ON THE USE OF A POLARIMETRIC X-BAND WEATHER RADAR FOR VOLCANIC ASH CLOUDS MONITORING

Gianfranco Vulpiani[1], Mario Montopoli[2], Errico Picciotti[2] and Frank S. Marzano[3]
(1) DPC - Department of Civil Protection - Rome, Italy
(2) CETEMPS, University of L'Aquila, L'Aquila, Italy
(3) Dept. of Electronic Engineering, Sapienza University, Rome, Italy.

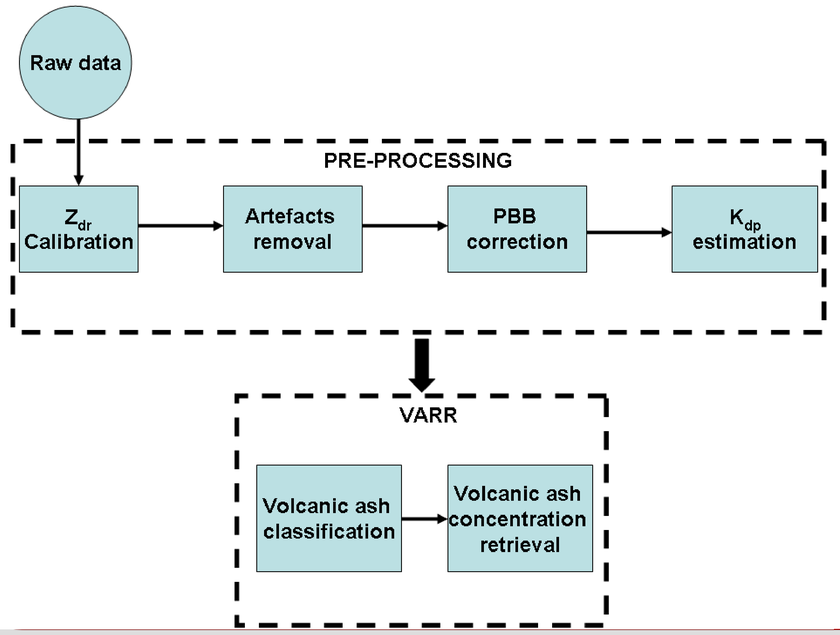
OUTLINE

- Volcanic ash retrieval is of significant interest for their environmental, climatic and socioeconomics effects.
- Ash fallout can also represent a serious hazard for aircraft.
- Satellite visible-infrared observations are typically used for long-range trajectory tracking purposes. However, the spatial and temporal resolution is relatively poor. Also the filed might be blocked by the presence of water and ice clouds.
- Weather radars potentially offer the possibility to monitor ash fallout with a relatively high spatial and temporal resolution, depending on the ash size, concentration, radar characteristics (i.e, wavelength, etc.), presence of meteorological targets.

OPEN QUESTIONS

- **Can we use weather radars for volcanic ash monitoring? To what extent?**
- **Is it possible to discriminate hydrometeor from volcanic ash radar echoes?**
- **Does polarimetry help?**

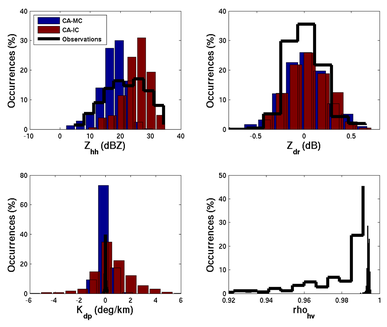
RETRIEVAL ALGORITHM



Model vs Observations: results

Volcanic Ash simulations (Marzano et al., 2006a) vs observations

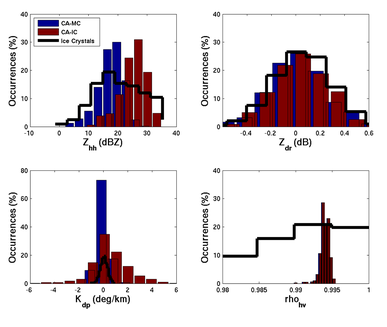
CA: Coarse Ash (D_{mean}=0.1 mm);
MC: Moderate concentration (Ca_{mean}=1 g/m3)
IC: Intense concentration (Ca_{mean}=5 g/m3)



Volcanic ash vs Ice crystals simulations

In hydrometeor clouds
Ice Crystals (IceC) may reach relatively high altitudes (especially in convecite clouds) as for volcanic ash particles.

IceC and CA have very similar radar signatures (Z, Zdr, Kdp).



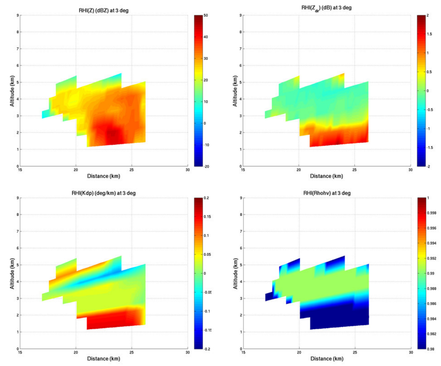
RETRIEVAL ALGORITHM: SENSITIVITY WITH RESPECT TO RADAR INPUTS

Volcanic ash size classification and concentration retrieval : RHIs of radar observables

RHIs of Zh, Zdr, Kdp, Rho - Azimuth: 3 deg

Below 2.5 km we note positive Zdr and Kdp and lower Rho. Do ash particles fall horizontally aligned?

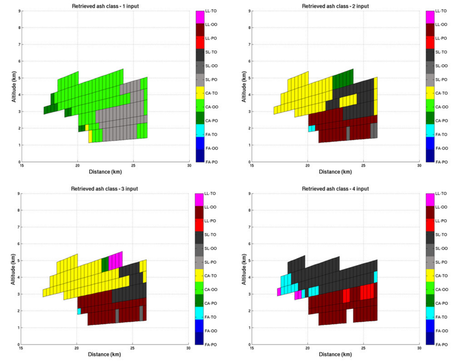
What about the maximum of Zh?



Volcanic ash size classification and concentration retrieval (Marzano et al., 2006b, 2011): RHIs Classification output

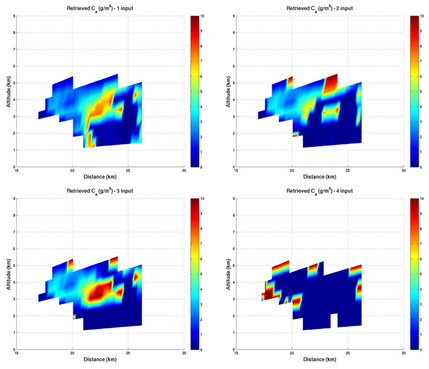
Sentitivity with respect to the number of input:

1. Zh;2. (Zh, Zdr); 3. (Zh, Zdr, Kdp); 4. 8Zh, Zdr, Kdp, Rho)



Volcanic ash size classification and concentration retrieval: RHIs of Ca

Different number of input in the classification step but only Zh used for the concentration estimation



References

Marzano, F. S., G. Vulpiani and W.I. Rose, 2006a: Microphysical characterization of microwave radar reflectivity due to volcanic ash clouds. IEEE Trans. Geosci. Rem. Sens., 44, 313-327.
Marzano, F. S., S. Barbieri, G. Vulpiani and W. I. Rose, 2006b: Volcanic ash cloud retrieval by ground-based microwave weather radar. IEEE Trans. Geosci. Rem. Sens., 44, 3235-3246.
Marzano, F. S., E. Picciotti, G. Vulpiani, M. Montopoli, 2011: Synthetic signatures of volcanic ash cloud particles from X-band dual-polarization radar. IEEE Trans. Geosci. Rem. Sens., in press.