Inference of regional patterns affected by ENSO dynamics – Post-doctoral position

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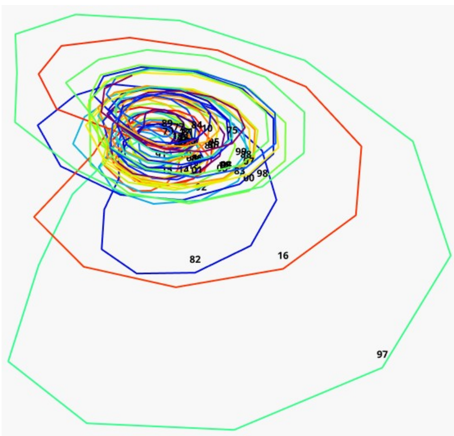
Scientific research context

Climate in the Pacific areas, from Australia to the Americas coastline, is strongly influenced by the ENSO phenomenon (El Niño Southern Oscillation) corresponding to irregular oscillations of the sea surface temperature and winds [1]. At the maxima of these oscillations, huge rainfall events create devastating floods on the Pacific South American coastline, while severe droughts and fires impact opposite regions (Australia, South East Asia, India). We focus especially on the area of the Pacific coast and slope (Andes) of Peru. We monitor the runoff of 49 river catchments, together with measured precipitations and temperatures over their watersheds, from the 1970s to the present [2]. We are then able to define regions with homogeneous hydroclimatology (e.g., wet or arid, coastal or montainous, etc) [3]. Four indices of sea surface temperature aggregate the influence of distinct zones of the Pacific Ocean on the ENSO phenomenon. Taken together, this approach allows to study the ENSO effects on separate regions. In particular, we aim at identifying the main influential factors that trigger extreme events in each region. We use a global approach in order to build an integrated model of the regionalized ENSO dynamics. Our goal is to produce reasonable predictions for each region, over the 3, 6 months to 1 year range, that the model states deviate from normal and may lead to an extreme event.

Work description

You will join an active team of multi-disciplinary research and must be prepared to work both on the theoretical aspects of dynamical systems inference, as well as the hydro-climatological aspects of the ENSO effects we are trying to model and quantify. This work is part of an on-going collaboration described on this page : https://team.inria.fr/comcausa/el-nino-southern-oscillation/

Our approach is based on computational mechanics and more precisely the method detailed in [4]. It consists in identifying the internal states of the natural process, states with the same causal influence, and how they evolve through time. These dynamical states are embedded in a low-dimensional state space, corresponding to the main influential parameters. These should also correspond to some combination of environmental factors driving the ENSO dynamics. This allows us to reconstruct attractors and make predictions along their trajectories. The example on the right is such an attractor, showing both the seasonal cycles and the extreme events of 1982, 1997 and 2016.



You will use the regionalized data described in [2,3] and the method from [4] to build predictive models for the 3, 6 months and 1 year range, over each hydro-climatologically consistent region. In order to best build these models, you will explore how each environmental parameter influences the dynamical reconstruction and affects predictions. But each descriptive variable (sea surface temperature, precipitations, water runoff…) is also the result of multiple interacting natural processes (oceanic, atmospheric and continental cycles), each with their own characteristic time scales. Theoretically, these scales also impact the relative influence of how each variable is accounted with respect to each other. Expliciting these multi-scale links in relation to the system dynamics (possibly reconstructed at different scales) is a methodological challenge that will also be addressed as part of this post-doctoral research.

[1] Bourrel L *et al.* (2015): Low-frequency modulation and trend of the relationship between ENSO and precipitation along the northern to centre Peruvian Pacific coast. Hydrological Processes 29(6): 1252-1266.
[2] Rau P *et al.* (2018): Assessing multidecadal runoff (1970–2010) using regional hydrological modelling under data and water scarcity conditions in Peruvian Pacific catchments. Hydrological Processes 33 (1) 20-35.
[3] Rau P *et al.* (2017): Regionalization of rainfall over the Peruvian Pacific slope and coast. International Journal of Climatology 37(1): 143–158.
[4] N. Brodu, J.P. Crutchfield : Discovering Causal Structure with Reproducing-Kernel Hilbert Space ε-Machines. https://arxiv.org/abs/2011.14821

About Inria and the Geostat research team

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Geostat is an Inria project located at Bordeaux. The team makes fundamental and applied research in the analysis of complex natural signals. This position is based at Inria Bordeaux under the supervision of Nicolas Brodu, but strong collaborations are expected with all our team members and especially with co-supervisor Luc Bourrel based at the Géosciences Environnement Toulouse (GET) laboratory.

General Information

Location : Inria Bordeaux

Starting date : 2021-11-01

End date : 2022-12-31

Salary: 2653€/month **before tax**
About 1900€/month after tax, maybe more depending on your situation. Benefits include social security (= medicare).

Instructions to apply

Deadline to apply : 2021-04-30

Prerequisites : A PhD in either computational sciences or environmental sciences. Candidates from either background are encouraged to apply, but must show a strong interest in both disciplines. A commitment to multidisciplinary and collaborative research is required.

Online application :
You *must* apply online with the link below, but please *contact us* in addition to applying to : https://jobs.inria.fr/public/classic/en/offres/2021-03561