

Snowfall over the Greenland Ice Sheet as observed from ICECAPS and CloudSat

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5: UC-Boulder/CIRES, Boulder, CO, USA

Overview

- ICECAPS
- CloudSat
- Snowfall at Summit
 - Type
 - Amount
- Extension to GrIS
- Conclusions

ICECAPS

- NSF-funded observatory at Summit Station, Greenland
- 2010 – 2020
- Von Walden (WSU)
- Matt Shupe (NOAA/ESRL- U-Colorado)
- Dave Turner (NOAA/NSSL- U-Colorado)
- Ralf Bennartz (U-Wisc, Vanderbilt)

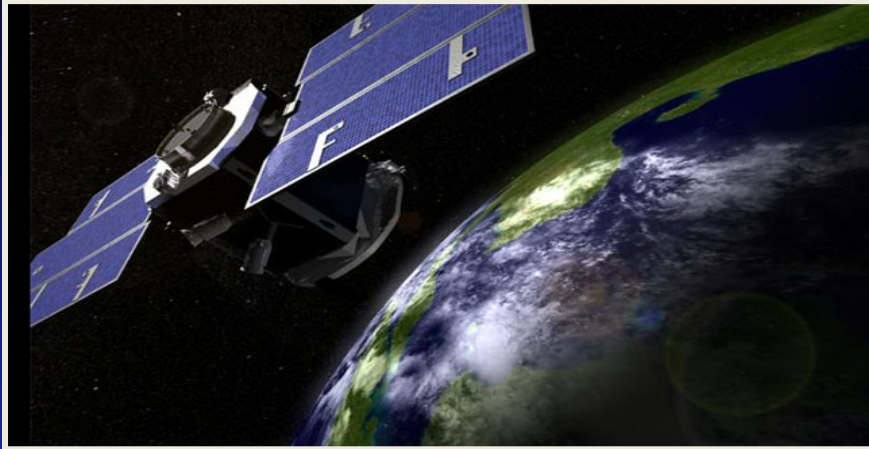


Shupe et al., BAMS 2013

Suite of Instruments

- MMCR- 35-GHz millimeter-wave cloud radar
- PAERI- Polar Atmospheric Emitted Radiance Interferometer
- 2 MWRs 14 channel water vapor line and 60-GHz oxygen absorption line and 90, 150 GHz
- Radiosondes – 2 per day, 1 GPS
- Ceilometer and Micropulse Lidar- identify cloud base
- POSS - Precipitation Occurrence Sensor System
- SODAR – boundary layer depth
- Hotplate
- Multi-Angle Snowflake Camera

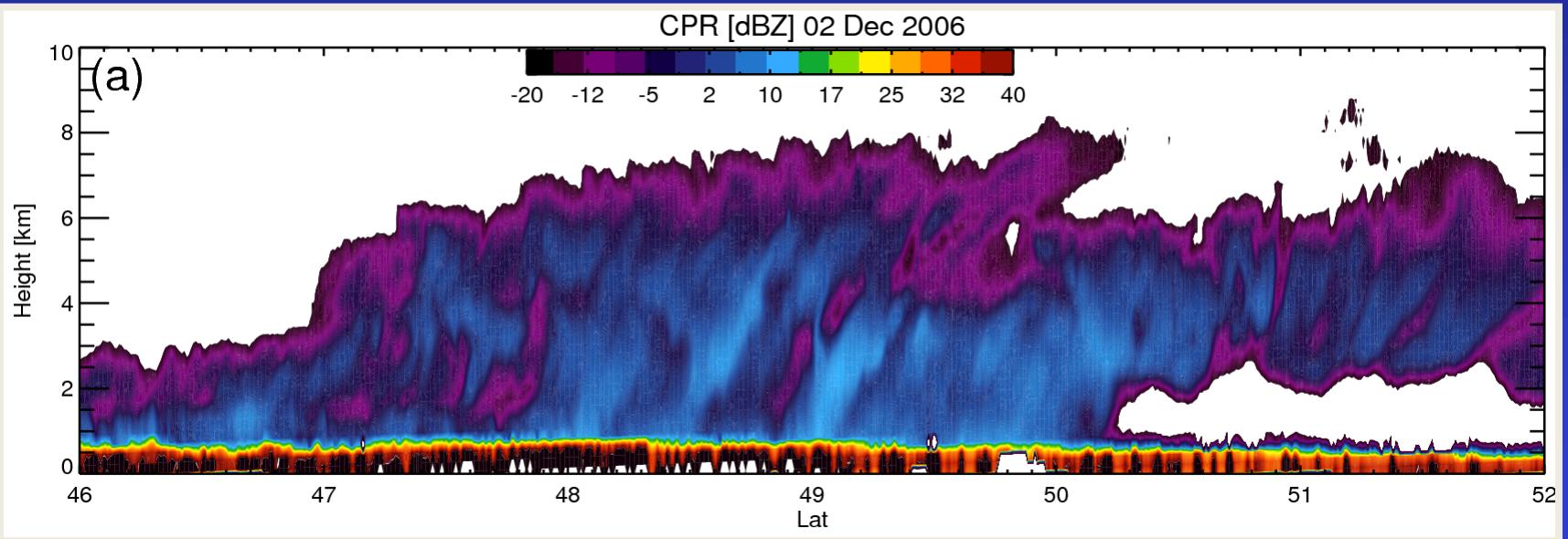
CloudSat Cloud Profiling Radar (CPR)



Global W-band observations of clouds and precipitation since 2006.

Reduced functionality since 2011

Part of A-train constellation



Precipitation regimes at Summit

Atmos. Chem. Phys., 18, 4715–4735, 2018

<https://doi.org/10.5194/acp-18-4715-2018>

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Atmospheric
Chemistry
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Precipitation regimes over central Greenland inferred from 5 years of ICECAPS observations

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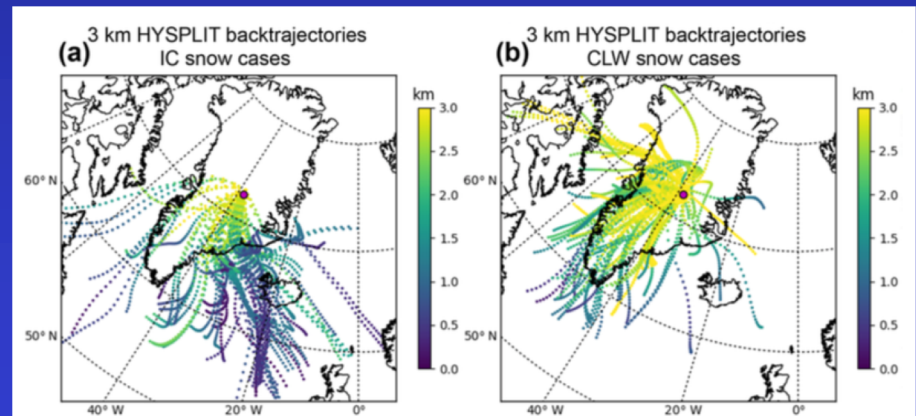
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Precipitation regimes at Summit

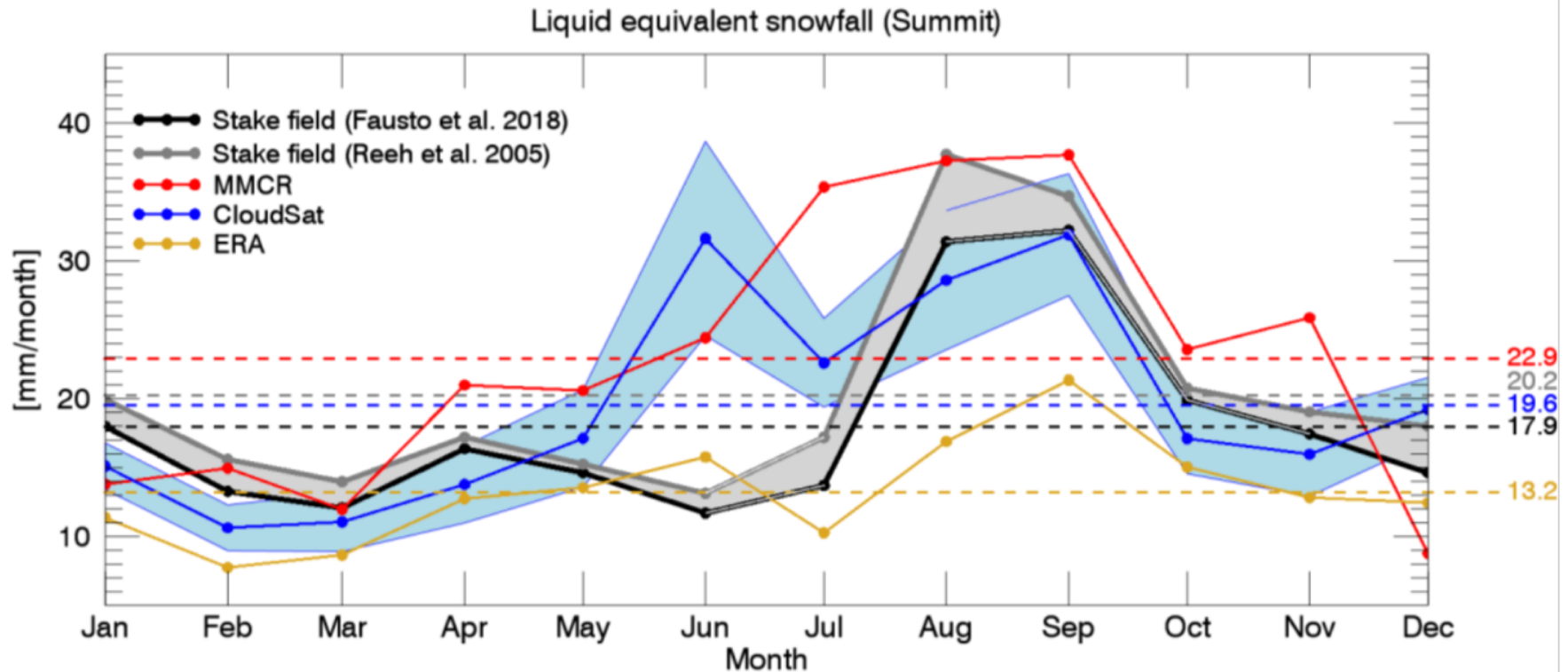
- Ice-phase ('IC') only precipitation typically associated with individual storm systems generated by low pressure over Baffin Bay and Greenland lee cyclogenesis
- Precipitation from mixed-phase clouds ('CLW') is shallower and has characteristics typical of supercooled cloud liquid water layers
- IC – 35% accumulation
- CLW – 51%
- Unclear – 14%



Comparing ground-based and spaceborne radar to accumulation at Summit

- Collocated all available MMCR and CloudSat as well as ERA-Interim data with stake field.
- Corrected CloudSat for various radar-related artefacts
- Used Z-S relations appropriate for dry snowfall
- Assumptions of Snowpack density, correction for sublimation/deposition

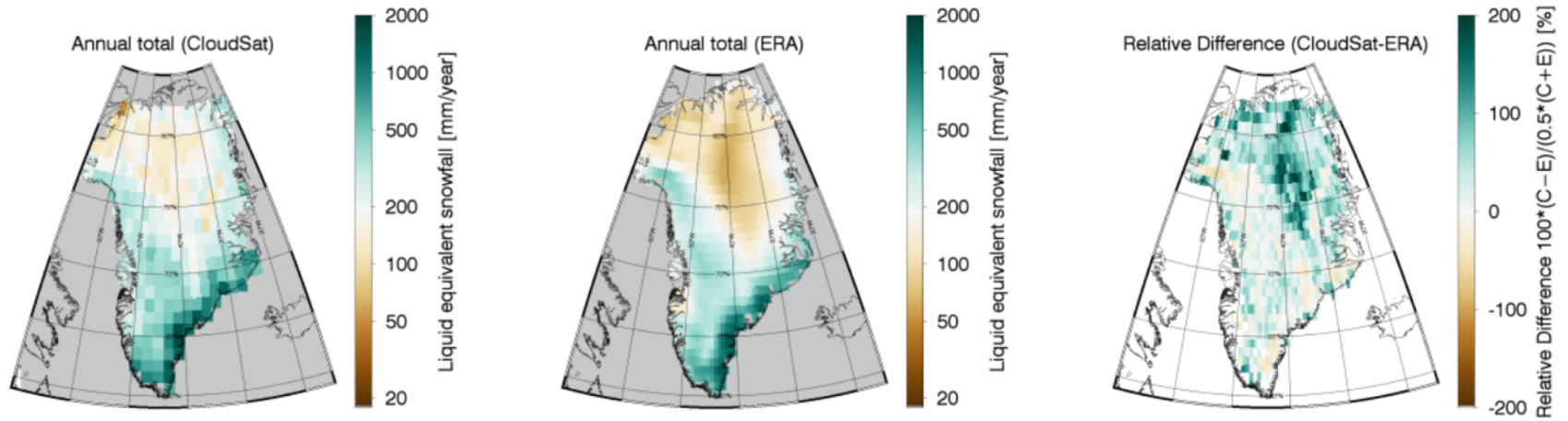
Comparing ground-based and spaceborne radar to accumulation at Summit



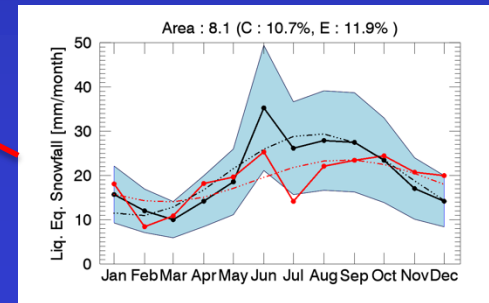
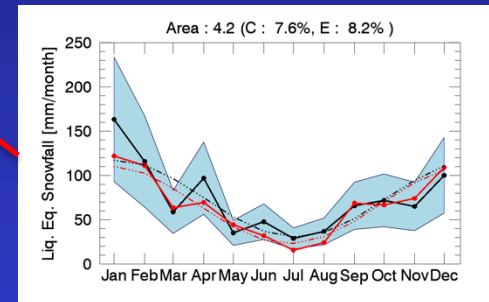
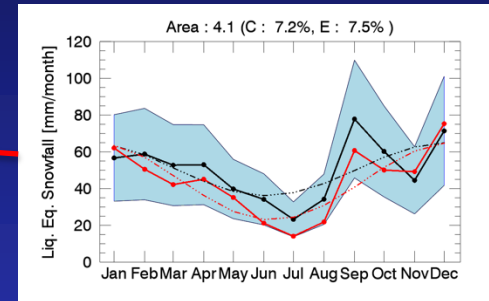
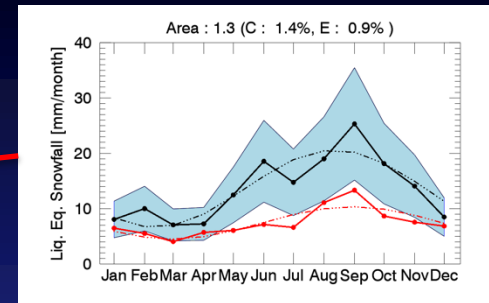
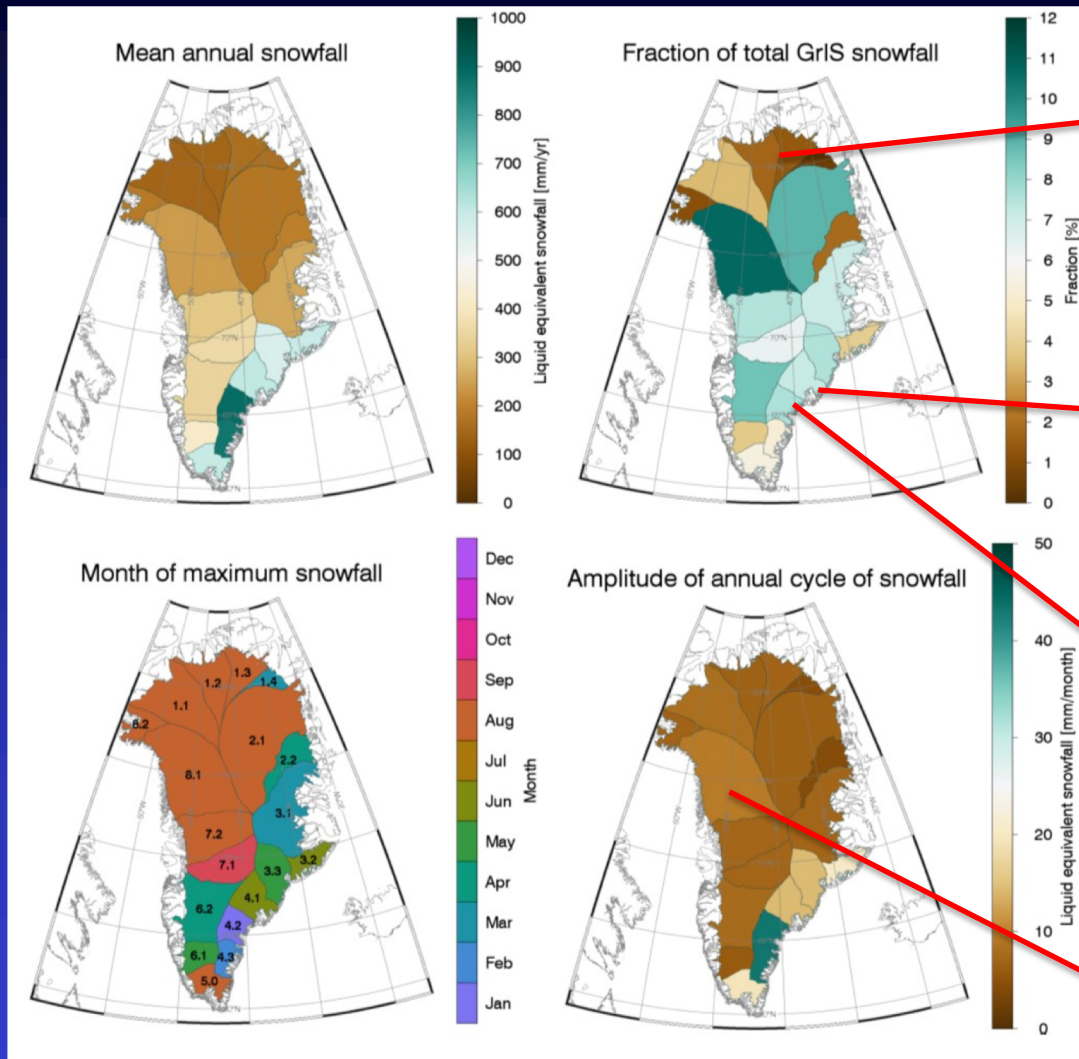
Comparing ground-based and spaceborne radar to accumulation at Summit

- Both MMCR and CloudSat agree ok with stake field....
- ... except for June (similar discrepancy already noted by Dobb and Fahnestock 2004)
- ERA-Interim under-estimates summer snowfall.
- Corrected CloudSat for various radar-related artifacts and issues related to height of observation.
- Used Z-S relations appropriate for dry snowfall
- Assumptions of Snowpack density

Extension to GrIS using CloudSat



Extension to GrIS using CloudSat



Extension to GrIS using CloudSat

- ERA-Interim under-estimates summer snowfall. Appears to be linked to shallow, mixed-phase precipitation.
- In regions with much orographic/frontal precipitation excellent agreement between CloudSat and ERA.

Conclusions/Outlook

- CloudSat appears to provide excellent precipitation estimates after artifact removal, adjustment to observation height and precipitation type over Greenland.
- Cloudsat end of lifetime. However, EarthCare will hopefully allow for similar exercise soon. (GPM only sees southern tip of Greenland).
- ERA-Interim seems to under-estimate summer precipitation, in particular for shallow mixed-phase events. Leading to low bias in accumulation over parts of GrIS
- ICECAPS data of high value for validation and as reference site.