NASA SPoRT Training: GPM Precip Products

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Fairbanks, Alaska
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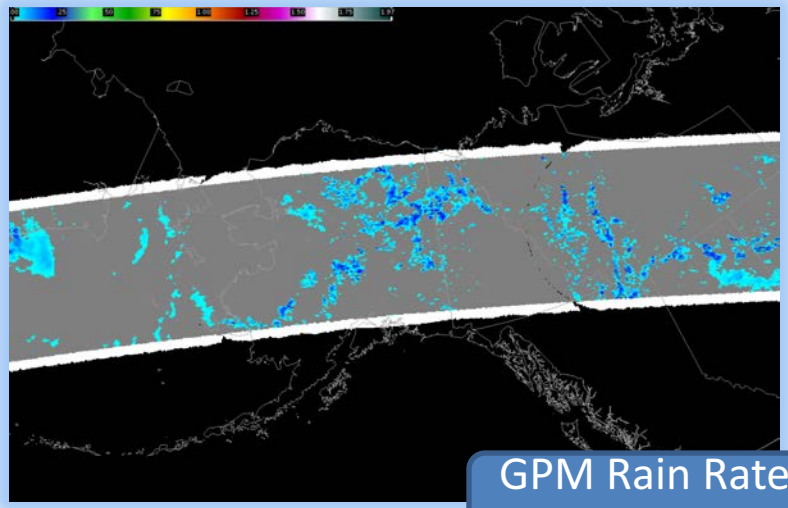
Introduction

Training Objectives

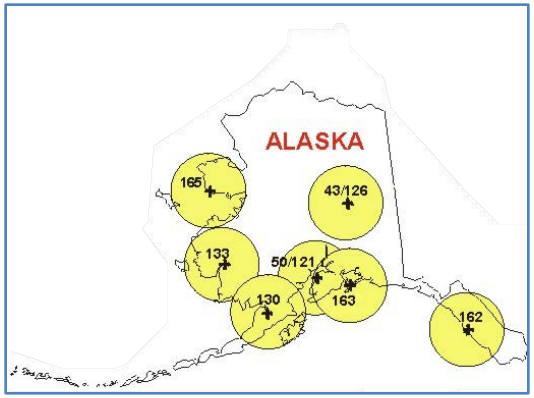
-Describe key features about GPM swath rain rates and IMERG and how rain rates are derived

-Identify where you should have high/low confidence in the GPM products

-Apply GPM products in operations with complementary products



GPM Rain Rate
2201Z 04Jul16

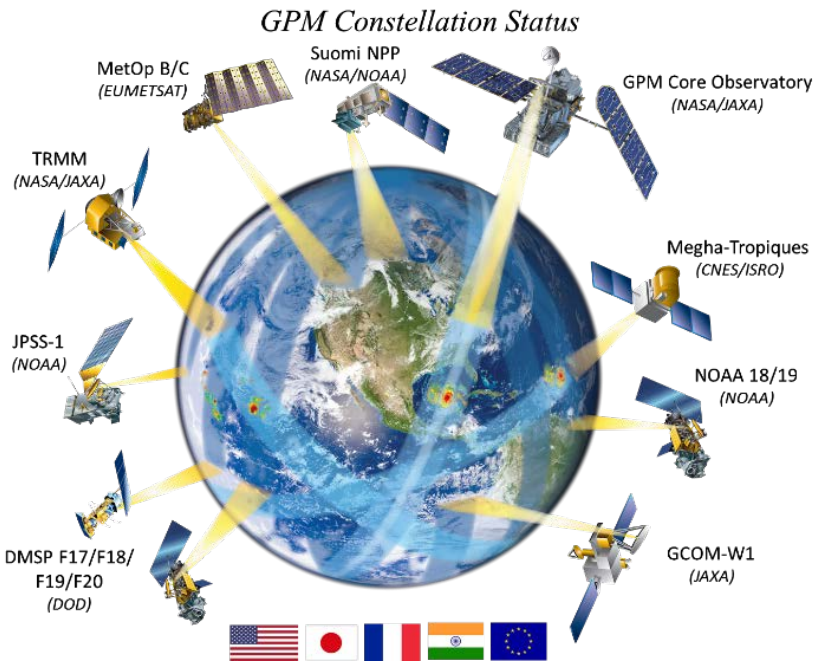


NASA GPM Mission Background

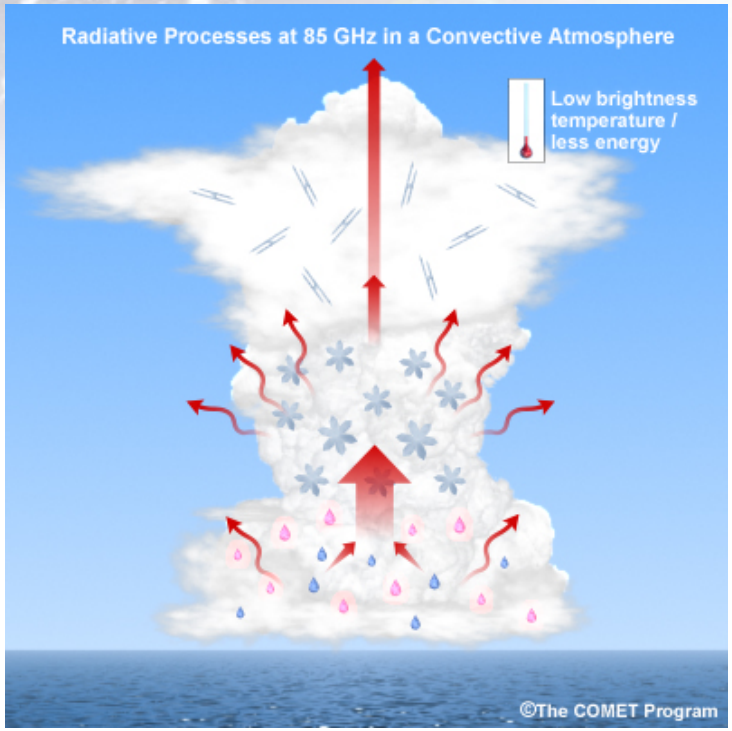
- **NASA GPM Mission purpose**:
  - observe global rainfall;
  - improve forecasts through assimilation and instantaneous precip info;
  - study the water cycle, water resources, precip microphysics, extreme weather events, climate sensitivity.
- **GPM Constellation**: international consortium of research and operational satellites that estimate rain and snow globally

Rain Rates from a Constellation

- Global coverage from several different satellites
- Temporal resolution varies and can be as high as several overpasses an hour
- Spatial resolution varies based on instruments and frequencies



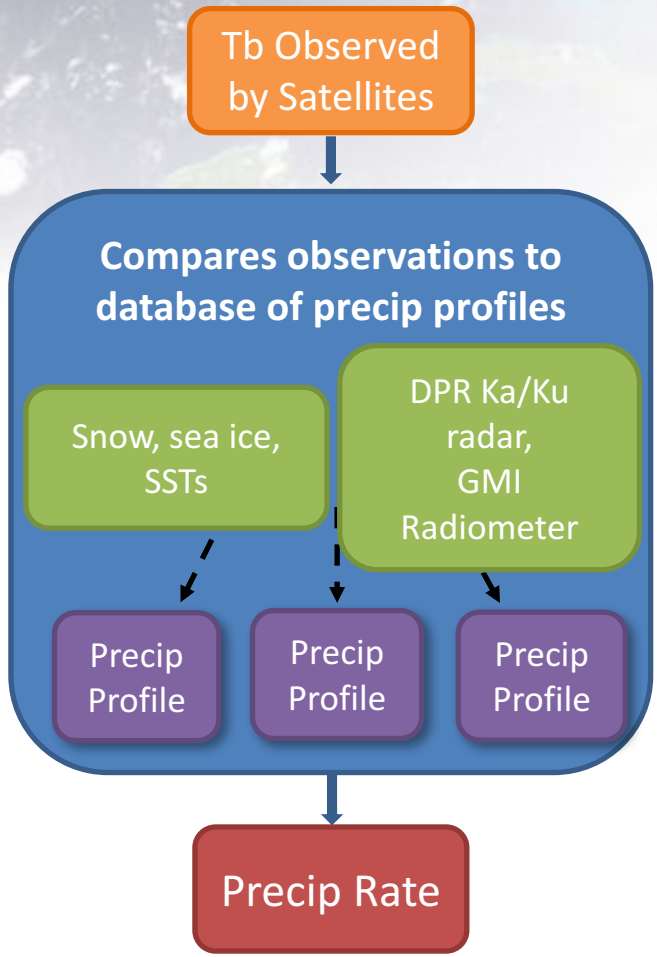
How are Passive Microwave Rain Rates (RRs) Derived



Imagery from the COMET Program

- Rain rates inferred from brightness temperatures
- Lower frequency channels observe emission from liquid hydrometeors
  - Works best over oceans
  - Cannot easily distinguish cloud emissions from land emissions
- High frequency channels observe scattering off of ice in clouds
  - Works best for ice process (convection)
  - Preferred for land

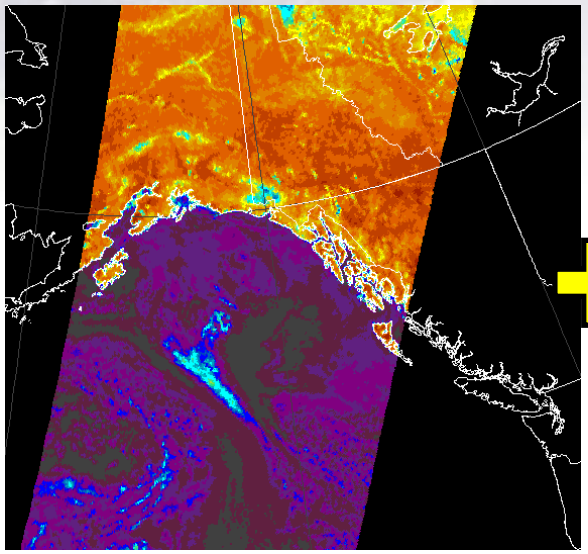
How are RRs Derived



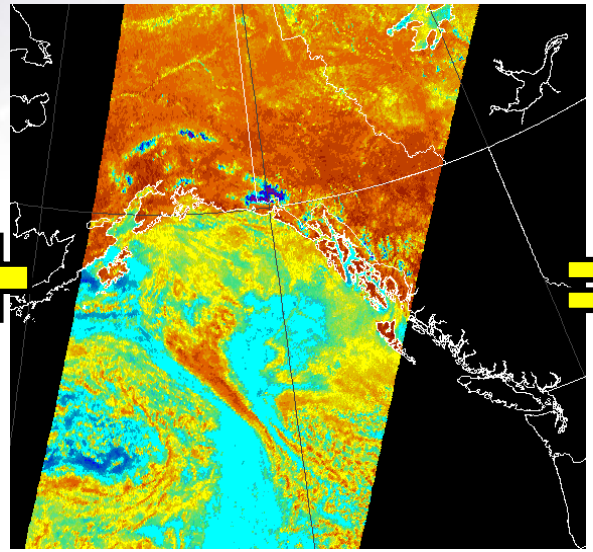
- Database incorporates GMI, DPR, model and surface obs
- Observes brightness temps (Tbs) using Constellation of passive microwave instruments
- Compares obs to database of observed precip profiles and associated Tbs from GPM core instruments to determine rain rates

Passive Microwave Rain Rates

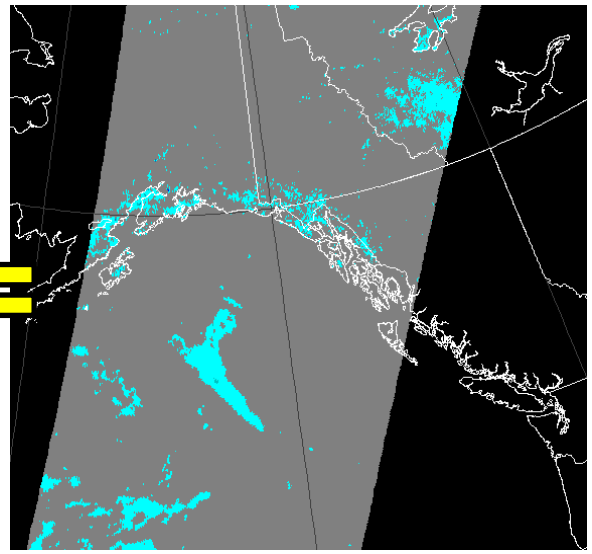
- Take advantage of unique capabilities
- Derive a rain rate product
  - SPoRT using data derived from the Global Precipitation Mission (GPM) science team
- GPM Microwave Imager includes higher frequencies for ice content
- Channel trade-offs
  - Lower frequency: Better cloud penetration
  - Higher frequency: Better resolution



37 GHz: Intensity and areal extent and at lower levels



89 GHz: Intensity and identifying storms with high ice content

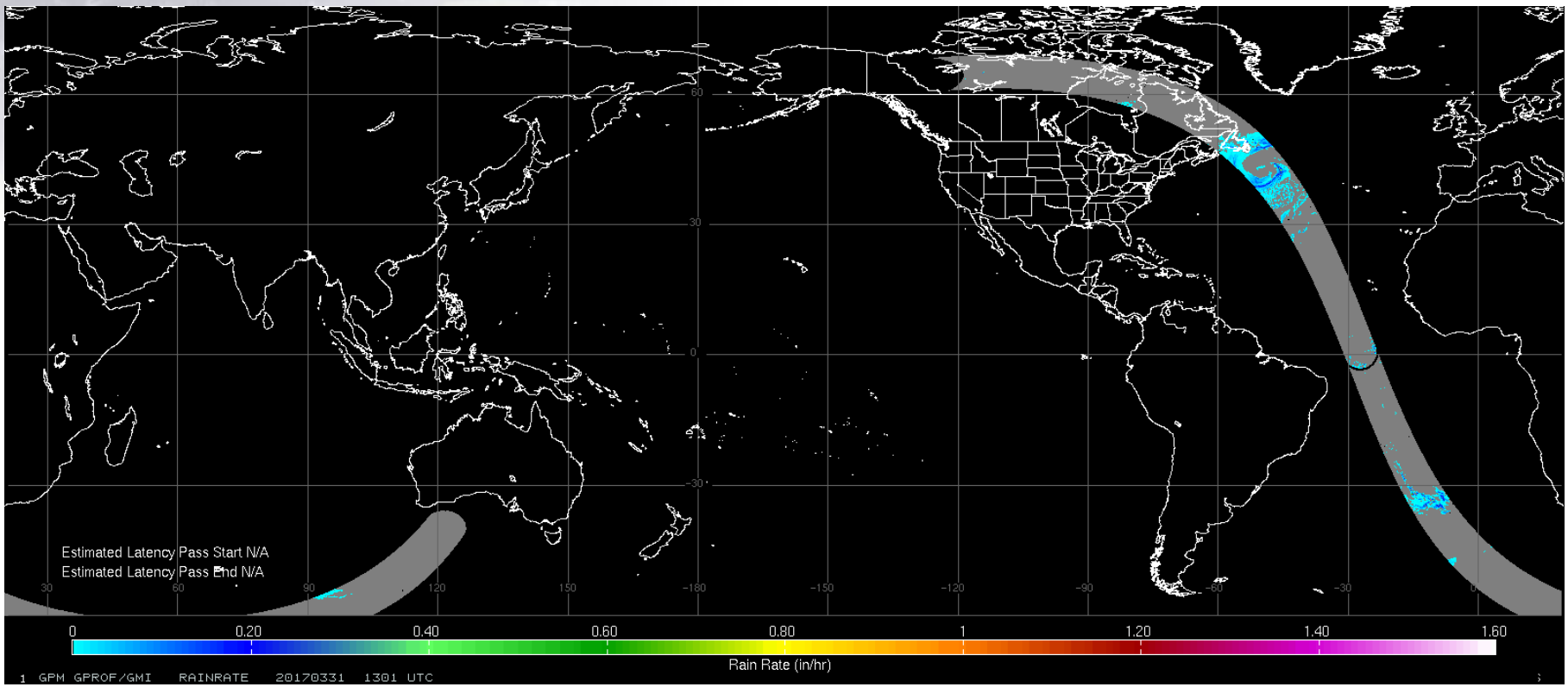


Rain Rate: Inches per hour

Quiz

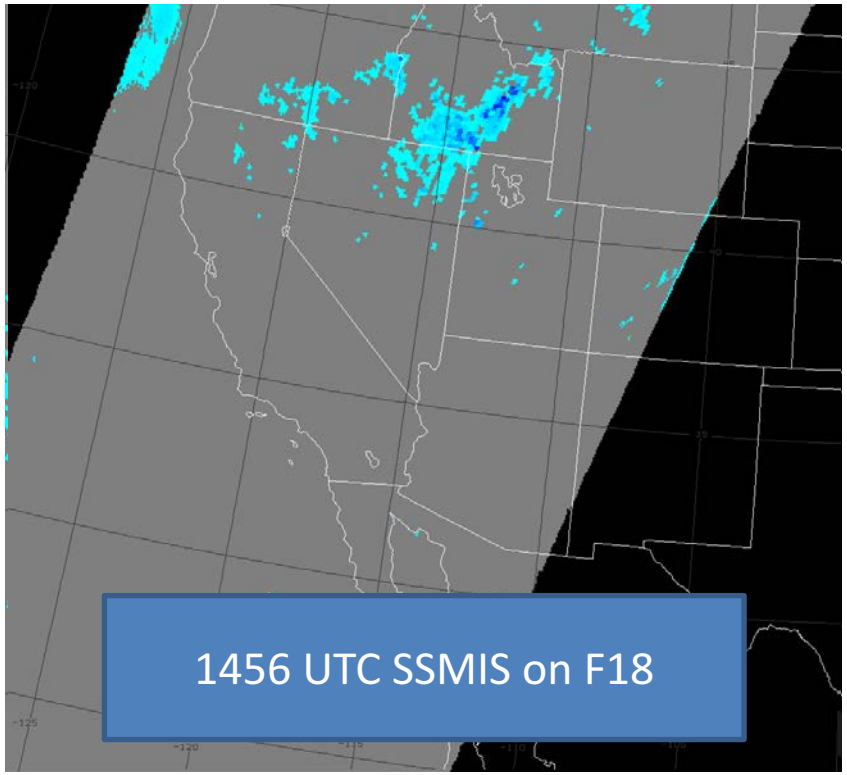
- GPM rain rates…
  - Come from a number of intercalibrated passive microwave instruments on different satellites
  - Were designed for research
  - Are derived by comparing observations to an existing database of precip profiles

GPM Swath Rain Rate Product



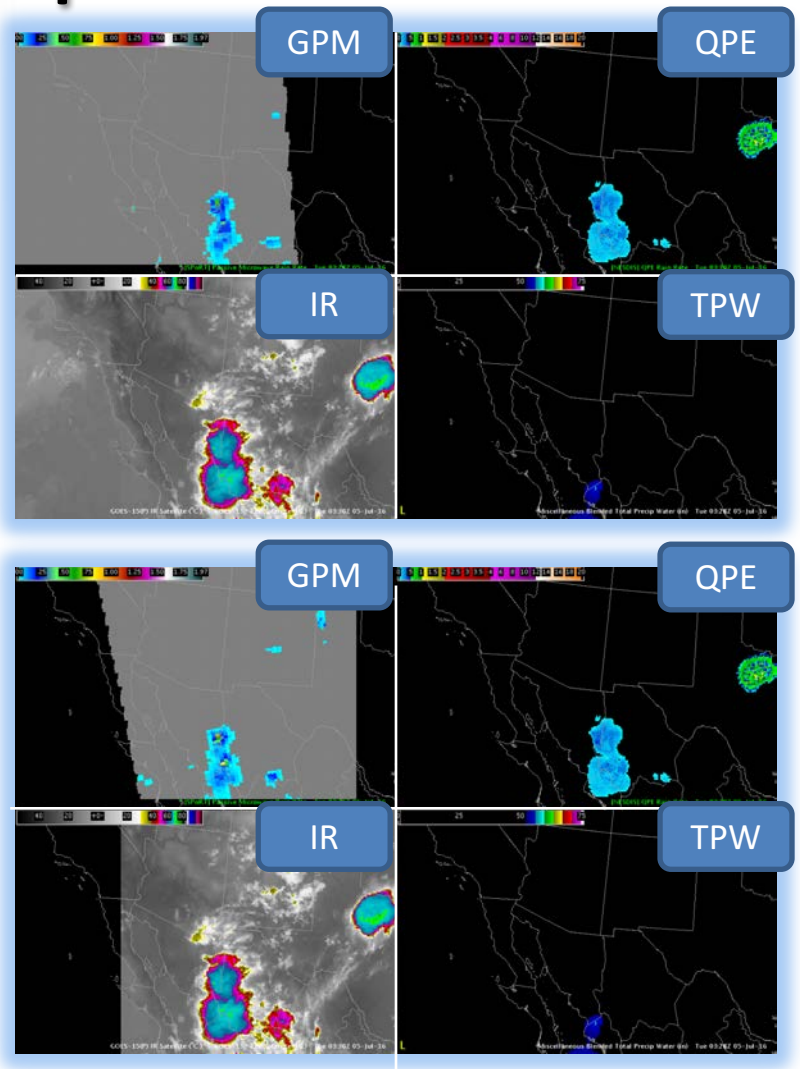
Product Details - GPM Swaths

- Temporal and spatial resolution vary by instrument
- Coverage
- Access the imagery
  - Satellite menu in AWIPS
  - NASA-SPoRT's Real Time Page: https://weather.msfc.nasa.gov/sport/
  - NASA Worldview: https://worldview.earthdata.nasa.gov/



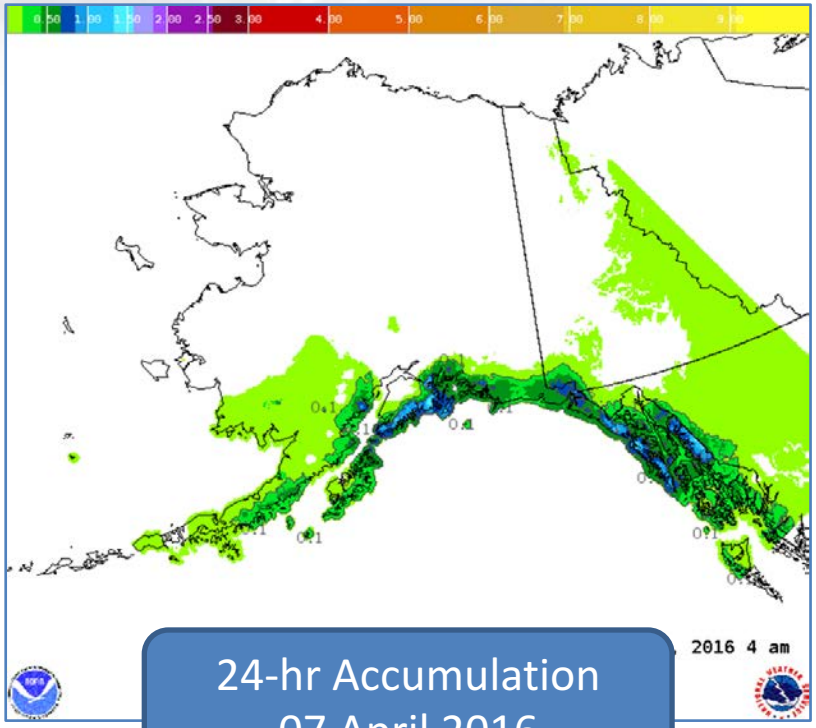
Utility in Operations

- Provides precip info in data-void regions and offshore
  - Where radar/gauges are unavailable or need supplementation
- Use in conjunction with IR to identify most intense convection

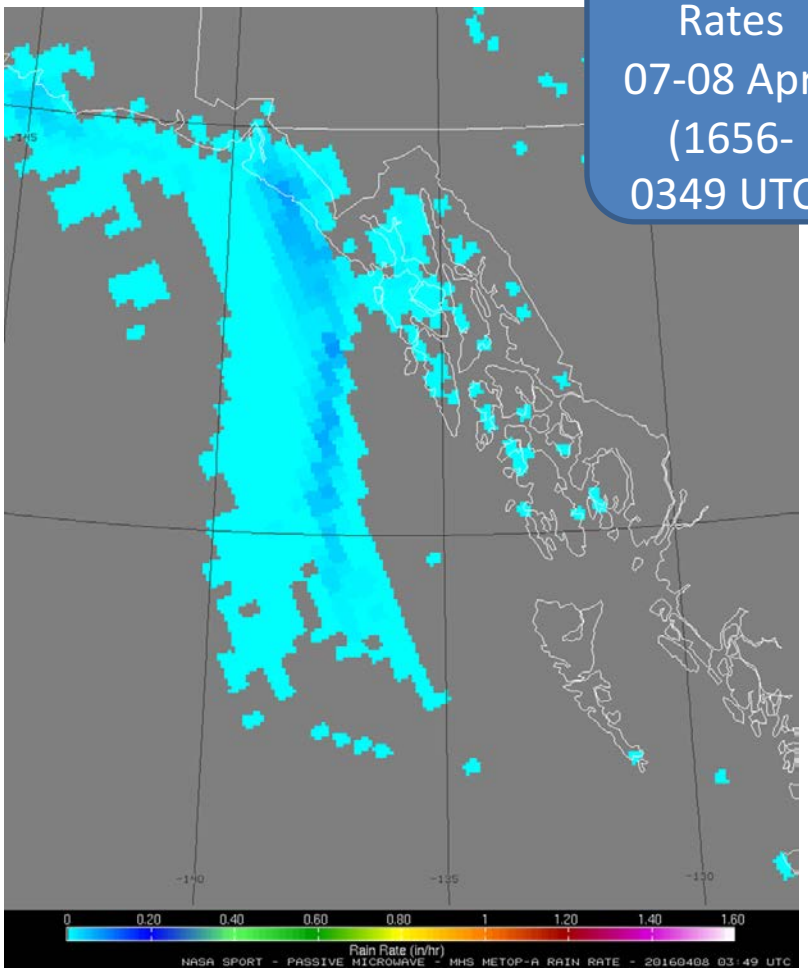


Product Application

Offshore precip in AJK area of responsibility



24-hr Accumulation
07 April 2016

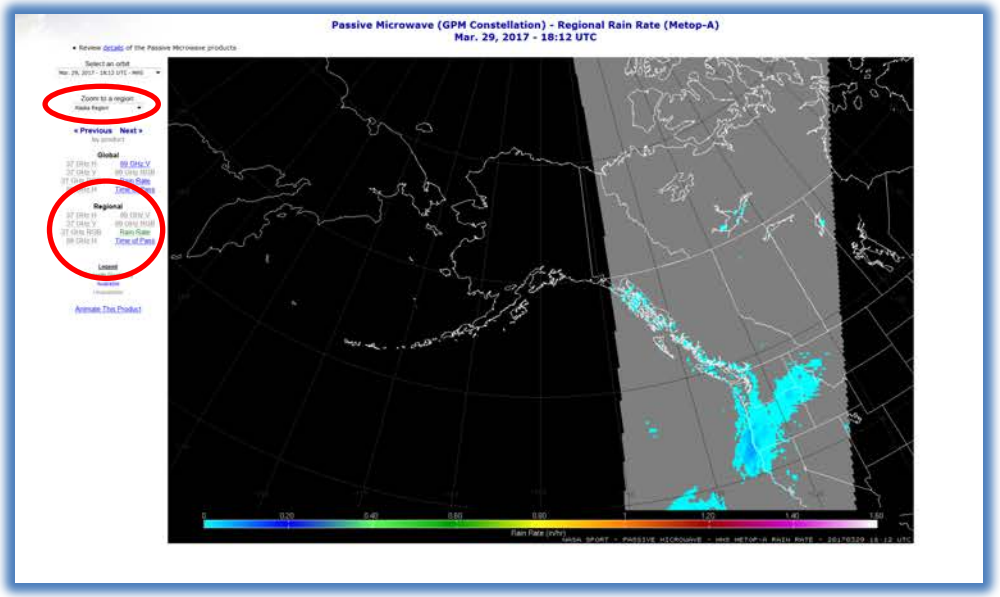


GPM Rain Rates
07-08 April
(1656-0349 UTC)

Access Swath Rain Rates and Quiz

- https://weather.msfc.nasa.gov/sport/

– Find “Global Precipitation Measurement” under “Real-Time Data” menu
– Go to “Passive Microwave”
– In “Zoom to a Region”, select “Alaska Region”

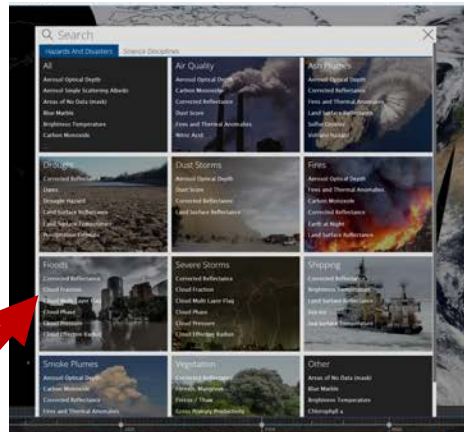


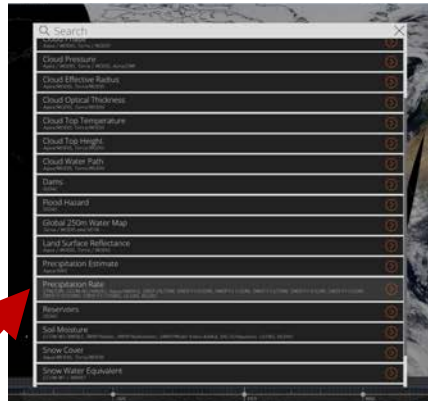
T/F: The “Alaska Region” domain of rain rates is displayed

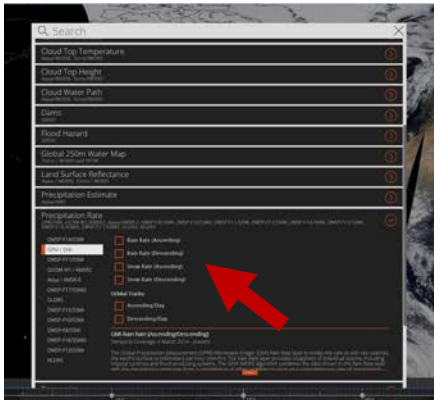
F: Use the Previous/Next buttons to find an orbit over your region…THEN select “Rain Rate” in the “Regional” section

Access Swath Rain Rates-Woldview

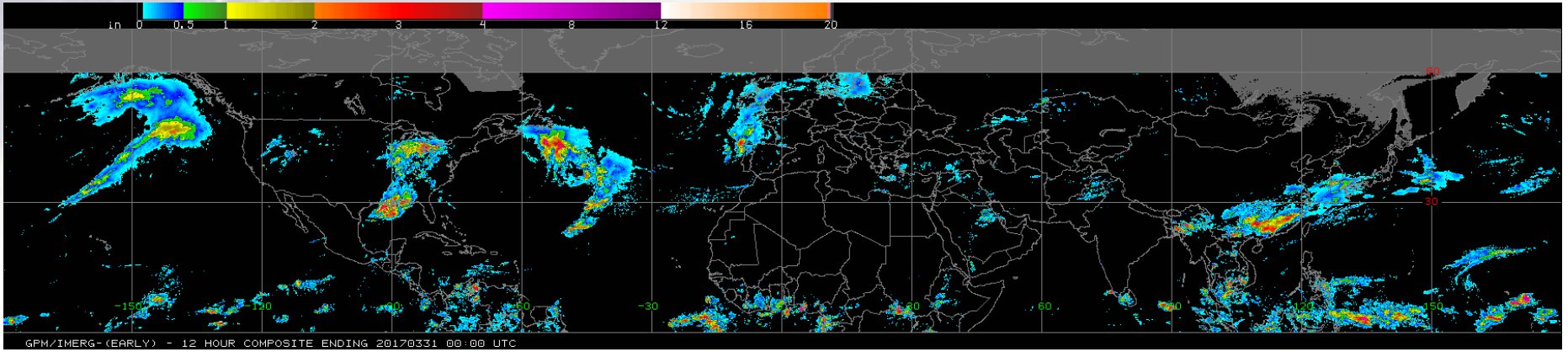
- https://worldview.earthdata.nasa.gov/
  - Click “Add Layer”
  - Select “Floods”
  - Select “Precipitation Rate”
  - Select as many data sources as you want. Want NRT? Use one of these:
    - GPM/GMI
    - GCOM-W1/AMSR2
    - DMSP-F17/SSMIS
    - DMSP-F16/SSMIS
  - Select date

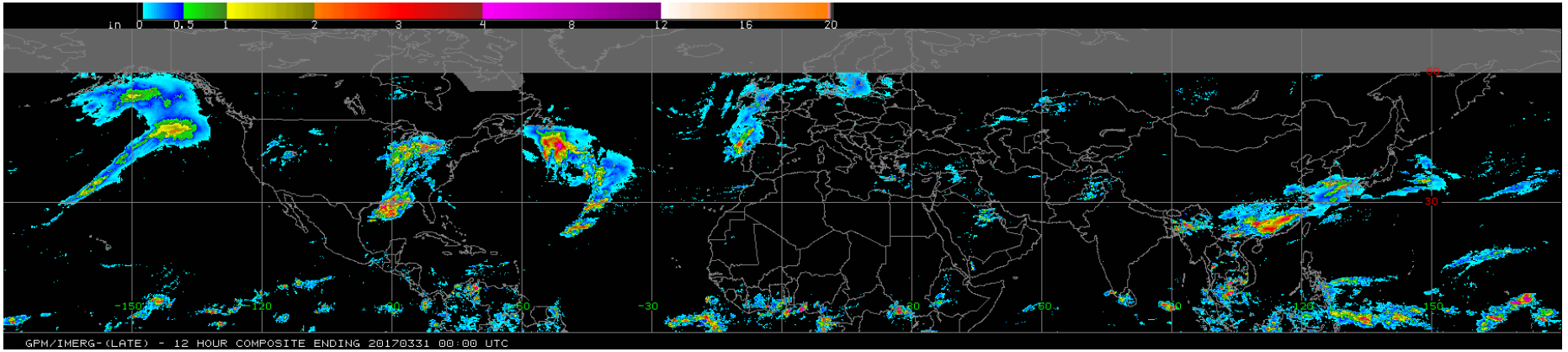






GPM IMERG Products: Early and Late





Products

- 3 different gridded data products
  - "early" 4+ hour latency and is half-hourly
  - "late" 8+ hour latency and is half-hourly
  - "final" research/climate product with a two month latency; produced monthly
- 0.1 deg spatial resolution
- 60N-60S (global product forthcoming)

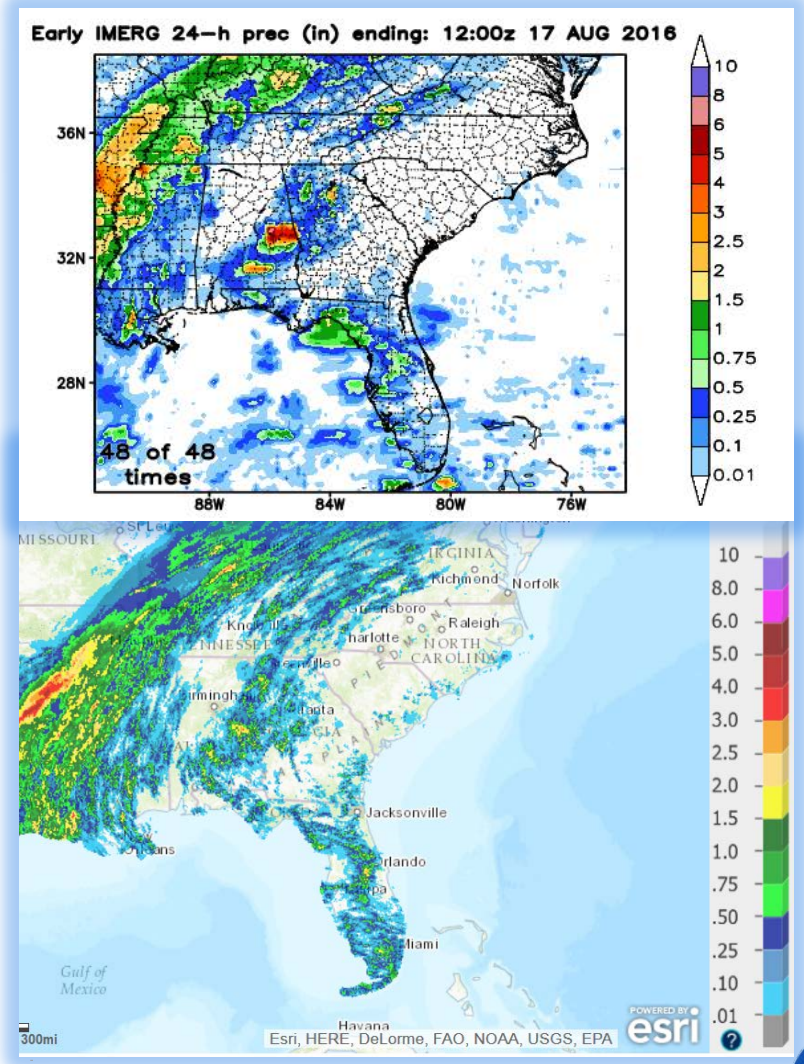
Application Example

IMERG can be used to:

-observe precip in data-void regions

-accumulate precip in synoptically significant time periods

-supplement existing data



Product Details - IMERG

- First algorithm to fuse techniques from TMPA, CMORPH-KF, and PERSIANN-CCS
  - CMORPH-KF uses PMW instantaneous RR looking forward and backward in time and space
  - CMORPH-KF fills in with IR if PMW is older than 90 minutes
  - PERSIANN-CCS uses IR (Tb-RR relationship) in a neural networking scheme for Cloud Classification

Early and Late Products

- Same input data in both products
  - **Passive microwave** – derived rain rates from several satellites
  - GPM DPR+GMI (merged **passive MW/radar**)
  - **IR data** (GOES, NPP CrIS, AIRS, Meteosat, MTSat)
- Processing is different in the Early and Late products
  - Forward morphing in Early product
  - Forward/Backward morphing in Late product
  - Result: **IR data more prevalent in Early product**

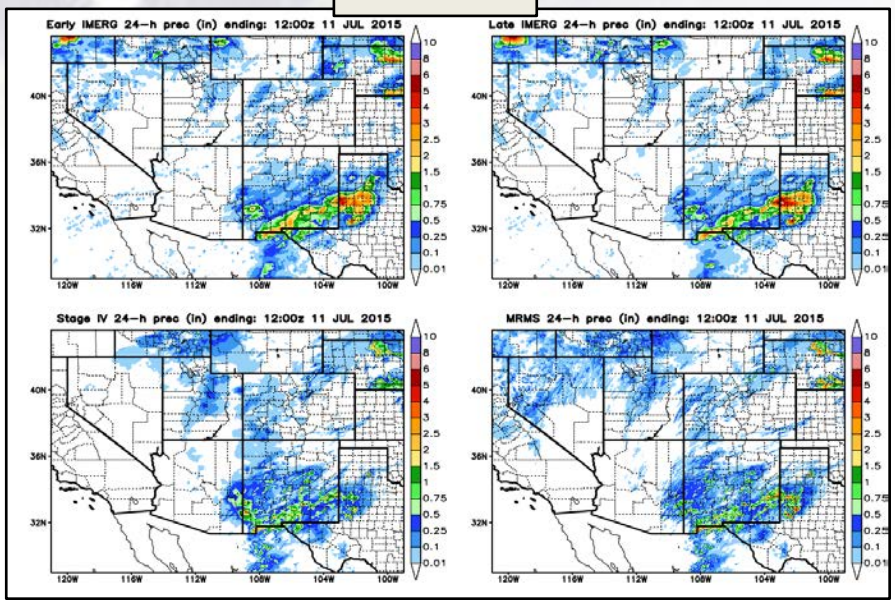
Final Product

- Uses monthly gauge data
  - Modified spherical Shepherd scheme:
  - Result: **accounts for distance and direction of propagation of precip**
  - **Gauge data calibrates Early and Late, but Early and Late do not have gauge data in them**

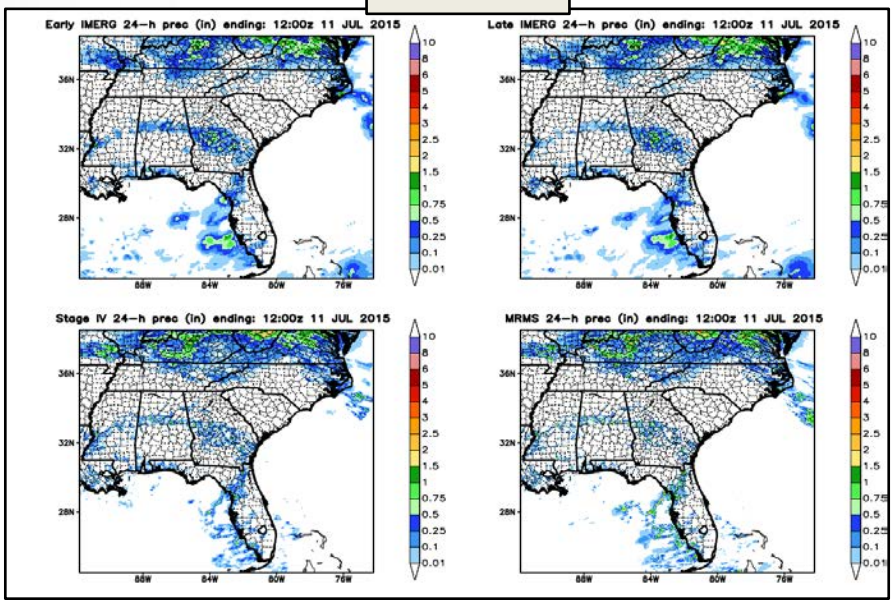
Comparisons

- SPoRT working on study to compare Early, Late, Stage IV, and MRMS

SW US

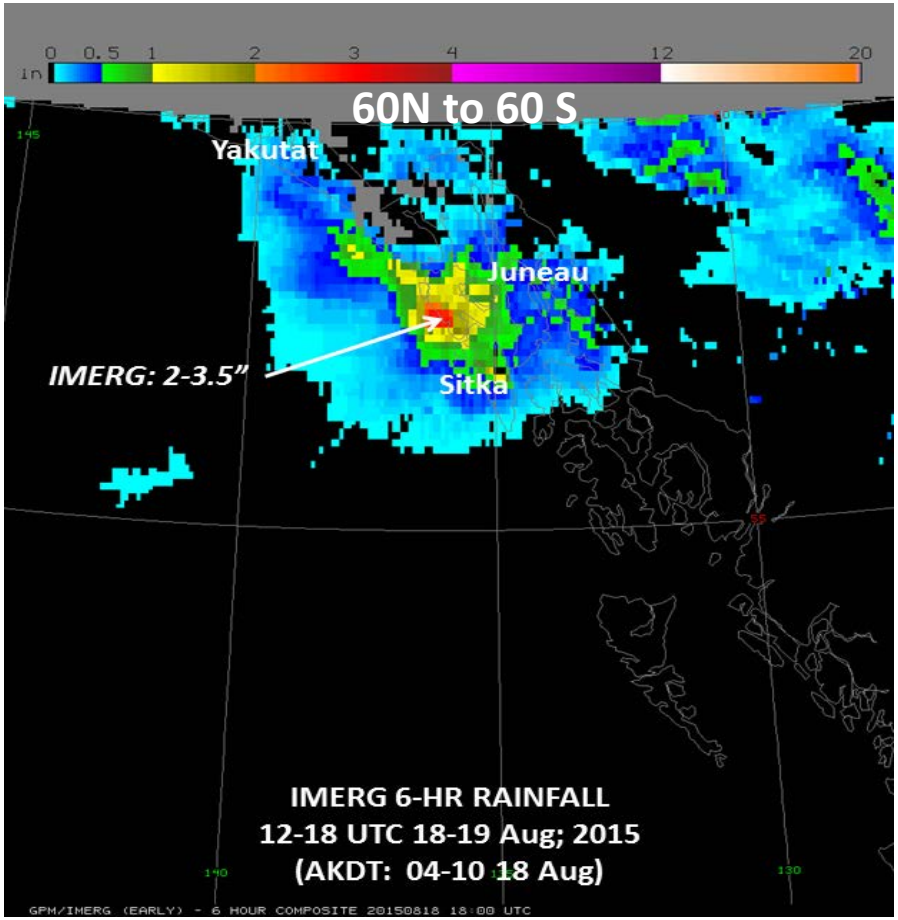


SE US



Transition of L3 IMERG Data to Forecasters

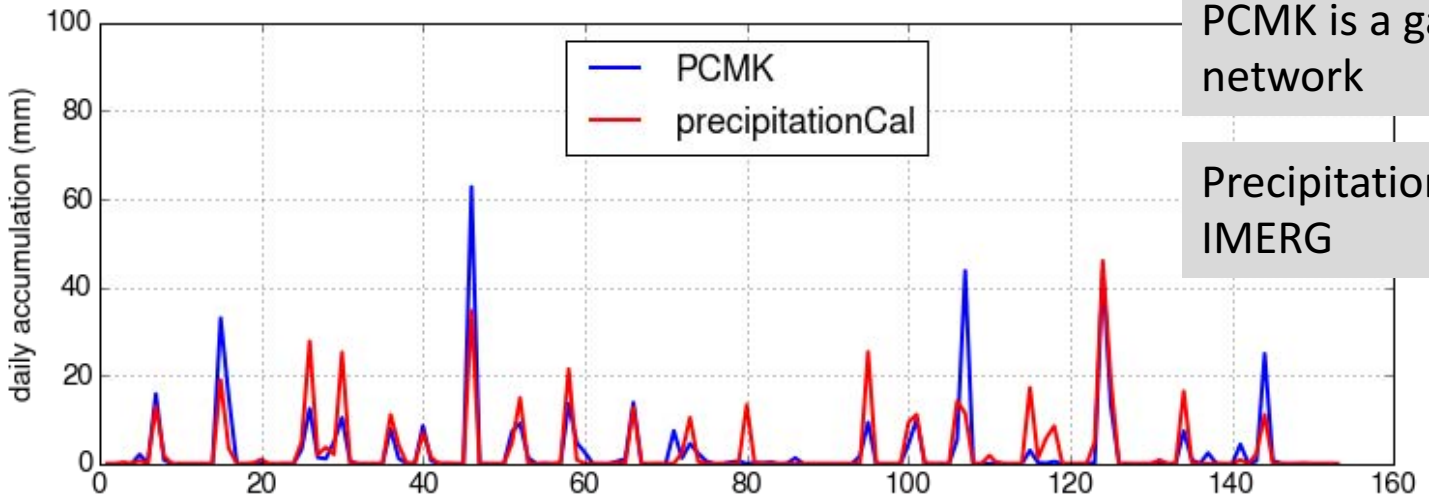
Image by Aaron Jacobs (NWS/Senior Surface Hydrologist, Juneau WFO



- Due to latency, most useful for hydrologic applications to pinpoint areas of heaviest rainfall outside of radar coverage
- Product used for post-event analysis of landslide event in the Juneau area on 18 August
- Also used by Albuquerque WFO to analyze flash flood event in July

Validation

- So far, validation has occurred over CONUS in radar-covered locations (i.e., not complex terrain) during spring and summer (i.e., predominantly convection)
- Compares well to MRMS



PCMK is a gauge network

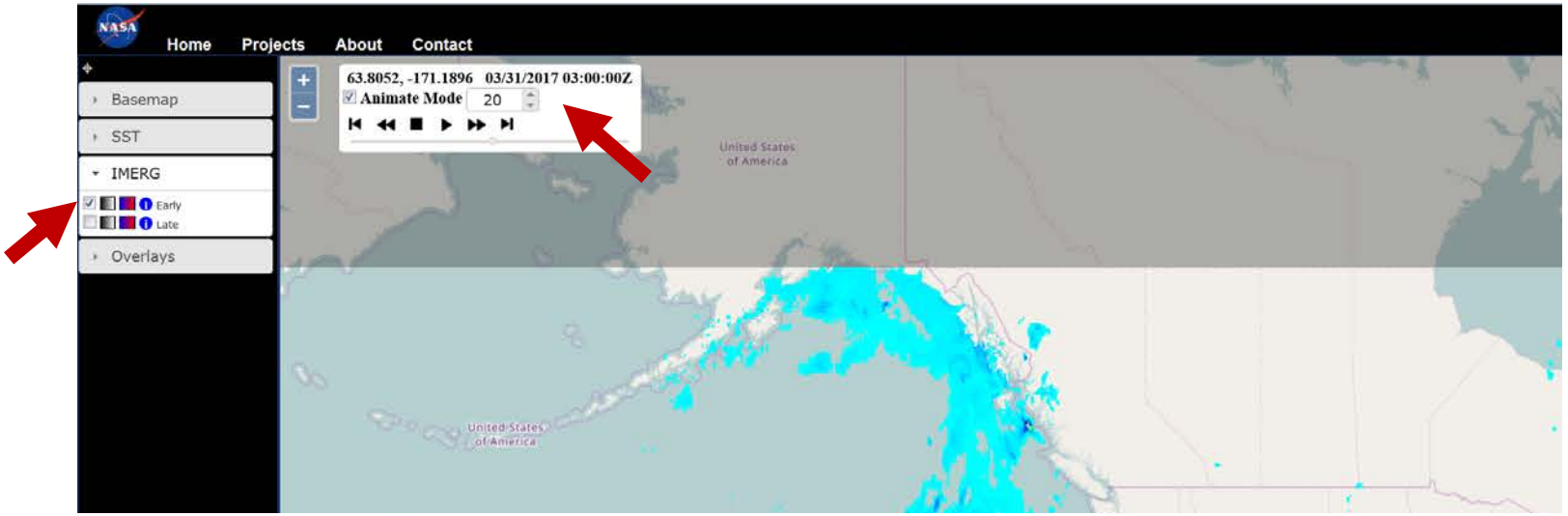
PrecipitationCal is IMERG

Access IMERG Rain Rates and Quiz

- https://weather.msfc.nasa.gov/sport/
  - Find “Global Precipitation Measurement” under “Real-Time Data” menu
  - Go to “IMERG” and “Early”
- T/F: Alaska is really well represented in the IMERG rain rates
- F: Currently, the IMERG domain is only from 60N-60S…but you can see incoming precip offshore

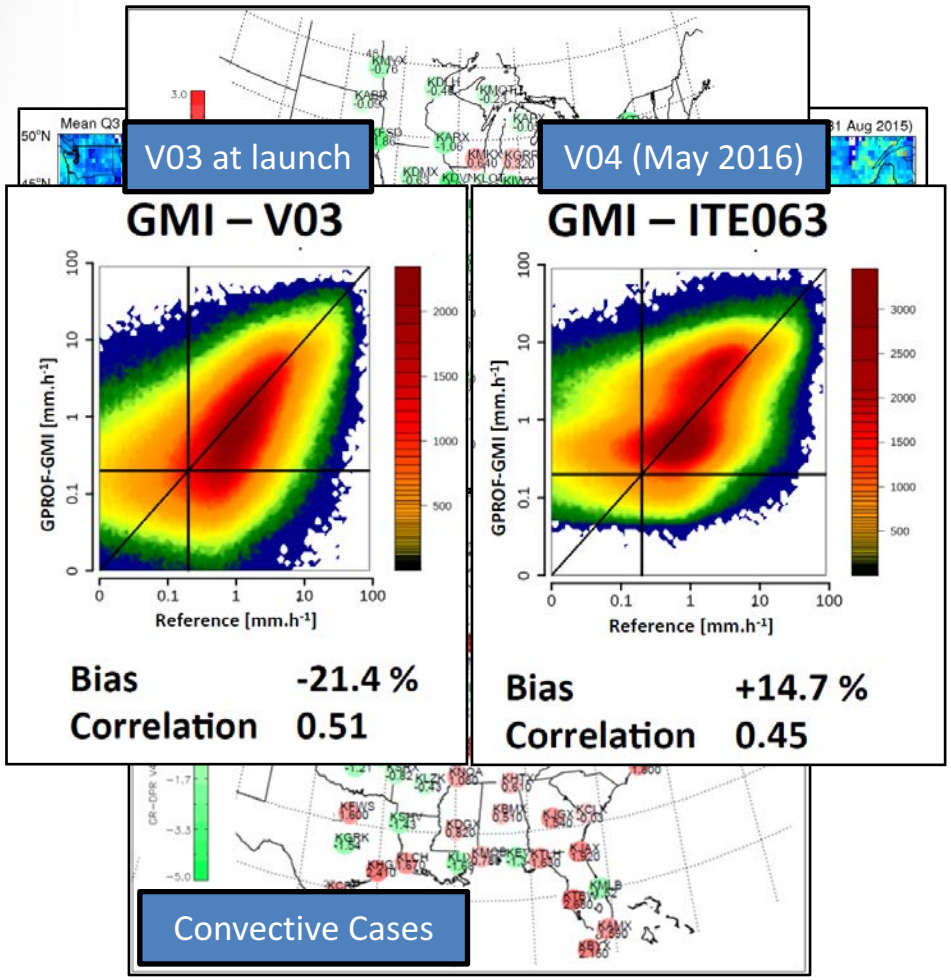
Access IMERG via SPoRT WMS

- https://weather.msfc.nasa.gov/viewer/viewer.html?config=akfireweather
- Can toggle products on and off from the pane on the left
- Animation mode…animate one product at a time



Validation

- WSR-88D vs DPR
  - DPR attenuates and underestimates convection
  - Stratiform cases match sources to within 1 dB
- Version 03 vs Version 04
  - V04 compares well with MRMS
  - V04 slight high bias but depends on precip mode
  - Light rain and heavy rain: overestimated
  - High lats: possible underestimates



Strengths

- Constellation improves spatial coverage and temporal resolution
- High frequency GMI channels better capture light rain events than predecessors
- PMW sees “through the clouds”, unlike IR which uses cloud top temps

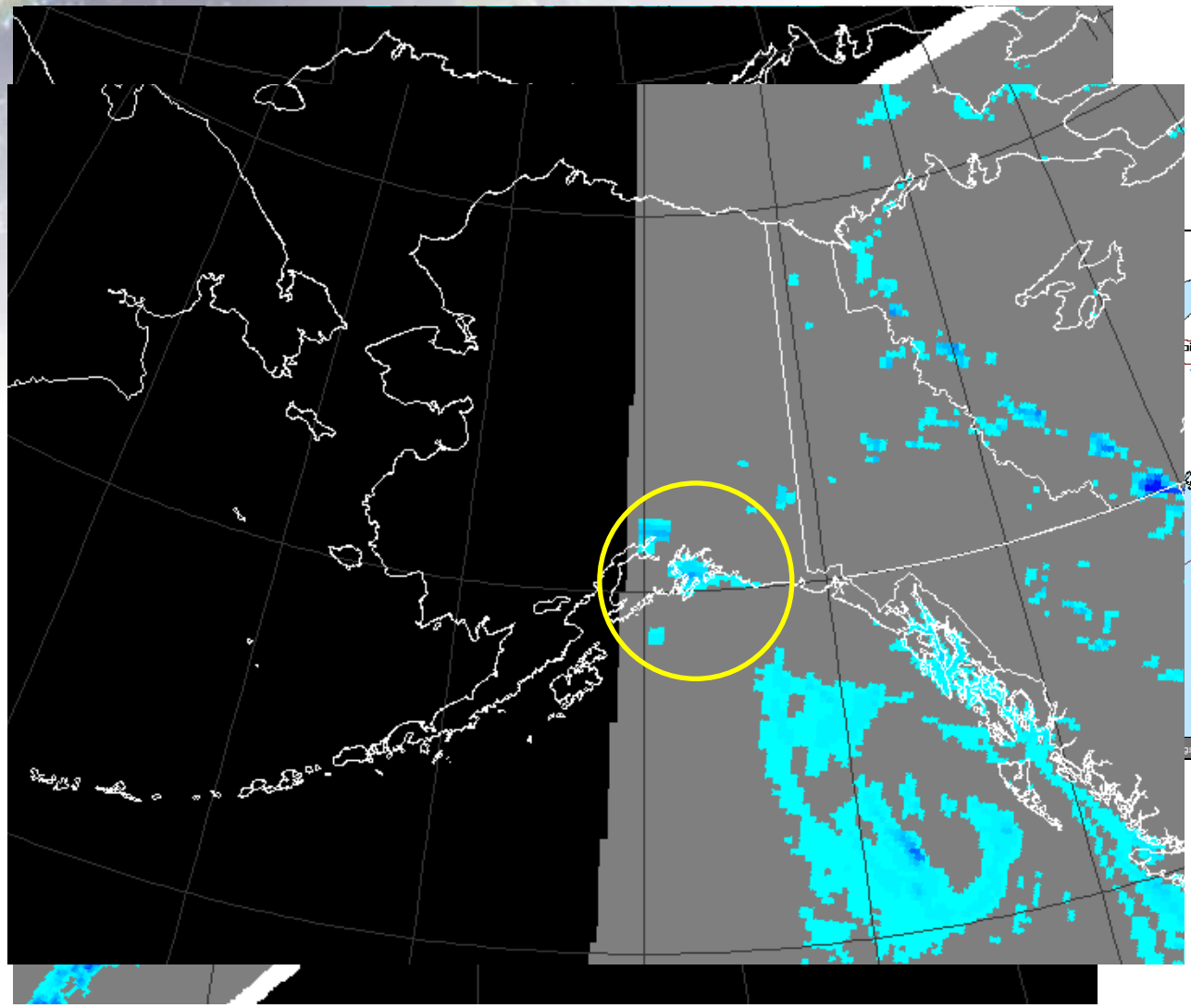
Limitations-GPM Swath Rain Rates

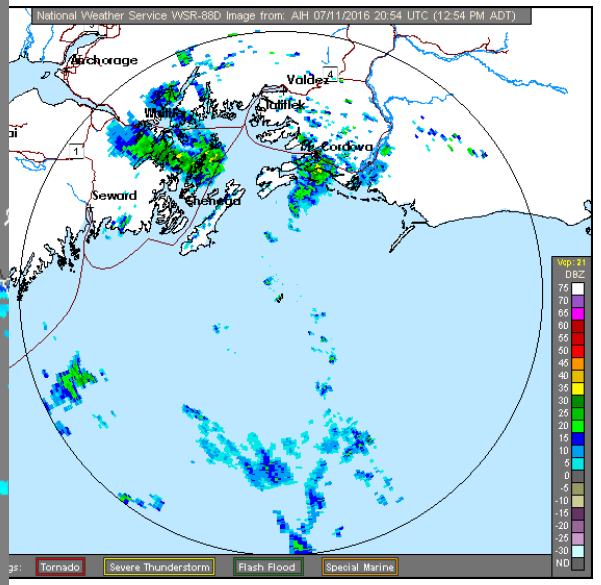
- Inconsistent spatial resolution and temporal frequency among instruments
- Decreased coverage and frequency equatorward
- Latency of 1+ hours
- PMW retrievals have continuity problems along coastlines

Limitations-IMERG Rain Rates

- Currently limited to 60N – 60S
- Latency of 4+ hours (Early Product) and 8+ hours (Late Product)

Quiz




National Weather Service WSR-88D Image from: AIH 07/11/2016 20:54 UTC (12:54 PM ADT)
Anchorage
Valdez
Cordova
Seward
Tornado
Severe Thunderstorm
Flash Flood
Special Marine

Conclusions

GPM Rain Rate Products…

- Are from a constellation of satellites;
- Can supplement existing data;
- Are utilized in data-void and offshore regions.

Additional resources:

NASA-SPoRT

COMET training

GPM Mission Page

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