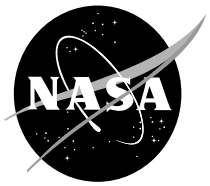
NASA/CP–2011-215885



# Report from the Passive Microwave Data Set Management Workshop

*Ed Armstrong, Helen Conover, Michael Goodman, Brian Krupp, Zhong Liu, John Moses, H. K. Ramapriyan, Donna Scott, Deborah Smith, and Ronald Weaver*

Prepared for the
Passive Microwave Data Set Management Workshop

Sponsored by the
NASA Earth Science Data and Information System (ESDIS) Project

Huntsville, Alabama
May 17–19, 2011

**December 2011**

The NASA STI Program Office … in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

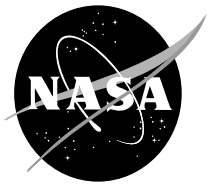
- TECHNICAL PUBLICATION. Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- TECHNICAL MEMORANDUM. Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- CONTRACTOR REPORT. Scientific and technical findings by NASA-sponsored contractors and grantees.
- CONFERENCE PUBLICATION. Collected papers from scientific and technical conferences, symposia, seminars, or other meetings sponsored or cosponsored by NASA.
- SPECIAL PUBLICATION. Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.
- TECHNICAL TRANSLATION. English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at http://www.sti.nasa.gov/STI-homepage.html
- E-mail your question via the Internet to help@sti.nasa.gov
- Fax your question to the NASA Access Help Desk at (443) 757-5803
- Telephone the NASA Access Help Desk at (443) 757-5802
- Write to:
  NASA Access Help Desk
  NASA Center for AeroSpace Information
  7115 Standard Drive
  Hanover, MD 21076

NASA/CP–2011-215885



# Report from the Passive Microwave Data Set Management Workshop

*Ed Armstrong*
*NASA Jet Propulsion Laboratory, Pasadena, CA*

*Helen Conover*
*University of Alabama in Huntsville, Huntsville, AL*

*Michael Goodman,*
*NASA Marshall Space Flight Center, Huntsville, AL*

*Brian Krupp*
*ADNET Systems, Inc., Greenbelt, MD*

*Zhong Liu*
*George Mason University, Fairfax, VA*

*John Moses*
*Goddard Space Flight Center, Greenbelt, MD*

*H. K. Ramapriyan*
*Goddard Space Flight Center, Greenbelt, MD*

*Donna Scott*
*University of Colorado – Boulder, Boulder, CO*

*Deborah Smith*
*Remote Sensing Systems, Santa Rosa, CA*

*Ronald Weaver*
*University of Colorado – Boulder, Boulder, CO*

National Aeronautics and
Space Administration

**Goddard Space Flight Center**
**Greenbelt, Maryland 20771**

**December 2011**

*Level of Review:* This material has been technically reviewed by technical management

Available from:

NASA Center for AeroSpace Information
7115 Standard Drive
Hanover, MD 21076-1320

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

## Acknowledgement

Special thanks to NASA Earth Science Data and Information System (ESDIS) Project for guiding and sponsoring this workshop and to NASA Headquarters Earth Science Division for encouragement and support. Thanks to the workshop committee members for planning, facilitating and recording the activities of the workshop, and to all workshop attendees for bringing their diverse expertise in the use and management of passive microwave data, and for their active and thoughtful participation. This report was drafted by the members of the workshop committee, and reviewed by all workshop participants.

## Passive Microwave Workshop Committee Members

** participated in workshop remotely*

*Ed Armstrong**, Physical Oceanography Distributed Active Archive Center, NASA Jet Propulsion Laboratory
*Helen Conover*, Global Hydrology Resource Center, University of Alabama in Huntsville
*Michael Goodman*, Global Hydrology Resource Center, NASA Marshall Space Flight Center
*Brian Krupp*, NASA Earth Science Data and Information System (ESDIS) Project, ADNET Systems, Inc.
*Zhong Liu*, Goddard Earth Sciences Data and Information Services Center, George Mason University
*John Moses*, NASA Earth Science Data and Information System (ESDIS) Project, Goddard Space Flight Center
*H. K. Ramapriyan**, NASA Earth Science Data and Information System (ESDIS) Project, Goddard Space Flight Center
*Donna Scott**, National Snow and Ice Data Center DAAC, University of Colorado – Boulder
*Deborah Smith*, Remote Sensing Systems
*Ronald Weaver*, National Snow and Ice Data Center DAAC, University of Colorado – Boulder

## Additional Workshop Participants

*Mark Anderson*, University of Nebraska
*Dawn Conway*, Earth Systems Science Center, University of Alabama in Huntsville
*Marilyn Drewry*, Global Hydrology Resource Center, University of Alabama in Huntsville
*Evan Fishbein*, AIRS Atmospheric Science Research Team, Jet Propulsion Laboratory
*John Forsythe*, Cooperative Institute for Research in the Atmosphere, Colorado State University
*Danny Hardin*, Global Hydrology Resource Center, University of Alabama in Huntsville
*Sherry Harrison*, Global Hydrology Resource Center, University of Alabama in Huntsville
*Amanda Leon*, National Snow and Ice Data Center DAAC, University of Colorado – Boulder
*Walt Meier*, National Snow and Ice Data Center DAAC, University of Colorado – Boulder
*Pamela Rinsland**, Atmospheric Science Data Center, NASA Langley Research Center
*Chung-Lin Shie*, Joint Center for Earth Systems Technology, University of Maryland Baltimore County

### Citation for Reference or Attribution:

Smith, D., D. Scott, H. Conover, eds. 2011. "Report from the Passive Microwave Data Set Management Workshop." Workshop held 17-19 May, 2011, Huntsville, AL. Sponsored by the NASA Earth Data and Information System (ESDIS) Project.

# Table of Contents

[This page intentionally left blank]

## Executive Summary

Passive microwave data sets are some of the most important data sets in the Earth Observing System Data and Information System (EOSDIS), providing data as far back as the early 1970s. The widespread use of passive microwave (PM) radiometer data has led to their collection and distribution over the years at several different Earth science data centers. The user community is often confused by this proliferation and the uneven spread of information about the data sets. In response to this situation, a Passive Microwave Data Set Management Workshop was held 17-19 May 2011 at the Global Hydrology Resource Center, sponsored by the NASA Earth Science Data and Information System (ESDIS) Project. We reviewed all primary (Level 1-3) PM data sets from NASA and non-NASA sensors held by NASA Distributed Active Archive Centers (DAACs), as well as high-value data sets from other NASA-funded organizations.

## Workshop Purpose

The main goal of the Passive Microwave Data Set Management Workshop was for data producers and data distributors to come together in order to organize and document all PM data sets available at NASA DAACs with the purpose of better informing users of data set choices. Data sets created from ESMR, SMMR, SSM/I, TMI, AMSR, AMSR-E, WindSat, and SSMIS instrument observations were reviewed.

The primary objectives of the workshop were to:

- Determine if PM data sets are duplicative and, if so, why each specific data set is important to a given user community.
- Discuss possible changes to level of service (LOS) for data sets with or without an active user community.
- Discuss ways in which we can more clearly describe and document the PM data sets held by NASA-funded providers with the intent to harmonize semantics, formats and documentation to the benefit of data users.

## Summary of Workshop Findings

The full report includes findings specific to various data discipline categories such as cryospheric, land or atmospheric data sets. Many findings were common across multiple discipline categories, and are applicable to other types of Earth science data as well. Listed below is a summary of the general findings.

- We only found a few duplicate PM data sets; however, we did find a lack of documented differences between some data sets, which were therefore construed to be duplicative.
- Some PM data sets are available from both the data producer and the archive of record. For example, most TRMM Microwave Imager data sets are available from both the Precipitation Processing System (PPS) and Goddard Earth Sciences Data and Information Services Center (GES DISC). Generally, data producers make data available on a temporary basis to a smaller community and the archive of record provides longer-term archival, broader community distribution, and may provide higher LOS.

- We found several instances in which information about the source data from which a data set was derived and/or the algorithm and version used, was absent or not clear.
- We found significant differences in the levels of documentation among different PM data sets, especially between the EOS missions (AMSR-E, TMI) and some of the others (e.g. SSM/I, SSMIS).
- While ESDIS provides guidelines for data set documentation, they are not consistently applied. Existing guidelines include:
    - Metadata requirements including Global Change Master Directory (GCMD) Data Interchange Format (DIF), Earth Observing System (EOS) Clearinghouse (ECHO) entries, and guide documents;
    - Templates for DAAC data set reviews;
    - Emerging Provenance and Context Content Standards.
- We found several data sets, which have been or will be superseded by newer data sets, often at the same data center or producer site.
- All participants – whether from DAACs, MEaSUREs projects, or ESDIS – found this exercise to be valuable and we recommend that other instrument/discipline groups host similar workshops.

## Summary of Workshop Recommendations

The Workshop Committee assembled the following high-level recommendations with the collaboration of the attendees. It is likely that these *high-level* recommendations apply to data sets from other types of instruments and/or cover other disciplines as well. The full set of recommendations in the following report is organized by data center in Section 3.2 to facilitate review by the relevant DAAC User Working Groups. The more detailed recommendations for specific data sets are also included in the tables in Section 4 in the form of suggested actions where appropriate. The high-level recommendations include:

- Provide clear documentation and cross-referencing between related PM data sets. Digital Object Identifiers (DOIs) can help clarify whether data sets are identical.
- For all NASA data sets, document the lineage clearly. In particular,
    - Versions of both the data set and the algorithm(s) used to generate it need to be verified, documented, and made more visible as necessary.
    - Source and version of data set(s) used as input to the product need to be identified, noting when the source data were published, and especially when the version of the source data has changed.
- Compile a checklist of required documentation for data sets, based on existing requirements and guidelines. Review and update documentation for PM data sets, coordinating across DAACs holding similar data.
    - Consider relating documentation requirements to LOS.
    - Review documentation for high value data sets first.
    - Maintain and update documentation regularly on a pre-determined schedule.
- Develop common NASA Data Center practices for retiring superseded data sets.

# 1 Introduction

## 1.1 Workshop Purpose

The main goal of the Passive Microwave Data Set Management Workshop was for data producers and data distributors to come together in order to organize and document all PM data sets available at NASA DAACs with the purpose of better informing users of data set choices. We included data sets made from ESMR, SMMR, SSM/I, TMI, AMSR, AMSR-E, WindSat, and SSMIS instrument measurements in the review process.

The primary objectives of the workshop were to:

- Determine if PM data sets are duplicative and, if so, why each specific data set is important to a given user community.
- Discuss possible changes to LOS for data sets with or without an active user community.
- Discuss ways in which we can more clearly describe and document the PM data sets held by NASA funded providers with the intent to harmonize semantics, formats and documentation to the benefit of data users.

## 1.2 Scope of Data Review

In order to keep the scope of the data review manageable, the workshop committee limited the review to satellite PM radiometer data sets. We did not consider data from satellite microwave sounders, or from any airborne microwave instruments.

The primary focus of the data review was on Level 1 through Level 3 data sets at the DAACs, as well as primary data sets generated and distributed by MEaSUREs projects. The committee also considered key PM data sets generated and distributed by other NASA-funded organizations. For those MEaSUREs projects generating higher level (e.g., merged) data sets, the Committee was more interested in which source PM data sets they are using and why. While not reviewed in detail at the workshop, other sources for PM data are discussed in Section 5.

Furthermore, the data review focuses on primary data sets that are both publicly available and archived for long-term preservation. The data set tables in Section 4 contain any publicly available data sets, but not data subsets whether created and stored beforehand or produced with software tools on the fly.

## 1.3 Workshop Process

The workshop committee first assembled lists of PM data sets at NASA and in some cases, at non-NASA organizations. The committee then categorized these PM data sets by discipline and instrument. Representatives of data producers and data centers were invited to the Workshop based upon their representation of the discipline categories and instrument types. Workshop participants, with contact information, are listed at the beginning of this document.

At the Workshop, the participants discussed each discipline category using a series of questions. The responses and discussion generated in these sessions constitute the material presented in this report and the workshop recommendations.

## 1.4 Data Set Terminology

One of the first issues we faced in this workshop was the difficulty in communicating about PM data sets at NASA and non-NASA centers due to the wide variety of terms and meanings used by each center. Therefore, we agreed on a set of definitions to be used during the meeting and within this report.

For the purposes of this report, a *data set* is a collection of similar science data files differing only in temporal and/or spatial extent. Typically, all files contain observations from the same instrument, and provide the same derived geophysical parameter(s). We use the word *product a*s a synonym for data set and use it to refer to a data set derived from raw instrument data or from higher level data by an individual or organization (such as creating a wind speed product from brightness temperature data). A *merged data set* may contain geophysical parameters derived from two or more instruments (such as a merged sea surface temperature (SST) data set created from TMI, AMSR-E and WindSat SSTs). ***We find the use of consistent terminology important to communication and therefore recommend NASA DAACs agree on a set of terms for use with data sets within NASA.***

For the purposes of this report*, data set status* definitions are given below. ***We recommend a consistent terminology describing data set status at all NASA DAACs.***

- PUBLIC: Users can find and access the data. Registration may be required, but no pre-qualifications are needed to register
- RESTRICTED: Users have to register for access to the data. Access to data may be limited through pre-qualification requirements (e.g., approved proposals, agreement to use only for research or education purposes).
- UNAVAILABLE: The metadata for the data set is available, although the data are not (e.g., a data set is not in a readily distributable form but on-line data discovery systems like ECHO or GCMD record the data set existence).
- RETIRED: This term is used very differently across data centers and we do not have agreement on its meaning. Retired data sets may be unavailable, or may still be public but at a low level of support. ***We recommend that a consistent retirement policy be developed for use across NASA data centers.***

Data sets are considered *duplicate data sets* in the strict sense if they contain the same bits and are in the same file format. However, in this workshop, we were more likely to find less strict forms of duplication, for example:

- Data sets similar enough in name, parameter, etc., that a reasonable data user could be unsure of which data set to use.
- Data sets that are scientifically and/or computationally the same, but in different file formats.
- Data sets that are computationally the same, but a different version of the processing algorithm was applied, or a different version of the source data was used.

In these cases, the workshop committee generally ***recommends improved documentation and cross-referencing, particularly in cases where one data set supersedes another, so that data users can distinguish which data set is appropriate to their research needs.***

# 2. Review of Passive Microwave Data Sets

## 2.1 Survey of NASA Passive Microwave Data by Discipline

The various data sets in the following subsections are grouped by science discipline. Subset data sets for specific regional studies are discussed in Section 2.2.2. Data and imagery generated on demand from a service (like Giovanni) are not considered as actual data sets, but the workshop committee has several recommendations about traceability for provenance of these derived products and related services. These recommendations are discussed throughout and listed in Section 3.1.

Within each discipline, we have identified primary data sources and duplicative data sets, as well as the need for clarification, cross-referencing and possible changes in LOS. While many of these findings are specific to a discipline, or to a specific PM data set, others are more general. The most common findings are presented in the Executive Summary and in Section 3.1. These findings should be considered applicable to all PM discipline groups discussed here.

An overview of the various satellite instrument observations and PM data sets surveyed is shown in Table 1, with a full list of products in each discipline group presented in the tables of Section 4.1.

**Table 1. Summary of NASA's Primary Passive Microwave Data Providers.**

| Organization | Type | Sensors held | Data Products |
|---|---|---|---|
| Atmospheric Sciences Data Center (ASDC) | NASA DAAC | SMMR, SSM/I | atmospheric products, ice/snow |
| Global Hydrology Research Center (GHRC) | NASA DAAC | SSM/I, AMSR-E | Tb, atmospheric products |
| Goddard Earth Sciences Data and Information Services Center (GES DISC) | NASA DAAC | SSM/I, TMI, AMSR-E | Tb, precipitation, atmospheric products |
| National Snow and Ice Data Center Distributed Active Archive Center (NSIDC) | NASA DAAC | ESMR, SMMR, SSM/I, AMSR-E, SSMIS | Tb, Cryosphere, land/soil moisture, precipitation, atmospheric products |
| Physical Ocean Distributed Active Archive Center (PO.DAAC) | NASA DAAC | SMMR, SSM/I, TMI, AMSR-E, WindSat | Sea surface temps, atmospheric products over oceans |
| Precipitation Processing System (PPS) | NASA SIPS | TMI | Tb, precipitation, atmospheric products |
| Remote Sensing Systems (RSS) | MEaSUREs | SSM/I, TMI, AMSR, AMSR-E, WindSat, SSMIS | Tb*, atmospheric products, sea surface temps |
| Colorado State University, Precipitation Research Group (CSU PRG) | MEaSUREs | SSM/I, TMI, AMSR-E | Tb, precipitation |

** Not publicly available*

### 2.1.1 Brightness Temperature Data Sets

Brightness temperature data sets are sensor records containing either radiometer brightness temperatures (Tb) or antenna temperatures (Ta). Tb estimates are derived from Ta values by adding relevant calibration information. These data are typically NASA Level 1 (L1) or Level 2 (L2) files, in swath or gridded formats, and are the primary source data sets for the rest of the products reviewed in this report. We noted that RSS brightness temperature data sets from some of the PM radiometers are available at separate data centers, such as SSM/I (NOAA NCDC), AMSR-E (NSIDC), and WindSat (tbd). The flow of brightness temperature data sets from the various PM radiometers is shown in Figure 1, and a full list of these data sets is provided in Table 4.1.1.

In general, we found that Tb users are typically knowledgeable science users, not novice users, and that the data centers do not field many user questions for these data sets. Given this level of sophistication among the primary users of these data, available documentation is considered good for the current data sets. We noted, however, that SMMR data sets are documented primarily through peer-reviewed publications, and that for some SSM/I Tb data sets, the version number is documented only in the file name. ***For all of these data sets, care should be taken to document input data sources and versions, as well as the versions of the Tb data sets.***

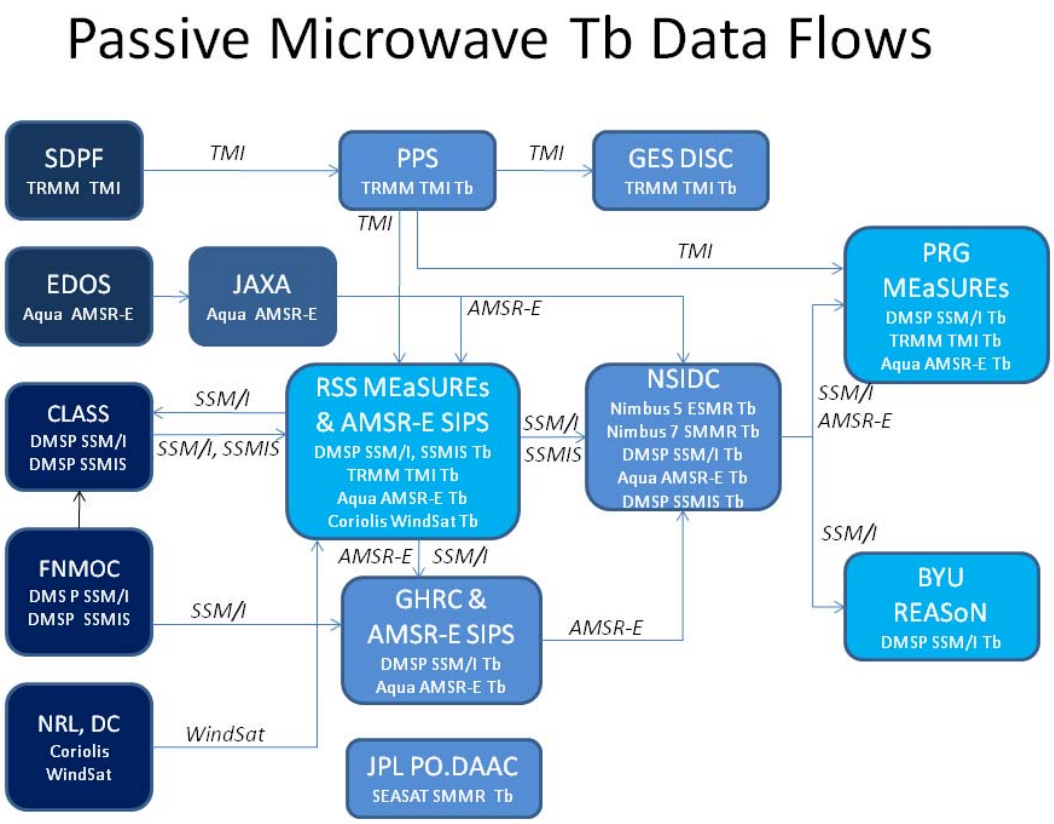



**Figure 1. Flow of Brightness Temperature Data Sets from Various Passive Microwave Radiometers.**

### 2.1.2 Atmospheric Data Sets

Within the spectral ranges of the satellite PM radiometers reviewed in this workshop, emissions from land are far stronger than emissions from the atmosphere. This is not the case for the oceans, where emissivities are typically low. As a result, most atmospheric parameters such as water vapor and wind speed can only be derived over the oceans. Quantitative rain rates are obtainable over land for cases where the rain is sufficient so that the scattering signal exerts a strong effect on the upwelling emissions from the surface. Rain rates over land as well as over ocean can be derived from SSM/I and AMSR-E retrievals, whereas only ocean rain rates are provided for SMMR and TMI. The usual atmospheric parameters from PM observations include water vapor, cloud liquid water, wind speed, and rain rates. Often, the derived parameters are provided as a suite of measurements (typically referred to as "ocean suites"), which can include sea surface temperatures if the instrument has the lower frequency channels needed such with TMI and AMSR-E. WindSat is a unique polarimetric radiometer with the capability to measure ocean surface wind vectors (speed and direction). WindSat wind vectors are available in the RSS WindSat ocean suite product, and will be available at the NASA PO.DAAC in NetCDF format.

Two tables are used to present the data sets. The first lists ocean suite products (Table 4.1.2) and the second lists additional atmospheric data sets by parameter (Table 4.1.3). Many of the atmospheric data sets are generated by RSS, (in a proprietary binary format) and in many cases, are also archived and distributed by a DAAC in a standard format such as HDF or NetCDF. A copy of AMSR-E atmospheric and rain rate data sets is held locally by GES DISC to meet performance requirements for serving Giovanni and associated A-Train precipitation research, Northern Eurasia Earth Science Partnership Initiative (NEESPI) monthly analysis of soil moisture, and Year Of Tropical Convection (YOTC) research projects. These data sets are publically available for the convenience of the GES DISC precipitation modeling and applications communities. ***These and other duplicative data sets should refer back to the archive of record. In addition, any subset data sets such as those offered by GES DISC need to refer back to the original source products.***

It was clear to the workshop participants that with the large number and widespread availability of data sets in this group, ***cross-referencing among these data sets is absolutely necessary. This is especially important where older versions of data sets are still readily available to users***; in these cases references to other more recently updated data sets is necessary. This could be accomplished through the use of a table listing the most recently processed data set for each radiometer or discipline category. We identified superseded collections such as SSM/I wind data at PO.DAAC and ASDC, and determined that ***removal of older data sets from public access (retirement) is appropriate in some cases.*** The general recommendation of clearly stating version and algorithm information, producer, and lineage applies to many of the data sets in this discipline.

We noted that the precipitation community has compiled a list of many of the precipitation data sets available. As part of their cross-referencing, ***we suggest that all DAACs holding precipitation data sets request that the International Precipitation Working Group list DAAC products on the IPWG web site (http://www.isac.cnr.it/~ipwg/data/data sets3.html) where an updated list of precipitation data sets is provided. NASA Data centers should also provide their users a link to the IPWG site.***

### 2.1.3 Sea Surface Temperature Data Sets

The PM data sets for sea surface temperature (SST) distributed in the United States are derived from the AMSR-E, TMI and WindSat instruments. Primarily, Remote Sensing Systems produces global Level 2 and Level 3 SST data sets from all these instruments and in general they are distributed through the framework of the Group for High Resolution Sea Surface Temperature (GHRSST) Project. This includes distribution from the JPL Physical Oceanography DAAC (PO.DAAC) for recent data, and the NOAA National Oceanographic Data Center (NODC) for longer term archive and distribution.

Furthermore, as part of GHRSST data fusion activities, the L2 data streams from both AMSR-E and TMI are found in many L4 blended SST data sets produced by various groups worldwide.

It was noted that RSS provides cross-references from its own SST data sets to those at the GHRSST sites so that the user knows there are other SST data sets available. In addition, PO.DAAC points to NODC for "rolled off" Level 2 data sets, and GHRSST discovery tools and references provide transparent access to data at PO.DAAC or NODC.

### 2.1.4 Cryospheric Data Sets

Sea Ice extent and concentration, snowmelt onset and extent, experimental snow water equivalence, and freeze/thaw signatures over ice constitute the major cryospheric data sets derived from PM measurements. Many operational and research organizations both in the US and internationally produce cryospheric data sets from PM data. Because the majority of cryospheric data sets discussed in the workshop were held at one data center, NSIDC, we did not find the same issues related to data duplication, cross-referencing, and variable documentation quality and LOS that were found when reviewing data sets across different data centers. However, we did note potential problems for users in determining which of the many similar NSIDC data sets are most appropriate for their use. Furthermore, in some cases, multiple versions of the source Tb data have been used to generate a long term cryospheric data set, and these are not well documented. We felt that **better guidelines are needed to help novice users sift through the many cryospheric data set possibilities**.

### 2.1.5 Land and Soil Moisture Data Sets

The range of NASA supported soil moisture and rain-over-land data sets is primarily limited to those produced from the AMSR-E instrument on the Aqua Satellite. Land freeze/thaw data sets are also included with soil moisture data for the purposes of this workshop. The archive of record for these data sets is NSIDC. As with atmospheric and precipitation data sets from AMSR-E, a copy of these data sets is also maintained at GES DISC, and cross-references should be reviewed. We also noted that two dated products (from SMMR and SSM/I Pathfinder) are still available, but use of these data sets is discouraged.

## 2.2 Survey of NASA Passive Microwave Data Services

Data services are valued for their ability to enable and simplify access to PM data sets for particular research applications. The workshop findings distinguish between *dynamic services* and *pre-selected subsets*.

### 2.2.1 NASA Dynamic Data Services

Online services for NASA PM data sets were discussed at the PM workshop in the context of broad services generally provided for all data sets and those services developed to achieve a critical level of support to targeted communities. Recommendations for services are listed in the Actions columns of the tables in Section 4.2, though we did not find services significantly lacking in any particular area.

The DAACs, PPS and RSS offer access to PM data sets via the same standard internet protocols and interfaces as for their other data sets. Two fundamental service approaches are employed, one using HTTP (i.e., via Web servers) and the other using file transfer protocols including FTP, Secure Copy Protocol (SCP) or Secure Shell FTP (SFTP). (The term FTP is used here generically to represent the various application protocols supported.)

HTTP enables immediate download of data sets via hypertext hotlink through the Web service. The Web service provides context information for the hotlinks. GES DISC and RSS encourage the use of HTTP for access to their data sets. NSIDC offers HTTP for metadata downloads and a custom HTTP-Web interface for access to AMSR-E data sets in the FTP server (such as the ECS Data Pool at NSIDC DAAC).

FTP, SCP and SFTP offer immediate download and subscription services through an FTP server and these methods are available at GHRC, NSIDC, PPS and RSS. But FTP methods expect users to know the data sets they want to access as they don't provide context information to the user.

Additional services are available from the DAACs for PM data sets. For convenience the services are grouped into the four categories below. Details are provided in the tables in Section 4.2. These tables identify the services, DAAC(s) and data sets that can be used with the service.

(1) Search and Discovery Tools – both data center centric (such as Mirador, Polaris) and across data centers (such as GCMD, Reverb/ECHO) [Table 4.2.1]
(2) Online Data Services including subsetting, re-projection (such as polar stereographic, geographic), file reformatting (such as GeoTIFF, NetCDF), and reformatting coupled with display (such as GIOVANNI) [Table 4.2.2]
(3) Online Services for use with Third Party Clients (such as OPeNDAP, OGC) [Table 4.2.3]
(4) User Facility Analysis Tools to download and analyze data at a user's facility (such as sample code in various languages or HDF Application Programming Interface libraries). [Table 4.2.4]

Some of the services described in the tables, such as GCMD, are applicable across all PM data sets, while others are clearly tailored to operate on only one data set. In the workshop we discussed service characteristics, focusing on provenance information and whether the service provided source data and version along with the derived subset, re-projected or reformatted output.

Many users find data sets through web search services. Custom search and discovery services enable more detailed examination and filtering of data to support both broad and focused PM research communities. However, information about where a data set came from and who created it was found to be inconsistently applied. The GCMD was typical, providing data set creator or source information based on what data centers provide through metadata using the Directory Interchange Format. As one example, GHRC provides TRMM TMI ocean data sets attributed to F. J. Wentz, while the originators of

RSS SST and SSM/I data sets are not listed in their GCMD entries. ***We find that it would be helpful if the various data centers review their published metadata and online documentation to clarify data source and originator information.***

When access involves basic services such as download HTTP, FTP, and SCP, researchers must use other methods to find source and version information associated with the data set. Associated web sites often include ways to find documentation and citation information. In addition, for instruments on EOS missions, there is a companion metadata file that provides this information. ***To help users obtain the data, we feel online documentation should be made readily available in FTP directories as well as on data center web sites.***

Typically, online servers such as OPeNDAP or OGC (Open Geospatial Consortium) servers which connect with third party clients to transform and deliver data for analysis and display do not apply standard approaches when passing metadata through the interface. In addition, the metadata transmitted with the product varies in completeness among the different services. For example, subsets displayed in GIOVANNI show source and version information for TMI data sets, however, neither the POET data viewer nor the NAIAD L2 subsetter provides source or version information on the display. Subsequently, it can be tedious to find this information, often requiring help from user services personnel. ***Provenance information with complete traceability of the origin of data and operations performed on the data should be readily available from any data service that transforms science data for delivery or display.***

Conceptually, it is easy to imagine that with a relatively small effort already existing subsetting services could be extended to handle other instrument data sets. We therefore find that ***extending the subsetting services as broadly as possible should be considered by the DAACs for not only PM data sets, but other NASA data sets as well.***

### 2.2.2 Subsets of Passive Microwave Data Sets

Pre-selected and stored subsets of PM data sets are available online for field campaigns and other sponsored research projects. There are general groups of such subsets at NSIDC, ASDC and GES DISC. For example, subsets of AMSR-E and SSM/I data sets at NSIDC are designed to cover the Polar Regions in standard EASE grids. They are comprised of re-sampled/re-gridded values, and contain selected geophysical parameters. There are two groups of TMI data sets at GES DISC considered subsets of standard data sets – the first group consists of gridded orbital rainfall data (G2A12) – mapped to 0.5 degree latitude-longitude grid from the standard swath data set. The second consists of subsets coincident with ground validation sites for the ground validation campaign. These subsets are created as part of an ongoing data acquisition and data set generation stream.

There is a growing demand for discipline-specific subsets that bring PM and other Earth science data sets with diverse temporal and spatial scales together for analysis. As we examined some of tools and services available, it became apparent that ***more attention is needed to address provenance issues***. Continued development of generalized subsetting tools and improvements in service availability are needed, and subsetting services need careful examination while still in development. In particular, ***provenance information needs to be brought along to the subset data, by the subsetting tool or***

***service. Provenance information includes identification of the tool, the source and version of the original data set, and metadata.*** Some of the more difficult issues to solve involve how to carry key metadata such as data set name, URL, or unique identifier with images provided to a data user. ***In addition, we find it is important to capture and report on the algorithmic steps taken to create the subset***.

# 3 Recommendations

Based on the data review and findings of the Passive Microwave Data Set Management Workshop, the workshop participants make the following recommendations to NASA Earth Science Data Systems management and the DAAC User Working Groups. General recommendations listed in Section 3.1 apply to most, if not all, PM data sets. Indeed, these recommendations are relevant across all NASA Earth Science data. More specific recommendations are organized by data center in Section 3.2. Finally, Section 3.3 provides several suggestions for best practices by the DAACs and other providers of PM data sets.

## 3.1 General Recommendations

- **Provide clear documentation and cross-referencing between related passive microwave data sets.**
  - This is particularly important where older versions of data sets are still readily available to users. In these cases, references to other, more recently updated data sets are needed.
  - Where copies of data sets are maintained at multiple organizations, each copy should refer back to the archive of record.
  - Data Object Identifiers (DOIs) can help clarify whether data sets are identical.
- **Consider common practices to handle data set retirement. Users should be referred to the replacement data set.**
  - A common terminology to describe data set status may help in developing these common practices. A candidate list of statuses is provided in Section 1.4.
- **For all NASA data sets, lineage should be clearly documented**. In particular,
  - Versions of both the data set and the algorithm(s) used to generate it need to be verified, documented, and made more visible as necessary.
  - Source and version of data set(s) used as input to a product need to be identified, noting when the source data were published, and especially when the version of the source data has changed.
  - Data centers should review their published metadata and online documentation to clarify source and originator information.
- **Compile a checklist of required documentation for data sets, based on existing requirements and guidelines**.
  - Consider tying documentation requirements to LOS.
  - Review documentation for high value data sets first.
  - Make online documentation available in FTP directories as well as on data center web sites.
  - Maintain and update documentation regularly on a pre-determined schedule.

- **Any data service that transforms science data for delivery or display should make provenance information readily available**. Such provenance information includes identification of the tool, the source and version of the original data set, and metadata.
- **The ability to identify groups of data sets that are internally consistent (i.e., all derived from the same source using the same algorithms) is particularly important to researchers**. Therefore, for all NASA data sets it is essential that their lineage be clearly documented. In particular,
  - Versions of both the data set and the algorithm(s) used to generate it need to be verified, documented, and made more visible as necessary.
  - Source and version of the data set(s) used as input to the data set need to be identified, noting when the source data were published, and especially when the version of the source data has changed.
- **The authoritative source for each Level-1 PM data set should be determined and documented**. For these primary data sets in particular, documentation needs to capture source, algorithm and version of source data used. For example, see Table 2 in Section 3.2.
- **Data citation information should be specified, to include producer, algorithm version, and location to obtain the data.**
- **Web sites of the different data centers should cross-reference each other**, identifying the primary source or archive of record for each data set, and locations of similar data sets. Cross-referencing to PM data sets at non-NASA data centers is also encouraged.
- **In cases where PM data sets are available from both the data producer and the archive of record, the two data providers should cross-reference each other**, indicating if the data sets available from each are identical. If the data sets differ, an explanation of those differences should be provided.
- **Any subsetting, visualization or analysis tools provided by the data centers should explicitly cite source data sets** used in generating imagery, subsets or other data sets.
- **It is recommended that extending the subsetting services as broadly as possible be considered** by the DAACs providing the PM data sets.
- **All DAACs holding precipitation data sets should request that the International Precipitation Working Group list those data sets on the IPWG web site** (http://www.isac.cnr.it/~ipwg/data/data sets3.html) where an updated list of precipitation data sets is provided. Data centers should also provide their users a link to the IPWG site.
- **Some organizations external to NASA, especially outside the U.S., are archiving and distributing NASA PM data sets due to difficulties in downloading the data**. Either these difficulties should be alleviated or these archives should be provided with guidelines regarding documentation, credit to NASA, data synchronization and updates.

## 3.2 Recommendations Specific to Data Sets

Workshop participants were particularly concerned that accurate information be available for all Tb data sets, as these are the primary source data from which all other PM data sets are derived. Therefore, the following recommendation applies to all holders and distributors of Tb data sets.

- **Make clear the primary source and calibrated sources for each sensor.** Table 2 below should be published in user guides and on data center web sites.

*Table 2. Authoritative Primary NASA Sources of Passive Microwave Data Sets*

**Authoritative Primary Data Sources Organized by Instrument**

for definitions of various services, see Section 2.2

| Instrument | Data Set Type | Data Set Details | Distributor(s) | Services Available |
|---|---|---|---|---|
| ESMR Nimbus-5 | Tb | polar grids | NSIDC | FTP |
| | cryospheric | sea ice, polar grids | NSIDC | FTP |
| SMMR Nimbus-7 | Tb | swath and gridded Tb | NSIDC | FTP |
| | ocean suite | global air-sea parameters | PO.DAAC | FTP |
| SSM/I | Tb | swath data from RSS | consult RSS | none |
| | Tb | gridded files | NSIDC | none |
| | ocean suite | gridded and swath products wind, vapor, cloud, rain | RSS (binary) GHRC (netCDF) | FTP, browse, zoom |
| | wind vectors | CCMP | PO.DAAC | FTP |
| | cryospheric | gridded snow and sea ice | NSIDC | FTP |
| | flux data | GSSTF2b | GES DISC | FTP |
| TMI | Tb | L1A data | GES DISC PPS | FTP, Mirador, OPeNDAP |
| | ocean suite | swath products on a standard grid SST, wind, vapor, cloud, rain | RSS (binary) GHRC (HDF-EOS) | FTP, browse, zoom |
| | SST | GHRSST TMI L2P | PO.DAAC/NODC | FTP, OPeNDAP, POET, |
| | rain rates | 2A12 (swath), 3A12 (gridded) G2A12 (gridded swath) | GES DISC, PPS GES DISC | FTP, Mirador, GDS, Giovanni, OPeNDAP |
| AMSR-E | Tb | swath and gridded products | NSIDC | FTP, browse |
| | ocean suite | swath and gridded products, SST, wind, vapor, cloud, rain | NSIDC | FTP, browse |
| | SST | GHRSST AMSR-E L2P | PO.DAAC/NODC | FTP, OPeNDAP, POET |
| | rain rates | swath and gridded products | NSIDC | FTP, browse |
| | cryospheric | sea ice and snow grids | NSIDC | FTP, browse |
| SSMIS | Tb | swath Tb files | RSS | not public |
| | ocean suite | gridded wind, vapor, cloud, rain | RSS | FTP, browse |
| | wind vectors | CCMP | PO.DAAC | FTP |
| WindSat | Tb | L1B swath data | RSS | none |
| | ocean suite | gridded SST, wind, vapor, cloud, rain | RSS | FTP, browse |
| | wind vectors | CCMP | PO.DAAC | FTP |
| | SST | currently only available within the WindSat ocean suite | RSS | FTP, browse |

Recommendations for specific data sets are grouped by data center in the following subsections.

### 3.2.1 Specific Recommendations for Data Sets at ASDC

- SSM/I Swath data sets: Determine and clearly document data source and algorithm. Cross-reference to more current data sets as appropriate.
- NVAP merged SSM/I and radiosonde gridded data: Determine what to do with old data set.
- Prabhakara SMMR data sets: Improve documentation to include identification of source data. Cross-reference to PO.DAAC SMMR data set.
- ISCCP ice and snow data set: Determine status of data set; consider LOS changes.

### 3.2.2 Specific Recommendations for Data Sets at GES DISC

- All data sets mirrored at PPS and GES DISC: Encourage cross-referencing of corresponding data sets between the two sites.
- SSM/I monthly rain, subset to TRMM geographic coverage area: document data source and algorithm.
- Merged rain data set (SSM/I, TMI, PR): document data source and algorithm.
- GSSTF: determine what to do with old data set.
- AMSR-E rain and soil moisture data sets: document data source and algorithm; cross-reference to NSIDC.

### 3.2.3 Specific Recommendations for Data Sets at GHRC

- SSM/I bundled Tb and data sets in HDF-EOS: uses old RSS algorithm. Determine whether to update to current data or retire data set. Cross-reference to NOAA CLASS for Tb and RSS for ocean suite data sets.
- TMI ocean data set suite in HDF-EOS: document data source and algorithm; determine whether to replace with NetCDF version; cross-reference to RSS.

### 3.2.4 Specific Recommendations for Data Sets at NSIDC

- Cryosphere data sets require help for users to sift through the many possible data sets. This is especially important for the novice user.
- SSM/I and SSMIS swath Tb (not public; used to generate science data sets): document known RSS versions to provide proper lineage information for derived data sets.
- SSM/I and SSMIS gridded Tb: document source data and algorithm.
- ESMR gridded Tb: work with ESDIS to evaluate for re-exposure to science community.
- AMSR-E L2, L3 ocean data sets: cross-reference to corresponding AMSR-E data sets at RSS.
- SSM/I and SSMIS gridded global sea ice data sets: document source data and algorithm; ensure proper versioning.
- SMMR gridded sea ice and snow cover data sets: ensure proper versioning.
- SMMR monthly snow data sets: evaluate LOS; consider retiring.
- Greenland melt onset data set: resolve possible version issues with MEaSUREs project.
- ESMR gridded sea ice concentrations: coordinate with ESDIS to insure best copies of these data are preserved.

- SSM/I F08 Pathfinder land parameters: evaluate LOS; consider retiring.
- Climate Data Records need input data set timelines.
- SEASAT SMMR Tbs: PO.DAAC and NSIDC work with ESDIS to evaluate for re-exposure to science community; ensure proper versioning.

### 3.2.5 Specific Recommendations for Data Sets at PO.DAAC

- Nimbus-7 SMMR data sets: fix link in documentation; provide data producer contact information.
- For all data sets obtained from RSS, provide cross-references to the corresponding binary data sets at RSS.
- CCMP multi-platform winds: increase LOS to include browse.
- Value added SST data need description of fill methods and source of the fill information.
- SEASAT SMMR Tbs: PO.DAAC and NSIDC work with ESDIS to evaluate for re-exposure to science community; ensure proper versioning.

### 3.2.6 Specific Recommendations for Data Sets at RSS

- For all RSS binary data sets that are archived and distributed in another format by a NASA or NOAA data center, provide cross-references to the corresponding data sets.
- AMSR-E ocean suite: cross-reference to corresponding NASA standard data set at NSIDC.

## 3.3 Suggestions for Data Center Best Practices

### 3.3.1 Data Set Documentation

Data set documentation was a general theme during each discipline category discussion. The following is a summary of the main points raised in those discussions.

- Documentation for the most highly used data sets should be assessed and improved first.
- The higher-level data sets that have more diverse users should be documented in a manner that the less experienced or non-discipline user can navigate and understand.
- Version information and algorithm information must be prominently available. This applies to many of the data sets reviewed.
- The producer of the data set as well as the source data lineage should be easily found. The source data version and acquisition date are important additions often overlooked.
- A recommended data set citation should be included. At a minimum, the citation should include the production algorithm and its version.

### 3.3.2 Cross-References

Given the large number of related PM data sets maintained at various NASA-funded data centers and research organizations, improved cross-referencing among these data sets is crucial.

- Data center websites providing access to similar data sets should reference each other. Such cross-references should
    - Identify the primary source of the data set.

- Identify locations of slightly different data sets.

- Data centers should jointly determine and provide to users the authoritative source for each PM Level-1 data set. All of their higher-level data sets should refer back to this primary source.
- Any data services that modify data sets (e.g., by generating subsets, imagery, and/or merged data sets) should always cite or reference all data sets used to generate the modified data set.
- Data centers should acknowledge and cross-reference (as appropriate) the existence of other PM data sets at non-NASA data centers.

### 3.3.3 Data Set Citations and DOIs

Both ESDIS and the ESIP Federation are developing guidelines for data citation. These guidelines cover recommended use of acknowledgements and citations in publications, and provide examples for both data sets and tools. The ESDIS data citation guidelines are being circulated among the data center managers at the time of this writing, and the complementary ESIP guidelines are available online at http://wiki.esipfed.org/index.php/Interagency_Data_Stewardship/Citations/provider_guidelines.

PM Workshop attendees discussed the use of data set identifiers to help address the issues of apparent data duplication, the need for improved cross-referencing for related data sets, and clear identification of source data sets. The discussion focused on the potential use of Digital Object Identifiers (DOIs) for PM data sets. The attractiveness of a DOI solution for publications hinges on fixing a DOI with a data item and maintenance of location (e.g., the URL of a data center's Web page that provides access to the data set) and related citation information at a central registry (managed by the International DOI Foundation). Questions were raised of how a versioning scheme would be implemented and how DOIs would be assigned. A versioning scheme in which individual teams determine major verses minor versions of PM data sets was discussed. One approach requires that new major versions have new DOIs, and old DOIs point to the new version of the data set. Approaches for assigning popular data identifiers have been discussed at ESIP, ESDSWG and DAAC meetings. NSIDC, GES DISC and PO.DAAC have expressed an interest in assigning DOIs to their NASA data sets, while ORNL DAAC has been assigning DOI's to its field campaign data sets since 2008. ESDIS reported plans to develop an implementation approach for consistency when assigning DOIs to NASA data sets.

- As NASA DAACs implement DOIs per ESDIS guidelines, the identifiers should be used for cross-referencing among related data sets and for providing a clear indication of source data and versions.

### 3.3.4 Levels of Service

Given the variety of data sets, the degree of their importance to the various user communities, and resource limitations, it is not practical to offer the same level of service to all data sets. The LOS is dependent on the data set and can be defined in terms of functions supported. The functions are: ingest and archive, metadata (generation/inclusion and maintenance), distribution, documentation and user services. A candidate approach for LOS is provided in Appendix B.

- Data centers should consider a common vocabulary and approach to defining appropriate LOS for PM data sets.

# 4 Detailed Information

## 4.1 NASA Passive Microwave Data by Data Group – Details

Detailed tables are provided in this section listing all the data sets available and specific actions recommended in each case where required. In each case, public distribution of the data is assumed unless stated otherwise.

### Table 4.1.1 NASA Supported Passive Microwave Brightness Temperature (Tb) Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|
| SMMR Geophysical Data Records | PO.DAAC | DAAC | SEASAT | All SEASAT instrument data including L1, L2, swath. Not available on FTP site | PO.DAAC and NSIDC to evaluate SMMR for re-exposure to science community. Ensure proper versioning |
| SMMR swath and gridded Tb data | NSIDC | DAAC | NIMBUS 7 | Goddard/Gloersen and JPL/Njoku reprocessed SMMR data sets at NSIDC | Ensure proper versioning |
| ESMR gridded Tb | NSIDC GSFC/NSSDC | DAAC | NIMBUS 5 | NSIDC has gridded data from the various ESMR instruments (GSFC/NSSDC has raw, film, and possibly gridded data) | NSIDC to work with J. Moses on evaluation of ESMR data for re-exposure to science community Ensure proper versioning |
| SSM/I swath Tb | GHRC | DAAC | SSM/I | Source is FNMOC, same data at NOAA CLASS *Not public, used internally* Considered alternate/backup data source by RSS and NSIDC | Ensure proper versioning |
| SSM/I swath Tb SSMIS swath Tb | NSIDC | DAAC | SSM/I and SSMIS | Acquired from CLASS (NRT) and RSS (science quality data) *Not public, used internally* NSIDC archives RSS v4, v6, and v7 | NSIDC to document known RSS versions in data sets held |
| Gridded (EASE-grid) Tbs, Gridded Polar Stereo Tbs | NSIDC | DAAC | SSM/I and SSMIS | Created from RSS for science quality Created from CLASS for NRT data | NSIDC to document RSS versions used in producing data sets |
| Enhanced Tb Swath data | BYU | REASON | SSM/I and AMSR-E | Spatial resolution enhanced data set | To be archived at NSIDC Ensure proper versioning |

### Table 4.1.1 NASA Supported Passive Microwave Brightness Temperature (Tb) Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|
| SSM/I bundled Tb and geophysical products | GHRC | DAAC | SSM/I | Swath and geo-gridded data<br>Created from TDRs using RSS V4 algorithm | Ensure proper versioning<br>X-ref to more updated data |
| RSS SSM/I and SSMIS swath Tb | RSS | MEaSUREs Project | SSM/I and SSMIS | Source is NOAA CLASS TDRs<br>NOAA NCDC distributes RSS v6 files, not available from RSS. | Ensure proper versioning |
| AMSR-E NRT Tb | GHRC | DAAC, SIPS | AMSR-E | Rolling archive of 7 days (LANCE AMSR-E)<br>Not permanently archived | None – already X-refs standard product at NSIDC |
| AMSR-E swath and gridded (EASE-Grid) Tb | NSIDC | DAAC | AMSR-E | Archive for NASA AMSR-E Tb data | Ensure proper versioning |
| TMI 1B11 swath | GES DISC<br>PPS | DAAC<br>SIPS | TMI | Distribution and archive data set from TMI,<br>Distribution to science team and others, but at a lower level of service at PPS than at GES DISC. | Ensure proper versioning<br>make sure users know the same data as PPS |
| TMI Tb data sets, subsets, browse | GES DISC | DAAC | TMI | Distributed using services built by GES DISC (Giovanni, Mirador etc.) | Ensure proper versioning |
| TMI Tb data sets, subsets | PPS | SIPS | TMI | Distributed to science team but without the services provided by GES DISC | Ensure proper versioning |
| WindSat swath | RSS | MEaSUREs Project | WINDSAT | RSS working to create NetCDF data files | Determine NASA DAAC for archival and distribution |

### Table 4.1.2 NASA Supported Passive Microwave Atmospheric Data Suites

| Data Set | Organization | Org Type | Sensor | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|
| NIMBUS-7 SMMR Global Air-Sea Parameters | PO.DAAC | DAAC | SMMR | wind speed, cloud, vapor<br>L2 swath data, binary format<br>FTP access, no higher LOS | Fix link in documentation, Provide producer contact info, Increase LOS to include browse imagery |
| SSM/I swath data set | ASDC | DAAC | SSM/I | monthly cloud, vapor, rain | Determine and clearly provide data source and algorithm. X-ref to more current data, or retire |
| SSM/I bundled Tb and geophysical products | GHRC | DAAC | SSM/I | Tbs, wind speed, vapor, cloud, (RSS algorithm) L2 swath, L3 grid in HDF-EOS format, online access, browse | Uses old RSS algorithm, determine whether to update to current data or retire data set. X-ref to RSS data sets and NOAA Tb files |
| SSM/I ocean data suite | RSS | MEaSUREs Project | SSM/I | wind speed, cloud, vapor, rain<br>L3 gridded swaths, binary format, FTP access, browse, daily, 3-day, weekly and monthly files | GHRC to provide same in NetCDF format, Clear X-ref between GHRC and RSS files once available |
| AMSR-E L2, L3 ocean data suites | NSIDC | DAAC | AMSR-E | SST, wind speed, vapor, cloud liquid water standard AMSR-E SIPS products,<br>HDF EOS format, RSS SIPS algorithm<br>swath, daily, weekly and monthly files | X-ref to binary format at RSS |
| AMSR-E ocean data suite | RSS | MEaSUREs Project | AMSR-E | SST, wind speed, cloud, vapor, rain; binary;<br>daily gridded swaths, latest algorithm (alternate product); daily, 3-day, weekly and monthly files | X-ref to standard AMSR-E products at NSIDC |
| TMI ocean data suite | RSS | MEaSUREs Project | TMI | SST, wind speed, cloud, vapor, rain; binary; daily gridded swaths, daily, 3-day, weekly, monthly files | X-ref to equivalent GHRC files |
| TMI ocean data suite | GHRC | DAAC | TMI | HDF-EOS format | X-ref to equivalent RSS binary files, Consider offering NetCDF files |
| SSMIS ocean data suite | RSS | MEaSUREs Project | SSMIS | wind speed, cloud, vapor, rain<br>daily gridded swaths, binary format<br>daily, 3-day, weekly and monthly files | GHRC to provide same in NetCDF format, Clear X-ref between GHRC and RSS files once available |
| WindSat ocean data suite | RSS | MEaSUREs Project | WindSat | wind speed, cloud, vapor, rain<br>daily gridded swaths, binary format<br>daily, 3-day, weekly and monthly files | X-ref to PO.DAAC NetCDF files when available, X-ref to NRL WindSat data at PO.DAAC |
| WindSat ocean data suite | PO.DAAC | DAAC | WindSat | Daily Level 2 data, NetCDF format, NRL algorithm, restricted access for science team | X-ref to RSS WindSat data set |

**Table 4.1.3 NASA Passive Microwave Individual Parameter Atmospheric Data Sets**

| Data Product | Data Set | Organization | Org. Type | Sensors | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|---|
| Wind Speed | SSM/I Ocean wind vectors | PO.DAAC | DAAC | F08 SSM/I | RSS SSM/I wind speeds with model wind directions created by R. Atlas<br>Listed in retired list with limited availability | None. Already clearly listed as retired and pointer to new CCMP data set |
| | SSM/I Pathfinder Wind Speed | PO.DAAC | DAAC | SSM/I | HDF format<br>Listed in retired list with limited availability | None. Already on retired list and pointers to RSS and CCMP provided for more recent data |
| | CCMP<br>Multi-platform ocean winds | PO.DAAC | DAAC | all SSM/I,TMI, AMSR-E, all SSMIS, WindSat | Made using RSS radiometer winds, 4x daily (L3.0),monthly and pentad data sets (L3.5a), or as separate instrument swaths with directions (L2.5) NetCDF files, FTP and OPENDAP access | Increase level of service to include browse capability |
| Water Vapor | PM Merged Water Vapor | RSS | MEaSUREs Project | SSM/I, SSMIS, TMI, AMSR-E, WindSat | 12-hr and 6-hr maps of vapor, V7 data | GHRC to provide same data set in netCDF. Provide clear X-ref between RSS binary and GHRC netCDF files |
| | NVAP merged SSM/I and radiosonde gridded data | ASDC | DAAC | SSM/I radiosonde | Will be updated with new MEaSUREs | Determine what to do with old data set |
| | Prabhakara SMMR Water Vapor | ASDC | DAAC | SMMR | L3 monthly 3x5 deg<br>binary data file<br>online ordering tool | Provide better documentation include data source, X-ref to PO.DAAC SMMR data set |
| Cloud Water | Prabhakara SMMR Atmospheric Cloud Liquid Water | ASDC | DAAC | SMMR | L3 type 3 x 5 deg gridded data, binary data files, web ordering tool | X-ref to PO.DAAC SMMR data, Improve documentation |
| Rain Rates | TMI rain data sets (3A11 and 3A12) | GES DISC<br>PPS | DAAC<br>SIPS | TMI | rain rate, conditional rain rate, rain freq, freezing height, 5degx5deg (3A11) and 0.5degx0.5deg (3A12), HTTP download, KMZ | Clarify to users that data at GES DISC and PPS are the same |
| | Combined Rainfall (3B31) | GES DISC | DAAC | TMI<br>PR | monthly 5degx5deg, rain rate, cloud liquid water, rain water, cloud ice, grauples at 14 levels, Browse, HTTP download, KMZ | Clarify to users that data at GES DISC and PPS are the same |

**Table 4.1.3 NASA Passive Microwave Individual Parameter Atmospheric Data Sets**

| Data Product | Data Set | Organization | Org. Type | Sensors | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|---|
| Rain Rates | SSM/I Global Rain Rate (3A46) | GES DISC | DAAC | SSM/I | monthly, 1degx1deg, temporal subset to match TRMM, HTTP download, KMZ | Document source and algorithm version |
| | Merged TRMM and other satellite estimates (3B42) | GES DISC | DAAC | TMI, PR, VIS | 3-hr, 0.25deg<br>HTTP download, KMZ, NetCDF conversion, subsets | None |
| | Merged TRMM and other rain data (3B43) | GES DISC | DAAC | SSM/I, TMI, PR, VIS, rain gauge | monthly, 0.25 deg,<br>HTTP download, KMZ, NetCDF conversion, subsets | None |
| | AMSR-E L2B Global Swath rain rate/type | NSIDC | DAAC | AMSR-E | swath product of rain rate and rain type, HDF-EOS format, GSFC profiling algorithm<br>(GPROF 2004), land and ocean | Document algorithm version |
| | AMSR-E L3 rainfall accumulations | NSIDC | DAAC | AMSR-E | 5x5 deg rainfall accumulations over ocean and land using Wilheit algorithm (ocean), gridded averaged GPROF 2004 product (land) | Document algorithm version |
| | AMSR-E NRT L2 rain data sets | GHRC | DAAC, SIPS | AMSR-E | Rolling archive of 7 days (LANCE AMSR-E), Not permanently archived | None – already X-refs standard product at NSIDC |
| | AMSR-E NRT L3 rain data sets | GHRC | DAAC, SIPS | AMSR-E | Rolling archive of 7 days (LANCE AMSR-E), Not permanently archived | None – already X-refs standard product at NSIDC |
| | L2 Rain over land subsets | GES DISC | DAAC | AMSR-E | Distributed through Mirador<br>Created from the L2 rain data set for CloudSat tracks | GES DISC to cross-reference NSIDC, Include algorithm version of L2 source data |
| Ocean Surface Fluxes | SSM/I global heat momentum fluxes | PO.DAAC | DAAC | SSM/I | data set is listed as retired | None, retired data set |
| | GSSTF1 and GSSTF2 data sets | GES DISC | DAAC | SSM/I | older products that will be updated with new MEaSUREs products | Users already pointed to new data set |
| | GSSTF2b data sets | GES DISC | DAAC | SSM/I | 1deg, HDF-EO5 format, daily, monthly, climatology and individual instruments (F8,F10,F11 etc) latent and sensible heat fluxes with other parameters, HTTP download | None |

### Table 4.1.4 NASA Supported Passive Microwave Sea Surface Temperature Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|
| GHRSST AMSR-E Level 2P | PO.DAAC | DAAC | AMSR-E | Created by RSS, NetCDF format, 45 day rolling store, archived at NOAA NODC | None |
| GHRSST AMSR-E Level 3 | PO.DAAC | DAAC | AMSR-E | Created by RSS, NetCDF format, archived at PO.DAAC and NOAA NODC | None |
| GHRSST TMI Level 2P | PO.DAAC | DAAC | TMI | Created by RSS, NetCDF format, 45 day rolling store, archived at NOAA NODC | None |
| GHRSST TMI Level 3 | PO.DAAC | DAAC | TMI | Created by RSS, NetCDF format, archived at PO.DAAC and NOAA NODC | None |
| GHRSST WindSat Level 3 | PO.DAAC | DAAC | WindSat | Created by RSS, NetCDF format, archived at PO.DAAC and NOAA NODC | None |
| AMSR-E OI SSTs | RSS | MEaSUREs Project | AMSR-E | Created by RSS, Binary format | X-ref to GHRSST data |
| TMI OI SSTs | RSS | MEaSUREs Project | TMI | Created by RSS, Binary format | X-ref to GHRSST data |
| WindSat Level 2 | PO.DAAC | DAAC | WindSat | restricted distribution for science team, NetCDF format | None |
| WindSat Level 3 | RSS | MEaSUREs Project | WindSat | Created by RSS, Binary format | None |
| 20 additional GHRSST Level 4 global and regional data sets that include AMSR-E and/or TMI | PO.DAAC | DAAC | Combinations of AMSR-E, TMI with other infrared radiometers | NetCDF format, Various national/ international providers for data sets including OSTIA, AVHRR_AMSR_OI, G1SST, ODYSSEA, K10_SST, and MUR. | Improve documentation on filling methods |

### Table 4.1.5 NASA Supported Passive Microwave Cryospheric Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|
| ISCCP ice and snow data set | ASDC | DAAC | SSM/I | Old data set, MEaSUREs project reprocessing | Determine status of data set at ASDC.<br>Consider LOS changes. |
| sea ice , ice motion snow depth on sea ice, melt onset, snow cover extent, snow water equiv. | NSIDC<br>Rutgers Univ. | DAAC<br>MEaSUREs | SSM/I<br>SSMIS | Gridded, different approaches and algorithms, polar stereo projection, MEaSUREs data might replace some data sets held by NSIDC | Verify and document version of RSS data used in NSIDC data sets<br>Instigate versioning and DOIs for all data sets |
| NISE EASE-Grid Daily Global Ice Conc. and Snow Extent | NSIDC | DAAC | SSM/I<br>SSMIS | Operational, daily data, occasionally reprocessed, consistency through time not guaranteed | None |
| NRT polar stereo daily global sea ice (north/south) | NSIDC | DAAC | SSM/I<br>SSMIS | Being updated and reprocessed to remain consistent with historical archive data set. | NSIDC should version this data set |
| Gridded sea ice and snow cover | NSIDC | DAAC | SMMR | Part of gridded sea ice data set suite at NSIDC | Same comments as above |
| Snow depth data set (A. Chang, PI) | NSIDC | DAAC | SMMR | Still distributed, superseded by MEaSUREs or NSIDC data set(s) | None |
| Greenland melt onset and cumulative melt days | NSIDC<br>Rutgers Univ. | DAAC, MEaSUREs | SMMR,<br>SSM/I,<br>SSMIS | Existing data set(s) might be updated by MEaSUREs data sets | NSIDC /MEaSUREs PIs should check duplication |
| L3 snow and ice data sets | NSIDC | DAAC | AMSR-E | Archive of record for all AMSR-E data sets | Document similar data sets, clearly provide version and quality info |
| L3 snow and ice data | GHRC, | DAAC, SIPS | AMSR-E | LANCE AMSR-E 7-day rolling archive, Not permanently archived | None – already X-refs standard product at NSIDC |
| Gridded sea ice concentrations, daily, monthly | NSIDC | DAAC | ESMR | Low use but only PM satellite data from 1970s | Coordinate with NSSDC to assure best copy of data are preserved |

### Table 4.1.6 NASA Supported Passive Microwave Soil Moisture Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information | Suggested Actions |
|---|---|---|---|---|---|
| L2 & L3 soil moisture | NSIDC | DAAC | AMSR-E | Official NASA standard data set | None |
| NRT L2 & L3 soil moisture | GHRC | DAAC, SIPS | AMSR-E | LANCE AMSR-E NRT 7-day rolling archive<br>Not permanently archived | None – already X-refs standard product at NSIDC |
| L3 monthly soil moisture averages and standard deviations | GES DISC | DAAC | AMSR-E | Distributed through Mirador/Giovanni (MAIRS Monthly)<br>Created from the L3 daily soil moisture | Expand data source description<br>GES DISC and NSIDC should X-reference to each other |
| Land parameters | NSIDC<br>Univ. Montana | DAAC,<br>MEaSUREs | AMSR-E | MEaSUREs data set distributed by MEaSUREs PI and the official data center | None |
| Monthly snow cover and snow depth | NSIDC | DAAC | SMMR | Users encouraged to use other data sets | Consider change in LOS to retired |
| Freeze/Thaw | NSIDC<br>Univ. Montana | DAAC,<br>MEaSUREs | SSM/I | MEaSUREs data set distributed by MEaSUREs PI and the official data center<br>Will eventually include AMSR-E | None |
| F08 Pathfinder land parameters | NSIDC | DAAC | SSM/I | Users being encouraged to use other data sets | Consider change in LOS to retired |

## 4.2 NASA Data Services and Tools - Details

### Table 4.2.1 Search and Discovery Tools Tailored to Serve Designated Communities

| Data Search Tool | Description | Data Centers with this Service | PM Data Sets accessed by service |
|---|---|---|---|
| Global Change Master Directory | Catalog of Earth science data sets and services. GCMD is one of the largest public metadata inventories with the responsibility to maintain a complete catalog of all NASA's Earth science data sets and services. | GES DISC, ASDC, NSIDC, GHRC, GSFC provide metadata to GCMD. NASA Science Computing Facilities, some other US agency and international agencies are also sources. | All AMSR-E, TMI, SSM/I data sets except those available from RSS. RSS reports one AMSR-E restricted data set. |
| Mirador | Google-based data search and download interface that allows searching, browsing, and ordering of earth science data | GES DISC | TMI |
| HyDRO | Context web search for searching, downloading and ordering Earth science data | GHRC | SSM/I, TMI, NRT AMSR-E; Merged products (RSS), other RSS data sets to be added via cataloging at GHRC |
| Reverb / ECHO | Client for searching and downloading data | GES DISC, NSDIC, PO.DAAC, ASDC, GHRC; Work is in progress to add data sets at RSS, via cataloging at GHRC | All AMSR-E, TMI, SSM/I data sets except those available from RSS (in progress) |
| Polaris | Polaris allows for the search, re-projection, subsetting, reformatting and immediate download of NSIDC data | NSIDC | SMMR, SSM/, SSMIS, AMSR-EI |
| Datacasting | RSS (Really Simple Syndication) based technology for publishing and accessing Earth Science information | NSIDC, PO.DAAC, GHRC (NRT AMSR-E) | AMSR-E |

### Table 4.2.2 Online Data Services with Closely Coupled Analysis and Display Tools

| Title | Description | Data Centers with this Service | PM Data Sets supported by this service |
|---|---|---|---|
| GIOVANNI | Simple and intuitive visualization and analysis tool that can access Earth science remote sensing data without having to download the data set | GES DISC | TMI data sets |
| Dataminer, NAIAD L2 Subsetter | Online subsetting Level 2 swath data and displays results | PO.DAAC | AMSR-E MW SST (RSS) |
| PO.DAAC Ocean ESIP Tool (POET) | online subsetting and visualization of Level 3 data sets | PO.DAAC | GHRSST PM data sets |

### Table 4.2.3 Online Data Services for use with Third Party or User-Built Analysis and Display Tools

| Title | Description | Data Centers with this Service | PM Data Sets accessed by this service |
|---|---|---|---|
| OPeNDAP | Converts HDF and other standard formats to subset in binary stream for IDV, IDL, MatLab, GrADS clients | 1. GES DISC<br>2. PO.DAAC | 1. TMI (HDF)<br>2. AMSR-E, TMI (NetCDF) |
| KMZ | Converts HDF and other formats to KMZ (for Google Earth client) | 1. GES DISC<br>2. NSIDC<br>3. RSS | 1. TMI<br>2 AMSR-E, SSM/I<br>3 SSTs |
| OGC Web Map Server | Provides map depictions over the network via a standard protocol, enabling clients to build customized maps with data from distributed sources. | GES-DISC | TMI |

### Table 4.2.4 User Facility Analysis Tools and Software

| Title | Description | Tool Host | Data Centers with Data sets that these tools work on | PM Data Sets supported by this service |
|---|---|---|---|---|
| Data read software | Sample code for Fortran, IDL, MatLab | RSS | RSS | SSM/I (binary) |
| Data read software | Sample code for C | GHRC | GHRC | SSM/I (HDF-EOS), TMI (HDF-EOS) |
| Data read software | Sample code for C and Fortran | GES DISC | GES DISC | TMI (HDF4) |
| Data read software | GrADS | COLA | GES DISC | TMI (HDF4) |
| Data read software | Sample code for C and IDL | PO.DAAC | PO.DAAC | AMSR-E and TMI (netCDF) |
| AMSR-E swath to Grid<br>EASE Grid Geolocation | AS2GT Tool in C for Linux<br>Sample code in IDL | NSIDC | NSIDC | AMSR-E (HDF4)<br>EASE grid data sets |
| TRMM Orbit Viewer | Displays TRMM data | GES DISC | GES DISC | TMI |
| TRMM Data Mining Tool | Allows users to upload data mining algorithms and have them run on TRMM data | GES DISC | GES DISC | TMI |
| HDF tools | API libraries<br>Data viewer, other tools | HDF EOS Tools and Information Center | GHRC<br>NSIDC | SSM/I, TMI (HDF-EOS)<br>AMSR-E (HDF-EOS) |

# 5 Other Passive Microwave Data Relevant to NASA Earth Sciences

This section describes PM data sets held outside the official NASA DAACs and affiliated data centers. It also excludes MEaSUREs projects or other NASA-funded organizations whose data sets are described in Sections 2 and 4.

Some of the non-DAAC NASA facilities providing PM data from satellites are located at GSFC; others are at different NASA centers, including the Goddard Institute for Space Science (GISS). The Oak Ridge National Laboratory (ORNL) DAAC archives PM data sets that are generally used to support various field and validation experiments. Those were excluded from this PM data review, since in most cases they represent a small addition to the aircraft, ground, and other in situ measurements that were the primary data sources.

Non-NASA domestic organizations distributing PM data sets include U.S. Government agencies such as the National Oceanographic and Atmospheric Administration (NOAA), consortia like the National Center for Atmospheric Research (NCAR), and several universities. Foreign organizations archiving and distributing PM data include government organizations, multi-agency consortiums, and university research centers. Several foreign data centers that hold satellite PM data sets require a research proposal or payment to gain full access to their data sets, even to view data catalog information. Those data centers are excluded from this survey. We use the general term Earth science data center (ESDC) in the tables in Section 5.2.

Brief descriptions and URL links are provided in Appendix A for the data centers whose data sets appear in the tables in Section 5. Some links to specific data sets are listed. The contents of Section 5.2 tables represent only a sample of available PM data sets. Obtaining a fully comprehensive list is made difficult by limitations of data discovery as many groups have not provided information to the Global change Master Directory (GCMD) or to catalogs maintained by the Consortium of Earth Observing Systems (CEOS). Some of the information available from these two catalog sources is out of date as information was added, but has not been maintained. Internet searches provided some additional data set information. An exhaustive search of global data centers is considered to be beyond the scope of this report.

The information on other PM data sets is organized the same way as in Section 2 and 4, with the data sets organized by disciplines. Since web site navigation to some data sets presented in this section can be rather complicated, embedded URL links are provided. The contents of the tables in Section 5.2 are current as of 6/10/2011.

## 5.1 Survey

### 5.1.1 Brightness Temperatures Data Sets

Non-DAAC organizations make available calibrated brightness temperatures from ESMR (Nimbus-5), SMMR (Nimbus-7), SSM/I, SSMIS, TMI, AMSR, and AMSR-E. L1A data sets, analogous to SSM/I antenna

temperatures, are also available for many instruments. An AMSR-E L2A data set (resampled brightness temperatures) is also included in Table 5.2.1.

### 5.1.2 Atmospheric Data Sets

The majority of PM derived atmospheric data sets listed in Table 5.2.2 consist of two or more parameters bundled together, such as water vapor with precipitation/rain, cloud liquid water/ice, and wind speed; sometimes all parameters from a particular instrument are bundled together. Single-parameter data sets containing precipitation, wind speed, or water vapor are also available from various organizations. The "Data Set Information" field provides parameter information when not obvious from the data set name.

### 5.1.3 Sea Surface Temperature Data Sets

PM SST data sets derived from AMSR-E and TMI are archived at numerous locations outside the primary NASA DAACs, including domestic and foreign facilities. In addition, AMSR-E and TMI L2 SSTs are incorporated in GHRSST L4 (model) data sets and are made available at NOAA and foreign data centers as listed in Table 5.2.3. In some cases, L2 data streams (L2P) produced by RSS for GHRSST are also available to users.

### 5.1.4 Cryospheric Data Sets

Cryospheric data sets also are archived and distributed by a large number of organizations, both domestic and foreign. Satellite snow and ice observations have been produced continuously since late 1978. Table 5.2.4 lists these data sets. No separate sea-ice parameter table is presented.

### 5.1.5 Land and Soil Moisture Data Sets

Land surface temperatures and surface types are generated from SSM/I observations and distributed by NOAA. Soil moisture retrievals are generated from AMSR-E data, but cannot be retrieved from SSM/I observations. The known soil moisture data sets are listed in Table 5.2.5.

## 5.2 Non-NASA Passive Microwave Data sets – Details

### Table 5.2.1 Non-NASA Brightness Temperature Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information |
|---|---|---|---|---|
| AMSR/AMSR-E swath L1A | JAXA/EORC/EOC/EOIS | Foreign ESDC | AMSR, AMSR-E | Also at NSIDC, Corresponds to SSM/I TDRs (antenna temperatures) |
| AMSR/AMSR-E swath L1B | JAXA/EORC/EOC/EOIS, JAXA/EORC/TCD | Foreign ESDC | AMSR ,AMSR-E | No U.S. AMSR-E L1B data set |
| TMI swath Tb (1B11) | JAXA/EORC/EOC/EOIS, JAXA/EORC/TCD | Foreign ESDC | TMI | Full swath 1B11 at the GSFC GES DISC and JAXA EORC/EOC/EOIS and ICARE |
| AMSR-E, TMI, and SSM/I Cross-calibrated Tb | CSU/PRG | University | AMSR-E, TMI, SSM/I | Requires login. Contact Chris Kummerow for a password., NASA REASoN funding |
| SSM/I swath SDRs | NOAA/NCDC/CLASS | NOAA ESDC | SSM/I | TDRs (L1A equivalent) also available |
| Tropical Cyclone Data Tbs | JAXA/EORC/TCD | Foreign ESDC | AMSR-E, TMI, SSM/I | With precipitation and water vapor |
| SSM/I, SSMIS, TMI swath Tb AMSR-E swath Tb (L2A) | Cloud-Aerosol-Water-Radiation Interactions (ICARE) Thematic Center | Foreign University | SSM/I, SSMIS, TMI, AMSR-E | Multi-agency facility at the University of Lille |
| EMSR swath Tb SMMR swath Tb | National Space Science Data Center (NSSDC) | NASA SSDC | ESMR, SMMR | ESMR Tbs on magnetic tape and photo facsimile film, SMMR Tbs on magnetic tape |

### Table 5.2.2 Non-NASA Atmospheric Data Sets

| Data Set | Organization | Org Type | Sensors | Data Set Information |
|---|---|---|---|---|
| ESMR Rainfall Atlas | NSSDC | NASA SSDC | ESMR | Rainfall atlas on microfiche |
| SMMR Data Sets | NSSDC | NASA SSDC | SMMR | In multi-parameter data sets on magnetic tape<br>Includes total water vapor, wind speed, and cloud liquid water |
| SSM/I Daily Data | Goddard Institute for Space Science (GISS) | NASA SSDC | SSM/I | Available for 23 of the regional studies comprising the GEWEX Cloud System Study: GCSS-DIME project. Includes wind speed, water vapor, cloud liquid water, and precipitation. |
| SSM/I EDRs | NOAA/NCDC/ CLASS | NOAA ESDC | SSM/I, SSMIS | In multi-parameter EDR, including wind speed, water vapor, cloud liquid water, and rain rate |
| SSM/I EDR Map Data sets | NOAA/NCDC/ CLASS | NOAA ESDC | SSM/I F14, F15 | In multi-parameter EDR, including water vapor, cloud liquid water, and rain rate |
| Microwave Integrated Retrieval System Data sets (MIRS) | NOAA/NCDC/ CLASS | NOAA ESDC | SSMIS | Includes total precipitable water (over ocean and land), cloud liquid water, ice water path, liquid water path, and rain rate<br>Orbital and daily maps |
| Microwave Surface and Precipitation Data sets System (MSPPS) | NOAA/NCDC/ CLASS | NOAA ESDC | SSM/I F13, F14, F15 | Includes same parameters as above |
| Blended sea winds | NOAA/NCDC | NOAA ESDC | AMSR-E , SSM/I, TMI | Surface vector winds, Global gridded 0.25 deg. data, 6-hourly, daily, monthly, and 11-year (1995-2005) monthly climatologies, Wind speeds overlaid with wind direction information from NCEP Reanalysis-2 (for research data sets). Made from RSS wind data sets. |
| Global Gridded SSM/I and SSMIS Data sets | NOAA/NCDC | NOAA ESDC | SSM/I, SSMIS | Includes Precipitation, Cloud liquid water, and Total precipitable water<br>http://www.ncdc.noaa.gov/oa/rsad/SSM/I/gridded/index.php<br>1 deg. monthly, 2.5 degree pentad and monthly |
| Shared Processing Data | NOAA/OSDPD | NOAA ESDC | SSM/I | Water Vapor and Wind speed maps |
| SSM/I Regional Winds | NOAA CoastWatch | NOAA ESDC | SSM/I | Link is to most recent data. The web page provides access to older data. |
| SSM/I Composite2 Images | Naval Research Laboratory | Research Laboratory | SSM/I | Water vapor |

### Table 5.2.2 Non-NASA Atmospheric Data Sets

| Data Set | Organization | Org Type | Sensors | Data Set Information |
|---|---|---|---|---|
| Tropical Cyclone Data | NRL | Research Laboratory | SSM/I, SSMIS, TMI, AMSR-E, WindSat | Wind speed |
| Crop Explorer Precipitation Maps | USDA/FAS | USDA ESDC | SSM/I | 10-day rainfall, With rain gauges; Data from Air Force Weather Agency (AFWA); Click on global map for regional rainfall maps |
| GEWEX NASA Water Vapor Project (NVAP) | NCAR/CISL/RDA | University Consortium | SSM/I | Includes Cloud liquid water/ice, Liquid water equivalent, Precipitable water Derived from radiosonde, TOVS, and SSM/I data |
| Chang's SSM/I Monthly Precipitation Estimates | NCAR/CISL/RDA | University Consortium | SSM/I | Precipitation amount over oceans on a 5 x 5 degree grid. July 1987-December 1994 |
| Cross-Calibrated Multi-Platform (CCMP) Ocean Surface Wind Velocity | NCAR/CISL/RDA | University Consortium | AMSR-E , SSM/I, TMI, SSMIS, QSCAT, WindSat, | Derived through cross-calibration and assimilation of ocean surface wind data from SSM/I, TMI, AMSR-E, SeaWinds on QuikSCAT, and SeaWinds on ADEOS-II Uses RSS wind products from all instruments, 1987 – ongoing CCMP data provided by MEaSUREs PI Bob Atlas, and distributed by PO.DAAC |
| SSM/I Gridded Data | NCAR/ EOL | University Consortium | SSM/I | Includes rainfall, cloud liquid water, and water vapor Regional subsets for various field experiments (EPIC, IHOP-2002, PACS, RICO, SALLJEX, VOCALS, NAME) |
| TMI Gridded Data | NCAR/EOL | University Consortium | TMI | Includes rainfall, cloud liquid water, and water vapor Regional subset for NAME field experiment |
| SSM/I Daily Gridded Imagery | NCAR/EOL | University Consortium | TMI | Includes rainfall, cloud liquid water, and water vapor, plus wind speed for DYCOMS-II Regional subsets for various field experiments (ACE-Asia, DYCOMS-II, INDOEX) |
| SSM/I 2.5 and 5.0 deg Rain Rates | George Mason University | University | SSM/I | Monthly maps Data distributed from the GMU Polar Satellite Precipitation Data Center |
| AMSR-E L2B Rain | ICARE | Foreign ESDC | AMSR-E | Generated at ICARE "Restricted" but can be downloaded after login |
| AMSR-E L3 Daily Ocean Data set | ICARE | Foreign ESDC | AMSR-E | Includes Wind speed, Cloud liquid water, and Total water vapor (with SST) |
| AMSR-E L3 RSS Ocean Data | ICARE | Foreign ESDC | AMSR-E | Includes SST, Wind speed, Cloud liquid water, water vapor, and rain rate |
| TMI L2B Rain | ICARE | Foreign ESDC | TMI | Generated at ICARE |

### Table 5.2.2 Non-NASA Atmospheric Data Sets

| Data Set | Organization | Org Type | Sensors | Data Set Information |
|---|---|---|---|---|
| L3 TRMM Combined Rain (3B42, 3B43) | ICARE | Foreign ESDC | TMI | Standard TRMM 3B42, plus daily, monthly, and seasonal averages<br>Standard TRMM 3B43 |
| AMSR L2 and L3 parameters | JAXA/EORC/ EOC/EOIS | Foreign ESDC | AMSR | All retrieval data sets in each L2 and L3 data set. Atmosphere parameters include Surface rainfall rate and accumulation, Cloud liquid water, Water vapor, and Sea surface wind speed<br>AMSR retrieval data sets were not produced by the U.S. science team |
| AMSR-E L2 and L3 parameters | JAXA/EORC/ EOC/EOIS | Foreign ESDC | AMSR-E | All retrieval data sets in each L2 and L3 data set. Atmosphere parameters include Surface rainfall rate and accumulation, Cloud liquid water, Water vapor, and Sea surface wind speed<br>JAXA standard data sets are made with JAXA-based algorithms except sea ice (from NASA)<br>The EOIS order system for AMSR-E allows individual; parameters to be selected. |
| TMI L2 and L3 Precipitation Data sets | JAXA/EORC/EO C/EOIS | Foreign ESDC | TMI | TMI stand-alone retrievals using JAXA algorithms |
| TRMM Combined L2 and L3 Precipitation Data | JAXA/EORC/EO C/ EOIS | Foreign ESDC | TMI, SSM/I | Combined TMI and other satellite instrument observations, some including rain gauge data<br>JAXA algorithms |
| Tropical Cyclone Database | JAXA/EORC/Tro pical Cyclone Database | Foreign ESDC | AMSR, TMI, AMSR-E | Includes Precipitation and Water Vapor |
| TMI L3 Precipitation | China CDC/CMA | Foreign ESDC | TMI | Stand-alone TMI-only retrieval<br>Chinese language site, but Google Chrome web page translates to English |
| TRMM Combined Precipitation (3B42, 3B43) | CDC/CMA | Foreign ESDC | TMI, SSM/I | 3B42: TMI and other satellite instruments<br>3B43: TMI, other satellite instruments, and rain gauges |

### Table 5.2.3 Non-NASA Sea Surface Temperature Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information |
|---|---|---|---|---|
| SMMR SST | NSSDC | NASA SSDC | SMMR | In multi-parameter data sets on magnetic tape |
| SSM/I EDRs | NOAA/NCDC/ CLASS | NOAA ESDC | SSM/I, SSMIS | In multi-parameter EDR |
| SSM/I EDR Map Data sets | NOAA/NCDC/ CLASS | NOAA ESDC | SSM/I | In multi-parameter EDR |
| GHRSST L2P SST | NOAA/NODC | NOAA ESDC | AMSR-E, TMI | Separate data sets form RSS and Europe |
| GHRSST L2P Gridded SST | NOAA/NODC | NOAA ESDC | AMSR-E, TMI | RSS only |
| GHRSST L4 Optimal Interp. SST | NOAA/NODC | NOAA ESDC | AMSR-E, TMI, MODIS | From RSS (data set MW-IR-OI) |
| GHRSST Optimally Interpolated SST | NOAA/ Coastwatch | NOAA ESDC | AMSR-E, TMI, MODIS | From RSS (data set MW-IR-OI) |
| TMI SST | NCAR/EOL | University Consortium | TMI | NAME (June-September 2004) field experiment daily data sets and imagery, SST only available as imagery |
| AMSR, AMSR-E L2, L3 Data | JAXA/EORC/EOC/EOIS | Foreign ESDC | AMSR, AMSR-E | Made with different algorithms than U.S. AMSR-E standard data sets |
| AMSR-E L3 Daily Ocean Data | ICARE | Foreign ESDC | AMSR-E | Not shown in data catalog, but in archive data list for AMSR-E. An L3 RSS data set is also archived. |
| GHRSST L2P SST | IFREMER/ Medspiration | Foreign ESDC | AMSR-E, TMI | Produced by RSS for distribution by the Medspiration Project. The link provided bypasses the IFREMER registered user login system. Free registration gives access to all IFREMER data sets. The official GHRSST link is ftp://eftp.ifremer.fr/cersat-rt/project/medspiration/data |
| GHRSST L4 Optimally Interp. SST | IFREMER/ Medspiration | Foreign ESDC | AMSR-E, TMI | Produced by the Medspiration Project at IFREMER from combined microwave and AVHRR data. Available from the same FTP links listed above. |

### Table 5.2.4 Non-NASA Cryospheric Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information |
|---|---|---|---|---|
| SMMR Sea ice concentration | NSSDC | NASA SSDC | SMMR | In multi-parameter data sets on magnetic tape |
| Value-added Cryospheric Research Data sets | NASA/GSFC Cryospheric Science Branch (CSB) | NASA Branch | SSM/I, SMMR, AMSR-E | Downloadable data sets (data, charts, imagery) include Sea Ice Concentration, Sea Ice Time Series, Arctic and Antarctic Snow Depth on Sea Ice, and Sea Ice Melt<br>Data set documentation but no user services<br>Link to data from home page |
| SSM/I EDRs | NOAA/NCDC/CLASS | NOAA ESDC | SSM/I | In multi-parameter EDR.<br>Cryosphere parameters include Sea ice concentration, Sea ice age, and Snow depth |
| SSMIS EDRs | NOAA/NCDC/CLASS | NOAA ESDC | SSMIS | SSMIS replaces SSM/I starting with DMSP F16.<br>Includes sea ice concentration, snow water equivalent, and snow cover |
| SSM/I EDR Map Data sets | NOAA/NCDC/CLASS | NOAA ESDC | SSM/I F14, 15 | In multi-parameter EDR<br>Includes Sea ice concentration and snow depth |
| Microwave Integrated Retrieval System Data sets (MIRS) | NOAA/NCDC/CLASS | NOAA ESDC | SSMIS | orbital and daily maps<br>http://www.osdpd.noaa.gov/ml/spp/sharedprocessing.html<br>Includes Sea ice concentration, Snow water equivalent (SWE), and Snow cover |
| Global Gridded SSM/I and SSMIS Data sets | NOAA/NCDC | NOAA ESDC | SSM/I, SSMIS | Includes Sea ice extent and Snow Cover1 deg. monthly, 2.5 degree pentad and month |
| SSM/I and SSMIS Shared Processing Data | NOAA/OSDPD | NOAA ESDC | SSM/I, SSMIS | Includes Snow depth and Sea ice concentration |
| Interactive Mapping System (IMS) data sets | National Ice Center (NIC) | NOAA ESDC | SSM/I, AMSR-E | Ice and snow analysis data sets<br>Daily, weekly, bi-weekly |
| University of Illinois Northern Hemisphere Sea Ice Data Set | University of Illinois | University | SMMR, AMSR-E | 1870-2008<br>Other data sources included over entire time series<br>Includes Sea ice concentration and Sea ice extent |
| AMSR-E L2 and L3 Parameters | JAXA/EORC/EOC/EOIS | Foreign ESDC | AMSR-E | In multi-parameter data set<br>Includes Sea ice concentration and Snow water equivalent |
| AMSR-E Sea ice drift vectors | IFREMER/ CERSA | Foreign ESDC | AMSR-E | Link provided to sea ice product page |
| SSM/I Sea ice data sets | IFREMER/CERSAT | Foreign ESDC | SSM/I F13, F14 | Includes sea ice concentration and merged sea ice drift vectors (with QuikSCAT)<br>Same link as above |

### Table 5.2.4 Non-NASA Cryospheric Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information |
|---|---|---|---|---|
| Daily and seasonal sea ice extent | Australian Antarctic Data Centre | Foreign ESDC | SMMR, SSM/I | Registration required |
| Atlas of Antarctic Sea Ice Drift | University of Karlsruhe IMK | Foreign University | SSM/I | Data are downloadable |
| AMSR-E Sea ice concentration | University of Bremen | Foreign University | AMSR-E | Images plus data in GeoTIFF, HDF format |
| AMSR-E and SSM/I Sea ice concentrations | University of Hamburg, Inst. of Oceanography | Foreign University | SSM/I, AMSR-E | FTP downloads |
| Global Sea Ice Concentration Data Set | OSI SAF High Latitude Processing Center | Foreign ESDC | SMMR, SSM/I | The Norwegian Meteorological Institute hosts the EUMETSAT high latitude OSISAF. FTP access from the Sea Ice Data sets web page. Data from 1978-2007 |
| Global Sea Ice Concentration | OSI SAF High Latitude Processing Center | Foreign ESDC | SSM/I F15 | Operational data set from the EUMETSAT OSI SAF. FTP access from the same sea ice data sets link above. |
| Global Sea Ice Edges | OSI SAF High Latitude Processing Center | Foreign ESDC | SSM/I F15 | Operational data set from the EUMETSAT OSI SAF. Also includes scatterometer data. FTP access from the same sea ice data sets link above. |
| Global Sea Ice Types | OSI SAF High Latitude Processing Center | Foreign ESDC | SSM/I F15 | Operational data set from the EUMETSAT OSI SAF. Made from combined SSM/I and scatterometer data. FTP same links above. |
| Low Resolution Sea Ice Drift | OSI SAF High Latitude Processing Center | Foreign ESDC | AMSR-E, SSM/I | Pre-operational data set. Scatterometer data also used in the retrieval. FTP access. |
| Global Sea Ice Concentration from AMSR-E | OSI SAF High Latitude Processing Center | Foreign ESDC | AMSR-E | Includes ECMWF model data for atmospheric corrections. Demonstration data set requiring additional validation. |
| Medium Res Sea Ice Drift | OSI SAF High Latitude Processing Center | Foreign ESDC | AMSR-E, SSM/I | Demonstration data set from EUMETSAT OSI SAF. FTP access. |

### Table 5.2.5 Non-NASA Land and Soil Moisture Data Sets

| Data Set | Organization | Org Type | Sensor(s) | Data Set Information |
|---|---|---|---|---|
| SSM/I EDRs | NOAA/NCDC/CLASS | NOAA ESDC | SSM/I | In multi-parameter EDR |
| SSM/I EDR Map Data sets | NOAA/NCDC/CLASS | NOAA ESDC | SSM/I F14, F15 | In multi-parameter EDR |
| SSM/I Shared Processing Data sets | NOAA/OSDPD | NOAA ESDC | SSM/I | Soil moisture and surface temperature |
| AMSR-E L2 and L3 Parameters | JAXA/EORC/EOC/EOIS | Foreign ESDC | AMSR-E | In multi-parameter data set<br>No AMSR/Midori-II soil moisture data set |
| AMSR LPRMSM L3 Soil Moisture | KNMI/Atmospheric Data Access for the Geospatial User Community | Foreign ESDC | AMSR-E | Derived from a Land Surface Parameter Model from GSFC<br>Web portal link. Use the "Select a Service" pull down menu to access soil moisture data for 2007.<br>A data set description is available along with a list of services provided for AMSR_LPRMSM |

# Appendix A – Organization Descriptions

Workshop participants considered PM data sets provided by organizations in the following broad categories, based on the nature of the relationship between the provider, the NASA Earth Sciences program, and NASA sponsored Earth Science Data Centers.

- **NASA Earth Science Data Centers** (i.e., DAACs and other NASA-funded centers): These institutions have a direct and formal link to NASA Earth Sciences with a mandate to manage Earth Science data for NASA and the wider scientific community.
- **MEaSUREs PI-hosted sites with data required to migrate to DAACs**: The MEaSUREs projects are funded by NASA's Earth Science Data Systems Program through the peer-reviewed proposal process. As part of their research, these projects must transfer data sets that meet certain MEaSUREs program criteria to DAACs chosen by NASA management.
- **NASA-funded, PI-hosted sites with data that may migrate to DAACs**: These data sites have less formal arrangements with the DAACs. Typically, arrangements for data transfer are made directly between the PI and the DAAC. Such data sets do not necessarily carry the same requirements as the MEaSUREs data sets. However, the data migration must follow the ground rules established by NASA, involving assessment by the respective DAAC User Working Groups.
- **NASA-funded data hosted at PI sites**: Some PM data of interest to the NASA science community are hosted at PI sites without involvement of a DAAC.

The primary focus of the data review was on Level 1 through Level 3 data sets at the DAACs. The committee also considered key PM data sets that are being generated and distributed by other NASA-funded organizations. Brief descriptions of all organizations identified at the workshop as distributors of PM data are provided in the following subsections.

## A.1 NASA Distributed Active Archive Centers (DAACs)

- Atmospheric Science Data Center (ASDC) – primarily focusing on atmospheric chemistry data sets, but also holding some heritage PM data
- Global Hydrology and Climate Center (GHRC) – focusing on the atmospheric components of the hydrologic cycle
- Goddard Earth Sciences Data and Information Services Center (GES DISC) – archive of record for the TRMM Microwave Imager data sets, among others
- National Snow and Ice Data Center (NSIDC) – focusing primarily on cryospheric data sets, AMSR-E archive of record
- Physical Oceanography DAAC (PO.DAAC) – extensive data sets of sea surface temperature, wind, and other ocean data.

## A.2 Other NASA-Funded Data Production / Distribution Facilities

- GSFC/Precipitation Processing System (PPS) – processes, analyzes and archives data from the upcoming GPM and the current TRMM mission, providing some overlap with standard TRMM data sets at the GES DISC plus value-added data sets that include a TRMM climatology.

- GSFC/National Space Science Data Center (NSSDC) – archives "heritage" data sets including magnetic tape data from the Nimbus-5 Electronically Scanned Microwave Radiometer (ESMR) and the Nimbus-7 Scanning Multichannel Microwave Radiometer (SMMR).
- GSFC/Cryospheric Science Branch (CSB) – makes publicly available several value-added research data sets derived from PM observations.
- Goddard Institute for Space Sciences (GISS) – archives and distributes SSM/I data for 23 of the regional experiments comprising the GEWEX Cloud System Study.
- Remote Sensing Systems (RSS) – produces and provides access to ocean data sets from many PM instruments, including SSM/I, TMI, and WindSat, and has intercalibrated all PM radiometers using a highly refined radiative transfer model. RSS receives funding from the MEaSUREs program, NASA Physical Oceanography program and AMSR-E and TMI science teams.
- Precipitation Research Group (PRG) at Colorado State University – currently developing a Fundamental Climate Data Record (FCDR) of SSM/I and SSMIS brightness temperatures; also produces the standard data set rain algorithms for TRMM and AMSR-E. While this research is sponsored by NOAA and will also be available through CLASS, it is based on PRG's heritage of NASA-funded research.

## A.3 Other U.S. Government Data Production / Distribution Facilities

- National Ice Center (NIC) – provides access to ice and snow analysis data sets from the Interactive Mapping System (IMS) which incorporates some PM data.
- NOAA/Coast Watch – provides regional wind data from SSM/I and GHRSST Optimally Interpolated SST.
- NOAA/National Climate Data Center (NCDC) – provides a large collection of PM data sets, including the mission archives for SSM/I and SSMIS via the Comprehensive Large Array-data Stewardship System (CLASS), as well as other products such as blended sea winds and globally gridded SSM/I and SSMIS data sets.
- NOAA/National Oceanic Data Center (NODC) – Long term archival center for Group for High Resolution SST (GHRSST) SST data set. SSTs are from individual instruments as well as optimally interpolated SST data from single instruments or multiple, combined instruments.
- NOAA/Office of Satellite Data Processing and Distribution (OSDPD) – provides SSM/I and SSMIS Shared Processing Data sets.
- Naval Research Laboratory (NRL) Monterey – provides SSM/I Composite2 images and tropical cyclone wind speeds.
- United States Department of Agriculture (USDA)/Foreign Agricultural Service (FAS) – provides Crop Explorer Precipitation Maps (10-day rainfall).

## A.4 Non-NASA-Supported Domestic Production / Distribution Facilities

- George Mason University (GMU) Polar Satellite Precipitation Data Center - processes, archives, and distributes oceanic monthly rainfall from data derived from SSM/I and the SSMIS observations.

- National Center for Atmospheric Research (NCAR) / Computational and Information Systems Laboratory (CISL) / Research Data Archive (RDA) – provides access to three satellite PM derived data sets (GEWEX NVAP, CCMP Ocean Surface Wind Velocity, and Chang's SSM/I Monthly Precipitation Estimates).
- National Center for Atmospheric Research (NCAR) / Earth Observing Laboratory (EOL) – provides regionally subsetted SSM/I data sets and imagery for several field experiments.
- University of Illinois – provides the University of Illinois Sea Ice Data Set covering the Northern Hemisphere over 1870-2008.

## A.5 International Production / Distribution Facilities

- Australian Antarctic Data Centre (AADC) [Kingston, Tasmania, Australia] – provides data management and spatial data services to Australia's Antarctic Programme, and produces daily and seasonal sea ice extent data sets from SMMR and SSM/I observations.
- China Meteorological Data Sharing Service System, Climatic Data Center (CDC), National Meteorological Information Center, China Meteorological Administration (CMA) [Beijing, China] - the official meteorological archive in China, collecting data from many sources including satellite PM remote sensing. Chinese language site; the Google Chrome browser provides translations of the web pages into English and other languages.
- Cloud-Aerosol-Water-Radiation Interactions (ICARE) Thematic Center [University of Lille, France] – a joint creation of CNES, CNRS, the Nord-Pas-De-Calais Regional Council, and the University of Lille, producing, archiving, and distributing remote sensing data derived from Earth observation missions from CNES, NASA, and EUMETSAT, among others. PM data sets include those from AMSR-E, SSM/I, SSMIS, and TMI.
- French Institute of Research for the Exploitation of the Sea (IFREMER)/Center for Satellite Exploitation and Research (CERSAT) [Brest, France] - a major world data center for oceanography, processing, archiving, and distributing satellite remote-sensing data, including some PM data sets derived from SSM/I and AMSR-E.
- Japanese Aerospace Exploration Agency (JAXA) / Earth Observation Research Center (EORC) / Earth Observing Center (EOC) / Earth Observation Data and Information System (EOIS) [Hatoyama, Japan]- created from a merger of the National Space Development Agency of Japan (NASDA) and two other Japanese space agencies, JAXA supported the development of AMSR-E flown on the EOS Aqua mission, and produces, archives, and distributes its own set of standard AMSR-E data sets.
- JAXA/EORC/Tropical Cyclone Database (TCD) [Hatoyama, Japan] - contains information and data for all tropical storms/hurricanes/typhoons from 1997 to the present for which observations by TRMM, AMSR (Midori-II), and/or AMSR-E (Aqua) are available.
- National Environment Research Council (NERC)/British Antarctic Survey (BAS)/Polar Data Centre [Cambridge, UK]– processes and distributes cryospheric data sets including Antarctic snow accumulation maps from AMSR-E measurements.
- Royal Netherlands Meteorological Institute (KNMI)/Atmospheric Data Access for the Geospatial User Community (ADAGUC) [De Bilt, Netherlands] – produces and distributes a global soil

moisture data set (AMSR LPRMSM L3 Soil Moisture) derived using a land surface parameter model (LPRM) applied to AMSR-E observations.

- Ocean and Sea Ice Satellite Application Facility (OSI SAF) High Latitude Processing Centre [Oslo, Norway] –A EUMETSAT OSI SAF group hosted at the Norwegian Meteorological Institute distributing several sea ice data sets.
- University of Bremen [Bremen, Germany] – provides daily sea ice concentration maps (imagery and data) for AMSR-E, both near real-time and long-term archive.
- University of Hamburg/Institute of Oceanography [Hamburg, Germany] – provides daily sea ice concentration data for AMSR-E and SSM/I via FTP.
- University of Karlsruhe (UK) Institute for Meteorology and Climate (IMK) [Karlsruhe, Germany] - distributes an Atlas of Antarctic Sea Ice Drift generated from SSM/I data.

# Appendix B – Levels of Service

Table B shows general categories of data and appropriate levels of service (LOS), with LOS increasing from left to right. Note that any combination through the columns under public availability is possible, as appropriate for a given data set and its user community. Terms used to describe the different service categories are described below.

| Function | | Level of Service (increasing to right) | | | | |
|---|---|---|---|---|---|---|
| | Not Public | Restricted | X-Ref | Public (any combination) | | |
| Ingest + Archive | Varies | Yes | None | 1-time ingest | Yearly ingest | Ongoing ingest |
| Metadata | Varies | Yes | Minimal collection | Full collection | Collection & File | Collection, File & Service |
| Distribution | No | Restricted | Other site | FTP access | File search & order | File services |
| User Services | No | Yes | Referral | Document support | USO tech support | Full tech support |
| Documentation | Varies | Varies | Ad only | Readme | Mini doc | Full doc |
| Examples | Retired data | RSS Tbs | Data held at other centers | | | DAAC EOS Standard Products |

Ingest + Archive

None – Data cross-referenced by data center, and is archived (and typically distributed from) the PI's home site.

1-time ingest – The entire data set, be it a multiplicity of directories with multiple files or a single file, is delivered at one time. No updates are expected.

Periodic ingest – Ongoing data set updates are expected on an ad-hoc periodic basis – typically yearly.

Ongoing ingest – Ongoing data set updates are expected on a routine automated scheduled basis – typically daily.

Metadata

None – Neither the provider nor data center develops nor maintains metadata about this data set.

Minimum collection – Only the 8 mandatory fields from the NASA DIF are provided.

Full collection– A complete collection-level metadata entry corresponding is provided for this data set.

Collection & File– Not only does the data set have a full collection entry but information is also kept about each and every file/granule within the data set.

Collection, File & Service – Not only does the data set have full collection and file metadata, but additional metadata such as that necessary to provide or describe advanced data services is also available.

Distribution

Other site – The data are distributed from the PI's site. This typically is used for brokered data where the data center does not hold a copy of the data.

FTP access – Data are staged to a permanent FTP area (currently on SIDADS) for users to access.

File search & order – Data may still be available directly from an FTP area, but in addition file-level search and order are available via mechanisms such as WIST.

File services– Not only are the data available directly via FTP and through file search and order mechanisms, but a variety of advanced services (e.g., subsetting, reformatting, OGC services, etc.) are available.

Documentation

Advertised Only – The data set may not held at the data center but is still advertised on the web site.

Readme – In addition to being advertised by a web site/page, a readme file is developed for the data set and placed in the FTP site for the data.

Mini doc – In addition to advertising the data set, a streamlined user guide document is developed for the data set mainly from information provided by the PI

Full doc – In addition to advertising, a complete user guide document is developed for the data set from PI provided information and technical writer research.

User Services

Referral– User Services refers user questions to the PI or an external site.

Document support – User Services uses documentation in an attempt to resolve user questions. User Services often points user to area in documentation with information.

USO technical support – User Services uses technical training on this data set to resolve user questions about ordering the data, extracting the data using available tools, etc.

USO technical support – User Services uses all available resources (documentation, web research, programming staff, scientists, etc.) to resolve user questions. NOTE: This may even include consulting with external sources to resolve user questions.

# Appendix C – Links to Data Sets

Explicit URLs are provided for all data centers listed in Appendix A as well as for those data sets for which embedded links have been provided in Section 5. The data center links are provided first.

**Part 1: Data Centers**

| Organization | Data Set URL |
|---|---|
| Atmospheric Science Data Cr (ASDC) | http://eosweb.larc.nasa.gov/ |
| Global Hydrology and Climate Center (GHRC) | http://ghrc.nsstc.nasa.gov/ |
| Goddard Earth Sciences Data and Information Services Center (GES DISC) | http://daac.gsfc.nasa.gov/ |
| National Snow and Ice Data Center (NSIDC) | http://nsidc.org/daac/ |
| Physical Oceanography DAAC (PO.DAAC) | http://podaac.jpl.nasa.gov/ |
| GSFC/Precipitation Processing System (PPS) | http://pps.gsfc.nasa.gov/tsdis/tsdis.html |
| GSFC/National Space Science Data Center (NSSDC) | http://nssdc.gsfc.nasa.gov/ |
| GSFC/Cryospheric Science Branch (CSB) | http://neptune.gsfc.nasa.gov/csb/index.php |
| Goddard Institute for Space Sciences (GISS) | http://www.giss.nasa.gov/ |
| Remote Sensing Systems (RSS) | http://www.remss.com/ |
| Precipitation Research Group (PRG) | http://rain.atmos.colostate.edu/ |
| National Ice Center (NIC) | http://www.natice.noaa.gov/ |
| NOAA/Coast Watch | http://coastwatch.noaa.gov/ |
| NOAA/National Climate Data Center (NCDC) | http://www.ncdc.noaa.gov/oa/ncdc.html |
| NOAA/NCDC/Comprehensive Large Array-data Stewardship System (CLASS) | http://www.class.ngdc.noaa.gov/saa/products/welcome |
| NOAA/National Oceanic Data Center (NODC) | http://www.nodc.noaa.gov/ |
| NOAA/Office of Satellite Data Processing and Distribution (OSDPD) | http://www.osdpd.noaa.gov/ |
| Naval Research Laboratory (NRL) Monterey | http://www.nrlmry.navy.mil/ |
| United States Department of Agriculture (USDA)/Foreign Agricultural Service (FAS) | http://www.pecad.fas.usda.gov/cropexplorer/mpa_maps.cfm |
| George Mason University (GMU) Polar Satellite Precipitation Data Center | http://gpcp-pspdc.gmu.edu/index.shtml |

| Organization | Data Set URL |
|---|---|
| National Center for Atmospheric Research (NCAR) / Computational and Information Systems Laboratory (CISL) / Research Data Archive (RDA) | http://dss.ucar.edu/ |
| National Center for Atmospheric Research (NCAR) / Earth Observing Laboratory (EOL) | http://www.eol.ucar.edu/ |
| University of Illinois | http://arctic.atmos.uiuc.edu/SEAICE/ |
| Australian Antarctic Data Centre (AADC) | http://data.aad.gov.au/aadc/envi/ |
| China Meteorological Data Sharing Service System, Climatic Data Center (CDC), National Meteorological Information Center, China Meteorological Administration (CMA) | http://cdc.cma.gov.cn/ |
| Cloud-Aerosol-Water-Radiation Interactions (ICARE) Thematic Center | http://www.icare.univ-lille1.fr/ |
| French Institute of Research for the Exploitation of the Sea (IFREMER)/Center for Satellite Exploitation and Research (CERSAT) | http://cersat.ifremer.fr/ |
| JAXA/Earth Observation Research Center (EORC) | http://www.eorc.jaxa.jp/en/index.php |
| JAXA/EORC/Earth Observing Center (EOC) | http://www.eorc.jaxa.jp/en/about/distribution/index.html |
| JAXA/EORC/EOC/ | https://www.eoc.jaxa.jp/iss/jsp/indexEn.html |
| JAXA/EORC/Tropical Cyclone Database (TCD) | http://sharaku.eorc.jaxa.jp/TYP_DB/index_e.shtml |
| National Environment Research Council (NERC)/British Antarctic Survey (BAS)/Polar Data Centre | http://www.antarctica.ac.uk/index.php |
| Royal Netherlands Meteorological Institute (KNMI)/Atmospheric Data Access for the Geospatial User Community (ADAGUC) | http://adaguc.knmi.nl/ |
| Ocean and Sea Ice Satellite Application Facility (OSI SAF) High Latitude Processing Centre | http://saf.met.no/ |
| University of Bremen | http://iup.physik.uni-bremen.de:8084/amsr/ |
| University of Hamburg/Institute of Oceanography | http://www.ifm.uni-hamburg.de/ |
| University of Karlsruhe (UK) Institute for Meteorology and Climate (IMK) | http://www.imk.kit.edu/english/index.php |

**Part 2: Data Set URLs**

| Organization | Data Set | Data Set URL |
|---|---|---|
| NOAA/NCDC | Blended sea winds | http://www.ncdc.noaa.gov/oa/rsad/air-sea/seawinds.html |
| NOAA/OSDPD | Shared Processing Data set | http://www.osdpd.noaa.gov/ml/spp/sharedprocessing.html |
| NOAA CoastWatch | SSM/I Regional Winds | http://coastwatch.noaa.gov/cwn/search/cwn_most_recent.php?sensor=SSMI&product=wind |
| NRL | SSM/I Composite2 Images | http://www.nrlmry.navy.mil/sat-bin/composite2.cgi |
| USDA/FAS | Crop Explorer Precipitation Maps | http://www.pecad.fas.usda.gov/cropexplorer/mpa_maps.cfm |
| NCAR/CISL/RDA | GEWEX NASA Water Vapor Project (NVAP) | http://dss.ucar.edu/datasets/ds722.0/ |
| NCAR/CISL/RDA | Chang's SSM/I Monthly Precipitation Estimates | http://dss.ucar.edu/datasets/ds729.0/ |
| NCAR/CISL/RDA | Cross-Calibrated Multi-Platform (CCMP) Ocean Surface Wind Velocity | http://dss.ucar.edu/datasets/ds744.9/ |
| NCAR/ EOL | SSM/I Gridded Data | http://www.eol.ucar.edu/data/data#project_view_data |
| China CDC/CMA | TMI L3 Precipitation | http://cdc.cma.gov.cn/shuju/index3.jsp?dsid=SATE_L3_TRM_TMI_SWB_3A12_GLB_V6&pageid=3 |
| China CDC/CMA | TRMM Combined Precipitation (3B42, 3B43) | http://cdc.cma.gov.cn/shuju/index3.jsp?tpcat=SATE&dsid=SATE_L3_TRM_MUTDS_MWB_3B42_GLB_V6<br>http://cdc.cma.gov.cn/shuju/index3.jsp?tpcat=SATE&dsid=SATE_L3_TRM_MUTDS_MWB_3B43_GLB_V6 |
| NOAA CoastWatch | GHRSST Optimally Interp.SST | http://coastwatch.pfeg.noaa.gov/erddap/griddap/erdGRssta1day.html |
| IFREMER/Medspiration | GHRSST L2P SST | ftp://ftp.ifremer.fr/ifremer/medspiration/data/l2p/ |
| IFREMER/Medspiration | GHRSST L4 Optimally Interp. SST | ftp://ftp.ifremer.fr/ifremer/medspiration/data/l4/ |
| National Ice Center | Interactive Mapping System (IMS) data sets | http://www.natice.noaa.gov/ims/ |
| University of Illinois | University of Illinois Northern Hemisphere Sea Ice Data Set | http://arctic.atmos.uiuc.edu/SEAICE/ |
| IFREMER/ CERSA | AMSR-E Sea ice drift vectors | http://cersat.ifremer.fr/data/discovery/by_parameter/sea_ice |
| IFREMER/CERSAT | SSM/I  Sea ice data sets | http://cersat.ifremer.fr/data/discovery/by_parameter/sea_ice |
| Australian Antarctic Data Centre | Daily and seasonal sea ice extent | http://data.aad.gov.au/aadc/envi/index.cfm#2 |
| University of Karlsruhe | Atlas of Antarctic Sea Ice Drift | http://imkbemu.physik.uni-karlsruhe.de/~eisatlas/ |

| Organization | Data Set | Data Set URL |
|---|---|---|
| IMK | | |
| University of Bremen | AMSR-E Sea ice concentration | http://iup.physik.uni-bremen.de:8084/amsr/ |
| University of Hamburg, Inst. of Oceanography | AMSR-E and SSM/I Sea ice concentrations | ftp://ftp-projects.zmaw.de/seaice/ |
| OSI SAF High Latitude Processing Center | Global Sea Ice Concentration Data Set | http://saf.met.no/p/ice/index.html |
| KNMI/Atmospheric Data Access for the Geospatial User Community | AMSR LPRMSM L3 Soil Moisture | http://geoservices.knmi.nl/adaguc_portal/index.html<br>Data set description:<br>http://adaguc.knmi.nl/contents/datasets/data%20setdescriptions/W_ADAGUC_Data%20set_description_AMSR_LPRMSM_L3_Soilmoisture.html<br>Data services provided:<br>http://adaguc.knmi.nl/contents/webservices/WebServices_AMSR_LPRMSMD_L3A.html |

# Appendix D – Acronyms

| Acronym | Definition |
|---|---|
| AADC | Australian Antarctic Data Centre |
| ADAGUC | Atmospheric Data Access for the Geospatial User Community |
| AE_L2A | AMSR-E Level 2A (U.S. AMSR-E standard data set) |
| AFWA | Air Force Weather Agency |
| AMSR | Advanced Microwave Scanning Radiometer (Midori-II) |
| AMSR-E | Advanced Microwave Scanning Radiometer for EOS (Aqua) |
| ASCII | American Standard Code for Information Interchange |
| ASDC | Atmospheric Science Data Center |
| ASTEX | Atlantic Stratocumulus Transition Experiment |
| AVHRR | Advanced Very High Resolution Radiometer |
| BALTEX | Baltic Sea Experiment |
| BAMEX | Bow Echo and Mesoscale convective Vortex Experiment |
| BAS | British Antarctic Survey |
| BASE | Beaufort and Arcitc Storms Experiment |
| BUFR | Binary Universal Form for the Representation of meteorological data |
| BYU | Brigham Young University |
| CASP2 | Canadian Atlantic Storms Project 2 |
| CCMP | Cross-Calibrated Multi-Platform |
| CDC | Climatic Data Center |
| CEAREX | Coordinated Eastern Arctic Experiment |
| CEOS | Consortium of Earth Observing Systems |
| CERSAT | Center for Satellite Exploitation and Research |
| CISL | Computational and Information Systems Laboratory |
| CLASS | Comprehensive Large Array-data Stewardship System |
| CliC | Climate and Cryosphere Project |
| CMA | China Meteorological Administration |

| Acronym | Definition |
|---|---|
| CNES | Centre National d'Etudes Spatiales (France) |
| CNRS | Centre National de la Recherce Scientifique (France) |
| CSB | Cryospheric Science Branch (GSFC) |
| CSU | Colorado State University |
| CSU/PRG | CSU/Precipitation Research Group |
| DAAC(s) | Distributed Active Archive Center(s) |
| DISC | Data and Information Services Center |
| DMSP | Defense Meteorological Satellite Program |
| DOI | Digital Object Identifiers |
| DQSS | Data Quality Screening Service |
| EASE | Equal Area Scalable Earth-Grid |
| ECMWF | European Centre for Medium-Range Weather Forecasts |
| EDR | Environmental Data Record(s) |
| EOC | Earth Observing Center |
| EOIS | Earth Observation Data and Information System (JAXA) |
| EOL | Earth Observing Laboratory |
| EORC | Earth Observation Research Center (JAXA) |
| EOS | Earth Observing System |
| EOSDIS | EOS Data and Information System |
| EPIC | East Pacific Investigation of Climate processes |
| ESDCs | Earth Science Data Center(s) |
| ESDIS | Earth Science Data and Information System |
| ESIP | Earth Science Information Partners |
| ESMR | Electrically Scanning Microwave Radiometer |
| EUMETSAT | European Organization for the Exploitation of Meteorological Satellites |
| EURO-CS | European Cloud and Radiation Experiment |

| Acronym | Definition |
|---|---|
| FAS | Foreign Agricultural Service |
| FASTEX | Fronts and Atlantic Storm Track Experiment |
| FCDR | Fundamental Climate Data Record |
| FIRE-II | First ISCCP Regional Experiment II Cirrus |
| FIRE-MS | First ISCCP Regional Experiment-Marine Stratocumulus |
| FNMOC | Fleet Numerical Meteorology and Oceanography Center |
| FTP | File Transfer Protocol |
| G1SST | Global 1-km SST data set (GHRSST) |
| GCMD | Global Change Master Directory |
| GDR | Geophysical Data Record |
| GeoTIFF | Geographic Tagged Image File Format |
| GES | Goddard Earth Sciences |
| GEST | Goddard Earth Sciences and Technology Center (UMBC) |
| GEWEX | Global Energy and Water Cycle Experiment |
| GHCC | Global Hydrology and Climate Center |
| GHRC | Global Hydrology Research Center |
| GHRSST | Group for High Resolution Sea surface Temperature |
| GIF | Graphical Interchange Format |
| GIS | Geographical Information System |
| GISS | Goddard Institute For Space Sciences |
| GMU | George Mason University |
| GPCP | Global Precipitation Climate Project |
| GPROF | Goddard Profiling algorithm |
| GrADS | Grid Analysis and Display System |
| GSFC | Goddard Space Flight Center |
| HDF | Hierarchical Data Format |
| HDF-EOS | Hierarchical Data Format - EOS |
| ICARE | Cloud-Aerosol-Water-Radiation Interactions |
| ICE89 | International Cirrus Experiment - 1989 |
| IDV | Integrated Data Viewer |

| Acronym | Definition |
|---|---|
| IFREMER | French Institute of Research for the Exploitation of the Sea |
| IMK | Institute for Meteorology and Climate (Germany) |
| IMS | Interactive Mapping System |
| INDOEX | Indian Ocean Experiment |
| IPWG | International Precipitation working Group |
| IR | InfraRed |
| ISCCP | International Satellite Cloud Climatology Experiment |
| JAXA | Japan Aerospace Exploration Agency |
| JPG | Joint Photographic experts Group |
| JPL | Jet Propulsion Laboratory |
| K10_SST | 10km SST (GHRSST L4 data set) |
| KNMI | Royal Netherlands Meteorological Institute |
| LANCE | Land and Atmosphere Near Real Time Capability for EOS |
| LEADEX | Leads Experiment |
| LOS | Level of Service |
| LPRMSM | Land Surface Parameter Model Soil Moisture |
| MAIRS | Monsoon Asia Integrated Regional Study |
| mil/TC | Making Earth Science Data Records for Use in Research Environments |
| MODIS | Moderate Resolution Imaging Spectroradiometer |
| MSPPS | Microwave Surface and Precipitation Products System |
| MUR | Multiscale Ultrahigh Resolution |
| NASA | National Aeronautics and Space Administration |
| NASDA | National Space Development Agency (Japan) |
| NCAR | National Center for Atmospheric Research |
| NCDC | National Climate Data Center |
| NCEP | National Centers for Environmental Prediction |
| NERC | National Environment Research Council |
| NetCDF | network Common Data Form |
| NIC | National Ice Center |
| NOAA | National Oceanic and Atmospheric Administration |

| Acronym | Definition |
|---|---|
| NODC | National Oceanographic Data Center |
| NRL | Naval Research Laboratory |
| NRT | Near-Real-Time |
| NSIDC | National Snow and Ice Data Center |
| NSSDC | National Space Science Data Center |
| NVAP | NASA Water Vapor Project |
| ODYSSEA | *Ocean* Data Analysis. System for mErSEA |
| OGC | Open Geospatial Consortium |
| OI | Optimally Interpolated |
| OPeNDAP | Open Source Project for Network Data Access Protocol |
| ORNL | Oak Ridge National Laboratories |
| OSDPD | Office of Satellite Data Processing and Distribution |
| OSI SAF | Ocean and Sea Ice Satellite Application FAcility |
| OSTIA | Operational Sea Surface Temperature and Sea Ice Analysis |
| PACS | Pan American Climate Studies |
| PI(s) | Principal Investigator(s) |
| PM | Passive Microwave |
| PMWC | Passive Microwave Water Cycle |
| PNG | Portable Network Graphics |
| PO | Physical Oceanography |
| POET | PO.DAAC Ocean ESIP Tool |
| PPS | Precipitation Processing System |
| PR | Precipitation Radar (TRMM) |
| PRG | Precipitation Research Group |
| RDA | Research Data Archive |
| REASON | Research, Education, and Applications Solutions Network |
| RICO | Rain In Cumulus over Ocean |
| RSS | Remote Sensing Systems |
| SALLJEX | South American Low Level Jet Experiment |

| Acronym | Definition |
|---|---|
| SDRs | Sensor Data Records |
| SeaSat | Sea Satellite (Seasat) |
| SHEBA | Surface Heat Budget of the Arctic Ocean |
| SIPSs | Science Investigator Processing Systems |
| SMMR | Scanning Multichannel Microwave Radiometer |
| SSDC | Space Science Data Center |
| SSM/I | Special Sensor Microwave/Imager |
| SSMIS | Special Sensor Microwave Imager Sounder |
| SST | Sea Surface Temperature |
| STC | Science and Technology Center |
| SWE | Snow Water Equivalent |
| TBs | Brightness Temperatures |
| TCC | TRMM Combined Climatology |
| TCD | Tropical Cyclone Database (JAXA) |
| TDR(s) | Temperature Data Record(s) |
| TMI | TRMM Microwave Imager |
| TMPA | TRMM Multi-satellite Precipitation Analysis |
| TOVS | TIROS-N Operational Vertical Sounder System |
| TRMM | Tropical Rainfall Measuring Mission |
| TSDIS | TRMM Science Data and Information System |
| UMBC | University of Maryland Baltimore County |
| URL | Uniform Resource Locator |
| USDA | United States Department of Agriculture |
| VIRS | Visible and Infrared Scanner (TRMM) |
| VOCALS | VAMOS-Ocean-Cloud-Atmosphere-Land Study |
| WindSat | Wind Satellite |
| WISP | Winter Icing and Storms Project |
| WIST | Warehouse Inventory Search Tool |
| WMS | Web Map Server |

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE *(DD-MM-YYYY)* | 2. REPORT TYPE | 3. DATES COVERED *(From - To)* |
|---|---|---|
| 01-09-2011 | Technical Publication | |

**4. TITLE AND SUBTITLE**

Report from the Passive Microwave Data Set Management Workshop

**5a. CONTRACT NUMBER**

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**

E. Armstrong, H. Conover, M. Goodman, B. Krupp, Z. Liu, J. Moses, H. K. Ramapriyan, D. Scott, Boulder; D. Smith, R. Weaver

**5d. PROJECT NUMBER**

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

NASA GSFC, Greenbelt, MD 20771

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**

National Aeronautics and Space Administration
Washington, DC 20546-0001

**10. SPONSORING/MONITOR'S ACRONYM(S)**

NASA

**11. SPONSORING/MONITORING REPORT NUMBER**

NASA/CP–2011-215885

**12. DISTRIBUTION/AVAILABILITY STATEMENT**

Unclassified-Unlimited, Subject Category: 43
Report available from the NASA Center for Aerospace Information, 7115 Standard Drive, Hanover, MD 21076. (443)757-5802

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**

Passive microwave data sets are some of the most important data sets in the Earth Observing System Data and Information System (EOSDIS), providing data as far back as the early 1970s. The widespread use of passive microwave (PM) radiometer data has led to their collection and distribution over the years at several different Earth science data centers. The user community is often confused by this proliferation and the uneven spread of information about the data sets. In response to this situation, a Passive Microwave Data Set Management Workshop was held 17-19 May 2011 at the Global Hydrology Resource Center, sponsored by the NASA Earth Science Data and Information System (ESDIS) Project. The workshop attendees reviewed all primary (Level 1-3) PM data sets from NASA and non-NASA sensors held by NASA Distributed Active Archive Centers (DAACs), as well as high-value data sets from other NASA-funded organizations. This report provides the key findings and recommendations from the workshop as well as detailed tabluations of the datasets considered.

**15. SUBJECT TERMS**

Passive Microwave, Information Systems, Libraries, Earth Sciences, Microwave Imagery, Remote Sensing, Microwave Radiometers, Sea Surface Temperature, Birghtness Temperature, EOSDIS, DAAC

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19b. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | Hampapuram Ramapriyan |
| Unclassified | Unclassified | Unclassified | Unclassified | 56 | 19b. TELEPHONE NUMBER *(Include area code)* (301) 614-5356 |