Abstract
VOLCANIC ASH CLOUD DETECTION FROM SPACE: A PRELIMINARY COMPARISON BETWEEN RST APPROACH AND WATER VAPOUR CORRECTED BTD PROCEDURE
Alessandro Piscini (1), Francesco Marchese (1), Luca Merucci (1), Nicola Pergola (2,3), Stefano Corradini (1), Valerio Tramutoli (1,2)
(1) Istituto Nazionale di Geofisica e Vulcanologia, via di Vigna Murata, 605, 00143 Roma, Italy
(2) Institute of Methodologies for Environmental Analysis (IMAA), National Research Council, c/o S.Loja, 85050 Tito Scalo (PZ), Italy
(3) University of Basilicata, Department of Engineering and Physics of the Environment, via dell’Aleno Lucano 10, 85100 Potenza, Italy

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The second event, following days reaching a paroxysm during 28-31 October, with in the summital area. The explosive activity increased during the eruption that began on the evening of 26 October with explosive activity (mainly in the crater of the 2002, high in particular bars of jet traffic. Particles with dimension of several millimeters can damage the aircraft structure (windows, wings, ailerons), while particles less than 10 μm and satellite data are useful for measuring volcanic clouds because of the large vertical range of these emissions and their likely large horizontal spread. Moreover, since volcanoes are globally distributed and inherently dangerous, satellite measurements offer a practical and safe platform from which to make observations. Two different techniques are used to detect volcanic clouds from satellite data: one is based on the preliminary analysis of historical, long-term satellite records, devoted to a former characterization of the measured signal, in terms of expected value and natural variability and a further identification of signal anomalies by an automatic, unsupervised change detection step. The BTD method is based on the difference between the brightness temperature measured in two channels in the 11–12 μm spectral range that tends to reduce (and in some cases completely mask) the BTD signal, a water vapor correction procedure, based on measured or synthetic atmospheric profiles, has been applied. Results independently achieved by both methods during recent M. Elia eruptions are presented, compared and discussed also in terms of further implications for quantitative retrievals of plume parameters.

TEST Cases and Data
Mt. Etna is located in the eastern part of Sicily (Italy) and is one of the major degassing volcanoes in the world ([Andronico, 2011]). Its generally quiescent state is periodically interrupted by eruptive periods when significant ash emissions reach areas surrounding the volcano causing problems to the population of the region ([Andronico, 2008]) and to airport traffic (Catania and Reggio Calabria airports are nearby). Three Mt. elia eruptions events have been considered as test cases.

The first event, the 26 October 2002, is part of the 2002 eruption that began on the evening of 26 October with explosive activity in the summit area. The explosive activity increased during the evening reaching a paroxysm by 28-31 October, with a fairly sustained eruptive column that rose up to 7 km a.s.l.

Ash fallout caused many problems to the surrounding population and infrastructures, including the closure of the Catania Fontanarossa (27 October) and the Reggio Calabria (31 October) airports. Prevailing winds directed the ash cloud towards the African coast, causing a light fallout in Libya 600 km from Mt. Elia, during the subsequent eruption of 2008.

The second event, the 24 November 2006, is part of the 2006 eruption. The ash emission can damage aircraft (≈500 UTC and ended at about 17:00 UTC) first showed up at the SE crater located in the southern flank of Mt. Elia and produced the largest volume of ash in the entire September-December eruptive period.

Third case, the 6 December 2006, was the eruptive activity that occurred in the Southeast crater of Etna (SEC) involving a number of explosive and effusive events on and around the SEC cone.

AVHRR

We analyzed different multispectral images related to the eruptions above described recorded by Advanced Very High Resolution Radiometer (AVHRR) on board the polar orbiting Environmental Satellites (POES).

The AVHRR is a cross-track scanning system with five spectral bands from Visible (V) to Thermal Infrared (TIR) having a resolution of 1 km at nadir and a frequency of earth-scans per day (0303 and 1430 local sidereal time).

The instrument has the two TIR bands used for the volcanic ash detection retrieval (11 and 12 μm central wavelength) and images, respectively.

All images have been preprocessed in ENVISAT ENV. ENV.

They were cut on specific area, georeferenced and calibrated in Albino (01) and Brightness Temperature (ch3, ch4, ch5) at 12:37 UTC.

Results

The figures depict ash cloud detected for BTD technique (left, green), BTVD water vapor corrected (center, green) RST approach (right, red). The upper, middle and lower rows refer to 28 October 2006, 24 November 2006 and 6 December 2006 images, respectively.

The table shows the ash cloud retrieval obtained for the three events in terms of number of pixels and area in km².

Conclusions

• Refined ash detection methods, like the BTD with WVC and the RST approach may significantly improve ash detection capability and sensitivity obtained by the basic BTD method, up to a 75% for the November 24 test case.

• The result is obviously an agreement on the ash area retrieved by BTD with WVC and RST procedures, confirming RST capability to account for water vapor content without requiring any ancillary information.

• In particular, the December 6 2006 case shows that refined ash detection methods, like the BTD with WVC and the RST approach are able to identify ash plumes.

• Further investigations, possibly with the availability of independent data and observations, are required in order to better assess differences and similarities of these two methods.

• Moreover, more test cases should be analyzed over a number of geographic areas and at different observational conditions (e.g. night-time).

References


For further information please write to: alessandro.piscini@ingv.it and fmarchese@imaa.cnr.it http://www.ecmwf.int/