

## Offre de Stage IPSL 2022

(soutenu par le programme EUR IPSL-Climate Graduate School)

Titre du sujet de stage :

**Subseasonal prediction of energy-relevant fields combining ensemble dynamical forecasts with deep learning**

Description du sujet (1 page maximum) :

**The internship project aims at improving subseasonal (2 to 6 weeks) forecasts of spatial fields relevant to the energy sector (wind power, temperature) using deep learning to better capture the statistical dependence between surface fields of interest and (multiple) large-scale fields which are better forecast by ensemble Numerical Weather Predictions (NWP). So far, Naveen Goutham has shown that the available ECMWF subseasonal NWP of surface fields could be improved by downscaling information from NWP of large-scale fields such as the geopotential height. This was achieved with an optimal combination of filtering and regression using a linear method known as Redundancy Analysis (RA, a variant of Canonical Component Analysis and of Reduced Rank Regression). Our objective is now to assess and better understand the role that nonlinearities, spatial heterogeneities and multi-scale interactions play in the statistical relationship between surface and large-scale fields and to eventually better capture these features to improve forecasts combining dynamics and statistics. To do so, we intend to apply deep learning methods such as UNETs and RESNETs to the 20 years of ensemble hindcasts and 5 years of ensemble S2S forecasts available. These methods have been designed to combine complex information on multiple scales while preserving some degree of interpretability and have been shown to improve rainfall forecasts by one of us (Bouget, V., Béréziat, D., Brajard, J., Charantonis, A., Filoche, A., 2021. Fusion of Rain Radar Images and Wind Forecasts in a Deep Learning Model Applied to Rain Nowcasting. *Remote Sensing* 13, 246).**

**The intern will be supervised by climate scientists with complementary skills on climate variability and predictability, deep learning and energy engineering and economics. The intern will not start from scratch as the supervisors will provide ECMWF data and data-parsing codes, as well as deep-learning codes that were used for similar applications. He/she will start working on a personal computer (provided by the LMD if necessary) and move to more intense computations on the GPU node of the IPSL meso-center. The intern will be part of a team specifically working on complementary aspects of subseasonal forecasting for the energy sector including Naveen and a postdoc working on the combination of model ensembles using optimal transport. He/she will also have the chance to engage in the SAMA activities on machine learning and to the Energy4Climate interdisciplinary dynamic. The supervisors are also committed to participate in the SAMA activities, as required.**

**The candidate is expected to be motivated by climate and energy-related topics, to have good Python coding skills and to be trained in machine learning, data science and statistics. A training on atmospheric dynamics and physics is a plus but is not mandatory.**

Résumé en anglais (5 lignes) :

**We aim at improving ensemble subseasonal forecasts of spatial fields relevant to the energy-sector using deep learning to better capture and understand the statistical dependence between surface fields of interest (e.g. wind) and more predictable fields (e.g. geopotential height). Beyond linear statistical models, well-designed neural networks should help capture the nonlinear, spatial and multi-scale characteristics of this dependence while leveraging information from all ensemble members.**

Responsable du stage (Nom/prénom/statut) :

**Tantet/Alexis/Professeur assistant (équivalent maître de conférence)**

Laboratoire concerné :

**LMD, LOCEAN**

Adresse à laquelle a lieu le stage :

**École Polytechnique, Palaiseau**

Equipe de recherche concernée (si pertinent) ou autre participant à l'encadrement du stage:

**Anastase Alexandre Charantonis (LOCEAN), Naveen Goutham et Riwal Plougonven (Équipe DPAO au LMD et E4C)**

Niveau du stage (Licence, M1, M2, internship) :

**M2**

Licence ou Master(s) où sera proposé le sujet :

**Master : TRIED Paris-Saclay, Data Science IP Paris, MOCIS, WAPE, SOAC Lyon, SOAC Toulouse  
Cycle ingénieur : IP Paris (Polytechnique, Telecom, ENSTA), Telecom Bretagne, IP Paris, ENS**

Thème scientifique de l'IPSL concerné :

**Statistics for Analysis, Modelling and Assimilation (SAMA)**

Durée du stage : **4-6 mois**

Période : **01/04/2022 - 01/10/2022 (ajustable en fonction des besoins l'étudiant.e)**

Rémunération de l'ordre de 580 euros par mois

Est-il prévu une thèse dans le prolongement du stage ?

**Sujet de thèse prévu, financement non assuré.**