Testimony to the Select Committee on Energy Independence and Global Warming
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Introduction

Thank you for the opportunity to testify before this Select Committee. I will talk only about Petermann Glacier where current events offer exciting new ways to explore a unique outlet glacier with great potential to uncover unexplored physics of changing ice-ocean-atmospheric interactions missing from current generation IPCC numerical models.

Discovery

In 2003 a small group of scientists from Canada, England, and the US worked off northern Greenland aboard icebreakers for 3-4 weeks in 2003, 2006, 2007, and 2009. Thursday morning Dr. Melling received an e-mail from Trudy Wohlleben on a break-up of Petermann Glacier. Everyone in our group knew it within seconds. The next 8 hours, a flurry of e-mails data, ideas, as well calculations on ice, tides, winds, satellites data went back and forth across 9 time zones. We forgot the rest of the world. This is how science works.

Figure-1 is one outcome of those 8 hours. Dark colors are water (or land shadows), yellow is glacial ice, red are ice sheets at higher altitudes, blues are either landforms or, if on water, sea-ice. From images like this one, ship-based expeditions to Greenland between 2003 and 2009, and a review of the literature (Higgins,1991; Rignot and Steffen, 2008; Johnson et al., submitted to J. Geophys. Res., June-2010; and references therein), we find that

(a) an ice island was born Aug.-5, 2010 that measures about 240 km^2 in area (4 times the area of Manhattan);
(b) the ice island has a volume of 18 km^3 and a mass about 16 GT. This corresponds to a freshwater equivalent of 2 years the average discharge rates of the Delaware Rivers or 120 days of the total US public tap water consumption (USGS web-sites);
(c) Smaller, but similar sized ice-islands formed in 1958 to 1961 when the glacier lost about 2.8 Manhattans (170 km^2 in area,12.8 km^3 in volume and in 11.5 GT mass) (Higgins, 1991) while in 1991 Petermann Glacier lost about 1.7 Manhattans (100 km^2 in area, 7.5 km^3 in volume and 6.8 GT in mass) (Gudmansen, 2001).

In summary, Petermann Glacier had 3 large calving events which took place near 1960, in 1991, and 2010. Last week's event was the largest, but since these large events occur only about every 25 years on average, the annualized rate is only about 0.6 GT/y. This number is identical to that for the1953-1978 period (Higgin, 1991). This is one of the reason that scientists expected the large break-up that happened. Implicitely this expectation assumes a stable flow, steady state at decadal time scales, and the observed constant calving rate.

Significance

The annual calving rate is only 5% of the 12 GT/y that the Greenland icesheet gives to Petermann Fjord at the grounding line where the glacier is in contact with the bed rock. Rignot and Steffen (2008) find that "… most of the difference in flux between the grounding line and the ice front is caused by the removal of ice from the bottom by warm ocean waters …" More detailed calculations reveal that 80% of Petermann Glacier is melted by ocean waters below the ice. Surface melting accounts for the remaining 15% of mass lost. The discovery of complex underice topography with valleys and ridges 200 m high at scales of a few km furthermore emphasizes that the flaoting glacier is not a flat plate (Figure-2). Nobody knows how these underice channels are formed or what causes them, but there are a number of speculations and most exciting boundary layer physics to explore to better predict melt rates and mass balances.

In summary, we really do not know how the dominant ice-ocean boundary layer physics work in response to a climate change scenario. We are rapidly improving our knowledge of surface ice velocity, air temperature, and ice thickness, but even more potential exists to improve less visible, but no less important ice-ocean interactions for IPCC numerical modeling that to me is the only way to quantify the contributions that global warming makes to the climate system and extreme events.

Global Warming

Global warming is very real to me as an avid gardener. My Native American Azaleas start blooming a few days earlier each year despite all variability in temperature and moisture. Global warming may be one contributing factor, perhaps minor, perhaps not, but an adjacent hybrid azalea always blooms at the same time. Why would one plant be affected by global warming and the other not?

The situation with Petermann Glacier and those in south-east Greenland is perhaps similar. If different physics dominate different glaciers, I would expect a different response to a uniform forcing by global warming. I believe that only ensembles of numerical models can decide what is and what is not global warming over scales much larger than one outlet glacier. This is what the IPCC projections have been doing, very successfully. Data on ice-ocean interactions are needed now develop next generation numerical models as well as to later test their projections that, perhaps will become predictions. This is the only way, I feel, to make attributions of observed change to global warming.

References

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