A Multi-Instrument "Forensic" Approach to Understanding NSA Winter Precipitation

Imposter Snowfall Events

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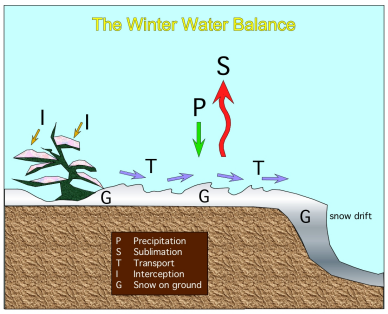
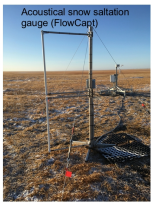
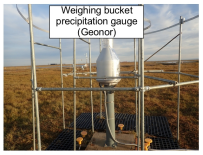
The Problem: Precipitation (P) is one of the most significant processes in the atmosphere, yet challenging to measure accurately during Arctic winter. Wind-transported ground snow (T) can appear as a precipitation event. Here we describe the expanded suite of instruments we have installed at ARM-NSA and OLI plus preliminary measurements documenting the occurence of *imposter* winter precipitation events where ground snow appeared to be snowfall.

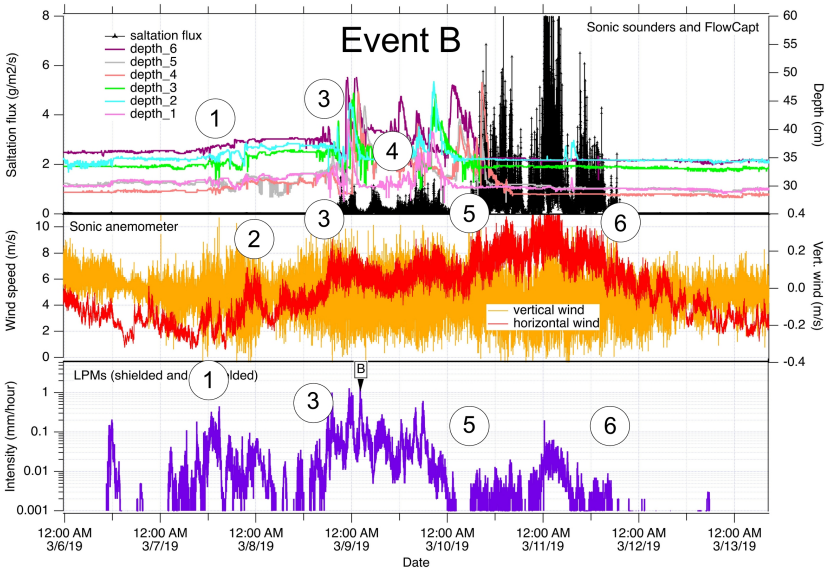


The Instruments: During a blizzard, few instruments work well. To solve the problem of winter precipitation, a multi-instrument approach is needed. We installed the instrument suite shown below at NSA and OLI, using double alter shields to reduce adverse wind effects. We added a dedicated steerable camera as well. Combined, these provide time series of all but sublimation (S) in the water balance figure to the left.



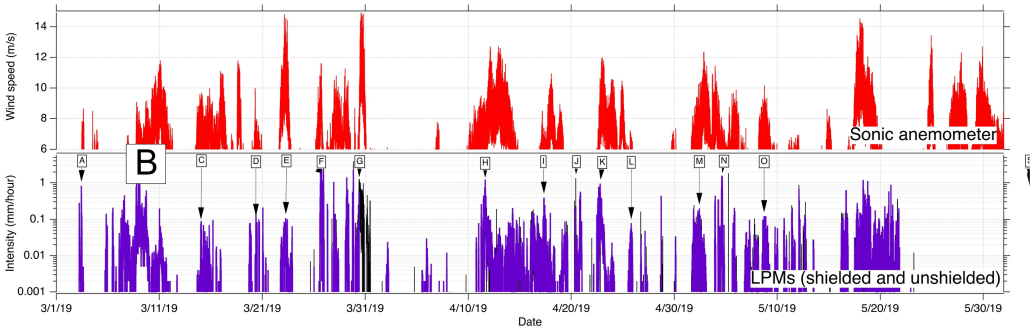


The Approach: We would eventually like to automate our analysis, but for now, we line up time series from the instruments, then use our understanding of snow, wind, temperature, and instrument behavior to decide if it was snowing, blowing, or both.



1. Light snowfall: slight buildup on ground.
2. Wind rises>6 m/s: scour stops ground build-up. Vertical gusts increase.
3. Increasing wind w/out snowfall: apparent fall intensity rise of 10x. Saltation begins.
4. Snow dunes traveling through sonic depth sounder farm: saltation sources LPMs.
5. Wind & saltation increase, but traveling dunes absent: sintering reduces LPM flux?
6. Wind drops < 6 m/s; saltation stops; LPMs cease to report precip.
   Ground snow same as prior to event, indicating very little real precipitation occurred.

The Winter of 2019: At least 19 possible precipitation events were recorded by the LPMs between March and June. The threshold wind speed needed to transport snow is about 6 m/s, so some events ([A], [D], [I], [J], [L], [P], [Q]) were likely true precipitation, but several events (e.g. [B], [F], [H] etc.) including a large event in early January, 2019 (not shown here) recorded precipitation at the LPMs that appears to have been generated by strong up and down drafts of wind and sourced from snow on the ground.



Conclusions: We need to understand these type of events better, develop easier ways to identify them, and we need to assess how much of current Arctic precipitation data is prone to these sort of errors. It is not a new problem: R. Black published a paper in 1954 called *Precipitation at Barrow Greater than Recorded.* In 1981 M. Sturm's mentor, C. Benson, published a paper called *Reassessment of Precipitation on Alaska's Arctic Slope*. The problem remains difficult: even whether the sign of the regional bias is + or - remains in doubt. In our opinion, it is solvable only using a multi-sensor approach, and we will be trying to improve that approach over the next few years.