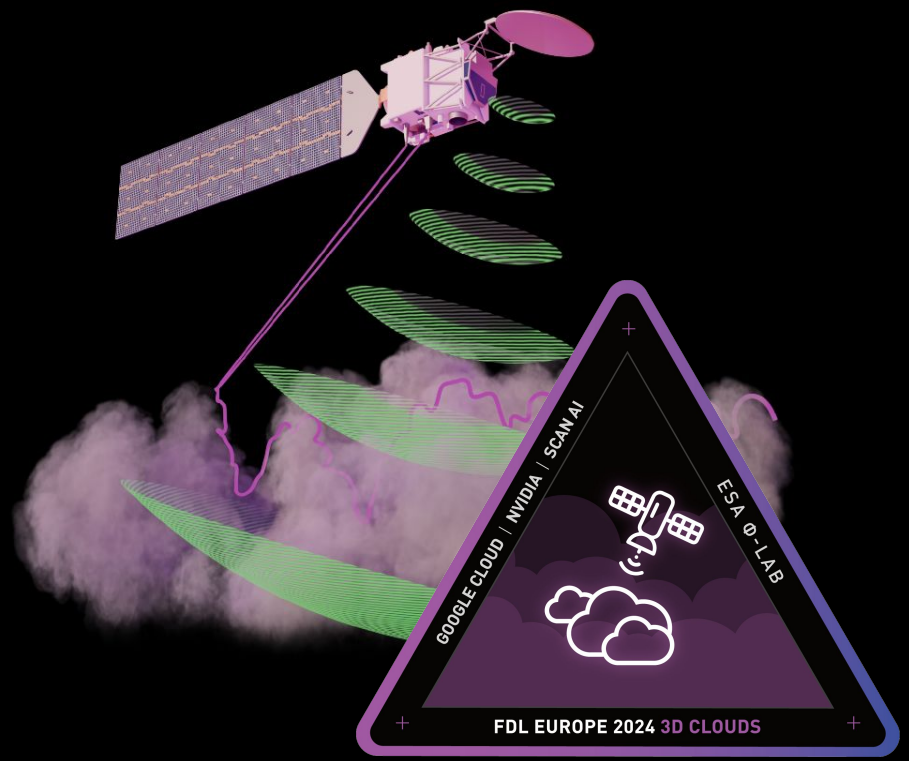
esa Φ-lab

FDL EUROPE

EARTH SYSTEMS LAB

TRILLIUM EUROPE



3D Clouds

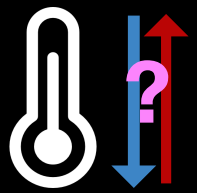
9 August 2024

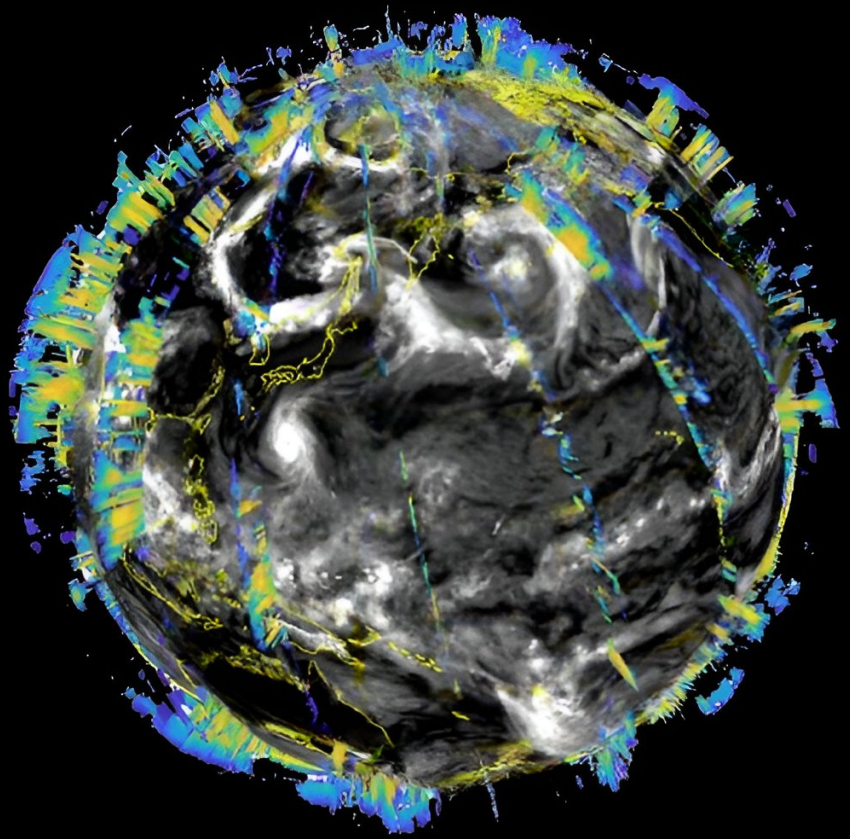
Google Cloud · LUXEMBOURG SPACE AGENCY · NVIDIA · SCAN AI · RSS-Hydro · LUX PROVIDE · UNIVERSITY OF OXFORD · D-ORBIT · AIRBUS · PASTEUR iSi · CATAPULT


change is "a distant problem that requires
now to avoid uncertain losses far in the future"
- Daniel Kahneman

Clouds heavily impact the climate and are a major source of uncertainty

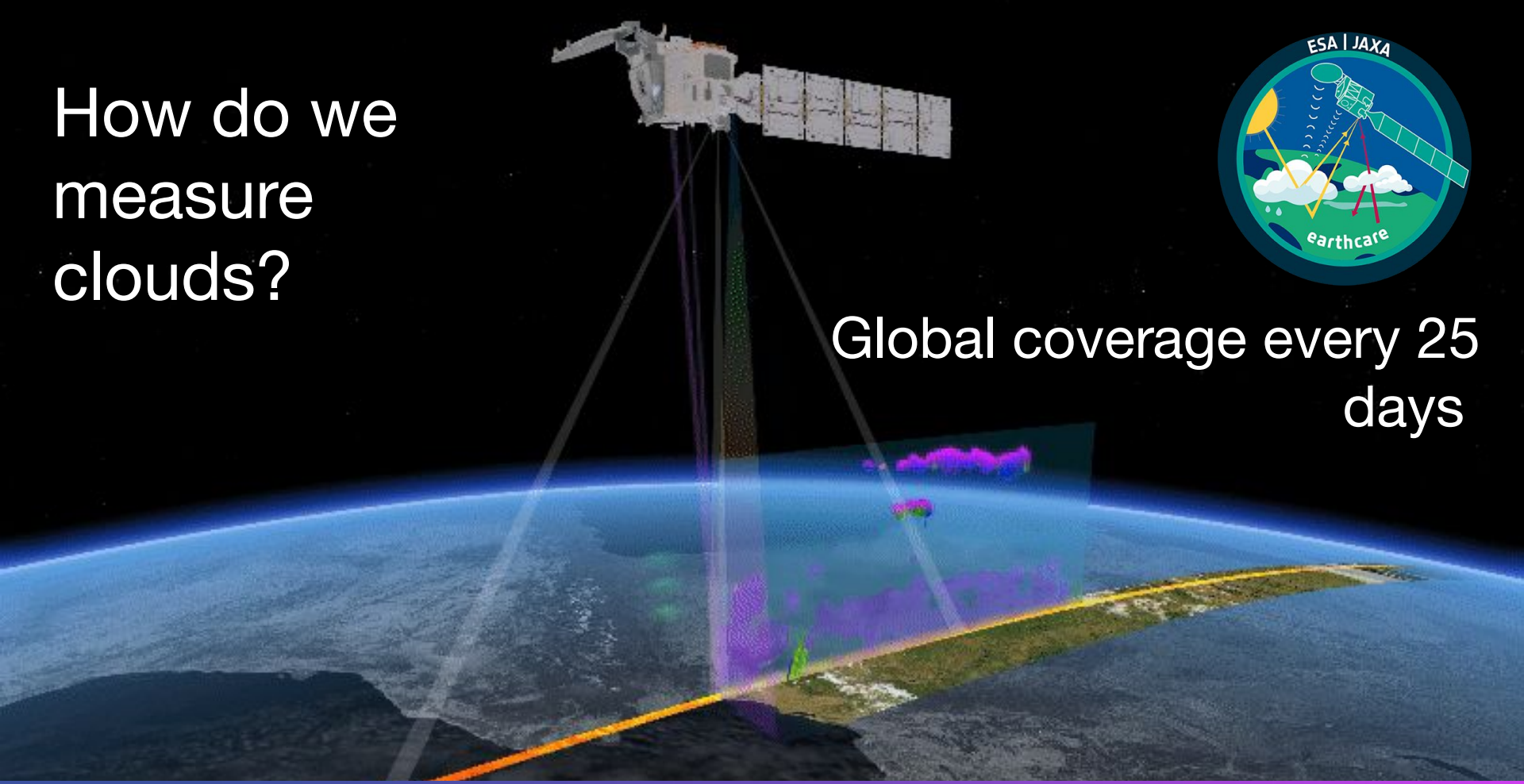
As the climate changes, so will the clouds





Real-time 3D global cloud maps are a **missing piece** of the climate puzzle

How do we measure clouds?

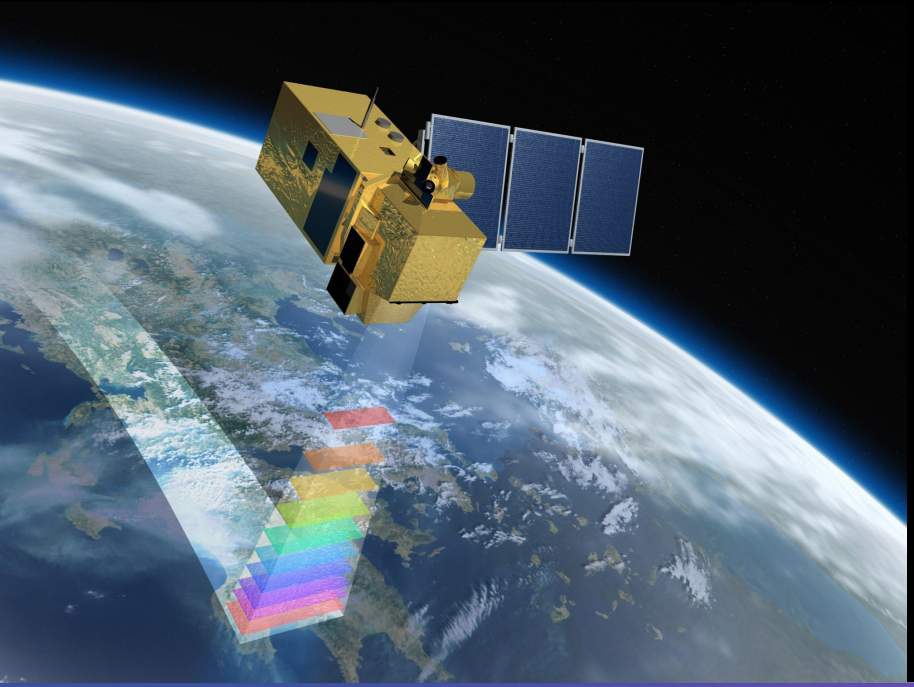


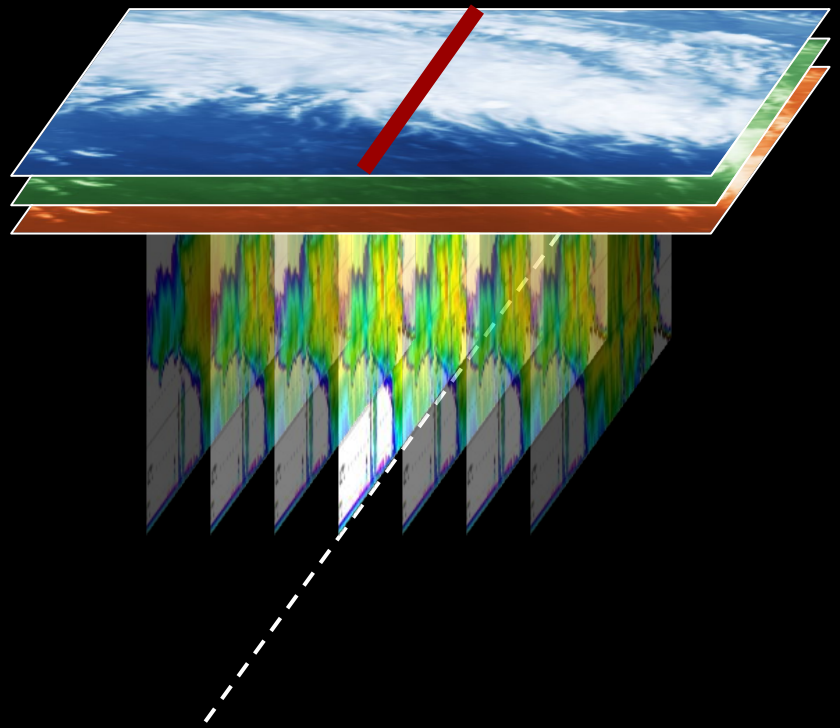
Global coverage every 25 days

Satellites image the entire Earth many times per day

Is it possible to get the cloud profile from imaging satellites?

Can this be extended to 3D?





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FDL 2024 EUROPE

EARTH SYSTEMS LAB

3D CLOUDS USING MULTI-SENISNG . 2024

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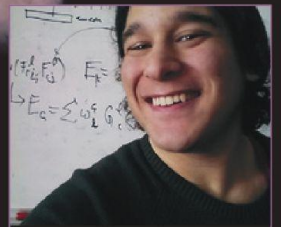

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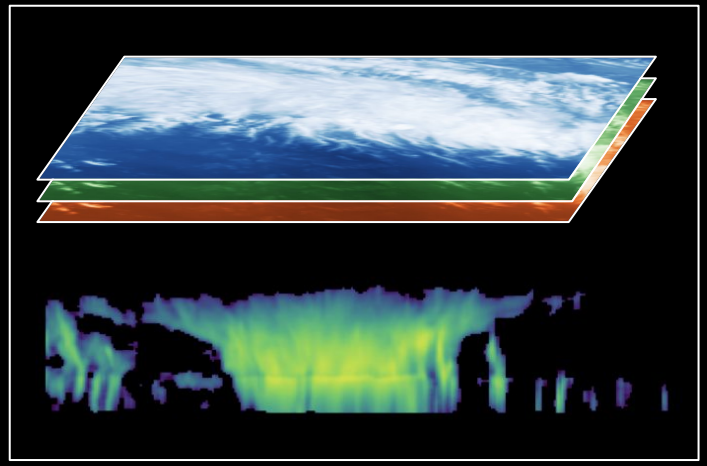
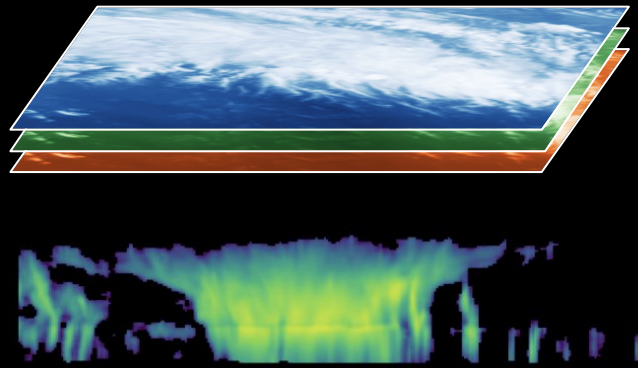
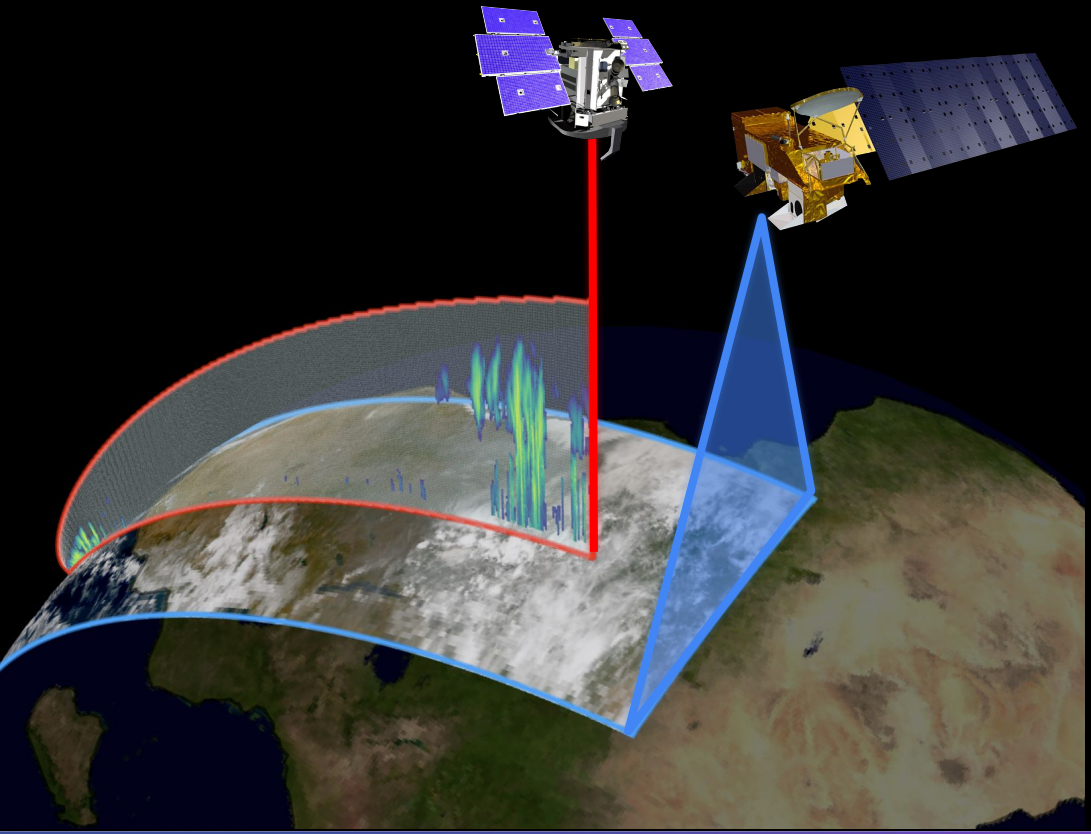
N3FOS

Satellite Images



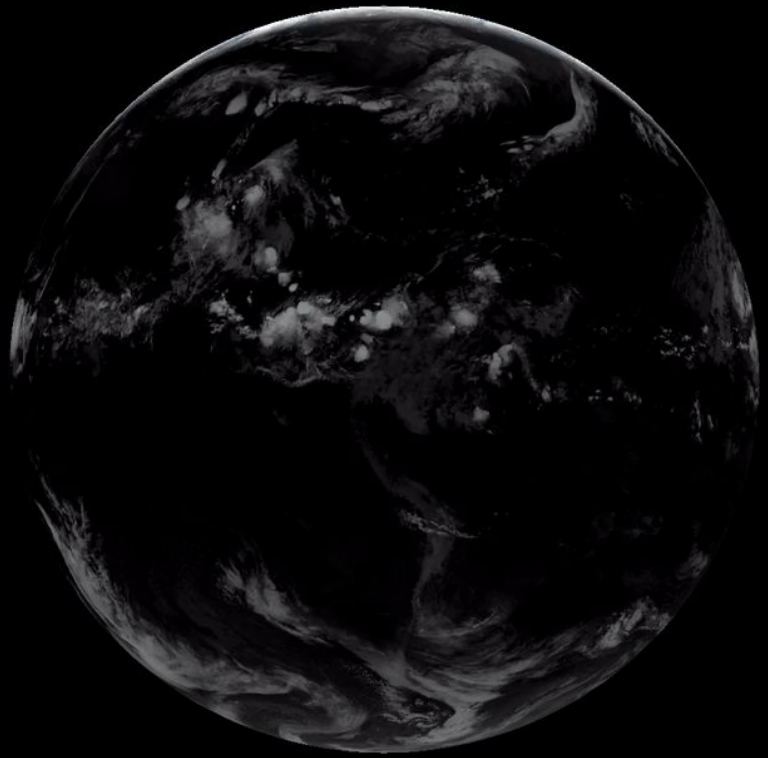
3D map of clouds





Satellites in same orbit

Cloud profiles with corresponding satellite images

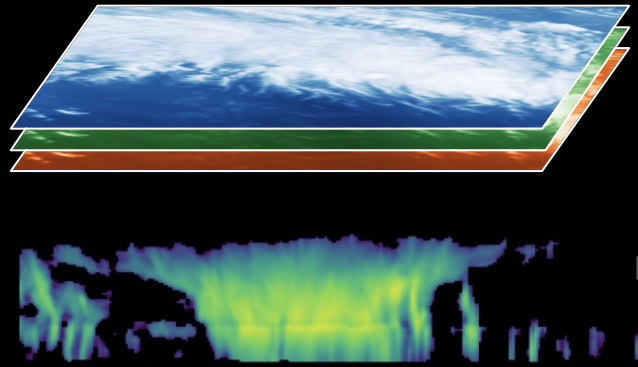


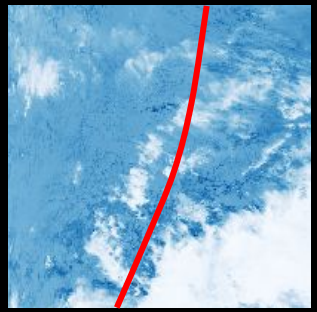
Satellites measuring every 15 minutes

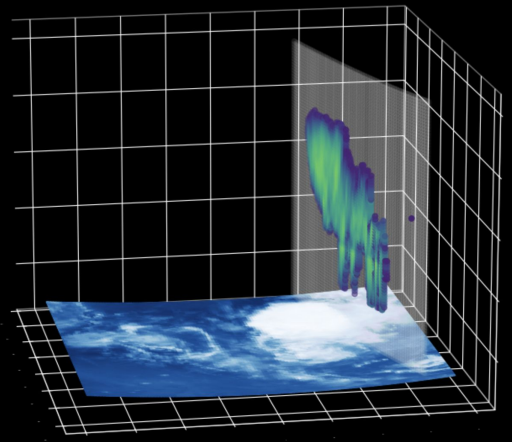
Possibility for real-time global map

Align in space and time

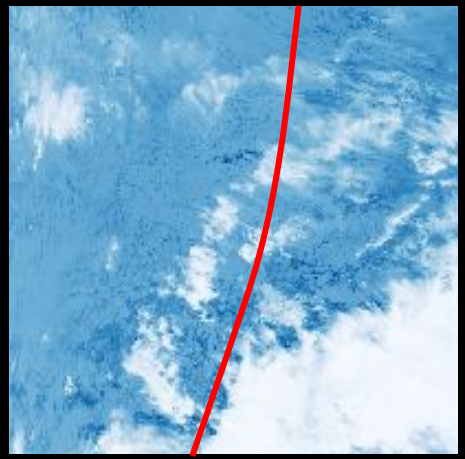
Transform to 3D cube

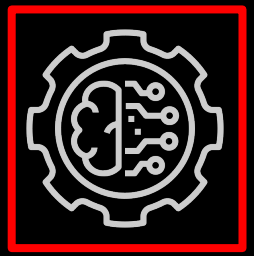


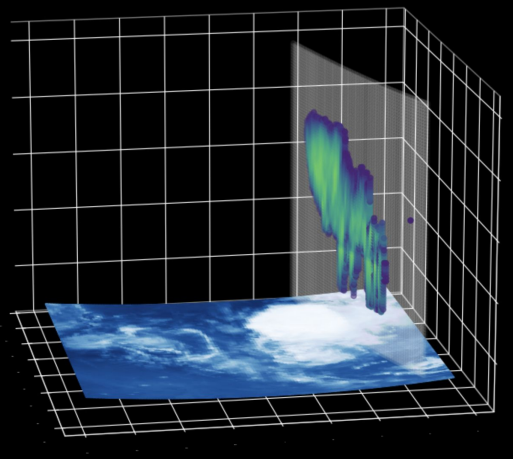




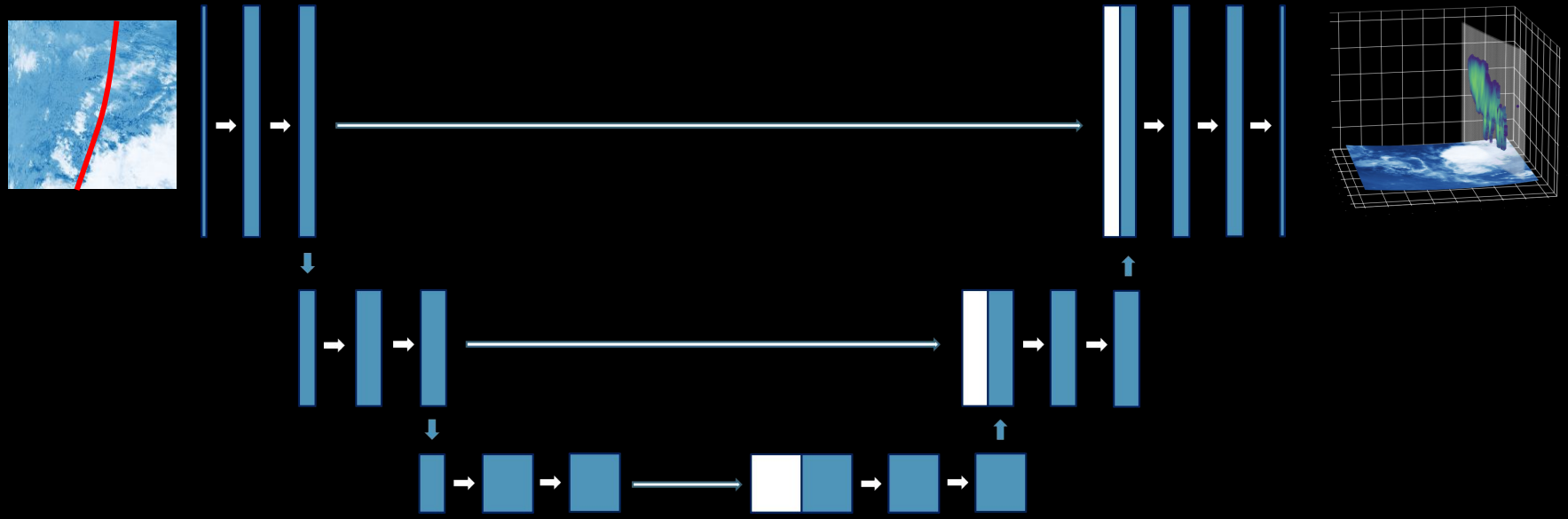
AI models to translate 2D satellite images to cloud profiles





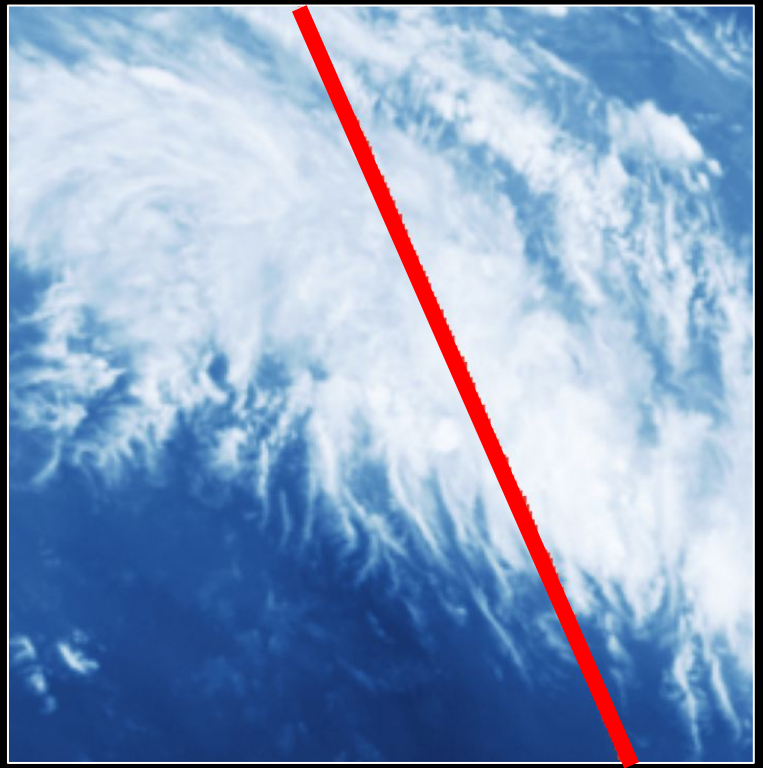


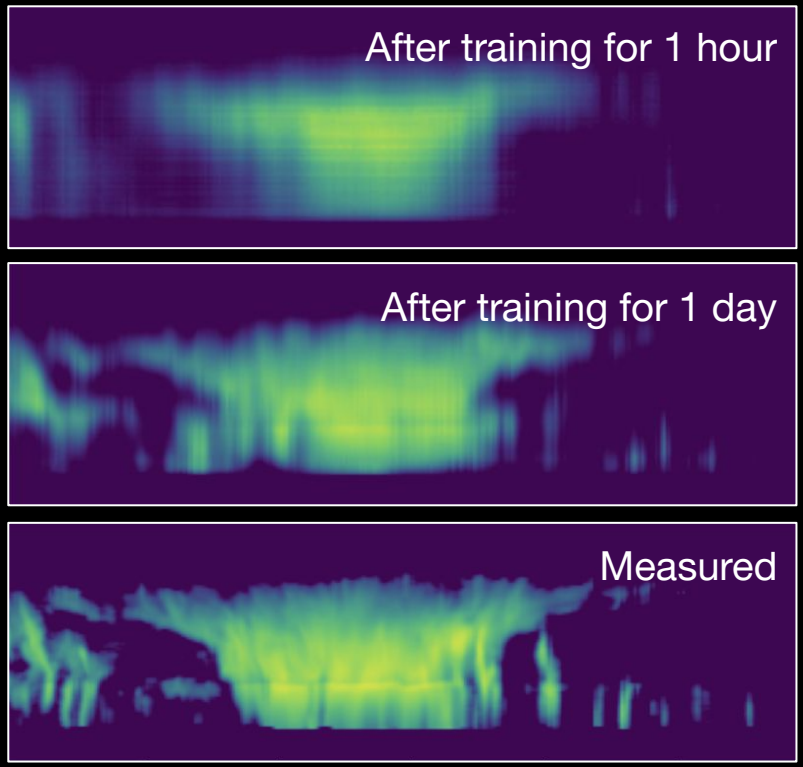
State-of-the-art approach: U-NET neural network

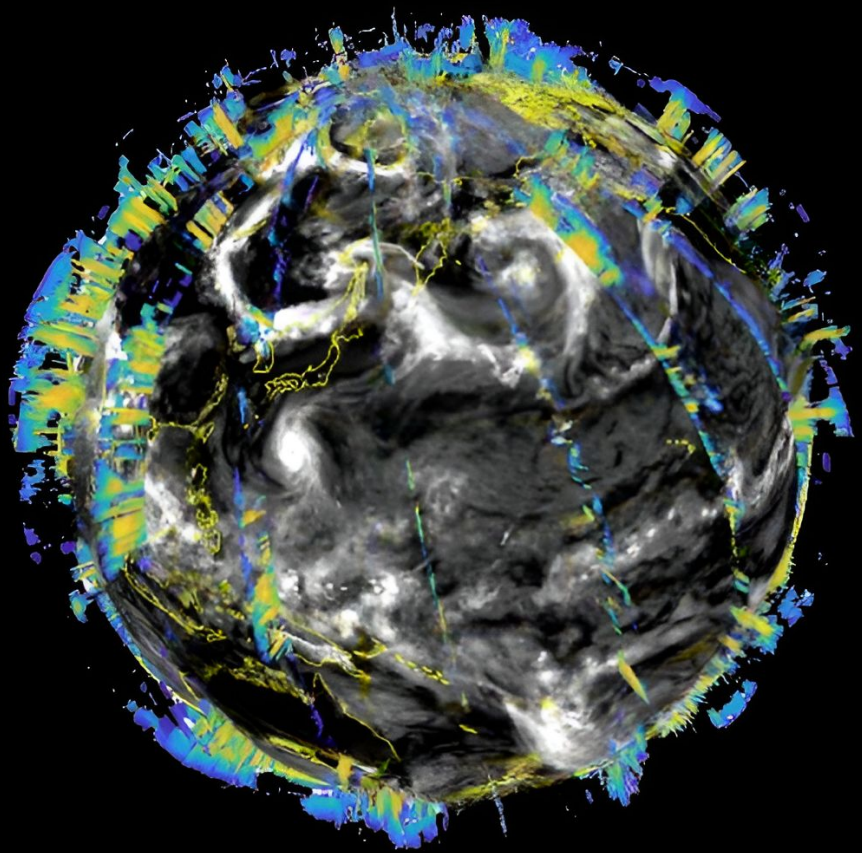


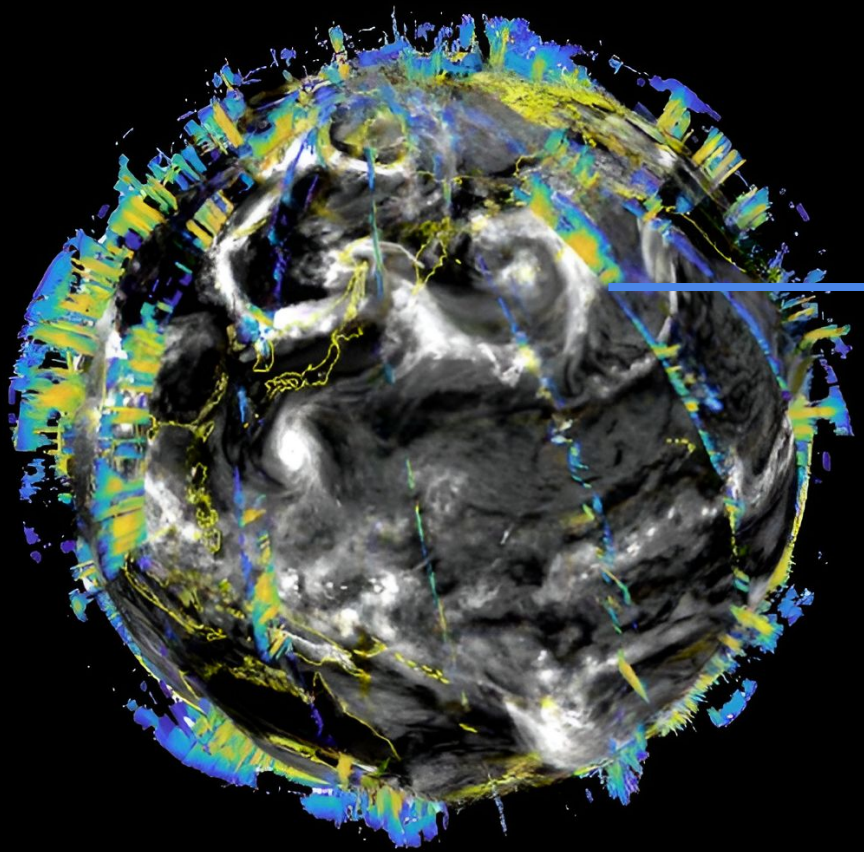
Model based on Brüning, et. al. (2023). AI-derived 3D cloud tomography from geostationary 2D satellite data

Results of state-of-the-art model

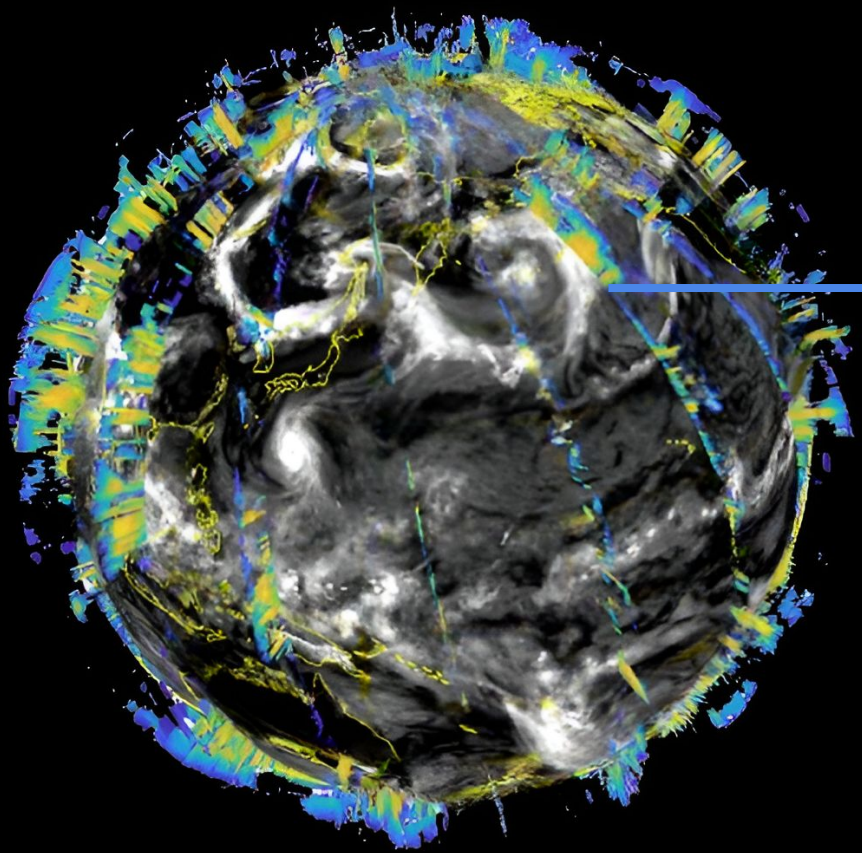




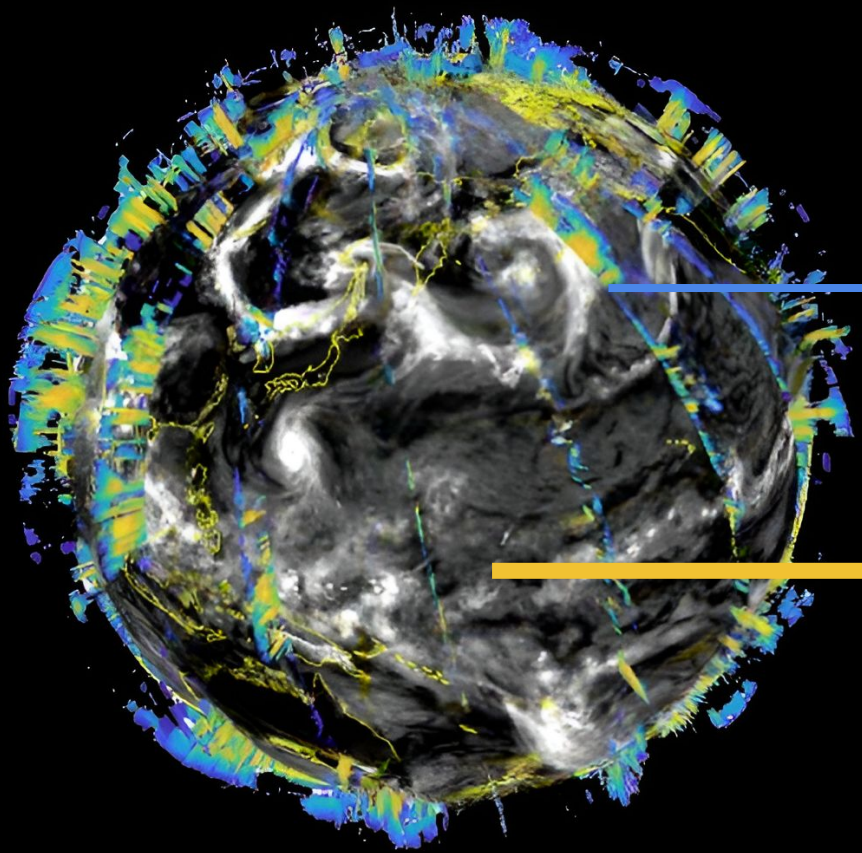




Limited coverage
of vertical profiles

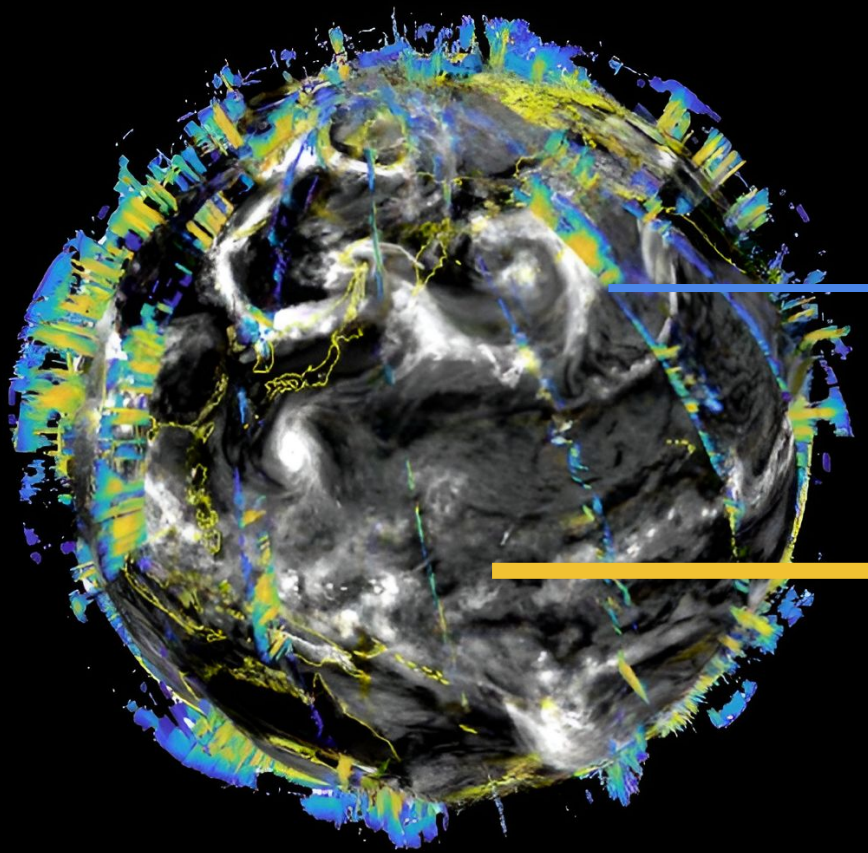


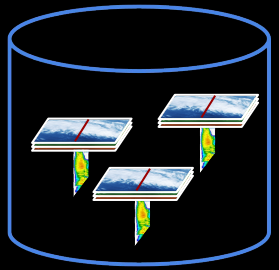
Gigabytes of **Image-Profile Pairs**



Gigabytes of **Image-Profile Pairs**

Satellite images without profiles





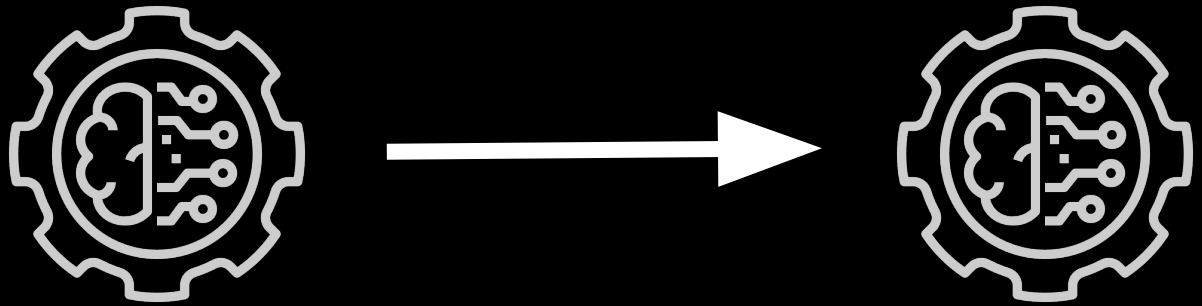
Gigabytes of **Image-Profile Pairs**

Terabytes of **Unpaired Images**

N3FOS

Step 1:
Learn from terabytes of unpaired images

Step 2:
Specialize to predict 3D using image-profile pairs



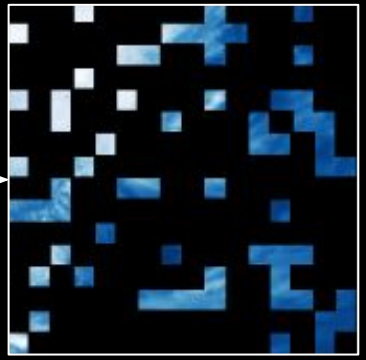
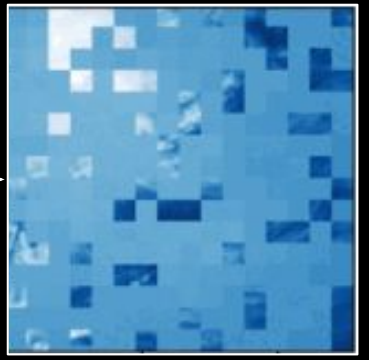
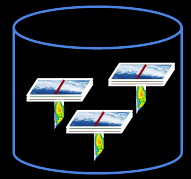


Image Encoder

Image Decoder



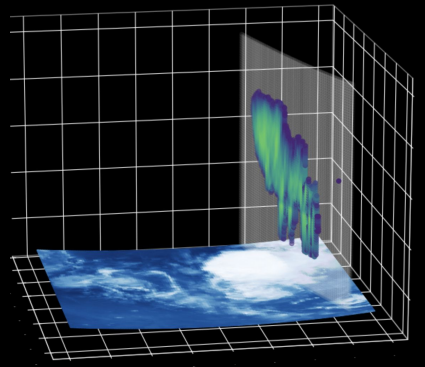


N3FOS

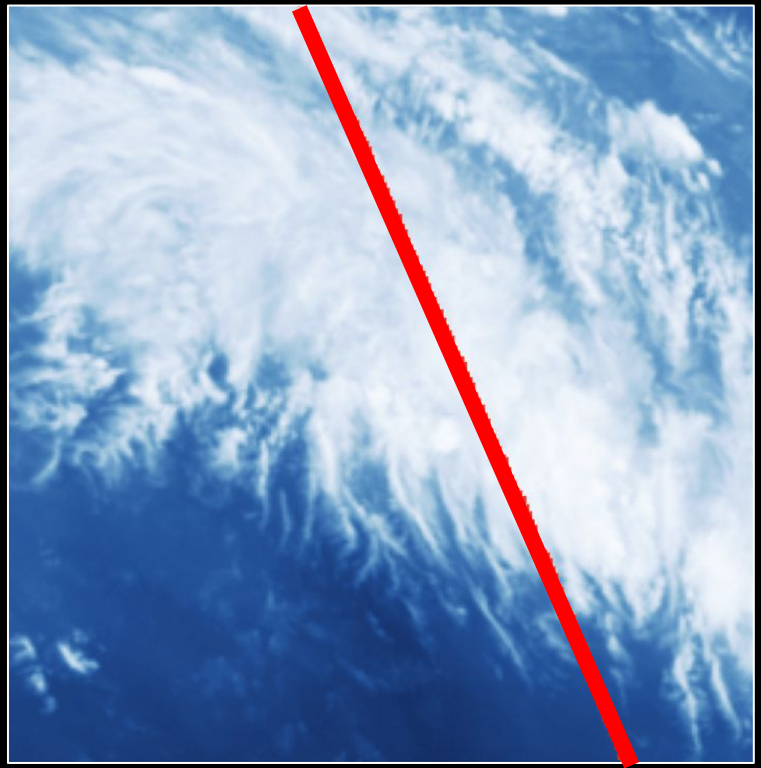
AI Model

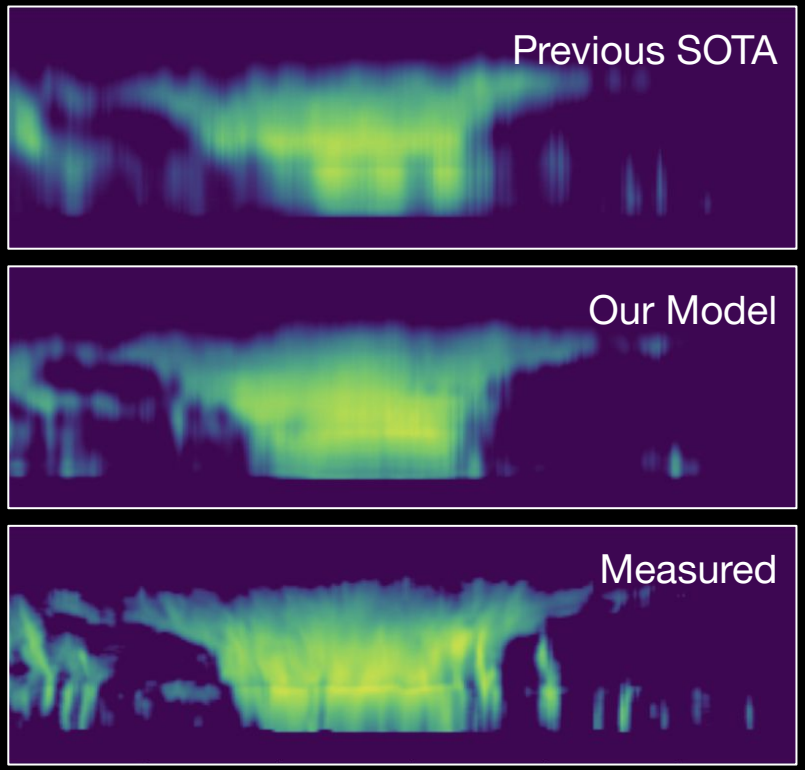
Image Encoder

3D Decoder



Results after pretraining



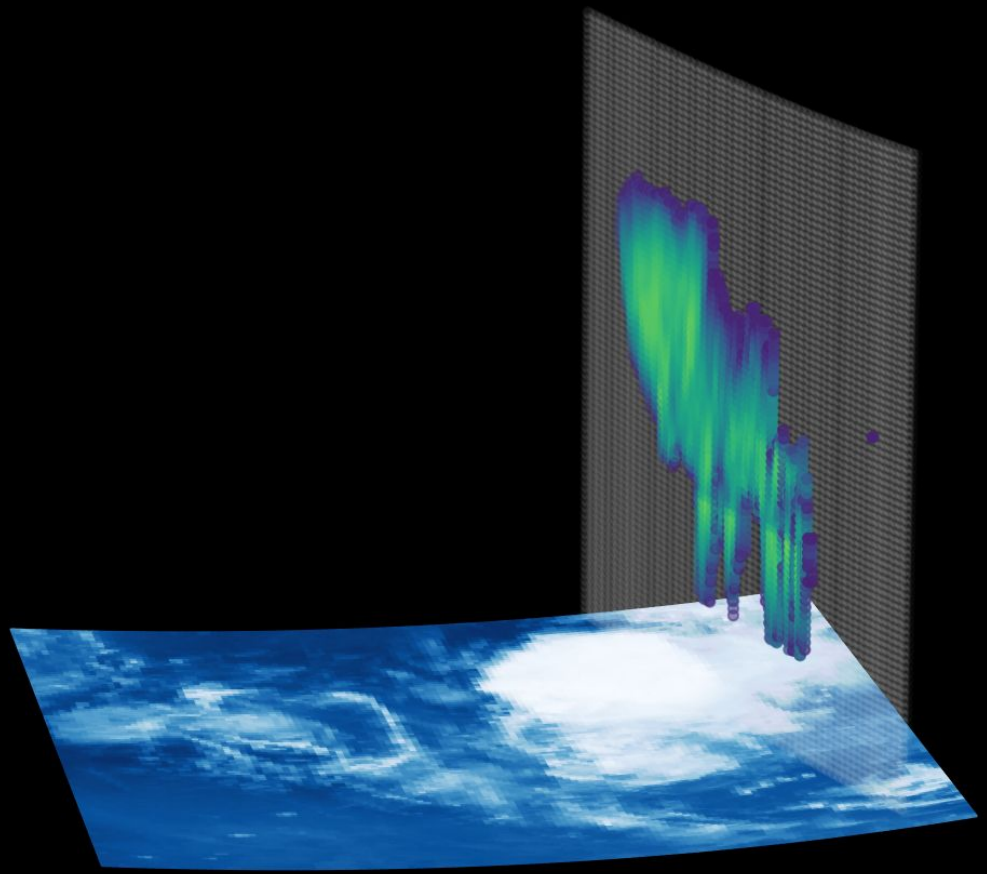


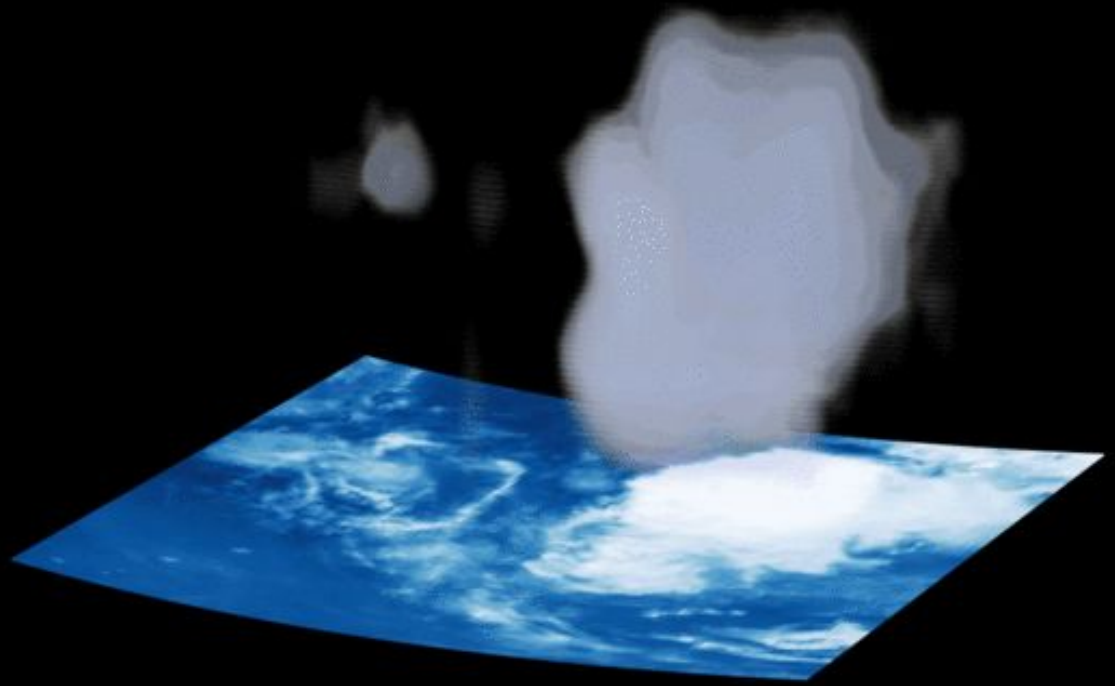
Predicting cloud type

Input

Predicted

True





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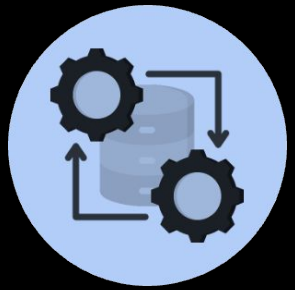


Modular Data Processing

Near real-time global satellite data

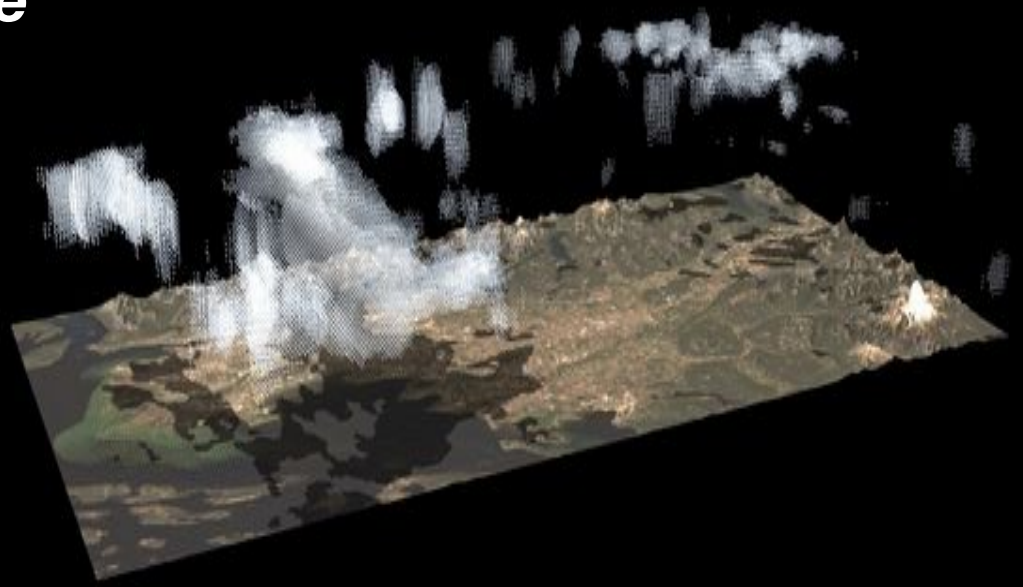
Near real-time global 3D cloud maps

Ready for EarthCARE

Provide N3FOS as a tool the community can build upon

Advance climate science via 3D cloud data

One step closer to solving the climate puzzle



Check it out yourselves!
https://3dclouds.vercel.app/