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# Transport Processes in the Coastal Atmospheric Boundary Layer

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## LONG TERM GOALS

The long term goals are to better understand and to be able to predict (model) the transport of different constituents in the marine atmospheric boundary layer, due to mesoscale flow systems at locations along mountaineos coastlines. The transported constituents may be air pollution or aerosols, both natural and manmade. In particular we are interested in the crosscoast mixing potential.

## OBJECTIVES

The dispersion and mixing of aerosols and other species in the coastal zone is influenced by meteorological processes different space and time scales. The dispersion is dependent on the local PBL turbulence structure, while on larger and longer scales the fate of these constituents are determined by the mesoscale flow that arise from the different surface forcing dependent both on different syrface types and the terrain height difference. The objective of this study is to compare and quantify the potential for aerosols generated over land, often from atropogenic sources, to be transported out over the coastal ocean and *vice versa*, to what extent the marine aerosols propagate over land for areas where the coastal flow is determined by the interaction between the marine atmospheric boundary layer and a mountaneous coastline.

## APPROACH

A necessary tool in estimating atmospheric transport in the coastal zone is an atmospheric model that can describe the mesoscale flow in adequate detail. This project thus rests on earlier studies of coastal mesoscale flow, also funded by ONR. However, the total picture is very complex and a complete description of the formation and development of all of these aerosols, including transport and mixing mechanisms, is difficult. It requires: 1/ resolved timedependent meteorological fields, 2/ accurate dispersion, 3/ emission inventory, 4/ a theoretical framework for aerosol formation 5/ schemes that describe both gas phase and heterogeneous air chemistry, 6/ deposition models. Although significant progress is continously reported on many of these issues, it is doubtful if all these processes are known with the accuracy needed, for all these building blocks to be put together in a meaningful fashion. Some models – mainly box models – treat details of nucleation and air chemistryand mesoscale meteorological models describe the air flow. In some cases it has been possible to successfully incorporated the mesoscale transport and dispersion with an airchemistry scheme, however, at large numerical cost. In one previous study, it was illustrated how trajectory calculations could be used to asses the fate of emitted substances and secondary pollutants in Athens, Greece. This is where we will start – we will use already performed simulations for the Coastal Waves experiment and for Blekinge in Sweden and calculate clusters of trajectories from different significant source areas (urban, marine etc). We then will proceed to characterize different source areas, where we can expect different types of aerosol to form (urban photochemical, coastal from breaking waves, marine from biogenic etc). These will initially be included in the mesoscale model as timedependent invariant species, with time dependent source functions and deposition. The resulting distribution of aerosols will indicate how different sources may influence the situation at different spatial locations.

## WORK COMPLETED

Meteorological simulations of coastal flows has been performed for coastal California and for Blekinge on the Swedish coast to the Baltic sea. In addition, we have acess to a data base with MM5 simulations for the California coastline, for the entire summer 1996, coinsiding with the Coastal Waves experiment. Several interesting mesoscale flows have been described, e.g. supercritical flow with expansionfan dynamics, flows with a significant crossshore flow and interactions between PBL structure and boundary layer development.

## RESULTS

We have built up a extensive data base of different flow situations, on the California coast and for the Blekinge coast in Sweden. This data base covers a wide range of potentially interesting flow types, both of alongcoast and acrosscoast flows, with significant mesoscale circulations and different PBL development. In one particularly interesting case from Blekinge we observed and simulated the development of a nonclassical intertialoscillation jet, that developed as a cloud layer dissipated. We will now proceed and use these modeled fields to estimate transport capability, using a lagrangian “random walk” model.

## IMPACT

Both aerosols and clouds cause visibility degradation in different electromagnetic wave length bands. This affects Navy operations and platform, sensor and weapons performance, that rely on electromagnetic observations. An improved understanding of the transport of different aerosols in different coastal environments should thus be beneficial for tactical decisions as well as for developing strategies and tactics and also in designing sensor systems intended for operations in such environments. The simplified approach in this study may facilitate development of parameterizations for larger scale models.

## RELATED PROJECTS

This project runs in paralellel with a similar project within a European so called EUREKAprogram. It is an accepted part of the CAPMAN subproject (program manager: Dr Gary Geernaert at NERI, Denmark) of EUROTRAC2. Our group also actively collaborates with Dr Darko Koracin at the Desert Research Institute in Reno, who will provide the MM5 simulations data set mentioned above, and with Dr Dave Rogers and Dr Clive Dorman at Scripps Institute of Oceanography. We also have informal contacts with staff at the Swedish Defence Research Institute in Sweden, that are working on the aerosol problem for various airborne sensors.

## PUBLICATIONS

Sundararajan, R., and M. Tjernström: Observations and simulations of a nonstationary coastal tmospheric boundary layer. Quarterly Journal of the Royal Meteorological Society, Submitted.