Incorporating crop growth modelling into JULES

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• The basis for our crop modelling: GLAM

• Incorporating crop growth & development into MOSES2

• Coupled crop – climate variability in HadAM3

• Future challenges for crops in JULES
Crop growth modelling in MOSES

**INPUT**
MOSES parameters, t

- Soil Moisture Availability
- Temperature
- Transpiration
- Specific Humidity
- Surface Pressure
- Temperature

**OUTPUT**
MOSES parameters, t + dt

- height
- LAI
- height
- roughness length
- LAI
- albedo
- evaporation
- canopy capacity
- final yield
- root depth
- soil water
- runoff

\[ \text{water stress factor} \]
\[ \frac{dLAI}{dt} \]
\[ \text{LAI} \]
\[ \text{height} \]
\[ \text{Growth Stage} \]
\[ \text{Thermal Time} \]
\[ \text{Harvest Index} \]
\[ \text{Biomass} \]
\[ \text{VPD} \]
\[ \frac{d(\text{extraction front})}{dt} \]

\( \bigcirc \): parameter accumulates within GLAM

1: height is derived from LAI at each timestep
Schematic of crop growth in JULES

- emerge to flowering
- flowering to pod-filling
- pod-filling to max LAI
- max LAI to maturity

Graphs show:
- Biomass
- Height
- LAI
- HI
- $d_r$

(time)
Sowing date based on soil moisture.

Emergence determined by thermal time accumulation.

In optimum environments, 10 day break post-harvest.

In sub-optimum environments longer restrictions on sowing date.
2 climate simulations
GROW: with growing crop
FIX: without growing crop (same annual cycle of LAI each year)

GROW simulation reproduces observed relationship between rainfall and yield for India
$r_{\text{obs}}=0.62$, $r_{\text{model}}=0.49$
Growing crops increase climate variability during the early part of the growing season.
Soil moisture composite

Response of LAI to SM anomaly amplifies response of surface climate which is maintained for longer.
Interactive crops enable a feedback of soil moisture on climate.
Other crops: wheat (spring and winter), maize, soyabean, grasslands

Integration into carbon (and nitrogen) cycling within JULES.

Multiple crop tiles in JULES/MOSES

Humans:

Management: sowing, season length (variety choice), rotations.

Technology: yield gap parameter

Irrigation

Adaptation