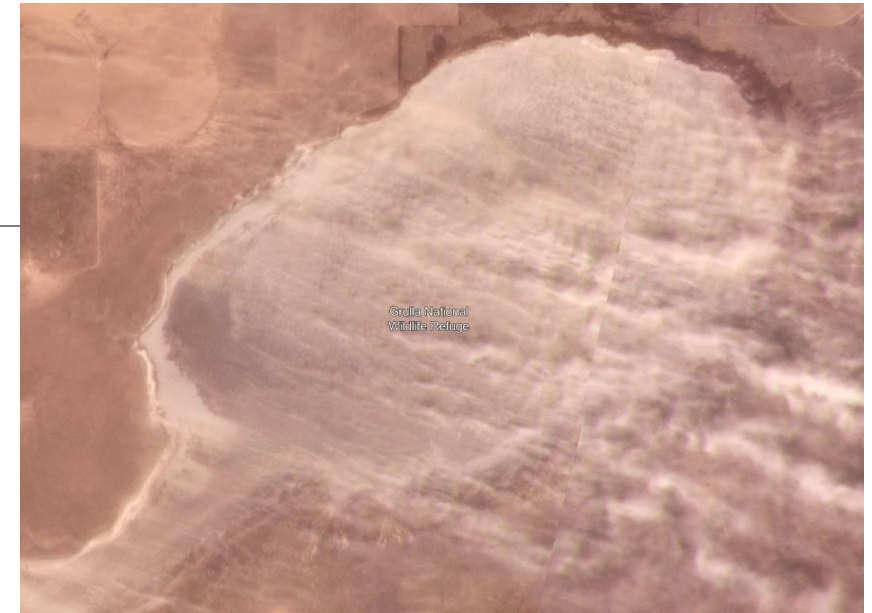
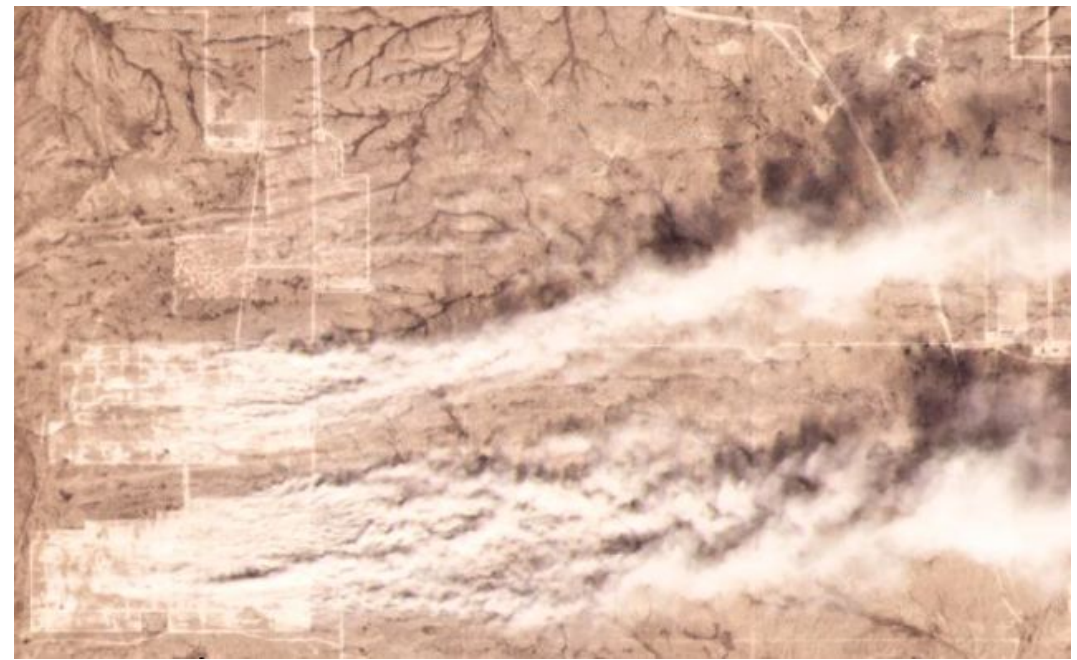


CubeSats. A New Tool In The Dust Storm Detection Toolbox

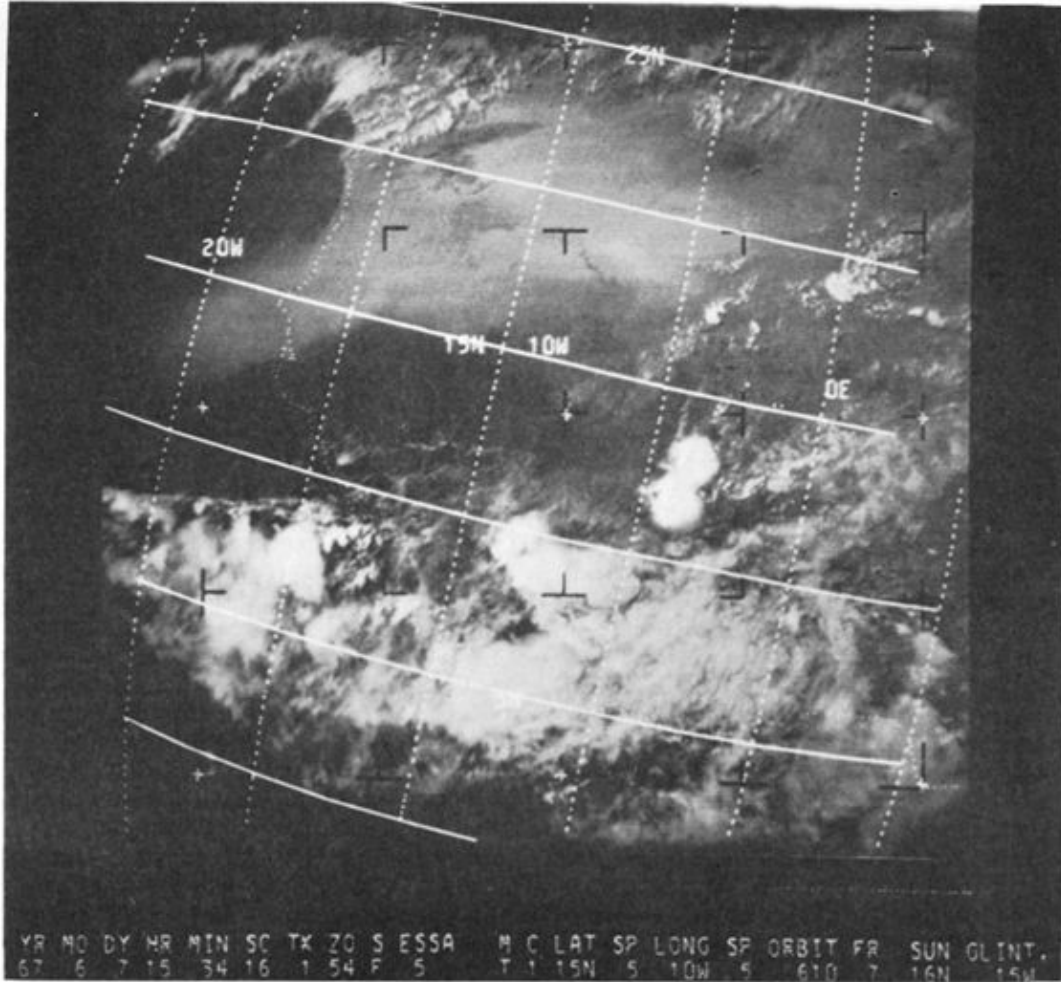


Tom Gill, The University of Texas at El Paso

Rob Bryant, The University of Sheffield (UK)

tegill@utep.edu and R.G.Bryant@Sheffield.ac.uk

We've been detecting dust storms from satellites for almost 55 years- and have come a long way!



Left: African dust cloud moving over the Atlantic, June 7, 1967, from ESSA-5 satellite (Prospero et al., 1970)

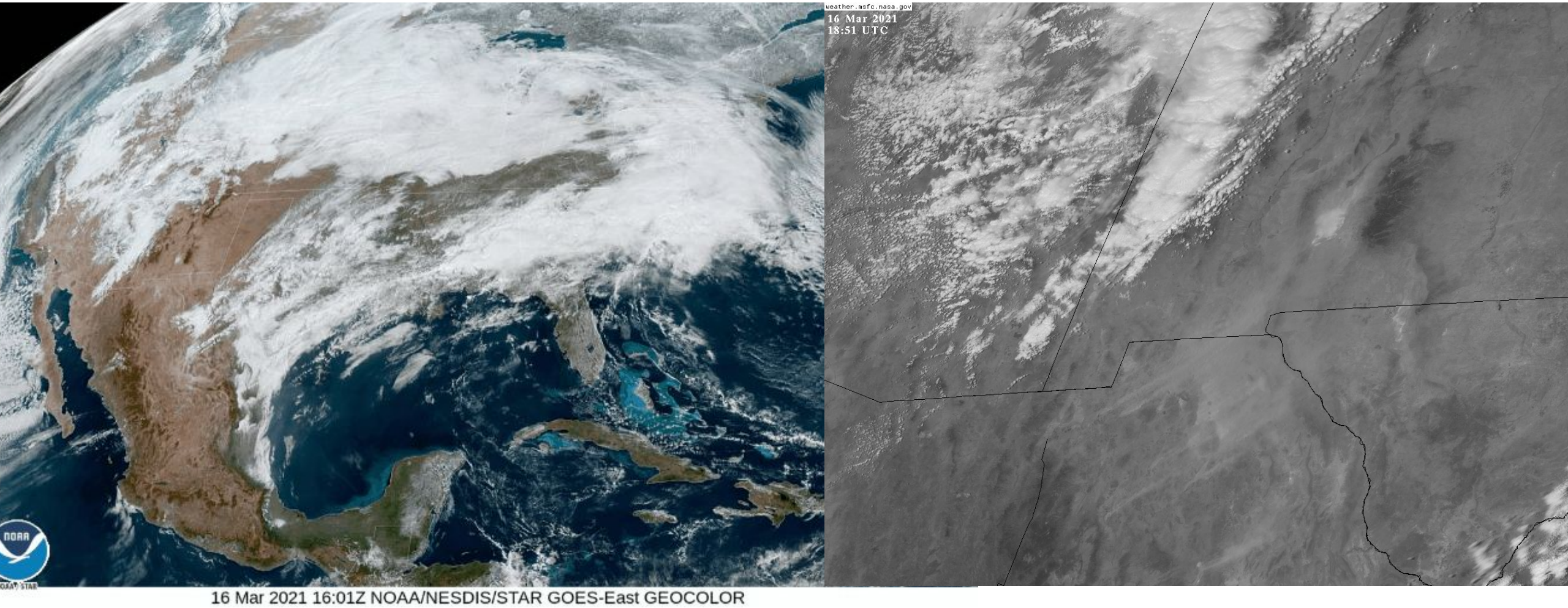
Right: LANDSAT-1 view of Southern California on January 1, 1973, showing dust plumes over the Mojave Desert.



L.W. Bowden et al., 1974, Science 184:1077-1078.

J. Prospero et al., 1970, Earth & Planetary Sci. Letters 9:287-293

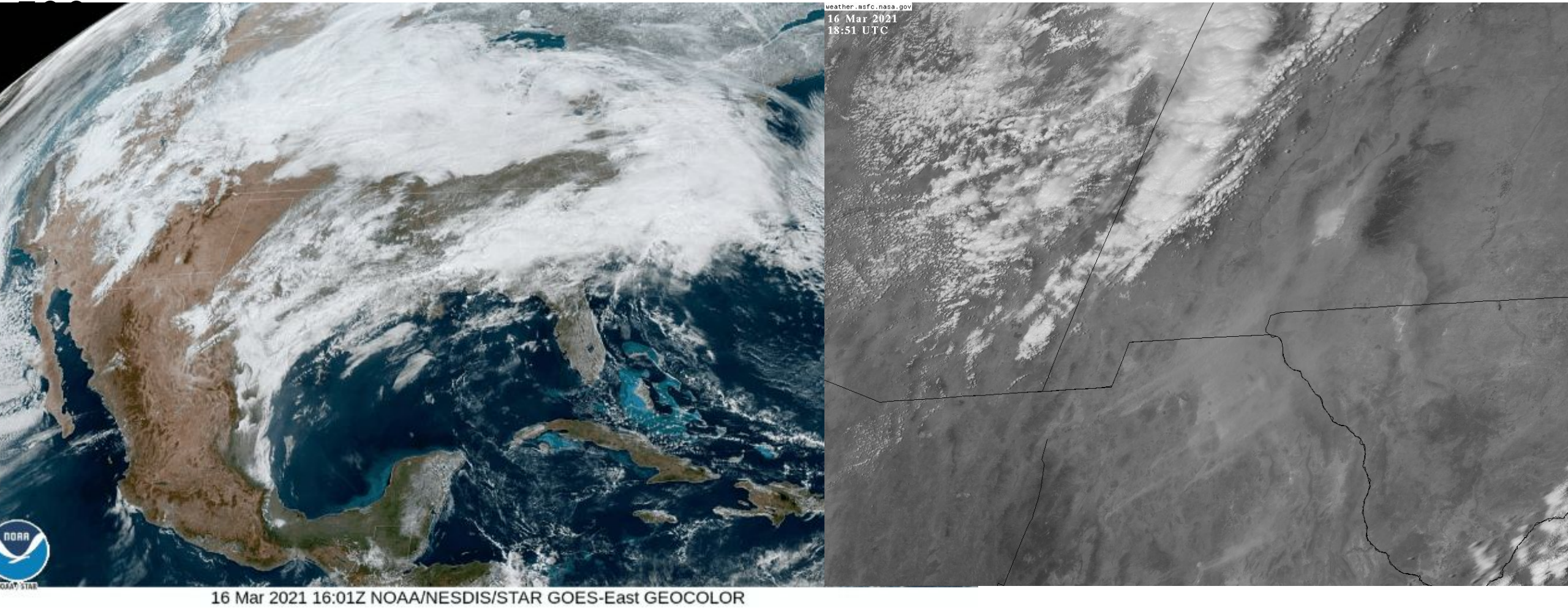
The NOAA-GOES series, from its first satellite 45 years ago to the current GOES-17, provides a great tool for monitoring dust storms.



GOES-East views of the dust storm affecting New Mexico, Texas and Chihuahua 3/16/21

National Weather Service 10th Dust Storm Workshop – March 24th, 2021

GOES now provides images minutes apart, great for watching evolution and progress of dust events, with spatial resolution to



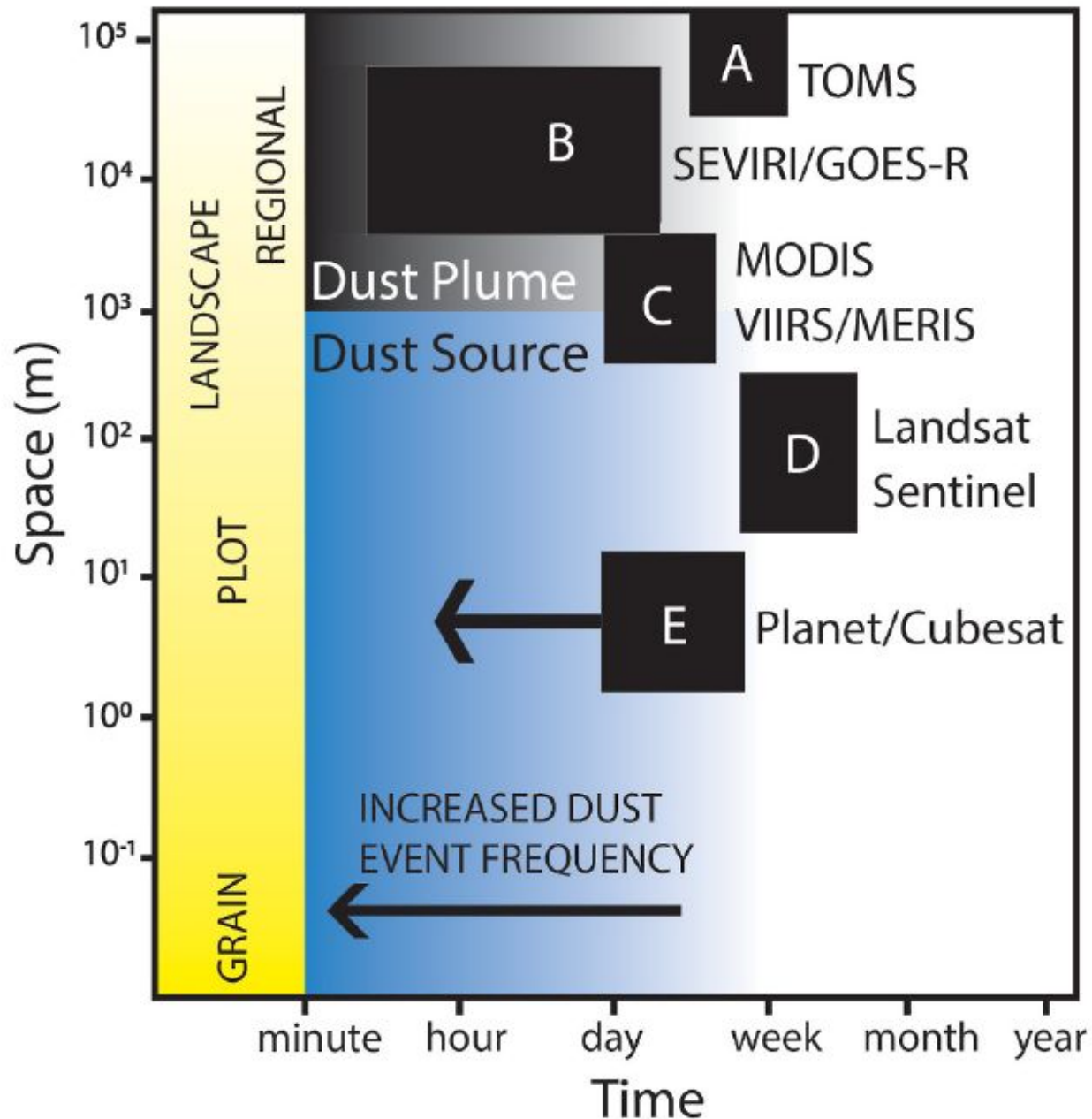
GOES-East views of the dust storm affecting New Mexico, Texas and Chihuahua 3/16/21

National Weather Service 10th Dust Storm Workshop – March 24th, 2021

NASA'S MODIS sensor on board Terra and Aqua satellites has been a revolution in detecting dust source locations, with spatial resolution to 250m, but at most two images are available per day.



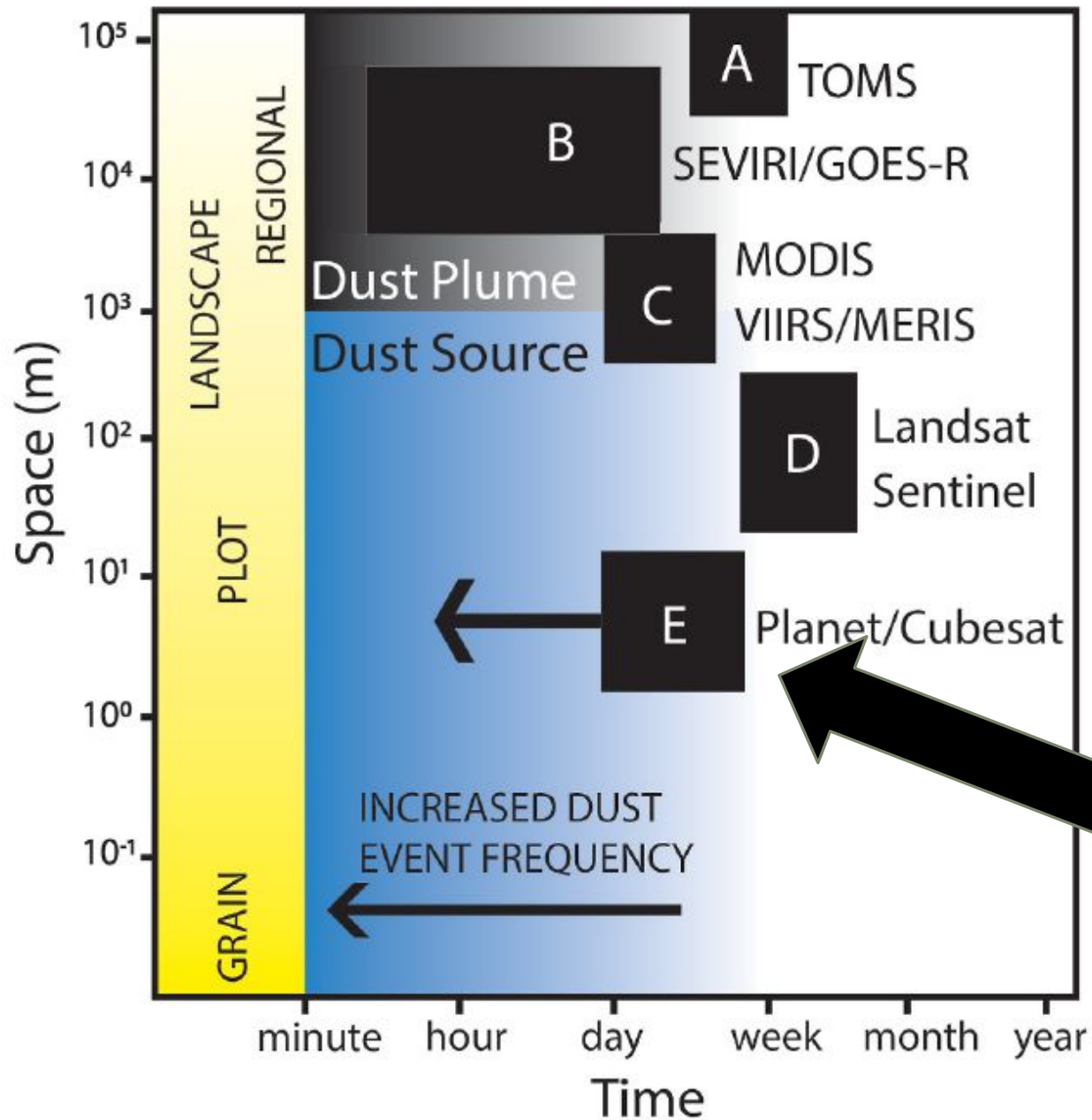
MODIS-Terra view of dust storm affecting New Mexico, Texas and Chihuahua 3/16/21



There is a trade-off between

- **Temporal frequency**
- **Spatial fidelity** and
- **Data availability**

when it comes to satellite imaging of dust storms.



**Now there's something new
in the toolbox- Cubesats,
especially PlanetScope from
Planet Labs.**

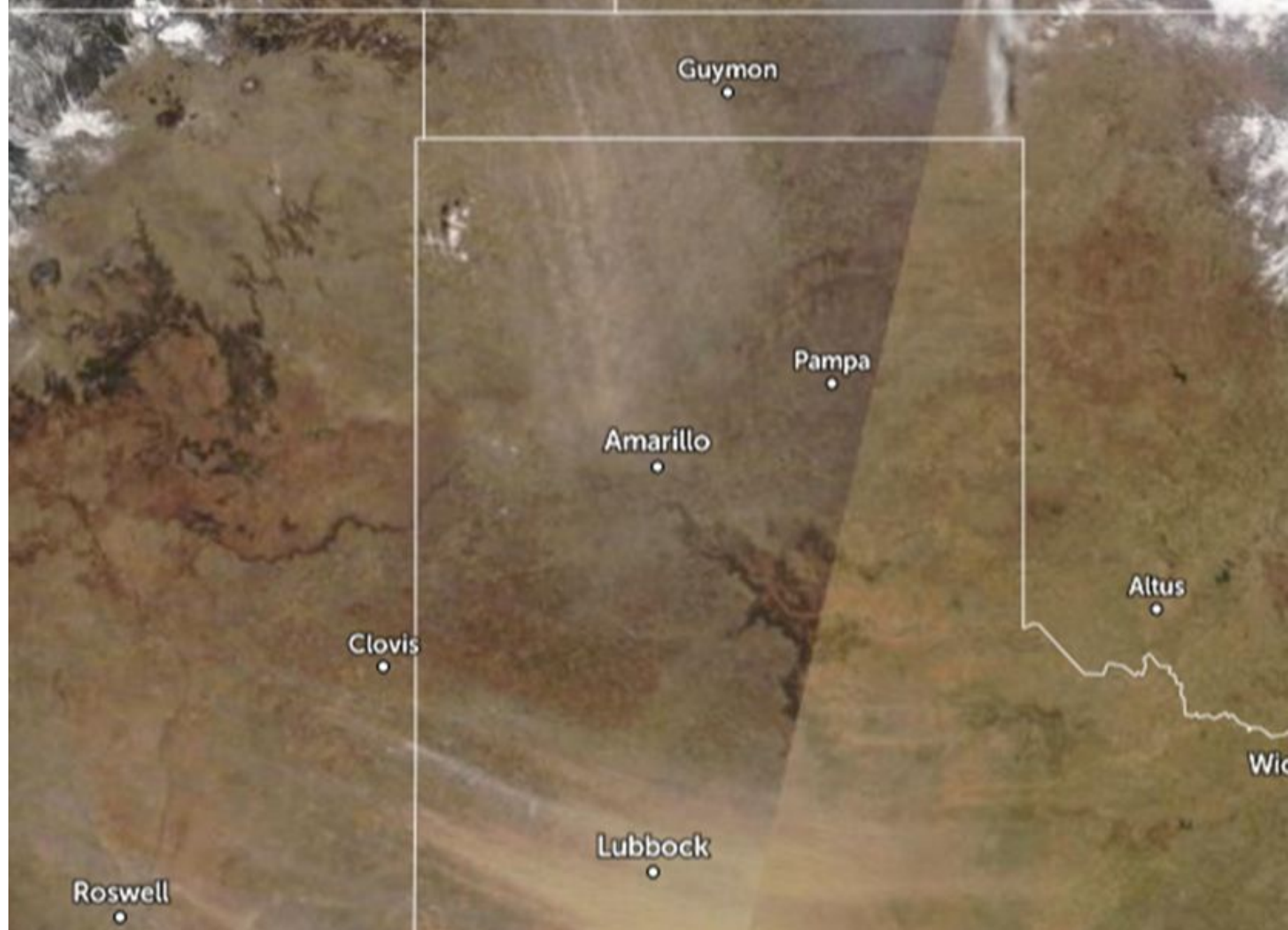


- Fleets or “flocks” of small, privately-launched miniature satellites (CubeSats) named “Doves” purposed for Earth imaging.
- More than 200 are currently in orbit.
- Various numbers cover the Earth at different times and frequencies.
- Spatial resolution is as good as 3 meters!
- Data is available in some quantity freely to university students and researchers, and NASA-supported researchers;
and through license to others (governmental agencies, nonprofits, and businesses)

Example:

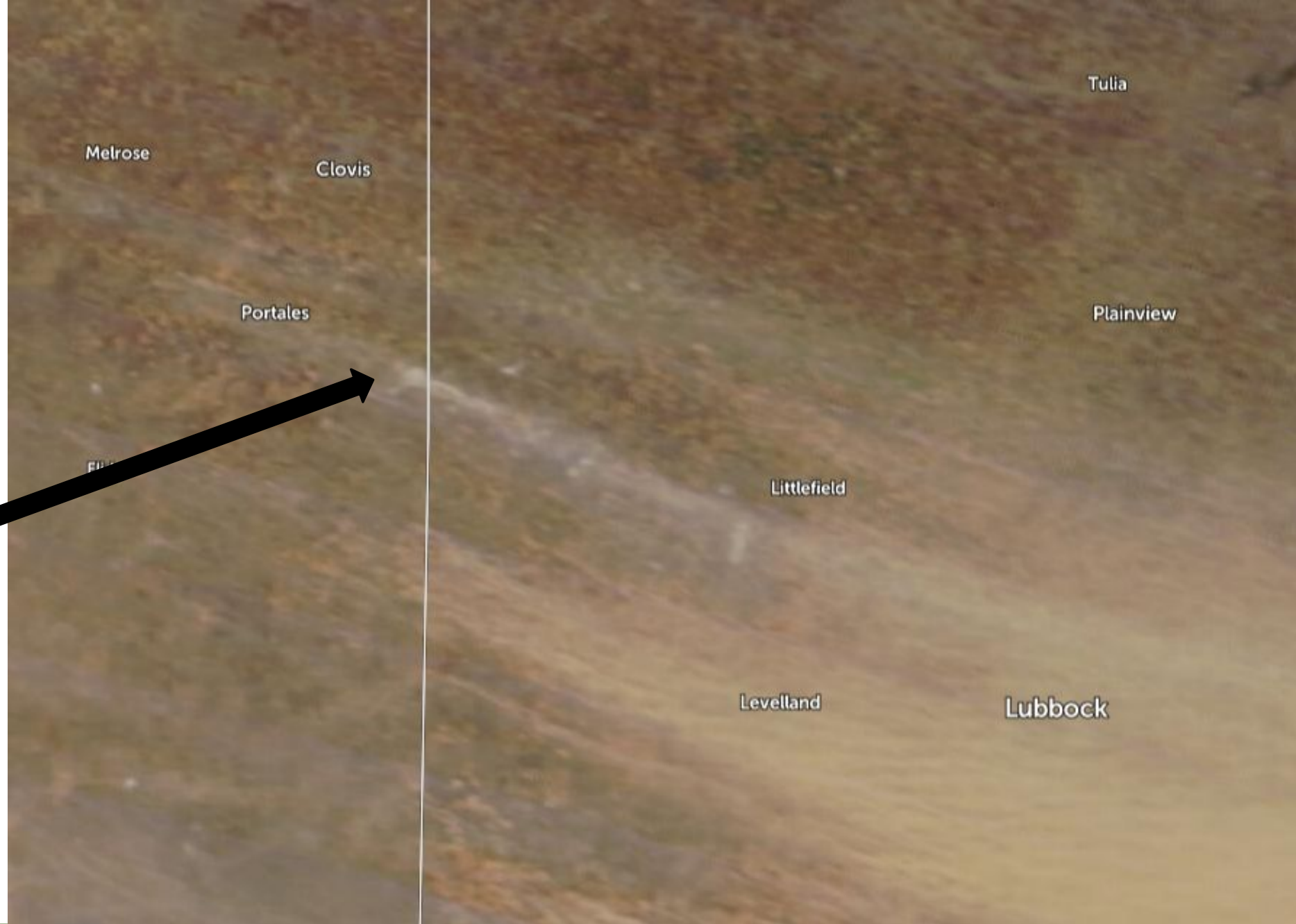
Dust storm of January 30, 2021 in the High Plains of the Texas Panhandle and extreme eastern New Mexico.

MODIS Terra



**Notice the one
strong dust plume
that's lighter in
color,
very close to the
TX/NM state line
SE of Portales,
New Mexico.**

MODIS Terra



**PlanetScope shows
the source in much
more detail:
a dry salt lake
(playa) named
Arch Lake.**



**PlanetScope shows
the source in much
more detail:
a dry salt lake
(playa) named
Arch Lake.**



Example:

Dust storm of
March 16, 2021
in the
Chihuahuan
Desert along
the US-Mexico
border.



MODIS Terra

Example:

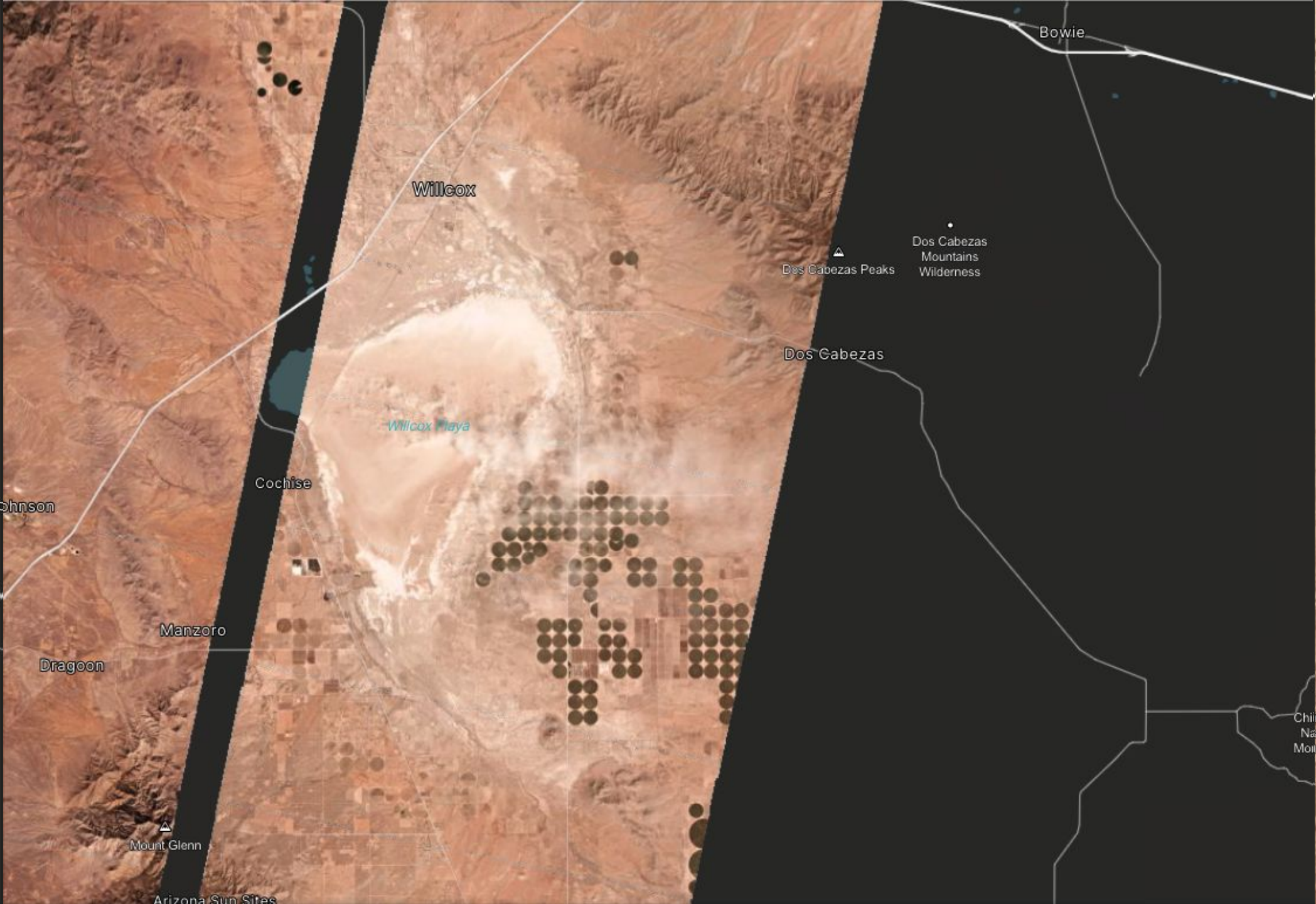
Dust storm of
March 16, 2021
in the
Chihuahuan
Desert along
the US-Mexico
border.



MODIS Terra



17:1
2
17:1
4
17:1
8
17:2
1
17:3
8
17:3
9
17:4
7
18:0
3
18:0
5



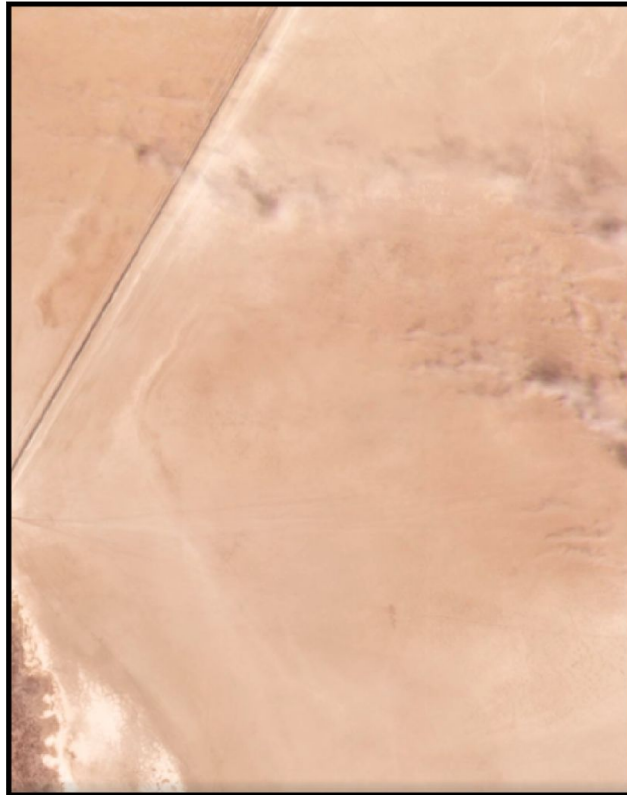
**Willcox
Playa,
March
22,
2021**



Example:

March 22, 2021
Willcox Playa,
Arizona:
Close-up along
railroad trestle

17:14



17:39



17:42



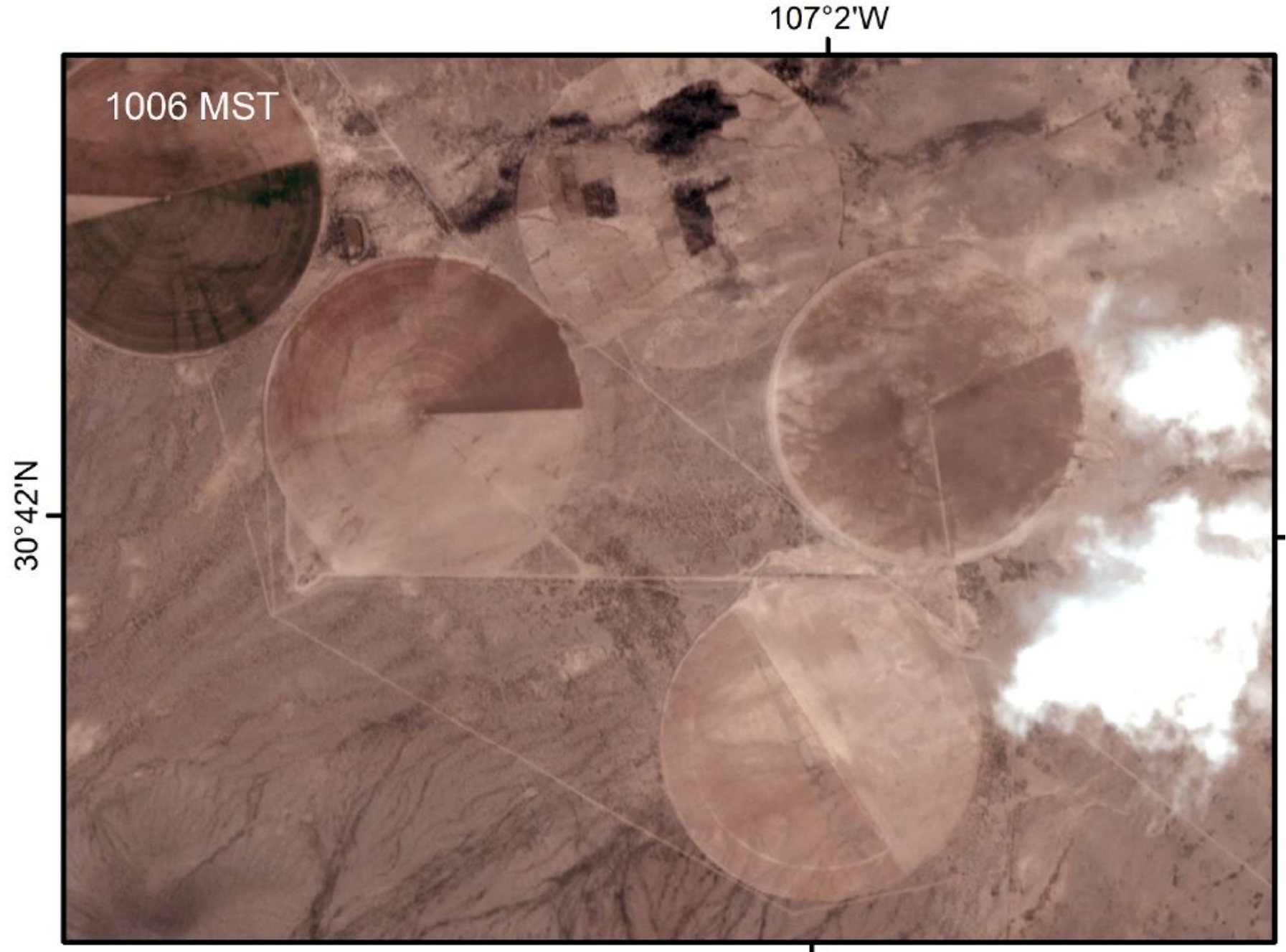
March 22 2021
PlanetScope
Overpass Times



Example:

Dust storm of November 30, 2018 in the Chihuahuan Desert south of Ciudad Juarez

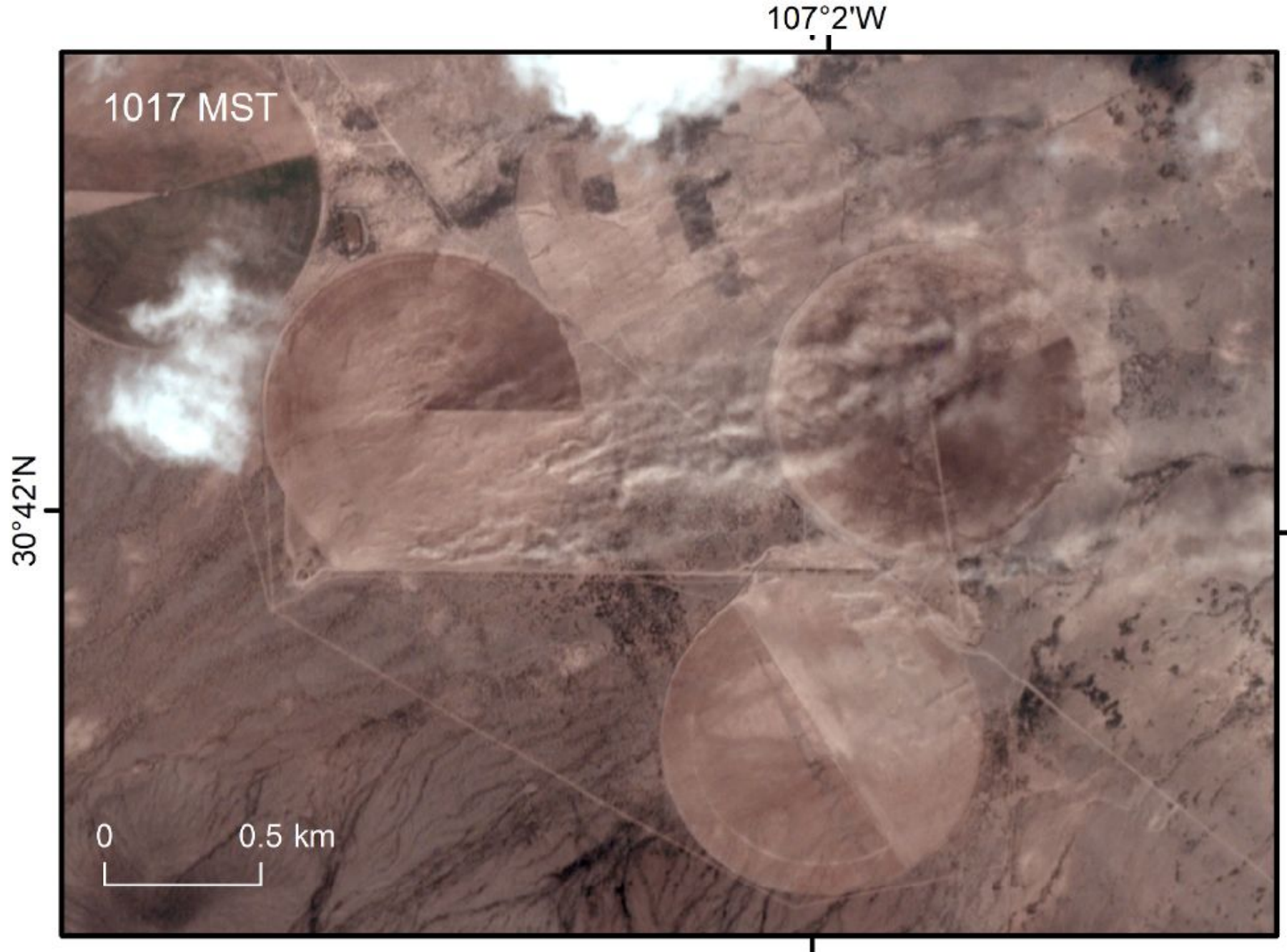
PlanetScope



Example:

Dust storm of November 30, 2018 in the Chihuahuan Desert south of Ciudad Juarez

PlanetScope





GET ACCESS, MAKE DISCOVERIES

We're looking for university researchers, academics, and scientists to unlock the power of a one-of-a-kind dataset. Depending upon your affiliation and country of origin, there are three ways to apply for access:

UNIVERSITY-AFFILIATED STUDENT, FACULTY MEMBER OR RESEARCHER:

Any university-affiliated student, faculty member or researcher may apply to the [Education and Research Program](#) for limited, non-commercial access to Planetscope Imagery and Rapid Eye Archive. A university email address is required, and nonprofit and government

GERMANY-BASED RESEARCHERS:

Any German researcher, including nonprofit researchers and those at government institutions, may apply for access to Planetscope, RapidEye and SkySat imagery through [RESA](#).

ANY OTHER RESEARCHER:

Any researcher, including nonprofit researchers and those at government institutions or non-commercial early adopters, may apply for access to Planetscope, RapidEye and SkySat imagery through the [European Space Agency Category 1 Portal](#).

GET STARTED TODAY

Level up your research and your classroom with flexible program offerings.

	BASIC	DEPARTMENTAL	CAMPUS
Users	Students and faculty	Grantees and research teams	Professors, administrators and your entire campus
Download Quota	5,000 km ² /month	15 Tb / year	100 Tb / year
License	Personal research license	Administrative license	Administrative license
	APPLY NOW	CONTACT SALES	CONTACT SALES

Planet Plugins for

- QGIS [this one works really well and is free]
- [ArcPro](#)

Cloud analysis available via Planet Explorer

Data delivery to Earth Engine:

https://samapriya.github.io/projects/planet_gee_pipeline_gui/

Note: Basic Users can have download access to up to 5,000 square kilometers of data/month

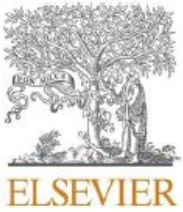
Cite: Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth.

San Francisco, CA. <https://api.planet.com>



Downside of PlanetScope for dust monitoring in our region:

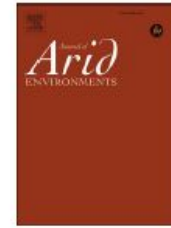
- 2 to 3 “flock” overpasses per day
- Overpasses between approximately 1500- 1900 hours
- Earlier in the day than most dust storms occur in the Southwest.
- Does not have additional sensors/channels and enhancements available with GOES, MODIS, VIIRS



Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

Journal of Arid Environments

journal homepage: www.elsevier.com/locate/jaridenv



Understanding dust sources through remote sensing: Making a case for CubeSats

Matthew C. Baddock^{a,*}, Robert G. Bryant^b, Miguel Domínguez Acosta^c, Thomas E. Gill^d

^a *Geography and Environment, Loughborough University, Loughborough, LE11 3TU, UK*

^b *Geography, University of Sheffield, Sheffield, S10 2TN, UK*

^c *Ingeniería Civil y Ambiental, Universidad Autónoma de Ciudad Juárez, 450 N. Avenida del Charro, Ciudad Juárez, Chihuahua, 32315, Mexico*

^d *Geological Sciences, University of Texas at El Paso, 500 W. University Avenue, El Paso, TX, 79968, USA*

ARTICLE INFO

Keywords:

Mineral aerosol
PlanetScope
MODIS
Chihuahuan desert
Dust emission
Playa

ABSTRACT

Dust sources have been revealed through remote sensing, first regionally by $\sim 1^\circ$ resolution sensors (TOMS), then at sub-basin scale by moderate-resolution sensors (MODIS). Sensors with higher spatial resolution until recently were poorly temporally-resolved, precluding their use for systematic investigations of sources. Now, “CubeSat” constellations with high-temporal-and-spatial-resolution sensors such as PlanetScope offer ~ 3 m resolution and daily (to sub-daily) temporal resolution. We illustrate the spatio-temporal dust plume observation capabilities of CubeSat data through a dust event case study, Bolson de los Muertos playa, Chihuahuan Desert, Mexico. For the event, PlanetScope showed numerous discrete point sources, revealing variability of surface erodibility and emission over $\sim 8\%$ of a focus area at time of capture. The unprecedented detail of PlanetScope imagery revealed plume development where outer-playa sands and fluvial-deltaic inputs contact lacustrine silts/clays, consistent with field-studies. PlanetScope’s high fidelity improves spatial quantification and temporal constraint of source activity, and we assess the spatio-temporal capabilities of CubeSat in context with other dust observation remote sensing systems. Compared to previous satellite technologies, CubeSats bring better potential to link remote sensing to field observations of emission. This leap forward in the remote sensing of dust sources calls for the systematic analysis of CubeSat imagery in source areas.

For questions or a copy of the scientific paper, email us at:

tegill@utep.edu

r.g.bryant@sheffield.ac.uk

Acknowledgements to:
NASA 80NSSC19K0195

NOAA Educational
Partnership Program

Agreement No.

NA16SEC4810006