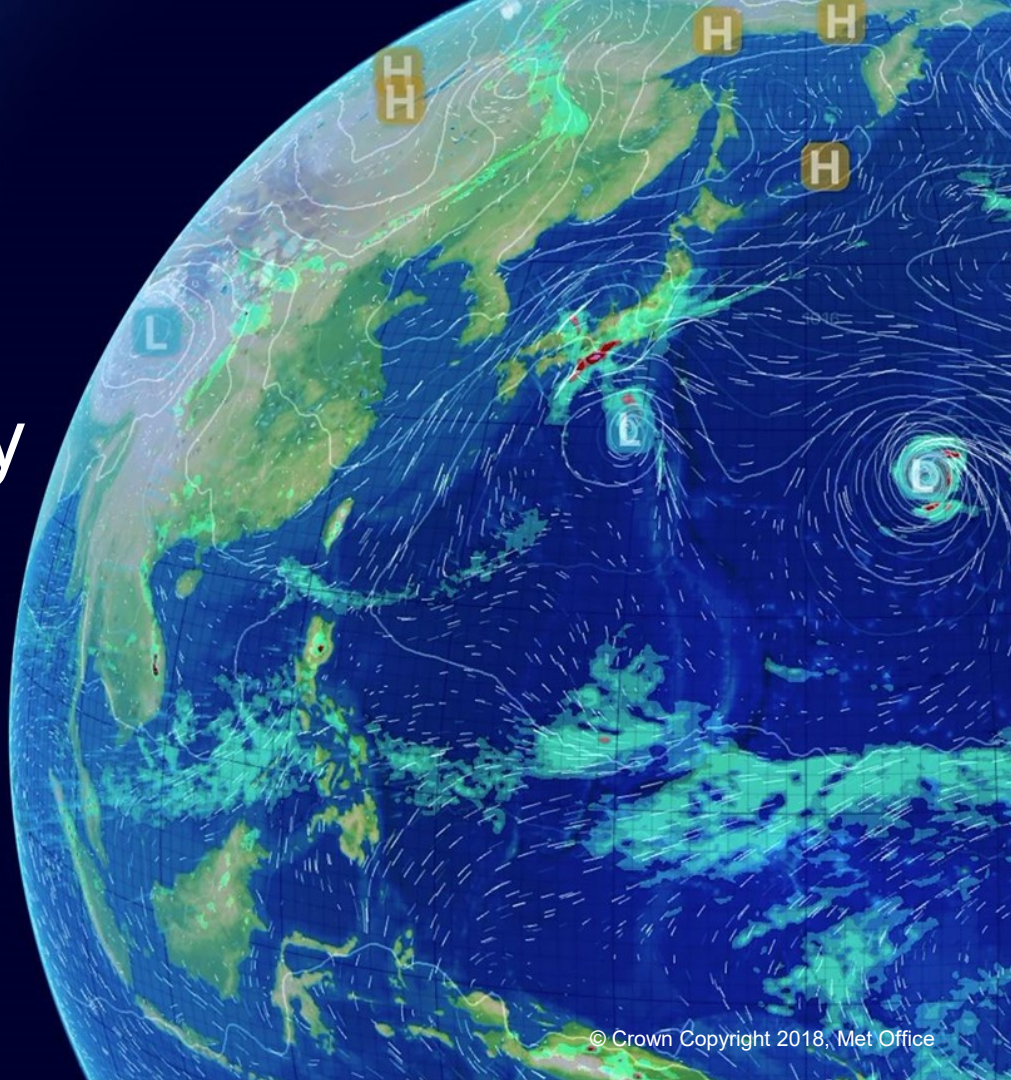
Modelling Sub-Canopy Temperature Profiles

Rob King



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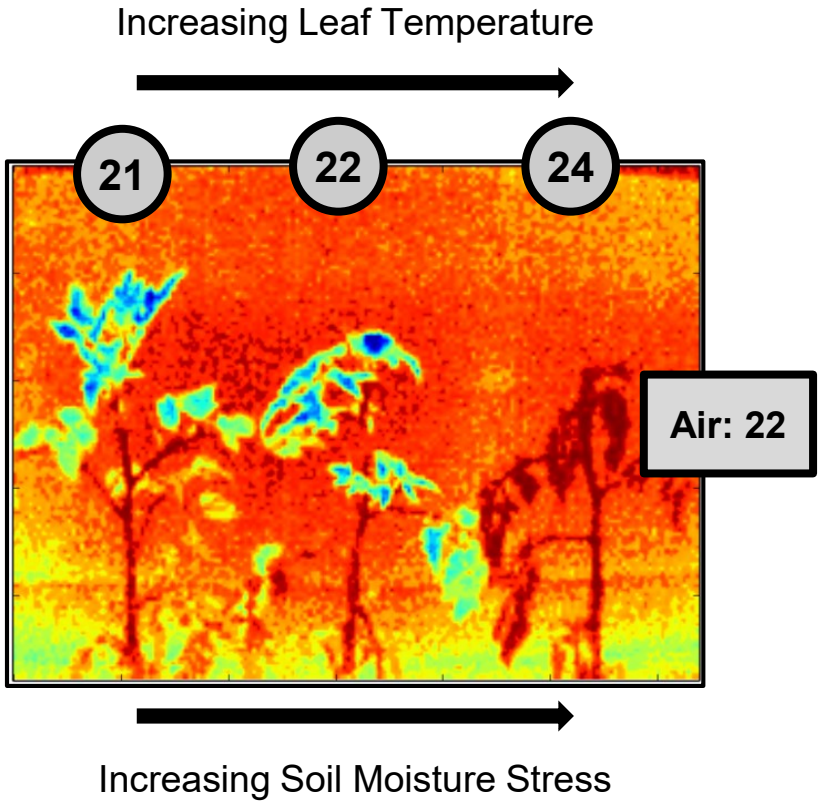
Motivation

- Interested in LST and relationship to Leaf Temperature
  - Soil moisture stress
  - Resilience to stress

- Example : Tomato plants
  - 3 different stress levels



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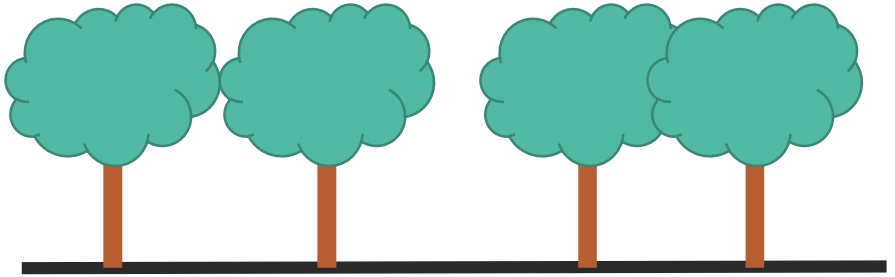
Motivation

- LST



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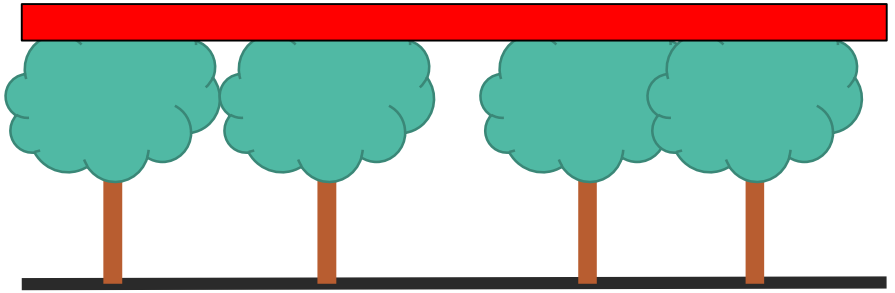
Motivation

- Single ‘skin’ temperature from JULES and observations



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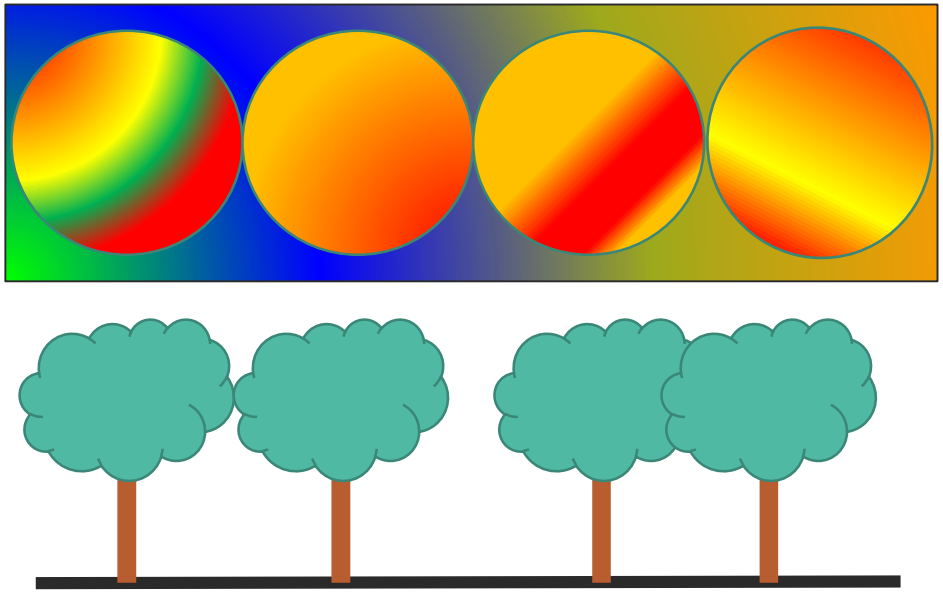
Motivation

- That's different to structure seen from above
- "can see through"



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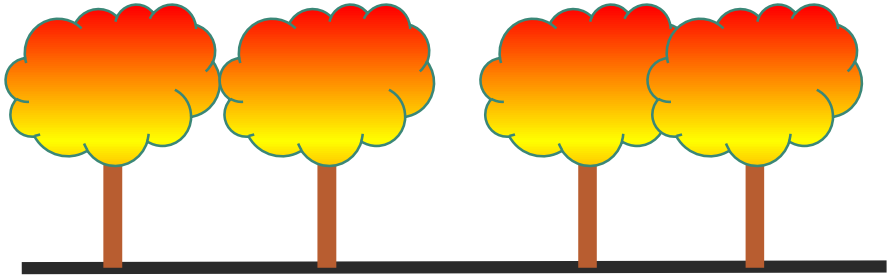
Motivation

- Also thermal gradients through the canopy



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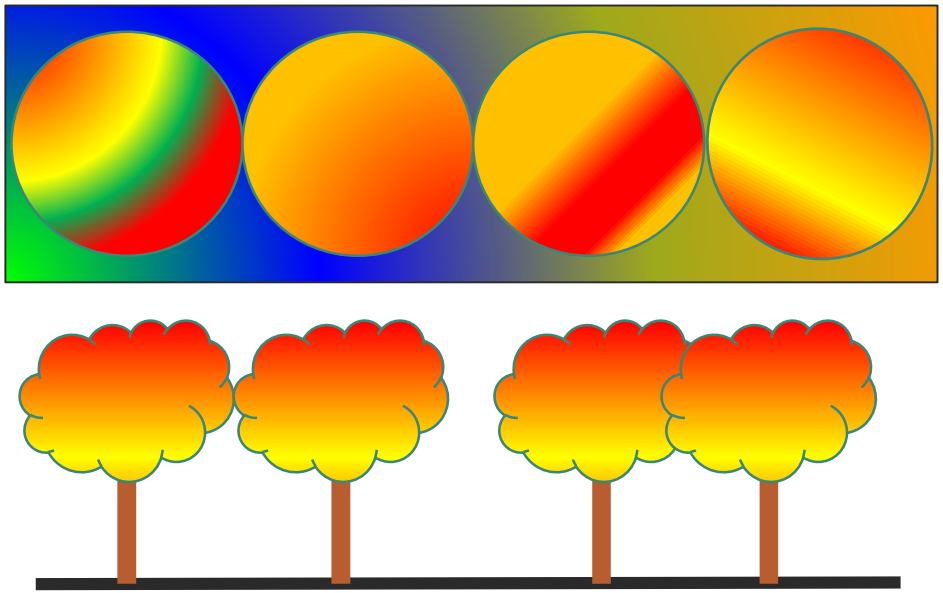
Motivation

- Model sub-canopy variation in temperature
- Vertical gradients
- Understand processes and impacts
    - LST
    - Photosynthesis
    - Pest incubation
    - ...



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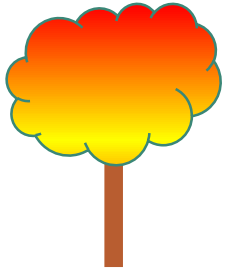
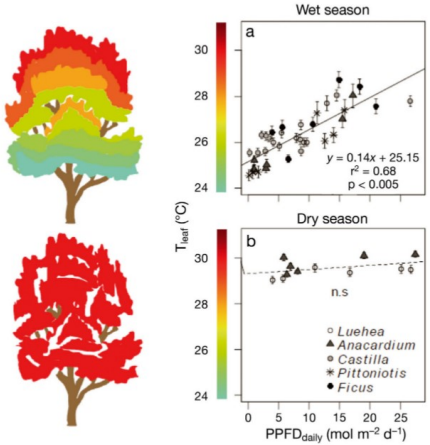
Outline

- Want to create:
  - Simple model that can be run from JULES outputs and driving data
  - Could run in JULES
  - Used to investigate effects of temperature variation through the canopy

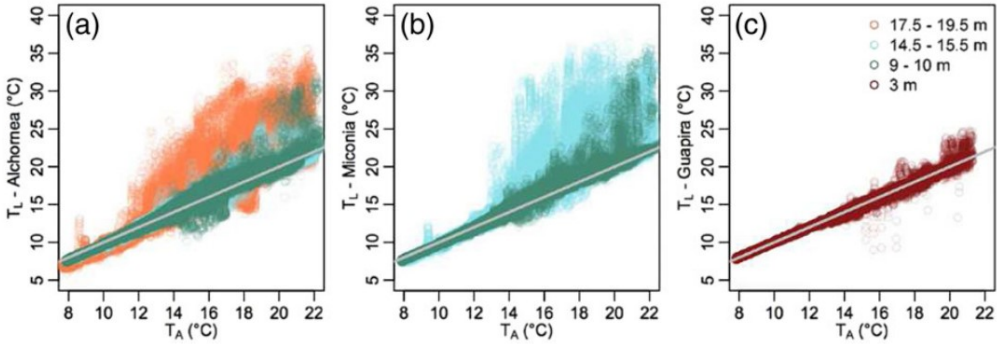


Examples



Seasonal and diurnal temperature distributions

Rey-Sanchez et al. 2016 Fig. 3



Radiation variations with height in canopy

Fauset et al. 2018 Fig. 3

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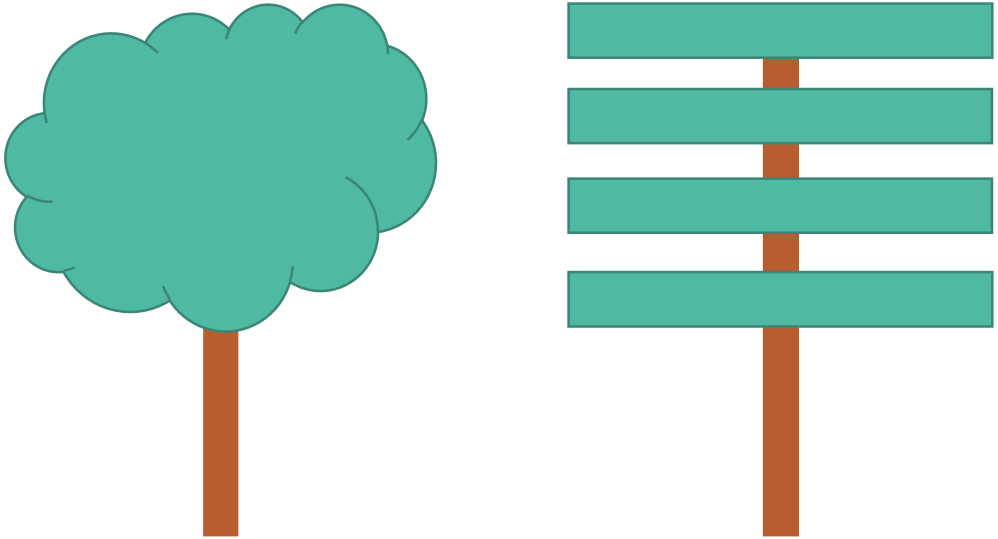
Method



- Model temperature of individual layers
- Capture interactions between layers
- Use layer temperature to drive processes / other models

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Method

I can model a plane!
Radiation, Convection
Latent heat, …

A tree is just lots of planes

Maybe….

Need to capture the interaction between layers

And planes don't normally `feedback' to temperature changes

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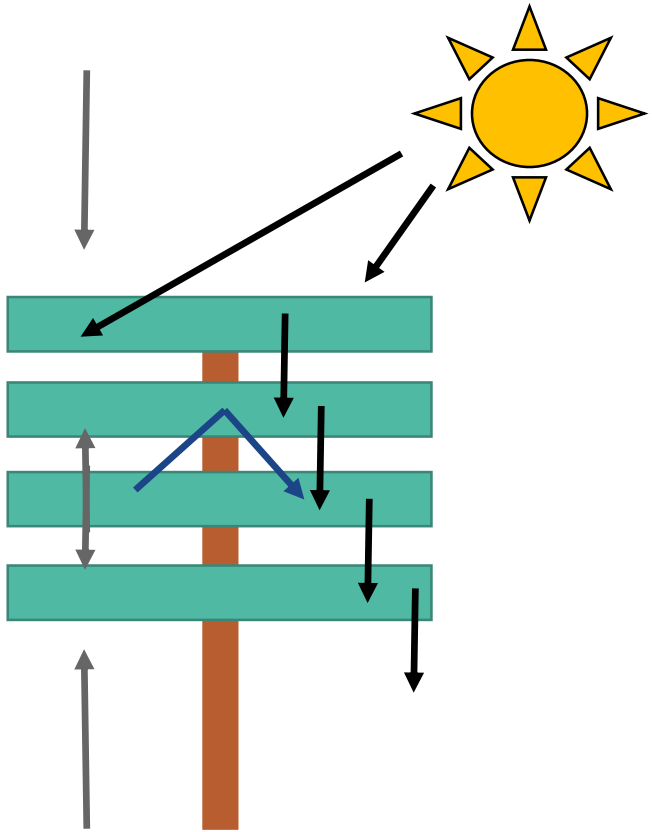
Radiation

- Absorption and transmission from layer to layer
- LW also emission, and upward source from ground
- Reflections and multiple paths to consider

- Using Tristan Quaife's standalone
    - *canradmod = 4*



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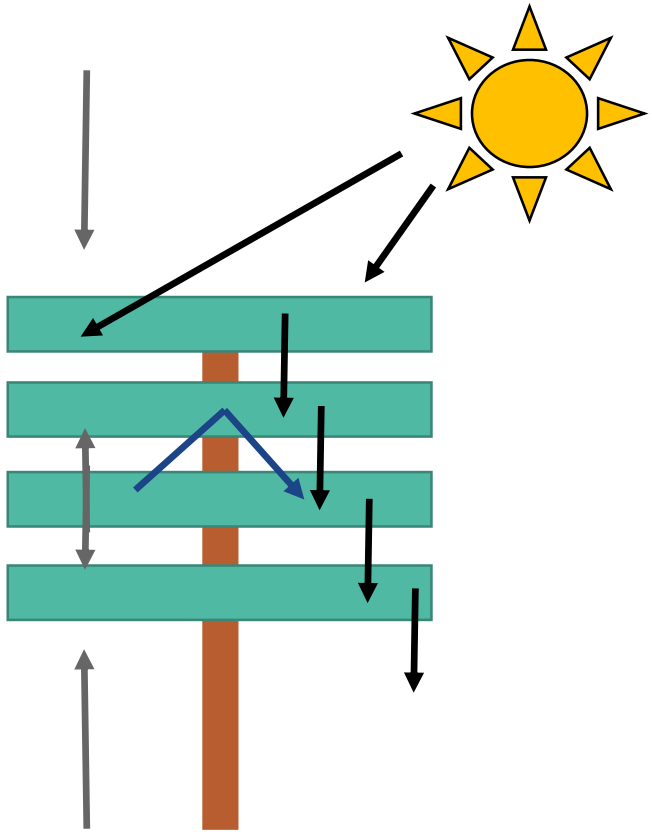
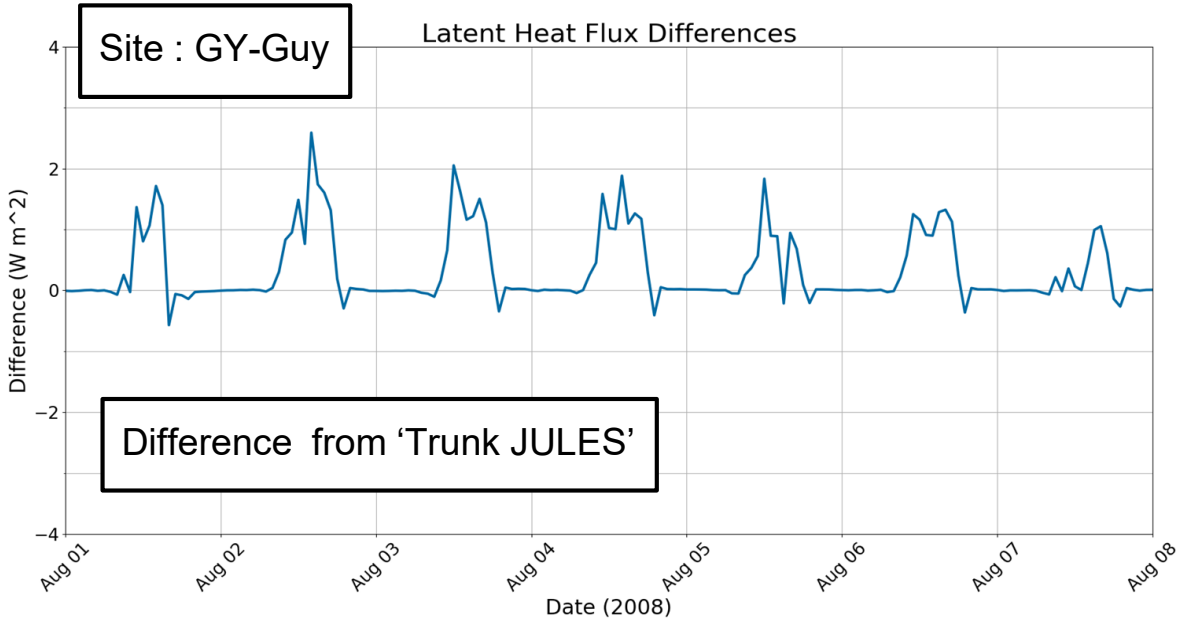
Radiation

- Other schemes, eg. Zhao and Quals (2006)
  - Scientifically different to JULES
- Want to remain consistent with JULES



JULES (very) Preliminary Example



- Changing Vcmax temperature dependence
- Tstar - 5 K
  - Simple but approximates average canopy temperature being cooler
- Rose suite
  - Karina Williams, Anna Harper, Patrick McGuire, Carolina Duran Rojas
  - U - AL752
- FLUXNET 2015 driving data
- JULES V5.4 (with my modification)

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Work in progress

- Not quite fully working
- Probably LW radiation issue
    - How to transmit LW from all sources
- Initial validation work with BIFoR
    - Interested in other validation datasets…

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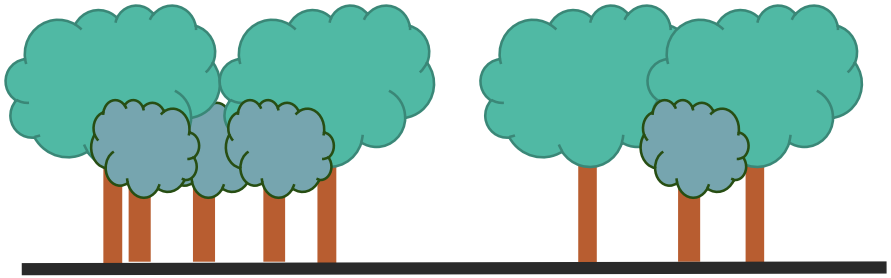
Work in progress

- Air temperature constant at all levels
  - i.e. not coupled
- No latent heat terms yet
  - Interesting as this is something a two-way coupling will effect
- Different properties in different layers



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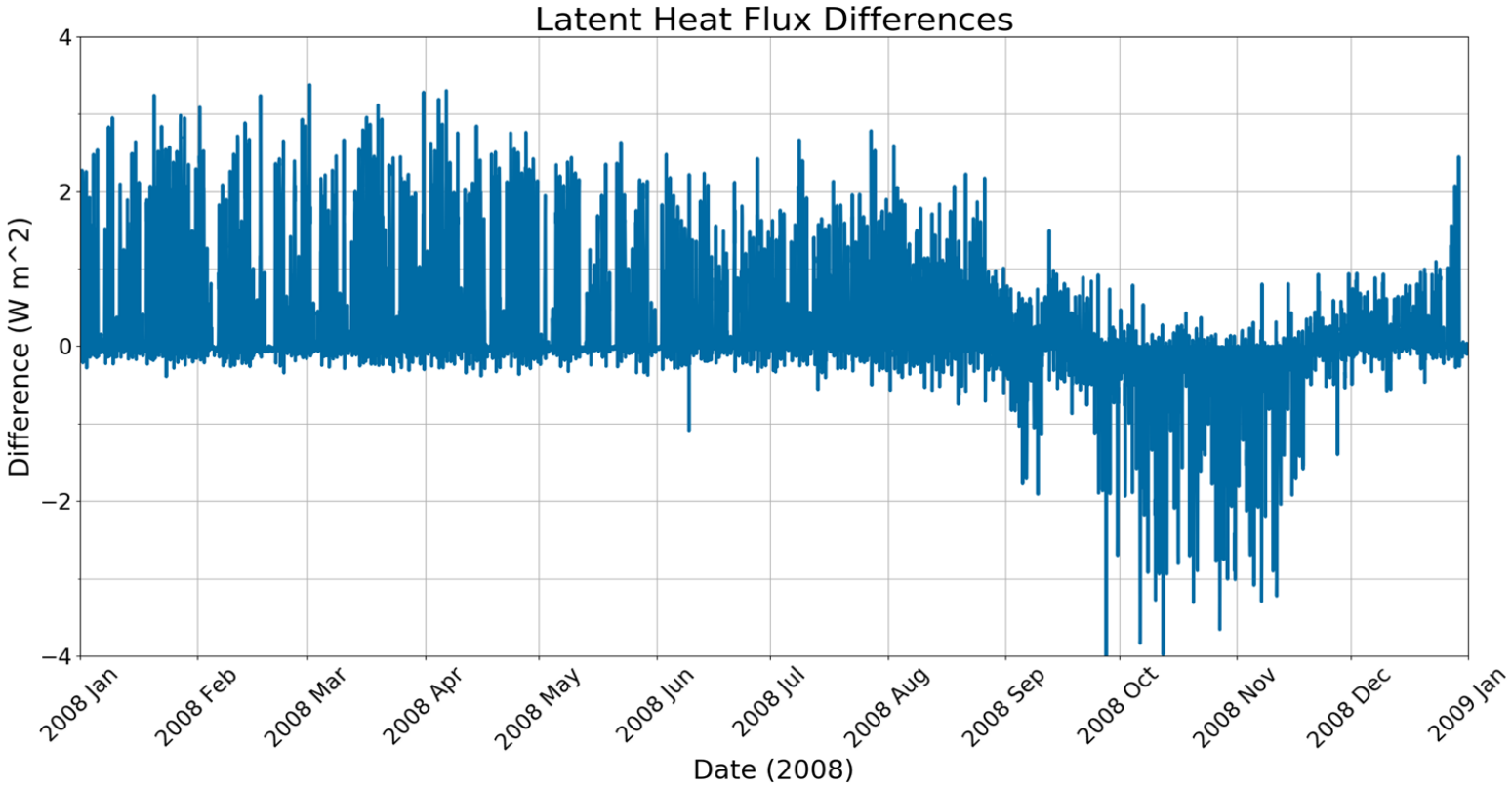
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