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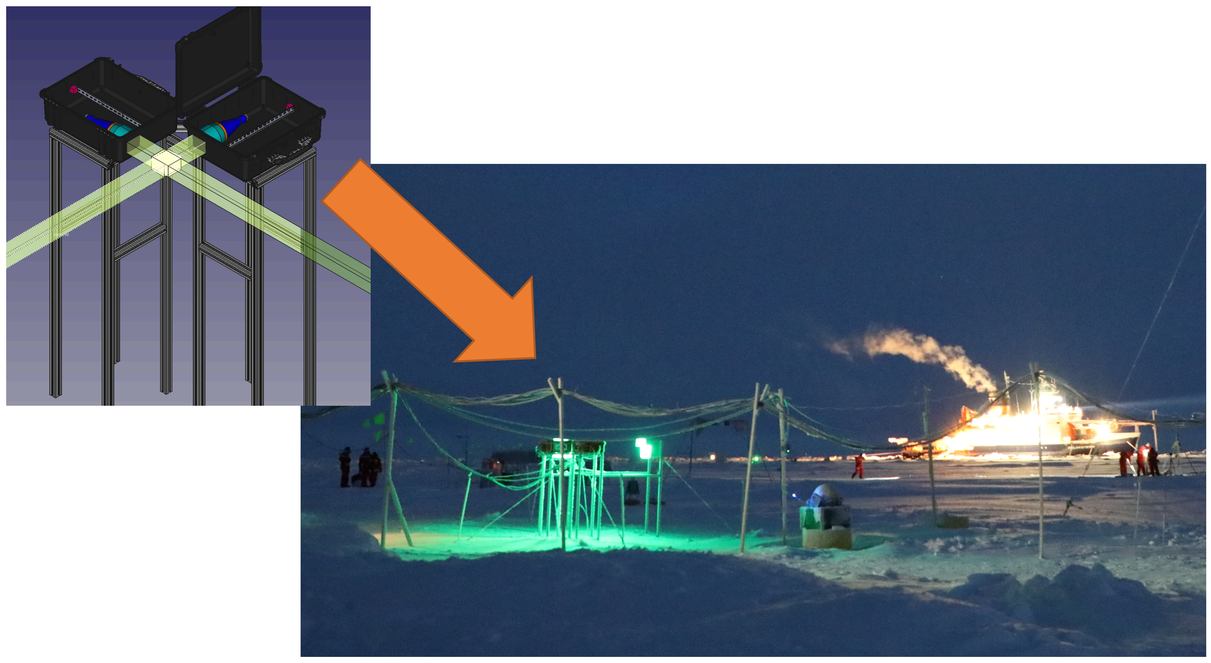
First results from a Video In-Situ Snowfall Sensor (VISSS) deployed during the MOSAiC campaign

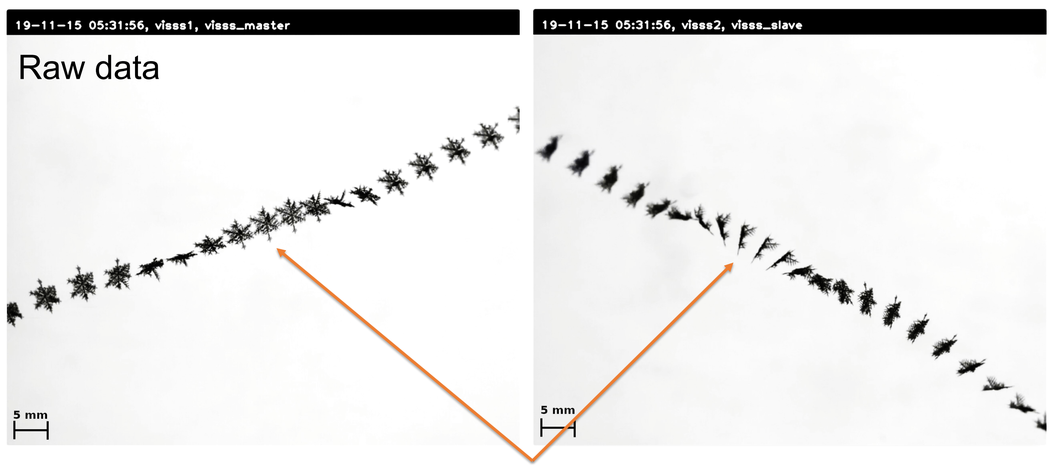
Maximilian Maahn[1,2*], Matthew Shupe[1,2], Taneil Uttal[2]

(1) University of Colorado Boulder, (2) NOAA Physical Sciences Lab. * now at Leipzig University

Motivation

- Snowfall formation is an essential process of the climate system impacting surface albedo, glaciers, sea ice, freshwater storage, and cloud lifetime.
- The processes involved in snowfall formation can be identified by their fingerprints on snow particles:
  - Water vapor deposition determines the general shape
  - Aggregation causes snowflakes consisting of multiple particles
  - Riming describes the freezing of cloud droplets onto the snow particle and can eventually form graupel
- In order to exploit these unique fingerprints of cloud microphysical processes, high quality optical observations are required
- Also, retrievals of remote sensing observations can be better constrained when knowing snow particle shapes and sizes
- Filling crucial observational gap for the MOSAiC campaign

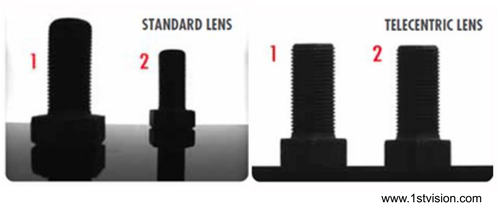




Snow particle observed at the very same moment from two angles

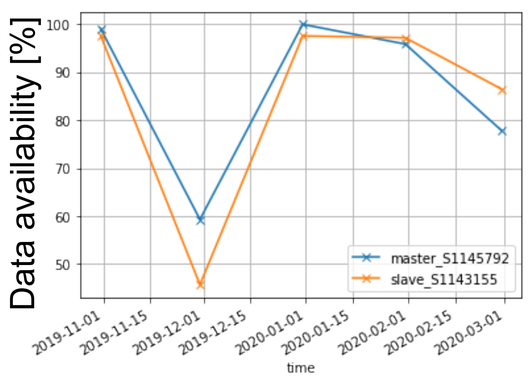
The Video In-Situ Snowfall Sensor (VISSS)

- Observes shadows of snow particles in front of green backlight
- Two synchronized cameras allow for observing snow particles from different perspectives
- Reliable particle size estimation due to telecentric optics
- Measurement volume approx. 8 x 6 x 10 cm
- Optical resolution approx. 60 µm
- 140 frames per second
- Data processing in development



Results

- MOSAiC Leg 1 & 2 data analyzed: October 2019 – February 2020
- Excellent instrument performance, data gaps mainly due to power issues
- Superior image quality
- Approx. 1,4 TB data/month
- Instrument induced turbulence and/or blowing snow disturbs measurements for high winds (> 10 m/s)
- First version of data processing applied to golden case (Nov 15th):
  - Particle recognition works
  - Particle tracking works in general, fast moving particles are sometimes lost
  - Detects particles > 2 mm
  - Median aspect ratio ~0.7
- Slower than real time on a single core



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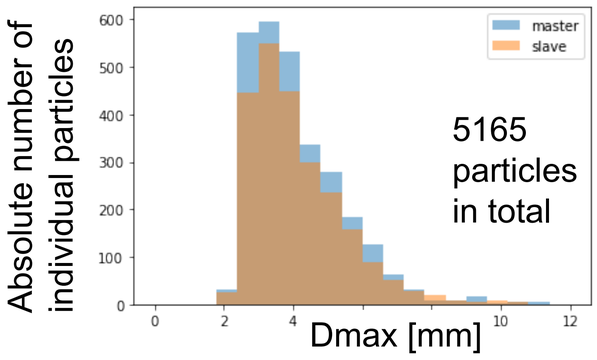

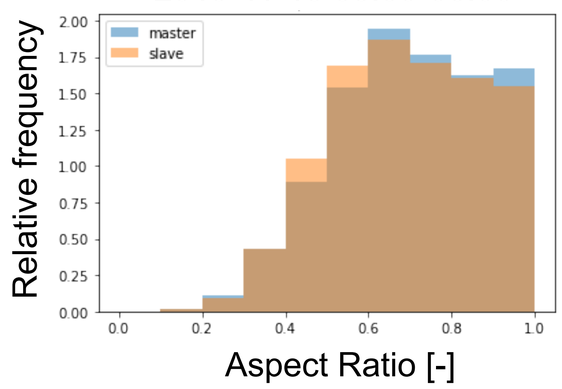

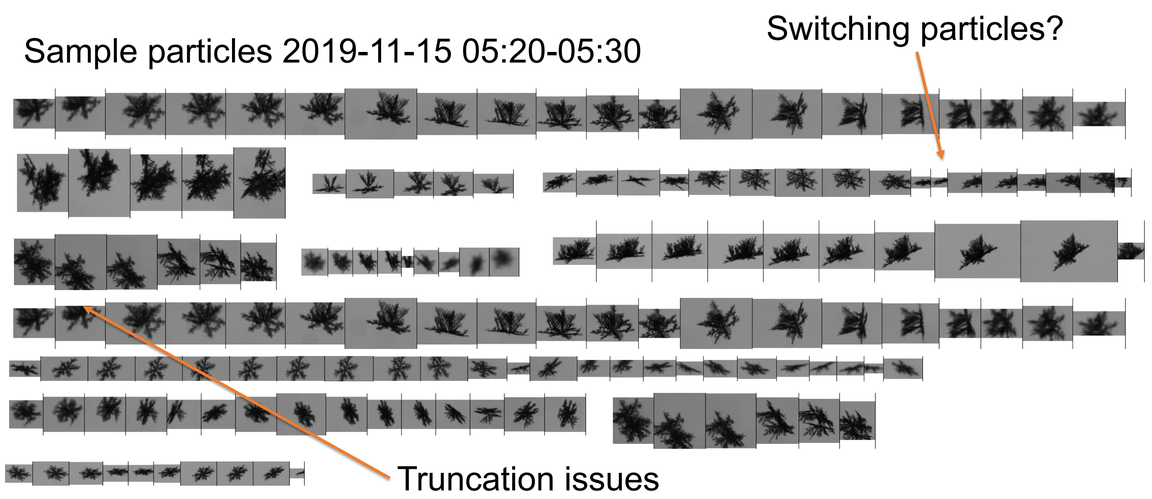

Next steps

- Develop probabilistic method for particle tracking *and* camera matching
- Estimate calibrated particle size distributions
- Develop particle shape retrieval
- After MOSAiC, VISSS will be installed at Hyytiälä, Finland in summer 2021
- 2nd gen VISSS with increased distance between camera and measurement volume and higher frame rate will be installed in Ny-Ålesund in fall 2021
- Proposal for data analysis will be submitted end of the month

maximilian.maahn@uni-leipzig.de, matthew.shupe@noaa.gov