STOCHCLIM

Improving the representation and prediction of climate processes through stochastic parameterization schemes

DURATION
01/10/2013 – 31/12/2017

BUDGET
912 973 €

PROJECT DESCRIPTION

A wide variety of climate-type phenomena have been discovered, from monthly time scales like the Madden-Julian Oscillation (MJO) up to decadal time scales like the Atlantic Meridional Overturning (AMO) circulation, which potentially have important impacts for medium term social and economic planning. Currently, large modelling uncertainties hamper the possibility to simulate and forecast accurately these medium to long term processes in a satisfactory manner. Improving the understanding and representation of these processes are considered as research priorities in the International scientific communities as reflected in the strategic research agenda of the Joint Programming Initiative, Connecting Climate Change Knowledge for Europe (JPI Climate).

The objective of this project is to improve the understanding and description of key physical processes in climate models of increasing complexity, with emphasis on the improvement of the variability of dynamical phenomena acting on monthly, seasonal and decadal time scales. This aim will be pursued by developing and assessing new parameterization (closure) schemes incorporating stochastic components.

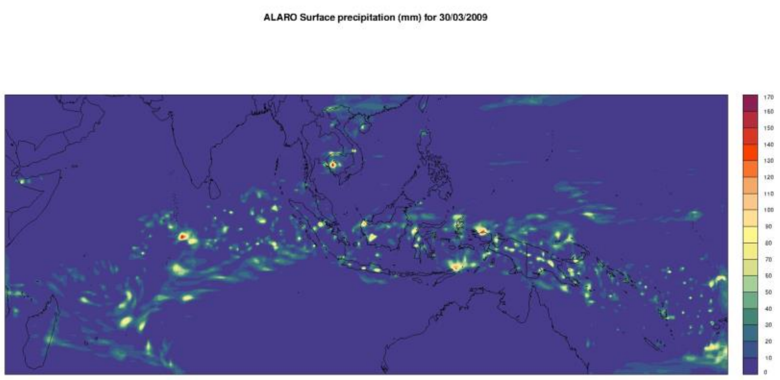
Four specific questions will be addressed:

(i) What type of parameterization schemes (including stochastic components) should be introduced in climate models (and where) in order to improve their variability, in particular at seasonal and decadal time scales? This question will be investigated by developing, calibrating and assessing stochastic schemes in low-order and intermediate order climate models.

(ii) What is the dynamical response of stochastic climate models to slow transient forcings, and what are the precursors of abrupt climate transitions? A theoretical analysis of the impact of stochastic processes in simple nonlinear dynamical climate systems in the presence of slow transient forcings and model errors will be performed, and extended subsequently to more detailed climate models.

(iii) What will be the usefulness of introducing stochastic components in current convection parameterization schemes of detailed climate models in order to improve the quality of their statistical properties, in particular for the water cycle? The investigation will mainly focus on new parameterization (convection) schemes developed at RMI, and their stochastic extensions, incorporated in the regional operational model ALARO. Other stochastic approaches (stochastic diabatic tendencies, backscatter schemes) will also be explored in the context of these models and compared to each other.

(iv) To what extent does stochastic parameterization improve the information on the forecast uncertainties of climate models? This question will be addressed in the context of the models already mentioned above, with emphasis on our ability to track processes acting from seasonal up to decadal time scales, like the MJO and the AMO.



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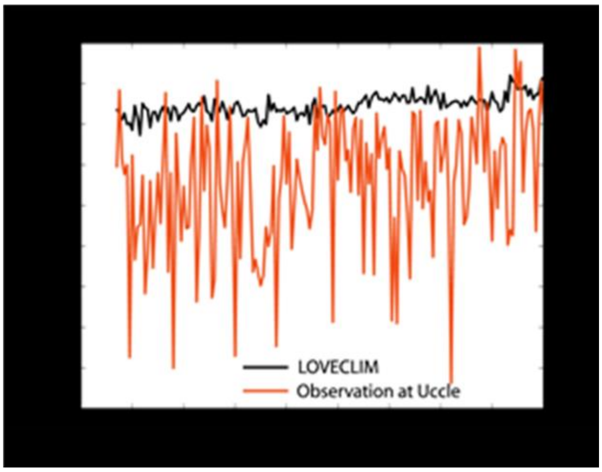
The fundamental aspects of stochastic physics for the correction of model errors and the quality of forecast will be implemented through the cross-fertilization of theory and practice. In particular real measurement data will be used for both the development and optimization of the stochastic schemes and their (independent) evaluation. These process-oriented investigations, drawing on an array of complementary approaches, are expected to reduce biases present in model climatologies, and allow for a more precise quantification of the forecast uncertainties. Specifically, statistical properties (mean, variance, higher order moments, correlations, forecast skill) of air temperature, precipitation and wind fields, surface fluxes, and oceanic transports will be compared with reanalysis data sets.

To realize these objectives, an approach integrating the complementary expertise of the different teams, namely stochastic processes and dynamical systems theory (RMI and UCL) and the dynamics and physics of intermediate order and detailed atmospheric models (RMI, UCL, Ugent), will be adopted.

Major outputs include a comprehensive implementation of stochastic representation of sub-grid scale and external (not explicitly modelled or unknown) processes for decadal predictions, together with an analysis of their usefulness as state-of-the-art simulation tools used for forecasting purposes. These different analyses will be disseminated through international peer-reviewed publications, workshops, conferences, and through posting results on a project website.



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LINKS

http://climdyn.meteo.be/meteo/view/en/14388004-STOCHLIM.html

http://www.climate.be/stochclim