



# DOE/UCAR Cooperative Agreement

## Regional and Global Climate Modeling Program



# THE DICHOTOMY BETWEEN FRESHWATER AND HEAT FLUX EFFECTS ON OCEANIC CONVEYOR BELT STABILITY AND GLOBAL CLIMATE

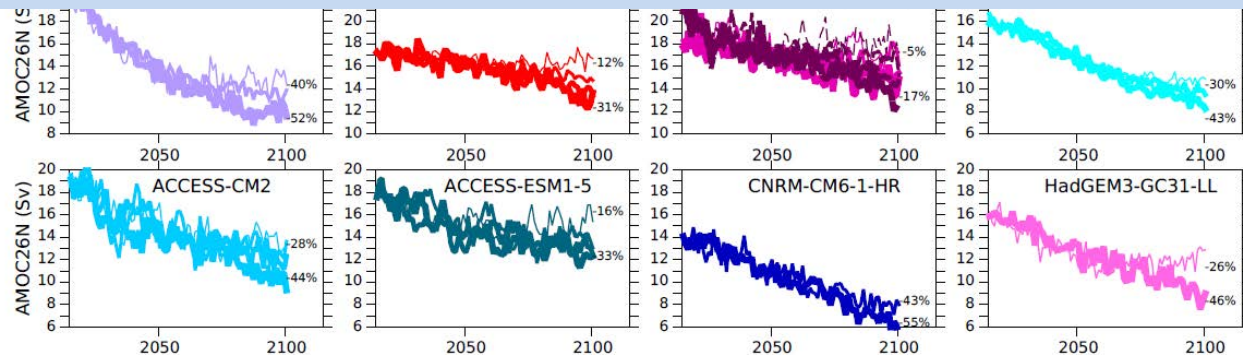
**AIXUE HU, GERALD A. MEEHL, AYAKO ABE-OUCHI, WEIQING  
HAN, BETTE OTTO-BLIESNER, TONGWEN WU, NAN  
ROSENBLOOM, WARREN G. STRAND**

**US AMOC SCIENCE TEAM MEETING 2022**

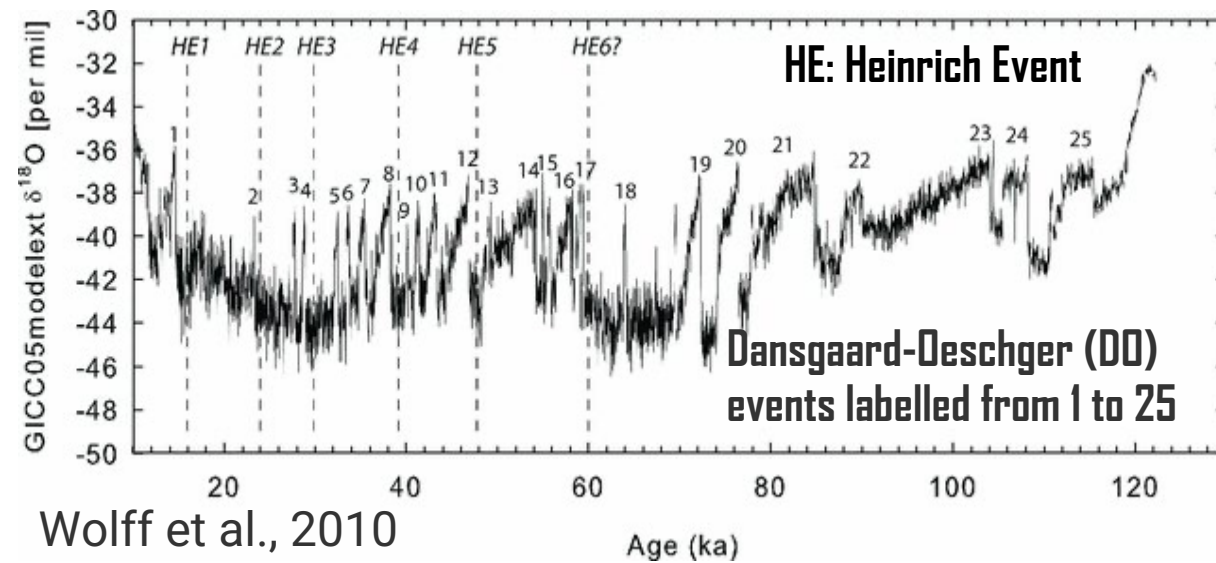
# OCEAN CONVEYER BELT OR ATLANTIC MERIDIONAL OVERTURNING CIRCULATION (AMOC)

AMOC CHANGES IN CMIP6 MODELS

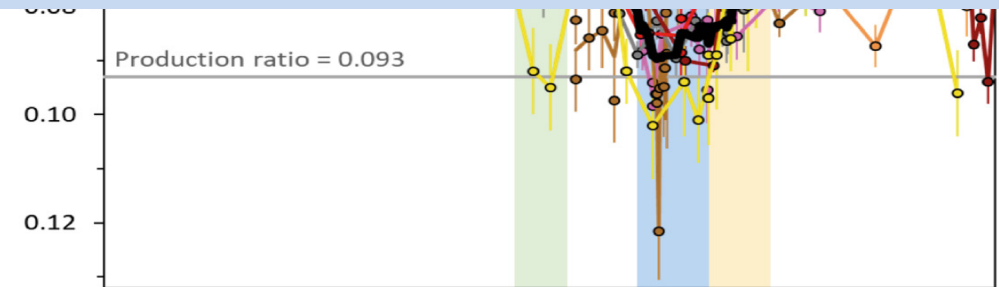
1. WHETHER THE AMOC HYSTERESIS DEPENDS ON THE BACKGROUND CLIMATE CONDITIONS?
2. WHETHER THE FRESHWATER-INDUCED AMOC HYSTERESIS DIFFERS FROM THAT INDUCED BY GHGS?



Weijer et al., GRL, 2020



Wolff et al., 2010



Ng et al., Nature Comm. 2018

# MODELS AND EXPERIMENTS

**Models:** Community Climate System Model versions 3 and 4 (CCSM3 and CCSM4)

**CCSM3:** ~2.8° (T42) for CAM3 and CLM, 1° for POP and CICE

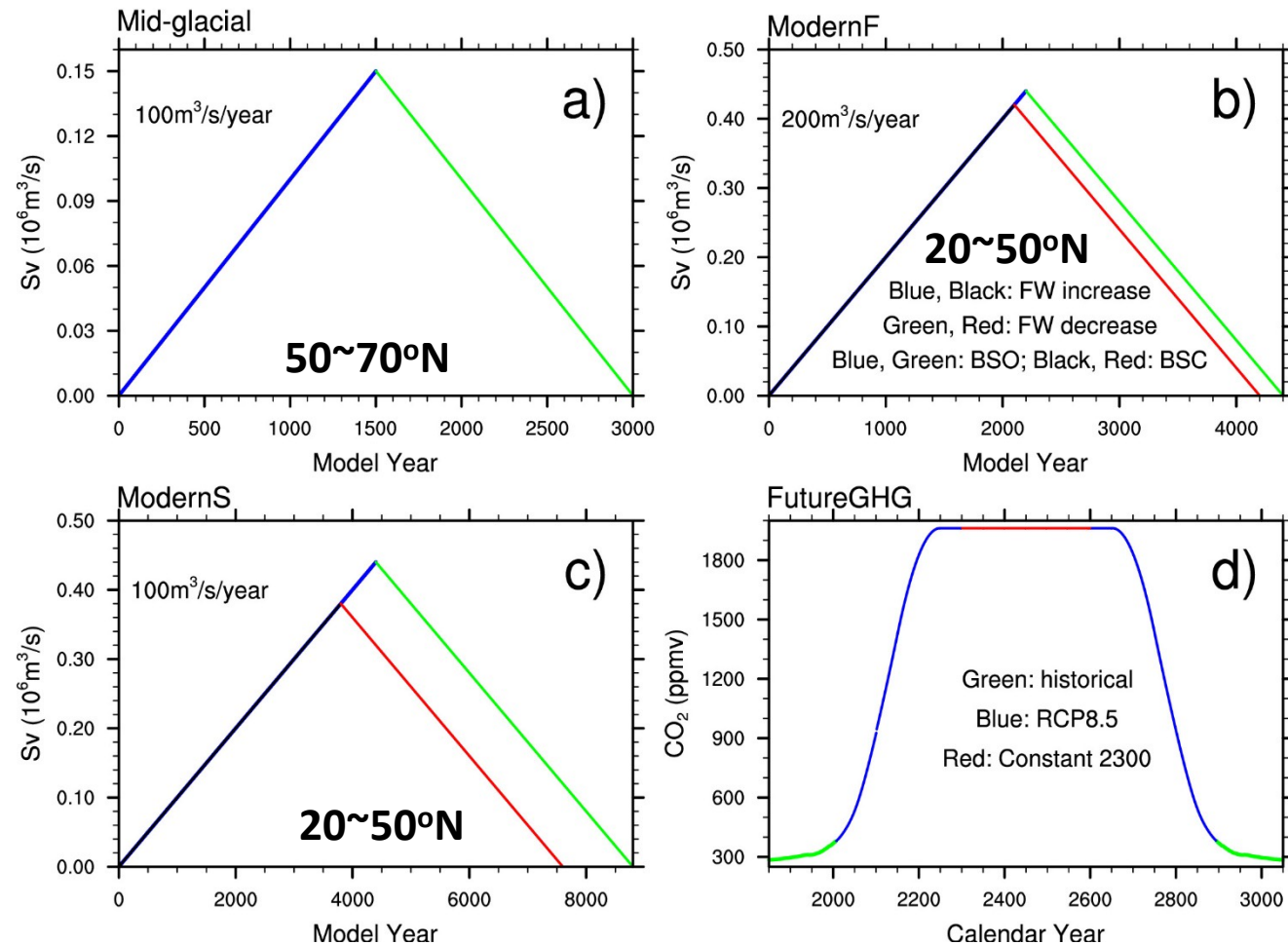
**CCSM4:** nominal 1° for all components

**Experiments:**

1. Mid-glacial-bso and Mid-glacial-bsc
2. ModernF-bso and ModernF-bsc
3. ModernS-bso and ModernS-bsc
4. FutureGHG

**BSO/BSC:** Bering Strait open/closed

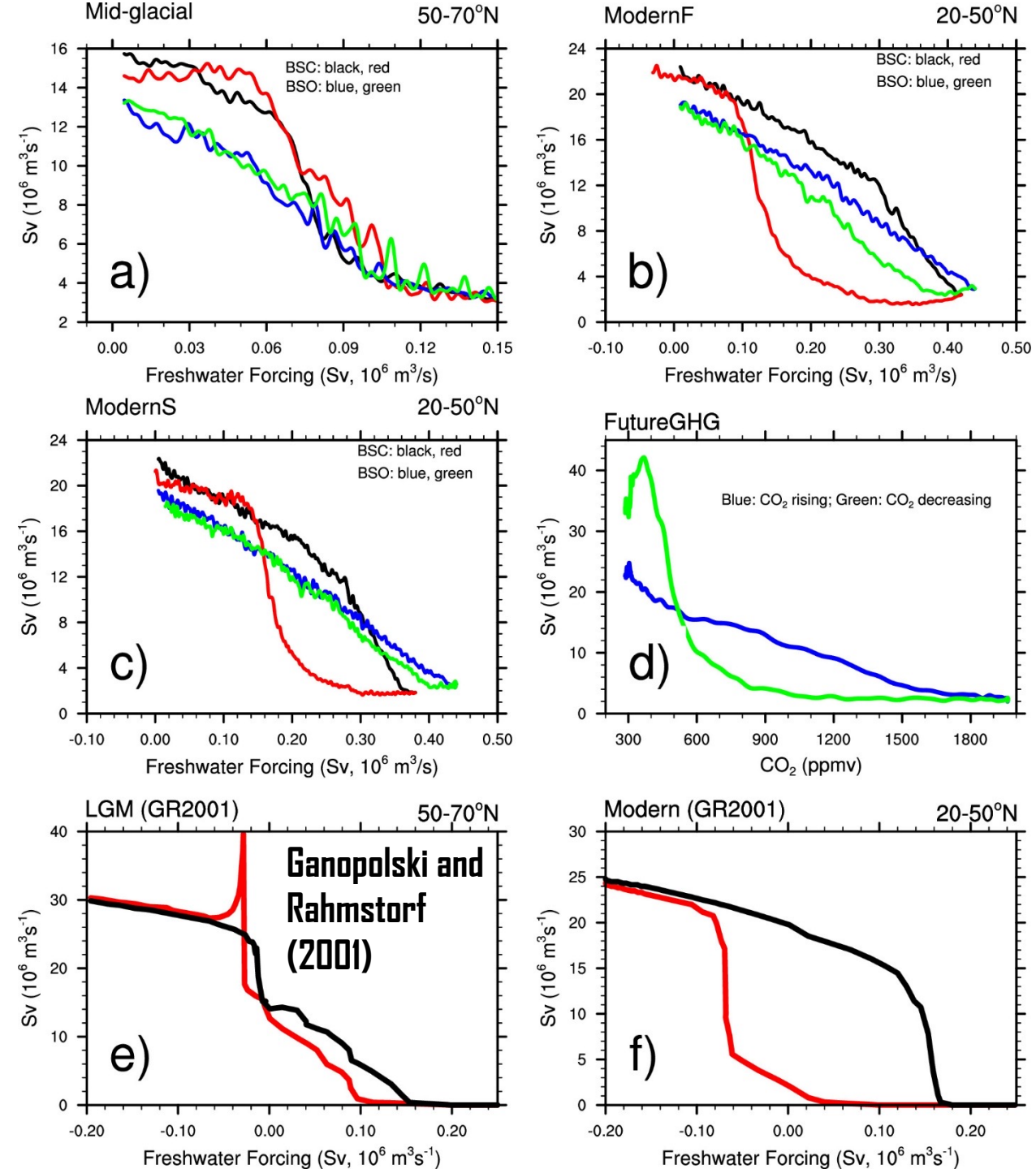
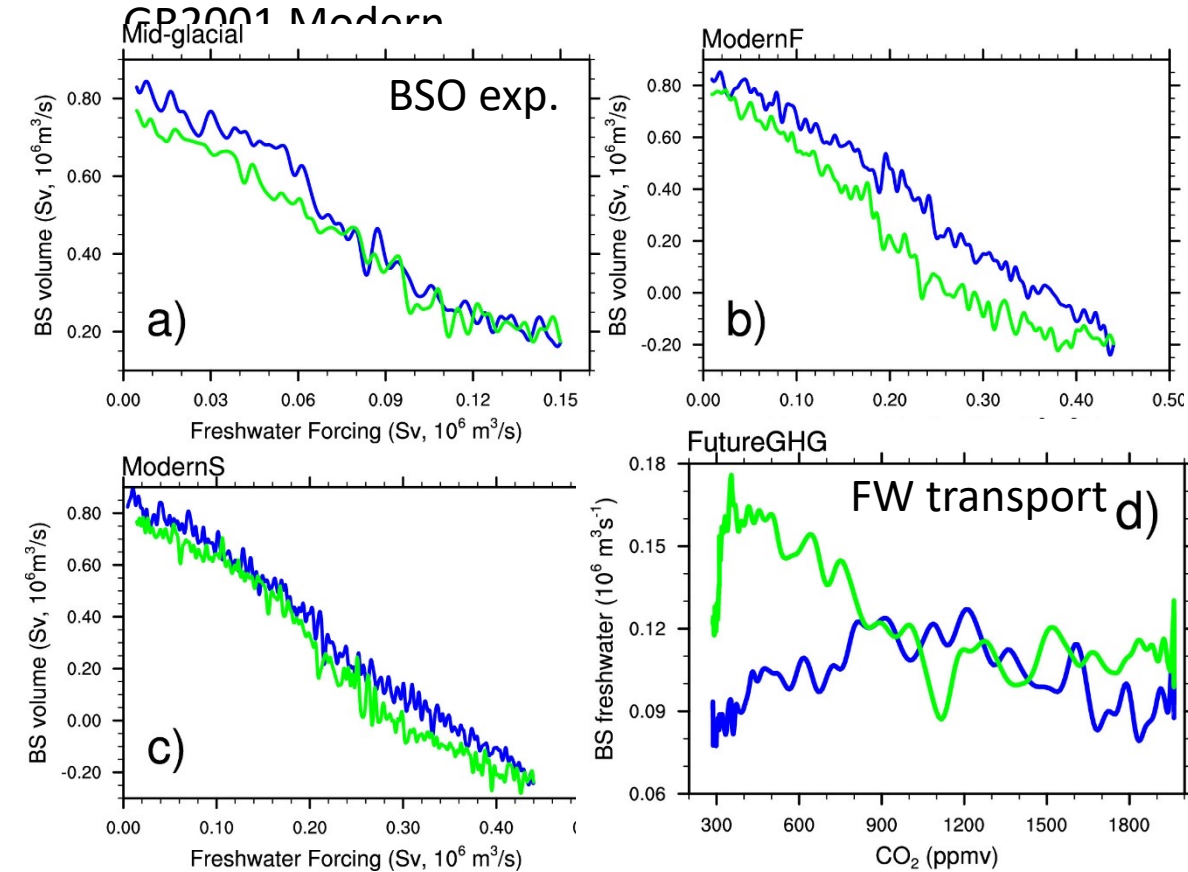
Change of freshwater or CO<sub>2</sub> forcings





# CHANGES OF AMOC

1. Abrupt transition of AMOC only occurs with a closed Bering Strait.
2. Slower rate of FW forcing change leads to a more abrupt transition of AMOC
3. Mid-glacial-bsc agrees better with GR2001 LGM; ModernF-bsc and ModernS-bso agree better with

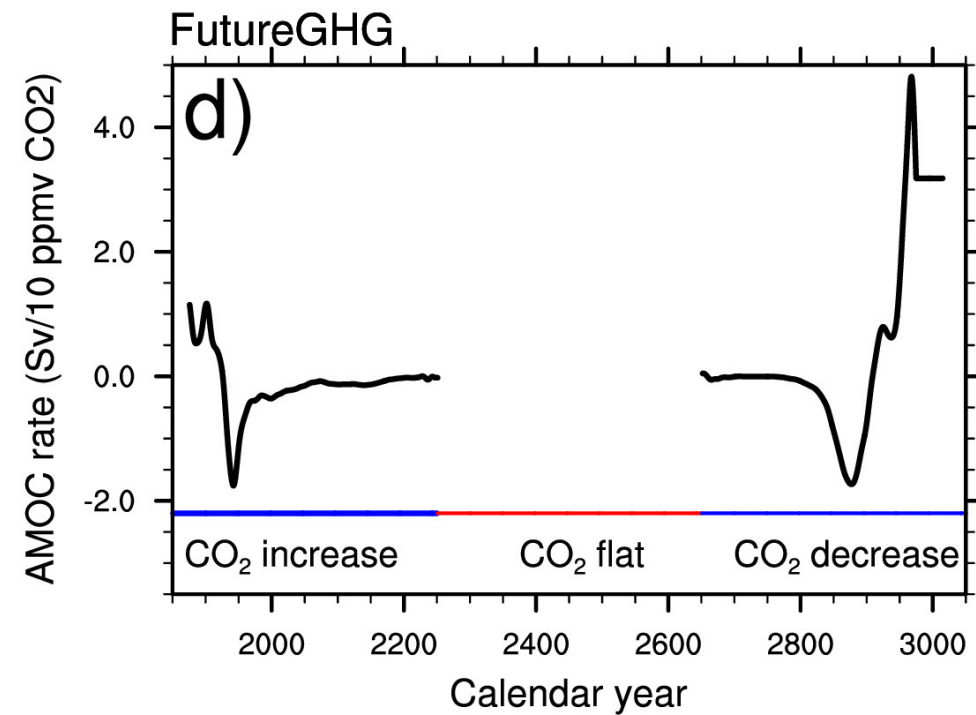
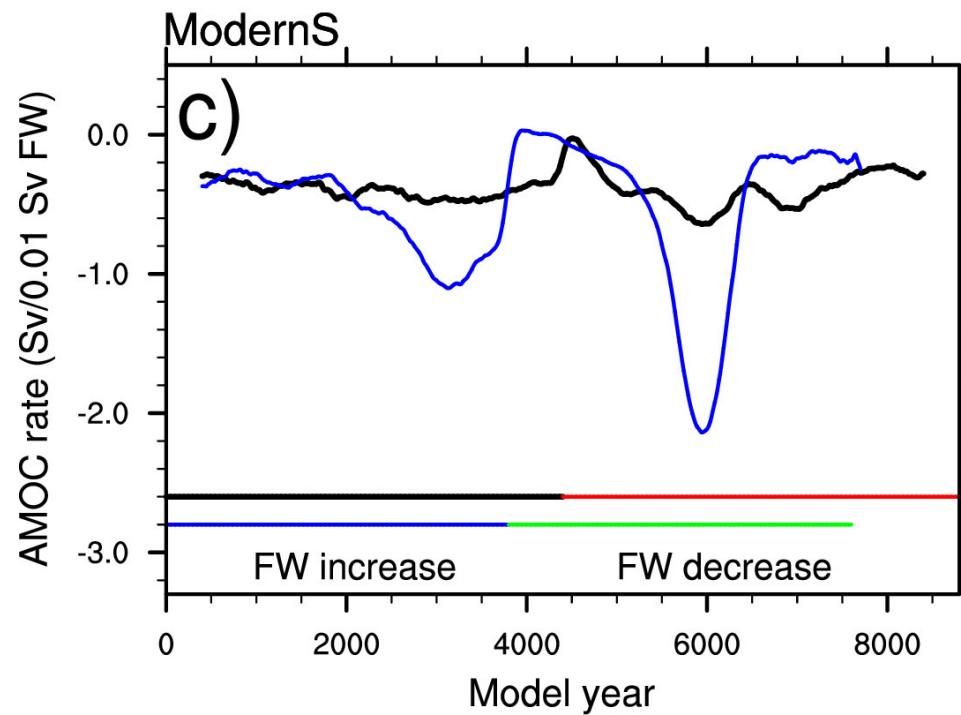
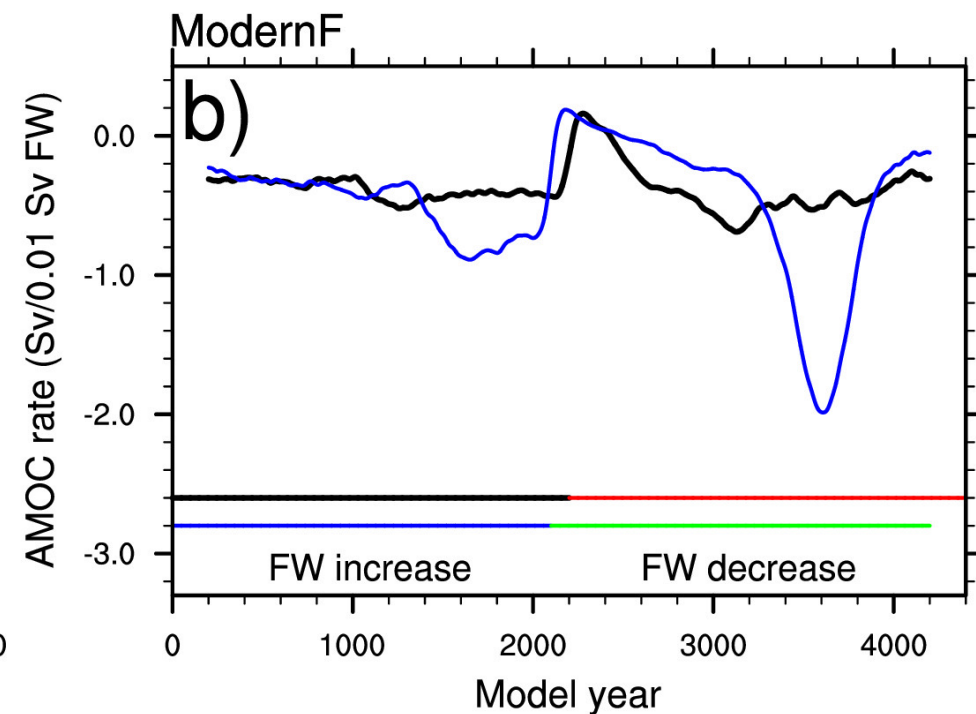
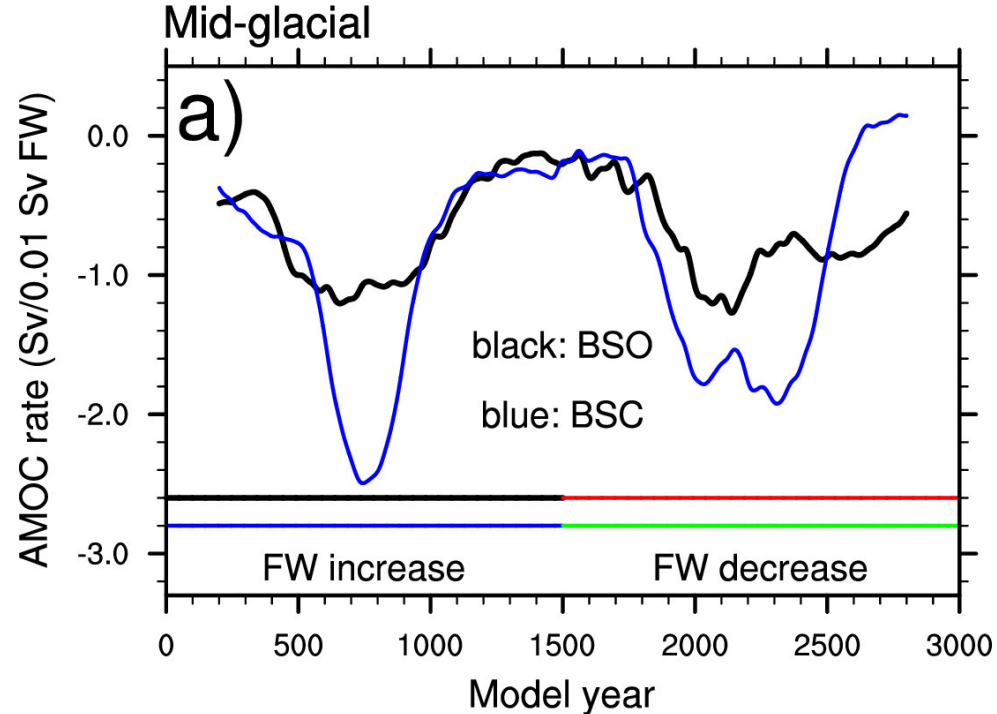




# PIECEWISE LINEAR TREND

WINDOW:  
0.01 SV FOR  
HOSING  
EXPERIMENTS

50-YEARS FOR  
FUTUREGHG



# SURFACE TEMPERATURE CHANGES

MID-GLACIAL

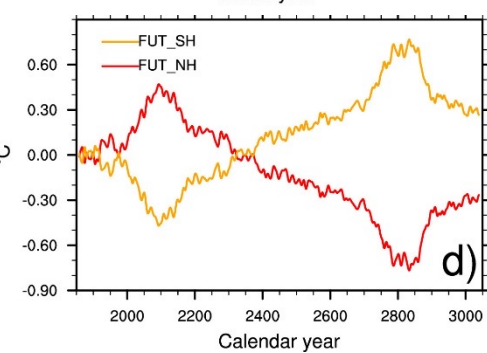
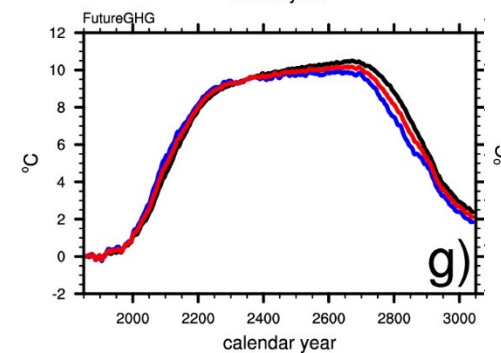
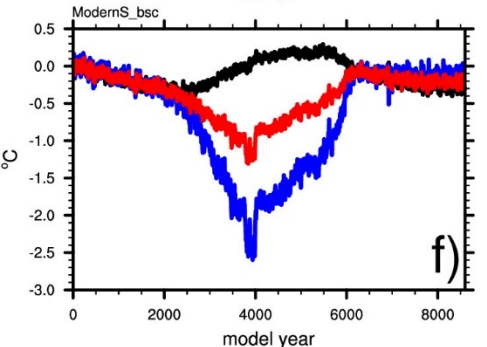
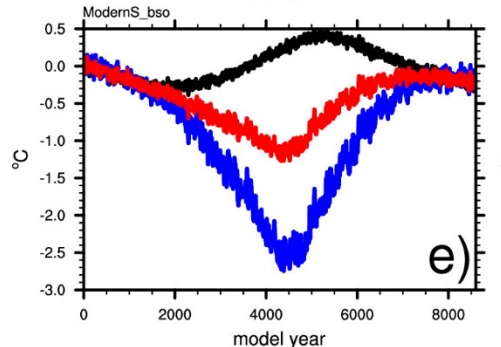
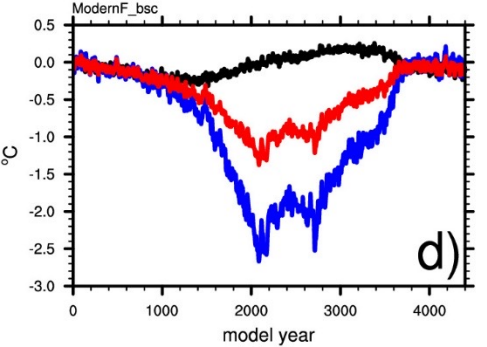
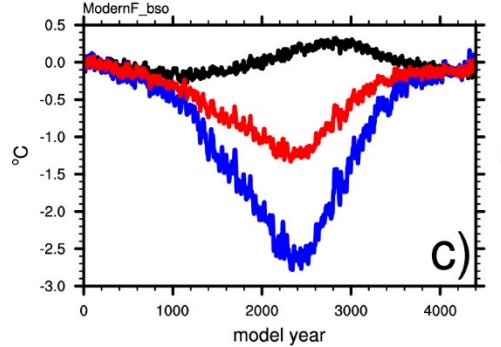
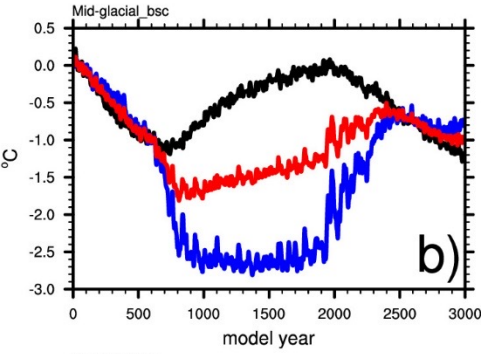
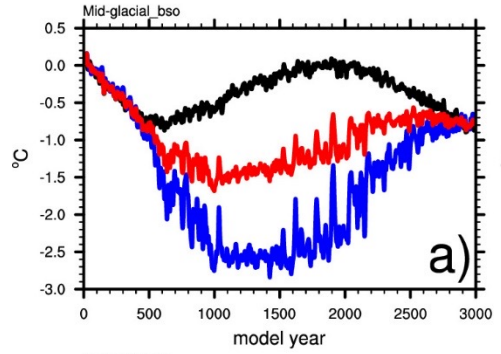
MODERNF

MODERNS

FUTUREGHG

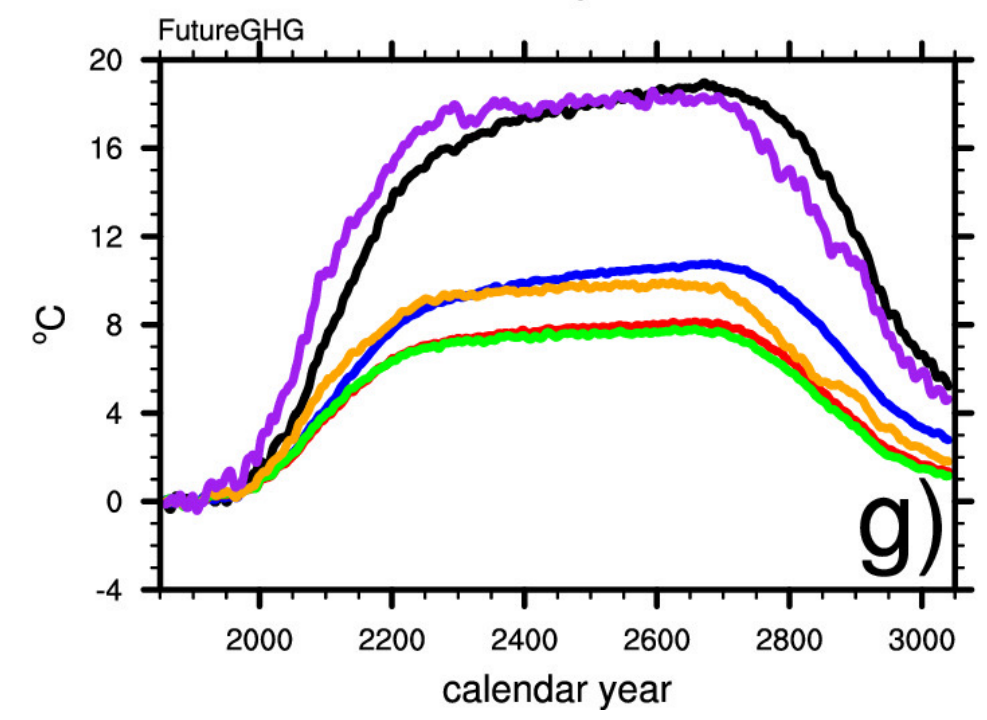
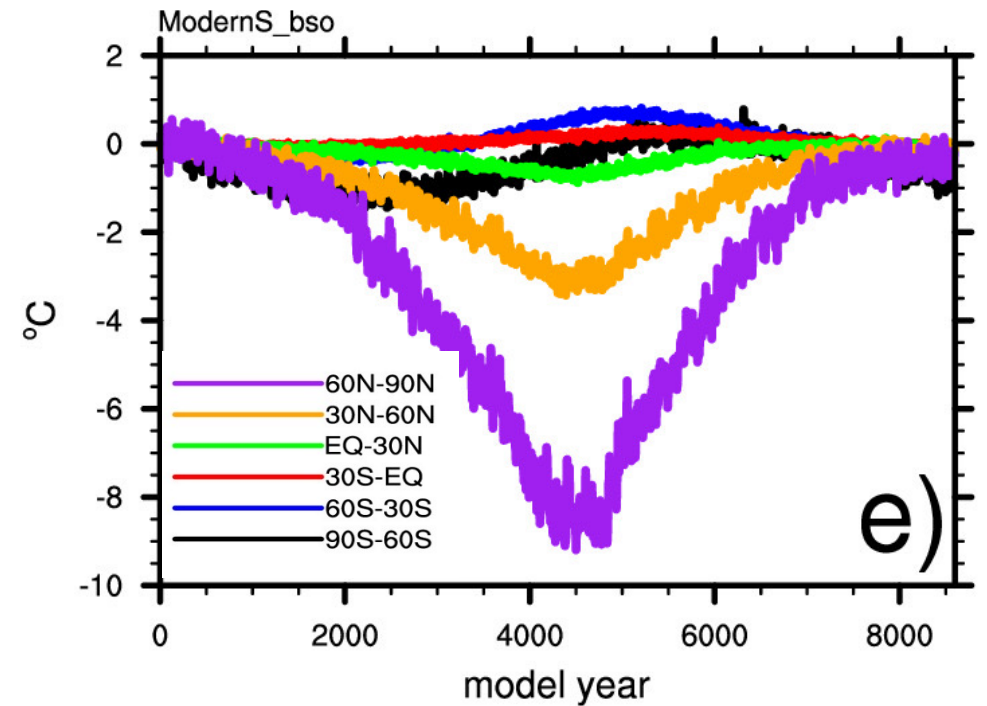
BSO

BSC



MODERNS

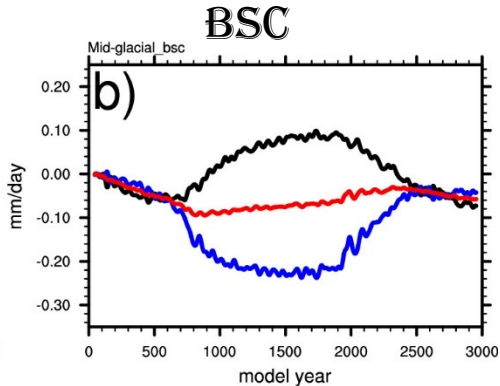
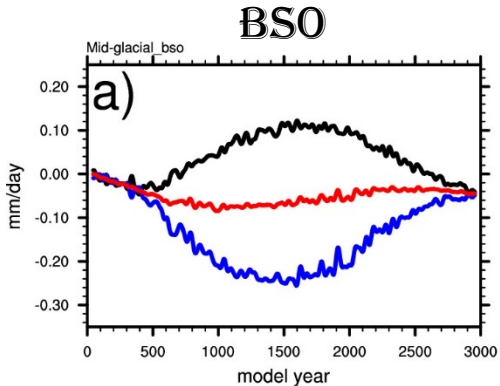
FUTUREGHG



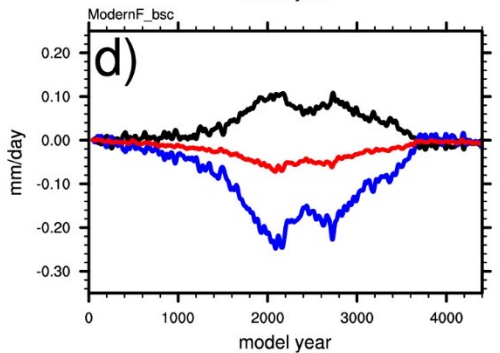
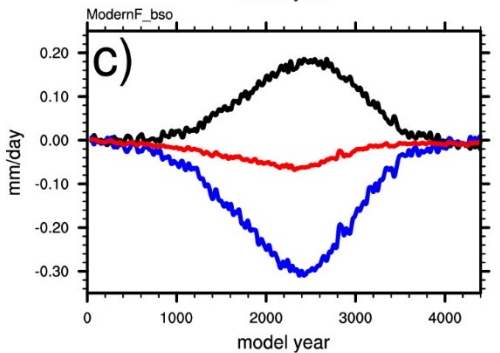


# PRECIPITATION CHANGES

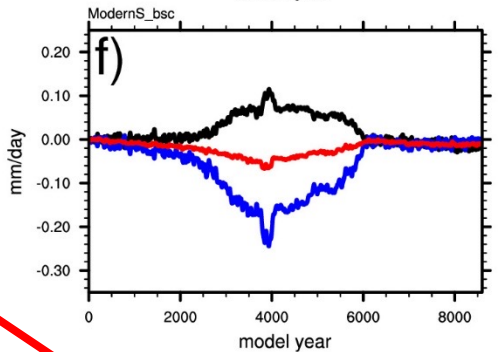
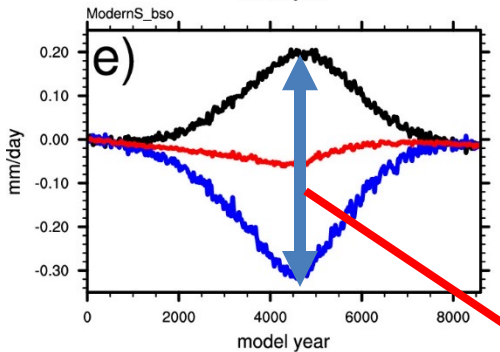
MID-GLACIAL



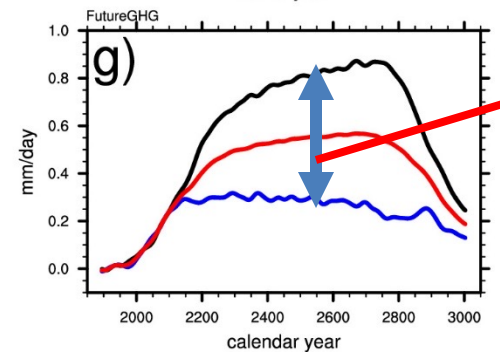
MODERNF



MODERNS



FUTUREGHG

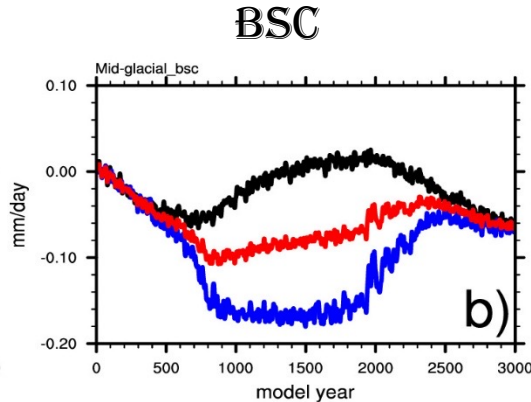
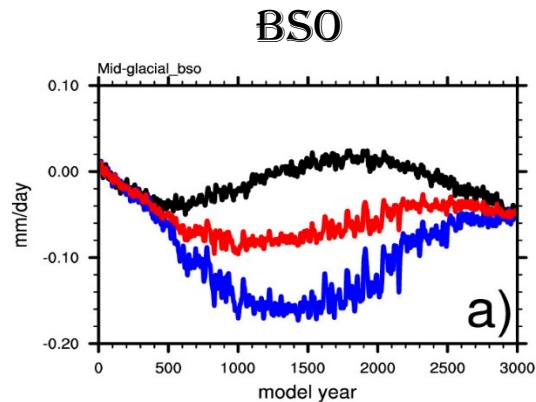


~0.5 mm/day

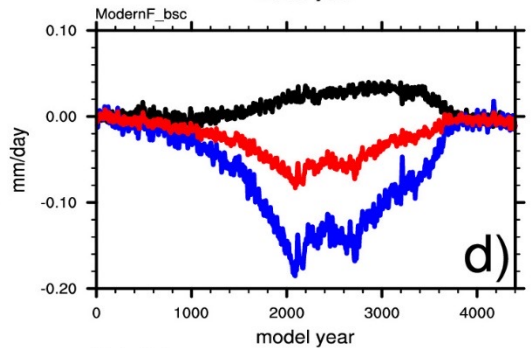
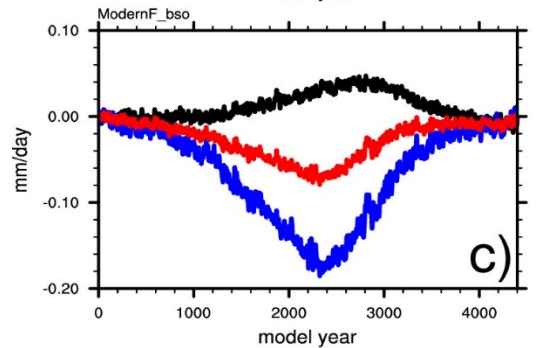
— Global  
— EQ-90N  
— 90S-EQ

# EVAPORATION CHANGES

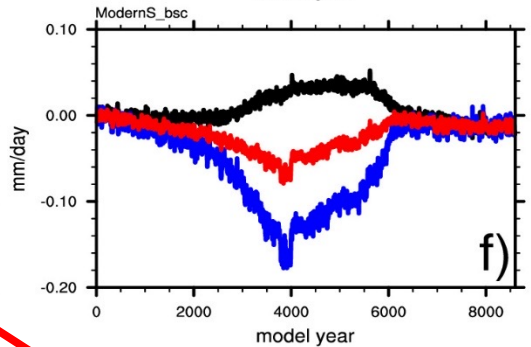
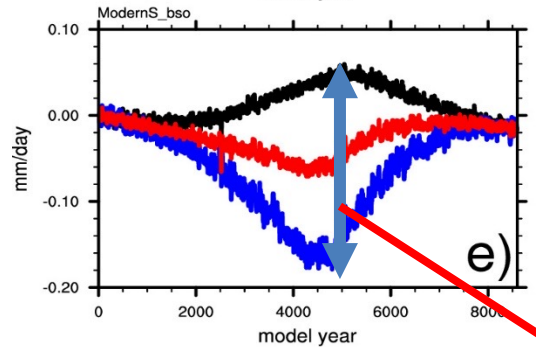
MID-GLACIAL



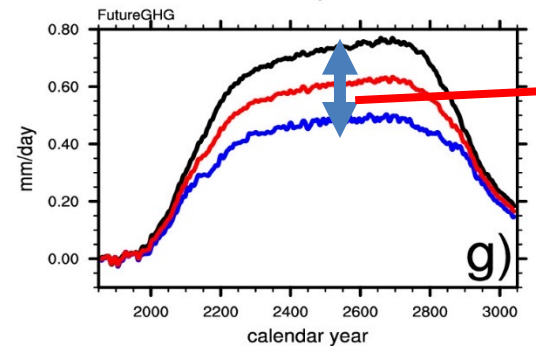
MODERNF



MODERNS



FUTUREGHG



~0.2 mm/day

— Global  
— EQ-90N  
— 90S-EQ



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# SUMMARY

- With freshwater flux as the dominate forcing, AMOC hysteresis depends on the status of Bering Strait – open vs. closed, not the background climate conditions. With an open Bering Strait, AMOC has no hysteresis; with a closed Bering Strait, AMOC has hysteresis.
- With GHGs as the dominate forcing, AMOC hysteresis exists.
- Collapsed AMOC induces a cooler and less cloudy NH with reduced hydrological cycle, but a warmer and more cloudy SH with enhanced hydrological cycle.
- The differentiated changes of hydrological cycle between NH and SH under GHG forcing is mainly due to the collapse of AMOC.





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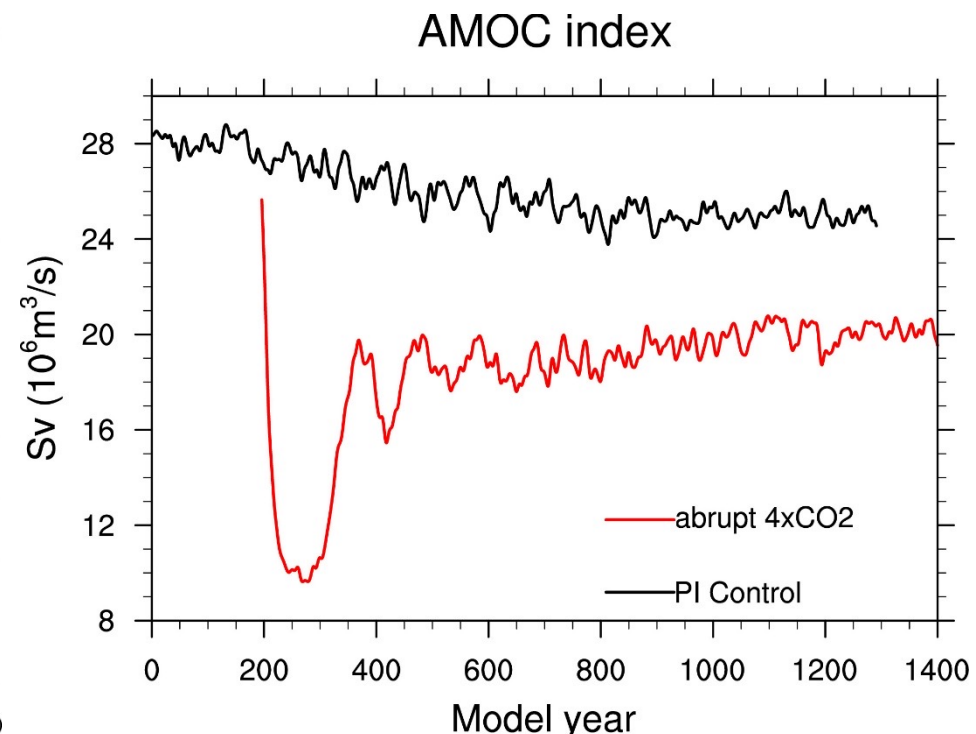
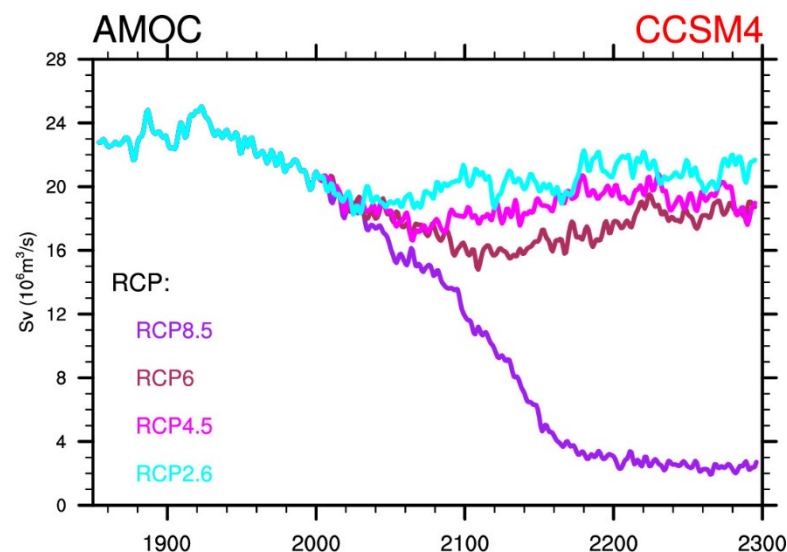
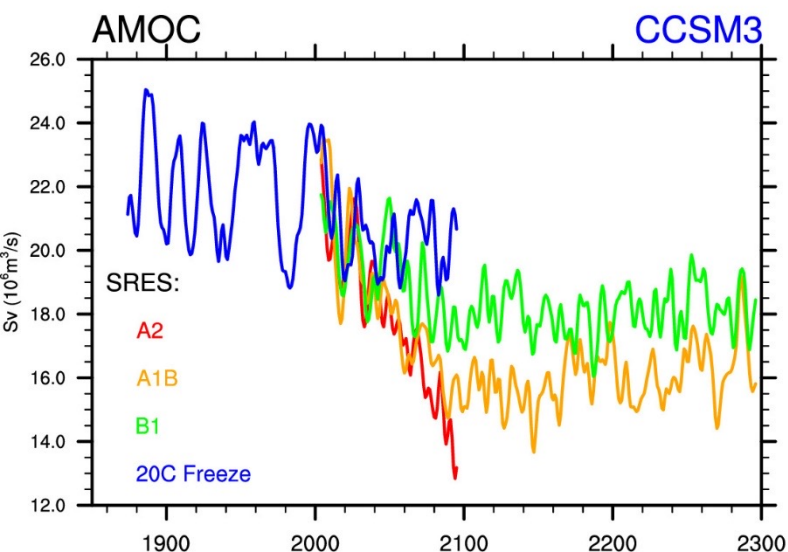
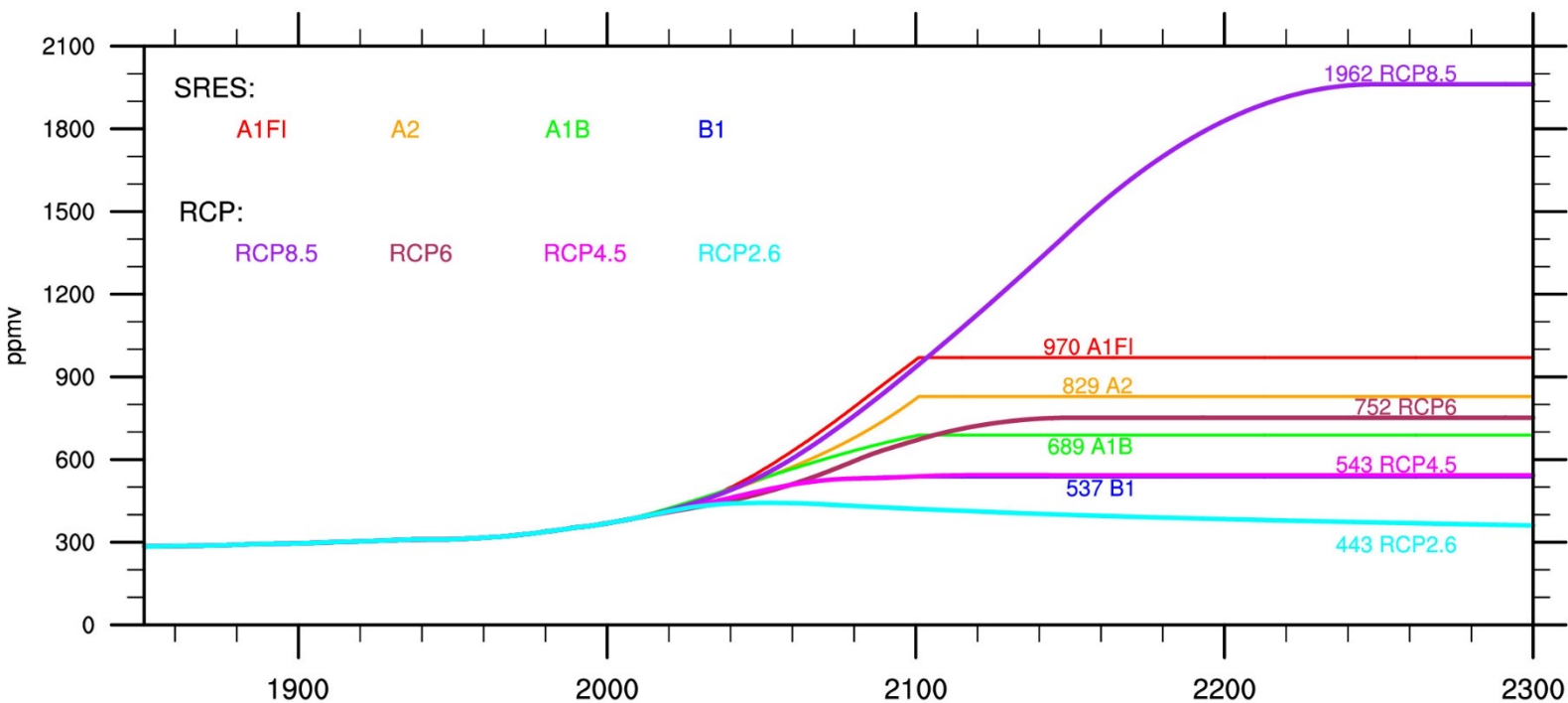


**THANK YOU!**

**QUESTIONS?**

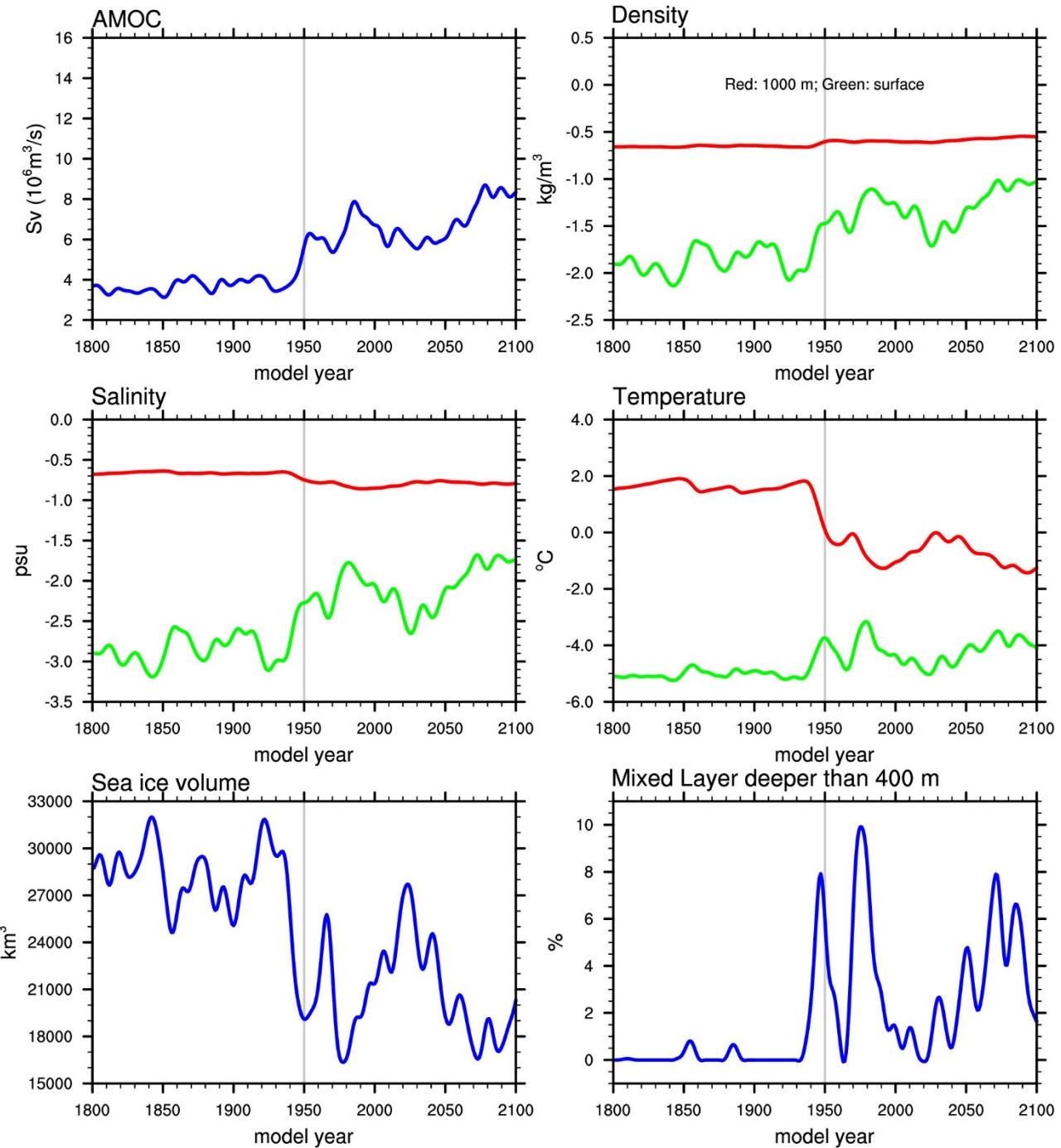
**CONTACT: [AHU@UCAR.EDU](mailto:AHU@UCAR.EDU)**

# CO<sub>2</sub> concentrations





# Mid-glacial-bsc



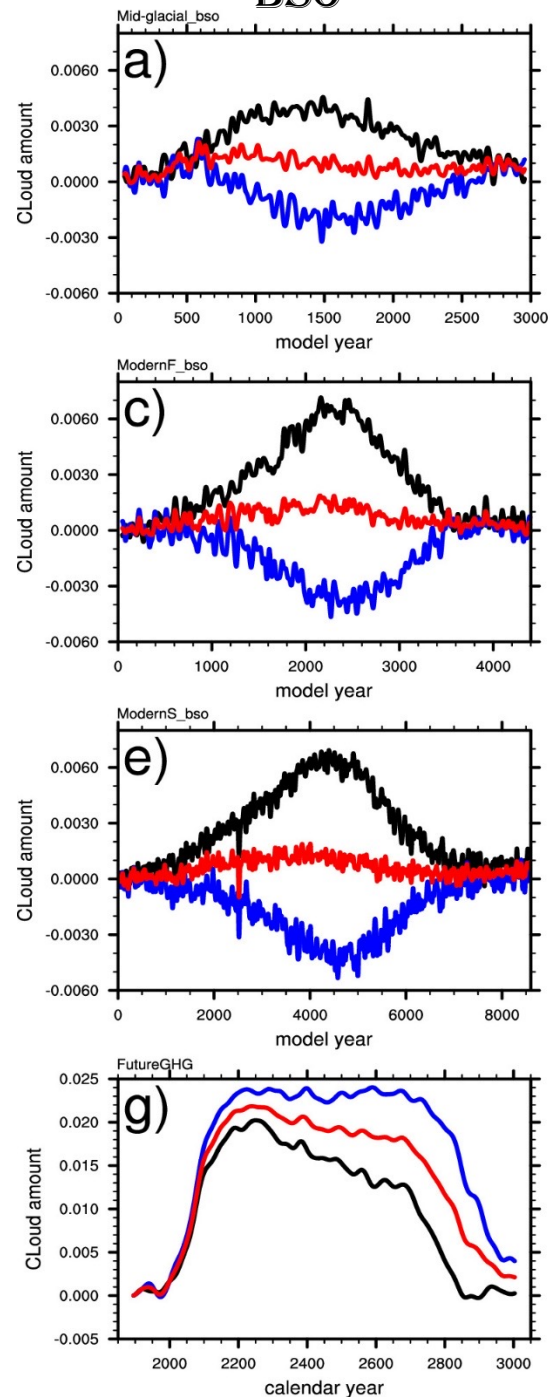
MID-GLACIAL

MODERNF

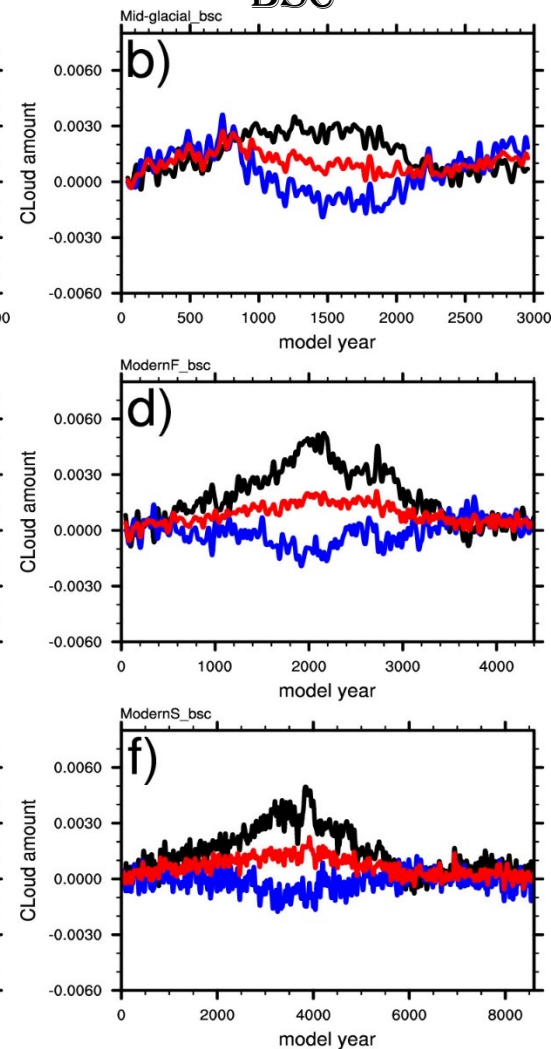
MODERNS

FUTUREGHG

## BSO

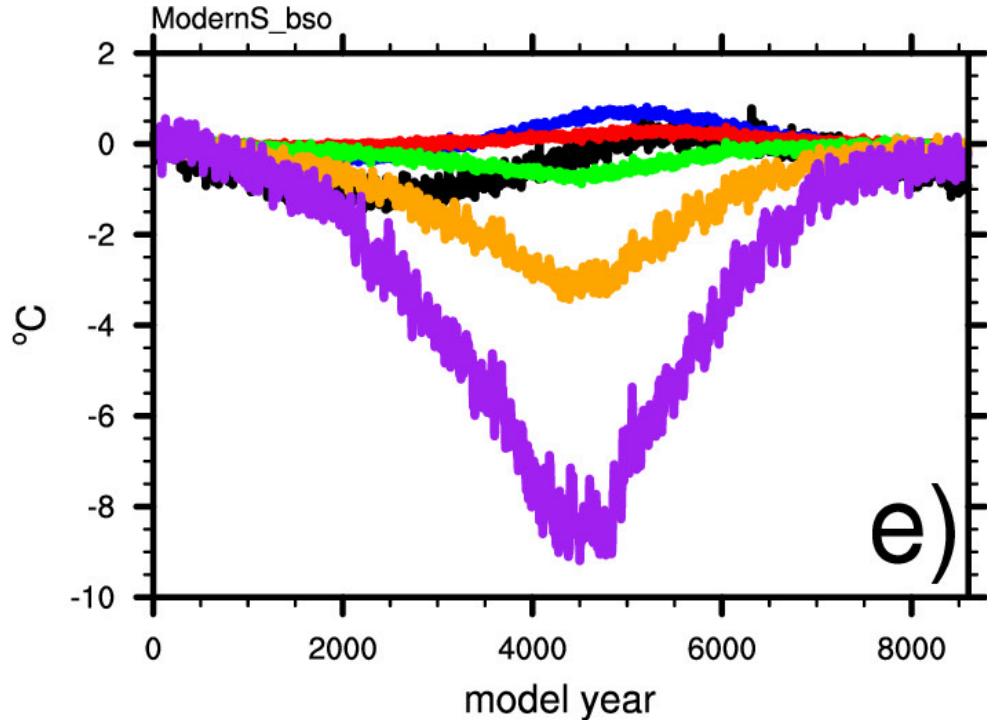


## BSC

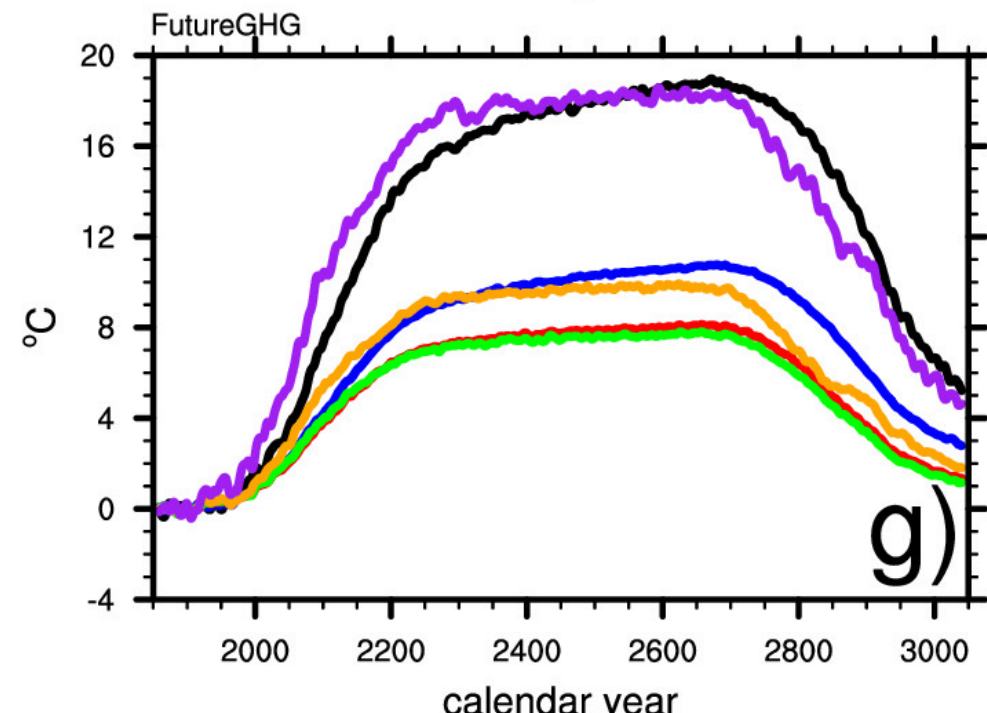


# SURFACE TEMPERATURE CHANGES

MODERNS

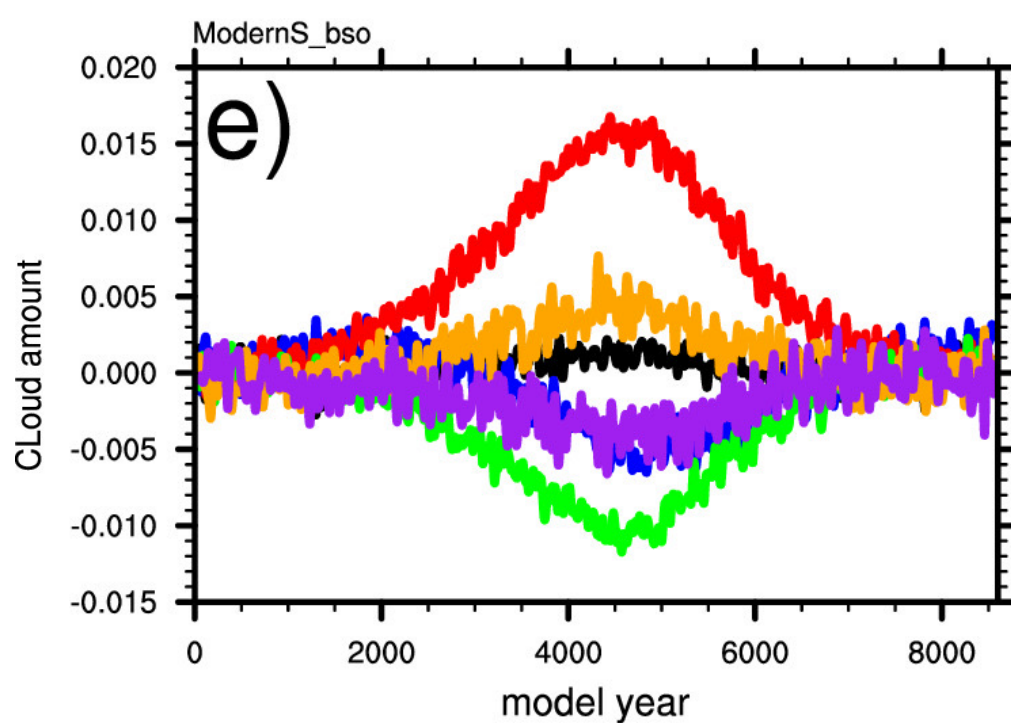


FUTUREGHG

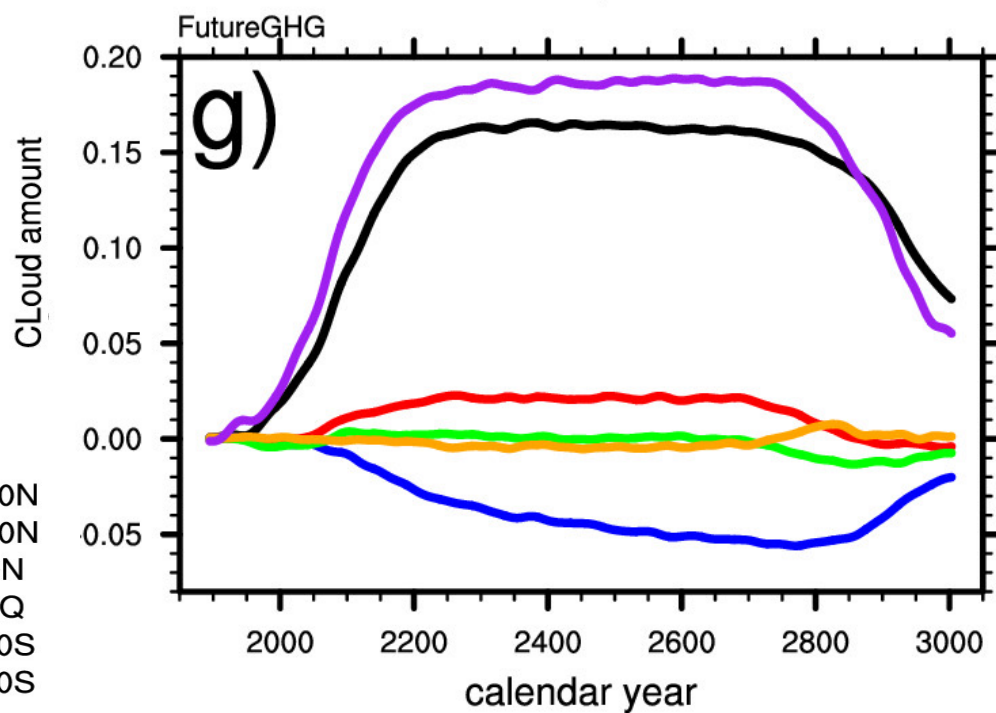


# CLOUDINESS CHANGES

MODERNS



FUTUREGHG



- 60N-90N
- 30N-60N
- EQ-30N
- 30S-EQ
- 60S-30S
- 90S-60S