# Plans for irrigation development in JULES based on future requirements

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Joint Annual R&D Workshop and 6th Momentum®UK Partnership Convective Scale Workshop

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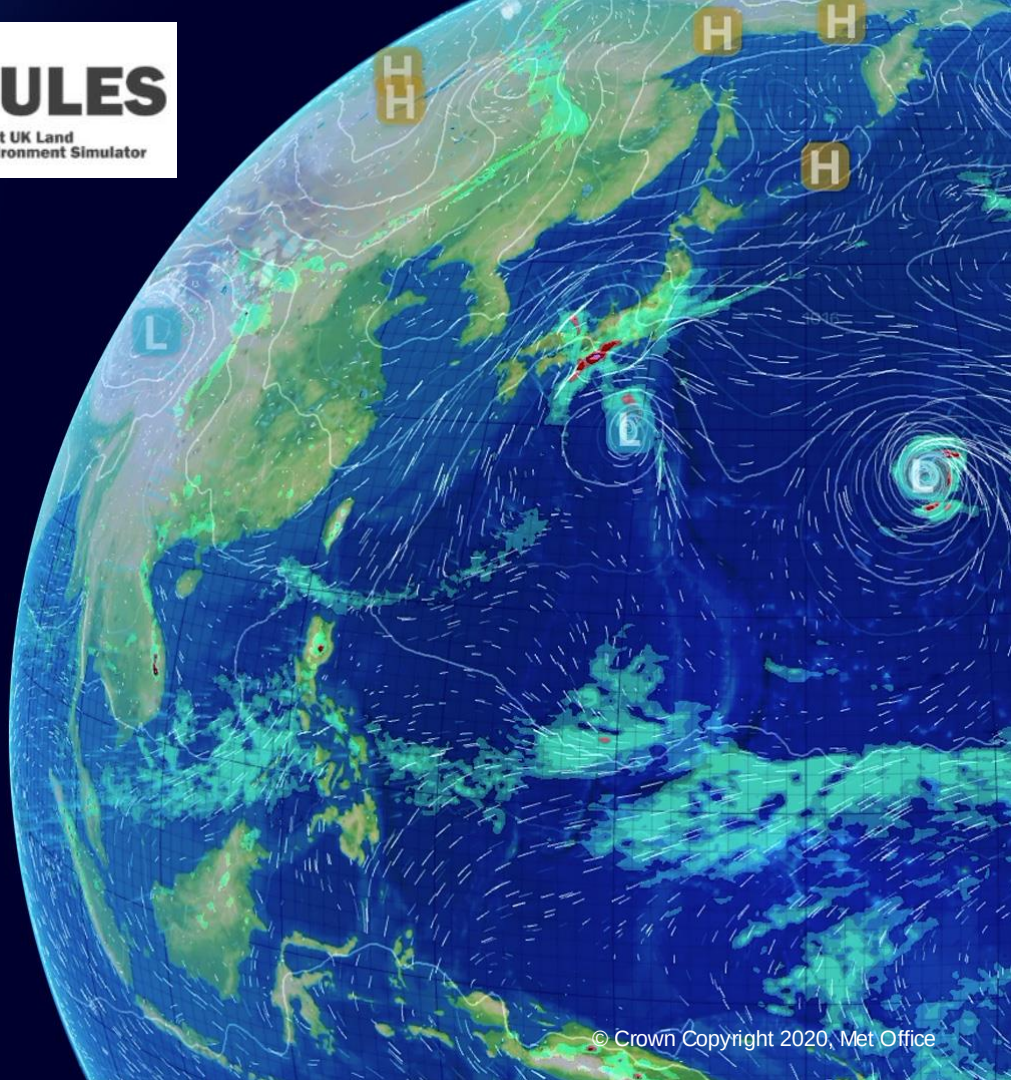
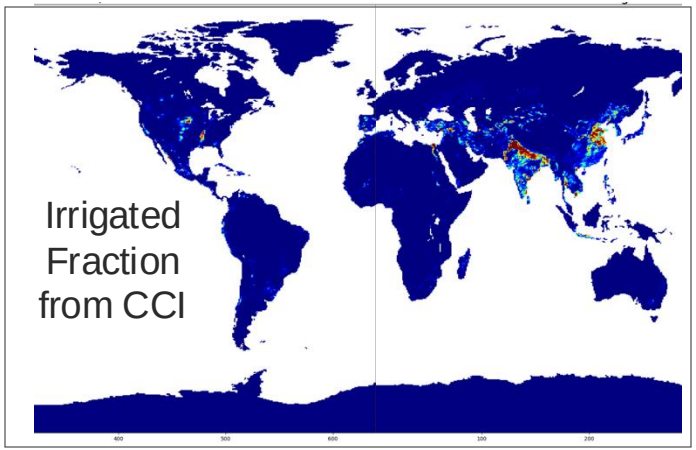
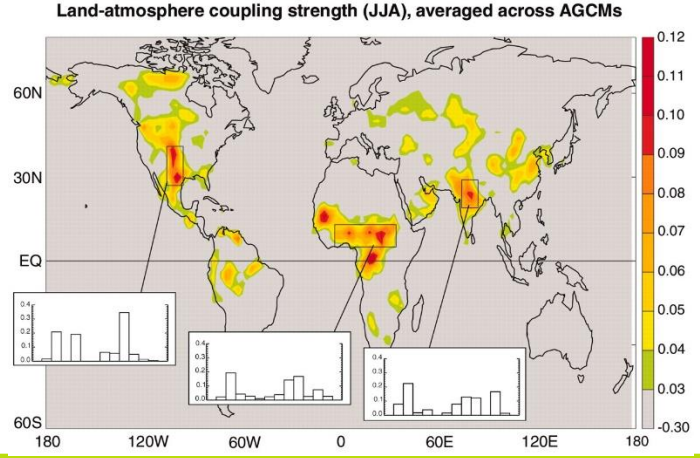


# Global irrigation context

- Application of water to the land with the aim to maintain plant productivity
- Over 324 million hectares of land are equipped for irrigation worldwide. 42% of this is in only two countries: India and China[1].
- These areas of high irrigation also coincide with hotspots in land atmosphere coupling strength[2], which highlights the importance of irrigation for land atmosphere coupling through the sensitivity of the atmosphere to soil moisture.




[1] FAO 2014, http://www.fao.org/nr/water/aquastat/infographics/Irrigation_eng.pdf
[2] Koster et al 2004, https://doi.org/10.1126/science.1100217

# Future Requirements for irrigation modelling

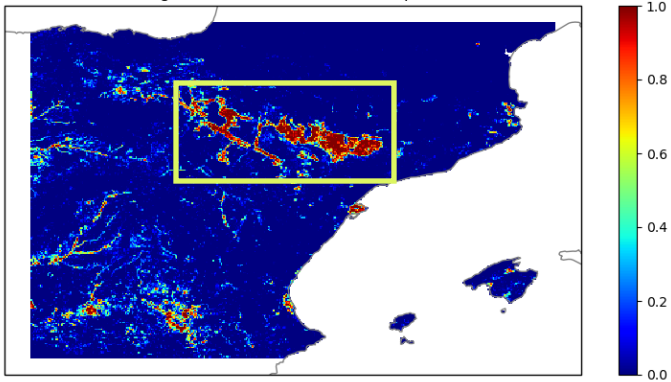
- Capability for partial irrigation of grid boxes which could include an irrigated and non-irrigated soil moisture column for each surface type.
- Irrigate surface tiles rather than fractions of grid boxes.
- Different types of irrigation and different crop based PFT's
- Irrigation seasonality
- Irrigation limitation and water conservation
- Adequate data sources for ancillary information (irrigated types, seasonality etc.)
- Need flexibility to run with/without soil tiling

# Impacts of irrigation in UM Simulations

Aim - Improve our ability to model a heterogenous irrigated land surface and understand the impact of irrigation on the terrestrial water fluxes, surface fluxes and the atmospheric evolution in UM simulations.

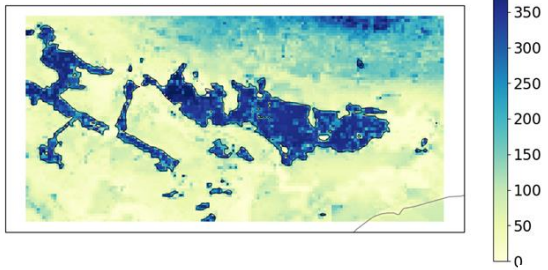
- Tested existing irrigation code using the UM Regional Nesting Suite over a 2.2km domain centred around the LIAISE field campaign area of north-eastern Spain

Irrigated Fraction Ancillary

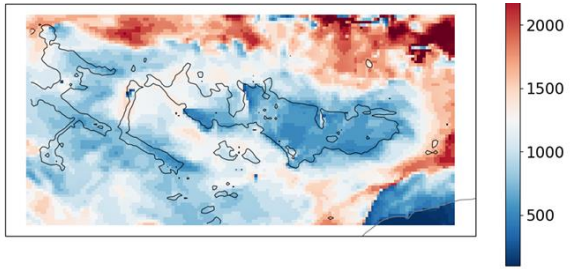



Ancillary derived from ESA Climate Change Initiative (CCI) land cover dataset

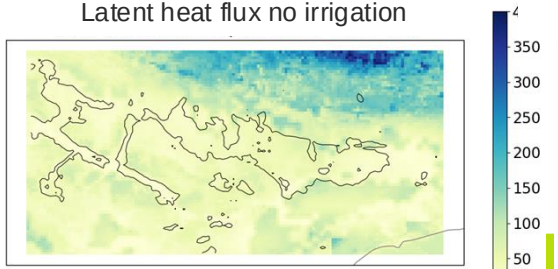
Latent heat flux with irrigation




Boundary layer height (m) with irrigation




Latent heat flux no irrigation

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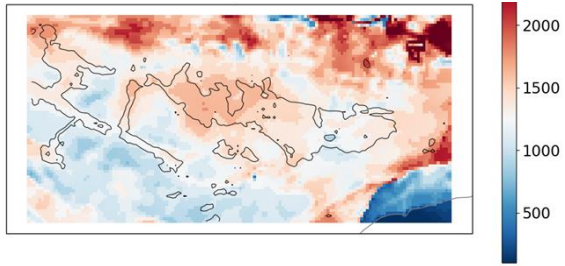
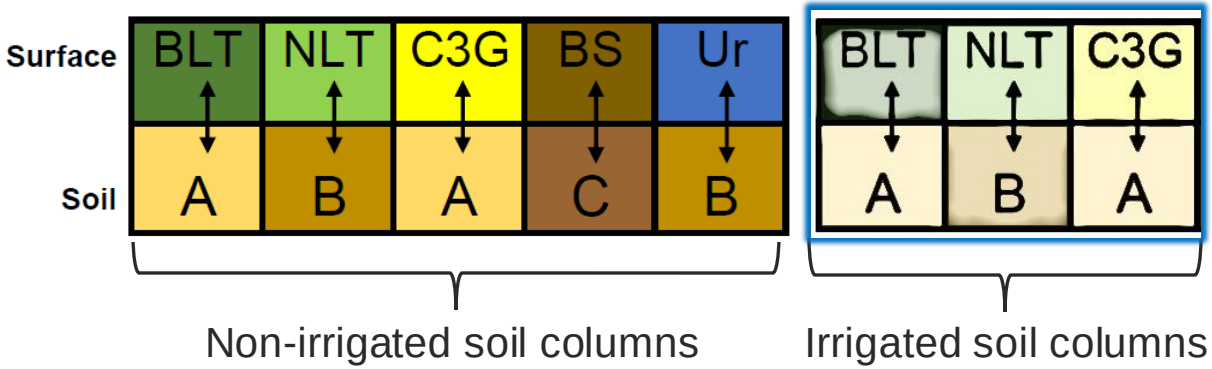


# Does the current scheme fulfil future requirements?

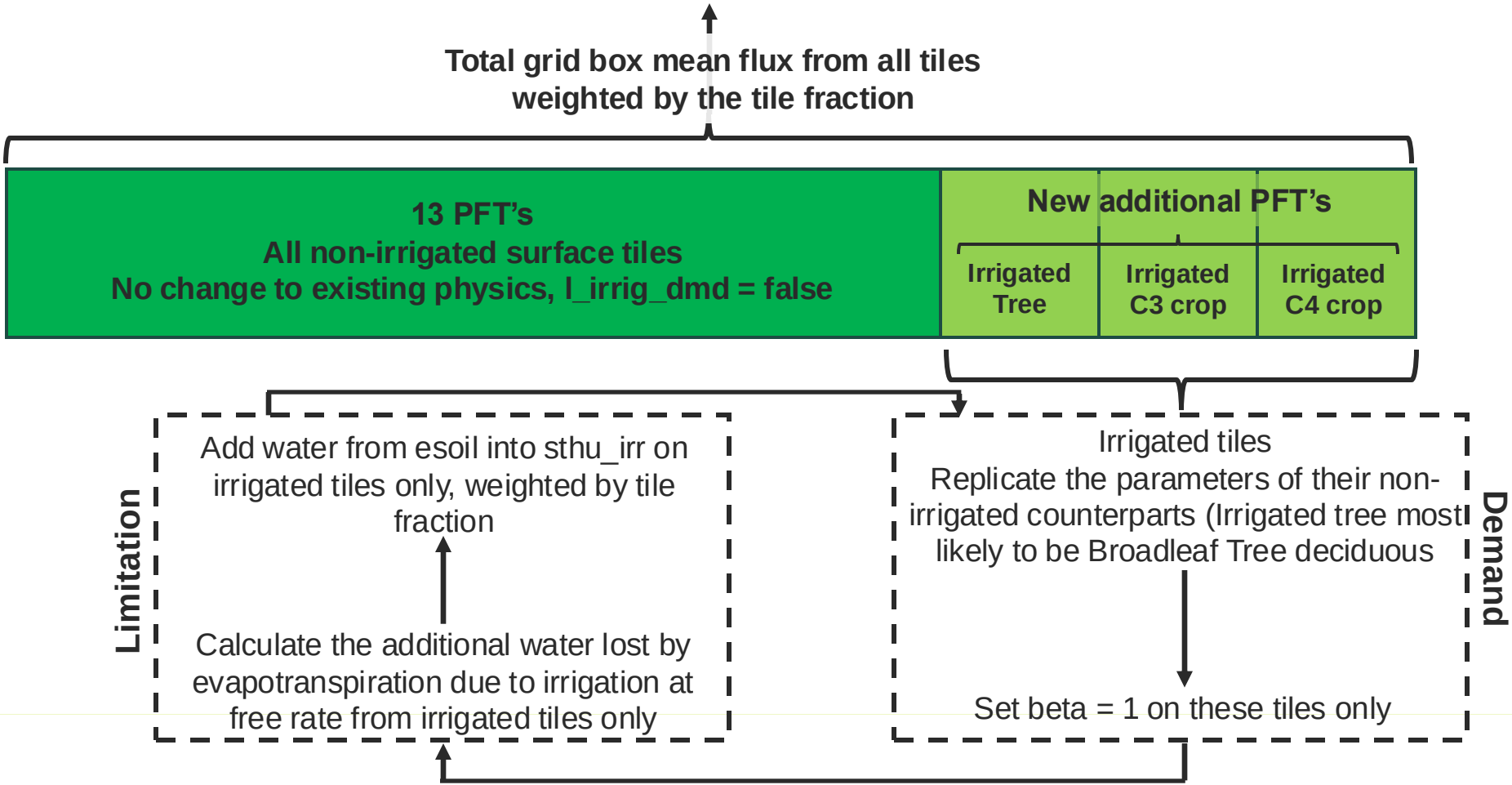
- Current scheme is not flexible
- Can not model irrigated and non-irrigated soil moisture for each surface type separately
- Assumptions made about the distribution of irrigated tiles within a grid box (e.g. preferentially irrigates C3 grass first).
- No distinct irrigation types, uses irrigated grid box fraction
- No irrigation limitation or water conservation
- No interfaces with existing water resources code or human influences (e.g. licensing of water, abstraction and dam controls)

# Soil Tiling



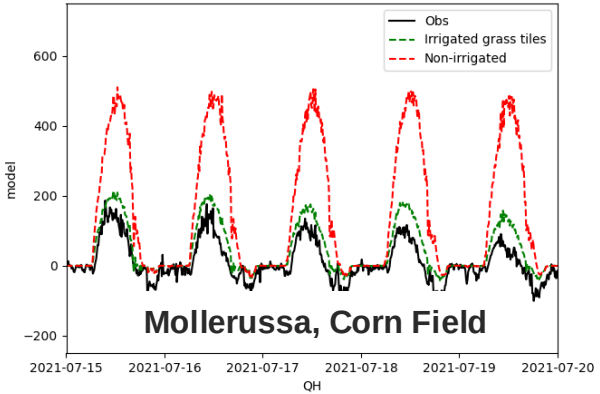

- Irrigated and non-irrigated surface tiles run with own soil tiles, separate non interacting soil water profiles, all within a single grid box.
- Irrigated soil moisture profiles to evolve independently, different rates of evapotranspiration.
- Flexibility to have different irrigation methods, flooded or ponded water.
- Good option for simulating irrigation in the longer term.
- However, due to technical complications, the soil tiling functionality won't be available until after LFRic is implemented.

# New Prototype Irrigation Scheme for JULES

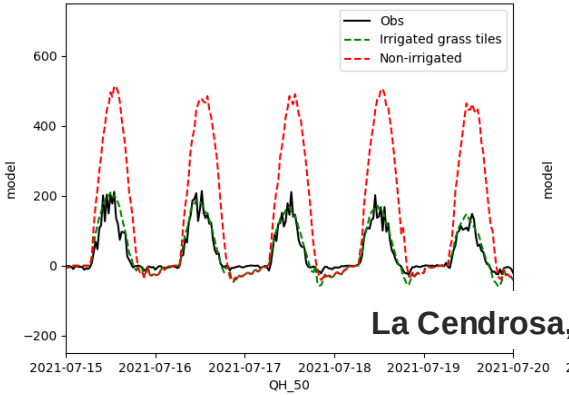


# Early results from LIAISE flux tower sites

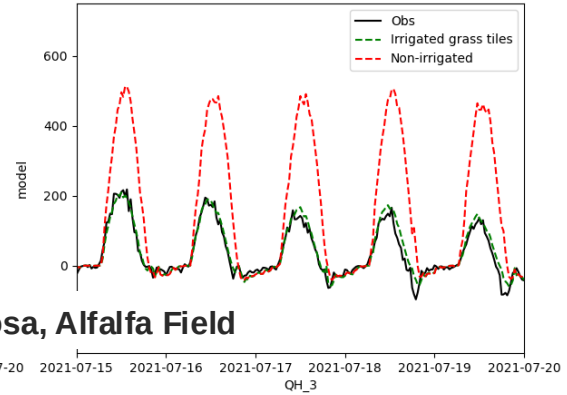
Sensible Heat Flux @3m



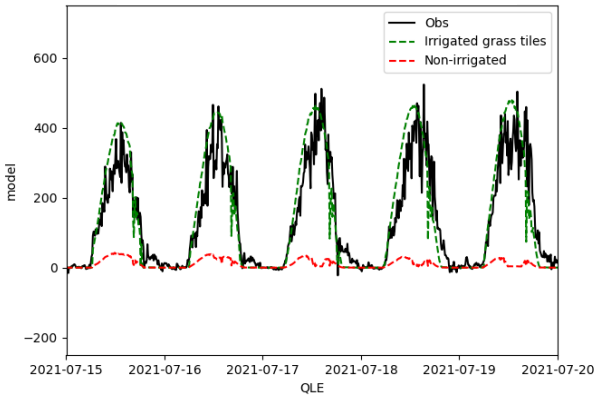

Sensible Heat Flux @50m




Sensible Heat Flux @3m




Latent Heat Flux @3m

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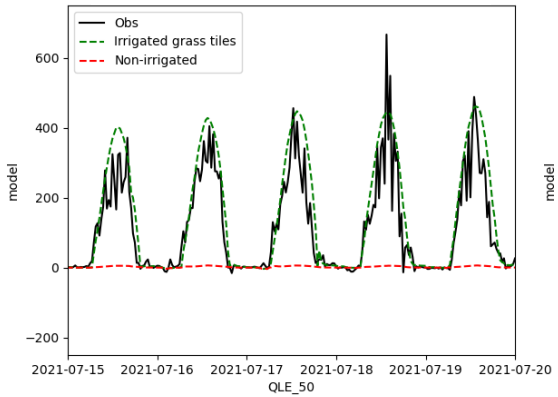


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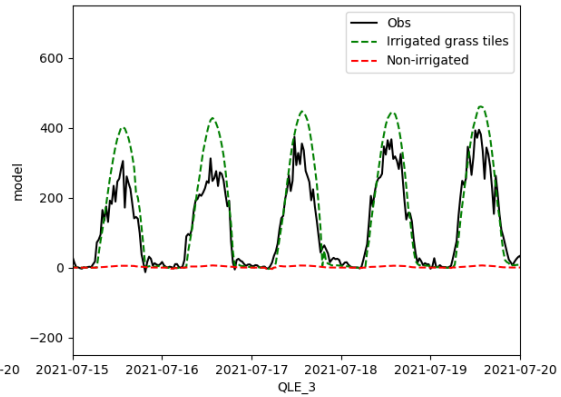

# How can we simulate different types of irrigation?

- Many different methods used in practise
- Bringing in water via pipes from rivers, canals and reservoirs
- Huge spatial and temporal variability in application of irrigation

Flood

(Credit: Jeff Vanuga, USDA Natural Resources Conservation Service)

Sprinkler

https://phys.org/news/2014-01-effects-earth.html

Drip

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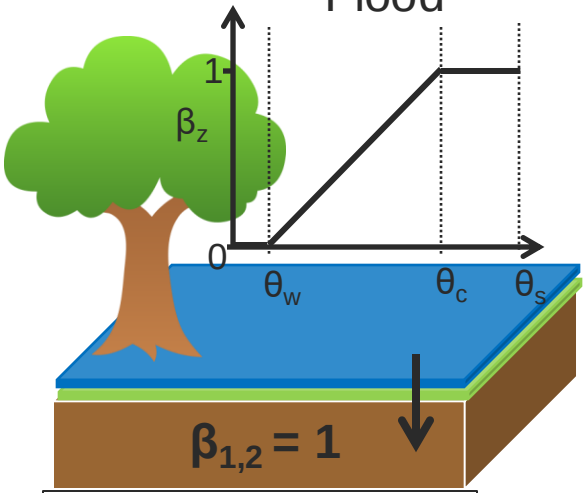
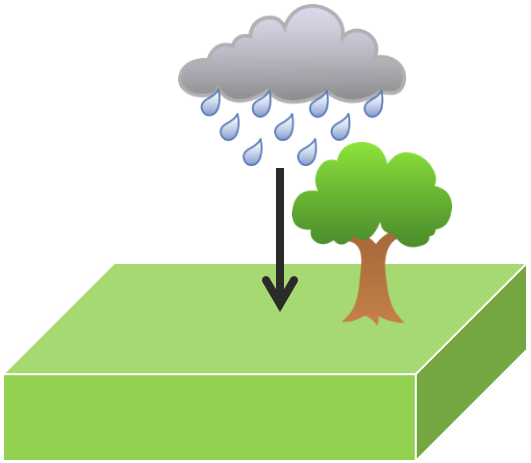
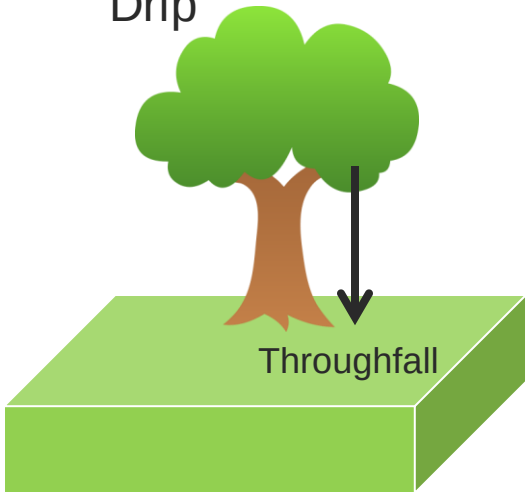



+ review infiltration & add ponding

Sprinkler



Drip



# Future Priorities

- Develop a new irrigation scheme with priority on developing:
  - Irrigated surface tiles
  - Irrigation types and ponding
  - Water conservation/irrigation limitation
- Allow flexibility for integrating with JULES soil tiling code post-LFRic
- Integrate with existing HydroJULES developments (e.g. water resources and groundwater)

# Thank you for listening

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