MIRS Delivery Memorandum Version 11.10

Date of Release:

March 15th 2024

Purpose of Delivery:

This delivery constitutes the official MIRS delivery algorithm package (DAP11.10) to NOAA/NESDIS/OSPO and STAR ASSISTT from NOAA/NESDIS/STAR.

Brief Description of the Package:

This MIRS package contains all source codes, scripts, makefiles, data, coefficients, etc. needed to run the MIRS package for the following operational satellites: NOAA-18, NOAA-19, METOP-A, METOP-B, METOP-C, DMSP-F17, DMSP-F18, S-NPP, GPM, NOAA-20, NOAA-21, and Metop-SG-A1 (preliminary). Note that the variational retrieval is sensor-independent and could be run for any other microwave sensor. The same observation applies to the forward operator and other sensor-independent applications. The testing was performed under a Linux environment using both ifort and gfortran Fortran compilers.

The package also contains more limited (research) capability to process the following satellites/sensors: TRMM/TMI, GCOM-W1/AMSR2, and AQUA/AMSR-E. **However, the retrieval products from these sensors have not been subjected to extensive validation, are not officially operational, and should be used for research purposes only. Please contact the MiRS team with any questions concerning the processing of these data, or before presenting any results to the community.**

List of Delivery Contents:

(1) Source codes, (2) Scripts, (3) Configuration files, (4) Makefiles, (5) Coefficients, (6) Sample data, (7) Documentation, (8) Version 2.1.1 of the CRTM forward model package, (9) Benchmark files for verification, (10) GUI-based tool to control MIRS execution, (11) A complete *readme* file

Version Number

The MiRS algorithm version and serial number of this delivery are contained in the name of the DAP tar file.

Officially Delivered Products

MiRS produces all core and derived products by design. However, depending on the information content of the particular sensor measurements, only certain retrieved products, resulting from either the core retrieval or the post-processing algorithm, may be of operational quality. The officially delivered products with this delivery are the following:

For Suomi-NPP, NOAA-18, NOAA-19, METOP-A, METOP-B, METOP-C, NOAA-20, NOAA-21, METOP-SG-A1:**

- Temperature profile over open water ocean
- Humidity profile over open water ocean
- Humidity Profile over non-coastal Land
- Total Precipitable Water (TPW) over open water ocean
- Total Precipitable Water over non-coastal land
- Land surface temperature
- Surface Emissivity over land and snow
- Surface Type Classification
- Snow Water Equivalent (SWE)
- Sea Ice Concentration (SIC)
- Snow Cover Extent (SCE), based on the SWE

- Vertically-Integrated Non-precipitating Cloud Liquid Water (CLW) over open water ocean
- Vertically-Integrated Ice Water Path (IWP)
- Vertically-Integrated Rain Water Path (RWP)
- Rainfall Rate (RR) over open water ocean and non-coastal, non-snow-covered land surface types
- Effective grain size of snow (over snow-covered land surface)*
- Multi-Year (MY) Type Sea Ice Concentration*
- First-Year (FY) Type Sea Ice Concentration*

*Note that FY and MY Sea Ice Concentration, as well as Snow Grain Size are not officially operational, but preliminary products, which is a higher maturity level than experimental status.
**Note that all retrieval products from NOAA-21 are at provisional maturity level.

The following products are also produced experimentally for NOAA-18, NOAA-19, Metop-A, Metop-B, Metop-C, Suomi-NPP, and NOAA-20. Note that they lack a thorough validation due to the absence of reliable ground truth measurements. These are made available to users for the purpose of evaluating their usefulness.

- Cloud Liquid Water Profile (CLWP) over ocean.
- Surface Temperature (skin) extended to snow-covered land surface type
- Surface Temperature (skin) extended to open ocean water

For DMSP-F17 and DMSP-F18:

- Temperature profile over open water ocean
- Humidity profile over open water ocean
- Total Precipitable Water (TPW) over open water ocean
- Total Precipitable Water over non-coastal land
- Land surface temperature
- Surface Emissivity over land and snow
- Surface Type Classification
- Snow Water Equivalent (SWE)
- Sea Ice Concentration (SIC)
- Snow Cover Extent (SCE), based on the SWE
- Vertically-Integrated Non-precipitating Cloud Liquid Water (CLW) over open water ocean
- Vertically-Integrated Ice Water Path (IWP)
- Vertically-Integrated Rain Water Path (RWP)
- Rainfall Rate (RR) over open water ocean and non-coastal, non-snow-covered land surface types
- Effective grain size of snow (over snow-covered land surface)*
- Multi-Year (MY) Type Sea Ice Concentration*
- First-Year (FY) Type Sea Ice Concentration*

*Note that FY and MY Sea Ice Concentration, as well as Snow Grain Size are not officially operational, but preliminary products, which is a higher maturity level than experimental status.

The following products are also produced experimentally for SSMI/S. These are made available to users for the purpose of evaluating their usefulness.

- Cloud Liquid Water Profile (CLWP) over ocean

For GPM:

- Total Precipitable Water (TPW) over open water ocean
- Total Precipitable Water over non-coastal land
- Surface Type Classification
- Snow Water Equivalent (SWE)
- Snow Cover Extent (SCE), based on the SWE
- Vertically-Integrated Non-precipitating Cloud Liquid Water (CLW) over open water ocean
- Vertically-Integrated Ice Water Path (IWP)
- Vertically-Integrated Rain Water Path (RWP)
- Rainfall Rate (RR) over open water ocean and non-coastal, non-snow-covered land surface types

For Megha-Tropics/SAPHIR:

- Humidity profile over open water ocean
- Humidity Profile over non-coastal Land
- Total Precipitable Water (TPW) over open water ocean
- Total Precipitable Water over non-coastal land
- Rainfall Rate (RR) over open water ocean and non-coastal, non-snow-covered land surface types. Please note that RR should be considered as a reduced-quality product relative to RR derived from conventional imager/sounder instruments. Known limitations include low or poor detection of rain from liquid water hydrometeors, and possible saturation (loss of sensitivity) for higher rain rates greater than approximately 10 mm/h.

Summary of Changes Made since Last Delivery:

The list below is an overview of all technical, scientific and other changes made to MIRS since the last official delivery (DAP11.9) which occurred in August 2022.

Scientific changes:

- Snowfall Rate (SFR): As of this version, **SFR is no longer supported under MiRS**. The SFR algorithm has transitioned to a stand-alone algorithm. For further information on the SFR status in operations, please contact Huan Meng at NOAA/NESDIS/STAR (Huan.Meng@noaa.gov).
- An updated radiometric bias correction and instrument+forward model error file for NOAA-21 ATMS has been included in this package. This should produce slightly better performance for water vapor and temperature profile retrievals, as well as total precipitable water (TPW).
- Total Precipitable Water (TPW): A correction was made to the computation of TPW from the retrieved water vapor profile. This should result in a slight decrease of about 1 mm on average globally. Water vapor profiles themselves are not affected by the change.

Technical changes:

- **IMPORTANT CHANGE:** Please note that **significant changes have been made to the variable representation and/or precision for several variables in the output netCDF files, specifically the IMG files which contain "single-level" variables**. The issue is summarized below.
    - The variable type and scale factors of several products stored in the MiRS output IMG* netCDF files are leading to significant issues that negatively impact the quality of the data for both operational and science users. The primary issues are:
        - 1) Signed 2-byte types and scale factor (0.01) for TSkin, YM (uncorrected brightness temperature), and BT (corrected brightness temperature) are leading to potential overflow/saturation in conditions of very high surface temperatures (i.e. greater than 327.67 K). Occurrences of saturation/overflow in these variables are likely to increase as Earth temperatures increase.
        - 2) Signed 2-byte types and scale factor (0.1 and 0.01) for hydrological variables: RR, RWP, GWP, CLW, LWP do not provide sufficient precision for scientific analysis.

  The table below summarizes the old (v11.9 and earlier) and new (v11.10) variable representations:

Variable	Old type	Bytes	Value range	Old scale factor	New type	New scale factor
RR	short	2	-32,768 to 32,767	0.1	float (4 bytes)	N/A
CLW	short	2	-32,768 to 32,767	0.01	float	N/A
GWP	short	2	-32,768 to 32,767	0.01	float	N/A
RWP	short	2	-32,768 to 32,767	0.01	float	N/A
TSkin	short	2	-32,768 to 32,767	0.01	float	N/A
LWP	short	2	-32,768 to 32,767	0.01	float	N/A
BT	short	2	-32,768 to 32,767	0.01	short (no change)	0.015
YM	short	2	-32,768 to 32,767	0.01	short (no change)	0.015

The changed variable representation is expected to increase the disk storage requirement for global data by approximately 38 MB per day or approximately 14 GB per year for ATMS for a single satellite. It is recommended that users update their processing software well in advance so that they can ingest MiRS products without interruption. The MiRS science team can provide sample v11.10 output files upon request.

MIRS Design & Development Team

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Point of Contact:

Feedback, comments, criticisms, and suggestions, are welcome and should be sent to:

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