PORT = PARALLEL OFFLINE RADIATIVE TRANSFER

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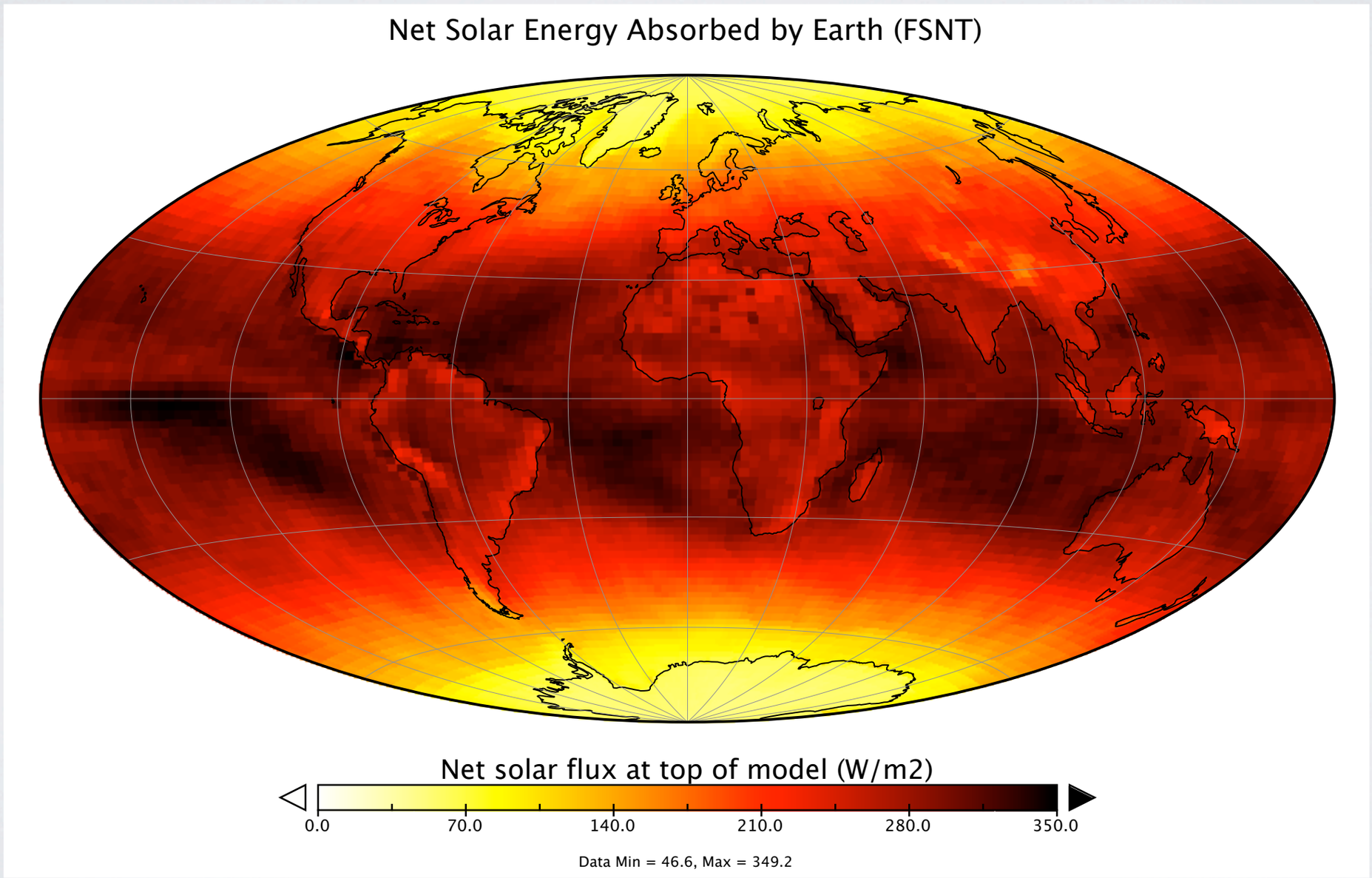
Mar 17, 2010

PORT: Vitt, Conley, Lamarque, Collins, Kiehl
CAMRT: ...
RRTMG: ...
CAM: ...

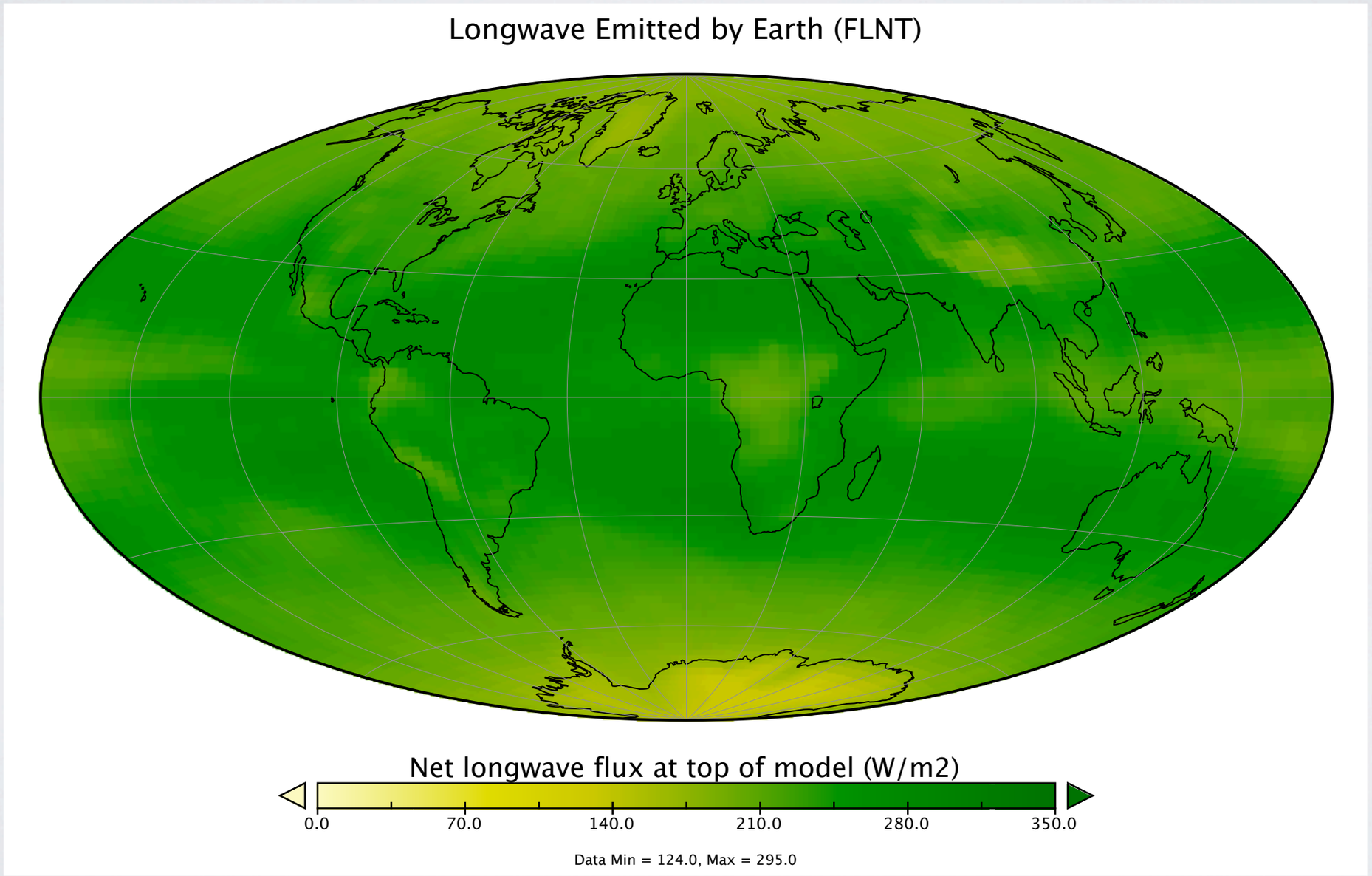
ENERGY BALANCE

- Solar Energy Warms Earth (SW)
- Earth Radiates Energy to Space (LW)
- SW-LW ~ slightly positive (=>T↗)

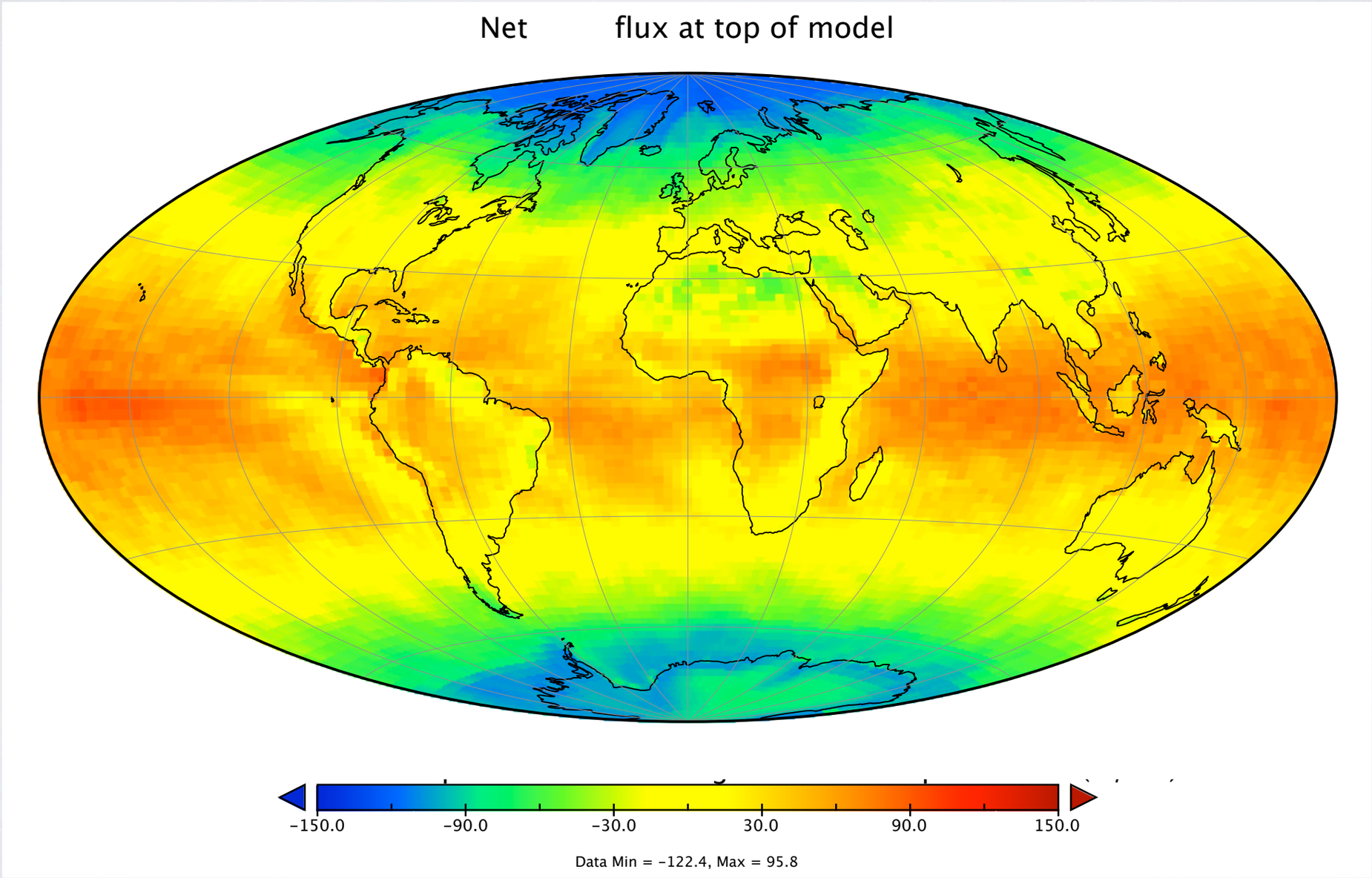
SOLAR HEATING (SW)



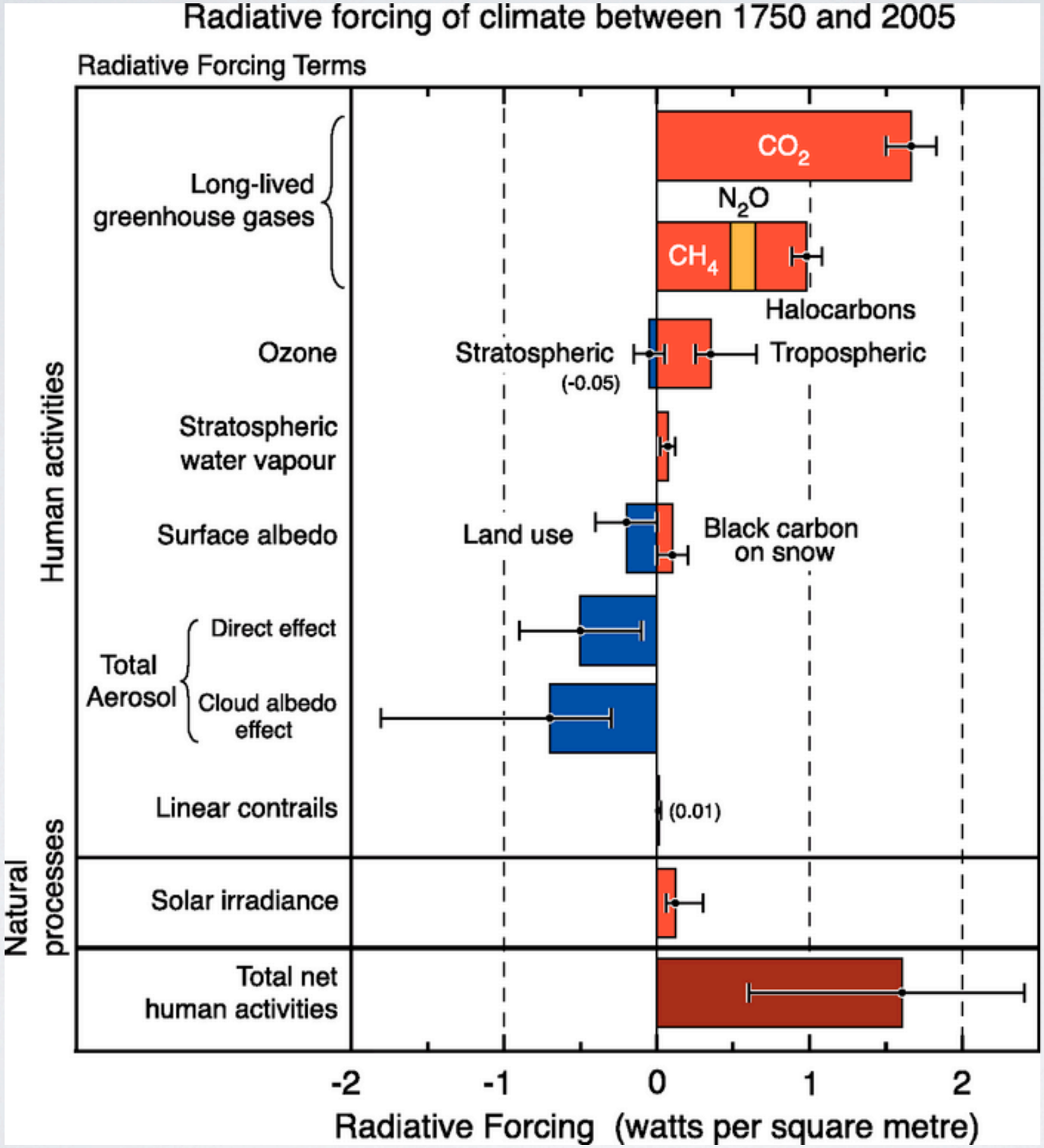
LW COOLING


Longwave Emitted by Earth (FLNT)
Net longwave flux at top of model (W/m2)
0.0
70.0
140.0
210.0
280.0
350.0
Data Min = 124.0, Max = 295.0

<SW-LW> ~ 0


Net flux at top of model
-150.0
-90.0
-30.0
30.0
90.0
150.0
Data Min = -122.4, Max = 95.8

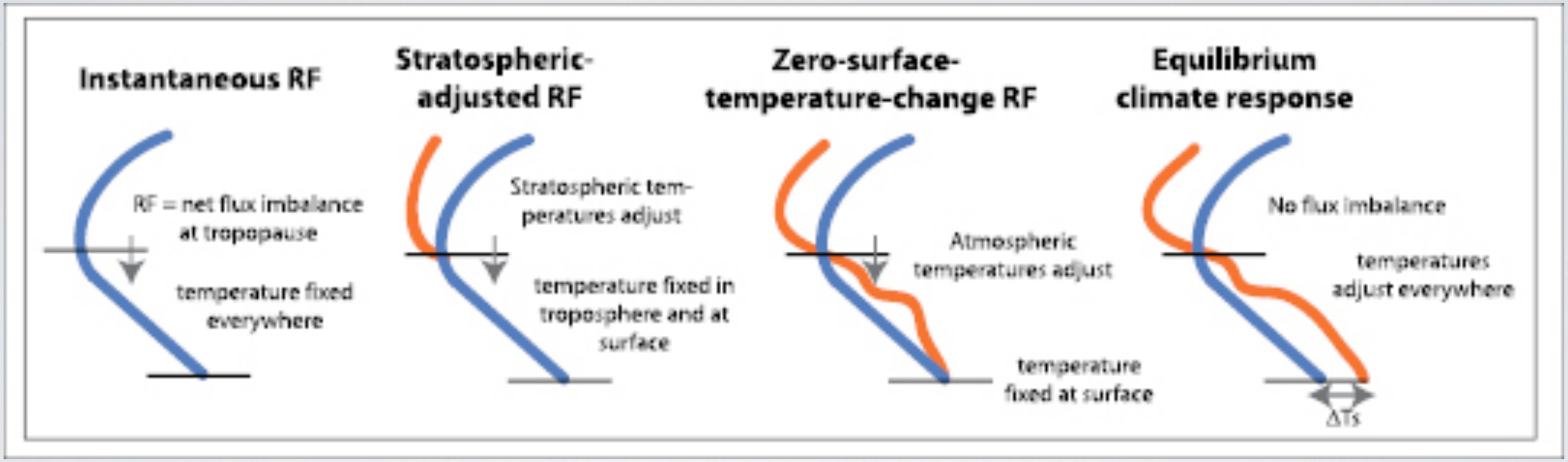
IPCC RADIATIVE FORCING



WHERE DOES ΔHEAT GO?

- Different layers of atmosphere
- Stratosphere: Δt ~ month
- Troposphere: Δt ~ decade

IPCC AR3/4


Instantaneous RF
RF = net flux imbalance at tropopause
temperature fixed everywhere
Stratospheric-adjusted RF
Stratospheric temperatures adjust
temperature fixed in troposphere and at surface
Zero-surface-temperature-change RF
Atmospheric temperatures adjust
temperature fixed at surface
Equilibrium climate response
No flux imbalance
temperatures adjust everywhere
ΔTs

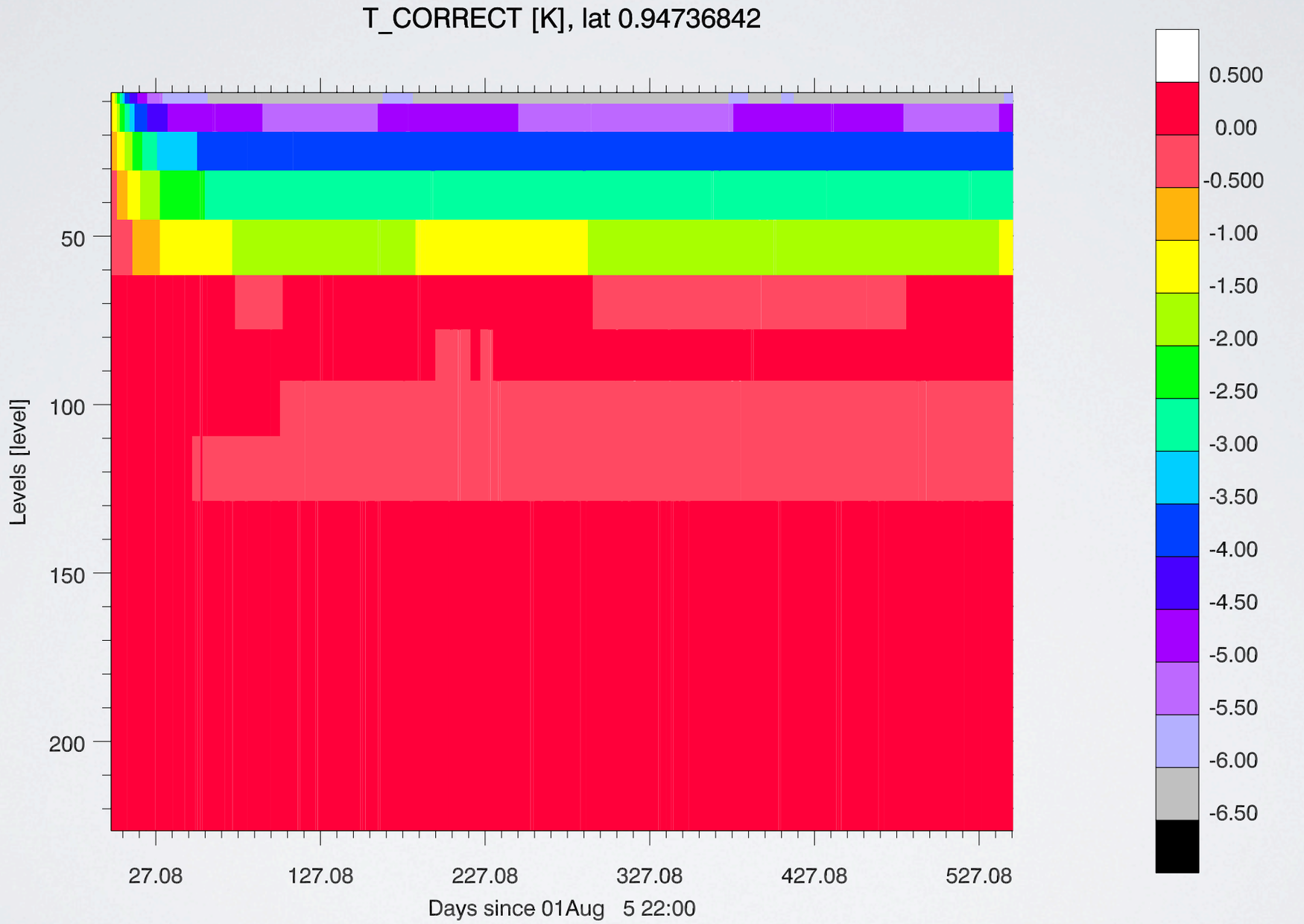
STRATOSPHERIC TEMPERATURE ADJUSTMENT

- Stratosphere Heat Terms:
  - SW Heating (+)
  - LW Cooling (-)
  - DH Dynamical Heating
- SW + LW(T) = DH
  - DH = const => T adjusts

STRAT TEMP ADJUSTMENT

- Fixed dynamical heating
  - qrs+qrl = dh (fixed)
    - T(t)
- Sample model state and composition
- Run PORT with doubled co2
- dT/dt = [qrs+qrl(T)](2xco2) - [qrs+qrl](1xco2)

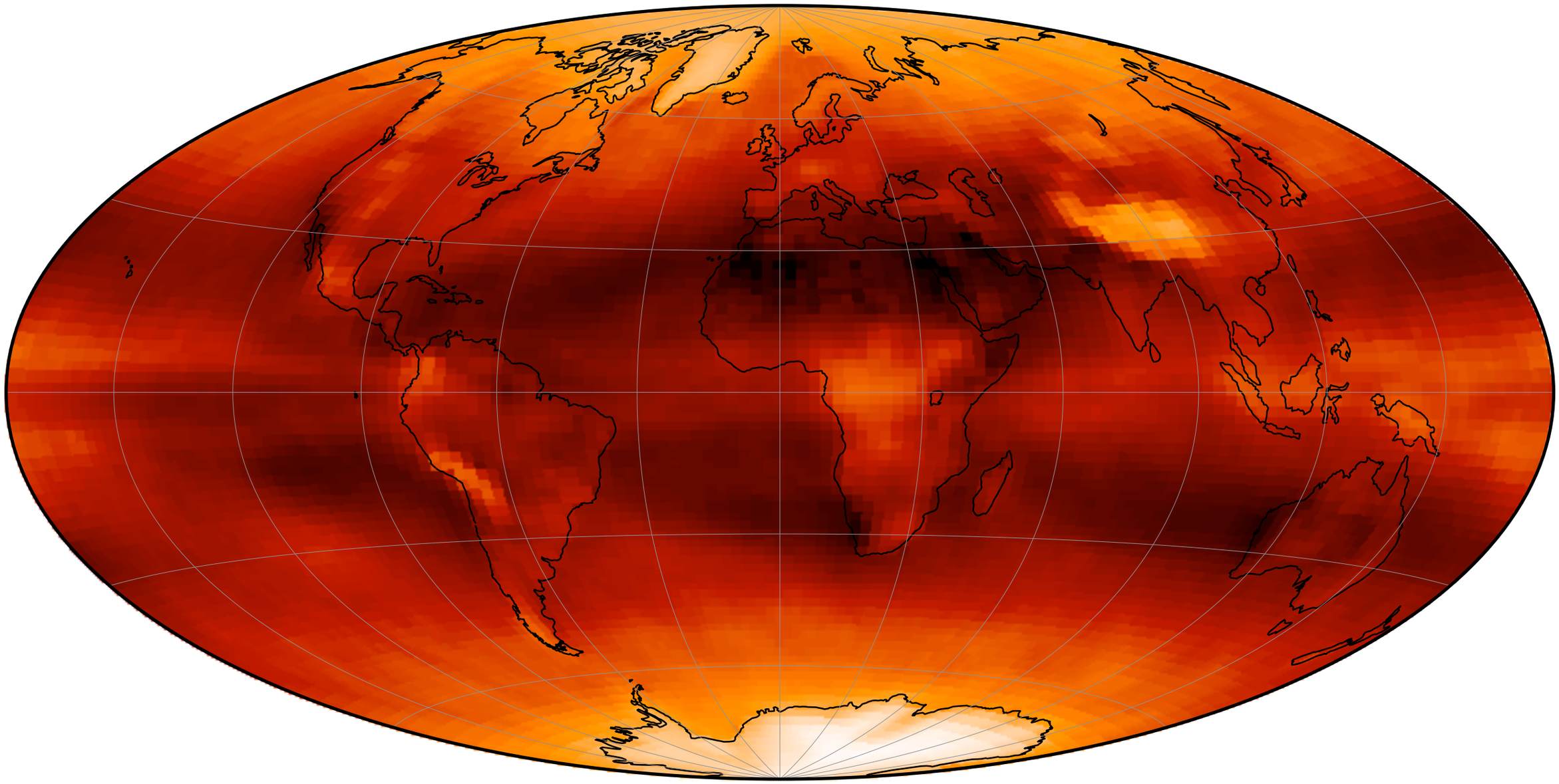
STRAT TEMP ADJUSTMENT



IPCC FORCING (CO2 + CFC, WACCM)

- Stratosphere Adjusts Temp
- Change in Flux at Tropopause
  - WMO definition: Bardeen

Net longwave forcing at tropopause

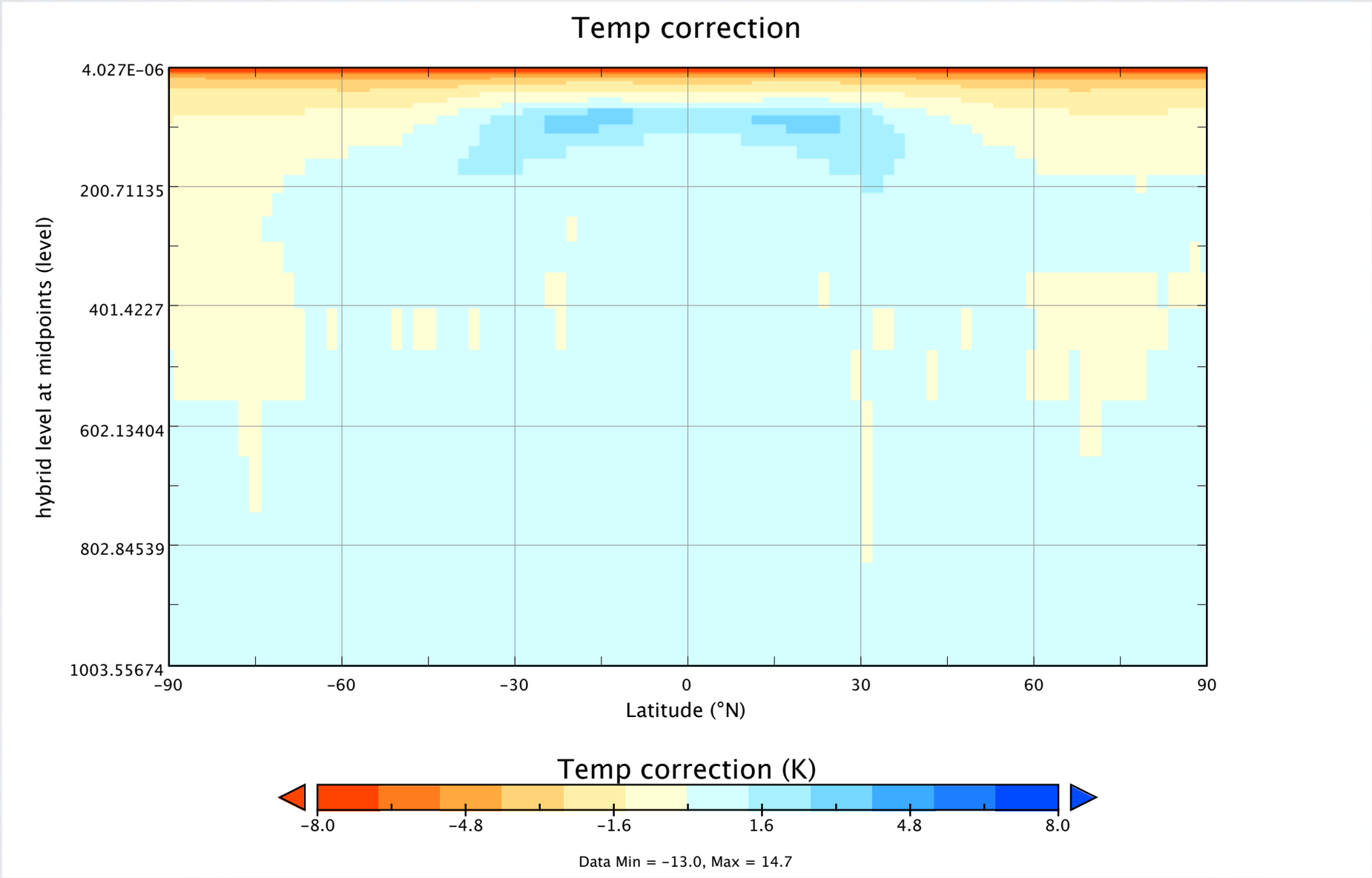


Net longwave flux at tropopause - Net longwave flux at tropopause (W/m2)

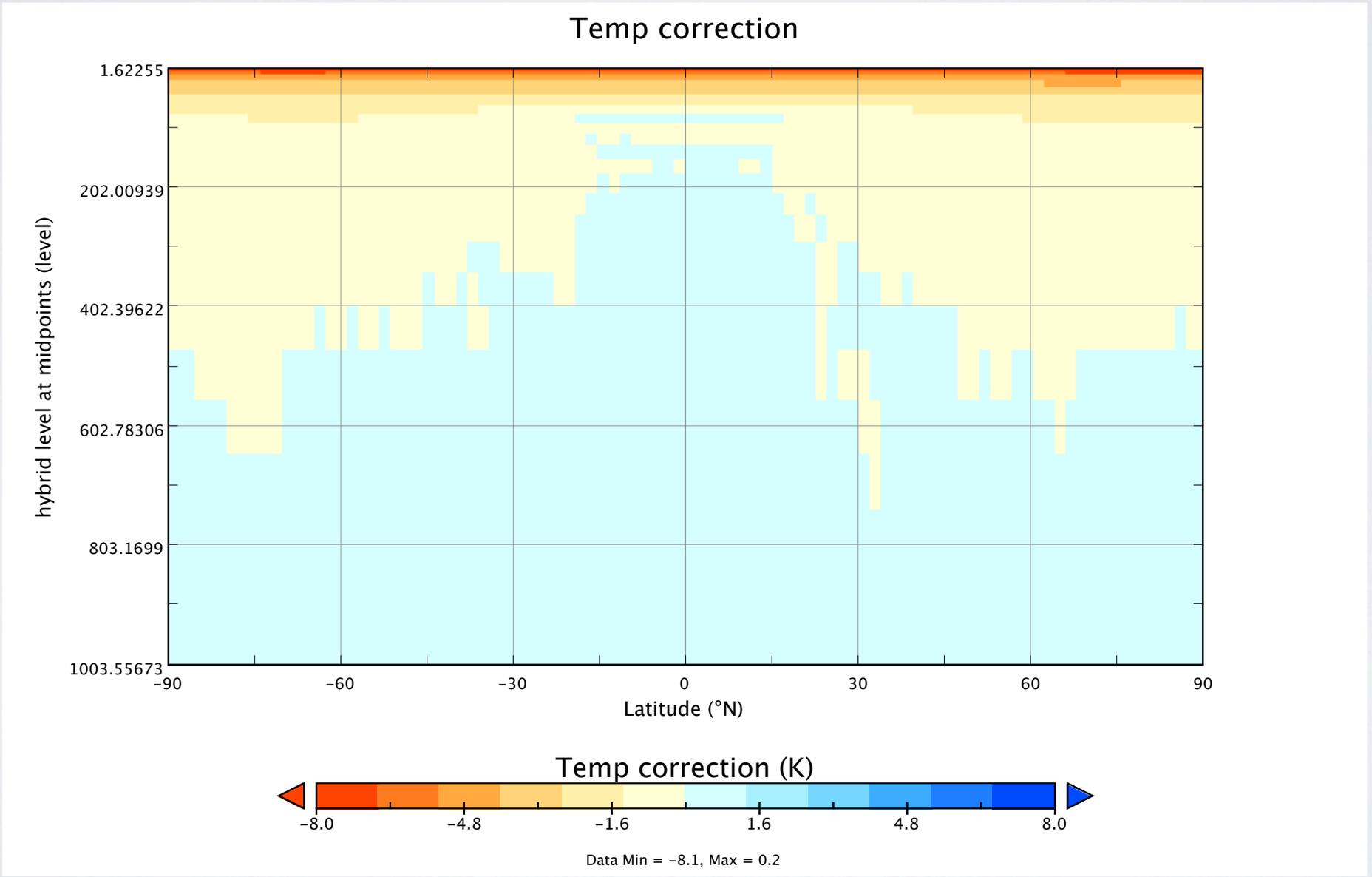
1.4 3.9 6.3 8.8 11.2 13.6

Data Min = 1.4, Max = 13.6

ΔT (CO2,CFC), WAVD



ΔT, 2XCO2, CAM

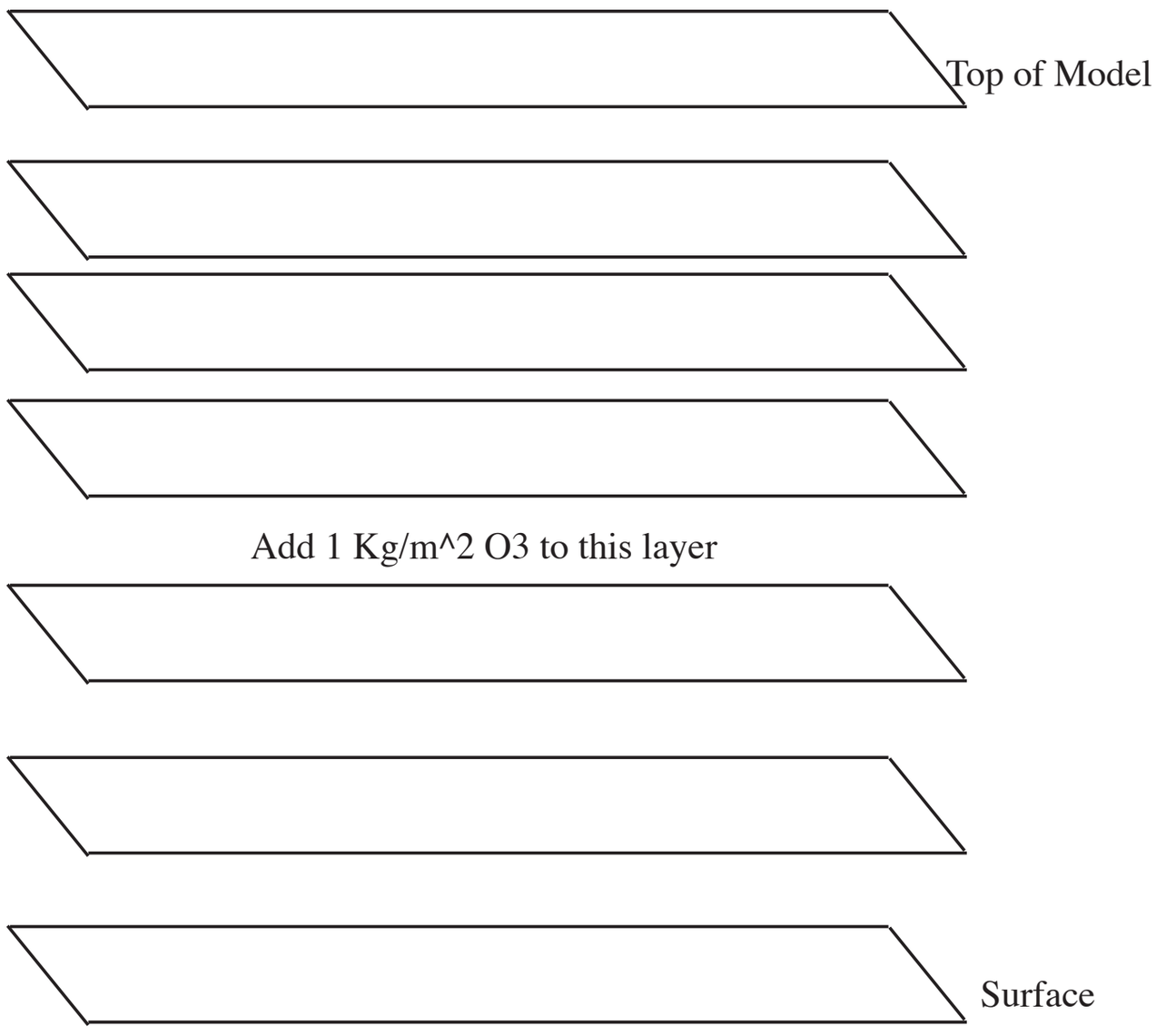

Temp correction
1.62255
202.00939
402.39622
602.78306
803.1699
1003.55673
hybrid level at midpoints (level)
−90
−60
−30
0
30
60
90
Latitude (°N)
Temp correction (K)
−8.0
−4.8
−1.6
1.6
4.8
8.0
Data Min = −8.1, Max = 0.2

PORT = PARALLEL OFFLINE RADIATIVE TRANSFER

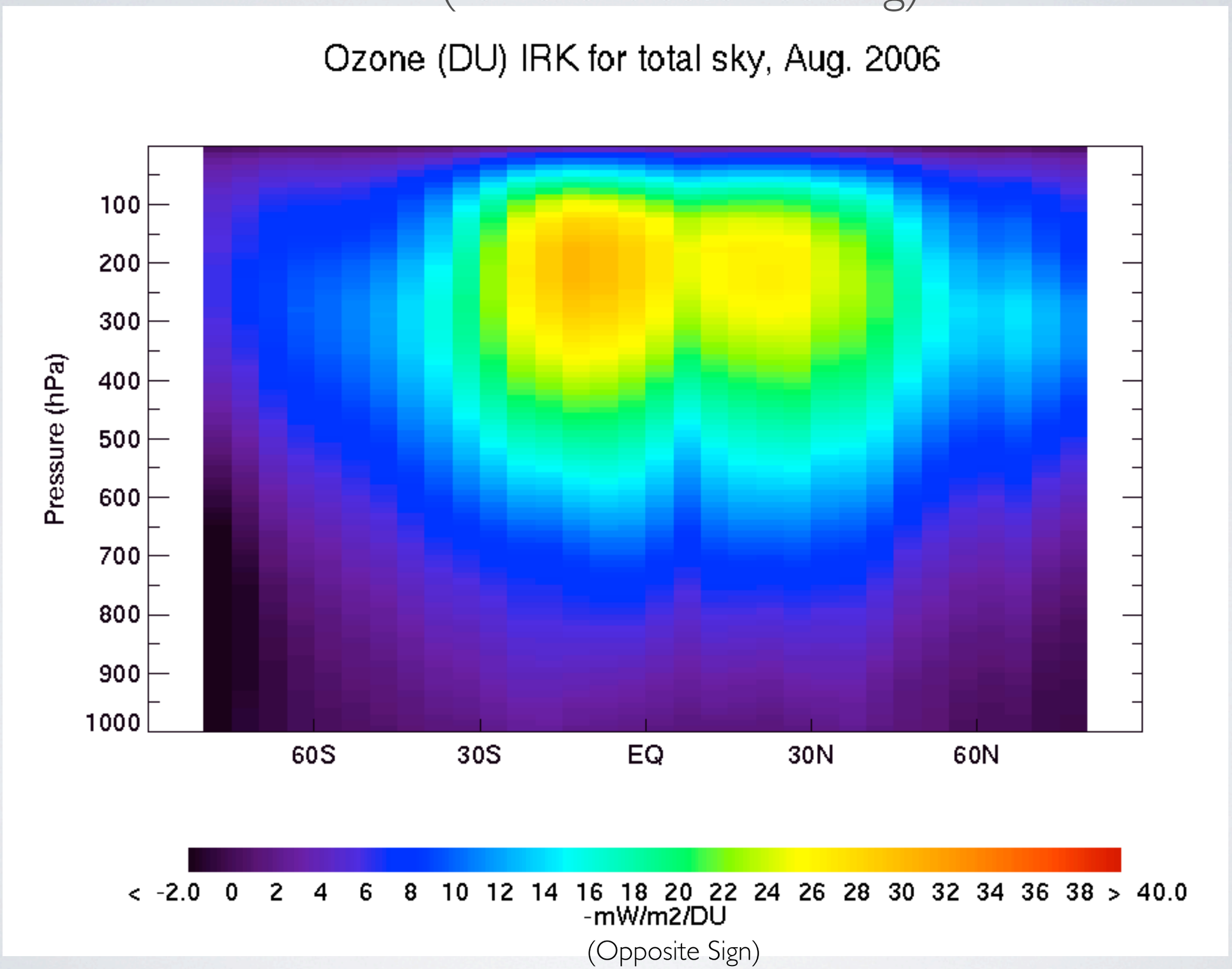
- Uses:
- IPCC (or not) Forcing from gases
- Forcing from aerosols, clouds
- Kernels
- Compare with Observations
- Compare RT methods, optics

RADIATIVE KERNELS
TOP, SURFACE, TROPOPAUSE (WMO)

How much does net (upward) flux W/m^2 change?

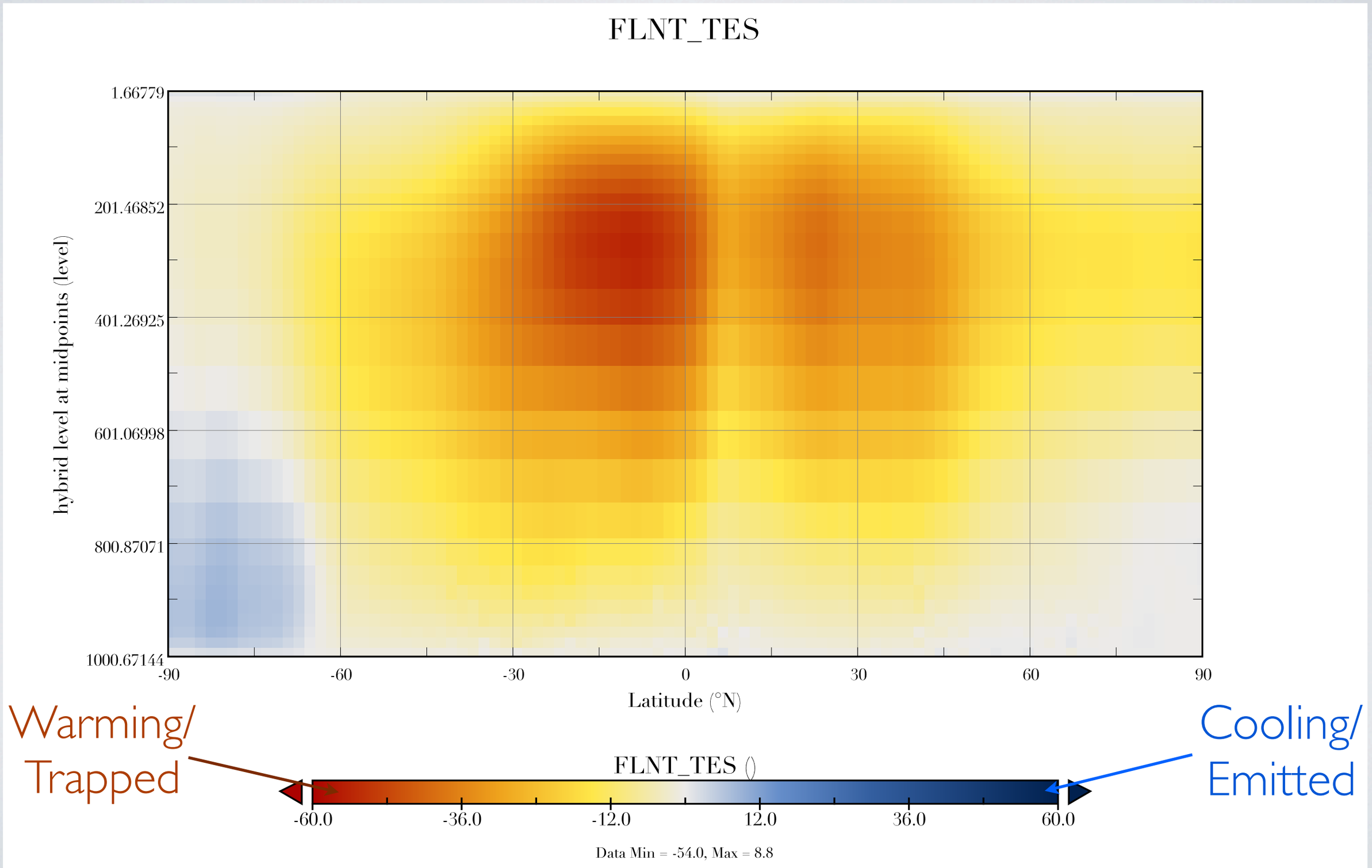


TES Kernel From Helen Worden
(different color coding)

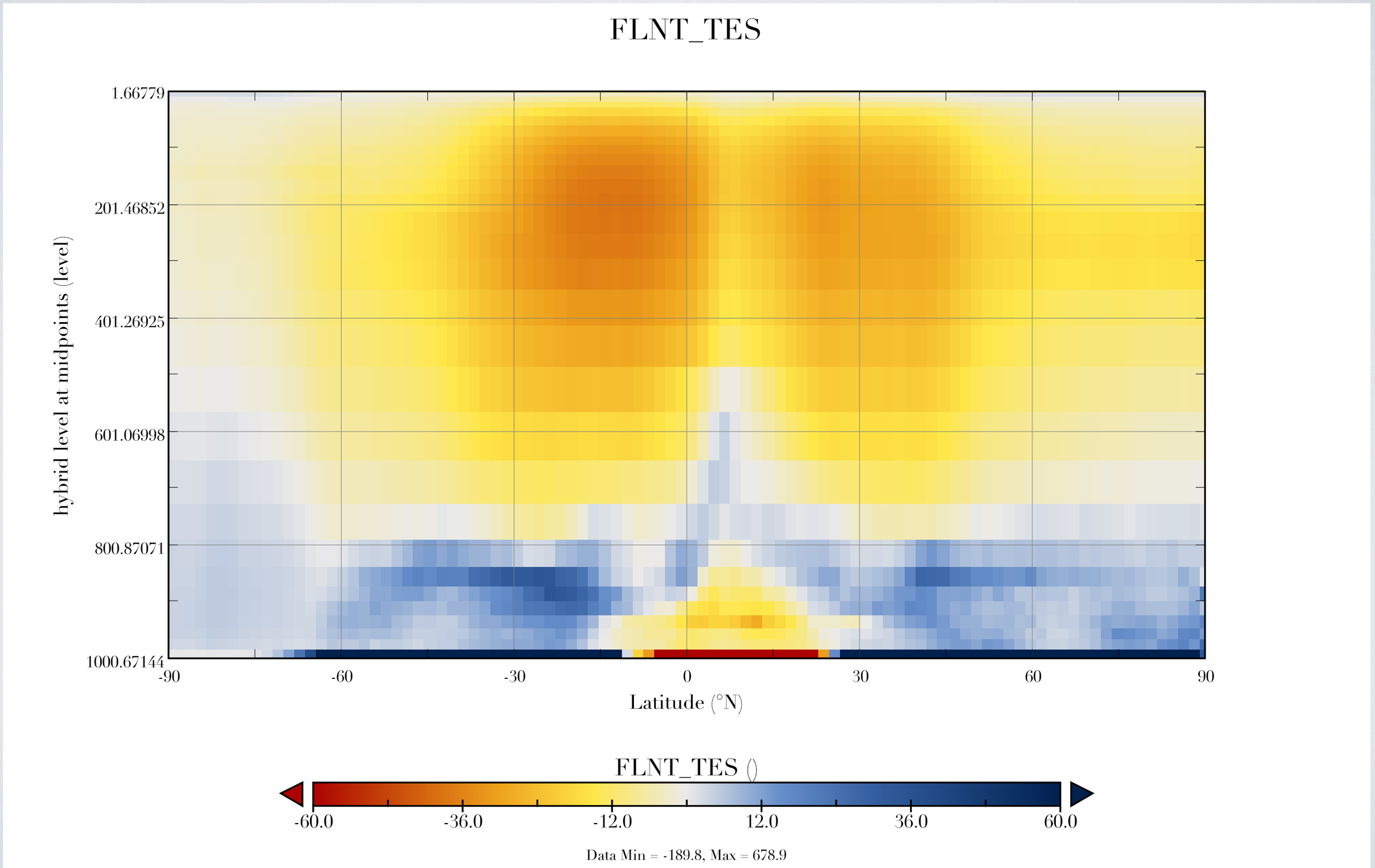


(Opposite Sign)

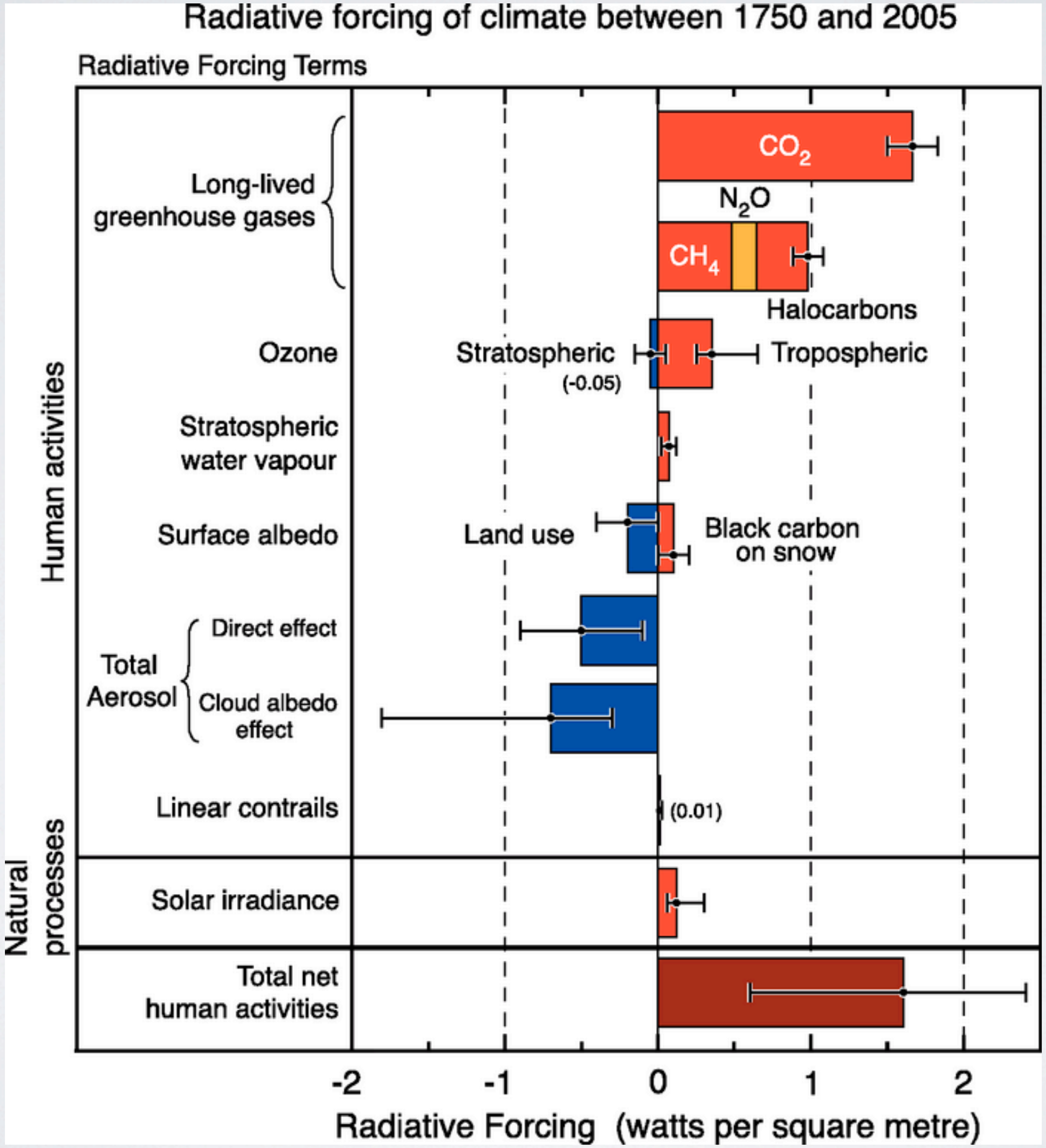
KERNEL FROM CAMRT



KERNEL FROM RRTMG



IPCC RADIATIVE FORCING



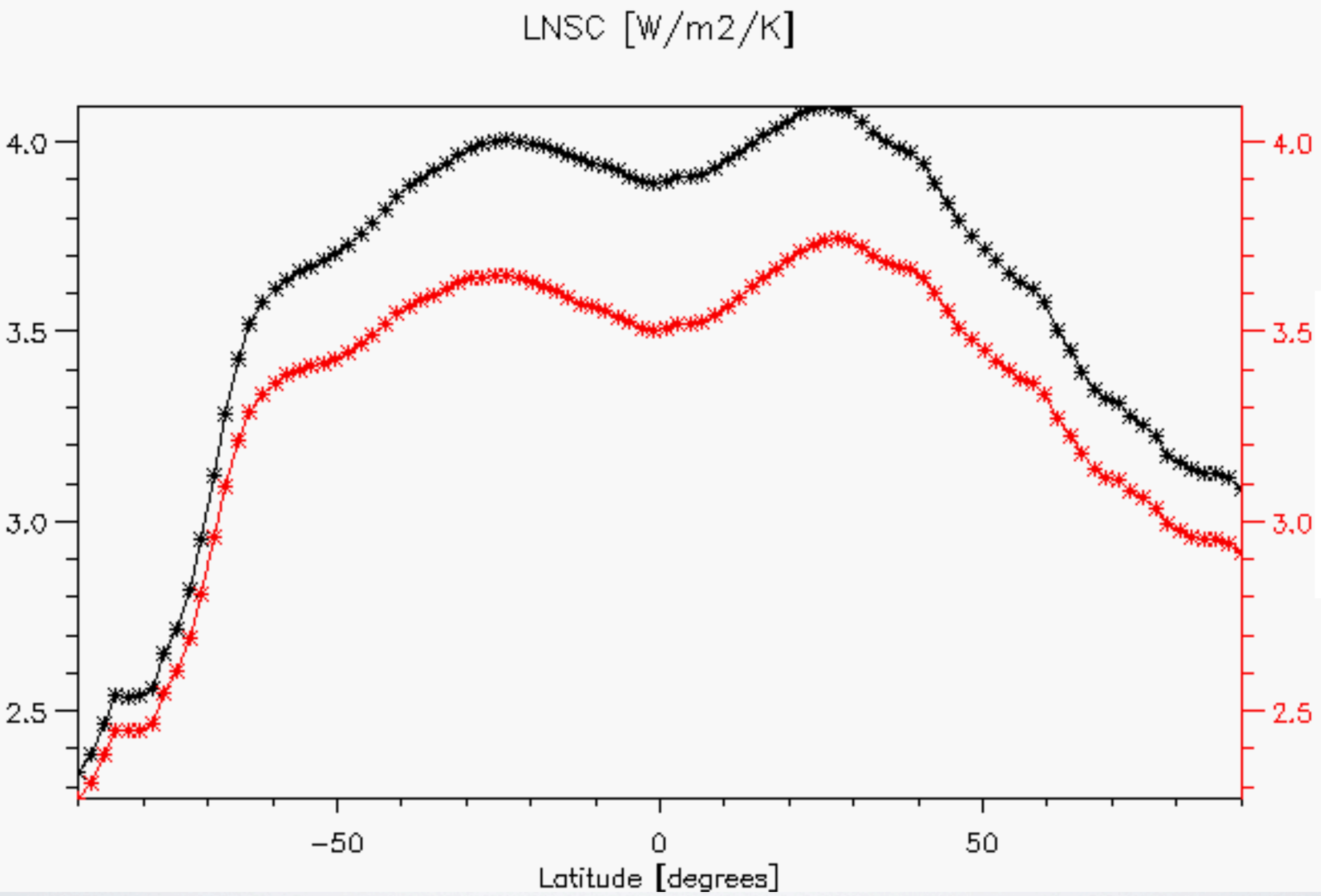
PORT

- Offline Radiative Transfer
- Forcing
- Kernels
- Comparison with Observations

TS SURF LW

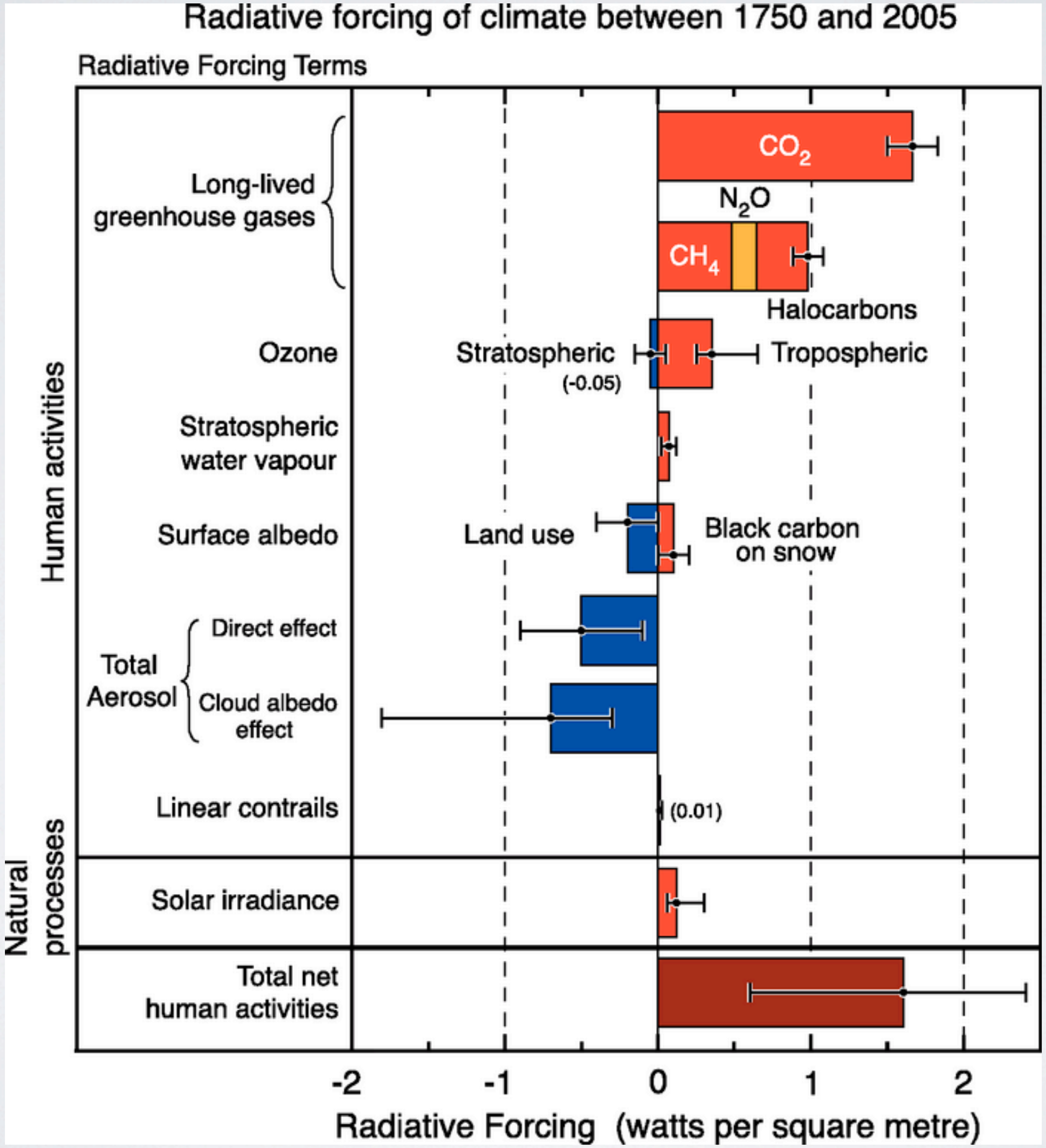
Surf Emissivity = 1.0

RRTMG



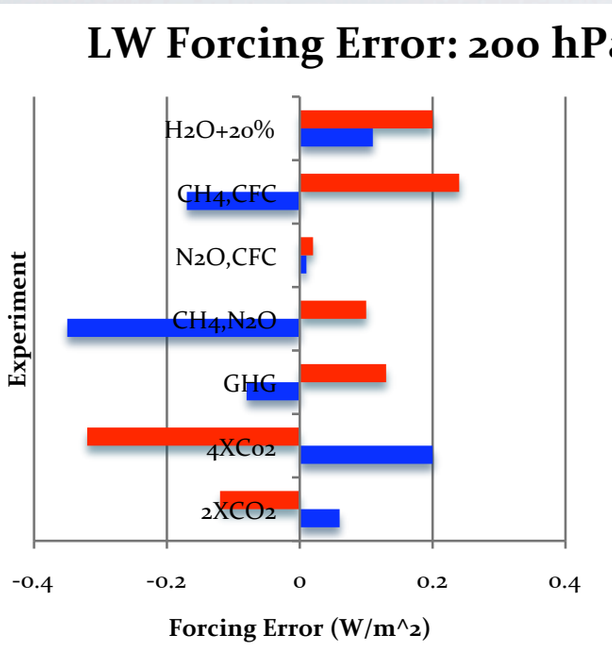
CAMRT

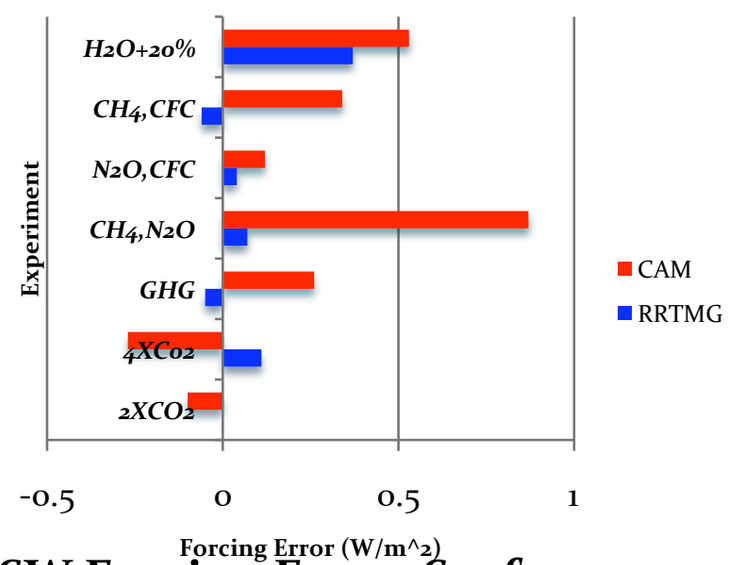
IPCC RADIATIVE FORCING



CLIMATE FORCING ACCURACY (RTMIP)

COLLINS, ET AL 2006, IACONO, ET AL 2008



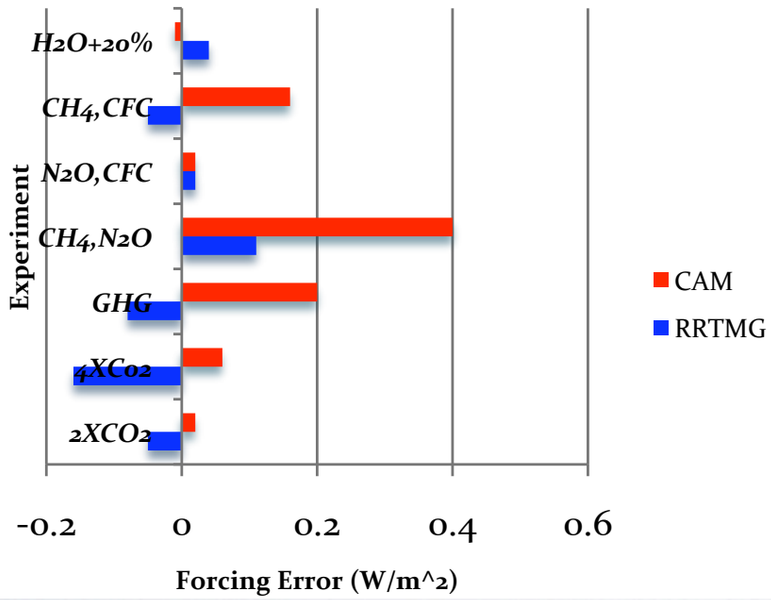


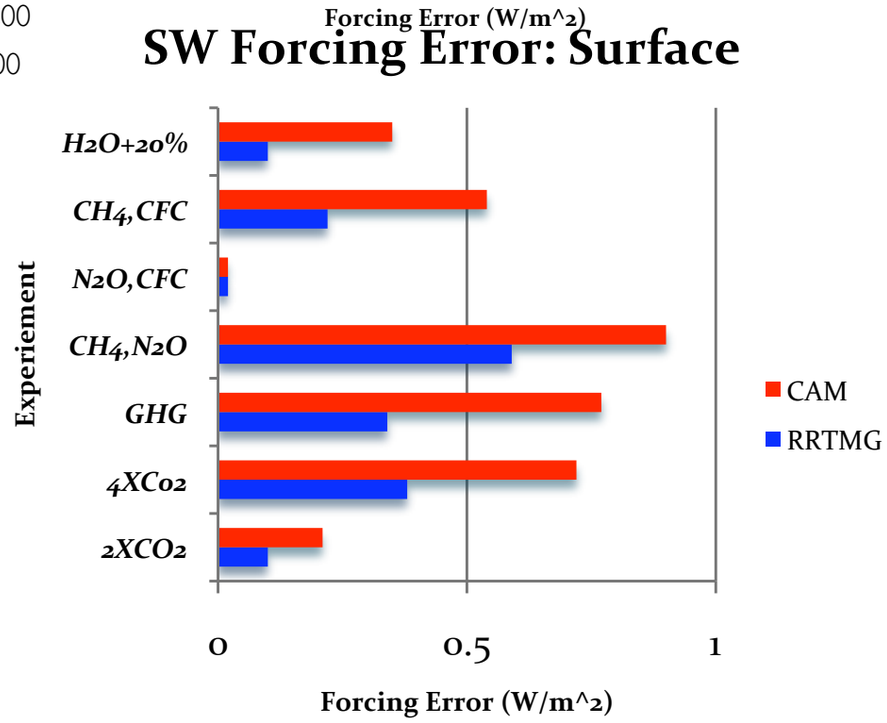
GHG: 1860->2000

CH4,N2O: 0ppm -> 2000

N2O, CFC: 1860 -> 2000

CH4,CFC: 1860 -> 2000





Sensitivity?

KERNELS (FORCING SENSITIVITY)

- Forcing = dF/dq * (dq_anthro)
- Might be able to estimate dq_anthro
- Kernel dependencies:
  - Thermodynamic State
  - Composition
  - Radiative Transfer method
- K=<dF/dq> time samples, lon