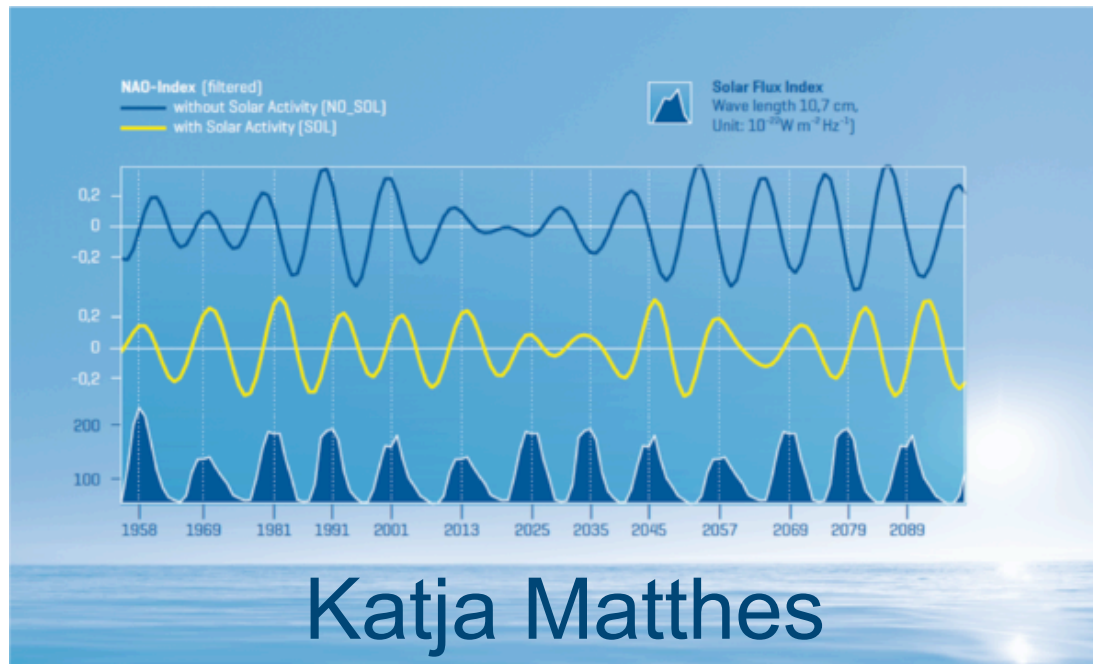


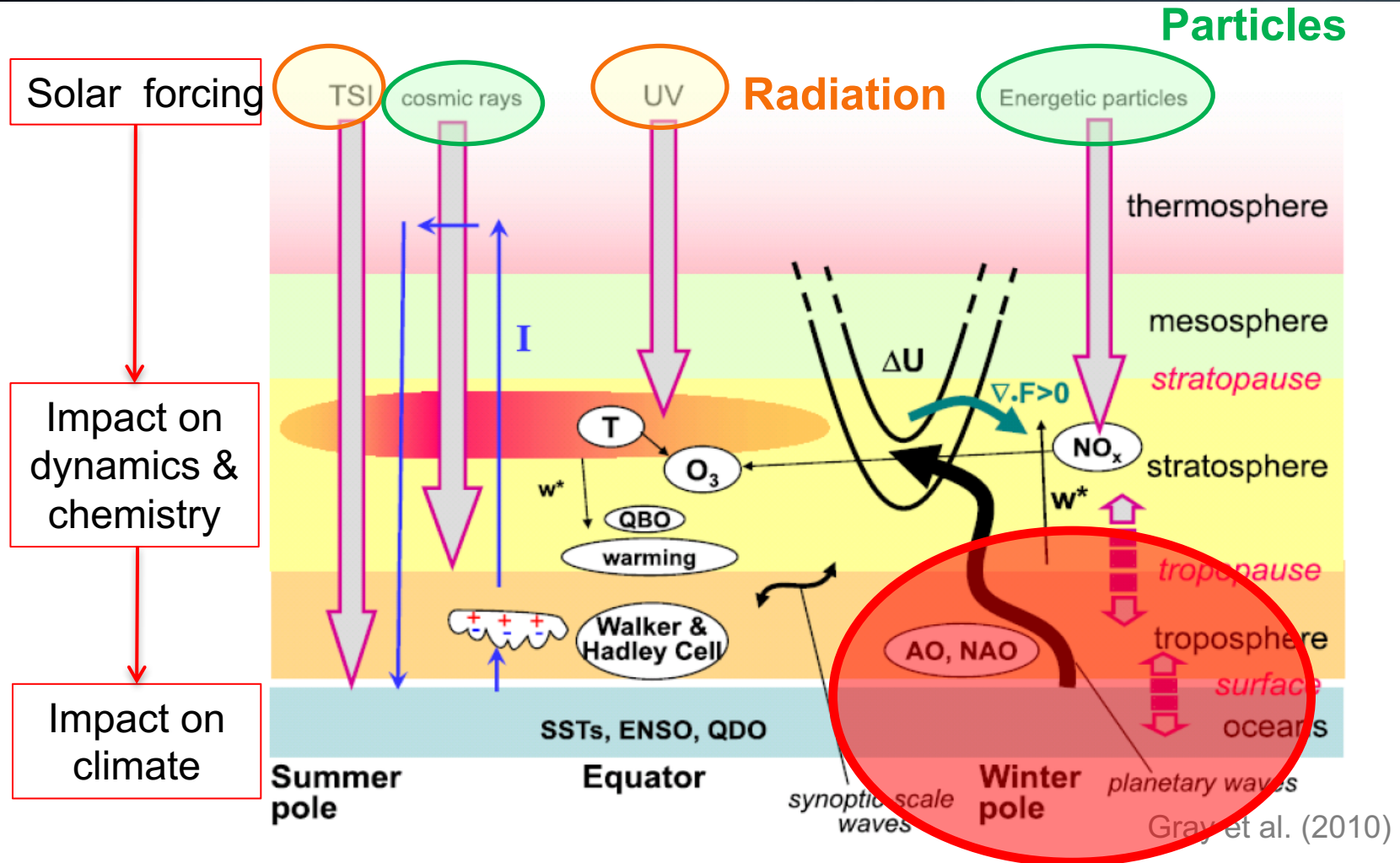
# Decadal Climate Variability: the Role of the Stratosphere and the Ocean



GEOMAR Helmholtz Centre for Ocean Research Kiel & Christian-Albrechts Universität zu Kiel

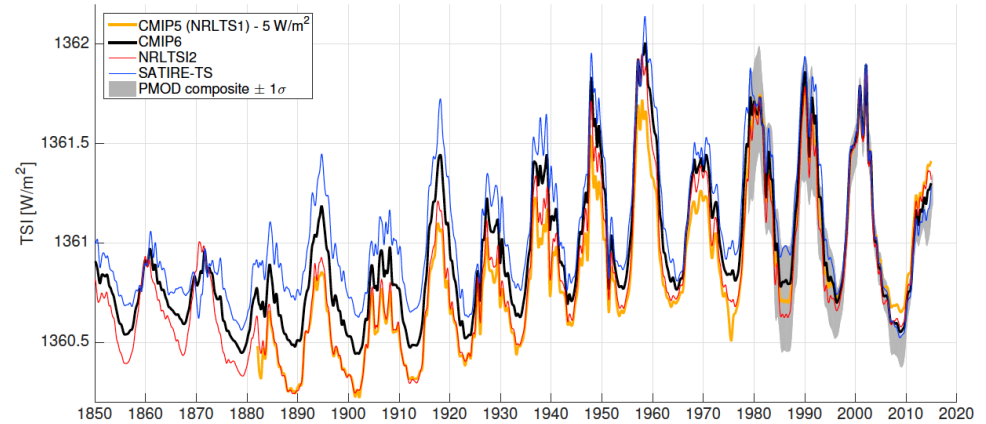
**Acknowledgments:** Annika Drews, Tim Kruschke, Rémi Thiéblemont, Wuke Wang, Nour-Eddine Omrani, Felicitas Hansen, Kuni Kodera

# Mechanisms: Solar Influence on Climate

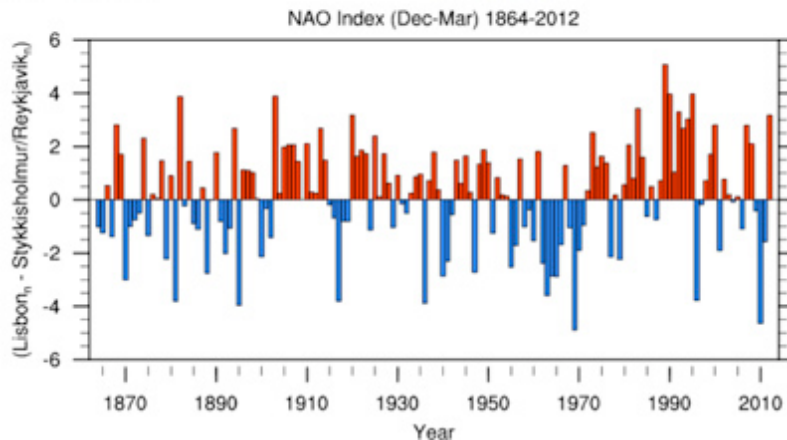


# Sources of Decadal Climate Variability

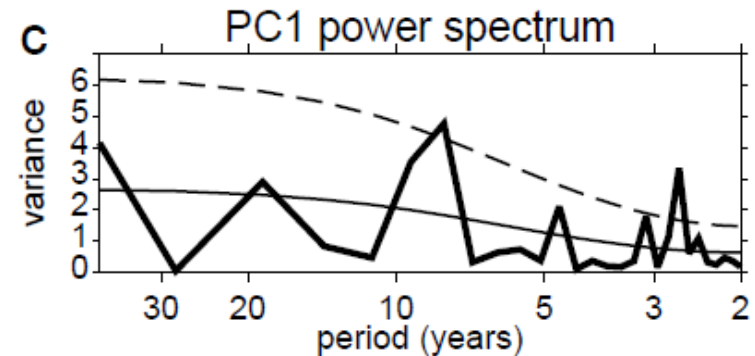
- External: Solar Cycle
- Internal: NAO, AMOC



Matthes et al. (2017)

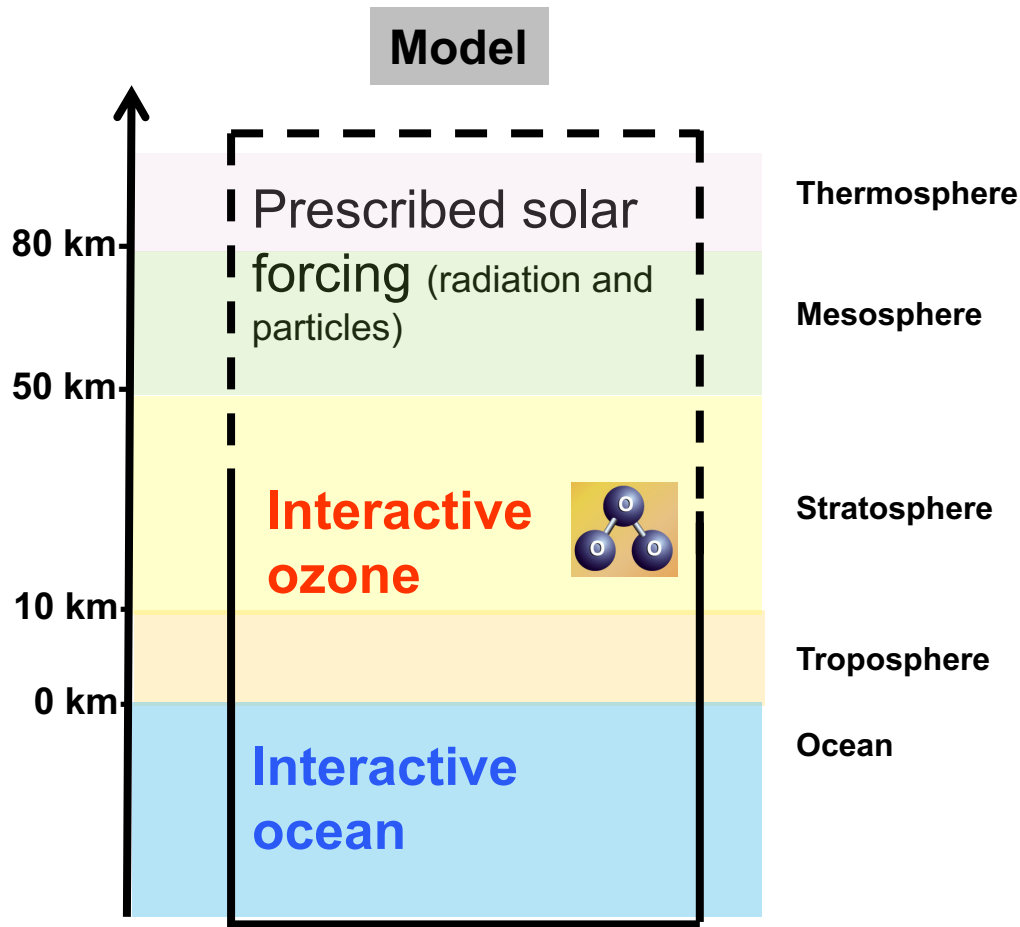


[http://www.clivar.org/sites/default/files/images/Pages/NAO\\_small.jpg](http://www.clivar.org/sites/default/files/images/Pages/NAO_small.jpg)



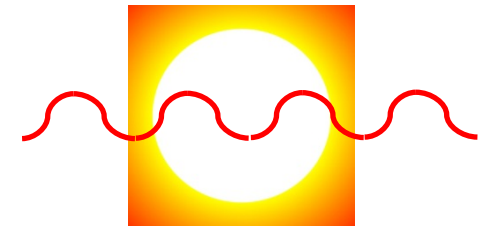
Thiéblemont et al. (2015)

# GEOMAR Model Experiments

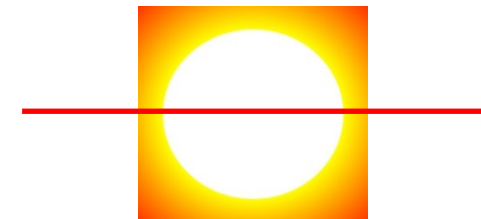


2 Model Experiments  
(145 years)

**SOL**



**NO\_SOL**



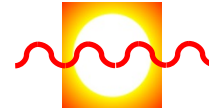
No climate change conditions (GHGs+ODS 1960ies)

# Regional Solar Surface Signal

## Solar Max-Min

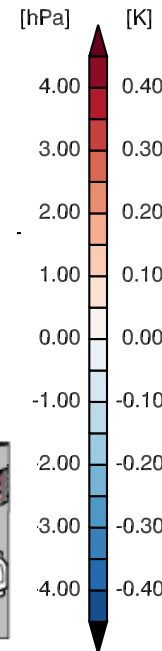
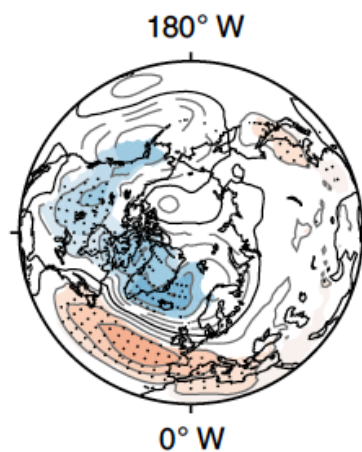
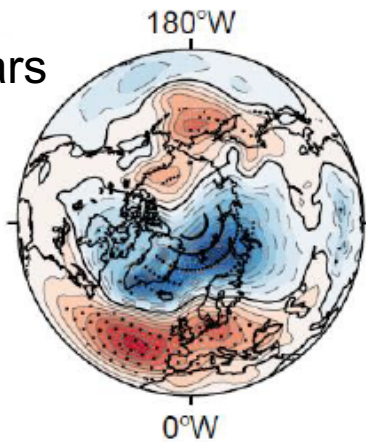
observations

model



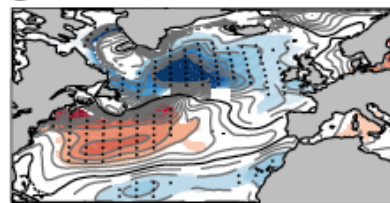
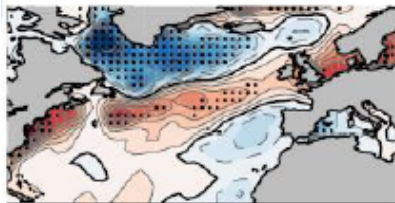
Lag 2 years

SLP  
DJF



**robust wintertime positive NAO-like response during solar maxima lagged by 2 years consistent with Scaife et al. (2013) & Gray et al. (2014), Andrews et al. (2015)**

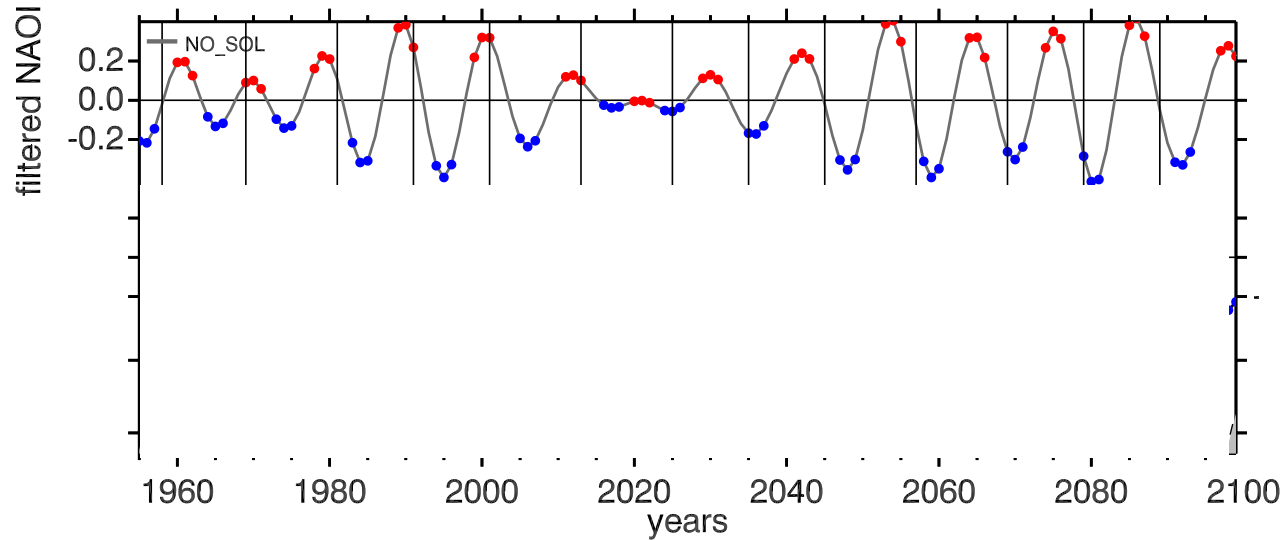
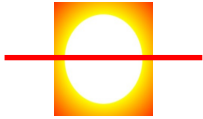
SST  
DJF



Thiéblemont et al. (2015)

Surface signal contribution from **solar irradiance and particle forcing, interactive chemistry, and atmosphere-ocean coupling.**

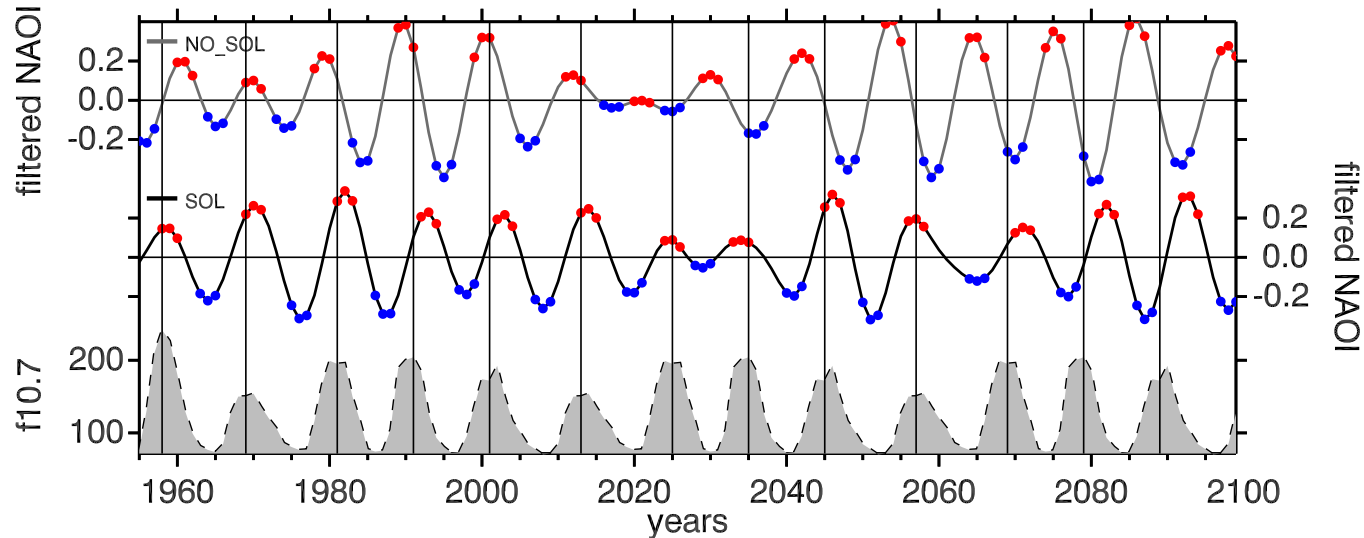
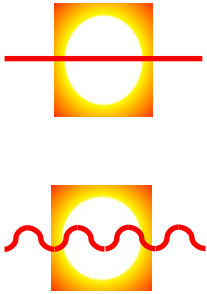
# Quasi-Decadal NAO Fluctuations without Solar Cycle



Thiéblemont et al. (2015)

**CESM-WACCM experiment without solar cycle forcing shows quasi-decadal NAO fluctuations**

# Synchronization of the NAO by the Solar Cycle



Switching **solar variability** in CESM-WACCM on **synchronizes quasi-decadal NAO fluctuations** with the solar cycle, maximizes 1-2 years after solar peak

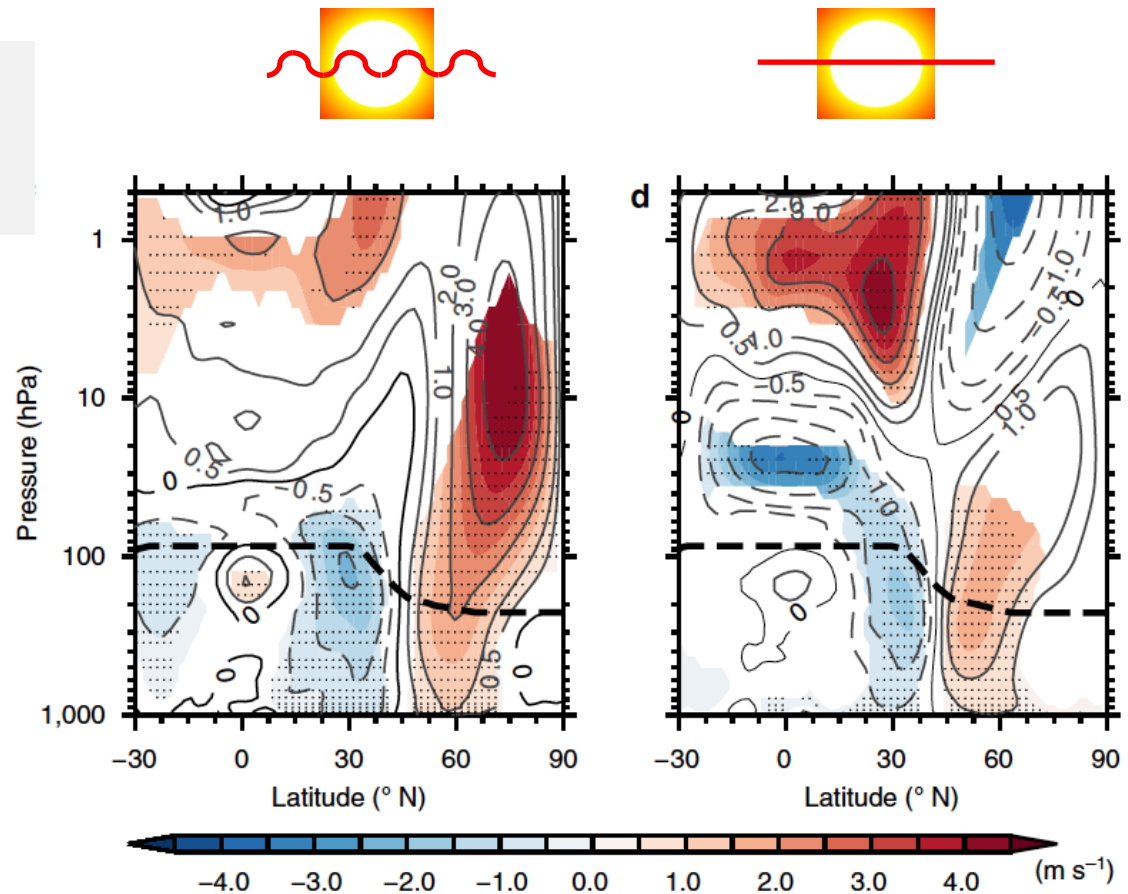
Thiéblemont et al. (2015)

# Synchronization by Stratosphere-Troposphere Coupling

NAO-based composites  
Max-Min at lag -1  
Zonal mean zonal wind

DJF

Synchronization  
consistent with „top-  
down“ mechanism





- **Solar cycle synchronizes NAO quasi-decadal internal variability** mode in model  $\Leftrightarrow$  **stratospheric influence and ocean-atmosphere coupling** crucial

- **Solar cycle offers skill to improve quasi-decadal regional climate predictions**

(Kushnir et al., 2018, submitted)

GC: Near-Term Climate Prediction

