Non-Structural Carbohydrate Storage in JULES

Simon Jones, Dr Lucy Rowland, Dr Deborah Hemming, Professor Peter Cox, Dr Anna Harper

University of Exeter

September 5, 2018

Introduction

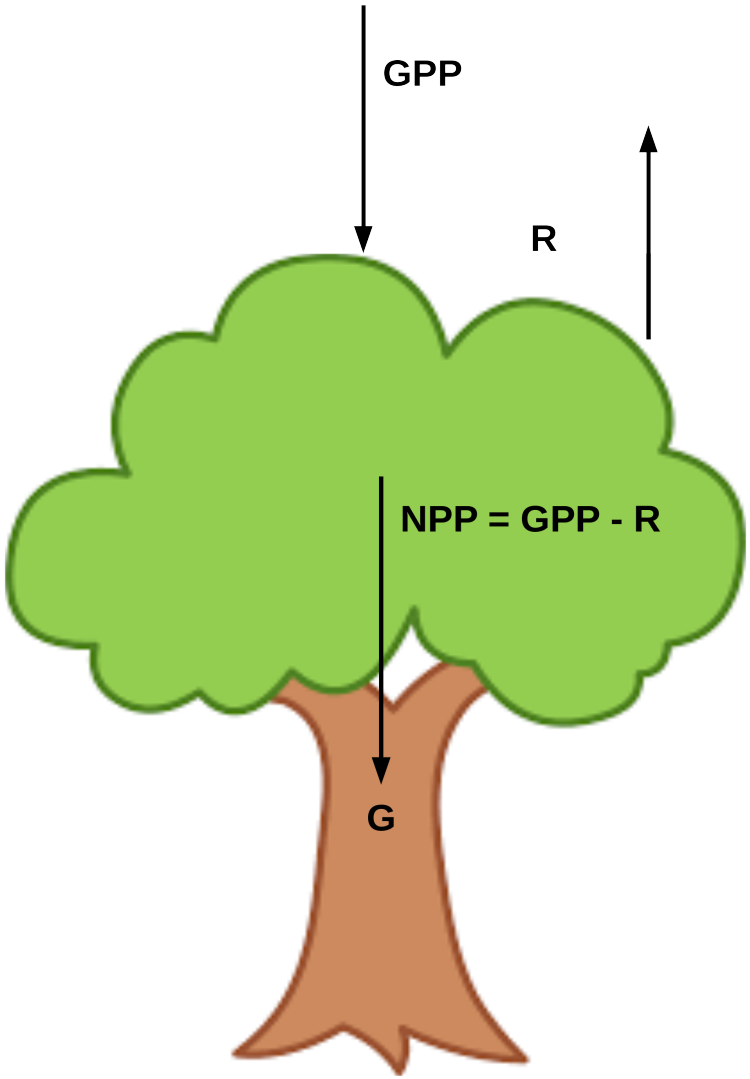
- What are Non-Structural Carbohydrates?
- How do/should they fit into JULES?
- Attempt at a simple model
- Some results

Non-Structural Carbohydrates

- A large range of molecules - mostly sugars and starches
- Stored by plants to act as a buffer to asynchronies in supply and demand
- Important in many plant processes eg. Metabolism, transport, growth...
- Think fat reserves in humans!

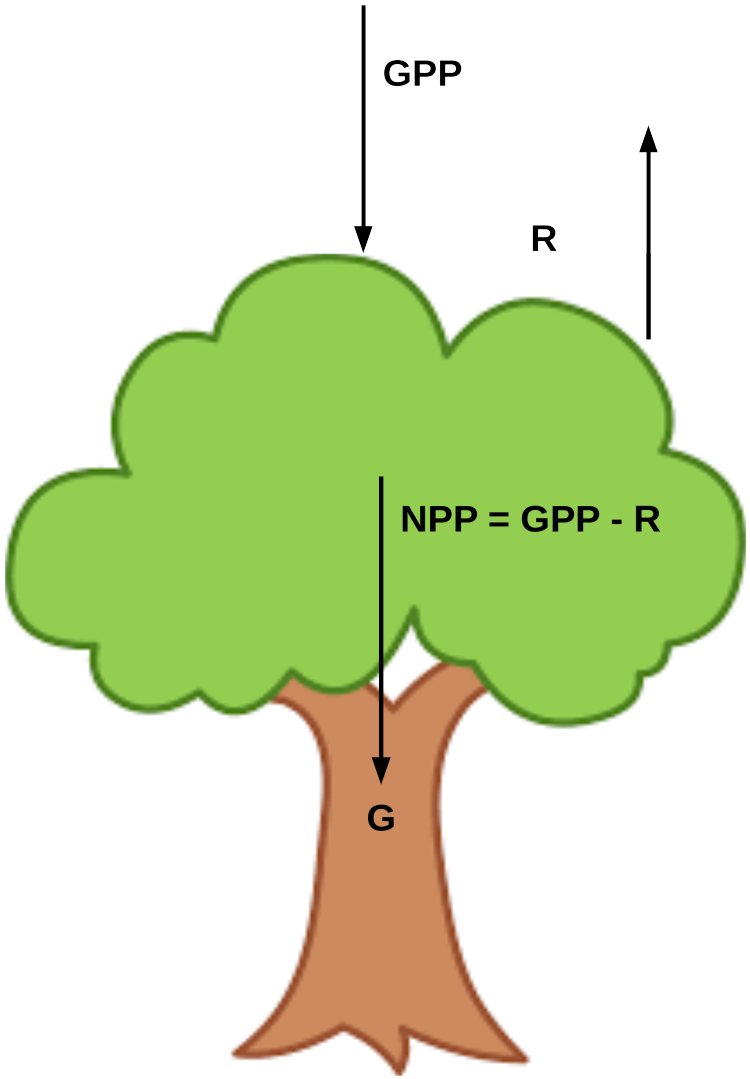
Carbon Fluxes in JULES

- Gross Primary Productivity (GPP) is all used for:
  1. Respiration - depends on temperature and Nitrogen content
  2. Growth - The remaining photosynthate is used for growth



Carbon Fluxes in JULES

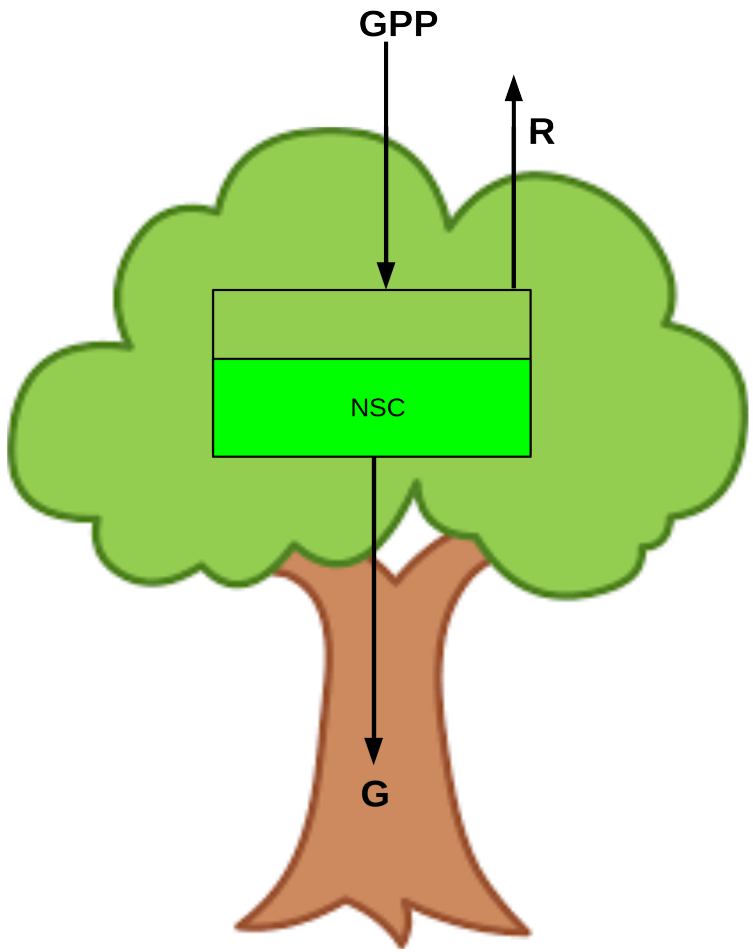
- Trees can respire themselves to death
- Trees shrink during stress!
- Structural growth is tied to NPP



Fluxes with a Non-Structural Carbohydrates pool

Introduction of a Non-Structural Carbohydrate pool.

- $\frac{dNSC}{dt} = GPP - R_m - R_g - G$
- $R_m = R_{m_0} Q_{10}(T) NSC$
- $G = G_0 Q_{10}(T) NSC$
- $R_g = \frac{1 - Y_g}{Y_g} G$



Fluxes with a Non-Structural Carbohydrates pool

$$\frac{dNSC}{dt} = GPP - \phi Q_{10} NSC$$

$$\phi = R_{m_0} + \frac{G_0}{Y_g}$$

Fluxes with a Non-Structural Carbohydrates pool

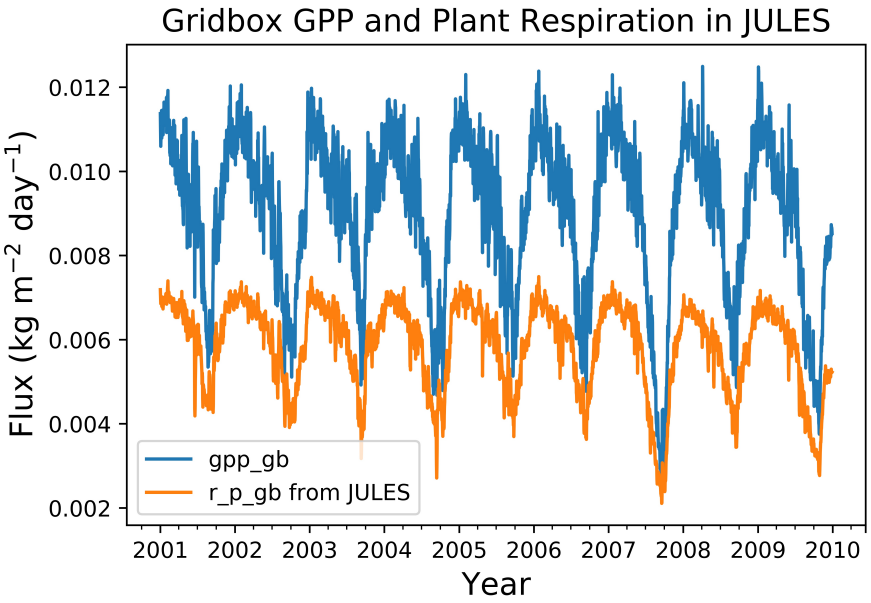
$$\frac{dNSC}{dt} = GPP - \phi Q_{10} NSC$$

$$\phi = R_{m_0} + \frac{G_0}{Y_g}$$

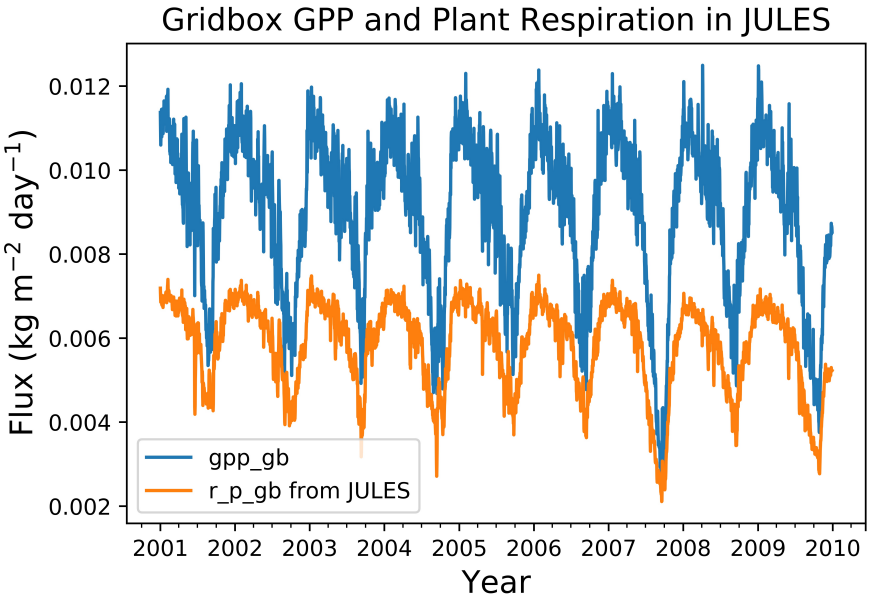
- Just two parameters:

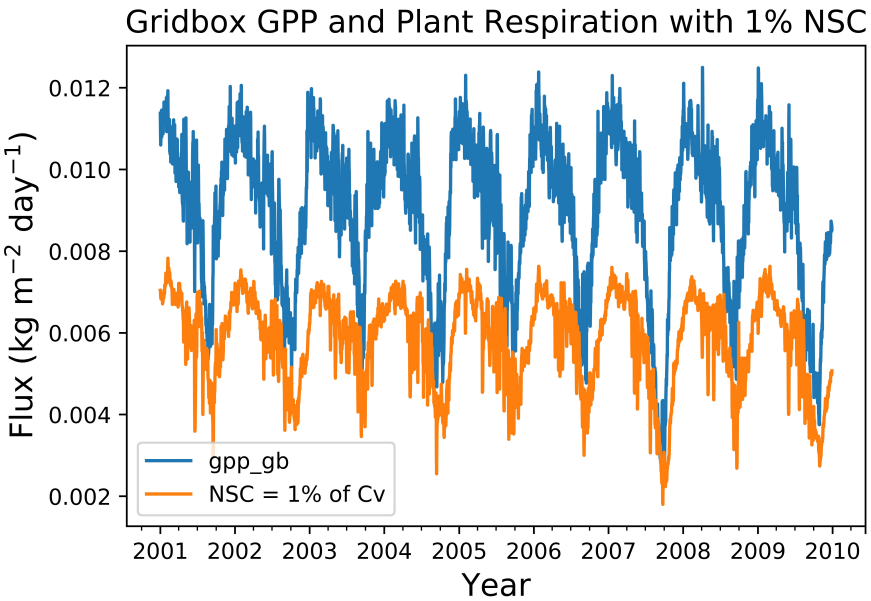
$$\phi \qquad \alpha = \frac{G_0}{\phi}$$

Post Processing JULES output

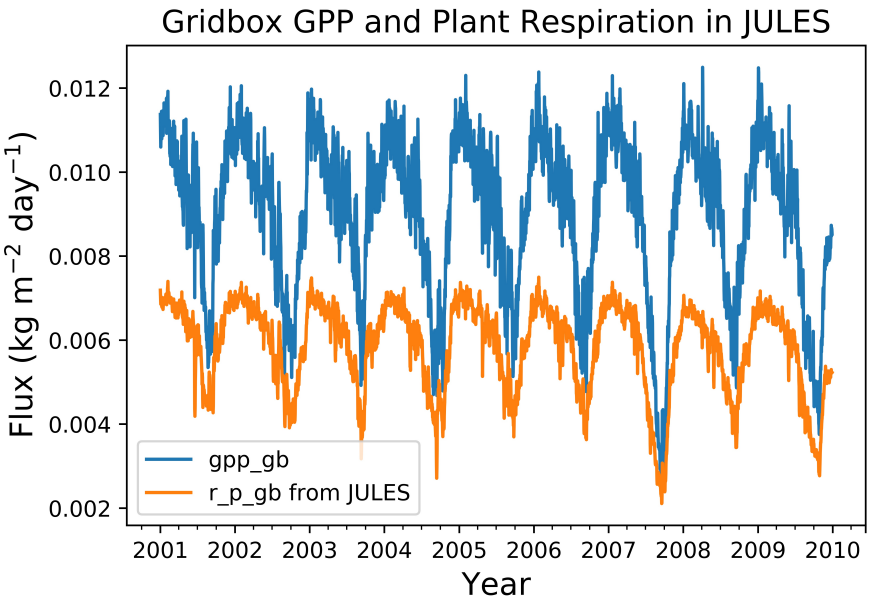


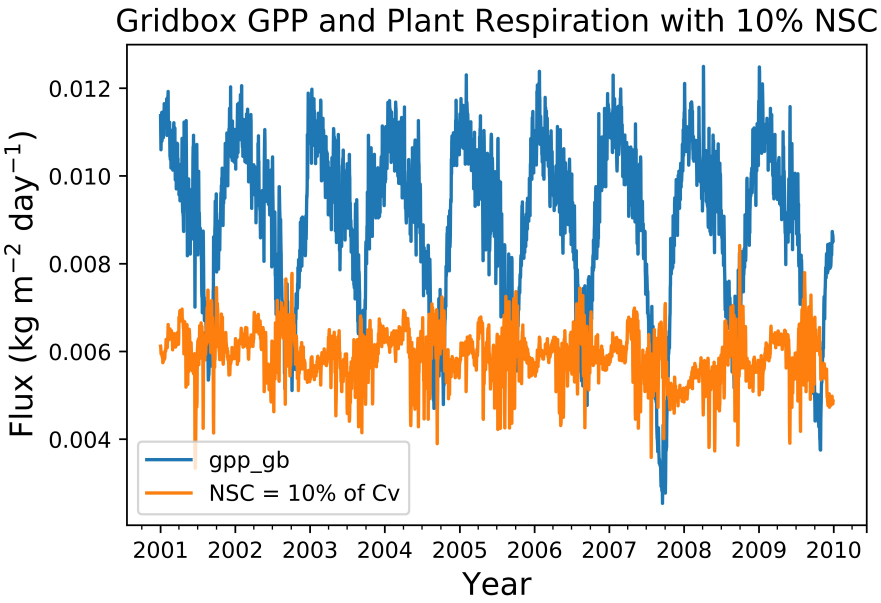
Post Processing JULES output

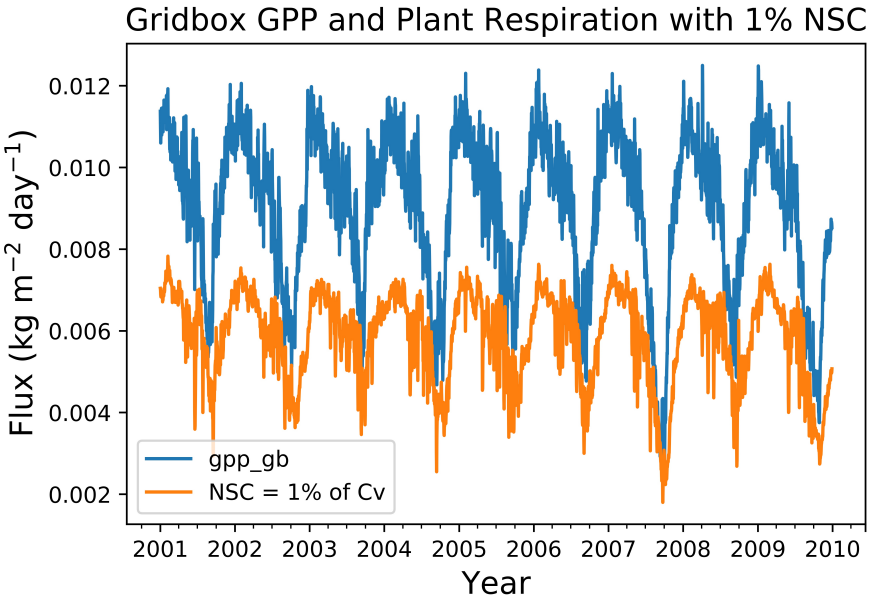




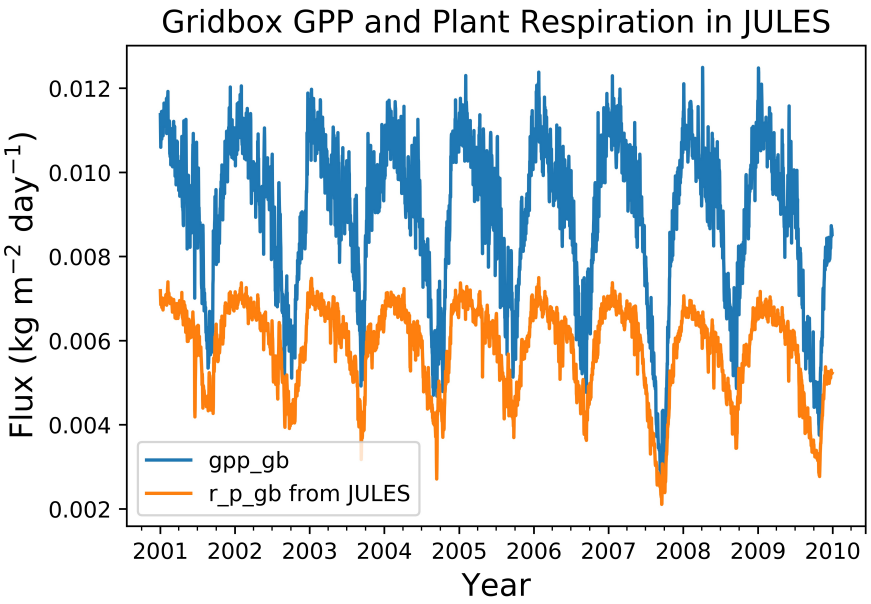
Post Processing JULES output

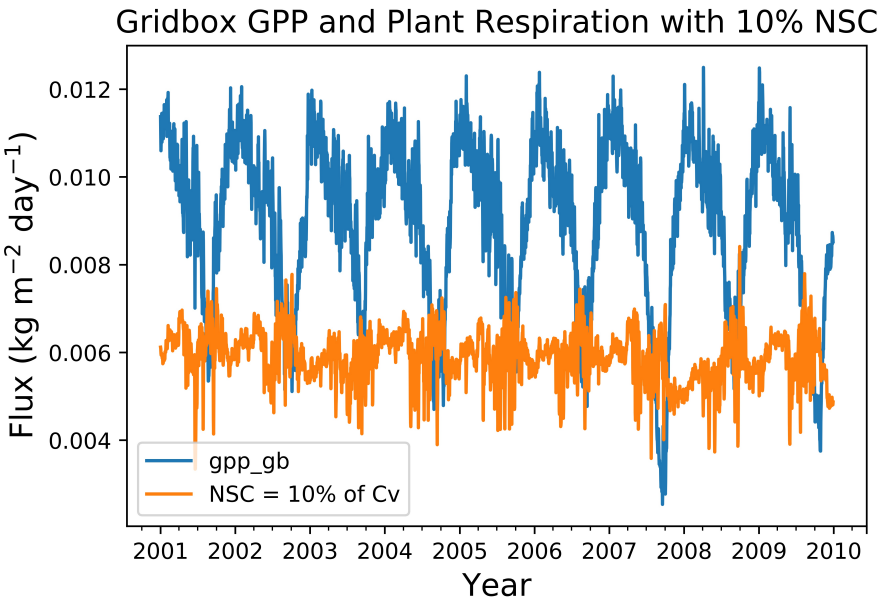


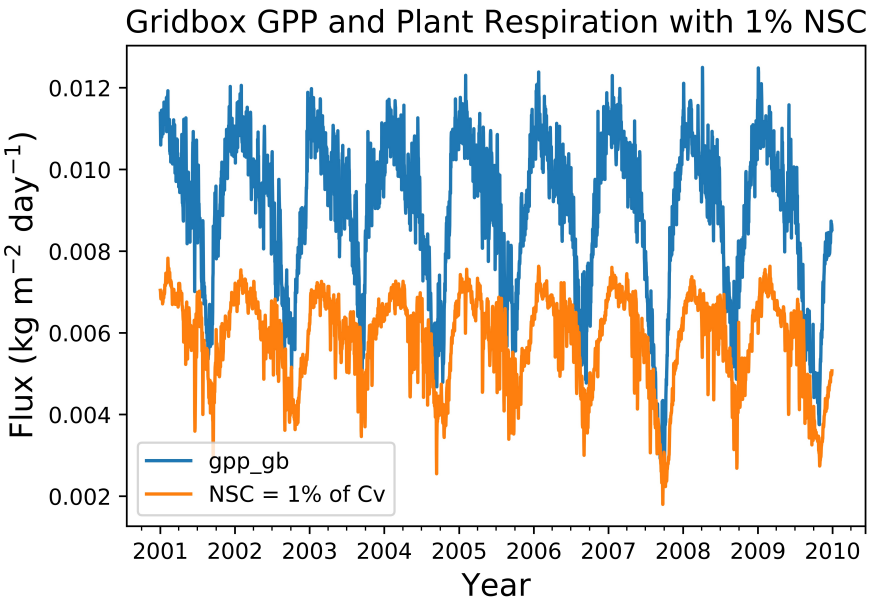


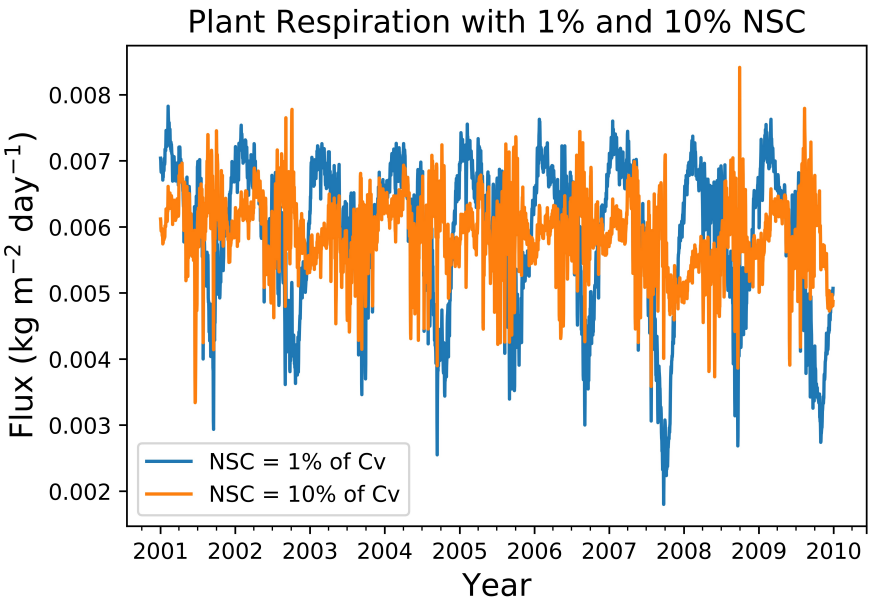


Post Processing JULES output



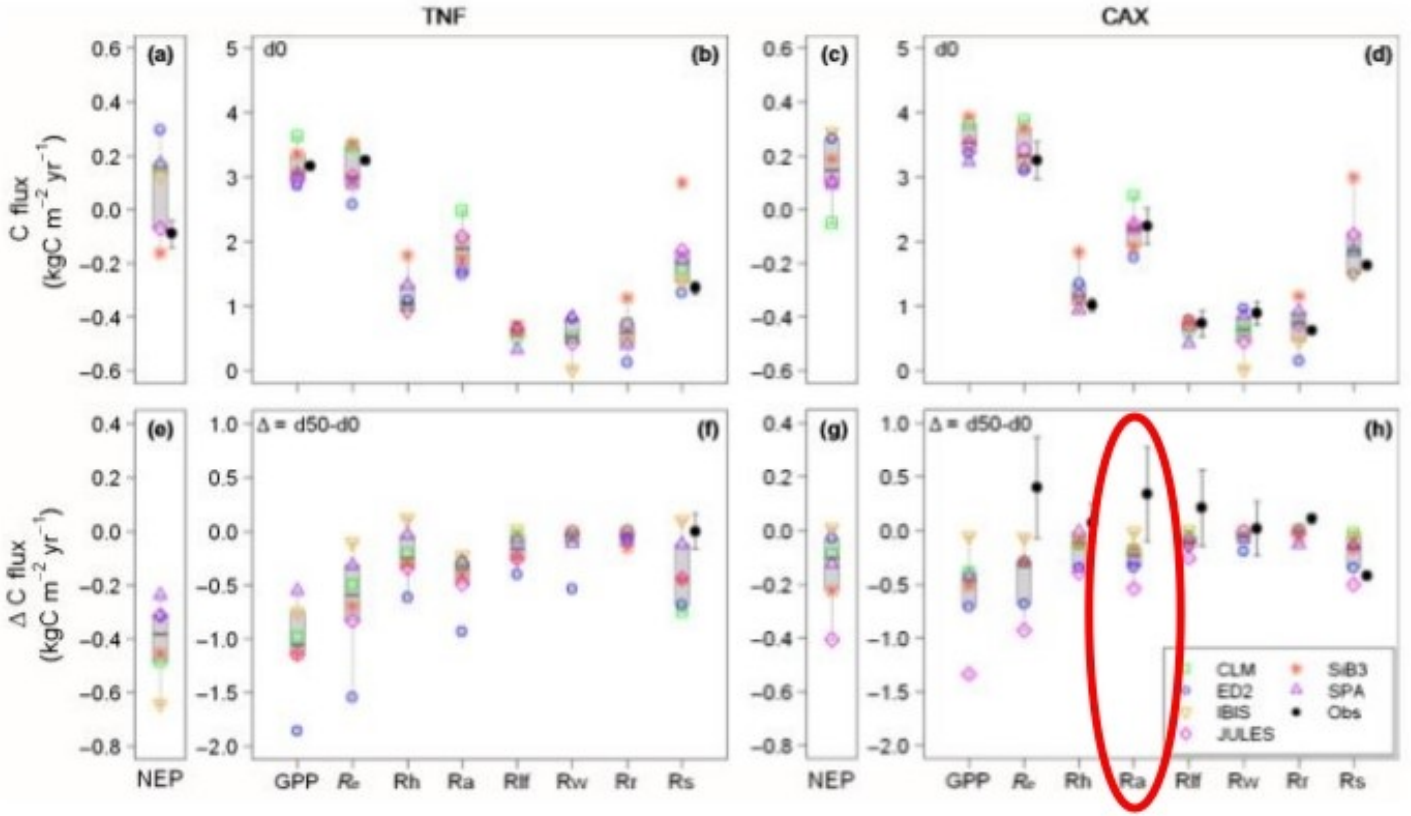






Non-Structural Carbohydrates during drought

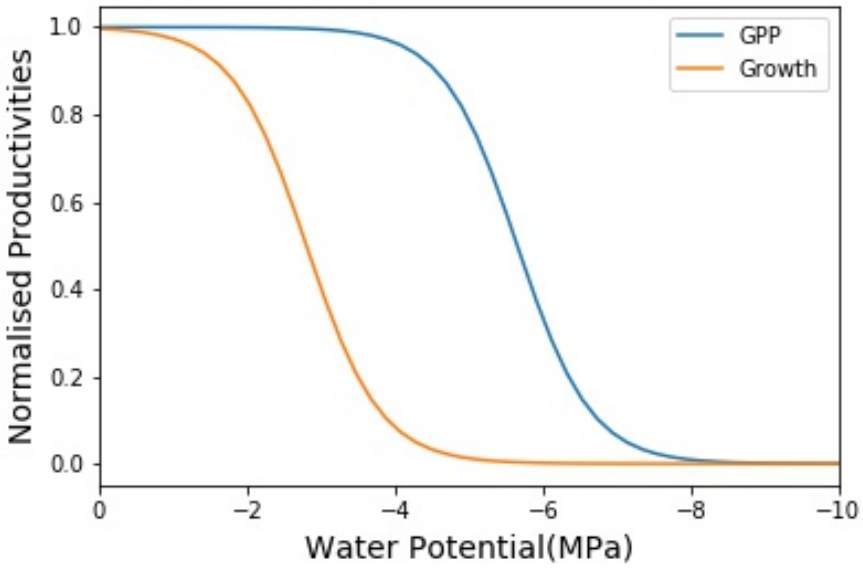
- Autotrophic Respiration fluxes are underestimated during droughts (not only by JULES!)

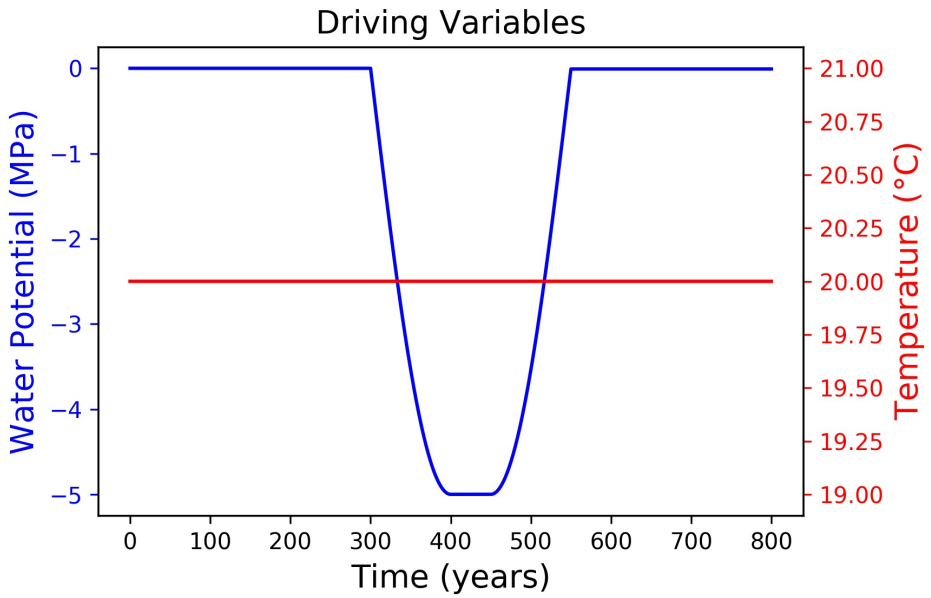


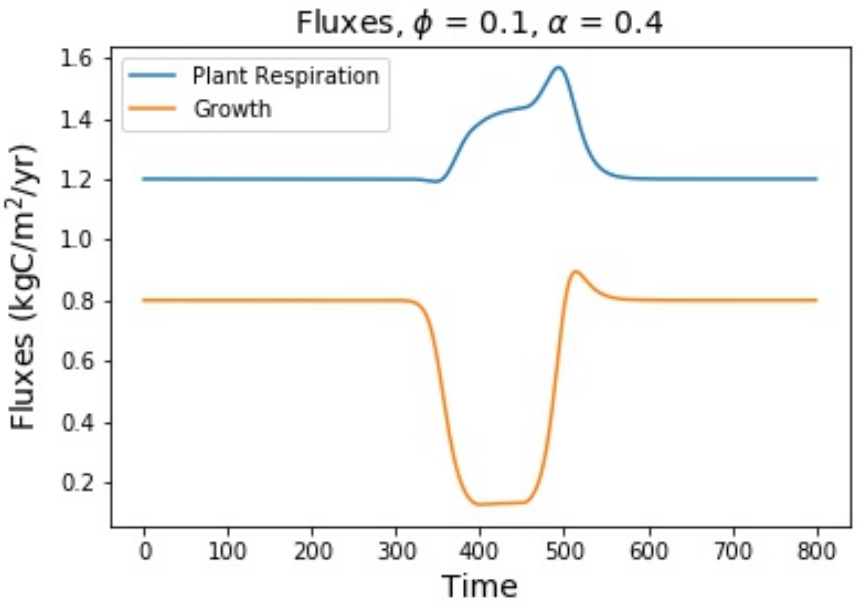
[1]

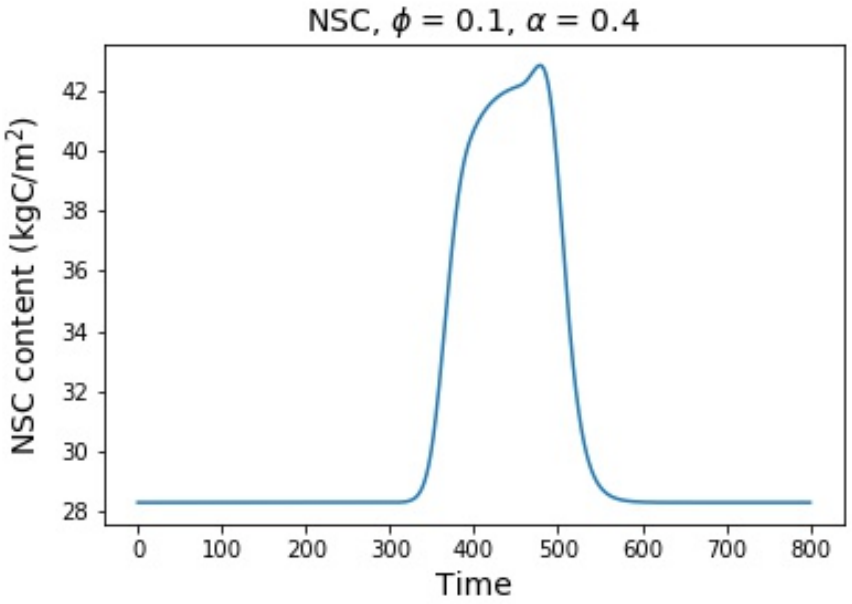
[1] Powell et al 2013 *Confronting model predictions of carbon fluxes with measurements of Amazon forests subjected to experimental drought*

Non-Structural Carbohydrates during drought









Questions?

sj326@exeter.ac.uk

ϕ in two limits

$$\frac{dNSC}{dt} = GPP - \phi Q_{10} NSC$$

$$\phi = R_{m_0} + \frac{G_0}{Y_g}$$

$$NSC^* = \frac{GPP}{\phi \times Q_{10}}$$

$$\phi \approx \frac{\overline{GPP}}{f_{NSC} \times \overline{Q_{10}} \times \overline{C_v}}$$