VO-TCS Report on Quality and Assurance

Volcanic Hazard Maps

V1.0

Quality assurance (data content)

Hazard maps are maps adopted to visualize the potential extension, in space and time, of hazardous phenomena that might occur around volcanic areas. A variety of maps exists depending on which data they are built with, which is the purpose of the map and which are the final users. Hazard maps are produced by VOs and VRIs in general and are often use to inform Civil protection agencies on potential impact associated to volcanic eruptions (https://volcanichazardmaps.org/).

In recent decades, hazard maps are often produced by simulating volcanic processes, like lava flow propagation, volcanic ash cloud transport, and gas distribution. In that case numerical models adopted to produce the maps need to be validated and tested to demonstrate their capabilities in reconstructing the main dynamics of the phenomenon of interest. Hazard maps could be showing the expected extension of phenomenon for a specific volcanological scenario, or for a multitude of scenarios (accounting for the uncertainty on the next expected eruption).

Most hazard maps rely on accessibility to geological/volcanological data from past eruptions to design and quantify the potential new scenario. In case hazard maps are prepared by using numerical models, volcanological data are required to quantify input data to characterize the scenario and run the simulations.

Probabilistic hazard maps:

At IMO volcanic hazard maps for tephra fallout, volcanic gas pollution and lava flow invasion are produced by running numerical models. Specifically, VOL-CALPUFF model is used for tephra fallout (https://doi.org/10.1029/2006JB004623), CALPUFF for gas (https://doi.org/10.1007/s00445-020-01395-3) and MrLavaLoba for lava (https://doi.org/10.1016/j.jvolgeores.2017.11.016).

Tephra-fallout:

VOL-CALPUFF model is executed for specific eruptive scenario which is specified in the map's header. The model is executed several times, following a MonteCarlo approach, using different meteorological conditions randomly selected amongst 10 years of data. The results are processed in such a away to compute the likelihood to exceed specific tephra load on the ground within the computational domain at the end of the simulation. One map is then produced for a specific cumulative threshold of interest and it shows the spatial probability to exceed that load value. A portfolio of maps is produced for a variety of thresholds and different eruptive scenarios.

Volcanic gas pollution:

CALPUFF model is executed following a MonteCarlo approach (similarly to tephra fallout maps) to calculate the probability of exceedance of different thresholds of hourly SO_2 concentration at the ground. These thresholds are suggested by the current table that the Environmental Agency of Iceland issued during the Holuhraun eruption in 2014-2015 (https://ust.is/english/air-climate/air-pollution-during-a-volcanic-eruption/). One eruptive scenario at a time is considered, so the calculated probability is conditional to that event to occur.

Metadata for volcanic hazard products (including maps):

Such metadata were defined within the VO-TCS activity (EPOS Task 11.5) and are adopted as standard for provision of volcanic hazard maps at IMO. Metadata are defined as follows:

1. *Name*:
2. *Functionality*: textual description
3. *Category*: e.g. maps, software, pamphlet, guidelines, tools, forecasts
4. *Item type (or format)*: ex. Png, fortran90, pdf, txt, kmz, shp, qgis, raster, georeferenced
5. *Authors*: e.g. Institutions, email contact
6. *Product reference:* e.g. Paper, url, doi
7. *Tags-keywords*:
8. *Dependencies*:
9. *Hazard type*: e.g. tephra fallout, PDCs, lava flow, volcanic gases
    a. *Data source* (e.g. model outputs, numerical simulations, field data, structured expert judgement)
    b. *Model name (e.g. BET+hazmap, VOL-CALPUFF)*
    c. *Scenario definition* (e.g. deterministic)
    d. *Product type* (probabilistic)
    e. (e.g. thickness, T, dynamic P, maximum run out)
    f. *Percentile*
    g. *Threshold*
    h. *Units*
10. *Geographycal localization*:
    a. *Country*
    b. *Volcano name*
    c. *Primary volcano type (SI)*
    d. *Volcano* ID
    e. *Volcano* Lat
    f. *Volcano* Long
    g. *Ll grid point (product reference system)*
    h. *Ur grid point (product reference system)*
    i. *Ll grid point (lat, long)*
    j. *Ur grid point (lat, long)*

   k. *Grid unit (product reference system)*
11. *Language*:
12. *Dates*:
    a. *Date of creation (for static products*), yyyy-mm-dd
    b. *Range of validity (for forecast products*), yyyyb-mmb-ddb/yyyye-mme-dde
    c. *Date of event*, yyyy (mm-dd possibly)
13. *Temporal extension*:
    a. *Initial date of temporal coverage of the volcanological dataset*, yyyy-mm-dd
    b. *Final date of temporal coverage of the volcanological dataset*, yyyy-mm-dd
    c. *Initial date of temporal coverage of the meteo dataset*, yyyy-mm-dd
    d. *Final date of temporal coverage of the meteo dataset*, yyyy-mm-dd
14. *Reference system*:

Additional data: e.g. DEM, meteo data, resolution, basemap, input data