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JULES-crop

A generic parametrisation of crops in JULES

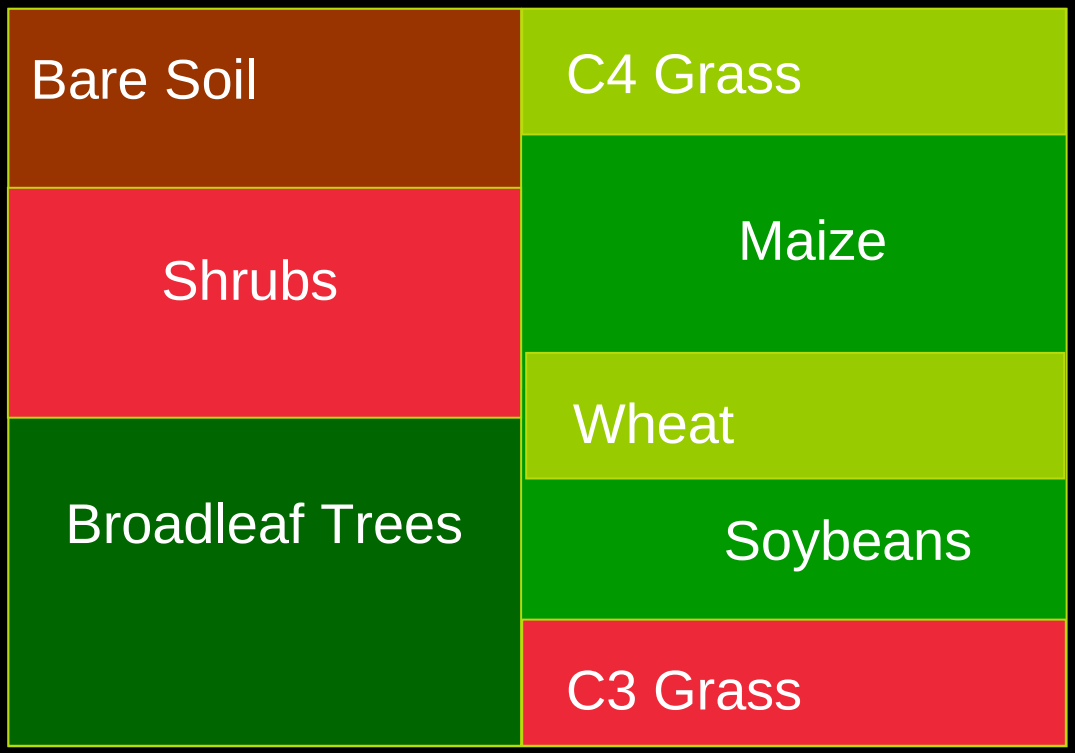
Karina Williams, with Tom Osborne, Josh Hooker, Jemma Gornall, Andy Wiltshire, Richard Betts, Tim Wheeler

Why add a crop model to JULES?

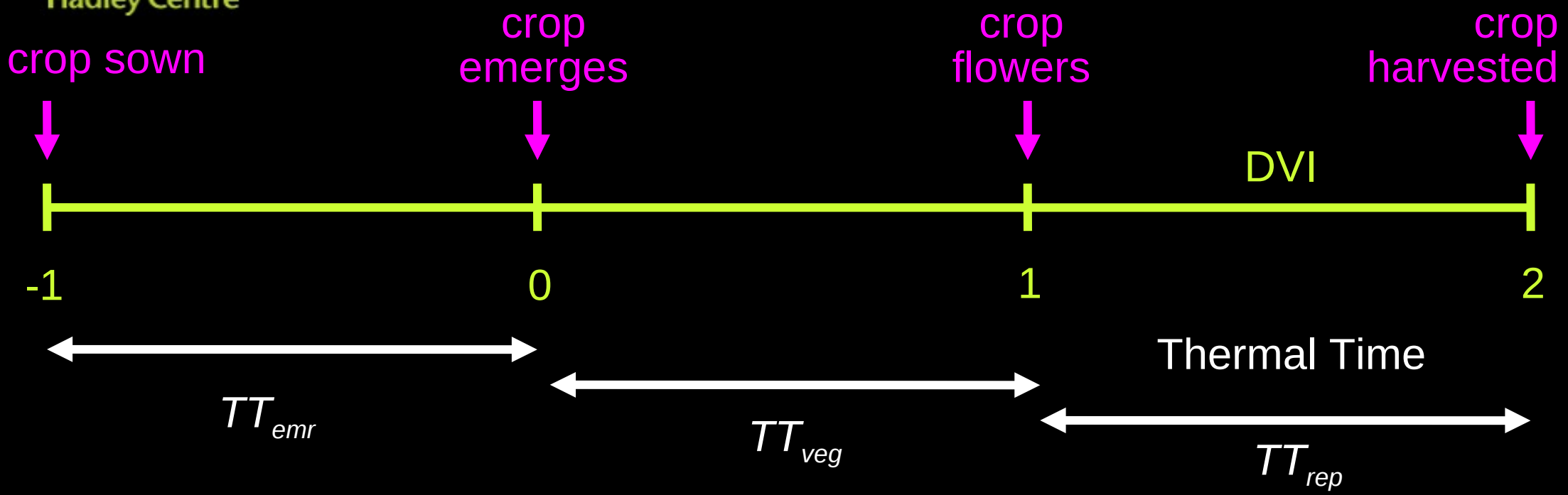
- An important factor in modelling surface properties
- Ability to model crop yield

Crop tiles

- Add each crop type as another tile type



Crop Phenology

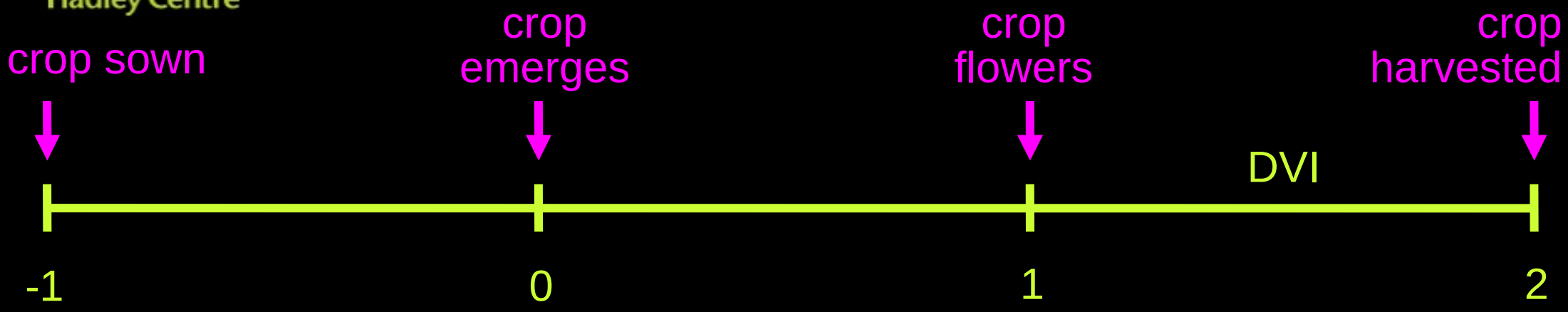


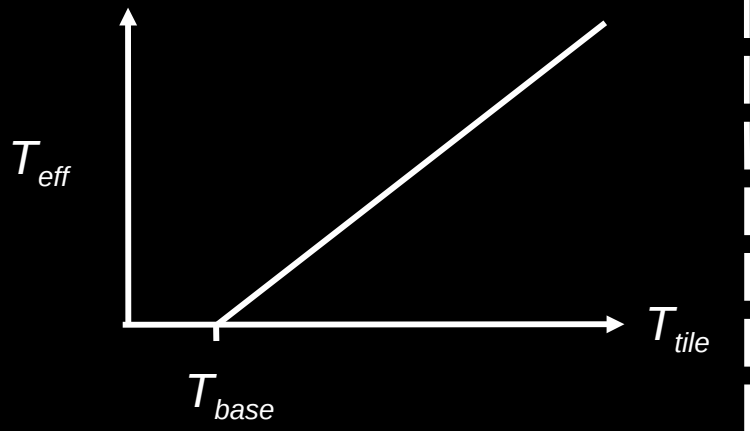
$$TT = \int \rho T_{eff}(t)\,dt$$

T_{eff} = effective temperature

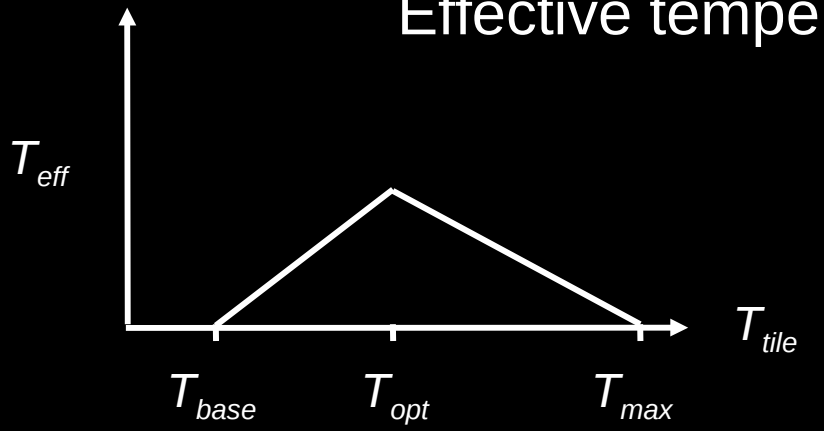
ρ = relative photoperiod effect (veg stage only)

Effective Temperature





Effective temperature T_{eff}

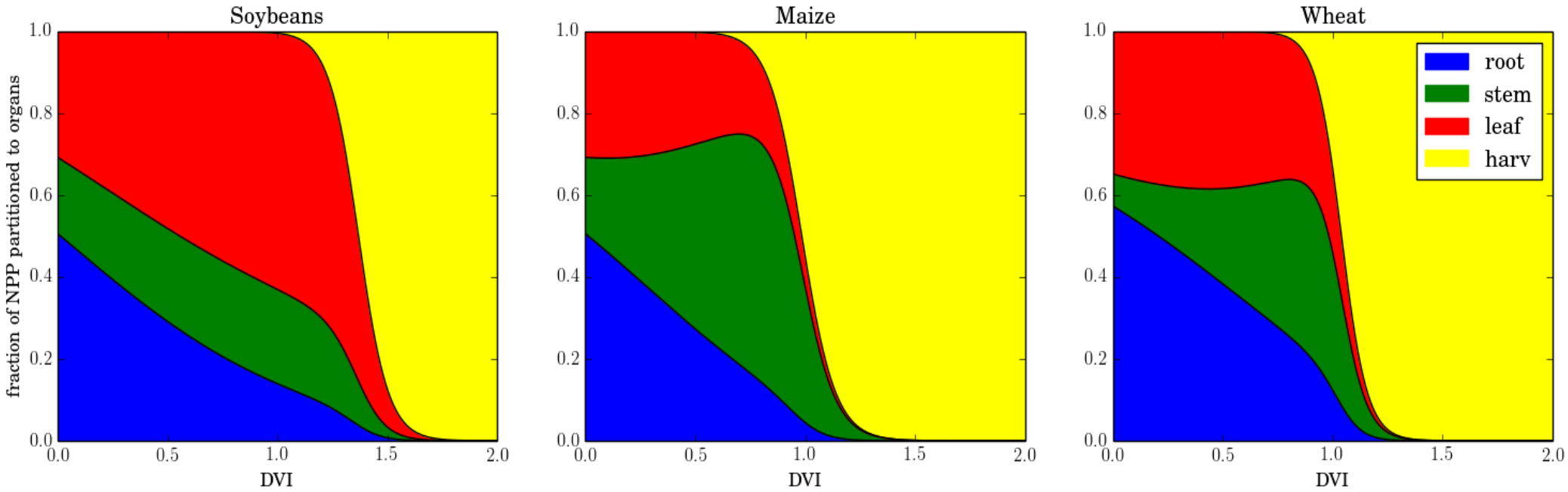


Net Primary Productivity for grass and crops

$$NPP = 0.012(1 - rg)(Ac - Rdc(Croot + Cstem)/Cleaf)$$

r_g = growth respiration constant
A_c = net canopy photosynthesis
R_{dc} = rate of canopy dark respiration

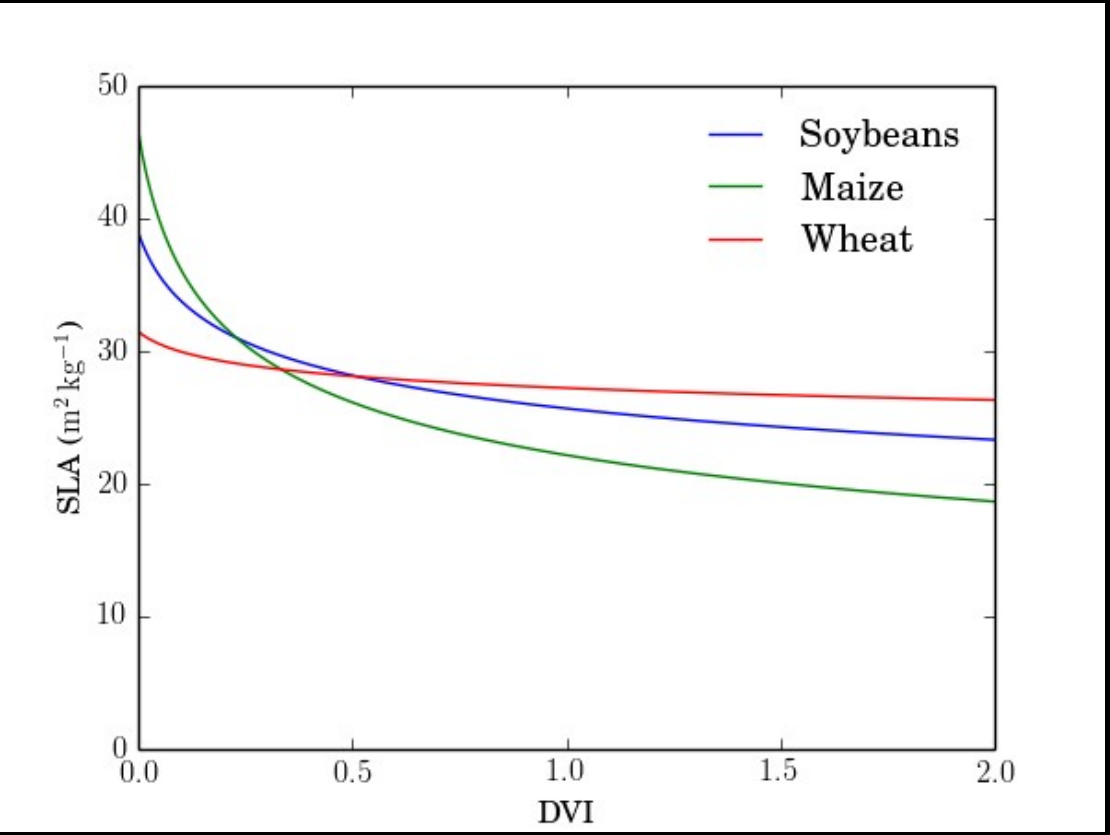
Carbon partitioning



Depends on DVI and crop-specific parameters.

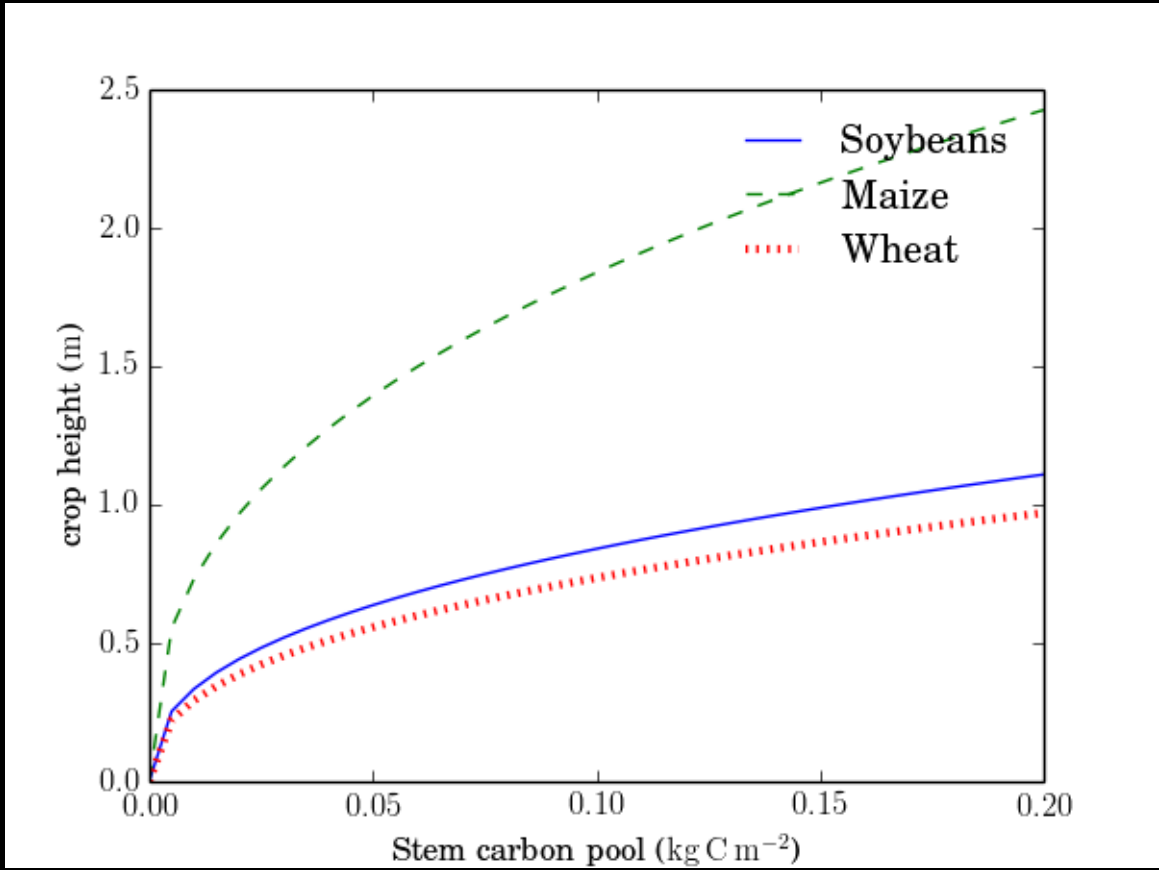
For DVI > 1.5, carbon gradually moved from leaf to harvest pool (leaf senescence)

Leaf Area Index

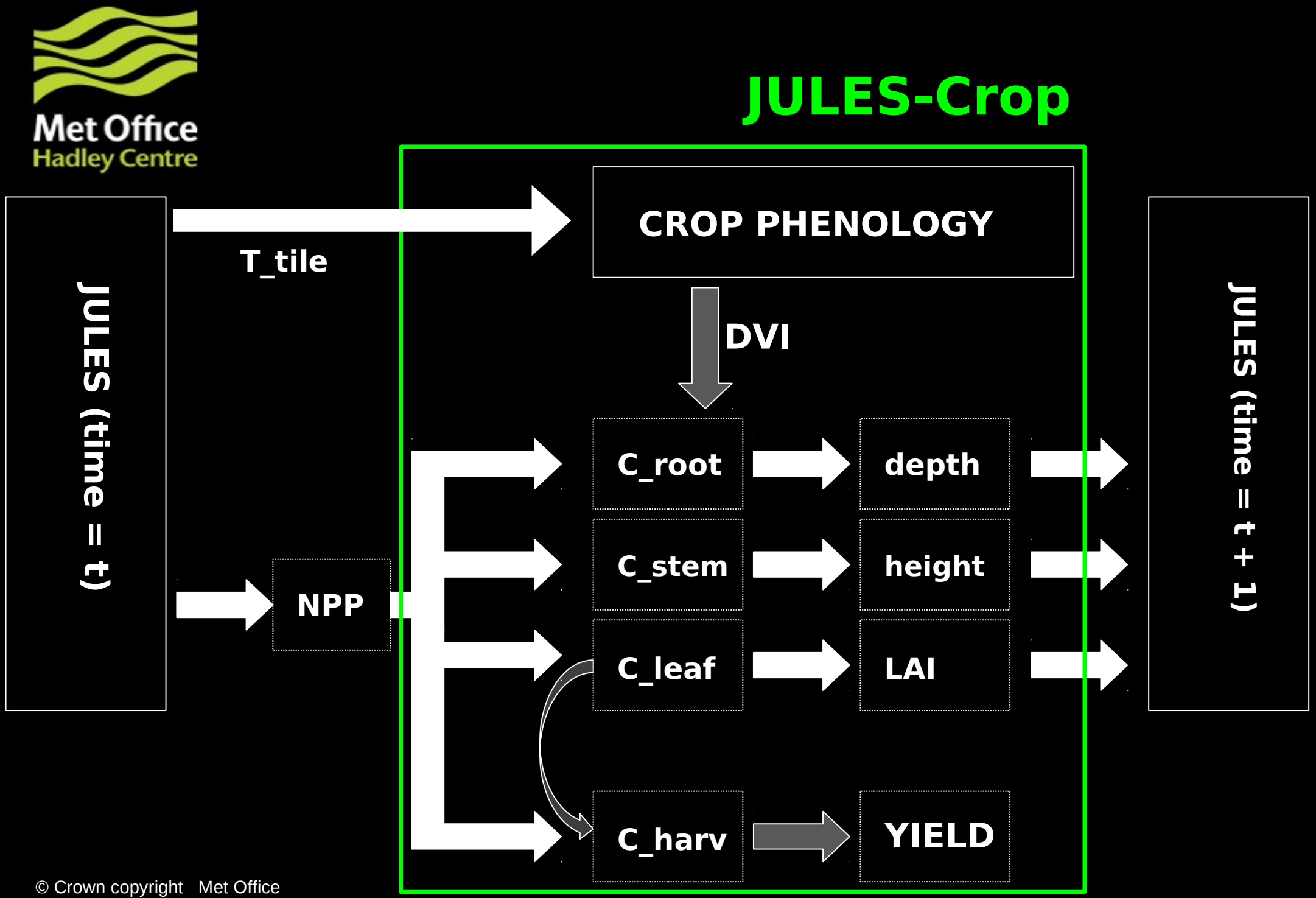


Depends on DVI (via SLA), carbon in leaves and crop-specific parameters.

Crop height



Depends on carbon in stem and crop-specific parameters.



JULES-crop in JULES 4.0

The crop model is switched on by setting a non-zero number of crop pfts (`ncpft`) in `JULES_SURFACE_TYPES`.

A new switch in `JULES_VEGETATION`:

- `l_prescsow`

Two new namelists:

- `JULES_CROPPARM` in crop_params.nml
- `JULES_CROP_PROPS` in ancillaries.nml

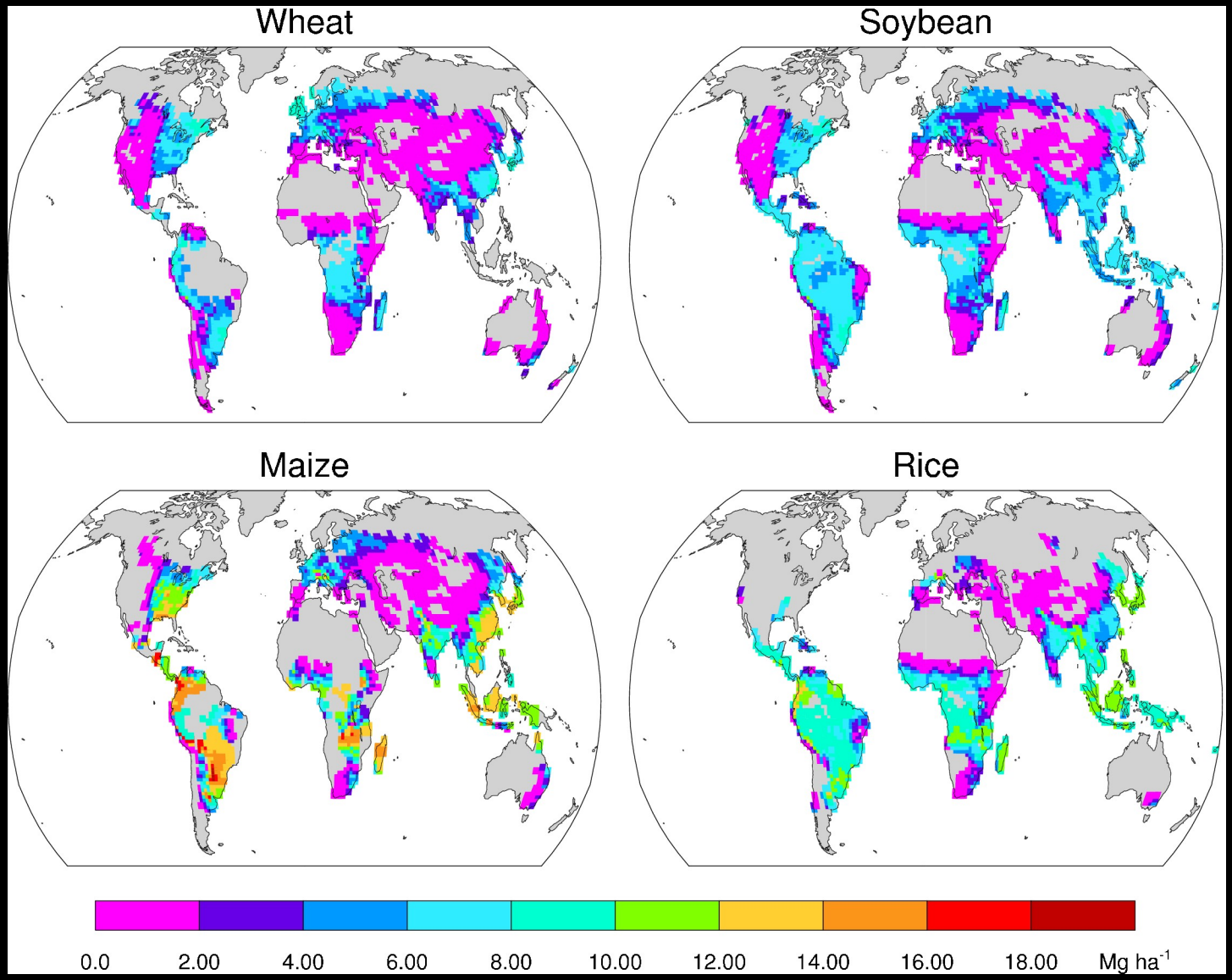
Extra crop-related variables to give at initialisation and available for output.

Preliminary results – global run

- CRU-NCEP forcing, 1960-2010
- Prescribed sowing dates (from Sacks et al 2010)
- Spatially varying TTveg and TTrep calculated from Sacks et al 2010 planting and harvesting dates
- No photoperiod sensitivity.
- Maize, soybean, wheat (spring), rice

Potential yield – global distribution

crop tile fractions from Monfreda et al 2008



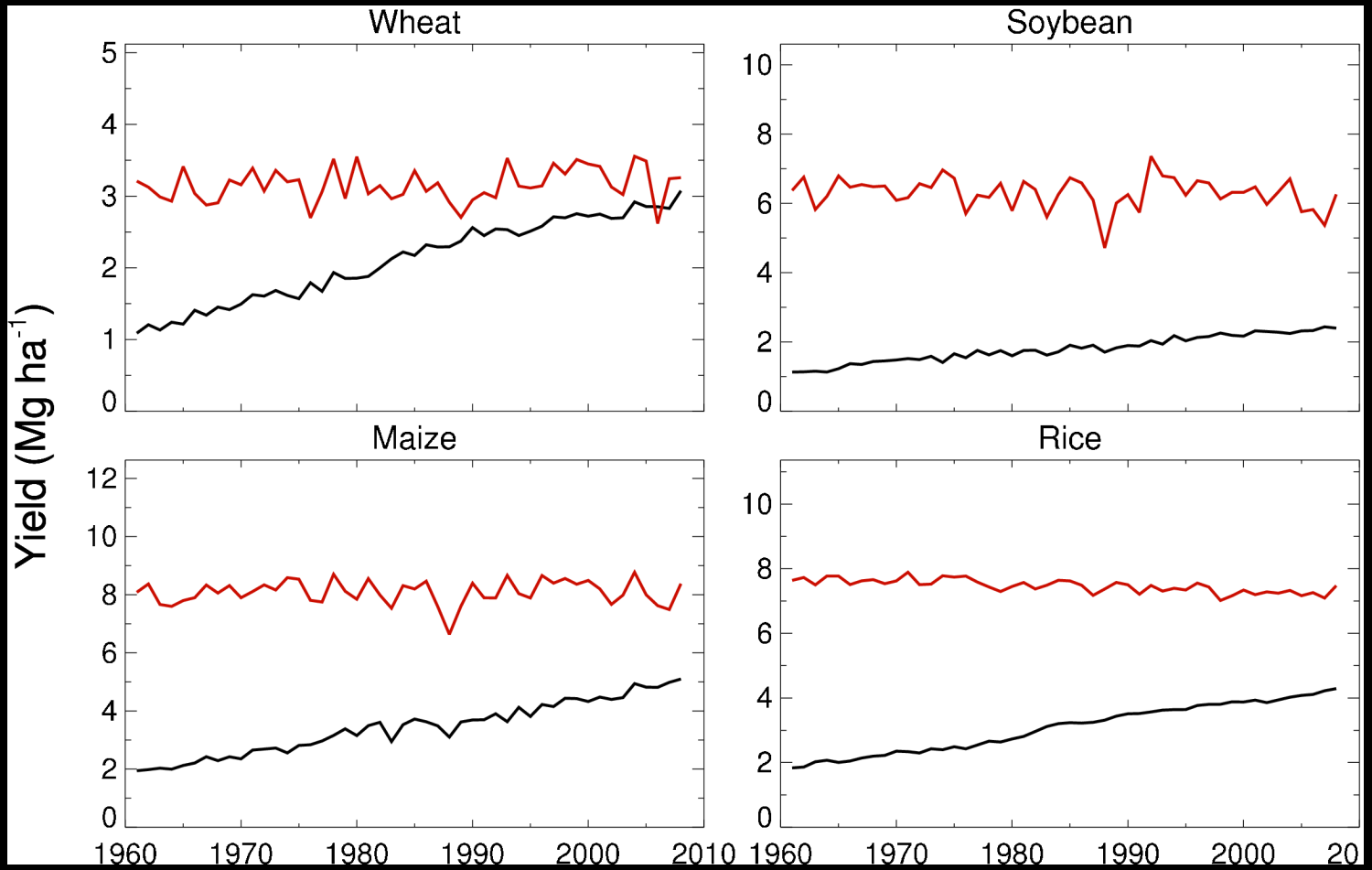
Potential yield – annual variability

Red: modelled yield
Black: FAO obs 2014

Gridboxes where DVI < 1.5 in one or more years are masked out

Correlations between modelled yield and detrended obs:

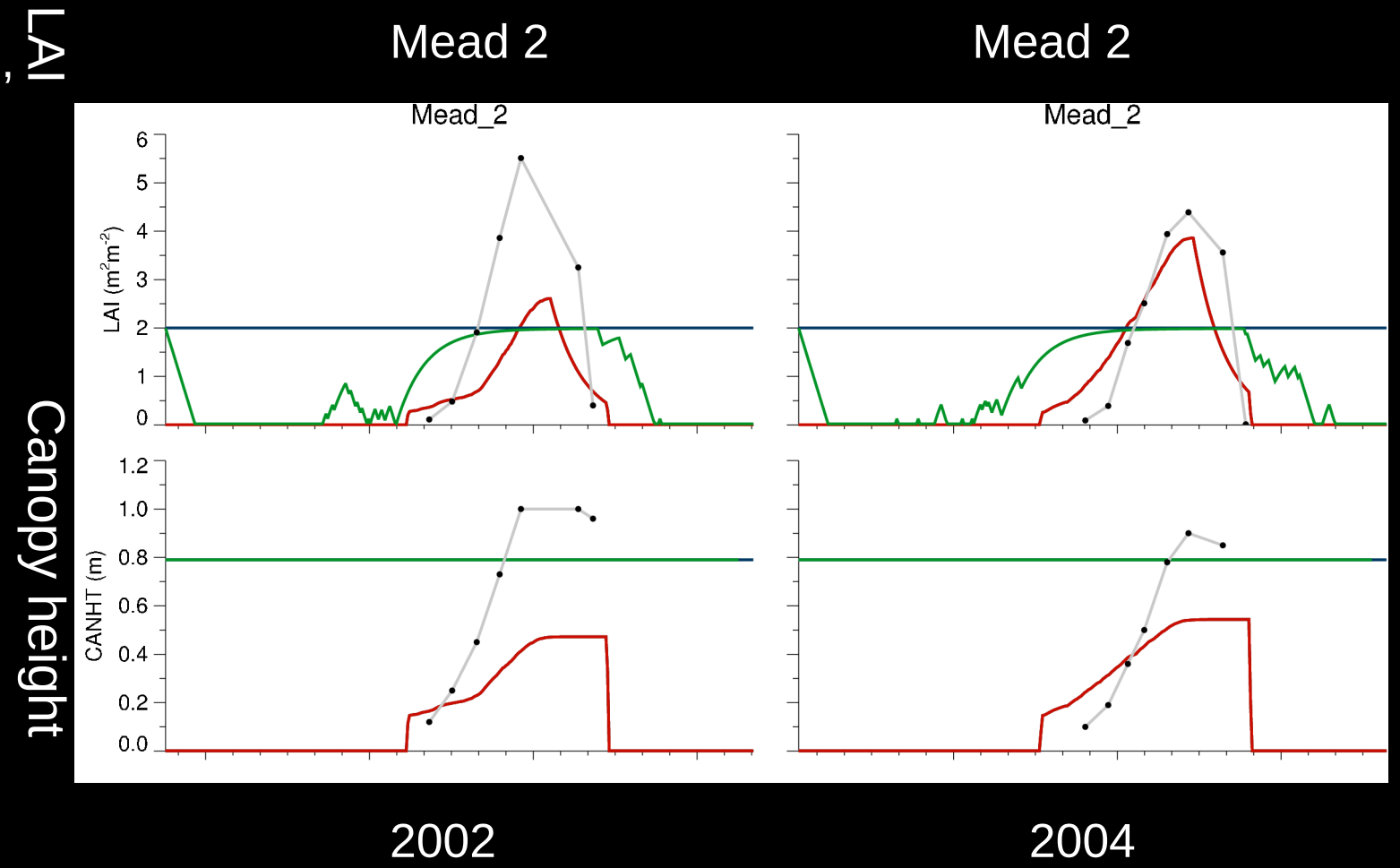
Wheat r=0.02
Soybean r=0.34
Maize r=0.47
Rice r=0.03



Soybean site examples

Mead 2 FLUXNET site, Nebraska

Dotted: obs
Red: JULES-crop
Green: C3 grass, phenol
Blue: C3 grass, no phenol



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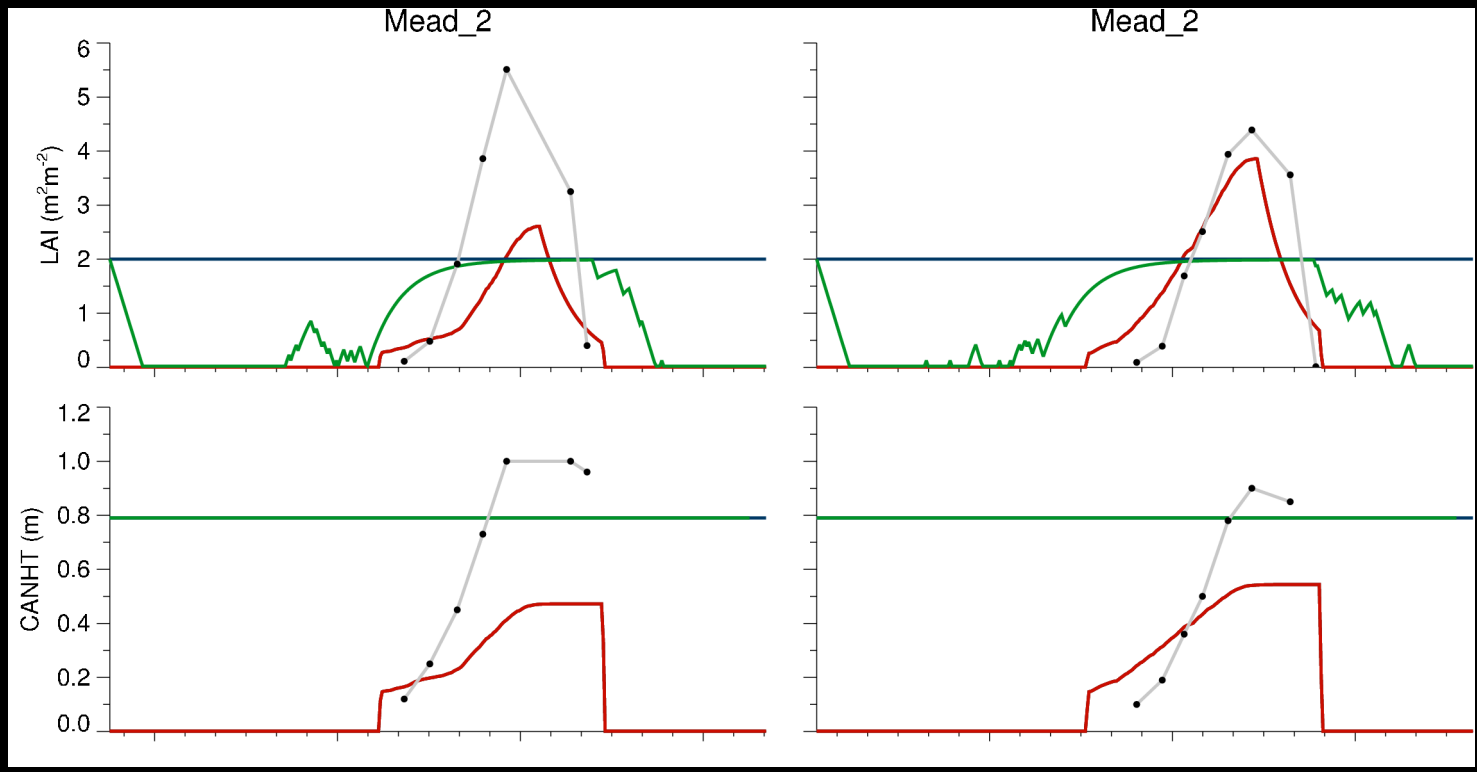
Mead 2 | Mead 2

Latent heat sensible heat



2002 | 2004

Soybean site examples

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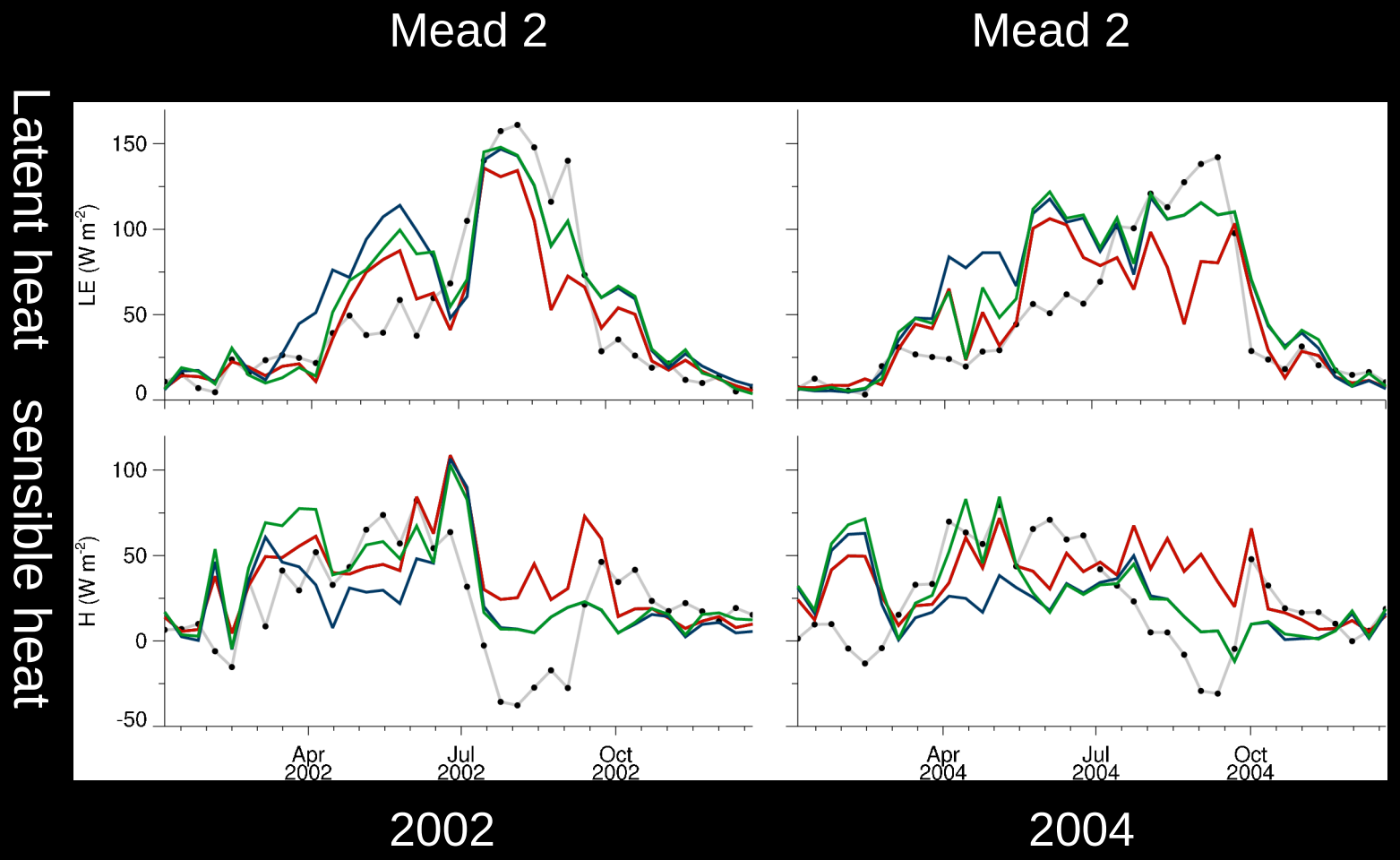


Maize site examples

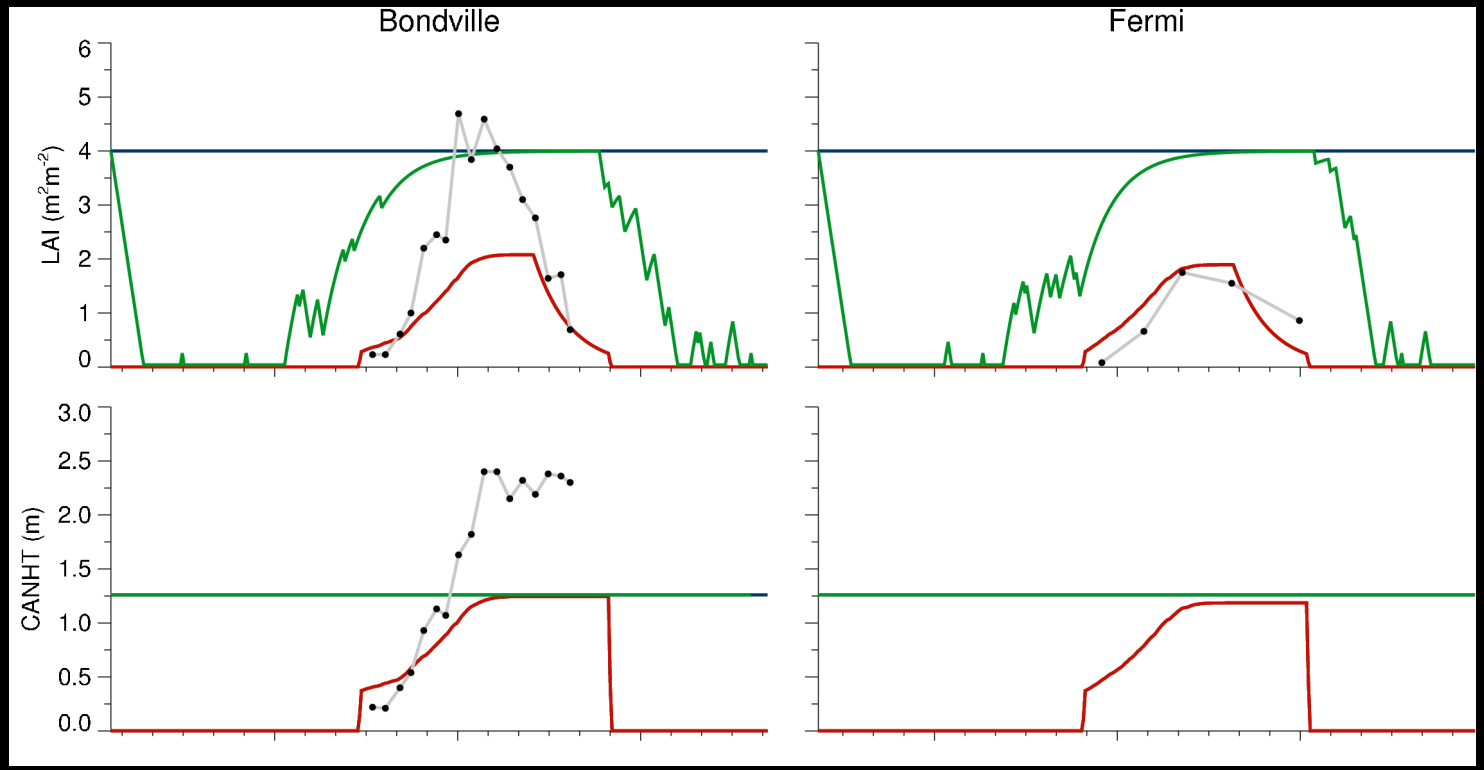
Bondville and Fermi FLUXNET sites, Illinois

Dotted: obs
Red: JULES-crop
Green: C4 grass, phenol
Blue: C4 grass, no phenol

LAI

Bondville

Fermi



Canopy height

2001

2006

Maize site examples

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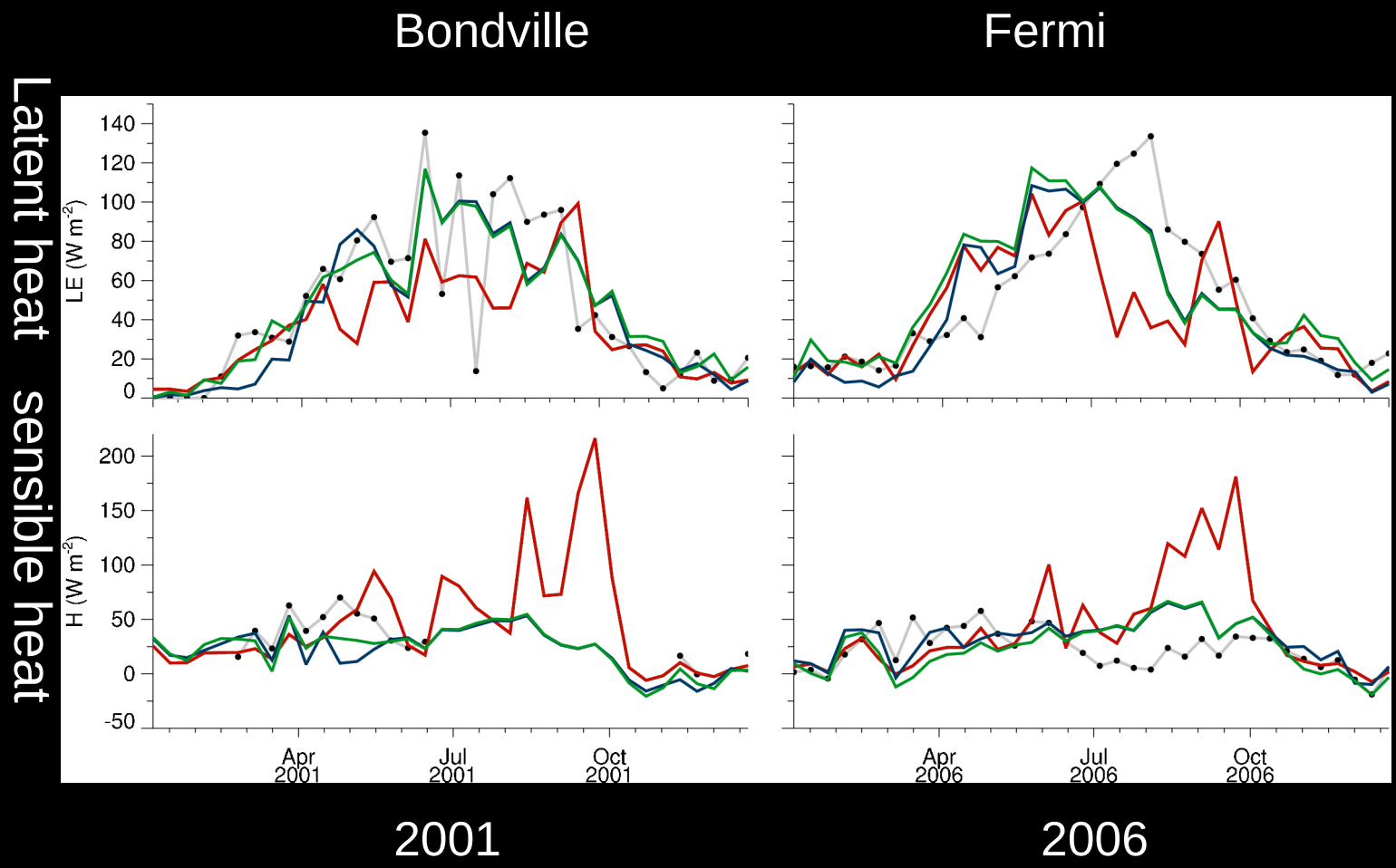

Summary

- JULES-crop is a generic parametrisation of crops available in JULES 4.0.
- Preliminary results from a reanalysis-driven global JULES-crop run, with 4 crop pfts (maize, soybean, spring wheat and rice) show some skill in capturing the variability of maize and soybean yield but do not yet show an improvement in surface fluxes.

Further work

- Tuning to specific crop varieties to improve modelling of interannual variability in yield in particular regions
- Improve ability of model to simulate fluxes e.g. by improving the representation of field conditions outside the growing season

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Questions