**Stratosphere-troposphere coupling**: Controls by the Zonal Mean Circulation on the Stationary Wave Response to Climate Change

### Background

Planetary stationary wave is an essential component of atmospheric general circulation and its response to climate change could have significant societal and ecological impact.

Both zonal mean circulation and zonally asymmetric forcing contribute to the response.

### Lessons learned from CMAM (CCMVal-1 REF2) simulation

#### Past Basic State

- \( \Delta ZM \)

#### Future Basic State

- \( \Delta ZM + \Delta H \)

#### Future Basic State

- \( \Delta H \)

#### Future Basic State

- \( \Delta ZM_a \)

#### Future Basic State

- \( \Delta ZM_d \)

CMAM NH winter zonal mean zonal wind response to climate change (1960-1979 vs. 2080-2099). Contour interval is 2 m/s for response (red/blue) and 20 m/s for climatology (cyan).

Grey shading represents the statistical significance at 5% level by H-test.

Taylor diagram of CMAM (CCMVal-1 REF2) NH winter stationary wave (streamfunction) response to the changes in (1) zonal mean basic state \( \Delta ZM \), (2) tropospheric jet \( \Delta ZM_a \), (3) stratospheric jet \( \Delta ZM_d \), and (4)diabatic heating \( \Delta H \) compared with the total response \( \Delta ZM + \Delta H \), the target diagnosed by the stationary wave model.

\( \Delta ZM \) dominates the total response;
Zonal mean dominance can be further narrowed down to \( \Delta ZM_a \);
\( \Delta ZM_a \) and \( \Delta H \) also contribute to the total response and all components reinforce each other.

### Results

- Hovmöller diagrams of ensemble mean (20 members from 14 models) stationary wave (geopotential height) evolution in CCMVal-2 REF-B2 (GHG + \( O_3 \) forcings) simulations.

- Stationary wave pattern shifts eastward in time except for SH troposphere;
- Stationary wave amplitude increases in NH troposphere and stratosphere, but decreases in SH stratosphere.

### Summary

- Stationary wave response to climate change is controlled by the changes in zonal mean circulation in most cases;
- Generally there is an eastward drift of the wave pattern, largely due to GHG increasing;
- Wave amplitude trends are due to collaboration between GHG and \( O_3 \) forcings.

### Reference