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Volcanic monitoring from space using neural networks approach. Simultaneous ash and sulfur dioxide retrievals using multispectral measurements

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In this work a Multi Layer Perceptron Neural Networks (MLPNN) approach has been used for a simultaneous volcanic ash and sulfur dioxide retrievals considering the MODIS measurements. As test case the 2010 Eyjafjallajokull eruption have been considered.
A network was built for each parameter to be retrieved. Additionally, for volcanic ash, a network for the classification of "ash image pixels" was implemented, which was then used to mask the estimates. Several network topologies were compared in terms of their performance.
Concerning the training phase and networks testing, a set of MODIS images was selected covering the Eyjafjallajokull May events. The classification NNs were trained with the volcanic ash classification map obtained with the Brightness Temperature Difference algorithm, assumed as benchmark. The neural networks for the quantitative estimation of the parameters associated with volcanic ash, mass, effective radius, aerosol optical depth and SO_2, were instead trained with maps obtained using consolidated estimation algorithms based on simulated radiances at the top of the atmosphere, generated in turn applying a radiative transfer model to remote sensing data.
The networks proved to be very effective in solving the inversion problem related to the estimation of the parameters of the volcanic cloud, settling the crucial issue related to false alarms in the detection of volcanic ash. Furthermore, once the training phase is complete, NNs provide a faster inversion technique, useful for the applications. From this point of view the technique satisfies the need to respond quickly as a result of disastrous natural hazards, such as volcanic eruptions.
Future activities include testing the effectiveness of the technique under different lighting conditions (night images) and on other types of multispectral data, such as that provided by high temporal resolution sensors like SEVIRI-MSG, on board the METEOSAT second Generation satellites. The latter would be particularly suitable considering its exceptional quick response characteristics for real-time monitoring of the atmosphere. The use of hyperspectral data, recently used for the estimation of parameters associated with volcanic clouds, is also under consideration for future work.