Climate Variables for Energy: WP2

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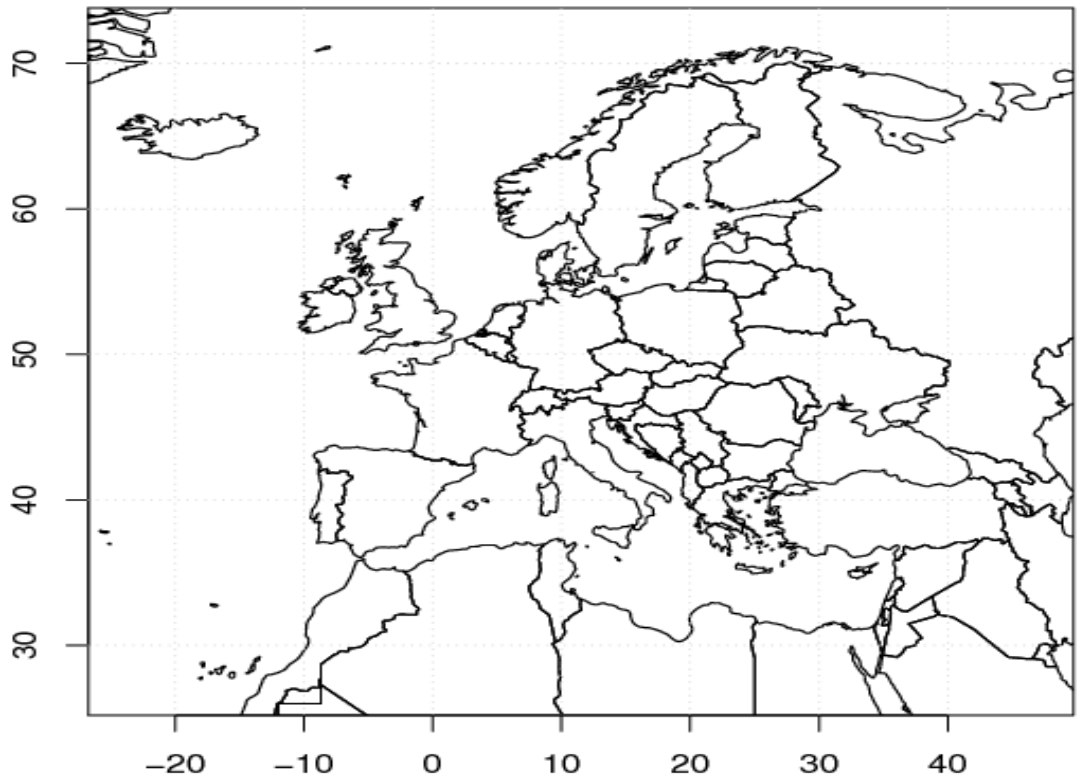
Within ECEM, WP2 provides climate data for numerous variables to feed into WP3, where ESCIIs will be used to produce energy-relevant series

Summary

- ECEM Domain
- ERA-Interim
- Assessing ERA-Interim quality in comparison to gridded observed data (over land areas) for various variables
- Emphasis here on Climate Variables of greatest relevance to Renewable Energy (sunshine/radiation and wind), but others (e.g. temperature, humidity influence Demand)
- ERA-Interim despite being the best Reanalysis is not perfect. We can assess how good it is (when and where) by comparisons with gridded observational datasets. Improving on it is termed bias adjustment

ECEM Domain and ERA Interim



- ERA-Interim regridded from its ~0.7° by 0.7° grid to a latitude/longitude grid at 0.5° by 0.5° spacing
- ERA-Interim available every 6-hours. Some variables are from the analysis, some from the forecasts
- Many gridded climate datasets available for assessment on the 0.5° by 0.5° grid
- Gridded climate datasets produced by interpolation of station observations accounting for elevation

Climate variables – relevant for Energy

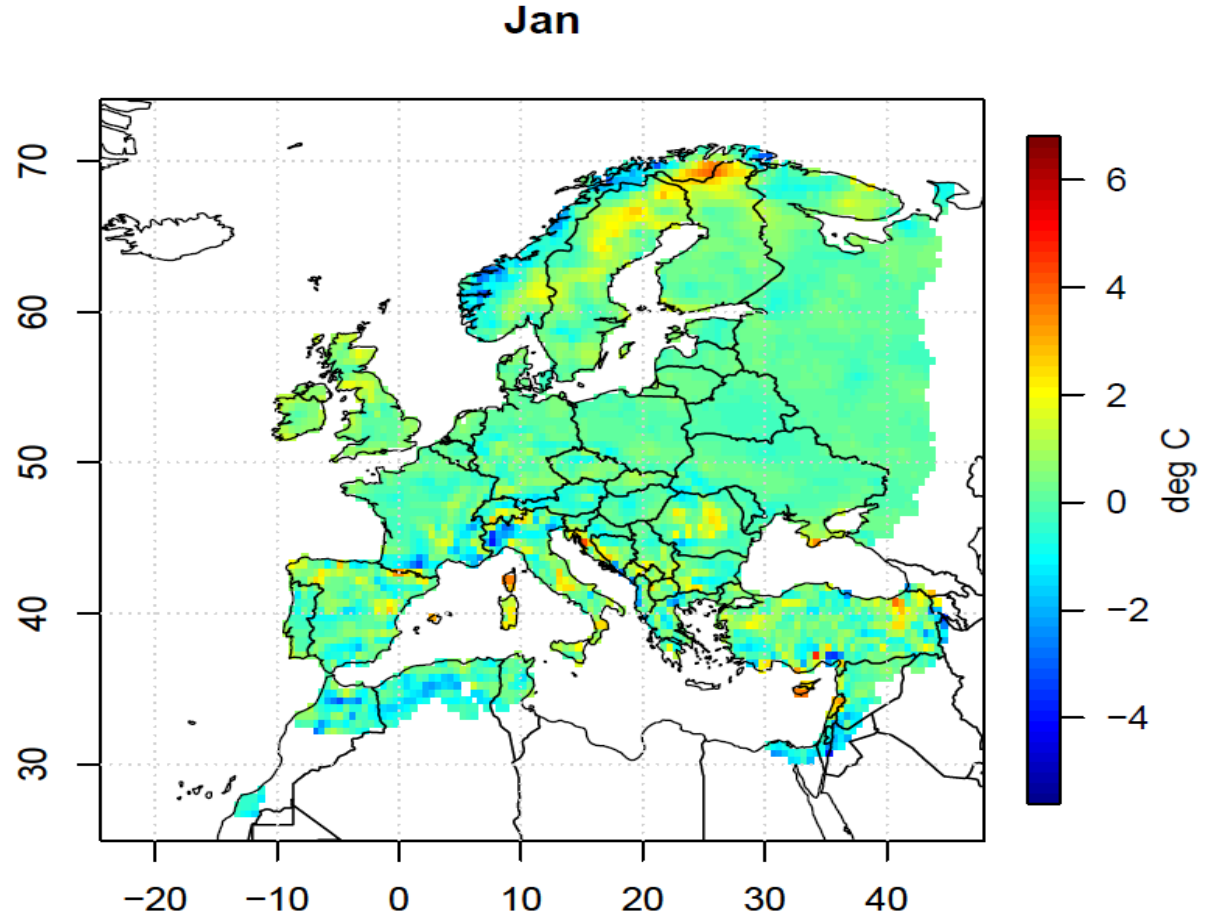
- ★ Air Temperature (mean, maximum and minimum)
- ★ Precipitation
- ★ Solar Radiation (also cloudiness and sunshine hours)
- ★ Wind Speed (including direction, in the Reanalysis world this is given as u and v components)
- ★ Relative Humidity (not yet looked at)

- ★ River Discharge (from SWICCA)
- ★ Water Temperature (also from SWICCA, or from Air Temperature)
- ★ Snow Cover
- ★ Snow Water Equivalent

Bias Adjustment (1)

- ERA-Interim is produced by a data assimilation system and a weather forecasting model
- Assessing ERA-Interim quality in comparison to gridded observed data (over land areas) for various variables
- Bias adjustment – numerous methods have been proposed to 'correct' Reanalyses. **Some treat variables independently**, but others consider variables in a **multivariate** way
- Required in ECEM for the historical period (1979-2015) where the examples here come from
- Bias adjustment also needed for Seasonal Forecasts and also for the Climate Projections
- Approaches for seasonal forecasts are somewhat different, but the potential bias adjustments for the historical Reanalysis period could be applied to the projections

ERA–EOBS monthly Tmean (1979–2014)



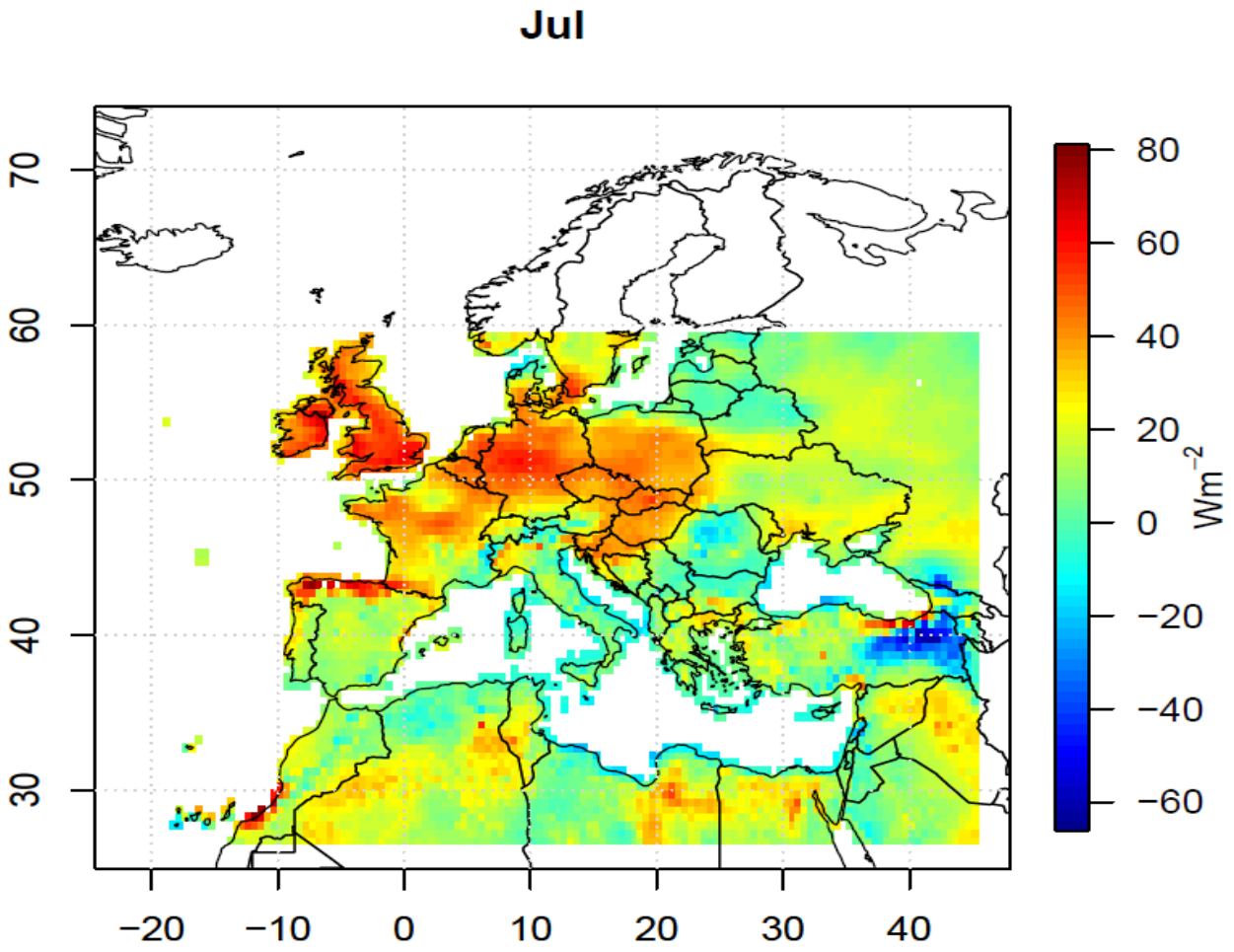
- E-OBS is a daily gridded product of observed air temperatures updated regularly by KNMI (Dutch Met Service)
- Larger differences in mountain areas and near coasts
- Variations differ for different months of the year
- Simple difference shown for the 36-year period from 1979 to 2014
- E-OBS has variable station input (e.g. few stations in Turkey, Near East and North Africa, for example), but this also affects ERA-Interim

Bias Adjustment (2)

- ★ Simple bias adjustment would use the offset (previous slide) and apply this separately for each month (regardless of the value or the time of day)
- ★ Independent of other variables

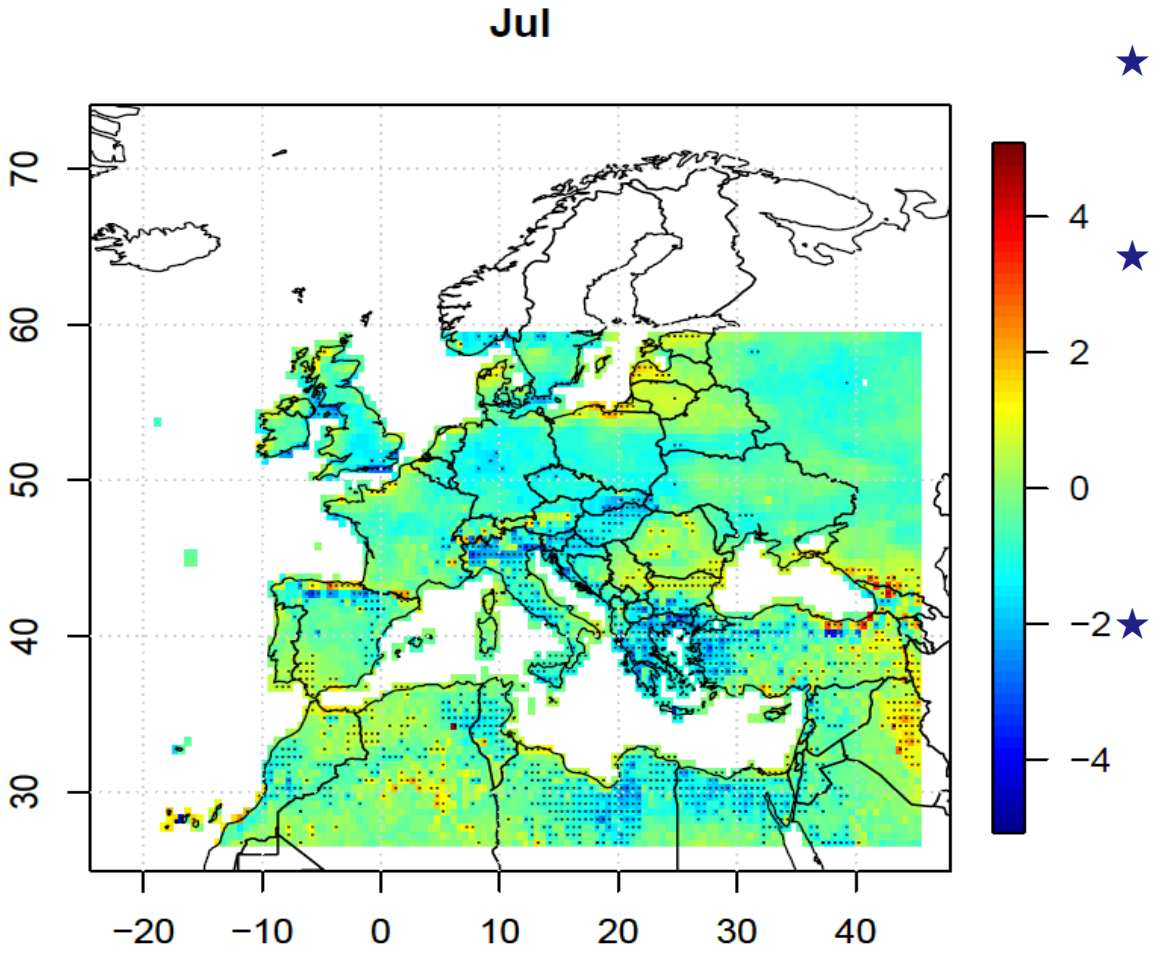
- ★ Some variables are clearly related to one another (e.g. generally cooler temperatures when it rains in summer, but warmer in winter). Dependence assessed by correlation and also state
- ★ Sunny days with high radiation correlated with diurnal temperature range (DTR, Tx minus Tn). Cloudy days have low DTR
- ★ Correlations of other variables with wind generally very low (although they would be high with pressure gradients)
- ★ ERA-Interim will incorporate these relationships, but will individual bias adjustment reduce inter-variable relationships?

ERA−Helioclim monthly radiation (1985−2013)

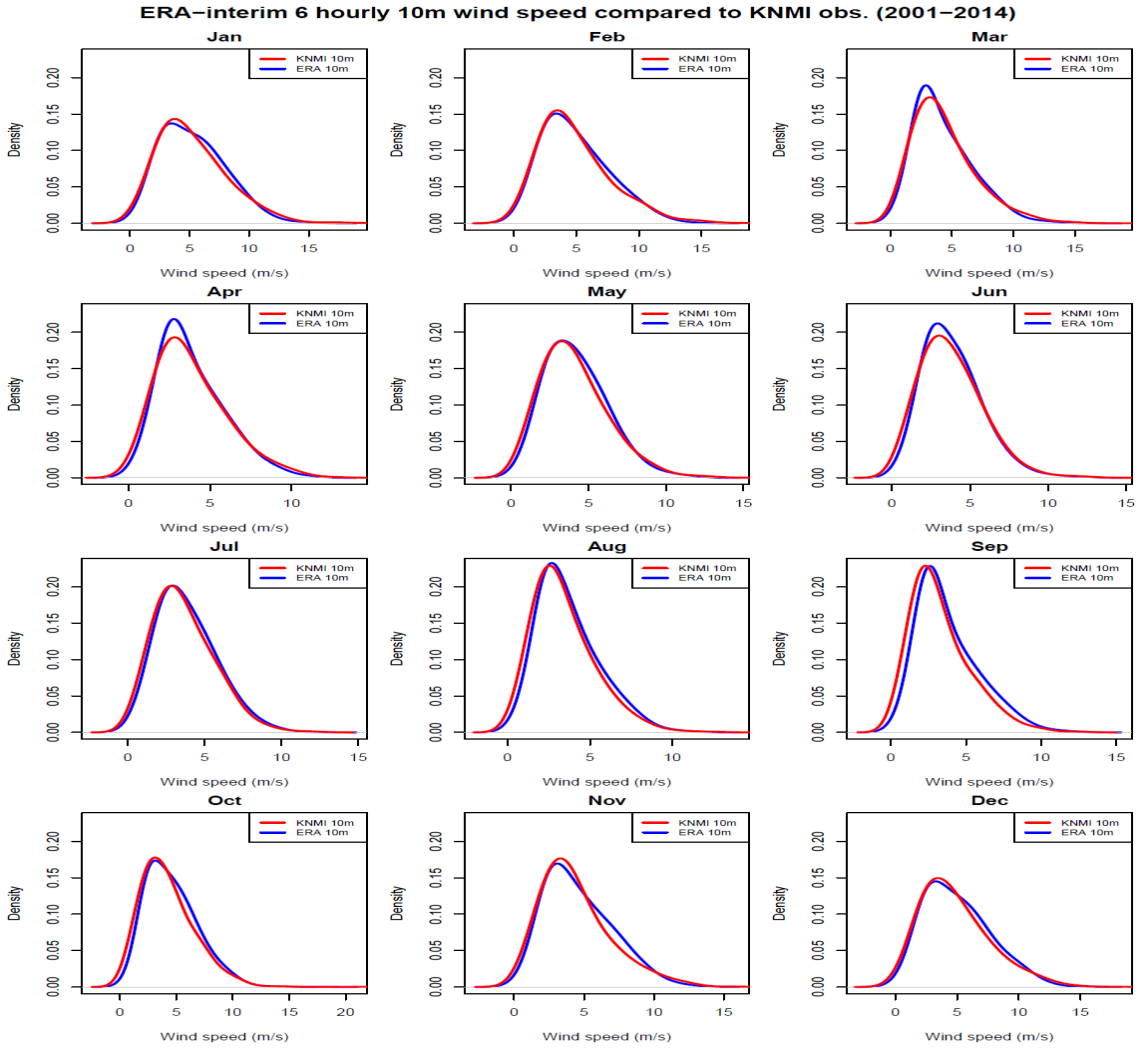


- HELIOCLIM is a combined satellite product (from two databases, 1985-2004 and 2005-2013/4)
- Only available up to 60°N
- Difference show for July
- Difference plots need to assessed in conjunction with similar plots for sunshine and cloudiness
- The satellite is an estimate from above the atmosphere, while ERA-Interim is an assessment from the model's surface

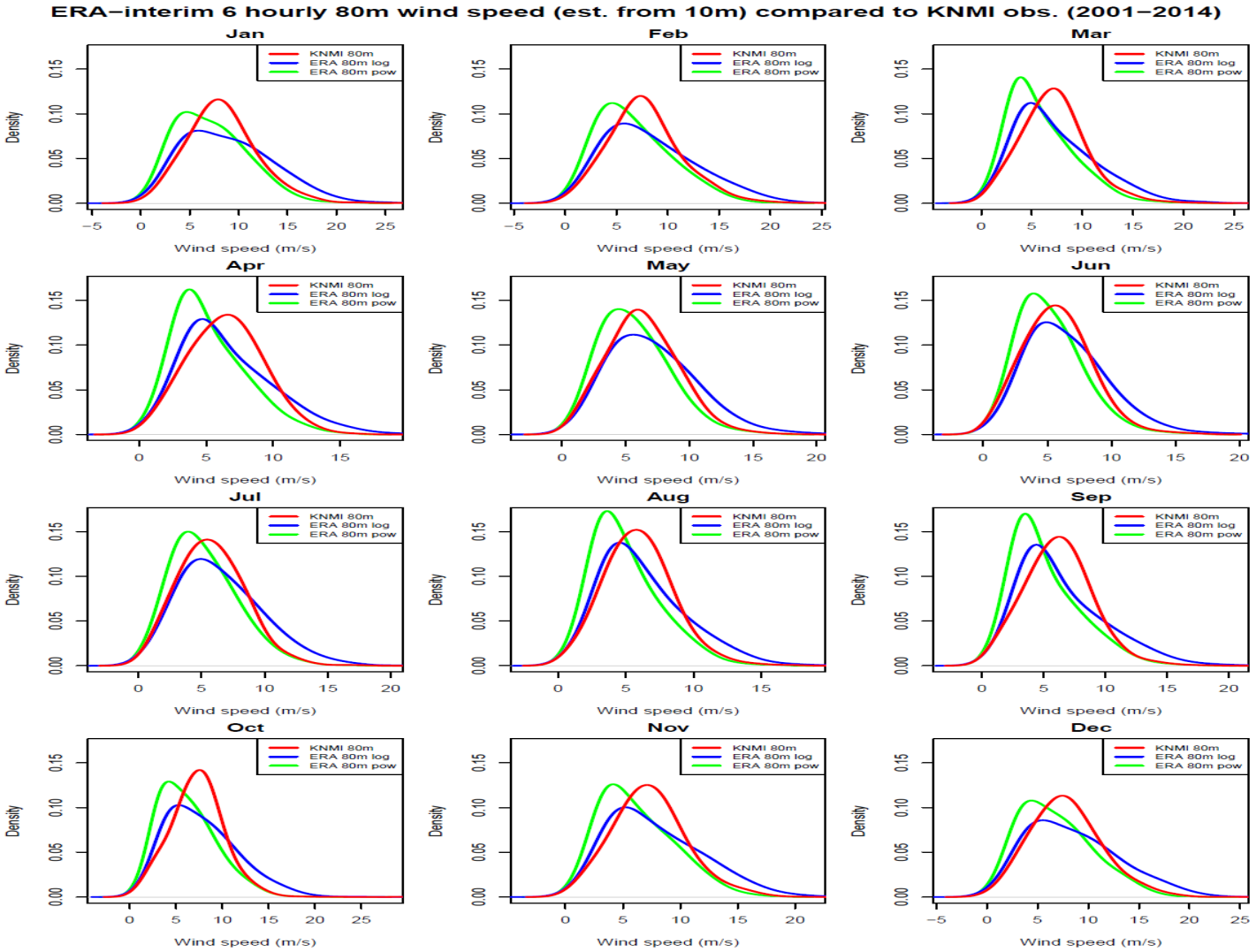
ERA−Helioclim monthly radiation trends (1985−2013)



- Differences in trends (Wm-2 per year)
- Significant differences shown by hatched areas, mostly in SE Europe, the Near East and North Africa
- This is based upon two databases though for 1985-2004 and 2005-2013/4



- **Wind speed assessments (1) – Masts**
- Assessed at two towers in Europe (Cabauw in the Netherlands and Karlsruhe in Germany). Two others exist in Germany, and there may be others.
- Comparison of the PDFs shown for 10m estimates every 6 hours from ERA-Interim (using the nearest ERA-Interim land point to the observed measurements made at Cabauw

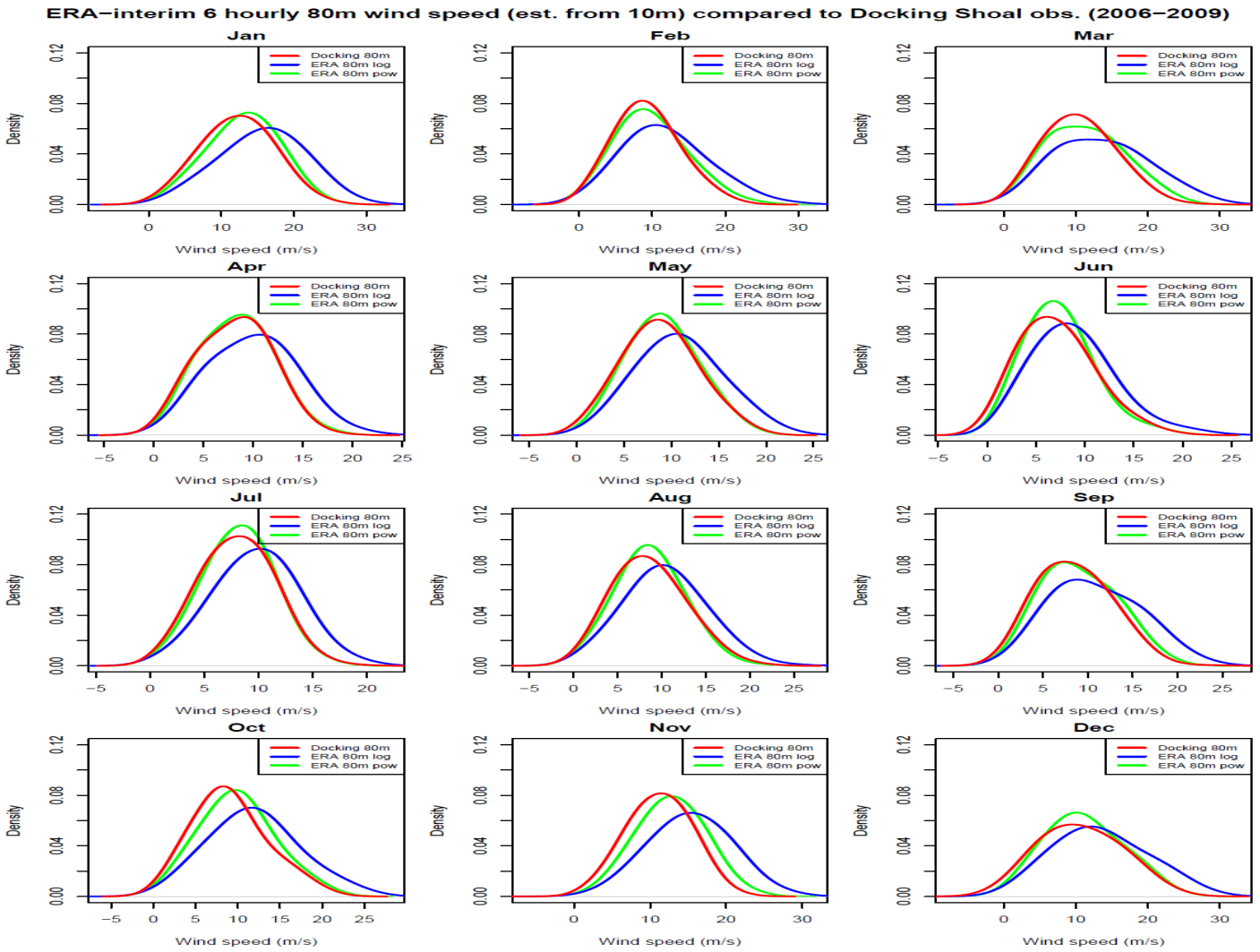


★ Wind Speed Comparisons (2) – measurements at higher heights

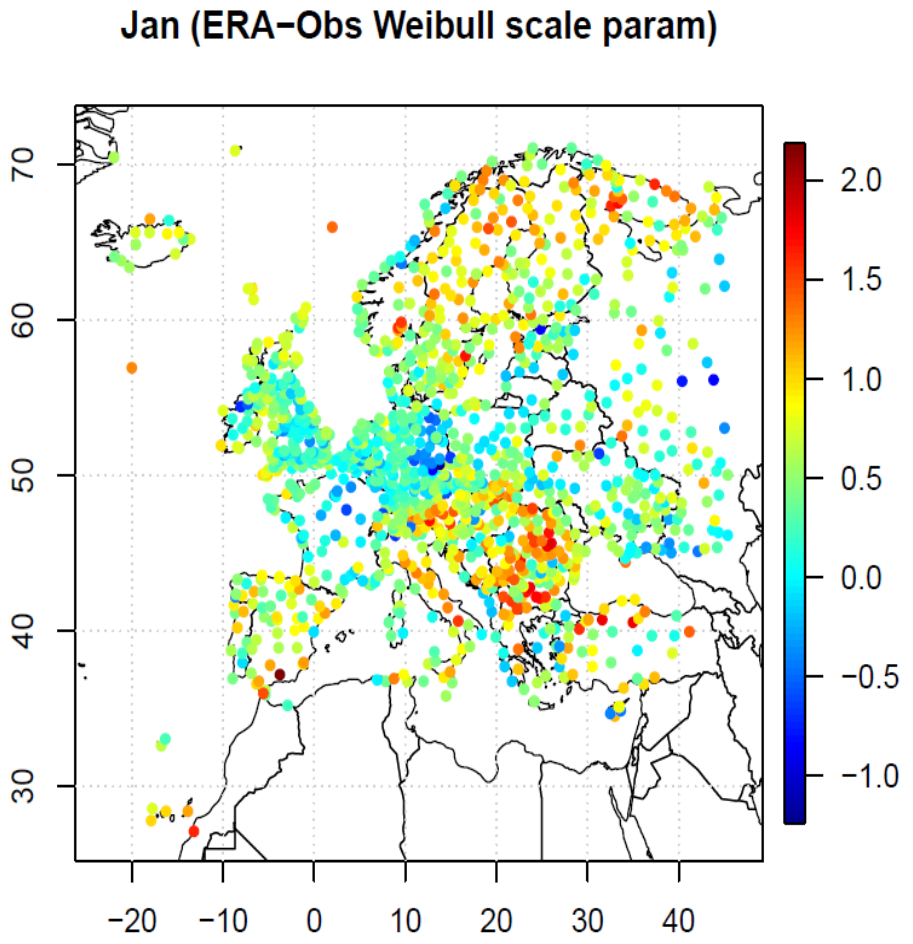
★ ERA-Interim doesn't just measure wind speed at 10m, but at levels in the atmospheric column

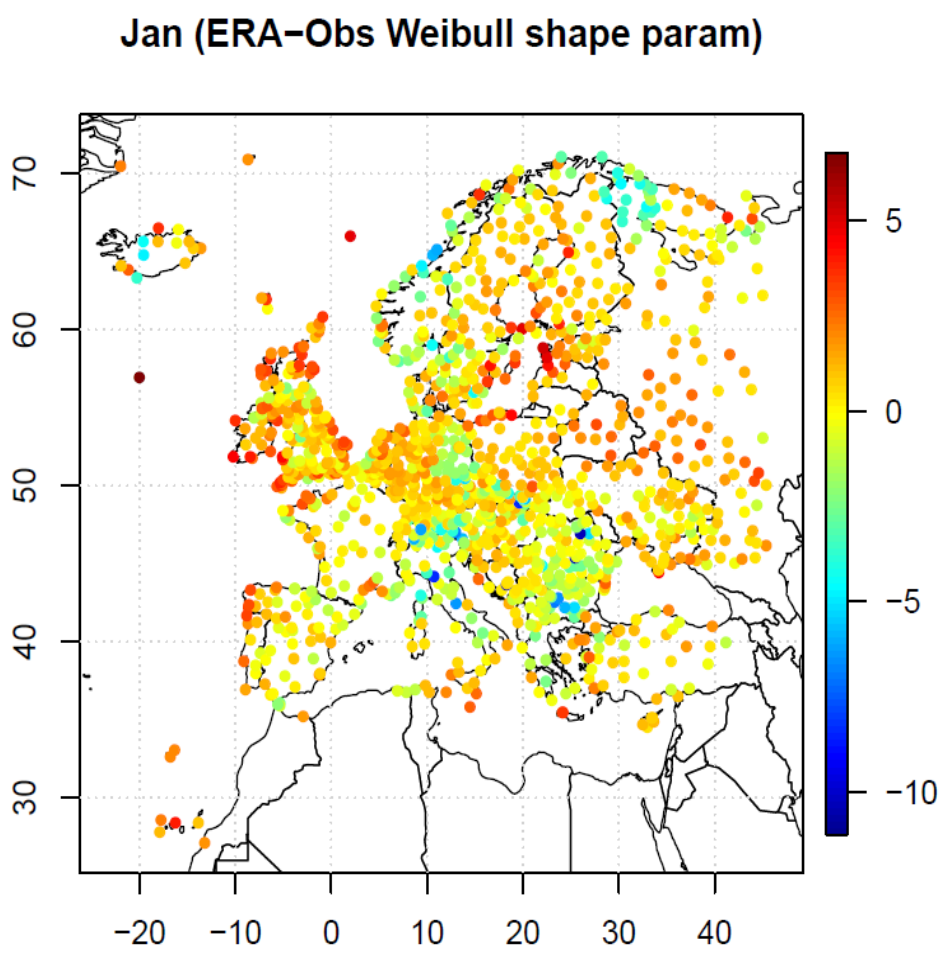
★ Here we use level-58 (in the boundary layer) to compare the pdfs with the Cabauw observations at 80m using a power or logarithmic transform to the specific height of 80m

★ Towers measure wind speeds at a variety of heights. 80 or 100m of most interest to potential hub heights



- **Wind Speed Comparisons (3) – measurements higher up the mast, but offshore**
- As previously but for the short record from Docking Shoal – a mast off the NW Norfolk coast
- Here the power law transform works considerably better than the logarithmic one





Comparison of ERA-Interim and Station Observations (at 10m) of the shape and scale parameters of the Weibull distribution fit to 6-hourly estimates. ERA-Interim set to missing when the station series has a missing value (1979-2014). Ongoing work will determine if modifying the Weibull parameters is a useful approach to bias adjustment of wind speeds.

Key Questions for Climate Variables

- ★ Data availability (6-hourly, daily), as ERA-Interim and where produced as bias adjusted. Available through the CDS
- ★ Bias adjustment in WP2 is for WP3, not necessarily for other (non energy) purposes
- ★ Is the uncertainty introduced by bias adjustment worth it in terms of added value? Can be assessed by the transfer functions within WP3 – are these improved with the adjustments?
- ★ How important is the inter-variable consistency in the energy context?
- ★ Can we bias adjust the variables independently, or are there key pairs that need multivariate adjustment?
- ★ Are there any variables missing?