GOESR3 Periodic Reporting

Reporting Period: July 2019 – December 2019 (1st half of FY19 funding cycle)

Team Lead: Claire Pettersen/Mark Kulie
Team Members: Heidinger/Wagner/Wanzong/Mateling/Langlieb/Ritzman

Project Title: An Enhanced Lake-Effect Snow Nowcasting Tool Using Synergistic GOES-R, NEXRAD, and Ground-Based Snowfall Microphysics Observations
Project Number: 408

Executive Summary

We are working to develop an enhanced Lake Effect Snow (LES) now-casting tool using products from the current GOES-16 observations. This product is in development with National Weather Service (NWS) offices in the Great Lakes Region and aims to improve forecasts of LES events through cultivating better estimates of radar and satellite derived snow accumulations.

Progress toward FY19 Milestones

Towards our Year 3 goals, we have achieved the following:

- Continued regular meetings with NOAA GOES-16 collaborators Dr. Mark Kulie (NOAA), and Ms. Marian Mateling.
- Planning and CLARVX data transfer meetings with Dr. Mark Kulie, and Mr. Steve Wanzong during Fall 2019
- Drs. Pettersen and Kulie in conjunction with Ms. Mateling used the Z to S assessment from Year 2 (courtesy of Dr. Wagner) to refine the GOES CLWP to NEXRAD snow rate calculations. The team identified key cases during the 2017 – 2018, 2018 – 2019, and 2019 – 2020 winter seasons in which to train the lake-effect nowcasting tool.
- Ms. Mateling produced plots of CLWP and three available channels from GOES16, which helped guide the joint GOES16 CLWP and NEXRAD snow rate analyses. See Figure 1 as an example of the resulting GOES-derived snow rate in liquid water equivalent (LWE) and geometric accumulation. These figures are being automatically generated as GOES CLAVRX data becomes available (about every 5 minutes), and stored on local UW servers.
- Drs. Pettersen and Kulie are assessing the variation of the PIP-derived snow density during lake-effect events, as the snow to liquid ratios (SLR) is highly variable (see Figure 2). The team will use these observations to recommend SLR ratios based on environmental conditions for lake-effect nowcasting in the future.
- Drs. Pettersen and Kulie and Ms. Mateling redeployed the network of Pluvios in November 2019. These snow accumulation instruments were installed in a 15 km radius area around the NWS Marquette, MI (MQT) office. These Pluvios will help augment data for the 2019 – 2020 winter season.

- Dr. Pettersen updated and maintained Precipitation Imaging Package (PIP – snow microphysics measurements) and Micro Rain Radar (MRR – profiling radar) instrumentation in November 2019. These instruments are deployed at the NWS MQT office and are used to refine radar reflectivity (Z) to snowfall rate (S) relationships.
- Dr. Pettersen completed a manuscript highlighting 4 winters of ground-based observations of snow at the NWS MQT office. This is published in the January 2020 issue of JAMC (citation listed below)

Plans for Next Reporting Period

- Drs. Pettersen and Kulie and Ms. Mateling are working on the final stages of a website to deploy to the MQT NWS with the GOES snow rate maps and information. The team is working with colleagues at the MQT NWS (Mr. Nick Langlieb, SOO, and Ms. Jacki Ritzman, Meteorologist) to refine a quality end-user product for the NWS MQT to implement. This product has GOES-derived LWE amounts (in mm hr^{-1}), as well as several geometric accumulation rates (in hr^{-1}) based on different SLRs (10:1, 20:1, 40:1).
- Drs. Pettersen and Kulie will work with Mr. Langlieb and forecasters from the NWS MQT office to assess the lake-effect nowcasting tool for events during the 2019 – 2020 winter season. This will help guide assumptions of recommended SLRs for events based on environmental conditions.
- Dr. Kulie and colleagues submitted a proposal to BAMS with a goal of producing a manuscript about the MQT snow dataset and this was accepted. The BAMS manuscript is currently in final preparation and will be submitted in Spring of 2020.

Additional Information

1. Interaction with operational partners –

   - Drs. Pettersen and Kulie and Ms. Marian travelled to the NWS MQT office twice: Once to attend and present at the “Winter Weather Workshop” in October of 2019. And once in November of 2019 to work with their colleagues to both update and maintain the enhanced snow observation site at the office (MRR, PIP, Parsivel, Pluvio) and re-deploy a Pluvio network to quantify spatial variability of snowfall accumulation for a third season.

2. Conference/workshop participation –

   - The team presented work at the Marquette, Michigan NWS WFO “Winter Weather Workshop”. Dr. Pettersen talked about the “Lake-Effect Nowcasting Tool” and on snow density variability as a function on snow type. Ms. Mateling showed her analysis on the spatial variation of snow accumulation in the Marquette region.

   - Dr. Pettersen presented a poster at the 2019 American Geophysical Union Annual meeting titled “A composite Analysis of Snowfall Modes from Four Winter Seasons in Marquette, Michigan”.

- Dr. Kulie presented a talk at the NSSL Satellite QPE Workshop in January 2020. On "GOES Product Development: Lake-Effect Snow Quantitative Precipitation Estimation (QPE)."

3. Outside project publicity –

- The Lake-Effect Nowcasting Tool research and development was highlighted in the 2019 NOAA Science report (https://nrc.noaa.gov/Council-Products/NOAA-Science-Report – see page 14).

- The JAMC manuscript was summarized and highlighted in a UW/SSEC News piece (https://www.ssec.wisc.edu/news/articles/12497/)

4. Journal articles –

- Pettersen, C., Kulie, M.S., Bliven, L.F, Merrelli, A.J., Petersen, W.A., Wagner, T.J., Wolff, D.B., and Wood, N.B.: A composite analysis of snowfall modes from four winter seasons in Marquette, Michigan, JAMC, 2020, doi: 10.1175/JAMC-D-19-0099.1.

- Kulie, M.S., Pettersen, C., et al.: Upper Great Lakes Snowfall: Lessons Learned from a Multi-Sensor Snowfall Observatory, BAMS, *submitted (proposal stage)*

Key Graphics

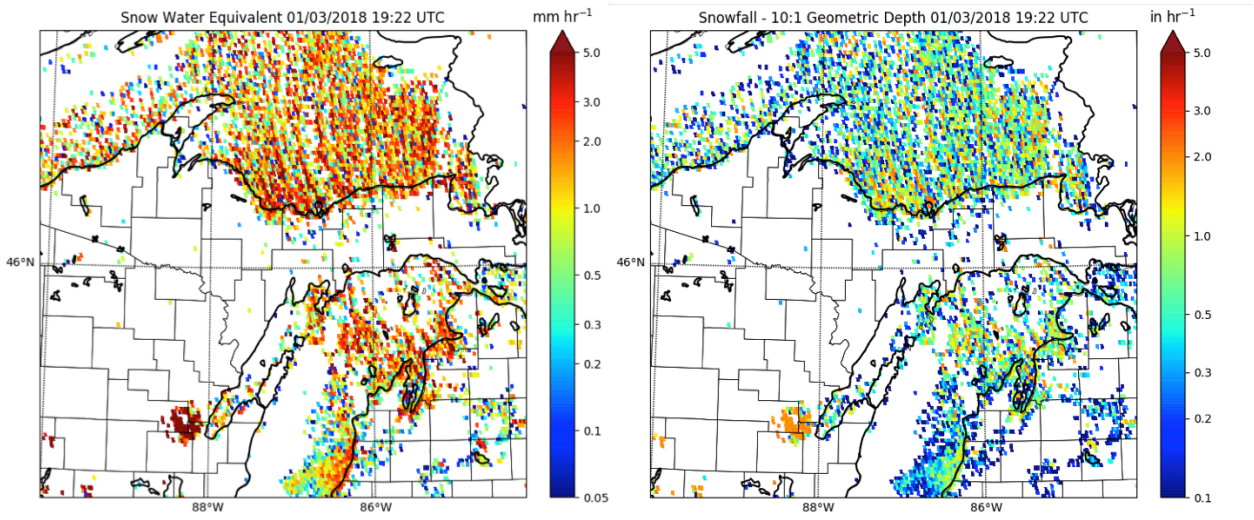

Figure 1: GOES CLAVRX CLWP- and NEXRAD reflectivity-derived LWE (mm hr^{-1}) during a lake-effect snow event (left panel) and the snowfall accumulation in geometric depth assuming a 10:1 SLR for forecasting (right panel).

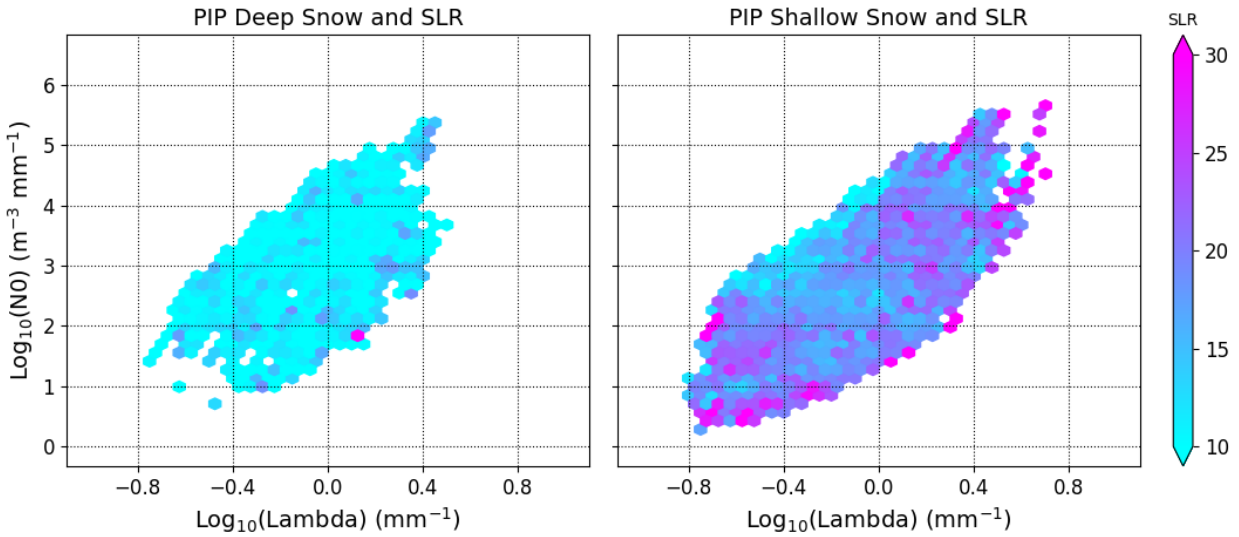

Figure 2: PIP-derived SLR values for deep snow events (left panel) and lake-effect snow events (right panel). The lake-effect snow events have highly variable SLRs, ranging from 10:1 to 30:1 and greater.