# Modelling of grass pollen interannual variation in the UK: A mechanistic approach

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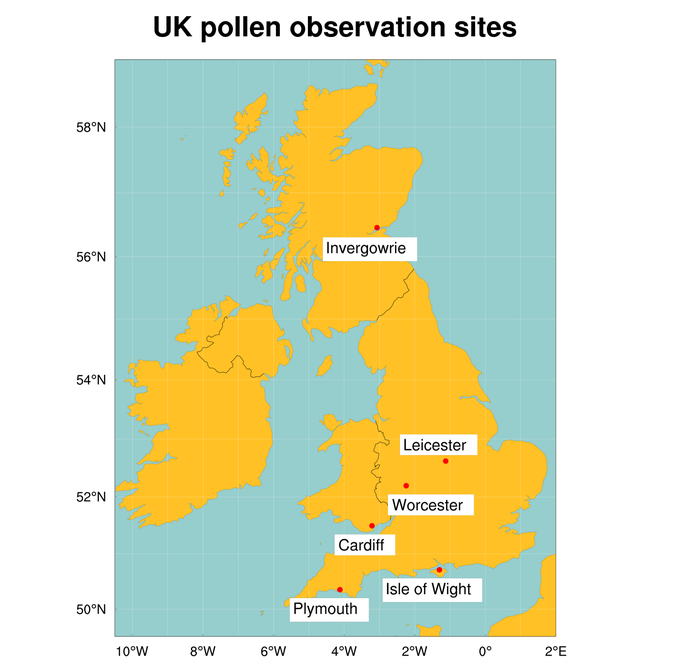
## Motivation

- Seasonal Pollen Integral (SPIn) is used to describe the grass pollen season strength/intensity.
- SPIn comprises: annual pollen production (APP) + atmospheric transport.
  - 10-20% - Long-range atmospheric transport (Sofiev, 2016).
  - 80-90% - APP $\longrightarrow$ SPIn varies as APP.

## Research Question

- We investigate whether variations of Net Primary Production (NPP) alone or in combination with other environmental variables can describe interannual variations of APP and, consequently, SPIn in the UK.

## Mechanistic Approach: Data and Model




- Six pollen observation sites (see Fig. 1) have been chosen to study variations of SPIn in the UK during 1996 - 2015 grass pollen seasons.
- The pollen observation data have been quality controlled by filtering non-representative seasons due to substantial number of data gaps.

Figure 1: Selected grass pollen observation sites located in the UK.

- JULES (Joint UK Land Environmental Simulator) has been set up to simulate variations of NPP at the selected pollen sites (Fig. 1).
  - A process-based model used to simulate the fluxes of carbon, water, energy and momentum between the surface and the atmosphere (Clark et al., 2011).
  - The model is driven by WFDEI (WATCH Forcing Data using ERA-Interim) meteorological dataset (Weedon et al., 2014).
  - Period of simulations: 1979 - 2015; default and sensitivity runs.
- Test for correlation with WFDEI environmental variables.

## Results and Discussion

- SPIn variation is about factor of 2, NPP variation is within 50% (Fig. 2), no linear relationship:
  - Low variation of NPP can cause large variation of SPIn (see Ziska et al., 2003).
  - Similar NPP year-to-year variations have been observed in the MODIS and CEH datasets.
- Doubling of $CO_2$ leads to increase of NPP up to 80% (Fig. 3).
  - This is also supported by Albertine et al., 2014, Rogers et al., 2006.
- Correlation between SPIn and WFDEI variations:
  - Temperature: positive (0.5-0.7, $p < 0.05$) for mid-flowering (half of the sites).
  - Precipitation: positive in pre-season (0.46-0.63, $p < 0.05$) and negative in season (half of the sites).

## Acknowledgments

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## NPP vs. SPIn interannual variations

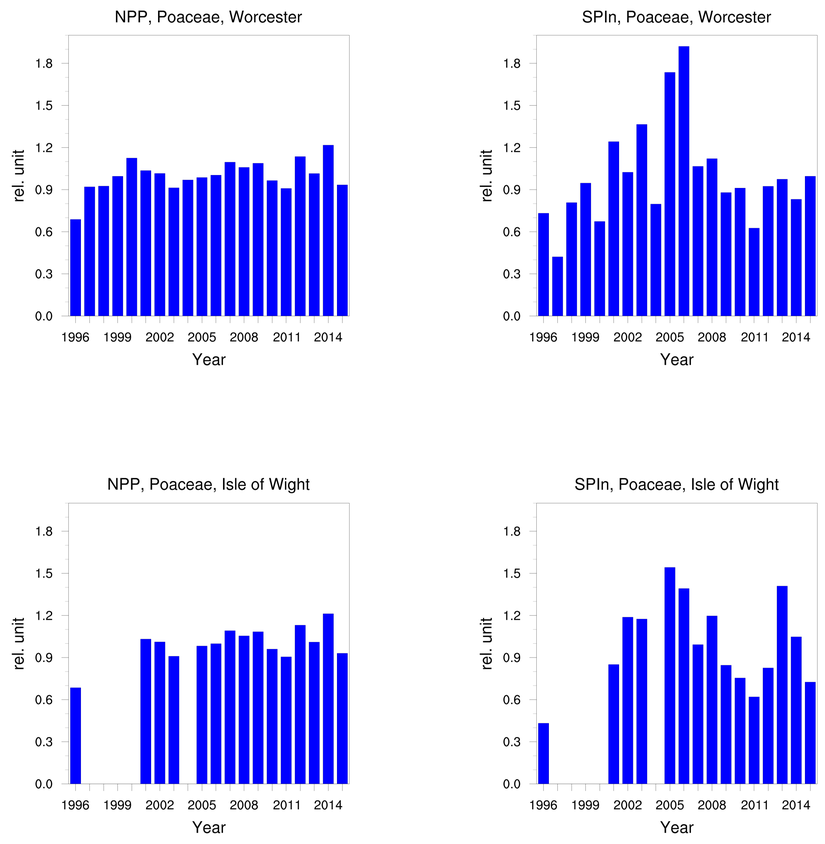


Figure 2: Interannual variations of NPP (left) and SPIn (right) at Worcester and Isle of Wight.

## JULES simulations: sensitivity of NPP to $CO_2$

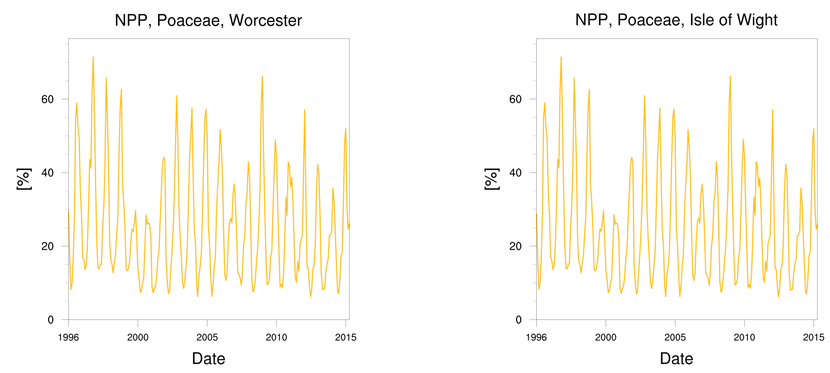


Figure 3: Percentage difference of monthly mean NPP (doubled $CO_2$ - default) according to JULES simulations.

## Conclusion and Further Perspectives

- NPP and SPIn variations are not regional scale phenomena in the UK.
- As an extension of the current approach local variations of meteorological and environmental variables (e.g. $CO_2$) should be taken into account for both NPP and SPIn.
- For more detailed investigation of the SPIn behavior - footprint modelling can be done to estimate local atmospheric transport and distribution of local grass pollen sources.
- The mechanistic approach has the practical application to be used for estimation of local variation in grass pollen productivity throughout the UK.

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