A survey of PERiLS cold pools

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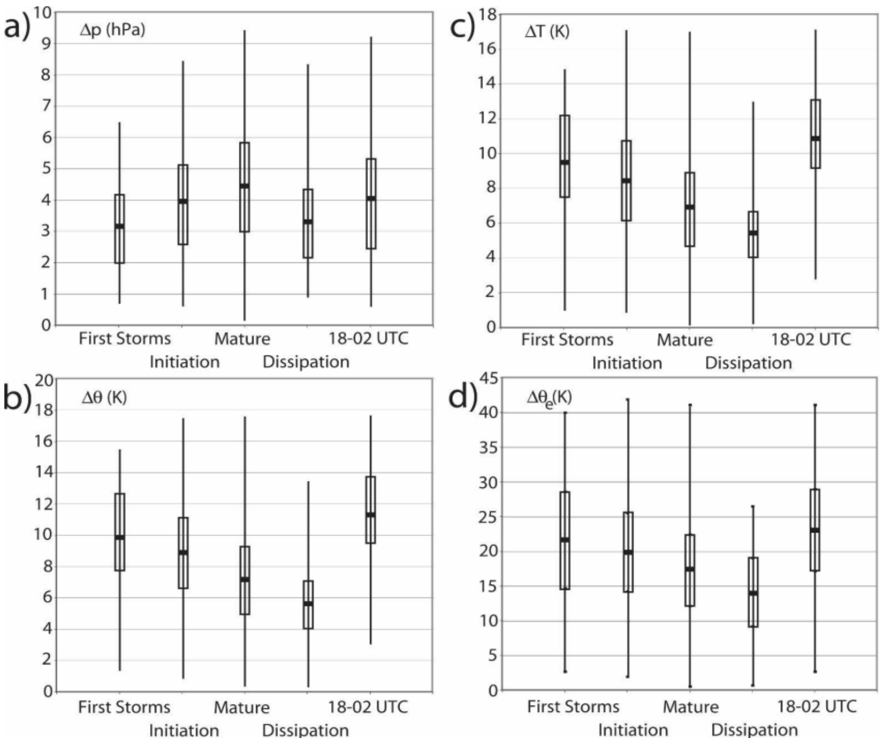
Acknowledgments: NSF grant AGS-2020588; B. Coffer; G. Lackmann; S. Yuter; numerous students and technicians who worked on our teams in the field

Cold pool properties are important for a number of squall line processes

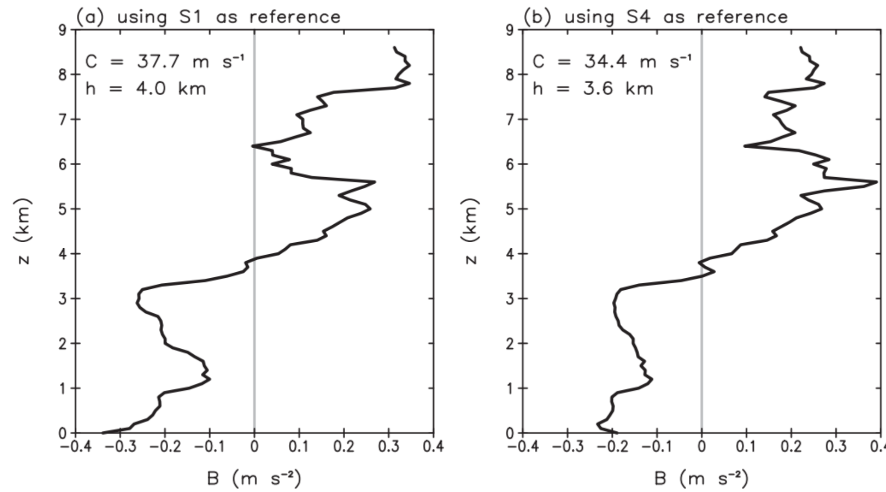
- Lifting that facilitates system maintenance
- Baroclinic generation of horizontal vorticity that might be linked to vortices

COMET: *MCS module*

Engerer et al (2008):
surface observations of 39 Oklahoma QLCSs



Bryan and Parker (2010):
series of soundings from one Oklahoma QLCS

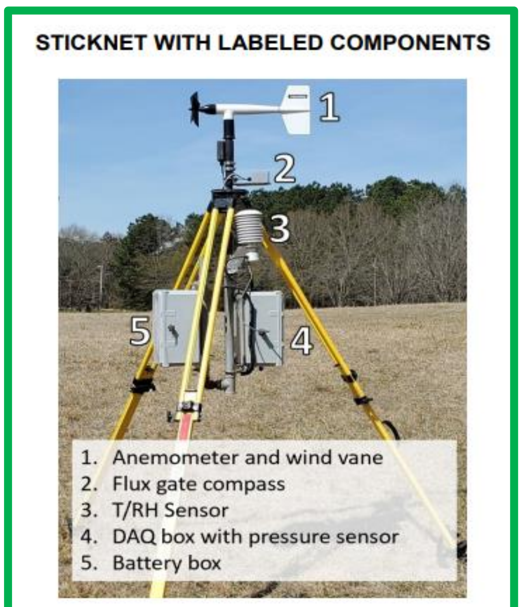


"Perhaps a cold pool 'audit' would be beneficial to the community." –Bryan and Parker (2010)

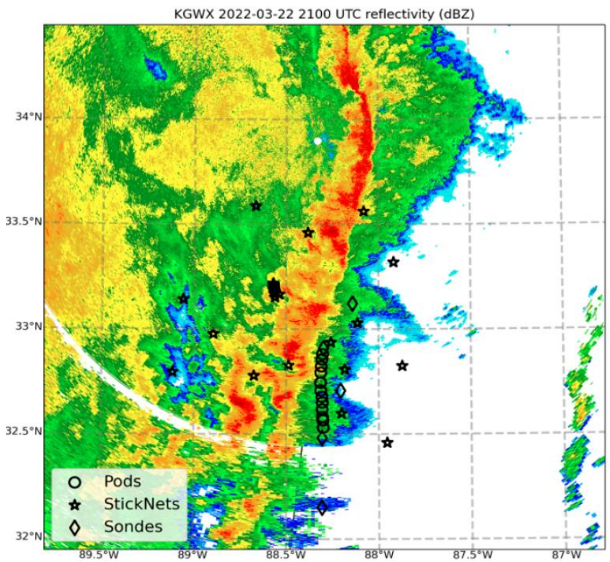
We've had only a few glimpses at cool season/Southeastern QLCS cold pools
(e.g. McDonald and Weiss 2021)

CORE DATASETS (SO FAR)

- 5 NCSU/UIUC/FARM Sounding Systems
- 2-3 NCSU/UIUC/FARM Mobile Mesonets + FARM Pods
- TTU Sticknets (“Stesonet”)
- Y1 full QC, Y2 pre-QC

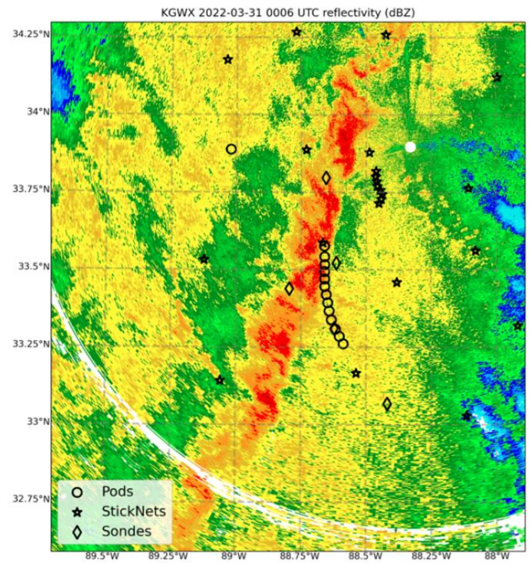


Y1 IOP1



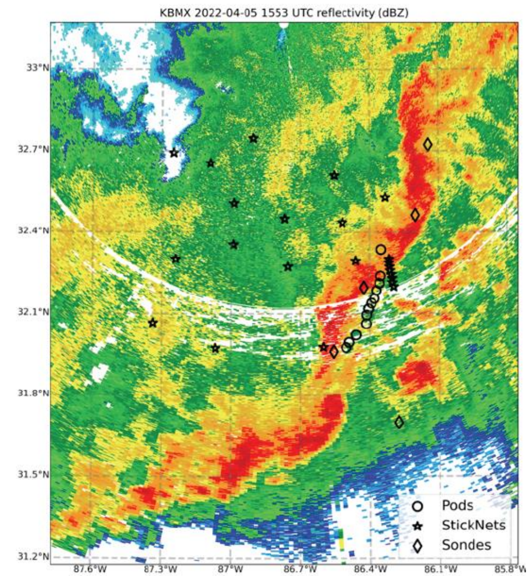
broken line (supercells) filling in

Y1 IOP2



classic HSLC QLCS

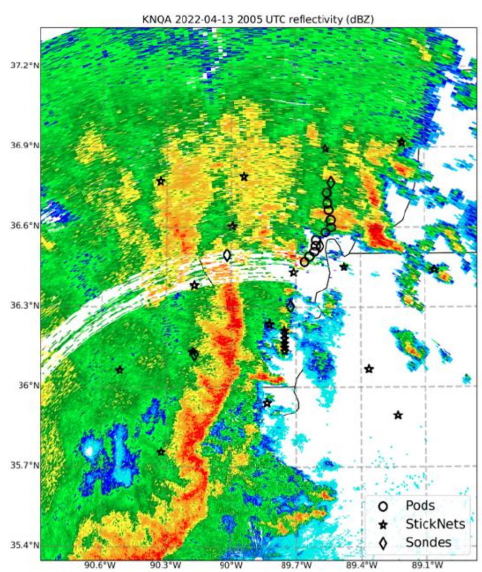
Y1 IOP3



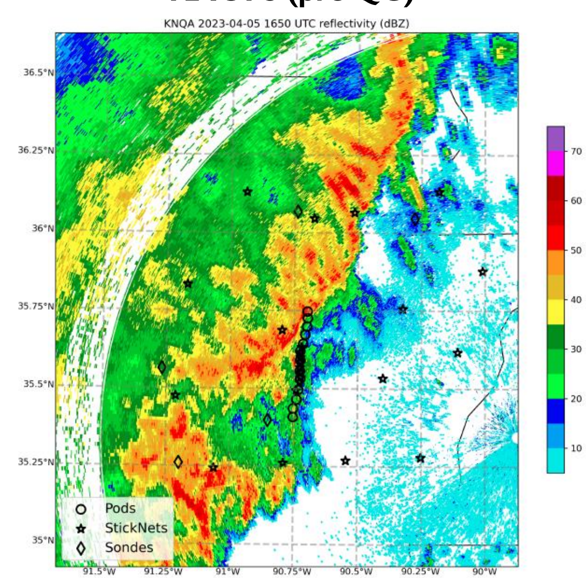
heavy pre-QLCS precip

Y1 IOP4

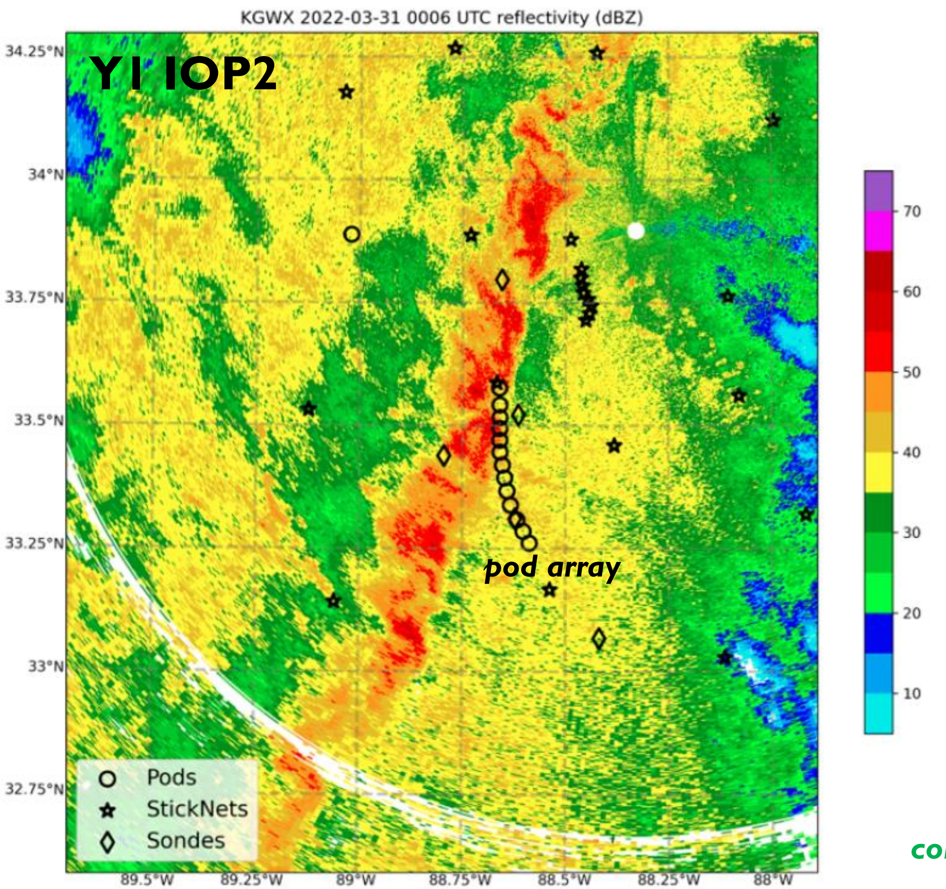
broken line (near miss for soundings and pods)

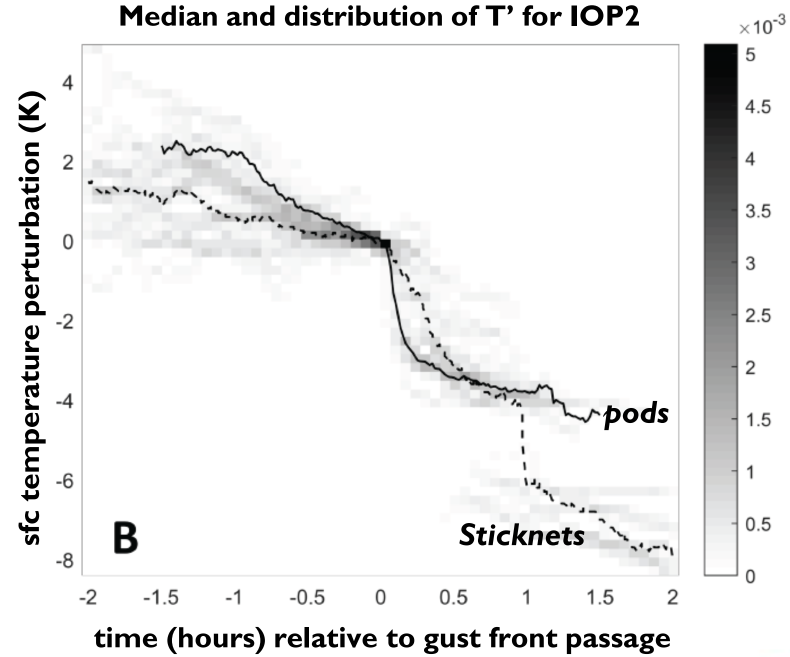


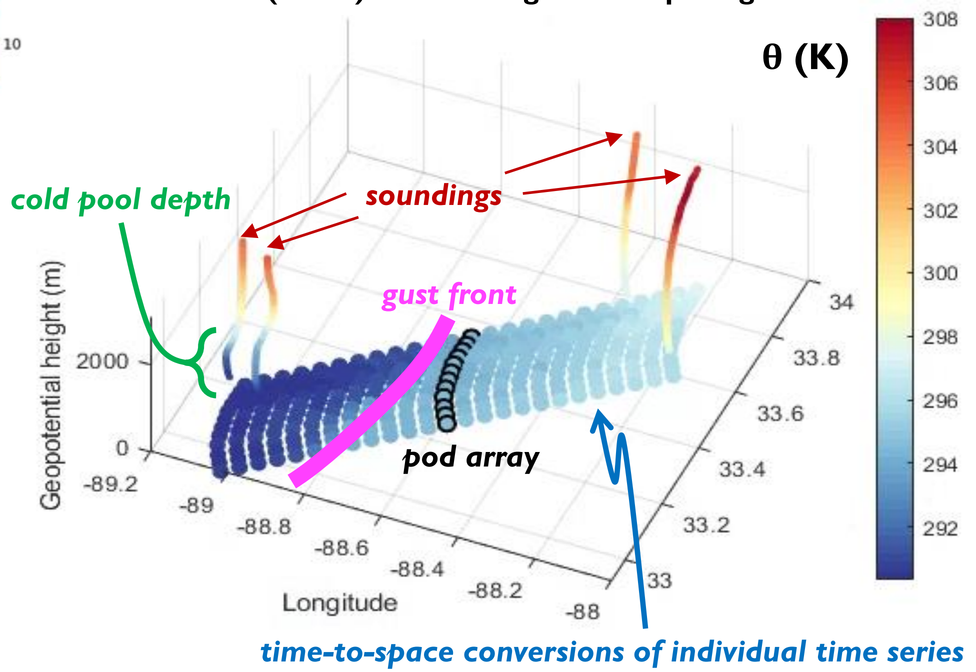
Y2 IOP5 (pre-QC)



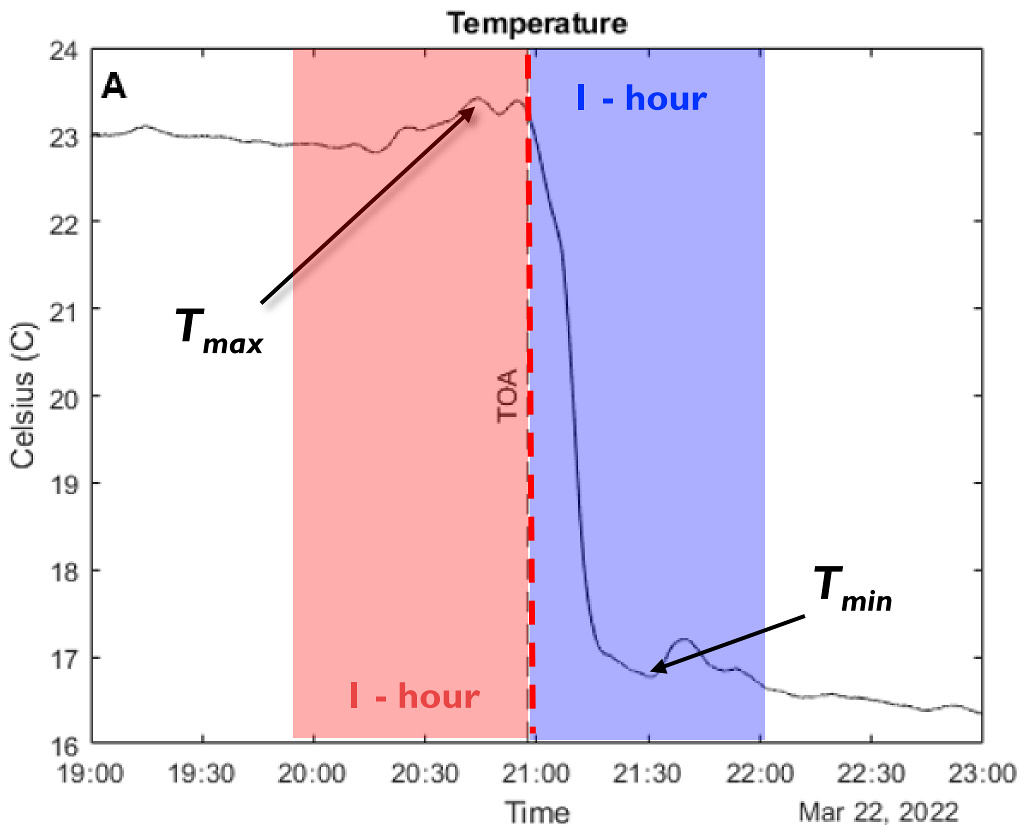
highest CAPE in PERiLS


KGWX 2022-03-31 0006 UTC reflectivity (dBZ)
Y1 IOP2
pod array
Pods
StickNets
Sondes
34.25°N
34°N
33.75°N
33.5°N
33.25°N
33°N
32.75°N
89.5°W
89.25°W
89°W
88.75°W
88.5°W
88.25°W
88°W
70
60
50
40
30
20
10


Median and distribution of T' for IOP2
sfc temperature perturbation (K)
time (hours) relative to gust front passage
B
pods
Sticknets
×10^-3


θ (K)
cold pool depth
soundings
gust front
pod array
Geopotential height (m)
Longitude
time-to-space conversions of individual time series

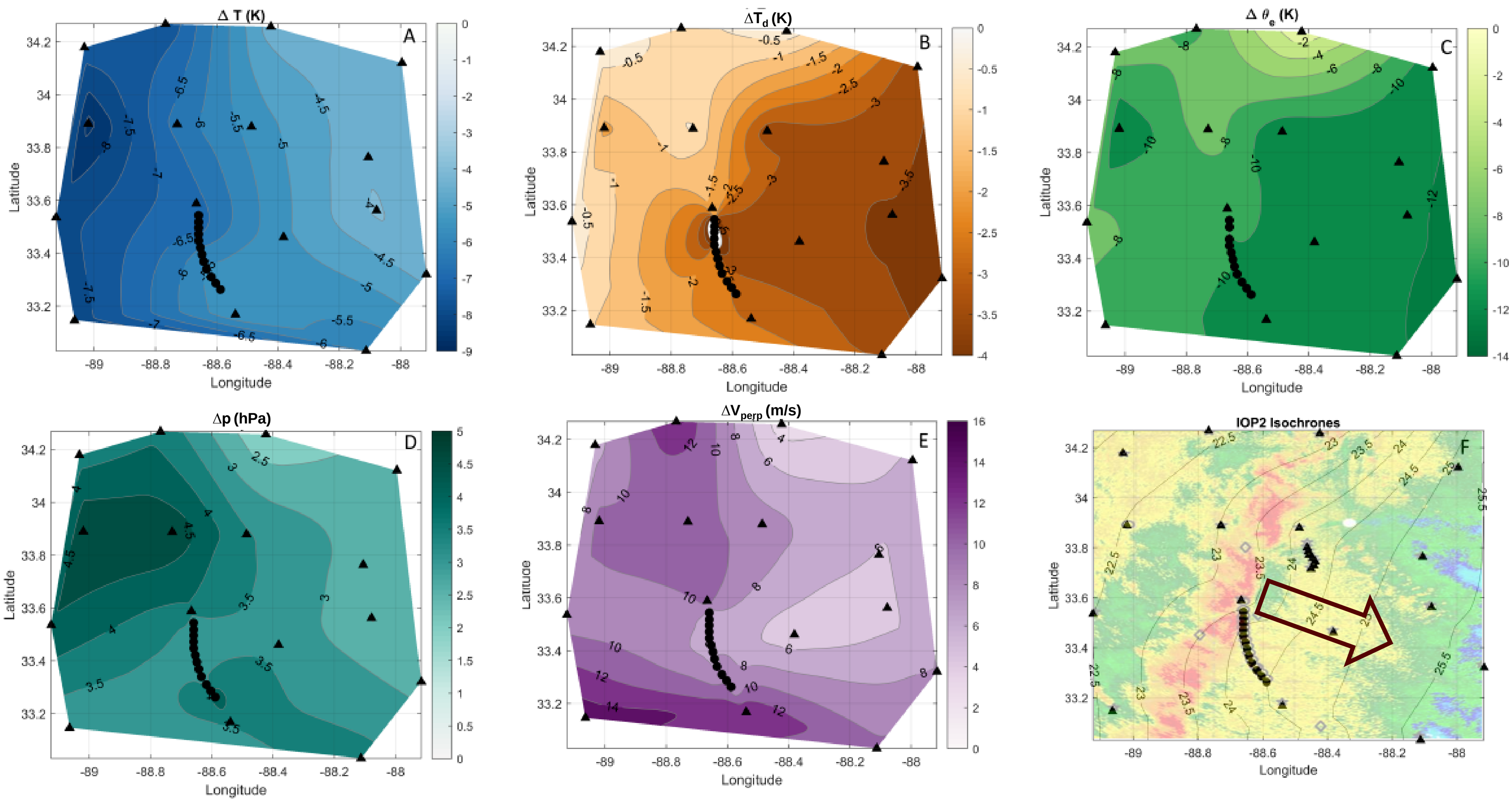
In surface observations, cold pools are characterized via changes (Δ) across the gust front



$$\Delta T = T_{max} - T_{min}$$

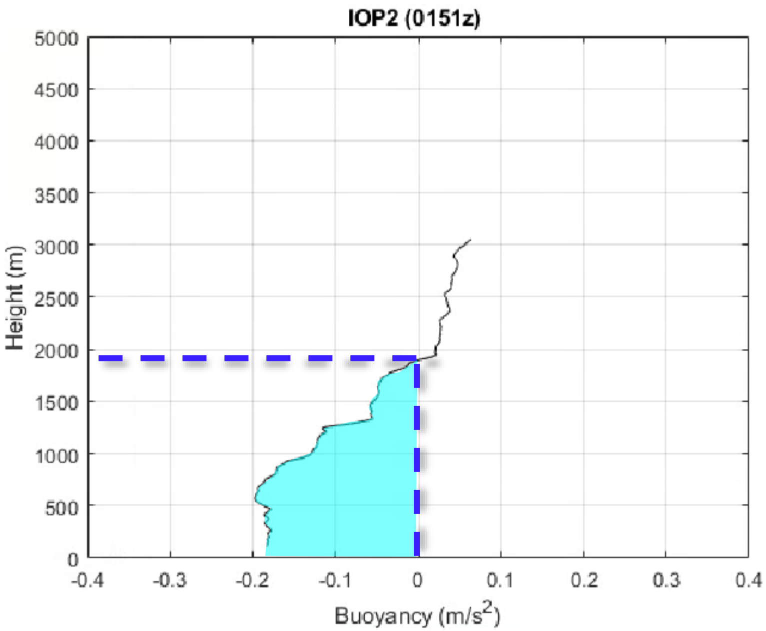
ΔT – Temperature
ΔT_d – Dewpoint
Δp – Pressure
ΔV_{perp} – Line-perpendicular surface wind (not the RKW thing)
$\Delta \theta_e$ - Equivalent Potential Temperature

As the cold pool crosses the surface array, we can characterize each Δ field at each instrument to capture spatial/temporal trends



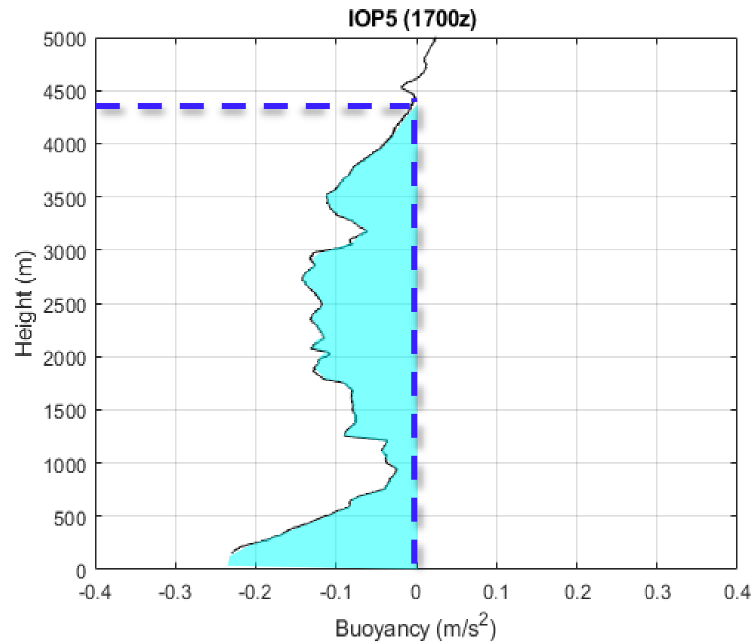
We compute a mean base state from soundings < 1 hour before gust front arrival and derive depth ("h") and intensity ("C") via the relative buoyancy profiles of soundings within the cold pool

Representative PERiLS cold pool profile (Y1 IOP2)



h = 1890 m
C = 21.0 m/s

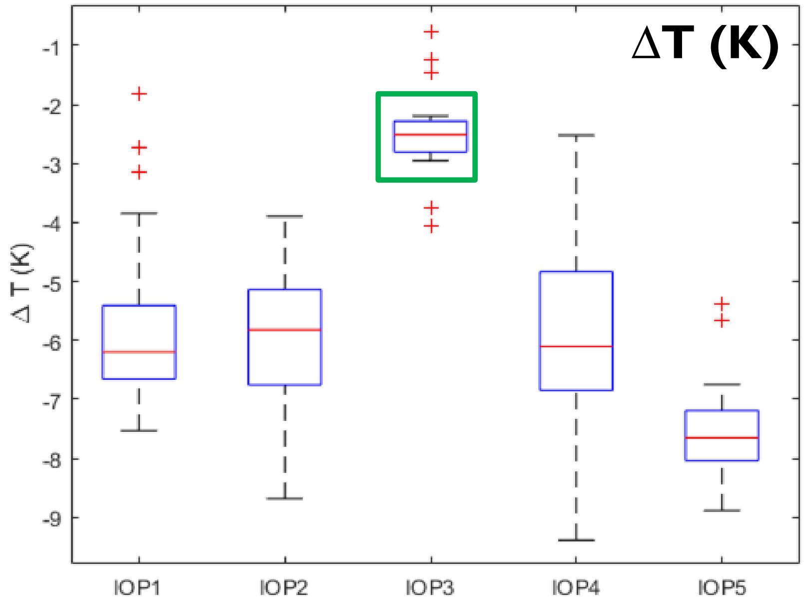
Strongest PERiLS cold pool profile (Y2 IOP5)

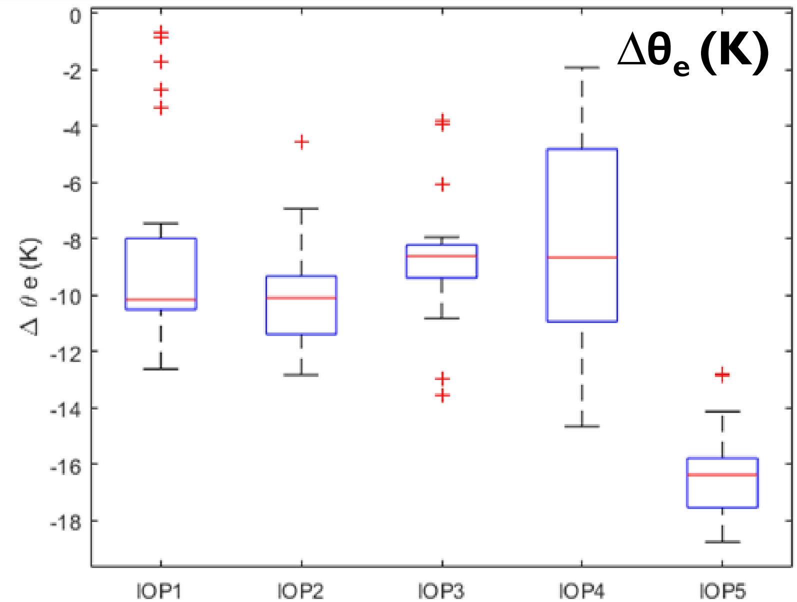


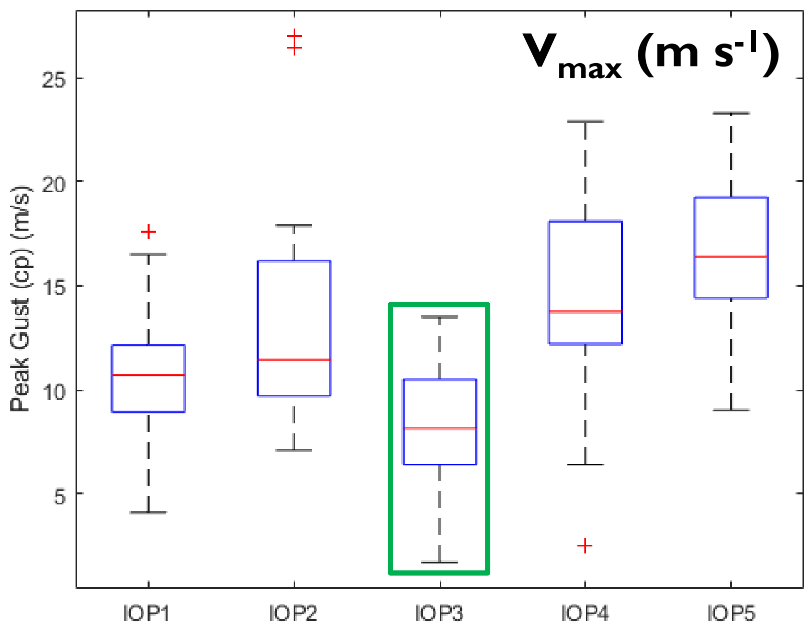
h = 4370 m
C = 27.7 m/s

$$C^2 = -2 \int_{sfc}^{h} B \, dz$$

Box and whisker plots of distributions

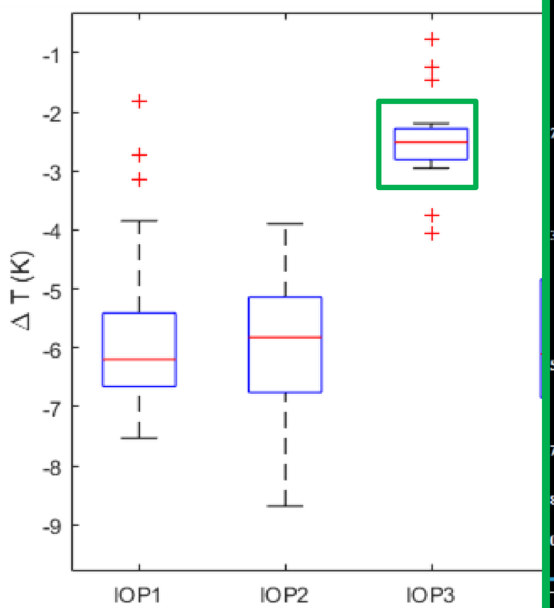


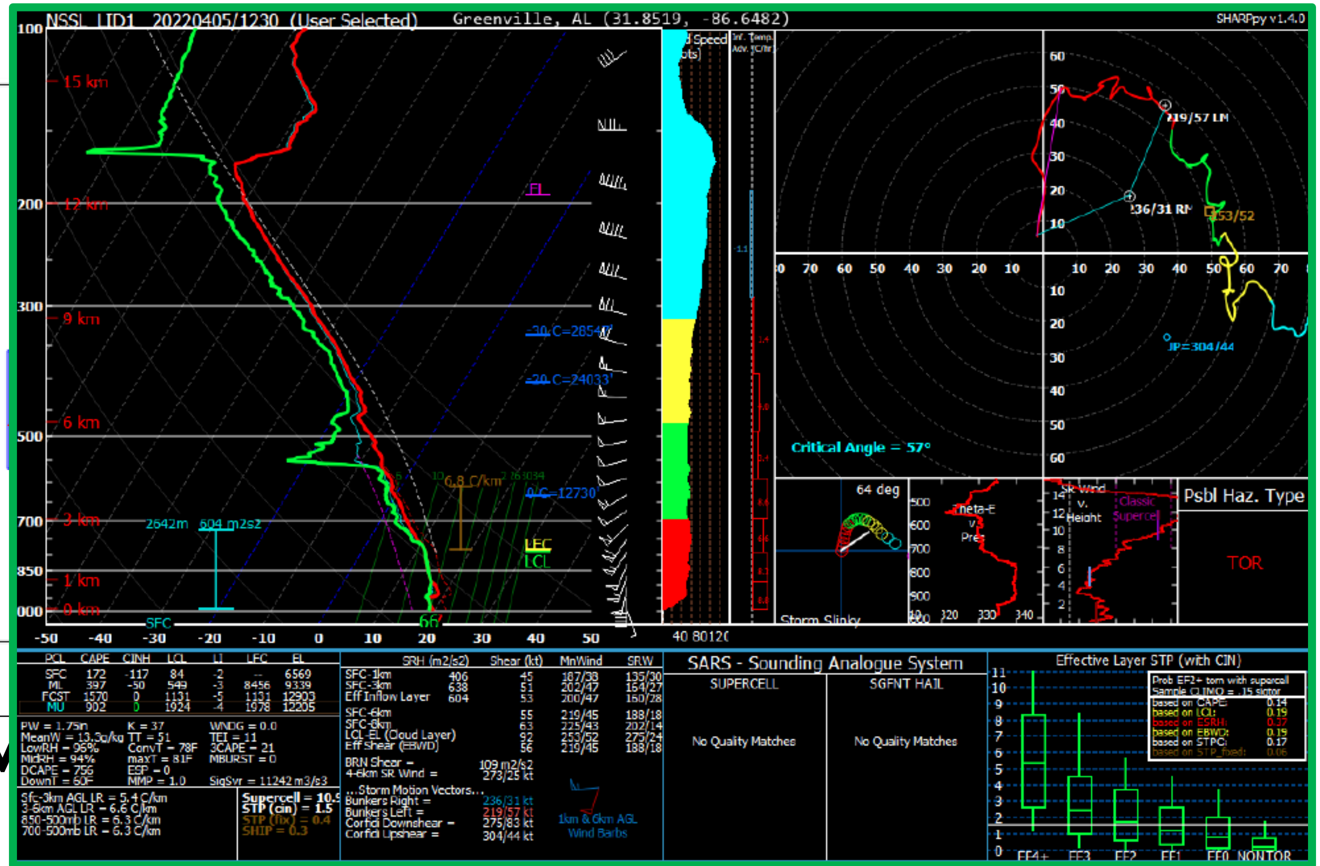


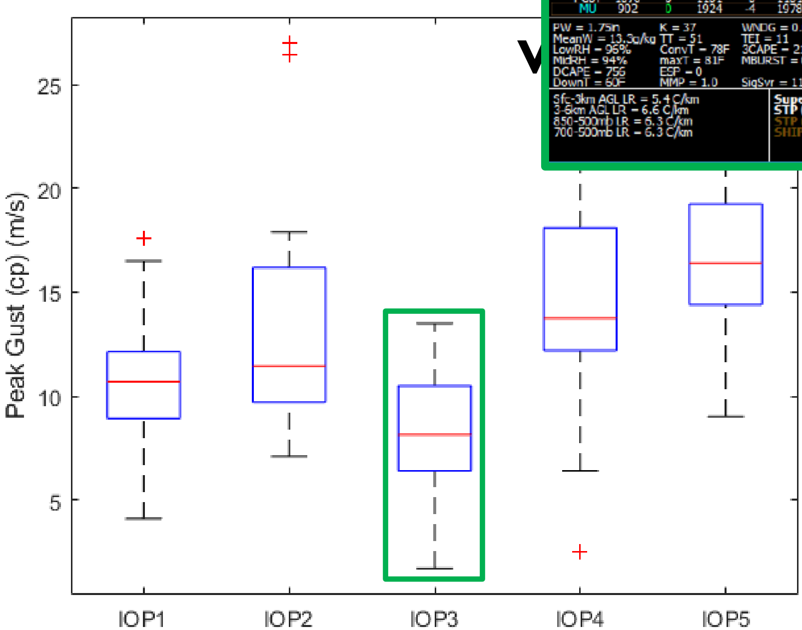


Generally: Consistency from case to case

IOP3: Nearly-saturated environment: almost no cooling!







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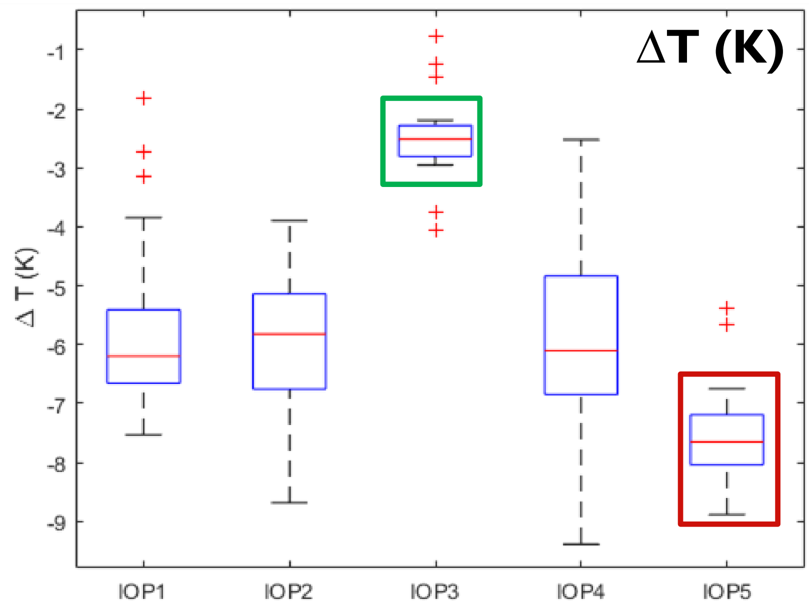

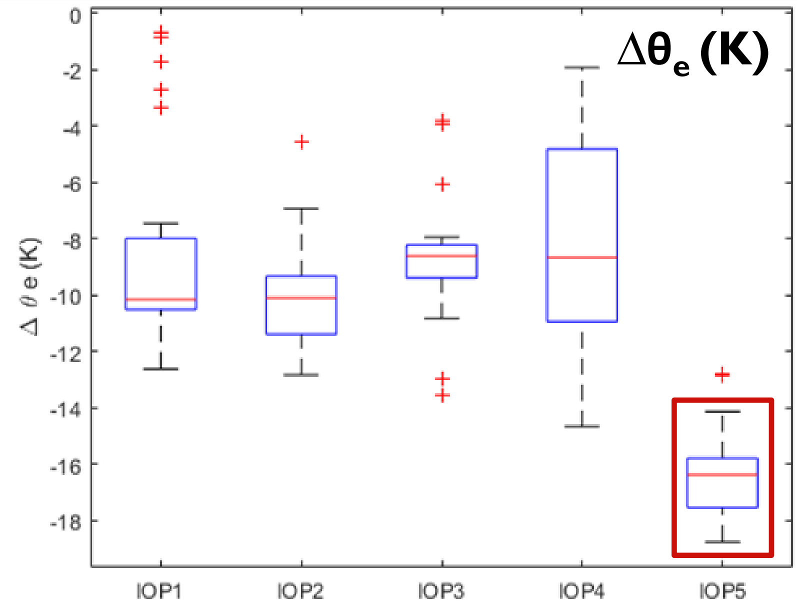

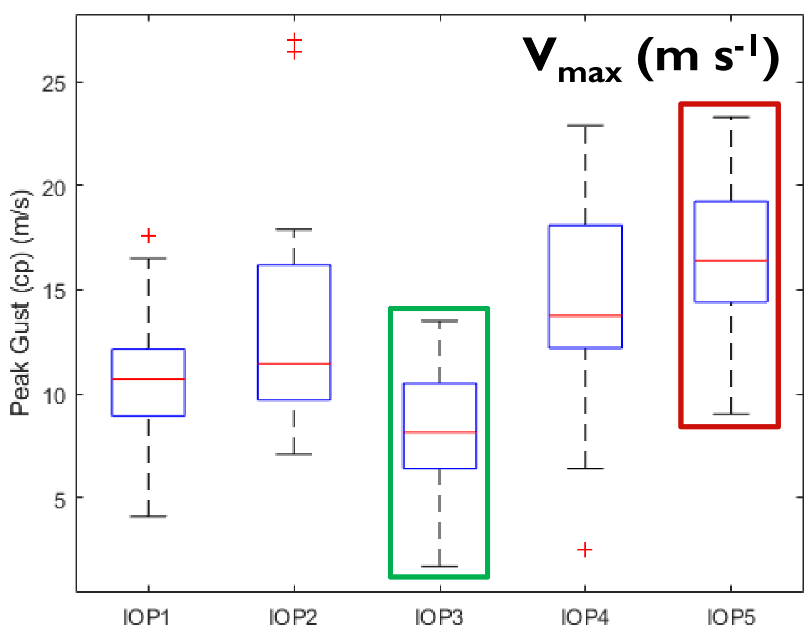

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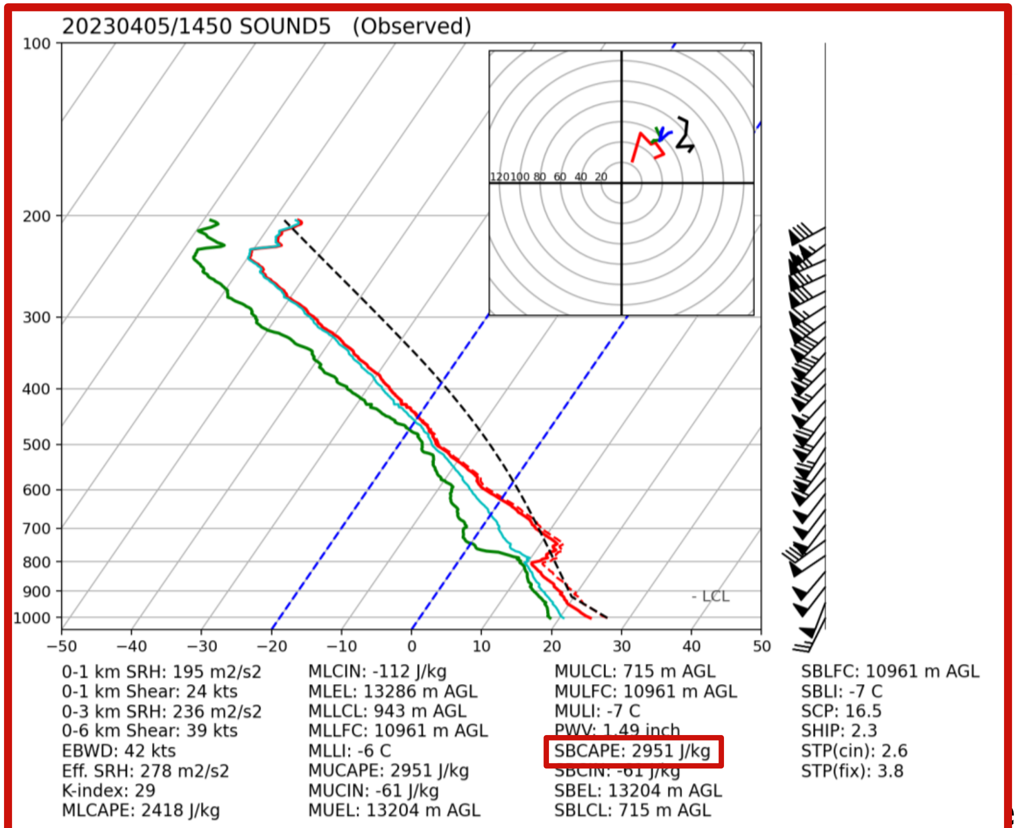
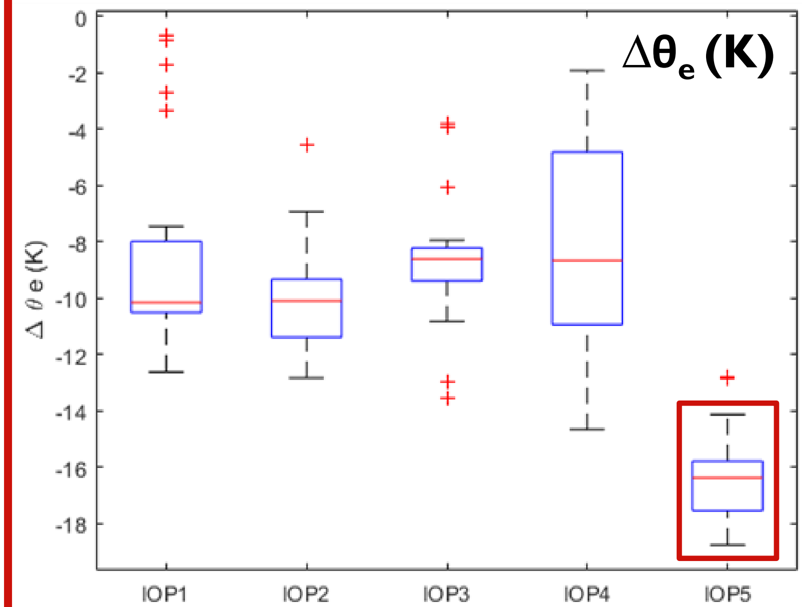
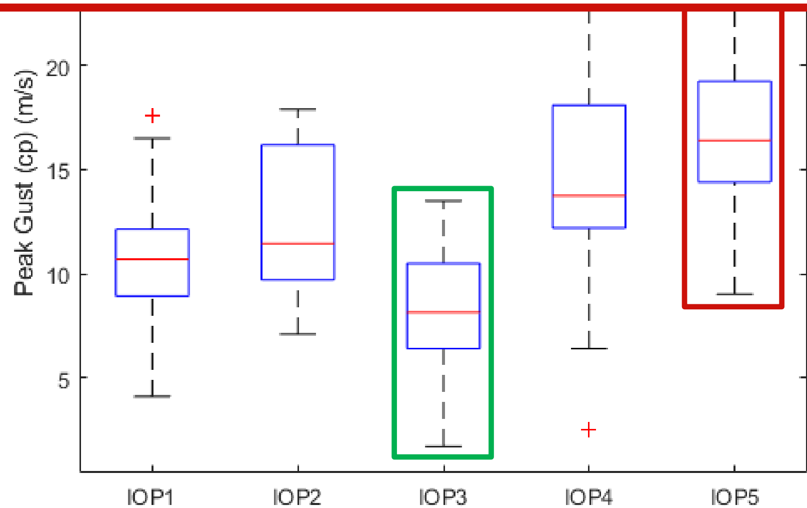
IOP3: Nearly-saturated environment: almost no cooling!

Y2 IOP5: Coldest outflows, very low θ_e : highest CAPE, driest mid-levels



of distributions





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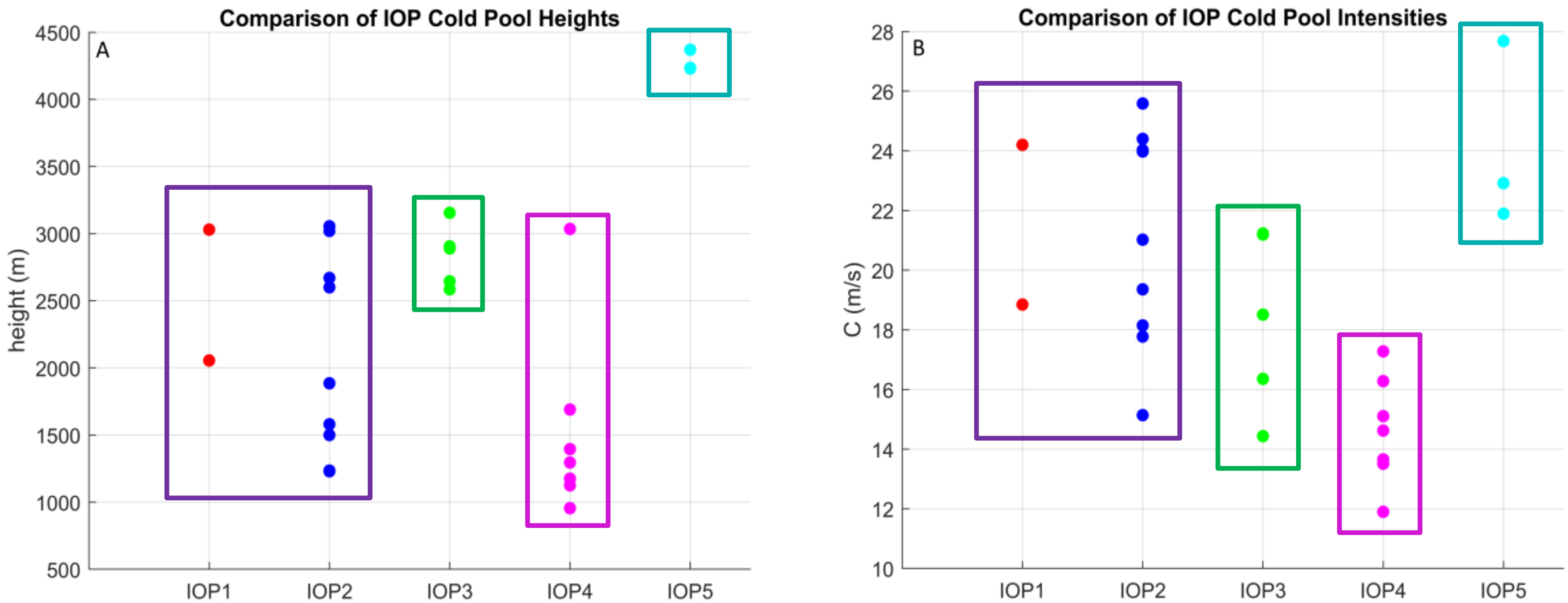


IOPs 1-2: Perhaps the cases that "typify" Southeastern HSLC cold pools?

IOP3: Nearly-saturated environment: cold pools deep but weak

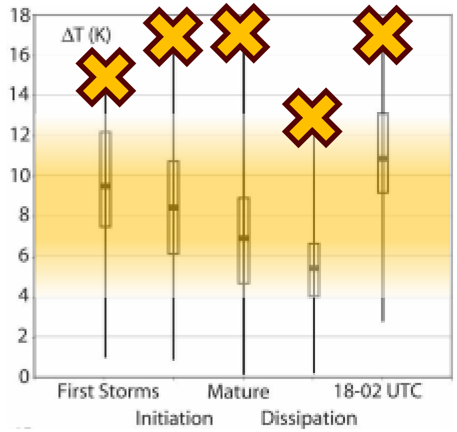
IOP4: Probably under-sampled (broken line); a singular deep cold pool ob

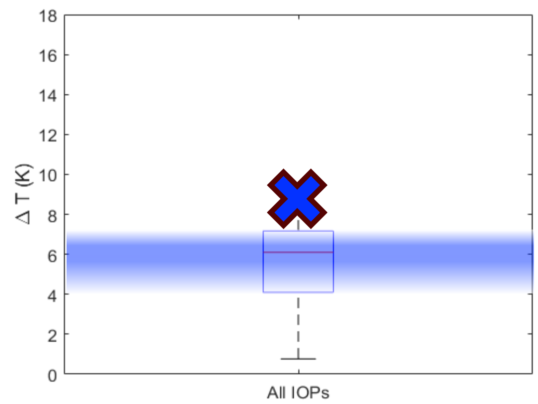
Y2 IOP5: Most "Plains-like" cold pools (deepest and coldest: high CAPE, dry mid-levels)

Box and whisker plots of distributions

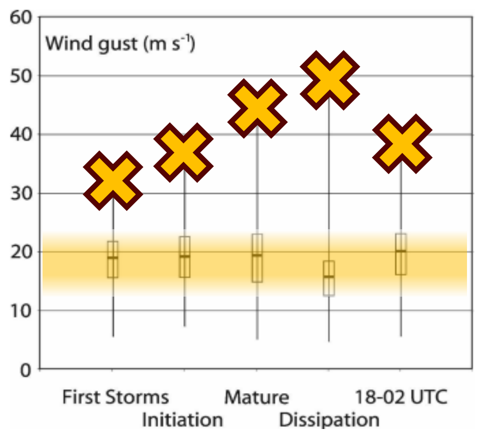
Great Plains values from Engerer et al (2008)

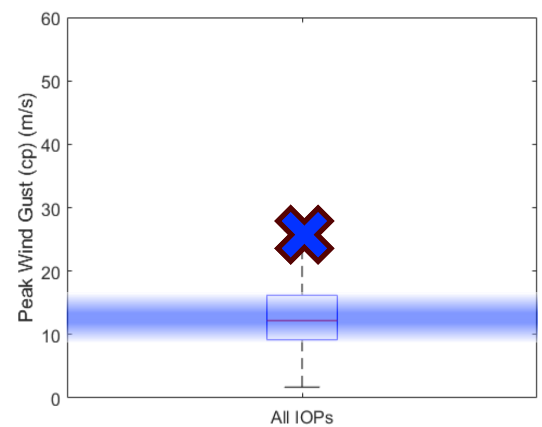
PERiLS surface observations across 5 cases





cold pool temperature deficits





cold pool peak wind gusts

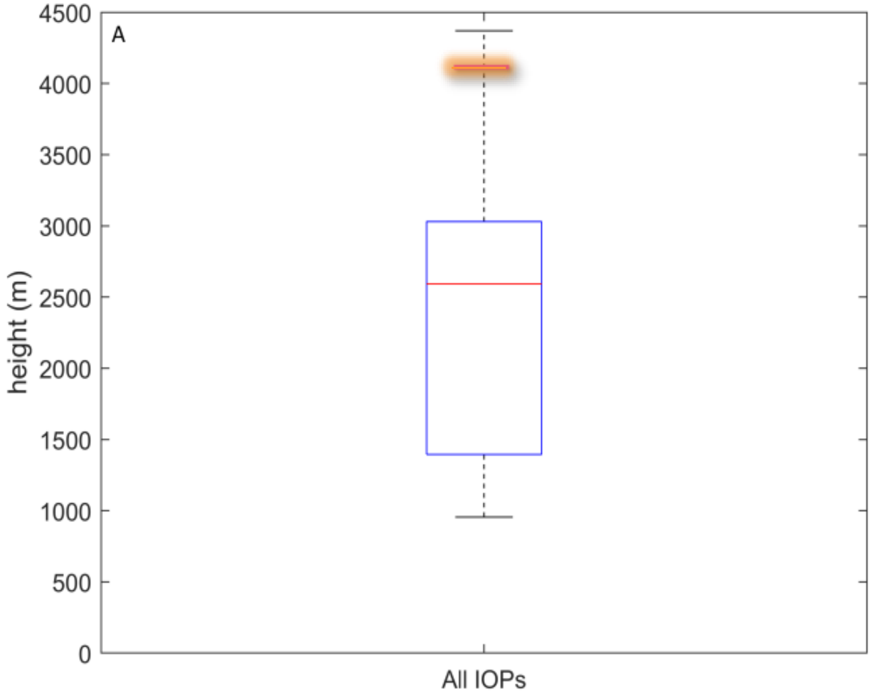
- There is some overlap in terms of typical temperature deficits in PERiLS and Great Plains cold pools.
- But, extreme temperature deficits were comparatively rare in PERiLS.
- And, peak outflow winds were generally weaker than those in the Plains.

Box and whisker plots of distributions

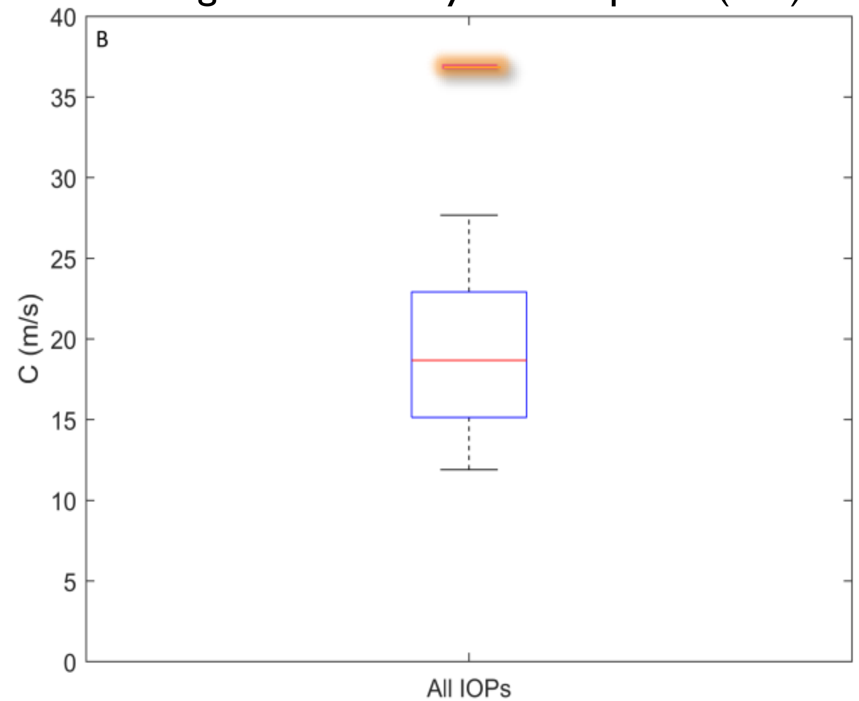
$$C^2 = -2 \int_{sfc}^{h} B \, dz$$

PERiLS sounding observations across 5 cases vs.
Great Plains values from Bryan and Parker (2010)

depth of cold pools (m)



integrated intensity of cold pools (m/s)



- Cold pools in PERiLS were almost always shallower and of lower integrated intensity ("C") than Great Plains cold pools.

All of the cold pools in ~~PILSNER~~ ~~ELVIS~~ PERiLS would be considered weaker than those studied in higher-CAPE midlatitude environments, typically being both less-cold and shallower than those studied by Engerer et al. (2008) and Bryan and Parker (2010).

- Lower CAPE
- Higher lower tropospheric RH
- Y2 IOP5 serves as a partial counter-example

Nevertheless, these QLCSs generally:

- Were long-lived
- Produced severe winds
- Exhibited mesovortices and often tornadoes

Perhaps even modest cold pools are sufficient for many QLCS processes… what does C look like vs. environmental ΔU? What is the large scale forcing doing? <u>What other PERiLS datasets could be brought to bear?</u> The saga continues…

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