GEOMIP using CESM1-CAM4

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- **Understand the impact of Solar Radiation Management (SRM) on the Earth's system**
- **Four proposed experiments uniformly defined based on CIMP5 simulations: G1-G4 (Kravitz et al., 2011)**
- **Some preliminary model results**

Understand the impact of Solar Radiation Management (SRM) on the Earth's System

Uniformly performed experiments to study:

- **Climate and local response**: Temperature and Precipitation/Hydrology
- **Atmosphere**: Circulation pattern, Chemistry, Aerosol Microphysics
- **Ocean**: acidification, Ocean circulation, Cryosphere
- **Biosphere,** Biogeochemistry, Agricultural and other vegetation
- **Feedbacks** on Temperature, Dynamics, TS
- **Volcanic responses** of different models (CIMP5) in comparison to observations

Understand the impact of Solar Radiation Management (SRM) on the Earth's System

Participating Models:

- right now about 15 plan to participate
- including at least 2 models that simulate microphysics (WACCM CARMA)
- only a few have chemistry

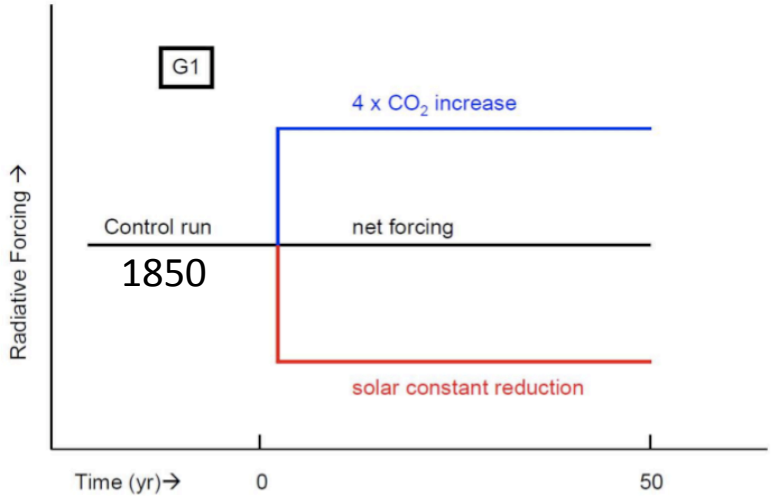
GeoMIP in CCMVal3

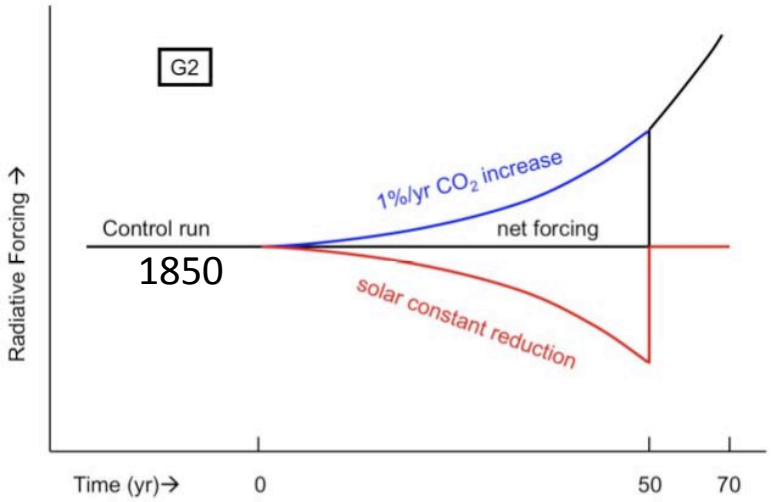
- possibly defined prescribed SAD from microphysical models

GEOMIP Simulations

Four proposed experiments: G1-G4

G1, G2: balancing incoming LW forcing with reduced SW forcing (reduction of solar constant)





G1: Baseline: CMIP5 4xCO_2, **Geoeng**.: radiative forcing will be balanced (model specific based on the planetary albedo)

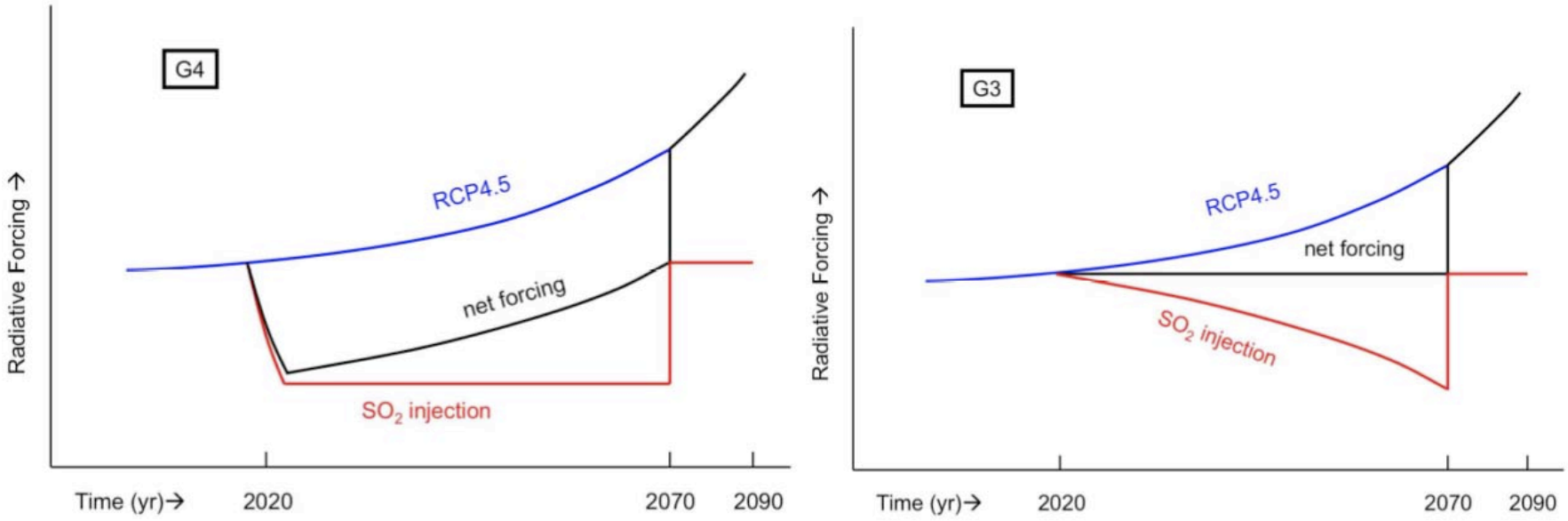
G2: Baseline: CMIP 1% /yr CO_2 increase, **Geoeng.**: derived from G1 experiment

NESL

NSF

GEOMIP Simulations

G3, G4: balancing incoming LW forcing with stratospheric aerosol injection

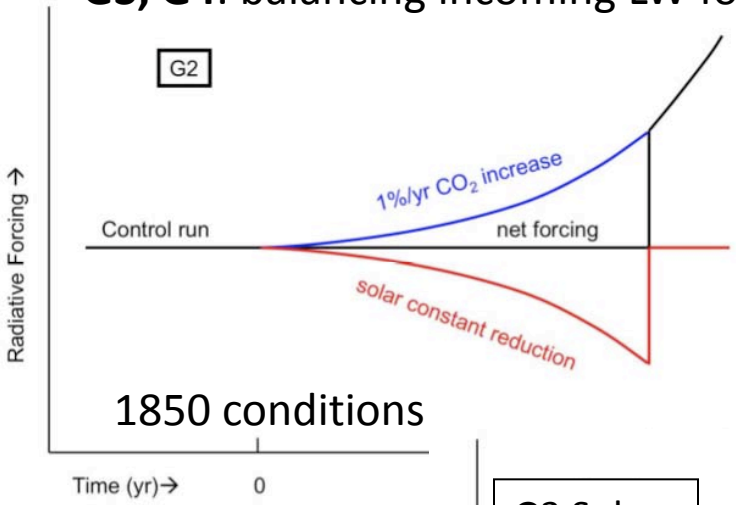


G4: Baseline: RCP4.5, **Geoeng.:** fixed aerosol injection of 5 Tg SO_2 per year, after 50 years, stop of injection

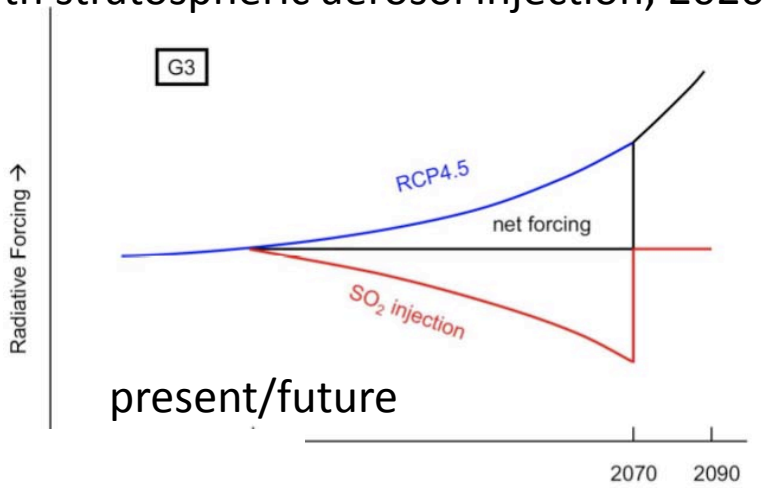
G3: Baseline: RCP4.5, **Geoeng.:** stratospheric aerosols in 2020 to balance are to be increased gradually, equatorial injection)

GEOMIP Simulations

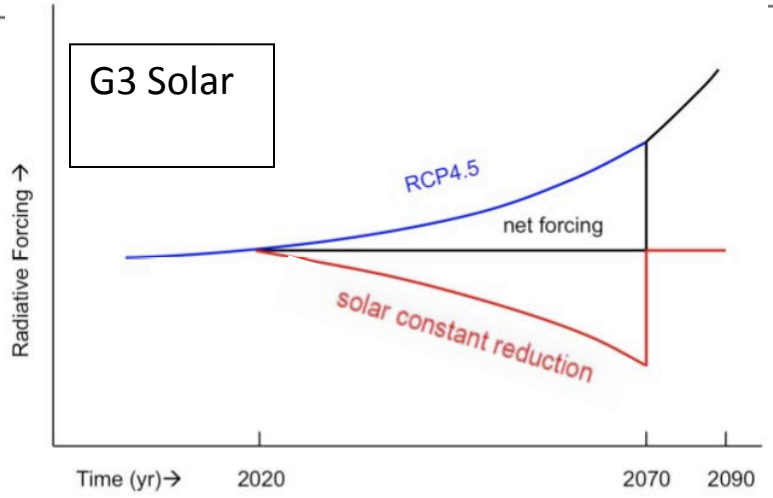
G1, G2: reduced SW forcing (reduction of solar constant), 1850 conditions
G3, G4: balancing incoming LW forcing with stratospheric aerosol injection, 2020



1850 conditions



present/future



CCSM4 G3 but with reduced SW forcing: G3 solar

GEOMIP Simulations with CESM1-CAM4

G1, G2, G3 solar: reduced SW forcing (reduction of solar constant), 1850 conditions
G3, G4: balancing incoming LW forcing with stratospheric aerosol injection, 2020

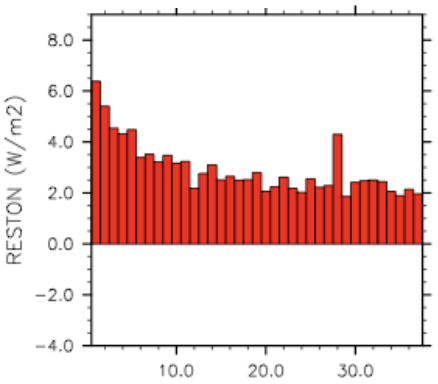
- Simulations planned with CESM4 (0.9x1.25x26L)
  G1, G2, G3 solar
- Simulations planned with CESM4-BGC (0.9x1.25x26L)
  G3 solar
- Simulations planned with CESM4 CAMChem (1.9x2.5x26L):
  G3 solar, G3, G4
- WACCM, WACCM-CARMA simulations (Mike Milles)
- CESM1-CAM5 (Phil Rasch)

Preliminary Test Results

G1 Experiment (1.9x2.5 deg)

4xCO_2, 1850 Simulation

SW+ LW



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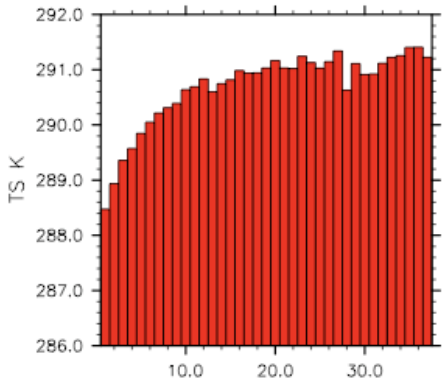
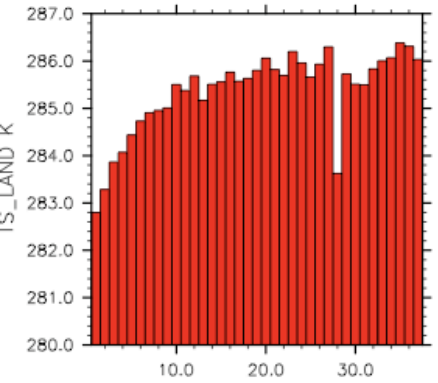
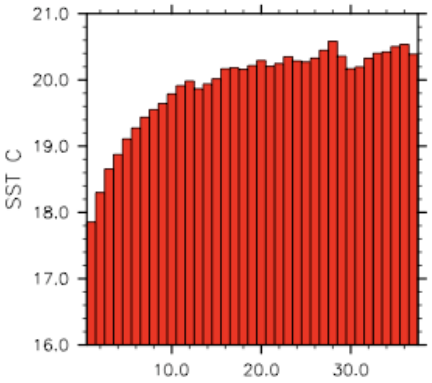


TS Land



SST



RF = (delta solar constant/4.)* (1-alpha) alpha = albedo 4%
dimming of solar constant (1360.89 – 54.4356) = 1306.45

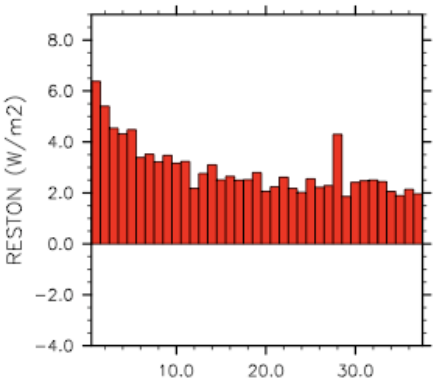
NESL

NSF

G1 Experiment (1.9x2.5 deg)

$4xCO_2$, 1850 Simulation

SW+ LW



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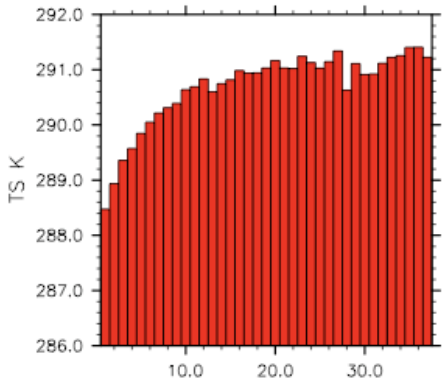

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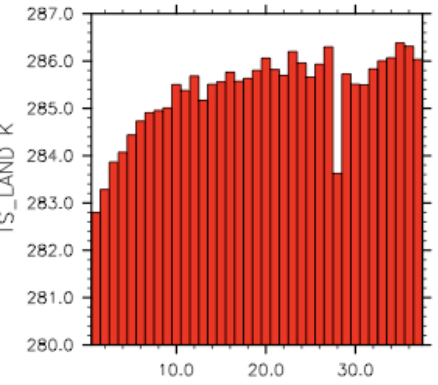
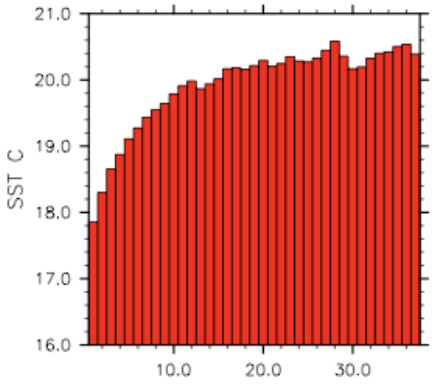
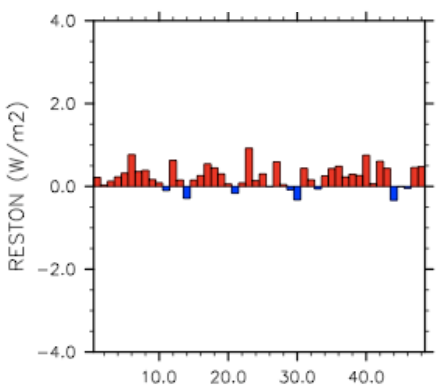


SST Land



$4xCO_2$ + solar dimming

SW+ LW



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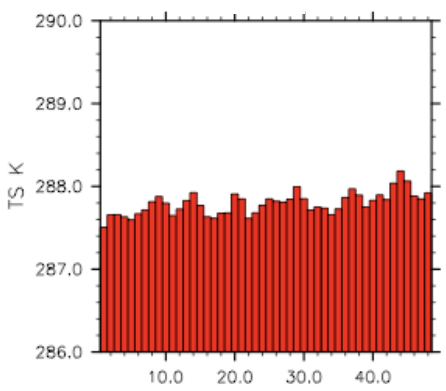
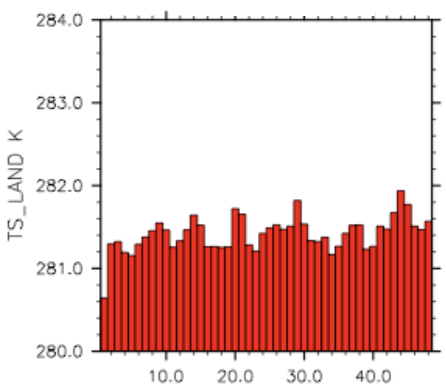


TS Land



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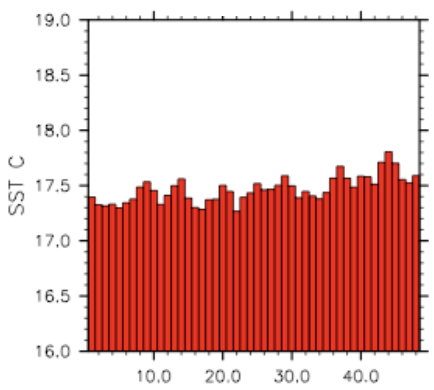

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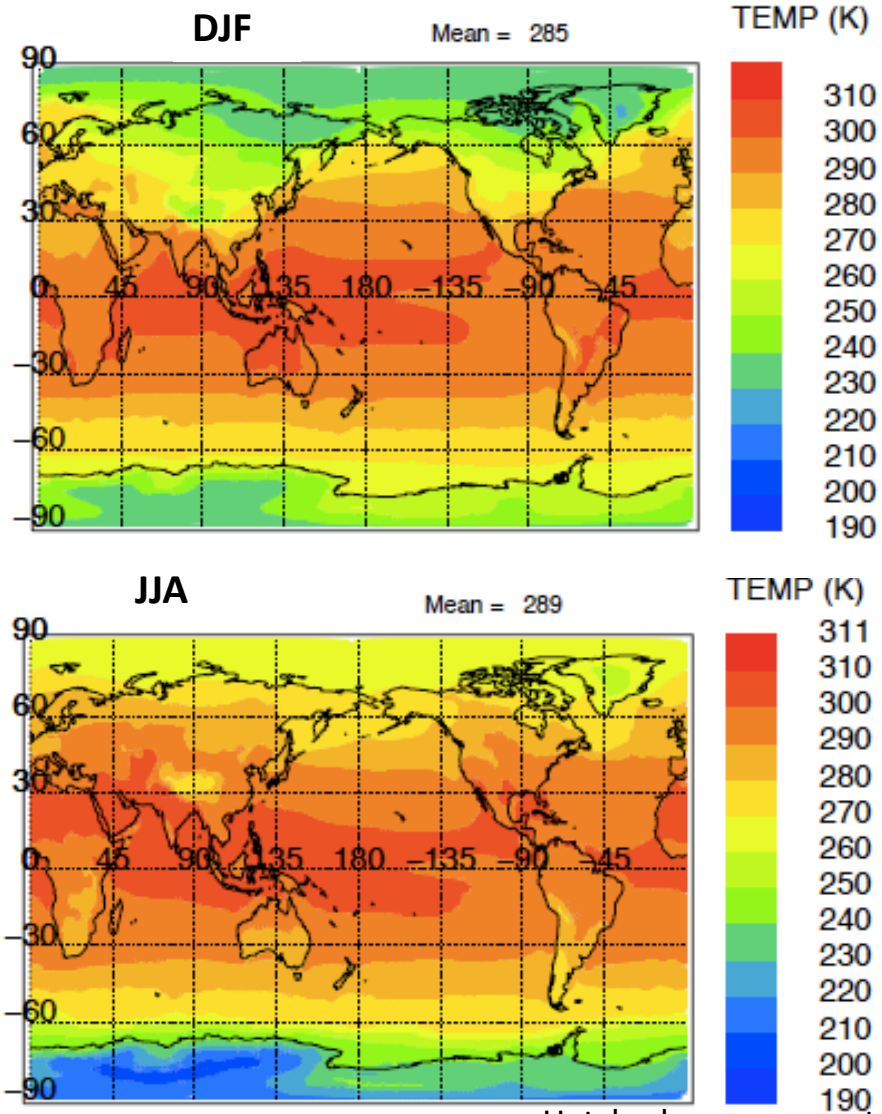
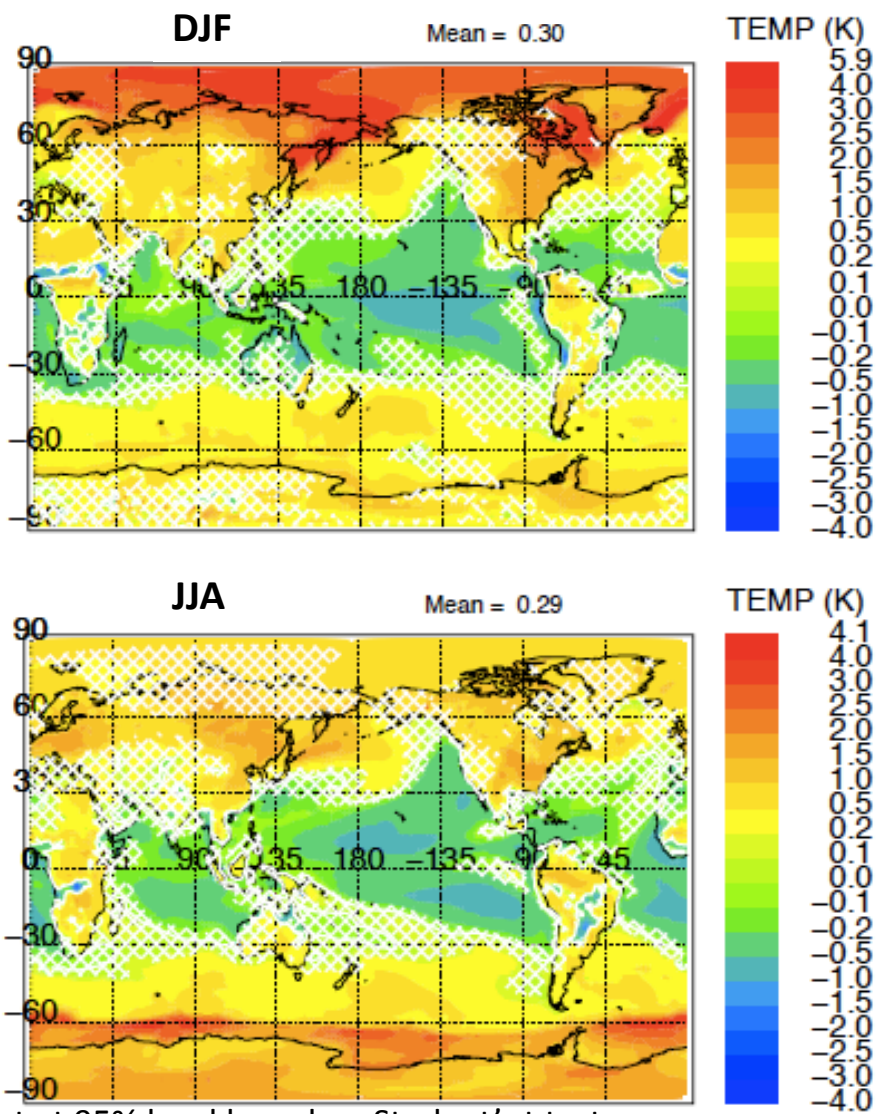
NSF

1850 Baseline

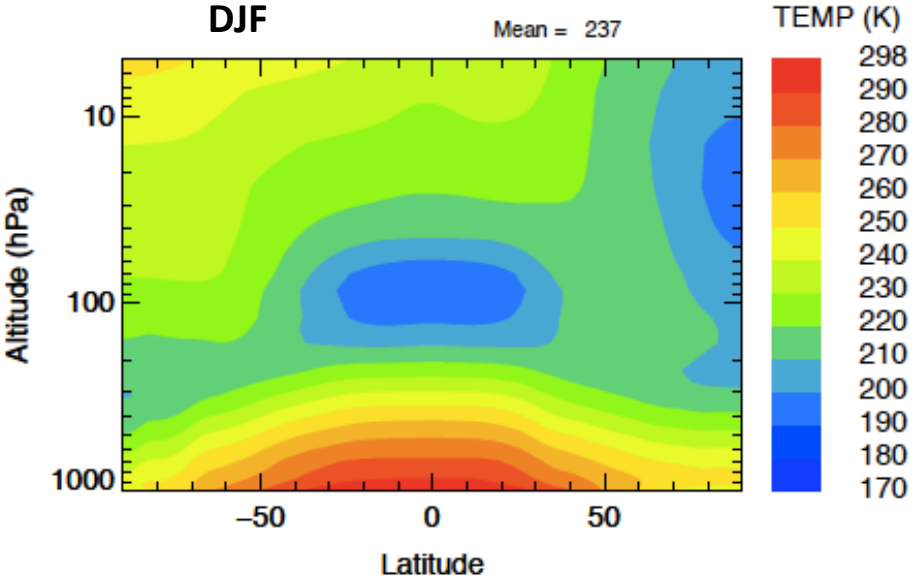


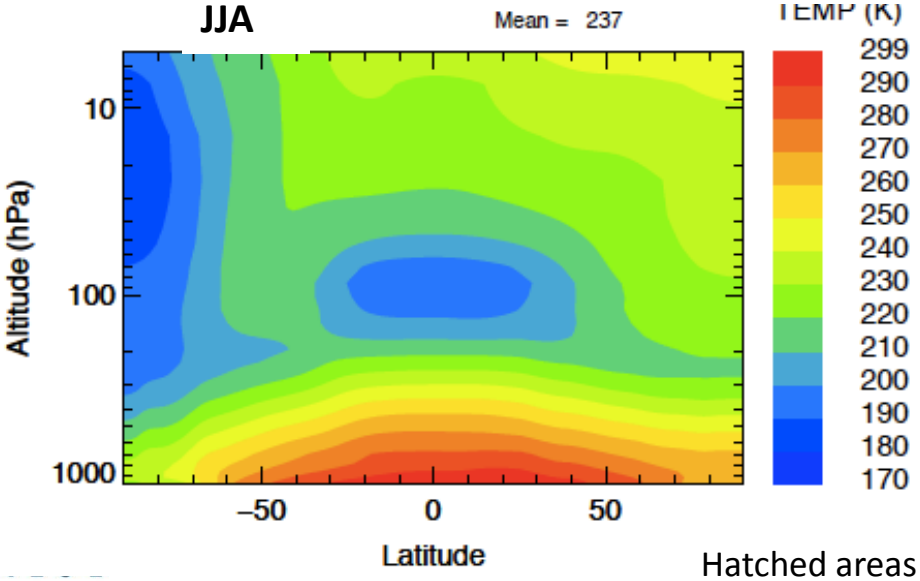
1850 4*CO_2 G1 – 1850 Baseline



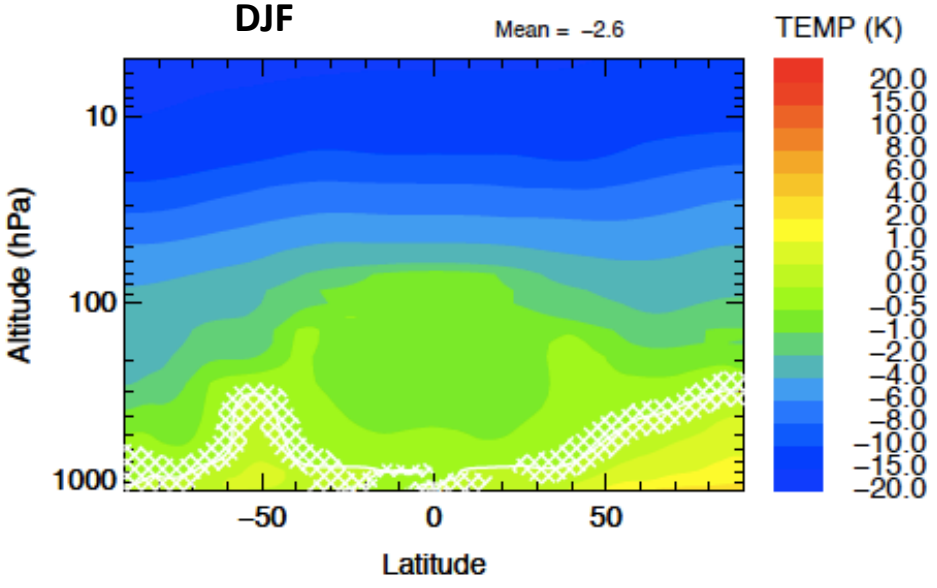
Hatched areas are not significant at 95% level based on Student's t test.

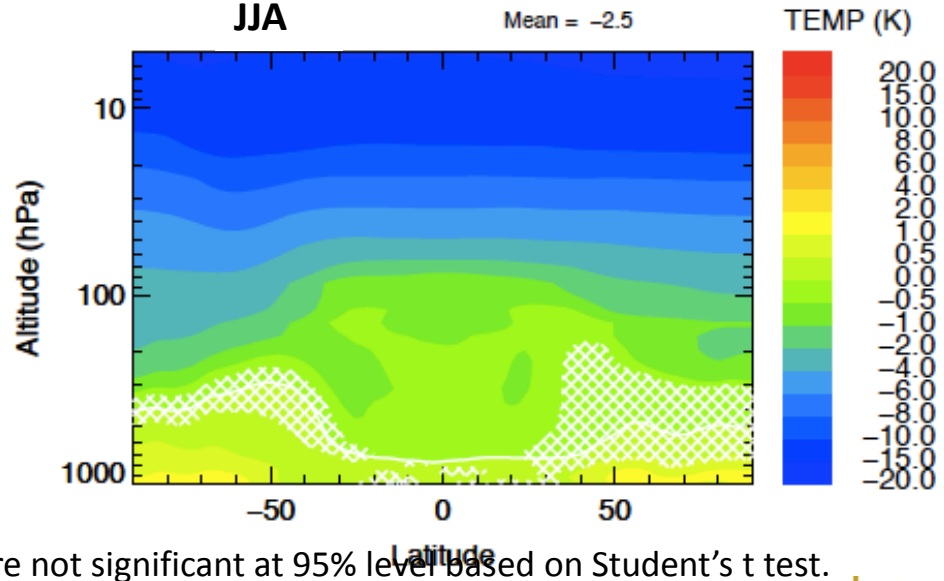
1850 Baseline





1850 4*CO_2, G1 – 1850 Baseline





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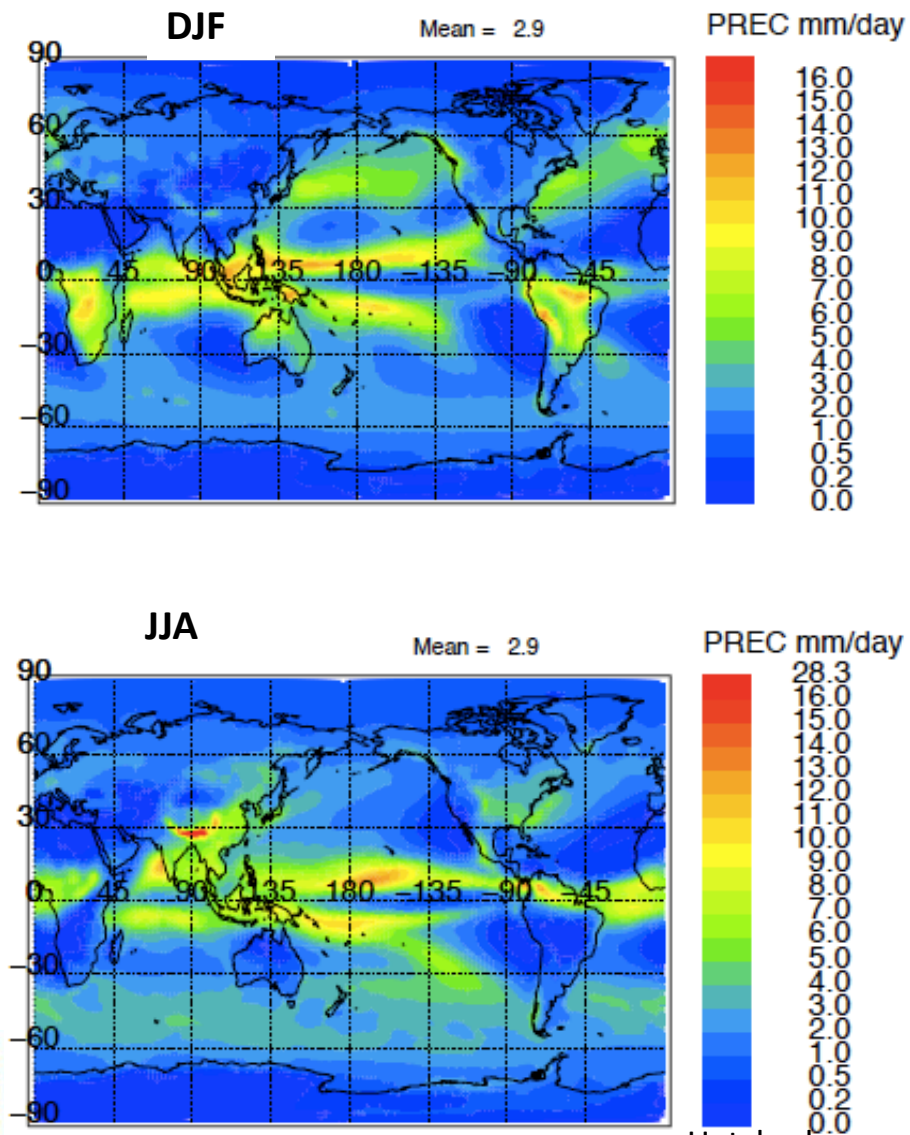
1850 Baseline



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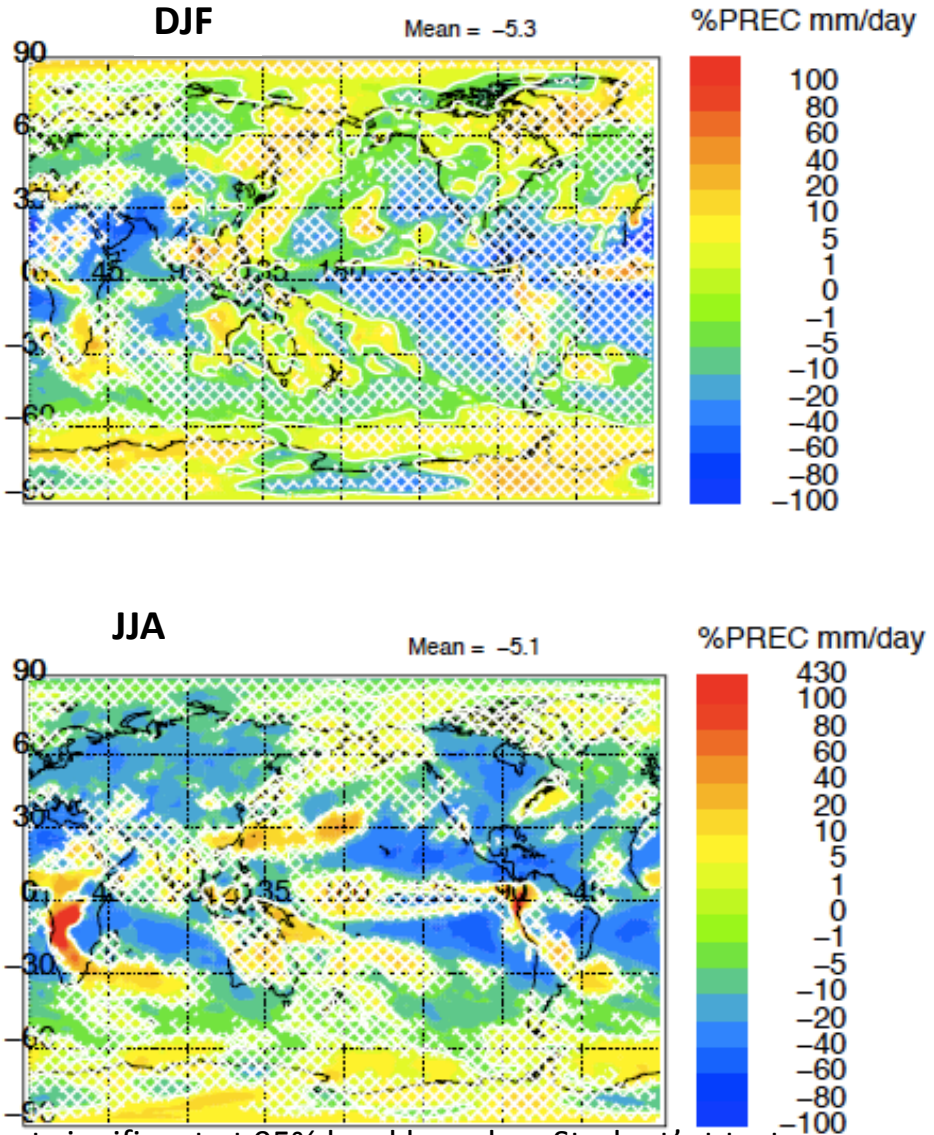

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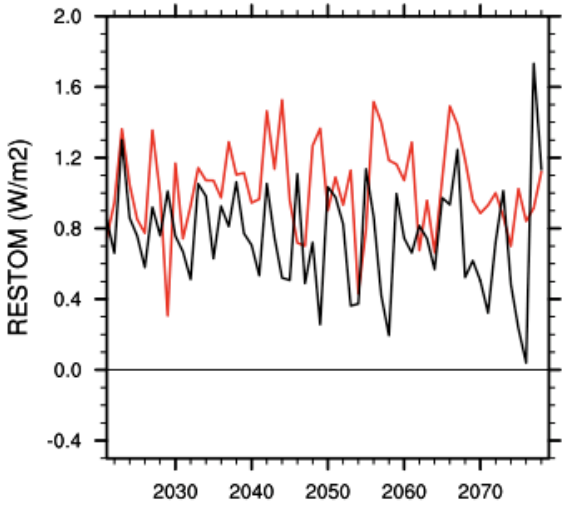
G3 Solar Experiment (1.9x2.5 deg)

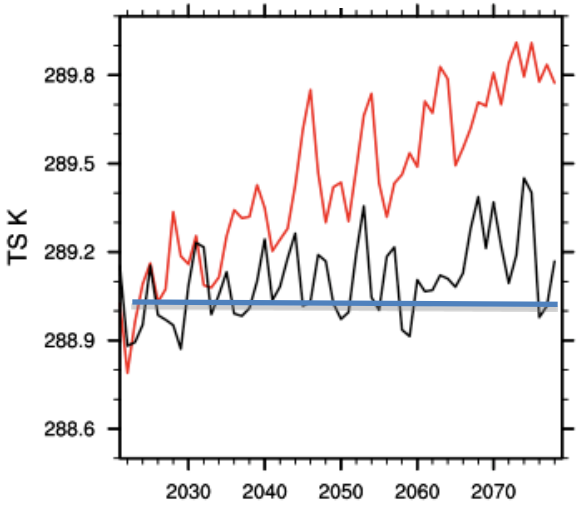
RCP4.5 2deg

RCP4.5 2dg + solar dimming

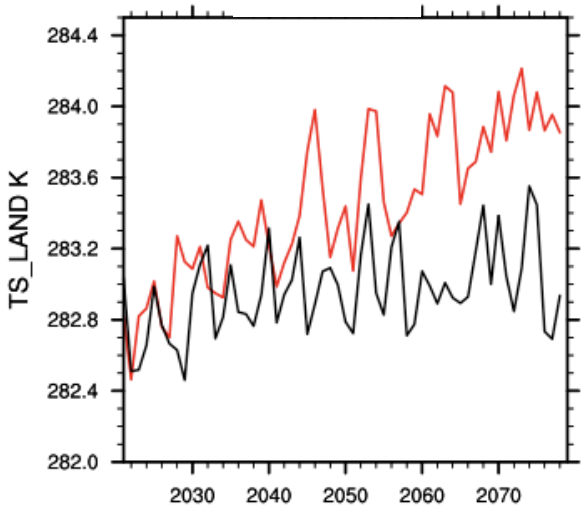
SW+LW



TS



TS Land



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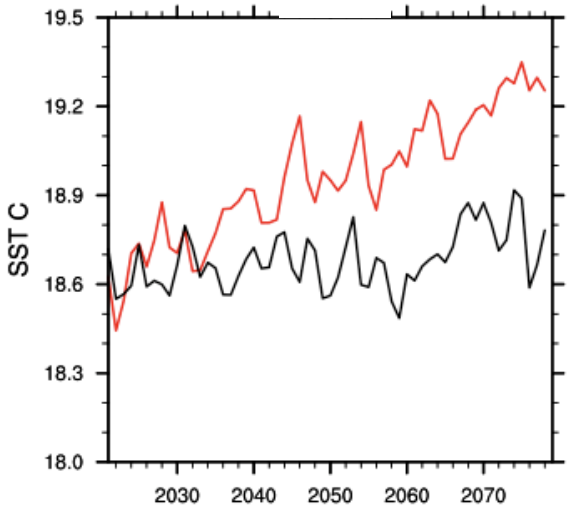
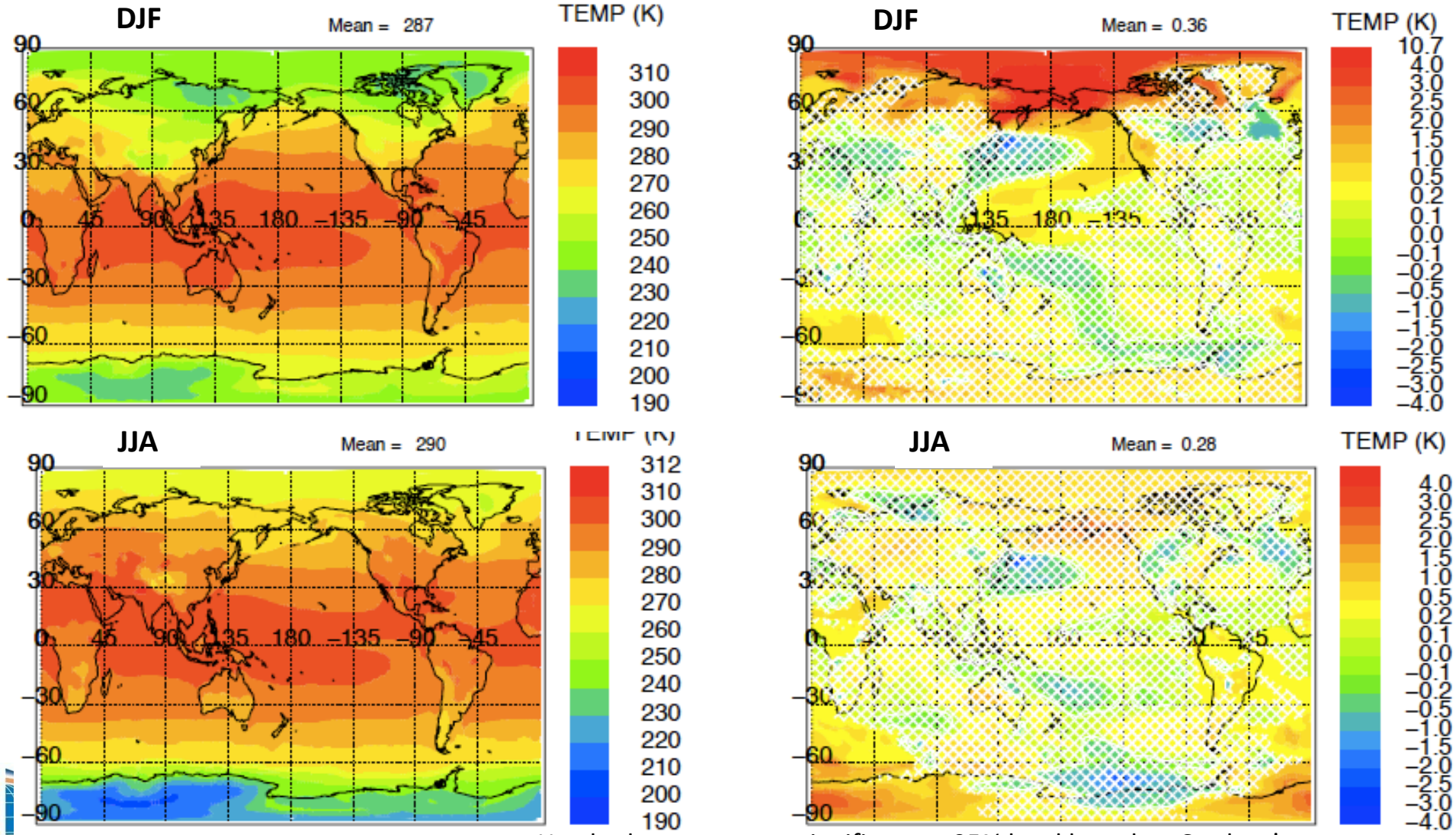


RCP 4.5 (2010-2024)

G3 Solar (2060-74) -RCP 4.5 (2010-24)



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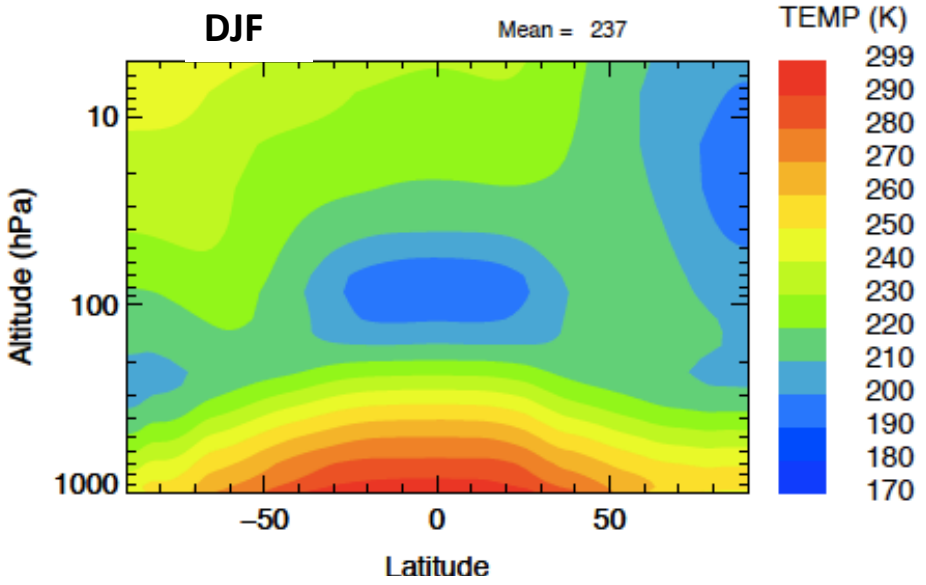
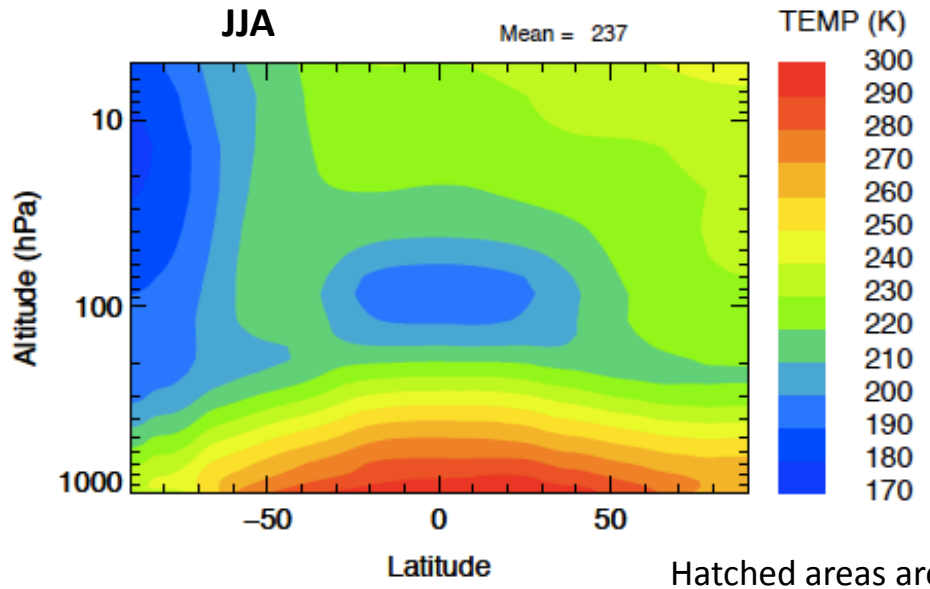
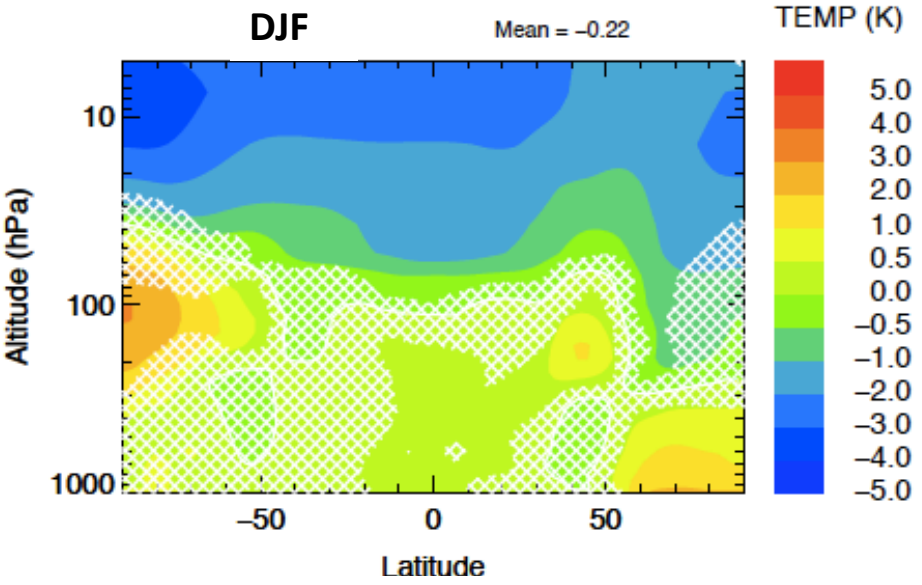
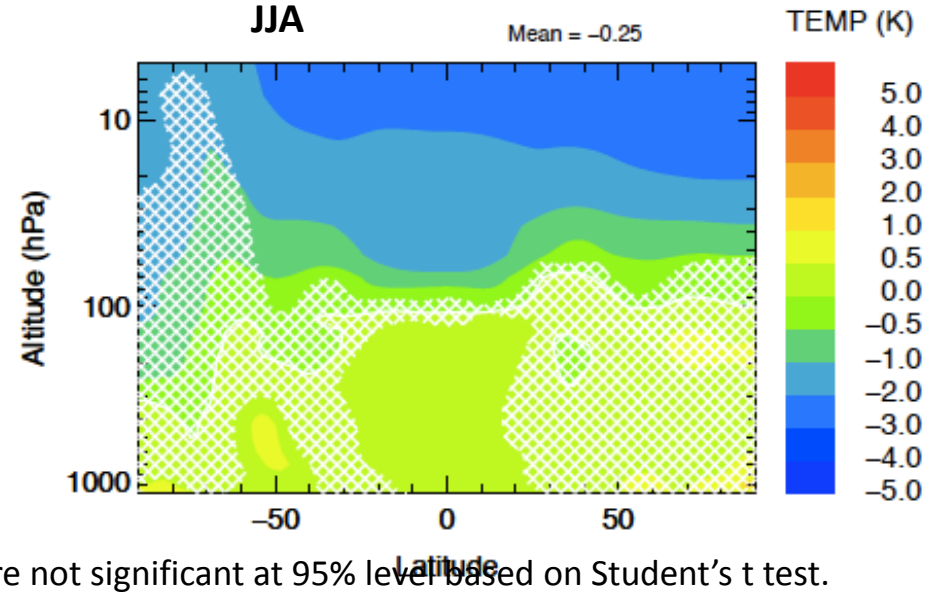
RCP 4.5 (2010-20-24)





G3 Solar (2060-74) -RCP 4.5 (2010-24)





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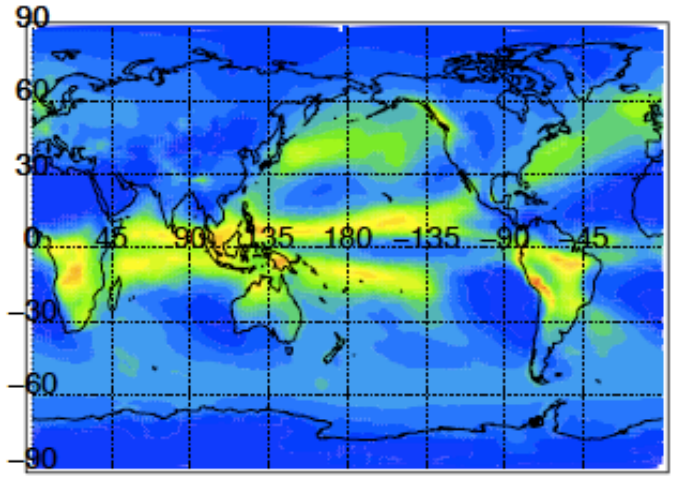
RCP 4.5 (2010-2024)

G3 Solar (2060-74) -RCP 4.5 (2010-24)

DJF

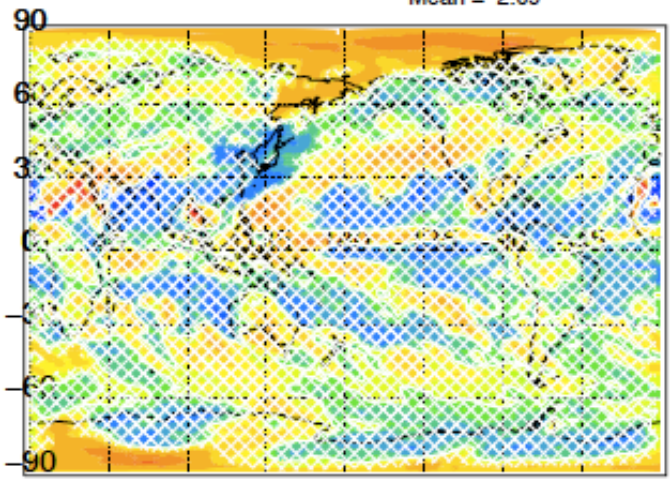


PREC mm/day

16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.5
0.2
0.0

DJF

Mean = 2.09



%PREC mm/day

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100
80
60
40
20
10
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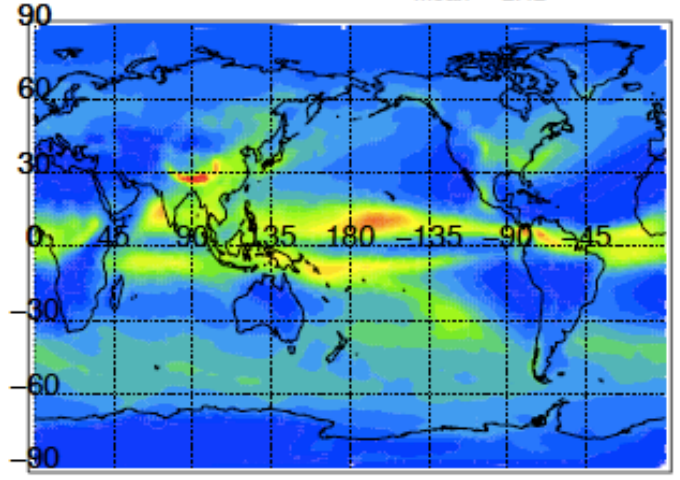
0
-1
-5
-10
-20
-40
-60
-80
-100

JJA

Mean = 2.42



PREC mm/day

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12.0
11.0
10.0
9.0
8.0
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2.0
1.0
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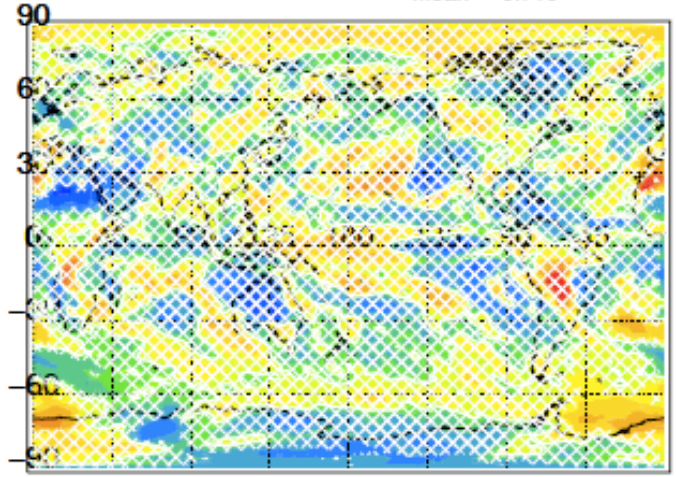
0.2
0.0

JJA

Mean =-0.710



%PREC mm/day

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60
40
20
10
5
1
0
-1
-5
-10
-20
-40
-60
-80
-100

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