Aerosol particle advection in the atmosphere: Eyjafjallajökull and Fukushima

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Investigation of the spreading of aerosol particles in the atmosphere (e.g. from volcanic eruptions or nuclear accidents) is a question of importance. The motion of an aerosol particle is described by an ordinary differential equation. The large-scale dynamics in the horizontal direction can be described by the equations of passive scalar advection, but in the vertical direction a well-defined terminal velocity should be taken into account as a term added to the vertical wind component. In the planetary boundary layer turbulent diffusion has an important role in the particle dispersion, which is taken into account by adding stochastic terms to the deterministic equations above. Far from the surface, in the free atmosphere, on large scales the effect of turbulent diffusion is negligible, the equation of motion does not contain stochastic term. The background wind field and other necessary data for the dispersion computations are taken from the ERA-Interim database of the European Centre for Medium-Range Weather Forecasts.

Simulations show that advection is chaotic. Since aerosol particles released in the free atmosphere sooner or later leave this zone and enter the planetary boundary layer, chaos is transient. We point out that quantities like escape rate and average lifetime of particles outside the boundary layer, as well as stretching rate of material line segments can efficiently be applied to characterize the volcanic ash dynamics in the free atmosphere. These quantities are evaluated for particular eruption examples of volcano Eyjafjallajökull (April 2010), as well as for time-averages taken at different geographical locations, and for global averages over the Earth. [1]

In the case of the Fukushima Daiichi nuclear accident (March-April 2011) the majority of the pollutants was released in the planetary boundary layer, hence turbulent diffusion plays an important role. Simulations (including the continuous, but unsteady emission from the nuclear power plant) covering the distribution over local and global scales will be presented for the period of 14-23 March. Results show that including only the dry deposition leads to an underestimation of the overall fallout. Wet deposition is an essential process in the lower levels of the atmosphere, however its precise parameterization is a challenge (and it is an ongoing work).

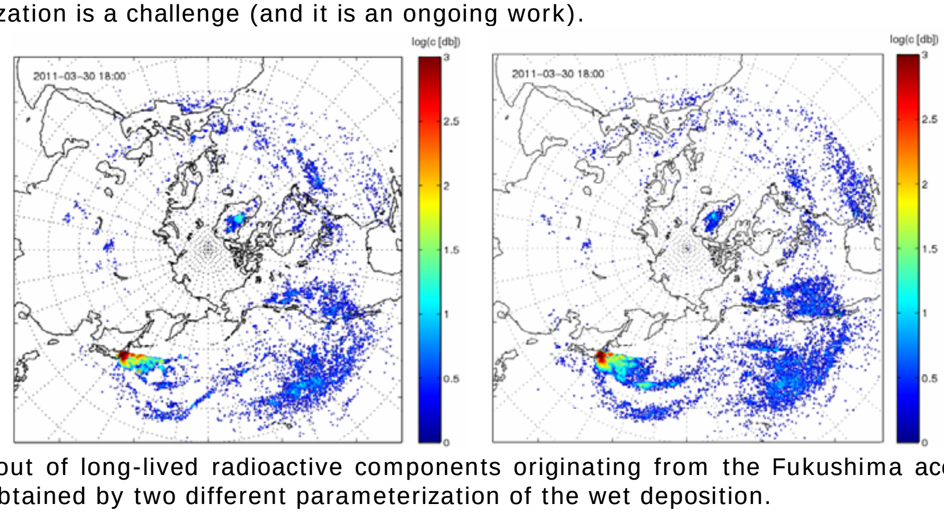

Fig. 1. Fallout of long-lived radioactive components originating from the Fukushima accident up to March 30 obtained by two different parameterization of the wet deposition.

[1] T. Haszpra, T. Tél, *Journal of Physics: Conference Series* **2011**, *333*, 012008.