vEGU2021 Display for ‘Minimal impact of model biases on northern hemisphere ENSO teleconnections.’

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Experimental setup:

- ECHAM6 atmospheric model was Bias-Corrected using a two-stage technique:
  - Dynamic variables (temp., div., vort., sfc press.) are nudged toward observations and nudging tendencies are saved.
  - Nuding tendencies are used to create a climatology of tendencies, which can be used to bias correct the model.
  - Model is re-run with the bias corrections added each timestep, globally, and at different levels for; the whole atmosphere (FullBC), stratosphere only (StratBC) and Troposphere only (TropBC).
- In each of the control and bias correct runs, a constant positive and negative ENSO anomaly is added to the tropical Pacific SSTs.

Results:

- Model biases impact the polar vortex response to ENSO, via changes to vertical waveflux into stratosphere.
- Differences in vertical wave flux are possibly related to biases in the Aleutian Low. For runs with deeper Aleutian Low the anomalies may saturate, such further deepening due to El Niño does not increase wave forcing to the stratosphere.
- Polar vortex response is driven by the vertical wave flux, and even large biases in the strength of the polar vortex do not impact the anomalous response of the vortex.
- Regressions between the surface pressure and vertical wave flux indicate a strong the relationship between the Aleutian Low and vertical wave forcing is reduced in El Niño experiments when the climatological Aleutian Low is deeper.
- Model biases, nor differences in the polar vortex response, did not influence the NAO response to ENSO.

Table 1. Experiment details and run names.

Bias corrections	**ENSO Neutral**	**El Niño**	**La Niña**
None	CTRL	CTRL_EN	CTRL_LN
850 hPa to 2.6 hPa	FullBC	FullBC_EN	FullBC_LN
100 hPa to 2.6 hPa	StratBC	StratBC_EN	StratBC_LN
850 hPa to 100 hPa	TropBC	TropBC_EN	TropBC_LN

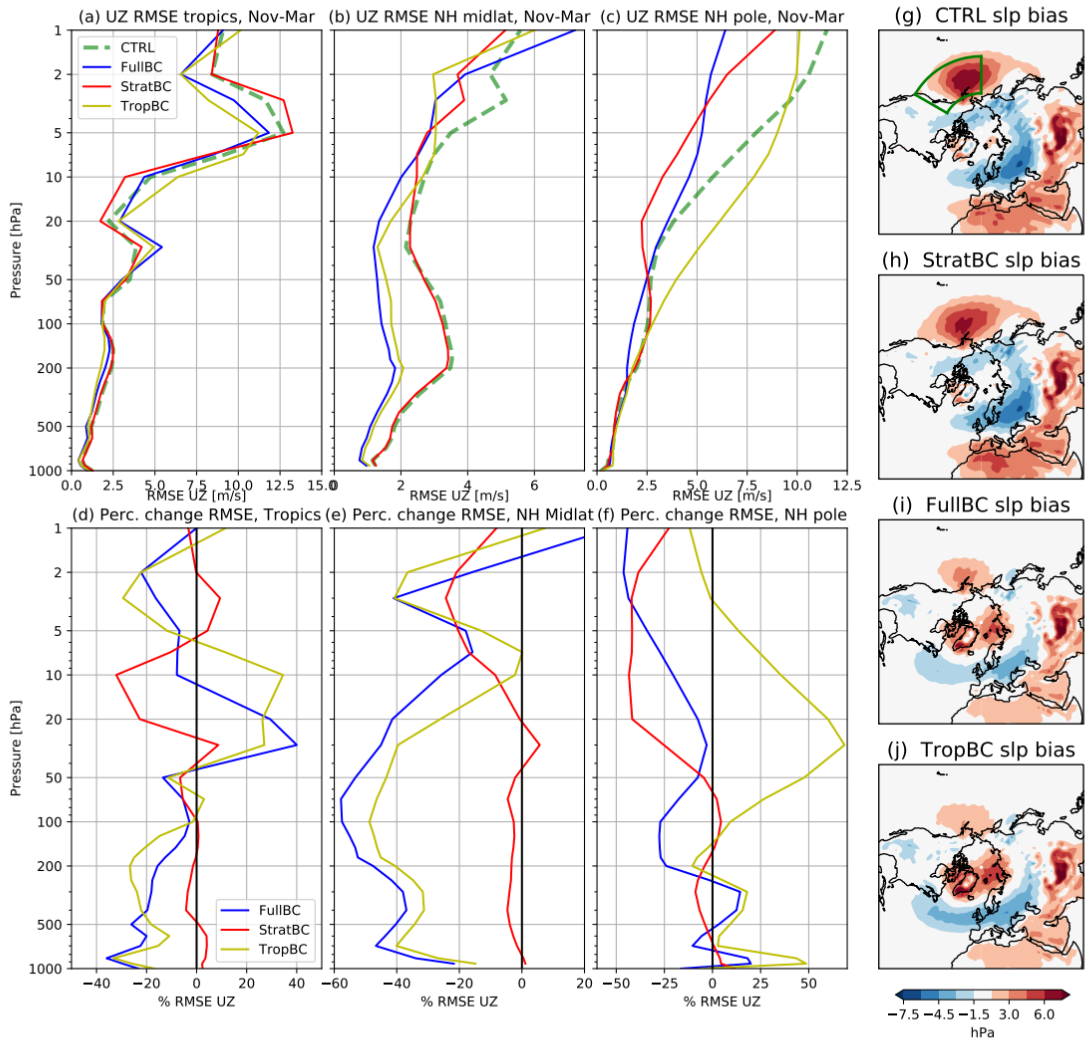

Figure 1: Panels a–c shows RMSE of UZ in the four experiment, in the tropics (20°S to 20°N), the mid–latitudes (20°N to 50°N) and the pole (50°N to 90°N). RMSE calculated using difference between model and ERA Interim climatology. Panels d–f are the percentage change of UZ RMSE between the control run and the three bias–corrected runs, with negative values showing improvement in the climatology of the bias corrected runs. Panels g–j show the bias in the control and bias corrected experiments, calculated as the experiment minus ERA interim. The green box in (g) shows area of the Aleutian Low Index.

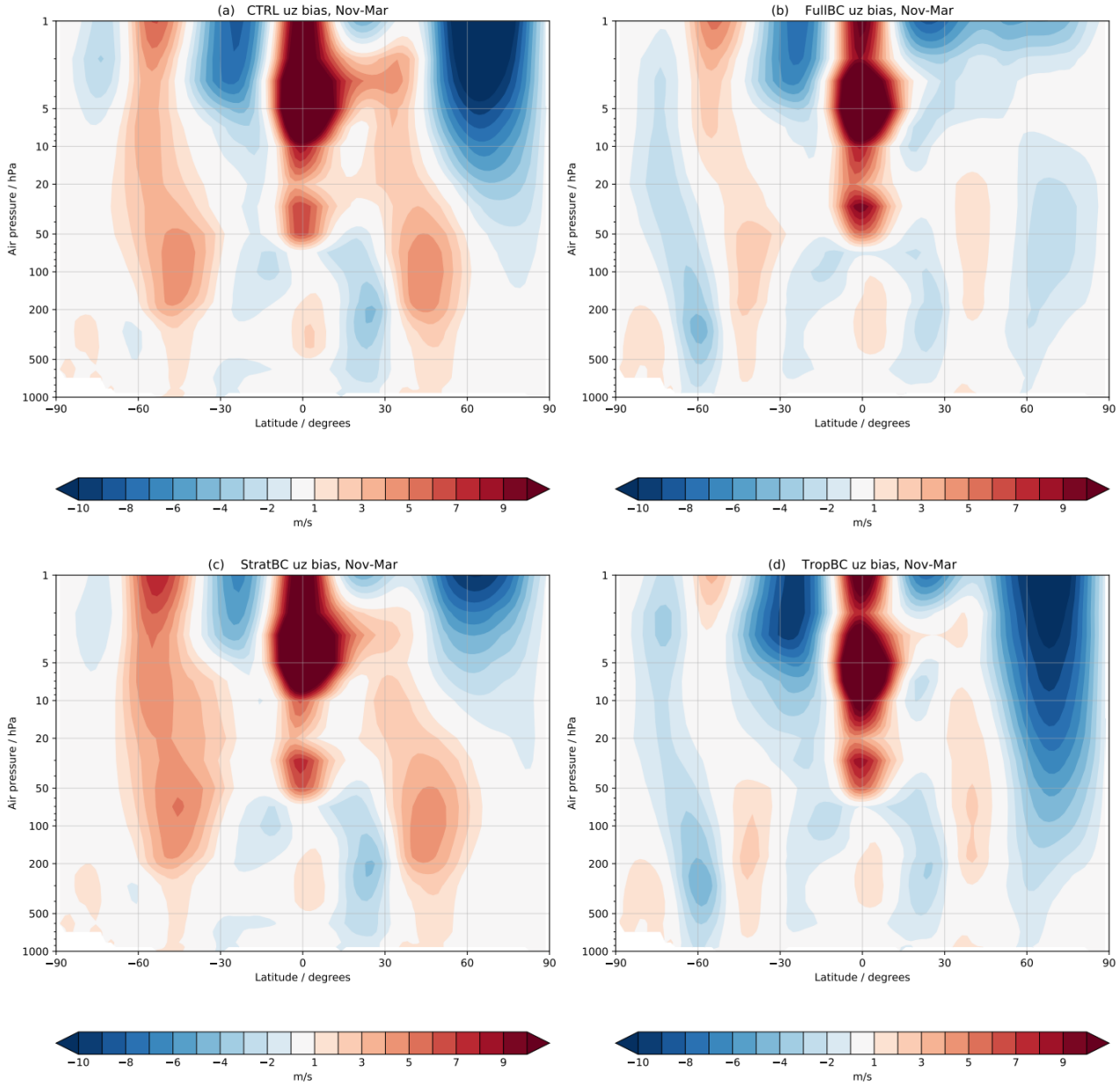

Figure 2. Biases relative to ERA5 of November-March zonal mean zonal wind in (a) CTRL, (b) FullBC, (c) StratBC, and (d) TropBC.

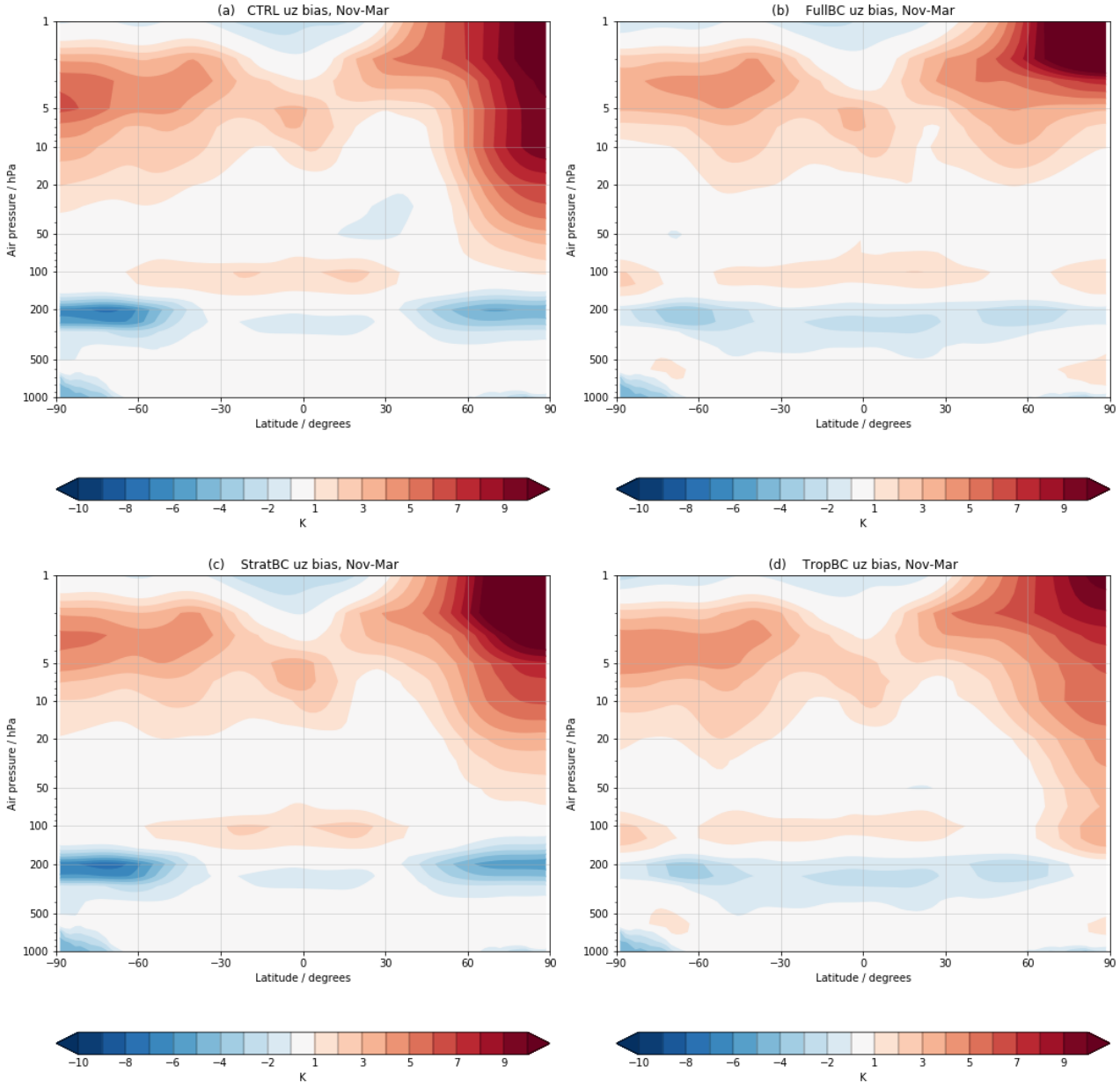

Figure 3. Biases relative to ERA5 of November-March zonal mean temperature in (a) CTRL, (b) FullBC, (c) StratBC, and (d) TropBC.

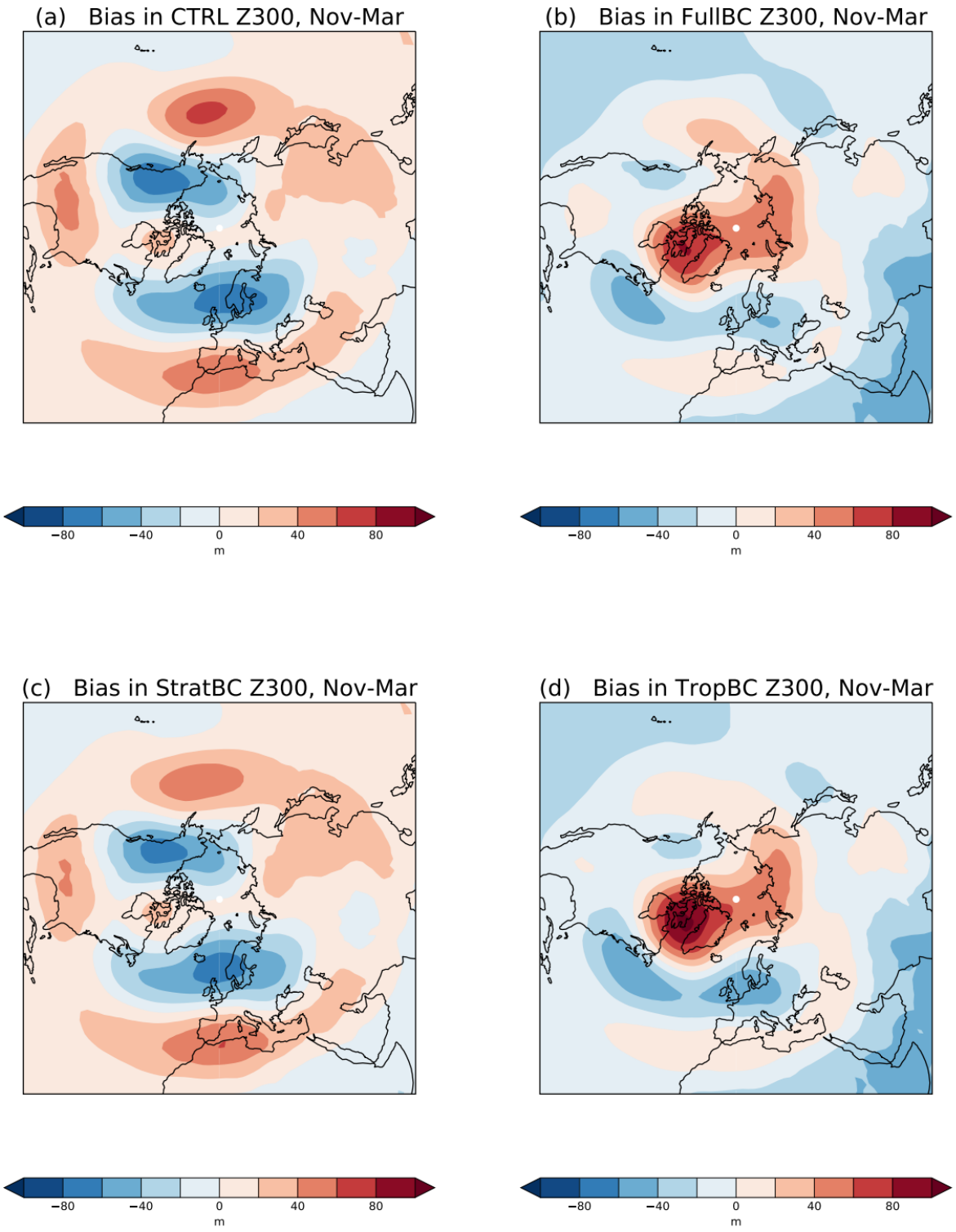

Figure 4. Biases relative to ERA5 of November-March geopotential height at 300hPa in (a) CTRL, (b) FullBC, (c) StratBC, and (d) TropBC.

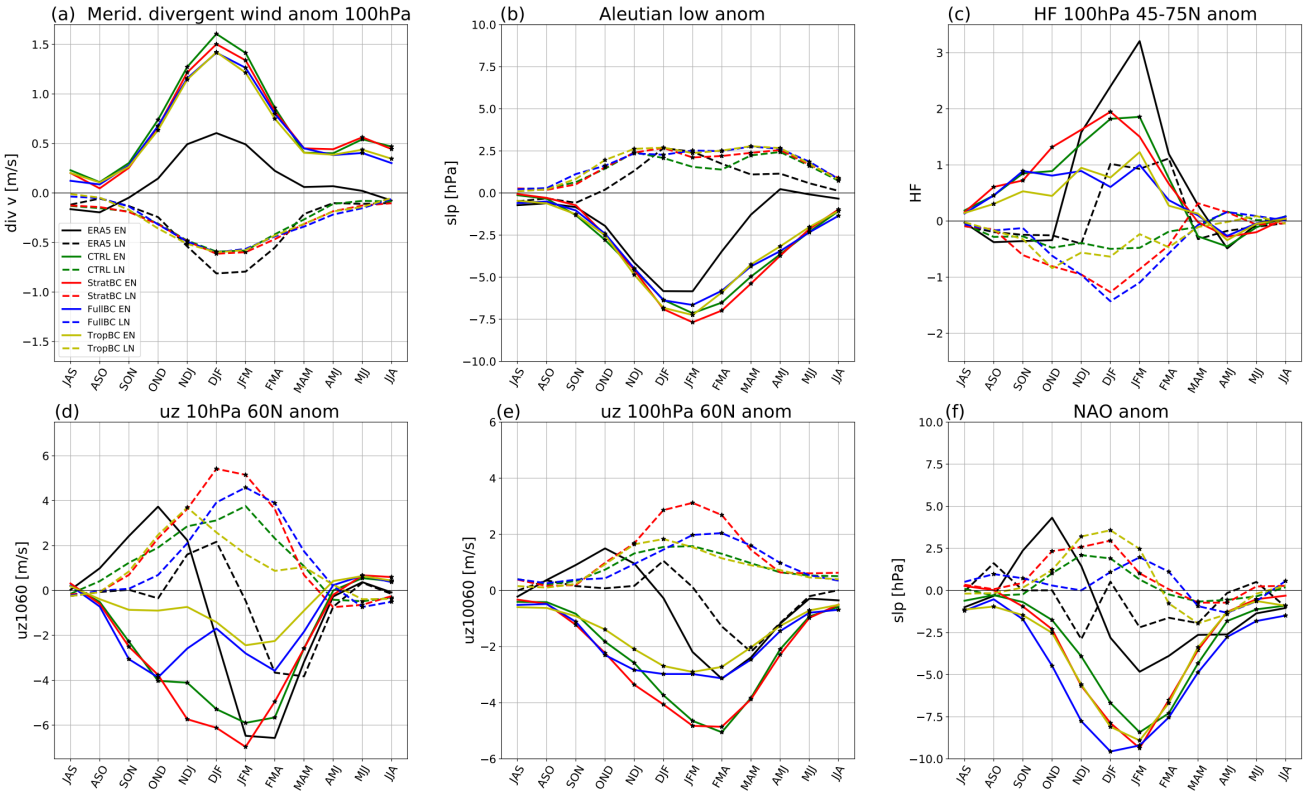

Figure 2. Progression of anomalies from the ENSO region to the stratospheric polar vortex and NAO, for the model and ERA5. Timeseries uses three–month means, and black dots indicate significance at $p < 0.05$. For model runs solid lines show 100 years of the El Niño run minus 100 years neutral run, dashed lines show 100 years of the La Niña run minus 100 years neutral run. ERA5 anomalies show the difference between a composite of 8 El Niño or La Niña years, and 12 neutral years.

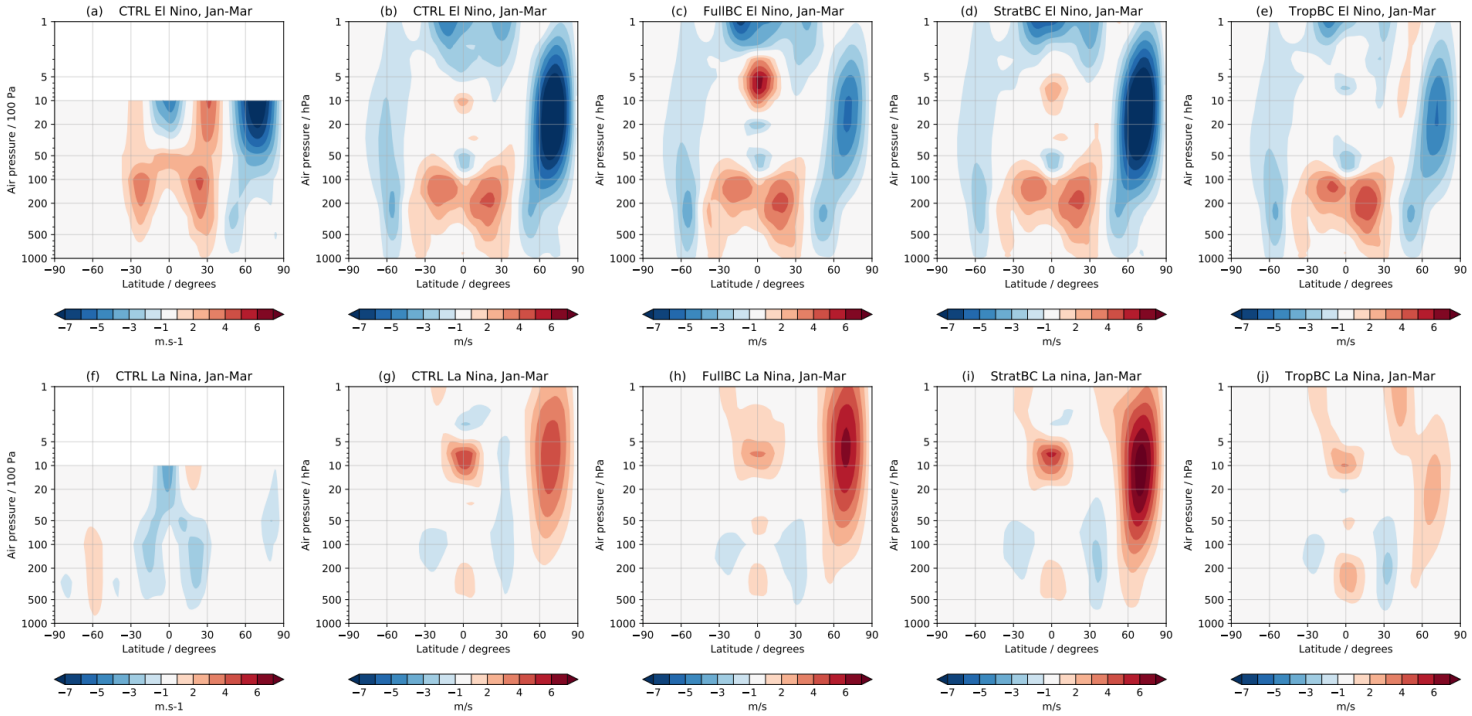

Figure 5. Response of zonal mean zonal wind to El Nino (a-e) and La Nina (f-j) , for December to March. Late winter season shown to emphasize ERA5 El Nino response.

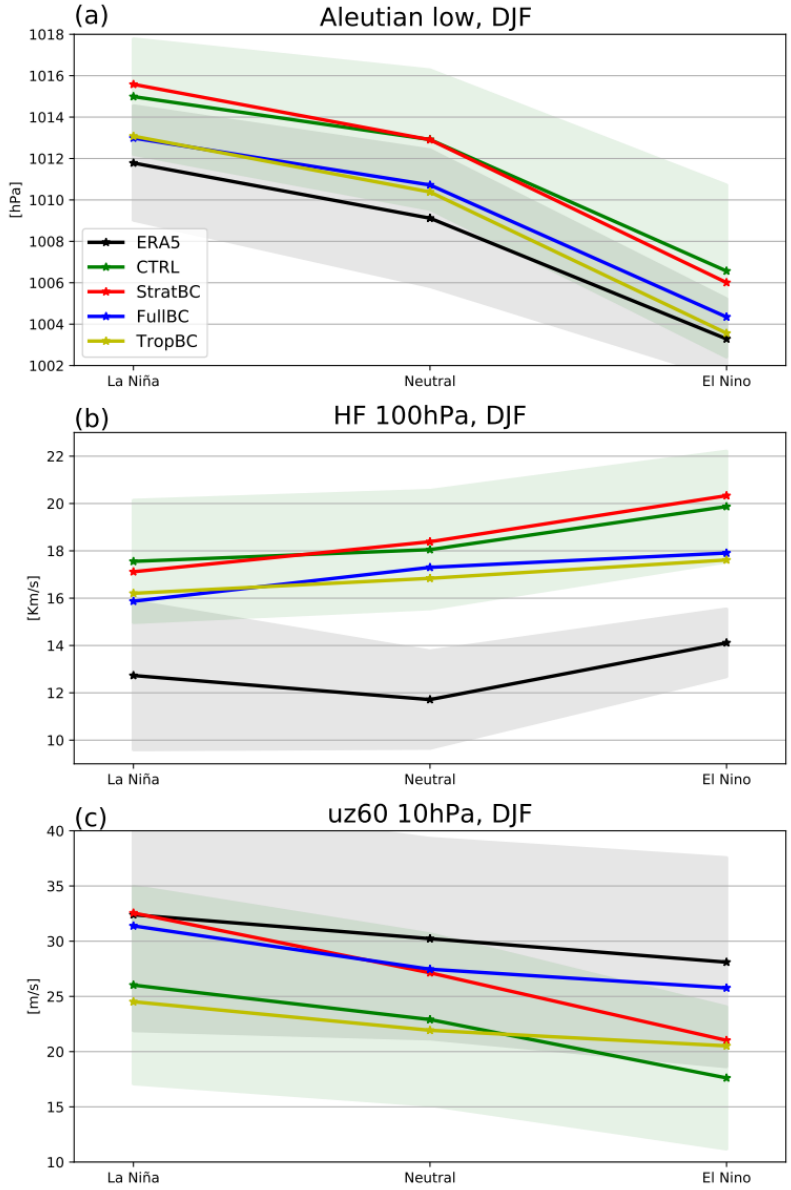

Figure 6. DJF values of (a) Aleutian Low Index, (b) heat flux between 45N–75N at 100 hPa and (c) UZ60 for La Niña, neutral and El Niño years. Shading shows one standard deviation for the CTRL run (green) and ERA5 (grey).

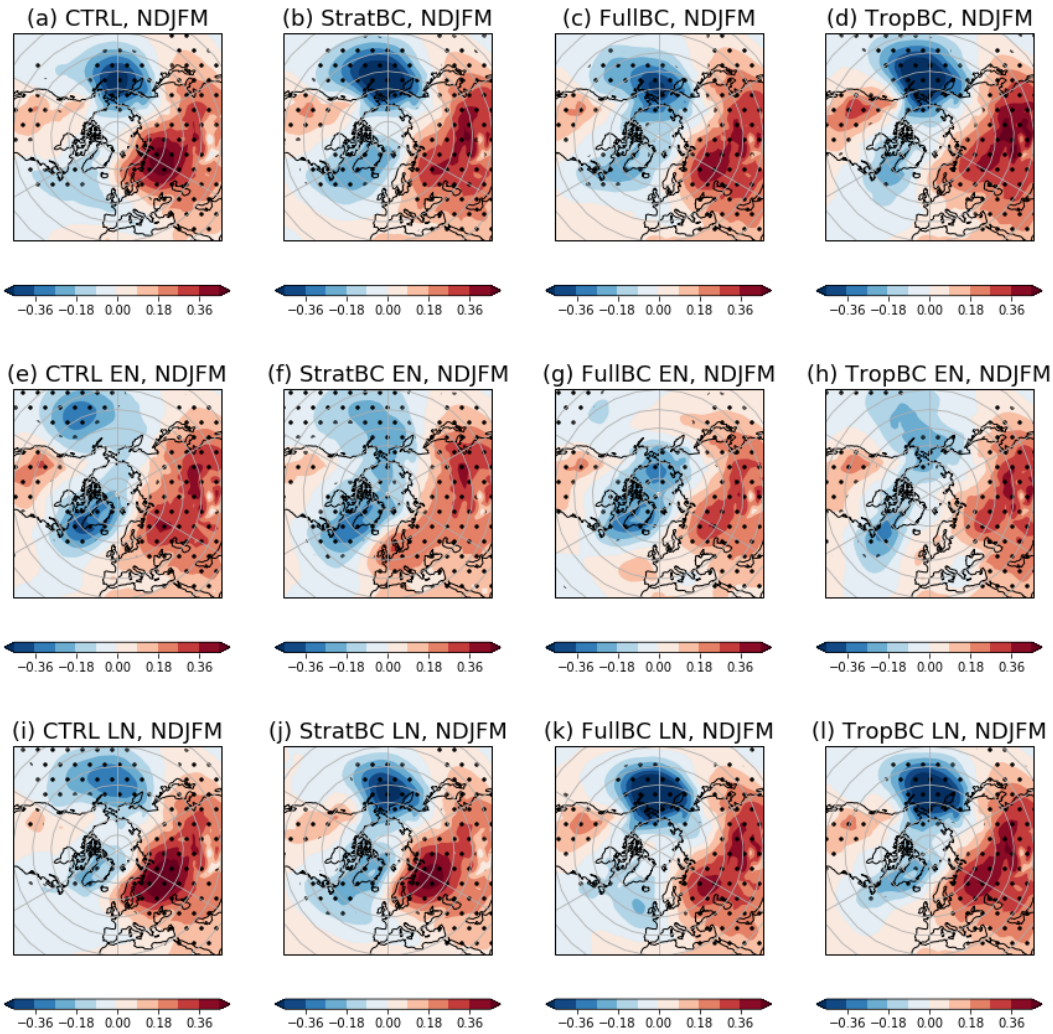

Figure 7. Regression of monthly HF and monthly sea level pressure for extended winter months (Nov–Mar). Top row is neutral years, middle row is El Niño years, bottom row is La Niña years. Stippling indicates significance at $p < 0.05$.

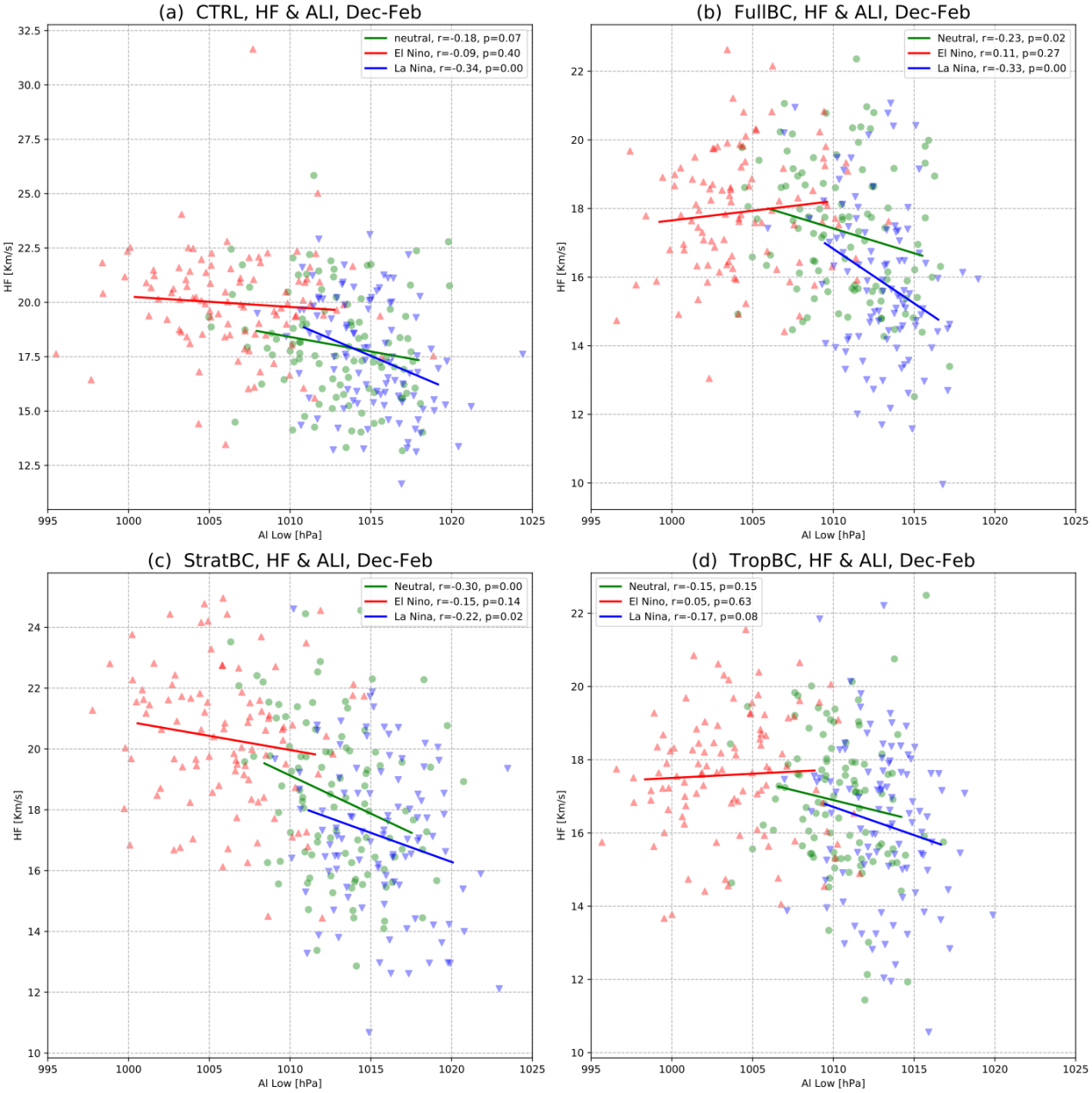

Figure 8. Scatterplot with regression line of mean DJF values of the Aleutian Low Index and the heat flux between 45N–75N at 100 hPa, for (a) CTRL, (b) FullBC, (c) StratBC and (d) TropBC. Neutral years are green, El Niño years are red, and La Niña years are blue.