Coastal-Zone Forests – a Resource at Risk: Role of Aerosols

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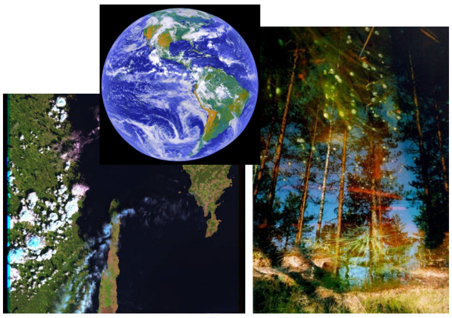
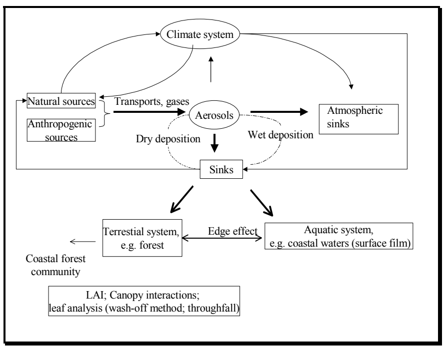


Introduction

Climate change in terms of meteorological shift or change affects the atmospheric aerosol behaviour that in turn affects the ecosystems by changing their biogeochemistry in rather unpredictable ways. These linkages therefore pose risks to natural resources and thus to society.

There are strong needs to advance the understanding of coastal-forest ecosystems, in particular important issues in basic biogeochemistry and biogeophysics science, such as sea-forest linkages (edge-effect) and atmosphere/canopy exchange (Wiman et al. 2002). These linkages can be summarized in figure below:

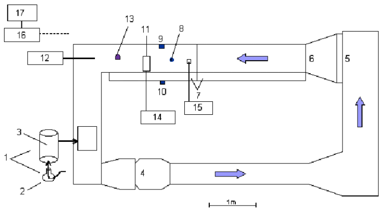


A distinction can be made between dry and wet deposition processes; however, focus in this paper is on dry deposition. **The aim** of the paper is to advance the understanding of atmospheric aerosol physical properties (e.g. particle size distributions) in an experimental situation and to study basic characteristics of the wind tunnel such as aerodynamics and wind patterns.

Methods

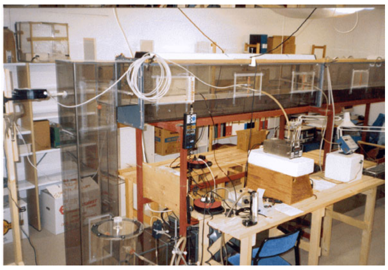
Atmospheric aerosols and their meteorological and biogeochemical effects on ecosystems can be studied in the field as well as laboratory. The paper addresses a wind-water tunnel approach as one of the ways to study meteorological and biogeochemical effects of atmospheric aerosols.

In brief, a physical model (a wind-tunnel facility) is designed to emulate basic transition properties in the coastal-zone sink mechanisms from sea to land (for technical information see Lundahl (1994a; 1994b). An aerosol was artificially generated and characterized by means of laser-based optical particle counters (LPCs) and condensational particle counter (CPC). Meteorological parameters as wind speed, temperature and relative humidity was controlled and logged in.



The wind-water tunnel

The wind water tunnel is of closed circuit type although fairly easy to re-design into open pass-through type. The tunnel is 6.5 m long.

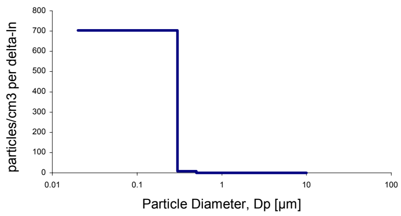


The wind-water tunnel

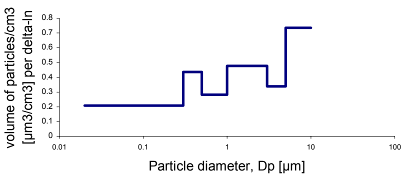
Results and Discussion

The aerosol source-sink mechanism (deposition) is strongly dependent on aerosol (aerodynamic) particle size. The two main factors for particle deposition are important the size distribution and the friction velocity (Erisman et al. 1997). The particle sizes are determined by the formation processes and subsequent physical and chemical reactions in the atmosphere, or in this case in within the wind tunnel.

Atmospheric aerosols contain particles with sizes from the nm range to several tens of µm. Particles are not evenly distributed over these six orders of size-magnitudes, however, but occur in "modes" (Whitby, 1978). Concentrations of particles in six size ranges (0.02-0.3 µm; 0.3-0.5 µm; 0.5-1.0 µm; 1.0-3.0 µm; 3.0-5.0 µm; >5 µm) were measured.



Particle number-size distributions at equilibrium

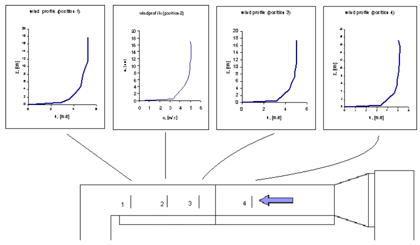


Particle volume-size distribution at equilibrium

During the experimental runs it was observed that at the start-up stage particle concentration tend to decline. After start of the aerosol generator the concentration curves begin to increase and grow towards equilibrium. In concentration equilibrium (steady state), the aerosol source strength balances the aerosol sink strength. It was observed that the fine particles (0.3-0.5 µm) and the coarse particles (3-5 µm and larger than 5 µm) behave differently in some respects. In particular, coarse particles show more noise in the concentration variations.

Since the particle size determines a wide range of physical and chemical characteristics and behavior, including the distances across which particles can be transported, and also deposition rates of substances carried by particles of given sizes, information about particle size distributions is fundamental.

Particle deposition mechanisms are highly dependent on wind speed. Therefore, wind patterns within tunnel were studied in order to get basic reference wind profiles at different sections of the wind tunnel. Reference wind speed (i.e., wind speed at the point where isokinetic aerosol sampling is carried out) was set to 5 ms^{-1}.



Wind profiles at different sections of the wind tunnel

Conclusions

The experiments provide valuable information about essential aerosol properties that are crucial for further experiments, in order to understand meteorological and biogeochemical effects of aerosol (e.g. atmosphere/canopy exchange).Time constants were quantified with respect to run time needed to achieve aerosol concentration equilibrium conditions that are important while studying aerosol deposition process to tree seedlings.Relative humidity and salinity effects will be studied.

References

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Wiman B.L.B., Donev E.H., Gaydarova P.N. and Yurukova L.D. (2002) *Integrated Environmental Diagnosis and Assessment: The IEDA October 99 Ahtopol/Silistar Biogeochemistry Campaign.* IEDA Report #4, Sofia, February 2002.

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