exprivia

future. perfect. simple.

ECMWF DE_350 Visualisation and Immersive Technologies

15-16 October 2024
Darmstadt, Germany

Destination Earth 3rd User eXchange Meeting

Gianluca Palumbo

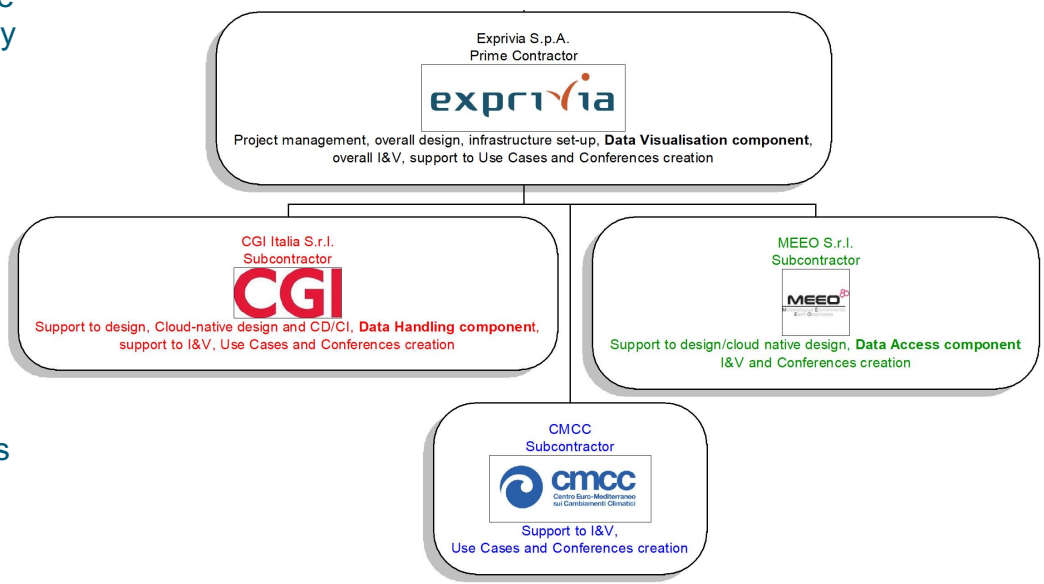
Partnership Overview

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

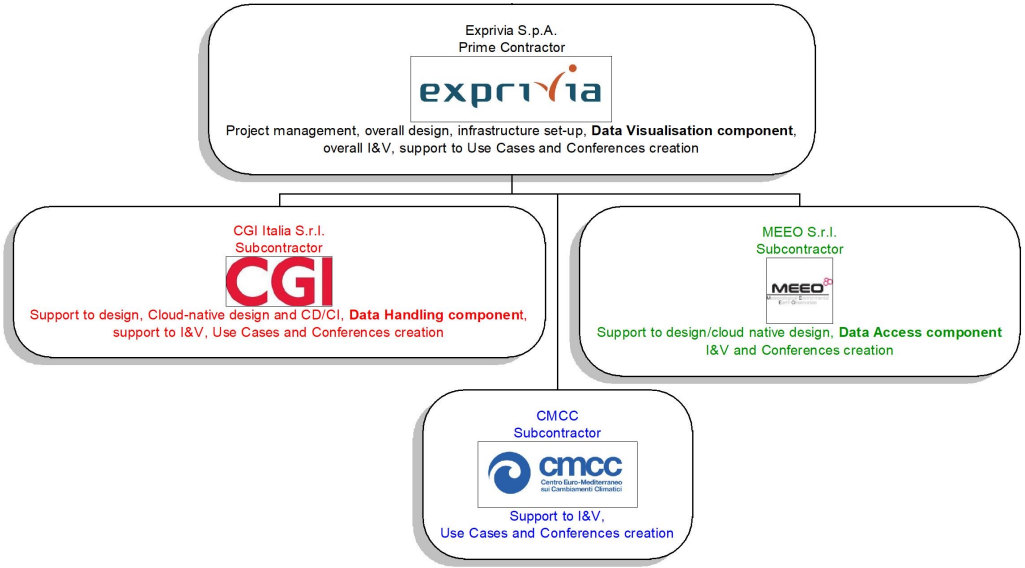
- **Data access/preparation**
- **Data handling**
- **Data visualization**
- **Communication (conferences)**



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

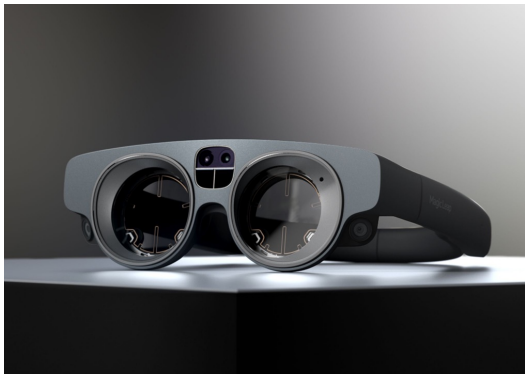
Interactive Immersive Experiences in AR/VR based on Real World Data

Oculus Quest 1

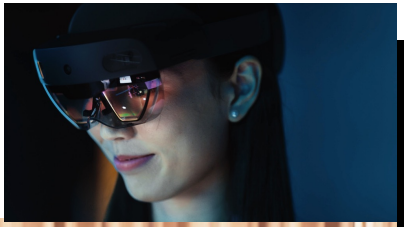
Meta Quest 2

Meta Quest 3

2019 — 2020 — 2023



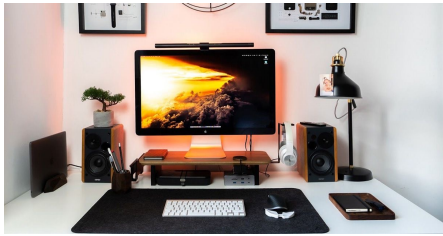
Interactive Immersive 3D



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

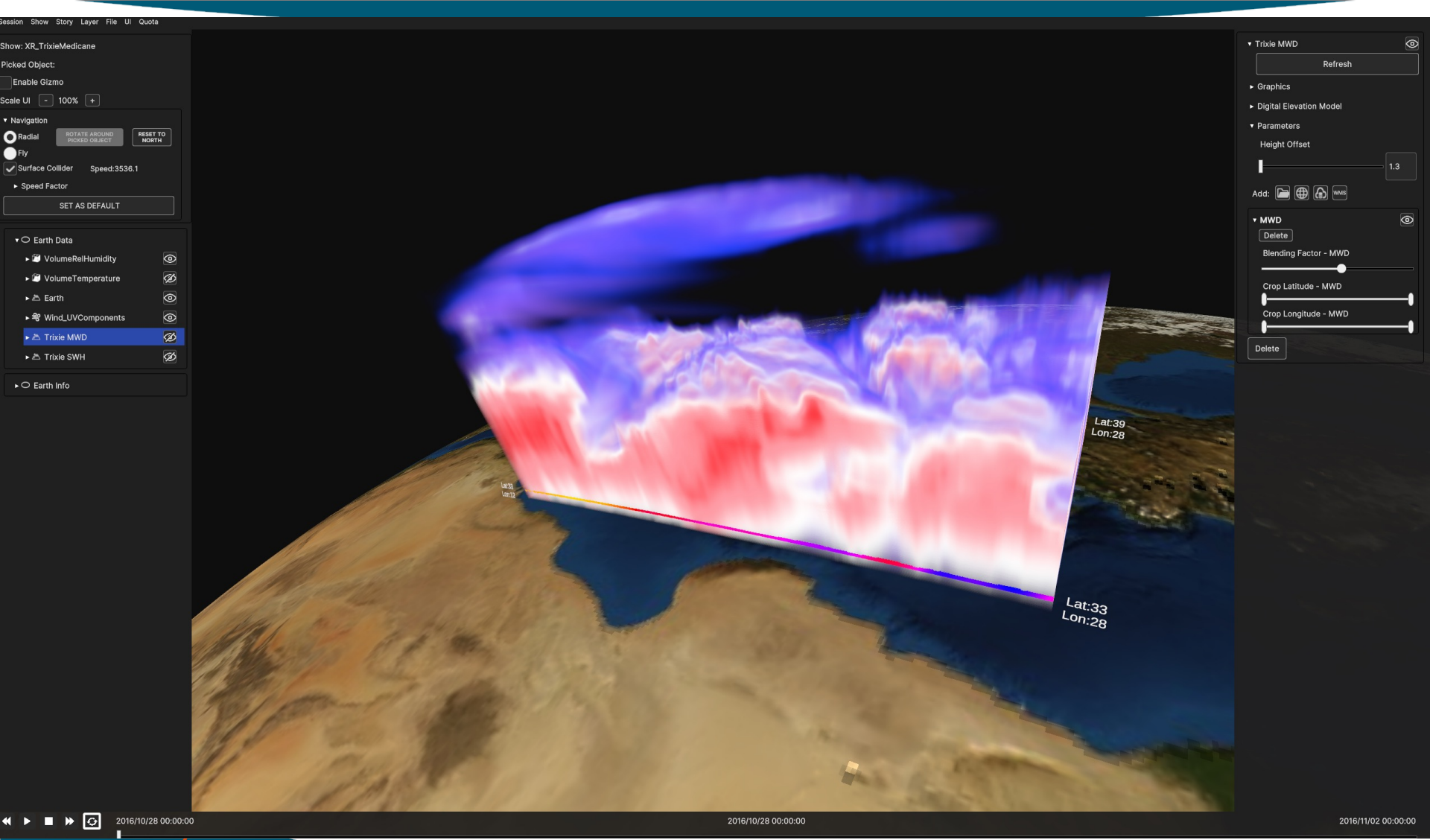
Project Timeline
End 2022 - Mid 2024

- **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 "A samples of VR shows"
- **DIC 2023**
- **GEN 2024**

- **FEB 2024** – Prototype R4/5
- **MAR 2024**
- **APR 2024**
- **...**
- **OCT 2024 - Prototype R5/5 Augmented Mixed Reality shows**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Scale UI - 100% +
Navigation
Radial
ROTATE AROUND PICKED OBJECT
RESET TO NORTH
Fly
Surface Collider
Speed:3536.1
Speed Factor
SET AS DEFAULT
Earth Data
VolumeRelHumidity
VolumeTemperature
Earth
Wind_UVComponents
Trixie MWD
Trixie SWH
Earth Info
Trixie MWD
Refresh
Graphics
Digital Elevation Model
Parameters
Height Offset
1.3
Add:
MWD
Delete
Blending Factor - MWD
Crop Latitude - MWD
Crop Longitude - MWD
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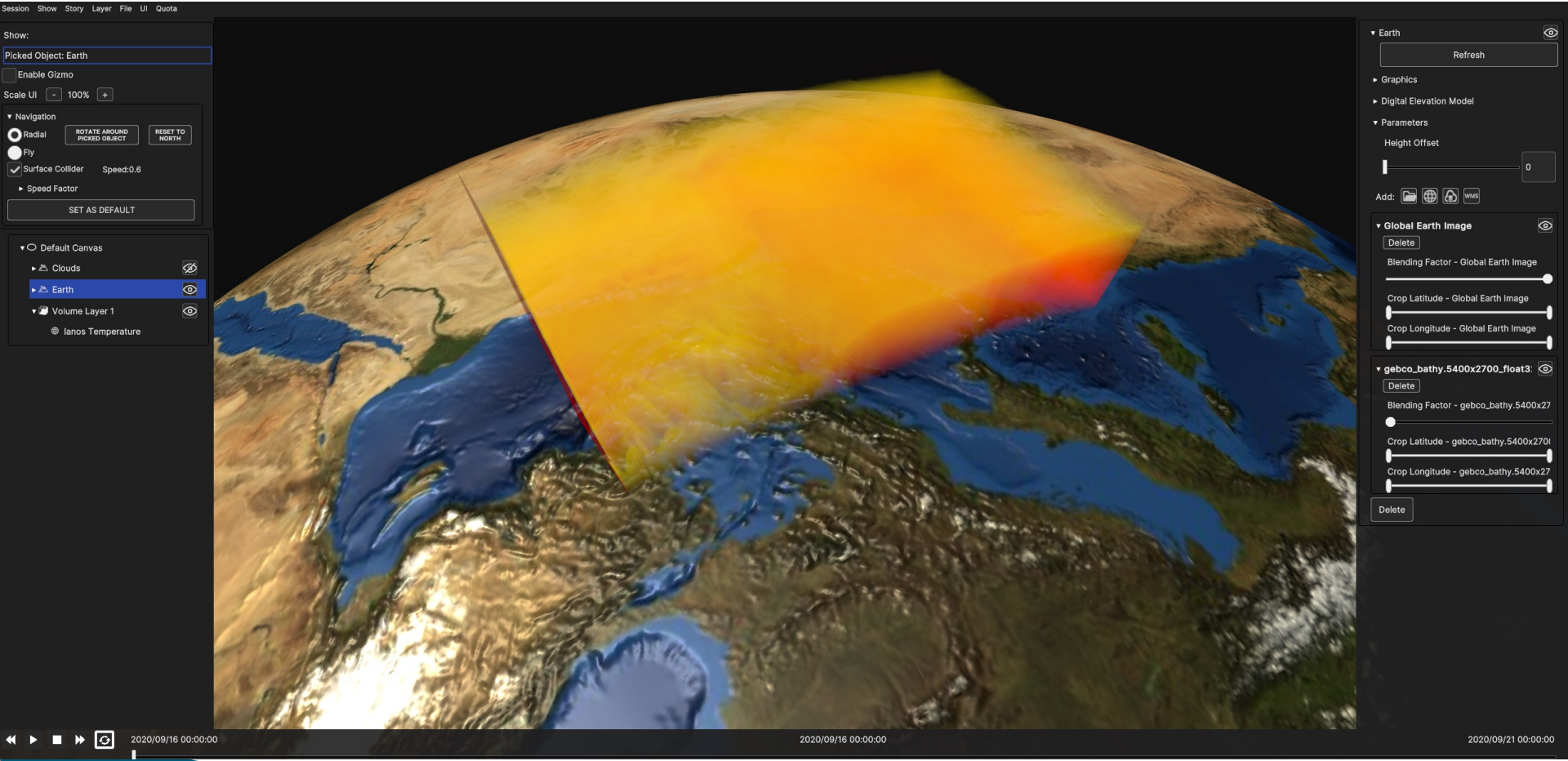
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Scale UI - 100% +
Navigation
Radial
ROTATE AROUND PICKED OBJECT
RESET TO NORTH
Fly
Surface Collider
Speed:0.6
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SET AS DEFAULT
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Clouds
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Volume Layer 1
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Earth
Refresh
Graphics
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Parameters
Height Offset
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Delete
Blending Factor - Global Earth Image
Crop Latitude - Global Earth Image
Crop Longitude - Global Earth Image
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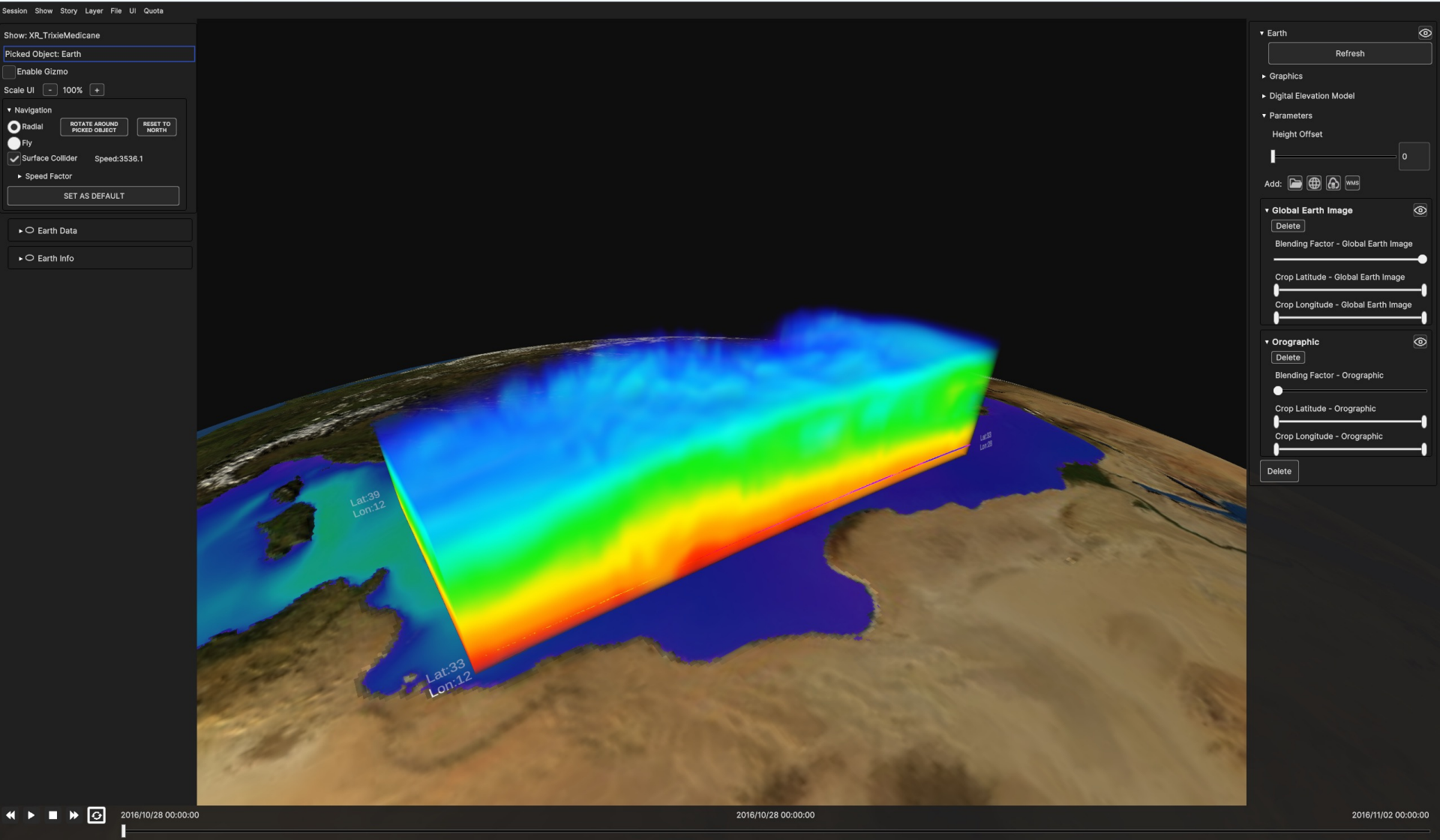
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Picked Object: Earth
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Radial
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RESET TO NORTH
Fly
Surface Collider
Speed:3536.1
Speed Factor
SET AS DEFAULT
Earth Data
Earth Info
Lat:39
Lon:12
Lat:33
Lon:12
Earth
Refresh
Graphics
Digital Elevation Model
Parameters
Height Offset
0
Add:
Global Earth Image
Delete
Blending Factor - Global Earth Image
Crop Latitude - Global Earth Image
Crop Longitude - Global Earth Image
Orographic
Delete
Blending Factor - Orographic
Crop Latitude - Orographic
Crop Longitude - Orographic
Delete
2016/10/28 00:00:00
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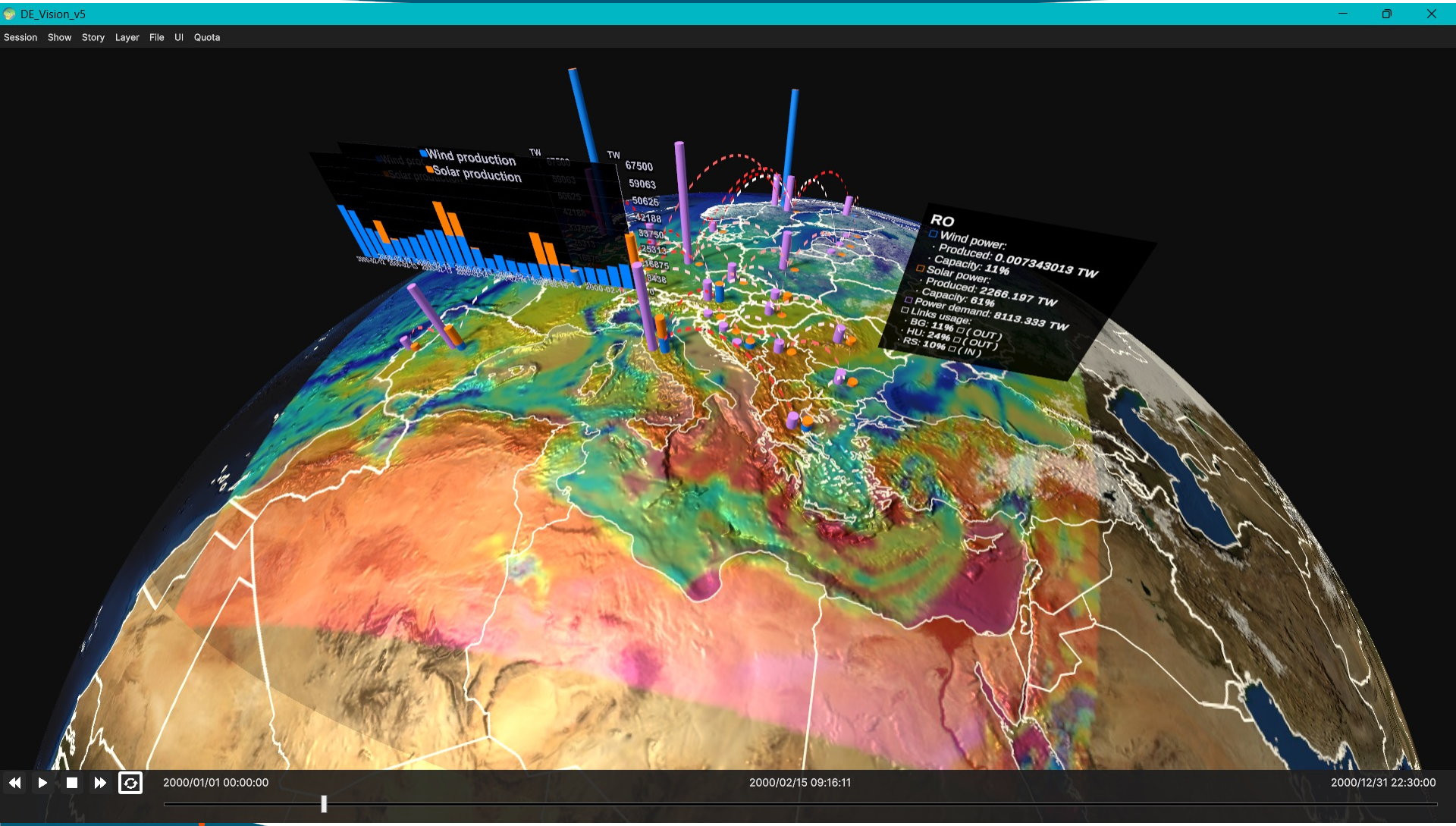
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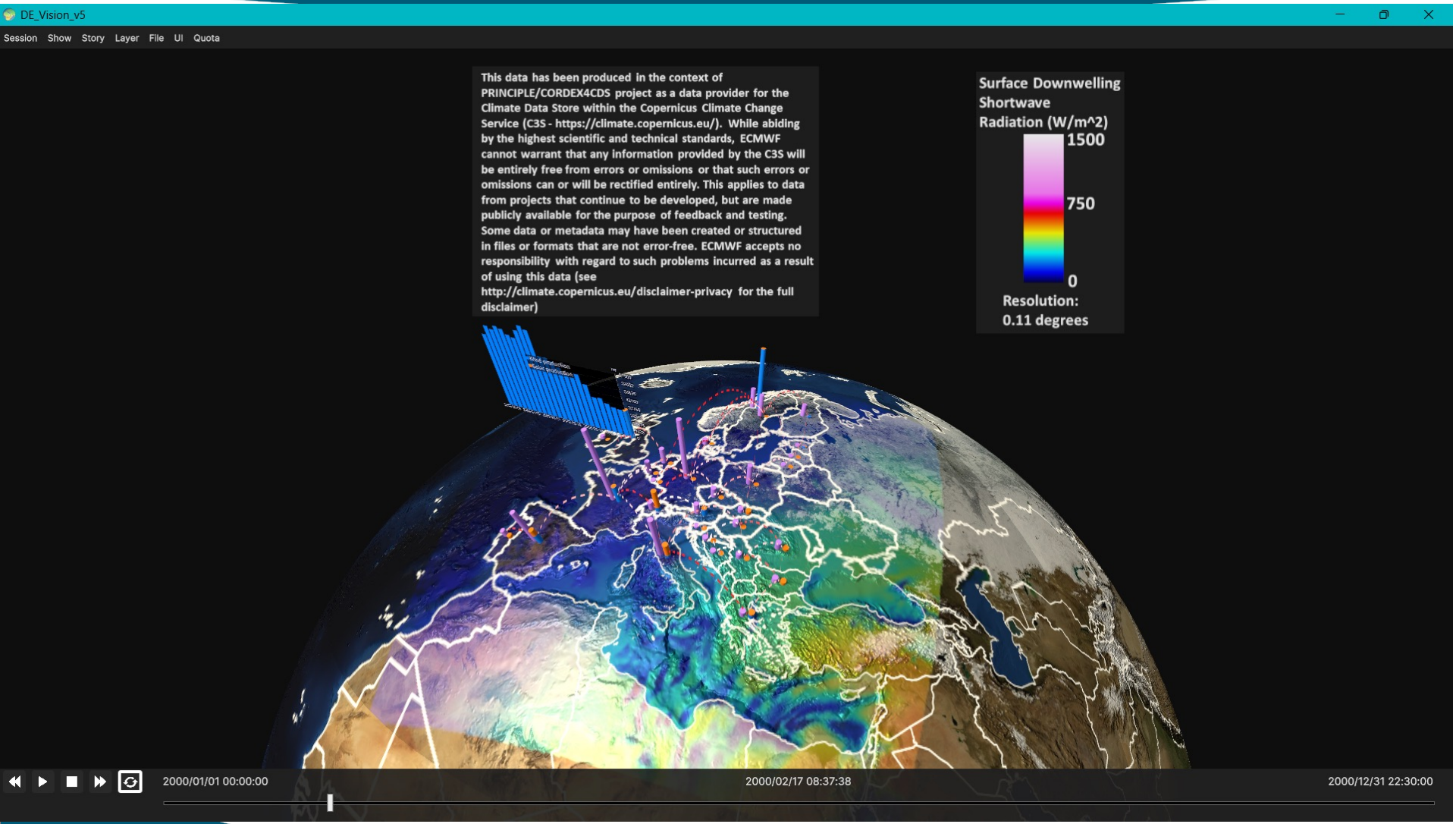
Session Show Story Layer File UI Quota
Wind production
Solar production
TW
67500
59063
50625
42188
33750
25313
16875
8438
0
RO
Wind power:
· Produced: 0.007343013 TW
· Capacity: 11%
Solar power:
· Produced: 2266.197 TW
· Capacity: 61%
Power demand: 8113.333 TW
Links usage:
· BG: 11% (OUT)
· HU: 24% (OUT)
· RS: 10% (IN)
2000/01/01 00:00:00
2000/02/15 09:16:11
2000/12/31 22:30:00


DE_Vision_v5
Session Show Story Layer File UI Quota
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Surface Downwelling Shortwave Radiation (W/m^2)
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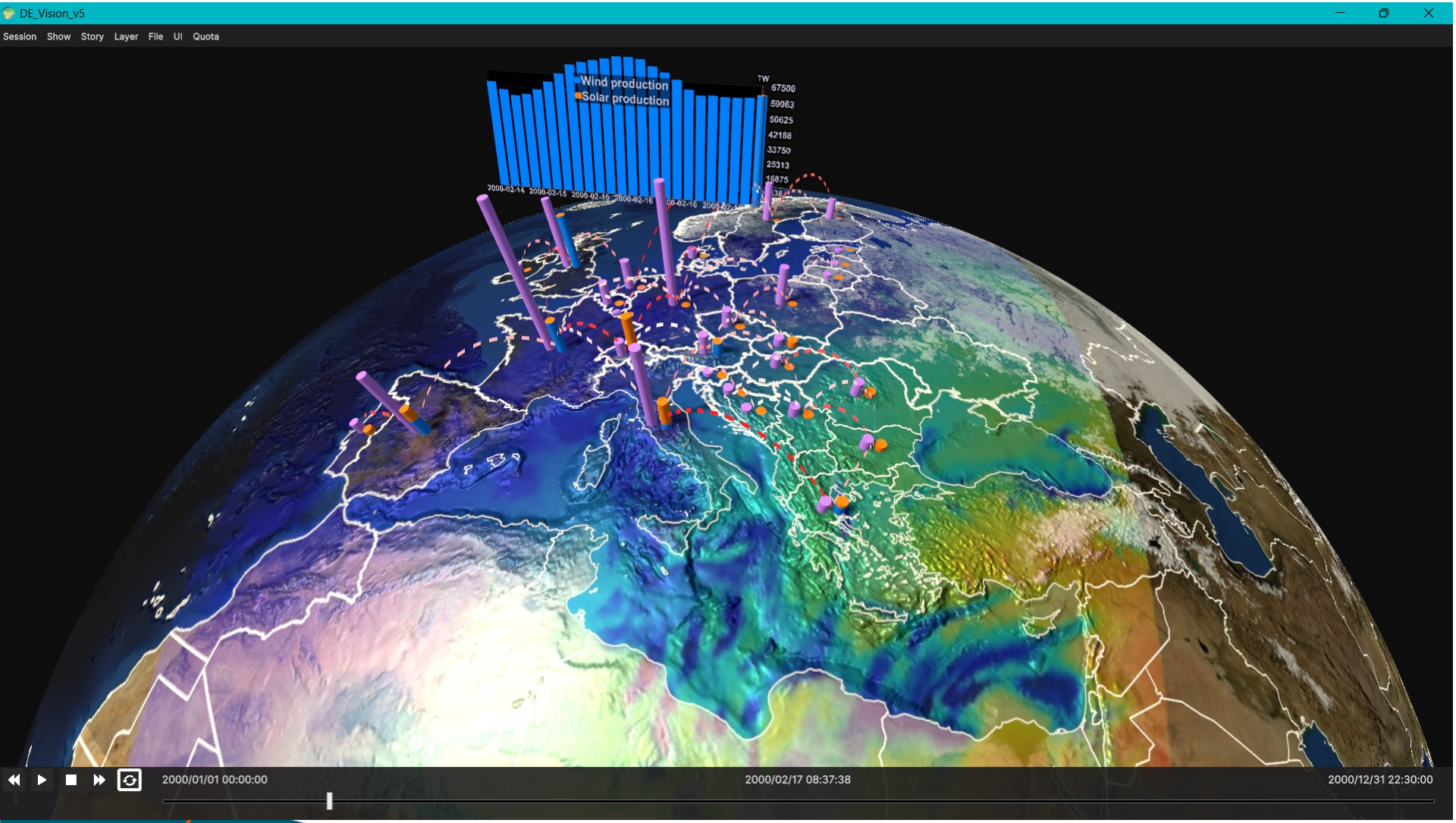
750
0
Resolution: 0.11 degrees
2000/01/01 00:00:00
2000/02/17 08:37:38
2000/12/31 22:30:00


DE_Vision_v5
Session Show Story Layer File UI Quota
Wind production
Solar production
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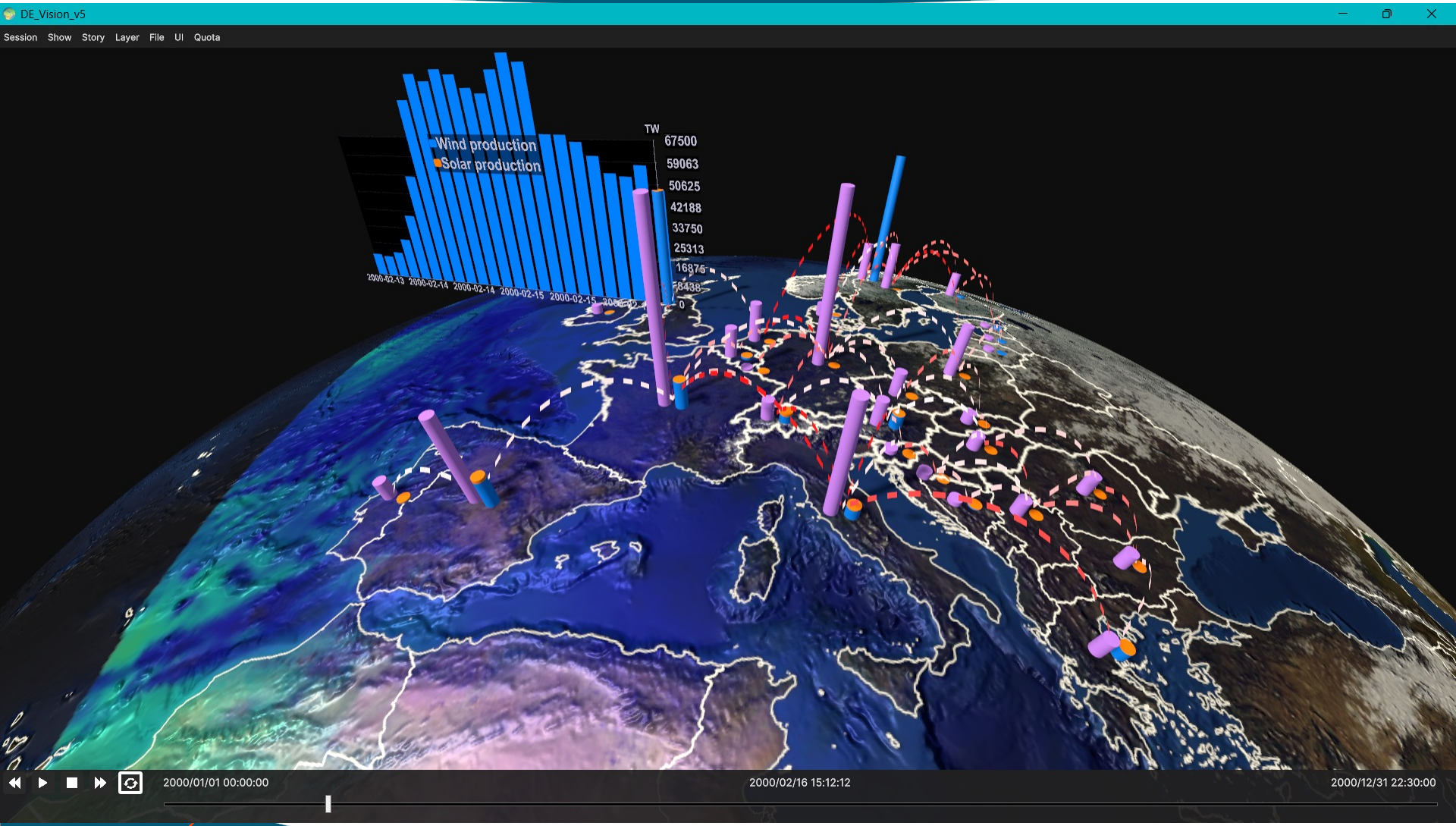
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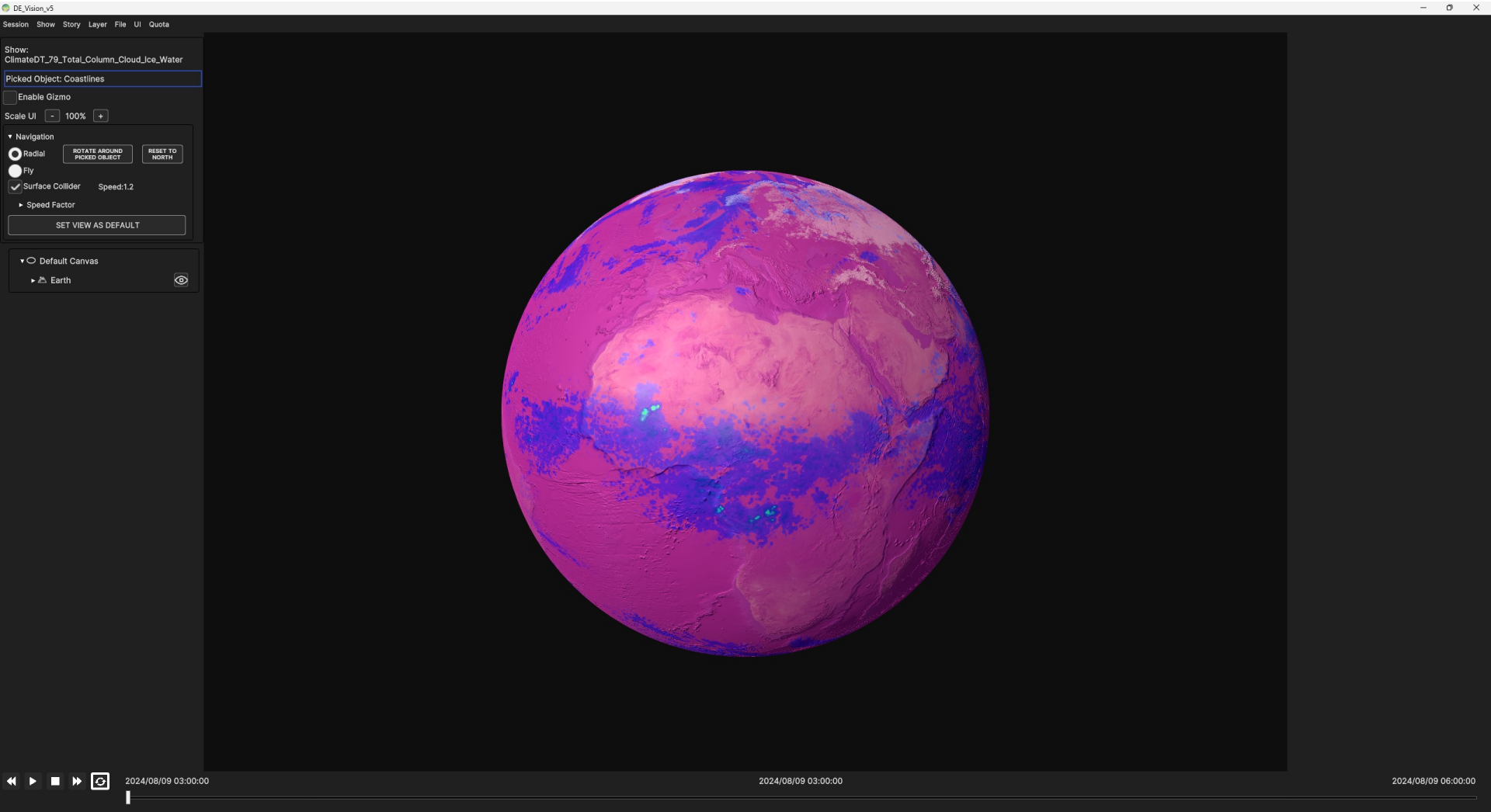
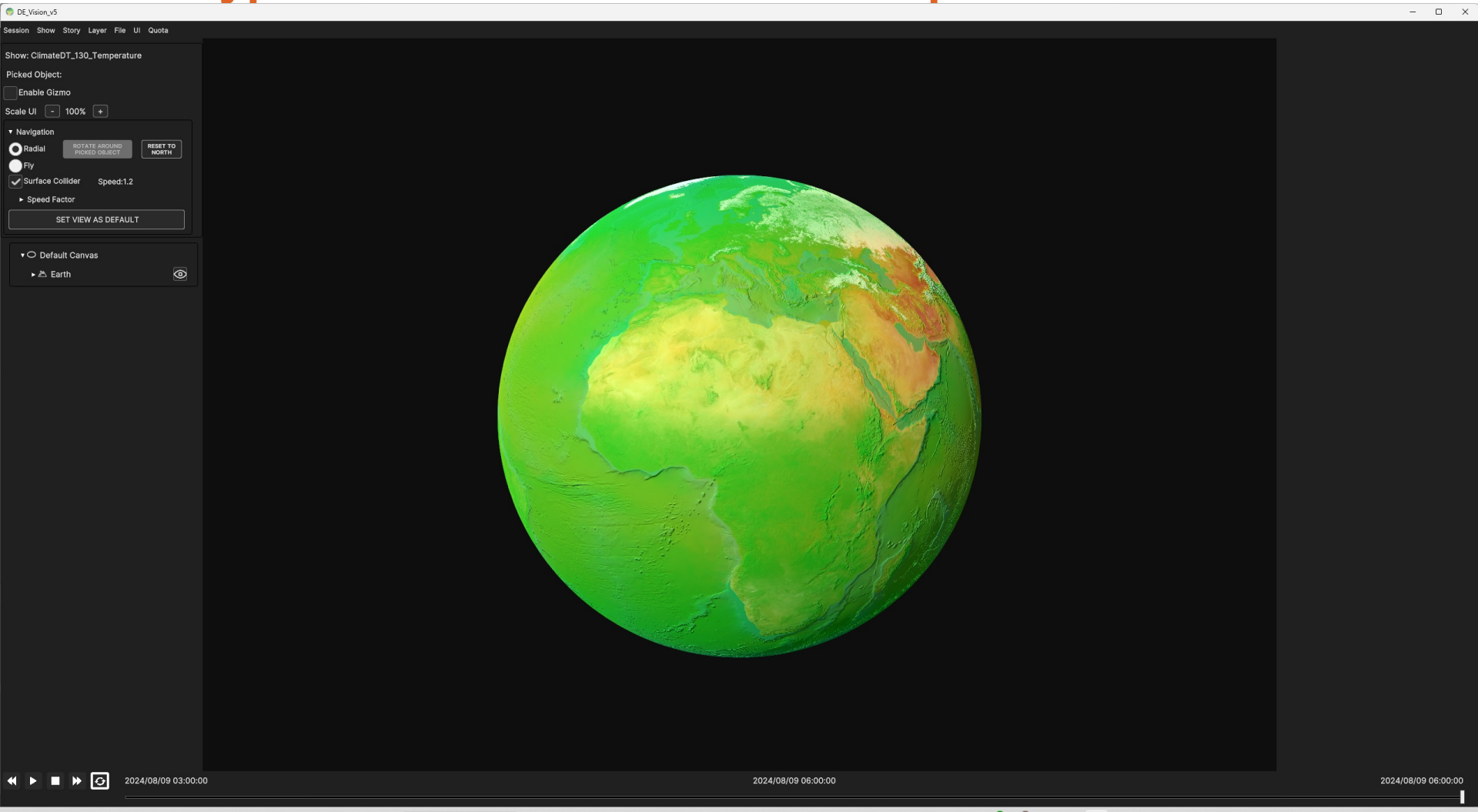
2000/01/01 00:00:00
2000/02/16 15:12:12
2000/12/31 22:30:00

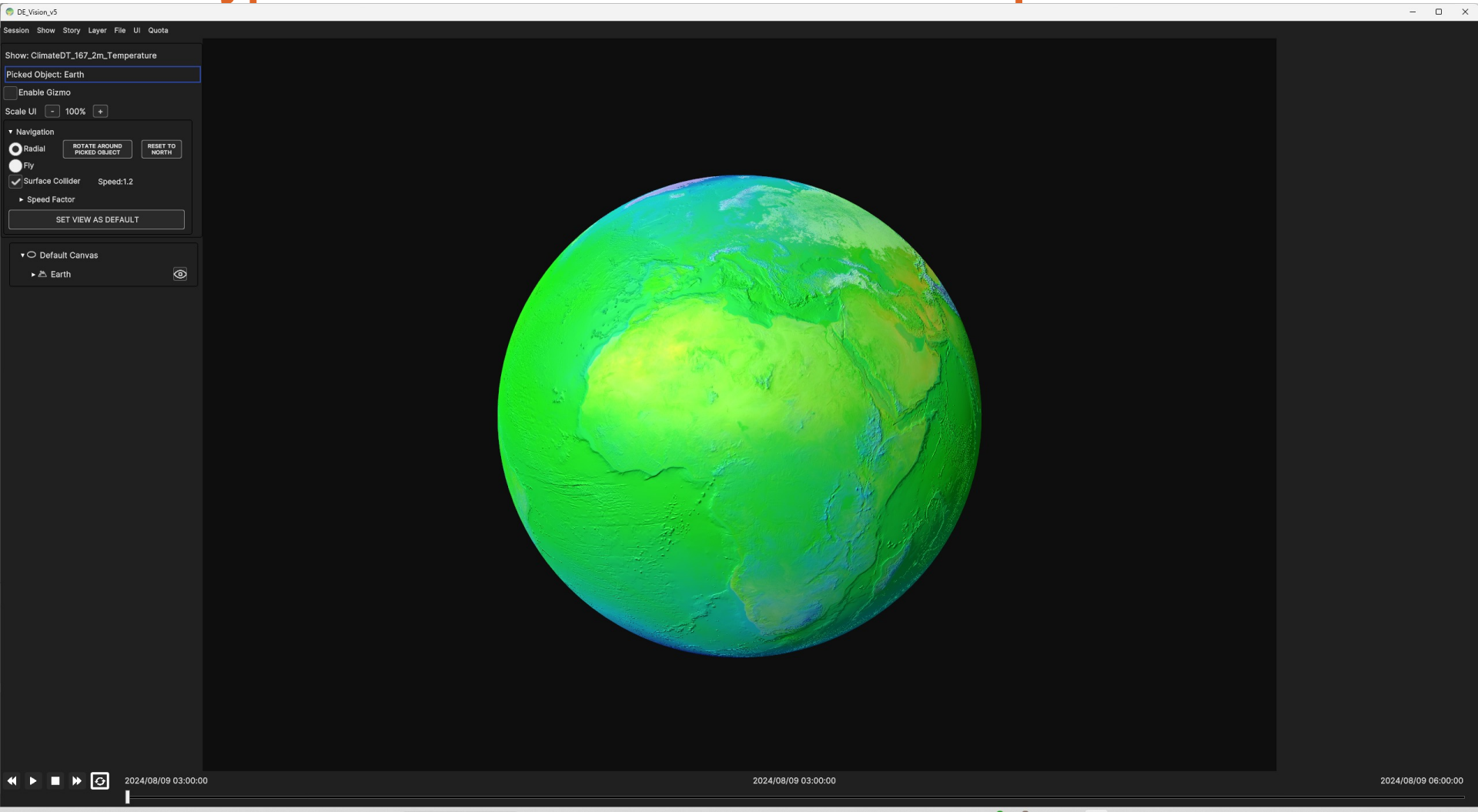
Prototype R5 – ClimateDT 79 – Total Column Cloud Ice



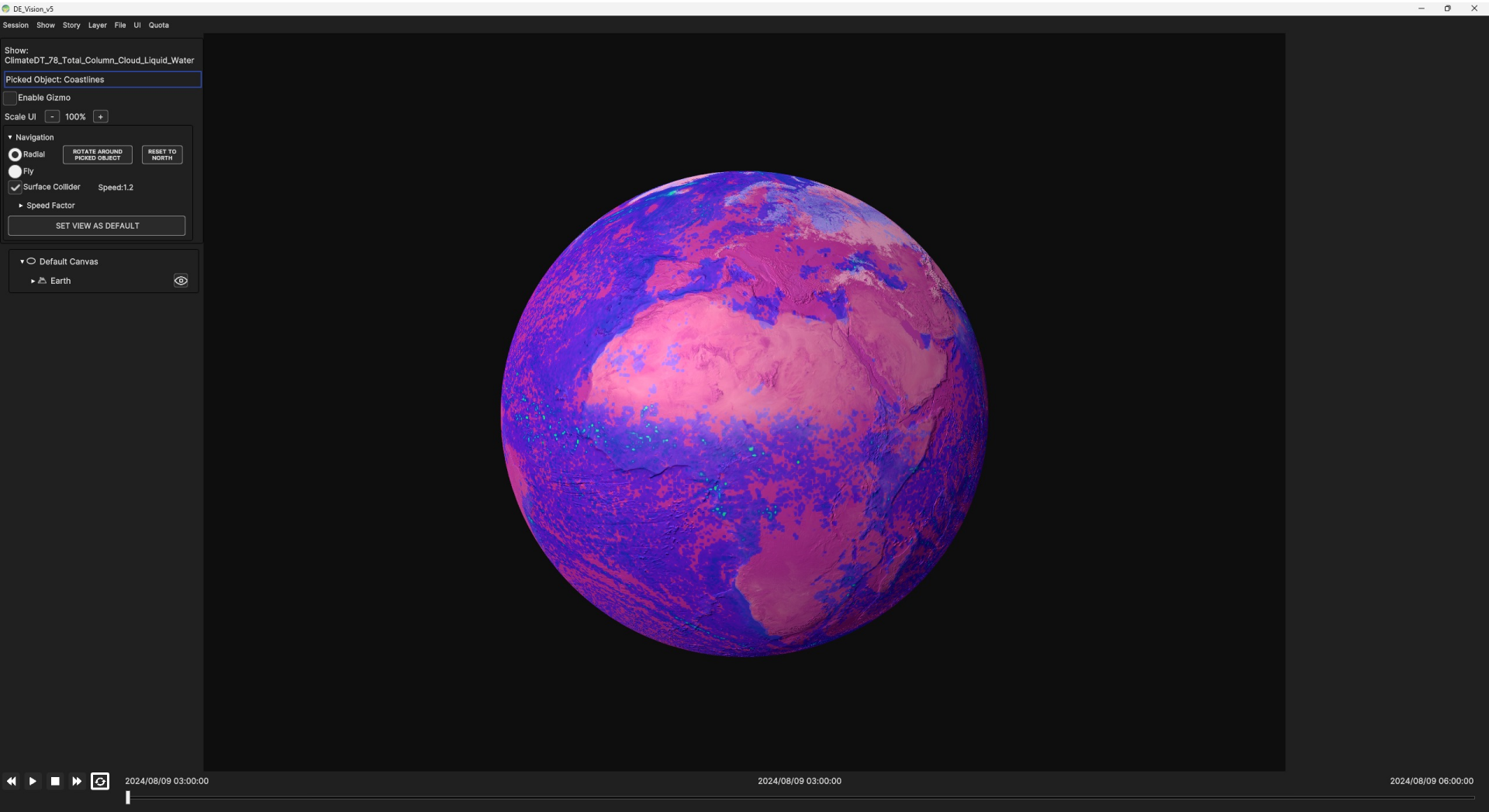
Prototype R5 – ClimateDT 130 – Temperature



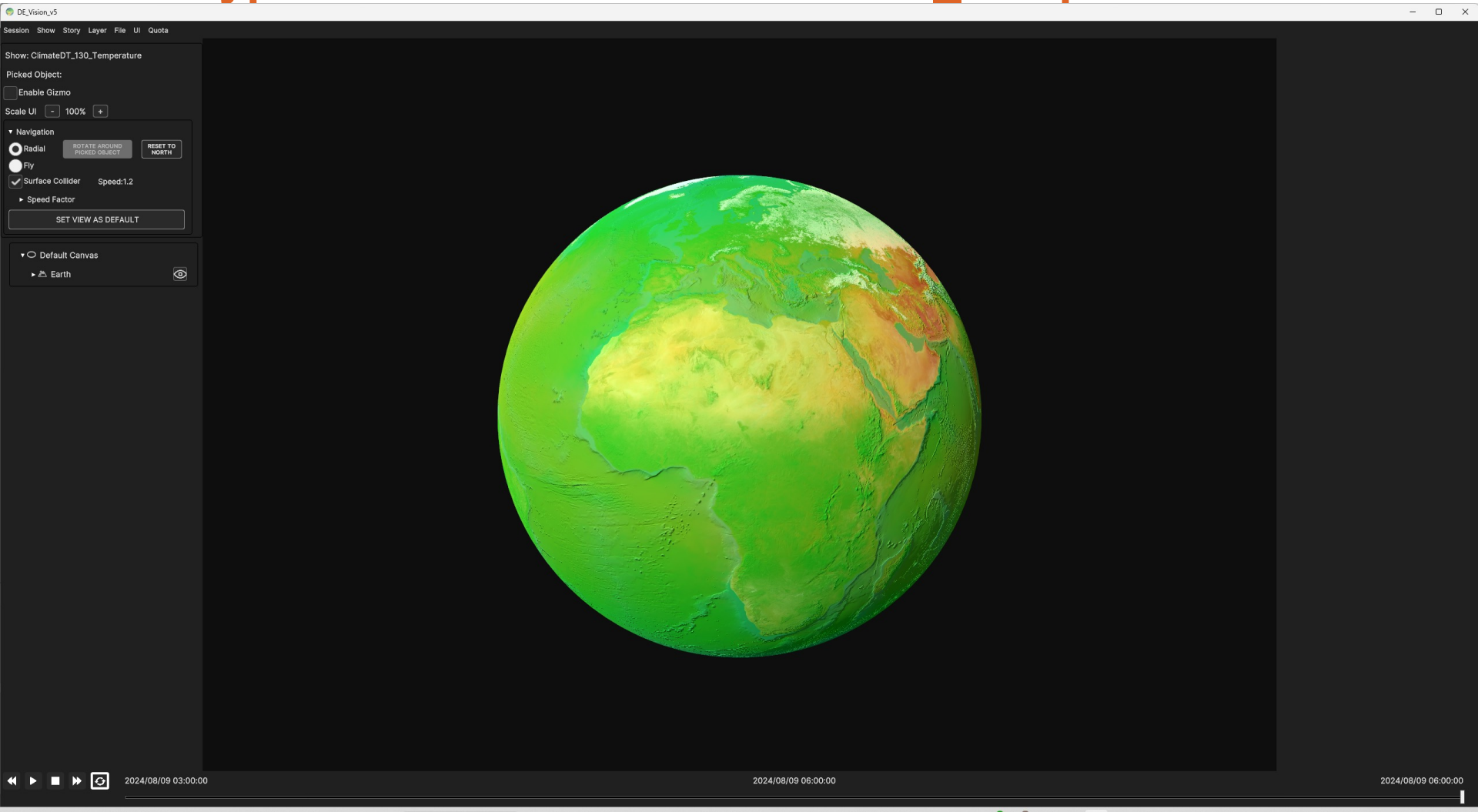
Prototype R5 – ClimateDT 167 – 2m Temperature



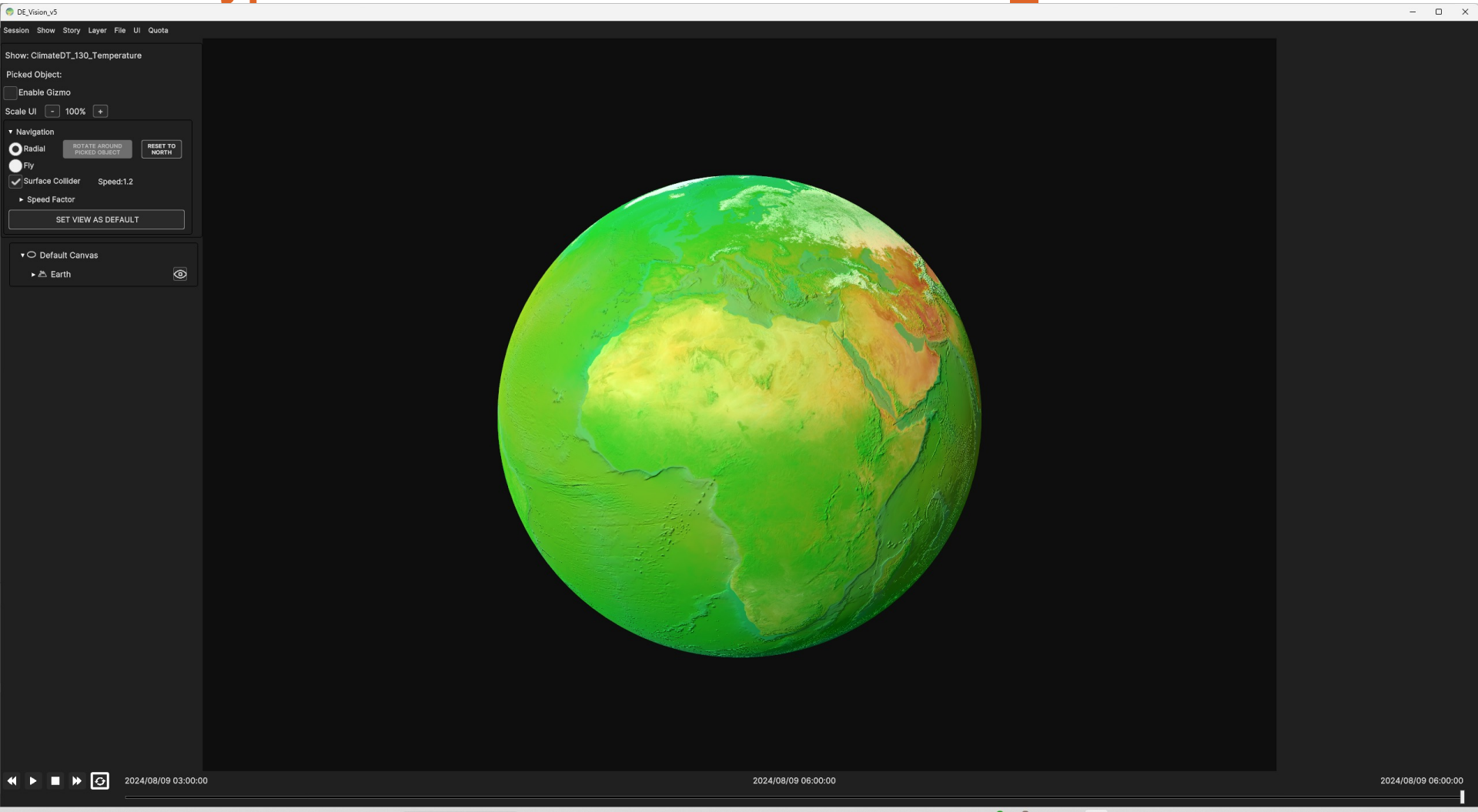
Prototype R5 – ClimateDT 78 – Total Column Cloud Liquid Water



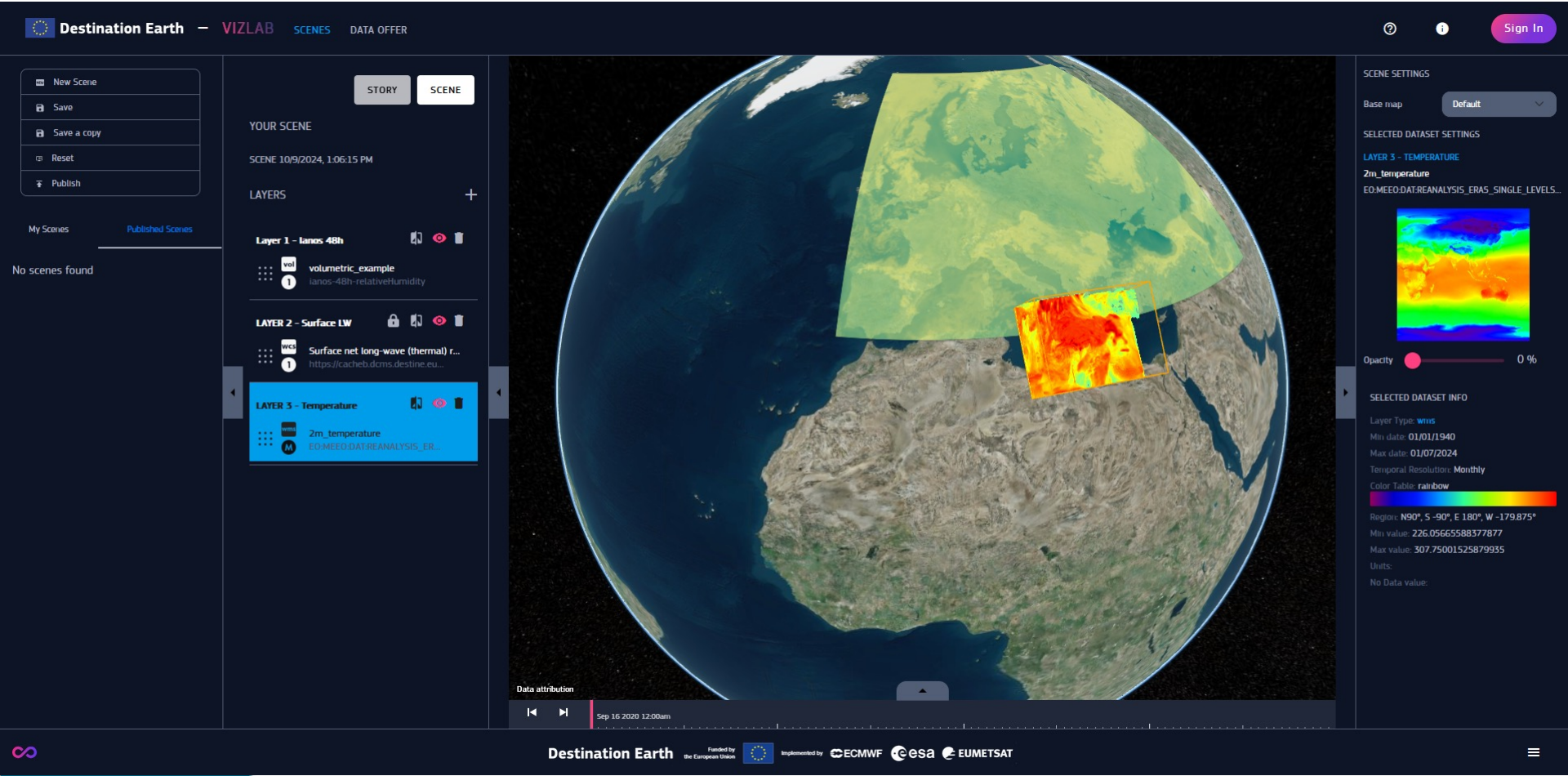
Prototype R5 – ClimateDT 235 – Skin_Temperature



Prototype R5 – ClimateDT 134 – Surface_Pressure



Prototype R5 Video


Destination Earth – VIZLAB
SCENES
DATA OFFER
Sign In
New Scene
Save
Save a copy
Reset
Publish
My Scenes
Published Scenes
No scenes found
STORY
SCENE
YOUR SCENE
SCENE 10/9/2024, 1:06:15 PM
LAYERS
Layer 1 - Ianos 48h
volumetric_example
ianos-48h-relativeHumidity
LAYER 2 - Surface LW
Surface net long-wave (thermal) r...
https://cacheb.dcms.destine.eu...
LAYER 3 - Temperature
2m_temperature
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Data attribution
Sep 16 2020 12:00am
SCENE SETTINGS
Base map
Default
SELECTED DATASET SETTINGS
LAYER 3 - TEMPERATURE
2m_temperature
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SELECTED DATASET INFO
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Temporal Resolution: Monthly
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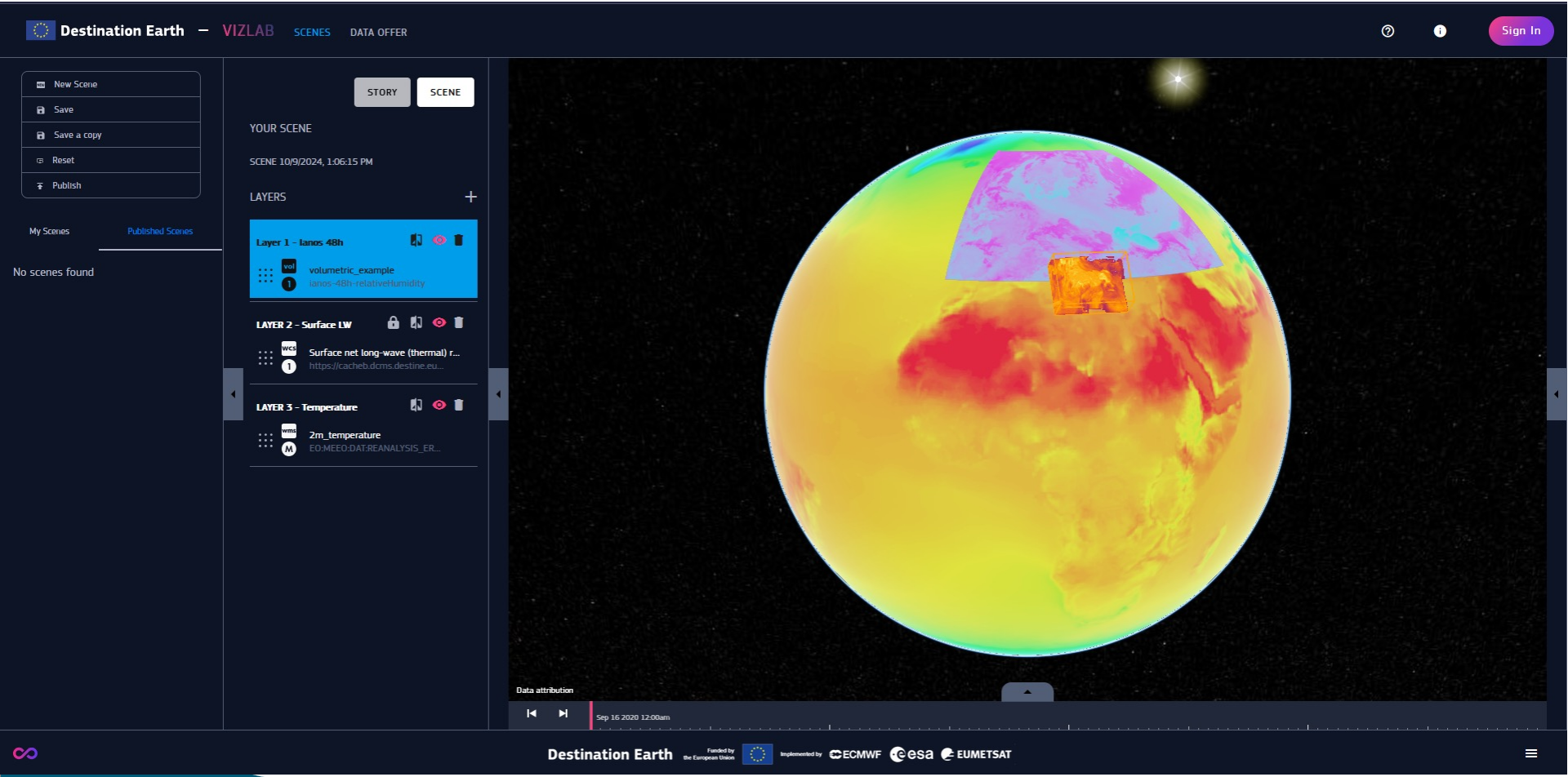
Units:
No Data value:
Destination Earth
Funded by the European Union
Implemented by
ECMWF
esa
EUMETSAT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SCENES
DATA OFFER
Sign In
New Scene
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STORY
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volumetric_example
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Surface net long-wave (thermal) r...
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LAYER 3 - Temperature
2m_temperature
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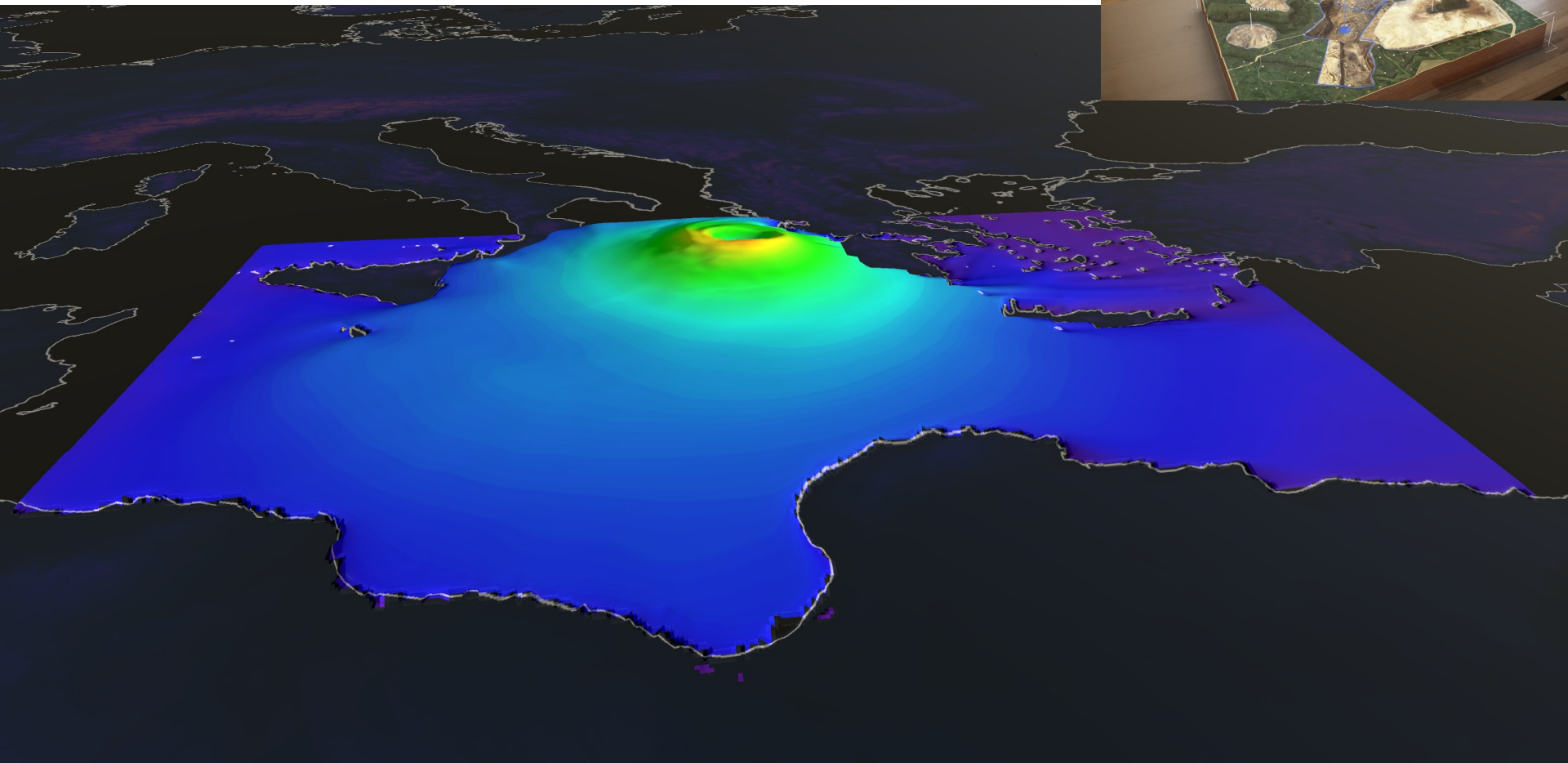
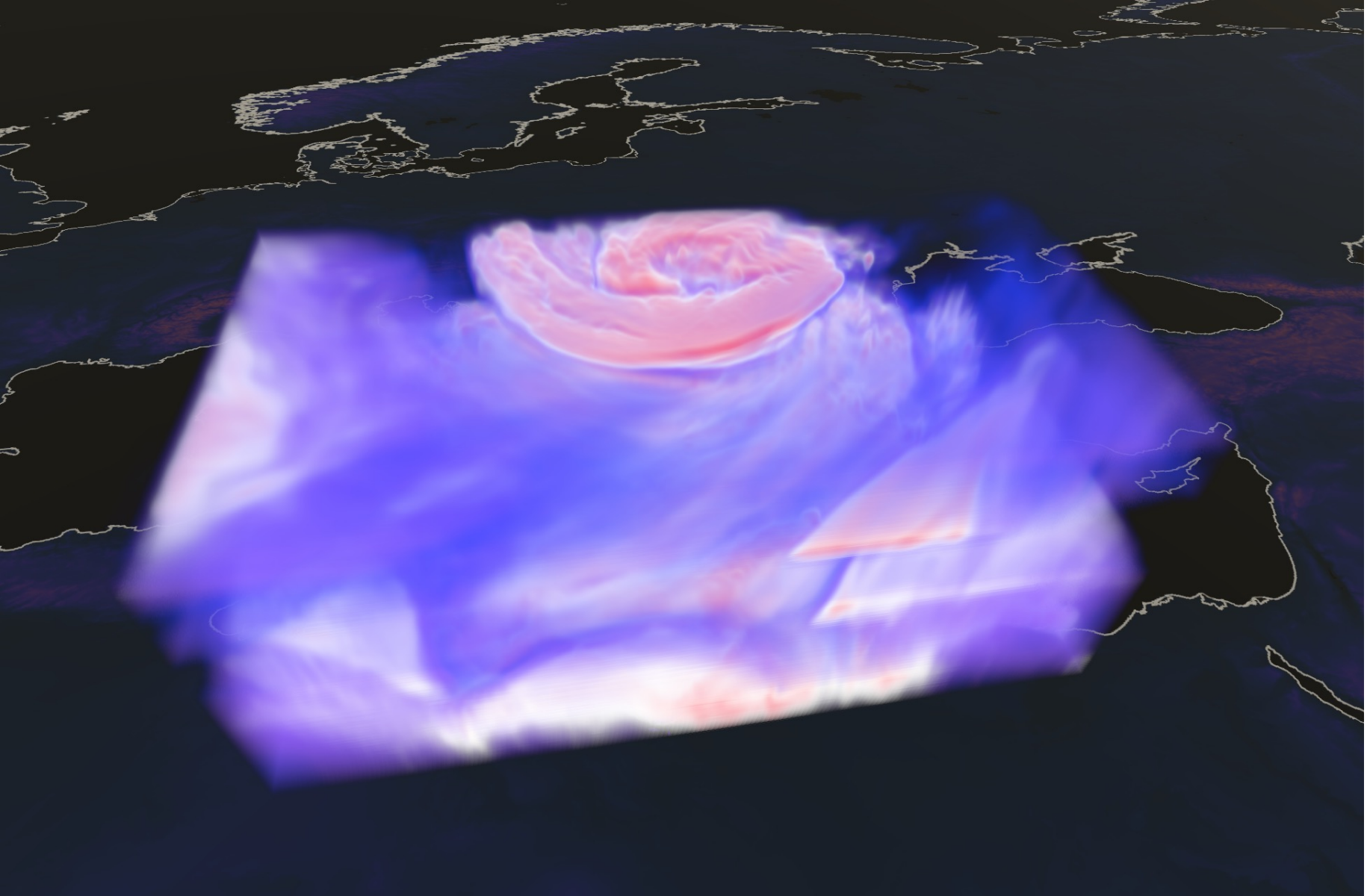
Destination Earth
Funded by the European Union
Implemented by
ECMWF
esa
EUMETSAT

Prototype R5





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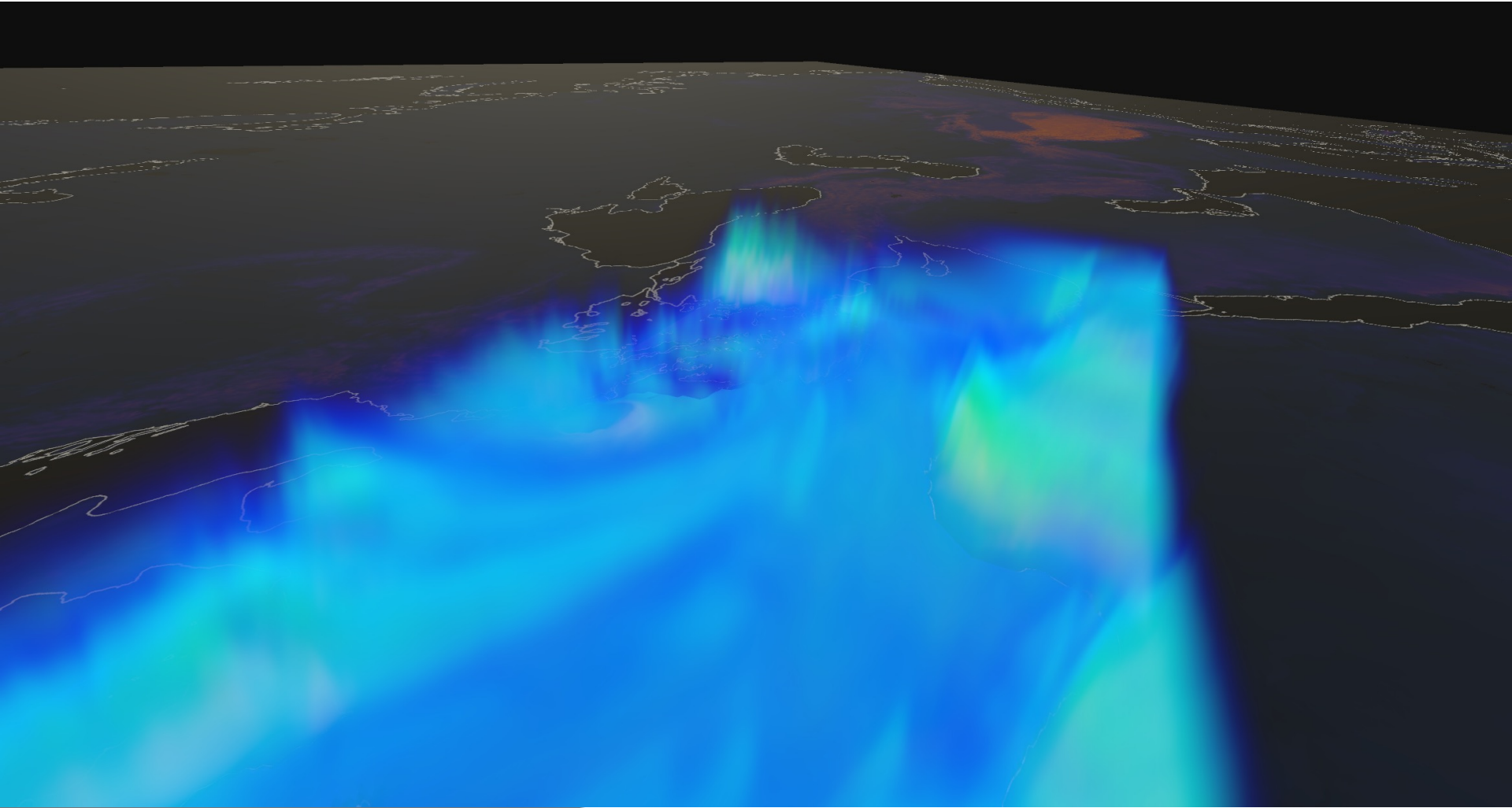

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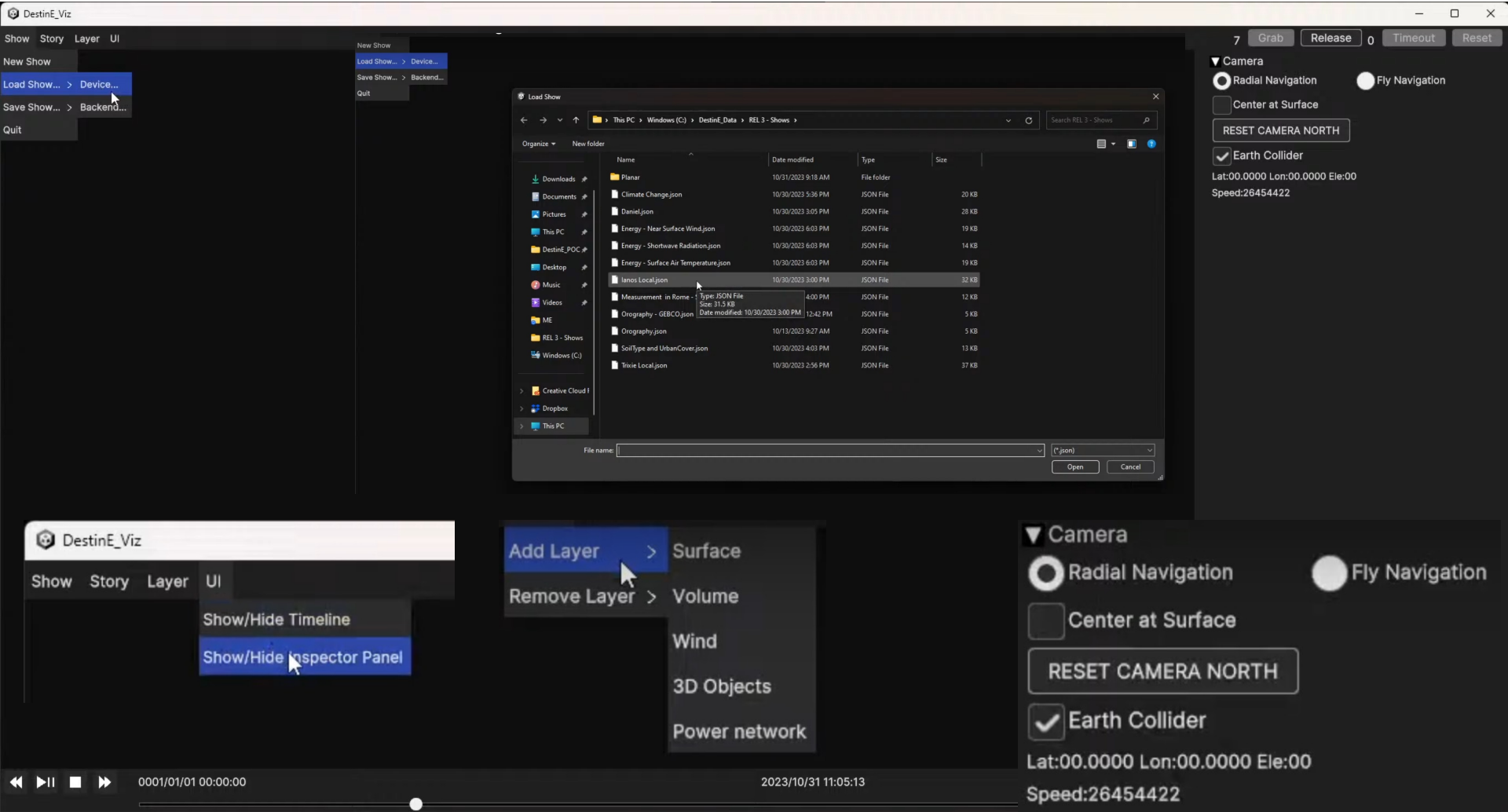

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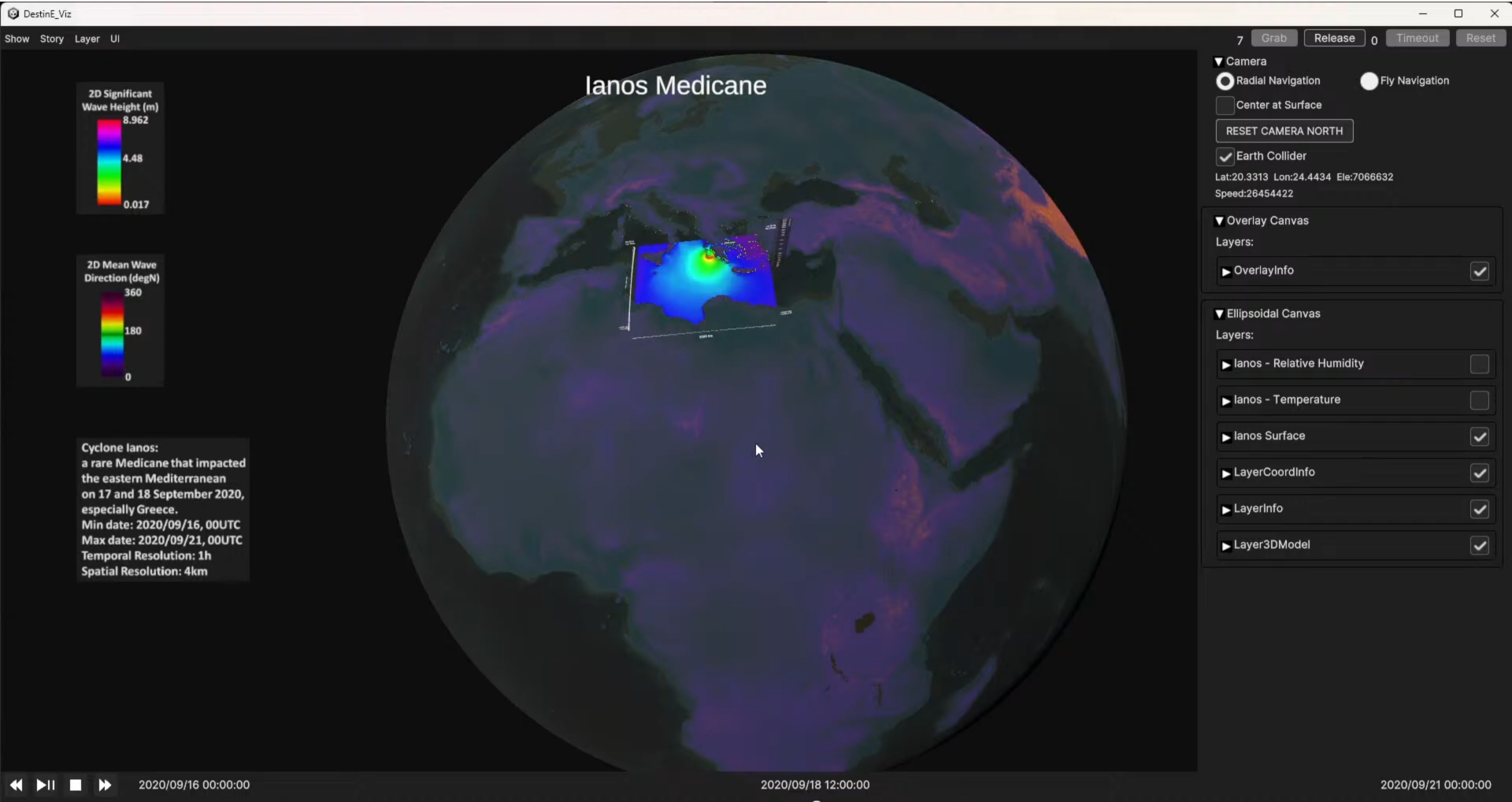

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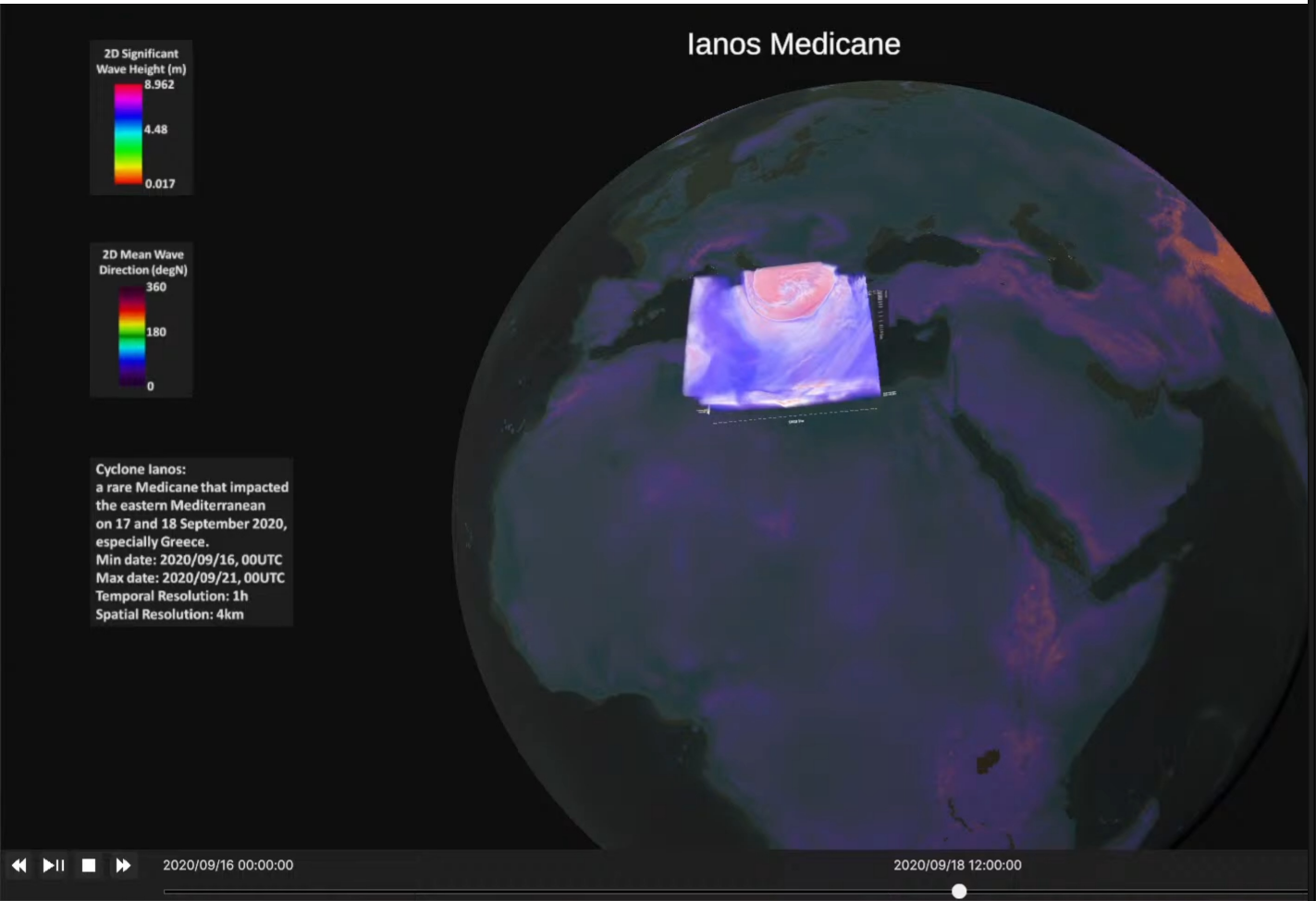

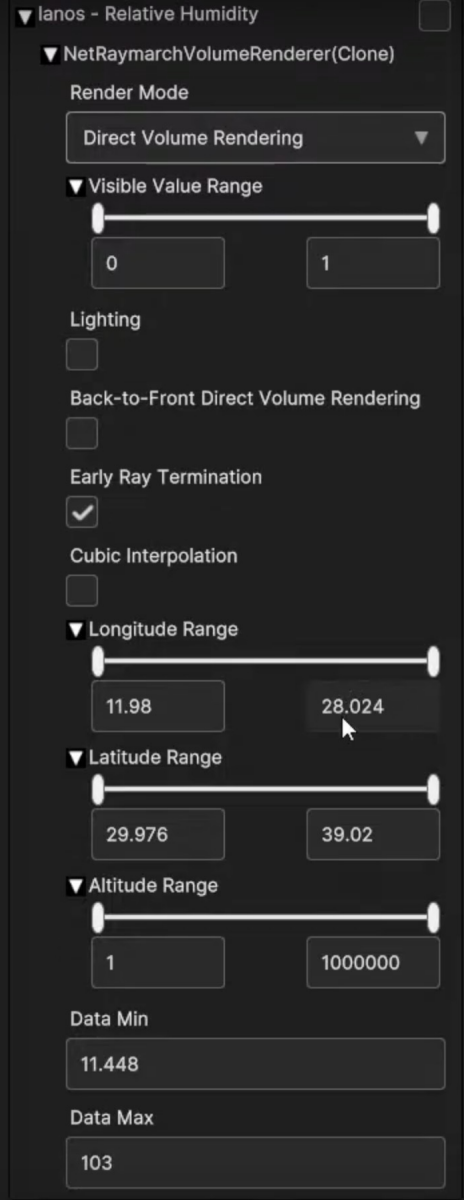

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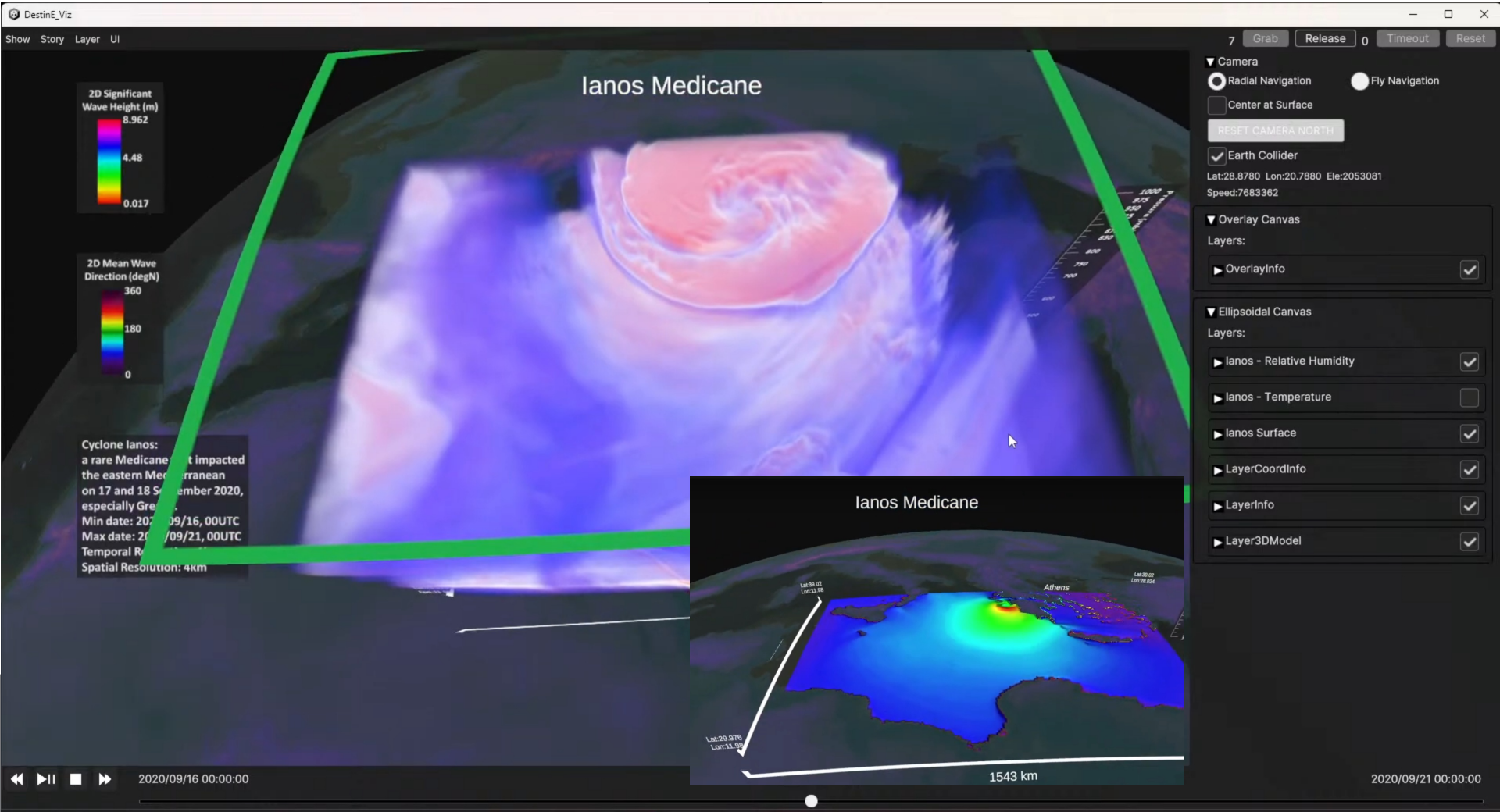

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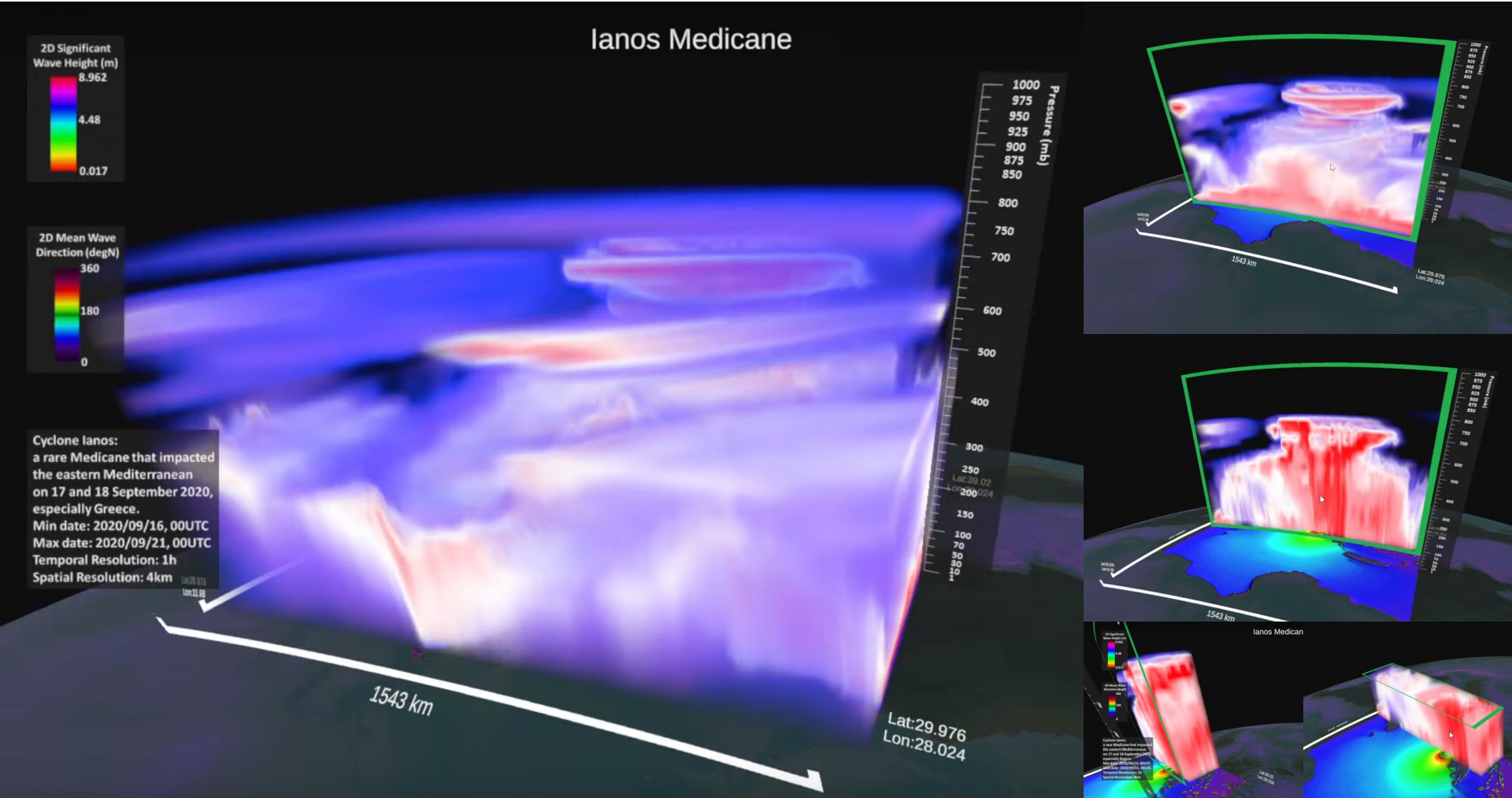

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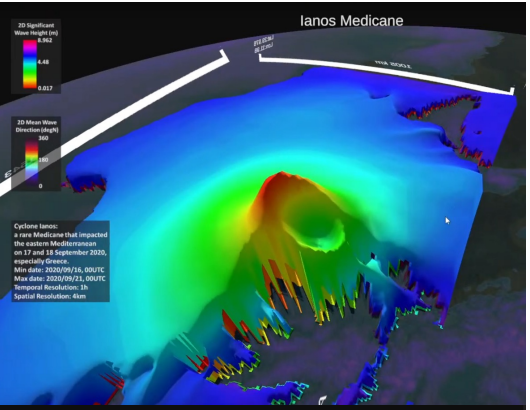
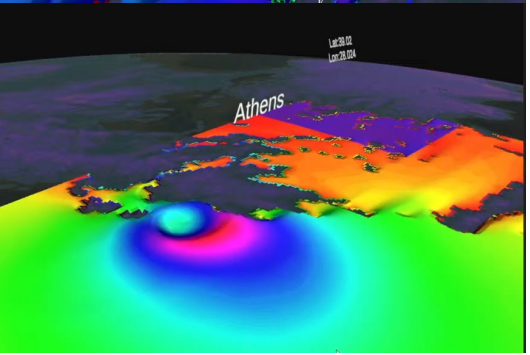




Ianos Surface

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

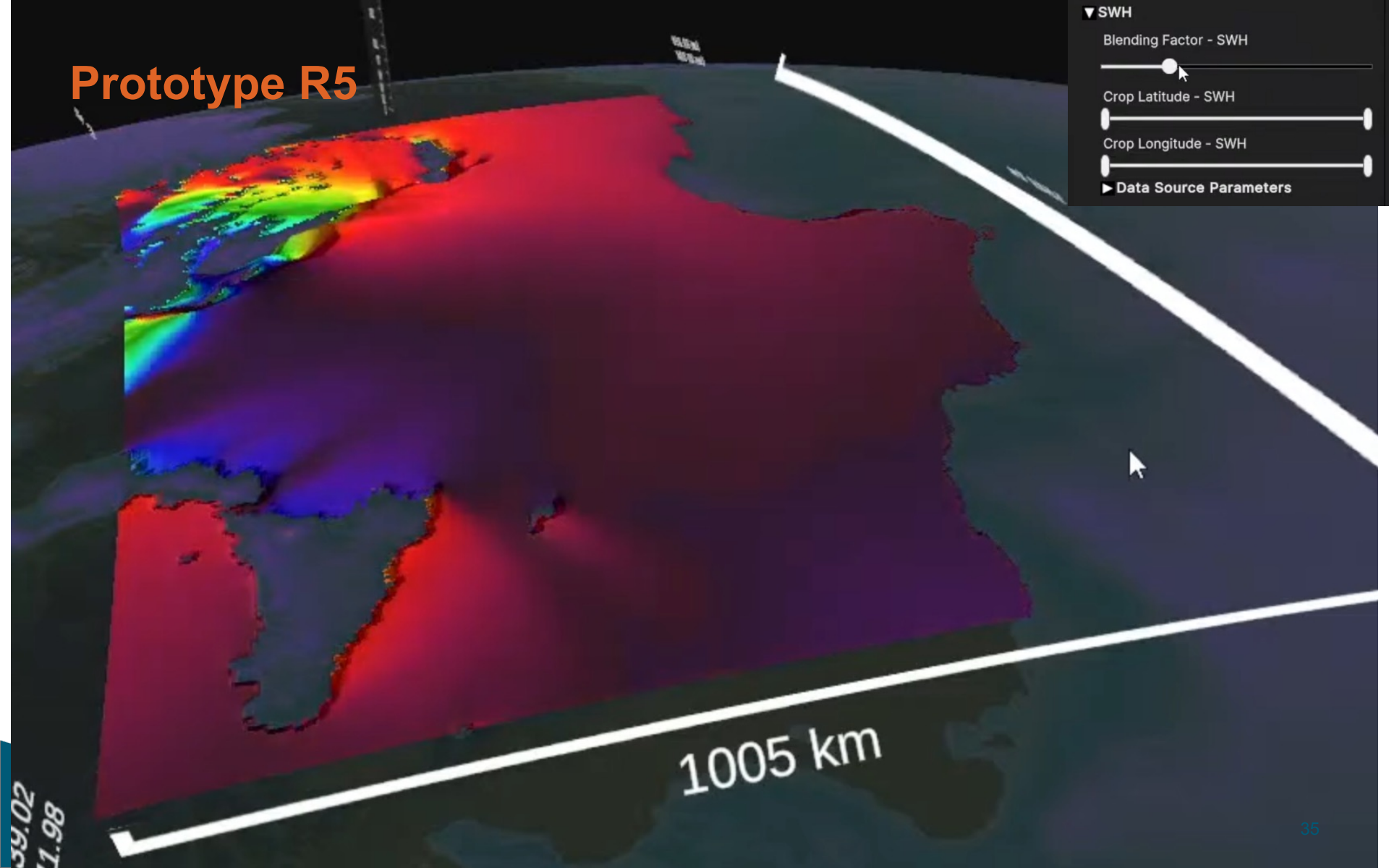
Latitude Range 30.85808 39.02

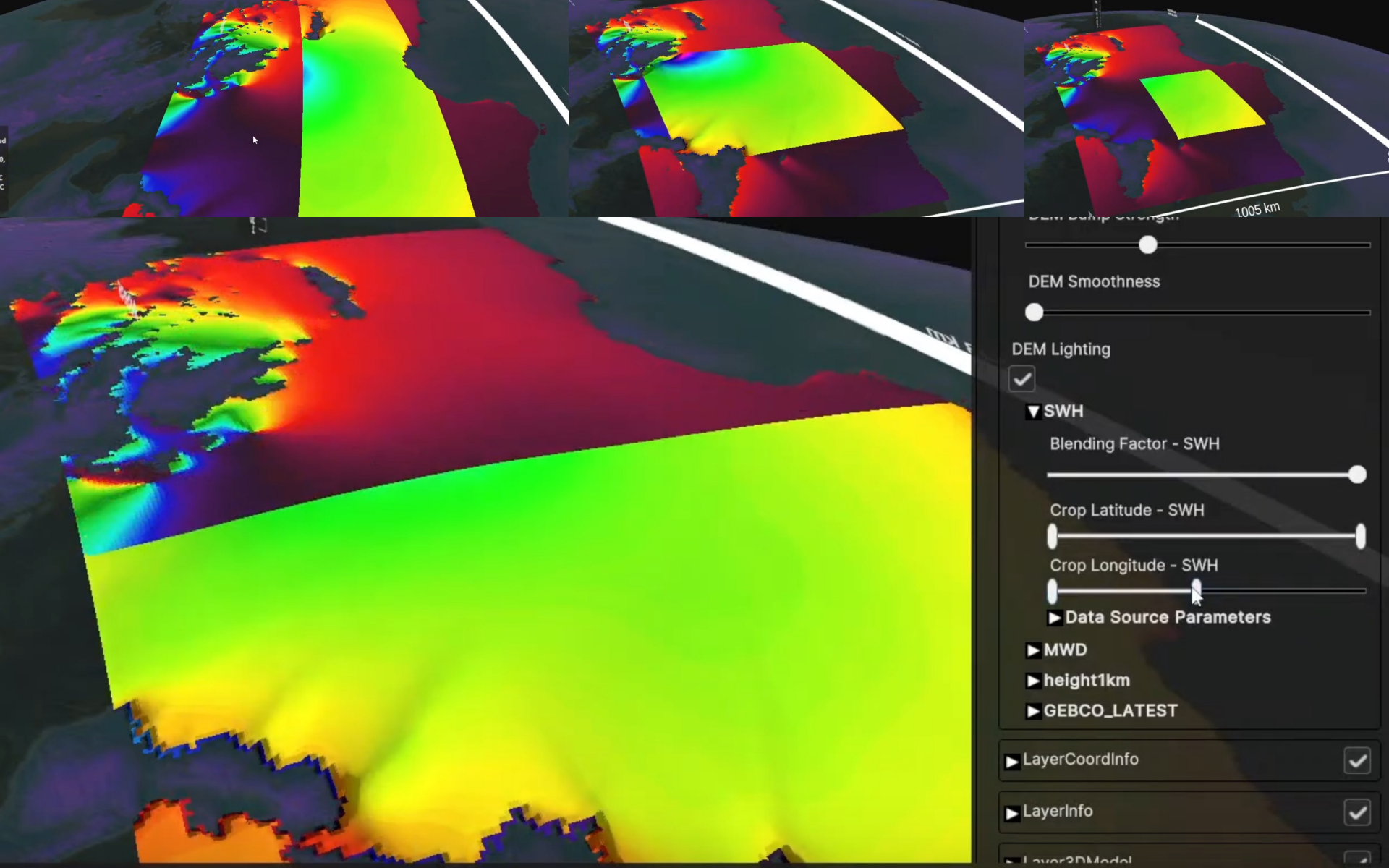
Altitude Range 1 517318

Data Min

exprivia
Defence & Aerospace Digital Factory

Prototype R5




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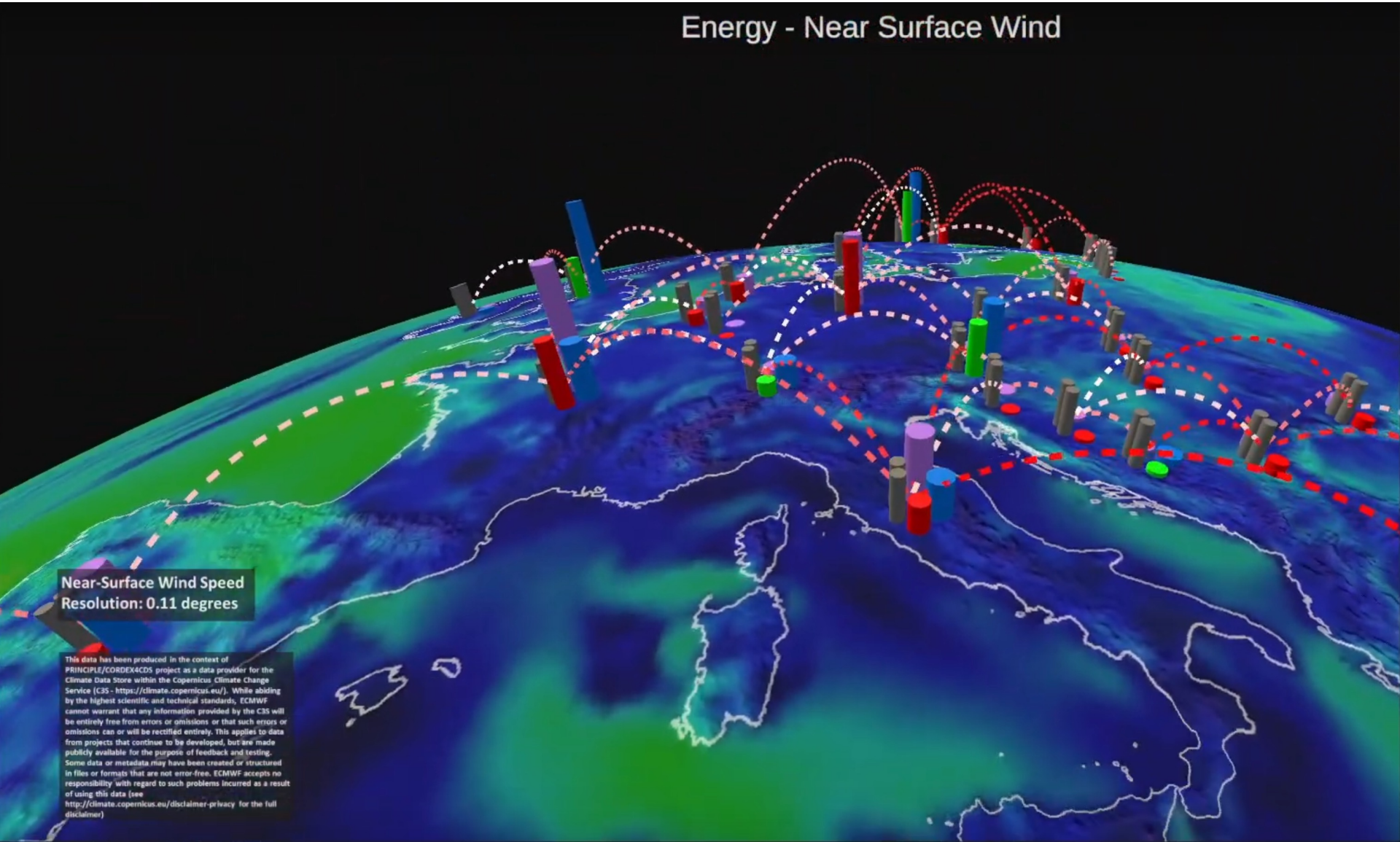
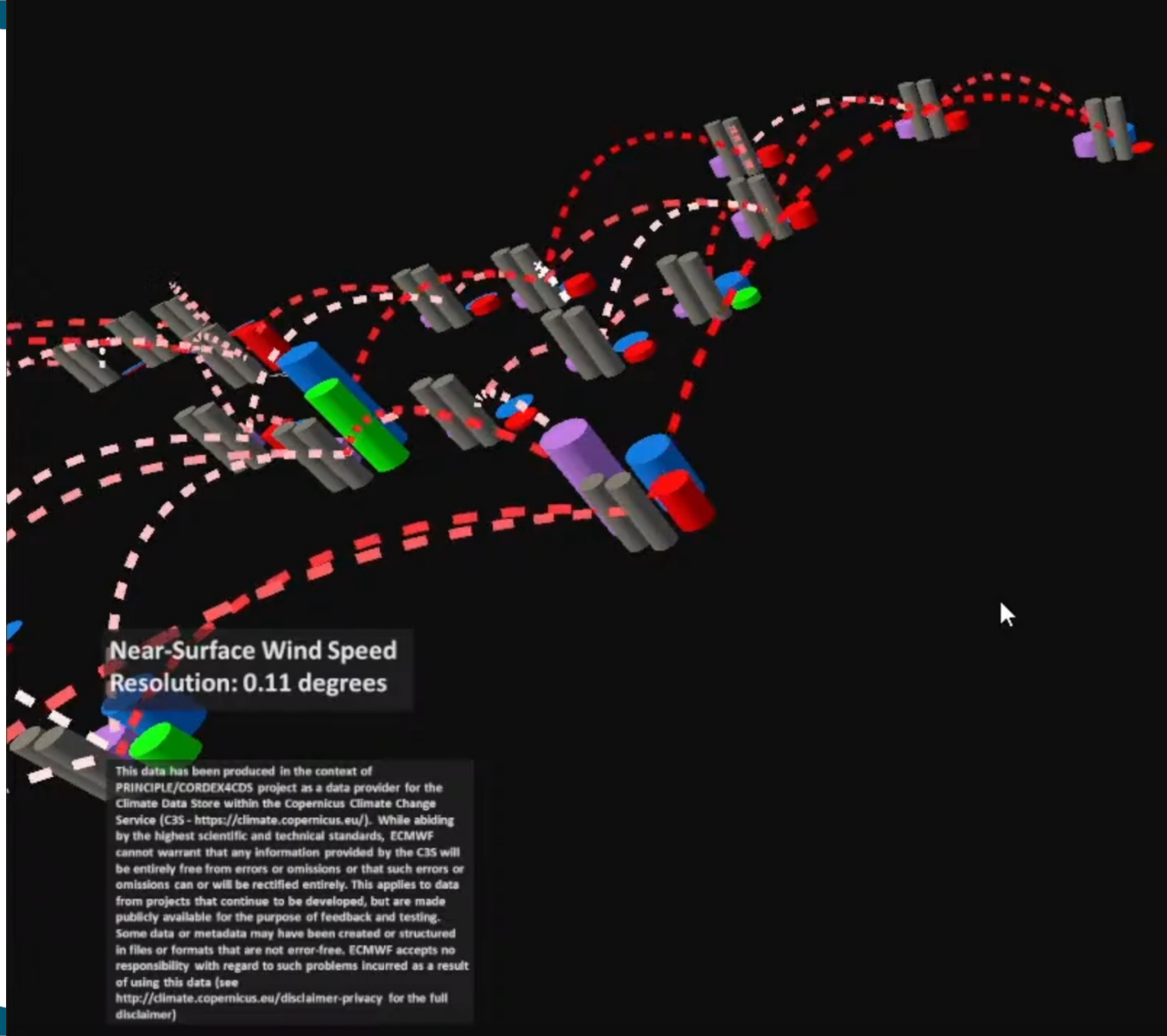
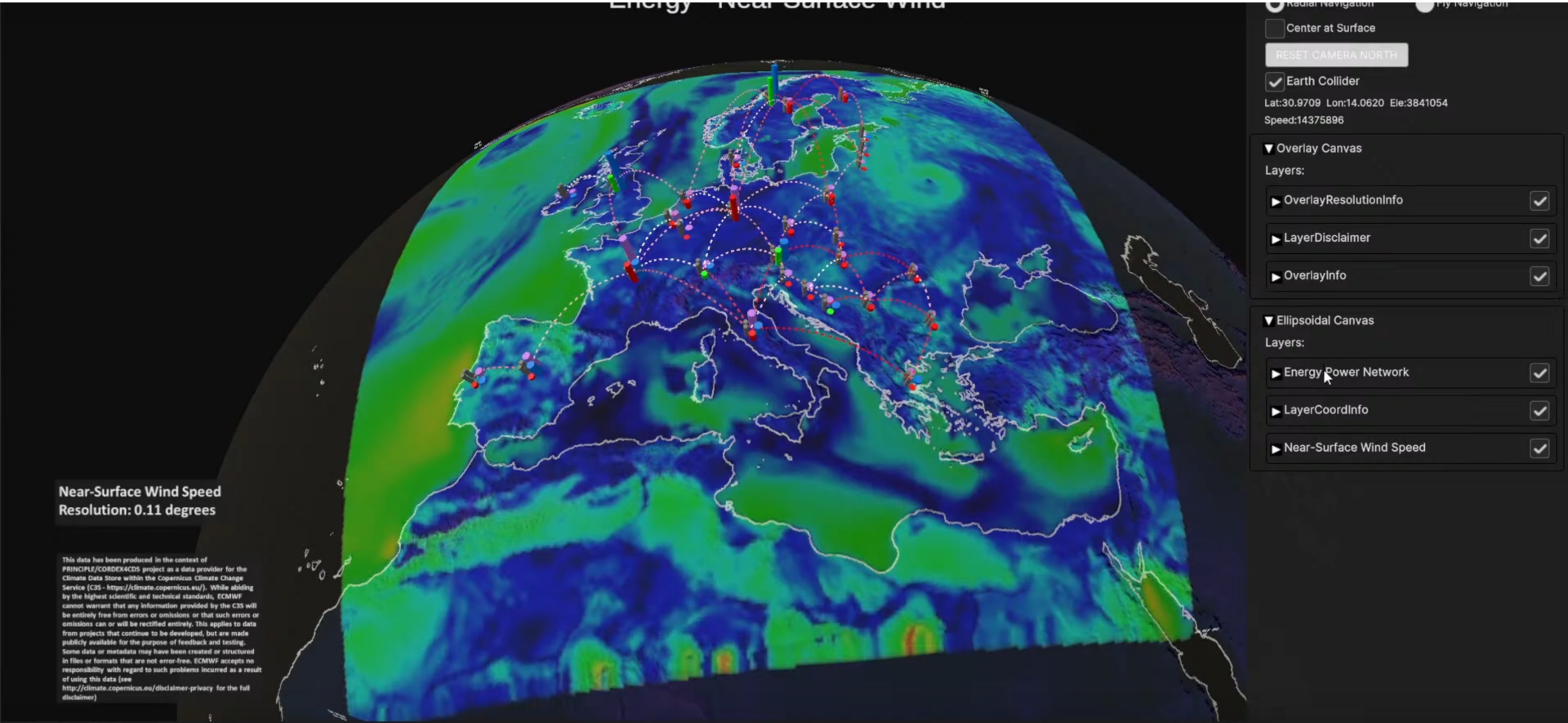
Crop Longitude - SWH
Data Source Parameters
MWD
height1km
GEBCO_LATEST
LayerCoordInfo
LayerInfo


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)

Prototype R5



Prototype R5



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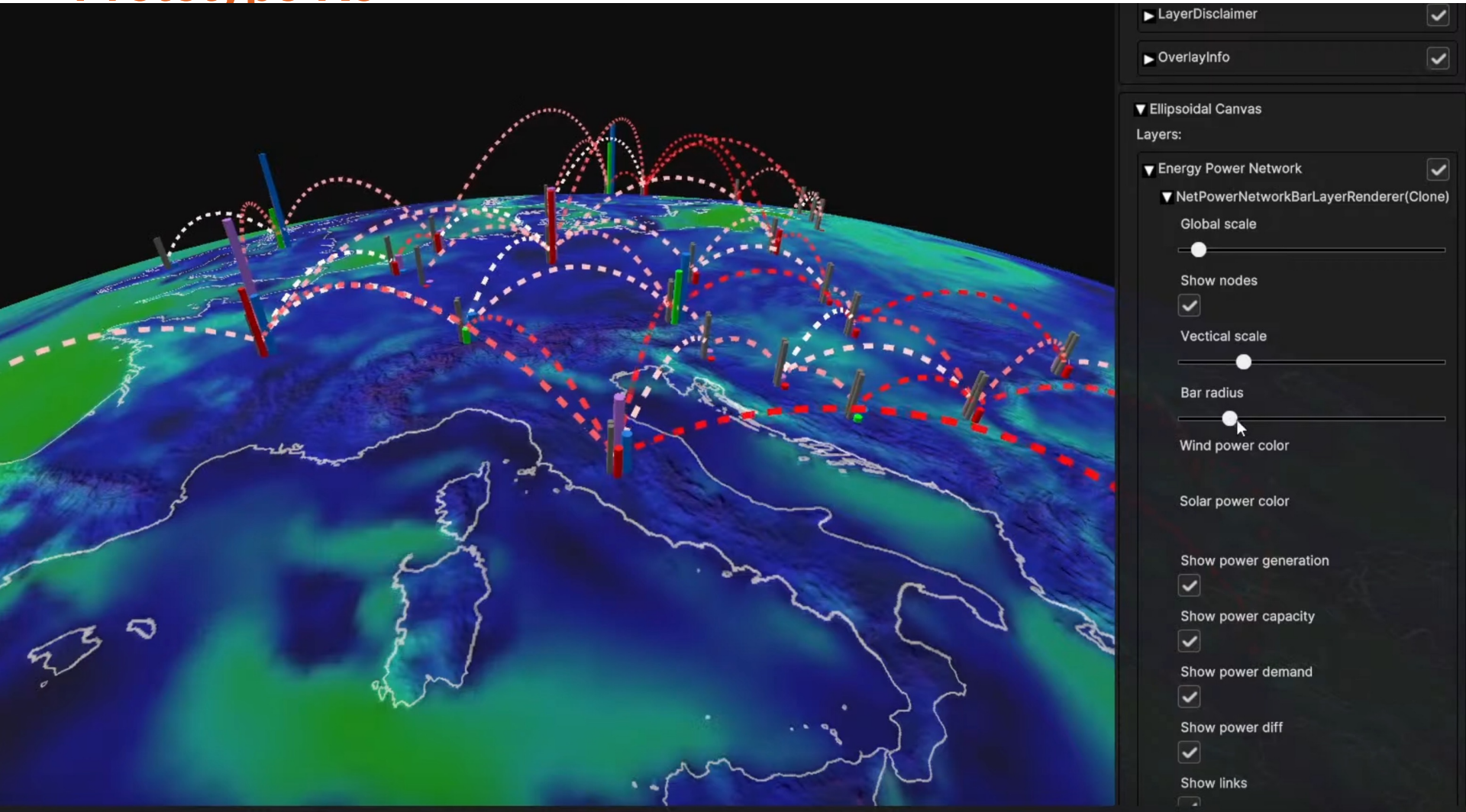
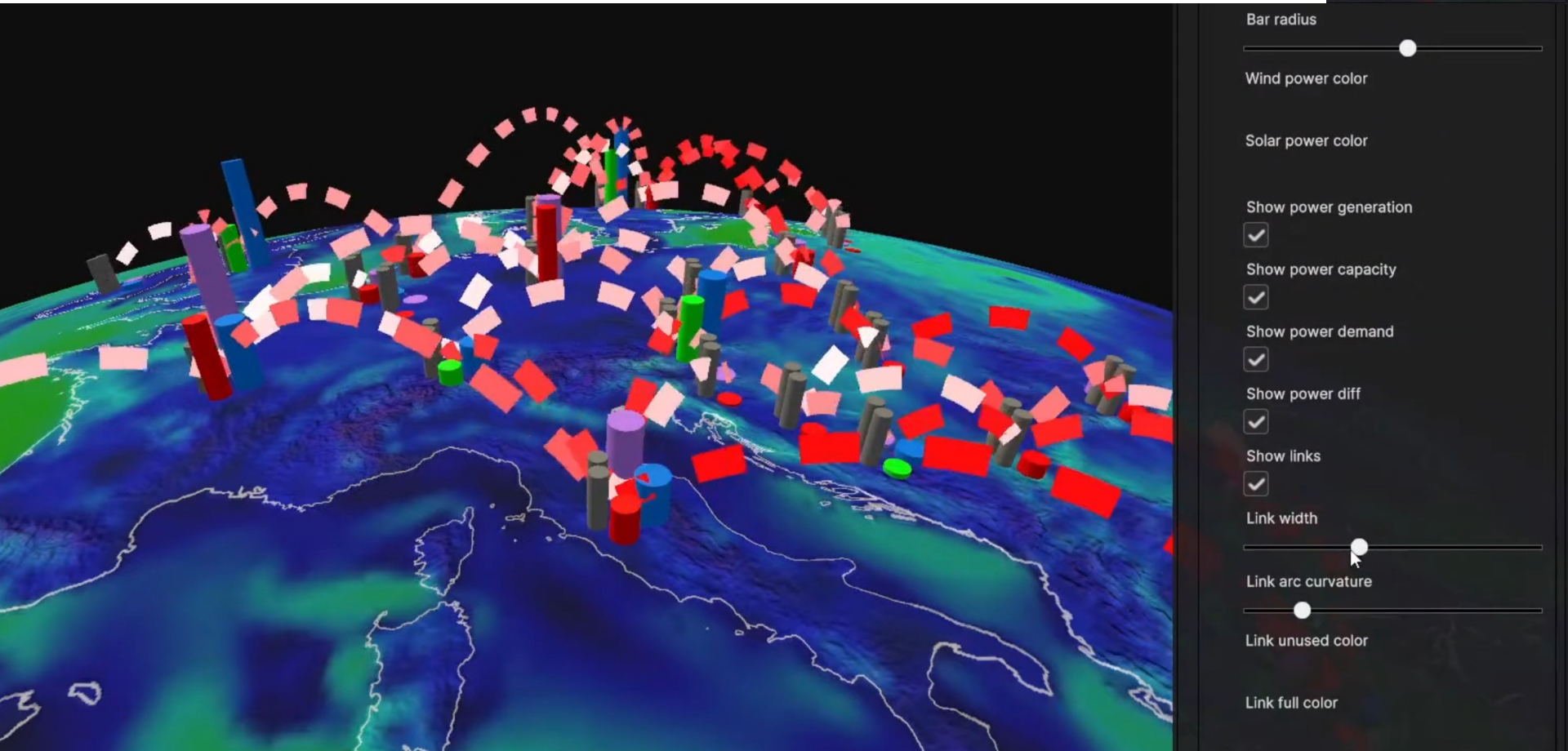
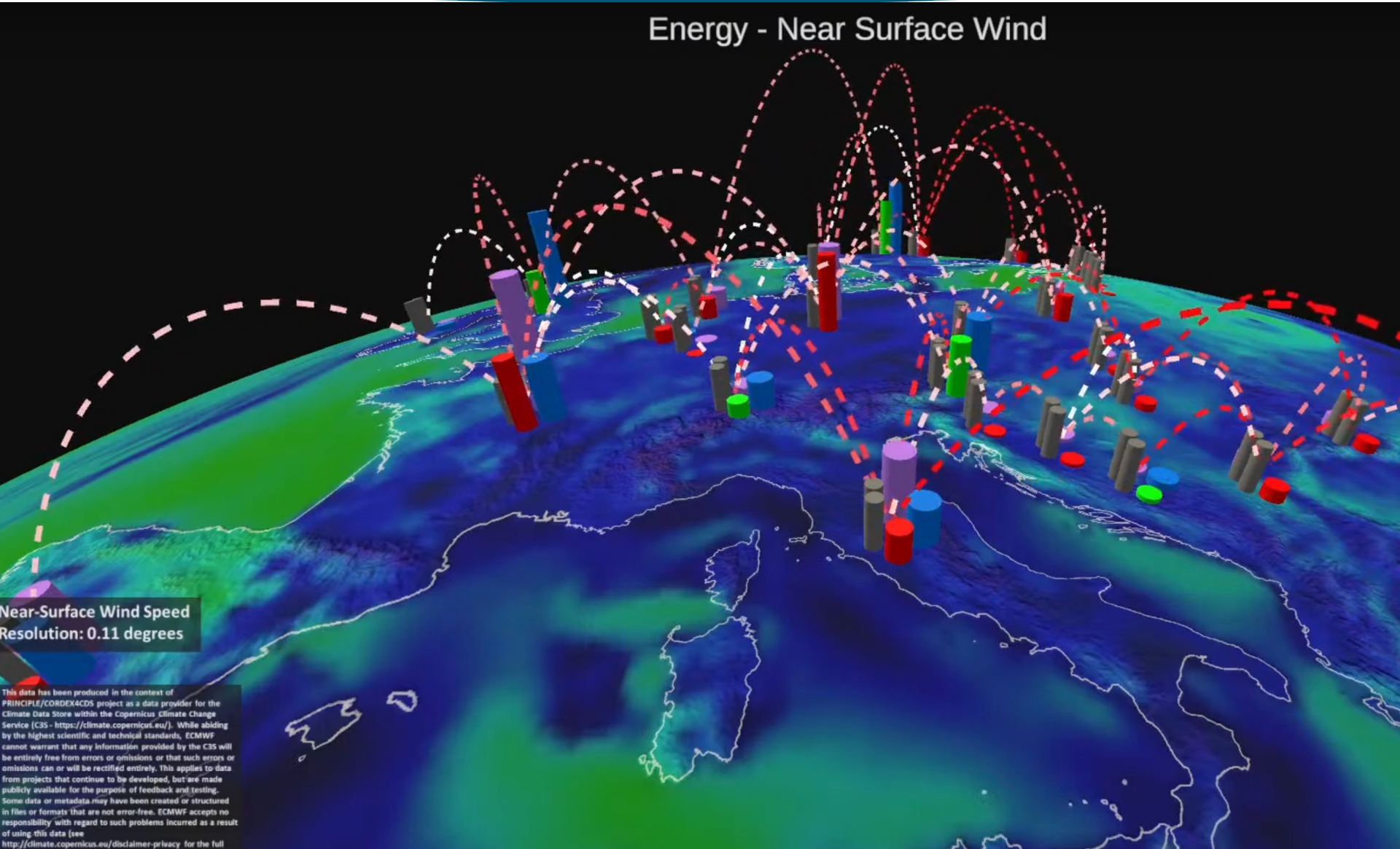
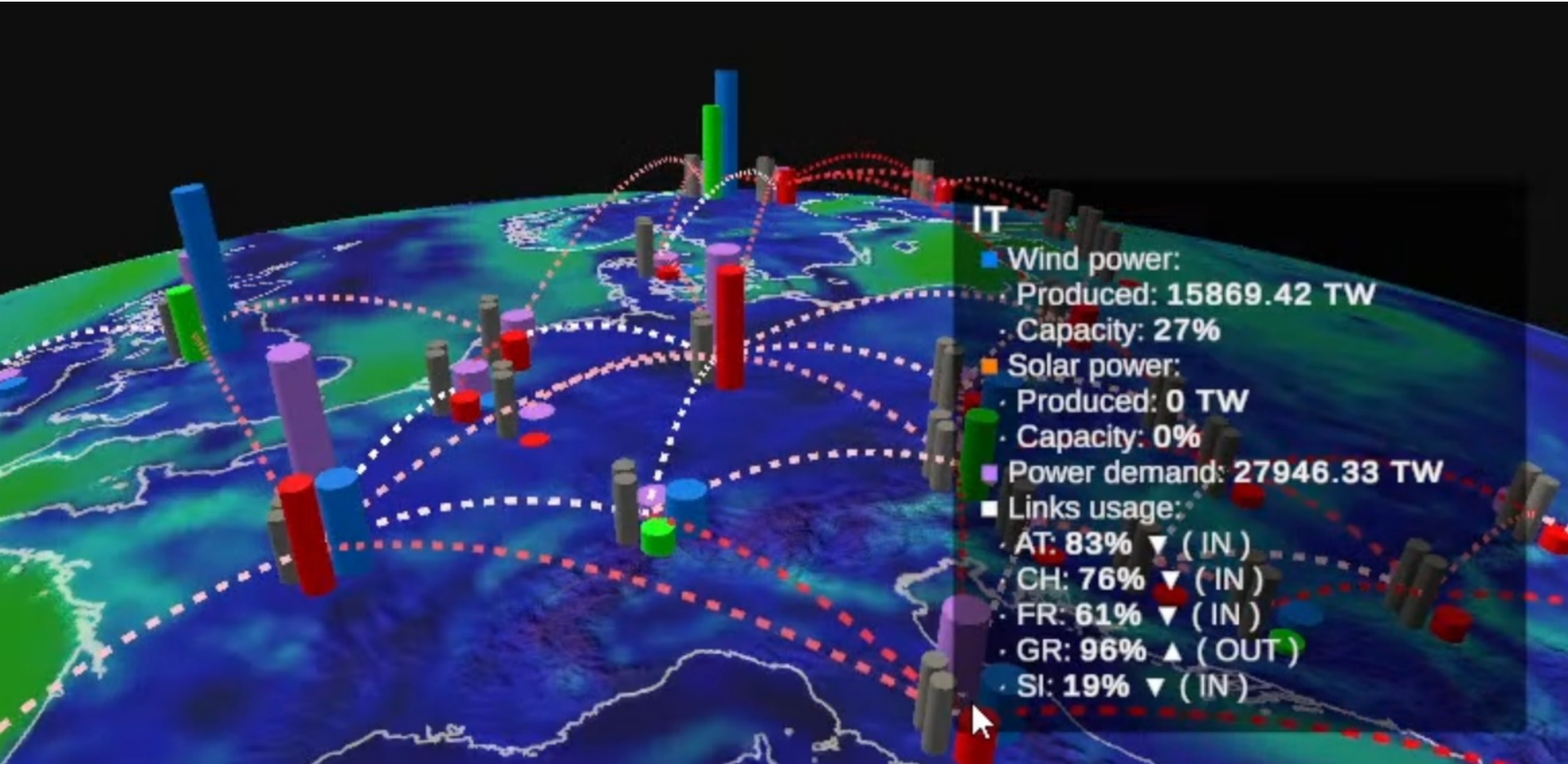


Prototype R5

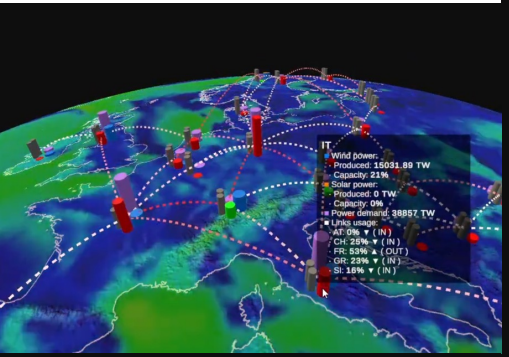


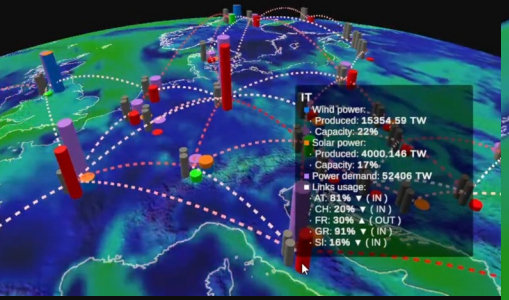

Energy - Near Surface Wind
Near-Surface Wind Speed
Resolution: 0.11 degrees
This data has been produced in the context of PRINCIPLE/CORDEX4CDS project as a data provider for the Climate Data Store within the Copernicus Climate Change Service (C3S - https://climate.copernicus.eu/). While abiding by the 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

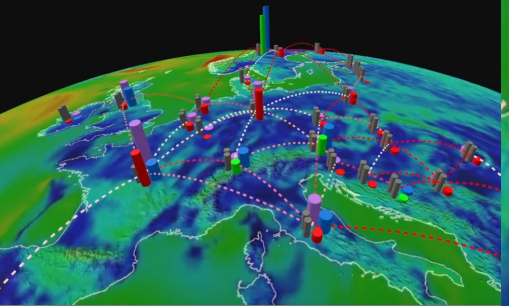
Prototype R5

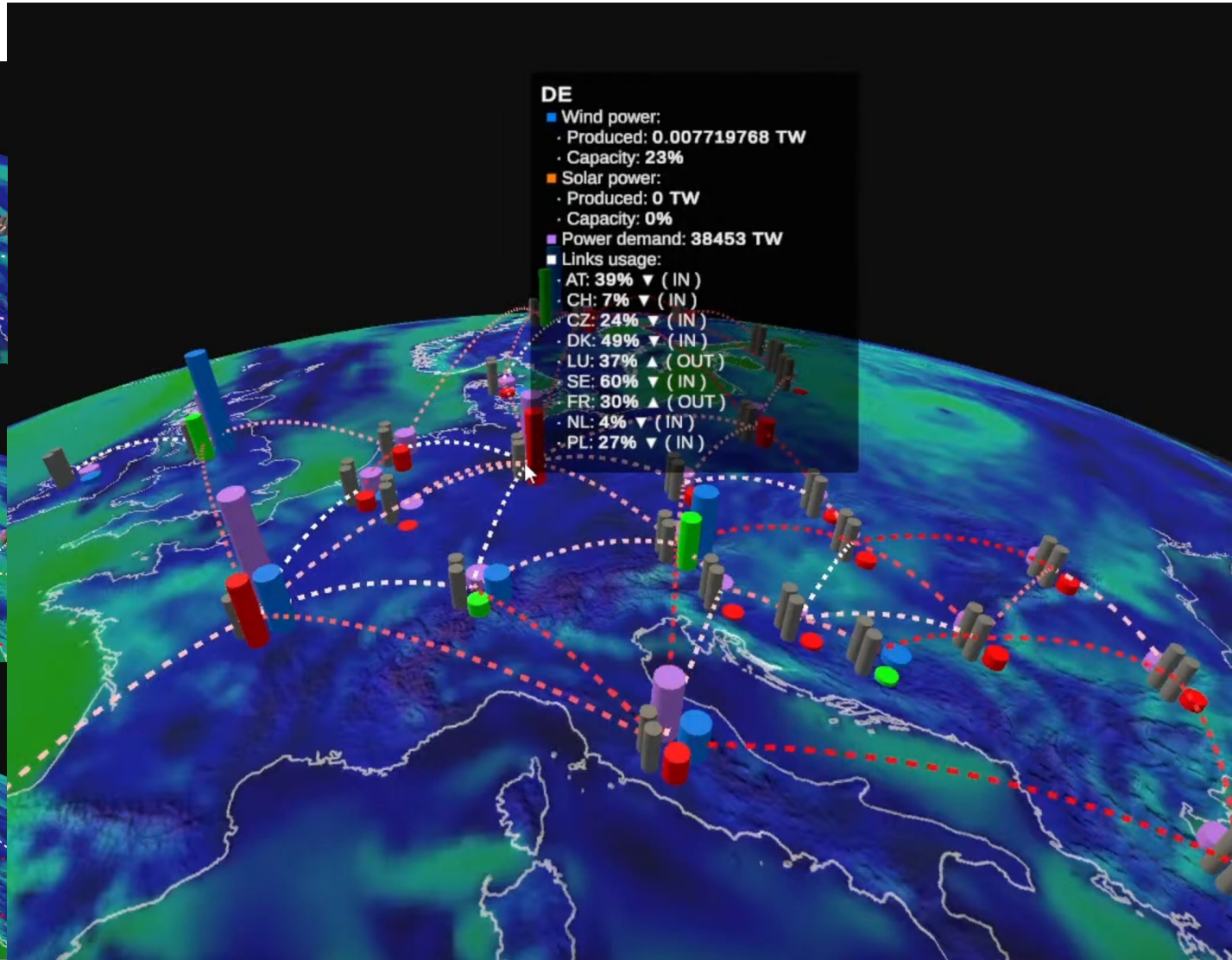


Prototype R5









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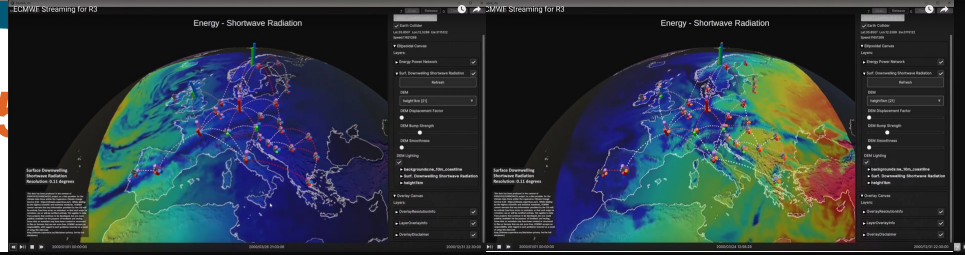

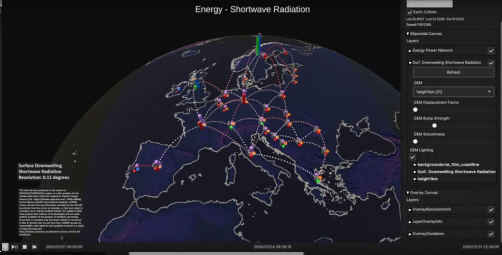

Energy - Shortwave Radiation

RESET CAMERA NORTH

Earth Collider

Lat:35.8507 Lon:12.5269 Ele:3115122

Speed:11651268

▼ Ellipsoidal Canvas

Layers:

▶ Energy Power Network

▼ Surf. Downwelling Shortwave Radiation

Refresh

DEM

height1km [21]

DEM Displacement Factor

DEM Bump Strength

DEM Smoothness

DEM Lighting

▶ backgrounds:ne_10m_coastline

▼ Surf. Downwelling Shortwave Radiation

Blending Factor - Surf. Downwelling Shortwave

Crop Latitude - Surf. Downwelling Shortwave

Crop Longitude - Surf. Downwelling Shortwave

▶ Data Source Parameters

▶ height1km

▼ Overlay Canvas

Surface Downwelling Shortwave Radiation Resolution: 0.11 degrees

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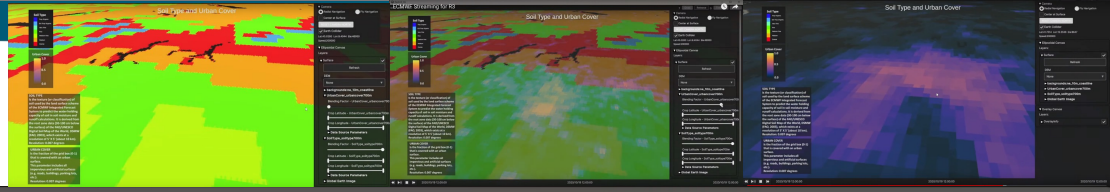
2000/01/01 00:00:00

2000/03/21 12:46:07

2000/12/31 22:30:00

Prototype R3



DestinE_Viz

ECMWF Streaming for R3

Soil Type and Urban Cover

Soil Type
- Trop Organic
- Ext Trop Organic
- Very Fine
- Fine
- Medium Fine
- Medium
- Coarse

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

7 Grab Release 0 Time

▼ Camera
Radial Navigation Fly Navigation
Center at Surface
RESET CAMERA NORTH
Earth Collider
Lat:37.0830 Lon:11.0536 Ele:781025
Speed:3446262

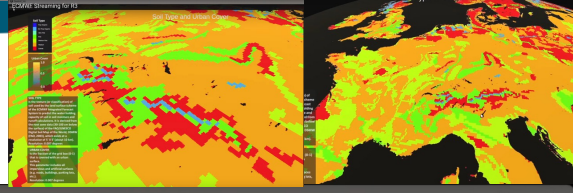
▼ Ellipsoidal Canvas
Layers:
▼ Surface
Refresh
DEM
None
▶ backgrounds:ne_10m_coastline
▶ UrbanCover_urbancover700m
▶ SoilType_soiltype700m
▶ Global Earth Image

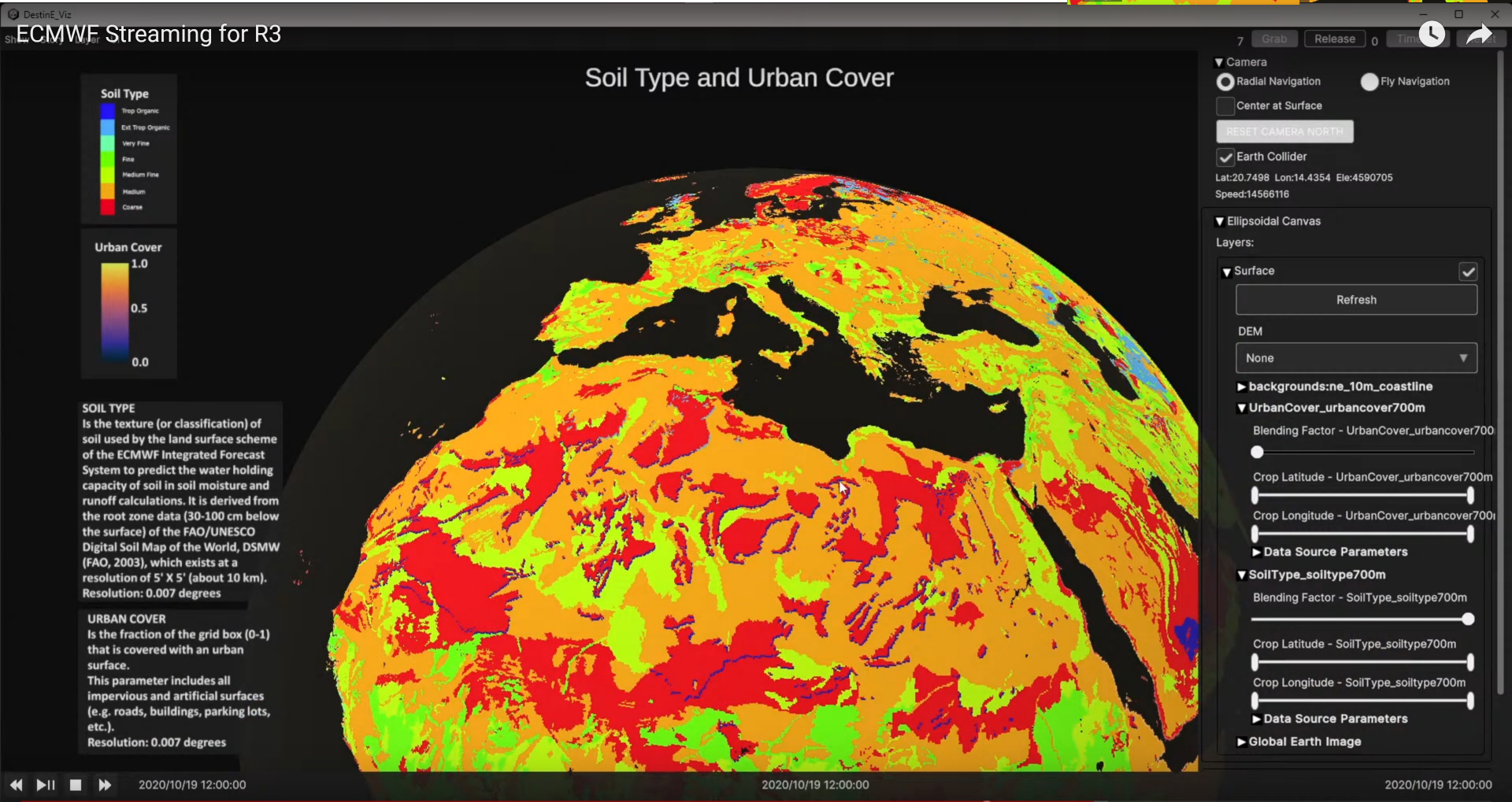
▼ Overlay Canvas
Layers:
▶ OverlayInfo

2020/10/19 12:00:00

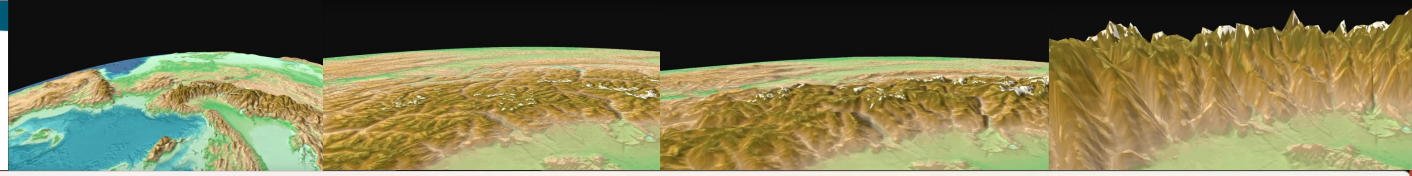
2020/10/19 12:00:00

Prototype R5





Prototype R5



DestinE_Viz

Show Story Layer UI

7 Grab Release 0 Timeout Reset

▼ Camera

Radial Navigation Fly Navigation

Center at Surface

RESET CAMERA NORTH

Earth Collider

Lat:40.9470 Lon:16.0782 Ele:579788

Speed:2173067

▼ Ellipsoidal Canvas

Layers:

▼ Orography

Refresh

DEM

height1km - Multi-Res Data Source [16]

DEM Displacement Factor

DEM Bump Strength

DEM Smoothness

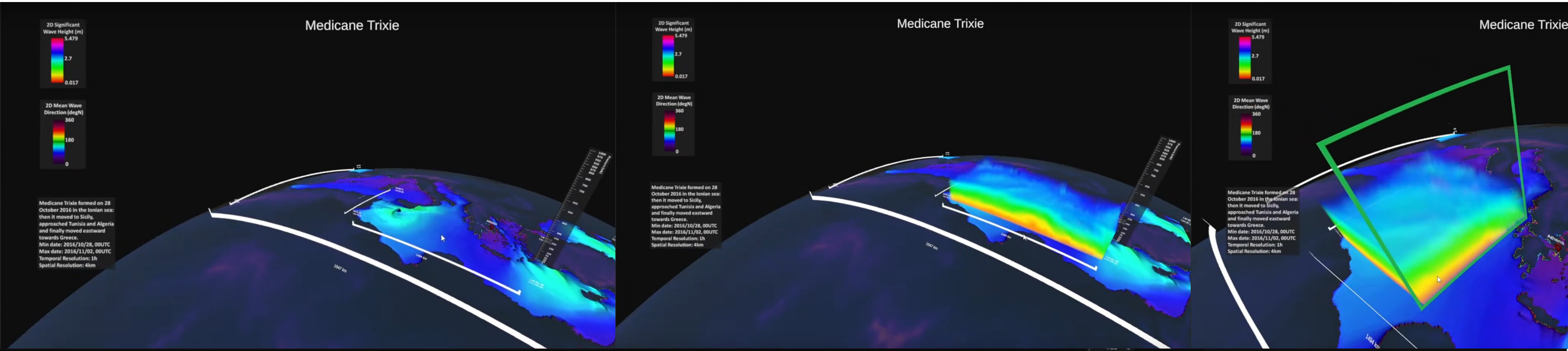
DEM Lighting

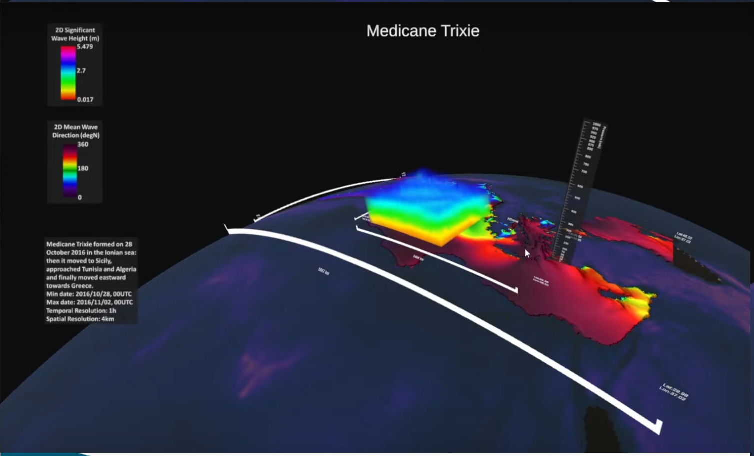
▶ height1km - Multi-Res Data Source

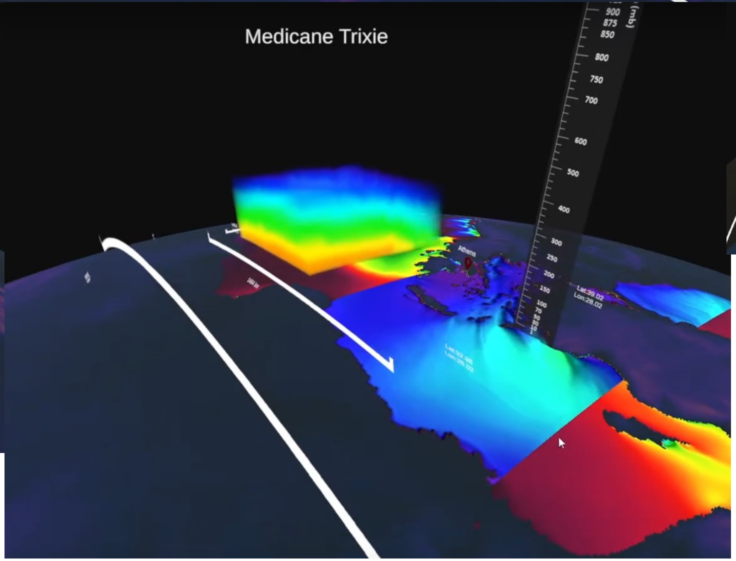
▶ GEBCO_LATEST

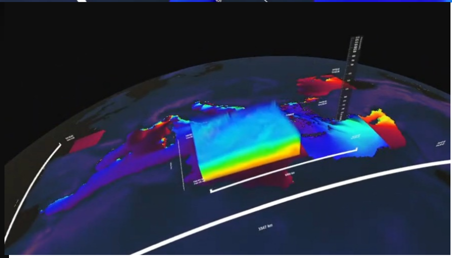
2020/10/19 12:00:00 2020/10/19 12:00:00 2020/10/19 12:00:00

Prototype R5

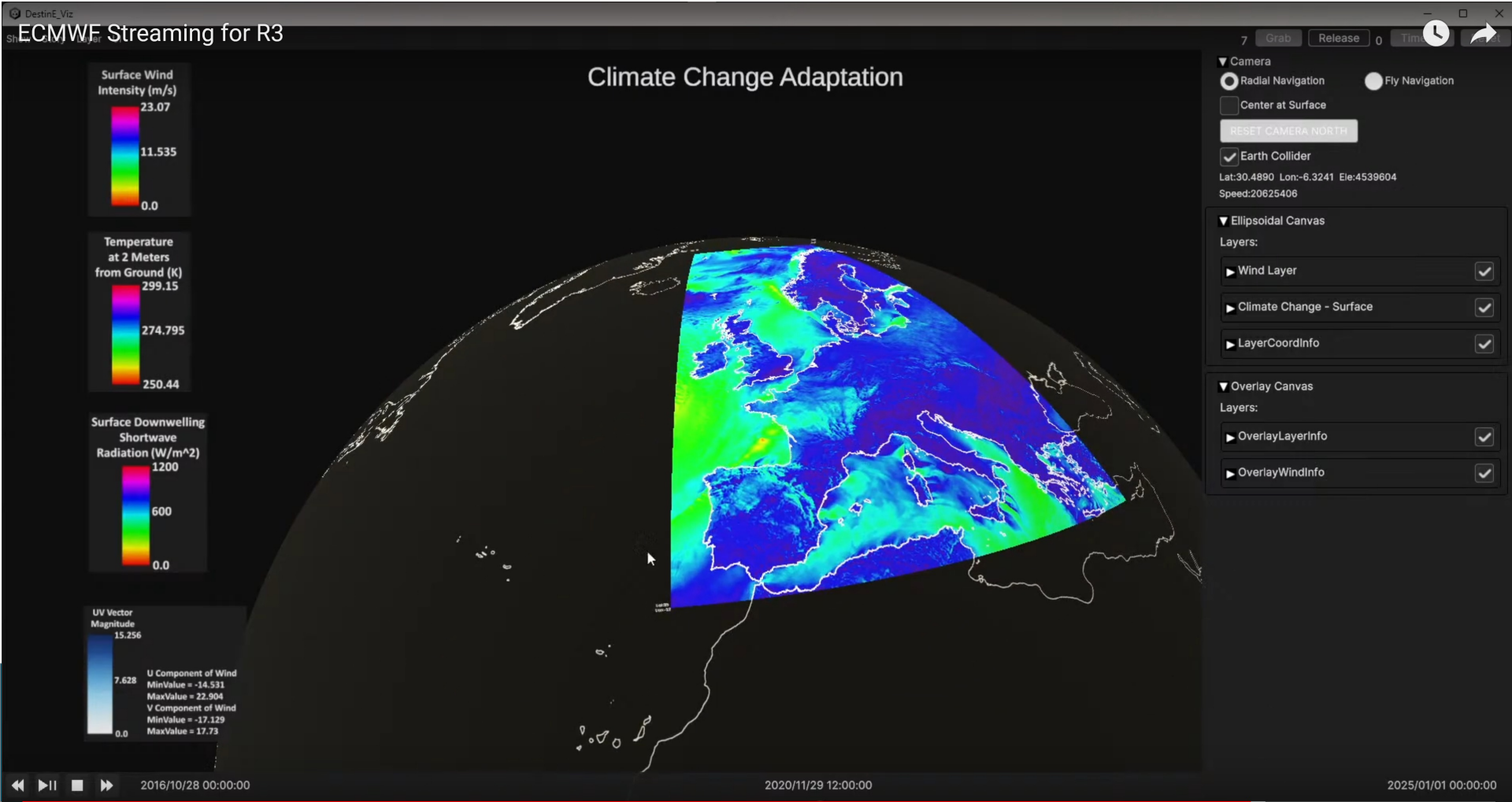








Prototype R5



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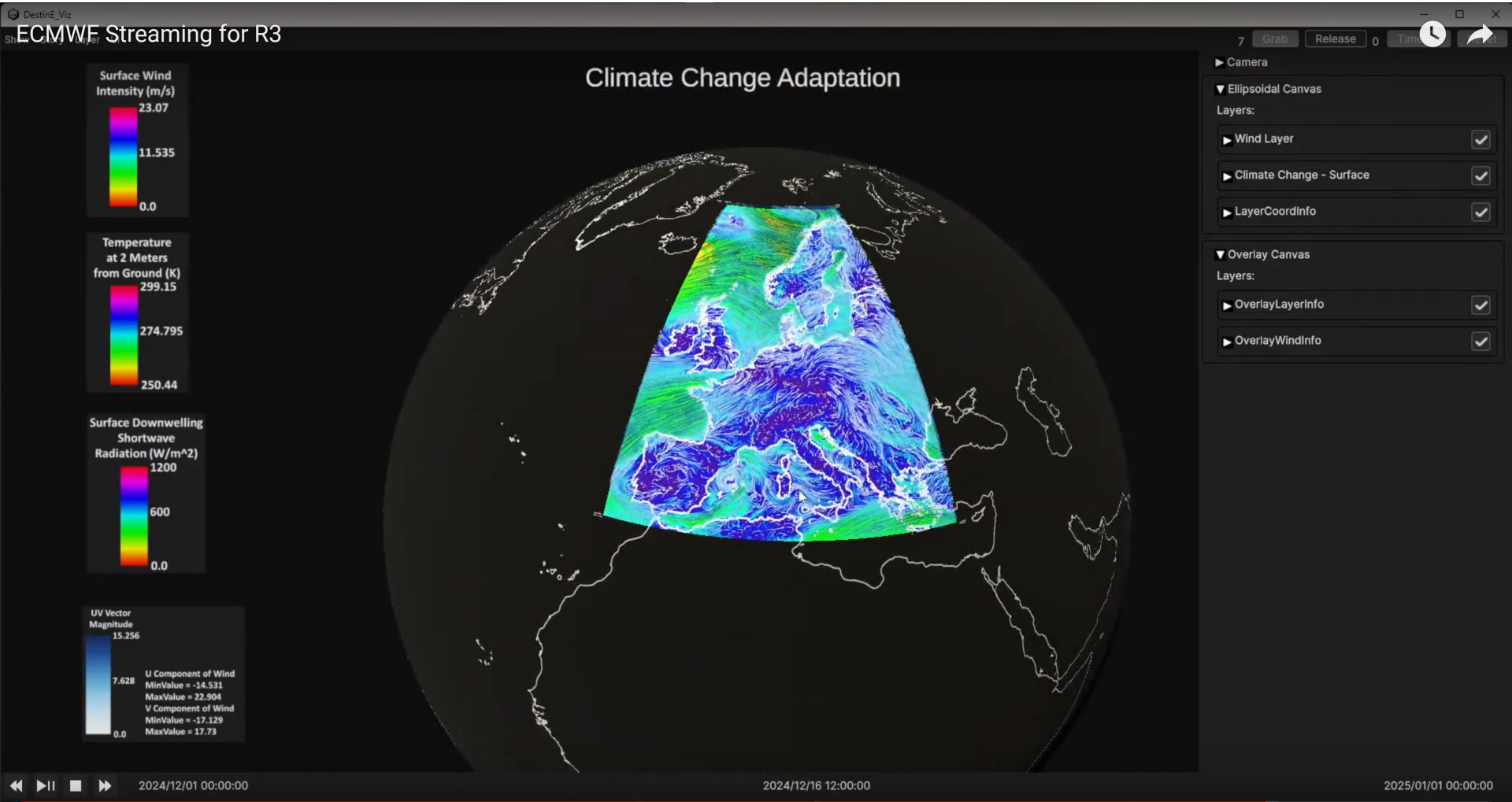
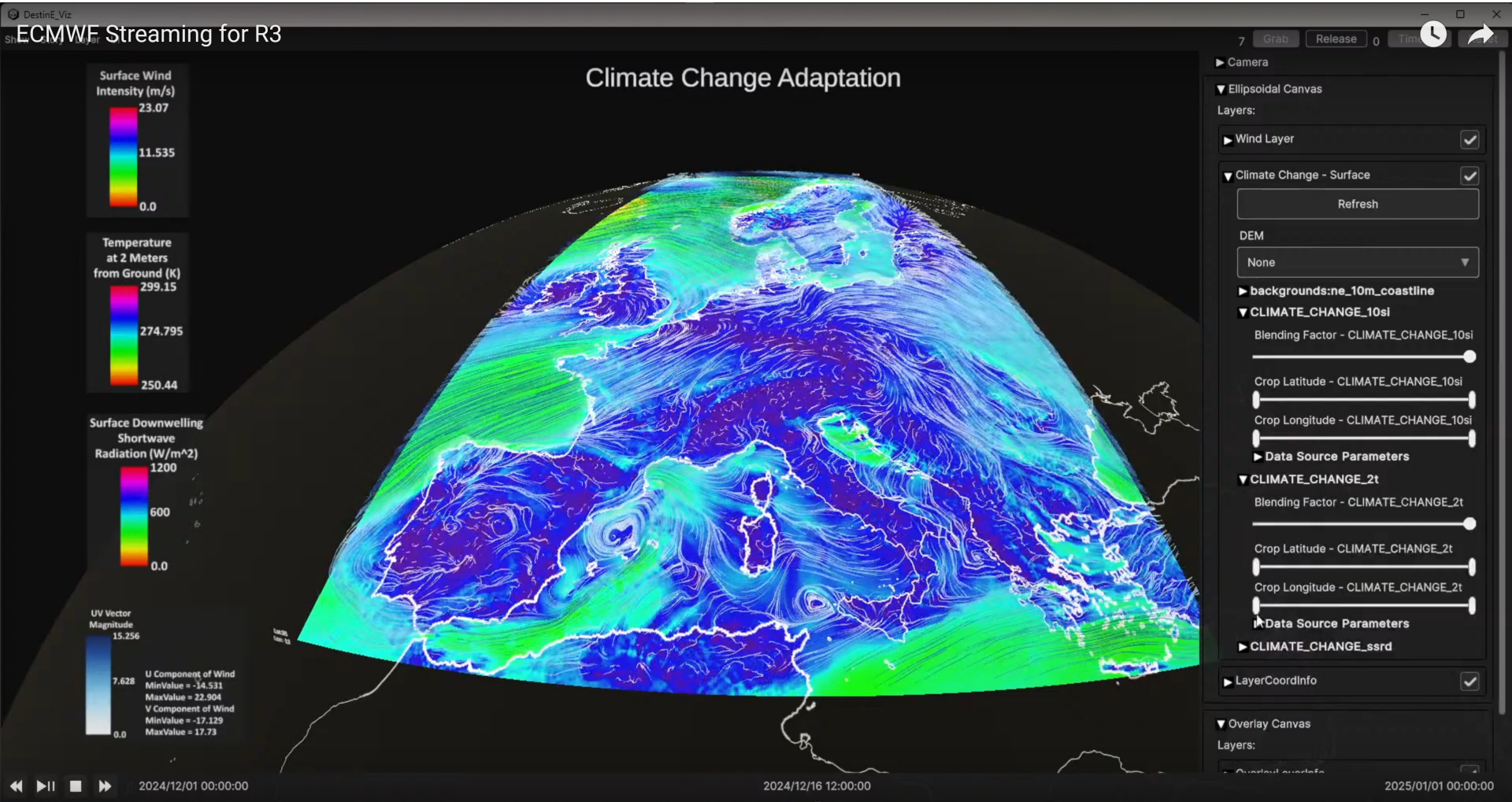
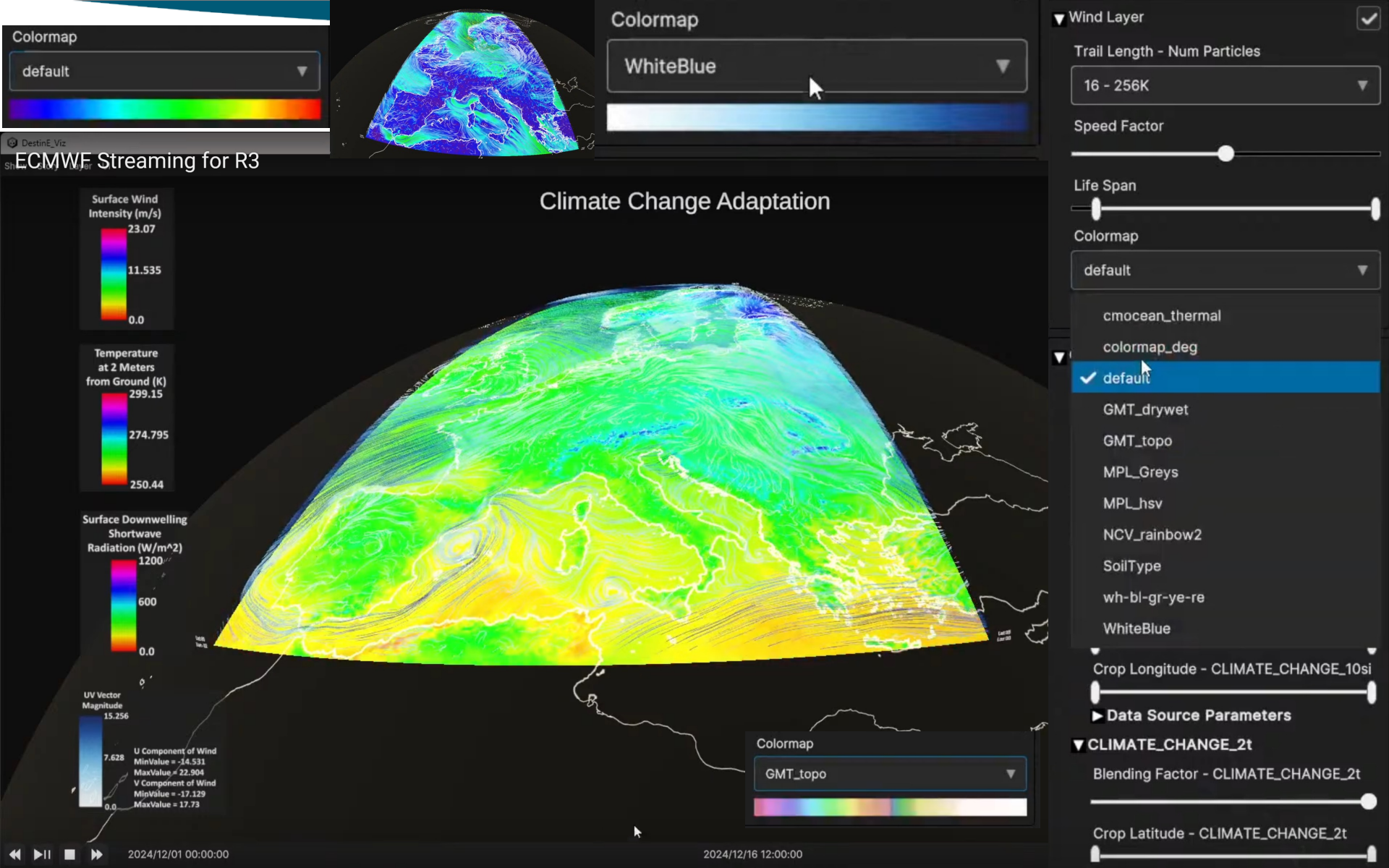
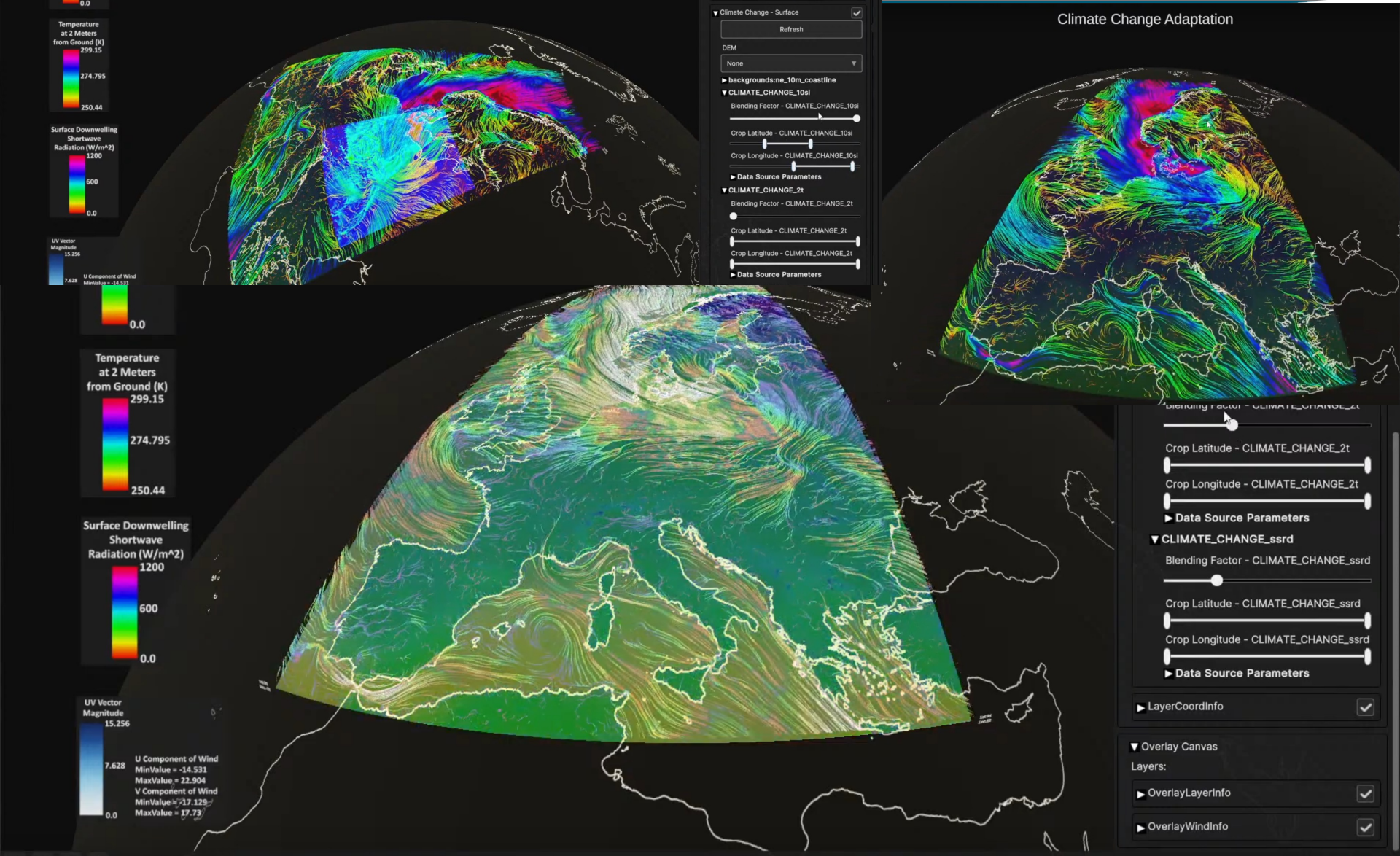


Prototype R5




Colormap
default
DestinE_Viz
ECMWF Streaming for R3
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
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 = -14.531
MaxValue = 22.904
V Component of Wind
MinValue = -17.129
MaxValue = 17.73
Colormap
GMT_topo
Crop Longitude - CLIMATE_CHANGE_10si
Data Source Parameters
CLIMATE_CHANGE_2t
Blending Factor - CLIMATE_CHANGE_2t
Crop Latitude - CLIMATE_CHANGE_2t
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
Climate Change - Surface
Refresh
DEM
None
backgrounds:ne_10m_coastline
CLIMATE_CHANGE_10si
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
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
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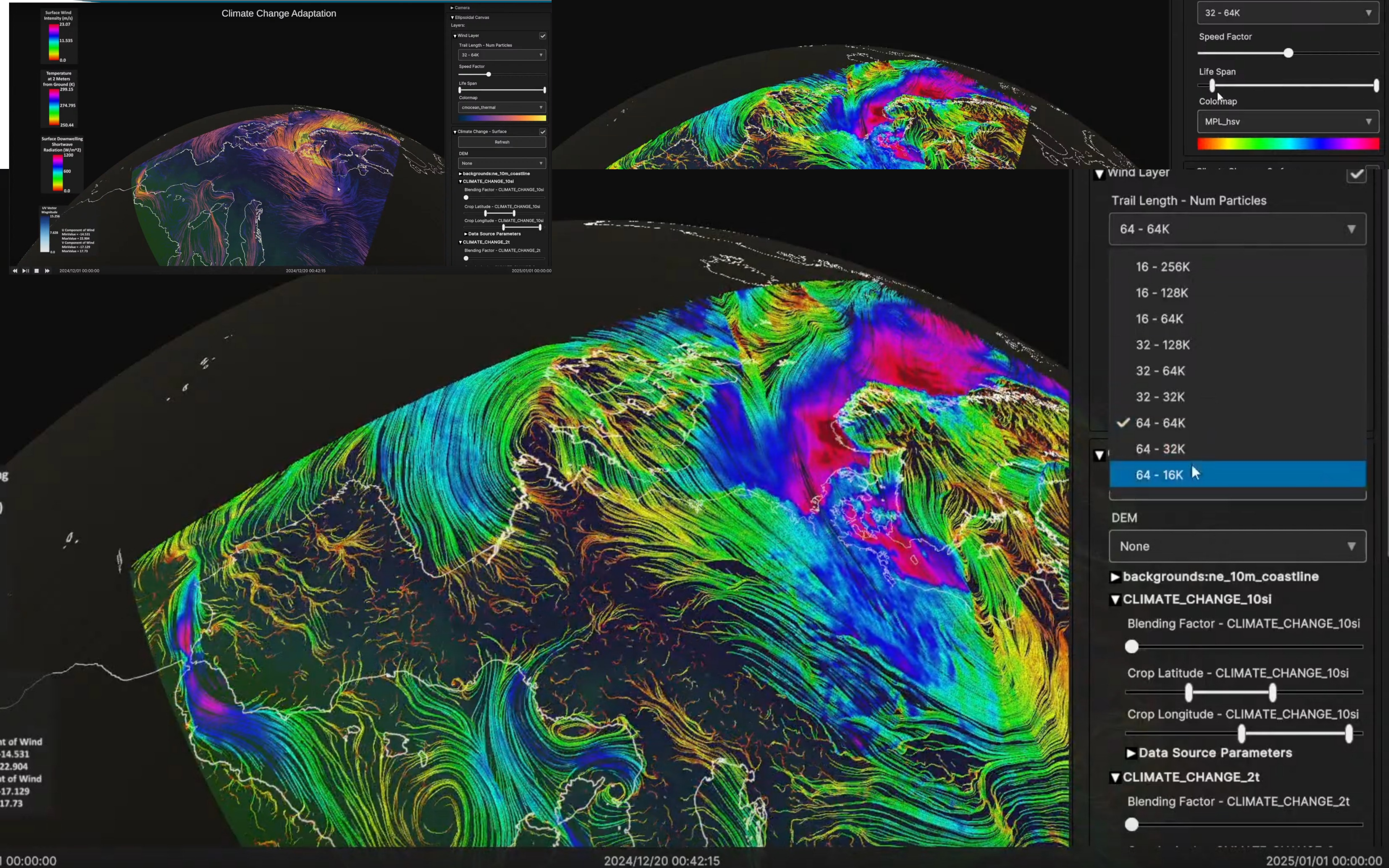
2024/12/20 00:42:15
2025/01/01 00:00:00



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
Camera
Ellipsoidal Canvas
Layers:
Wind Layer
Trail Length - Num Particles
32 - 64K
Speed Factor
Life Span
Colormap
cmocean_thermal
Climate Change - Surface
Refresh
DEM
None
backgrounds:ne_10m_coastline
CLIMATE_CHANGE_10si
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
2024/12/01 00:00:00
2024/12/20 00:42:15
2025/01/01 00:00:00
32 - 64K
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
CLIMATE_CHANGE_10si
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
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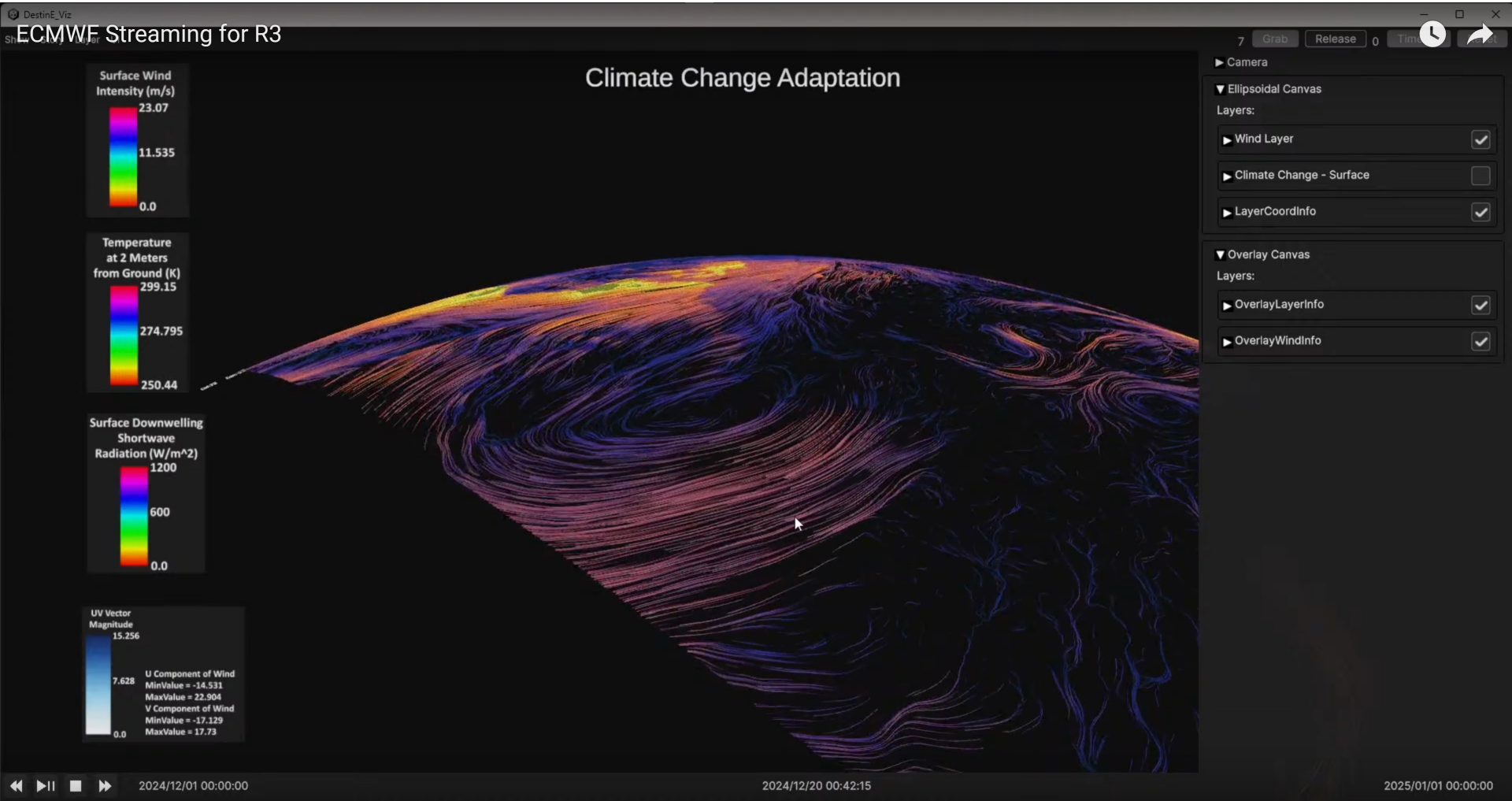
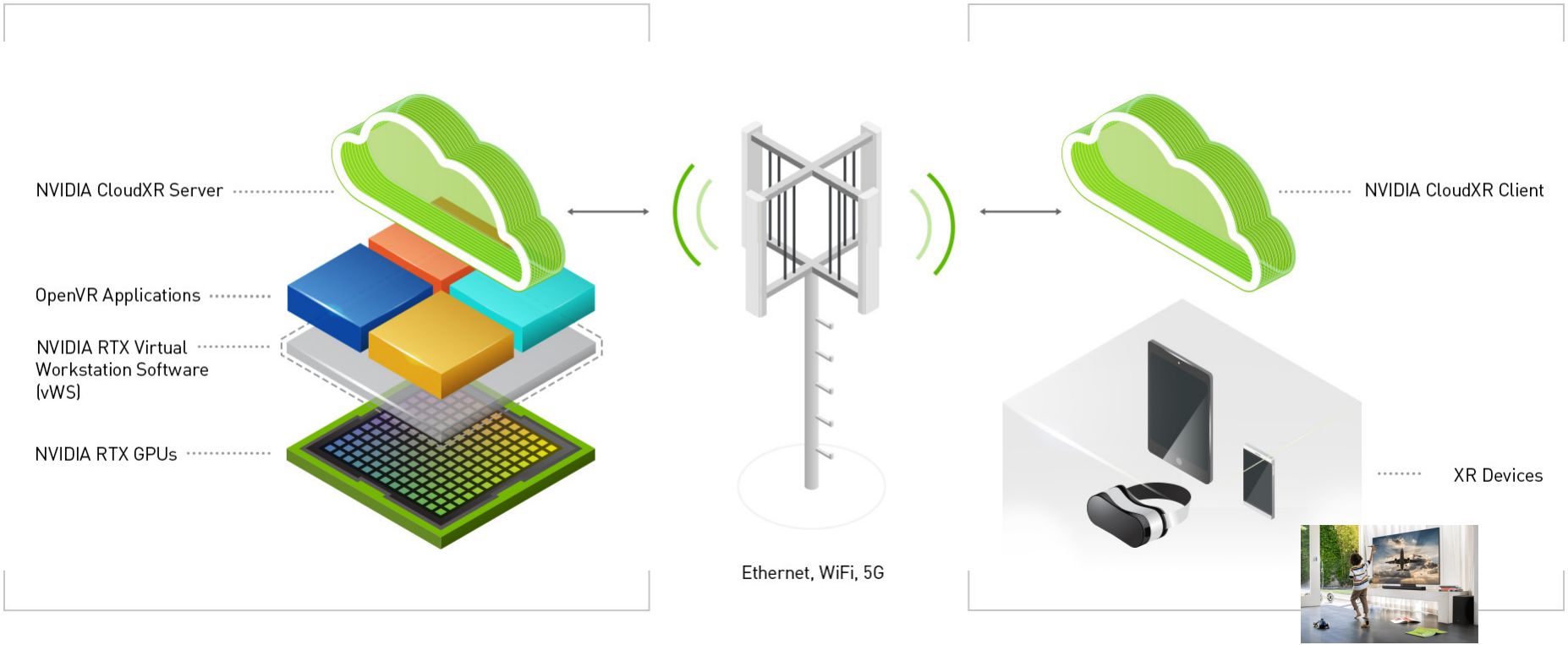
2024/12/20 00:42:15
2025/01/01 00:00:00

Prototype R5



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

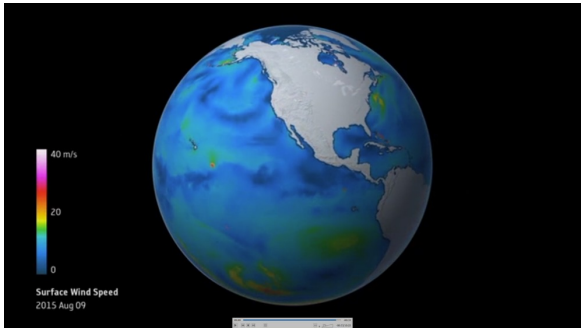
1. **User Flow**: Describing the user's journey through the 3D experience, including the different scenes and interactions they will encounter. Will start after use-cases are defined.
2. **Technical Requirements**: Outlines the technical specifications and requirements for the 3D app, such as hardware 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.*

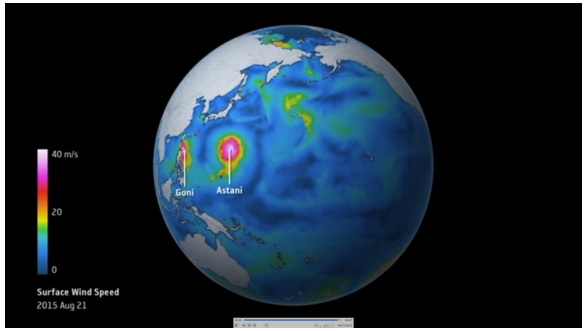
Global Scale

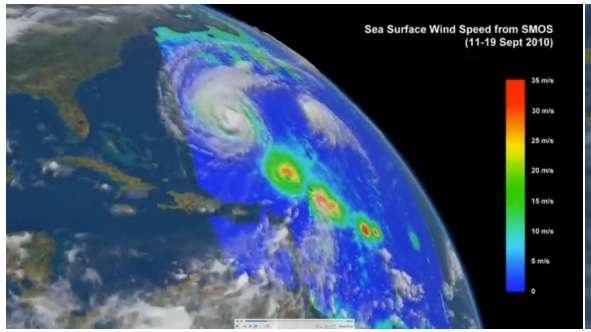
At the global scale, EO visual data is used to study and understand large-scale patterns and trends on Earth, such as climate change, deforestation, and land use change.

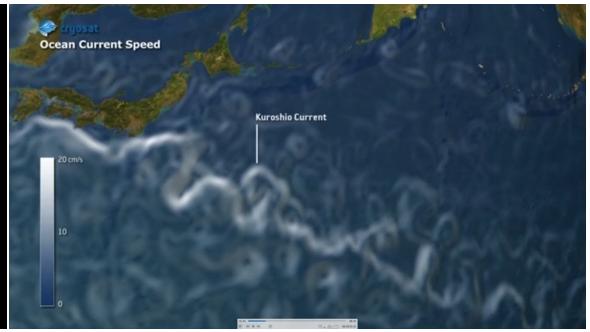
These visual data are processed from satellites products, allowing to perceive the entire planet at once.

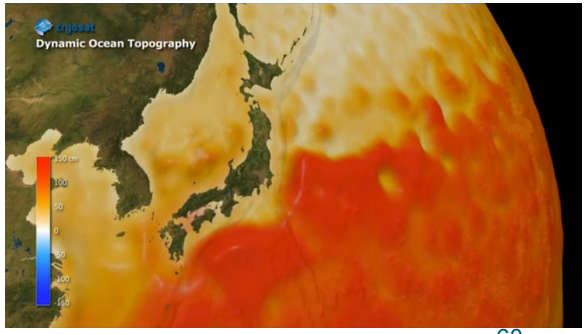
Multi resolution assets management.









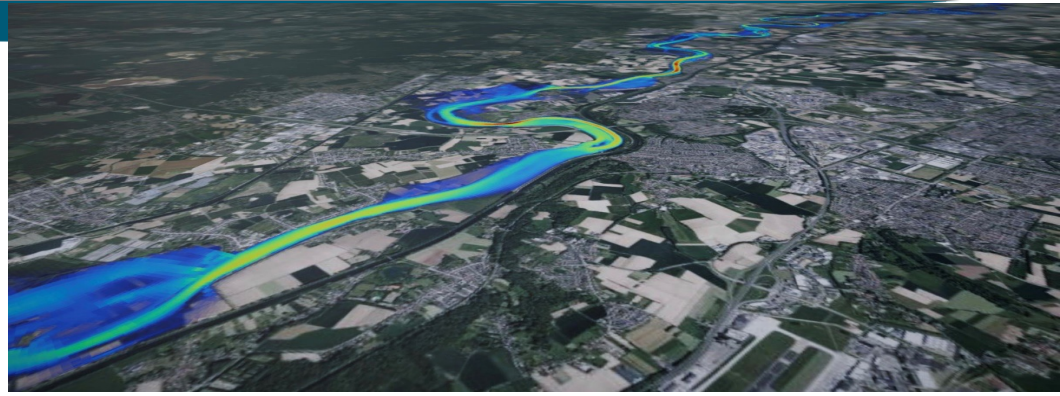


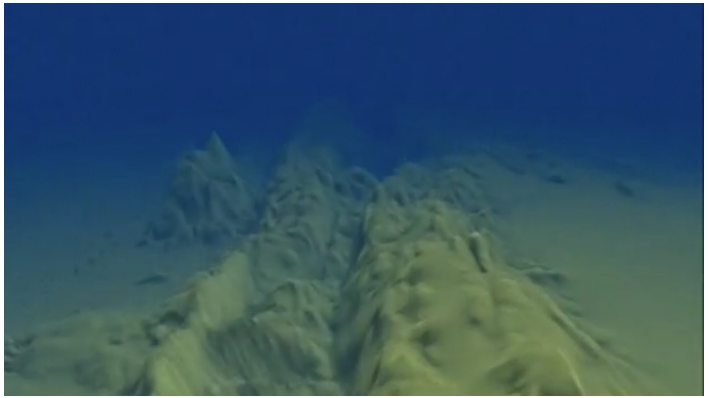
Local Scale

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.

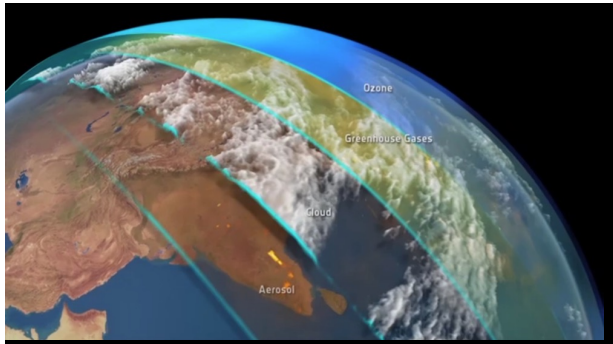


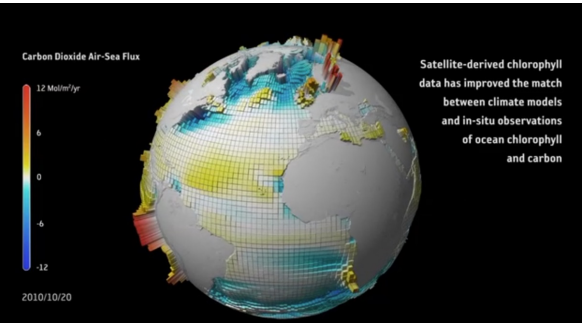


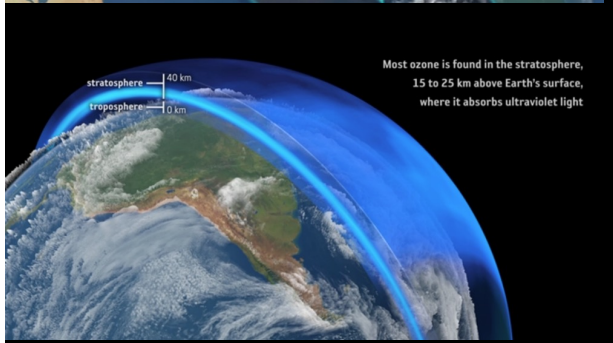
Multi Layer Visualisation

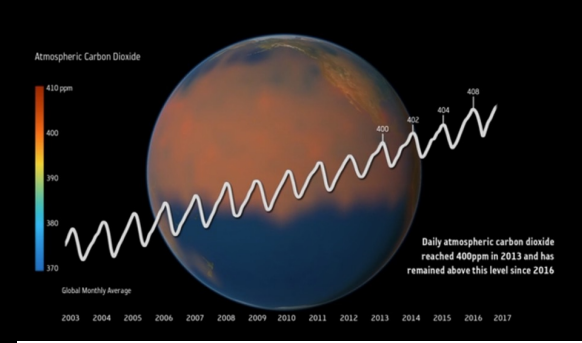
Multi-layer visualisation refers to the use of multiple layers of data, such as satellite based products and/or elevation data, to create a more comprehensive and detailed view of a specific area.

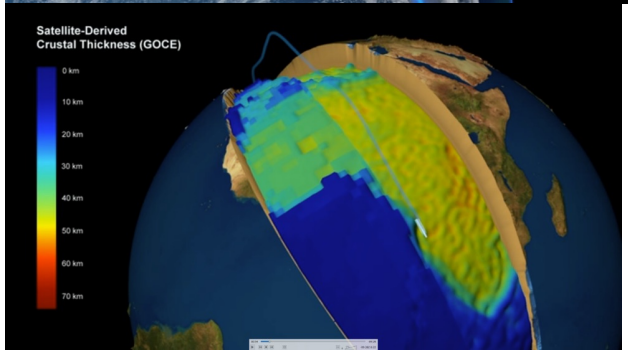
Each layer of data provides a different type of information, such as vegetation, land use, topography, and more.



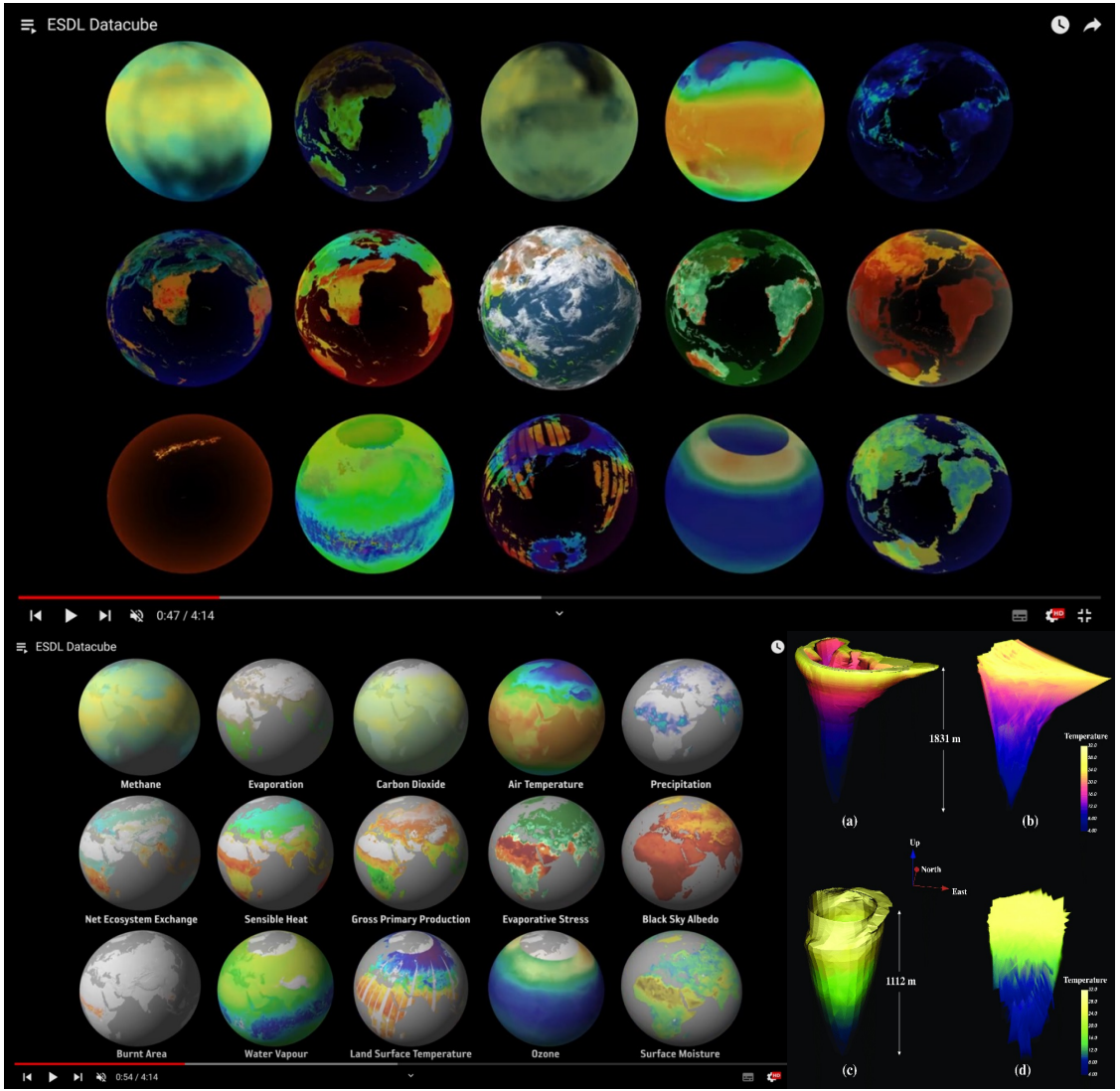








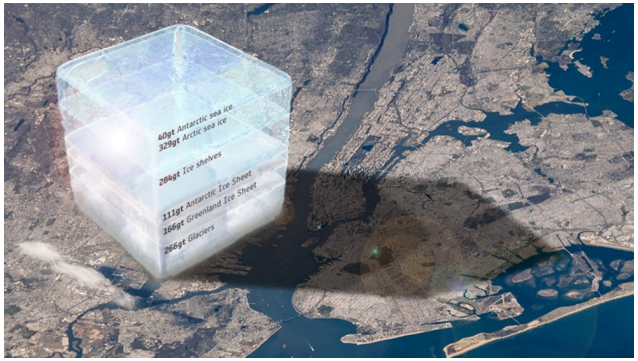
Comparing Multiple Datasets

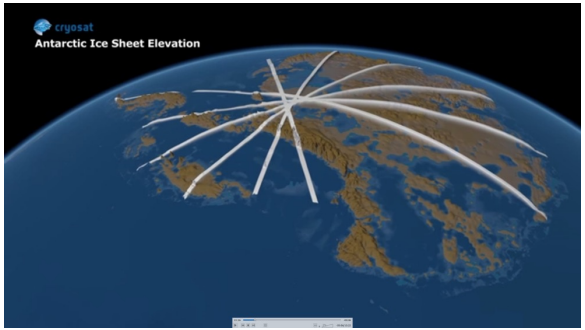


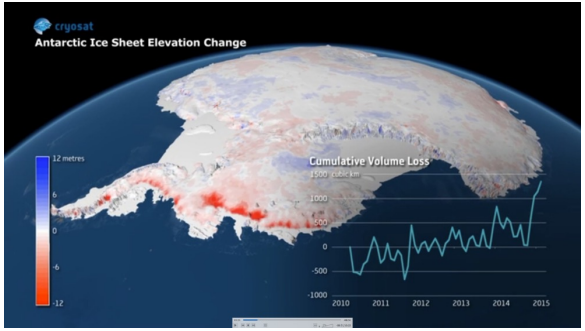
VFX, Animation, Illustration

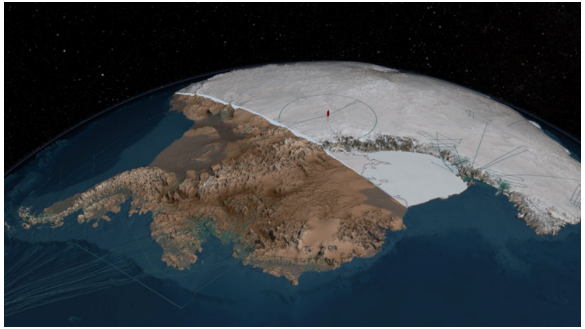
Visual display of Quantitative Information

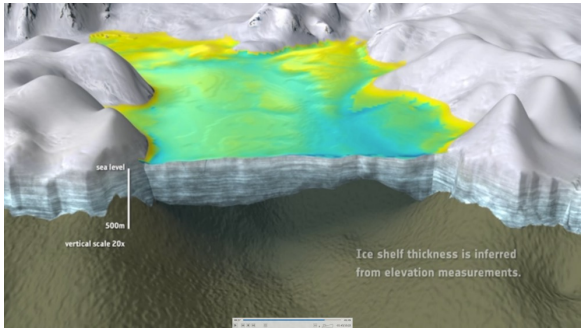
Visual Explanations

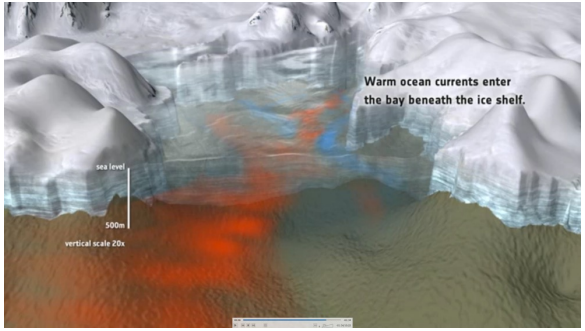


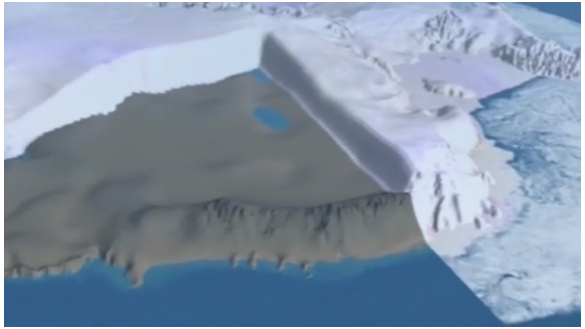












Thank you for your attention (Q&A)