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# Monitoring and Adapting to Change in Cryosphere


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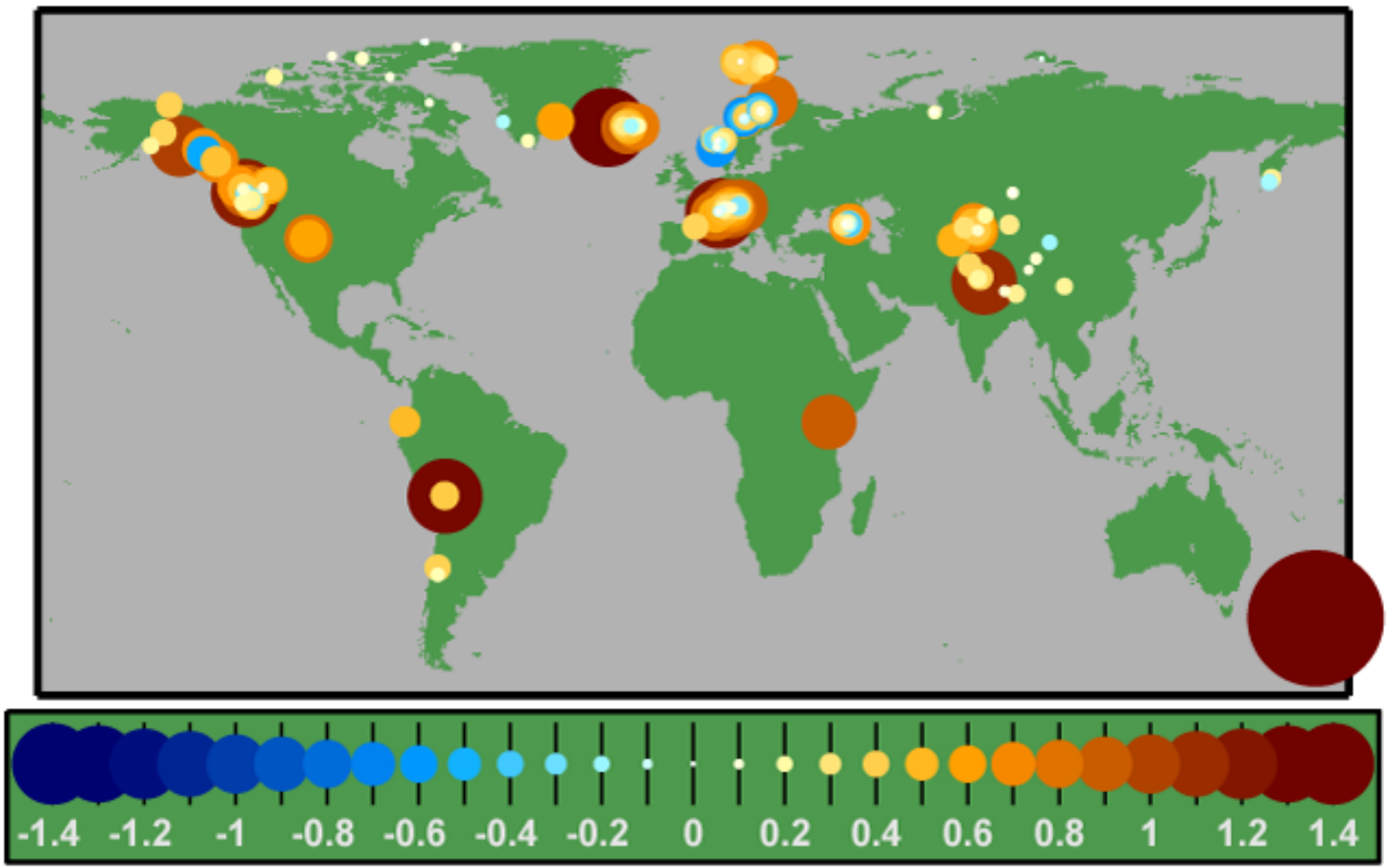
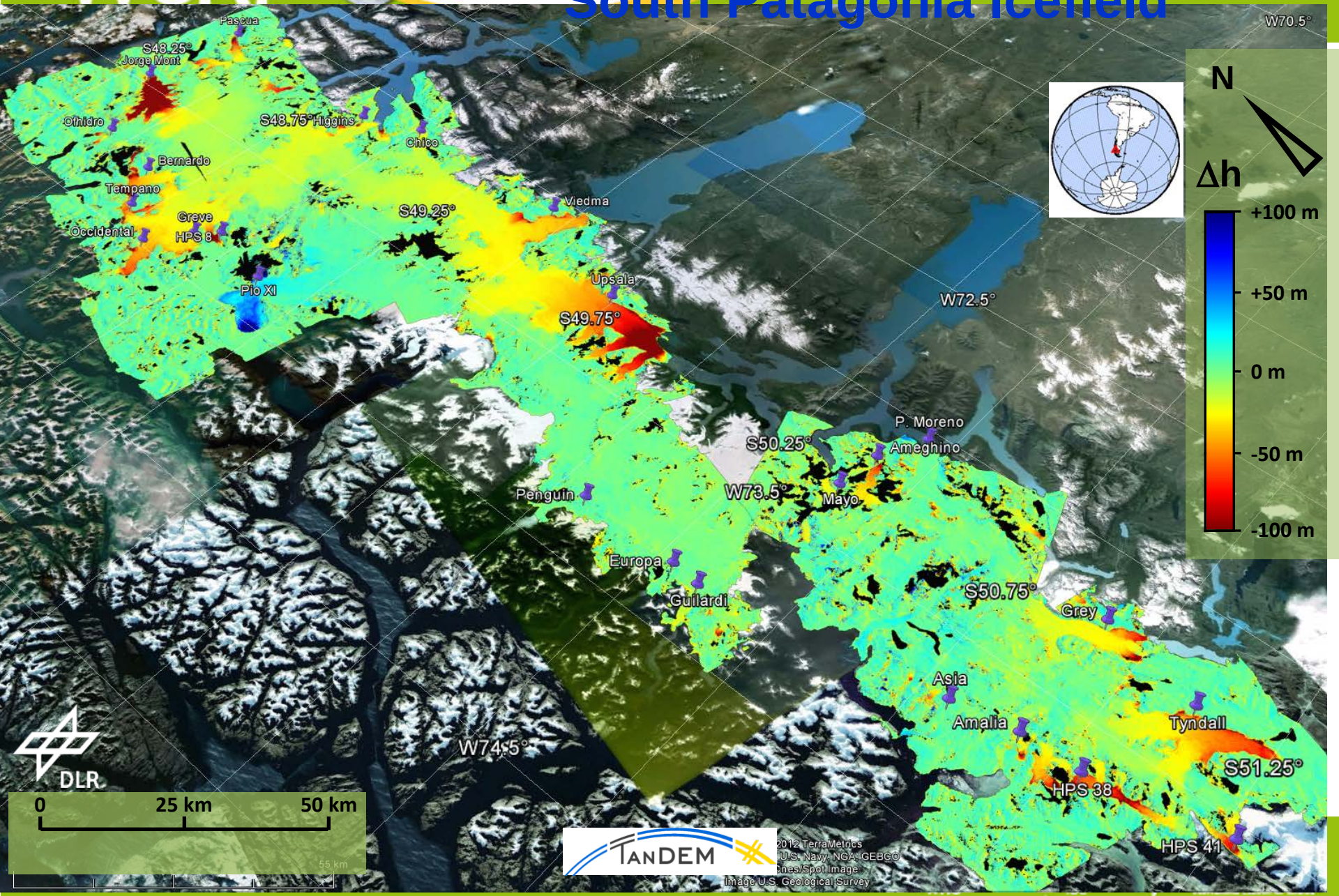
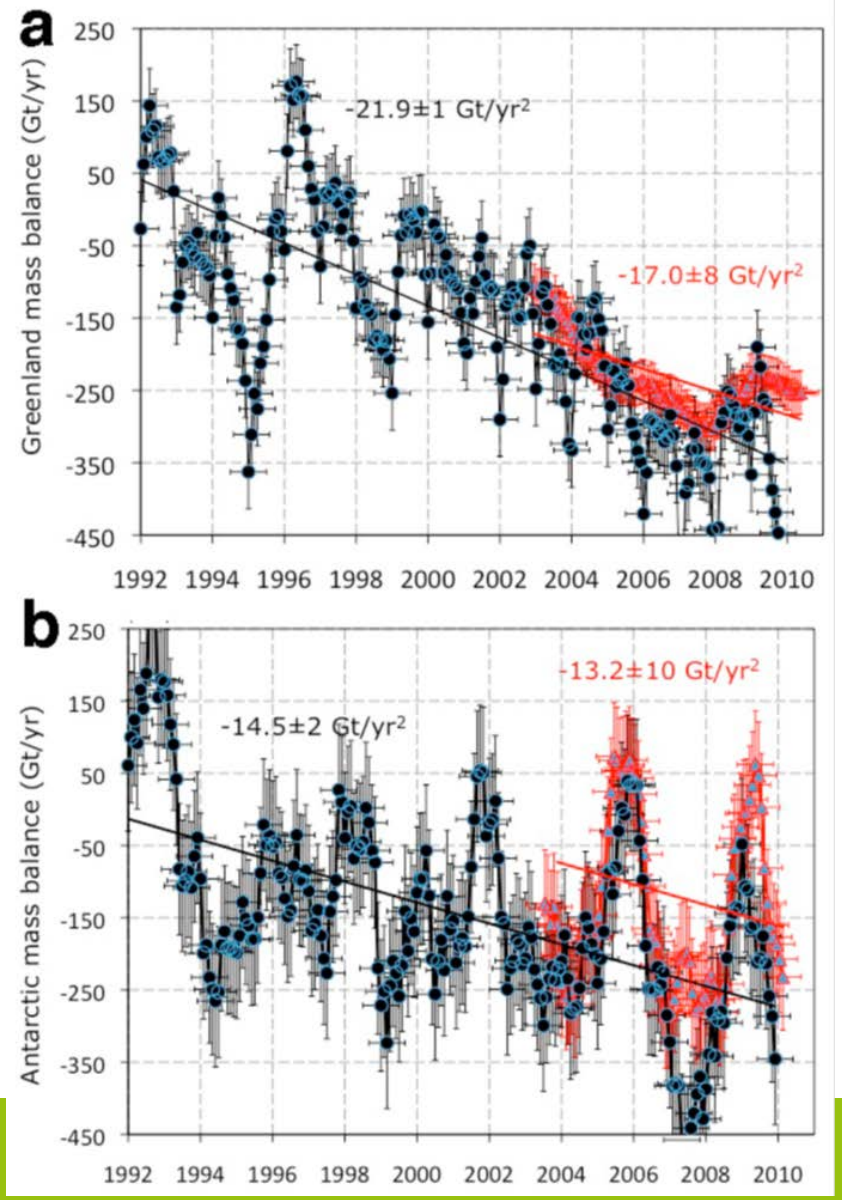
# Glaciers and Ice Cap Changes Since 1970



# Ice Elevation Changes 2000-2011
## South Patagonia Icefield



# Ice Sheet Mass Change:1992-2010




- In 2006, the Greenland and Antarctic ice sheets experienced a combined mass loss of 475 ± 158 Gt/yr, equivalent to **1.3 ± 0.4 mm/yr** sea level rise.
- Acceleration in ice sheet loss over the last 18 years was 21.9 ± 1 Gt/yr² for Greenland and 14.5 ± 2 Gt/yr² for Antarctica, for a combined total of **36.3 ± 2 Gt/yr²**
- Acceleration is 3 times larger than for mountain glaciers and ice caps (12 ± 6 Gt/yr²).

Rignot et al., 2011, GRL

# Greenland Ice Sheet Mass Balance

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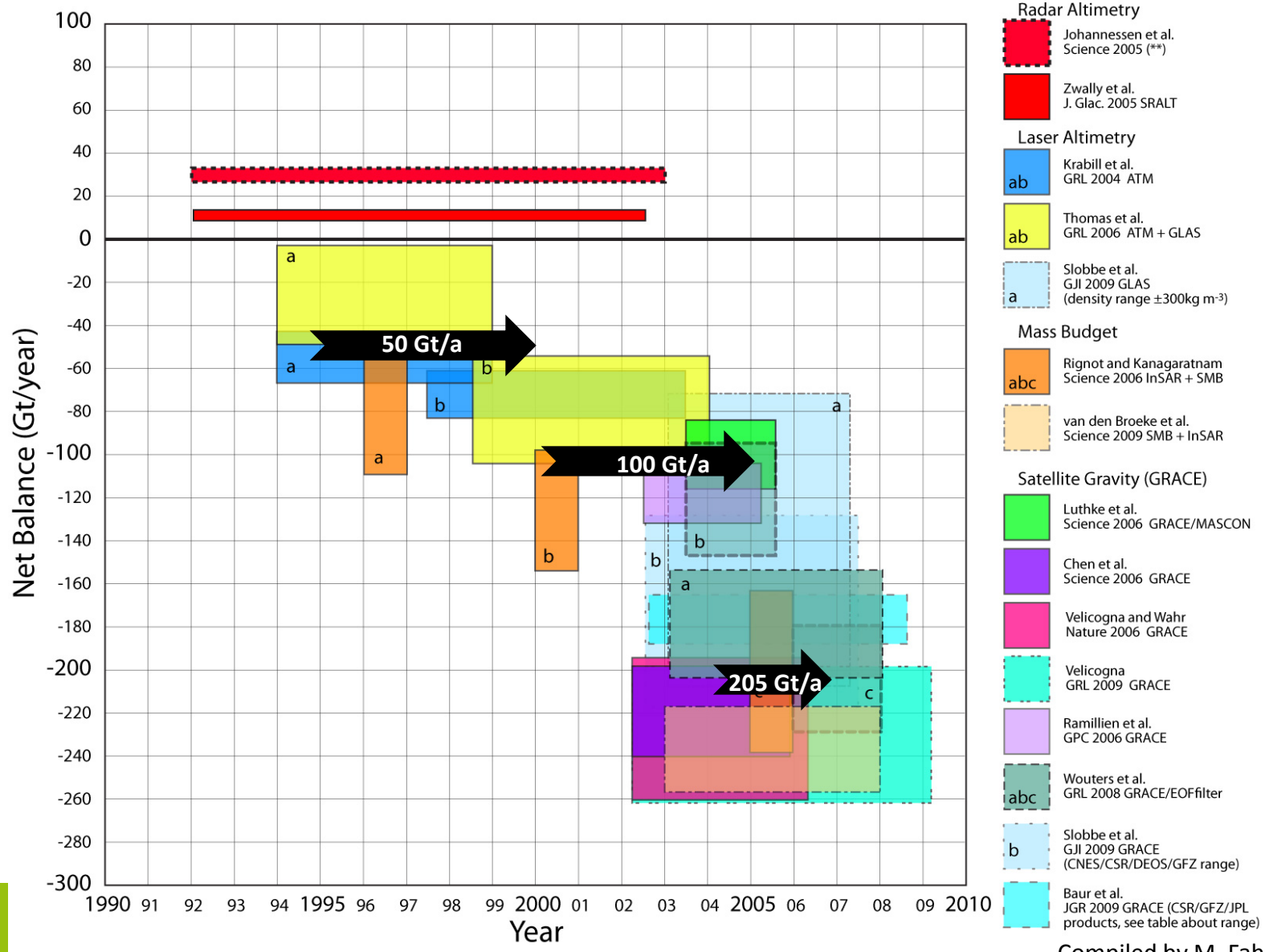


Compiled by M. Fahnestock for AMAP

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# Arctic Sea Ice

- The Arctic sea ice extent was, for the 16th consecutive year, below average, reaching its lowest extent in its annual cycle on record on September 16th, 2012 at 3.41million square kilometers. The 2012 minimum extent was 49% or 3.29 million square kilometers below the 1979–2000 average minimum and **18% less than the previous record set in 2007.**

- During 2012, the Arctic sea ice extent tracked near or above the 2007 daily levels through July, rapidly declining in early August and tracking below levels observed in 2007. The Arctic sea ice lost in August an average of 91,700 square kilometers of ice per day, **the fastest observed loss for the month of August on record.**

- The ice melted in such a rapid pace in August that the Arctic sea ice extent surpassed the previous record low extent set in September 18th, 2007 on August 26th, 2012, 18 days before the 1979–2000 average minimum date of September 13th. The sea ice extent continued to decrease and by August 31st, the Arctic sea ice had dropped to 3.7 million square kilometers, **first time in the 34-year record that the month of August recorded a sea ice extent below 4.0 million square kilometers.**

- The Arctic sea ice extent freezes and expands during the Northern Hemisphere cold season, reaching a maximum extent in March, then melts and contracts during the Northern Hemisphere warm season, reaching a minimum extent in September. **The total ice loss since the maximum extent on March 20th, 2012 and its lowest minimum extent set in September 16th was 11.83 million square kilometres, the largest seasonal ice extent loss in the 34-year satellite record**.

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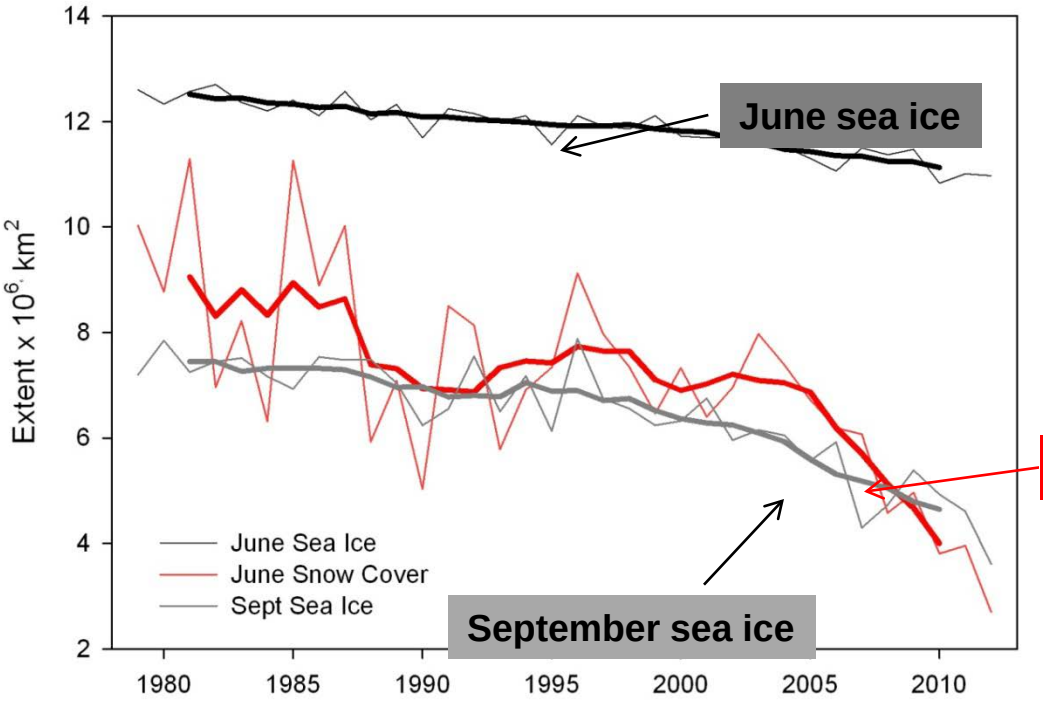
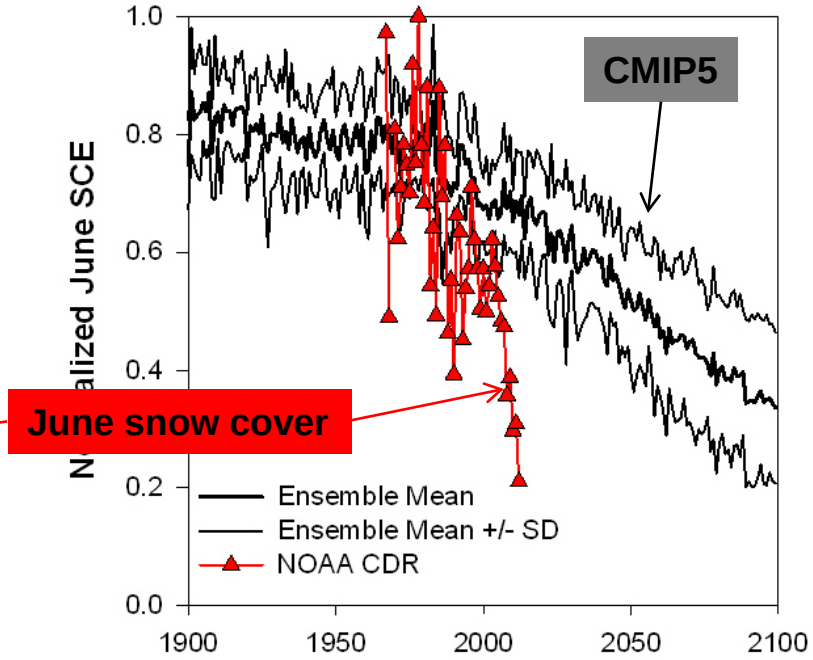
# Northern Hemisphere Snow Extent: 1979-2012




*(C. Derksen, R. Brown, GRL, 2012)*

- The 1979–2012 NH June snow extent decrease rate: -17.6% per decade
- September sea-ice extent decreasing rate: -13.0% per decade *(NSIDC)*

rapid retreat of glaciers: Alaska ~1/2 of global loss

Arctic precipitation +8% over last 100 yr

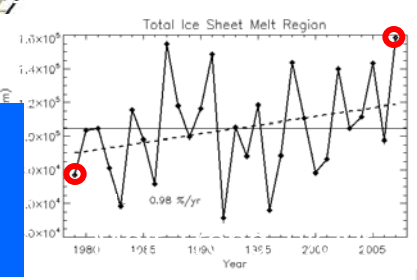
Eurasian discharge increased at ~2 km3/yr 1936-99

150°E
180°
120°E
120°W
60°E
90°W
60°W
30°W

191
0
298
6
582
3950
1075
713

Inflow km³/yr

Outflow km³/yr


Increasing melt of Greenland Ice Sheet 1979-2007

OBSERVED CHANGES IN THE FRESHWATER BUDGET COMPONENTS

e.g., from ACIA, 2005; IPCC 2007, 2008

Examples from ACIA: Walsh et al., 2005

*(Courtesy T. Prowse)*

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# Agenda

- Global Glaciers- Dr. Frank Paul, University of Zurich, Switzerland
- Polar Ice Sheets- Dr. Rene Forsberg, National Space Institute, Denmark
- Living in the Arctic, Mr. Jimmy Qaapik, Nunavut Arctic College, Canada
- Extending Systemic Observation from Space, Dr. Mark Doherty, European Space Agency, Italy
- Discussion

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