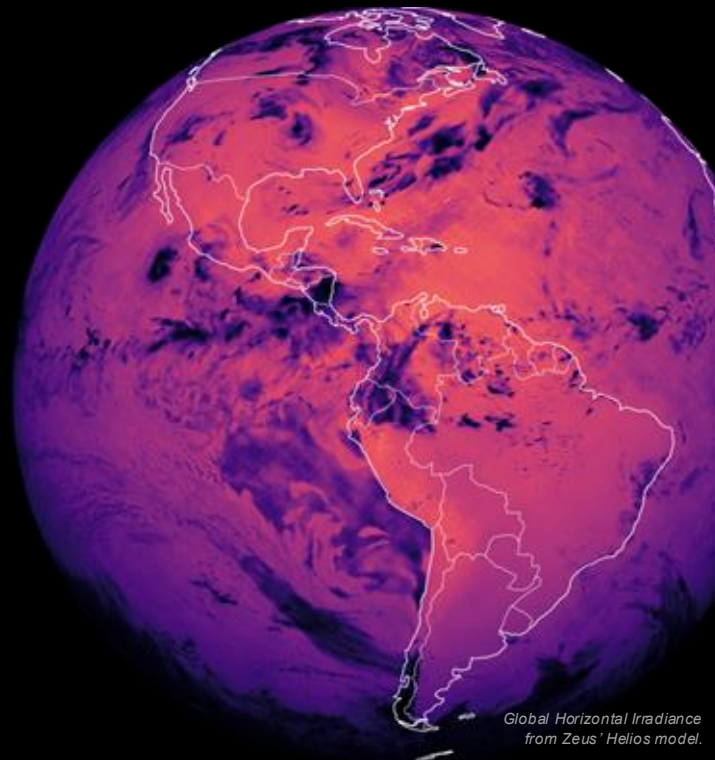


Building an observation-to-observation regional air quality model

Elise Penn

HA QAST Madison - May 14, 2026



Zeus AI builds AI models for Earth Observations

- Specialize in observation-to-observation analysis products, targeting low-latency weather and air quality applications.
- Spun out of NASA Ames in 2022, based in Cambridge, MA.
- Supported by 6 SBIR awards from **NASA**, **DOE**, and the **Navy**.
- Computing provided by **NASA NCCS** and **DOE NERSC HPC**.



TJ Vandal, Ph.D.
Co-Founder & CEO



Kate Duffy, Ph.D.
Co-Founder & CSO



Tristan Ballard, Ph.D.
Sr. Research Scientist

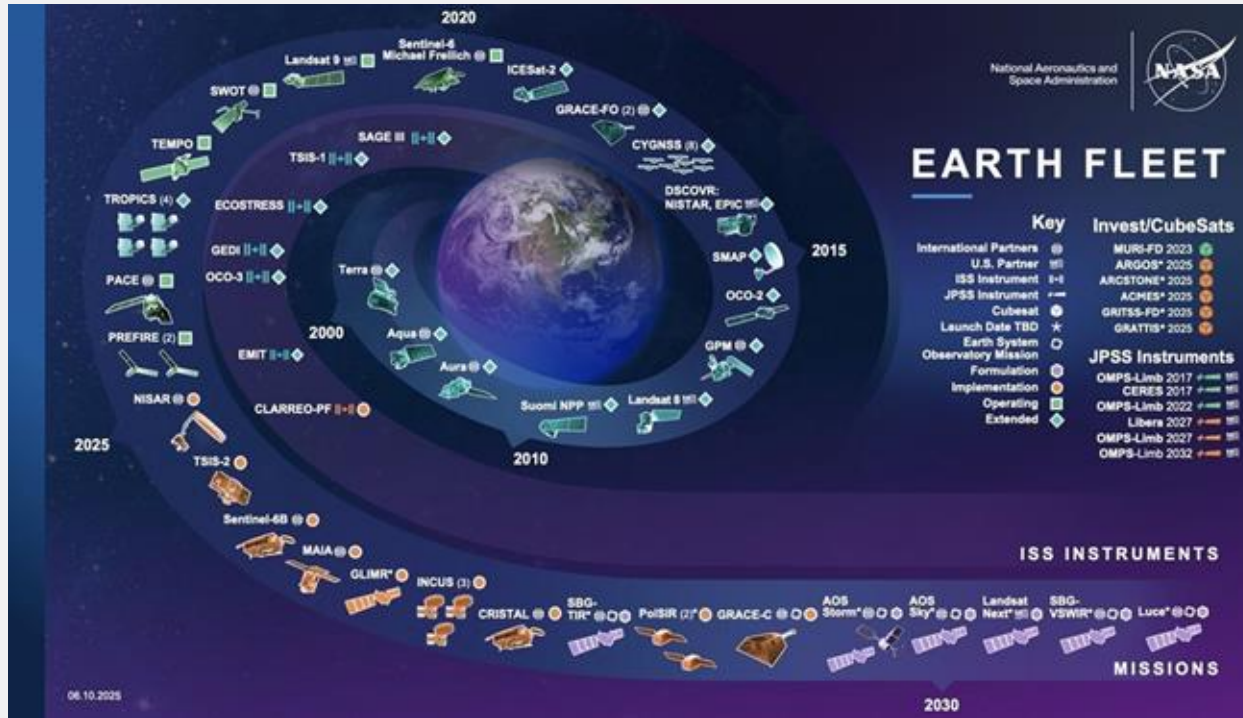


Elise Penn, Ph.D.
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August Posch
Data Scientist

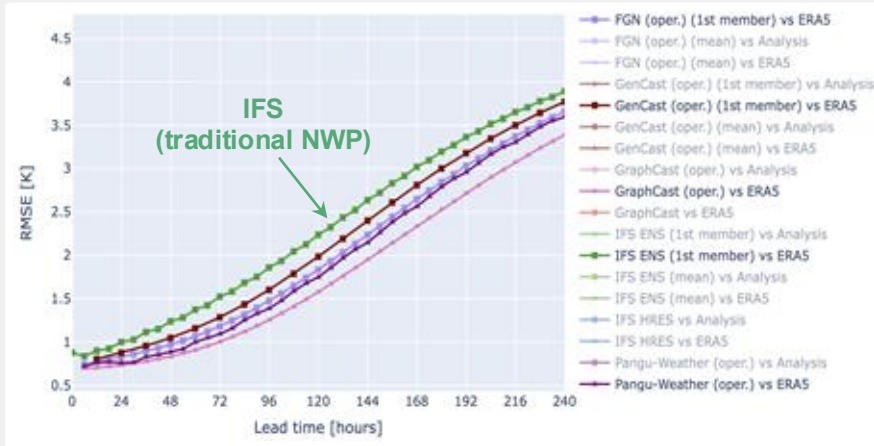
We have more satellite data than ever. How can we use it?



Data assimilation remains a bottleneck for weather forecasting.

Machine Learning Weather Prediction (MLNWP) is fast improving over NWP.

But data assimilation remains a challenge.

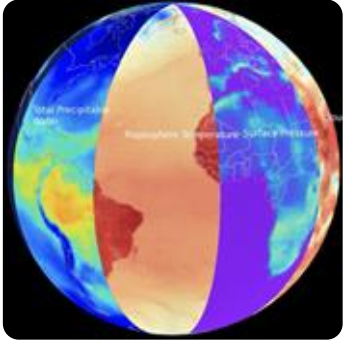


WeatherBench 2 Deterministic scores from Google Research

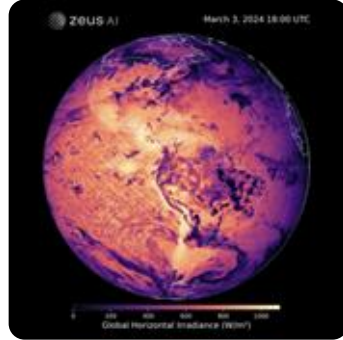
- MLNWP still relies on traditional data assimilation.
- By the time initial conditions are generated, they are already **4 hours old**.
- Only ~5% of satellite data is assimilated into weather forecasts.
- **Zeus AI creates data assimilation products that bridge this gap**

Zeus AI specializes in **observation-to-observation** forecasting and **derived satellite products**

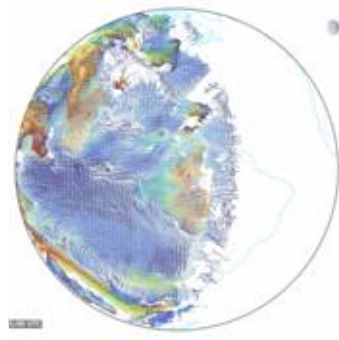
EarthNet



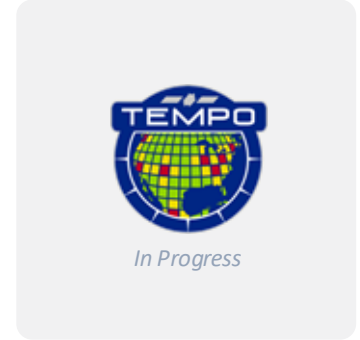
Helios



Stereo Wind Vectors

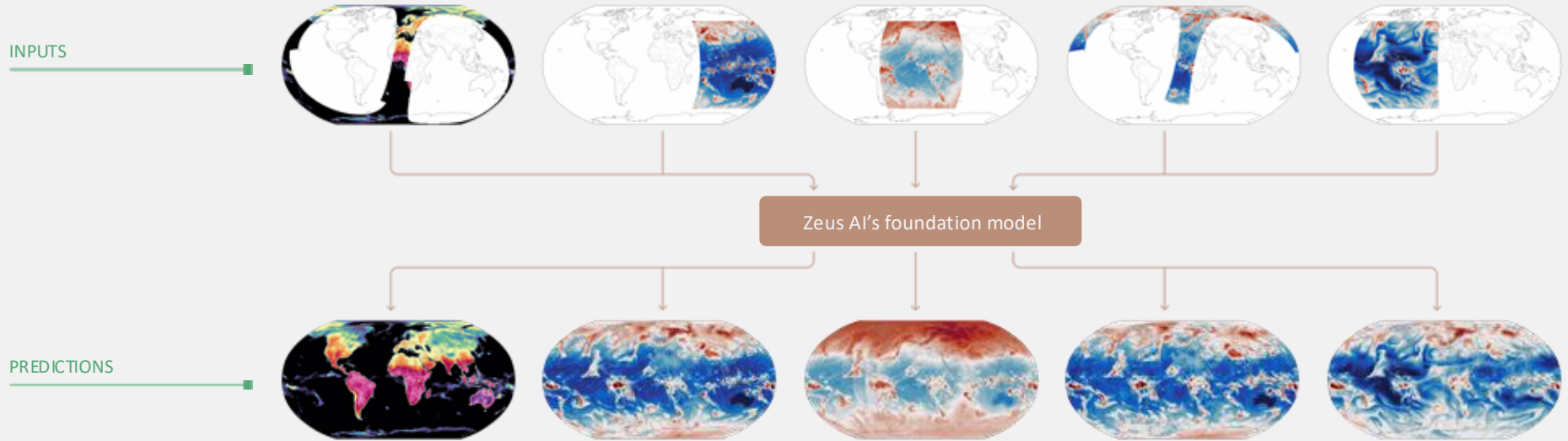


Regional Air Quality



Historical data available **for free** at Earthmover Marketplace
<https://app.earthmover.io/marketplace/providers/zeus-ai>

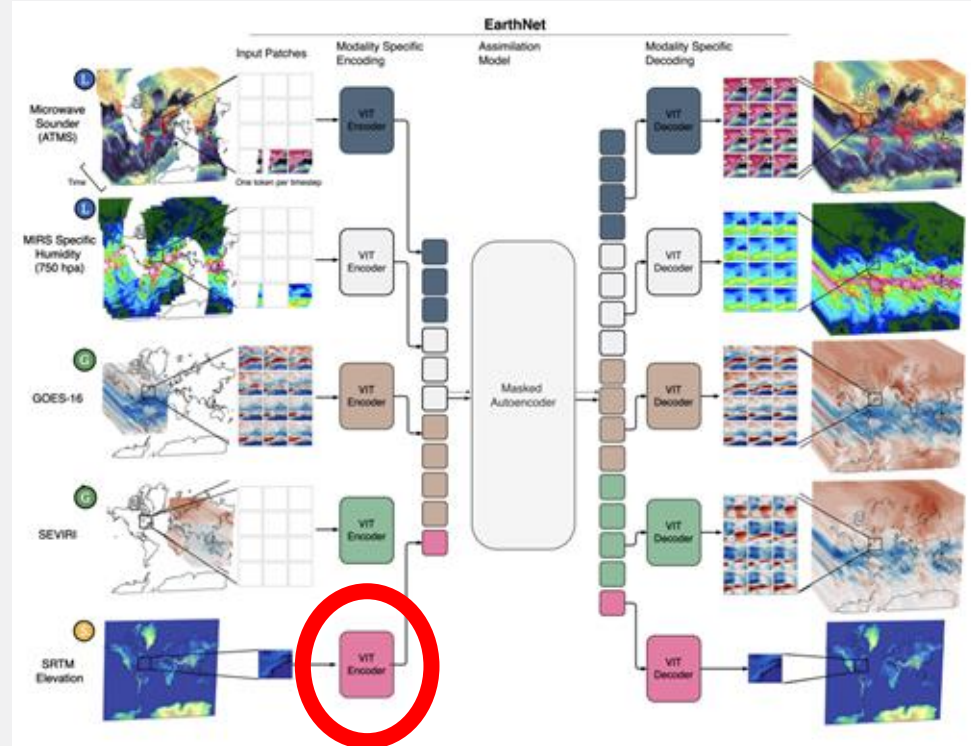
EarthNet predicts a global gap-filled atmospheric state using only satellite observations



Vandal et al., 2025 (ICDMW)

EarthNet's model structure allows easy extension to new datasets

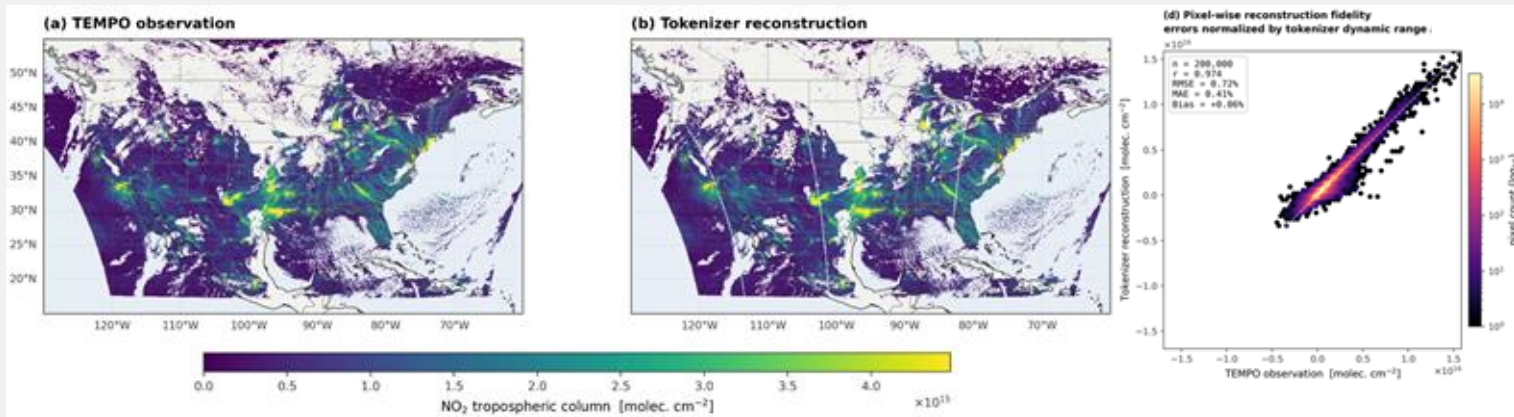
- Any -> any translation
- Gap-fills missing data
- Encoder-decoder transformer
- Easy to extend to other datasets.**



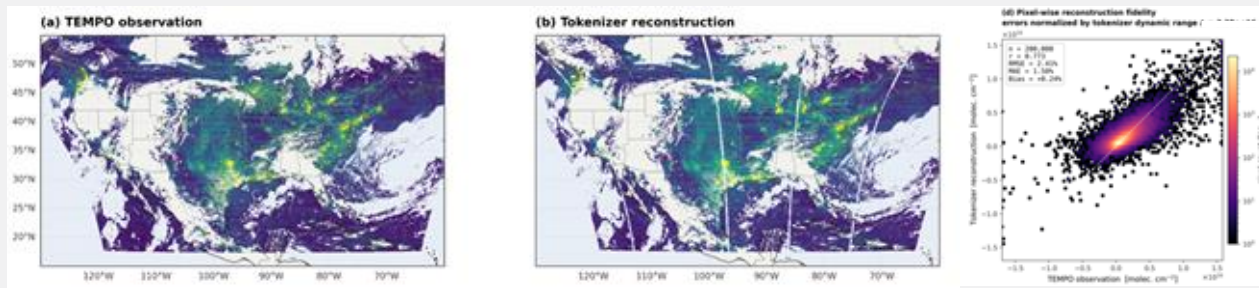
Vandal et al., 2025

Our tokenizer compresses TEMPO NO₂ data with less than 1% reconstruction error.

TEMPO
v04



TEMPO
v03



We are extending EarthNet to air quality applications using TEMPO.

Goal:

- Gap-filled TEMPO + surface products
- Every 15 minutes, 6 km resolution
- **Multi-modal:** Brings together **GOES**, **TEMPO**, & **station observations**.
- **Predictive:** Responds to perturbations.
(e.g. can add location of fires and predict plumes.)

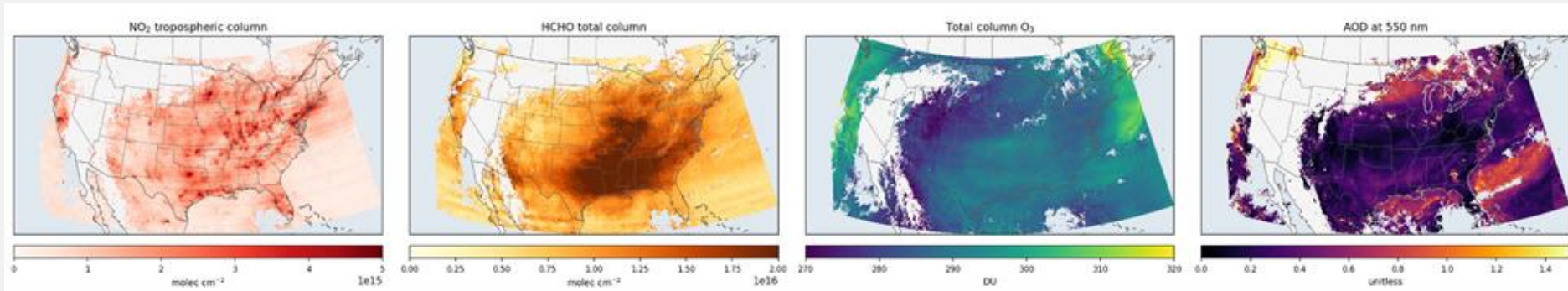


Station observations



How would you use this dataset?

- We can provide our datasets for free to non-commercial users





Thank you!

Funding

NASA Small Business Innovation Research Phase I/II/III (2023-2027)

DOE Small Business Innovation Research Phase I/II (2024-2027)

Navy Small Business Innovation Research Phase I (2025-2026)

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