Transitioning from Version 3 to Version 4 IMERG

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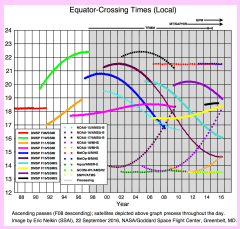
INTRODUCTION – WHAT MULTI-SATELLITE SCHEMES TRY TO DO

A diverse, changing, uncoordinated set of input **precip** (GPROF2014) estimates

Goal: seek the longest, most detailed record of "global" precip

Climate Data Record (CDR) emphasizes homogeneity
- latency of months or more
- CMAP, GPCP

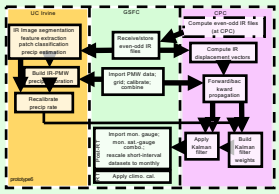
High-Resolution Precipitation Products (HRPP) focus on the best snapshot
- possible drift with change in constellation
- CMORPH, GSMaP, IMERG, TMPA



IMERG DESIGN – PROCESSING

IMERG is a unified U.S. algorithm that takes advantage of
- Kalman Filter CMORPH (lagrangian time interpolation) – NOAA
- PERSIANN with Cloud Classification System (IR) – U.C. Irvine
- TMPA (inter-satellite calibration, gauge combination) – NASA
- all three have received PMM support
- PPS (input data assembly, processing environment) – NASA

Institutions are shown for module origins, but
- package is an integrated system
- goal is single code system appropriate for near-real and post-real time
- "the devil is in the details"



IMERG DESIGN – DATA SETS

Multiple runs accommodate different user requirements for latency and accuracy
- "Early" – 5(4) hr (flash flooding)
- "Late" – 16(12) hr (crop forecasting)
- "Final" – 3.5(2.5) months (research data)

Time intervals are half-hourly and monthly (Final only)

0.1° global CED grid
- PPS provides subsetting by parameter and location
- initial release covers 60° N-S

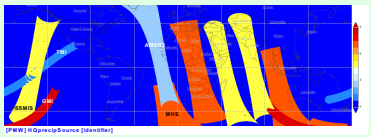
User-oriented services by archive sites
- interactive analysis (GIOVANNNI)
- alternate formats (KMZ, KML, TIFF World files, …)
- area averages

	Half-hourly data file (Early, Late, Final)
1	*[multi-sat.] precipitationCal*
2	[multi-sat.] precipitationUncal
3	*[multi-sat. precip] randomError*
4	[PMW] HQprecipitation
5	[PMW] HQprecipSource [identifier]
6	[PMW] HQobservationTime
7	IRprecipitation
8	IRkalmanFilterWeight
9	*probabilityLiquidPrecipitation [phase]*
	Monthly data file (Final)
1	*[sat.-gauge] precipitation*
2	*[sat.-gauge precip] randomError*
3	GaugeRelativeWeighting
4	*probabilityLiquidPrecipitation [phase]*

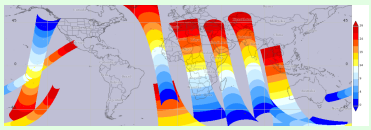
IMERG DESIGN – SAMPLE DATA FIELD MAPS

1430-1500Z 3 April 2014

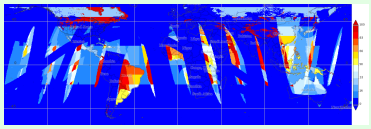
PMW sensor contributing the data
- selected as imager first, then sounder, then closest to center time



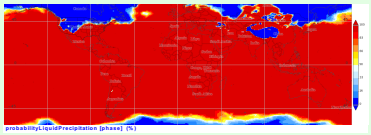
PMW sensor observation time
- minutes after start of half hour



weighting of IR in the Kalman filter step



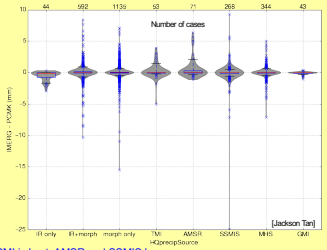
probability that precipitation phase is liquid
- diagnostic computed from ancillary data



VERSION 3 VALIDATION TENDS TO LOOK GOOD

Half-hourly IMERG Sources and (single) Pokamoke fine-scale gridbox
- April 2014 – March 2015, Virginia Eastern Shore

"Violin diagram" for individual sources of the half-hourly IMERG estimates
- width shows relative contribution for each difference bin



GMI is best; AMSR and SSMIS less so

The extra scatter for no-PMW (interpolated) is partly driven by the large number of cases

No-PMW (interpolated) data are competitive with the skill for most of the sensors

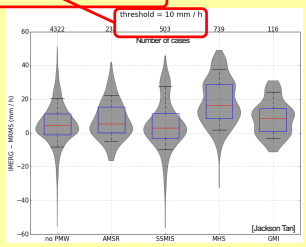
This is pre-launch calibration; the shift to Version 4 is designed to give more consistency

VERSION 3 HEAVY RATES ARE OVERDONE

Half-hourly IMERG sources and MRMS radar/gauge product
- 2-4 October 2015, South Carolina flooding

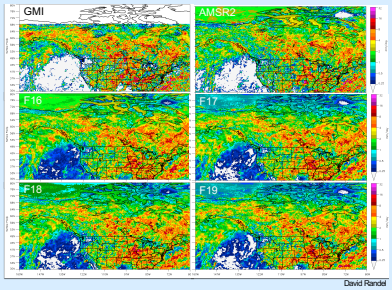
Actual accumulations of rain were up to 24"
- IMERG overestimated some totals by a factor of 2

This diagram focuses solely on heavy rain

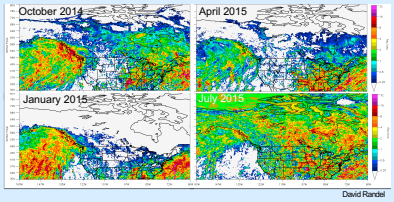


All sensors are positively biased
- MHS is particularly biased due to an IMERG error
- "no PMW" (morphed and IR) is better
- again, low number of samples

HIGH LATITUDE GPROF2014V2, JULY 2015



HIGH LATITUDE SEASONS, GPROF2014V2 AMSR2



Warm-season estimates look similar across sensors and useful at high latitudes

Input precip estimates are still deficient in snow/ice-covered surface regions
- still plan to screen out microwave estimates in snow/ice areas and use microwave-calibrated PERSIANN-CCS estimates

VERSION 4 UPGRADES

Reduce Final Run latency from 3.5 to 2.5 months
- change how ancillary data are handled

Shift from static to dynamic calibration of PERSIANN-CCS by microwave precip

Extend gridders to 90° N-S

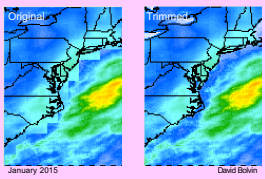
Reduce blockiness
- turn off volume adjustment in gauge analysis
- screen off-shore gauge influence
- spatially average GCI-GMI calibrations

Correct bug that placed morphed values one gridbox south of actual location
- found thanks to a user's question

Adjust high-latitude estimates to the mean of MCTA V2 (ocean) and GPCC (land)

Calibrate all microwave sensors to GCI using latest adjusted datasets

TRIMMING GAUGE INFLUENCE ALONG THE COAST



At the 0.1° IMERG resolution the 1° GPCC resolution causes unphysical blockiness along coasts where satellites and gauges disagree

The transition off-shore is now a jump, but perhaps should be a taper

VERSION 4 GPM PRODUCTS TEND TO BE LOW IN THE EXTRATROPICS

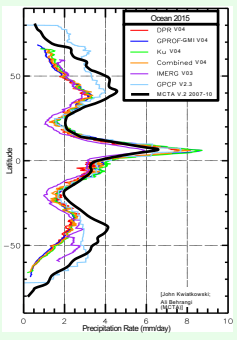
Ocean-only zonal averages for 2015 (except 2007-10 for MCTA)

Version 4 GPM products tend to be similar (by design)
- Version 3 IMERG somewhat similar
  - Day 1 (pre-launch calibration)

GPCP is higher in the extratropics
- new Version 2.3

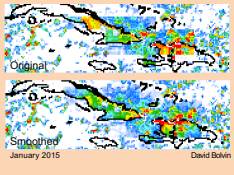
CloudSat-based estimates higher still in mid-latitudes; roughly agree with GPCP at high latitudes
- Behrangi Multi-satellite CloudSat, TRMM, Aqua product (MCTA)
- includes rain, snow, mixed

Working to adjust IMERG to MCTA for Version 4



GMI-GCI CALIBRATION SMOOTHING

GMI-GCI calibration is a 1° x1° grid based on a 3° x3° template
- when gradients in GMI and GCI are not similar, jumps between boxes are intrusive (top)
- a distance-weighted average of the four adjacent calibration values improves performance (bottom)



TRANSITIONING FROM VERSION 3 TO VERSION 4

Version 3 IMERG is available
- Final Run from mid-March 2014 to February 2016
- Late Run from 7 March 2015
- Early Run from 1 April 2015

Early November 2016: Version 4, first-generation GPM-based IMERG archive, March 2014–present

Mid-2017: Version 5 IMERG, March 2014–present

Late 2017: TRMM V.8/GPM V.5 TRMM/GPM-based IMERG archive, 1998–present

Winter 2017-18: Legacy TMPA products retired