THE IMPORTANCE OF AND USE OF SNOW PRODUCTS IN PRECIPITATION RETRIEVALS

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With contributions from many others – Peter Romanov, Patrick Meyers, Veljko Petkovic
OUTLINE

• Scientific Issue
• Historical perspective
• Current status
• What was requested and done for NASA
• Impacts
• What are future plans for GCOM precipitation EDR at NOAA
Precipitation has a similar signal to surface snow and arid surfaces in the microwave spectrum.

- Also impacted by diurnal variations.
- Many measurements are correlated, so not enough unique information to separate all signals all of the time.
- Impact of misclassification can be quite dramatic (next slide).

Meyers and Ferraro, 2015 – AMSR-2
Example of Misclassification using radiometric screening

Meyers et al 2015 – AMSR-2

15 April 2011
Deep convection confused with snow cover
Historical Perspective

- Restricted to just MW satellite data and static data bases – stove pipes, lack of data interoperability, etc.

- Need for simple approaches for operational use – shared computer resources, etc.

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*Fig. 5. SSMI measurements at 22 GHz plotted against the 85-GHz vertically polarized measurements for (a) snow cover and (b) precipitation over land. The dashed sloping line is given by equation (36), and the horizontal line is given by equation (30) of the text. Also shown is the line of perfect agreement.*
• Additional MW sensors followed SSM/I
  – Better spatial resolution
  – MW sounders/additional channels
  – Better ability to separate surfaces

• Access to other real-time, dynamic data sources become a reality
  – NWP model fields
  – Other satellite and in-situ data
  – Climatological data sets

• Physical retrievals developed and now feasible for operational use
  – Leverage off of other disciplines
    • Land sfc. Emissivity (TELSEM)
    • RTM community (RTTOVS, CRTM)
  – Examples – GPROF, MiRS

Meyers et al 2015 – AMSR-2

Aires et al 2011 – AMSR-E
Impact of using climatology
Current Status/Needs by NASA and Community

Via Peter Romanov

- A global, high resolution daily snow cover field for as long as a time period as possible – back to 1998/TRMM era

  - Produces daily spatially-continuous (gap-free) global snow/ice cover maps ~4 km for use in operational applications
  - Synergy of satellite snow/ice retrievals from observations in the Vis/IR and passive microwave
  - Operational since 2006….
## Autosnow Reprocessing: Sensors used

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Many thanks to CREST for supporting this activity!
Which NASA Products use the Autosnow?

- **All GPM GPROF** (GMI, AMSR2, SSMIS, MHS, ATMS) use the autosnow product to produce the retrievals.

- **GPM Radar L2 Ku/Ka/DPR** uses the autosnow data for retrieval and stored in ENV file.

- Combined **GPM GMI/DPR L2** uses the autosnow information that the radar L2 put into the ENV file.

- **GPM IMERG half-hourly** uses the autosnow file for its retrievals.

- **TRMM PR/Ku** does not use autosnow files but the **TRMM TMI GPROF** retrievals do use the autosnow.
GPROF Algorithm Structure

Sensor data - Observed
- Spacecraft position: Pixel lat/lon, TBs, time, EIA, channels, errors

Sensor Profile Database
- A-priori Matched Profiles
  - GMI/DPR
  - CloudSat/MHS
  - GMI/SSMIS/AMSR2 & MRMS

PreProcessor

GPM Precipitation Algorithm

Post-processor (output, format)

Ancillary Datasets - Modeled
- Surface & Emissivity Classes
- ECMWF / GANAL Model Fields
- Autosnow Snow Cover
- Reynolds Sea-Ice

*Bayesian-approach to form a weighted mean of a priori profiles based on their distances from the observed TB vector.

Daily snow maps from NOAA’s AutoSnow product (Romanov et al. 2000) are used to update the climatological surface classes defined by Aires et al.
Snow surface type in GPROF Algorithm

Step 1 in preprocessor:
- Emissivity Class from TELSEM – monthly climatology
- Four snow categories (min, low, moderate, max)

Step 2 in preprocessor:
- Autosnow Snow Cover
- TELSEM category is adjusted to match Autosnow product
- If TELSEM snow is to be removed, the closest (in time) non-snow surface type for a given pixel is assigned

Ancillary Datasets - Modeled
- Surface & Emissivity Classes
- ECMWF / GANAL Model Fields
- Autosnow Snow Cover
- Reynolds Sea-Ice
Effect of adding Autosnow surface type information to the Bayesian averaging

• Operational PPS GPROF V5 precipitation retrieval using both monthly TELSEM climatology and daily Autosnow surface type information.

• In the plot: snowing pixels only; globally; over land; October – April 2017.

• Overall bias: -31 %

• When Autosnow is EXCLUDED, bias increases by 15% (to -35%)
Example of current NOAA GCOM vs. GPM GCOM

False rain retrievals due to confusion with snow on ground and outside of climatology

Accurate “no rain” retrieval via dynamic use of Autosnow in GPROF retrieval

AMSRR2 & MRMS Precipitation Rate – 20180118–0740UTC

GPROF2010V2 AMSR2

GPROF2017 AMSR2

MRMS (OU/NSSL)
Summary and looking ahead

- Accurate snow cover information is critical for passive microwave precipitation retrievals
  - Lack of unique radiometric information to delineate “scattering” surfaces
  - Even using ancillary data and full physical retrievals does not work 100% of time

- Autosnow provides global, high spatial resolution information that is compatible with passive MW sensors and provides complimentary information

- NOAA GCOM project is evaluating latest NASA GPM passive MW retrieval (GPROF2017) for future implementation
  - Anticipated for sometime in 2019