The Influence of Parametrized Gravity Waves on the Quasi Biennial Oscillation in ECHAM6

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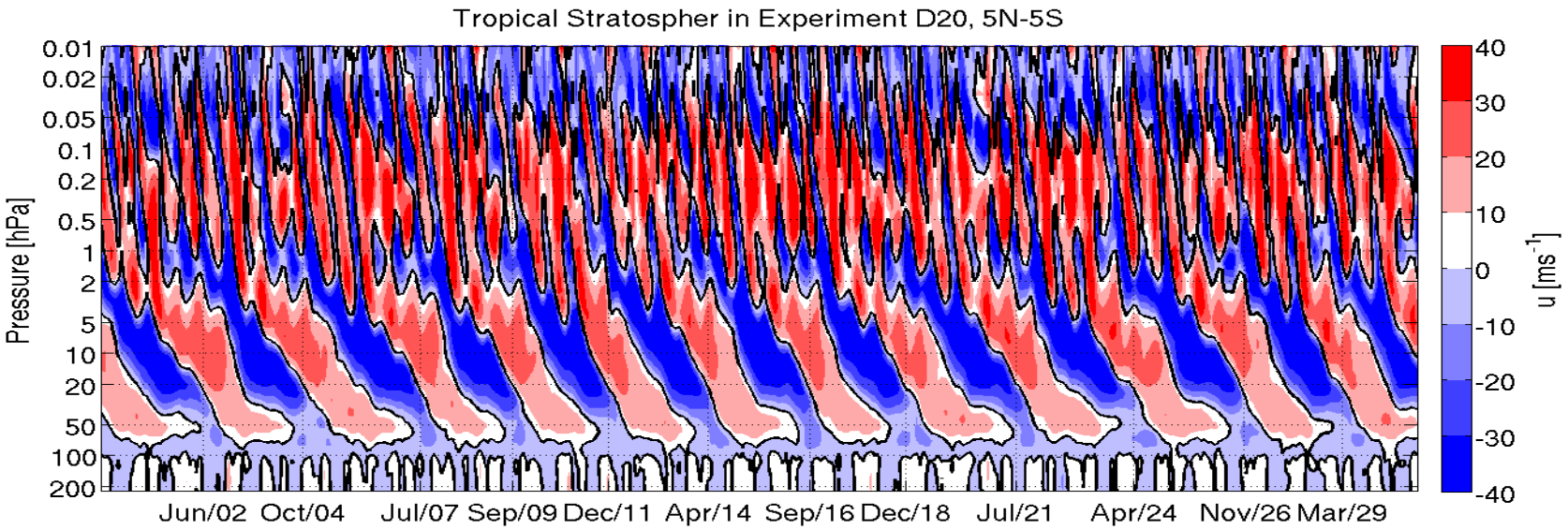
The Quasi Biennial Oscillation in the Tropical Stratosphere



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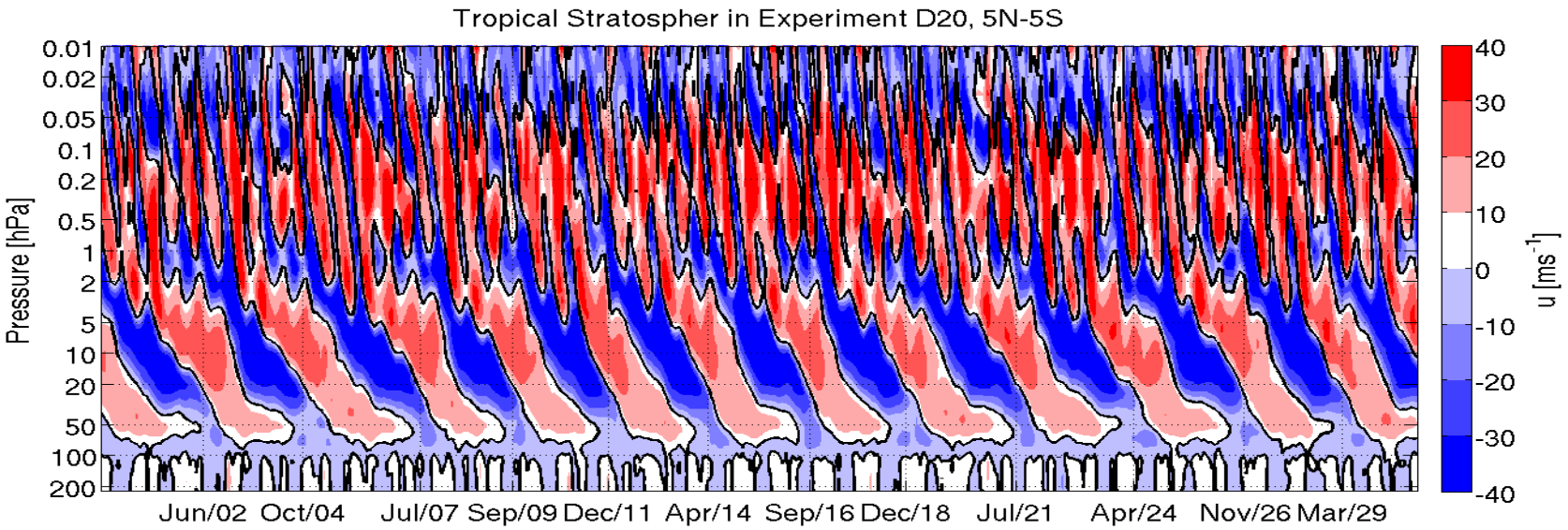

$$\frac{\delta u}{\delta t} = vertical\,advection + wave\,momentum\,deposition$$

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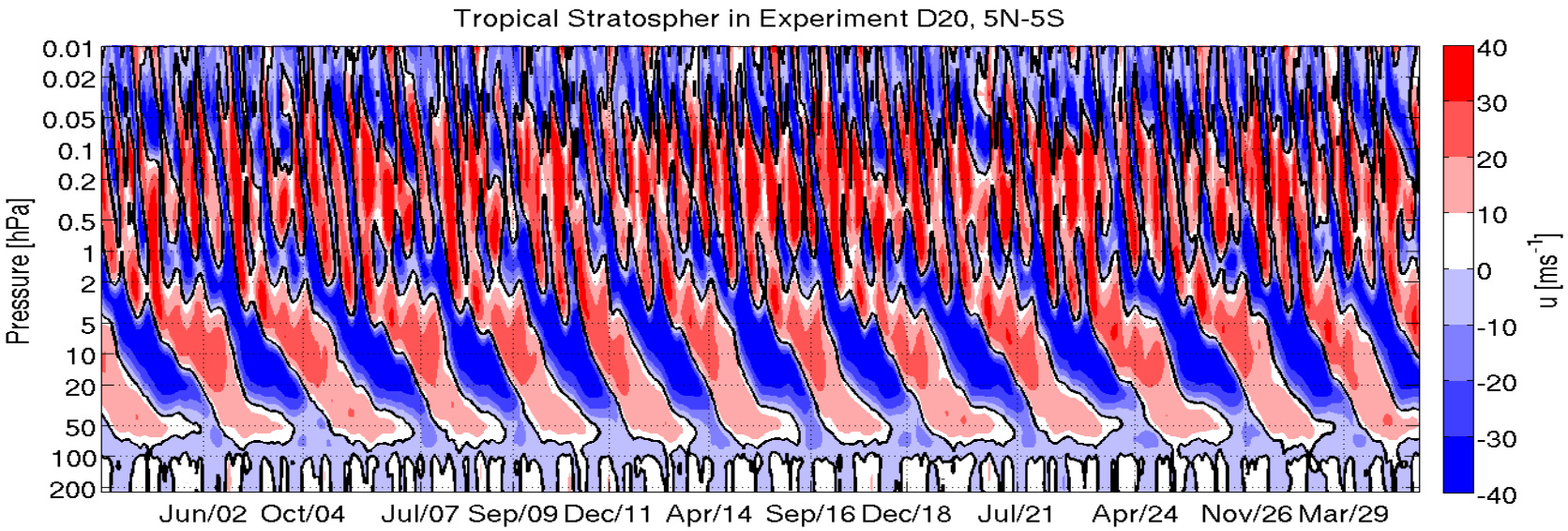


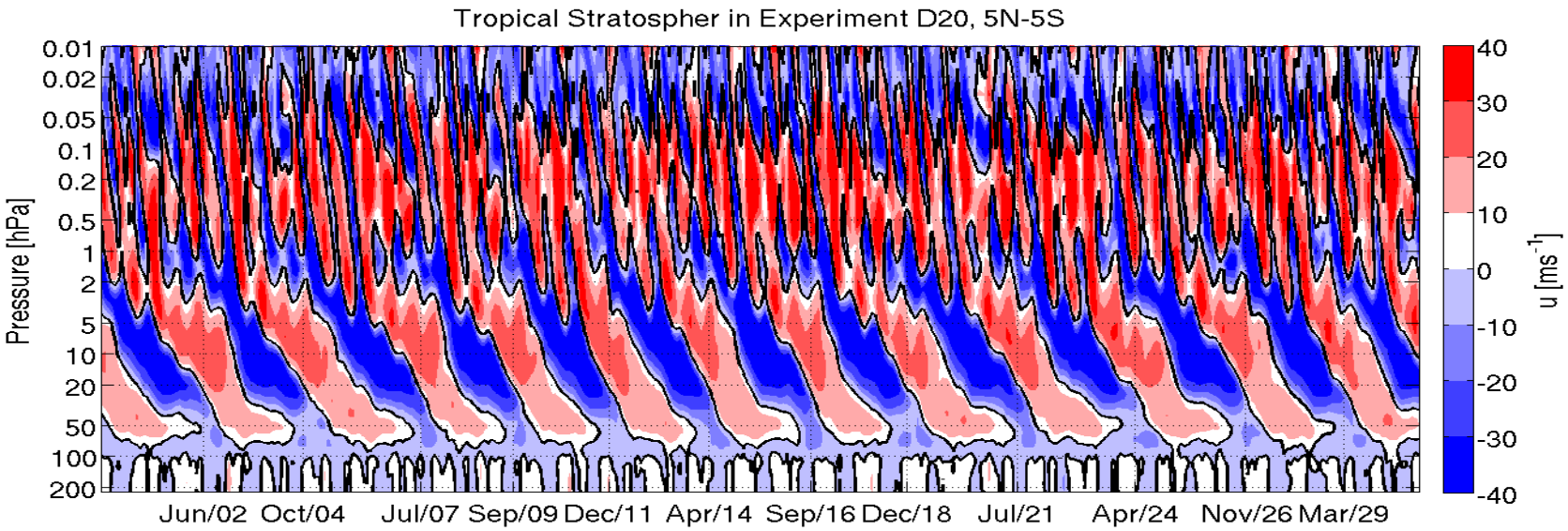
The QBO period ranges from 22 to 34 months (in accordance with observations)

<u>Why is the QBO as variable as observed?</u>

The variability of the QBO manifests in

- the downward propagation rate of the jets
- the stability of the westerly jet in the lower stratosphere

The QBO in ECHAM6



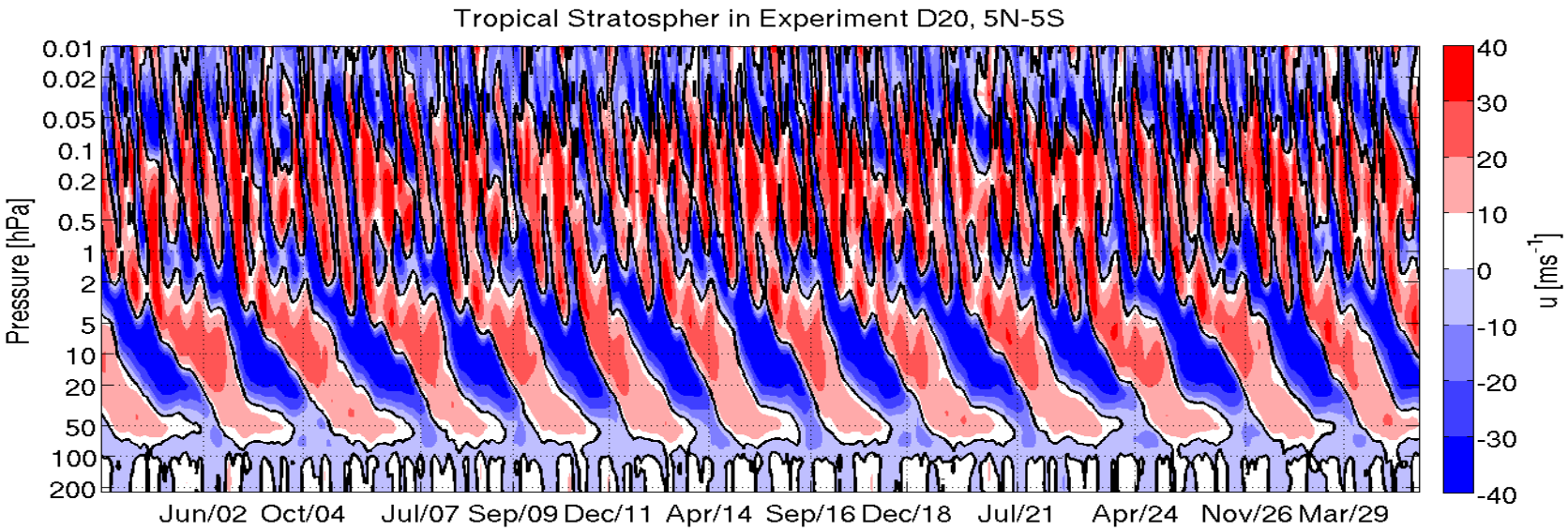
Atmosphere: ECHAM6 (T63L95)
Ocean: MPIOM (0.4°,L40)

Preindustrial Conditions

30 years of data

QBO Period: 25-34 months

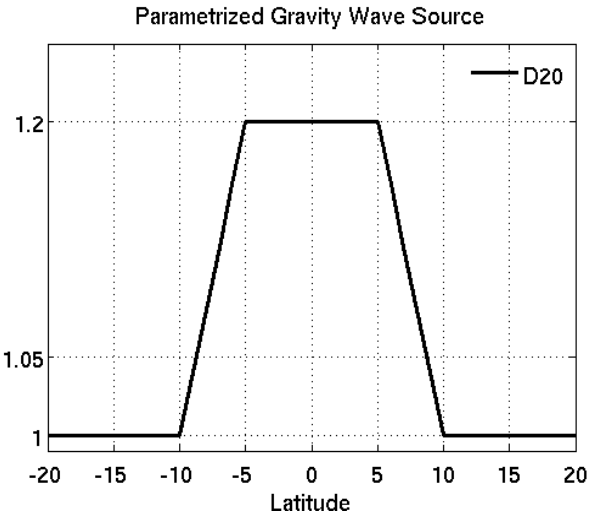
The QBO in ECHAM6



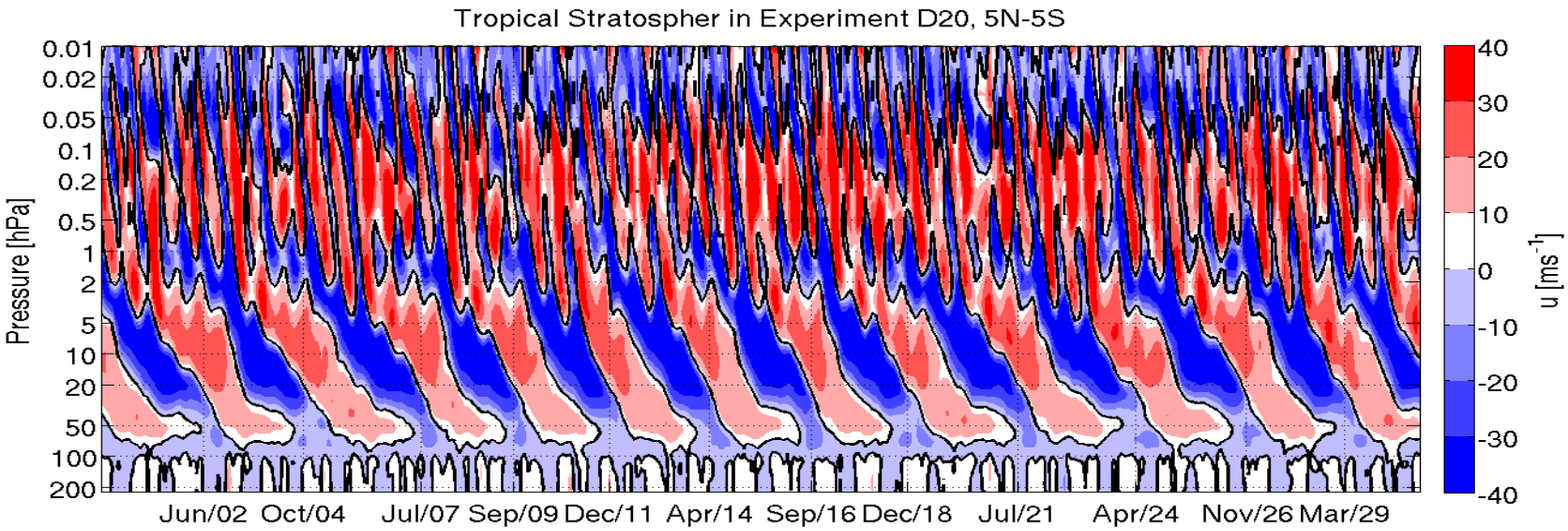
Parametrized Gravity Wave Sources in the Tropics

<u>The contribution of small scale gravity waves to QBO variability?</u>

$$\frac{\delta u}{\delta t} = Advection + Waveforcing$$



Changing the parametrized Gravity Wave Sources



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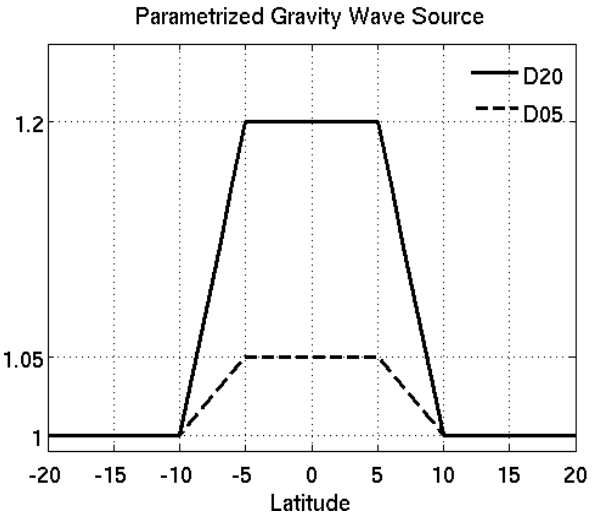
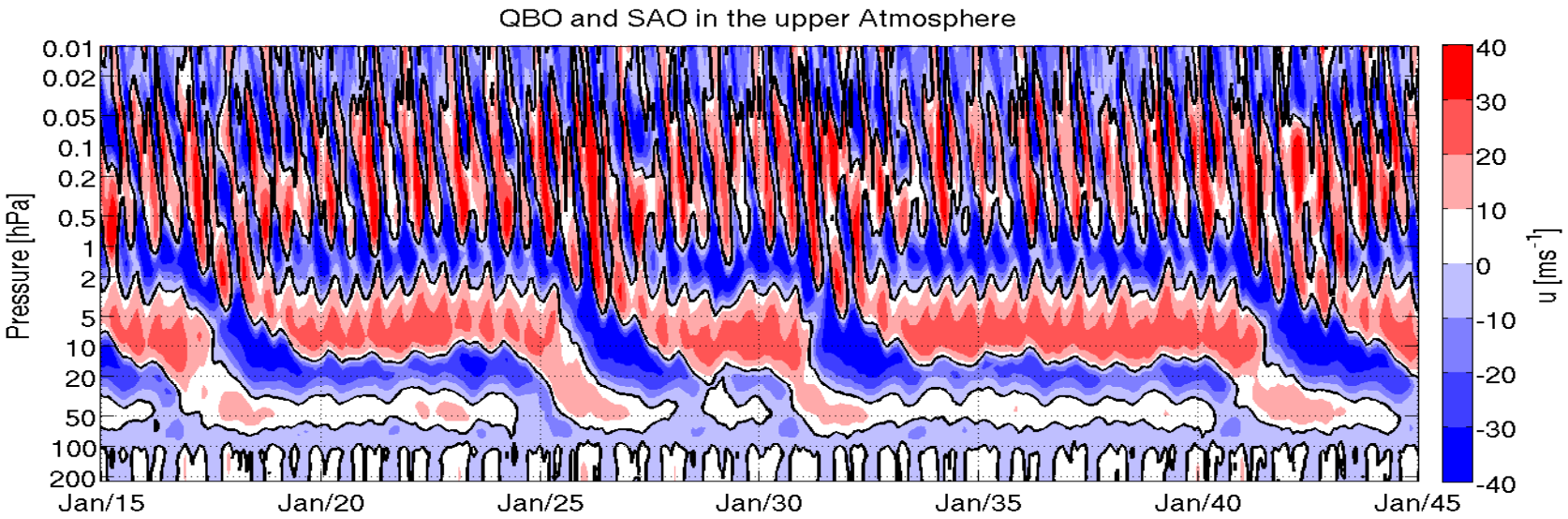
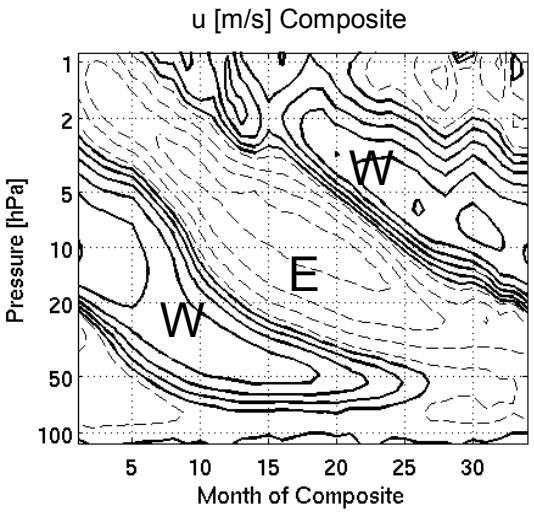


Impact of Changing the parametrized Gravity Wave Sources

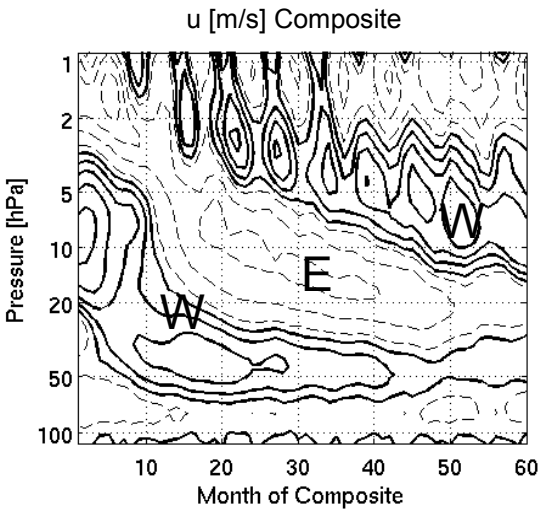


Forcing of the Westerly Jet at 20hPa

Control Run



1.05 Run



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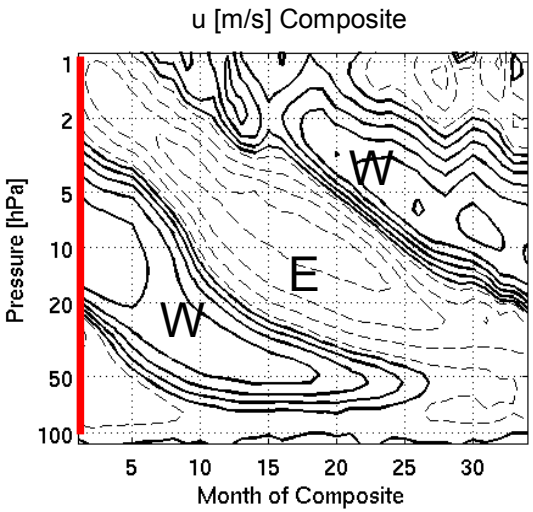

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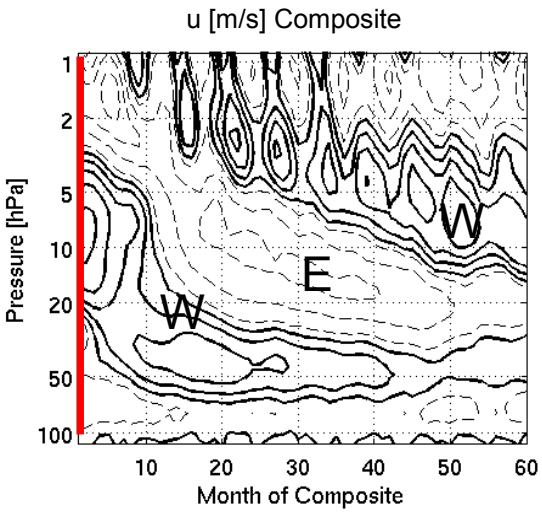

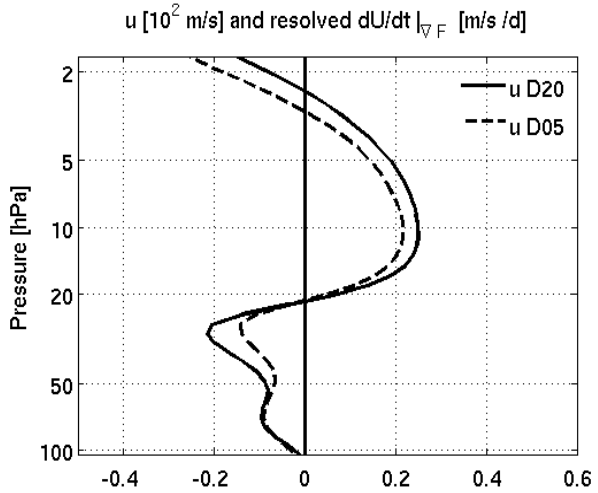

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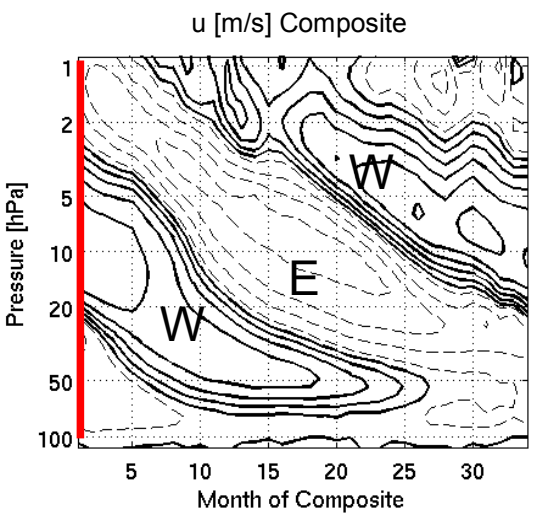

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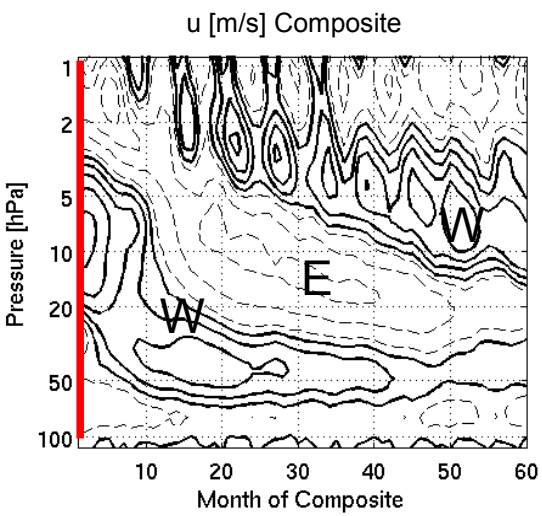
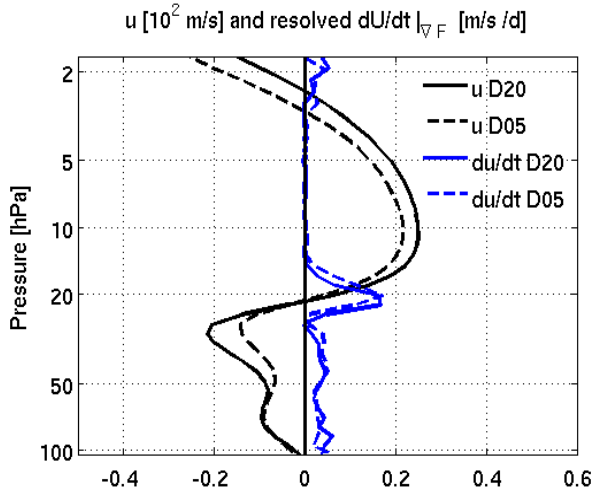


Resolved Wave Forcing



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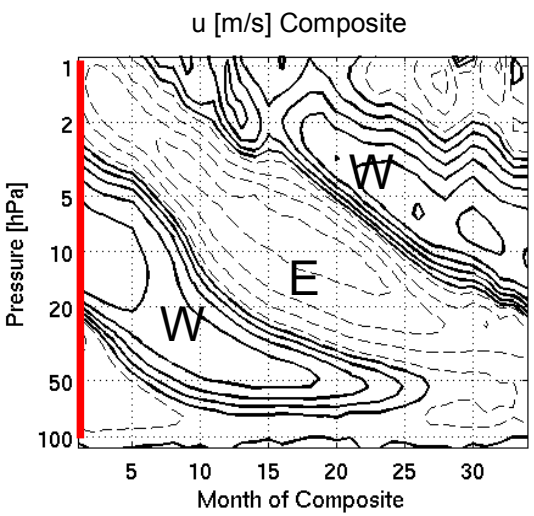

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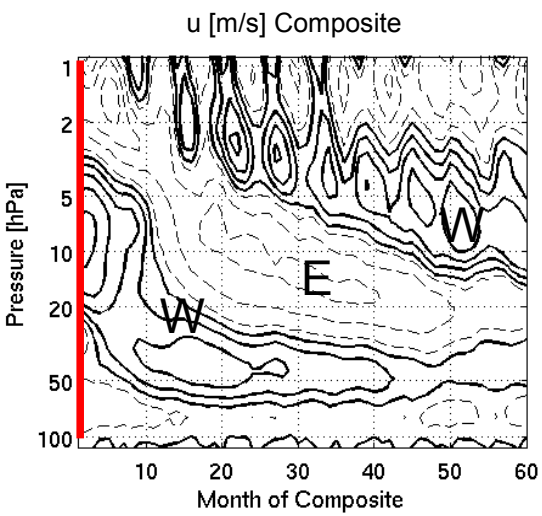

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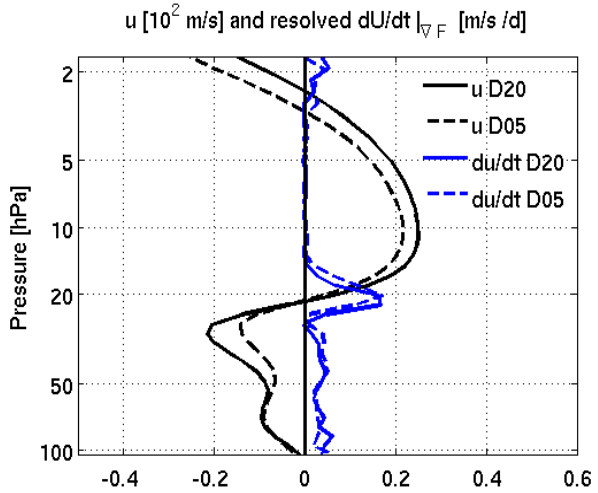
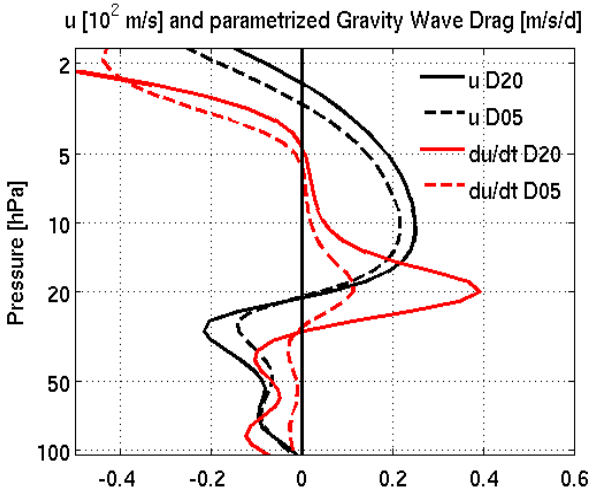
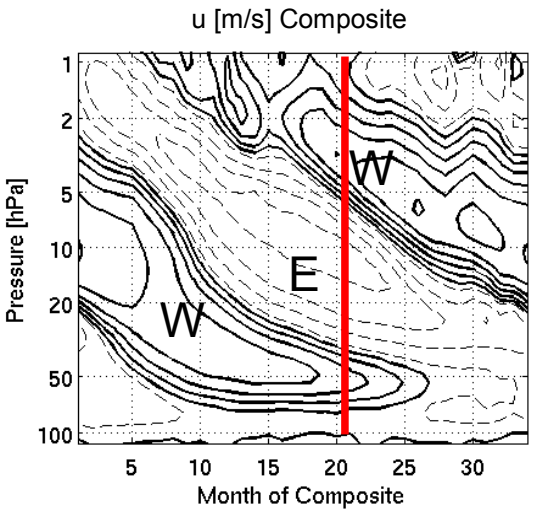


Parametrized Wave Forcing



Dissipation of the lower Westerly Jet

Control Run



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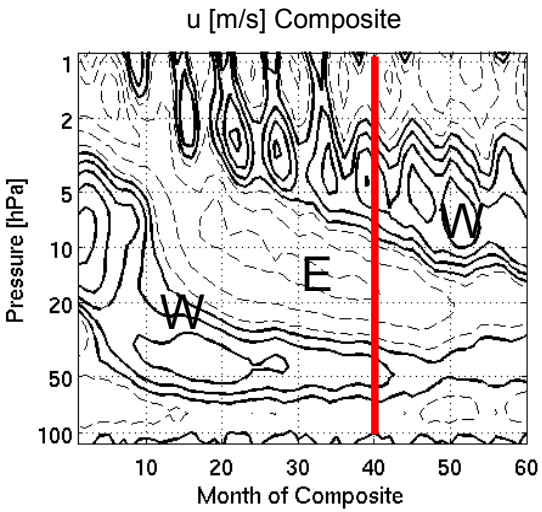

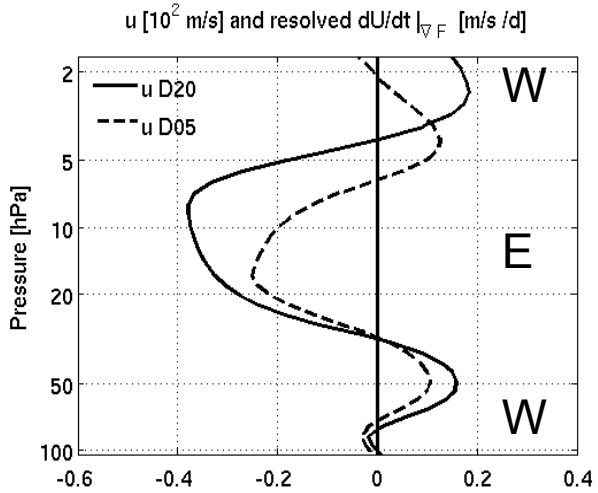

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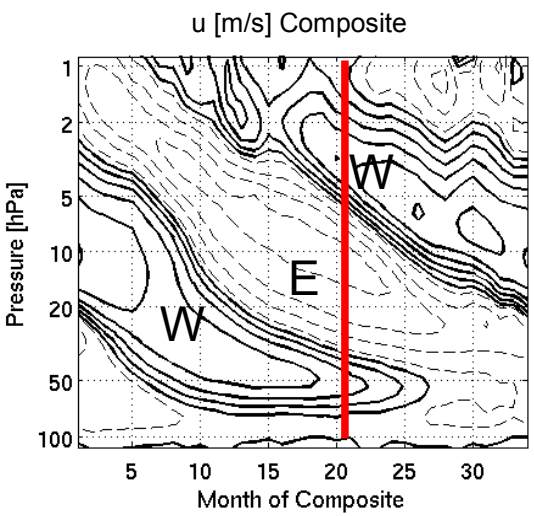

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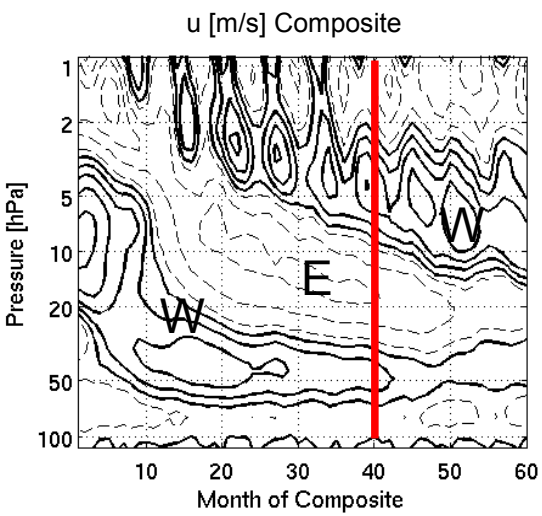
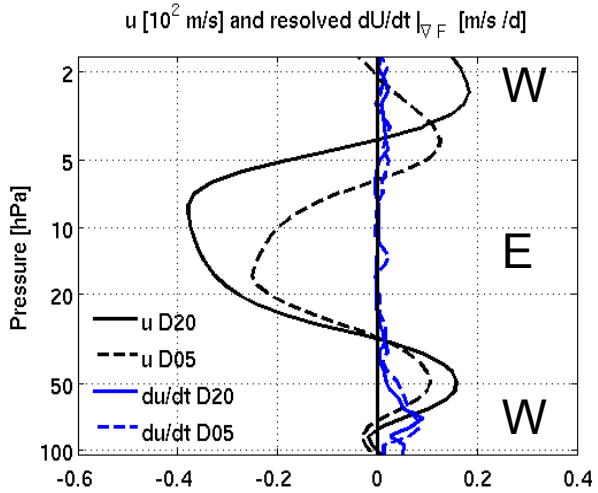


Resolved Wave Forcing



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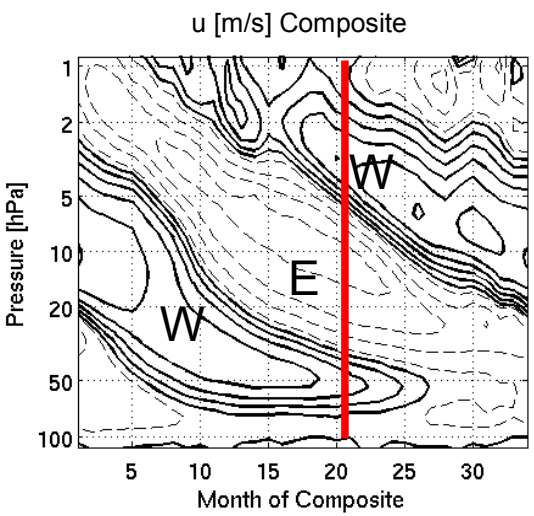

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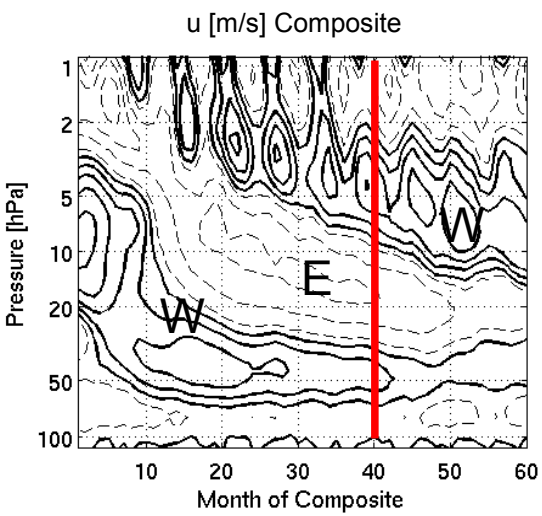

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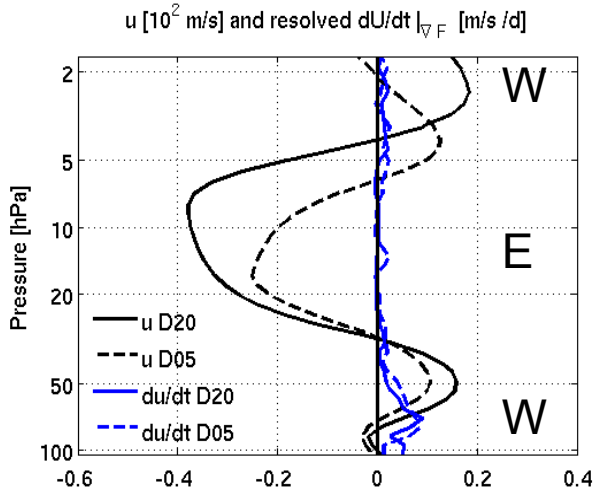
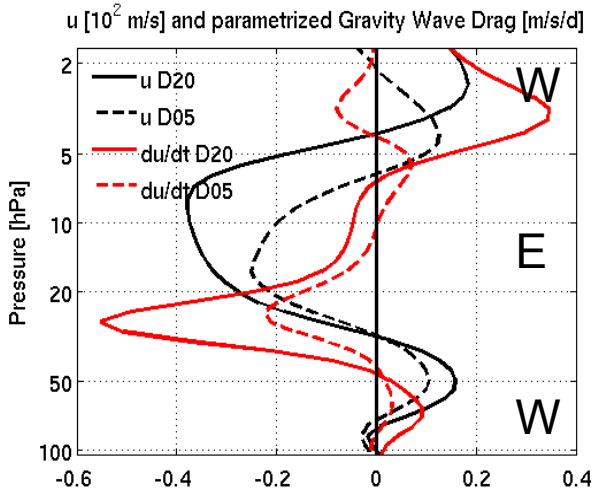
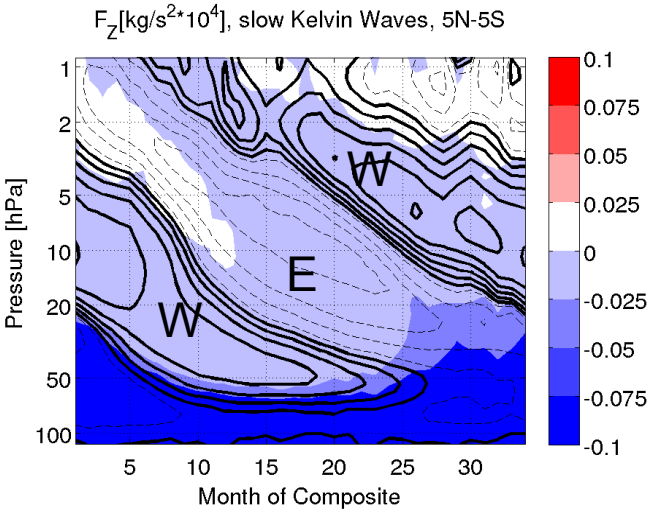


Parametrized Wave Forcing



Implications for the Resolved Wave Drag

Control Run



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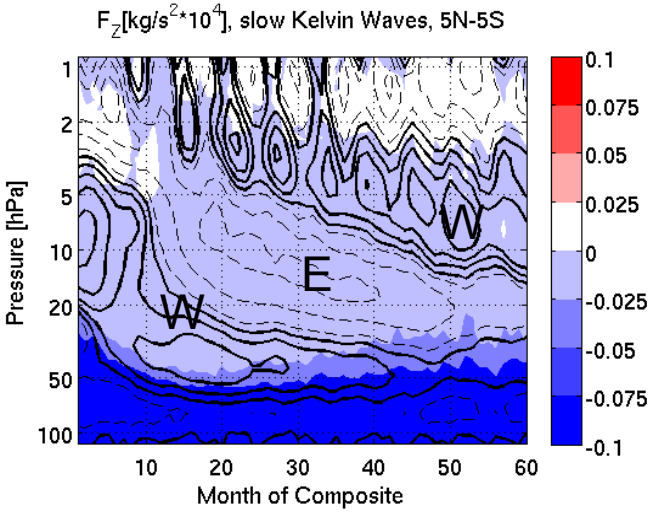
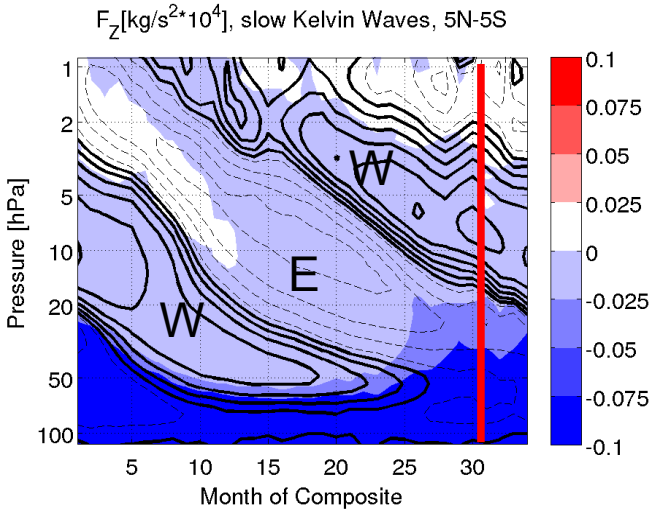
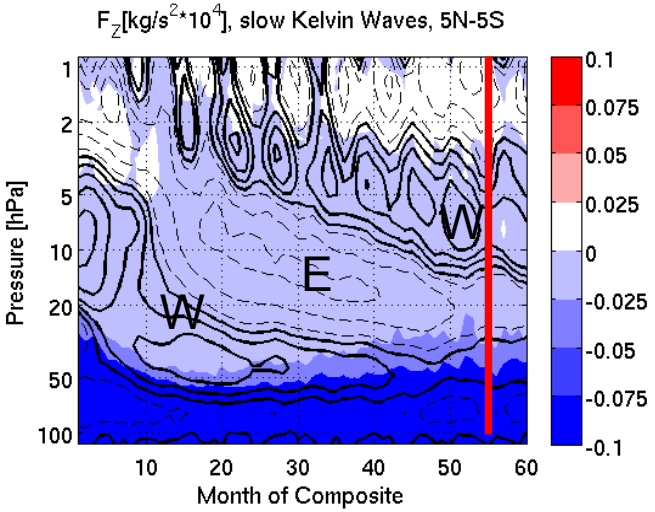


The Subsequent QBO Westerly Jet

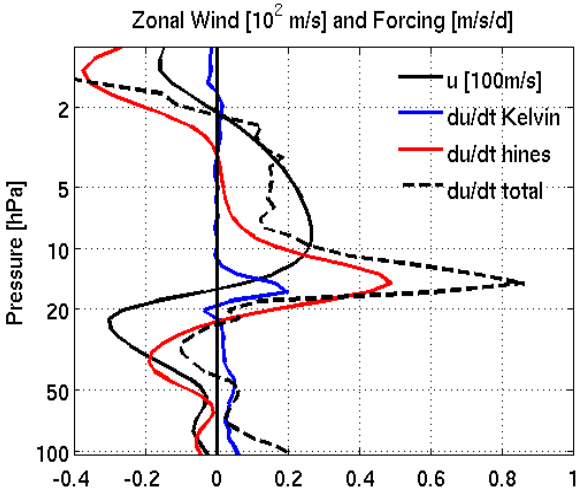
Control Run



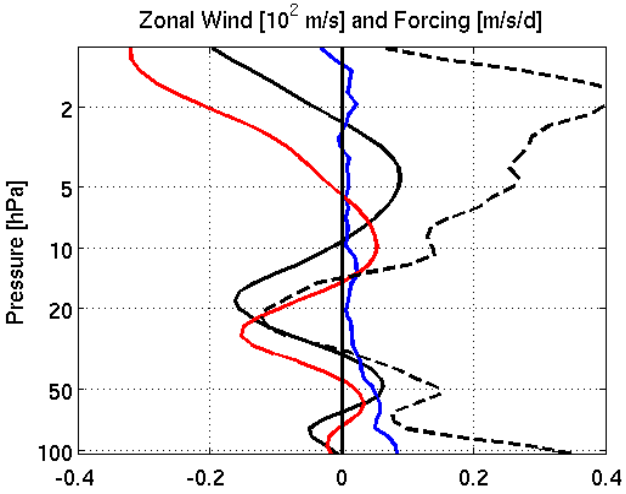
1.05 Run



Total Forcing Control



Total Forcing 1.05 Run



Conclusions

The experiment showed that:

with reduction of parametrized gravity wave sources

- the regular structure of the QBO changes strongly and shows periods of quasi stable configurations

- the lower westerly jet persists and is stable because erosion by the easterly jet is too weak

- resolved, equatorial wave momentum deposition is sufficient to maintain a westerly jet in the lower stratosphere

- the upper westerly jet persists and can not propagate because it is shielded from resolved and parametrized waves

Future Work:
Find variations of resolved gravity and large scale wave sources which cause similar changes in the QBO (ENSO, Madden Julian Oscillation, Seasonality)