



A digital twin component for volcanic dispersal and fallout

Leonardo Mingari¹, Arnau Folch¹, Alejandra Guerrero¹, Sara Barsotti², Talfan Barnie², Giovanni Macedonio³, and Antonio Costa⁴

¹Geociencias Barcelona (GEO3BCN-CSIC), Barcelona, Spain, Spain

²Icelandic Meteorological Office (IMO), Iceland

³Istituto Nazionale di Geofisica e Vulcanologia (INGV), Osservatorio Vesuviano, Naples, Italy

⁴Istituto Nazionale di Geofisica e Vulcanologia (INGV), Sezione di Bologna, Bologna, Italy

A Digital Twin Component (DTC) provides users with digital replicas of different components of the Earth system through unified frameworks integrating real-time observations and state-of-the-art numerical models. Scenarios of extreme events for natural hazards can be studied from the genesis to propagation and impacts using a single DTC or multiple coupled DTCs. The EU DT-GEO project (2022-2025) is implementing a prototype digital twin on geophysical extremes consisting of 12 interrelated Digital Twin Components, intended as self-contained and containerised software entities embedding numerical model codes, management of real-time data streams and data assimilation methodologies. DTCs can be deployed and executed in centralized High Performance Computing (HPC) and cloud computing Research Infrastructures (RIs). In particular, the DTC-V2 is implementing an ensemble-based automated operational system for deterministic and probabilistic forecast of long-range ash dispersal and local-scale tephra fallout. The system continuously screens different ground-based and satellite-based data sources and a workflow is automatically triggered by a volcanic eruption to stream and pre-process data, its ingestion into the FALL3D dispersal model, a centralized or distributed HPC model execution, and the post-processing step. The DTCs will provide capability for analyses, forecasts, uncertainty quantification, and "what if" scenarios for natural and anthropogenic hazards, with a long-term ambition towards the Destination Earth mission-like initiative.