



Ice Sheets from Space: The Big Picture View (Louis Agassiz Medal Lecture)

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Instead of heroic efforts to acquire a few dozen field-based measurements of ice-flow velocity at some of the Earth's most remote locations, computer servers now crunch satellite data to spew out millions of measurements, providing a whole new perspective on how ice sheets function. Prior to such observations, outlet glaciers and ice streams were perceived to respond slowly to climate change, with little change at timescales of months to decades. While some glaciers flow at steady rates, a remarkable number have responded to recent warming with large variations in speed over periods as short as seconds. A wide variety of behavior is observed with some glaciers steadily gaining speed, others accelerating and then leveling off, and a handful varying substantially with no clear trend. While in the minority, a few glaciers have steadily decelerated over the last decade. As examples of recent change, two of the most rapidly changing glaciers are examined: Jakobshavn Isbrae in Greenland and Pine Island Glacier in West Antarctica. In addition to documenting the dramatic changes on these glaciers, satellite observations provide important new spatio-temporal data sets with which to understand such change, particularly when used in conjunction with ice sheet models. Although models constrained by these data reveal that ice-shelf buttressing is an important control on ice-sheet flow, the actual speedups are a complex response to the loss of buttressing, involving several other feedbacks that contribute to the acceleration. Although satellite observations have produced tremendous progress in understanding ice sheets, so far these data have raised more questions than they have answered. The contribution that ice dynamics will make to future sea level remains poorly understood and remains a grand challenge for glaciology. The ongoing record of spaceborne measurements is and will remain a key component in addressing this challenge.