Early Examples and Plans for IMERG

The GPM Multi-Satellite Team

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IMERG = Integrated Multi-Satellite Retrievals for GPM

1. INTRODUCTION

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

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

The GPM multi-satellite product goals:

- seek the longest, most detailed record of "global" precip
  - don't use regional data sets
  - do use gauge data
- combine the input estimates into a "best" data set
  - not a Climate Data Record
  - but we strive for relatively uniform input data

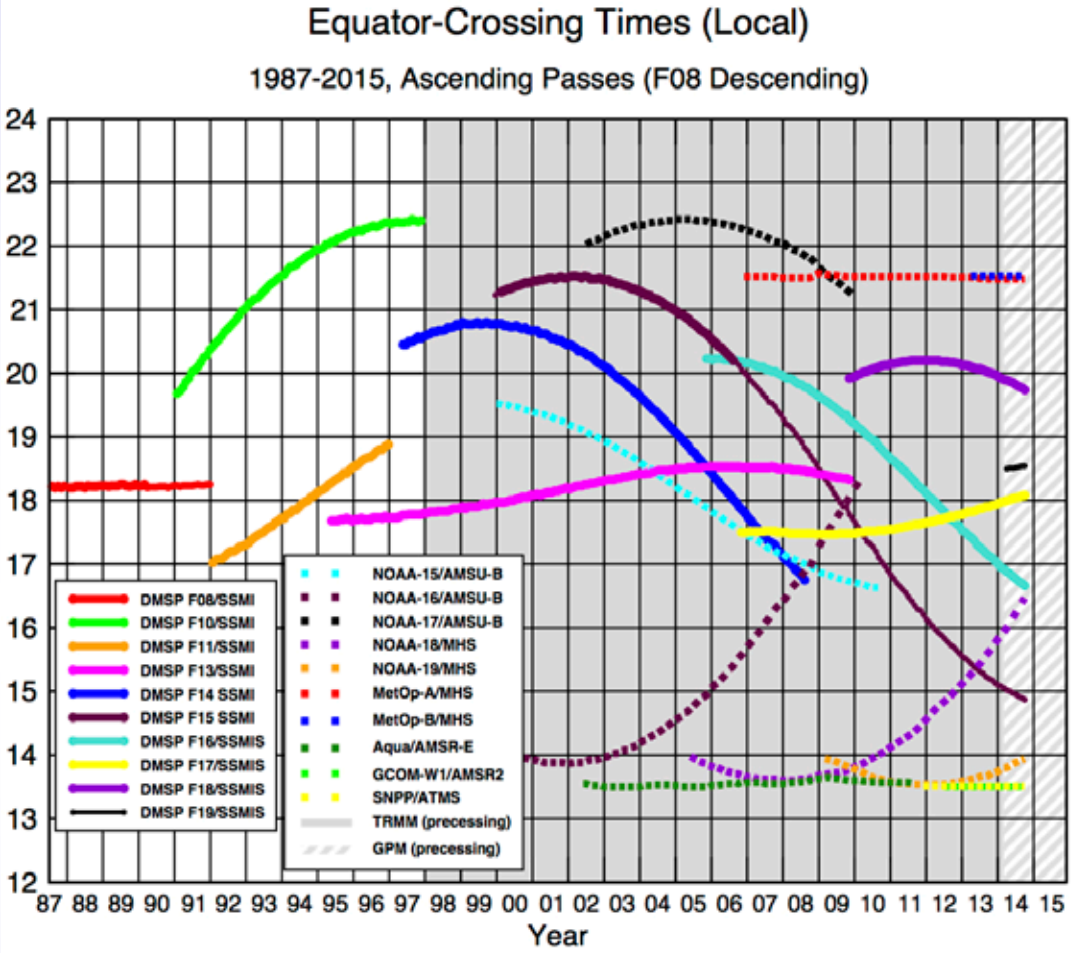


Image by Eric Nelkin (SSAI), 13 November 2014, NASA/Goddard Space Flight Center, Greenbelt, MD.

2. IMERG DESIGN – Processing

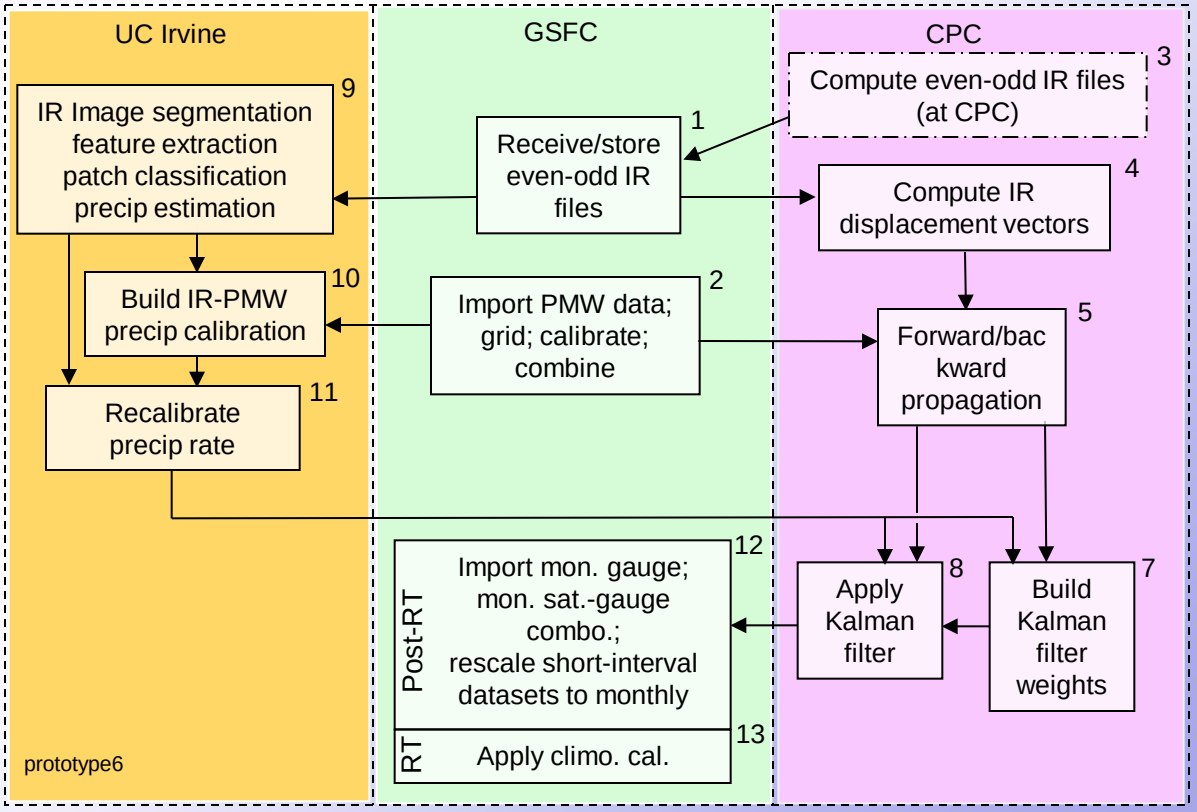
IMERG is a unified U.S. algorithm that takes advantage of

- 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

The Japanese counterpart is GSMaP

Institutions are shown for module origins, but

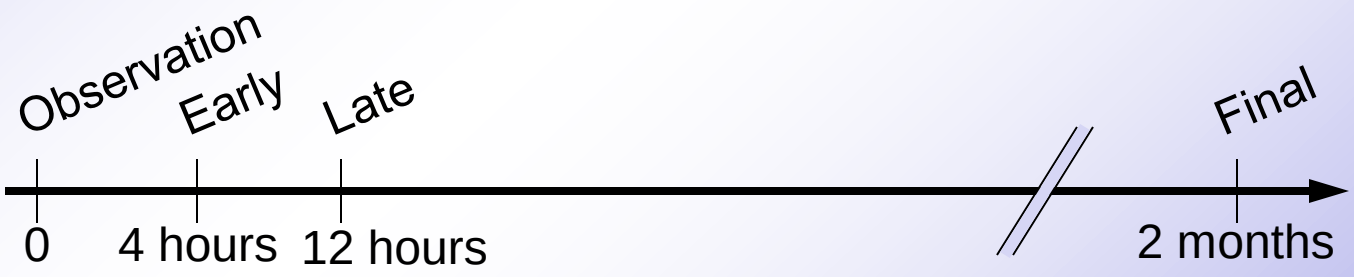
- package will be an integrated system
- goal is single code system appropriate for near-real and post-real time
- "the devil is in the details"



2. IMERG DESIGN – Multiple "Runs"

Different users have different requirements for latency and accuracy

- "early" – forward-only morphing 4 hours after observation time for users needing a quick answer (flash flooding, landslides)
- "late" – a complete forward/backward morphing 12 hours after observation time for "next-day" users (agricultural forecasting)
- "final" – combined multi-satellite and gauge analyses 2 months after observation for archival science research data (climate statistics, model validation)
- studies underway for reducing near-real-time latency



2. IMERG DESIGN – Data Fields

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

0.1 ° global CED grid

- 3600x1800 = 6.2M boxes
- but dataset compression in HDF5 means smaller disk files – 3MB
- PPS will provide subsetting by parameter and location
- initial release covers 60 ° N-S

Dataset includes intermediate data fields

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

"User" fields in italics, darker shading

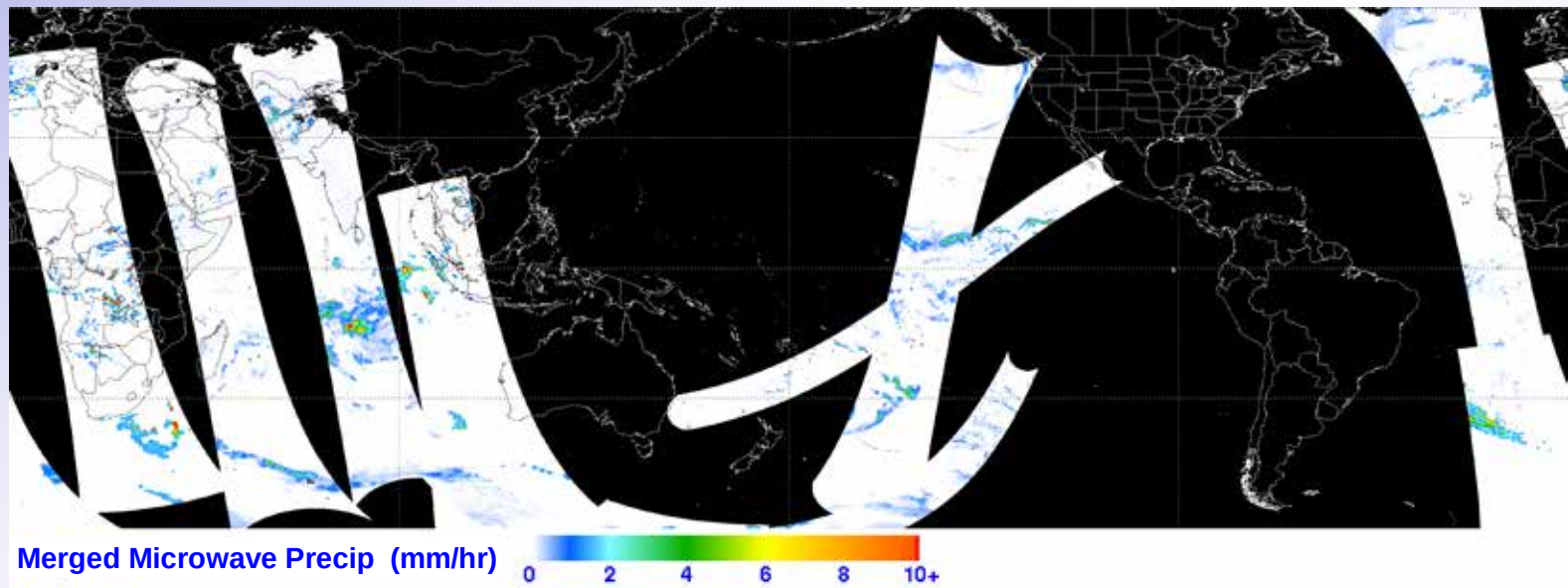
	Half-hourly data file (Early, Late, Final)
1	*Calibrated multi-satellite precipitation*
2	*Uncalibrated multi-satellite precipitation*
3	*Calibrated multi-satellite precipitation error*
4	PMW precipitation
5	PMW source identifier
6	PMW source time
7	IR precipitation
8	IR KF weight
9	*Probability of liquid-phase precipitation*
	Monthly data file (Final)
1	*Satellite-Gauge precipitation*
2	*Satellite-Gauge precipitation error*
3	Gauge relative weighting
4	*Probability of liquid-phase precipitation*

3. EXAMPLES – Data Fields from IMERG Test Data (1/4)

1430-1500Z 3 April 2014

Microwave precip

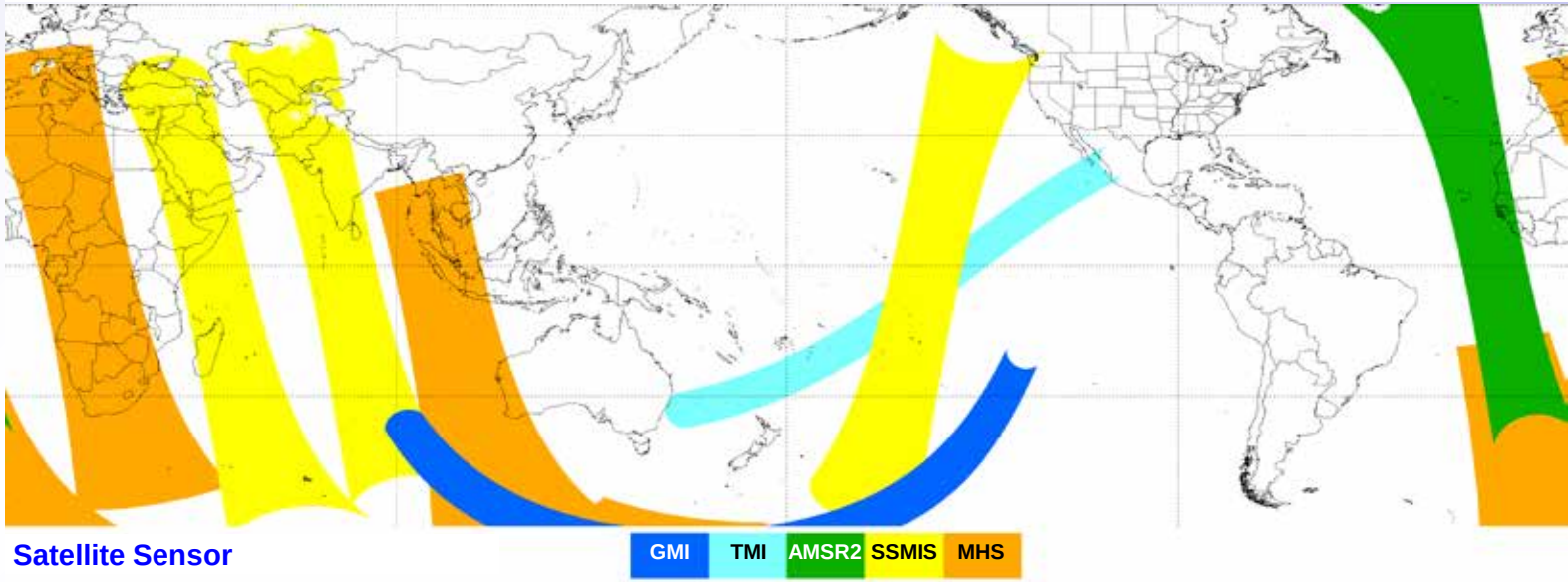
data collected in the half hour, with dropouts due to snow/ice



Source

microwave sensor contributing the data

selected as imager first, then sounder

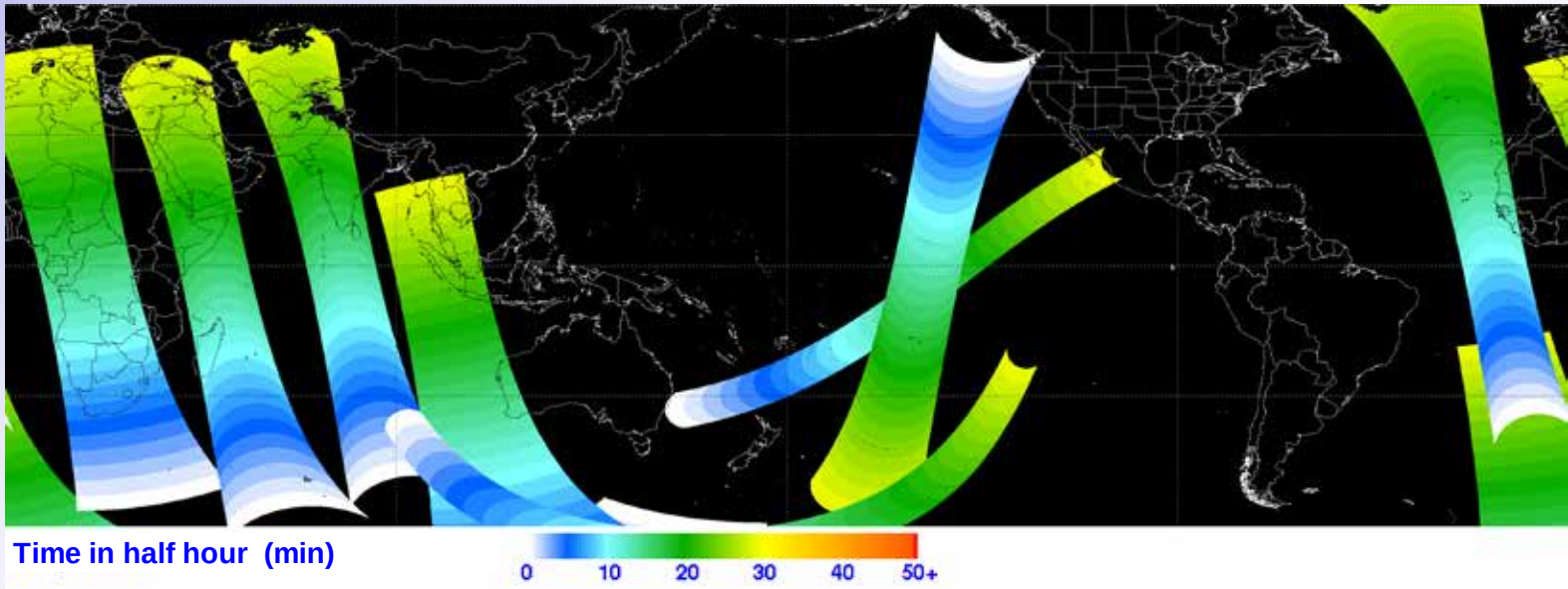


3. EXAMPLES – Data Fields from IMERG Test Data (2/4)

1430-1500Z 3 April 2014

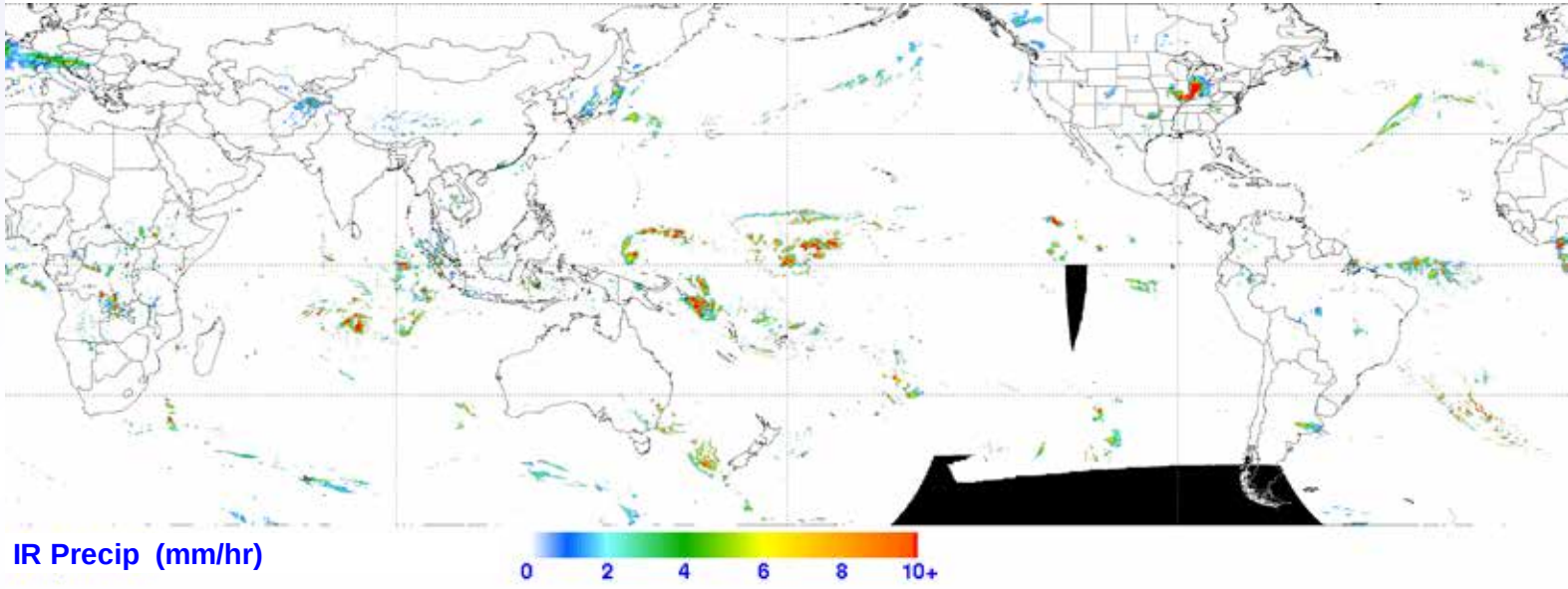
Time

time after start of half hour



IR Precip

precip from merged geo-IR data

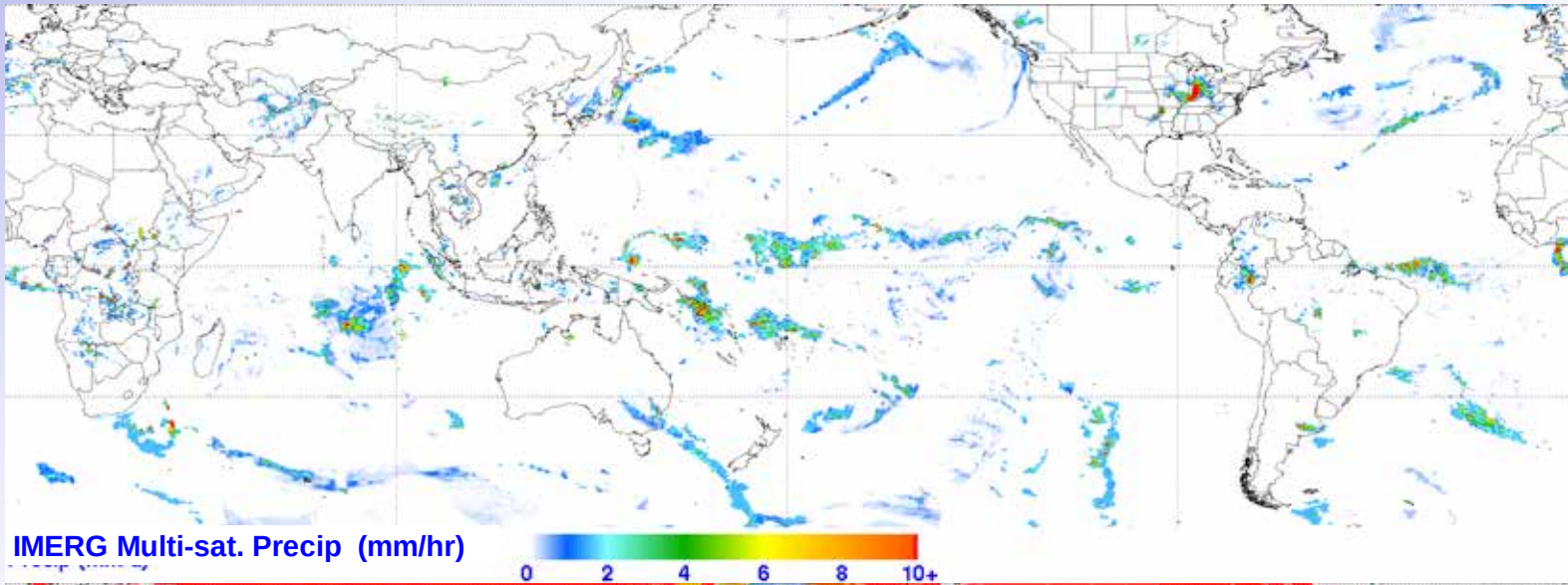


3. EXAMPLES – Data Fields from IMERG Test Data (3/4)

1430-1500Z 3 April 2014

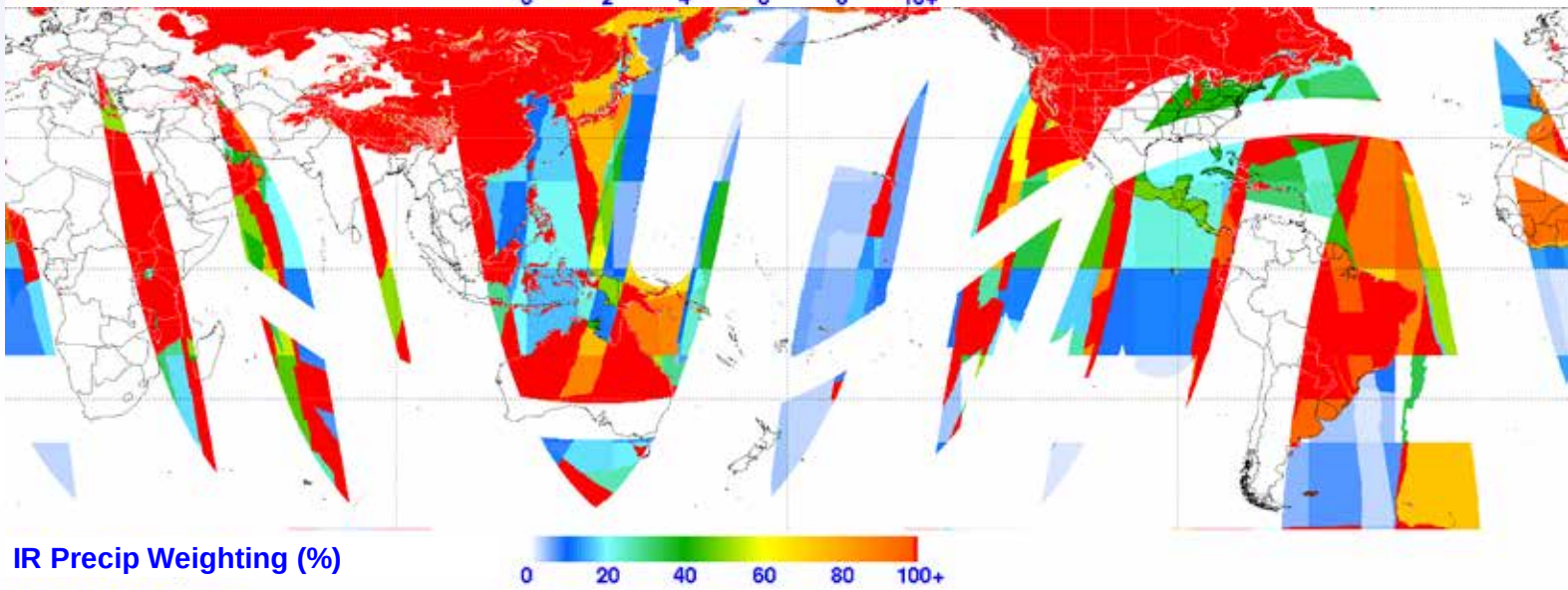
IMERG

"Early" IMERG field: forward morphed microwave, Kalman filter with IR data



IR Weighting

weighting of IR in the Kalman filter step

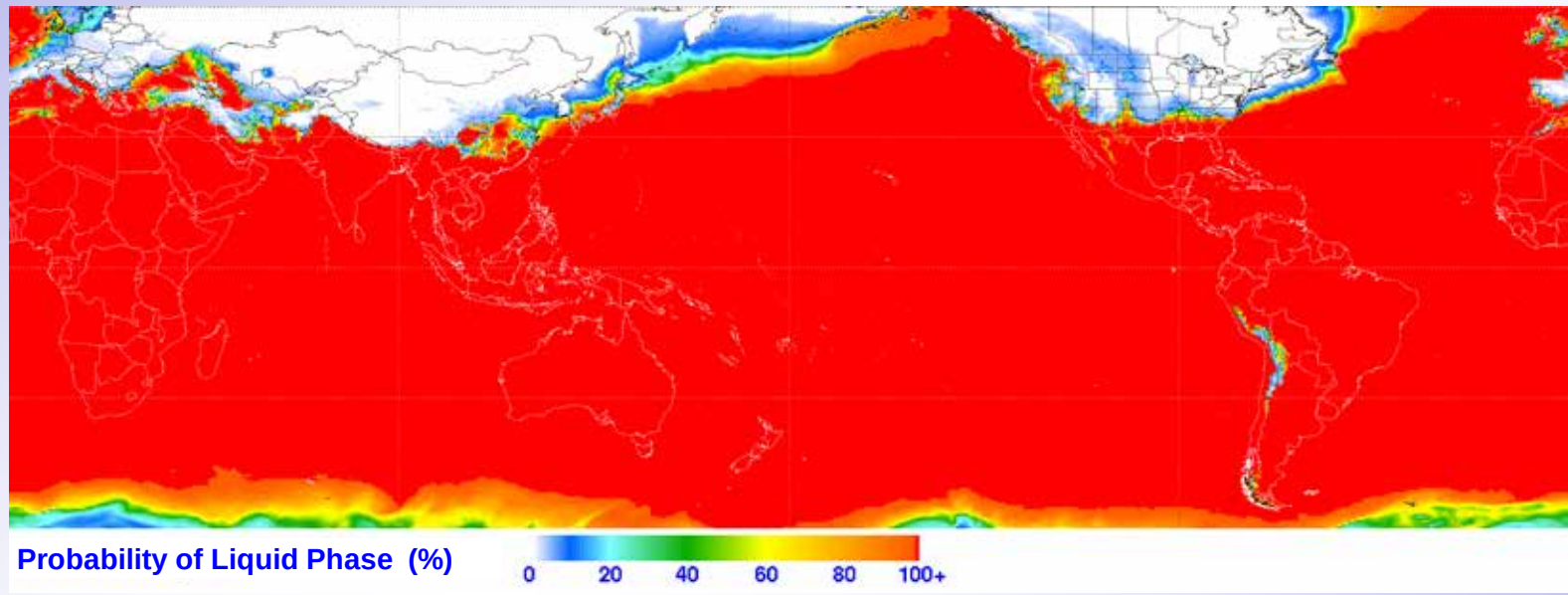


3. EXAMPLES – Data Fields from IMERG Test Data (4/4)

1430-1500Z 3 April 2014

PPLP

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



4. FUTURE – Transitioning from TRMM to GPM

IMERG is currently in early testing at PPS

- a severe test for individual algorithms
- a severe test for the developers

December 2014: expect to release the first IMERG for the GPM era

Early 2016: (1 year of data plus development time) expect to compute the first-generation TRMM/GPM-based IMERG archive, 1998-present

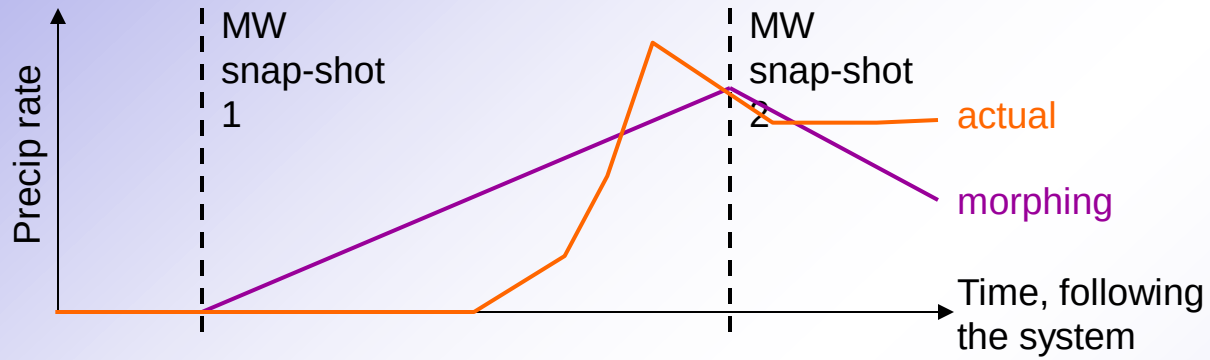
What happens to TMPA now that the TRMM satellite has run out of fuel?

- TRMM will be shut down in Spring 2015
- TMI should be useful throughout, but PR products stopped 8 October 2014
- TMPA-RT uses climatological calibration, so continues to run “as is”
- production TMPA partly depends on PR for calibration
  - we expect to continue production with climatological calibration
  - performance will have to be scrutinized
  - gauge calibration over land should continue to yield consistent results
  - climatological calibration over ocean is likely to cause a discontinuity
- loss of legacy MSPPS could raise issues for continuing TMPA

4. FUTURE – Where do we need help? (1/2)

We need a better treatment for (precipitation system) cloud growth and decay

- current morphing is linear interpolation between microwave snapshots



- how do we use more-frequent GEO data to capture short-interval variations?

Orographic enhancement and suppression

- that happens in the liquid phase
- is missed by current microwave algorithms
- because they only quantitatively detect solid hydrometeors using scattering channels) over land
- “obvious” choices are hard:
  - compute quantitative results for liquid phase (use emission channels)
  - model moisture convergence and precipitation with ancillary data

4. FUTURE – Where do we need help? (2/2)

Error estimation is a major issue

- combined-satellite errors are an amalgamation of errors from
  - input retrievals
  - sampling
  - combination algorithm
- monthly random error estimate is reasonable
- monthly bias has some draft concepts
- short-interval error is a work in progress (Maggioni et al. 2014)
- user requirements tend to be fuzzy
  - cdf or quantiles seem like a natural approach
  - how to do this compactly?
  - likely need to have “expert” and “simple” estimates
- the grand challenge is aggregating errors in space and time

User-oriented services are becoming more important

- interactive analysis (TOVAS à Giovanni)
- alternate formats (KMZ, KML, TIFF WRF files, …)
- area averages (political and geographical subdivisions, river basins)

5. FINAL COMMENTS

The U.S. Day-1 GPM multi-satellite precipitation algorithm is constructed as a unified U.S. algorithm

IMERG will provide fine-scale estimates with three latencies for (eventually) the entire TRMM/GPM era

The system is planned to meet GPM requirements and to provide the hooks for future extensions

There are still lots of interesting combination and science projects to address

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