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A three-dimensional multivariate representation of atmospheric variability

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A recently developed MODES software has been applied to the ECMWF analyses and forecasts and to several reanalysis datasets to describe the global variability of the balanced and inertio-gravity (IG) circulation across many scales by considering both mass and wind field and the whole model depth. In particular, the IG spectrum, which has only recently become observable in global datasets, can be studied simultaneously in the mass field and wind field and considering the whole model depth.

MODES is open-access software that performs the normal-mode function decomposition of the 3D global datasets. Its application to the ERA Interim dataset reveals several aspects of the large-scale circulation after it has been partitioned into the linearly balanced and IG components. The global energy distribution is dominated by the balanced energy while the IG modes contribute around 8% of the total wave energy. However, on subsynoptic scales IG energy dominates and it is associated with the main features of tropical variability on all scales.

The presented energy distribution and features of the zonally-averaged and equatorial circulation provide a reference for the intercomparison of several reanalysis datasets and for the validation of climate models. Features of the global IG circulation are compared in ERA Interim, MERRA and JRA reanalysis datasets and in several CMIP5 models.

Since October 2014 the operational medium-range forecasts of the European Centre for Medium-Range Weather Forecasts (ECMWF) have been analyzed by MODES daily and an online archive of all the outputs is available at http://meteo.fmf.uni-lj.si/MODES. New outputs are made available daily based on the 00 UTC run and subsequent 12-hour forecasts up to 240-hour forecast. In addition to the energy spectra and horizontal circulation on selected levels for the balanced and IG components, the equatorial Kelvin waves are presented in time and space as the most energetic tropical IG modes propagating vertically and along the equator from its main generation regions in the upper troposphere over the Indian and Pacific region. The validation of the 10-day ECMWF forecasts with analyses in the modal space suggests a lack of variability in the tropics in the medium range.

Reference:

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The MODES software is available from http://meteo.fmf.uni-lj.si/MODES.