Offre de Stage IPSL 2020

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

Titre du sujet de stage : Influence of the Arctic sea ice loss on Marine Cold Air Outbreaks

Description du sujet (1 page maximum) : Observational studies have documented trends in temperature and precipitation extremes that could be associated with severe impacts on human society, the economy, and ecosystems. There is a widespread warming trend of both maximum and minimum temperature extremes, generally stronger for the daily minimum (nighttime) temperature. In most regions there are less frequent cool days and shorter cold spells, and more frequent warm days and longer warm spell duration. These trends have amplified since the 80s. Model studies suggest that the overall temperature trends are largely due to human influence, although natural variability also significantly contributes. The North Atlantic/Arctic Oscillation, ENSO, the Pacific Decadal Oscillation, and the Atlantic Multidecadal Oscillation may substantially affect the temperature in certain regions, and there is substantial variability at the interannual scale that reflects natural atmospheric circulation fluctuations.

Of particular interest are the marine cold air outbreaks (MCAO), which are high-impact weather events in which cold and dry air masses are transported from over sea ice or cold land masses over the relatively warm open ocean. Such events pose a hazard for human activity, and they constitute a favorable environment for the formation of polar lows, which are strong mesoscale cyclones that form over the high latitude oceans, and for boundary layer fronts. The associated strong surface wind speed poses a high risk to navigation, and the intense oceanic heat loss to the atmosphere plays a key role in ocean-atmosphere interactions. Polar low are of too small scale to be directly predicted by weather forecasts in the sparse observational network of the Arctic Ocean, so that much attention is given to the environment in which they form in order to establish their likelihood. However, even when they are not associated with polar lows, the strong MCAO surface wind speed still poses a high risk to navigation. MCAOs frequently occur in the northern North Atlantic (Nordic Seas, Barents Sea) during winter. As the sea ice edge retreats because of global warming, navigation will continue to intensify in these high latitude regions. A few authors have suggested that Arctic sea ice loss may have increased the occurrence of extreme events, but some climate model projections suggest a future decrease in MCAO. It is thus crucial to further establish whether the frequency and intensity of MCAOs will change, and to understand if the changes are due to the melting of the Arctic sea ice or to other factors such as sea surface temperature or greenhouse gas concentration (GHG). This is difficult using observations alone, but can be done using climate model simulations where some forcing can be held constant.

During this internship, we will use already available ensemble simulations coordinated in the European Union Blue-Action program with the atmospheric component of the IPSL-CM6 climate model forced by prescribed sea ice and SST from 1979 to 2015. The first ensemble uses observed sea ice, SST, and GHC, thus best mimicking observations, while the second ensemble uses climatological

sea ice conditions instead of time-varying ones, thus allowing to isolate the impact of the sea ice loss. There are 30 independent simulations in each ensemble. We will also consider similar 30-member ensemble simulations made with the NCAR WACCM6 atmospheric model. We will map the MCAOs in the northern North Atlantic and compare different methods to detect them, including a new method based on the square or the cube of the daily surface wind, as well as compare them with observations. We will then investigate their simulated trends in the historical period and determine to what extent they are due to sea ice loss. Finally, the MCAO evolution in the 21st century will be investigated using the IPSL-CM6 ensemble simulation under the RCP8.5 scenario.

References:

Fletcher, J.,S. Mason, C. Jakob (2016). The climatology, meteorology, and boundary layer structure of marine cold air outbreaks in both hemisphere. J. Climate, 29, 1999-2014

Kolstad, E.W. (2017). Higher ocean wind speeds during marine cold air outbreaks. Quart. J. Roy. Meterological. Soc. 143, 2084-2092.

Landgreen, O.A., I.A. Seierstad, T. Iversen (2019). Projected changes in marine cold air outbreaks associated with polar lows in the northern North Atlantic ocean

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Laboratoire concerné : LOCEAN

Equipe de recherche concernée (si pertinent) : VARCLIM

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

Licence ou Master(s) où sera proposé le sujet : MOCIS, WAPE, STEEM, RES

Thème scientifique de l'IPSL concerné : changement climatique

Durée du stage : ___4_ mois

Période : 01/03/19 → 30/06/19 (avec éventuel décalage)

Est-il prévu une thèse dans le prolongement du stage ? peut-être, mais pas dans le prolongement direct