P3.1 **WHAT ARE THE SOURCES OF MECHANICAL DAMPING IN MATSUNO-GILL TYPE MODELS?**

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ABSTRACT

The Matsuno-Gill model has been widely used to study the tropical large-scale circulations and atmosphere-ocean interactions. However, a common critique of this model is that it requires a very strong damping to get realistic response and it is unclear what could provide such damping in the upper troposphere. This study analyzed the momentum budget in the tropics using 15 years of daily NCEP/NCAR and ECMWF reanalyses. The results show that in the Walker circulation, the pressure gradient force is strong at both the lower and upper levels, and requires a strong ($\tilde{5}$ day) damping to balance it. This supports the use of strong damping in the Matsuno-Gill type models. At the upper levels, the damping comes from CMT in the deep convection region, and from nonlinear advection in the shallow convection region, At the lower levels above the boundary layer, the damping comes from CMT in both regions. Damping is also strong in the Asian summer monsoon, and in oscillations such as the ENSO and the MJO.

DATASETS AND METHODOLOGY

The datasets used include 15 years (1979-1999) of daily reanalyses data from two different centers: NCEP (Kalnay et al. 1996) and ECMWF (the ERA-15 reanalysis, Gibson et al. 1999) The variables used include upper air wind, geopotential height, and vertical pressure velocity on pressure surfaces. The horizontal resolution is 2.5 degree longitude e by 2.5 degree latitude. The zonal momentum budget is calculated for both reanalyses following Carr and Bretherton (2001), based on the zonal momentum equation:

$$\frac{\partial u}{\partial t} = -u\frac{\partial u}{\partial x} - v\frac{\partial u}{\partial y} - \omega\frac{\partial u}{\partial p} + f(y)v - \frac{\partial \phi}{\partial x} + X \quad (1)$$

where u is the grid-resolved zonal wind, v the meridional wind, ω the vertical pressure velocity; x and y are E-W and N-S distance, f the Coriolis parameter, and ϕ the geopotential. Here X represents accelerations due to all subgrid-scale processes. Each budget term except X was calculated using daily average data at each 2.5 degree grid point. X is computed as the residual, meaning that all errors in the other terms are included in its observational estimate, requiring caution in interpretation. Derivatives were evaluated using 3-point central differencing. The results were then averaged to pentad data along the equator (between 5N and 5S) with a zonal resolution of 10 degree longitude.

For studying the deep convection, we also used 15 years (1979-1993) of pentad CMAP precipitation data (Xie and Arkin 1997) averaged along the equator (between 5N and 5S).

RESULTS

The observed zonal momentum budget for the Walker circulation is summarized schematically in Fig. . The pressure gradient force is strong at both the lower and upper levels, and requires a strong ($\tilde{5}$ day) damping to balance it. This supports the use of strong damping in the Matsuno-Gill type models. At the upper levels, the damping comes from CMT in the deep convection region, and from nonlinear advection in the shallow convection region, At the lower levels above the boundary layer, the damping comes from CMT in both regions. Damping is also strong in the Asian summer monsoon, and in oscillations such as the ENSO and the MJO (Lin et al. 2004).

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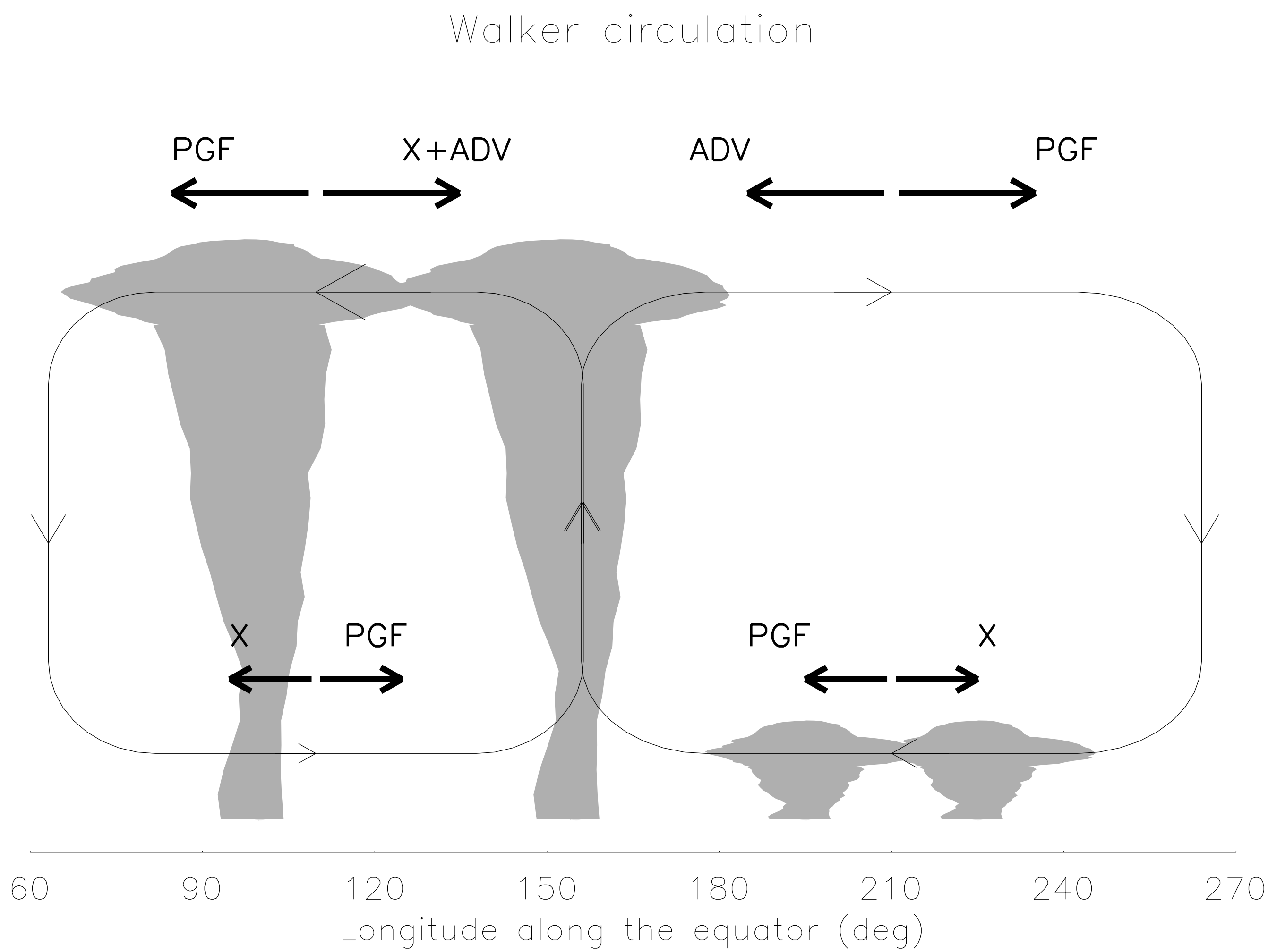

Figure 1: Schematic depiction of the zonal momentum budget of the Walker circulation. PGF is pressure gradient force, ADV is advection, and EMFC is eddy momentum flux convergence.