(128-170420-A) **Keynote Address - Climate, Melting Ice, and Rising Seas: Observing and Understanding to Reduce Risks**

R.B. Alley

The Pennsylvania State University, Department of Geosciences, and Earth and Environmental Systems Institute, University Park, PA 16802; 814-863-1700, E-mail: rba6@psu.edu

Sea-level rise is ongoing from thermal expansion of the ocean, melting mountain glaciers, small changes in the great ice sheets, and perhaps from changing groundwater storage. Climate history shows strongly that past rises in CO_2 have driven warming that forced sea-level rise, supporting physical understanding and models that additional rise is almost unavoidable, with amount and rate depending especially on CO_2 emissions. Large deviations from the mean rise can occur locally, due to the effects of changes in winds and currents, as well as local ground motion from tectonic processes, ongoing response to the end of the ice age, local withdrawal or injection of fluids, and other processes. Thus, providing policymakers and the public with actionable assessments and projections of local mean rise and risks of extrema requires multifaceted, accurate measurement and modeling spanning atmosphere, ocean, ice and the not-so-solid Earth. The potential exists for threshold-crossing behavior in ice sheets causing rapid ice-cliff failure (see Figure) that could greatly increase sea-level rise - we may plan for less than a meter in the next century or so with an uncertainty smaller than the mean, and instead get several meters. The research required to assess the associated risks overlaps with that for smaller rise but includes many additional issues. Costs of sea-level rise likely are notably super-linear, increasing perhaps as the square of the rise, or some other power greater than one. Perhaps non-intuitively, this in turn means that ice-sheet collapse would increase the societal costs associated with rise from other sources, and thus increase the value of knowledge of the full suite of processes affecting sea level. Great challenges remain to model these processes and provide accurate projections, especially near tipping points, for the full range of possible forcings. Maintenance and extension of key observational datasets on atmosphere, ocean and ice will help guide process-based studies and enable model improvements through data assimilation, greatly advancing understanding and societally useful projections.

Figure 1. The ~100-m-high calving front of Jakobshavn Glacier, Greenland is near failure. Retreat in West Antarctica could generate even higher cliffs with faster failure, driving rapid sea-level rise. Photo by R. Alley.