# Assessing decadal climate and evaporation trends in the UK using high-resolution gridded climate data

Emma L Robinson
Eleanor Blyth, Douglas B Clark, Jon Finch, Alison Rudd

Centre for Ecology & Hydrology

8th September 2015
Lillehammer, Norway

CEH Centre for Ecology & Hydrology
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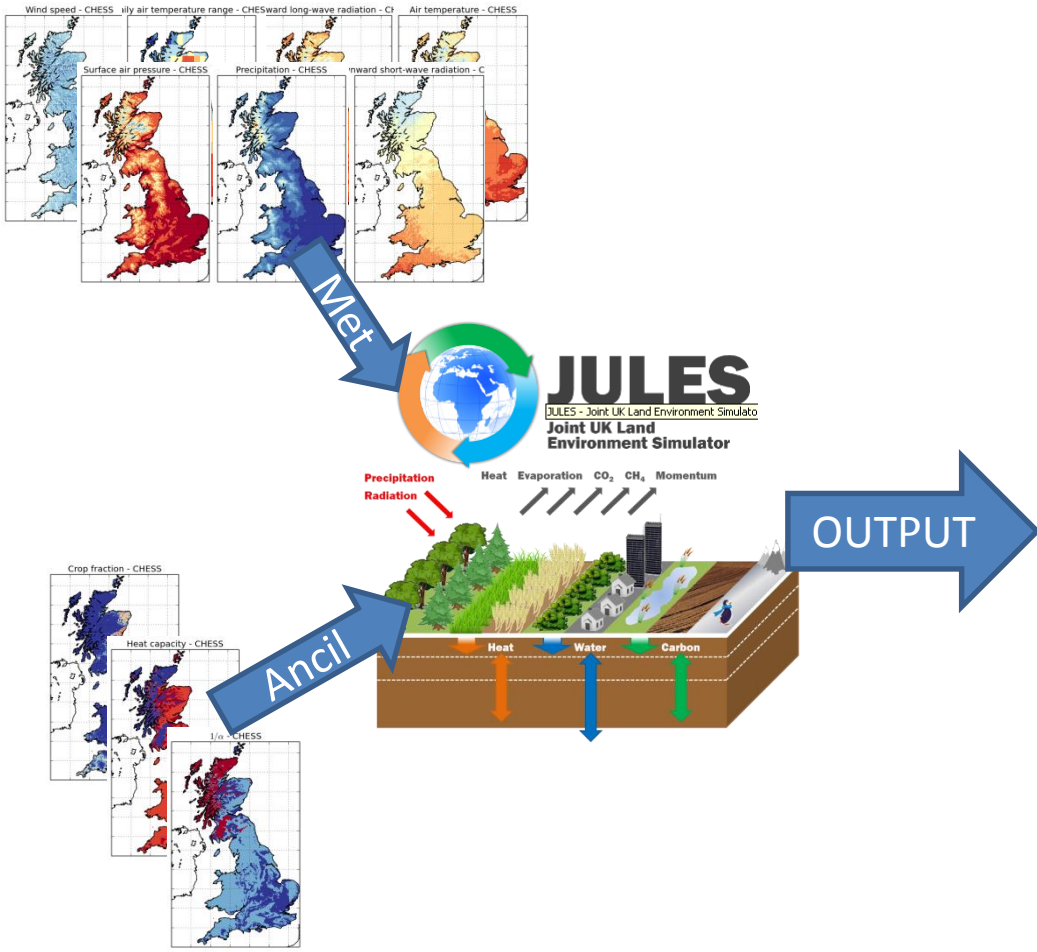
# CHESS meteorological data

- 1km resolution UK driving data set
- 230k land points
- 1961-2012 daily data
- 8 meteorological variables (netCDF)
- + ancillary files

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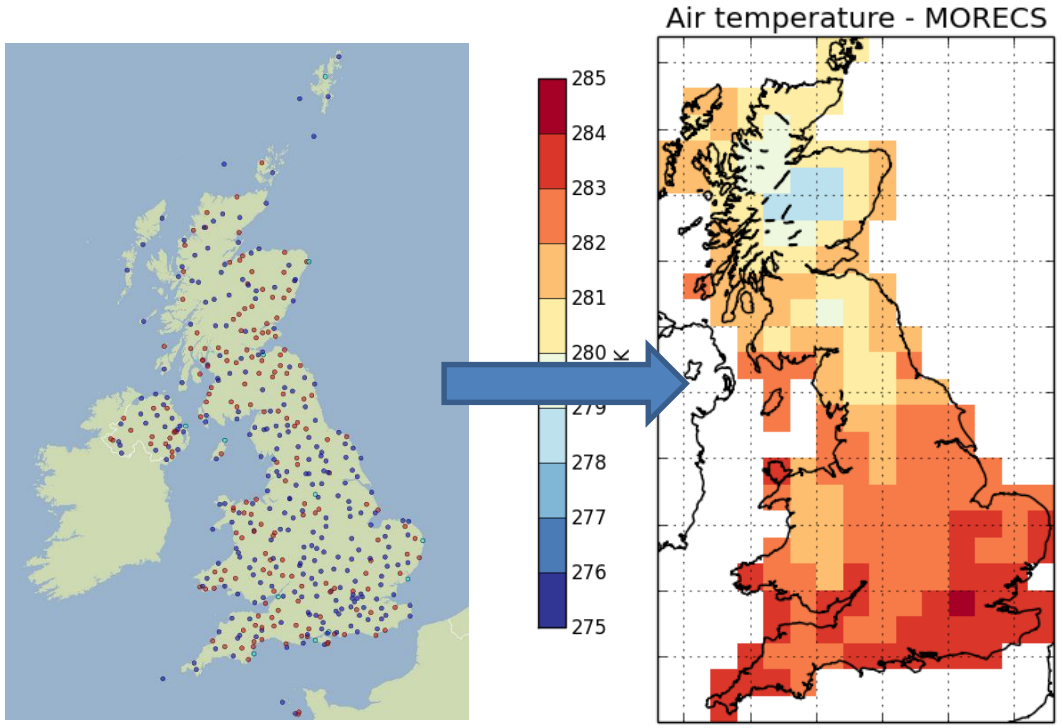
# Ingredients: MORECS

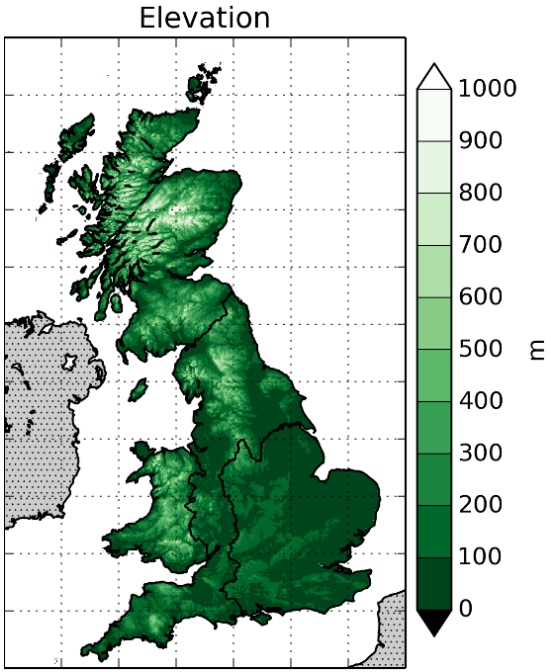
MORECS: Daily meteorological synoptic station data interpolated to 40km grid (Met Office)
1961-Present

- air temperature
- humidity
- wind speed
- sunshine hours

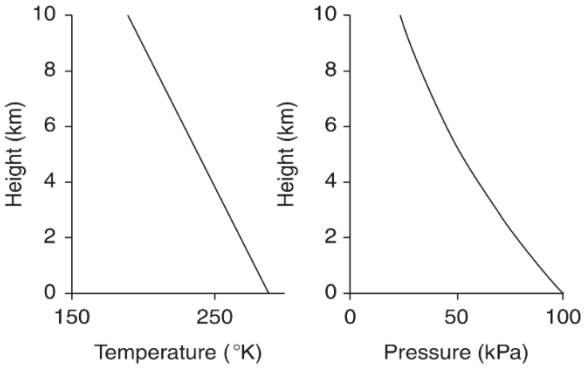



*MetOffice*

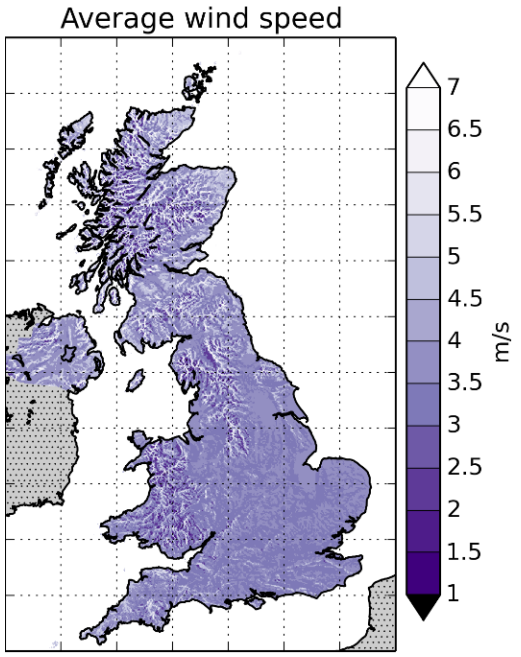
# Topographic corrections




*Morris & Flavin (1990)*




*Shuttleworth, Terrestrial Hydrometeorology*




*Burch & Ravenscroft (1992)*

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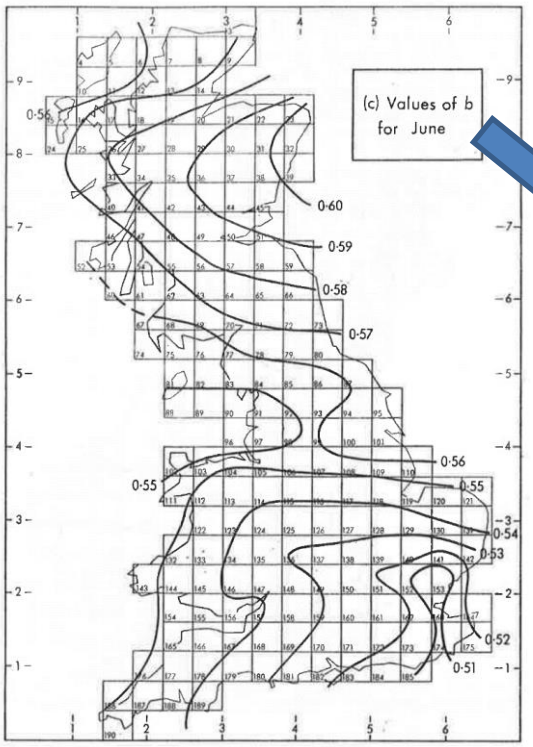
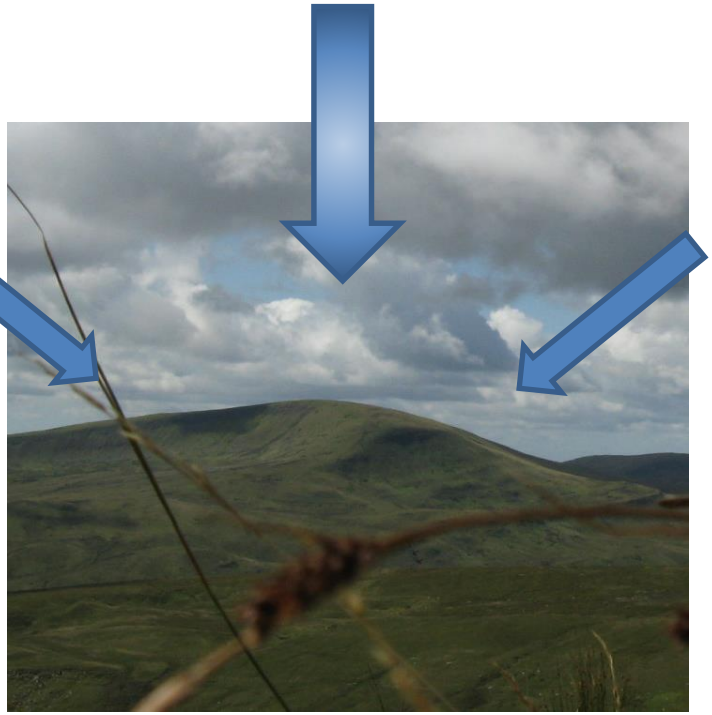
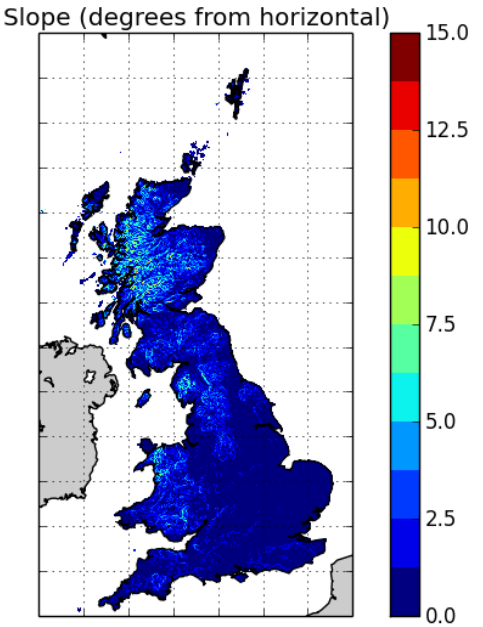
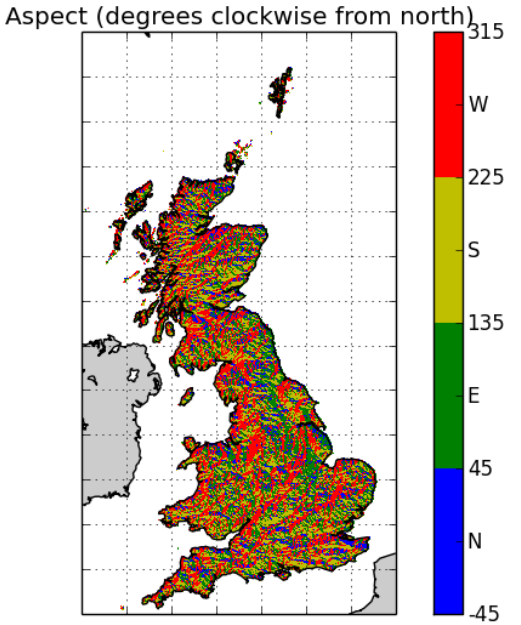
# Radiation corrections




*Cowley (1978)*



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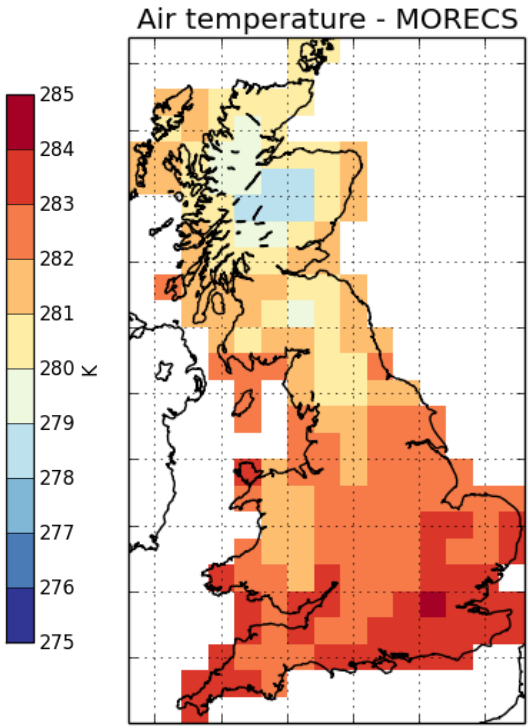
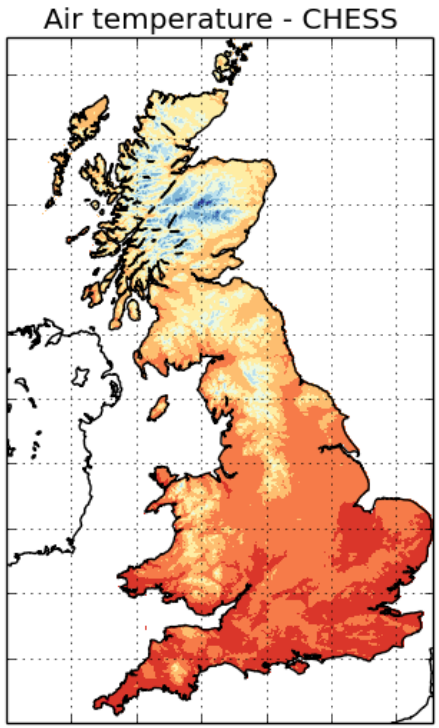
# Ingredients: MORECS




- air temperature
- humidity
- wind speed
- sunshine hours

- air temperature
- humidity
- wind speed
- LW radiation
- SW radiation

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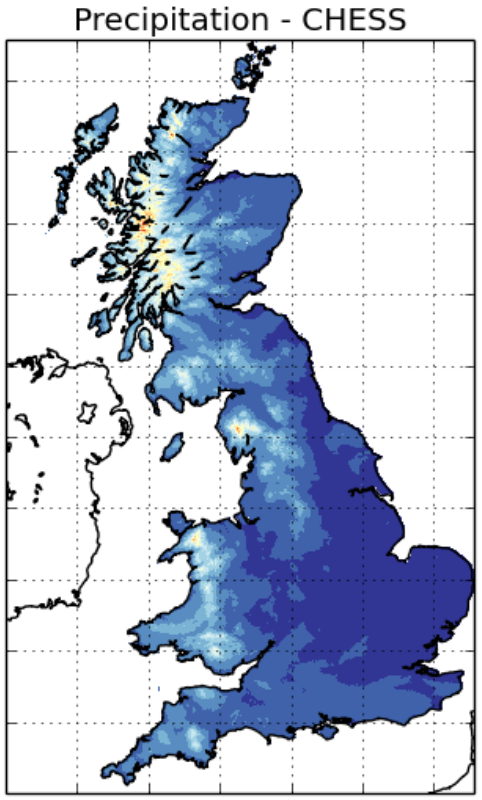
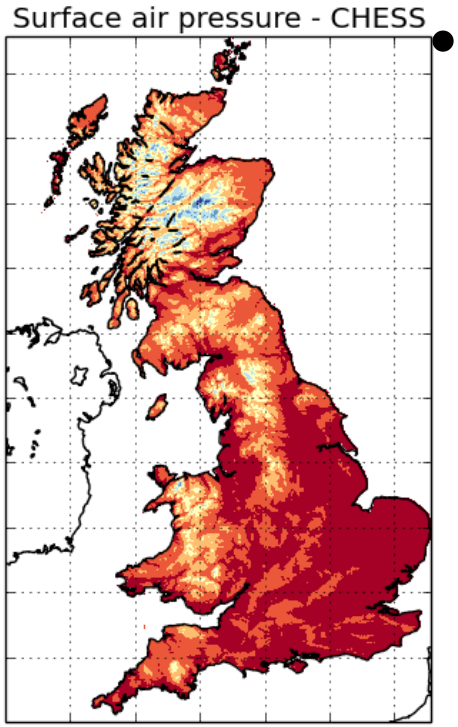
# Ingredients: CEH-GEAR

- Gridded estimates of daily and monthly areal rainfall for the United Kingdom
- 1890-2012
- 1km resolution
- Interpolated from Met Office observed precipitation




*Keller et al (2015)*

# Ingredients: Other data

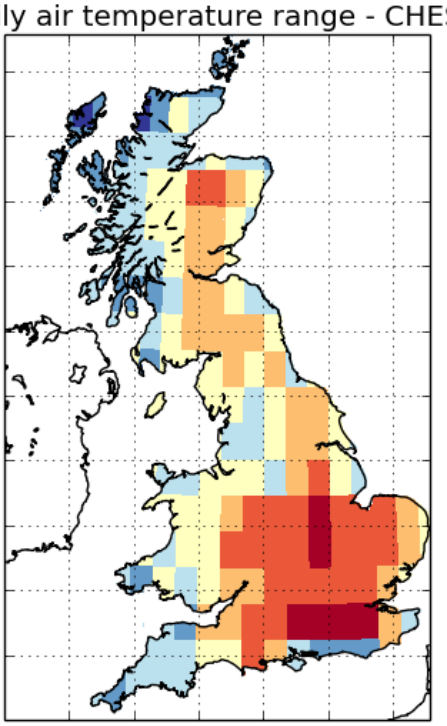



- Surface air pressure
  - WFD data (0.5° resolution)
  - 1961-2001
  - Monthly climatology
  - Adjusted to 1km resolution altitude

*Weedon et al, 2011*

- Daily temperature range
  - CRU data (0.5° resolution)
  - 1901-2012
  - Monthly average

*Jones and Harris, 2013*

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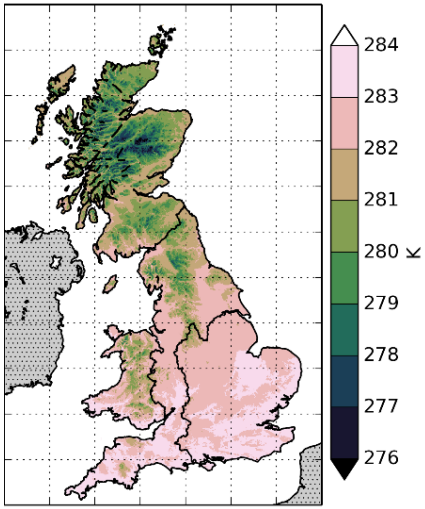
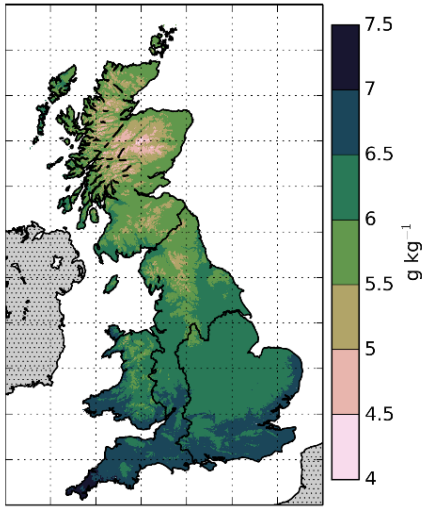
# CHESS meteorological data

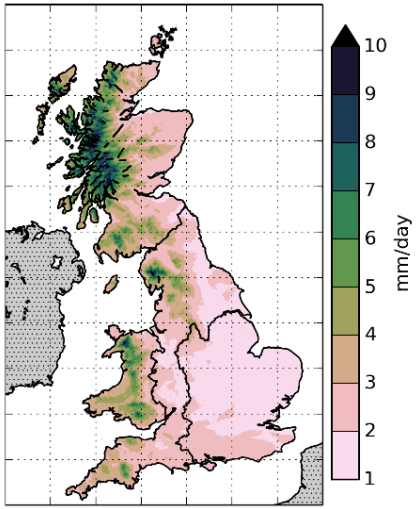
Air temperature



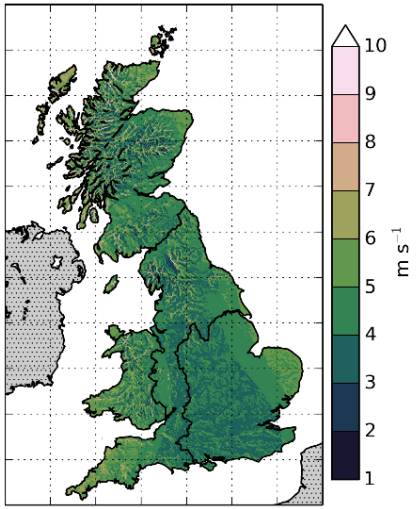

Specific humidity



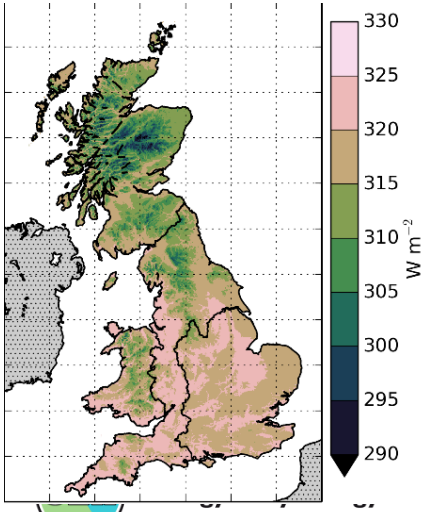

Precipitation



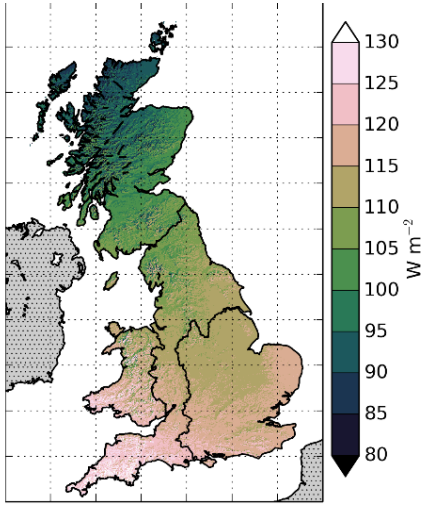

Wind speed



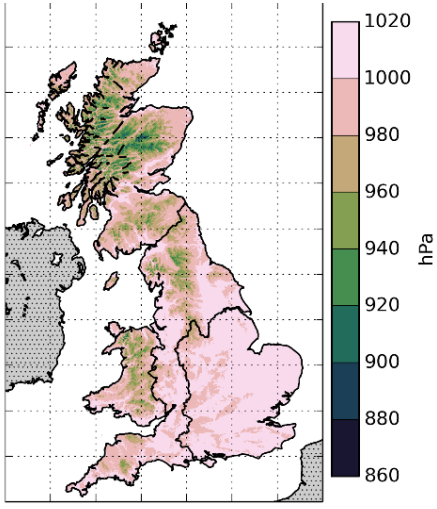

Downward LW



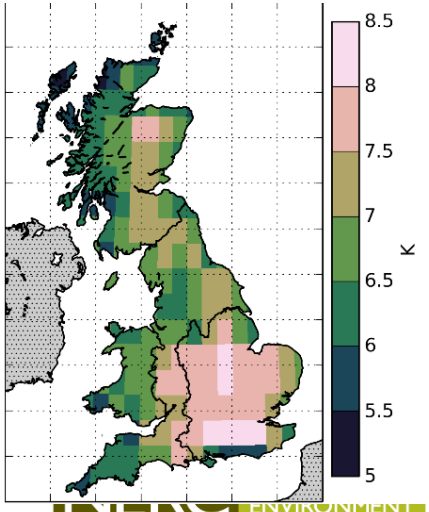

Downward SW




Air pressure




Daily temp range

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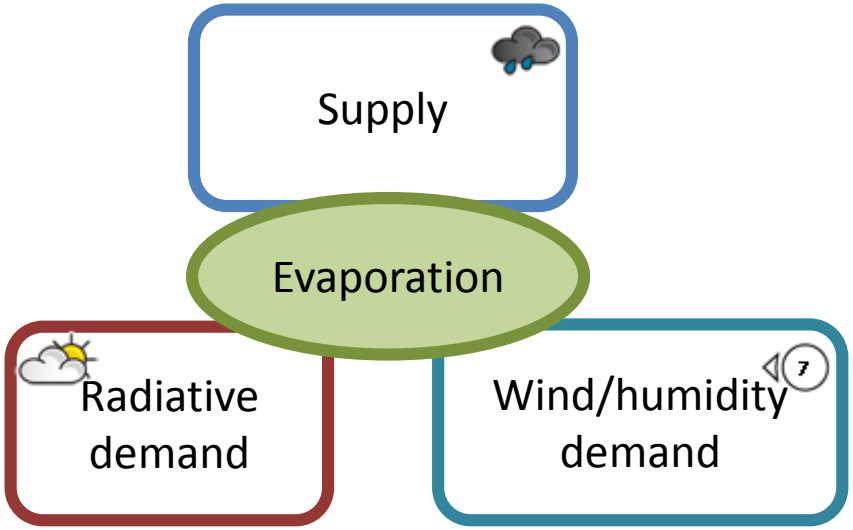
# Uses of CHESS data

- JULES (and other LSMs)

- Rainfall-runoff models (CLASSIC, Grid To Grid)

- Soil moisture regulation of heatwaves
- Macronutrient cycles in Wales (Turf2Surf)
- River water quality
- Changes in bird populations, cricket populations
- Insect-borne disease
- …

# Potential evapotranspiration




Penman-Monteith equation

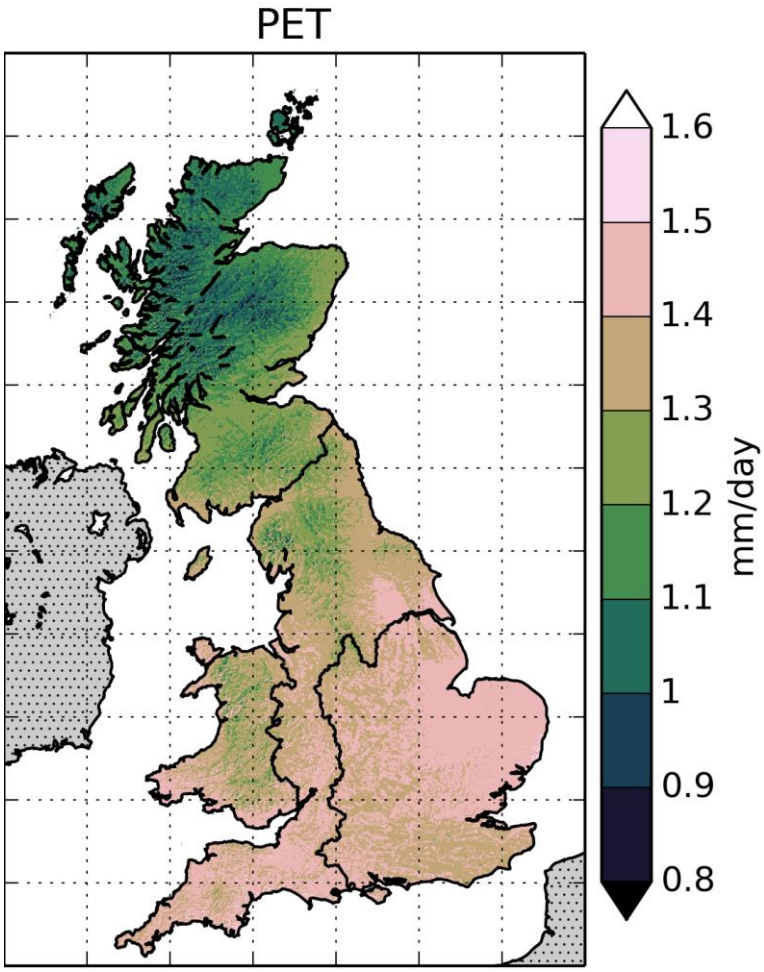
$$\lambda E_P = \frac{\Delta A + \frac{c_p \rho_a}{r_a}(q_s - q_a)}{\Delta + \gamma\left(1 - \frac{r_s}{r_a}\right)}$$

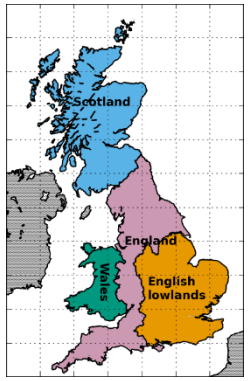
Function of:

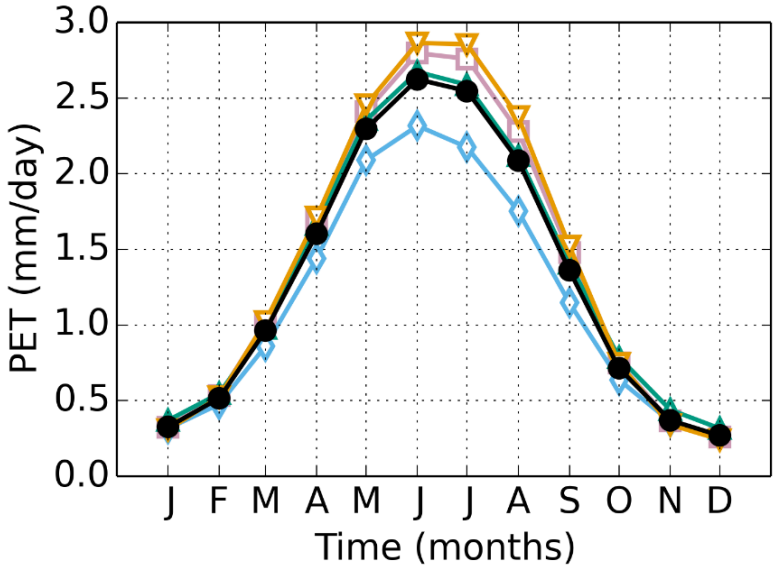
- Air temperature
- Specific humidity
- LW and SW radiation
- Air pressure
- Wind speed

*MetOffice*

# Potential evapotranspiration

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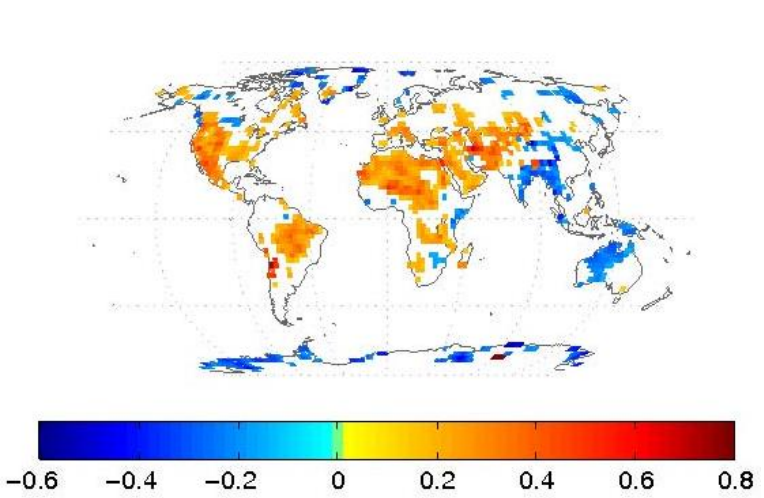
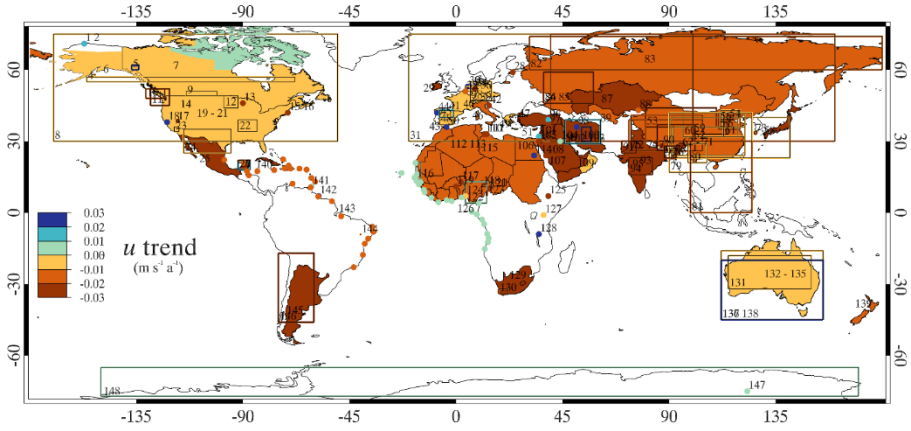
*Robinson et al (in prep)*

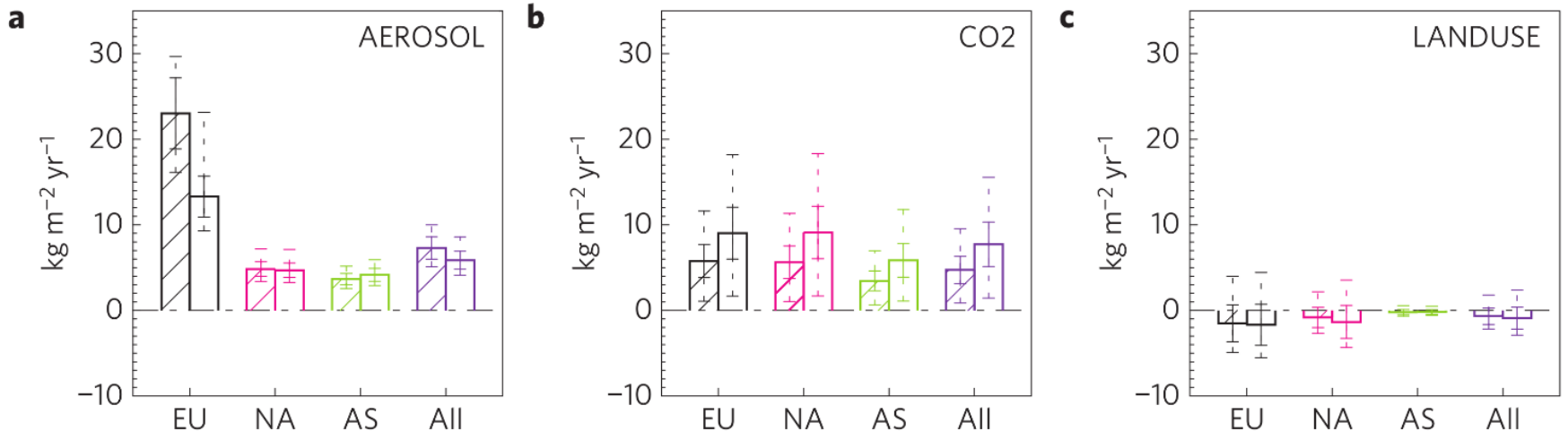
# Changing PET




*Matsoukas et al (2011) Atmos Chem Phys*




*McVicar et al (2012) J Hydrol*




*Gedney et al (2014), Nature Geoscience*

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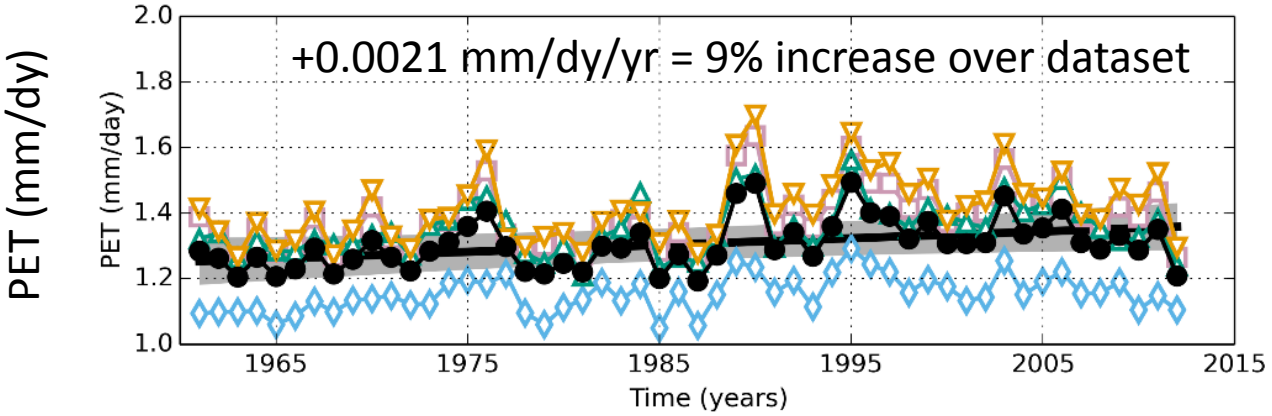


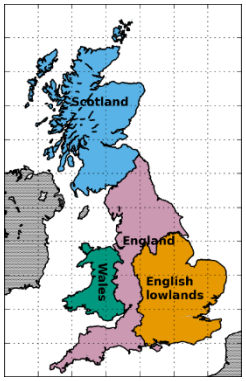


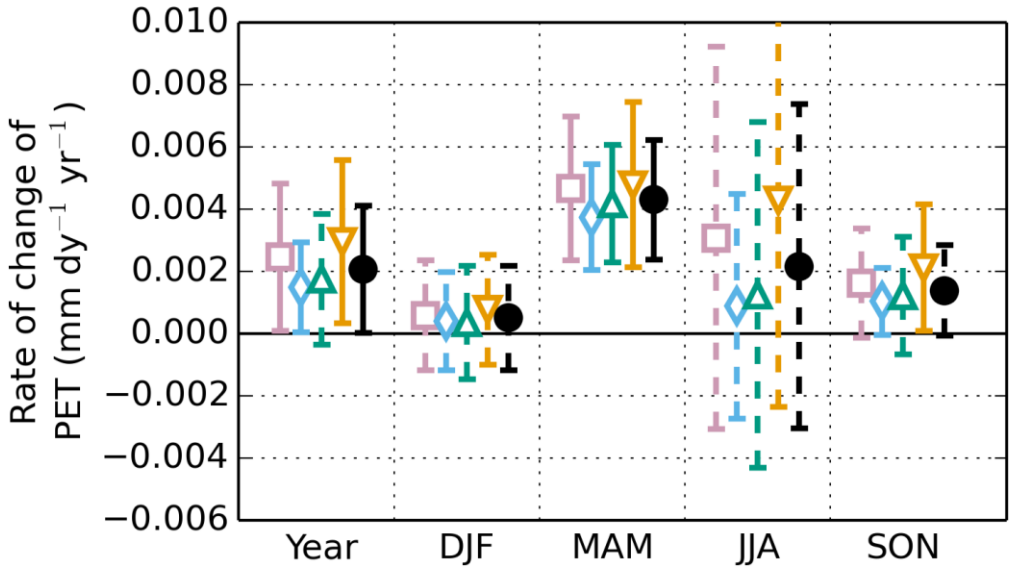


*Robinson et al (in prep)*

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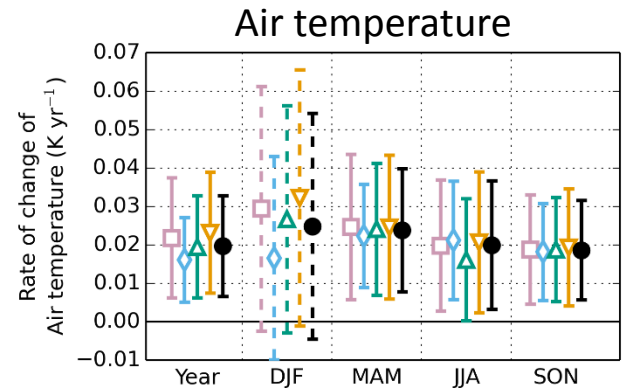
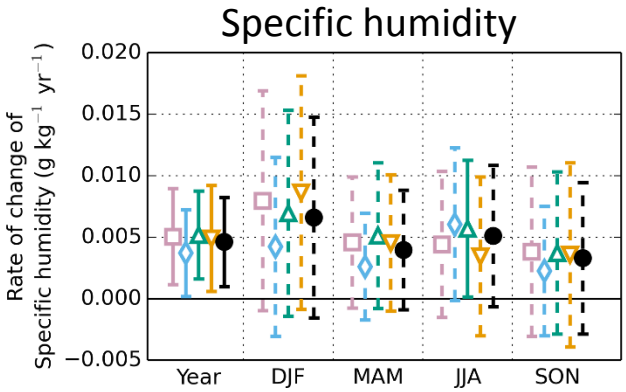
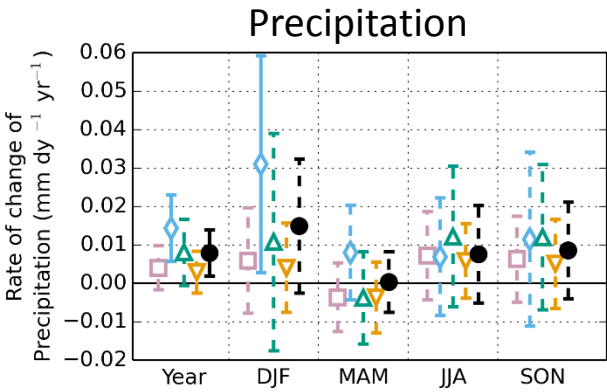
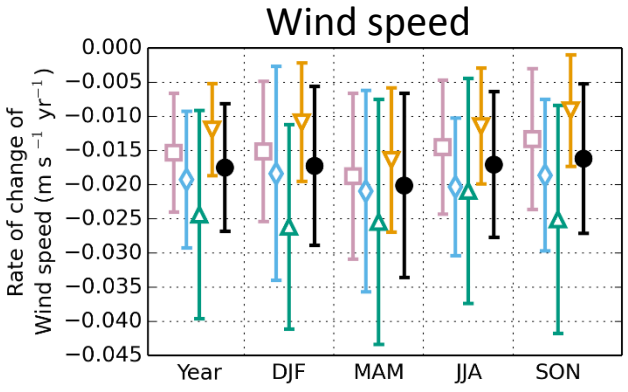
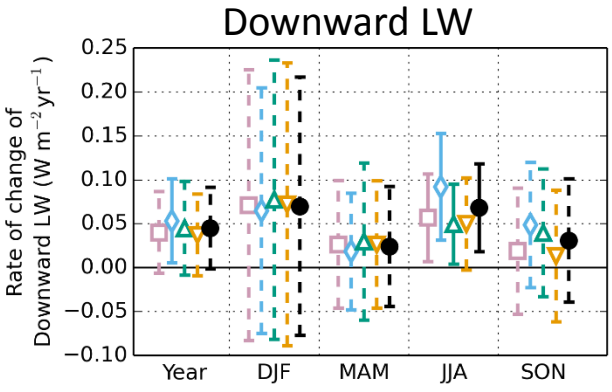
# Climate trends

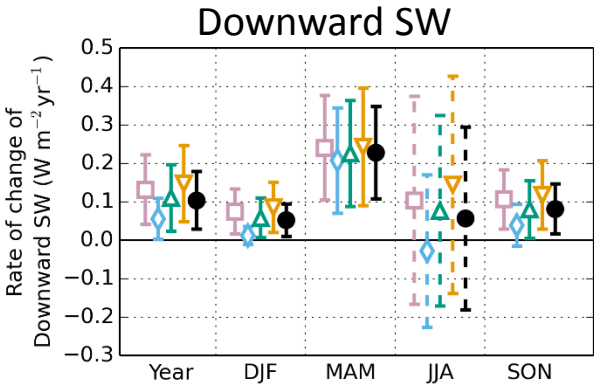


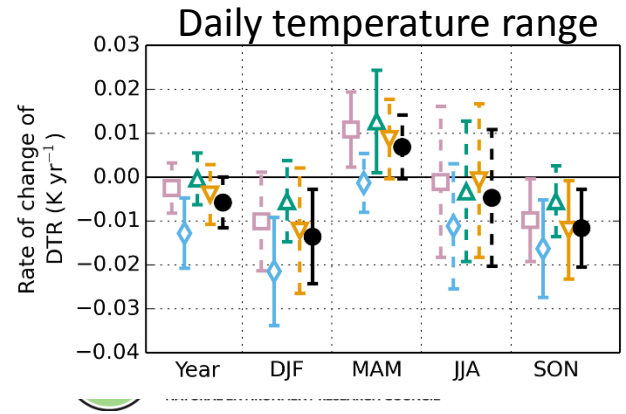



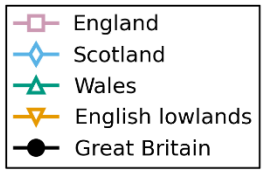



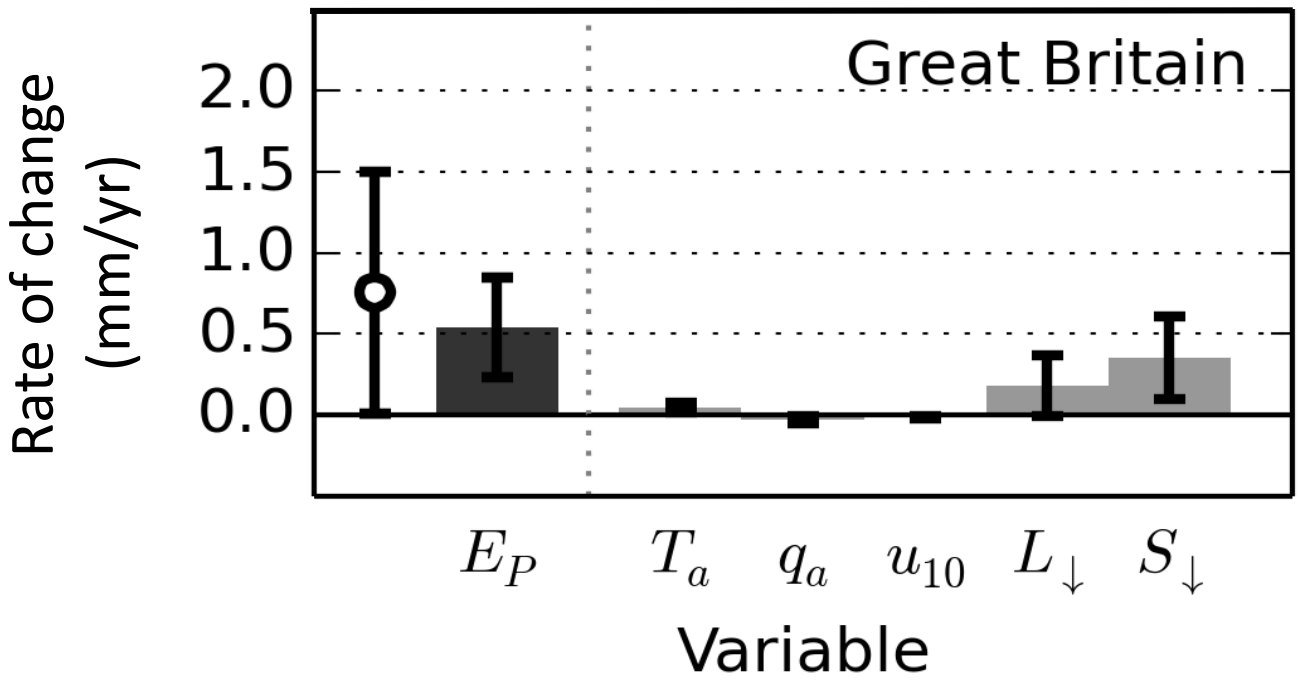



# Attributing change

$$\frac{\mathrm{d}E_P}{\mathrm{d}t} = \frac{\partial E_P}{\partial T_a}\frac{\mathrm{d}T_a}{\mathrm{d}t} + \frac{\partial E_P}{\partial q_a}\frac{\mathrm{d}q_a}{\mathrm{d}t} + \frac{\partial E_P}{\partial u_{10}}\frac{\mathrm{d}u_{10}}{\mathrm{d}t} + \frac{\partial E_P}{\partial L_\downarrow}\frac{\mathrm{d}L_\downarrow}{\mathrm{d}t} + \frac{\partial E_P}{\partial S_\downarrow}\frac{\mathrm{d}S_\downarrow}{\mathrm{d}t}$$



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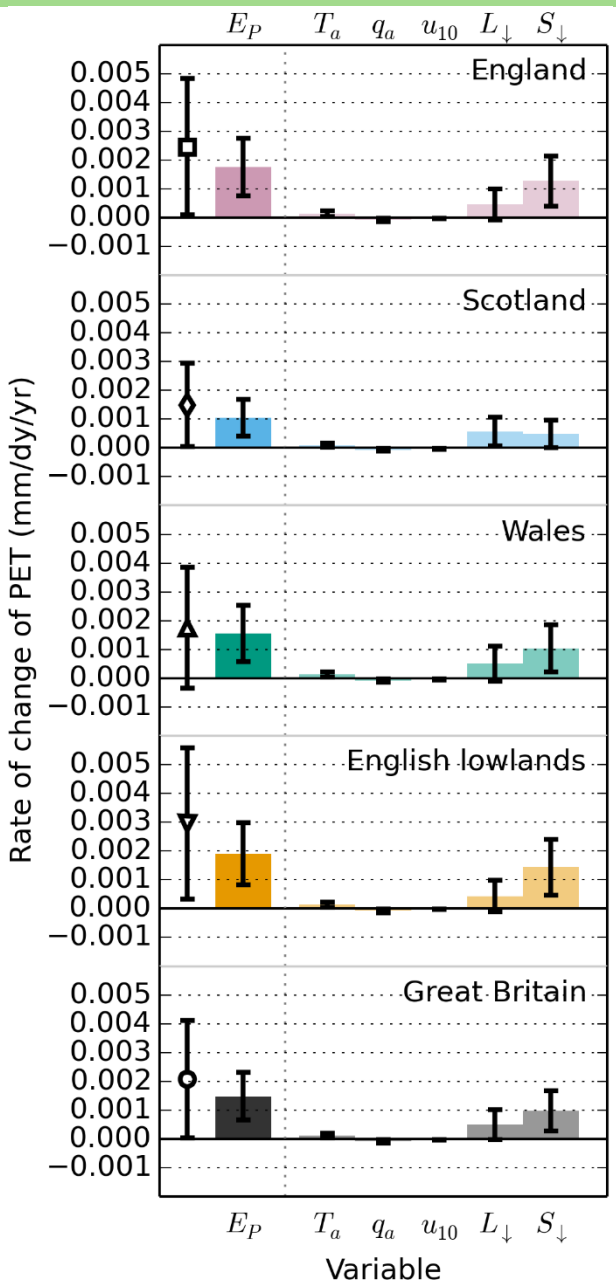


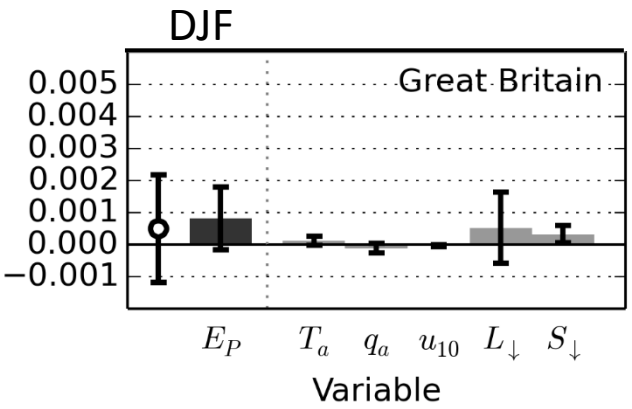


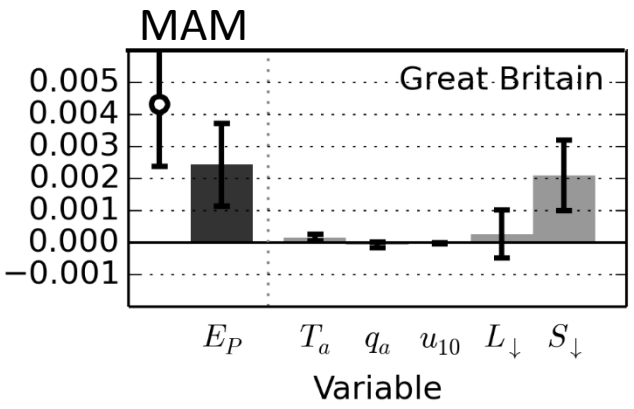


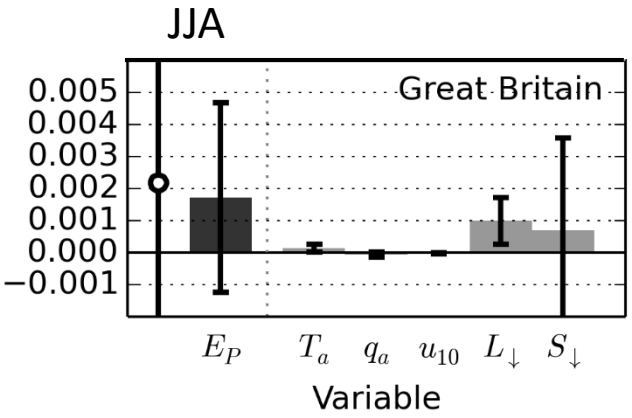


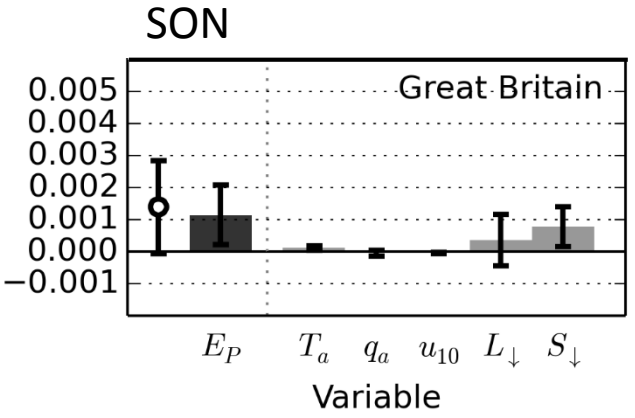


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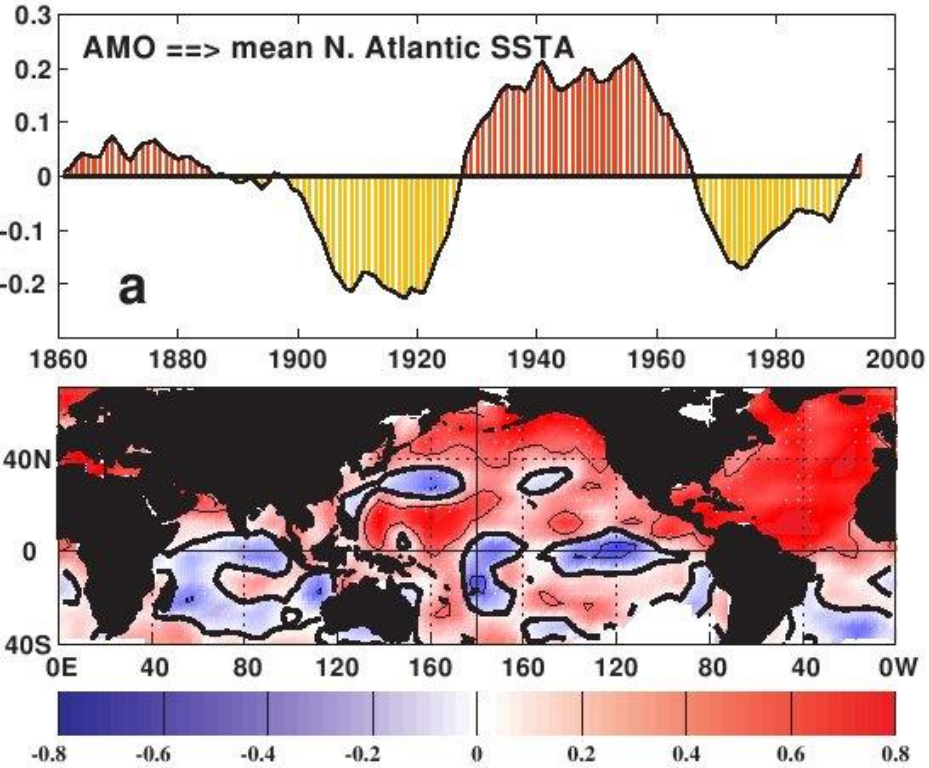
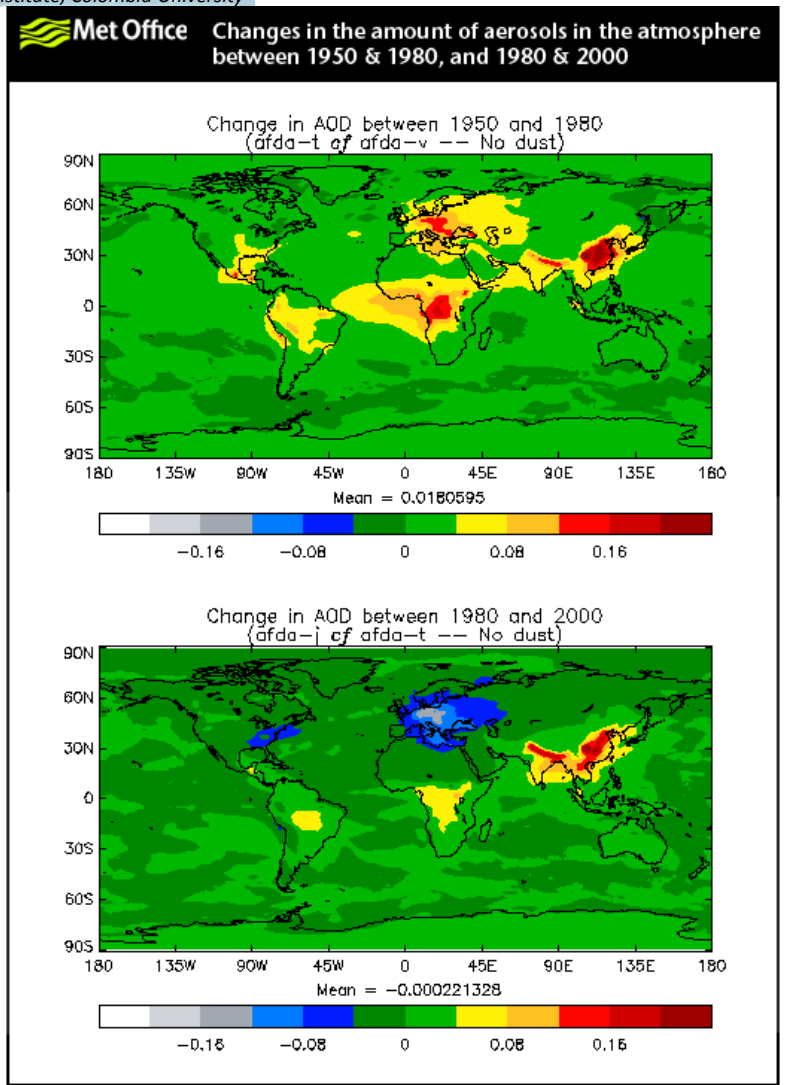
# Radiation trends


*The Earth Institute, Colombia University*




*NOAA Physical Oceanography Division*

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# Summary

- New high-resolution meteorological data set plus evaporative demand available for community use
  - LSMs
  - Hydrological modelling
  - Other investigations...

- Trend in evaporative demand attributed to radiation trends
  - Increasing demand in the spring
  - Consistent with cloud cover changes
  - Some explicit aerosol effects unaccounted for

- Robinson, E. L., Blyth, E. M., Clark, D. B., Finch, J. and Rudd, A. C.: Trends in evaporative demand in Great Britain using high-resolution meteorological data, in prep
- Best et al.: The Joint UK Land Environment Simulator (JULES), model description – Part 1: Energy and water fluxes, Geosci. Model Dev., 4, 677–699, doi:10.5194/gmd-4-677-2011, 2011
- Clark et al.: The Joint UK Land Environment Simulator (JULES), model description – Part 2: Carbon fluxes and vegetation dynamics, Geosci. Model Dev., 4, 701–722, doi:10.5194/gmd-4-701-2011, 2011
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- Burch, S. F., and Ravenscroft, F.: Computer modelling of the UK wind energy resource: Final overview report., AEA Industrial Technology, 1992.
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