The NASA Short-term Prediction Research and Transition Center and a Paradigm for Engaging Stakeholders

AOS Applications Seminar Series

17 November 2021

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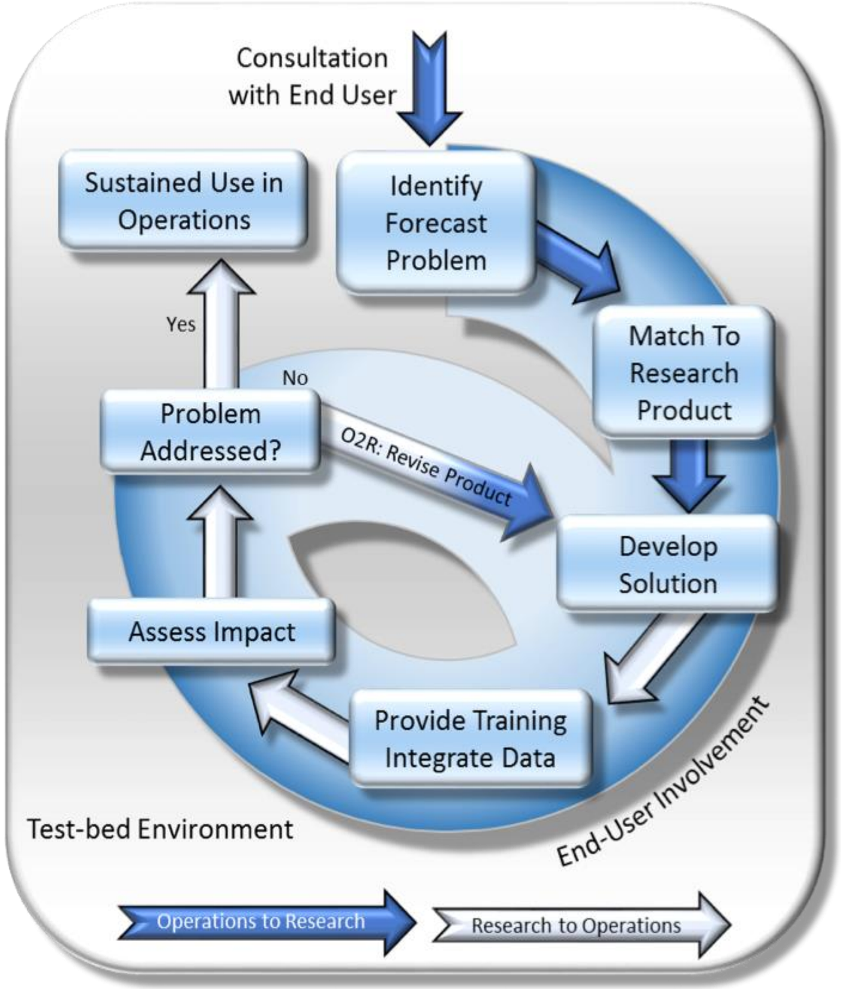
NASA SPoRT Overview

SPoRT was established in 2002 in the Weather Focus Area with a focus on transitioning unique NASA satellite observations and research capabilities to end users to improve short-term operational weather forecasting and decision support.

The SPoRT paradigm (right) has been used to successfully *'transition'* over 40 satellite datasets and research capabilities to operational users for nearly 20 years.

- SPoRT has built and maintained a strong relationship between NASA and NOAA/NWS. The project actively collaborates and provides support to over 30 NWS offices in all 6 NWS regions and multiple NWS National Centers (e.g., WPC, SPC, AWC, OPC, NHC).
- SPoRT's user-focused "research-to-operations" and "operations-to-research" paradigm and applications-based training concepts have been adopted by other groups nationally and internationally.
- SPoRT remains focused on applying and utilizing its "research-to-operations" paradigm to support the current suite of NASA satellites, Early Adopter Programs and upcoming future missions, with a focus on future missions related to the Earth System Observatory.



An iterative process between scientists, algorithm/product developers, and end users is key to transition of research to the community of end users.

[SPoRT Decade Review: 2010-2019]

NASA SPoRT Team Structure

SPoRT
Short-term Prediction Research and Transition Center

Over the past several years, SPoRT has been broadening its reach and has begun to apply its known "research-to-operations" paradigm to a number of new partners that can benefit from the integration of unique NASA satellite observations and research capabilities.

Current SPoRT "research-to-operations" Thematic Areas:

Research Areas:

- Tropical Meteorology
- Atmospheric Remote Sensing
- Lightning/ Convection
- Air Quality / Human Health
- Land Surface Remote Sensing
- Machine Learning

Transition Activities:

- End-User Training
- Product Assessments
- Data Production

Current Partners

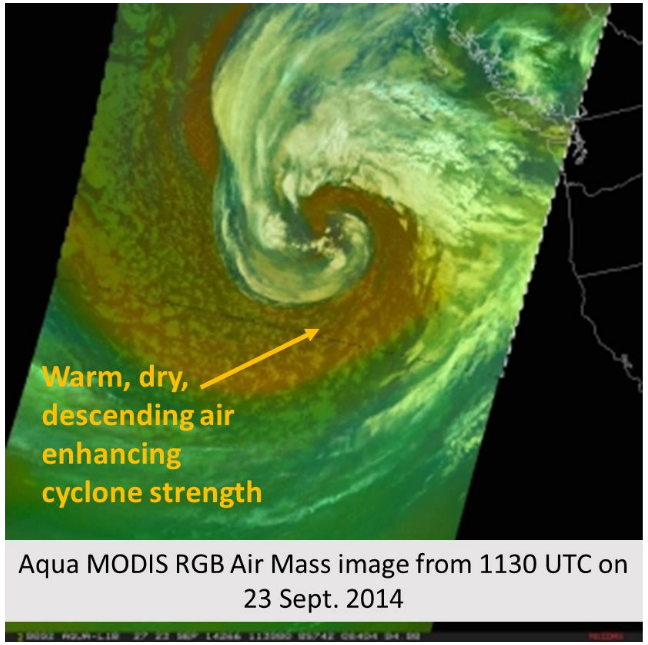
NOAA
National Weather Service
USDA
SERVIR
Forest Service
USGS science for a changing world
NDMC National Drought Mitigation Center University of Nebraska
Smithsonian
FEMA
National Guard
United States Environmental Protection Agency
CAL FIRE
U.S. Department of the Interior Bureau of Reclamation
AICC

Remote Sensing – Multispectral Imagery

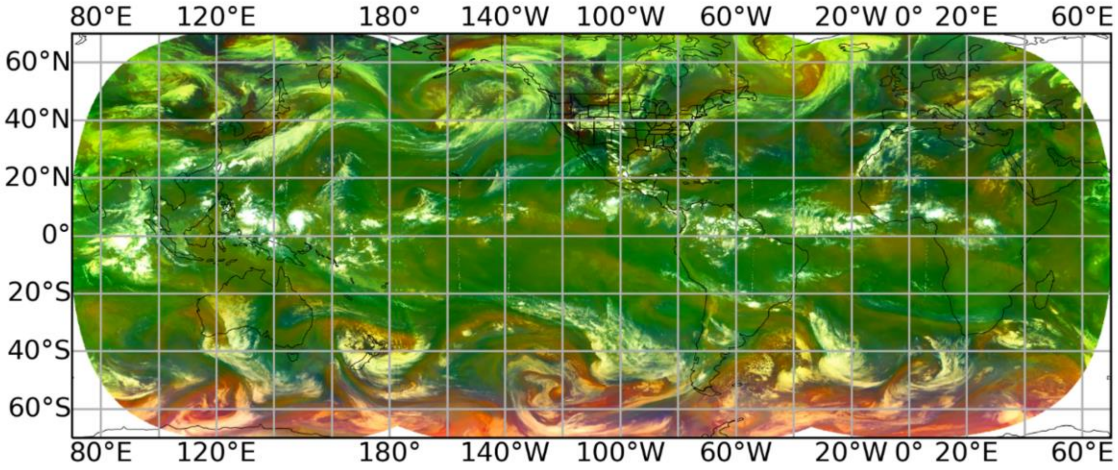
Project Objective: Development and refinement of multispectral composite (e.g., RGB) imagery to support weather forecasting applications and applied research. Early focus on use of NASA data to prepare forecasters for GOES-R and development of innovative display capabilities.

Cross-Benefit of Science/Applications:

- Operations to research feedback led to development of additional RGBs, refinement of recipes, and intercalibration/limb-correction methods
- Interaction with World Meteorological Organization experts and NOAA NWS to guide RGB standards
- Development of applications training including SPoRT applications library, modules, and contributions to official GOES-R NWS training
- Data from GOES-R receiving station at MSFC provide low latency RGBs to NASA's Worldview and NOAA NWS National Centers



Aqua MODIS RGB Air Mass image from 1130 UTC on 23 Sept. 2014



Example of limb corrected and intercalibrated Air Mass RGB, globally composited AMI, AHI, GOES-17, GOES-16, and SEVIRI

SPoRT Lead / PI: Emily Berndt

Funded by NASA Research Announcement NNH19ZDA001N-ESROGSS ROSES-2019

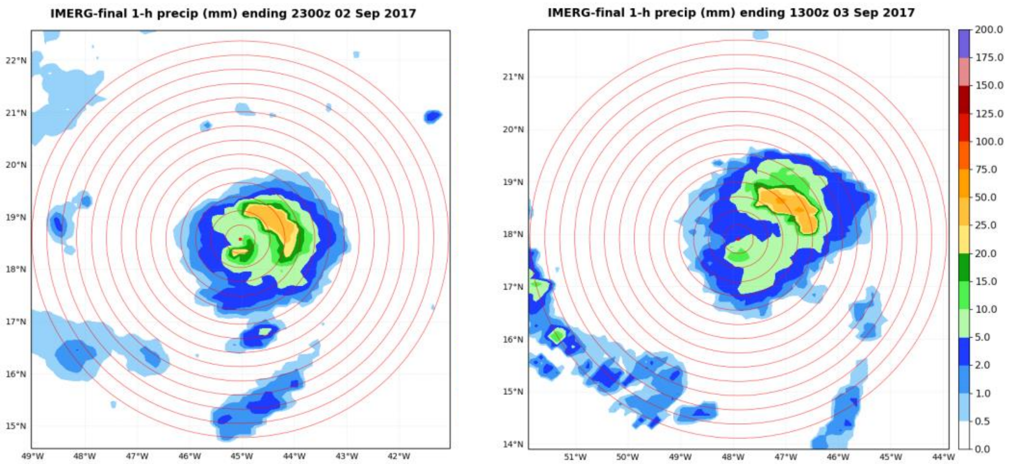
Tropical Meteorology – Tropical Cyclone Diurnal Cycle

SPoRT Short-term Prediction Research and Transition Center

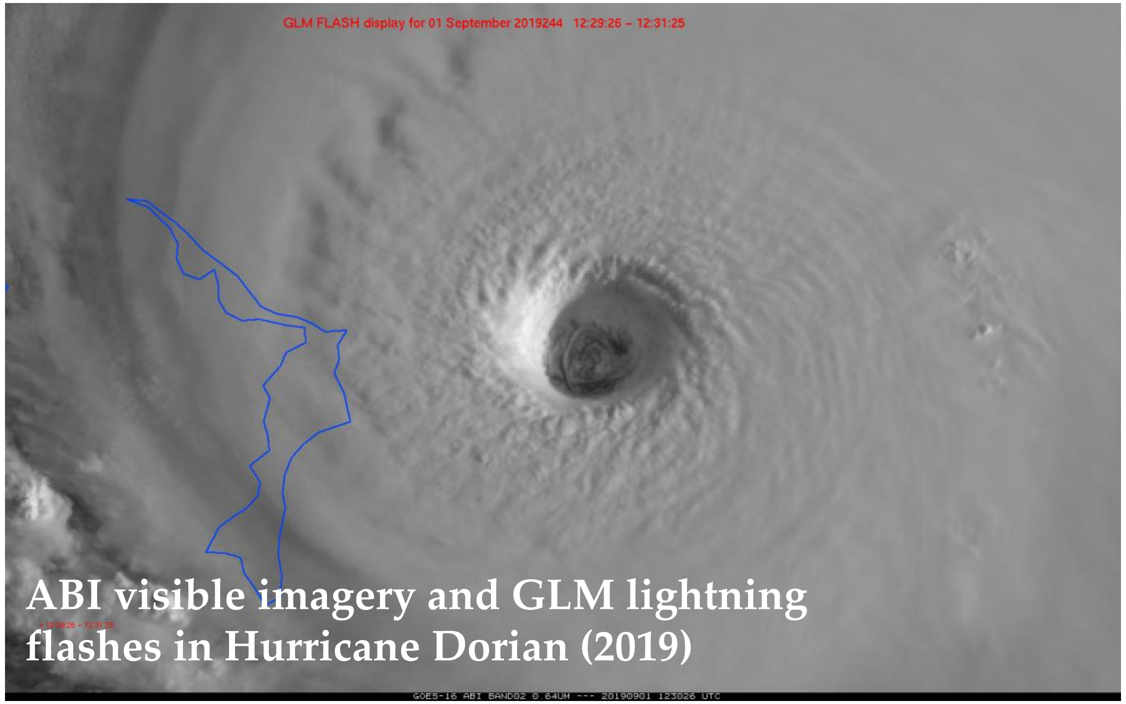
<u>Project Objective(s)</u>: Recent studies have documented a distinct expansion/contraction of tropical cyclones (TCs) throughout the day, called the TC diurnal pulse. SPoRT seeks to advance our understanding of these diurnal pulses using remotely sensed observations of thermodynamic soundings, rainfall, wind speed, and lightning, alongside idealized numerical modeling.

<u>Cross-Benefit of Science/Applications</u>:

- Leverage observations from the GPM mission and future TROPICS and AOS missions to characterize the diurnal pulse of TC convection and rainfall.
- GPM IMERG rainfall and CYGNSS winds help to diagnose changes in storm structure
- Characterize the variability in lightning flash characteristics across the TC diurnal pulse using GLM.
- Create real-time diagnostics of TC rainfall and lightning using GPM and GLM.
- Synergy with Applied Sciences TROPICS DPA and Early Adopter roles
- Interaction with existing partnerships with NOAA NWS, NOAA's Hurricane Research Division (HRD), NCAR, and University researchers



GPM IMERG reveals an expanding rain field associated with the TC diurnal cycle.



ABI visible imagery and GLM lightning flashes in Hurricane Dorian (2019)

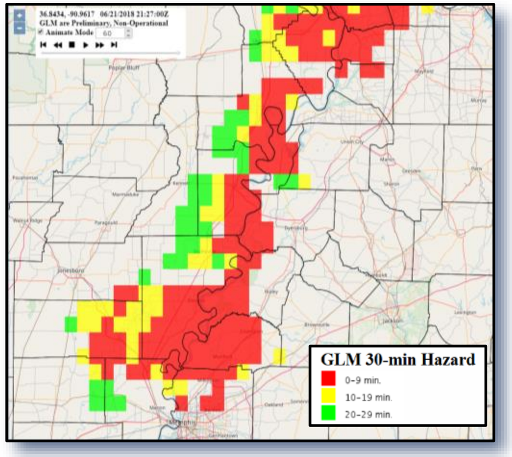
SPoRT Lead / PI: Patrick Duran

Project Objective: Improve and refine lightning safety metrics to take advantage of new technologies

Cross-Benefit of Science/Applications:

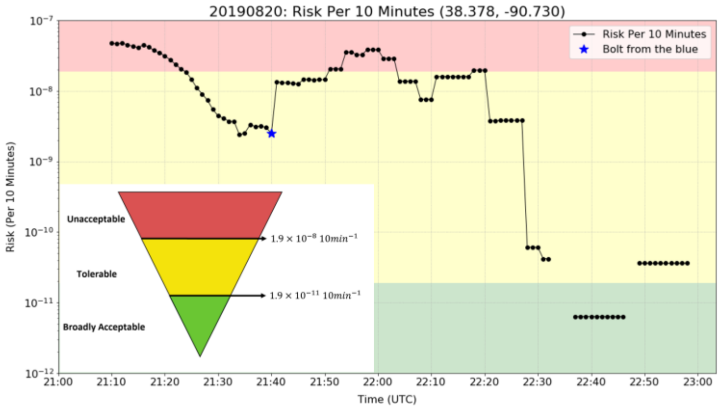
- Improvement of lightning safety methodologies leads to time and cost savings, and reduced down-time and false alarms
- Methods are applicable to all NASA Centers, the public, and eventually the globe.
- Continue the development of machine learning methods to predict lightning initiation, propagation and cessation, and expand globally in next decade.
- Utilize microwave (e.g., GPM, TROPICS, future AOS) information to characterize storm structure at lightning initiation and cessation for areas with poor radar coverage.

SPoRT Stoplight Product



Observed Lightning in the last 30 minutes from GLM near Memphis, TN on 21 June 2018

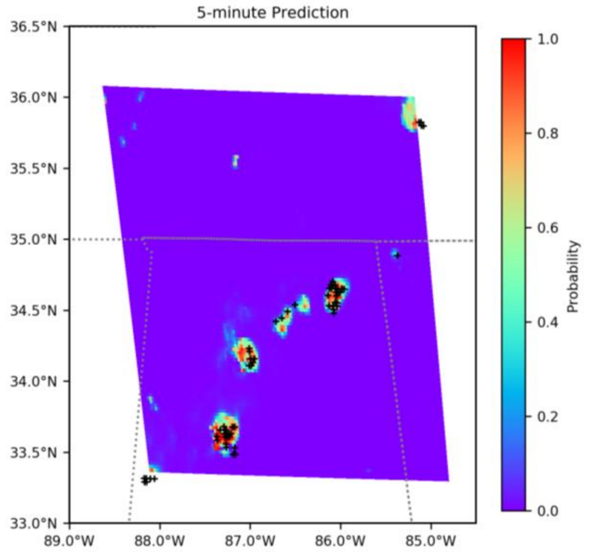
SPoRT Lightning Risk



Time trend of lightning risk at a bolt from the blue incident

ML for short term prediction of lightning

5 Minute prediction of lightning activity (Contours) and verification of lightning occurrence (black + signs)



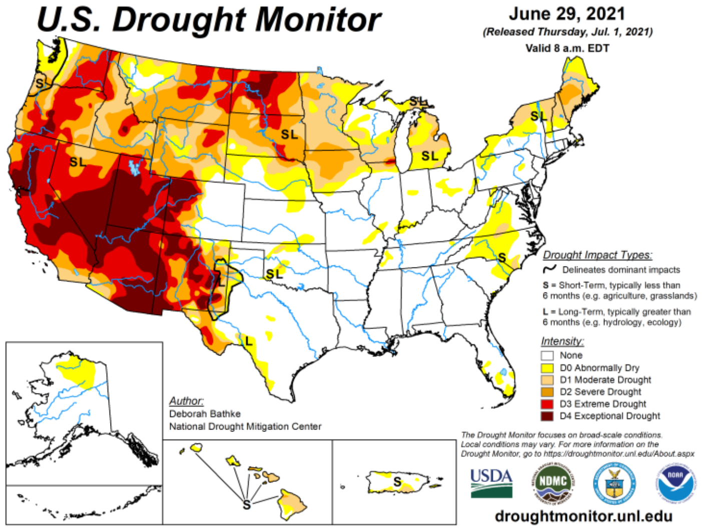
SPoRT Lead / PI: Chris Schultz

Land Surface Remote Sensing - Land Information System

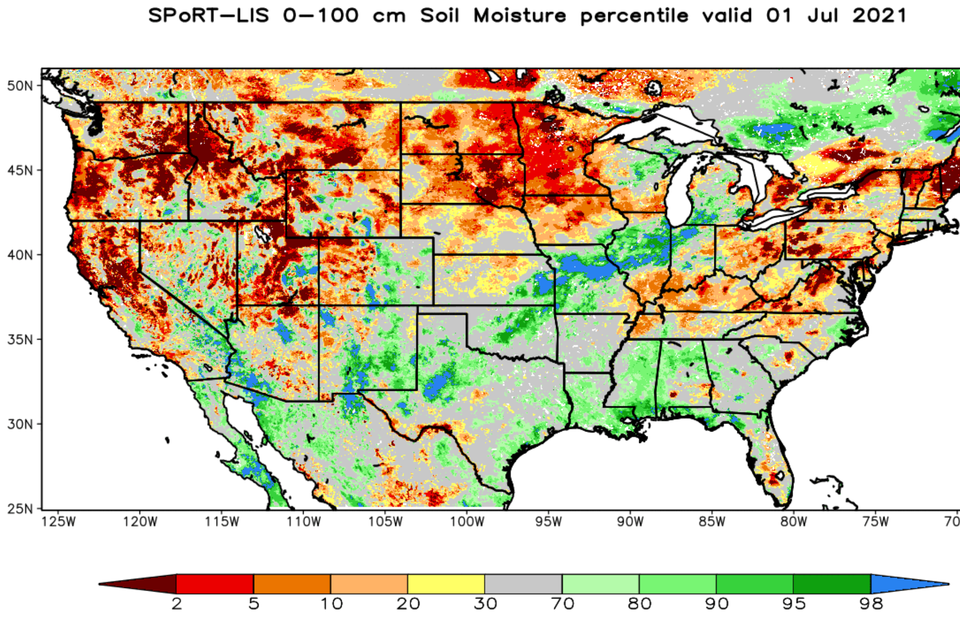
<u>Project Objective</u>: Development of high spatial resolution land-surface fields for improved situational awareness

<u>Cross-Benefit of Science/Applications</u>:

- Multiple end-users in NOAA/NWS (available in 30+ NWS WFO offices), drought monitoring community, wildfire community, private-sector organizations
- Proven vehicle for applications and research activities in flooding, drought, and wildfire research
- Development of applications training for use in flash flood guidance and drought monitoring for improved situational awareness
- Continued transition activities with new stakeholder organizations
- Continued engagement with NASA-GSFC LIS Team

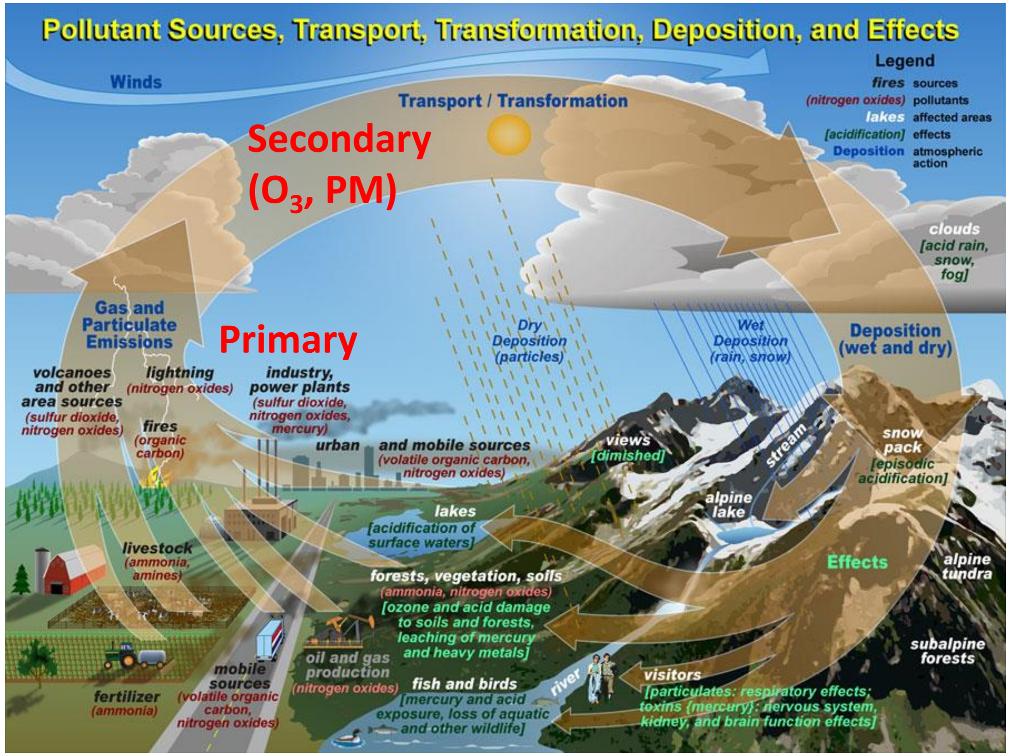


June 2021 US Drought Monitor (top) and 0-100 cm soil moisture percentile from SPoRT-LIS for 1 July 2021.

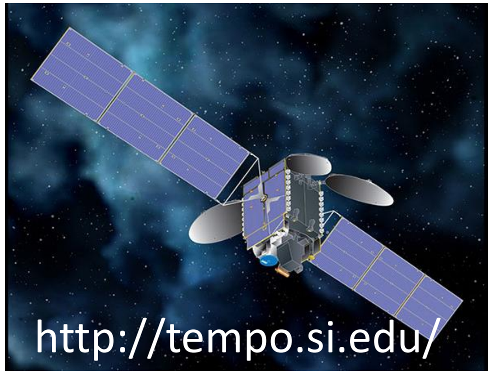


SPoRT Lead / PI: Chris Hain

Health and Air Quality – TEMPO Mission & Science Objectives



https://www.fws.gov/refuges/AirQuality/sources.html



Expected launch date:
December 2022
on geostationary satellite with Field of Regard over Greater North America

TEMPO Early Adopters / Applications Program site
https://weather.msfc.nasa.gov/tempo/

<u>TEMPO Science Objectives</u>:

- Assess the temporal and spatial variations of emissions of gases and aerosols
- Determine the processes that transform tropospheric composition and air quality (AQ) over range of spatial and temporal scales (e.g., urban, diurnal)
- Understand how air pollution drives climate forcing and how climate change affects AQ
- Characterize how observations from space can improve AQ forecasts and assessments
- Understand the impact of episodic or disaster events (e.g., wildfires) on AQ
- Characterize the role of intercontinental transport on AQ

TEMPO science objectives have large overlap with AQ and aerosol related objectives of AOS

Health and Air Quality – TEMPO Data Products

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Level	Product	Major Outputs	Res km^2 **	Freq/Size
L0	Digital counts	Reconstructed / reformatted digital counts	2.0 x 4.75	Daily/hourly
L1-b	irradiance	Calibrated & quality flags		daily
	radiance	Geolocated, calibrated, viewing, geolocation & quality flags	2.0 x 4.75	Hourly, granule
L2	Cloud ★	Cloud fraction, cloud pressure	2.0 x 4.75	Hourly, granule
	O_3 profile	O3 profile, total/strat/trop/0-2 km O3 column, errors, a priori, averaging kernels	8.0 x 4.75	Hourly, granule
	Total O_3	Total O3, Aerosol Index, cloud fraction	2.0 x 4.75	Hourly, granule
	NO_2 ★	SCD, strat./trop. VCD, error, shape factor, scattering weights	2.0 x 4.75	Hourly, granule
	H_2CO ★	SCD, VCD, error, shape factor, scattering weights	2.0 x 4.75	Hourly, granule
	$C_2H_2O_2$		2.0 x 4.75	Hourly, granule
	H_2O		2.0 x 4.75	Hourly, granule
	BrO		2.0 x 4.75	Hourly, granule
	SO_2 ★	SCD, VCD (PBL,TRL,TRM,TRU,STL)	2.0 x 4.75	Hourly, granule
	Aerosol ★	AAI, UVAOD, UVSSA, AOCH, VISAOD	8.0 x 4.75	Hourly, granule
	TEMPO/GOES-R Synergistic	Radiance, aerosol, cloud & mask, fire/hotspot, lightning, snow/ice, etc.	2.0 x 4.75	Hourly, granule
L3	Gridded L2	Same as L2	2 x 2 (TBD)	Hourly, scan
L4	UVB	UV irradiance, erythemal irradiance, UVI	TBD	Hourly, scan

Black text: Baseline products; **Orange text**: Additional / proposed products

★ **Near real-time products (latency < 3 hours)**

** Center of Field of Regard

SCD: Slant Column Density

VCD: Vertical Column Density

AAI: Aerosol Absorption Index

UVAOD/VISAOD: UV/VIS Aerosol Optical Depth

UVSSA: UV Single Scatter Albedo

AOCH: Aerosol Optical Centroid Height

Health and Air Quality – TEMPO Early Adopter Program Overview

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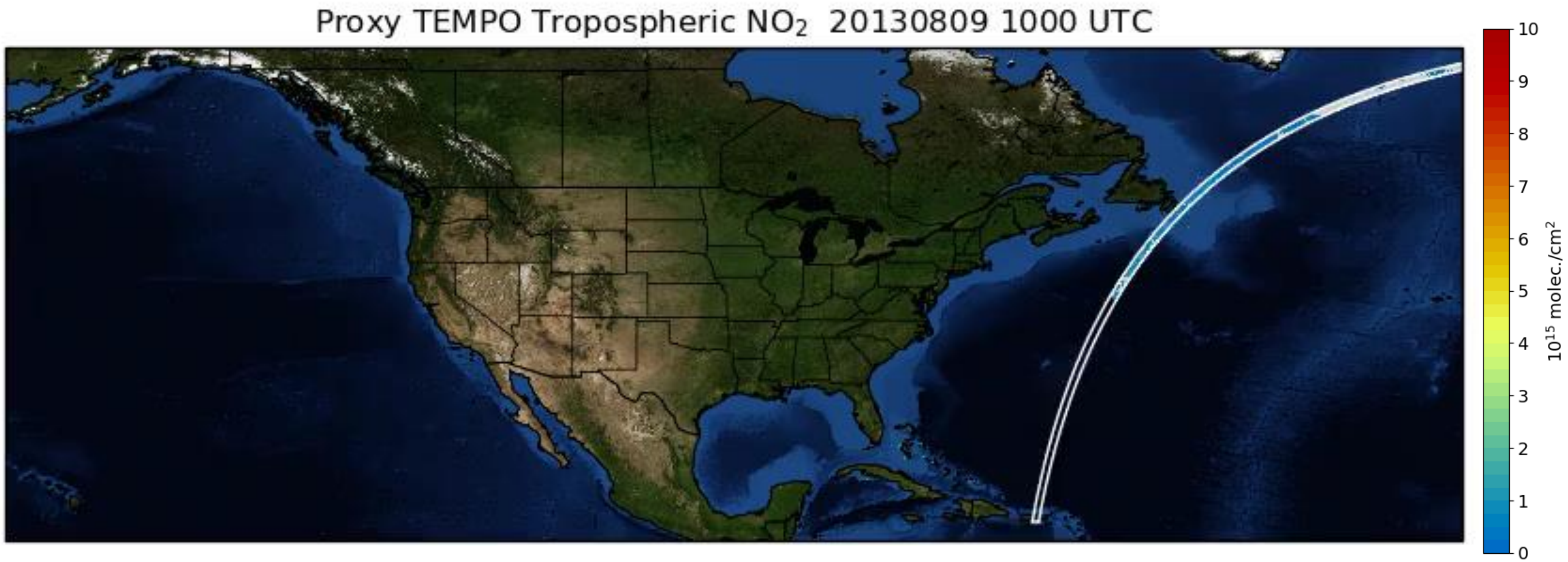

Early Adopter Program Objectives:

- Engage a broad spectrum of stakeholders / end users to expand the use of TEMPO data and characterize user needs
- Use current sensors and proxy data to demonstrate TEMPO capabilities and enhance air quality & health applications
- Align the TEMPO observing time, products, and data interfaces to user needs and applications

Goal:

- Prepare users for operational TEMPO data and maximize and accelerate the value of TEMPO data for societal benefit

Health and Air Quality – TEMPO Applications

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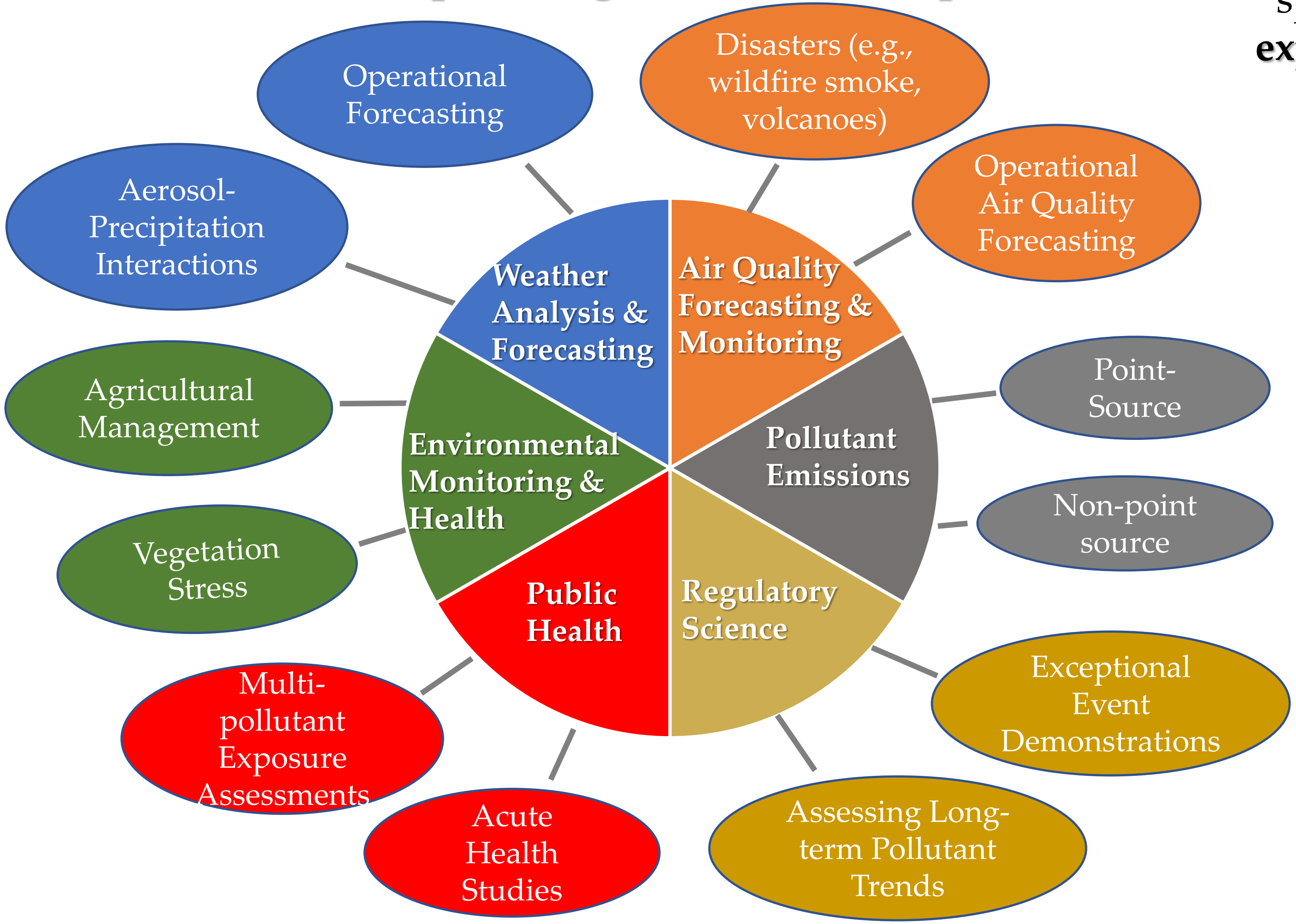
Application focus areas of TEMPO Early Adopter Program & Green Paper



TEMPO Green Paper – Living document specifying fundamental and **applied science experiments** in preparation for TEMPO launch

https://weather.msfc.nasa.gov/tempo/

- Input from stakeholders / end users on impactful applications are key to building a comprehensive Green Paper of designated experiments
- Identifying and implementing applications from a diversity of end users will enhance societal benefits of TEMPO data after launch

***TEMPO applications closely align with Health, Air Quality, & Disaster applications of AOS**

***Synergistic products from TEMPO & AOS can enhance application benefits**

Health and Air Quality – TEMPO Early Adopter Program Activities

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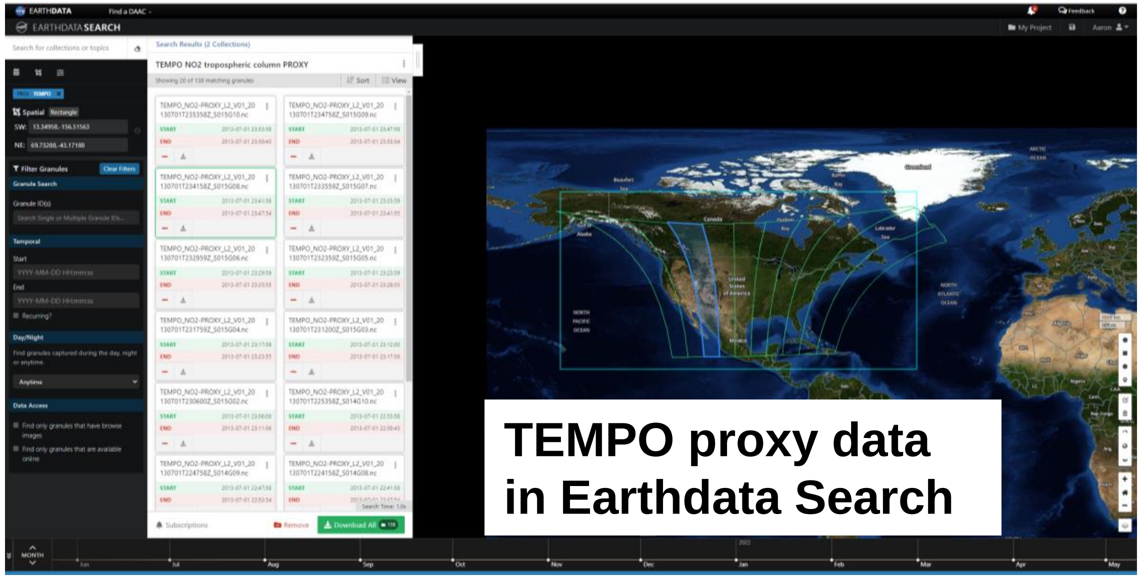
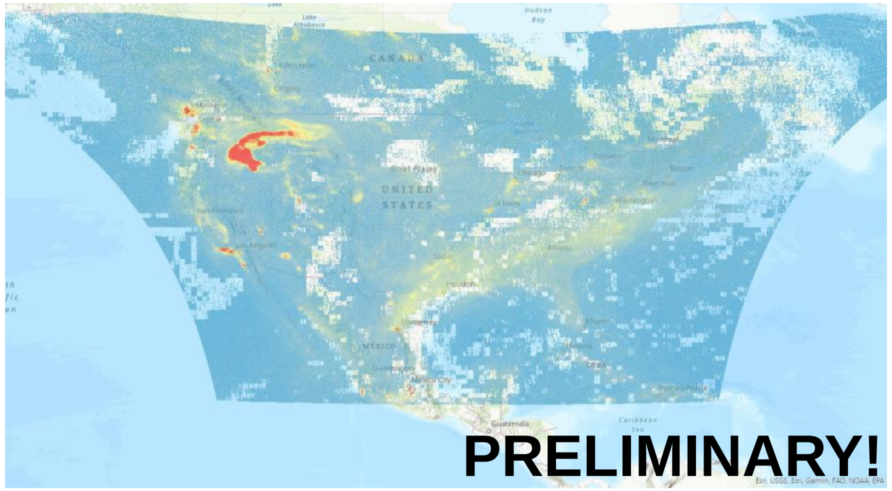
- **TEMPO Early Adopter Program and NASA SPoRT** have been engaged with U.S., state, & local AQ agencies, NGOs, health organizations, academia, and private companies
  - Development and distribution of TEMPO proxy products to enable pre-launch understanding and application of TEMPO data
  - Hosted multiple hands-on tutorials to facilitate use of TEMPO proxy products and prepare user community for immediate application of operational TEMPO data
  - Hosted a series of workshops to engage users on the TEMPO mission and gather feedback on TEMPO data and applications
  - Led focused sessions and group discussions to understand and promote synergistic applications with other satellite instruments (e.g., ABI, MAIA, GLIMR)
  - Working with users to develop Green Paper experiments ideas and enable successful execution of experiments



TEMPO proxy L3 tropospheric NO_2



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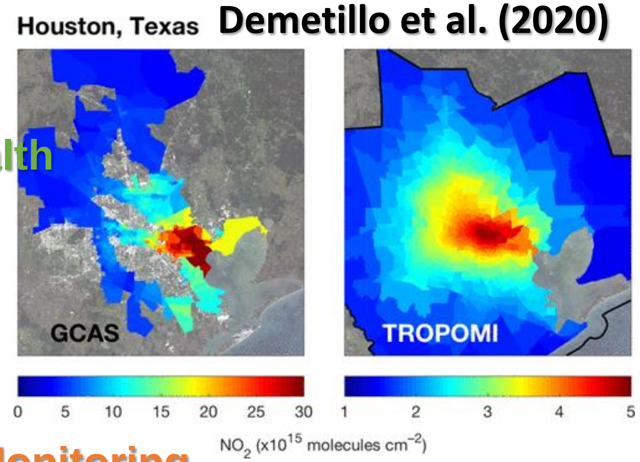
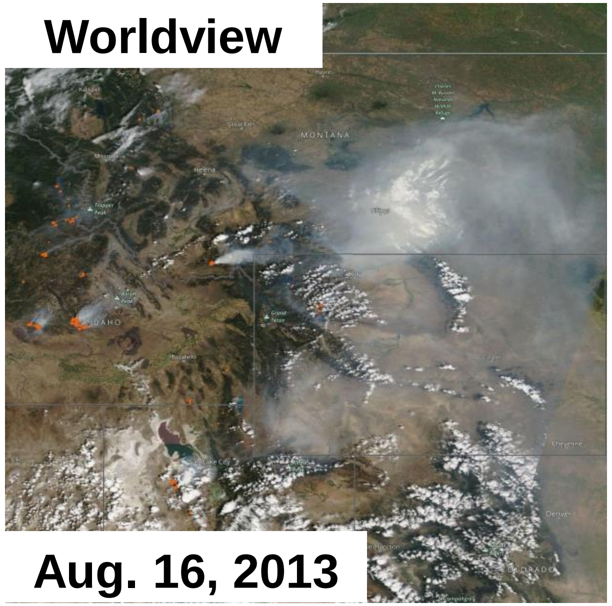
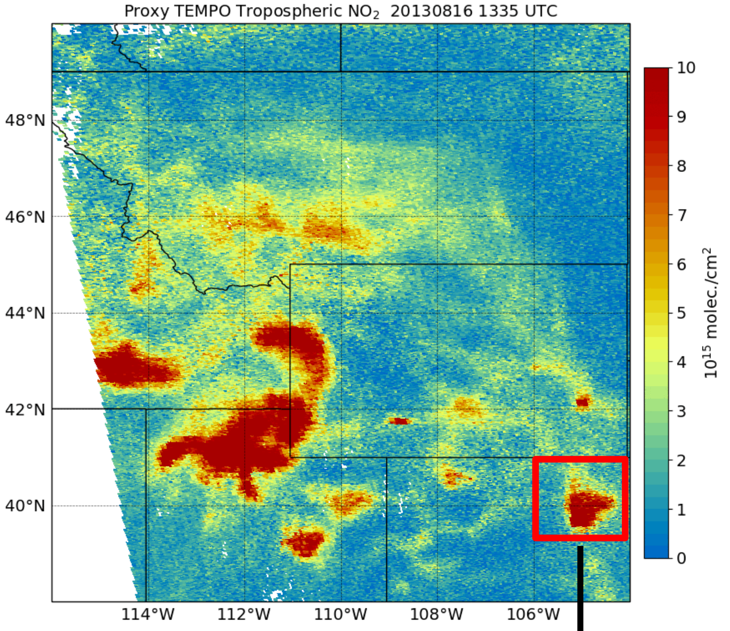
Example Green Paper Experiments:

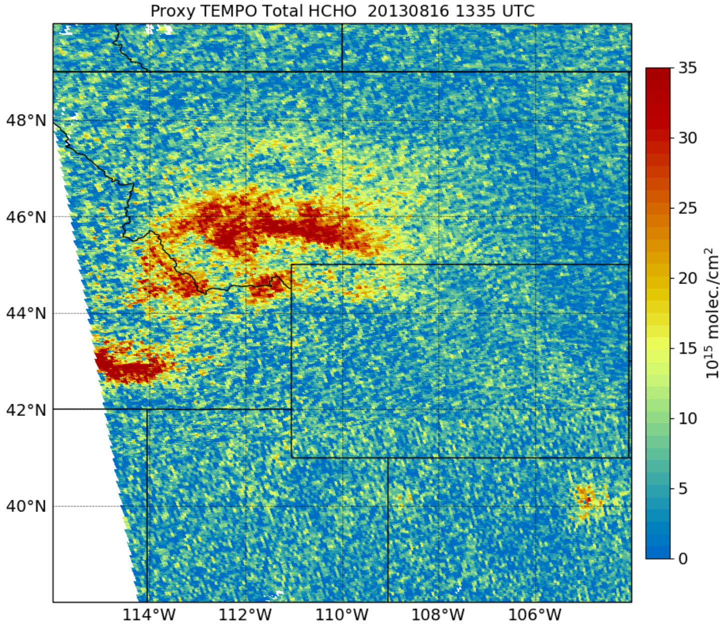
- **Observing NO_2 pollution inequality in North American cities** Environmental Monitoring & Health
    - TEMPO observations will provide new insight into the identity and timing of the emission sources and atmospheric drivers of air pollution inequality at intra-urban scales. TEMPO data will improve our ability to not only describe inequalities, but also to eliminate them through policy making.
- **Examining impacts of warehouse density on Inland Empire Air Quality** AQ Monitoring
    - The logistics industry has greatly expanded in this region to accommodate increases in online shopping. This increase is associated with further declines in air quality throughout the region. TEMPO data will be used to examine columns of NO_2 and HCHO in the vicinity of extensive warehouse developments.
- **Tracking short-term public health outcomes using high-resolution TEMPO data** Public Health
    - Near real-time daytime hourly estimates of gaseous air pollutants from TEMPO will be included as acute exposures in epidemiological case-crossover analyses of children's asthma exacerbations in the greater New York metropolitan area.
- **High Resolution Scanning over the NYC Area** Regulatory Science
    - The area around NYC emits noticeably larger amounts of NO2 on days that monitor elevated ground level ozone. It is vital that the source, strength, and timing of the ozone precursors be determined. TEMPO will enhance source contribution assessments by scanning more frequently (e.g., every 10 min) and producing spatial resolution images greater than the nominal 2.0 km x 4.75 km pixel size.

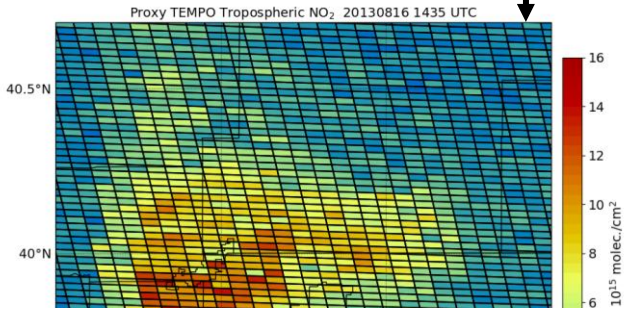
Demetillo et al. (2020)

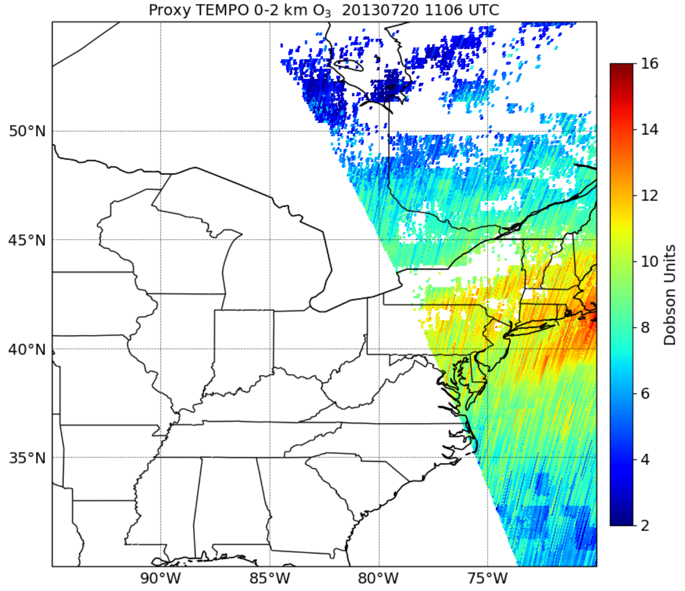








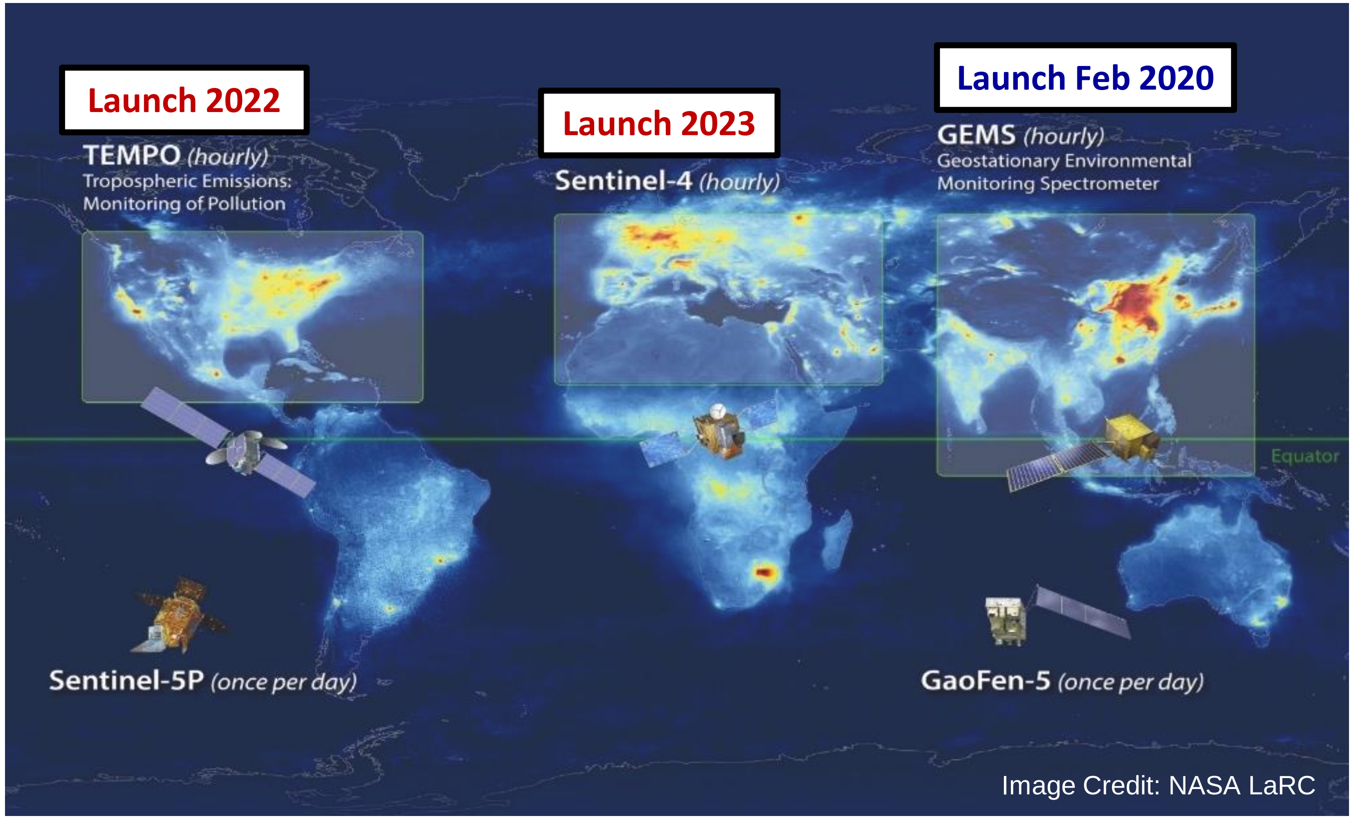


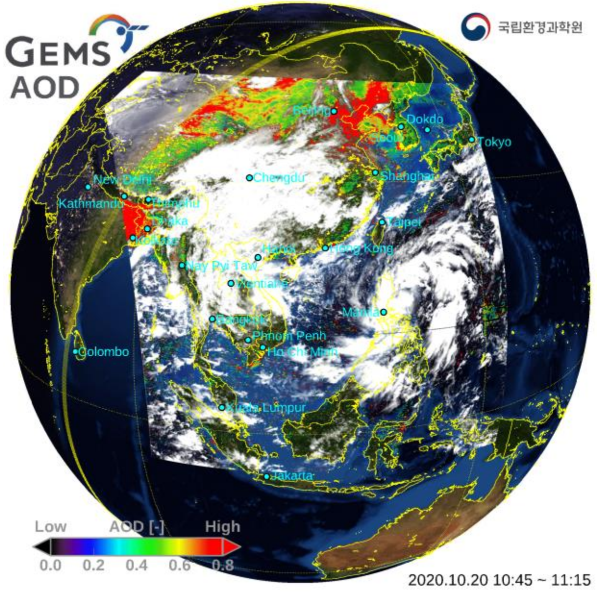


- TEMPO will monitor the diurnal variability of pollutant mixtures and concentrations and characterize fine horizontal gradients in pollutants
- Ozone pollution will be tracked in the tropospheric and 0-2 km layer throughout the daytime
  - Information on ozone pollution within the PBL where people live!

***Surface-gridded PM2.5 from AOS and 0-2 km O_3 from TEMPO can enable unprecedented AQ and Health studies**

Health and Air Quality – Geostationary Air Quality Constellation



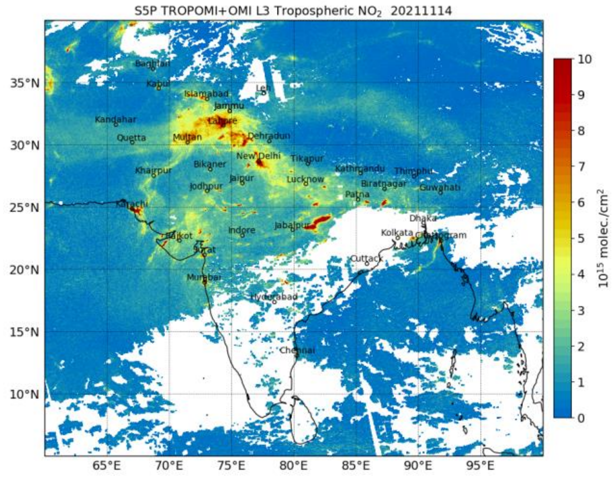


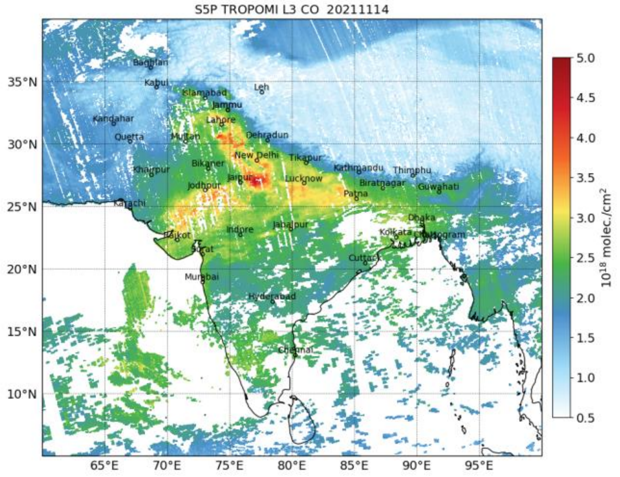
Credit: Ministry of Science and Technology Information and Communication·Ministry of Environment·Ministry of Oceans and Fisheries

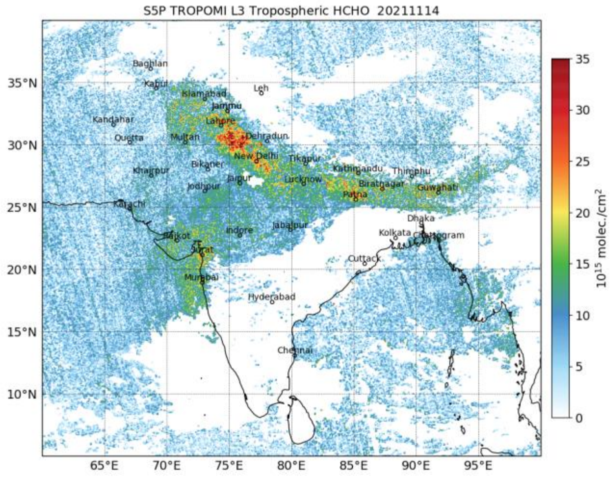
- GEMS mission is first to provide hourly daytime observations of trace gases and aerosols from space
- TEMPO and Sentinel-4 will follow to form revolutionary geostationary constellation of AQ observations
- NOAA's GEO-XO (2030s) will include a TEMPO-like spectrometer in geostationary orbit
- Extension of TEMPO-like capabilities into the AOS mission lifetime

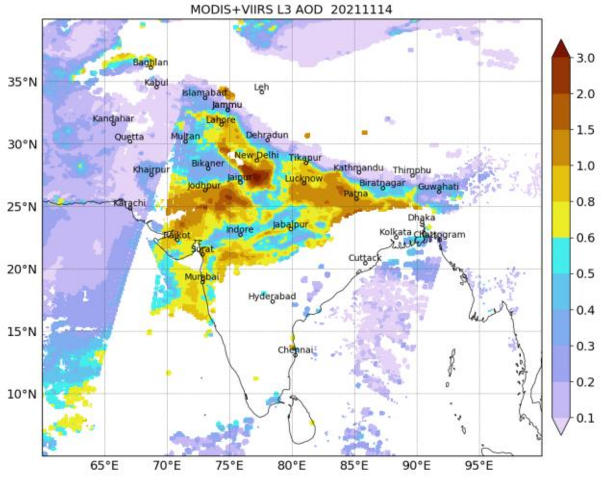
Health and Air Quality – Thematic Area Overview

- **NASA SPoRT Health & AQ Thematic Area – Current & Future Activities**
  - Development of multi-sensor satellite products for air quality monitoring, with special attention on upcoming GEMS data!
  - Assimilation of satellite trace gas and aerosol products into regional, tailored air quality models for providing accurate and timely pollution forecasts
  - Designing lagrangian trajectory models to enable rapid response to hazardous air quality events and disasters
  - Assessing the impacts of soil NO_x emissions on air pollution using advanced satellite products (TEMPO!) in conjunction with ground-based and model data
  - Develop customized training modules, user guides, product documentation, and tools for users of satellite air quality products
  - Organize additional workshops, tutorials, and focused working group meetings to prepare for TEMPO launch
  - Develop plan for executing TEMPO Green Paper experiments, including prioritizing experiments, scheduling logistics, and working with users









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The Research to Operations/Applications Chasm:

- How do you get promising, cutting-edge research to decision makers?
- How do you know what's promising?
- How can researchers learn what is needed in ops?
- What products, in what formats, at what latency, etc.?
- Who transitions and maintains the product?
- Who provides resources for all this?

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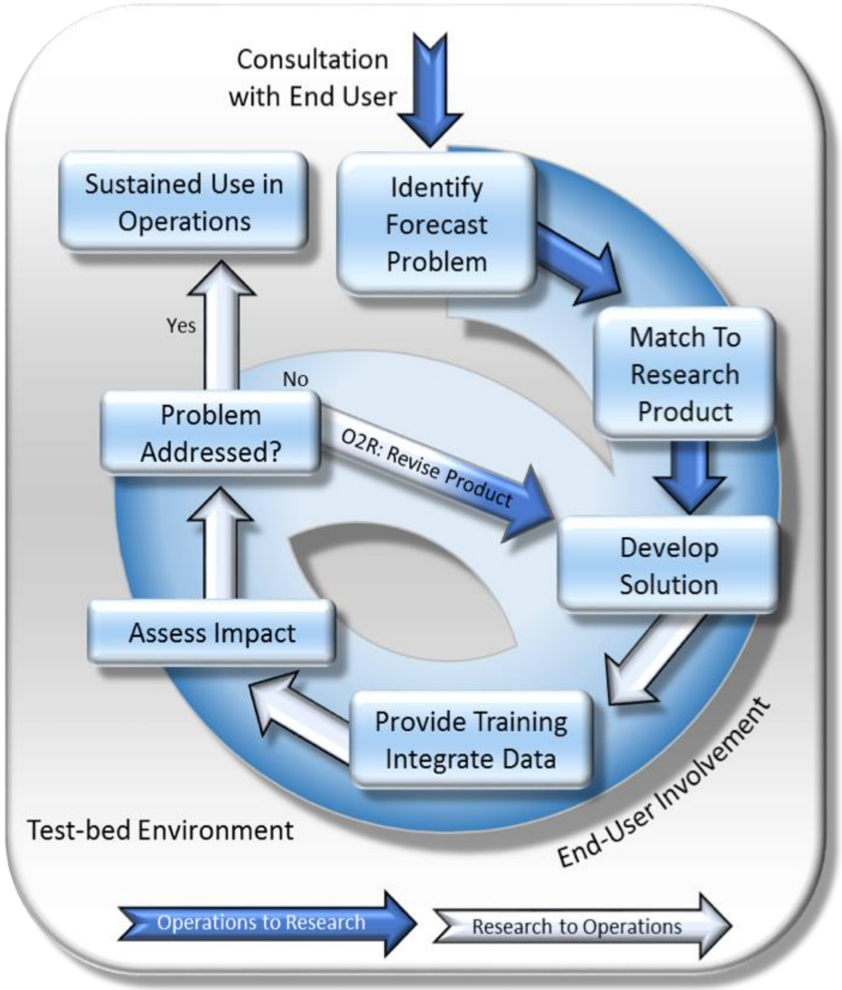


Successful R2O/O2R requires intentionality.

Understanding the Forecast Challenge

Precip estimates in data sparse regions (forecasting/nowcasting)

High impact precip: convective flash flooding, areal flooding, atmospheric rivers

Data sparse regions with high impact precip as a forecast challenge: Alaska, Intermountain West, Coasts, Islands

GPM aims to "advance our understanding of Earth's water and energy cycle, improve forecasting of extreme events that cause natural hazards and disasters, and extend current capabilities in using accurate and timely information of precipitation to directly benefit society."

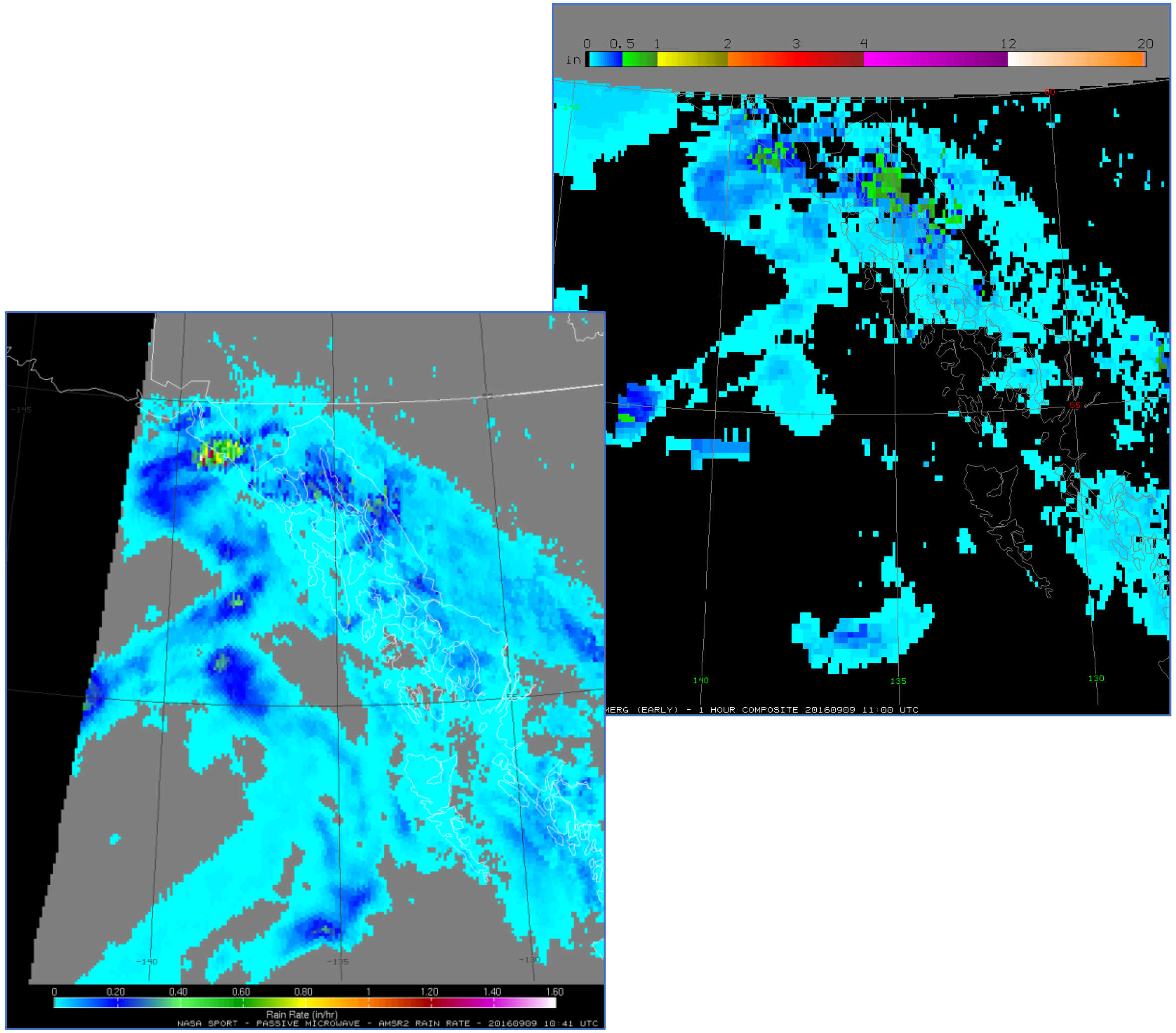
Remote Sensing – Passive Microwave R2O/O2R

Short-term Prediction Research and Transition Center

GPM Mission Science to Applications : Making GPM datasets accessible to end users, focusing on relevancy, latency, coverage. format, and ease of interpretation

The Details:

- **Relevancy:** Address forecast challenge for a specific set of end users
- **Latency:** GPM provides several precip-related datasets, but which ones are valuable for Weather Forecast Offices? For River Forecast Centers? (e.g., < 1 hr for WFOs, < 12 hrs for RFCs)
- **Coverage:** As much as possible, north of 60N (e.g., DPR is interesting and valuable, but too narrow for regular "operational" use)
- **Format:** Can we quickly acquire these datasets and turn them into something viewable at NWS offices, like AWIPS or a hydro model?
- **Interpretation:** e.g., L2 GPROF precip and L3 IMERG were chosen because they represent a kind of straight-forward "truth", resolution is appropriate (as opposed to, say, CMB the combined algorithm datatype)

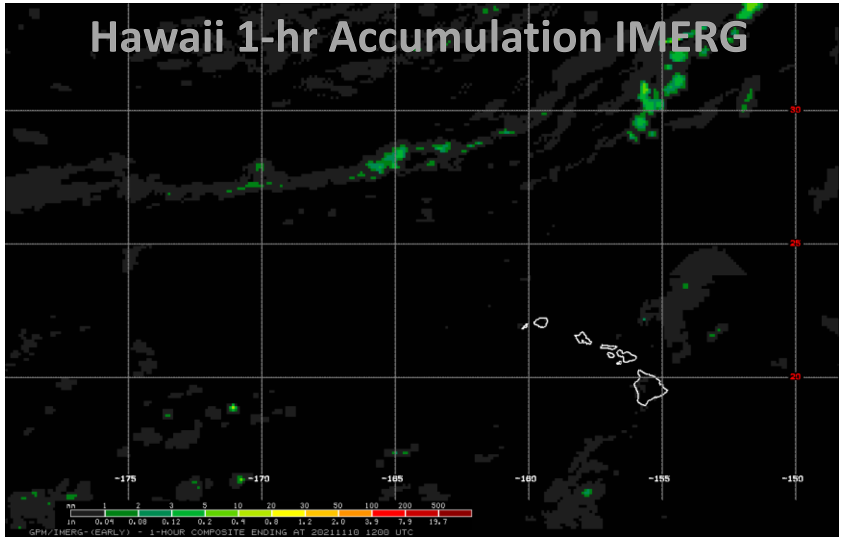


Atmospheric river nowcasting and forecasting: using L2 rain rate and 1-hr accumulation of IMERG.

Remote Sensing – Passive Microwave R2O/O2R

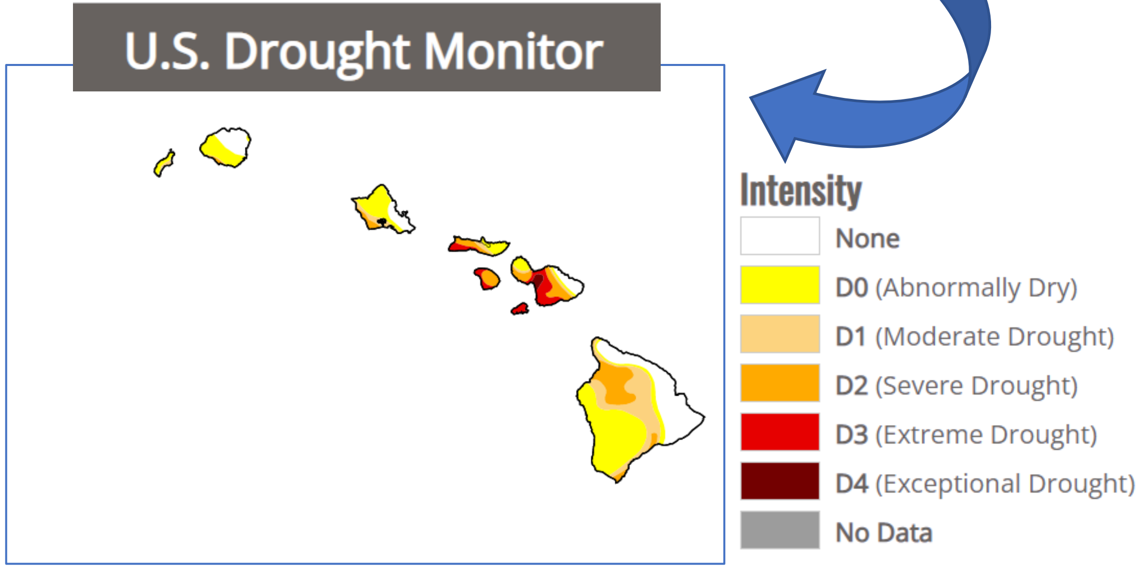
Other Considerations:

- **Validation:** GPM has loads of validation studies from different regimes/regions…and forecasters are interested!
- **Case analysis:** Validation studies show large statistical studies, but forecasters are looking at specific cases
- **The need for "value-adds":** accumulations (we created 1-hr to 7-day), targeted displays (USDM specific displays of IMERG accumulations)
- **"Off-Label Usage":** be open to non-traditional uses e.g., anticipating antecedent conditions for landslides; drought monitoring in data-sparse regions



IMERG as a decision aid

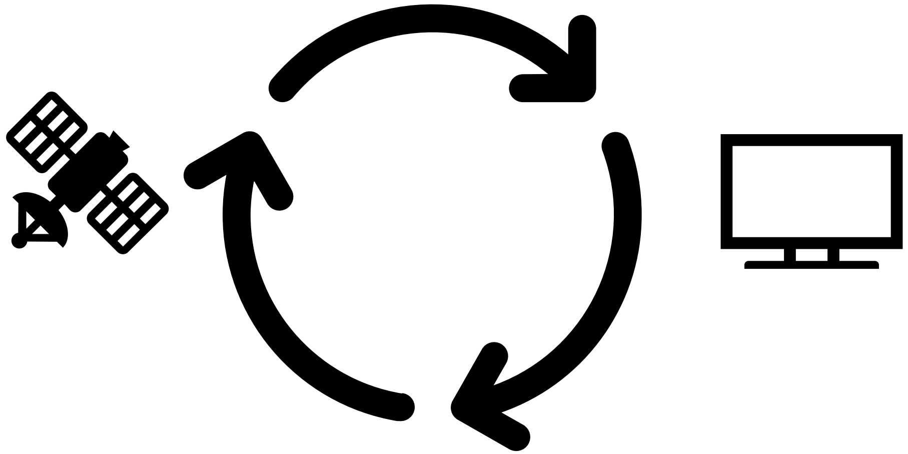
Hawaii US Drought Monitor Report 9 Nov 2021



Remote Sensing – Passive Microwave R2O/O2R

Benefits to GPM Science (Operation to Research Feedback):

- **Validation:** AK is different; GPM now does ground validation with support from forecasters.
- Forecasters provided **case examples** from regimes/events of interest to the GPM cal/val scientists on several occasions
- **Prioritization:** The need for gridded precip in AK and the value of IMERG helped G. Huffman prioritize some algorithm changes to earlier than anticipated to increase benefit of this data to end users (e.g., high-latitude data was prioritized 1.5 versions before the notional algorithm plan called for it)



LeRoy A. et al. (2020) Operational Applications of Global Precipitation Measurement Observations. In: Levizzani V., Kidd C., Kirschbaum D., Kummerow C., Nakamura K., Turk F. (eds) Satellite Precipitation Measurement. Advances in Global Change Research, vol 69. Springer, Cham. https://doi.org/10.1007/978-3-030-35798-6_23

NATIONAL WEATHER SERVICE

Building a Weather-Ready Nation

Usage Of NASA RainRate Products In NWS Alaska Operations & NASA SPoRT Interaction

NASA Atmosphere Observing System Applications Seminar

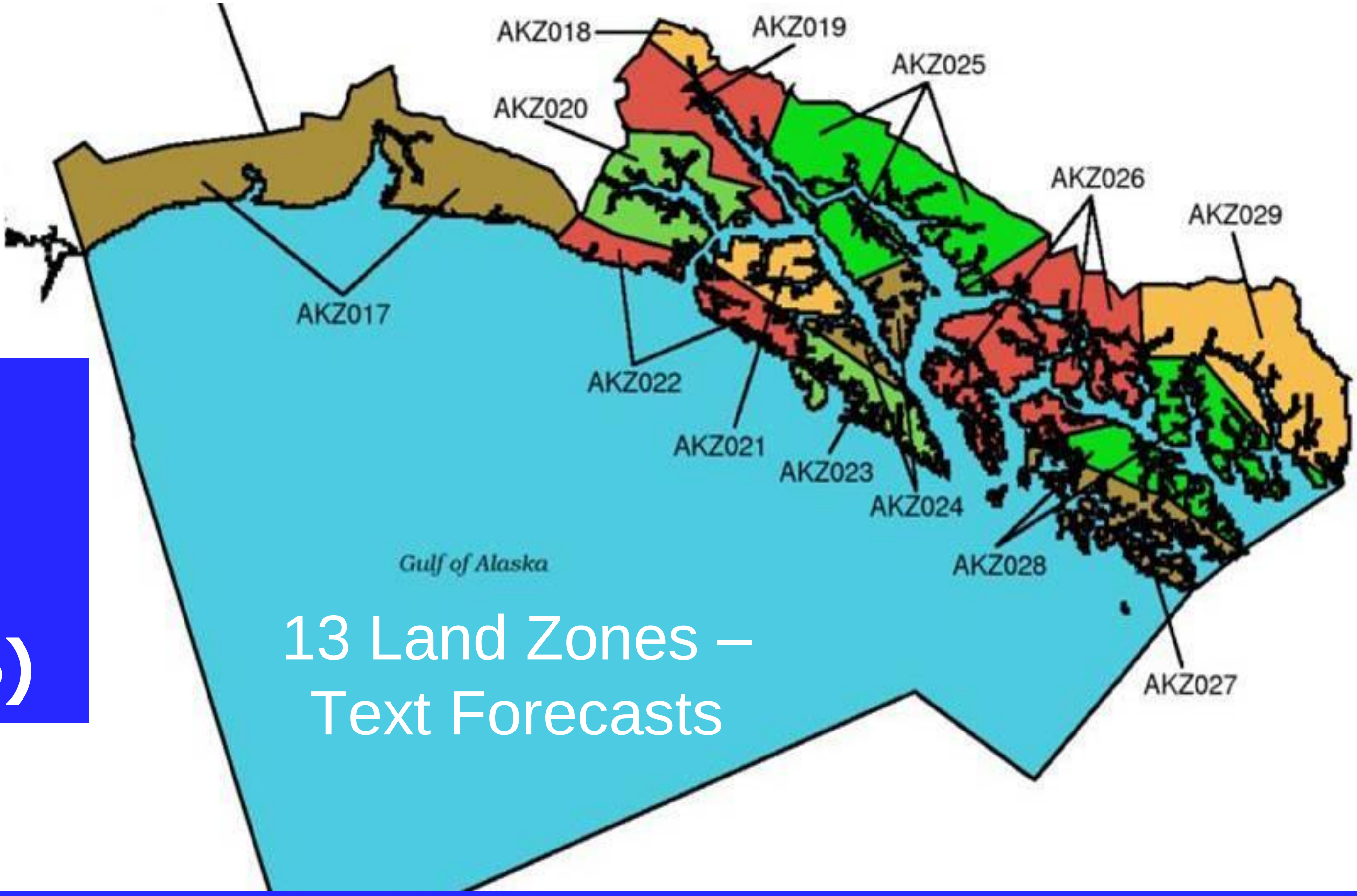
Aaron Jacobs:
Senior Service Hydrologist/Meteorologist, NWS WFO Juneau AK

Talk Outline

- Southeast Alaska area familiarization & challenges
- Why need space borne observations besides surface base
    - Impact (flooding, landslides)
- Current rainrate products in NWS Juneau’s operations
- Needs in the future to enhance forecaster’s situational awareness to enhance NWS’s Impact Decision Support Services (IDSS)
- Relationship between NASA-SPoRT and NWS Juneau

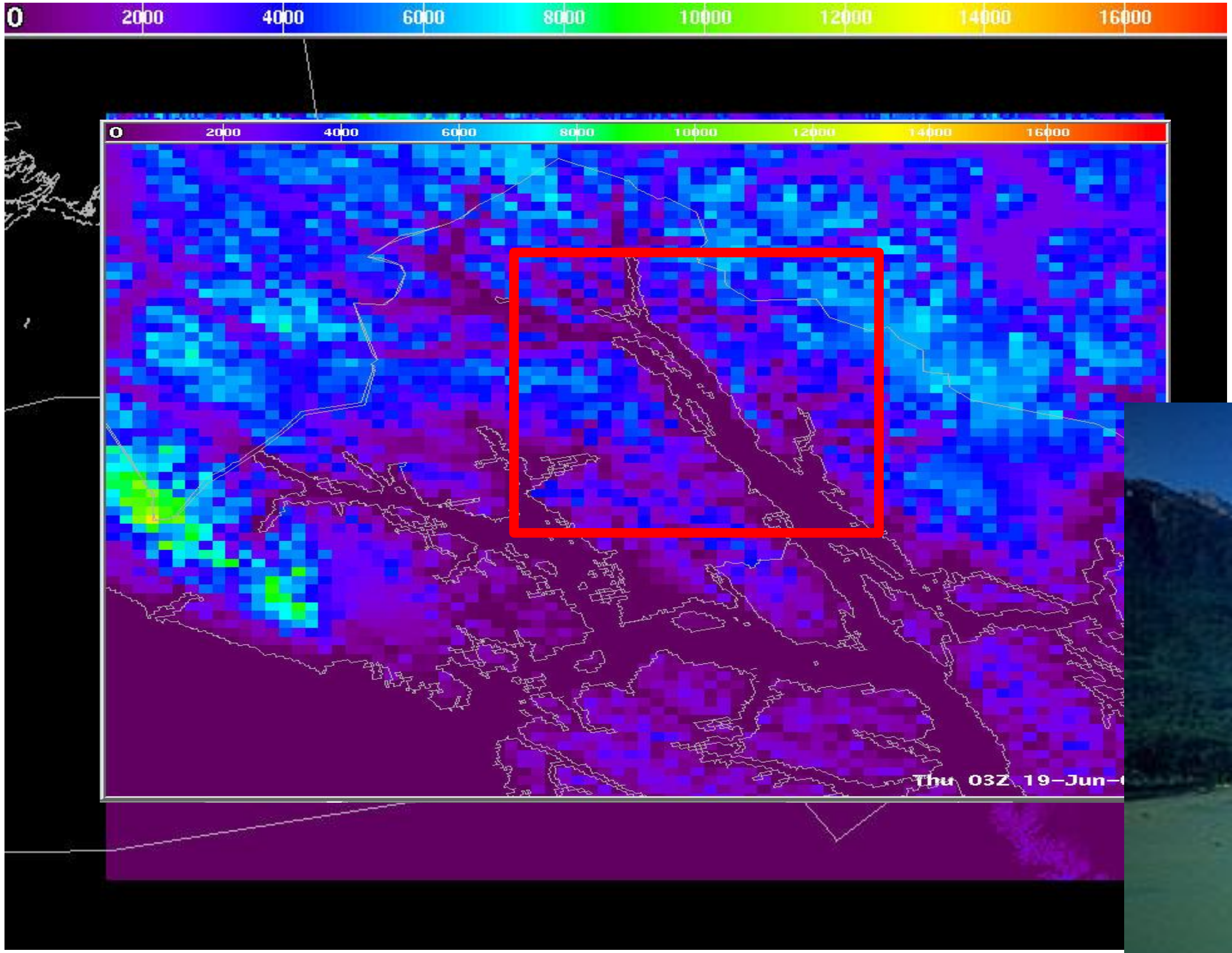
WFO Juneau Forecast Area

Area of Responsibility: 155,000 sq mi (3rd Largest in NWS)



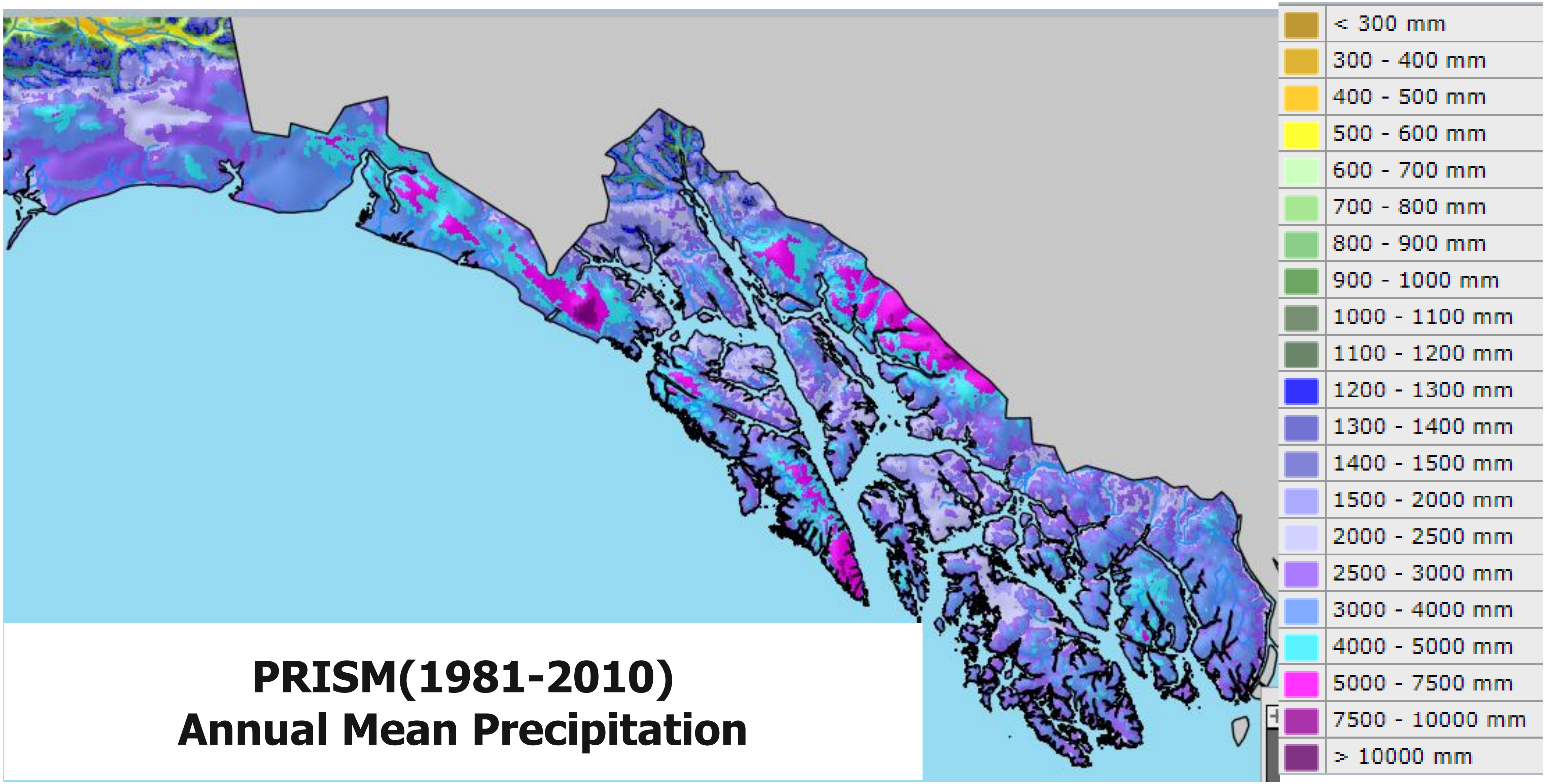
75 % of Forecast Area is covered by Water

WFO Juneau Forecast Area Terrain



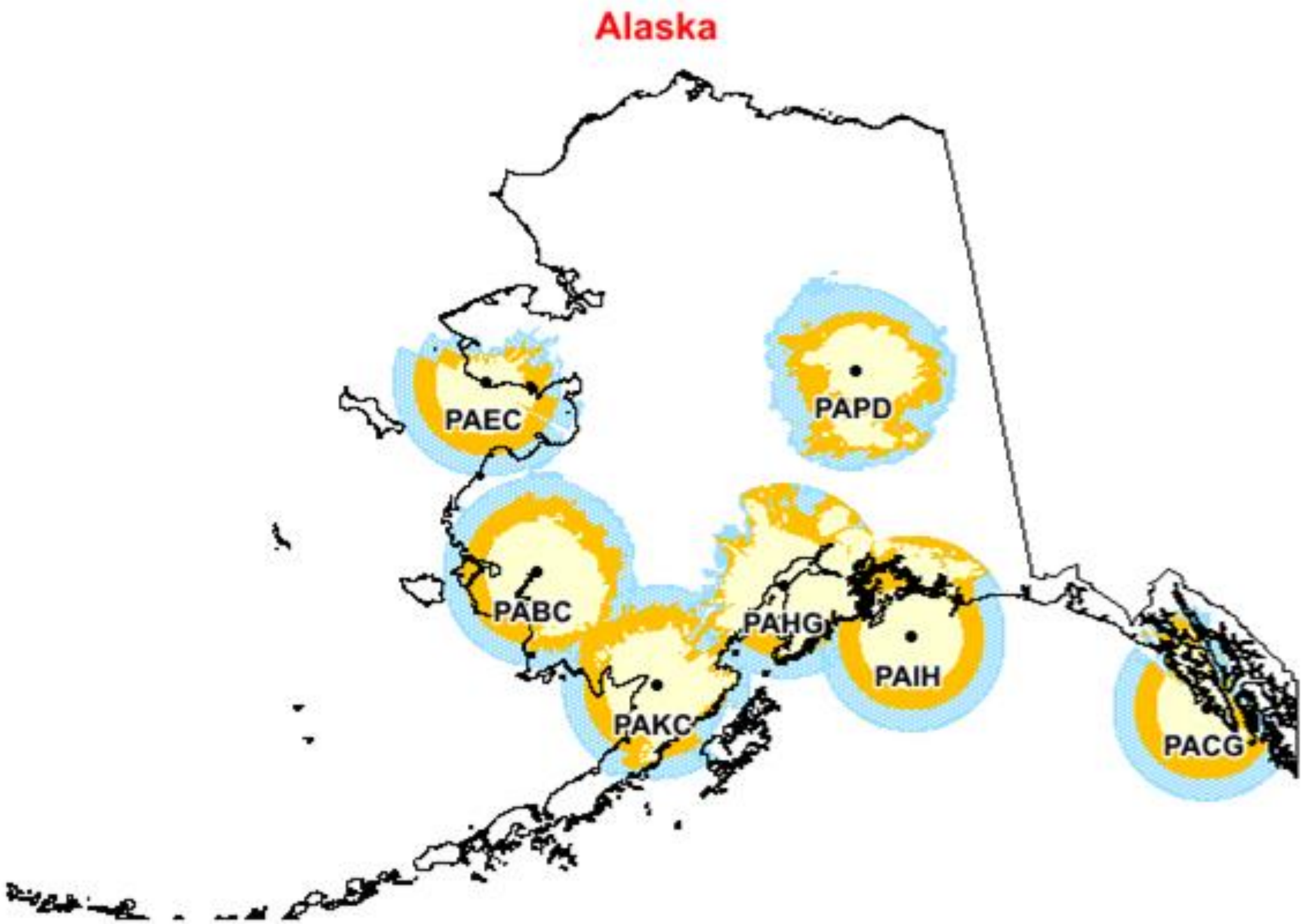
- Very steep terrain next to ocean. Area average=sea level to 3,000ft in 3 miles and in some cases sea level to 15,000ft in 8 miles

WFO Juneau Forecast Area



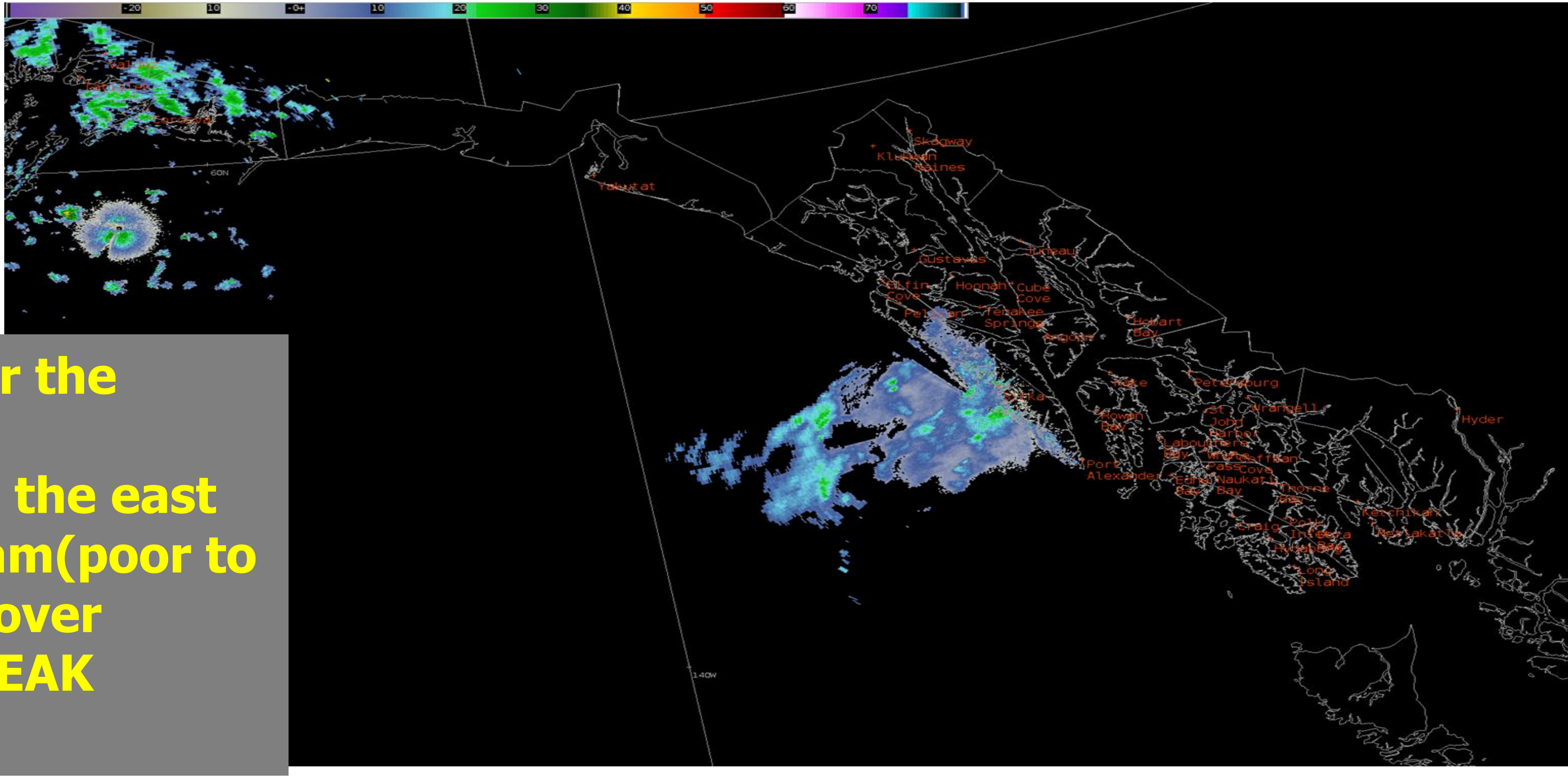
PRISM(1981-2010)
Annual Mean Precipitation

Limited Radar Coverage In Alaska



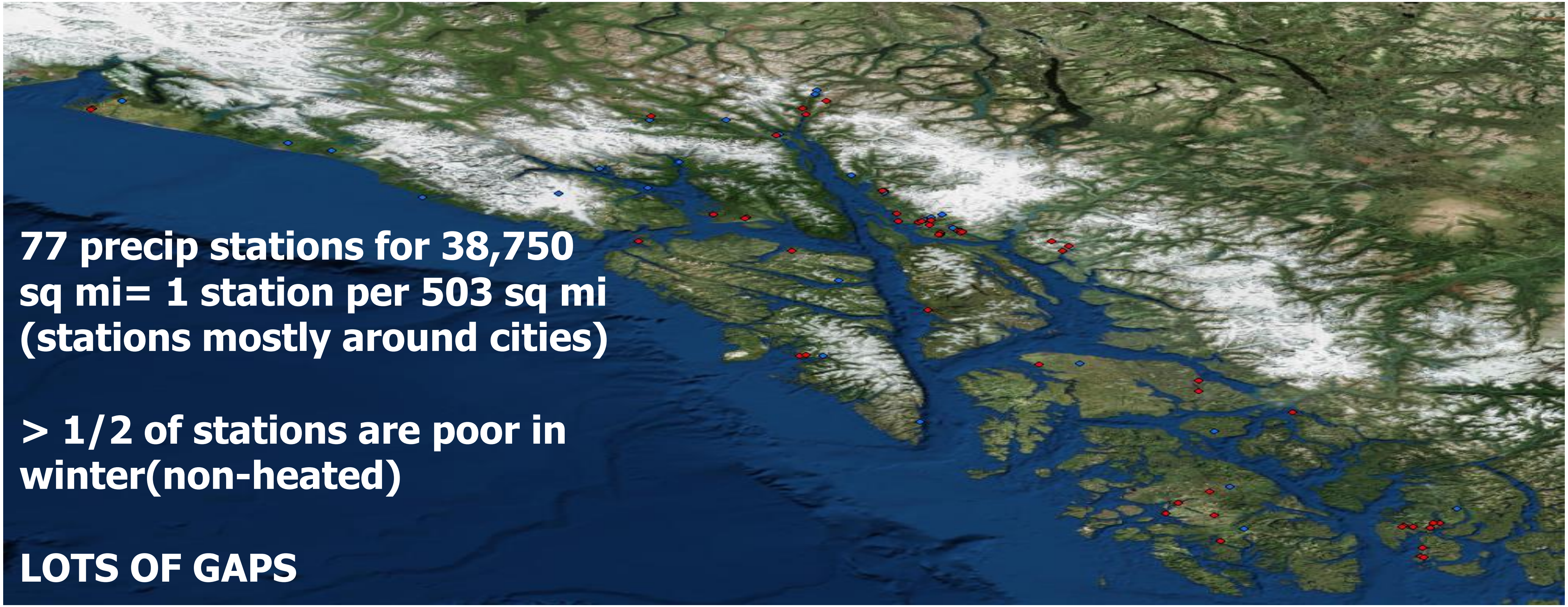
- NWS Rain/Flood monitoring:
  - assumes WSR-88D at WFO
  - AWIPS FFMP tool designed for radar.
- Effective radar coverage in Alaska greatly reduced:
  - Only 7 radars (over 140 in CONUS).
  - Most Alaskan radars and some western CONUS have beam blockage.
  - Accumulated QPE range 124 nm.

WFO Juneau Biorka Radar Coverage



- One Radar for the entire area
- Mountains to the east block the beam(poor to no coverage over majority of SEAK

WFO Juneau Real-time Precip Gauge Network



77 precip stations for 38,750 sq mi= 1 station per 503 sq mi (stations mostly around cities)

> 1/2 of stations are poor in winter(non-heated)

LOTS OF GAPS

Types of Impacts:

- Flooding of infrastructures
- Damage/erosion to trail systems
- Flooded/eroded roadways/US Forest Service roads
- Landslides

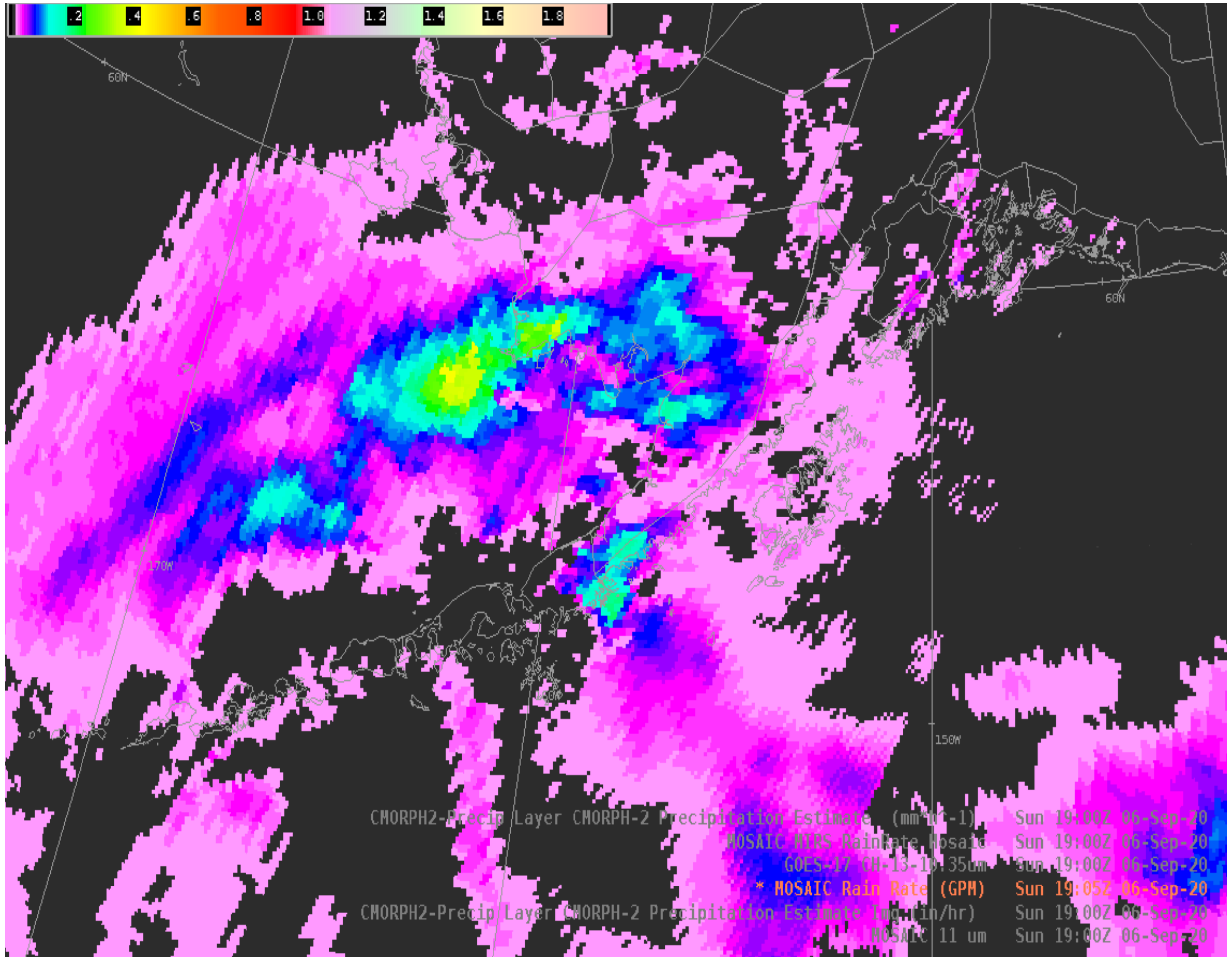
Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

- NASA GPM
- NASA IMERG
- MiRS
- CMORPH2
- AMSR2

Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

NASA GPM Rain Rate (SPoRT)

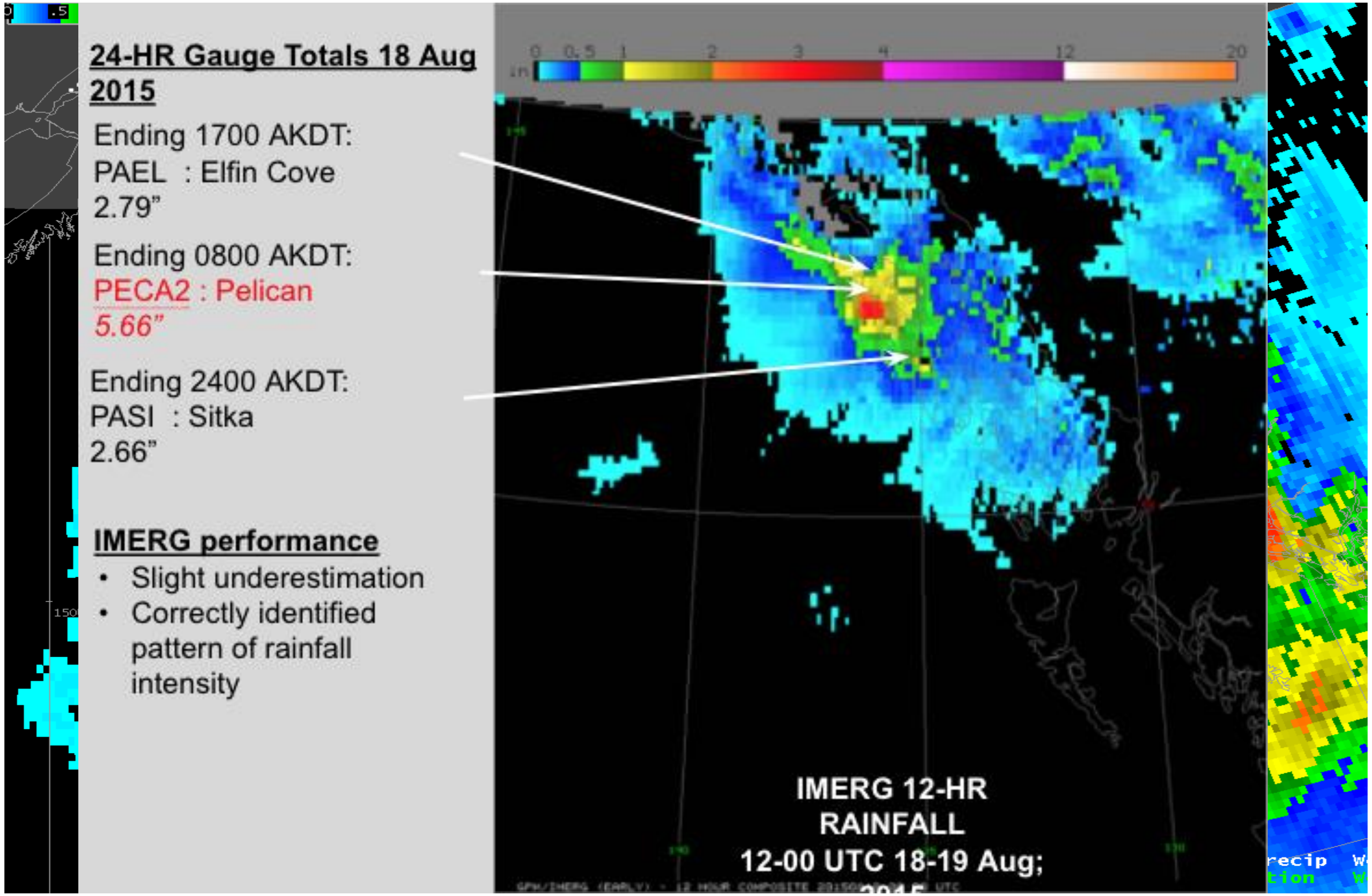
- Goddard Profiling Precipitation Retrieval (GPROF)
- Many satellites in constellation (9 over AK)
- Frequency: 20-30 passes/day S to N
- TDRS downlink: Avg latency ~130 min. (valid time different than DB)
- Resolution: ~ 15-25 km (sensor dep)
- Works with mosaic script
- Considerations:
    - Represents a general condition
    - Light precip overdone at times
    - Some discontinuities
    - Some values in snowfall
    - More uncertainty over land
    - No retrievals over snow/ice?



NASA GPM
1,3,6,12,24hr IMERG QPE

NASA IMERG QPE (SPoRT)

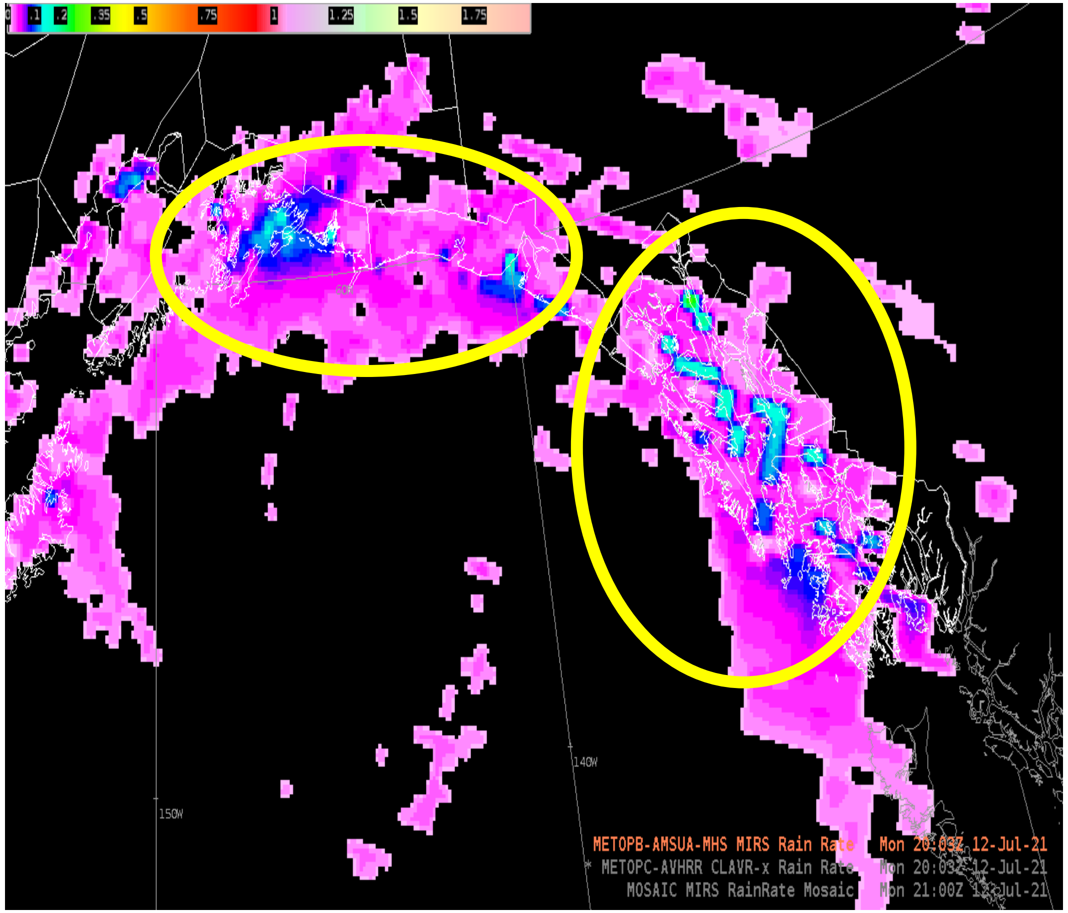
- Latency on fairly large (>4hr for early rainrate, >12hr for late) not used by operational forecasters.
- QPE used for post event analysis or verification



Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

MiRS Rain Rate (UAF Geographic Information Network of Alaska - GINA)

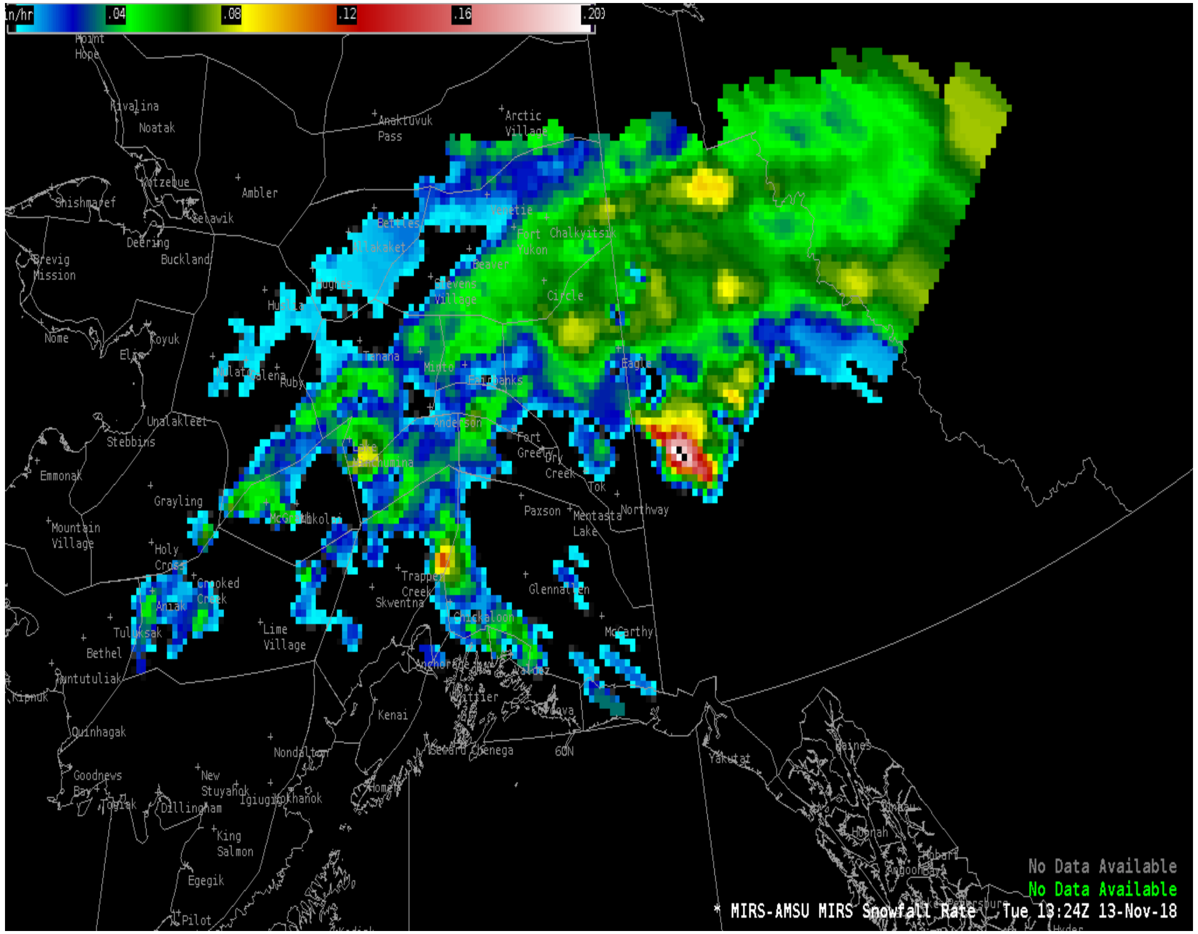
- CSPP MiRS package for DB
- Multiple satellites: 5 received by GINA
- Frequency: 12-20 passes/day S to N
- Low latency: Avg ~28 min
- Resolution: 15-25 km (sensor dep)
- Works with mosaic script
- Considerations:
    - More uncertainty over land
    - Water values more representative
    - Light precipitation underdone
    - Use as a general condition rather than specific point values
    - No retrievals over snow/ice



Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

MiRS Snowfall Rate (GINA)

- CSPP MiRS package for DB
- Multiple satellites: 5 received by GINA
- Frequency: 12-20 passes/day S to N
- Low latency: Avg ~28 min
- Resolution: 15-25 km (sensor dep)
- Works with mosaic script
- Considerations:
  - Not affected by snow on ground
  - No retrievals temps < 7 deg F
  - Max 2” / hr
  - No retrievals over water

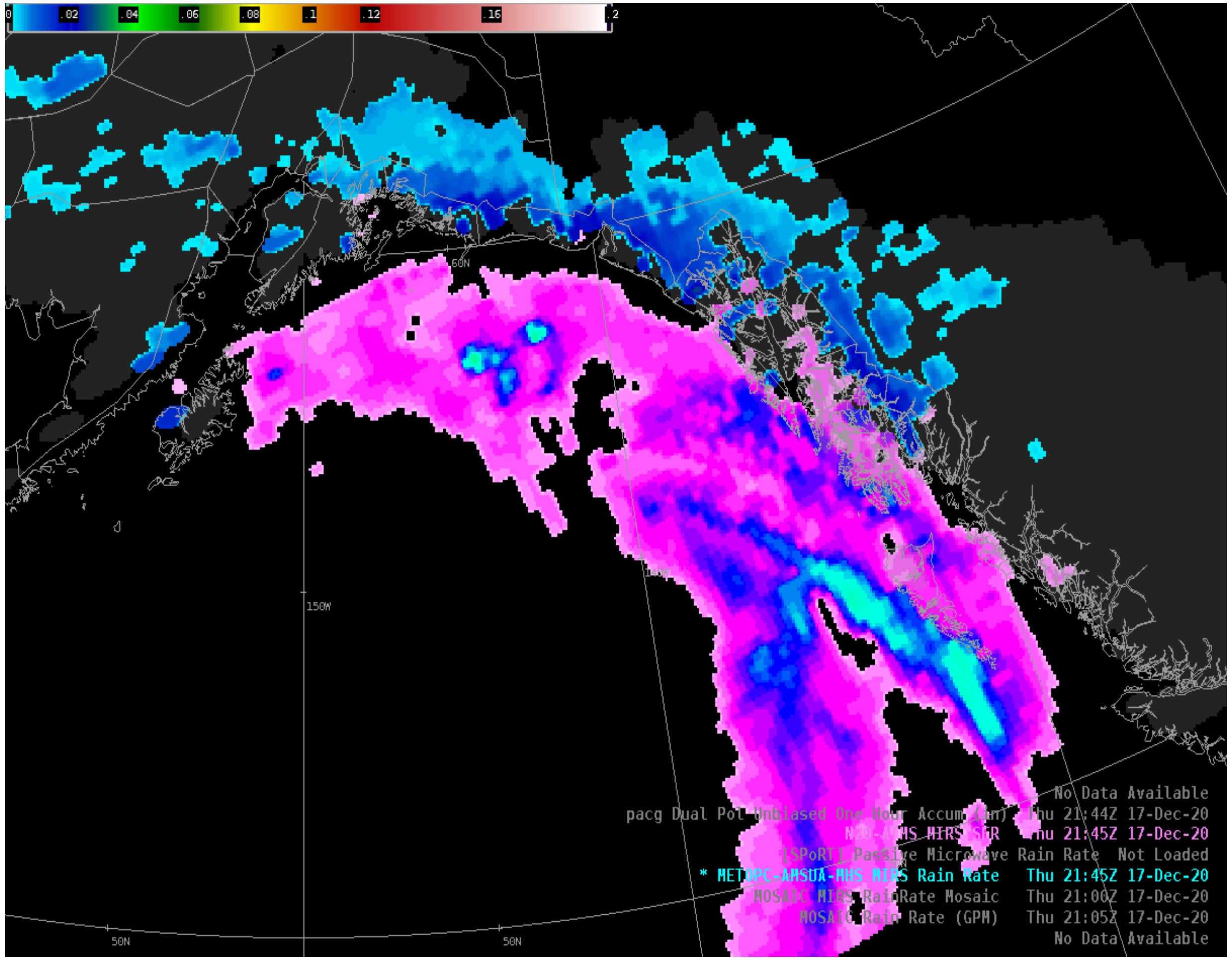


Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

Winter Precipitation Considerations

Snow/Ice on ground is challenging:

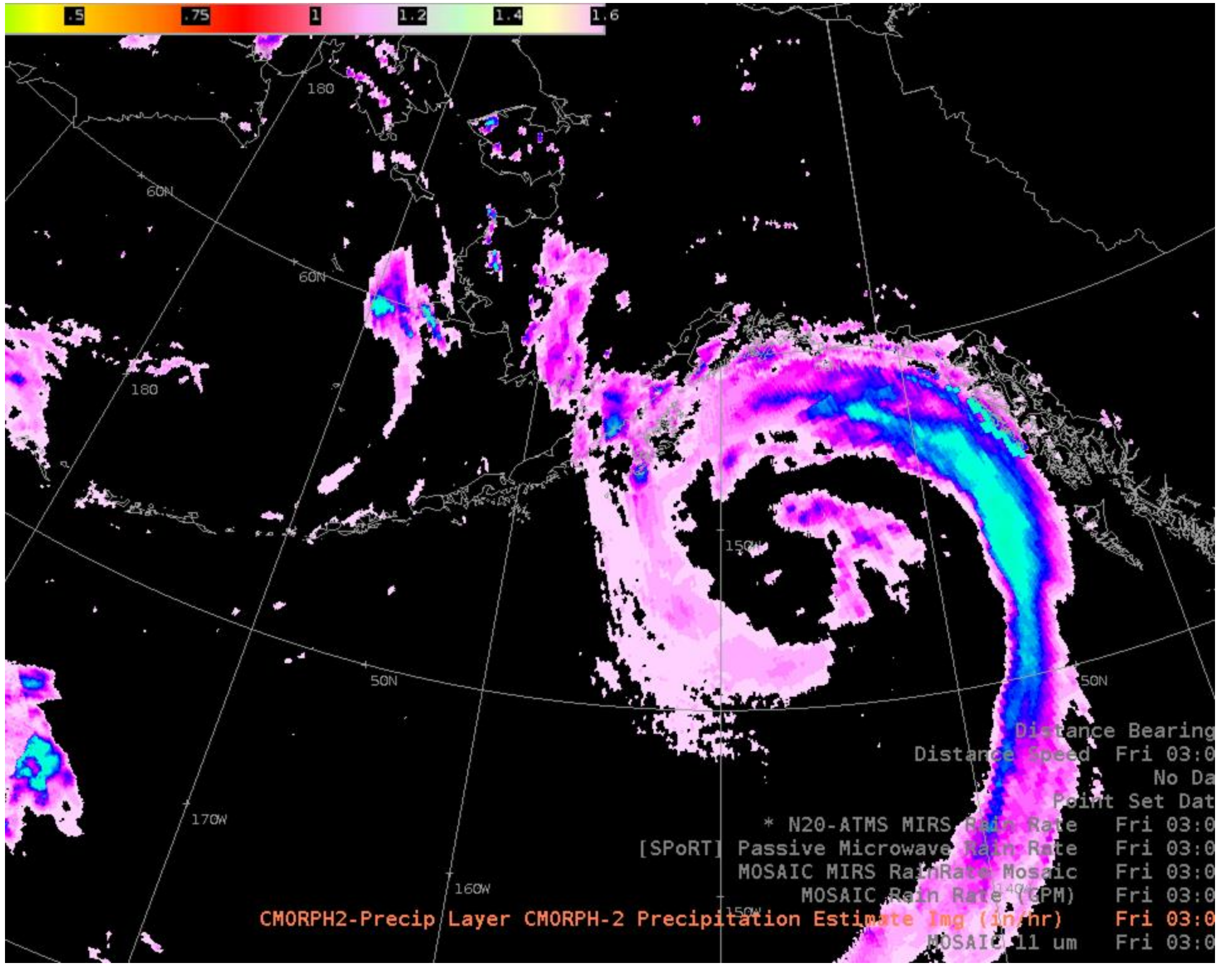
- No MiRS Rain Rate for snow or rain on snow/ice.
- SFR not affected by snow cover.
- RainRate + SFR more complete <u>except for rain on snow.</u>



Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

CMORPH2 Rain Rate (CPC)

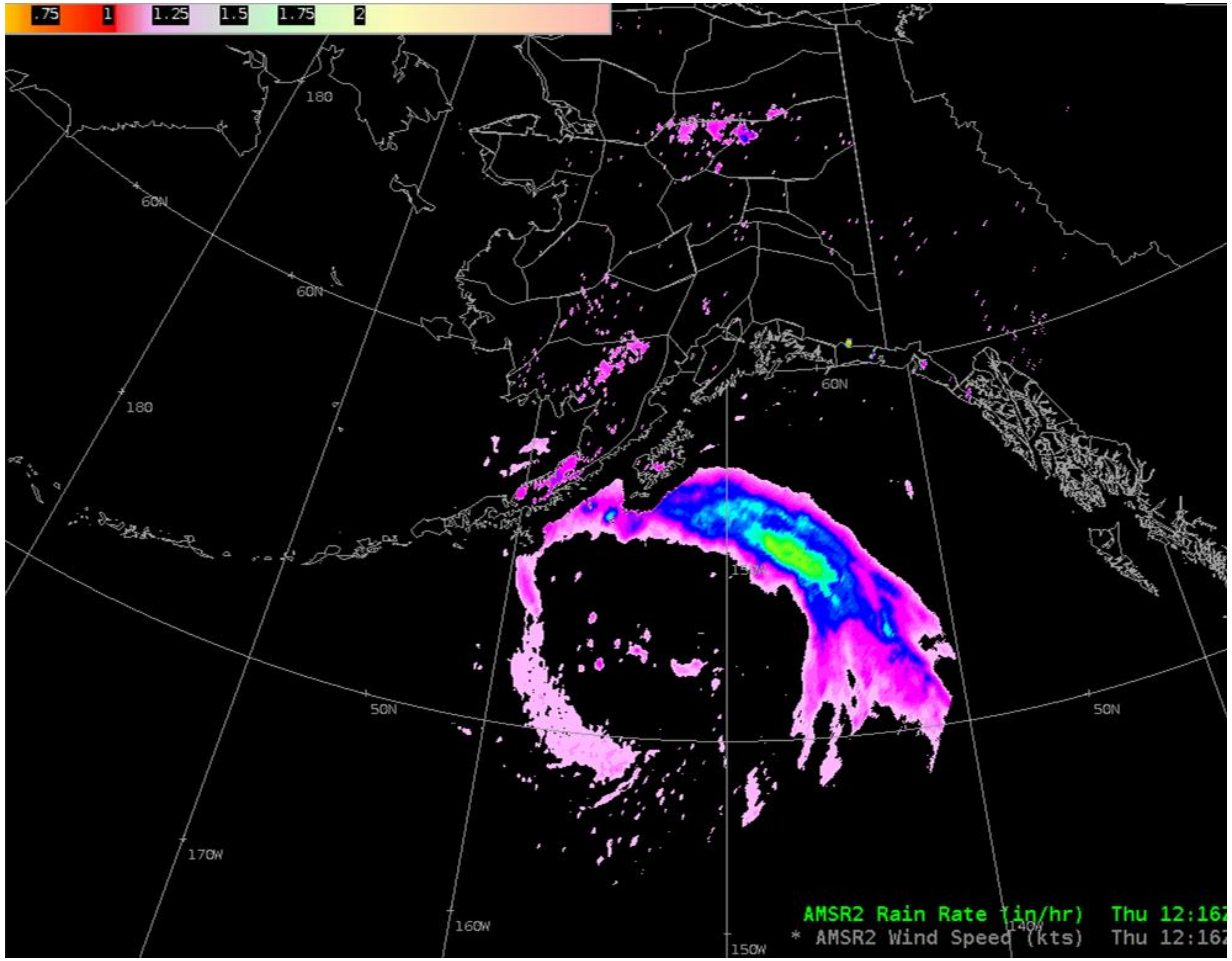
- Blend of satellite sources (GPM, MiRS, GEO Rain Rates)
- GEO wind vectors used for morphing technique to generate products every 30 min.
- Coverage: global every 30 min.
- Latency: 225-255 min (goal is 60 min)
- Regular time steps can convert to QPE
- Considerations:
  - Incorporates MiRS SFR liquid equiv.
  - Blending/morphing causes spacial discontinuities
  - GEO cloud top rain rates cause discontinuities in time
  - More uncertainty over land
  - Limited estimates over snow/ice



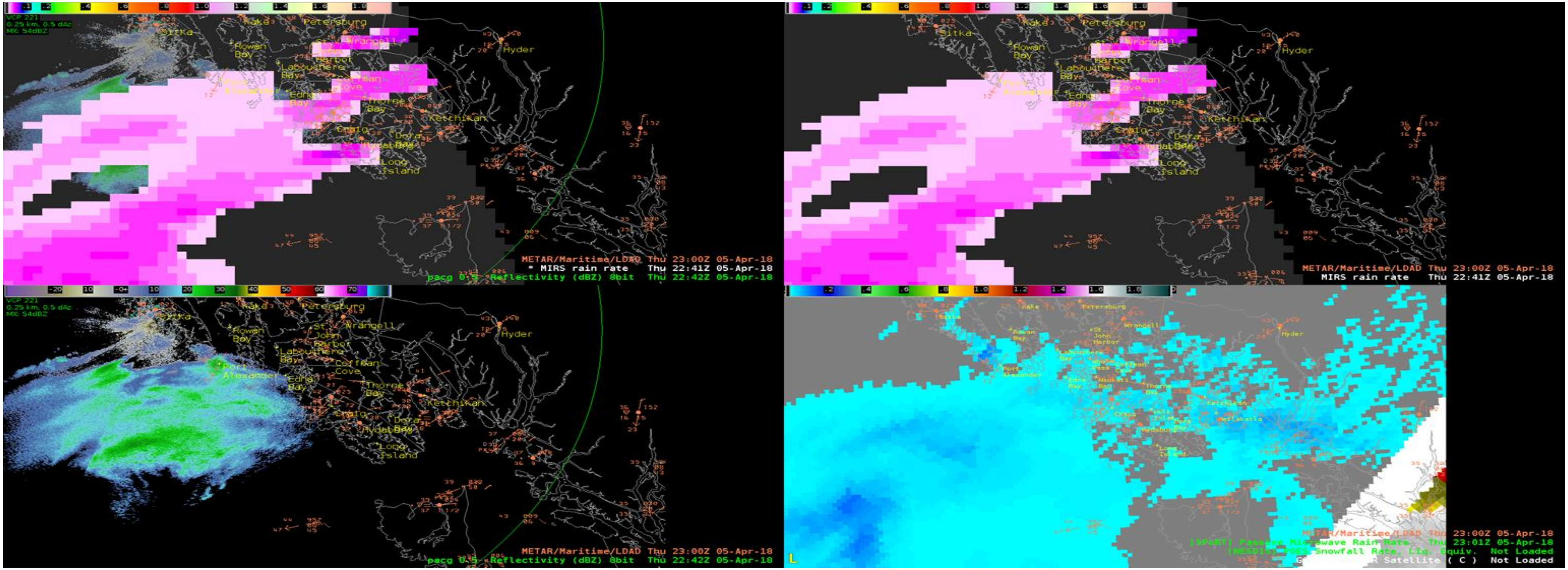
Polar Satellite Rain Rate Products In Operations at NWS Alaska WFOs

AMSR2 Rain Rate (GINA)

- CSPP GAASP package for DB
- Only 1 satellite
- Frequency: 2-4 passes/day S to N
- Low latency: Avg ~20 min
- Resolution 5-10 km.
- Considerations:
  - no retrievals near coast
  - No retrievals in snow or over snow/ice
  - More uncertainty over land

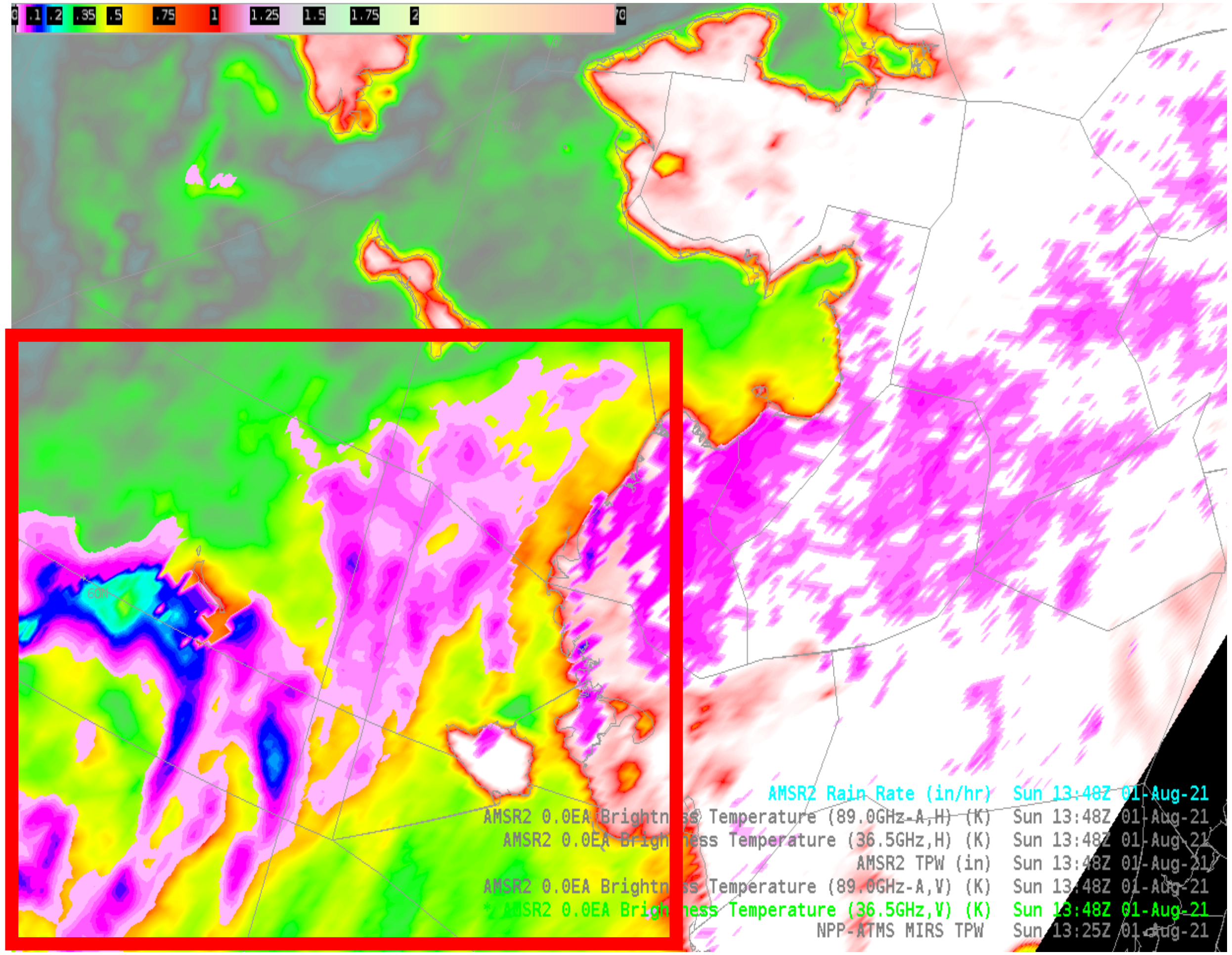


Compare MiRS & NASA GPM rain-rates products



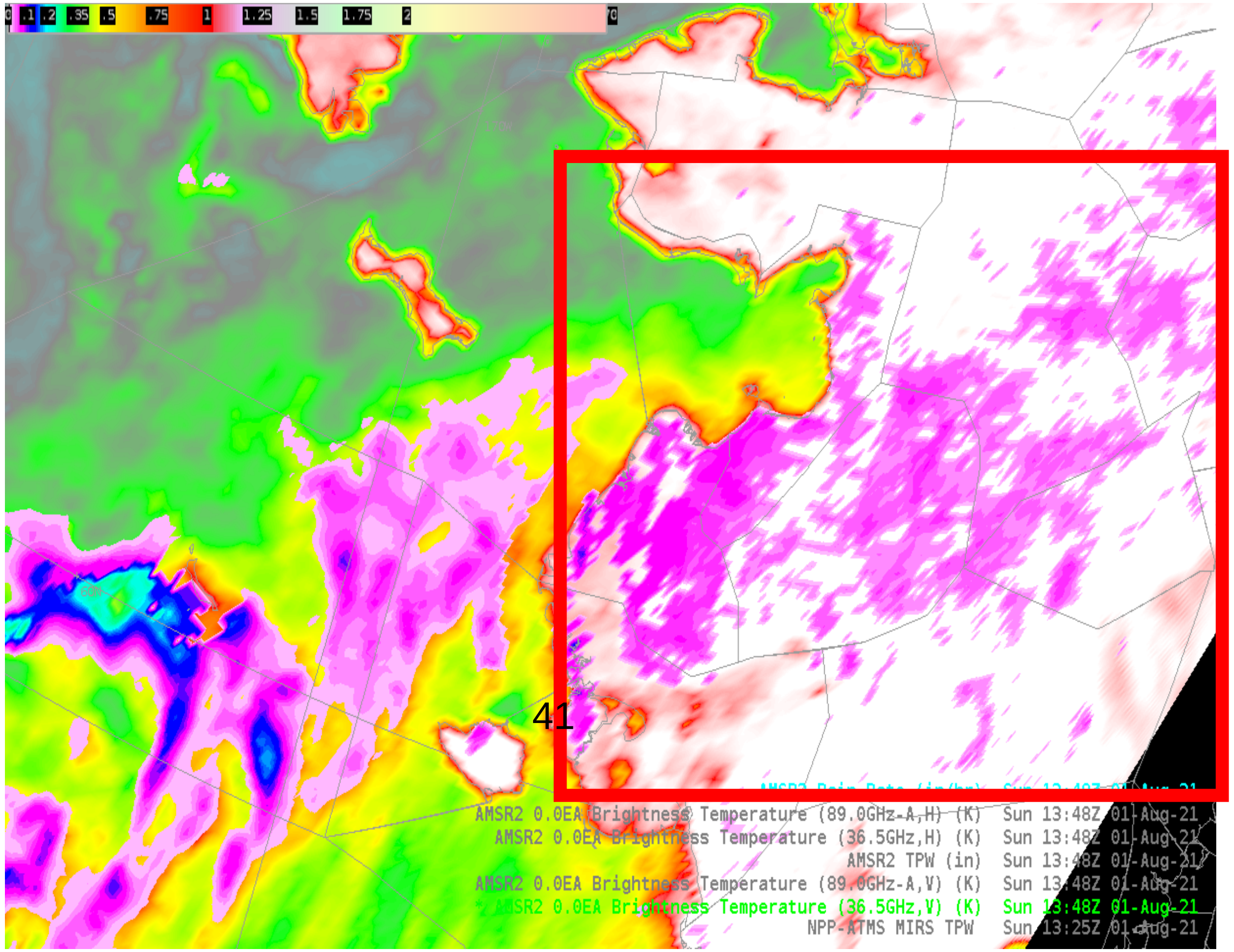
Needs In Future To Support Operations: Have Sufficient Microwave bands

- Like radar, longer wavelength microwave radiation from the surface is less affected by tiny cloud droplets.
- Larger drops within the cloud augment surface energy emissions.
- Over water:
  - Rain is warmer than ocean.
  - Warm temps in 36.5GHz,V indicate rain



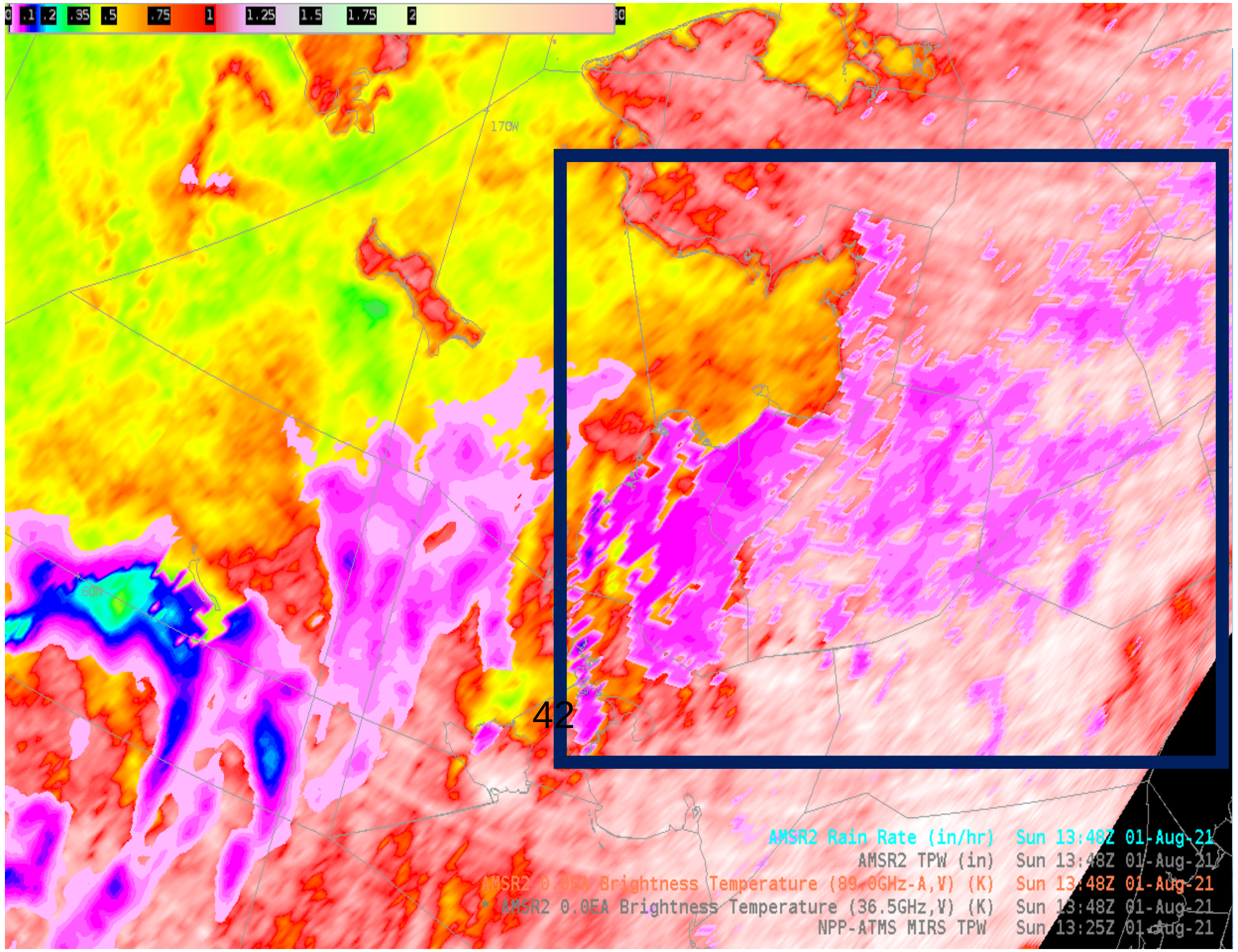
Needs In Future To Support Operations: Have Sufficient Microwave bands

- Over land:
  - More energy is emitted from the surface so augmentation by rain is less significant.
  - More difficult to see warm temps and rainfall in 36.5 GHz,V
  - So rain rates over land utilize a different strategy



Needs In Future To Support Operations: Have Sufficient Microwave bands

- Higher frequency scattering channels, such as 85 GHz, provide different information
- Emitted energy from the surface and rain in cloud is attenuated due to scattering by precipitation-sized ice particles.
- At 85 GHz rain appears cooler than surface.
- Emissivity differences too weak with snow/ice on ground
- Rain rate algorithms use multiple bands and strategies.
- Having lower frequency (higher wavelengths) will make sure to give a good representation of rain drops for a rain rate product.



Needs In Future To Support NWS Mission, Enhance AK Forecaster's Situational Awareness & Improve NWS's IDSS

- Be able to detract warm rain process for shallow/terrain induced moderate to heavy rain (occurs often over Southeast Alaska)
- Be able to detect rainrate over land/ice and water in complex terrain
- Need for more Microwave polar satellites to increase temporal frequency to fill in data gaps.
- Reduced latency of products to operational forecasters through direct broadcast:
    - Presently GINA data gets to NWS forecasters the quickest near 30min from acquisition
- Potential usage of LiDAR from space for landslide potential threat to enhance NWS IDSS at the WFO level.

Relationship between NASA-SPoRT & NWS Juneau

- Started with Sumi-NPP RGB satellite product assessment for the GOES-R program (2012-13?), Nighttime Microphysics (NtMicro) RGB
- NESDIS QPE/ CIRA LPW assessment/evaluation for polar MV satellites (2013)
- NESDIS Snowfall Rate Product (SFR) assessment (2014) from NOAA POES, Metop, S-NPP satellites
- 24-hr Microphysics RGB assessment (2015) from MODIS, S-NPP (VIIRS)
- Precip evaluation/assessment NASA-IMERG, GPM rainrate (2015)
- Second NESDIS SFR evaluation (2016)
- Evaluation of NtMicro from AVHRR to increase passes for AK office (2016)
- VIIRS Daytime Microphysics RGB assessment (2016)
- Second GPM/IMERG assessment (2017)
- Collaborator & presenter at AMS annual conference on GPM at the R2O session (2017)
- Collaborator on National Weather Association Annual Conference poster presentation on “best practices” using GPM and other satellite assist in operational hydrology (2018)

Relationship between NASA-SPoRT & NWS Juneau

- Strong Atmospheric River impacted Sitka AK Aug 18 2015 causing multiple landslides resulting in 3 deaths
- WFO Juneau worked with SPoRT to get IMERG data and GPM DPR data for a post event review and Sitka Geo-task force report laying the groundwork for a Sitka landslide warning system (in development)

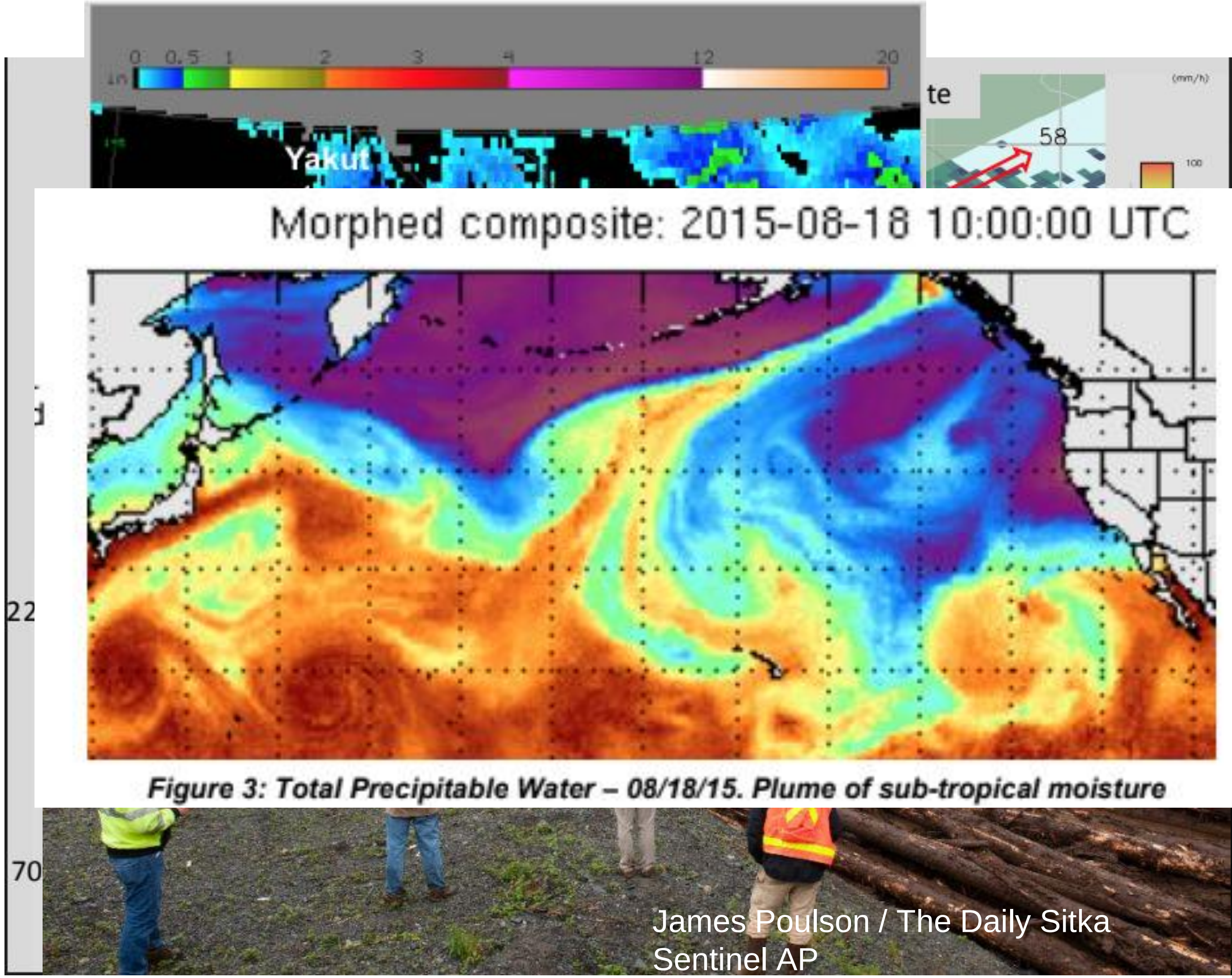
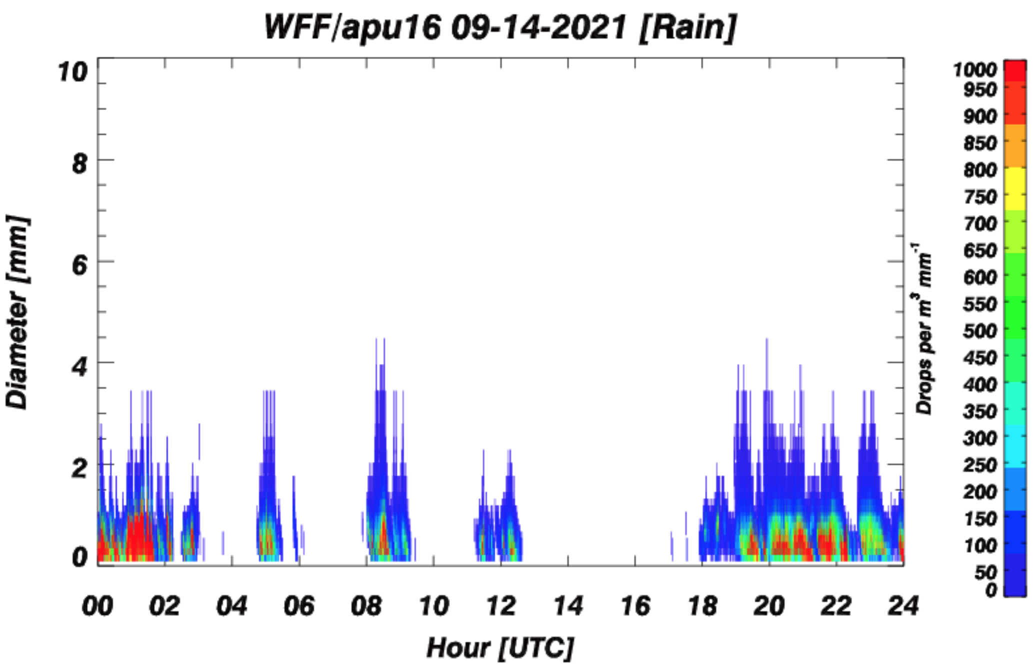
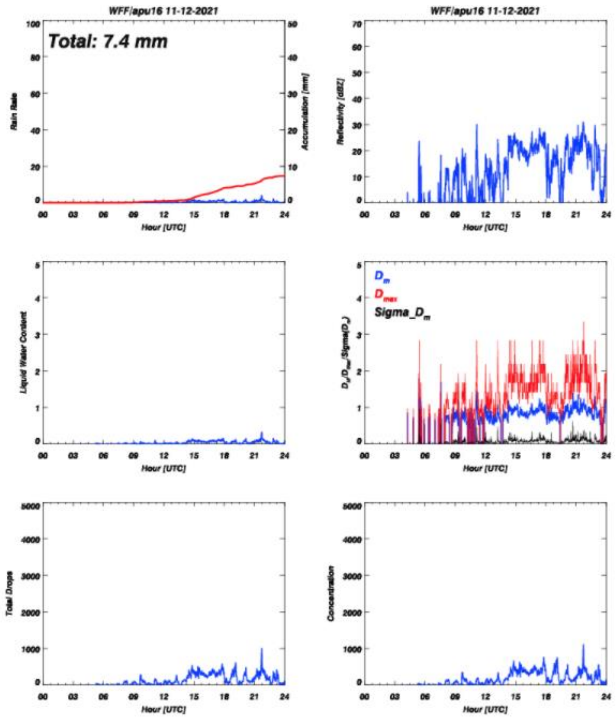


Figure 3: Total Precipitable Water – 08/18/15. Plume of sub-tropical moisture

Relationship between NASA-SPoRT & NWS Juneau

- SPoRT help WFO Juneau and other Alaska WFOs get involved with the GPM cal/val program by getting us in touch with the right people within NASA.
- This came from all the AK assessment work with the GPM rainrate products to improve the performance of the output to operational forecasters.
- Now there are 3 distrometers in AK providing data to the GPM cal/val team.





THANK YOU

QUESTIONS???