DIGITAL TWIN FOR
WEATHER-INDUCED EXTREMES

Sharpening our vision of extreme weather and its impacts

KEY FEATURES

Km-scale Earth system models

Uses "km-scale" models to better represent extreme weather events and deliver information at scales where their impacts are felt.

Routine production of global simulations

Produces global simulations at 4.4 km resolution for 4 days ahead to predict extreme weather events worldwide.

On-Demand refinement over Europe

Produces on-demand regional simulations at 750 to 500 m resolution for 2 days ahead to refine the representation of extreme events occurring over Europe.

From weather to impact-sector information

Integrates impact sector models in the Digital Twin workflows, to transform meteorological data into user-relevant information.
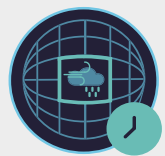
The Digital Twin for Weather-Induced Extremes (Extremes DT) supports decision-making in response to meteorological, hydrological and air quality extremes. **It has both a global component, producing simulations at resolutions of a few kilometres for four days ahead, and a regional component, producing simulations at hundreds of metres for two days ahead.** Later in Phase 2, it will become possible to configure and activate on demand this regional component, providing a magnifying glass on extreme events occurring in Europe.

INNOVATIVE DEVELOPMENTS

☑ Regular use of km-scale models exploiting pre-exascale EuroHPC supercomputers

☑ On-demand workflows for bespoke global and flexible regional simulations of past, current or future extreme events

☑ An automated detection and activation mechanism for selected extreme events

☑ AI-supported uncertainty quantification and interactivity.

Harnessing the latest developments in:

Earth System Prediction
Building on decades of expertise in operational Numerical Weather Prediction and impact modelling.

Supercomputers
Adapting to and exploiting distributed (pre-)exascale EuroHPC computing resources across Europe.

Artificial Intelligence
Exploiting recent breakthroughs in AI for weather and climate sciences.

TECHNICAL INFORMATION

	Global Component	Regional Component
Models	IFS-NEMO	Arome, Harmonie-Arome, Alaro
Resolution	Atmosphere: 4.4 km Ocean: 25 km	Atmosphere: 750 m, 500 m
Initialisation frequency	Daily	On-Demand *
Initial Time	00 UTC	
Simulation Length	4 Days	2 Days
Initial conditions	ECMWF operational analysis (9 km)	
Boundary conditions		Global Extremes DT
HPCs	Euro HPC systems, LUMI in phase 1, Leonardo in phase 2	
Output grid	Reduced gaussian cubic octahedral	(Projected) lat-lon
Output parameters	DestinE data portfolio	
Output frequency	Hourly Surface and pressure levels	Sub-hourly

* This feature will become available later in phase 2

Explore the currently available simulations: https://destine.ecmwf.int/extremesDT_simulations

DELIVERING SECTORAL INFORMATION FOR EXTREME WEATHER EVENTS

Hereunder an example of a workflow answering the question: **"How much wind energy production can we expect during a windstorm?"**

The extreme event detection algorithm identified a windstorm for February 18, 2022. In response, a regional model was configured with a 750-metre resolution off the coast of Belgium and driven by the global component of the Extremes DT. This model provided high-frequency wind data, which was utilized by a wind farm parameterization. The system successfully predicted a drop in energy production due to the shutdown of the wind farms, two days in advance.

EXTREMES DIGITAL TWIN CONSORTIUM

The **global component is delivered by ECMWF.** The **regional component** is delivered by a consortium of **29 partners** led by **Météo-France** through a contract procured by ECMWF.