NATIONAL WEATHER SERVICE
Building a Weather-Ready Nation

Forecaster Utilization of NUCAPS Products

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The NOAA Unique Combined Atmospheric Processing System (NUCAPS)

The NOAA Unique Combined Atmospheric Processing System (NUCAPS) is the NOAA operational hyper-spectral sounding product system to derive radiance products, vertical profiles of temperature, water vapor, ozone, and six trace gas products (CO, CH4, CO2, Volcanic SO2, HNO3 and N2O). The algorithm has the heritage from the AIRS Science Team algorithm.
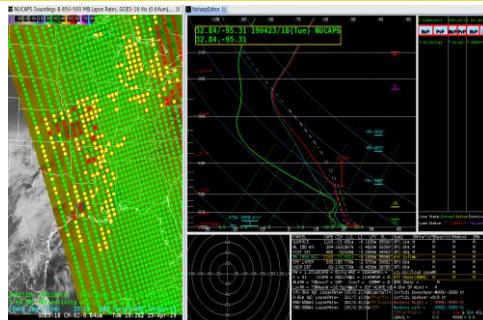
- NUCAPS runs within the Hyper-Spectral Enterprise Algorithm Package (HEAP) to operationally generate retrieval products from hyperspectral infrared instruments. Microwave sounder data are used to produce an initial guess for the hyper-spectral IR sounding retrievals.

- NOAA/NESDIS/STAR has been operationally running NUCAPS since 2009 and distributing NUCAPS products in near real time to the science community through NOAA- Comprehensive Large Array-Data Stewardship System (CLASS, https://www.avl.class.noaa.gov/saa/products/welcome)

- NUCAPS has been operationally running on the CSPP/Direct Broadcast (DB) network producing near real time products for many regional applications.

- NUCAPS products are available through AWIPS for Weather Forecast offices for many regional applications.

- Websites of Interest: Maturity Review Presentations: https://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php
- https://www.star.nesdis.noaa.gov/jpss/mapper; https://www.star.nesdis.noaa.gov/jpss/EDRs/products_Soundings_N20.php

NUCAPS Product Maturity and Users

	S-NPP/NOAA-20 CrIS, MetOp-IASI
Channels	NOAA-20 CrIS (2211 channels)/ATMS; MetOP-B/C IASI (8461 channels), AMSU-A/B; Currently Augmented for EPS-SG:IASI-NG
Product Spatial Resolution	50 km^2 Field of Regard (FOR) EDR products
Operational Products	Global: T(p) (AVTP), q(p) (AVMP), O3(p), CO(p), CH4(p), CO2(p), OLR
User Agencies International Collaborations	AWIPS/WFO, NOAA/NASA, ESRL, EPA, NFS, USDA, CPO-AC4, ESRL/CSD, ESRL/GMD, GFDL, NWP Assimilation Groups
Maturity, Reprocessing Enterprise Alg. Operational Status	Validated Maturity. Reprocessing Planned. NOAA-20/S-NPP; MetOp-IASI Yes
POC(s)	Fed lead: Ken Pryor (Ken.Pryor@noaa.gov) Technical lead: Murty.Divakarla@noaa.gov

- Products derived from NUCAPS are validated according to the JPSS product requirements (JERD, L1RDs).

Gridded NUCAPS provides plan views at temperature, moisture, and stability indices (CAPE, lapse rate, etc.) at specific pressure level(s).

Dot Color Meaning

Green	Yellow	Red
Successful infrared (IR) + microwave (MW) NUCAPS retrieval under clear or partly cloudy conditions	Failed IR + MW NUCAPS retrieval. Successful MW-only NUCAPS retrieval under cloudy conditions	Failed IR + MW NUCAPS retrieval. Failed MW-only NUCAPS retrieval under precipitating cloudy conditions

NUCAPS Products	Maturity Level
AVTP/AVMP	✓ Validated
Ozone	✓ Validated
OLR	✓ Validated
CO	✓ Validated
CH4	✓ Validated
CO2	✓ Validated
OLR	✓ Validated

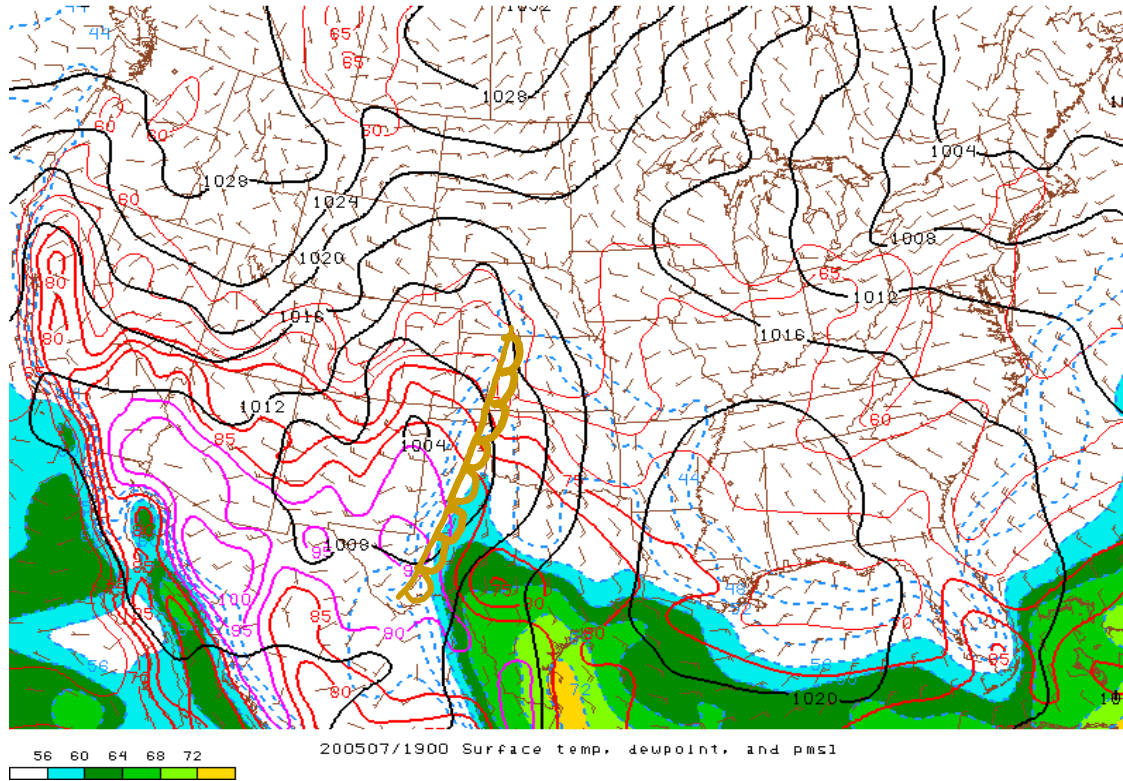# How is NUCAPS Utilized by Forecasters?

- Environmental analysis

- Sounding comparison with hi-res models

- Visualizing the environmental parameters spatially

- Supplemental form of observational analysis

- Severe weather
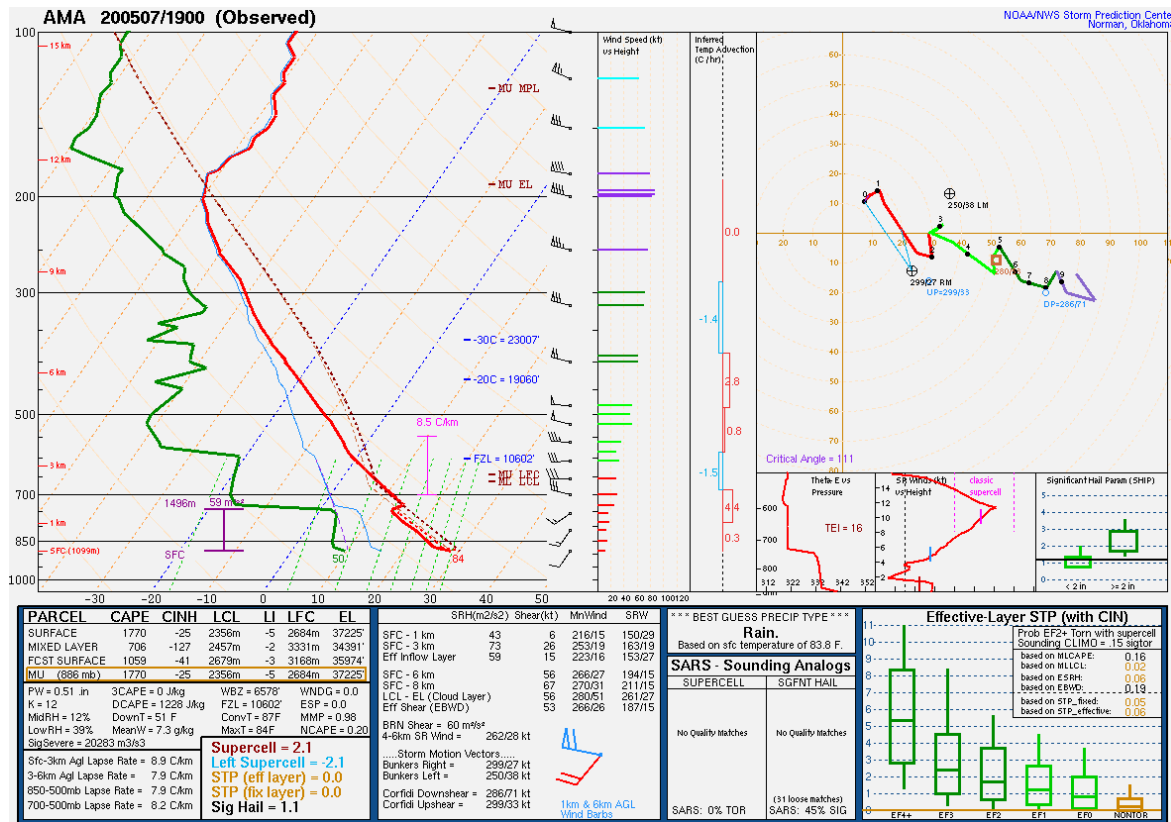
- Much more…

Example: May 7, 2020

19z Surface Analysis

- Surface low on the New Mexico/Texas border
- Surface temps in upper 70s to the upper 80s
- Surface dryline is present along a line from north-central KS to southwest Texas

200507/1900 Surface temp, dewpoint, and pmsl

56 60 64 68 72

Amarillo 19z Sounding Analysis

- Convective heating is slowly eroding the morning capping inversion

- Amarillo is just along dryline with 50 dewpoints present at the surface

- Most unstable CAPE values are around 1500-2000 J/kg

- Mid-level lapse rates are steep around ~8 C/km

NOAA-20 Availability and Profiles
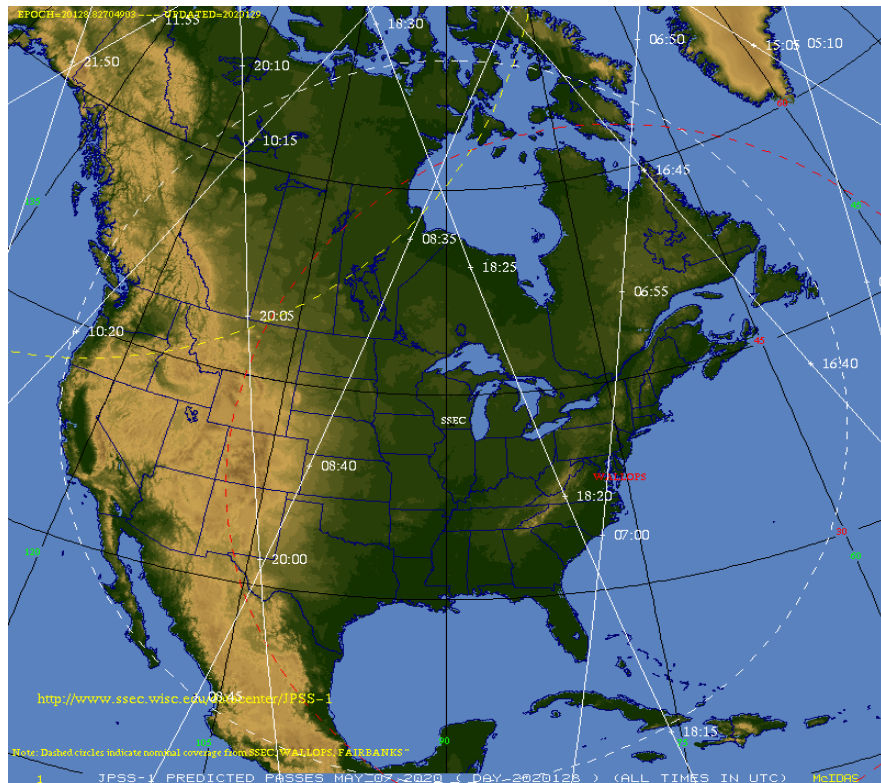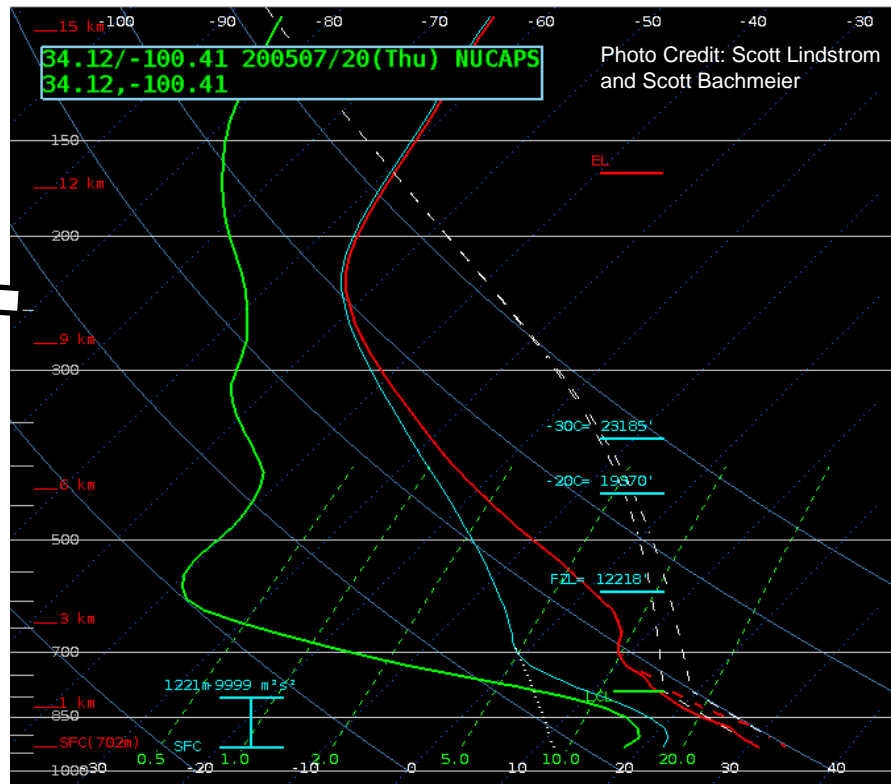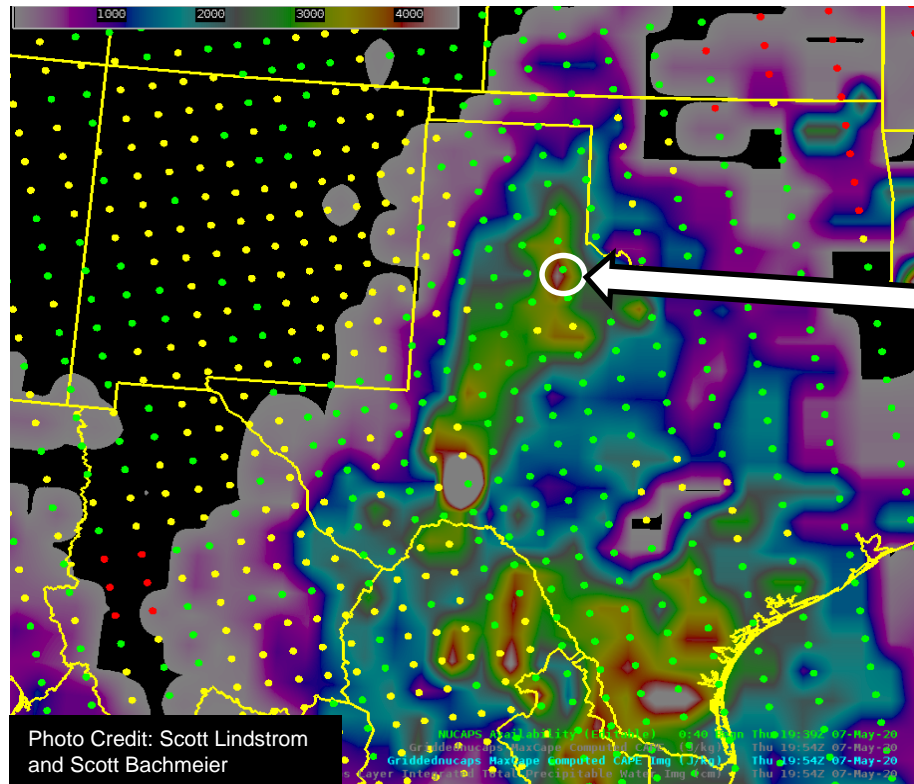

JPSS-1 Predicted Passes

Photo Credit: Scott Lindstrom and Scott Bachmeier
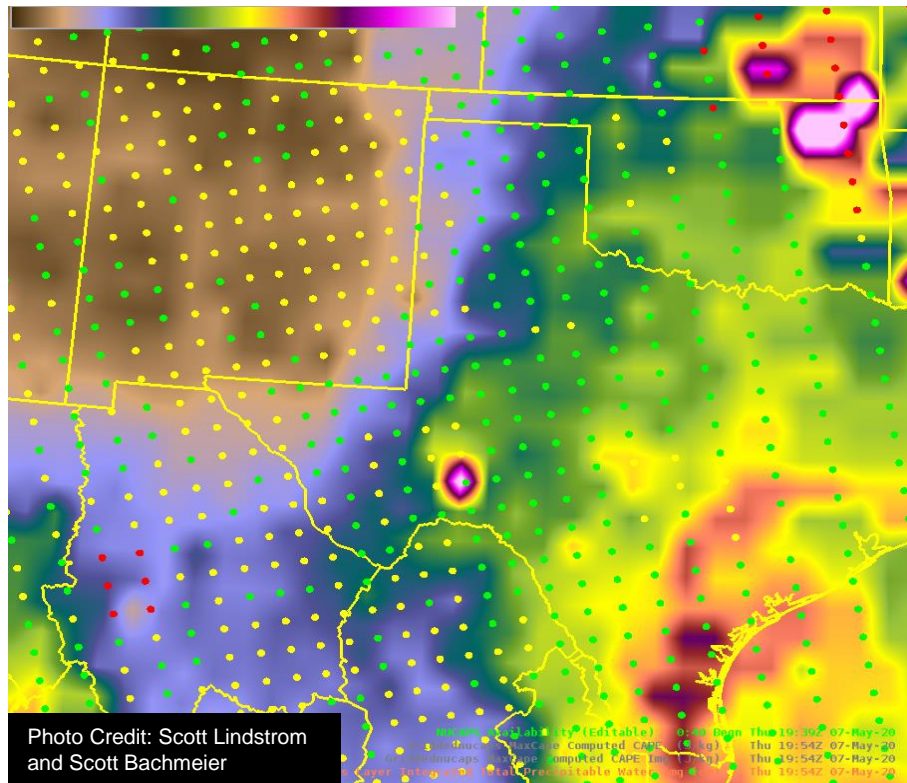
NUCAPS Soundings and Gridded NUCAPS TPW

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NOAA-20 NUCAPS Profiles and Soundings

NUCAPS Soundings and Gridded NUCAPS MaxCAPE

Did Convective Initiation Occur?

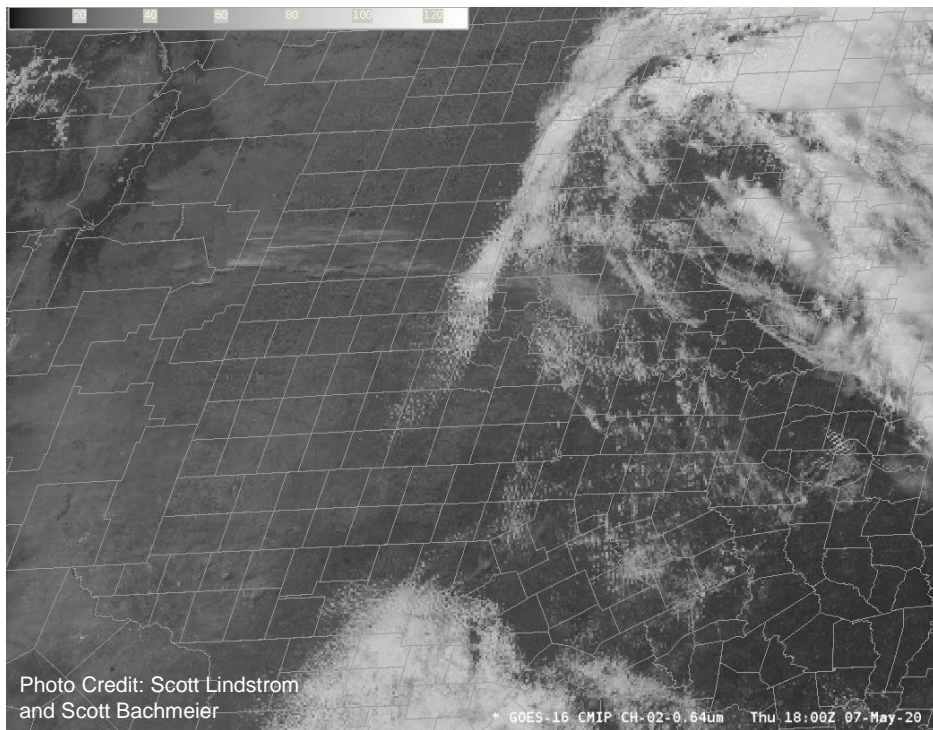Photo Credit: Scott Lindstrom and Scott Bachmeier

* GOES-16 CMIP CH-02-0.64um   Thu 18:00Z 07-May-20

GOES East 0.64 µm visible imagery

- Cumulus field once again is present along the Texas/Oklahoma border

- With time, more cumulus clouds begin to form along and just east of the dryline in the southeast Texas Panhandle while storm initiation occurs in southwest Texas

- Only an hour or so later, storm initiation occurs in the southeast Texas Panhandle

Example: May 16, 2021

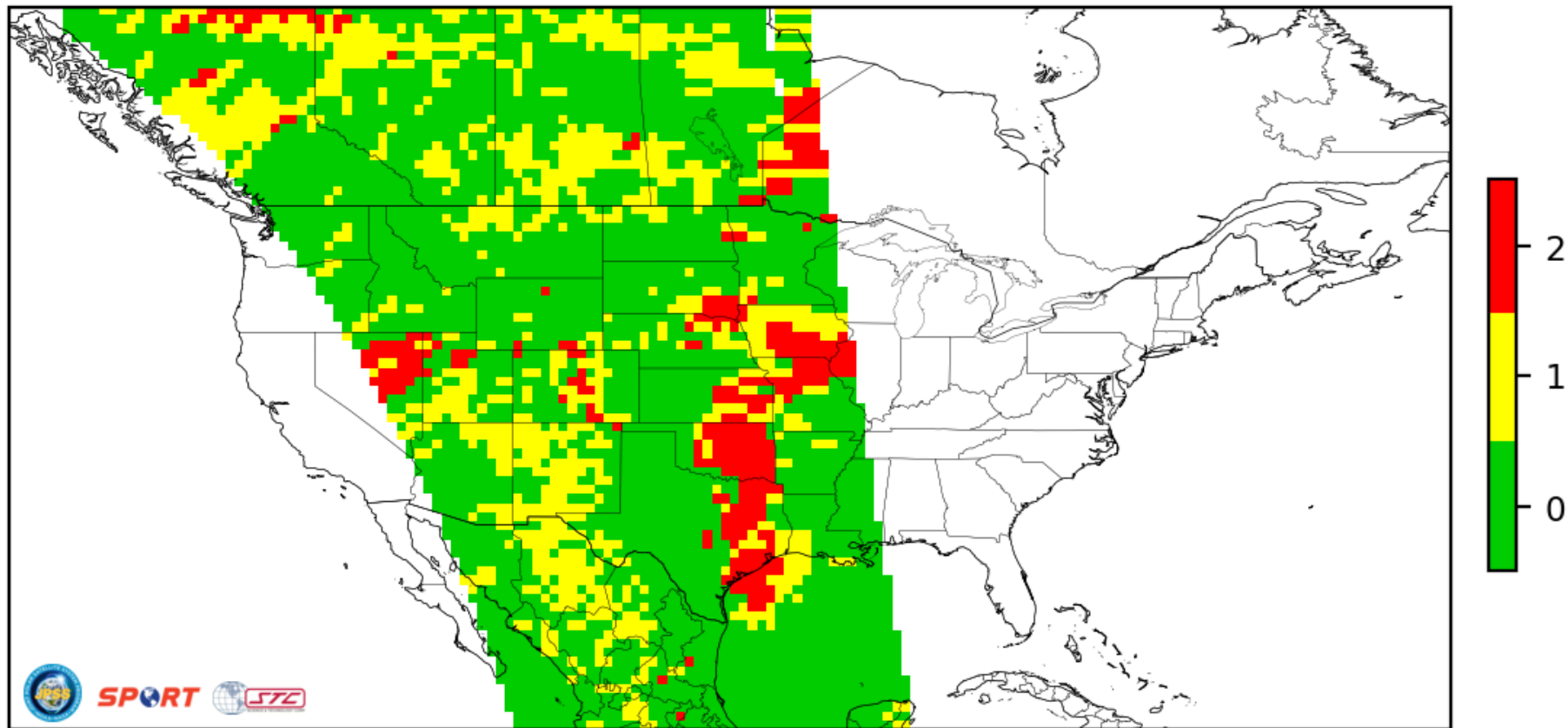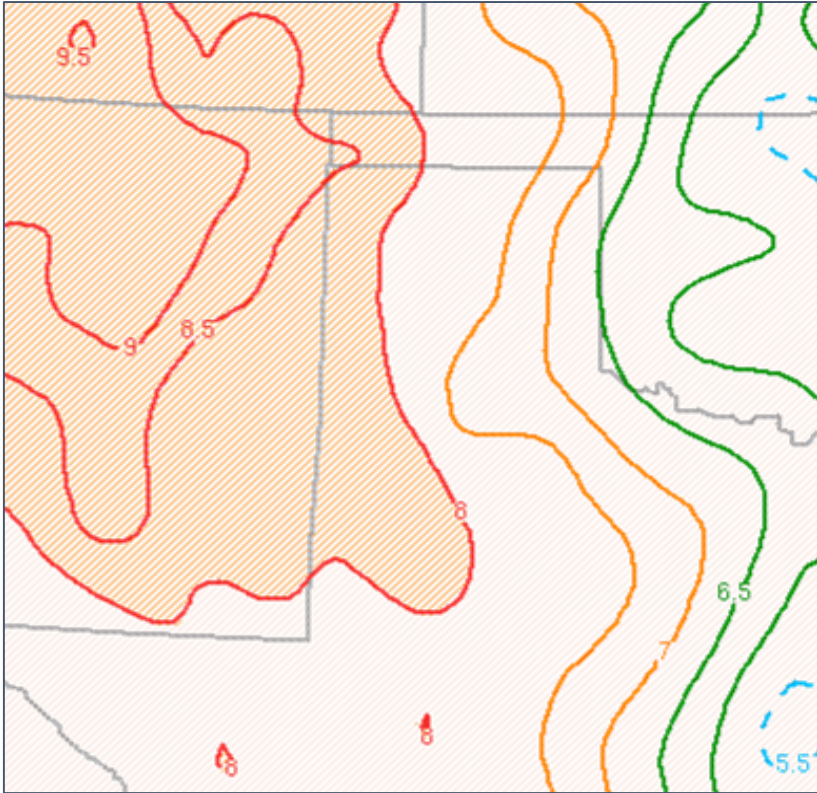SPoRT NOAA-20 Gridded NUCAPS Quality Flags 20210516 1938 UTC
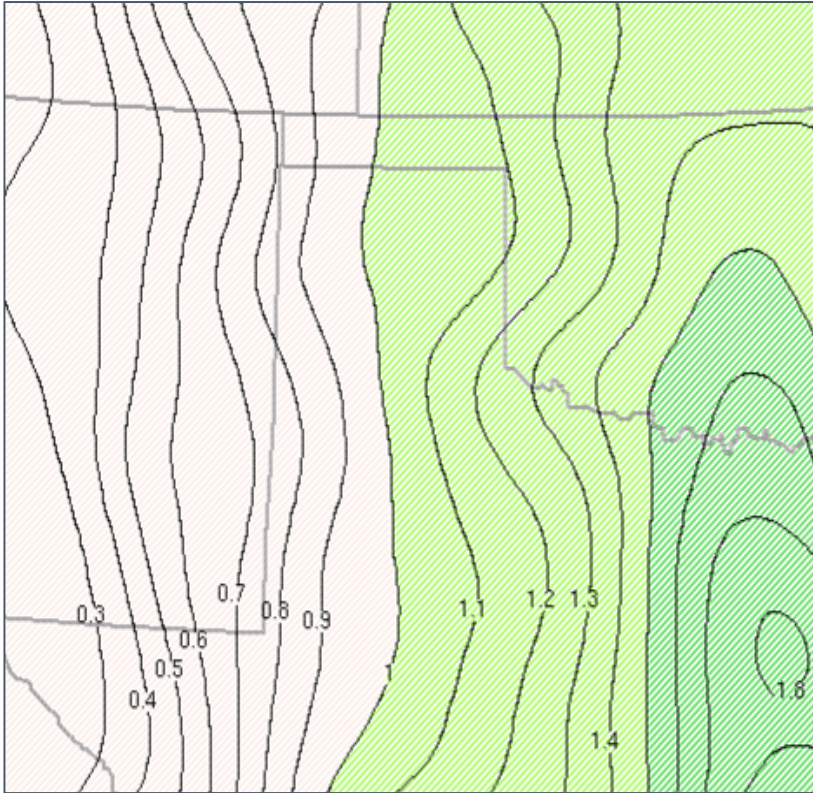
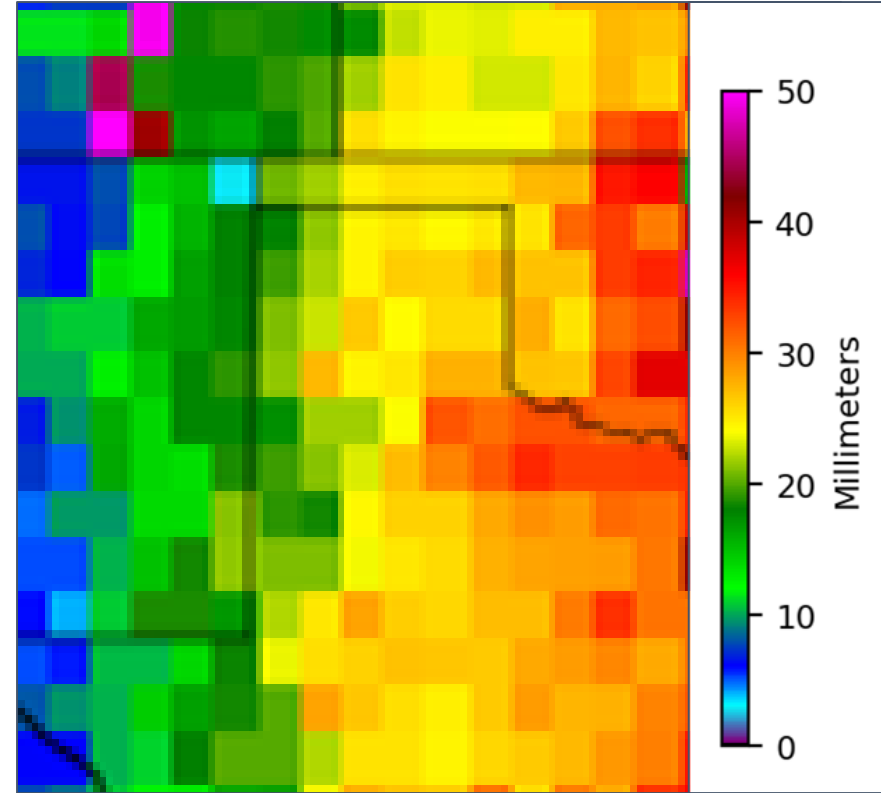NATIONAL WEATHER SERVICE

20z Mid-Level Lapse Rates

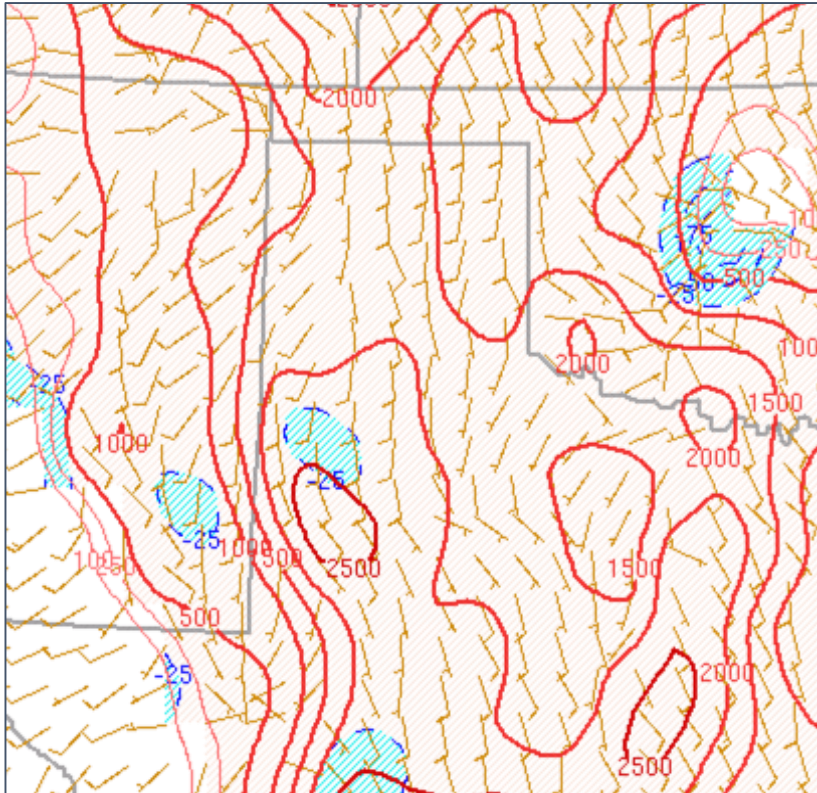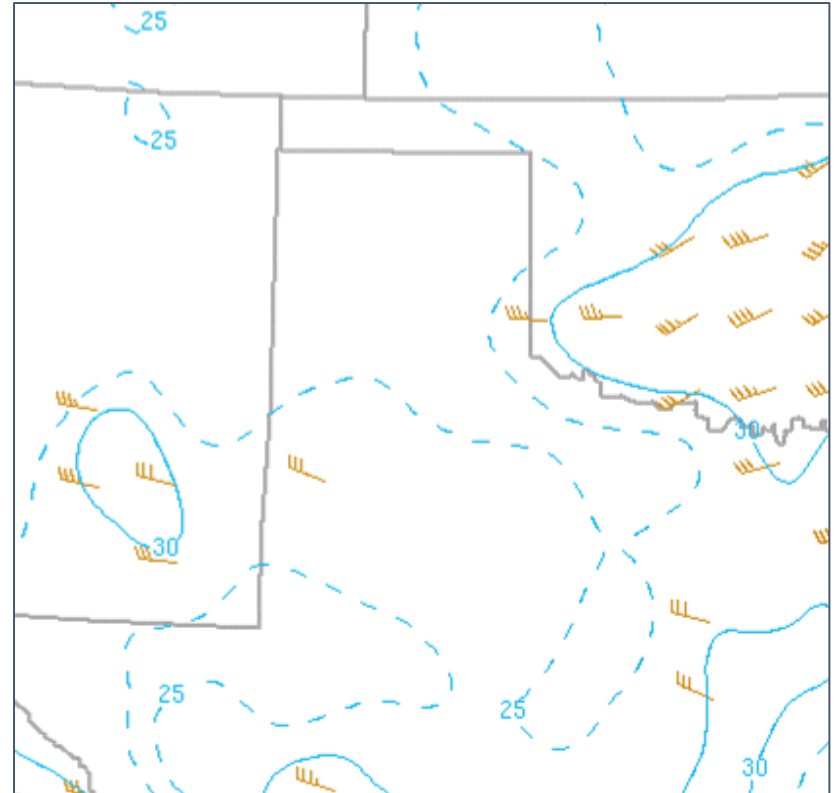# 20z Nucaps Mid-Level Lapse Rates
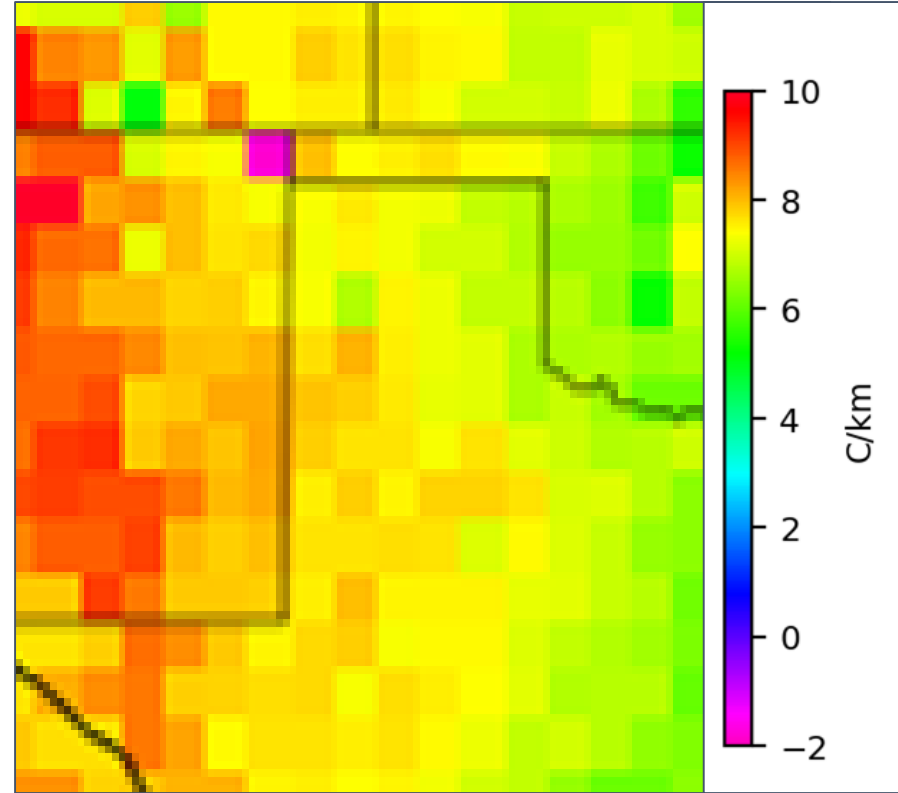
20z Precipitable Water (in)

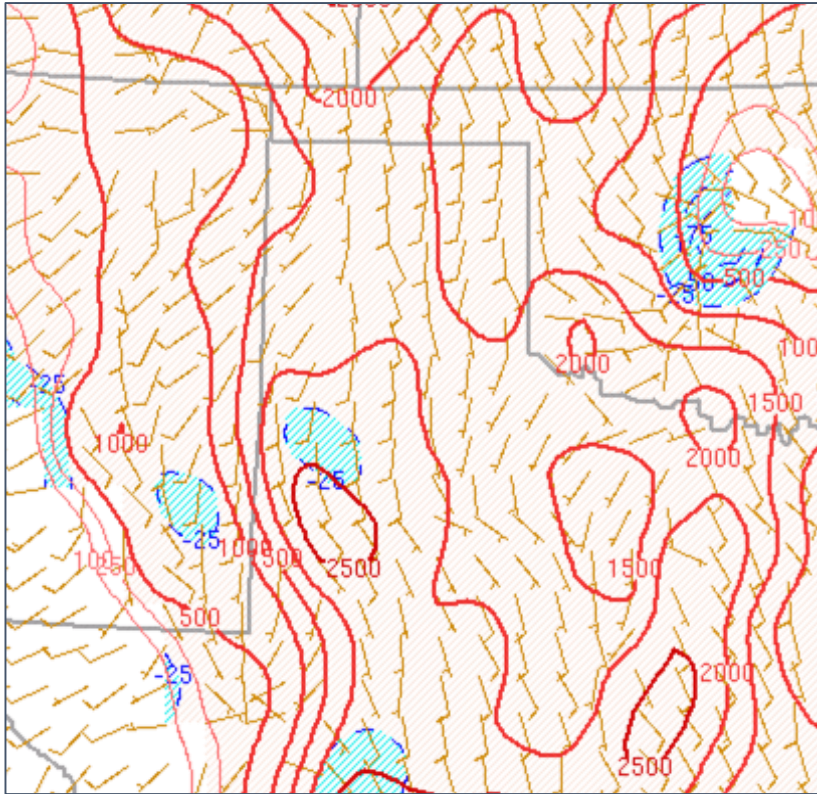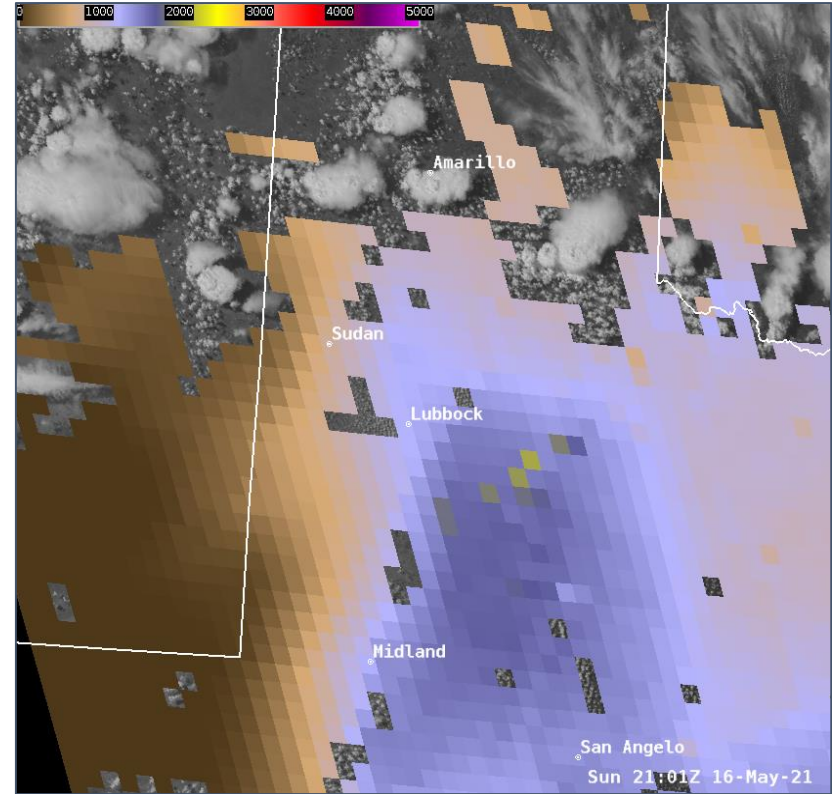# 20z Nucaps Precipitable Water (mm)

21z MLCAPE and MLCIN

21z 0-6 km Bulk Shear

21z MLCAPE and MLCIN
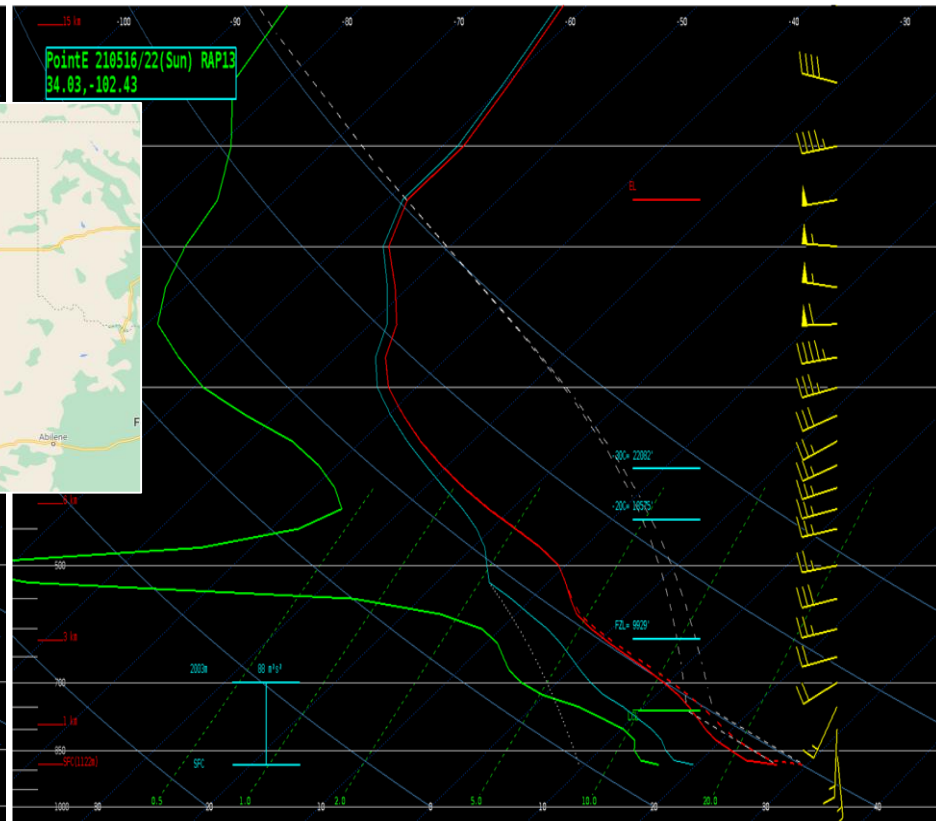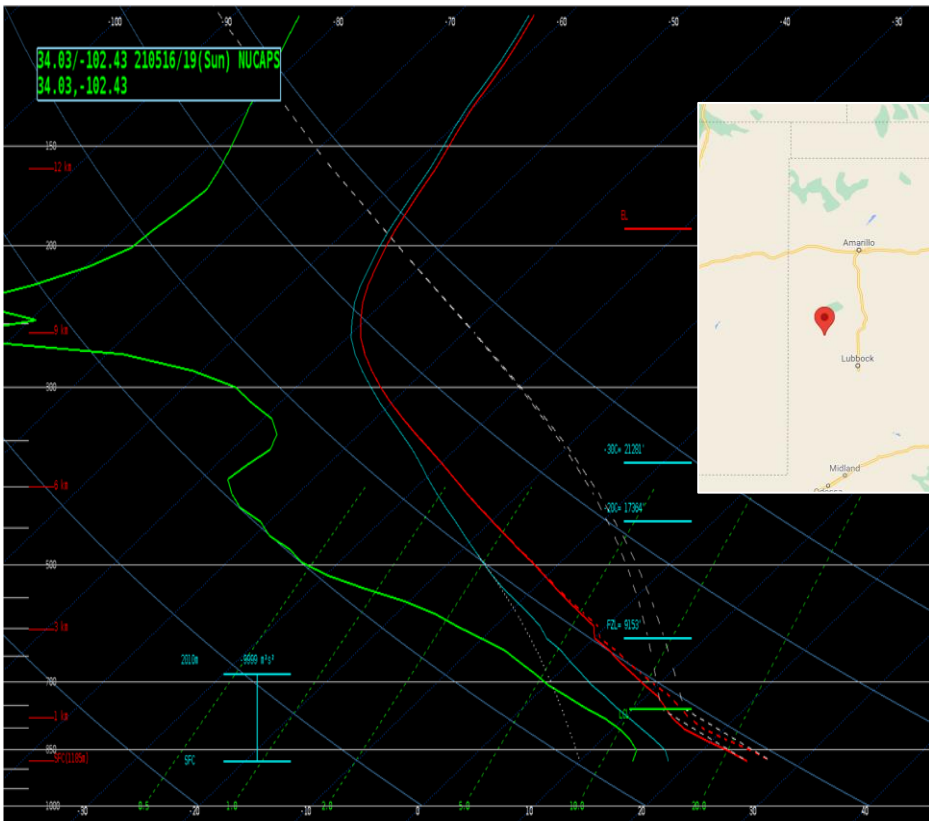

21z GOES-East Visible and CAPE

19z Nucaps Sounding

22z RAP Sounding

19z Nucaps Sounding Data

Sum1	CAPE	CINH	LCL	LI	LFC	EL
SB PARCEL	3197	0	1217m	-9	1217m	35784'
FCST PARCEL	2913	0	1587m	-8	1587m	35173'
MU PARCEL	3197	0	1217m	-9	1217m	35784'
ML PARCEL	2486	-12	1343m	-7	1604m	34542'
USER PARCEL	3042	0	1228m	-9	1228m	35173'
EFF PARCEL	1373	-22	1889m	-4	2271m	32446'

PW= 0.88 in   3CAPE= 135J/kg   WBZ= 7433'   WNDG= -407.71
K= 39   DCAPE= 1240J/kg   FZL= 9153'   ESP= 5.98
MidRH=41%   DownT= 50F   ConvT= 78F   MMP= 0.00
LowRH=61%   MeanW=10.9g/kg   MaxT= 80F   NCAPE= 0.33

sfc-3km Agl LapseRate= 26C/9.2C/km
3-6km Agl LapseRate= 25C/8.5C/km
850-500mb LapseRate= 34C/8.8C/km
700-500mb LapseRate= 20C/8.3C/km

Supercell= 0.0
STP(CIN)= 0.0
STP(fixed)= 0.0
SHIP= 0.7

Sum2	SRH(m²/s²)	Shear(kt)	MnWind	SRW
SFC-1km	M	M	M	0/0
SFC-2km	M	M	M	0/0
SFC-3km	M	M	M	0/0
Eff Inflow Layer	M	M	M	0/0
SFC-6km	M	M	M	0/0
SFC-8km	M	M	M	0/0
LCL-EL(Cloud Layer)	M	M	M	0/0
Lower Half Storm Depth		M	M	0/0

BRN Shear =   M
4-6km SR Wind =   0/0 kt
Corfidi Downshear =   -9999/-9999 kt
Corfidi Upshear =   0/0 kt
Bunkers Right =   -9999/-9999 kt
Bunkers Left =   -9999/-9999 kt
STPC(test) =   M

1km & 6km AGL Wind Barb

22z RAP Sounding Data

Sum1	CAPE	CINH	LCL	LI	LFC	EL
SB PARCEL	4271	0	1332m	-10	1332m	38870'
FCST PARCEL	3113	0	1897m	-8	1897m	37165'
MU PARCEL	4271	0	1332m	-10	1332m	38870'
ML PARCEL	2523	-34	1548m	-6	2003m	36102'
USER PARCEL	2525	-45	1453m	-6	2003m	36102'
EFF PARCEL	1549	-43	2082m	-4	2611m	33618'

PW= 0.85 in   3CAPE= 80J/kg   WBZ= 7909'   WNDG= 0.31
K= 33   DCAPE= 1467J/kg   FZL= 9929'   ESP= 4.14
MidRH=35%   DownT= 49F   ConvT= 82F   MMP= 0.96
LowRH=56%   MeanW=10.9g/kg   MaxT= 83F   NCAPE= 0.41

sfc-3km Agl LapseRate= 27C/9.6C/km
3-6km Agl LapseRate= 24C/8.0C/km
850-500mb LapseRate= 32C/8.0C/km
700-500mb LapseRate= 20C/7.8C/km

Supercell= 5.5
STP(CIN)= 0.3
STP(fixed)= 0.3
SHIP= 1.8

Sum2	SRH(m²/s²)	Shear(kt)	MnWind	SRW
SFC-1km	29	4	175/15	149/26
SFC-2km	88	19	196/13	158/21
SFC-3km	111	26	218/13	166/18
Eff Inflow Layer	88	19	196/13	157/22
SFC-6km		29	240/16	189/15
SFC-8km		33	242/17	192/15
LCL-EL(Cloud Layer)		42	260/26	230/18
Lower Half Storm Depth		29	240/16	187/15

BRN Shear =   44 m²/s²
4-6km SR Wind =   237/18 kt
Corfidi Downshear =   272/39 kt
Corfidi Upshear =   293/21 kt
Bunkers Right =   299/13 kt
Bunkers Left =   225/30 kt
STPC(test) =   0.3

1km & 6km AGL Wind Barb

GOES-East Day Cloud Phase Distinction and VIS/IR Sandwich
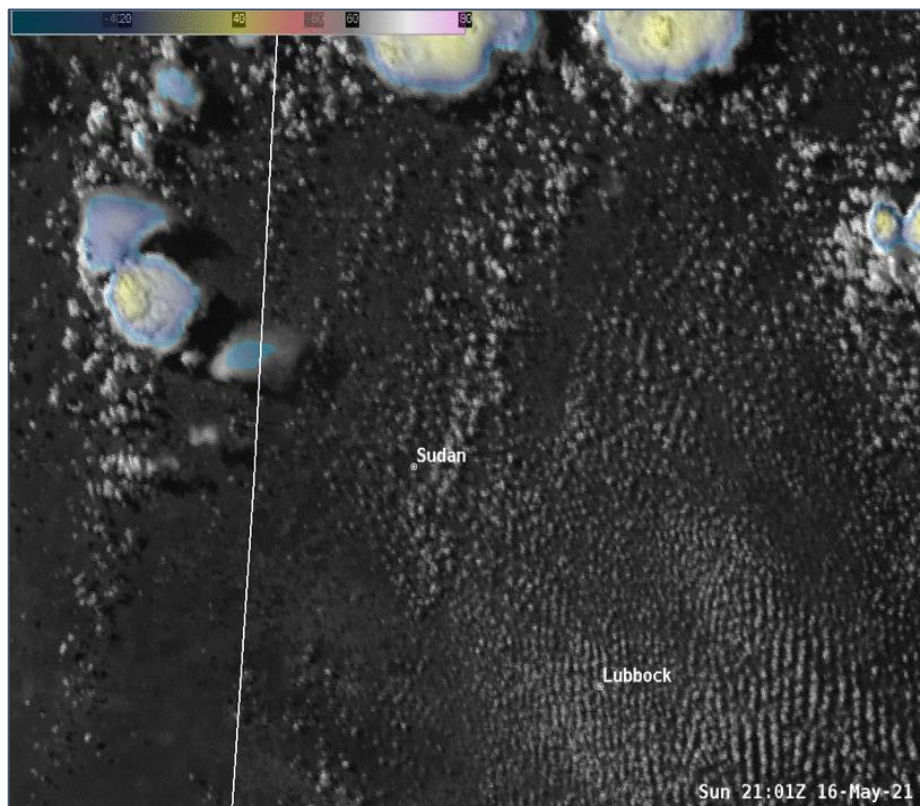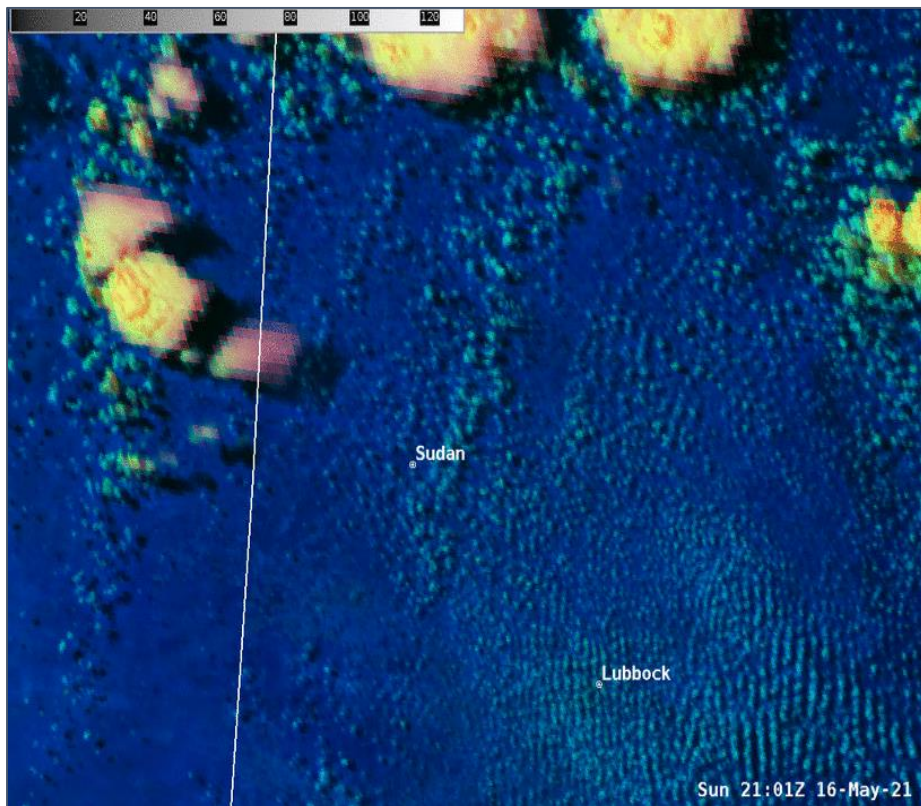
User Improvements?

- More passes in a 24-hour time period

- More instability parameters available spatially (i.e., CAPE, CIN)

- Easier access to previous events for case review (maybe even just a 7-day rollover period, if possible)

- Utilizing surface observations to modify the NUCAPS soundings (This is already being done, but not sure where it is in terms of getting it into forecast offices AWIPS systems)

- Online visualization of NUCAPS soundings (like what is available for the gridded NUCAPS)

Thank You!

Questions?