Global Snowfall as Revealed by Satellite Precipitation Products (IMERG V07 and GPCP V3.2)

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Snowfall in IMERG and GPCP

- IMERG (Integrated Multi-satellitE Retrievals for GPM) is the gridded high-resolution precipitation product from the U.S. Science Team of the GPM mission.
- GPCP (Global Precipitation Climatology Project) is the gridded Climate Data Record for precipitation with a priority on consistency across the record.
- The most recent versions of IMERG and GPCP include a diagnostic variable for the precipitation phase.
 - * As well, there has been continuing improvements to the algorithms for precipitation rates.

This presentation examines the snowfall as represented by these two satellite products globally.



IMERG, GPCP, Phase Estimate, CloudSat

- IMERG V07B half-hourly and daily precipitation data.
 - ✤ Native resolution: 0.1°, ½ h
 - Coverage: global, 2000–present
 - ✤ Source: PMW/IR
 - JAXA counterpart: GSMaP
- GPCP V3.2 daily and monthly data.
 - Native resolution: 0.5°
 - Coverage: global, 2000/1983-present
 - Source: IR calibrated by PMW
- Probability of liquid phase.
 - ***** ERA5/MERRA-2 wet-bulb temperature \rightarrow probability of liquid phase
 - Derived from station and ship-based observations (credit: Guosheng Liu)
- CloudSat 2C-SNOW-PROFILE R05.
 - Resolution: Footprint observations gridded to 1°
 - Coverage: quasi-global, Sep 2006–Aug 2010 (Full Operation period)
 - Source: W-band radar
- * Also for comparison: the ERA5 and MERRA-2 reanalysis products.



Used as the reference in this study



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Snowfall Climatology

- IMERG and GPCP are able to capture the broad patterns of the 4-year CloudSat snowfall climatology.
- GPCP is generally close to CloudSat.
- IMERG underestimates the snowfall climatology with severe blind spots over Antarctica and Greenland compared to CloudSat.

mean snowfall rate (mm / yr)

IMERG V07B (2006 09-2010 08)

512

1024

256

128

64

GPCP V3.2 (2006 09-2010 08)



GPCP V3.2 - CloudSat R05 (2006 09-2010 08)

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-640 -320 -160 -80 -40 -20 -10 10 20 40 80 160 320 640 mean snowfall rate (mm / yr)

IMERG V07B - CloudSat R05 (2006 09-2010 08)





Monthly global averages

Monthly global averages



← CPR ← IMERG ← GPCP



Snowfall Occurrence

- IMERG and GPCP are able to capture the broad patterns of the 4-year CloudSat snowfall occurrence (defined by avg. no. of days with at least 1 mm / day of snowfall).
- GPCP has lower occurrence than CloudSat while IMERG has higher occurrence than CloudSat. Both IMERG and GPCP underestimate the snowfall occurrence over Antarctica and Greenland.

The lower climatology and higher occurrence in IMERG imply that IMERG has a much lower conditional snowfall rate than CloudSat.

> 16 mean snow occurrence (day / yr)

IMERG V07B (2006 09-2010 08)

32

64

8

128

256

GPCP V3.2 (2006 09-2010 08)



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GPCP V3.2 - CloudSat R05 (2006 09-2010 08)

Snowfall Occurrence

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160

-160 -80 -40 -20 -10 -5 5 10 20 40 80 mean snow occurrence (day / yr)

IMERG V07B - CloudSat R05 (2006 09-2010 08)

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GPCP: Changes in Japan Snowfall



- Being a Climate Data Record, GPCP is suitable for long-term analysis, so we examine the trends of rainfall and snowfall in the grid boxes over Japan.
- GPCP suggests that rainfall has remained roughly the same, but snowfall has decreased.
- Volume of precipitation that fell as snowfall has also decreased.



IMERG: Tracking Snowfall Events

- On 28 Jan 2022, a nor'easter produced precipitation over multiple eastern states, with ground observations reporting 500 to 750 mm (20 to 30 inches) of snowfall.
- With its high resolution, IMERG can track the event and provide a big-picture view over its lifetime, well beyond the range of ground observations and domain of the IMPACTS field campaign.

Conclusions

IMERG and GPCP are two leading satellite precipitation products with different focuses. The inclusion of a precipitation phase estimate permits an analysis of global snowfall.

Comparisons with the CloudSat indicate that:

- IMERG lower climatology esp. over Antarctica and Greenland
- GPCP generally similar climatology (not clear trend)
- MERRA-2 higher climatology except over northern hemisphere ocean
- ERA5 generally similar climatology (not clear trend)

higher occurrence except over Antarctica and Greenland

lower occurrence including over Antarctica and Greenland

higher occurrence except over Antarctica and Greenland

higher occurrence except over Antarctica and Greenland

All products struggle over Antarctica and Greenland.

- **GPCP's consistency allows studying changes in snowfall** over any location globally.
- IMERG's high resolution allows studying snowfall at fine spatial scales and tracking snowfall events anywhere over the globe.
- This presentation demonstrates the maturing capabilities of satellite precipitation products for global snowfall analysis.

