Frontier Research in Earth System Prediction

Andrea Alessandri
Royal Netherlands Meteorological Institute

Abstract

So far, the lack of observations to constrain the model complexity has determined the development of different modeling systems for different time scales. The models that are developed for short time-scales (Weather to seasonal climate predictions) include only that part of the land surface variability for which observations are available and that can be suitably modelled/initialized in order to positively contribute to the forecasts. For instance, the land surface model developed at ECMWF (HTESSEL), and included in the ECMWF Integrated Forecasting System (IFS), assumes land cover and vegetation characteristics to be constant in time, therefore evidencing considerable biases and weak prediction signal over the interested land areas. On the other hand, for the interannual and longer time scales, the Earth System Models (ESMs) used for climate variability/change research contain comprehensive soil-vegetation-atmosphere-transfer schemes that are intended to represent as many processes as possible, even those that are still poorly constrained or understood**¡Error! Marcador no definido.** The "PROCess-based sEamless development of useful Earth system predictions over land" (PROCEED; http://projects.knmi.nl/proceed) project aims at achieving improved Earth system predictions on multiple time scales by filling the gap between the models used for short-term prediction (verification-based) and the latest developments in the ESMs (process-based). In the frame of PROCEED, a methodology is being proposed to properly include the land processes that can suitably contribute to prediction performance in the IFS/EC-Earth system. Following this approach, we show for the first time that the implementation of a realistic representation of effective vegetation-cover variability in EC-Earth can significantly improve climate prediction across multiple time-scales. By comparing two sets of simulations performed with and without the inclusion of the new parameterization of vegetation-cover variability, spanning from centennial (20th Century) simulations and retrospective predictions to the decadal (5-years), seasonal (2-4 months) and weather (4 days) time-scales, we show a significant enhancement in climate simulation and prediction over land that is consistently obtained at the multiple time-scales considered (see details of the results in the peer-review paper

published on Climate Dynamics: Alessandri et al., 2017; doi:10.1007/s00382-017-3766-y).

Long-term enhancements in climate/Earth system predictions must come from improving the description of the physical & Earth-system processes on the basis of dedicated process studies and observational databases. This is a slow, but necessary process. In the meanwhile, given a set of imperfect models, we can improve predictions by combining individual models through the multi-model approach.

Multi-Model Ensembles (MMEs) are powerful tools in dynamical climate prediction as they account for the overconfidence and the uncertainties related to single-model ensembles. Previous works suggested that the potential benefit that can be expected by using a MME amplifies with the increase of the independence of the contributing Seasonal Prediction Systems (SPSs). Here we combine the two MME SPSs independently developed by the European (ENSEMBLES) and by the Asian-Pacific (APCC/CliPAS) communities. We demonstrate the potential of the Grand MME to significantly contribute in obtaining useful predictions at the seasonal time-scale for the application in the energy sector (see details in a peer-review paper recently published on Climate Dynamics: Alessandri et al., 2017; doi:10.1007/s00382-016-3372-4). This work further motivated the "WP2 - Optimization of Seasonal Forecasts" activities in the H2020 SECLI-FIRM project [http://www.secli-firm.eu; started 1st February 2018] where the application of latest available multi-model seasonal predictions from independent sources [European (Copernicus), North American (NMME) and Asian Pacific (APCC)] will be performed.

Short bio

Dr. Andrea Alessandri has an interdisciplinary background and a wide experience in studying climate variability and predictability with particular focus on land surface/climate interactions and in modeling the Earth Climate System. He contributed in studying the couplings and climate feedbacks over transition zones between wet and dry climates such as the Euro-Mediterranean domain. He contributed to several international predictability efforts in the framework of the EU projects DEMETER [FP5, 2000-2003], MERSEA [FP5, 2004-2008], ENSEMBLES [FP6, 2004-2009], SPECS [FP7, 2012-2017] and the international project ISVHE [2009-2013].

While keeping his affiliation as senior researcher at the Italian National Agency for New Technologies, Energy and Sustainable Development (ENEA, Italy), he joined the Royal Netherlands Meteorological Institute (KNMI, Netherlands) in 2017 to fulfill his H2020-MSCA individual grant PROCEED (http://projects.knmi.nl/proceed/). The aim of PROCEED is to achieve improved Earth system predictions on multiple time scales by filling the gap between the models used for short-term prediction (verification-based) and the latest developments in the Earth System Models (process-based).

Author of about 60 between refereed papers and other relevant publications. In the last 5 years, his papers received over 1000 citations and his H-index is 16 (source Google Scholar). He won the “Marie Curie Award” in 2012 by European Commission Research Executive Agency and the “Norbert Gerbier-Mumm International Award” for 2006.

Since 2013 he is convener at the EGU General Assembly, since 2017 convener at the AGU Fall meeting and since 2010 Editor for the EGU journal Earth System Dynamics. He served as contract professor in the PhD Programme in Science and Management of Climate Change at University of Venezia - Cà Foscari: Earth System Dynamics class (2014-2016) and Biogeochemistry class (2007-2011) and currently as invited lecturer at the Vrije Universiteit Amsterdam (Master class on Climate Hydrology).