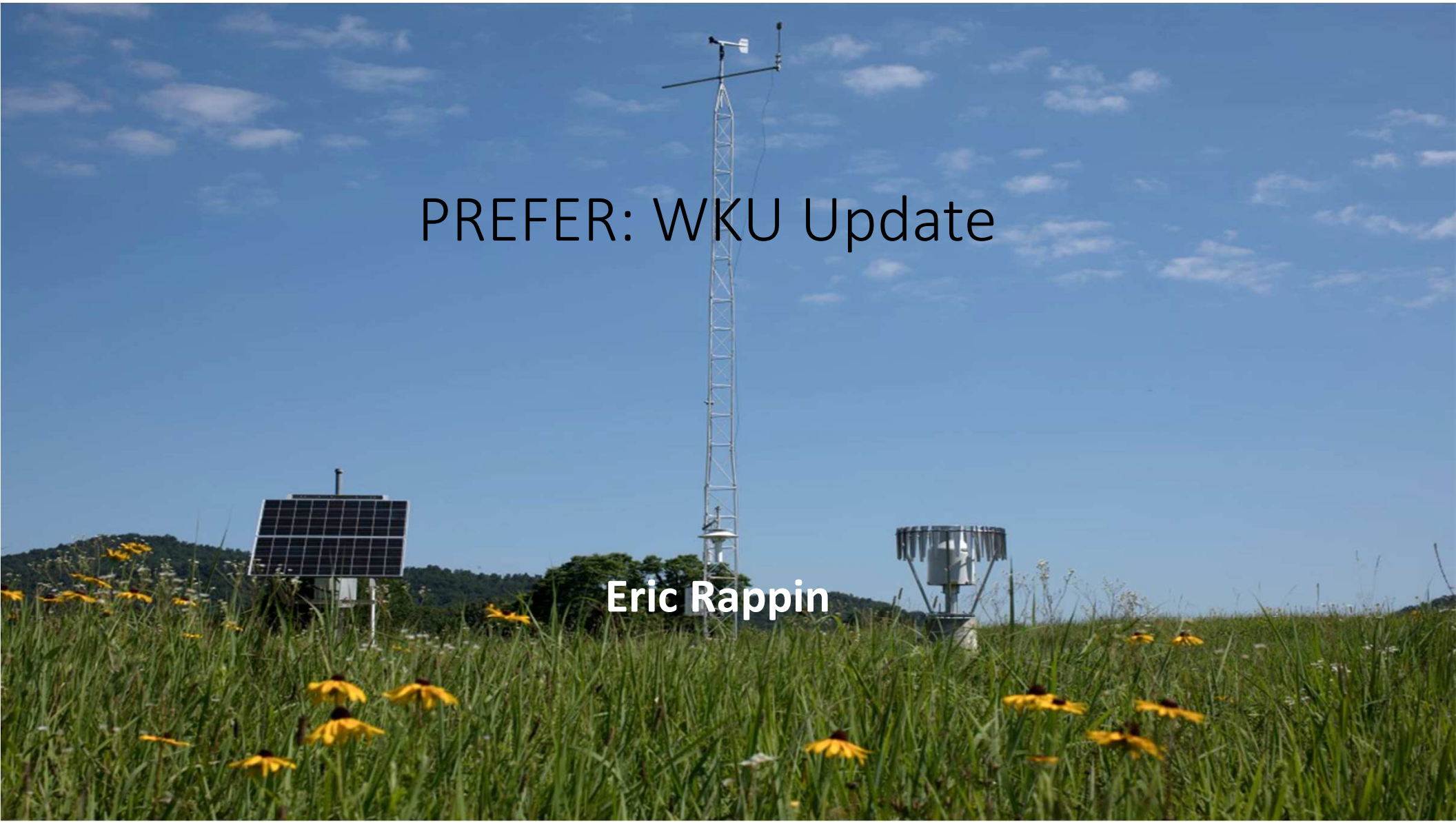
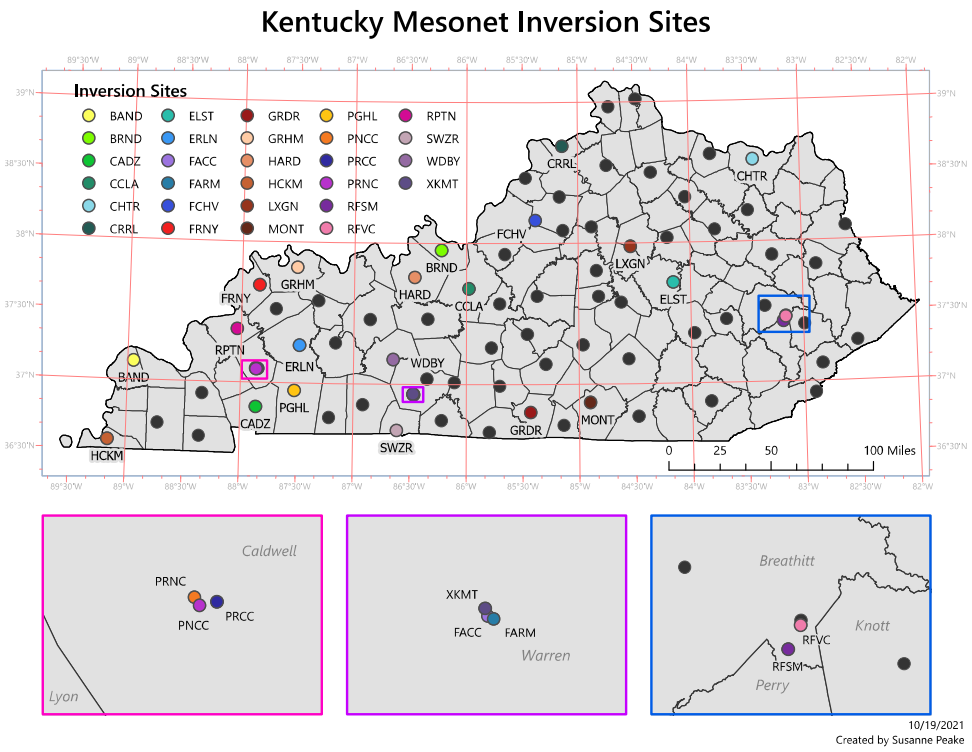
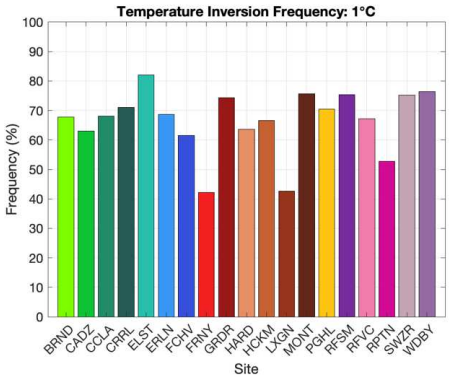


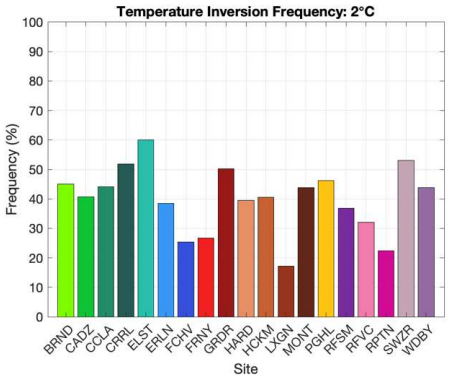
PREFER: WKU Update

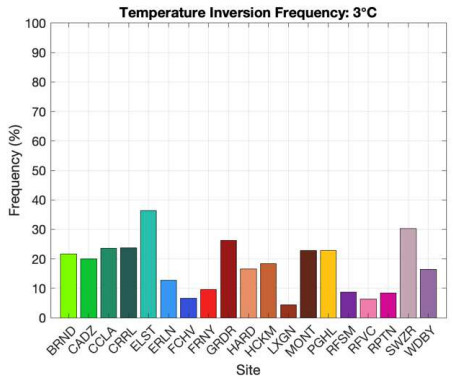
Eric Rappin

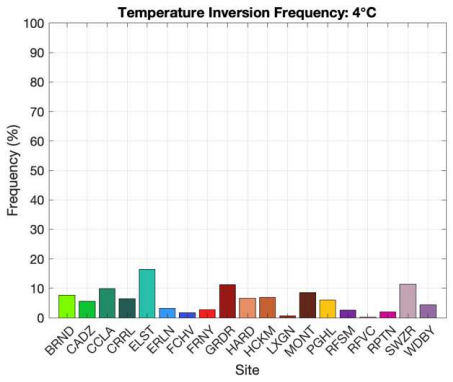
KY Mesonet: Inversion Sites





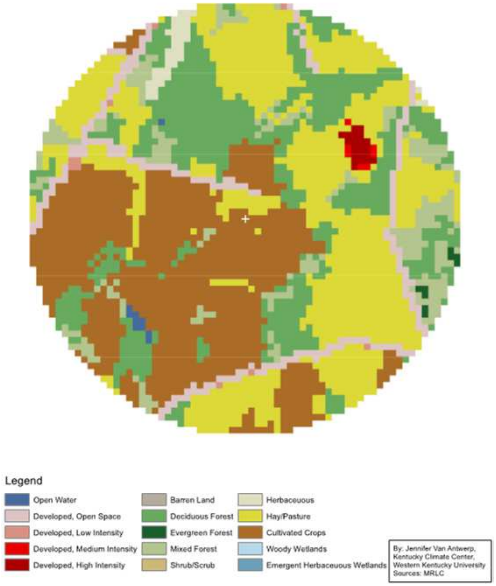


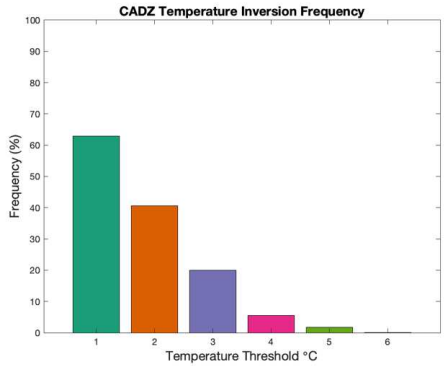


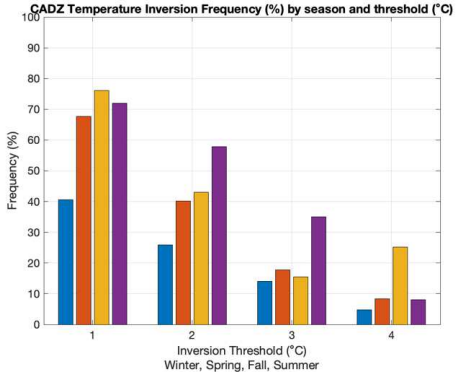


EXAMPLE: CADZ

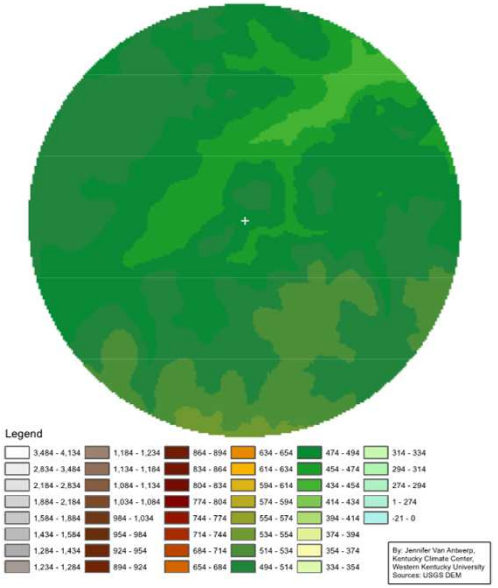
Land Cover (2016) for CADZ in Trigg County 1 km Buffer



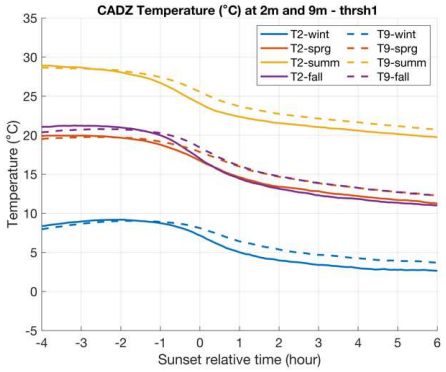


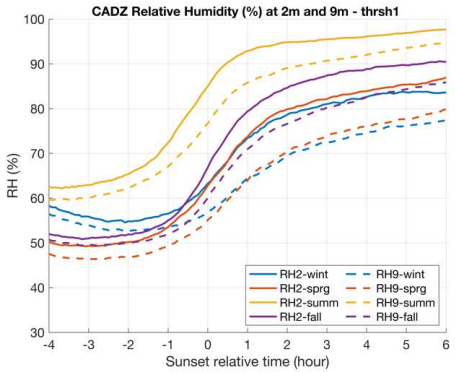


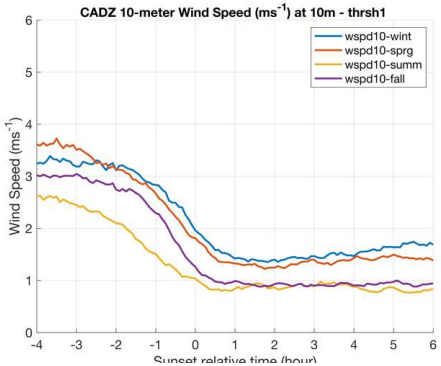
Elevation (Feet) for CADZ in Trigg County 1 km Buffer

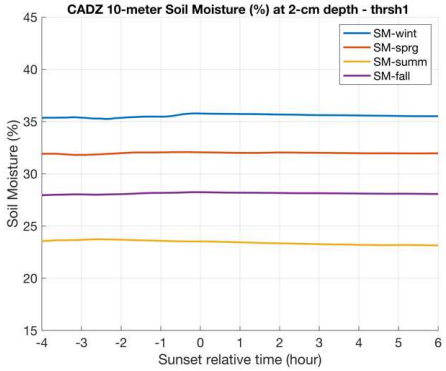


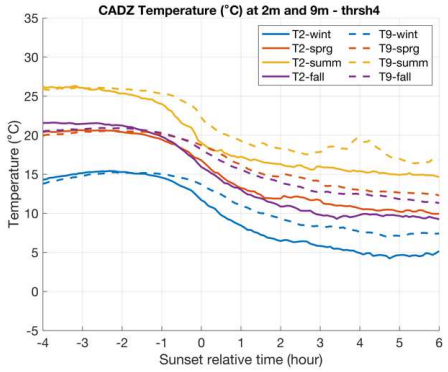
EXAMPLE: CADZ

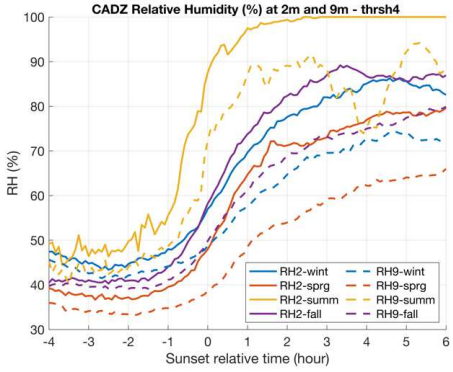


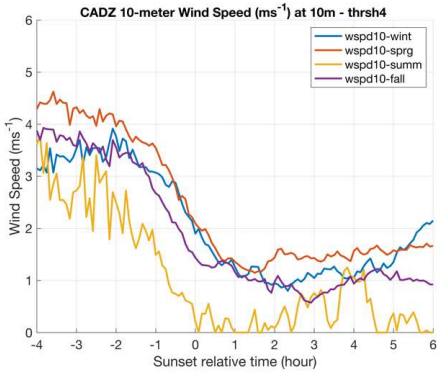


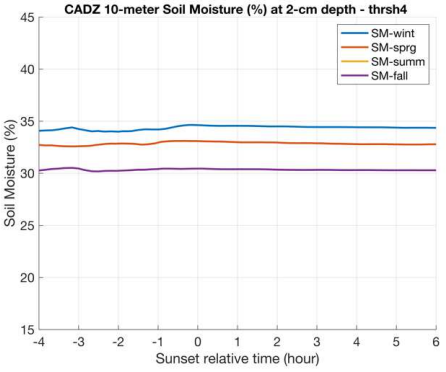




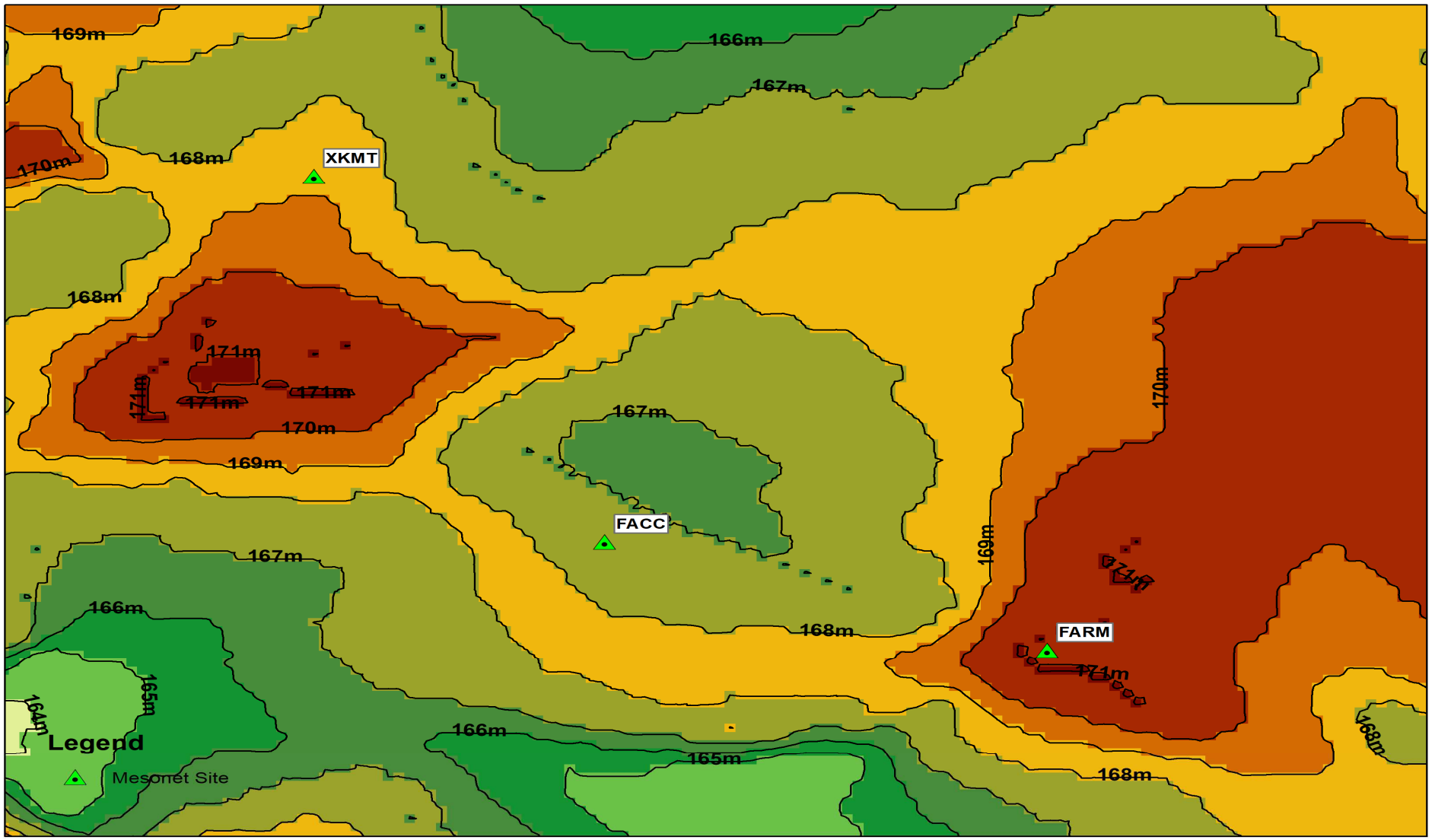









Bowling Green, KY
Inversion Locations
Legend
Mesonet Sites
XKMT
FACC
FARM
Google Earth
© 2021 Google
N
1000 ft


169m
166m
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XKMT
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Legend
Mesonet Site
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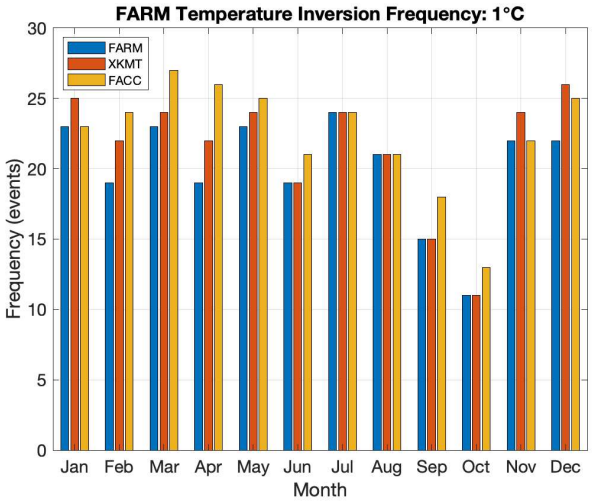
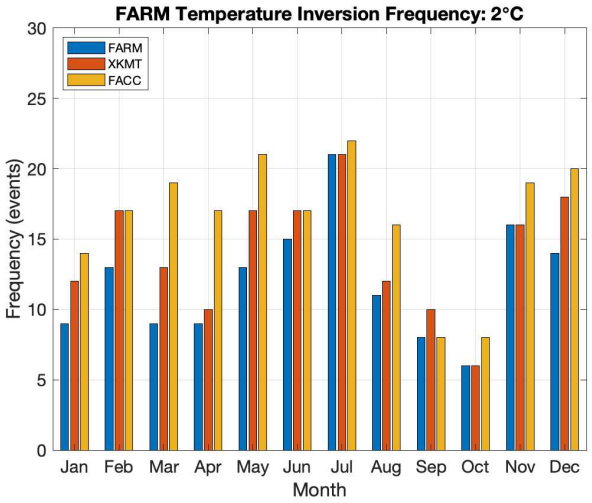
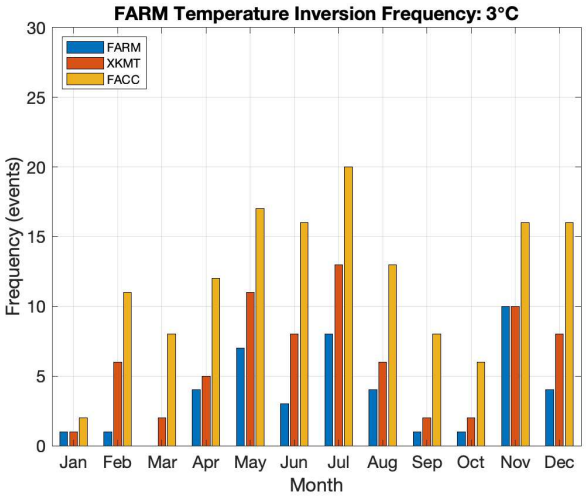
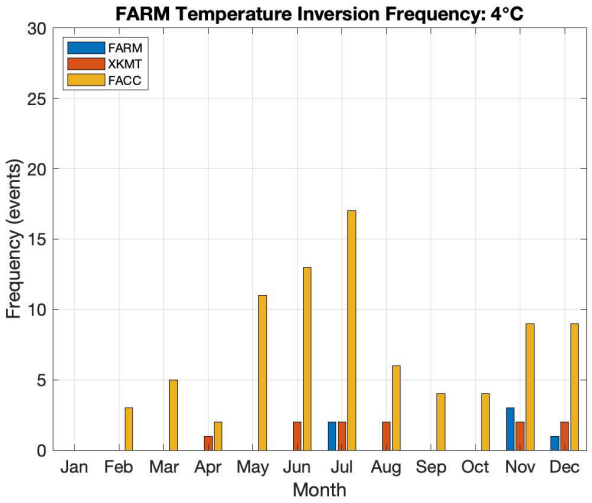
168m





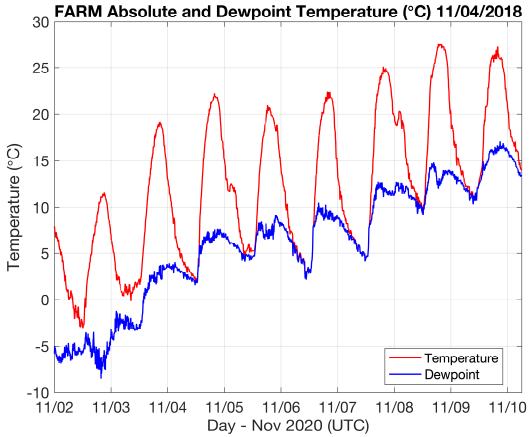


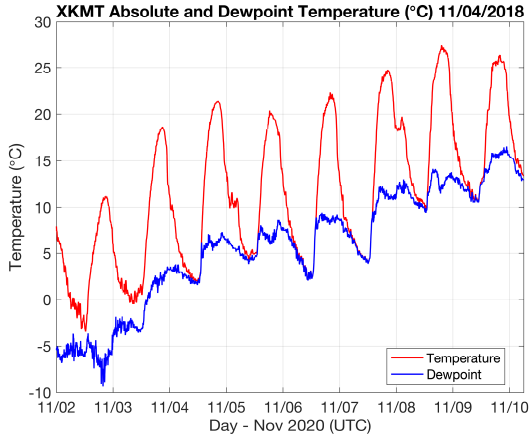


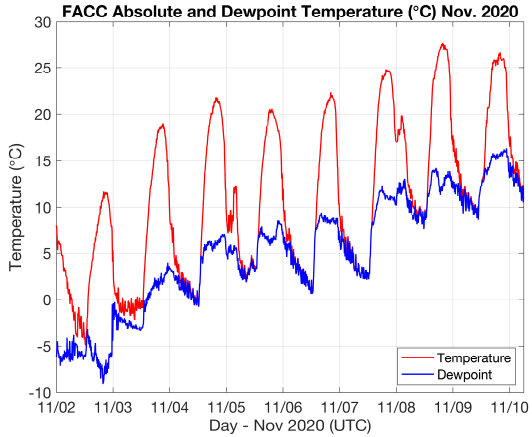
WKU Farm Inversion Frequency

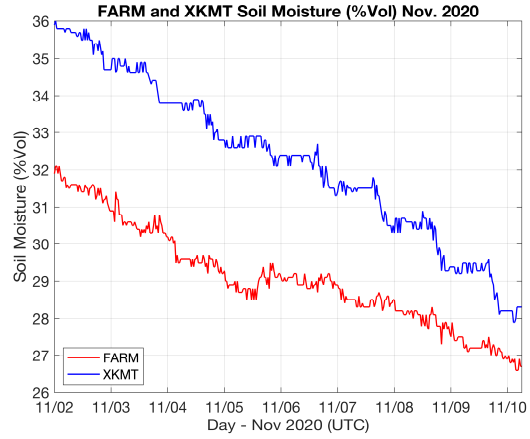
	FARM (170.4m)	XKRT (171.0m)	FACC (167.3m)
1°C	66%	71%	74%
2°C	40%	46%	54%
3°C	12%	20%	40%
4°C	2%	3%	23%

Land-Atmosphere Coupling (Cool things Mesonets can observe)



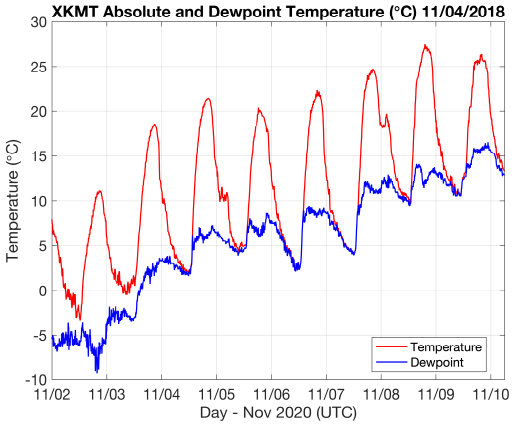


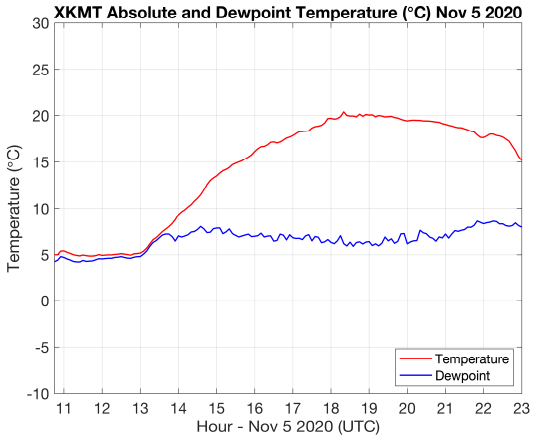




- A week of fair weather brought on strong L-A coupling
- The Bermuda high extended west of the Mississippi leading to southerly flow at the surface.
- Flat geopotential at 250 hPa
- **Perfect setup for warm days and cold stable nights! (note FACC) And…….**
- **DROUGHT**
- Warm surface temperatures during the day → increased saturation vapor pressure and vapor pressure deficit →increase potential ET → increase actual ET → depletion of soil moisture and plant/crop wilting → decrease of actual ET →loss of atmospheric water vapor for clouds/precip.
- This is a good example of the early onset of meteorological drought. Rapid incraseses in dewpoint depression would soon follow

Three-Dimensional Evolution (Cool things Mesonets can do)

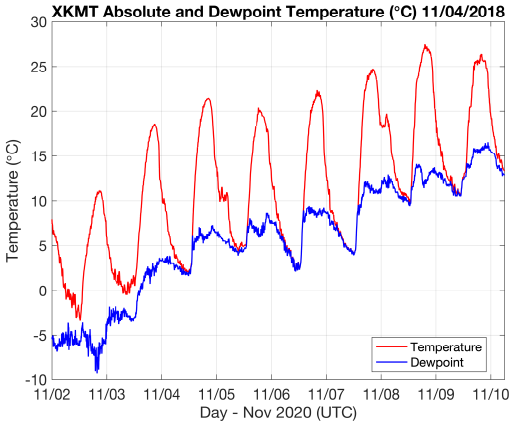


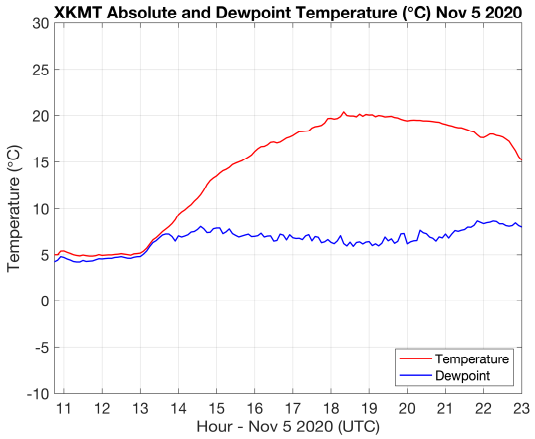


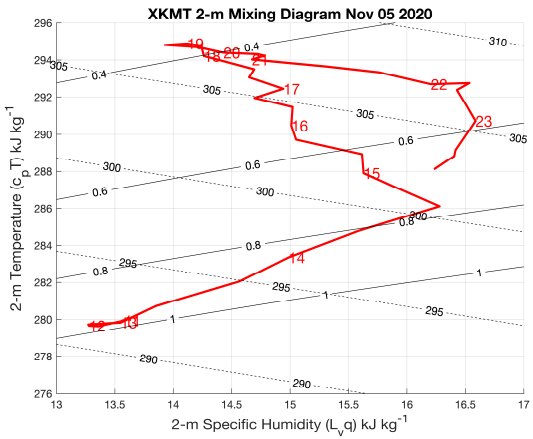
- Note the dual dewpoint peaks during the well-mixed phase of boundary layer diurnal cycle:
  - Peak 1: Rapid moistening after sunrise prior to explosive PBL growth
  - Peak 2: Moisture flux convergence due to continued latent heating during the transition to a stable PBL

- Behavior between the two peaks dependent on the land surface state, particularly the soil moisture
  - Slow decline in midday dewpoint if moisture fluxes cannot compensate entrainment heating/drying
  - Slow increase if soil moisture sufficiently large to maintain a large Bowen Ratio to reduce sensible heating, PBL growth and subsequent dry air entrainment and mixing

Three-Dimensional Evolution (Cool things Mesonets can do)



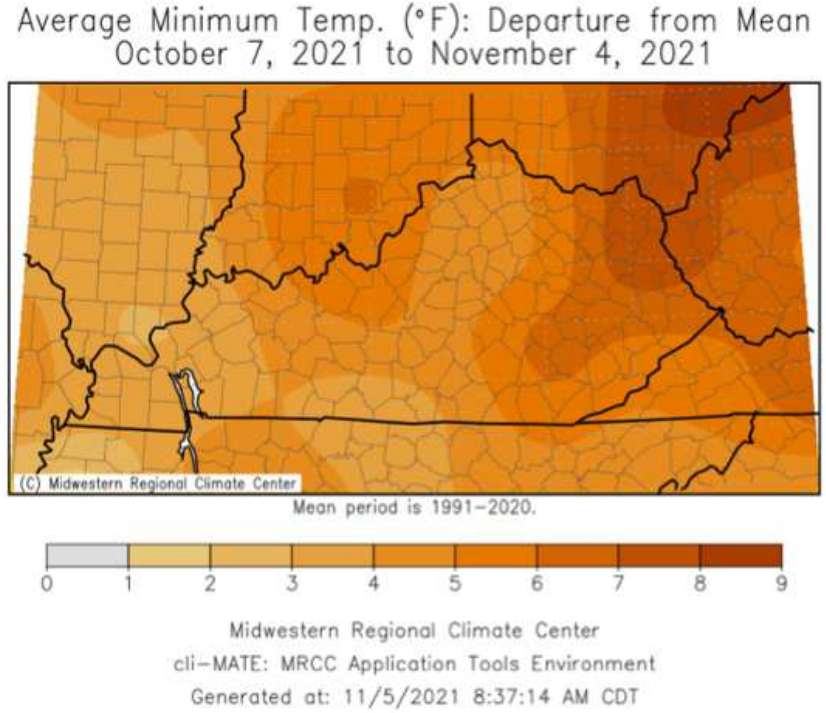




- Mixing Diagrams, or phase space diagrams of moist static energy, allows us to visualize the three-dimensional evolution of surface layer behavior without knowledge of surface or entrainment fluxes:
- **Idealized cycle:**
  - Constant RH (near saturation) period (90-120 minutes) prior to PBL growth
  - Vigorous mixing during explosive PBL growth and entrainment
  - Moist adiabatic drying, the duration of which is dependent upon the land surface state
  - Constant RH moistening as the near surface stability increases with the loss of sensible heating
  - Moist adiabatic moistening as the boundary layer transitions to very stable due to radiative cooling

Climate Indices and Micro-Macro: Tropical Nights Example

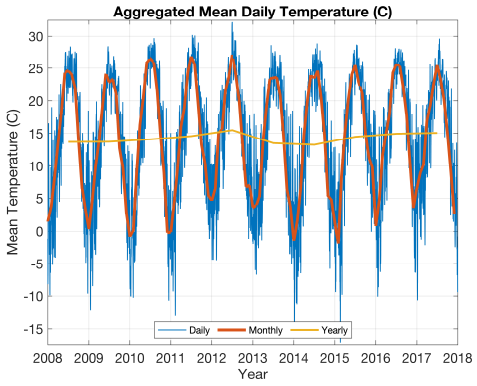
- On the northern edge of the North American energy constrained sub-tropical climate, tropical nights are the most evident impact of climate change.
- Different in Gulf Coastal regions?

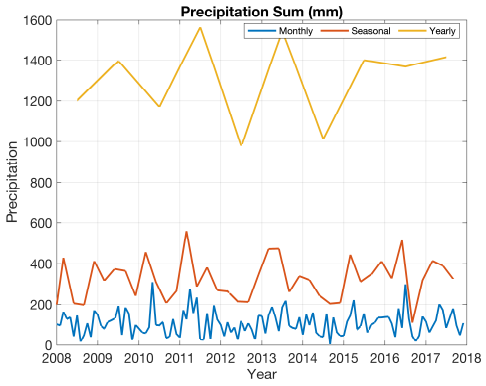


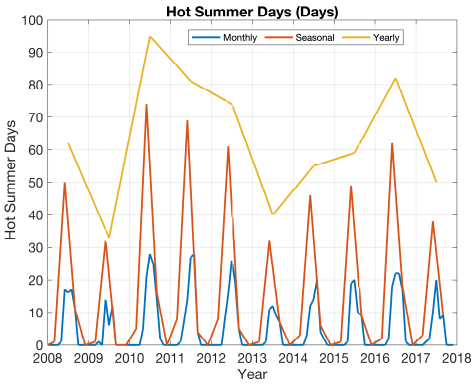
- Underlying Methodology of PREFER (e.g. machine learning with mesonet training data sets) lends itself naturally to find important correlations in the understanding of climate change

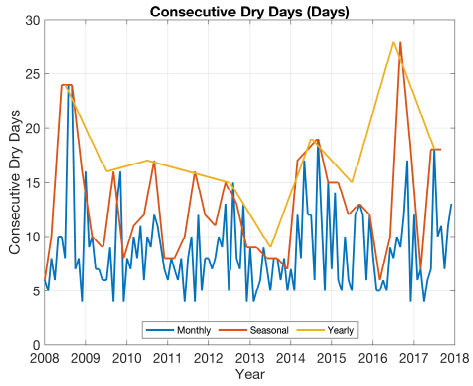
Climate Indices: Aggregate on daily, weekly, monthly, seasonal, and annual timescales

- Temperature, Pressure, Humidity Indices (e.g. Mean, Min., Max values)
- Cold Wave Indices (Growing Degree Days, Frost Days, etc.)
- Heat Wave Indices (15 different definitions of a heat wave)
- Precipitation Indices (e.g. Precipitation sums: see below)
- Wind Indices (e.g. Days with a given wind direction)
- Heat/Drought Indices (Drought Measures, Reference Evapotranspiration, etc.)
- Compound Indices (e.g. Soil Moisture – Precipitation: next slide)



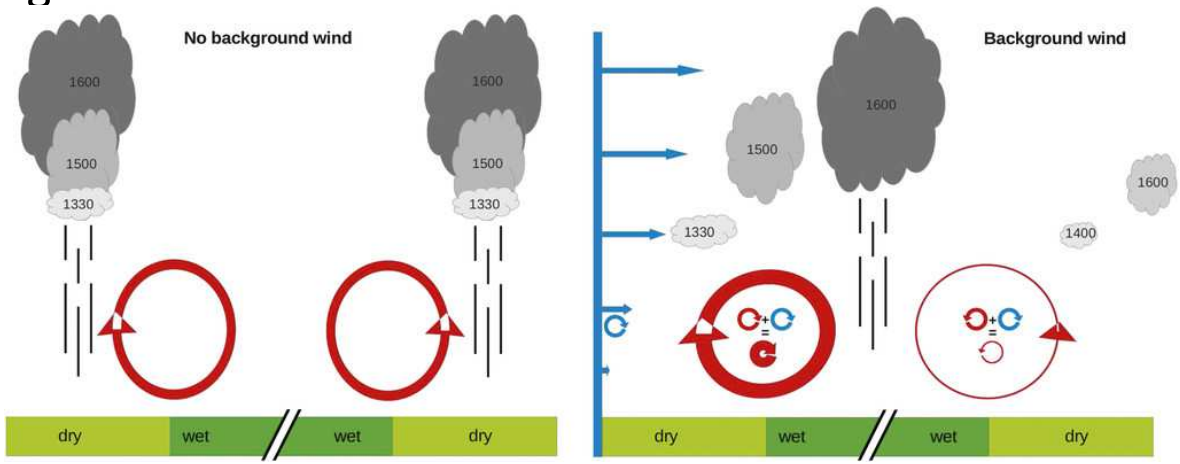






Soil Moisture – Precipitation Feedbacks

- A problem that has vexed meteorologists for decades is the relationship between soil moisture and precipitation
- Transitions between wet and dry soil patches may produce thermal circulations like a land/sea breeze that produce clouds/rain
- Do wet soils promote heavy rain locally or regional/downstream. Does a soil moisture gradient impact the precipitation gradient?
- With a decade plus of soil and precipitation data, the PREFER project can explore a vast treasure of soil moisture-precipitation data and utilize the results for forecasting warm season rainfall.



Froidevaux, P., Schlemmer, L., Schmidli, J., Langhans, W., & Schär, C. (2014). Influence of the background wind on the local soil moisture–precipitation feedback. *Journal of the atmospheric sciences*, *71*(2), 782-799.

Student Engagement

- WKU has 5 students working on this project
  - 1 GIS for map making.
  - 2 working on temperature inversions
  - 2 working on climate indices
- 2 dual student presentations at the upcoming American Meteorological Society Annual Meeting
  - Mesonet Observations of Land-Atmosphere Interactions in an Energy Constrained Climate
  - Climate Statistics for Kentucky based on Mesonet Observations
- REU summer camp preliminary plans?