PEHRPP Planning Meeting
June 25, 2005   Sproul Hall, UC-Irvine, California

The planning meeting for the Proposed Evaluation of High Resolution Precipitation Products (PEHRPP) started at 8:45 AM with introductions by Phil Arkin and Kuo-Lin Hsu. A total of 17 representatives were in attendance:

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Phil Arkin started the meeting by referring to the four goals of PEHRPP, as proposed at the 2nd IPWG meeting in Monterey (October 2004):

1) Develop an understanding of the differences among the various HRPP and the strengths and weaknesses of each.

2) Document, for satellite operators, the data requirements necessary to enable HRPP production and development to proceed optimally and efficiently.

3) Facilitate the development of improved HRPP for various applications.

4) Identify requirements, opportunities and uses for retrospective processing of selected HRPP.

For this evaluation, or for use any HRPP for climate applications, the longer the available times series the better. Since many of the current HRPP's use similar products and intermediate processing steps, it is important to identify basic processing that could be done by satellite operators to make future algorithm development and implementation easier.

Phil Arkin gave a brief introduction to CEOP (Coordinated Enhanced Observing Period), which is basically a collection of sites with high-quality observational data, representing an opportunity to validate products in different regions, including those with high-quality radar datasets. A map of the ~30 CEOP sites was shown by K.L. Hsu with example validation data from a site in the Indian Ocean. The timeline for PEHRPP would consist of action items necessary to prepare a final report on the performance of the various HRPP (and NWP model forecasts) across as many regions and climatologies as possible, and conclude with a final workshop at IPWG-3 (currently schedule for autumn 2006 in Australia), with a final report for CGMS and various publications.

<u>Presentations by Technique Developers</u>

J. Turk described the NRL-Blended technique: The NRL-Blend is run in a near real-time research mode at NRL-Monterey. The technique operates with one or more operational geostationary datasets at native resolution and coverage sectors, at least the 11 um channel, calibrated. It uses as much passive microwave satellite data as possible together with associated rain rate datasets. The algorithm relies upon an underlying background procedure which aligns arriving LEO/PMW and GEO/IR in space and time, and updates 2^{o}-spaced (in latitude and longitude) lookup tables between ±60 degrees latitude. Basic minimum product is a 3-hourly global accumulations (longer intervals also), which increasingly weights the geostationary-calibrated rain rates the further they are in time from a nearby PMW overpass. The technique is computationally fast (built in Terascan® binaries). Portable to other systems since lookup tables are ASCII. Robust - handles missing datasets gracefully. Underlying error not established (highly variable and depends upon PMW revisit among other things). Poor relationship between thermal channels and underlying rain outside of tropics. Artifacts in PMW are manifested in accumulations.

R. Kuligowski described the HydroEstimator (HE): Algorithm inputs are geostationary IR, PMW, and NWP data (10.7-µm IR window Tb's from GOES-9, -10, -12, Meteosat-5 and -7, and NAM or GFS PW, 1000-700 hPa mean RH, u, v, convective EL computed from T, q profile). Satellite inputs are from GVAR feeds; model inputs come from NCEP. Algorithm process is to adjust Tb (Tadj) by reducing values where convective EL temperature>213 K ($Z=-(Tadj-\mu T)/\sigma T$: rain only where $Z>0$), then rain rate=f(Tadj, Z, PW). Reduces rain rate in low RH environments. Uses standard IR assumption that Tb is a proxy for cloud depth / updraft strength and hence for rain rate; works best for convective precipitation. Assumes rainfall only in areas of positive Z (local Tb minima); effective screening of cirrus by using Z. Adjusts for environments with low convective EL by adjusting Tb downward based on convective EL temperature, but still underestimates warm-cloud rainfall. Underestimates rainfall early in convective life cycle where updrafts are strong and clouds are rapidly cooling, but still relatively warm.

R. Kuligowski described the Self-Calibrating Multivariate Precipitation Retrieval (SCaMPR): SCaMPR uses the 6.9, 10.7, and 13.2-µm Tb's from GOES-12, SSM/I rain rates from NRL, AMSU rain rates from MSPPS, and all GOES inputs are from GVAR feeds. The rain/no-rain separation via discriminant analysis, and rain rate estimation via stepwise linear regression. The technique uses an "IR Calibration Data Cube" composed of GOES inputs aggregated to SSM/I or AMSU footprints plus SSM/I or AMSU rain rates. The most recent matched data used such that 5000 nonzero rain points are available (non-raining points are included, but the number does not matter). The technique is only as reliable as the SSM/I and AMSU rain rates; SCaMPR will perform poorly where they perform poorly. Differences between SSM/I and AMSU rain rates make adjustments necessary before calibration. Currently calibrated for CONUS as a whole, but geographic differences in Tb-rain rate relationships are inducing time-varying biases in SCaMPR rain rates. Balance of having a long enough training period for statistically significant training, but a short enough training period to capture nonstationarity in relationships between predictors and rain rate; no objective way to determine this.

K. Hsu described the Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN): Uses TMI, SSMI, AMSRE, AMSU and CPC 4-km IR composites. Output is 30-min 0.25-deg composite with a 2-day delay in products. Archive back to Mar 2000, could go back to 1998 w/current datasets. The "IR Calibration Data Cube" covers an area between ±60^{o} latitude and is separated into a number of 15^{o} x70^{o} lat-lon subregions, with partial overlapping of 5^{o} in each subregion. Rainfall rate is calculated at 0.25^{o} and 30 minutes spatial-temporal scale. IR textures, in terms of mean and standard deviation of longwave IR brightness temperature within 5x5 neighboring pixels, are collected. Within each subregion, 30-minute/0.25^{o} matched MW and IR pixels are collected. Rainfall rate in the classified IR feature group is temporal adjusted at each 30 minutes period. The parameters of PERSIANN are adaptively adjusted every 30-minute period when concurrent PMW-RR from TRMM and other (DMSP & NOAA) satellites are available. The output is 0.25^{o} 30-minutes rain rate. Operational PERSIANN provide data around 2-day delay. There is also an operational PERSIANN-CCS (IR patch-based algorithm) to cover North America at resolution of 0.04^{o} hourly scale. Also an adjusted PERSIANN based on GPCC gauge data is used to produce a merged historical data set.

G. Huffman described the Multi-Satellite Precipitation Analysis (MPA): MPA has both experimental and real-time products. Post real-time V6 3B42 is the current MPA. 3B42RT is the current real-time (experimental version) of the MPA and is run 10 hours after real time. Plan to replace the 10-hr run with a 4-hr "early" and 7-hr "final" to better support operations. The "IR calibration cube" is a 3-hr/0.25° matched HQ and IR, aggregated for a month on overlapping 3°x3° blocks. Currently, all PMW are used. Aggregating MW to 3-hr maps introduces time errors at fine scale. Intercalibration of

MW and calibration of IR to MW traceable which is good, except bad if the calibrator goes bad. Different calibrators are used for RT (TMI) and Version 6 (TCI and gauge). VAR scheme for IR assumes that instantaneously colder clouds rain more and takes calibration from a month of data (stable, but stiff). HQ-VAR combination scheme is priority-based: HQ, else VAR; minimum assumptions, but introduces boundaries. Currently are modifying to update the RT VAR calibration coefficients every 3 hours (vs. 5 days).

T. Ushio described the Global Satellite Mapping of Precipitation GSMaP): TMI + Global-merged IR, 0.1-deg/1-hr resolution. Radar-GSMaP correlations fall off w/time of last sat overpass; IR moving vectors advect precip between TMI passes. +/-35 with TMI but +/-60 w/AMSRE included. Not yet operational. Has taken B. Ebert's IDL and produced validation comparisons with Japanese gauge/radar profiles – examples shown from late 2003. Extends about 200-km offshore w/radar.

J. Janowiak described the CMORPH technique: CMORPH is a combination of forward and backward propagated features, in between successive PMW overpasses, to produce a final morphed product. Not channel dependent on geo data, 15-hr latency, only goes back to Dec 2002, use of IR to govern motion in tropics is not very good assumption. Planned updates: Input product "normalization" between PMW datasets, evaporation correction, advection with model winds. Output is 8-km at equator, +/-60 deg. Variants: GMORPH has model winds in it, QMORPH is version with 2.5-hr latency (since it only has forward propagation, does not wait for the next PMW overpass), CMORPH+IR is a separate product. Noted more variation amongst techniques in cold season than in warm season, especially amongst the PMW-only combined products.

T. Bellerby showed ongoing work on the uncertainty in high-resolution estimates (see *J. Hydromet*., **5**, 2004. pp 910-921). Very high res. cloud top advection at 4-km resolution. Ensemble statistical retrieval model. Produces ensemble of rainfall fields.

Action Items

An article to the Bulletin of the AMS (BAMS) has been proposed by B. Ebert and J. Janowiak on combined performance of various algorithms/techniques.

B. Ebert showed aggregated statistics, where the various techniques and models are analyzed by season (months, e.g., DJF, MAM, etc.) as well as pooled space-time values with confidence intervals, over last 29 mos. John J. has also statistics gathered over many years. Suggest looking at 5-day variability (for example), seasonal dependence, etc.

Action items to Joe Turk to update algorithm description and publication lists on the IPWG website.

We have approximately 16 months between now and IPWG-3. By end of year J. Janowiak, Chris Kidd and B. Ebert to create useful composites over long term graphics, which is a significant piece of the proposed BAMS paper. B. Ebert has already started working with T. Ushio's student at Osaka Prefecture Univ. (Yasuhida Iida) to get the IDL verification software working with the Japanese gauge/radar analysis, and will continue to get a common period analyzed. For now, the Japanese analysis to be 24-hrs first and then 3-hourly depending on time/workload.

Also, possible input from Taiwan's gauge/radar dataset. Dr. Ben Jou at Taiwan National Univ. is the POC in Taiwan and J. Turk and B. Ebert to investigate their interest in performing validation (either historical or real-time).

Yang Hong is aware of a Chinese dataset(s) over a long-term period. Y. Hong to investigate.

EMC makes stage-4 products from a composite of stage-3 which are produced by the various river forecast centers. Analysis of the 6-hourly pieces done by B. Kuligowski and suggest him to 3-hourly (diurnal) variability in US with datasets from other algorithm developers- he will work with J. Janowiak to disaggregate stage-4 to 3-hourly 0.25-deg pieces (US only). From these data (8 times/day), perform analysis for the 3-hourly rainfall products.

Arkin: CEOP- GEWEX-related activity. Period of time in which coordinated obs were gathered. Project which has identified #sites (40?) different regimes. (2002-2003). Also model output as well as precip obs, all different, all HQ and sample different regions. All land sites. ARM-SW Pacific sites are quasi-ocean. P. Arkin and K.L. Hsu to evaluate various sites (Africa, SE Asia, S America etc). Some sites will be fine scale and others not, for fine scale could look at fine scale variability.

NAME field program datasets are a composite of 3 radars along W coast of Mexico, 15-min, 4-km resolution. 6 weeks of data from last summer (2004). Arkin has discussed with Rit Carbone and Steve Rutledge and they are about to release the QC'ed version (JOSS UCAR website). P. Arkin to investigate data release, coverage, and data product availability.

G. Huffman has already been examining the TOGA TAO buoys (siphon gauges) Atoll daily is daily but when the "day" is defined is not consistent. Investigate them to decide what to validate against. Gauges and atolls are separated from each other and will have to be treated as point obs. G. Huffman to further analyze availability and quality of these data, as well as the Kwajelein radar datasets.

Bob Weller (Woods Hole OI) as series of siphon gauges (E Pacific, W. Atlantic and probably others) IMET is the name. P. Arkin to investigate.

T. Bellerby to send Phil the domains and areas that he has streamflow data for in Africa (1990 to date?).

J. Turk to contact G. Pegram (Univ. of KwaZulu-Natal, S. Africa) to gather information on S. African datasets, and report this to P. Arkin.

J. Turk to contact B.J. Sohn (Seoul National Univ.) about KMA gauge network, either 2001 3-month data collection (data already prepared for a previous work), and also discussing possibility of a longer-term validation site in Korea.

Action for J. Turk for future IPWG-3 presentation: Present breakdown of various blending techniques and how “pieces” could be interchanged and modularized.

Meeting was adjourned at approximately 2:30 PM, with a special thanks to Drs. Soroosh Sorooshian and Kuo-Lin Hsu and Ms. Diane Holmblum who arranged the meeting room and refreshments. Action items to be reported back to P. Arkin and J. Turk with the goal of a final presentation at IPWG-3 and a formal report for GEWEX Scientific Steering Committee.