

ECMWF – DESTINATION EARTH

DEMONSTRATION OF VISUALISATION: THE ART OF IMMERSIVE DATA

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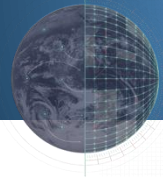


Funded by
the European Union

Destination Earth

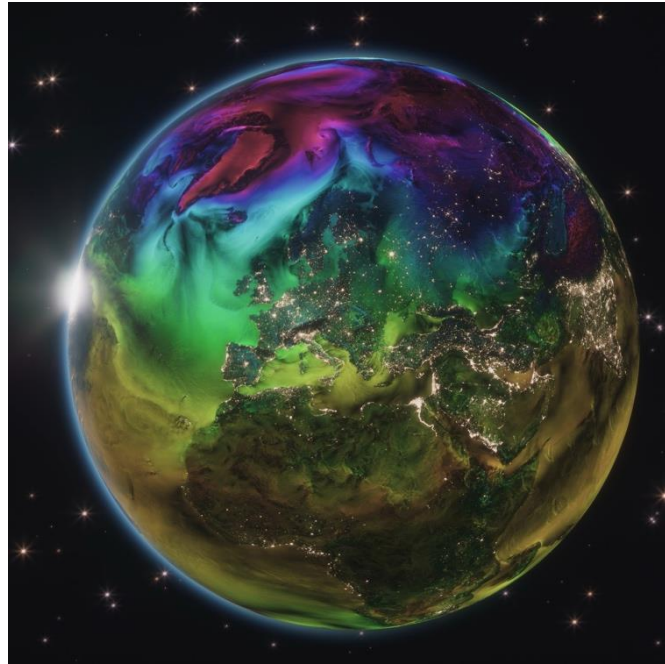
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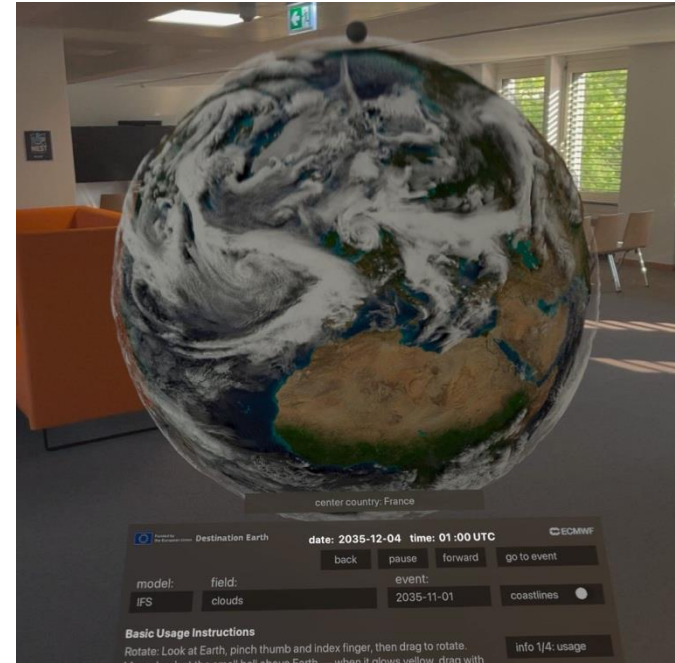


GOAL: SHOWCASE GLOBAL 5 KM-RESOLUTION ATMOSPHERE & OCEAN DATA

- Originally focused on high-quality cinematic rendering
- Increasing interest in interactivity
- Apple Vision Pro sparked demand for mixed reality experiences
- Result: two custom-built apps
- Work in progress



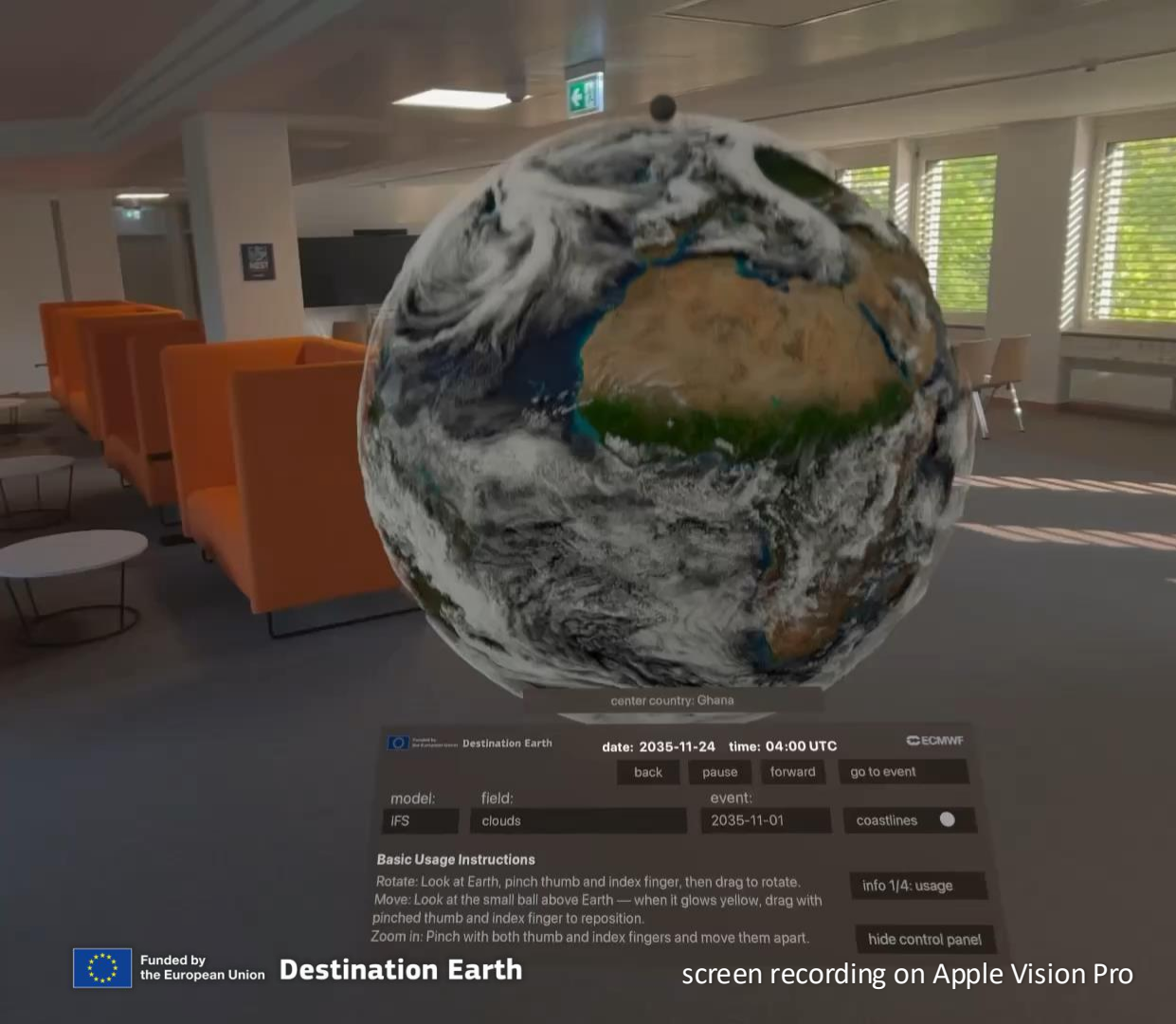
Cinematic App



Mixed Reality App

CINEMATIC APP

- Rendered in real-time using cinematic camera movement and high-fidelity graphics
- Runs smoothly on all Apple Silicon MacBooks, recent iOS devices as well as Windows and Linux computers with dedicated GPU
- Ideal for large screens at exhibitions, showing scientific fields in artistic ways
- Touchscreen and game controller support implemented
- ToDo: more fields, user interface



MIXED REALITY APP

- Developed for the Apple Vision Pro to bring climate data into the real world
- View and explore a curated selection of variables and events with a simple control panel
- Eye-tracking and hand gestures enable natural interaction with a floating virtual Earth
- Freely walk around the Earth to explore oceans, mountains, and atmospheric flows from any angle
- Designed for experience, understanding, and emotional impact

Destination Earth date: 2035-11-24 time: 04:00 UTC ECMWF

back pause forward go to event

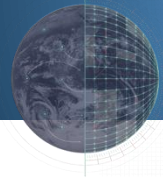
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IFS	clouds	2035-11-01	coastlines <input type="checkbox"/>

Basic Usage Instructions

Rotate: Look at Earth, pinch thumb and index finger, then drag to rotate.
Move: Look at the small ball above Earth — when it glows yellow, drag with pinched thumb and index finger to reposition.
Zoom In: Pinch with both thumb and index fingers and move them apart.

info 1/4: usage

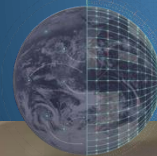
hide control panel



BEHIND THE SCENES – BUILDING THE EXPERIENCE

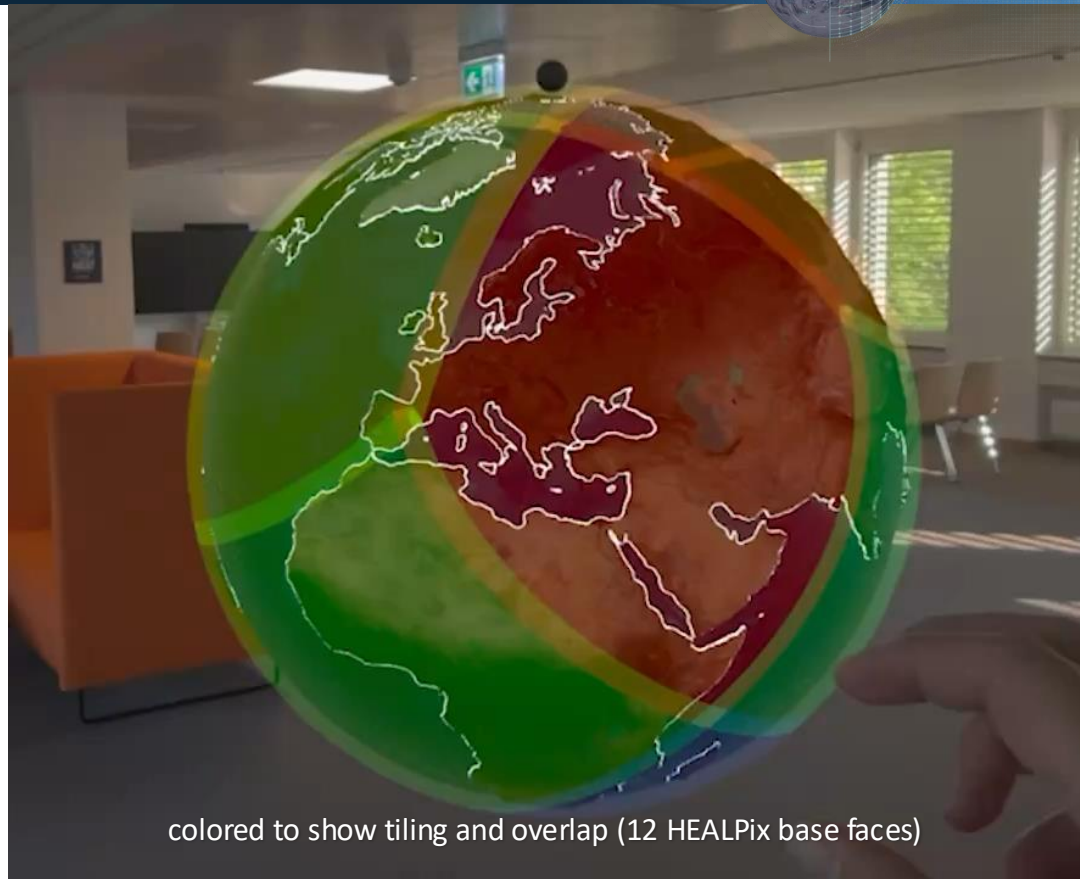
- No off-the-shelf tools exist for visualizing global climate data in this way
- Development process is similar to real-time 3D content creation in the gaming industry
- Game engines offer building blocks (rendering, materials, interaction) — but extensive custom work is needed
- This work explored multiple toolchains to find the best fit for each platform:

options	pros	cons	used for
Unreal Engine	high-end graphics and cinematic control	very limited mixed reality support	cinematic app
Xcode + RealityKit (Apple)	best performance on Apple devices	locked to Apple platforms	early mixed reality prototype
Unity + RealityKit	full access to Apple Vision Pro features	expensive license	mixed reality app



EXAMPLE OF THE CHALLENGES WITH MIXED REALITY

- Flat projections or “fake 3D” break immersion in spatial experiences
- True 3D meshes are required — but are computationally expensive
- Streaming not viable on Apple Vision Pro (ALVR too experimental)
- Solution: split Earth into chunks
- Based on nested HEALPix mesh
- 12 base faces with overlap for seamless stitching



colored to show tiling and overlap (12 HEALPix base faces)



CUSTOM DYNAMIC LOD MANAGEMENT

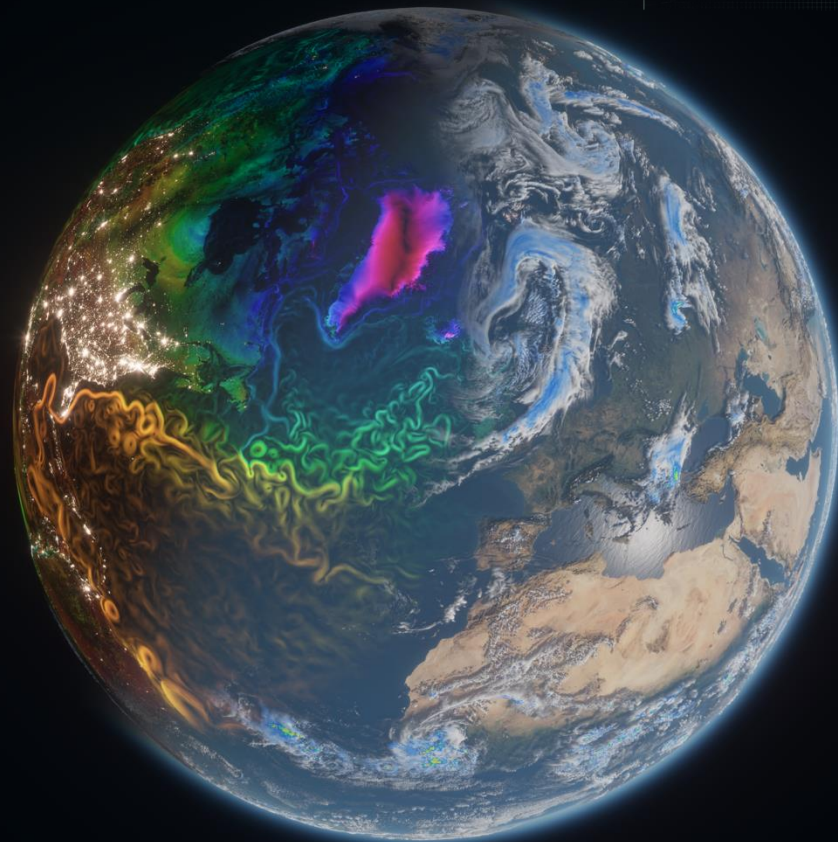
- LOD = level of detail (common in real-time 3D)
- Implemented in C# for Apple Vision Pro
- Adjustable at runtime to balance performance and quality
- Ground and cloud layers handled independently





PLANS

- Comparison of different fields
- Storylines: let the user choose any event of the past seven years and explore how it changes in a different climate
- Adding animations for: wind particles, lightning in thunderstorms, aurora
- Landing in selected locations on the ground with vegetation that responds to simulated climate (wind, storms, droughts, floodings, wildfires)





WHAT ABOUT MACHINE LEARNING?

