Revisiting satellite sounder applications
–
Reimagining how to connect complex products to stakeholder applications and decision making

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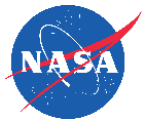

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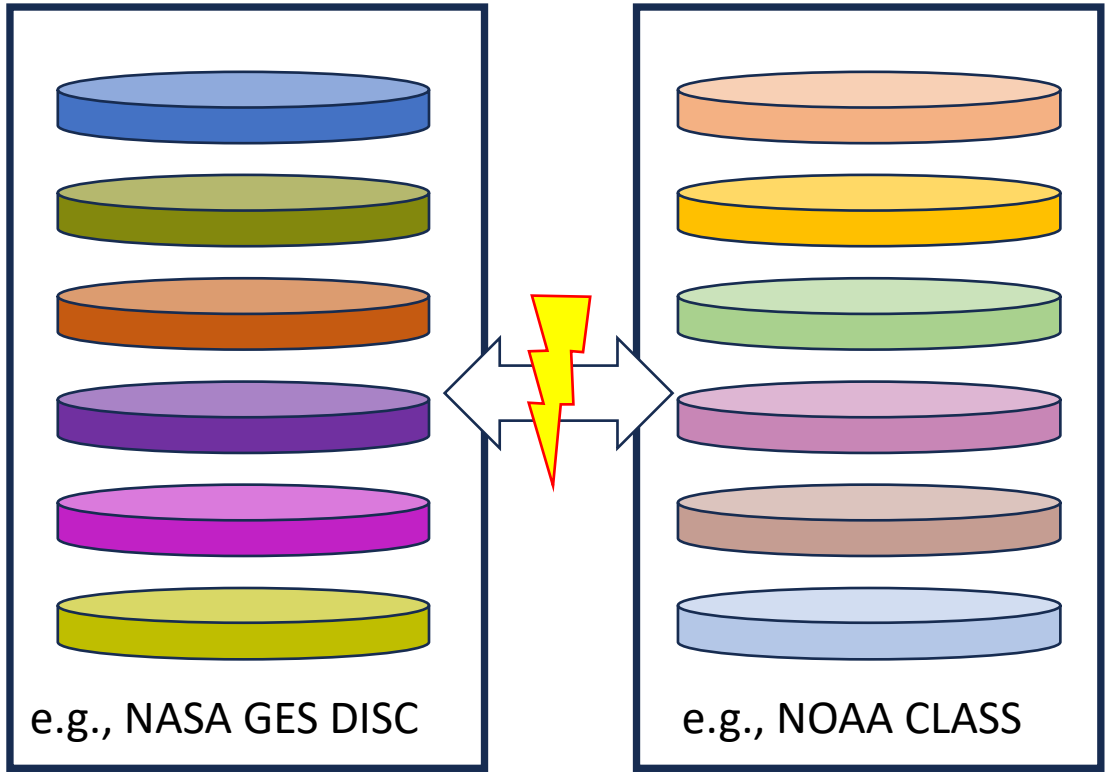
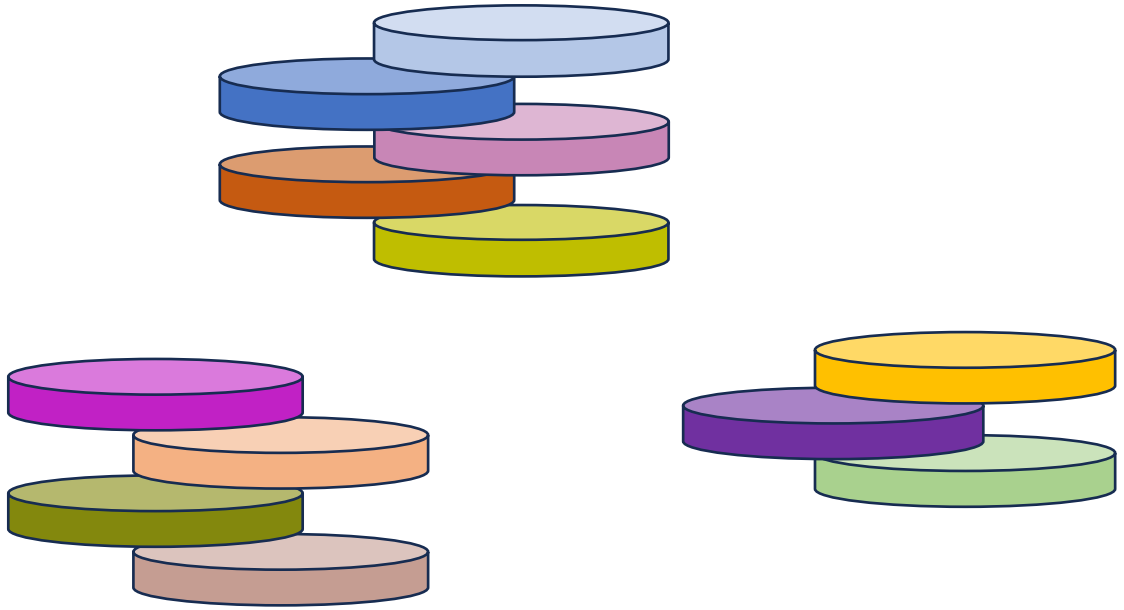
The problem…

Multiple distributed archives



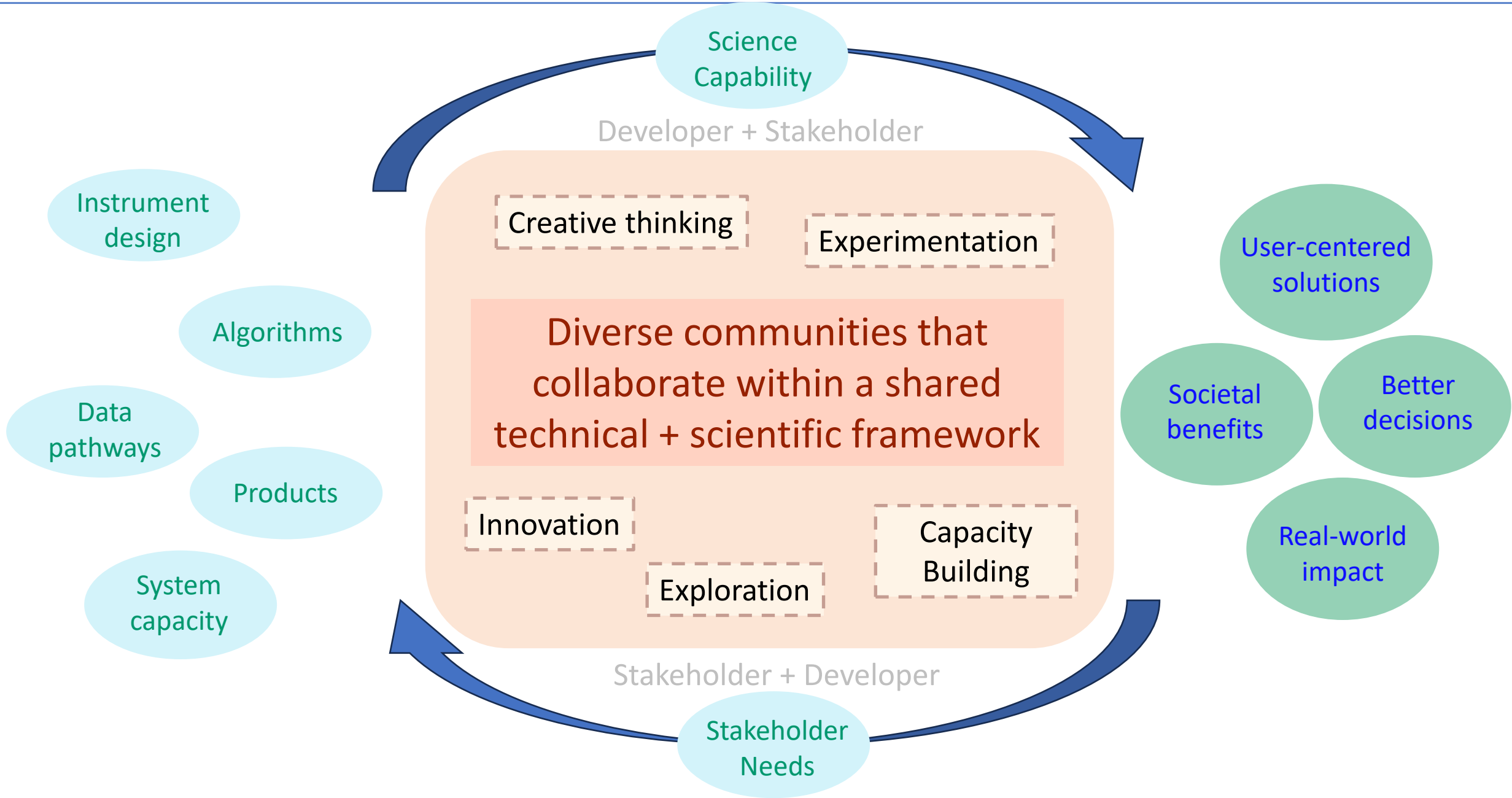
- Difficult to find the right product from online “firehose”
- Jargon and technical terms overwhelm common sense descriptions
- Failure to guarantee interoperability of files and exchange between archives

User needs are not straightforward



- In practice, products often need to be merged/aggregated before they can be useful in analyses
- Difficult to anticipate all future data needs; applications evolve as stakeholders gain experience
- High probability for product misuse due to insufficient communication pathways

The solution…



– Identify Data Gaps & User Needs

Collaborative discussions uncover novel perspectives…

Real-time weather

- Sparse observations
- Infrequent radiosondes
- Complement forecast models

Weaver et al. 2019
Esmaili et al. 2020
Berndt et al. 2020
Kahn et al. 2023

- Quality observations in mid-troposphere, cloud free
- Soundings provide a dense network of observations
- Sounding capture spatial gradients and patterns

Applied science

- New instrument concepts
- Modelling experiments
- Application development

Barnet et al. 2023
Gaubert et al. 2024
Berndt et al. 2023
Ouyed et al. 2024

- Will new instrument augment the program-of-record?
- How can soundings improve model accuracy?
- Do soundings support new data applications?

Seasonal & climate studies

- Continuity of Aura & Aqua
- Data reports for policy guidelines
- Large-scale process studies

Smith & Barnet, 2024
Gaudel et al. 2024

- How to combine observations from multiple instruments?
- How well do soundings characterize long-term change?
- Can soundings help fill looming data gaps?

– Develop a Shared Understanding

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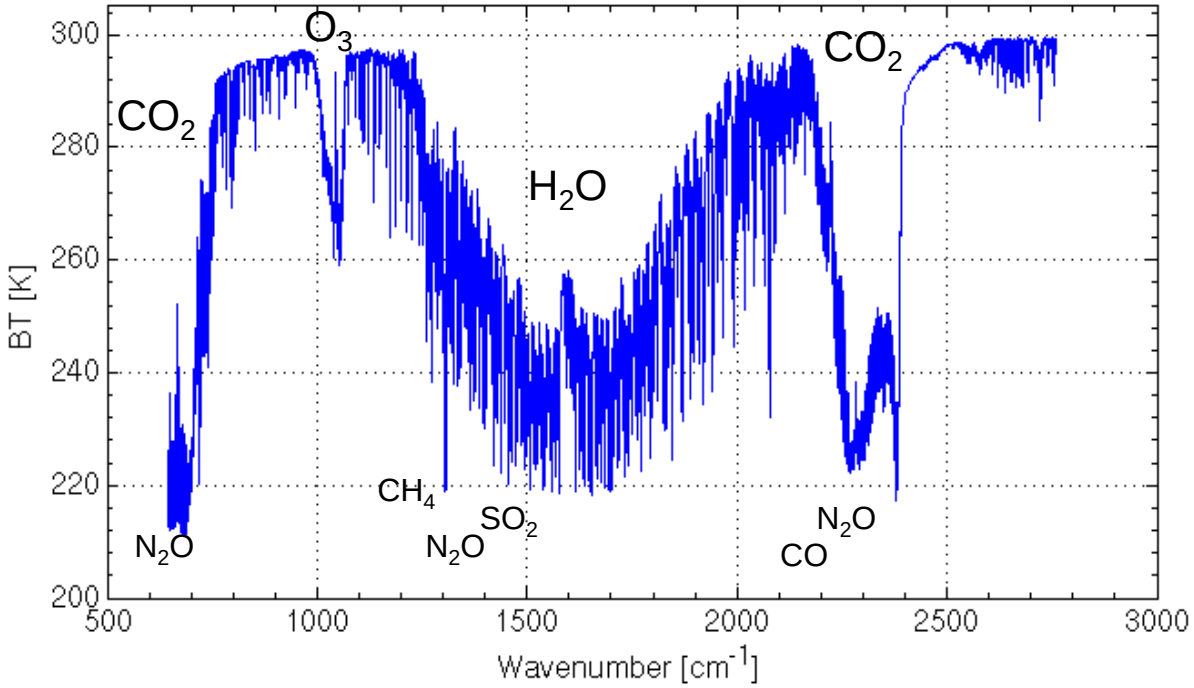
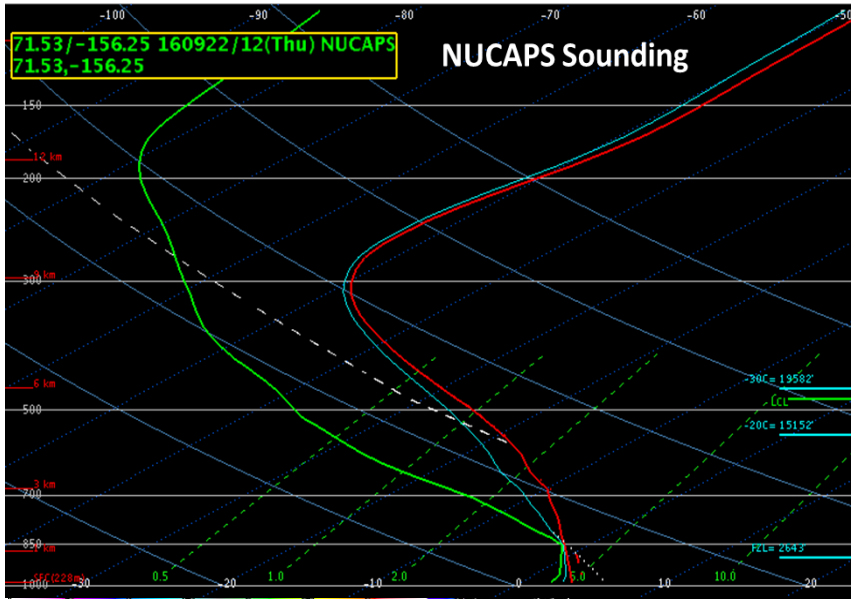
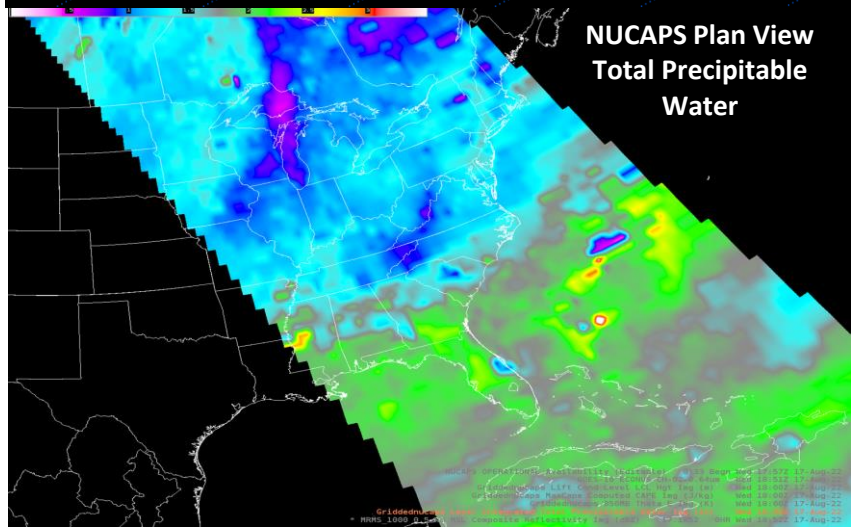
What infrared instruments measure ⟷ **What users want to see**

Top-of-atmosphere emitted radiation



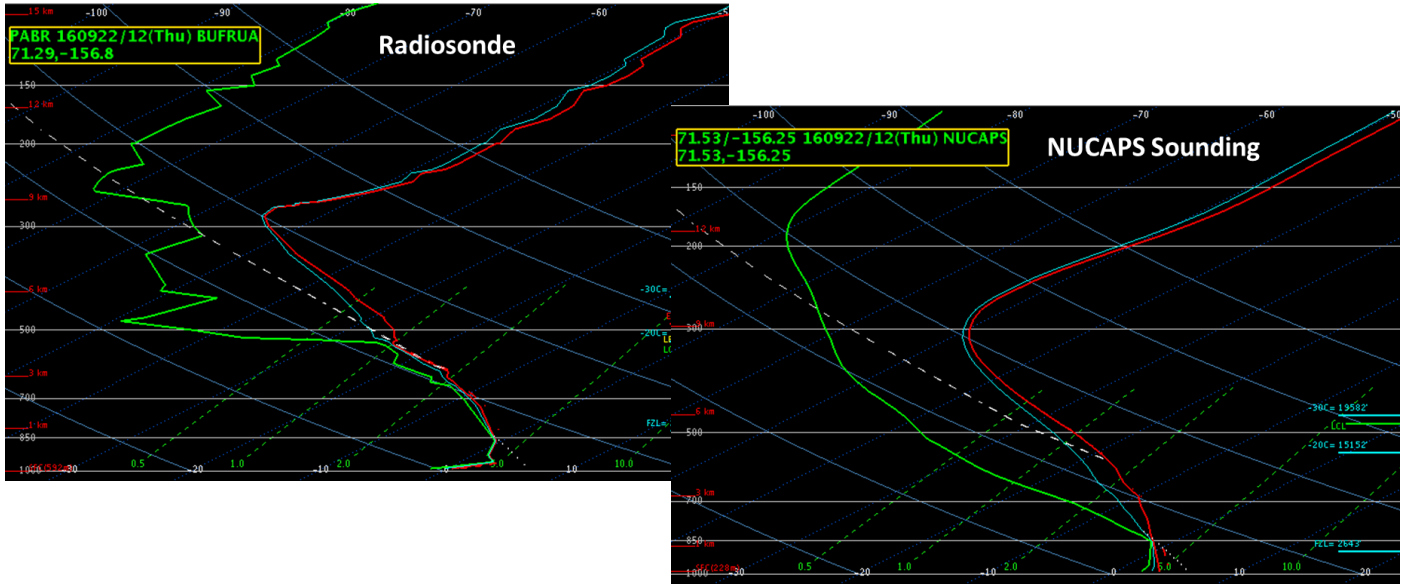
Gridded fields, skew-T plots, geophysical quantities

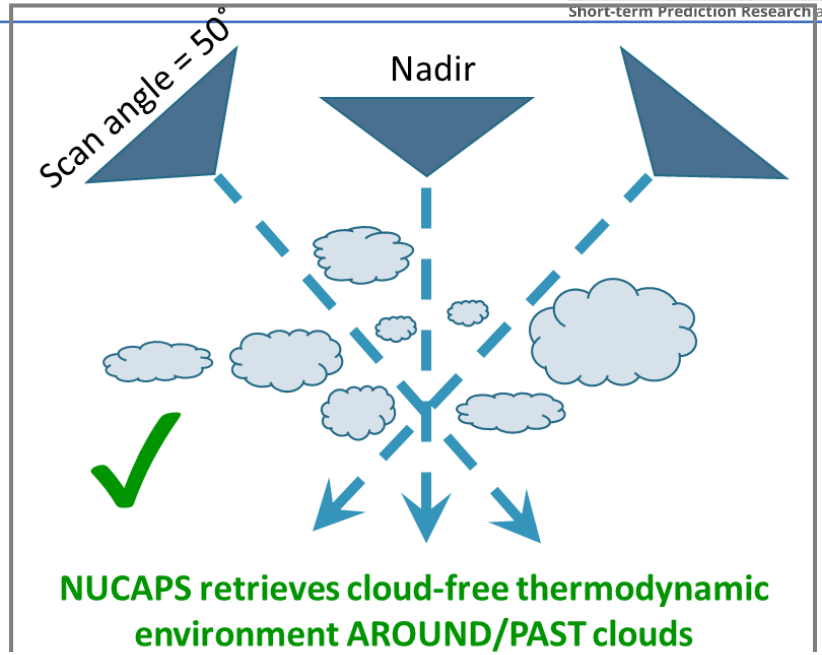




- We have to be intentional about collaboration – siloed work environments keep us isolated from each other
- Honest assessment of instruments and products lead to better understanding
- Validation of applications help inform data product design
- Open communication pathways foster the confidence to ask questions

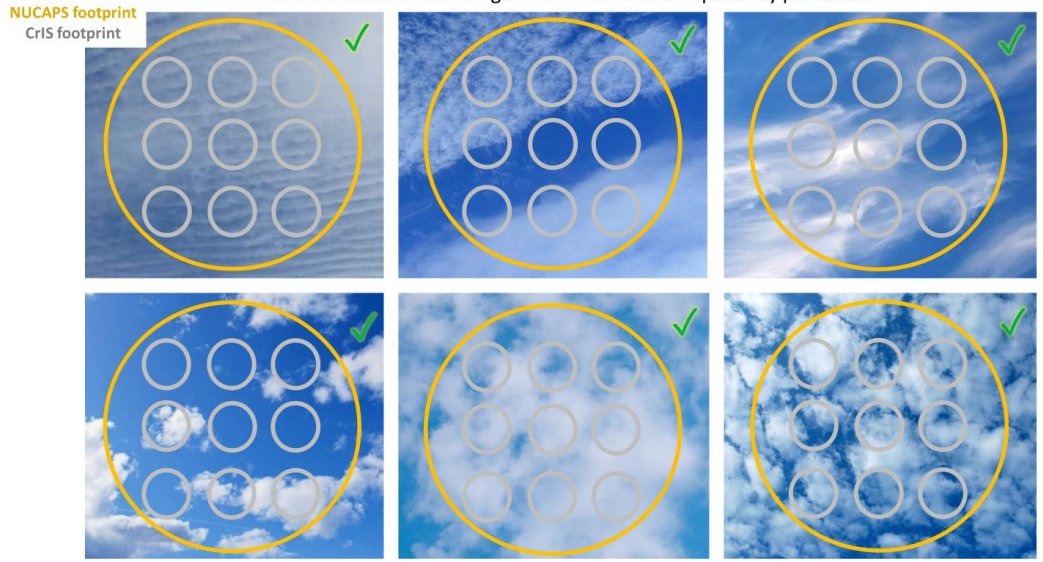
– Developing a shared language





Cloud Clearing **succeeds** when NUCAPS footprint has **cloud variability**; i.e. when the CrIS footprints have variable cloud fractions

NUCAPS retrieve soundings if there is a radiative pathway past clouds

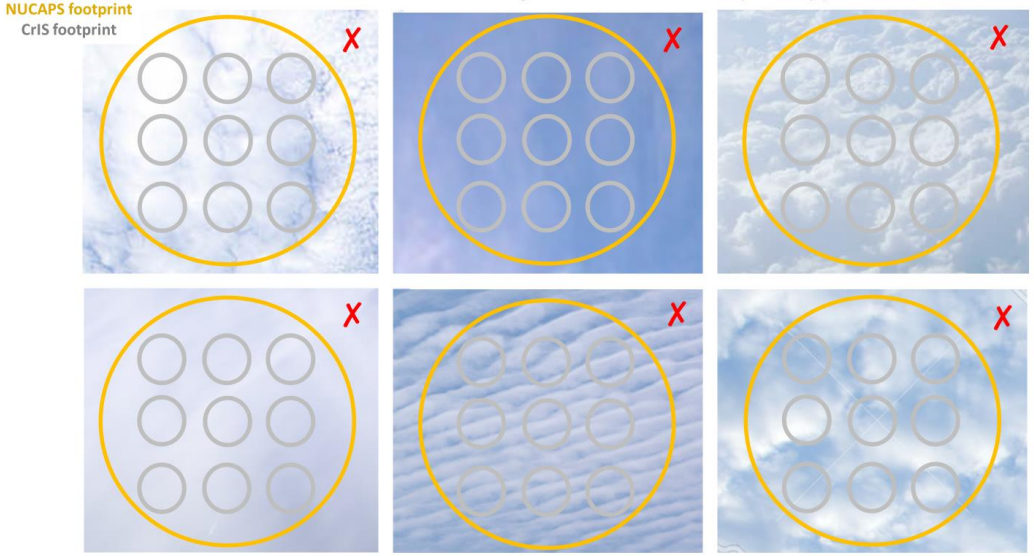


The clear-sky radiative pathway PAST clouds can be determined using a cluster of 3x3 CrIS footprints with variable cloud fractions.

NUCAPS soundings are successfully retrieved from clear-sky or cloud-cleared radiance measurements

Cloud Clearing **FAILS** when NUCAPS footprint is **uniformly cloudy**, i.e. when each CrIS footprint has the same cloud fraction

NUCAPS cannot retrieve soundings if there is no radiative pathway past clouds



NUCAPS soundings CANNOT be retrieved from cloudy measurements of the radiative the pathway through clouds.

This is why optical thickness (cirrus versus stratocumulus) is irrelevant to NUCAPS.

– Nurture Exploration and Experimentation

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Formal Testbeds

Case studies

Surveys

Seminars

Think outside the box

Test & Feedback Cycles

Science Discussions

Building relationships

Q&A forums

Iterative development

User Working Groups

Prototyping

Application Demonstration

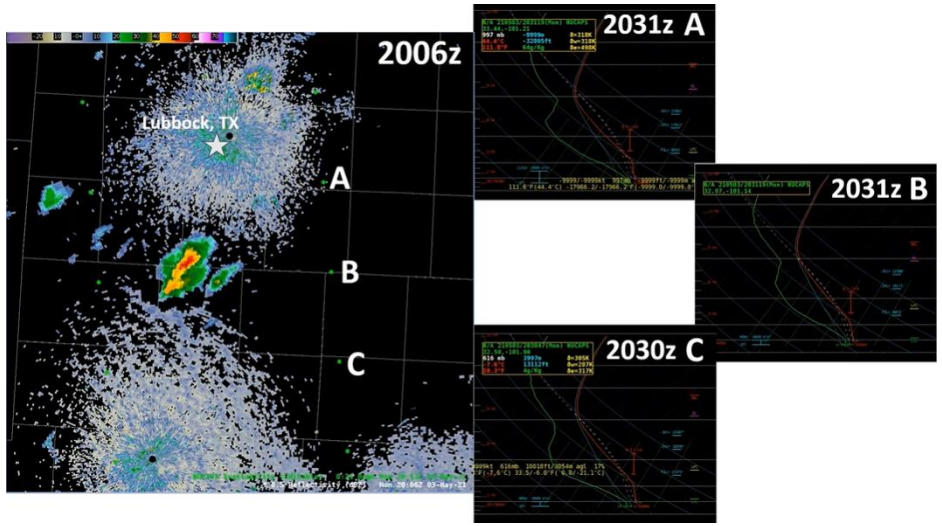
Open Science

Willingness to learn

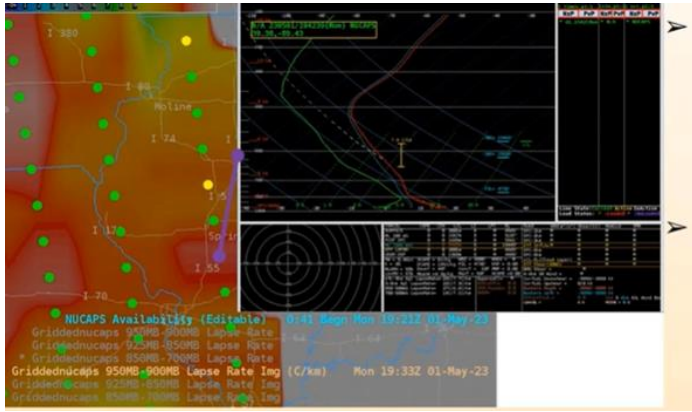
Adopt new perspectives

Community Building Toolkit

– Evaluate Applications & Decisions



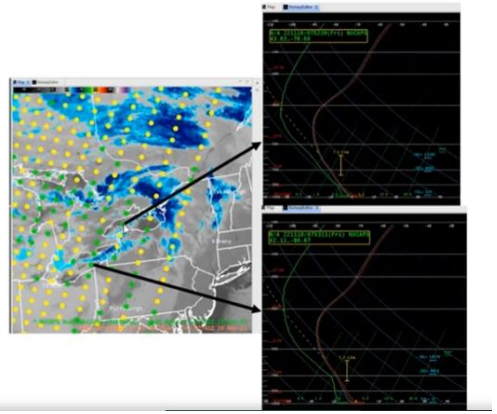
[NWS Amarillo](#) used sounders to assess thunderstorm environment (e.g., stability, capping inversion, moisture availability) for hail-producing storm in May 2021 stability, capping inversion, and moisture availability for hail producing-storms in May 2021



- NUCAPS derived soundings valid ~1930z (during mid-afternoon) indicated a local maximum in low-level lapse rates (superadiabatic) across south-central IL.
- This local maximum suggests that boundary layer mixing was most pronounced where the plumes of blowing dust occurred.

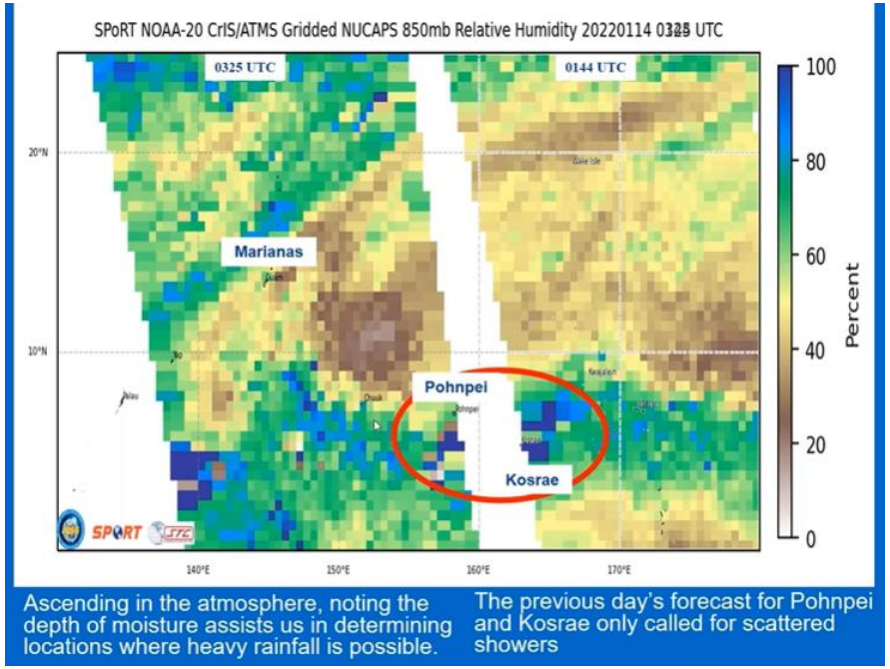
~06Z and ~18Z NUCAPS can fill in the gaps between 12Z and 00Z upper air launches.

Shown here: 0752Z data over Lake Ontario (top) and Lake Erie (bottom) with clear evidence of steep lapse rates.



Images courtesy of Bill Line

[NWS Buffalo](#) used sounders to assess the presence of steep lapse rates, important for lake effect snow forecasts during a Nov. 2022 event

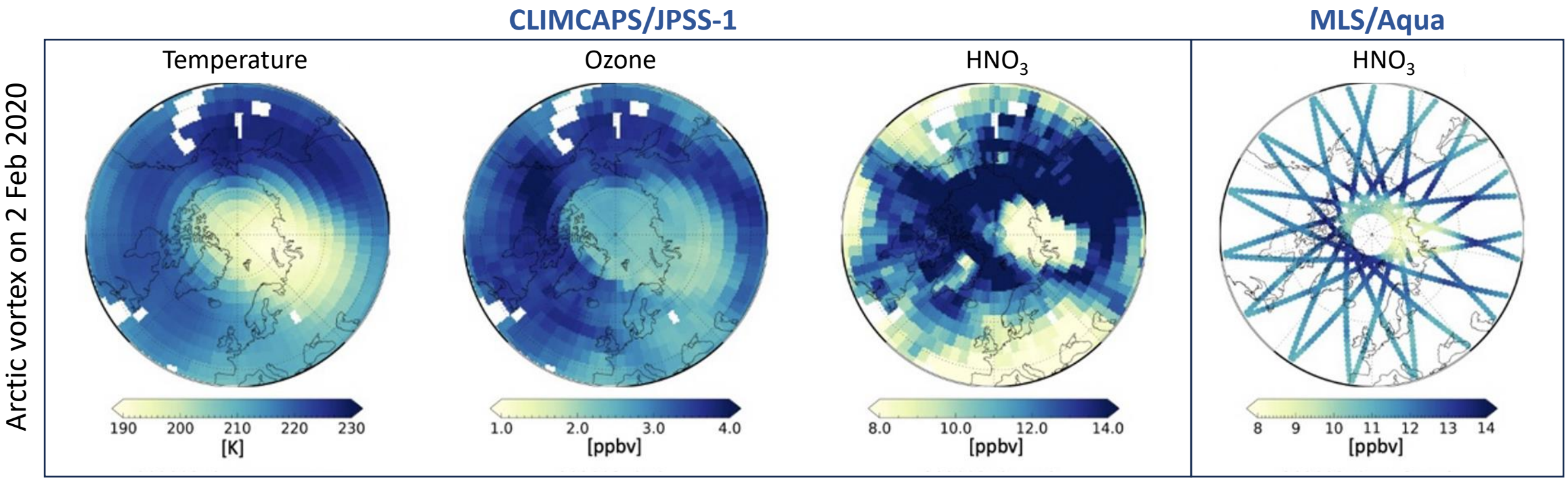


[NWS Guam](#) with few observations available relies on sounders for synoptic analysis and assessing moist layers to inform heavy precipitation forecasts

[NWS St. Louis and Springfield](#) used sounders to inform dust forecasts and warnings during the May 2023 agricultural dust storm that led to 7 fatalities and 37 injuries

– Prototype new products

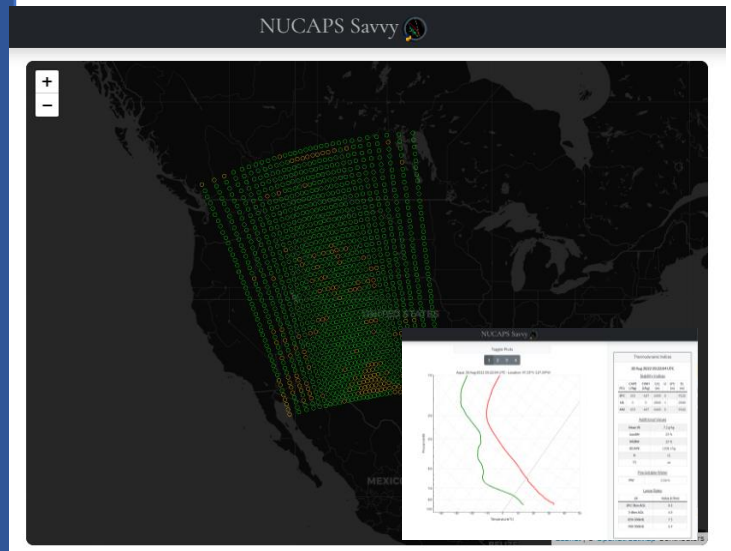
Soundings could prove useful in monitoring polar processes with an HNO_3 retrieval indicating polar stratospheric cloud formation. When MLS/Aura is decommissioned in next couple of years, the long record of stratospheric HNO3 observations will be interrupted.



Day-to-day variations (relative changes) in CLIMCAPS HNO_3 abundances over the course of a season, as well as anomalies from a long-term climatology, might convey meaningful information even if the absolute magnitudes are biased.

– Lowering Barriers: Providing Data in DSS

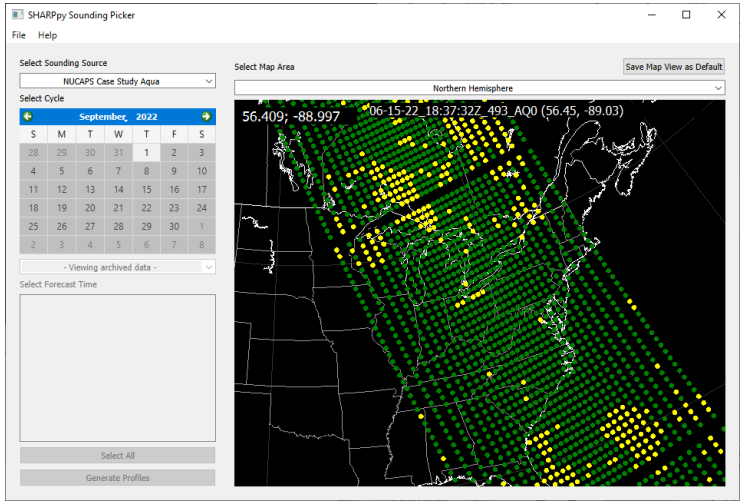
SPoRT develops visualization tools for ease of access and works with end-user organizations to integrate data into decision support systems (DSS)



[Savvy]

Satellite sounding **a**nalysis and **v**isualization **s**ystem

A partnership between SPoRT, JPL, SSEC, & STC



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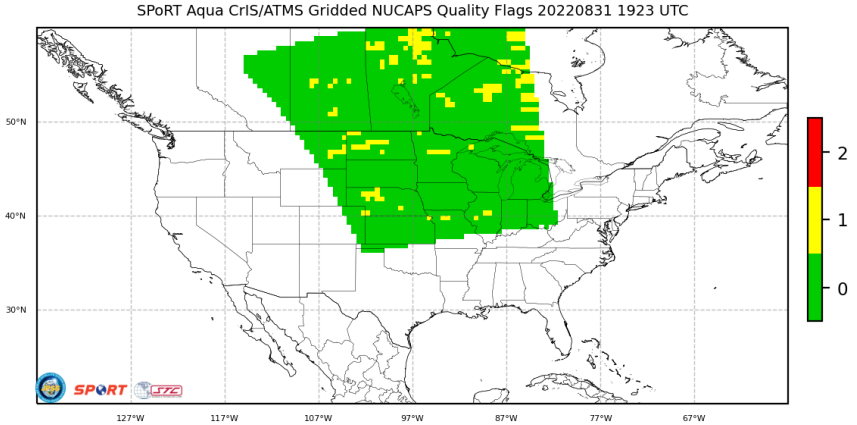
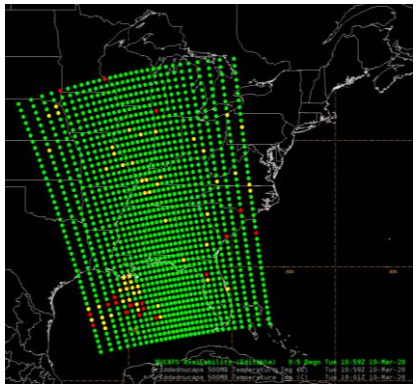
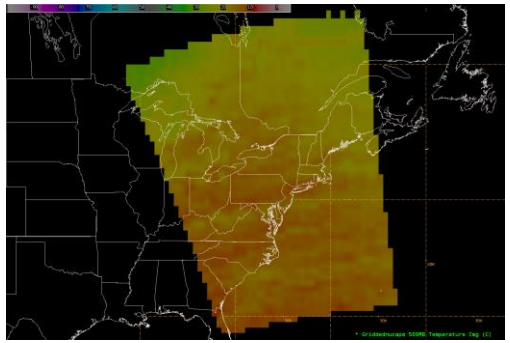


[SPoRT Web Page]





AWIPS

Lessons Learned

- Applications innovation requires working across organizations, aggregating capabilities/expertise, and expanding typical science roles
- Empathy, flexibility in responding to stakeholder feedback
- Interactive stakeholder involvement
- Peer-to-peer training within the user community
- Sense of community, purpose, collaboration
- Shared space, trust, known roles
- ***Supporting future missions with large, compound data sets, intentional community interaction is important for developing and fostering user applications***