Synergy between Doppler radar and Raman lidar for aerosol investigation

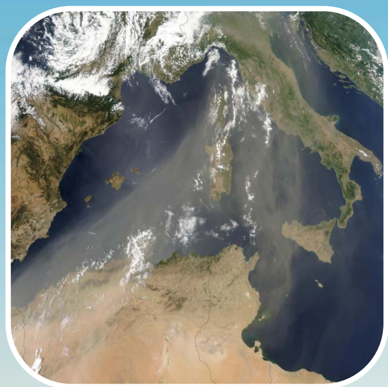
Pilar Gumà-Claramunt, Aldo Amodeo and Fabio Madonna

Consiglio Nazionale delle Ricerche – Istituto di Metodologie per l'Analisi Ambientale (CNR-IMAA), Tito Scalo, Potenza, Italy

pilar.guma@imaa.cnr.it

Introduction & Aim

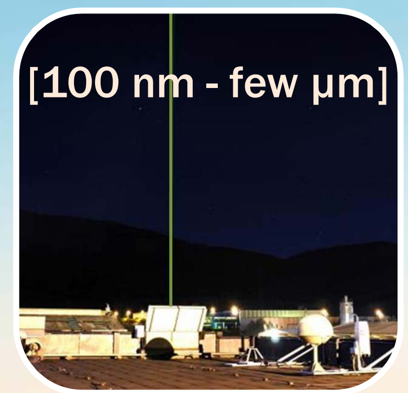
Which is the problem?



Giant and **ultra-giant aerosols** (r>5μm) distribution and importance for global meteorology and climate through **warm rain** processes and **ice nucleation** is not well known. They expedit warm rain processes by acting as **GCCN** (Giant Cloud Condensation Nuclei)[1-3] and are efficient **IN** (Ice Nuclei), increasing the ice formation temperature.

What can we do?

Combine different instruments aerosol measurements:



Lidar and sun photometer are used to retrieve aerosol microphysical properties from 100 nm to few μm[4] in absence of thick clouds

Cloud radar can detect giant and ultragiant aerosols[5]

Methodology

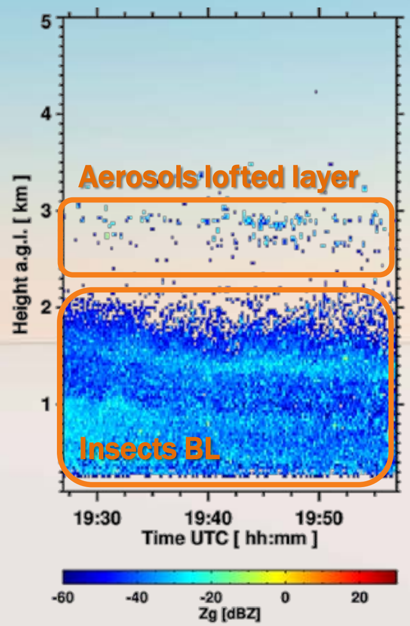
1. Development of an **aerosol detection** methodology with **cloud radar**
2. Analysis of the **lidar simultaneous measurements**
3. **Synergy** for an aerosol **enlarged size range** retrieval

Pilar Gumà-Claramunt
pilar.guma@imaa.cnr.it

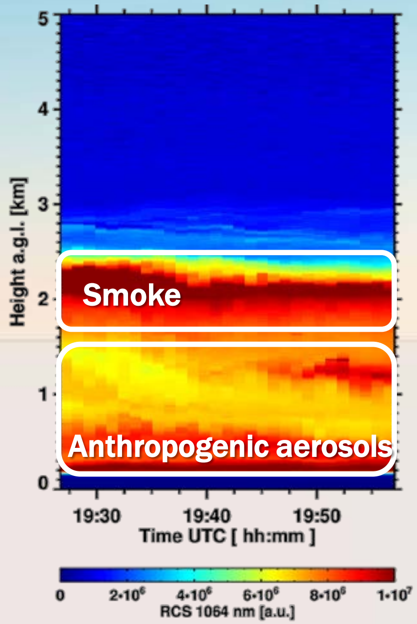
Example (19/06/2013)

Radar + **Lidar** = **Backscatter and depolarization profiles**

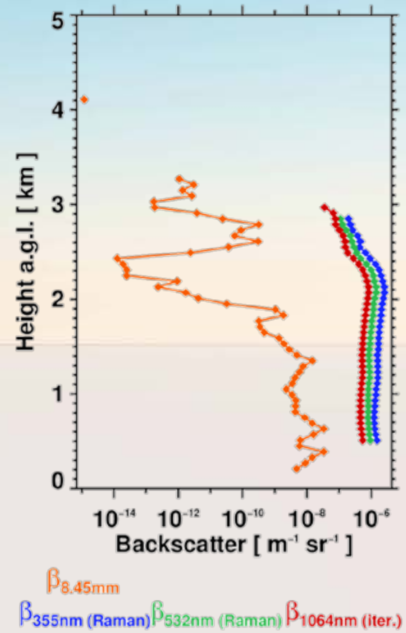
Reflectivity @8.45mm



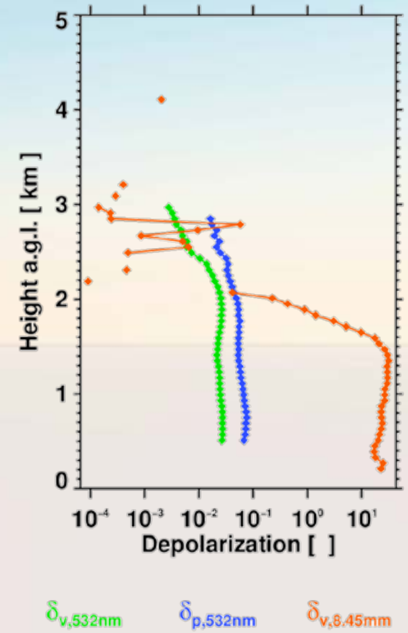
RCS @1064 nm



Backscatter



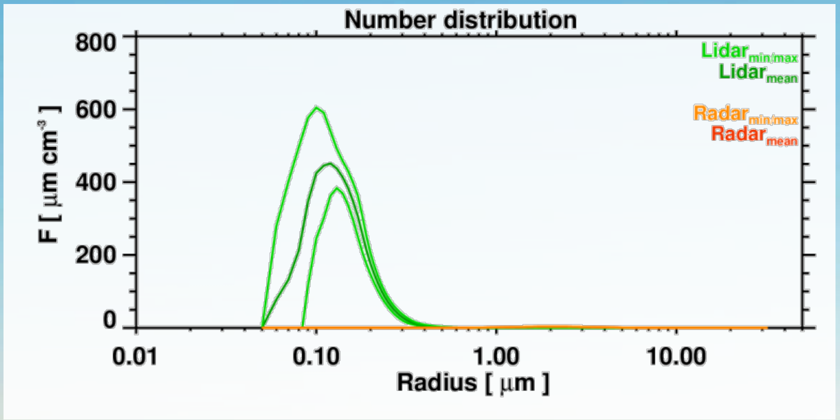
Depolarization

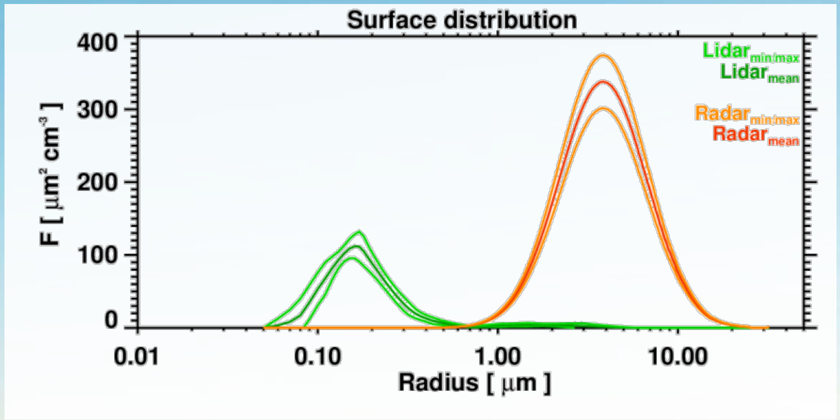


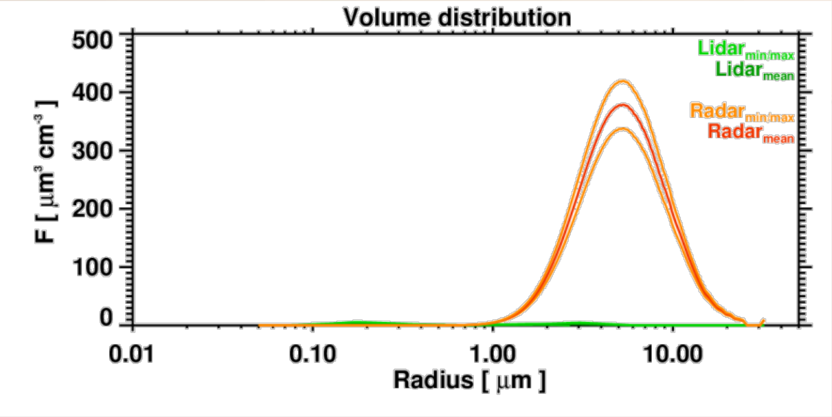
Pilar Gumà-Claramunt
pilar.guma@imaa.cnr.it

Example (19/06/2013)

Aerosol size distribution







Lidar inversion

- r_{eff} = 0.14 ± 0.018 µm
- r = 0.27 ± 0.05 µm
- N = 420 ± 140 cm^{-3}
- Spheroid fraction = 0%
- RI = 1.53 - 0.005i

Radar inversion

- r_{eff} = 2.11 ± 0.22 µm
- r = 1.87 ± 0.19 µm
- N = 90 ± 10 cm-3
- Axis ratio = 1.3 ± 0.2
- RI = 2.22 – 0.51i

Pilar Gumà-Claramunt
pilar.guma@imaa.cnr.it

General results & Conclusions

Cloud radar aerosol observation

- **Giant aerosols** can be **observed** with a cloud radar
- For the **first time**, they were methodologically **studied**
- A **method** to automatically detect aerosols has been **created**
- **Entomology criteria** are appropriate to discriminate aerosols and insects
- A large number of layers (**~ 40/year**) were detected in the **6 years dataset**

Giant aerosols effects

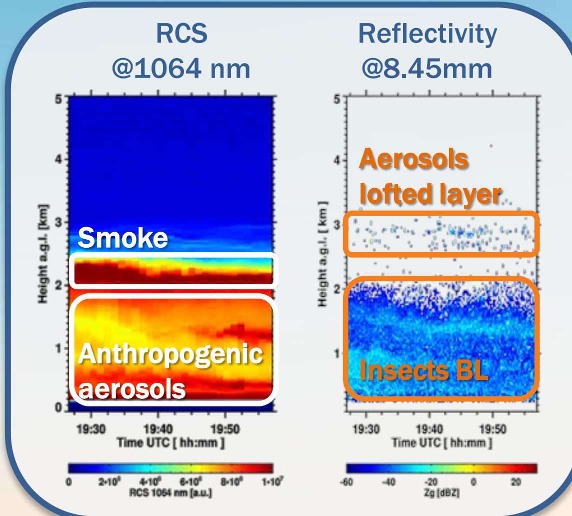
- The **AOD seasonal evolution** is in accordance with aerosol observations
- The **precipitation life cycle** is modified: lower accumulation and more probability of intense rainfall, occurring preferentially ~1½ days after the observation

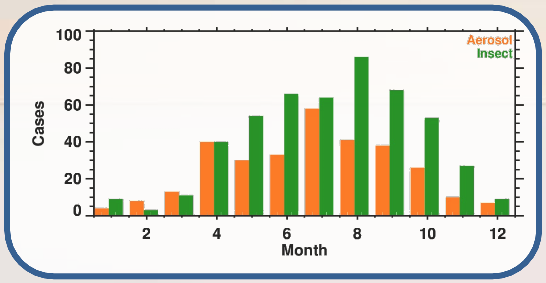
Synergy

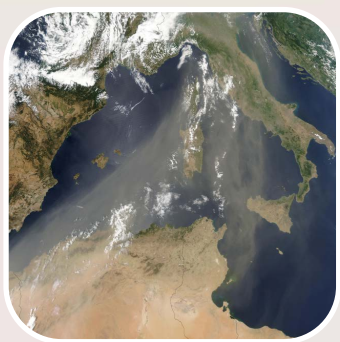
- The **particles observed** by the two instruments are **different**
- The **aerosol size distribution** can be retrieved by **inversion methods**; they are applied separately to lidar and radar measurements and afterwards combined. For the lidar an existing method is used, while for the radar a new one was developed
- For the first time, **enlarged aerosol size distributions** can be obtained by using the lidar and cloud radar synergy

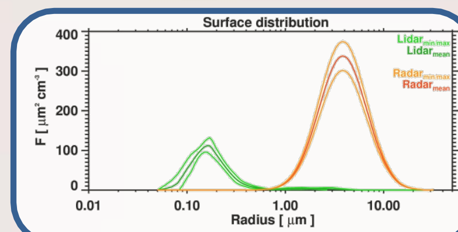
For more information…

…please contact pilar.guma@imaa.cnr.it!









Thank you!

Bibliography

[1] Eagan, R., Hobbs, P., and Radke, L. (1974). Measurements of CCN and cloud droplet size distribution in the vicinity of forest fires. J. Appl. Meteor., 13:553–537.

[2] Feingold, G., Cotton,W., Kreidenweis, S., and Davis, J. (1999). The impact of giant cloud condensation on drizzle formation in stratocumulus: Implications for cloud radiative properties. J. Atmos. Sci., 56:4100–4117.

[3] Ginoux, P., Prospero, J., Gill, T., and Hsu, N. (2011). Natural and anthropogenic dust: From sources to radiative forcing derived from satellite data and gfdl climate model. Proceedings of the Fall Meeting, American Geophysical Union.

[4] Veselovskii et al., 2010

[5] Madonna, F., Amodeo, A., D'Amico, G., and Pappalardo, G. (2013). A study on the use of radar and lidar for characterizing ultragiant aerosol. Geophys. Res., 118.

Acknowledgements

*The financial support by the European Community through the **ITaRS** Grant Agreement n° 289923 and the **ACTRIS** Grant Agreement n° 262254, both under the 7th Framework Programme, and by the national project "Programma Operativo Nazionale (**PON**) Regione Basilicata 2000/2006" are gratefully acknowledged.*