Geophysical Fluid Dynamics Laboratory Review

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Sea Level and Its Components

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Sea Level Perspectives

- **Stakeholders & Impacts**: greatest interest in total sea level change at a point; local perspective
  (e.g., NOAA Office of Ocean & Coastal Resource Management – OCRM)

- **Modeling & Understanding**: interest in contributions of individual terms & mechanisms; focusing first on the large-scale effects

- **Observations**: (satellites, tide gauges, ARGO, XBTs, etc.)
  Questions of uncertainty ranges, time scales, forced vs. natural variability
Components of Sea Level Change

\[ \text{Total Sea Level Change} = \text{Steric} + \text{Change in Mass} + \text{Land Movements} \]

- **Steric**: we model it & work with observations
  
  *e.g. Delworth et al (2005), Chang, et al. (man. in prep.)*

- **Land Ice**: currently only crude offline calculations from our model output. A nascent research topic at GFDL
  
  *Olga Sergienko & Daniel Goldberg with M. Oppenheimer (PU)*

- **Other mass changes**: we model some terms (e.g., soil moisture), but do not address others (e.g., water mining, dams, reservoirs); large uncertainties in obs of some terms complicate 20th century model-to-obs comparisons
  
  *e.g. Lettenmaier and Milly (submitted)*

- **Land Movements**: we don’t model
Total Sea Level Change = Steric + Change in Mass + Land Movements

Ch. 11; Fig 11.9
IPCC TAR (2001)
CM2.1 - Ocean Heat Uptake

Global Ocean Temperature Change
(surface to 3000m depth average)

- CM2.1 realistically simulates observed global ocean warming (1950-2000).
- Aerosols (anthro & volcanic) have offset ~2/3 of the GHG-induced warming.

Delworth, et al. (2005) GRL

Delworth, et al. (2005)

GRL
CM2.1: Sizable steric signals from poorly observed regions

- Southern Ocean circulation factors in AR4 models (Russell, et al. [2006, J Clim])
- Basin-scale: does Argo + Grace = or ≠ Jason? (Chang, et al. [man. in prep.])
- Model projections of Sea level: NE US (Yin, et al. [2009, Nature Geosci.])
• Ongoing efforts to advance the understanding of sea level change and to communicate the relevant findings to stakeholders. Research includes observational analyses and modeling.

• Significant challenges remain in directly comparing simulated sea level change to observational estimates:
  – Observational and modeling uncertainties
  – Current models do not represent all processes important for sea level change

• Ice Sheets: The largest wildcard in sea level change