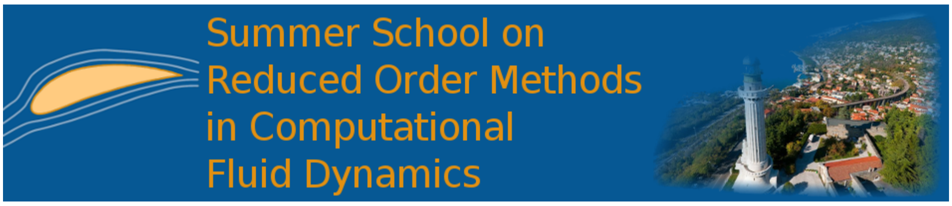

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The polluted atmosphere as a shallow domain

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Considered as a geophysical fluid, the polluted atmosphere shares the shallow domain characteristics with other natural large-scale fluids such as seas and oceans. This means that its domain is excessively greater horizontally than in the vertical dimension, leading to the classic hydrostatic approximation of the Navier-Stokes equations. We consider the so-called anisotropic model as a starting point, i.e. a set of equations that describe the atmosphere including the effects of pollution, where the fluid velocity function governed by the classical Navier-Stokes equations is combined with a concentration function representing the pollution. We provide a convergence theorem for the weak solutions of the anisotropic model towards the hydrostatic system. Our results are valid on local domains where the use of Cartesian coordinates are legitimate and effects such as the curvature of the Earth are negligible. The shallow domain concept of the atmosphere is grasped by the small variable ϵ which stands for the aspect ratio, i.e. the ratio of the characteristic depth and characteristic width. We explicitly involve this aspect ratio in the coordinates and variables that describe the phenomena, then perform a rescaling process according to the "almost two-dimensional" concept we use that makes the domain independent of ϵ. The main two models between which we describe the convergence result are the original anisotropic model and the hydrostatic limit model. In the first one we use the Navier-Stokes equations in all three space dimensions to describe the fluid velocity, while in the latter model we arrive to a simpler equation in the vertical dimension, namely we see the hydrostatic approximation incorporated into the model. The main steps of the proof for the convergence result between the two models are *a)* using the classical method of extracting a priori bounds from the energy inequality, *b)* passing to the limit in the linear terms, and, finally, *c)* using a compactness result that allows us to pass to the limit in the nonlinear terms that require stronger regularities. The visualisation of this convergence result using the finite element method is challenging as a result of the disappearing control over the vertical velocity: the matrix of the anisotropic system becomes more and more badly conditioned as the weight of the vertical velocity is decreasing with ϵ from the vertical momentum equation.

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