Geophysical Research Abstracts
Vol. 21, EGU2019-3346-1, 2019
EGU General Assembly 2019

An Extreme Event linking an Atmospheric River melting Greenland and Hurricane Irene in August 2011

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During August 24-31, 2011 a warm and wet weather system resulted in extensive surface melt along the western Greenland ice sheet (GIS) [Doyle et al. 2015]. Recently, this event provided an example of an atmospheric river (AR) event affecting the GIS (Neff, 2018), during a period of increase in AR events since about the year 2000 (Mattingly, et al. 2018). This presentation will show a link to hurricane Irene, which reached Category 3, and then followed the North American coastline and decayed at the southern tip of Greenland.
The weather pattern consisted of high pressure over the mid-Atlantic with low pressure located over Hudson Bay and eastern Canada: This pattern favored SW winds along the east coast of North America (NA) extending to Greenland. Along this boundary, a plume of moisture originated north of Puerto Rico and extended into the Labrador Sea in the form of an Atmospheric River on 24 August. Meanwhile, Hurricane Irene had formed in the Atlantic and was located just NE of Puerto Rico. By the 26th it was offshore of Florida and a plume of integrated water vapor (IWV) extended from Irene along the boundary of high- and low-pressure areas with IWV of about 30 kg/m2 near Kangerlussuaq on the 27th at the time of maximum precipitation [Doyle et al. 2015]. This plume of moisture evolved from the classical AR on the 24th into a plume with a more fragmented internal distribution of IWV as seen in SSMI imagery but with a consistent northeasterly progression. By the 30th, Irene had decayed to a weak cyclonic system located just south of Greenland. The moisture intrusions also extended inland over Summit Station with a temperature maximum of -4.9C on 28 August. This moisture increase was accompanied by a decrease in Deuterium Excess from 23 permil to 12 permil and corresponding enrichment in δD ($\sim$100 permil) in samples of surface snow and frost/rime collected daily (doi: 10.18739/A2SX6487H). This isotopic signature is indicative of an extratropical source of humidity based on the analysis for the 2012 melt episode by Bonne et al. 2015. Boundary layer remote sensing observations from the ICECAPS data set show a progression from clear skies on the 24th through stratiform clouds late on the 25th through mid-day on the 27th followed by a mixture of background stratiform clouds with periodic deeper, precipitating cloud systems for the following days. Reanalysis data also show a general progression of weather from west to east past Greenland with temperature anomalies aloft between 6C and 8C, as well as specific humidity anomalies following the same progression. Consistent with this progression, coastal glacier melt occurred first along the west coast as far north as 75N between the 24th and the 29th of August and then later starting on the 29th to the east and as far north as 70N. Doyle et al. 2015 reported that the melt in water equivalent during this singular event represented 10% of the annual total.