

20 March 2025

14:00 CET

# DATAVIZ

WEBINAR SERIES 

#3

EXPRESS  
OCEAN DATA



PROGRAMME OF  
THE EUROPEAN UNION



Copernicus  
Marine Service



implemented by  
MERCATOR  
OCEAN  
INTERNATIONAL

**#3** EXPRESS  
OCEAN DATA

Inspiration for  
Data Visualisation  
beyond the ordinary

- 1) Open Ocean Data
- 2) Open Source tools
- 3) Science & Creativity



# OVERVIEW

I



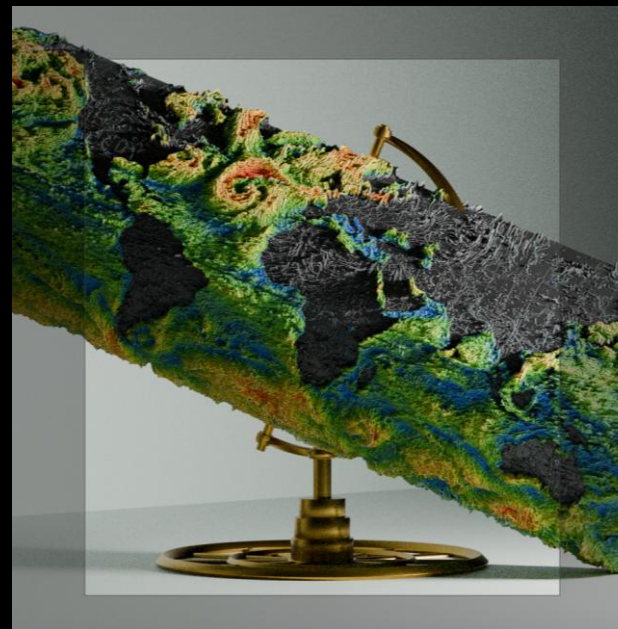
**Background**

II



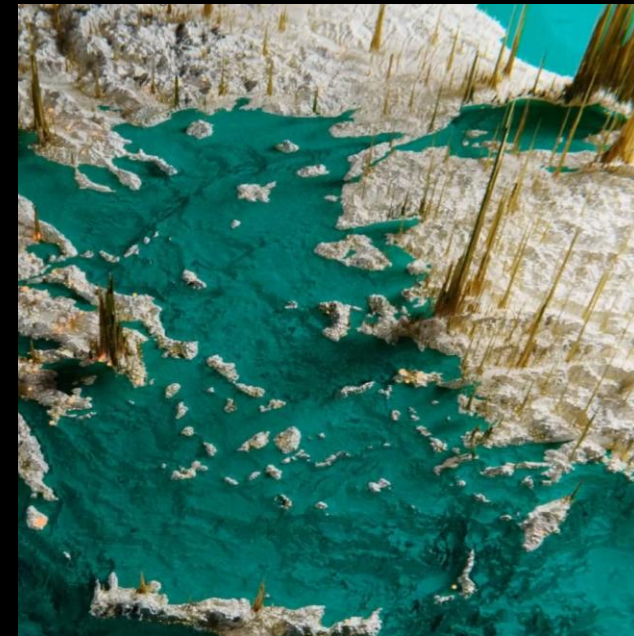
**Importance of Data  
Visualisation**

III



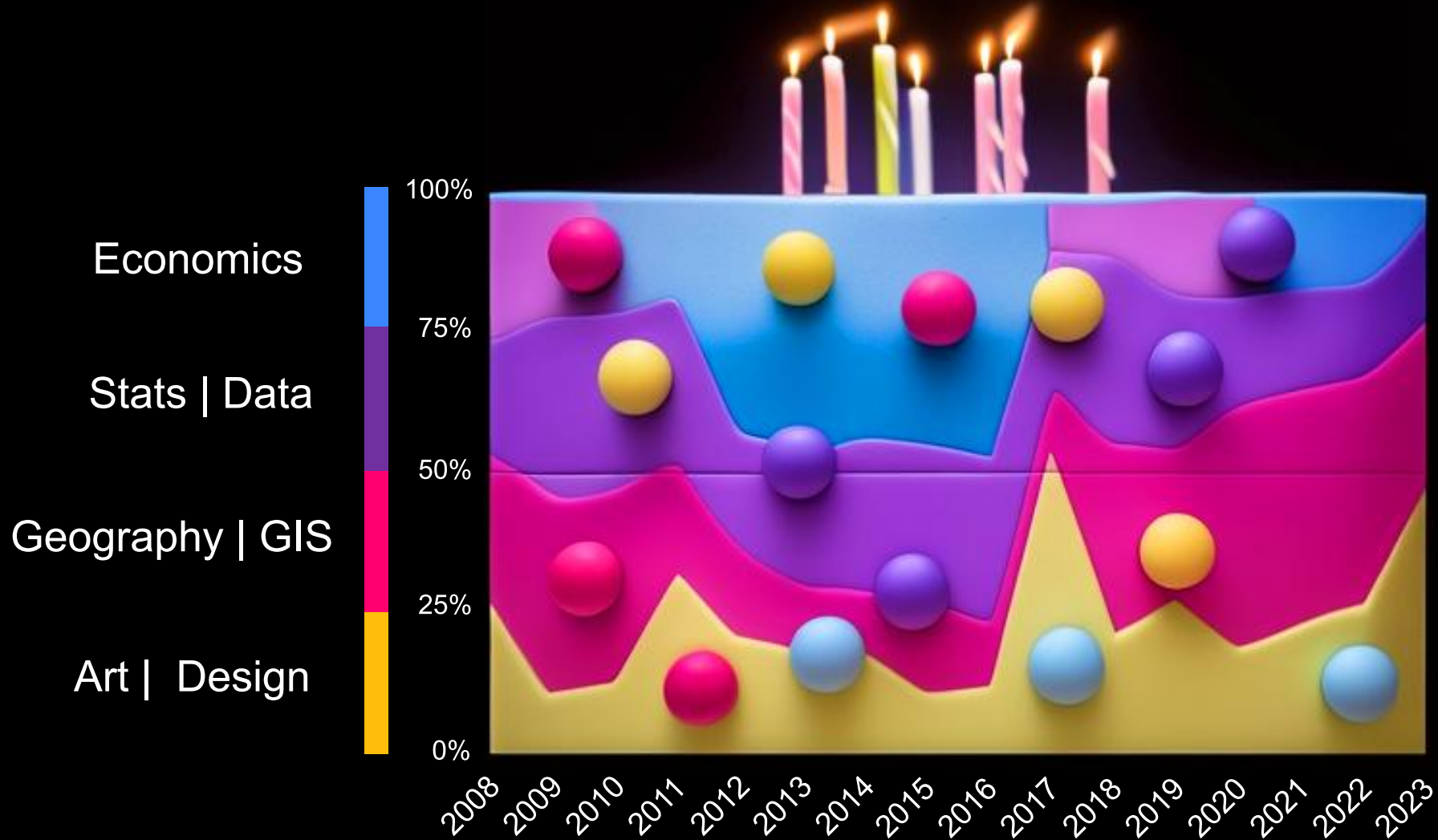
**Open workflows for  
visualisations beyond the  
ordinary**

IV



**YOUR TURN**

I.



I.



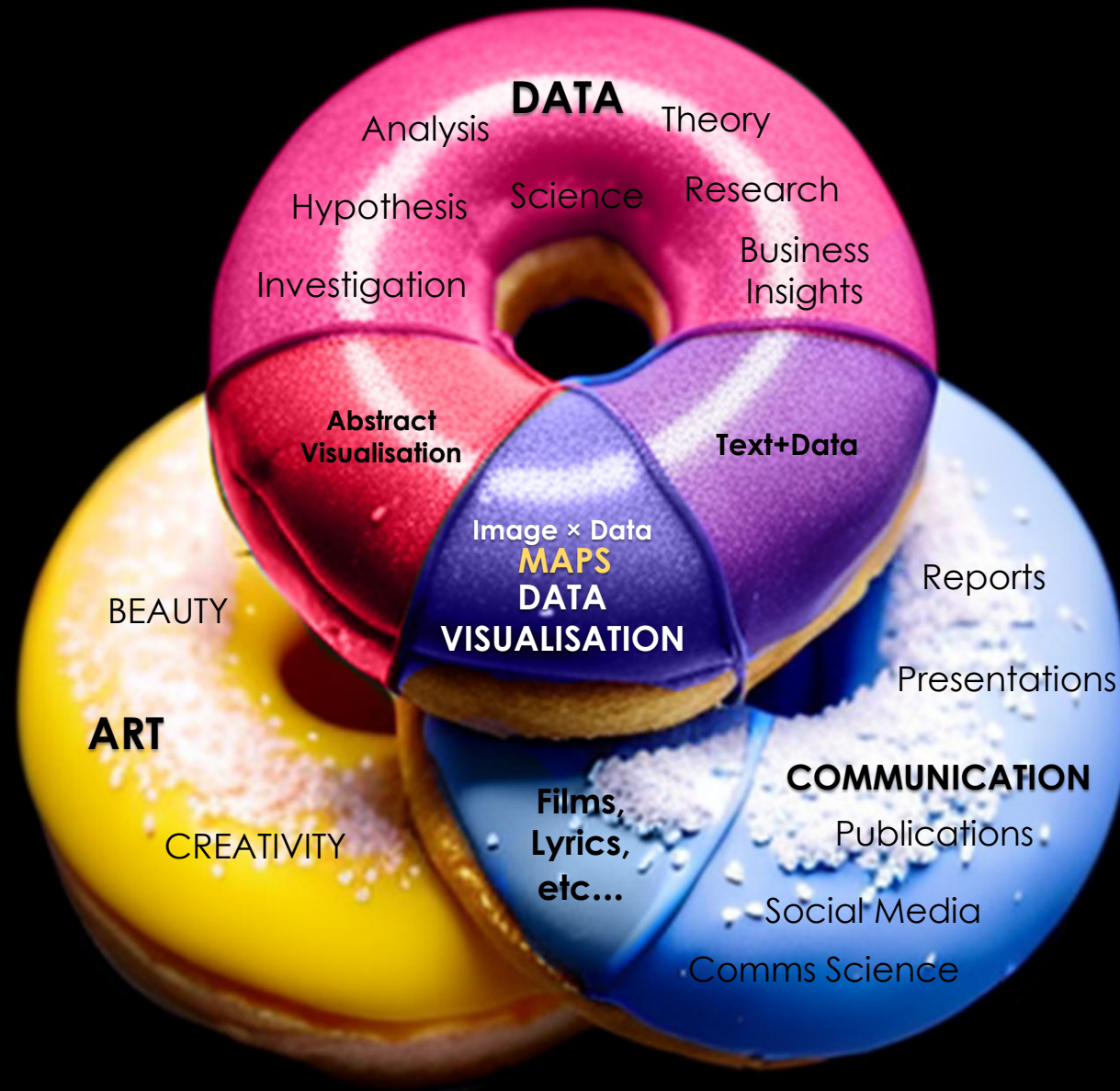
## MULTIPLE HATS

- Researcher at UCL, London
- Freelancer: Data Science & Visualisation 3D / 2D
  - Spatial Data Analyst
- Motion Graphics and Digital Art

MSc Urban Analytics and Smart Cities (UCL Bartlett CASA, London UK)

BSc Economics (ULB Solvay Brussels, Belgium)

II.



ANIMATION ►

# The Spectrum of Dataviz | Maps

## For DATA ANALYSIS

Exploration,  
analyse &  
convince  
**yourself or the  
team**

## For DATA COMMUNICATION

- Understanding the data
- Sharing insights
- Explain to the viewer / user
- Engage with the audience
- Support decision making
- Convincing the **audience**
- Catch the attention
- Start a conversation
- Prove

## For ART

Sharing emotions,  
perspectives,

**Creativity and  
beauty**

**For yourself**

**For audience**

## II. WE WANT RESULTS !

**BAD DATA** + **GOOD ANALYSIS** + **GOOD COMMUNICATION** = **WRONG RESULTS**

**GOOD DATA** + **BAD ANALYSIS** + **GOOD COMMUNICATION** = **WRONG RESULTS**

**GOOD DATA** + **GOOD ANALYSIS** + **BAD COMMUNICATION** = **WEAK or NO RESULTS**

 + **GOOD ANALYSIS** + **GOOD DATA VISUALISATION** = **TRUE RESULTS**

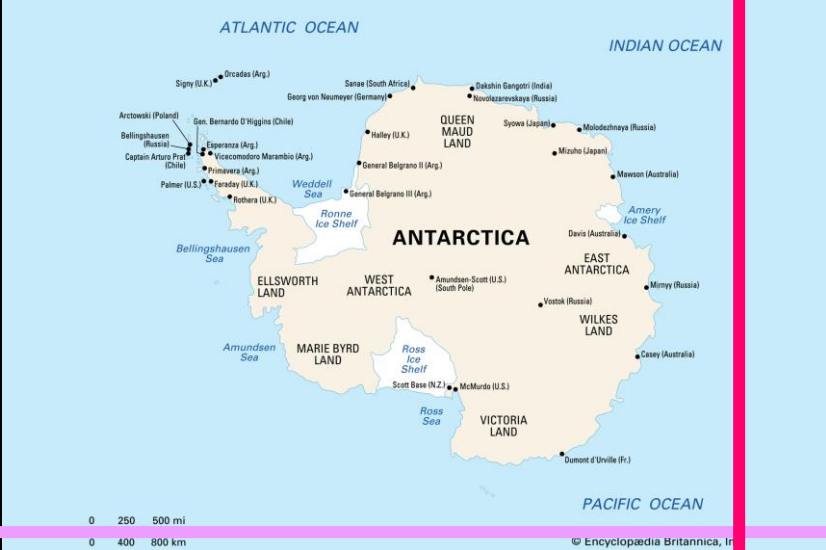
**AUDIENCE**

**SCIENCE**

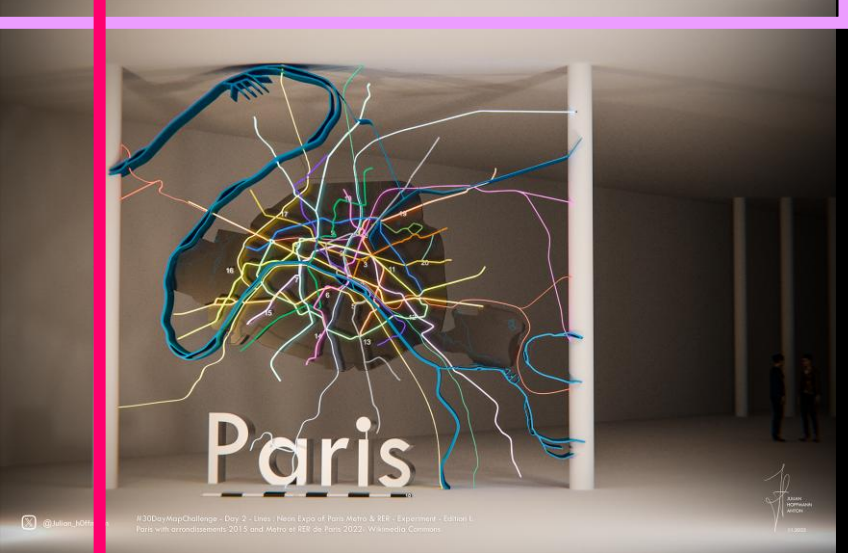
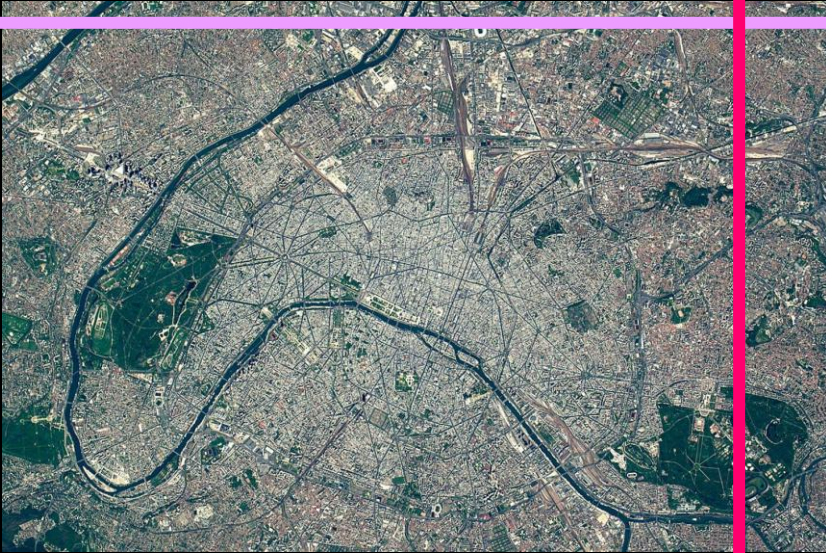
**BOTH**

**ART**

**SIMPLICITY**



**BALANCED**



**COMPLEXITY**

# Global Shipping Traffic Density



ANIMATION ►

  
JULIAN  
HOFFMANN  
ANTON

Experimental visualisation with all observed ship movement from 2015-2020, at 500 m resolution from IMF's World Seaborne Trade Monitoring System & NASA's Black Marble satellite imagery. #30DayMapChallenge - Day 7 - Navigation - frame n°217 from animation, made in Blender. X: @Julian\_h0ffmann

# III.

**GOAL:** show possibilities of

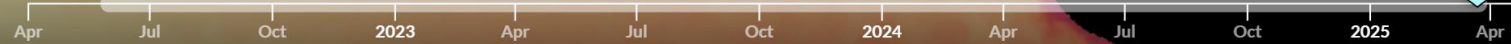
- 1. Open Data + your data
- 2. Free Tools Open Source + your tools of choice
- 3. One step further to stand out communicating Science effectively

The screenshot shows the MyOcean PRO interface with a settings panel for the 'Sea water potential temperature thetad' layer. The panel includes a color scale from 0 to 30°C, a 'Geographic area' section with 'Define on map' and input fields for N, W, E, and S coordinates, a 'Date range' section with a date selector and 'As in map' buttons, and a 'Depth range' section with input fields and 'As in map' buttons. At the bottom, there are buttons for 'Browse file', 'Automate', and 'Download', with the 'Download' button highlighted by an orange box. The file size is indicated as ~35.29 MB. The background shows a map of the North Pole region with a color-coded temperature overlay.

# OPEN DATA !



- Points
- Lines
- Areas
- Import
- Settings



## Filters ×

### FREE-TEXT SEARCH

### TIME RANGE ▲

Covering full interval

### WITH DEPTH 4

### DEPTH RANGE ▲

### UNIVERSE ▲

Blue Ocean 68

White Ocean 6

Green Ocean 3

### MAIN VARIABLES ▲

Carbonate system 3

Mixed layer thickness 1

Nutrients 2

Optics 1

Oxygen 2

Plankton 2

Salinity 1

Sea ice 5

Sea surface height 6

Temperature 14

Velocity 22

Wave 26

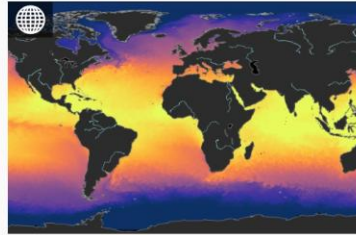
Wind 18

### AREA ▲

Global Ocean 24

Arctic Ocean 11

## Products 73

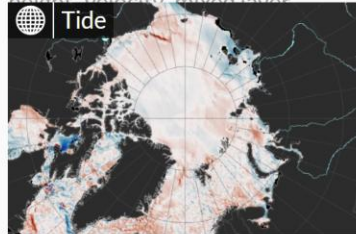


### Global Ocean Physics Analysis and Forecast

GLOBAL\_ANALYSISFOR... 001\_024  
Models

Global, 0.083° × 0.083° × 50 levels  
1 Nov 2020 to 25 Mar 2025,...

Temperature, salinity, sea surface height, velocity, mixed layer...

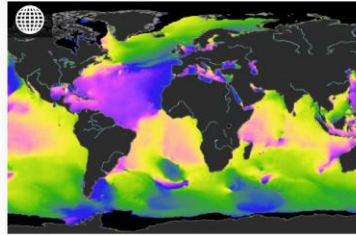


### Arctic Ocean Tidal Analysis and Forecast

ARCTIC\_ANALYSISFORE...002\_015  
Models

Arctic, 3 × 3 km

Since 19 Dec 2017, sub-hourly

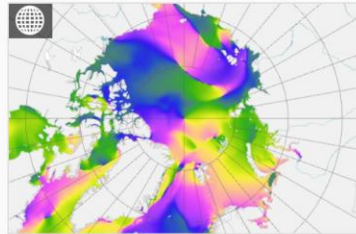


### Global Ocean Waves Analysis and Forecast

GLOBAL\_ANALYSISFOR... 001\_027  
Models

Global, 0.083° × 0.083°  
1 Nov 2022 to 25 Mar 2025,...

Velocity, wave



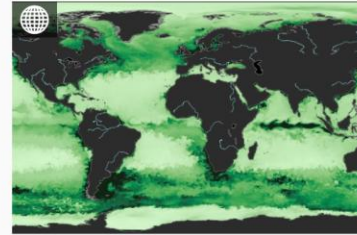
### Arctic Ocean Wave Hindcast

ARCTIC\_MULTIYEAR\_W... 002\_013  
Models

Arctic, 3 × 3 km

1 Jan 1977 to 30 Nov 2022,...

Velocity, wave, sea ice

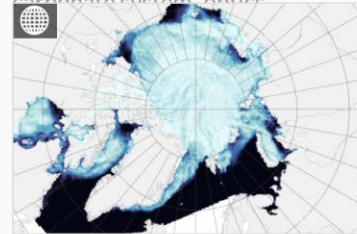


### Global Ocean Biogeochemistry...

GLOBAL\_ANALYSISFOR... 001\_026  
Models

Global, 0.25° × 0.25° × 50 levels  
1 Oct 2021 to 21 Mar 2025, daily...

Plankton, nutrients, oxygen, carbonate system, optics...



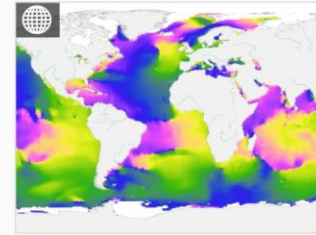
### Arctic Ocean Sea Ice Reanalysis

ARCTIC\_MULTIYEAR\_P... 002\_016  
Models

Arctic, 3 × 3 km

1 Jan 1993 to 31 Dec 2023, hour...

Velocity, wave, sea ice



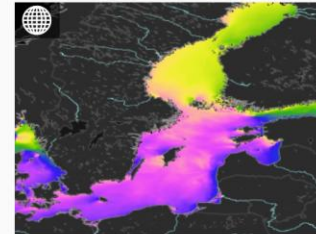
### Global Ocean Waves Reanalysis

GLOBAL\_MULTIYEAR... 001\_028  
Models

Global, 0.2° × 0.2°

1 Jan 1980 to 31 Jan 2025, hourly...

Velocity, wave



### Baltic Sea Wave Analysis and Forecast

BALTICSEA\_ANALYSISF... 003\_016  
Models

Baltic, 2 × 2 km

1 Oct 2021 to 24 Mar 2025,...

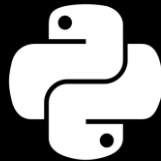
Velocity, wave



## Tools to read Open Data in NetCDF format



Libraries: ncd4, rhdf5, terra, etc



Packages: ncd4, etc.



plugin Netcdf



BlenderNC

docs failing Test passing codecov 74% maintai  
tag v0.7.0 pre-commit.ci passed semantic-release

Or after analysis as raster tif, png, svg, jpg, csv

# III. WHERE CAN YOU ADD THINGS TO YOUR CURRENT WORKFLOW?

## LONG PROCESS IN SHORT :

### Data

### Analysis/ GIS/ 2D Visualisation

| ISO3 Alpha-code | ISO2 Alpha-code | SDMX code** | Type     | Parent code | Year | Total Population, as of 1 January (thousands) |
|-----------------|-----------------|-------------|----------|-------------|------|---|
| ZWE             | ZW              | 716         | Country/ | 910         | 1950 | 2 746   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1951 | 2 836   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1952 | 2 927   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1953 | 3 020   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1954 | 3 116   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1955 | 3 213   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1956 | 3 314   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1957 | 3 417   |
| ZWE             | ZW              | 716         | Country/ | 910         | 1958 | 3 524   |

```

## ---- NEW BOUBBLE CENTRES ----
### ---- LOOP FOR MAP CREATION ----
# Set number of iterations
num_iters <- 157

for (i in 1:num_iters) {
  #local_max <-max(hot_world_sf_wide %>% as_tibble() %>% select(colnames(hot_world_sf_wide)[1]))

  pop_dorling_cartogram <- cartogram_dorling(hot_world_sf_wide%>%
    st_transform(crs = "+proj=eqc +datum=WGS84"),
    colnames(hot_world_sf_wide)[1], k=3)

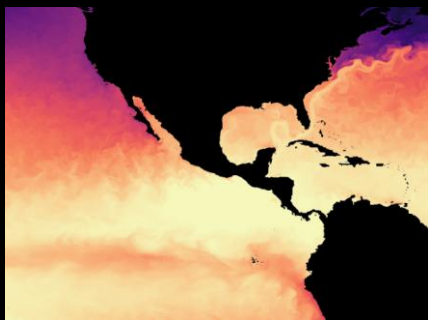
  pop_dorling_cartogram_sp <- as(pop_dorling_cartogram, "Spatial")

  circle_centres_sp <- SpatialPointsDataFrame(gCentroid(pop_dorling_cartogram_sp, byid = TRUE),
    pop_dorling_cartogram_sp@data,
    match.ID = FALSE)

  # choose Robinson projection
  circle_centres_sf <- spTransform(circle_centres_sp, CRS = ("+proj=robin"))

  circle_centres_sf <- circle_centres_sf %>% st_as_sf(region = "ISO3", keep = T)
  
```

Netcdf, CSV, .SHP



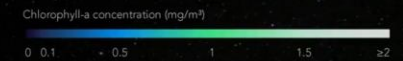
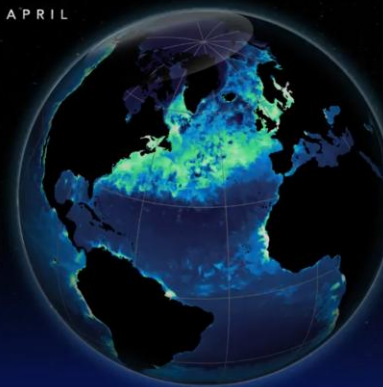
EXPORT IN THE RIGHT FORMATS:  
.SVG or .PNG, .TIF, etc.



IT'S WORTH to enhance your work with free vector & image editing software for a final touch

### 2024 SPRING PHYTOPLANKTON BLOOM

APRIL



With the arrival of spring in the North Atlantic, longer days, calmer seas, and nutrients stirred up by winter storms fuel massive phytoplankton blooms that spark a cascade of ocean life.

Cartography  
Chiara Phillips | chiaraphillips.com  
Created with QGIS, Adobe Illustrator, Adobe Premiere

Modeled data  
Global Ocean Biogeochemistry Analysis and Forecast.  
E.U. Copernicus Marine Service Information (CMEMS).  
Marine Data Store (MDS). DOI: 10.48670-moi-0015.  
(Accessed on 09-02-2025)

Webinar 2:  
by Chiara Phillips!

Webinar 3:  
today



Or test meaningful 3D Visualisations and animations in Blender

# Software to produce my work for FREE (or similar payed alternatives)

non - exhaustive list !



MS Excel

**FREE Analytics**

R - RStudio  
Python - Jupyter, Spyder  
Google Sheets  
etc.



Photoshop

**FREE Image editor**

GIMP  
Paint.NET  
Krita  
Photopea  
Darktable



AfterEffects

**FREE Video & Effects**

DavinciResolve  
Blender + 3D VFX  
etc.



Notion

**FREE Note Taking & Planning, Lists & Organising**



ArcGIS

**FREE GIS**

QGIS  
R - RStudio  
Python - Jupyter, Spyder  
etc.



Illustrator

**FREE Vector Graphics editor**

Inkscape  
BoxySVG  
Vectr  
Krita



ChatGPT pro

**FREE Assistant**

ChatGPT  
Bing Chat  
etc.



Midjourney

**FREE Generative AI**

Stablediffusion  
Dall-e  
etc.

# 3D Beauty = More impact?

## CONS

- I. OFTEN TAKES **MORE TIME TO CREATE** (NOT ALWAYS!)
- II. CAN BE **TERRIBLY UNNECESSARY** (if it doesn't add anything)
- III. CAN BE **TRULLY COUNTERPRODUCTIVE** (if done badly)
- IV. Please, **use it wisely or for fun**, don't use 3D without reason, or **just call me**.

# 3D Beauty = More impact ?

## PROs

- WE ARE **SPATIAL BEINGS LIVING IN A 3D WORLD**
- More **memorable** in a fast-paced world
- **Awaken emotions and senses**
- **Compelling** (short attention span of humans)
- Drives curiosity
- More **entertaining**
- **Attractive**
- **More dimensions** to play with
- Art = ART
- Emotional and involves **feelings**
- Can add Beauty and Style
- Infinity of angles
- An Incentive to explore !
- More accessible
- Realistic & physical: **Intriguing**
- Cinematic & cool
- Playful
- **Innovative**
- „Feel the insights“
- „Nourishing the mind“
- „Savour the insights“

... The list goes on



Open-source  
3D Software

The image shows the Blender 3D software interface. The main 3D viewport displays a grey sphere on a grid floor. The text "VISUALISATION OF OCEAN AND WORLD DATA??" is overlaid in the center of the sphere. The interface includes a top menu bar with options like File, Edit, Render, Window, Help, Layout, Modeling, Sculpting, UV Editing, Texture Paint, Shading, Animation, Scene, and ViewLayer. Below the menu bar is a toolbar with various tools. On the right side, there are two panels: the top one shows the Outliner with a hierarchy of objects (Collection, Camera, Light, Sphere) and the bottom one shows the Properties panel for the selected 'Light' object, displaying its Transform properties (Location, Rotation, Scale) and other settings. The bottom status bar shows the current frame (1) and a timeline from 1 to 250.

File Edit Render Window Help Layout Modeling Sculpting UV Editing Texture Paint Shading Animation Scene ViewLayer

Object Mode View Select Add Object Global

User Perspective  
(1) Collection | Light

Options

Scene Collection  
Collection  
Camera  
Light  
Sphere

Light

Light

Transform

|          |      |  |
|----------|------|--|
| Locat... | 4.   |  |
| Y        | 1.   |  |
| Z        | 5.   |  |
| Rotat... | 37   |  |
| Y        | 3.   |  |
| Z        | 10   |  |
| Mode     | X... |  |
| Scal...  | 1.   |  |
| Y        | 1.   |  |
| Z        | 1.   |  |

Delta Transform

Relations

Collections

Motion Paths

Playback Keying View Marker

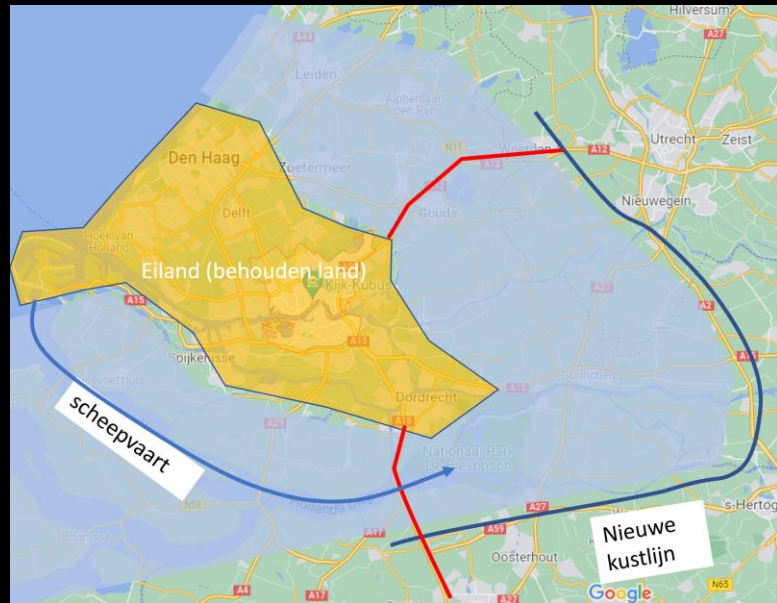
1 20 40 60 80 100 120 140 160 180 200 220 240

1 Start 1 End 250

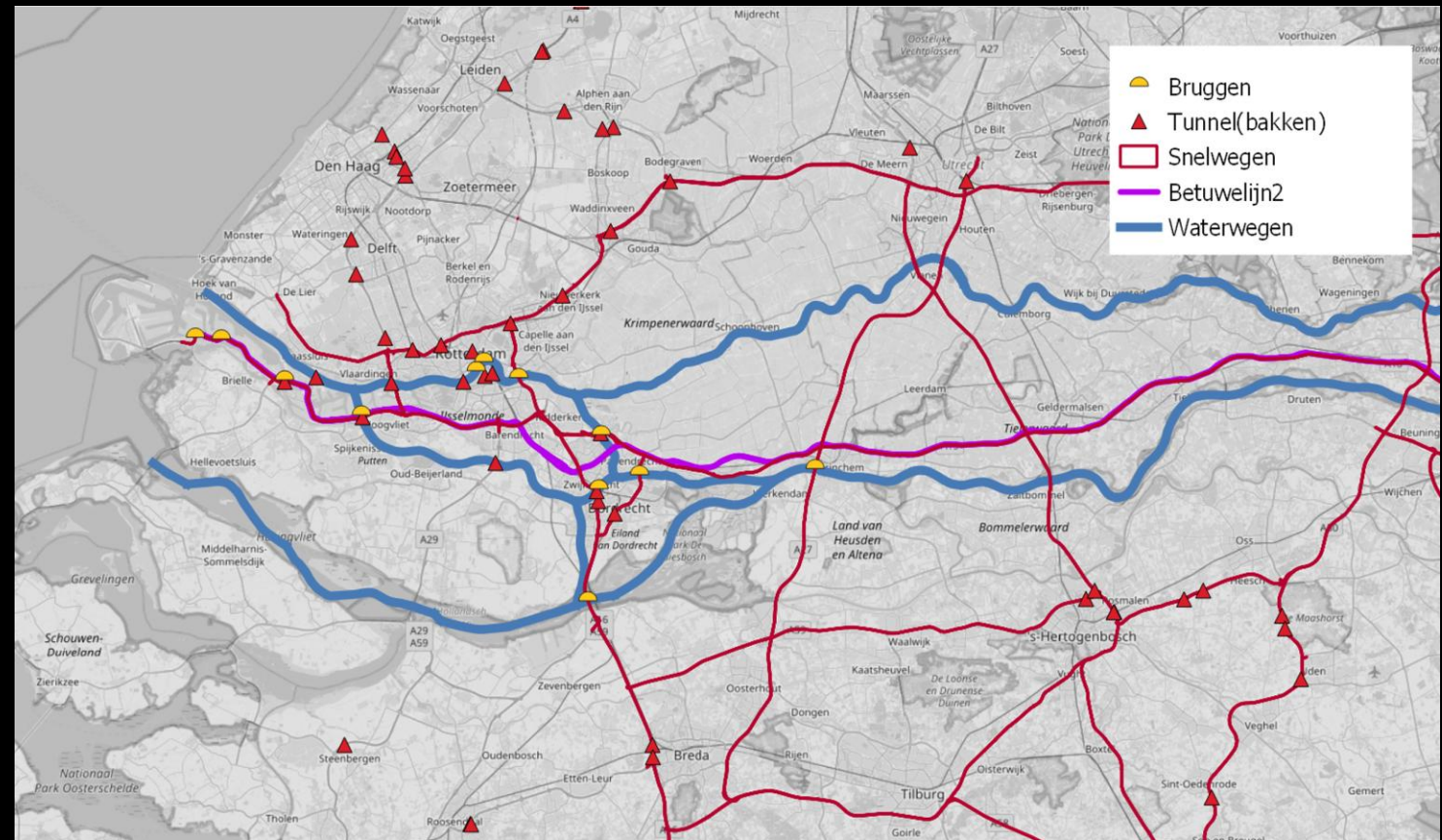
Resize Options

4.3.2

# AUDIENCE?

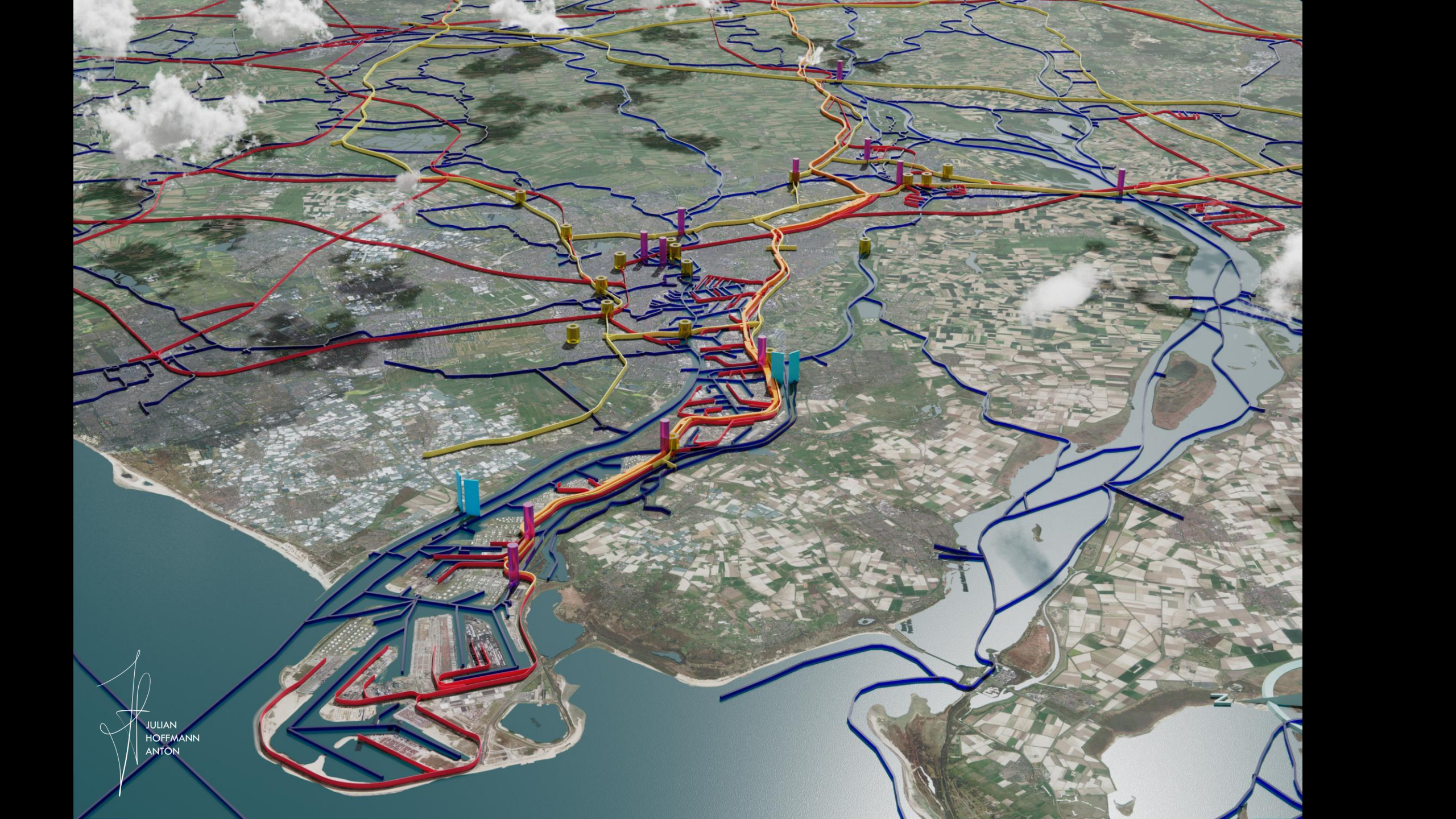


**SEA RISE, Climate change and flooding scenarios**  
**EXAMPLE CASE:**  
in Rotterdam for Deltares, a brilliant Dutch thinktank





  
JULIAN  
HOFFMANN  
ANTON



# ROTTERDAM

Transport Infrastructure Study  
Rotterdam - Ruhr Corridor

## Port of Rotterdam

In 2020, 437 million tons per year  
in both directions:

- 151 mil. ton container load
- 30 mil. ton break bulk
- 192 mil. ton liquid bulk
- 64 mil. ton dry bulk

## Nieuwe Waterweg

- 15.000 sea-going ships per year

## From Port to Dutch inland waterways

- 150 million tons per year

## Vessel activity at the port

- 93.000 inland vessels per year
- 28.000 sea-going vessels

## Maeslant Barrier & Hartel Barrier

- Closure results in 750 waiting inland vessels  
and 63 sea-going vessels per day

## Betuwe route

- 31.000 trains per year
- 53 million tons per year  
(both directions)



\* Rotterdam area  
east wards

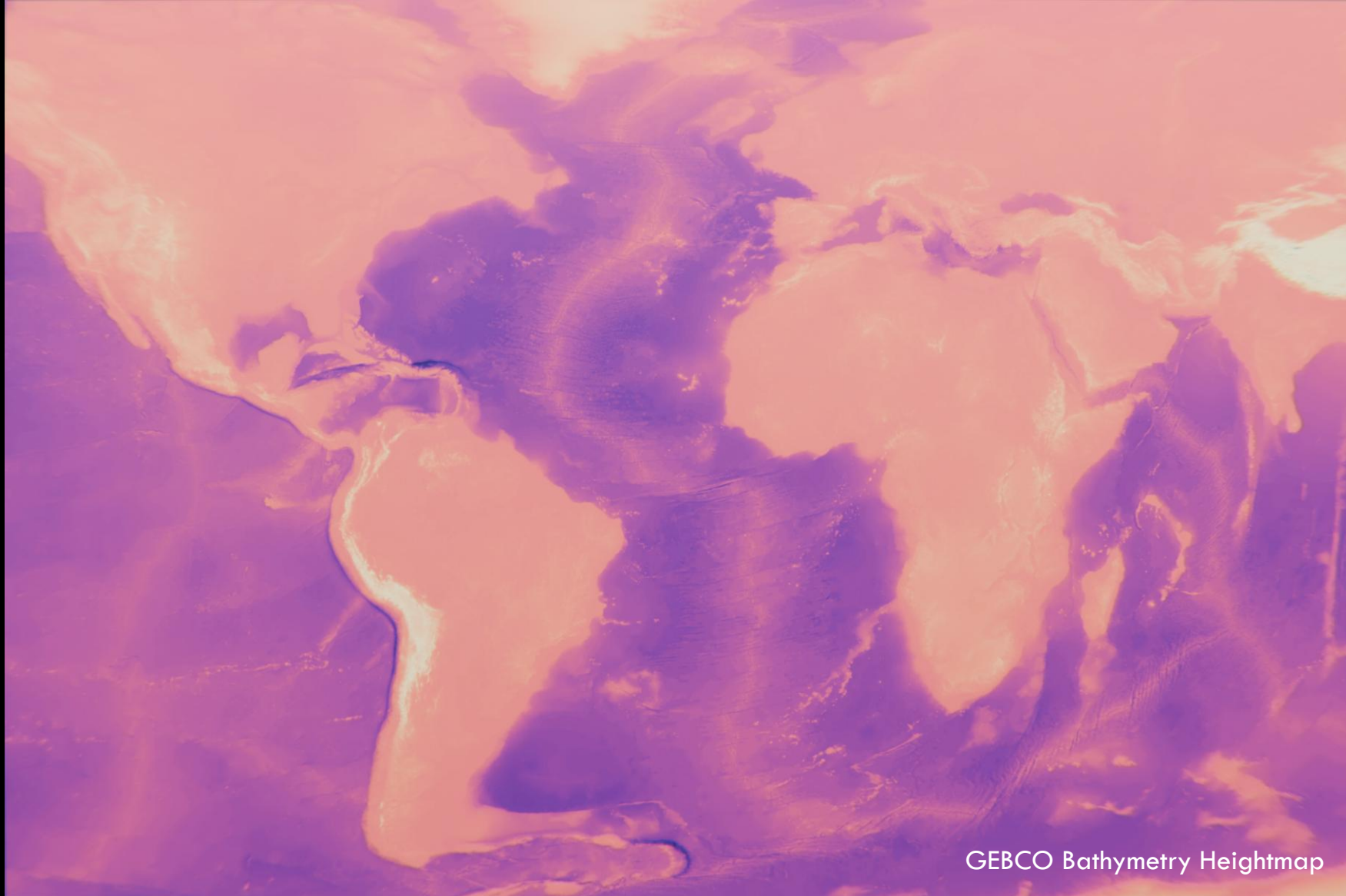
Rail



# Open Ocean and Planet Data: Bathymetry and Topography

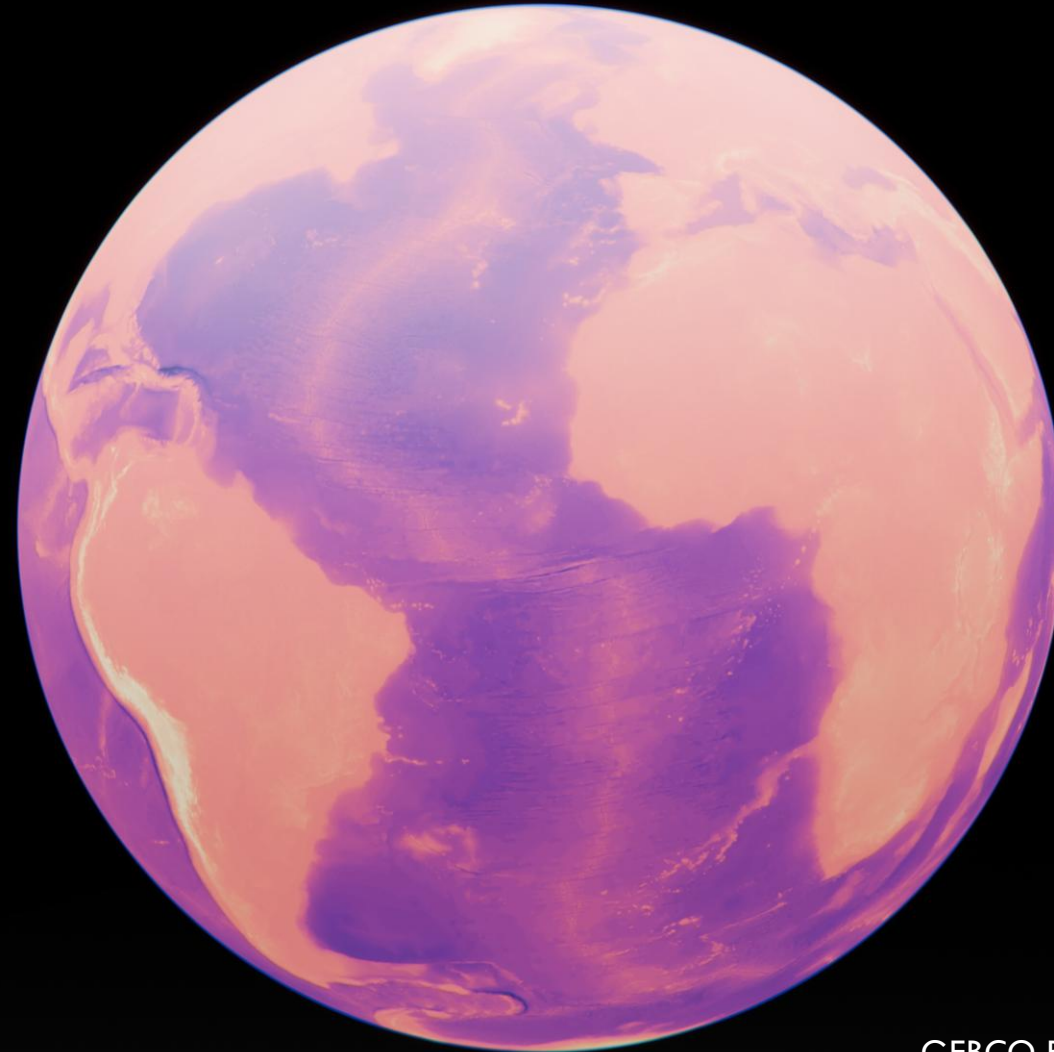


The right colour palette matters!



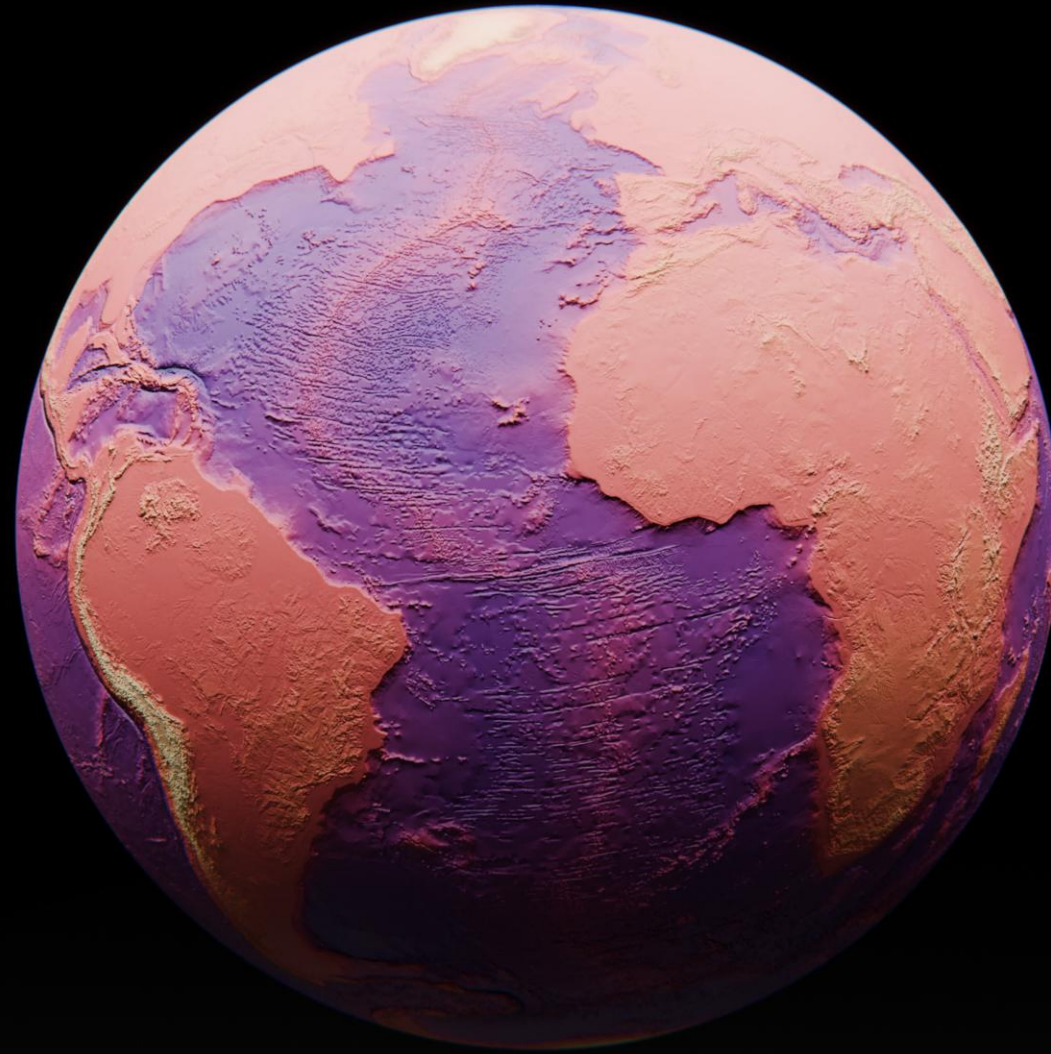
GEBCO Bathymetry Heightmap

Global shape with less projection distortion?



GEBCO Bathymetry Heightmap

Exaggerated the geographic features, improved lighting,  
creating physical illusion and realism



Exaggerated GEBCO Bathymetry Heightmap

Ocean Bathymetry  
&  
Land Topography



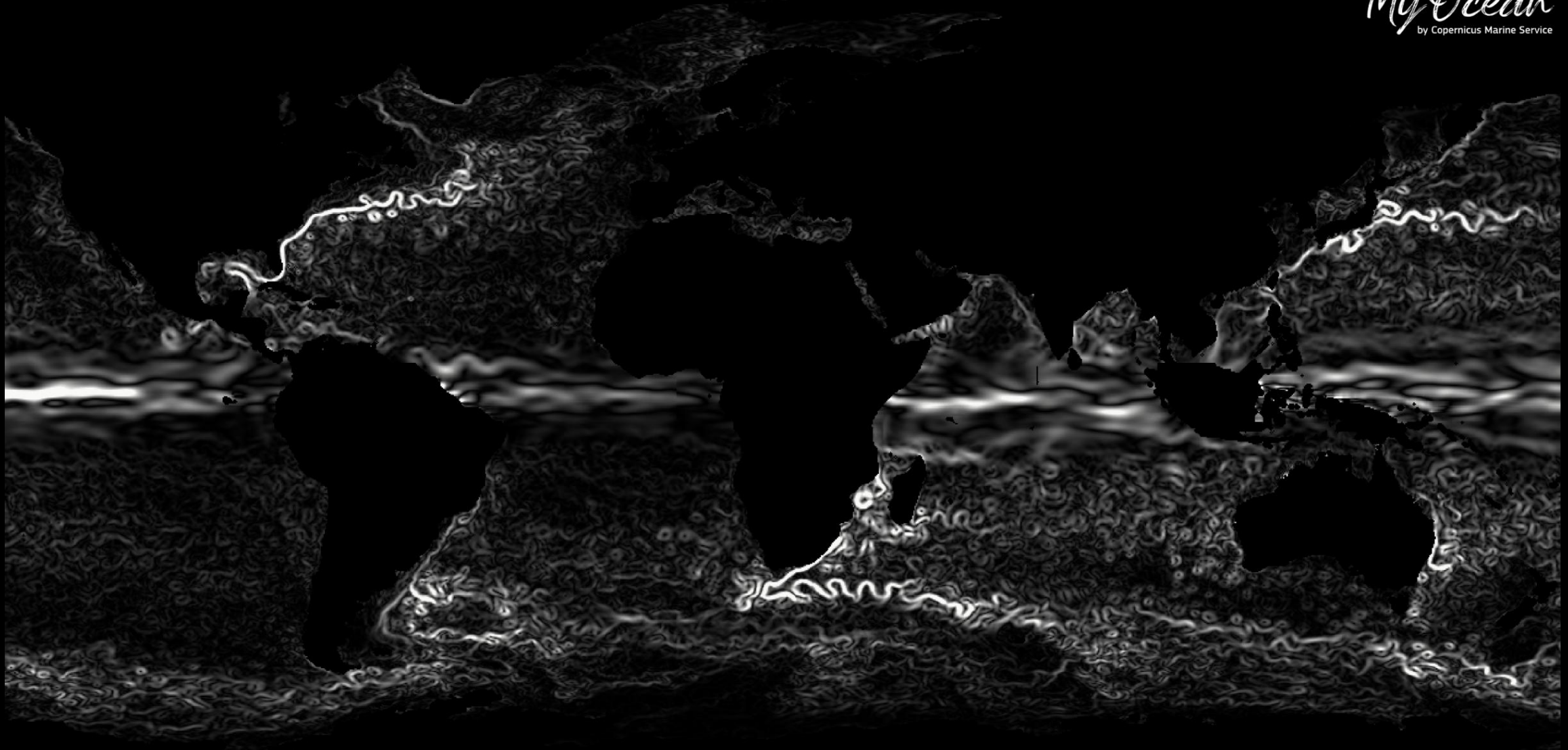
ANIMATION ►

  
JULIAN  
HOFFMANN  
ANTON

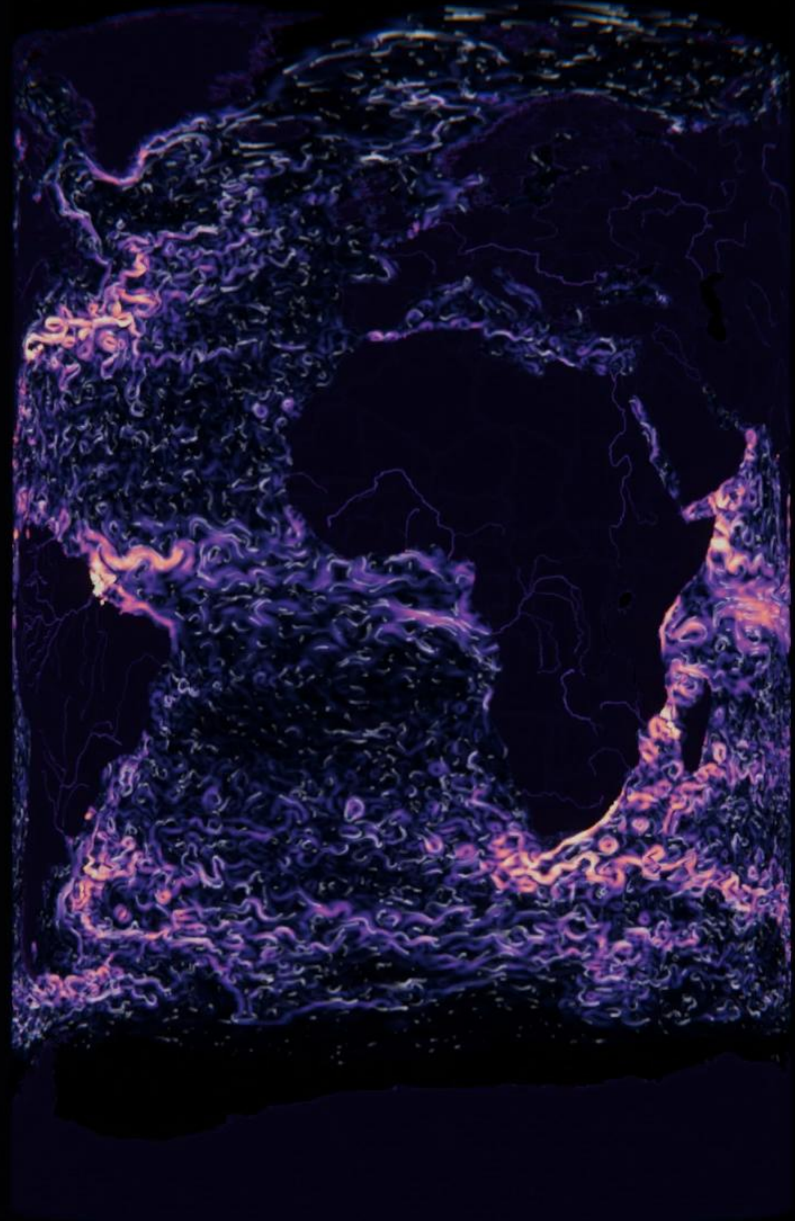
Exaggerated GEBCO Bathymetry Heightmap

# LET'S PUT THE WATER BACK IN : COPERNICUS-GLOBCURRENT!

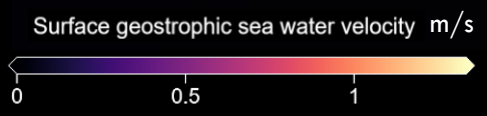
*MyOcean*  
by Copernicus Marine Service



COPERNICUS-GLOBCURRENT



ANIMATION ►



# Sea water potential water temperature

-0.5m



Local Length: 0.01 m  
End: 1000 m

Local Camera: Camera.FI...  
Passepartout:   
Render Region:

View Lock

Lock to Object: Object  
Lock:  To 3D Cursor  Camera to View

3D Cursor

Location:

|   |     |
|---|-----|
| X | 0 m |
| Y | 0 m |
| Z | 0 m |

Rotation:

|   |       |
|---|-------|
| W | 0.000 |
| X | 0.000 |
| Y | 0.000 |
| Z | 0.000 |

Quaternion (WXYZ)

Collections

Annotations



ANIMATION ▶

Sea water potential water temperature



-0.5m



*JH*  
JULIAN  
HOFFMANN  
ANTON

Timeline interface with markers and playback controls.

Timeline: 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800

Timeline tracks: Satellite Earth, Action.001, Deform

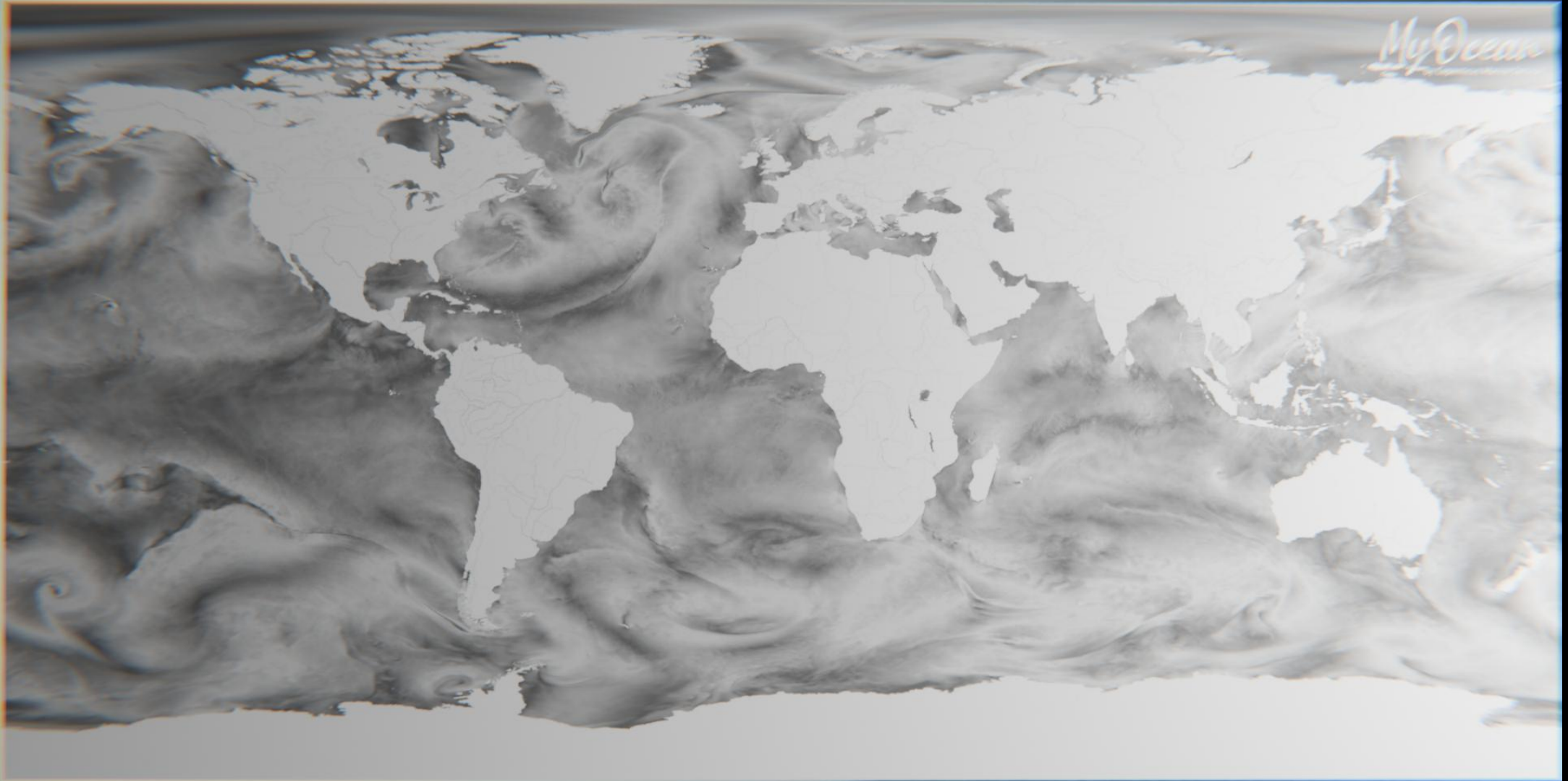
Timeline controls: Play, Stop, Previous, Next, Home, End

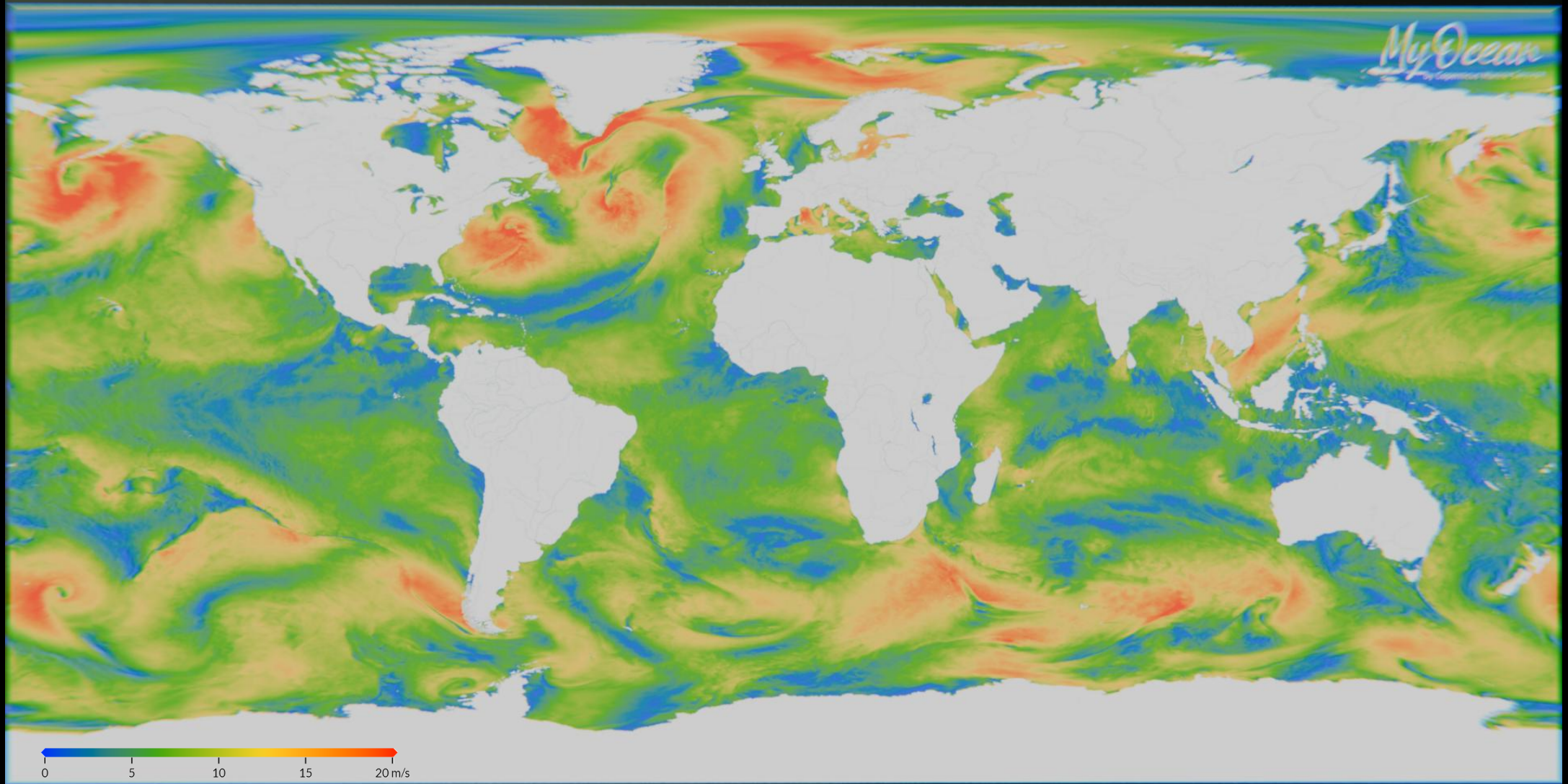
Timeline markers: 0, Start, End



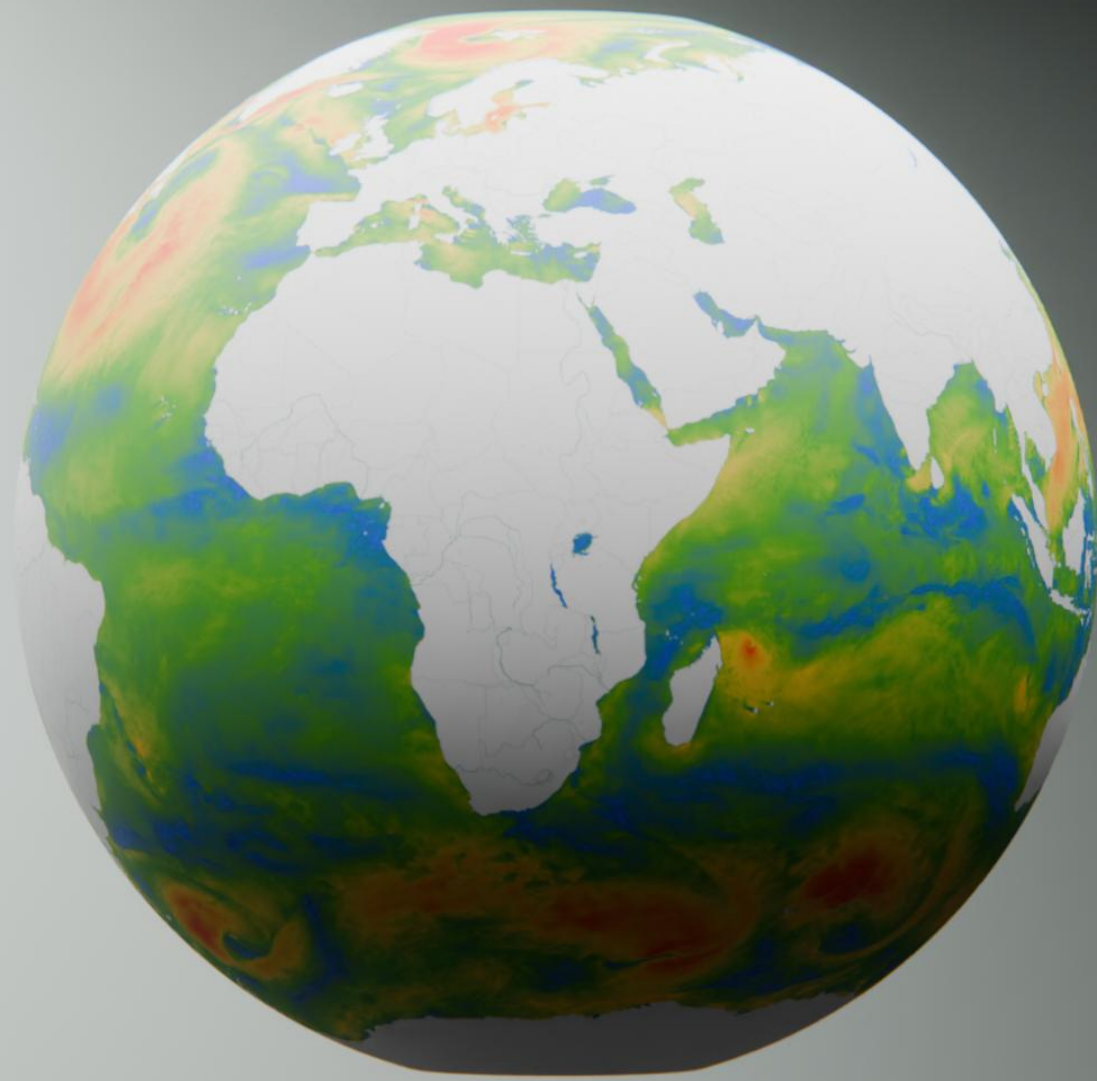
ONE LAST ONE  
GLOBAL WIND SPEED ?

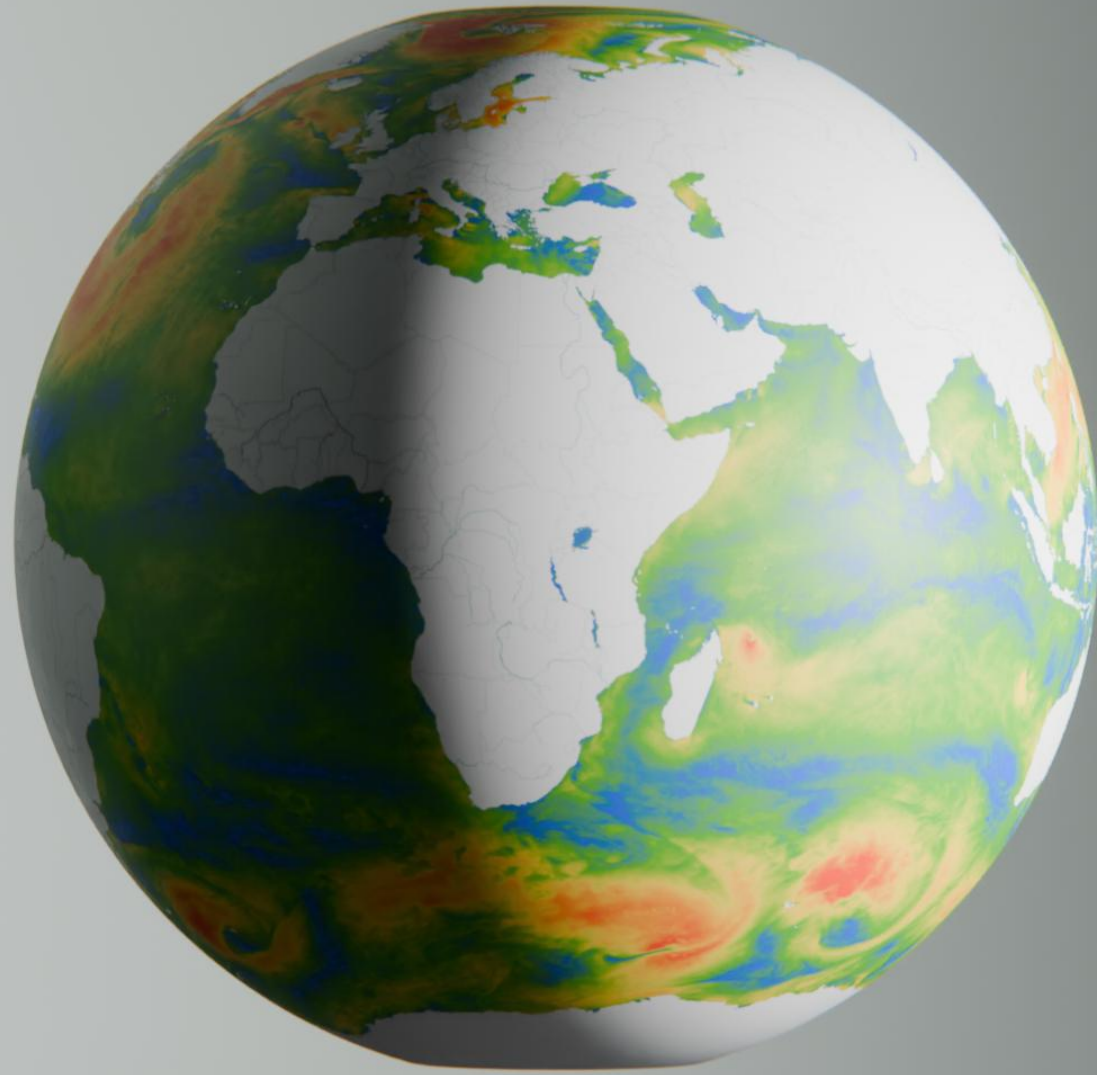
# WIND SPEED ?





Global Ocean Hourly Sea Surface Wind and Stress from Scatterometer and Model - Hourly Jan 10-12 2025



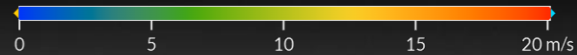
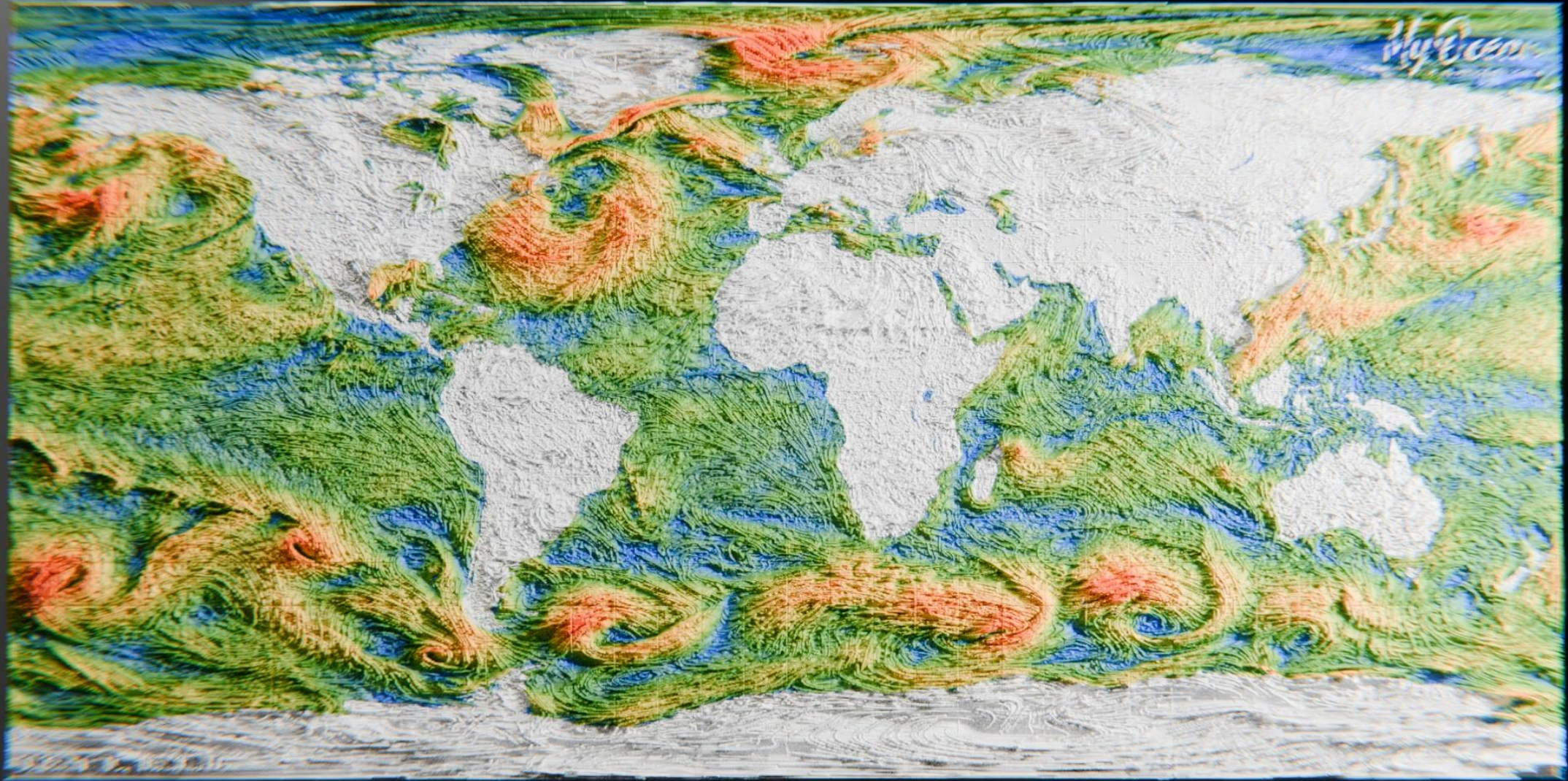


- Different light
- Interesting contrast

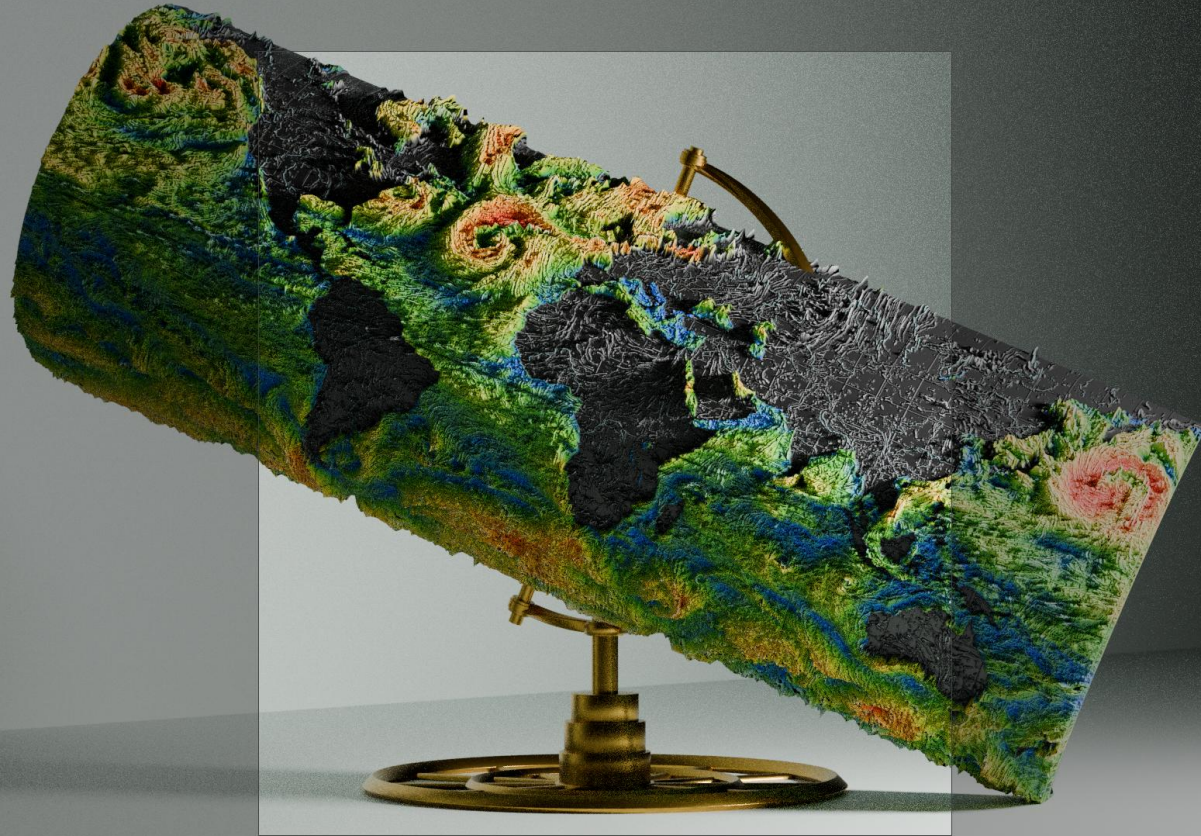
Can we do more?



- Encoding wind speed into exaggerated elevation
- with added particle simulations
  - Physical texture
  - Details
  - Photo realism
  - Art Gallery style
  - Mysterious
  - Surprising



# BEHIND THE SCENES



View

- Focal Len... 50 mm
- Clip Start 0.01 m
- End 100000 m

Local Cam... Ca... x

- Passepartout
- Render Regl...

View Lock

Lock to O... Object

Lock  To 3D Cursor  Camera to Vi...

3D Cursor

Location:

|   |     |
|---|-----|
| X | 0 m |
| Y | 0 m |
| Z | 0 m |

Rotation:

|   |       |
|---|-------|
| W | 0.000 |
| X | 0.000 |
| Y | 0.000 |
| Z | 0.000 |

Quaternion (WXYZ)

Collections

Annotations

+ New

- Camera.Fixed
- Camera.Fixed.001
- Camera.Zoom
- Camera Centre.001
- Camera Centre.002
- Environment\_Empty
- Plane
- Ring.002
- True Earth
  - 4th ring
  - Base Sphere
  - Base Sphere.001
  - Base Sphere.002
  - Base Sphere.004
  - Camera Centre
    - Cylinder.016
    - Metal Side
    - Plane.001
    - Ring
    - Tella.002
    - Torus
  - True Centre
    - Animation
    - Transformation Empty
      - Atmosphere
      - The Clouds
      - The Satellite Earth
        - Saturn Rings

- Lights
- Area
- Area.001
- Area.002
- Area.004

Catmull - Clark

Levels Viewport

Render

Advanced

Quality

UV Smooth

Boundary Smooth

SimpleDeform

Twist Bend

Angle

Origin

Axis

Restrictions

SimpleDeform.001

Twist Bend

Angle

Origin

Axis

JULIAN  
HOFFMANN  
ANTON

Keying View Marker

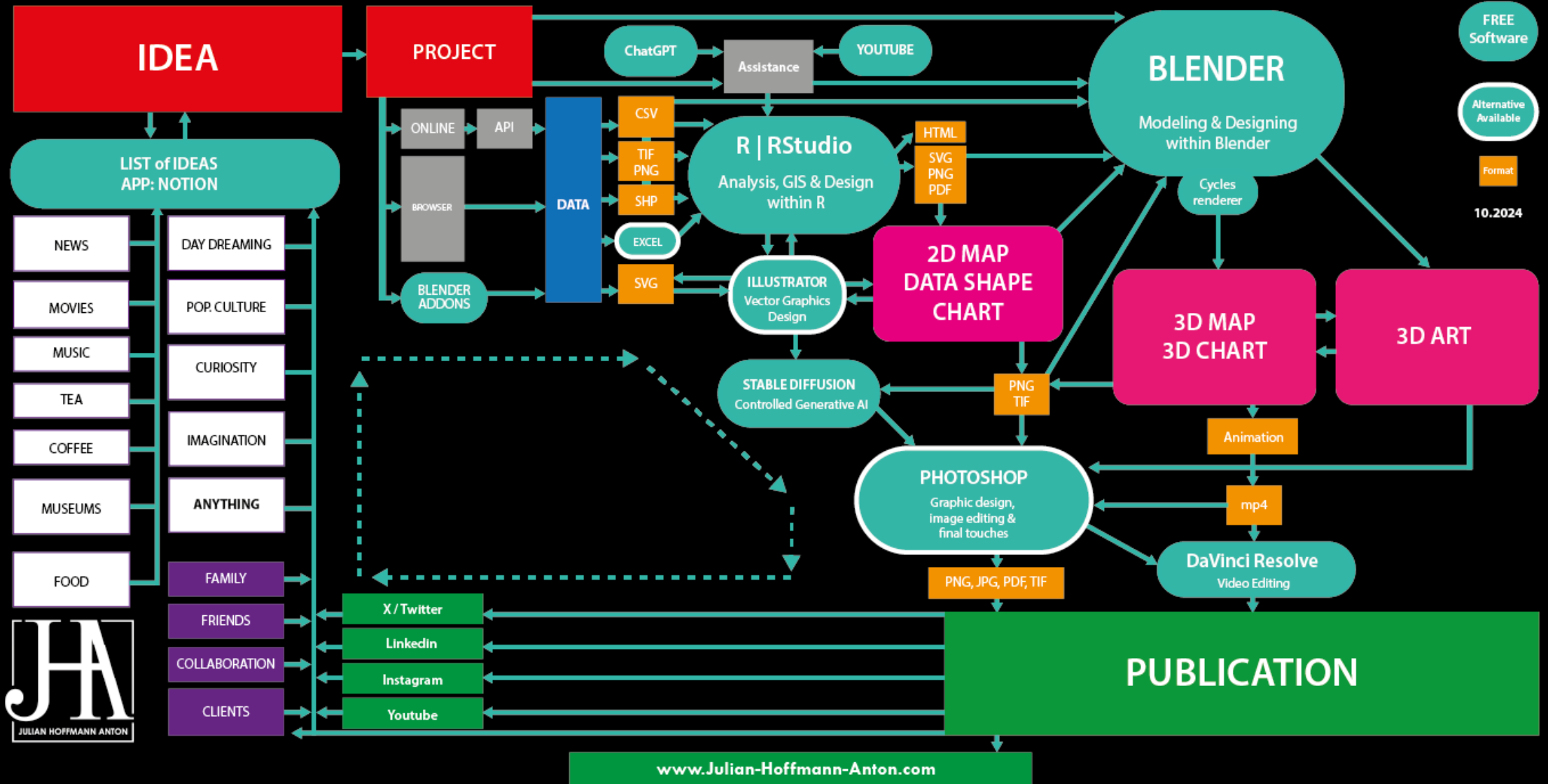
48 Start 1 End 200

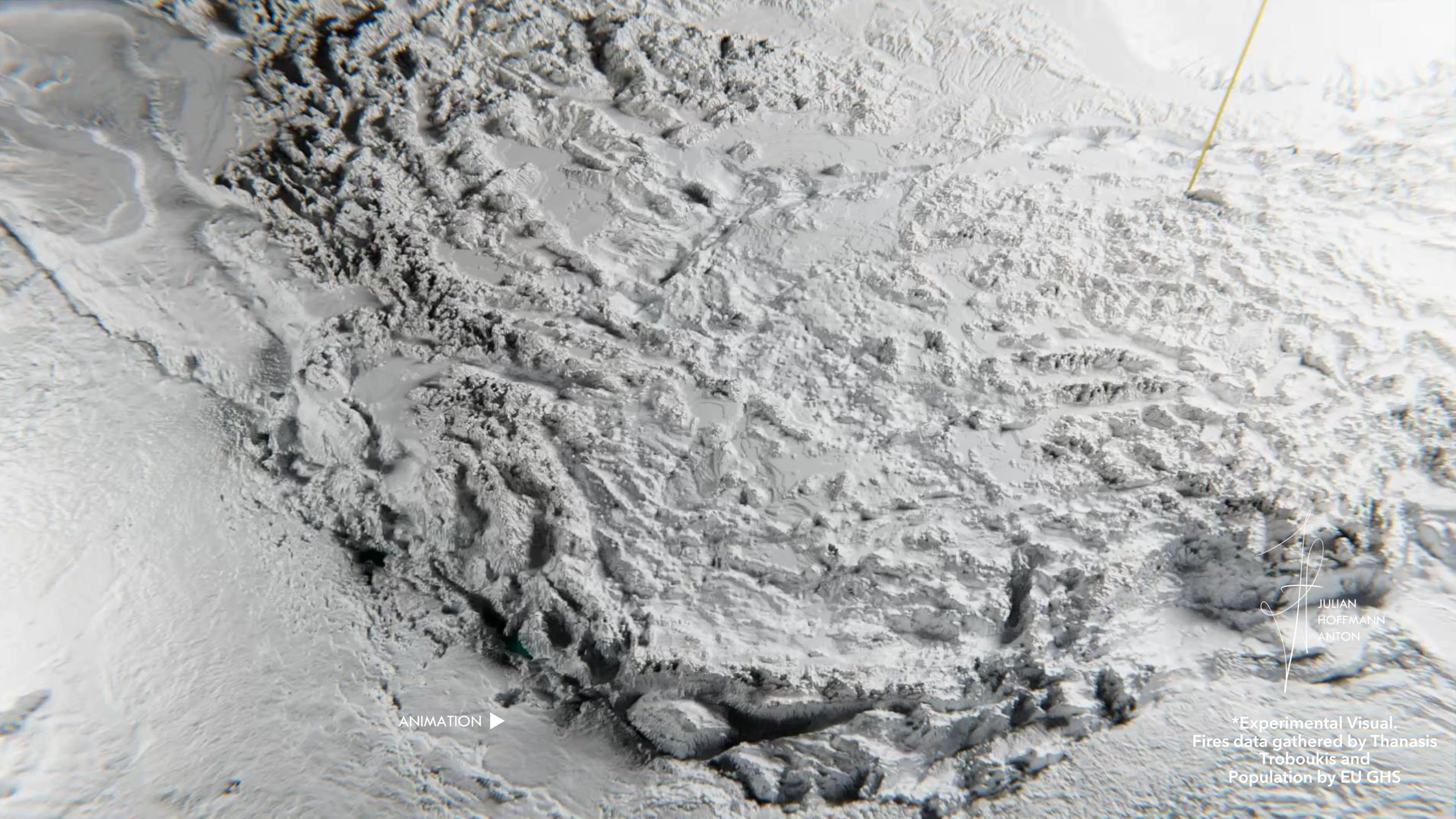
-500 -400 -300 -200 -100 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500

View Select Add Node

+ New

# CREATIVE WORK FLOW LOOP

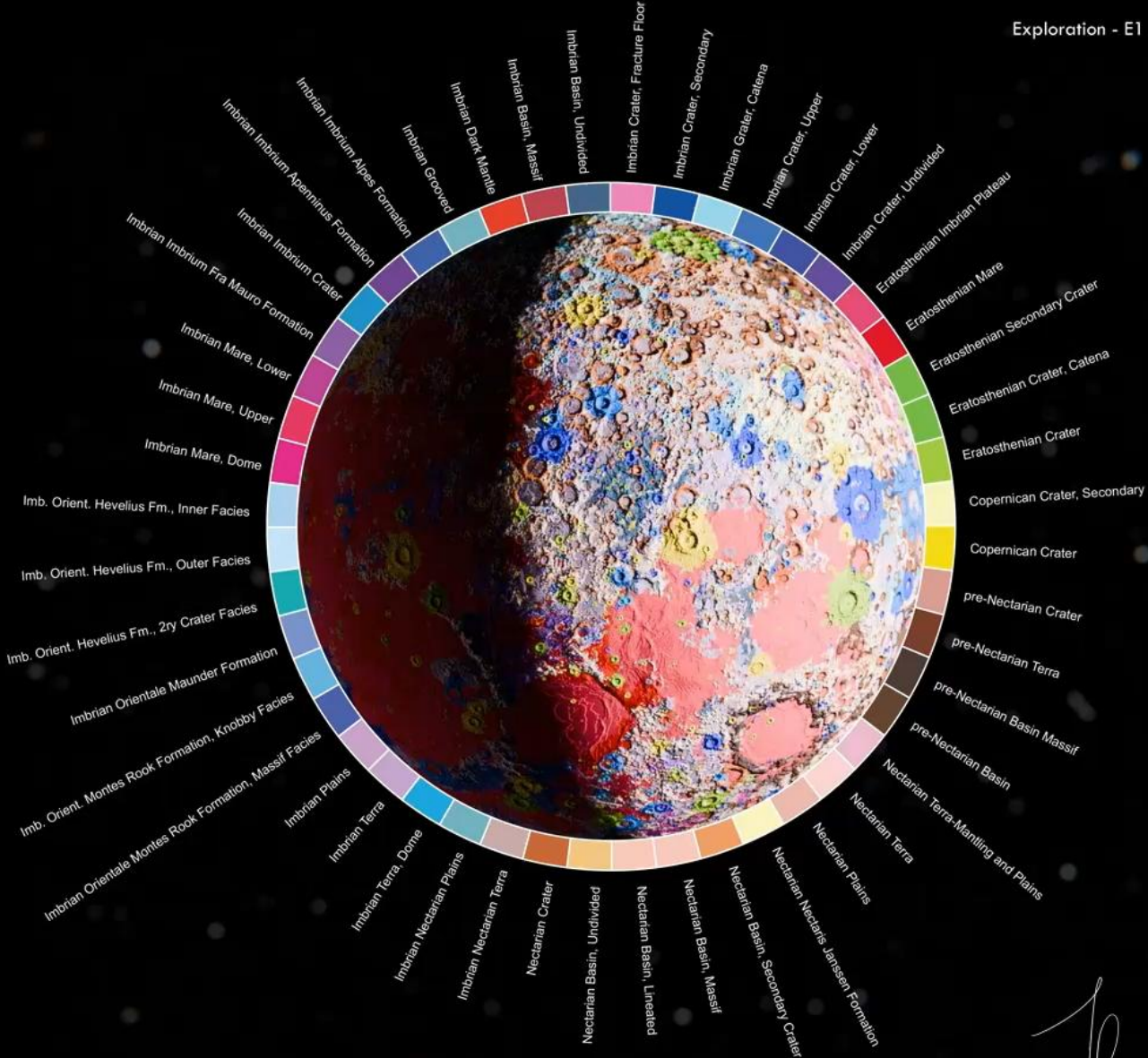




ANIMATION ▶

JULIAN  
HOFFMANN  
ANTON

\*Experimental Visual.  
Fires data gathered by Thanasis  
Troboukis and  
Population by EU GHS



ANIMATION ▶

**Selenology**  
 3D concept adapted from 2D  
 "Unified Geologic Map of The Moon"  
 by C.M. Fortezzo, P.D. Spudis, and S.L. Harrel, 2019

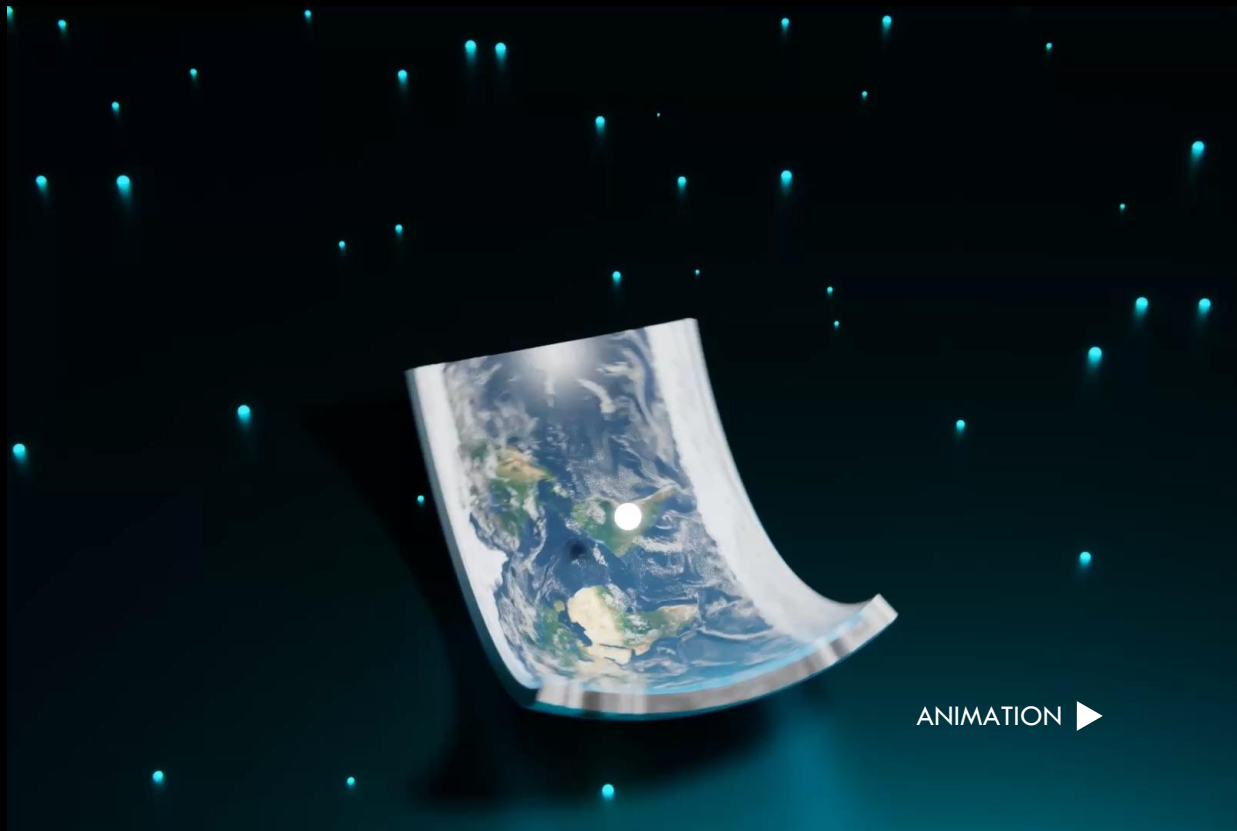
**Geology Of The**  
**MOON**

*JH*  
 JULIAN  
 HOFFMANN  
 ANTON

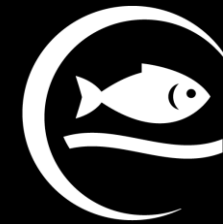
# 4 Key Takeaways

- I. Explore and experiment to stand out, the sky is not the limit
- II. Science needs visual communication
- III. Open source tool and open data are powerful and are evolving extremely quickly
- IV. **Beautiful information** is **memorable** and **impactful**

# YOUR turn to explore, explain and express Data visually in new ways



THANK YOU  
FOR THE  
OPORTUNITY



Copernicus  
Marine Service

We can connect:



E-Mail:

[Julian.hoffmann.anton@gmail.com](mailto:Julian.hoffmann.anton@gmail.com)

Explore:

[www.julian-hoffmann-anton.com](http://www.julian-hoffmann-anton.com)