WCRP World Climate Research Programme

CLIVAR

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

Highlights from WCRP/IOC 2017 Sea Level conference

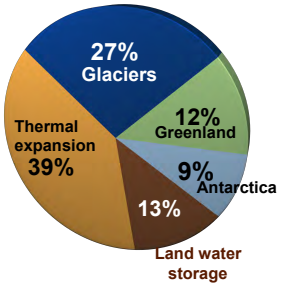
NADYA VINOGRADOVA

CARMEN BOENING

Questions:

1. WHAT ARE THE MAIN FACTORS CONTRIBUTING TO SEA LEVEL RISE?
2. WHAT ARE THE FUTURE REQUIREMENTS FOR SEA LEVEL RESEARCH?
3. WHAT ASPECTS OF RESEARCH RECEIVE LESS ATTENTION THAN THEY SHOULD?

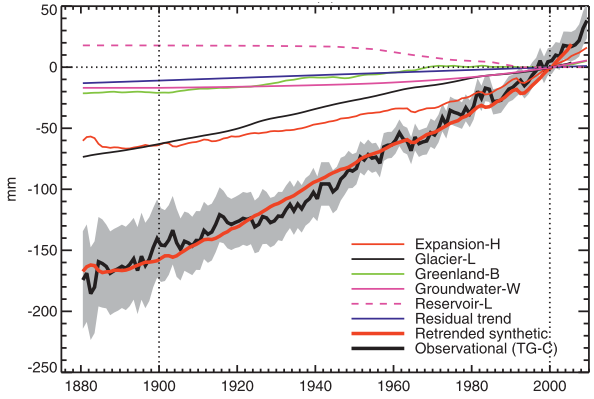
1. Contemporary sea level budget



1992-2009, IPCC 2013
Presented by R. Hock

Main factors contributing to sea level rise:

- Thermal expansion due to heat uptake [*von Schukman, Gregory, Charles*]
- Mass loss from ice sheets (GIS, AIS), ice caps, and glaciers [*Hock, Bamber, Davis*]
- Changes in land water storage due to groundwater depletion and reservoir construction [*Yu, Slangen*]



Gregory et al. (2013)
Presented by J. Church

Use of the sea level budget approach:

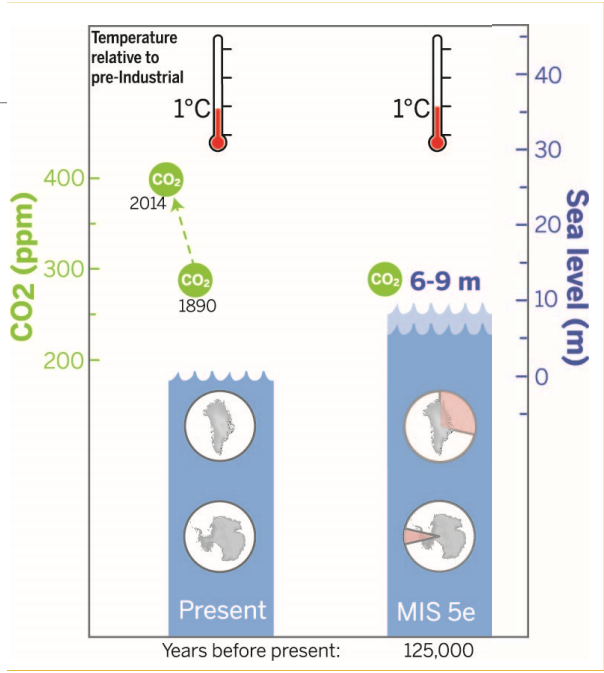
- Quality monitoring
- Constraining energy imbalances and deep-ocean warming
- Detection and Attribution
- Climate model validation and prediction

Understanding paleo records

- Look for evidence of ice-sheet retreat in the past to inform future sea level projections
- *Dutton*: during the Last Interglacials, global sea level was at least 6 m above present, involving large contribution from AIS
- Geodynamic processes may complicate estimates of ancient ice volumes and sea level:

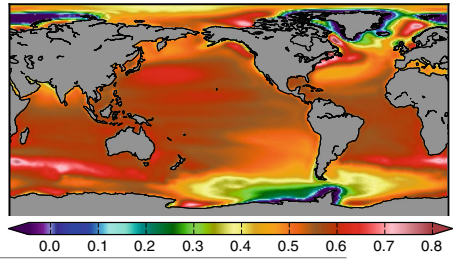
1. Glacial Isostatic Adjustment [*Mitrovica*] - Earth's 3D structure is important to accurately model GIA, with implications to tide-gauge corrections

2. Dynamic topography [*Gomez, Dutton*] - Surface elevation due to dynamic topography can be several meters on 100,000 year timescale and needs to be considered on "shorter" timescales (i.e., not just millennial)



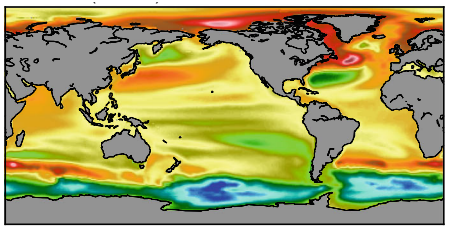
Dutton et al. (2015)

Looking ahead – sea level projections



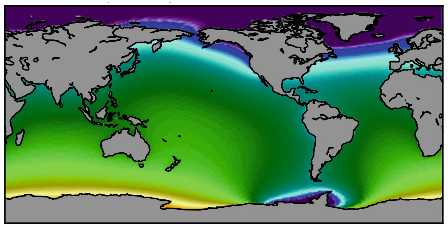
Sea level change (m) by 2100

Ocean



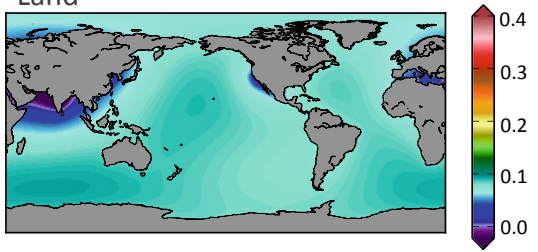
- Contribution from both steric and dynamic ocean changes
- Fully coupled atmosphere and ocean models, e.g., CMIP5 AR5
- CMIP6 (IPCC AR6) pertaining to sea level change is in preparation [*Masson-Delmotte*]

Ice



- Changes in ice mass and volume is based on expert assessments [*AR5, Bamber & Aspinall 2013*]
- ISMIP6 [*Nowicki*]:
  - Work towards full integration of GIS, AIS with ocean and atmosphere
  - Investigate the role of feedbacks between ice sheets and climate

Land



- Land water storage and redistribution from land to ocean
- Groundwater depletion will likely increase with rates proportional to population [*Wada et al 2012*]

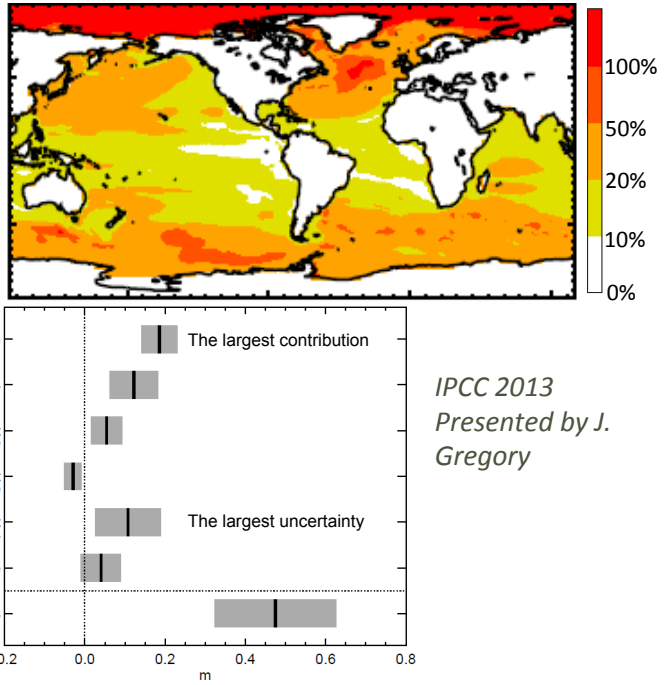
Slangen et al. (2014)
See also, Kopp et al. 2014

2. Future requirements for sea level research

a) Reducing uncertainties in sea level projections:

- Accounting for model spread in predicting ocean's thermosteric and dynamic response:
  - Flux-Anomaly-Forced Model Intercomparison Project (FAFMIP) [*Gregory*]
  - Detection and Attribution as a tool to isolate chaotic vs predictable variability [*Charles*]
- Improving modeling of ice-sheets and surrounding ice-shelf (largest uncertainty in sea level error budget):
  - Ice Sheet System Models (ISSM) [*Boening*]
  - AIS stability and long-term response [*Winkelmann, Griffes*]

CMIP5 spread: dynamic sea level % of thermal expansion

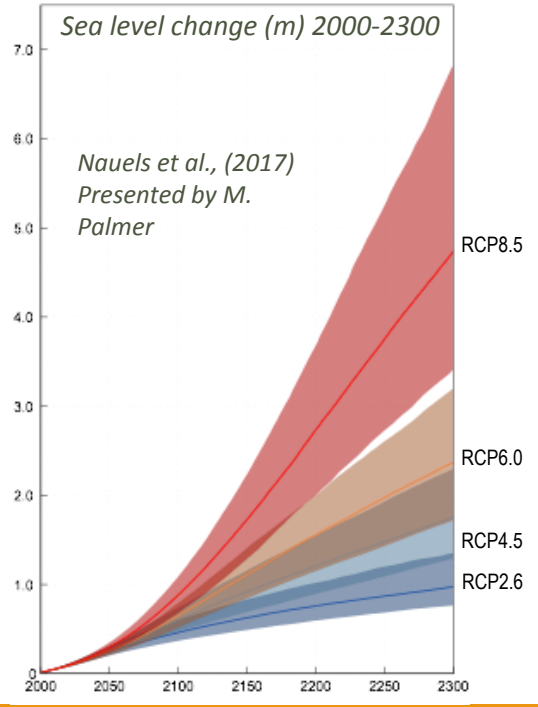


IPCC 2013
Presented by J. Gregory

2. Future requirements for sea level research

b) Expanding the range of timescales of sea level projections:

- Long-term projections
  - Explore multi-century horizons beyond 21st century
  - *Palmer*: Sea level rise by a few meters by 2300 is possible
- Short-term variability:
  - Characterize the role of internal variability and its potential to mask long-term sea level trends on decadal [*Thompson, Proshutinsky*] and inter-annual [*Liu*] timescales
- Acceleration:
  - Global accelerations are small, near resolving power of observing system [*Nerem, Cazenave*]
  - Regional accelerations can be significant [e.g. US East: 1-3 m/cy^2, *Davis*]



2. Future requirements for sea level research

c) Moving towards “actionable sea level science”:

- Reducing the gap between available scientific information and specific decision-making context
  - *Hinkel*:
    - Short-term, cost-benefit analysis requires probabilistic information
    - Loner term, risk averse decisions need information on the upper tail-end (worst case scenario)
- Establishing interactive exercise between coastal risk managers, decision scientists and sea level scientists [*Sweiss, Behar, Bindschadler, Losada*]

3. Aspects that needs more attention

- Define connections between the mean sea level state and the local changes, including extreme events from storm surges and tides

- Integration of information from different research fields, as well as different components of the Earth's system as a function of scales will require quantification of a new cascade of uncertainties