

# Tropical variability and stratospheric equatorial waves in the IPSLCM5 model

Contacts for those diagnostics: P. Maury, F. Lott, L. Guez and J.P. Duvel  
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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

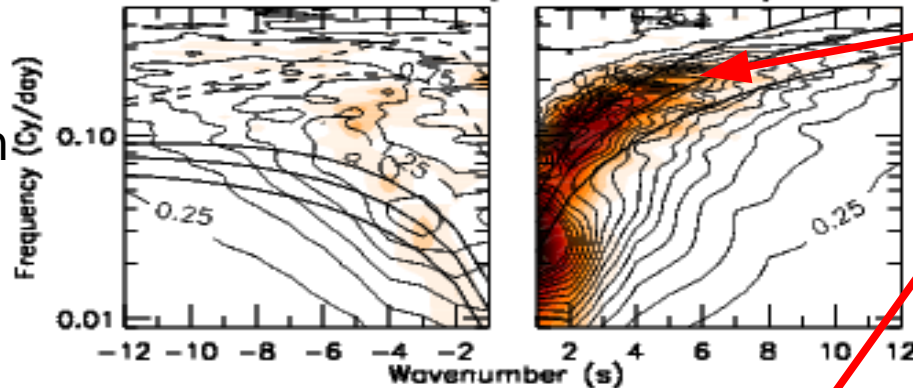
Relation between stratospheric and convectively coupled tropospheric waves

Relation with ENSO (ENSO → QBO relation?)

# Tropical variability and stratospheric waves in IPSLCM5

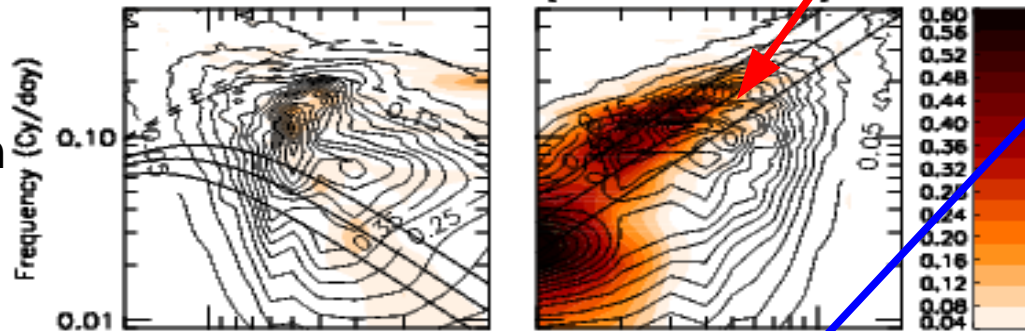
## 2) Equatorial waves

U Sym vs OLR Sym [-10S,10N], NCEP2 and NOAA 1997-2008  
OLR and Coh\*\*2 of {OLR vs U 250hPa}



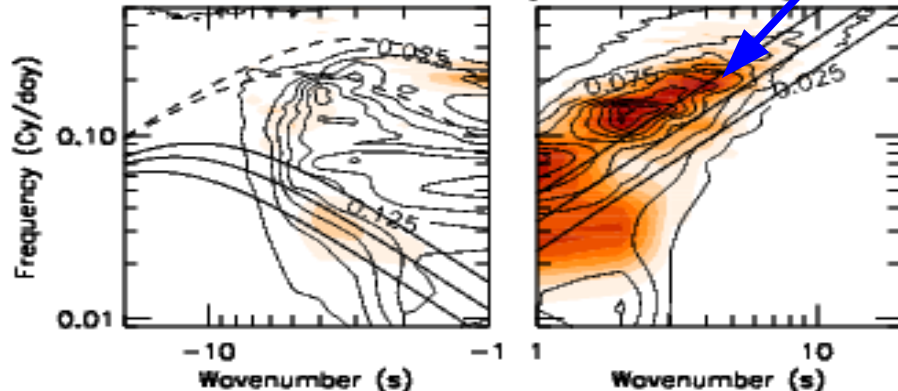
OLR from NOAA

U 250hPa and Coh\*\*2 of {OLR vs U 250hPa}



U250hPa from NCEP

U 50hPa and Coh\*\*2 of {OLR vs U 50hPa}



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?

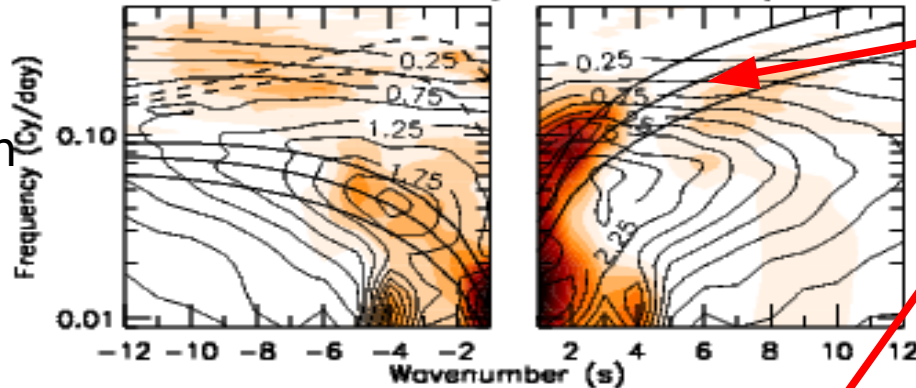
Red shadings are for coherencies between zonal wind and OLR

*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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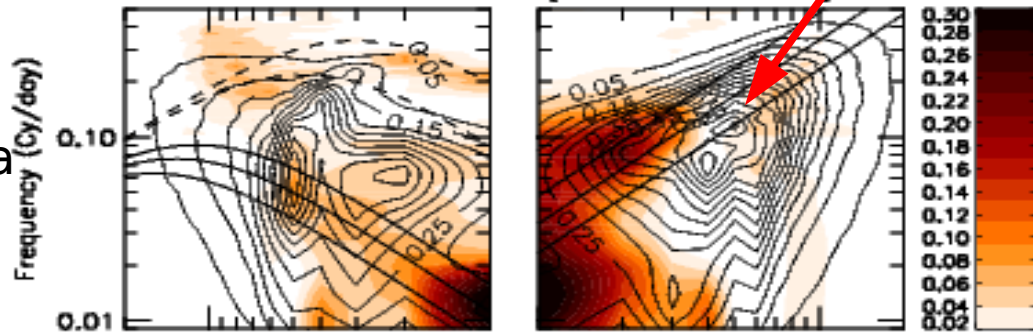
## 2) Equatorial waves

U Sym vs OLR Sym [-10S,10N], piControl2 1800-1999  
 OLR and Coh\*\*2 of {OLR vs U 250hPa}



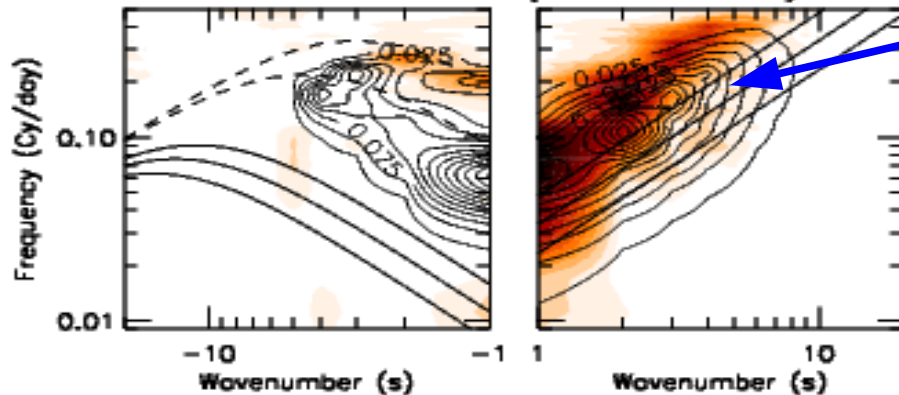
OLR from  
 $\pi$ Ctl2

U 250hPa and Coh\*\*2 of {OLR vs U 250hPa}



U250hPa  
 from  
 $\pi$ Ctl2

U 50hPa and Coh\*\*2 of {OLR vs U 50hPa}



U50hPa  
 from  
 $\pi$ Ctl2

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

but

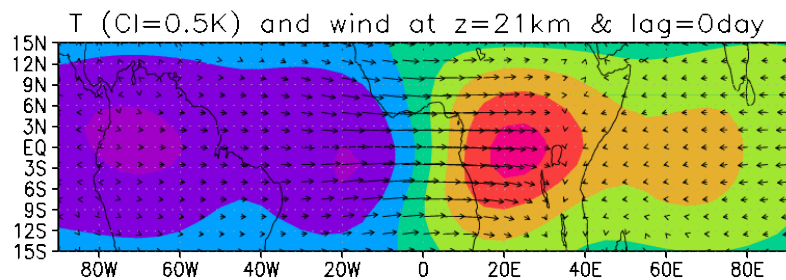
The freely propagating Stratospheric waves Are quite right and still Related to convection (to a weaker extent than in obs though)

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

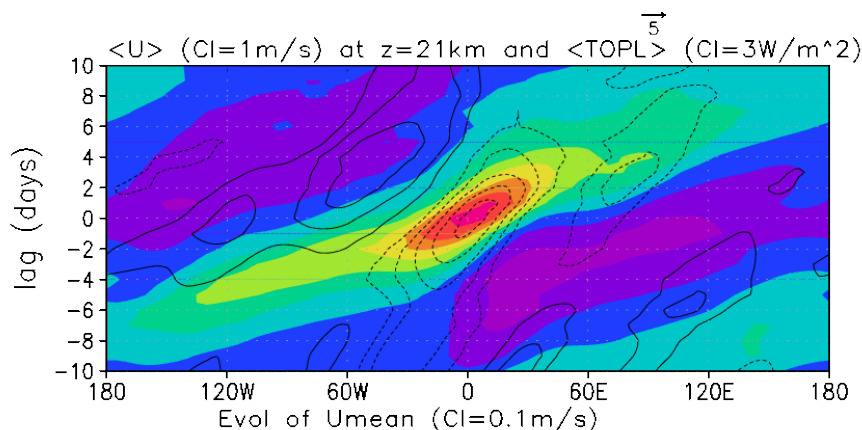
# Tropical variability and stratospheric waves in IPSLCM5

## 2) Equatorial waves

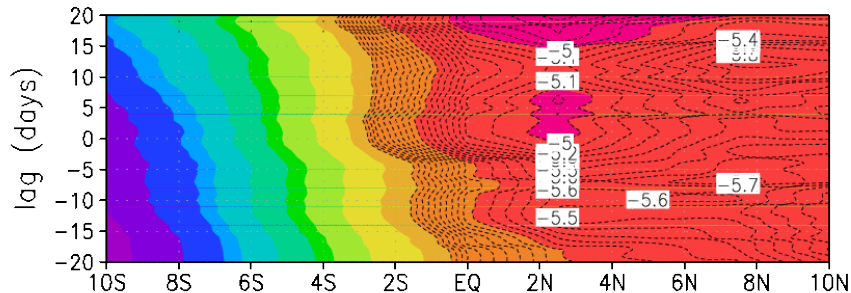
Kelvin 15 cases in NCEP2 (1979–2010)



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)

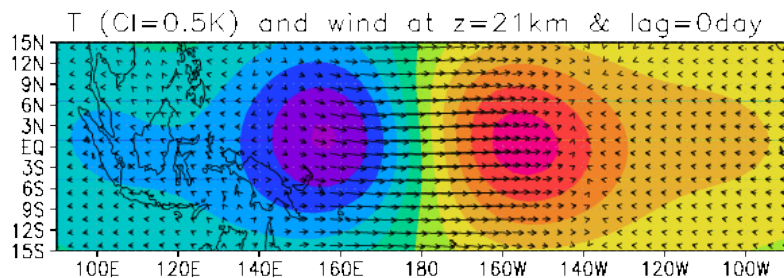
Note how the signal on OLR (dashed) to that on zonal wind, and even follows it. The stratospheric wave looks tied to the convective signal presumably associated to the convectively coupled wave

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

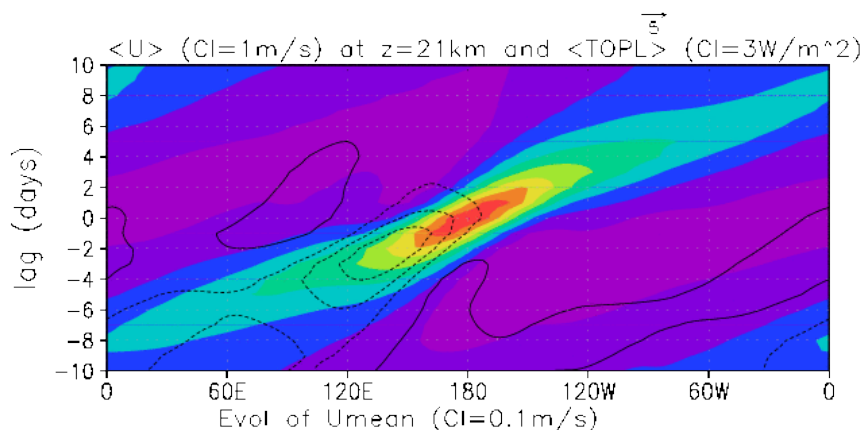
# Tropical variability and stratospheric waves in IPSLCM5

## 2) Equatorial waves

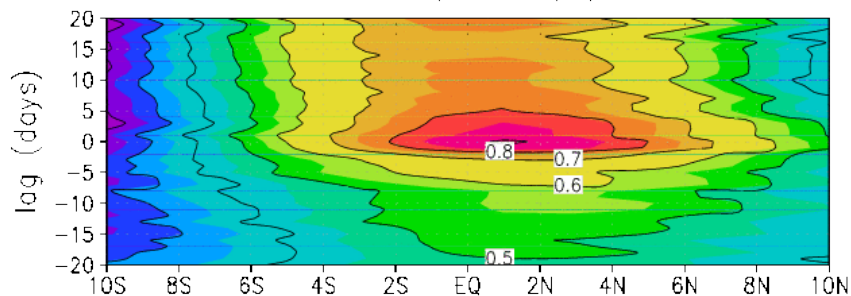
Composite kelvin in piCtI2 (1800–2000)



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) precedes 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 midlatitude forcings described in Hoskins and Yang 2000).

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