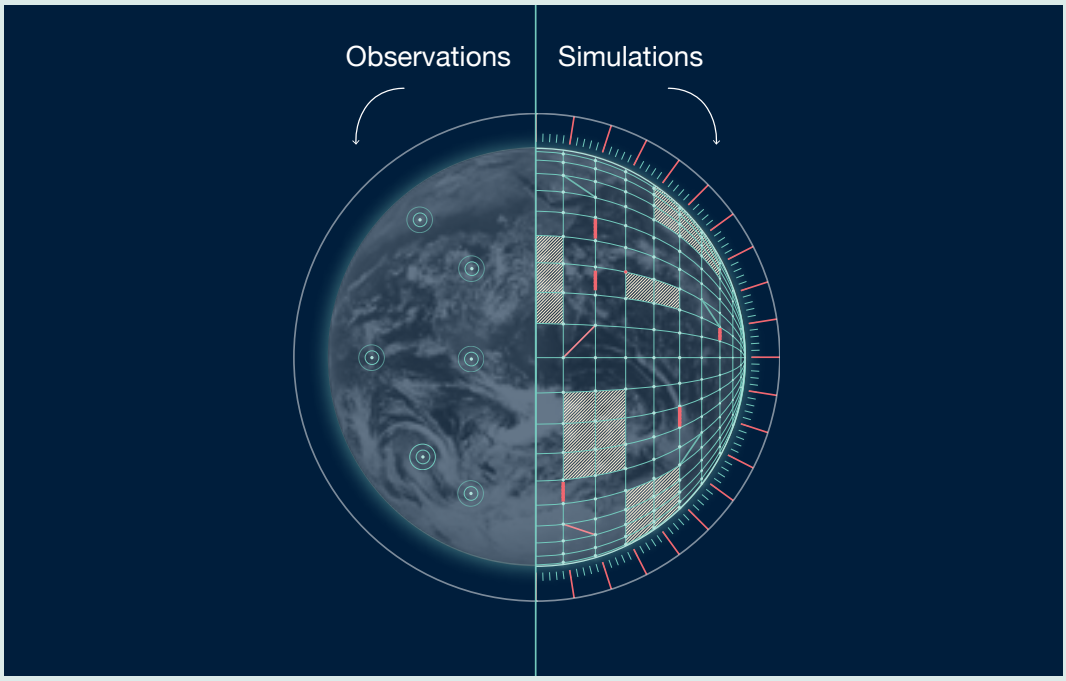


# ECMWF and the EU's Destination Earth initiative

### What is Destination Earth?

Destination Earth (DestinE) is an ambitious initiative of the European Union to develop highly accurate digital replicas or twins of the Earth system by 2030. Digital twins can be used to monitor, simulate and predict the interaction between natural phenomena and human activities at a new level of detail, quality and interactivity. They will facilitate greater understanding of our changing climate and of associated extreme weather events. DestinE was started in December 2021, and it entered its second phase in June 2024.

### How does ECMWF contribute to DestinE?

ECMWF is one of three entrusted entities to implement DestinE under the leadership of DG CNECT. Its role is to deliver the digital twins and the Digital Twin Engine. The first two digital twins are the Weather-Induced Extremes Digital Twin and the Climate Change Adaptation Digital Twin. ECMWF delivers the digital twins and the Digital Twin Engine together with 90 partners across Europe.

### Who are the other two entrusted entities?

The other two entrusted entities are the European Space Agency (ESA) and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). ESA implements the DestinE Platform, which provides access to applications, tools and services supporting DestinE data exploitation. EUMETSAT provides the Data Lake, which federates different data spaces and provides users with harmonised access to the datasets.

### What is the Weather-Induced Extremes Digital Twin?

The Weather-Induced Extremes Digital Twin (Extremes DT) supports responding and adapting to extreme events in a changing world. It provides a capability to produce

tailored simulations and address what-if scenarios related to extreme events in a past, present and future climate, which complements existing prediction capabilities at national and European level. It includes a global component developed by ECMWF, based on its Integrated Forecasting System (IFS), at a grid spacing of 4.4 km to produce four-day simulations. It also includes a regional component, developed by a partnership led by Météo-France involving many national weather services across Europe, through a contract procured by ECMWF. This can produce on-demand regional simulations at a grid spacing of 500 to 750 metres for two days ahead and refine the representation of extreme events over Europe. Impact-sector elements, for example on water management, agriculture and renewable energy, are integrated into the two components.

### What is the Climate Change Adaptation Digital Twin?

The Climate Change Adaptation Digital Twin (Climate DT) aims to produce multi-decadal climate projections to support decision-making in support of climate change adaptation. It will provide globally consistent data with higher spatial and temporal resolution than current climate models: a grid spacing of 5 to 10 km globally, with hourly output leveraging the world-leading supercomputing facilities of the EuroHPC Joint Undertaking. The Climate DT represents the first-ever attempt to operationalise the production of global multi-decadal climate projections at such resolutions. It will also provide a framework for bespoke, on-demand climate simulations. These can, for example, be used to assess the impact of certain scenarios. The Climate DT uses three models: the ICON model, and ECMWF's IFS used with two different ocean models, NEMO and FESOM. It is developed by a partnership led by CSC – IT Center for Science in Finland, involving 12 leading climate institutions, supecomputing centres, national meteorological services, academia and industrial partners, through a contract procured by ECMWF.

### What role does the Digital Twin Engine play?

The Digital Twin Engine enables the digital twins to smoothly operate in a physically distributed European supercomputing landscape. It:

- handles data volumes and data production rates that go beyond numerical weather and climate prediction practices today
- adapts to new supercomputer environments
- defines end-to-end workflows to fully deploy and operate the digital twins
- handles and tailors big data streams efficiently
- empowers users to interact with the digital twins and their data, and
- enables machine learning.

### What enables the digital twin simulations?

The digital twin simulations are enabled by the strategic partnership with the European High Performance Computing Joint Undertaking (EuroHPC). EuroHPC has granted DestinE computing resources through a Special Access call on its world-class supercomputers: LUMI based in Finland; Leonardo in Italy; MareNostrum5 in Barcelona; and MeluXina in Luxembourg. This makes it possible to carry out complex digital twin simulations at unprecedented spatial resolutions.

### What does the future hold?

The second phase of DestinE evolves the DestinE system and ramps up operations, with a focus on users, consolidation, maintenance, and continuous evolution of the components of the DestinE system. An important aspect of this phase is the growing use of breakthroughs in machine learning and artificial intelligence (ML/AI). More details on ECMWF's involvement in DestinE can be found on our DestinE website.