Mechanisms in regulating the quasi-biennial oscillation in E3SM version 2

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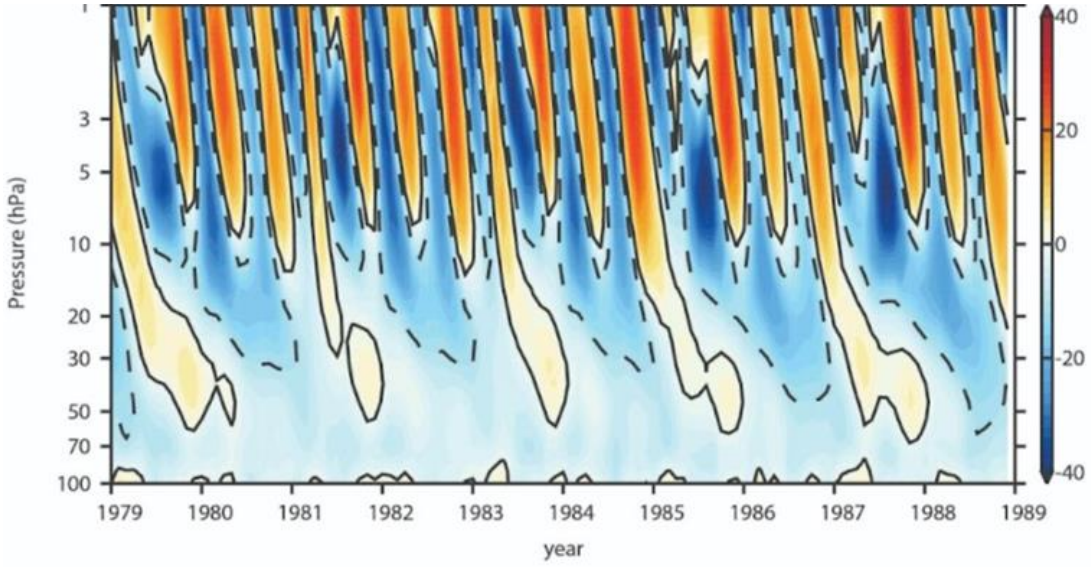
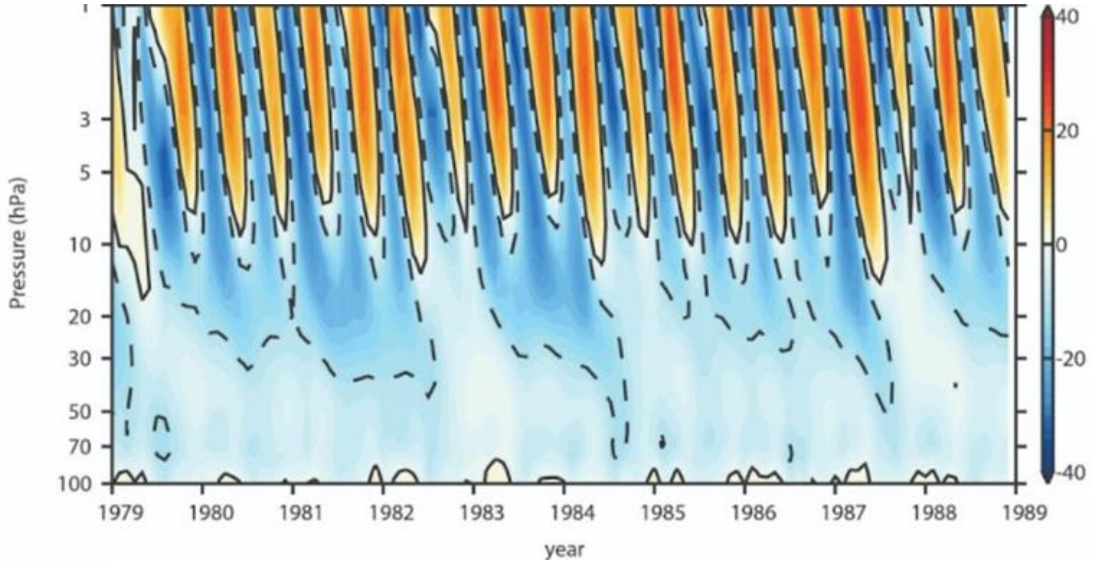
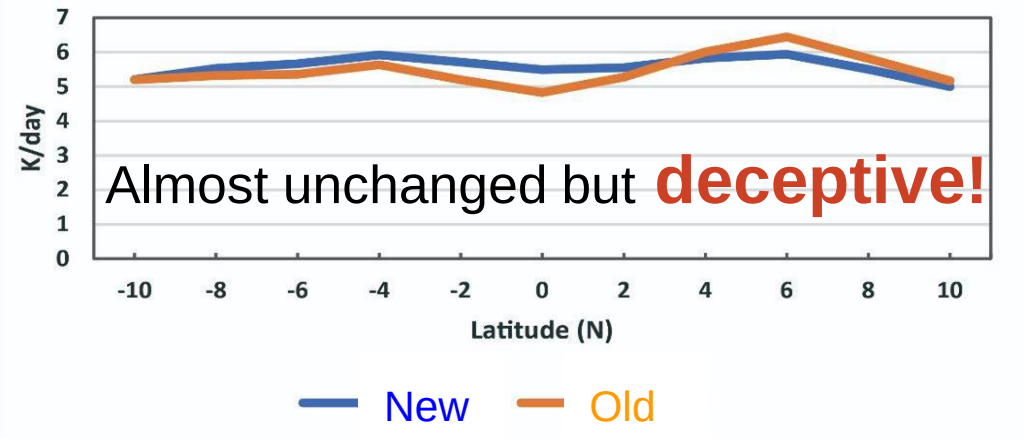
New deep convection parameterization



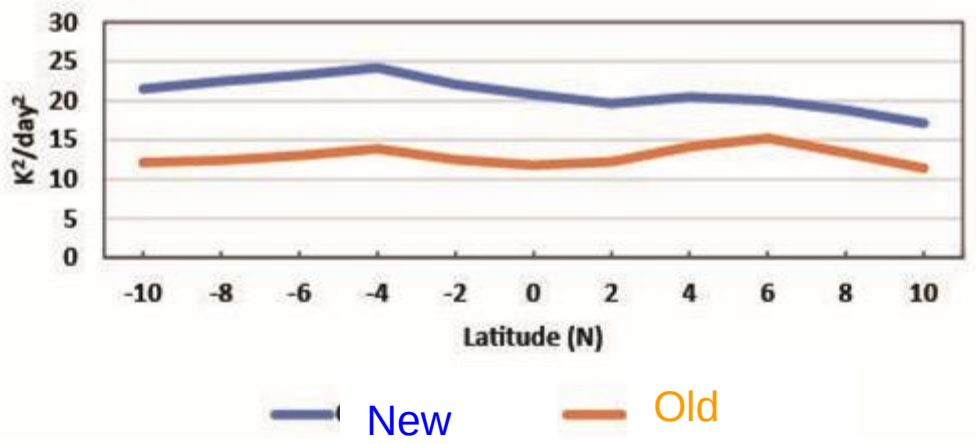
Old deep convection parameterization



Zonal and time mean of Qmax



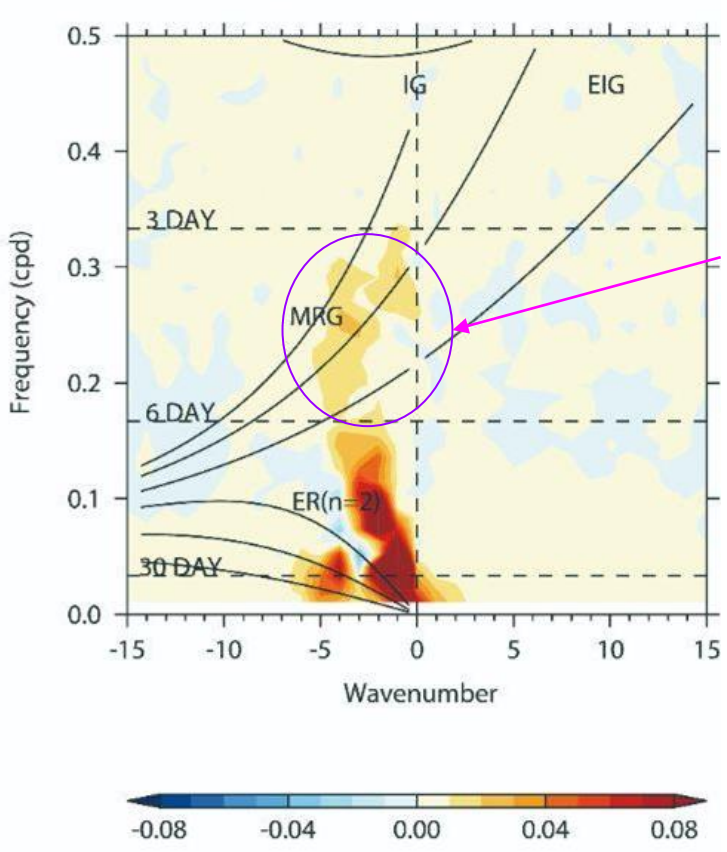
Zonal and time mean of Qmax square



Key point #1: New deep convection scheme enhances the time mean of heating rate square, which proportionally scales up the gravity wave stresses and strengthens QBO

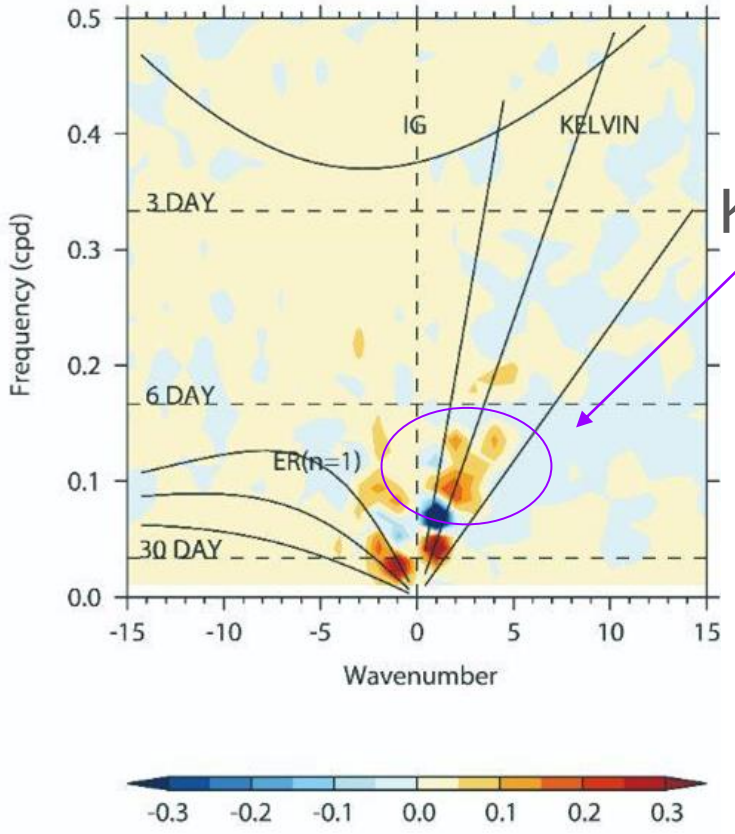
Difference in space-time spectra of zonal wind (U) at 45 hPa (with gravity waves-without gravity wave)

Antisymmetric wave



MRG wave

Symmetric wave



Kelvin wave

Key point #2: There is evidence that planetary wave generation is present in the stratosphere due to dissipation of parameterized gravity waves. (This mechanism is not reported before and may lead a series of theoretical works)