

SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year 2016

Project Title: Effects of a stochastic gravity wave parameterization on the simulation of stratospheric dynamics

Computer Project Account: SPITCHCG

Principal Investigator(s): Chiara Cagnazzo, Federico Serva, Gloria Rea

Affiliation: ISAC-CNR

Name of ECMWF scientist(s) collaborating to the project (if applicable)

Start date of the project: 2016

Expected end date: 2019

Computer resources allocated/used for the current year and the previous one (if applicable)

Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	NA	NA	1,000,000	50,000
Data storage capacity	(Gbytes)	NA	NA	25,000	200

Summary of project objectives

(10 lines max)

Within the SPITCHCG project we aim to study the response of the simulated stratospheric dynamics of the climate model MA-ECHAM5 to a stochastic modification of the parameterization of nonographic gravity waves (which are inherently intermittent, being generated in the atmosphere from frontal activity and convection). In order to get a better understanding of the effects on long term trends and variability in the stratosphere, multi-decadal simulations will be performed. The possible improvements of this modification will be assessed also coupling the same atmospheric model with an interactive ocean model, and possibly implementing and testing the stochastic parameterization for the EC-EARTH model.

Summary of problems encountered (if any)

(20 lines max)

We found some difficulties with the usage of the PBSpro tool for managing our simulations. We would like to acknowledge the ECMWF support (specifically Dr. Modigliani) for insight on how to reformulate our launching scripts for the ECMWF infrastructure.

Summary of results of the current year (from July of previous year to June of current year)-- next 2 pages

The SPITCHCG is still at an early stage. The majority of our time was devoted to technical aspects such as compiling and running the code on the machines and preparing the boundary condition files. Our plan is to use the QBOi initiative boundary conditions and possibly to partially contribute to QBOi itself (<http://users.ox.ac.uk/~astr0092/QBOi.html>), aimed at studying and improving the QBO (i.e., the variability of the tropical stratosphere) simulated by modern climate models. In the first months we worked on the boundary conditions since most the boundary conditions needed for the QBOi initiative differ from the ones we initially used. Specifically we focused on the solar cycle, the ozone and the aerosols fields, needed as input to our model.

During the first months of the SPITCHCG, we performed some initial tests on the geometry to use for running the model at a reasonable cost. However, the space required for model outputs cannot be further reduced and that may possibly be a limiting factor in the future.

Apart from initial tests, we just started our multi-decadal simulation, after a period of model spin-up. The model uses the Hines parameterization for GWs that employs several parameters that can be adjusted for tuning the model towards observations.

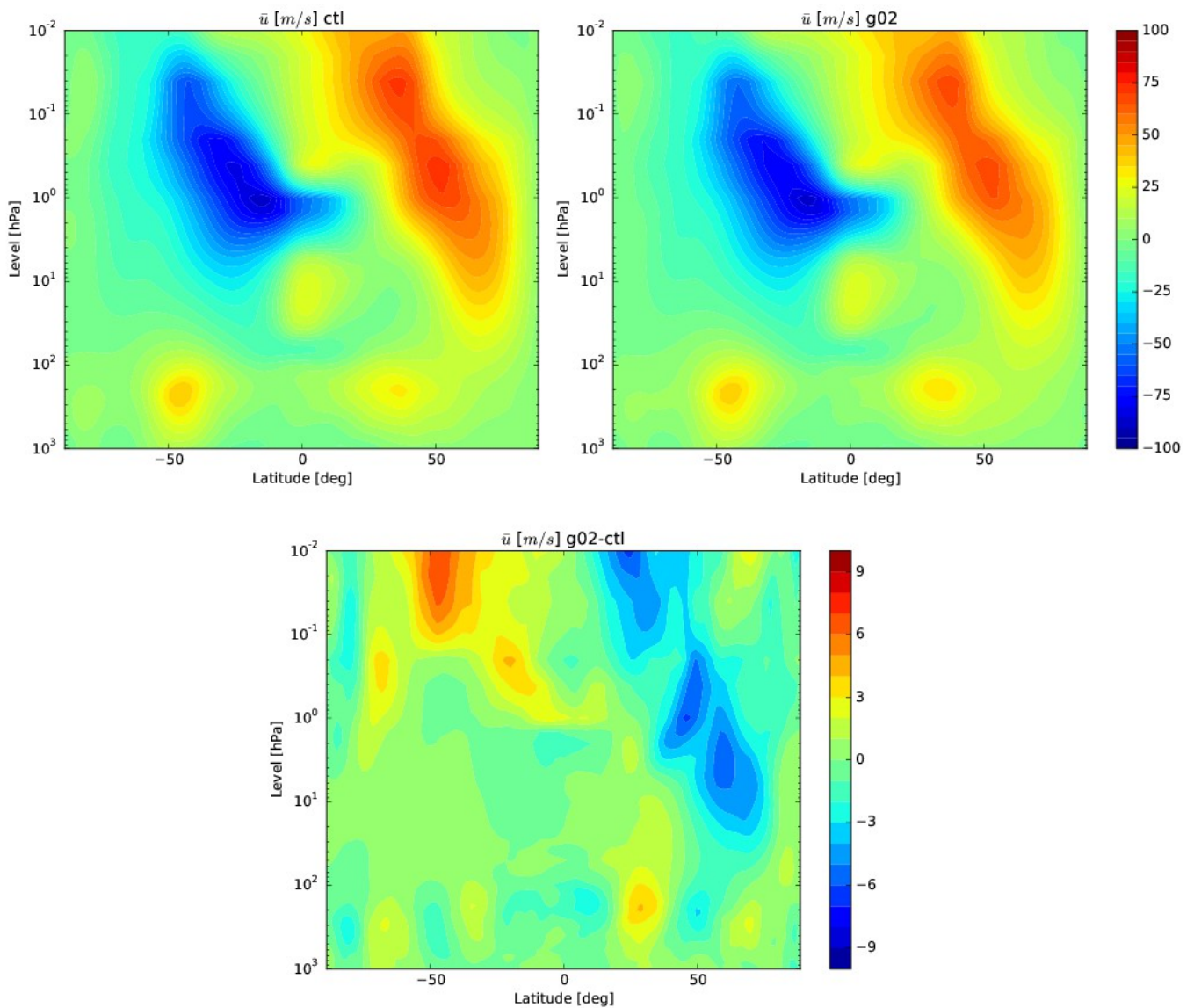


Figure 1: Zonal mean zonal wind for January, 1960. Top left: deterministic ECHAM; Top right: stochastic ECHAM; Bottom: stochastic minus deterministic.

The modification we have implemented is quite simple: the only parameter which is random (extracted from a given PDF at each timestep and grid-point) is *rmscon*, that is, the perturbation due to the NOGW field at launching level (fixed at level 11, at about 500 hPa). The default value for the T63L95 configuration is 1 m/s. Since the "default" model already has a realistic mean state and variability of the middle atmosphere, we opted to perturb the default **rmscon** with Gaussian (symmetric) distributions, with $\mu = 1$ and σ as a tunable parameter. Some preliminary results are shown in Fig.1, in which the zonal mean zonal wind of the deterministic (ctl) and stochastic (g02: std dev 0.1 m/s) versions of the model, and their difference, are reported.

The stochastic version of the model, in which as explained above the drag exerted by parameterized gravity waves of nonographic origin is not constant, but is assumed to be random (following an assigned PDF) at the launching level, exhibits a realistic mean state for January, but also a weaker vortex in the winter (northern) hemisphere and a positive anomaly in the summer (southern) hemisphere. Such differences, which are larger above 100 hPa, show that gravity wave forcing alter significantly the dynamics of the stratosphere.

The simulated dynamics will be evaluated against ERA-Interim reanalysis products, specifically in terms of the stratosphere-troposphere coupling and the effects of an improved equatorial dynamics on the extratropical regions.

List of publications/reports from the project with complete references

Summary of plans for the continuation of the project

(10 lines max)

In the next months, we will continue the multi-decadal simulation we just started with both model version (default and stochastic). We will then proceed with some tests and with the spin-up of the ocean model to be coupled with our atmospheric model, that we will do as soon as possible.

Depending on available resources, we shall tackle a certain number of experiments from the list of QBOi initiative using the modified version of the atmospheric model, in order to contribute to this comparison exercise. Implementation of the stochastic scheme in the IFS model of the EC-EARTH Earth System Model and its testing will be done, depending on available resources. ...