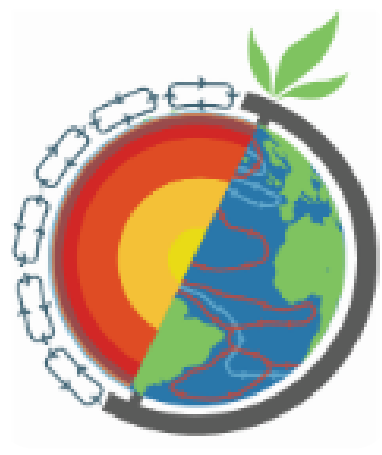




Impact of Parameterized Convection on the Jet Response to Global Warming: isolating tropical vs. midlatitude vs. polar convective heating

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Motivation:

- Large intermodel spread in CMIP6 jet projections (Bartana et al., 2026).
- Convection scheme has a leading-order impact on the circulation response to global warming (Garfinkel et al., 2024).
- Here, we induce latitudinal dependence on the settings for the convective parameterization from Garfinkel et al., 2024 in order to further clarify the mechanisms of the Eddy Driven Jet (EDJ) projected shifts.

Model of an idealized Moist Atmosphere (MiMA):

- No clouds, no ice; Aquaplanet; T42.
- convection parameterization (Simplified Betts-Miller convection scheme):
 - M** (more convection): RHrelax = 0.8; shallow convection on.
 - L** (less convection): RHrelax = 0.7; shallow convection off.

Latitudinal separation:			
exp	0-30	30-50	50-90
a	M	M	M
b	L	L	L
c	M	M	L
d	L	L	M
e	L	M	M
f	M	L	L
g	M	L	M
h	L	M	L

Steady-state simulations: Annual mean of 100 years for each convection combination with: (1) pre-industrial settings (ctrl) and (2) increased CO2 to force an 8K increase in global mean surface temperature (+8K).

Transient simulations: M-M-M and L-L-L initial conditions with three different physical developments: (1) increased CO2 to force an 8K increase in global mean surface temperature (+8K) and variations in (2) tropical and (3) midlatitude convection schemes. 50 years yield 50 ensemble members for each experiment.

ΔU and jet latitudes

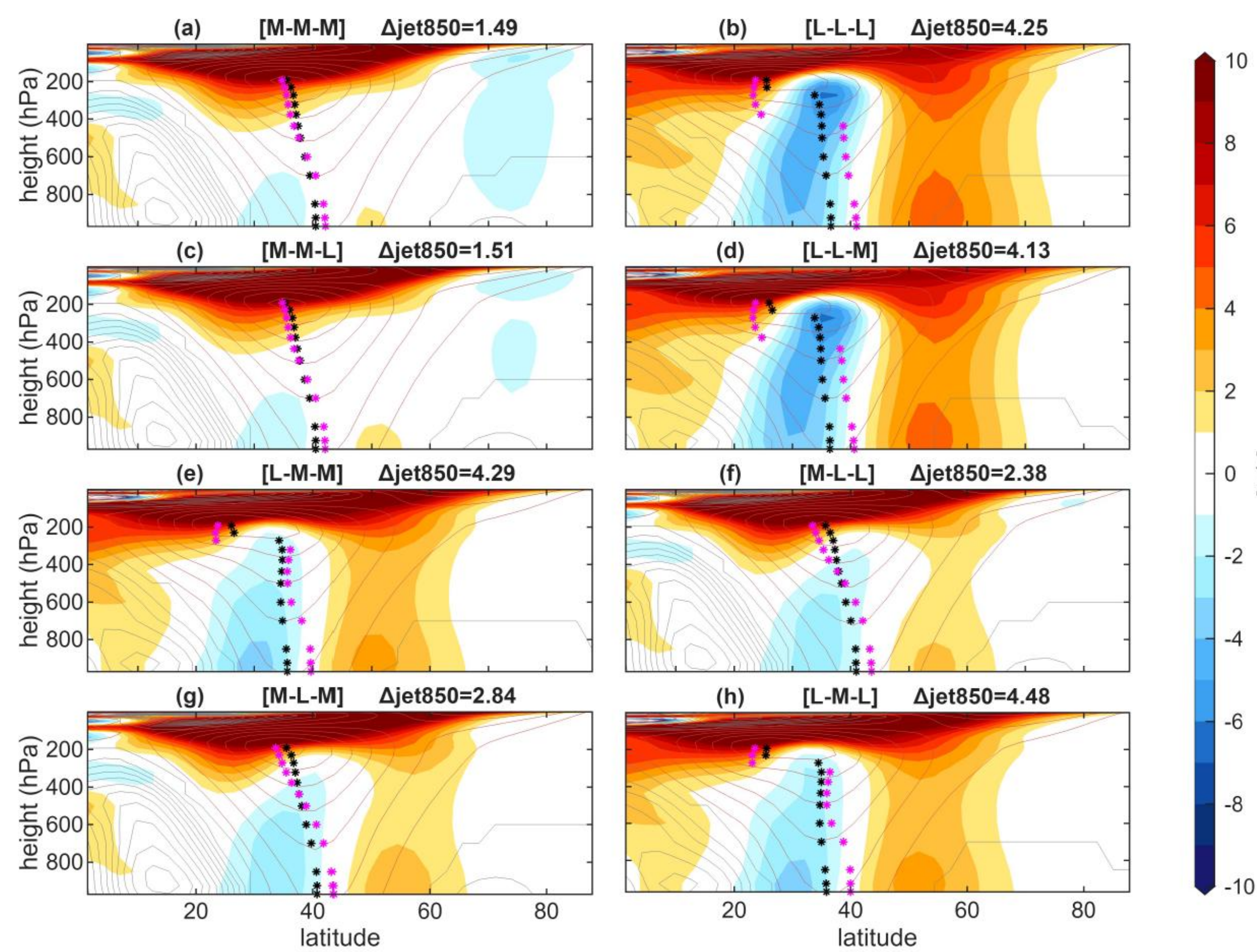


Figure 1. Differences in zonal mean zonal winds (m/s) between +8K and control simulations (shading) and climatology (contours). Asterisks mark the latitude of maximum jet in climatology (black) and in global warming (magenta).

ΔT and jet latitudes

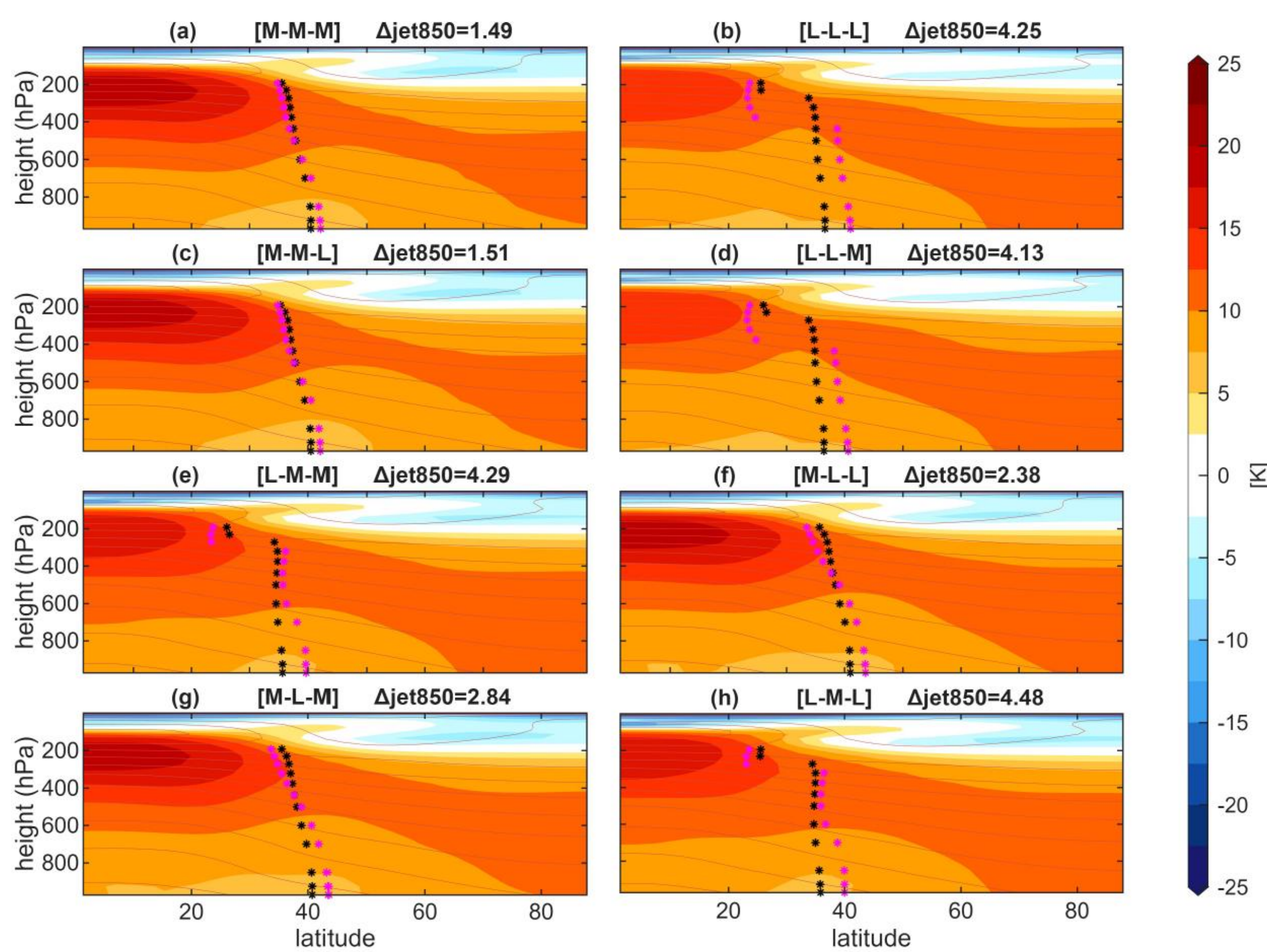


Figure 2. Differences in zonal mean temperature (K) between +8K and control simulations (shading) and climatology (contours). Asterisks mark the latitude of maximum jet in climatology (black) and in global warming (magenta).

Steady-state simulations:

- Tropical convection parameterizations is crucial for the climatological EDJ latitude (Figure 1) and latent heating pattern (Figure 3).
- Midlatitude convection parameterizations is crucial for simulating EDJ shifts (Figure 1) and latent heating patterns (Figure 3).
- EDJ shift predicted by tropical temperature is opposite to actual shift (Figure 2).
- Correlations show the importance of changes in the heat budget and Ferrel cell circulation, and not tropical temperature (Figure 4).

Transient simulations:

Tropical convection determines initial jet location (Figure 5).

Future work: Earth-like configuration simulations.

Take-home message: Tropical convection parameterization sets the climatological EDJ latitude, while midlatitude parameterization dominates the projected response to global warming.

Heat budget equation (Garfinkel et al., 2024):

$$\bar{\omega} \left(\frac{\partial \bar{T}}{\partial p} - \kappa \frac{\bar{T}}{p} \right) = - \frac{1}{a \cos \phi} \frac{\partial \cos \phi (\bar{v}' \bar{T}')}{\partial \phi} - \left(\frac{\partial \bar{\omega}' \bar{T}'}{\partial p} - \kappa \frac{\bar{\omega}' \bar{T}'}{p} \right) + \frac{\bar{J}}{c_p}$$

adiabatic heating meridional eddy heat flux vertical eddy heat flux diabatic heating

Based on Lachmy, 2022:

Ferrel cell without diabatic heating: $\text{EHF}_{\text{sub}} > 0$, $\text{EHF}_{\text{high}} < 0$

Ferrel cell with diabatic heating: $\text{EHF}_{\text{sub}} > 0$, $\text{EHF}_{\text{high}} > 0$

Δlatent heating and jet latitudes

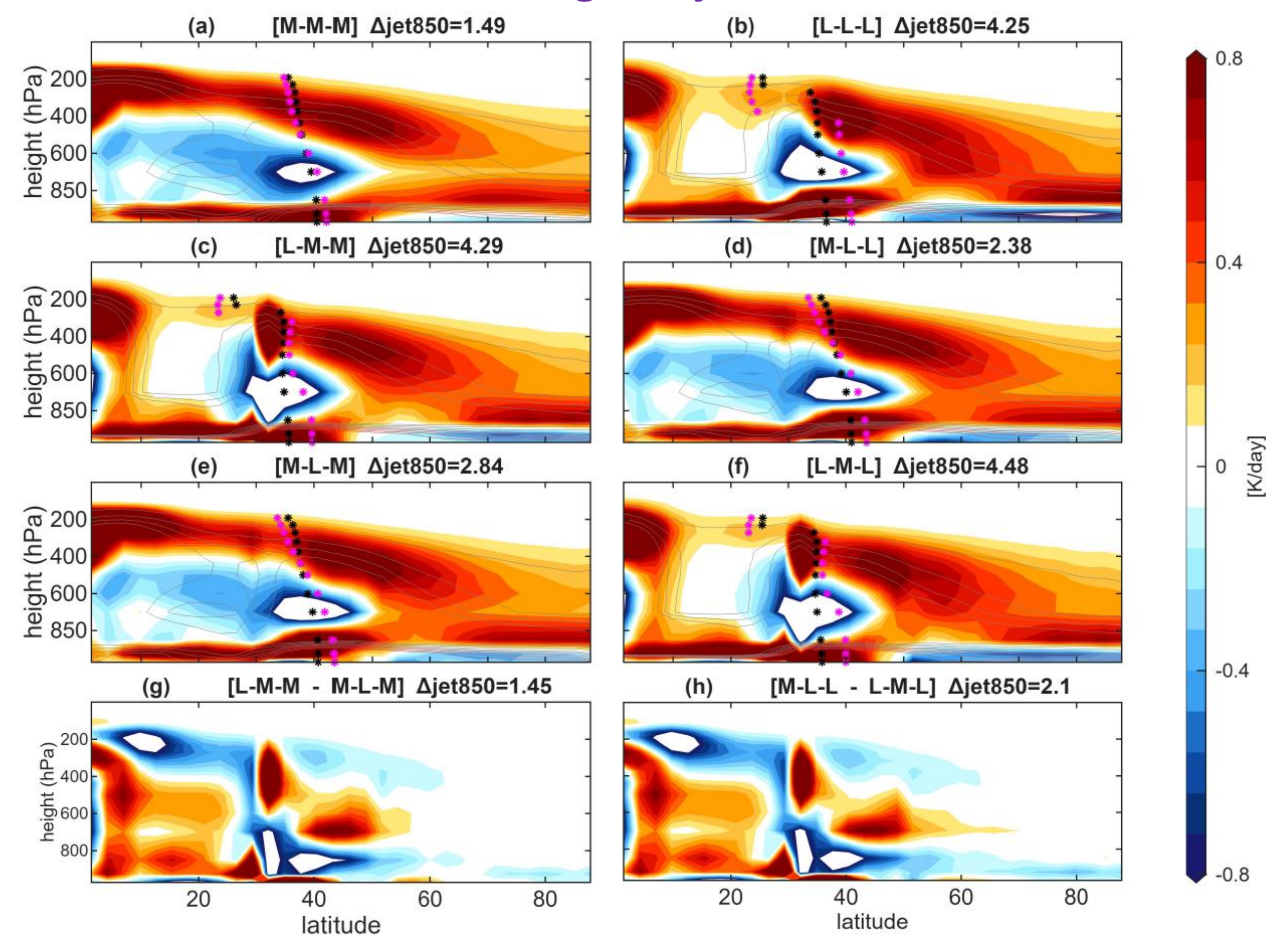


Figure 3. Differences in zonal mean latent heating in the heat budget equation (K/day) between +8K and control simulations (shading) and climatology (contours).

Correlations with Δjet at 850 hPa

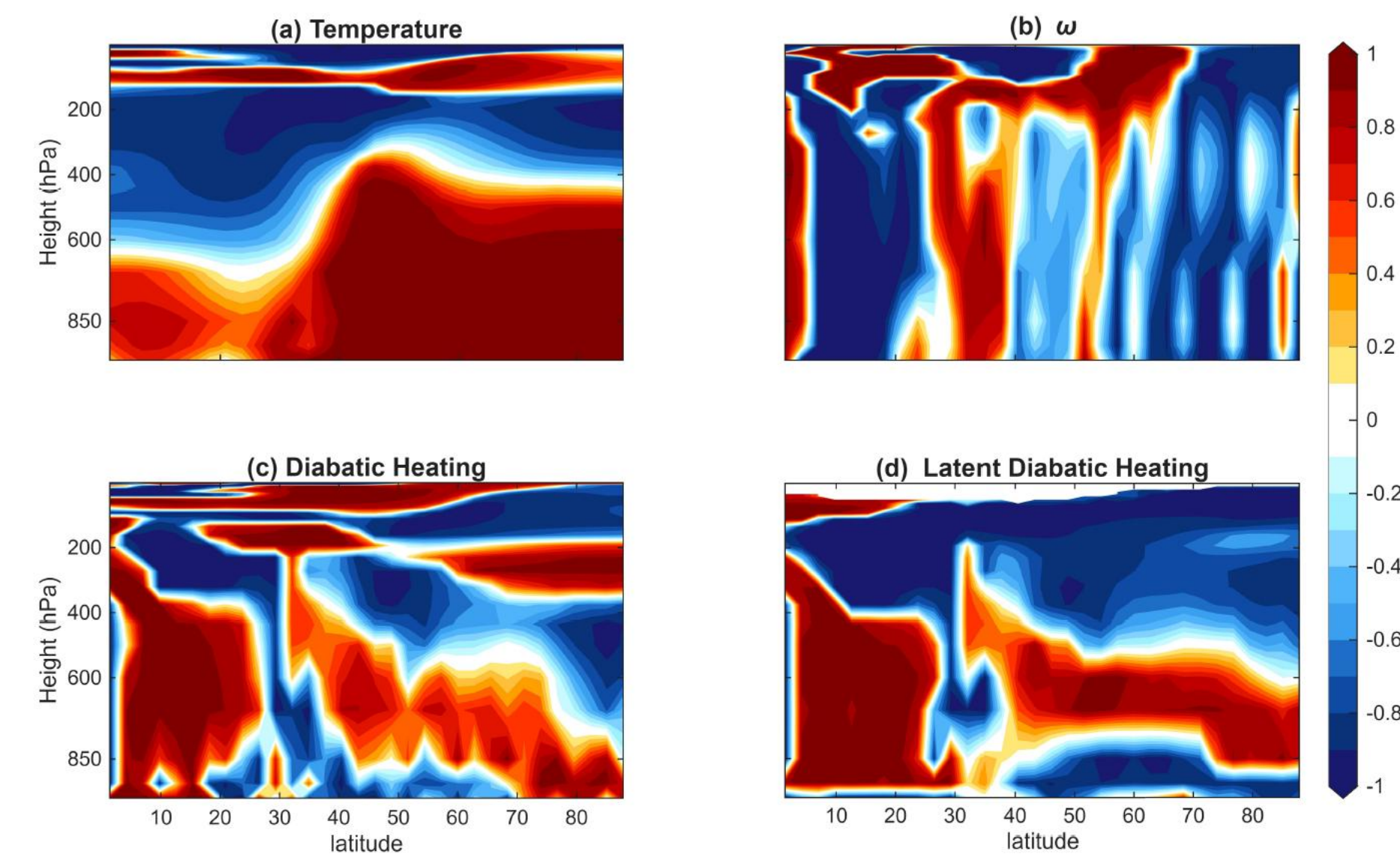


Figure 4. Correlations among the simulations between the jet shift at 850 hPa and (a) temperature (b) adiabatic heating (c) omega and (d) diabatic heating.

Δlatent diabatic heating and jet latitudes in transient

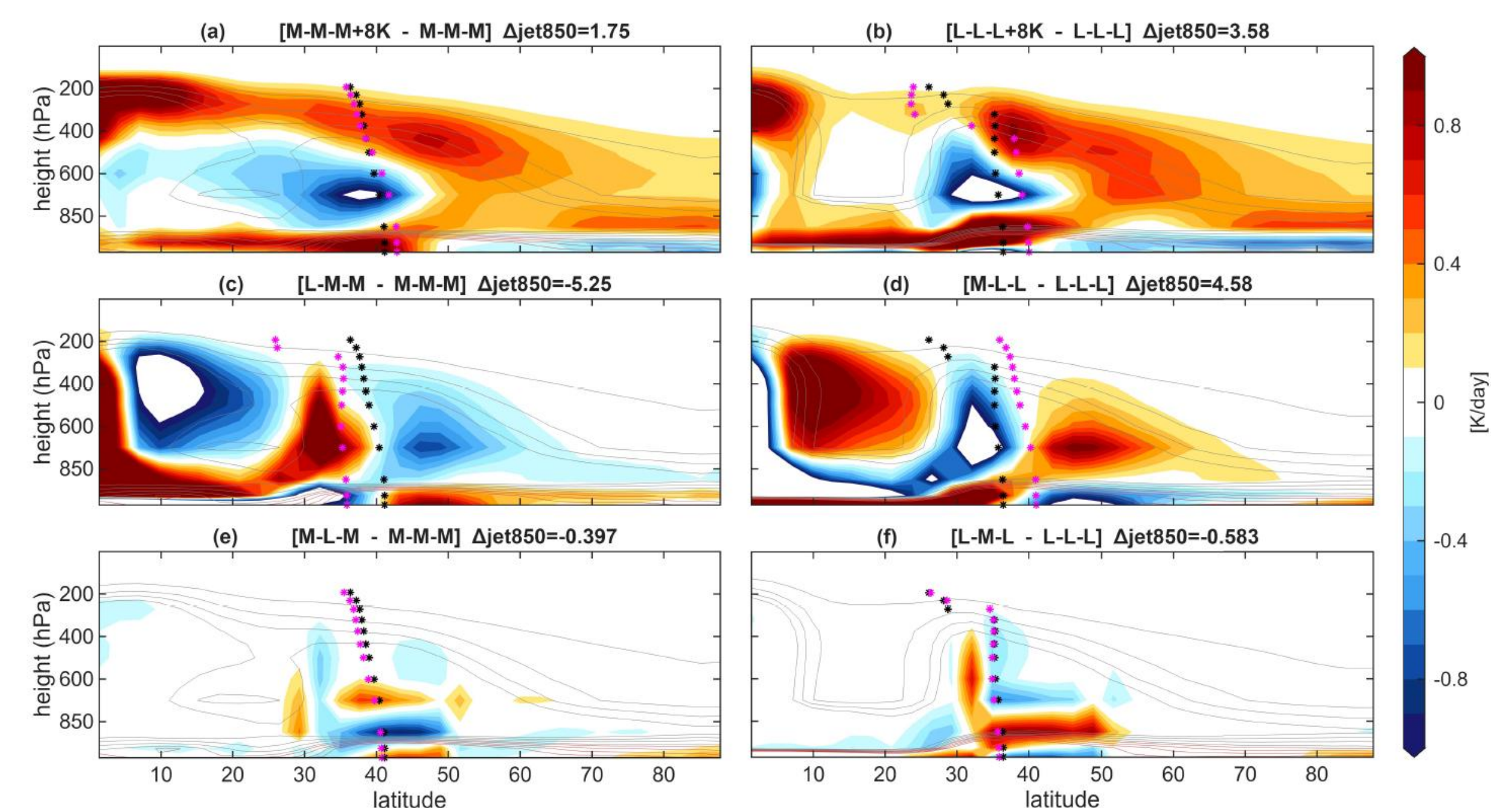


Figure 5. Differences in zonal mean latent diabatic heating (K/day) between days 1-30 of the transient simulations and the respective control simulations (shading) and climatology (contours).

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