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Improving Probabilistic Gas Hazard Assessment through HPC: Unveiling VIGIL-2.0, an automatic Python workflow for probabilistic gas dispersion modelling

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The atmospheric dispersion of gases (of natural or industrial origins) can be very hazardous to life and the environment if the concentration of some gas species overcome specie-specific thresholds. In this context, the natural variability associated to the natural phenomena has to be explored to provide robust probabilistic gas dispersion hazard assessments.

VIGIL-1.3 (automatic probabilistic VolcanIc Gas dIspersion modeLling) is a Python simulation tool born to automatize the complex and time-consuming simulation workflow required to process a large number of gas dispersion numerical simulations. It is interfaced with two models: a dilute (DISGAS) and a dense gas (TWODEE-2) dispersion model. The former is used when the density of the gas plume at the source is lower than the atmospheric density (e.g. fumaroles), the latter when the gas density is higher than the atmosphere and the gas accumulates on the ground and may flow due to the density contrast with the atmosphere to form a gravity current (e.g. cold CO_2 flows).

In the enhancement of the code towards a higher-scale computing, here we present the ongoing improvements aimed to extend some code functionalities such as memory management, modularity revision, and full-ensemble uncertainty on gas dispersal scenarios (e.g. sampling techniques for gas fluxes and source locations).

Optimizations are also provided in terms of tracking errors, redesignation of the input file, validation of data provided by the users, and addition of the Latin hypercube sampling (LHS) for the post-processing of model outputs.

All these new features will be issued in the future release of the code (VIGIL-2.0) in order to facilitate the users which could run VIGIL on laptops or large supercomputer, and to widen the spectrum of model applications from routinely operational forecast of volcanic gas to long-term hazard and/or risk assessments purposes.