

**Research Topic for the ParisTech/CSC PhD Program**  
*(one page maximum)*

**\*Field (cf. List of fields below):** Materials Science, Mechanics, Fluids

**Subfield:**

Environment Science and Technology, Sustainable Development, Geosciences

**Title:** Dynamics of turbulence and vortices in stratified-rotating fluids under the complete Coriolis force.

**ParisTech School:** Ecole Polytechnique

**Advisor(s) Name:** Paul Billant

**Advisor(s) Email:** [billant@ladhyx.polytechnique.fr](mailto:billant@ladhyx.polytechnique.fr)

**(Lab, website):** **Hydrodynamics Laboratory of Ecole Polytechnique (LadHyX).**

<https://www.ladhyx.polytechnique.fr/en/>

**Short description of possible research topics for a PhD:**

In geophysical fluid dynamics, the effect of the Earth's rotation is generally taken into account as if the Earth were flat. This approximation, called "traditional", consists in considering only the Coriolis force due to the component of Earth's rotation about the vertical axis at a given latitude while the rotation's component along the horizontal is neglected. Yet, the corresponding Coriolis force, called 'non-traditional', can affect several phenomena at intermediate scales in the atmosphere and oceans, especially near the equator since it introduces a misalignment between the buoyancy force and the rotation's vector. This has been evidenced in the particular case of waves and convective motions. In contrast, the effect of the non-traditional Coriolis force on vortices and turbulence is largely unknown.

Hence, the goal of the thesis will be to study its effect on the dynamics of turbulence and vortices by means of direct numerical simulations, theoretical analyses and experiments.

**Required background of the student:**

Fluid mechanics

Numerical simulations

**A list of 5(max.) representative publications of the group:** (Related to the research topic)

J. Park and **P. Billant**, 2013 Instabilities and waves on a columnar vortex in a strongly-stratified fluid. *Phys. Fluids*, 25, 086601.

P. Augier, **P. Billant**, M. E. Negretti and J.-M. Chomaz 2014 Experimental study of stratified turbulence forced with columnar dipôles. *Phys. Fluids*, 26, 046603.

P. Augier, **P. Billant** and J.-M. Chomaz, 2015 Stratified turbulence forced with columnar dipoles. Numerical study. *J. Fluid Mech.*, 769, 403-443.

E. Yim and **P. Billant**, 2016 Analogies and differences between the stability of an isolated pancake vortex and a columnar vortex in stratified fluid. *J. Fluid Mech*, 796, 732-766.

J. Park, **P. Billant**, J.-J. Baik, J. Seo, 2018 Competition between the centrifugal and strato-rotational instabilities in the stratified Taylor-Couette flow. *J. Fluid Mech*, 840, 5-24.