

Algorithm Inventory – AMSU orbital, pentad and monthly rainfall

Updated 11 November 2008

1. Description/Theory

References:

Ferraro, R.R., F. Weng, N. Grody, L. Zhao, H. Meng, C. Kongoli, P. Pellegrino, S. Qiu and C. Dean, 2005: NOAA operational hydrological products derived from the AMSU. *IEEE Trans. Geo. Rem. Sens.*, **43**, 1036 – 1049.

Kongoli, C., P. Pellegrino and R. Ferraro, 2007: The utilization of the AMSU high frequency measurements for improved coastal rain retrievals, *Geophys. Res. Lett.*, **34**, L17809, doi:10.1029/2007GL029940

Kongoli, C., P. Pellegrino, R. Ferraro, N. Grody and H. Meng, 2003: A new snowfall detection algorithm over land using measurements from the Advanced Microwave Sounding Unit (AMSU). *Geophys. Res. Lett.*, **30**, 1756-1759.

Qiu, S., P. Pellegrino and R. Ferraro, 2005: An evaluation of an improved AMSU rain rate algorithm and its application to winter season rainfall in the western United States. *Weather and Forecasting*, **20**, 761 – 774.

Vila, D., R. Ferraro, R. Joyce, 2007: Evaluation and Improvement of AMSU Precipitation Retrievals. *J. Geophys. Res.*, **112**, D20119, doi:10.1029/2007JD008617.

The AMSU instantaneous/orbital precipitation rate product is based on the derivation of ice water path (IWP) and particle effective diameter size (De) through the use of AMSU-B 89 and 150 GHz measurements. As such, it is primarily a scattering approach. The rain rate is then computed using cloud model based simulations between IWP and rain rate. A convective and non-convective IWP to rain rate relationships are used, where the distinction between the two is based upon a series of comparisons between the three AMSU-B channels centered at the 183.31 GHz water vapor absorption band. Additionally, the algorithm identifies regions of falling snow over land through the use of AMSU-A measurements at 53.8 GHz. At present, falling snow is assigned a rate of 0.1 mm/hr, although an experimental snowfall rate is being tested and evaluated.

In 2007, an emission component was added to increase the areal of coverage of rainfall over oceans through the use of a liquid water estimation using AMSU-A 23.8 and 31 GHz (Vila et al. 2007). Additionally, an improved coastline rainrate module was added that computes a proxy IWP using the 183 GHz bands (Kongoli et al. 2007).

2. Strengths and Weaknesses

Strengths:

- Use of 150 GHz enhances sensitivity to precipitation ice; improves the ability to detect lighter precipitation rates

- Use of AMSU-A sounding channels expands precipitation detection over land to some snow covered and frozen surfaces
- Use of 183 GHz water vapor bands reduces surface emissivity effects over land
- Wide swath width of AMSU (2200 km)

Weaknesses:

- Primarily a scattering technique, indirect relationship between IWP and rain rate. In particular, over ocean, limited use of emission signals due to lack of desirable channels in this frequency range (only 23.8 and 31.4 GHz) does not give a desirable dynamic range of rainfall.
- The IWP/De retrieval does not always converge, thus, there are indeterminate areas, sometimes which coincides with light rain areas (in particular, over ocean)
- Cross-track scan configuration of AMSU: varying FOV size with scan angl

3. Algorithm Inputs

A. Satellite Data

1. Geostationary - None

2. Low Earth Orbit

A. NOAA-15, -16, -17, -18 and MetOp-A. Obtain level 1b files directly from NESDIS. Use AMSU-A (23.8, 31.4, 50.3 and 52.8 GHz) and AMSU-B (89, 150, 183 \pm 1, \pm 3, \pm 7 GHz) on NOAA-15, -16 and -17 (MHS 89, 157, 183 \pm 1, \pm 3 and 190.3 GHz) on NOAA-18 and MetOp-A. Data latency is 1 – 3 hours.

B. Ancillary Data

1. Model Data

A. NCEP GDAS land surface temperature and ocean surface wind speed is used. The 24-hour forecast fields are updated twice a day and stored in files that represent 0000, 0600, 1200 and 1800 UTC which are then matched with the AMSU overpass times. The ocean surface wind speeds are used indirectly in the ocean rain algorithm (as part of the retrieval of water vapor and cloud water) and the land surface temperature is used to screen for cold/frozen land.

2. In Situ - None

3. Other (i.e. topography data base)

A. A static Land/Sea/Coast databases at 25 and 50 km resolution are used, depending on the AMSU scan angle/FOV size.

4. Processing (i.e. Level 2 processing ingests Level 1 products as input)

A. Product Development Level 1 - Generate AMSU-B (or MHS) L1 orbital/swath products

1. Input L1b AMSU-A and AMSU-B (or MHS) radiances.
2. Access ancillary data, including surface type and GDAS surface temperature.
3. Generate FOV specific AMSU derived products, including TPW, CLW, IWP, snow cover and sea-ice concentration.
4. Perform IWP and De retrieval; pass this information, along with land surface temperature, sea-ice concentration and snowcover into precipitation rate algorithm. Generate FOV specific rain rate.
5. Store products in HDF-EOS Swath file; make accessible to users on NESDIS FTP server.

B. Product Development Level 2 – Generate AMSU pentad rainfall at 1.0 and 2.5 degree

1. Input all L1 swath files for five day period. This is done individually for each satellite type, as well as combined for all.
2. Compute mean rain rate at particular grid size for five day period.
3. Output in binary format

C. Product Development Level 2 – Generate AMSU monthly rainfall at 1.0 and 2.5 degree

1. Input all L1 swath files for five day period. This is done individually for each satellite type, as well as combined for all.
2. Compute mean rain rate at particular grid size for five day period.
3. Output in binary format

5. Output Products

A. AMSU Swath rain rates

- 1. Temporal/Spatial Resolution:** Instantaneous; 16 km at nadir, 48 km at limb. *Note that at the time of this writing (November 2008), the time of the local ascending overpass for each of the NOAA satellites is as follows: NOAA-15 1659; NOAA-16 1657; NOAA-17 2149; NOAA-18 1338; MetOp-A 2130.*

2. **Spatial Coverage:** 2200 km swath width; provides near global coverage in 24 hours.
3. **Dedicated Product Web Page Location:**
<http://www.star.nesdis.noaa.gov/corp/scsb/mspps/>
http://www.osdpd.noaa.gov/PSB/IMAGES/MSPPS_day2.html
4. **Processing Specifics**
 - **Latency** – 0 to 3 hours
 - **Update Frequency** – Whenever new orbit is received (orbits are approximately 100 minutes in length)
5. **Operational Availability of Product**
 - **Source** – Available on NESDIS FTP server; contact Limin.Zhao@noaa.gov for registration form.
 - **Latency** – 0 to 3 hours
 - **Update Frequency** - Whenever new orbit is received (orbits are approximately 100 minutes in length)
 - **Available Record Length** – last 48 hours
6. **Historical Availability of Product**
 - **Source** – NOAA CLASS system: <http://www.class.noaa.gov/>; access MSPPS_ORB files
 - **Update Frequency** - Daily
 - **Available Record Length:**
 - i. **NOAA-15:** January 2000 to present
 - ii. **NOAA-16:** October 2000 to present
 - iii. **NOAA-17:** July 2002 to present
 - iv. **NOAA-18:** September 2005 to present
 - v. **MetOp-A:** March 2007 to present

B. AMSU pentad and monthly rainrates

1. **Temporal/Spatial Resolution:** 5-day and monthly/1.0 and 2.5 degree.
Note that at the time of this writing (November 2008), the time of the local ascending overpass for each of the NOAA satellites is as follows: NOAA-15 1659; NOAA-16 1657; NOAA-17 2149; NOAA-18 1338; MetOp-A 2130.
2. **Spatial Coverage:** Global
3. **Dedicated Product Web Page Location:**
<http://www.star.nesdis.noaa.gov/corp/scsb/mspps/>
4. **Processing Specifics**

- **Latency** – Monthly
- **Update Frequency** – Monthly

5. Operational Availability of Product - None

6. Historical Availability of Product

- **Source** – Upon request from Ralph.R.Ferraro@noaa.gov
- **Update Frequency** - Monthly
- **Available Record Length:**
 - vi. **NOAA-15:** January 2000 to present
 - vii. **NOAA-16:** October 2000 to present
 - viii. **NOAA-17:** July 2002 to present
 - ix. **NOAA-18:** September 2005 to present

6. Planned Modifications/Improvements

- Inclusion of snowfall rates over land

7. Capability of Producing Retrospective Data

Periodic reprocessing (1 time/year) is nominal plan, but subject to resource availability. Last reprocessing took place in April 2007.

8. Contact Personnel

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9. Additional Comments

NESDIS is migrating to a new, portable microwave retrieval system (MIRS) and within two years, the MIRS precipitation product will replace MSPPS. For more information, see <http://mirs.nesdis.noaa.gov/>.

