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Early 21st-Century Mass loss of the North-Atlantic Glaciers and Ice Caps (Arne Richter Award for Outstanding Young Scientists Lecture)

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Historically, ice loss from mountain glaciers and ice caps has been one of the largest contributors to sea level rise over the last century. Of particular interest are the glaciers and ice caps in the North-Atlantic region of the Arctic. Despite the cold climate in this area, considerable melting and runoff occurs in summer. A small increase in temperature will have an immediate effect on these processes, so that a large change in the Arctic ice volume can be expected in response to the anticipated climate change in the coming century.
Unfortunately, direct observations of glaciers are sparse and are biased toward glaciers systems in accessible, mostly maritime, climate conditions. Remote sensing is therefore essential to monitor the state of the the North-Atlantic glaciers and ice caps. In this presentation, we will discuss the progress that has been made in estimating the ice mass balance of these regions, with a particular focus on measurements made by ESA's Cryosat-2 radar altimeter mission (2010-present). Compared to earlier altimeter mission, Cryosat-2 provides unprecedented coverage of the cryosphere, with a resolution down to 1 km or better and sampling at monthly intervals.
Combining the Cryosat-2 measurements with the laser altimetry data from ICESat (2003-2009) gives us a 12 yr time series of glacial mass loss in the North Atlantic. We find excellent agreement between the altimetry measurements and independent observations by the GRACE mission, which directly 'weighs' the ice caps, albeit at a much lower resolution. Mass loss in the region has increased from 120 Gigatonnes per year in 2003-2009 to roughly 140 Gt/yr in 2010-2014, with an important contribution from Greenland's peripheral glaciers and ice caps. Importantly, the mass loss is not stationary, but shows large regional interannual variability, with mass loss shifting between eastern and western regions from year to year. Comparison with regional climate models shows that these shifts can be explained by changes in surface mass balance processes, highlighting the sensitivity of the glaciers and ice caps to changes in the atmospheric circulation and underscoring the need for long-term observations of the region.