Tropical variability and stratospheric equatorial waves in the IPSLCM5 model

Contacts for those diagnostics: P. Maury, F. Lott, L. Guez and J.P. Duvel
LMD/IPSL, Ecole Normale Supérieure, Paris France

All the simulations done with the ESM IPSLCM5, include the stratosphere,
The equilibrium pre-industrial 1000yrs, starting in 1800 control is analysed here

A good representation of the tropospheric variability is a pre-requisite to a realistic forcing of the equatorial stratosphere

1) Tropospheric mean climate and variability (Interannual and intraseasonal)

Model validation: repeating here diagnostics often done on multi-model papers for CMIP3/4 and concerning ENSOs and MJOs in coupled models.

2) Equatorial waves

More recently developed diagnostics

Relation between stratospheric and convectively coupled tropospheric waves

Relation with ENSO (ENSO → QBO relation?)

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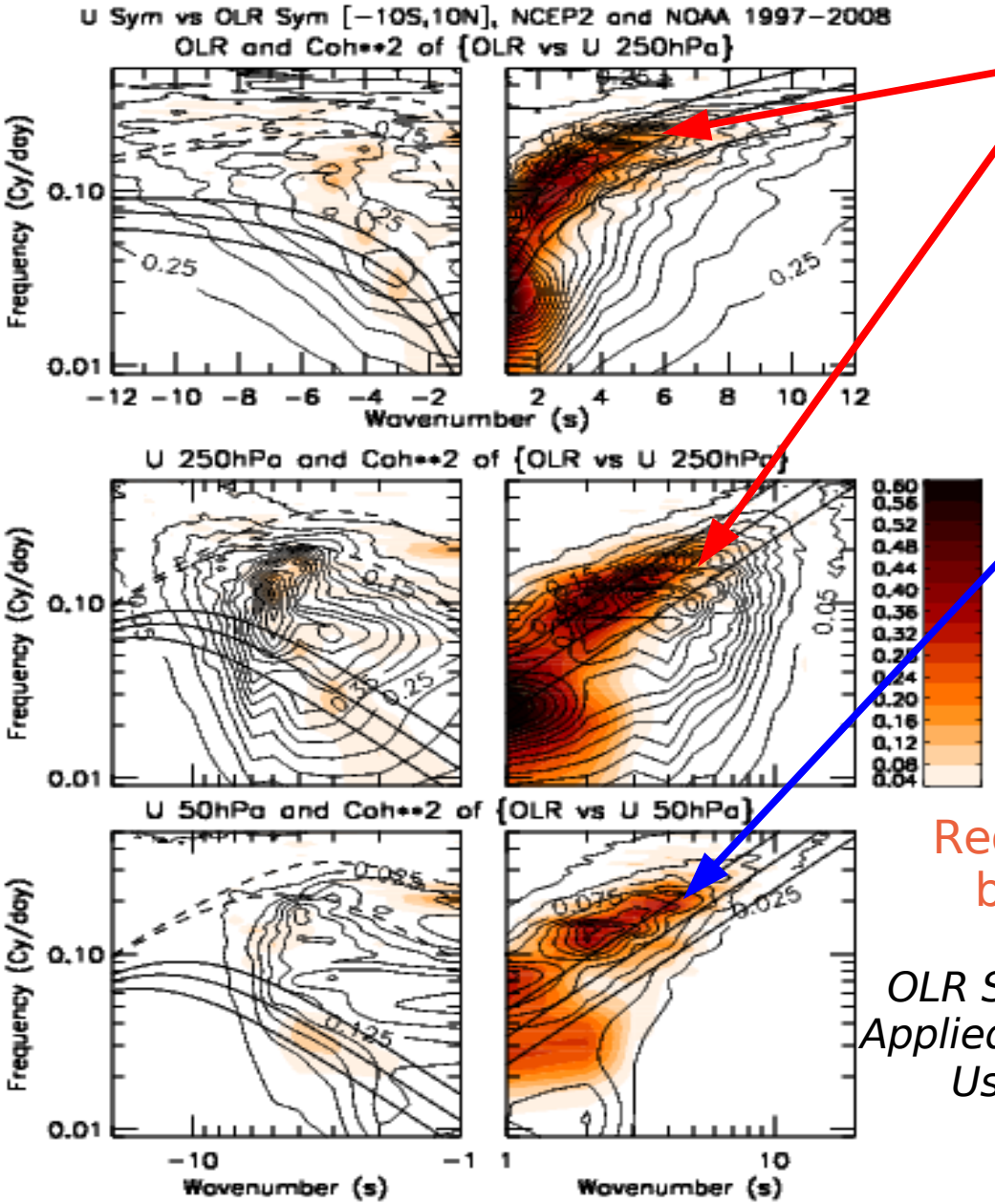
2) Equatorial waves

OLR from NOAA

U250hPa from NCEP

U50hPa from NCEP



The tropospheric convectively coupled equatorial waves (here of Kelvin wave type)

are not so distinct from

The freely propagating Stratospheric waves

Is it critical for the model Stratospheres since CCEWs are known to be weak in models?

Red shadings are for coherencies between zonal wind and OLR

OLR Spectra: Wheeler and Kiladis (1999), Applied to CMIP4 by the same team (2008?) Use of coherencies and log-axis to Better visualize the Eq Waves (Wheeler et al. 2009)

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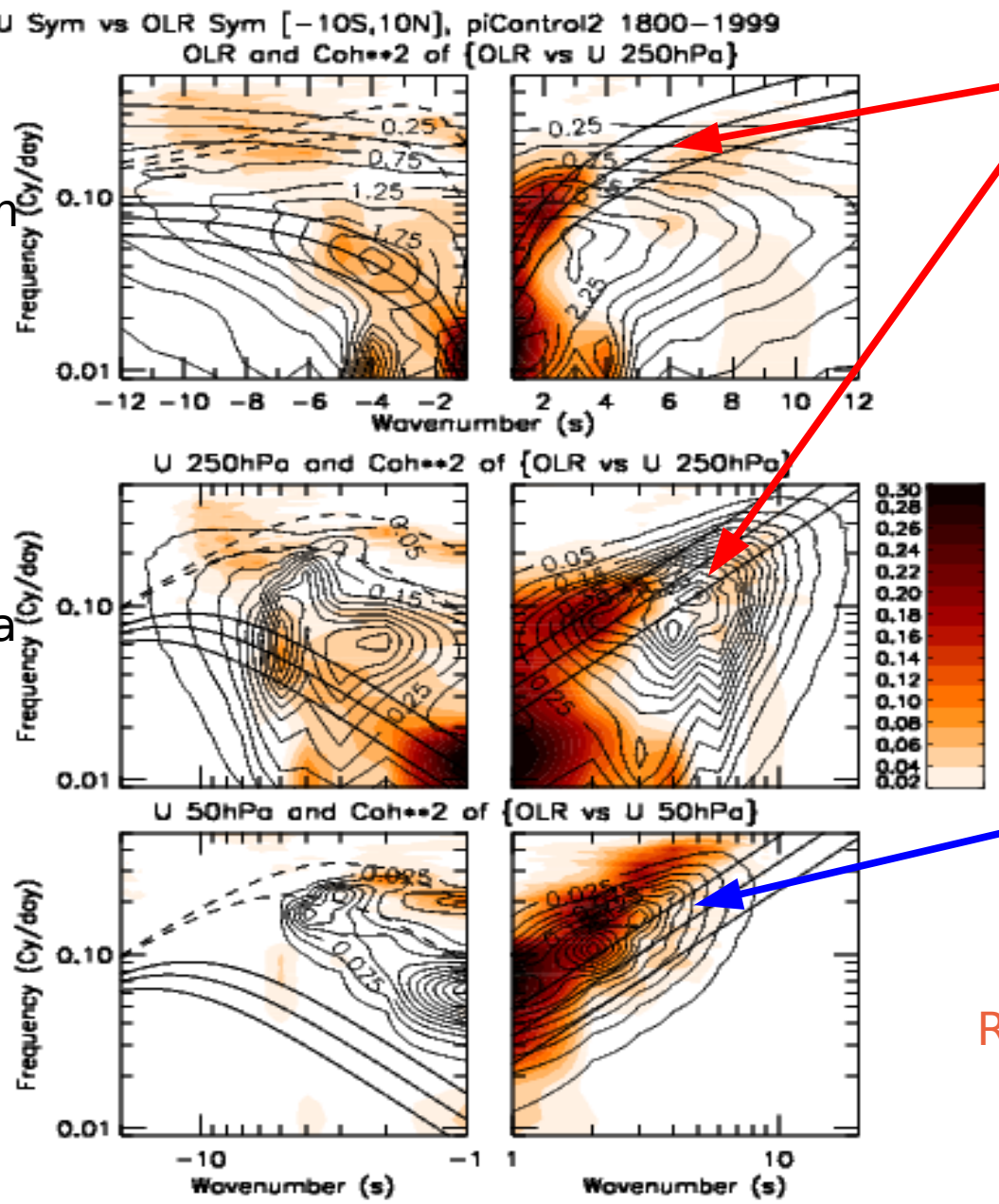
2) Equatorial waves

OLR from πCtl2

U250hPa from πCtl2

U50hPa from πCtl2



The tropospheric convectively coupled equatorial waves are weak:
almost no signal on OLR,
weaker coherencies,
slightly more on precips
(not shown)

but

The freely propagating Stratospheric waves Are quite right and still Related to convection (to a weaker extent than in obs though)

Red shadings are for coherencies between zonal wind and OLR, Scales on Coh are divided by 2

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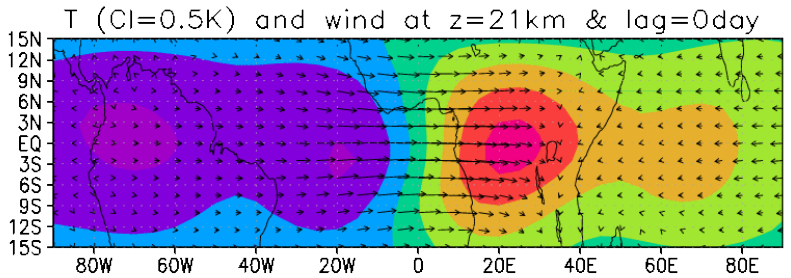
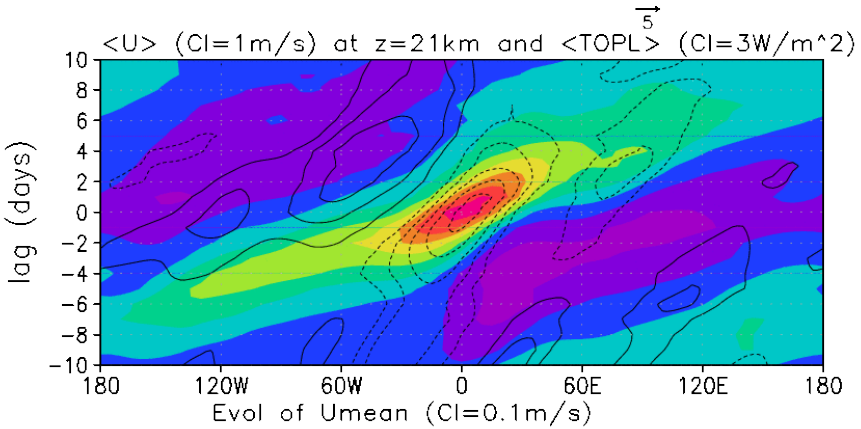
2) Equatorial waves

Kelvin 15 cases in NCEP2 (1979–2010)

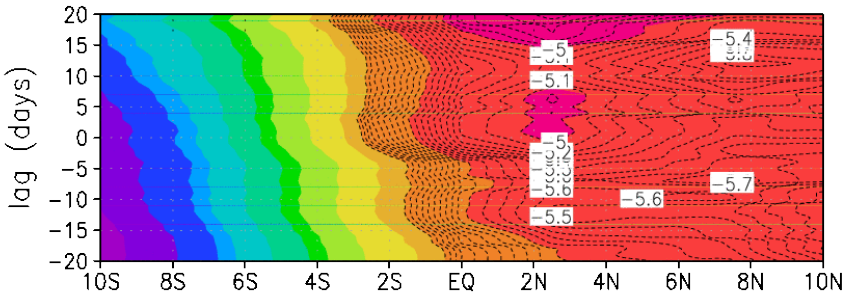
T is in color,



U is in color,
OLR in contours



Zonal mean
of U



Composite analysis illustrates better the structure of the waves
(Lott et al. 2009, Yang et al 2010)

(here at 50hPa, except for the OLR)

Note how the signal on OLR (dashed) to that on zonal wind, and even follows it. The stratospheric wave looks tied to the convective signal presumably associated to the convectively coupled wave

Zonal wind negative since large Kelvin waves more easily occur in negative zonal mean zonal wind

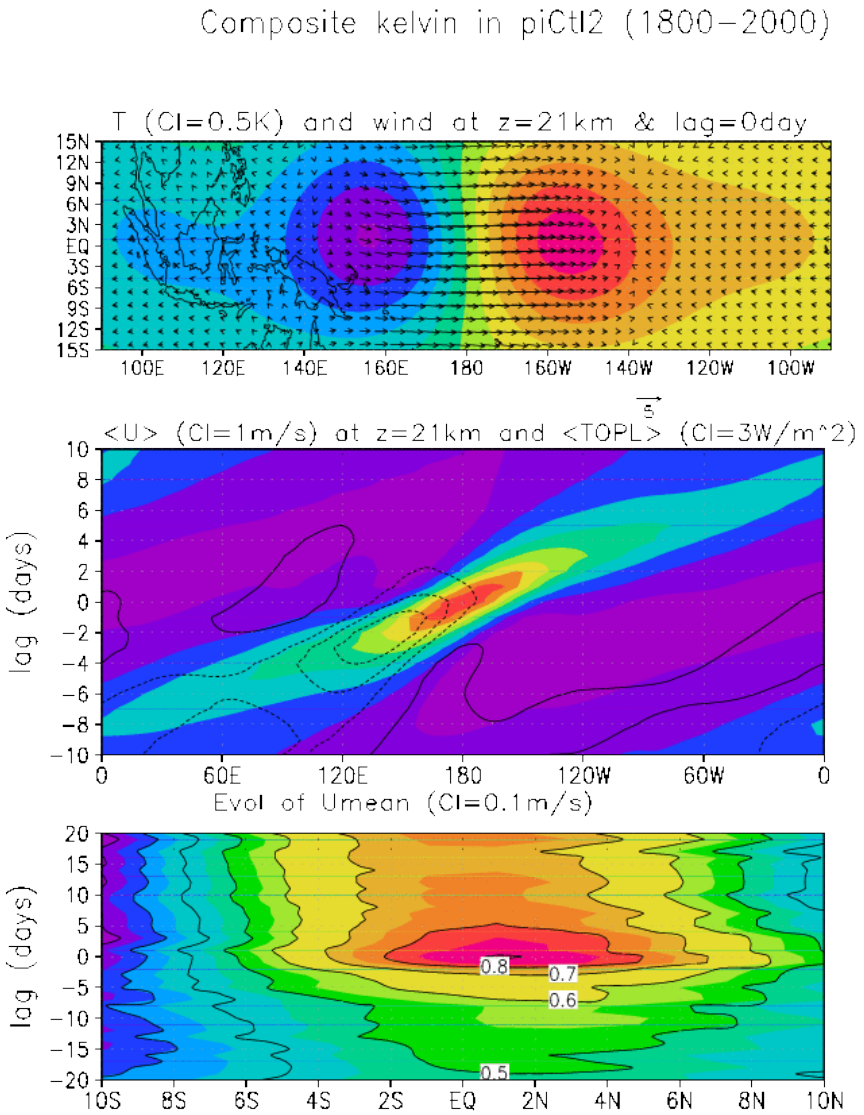
Tropical variability and stratospheric waves in IPSLCM5

2) Equatorial waves

T is in color,

U is in color,
OLR in contours

Zonal mean
of U



Composite analysis illustrates better the structure of the waves
(Lott et al. 2009, Yang et al 2010)

(here at 50hPa, except for the OLR)

Note how the signal on OLR (dashed) preceeds that on zonal wind, and is less pronounced than in re-analysis

Evolution of the zonal mean wind during the passage of the Kelvin waves (wave-mean flow interaction clearly visible here)

Note the absence of QBO

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The model underestimate the tropospheric equatorial waves
but seems to have a reasonable signal on the stratospheric equatorial waves
(here only the Kelvin Waves since the dominant westerly wind in the model stratosphere filters the Rossby Gravity waves).

The model stratospheric waves are less related to convection than the observed ones (more of the midlatude forcings described in Hoskins and Yang 2000).

To be continued on other CCWs (Rossby-Gravity) and using the CMIP5 database