

Study of the production and dynamics of marine aerosols

A contribution to the EUROTRAC subproject ASE

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Summary: The aim of the research is to yield a description of the factors determining aerosol production, dynamics and deposition in the marine atmospheric surface layer through experimental work in an air/water tunnel and numerical modelling.

Activities and plans

1. The 1988 CLUSE and PIE-88 experiments were conducted in the Air-Sea Interaction Simulation Tunnel at IMST, Marseille, France. During the course of these experiments, the first author has made numerous aerosol measurements, using impactor and light scattering systems to provide investigators with droplet concentration profiles in a variety of combinations of wind speed, relative humidity, air and water temperatures. The results are used in the development and testing of the CLUSE numerical models (Edson, 1989; Rouault, 1989). An important parameter in these models is the droplet source function. Much effort was put into the direct measurement of the surface production rate of the droplets by using bubbles in the tunnel configuration with a whitecap simulated with an array of submerged aquarium frits. This was achieved by collection of droplets on a MGO-coated slide. An unambiguous calibration for this method is presently not available. To resolve this calibration problem, additional experiments were made at the Naval Postgraduate School (Monterey, CA, USA) to compare this impaction method with optical sampling methods. Other efforts were directed to the assessment of the influence of waves on droplet concentrations near the surface. Results show that the droplet concentration and humidity fluctuations are highly correlated at the dominant wave frequency.

2. The results are being further evaluated for use in the CLUSE numerical models. These will be adapted to include the influence of waves.

3. Similar techniques were employed during the Petit-CLUSE 3 and 4 experiments, in the wave tank at the University of Connecticut, Avery Point, Groton. These experiments were aimed at the determination of the source function by bursting bubbles over a 1 m² simulated whitecap, using three different methods. In addition, bubble and droplet spectra were simultaneously measured to determine the relation between bubble and droplet size distributions. These experiments were made in both fresh and salt water, to facilitate the interpretation of the CLUSE results to open ocean conditions.

4. During the HEXMAX experiment, fall 1986, impaction and optical methods were employed to measure aerosol concentration profiles near the sea surface. Upon completion of the data analysis, these results (in conjunction with the knowledge obtained from the various laboratory experiments) will be used to estimate the surface production of droplets over the sea. A summary of the various source functions postulated in recent years will be made for comparison purposes. The consensus source function will then be used in an updated version of the CLUSE numerical model, which is currently being adapted for marine conditions at Risø National Laboratory.

5. Participation in a second, more extensive particle interaction experiment is planned for June 1990. This experiment, PIE-90, will study the influence of droplet production (disruption of the laminar sublayer adjacent to the surface) and interactions between large droplets and smaller particles on the deposition velocities of sub-micron particles. These deposition velocities are important in any aerosol model for the marine atmospheric boundary layer because of the background aerosol present due to evaporation of the sea-salt aerosol, advection of aerosols of non-marine origin, and production of aerosols by chemical processes.

Acknowledgement

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References

- de Leeuw, G., 1989. The occurrence of large salt water droplets at low elevations over the open ocean. In: *Climate and Health Implications of Bubble-Mediated Sea-Air Exchange* (Eds. E.C. Monahan and M.A. van Patten), Connecticut Sea Grant College Program, University of Connecticut, Groton, Connecticut, USA, 65-82.
- de Leeuw, G., 1989. Investigations on turbulent fluctuations of particle concentrations and relative humidity in the marine atmospheric surface layer. *J. Geophys. Res.*, **94**, 3261-3269.