



# BASIC APPLICATION OF THE SKEW-T AND HODOGRAPH

IN SEVERE WEATHER FORECASTING

## I. THE SKEW-T

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# I. REVIEW



# FORECASTING SEVERE CONVECTIVE STORMS

**S.L.I.M**

**SHEAR. LIFT. INSTABILITY. MOSITURE.**

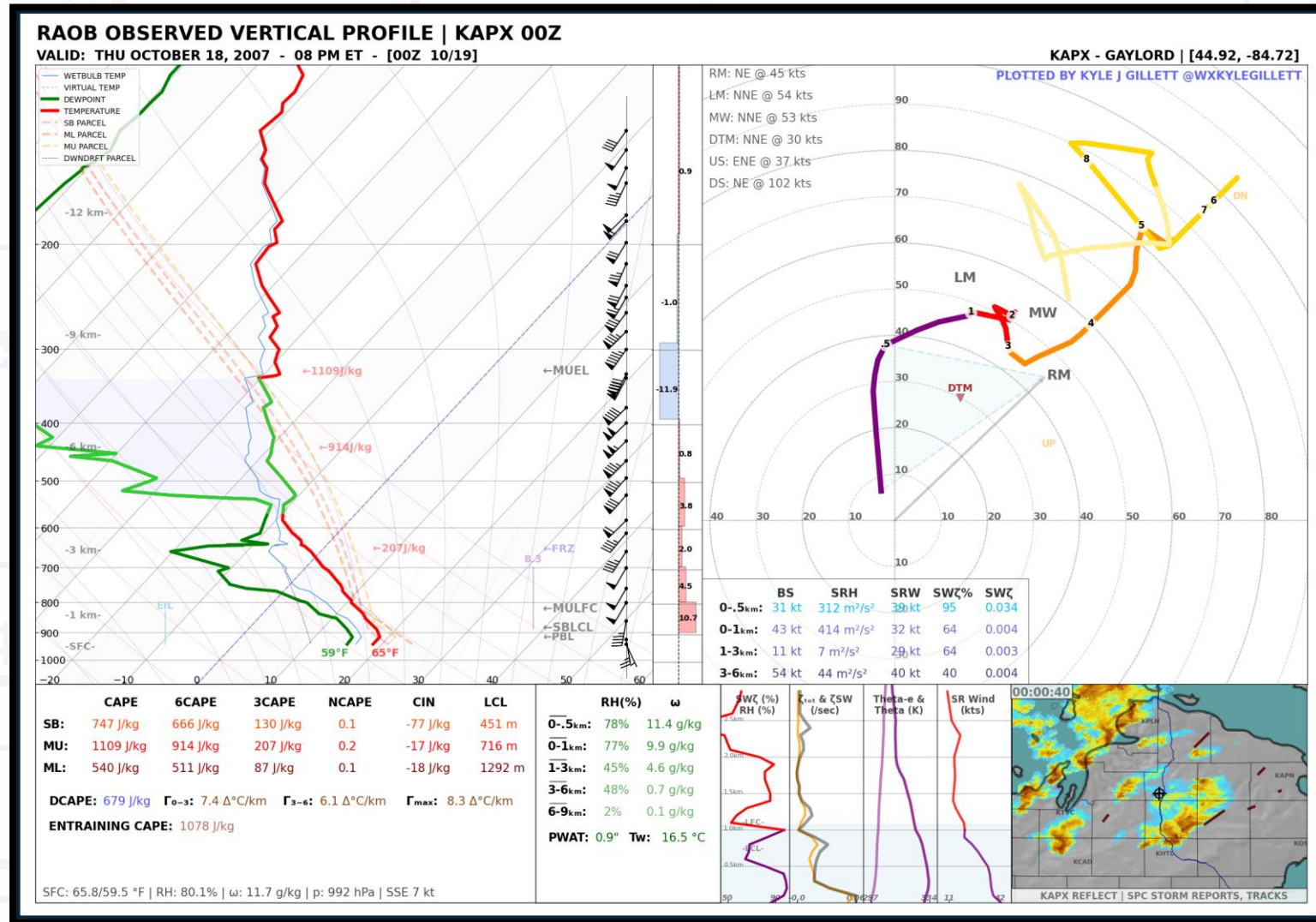


# WHAT'S A SOUNDING?

TEMPERATURE  
DEWPOINT  
WIND

**\*\*That's *it!* \*\***

Everything else plotted on  
a sounding is derived from  
those three values

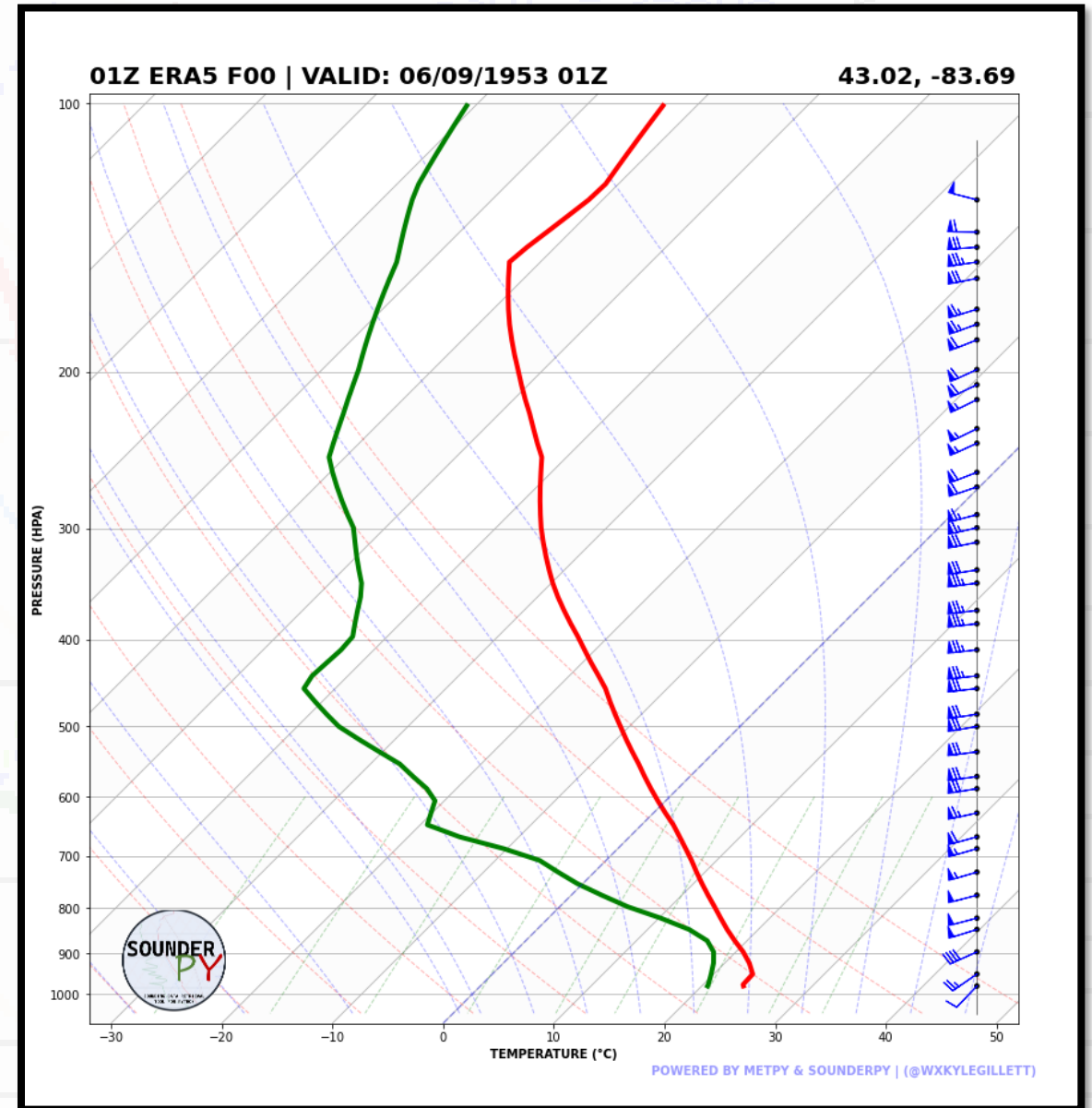


# BASICS TO READING A SKEW-T

**TEMPERATURE**  
**DEWPOINT**  
**WIND**

THUS, WE CAN BEGIN TO  
ANSWER QUESTIONS ABOUT...

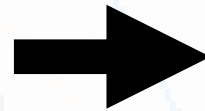
- **INSTABILITY.**
- **MOISTURE.**
- **SHEAR.**



# WHY THE SKEW-T IS IMPORTANT

IF WE CAN ANSWER  
QUESTIONS ABOUT...

- **INSTABILITY.**
- **MOSITURE.**
- **SHEAR.**



THEN, WE CAN \*START\* TO  
ANSWER QUESTIONS  
ABOUT...

- **STORM ORGANIZATION**
- **STORM MODE**
- **STORM THREATS**
- **AND LOTS MORE...**

## II. ASSESSING INSTABILITY





# INSTABILITY: REVIEW

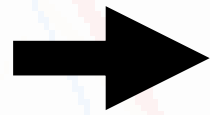
IN THIS SENSE, WE ARE CONSIDERING VERTICAL INSTABILITY

VERY SIMPLY: WE ARE LOOKING AT WHERE AIR IS RISING OR SINKING

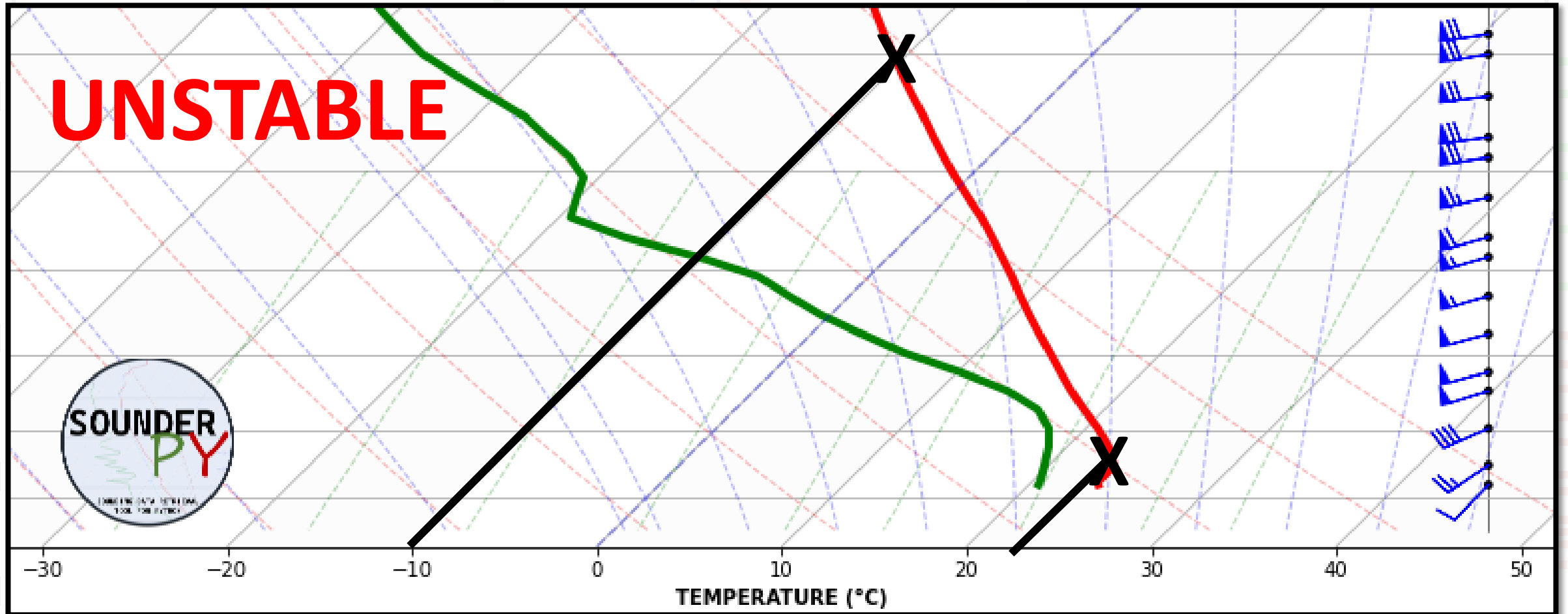
ALSO VERY SIMPLY: STORMS WANT RISING AIR, OR INSTABILITY

# INSTABILITY

SFC: **22°C**

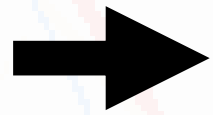


500 hPa: **-10°C**

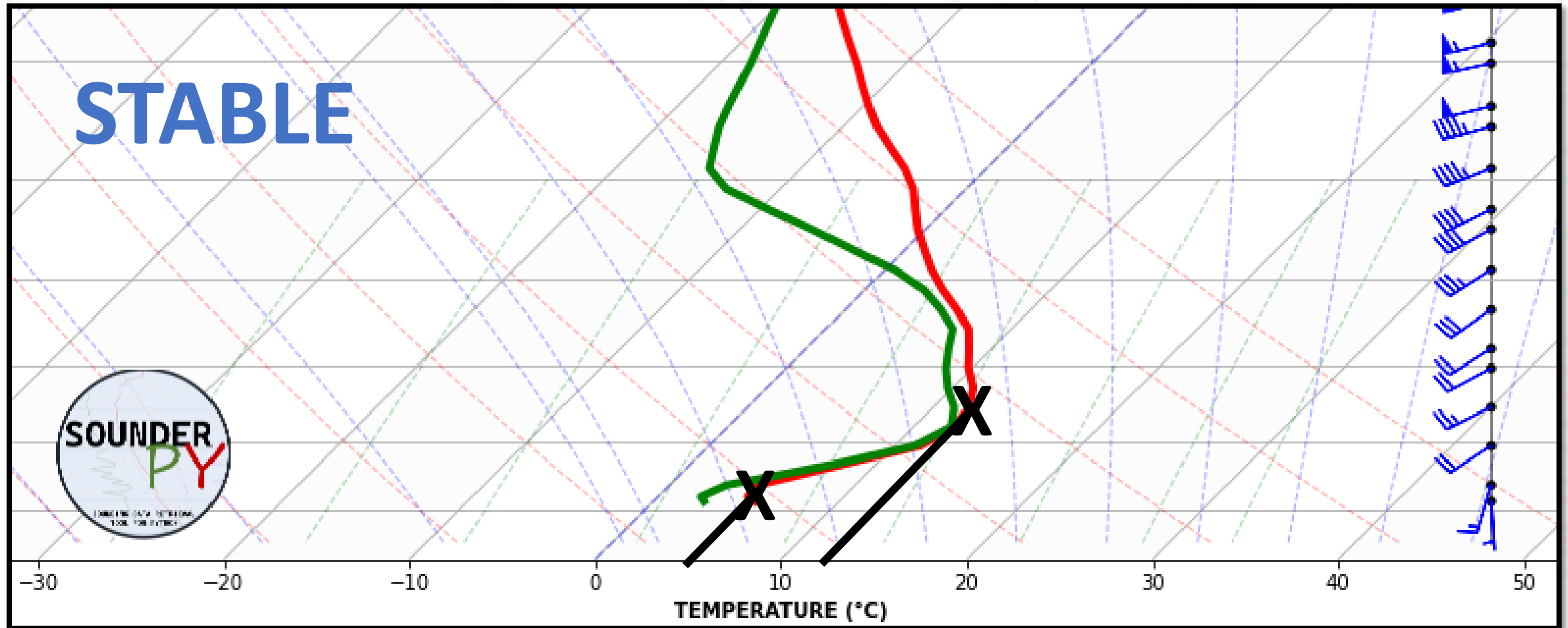


# INSTABILITY

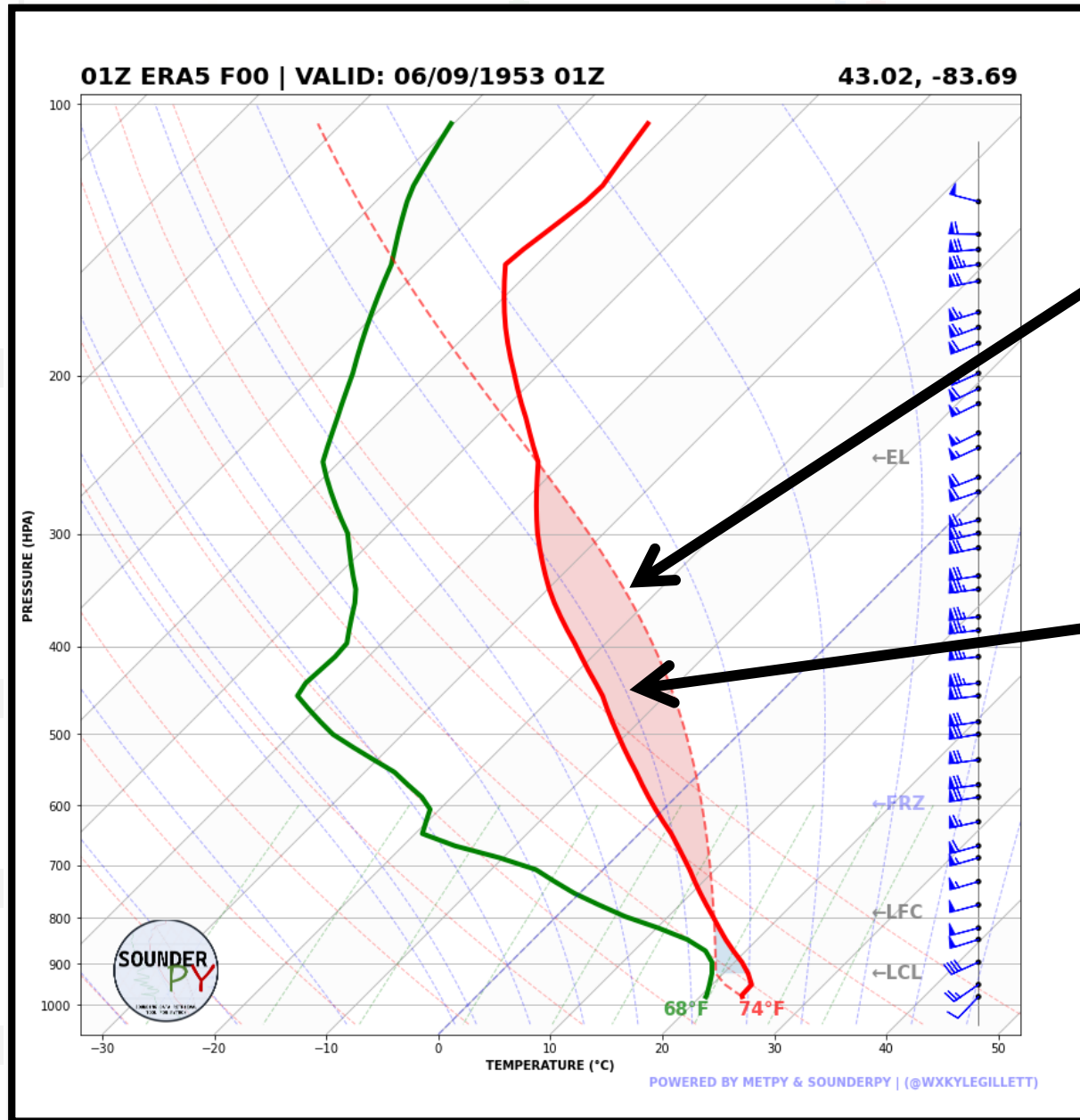
SFC: **5°C**



950 hPa: **12°C**



# ASSESSING PROFILE STABILITY

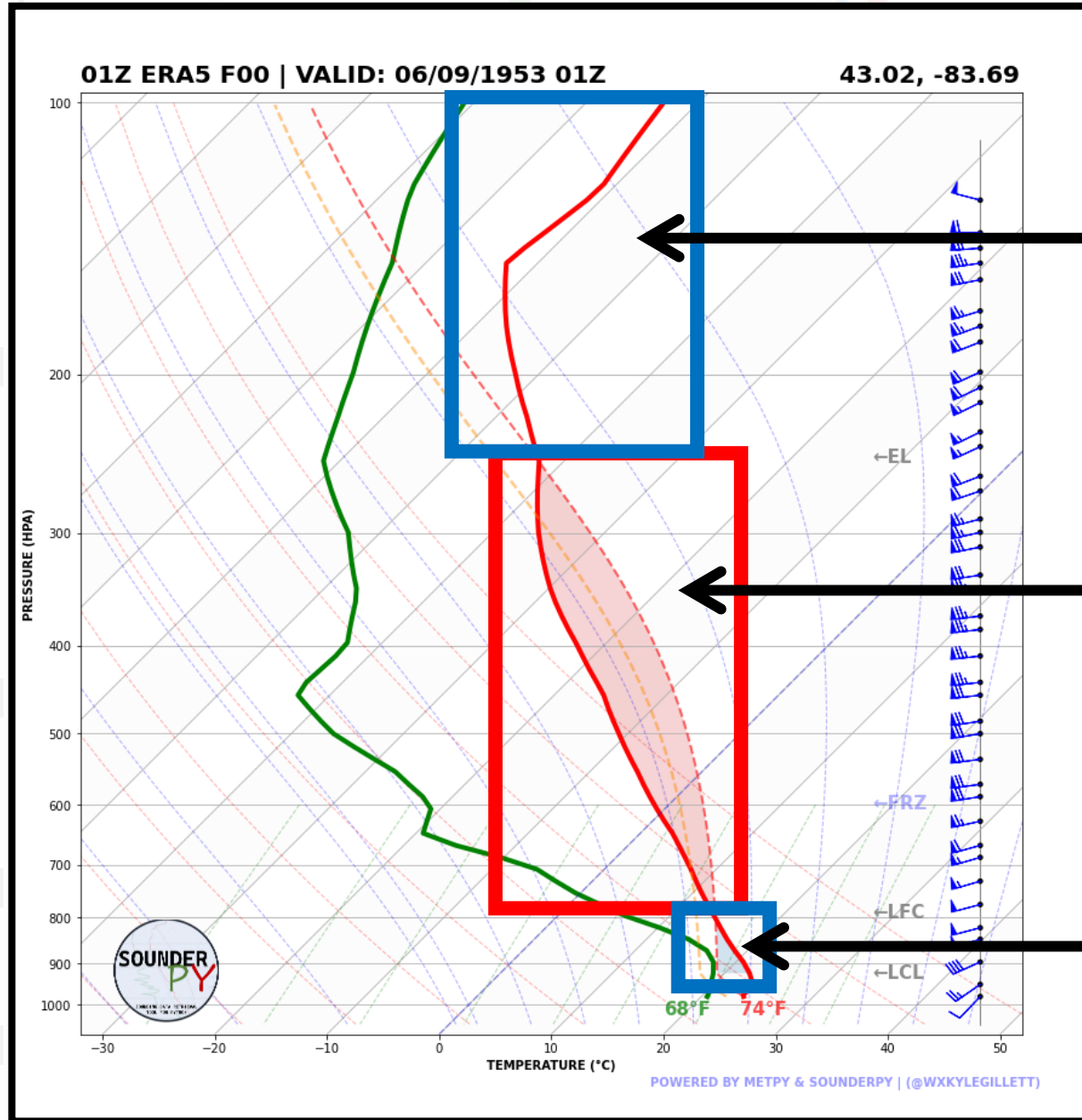


Parcels are unstable where the dashed 'parcel-trace' line is right of the environmental temperature line.

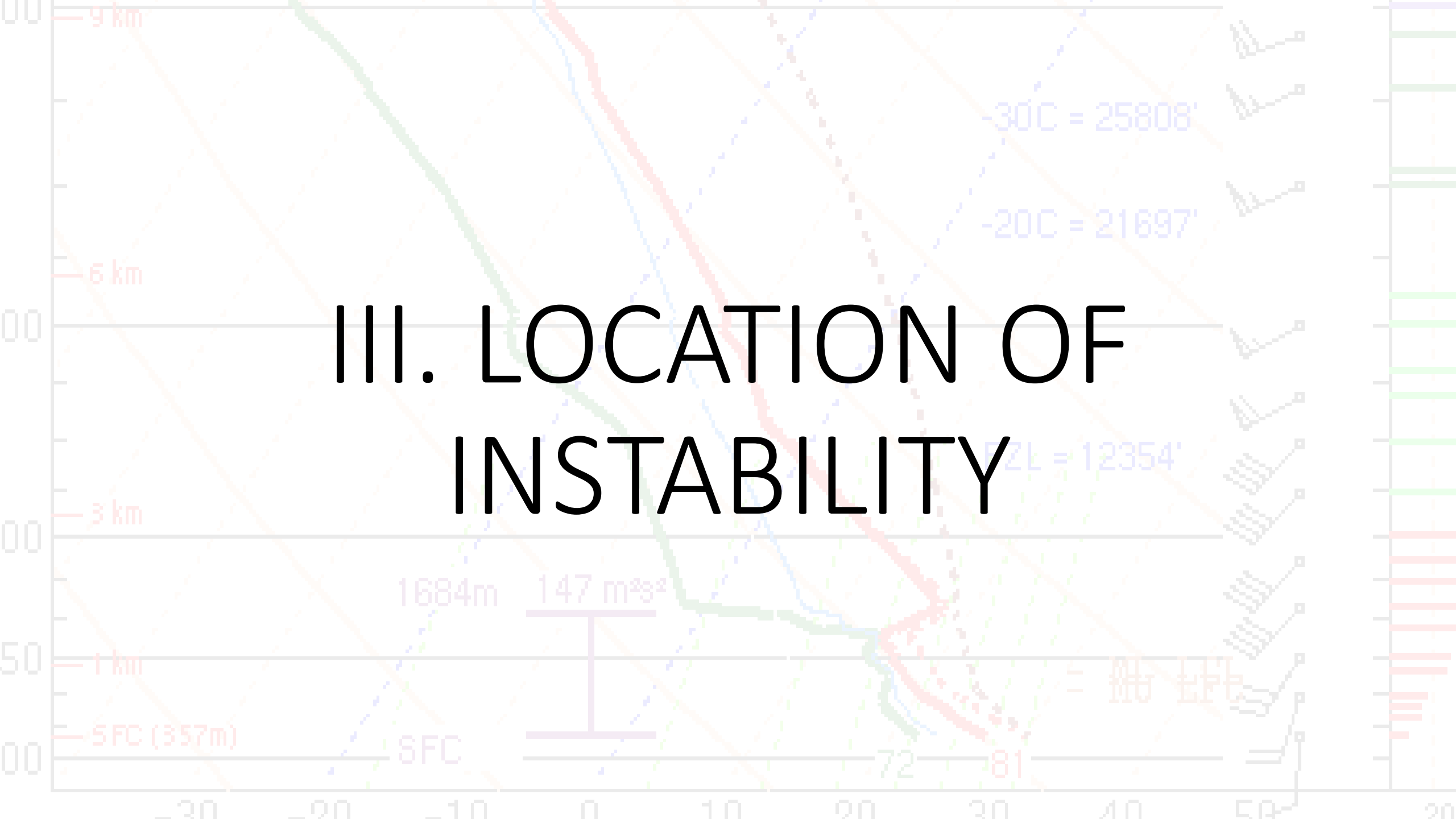
***This is CAPE!***

Conceptually, it's the area between a **lifted parcel's temperature** & the **environmental temperature**.

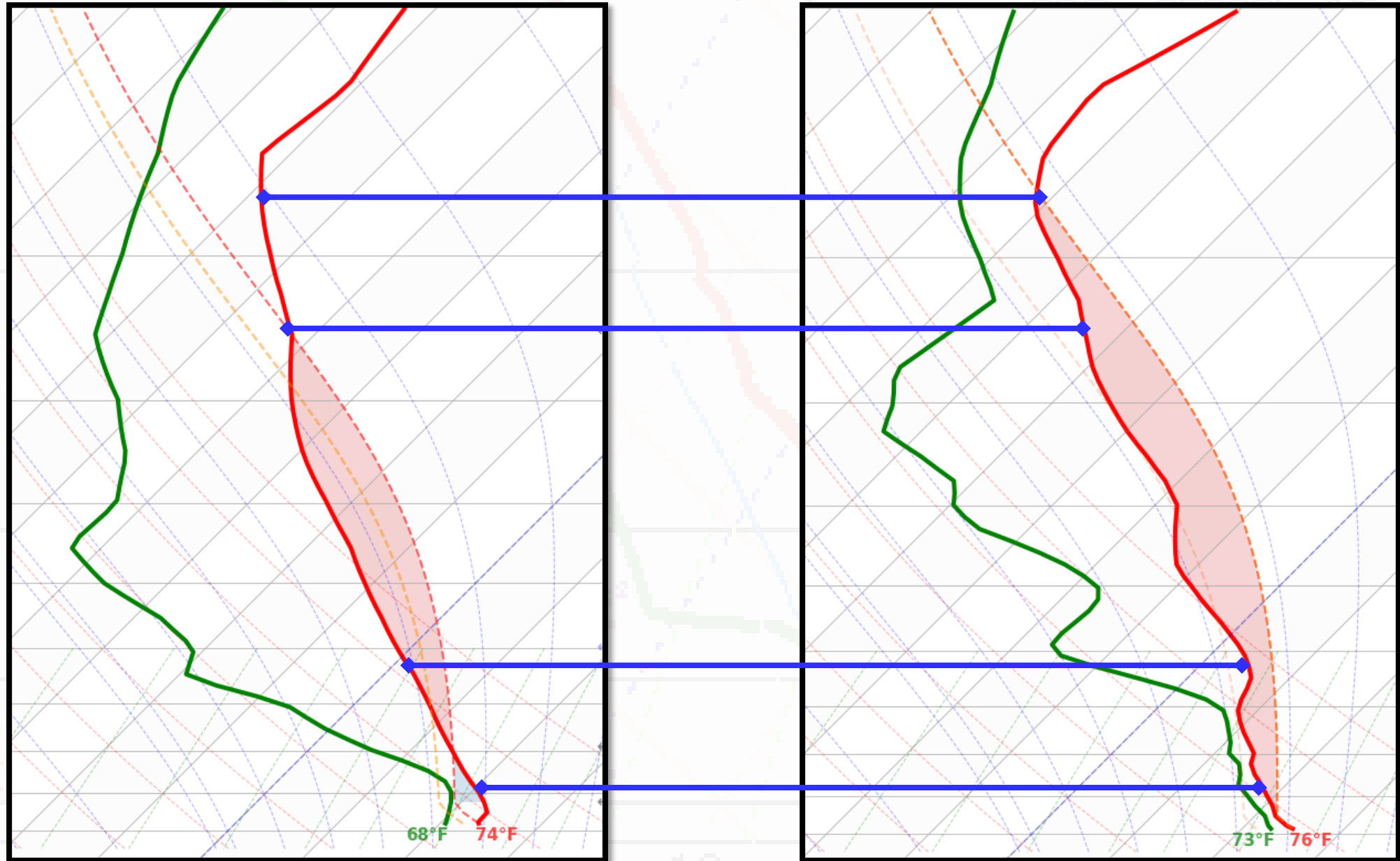
# ASSESSING PROFILE STABILITY



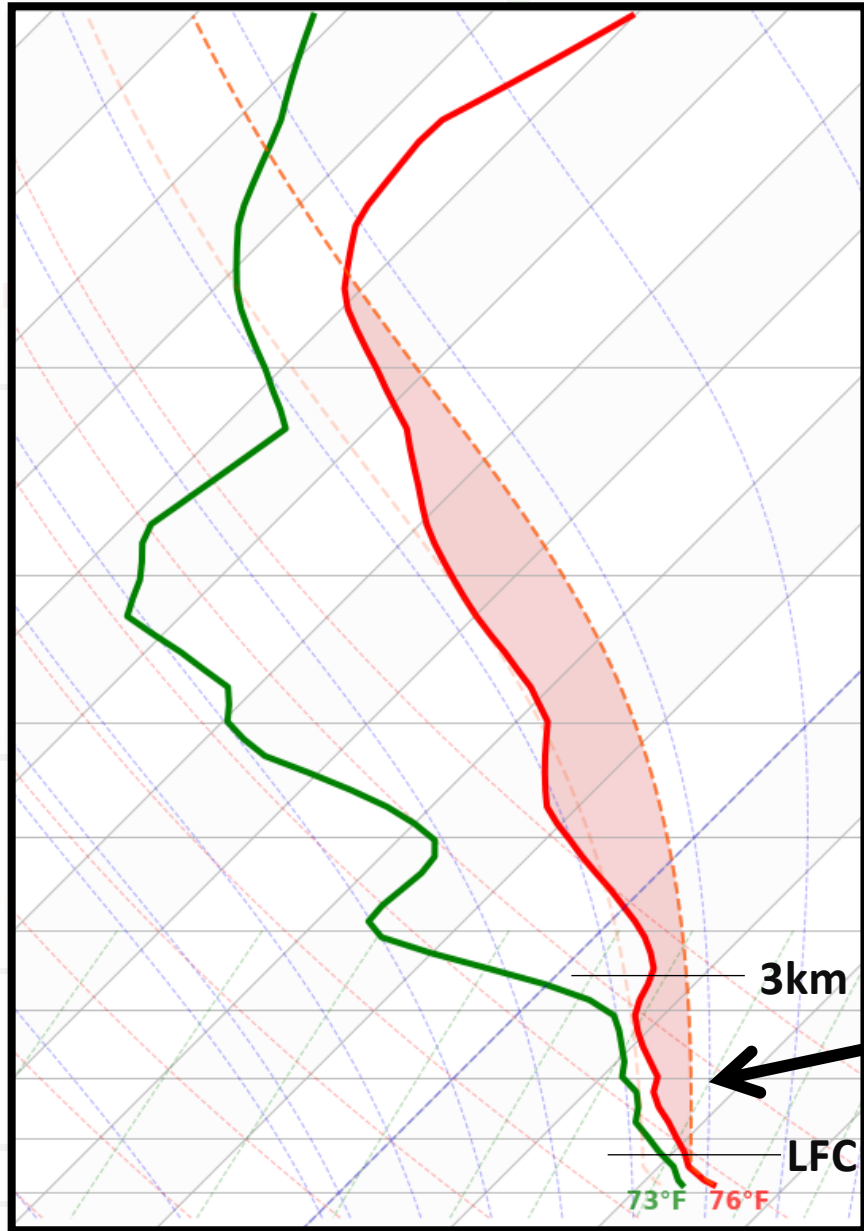
# III. LOCATION OF INSTABILITY



# WHERE IS THE INSTABILITY?



# WHERE IS THE INSTABILITY?



Low-level instability is  
*\*very\** important for  
tornadic storms.

Analytically, we can use  
**0-3km CAPE**  
to assess low-level instability

250 J/kg of 3CAPE!

**FULL CAPE: 3000J/kg**



# WHERE IS THE INSTABILITY?

FULL CAPE: 3000 J/kg

3CAPE: 250 J/kg

BOTH PRODUCED EF-2s!

FULL CAPE: 1300 J/kg

3CAPE: 200 J/kg

**3CAPE  
VALUES**

**MODERATE**

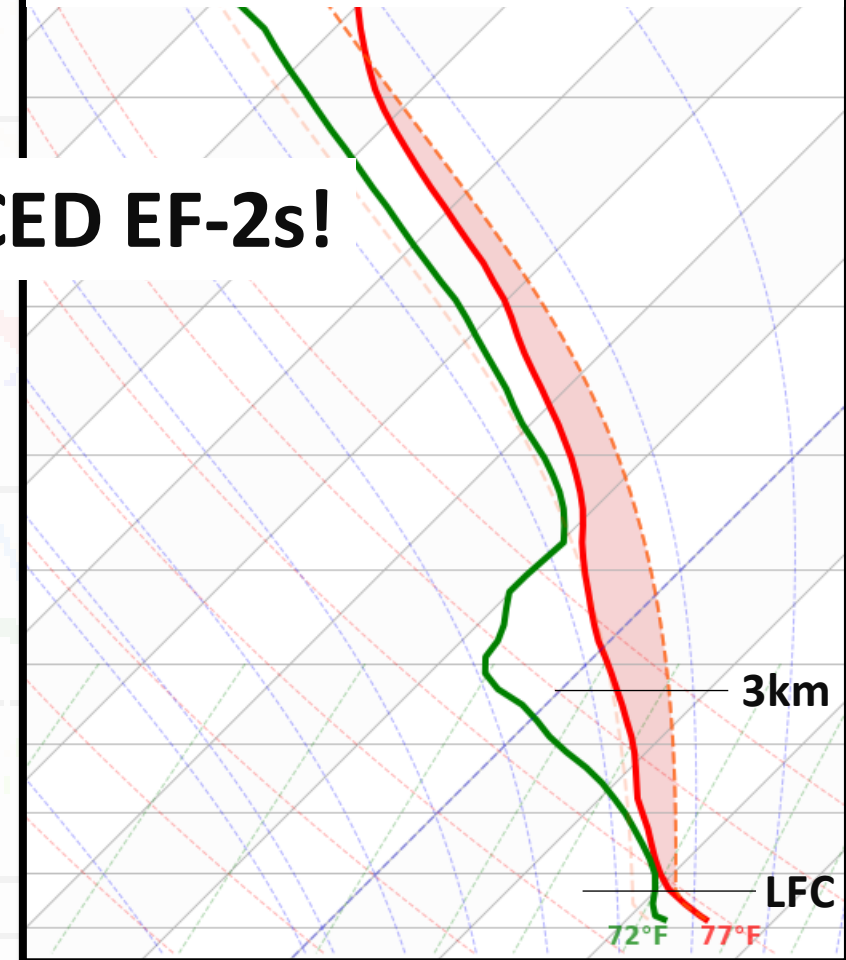
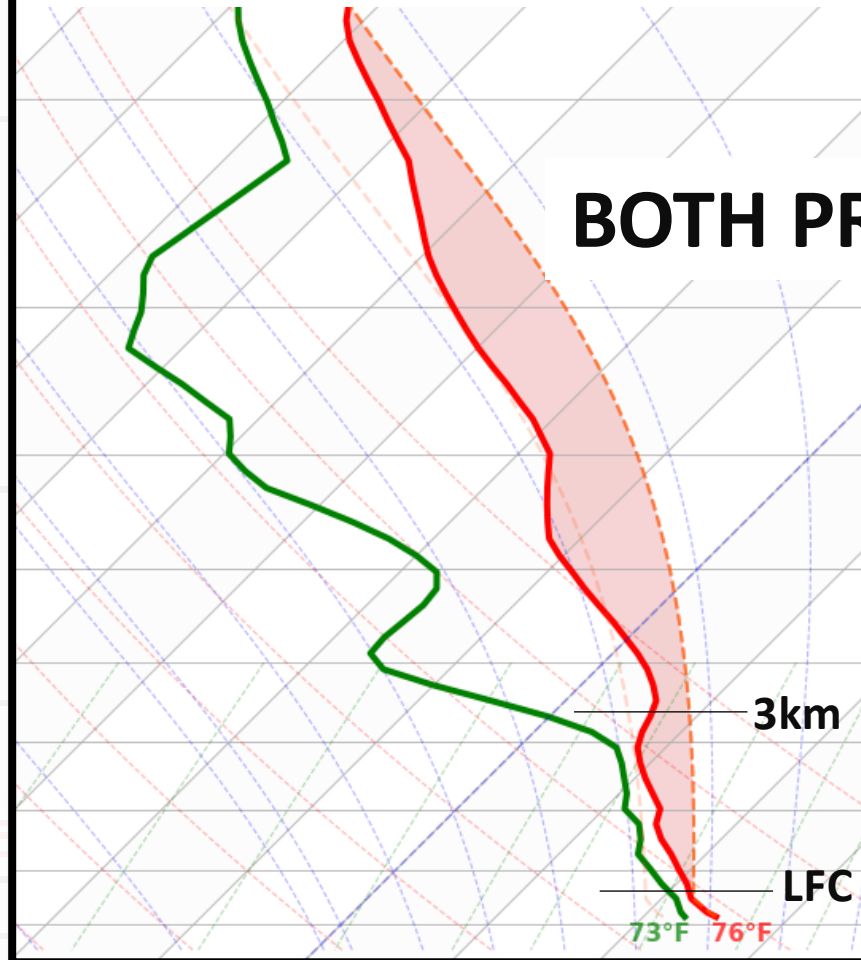
75

**STRONG**

150

**EXTREME**

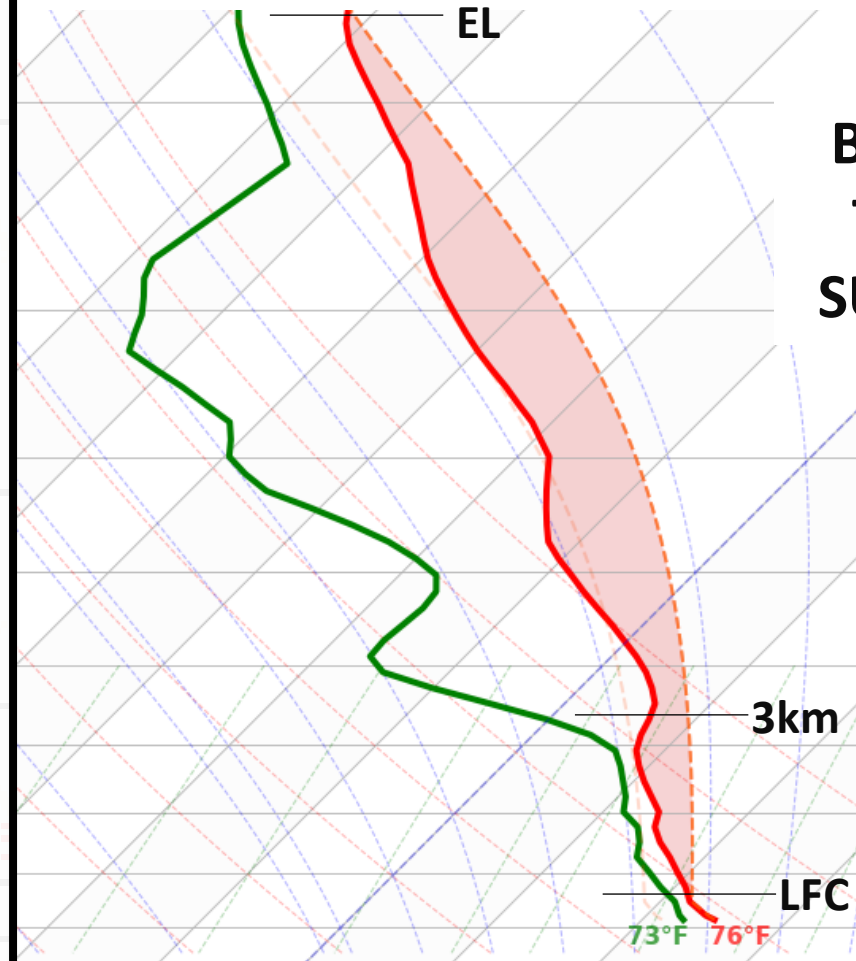
200



# WHERE IS THE INSTABILITY?

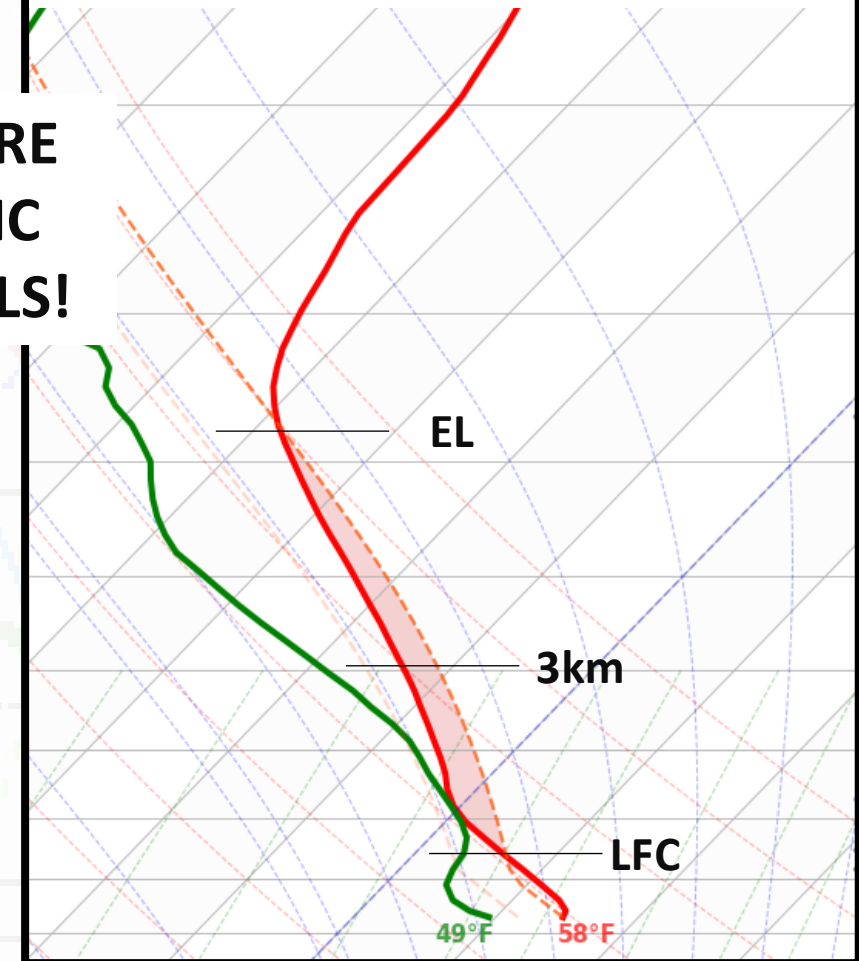
FULL CAPE: 3000 J/kg

3CAPE: 250 J/kg



FULL CAPE: 500 J/kg

3CAPE: 105 J/kg



BOTH WERE  
TORNADIC  
SUPERCELLS!

3CAPE  
VALUES

MODERATE

75

STRONG

150

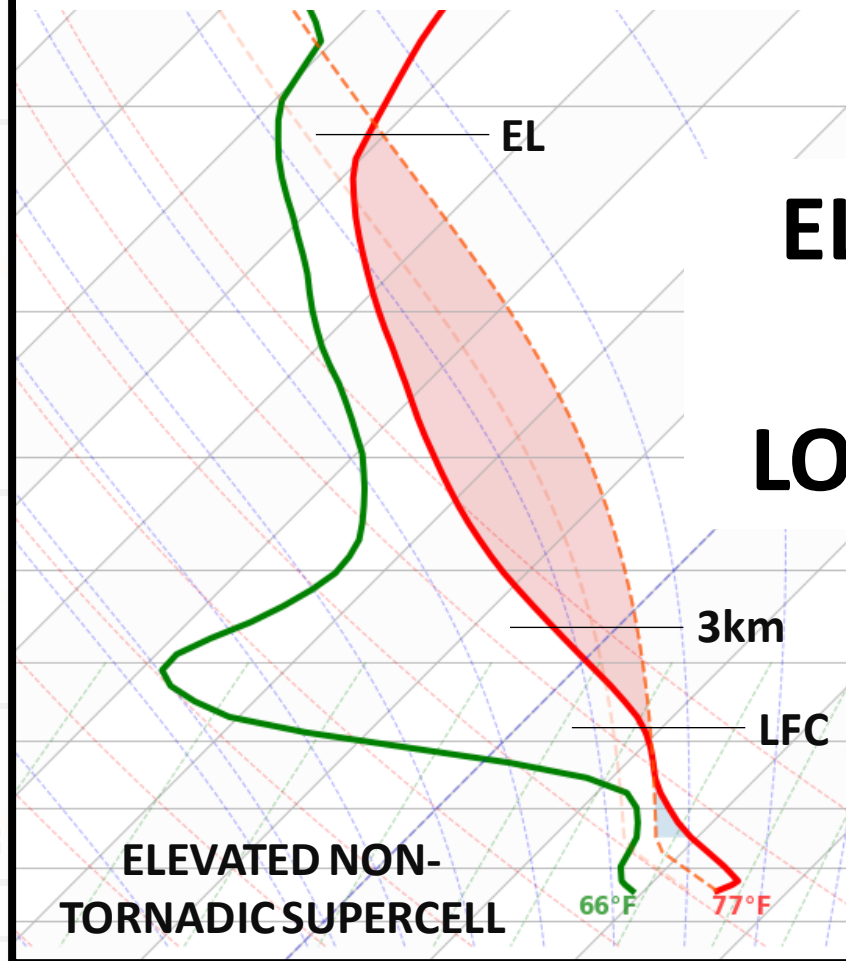
EXTREME

200

# WHERE IS THE INSTABILITY?

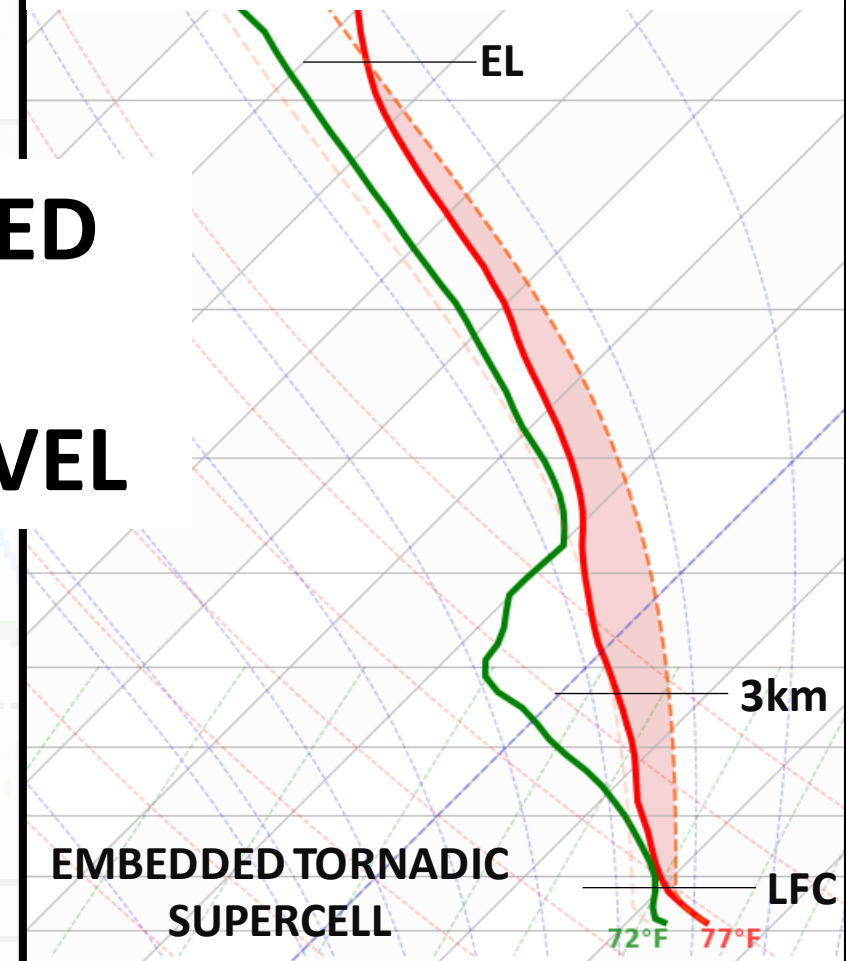
FULL CAPE: 3000 J/kg

3CAPE: 57 J/kg



FULL CAPE: 1300 J/kg

3CAPE: 200 J/kg

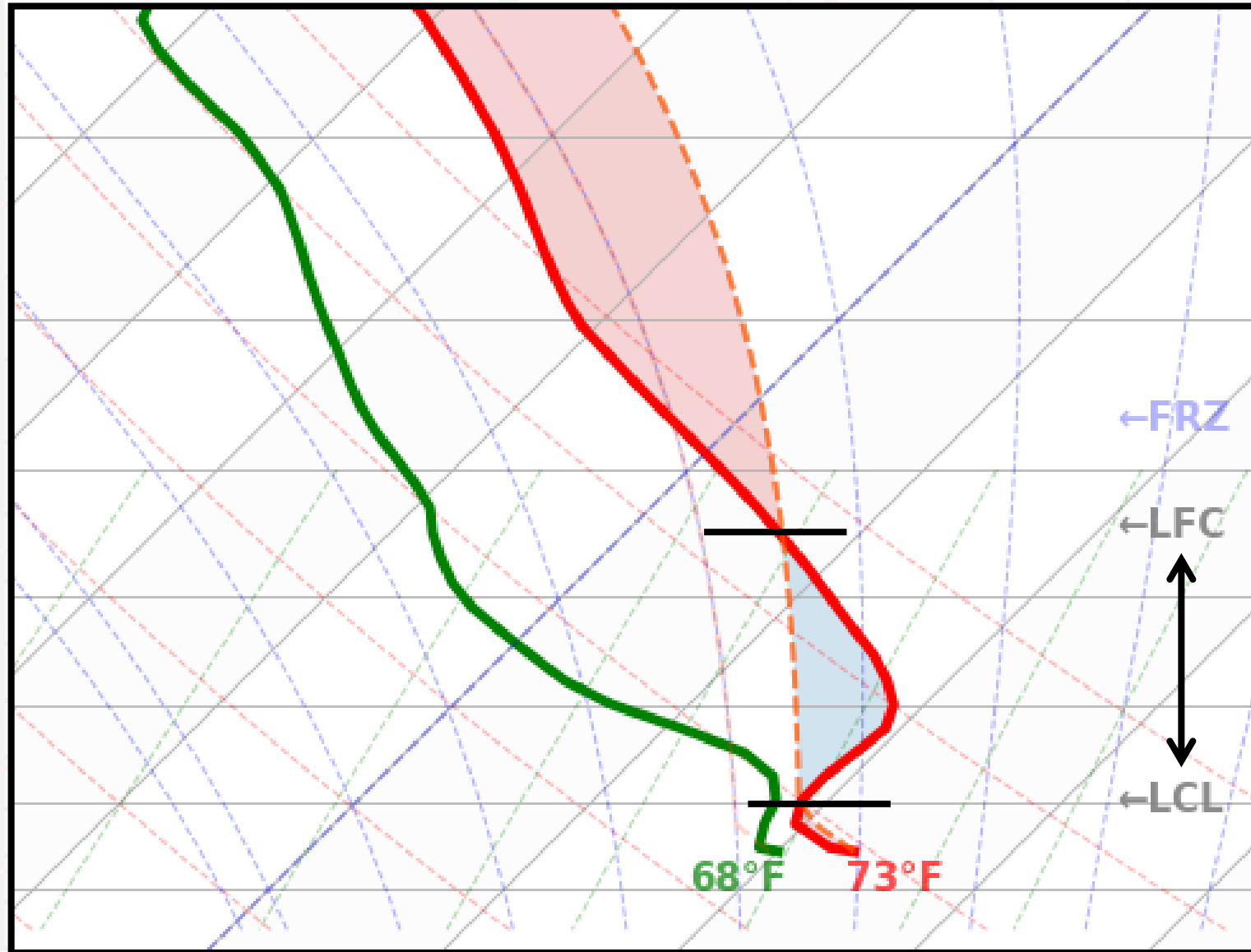


ELEVATED  
VS  
LOW-LEVEL

# IV. THE CAP



# WHAT IS "THE CAP"?

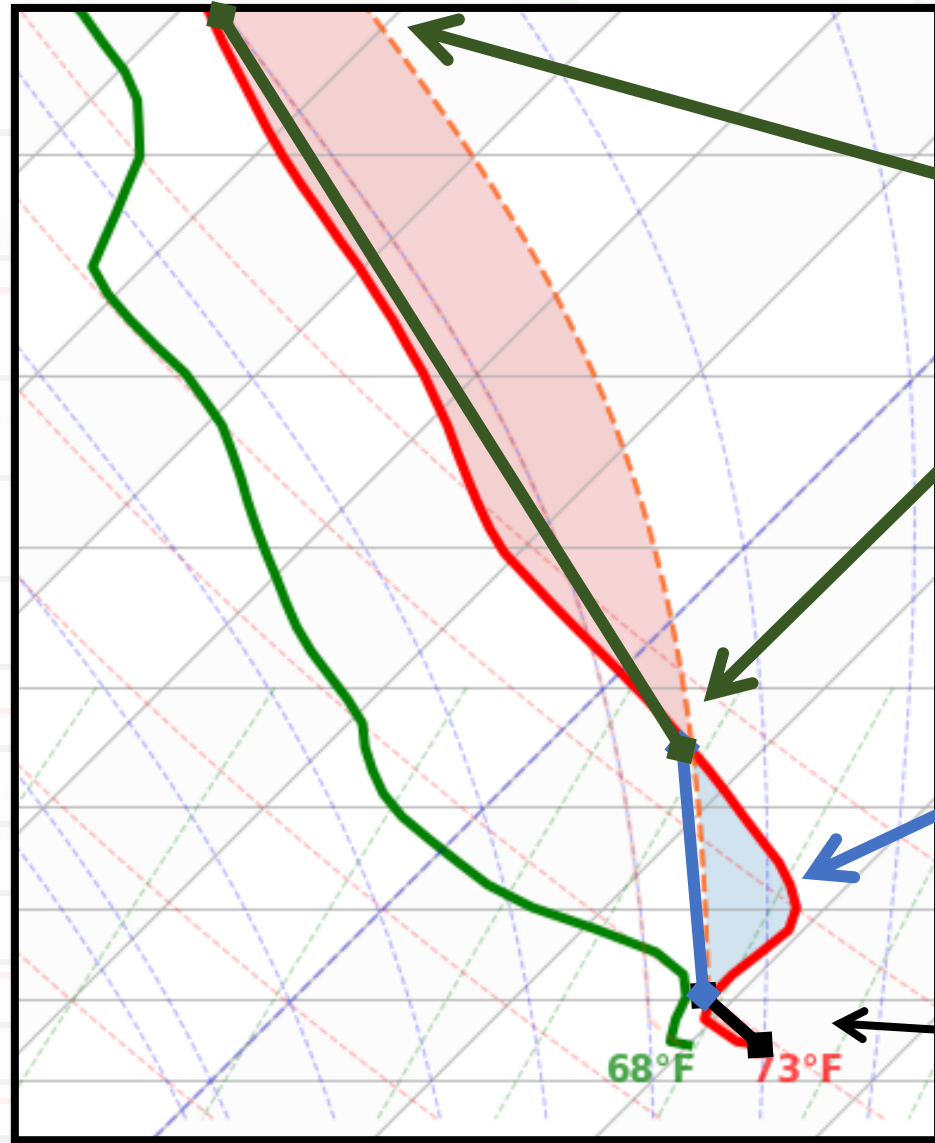


A STABLE LAYER IN THE  
LOW-MID LEVELS

A WARM AND DRY  
WEDGE OF AIR ABV THE  
SURFACE

PARCELS ARE SUDDENLY  
COOLER THAN THE  
ENVIRONMENT, HALTING  
CONVECTION

# WHAT IS "THE CAP"?



Layer of Free Convection.  
Parcels can freely convect  
and ascend.

Elevated Mixed Layer (EML)  
or the "cap". Parcels can not  
freely convect here – they  
must be *\*strongly\** forced to  
rise in this layer.

Shallow convective layer.  
Parcels ascend only a short  
distance here.



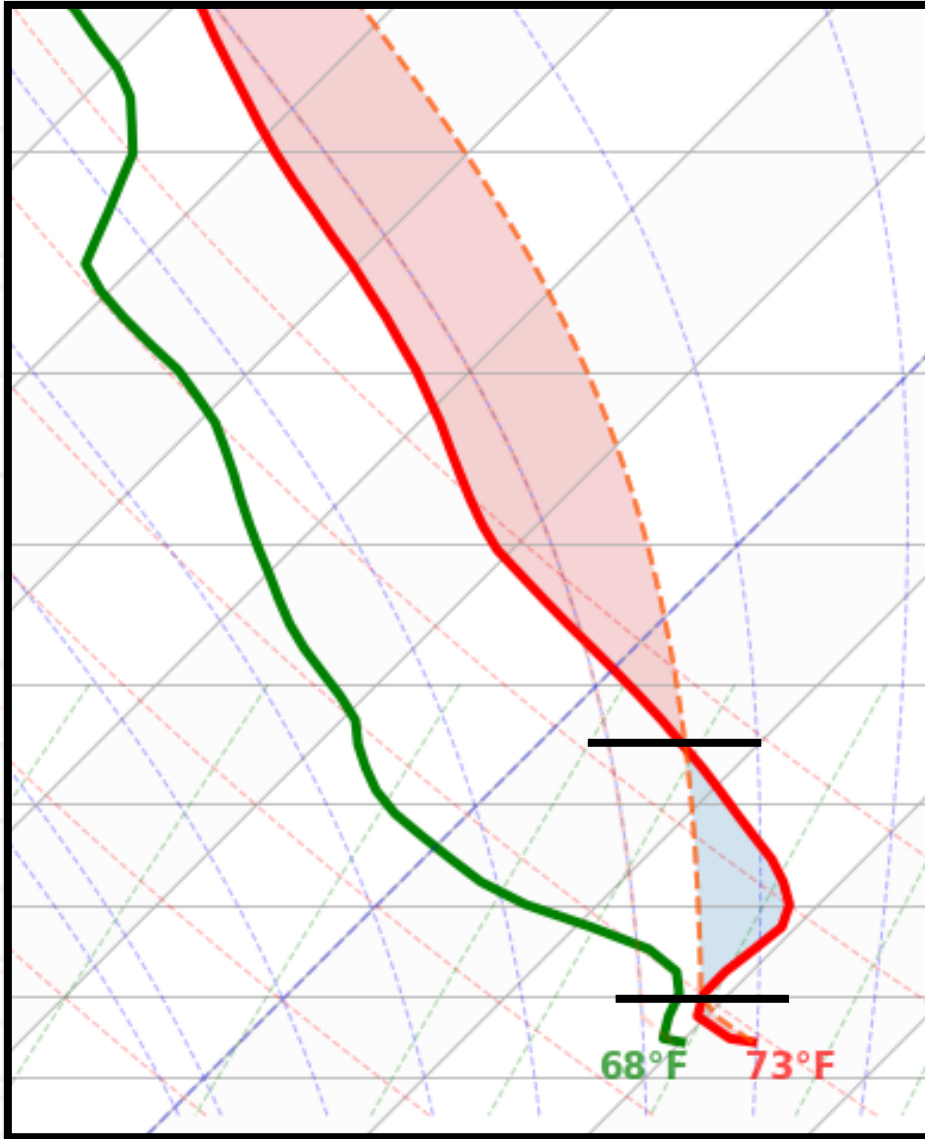
# WHAT IS "THE CAP"?

THE CAP INHIBITS DEEP MOIST  
SURFACE-BASED CONVECTION  
(THUS, WE FIND **CIN** OR CONVECTIVE  
INHIBITION -- LIKE INVERSE CAPE)

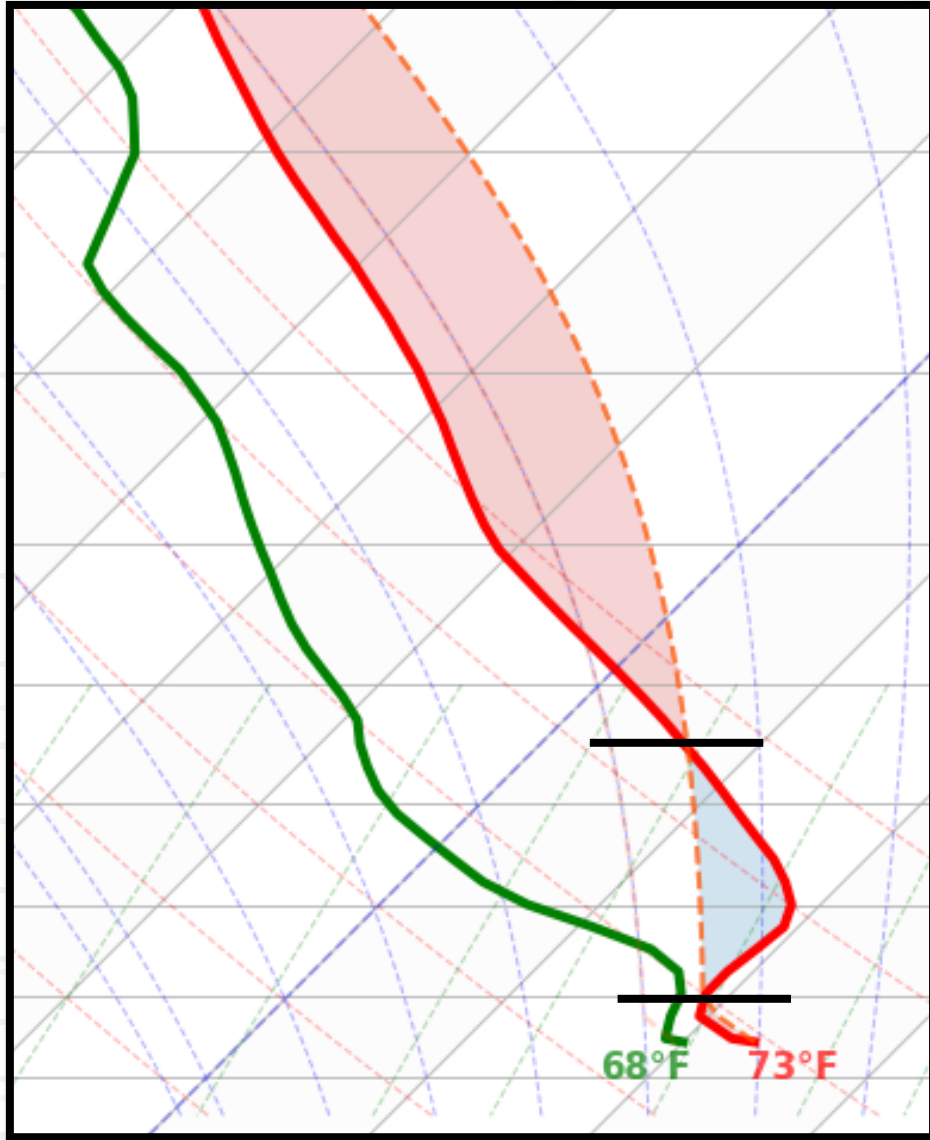
INSTABILITY IS BUILDING ABOVE THE  
CAP, BUT STORMS CAN'T ACCESS IT  
(UNLESS THEY ARE ELEVATED)

THE CAP PREVENTS SUFFICIENT  
CONVECTION FOR STORMS TO  
DEVELOP\*

\* Sometimes a strong steady-state storm can \*move into\* a capped environment & remain strong – the updraft is \*forcing\* convection through the cap!



# 'BREAKING THE CAP'



THE CAP CAN BE 'BROKEN' BY  
SUFFICIENT FORCING FROM...

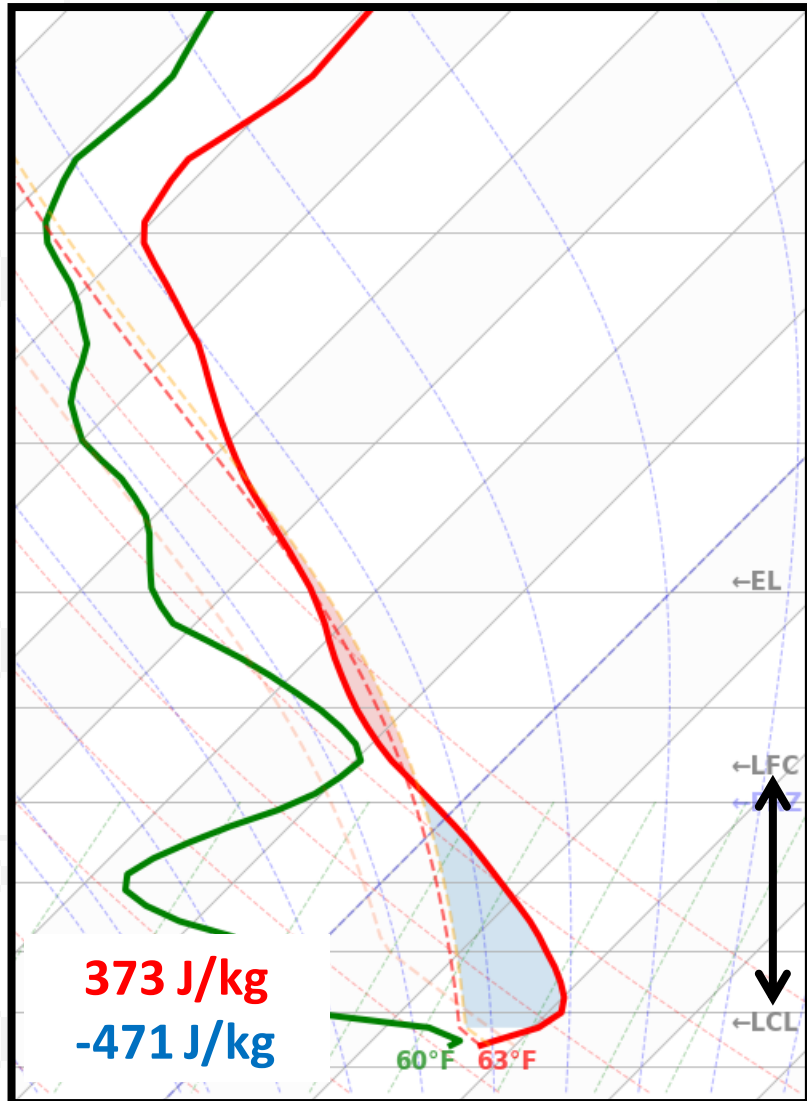
A BOUNDARY (FRONT, DRYLINE)  
LARGE SCALE ASCENT (SHORTWAVE,  
GRAVITY WAVES)

OR BY SUFFICIENT DIURNAL HEATING +  
MOISTURE TRANSPORT + MIXING.

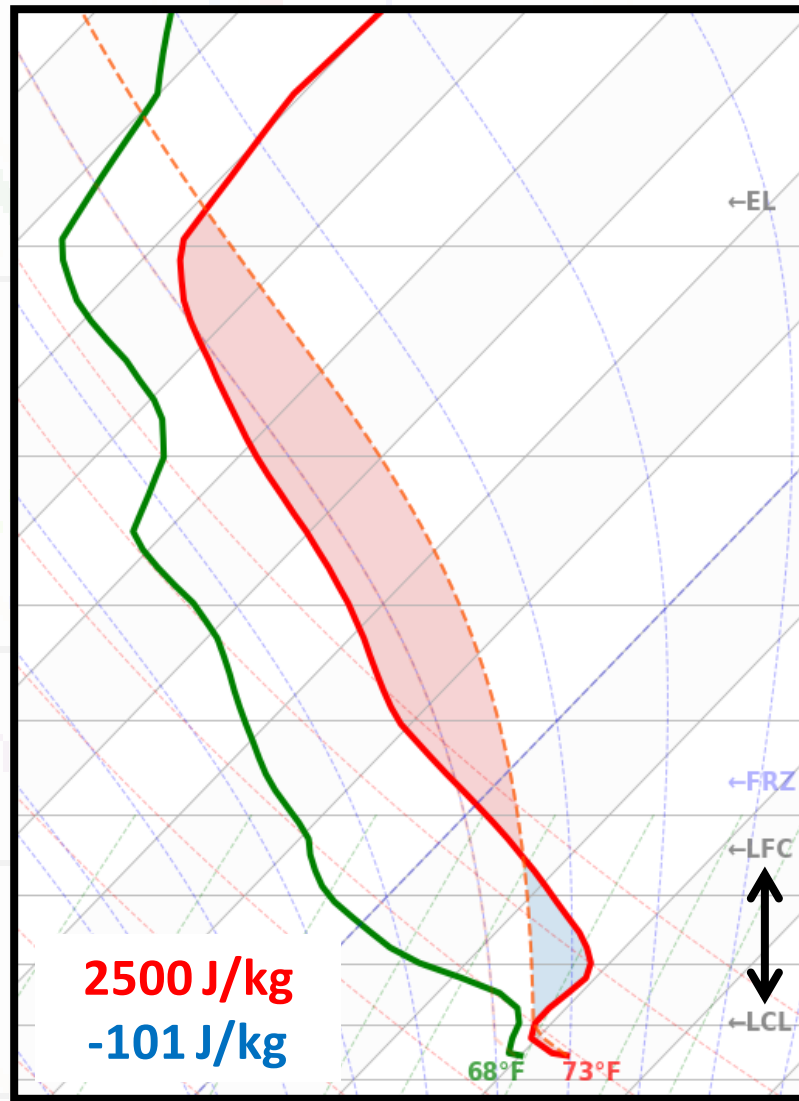


# THE “LOADED GUN” SOUNDING

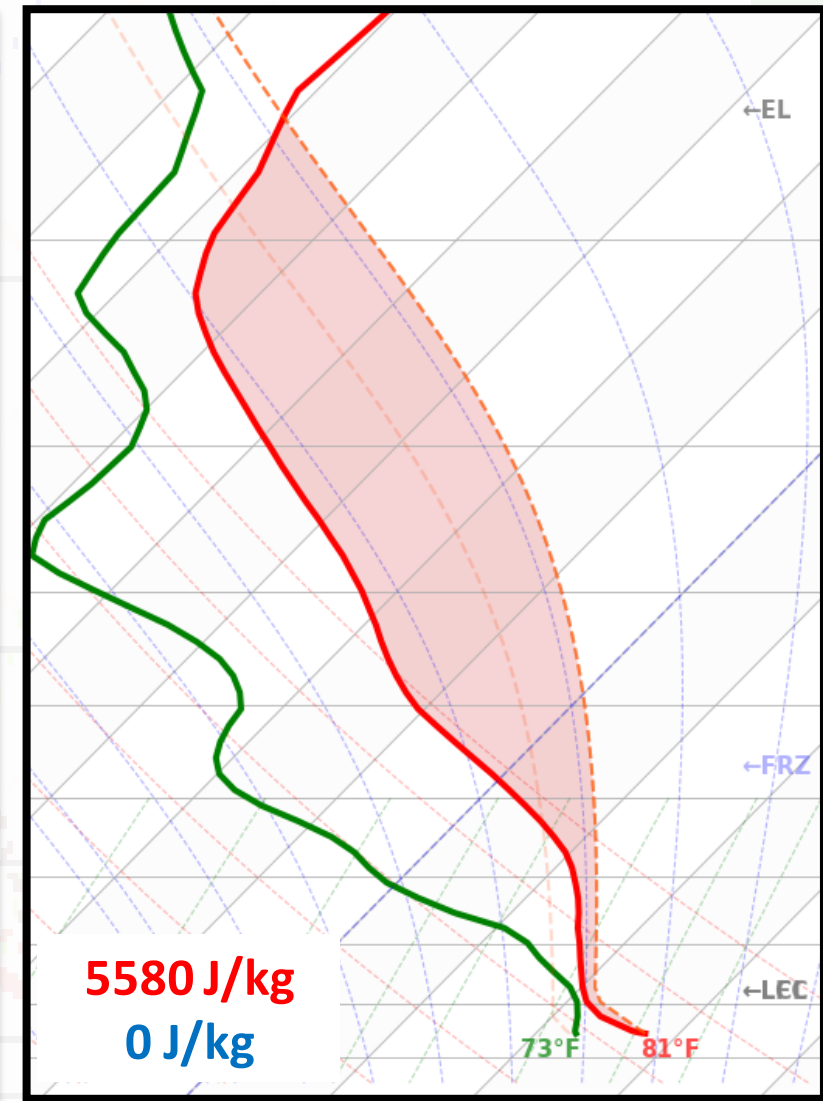
12z



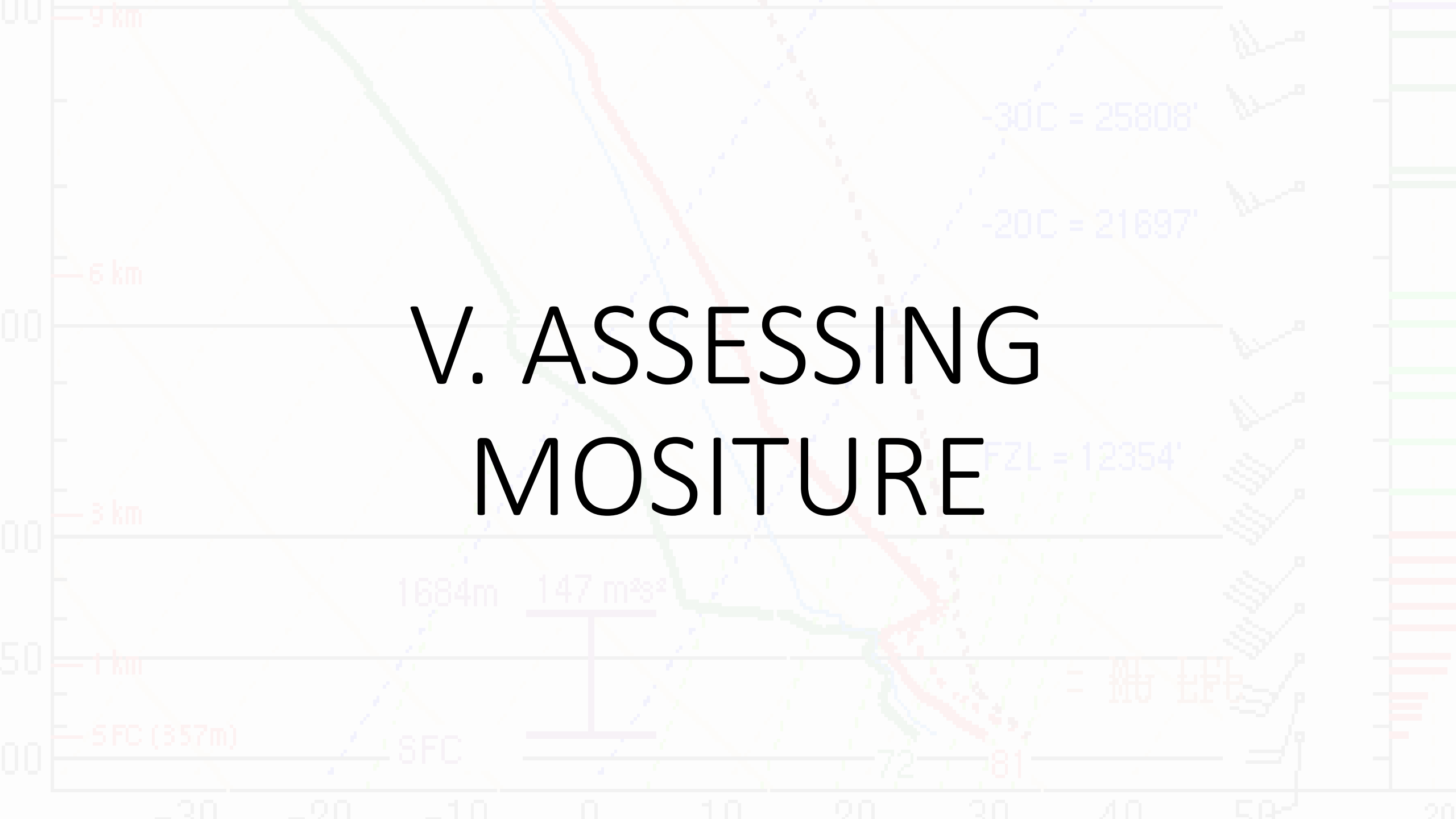
18z



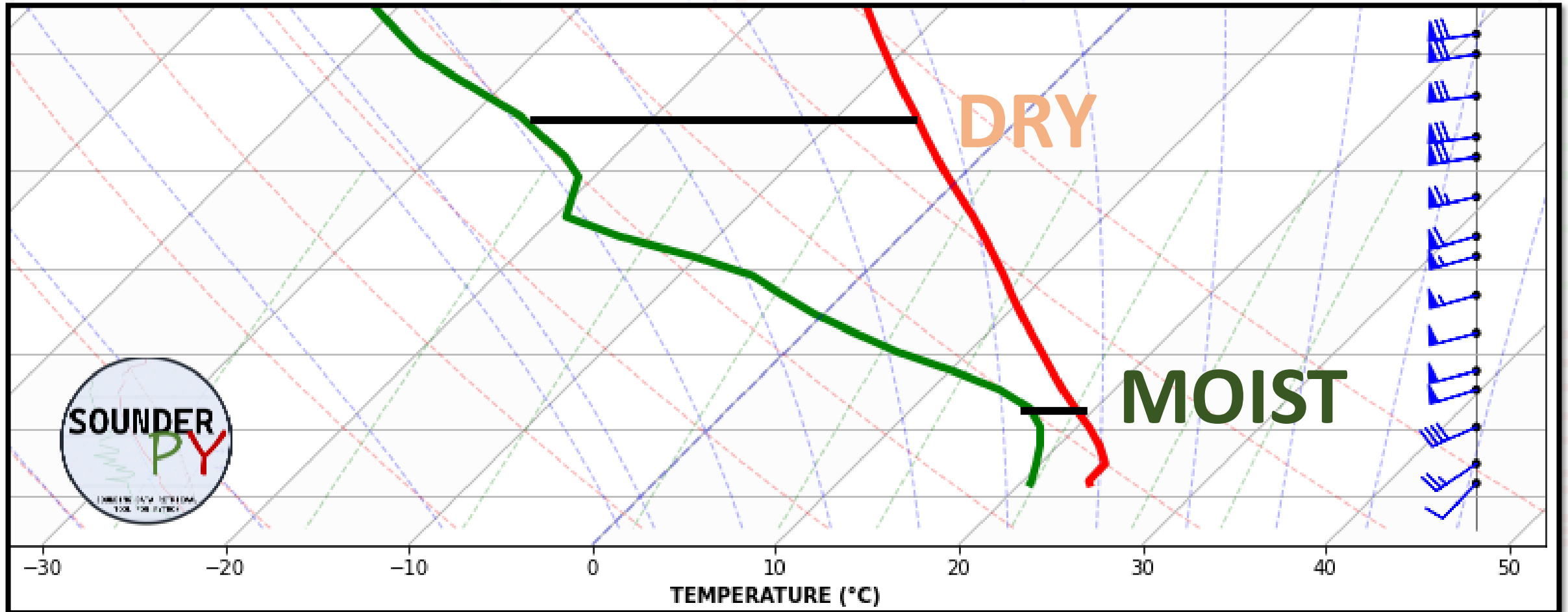
20z



# V. ASSESSING MOSITURE



# ASSESSING THE MOISTURE PROFILE



# ASSESSING THE MOISTURE PROFILE

$$CAPE = \int_{LFC}^{EL} \frac{T_v' - \bar{T}_v}{\bar{T}_v} dz$$

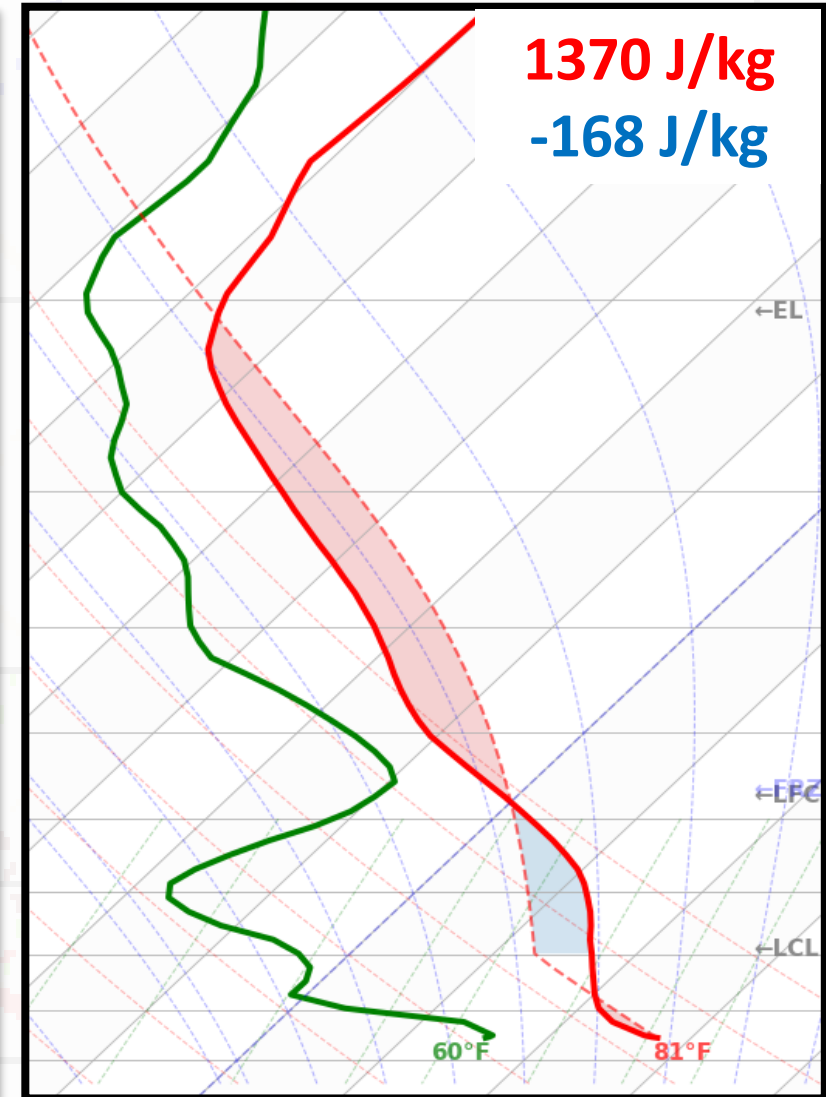
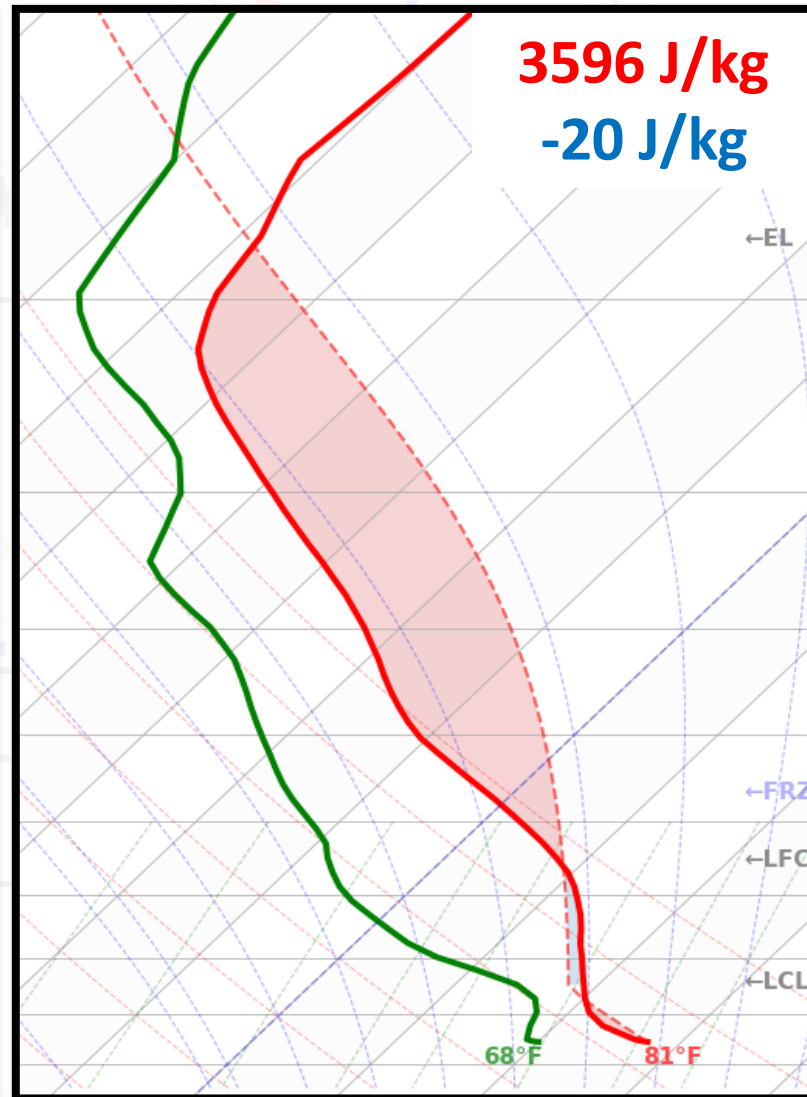
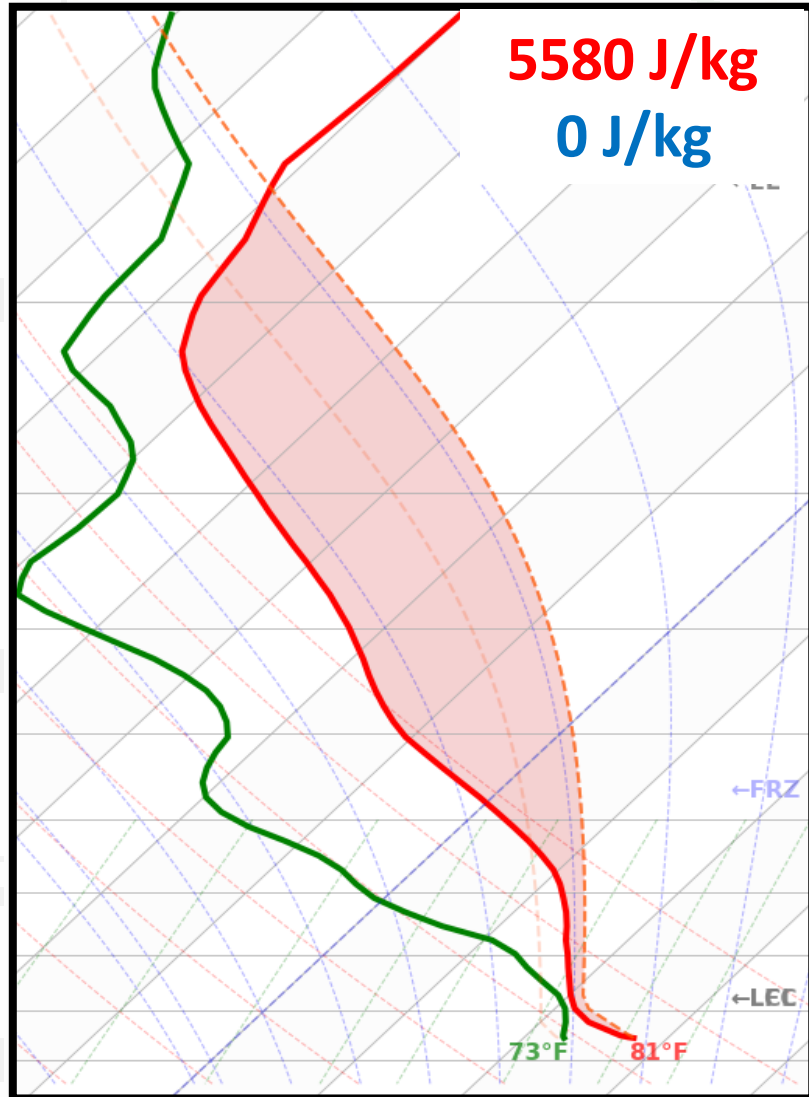
Virtual Temperature  
of a parcel

$$T_v' = T'(1 + 0.61q')$$

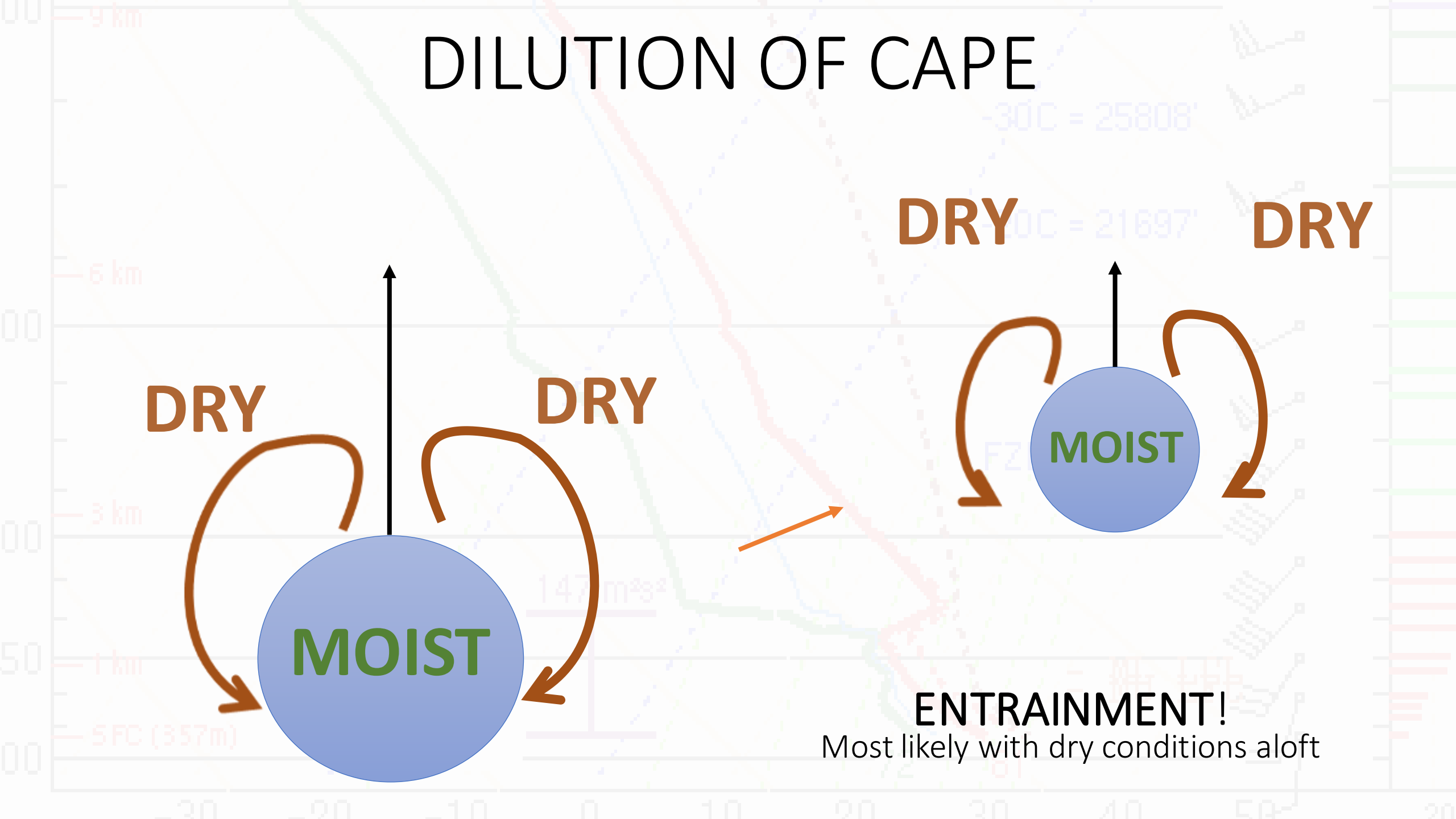
**Specific Humidity = MOISTURE!**

# MOISTURE IMPACTS ON INSTABILITY

20z proximity temperature profile to Pilger 2014 with 20z, 18z, & 12z dewpoint profiles

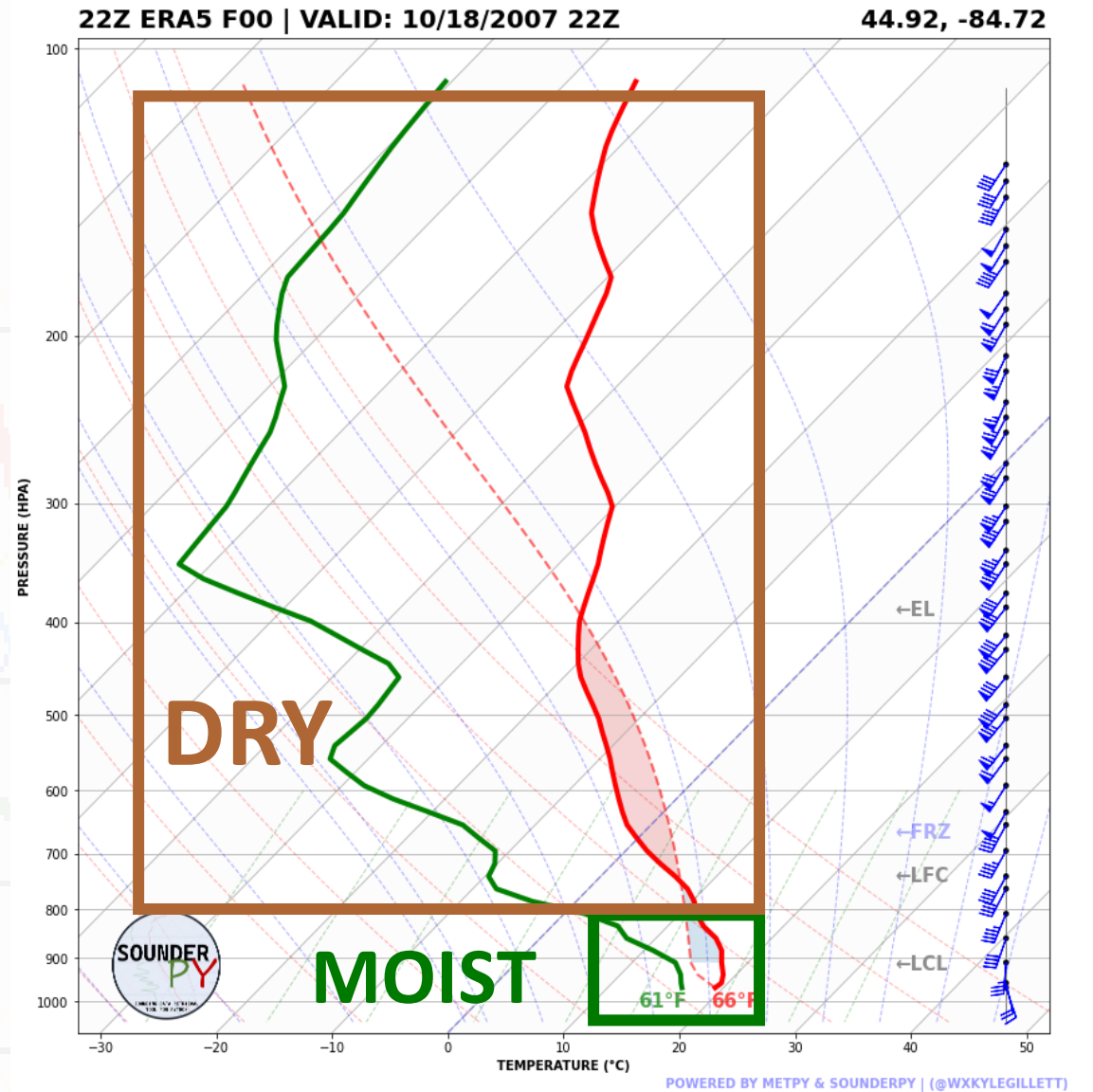
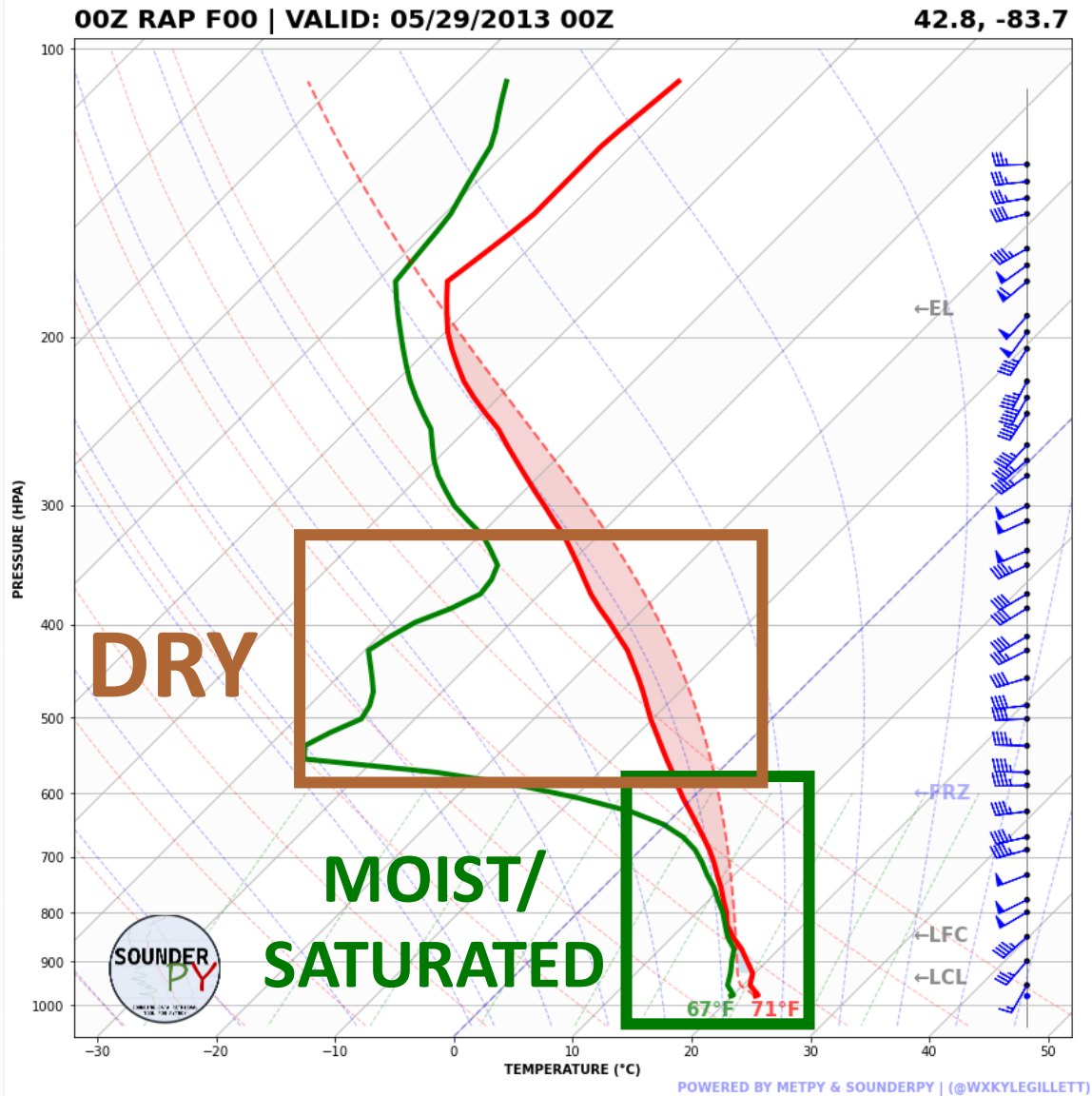


# DILUTION OF CAPE



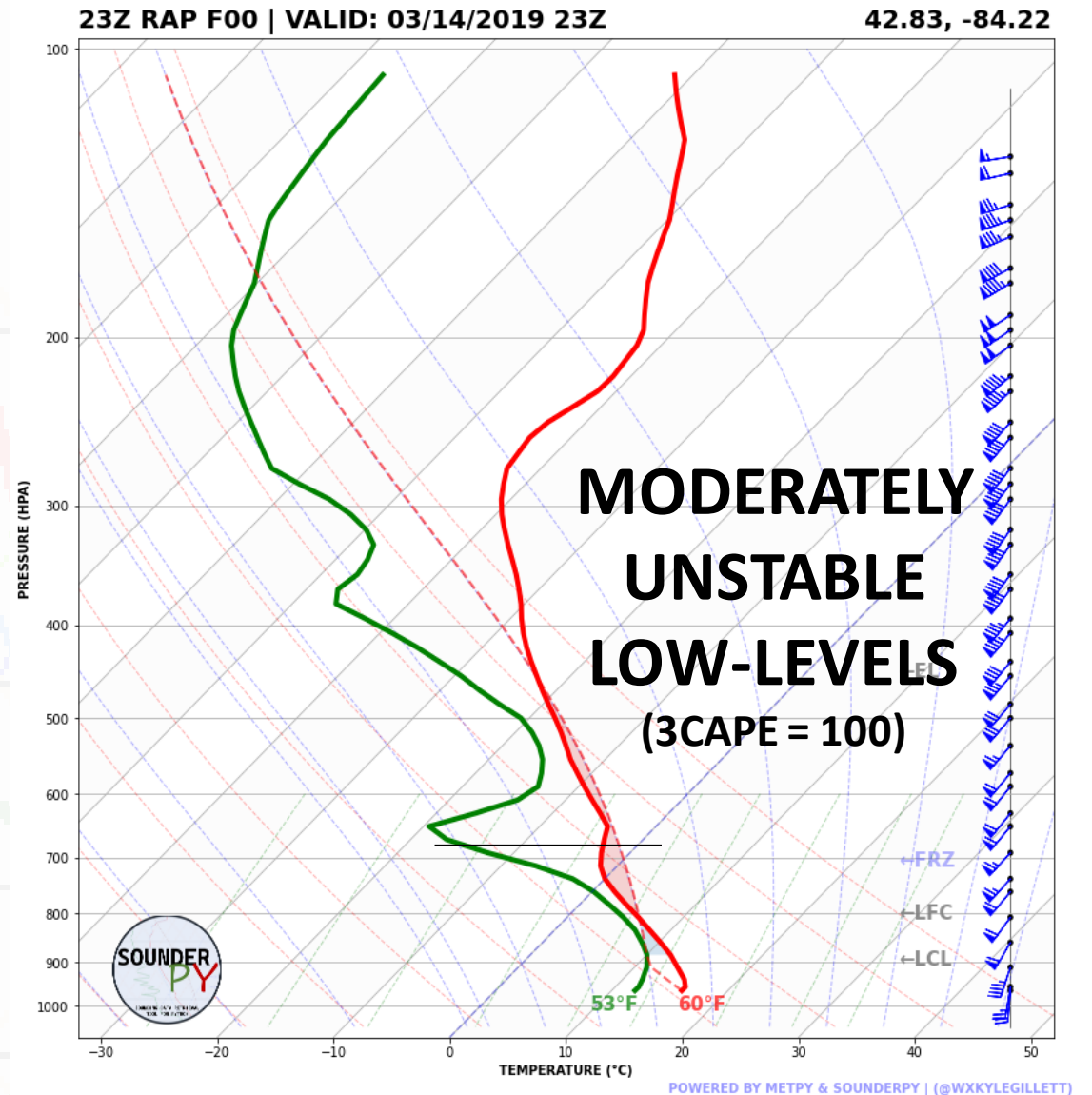
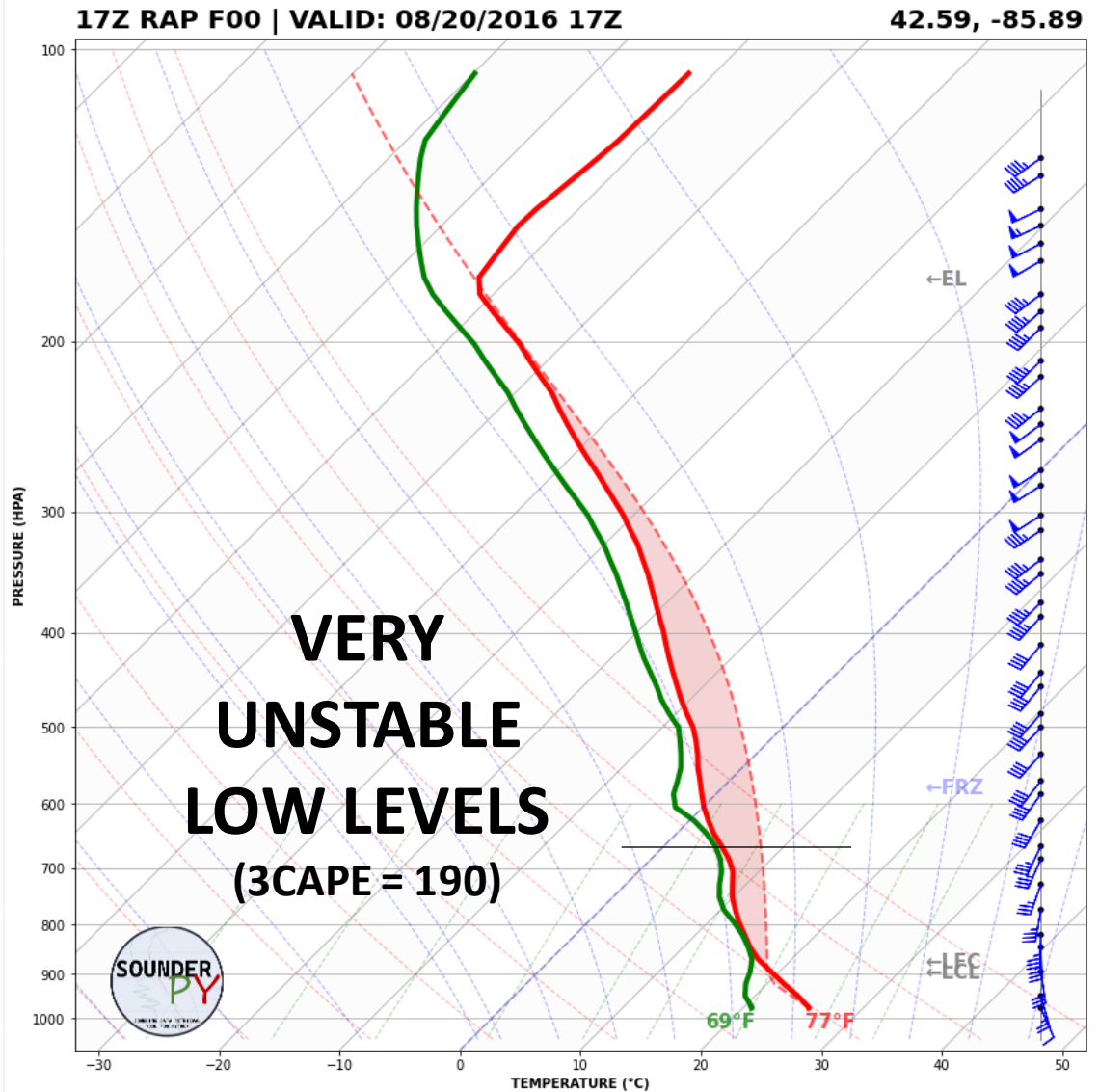
## VI. EXAMPLE SEVERE CONVECTION SKEW-Ts

# MOIST vs DRY

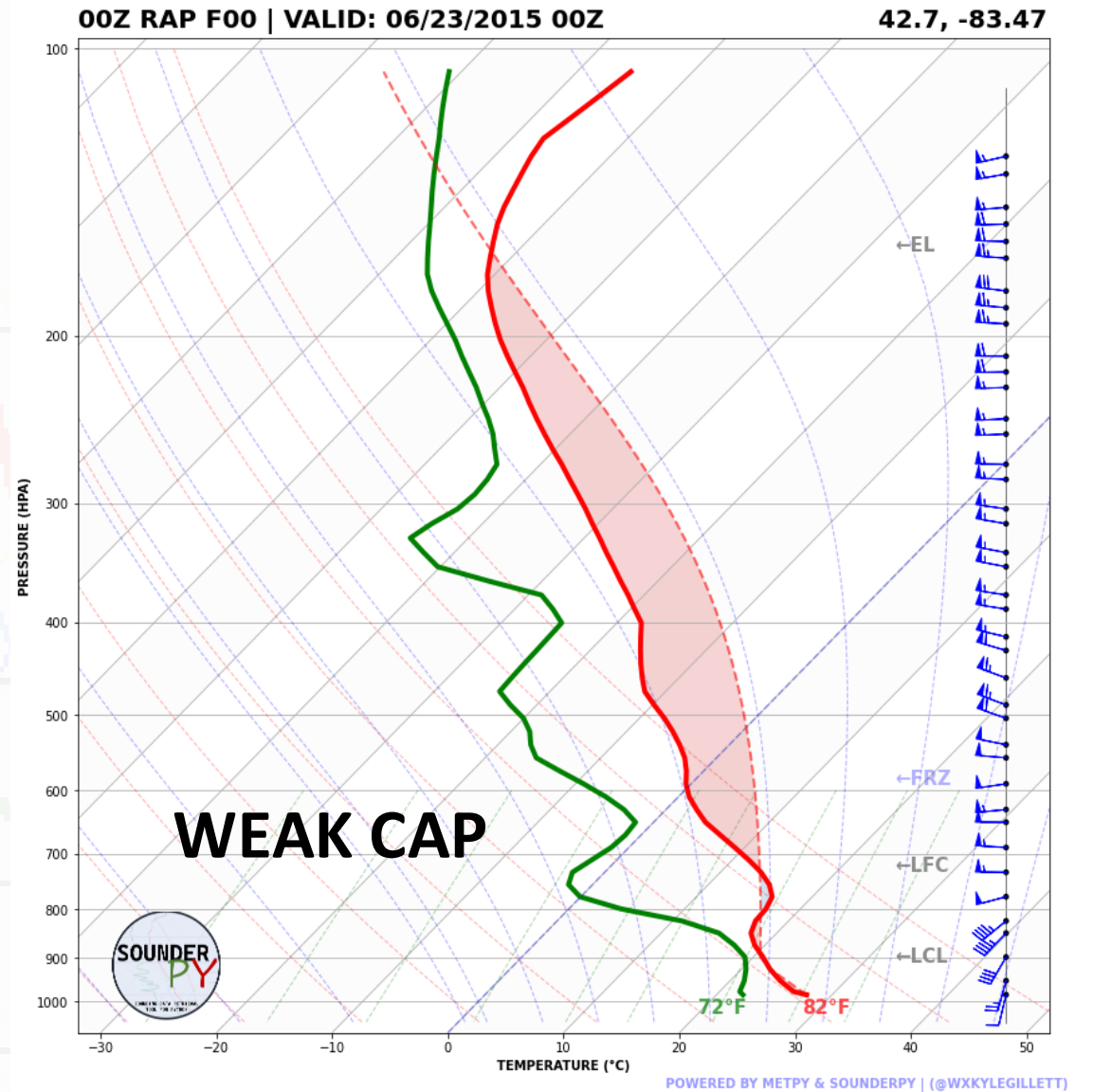
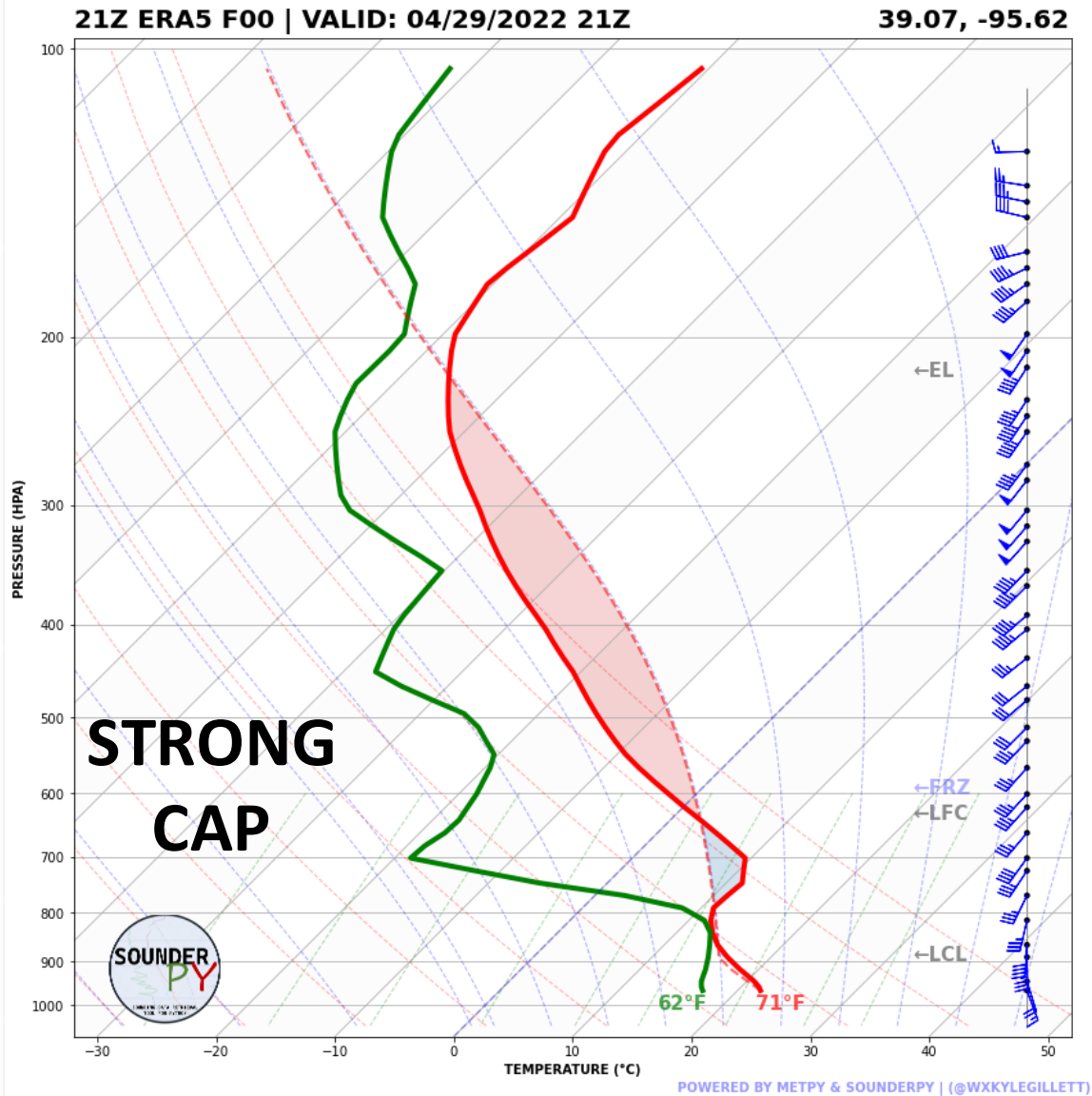




# LOW LEVEL INSTABILITY



# CAP STRENGTH



THAT'S THE BASICS OF THE SKEW-T  
ITSELF.

THE HODOGRAPH IS NEEDED TO  
PROVIDE FURTHER INSIGHT.

THAT'S NEXT TIME ;)