Overview of Current Global Precipitation Products and GPM

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Background
TMPA Algorithms and Inputs
Results
Future – GPM
Concluding Remarks

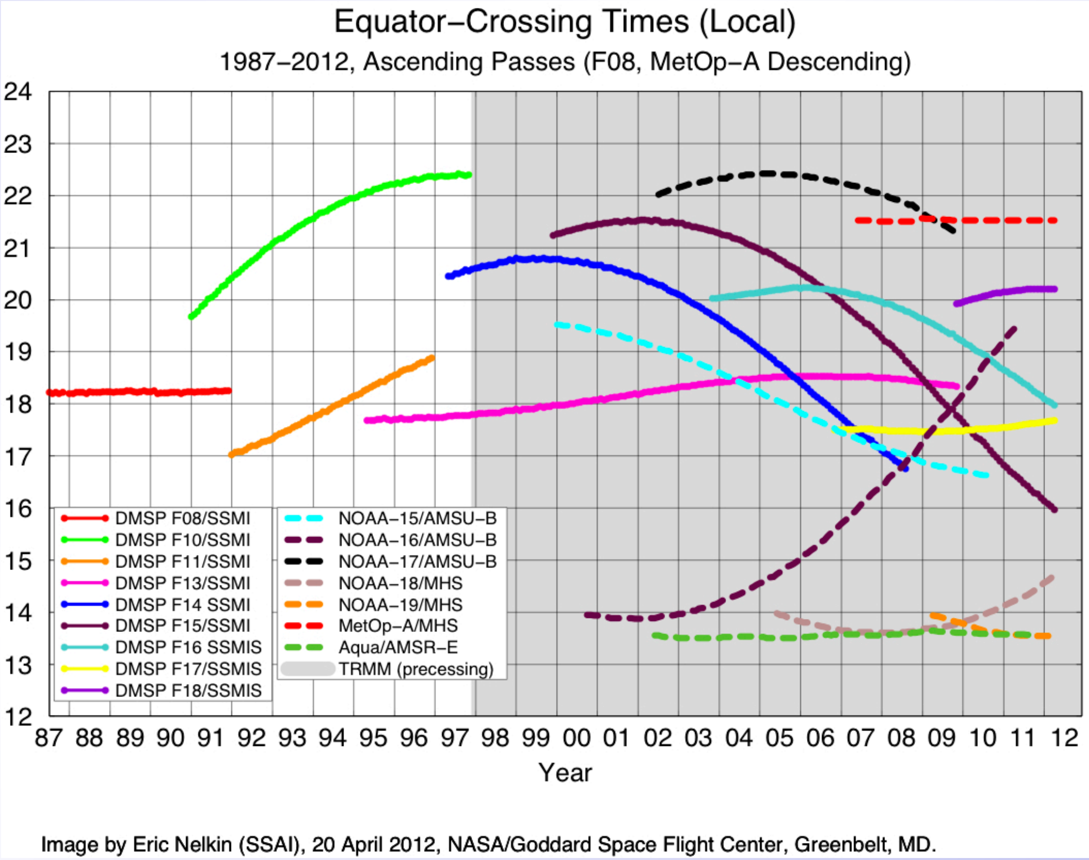
1. Background (1/2)

A diverse, changing, uncoordinated set of input precip estimates, with various

- periods of record
- regions of coverage
- sensor-specific strengths and limitations

	infrared	microwave
latency	15-60 min	3-4 hr
footprint	4-8 km	5-30+ km
interval	15-30 min (up to 3 hr)	12-24 hr (~3 hr)
"physics"	cloud top weak	hydrometeors strong

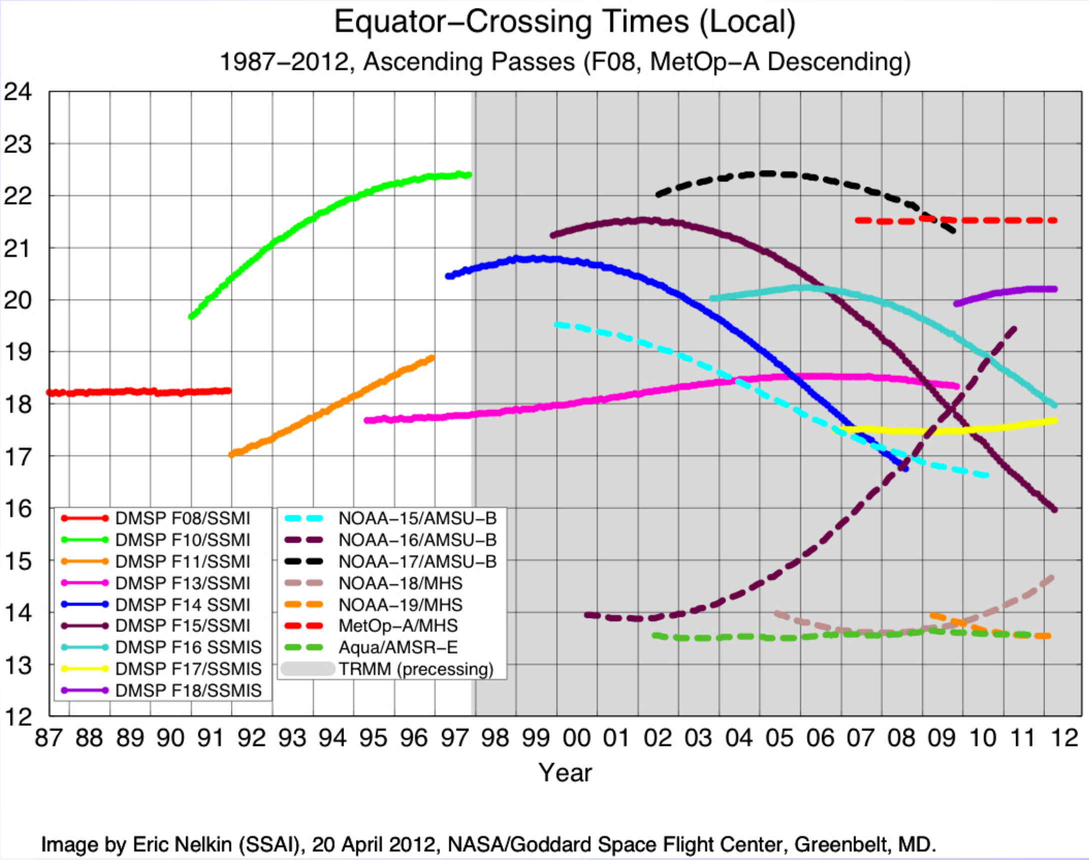
- additional microwave issues over land include
  - scattering channels only
  - issues with orographic precip
  - no estimates over snow



1. Background (2/2)

Combination products discussed here are High-Resolution Precipitation Products (HRPP)

- emphasize fine-scale accuracy over homogeneity
  - but homogeneity still valued
- not a Climate Data Record
- current products summarized in IPWG data listings:
  - http://www.isac.cnr.it/~ipwg/data/datasets.html
  - planning to to beef up user-oriented information
- examples
  - CPC Morphing algorithm (CMORPH)
  - Global Satellite Map of Precipitation (GSMaP)
  - Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks (PERSIANN)
  - Self-Calibrating Multivariate Precipitation Retrieval (SCaMPR)
  - TRMM Multi-satellite Precipitation Analysis (TMPA)



2. TMPA – Flow Chart (1/2)

Computed in both real and post-real time, on a 3-hr 0.25° grid

Microwave precip:

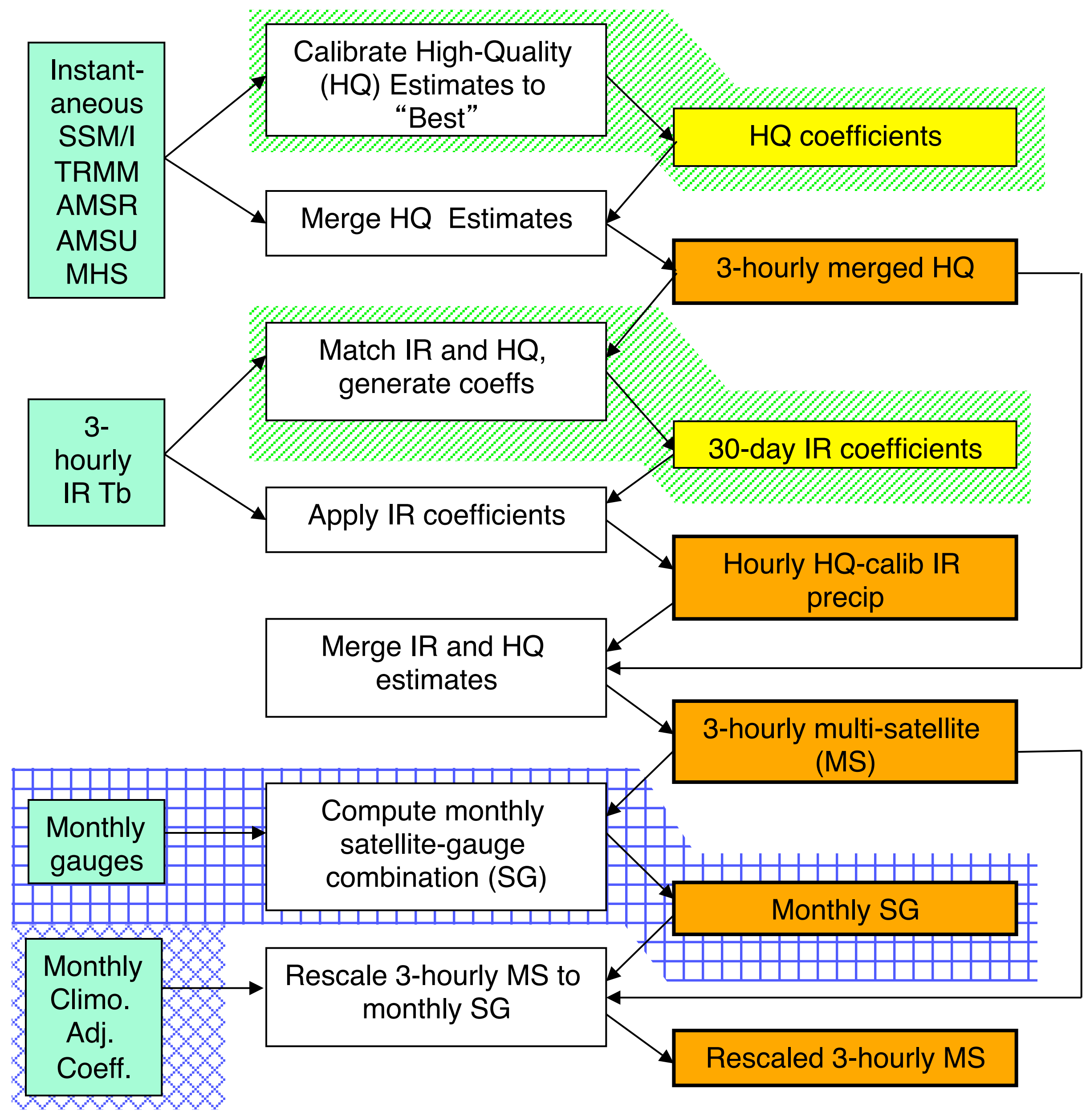
- intercalibrate to TMI/PR combination for P
- intercalibrate to TMI for RT
- then combine, conical-scan first, then sounders

IR precip:

- calibrate with microwave

Combined microwave/IR:

- IR fills gaps in microwave



2. TMPA – Flow Chart (2/2)

Both RT and P calibrate the initial 3-hr MS

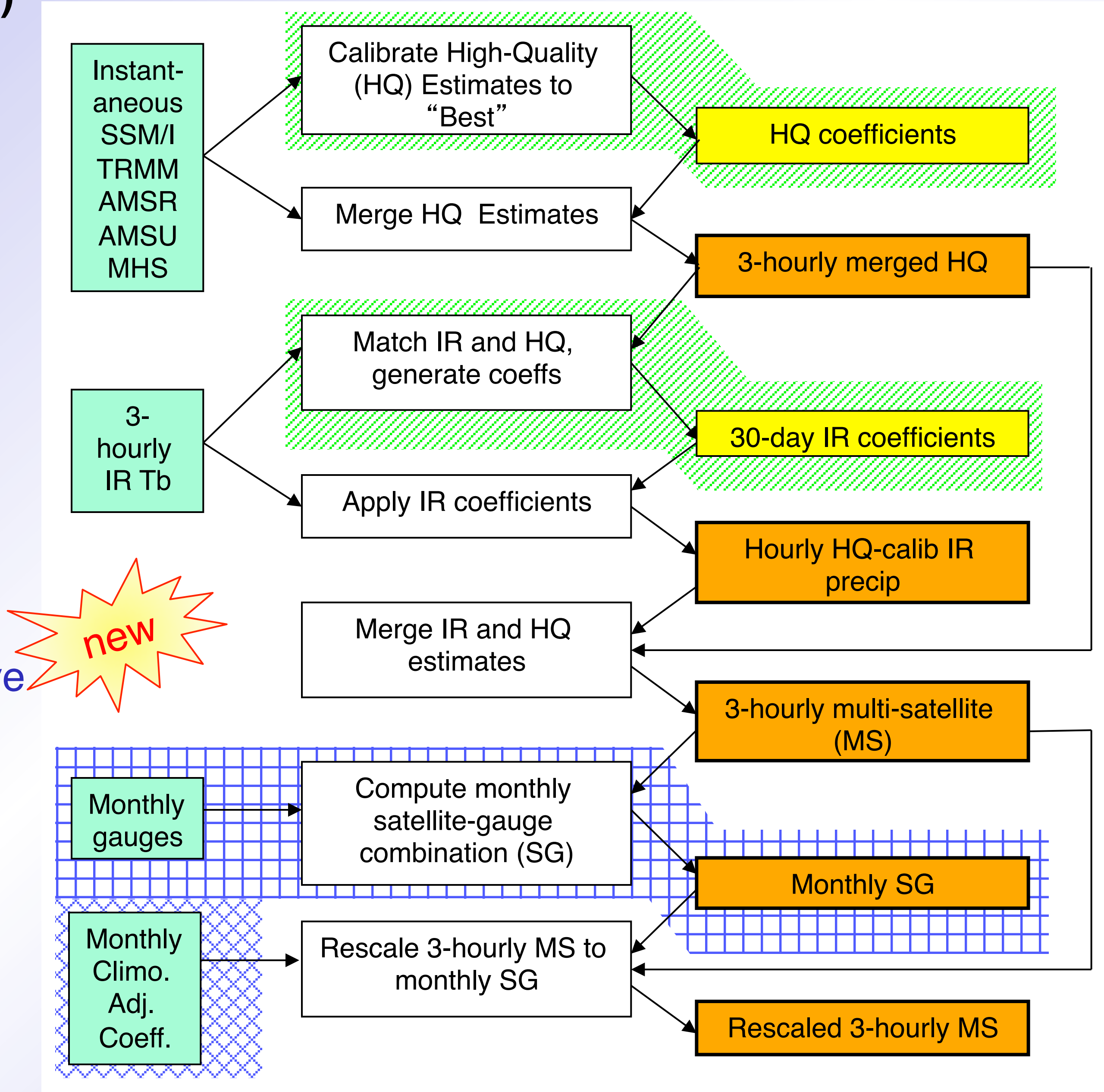
- P uses monthly gauges
- RT uses climatological calibration to TMI/PR, P

In V.7, both RT and P

- provide both cal. and uncal. 3-hr MS
- include SSMIS data

V.7 RT features retrospective processing starting March 2000

- start date determined by IR dataset
- implements concept first developed for GPM
- driven by user feedback



2. TMPA – V.7 vs. V.6

"Production" TMPA monthly MS

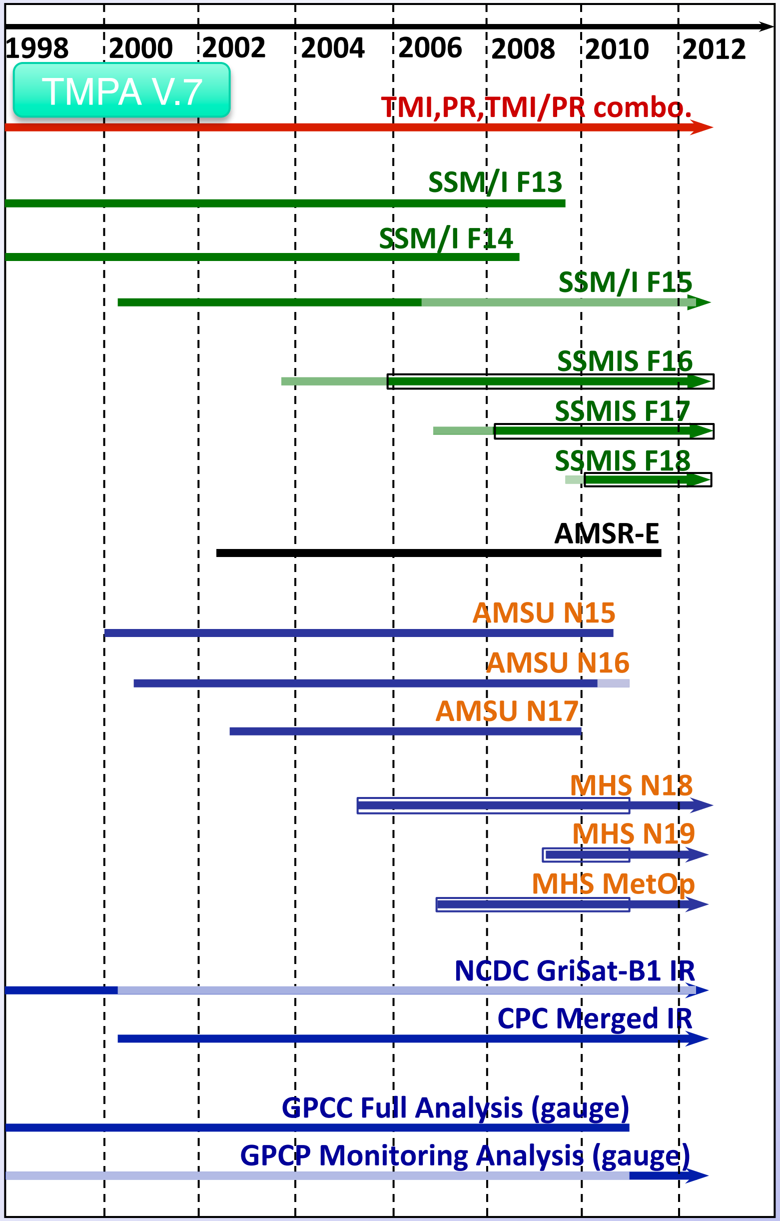
- additional periods of data (boxes) – SSMIS
- improved IR record for 1998 – February 2000
- updated algorithms (GPROF, in particular)
- consistently reprocessed input data
- single source of gauge analysis
- publication of additional intermediate data fields

"Real-Time" TMPA MS

- additional periods of data – SSMIS
- updated algorithms (GPROF, in particular)
- consistently reprocessed input data
- retrospective processing back to March 2000

Second processing necessary in V.7

- AMSU ignored the first time



Periods of record not used in the datasets are shown in lighter color

Additional data records used in TMPA V.7 are boxed

2. TMPA – Final Calibration

Production TMPA

- monthly MS and GPCC gauge analysis combined to Satellite-Gauge (SG) product
- weighting by estimated inverse error variance
- 3-hrly MS rescaled to sum to monthly SG

Real-Time TMPA

- 3-hrly MS calibrated using climatological TCI, 3B43 coefficients

Each product should tend to follow its calibrators

- over land – the GPCC gauge analysis
- over ocean – satellite calibrator
- climatological calibration only sets long-term bias, not month-to-month behavior
- current work with U. Wash. group uncovering regional variations

3. Dominant Controls on Performance

Fine-scale variations

- land and ocean: occurrence of precipitation in the individual input datasets
- inter-satellite calibration attempts to enforce consistency in distribution
- event-driven statistics depend on satellites, e.g. bias in frequency of occurrence

Differences between sensors tend to be noticeable

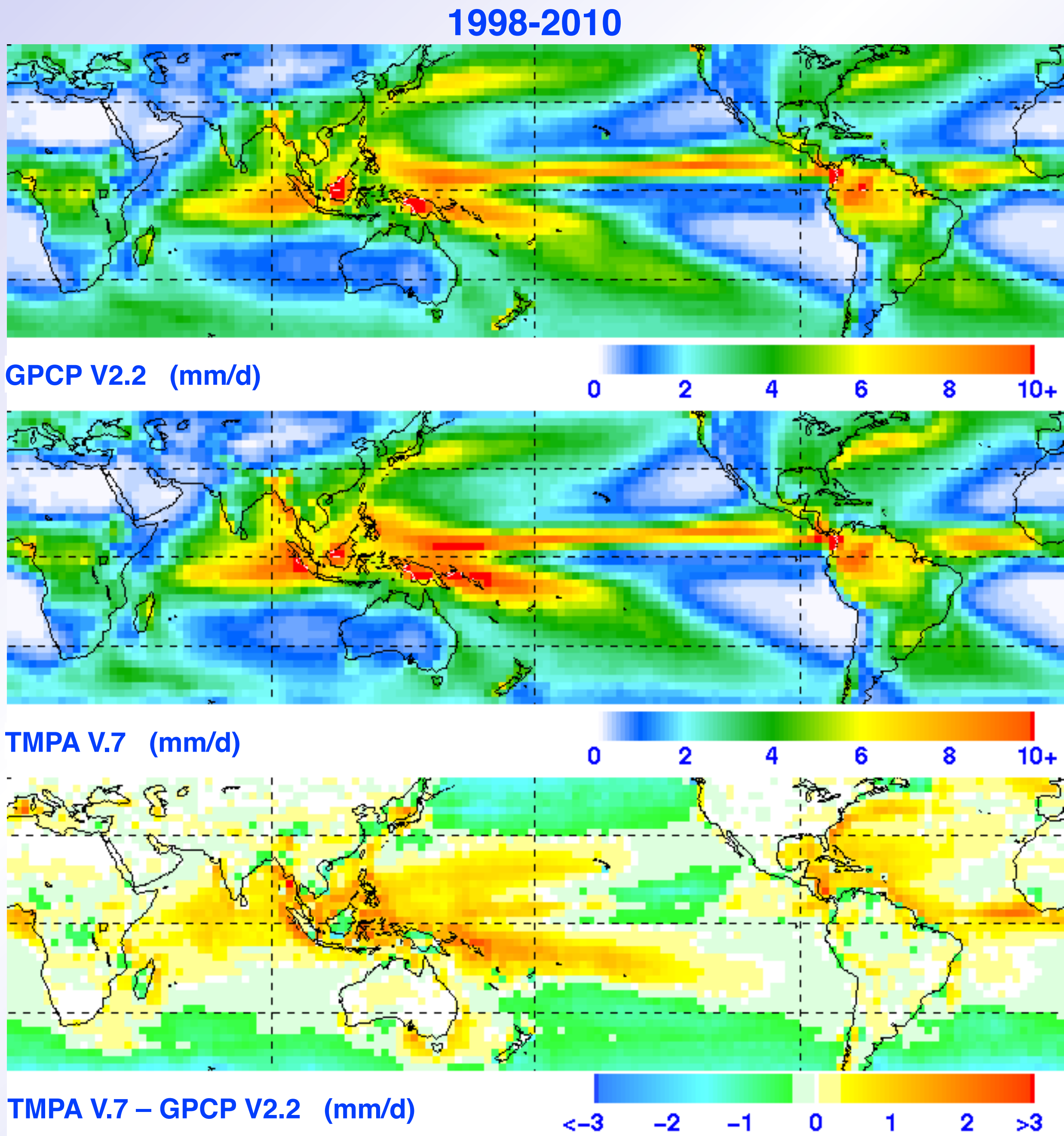
- different sensors "see" different aspects of the same scene
- limited opportunities to "fix" problems with the individual inputs on the fly
- satellite sensors tend to be best for tropical ocean
- satellite sensors and rain gauge analyses tend to have more trouble in cold areas and complex terrain

3. TMPA V.7 vs. GPCP V2.2

TMPA averaged to 2.5° grid

Monthly (and longer) bias in amount governed by

- land: rain gauge analysis
  - very similar
  - both use the latest GPCC analysis
  - some differences due to details of averaging at original grid scales



4. Future – GPM Combination (1/3)

The GPM Day-1 multi-satellite algorithm will be a unified U.S. algorithm

- Integrated Multi-satellitE Retrievals for GPM – IMERG
  - NASA TMPA: intersatellite calibration, gauge adjustment
  - NOAA CMORPH: Lagrangian time interpolation
  - U.C. Irvine PERSIANN: neural-net microwave calibrated IR
  - NASA PPS: input data assembly, processing environment
- 0.1°x0.1° half-hourly gridded data
- cover 50°N-S (later global) for the period 1998-present
- early samples expected Summer 2013
- at-launch runs will be computed with TRMM calibration
- TMPA, TMPA-RT will be computed until IMERG is approved in the GPM check-out

We will expand on the (near-)real-time and after-real-time production concept

- address different user needs in 3 "runs"
  - "early" (~4 hr after observation; flood, landslide)
  - "late" (~12 hr after observation; drought, crops)
  - "final" (with gauge, ~2 months after observation; research quality)
- episodic retrospective processing for all 3 runs

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Interpolate between PMW overpasses, following the cloud systems. The current state of the art is

- estimate cloud motion fields from geo-IR data
- move PMW swath data using these displacements
- apply Kalman smoothing to combine satellite data displaced from nearby times

Currently being used in CMORPH, GSMaP (Japan)

Introduces additional correlated error

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4. Future – GPM Combination (2/3)

Output dataset includes intermediate data fields

- users and developers require
  - processing traceability
  - support for algorithm studies

0.1° global CED grid

- 3600x1800 = 6.2M boxes
- fields are 1-byte integer, and scaled 2-byte integer or 4-byte real
- but dataset compression means smaller disk files
- PPS will provide subsetting

"User" fields in italics, darker shading

	Half-hourly data file (early, late, final)	***Size (MB) 96 / 161***
1	*Calibrated multi-satellite precipitation*	*12 / 25*
2	*Uncalibrated multi-satellite precipitation*	12 / 25
3	*Calibrated multi-satellite precipitation error*	*12 / 25*
4	PMW precipitation	12 / 25
5	PMW source 1 identifier	6
6	PMW source 1 time	6
7	PMW source 2 identifier	6
8	PMW source 2 time	6
9	IR precipitation	12 / 25
10	IR KF weight	6
11	*Probability of liquid-phase precipitation*	*6*
	Monthly data file (final)	***Size (MB) 36 / 62***
1	*Satellite-Gauge precipitation*	*12 / 25*
2	*Satellite-Gauge precipitation error*	*12 / 25*
3	Gauge relative weighting	6
4	*Probability of liquid-phase precipitation*	*6*

4. Future – GPM combination (3/3)

We will continue seeking to employ all precip-relevant satellite data

- IR data from international geo-satellites (merged at NOAA)
- microwave data from "all" DoD, EUMETSAT, NASA, NOAA, other partner (Japan, France/India, …) leo-satellites
- next-generation precip inputs from groups at NASA, NOAA; others in planning
- improved DWD precip gauge analyses

We expect to add a parallel model-observation product set

- model precip is better at high latitudes, satellite are better in the tropics
- IMERG framework is a natural for using both
- main issue is merging sometimes-very-different precip system depictions

Error estimation is a major issue

- errors are a weird amalgamation of errors from inputs, sampling, and combination
- monthly random error estimate is reasonable
- monthly bias has some draft concepts
- short-interval error is a work in progress
- user requirements tend to be fuzzy
- likely need to have "expert" and "simple" estimates

5. Concluding Remarks

Combined precip algorithms are critical for providing uniform fine-scale data

Issues in combined datasets are usually traceable to

- input data problems
- calibrations in combined algorithm

Morphing is now the state of the art, but really a first approximation

Error expressions are still a work in progress

Ask! We answer questions, even if it's "can't fix that now."

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