exprivia

future. perfect. simple.

ECMWF DE_350 Visualisation and Immersive Technologies

13 November 2023

Destination Earth 2nd User eXchange Meeting

Gianluca Palumbo

Partnership Overview

The Project Team is coordinated by **Exprivia** as the Prime Contractor. **Exprivia** leads a strategic partnership with key players in the fields of **AR/VR, Geospatial Scientific Data Visualisation, Big Data.**

Thanks to long experience and deep knowhow, the **project Team** brings **a consolidated technical** basis leveraging on the contract team **diverse yet complementary heritage**

The allocation of activities between the partners' mirrors their core expertise in proposed system main components

- **Data access/preparation**
- **Data handling**
- **Data visualization**
- **Communication (conferences)**

Partnership Overview

The **Project Team** is coordinated by **Exprivia** as Prime Contractor.

- **G. Palumbo** – Overall PM
- **M. Cuomo** – Technical Leader
- **M. Ricci** – Development Coordinator
- **P. Farinelli** – Senior SW Development
- **R. Rietti** – Senior SW Development
- **A. Pettazzoni** – SW Development
- **L. Compagnone** – CADM
- **G. Pace – CGI lead**
  3D, Data preparation/Backend
- **C. Rossi, S. Marra,** CGI SW Development
- **S. Mantovani – MEEO Lead**
  Data preparation/Backend
- **D. Barboni, F. Govoni. L. Vettorello,**
  MEEO SW Development
- **G. Coppini – CMCC Lead** – Climate Science
- **R. Lecci, P. Lanteri, E. Scoccimarro** –
  Scientific Support and Communication

Interactive Immersive Experiences in AR/VR based on Real World Data

Interactive Immersive 3D

PC and Mobile Platforms

Interactive 3D Experiences

Support for multiple types of devices

Project Timeline
End 2022 - Mid 2024

Iterative Approach

Continuous Integration of Feedback (internal / external)

Always Based on Data

These are interesting years for AR/VR (2023-24)
rapid evolution, acceleration to wider adoption
(e.g., “metaverse” in the news)

- **NOV 2022** Kick Off, project startup activities, workshops / clarifications / Q&A
- **DEC 2022** Definition of Requirements, Design, Acceptance Tests, etc
- **JAN 2023** Definition of Documentation Architecture, Workshops Use-Cases
- **FEB 2023** Start of Implementation, SW Development, Workshops Visual Styles,
  - work on User Flow, Interaction Design (3D, AR, VR),
  - Data management
- **MAR 2023** presentation of 1st Proof of Concept (prototype 1/5)
  - **Front end, demo**: early stage 3D visualisation based on Unity
  - **Back end demo**: early stage data access/preparation pipelines

Project Timeline
End 2022 - Mid 2024

- **APR 2023**
- **MAY 2023**
- **JUN 2023** – Prototype R2/5 (frontend + backend integration)

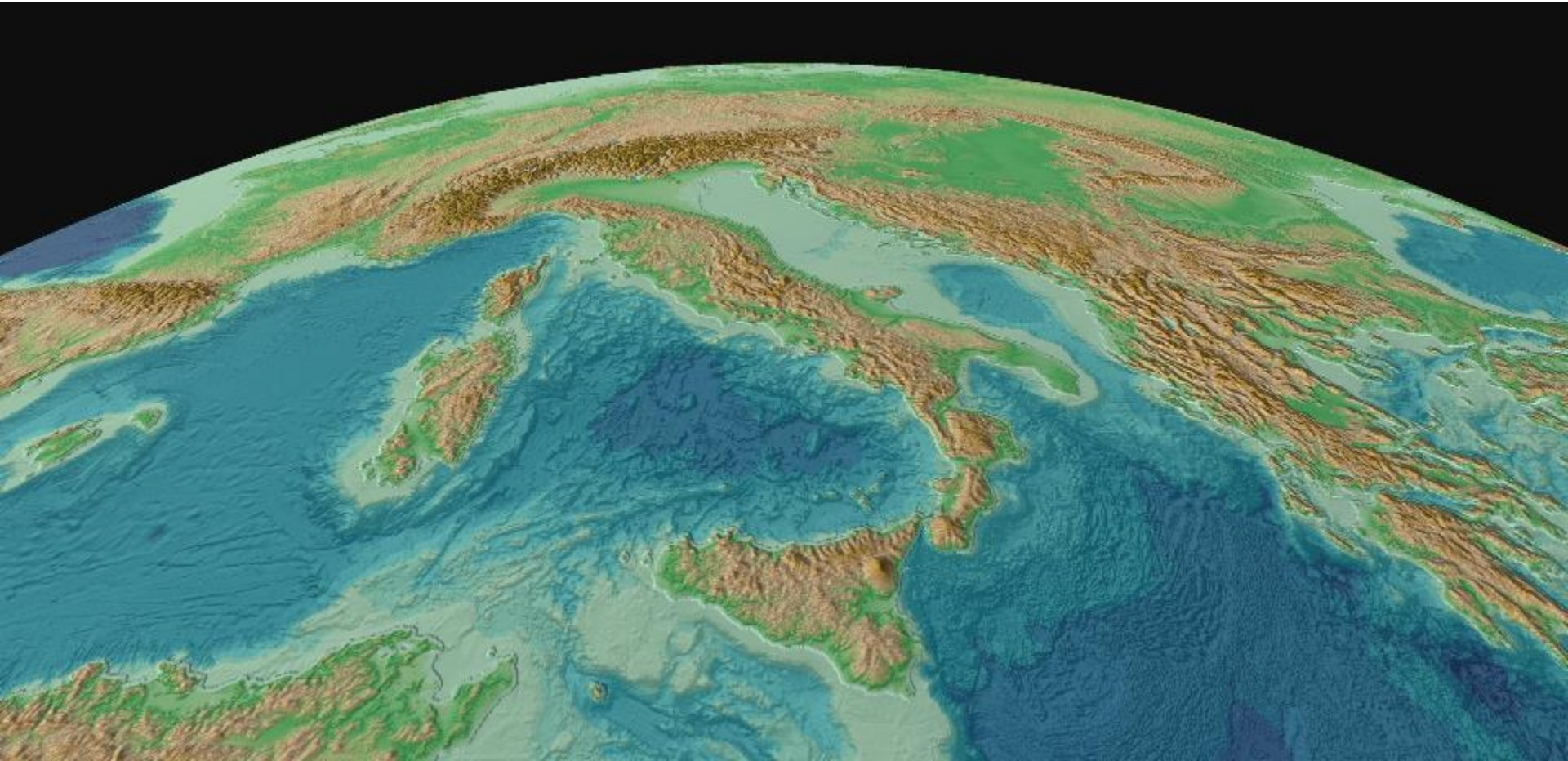
- **JUL 2023**
- **AUG 2023**
- **SEP 2023**
- **OCT 2023** – Prototype R3/5 (GUI, Interaction, “Show Loading/Saving”)

- **NOV 2023** – 2nd DestinE User eXchange Bonn “samples of shows”
- **DIC 2023**
- **GEN 2024**

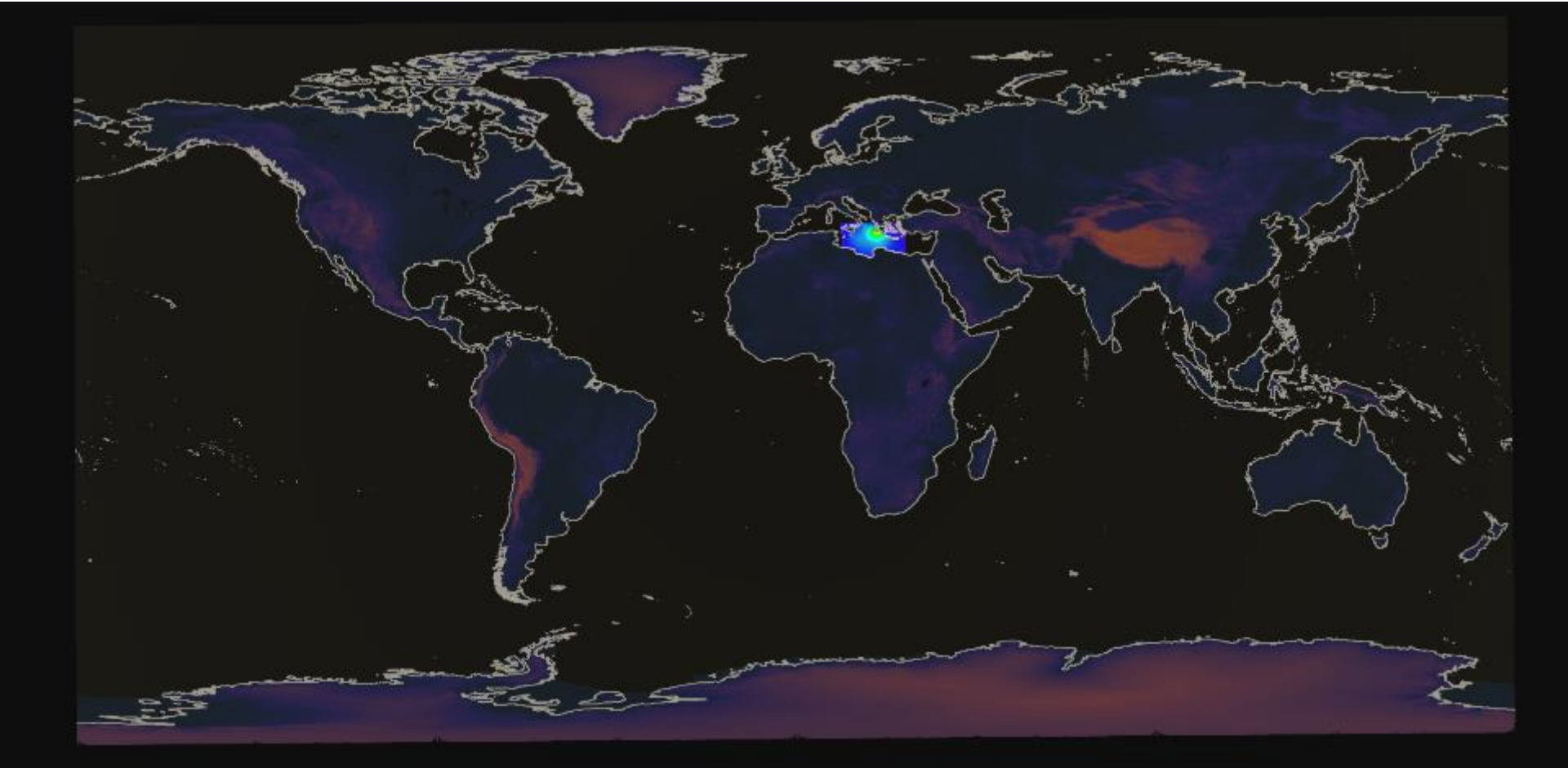
- **FEB 2024** – Prototype R4/5
- **MAR 2024**
- **APR 2024**

- **Prototype R5/5**

Prototype R3



Prototype R3



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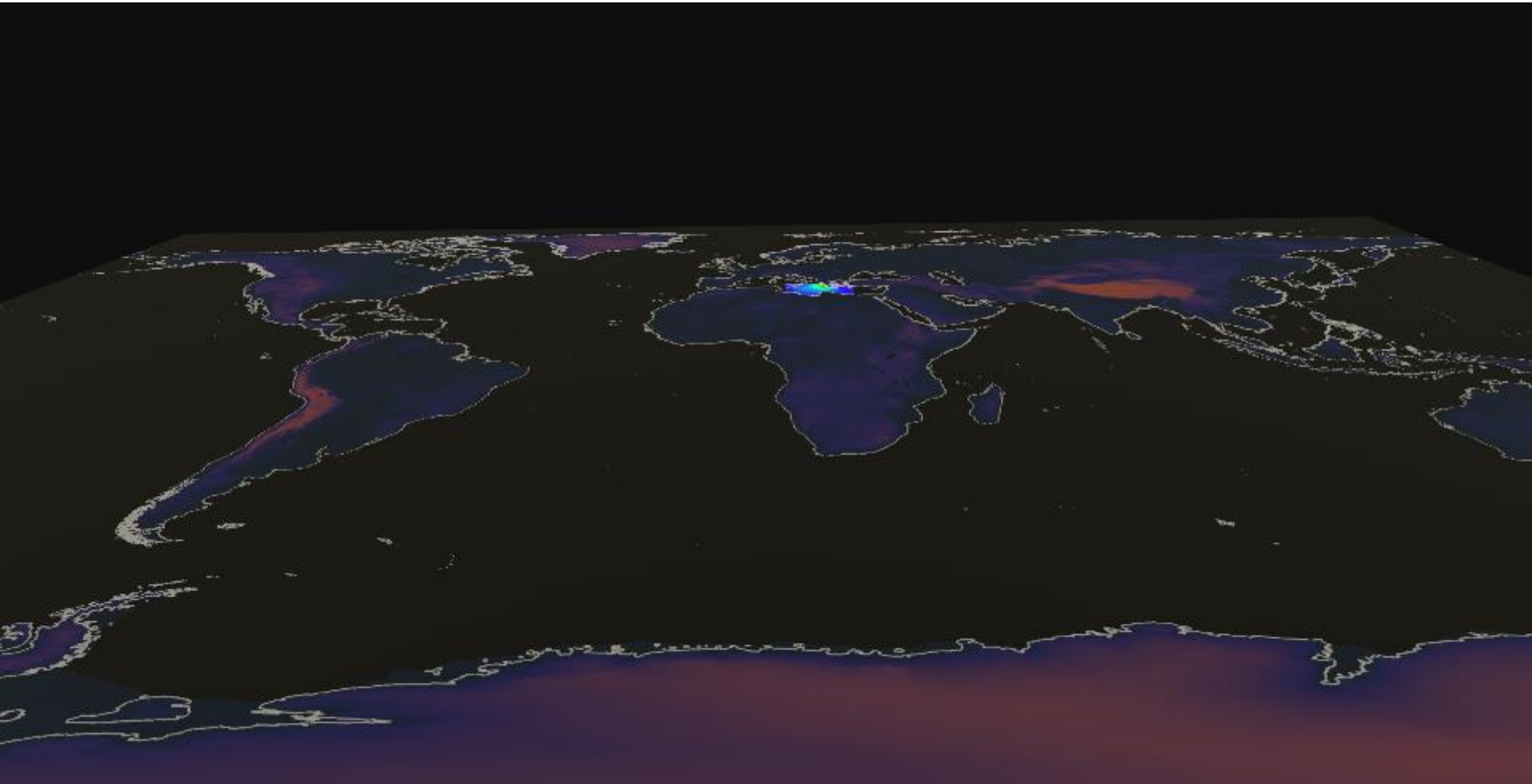

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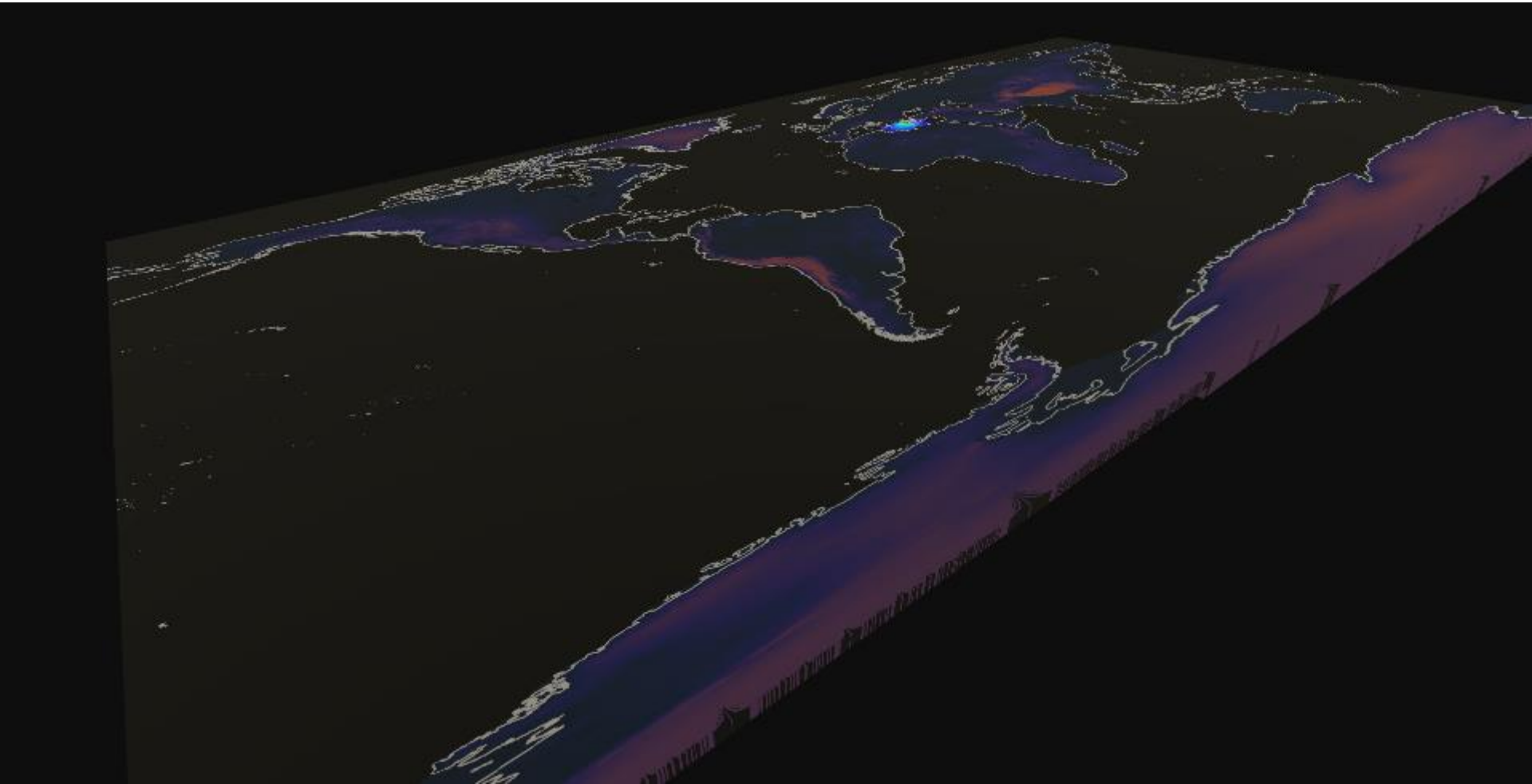

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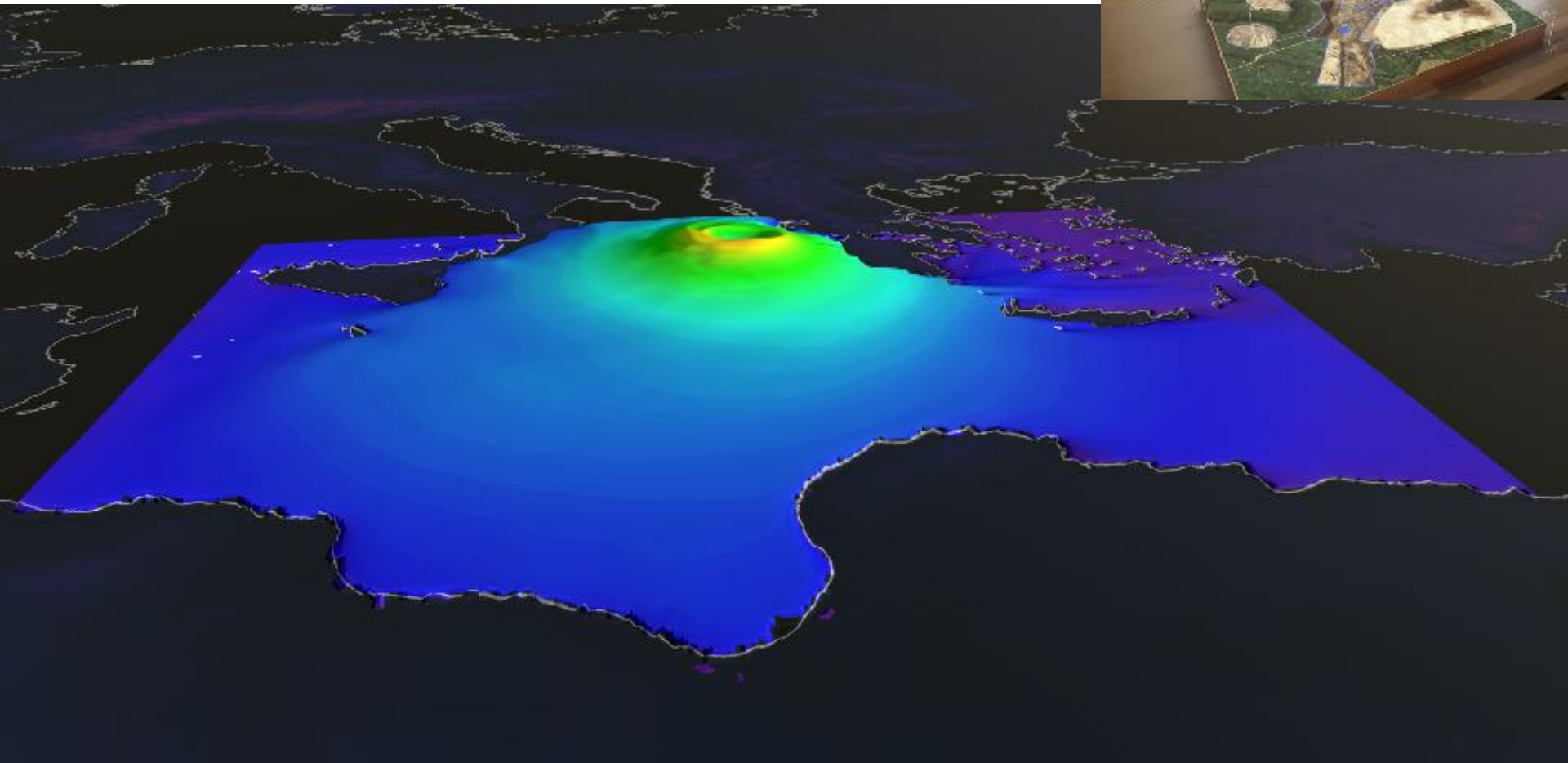

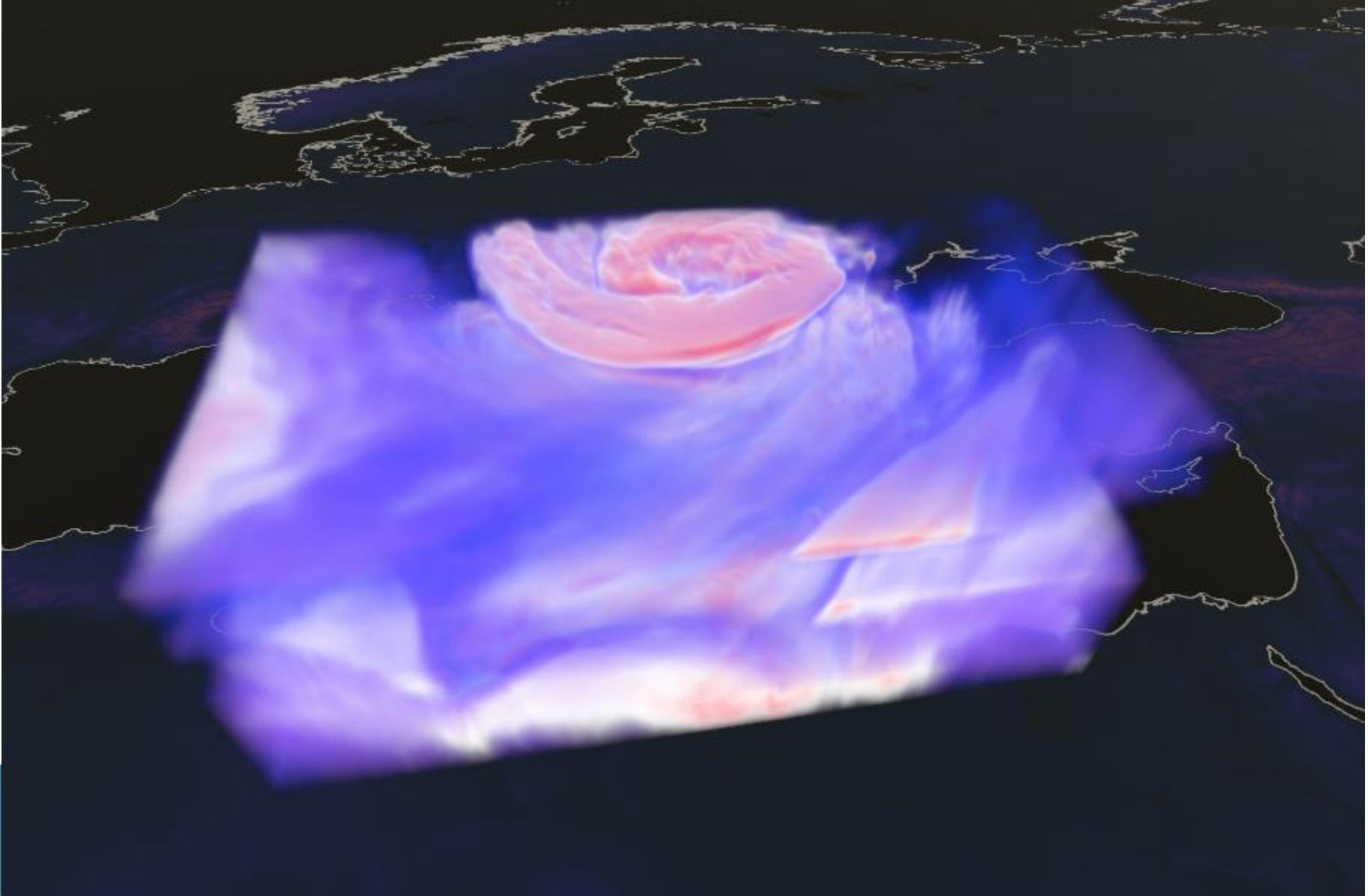

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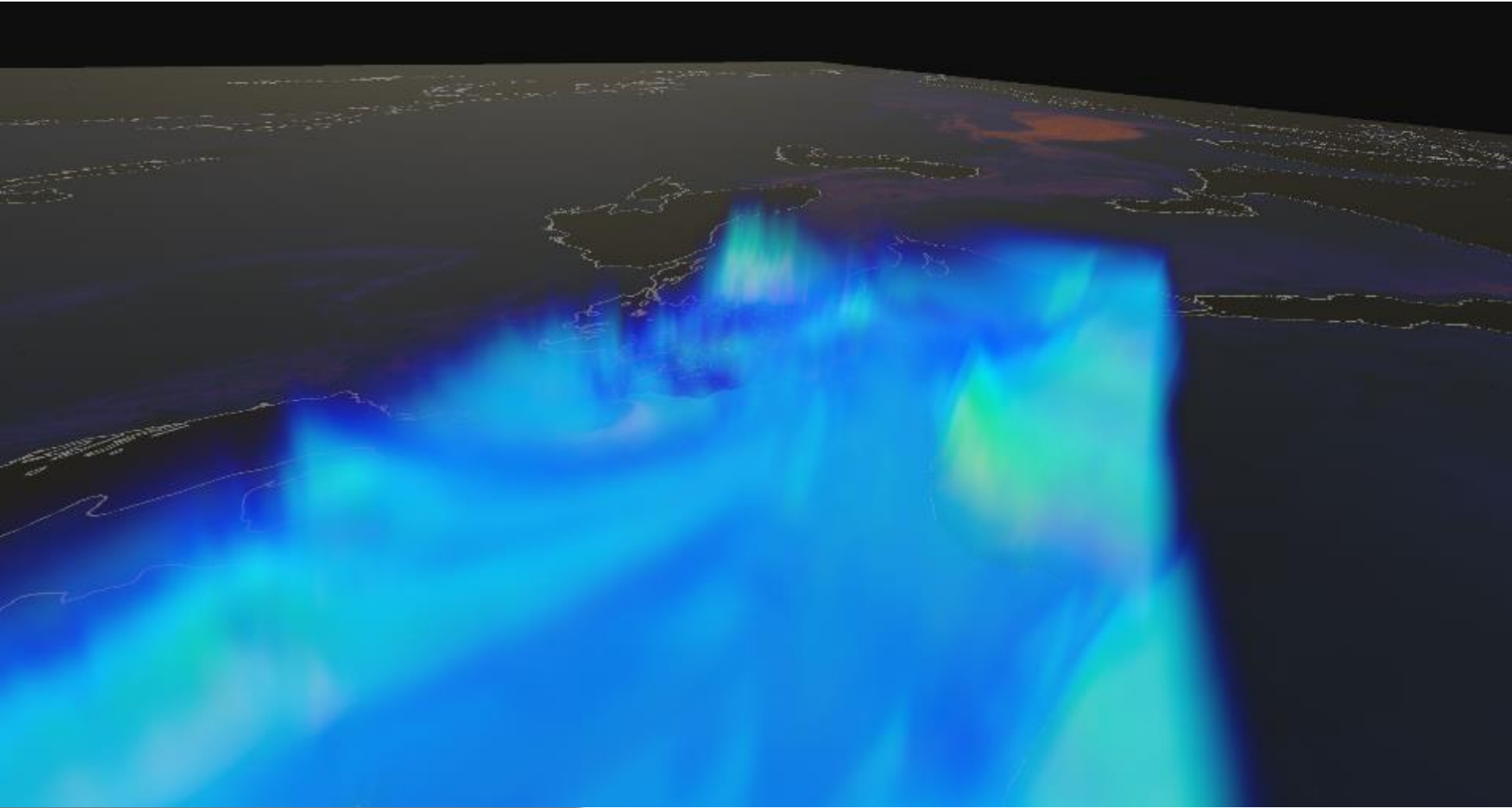

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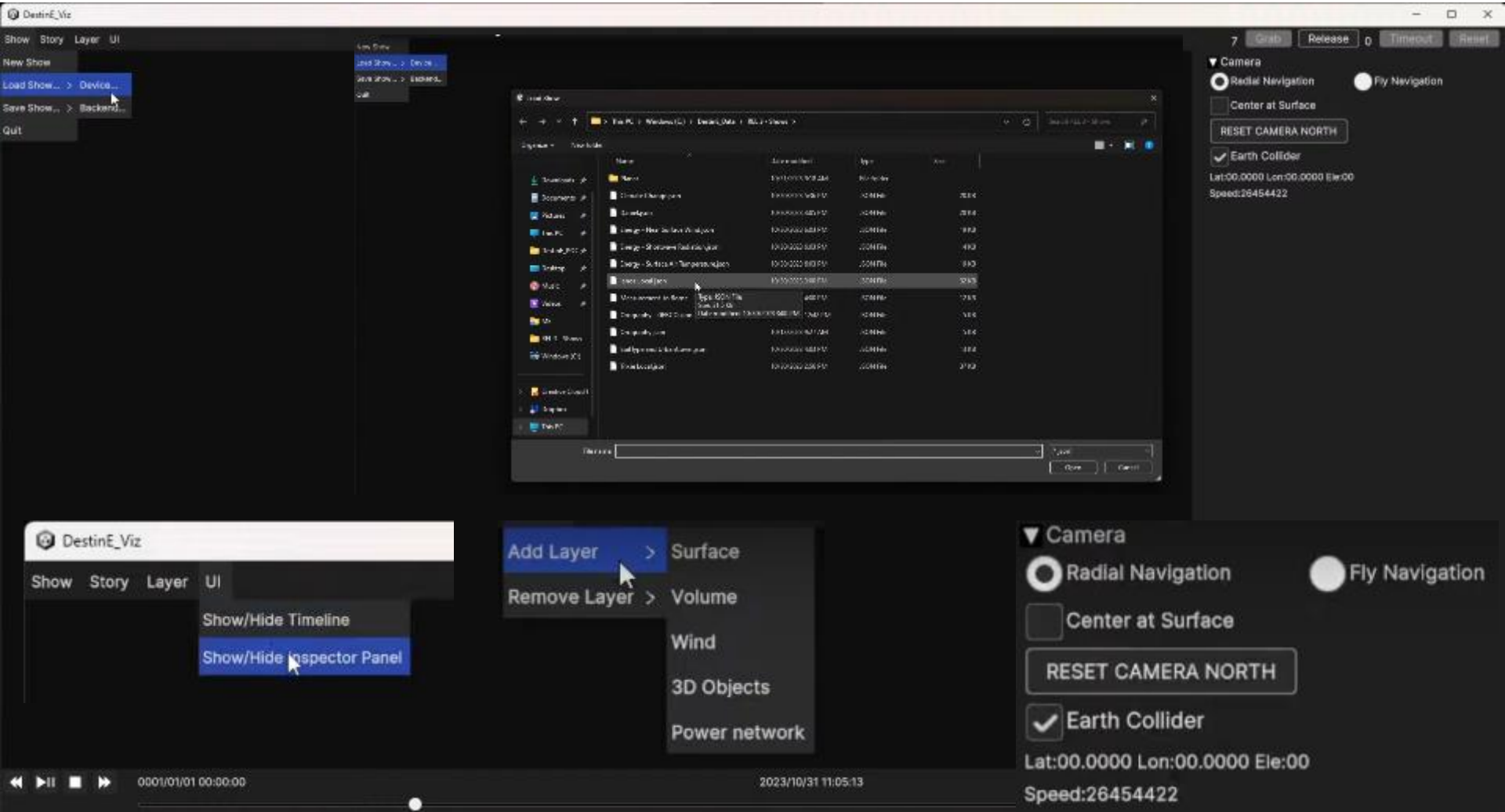

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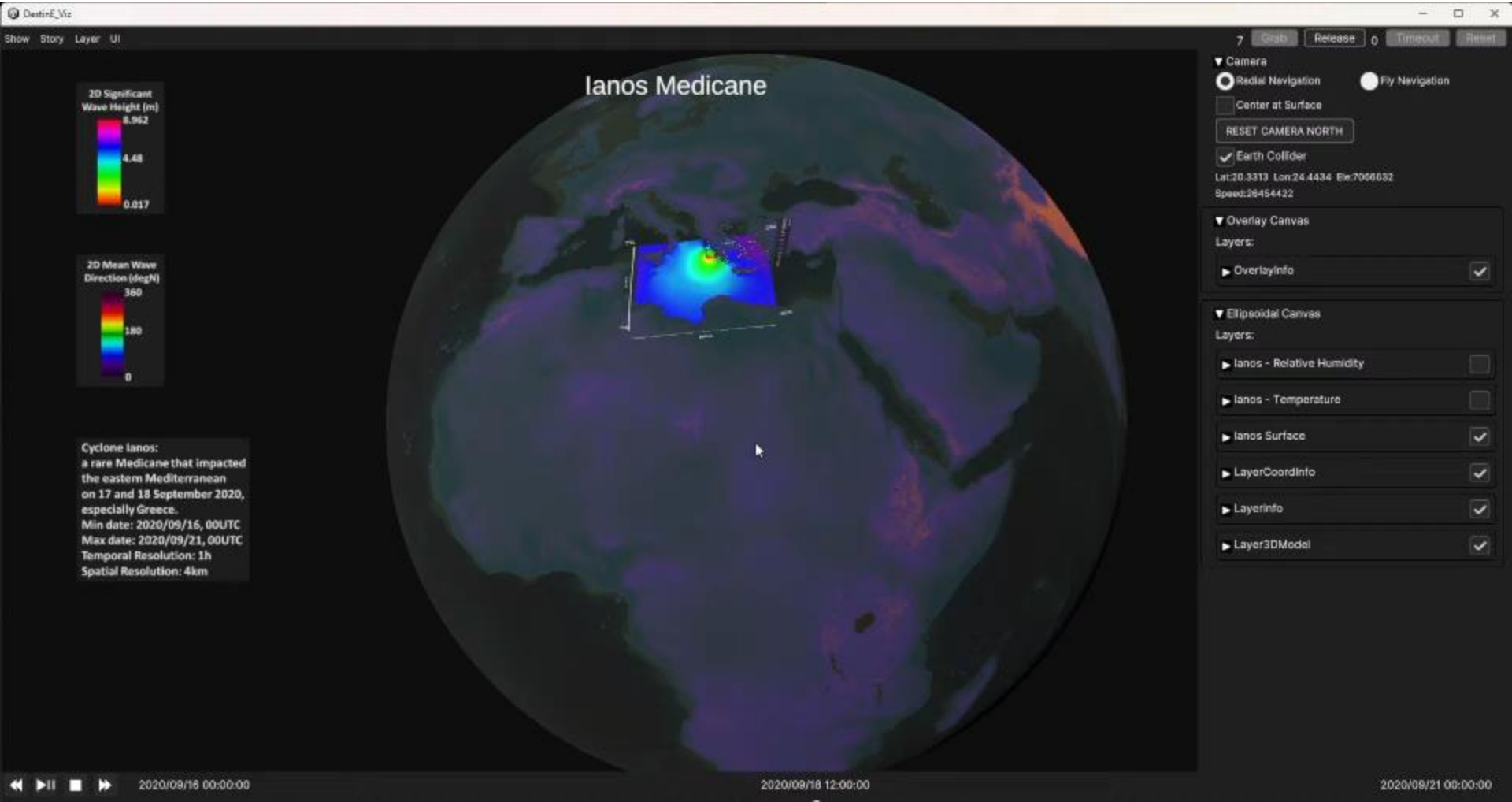

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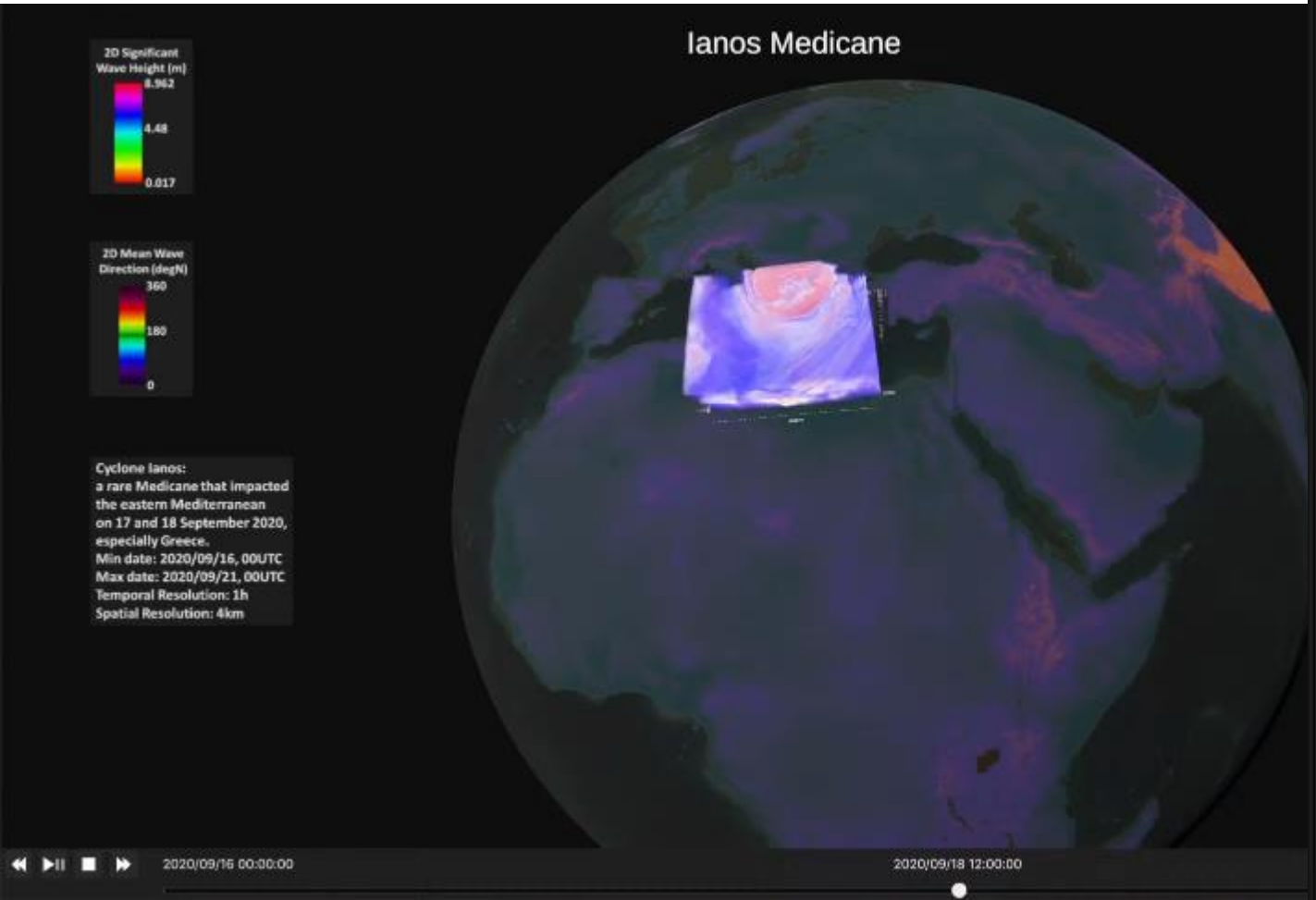

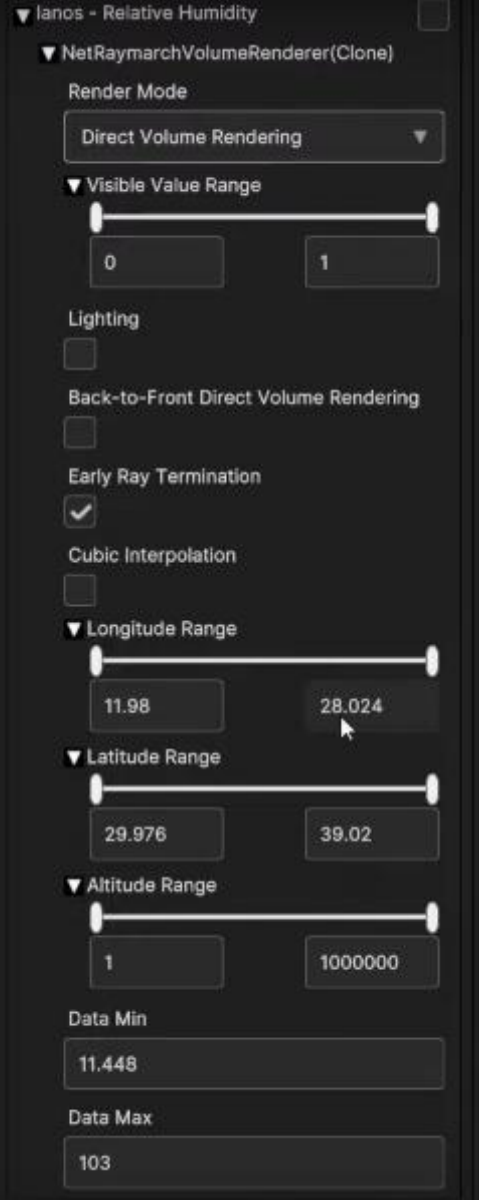

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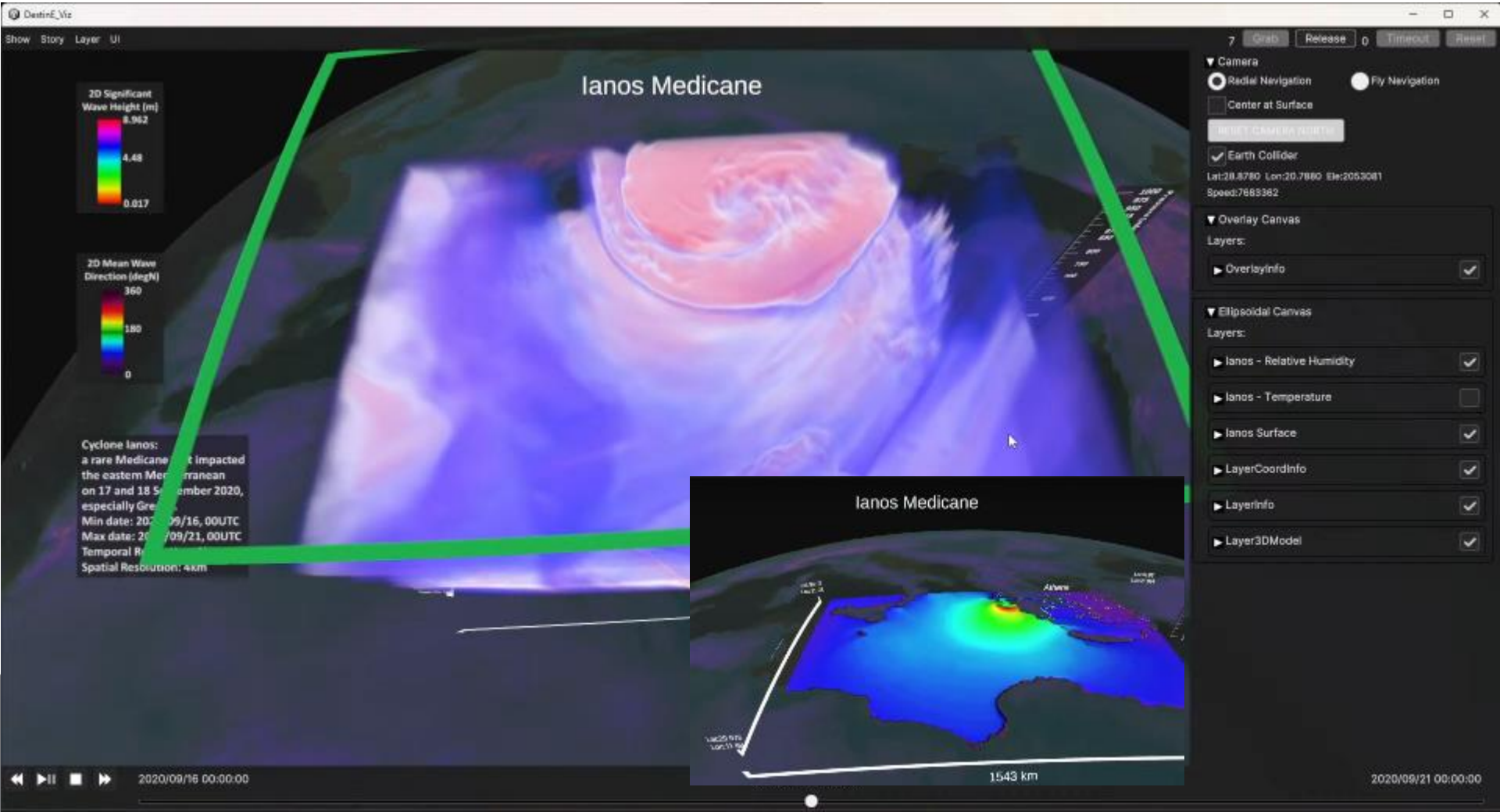

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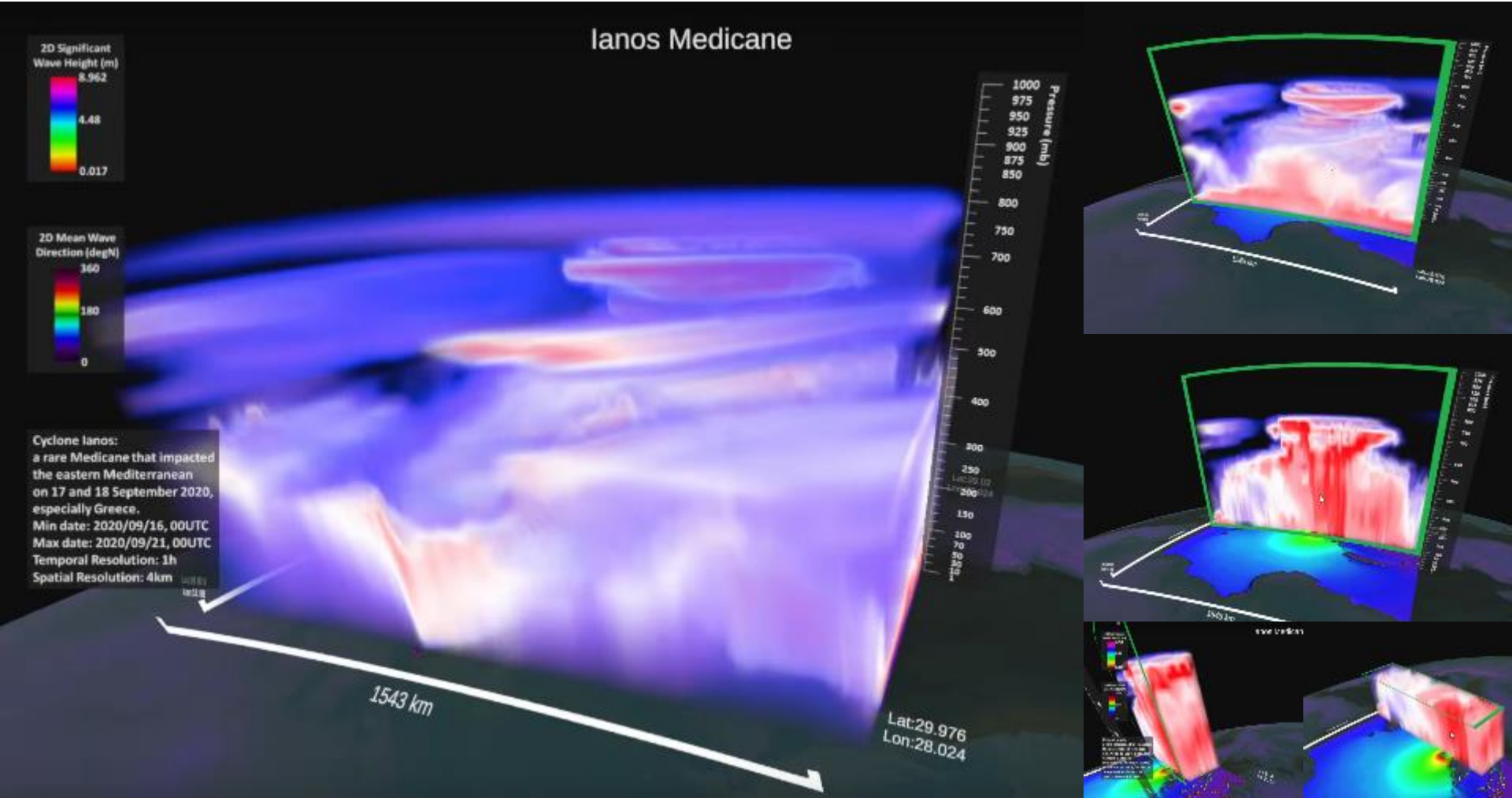

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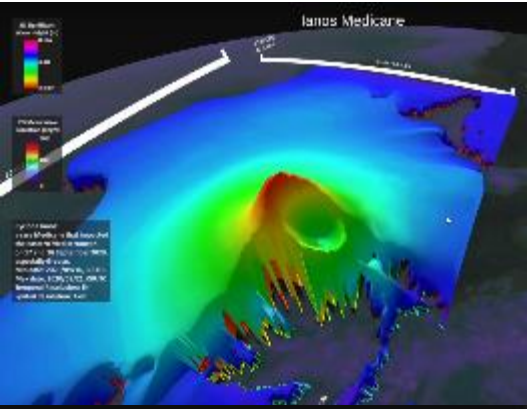
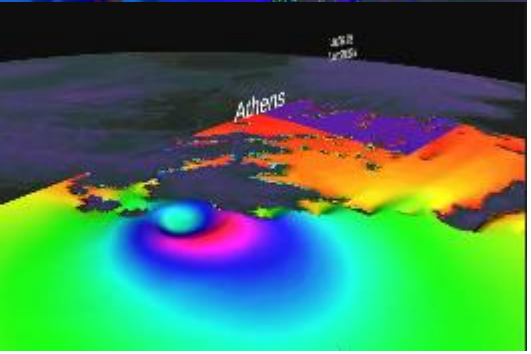




Ianos Surface

Refresh

DEM

SWH [2]

DEM Displacement Factor

DEM Bump Strength

DEM Smoothness

DEM Lighting

▶ SWH

▶ MWD

▶ height1km

▶ GEBCO_LATEST

▼ Data Source Parameters

Dataset IANOS

Sub Dataset SWH

Bilinear Filter:

Mode:

Preview | High-Res

Preview status: successful

High-Res status: successful

Min Value 0.02

Max Value 8.96

No Data Value 9999

Colormap default

▶ Time Of Interest

▶ Area Of Interest

Info | Apply

▼ Ellipsoidal Canvas

Layers:

▼ Ianos - Relative Humidity

▼ NetRaymarchVolumeRenderer(Clone)

Render Mode

Direct Volume Rendering

▼ Visible Value Range

0 1

Lighting

Back-to-Front Direct Volume Rendering

Early Ray Termination

Cubic Interpolation

▼ Longitude Range

11.98 26.82203

▼ Latitude Range

30.85808 39.02

▼ Altitude Range

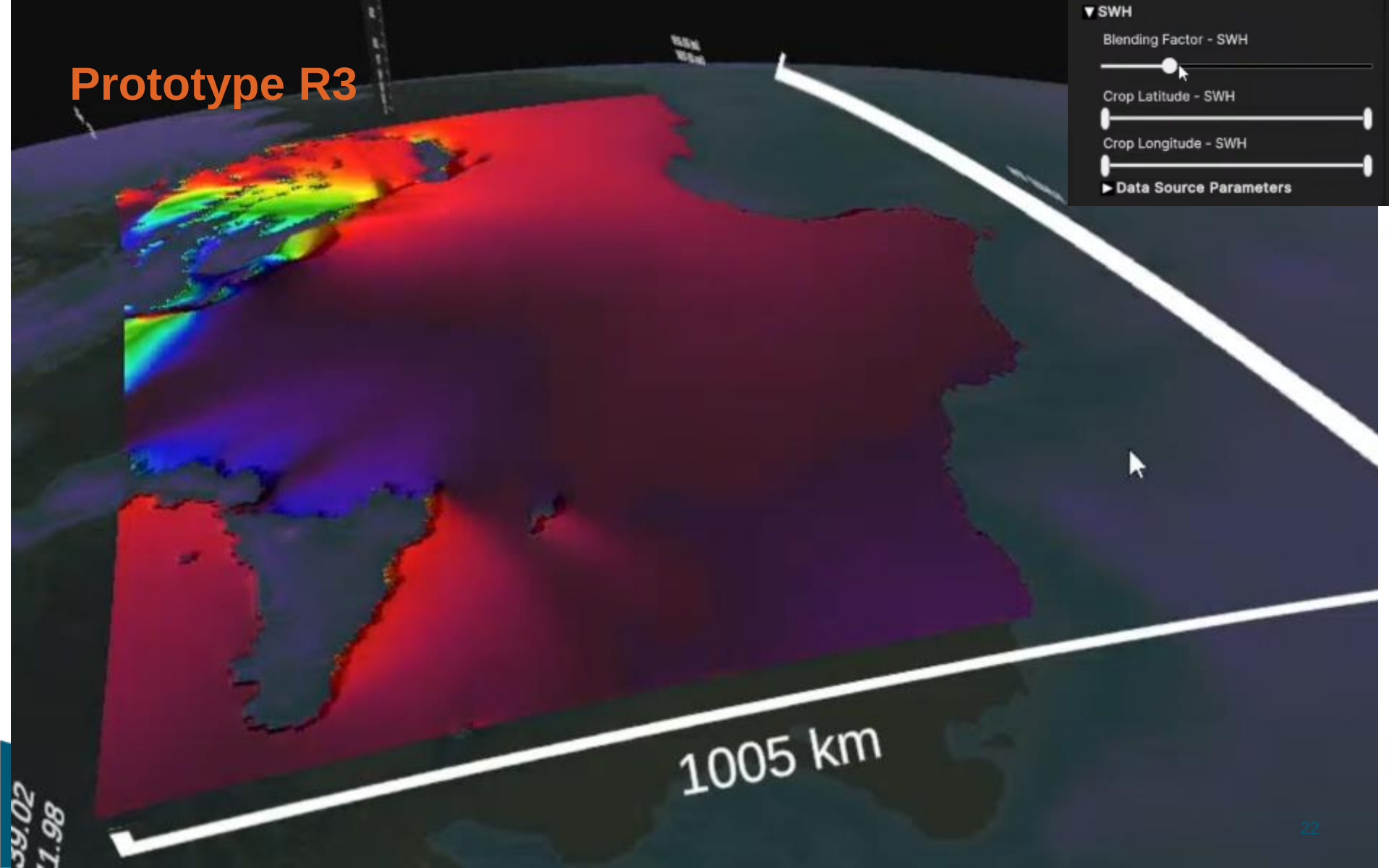
1 517318

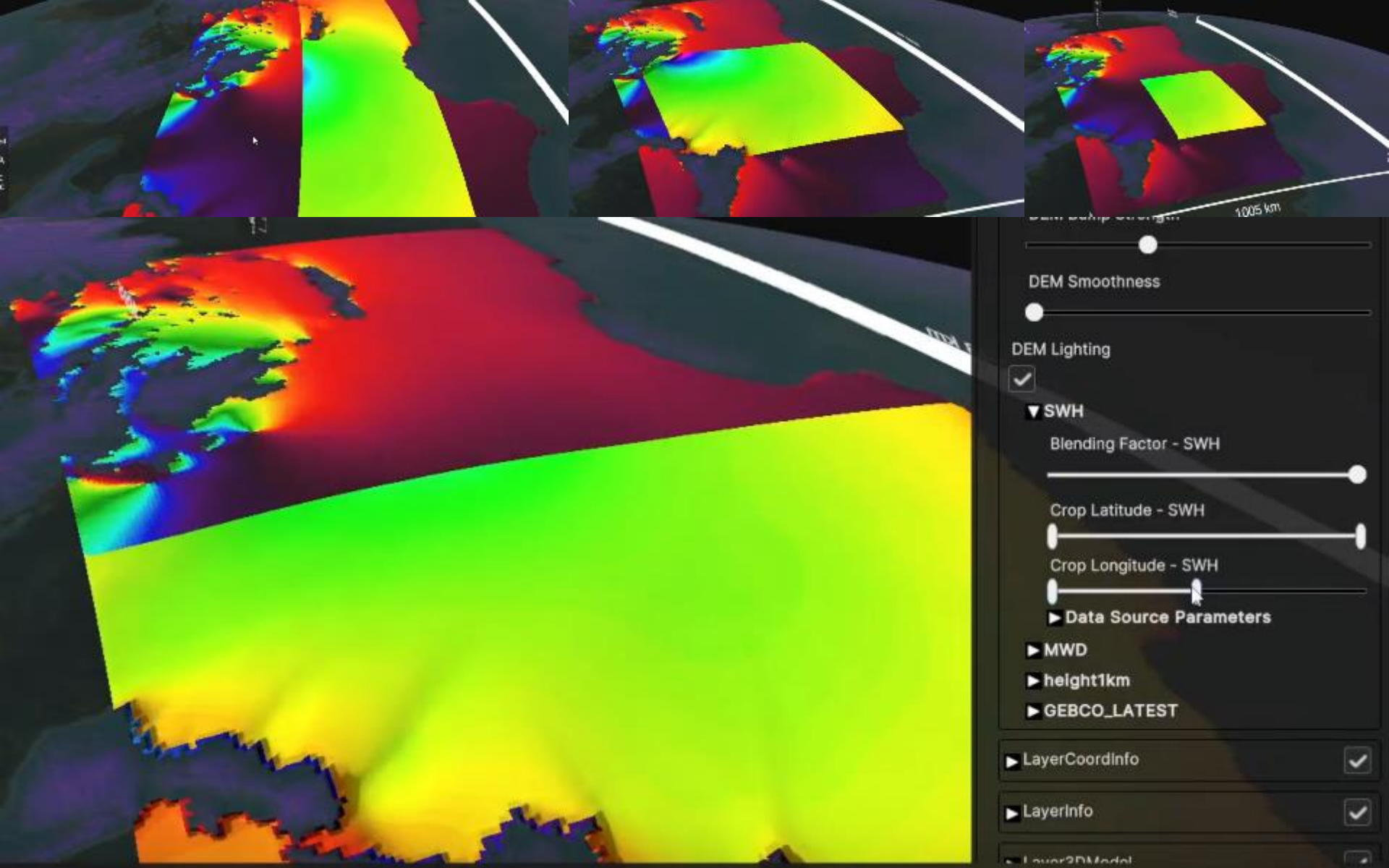
Data Min

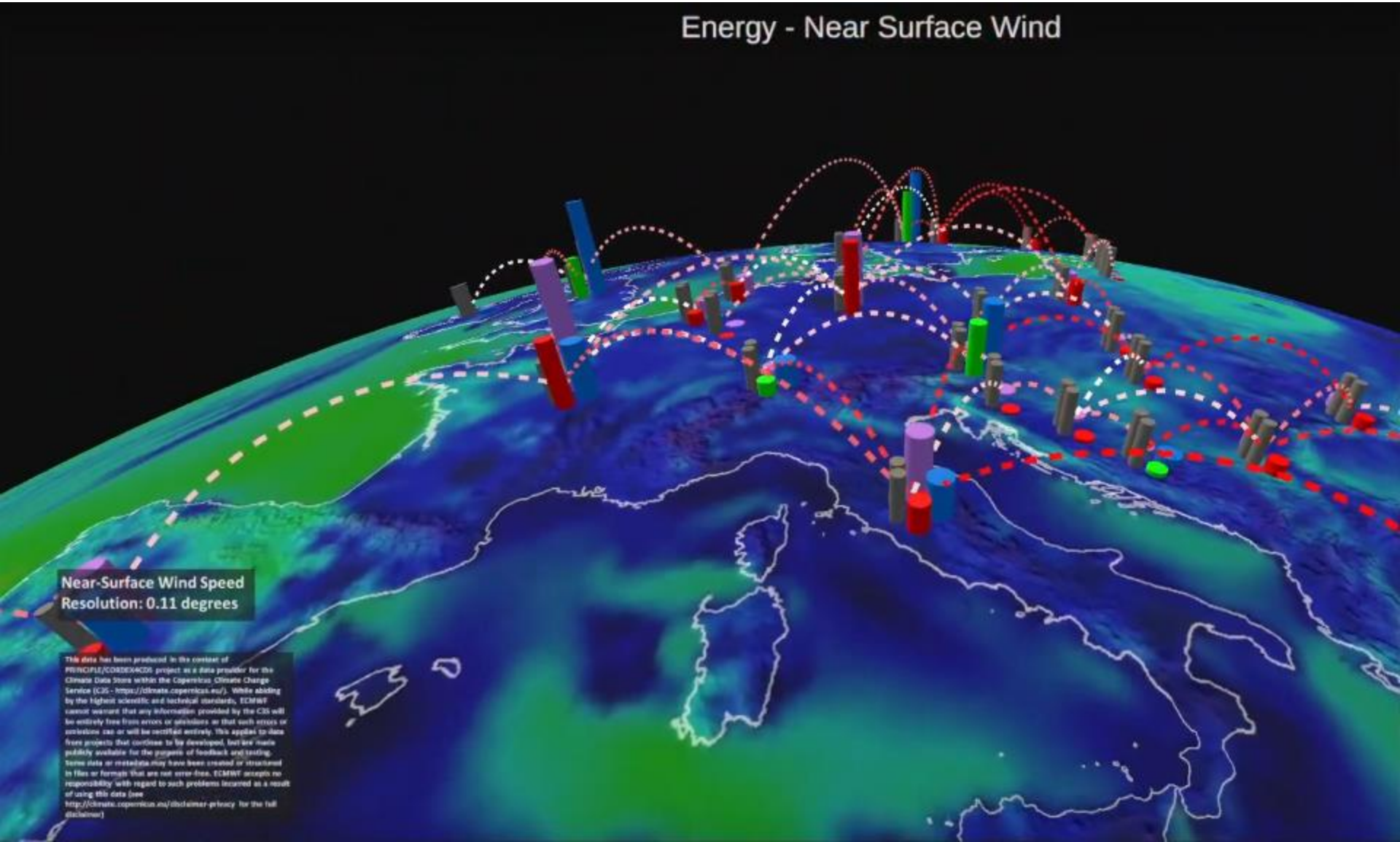
exprivia

Defence & Aerospace Digital Factory

Prototype R3




1005 km
DEM Smoothness
DEM Lighting
SWH
Blending Factor - SWH
Crop Latitude - SWH
Crop Longitude - SWH
Data Source Parameters
MWD
height1km
GEBCO_LATEST
LayerCoordInfo
LayerInfo


Energy - Near Surface Wind
Near-Surface Wind Speed
Resolution: 0.11 degrees
This data has been produced in the context of PRINCIPLE/CORDEX4CDS project as a data provider for the Climate Data Store within the Copernicus Climate Change Service (C3S - https://climate.copernicus.eu/). While abiding by the highest scientific and technical standards, ECMWF cannot warrant that any information provided by the C3S will be entirely free from errors or omissions or that such errors or omissions can or will be rectified entirely. This applies to data from projects that continue to be developed, but are made publicly available for the purpose of feedback and testing. Some data or metadata may have been created or structured in files or formats that are not error-free. ECMWF accepts no responsibility with regard to such problems incurred as a result of using this data (see http://climate.copernicus.eu/disclaimer-privacy for the full disclaimer)

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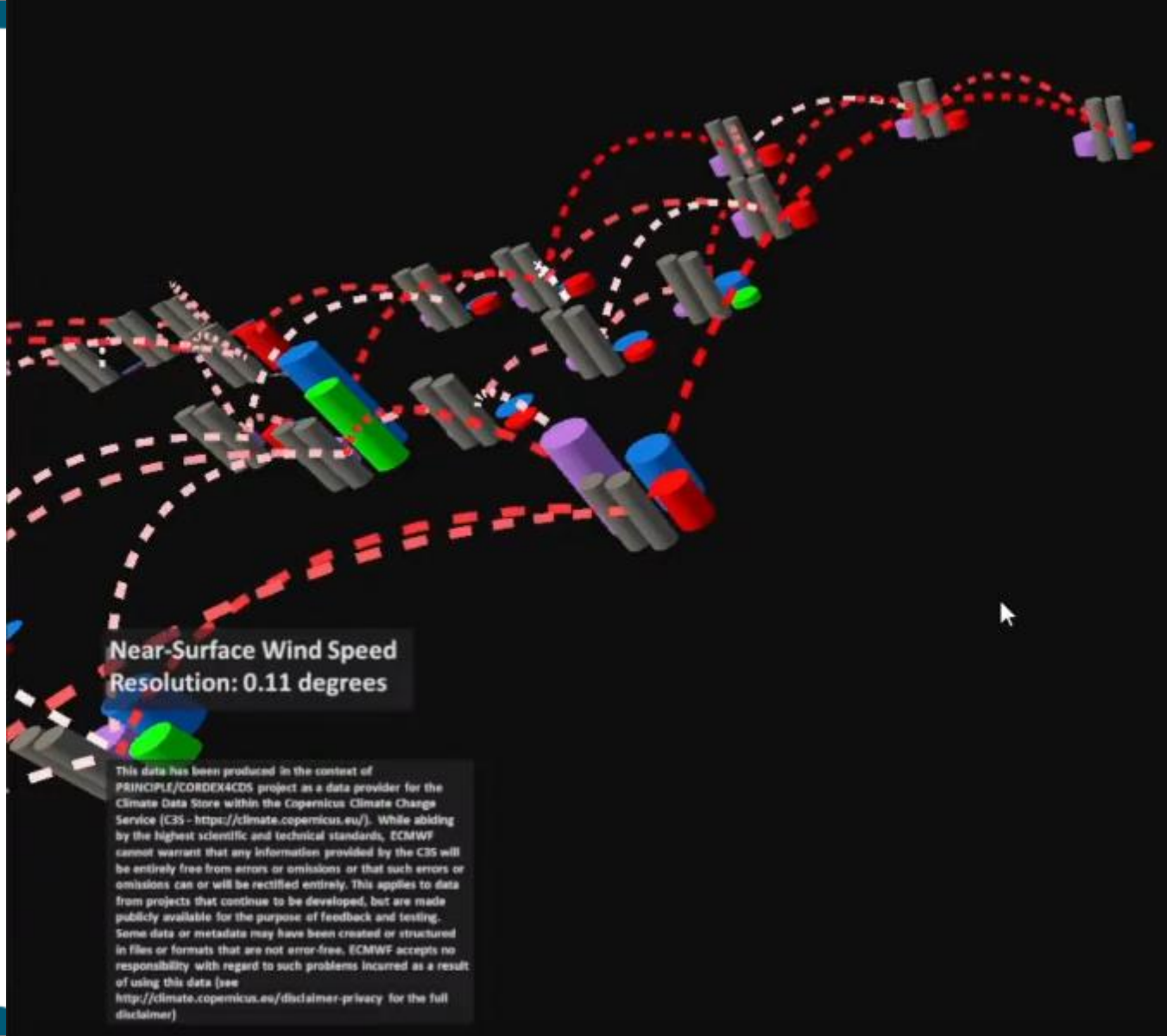

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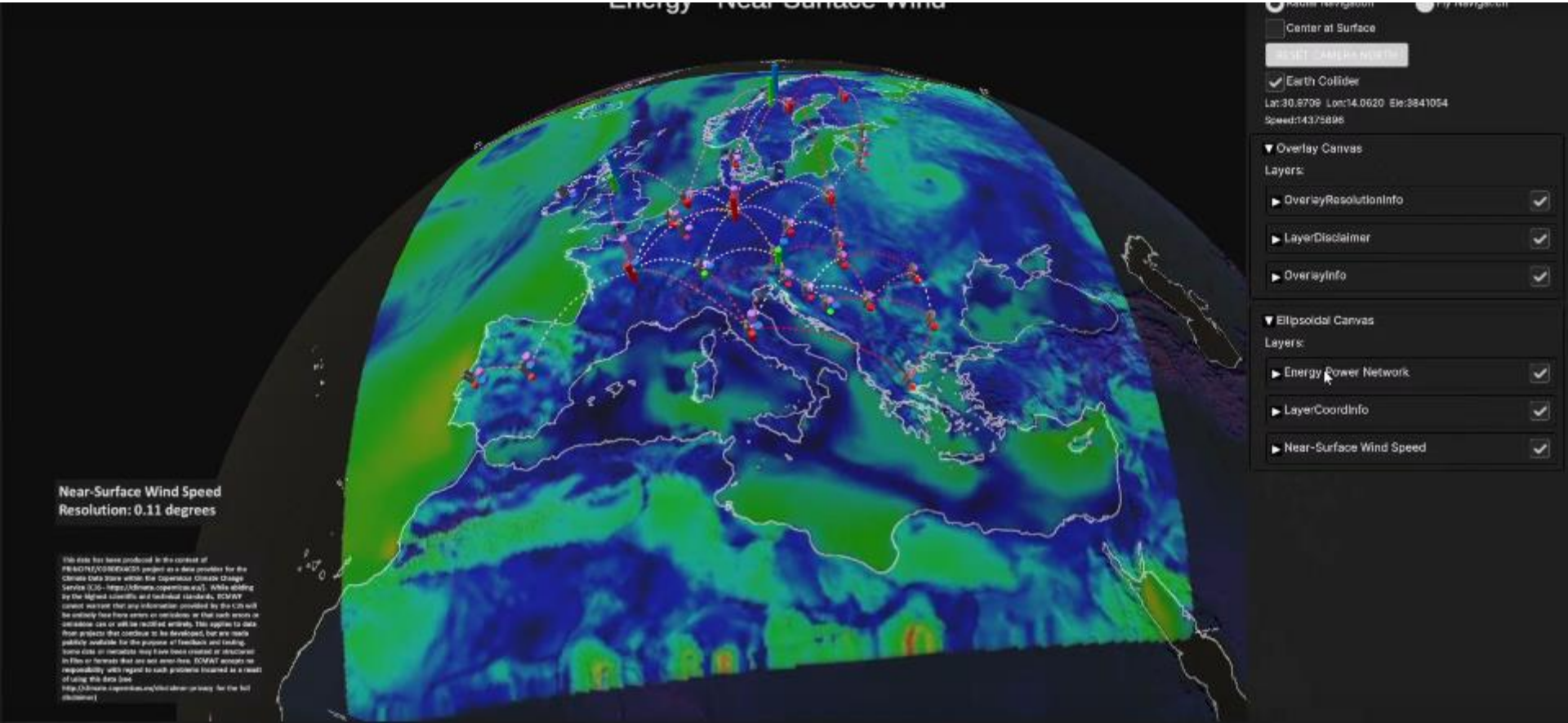

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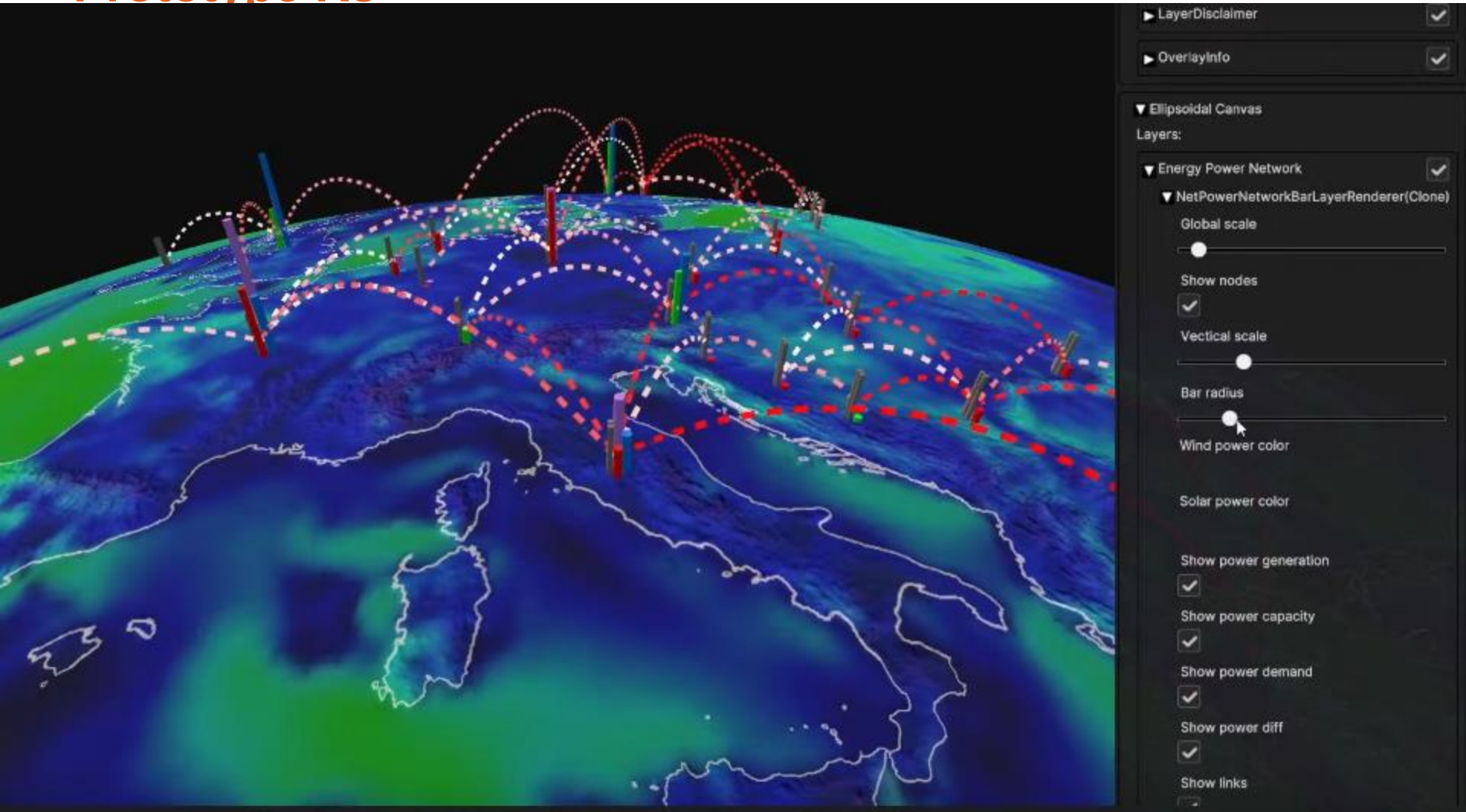

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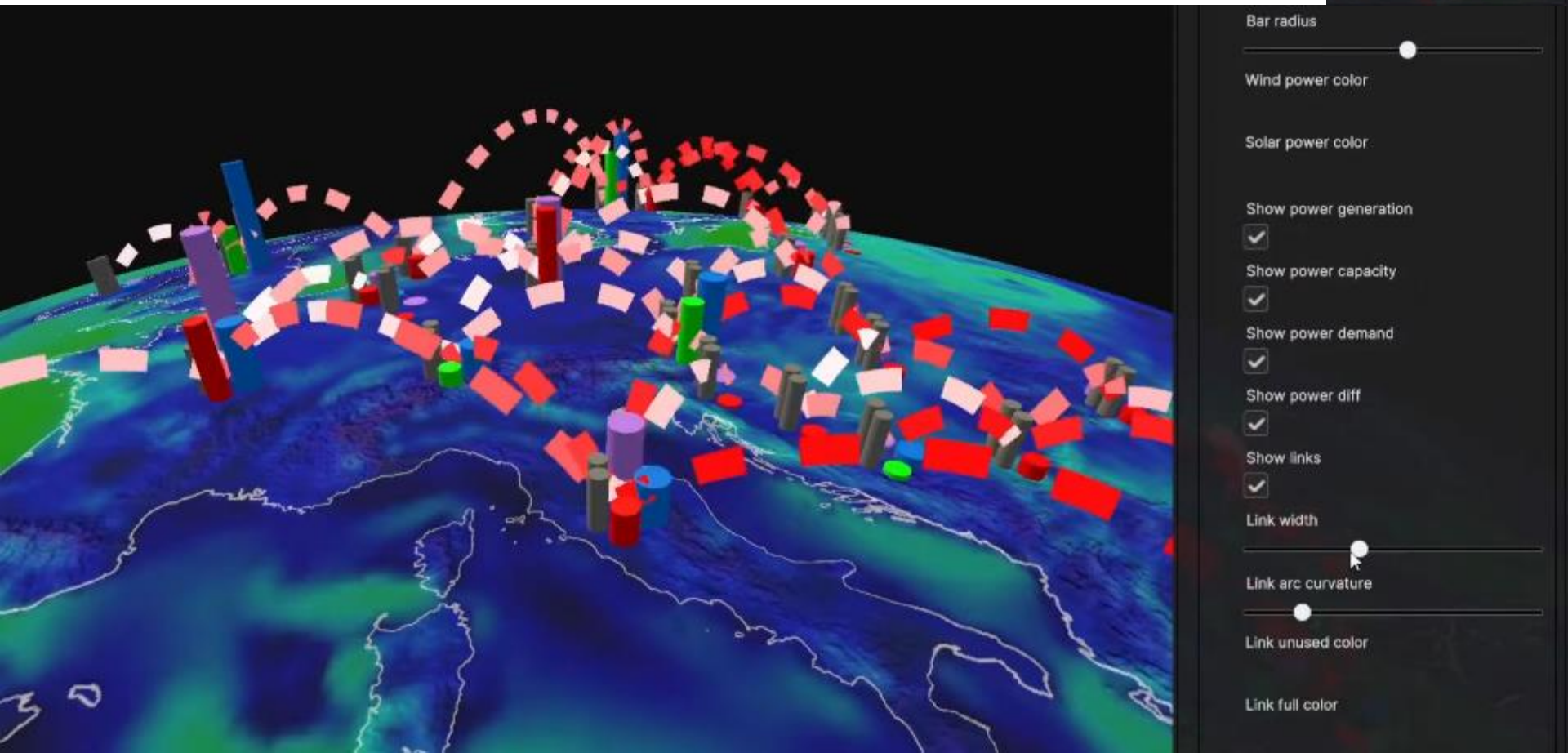

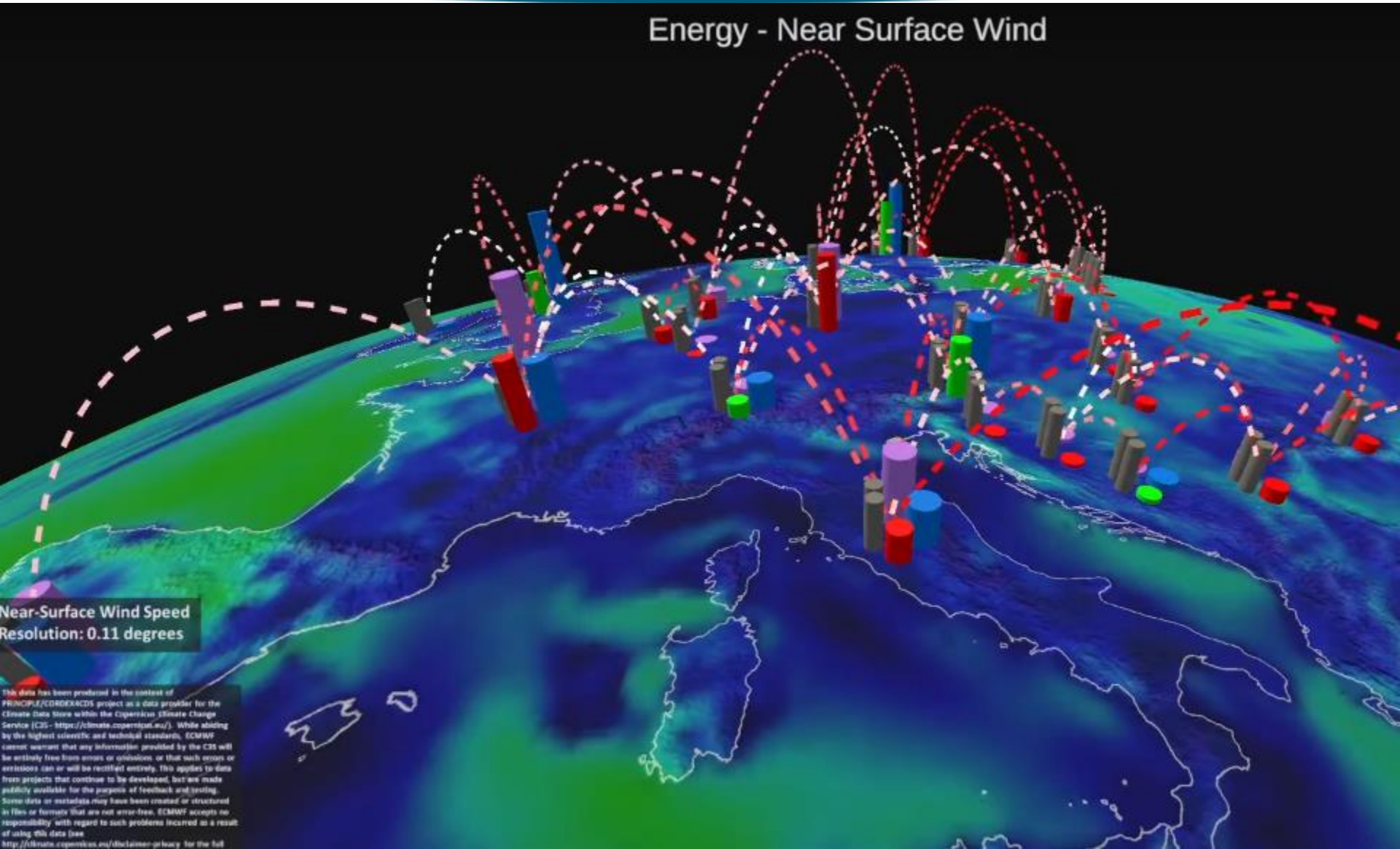
Energy - Near Surface Wind
Near-Surface Wind Speed
Resolution: 0.11 degrees
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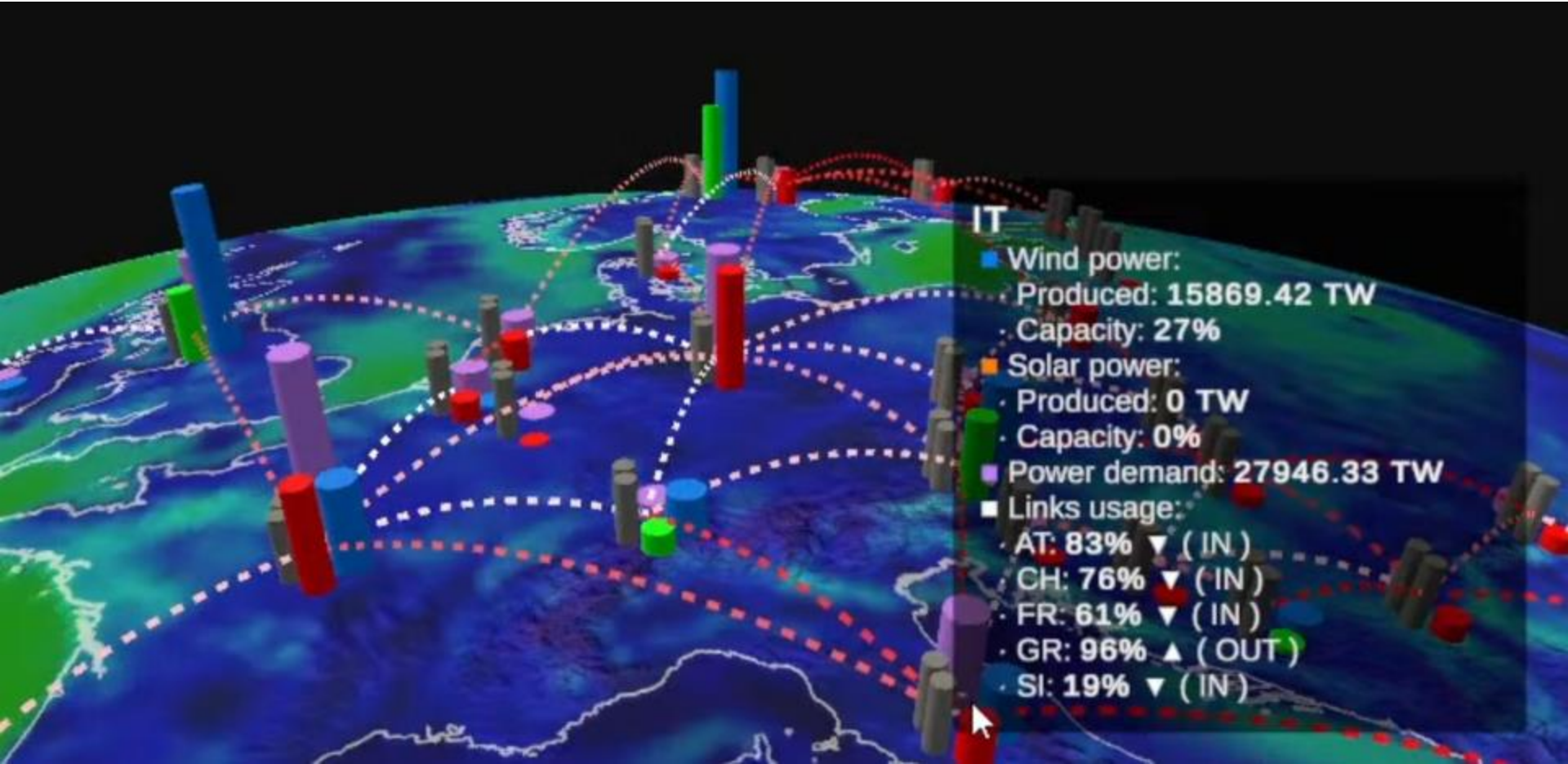

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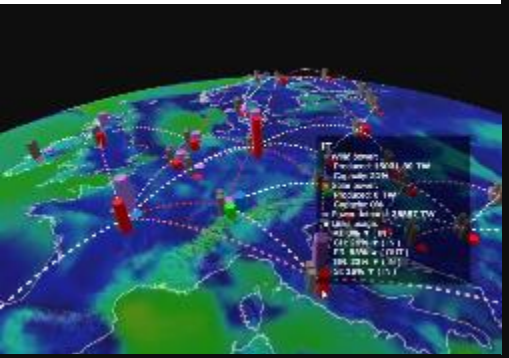

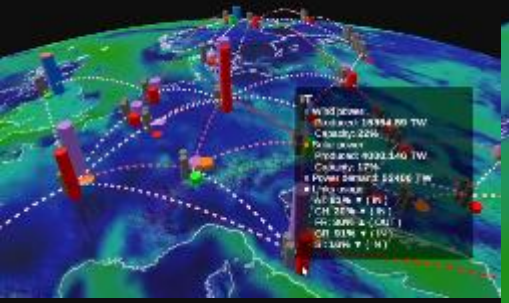

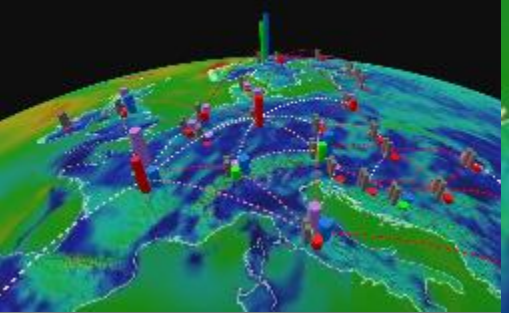

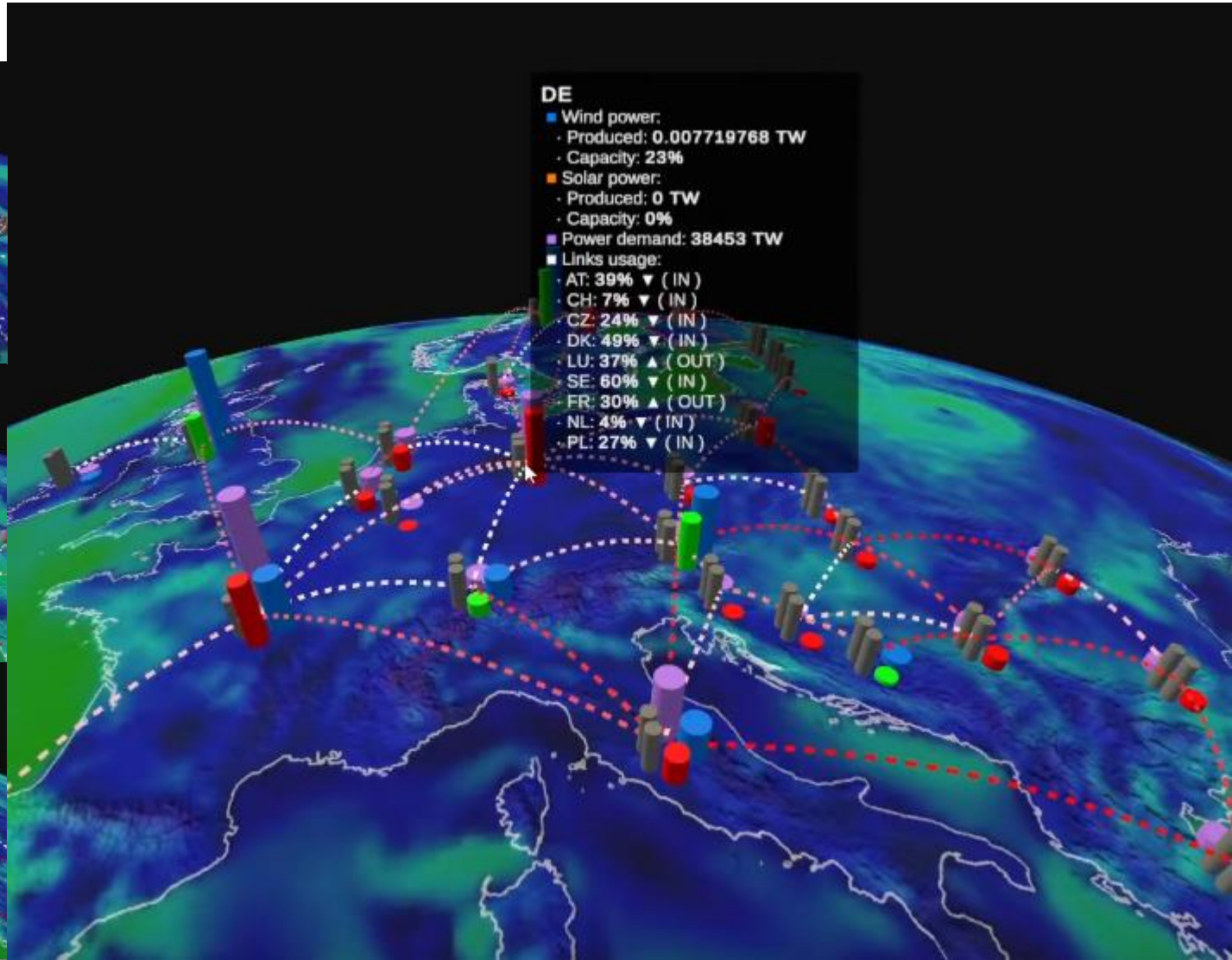

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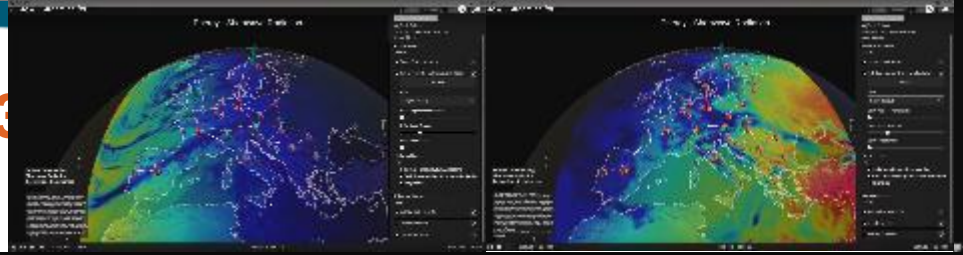

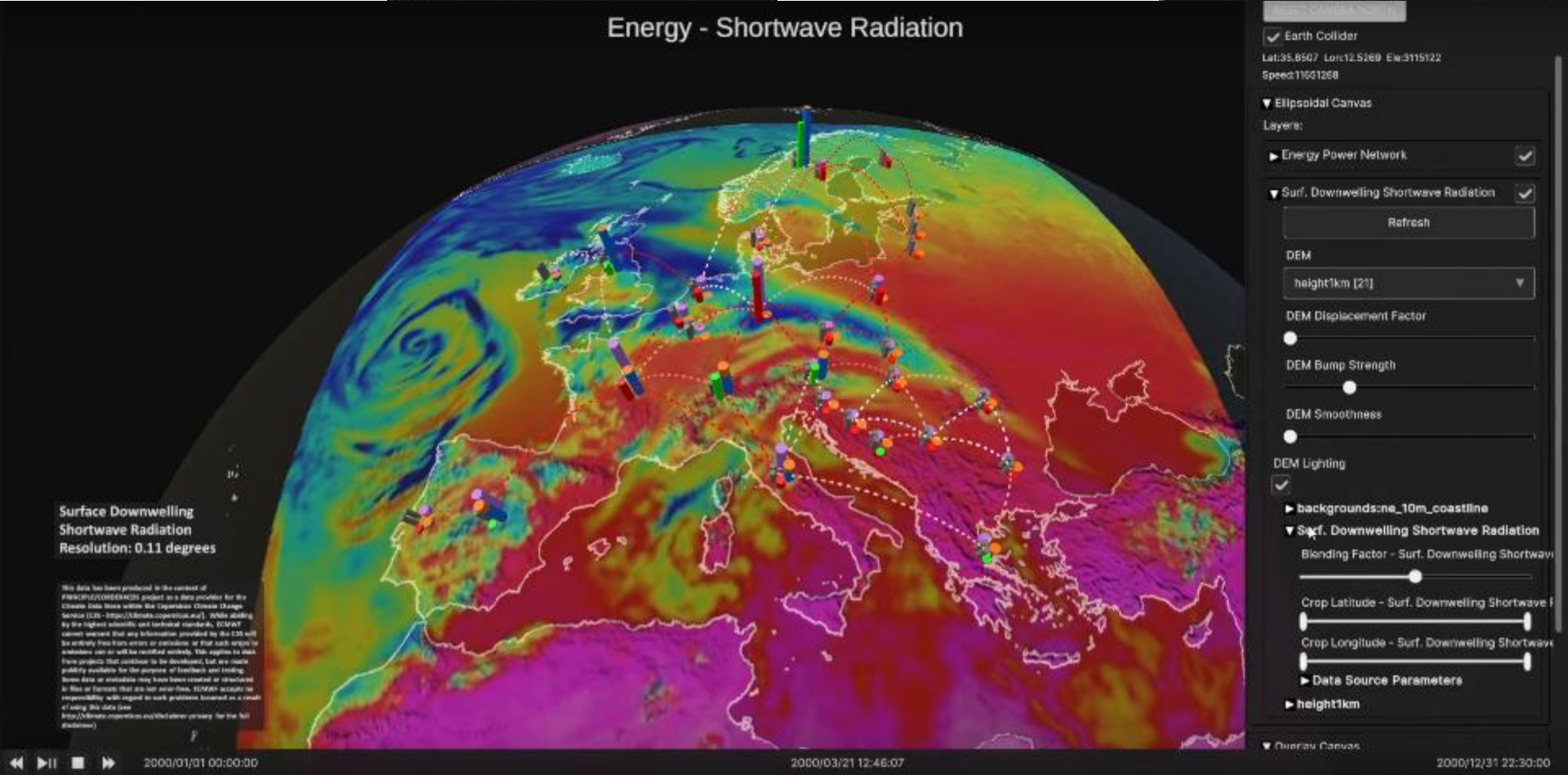

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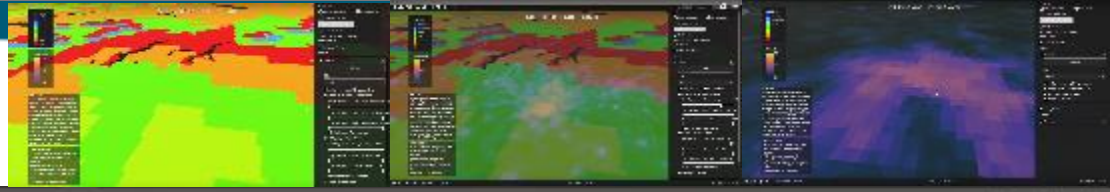


ECMWF Streaming for R3

Soil Type and Urban Cover

Soil Type

Urban Cover

1.0

0.5

0.0

SOIL TYPE
Is the texture (or classification) of soil used by the land surface scheme of the ECMWF Integrated Forecast System to predict the water holding capacity of soil in soil moisture and runoff calculations. It is derived from the root zone data (30-100 cm below the surface) of the FAO/UNESCO Digital Soil Map of the World, DSMW (FAO, 2003), which exists at a resolution of 5' X 5' (about 10 km).
Resolution: 0.007 degrees

URBAN COVER
Is the fraction of the grid box (0-1) that is covered with an urban surface.
This parameter includes all impervious and artificial surfaces (e.g. roads, buildings, parking lots, etc.).
Resolution: 0.007 degrees

2020/10/19 12:00:00

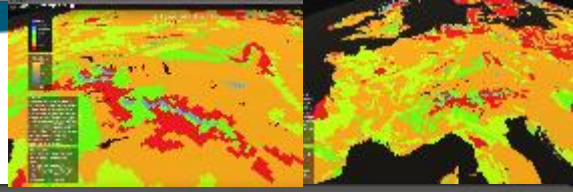
2020/10/19 12:00:00

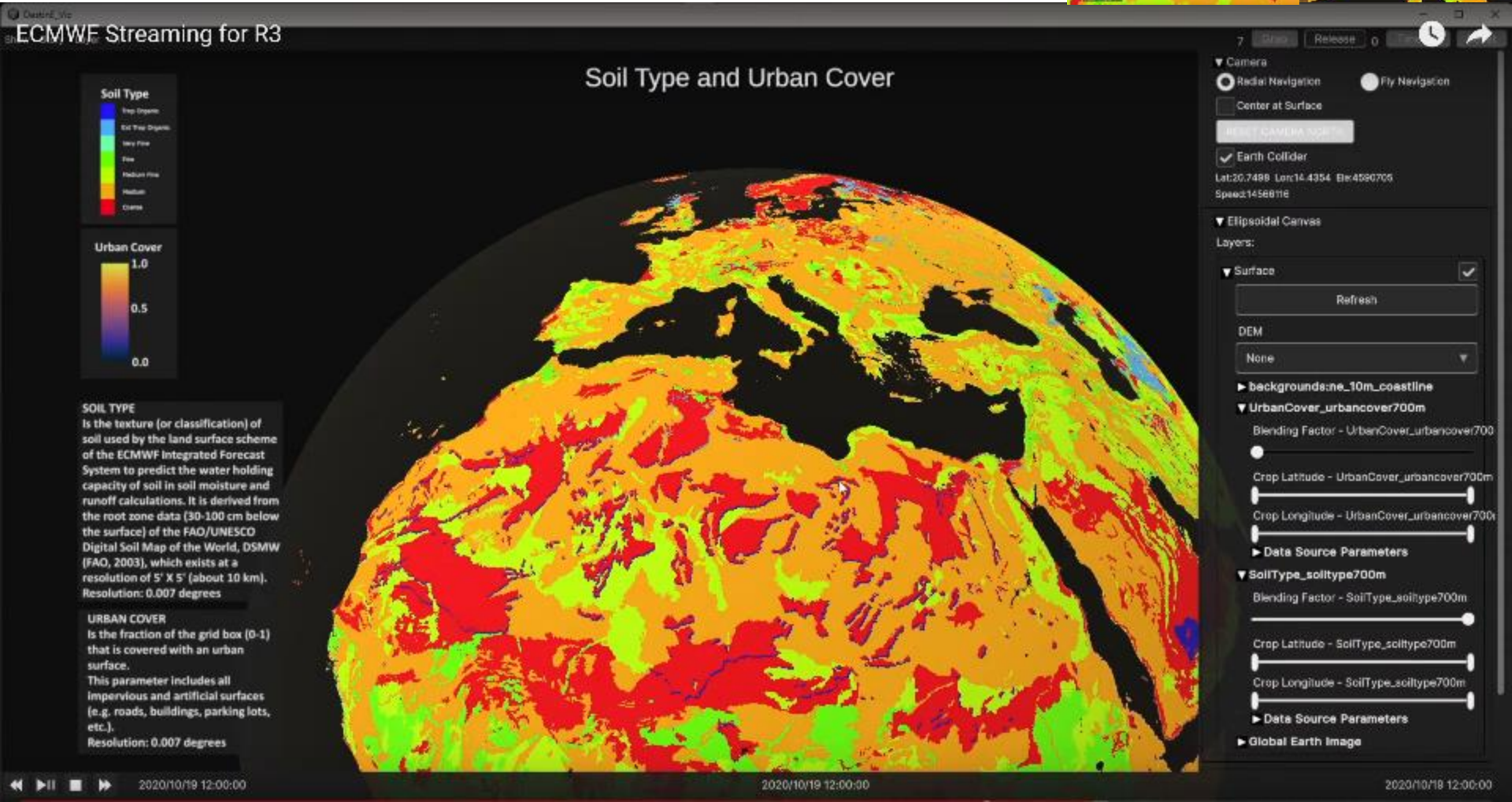
▼ Camera
Radial Navigation
Fly Navigation
Center at Surface
Earth Collider
Lat:37.0830 Lon:11.0696 Ele:781025
Speed:3446282

▼ Ellipsoidal Canvas
Layers:
▼ Surface
Refresh
DEM
None
▶ backgrounds:ne_10m_coastline
▶ UrbanCover_urbancover700m
▶ SoilType_soiltype700m
▶ Global Earth Image

▼ Overlay Canvas
Layers:
▶ OverlayInfo

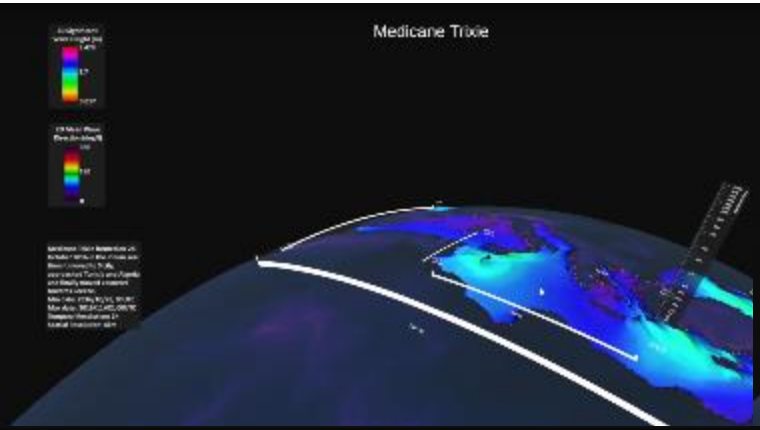
Prototype R3

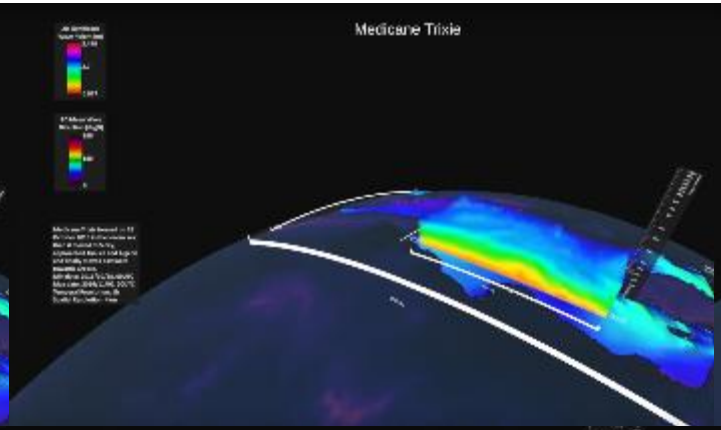


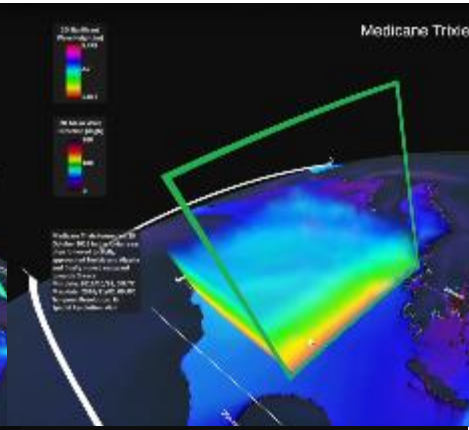


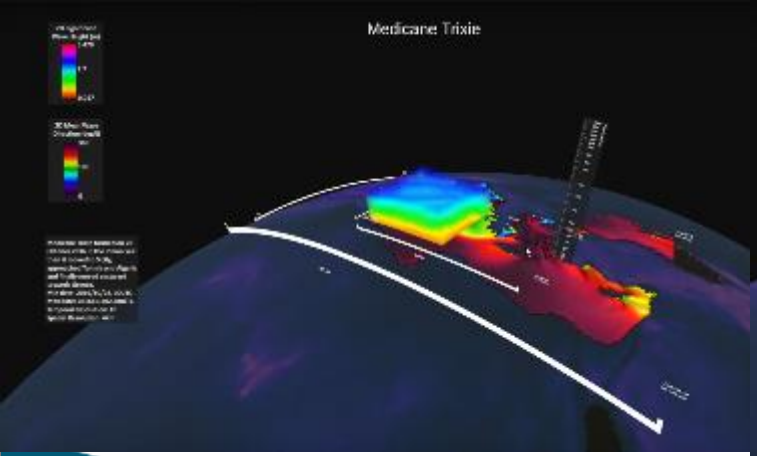
Prototype R3

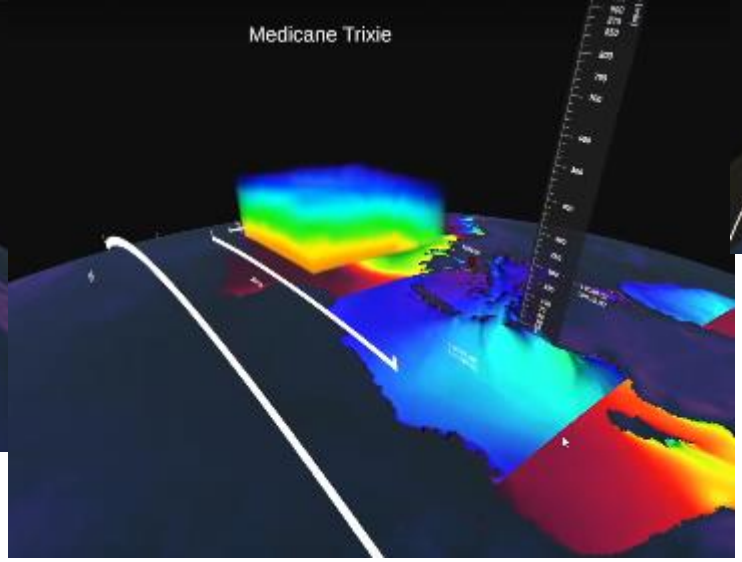
Prototype R3

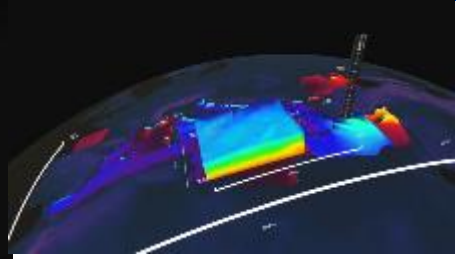




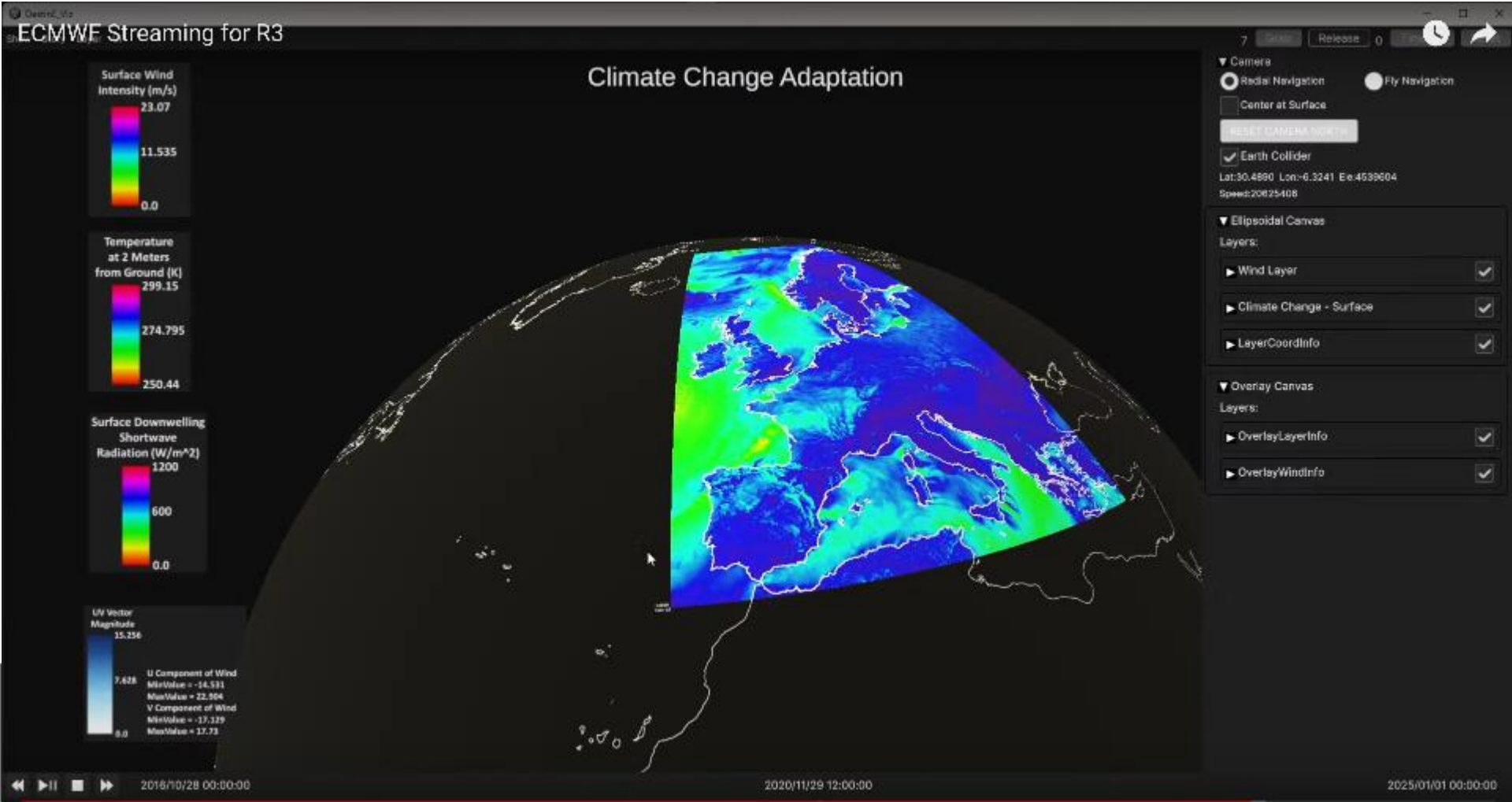




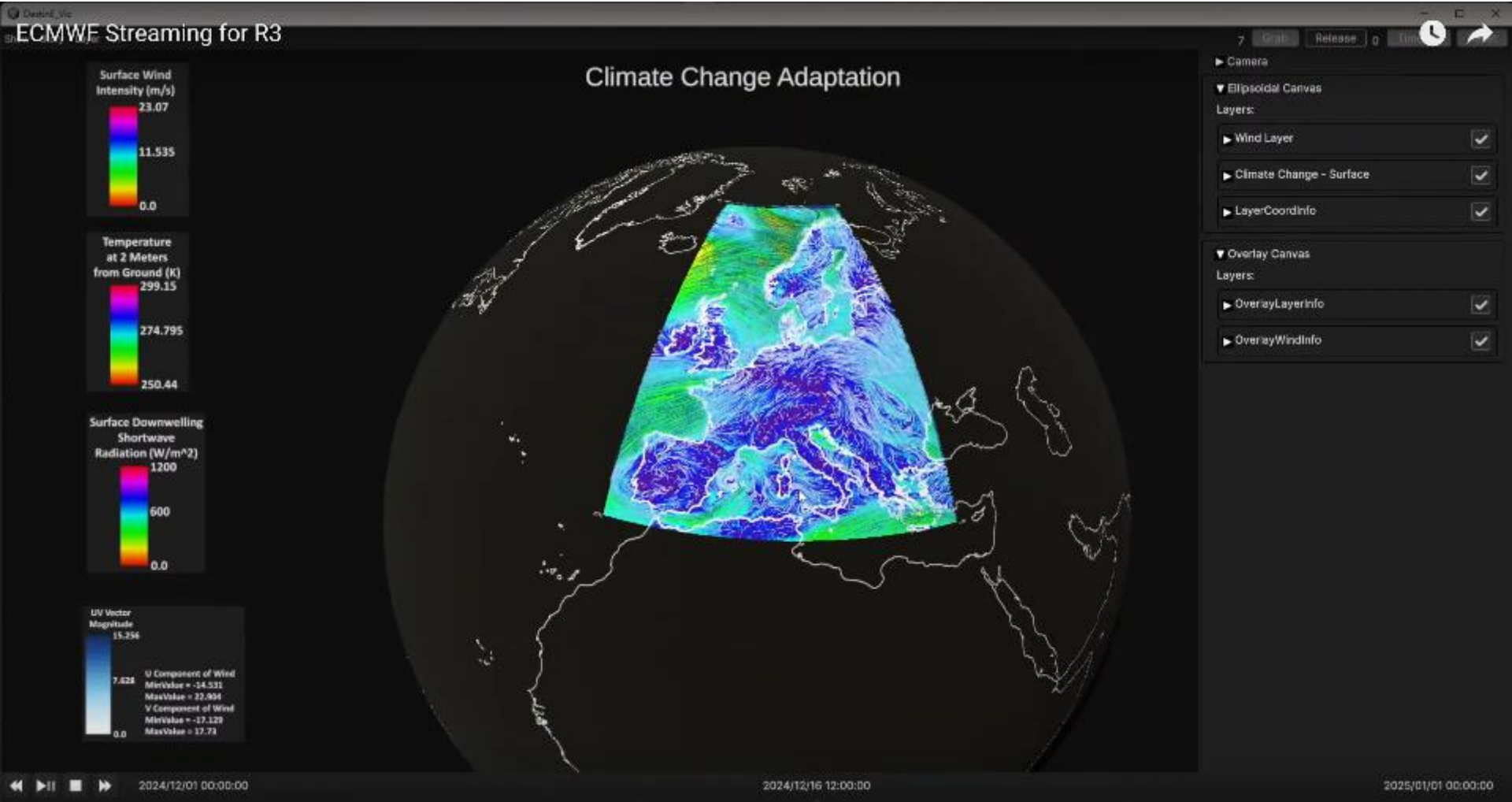




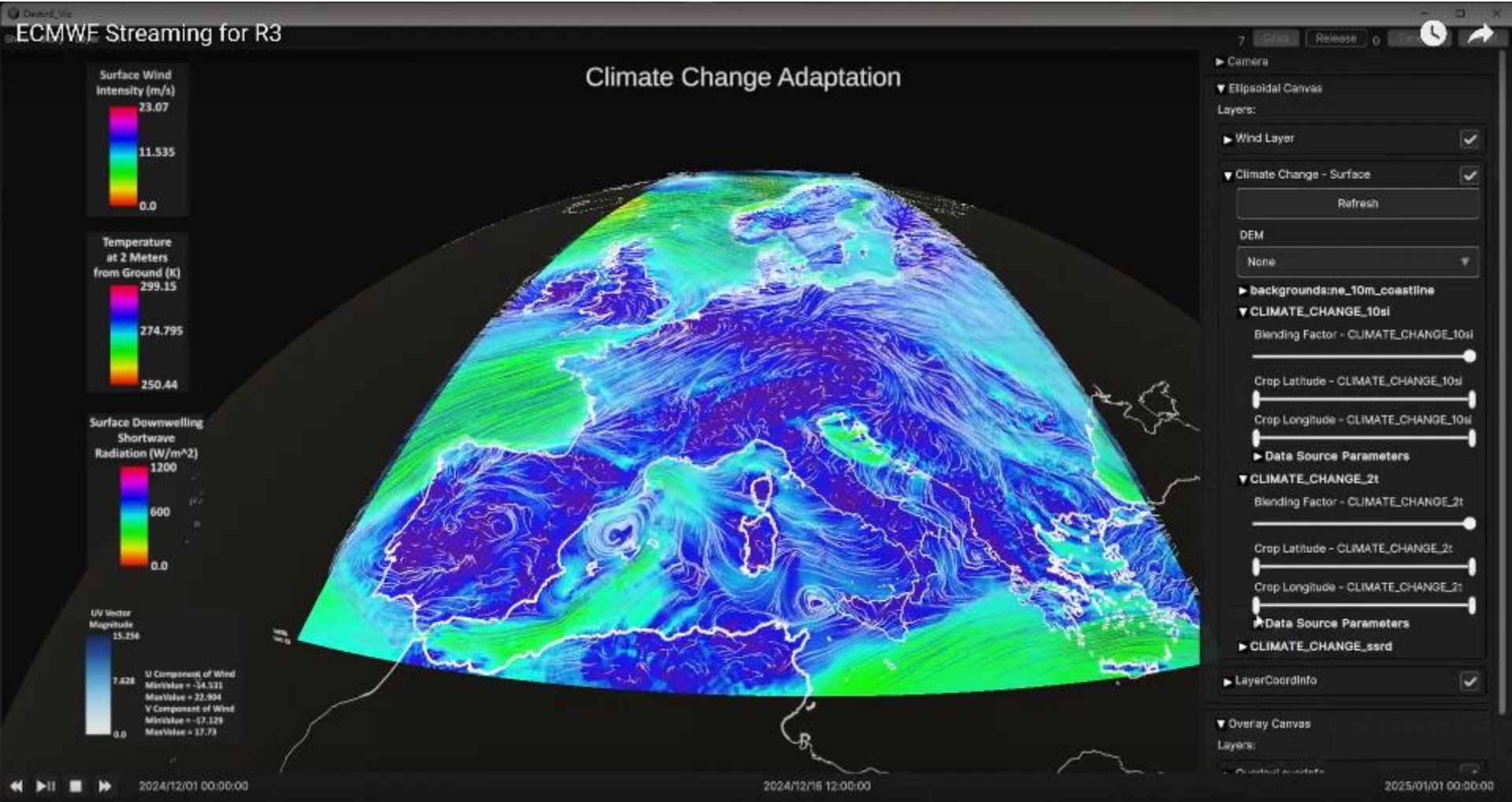
Prototype R3

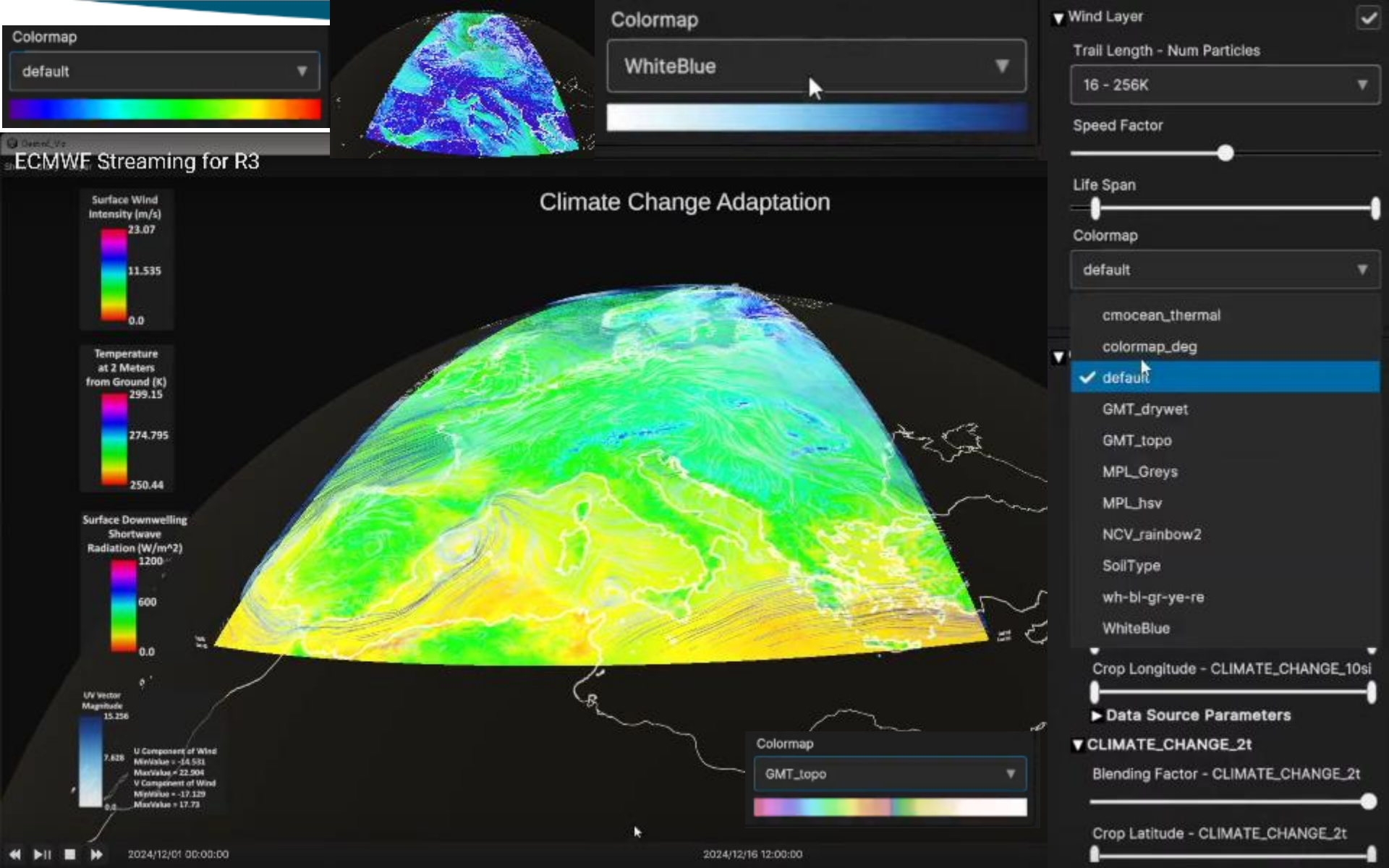


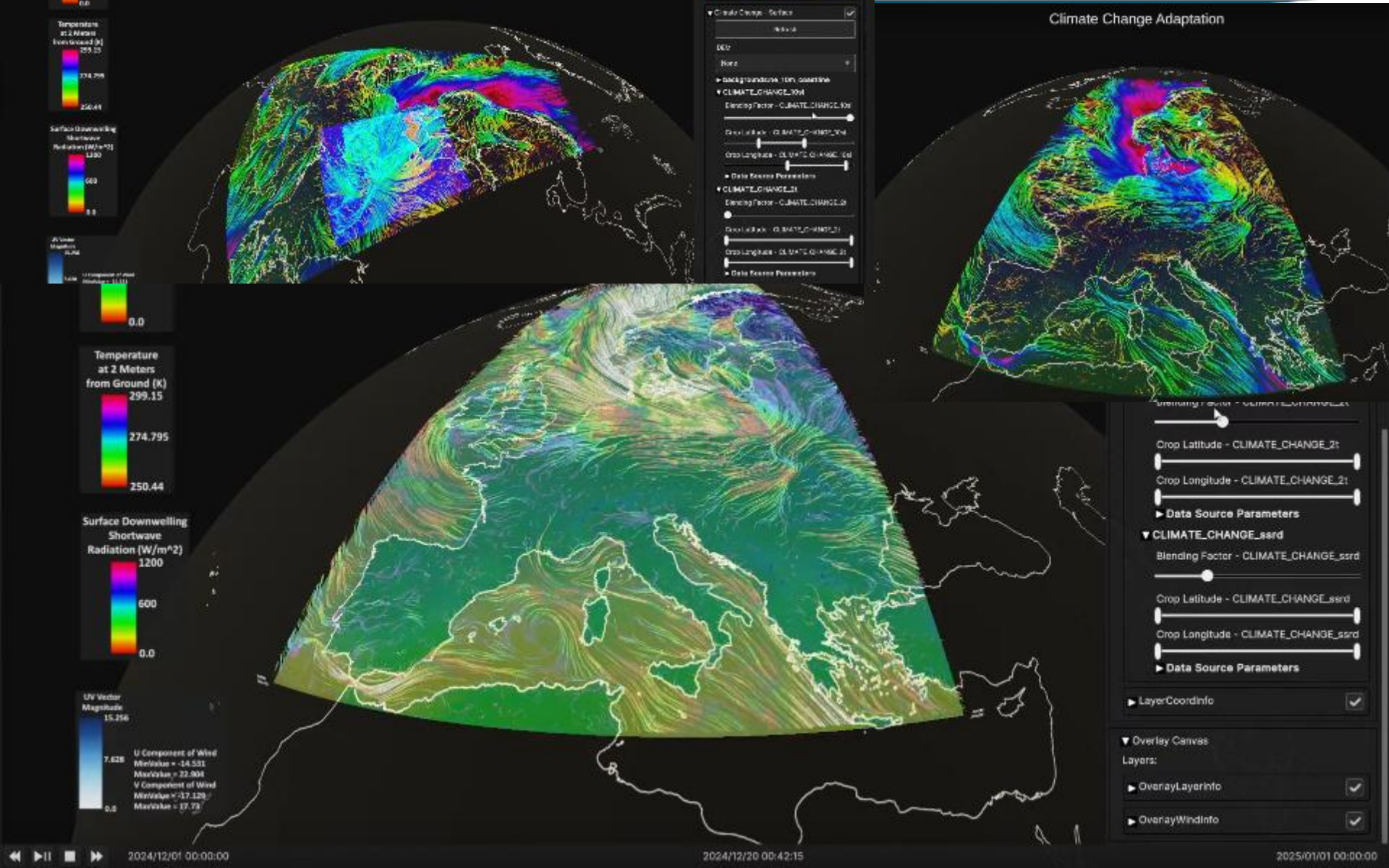
Prototype R3

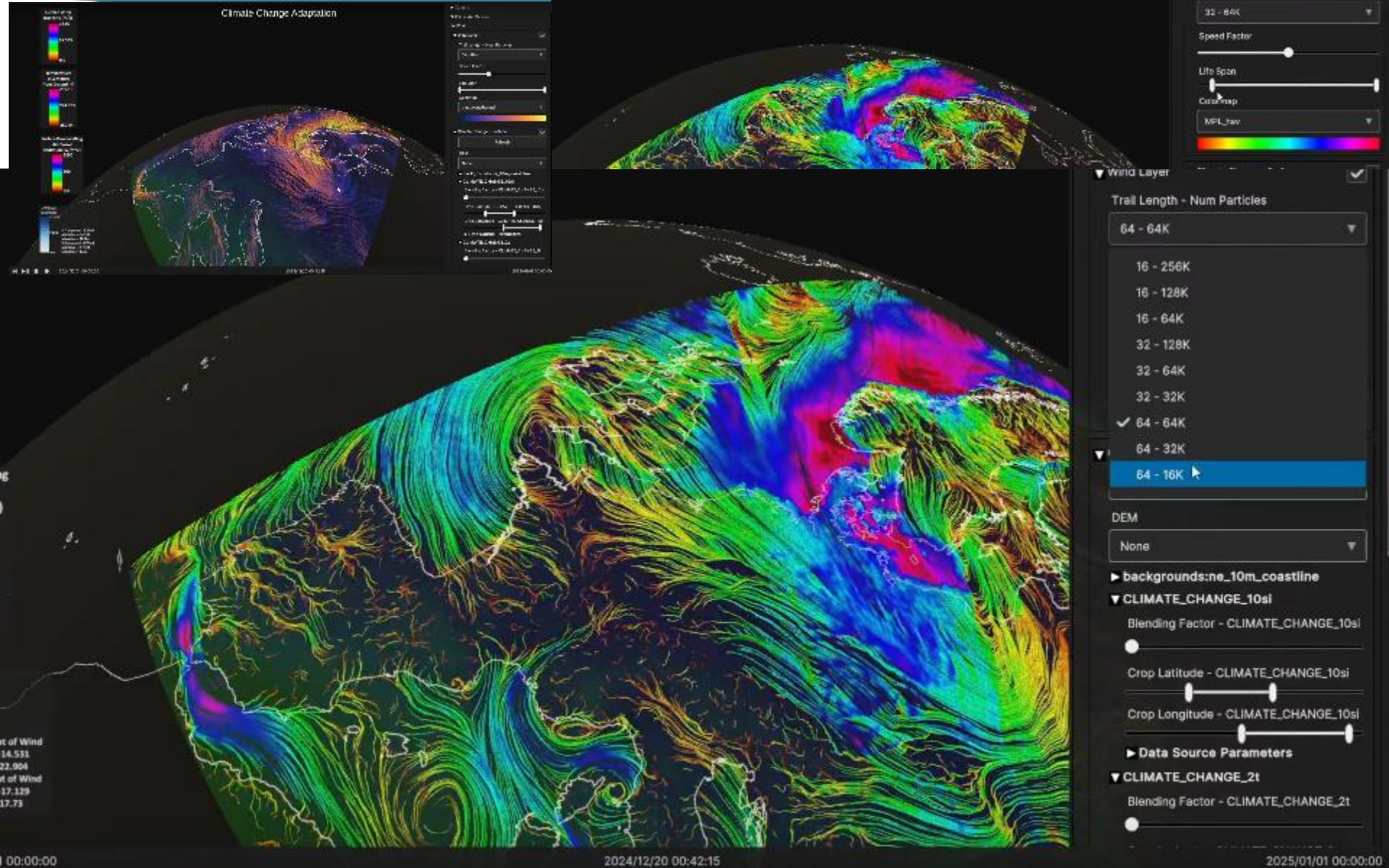


Prototype R3




Colormap
default
Colormap
WhiteBlue
Wind Layer
Trail Length - Num Particles
16 - 256K
Speed Factor
Life Span
Colormap
default
cmocean_thermal
colormap_deg
default
GMT_drywet
GMT_topo
MPL_Greys
MPL_hsv
NCV_rainbow2
SoilType
wh-bl-gr-ye-re
WhiteBlue
Crop Longitude - CLIMATE_CHANGE_10si
Data Source Parameters
CLIMATE_CHANGE_2t
Blending Factor - CLIMATE_CHANGE_2t
Crop Latitude - CLIMATE_CHANGE_2t
ECMWF Streaming for R3
Climate Change Adaptation
Surface Wind Intensity (m/s)
23.07
11.535
0.0
Temperature at 2 Meters from Ground (K)
299.15
274.795
250.44
Surface Downwelling Shortwave Radiation (W/m^2)
1200
600
0.0
UV Vector Magnitude
15.256
7.628
0.0
U Component of Wind
MinValue = -14.581
MaxValue = 22.904
V Component of Wind
MinValue = -17.129
MaxValue = 17.73
Colormap
GMT_topo
2024/12/01 00:00:00
2024/12/16 12:00:00


Climate Change Adaptation
Temperature at 2 Meters from Ground (K)
299.15
274.795
250.44
Surface Downwelling Shortwave Radiation (W/m^2)
1200
600
0.0
UV Vector Magnitude
15.256
7.628
0.0
U Component of Wind
MinValue = -14.531
MaxValue = 22.904
V Component of Wind
MinValue = -17.129
MaxValue = 17.73
Crop Latitude - CLIMATE_CHANGE_2t
Crop Longitude - CLIMATE_CHANGE_2t
Data Source Parameters
CLIMATE_CHANGE_ssrd
Blending Factor - CLIMATE_CHANGE_ssrd
Crop Latitude - CLIMATE_CHANGE_ssrd
Crop Longitude - CLIMATE_CHANGE_ssrd
Data Source Parameters
LayerCoordInfo
Overlay Canvas
Layers:
OverlayLayerInfo
OverlayWindInfo
2024/12/01 00:00:00
2024/12/20 00:42:15
2025/01/01 00:00:00


Climate Change Adaptation
Speed Factor
Life Span
Colormap
MPL_hsv
Wind Layer
Trail Length - Num Particles
64 - 64K
16 - 256K
16 - 128K
16 - 64K
32 - 128K
32 - 64K
32 - 32K
64 - 64K
64 - 32K
64 - 16K
DEM
None
backgrounds:ne_10m_coastline
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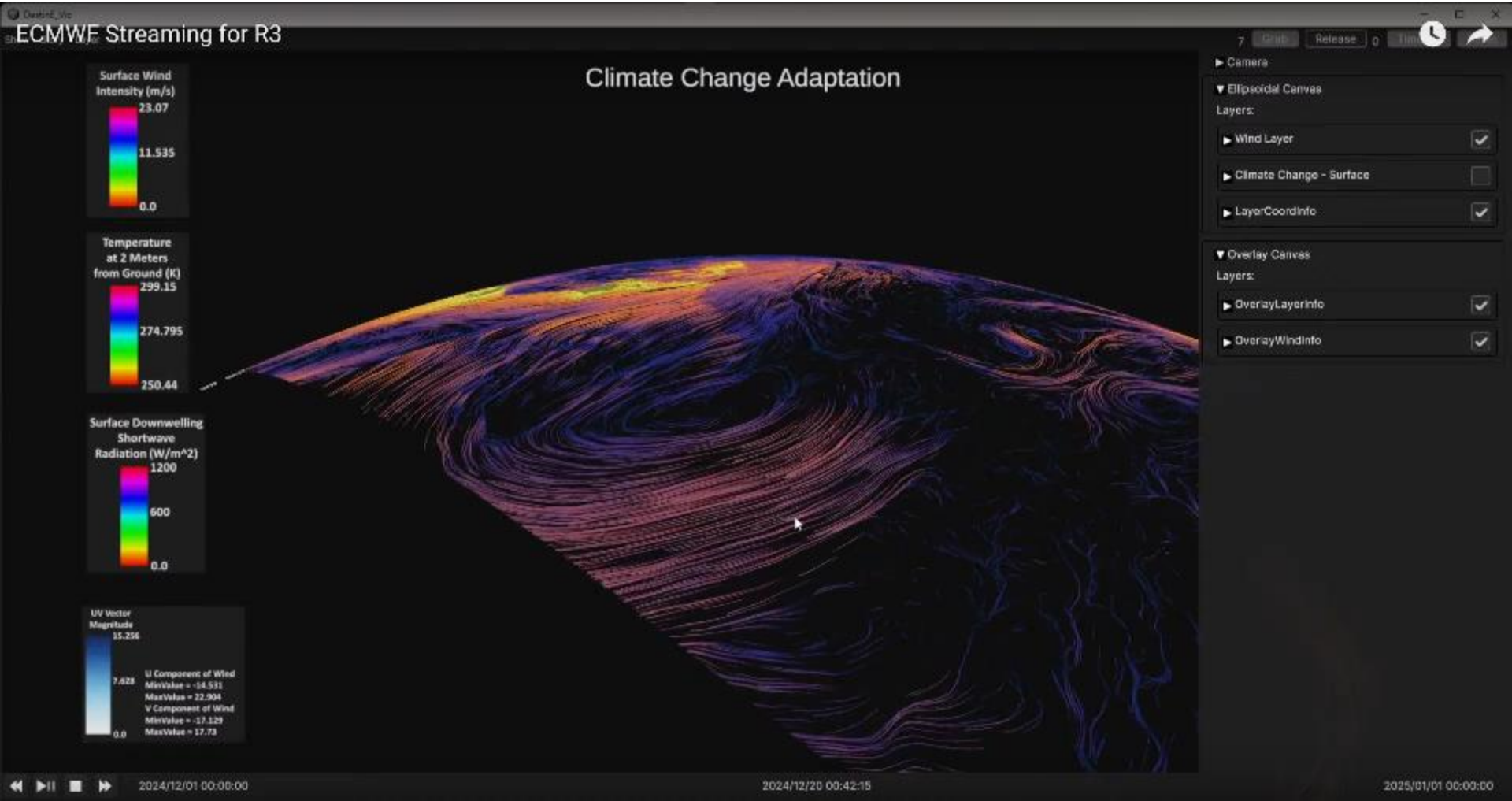
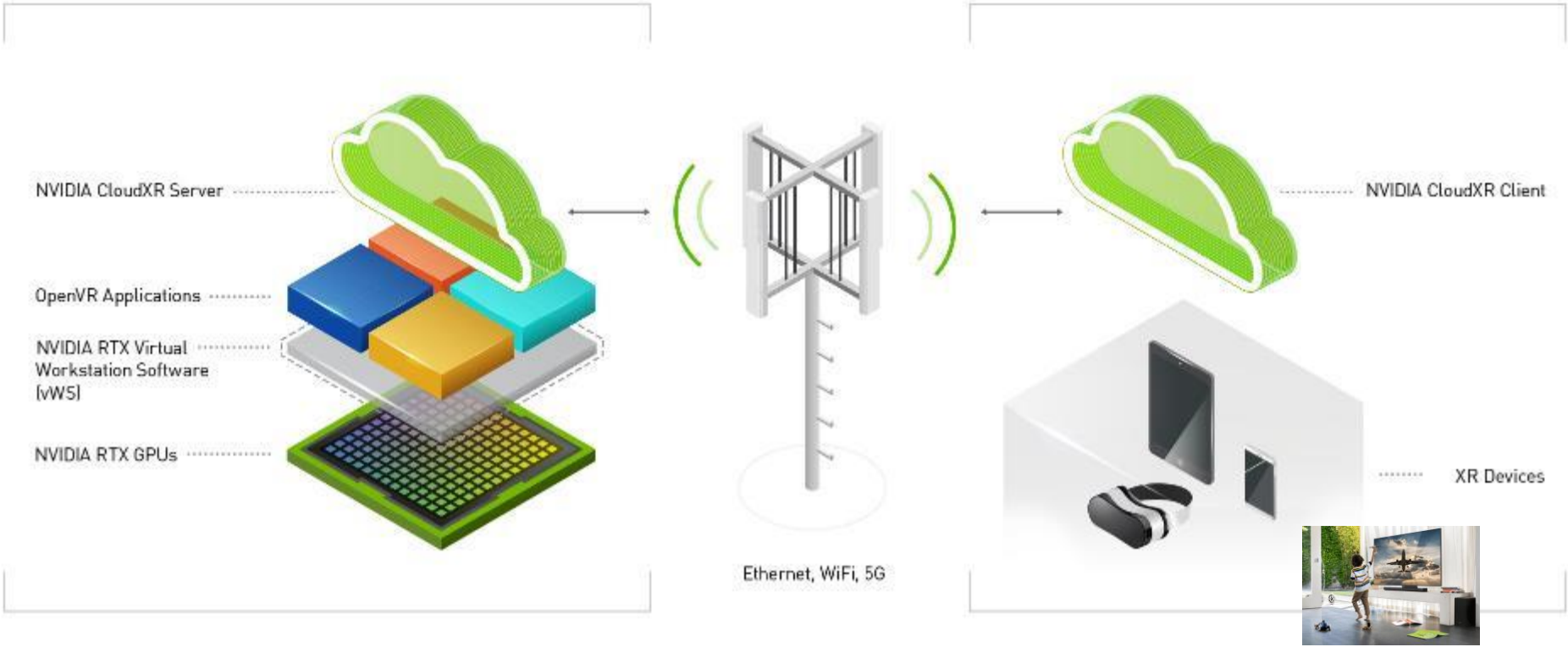
Blending Factor - CLIMATE_CHANGE_10si
Crop Latitude - CLIMATE_CHANGE_10si
Crop Longitude - CLIMATE_CHANGE_10si
Data Source Parameters
CLIMATE_CHANGE_2t
Blending Factor - CLIMATE_CHANGE_2t
2024/12/20 00:42:15
2025/01/01 00:00:00

Prototype R3



NVIDIA CloudXR Architecture



Exploring Visualisations that are Useful

To converge on a **visualization** useful to DestinE, it is important to first understand the general **needs and goals**. This can be done through **communication** and gathering **information about the data** and the context in which it will be used. Use cases: **Extreme Weather**: “Medicanes”, **Climate Change**: “Energy”.

Once the needs and goals are understood, it is important to **experiment with different visualization techniques** and formats to find the one that best communicates the ECMWF information. Involve creators of videos and imagery (non-interactive non-realtime) and implement an interactive realtime AR/VR application.

It is also important to gather **feedback** from ECMWF throughout the process and make adjustments as needed.

Finally, we will execute an internal testing phase specifically for the visualization with a **small group of typical users** before presenting to the general public to help ensure that our choices are effective and useful.

From Use-Case to Visual Design

An iterative Visualisation Design Strategy

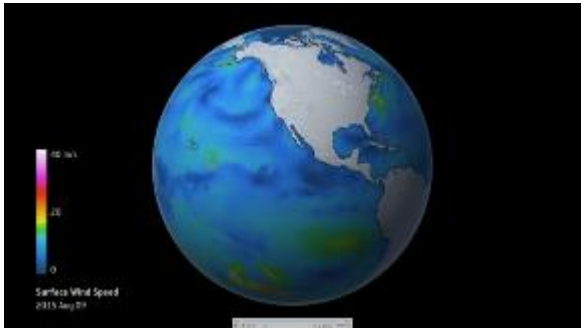
1. **User Flow**: Describing the user's journey through the 3D experience, including the different scenes and interactions they will encounter. Will start after use-cases are defined.
2. **Technical Requirements**: Outlines the technical specifications and requirements for the 3D app, such as hardware and software requirements, performance, and optimization. This technical process has already started.
3. **Low-fidelity sketches:** low resolution wireframes of the different scenes in the 3D experience, outlining the layout and functionality of each one.
4. **Style Guide**: The **visual style** and guidelines for the 3D app, including **color palettes**, **typography**, and **imagery**.
5. **Interaction Design**: How the user will interact with the 3D environment, including details on **navigation, selection**, and **input** methods.
6. **Asset List**: A list of all the **assets** required for the 3D app, including **3D models**, textures, **audio files**, etc
7. ***Usability testing****: The plan for testing the usability of the 3D app, including the **methods** and **metrics** to be used.*

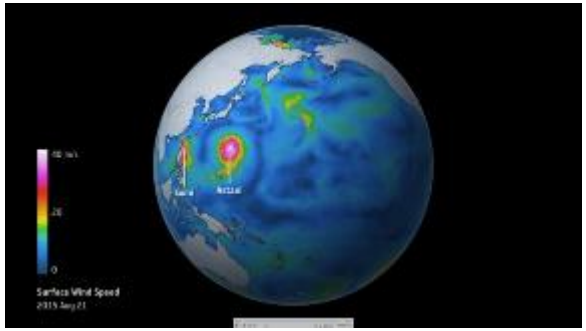
Global Scale

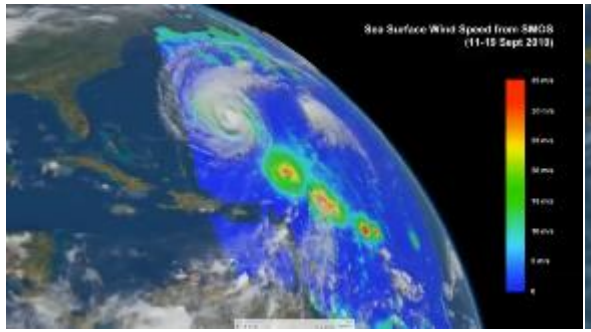
At the global scale, EO visual data is used to study and understand large-scale patterns and trends on Earth, such as climate change, deforestation, and land use change.

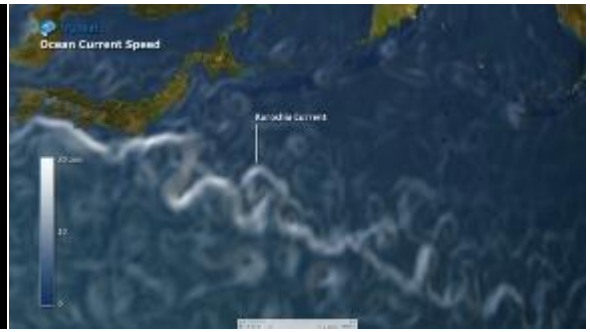
These visual data are processed from satellites products, allowing to perceive the entire planet at once.

Multi resolution assets management.







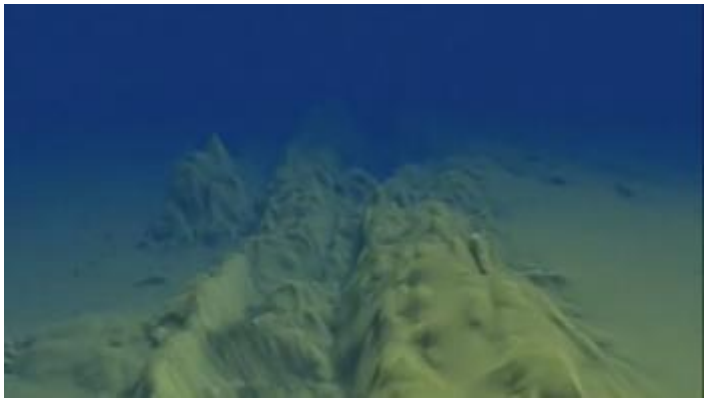


Local Scale

At the local scale, visual data is used to study and understand specific areas or regions on Earth, such as cities, towns, or natural landscapes.

This data is collected from both satellites and aircraft, allowing to view smaller areas in greater detail.

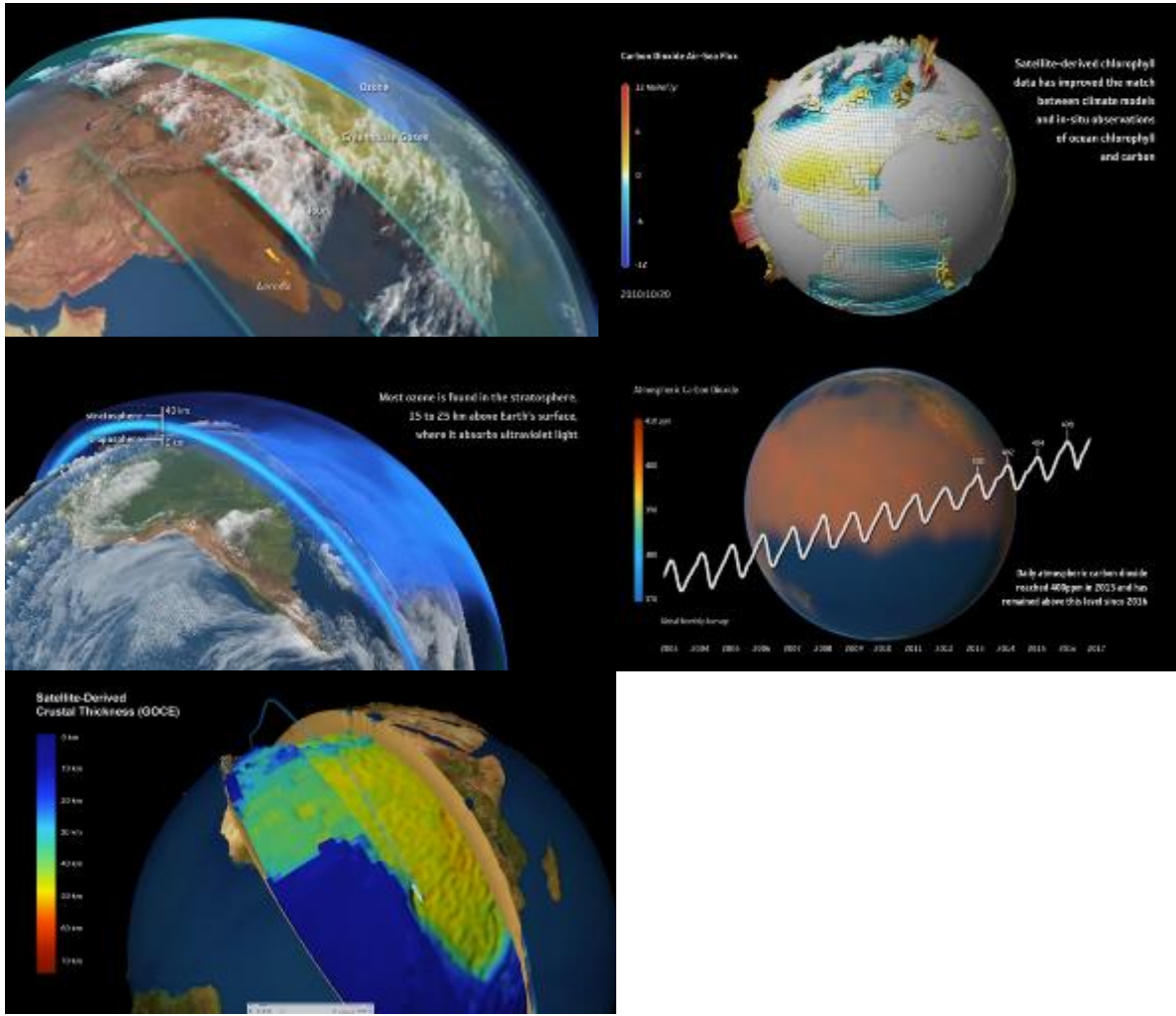
Multi resolution.



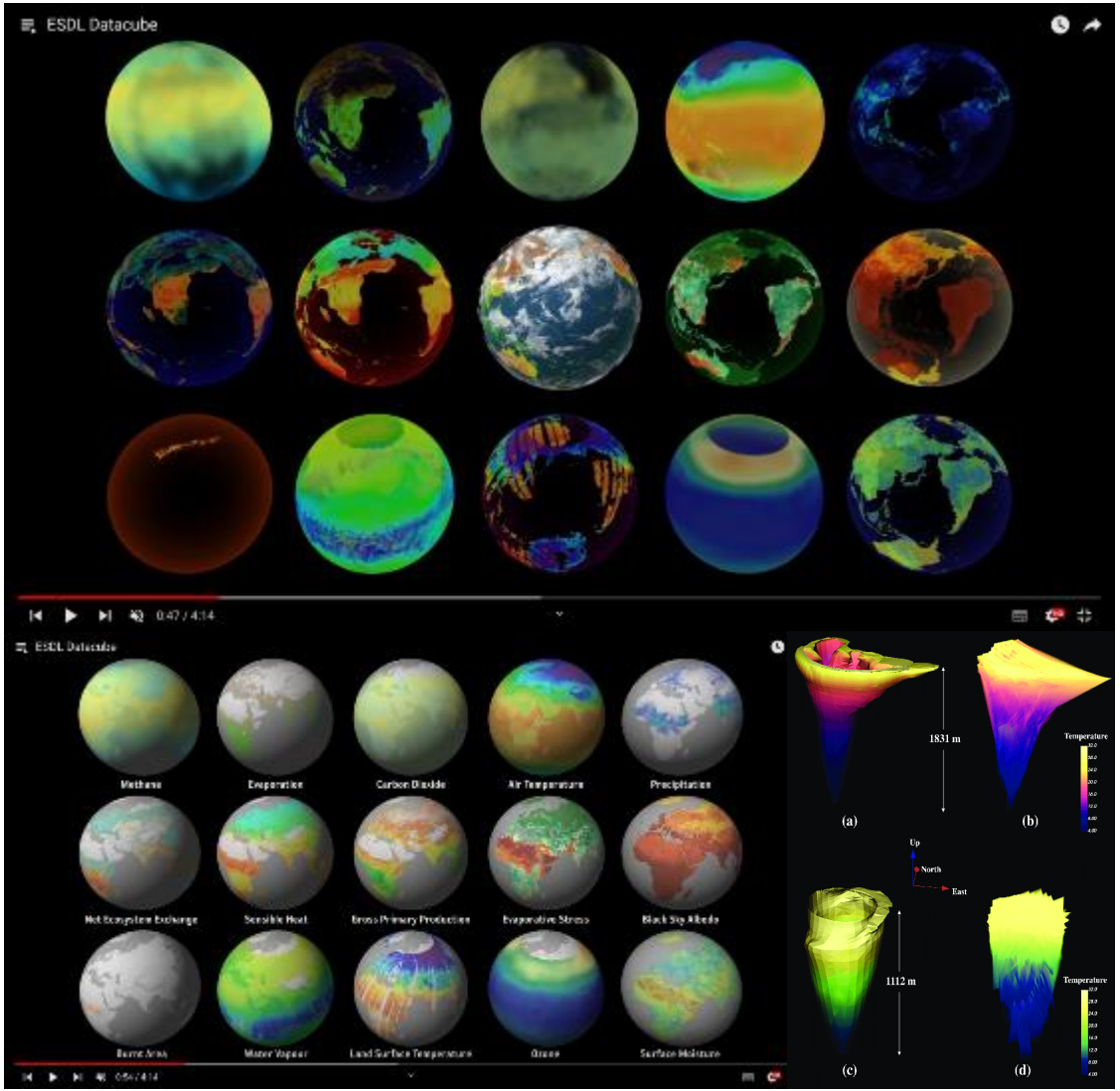
Multi Layer Visualisation

Multi-layer visualisation refers to the use of multiple layers of data, such as satellite based products and/or elevation data, to create a more comprehensive and detailed view of a specific area.

Each layer of data provides a different type of information, such as vegetation, land use, topography, and more.



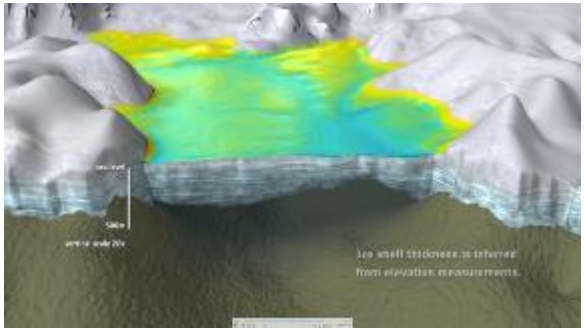
Comparing Multiple Datasets

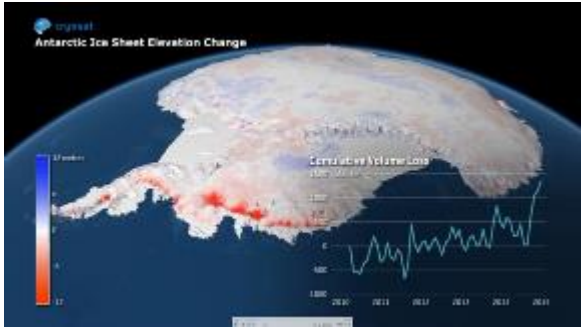


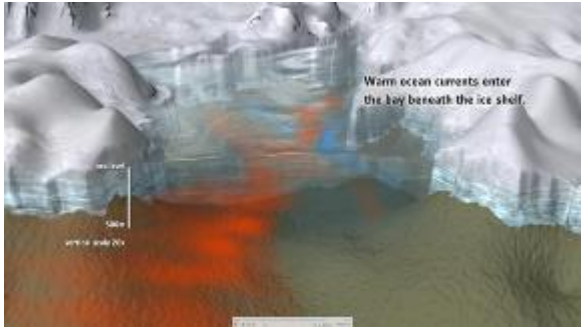
VFX, Animation, Illustration

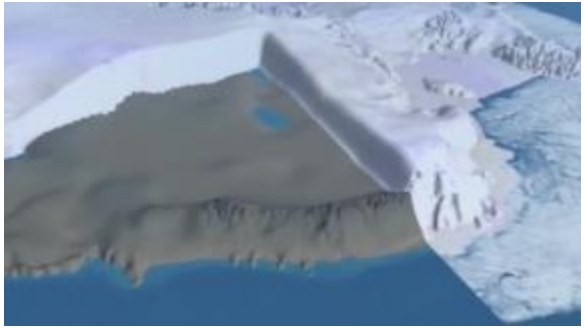
Visual display of Quantitative Information

Visual Explanations









Thank you for your attention (Q&A)