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Siberian Snow Forcing in a Dynamically Bias-Corrected Model

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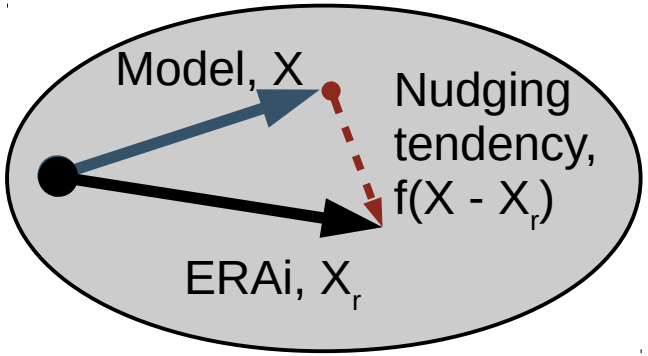
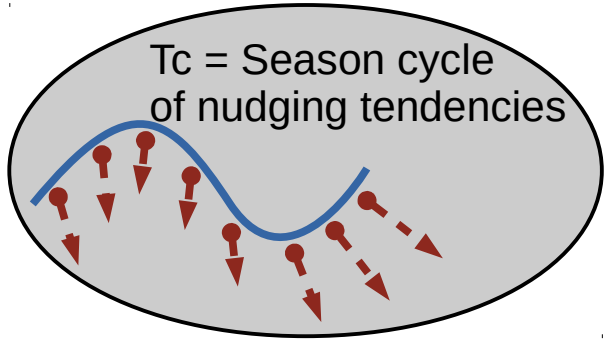
Bias Corrections

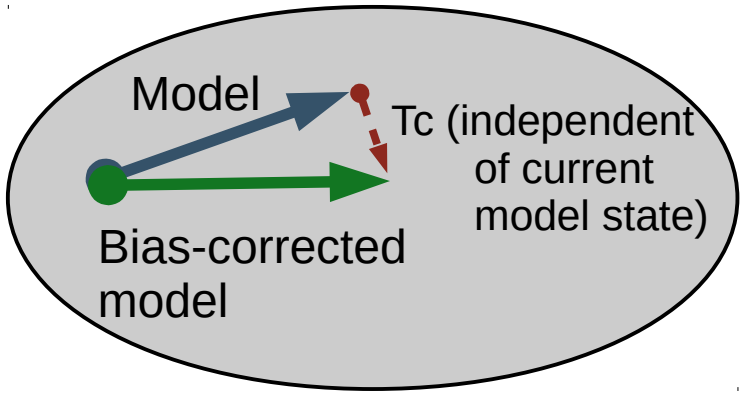
- ECHAM6 AGMC T63L95
- Two-step correction process for winds, surface pressure

1) • Nudge towards ERA Interim.
   - Record 6hrly nudging tendencies to create a 12 month climatology of inherent bias.

2) • Re-run model, remove bias at each time-step.







Kharin & Scinocca, 2012

Simpson, et al., 2013

Chang, et al., 2019, Schubert, et al., 2019

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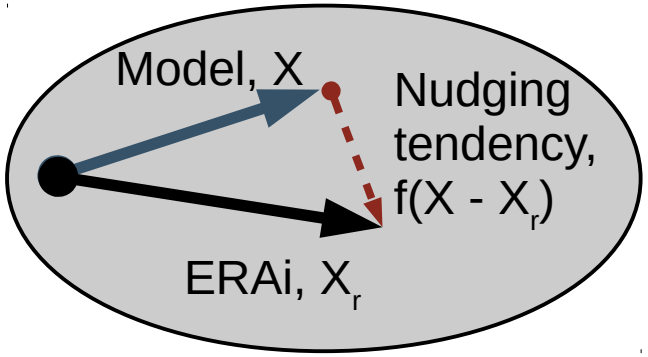
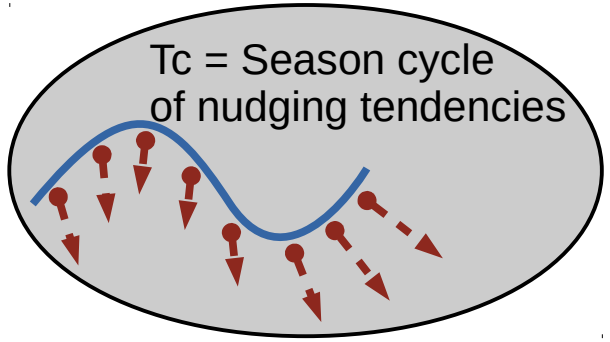
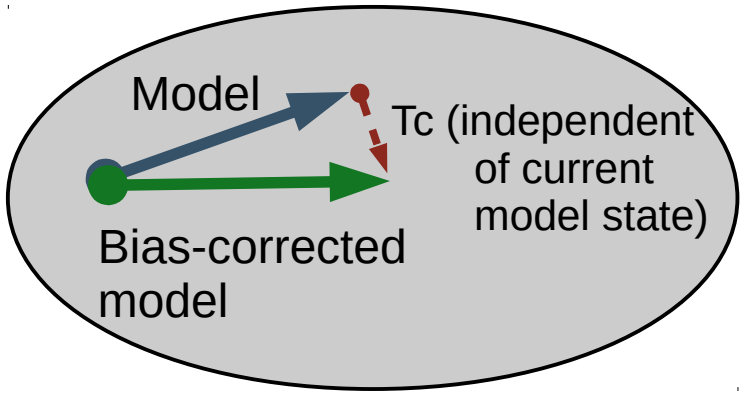






Key Points

- Bias-corrections are independent of current model state.
- Bias-corrected model can respond to perturbations.

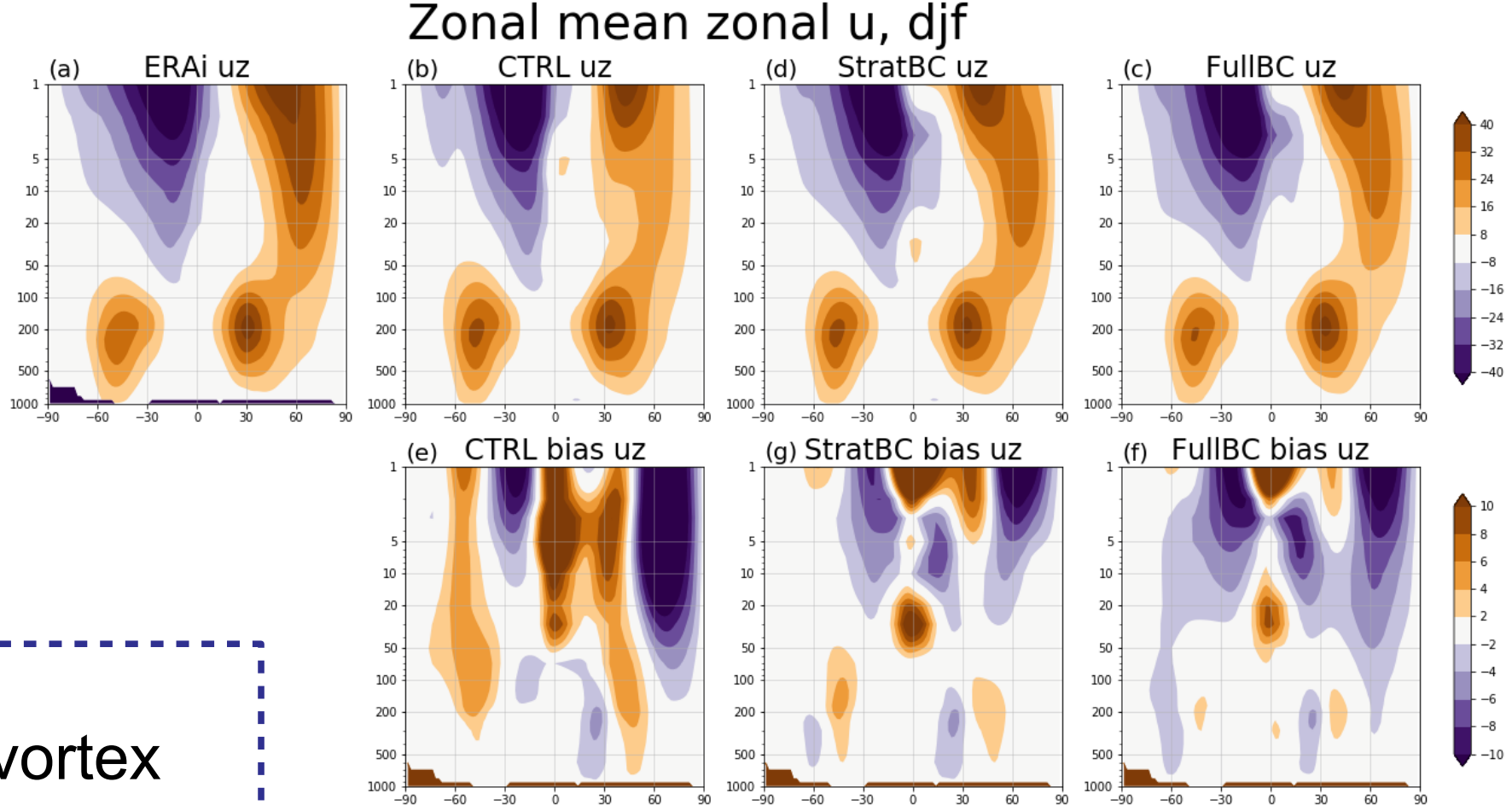
Bias Corrections – Zonal Wind

3 experiments:

- Control
- Strat. Bias-Corr

  ~100hPa-~1hPa
- Full Bias-Corr

  ~850hPa-~1hPa



Key point: bias in stratospheric polar vortex reduced by <10m/s

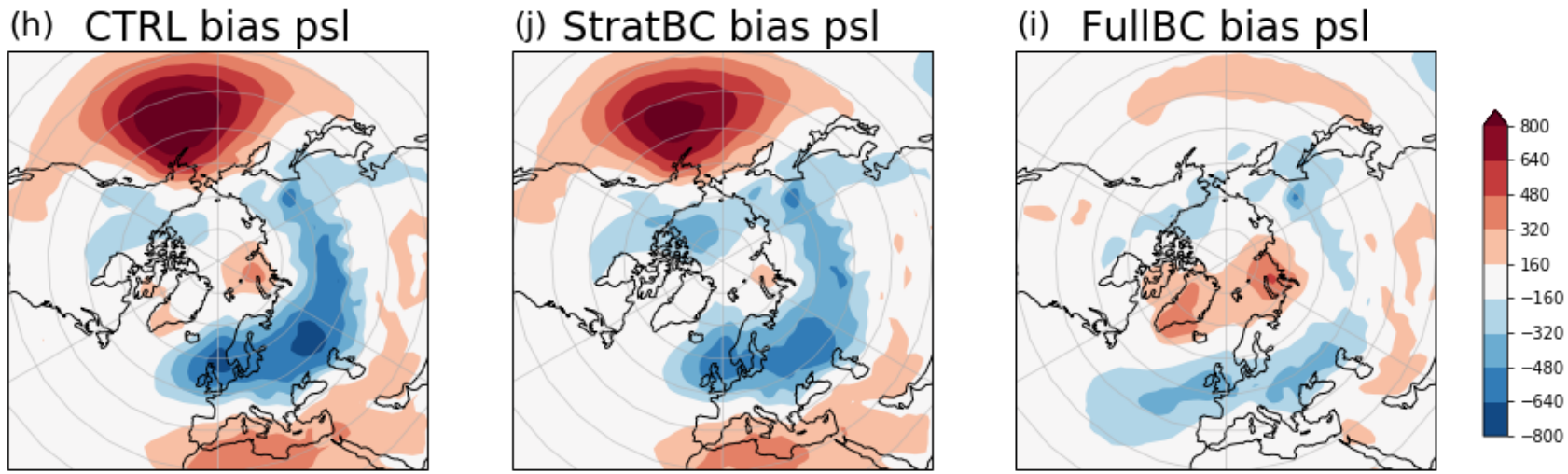
Bias Corrections – Surface Pressure

3 experiments:

- Control
- Strat. Bias-Corr

  ~100hPa-~1hPa
- Full Bias-Corr

  ~850hPa-~1hPa

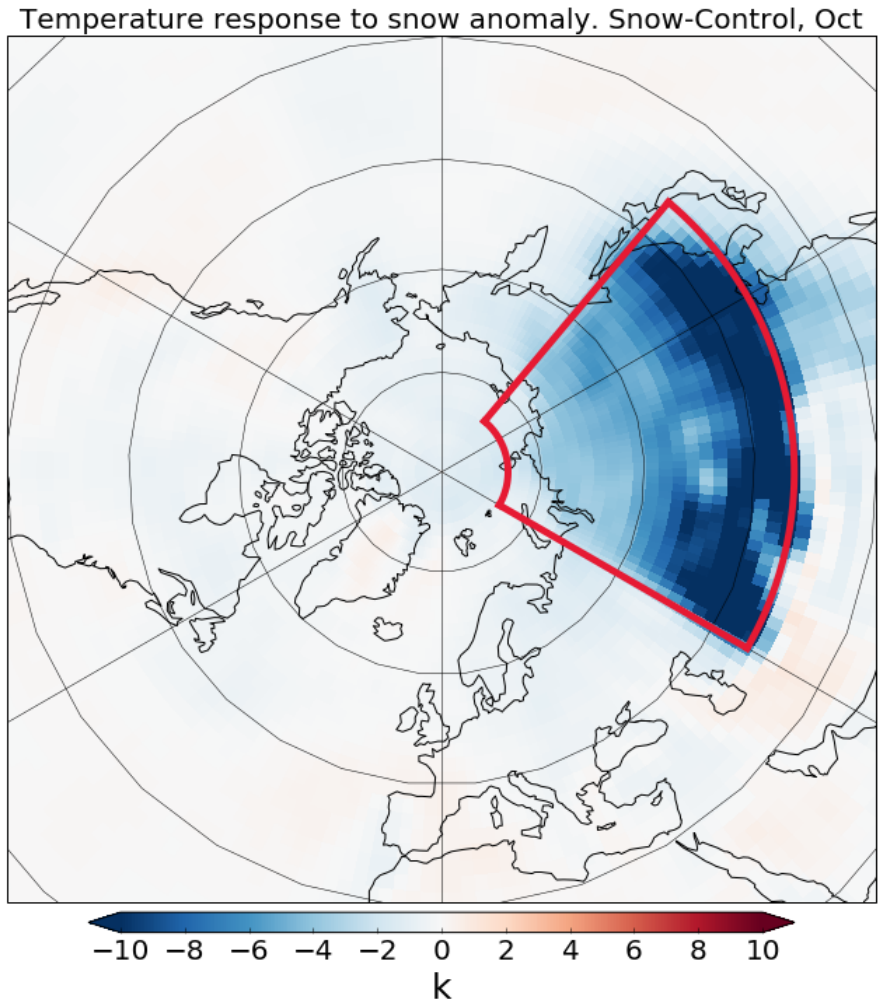


Key point: CTRL and StratBC have similar surface pressure bias.

October Snow Cover Experiment

- Snow cover added over Siberia in October.
- 100 winters snow/control.
- For CTRL, StratBC, FullBC.

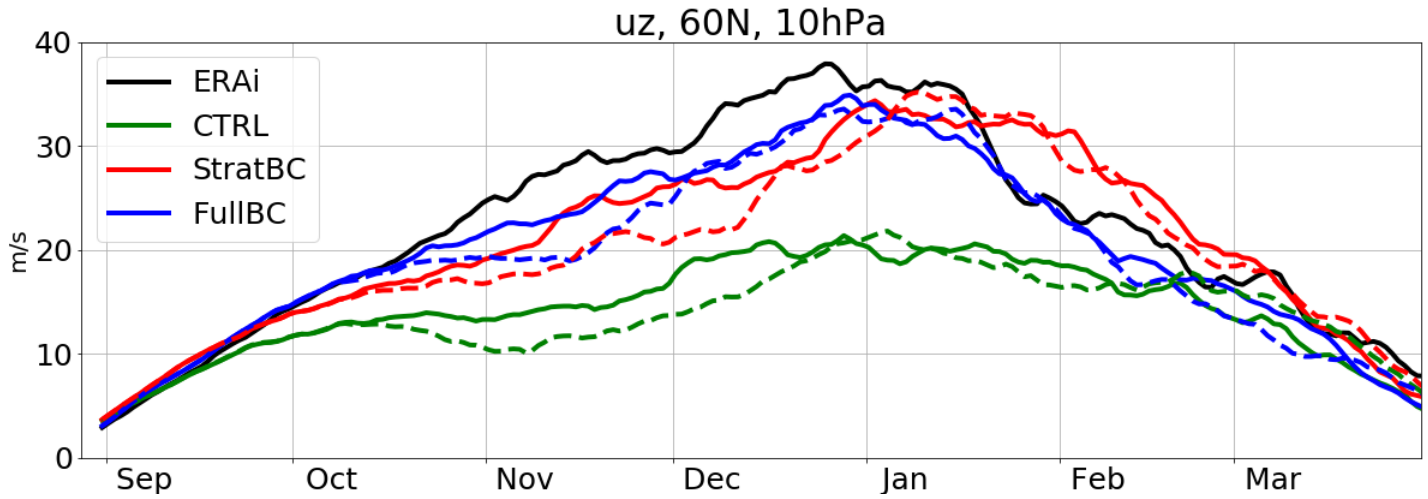
Key point: Strong surface cooling induces planetary waves, weakens vortex, can lead to negative AO in winter.



Polar vortex response to snow

Key points:

- Clear increase in vortex strength in bias corrected runs,

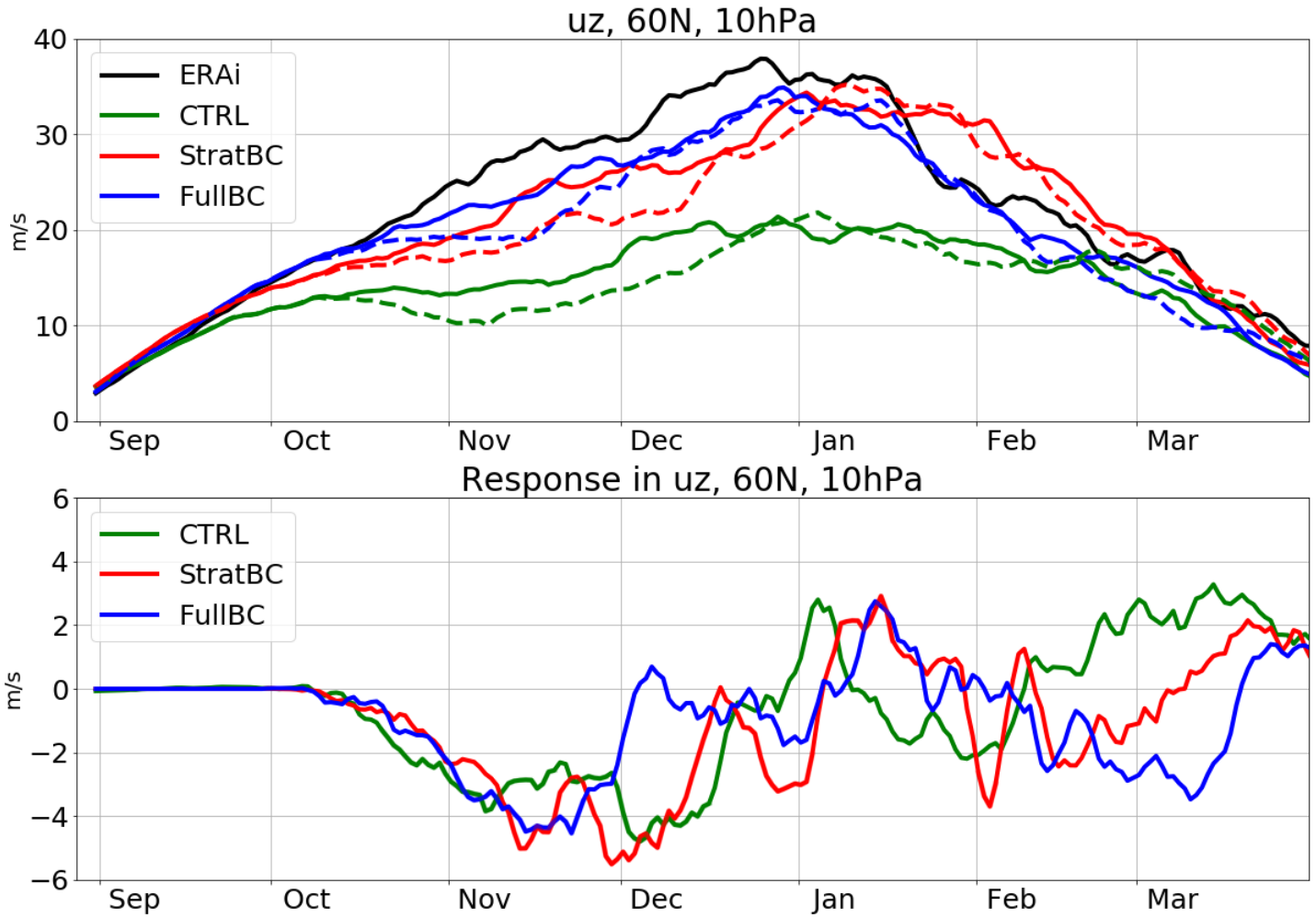


Daily zonal mean wind 60N, 10hPa.
Dashed lines = Snow experiment

Polar vortex response to snow

Key points:

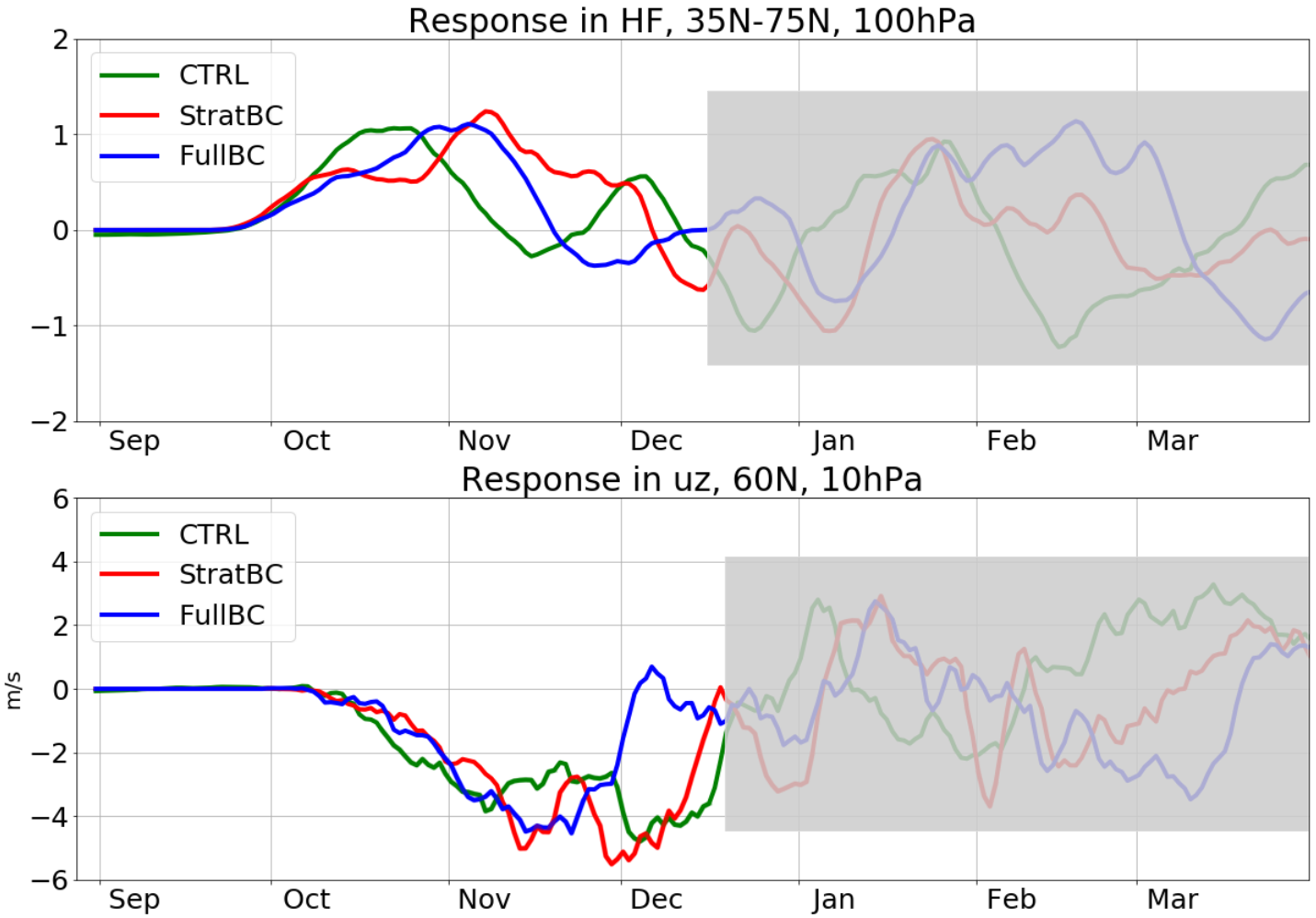
- Clear increase in vortex strength in bias corrected runs,
- yet no significant difference in magnitude of vortex weakening.
- Difference in timing of vortex recovery.



Heat Flux response to snow

Key points:

- Heat flux response has similar max magnitude between climatologies
- CTRL has two peaks, FullBC one peak, StratBC positive HF for Oct, Nov.
- No obvious relationship between HF and vortex strength



Polar cap geopotential height response to snow

- CTRL

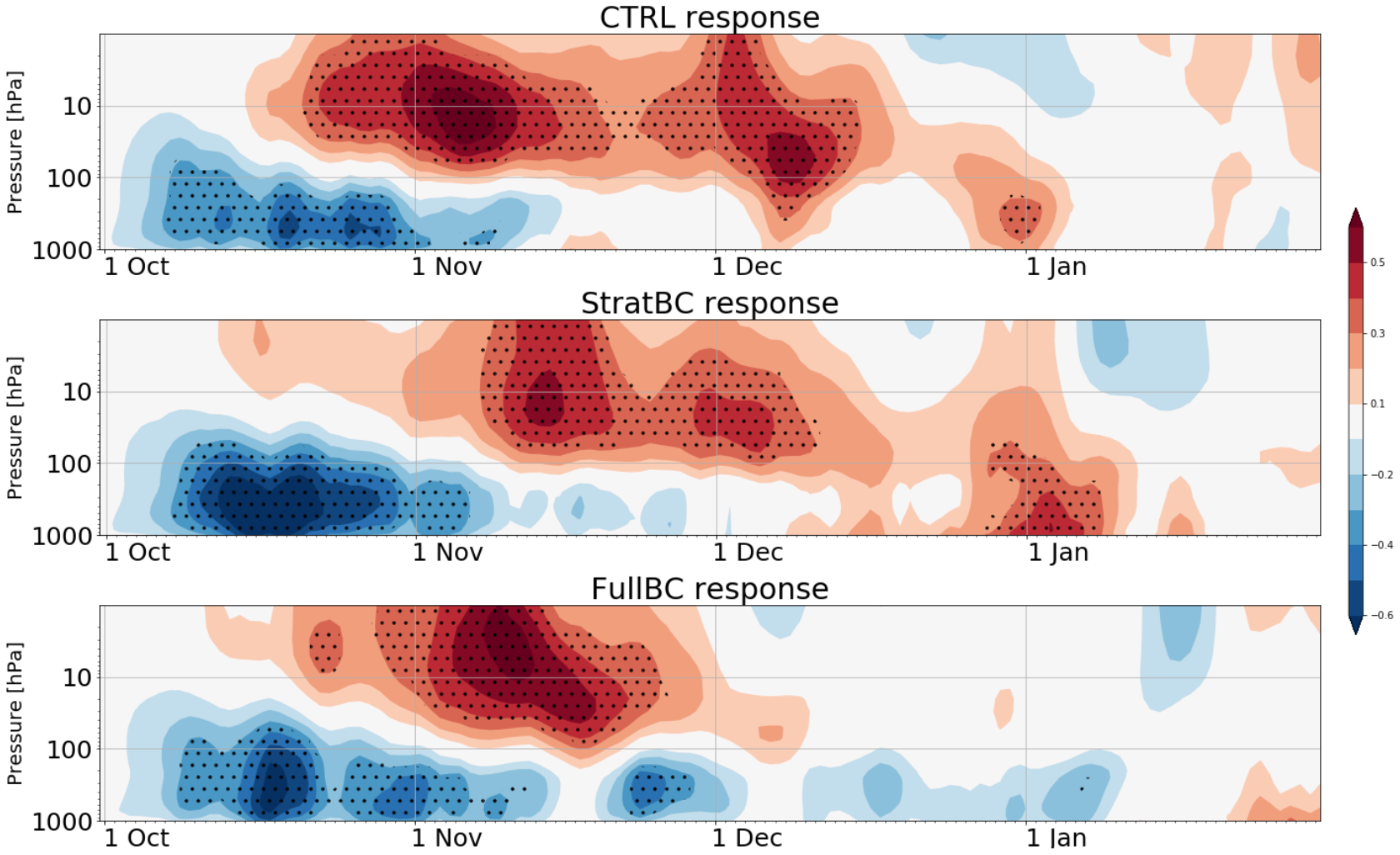
  Strat. Response leads to weak surface response.

- StratBC

  Strong surface response.

- FullBC

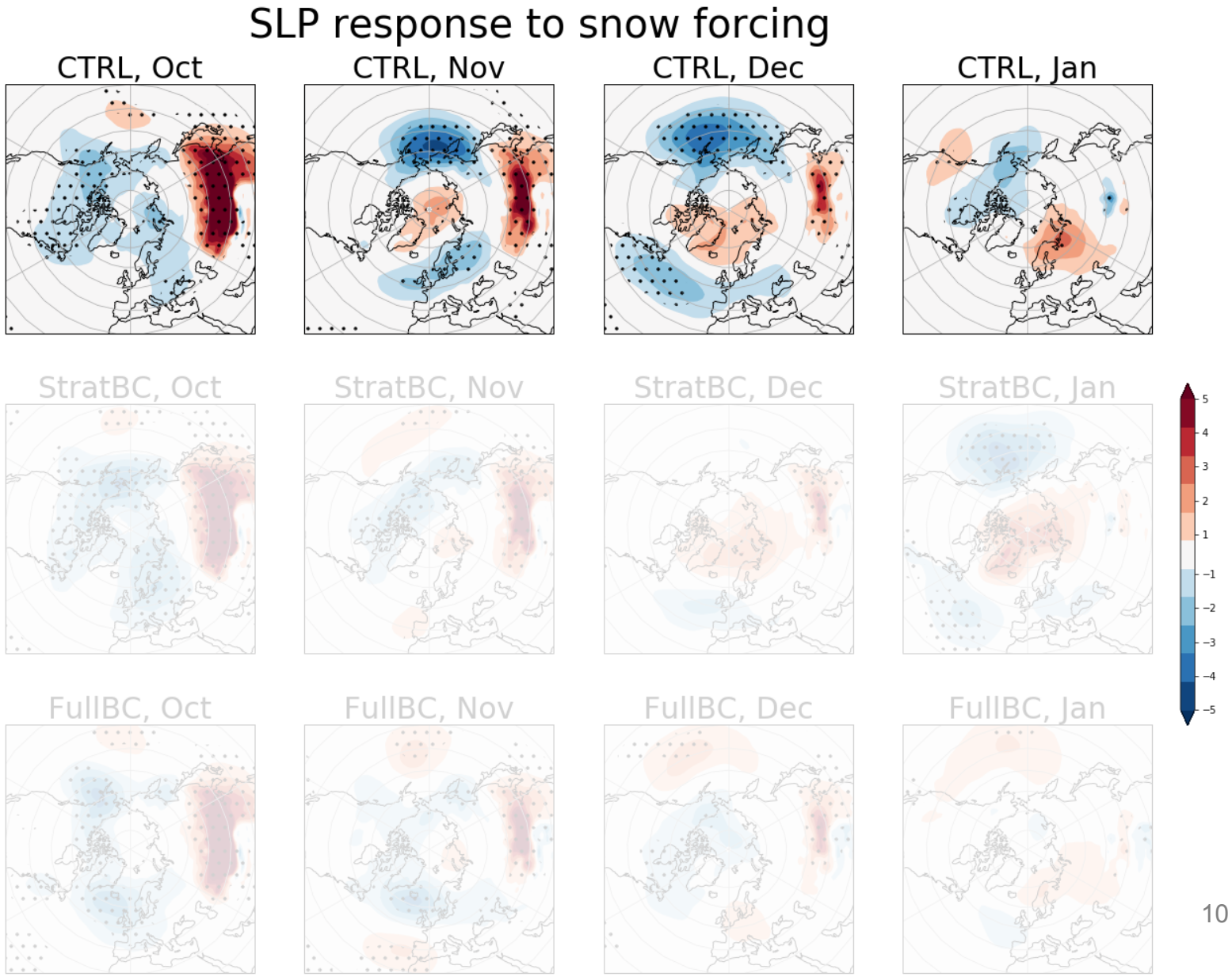
  No surface response



Surface Pressure response to snow

CTRL response

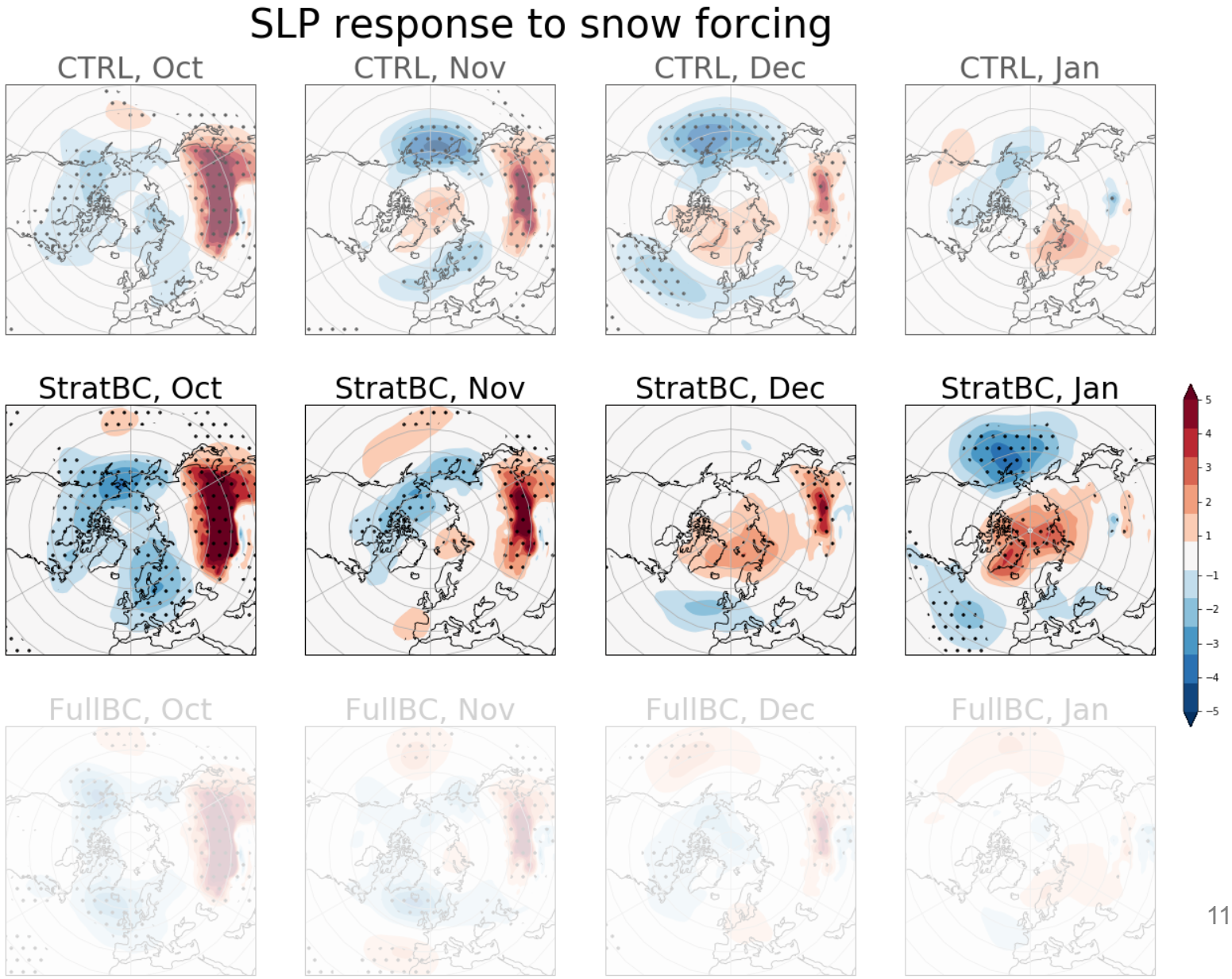
- Nov: Negative AO
- Dec: Strengthens
- Jan: Weakens



Surface Pressure response to snow

StratBC response

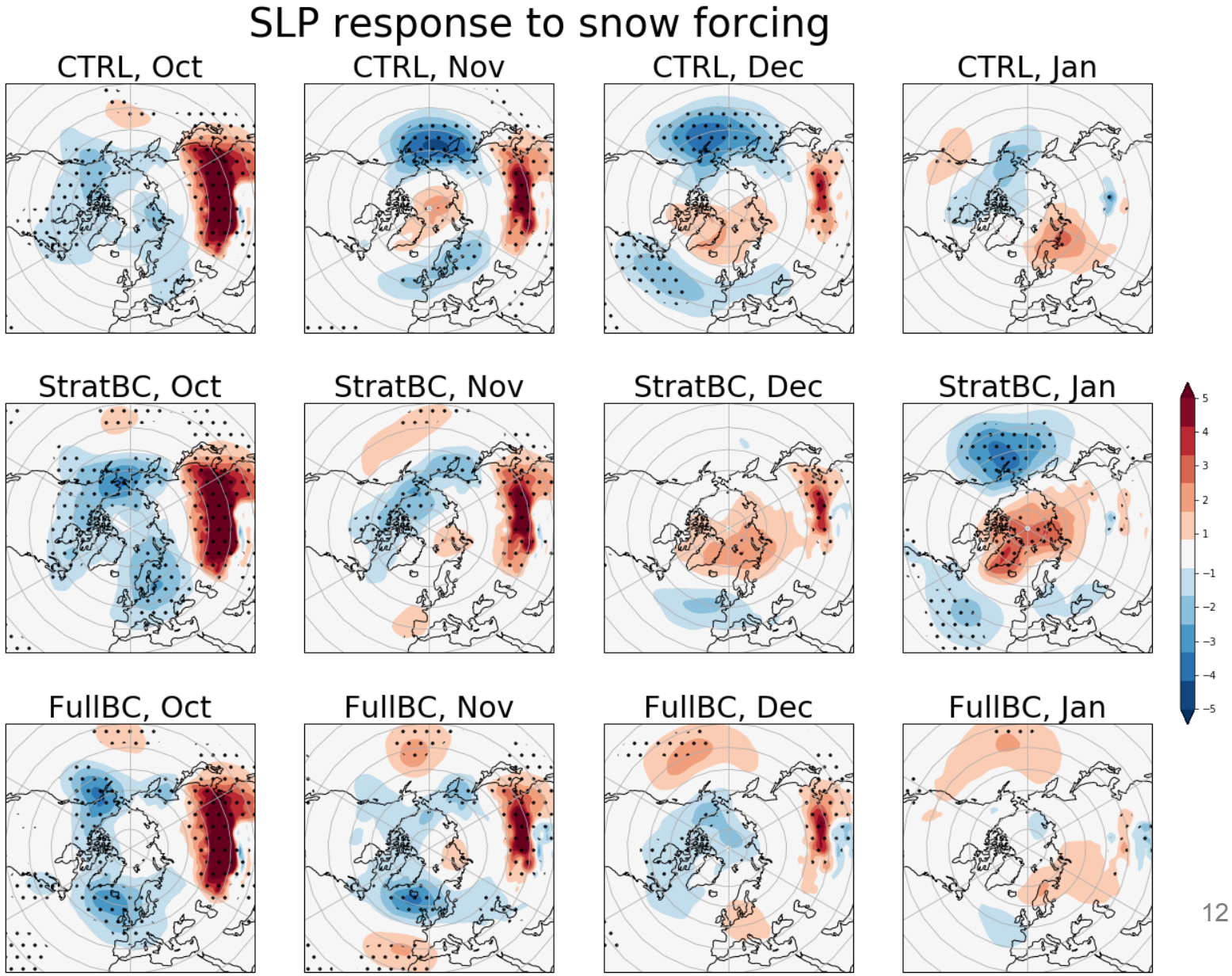
- Nov: Weak response
- Dec: Negative AO
- Jan: Strengthens



Surface Pressure response to snow

FullBC response

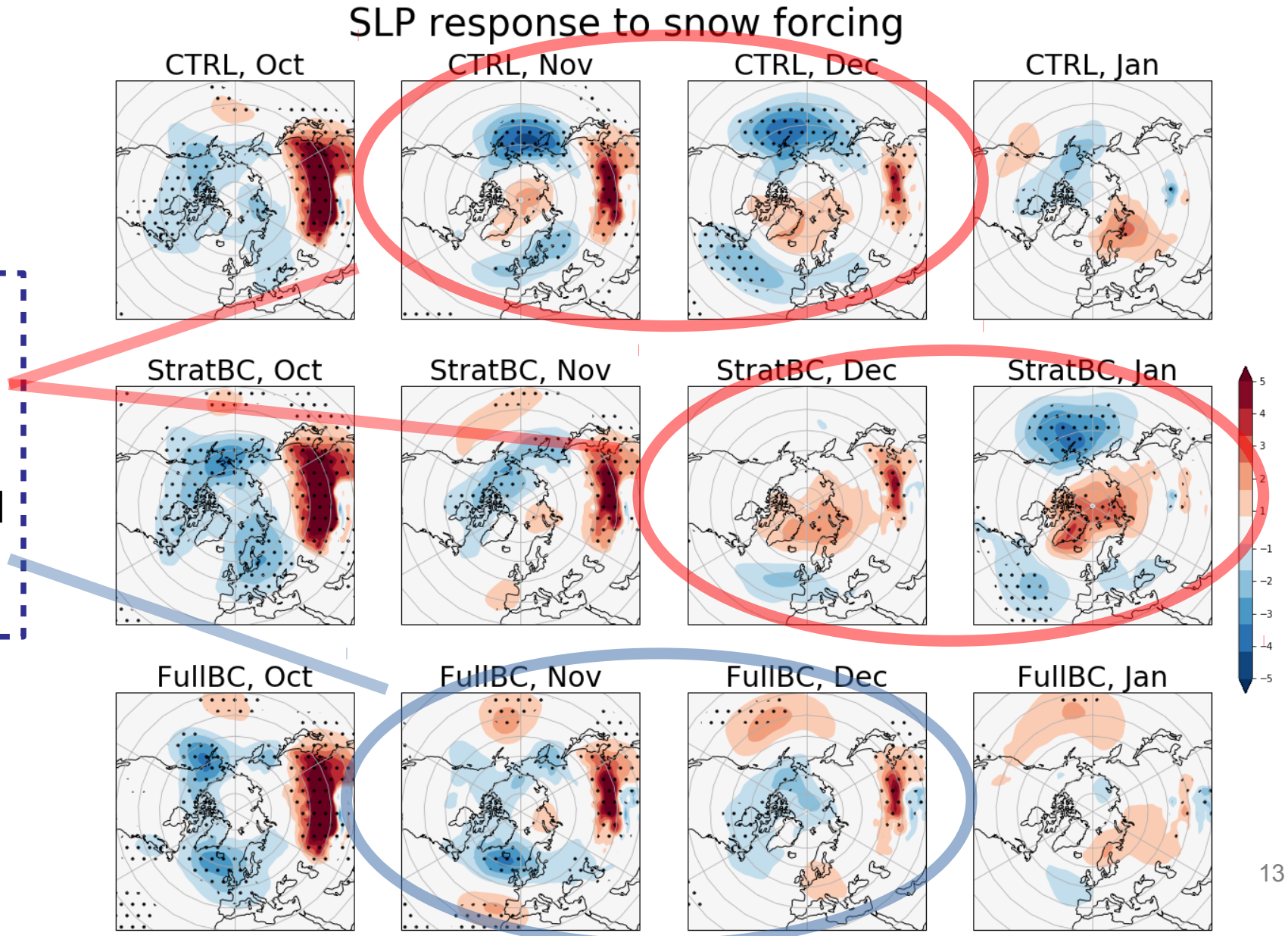
- Nov: Positive AO
- Dec: Positive AO
- Jan: Weak response.



Surface Pressure response to snow

Key Points

- Negative AO, downward propagation.
- Positive AO suppressed downward propagation.



Conclusions

- Bias corrections used to reduce errors in polar vortex, to create three different climatologies.
- Stratospheric response to Siberian snow forcing not strongly dependent on strength of vortex.
- Downward propagation sensitive to tropospheric climatology.