Iasi County: Atmospheric volcanic ash cloud investigations. Modeling-forecast and experimental environmental approach

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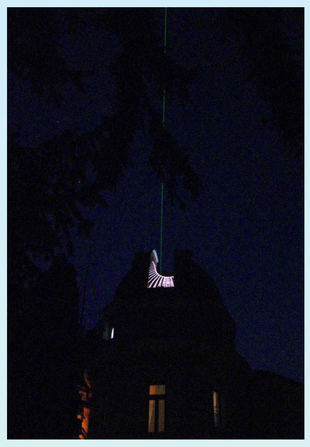
Context …

Volcanic ash (Grimsvotn, in South-East Iceland: Lat: 64.42 Lon: -17.33) cloud diffusion over Iasi county and its vertical distribution in the Iasi-North east region of Romania have been deeply analyzed during the period May 21 – 28, 2011. Because of numerous air pollutants with variable concentrations, size and chemical compositions depending not only of space and time but also of meteorological data, a complex panel of atmospheric pollution tools, satellite data and forecast model must be taken into account. The dynamics of the air pollutants are performed using the new 3D Atmospheric Observatory Site of the "Alexandru Ioan Cuza" University of Iasi, part of national LIDAR systems network implemented within ROLINET (ROmanian LIdar NETwork) and RADO (Romanian Atmospheric 3D Observatory) projects.

Experiment …



•For the monitoring of the ash cloud, the satellite images (Meteosat Second Generation), meteorological and the LIDAR data were used. The satellite allowed us to distinguish the moment in which the ash cloud took shape, expanded and dispersed into the atmosphere, too. The eruption of the Grímsvötn volcano and its impact on the environment have been studied by means of specialized instruments (optical remote sensing technology), thus confirming the transportation over great distances of sulphates and ash aerosols produced by the volcano in question. Using the LIDAR methodology described by, both the moment of the intrusion of the observed local cloud and the ceiling (at which the cloud is situated) have been deeply investigated. In order to investigate both the layers of the atmosphere and the height of the "particle intrusions", LIDAR system has been successfully used. As far as quality is concerned, one could notice the prevalence of the small and medium particles as compared to the gigantic ones, through the backscattered laser light.

•The used LIDAR system developed in the framework of ROmanian LIdar NETwork (ROLINET) research project is dedicated to monitor the atmospheric aerosols and clouds in the troposphere (from 700 m to 12 - 15 Km altitude). This is a multi - wavelengths mini-LIDAR system with the transmitter based on a coaxial UV (355 nm) – VIS (532 nm) – NIR (1064 nm) emission of a powerful and stable Nd:YAG laser with a variable repetition rate up to 30 Hz. The initial divergence of the 6 mm laser beam diameter of 0,75 mrad is improved 5 times to 0,15 mrad, by using a 3λ beam expander (BE) resulting thus a single beam of 30 mm diameter and a final divergence of 0,15 mrad. The high repetition rate and the low divergence (which provides a lower attenuation of the incident beam energy) are useful to mediate the LIDAR profiles with a good signal noise ratio at high altitudes. These features of laser offer the possibility to perform measurements up to high altitudes (12 km during daytime and 15 km during night) for one minute integration time.

•Different experimental results, satellite data and models have been deeply analyzed and compared as following: prognostic materials from ECMWF, synoptic maps at the ground level, prognostic materials for the ash (Volcanic Ash Advisory – Met Office), LIDAR data, geostationary satellite MSG Eumetcast data (Meteosat Second Generation), dispersion models (RIU, ZAMG) and the HYSPLIT model for backwards trajectories. In order to analyze the satellite images, IR images, SEVIRI High Resolution Visible channel combined with data from the IR10.8 channel were used.

Results

•On 26.05.2011, Romania was under the influence of a high pressure field, that after being crossed by a cold front, the day before. Central-eastern part of the continent was in a relatively high pressure field. In the west of the continent, a field of low pressure was acting, with a depression center of 1000 hPa, located in the North Sea (Fig. 1). During the measurements were made, atmospheric pressure at sea level, at Iasi Meteorological Station was above 1020 hPa, the biggest value being 1024.7 hPa. Initially, the day started with quite a lot of cloudiness (between 6/8 and 8/8), cloud ceiling being quite low (somewhere around 1000 m), then the sky cleared gradually until becoming a clear one, Fig. 2 (in the afternoon the cloudiness was between 1/8-4/8, Cumulus and Stratocumulus cloud type being initially present, then just Cumulus Humilis and / or Cumulus Fractus existing).

•In the altitude, above our point of observation, the wind had a northern component (see Fig. 3), with not a high speed

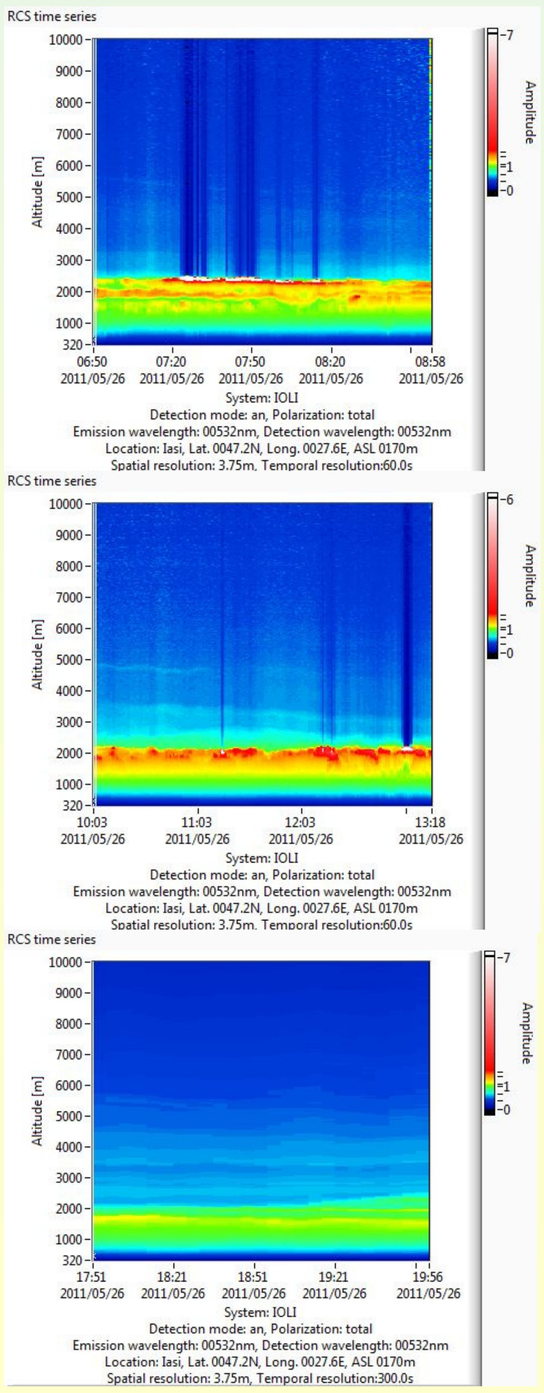


Fig. 1. RCS Time series - between 06:50-08:58 UTC, 26.05.2011

Fig. 2. RCS Time series - between 10:03-13:18 UTC, 26.05.2011

Fig. 3. RCS time series (night profiles) for highlighting the fine volcanic dust in very low concentrations

During this period, simulations and forecasts of ash cloud intrusion above our territory were quite contradictory. On the one hand, the Volcanic Ash Advisory gave us no signs that our territory will be affected by the ash cloud, in contrast, simulations of ZAMG and RIU, showed that on 26.05.2011 our territory will be affected by this event (Fig . 4).

By taking advantage of the fact that sky gradually cleared, so we removed from the start the presences of cloudiness and that some simulations signaled the presence of traces of ash on our territory and that we have a LIDAR system, we did few measurements (Fig.5).

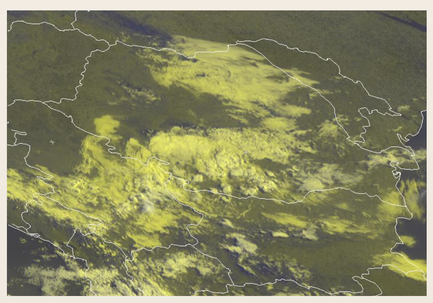


Fig. 4. Meteosat Second Generation images- based on data from the SEVIRI High Resolution Visible channel combined with data from the IR10.8 channel (EUMETSAT)- h06 UTC

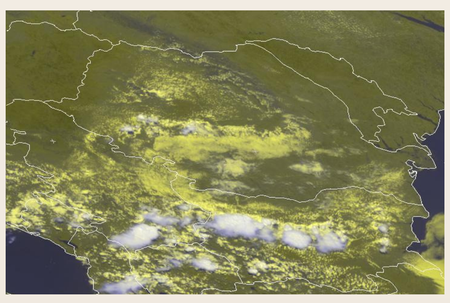


Fig. 5. Meteosat Second Generation images- based on data from the SEVIRI High Resolution Visible channel combined with data from the IR10.8 channel (EUMETSAT)- h12 UTC

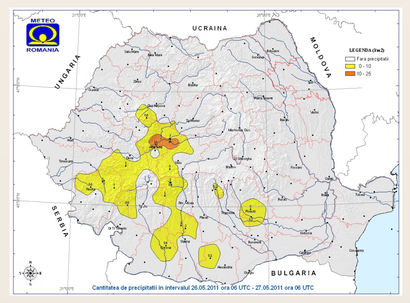


Fig.6. Rainfall from 26-05.2011, 06 UTC- to 27-05.2011, 06 UTC

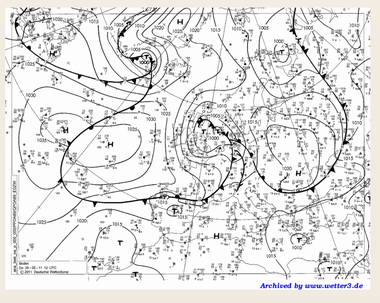


Fig. 7. Synoptic situation at the ground level (DWD), on 26.05.2011 at 12 UTC

satellite and meteorological data

- the backscattering signals are quite intense between 1500 and 2000 m. During this period (06 - 13 UTC) low clouds have been reported also in the observation data from the meteorological station Iasi, (Cumulus and Stratocumulus clouds); the sky cleared, we got an intense signal at an altitude of 1700 - 2000 m (Fig. 6).
- on 26/05/2011, at of our observation point (RADO-Iasi station), then at 15 UTC, we noticed the presence of fine dust (fine volcanic ash, under 0.063 mm). From qualitative analysis of LIDAR data, we can see the distribution of ash traces. From simulations (Fig. 4), concentrations seem to be quite low and precipitation were not been reported (no acid rain) (Fig. 5).
- to support our claims, we used the back trajectories HYSPLIT model (Fig.6), which shows, in addition to data already presented, trajectories of air masses moving towards to our observation point from the volcano Grímsvötn, still erupting.
- to eliminate any source of aerosols that could have a distribution at specified altitudes, the satellite data and the local data of pollutants at ground level confirm the absence of any other source; however the lack of local sources of aerosols cannot be excluded yet.

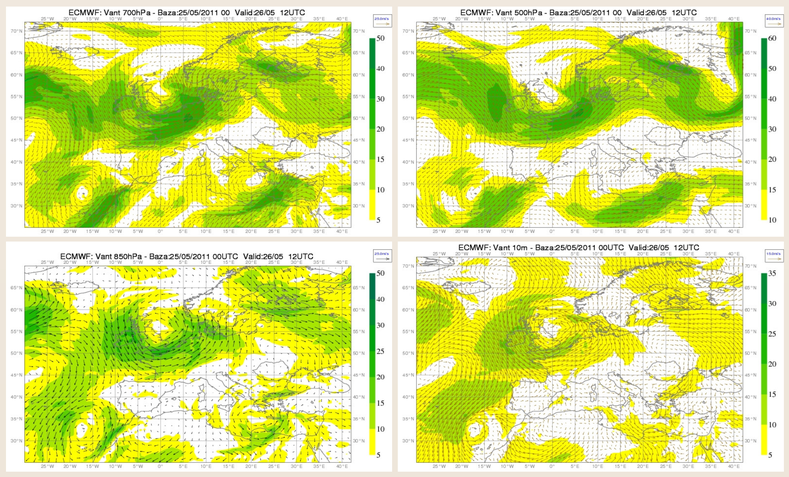


Fig. 8. Images from ECMWF-wind direction at 10 m, 850 hPa, 700 hPa and 500 hPa

qualitative and quantitative data model

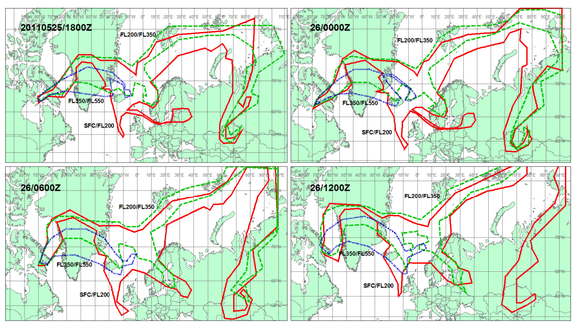


Fig. 9. Volcanic Ash Advisory image- Met Office

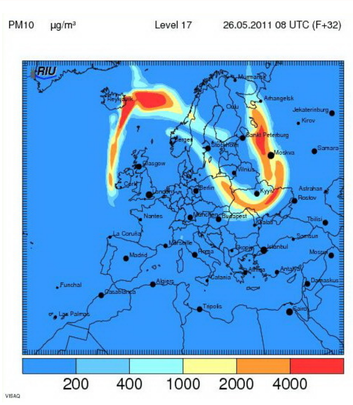


Fig. 10. Image representing simulation of RIU

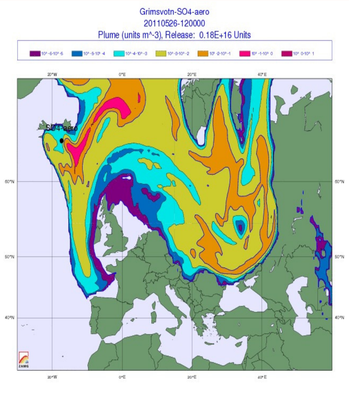


Fig. 11. Image representing simulation of ZAMG

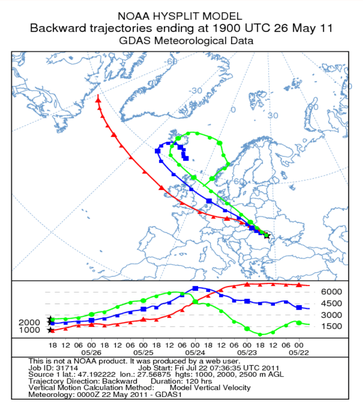


Fig. 12. Backward trajectory - HYSPLIT

Conclusions

Volcanic ash (Grímsvötn, in South-East Iceland: Lat: 64.42 Lon: -17.33) cloud diffusion over Iasi county and its vertical distribution have been analyzed. During our observations, low clouds Cumulus and Stratocumulus have been reported and after the sky cleared, we got a relatively intense signal at an altitude of 1700 - 2000 m. We noticed the presence of fine dust (fine volcanic ash, under 0.063 mm) and the distribution of ash traces can be evidenced. Concentrations seem to be quite low and precipitation were not been reported (no acid rain). The back trajectories HYSPLIT model shows, in addition to data already obtained, trajectories of air masses moving towards to our observation point from the volcano Grímsvötn, still are erupting.

In order to study the Earth atmospheric observations, relevant parameters for climate triggering like clouds, temperature and water have been investigated take into account both meteorological data (ECMWF, DWD, MetOffice- Volcanic Ash Advisory), satellite data (EUMETSAT), HYSPLIT and MAP3D models.

Because of low evidenced concentration of volcanic cloud ash, different other dusty particle sources (that cannot be total excluded) may influence our preliminary results and further investigations must be taken into account.

Acknowledgement. This paper was supported by ROmanian NETwork LIdar project (ROLINET) and Romanian Atmospheric Observatory 3D project (RADO)

The financial support from the Grant POSDRU/89/1.5/S/63663 is highly acknowledged.