The 03-09 December 2015 Etna eruption volcanic parameters retrieved using Volcanic Plume Retrieval procedure on EVER-EST project platform

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1. SUMMARY

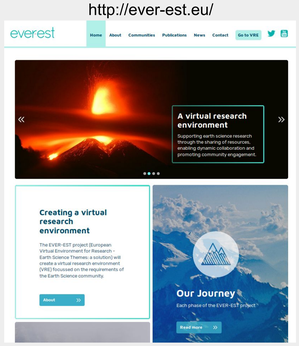
Volcanic eruptions can emit large quantities of gas and solid particles into the atmosphere, with significant impact on environment, climate, human health and air traffic.

The EVER-EST project (European Virtual Environment for Research - Earth Science Themes: a solution) is a H2020 project (2015-2018) focussed on the creation of a Virtual Research Environment (VRE) to enhance the ability to interoperate and share knowledge within the Earth Science community. Using the VRE, the scientists should be able to collaborate with colleagues located in different parts of the world, to remotely access and share data and research results, to carry out training sessions and discussions, to compare different results and models. Through the VRE, using the Research Object concept (www.rohub.org), the researchers will have the opportunity to reuse data and, above all, algorithms developed by others scientists.

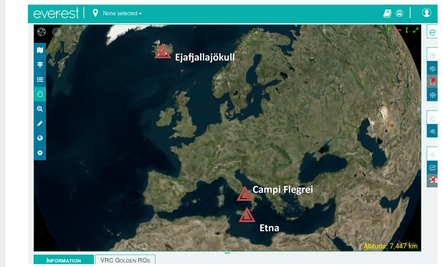
The VPR (Volcanic Plume Retrieval) procedure for the retrieval of volcanic ash, ice and SO_2 cloud parameters has been implemented into a VRE to process the MODIS sensor data on board the polar NASA Aqua/Terra satellite platforms.
In this work all the MODIS images collected during one of the biggest lava fountains occurred at Etna volcano after 2011, the 3-9 December 2015 eruption, have been processed with the VPR procedure implemented in the VRE platform.

2. EVER-EST PROJECT PLATFORM

http://ever-est.eu/

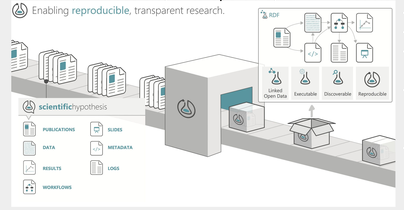


Three VOLCANIC SUPERSITES



3. RESEARCH OBJECT CONCEPT

What is a Research Object (RO)?
Aggregation of resources that bundles the content of a research work to facilitate reusability , reproducibility and a better understanding. It is based on common set of features that are required to support a research that is Findable, Accessible, Interoperable, and Reusable (FAIR).
Resources are:
- Data
- Experiment
- Workflows
- Metadata
- Annotations
- Bibliography
- Results
- Provenance
- ....



Why Research Object?
- **Process Preservation** - url/DOI for referencing resources
- **Reusability** of any part of the RO
- **Reproducibility** of the method
- **Traceability** and error detection
- **Attribution** - cite data and publication of the RO
- **Understandability** - links between data, results and annotations
- **Curation** - explicit exposure of the method

EVER-EST is implementing ROs in Earth Sciences for the first time.

4. VPR Procedure Description

- The Volcanic Plume Retrieval is a robust procedure presented in Pugnaghi et al. (2013) and Guerrieri et al. (2015) for simultaneous estimation of SO_2 and ash abundance, optical depth, particle effective radius in a volcanic plume using thermal infrared (TIR) radiance at 8.7, 11, and 12µm.
- The VPR procedure is simple, extremely fast, and can be adapted to estimate the ash cloud burden for different satellite data, ash cloud particle types and volcanoes.
- Plume altitude is the only input parameter needed, while surface emissivity, temperature, atmospheric profiles, ash optical properties, and radiative transfer models are not required to perform the atmospheric corrections at run time.
- By linearly interpolating the radiances measured in the area surrounding the volcanic plume, the VPR procedure computes the radiances that would have been measured in the absence of a plume, and reconstructs a new image without it.
- The v.04042018 VPR version is implemented to work using MODIS data for Etna (Italy) and Eyjafjallajokull (Iceland) volcanic eruptions and their pumice and andesite ash cloud optical properties. Additional VPR versions could be tuned also for other volcanoes.
- On this test-cases this version of VPR was applied on two MODIS satellite images of 3th and 4th December 2015 during Mt.Etna volcano (Sicily, Italy) eruption.

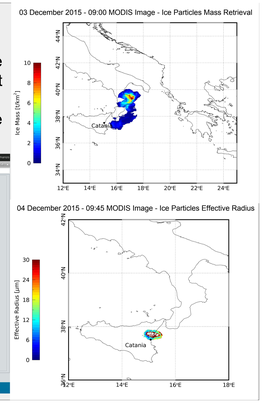
Research Object re-used in this test-case contains: the abstract (documents folder), the Taverna Workflow (workflow folder), the example of data (dataset/input folder) and the bibliography (biblio folder)

Pugnaghi, S., Guerrieri, L., Corradini, S., Merucci, L., and Arvani,B.: A new simplified approach for simultaneous retrieval of SO_2 and ash content of tropospheric volcanic clouds: an application to the Mt Etna volcano, Atmos. Meas. Tech., 6, 1315–1327, doi:10.5194/amt-6-1315-2013, 2013

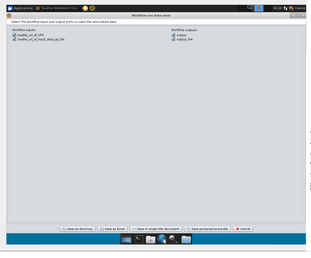
Guerrieri, L., Merucci, L., Corradini, S., and Pugnaghi, S.: Evolution of the 2011 Mt. Etna ash and SO_2 lava fountain episodes using SEVIRI data and VPR retrieval approach, J. Volcanol. Geoth. Res., 291, 63–71, doi:10.1016/j.jvolgeores.2014.12.016, 2015.

7. VPR RESULTS

Running VPR on EVER-EST the workflows create directly the Seafile URLs of log and output VPR data files. In Taverna software (screenshot below) the user checks the URL he/she wants to save in a bundle.
In this box the maps of two VPR outputs obtained running the procedure in the EVER-EST platform.

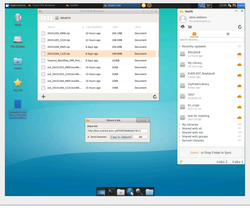


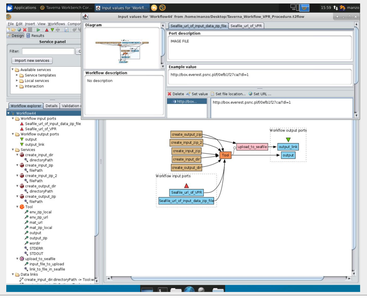
The first shows the Ice Particles Mass retrieved using MODIS image of 03 December 2015. The second reports the Effective Radius for same particles type using MODIS image of 04 December 2015 at 09.45. Other retrievals obtained from VPR (box 4) are not shown here but also produced and stored in the bundle.



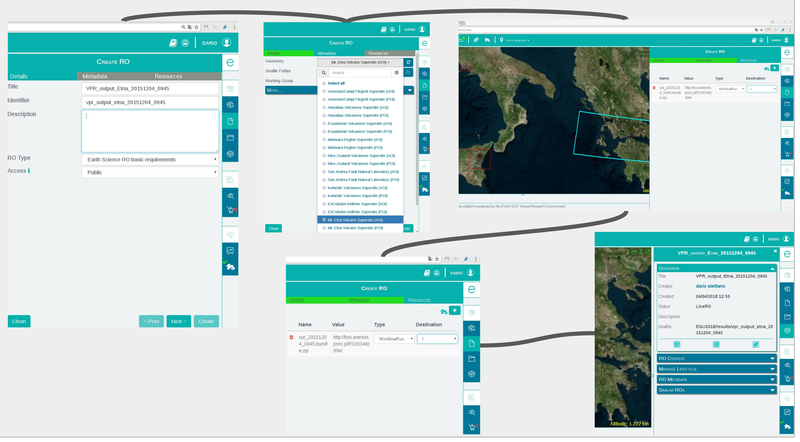
6. VPR RUN on EVER-EST VIRTUAL MACHINE

A compressed file within all input data requested by procedure is created on Seafile repository. The user generates the URL of .zip file using project Virtual Machine. In the same virtual environment, opening Taverna Software, the URL is used as input of VPR workflow previously downloaded.The VPR procedure, nested inside the Taverna Workflow, is completely automated and the user interacts with it only to insert the altitude of the ash/SO_2 cloud he/she wants to retrieve.



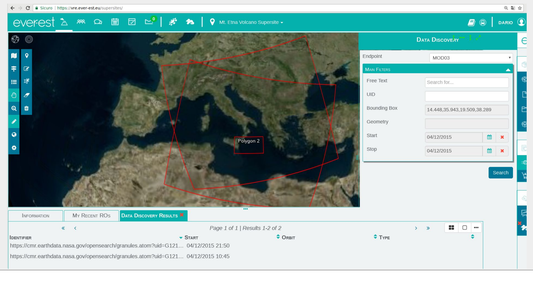


8. CREATION OF VPR RESULTS RESEARCH OBJECT



5. MODIS DATA DISCOVERY EVER-EST VRE

VRE Data Discovery section has the capability to search and download MODIS radiance data and products. Queries to platform can be done by date and area of interest defined by the user on a virtual globe.



The user inserts the data in a basket and selects the Seafile folder as repository where the platform downloads the data asked.

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