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Land Surface Characterization for Precipitation Retrieval in the GPM Era

The Precipitation Measuring Missions (PMM) Land Surface Working Group
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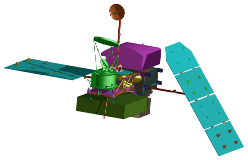


Purpose and Structure

The purpose of the Land Surface Working Group (LSWG) is to coordinate investigations and studies directed for improved over-land precipitation retrievals, in preparation for the Global Precipitation Mission (GPM). Current efforts include an assessment of the current state of land surface emissivity models and retrievals, which are needed to advance the GPM over-land precipitation algorithms. The various ad-hoc LSWG efforts (only several are summarized in this poster) are focused on establishing methodologies to dynamically characterize the land surface for sensors onboard the GPM core and constellation satellites.

LSWG Study Areas

The study areas included 12 targets, with 9 types of surfaces. The one year period covered 1 July 2006 through 30 June 2007.

C3VP – 44 N, 80 W
Amazon(2) – 7 S, 70 W and 2 N, 55 W
Open Ocean(3) – 0 N, 150 W; 35 N, 30 W; 45 S, 35 W
Desert – 22 N, 29 E
SGP – 35 N, 97 W
Inland Water – 48 N, 87 W
SE US (HMT-E) - 34 N, 81 W
Wetland surface - 18 S, 57 W
Finland – 60 N, 25 E

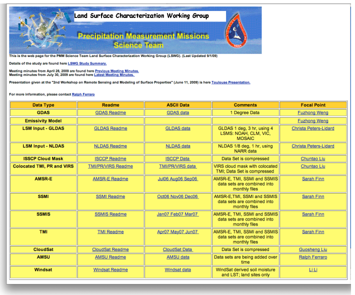
Three types of datasets were assembled:

Satellite *(AMSR-E, SSMI, SSMIS, TMI, AMSU, WindSat)*
Ancillary satellite *(ISCCP, PR/VIRS, CloudSat)*
Model *(GDAS, LSM, JCSDA Emissivity)*

Each participant generates emissivity products, using only the data sets supplied, and make results freely accessible by others (public website). The results are stratified by site, cloud mask, etc. In this poster we present a only a small sample of the various ongoing investigations.

For more information:

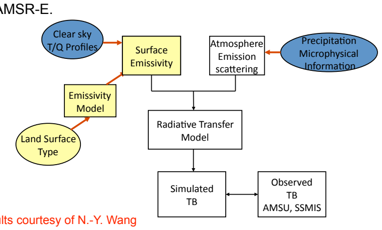
http://cics.umd.edu/~rferraro/LSWG.html



Using Emissivity Information

Over-land precipitation retrieval using passive microwave (PMW) measurements requires accurate estimates of the radiometric signature of the surface to constrain the rainfall solutions. The land surface emissivity typically is characterized by statistical analyses of PMW observations or emissivity models taken under rain-free conditions. Such a database can account for spatial variability of surface emissivity at global scales due to change in surface type, but they are not designed to reduce the uncertainties introduced by temporal variations of soil moisture and vegetation water content. Because no such characterization of the surface signature is available at microwave frequencies above L-band, current PMW land rainfall algorithms rely upon scattering-induced signatures at high frequencies (≥ 85 GHz) and are empirical in nature.

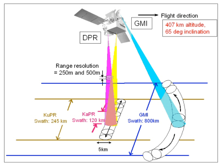
Modeling of the surface emissivity at GMI frequencies requires as much knowledge of the background characteristics as possible, and of the vertical structure of the intervening atmosphere. Emissivity models which convert geophysical properties (soil moisture, surface type/roughness, etc) into electromagnetic properties (emissivity) are being examined for current PMW sensors such as AMSU-B/MHS, TRMM and AMSR-E.

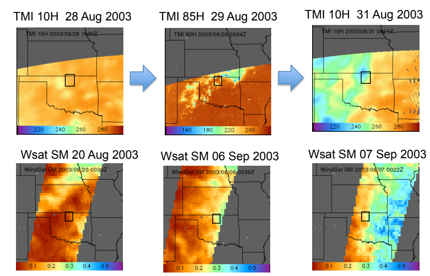


Results courtesy of N.-Y. Wang

The GPM Mission

The NASA/JAXA Global Precipitation Measurement (GPM) mission, currently scheduled for a 2013-2014 launch, will extend the observations from the current Tropical Rainfall Measuring Mission (TRMM) to higher latitudes, with a core spacecraft serving as the calibration reference system for a constellation of support satellites, providing more frequent time sampling. The core will deploy the Dual-frequency Precipitation Radar (DPR) and the GPM Microwave Imager (GMI). The GMI is similar to the current TRMM Microwave Imager (TMI) with the additional of high frequency channels (157/183 GHz) needed for improved detection of light rain and snow. The two different radar frequencies of the DPR make it possible to infer information regarding rainfall rate, cloud type, snow/rain, and the drop size distribution.





WindSat Soil Moisture Retrievals

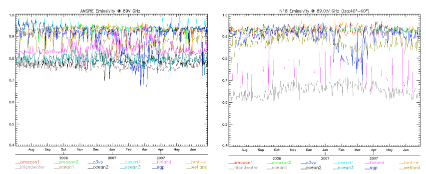
Physically-based soil moisture estimates from WindSat are being used to examine the potential for TRMM-based surface emissivity retrievals.

The change in the TRMM 10 GHz T_B over the southern US due to series of rain events that moved across the area in late August 2003. The 85H T_B overpass on 29 August indicates the presence of convective precipitation moving across the area in late August and early September. The 1-degree box indicates the domain of the Southern Great Plains (SGP) site. Associated soil moisture estimates retrieved from WindSat increase during this time.

WindSat data courtesy of Li Li

NOAA/NESDIS Microwave Integrated Retrieval System (MIRS)

AMSU (acrosstrack) and AMSR-E (conical) comparison for various targets

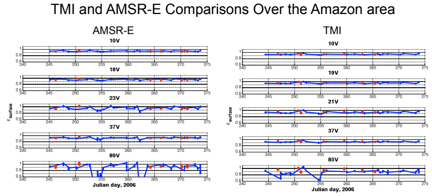


- AMSR-E ~50 deg incidence angle, AMSU shown here between 40-60 deg.
- AMSU is also mixed polarization
- Only 5 targets of AMSU data were made available to date
- Similarities:
  - a) Large annual cycle changes at C3VP and wetland (and magnitudes)
  - b) Finland is clearer lower than other targets
- Differences:
  - Water targets (mixed polarization?)

Results courtesy of S. Boukabara/W. Chen

Cooperative Institute for Climate Studies (CICS)

TMI and AMSR-E Comparisons Over the Amazon area



37 GHz or less
Reasonable stability of Є over vegetated target
Cloud affects minimal

89 GHz
Cloud and precipitation affects dramatic
Similar values during clear conditions

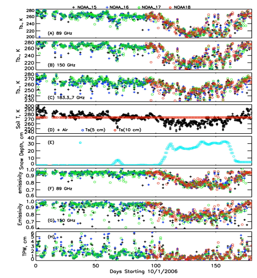
Clear Sky
Cloudy

1

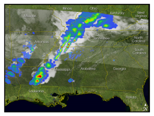
Results courtesy of N-Y. Wang/K. Gopalan

NASA GSFC

AMSU-B Comparisons at C3VP (Canada) winter site



Results courtesy of J. Wang/G. Skofronick-Jackson



Relevance to the SMAP Mission

GPM is currently planned to be active during the Soil Moisture Active Passive (SMAP) mission. There exists significant GPM-SMAP overlap in terms of science goals and measurement requirements, specifically towards the utilization of frequent precipitation estimates. For example, SMAP can benefit GPM over-land retrievals via improved dynamical characterization of GMI channel surface emissivities, and GPM can benefit SMAP science with the capability for improved tracking of precipitation evolution between SMAP revisits.

ACKNOWLEDGEMENTS

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