Observational imprints of the low-frequency chaos in the ocean: improving the climate monitoring system in the South Atlantic

- **Postdoctoral Research Associate** (15 months, renewable once)
- **Location:** MultiscalE Ocean Modelling (MEOM) team, Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE), Grenoble, FRANCE.
- **Salary Range** (H2020 funding): ~2000-2500 € monthly, depending on experience (net salary, health insurance included).

We seek a Physical Oceanographer to join the MEOM team in LGGE on the European AtlantOS project (WorkPackage 5), in collaboration with LMD-ENS. The goal is to assess/improve in the South Atlantic the observational monitoring of ocean climate variability, which results from an ocean-driven low-frequency chaos modulated by the atmospheric variability.

How to apply:

Application (detailed CV, letter of motivation, list of publications, name/email of referees) and/or informal enquiries should be directed to T. Penduff (thierry.penduff@univ-grenoble-alpes.fr) and S. Speich (speich@lmd.ens.fr)

Closing date: as soon as possible

About the proposed research, the AtlantOS and OCCIPUT projects:

The main objective of AtlantOS-WP5 is to improve the observational sampling for the monitoring of climate variability in the Atlantic ocean, in relation with nonlinear ocean dynamics. It will assist in the design of ongoing and upcoming regional field experiments in this basin, anticipating how to "best" achieve the observations of key variables and processes, in terms of spatio-temporal coverage and dynamical nature.

The focus of the proposed work is the South Atlantic subtropical gyre which is a hotspot region to monitor the Atlantic Meridional Overturning (AMOC) and the transport of heat, freshwater and carbon fluxes across the Atlantic (Cimatoribus et al., 2012). Within the international CLIVAR project SAMOC, an observational network across this oceanic circulation feature has been initiated at 34.5°S (Meinen et al., 2013; Garzoli et al., 2012). The South Atlantic is also characterized by a strong mesoscale variability (50 to 200 km, weeks to years). It was recently shown that in this nonlinear regime, the yearly-to-multidecadal variabilities of the AMOC, Sea-surface Temperature (SST), Sea-Surface Height (SSH), Ocean Heat Content (OHC), water mass properties and transports are only partly driven by the atmosphere: a low-frequency intrinsic variability spontaneously emerges and makes these variabilities partly chaotic (*Penduff et al., 2011; Hirschi et al., 2013 ; Arbic et al., 2014; Sérazin et al., 2015; Grégorio et al., 2015*). The main objectives of the proposed study is to [1] characterize the impact of the atmospheric variability and chaotic variability on these oceanic climate indices at synoptic, annual, interannual and multidecadal scales in this region, in order to [2] optimize the observational sampling strategy and maximize the benefits of the observing system.

We will jointly investigate observations and a pioneering ensemble of long numerical simulations performed within the ANR/PRACE OCCIPUT project (Penduff et al., 2014). It consists in a 50-member ensemble of global ocean/sea-ice simulations (1/4° resolution) that were slightly perturbed initially and driven by the same atmospheric variability between 1960 and 2015. The ensemble mean provides an estimate of the atmospherically-forced variability, the ensemble dispersion of the chaotic variability. We will characterize at various scales the forced and chaotic (co)variabilities of dynamical and thermodynamical fields at SAMOC and over the basin, their possible imprint on local and distant observational data (altimetry, Argo, RAPID, etc), and propose improvements, extensions, or alternative uses of the existing observed data.

- *Garzoli, S.,M.O. Baringer, S. Dong,R. Perez, and Q. Yao, 2012: South Atlantic meridional fluxes.* ***Deep-Sea Res****.I, 71:21-32*
- *Grégorio, S., T. Penduff, G. Sérazin, J.-M. Molines, B. Barnier, and J. Hirschi, 2015 : Intrinsic variability of the Atlantic Meridional Overturning Circulation at interannual-to-multidecadal timescales.* ***J. Phys. Oceanogr****., 45, 7, pp. 1929-1946.*
- *Meinen, C.S., Johns, W.E., Garzoli, S.L., van Sebille, E., Rayner, D., Kanzow, T.,Baringer, M.O., 2013. Variability of the Deep Western Boundary Current at 26.51°N during 2004–2009.* ***Deep Sea Res****.II 85, 154–168*
- *Penduff, T., B. Barnier, L. Terray, L. Bessières, G. Sérazin, S. Grégorio, J.-M. Brankart, M.-P. Moine, J.-M. Molines, and P. Brasseur, 2014 : Ensembles of eddying ocean simulations for climate.* ***CLIVAR Exchanges****, Special Issue on High Resolution Ocean Climate Modelling, 65, Vol 19 No.2, July 2014.*
- *Penduff, T., G. Sérazin, S. Grégorio, S. Leroux, L. Bessières, J.M. Molines, B. Barnier, and L. Terray, 2015: Spontaneous emergence of low-frequency variability in the global eddying ocean. Second* ***IUGG Quadriennal Report****.*
- *Penduff, T., M. Juza, B. Barnier, J. Zika, W.K.Dewar, A.-M. Treguier, J.-M. Molines, and N. Audiffren, 2011: Sea-level expression of intrinsic and forced ocean variabilities at interannual time scales.* ***J. Climate****, 24, 5652–5670. doi: 10.1175/JCLI-D-11-00077.1.*
- *Sérazin, G., T. Penduff, S. Grégorio, B. Barnier, J.-M. Molines, and L. Terray, 2015 : Intrinsic variability of sea-level from global 1/12° ocean simulations: spatio-temporal scales.* ***J. Climate,*** *28, 4279–4292. doi: http://dx.doi.org/10.1175/JCLI-D-14-00554.1.*

About You:

The postdoctoral fellow (you) will perform physical/statistical analyses of the ensemble simulation outputs, in relation with observations. Scientific questions will be related to the balance between forced and chaotic variabilities for climate-relevant variables in key regions of the South Atlantic, their spatial and temporal structures (spatio-temporal scales/patterns), their possible coherence with neighboring basins. In particular, our recent results (Leroux et al., in preparation) suggest that the interannual chaotic AMOC variability at 24.5°S is nearly as strong as its atmospherically-forced counterpart and has a rather clear phase relationship with that simulated at 26°N. The joint analysis of simulated AMOC variabilities at 26°N (observed since 2004) and 34.5°S (observed since 2009) may thus help reduce the imprint of the chaotic variability in both timeseries, and highlight the atmospherically-forced component. Observed/simulated SSH data will also be investigated since they are related to OHC, and to AMOC in certain regions. Covarying patterns of these variables will be investigated for both the forced and chaotic variabilities, hence highlighting their multivariate spatio-temporal structures.

This research subject is directed toward a motivated scientist interested in observational oceanography, statistical and physical analyses of this ensemble simulation, with a good experience of large datasets. A PhD in physical oceanography, meteorology, climate science, or geophysical fluid dynamics is required. You will be expected to publish in the relevant peer reviewed literature.