Validation Working Group – Final Report
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Chair: Paul Kucera
Rapporteur: Christian Klepp

Participants 2008: Paul Kucera (pkucera@ucar.edu), Christian Klepp (christian.klepp@zmaw.de), Daniel Vila (dvila@essic.umd.edu), Takuji Kubota (Kubota.takuji@jaxa.jp), Arief Sudradjat (arief@essic.umd.edu), Sagar Ratna Bajracharya (sagbajracharya@icimod.org), Robert Lund (lund@clemson.edu), Lynne Seymour (seymour@stat.uga.edu), Qiqi Lu (qlu@math.msstate.edu), Tristan L'Ecuyer (tristan@atmos.colostate.edu), Yang Hong (yanghong@ou.edu), Mekonnen Gebremichael (mekonnen@engr.uconn.edu), Steve Nesbitt (snesbitt@illinois.edu), Matt Sapiano (msapiano@essic.umd.edu), Bozena Lapeta (bozena.lapeta@imgw.pl), Shi Chenxiang (shix@cma.gov.cn), Jerzy Niedbala (jerzy.niedbala@imgw.pl

Validation Needs of Precipitation Estimate Users

http://www.isac.cnr.it/~ipwg/validation.html

Overall there are different groups of users of satellite precipitation products with different needs regarding the type of validation information required to make best use of the products. These are algorithm development, hydrological applications, climate applications, numerical weather prediction (data assimilation), and operational nowcasting.

There is clearly a need for ongoing and comprehensive validation of the more widely used "operational" satellite precipitation algorithms to benefit both the developers and the users of those algorithms. It would be wise to consult with representatives of the user groups to better define which validation products are of greatest interest and usefulness to them. WMO may be able to assist in connecting members of IPWG with members of these other communities.

Direct validation against high quality surface reference data such as rain gauges, radars, and disdrometers may often not be possible in many regions of the globe and that alternative approaches such as physical error modeling and validation of rain PDFs may be required to characterize the errors in the algorithms.

Significant validation effort is done with 24 h rain accumulations from several operational and semi-operational algorithms being validated on a daily basis in near real time in Australia, the United States, and Western Europe. Some NWP validation results are included for intercomparison. Web sites showing these validation site results are i.e.:

http://www.bom.gov.au/bmrc/wefor/staff/eee/SatRainVal/sat_val_aus.html (Australia)
http://www.cpc.ncep.noaa.gov/products/janowiak/us_web.shtml (United States)
http://Kermit.bham.ac.uk/~kidd/ipwg_eu/ipwg_eu.html (Europe)
among others (South America)

Feedback on the current validation sites would be extremely helpful, particularly from algorithm developers, who are anticipated to be its most important users. Analysis of the large number of validation results is underway, with the findings to be reported in meetings, on the web, and in the referred journals. We hope this will encourage a convergence of the satellite algorithms toward the most successful methodologies.

As users require satellite precipitation estimates on increasingly finer space and time scales, validation at these scales will also become important. For sub-daily time scales radar data is required for validation over large regions, but the errors associated with radar data are too large to accurately measure the satellite errors. For this, high quality gauge datasets (e.g. Oklahoma Mesonet, Korean gauge network) must be used. Both PDF (probabilistic) and traditional point-to-point validation methods may be appropriate, depending on the needs of the user. Some of the newer diagnostic validation techniques developed for mesoscale QPFs can be applied to satellite precipitation estimates.

In two breakout sessions the validation working group focused on reviewing the achievements since the last meeting in 2006 and the continuation and implementation of the 2008 recommendations. First, the recommendations of the 2006 Melbourne working group meeting were discussed and determined if they had been addressed and if so, to what level. The group determined that several of the 2006 recommendations were not addressed since the last meeting and were brought forward to the second group meeting. The agenda for the second meeting was to develop an updated set of recommendations to bring forward to IPWG. Additionally a subset was determined to be recommended and brought forward to CGMS. These are highlighted in bold within the recommendation list below. The recent list of 14 recommendations from the IPWG 2008 Validation Working group is presented in the following.

IPWG Validation Working Group Recommendations

Recommendation 1: The committee recommends the creation of a subcommittee on validation for PEHRPP (Program to Evaluate High Resolution Precipitation Products; http://essic.umd.edu/~msapiano/PEHRPP/)

The goals of PEHRPP are to

- Characterize errors in various high resolution precipitation products (HRPP) on many spatial and temporal scales, over varying surfaces and climatic regimes
- Enable developers of HRPP to improve their products and potential users to understand the relevant characteristics of the products
- Define data requirements and computing resources needed for retrospective processing of HRPP

The aim is to bring together scientists with different rainfall concerns in four suites of activities. These are regional comparisons, high time resolution comparisons, very high quality field programs, and "Big picture" comparisons.

Discussion: The goal of the new committee is to carry forward the recommendations of the IPWG and PEHRPP Validation Working Groups. We suggest that the group would have a fixed membership and 2 co-chairs. The committee suggested that IPWG select members that represent algorithm, application, and validation developers. The members should be involved in PEHRPP. The committee recommended Beth Ebert and Chris Kidd as the first co-chairs because of their experience and involvement in PEHRPP.

Action Items: We suggested that the members of the committee be selected within the next three months.

Recommendation 2: The committee recommends an inter-comparison project (similar to the Precipitation Intercomparison Project (PIP), and the Algorithm Intercomparison Project (AIP) for the evaluation of HRPP.
Discussion: For the intercomparison, the products should aim for a standard of three hourly, 0.25° resolution with quasi-global coverage, with validation done at a regional scale. The focus should be on the validation of both the level 3 products and the components (level 2). The intercomparison should focus on how errors at high resolution propagate through the products. Details of the inter-comparison, i.e. locations from high latitude to tropics, case studies, temporal scale, etc. will be determined by the new PEHRPP working group. The committee should coordinate with the GPM ground validation working group to maximize the impact of such a comparison. If possible, the intercomparison should be conducted in the next 12 to 18 months with a workshop to be held at the end of the intercomparison.

Action Items: PEHRPP Working Group should organize the intercomparison study within the next six months.

Recommendation 3: The committee recommends the support of the proposal for Joint Precipitation Intercomparison Activities between International Precipitation Working Group (IPWG) and the Working Group on Numerical Experimentation (WGNE).

Discussion: The goal of the proposal is to expand PEHRPP to include short-range QPF from NWP model forecasts, assimilations and reanalysis. The IPWG is requesting assistance and collaboration with WGNE in these activities. A copy of the proposal can be obtained from Matt Sapiano (msapiano@essic.umd.edu).

Action Items: Matt Sapiano will forward any feedback on the proposal to the IPWG and WGNE.

Recommendation 4: The committee recommends the development of a list with links on the IPWG web page of existing high quality reference data to enable improved validation of satellite rainfall estimates.

High quality reference data sets are necessary and important in being able to measure and characterize errors in the satellite precipitation estimates. Since no reference dataset is perfect, it is also necessary to understand the errors associated with the validation data itself. This calls for the inclusion of metadata. For rain gauge networks, the errors include instrument error, undercatch due to wind effects, and sampling and representativeness errors. Radar observations provide indirect measurement of rainfall, and are effected by beamfilling, attenuation, noise, calibration error, anomalous propagation, bright band contamination, and conversion of reflectivity to rain rate. To measure the errors in spatial rain estimates from gauge and radar data it is necessary to compare against an extremely high density gauge network. Studies of this nature are underway and are expected to provide valuable information on the nature in the reference data.

Orographic precipitation, solid precipitation, and very light precipitation are types that are particularly difficult to measure, both for the satellite algorithms and for conventional instruments. Special data sets may be needed for validating these "difficult" types of precipitation, as rainfall measurements from the standard rain gauge and radar networks may not be sufficiently accurate to be useful. Some improvement is possible by adjusting gauge measurements for wind-related undercatch and including orographic enhancement effects in gauge analyses. The International Polar Year, which will address the challenge of (among other things) creating

multidisciplinary observing networks in the polar regions, may provide some good high latitude precipitation information.

There exist a number of good and high quality reference data sets, but they may be difficult to obtain in many cases. IPWG can play a role in making these data more widely available. It may be necessary in some cases to provide justification, i.e., the characterization of errors in the satellite precipitation estimates. As routine error characterization of some future rainfall missions (GPM in particular) will be based on international partnerships with "supersites", every effort should be made to make these data available to scientists.

There is a strong need for reference data to validate oceanic satellite precipitation estimates, i.e. LOFZY (LOfotes Cyclones) offshore Norway. A small amount of coastal radar data is available (for example, both of the daily validations over the US and Europe use radar data that extend offshore) and could be used to validate mid-latitude oceanic estimates. Tropical rainfall measurements are available from the Pacific atoll rain gauge network, the TOGA/TAO and PIRATA moored buoys, and the Kwajalein radar; these have been used to validate satellite precipitation estimates in the past.

Discussion: The group discussed that it is very important for improved validation activities in different geographical regions that a reference data website be developed. This activity should focus on the determination of the locations and availability of rain gauge networks, disdrometer data, and radar data from national networks, international experiments, the Global Precipitation Climatology Center (GPCC), experimental test sites, TRMM validation sites, and other unique surface precipitation datasets. One issue is data sharing for many countries. In these cases, IPWG should encourage participation of other countries to use the HRPP satellite products and provide feedback to the product developers.

Action Items: Paul Kucera will take the lead on organizing the web link database. **The committee recommends that CGMS pursues the activity of the generation and providing access to a global unified gridded rain gauge database from all nations on a daily scale for validation, hydrology, and other applications to help address this issue.**

Recommendation 5: The committee encourages providers of validation observations to provide some type of quality index (e.g., 1 = poor, 10 = excellent).

Discussion: The quality index could be assigned based on if it has been corrected, interpolated, or flagged as suspicious. It was discussed during the working group presentations that this is useful. It was brought forward that the definitions of the quality index should be determined in a formal workshop supported by CGMS. It was suggested that this should be a recommendation to CGMS.

Action Items: **The committee recommends that this should also be an item for CGMS (Note: this was not one of the original CGMS recommendations, but was added after the working group presentations).**

Recommendation 6: The committee recommends that a feedback website be developed.

Discussion: The goal of this activity would allow users of validation data to provide feedback on the usefulness of the validation products and provide a mechanism to suggest what products/data that would improve the development of HRPP.

Action items: Matt Sapiano will take the lead developing the website. It could include a feedback form and/or an interactive page such as a wiki to provide the necessary feedback to the validation product developers.

Recommendation 7: The committee encourages the production/availability of quantitative precipitation estimates (QPE) products from new sensors (e.g., SSMIS, FY-03) for validation purposes.

Discussion: This activity would provide case study analysis for periods beyond SSM/I. Also it would help prolong climate data records beyond SSM/I. There is a need of close coordination with the SSMIS / ITWG working group and also the provision of corrected Tb data of SSMIS for this activity.

Action Items: **The committee recommends that this should be an item for CGMS.**

Recommendation 8: Recommend the use of existing HRPP in hydrological impact studies, such as the EUMETSAT H-SAF and HydroMet test beds in the US, to assess the usefulness of the HRPP products in hydrological models.

Discussion: The group thought that these types of applications were essential to understand the usefulness of the products and would also provide good feedback to the algorithm developers.

Action Items: The PEHRPP validation committee should coordinate with institutions (e.g., H-SAF, NOAA, etc.) to explore this activity.

Recommendation 9: The committee recommends that the meteorological modeling community actively (make available) provides model outputs (e.g. precipitation fields, 700mb winds) to the satellite precipitation development and validation communities.

Discussion: None

Action Items: The PEHRPP validation committee should coordinate with the modeling community (e.g., WGNE) to explore this activity.

Recommendation 10: The committee recommends that investigators should evaluate the usefulness of other validation tools and encourage the development of methods to address the issue of validation in regions of sparse surface data.

Discussion: There was a good, extended discussion that this must be done. However, it was pointed out that previous papers have been published on this topic, but those studies have not provided tools or applications that could be used easily by the validation community. The group emphasized that any new techniques should also include the development of a "toolbox" that could be used by the diverse user community. During the general discussion in the working group presentations, this was also highlighted as an important activity for IPWG.

Action Items: Robert Lund and Mekonnen Gebremichael volunteered to develop a white paper to present new statistical methods (e.g., extreme value statistics, PDF of the errors, etc.). Before any new method(s) is supported by the group, the white paper will be circulated for comments and feedback. The PEHRPP validation committee should follow up on this activity in 3-6 months to determine the progress in the development of the white paper.

Recommendation 11: The committee recommends that guidelines are established for the standardization of product formats and filename conventions (grid format, units, etc) with the goal of making the data more easily usable among the validation community.

Discussion: This was a topic of extensive discussion during the working group meeting. The discussion pointed out this was a very important activity to make the products more usable by the application community. However, it would be very difficult to impossible to standardize all the formats. Some of the developers would likely not put effort in reformatting their products. One suggestion is that simple reader programs (e.g. convert to standard formats such as ArcGIS) be developed in an effort to resolve this issue. Everyone agreed that at minimum, detailed documentation should be required for all the HRPP to make the products more usable.

Action Item: The PEHRPP Working Group will develop guidelines for data format specifications and documentation.

Recommendation 12: The committee recommends that a discussion at a higher level, maybe WMO, concerning the distribution of HRPP through networks such as GEONETCast, should be made to maximize the utility of such products.

Discussion: None

Action Items: **The committee recommends that this should also be a recommendation to CGMS.**

Recommendation 13: The committee recommends that we include and/or encourage the development of high-latitude validation sites such as the BALTEX, LOFZY follow up 5 years Nordic Seas, high latitude maritime radar sites, Alaskan WSR-88D radars, and/or the Canadian sites.

Discussion: This activity should be coordinated with the GPM ground validation (GV) activities to maximize both efforts in high latitude validation. There was discussion during the IPWG working group summary that this should be a high-priority because the amount of precipitation in the high-latitude regions, especially over the ocean, is often unknown. During the discussion, it was also pointed out that many other regions (e.g., Rocky Mountains) also needed improved validation observations.

Action Items: The PEHRPP validation subcommittee should determine the best method to make the high-latitude datasets available to IPWG community for validation activities.

Recommendation 14: The committee recommends that countries or weather institutions with high quality ground validation dataset actively participate in IPWG sponsored validation activities. Overall, the committee encourages the inclusion of members of the NWP data assimilation, nowcasting, hydrology, and climate communities at future IPWG meetings, and encourage IPWG members to attend meetings of these user groups.

Discussion: None

Action Items: None

B. Discussion Topics

Matt Sapiano and Daniel Vila pointed out that the Real-time Cooperative Institute for Climate Studies (CICS) validation database contains daily products that are partly out-of-date (i.e., TMPA). There is a concern that investigators still use products that may have errors and artifacts known to exist in these older versions. Sapiano mentioned that he knows of at least one case were an investigator was submitting a paper using the old products. This problem needs to be addressed either with the development of methods to include the re-processed products into the database in a systematic way or the database should be removed from the website. A note to mention is that the latest sub-daily products are available online and investigators could generate the daily products from these files. We brought this up in the summary, but it was not discussed. It could be a topic that is addressed by the PEHRPP validation committee.

Response on any open action items from the 2006 meeting not covered in the 2008 report is very welcome. Please correspond with these items to the working group chairs. The working group plans to keep an open email exchange to foster ideas between working group meetings.