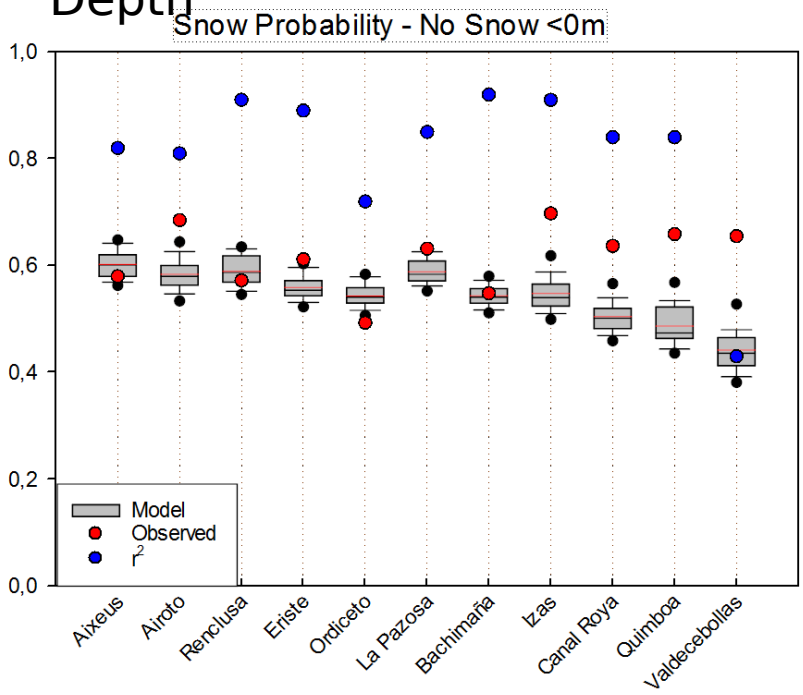
Overestimation:

- Precipitation overestimation WRF

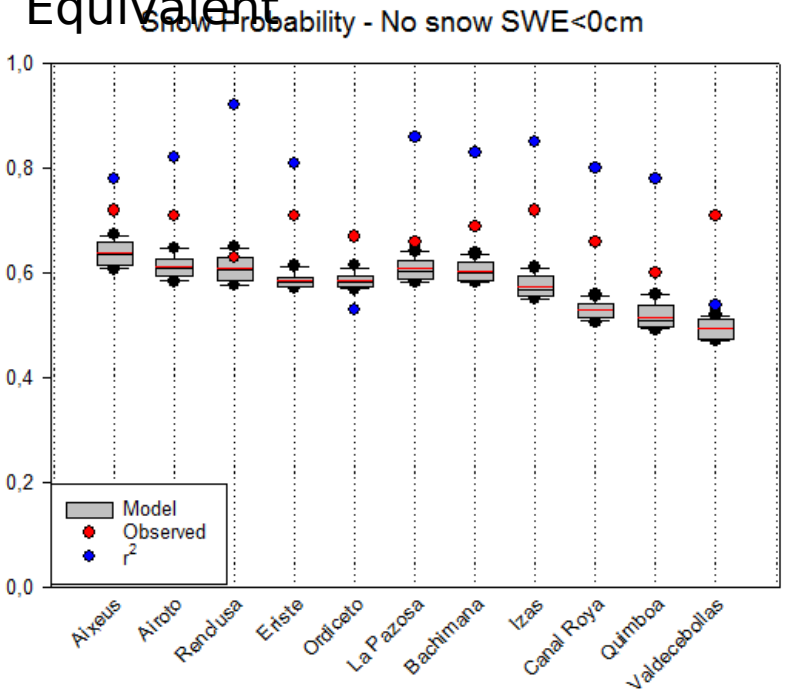
FSM 1.0 Validation: Automatic Snowpack measurers and Automatic Stations

Snow Probability = Days with snow/ Days of the year

Snow Depth



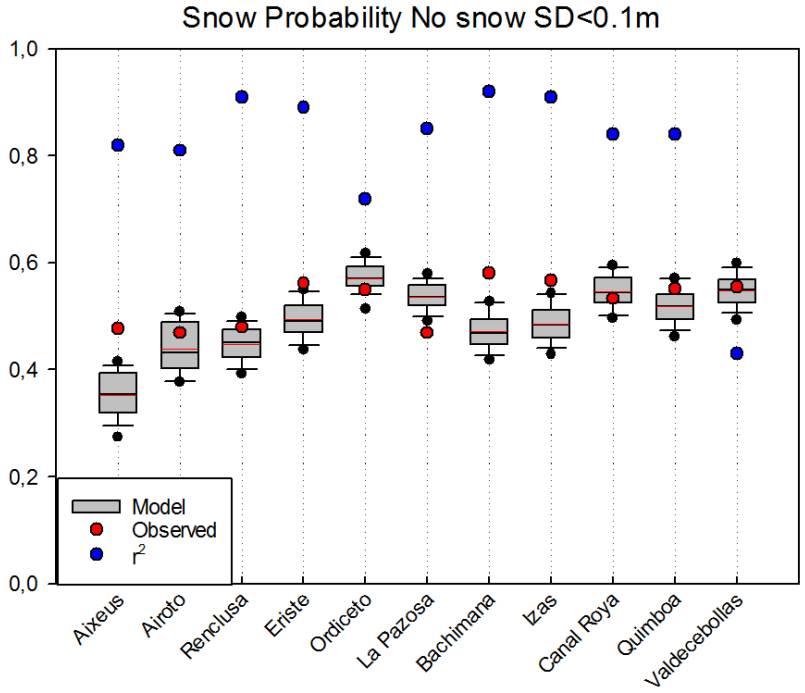
Snow Water Equivalent

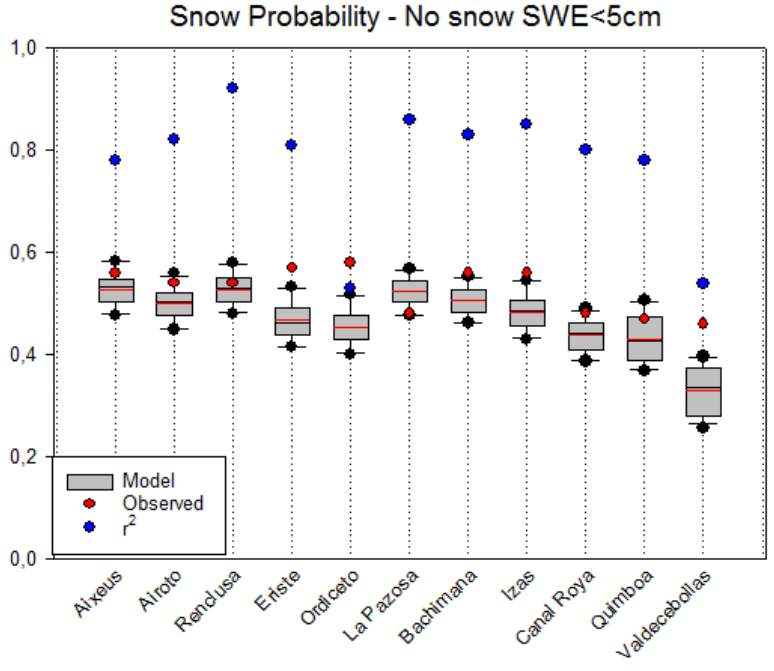


Its ok, but can be better. There is some overestimations in the device with think snowpacks.

FSM 1.0 Validation: Automatic Snowpack measurers and Automatic Stations

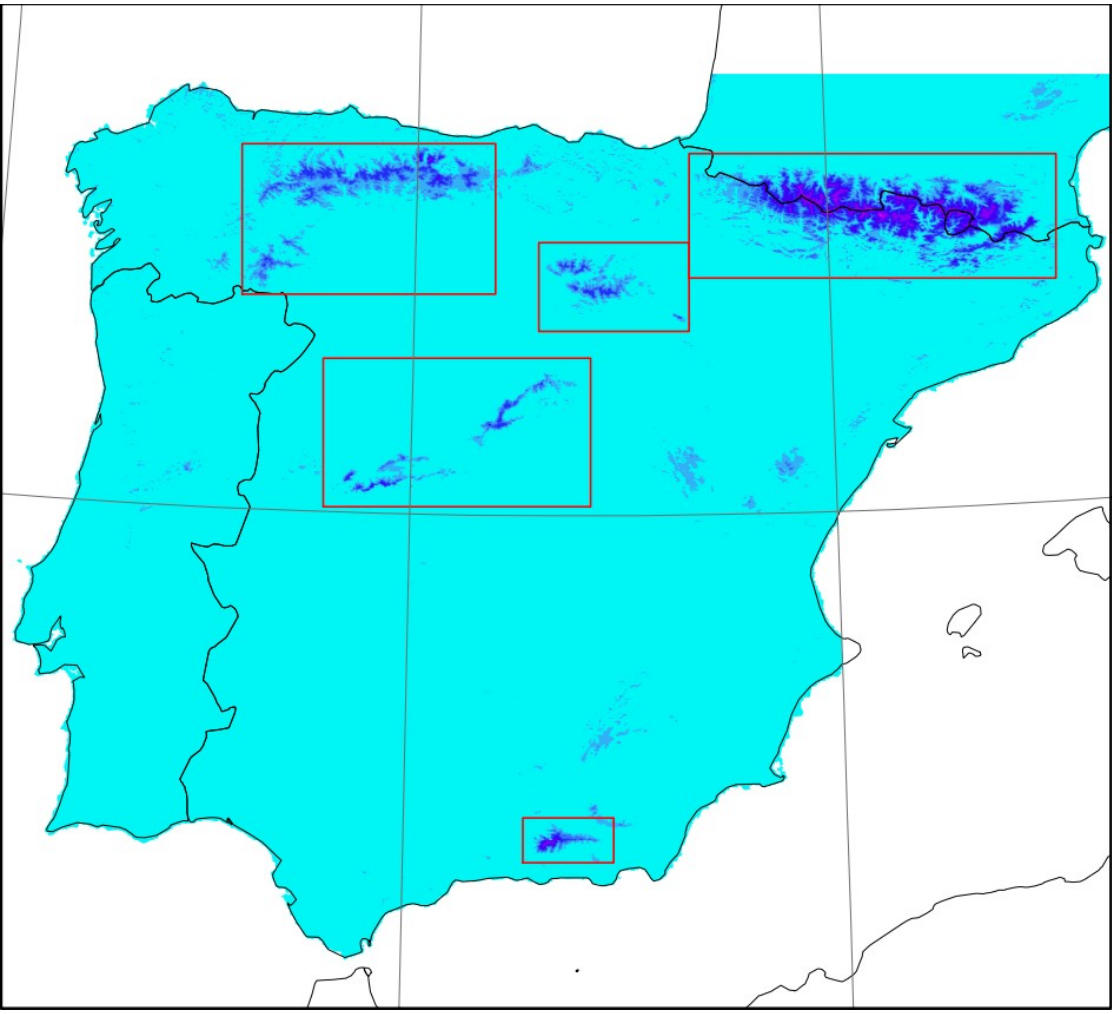
Calculating the probability map when the SD is bigger tan 10 cm and SWE is bigger tan 50mm improves a lot the validation



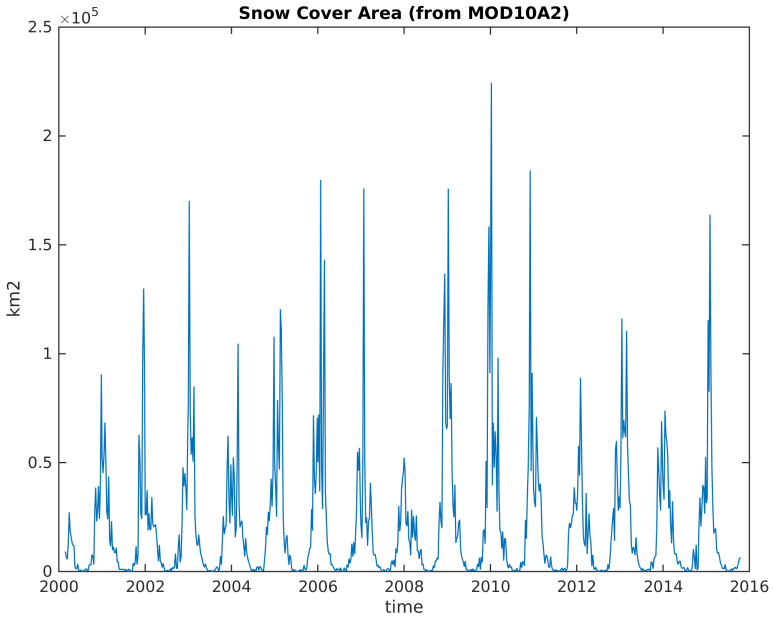


Snowpack measurers signal its quite near of the FSM ensemble variability with very good coefficients of dettermination.

MODIS



Areas of intesrest

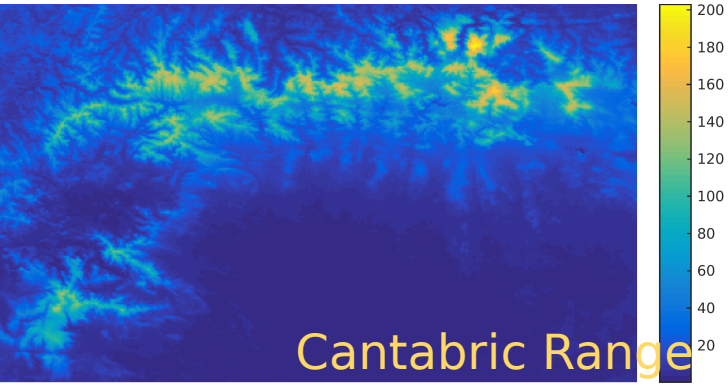


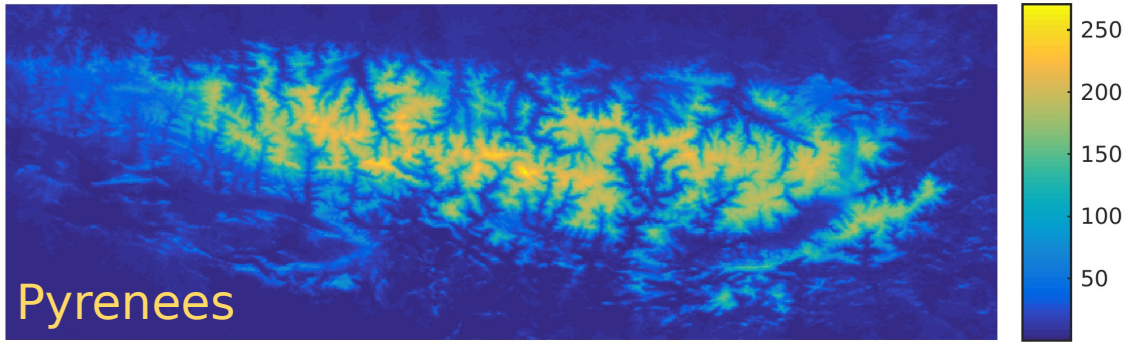
8 Day Mean Snow cover duration after gapfilling. (1/09/2009-31/08/2015)

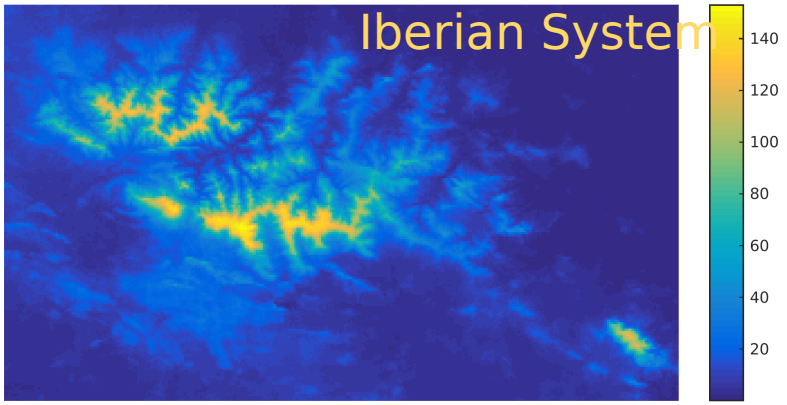
MODIS snow cover database

Gapfilling procedure *Gascoin et al. (2015)*

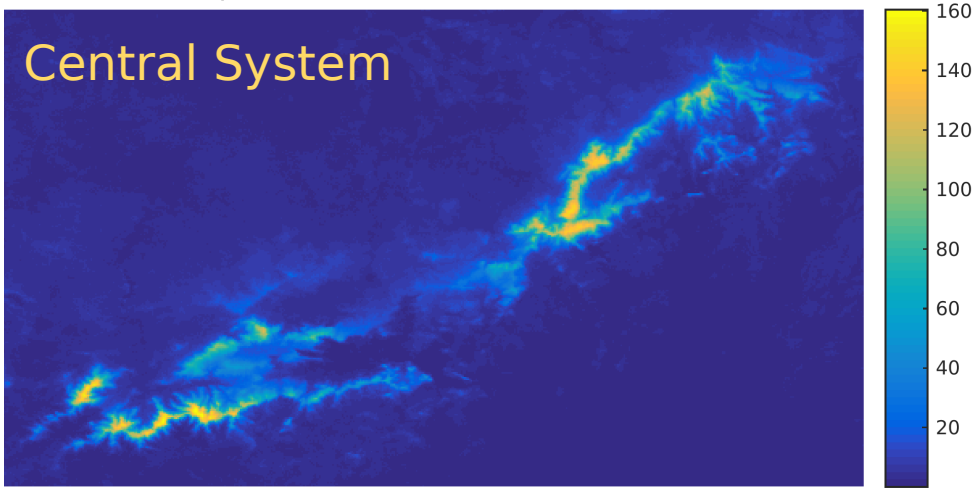
MODIS

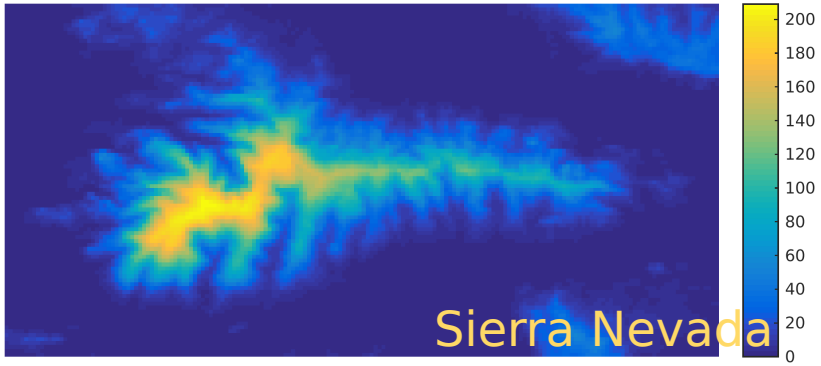




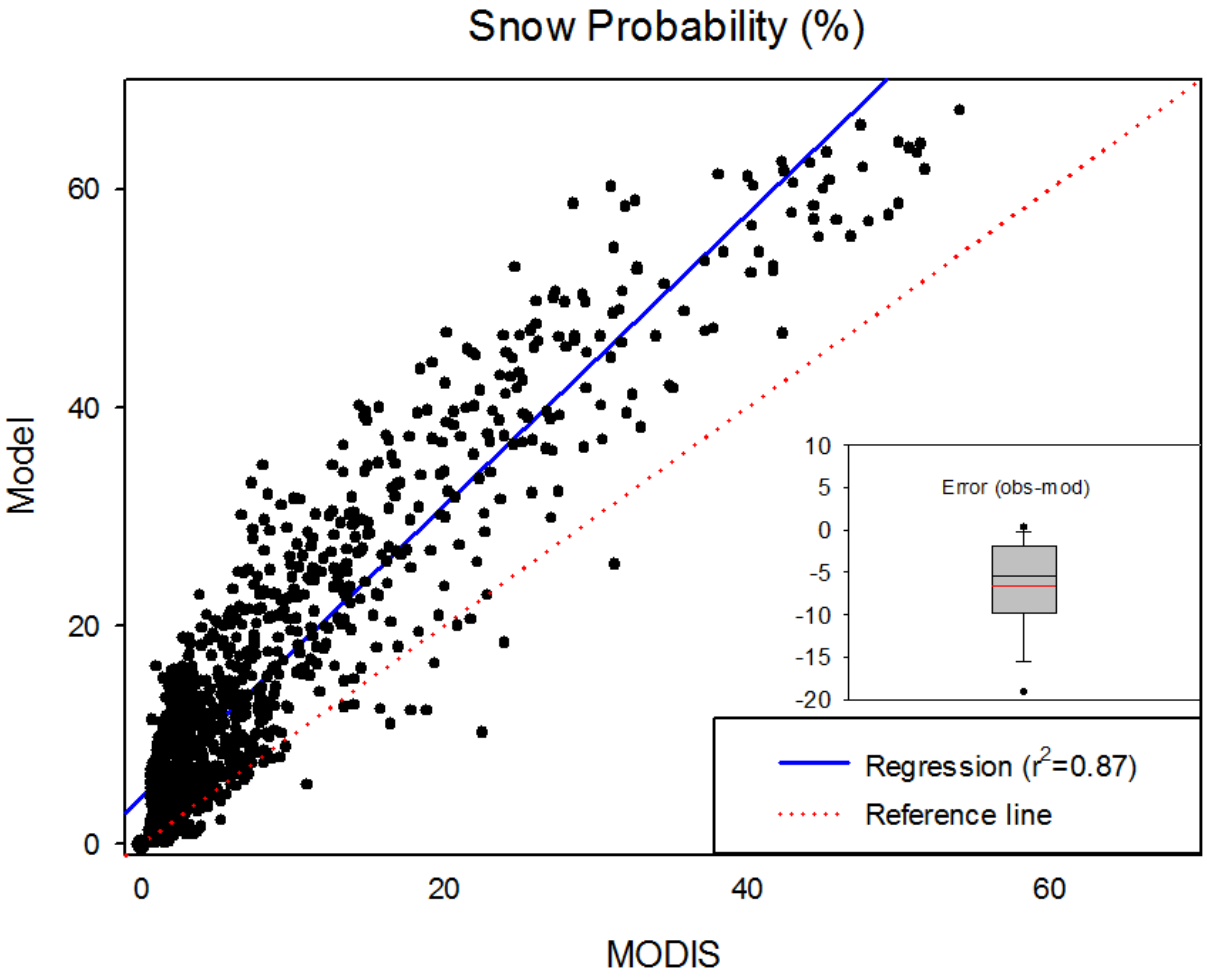


1 Day Mean Snow cover duration after gapfilling. (1/09/2009-31/08/2015)





FSM-MODIS Validation



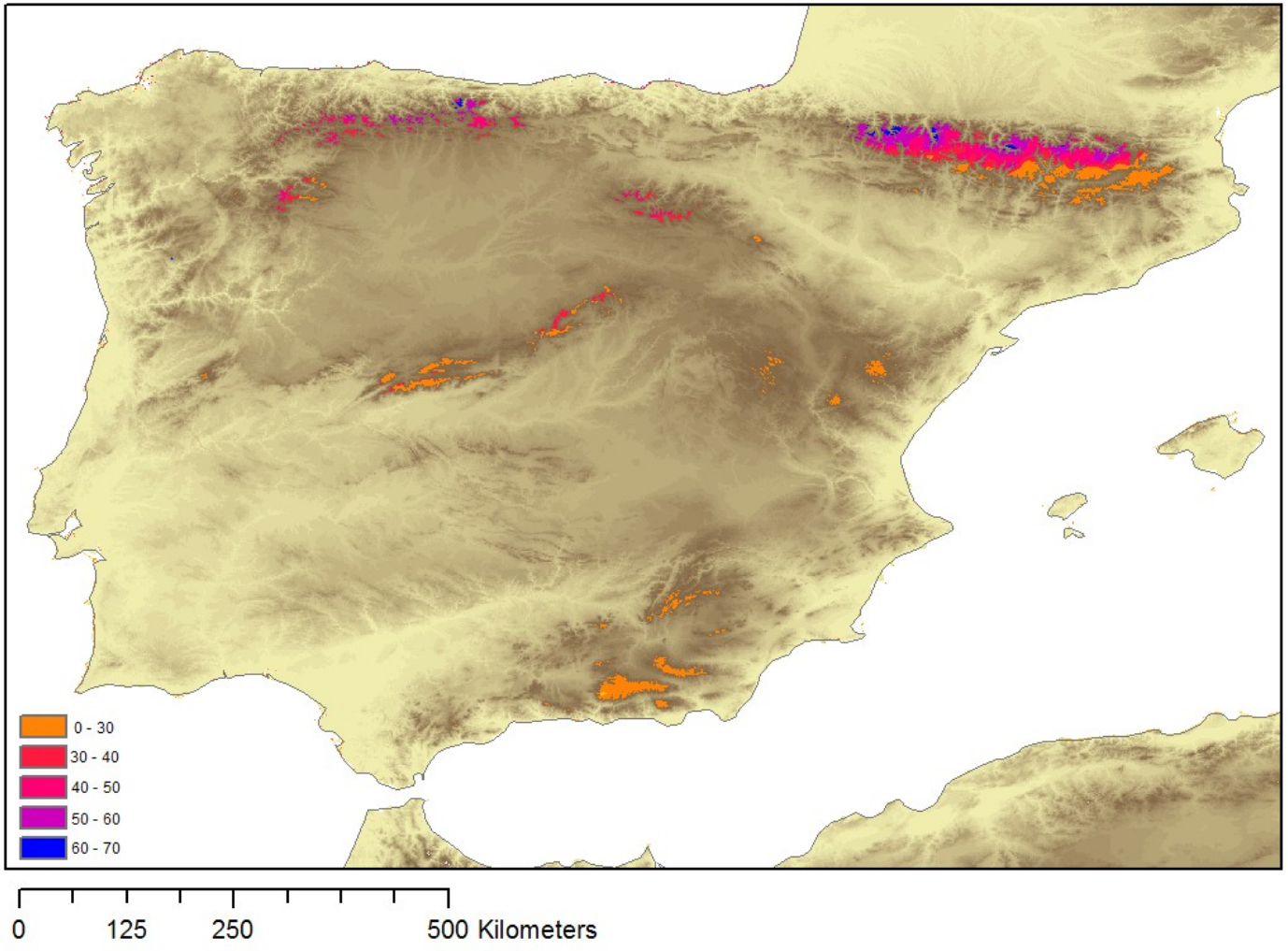
We increase the MODIS resolution from 500m to 10km (mean method)

Main error ≈ -7% of probability
Very good correlation

We could find almost the same result from two complete different sources (Snow Cover Satellite data and Snow Depth Modelled data)

Intercomparison between Spanish mountains

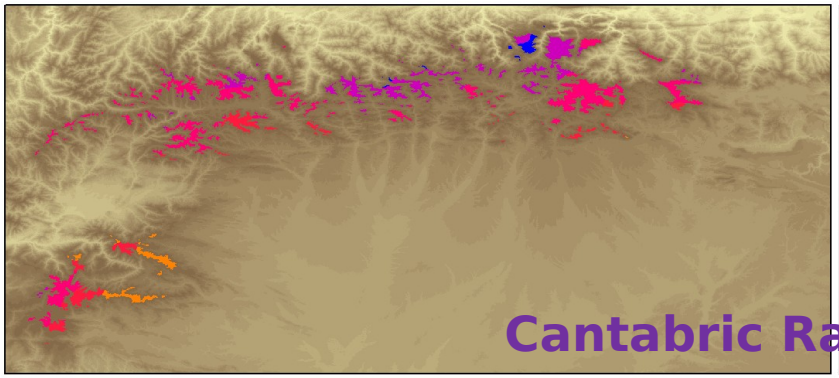
To compare different mountain ranges we should project all of our simulations to a common elevation (2000m)

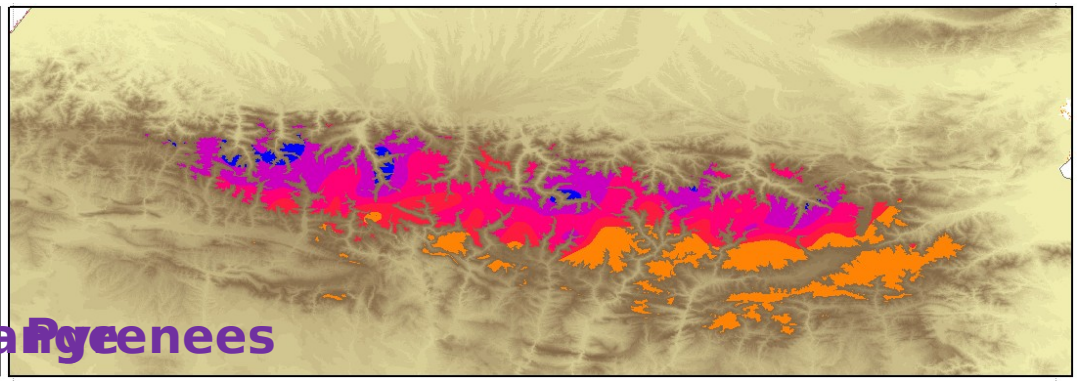


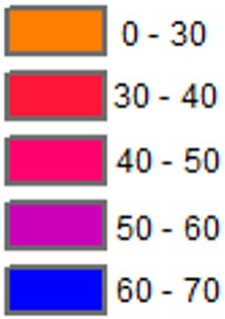
Final product:

Percentage of time with snow presence

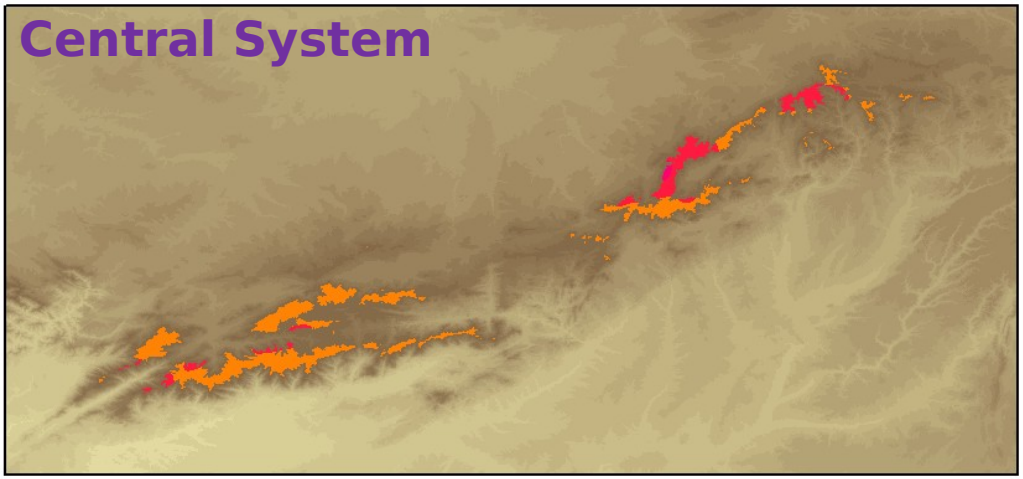
Intercomparison between Spanish mountains





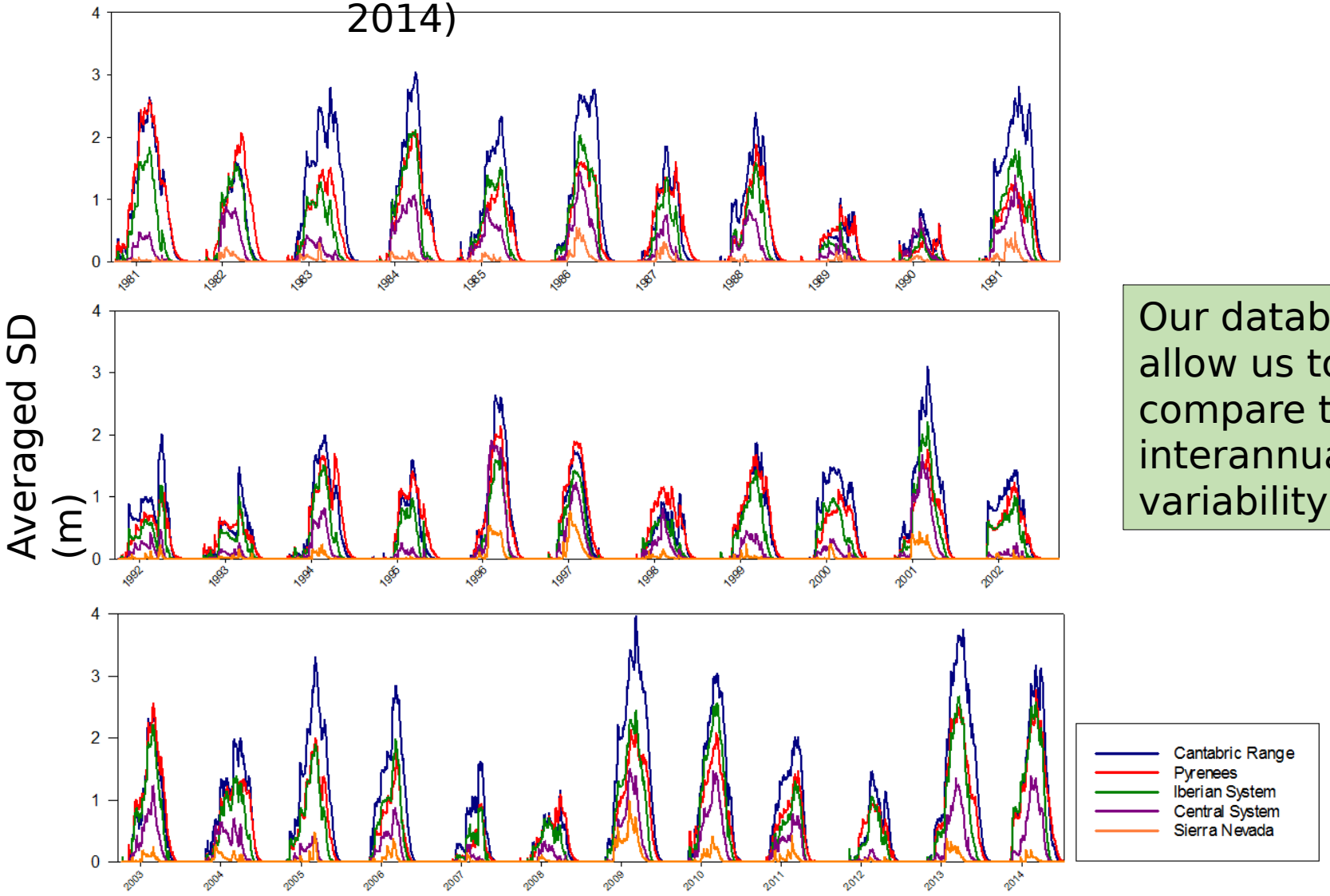


Percentage of time with snow presence (regional scale)



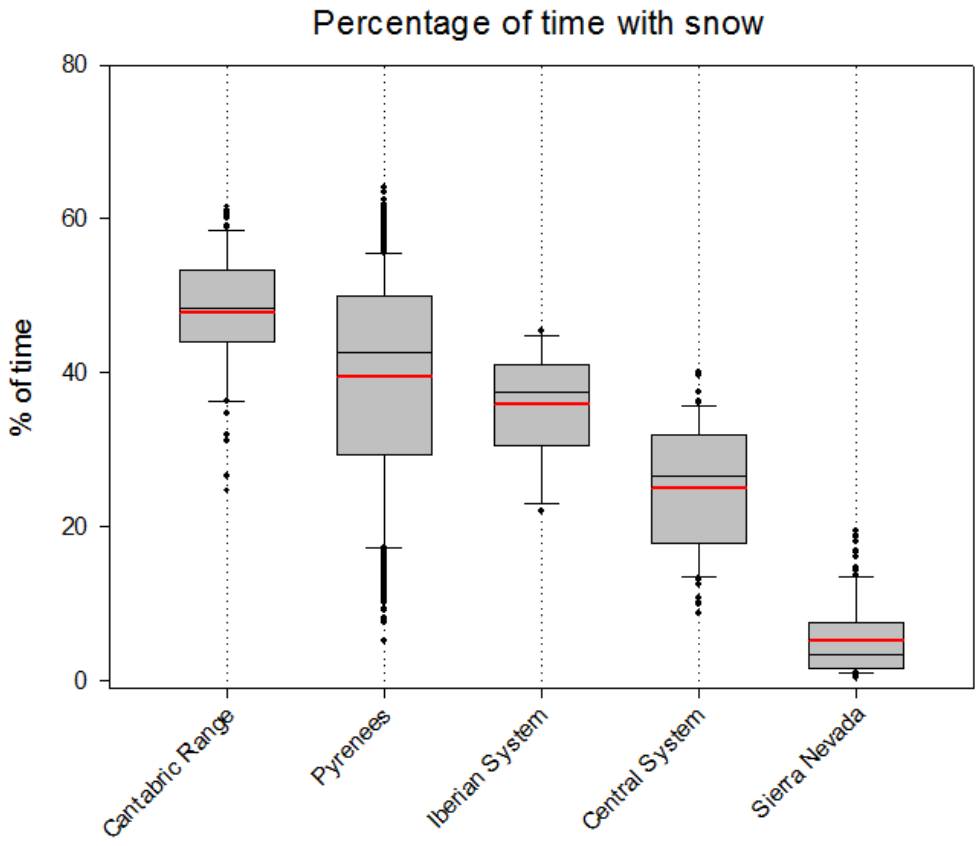
Intercomparison between Spanish mountains

SD series (1981-2014)



Our databases allow us to compare the interannual variability of SD.

Intercomparison between Spanish mountains



Distribution of values of % of snow for each Range:

High Variability on the Pyrennes

Cantabric Range -> highest SD mean, but not the highest values

Results and Conclusions

We had developed a database of SD and SWE for all Iberian Peninsula , useful for regional scale hydroclimatological studies.

We have developed a Snow Cover database from satellite data for the most important mountain ranges of Iberian Peninsula

The behaviour of the snowpack over Iberian Peninsula shows great differences depending the area of study at the same elevation.

The values of snow presence varies from ≈ 5 to ≈ 64% of time with snow presence at 2000m

At the same elevation (2000m) Cantabric Range shows the highest mean values, but the biggest accumulations are in some points of the Pyrenees.

Pyrennes shows all the variability of the Iberian Peninsula for percentage of time with snow. (≈ 5% to ≈ 64%

Thank you !