Variability of Northern Hemisphere storm-tracks under future climate conditions in INM-CM5 climate model output

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Introduction

- Storm tracks (ST): areas of strong baroclinicity, where extratropical cyclones are formed, accompanied by strong winds and precipitation.
- STs transfer a large amount of heat, momentum, and moisture to high latitudes.
- Two ST are dominant in the Northern Hemisphere (NH): the North Pacific (NP) and the North Atlantic (NA).
- The shift or expansion of the ST regions as well as its intensification or weakening leads to changes in the weather conditions and precipitation.

Our Purpose

to assess the response of STs,

their geographic location and intensity,

to present and possible future climate changes

Model and Scenarios

Climate model INM-CM5.0 (CMIP6)

includes atmosphere, ocean, sea ice, land, and aerosol modules (Volodin et al., 2017)

- increase in the vertical resolution for the upper stratosphere and lower mesosphere;
- improvement of the parameterization of large-scale condensation and cloudiness;
- addition of the aerosol module;
- simulate the quasi-biennial oscillation of the equatorial zonal wind in the stratosphere;
- better statistics of Sudden Stratospheric Warming events.

Climate Scenarios: SSP2-4.5 and SSP5-8.5

Storm-Tracks

Eddy kinetic energy (Intensity): $\boldsymbol{v'v' = \overline{[v(t+24h) - v(t)]^2}}$

Eddy momentum flux:

$$u'v' = \overline{[u(t+24h) - u(t)][v(t+24h) - v(t)]} \cos\varphi$$

Eddy heat flux:

$$v'T' = \overline{[v(t+24h) - v(t)][T(t+24h) - T(t)]}$$

Eddy moisture flux:

$$v'q' = \overline{[v(t+24h) - v(t)][q(t+24h) - q(t)]}$$

Previous Results

INM-CM5.0 STs: good agreement with NCEP2 and ERA-Interim

The realization of Northern Hemisphere storm tracks in the INM CM5 **historical simulations** and their responses to the **strengthening and weakening of the Arctic stratospheric polar vortex** with the tropospheric impact and the recently observed Arctic amplification are comparable with the storm track parameters revealed in the reanalysis data (Vargin et al., 2019).

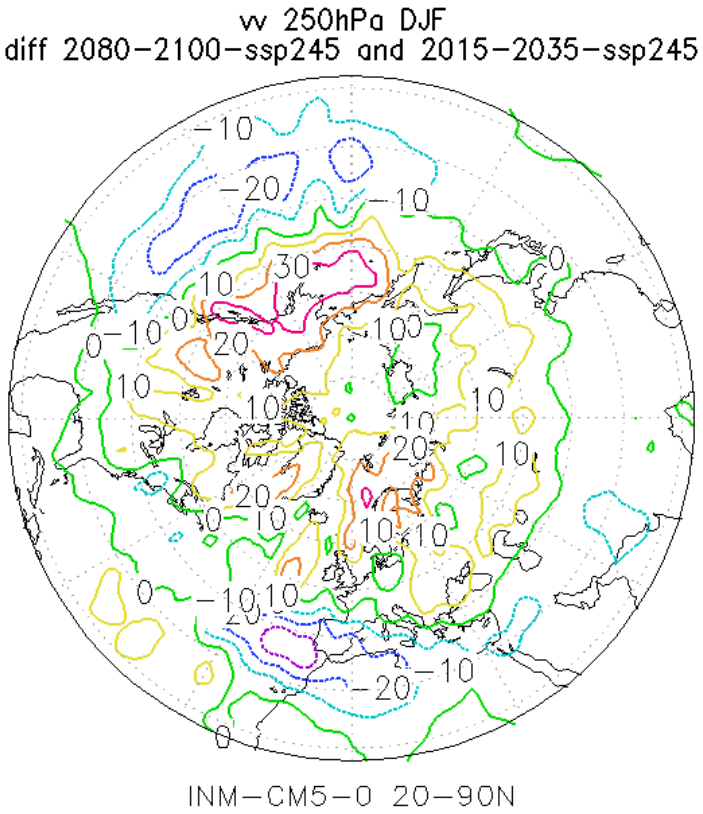
Current Research

- STs variation under climate change.
  - periods: 2015-2035 and 2080-2100

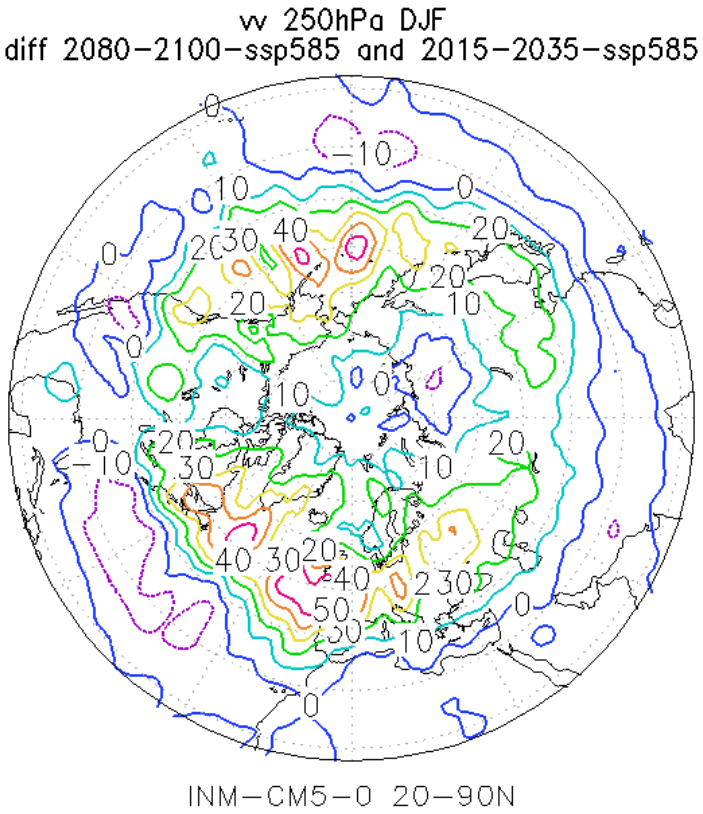
- Variation of the response of the STs on stratospheric cooling/warming.

STs under Climate Change

SSP2-4.5

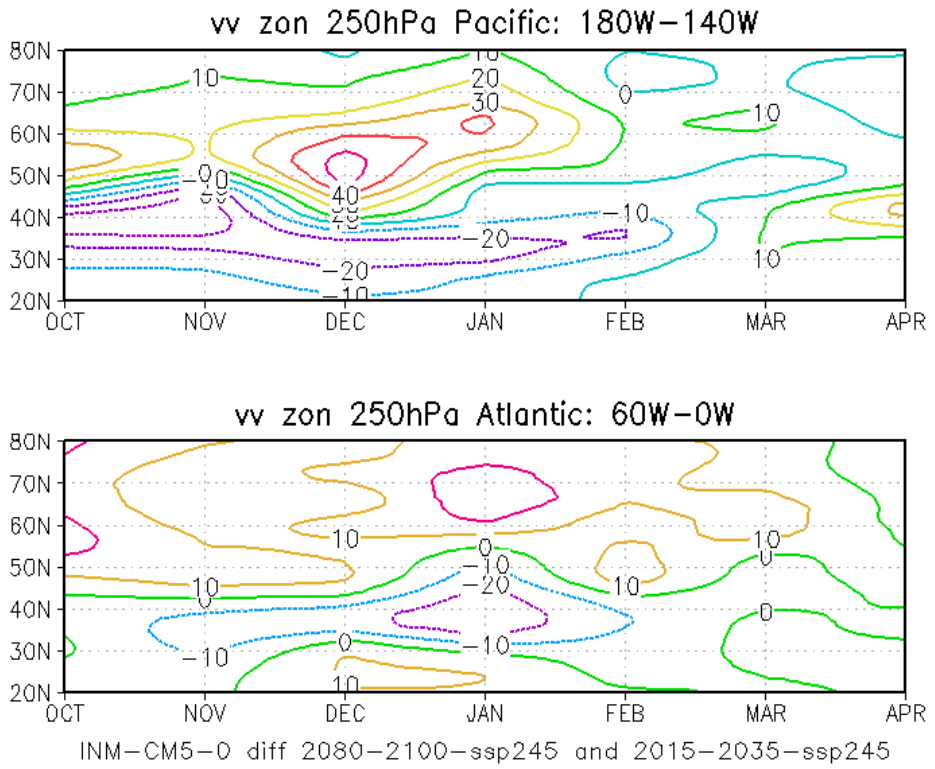


SSP5-8.5



Difference between 2080-2100 and 2015-2035

SSP2-4.5



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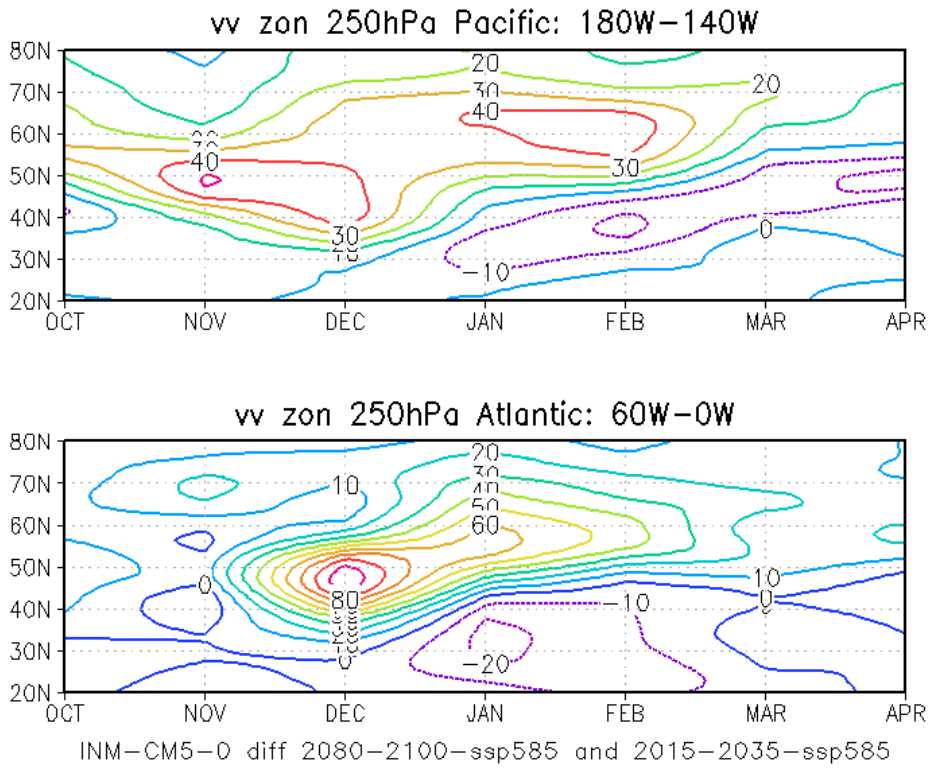

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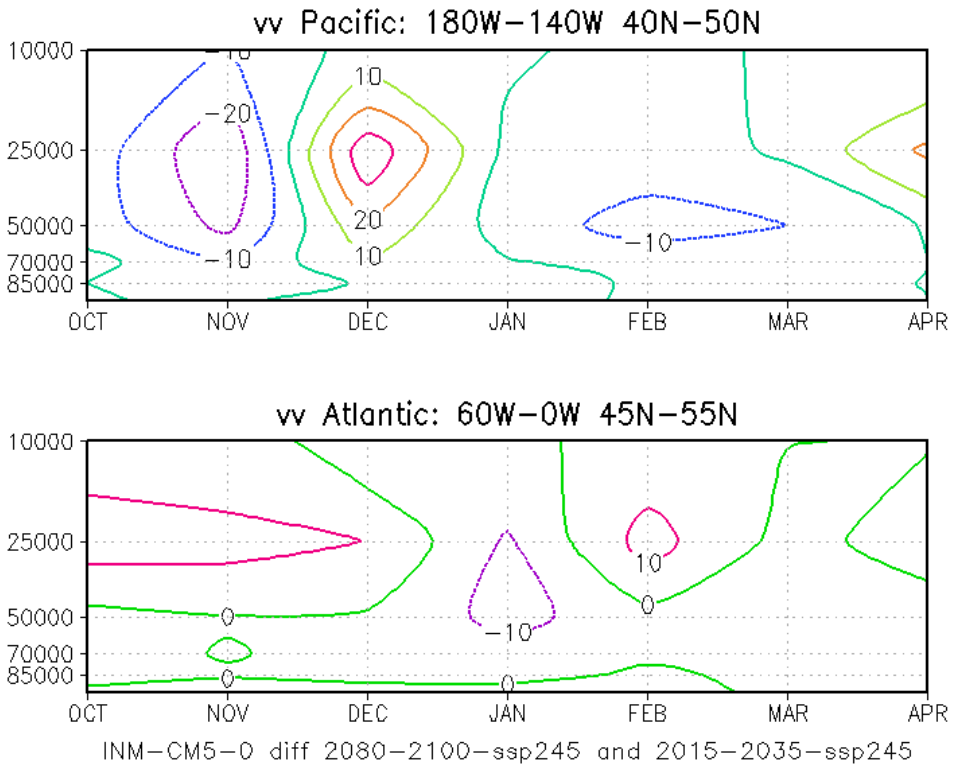

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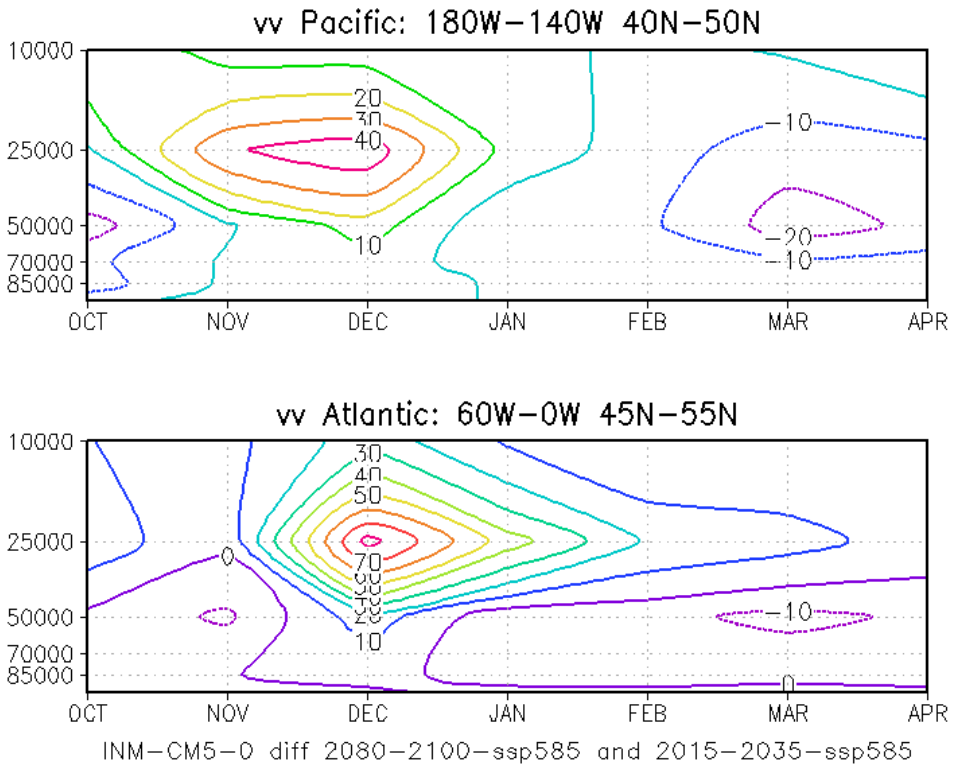


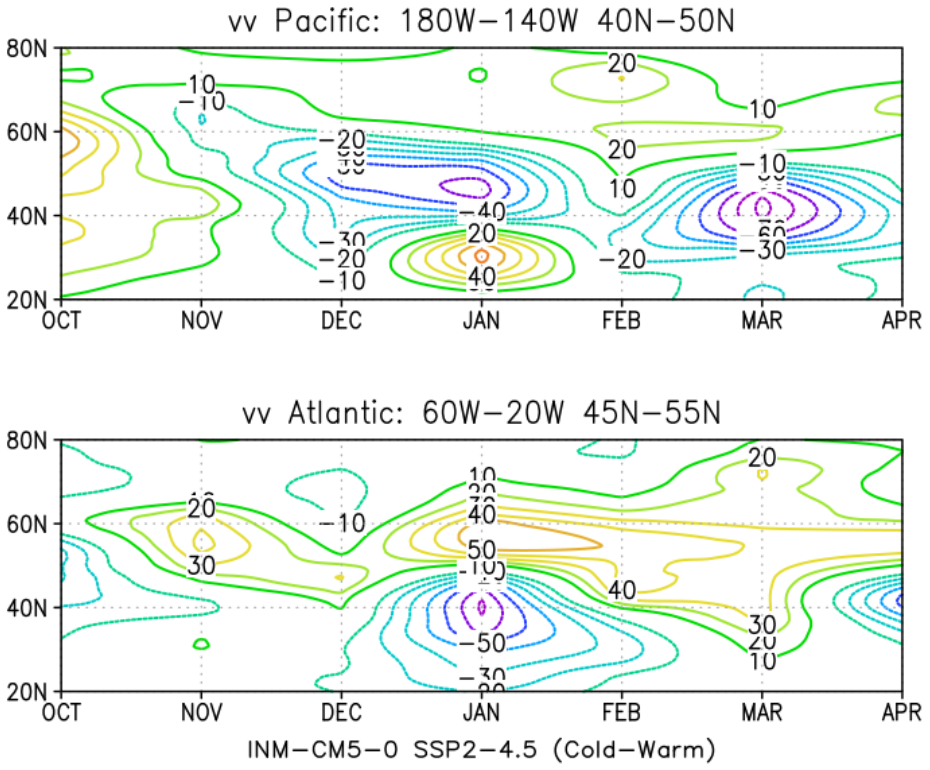
Stratospheric Cooling and Warming

Winters with influence of the stratosphere to troposphere

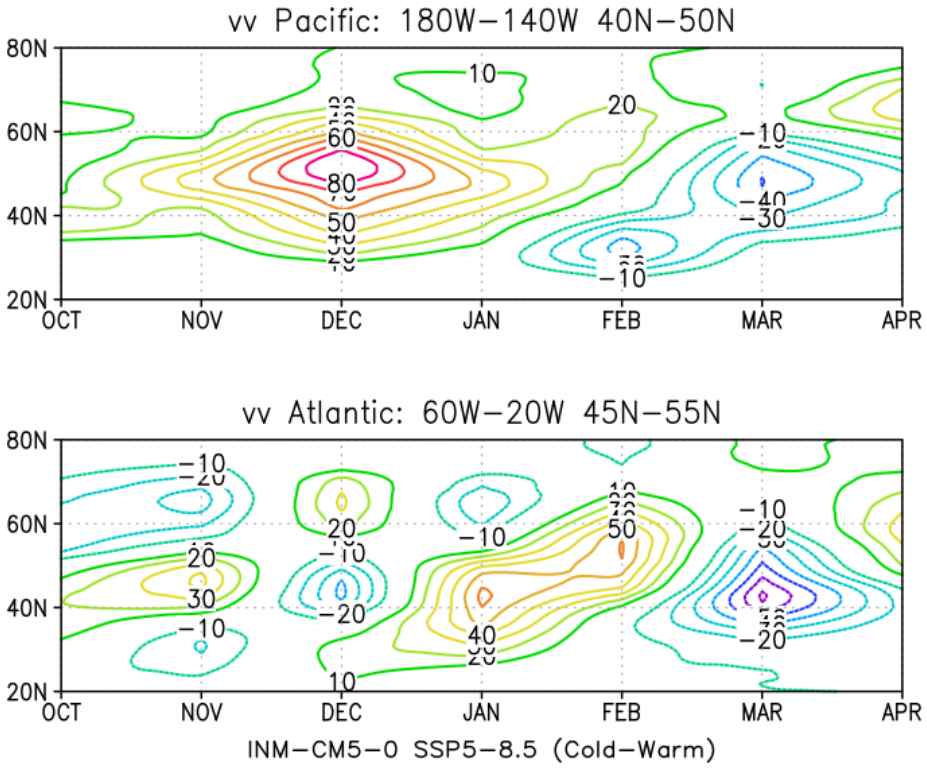
Composites: cool (strong Polar vortex) and warm (weak Polar vortex) winter stratosphere

STs: “Cold” - “Warm” Stratosphere

SSP2-4.5



SSP5-8.5



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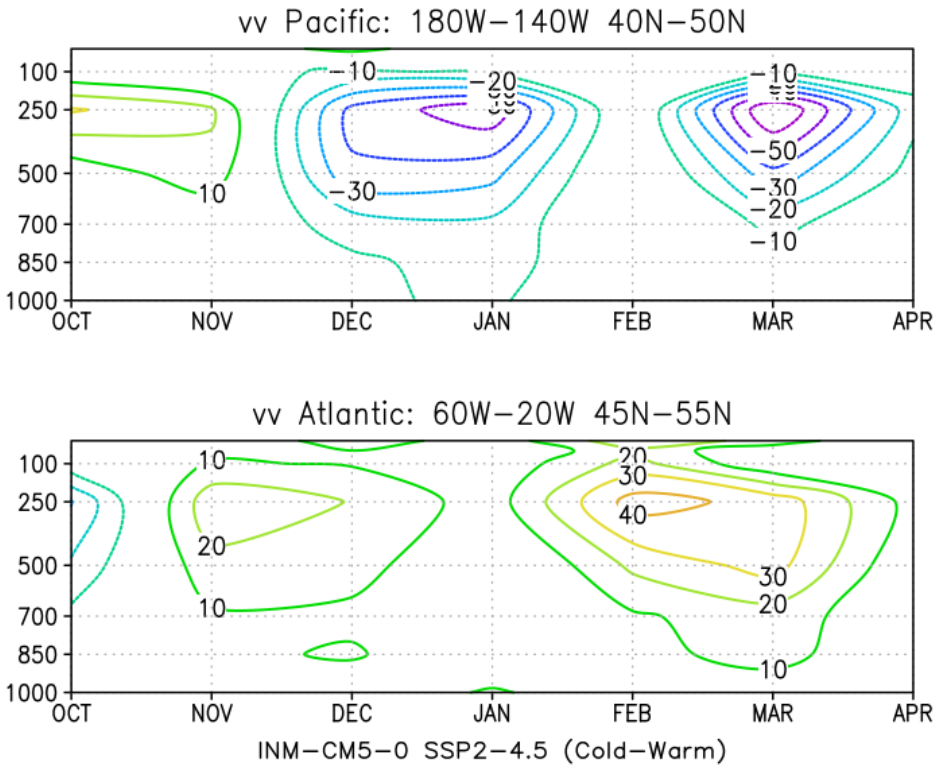
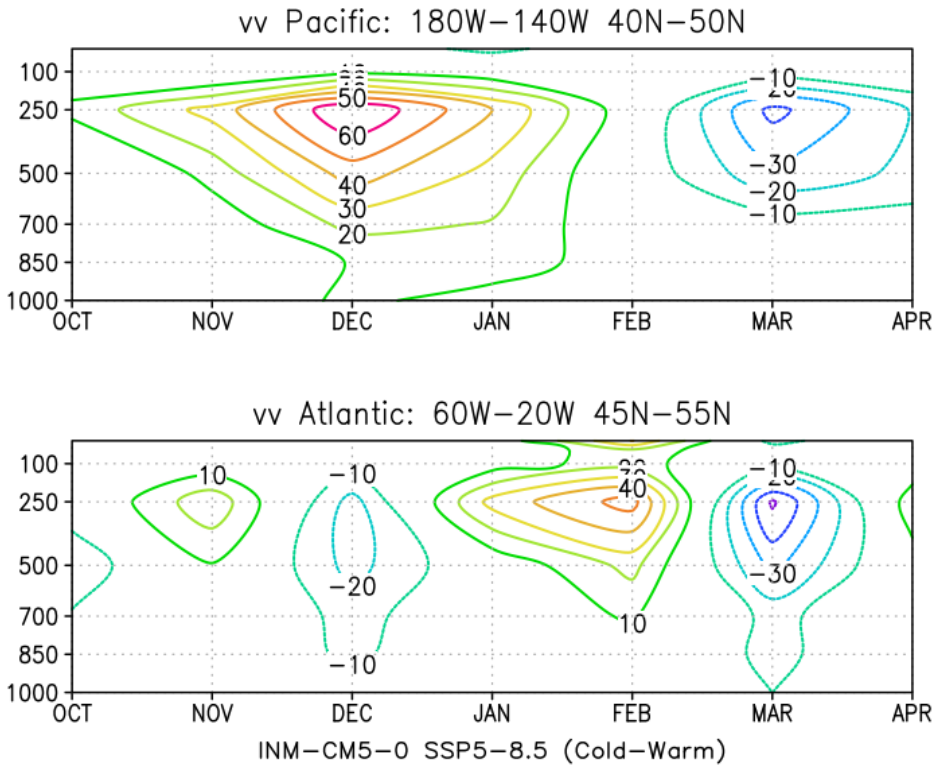


SSP5-8.5



STs: “Cold” - “Warm” Stratosphere

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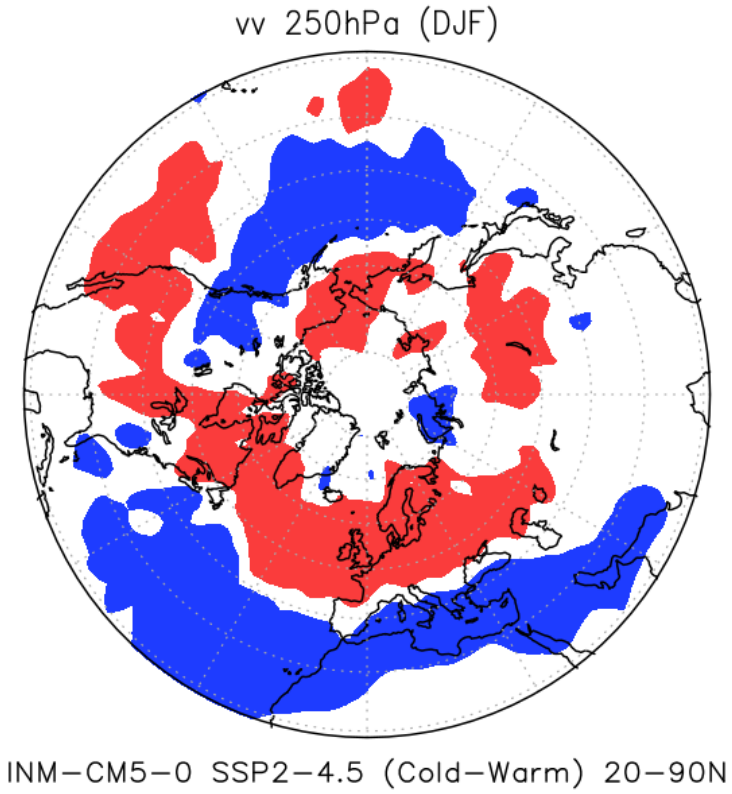
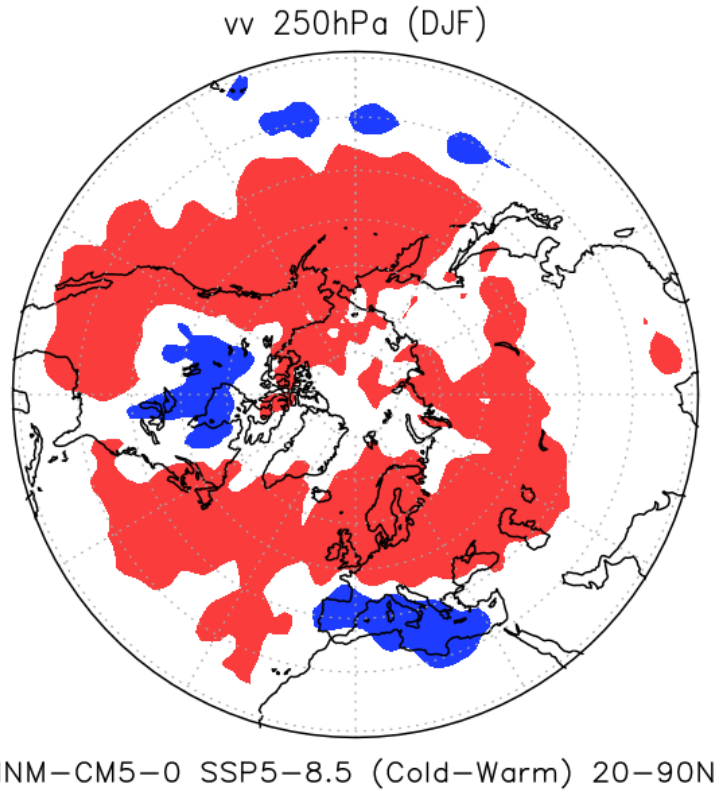


SSP5-8.5



diff. < -10 m^2/s^2 diff. > 10 m^2/s^2

Conclusion

- High sensitivity of NH Sts
- North Pacific ST: stronger response to the climate change then North Atlantic ST

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Thank you for your attention!