An Assessment of Long Term Temperature Variability in the Sierra de Guadarrama

GuMNet:
Guadarrama Monitoring Network

Vegas & GuMNet Consortium

Vegas-Cañas C., J. F. González-Rouco, J. Navarro-Montesinos,
E. García-Bustamante, I. Álvarez-Arévalo

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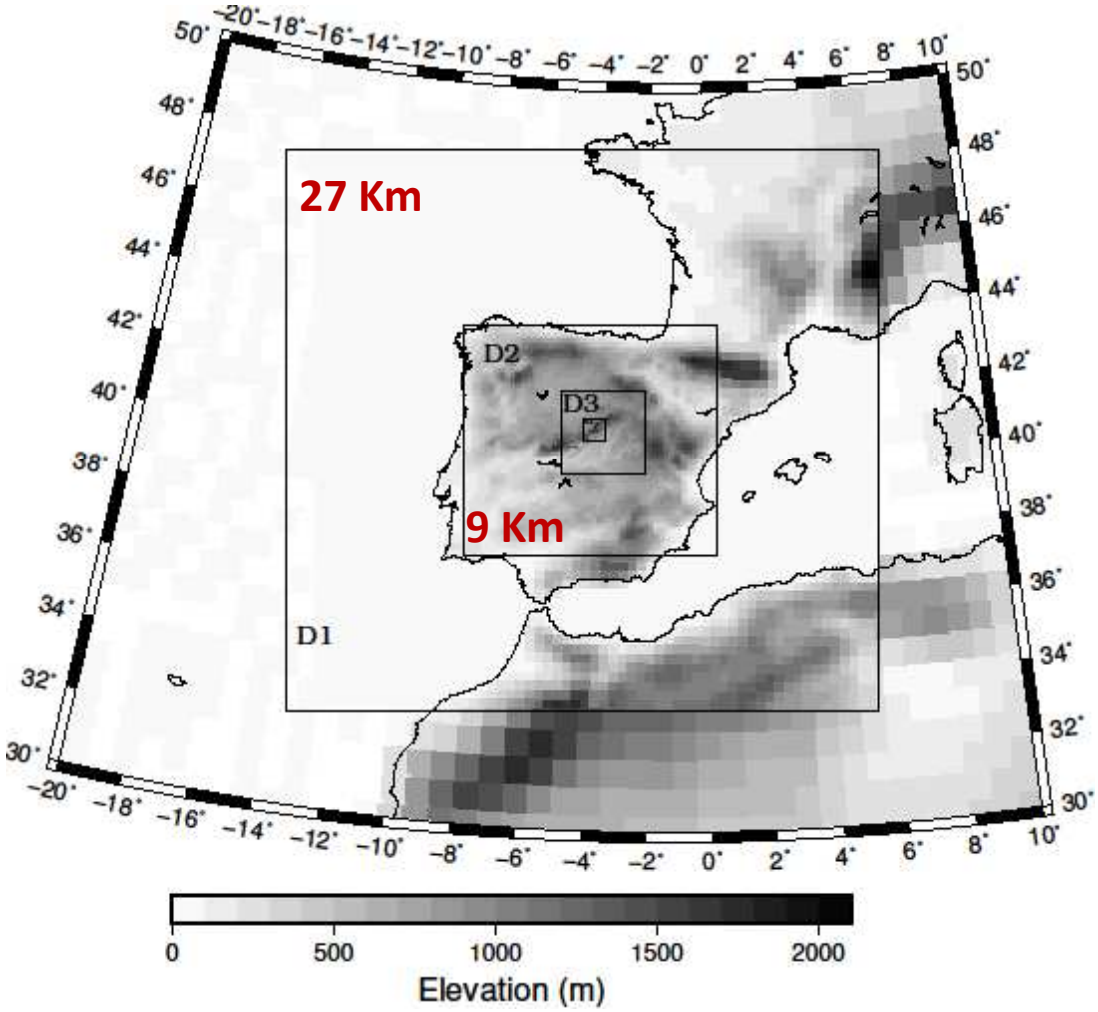
cvegas@ucm.es
Departamento de Física de la Tierra y Astrofísica
UCM
Universidad Complutense de Madrid

Data



- **WRF:** 1 km finest resolution → no turbulent kinetic energy *(Gibbs et al., 2011).*
- **WRF:** the closest grid points to the observational stations are selected → *WRF**
- **ERA Interim (ERAIT):** boundary conditions for WRF.
- **ERAIT:** 80km horizontal resolution → just 2 grid points associated to the stations.
- **Observations:** 6 stations located in the Sierra de Guadarrama National Park (SGNP).

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https://www.ucm.es/gumnet

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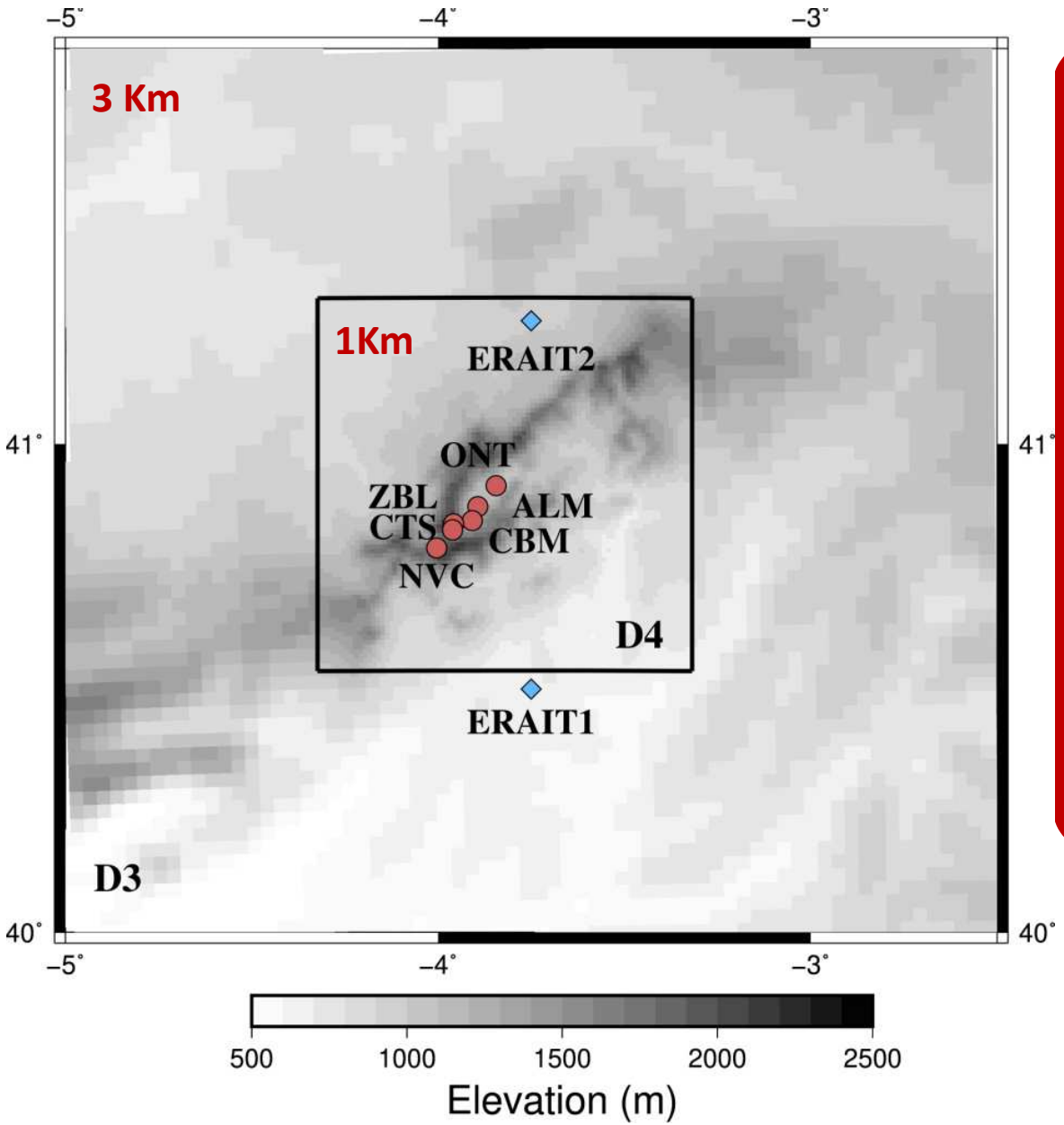

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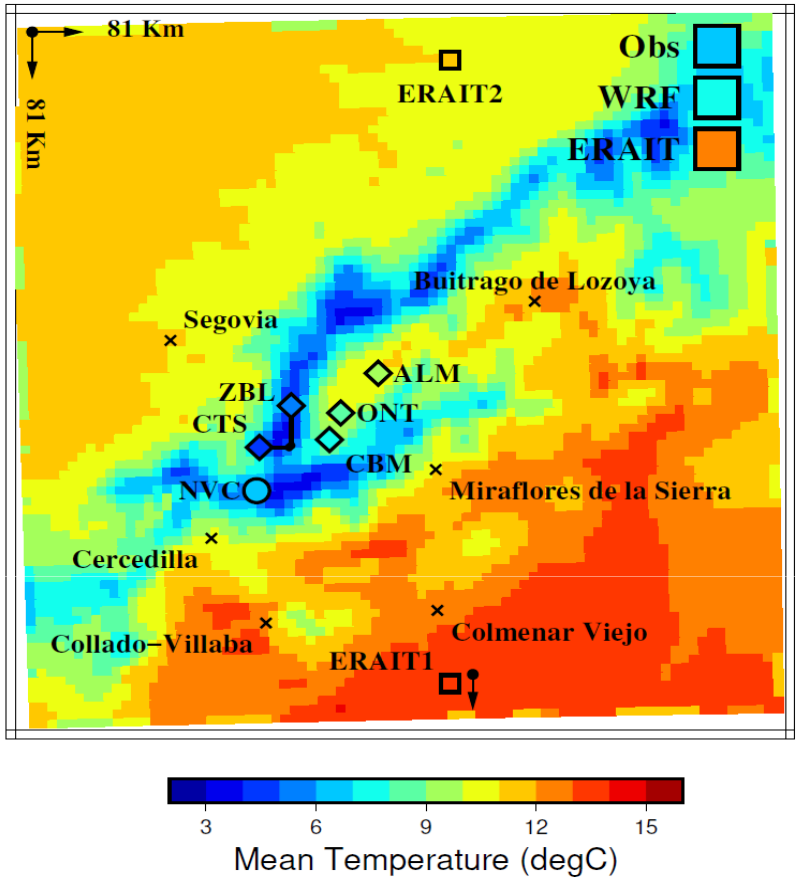
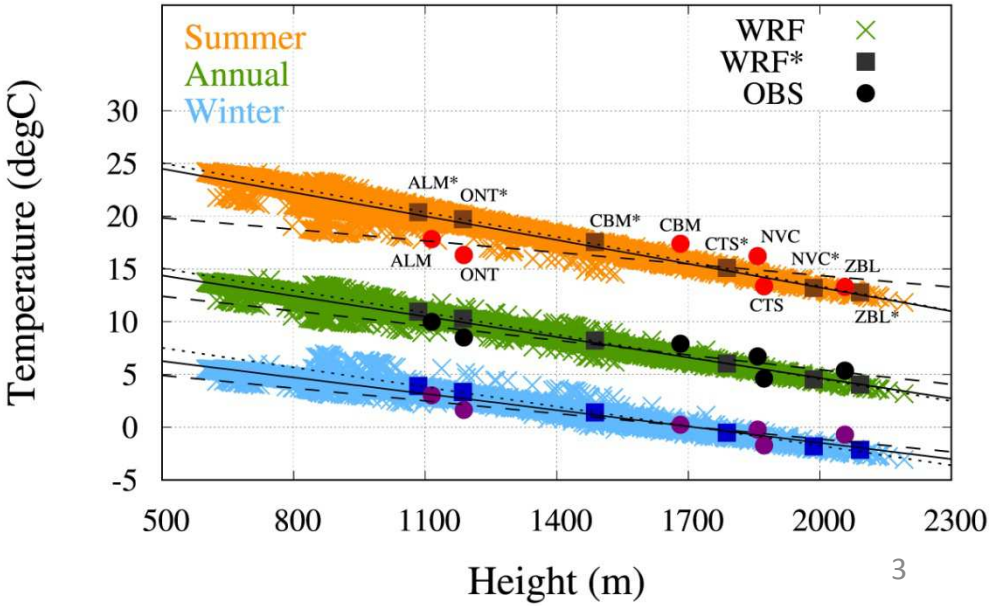
Evaluation of WRF. Mean temperature & vertical gradient

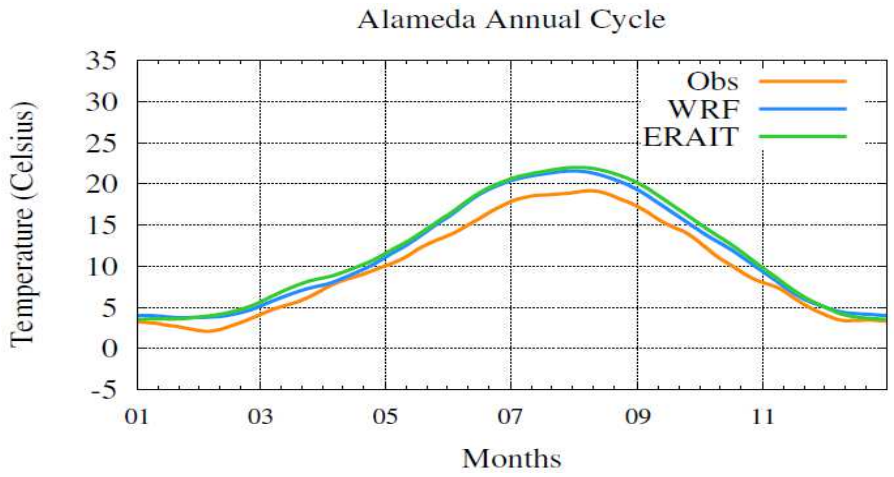


- Basic climatological description.
- Dominant orography.
- Local values in agreement with WRF.
- Regional averages → similar WRF & Obs. Warmer bias in ERAIT

- WRF trend: -6.48 °C/km
- OBS trend: -4.64 °C/km
- OBS at high altitudes underestimated by WRF

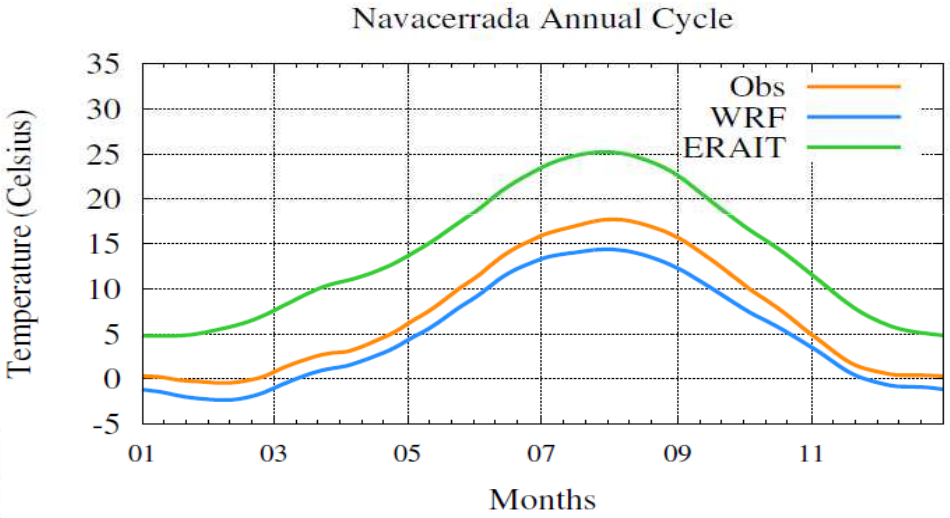


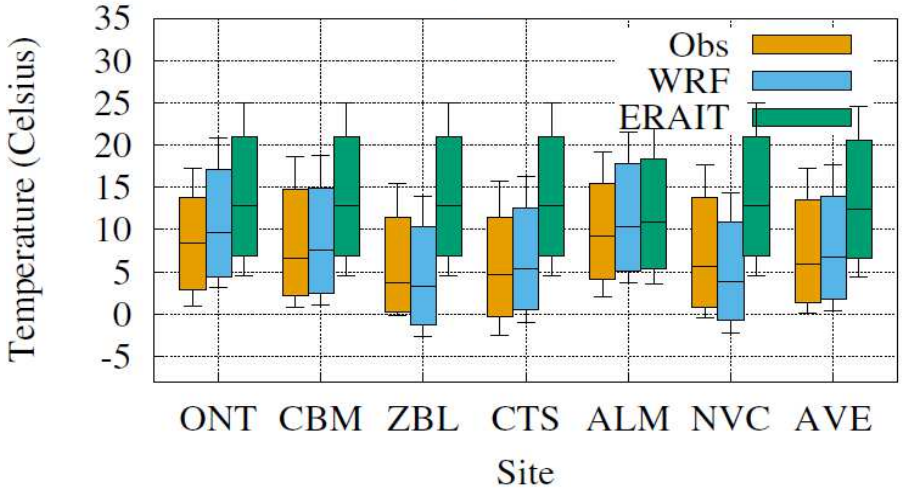
Evaluation of WRF. Annual Cycles



- Annual cycle of Obs in agreement with WRF.
- ERAIT in agreement with Obs & WRF

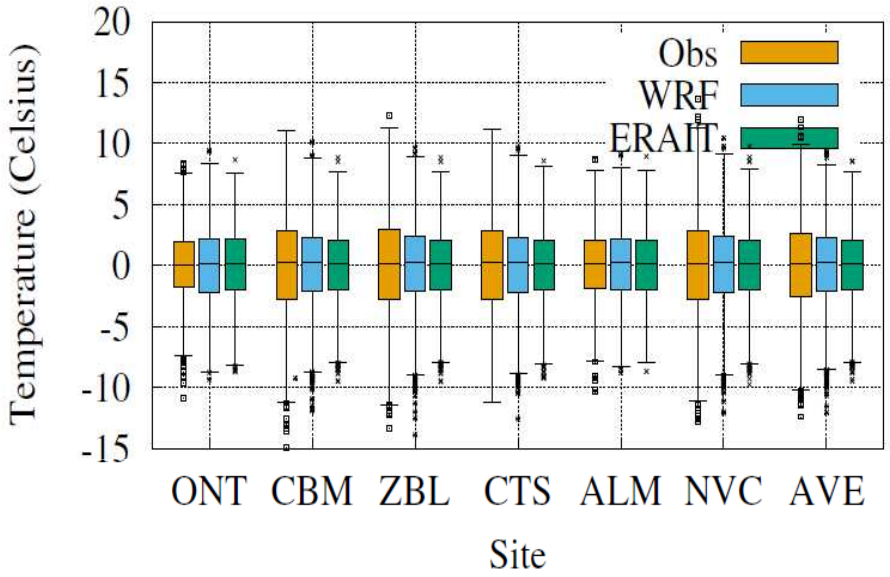
- ERAIT shows a warmer bias (+5°C).
- Same for the rest of the stations → associated to the same ERAIT grid point

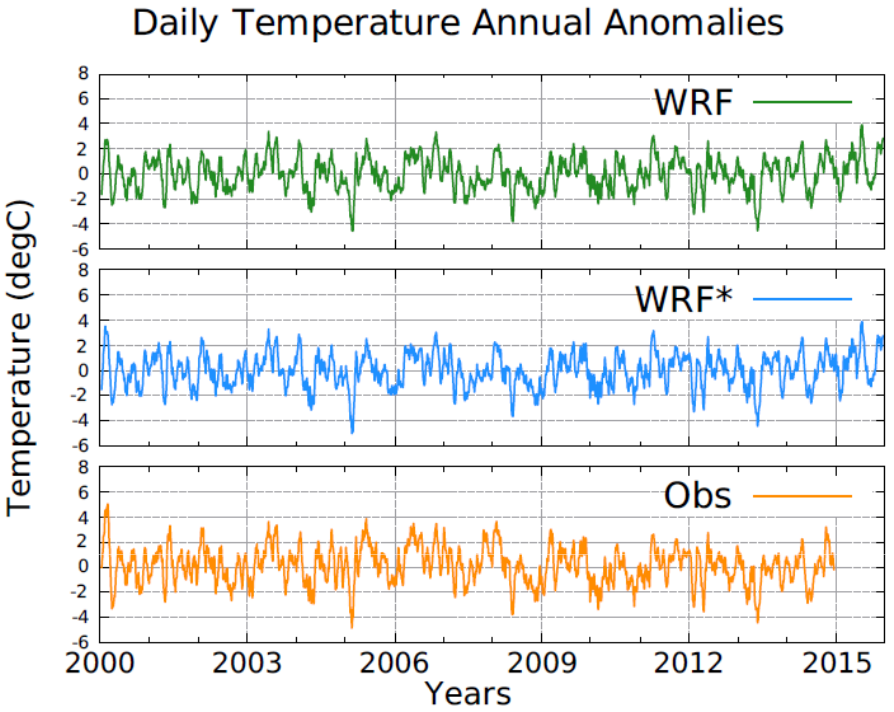




- WRF shows colder T than Obs at high altitude stations, but warmer T at the stations in the valley.

Evaluation of WRF. Temperature anomalies

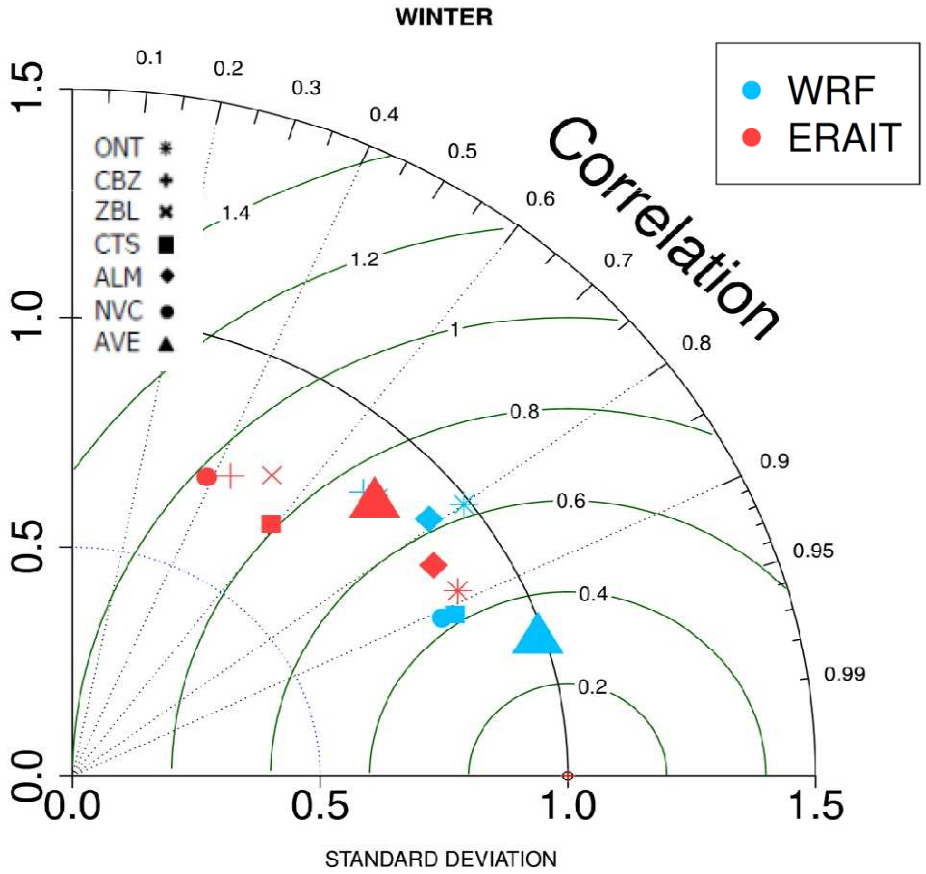


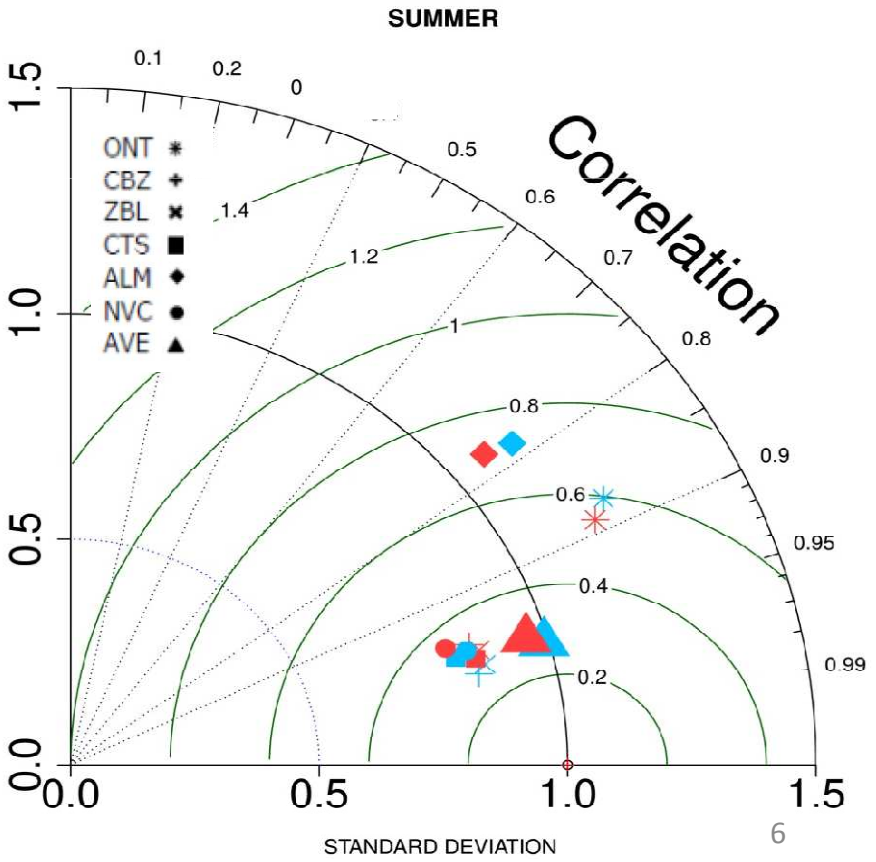


- WRF adds value at reproducing extreme events.
- Correlations >0.9 → 6 stations/WRF grid points are able to adequately reproduce the variability in the Sierra de Guadarrama.

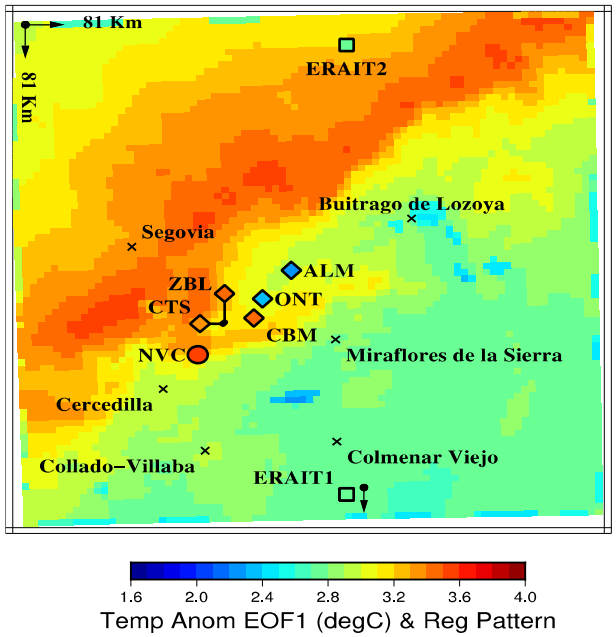
Evaluation of WRF. Taylor Diagrams

- **Winter:** WRF shows a better performance than ERAIT.
- **Summer:** WRF shows a better performance than ERAIT, except at CTS and ALM.

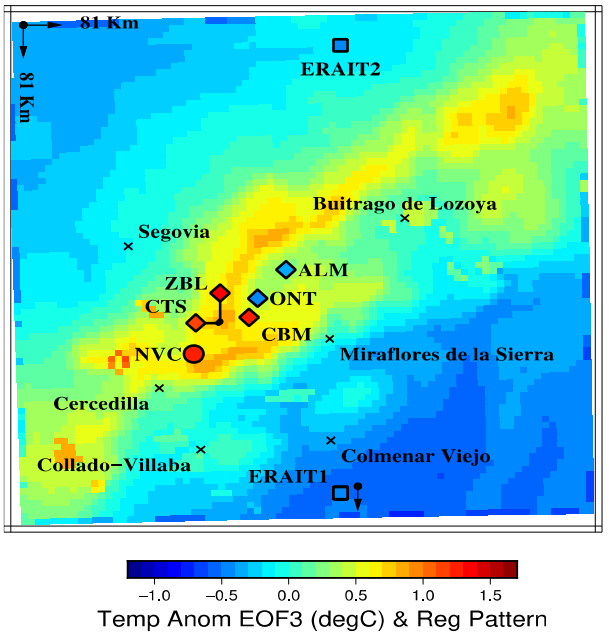




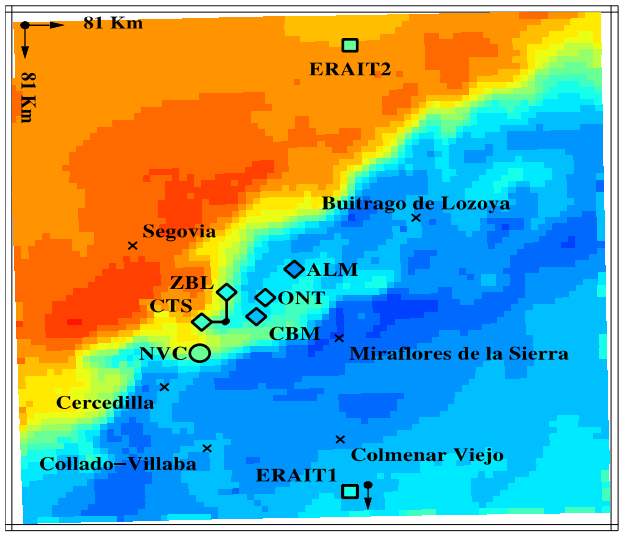
PC Analysis



- **2nd mode** explains the **3%** of the variance, with 2 areas over the NW and the SE.
- It explains some of the variability in the valleys for some extreme situations

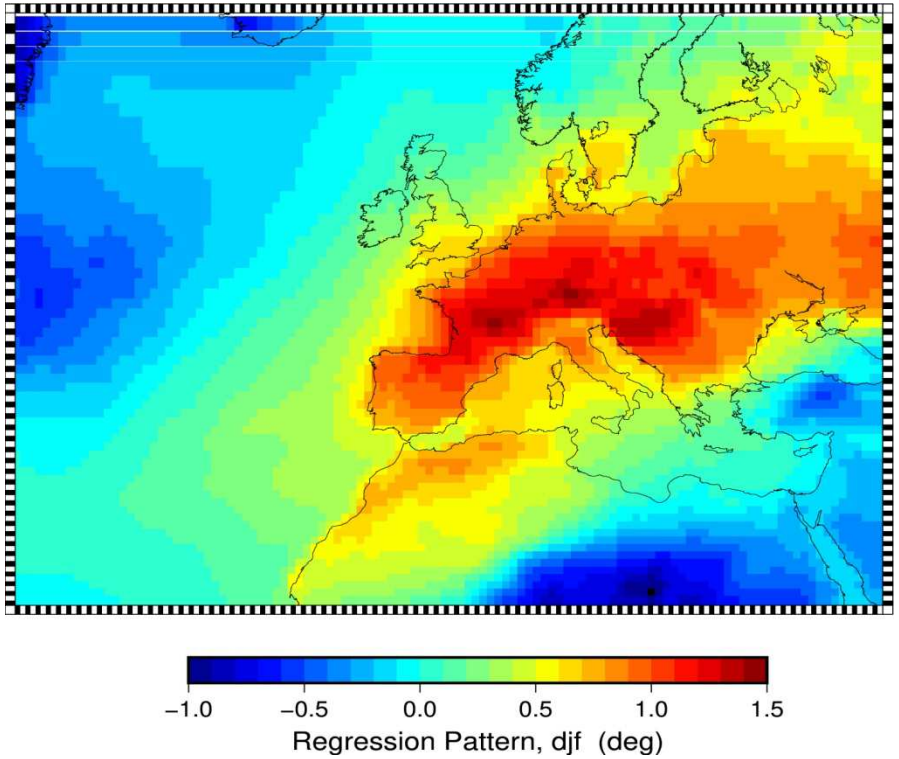


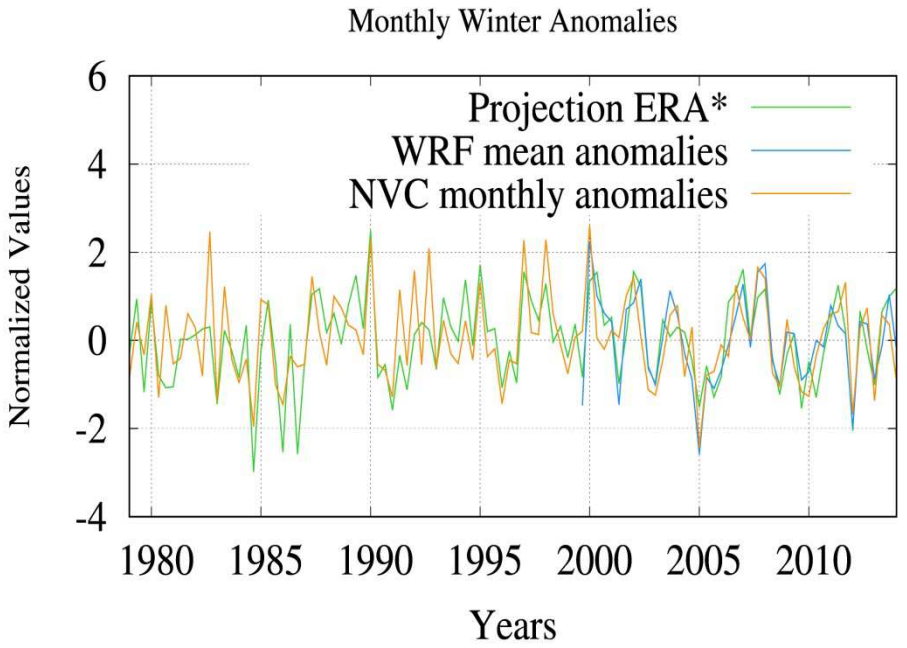
- **1st mode** explains the **94%** of the variance → it explains to a large extent the overall variability in the area.
- Very orographic pattern



- **3rd mode** explains only the **1%** of the variance → barely significant contribution to the temperature anomalies.
- It shows a large orographic influence → highest altitude locations

ERAIT temperature anomalies reconstruction





- ERAIT reconstructed monthly anomalies are in agreement with both WRF and the anomalies in Navacerrada
- High correlation over the Iberian Peninsula (about 0.9).

Conclusions

- Evaluation of WRF: the model improves the bias of ERAIT and shows a more realistic simulation, although it underestimates temperatures at high altitude stations
- Few sites, but representative of the temperatures over the Sierra de Guadarrama → good estimate of the variability over the region .
- PCA. PC1: orografic. PC2: western flux. PC3: Radiative cooling?
- No long term trends since the 1980s

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THANK YOU!

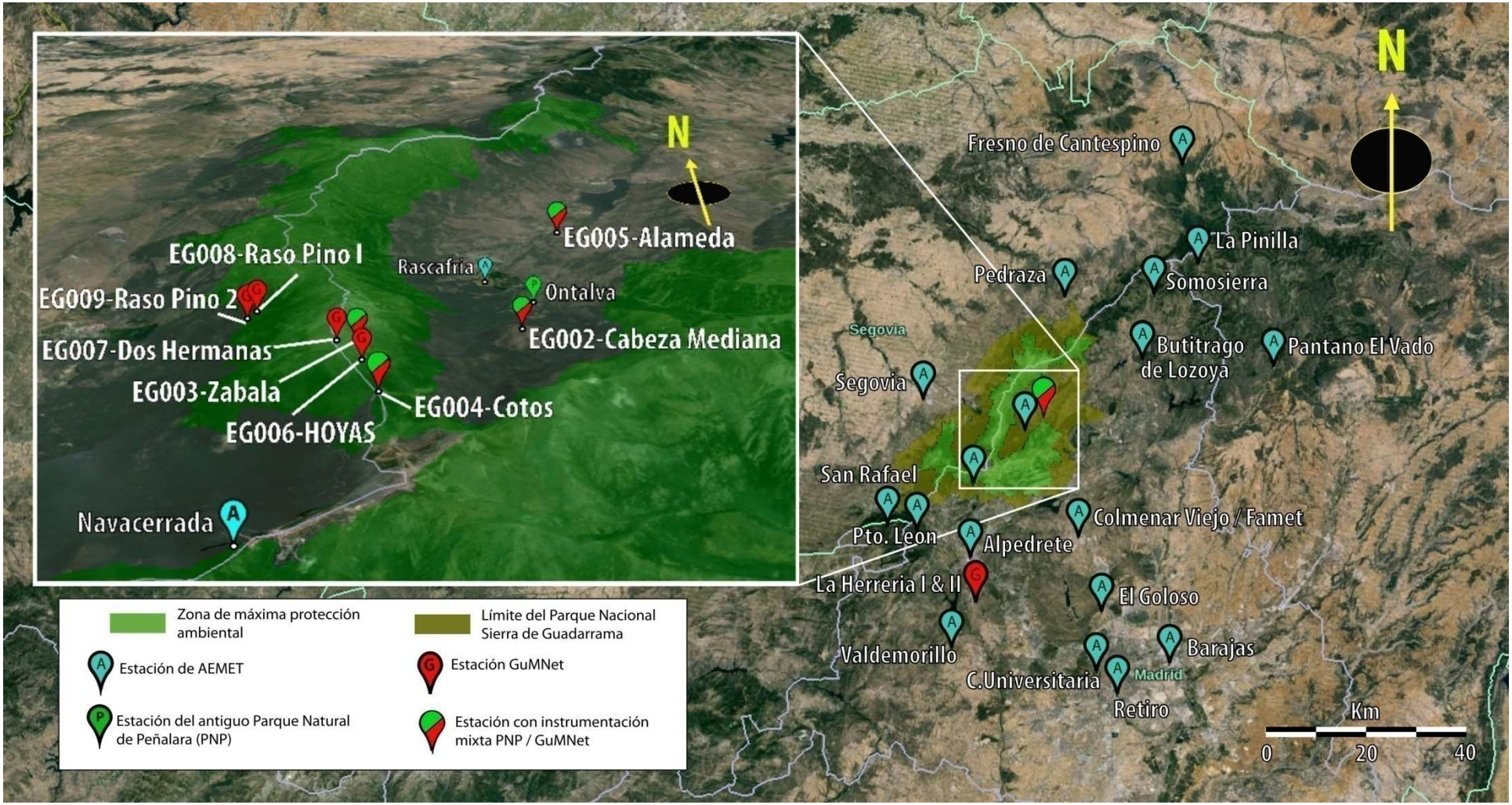
¡Gracias!

What is GuMNet?

a glimpse at the facility

GuMNet is a new infrastructure of atmosphere, surface and subsurface observation

It is composed of 10 sites distributed from 900 masl to 2200 masl



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Resources

Watch

Seguridad

Sustainability

Resilience

Decision making

Education

Research

Health/Leisure

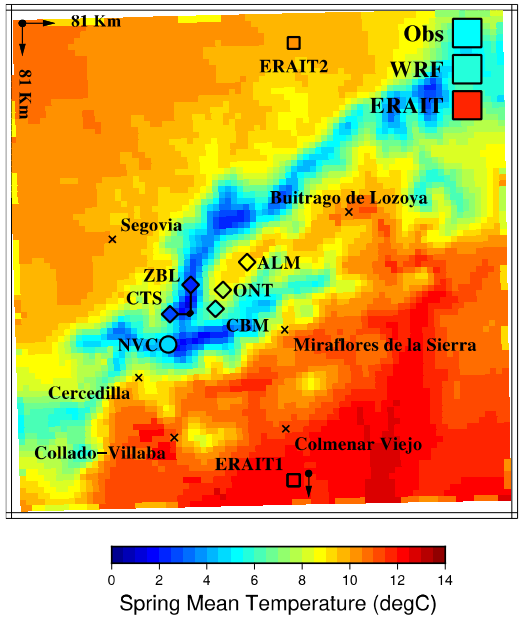
Management

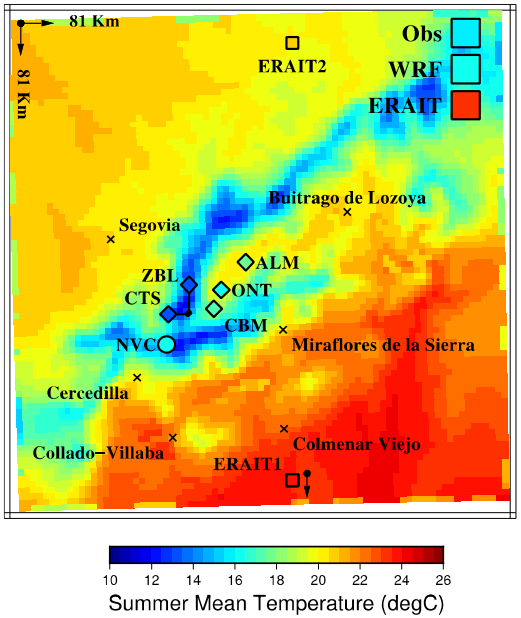
Motivation

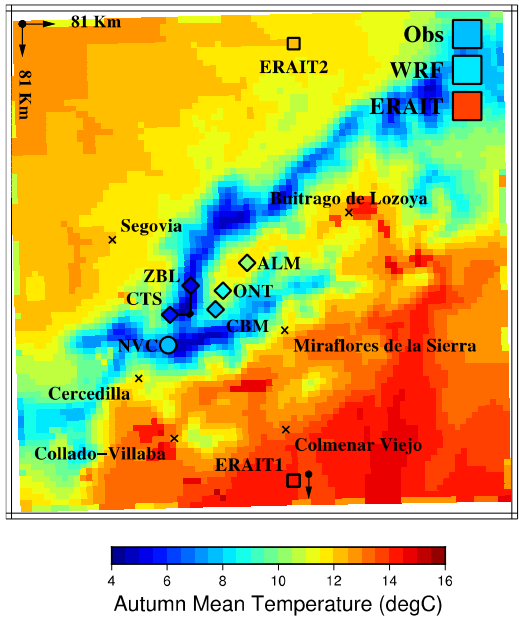
- Mountains offer many natural resources and a space for many activities.
- Mountains serve as home for many species, both animals and plants.
- Mountains have been greatly affected by climate change → extreme events (Kohler et al., 2014) → observations in the mountains are very important.
- Obtaining meteorological observations represents a challenge → use of models as an alternative.
- Complex terrains not easy to simulate → increase of the horizontal resolution.
- This study is focused on the Sierra de Guadarrama.
    - Temperature variability will be analysed by the use of a high-resolution Weather Research Forecast (WRF) model configuration, the ERA Interim (ERAIT) reanalysis and observations. A Principal Component Analysis (PCA) will be applied.
    - WRF model will be evaluated.

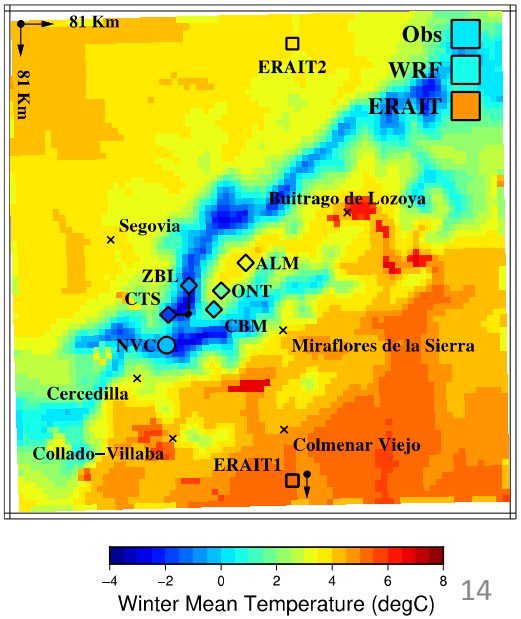
Evaluation of WRF. Mean temperature

Seasonal averages in WRF and observations









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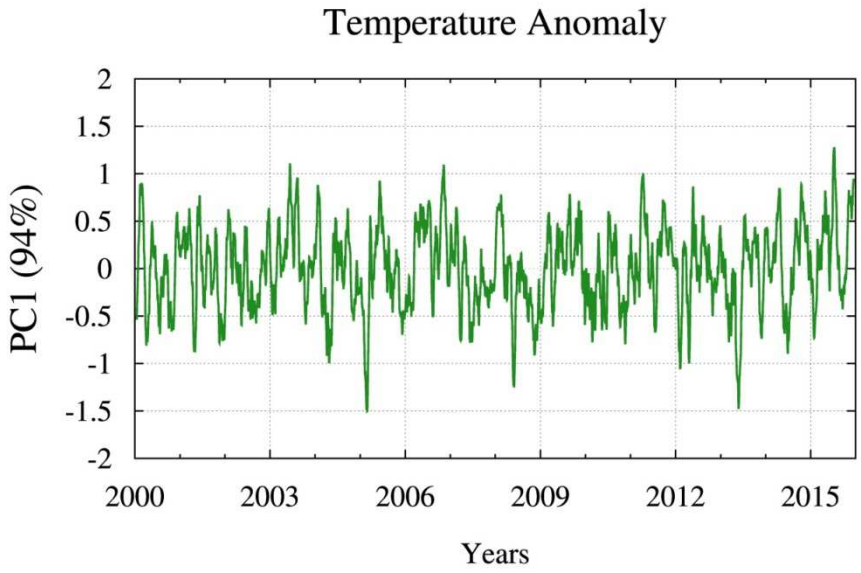
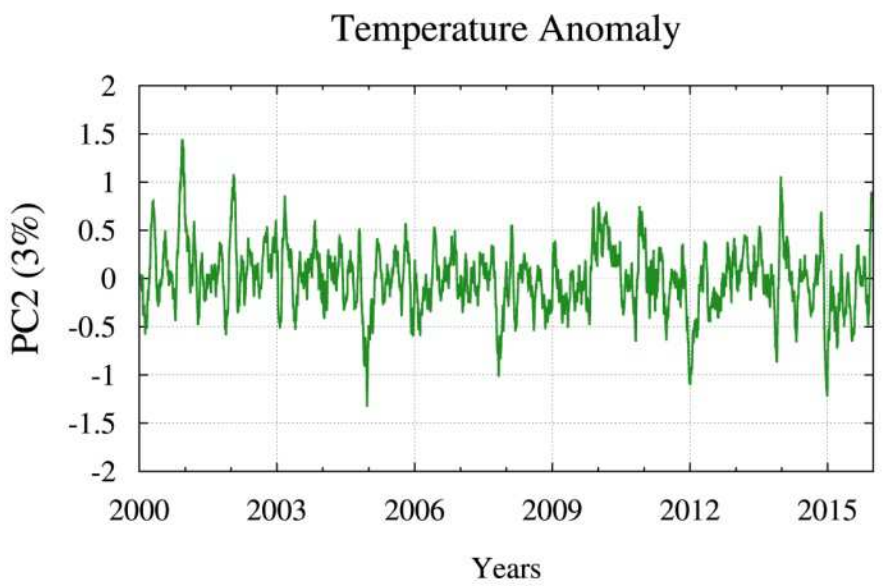
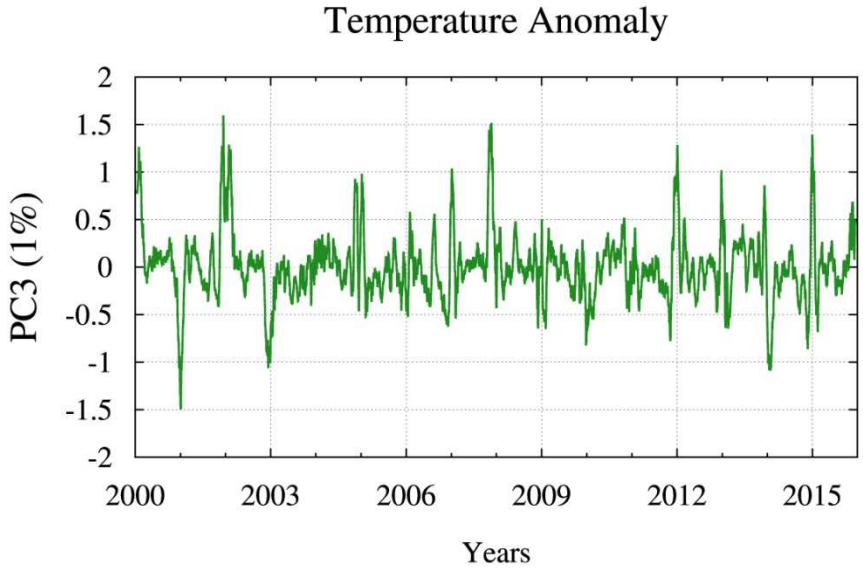
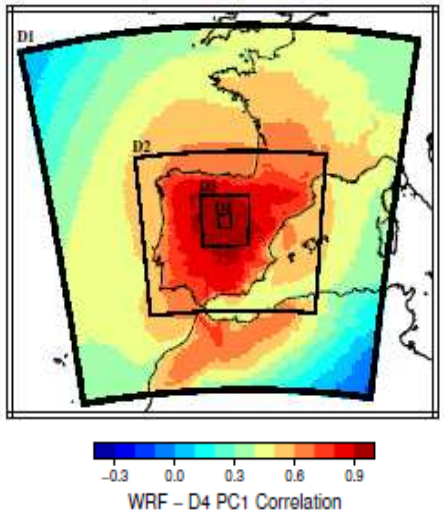
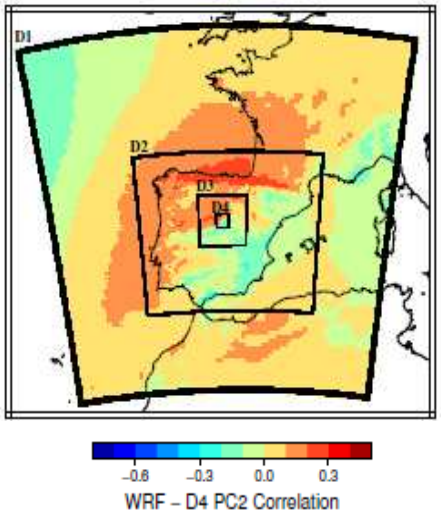

Temperature Anomaly
PC1 (94%)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
2000
2003
2006
2009
2012
2015
Years

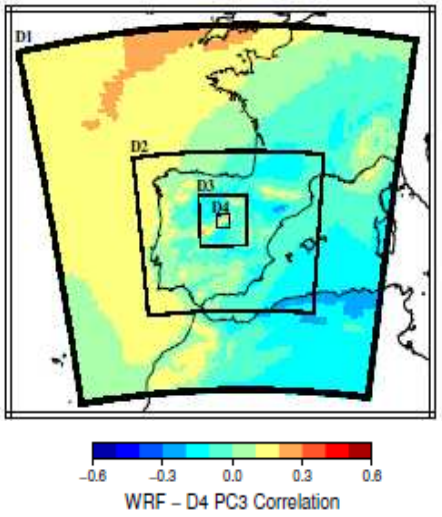

Temperature Anomaly
PC2 (3%)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
2000
2003
2006
2009
2012
2015
Years

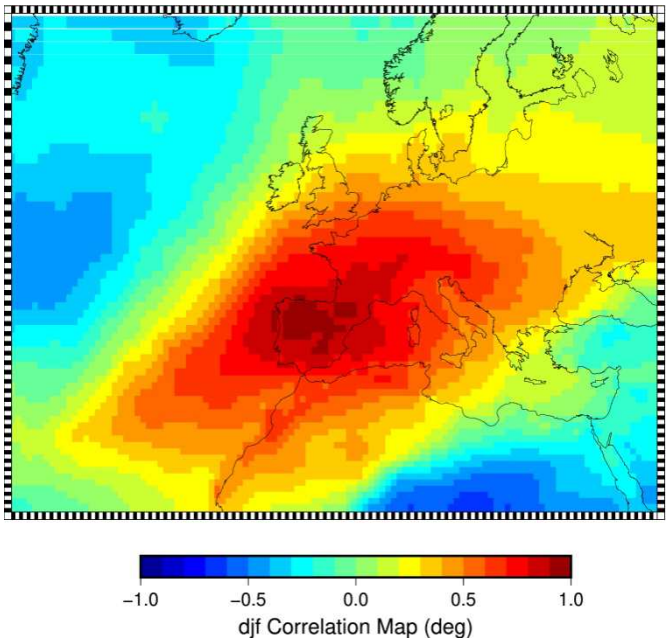

Temperature Anomaly
PC3 (1%)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
2000
2003
2006
2009
2012
2015
Years

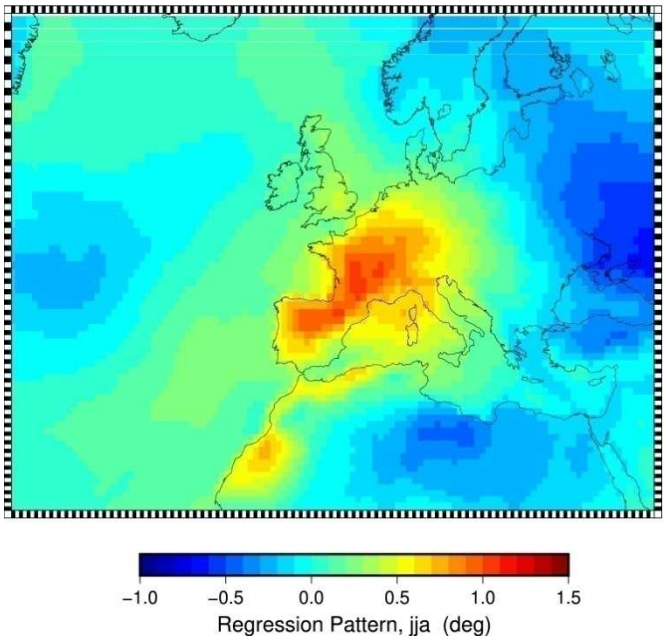
Extended PCA











- **PC1**: continental pattern.
- **PC2:** NW - SE contrast → higher values over the basins of the main rivers.
- **PC3:** influence of orography
- **Regression Pattern:** continental pattern with the highest correlations far from the ocean.

Conclusions

- Two main targets: evaluation of the performance of the WRF model and the analysis of the variability of temperature over the area of the Sierra de Guadarrama.
- The high resolution WRF model improves the bias of ERAIT and shows a more realistic simulation, although it underestimates temperatures at high altitude stations.
- Few sites, but representative of the temperatures over the Sierra de Guadarrama → good estimate of the variability over the region .
- PC1: orografic. PC2: western flux. PC3: Radiative ?
- No long term trends since the 1980s

THANK YOU!

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