Second Destination Earth User eXchange

13–14 November 2023
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Visualization and Immersive Technologies for DestinE

Visualisation examples from DestinE Use Cases

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DE 350 – Digital Twin Visualisation

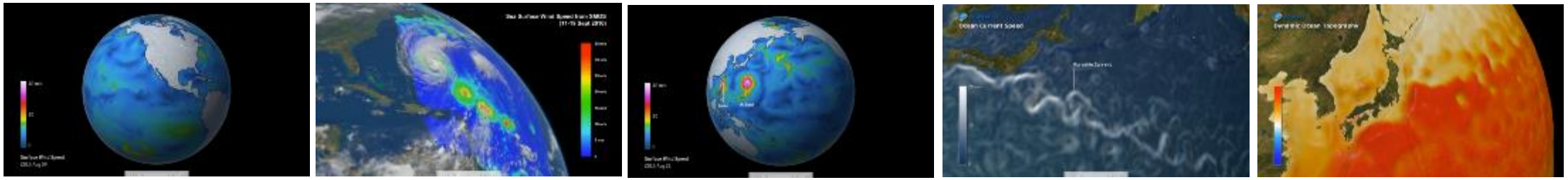
Funded by the European Union

Destination Earth implemented by ECMWF esa EUMETSAT

exprivia CGI MEEO cmcc

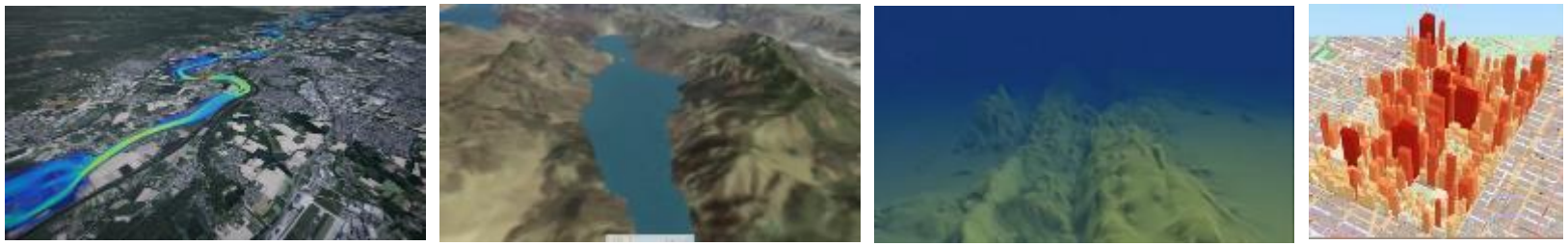
Use Cases: Extreme Events – Climate Change

- 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.



- 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.

- Development and implementation of an innovative tool, with the aim of making ECMWF's data more accessible and engaging for the scientific community, while providing a deeper understanding for the general public



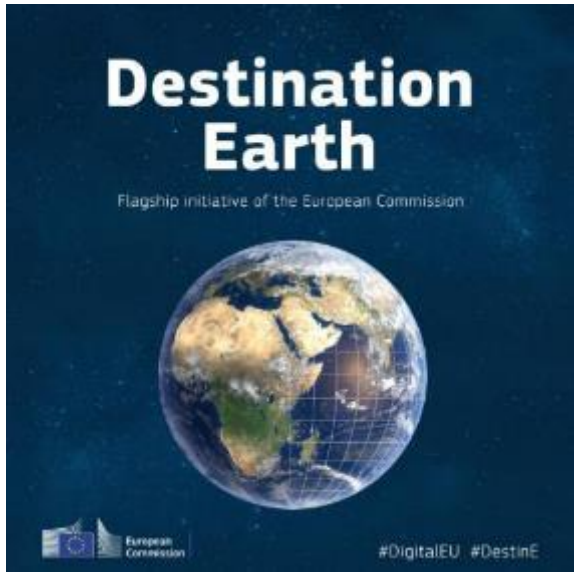
Development of Use Cases for Digital Twin visualisation

Digital twin:

- Weather and climate
- Global coverage
- High resolution (1 to 4 km)

Use cases:

- Extreme events
- Climate change



Extreme event: Medicanes

- Medicanes are Tropical-like cyclones that develop over the Mediterranean Sea.
- They produce significant damage due to the combination of intense winds and heavy precipitation.
- The horizontal extent is generally confined to a few hundred km while the intensity rarely exceeds category 1 of hurricane strength (Cavicchia et al., 2014, Miglietta and Rotunno 2019).

Why ?

- Impact very devastating for coastal populations.
- Strong added value of DT simulations.

- Cavicchia, L., von Storch, H. & Gualdi, S. A long-term climatology of medicanes. *Clim Dyn* **43**, 1183–1195 (2014). https://doi.org/10.1007/s00382-013-1893-7
- Miglietta, M. M., & Rotunno, R. (2019). Development mechanisms for Mediterranean tropical-like cyclones (medicanes). *Quarterly Journal Of The Royal Meteorological Society*, *145*, 1444-1460. doi:10.1002/qj.3503

Extreme event: Medicanes

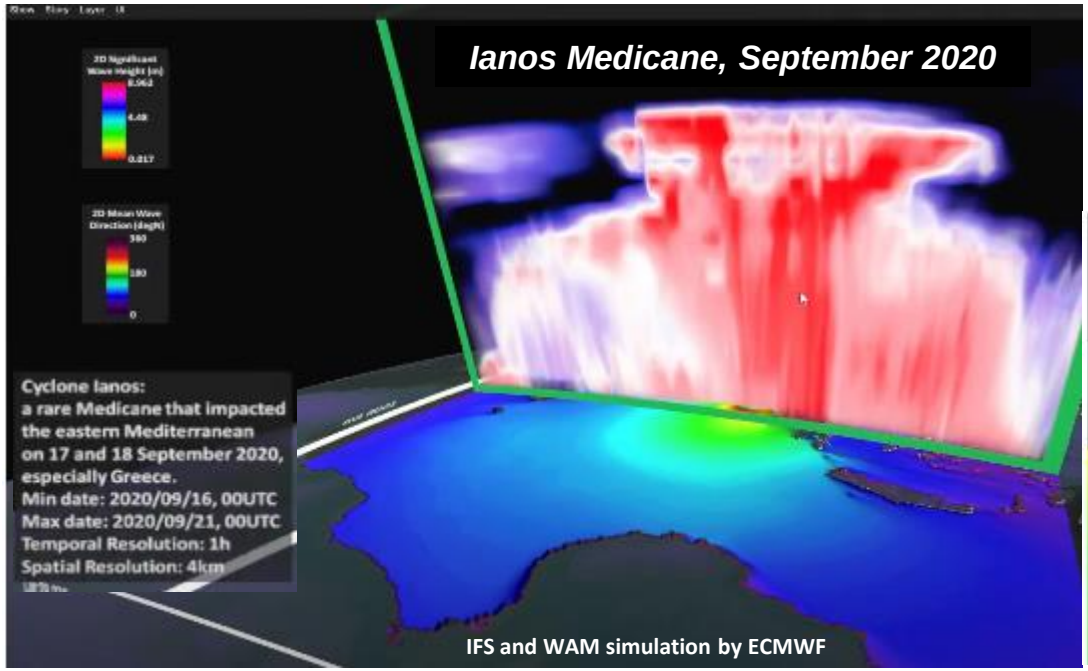
Visualisation is:
- Interactive
- Immersive

Selection between:
- Multiple variables
- Ancillary data

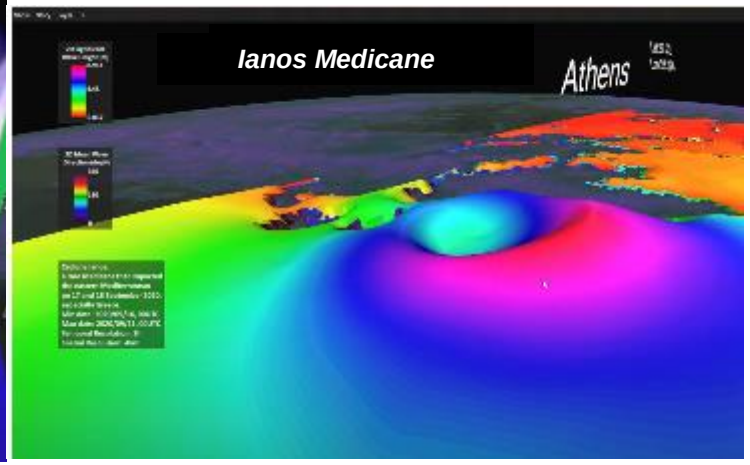
→ Wind field, air temperature, relative humidity, wave height and direction

- slice the dataset
- modify ranges and colorbar
- stretch time evolution.

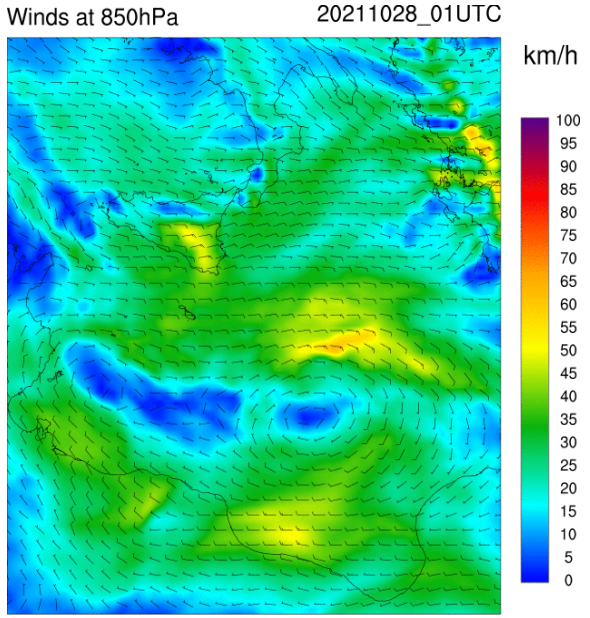
Impacts on urban environments caused by the extreme event through pictures and satellite observations.



Interactive/Immersive Visualisation



Apollo Medicane, October 2021



IFS simulation by ECMWF

Climate Change impacts on the energy system

- Climate changes pose severe threats to the reliability, sustainability, and resilience of our **energy infrastructure**, from *power generation*, to *distribution* and *consumption*

- Need of considering climate and energy models as fundamental tools to evaluate the impact of climate changes on our energy system.

Why?

- Show how present-day meteorological conditions propagate in the energy system;

- Understand how climate changes will impact the production of renewable energy and the energy availability

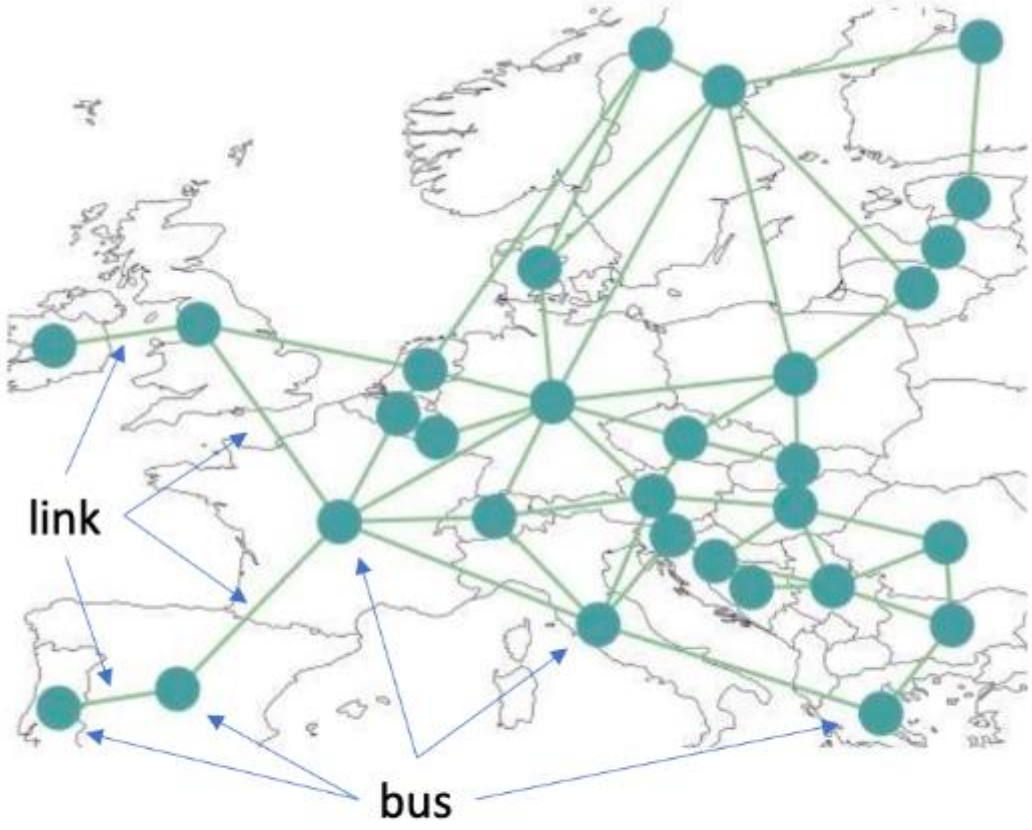


Figure 1: Illustration of a simplified European power system. Dots mark buses, lines show transmission links connecting these buses.

To each bus several different components for generating, storing and/or consuming electricity can be assigned.

A simplified European power system model

Digital twin meteorological fields of:
- Wind speed → wind power
- Surface air temperature and Downwelling sw radiation at surface → solar photovoltaics (PV)

↓

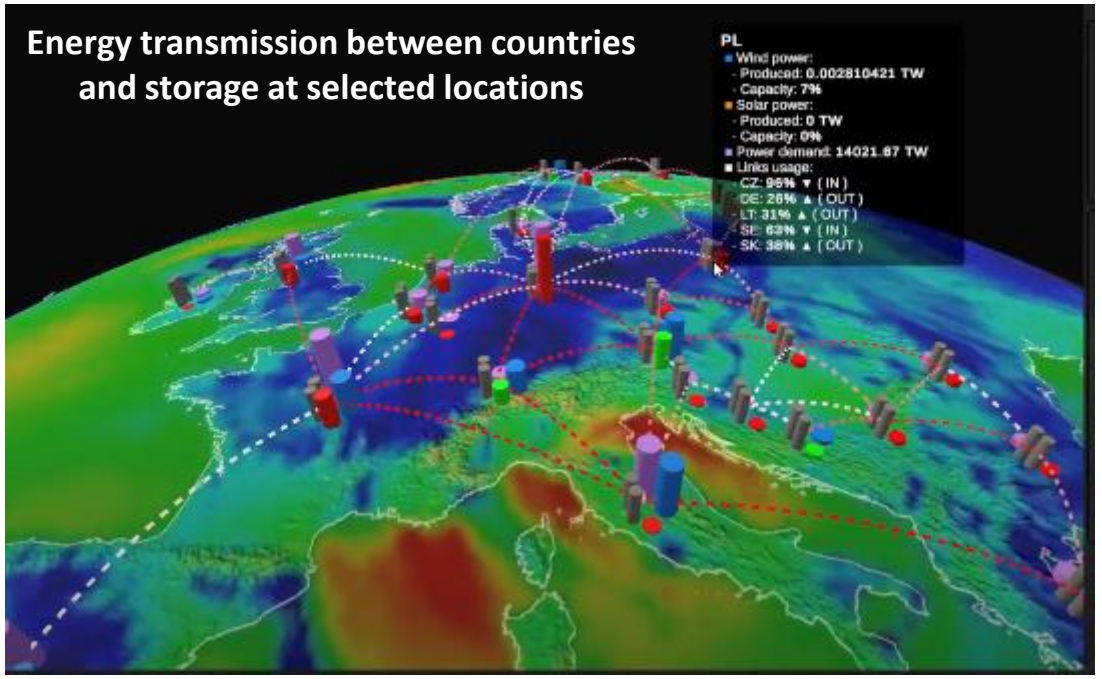
Power system model (DE370b)
Dunnett et al. (2020)

↓

Output:
- Solar energy production
- Wind energy production
- Energy consumption/storage at buses
- Energy transmission at links
- Warning signals
- Climate change impacts

Wind gusts over Europe (IFS simulation by ECMWF)

Energy transmission between countries and storage at selected locations



- From continental to local scale.
- Comparison between present climate and future high emission scenarios
- Focus on climate change impacts on renewable energy production and on situations of warning detected by the energy model.

Interactive/Immersive Visualisation

Dunnett, S., Sorichetta, A., Taylor, G. *et al.* Harmonised global datasets of wind and solar farm locations and power. *Sci Data* **7**, 130 (2020). https://doi.org/10.1038/s41597-020-0469-8

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