Tracking Ice: The Latest Efforts to Measure the Polar Ice Sheets

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Greenland ice would raise sea levels by 7 meters

Antarctic ice would raise sea levels by 57 meters
IPCC AR5 sea level projections

Global mean sea level rise (m)

Year

2000  2020  2040  2060  2080  2100

- Sum
- Thermal expansion
- Glaciers
- Greenland ice sheet
- Antarctic ice sheet
- Greenland ice-sheet rapid dynamics
- Antarctic ice-sheet rapid dynamics
- Land water storage

![Attention Symbol]
Ice and climate feedback processes

Lubrication

Calving

Ocean Melting
How satellites detect ice sheet mass changes

(1) **Altimetry** measures changes in ice sheet shape

(2) **Mass budget** differences snowfall and ice discharge

(3) **Gravimetry** measures changes in ice sheet weight
Changes in the polar ice sheets

![Map showing ice thickness change (m/yr)]
The ice sheet mass balance inter-comparison exercise (imbie)

- First community assessment of ice sheet sea level contribution
- ESA & NASA contribution to IPCC AR5
- Uses all satellite methods & common domains
- Replaces 40-50 individual assessments which had 2.1 mm/yr spread
The 2012 *imbie* assessment
Using **imbie** to improve sea level projections

Simulated Antarctic ice sheet retreat by 2100

Bed elevation
- **-2000**
- **-1000**
- **-500**
- **0**
- **500**

Probability of retreat
- **>0%**
- **5%**
- **33%**
- **50%**
- **66%**
- **95%**
- **5%**

Ritz et al. 2015
New observations since imbie 2012

- 10 satellite missions, 54 years of data
- 15
- 80+
52 new estimates of Greenland ice sheet mass balance!
Progress since imbie 2012

34 new estimates of Antarctic ice sheet mass balance!
Progress since imbie 2012

Antarctica has contributed 4.3 ± 2.3 mm to sea levels since 1992.

Greenland has contributed 10.1 ± 1.1 mm to sea levels since 1992.
Next generation of satellite missions

- ESA Sentinel-3 (2016)
- NASA/DLR GRACE-FO (2017)
- NASA ICESat-2 (2017)
- NASA/ISRO NISAR (2020)
Bridging the gap to ICESat-2
Achievements of imbie

- Using common domains, techniques concur
- Combining missions provides a single community assessment
- Accuracy 10 times better than spread of individual studies
- Challenges are Antarctic Peninsula and East Antarctica
- Combined ice losses tripled between 1992 and 2012
- Latest surveys suggest ice losses have increased by 20% in last 5 years
Adapting **imbie** for the future

- **imbie-2** begins **today** at Fall AGU
- Aim is to produce an annually-updated climate data record
- Next phase is open to anyone able to contribute a unique dataset
- Activity will be coordinated via an executive committee
Spatial variations of global sea-level change from Greenland and Antarctica during GRACE observing period

Adhikari et al., 2015 GMD