Progress towards simulating integrated impacts for South Asia

Implementing sequential cropping in JULES

Camilla Mathison
with thanks to Pete Falloon, Andy Challinor and Karina Williams.

September 2018, JULES meeting

Presentation outline

- ▶ Background and motivation
- ▶ Working toward integrated impacts simulations
- ▶ Sequential (multiple) cropping
- ▶ Site simulation
- ▶ Initial results
- ▶ Summary

South Asia

- **Population:** 1.6 billion forecast to rise to more than 2 billion by the 2050s
- **Economy:** Expanding 2015 forecast of 6.1 percent growth.
- **Region:** depends on climate sensitive industries such as agriculture with a high demand for water.
- **Diverse:** ranges from glacierized, mountainous regions to lowland deltas and dry arid regions to areas with some of the highest rainfall in the world.

Integrated impacts for South Asia

- **Climate change:**
  - South Asia has already experienced an increase in annual mean temperatures and this is likely to continue into the future (IPCC AR5).
  - Some crops in this region are already at their limit in terms of temperature any further increase could severely impact food production.

- **Irrigation:**
  South Asia is home to some of the largest irrigation systems in the world

- Really important for models to be able to simulate glaciers, rivers, irrigation and crops and be able to link all these things together. These are needed for understanding future climate impacts.
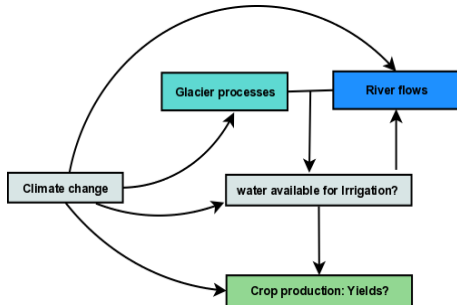
Integrated impacts using JULES: Progress so far?

▶ **Glaciers:**
  S. Shannon et al, 2018 in review Cryosphere discussions (Sarah Shannon's talk - this pm).

▶ **Rivers:**
  Link rivers and irrigation using TRIP river-routing.

▶ **Irrigation:**
  Both unlimited/limited by availability.

▶ **Crops:**
  Available and functional BUT don't assume it will work out of the box!

Photo of Langtang glacier in Nepal. Source: ICI-MOD/Samjwal Bajracharya

Photo of Indus from Karakoram highway. Source: World of ancient arts webpage

Photo irrigation in Northern India.Source: http://www.devalt.or

Photo wheat fields Source: all-free-download.com

Sequential cropping

- ▶ The practise of growing two or more crops on the same field in a given year.
- ▶ Important feature of many tropical regions.
- ▶ Allows the most efficient use of limited resources and has an important influence on ground cover, soil erosion and chemical properties, albedo and pest infestation.
- ▶ Important to include this as it influences the present day demand for resources and is therefore important for understanding future climate impacts and potential changes in resources.

The Approach:

- To implement a method for simulating sequential cropping in JULES.
  - Code for running with sequential cropping is in a branch of JULES
  - Code for ensuring irrigation is only on irrigated tiles is also in this branch.
  - Ticket 871 opened but not quite ready for code review!
- Test the method at a well observed and understood site that grows crops in rotation over a number of years.
  - Initial results show this works.
- Use the method to run a simulation for a small region in India known to use this cropping system.
 - Watch this space!

Process followed by JULES
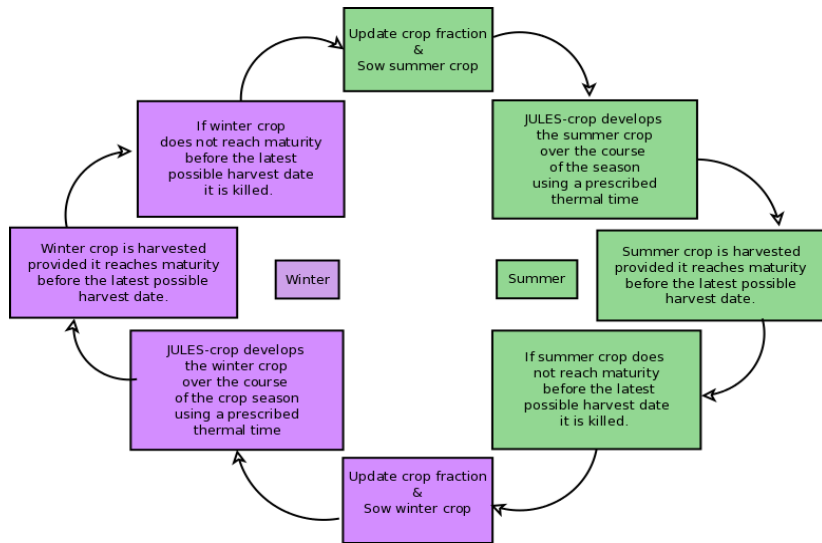
Site Simulation

- The Avignon "remote sensing and flux site" of the National Institute Agronomic Research (INRA) (*HESS*: Garrigues et al, 2015).
- Use in JULES to simulate the wheat-sorghum rotation between December 2005 and June 2012.
- We use the LAI to check the growing seasons for each crop.

LAI Timeseries: using site sowing and harvest dates

- ▶ Sorghum: too low in 2009 and too high in 2011.
- ▶ Wheat: too high in 2008.
- ▶ Small peaks are regrowth which sometimes occurred between crops
- ▶ Over all: Not too bad considering the crops are sorghum and winter wheat.

Avignon: Modelled and observed leaf area index (LAI)
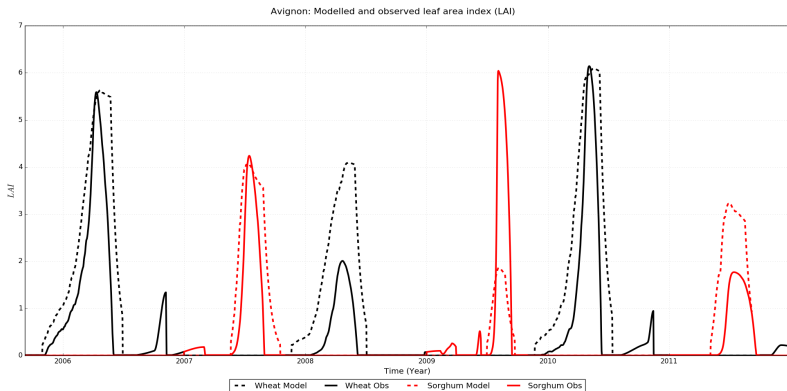
LAI Timeseries: using climatological sowing and harvest dates

- ▶ Sorghum: A much improved 2009 simulation!
- ▶ Wheat: Very similar LAI for actual sowing and harvest dates.
- ▶ Again: over all not too bad.

Avignon: Modelled and observed leaf area index (LAI)
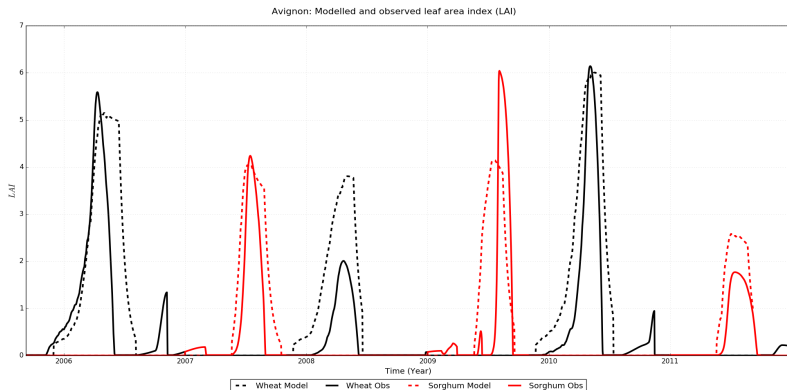
Summary and next steps

- **We have shown sequential (double) cropping implemented for a crop site in Avignon runs in JULES:** Demonstrates that JULES can now do sequential cropping although the representation of individual crops could be improved.
- **Technically speaking there is a working regional JULES rose suite:**
    - It runs for a region of India using the rice-wheat cropping system
    - Need to check this is working properly,
    - Need to update rice and wheat parameters
- **A paper... in preparation**