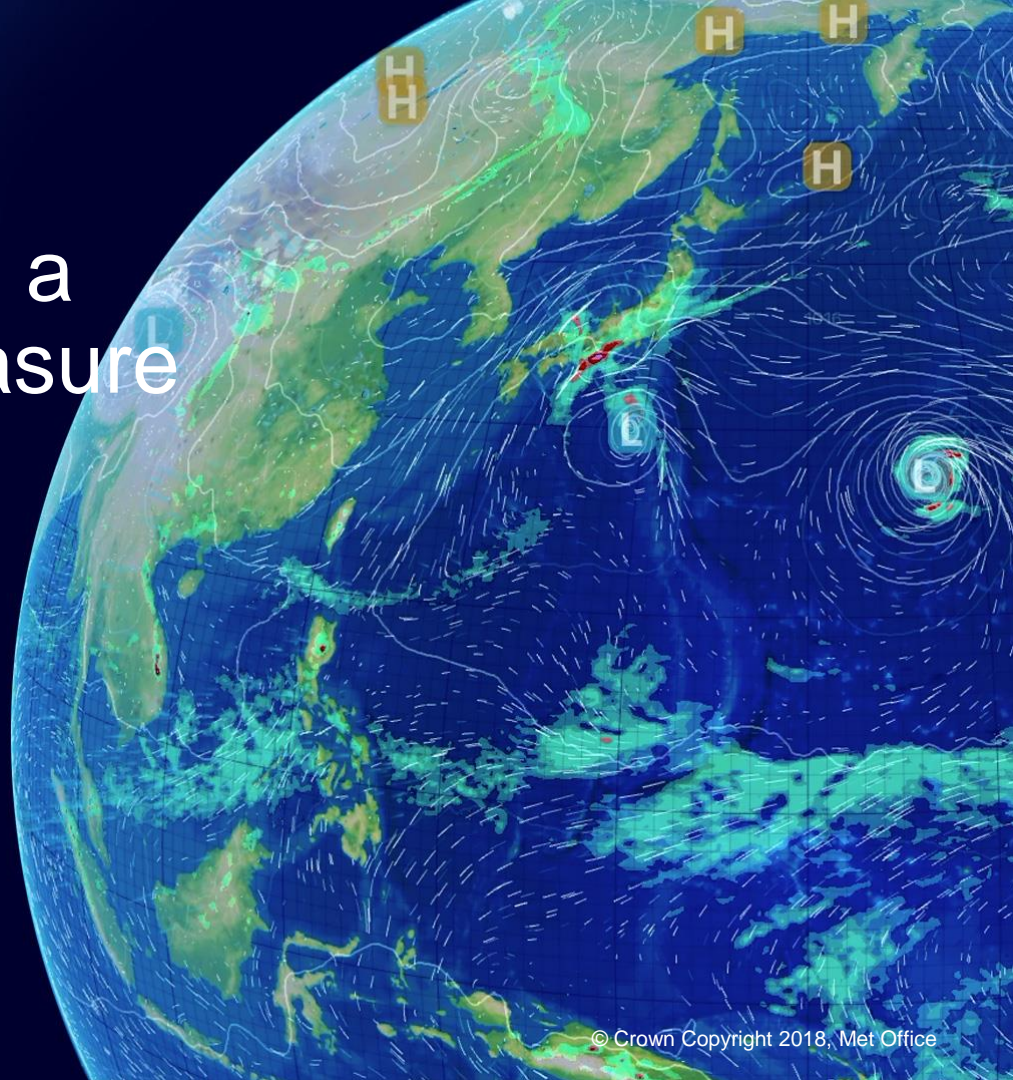
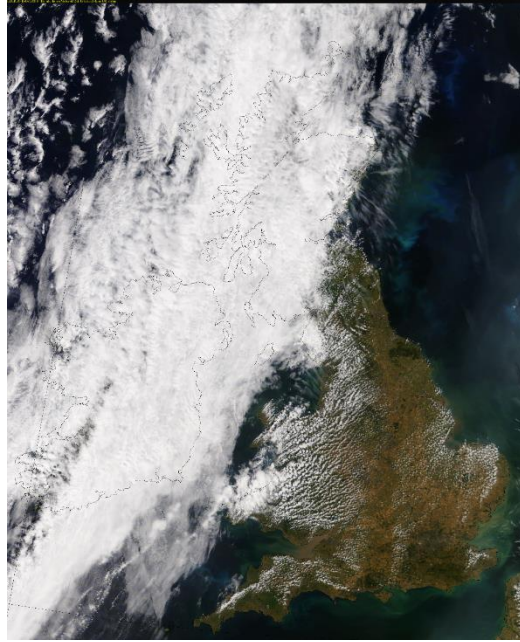
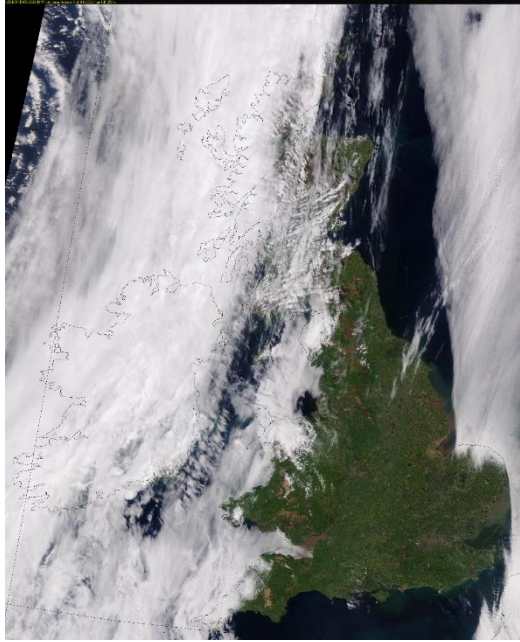


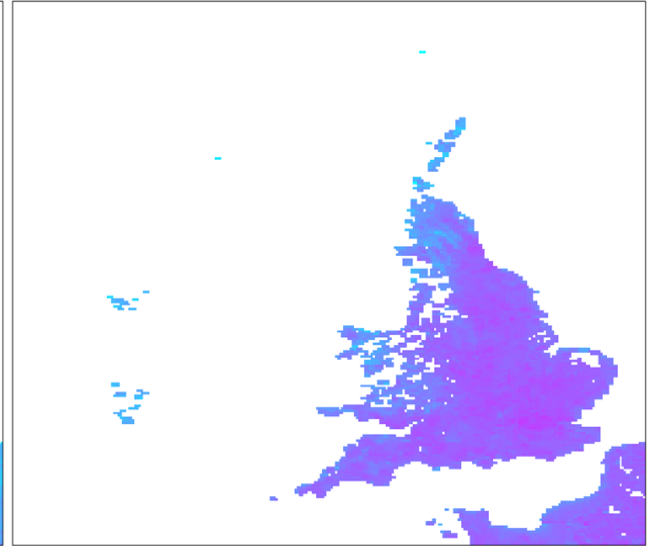
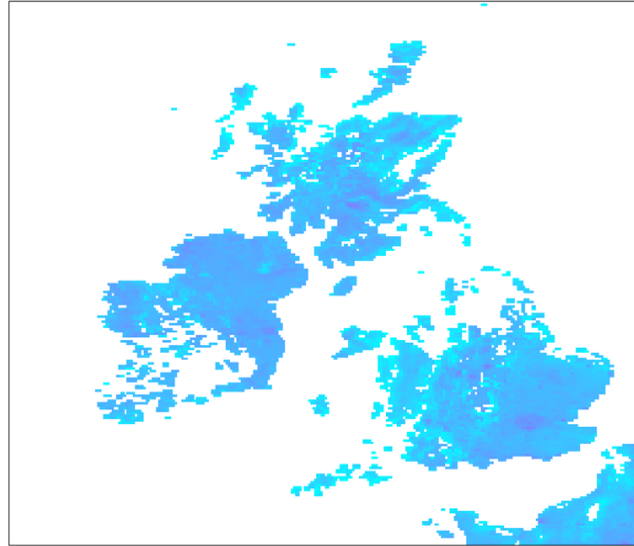
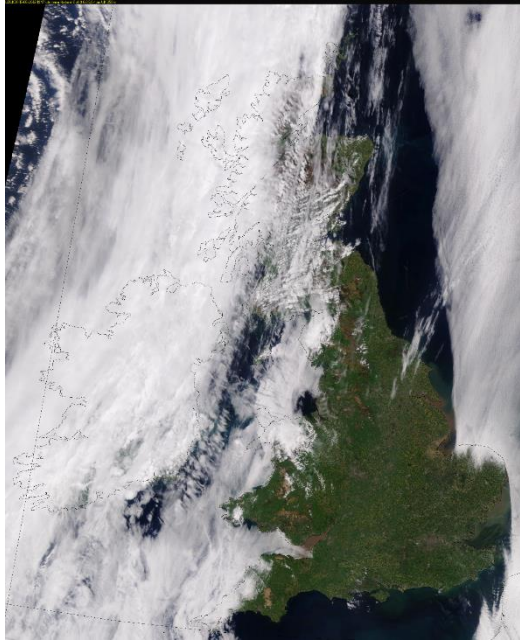
# Using Satellite LST as a Biome Resilience Measure

Rob King

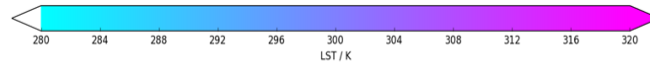




15<sup>th</sup> May -> 15<sup>th</sup> July  
2018



15<sup>th</sup> May -> 15<sup>th</sup> July  
2018



# Outline

- Leaf Temperature of moisture stressed plants
- LST – Air temperature difference
  - Brazil
- Challenges of global measurements
  - Cardington, UK

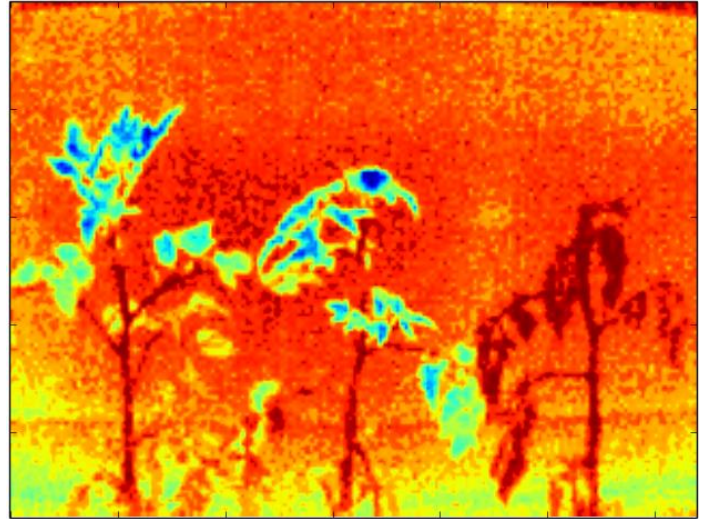
# Leaf Temperature and Moisture Stress

Idea:

- Plants transpire less when moisture stressed
- Less evaporation from leaf surface
- Leaves warmer than air when moisture stressed

Example:

- Three tomato plants
- Watered twice daily, once a day, sporadically
- IR image after ~3 weeks



Ave leaf temp: 21-22    22-23    24    Air: 22

# Data used

- LST
  - MODIS (AQUA) 0.05 degree
  - Crosses equator ~1330 local solar time
- Air Temperature, Rainfall
  - WFDEI 0.5 degree
  - GPCC rainfall
- LST averaged to WFDEI grid
  - view angles, QC flags, cloud cover... limit actual number of days available
  - 2010-2013, all days with valid LST

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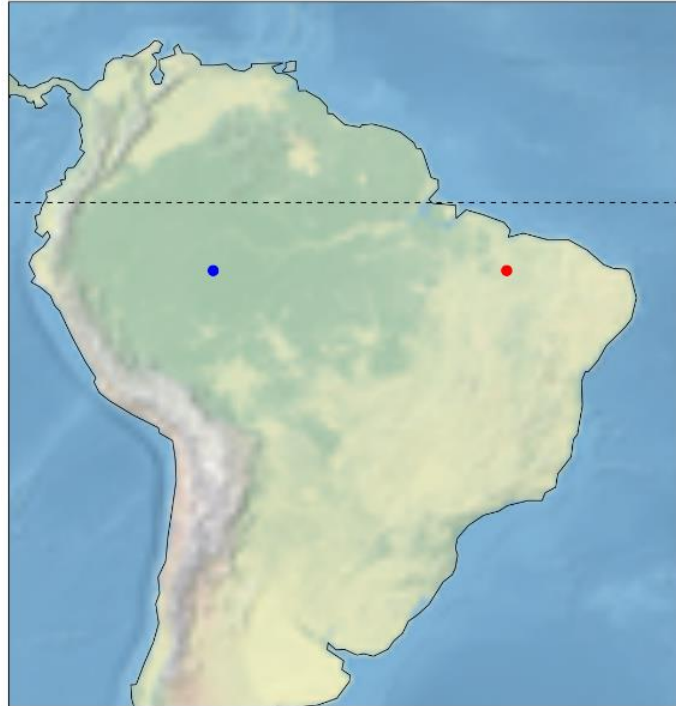
Folwell, Harris & Taylor 2016 looks at similar ideas

# Brazil

North West Brazil  
Wet all year round

67.25 W  
State of Amazonas

Both 5.25 south

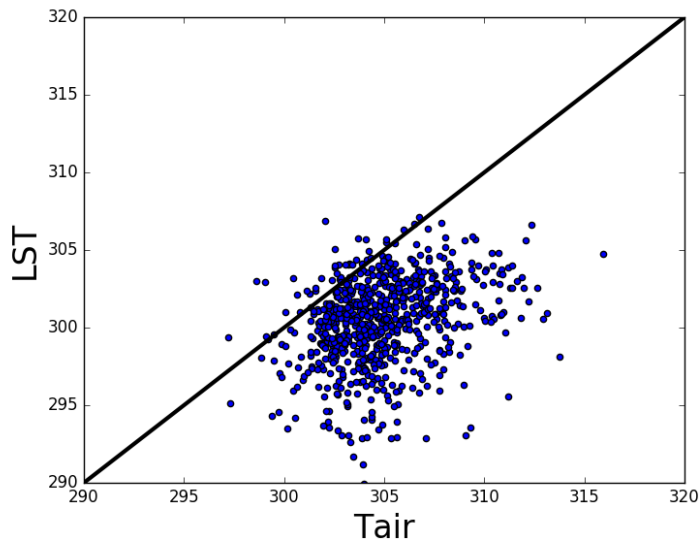


North East Brazil  
Seasonal variation in  
rainfall

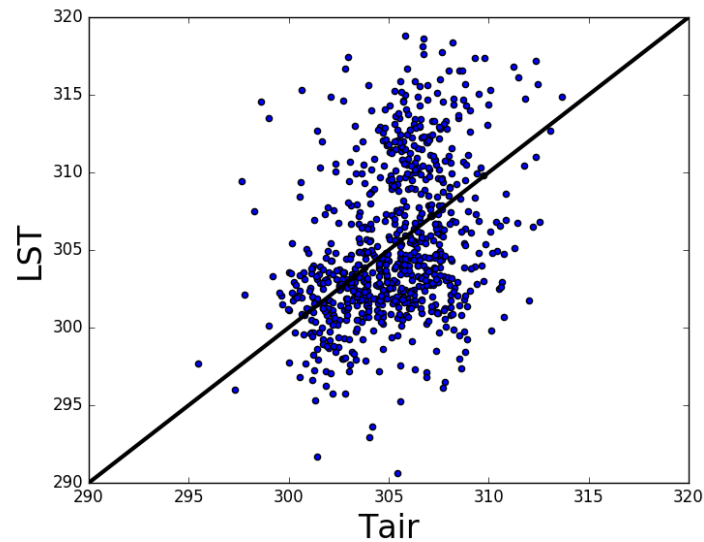
44.75 W  
West of Teresina



# Land and Air Temperature Differences



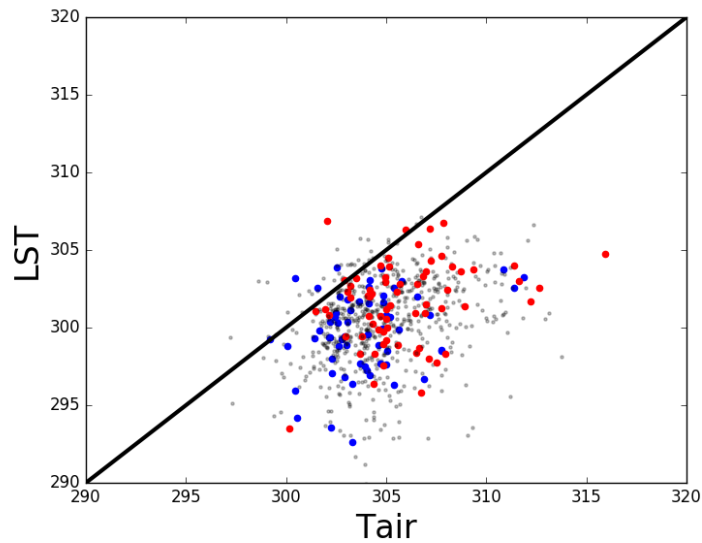
NW Brazil



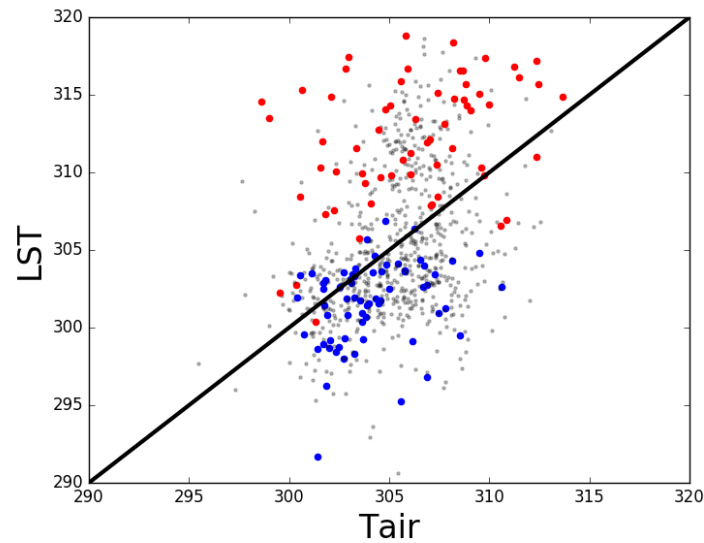
NE Brazil

# LST - Tair

March  
October

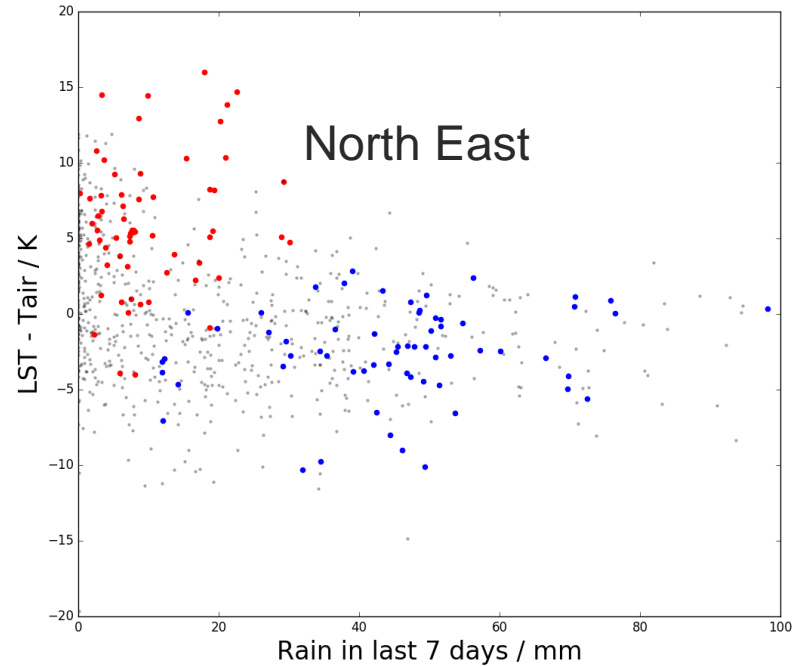
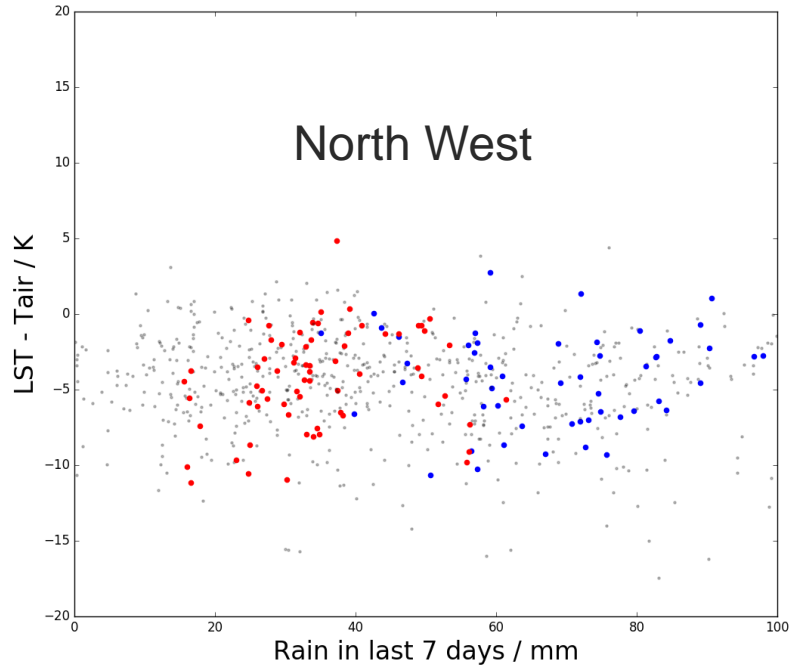


North West



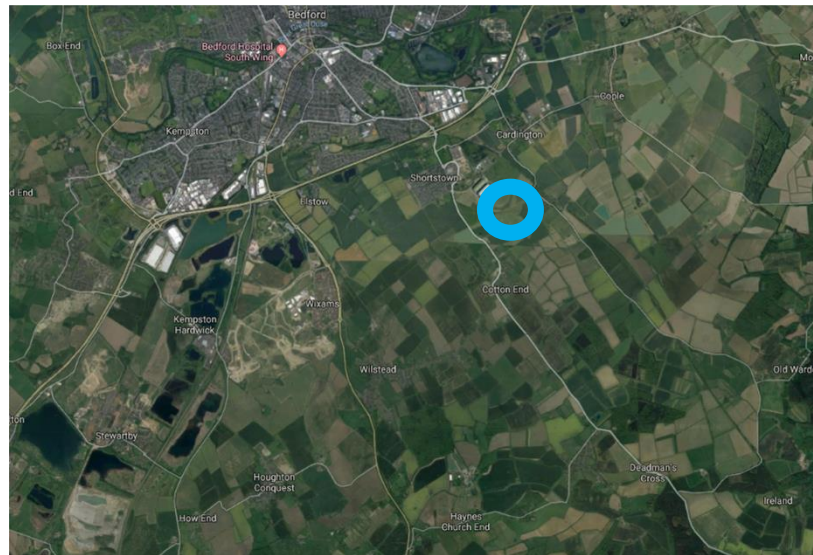
North East

# Difference in LST to Air Temperature



# What are we measuring?

- Satellite sees a large area, compared to a leaf
- Individual fields look different, even if same crop
- Urban areas influence satellite LST
- Can look at in-situ 'LST' measurements as proxy for leaf temperature



Cardington, south of Bedford

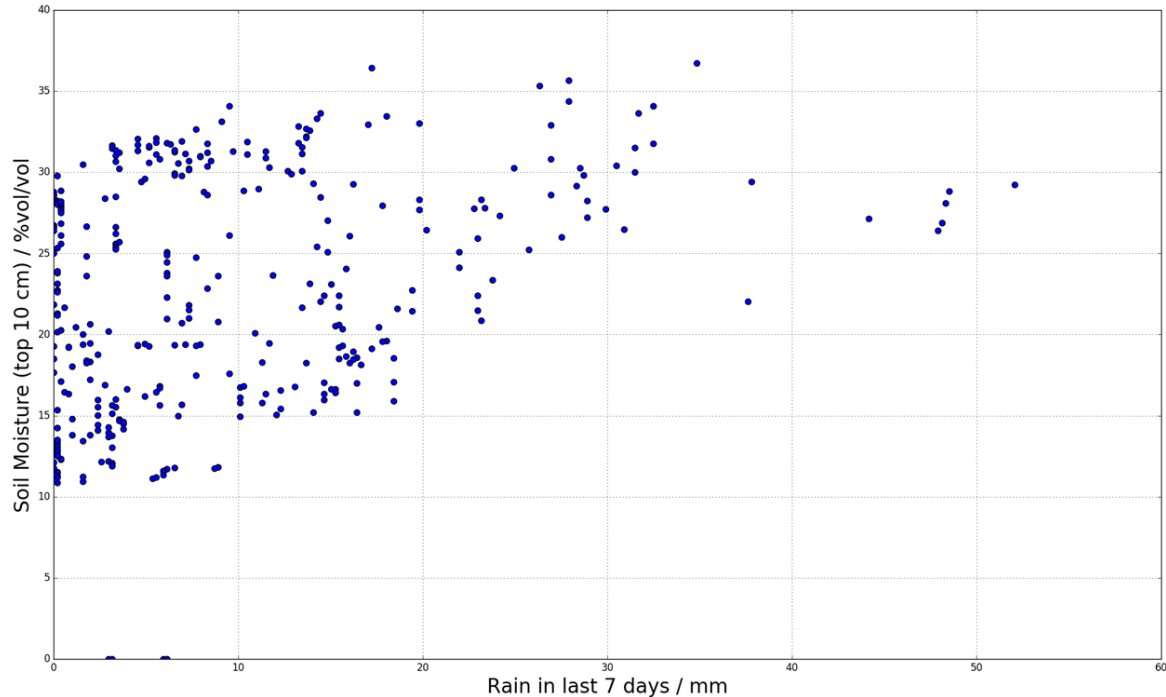
# Cardington

- Met Office research site
- Long time-series of `all` variables
  - Using 2017 here
- Currently two grass temperatures
  - IR Thermometer
  - In the grass
- Soil moisture profiles; compare different ways of measuring

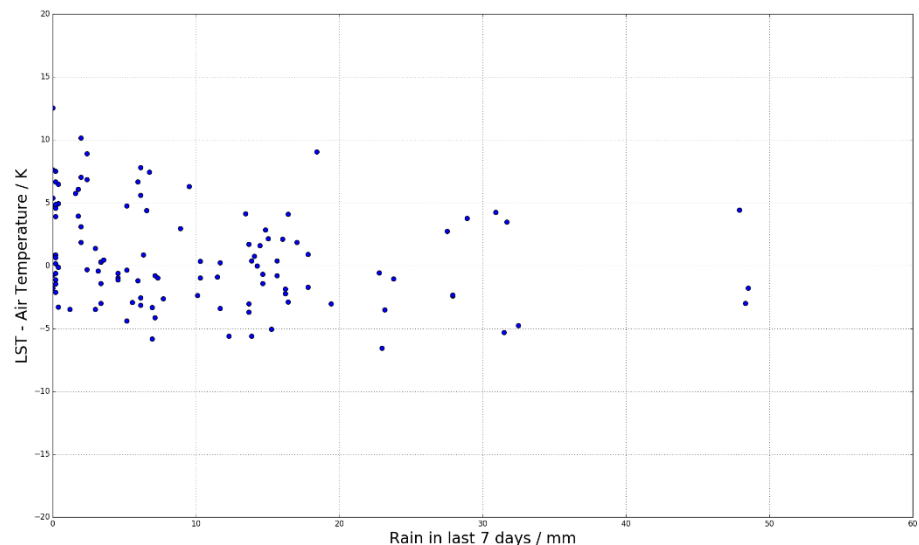
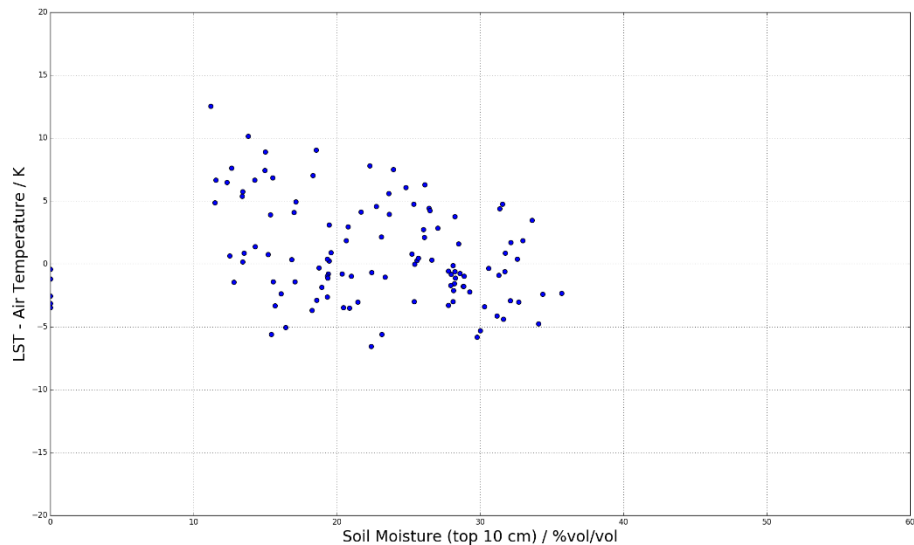


# Cardington Soil Moisture

- Soil moisture measured with DeltaT Theta Probes (at 10cm)
- Rain is total rain in previous 7 days
- All days with valid data in 2017



# Soil Moisture vs Rainfall



# Summary and Outlook

- LST to Air Temperature difference is responsive to the recent rainfall
  - Recent rainfall as a proxy for soil moisture
- Satellite LST is different to leaf temperature
  - Leaf temperature itself needs care in its measurement
- Cardington shows similar but different response in LST/Air Temperature difference with Rainfall and Soil Moisture



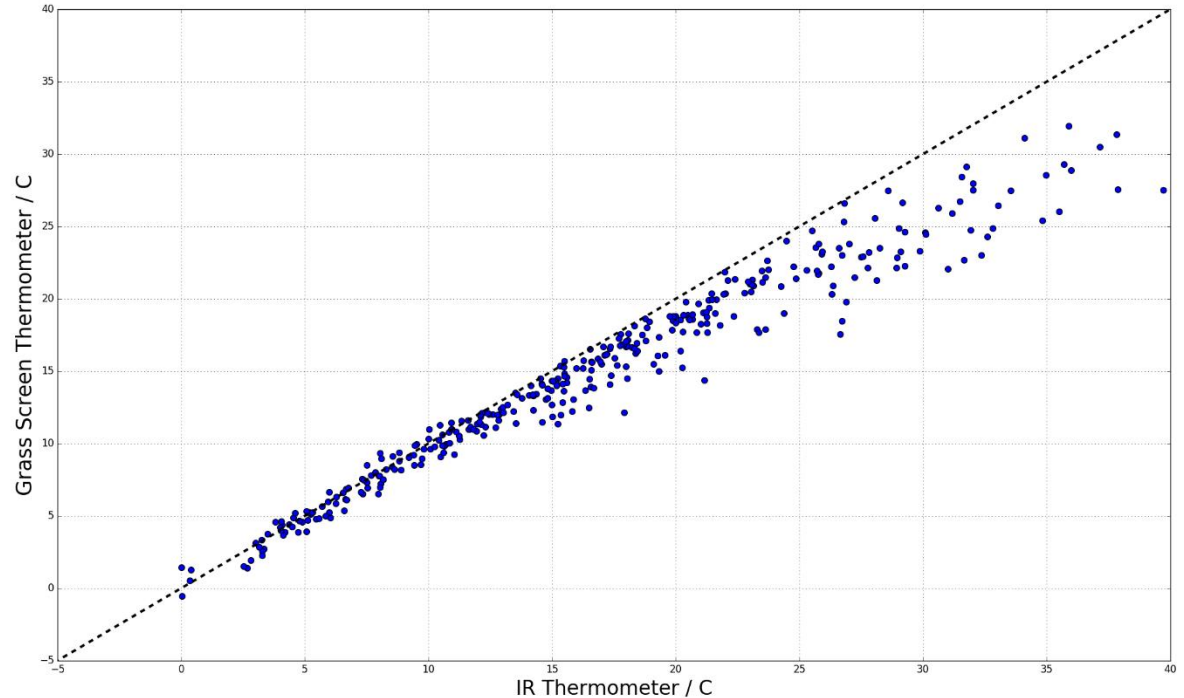
# Summary and Outlook

- Define biome resilience using LST/Air Temperature in different ways:
  - $LST - Air\ Temp < 0$  when soil moisture reduces, ie plants not stressed
  - How quickly moisture stress plants respond when moisture increases
- Understand how JULES model runs capture (or not) this measure of resilience
- Carefully choose global datasets of soil moisture or related variables to make sure they observe what we model



# Cardington

- Do we get it right on the ground?
- Different instruments show large variation of same measurement



# Cardington

