New science project:

Interaction/teleconnection between tropics and extratropics

Laura Ferranti (co-lead), Hervé Douville (co-lead), Adam Scaife, Swadhin Behera, Francisco Doblas-Reyes

The objective of this project is to analyse tropical-extratropical interactions at seasonal and sub-seasonal time scales in different models and observational data sets using a common framework for a straightforward intercomparison.

Midlatitude low frequency variability is often described in terms of recurring, persistent teleconnection patterns (Wallace and Gutzler 1981; Barnston and Livezey 1987). Amongst these various patterns, most studies find that the North Atlantic Oscillation (NAO) and the Pacific– North American (PNA) teleconnection patterns are the two most dominant in the northern hemisphere.

The initial phase of the project will document:

- the variability of the NAO and PNA,
- how the NAO and PNA are associated with precipitation, 2m temperature and SST anomalies on a global scale,
- their dependence on the mean climate, seasonal cycle and different phases of ENSO, tropical Atlantic variability, MJO and QBO forcings

It is desirable the use of a common NAO and PNA definition in order to facilitate comparison of results among different models. We propose to use the first EOF patterns of both slp and Z500 computed from seasonal values. Since some models seems to have difficulties to reproduce the teleconnections at the surface it is important to carry on the analysis at 2 different levels.The EOF can be computed using either NCEP or ECMWF re-analysis data covering at least a period of 20 cold periods (Nov to March). For the NAO the domain to consider is the Atlantic sector (80W-40E, 25-85N) while for the PNA it is the Pacific sector (160E-80W, 25-85N). It is also worth considering the NAO pattern over an extended sector covering the Atlantic and the Asian continent (80W-140E, 25-85N).

The importance of using precipitation to assess teleconnections originated from the tropical Indian and West Pacific Oceans is well known (e.g. Hoskins

and Karoly 1981, Kumar el at. 2013) and has been recently discussed by Manola et al 2013 and Molteni et al. 2015. Because of the weaker constraint of SST on rainfall, teleconnections diagnosed as a function of SST anomalies in the Indian and West Pacific Oceans fail to adequately represent the response to anomalous atmospheric heat sources in these regions. When teleconnections are computed from Rossby wave sources or covariances with rainfall anomalies, a stronger consistency is found both between observed and modelled patterns, and between diagnostics derived from seasonal and intra-seasonal time scales. Molteni et al. showed that, in association with increased rainfall in the western and central Indian Ocean, an extra-tropical mode, consisting in the Alaskan low and positive NAO combination, can be consistently detected on both intra-seasonal and inter-annual time scales.

The second phase of the project will focus on the analysis of:

- the SST-precipitation relationship over the tropical regions.

- the predictive skill of tropical precipitation;

- the predictive skill of the NAO and PNA via tropical teleconnections

Over the regions where atmospheric variability drives the ocean variability and consequently the local SST- precipitation correlation is weakly negative, the inherently unpredictable nature of atmospheric variability leads to limited predictability for seasonal precipitation (Kumar et al. 2013). On the other hand, over the regions where slow time scale ocean variability drives the atmospheric circulation, and the local SST–precipitation correlation is large positive, the predictability of seasonal mean precipitation is high. Therefore it is interesting to document how the different dynamical models represent the SST-precipitation relationship and how this compares with the relationship described by the observational data set.

As a first step we suggest to use monthly means data aggregated over a 3-months period from existing seasonal hind-cast archives, such as the CHFP. The seasonal means, their predictability and the associated teleconnections will be evaluated for different forecast ranges (e.g. lead time=month1, month2 etc.). For observational data we suggest using GPCP and OSTIA SST and NCEP or ECMWF/NCEP re-analysis for Z500 and slp. Verification of the 1st

month may have a special importance since it can show how the first month(s) matters for the skill of seasonal to interannual forecasts. Month 1 of the CHFP model data (if daily data is available in the archive) can be used to investigate the MJO and ENSO scale interactions. The effect of the planetary scale teleconnections associated with intraseasonal variability, on the seasonal time scale during neutral ENSO years could also be investigated. On the monthly time scale the role of the land surface and of the stratosphere are important and it is of great interest, for seasonal forecasting, to understand the necessary conditions for this role to persist beyond month-1. Since a similar initiative is promoted by the S2S, this project will benefit from synergy between the S2S and WGSIP community.

References:

Kumar et al. 2013: "Understanding prediction skill of seasonal mean precipitation over the tropics" Journal of Climate Vol. 26 p.5674-5681

Manola et al 2013: "Drivers of North Atlantic Oscillation Events", Tellus A, 65, 1-13.

Molteni et al. 2014: "Understanding and modelling extra-tropical teleconnections with the Indo-Pacific region during the northern ". Climate Dynamics. Ref.: Ms. No. CLDY-D-14-00256R2