ChEESE

Centre of Excellence for Exascale in Solid Earth

Who We Are

- A European initiative advancing **flagship codes for Exascale, ready for EuroHPC systems**
- A community using supercomputing to explore **geohazards such as earthquakes, tsunamis, volcanoes, glaciers, and geodynamics**
- A **hub linking science, HPC, and civil protection**, turning research into tools for society

Where We're Heading

- Optimise **flagship codes for Exascale computing** to run efficiently on EuroHPC systems
- Develop Pilot Demonstrators and Simulation Cases showcasing **real-world applications**, from early warning systems to urgent computing
- Build capacity and train communities, enabling **scientists, institutions, and stakeholders to harness HPC for disaster preparedness** and response

The Codes Behind ChEESE

11 open-source codes optimised for exascale.

COMPUTATIONAL SISMOLOGY

ExaHyPE
Tandem
SeisSol
SPECFEM3D

TSUNAMI MODELLING

HySEA

VOLCANOLOGY

OpenPDAC
FALL3D

EARTH CORE

xSHELLS

GEODYNAMICS

LaMEM
pTatin3D

GLACIER HAZARDS

Elmer/ICE

DELIVERABLES   SOFTWARE   EGU GALILEO CONFERENCE CONSENSUAL DOCUMENT

Impacts & Collaborations

Validating Exascale Workflows for Disaster Response

ChEESE is successfully testing **urgent computing in real-world emergency drills**, showcasing how European HPC can directly support disaster response.

- In **Mexico's National Earthquake Drill** (2025), ChEESE used the MareNostrum 5 supercomputer to simulate a magnitude 8.1 earthquake, generating **ground-shaking maps and hazard forecasts**.

- In **Spain's first national volcanic-eruption exercise** in the Canary Island, ChEESE tested **ash-dispersion and eruption-source models** with civil protection authorities.

- In Campi Flegrei unrest, Italy, ChEESE used supercomputers to simulate **volcanic explosions**, helping authorities plan faster emergency responses and enhance public safety.

- ChEESE supported the Icelandic Meteorological Office with advanced assessments of **volcanic gas hazards**. These analyses informed national risk planning and are now being integrated into a government-funded **risk assessment programme**.

These large-scale demonstrations validated ChEESE research in operational settings, proving that exascale computing can be integrated into real-time disaster preparedness and response.
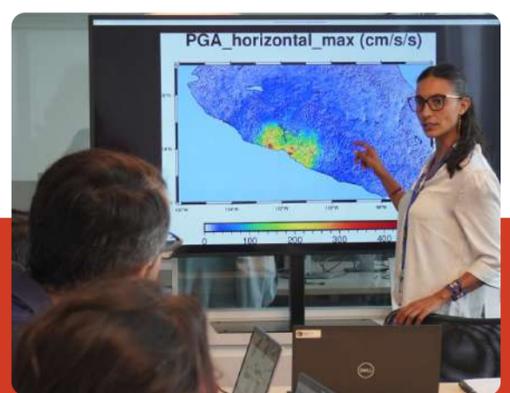
Integrated Multi-Hazard Tsunami Simulation

ChEESE's Pilot Demonstrator on **Multi-Source Tsunami Modelling** integrates earthquakes, landslides, volcanic eruptions, and atmospheric forcing into **a single exascale workflow for near real-time forecasting**.

It demonstrates how advanced computing can power **next-generation multi-hazard Early Warning Systems**.

Shaping the Exascale Geoscience Roadmap

ChEESE led the **EGU Galileo Conference on "Solid Earth and Geohazards in the Exascale Era"** (2023), uniting the scientific community to define a shared roadmap for future collaboration in exascale geoscience.

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