How climate change is affecting the patterns of electricity demand in Spain

J.M. Garrido-Perez[1,2] , D. Barriopedro[2], C. Ordóñez[1] and R. García-Herrera[1,2]

[1]Dpto. Física de la Tierra y Astrofísica, Universidad Complutense de Madrid, Madrid, Spain

[2]Instituto de Geociencias, CSIC-UCM, Madrid, Spain

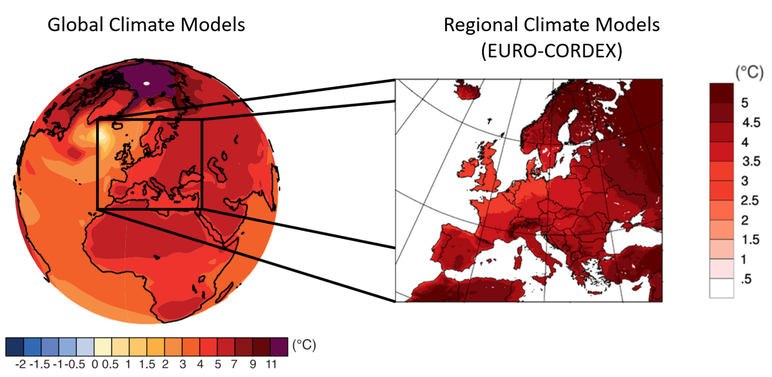
josgarri@ucm.es

1. Introduction

Climate change is one of the main concerns worldwide due to its environmental and socio-political implications. In particular, the need to balance electricity supply and demand has become an important international policy concern in a context of growing world energy consumption. However, there has been little quantitative analysis about how the regional patterns of electricity demand will change under global warming. This work analyses the expected future demand in Spain by using projected temperatures from climate models and an observational demand-temperature relationship.

2. Temperature

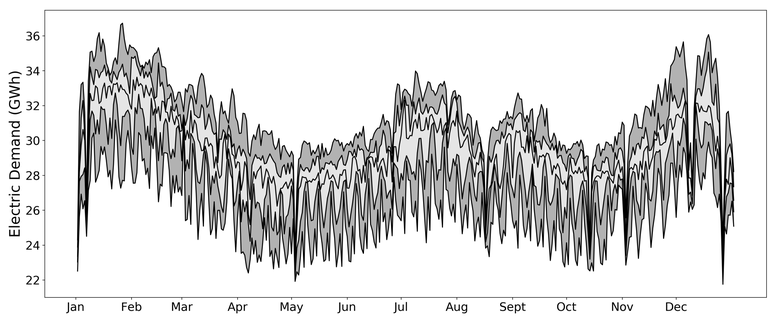
Both GCMs and RCMs show robust and statistically significant warming of 2.5-5.5 C over Europe along the 21st century under RCP8.5 (business as usual scenario). The largest annual mean warming is projected to occur over southern and northeastern Europe.



IPCC (2014) Jacob et al. (2013)

3. Electricity Demand

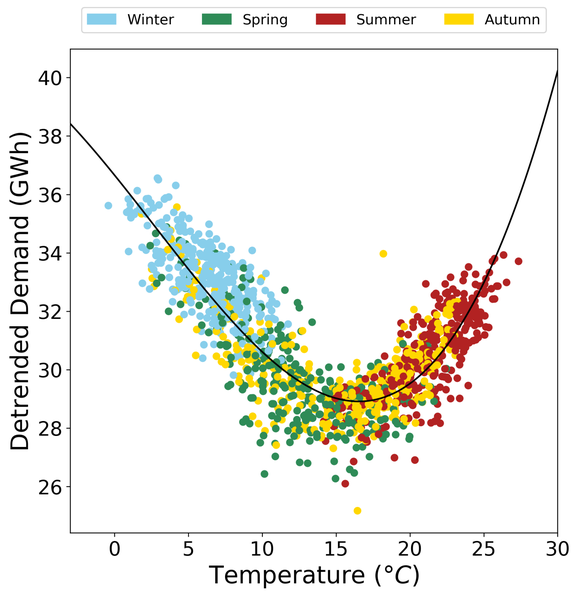
Spanish energy system is characterized by a seasonal cycle of electricity demand with two relative maxima in winter and summer associated with the use of electricity heating appliances and cooling systems, respectively.



Data source: REE

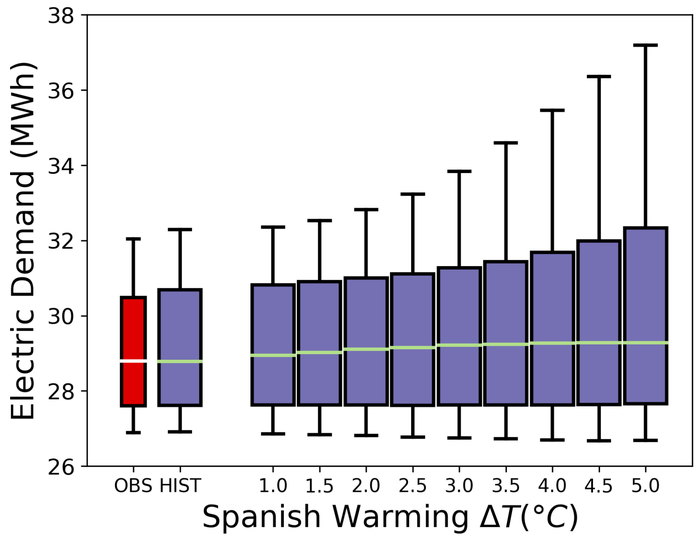
4. Demand - Temperature relation

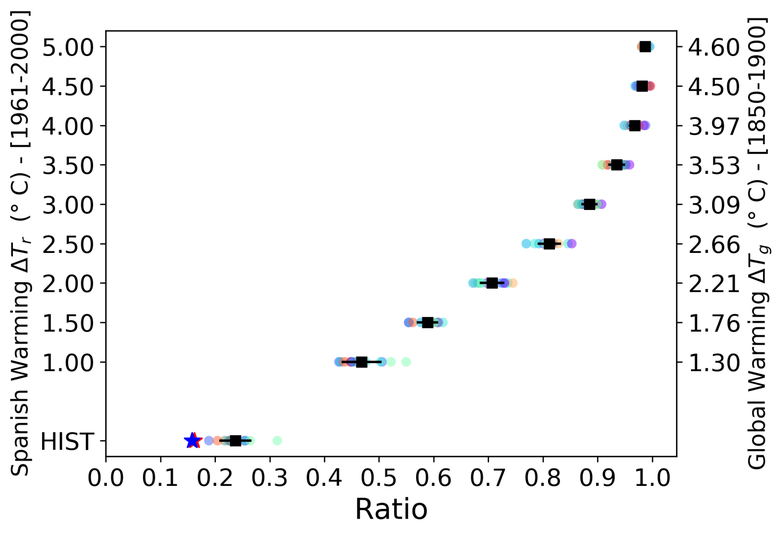
Temperature is the main meteorological driver of the day-to-day variability of electricity demand. This relationship is characterized by an asymmetric U-shaped curve with a minimum around 17°C that increases monotonically for lower and higher temperatures.



Data source: AEMET (obs. & projections)

5. How do electricity demand patterns change with global warming?





Daily electricity demand distribution

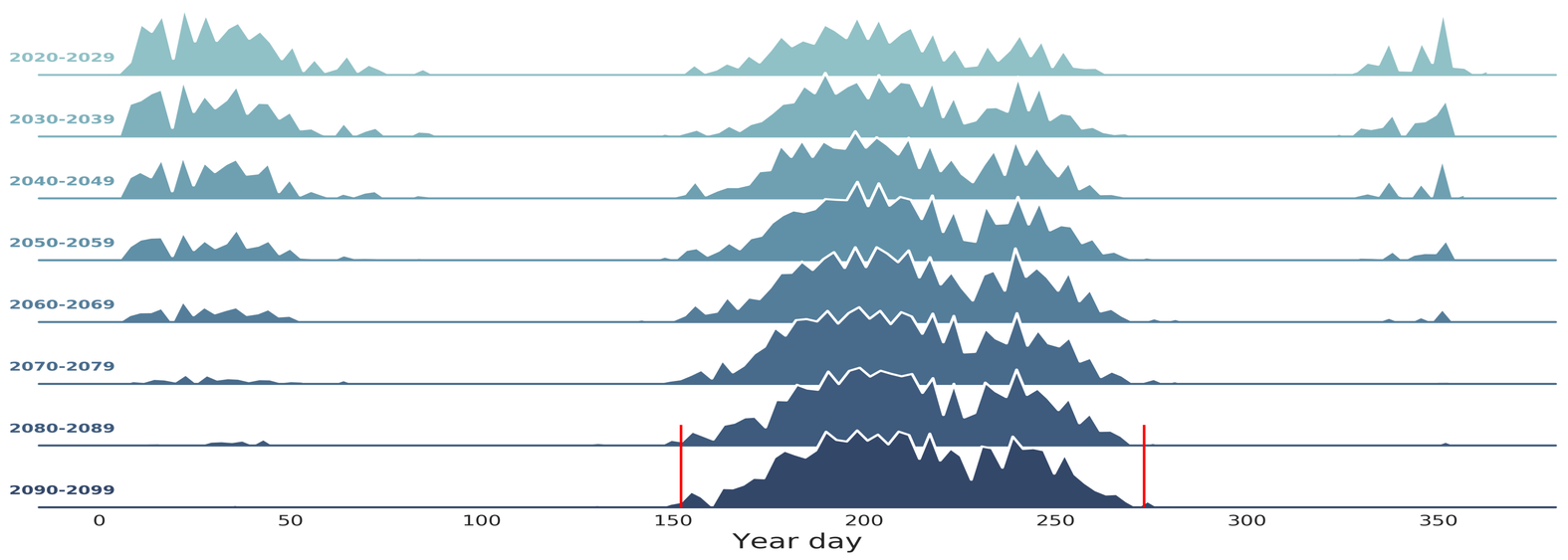
- Good agreement between observations and historical climate simulations
- Widening of the distribution of daily electricity demand under the projected global warming
- Extreme electricity demand days are expected to increase
- Implications on the energy system, as it is designed to meet peak demand on the highest load day of the year

Seasonal ocurrence of demand extremes

- Climate projections overestimate summer ratios
- Warmings shift the occurrence of extreme electricity demand days from winter to summer
- Implications on the type of generating capacity and future storage requirements

6. When will these changes occur?

The rate of change of the electricity demand patterns depends on the Representative Concentration Pathway (RCP) considered. Here we illustrate the seasonal frequency occurrence of electricity demand extremes per decade under a "business as usual" scenario. Based on this, most of the extremes will occur in summer by the mid-century.



7. Conclusions

Climate change presents a challenge to electric power infrastuctures. Since the beginning of the century, Spain has experienced a strong penetration of air conditioning and higher temperatures due to global warming will intensify this trend. The results presented here show a widening of the distribution of daily electricity demand and a seasonal shift of extremes from winter to summer. The implications of these changes of electricity demand patterns for energy system are relevant and might help policy-makers to plan the future electricity pool design.

8. References

[1] Jacob, D. et al., 2013. *EURO-CORDEX: new high-resolution climate change projections for European impact research.* Regional environmental change, 14(2), 563-578.

[2] IPCC, 2014. *Fifth Assessment Report of the IPCC.* Cambridge University Press, 1029-1136