

# Real-time NUCAPS in science and weather forecasting

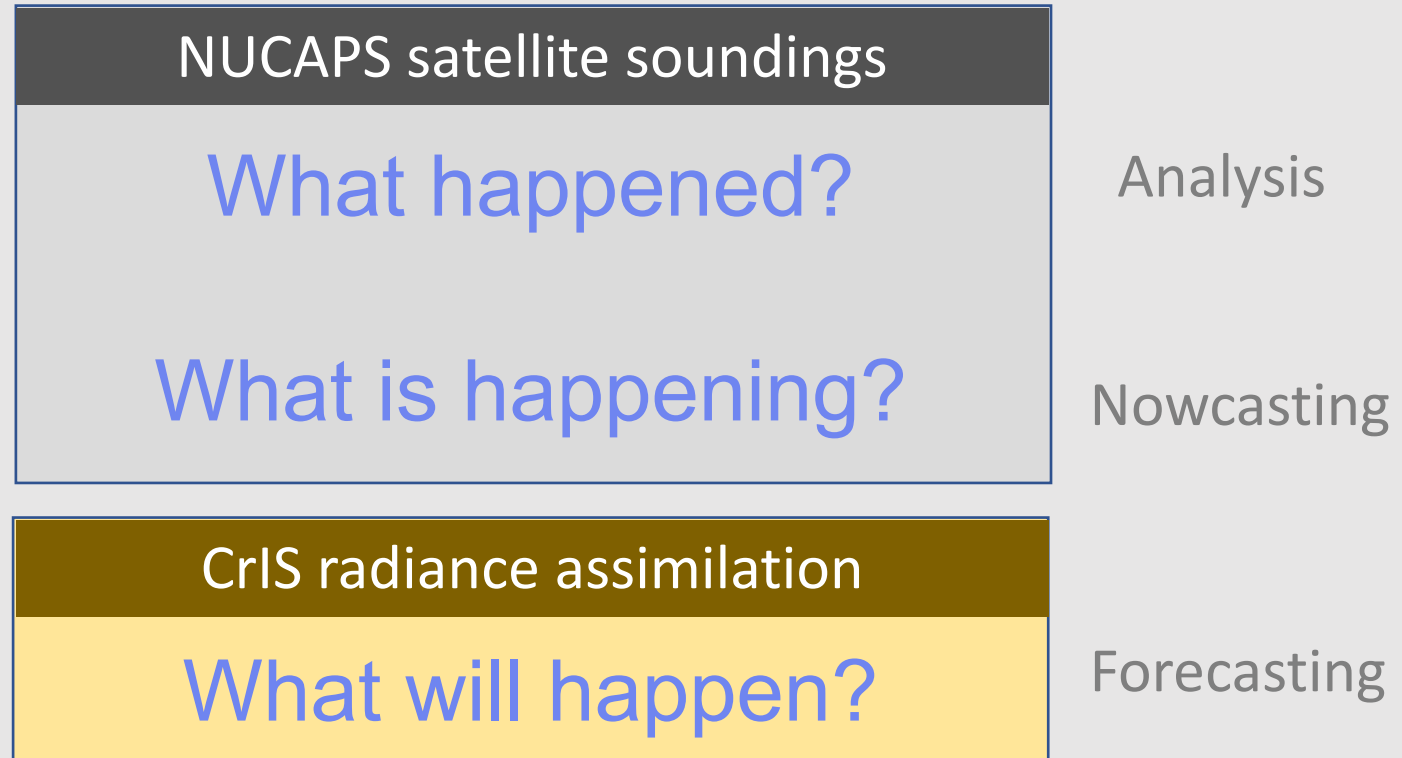
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<sup>1</sup> Science and Technology Corporation (STC)

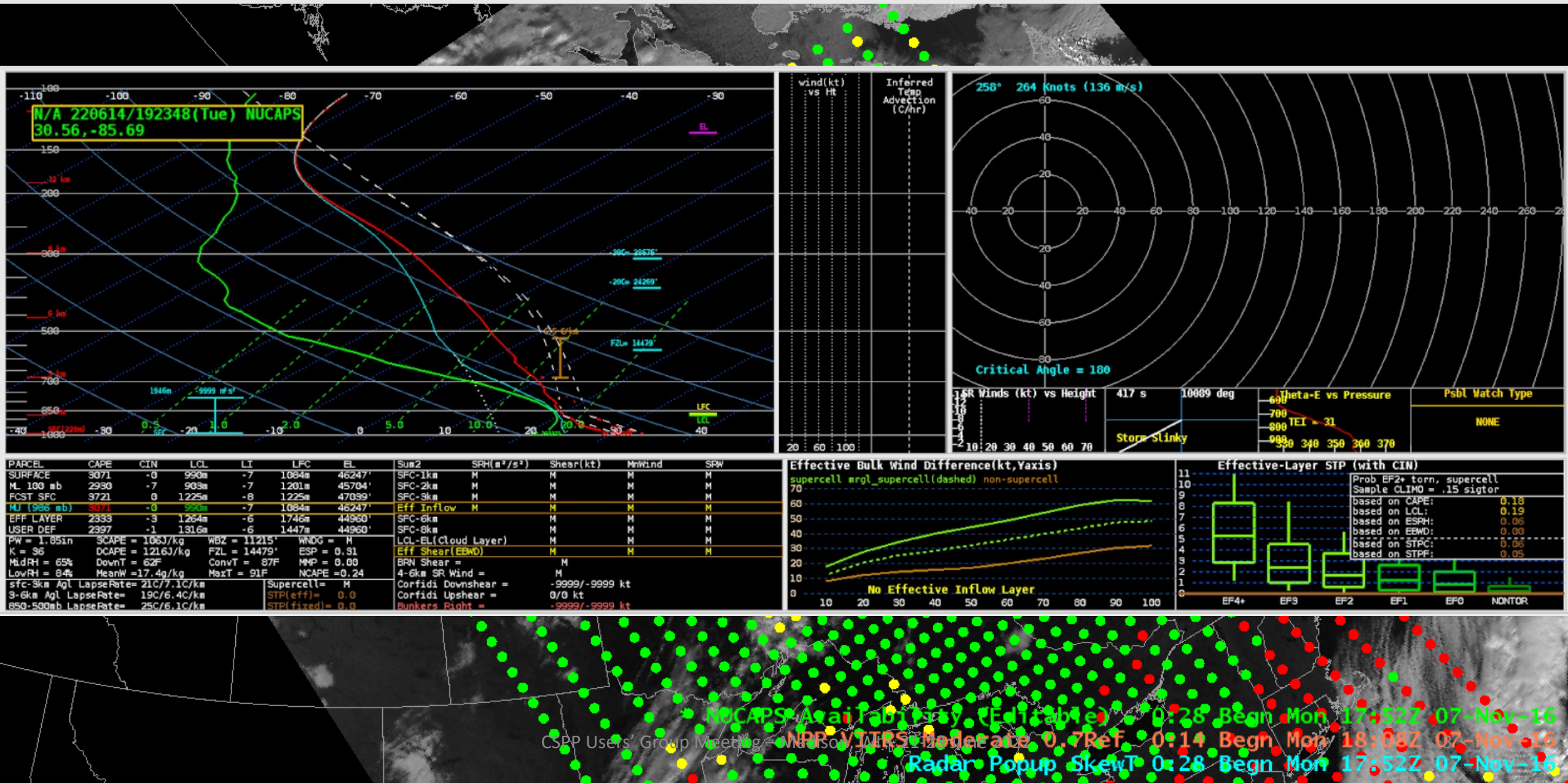
<sup>2</sup> NASA MSFC, Short-term Prediction Research and Transition Center (SPoRT)

<sup>3</sup> Univ. WI-Madison, Space Science and Engineering Center (SSEC)

# The value of IR observations in the weather service **today**



# NUCAPS in AWIPS-II as skew-T diagrams



# The value of IR observations in the weather service in 2016

NUCAPS-SNPP

>2 hour latency

NUCAPS satellite soundings

What happened?

What is happening?

Analysis

Nowcasting

CrIS radiance assimilation

What will happen?

Forecasting

**CSPP** tools and services were instrumental in fostering an active, well-equipped user base for NOAA and NASA satellite sounding observations

# #1: Develop a new low-latency sounder product

Alaskan Center Weather Service Unit (CWSU) provide Meteorological Impact Statements (MIS) to Air Traffic Controllers to direct flights around cold air aloft features. In data sparse Alaska, forecasters have relied on analysis and model fields and limited radiosonde observations to guess the 3D extent of the Cold Air Aloft

## Example text product disseminated by Alaska CWSU for Cold Air Aloft; valid 14 November 2015

```
FAAK20 KZAN 121458  
ZAN MIS 01 VALID 121500-130300  
...FOR ATC PLANNING PURPOSES ONLY...  
COLD AIR ALOFT  
FROM 185NE SCC-65NE ORT-55SW ENN-110NW BRW-185NE SCC  
TEMPS -65C OR LESS FM FL350-400. AREA MOVG NE 40 KTS.  
CMW NOV 14
```

Lat/Lon Extent of Cold Air from soundings, aircraft reports, model

Vertical Extent of Cold Air from soundings/aircraft reports/model

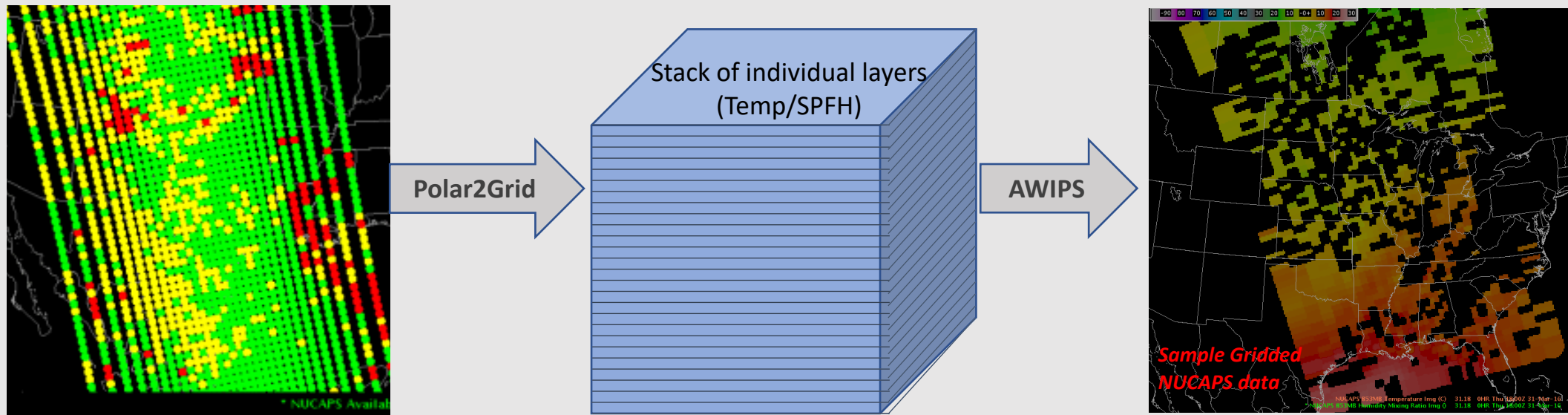
Motion determined from model data





# #1: Develop a new low-latency sounder product

- CSPP polar2grid software modification to read CSPP NUCAPS Level 2 files
- SPoRT obtains CSPP Direct Broadcast data, runs polar2grid, and converts output to gridded binary (GRIB2) format for ingest into AWIPS
- GRIB2 files are pushed to NWS partners in real-time



## NUCAPS Soundings:

Need to click on each 'point' to review the vertical information

- *Pros: Can choose specific locations*
- *Cons: A lot of individual interrogation*

A subset of 58 layers are output using Polar2Grid from the 100 layers output by NUCAPS.

The grib2 file only contains:

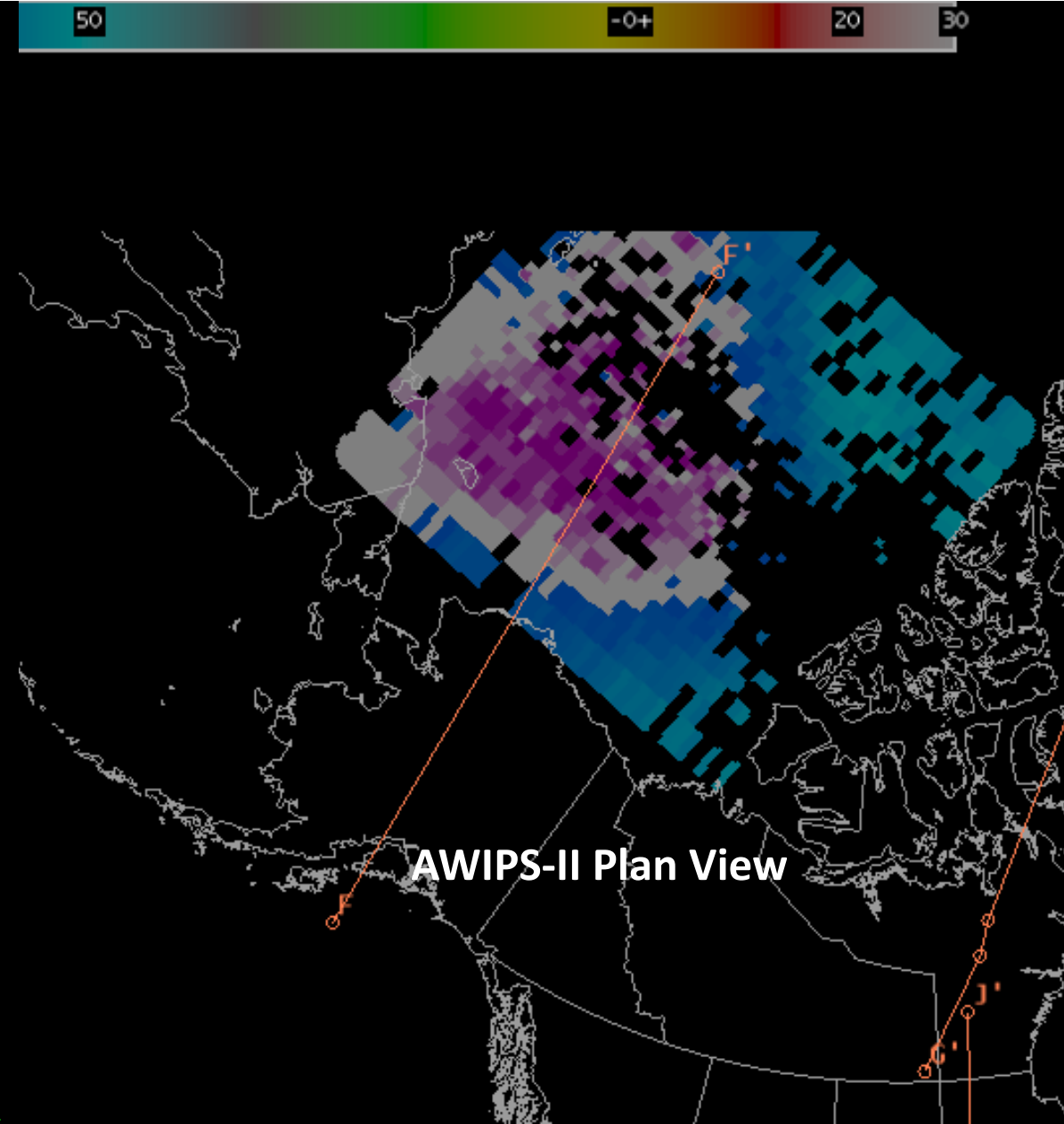
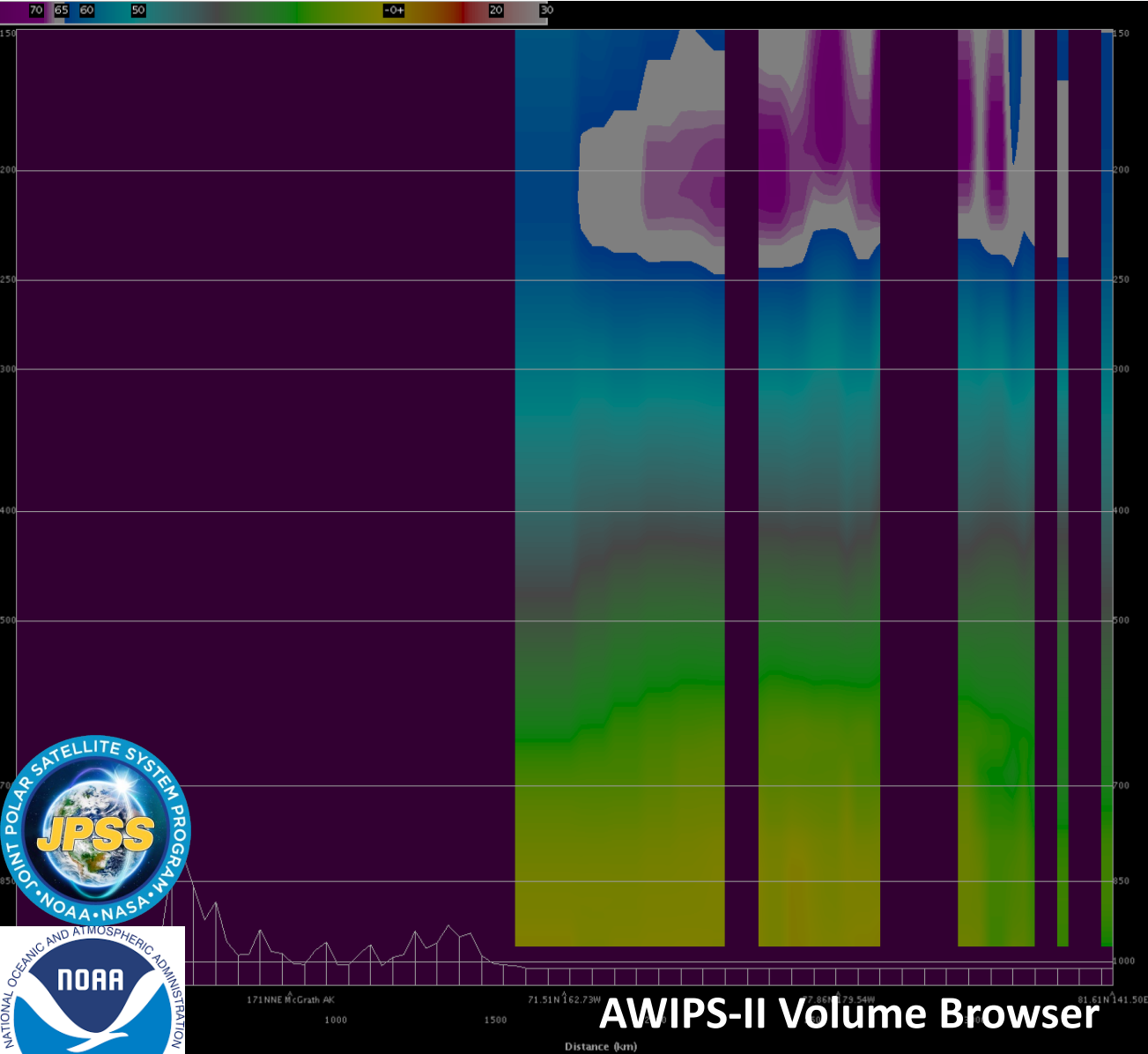
- Temperature, Specific humidity
- Surface pressure and temperature
- Topography

Ingested into AWIPS on a uniform model grid, so AWIPS will interrogate the information in the same way it handles model data.

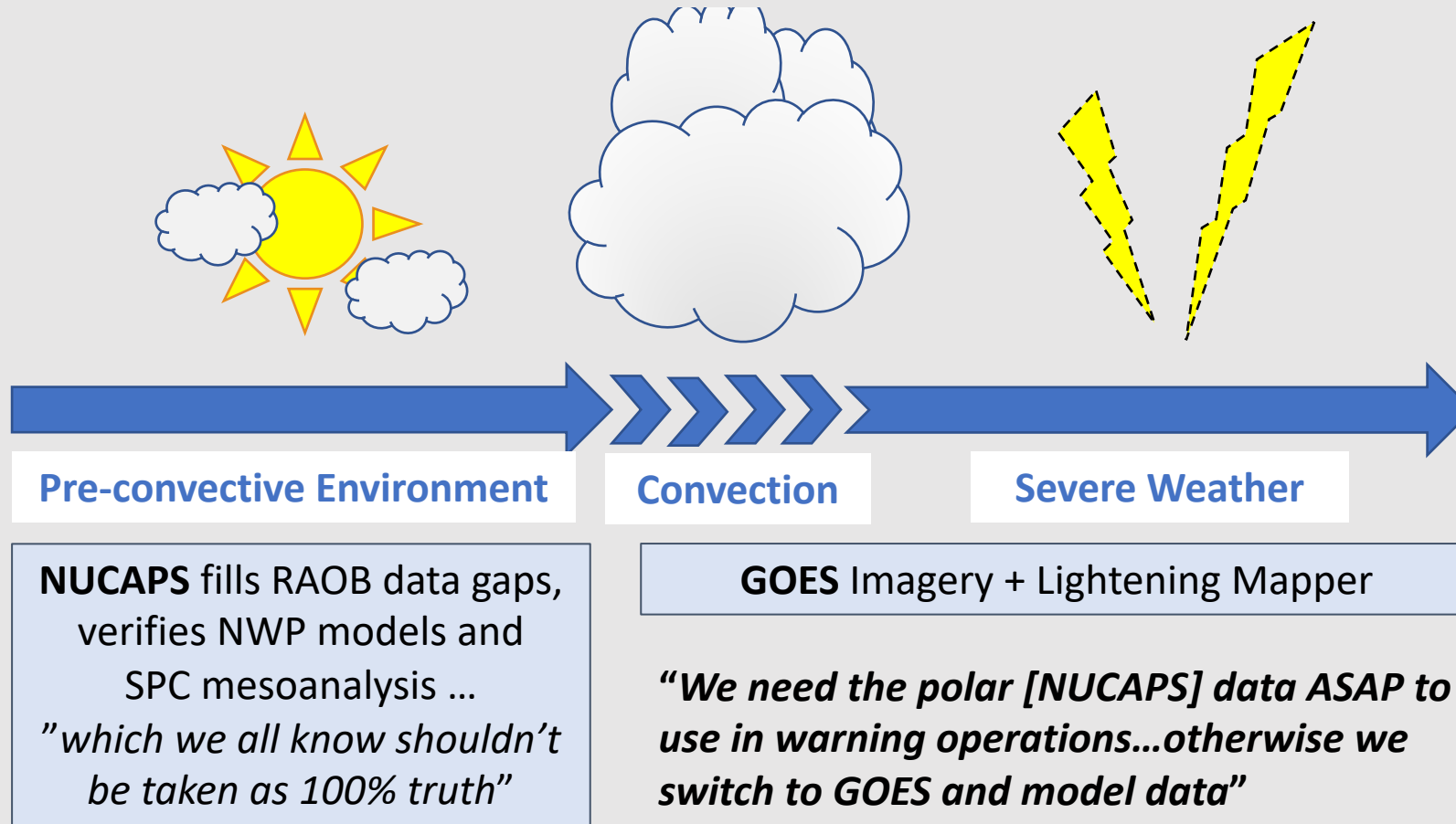
- Plan view and cross sections
- Temperature, moisture, and stability indices.

**Use CSPP to bypass NOAA SBN pipeline to develop custom products and significantly increase latency**

# NUCAPS in AWIPS-II as 3-D fields



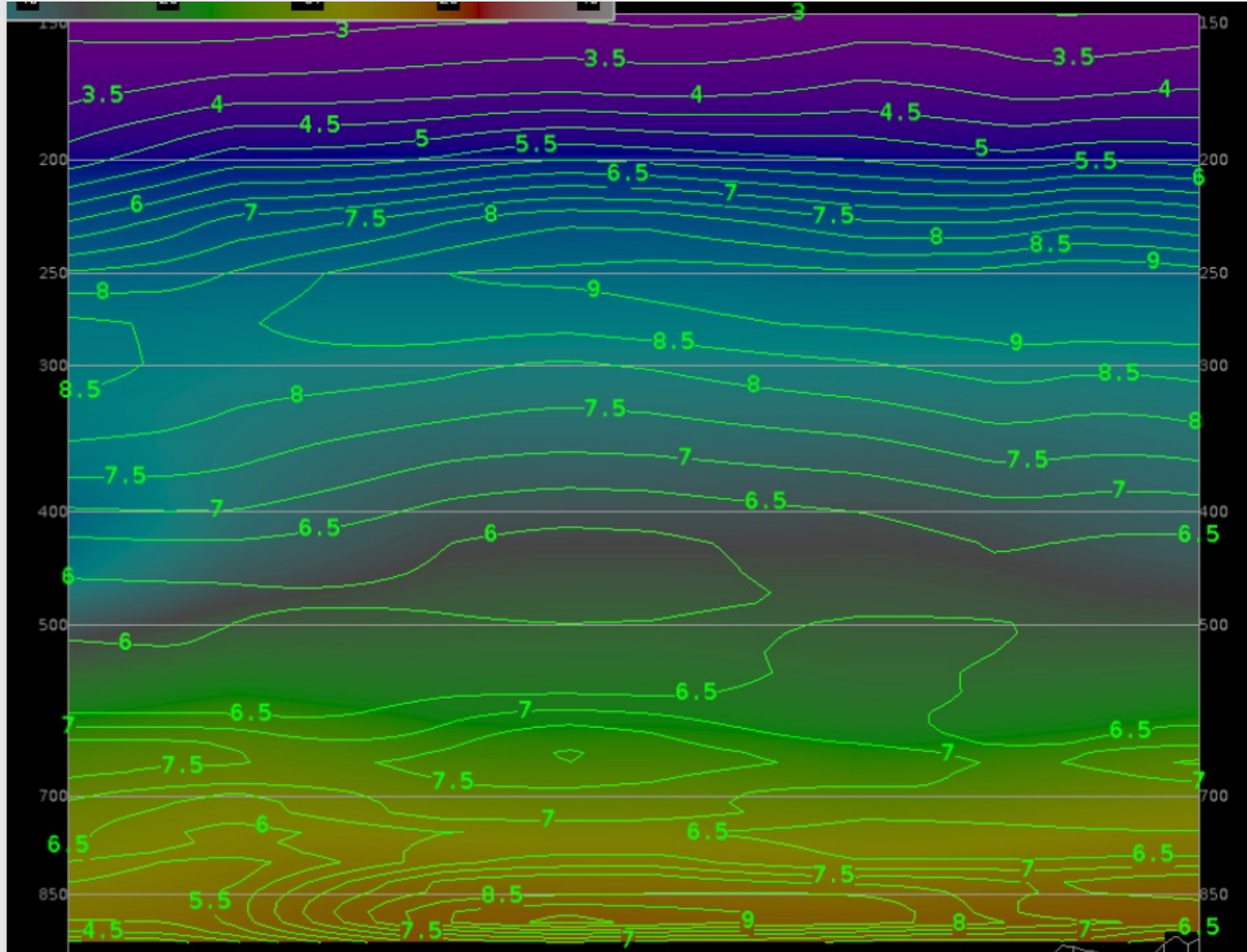
# NUCAPS in severe weather forecasting



Operational meteorologists need NUCAPS as mesoscale observations of real-time atmospheric state ahead of storm development – compare NUCAPS to NWP models and SPC mesoanalysis for **situational awareness** and **confidence in their conceptual models** of storm potential.

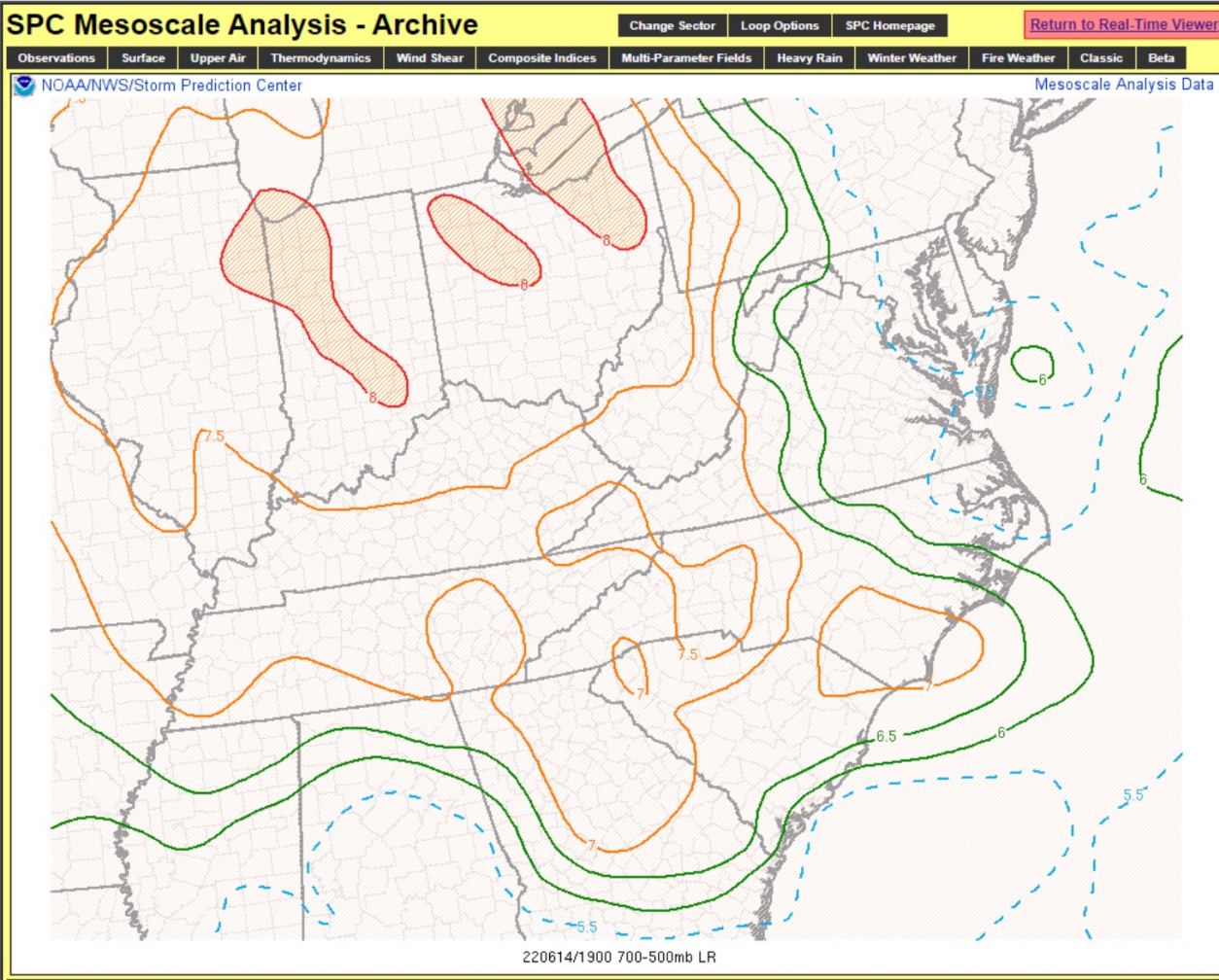


# Cross-section of NUCAPS showing dewpoint as image and lapse-rate as contour

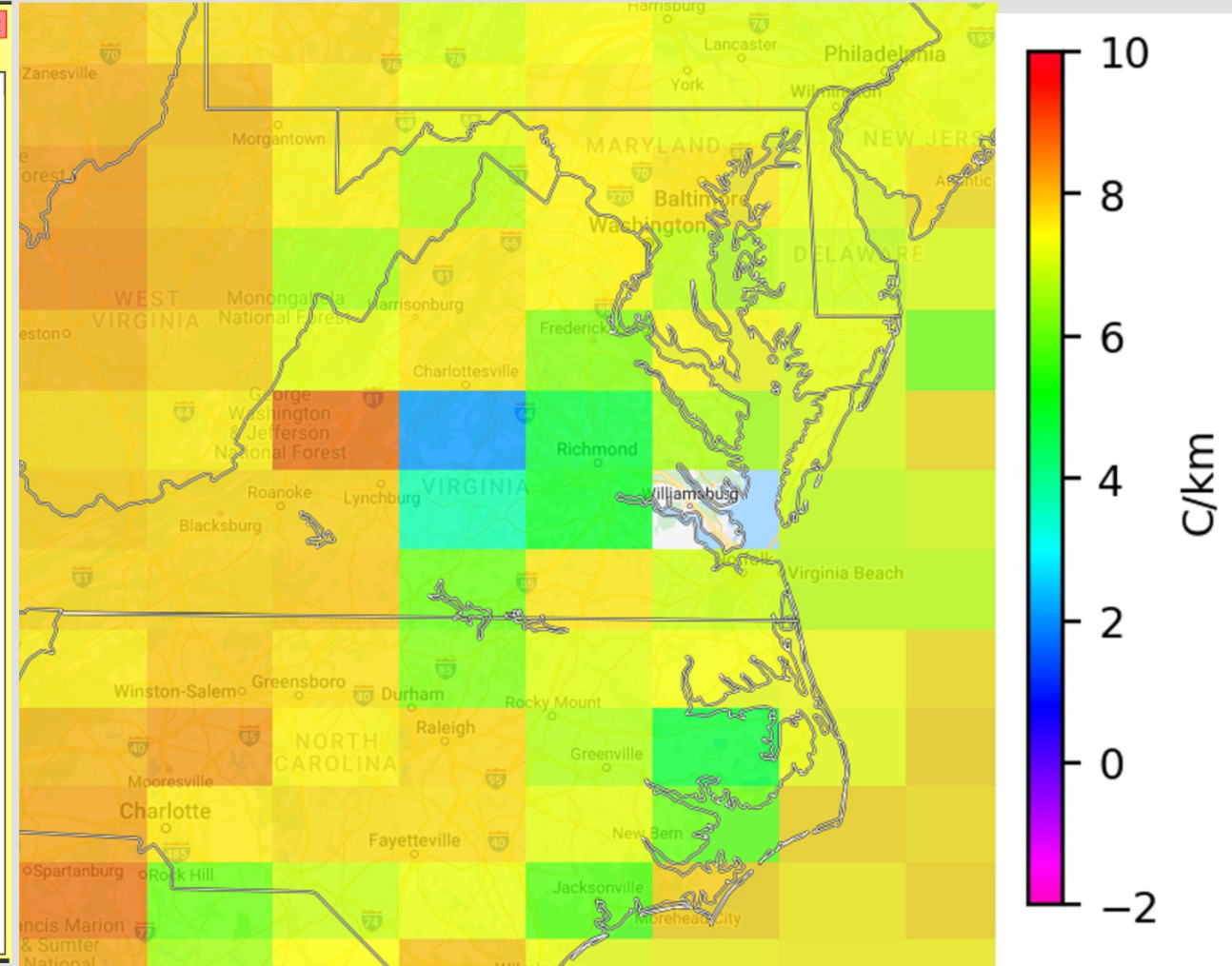


<https://goesrhwt.blogspot.com/search/label/NUCAPS#:~:text=Gridded%20NUCAPS%20Cross%20Sections>





SPC Meso-A 700-500 mb lapse rates at 19h00 UTC



Gridded NUCAPS-NOAA20 from 18h19 UTC overpass

“As you can see from the SPC mesoanalysis graphic, there was a region of 7.5 C/km to 8.4 C/km maximum lapse rates in the 2-6 km AGL layer. The NUCAPS sounding above sampled a layer of 7.9 C/km lapse rates from just below 700 mb to just below 500 mb, which verifies the SPC Meso-A field.”

# #2: Increase temporal resolution of LEO soundings

NOAA Satellite Broadband Network

HEAP(NUCAPS-NOAA20)

AWIPS-II

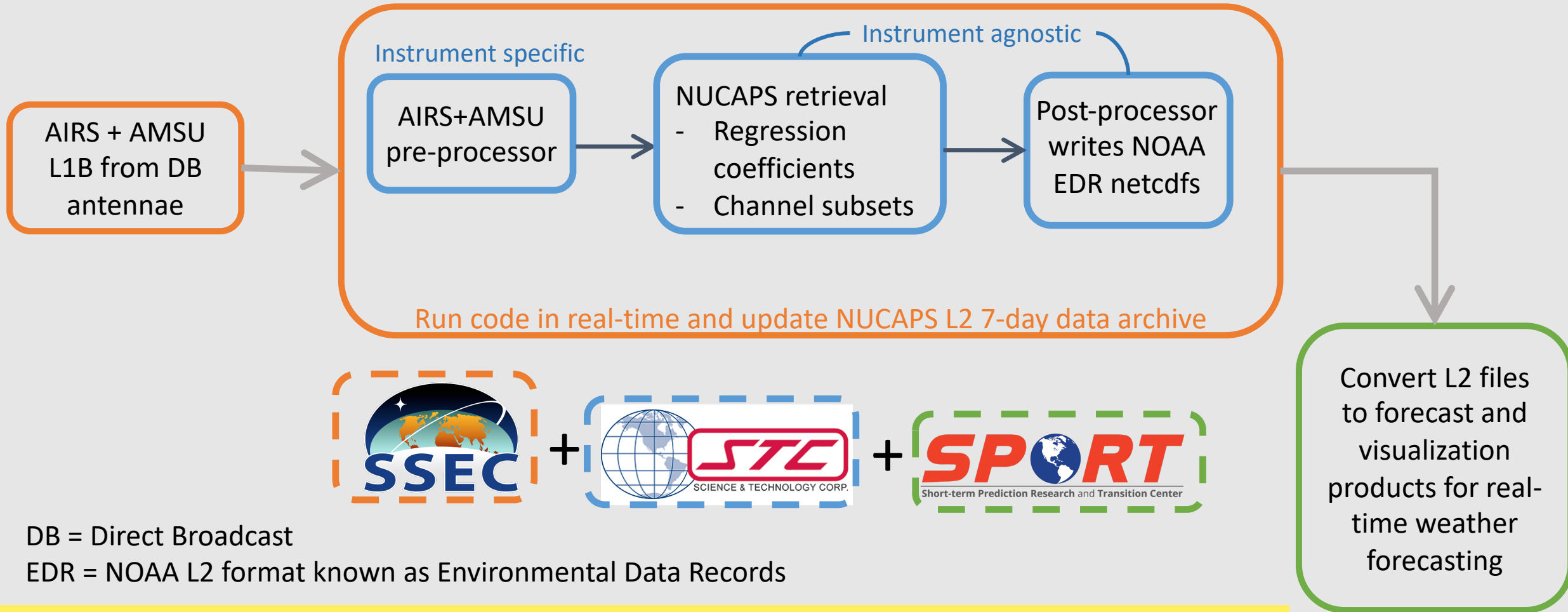
NUCAPS-Aqua

A tandem of satellite soundings in early afternoon orbit to improve situational awareness of pre-convective environment

IMAPP Level 1 Aqua products  
Direct Broadcast data stream  
Off-line NUCAPS science code



# #2: Increase temporal resolution of LEO soundings



DB = Direct Broadcast

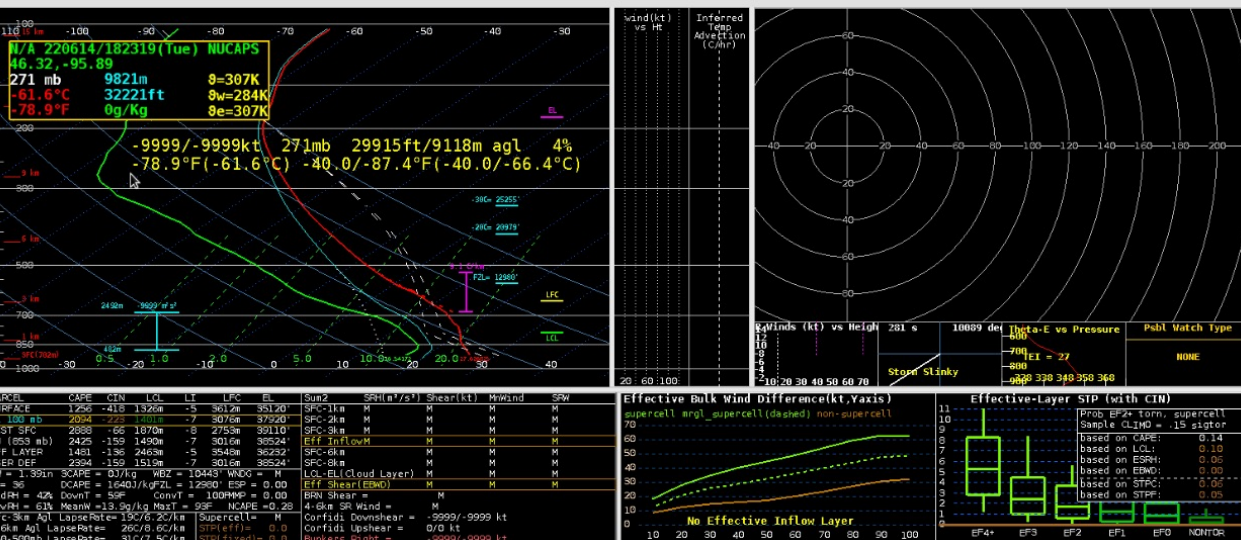
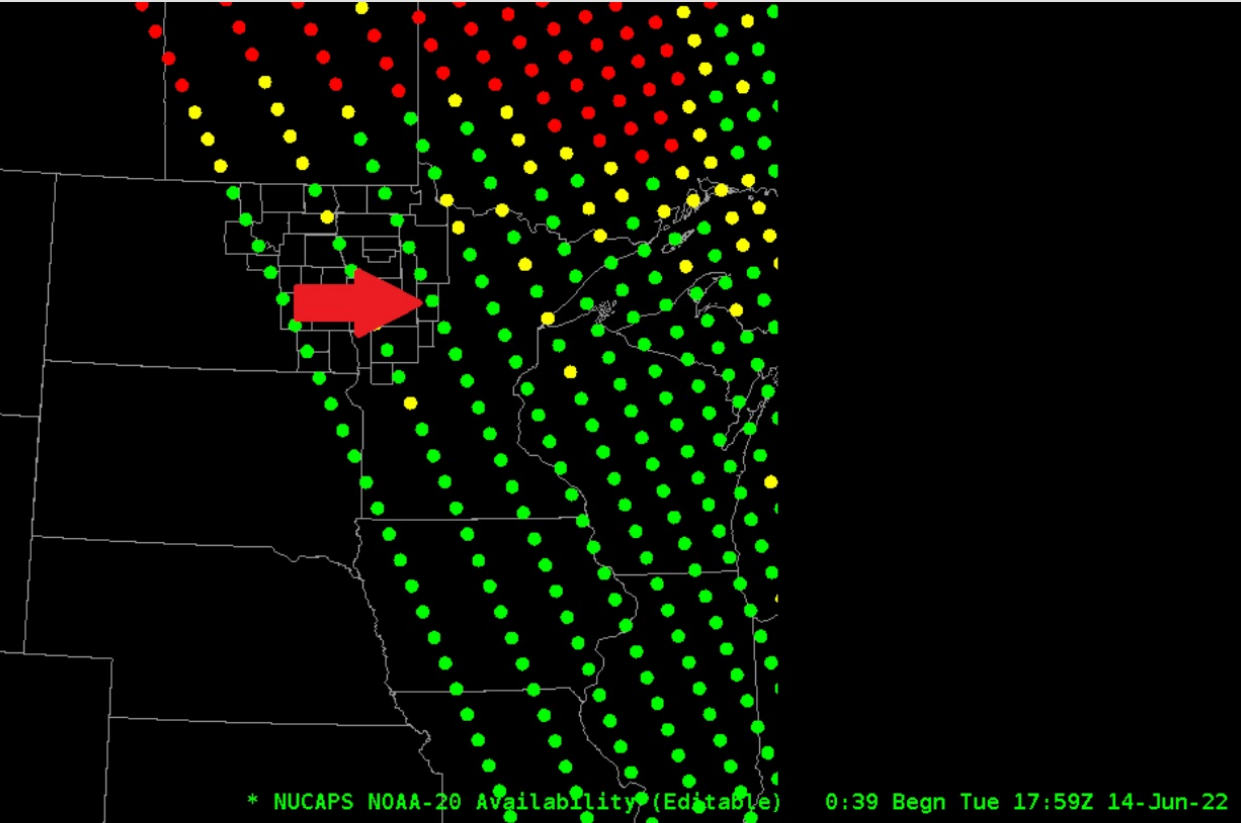
EDR = NOAA L2 format known as Environmental Data Records

Demonstrate a prototype ground system for high frequency real-time sounding capability with value to National Weather Service



# NUCAPS-NOAA20 overpass at 18h23 UTC

Convection developed rapidly to the south of the main area of convection in an area of high instability. This was first picked up by higher probabilities in the LightningCast data. There was some rapid cumulus development that was picked up well by the algorithm. Probabilities went well above 75% around 5 minutes or so from the first GLM detection. NUCAPS data indicated MLCAPEs of around 2000 J/Kg in this area supporting the quick upscale growth.



<https://goesrhwt.blogspot.com/2022/06/lightningcastnucaps-and-isolated-to.html>

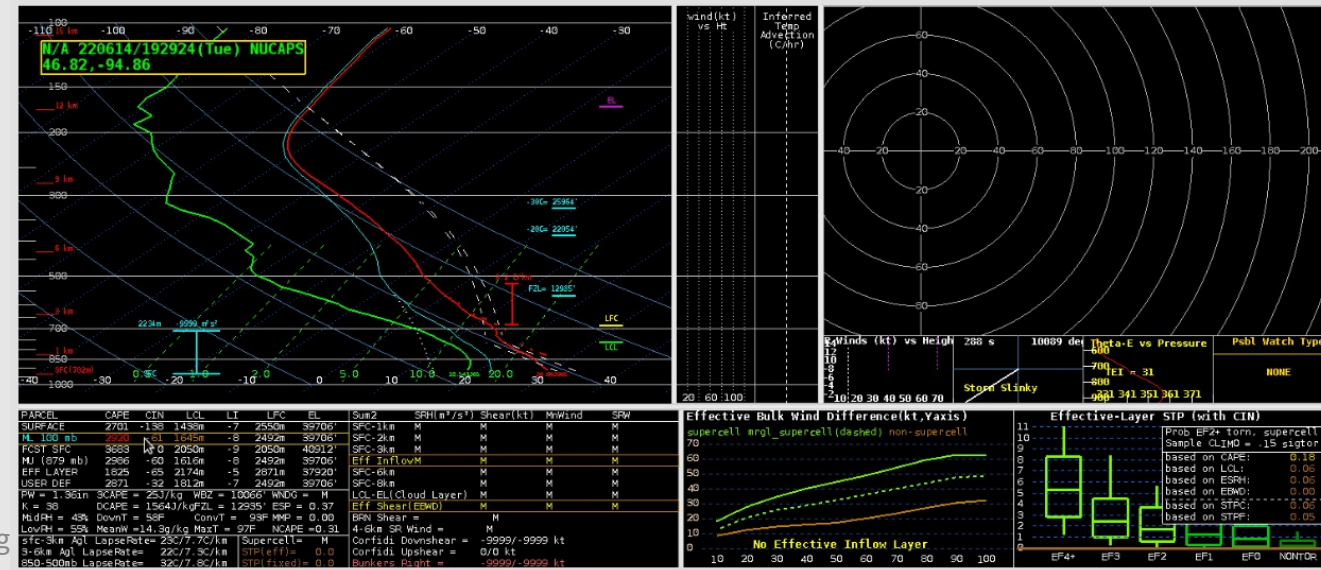
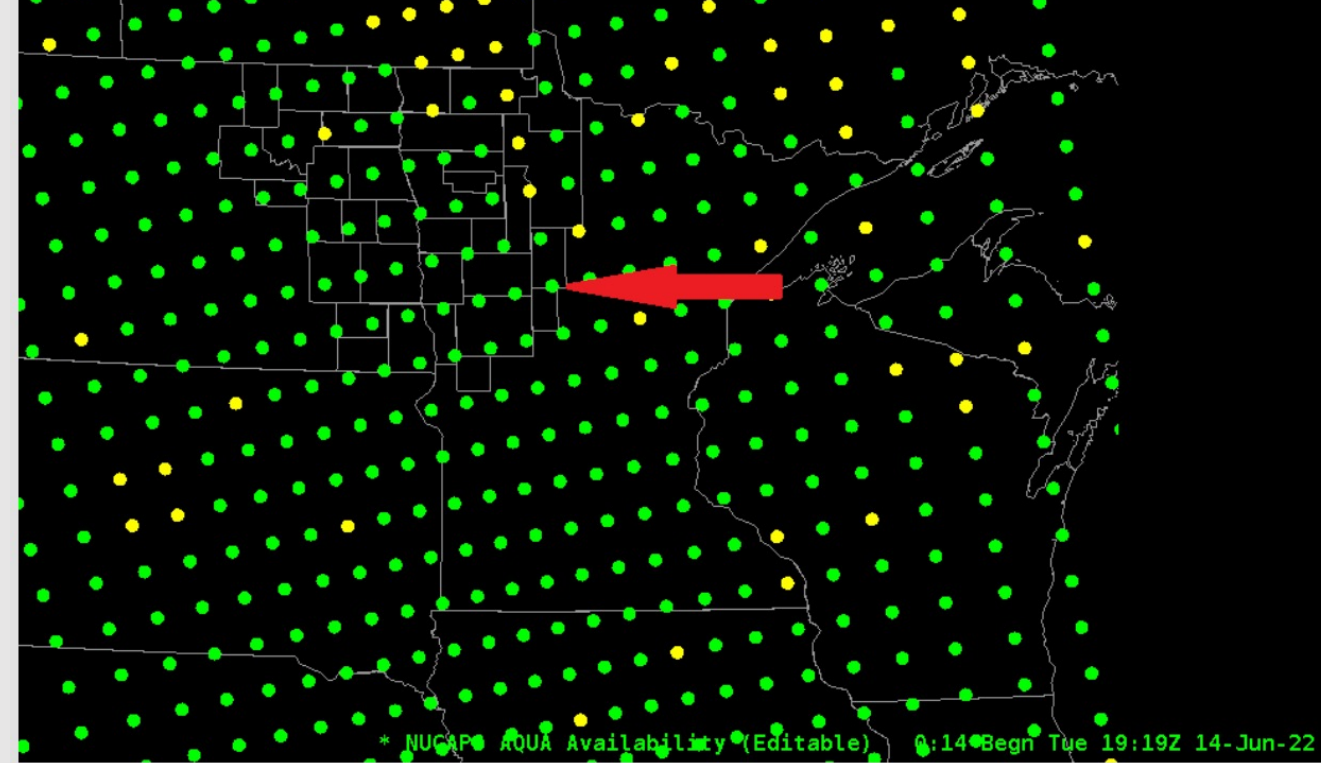


# NUCAPS-Aqua overpass at 19h19 UTC

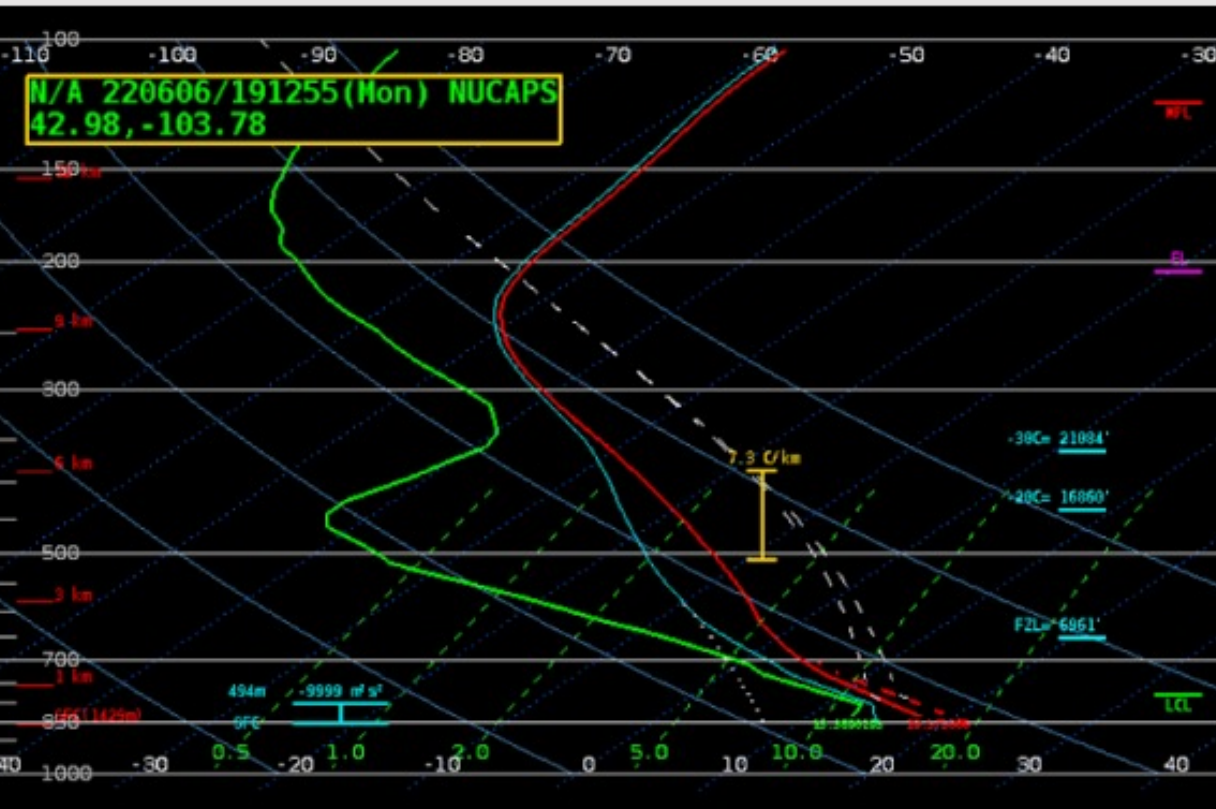
This was almost directly under NADIR so we should have much better profile retrieval. Sure enough, MLCAPE value is almost 3000 J/kg in between the 1823 and 2003 UTC NOAA-20 sounding retrievals.

<https://goesrhwt.blogspot.com/2022/06/lightningcastnucaps-and-isolated-to.html>

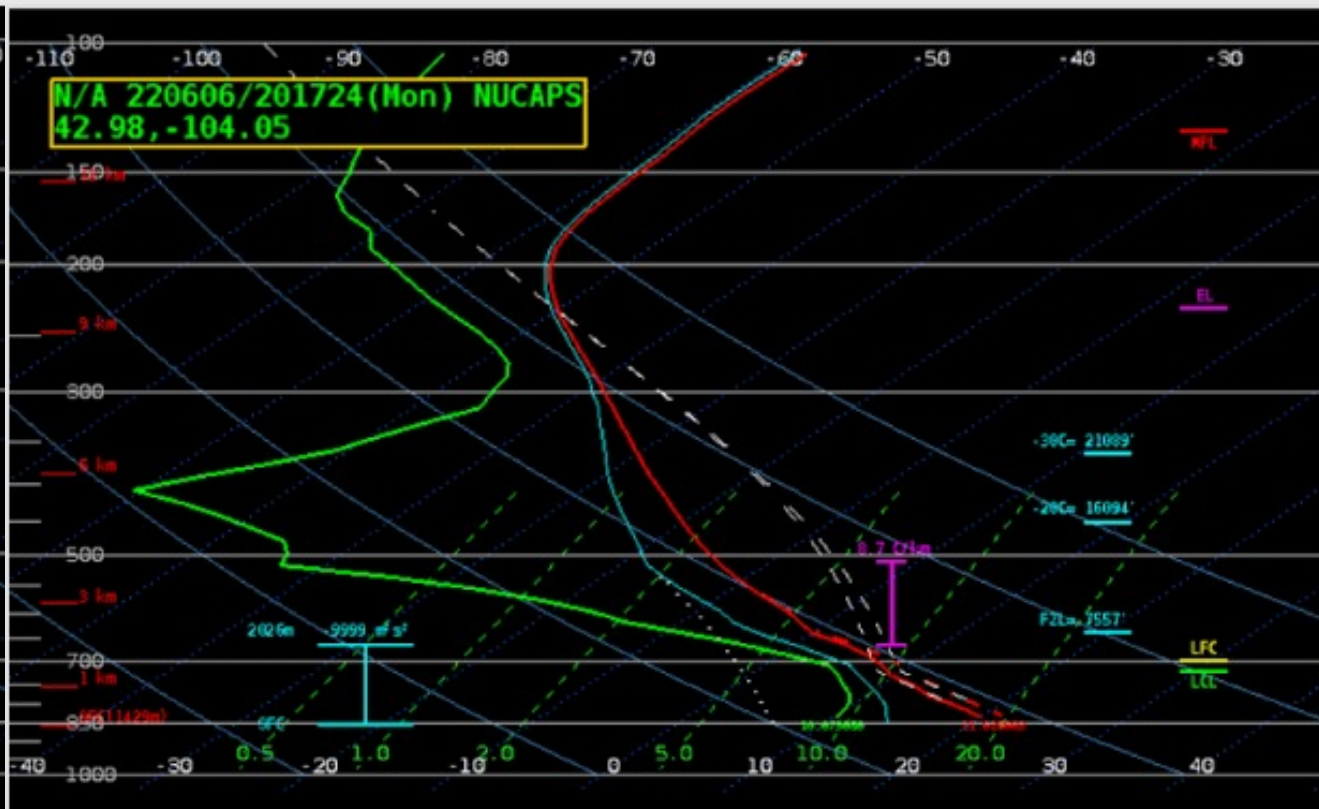
They (models/observation) all combine to increase confidence on what conditions COULD be in areas where the models are saying one thing and an observational system is indicating potential reality (remember, it's still a remote sensing platform with their own set of issues). In our case, the bulls-eye of 3000 J/kg in east central Minnesota is likely real and needs to be an area to watch...and that is where the Lightning Cast product at the start of our post indicated the potential for new activity to develop. Pretty cool stuff...



## NUCAPS-NOAA20 at ~19h00 UTC



## NUCAPS-Aqua at ~20h30 UTC

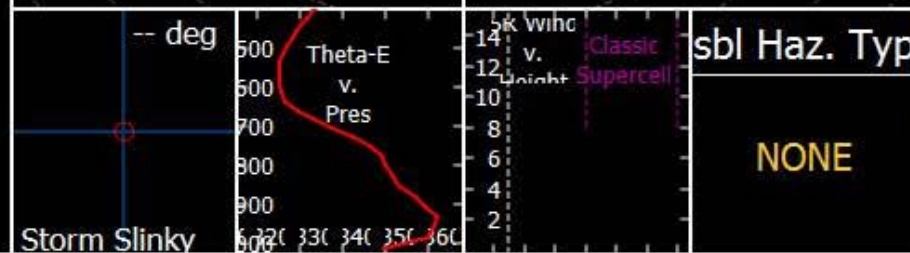
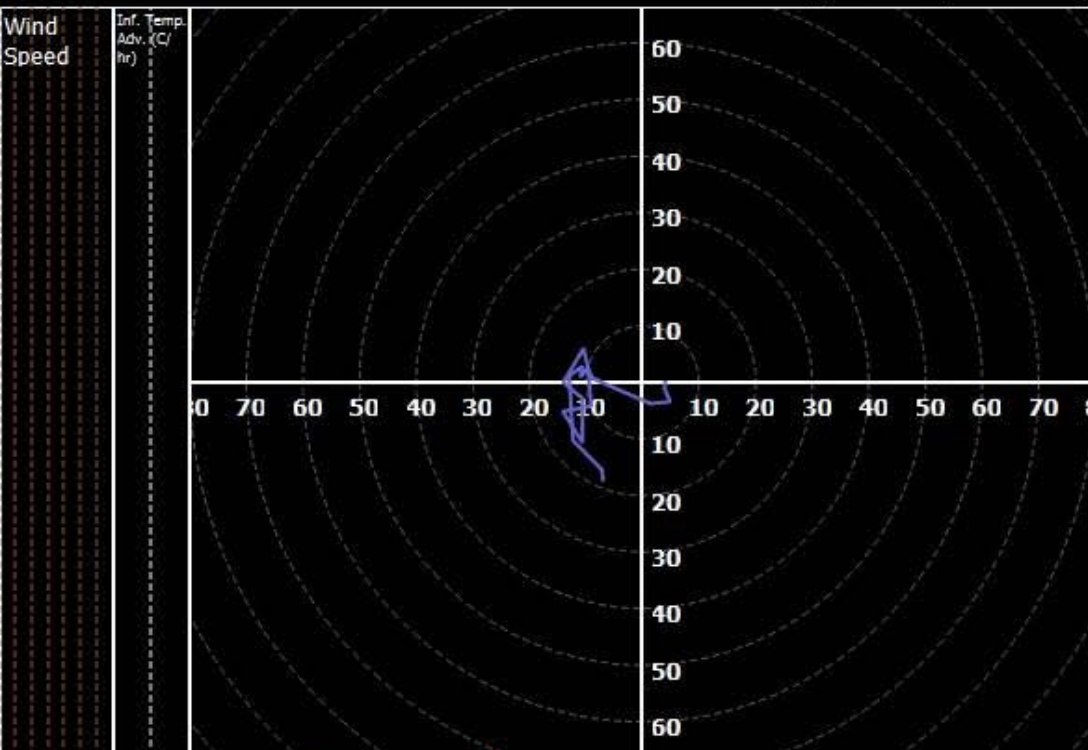
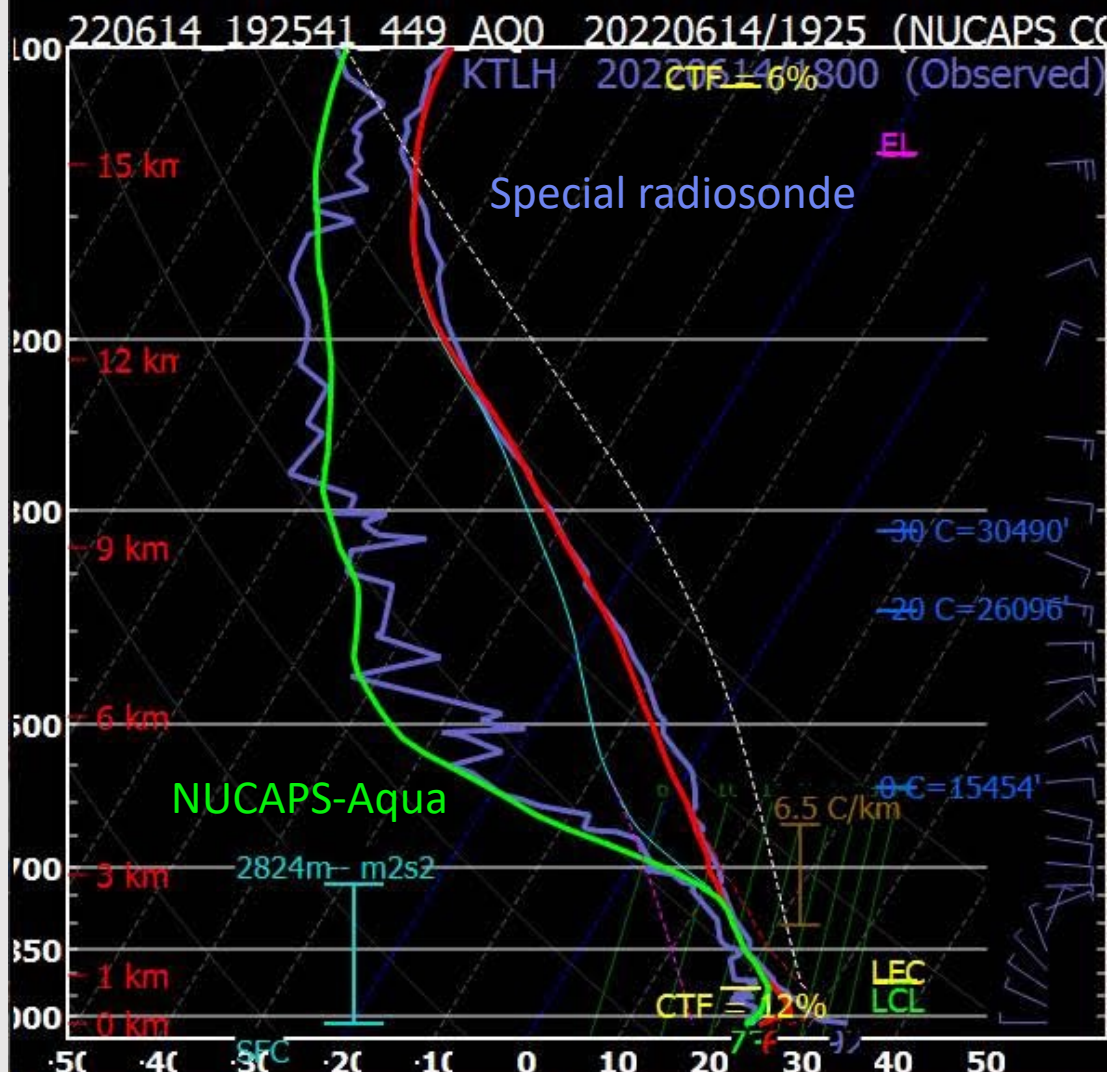


PARCEL	CAPE	CIN	LCL	LI	LFC	EL	Sum2	SRH(m <sup>2</sup> /s <sup>2</sup> )	Shear(kt)	MnWind	SPW	PARCEL	CAPE	CIN	LCL	LI	LFC	EL	Sum2	SRH(m <sup>2</sup> /s <sup>2</sup> )	Shear(kt)	MnWind	SPW
SURFACE	2380	0	744m	-8	744m	33233'	SFC-1km	M	M	M	M	SURFACE	1500	-27	1307m	-8	1676m	30573'	SFC-1km	M	M	M	M
M 100 mb	2029	-2	848m	-7	848m	32736'	SFC-2km	M	M	M	M	M 100 mb	1473	-7	1422m	-8	1766m	30573'	SFC-2km	M	M	M	M

The forecaster was able to integrate NUCAPS Aqua into their analysis to determine stability was increasing or had the potential to increase. The models were not pointing to this increase but it was seen in the sounding observations

SFC-3km Agl LapseRate= 25C/6.4C/km	Supercell= M	Corfidi Downshear = -9999/-9999 kt	SFC-3km Agl LapseRate= 27C/9.0C/km	Supercell= M	Corfidi Downshear = -9999/-9999 kt
-6km Agl LapseRate= 21C/7.0C/km	STP(eff)= 0.0	Corfidi Upshear = 0/0 kt	3-6km Agl LapseRate= 22C/7.3C/km	STP(eff)= 0.0	Corfidi Upshear = 0/0 kt
50-500mb LapseRate= 32C/7.8C/km	STP(fixed)= 0.0	Bunkers Right = -9999/-9999 kt	850-500mb LapseRate= 36C/8.8C/km	STP(fixed)= 0.0	Bunkers Right = -9999/-9999 kt



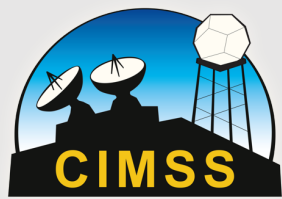


PCL	CAPE	CINH	LCL	LI	LFC	EL	SRH (m2/s2)	Shear (kt)	MnWind	SRW	SARS - Sounding Analogue System		Effective Layer STP (with CIN)	
SFC	1311	-165	199	-4	2293	13353	SFC-1km	--	--	--	SUPERCELL	SGFNT HAIL	11	Prob EF2+ torn with supercell Sample CLIMO = .15 sigtor based on CAPE: 0.2 based on LCL: 0.19 based on ESRH: --
ML	3663	-14	700	-8	1002	14766	SFC-3km	--	--	--			10	
FCST	4750	0	1135	-10	1135	15358	Eff Inflow Layer	--	--	--			9	
MU	4256	0	825	-9	872	15191	SFC-6km	--	--	--			8	
PW = 2.13in		K = 38		WNDG = --			SFC-8km	--	--	--	No Quality Matches	No Quality Matches	7	

<https://goesrhwt.blogspot.com/2022/06/nucaps-sounding-comparison-vs-observed.html>

DCAPE = 1320	ESP = 0	4-6km SR Wind =	
DownT = 63F	MMP = --	...Storm Motion Vectors...	
Sfc-3km AGL LR = 5.6 C/km	SigSvr = -- m3/s3	Bunkers Right =	
3-6km AGL LR = 6.2 C/km	Supercell = --	Bunkers Left =	
	STP (cin) = --		

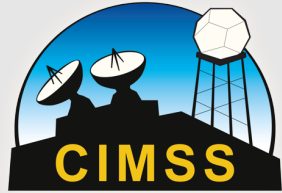




## We leverage CSPP tools and DB capability to...

- meet emerging needs for satellite sounding products
- prepare sounding products, services and user base for NUCAPS-JPSS2
- move beyond AWIPS-II to build web-based visualization (SPoRT viewer), stand-alone tools (sharpy), AWS tools (watch this space...)
- develop new applications for NUCAPS trace gas retrievals (data assimilation, ozone as indicator of storm intensity)





Thank you



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