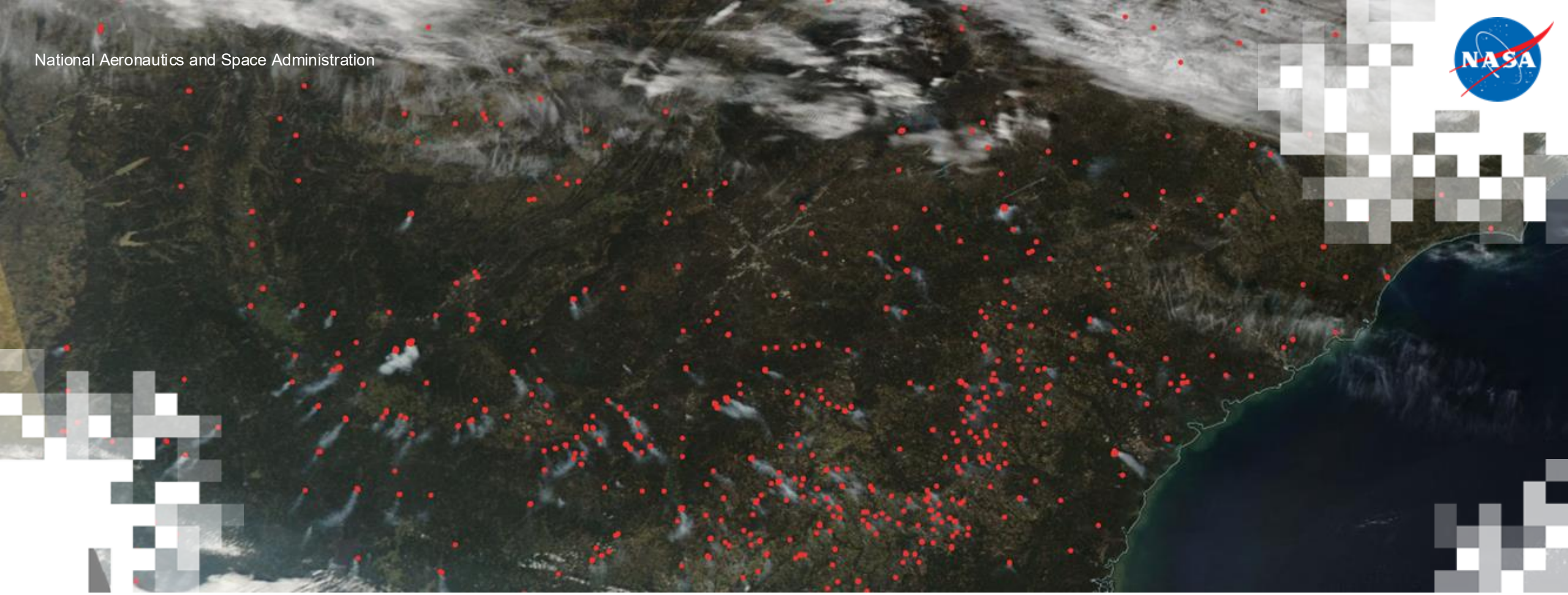
National Aeronautics and Space Administration



NASA Satellite Observations and Tools for Fire and Smoke Monitoring

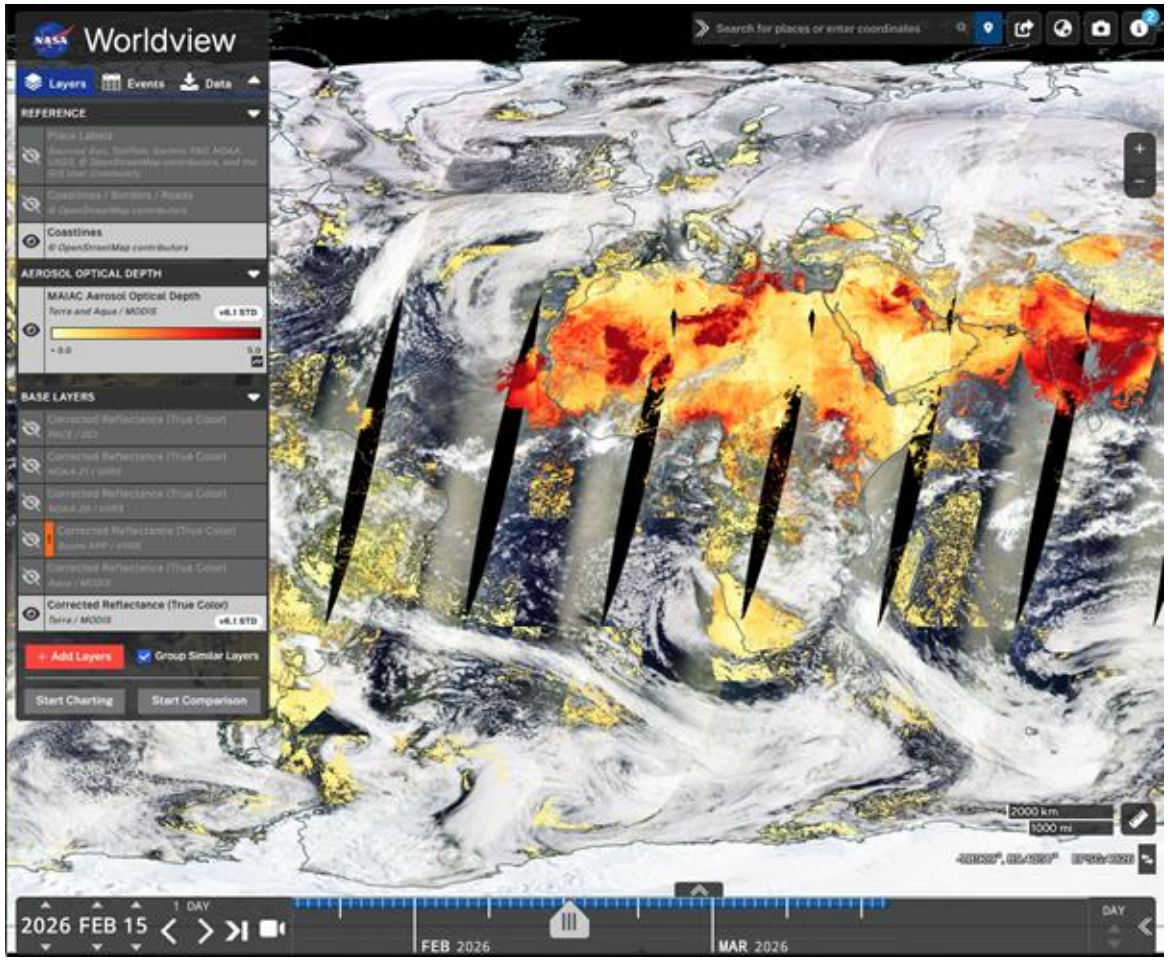
Using NASA Worldview

Caterina Mogno (UMBC & NASA GSFC)

March 23, 2026

NASA Worldview

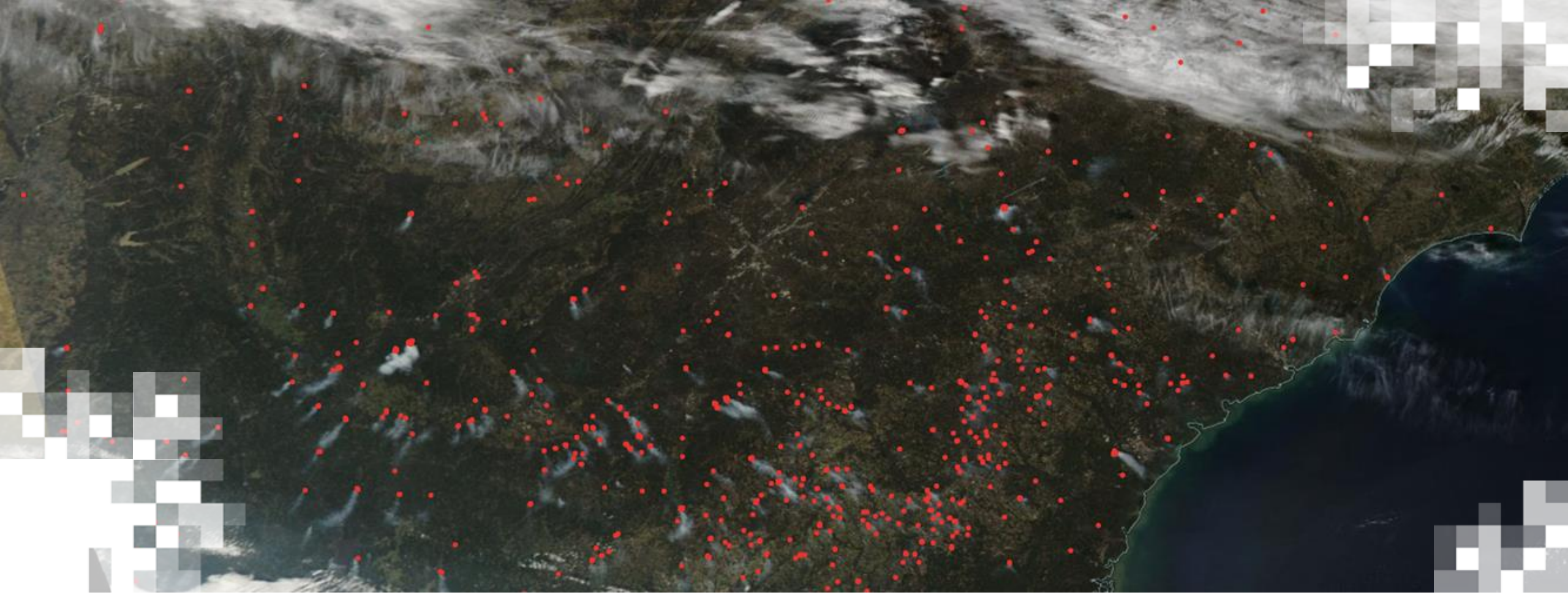
https://worldview.earthdata.nasa.gov/



NASA Worldview: an interactive interface for browsing full-resolution, global, daily satellite imagery

- **Over 1,200 global imagery layers, updated within hours.** Full-resolution satellite imagery covering the entire Earth, from 2000 to present.
- **Imagery available within 3–4 hours of satellite observation.** Supporting wildfire, air quality and flood management
- **Explore, animate, compare, and share.** All in your browser — no software needed.

Resources: https://www.earthdata.nasa.gov/data/tools/worldview



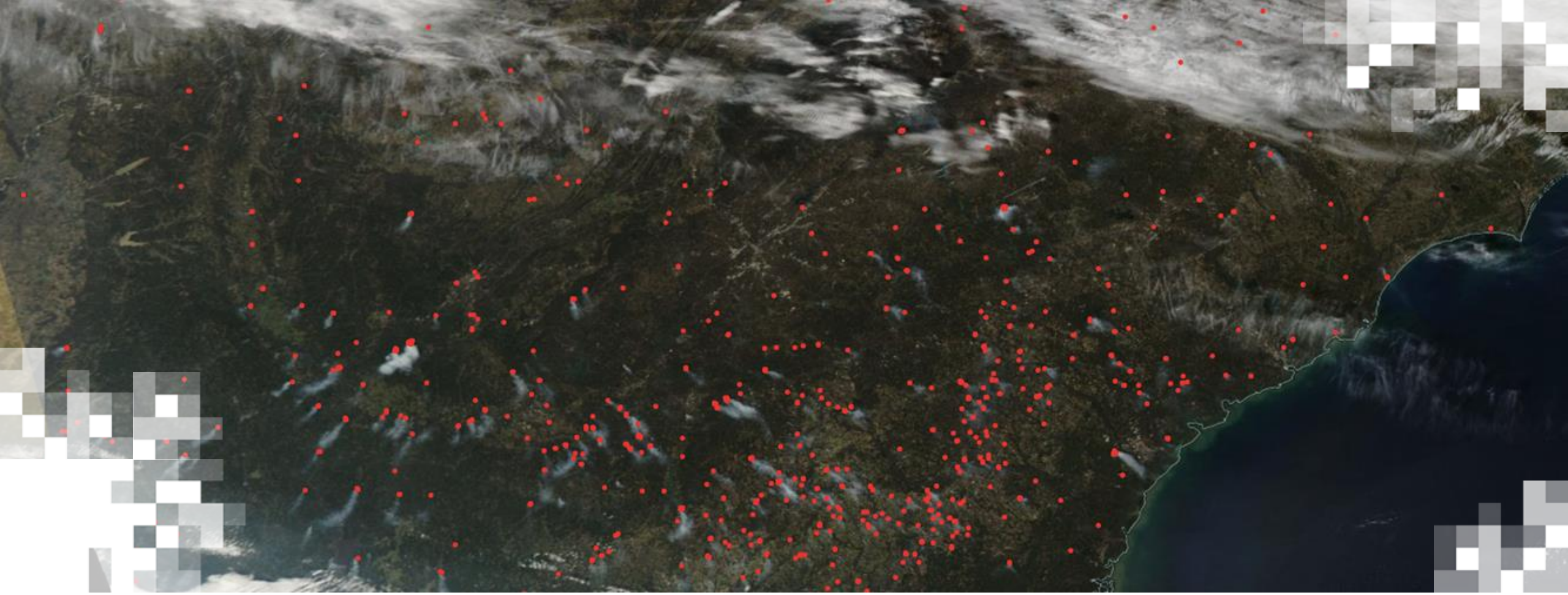
Intro to Worldview Demo in Worldview

Case Study: Ranger Road Fires, Oklahoma

February 17–24, 2026

Source: CNN

- The Ranger Road Fire was first reported at approximately 11:40 a.m. CST on Feb. 17, 2026, Southeast of Beaver, Oklahoma.
  The cause remains unknown.
- Dangerous fire weather (dry air, sustained winds up to 20 mph, dry vegetation) spread the fire quickly and caused also a dust storm.
- The wildfire smoke combined with strong winds caused extremely low visibility.
- The fire has been fully contained by Feb. 24. The total area burned is ~283,283 acres (~1,146 km^2)



Range Road Fires Demo in Worldview

Demo Overview

Step	Topic
1	True Color — Setting the scene
2	Fire Detections + FRP
3	False Color — Burned area
4	AOD: aerosol in the plume DT/DB vs MAIAC
5	TEMPO Hourly smoke tracking: UVAI
6	TEMPO Hourly smoke tracking: Trace Gases
7	Summary

Satellite Overpass Times for OK

Satellite	Approx. Local Time Feb 2026 (CST, UTC−6)
Terra	~09:45–10:15 AM
Aqua	~3:00–3:30 PM
NOAA-21	~1:00–1:30 PM
S-NPP	~25 min after NOAA-20
NOAA-20	~25 min after S-NPP
TEMPO	~9AM–6PM CST

Products Used in this Case Study

Product	Layer Name in Worldview
True Color (default layers)	Corrected Reflectance (True Color) Terra/MODIS, Aqua/MODIS, NOAA-20/VIIRS, NOAA-21/VIIRS, Suomi NPP/VIIRS, PACE/OCI
False Color	NOAA-20/VIIRS Corrected Reflectance (Bands M11-I2-I1)
Fire Detections	NOAA-20/VIIRS Fires and Thermal Anomalies (Day, 375m)
AOD	MODIS Aqua Merged DT/DB Aerosol Optical Depth (Land and Ocean)
AOD	MODIS Terra/Aqua MAIAC Aerosol Optical Depth
TEMPO UVAI (L2)	TEMPO Ozone (L2, UV Aerosol Index, Subdaily)
TEMPO UVAI (L3)	TEMPO Ozone (L3, UV Aerosol Index, Subdaily)
TEMPO NO_2 (L2)	TEMPO Nitrogen Dioxide (L2, Vertical Column Troposphere, Subdaily)
TEMPO NO_2 (L3)	TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily)
TEMPO HCHO (L3)	TEMPO Formaldehyde (L3, Vertical Column, Subdaily)
TEMPO O_3 (L3)	TEMPO Ozone (L3, Column Amount O3, Subdaily)
TEMPO Cloud Fraction (L3)	TEMPO Clouds (L3, Cloud Fraction Total, Subdaily)

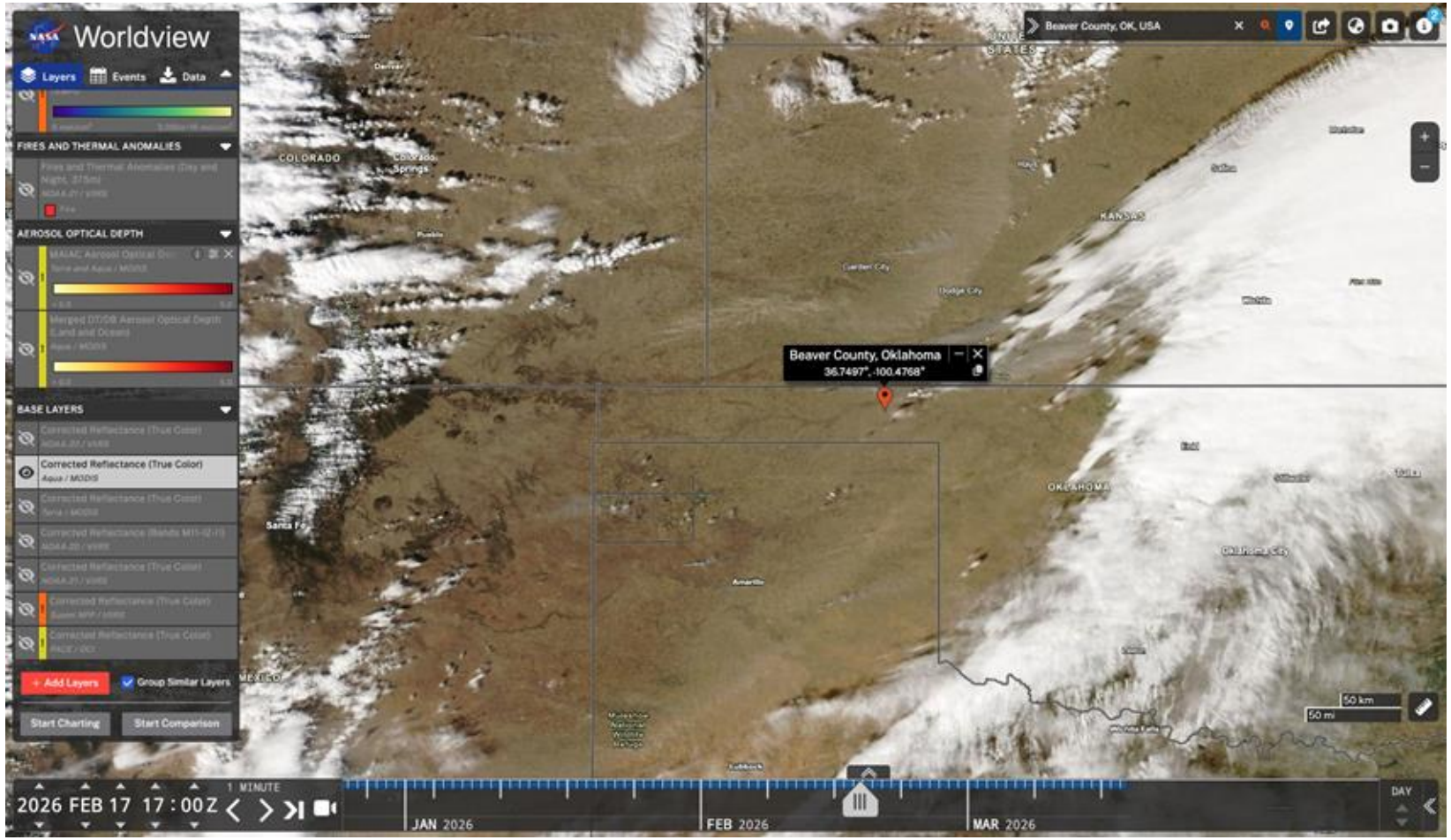
Step 1 – True Color: Setting the Scene

Actions

- Search / locate Beaver, Oklahoma using the Worldview search bar.
- Select Feb. 17 17 Z (11am CST) 2026 in the time bar lower left.
- Turn on Reference Labels and Coastlines/Borders layers.
- Toggle MODIS Aqua → MODIS Terra → VIIRS NOAA-20 → VIIRS NOAA-21 → VIIRS Suomi NPP to compare overpasses.
- Click ‘View Options’ on MODIS Aqua, and check the box for ‘Associated Layer’ ‘Orbit Track’,
- To show overpass time for MODIS Aqua on the day. Repeat for MODIS Terra, VIIRS NOAA-21, VIIRS NOAA-20 and VIIRS Suomi NPP.

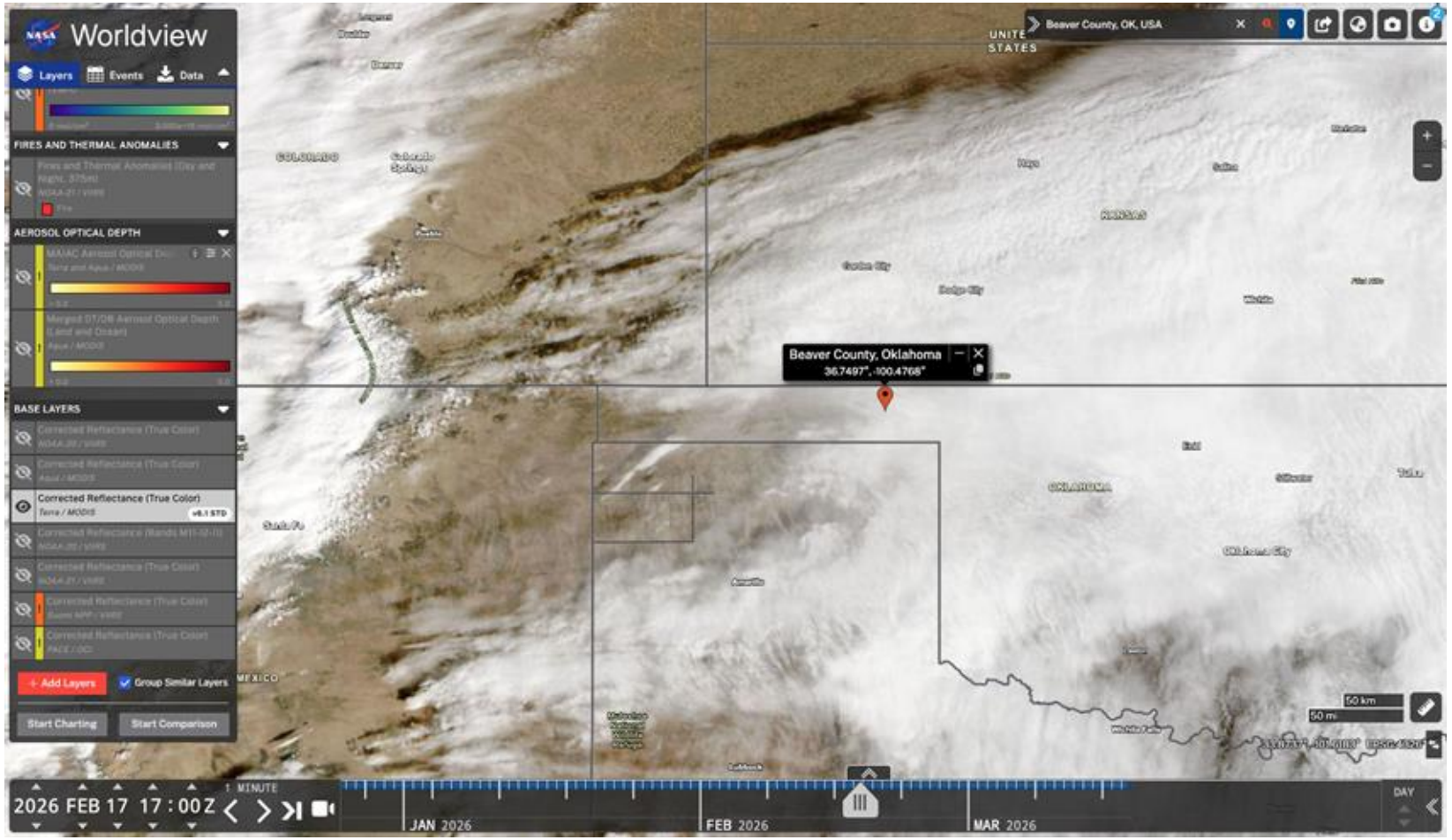
Note: MODIS Aqua ha the clearest scene and the fire plumes are clearly visible.

Step 1 – True Color: Setting the Scene



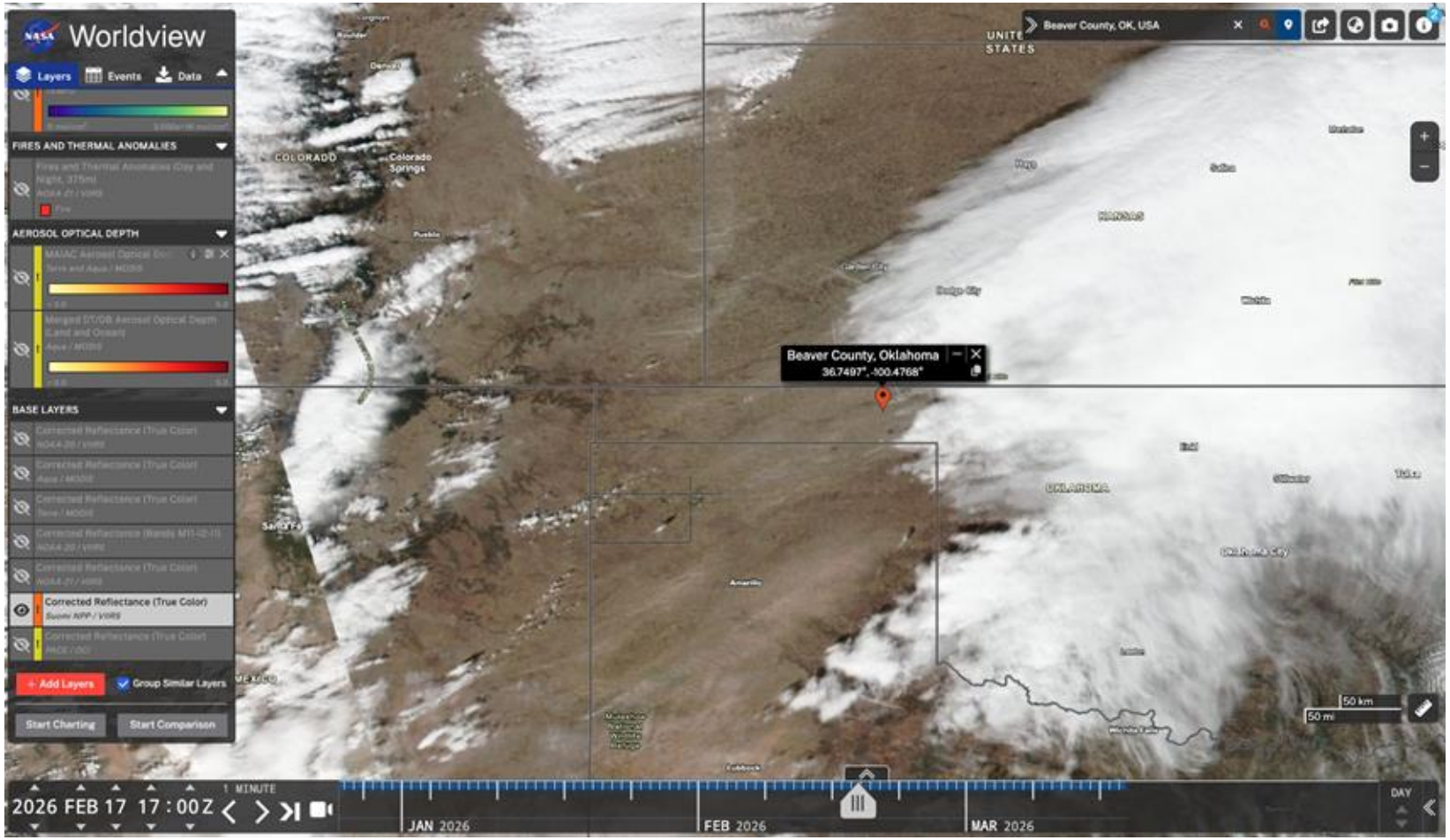
Product: MODIS/Aqua True Color

Step 1 – True Color: Setting the Scene



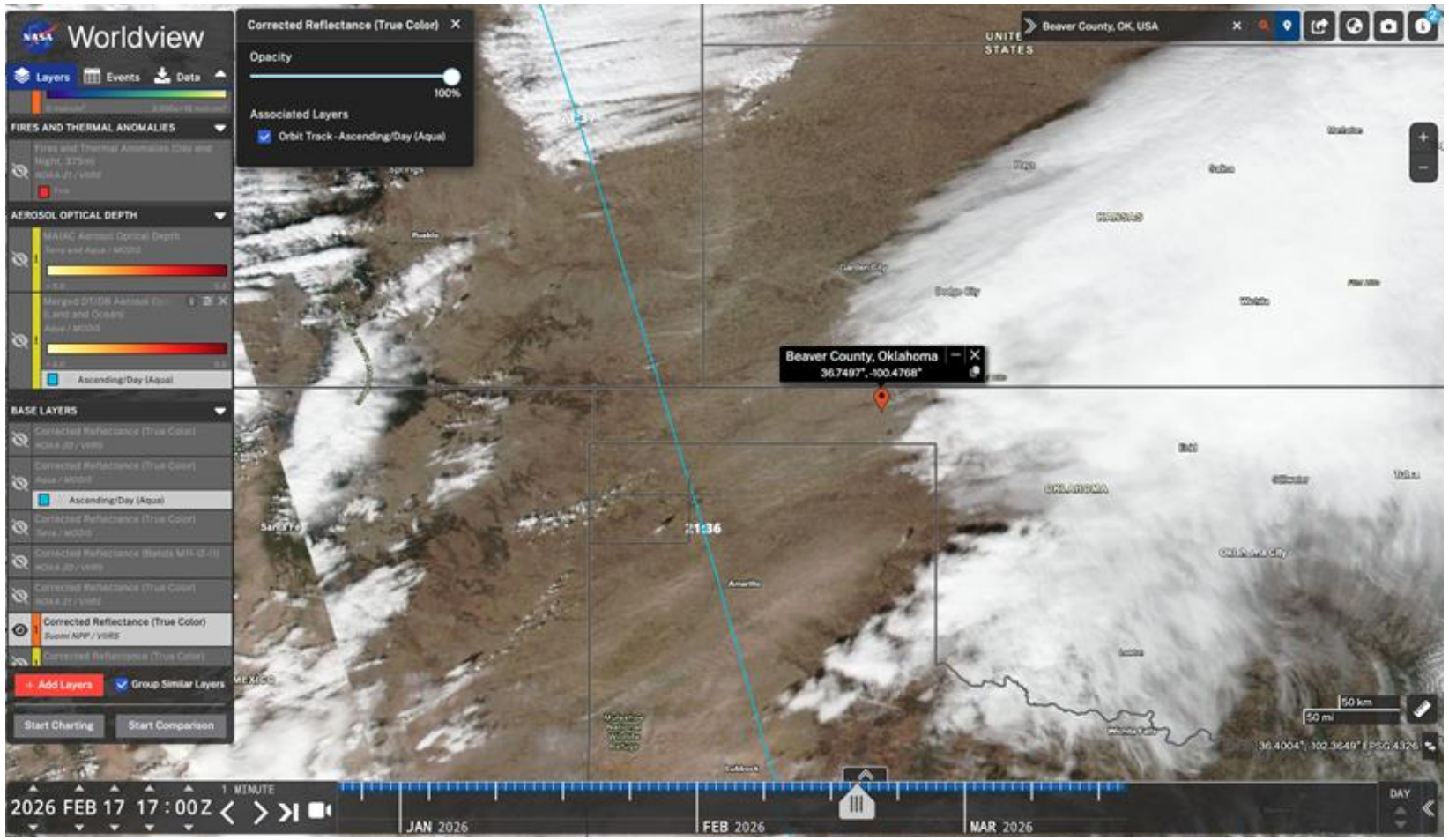
Product: MODIS/Terra True Color

Step 1 – True Color: Setting the Scene



Product: VIIRS/Suomi-NPP True Color

Step 1 – True Color: Setting the Scene



Product: Aqua/MODIS True Color – Orbit Overpass (~21.36 UTC, 15.36 CST)

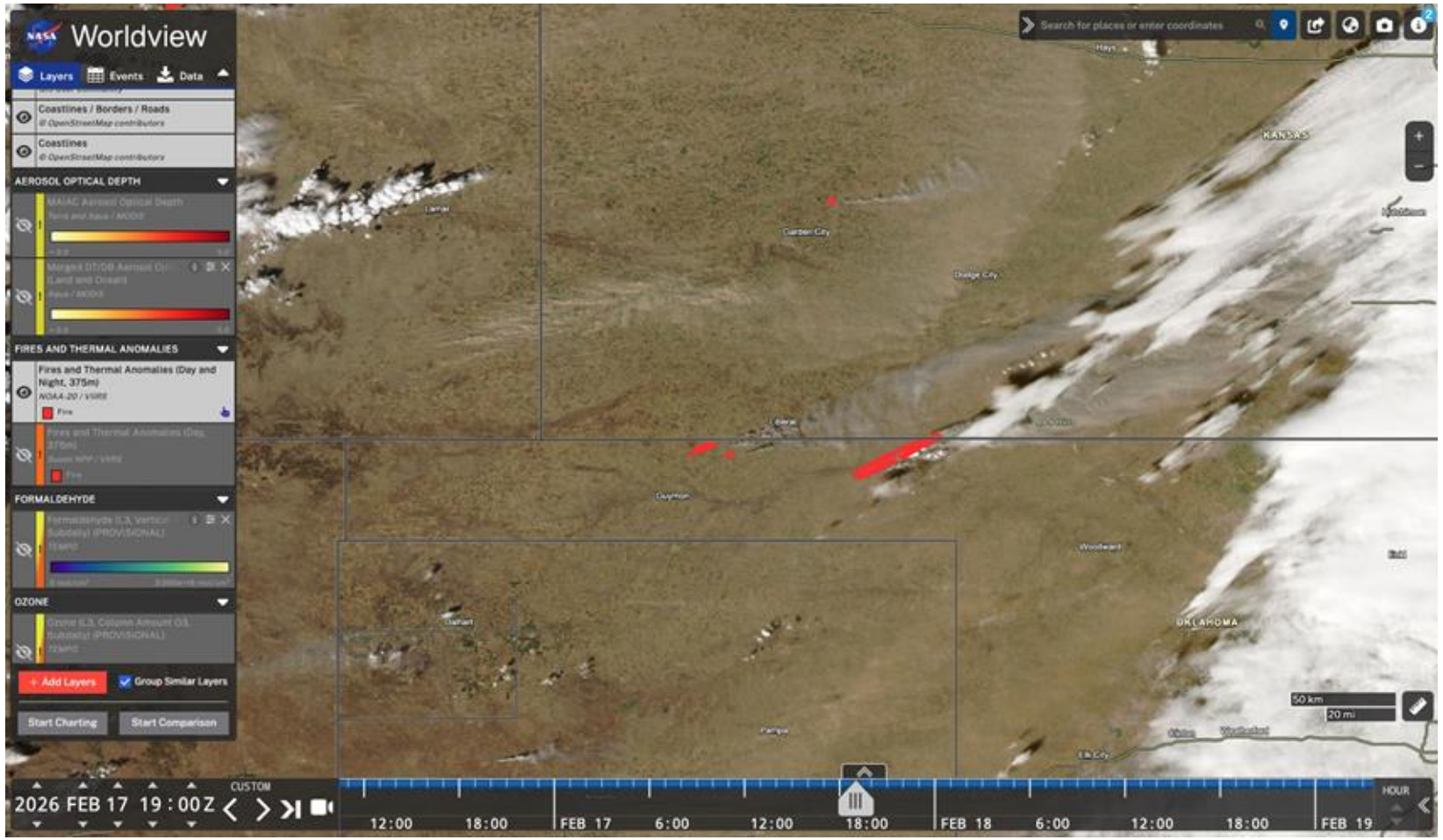
Step 2 — Fire Detections (FRP)

Actions

- Keep MODIS Aqua true color as base layer.
- Toggle on VIIRS NOAA-20 Fires and Thermal Anomalies (Day and Night, 375m) to see active fires. Highlight fire detection clusters, at the start of the smoke plume.

Note: There is one oblong-shaped thermal anomaly detection along the plume. It may be that the thermal anomaly picks the plume (which is very hot as well), not the ground in this case. Usually fires thermal anomalies at ground are more spread out, following the shape of the evolving fire. However, in fast wind-driven fire spread the shape could be more oblong-shaped as well.

Step 2 — Fire Detections (FRP)



Product: VIIRS/NOAA-20 Fires and Thermal Anomalies

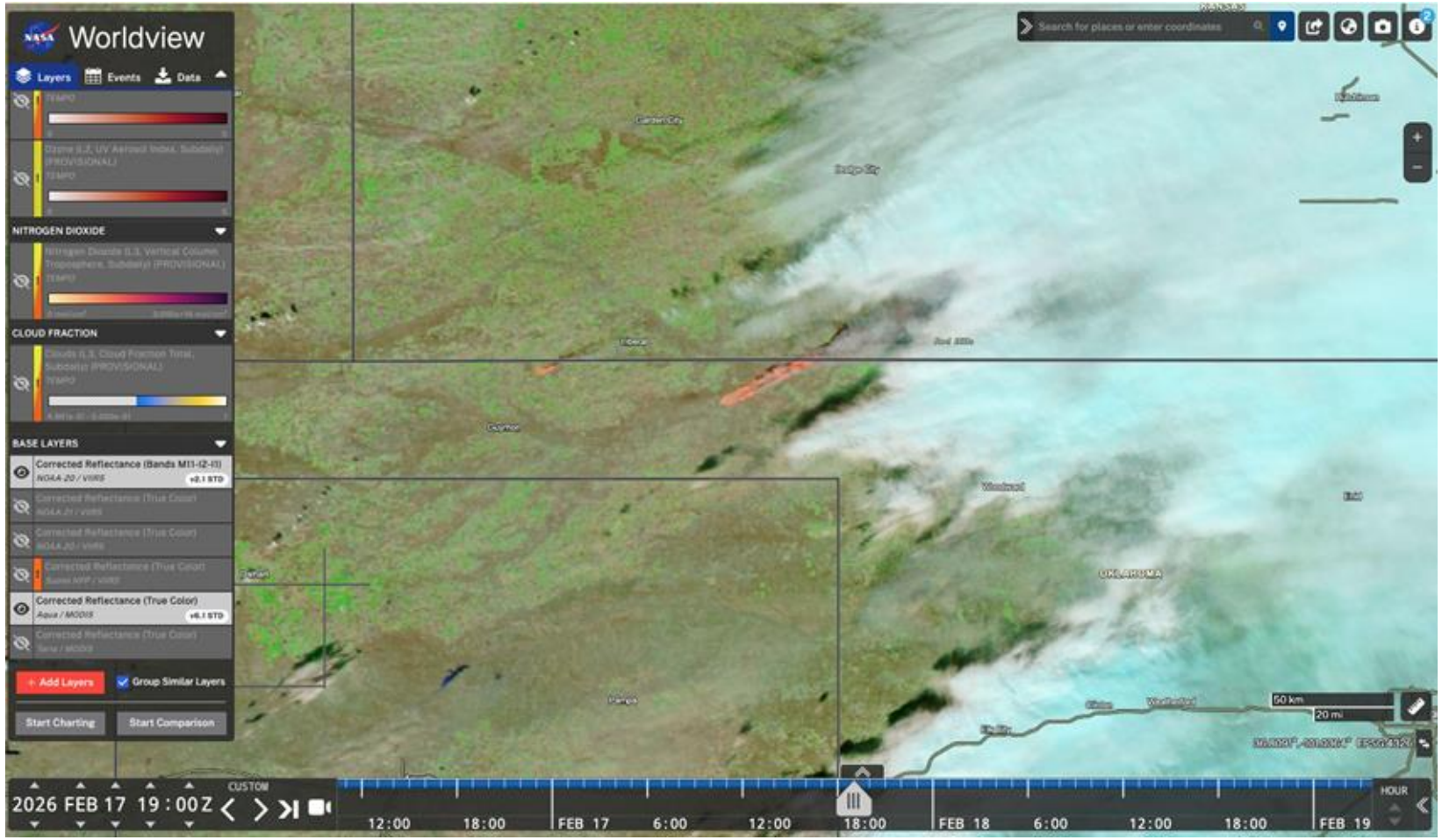
Step 3 — False Color: Burned Area

Actions

- Toggle off VIIRS NOAA-20 Fires and Thermal Anomalies layer.
- Toggle on the VIIRS NOAA-20 False Color (Bands M11-I2-I1) layer. If not already, reorder it above MODIS Aqua true color layer in the 'Base Layers' section on the left.
- Rapidly toggle between true color and false color on Feb. 17.
- Step through Feb. 17–24 false color layer showing burned area development and stabilization after Feb. 18.
- Use the Comparison Tool (slide) to show the comparison burned area (slide) before and after the fires. Compare Feb. 16 to Feb. 24.

Note: Burned area for the lower right fire on Feb. 17 looks unusual (very reddish contour). It may indicate a possible retrieval artifact under dense plume, like for the thermal anomalies layer.

Step 3 — False Color: Burned Area



Product: VIIRS/NOAA-20 False Color

Step 3 — False Color: Burned Area

Product: VIIRS/NOAA-20 False Color

Step 3 — False Color: Burned Area

Product: VIIRS/NOAA-20 False Color

Step 4 — AOD: aerosols in the plume

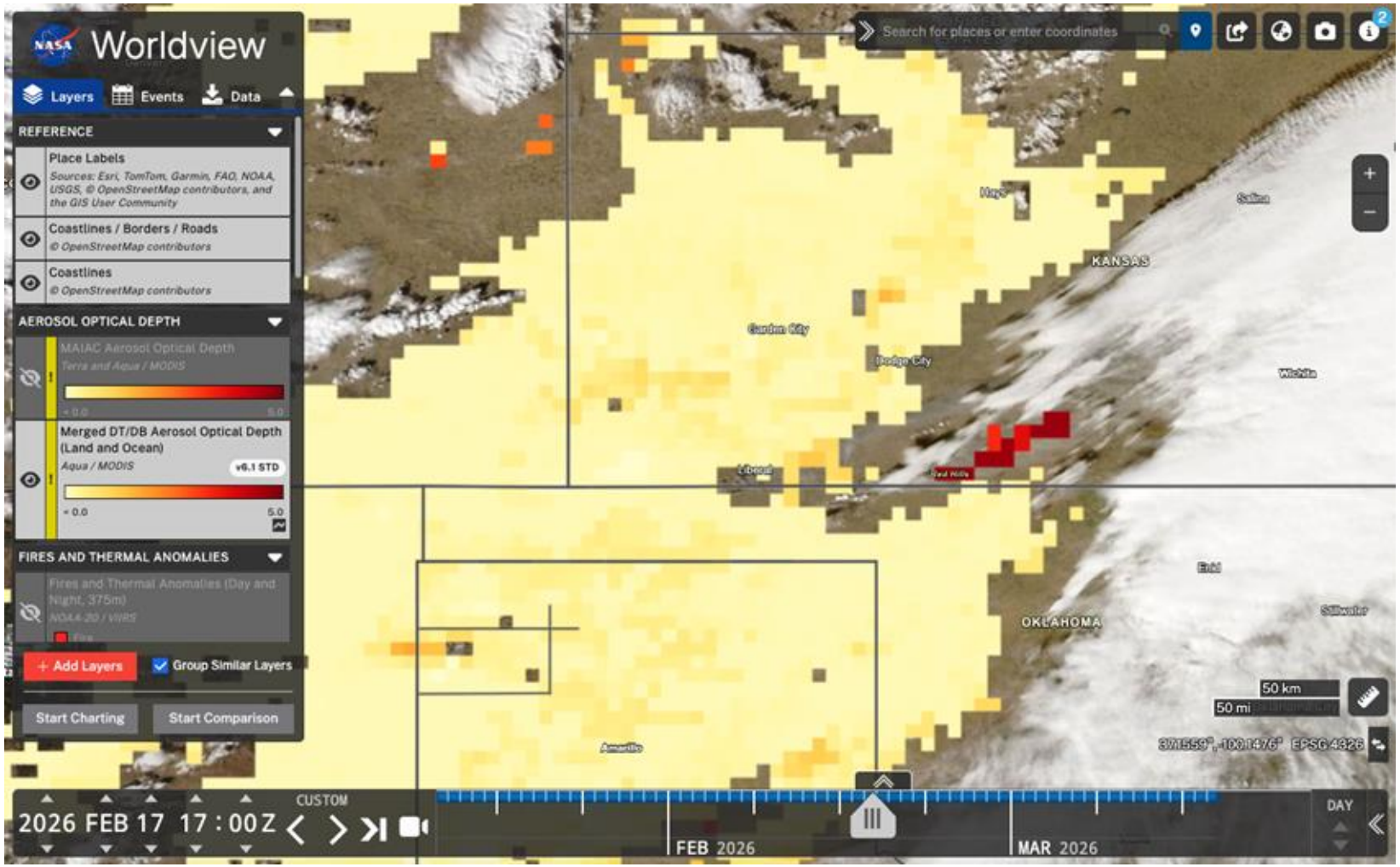
Actions

- Keep MODIS Aqua true color as base layer, Feb. 17.
- Toggle on MODIS/ Aqua Merged DT/DB Aerosol Optical Depth Toggle to MAIAC AOD — same date — for direct comparison.

Note:

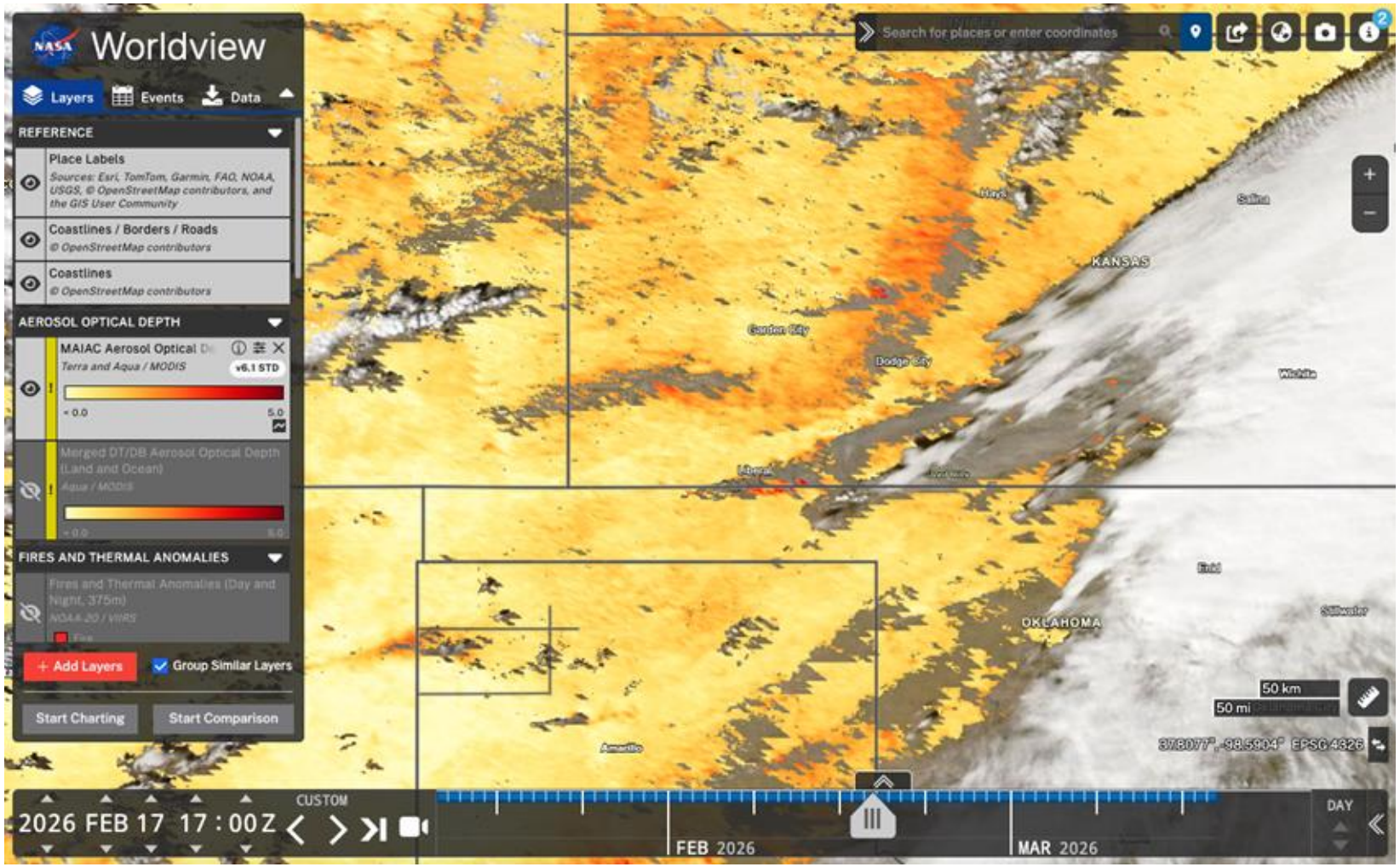
- We pick Aqua AOD layer because we know it has the clearer scene for today compared to the other satellites (AOD cannot be retrieved in cloudy conditions).
- A dust storm driven by high winds is detected by MAIAC AOD north of the fire plumes.
- Gaps in both products occur where thick smoke is misclassified as cloud and retrievals are withheld. MAIAC recovers slightly more coverage than DT/DB at plume edges, and DT/DB retrieve few pixels of high AOD at the center of one plume.

Step 4 — AOD: aerosols in the plume (DT/DB)



Product: MODIS/ Aqua Merged DT/DB Aerosol Optical Depth (Land and Ocean)

Step 4 — AOD: aerosols in the plume (MAIAC)



Product: MODIS Terra & Aqua_MAIAC Aerosol Optical Depth

Step 5 — TEMPO: Hourly Smoke Tracking (UVAI)

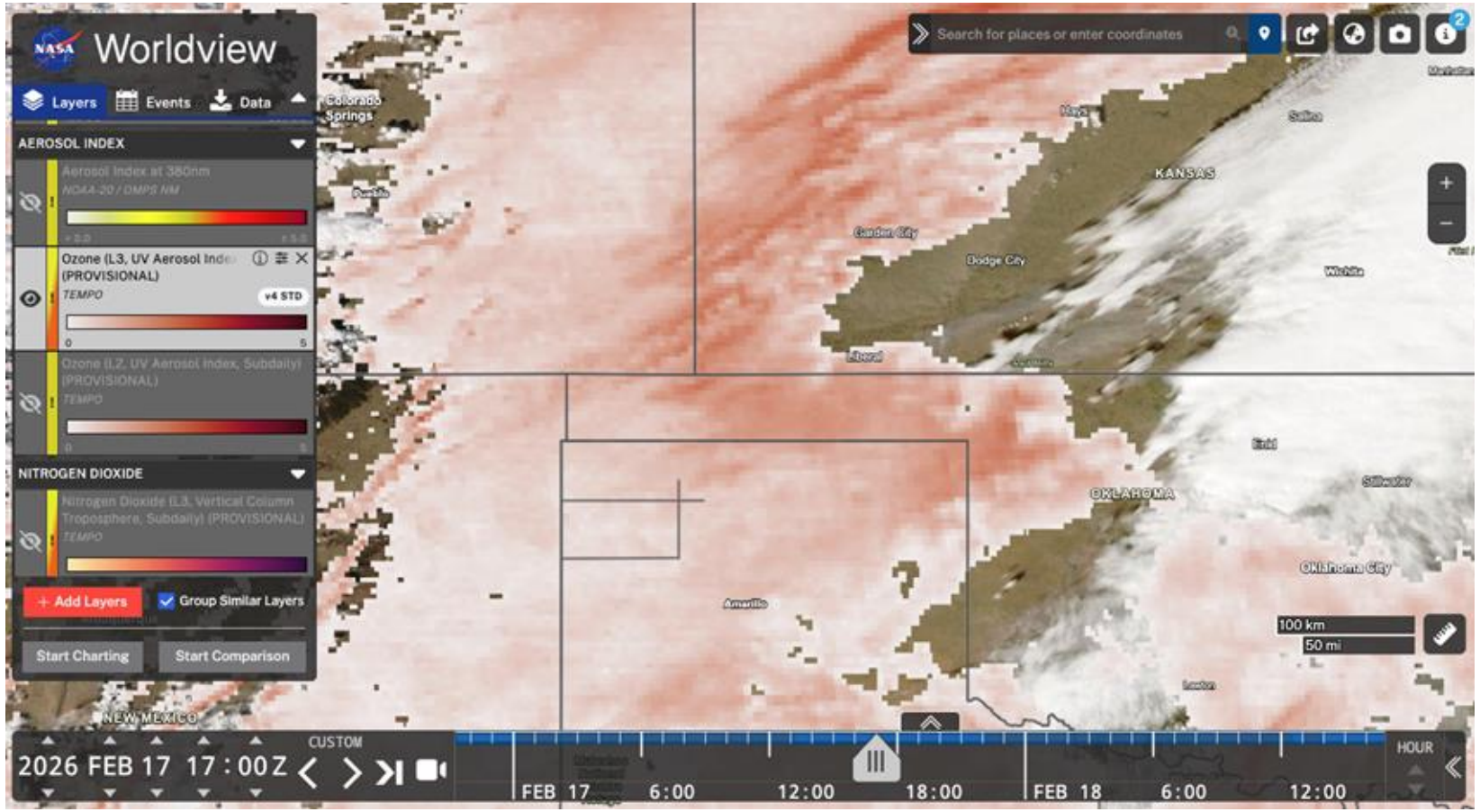
Actions

- Keep MODIS Aqua true color as base layer, Feb. 17.
- Toggle on TEMPO L3 Ozone-UV Aerosol Index layer.
- Start at 17Z (11am CST); step forward hourly to ~23Z (5pm CST) visualizing the plume evolution.
- With the animation tool, create an animation of the UVAI from Feb. 17 13Z to Feb. 17 23Z; 2 frames per second; loop through it.

Note:

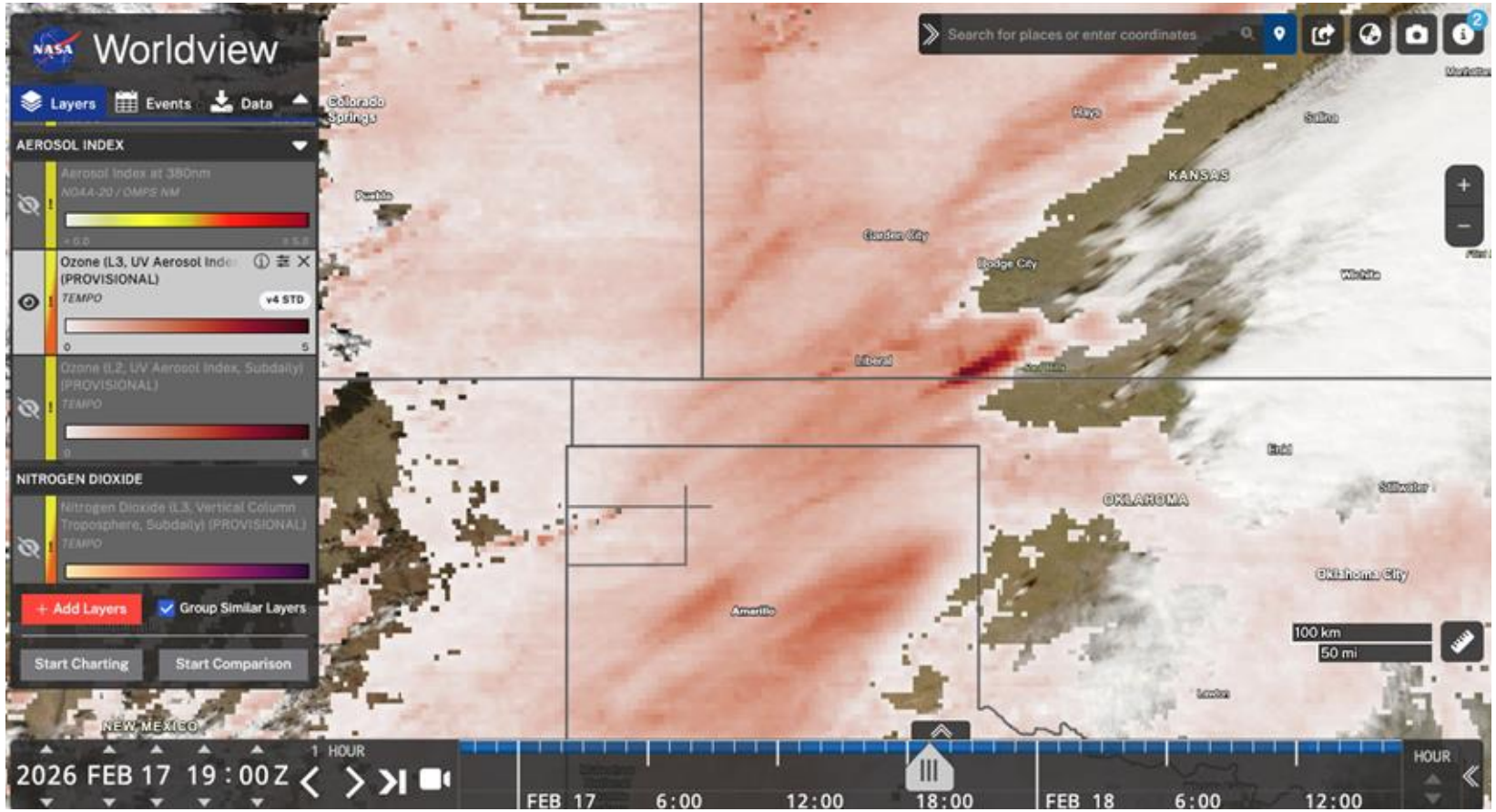
There is an UVAI gap in the dense plume center at 21Z. This has being mistakenly taken out during the process from L2 to L3 data. Usually UVAI is well retrieved in cloud and even in dense smoke. If you look at L2 UVAI data for the same scene, the UVAI is retrieved throughout the plume, with no gaps.

Step 5 — TEMPO: Hourly Smoke Tracking (UVAI)



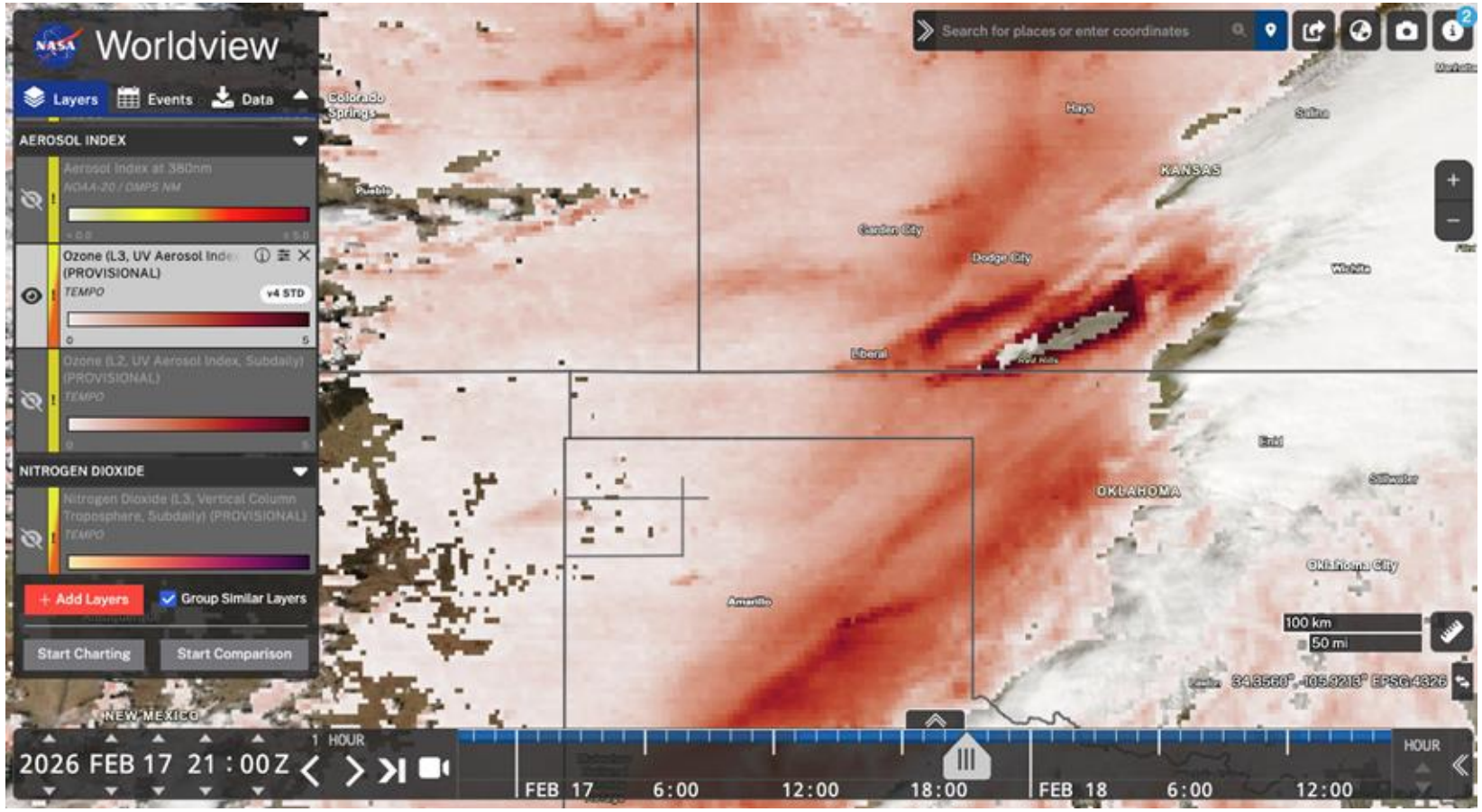
Product: TEMPO Ozone (L3, UV Aerosol Index, Subdaily) – 17Z (11am CST)

Step 5 — TEMPO: Hourly Smoke Tracking (UVAI)



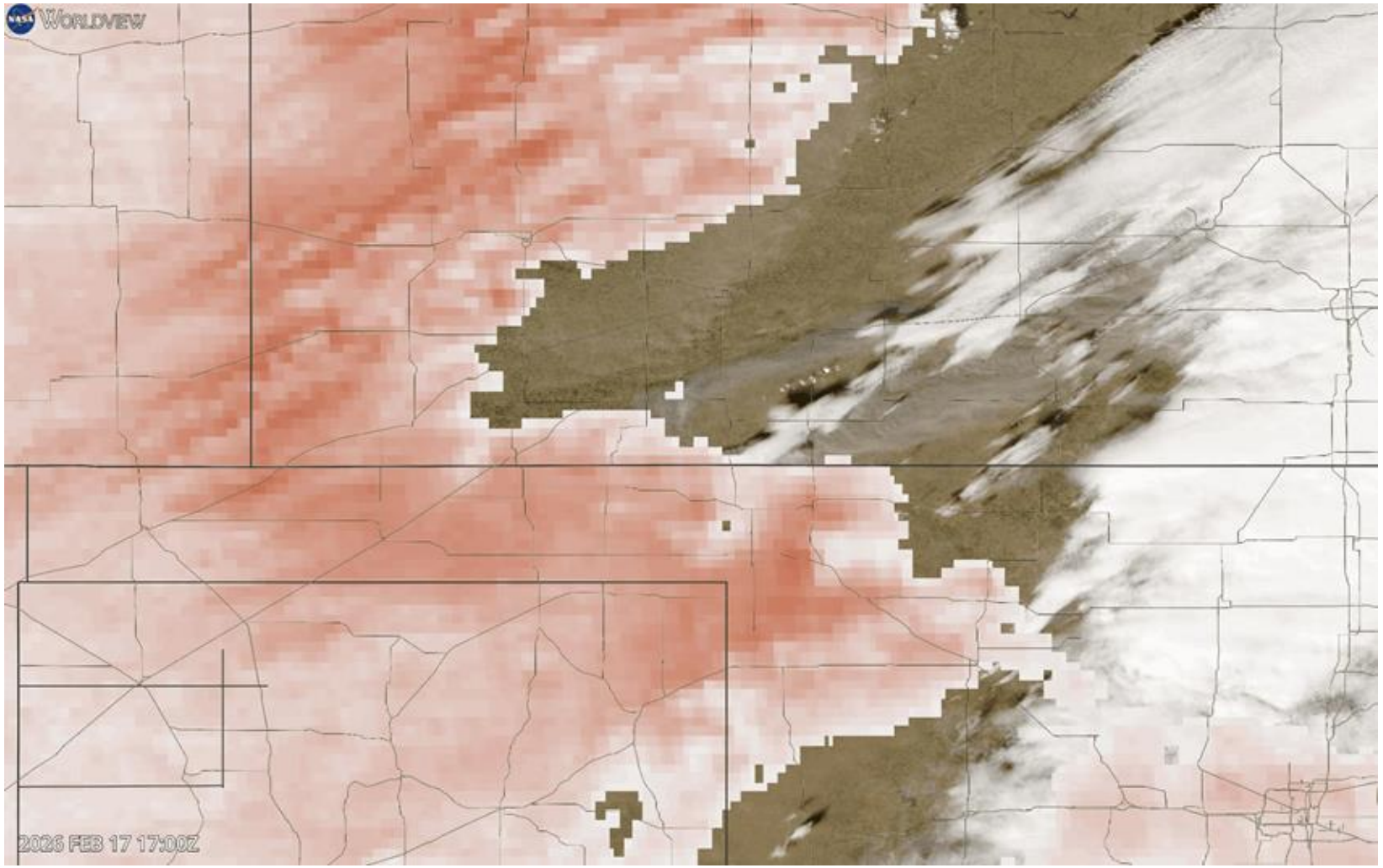
Product: TEMPO Ozone (L3, UV Aerosol Index, Subdaily) - 19Z (1pm CST)

Step 5 — TEMPO: Hourly Smoke Tracking (UVAI)



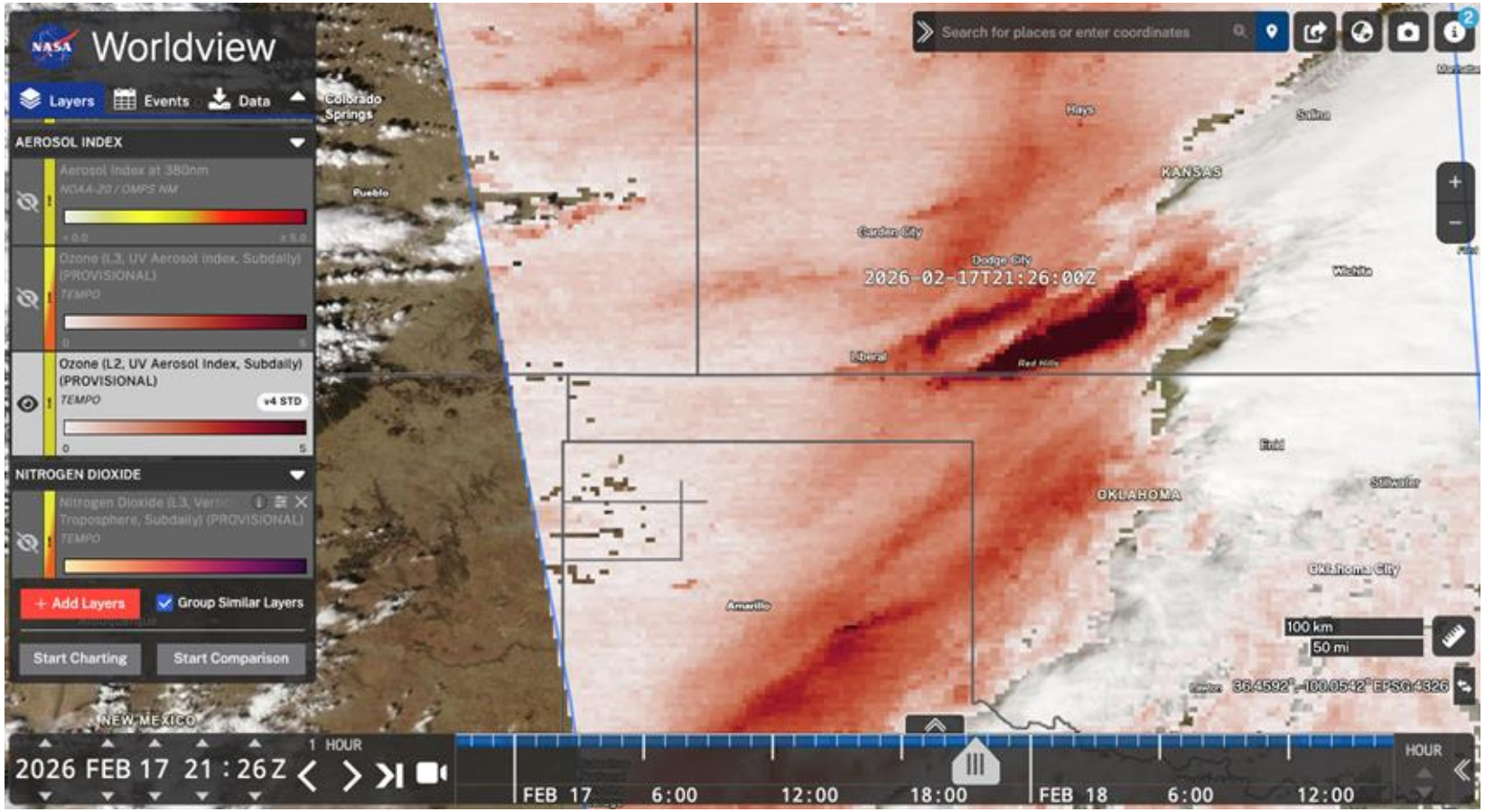
Product: TEMPO Ozone (L3, UV Aerosol Index, Subdaily)- 21Z (3pm CST)

Step 5 — TEMPO: Hourly Smoke Tracking (UVAI)



Product: TEMPO Ozone (L3, UV Aerosol Index, Subdaily) – hourly animation

Step 5 — TEMPO: Hourly Smoke Tracking (UVAI)



Product: TEMPO Ozone (L2, UV Aerosol Index, Subdaily)

Step 6 — TEMPO: Hourly Smoke Tracking (Trace Gases)

Actions

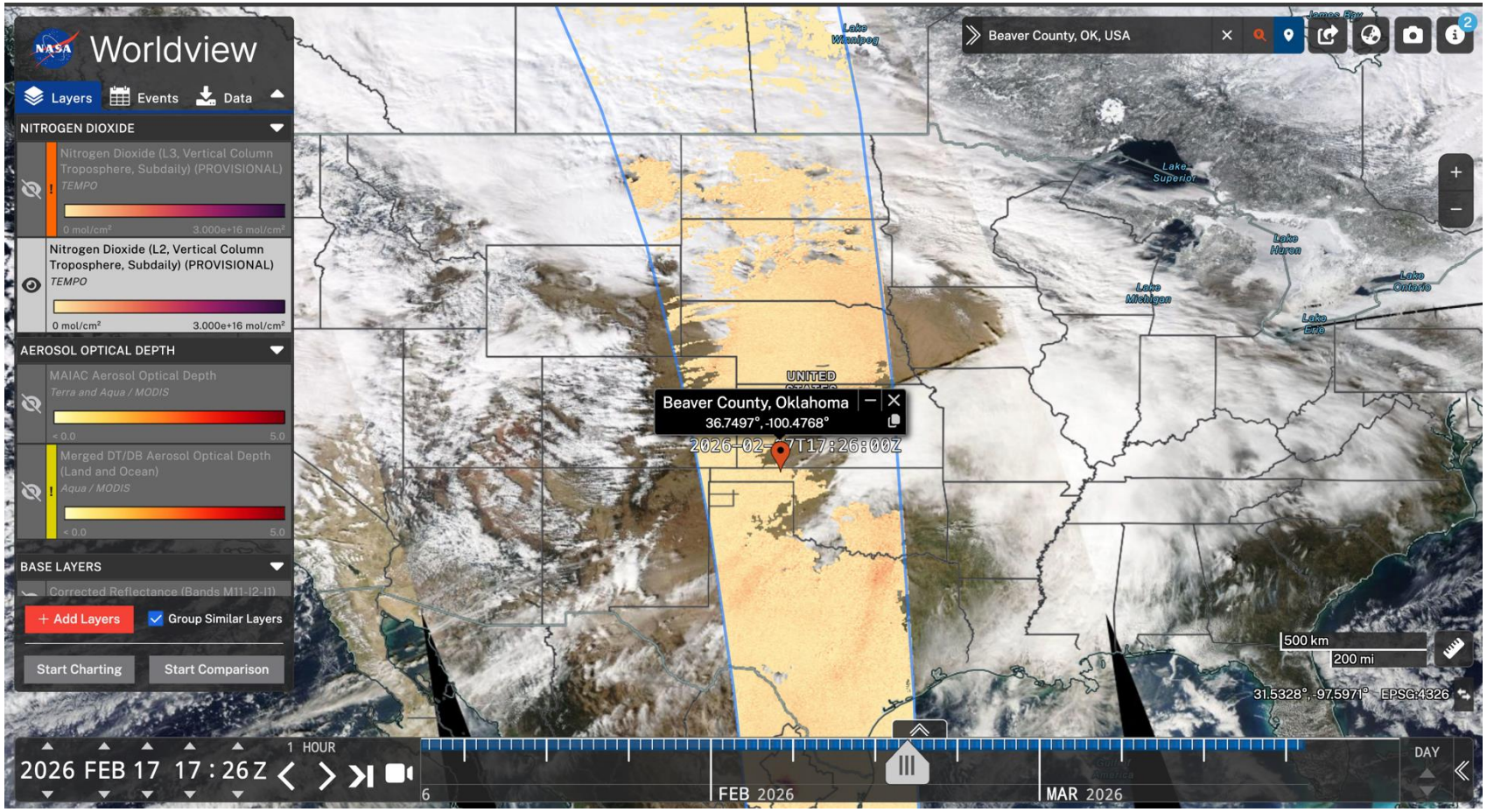
- Keep MODIS Aqua true color as base layer, Feb. 17, 17Z (11am CST)
- Toggle on TEMPO L2 NO_2 layer; set granule count to 1 in settings; show overpass timestamp; zoom out to full US and step through 10-minute intervals to demonstrate hourly granule coverage; zoom back to Beaver County, OK
- Toggle TEMPO NO_2 L3 Troposphere on; step forward at 1h increments to 21Z to show NO_2 plume evolution over time.
- Add TEMPO Cloud Fraction layer; drag it below all TEMPO trace gas layers; In View Options for Cloud Fraction, set lower threshold to 50%
- Toggle NO_2 and Cloud Fraction on/off together.
- Switch to TEMPO HCHO L3; repeat time progression as for NO_2.
- Switch to TEMPO O_3 L3 on; go into View Options; squash values palette to ~250–300 DU to better see differences in values.
- Return to NO_2 L3; navigate to a timestep with clear retrieval gaps in the plume.

Step 6 — TEMPO: Hourly Smoke Tracking (Trace Gases)

Notes

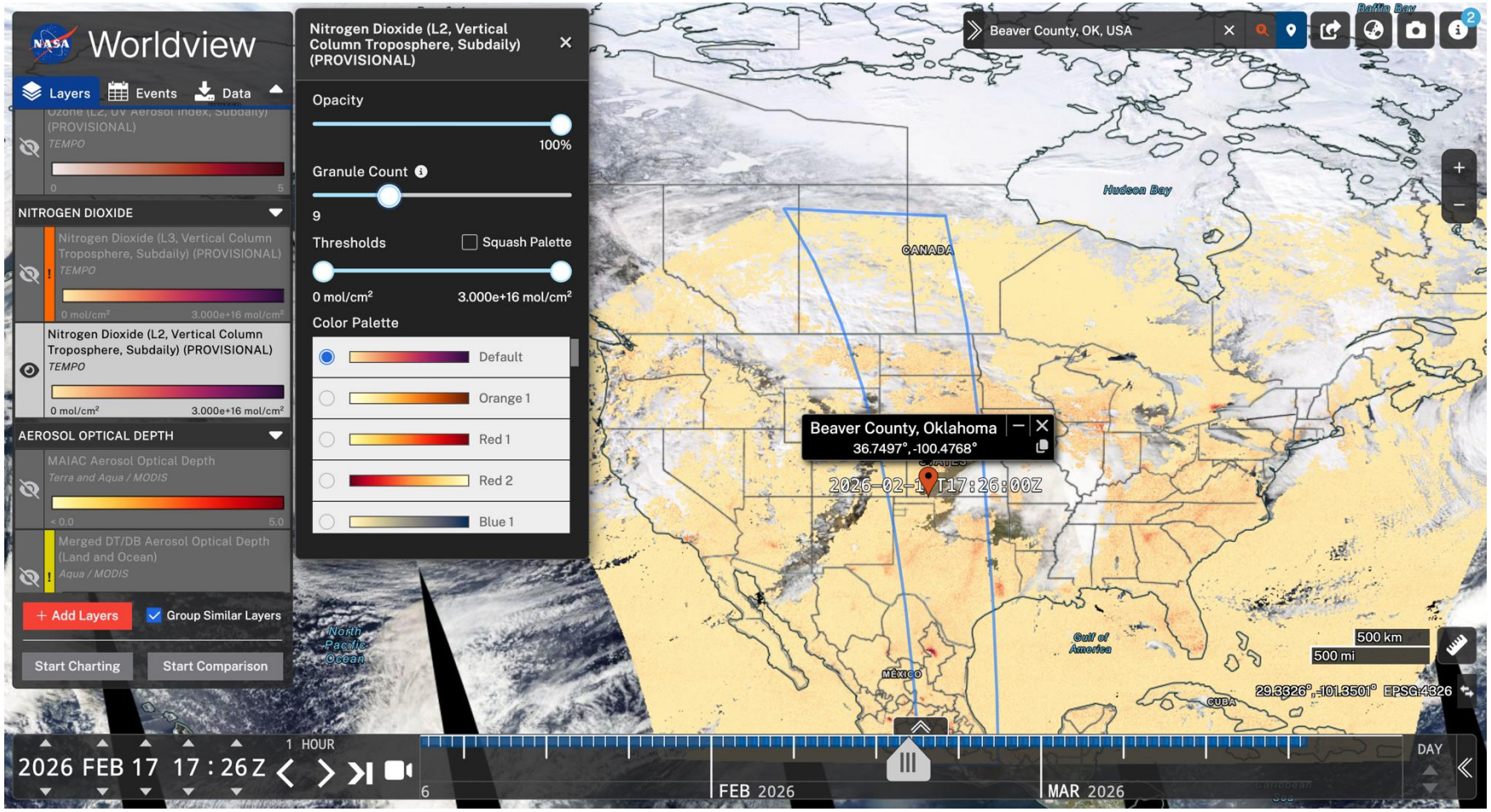
- The Cloud Fraction toggle shows the correspondence of filtered out NO_2 pixel for the retrieval(cloud masking).
- HCHO shows noisier signal compared to NO_2.
- Total column O_3 is stratosphere-dominated; even with palette squashed to 250–300 DU, tropospheric signal is hard to detect for this event. Not every case shows clear ozone signature.

Step 5 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



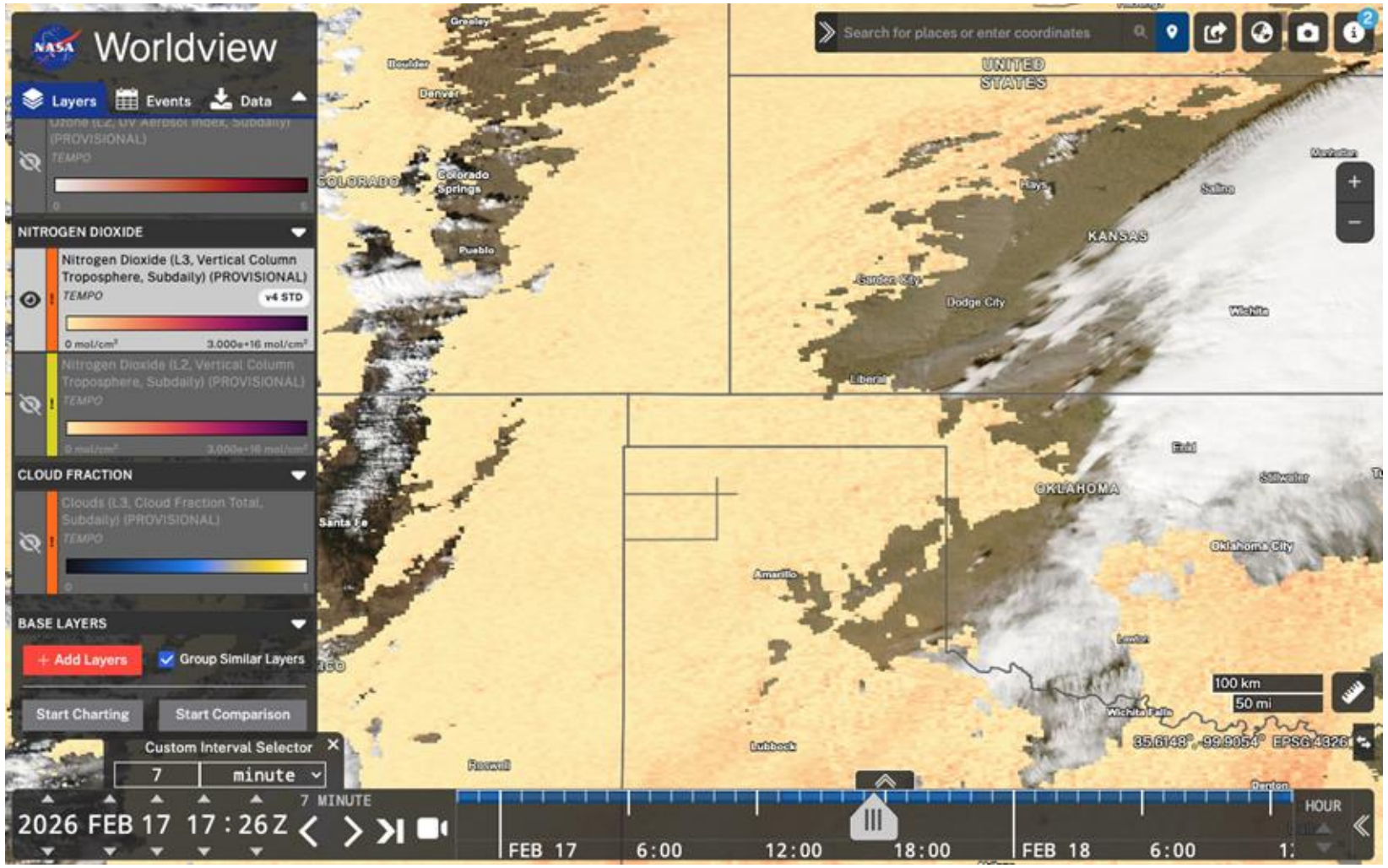
Product: TEMPO Nitrogen Dioxide (L2, Vertical Column Troposphere, Subdaily) -17.26Z (11.26am CST) 1 granule

Step 5 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



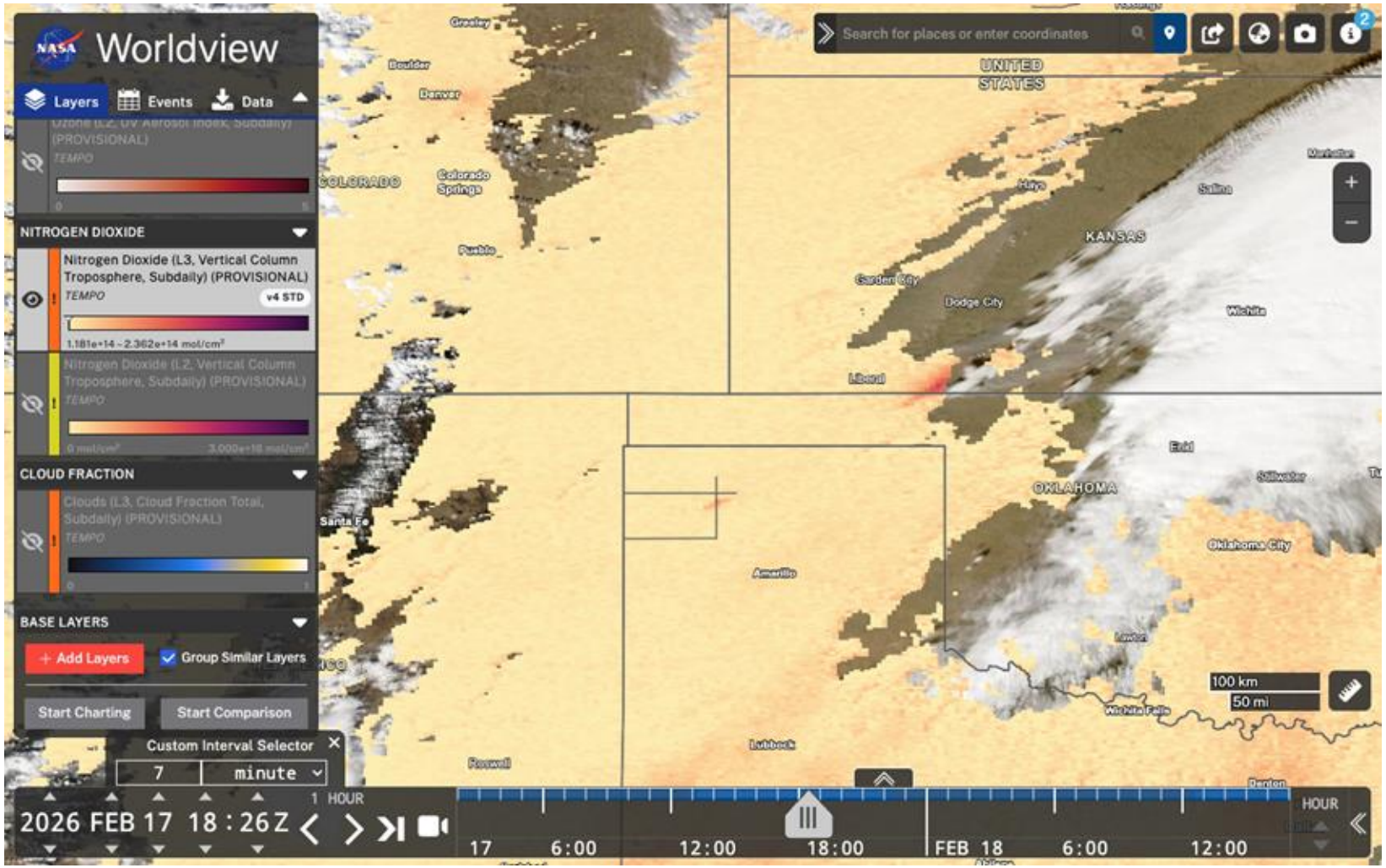
Product: TEMPO Nitrogen Dioxide (L2, Vertical Column Troposphere, Subdaily) -17.26Z (11.26am CST) 9 granules

Step 5 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



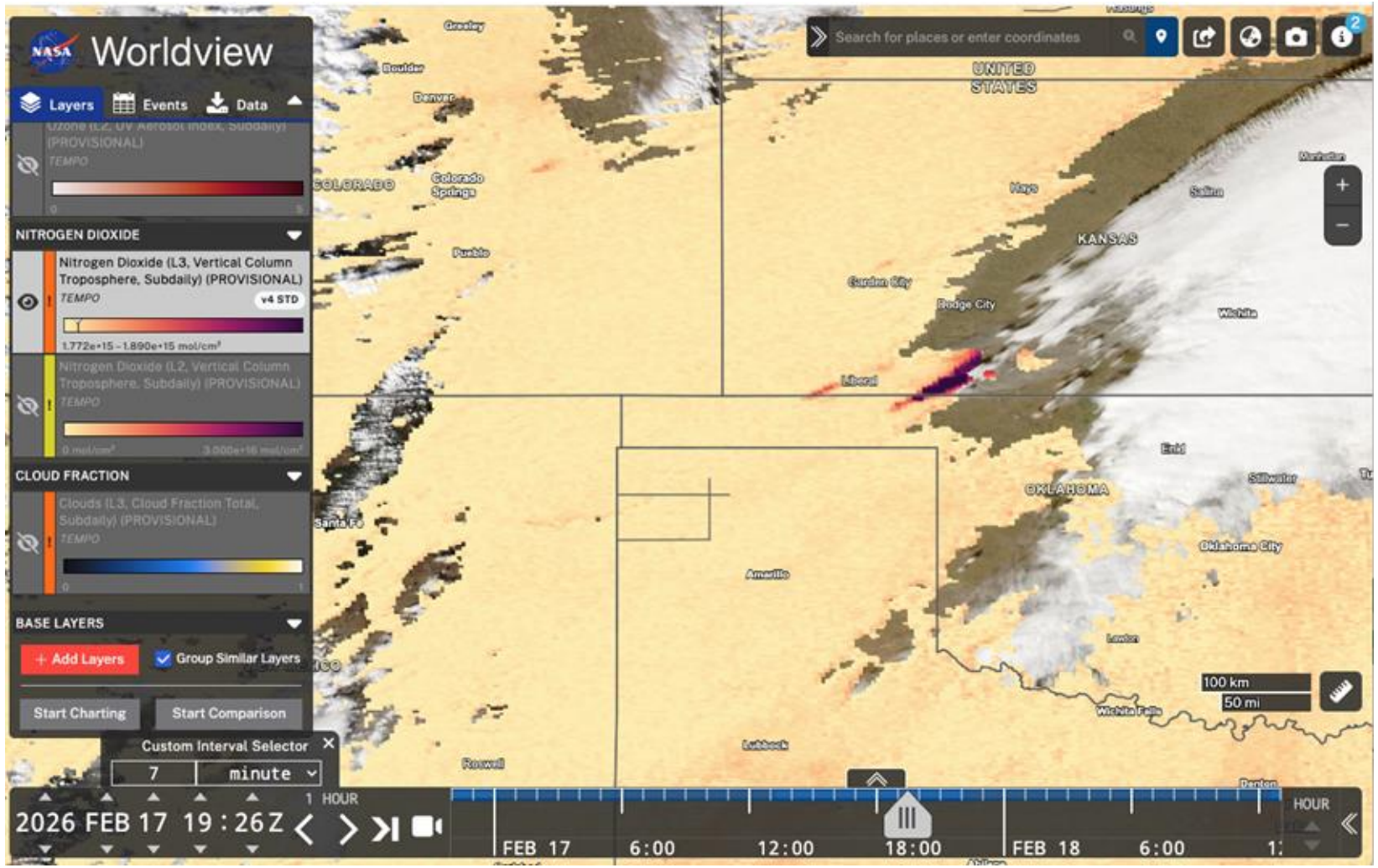
Product: TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily) -17.26Z (11.26am CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



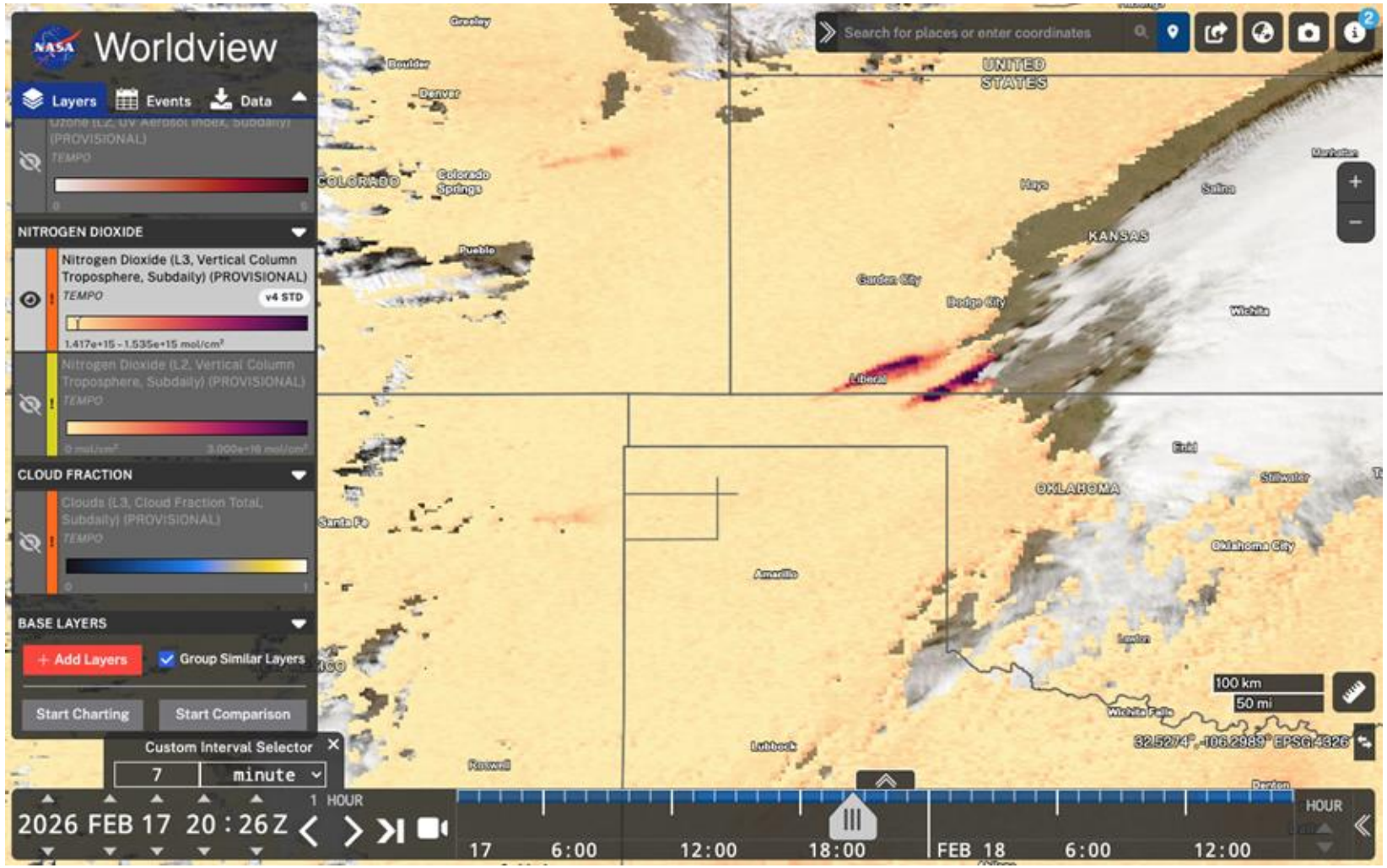
Product: TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily) – 18.26Z (12.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



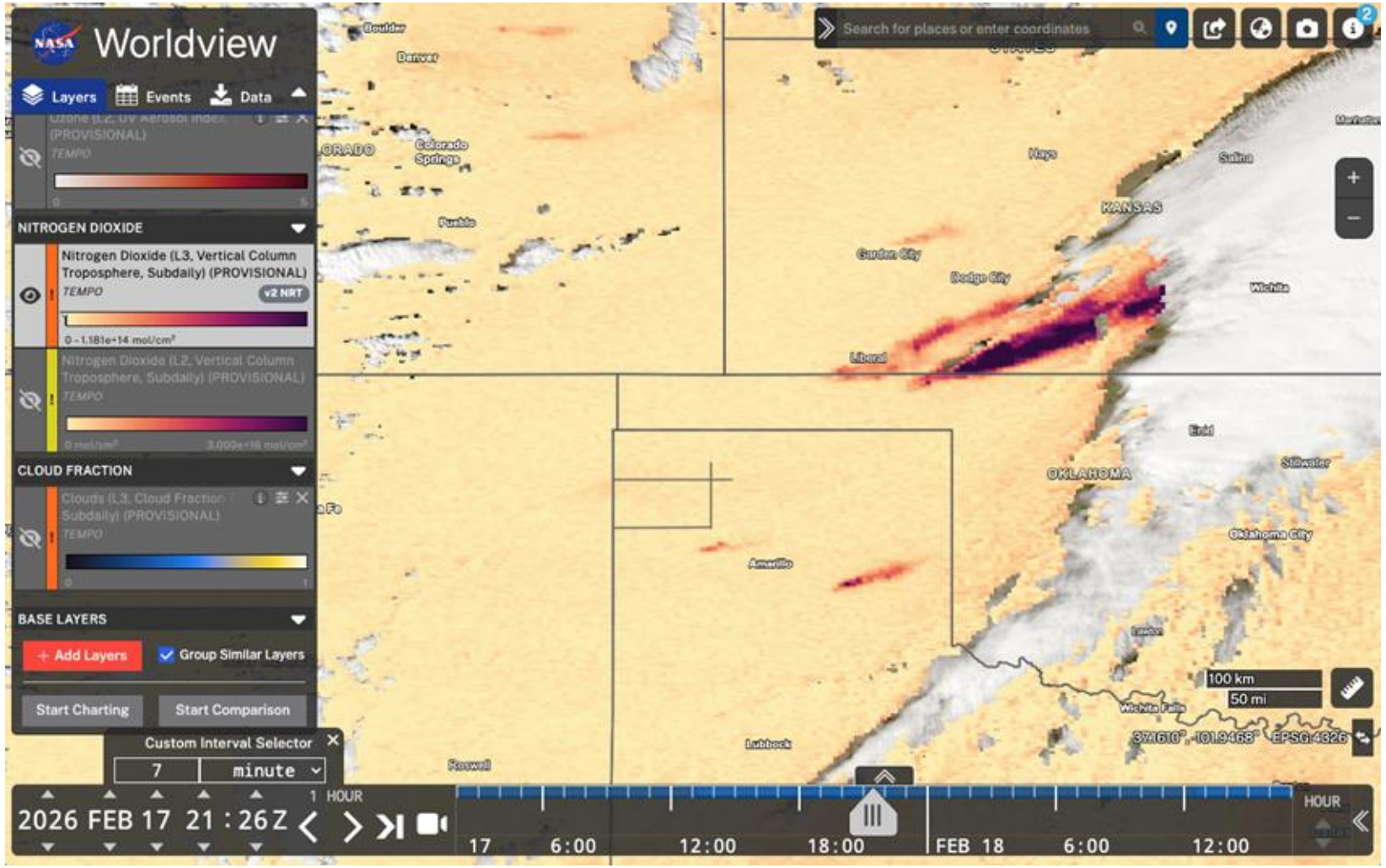
Product: TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily) 19.26Z (1.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



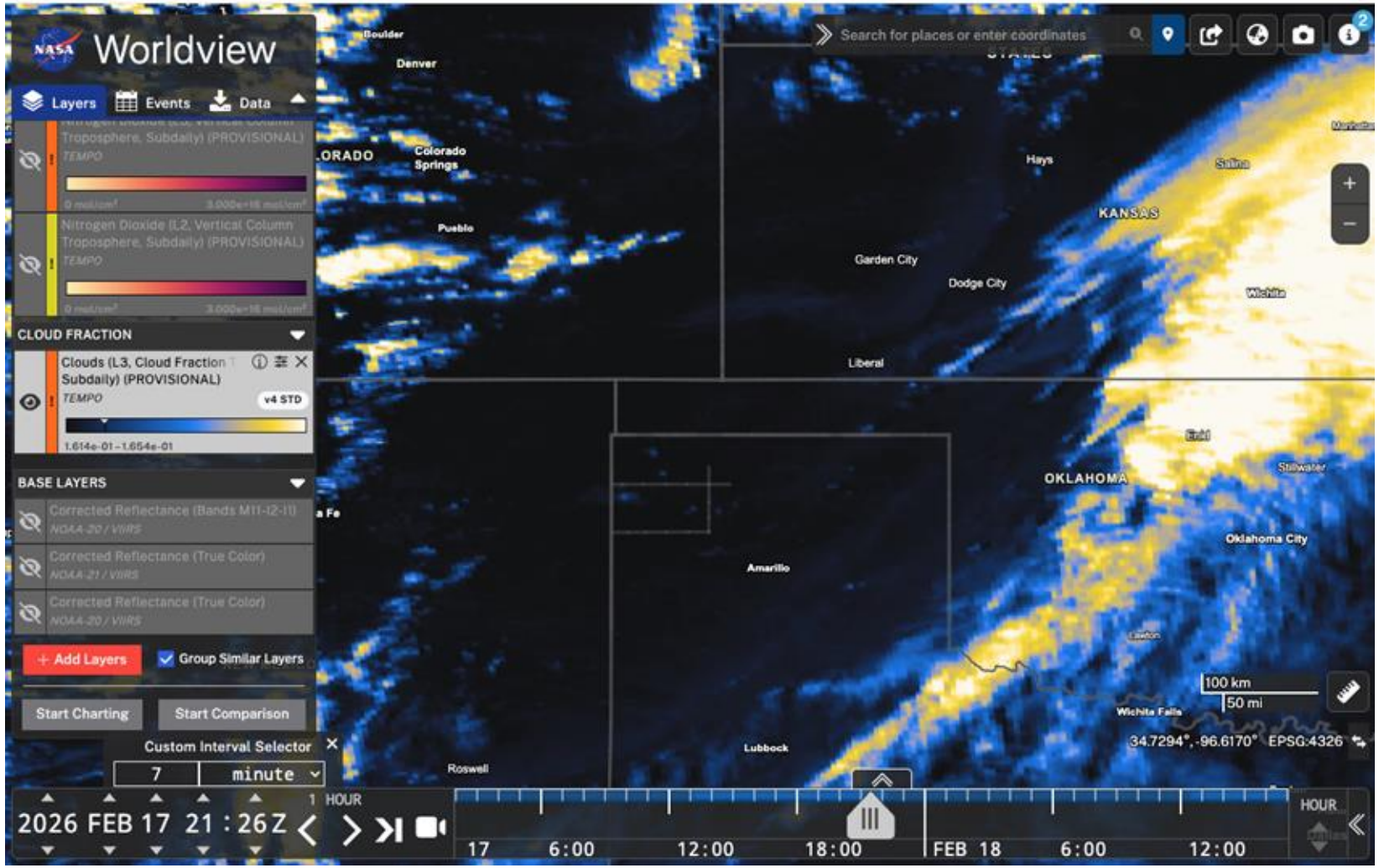
Product: TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily) 20.26Z (2.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2)



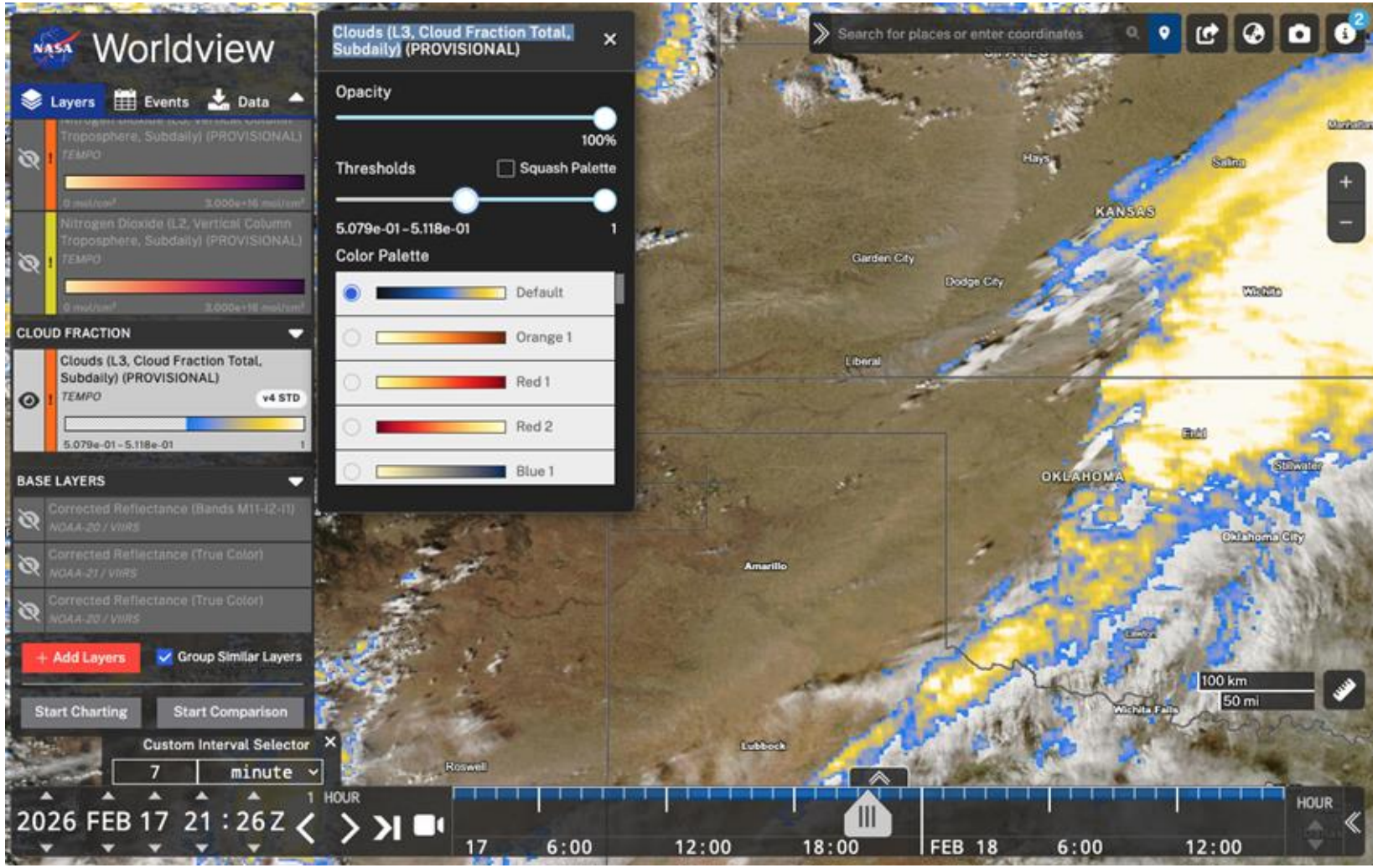
Product: TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily) 21.26Z (3.26pm CST)

Step 5 — TEMPO: Hourly Smoke Tracking (Cloud Fraction)



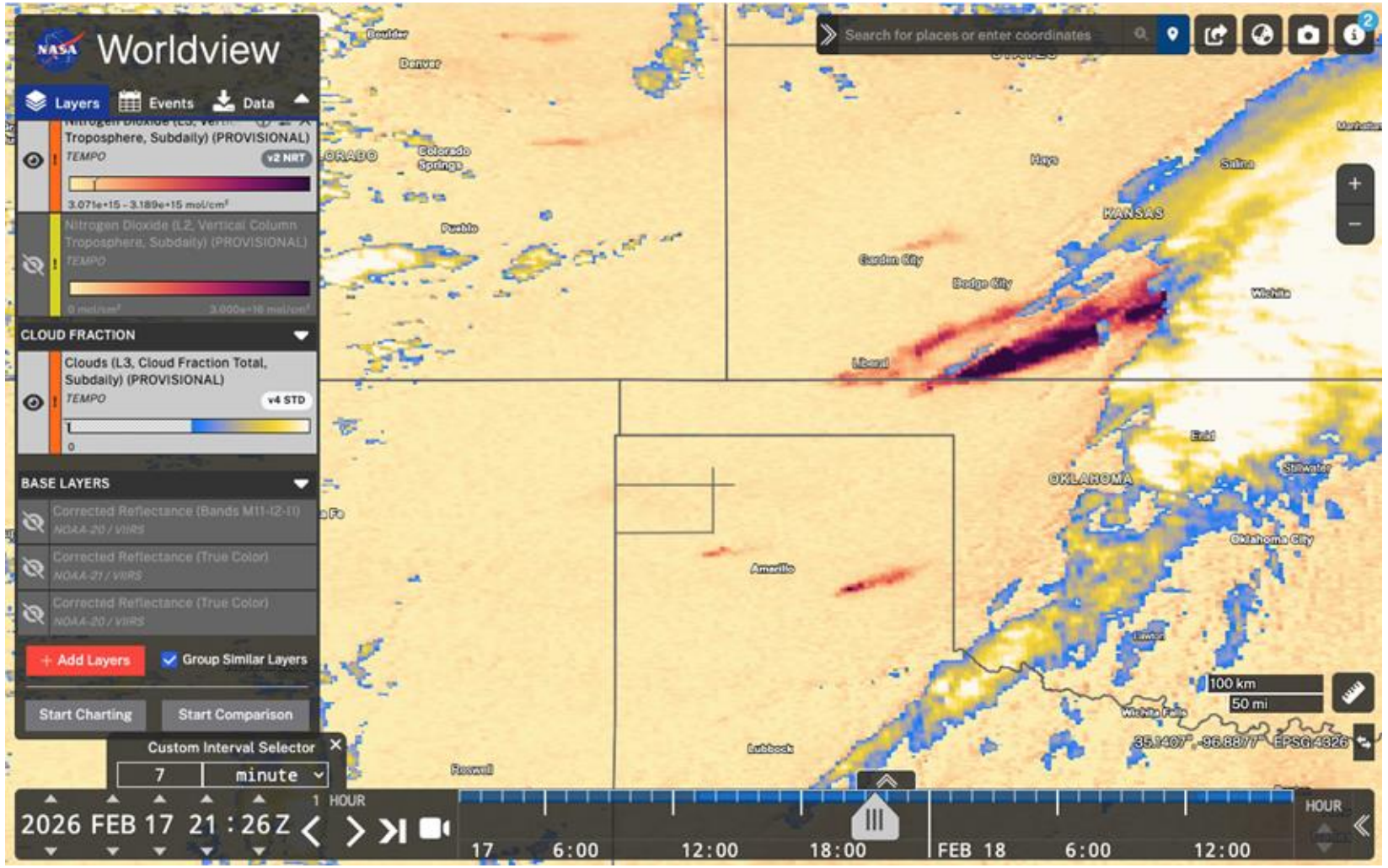
Product: TEMPO Clouds (L3, Cloud Fraction Total, Subdaily)

Step 6 — TEMPO: Hourly Smoke Tracking (Cloud Fraction Mask)



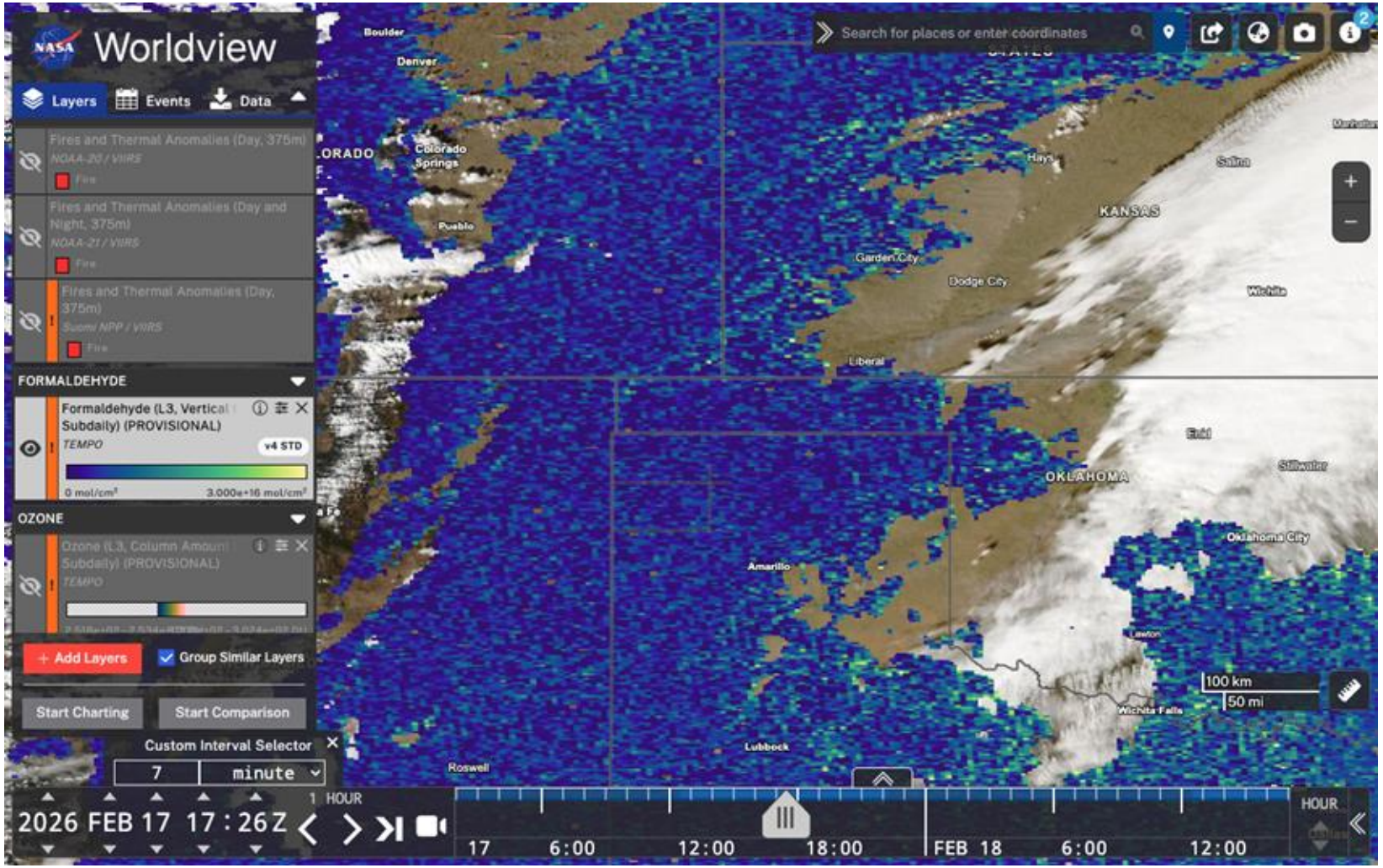
Product: TEMPO Clouds (L3, Cloud Fraction Total, Subdaily)

Step 6 — TEMPO: Hourly Smoke Tracking (Tropospheric NO_2 + Cloud Fraction)



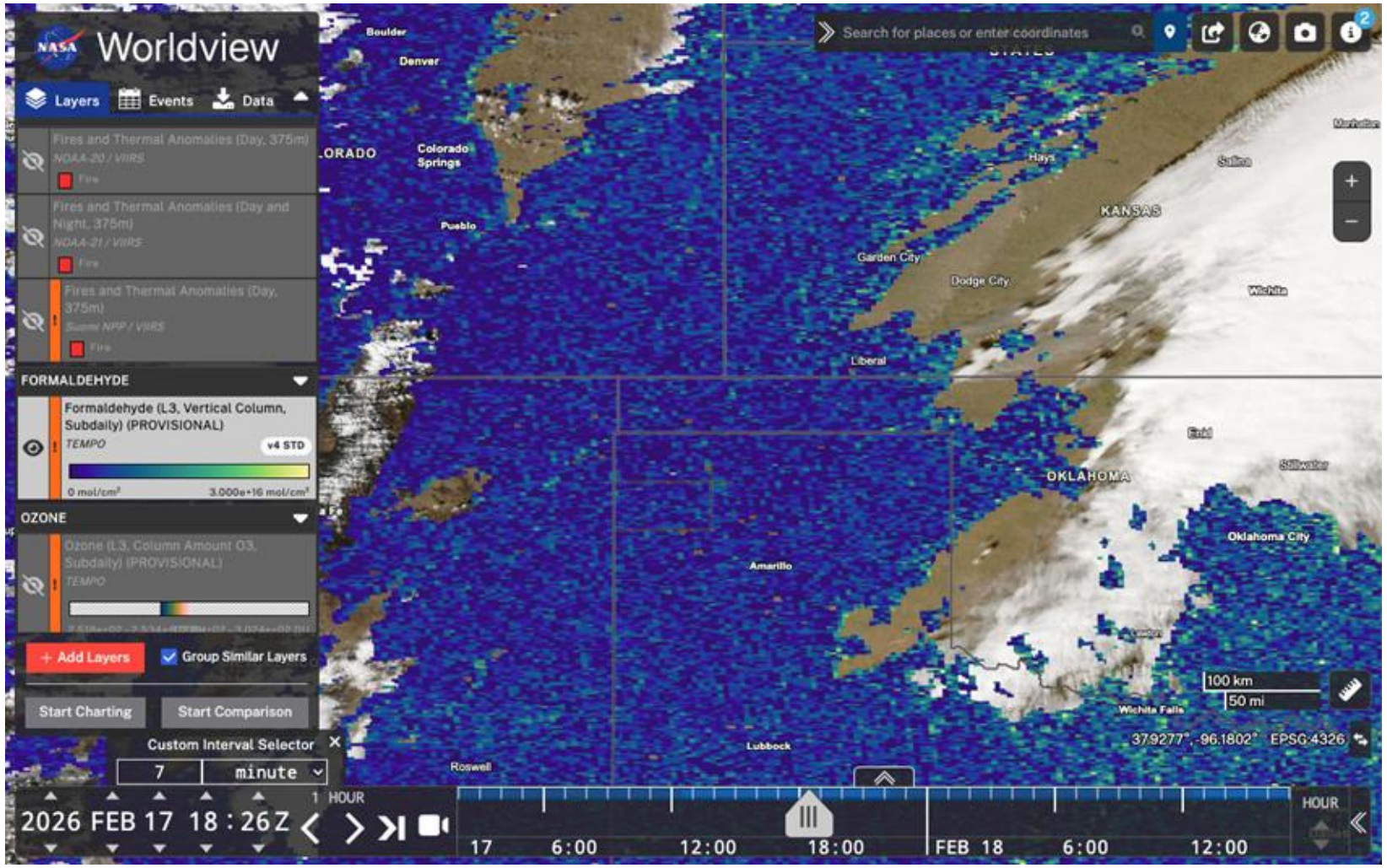
Products: TEMPO Nitrogen Dioxide (L3, Vertical Column Troposphere, Subdaily); Clouds (L3, Cloud Fraction Total, Subdaily)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column HCHO)



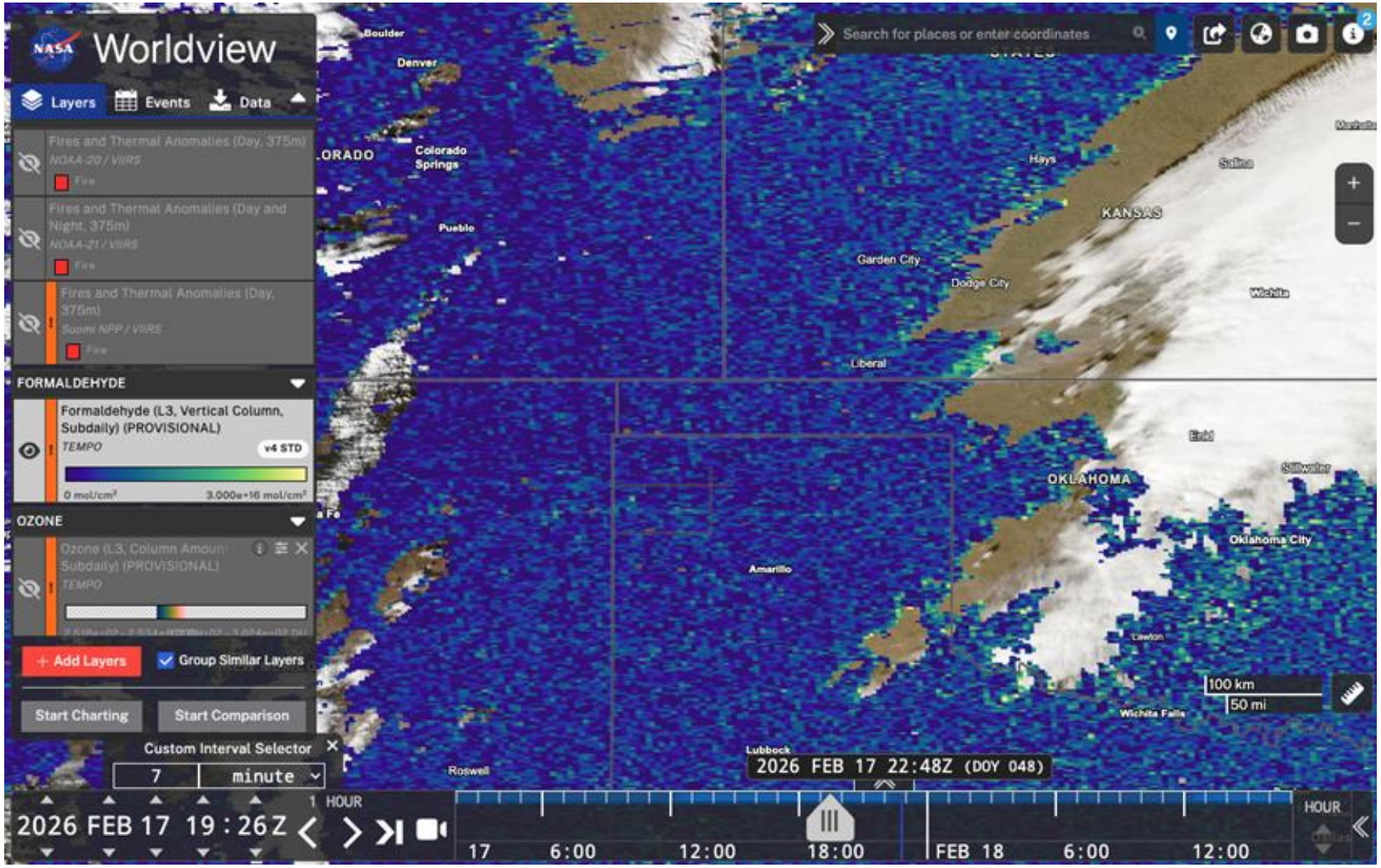
Product: TEMPO Nitrogen Dioxide (L3, Vertical Column, Subdaily) -17.26Z (11.26am CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column HCHO)



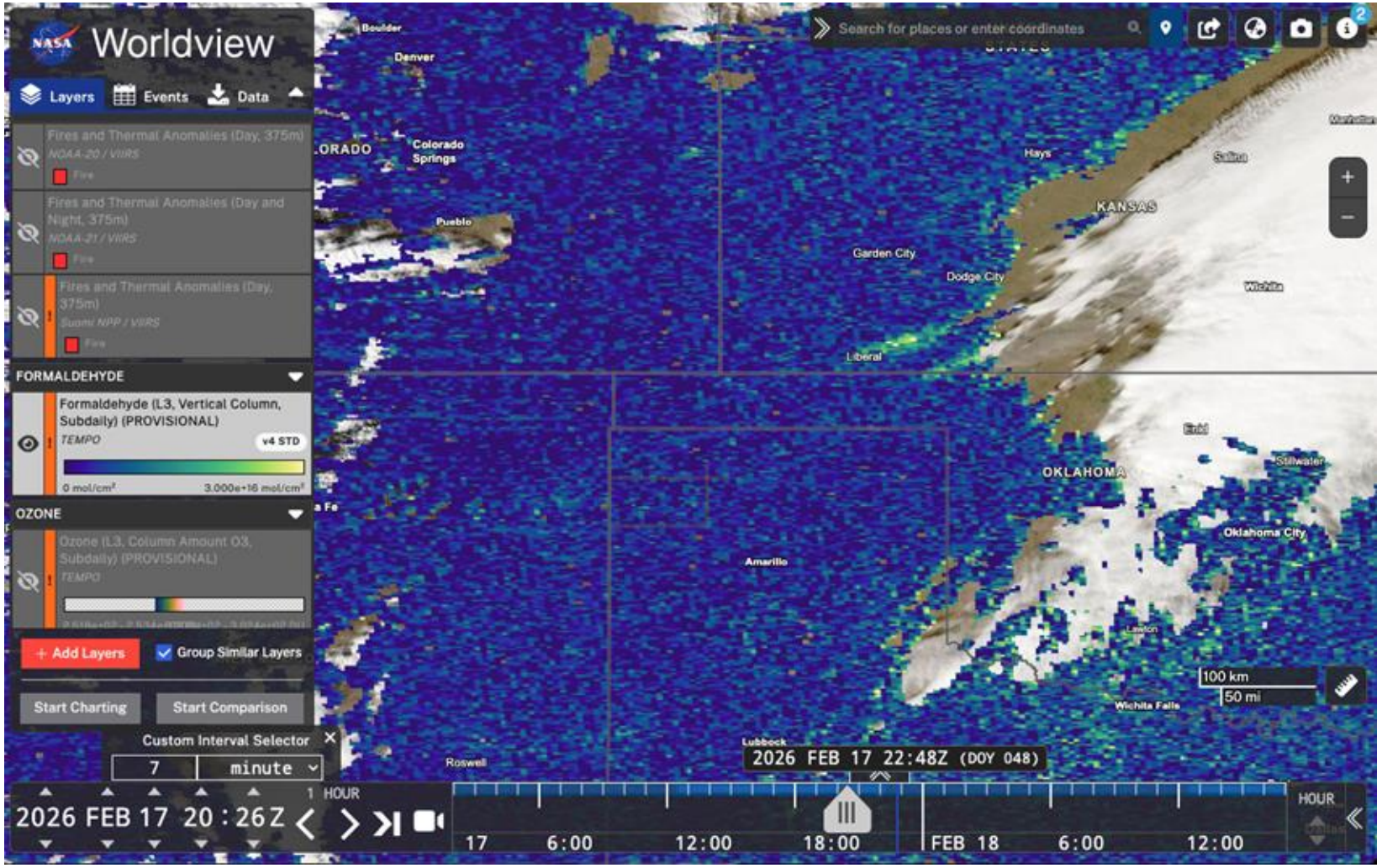
Product: TEMPO Formaldehyde (L3, Vertical Column, Subdaily) – 18.26Z (12.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column HCHO)



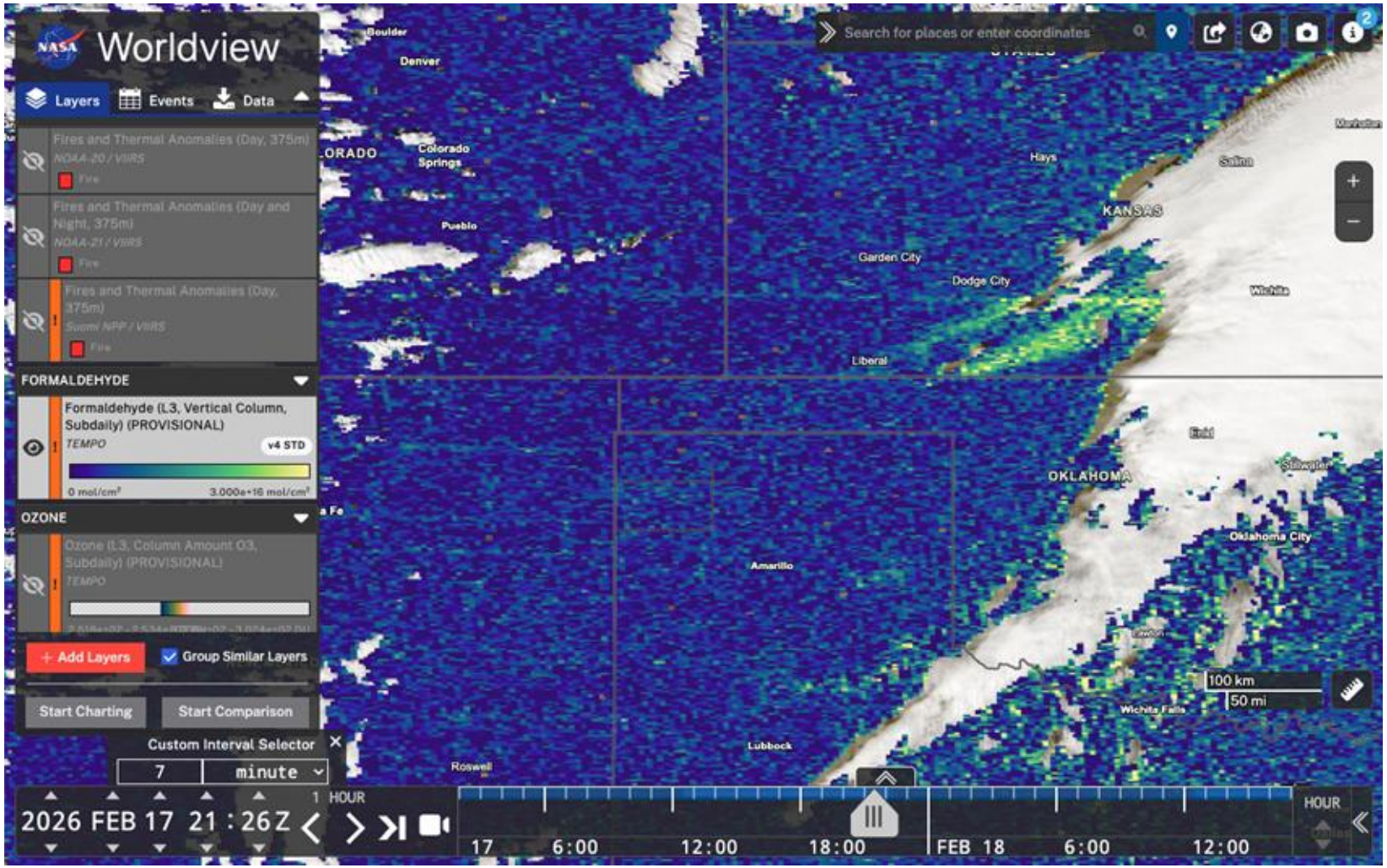
Product: TEMPO Formaldehyde (L3, Vertical Column, Subdaily) 19.26Z (1.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column HCHO)



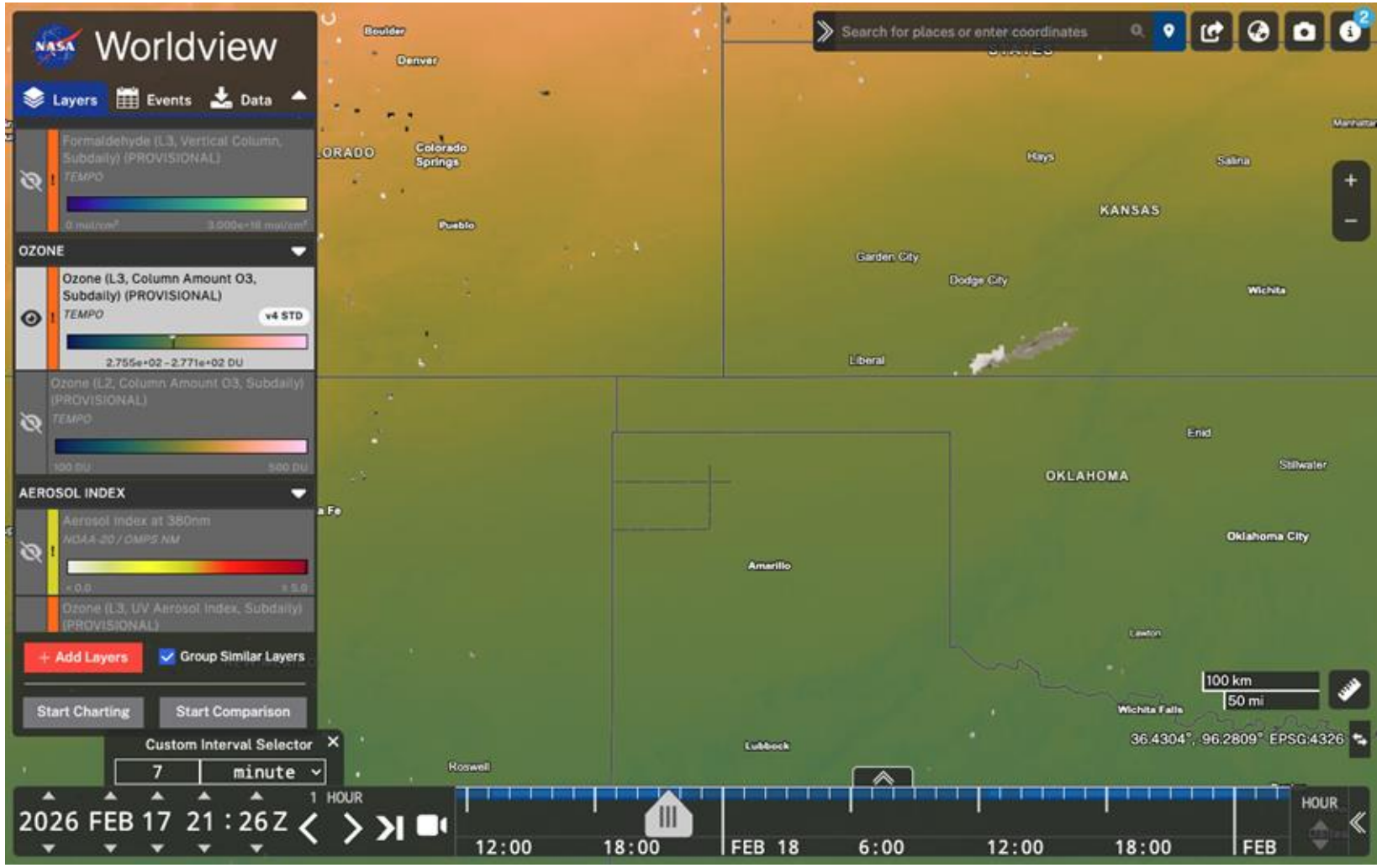
Product: TEMPO Formaldehyde (L3, Vertical Column, Subdaily) 20.26Z (2.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column HCHO)



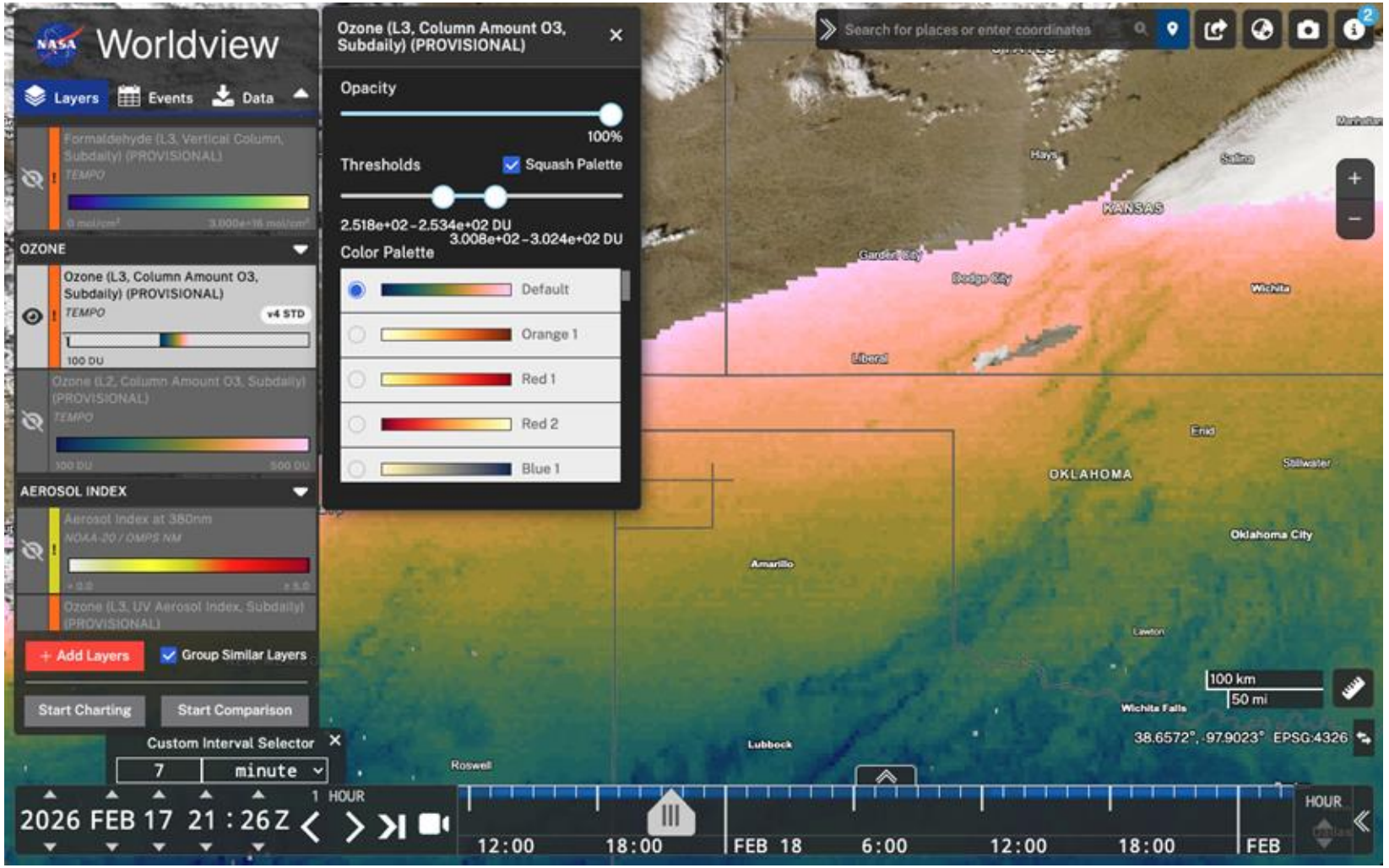
Product: TEMPO Formaldehyde (L3, Vertical Column, Subdaily) 21.26Z (3.26pm CST)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column O_3)



Product: TEMPO Ozone (L3, Column Amount O3, Subdaily)

Step 6 — TEMPO: Hourly Smoke Tracking (Total Column O_3)



Product: TEMPO Ozone (L3, Column Amount O3, Subdaily)

Summary

- The Ranger Road Fire (Oklahoma, Feb. 2026) is detectable across multiple NASA satellite products within hours of ignition.
- True color, false color, and fire detection layers together confirm fire location, plume extent, and burned area footprint.
- MODIS and MAIAC AOD track daily smoke column loading, though thick smoke can be misclassified as cloud, causing retrieval gaps. TEMPO UVAI provides a robust way for tracking the aerosol plume where AOD is not retrieved.
- TEMPO provides hourly aerosol and trace gas observations—NO_2, HCHO, and UVAI—enabling tracking of the plume's evolution during daytime.


APPLIED REMOTE SENSING TRAINING PROGRAM
TRAIN - EMPOWER - ADVANCE

Thank You!