Differences between Marine Aerosol Backscatter and size-distribution in Upwind and Downwind conditions with respect of the Ship

M. Del Guasta, F. Castagnoli, V. Venturi

Istituto Fisica Applicata “Nello Carrara” CNR, Via Madonna del Piano 10, Sesto Fiorentino, Italy (m.delguasta@ifac.cnr.it)

Within the framework of the Italian Antarctic Research Program (PNRA), an aerosol experiment was carried out on board the cargo ship ITALICA (Length 130 m, beam 17 m, Tonnage 6.000) in the Ross Sea (Antarctica) during the 2005-2006 winter. The experiment included three instruments developed at IFAC CNR: a backscatter PBL aerosol LIDAR, a telemetric-LIDAR, and an Optical Particle Sizer (OPS). A commercial DMA aerosol sizer (Grimm) was also used. A Gill sonic anemometer and ordinary meteo sensors completed the station. During the experiment, using an original remote-sensing instrument (telemetric-LIDAR), we continuously monitored the aerosol backscatter (5 m above sea level, 10-12 meters far from the ship left side. By means of in-situ sampling (DMA,OPS, also performed on the left side of the ship, 5 meters a.s.l.), we derived the size distribution of aerosols in the 15 nm - 10 μm range. The instruments operated in (almost...) all weather conditions. Results for January 10, 2006 are shown.

Taking advantage of a bathimetric scan of the sea bottom performed by the ship, we were able to establish the differences in aerosol backscatter and size distribution when the aerosol lab was, respectively, downwind or upwind of the ship. Due to the zig-zag course of the ship, the aerosol lab was alternatively upwind and downwind of the ship. 24 hours of LIDAR-derived PM10 is plotted vs the direction of the wind relative to the ship axis, as measured with a Gill 2-D sonic anemometer. The PM resulted larger in down-wind conditions.

The speed of the ship was almost constant (~13 kt) during the scan, while the absolute wind speed was approximately 15 kt in the morning, and slowly decreased down to 5 kt in the evening.

CONCLUSIONS: As a result, the ship acted as an efficient “source” of coarse-aerosols, thus spoiling the collection of natural marine aerosols when the laboratory was downwind of the ship. This effect extended for at least 10 meters away from the ship walls, as confirmed by the telemetric-LIDAR data.

The IFAC Telemetric LIDAR on its anti-rolly mounting. The instrument measured aerosol backscatter (532 nm) at a distance of 10-12 m from the lab.

The DMA+OPS Size Distributions overlapped for the entire day of study. The events of contamination from the ship exhausts were evidenced.