Systematic evaluation of assimilating ground-based remote-sensing profiling observations of the New York State Mesonet

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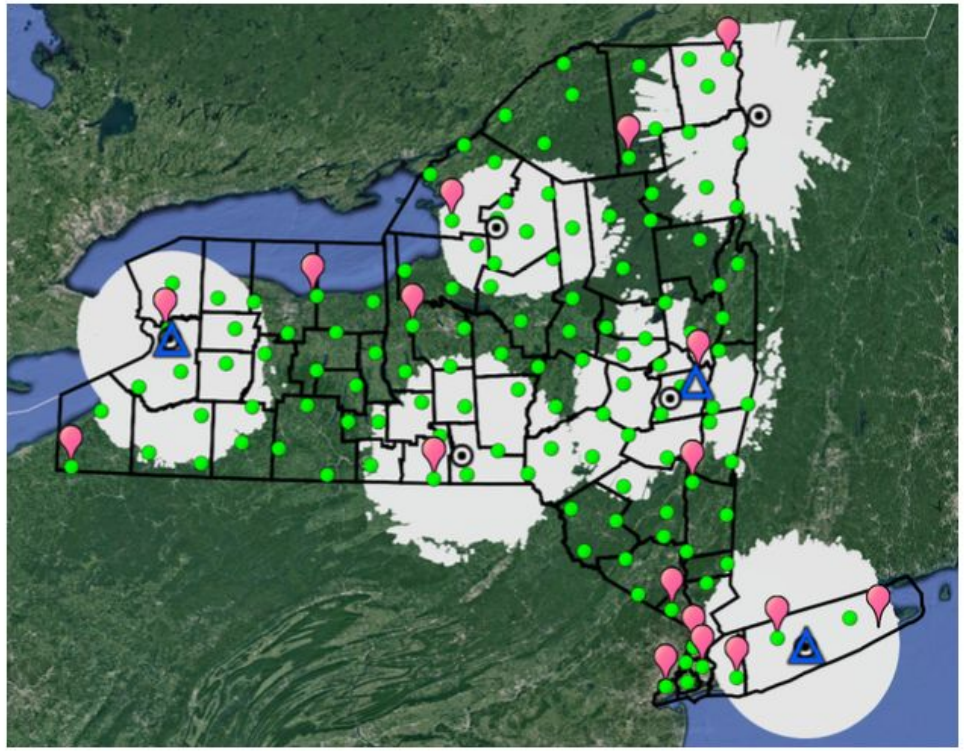
New York State Mesonet (NYSM)



(Green circles) NYSM surface station sites
(Magenta pins) NYSM profiler sites
(Blue triangles) NWS radiosonde sites

- A network of 127 surface weather stations deployed across the state with an average spacing of 27 km
  - Continuous observations of the surface conditions and lower atmosphere from the NYSM are used by National Weather Service (NWS) forecasters to aid in the development of short-term forecasts, particularly for severe weather events
- A statewide profiler network that consists of 17 profiler sites that include Doppler wind lidars (DWL) and Microwave Radiometers (MWR)
  - Critical for various applications, including air quality and human health, forecasting of severe storms, and predicting renewable energy production

New York State Mesonet (NYSM)

Surface station sensors

(Courtesy: NYS mesonet)

MWR

(Courtesy: Radiometrics)

DWL

(Courtesy: Vaisala)

Standard Surface station	**M**icro**W**ave **R**adiometer (MWR**)**	**D**oppler **W**ind **L**idar **(DWL)**
• 10 m wind • 2/9 m temperature • 2 m RH • Solar insolation • Precipitation • Snow depth • 5/25/50 cm soil • Camera	▪ Autonomous microwave radiance based passive remote sensing ▪ T, humidity ▪ Range: Surface - 10 km ▪ *Resolution: 10 m - 2 km/1 min*	▪ Wind, aerosol backscatter measurements ▪ Autonomous remote operation ▪ Range: Surface - 7 km ▪ *Resolution: 30 m/15 min*

Background

1. Recent improvements in the retrieval methods applied to MWR data has significantly reduced the systematic biases of MWR temperature retrievals (Dr. Chris Chau-Lam Yu's talk)

2. Conduct DA experiment with 10 convection initiation (CI) cases in 2024 to explore the statistical impact of assimilating NYSM surface and profiling observations

3. Analyze the effect of assimilating the MicroPulse Differential absorption lidar (MPD) and the Uncrewed Aircraft System (UAS) observations collected with the NYSM during the April 2024 Eclipse field campaign (Dr. June Wang's talk)

Case selection and classification:

- 10 CI cases during April 2024 ~ August 2024

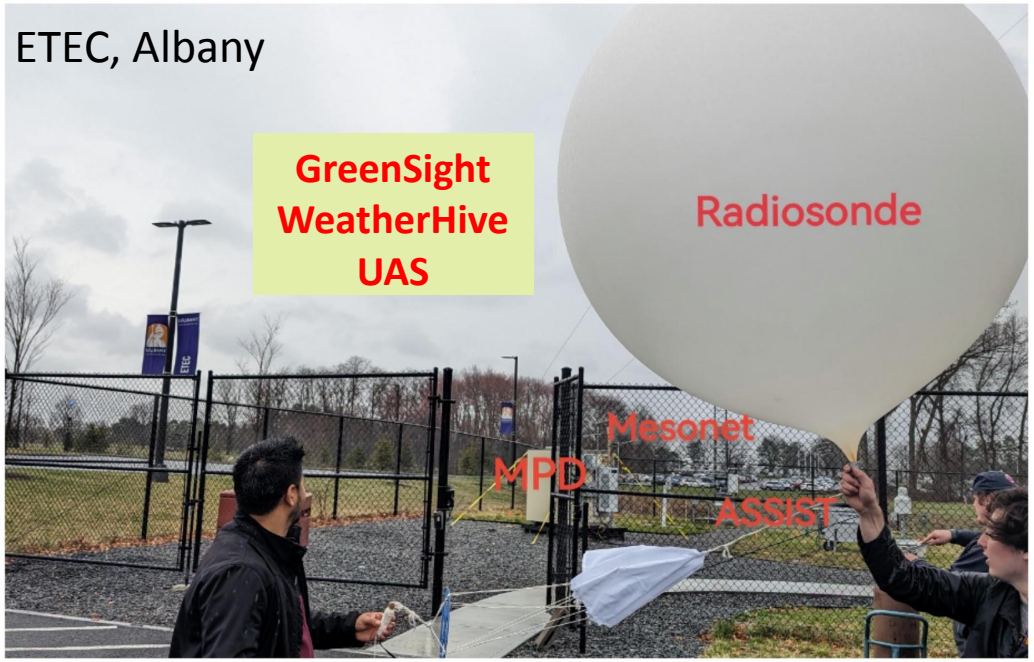
- 2 CI cases in April during the 2024 TSE field campaign

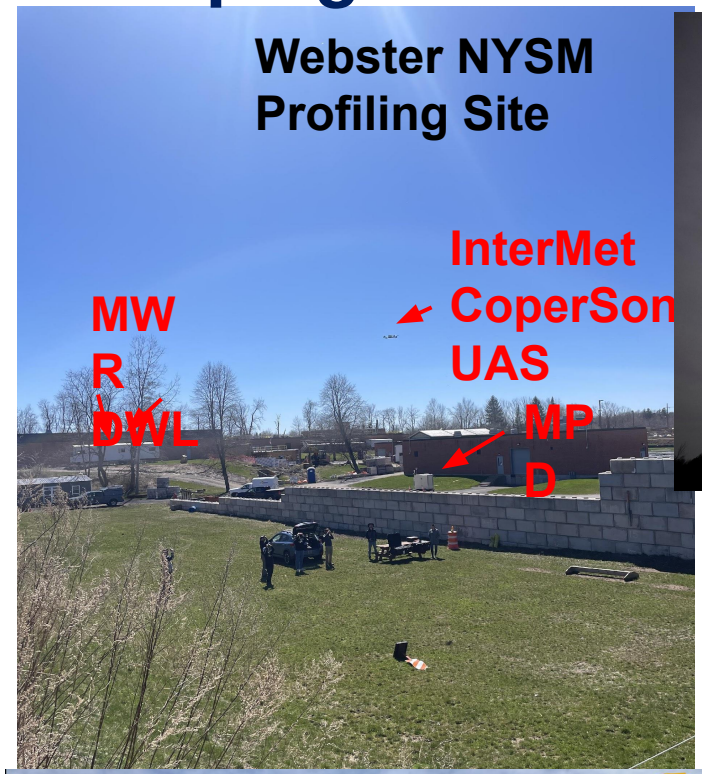
- Weakly forced CI case: CI events that did not develop near a 500- or 700-hPa upstream trough (Degelia et al. 2024)

- In this presentation, the results for 3 CI cases will be presented:

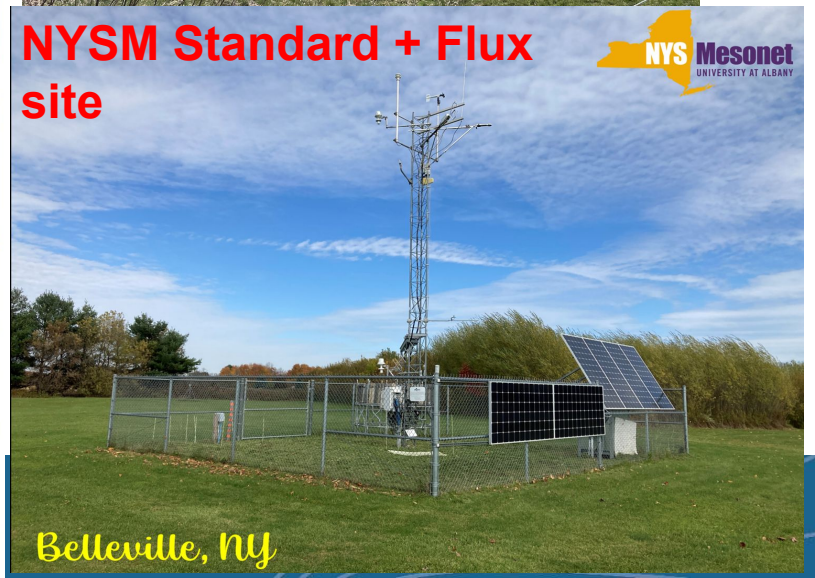
Date
April 28
April 30
May 8
May 21
June 6
June 20
July 10
July 15-16
July 24
August 18

2024 Total Solar Eclipse Field Campaign



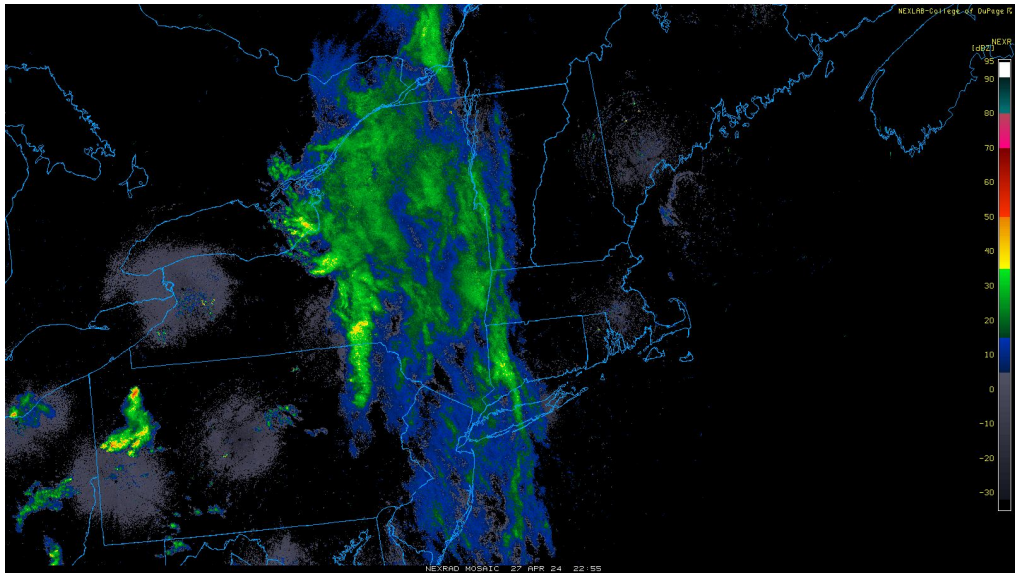


Courtesy: June Wang (U. Albany)

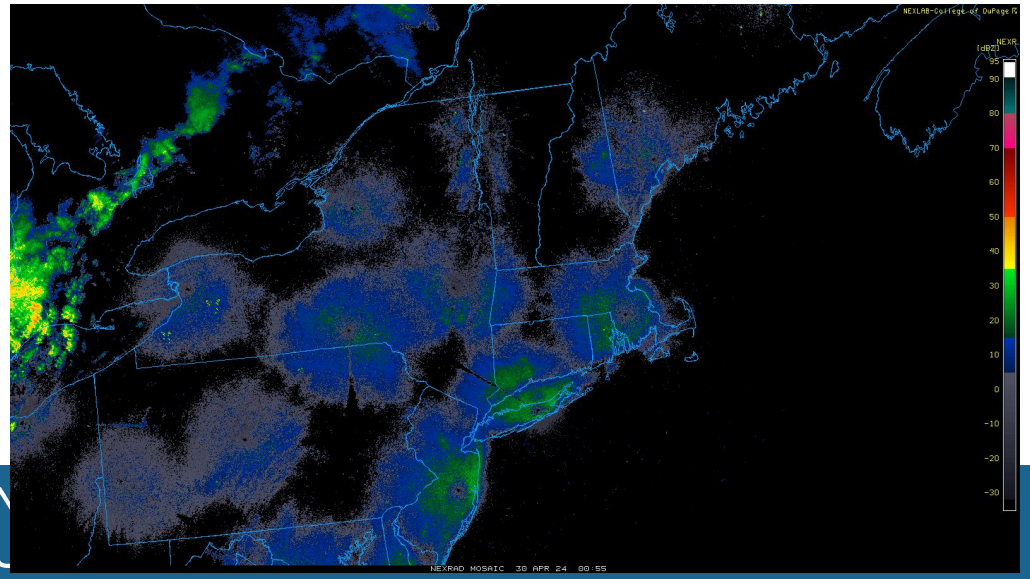


Case selection and classification:

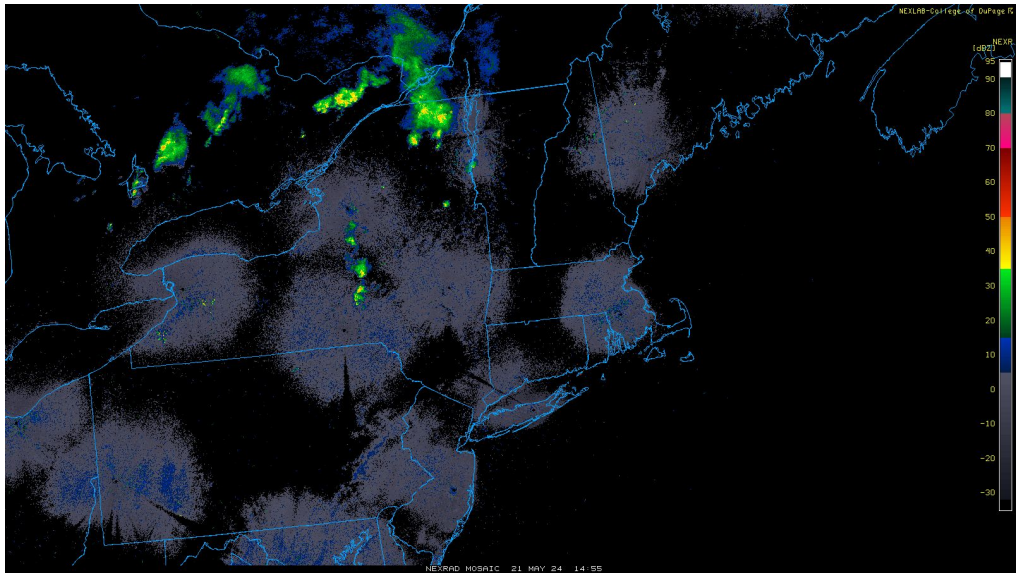
28 April 2024 (CI: 01 UTC)



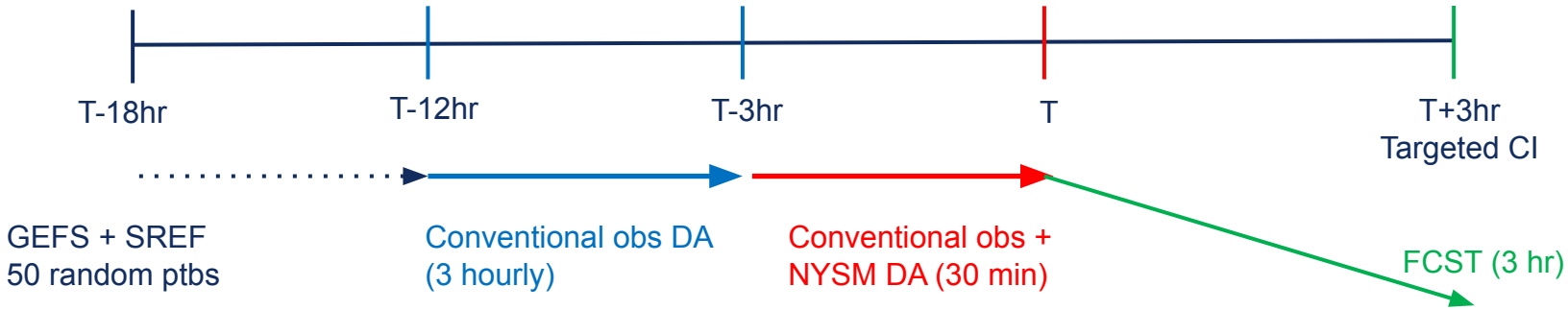
30 April 2024 (CI: 03 UTC)

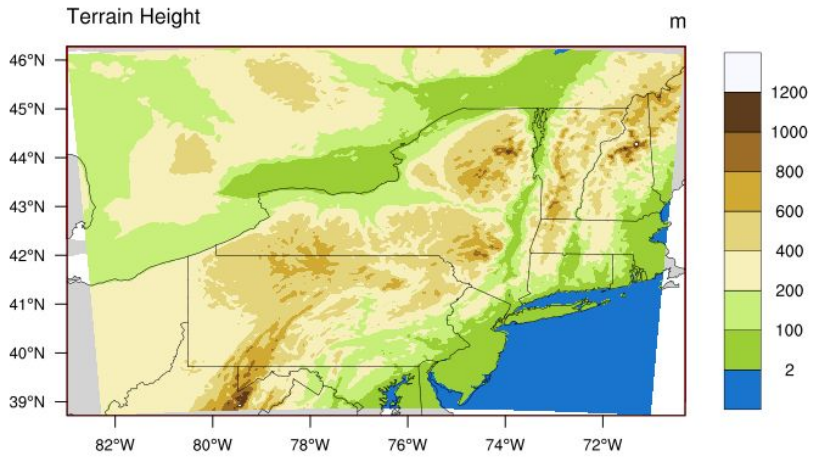


21 May 2024 (CI: 17 UTC)



Experimental design





DA experiment	Description
CONV	GTS conventional obs
SFC	CONV + NYSM SFC station
SFC+PROF_UV	CONV +SFC + DWL profiler
SFC+PROF_UVT	CONV +SFC + DWL profiler +MWR T profiler

1. Model

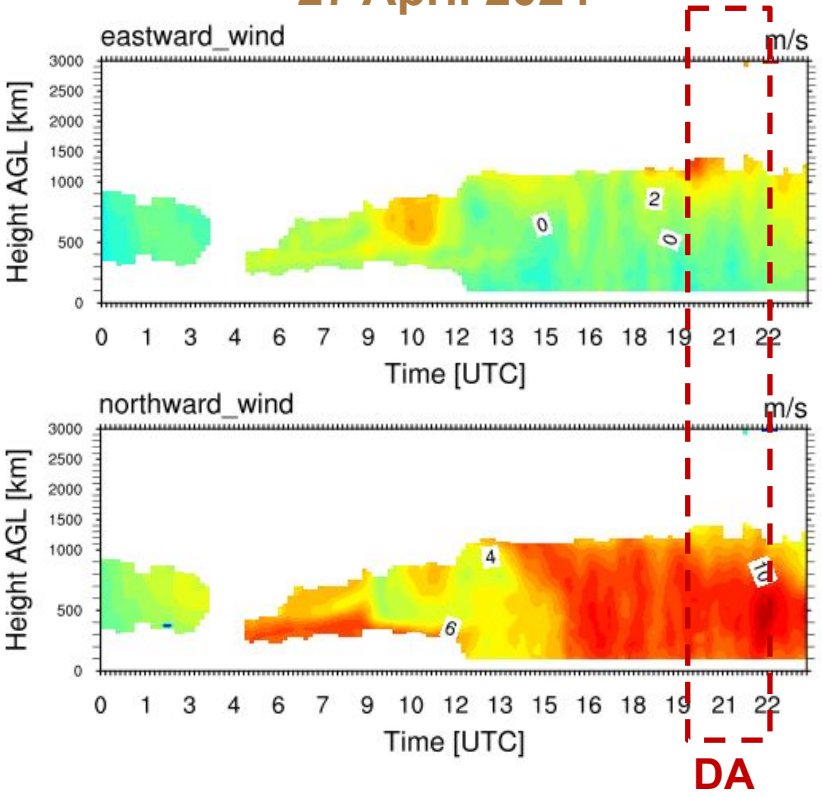
- Model : WRF 4.1.2
- Domain : 3 km, 50 levels
- Aerosol–aware & Hail/Graupel/Aerosol Thompson Schemes, RRTMG/RRTMG, MYNN surface layer, RUC land-surface, MYNN 2.5 level TKE scheme

2. Data assimilation

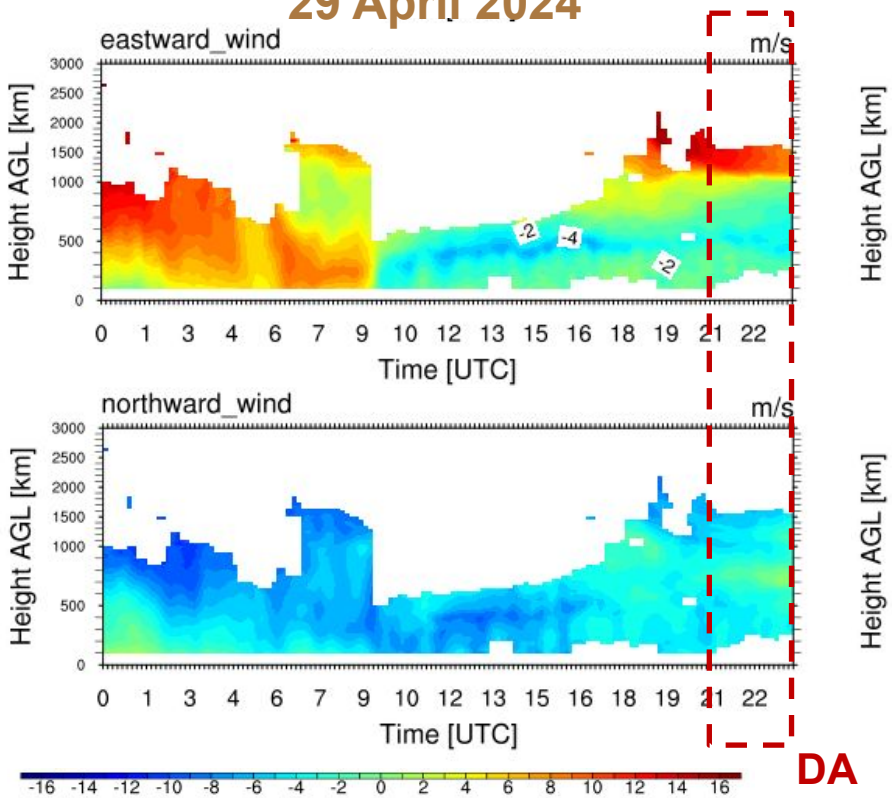
- OBS : CONV, NYSM
- NCAR DART (50 members)
- 200 km H localization radius
- BCs are provided by HRRR analysis

Data – DWL wind profile @ ALBA

27 April 2024



29 April 2024



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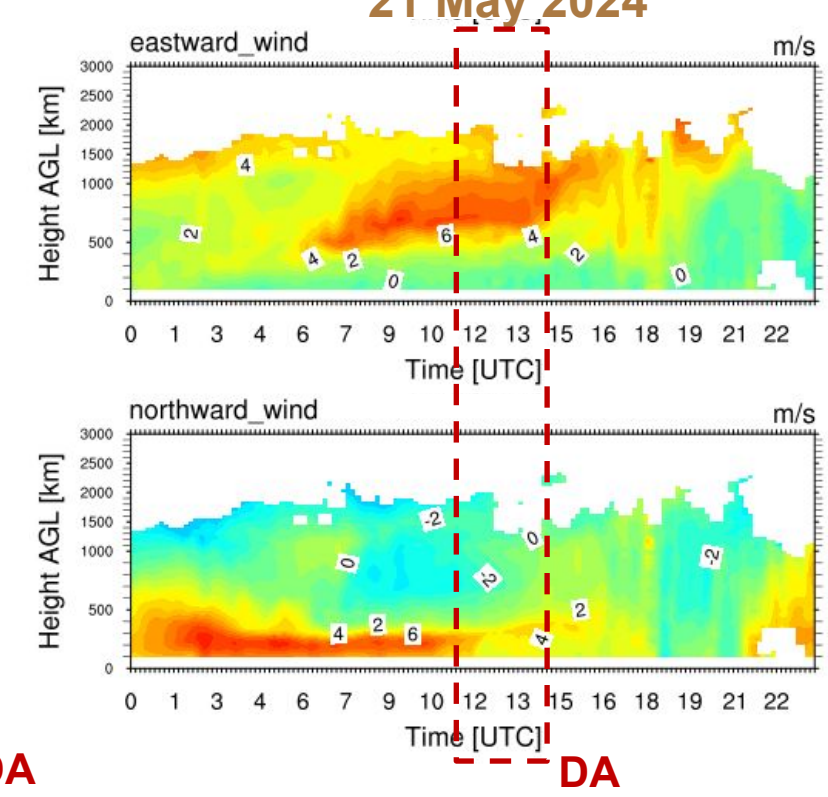
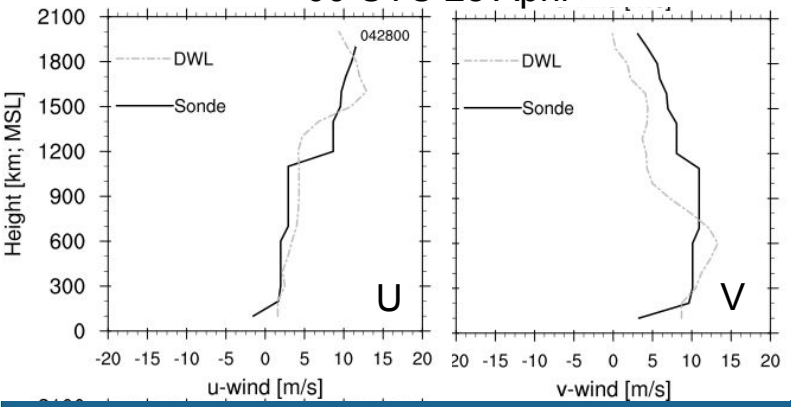


00 UTC 28 April



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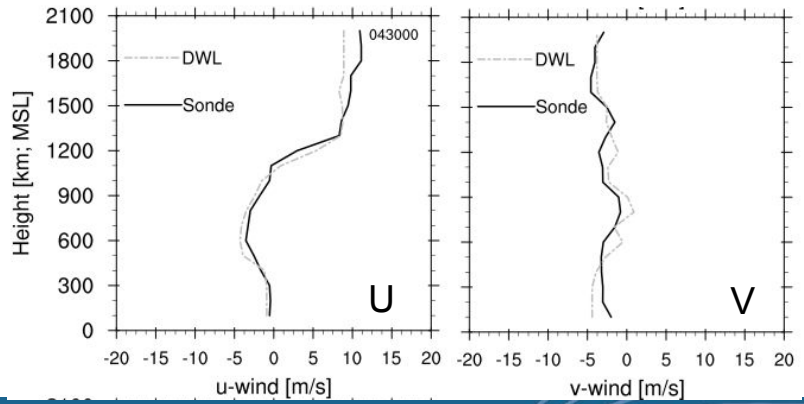

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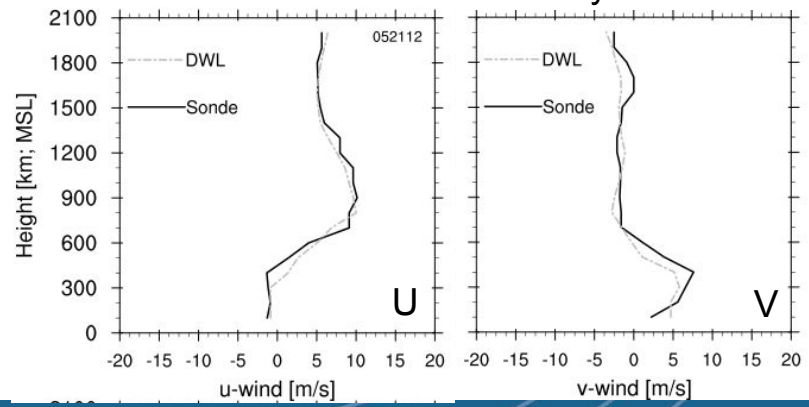
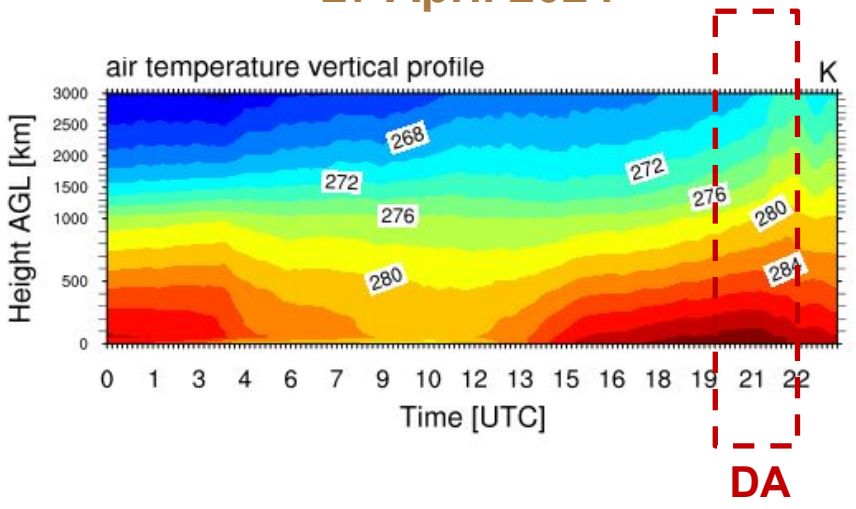


Data – MWR Temperature profile @ ALBA

27 April 2024



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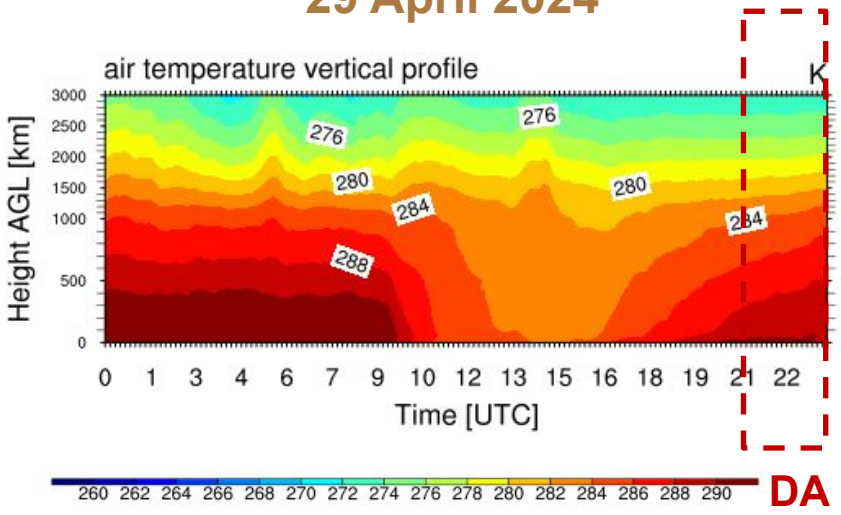

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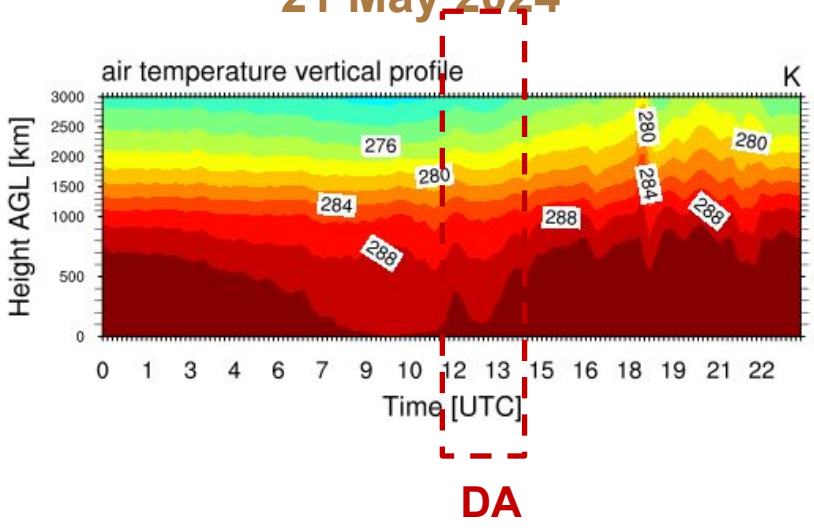

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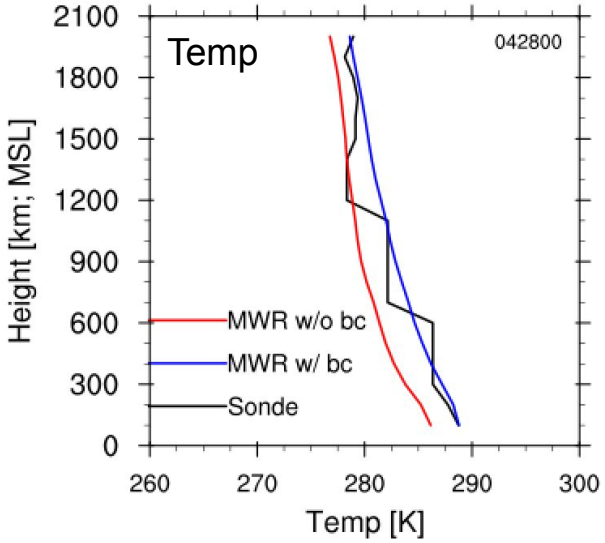

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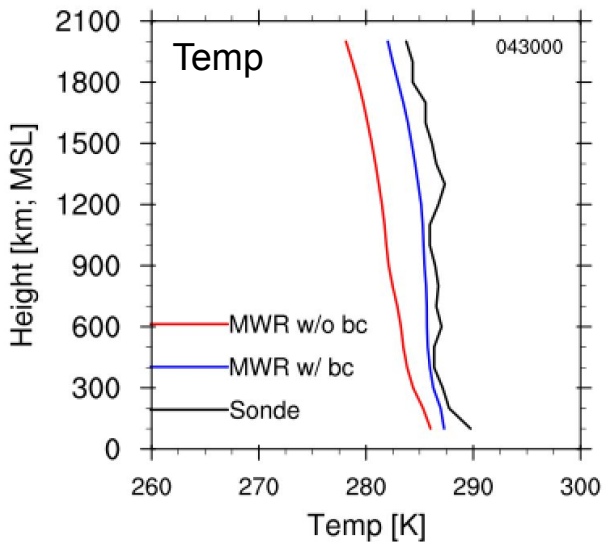

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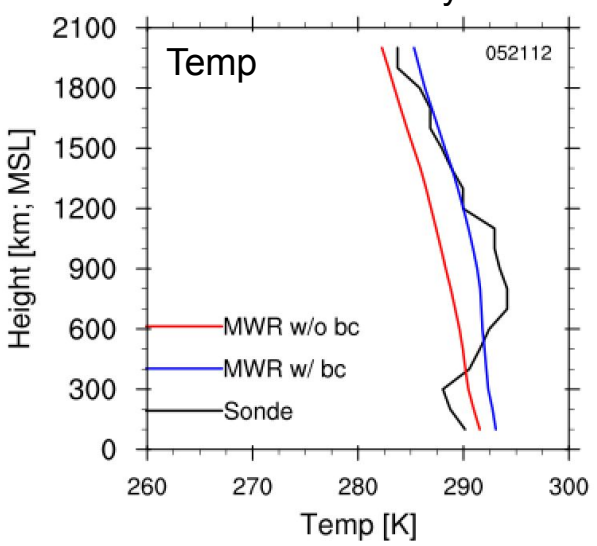
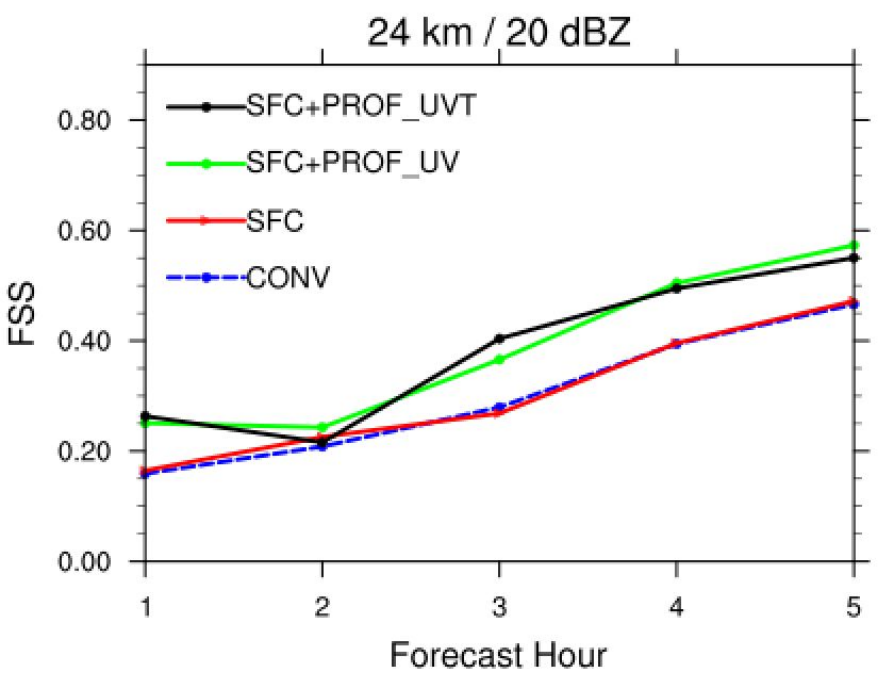


Results – Skill scores

Fractions Skill Scores (FSS) for reflectivity : Higher the better

28 April 2024



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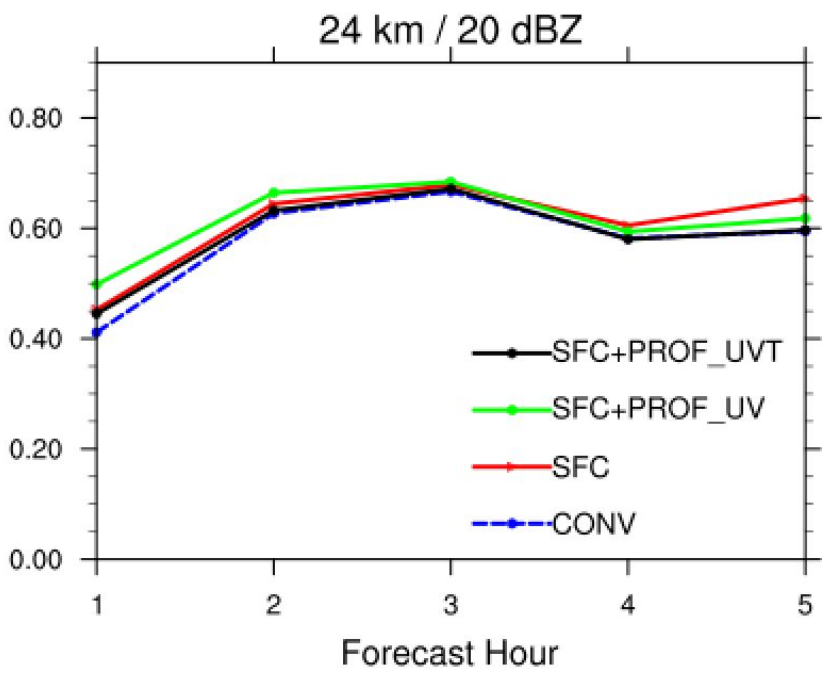

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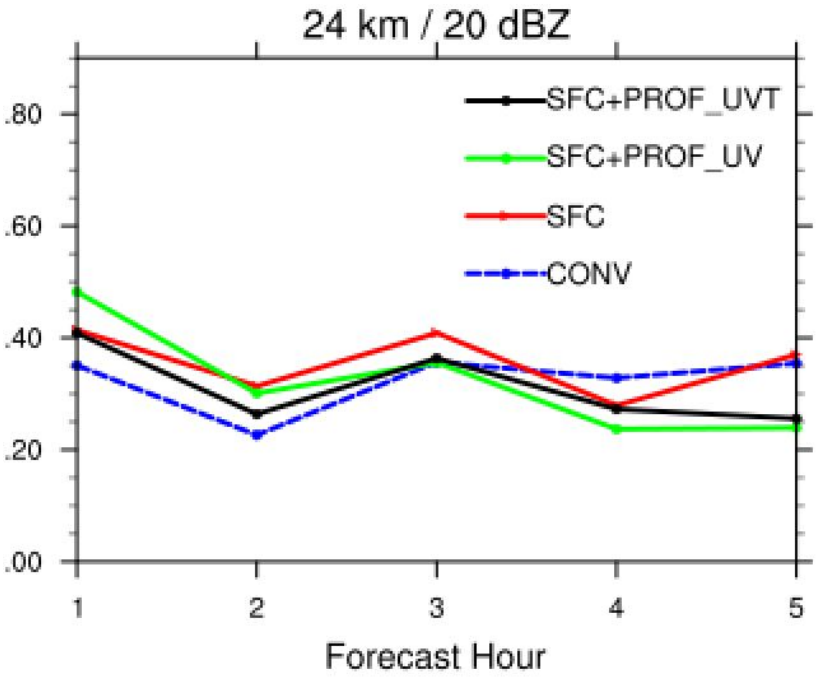
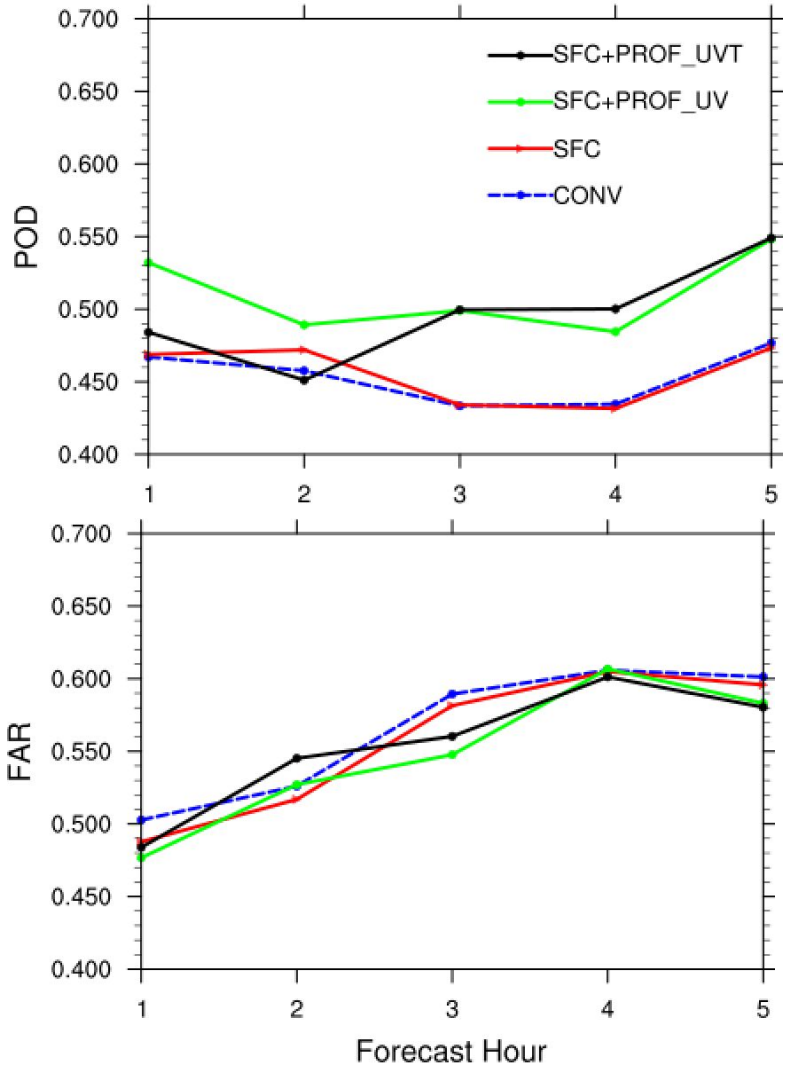


Results – Skill scores

Probability Of Detection (POD): Higher the better

False Alarm Ratio (FAR): Lower the better

28 April 024



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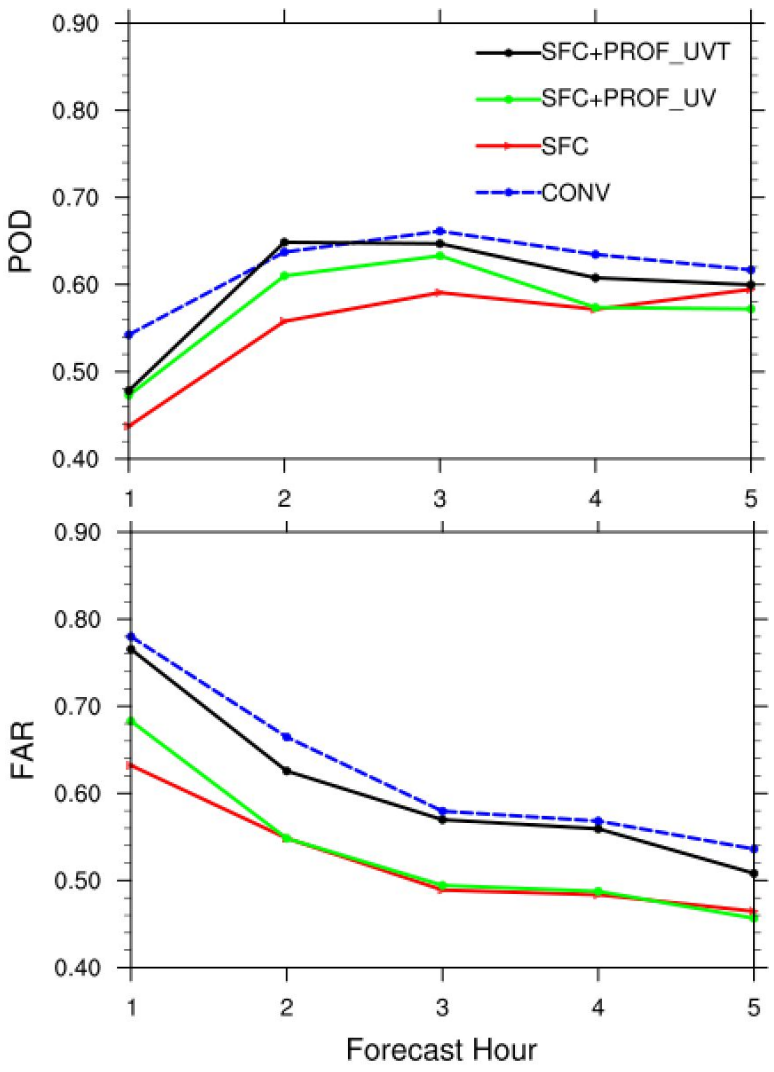

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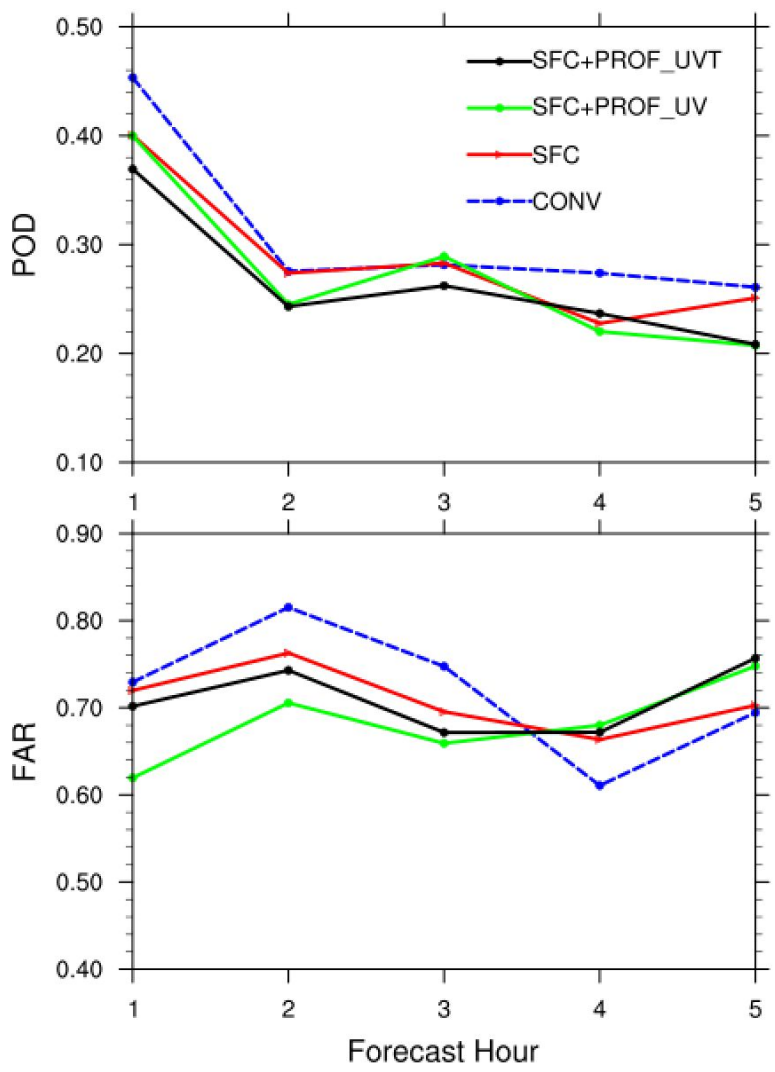
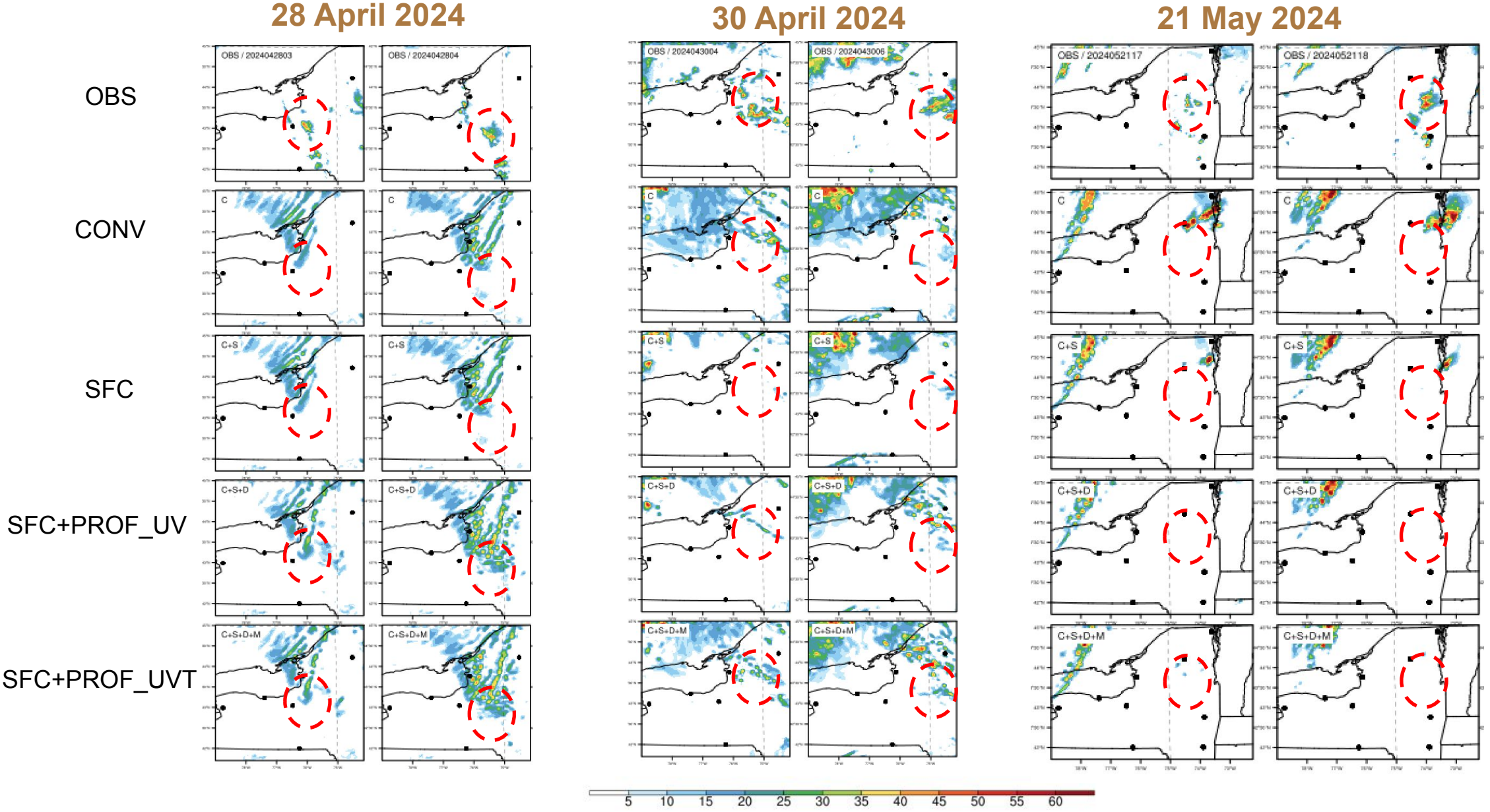


Results – Reflectivity



Summary and future work

1. We are running DA experiments on 10 CI cases to analyze the systematic impact of NYSM surface and profiling data on convective weather predictions.

2. Currently, 3 experiments have been completed and super preliminary results show that NYSM's profilers, especially DWL, have a positive effect on short-term forecast (FSS).

3. NYSM's surface data and DWL improve FAR.

4. We will complete DA experiments on more cases to get significant statistical results.

5. We will assimilate MPD and UAS observations, in addition to NYSM, from the 2024 TSE field campaign to determine if additional profiling observations further improves the prediction skill.

Acknowledgments

- NSF National Center for Atmospheric Research is a major facility sponsored by the National Science Foundation under Cooperative Agreement No. 1852977

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Thank you for your attention!

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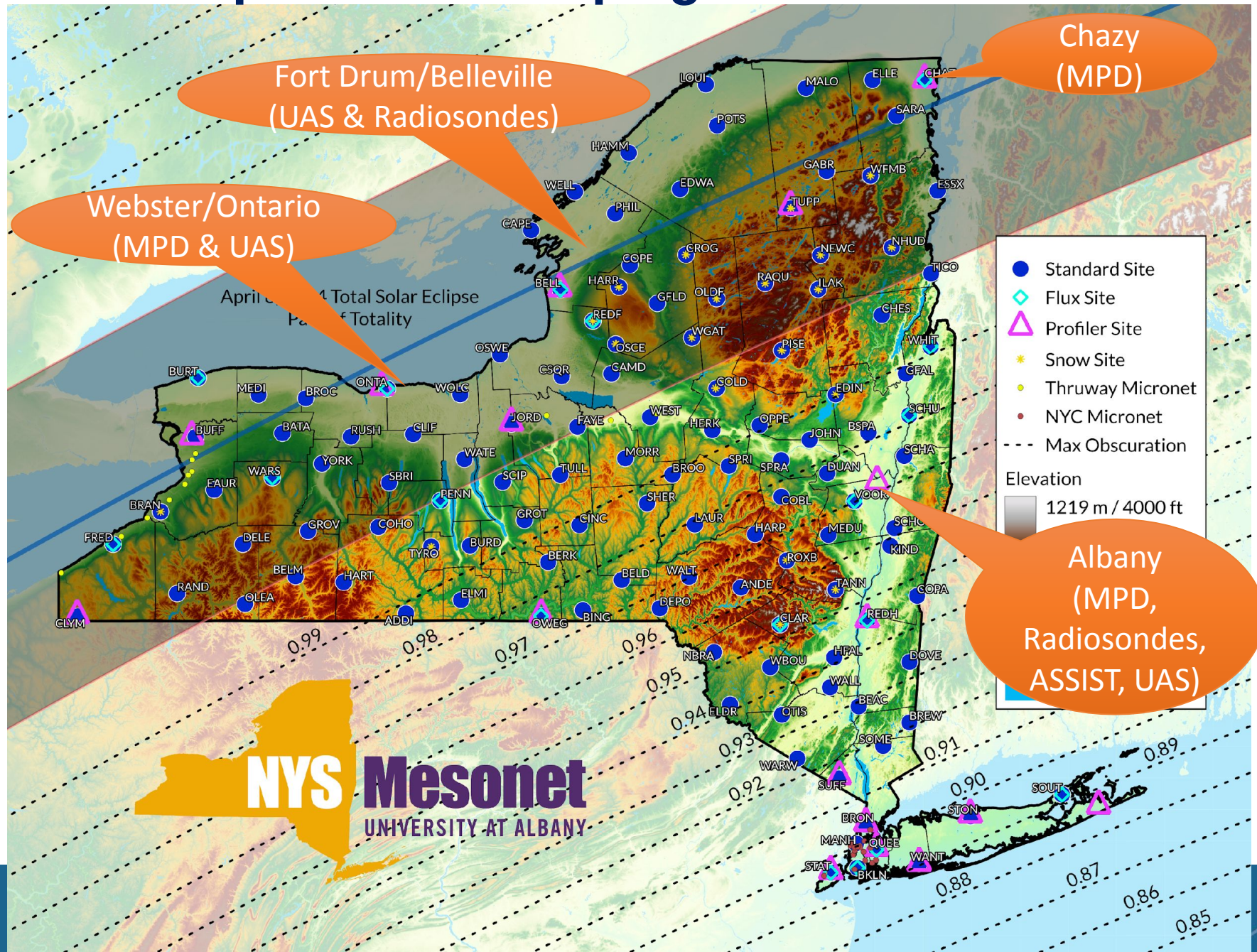
Supplementary slides

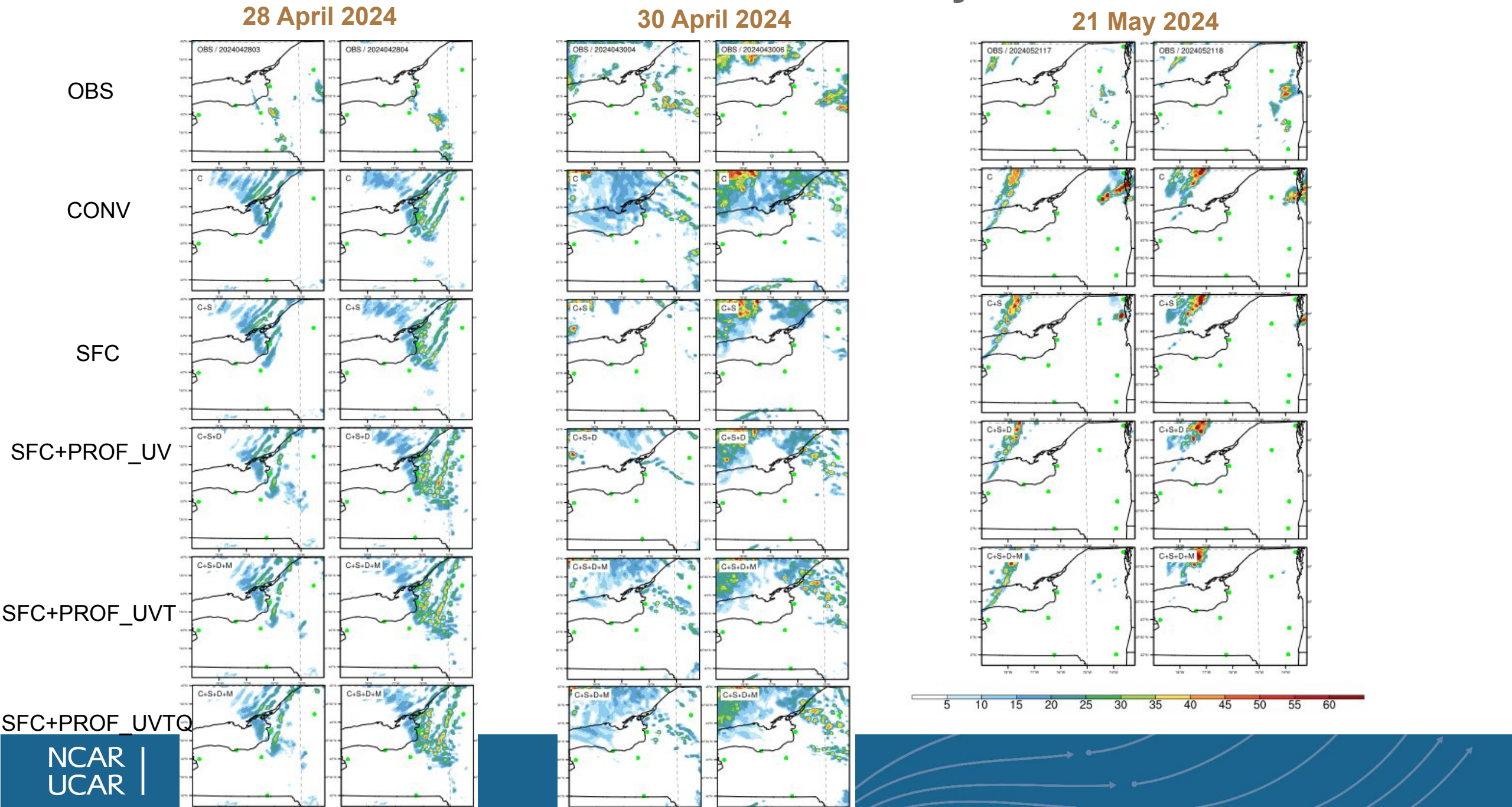
2024 Total Solar Eclipse Field Campaign

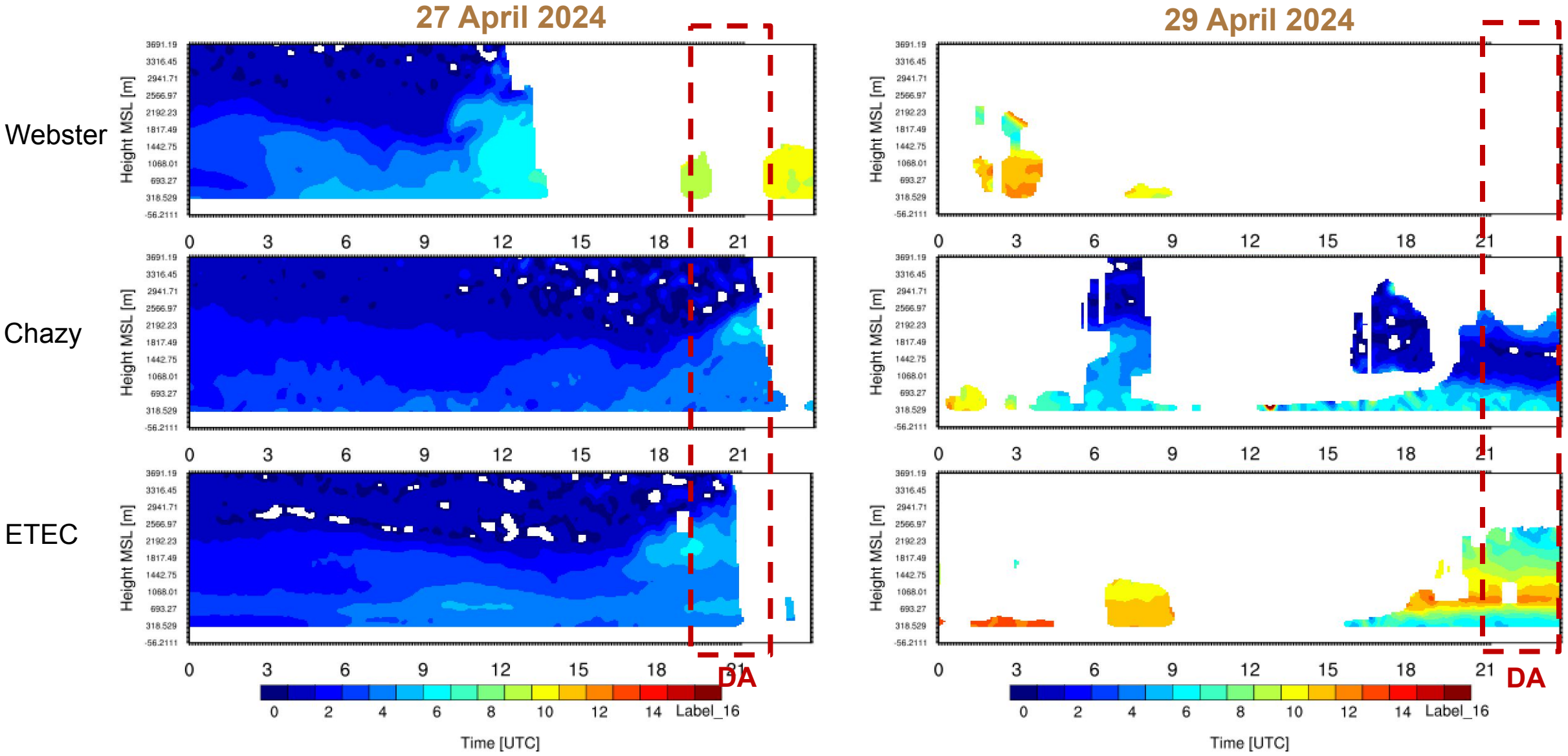


Additional instruments:

- MPDs
- Radiosondes
- ASSIST
- Drones

Results – Reflectivity



NCAR | UCAR

Data – MPD Water vapor profile @ ETEC