Project: **966**

Project title: **DynVar**

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Report period: **2016-01-01 to 2016-12-31**

Text: maximum of two pages incuding figures.

Given that the CMIP6 simulations are still in preparation, resources have been used so far, for the following tasks:

(1) Prepare and test the software for the DynVar diagnostics to be used at the MPI, specifically the software for the Transformed Euleran mean (TEM) diagnostics (Gerber and Manzini 2016). This task is partially completed, as a few modifications of the original codes available with the Middle and Upper Atmosphere Group are still needed.

(2) A first illustrative analysis of the TEM atmospheric momentum balance, from 20 years of an historical experiment performed with a CMIP5 model, specifically the CMCC-CMS (one of the models used in Manzini et al 2014). Results from the last 10 years of this analysis are reported in Figure 1, which shows the evolution of the atmospheric momentum balance from the lower mesosphere to the upper stratosphere. Figure 1 demonstrates that in this model in the middle atmosphere and at the monthly scale, there is a very good balance between the momentum tendency (e.g. "forcing") due to large scale meridional and vertical advection on one side, and the momentum tendency due to the gravity wave and the resolved waves on the other side, although the relative contribution of the latter terms changes with elevation: the gravity wave contribution decreases from the mesosphere to the stratosphere and is negligible in the lowermost stratosphere, while the resolved wave contribution is significant at all elevations and dominant in the lowermost stratosphere. Therefore, the momentum balance is realized by physically meaningful processes and numerical dissipation is negligible, an important assessment for the interpretation of the mechanics of a model.

(3) Application of the momentum balance diagnostics to idealized model simulations performed with the ICON-SLAM (icosahedral non-hydrostatic atmosphere - spherical limited area model), to gain experience on how to interpret the flux of atmospheric momentum in ICON in a simplified case, where only the tropical atmosphere and gravity waves are considered. This application was motivated by our inexperience on how the atmospheric momentum is balanced in the ICON model, specifically on the relative roles of momentum transfer by waves and momentum dissipation by numerical diffusion (which at this stage we do not know, if negligible, as in the example of Figure 1). This application will be relevant for interpreting the DynVarMIP diagnostic when ICON will be used in CMIP6. For this application, so far we have performed short ICON-SLAM experiments and used temporary storage within this project.

References:

Gerber and Manzini (2016) The Dynamics and Variability Model Intercomparison Project (DynVarMIP) for CMIP6: assessing the stratosphere–troposphere system, Geosci. Model Dev., 9, 3413–3425, doi:10.5194/gmd-9-3413-2016, http://www.geosci-model-dev.net/9/3413/2016/

Manzini, E., et al. (2014) Northern winter climate change: Assessment of uncertainty in CMIP5 projections related to stratosphere-troposphere coupling, J. Geophys. Res. Atmos., 119, 7979–7998, doi:10.1002/ 2013JD021403.

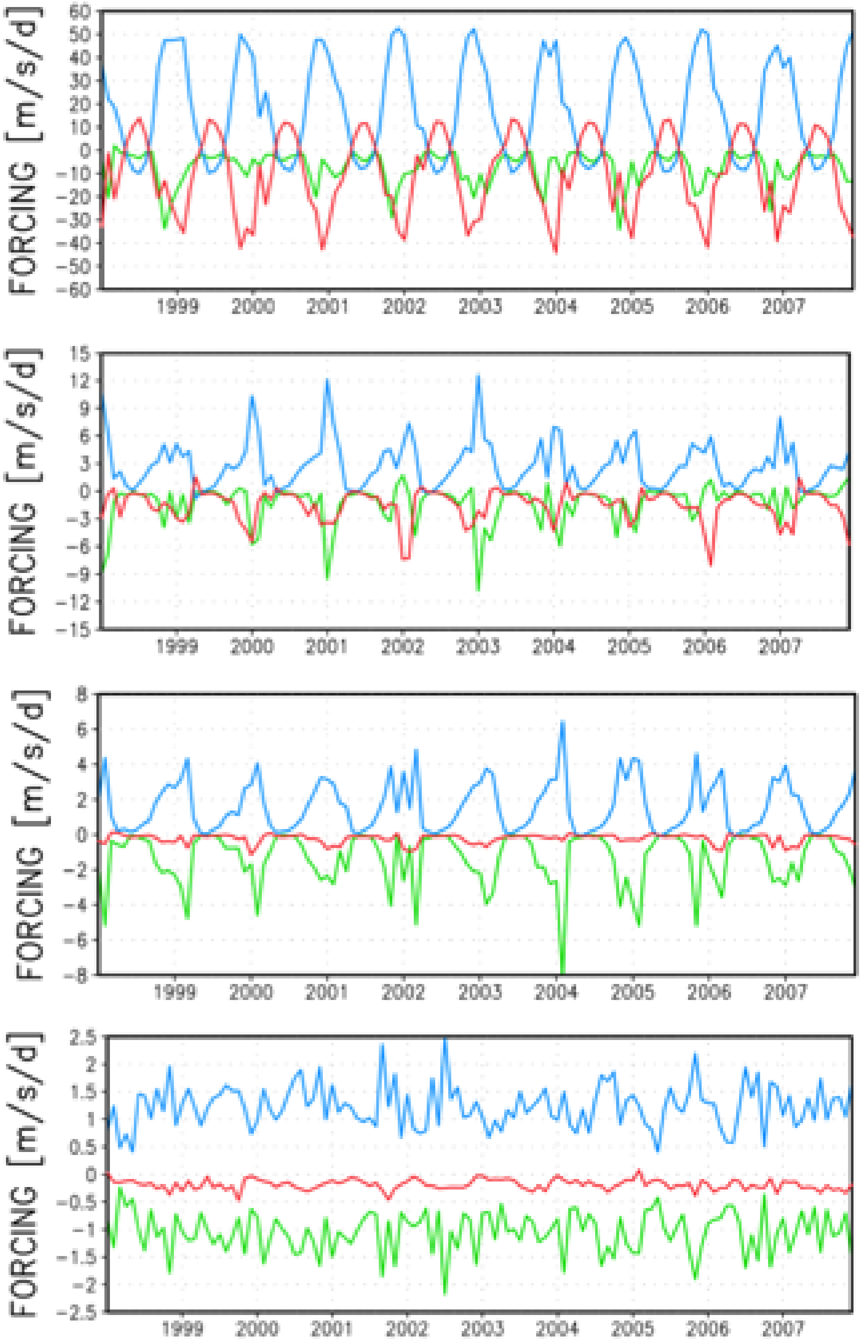

Figure 1. DynVarMIP diagnostics for 10 years of an historical experiment performed with a CMIP5 model, CMCC-CMS. Shown are averages over 50°-80°N of monthly mean tendencies (m/s/d) due to meridional and vertical TEM advection (blue), parameterized gravity wave drag (red) and resolved waves (Eliassen-Palm divergence, green), at the following levels, form top: 0.1 hPa (lower mesosphere), 1 hPa (mesopause), 10 hPa (middle stratosphere) and 150 hPa (lowermost stratosphere).