# Numerical simulation of the fall of an ice particle

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## Abstract

We investigate in this study the settling of a spherical ice particle falling in a fluid composed of a mix of dry air and water vapour. The aim is to provide a characterization of the saturation field in the wake of the sphere depending on the settling velocity and the temperature of the particle and the surrounding fluid. This system can be of relevance for meteorological applications and more specifically in the context of secondary ice nucleation.
We use a numerical approach based on direct numerical simulation of the incompressible Navier-Stokes equations in the Boussinesq approximation with the spectral / spectral element method of Kotouč *et al.*(2009) with two separate transport equations for temperature and vapour. We consider different parameters in order to explore the influence of the wake regime on the structure of the saturation field. For this we consider different Galileo numbers $Ga = u_g D/\nu$, where $D$ is the particle diameter, $\nu$ the viscosity of the fluid, and $u_g$ the gravitationnal velocity defined as $u_g = (|(\rho_p/\rho_f - 1)g|\, D)^{1/2}$, with $\rho_p/\rho_f$ the ratio between particle and fluid density, and $g$ is the acceleration due to gravitaty. We vary $Ga$ in order to access wake regimes ranging from steady axisymmetric for the smallest Galileo number to chaotic regime for larger Ga (Jenny et al.(2004)).

## References

Jenny, M., Dušek, J. and Bouchet, G. (2004) "Instabilities and transition of a sphere falling or ascending freely in a Newtonian fluid", *J. Fluid Mech.*, vol. 508, pp. 201–239.

Kotouč, M., Bouchet, G., Dušek, J. (2009) "Transition to turbulence in the wake of a fixed sphere in mixed convection", *J. Fluid Mech.* 625, 205–248.