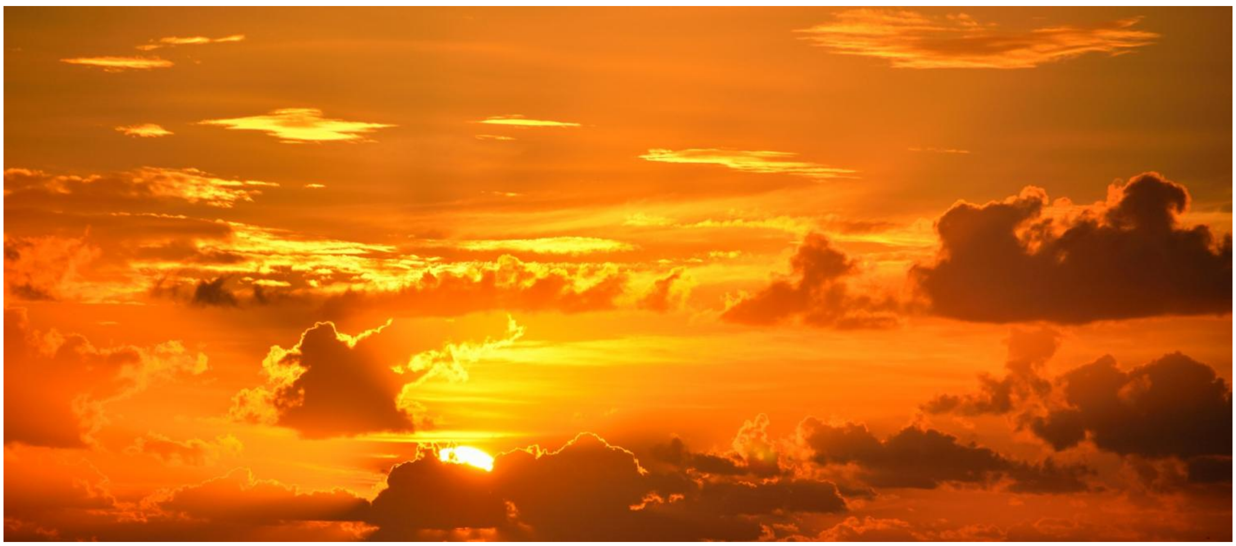
Structural decomposition of decadal climate prediction errors

October 13 2017



Credit: CC0 Public Domain

Climatologists and statisticians of Ca' Foscari University of Venice have elaborated a method to accurately estimate systematic errors affecting decadal climate predictions. The proposed method promises great progress toward the achievement of reliable near-term climate forecasts. The result was published yesterday on the prestigious journal *Scientific Reports* of the *Nature* publishing group.

Decadal climate prediction explores the climate evolution with a forecast horizon of about a decade, and represents one of the most interesting frontiers of climate research due to its potentially huge economic, political and social repercussions.

The numerical models currently employed in decadal climate prediction systems are affected by severe systematic errors (or biases) in key regions of the ocean and atmosphere, due to their imperfect representation of fundamental physical processes. Because of these biases, the simulated mean state of the climate can be significantly different from the observed one over large regions.

As in the case of weather forecast, these models are initialized – they assimilate observed data so that the simulated climate evolution is as close as possible to the observed one. To predict the future evolution, the model is "set free". In the first phase the model is thus "forced" to follow the observations; then, from the moment it is "set free" it progressively departs from the observed mean climate and relaxes toward its own, specific mean climate. As if these were two separate parallel worlds: observed and simulated realities. By the time the model evolves freely without observational constraints, the model drifts, with a progressive "transition" from the first to the second (biased) reality.

The issue is complex, and the drift's evolution is therefore most often just estimated by means of simple empirical methods, and quantification of its uncertainty neglected: In other words, the drift is typically considered as a mere error to be corrected.

This research, in contrast, focuses on the drift, which is considered for the first time as a statistical process with its own temporal dynamics. The statistical model allowed to separate the different components that concur determining drift and bias, including long-term error trends and seasonalities. Further, it allowed to establish causal relationships between drift and other climatic processes.

The article published yesterday is coauthored by Davide Zanchettin, Carlo Gaetan, Angelo Rubino and Maeregu Arisido from the DAIS together with researchers from the Max Planck Institute in Hamburg, the Bjerknes Centre for Climate Research and the Geophysical Institute of Bergen University, as part of the large European Project PREFACE (preface.b.uib.no/).

The proposed method - based on a linear dynamic model - is the result of synergies between research groups on statistics, numerical modelling and climate dynamics coordinated by professors Gaetan and Rubino (work package leader in the project PREFACE).

"Ours represents an innovative application, in the field of climate research, of a statistical methodology that has been well established in other fields, such as economics. Our result can hopefully foster the cooperation between European researchers in the fields of statistics and climatology, following a trend anticipated by colleagues in the United States", explains Davide Zanchettin.

"We aimed at bringing more sophisticated statistical methods to climate research. We achieved this goal thanks to the commitment of the DAIS to build a "bridge between two worlds" - dynamic climatology and statistics - that often use different languages", says Angelo Rubino.

"PREFACE represented a great opportunity to show how complex statistical theory is not a mere theoretical exercise, but a potential support in other fields" concludes Carlo Gaetan.

More information: Davide Zanchettin et al. Structural decomposition of decadal climate prediction errors: A Bayesian approach, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-13144-2

Provided by Ca' Foscari University of Venice