New Approaches – Constraining Climate sensitivity (ECS, TCR, TCRE)
Equilibirum Sensitivity (ECS/TCR)

- Interpreting the 20th century record
  - Non-constancy of feedbacks and drivers
  - Model-data discrepancies in the ocean
    - Warmpool width, ENSO air temperature
    - Southern Ocean Heat uptake
    - Possible links between \( \wedge \) and cloud responses

- Quantification of feedbacks and forcings
  - Radiative forcing quantification
  - Middle and high cloud mechanisms
BGC impact on TCRE

Definition: global mean surface temperature change per 1000 PgC emitted CO$_2$

$$\text{TCRE} = \Delta T / E = \alpha / (1 + \beta + \alpha \times \gamma)$$

- $\alpha = \Delta T / \Delta \text{CO}_2$
- $\beta = \Delta C / \Delta \text{CO}_2$
- $\gamma = \Delta C / \Delta T$

Understanding limits of TCRE

- 50-50 physical (TCR) and BGC on model spread
- Beta more influential $\rightarrow$ more focus

Matthews et al., 2009, Nature, Fig. 3
Long-term perspective

- Cirrus clouds
- Use of Paleoclimate archives
- Model representations of aerosol-cloud interactions
- Improve models using Emergent Constraint studies