Validation of a climate model by using MODES

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Introduction

On the poster we present some properties of the simplified general circulation model SPEEDY (Molteni, 2003, Clim. Dyn.) in comparison to the ERA Interim reanalyses by using the 3D orthogonal normal-mode function decomposition (Žagar et al., 2015, Geosci. Mod. Dev.).

SPEEDY is used to simulate the present day climate. The goal of this study is to validate to what extent a climate model can reproduce the global circulation in comparison to the reanalysis datasets.

The model data

SPEEDY model

- ICTP AGCM, known as SPEEDY (Molteni, 2003, Clim. Dyn.), version 41
- Primitive equations spectral model, 8 vertical sigma levels, T30, simplified physical parametrization
- Include simple ocean model (mixed layer of constant depth)
- Model run for period January 1979 to December 2010, with ocean model
- Output: monthly mean fields on model levels
- Spectral filtering of Gibbs oscillations was applied using 2D isotropic filter from Navarra et al. (1994, J. Clim.).

ERA Interim reanalysis

Monthly mean data was upscaled to the resolution of SPEEDY, and only the nearest vertical levels to SPEEDY levels were used

NMF analysis with MODES software was done on monthly mean fields over period January 1981 to December 2010. We present annual picture and January and July climate.

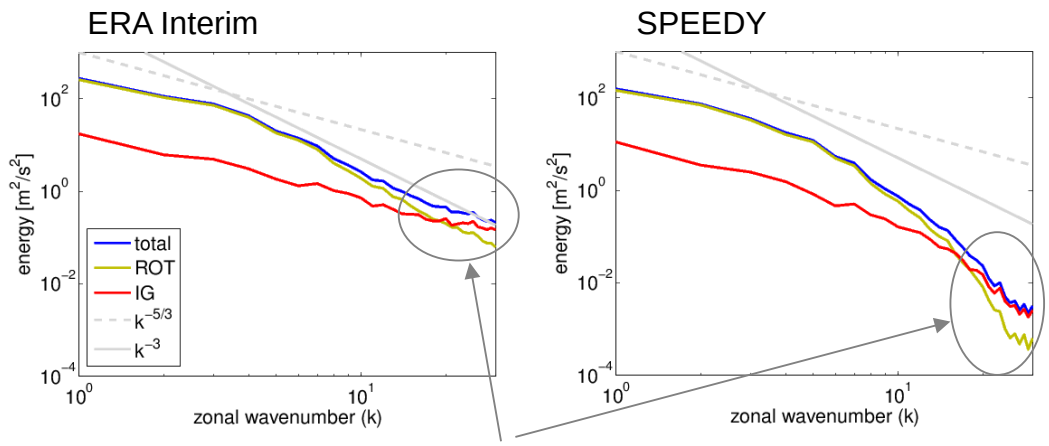
All results were linearly interpolated to the nearest pressure levels.

Comparison of energetics

Percentage of wave energy (k>0) in different motions:

	30-year average (over all months)		January average		July average	
Motion type	SPEEDY	ERA Interim	SPEEDY	ERA Interim	SPEEDY	ERA Interim
EIG	5.0 %	4.7 %	4.1 %	3.7 %	5.9 %	6.6 %
WIG	1.8 %	3.4 %	1.4 %	3.0 %	2.0 %	3.0 %
ROT	93.2 %	91.9 %	94.5 %	93.3 %	92.1 %	90.4 %

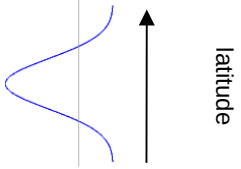
Energy spectra (30-year monthly average)



Consequence of different model resolution

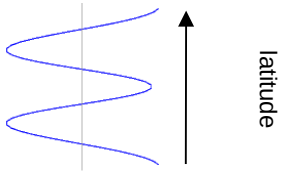
2D energy spectra for SPEEDY (30-year monthly average)

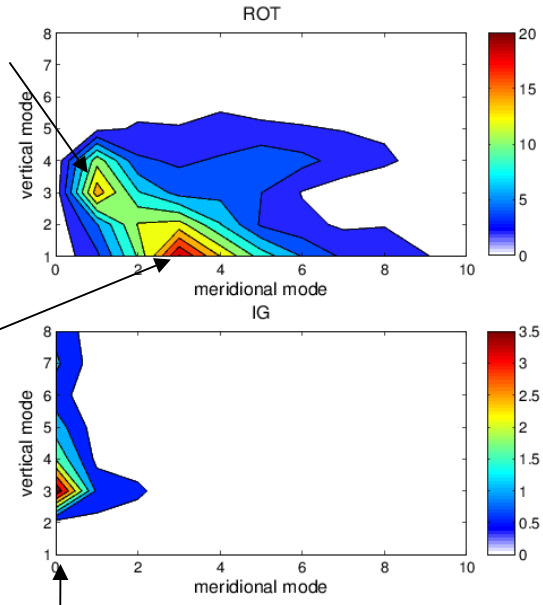
Vertical mode with maximum in the stratosphere.
Meridional expansion function for zonal wind:



Barotropic mode

Meridional expansion function for zonal wind:





Kelvin waves (meridional mode 0, part of EIG modes)

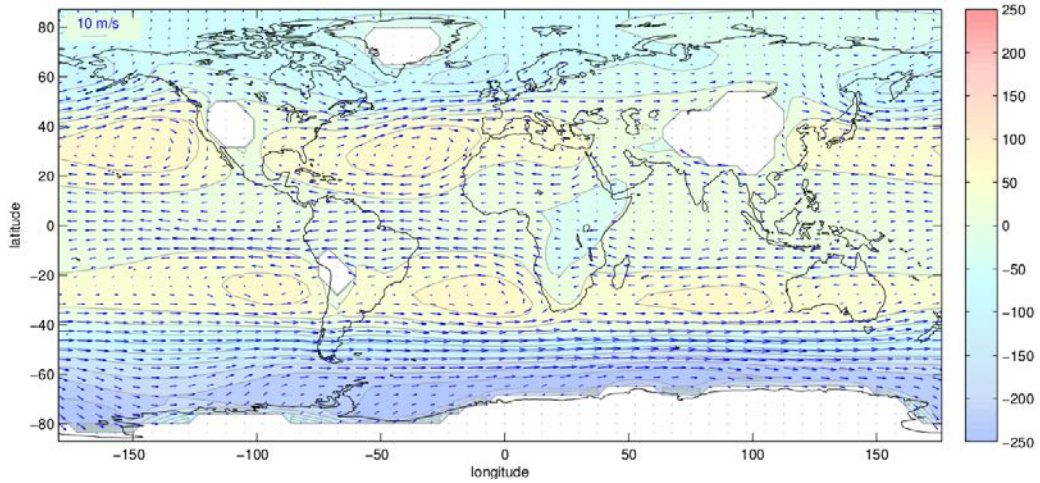
Balanced and IG circulation

Balanced circulation

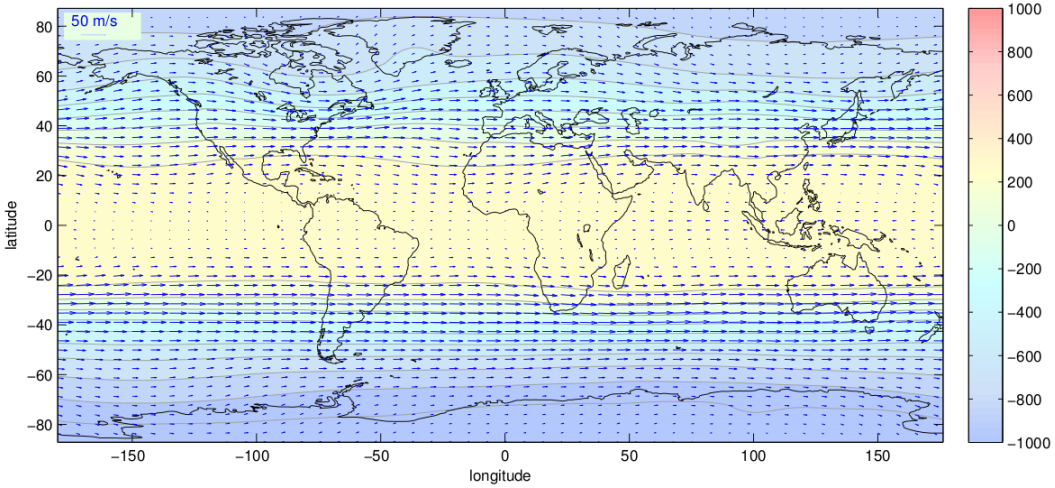
SPEEDY ROT, 30-year average (all months)

Contours: Geopotential height in meters

850 hPa



200 hPa

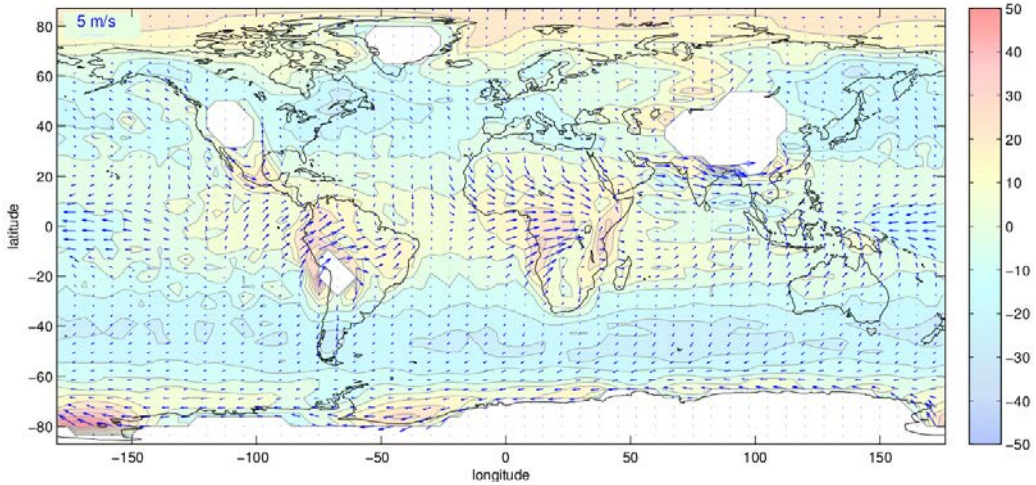


Inertio-gravity circulation

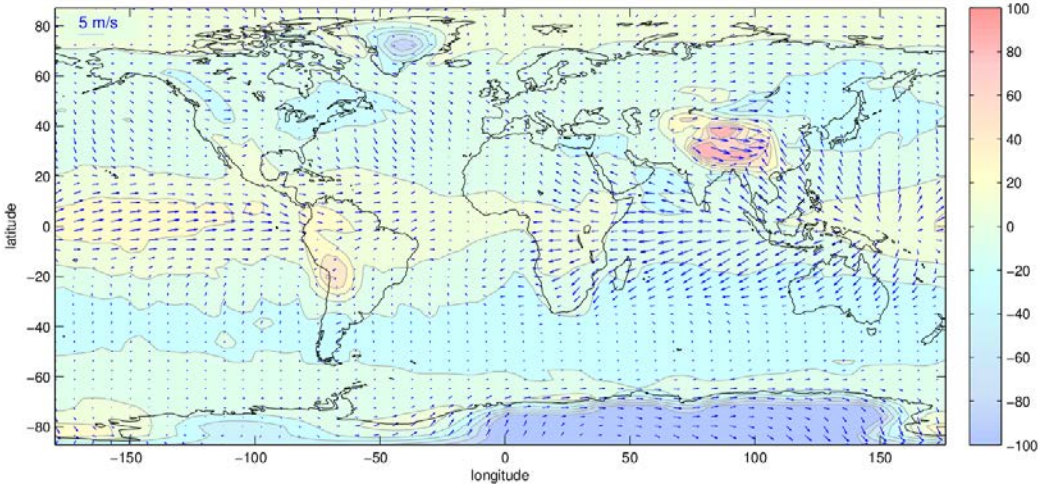
SPEEDY IG, 30-year average (all months)

Contours: Geopotential height in meters

850 hPa



200 hPa



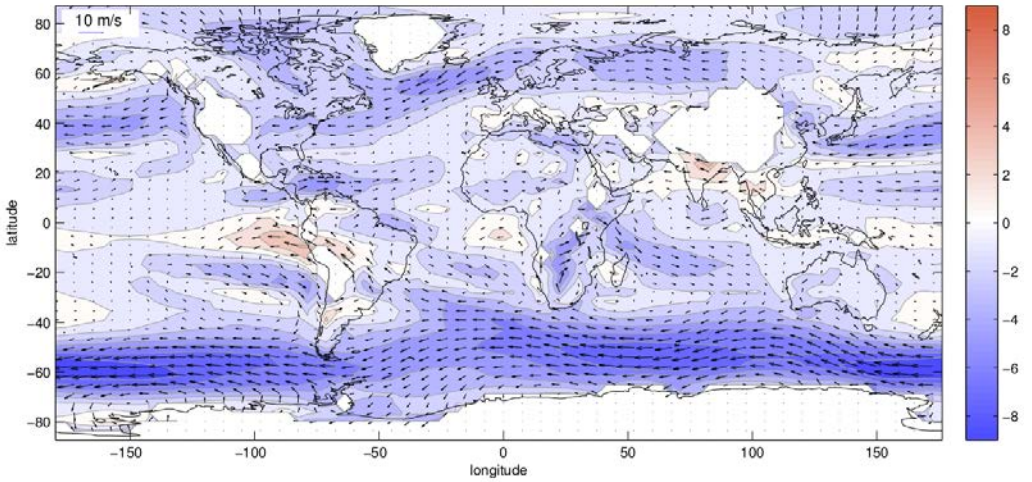
Balanced and IG circulation

Balanced circulation

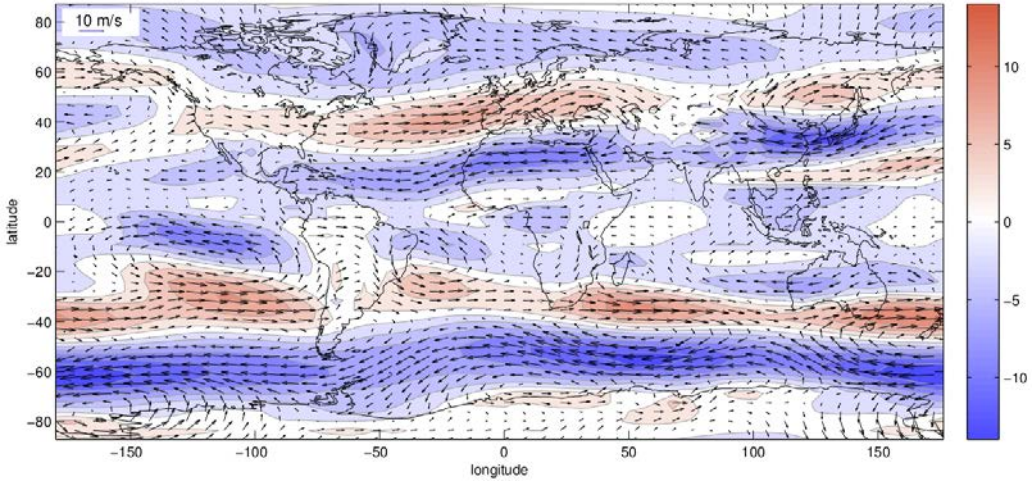
Wind difference SPEEDY-ERA Interim, ROT, 30-year average (all months)

Contours: difference in wind speed in m/s

850 hPa



200 hPa

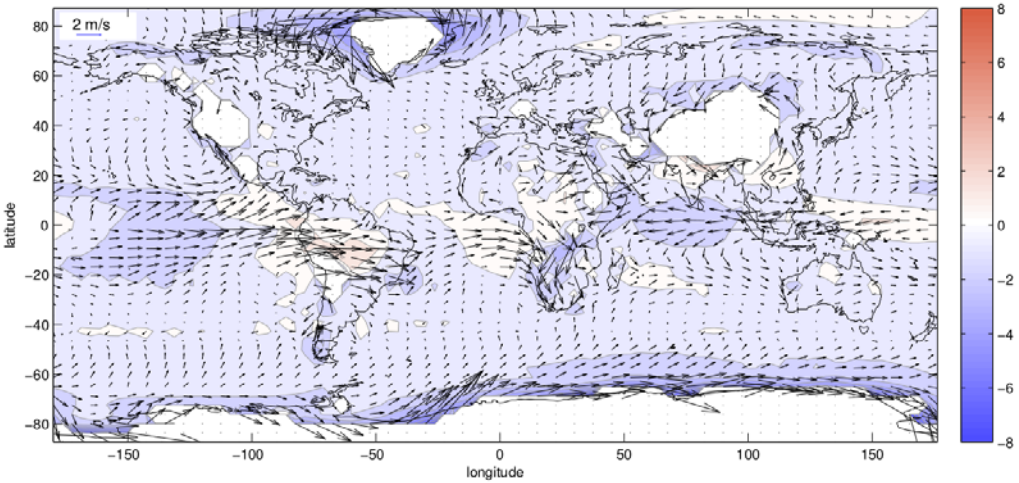


Inertio-gravity circulation

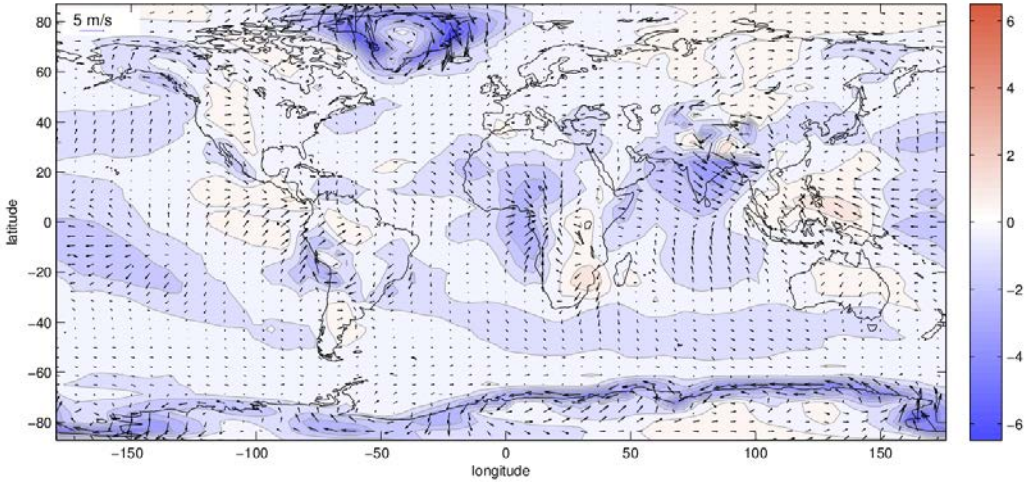
Wind difference SPEEDY-ERA Interim, IG, 30-year average (all months)

Contours: difference in wind speed in m/s

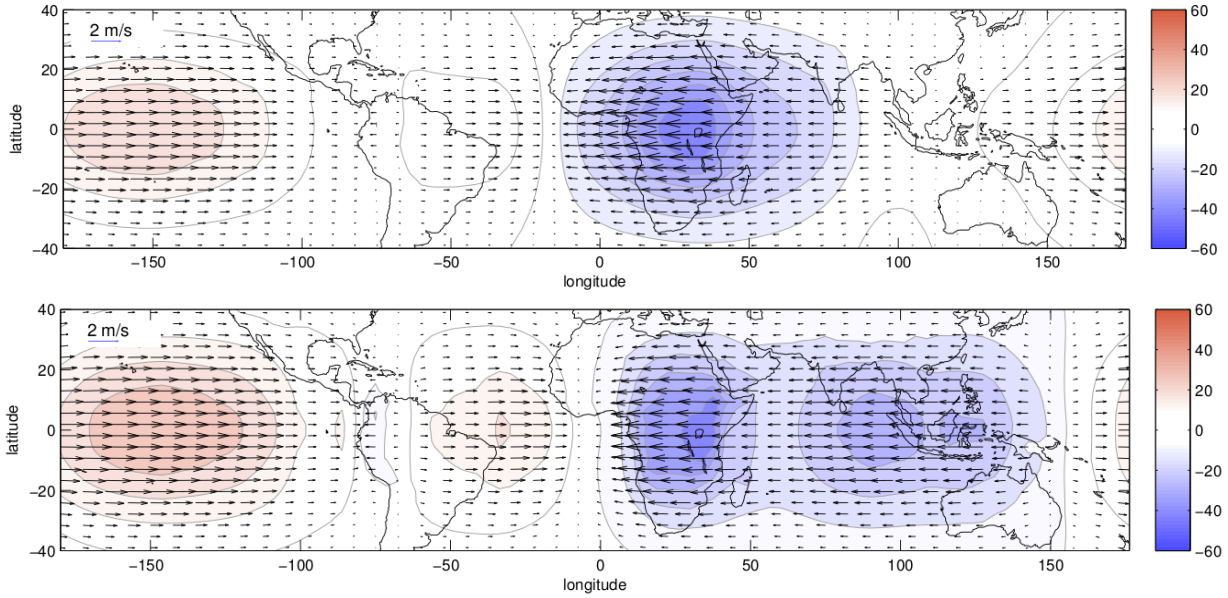
850 hPa



200 hPa

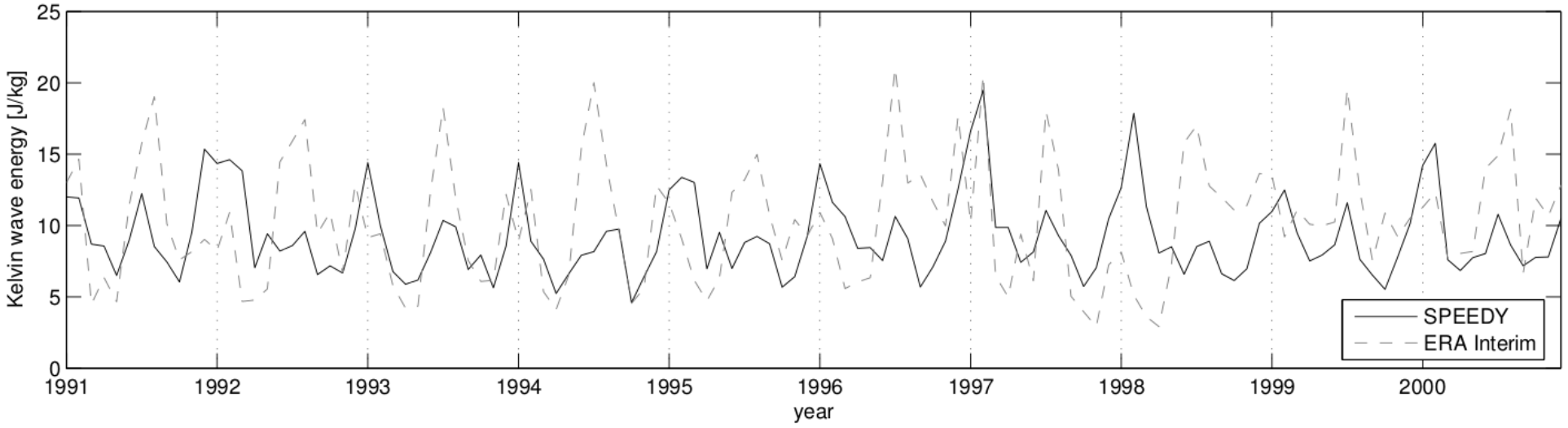


Kelvin waves



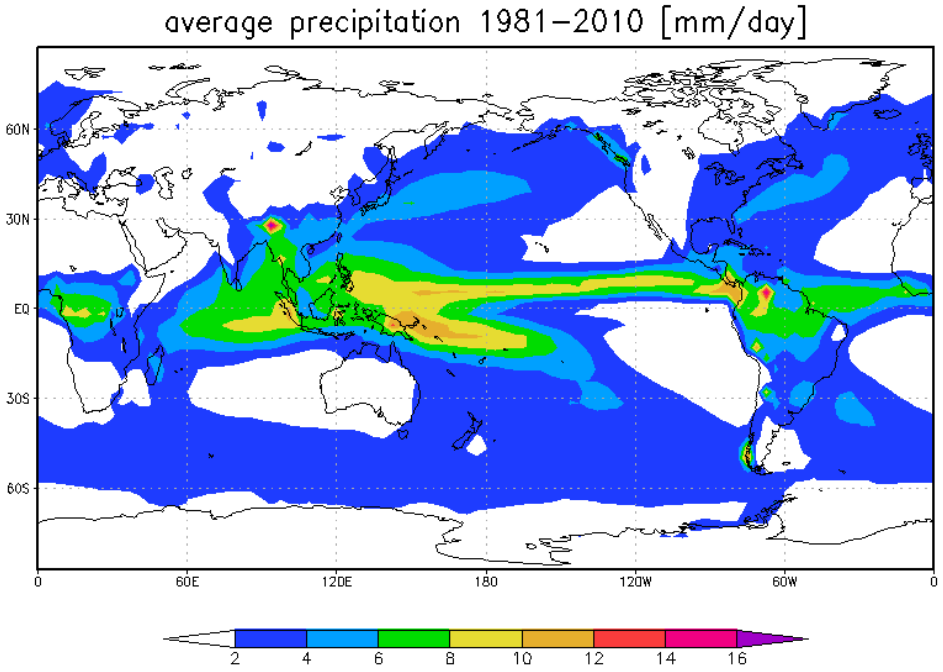
Annual mean of Kelvin waves at 100 hPa.
Top: SPEEDY, bottom: ERA Interim.
Contours: Geopotential height in meters

Variability of monthly mean Kelvin energy for period 1991 to 2000

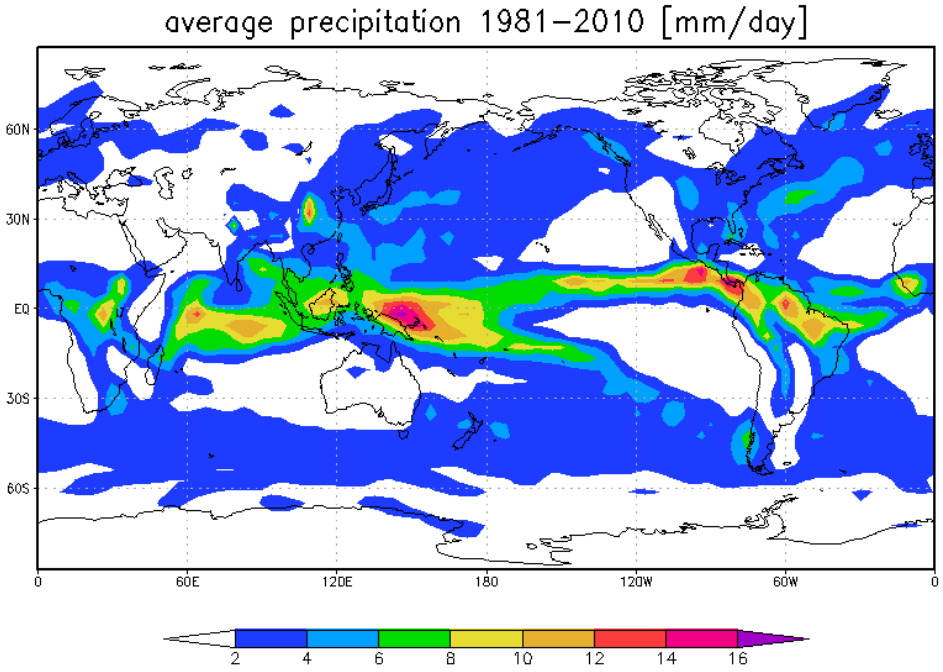


Precipitation pattern

ERA Interim



SPEEDY



Conclusions

- The simplified model SPEEDY is capable to represent main properties of the present-day climate. Seasonal changes of global circulation are appropriate and in agreement with ERA Interim reanalyses.
- Precipitation pattern show that SPEEDY is also able to adequately represent physical properties of the climate.
- More than 90% of energy is in balanced motions, less than 10% in IG motions, in agreement with other datasets (Žagar et al., 2015, Geosci. Mod. Dev.).
- Average climatology of Kelvin waves in SPEEDY resembles to ERA Interim showing semiannual cycle. Monthly means may differ significantly.