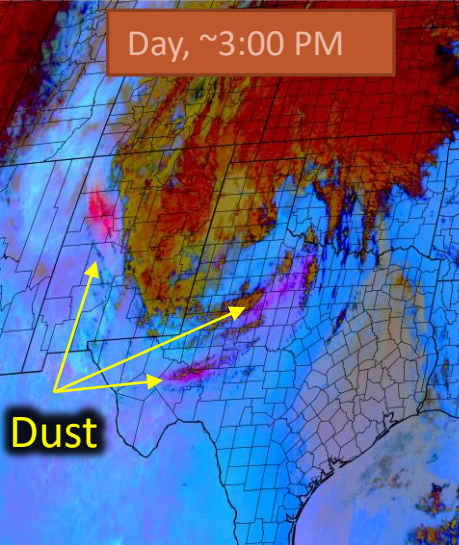


Advancements in Blowing Dust Detection at Night via Machine Learning

- Kevin Fuell, Emily Berndt, Rob Junod

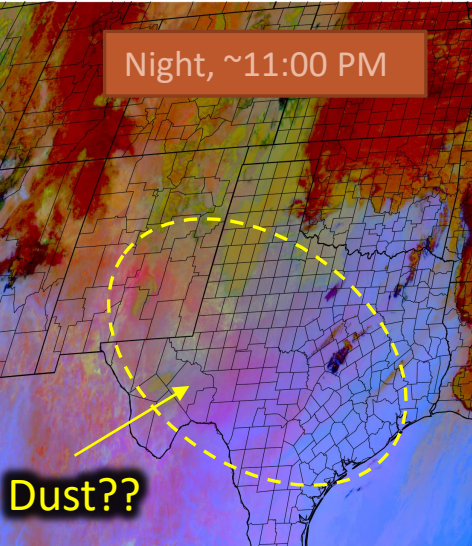
GOES-16 ABI Dust RGB 2022-03-17 20:56 UTC

Day, ~3:00 PM



GOES-16 ABI Dust RGB 2022-03-18 05:01 UTC

Night, ~11:00 PM



Product ... GOES/ABI Dust RGB Imagery improves dust detection, for both day and night compared to single channel imagery.

Problem ... The RGB at night has low contrast which makes dust less obvious.

Solution ... A Dust 'Machine Learning' (ML) model was created for dust probability.

For images with dust present, the model **correctly labels 85%** of dust pixels and 99.96% of no-dust pixels. ([See ML details here](#))

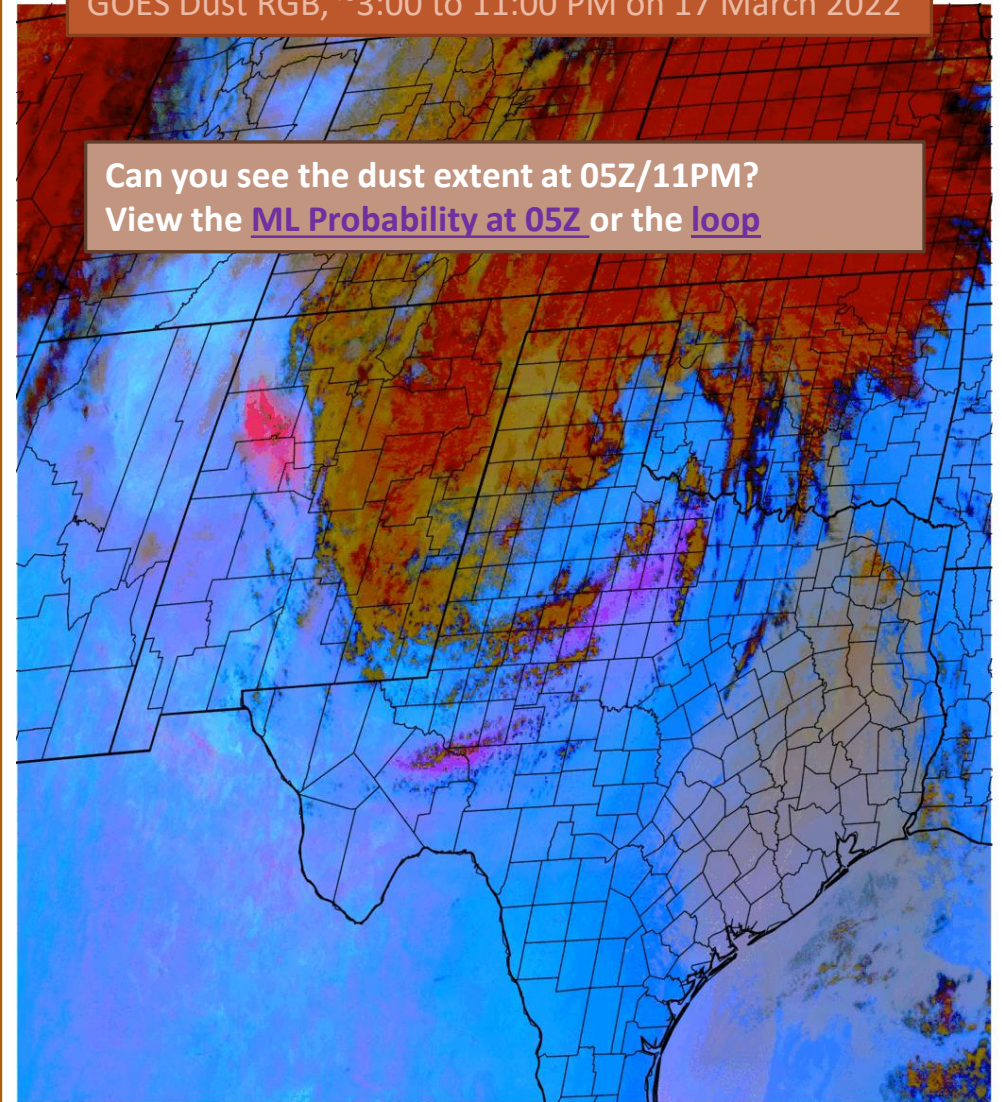
March 17 Dust
Probability
Impact &
Feedback

April 7/8
Feedback,
Timeline, and
Public Health

Overall Impact and Next Steps

GOES Dust RGB, ~3:00 to 11:00 PM on 17 March 2022

Can you see the dust extent at 05Z/11PM?
View the [ML Probability at 05Z](#) or the [loop](#)



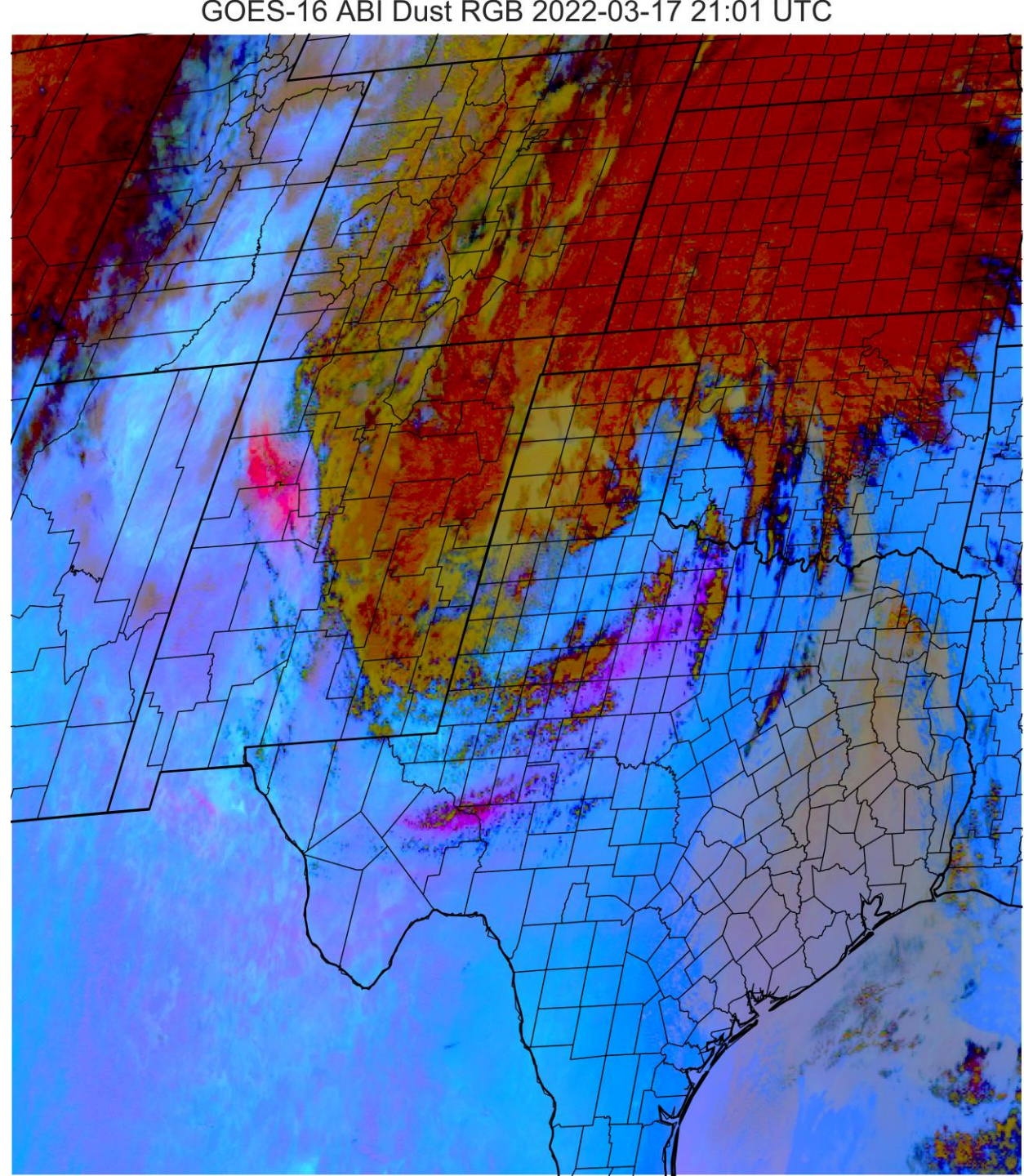
March 17, 2022

Dust RGB at
2100 UTC

Dust plumes in
northwest NM,
and Texas.

Contrast between
the dust plumes
and land surface
due to warm
ground

[Back to Title Page](#)



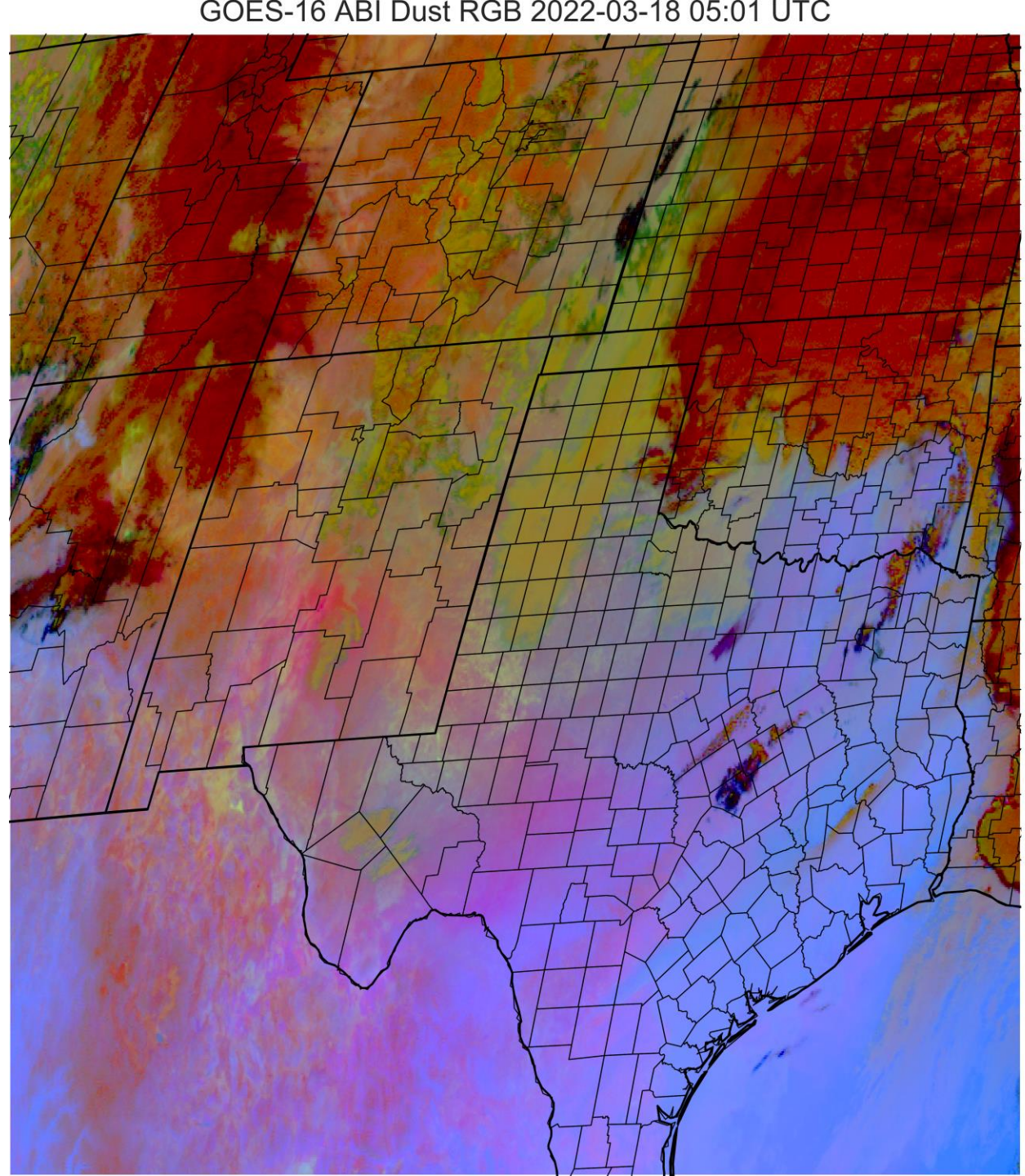
March 17, 2022

Dust RGB at
0500 UTC

Dust extent is not
easily evident.

Contrast is low
between the dust
plumes and land
surface due to
radiational cooling,
cause less 'blue' in
RGB for land.

[Back to Title Page](#)



Dust 'Machine Learning' Model Methodology

[Back to Title Page](#)

- Overcoming the limitations of night-time dust detection is addressed by using expert analysis and remote sensing principles to develop training data, model inputs, and architecture.

Focus on refining the training for Night-time dust detection

- Collect night-time training dataset
- Classify false surface and smoke detections

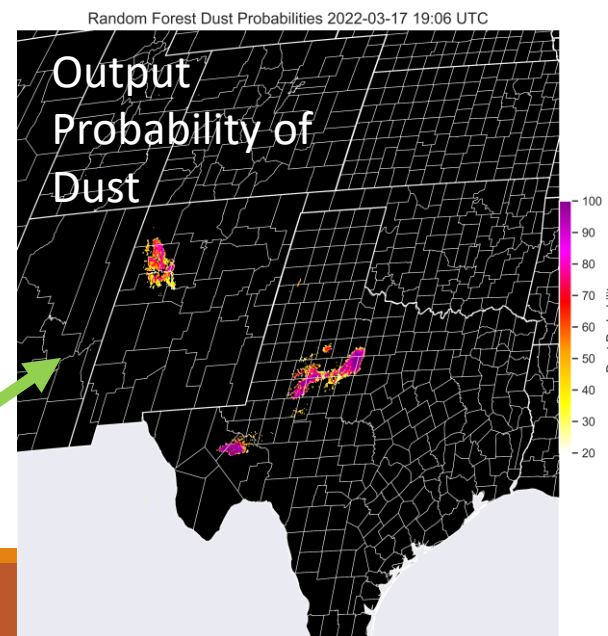
- GOES-16 ABI imagery in the SW U.S. Jan. 2018-Jun. 2020
- Cases were randomly split for Dust ML model training (60%), testing (20%), and validation (20%)
- A total of 28 cases were gathered, which incorporates 83 distinct images a total of **790,921 dust pixels** and **37,698,467 null pixels**

Model Inputs

Single channels: 7.3, 10.35, 11.2, 12.3, 13.3
Differences: 12.3-10.35, 11.2-8.4
Dust RGB components

[More information at Berndt et al. 2021](#)
[NASA ESDS Article "Dust in the Machine"](#)

Random Forest Model



Evaluate Training, Model Inputs, and Performance with Statistical Approaches

- Loss functions/Jaccard score
 - Confusion matrix
- Permutation Importance
 - ROC/AUC
 - + a few more

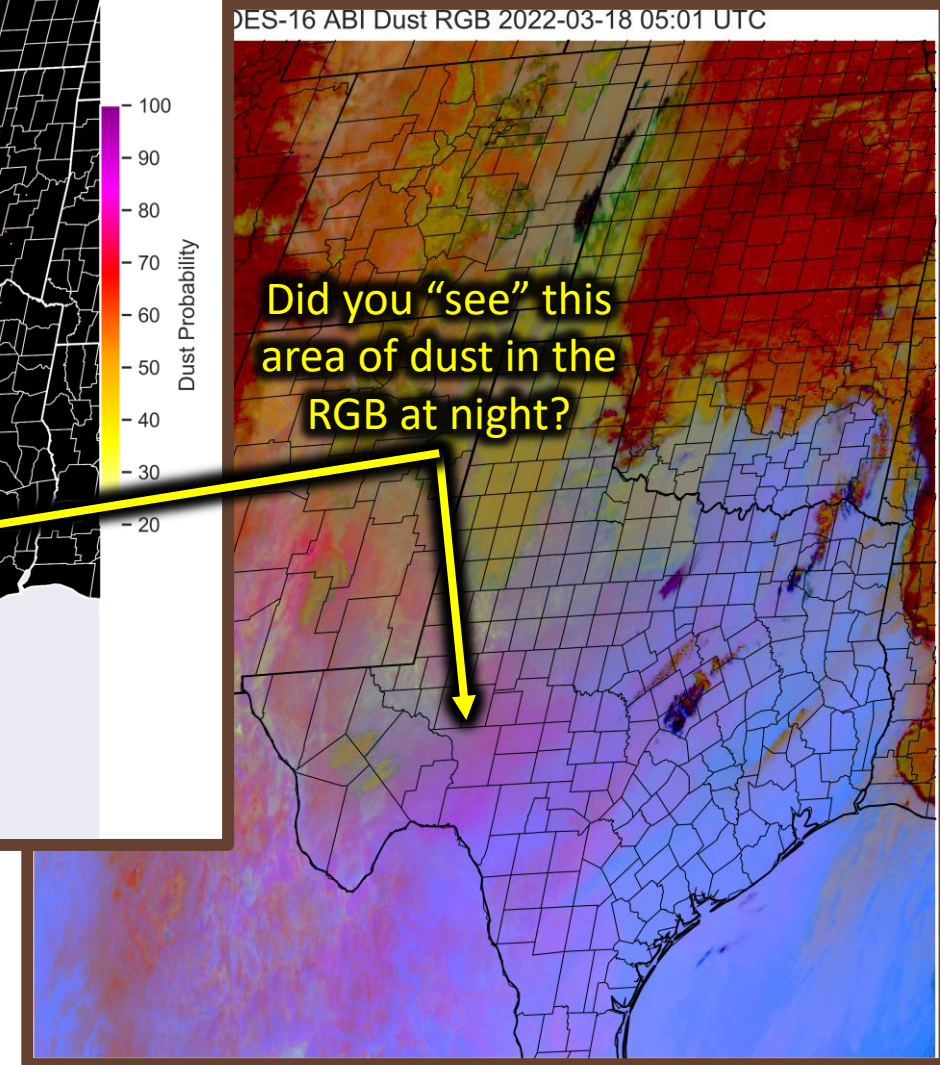
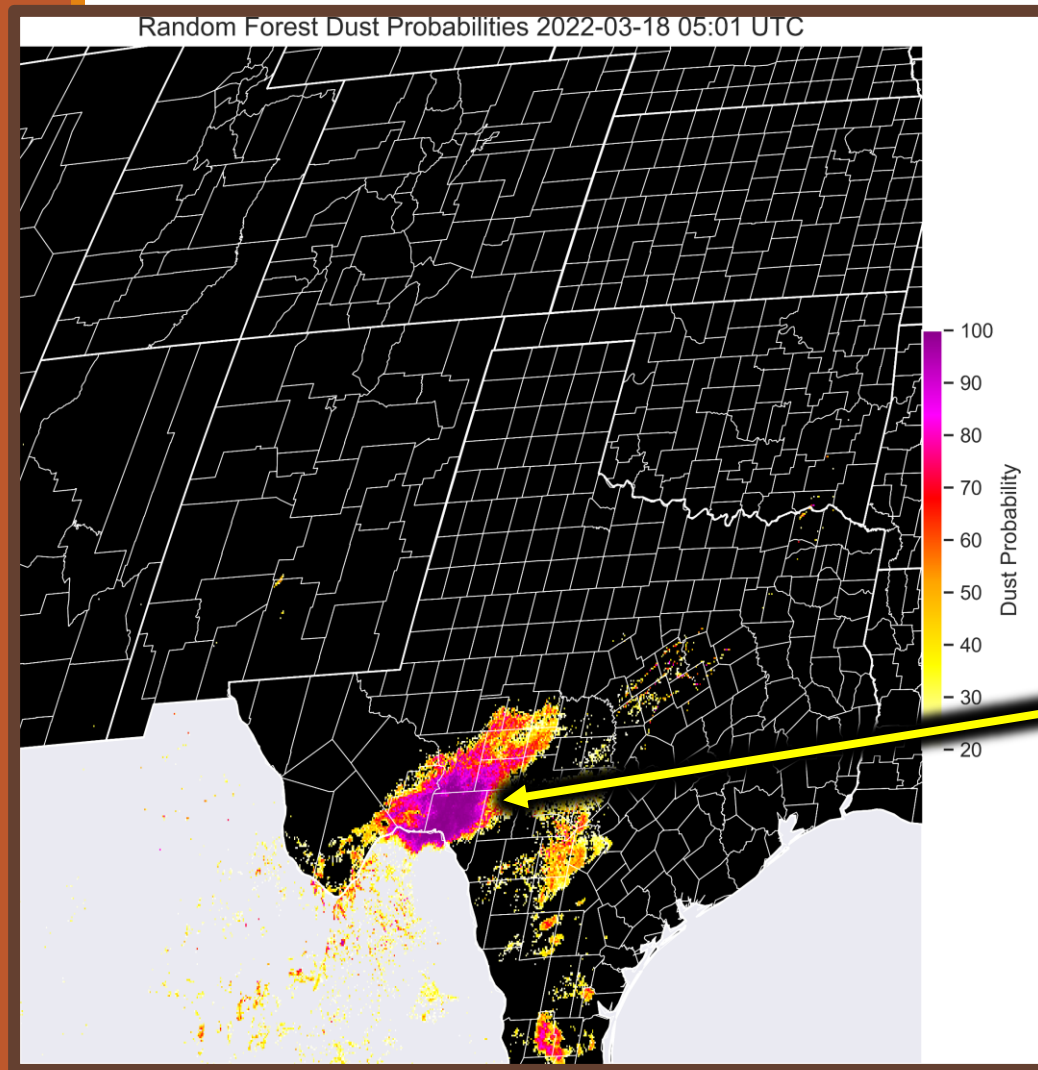
[Back to Title Page](#)

March 17, 2022

Dust ML Probability
and Dust RGB at
0500 UTC

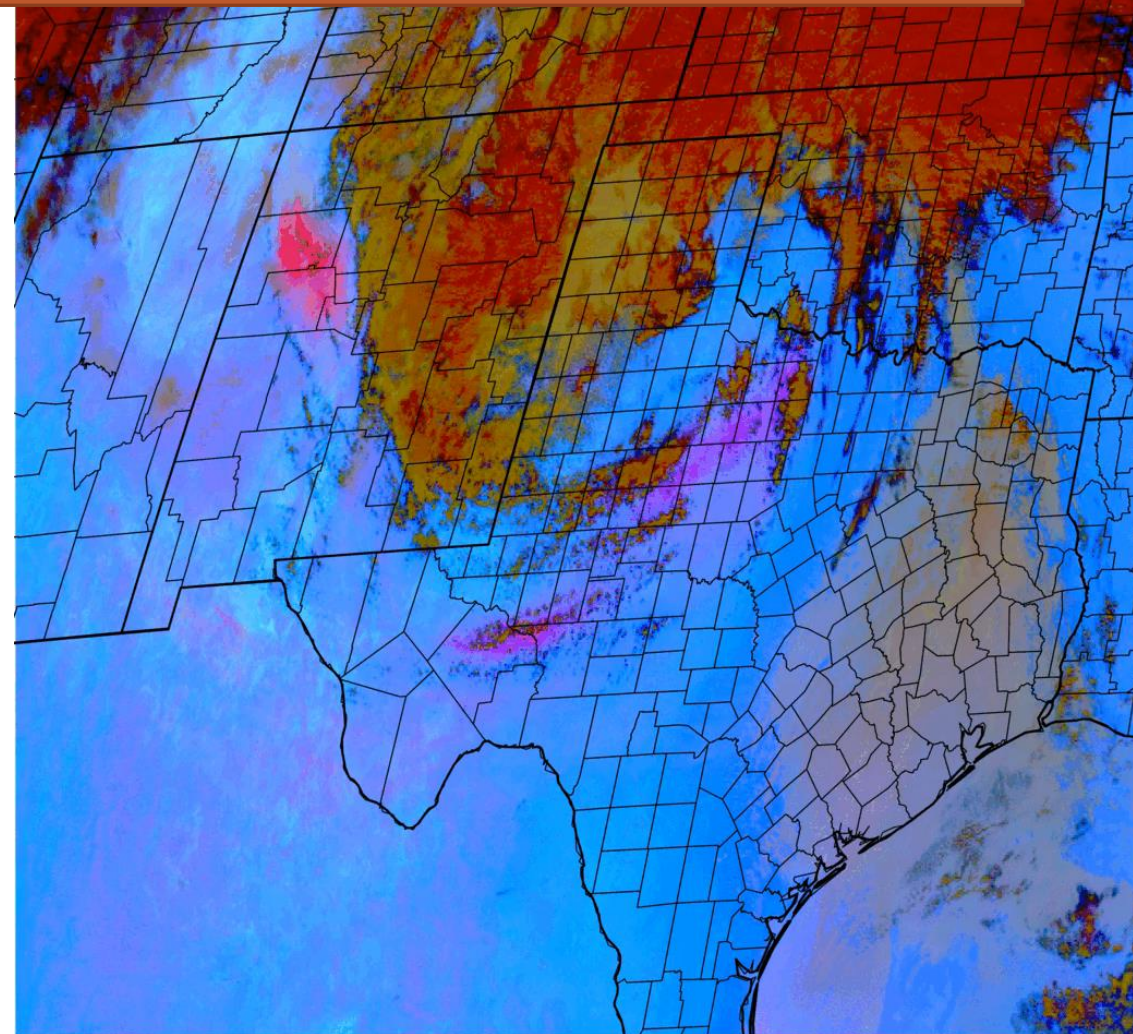
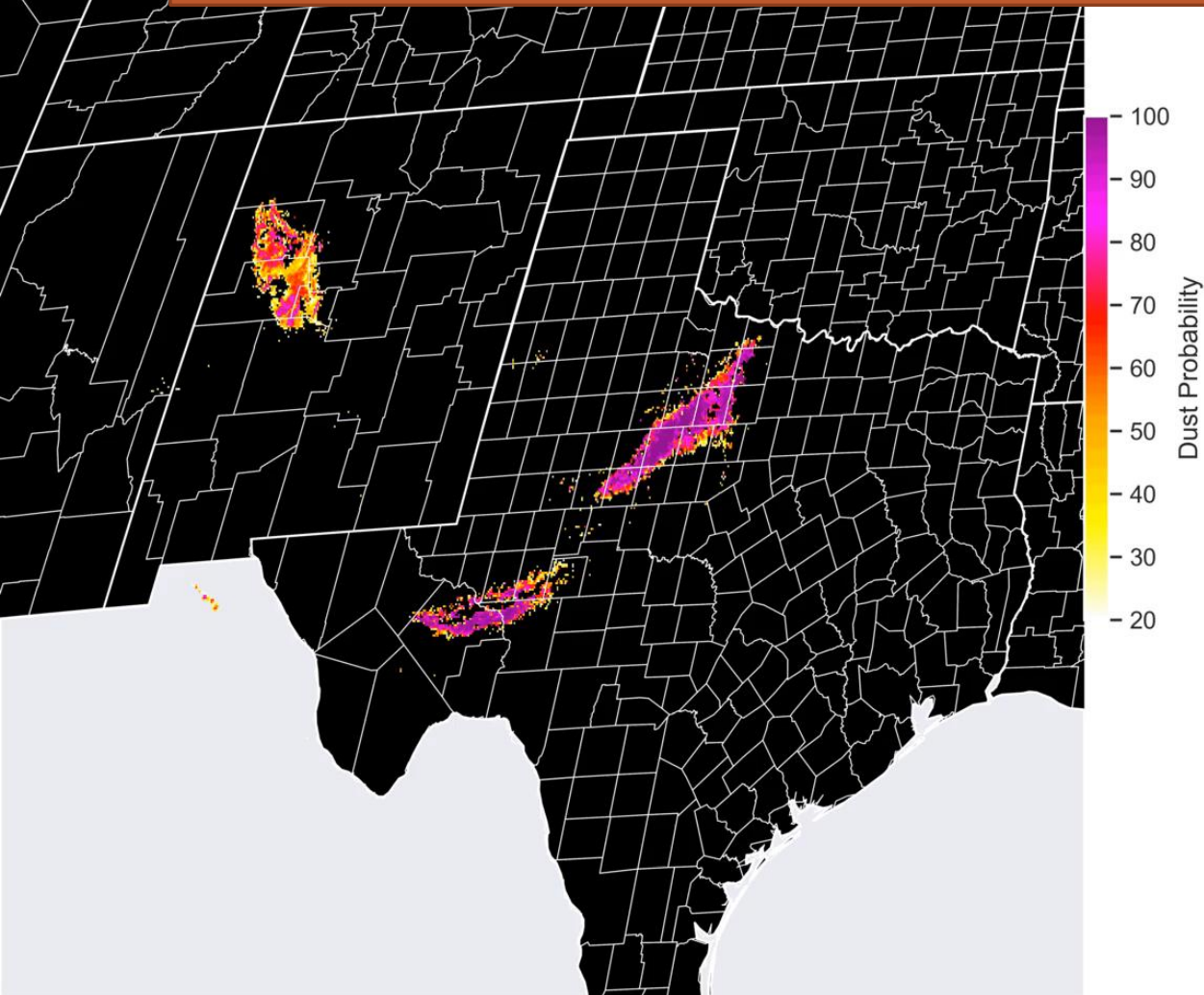
Dust extent via ML
model output
provides extent in low
contrast area for more
efficient analysis and
tracking.

[Back to Title Page](#)



Dust ML Probability and RGB

[Back to Title Page](#)



[Back to Title Page](#)

March 17 Event

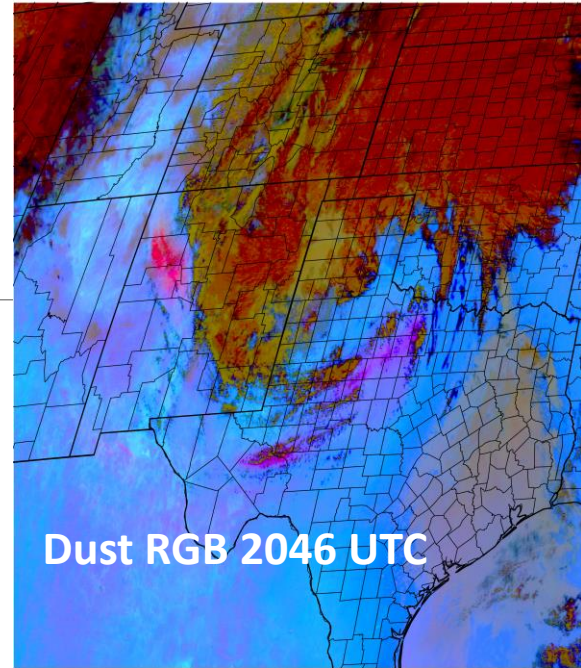
~Midland, TX WFO

*“The ML probabilities matched observations and **supplemented our decision making** when issuing a Blowing Dust Advisory,*

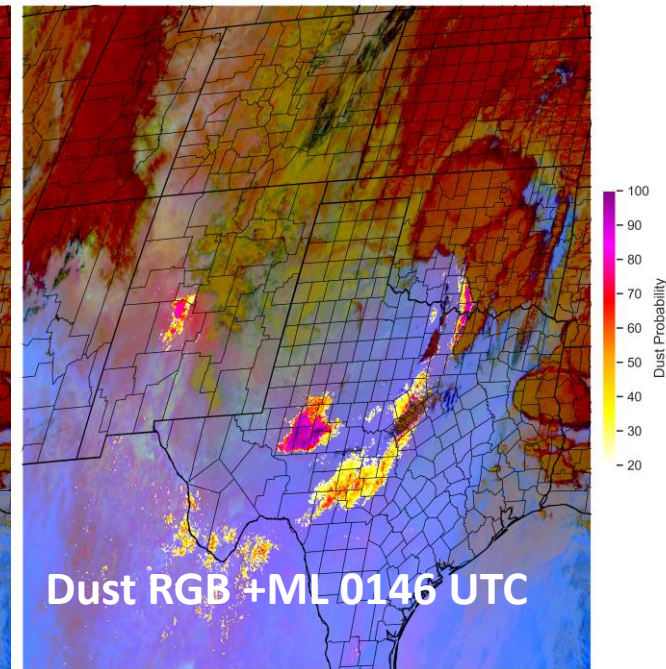
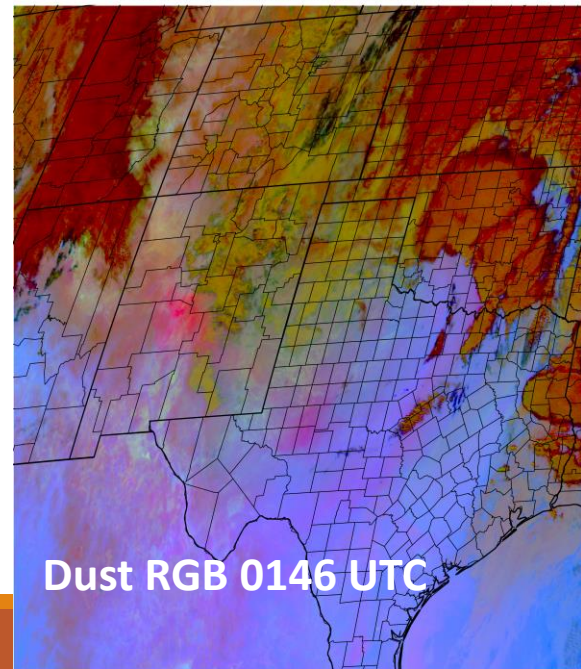
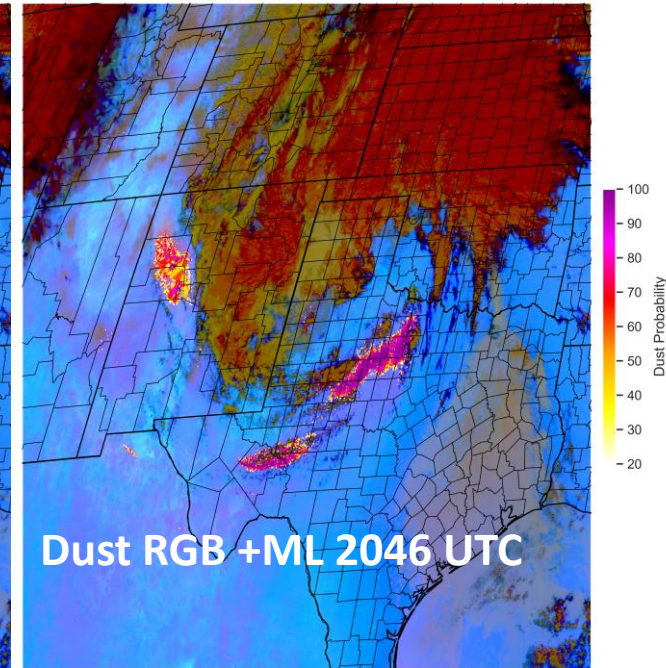
*as well as **supplemented our briefing** to Emergency Managers who were dealing with an ongoing large wildfire.”*

[Back to Title Page](#)

GOES-16 ABI Dust RGB 2022-03-17 20:46 UTC



GOES-16 ABI Dust RGB with Dust Probabilities 2022-03-17 20:46 UTC



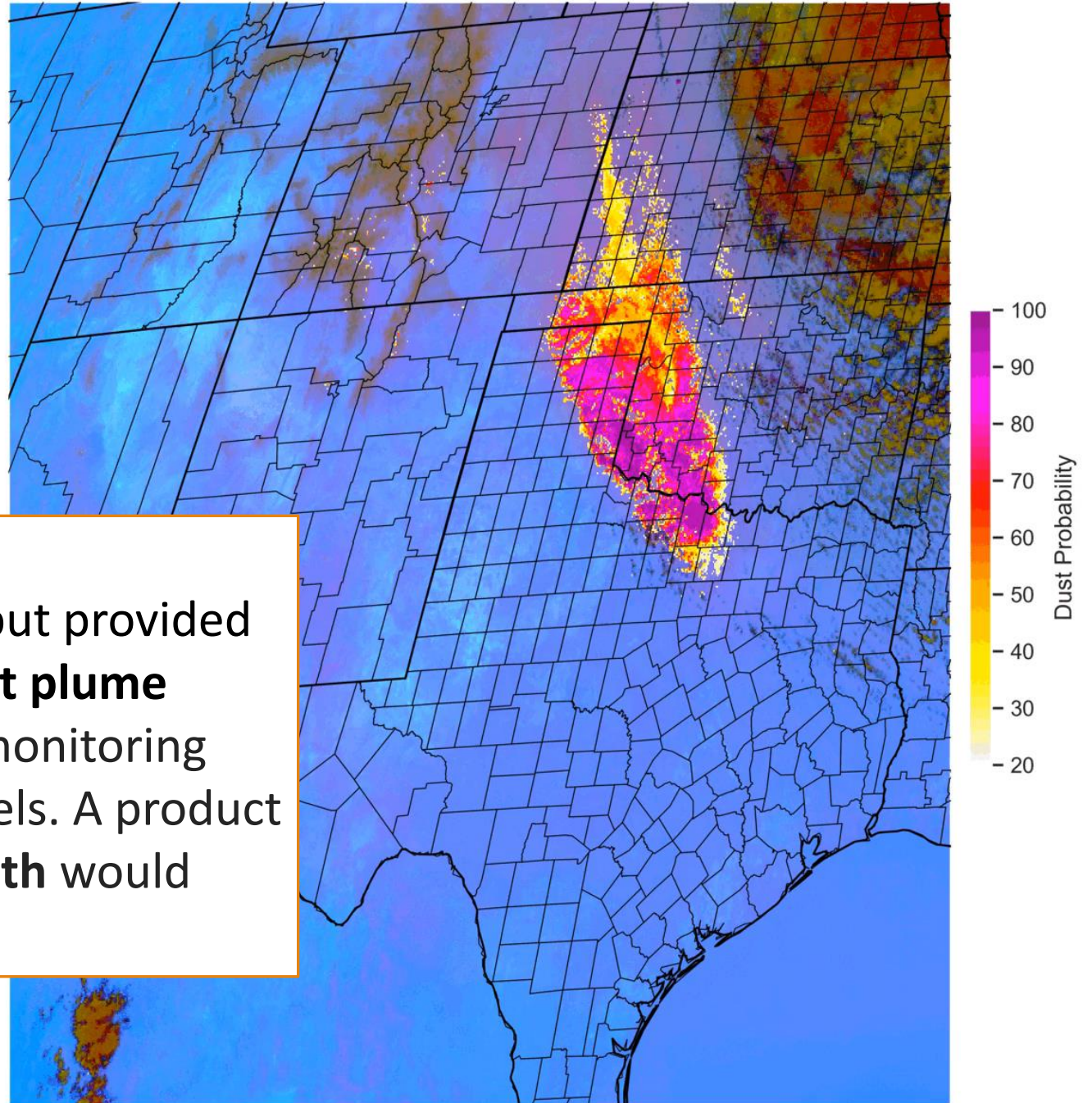
April 7, 2022

Dust RGB
with overlay of
Dust ML Probability
from 23Z to 08Z

From AMA:

- Dust RGB was valued, but ML output provided **longer period of time to track dust plume**
- Opportunity: DSS often relies on monitoring dropping visibility in the lower levels. A product **enhancement to include dust depth** would benefit operational use for DSS.

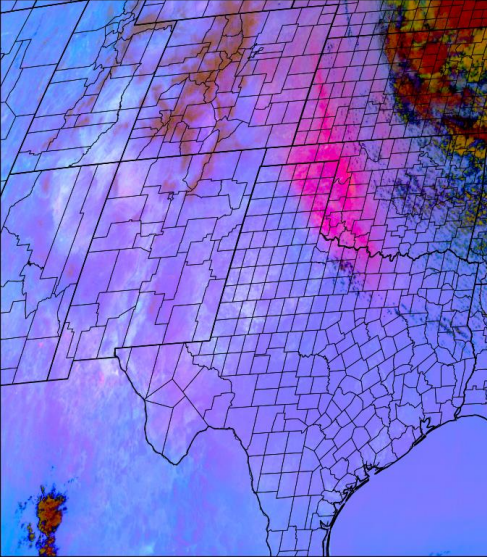
GOES-16 ABI Dust RGB with Dust Probabilities 2022-04-07 23:01 UTC



April 7-8 Event: timeline images

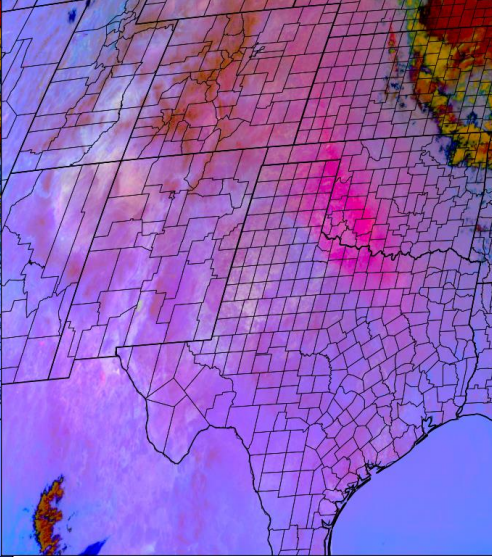
23 Z

GOES-16 ABI Dust RGB 2022-04-07 23:01 UTC



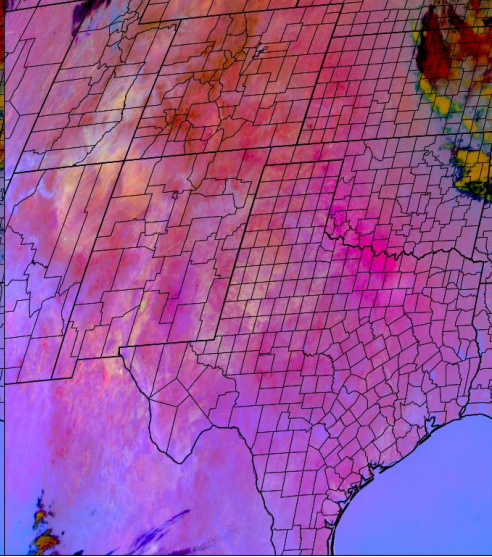
01 Z

GOES-16 ABI Dust RGB 2022-04-08 01:01 UTC



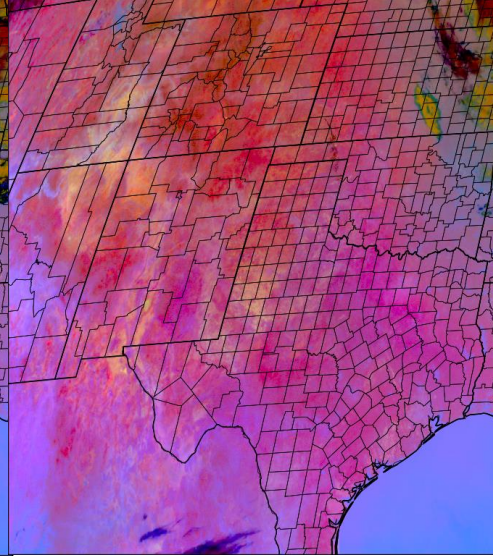
03 Z

GOES-16 ABI Dust RGB 2022-04-08 03:01 UTC



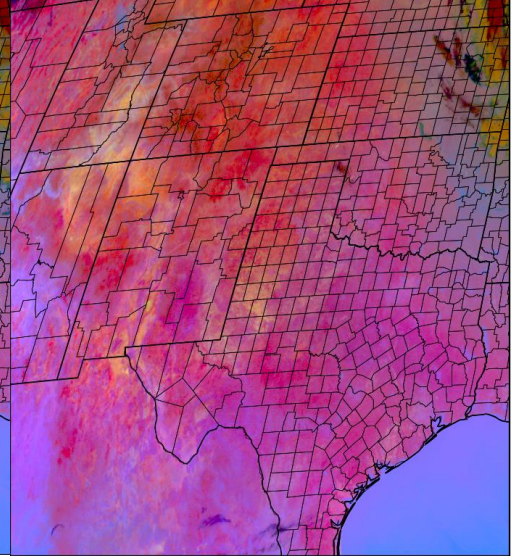
05 Z

GOES-16 ABI Dust RGB 2022-04-08 05:31 UTC

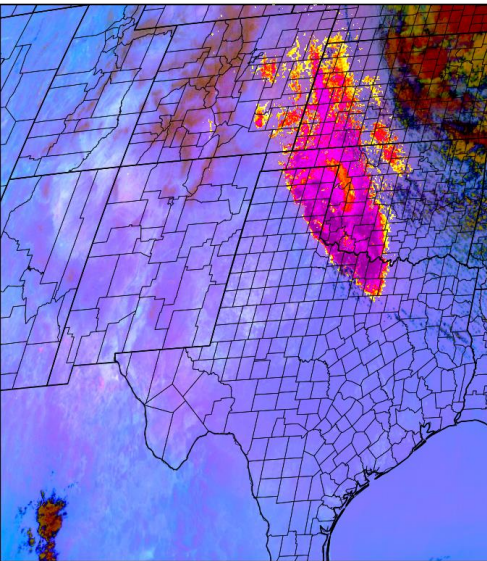


07 Z

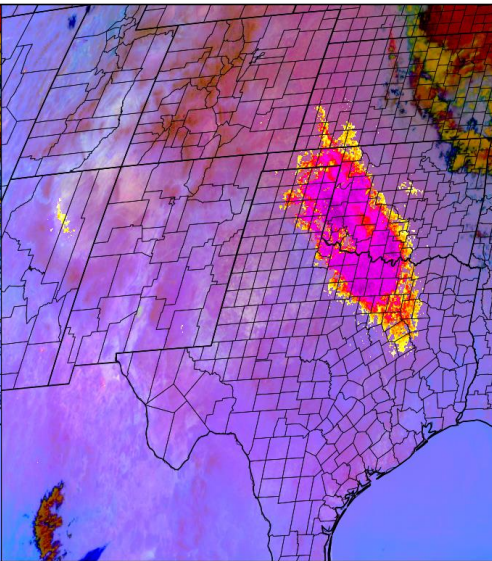
GOES-16 ABI Dust RGB 2022-04-08 07:01 UTC



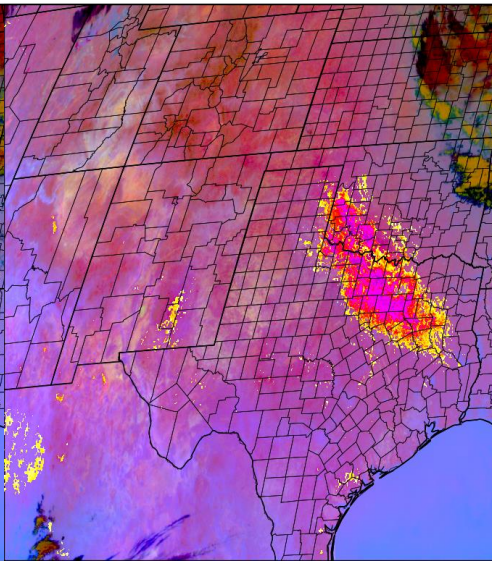
GOES-16 ABI Dust RGB / Dust Probabilities 2022-04-07 23:01 UTC



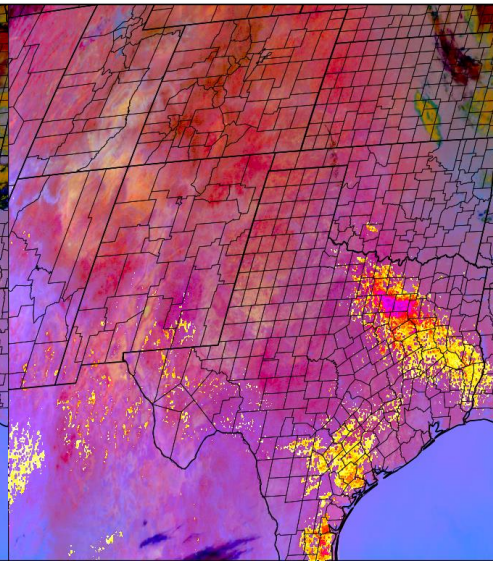
GOES-16 ABI Dust RGB / Dust Probabilities 2022-04-08 01:01 UTC



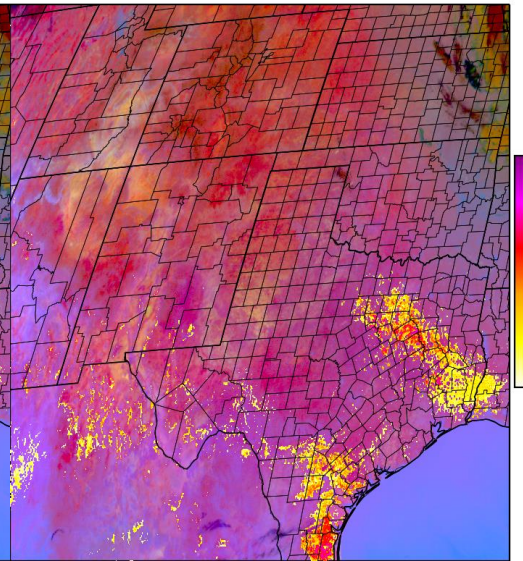
GOES-16 ABI Dust RGB / Dust Probabilities 2022-04-08 03:01 UTC



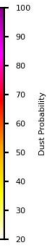
GOES-16 ABI Dust RGB / Dust Probabilities 2022-04-08 05:31 UTC



GOES-16 ABI Dust RGB / Dust Probabilities 2022-04-08 07:01 UTC

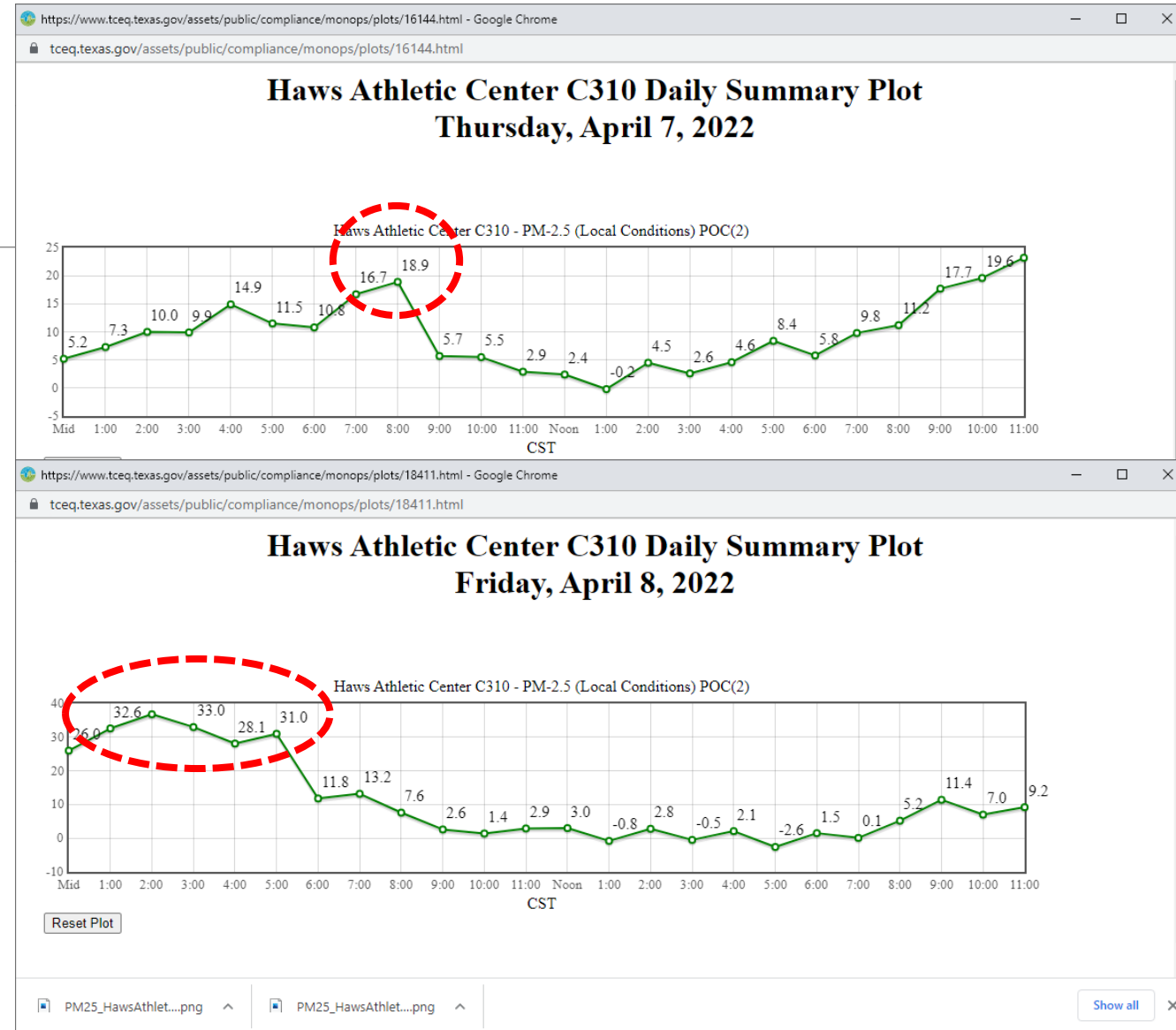
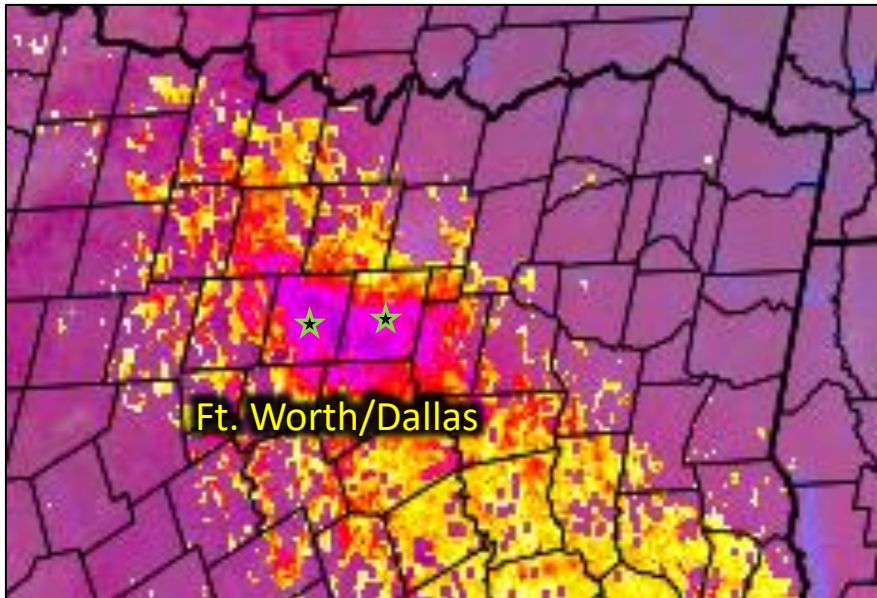


Dust Probability



April 7-8: Feedback/Impact

- No AQ alerts for Dallas/Ft. Worth
- Double the PM2.5 from prior day: 18.9 to 33.0
- Local media/stakeholders would be able to act in near term.



Overall Impact and Next Steps

The Dust ML probabilities **increased situational awareness of lofted dust**, especially when not captured by other satellite products or surface observations

- In 62% of cases, the Dust ML probabilities **added confidence to interpreting the Dust RGB** and other satellite products to objectively assess the dust extent and trends

- In 75% of cases, the Dust ML probabilities **increased the time of plume tracking**

Continued work focuses on expansion of the training dataset, **development of a day component of the model**, and continued evaluation of performance and validation