IPWG6 Research and New Technologies WG Report

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Specific Research and New Technology Recommendations to CGMS

- IPWG recommends the long-term continuity of conically-scanning microwave imagers as well as space based radars. Particularly, for future operational NOAA / DoD polar platforms conically-scanning microwave imagers are critical. Furthermore, the coordination of satellite overpass times has to be ensured including non sun-synchronous platforms.

- IPWG recommends that CGMS partners release precipitation relevant information from research missions in a timely manner. In particular IPWG recognizes the critical importance of data from the Megha-Tropiques MADRAS sensor.

- IPWG recommends the implementation of new technology, such as geostationary microwave and advanced radar instrumentation.

- CGMS members and WMO should provide adequate support to ensure active participation at meeting

Research

Algorithms and Retrievals

1. **Status/direction of high latitude, light rain/snowfall- over ocean, over land?**
    - The definition of light rain is still unclear. Separation by rain rate threshold seems not to be generally applicable. It is suggested to take droplet spectra into account for characterization of precipitation types.
    - HF (150/183) microwave methods are useful to detect shallow and light rain. However, light and shallow rain should be treated separately, since shallow rain might not be detected in 183GHz channels as the maximum of the weighting function may be too high in the atmosphere.

- Cloudsat and/or model data may be used to see sub-cloud evaporation, light rain over land.
- Retrievals over snow covered regions are an open research issue. Furthermore, reliable surface snow flags are needed for the development and application of such retrievals. Action: Investigate availability of data sets to be used for retrievals. Potentially useful existing products (POC: Ralph Ferraro).
    - IMS / NESDIS
    - Siberian data set from Prof. Koike, Univ. Tokyo
    - Nordrad data may have snowfall
    - Snow cover products from H SAF / Land SAF
    - GLOBsnow (ESA / FMI)
    - WCRP CLIC project ?
    - Ground data availability from NCAR repositories. Parameters that assist deep snow emissivity modeling (density profile). (P. Kucera?)
- Several in-situ data sets for precipitation are available from GPM-GV and may be used for algorithm development (see next item)

2. **GV activities and algorithm development.**
   Leverage ground-based methods (radars, gauges etc) to complement space based retrievals, vertical profiles, etc.
    - GPM-GV program as a template of how this is to be done.. Several data sets from GPM-GV activities have become available in the recent years. Data is available from a number of GPM-GV and other campaigns (CHUVA, MC3E, LPVEx)
    - Need to expand gauge / radar data collection particularly at high latitudes and over oceans:
        i. GPM-GV project ongoing
        ii. Investigate further data availability, data sources
    - Rain gauges and/or radar network data sets are used to train algorithms.
    - Integration and incorporation of ground data to modelers, and for continuous observation of surface emissivity. Many projects are involved with this issue
    - Synergistic / complementary use of (multi-frequency) ground radar and radiometric information from space (in retrieval development) is encouraged. Mature radar data set are available.

3. **Leveraging non-precip specific missions** e.g. SMAP, Aquarius, SMOS, humidity sounders, lightning, aerosol/cloud interaction, hydrology records, etc. (Also scatterometers, GRACE, GPS, MODIS).
   Information from these missions is useful to components of the precipitation retrieval problem. Particularly over land surfaces better emissivity data needed for algorithm development and retrieval application. Encourage interaction amongst these programs at the program management level rather than only at the science level.

- More representation from soil moisture community in particular (e.g., Joe Turk, Ralph Ferraro).
- Interdisplinary Data is used, interaction with some communities started and ongoing (e.g., with soil moisture)
- Some GV data is available. The data has to be exploited.
- Use of satellite data (AMSR-2 etc)?
- ITWG interaction has yet to be fully exploited

4. **Error characterization of precipitation** is still an open issue. The error and uncertainty information is considered very important for products to be used in hydrology and other applications.
    - Retrieval error characterization should already be included in the retrieval development.
    - Probabilistic rain/no rain determination, distribution of rain rate as an option for future algorithms.
    - All precipitation products (L3/L4) should include error information suitable for users.
    - Advanced error models need to be investigated and developed to provide error information and should be transparent and traceable to the data user.
    - Error uncertainty in data void regions is a particular difficult problem to solve.
    - Error information from validation data is crucial.
    - Feedback from data users regarding error propagation in applications (models) is needed in order to improve retrievals.

5. **Multispectral/multi-sensor retrieval techniques** (with SEVIRI-like imagers). The rising popularity of distributed hydrologic and land-surface modeling and recent enhancements of atmospheric models' resolution have contributed to the increasing demands for accurate high resolution precipitation data.
    - There are some activities that infer cloud phase/property information from multispectral geostationary data.
    - IPWG sees value in such products, encourages continuation of development.
    - We recommend standardized multi-spectral globally consistent input data sets, CPC 4km IR as prototype (→ see report of applications working group). Near real-time products are considered a key application for such data.

6. **Extreme precipitation events** are often not well captured by current retrievals. Do we need more / better sensors / retrievals with better capabilities to detect extreme precipitation events?
    - Research item on accurate quantification of extreme precipitation events (e.g. improve retrieval methods, sensor capabilities).
    - Continuous support of sensors capable to detect extreme precipitation is needed.

Climate Products/ Data Fusion

1. **SSMI and SSMIS data records** (Scope-CM, NCDC/CSU, EUMETSAT CM SAF, RSS)
    - SSM/I FCDRs nearly finished (CSU, CM SAF)
    - Cooperation for SSMIS ongoing between CSU and CM SAF, based on UPP-CP
    - Further work on SSMIS has to be done in terms of intercalibration with SSM/I
    - Creation of fundamental climate records ongoing thru GSICS, Scope-CM.
    - FCDRs for all precipitation relevant sensors need to be produced

2. **Encourage better coordination of overpass times between satellite operators**. Early afternoon gap is particularly vulnerable. A-Train samples at 1330 and often the NOAA satellites drift in time to slots that are not ideal for precipitation. Consider overpass times for NOAA/JPSS that are coordinated to drift to revisit gap periods. Maintenance of backup satellites to fill revisit time gaps as long as possible (action for operational satellite group). Currently miss (late) afternoon if NOAA-18 is unavailable.
    - GCOM-W AMSR-2 now available, filling the early afternoon gap
    - Current status of satellite constellation available here:
        - http://www.wmo-sat.info/oscar
        - http://www.wmo.int/pages/prog/sat/satellitestatus.php

3. **Representation from the ocean fluxes and other communities** is a good idea and to encourage more synergy between ocean heat flux and precipitation communities regarding the use of similar data, etc. Ocean salinity community (e.g. Aquarius) may also be of interest.
    - ongoing, SEAFLUX meeting next year in combination with EUMETSAT/AMS conference

4. **Provision of gauge data by weather services** is still considered as unsatisfactory.
    - Timely and complete release of gauge data is essential for precipitation products, particularly for near real time.
    - Also, the delayed release of gauge data is often not complete and/or of mixed quality.
    - High resolution (daily) data is highly desired, but often not available.

5. **General recommendation**:
   All forms of precipitaion (meteorological) data (gauge, radar, model, satellite) should be made freely available.

Data Assimilation

1. **Assimilation of Cloud/Rain affected radiances**
    - ongoing activities, (Goddard EDAS; Japan) not operational
    - assimilation in cloud resolving model: strong impact of microphysical schemes on particle growth (Aonashi), bias correction needed
    - feedback from data assimilation community needed to improve microphysic schemes of cloud resolving models
    - status at ECMWF and other agencies unclear. More input/interaction on this topic is desirable.

2. **Assimilation in climate models**. Climate models have been increasingly using techniques to assimilate satellite data. This requires homogeneous data sets as well as error estimates. Satellite precipitation data providers should be aware of the needs of the climate model developers for the information such as spatial and temporal resolution, and uncertainty estimates.

New Sensors and Technology

1. Due to technical and administrative problems **MADRAS data from Megha-Tropiques** is currently only sporadically available. IPWG strongly recommends a quick Release of Megha-Tropiques / MADRAS data as it is seen as critical to the development of precipitation data.

2. **Geo-MW.** Encourage model simulation studies showing benefit of rapid refresh of microwave data for severe weather forecasting. This data could complement geostationary IR/VIS data and MW instruments on polar orbiters.
    - several proposals to agencies have been submitted

3. Continue **studies of microwave spectral measurements**, e.g. 118, 220, 340 GHz, etc. in the context of NWP applications and storm intensity/track predictions.
    - Ice Cloud Imager (ICI) will fly on MetOp follow on (183 – 664 GHz)
    - ISMAR led by MetOffice (airborne, ICI demonstrator)
    - Microwave imager on MetOP follow on (PostEPS)

4. **Status of space based radar techniques**?
    - CloudSat/A-Train Studies have shown potential for improving satellite retrievals of precipitation. Further research using CloudSat data is ongoing, However, CloudSat operates now during daytime only due to power supply issues.
    - The communication between the cloud and precipitation communities should be

improved to achieve a better synergy between cloud and precipitation retrieval algorithms and dataset generations for weather and climate studies.

- EarthCare doppler radar scheduled in 2015

5. **Long-term continuity of cloud/precip space radars**. Cloud radar has shown potential for precipitation application, we need to keep focus on new missions.
    - ESA PPM was not selected but will be reconsidered for later missions.
    - China is currently exploring space radar possibility.
    - constellation of radars? - convince space agencies, that cost disadvantage of radars is not significant.
    - Propose cross track CPR and multi-frequency radar to enhance cloud-precipitation studies (Improved precip radar, eg 14/35/94 GHz, in addition to Doppler, polarimetric measurements, with swath capability. Promote radar technologies that are able to probe closer to the surface than current PR is able to.).
    - Propose scanning Doppler radar.

6. **Lightning mapper**. Data from lightning mappers shows potential to improve precipitation detection and retrievals.
    - GOES-R, MTG, FY-4 already slated.
    - Also support a LEO lightning mapper (GPM will not have) for finer resolution. However, GEO first priority.
    - Continue support for studies to fuse lightning data into precipitation retrievals (e.g., GOES-R risk reduction activities), model assimilation, etc.

7. Encourage the **maintenance of conically scanning microwave series**, as these are crucial for long term precipitation climate data.
    - Microwave Imager together with Ice Cloud Imager by ESA on MetOp follow on. Future operational NOAA / DoD conical scanner unclear.
    - DWSS canceled; Continuity for SSMIS and AMSR2/GCOM-W is crucial for climate records and operational users.
    - Encourage the discussion on GPM follow on:
        - Idea for next IPWG meeting: Special session on the future of space based precipitation measurements
    - Low-inclination orbits are preferred. Prefer GPM-constellation at 40-degree latitude to maintain TRMM climate continuity.
    - 10 GHz channel needed for cross calibration with other sensors, also for soil moisture retrieval.
    - Encourage use of FY series data