

***Particle deposition in marine environment:
How far have we progressed since Slinn & Slinn?
28th / 29th April (Sopot, Poland)***

Meeting report:

The aim of the meeting was to gather together a small group of experts in both dry and wet particle deposition over the ocean to discuss progress in the field in recent decades, especially within the last 10 years. The progress in parameterisation of particle deposition velocity formulas used in regional and global models were to be discussed as well as the relation of this problem to broader field of air-sea interaction.

This meeting's original invite list included members of the community who recently published within the field or were considered to have been proactive in undertaking relevant research. It was decided that a small group would be best suited to make rapid progress during a short two-day meeting. Participants were Jacek Piskozub (Poland), Tom Bell (UK), Leiming Zhang (Canada), Gilles Foret (France), Lise Lotte Sorensen (Denmark), Patrick Boyer (France), Nevenick Calec (France), Violetta Drozdowska (Poland), Jakub Kowalczyk (Poland) and Stanislaw Pogorzelski (Poland).

The first day of the meeting was devoted to the presentations prepared by the participants on various aspects of particle deposition research.

Tom Bell gave an introductory talk on the aims of COST Action 735, describing the effort on providing the best parameterisation of gas transfer velocity, k , as well as an initiative to produce a global climatology of k (Jeff Hare et al., NOAA, USA). He mentioned that data collation work has begun on aerosol and rain data sets for Fe, N, P deposition, dry deposition global fluxes (Baker et al.). Wet deposition is also important but more difficult.

Jacek Piskozub presented some existing gaps in our particle deposition knowledge such as the problem of dry deposition when the source is not from the above but at the sea surface, and the empirical evidence that wet deposition is the weak link in aerosol transport models.

Leiming Zhang talked about parameterizations of size-dependent dry and wet removal. Uncertainties in the theoretical scavenging-coefficient formulas and associated input parameters, including raindrop spectra, droplet-particle collision-efficiency, and droplet terminal velocity, have been investigated in detail. Sources of the large discrepancies between theoretical formulas and the majority of field measurements have also been suggested. It is recommended that a theoretical formula (instead of the empirical ones which produce too large scavenging coefficients) that produces relatively high scavenging coefficients for particles 0.001-3 μm should be used for aerosol transport models. An update of a widely used particle dry deposition model (Zhang et al., 2001) has also been presented. The updated model has been evaluated by comparing model results with measurements over typical surfaces, e.g. forest, grass, bare soil, snow, and water.

Gilles Foret presented progress with dividing size distribution spectra for aerosol transport models. Using a new parameterisation (iso-bins) with the bin size defined by equal deposition velocity increments one can decrease (for Saharan dust) the number of the bins without increasing the deposition-related error, which is important for model computational speed.

Lise Lotte Sorensen gave a talk on evaluating particle dry deposition from particle fluxes, especially from moving platforms. She mentioned the problems of determining both the aerosol source function and deposition velocity from direct flux measurements. The eddy covariance technique records only turbulence generated particle flux and is unable to observe gravitational

deposition. The existing particle meters are not quick enough for the dissipation methods. However, there is hope in a new co-spectrum peak method. Also the problem of interaction of particles and trace gases should be taken into account as it influences the measured fluxes of both particles and gases.

Nevenick Calec presented the tank experiments he conducted with **Patrick Boyer**, which focussed on the deposition of sub-micron particles onto a water surface. Several deposition mechanisms in this range: diffusion (turbulent, Brownian, diffusiophoresis), impaction, interception, thermophoresis etc. make the dependency of deposition velocity in this size range especially complicated. The experiments showed a decrease, with friction velocity (u_*) increasing to 0.2 m/s and a strong increase above this (possibly because of the waves going beyond the sub-layer thickness at this friction velocity).

Jacek Piskozub presented the work done in his group (with Tomasz Petelski who was not present at the meeting) on scavenging of particles by marine aerosol. Calculations show that large aerosol droplets (especially the spume size range) can be effective in 'cleaning' the mixing layer of small particles. This may be a reason for the discrepancies between different methods of measuring particle fluxes (namely gradient and deposition velocity ones) for small particles.

Stanislaw Pogorzelski talked about the effect of particle deposition influencing the surfactant load on physical properties of sea surface. The physical parameters of sea surface (surface tension, contact angles for different substances, theory of surfactant adsorption vs. surface free energy) are generally understudied. A fundamental database should be collected, which would be needed for a future closure of k and aerosol source functions.

The second day of the workshop was devoted to discussion of the topics presented on the previous day. Among the discussed points were:

- Modelling (with recommendations to bring different approaches together).
- Measurement of aerosol concentration (recommendations on further research into how this interacts with deposition: source functions vs. deposition of different size fraction and different chemical species).
- Experimental tanks (a recommendation for further tank studies of deposition velocity).
- Size parameterisation (a recommendation about the value of the iso-bin approach, especially as it has been independently developed for marine aerosols – Witek et al 2006, 2007).
- Submicron deposition velocity (recommendations for further study).
- Wet deposition (recommendations for further study, especially vs. transport models).
- Other effects (recommendations for looking into the efficiency of scavenging by marine aerosol).

The main future action points decided by the participants were plans for:

- a joint experiment involving coupled eddy correlation, dissipation technique and gradient methods;
- exchange of experimental data on particle deposition;
- a joint session at a major scientific conference;
- joint grant applications in case of any relevant calls;
- a joint effort toward writing a review paper on the state of knowledge on dry and wet deposition and recommendations for future work.