ClimateDT for Destination Earth

Climate Change Adaption Digital Twin (Climate DT) is one of the high-priority projects of the Destination Earth (DestinE) initiative of the European Commission to create Digital Twins of the physical Earth system to support decision-making. Climate DT aims to provide highly accurate, interactive and dynamic simulation of the Earth system over multi-decadel time scales. Phase 3 of Climate DT will commence for a 24-month period starting in May 2026.

Climate DT deploys three cutting-edge coupled climate models (IFS-NEMO, IFS-FESOM, and ICON) at high spatial resolutions between 5 and 10km for the different Earth-system components (atmosphere, land, ocean and sea ice). Multi-decadal simulations span from the recent past (starting from 1990) to future climate scenarios (up to 2050). The so-called storyline simulations are carried out to reconstruct the unfolding of recent extreme events, such as heatwaves, floods, and droughts across potential future climate conditions from CMIP. The operational Climate DT simulation protocol contains three types of global multi-decadal core simulations, including the required spin-ups. The core simulations are 1) a control simulation at fixed 1990 conditions, which covers a minimum 10 year period, 2) a historical simulation from 1990 to 2015, and 3) a projection using a Shared Socioeconomic Pathways (SSP) scenario until 2050. Each climate model will perform all of the core simulations, possibly including additional ensemble members to contribute to uncertainty quantification.

Phase 3 builds upon work in earlier phases (Phase 1 - 20 months from September 2022, and Phase 2 - 24 months from May 2024) to bring Climate DT to a stable operational level. The latest phase will deliver impact sector information relevant for climate adaptation to the four impact sector applications renewable energy, wildfires, hydrology, and hydrometeorology by leveraging the developments in earlier phases by improving relevance and quality of information, and improving the storyline scenarios. In addition, the latest phases will include an activity to enhance the update of Climate DT, by offering the Climate DT workflow to external users to integrate into their local workflow, and by supporting transforming select simulations to AI ready data sets.

Climate DT uses the AQUA and OBSALL applications for operational evaluation, monitoring and uncertainty quantification and the latest phase will see a consolidation of the two packages and extension of the uncertainty quantification. The EuroHPC machines LUMI and MareNostrum 5 are the main operational systems, while phase 3 will see the introduction of EuroHPC's first Exascale system JUPITER. Other European machines such as the Levante system hosted at DKRZ, provide tertiary resources for climate model development and data analysis.

The joint effort for the Climate DT also sets a perfect example for fostering innovation through European collaboration. Showing how European investments in research through Horizon projects (nextGEMS, EERIE), national funding (WarmWorld) and European cooperation (ECMWF), combined with investments in digital technologies, supercomputing, and AI, through the Digital Europe Programme of the European Commission ensure Europe's global leadership in climate modelling and the provision of climate information.