Coupling of Arctic ozone and stratospheric dynamics and its influence on surface climate:

The role of CFC concentrations

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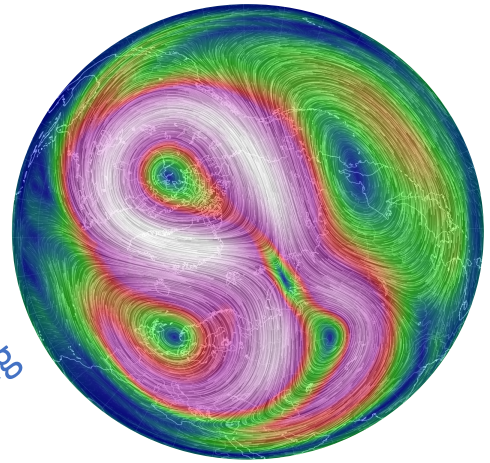
Coupling of Arctic ozone and stratospheric dynamics

What?

Ozone Feedbacks during Sudden Stratospheric Warmings (SSWs)

Disrupted vortex

10 hPa, 10th February 2018 (earth.nullschool.net)



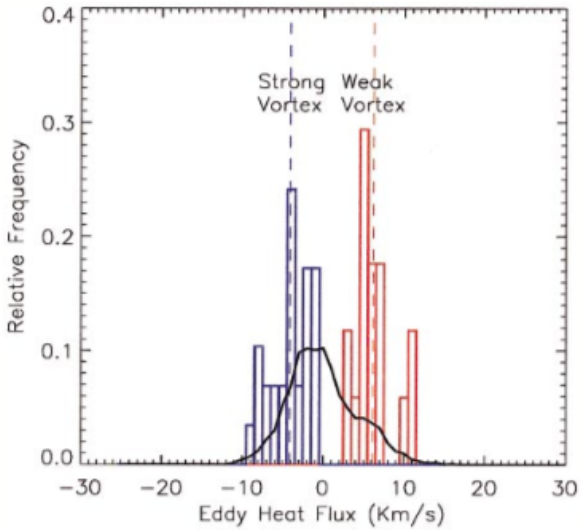
Increased upward wave activity

Feedback on wave breaking

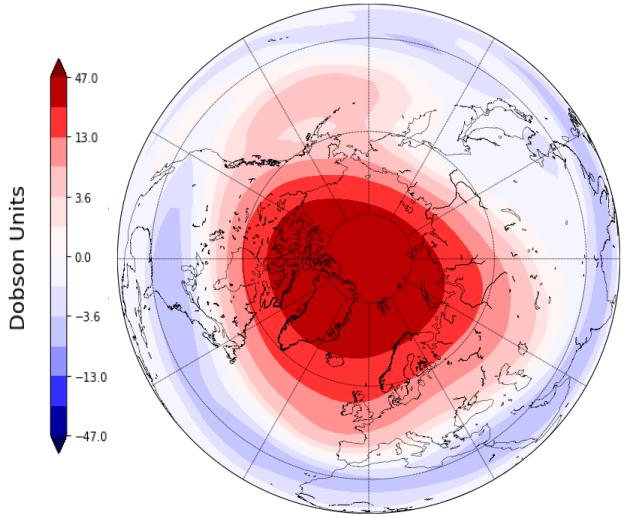
Downward propagation of circulation anomalies

Ozone anomalies

Feedback on circulation

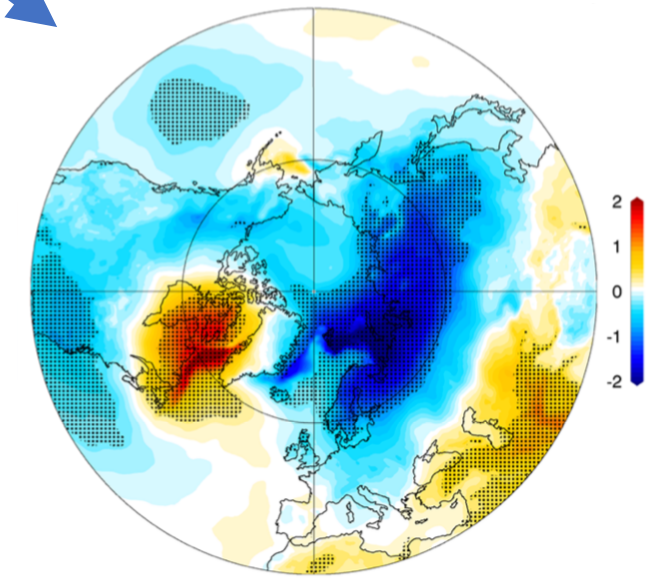


Meridional eddy heat flux, 100 hPa, Polvani and Waugh, 2004



Ozone column anomalies, based on Muthers et al., 2014

Direct radiative Impact



Surface Temperature anomalies after SSWs, Butler et al., 2017

Motivation & Method

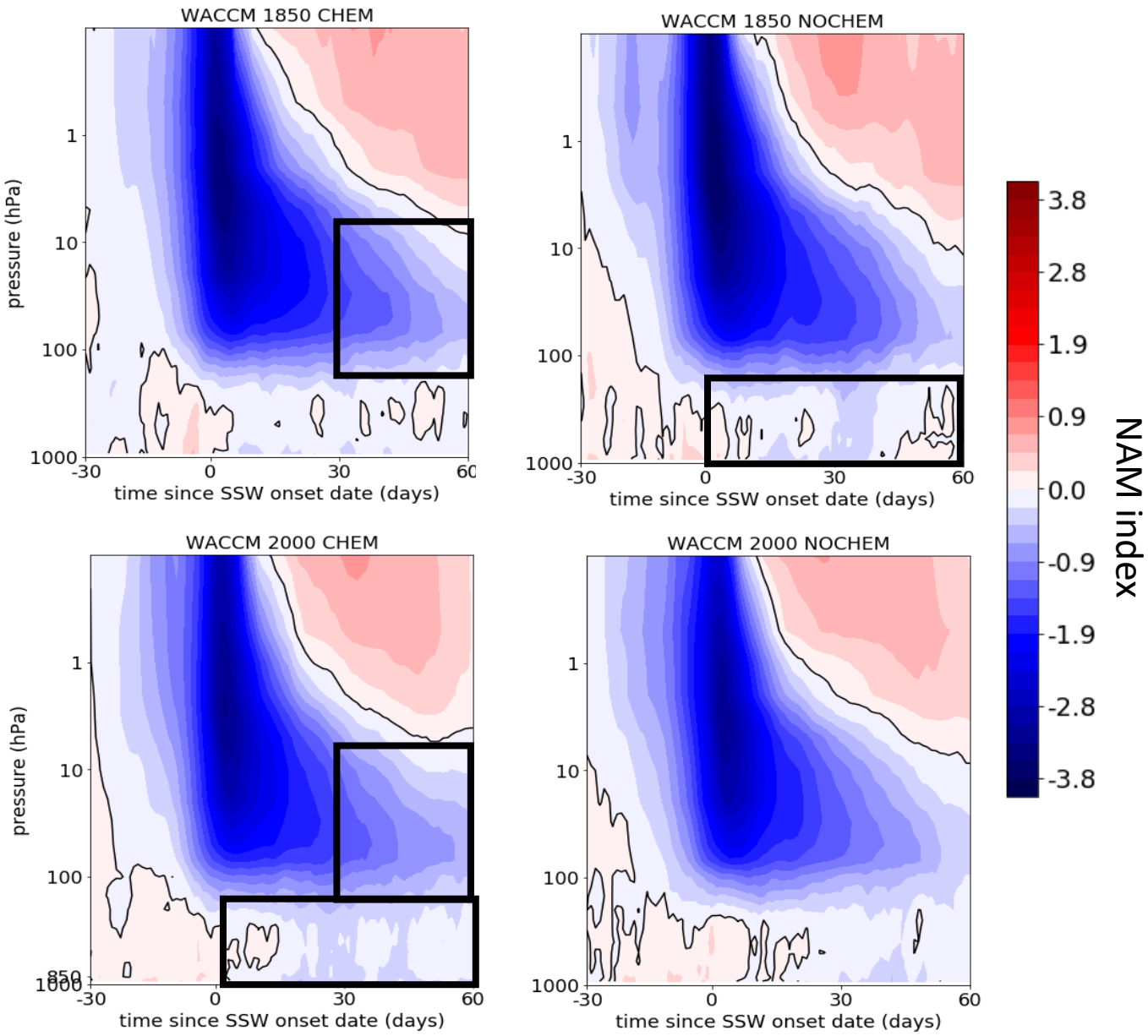
Why?

Understanding ozone - circulation - climate coupling could result in better seasonal predictions and long-term climate projections!

How?

- 2 Chemistry Climate Models (SOCOL & WACCM)
- Contrasting runs with (CHEM) and without (NOCHEM) interactive chemistry (interactive vs. prescribed O_3)
- Contrasting preindustrial vs. year-2000 time slice simulations (200 years each)
- Contrasting Northern Annular Mode (NAM) indices for SSW composites

Preliminary Results - WACCM



WACCM **preindustrial** runs:

→ Stronger downward propagation in **NOCHEM**

→ Longer lasting signal in lower stratosphere in **CHEM**

WACCM **year-2000**:

→ Stronger downward propagation in **CHEM**

→ Longer lasting signal in lower stratosphere in **CHEM**

(to be confirmed by SOCOL)

Preliminary Results

Ozone feedbacks seem to enhance the downward propagation of Sudden Stratospheric Warming signals in recent times (CHEM vs. NOCHEM year 2000).

Ozone feedbacks seem to extend and intensify the sudden stratospheric warming signature in the lower stratosphere (CHEM vs. NOCHEM).

CFC and/or GHG concentrations might influence the sign of the ozone-circulation feedback (preindustrial vs. year-2000). Internal variability might also play a role.

References

Polvani, L.M. and D.W. Waugh, 2004: Upward Wave Activity Flux as a Precursor to Extreme Stratospheric Events and Subsequent Anomalous Surface Weather Regimes, *J. Climate,* **17**, 3548–3554, https://doi.org/10.1175/1520-0442(2004)017<3548:UWAFAA>2.0.CO;2

Muthers, S., Anet, J. G., Stenke, A., Raible, C. C., Rozanov, E., Brönnimann, S., Peter, T., Arfeuille, F. X., Shapiro, A. I., Beer, J., Steinhilber, F., Brugnara, Y., and Schmutz, W.: The coupled atmosphere–chemistry–ocean model SOCOL-MPIOM, *Geosci. Model Dev.*, **7**, 2157–2179, https://doi.org/10.5194/gmd-7-2157-2014, 2014.

Butler, A. H., Sjoberg, J. P., Seidel, D. J., and Rosenlof, K. H.: A sudden stratospheric warming compendium, *Earth Syst. Sci. Data*, **9**, 63–76, https://doi.org/10.5194/essd-9-63-2017, 2017.