esipp
Energy Systems Integration Partnership Programme

Forecasting for an Integrated Energy System

Conor Sweeney, UCD, Ireland

Wednesday, 20th June 2018

ESIG 2018 Forecasting Workshop, St Paul, MN

Outline

1. Forecast Applications
2. Forecast Ranges
3. Reanalysis Data
4. ShortWave Radiation
5. Wind/SW correlations
6. Systematic Errors
7. PostProcessing
8. Weather and Demand
9. Probabilistic Forecasting
10. MultiVariate Spatial PP

Forecast Applications

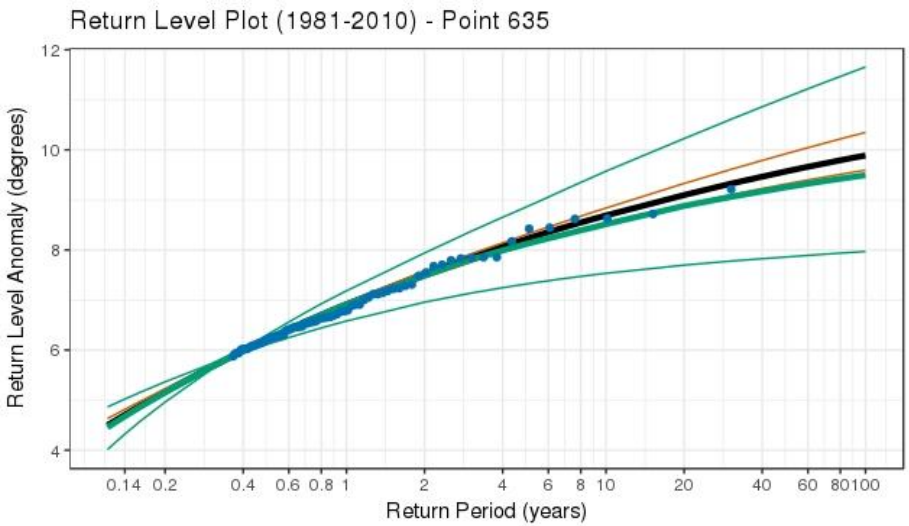
Wind
Solar/PV } Ramping

Thermal: Heating/cooling

Clouds: Lighting

Precipitation: WWT

Extremes, Return periods



Forecast Applications

esipp
Energy Systems Integration Partnership Programme

Wind
Solar/PV
} Ramping E G

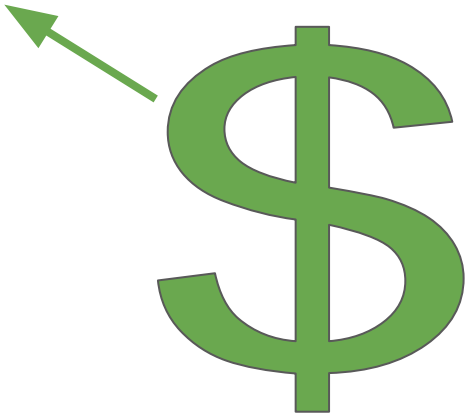
Thermal: Heating/cooling E G

Clouds: Lighting E

Precipitation: WWT E W

Extremes, Return periods E G W

Trading. Hedging.

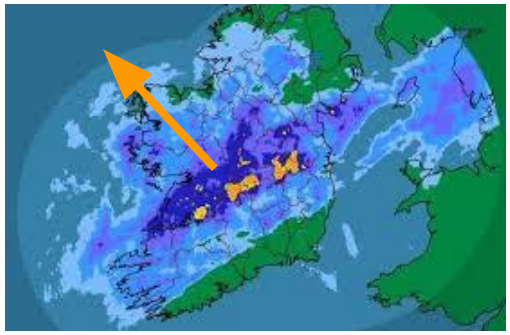


Electricity

Gas

Water

Forecast Ranges



Nowcasting/Stats:

Short term. < 6 hours. Stats.

Operational:

Short range: 6 hours to 5+ days.

We do this…

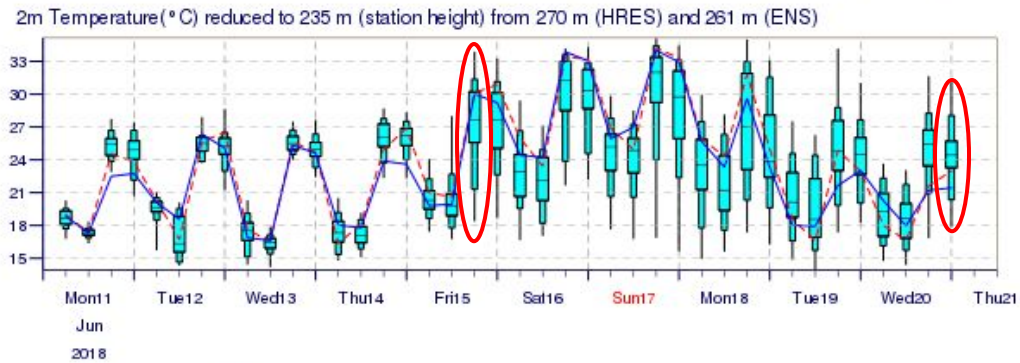
ECMWF

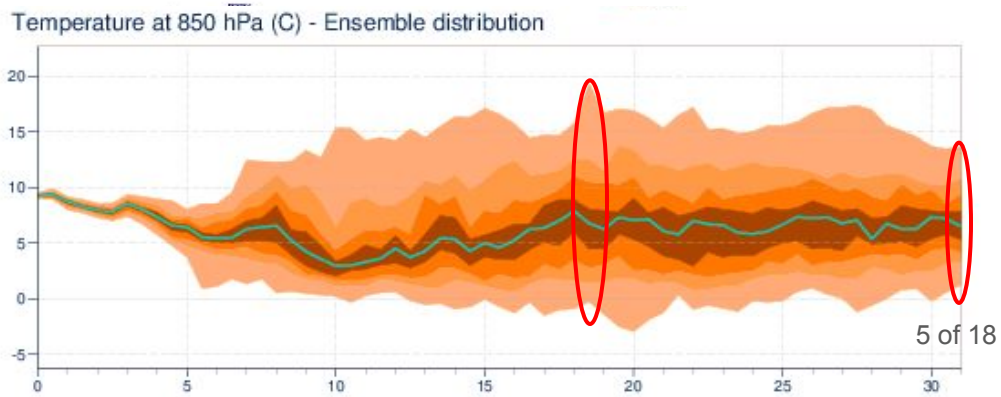
Medium range: 15 days

Extended range: 32 day

Long range. Seasonal: 1-3 months

And this!





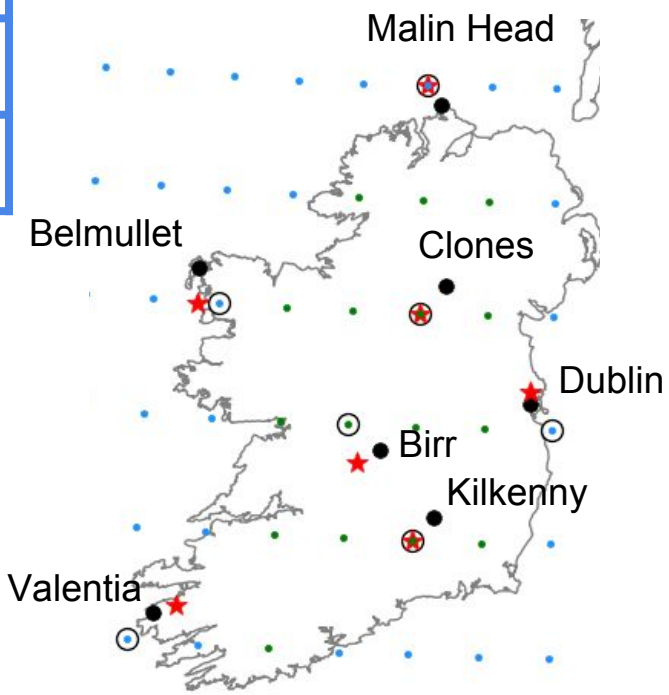
Reanalysis Data

ERA-Interim	80km. 3-hourly	○
MERRA2	55km. Hourly	★
MÉRA	2.5km. Hourly	●

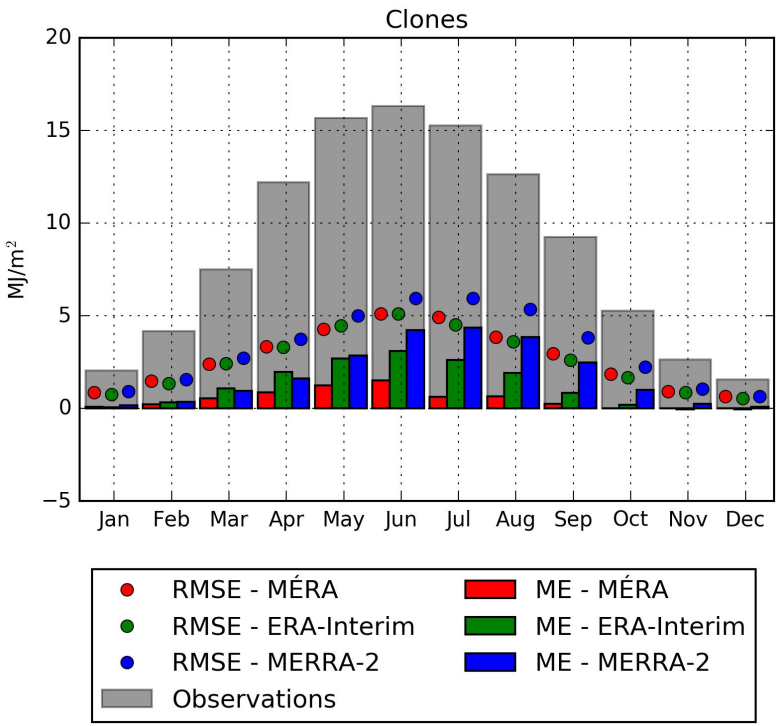
Observations:

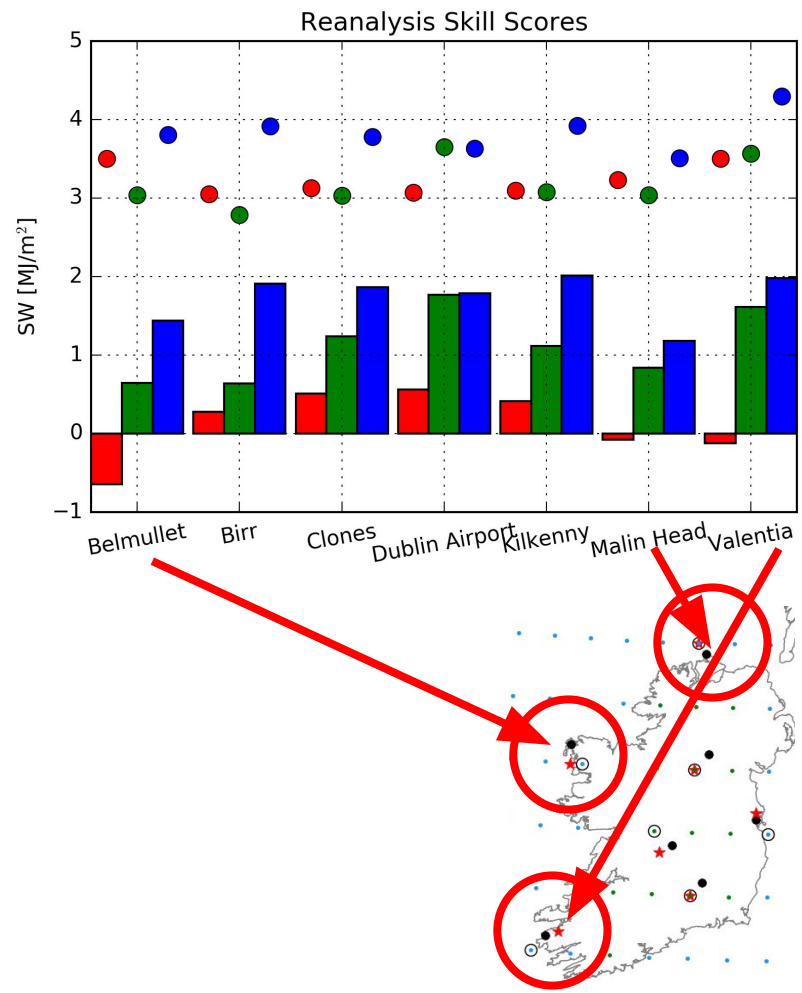
- 10 metre wind
- ShortWave radiation

Common validation period:
1982-2007



ShortWave Radiation (SW)



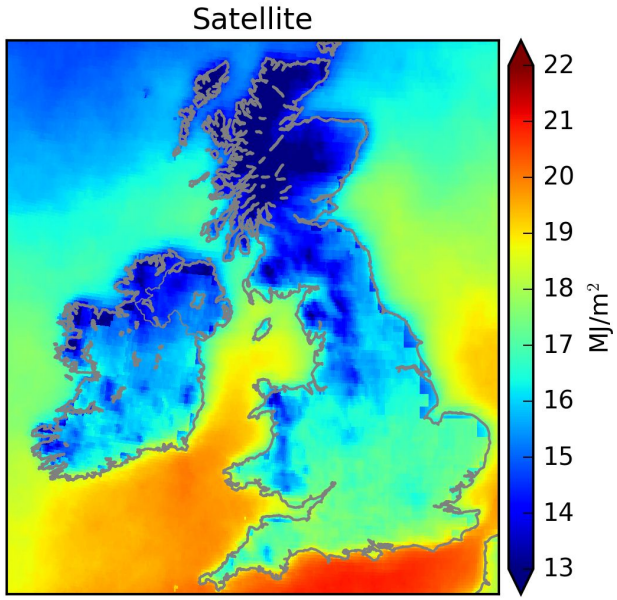


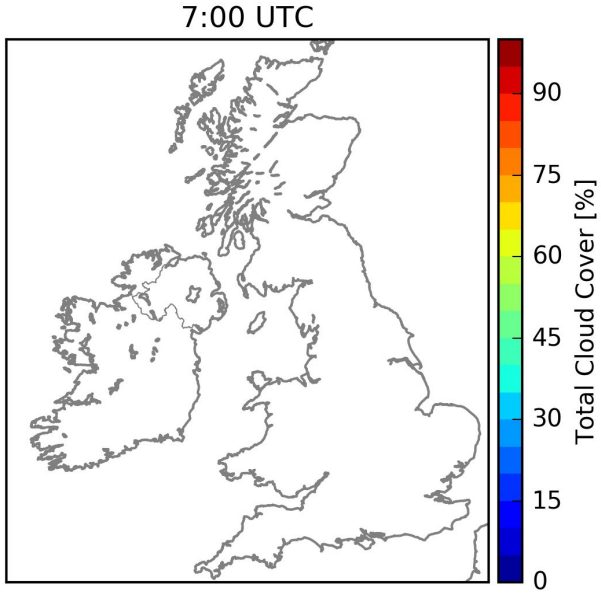
Large relative errors.

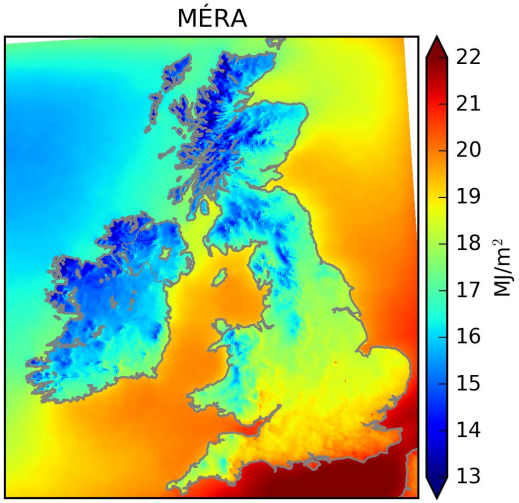
Coast bias: Modelled clouds.

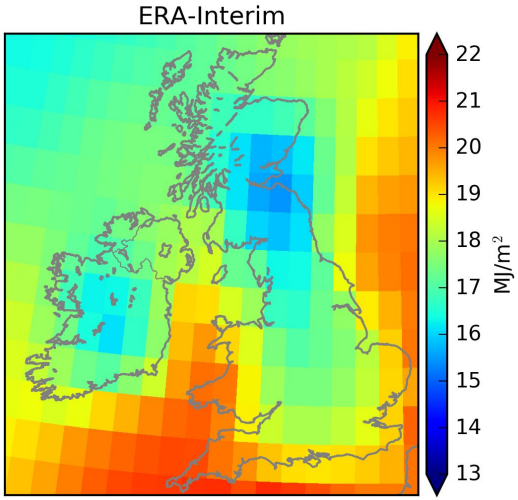
Spatial SW

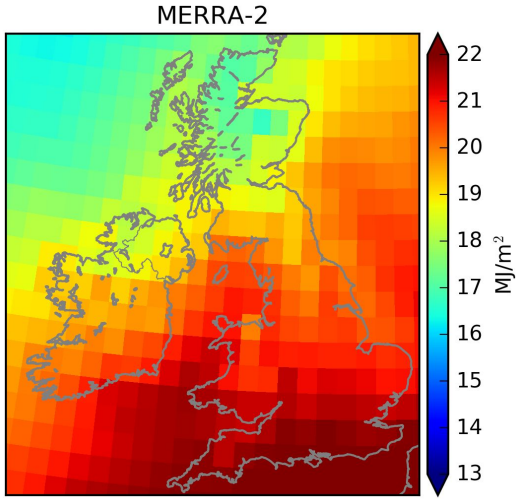
Land/sea pattern



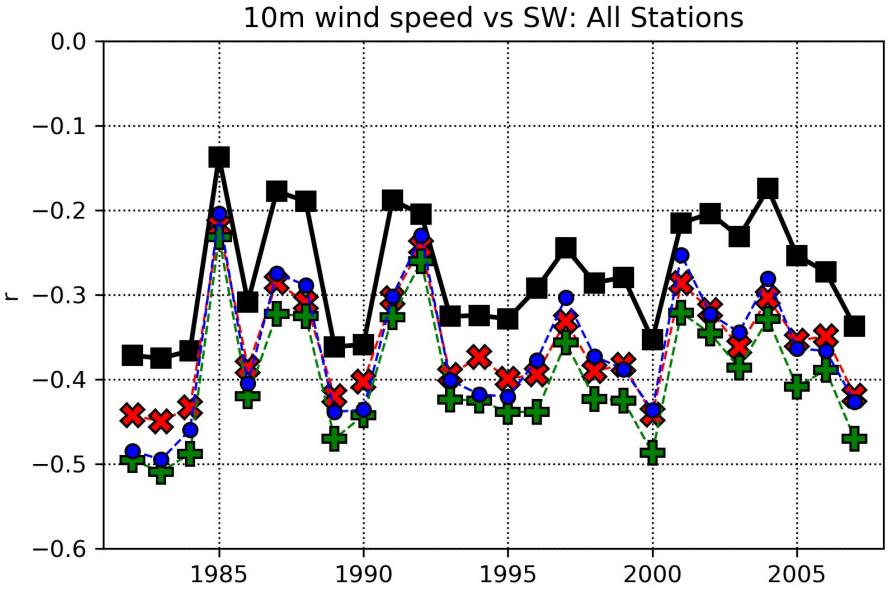


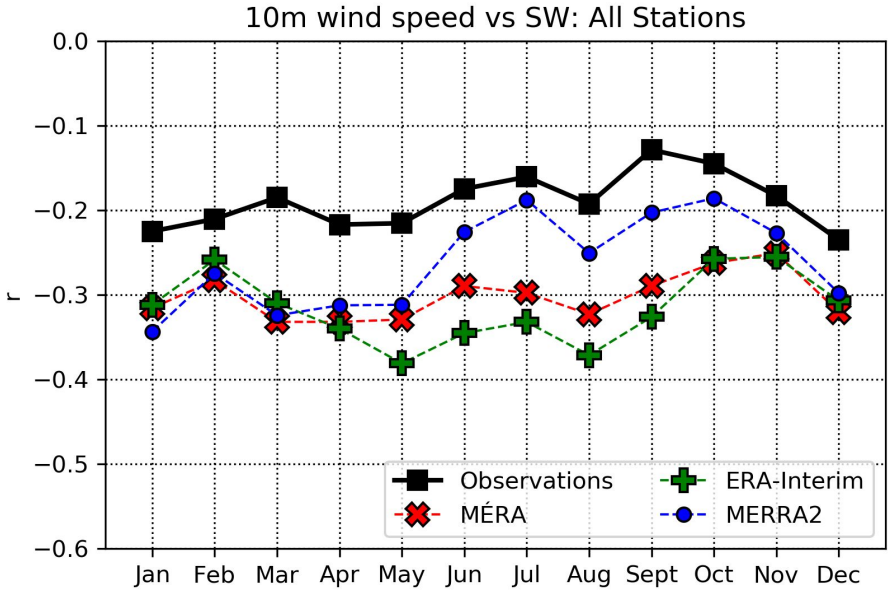






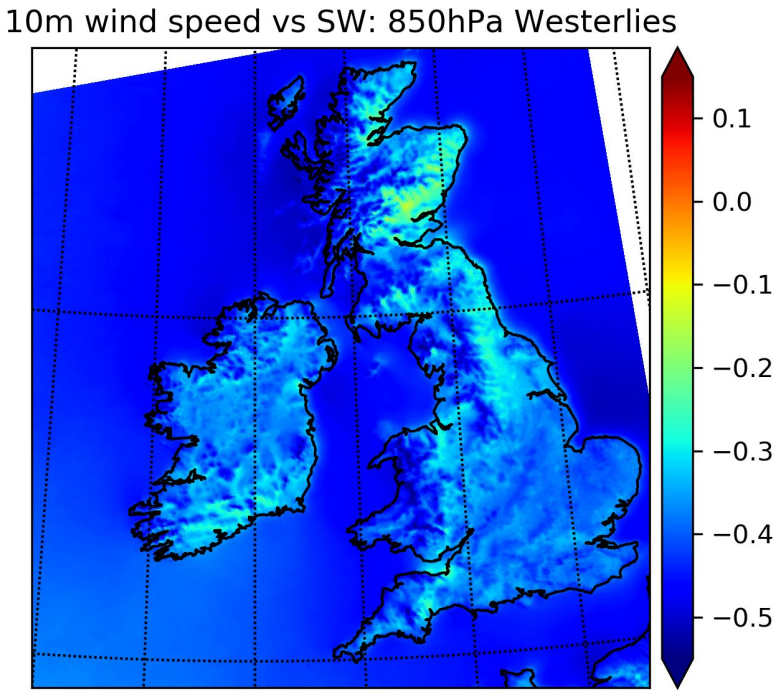
Wind/SW correlations

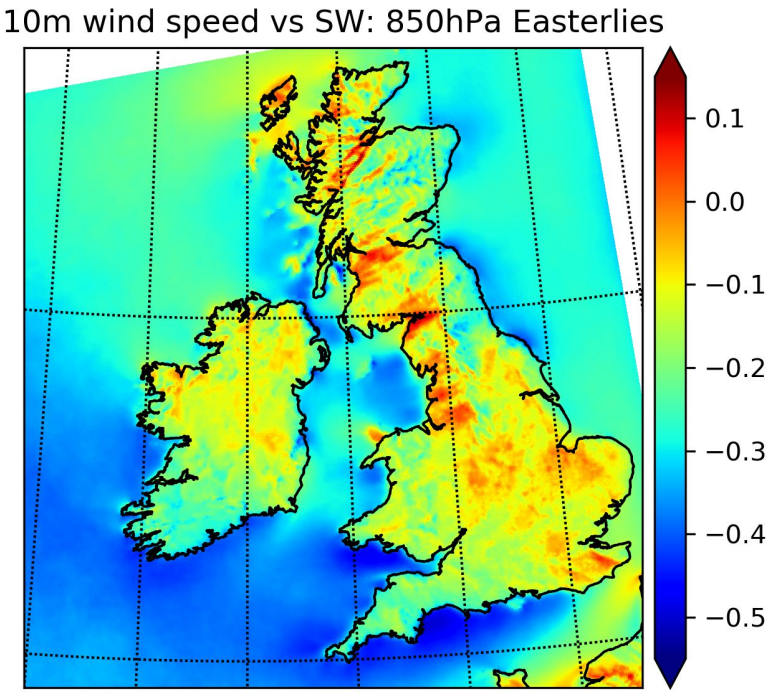




Year-on-year changes > average monthly.

Spatial Wind/SW correlations





Influence of orography
Correlation changes with wind direction
Not seen in global reanalyses

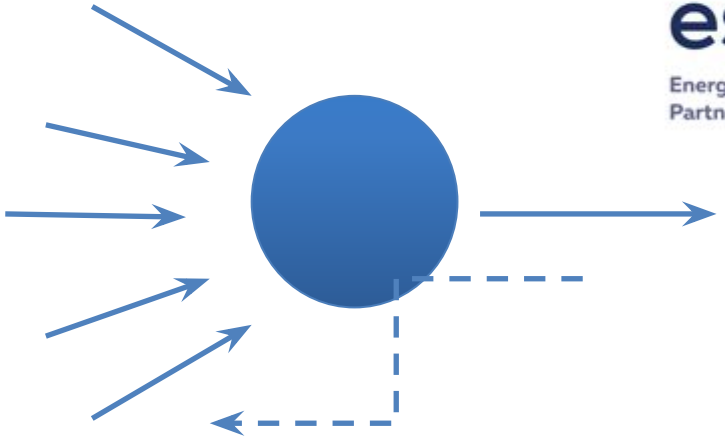
Systematic Errors

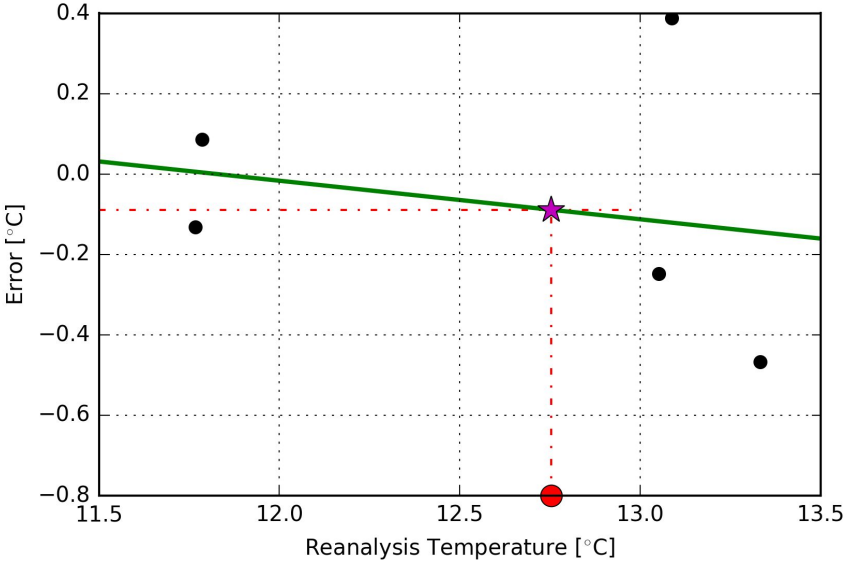
Adaptive PP

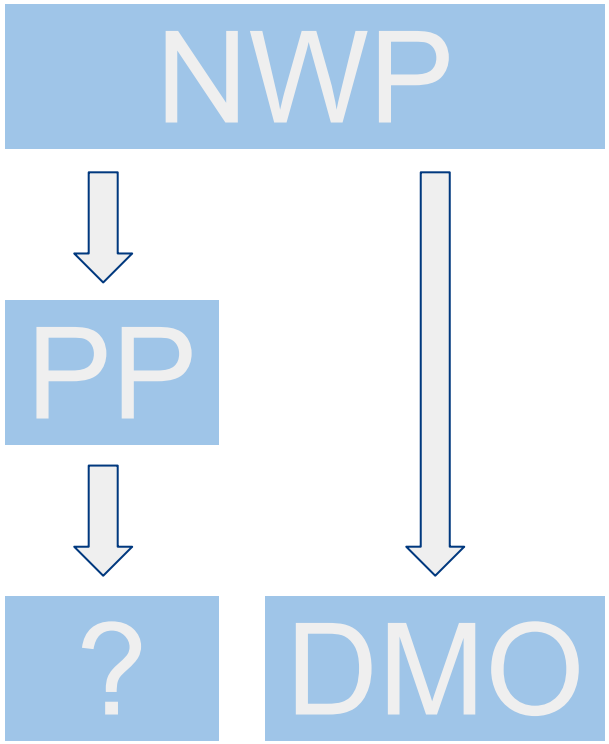
- train from past x days

Machine learning

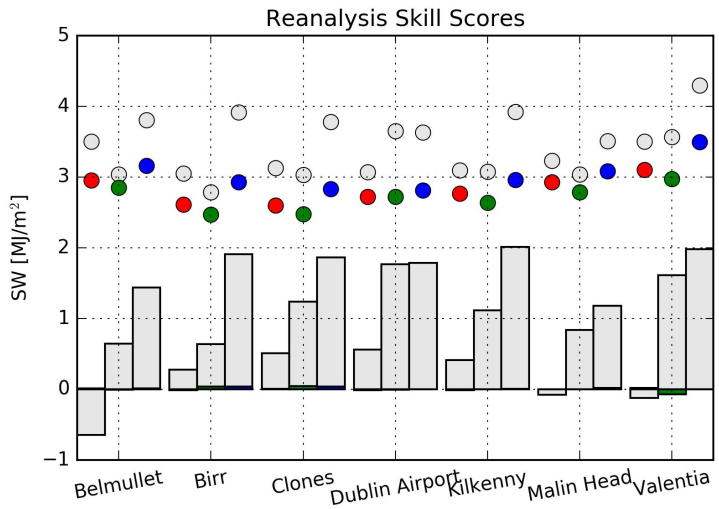
- Physical reason?

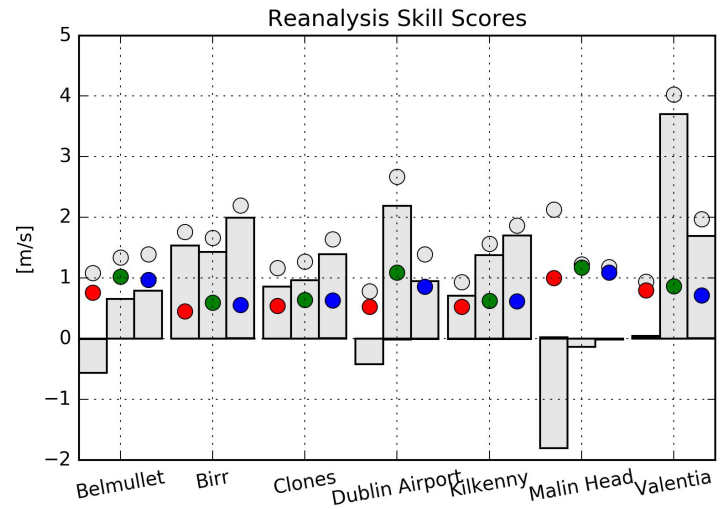


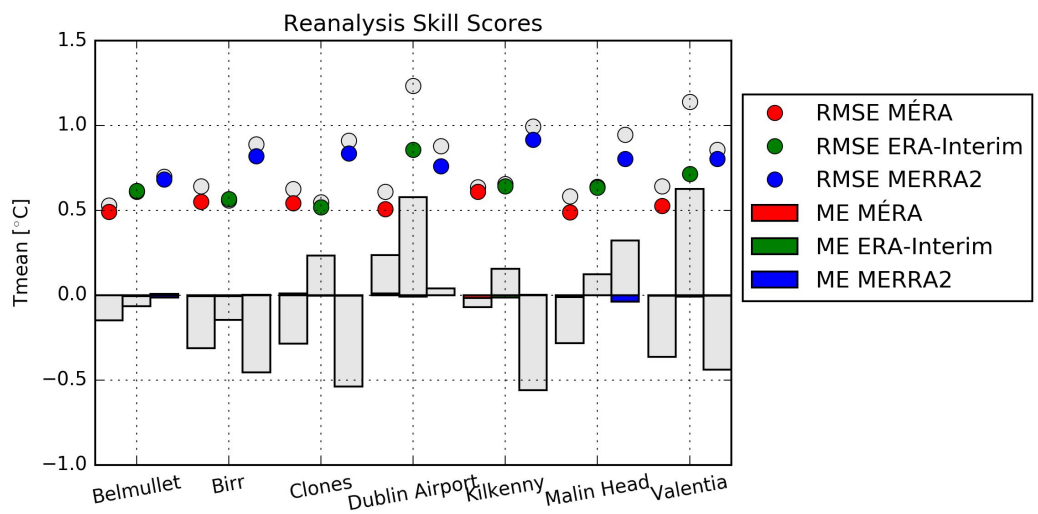




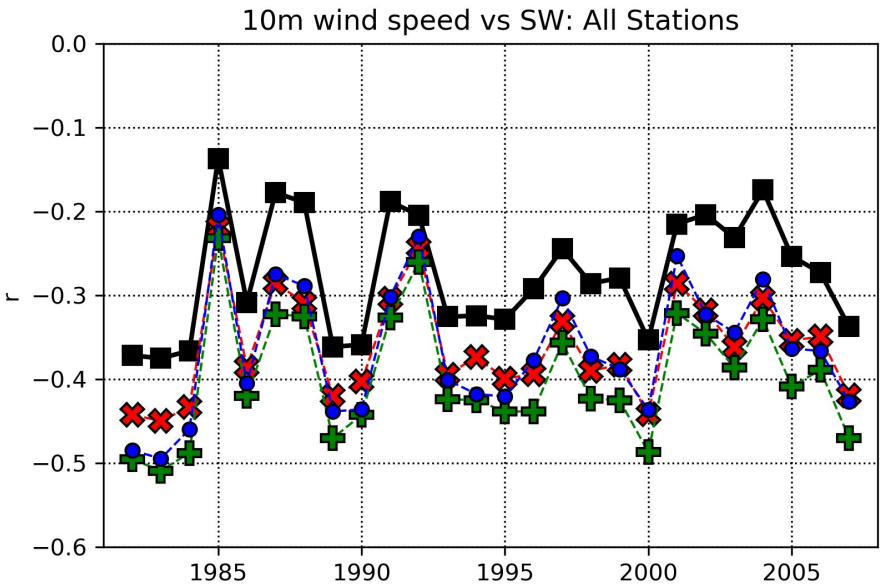
PostProcessing

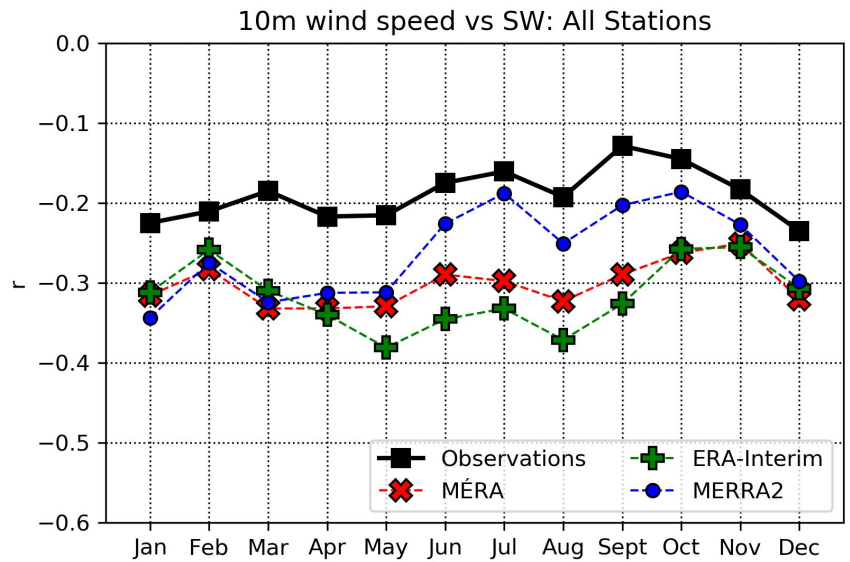


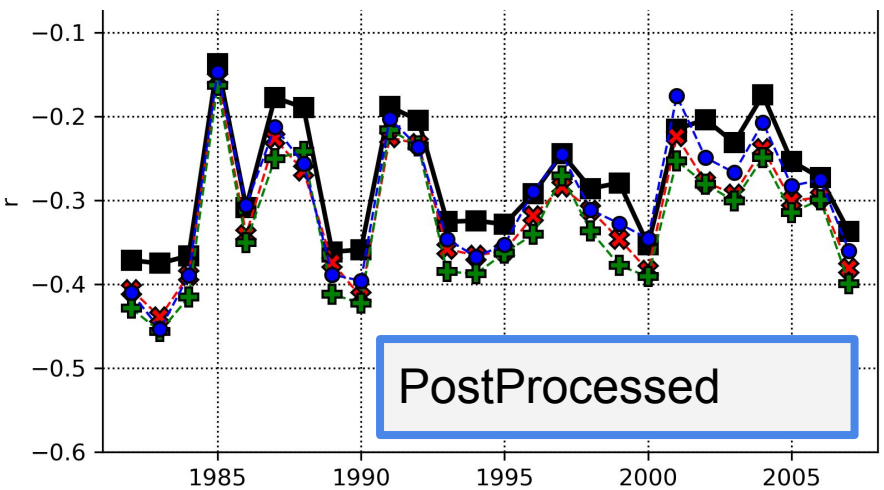


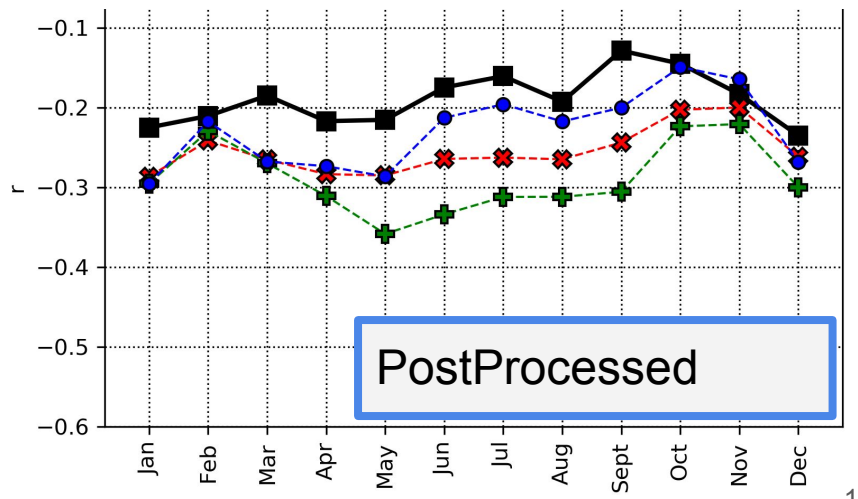


PostProcessing

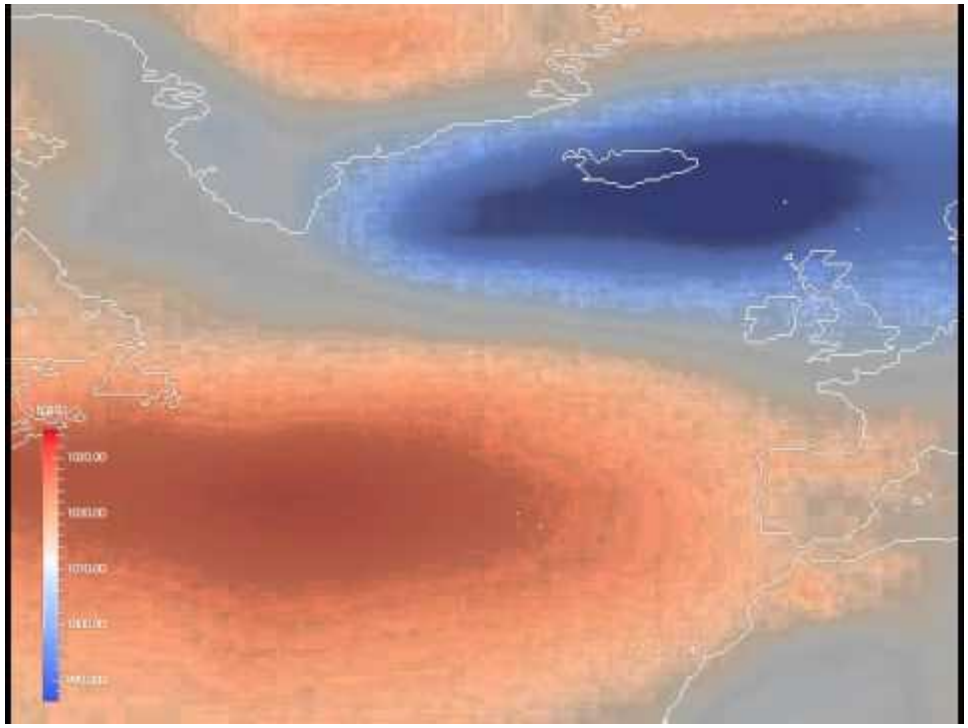






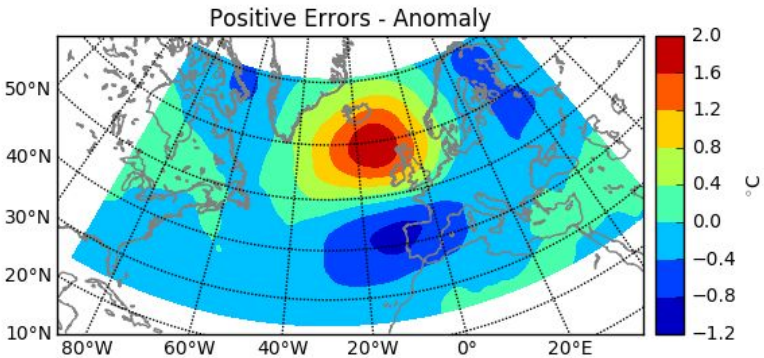


Don’t Average everything

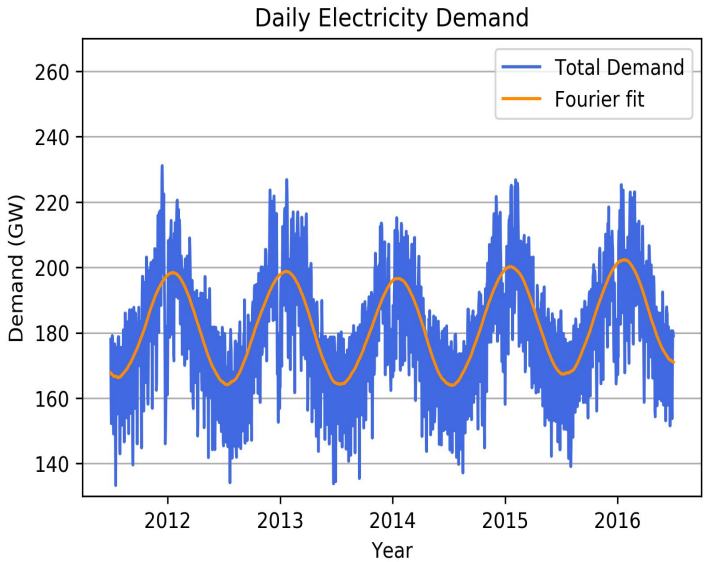


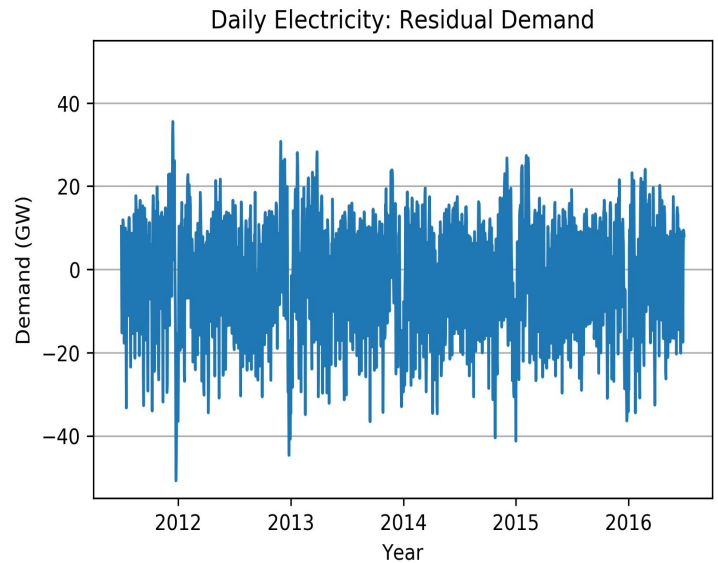
https://www.youtube.com/watch?v=9D451XcuQmY

Largest SW errors:
T at 500hPa



All Ireland Electricity Demand Profiles





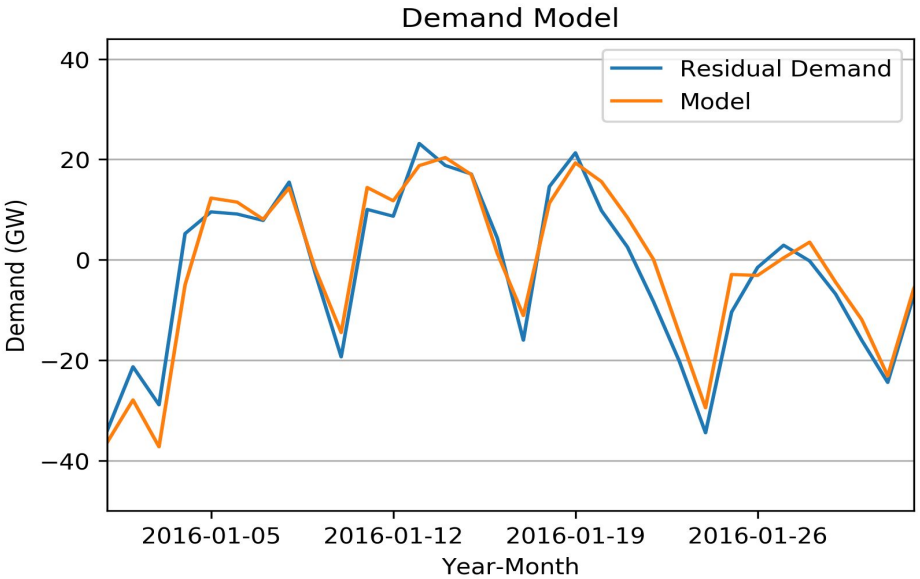
Total Demand - Fourier Fit = Residual Demand

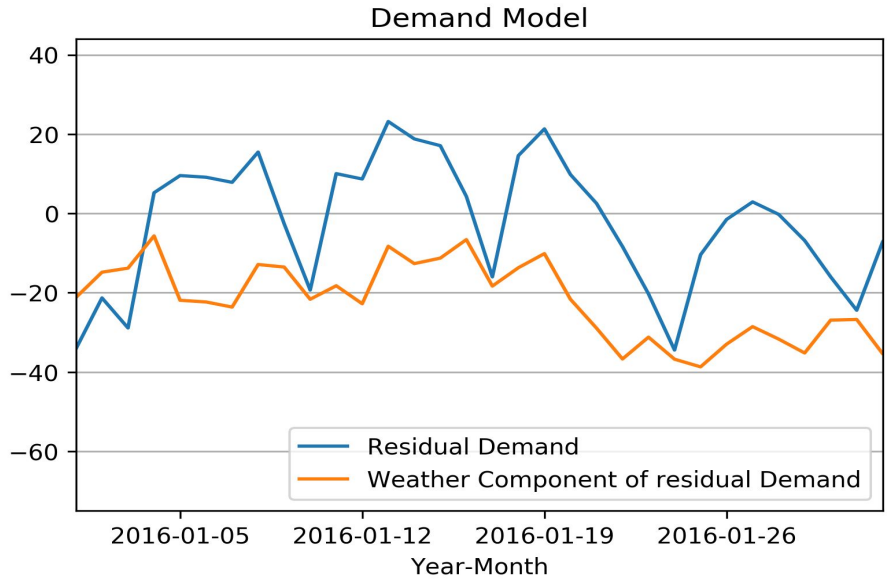
Annual trend:
- Climate, GDP, elec price, tech, society.

Seasonal:
- Temperature, daylight...

- Day of Week
- Holidays
- Weather

Weather Driven Demand





$$D_R = aTe + bTe^2 + cCloud + dWind + eDay + fHol + gXmas$$

$$D_{RW} = D_R - eDay - fHol - gXmas$$

Atmospheric patterns ∝ Demand. Extremes.
Spatial Demand

Probabilistic forecasting

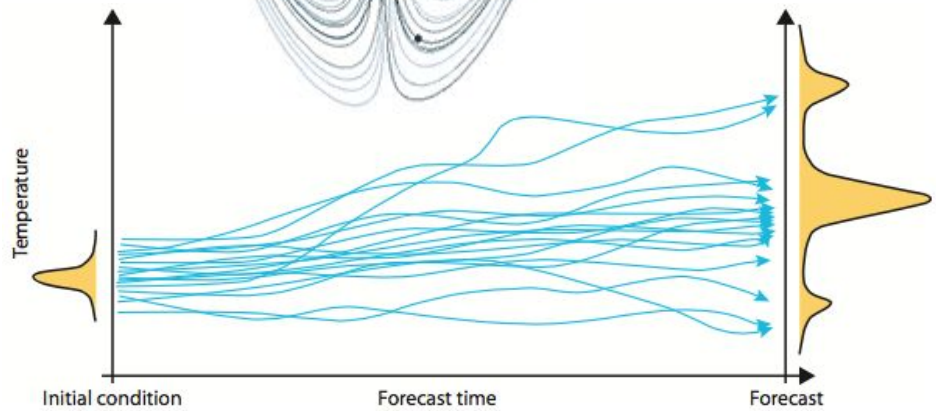
Chaos

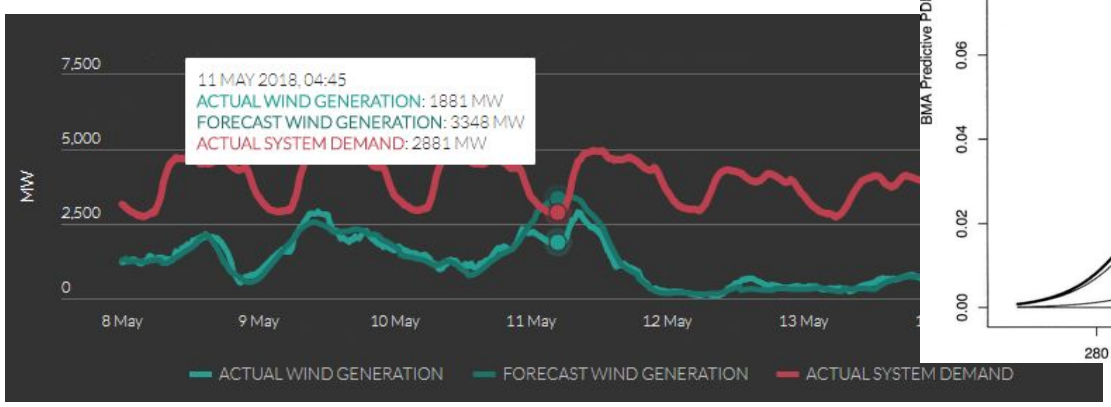
High-Res Ensembles

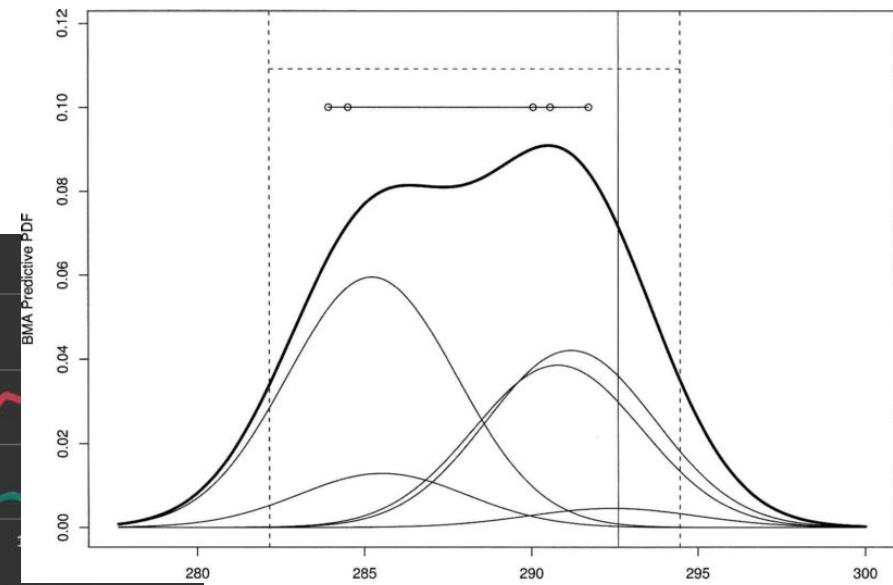
- Adaptive physics
- Satellite updates

Post-processing

Bayesian Model Averaging





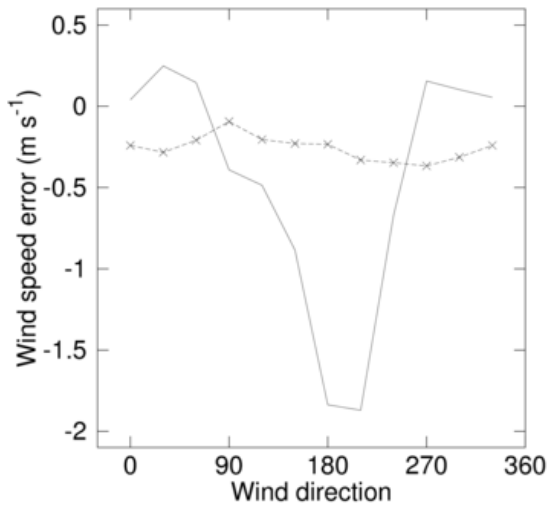


MultiVariate Spatial Post-Processing

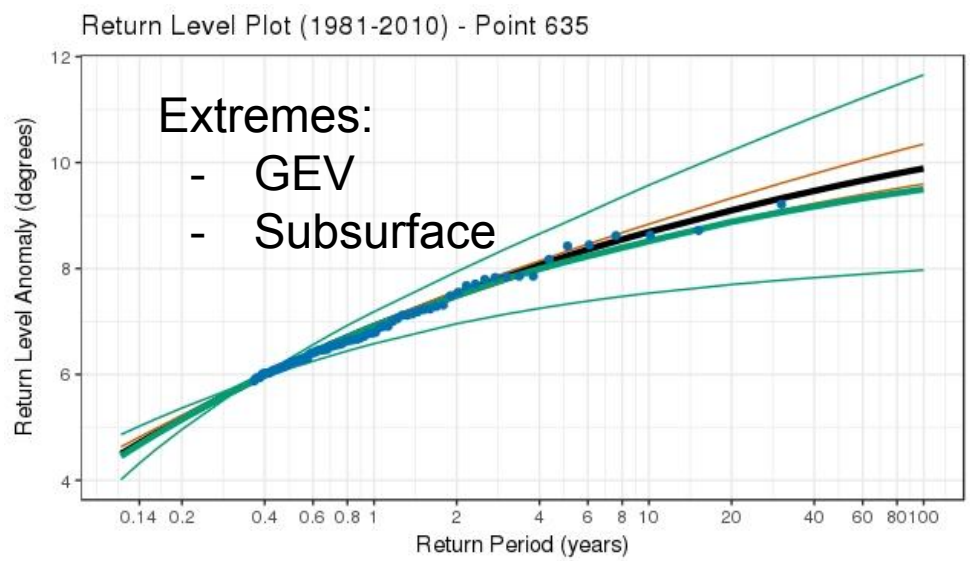
Wind speed, direction. T2m. Cloud, type. Stability, CAPE.

MultiVariate

Spatial input:
Pattern recognition
- MSLP.
- Jet stream.
- 500hPa T



Spatial PP:
Hyperparameter surface



Extremes:
- GEV
- Subsurface

esipp

Energy Systems Integration Partnership Programme

Thank you.

Fondúireacht Eolaíochta Éireann
Science Foundation Ireland

This publication has emanated from research conducted with the financial support of Science Foundation Ireland under the SFI Strategic Partnership Programme Grant Number SFI/15/SPP/E3125. The opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Science Foundation Ireland.