Aerosol optical depth and its connection with macrometeorological features

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The contribution of aerosol particles to moisture and energy exchange processes at the sea surface, to the global salt flux, their role in cloud droplet formation processes and their influence both upon the maritime atmospheric radiation balance and propagation at visible and infra-red wavelengths or visibility assessment are of increasing concern (Sakerin et al., 2007).

This has a significant influence on both the performance of electro-optical systems and our experience in everyday life. A thorough understanding of such phenomena is essential to an accurate assessment of many processes important for the development of coupled ocean-atmosphere global circulation models, including the pollution problem. Due to its light attenuation properties, aerosols are important in satellite investigations of the ocean surface (Smirnov et al., 2009).

The aerosol studies during the AREX campaigns were carried out onboard the r/v Oceania between 2000 and 2008. During each campaign the vessel cruised for six weeks in the European Arctic between 0 and 14°E and 69 and 79°N. In 2006 the ship cruised in the area of ALOMAR laboratory on Island Andoya in northern Norway (16°E and 69°N). Data were also collected during the SOAP experiment in 2006 in Crete.

The studies were conducted using an ensemble of instruments, including lidars, ceilometers, laser particle counters, CPC and sunphotometers. The full meteorological coverage (wind speed, direction, air mass backtrajectories, relative humidity, air temperature, etc.) was provided by the ship meteo station, which collected data every 10s, from the British Atmospheric Data Center and using HYSPLIT (Zielinski et al., 2005).

In order to find the relationships between the aerosol variability in the marine boundary layer and above we compared our data against the pressure levels charts (850, 700, 500 hPa). We observed that the state of the atmosphere between 1 to 3 kilometers above sea level can reflect the changes in the marine boundary layer.

We examined the spatial and temporal variation of aerosol optical depth in different marine areas (including coastal zones) using the upper troposphere charts for the northern hemisphere. Comparison of manual analysis charts with empirical data facilitates detection of different behavior patterns of aerosol optical depth and the characterization of the influence of vertical water vapor distribution on AOD values (present as atypical spectral behavior). During our investigations the calculation of useful backscatter coefficient parameter was made at above 1.5 km altitude and it occurred that the columnar AOD can be significantly affected by the ridges of northern hemisphere circulation. The principal conclusions are also combined with detection of jet stream event over Lofoten Islands. The range of changes between the “Before” and “During” state of AOD was significant.

The results show that local emissions are not always most important factors, which influence the composition of marine aerosol in the near water atmospheric layer, even for the coarse mode aerosols, also known as the sea salt mode. The air mass history must be taken into consideration.

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