Ice Sheet Dynamics and Sea Level Change

The Antarctic Ice Sheet
Outline:

- Data: Collection & Application

- Studies:
  - Can We Use Models of the Past?
    Clark and Huyber (2009)
  - Current Mass Balance
    Chen, et al. (2009)
  - Looking Forward
    Bamber, et al. (2009)

- Summary & Conclusions
Data
Sea Level Reconstructions

- Stratigraphic Record
  - Fossils
  - Coral Record
  - Sediment Facies

http://www.shelleffects.com/images/manicina-areolata.jpg

geology.isu.edu/
Surface Height & Topography

- Surface Height
  - Satellites

- Sub Glacial Topography
  - Seismic Sounding
  - Radar
Gravity Anomaly

- Deviation from gravity of an ideal spheroid
- **Gravity Recovery and Climate Experiment** (GRACE)
  - NASA and German Aerospace Center Mission (2002–2013)

http://www.csr.utexas.edu/grace/
Are Past Reconstructions a Viable Option?
Is the Past an Accurate Benchmark?

- Clark and Huyber (2009)
- Looking to the last interglacial (125 kyr ago) to predict future sea level change.

- Methods:
  Proxy Data Temperature Reconstruction

- Results:
  6.6 m peak (95%)
  ~ 2.5 m Antarctica
  ~ 2.5 m Greenland
  (Kopp et al., 2009)

![Graph showing estimated and projected surface temperatures](image-url)
Current Antarctic Ice Sheet (AIS) Mass Balance

- Chen, et al. (2009)

- Methods: GRACE
  Surface Altitude
  (Isostatic rebound filter)

- Results:

  $-190 \pm 77 \text{ Gt/yr}$
  (AIS average)

  $360 \text{ Gt} \approx 1 \text{ mm}$
  $0.53 \text{ mm/yr}$

Data Series: 2002–2008
Future Prediction: Closing the Gap
Antarctic Ice Sheet Instability

- Bamber, et al. (2009)
  Runaway Instability
  - Bedrock below sea level
  - Negative bed slopes

- Methods: GRACE
  - Surface Altitude
  - Topography

- Results: 3.3 m SLR
West Antarctic Ice Sheet Collapse

- **Effect:** Uneven global distribution
  - Isostatic adjustment
  - Gravitational changes
  - Rotational changes
  - Ocean–continent geometry
- Milne, et al. (2009)
Summary:

- Past sea level reconstructions may be analogous to future sea level change.
- The Mass Balance of the Antarctic Ice Sheet is currently negative.
- At an unknown threshold a runaway instability scenario is possible for the West Antarctic Ice Sheet.
- Sea level rise would be unevenly distributed globally.
- All predictions have a wide range of error.
Conclusions:

- West Antarctic Ice Sheet is unstable

Uncertainties:
- Acceleration/Threshold
- Ice Sheet Dynamics
  - Longer-term data collection needed
References:


