How sensitive is the climate to external radiative forcing?


GEOL 437 Global Climate Change
5/1/18: Climate Sensitivity

*Key concepts*

- Climate sensitivity
- Equilibrium climate response
- Transient climate response
Climate Sensitivity

- Analytical expression: climatic response per unit forcing

Climate Sensitivity

- Analytical expression: climatic response per unit forcing
- Can it be observed from observations and simulations?
  - Quantitative, physically (model) linking radiative forcing to climatic response
  - Observational estimates of the forcing and the response
Radiative forcing of the climate system (3/27/18)

- Instantaneous change in the radiative balance at the top of the troposphere, and originating from *outside* the climate system, relative to that estimated for the global and annual average for 1750. An instantaneous RF does not account for temperature change in the stratosphere.

![Instantaneous RF](image)

\[ RF = \text{net flux imbalance at tropopause} \]

- temperature fixed everywhere

ERF and equilibrium climate response (3/27/18)

- Instantaneous change in the radiative balance at the top of the troposphere, and originating from outside the climate system, relative to that estimated for the global and annual average for 1750. An instantaneous RF does not account for temperature change in the stratosphere.

ECS: equilibrium change in annual mean global surface temperature following a doubling of the atmospheric CO₂ concentration.

ERF and transient climate response

- Instantaneous change in the radiative balance at the top of the troposphere, and originating from *outside* the climate system, relative to that estimated for the global and annual average for 1750. An instantaneous RF does not account for temperature change in the stratosphere.

TCR: mean global surface temperature change at the time of CO2 doubling following a linear increase in CO2 forcing over a period of 70 years.

Observed and simulated patterns of surface temperature change (3/27/18): ECR or TCR?

Bindoff, Stott et al (2013), FAQ 10.1, Fig 1
Equilibrium and transient climate response

Collins et al (2013) Fig 12.43, 12.44
Equilibrium and transient climate response

Collins et al (2013) Fig 12.43, 12.44
Equilibrium climate sensitivity estimates take into account slow processes, but for non-equilibrium conditions, transient climate response may be a better near-term indicator of climate change.

Next:
- Thurs: Discussion of Paleosens (2012) Figs 1,4
Observed patterns of surface temperature change

1901-1950                     1951-2010

Bindoff, Stott et al (2013), Fig 10.2
Simulated patterns of surface temperature change
All forcings
1901-1950                     1951-2010

Bindoff, Stott et al (2013), Fig 10.2
Simulated patterns of surface temperature change

Natural forcings

1901-1950  1951-2010

Bindoff, Stott et al (2013), Fig 10.2