National Aeronautics and Space Administration

# The SPoRT REPORT
## *Special Alaska Edition*

SPoRT Report
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November 2013

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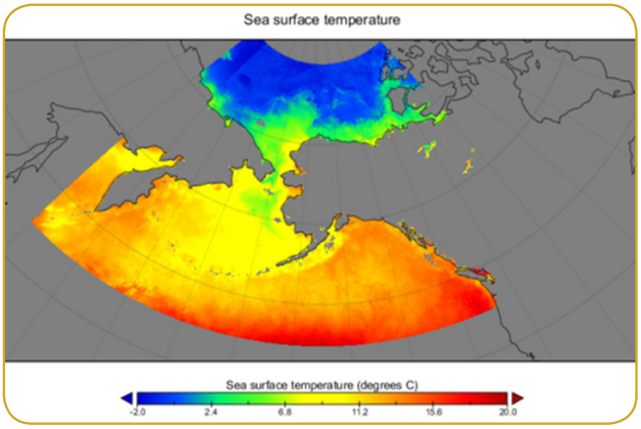
Short-term Prediction Research and Transition (SPoRT) Center
NASA Marshall Space Flight Center (MSFC), Huntsville, AL
http://weather.msfc.nasa.gov/sport/

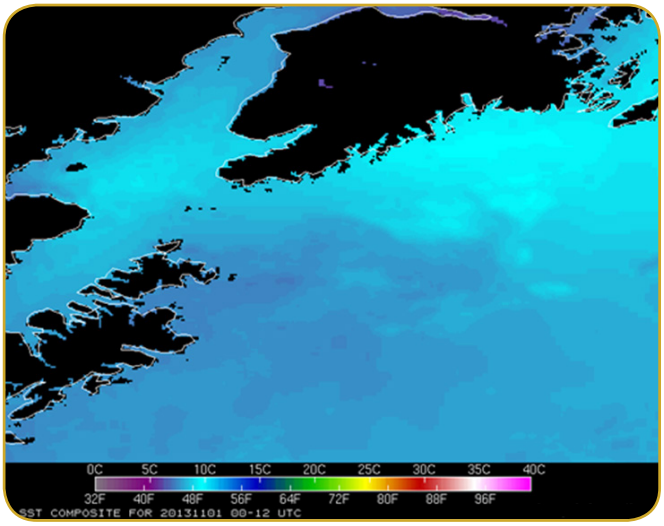
The SPoRT Center is a NASA- and NOAA-funded project to transition unique observations and research capabilities to the operational community to improve short-term weather forecasts on a regional scale. While the direct beneficiaries of these activities are Selected Weather Forecast Offices (WFOs) and National Centers, the research leading to the transitional activities benefits the broader scientific community.

## Alaska Highlights

### SPoRT SSTs at the Alaska Ice Desk

Two years ago Kathleen Cole (Alaska Sea Ice Program in Anchorage, aka "the Ice Desk") began using the SPoRT SST composite product as one of several resources she uses every time she provides graphical sea ice products to the many users, from small fishing vessels to coastal communities and marine search and rescue efforts. The composite product uses medium resolution (9 km) once-per-day SST data from NESDIS (from GOES and NOAA polar orbiters), as well as higher resolution (1 km) near real-time MODIS data from two NASA satellites, using both latency- and resolution-weighting schemes. The final product is calculated twice per day on a 2-km grid covering almost the entire Northern Hemisphere. SPoRT sends a smaller Alaska region domain (below, left) to the Ice Desk. Beginning in October, Kathleen began routinely using the SPoRT composite. The quality and coverage of SPoRT data will greatly reduce the time needed to produce the SST charts. In some cases, this is up to a 60% reduction. This, in turn, will enable the SST graphics to expand from a twice weekly product to daily over the coming months. A Gulf of Alaska sample is shown below.



# GOES-R Proving Ground (PG) OCONUS Annual Meeting

The annual GOES-R Proving Ground (PG) OCONUS meeting took place in Anchorage and Fairbanks (June 18-21, 2013). It provided an opportunity for SPoRT to share recent accomplishments with the PG community and learn more about the activities of other PG participants in Alaska and Hawaii regions. With the meeting held in Alaska, it also provided a timely opportunity for SPoRT to re-establish a collaborative relationship with the staff at the Alaska WFOs. Previous collaborations with Alaska WFOs have been limited over the last year because of a reduction in NWS staff that had been critical in dissemination of data and products. SPoRT knows that a close collaborative relationship with forecasters and SOOs at WFOs is critical to the successful integration of data products and evaluation of the utility of the products in the operational environment. The meeting created an opportunity to work on these collaboration issues.

The OCONUS meeting was a three day meeting jam-packed with presentations from various PG partners and OCONUS end users. After overview presentations of GOES-R and JPSS PG by Steve Goodman and Mitch Goldberg, the participants enjoyed presentations by Steve Businger, Bill Ward, and Eric Lau on the Pacific activities and Eric Stevens on the Alaska activities. Other external presenters included staff from NESDIS, UW/CIMSS, and several of the GOES-R PG Satellite Champions. The Pacific Region discussions focused on the direct broadcast downlink being installed for MODIS and VIIRS data, and the use of VIIRS DNB for convection, and correlations between lightning flashes and precipitation rate in tropical systems. Later, Bill Ward and Eric Lau indicated that (because of their broad range of responsibilities and relative isolation from other collaborators) the Pacific Region cannot get enough training and encouraged PG partners to coordinate with him on visits to support the Region's training needs. They also expressed their thanks to SPoRT for getting QPE and SSTs in Pacific Region and believed these products to be quite helpful with the monitoring of tropical storms and possibly trade winds showers. They look forward to receiving hybrid and RGB products produced by SPoRT.

Jim Nelson (Anchorage SOO) talked about the WFO activities including functions of the ice desk. The WFO receives the SPoRT composite SST product, the Geo/LEO hybrid, the NESDIS GOES-R PG QPE product, and the CIRA LPW product, a standard suite of UW/CIMSS products, and VIIRS imagery including the DNB from GINA. He says the forecasters love the hybrid product and are looking forward to the summer evaluations of the QPE and LPW products. His office is also very interested in the RGB products produced by SPoRT.

Eric Stevens (the new Alaska Region Proving Ground Satellite Champion working for GINA) showed applications of a stray light correction for VIIRS DNB data (provided by UW) and GINA's Puffin feeder web site. He, along with Fairbanks WFO staff, mentioned the need to integrate various polar data into one AWIPS loop, a concept that SPoRT has successfully demonstrated with its "Geo/LEO hybrid" product.

As a result of the expressed needs in Alaska, SPoRT began working with Fairbanks WFO and GINA staff on several activities: 1) getting SPoRT product menus installed at the WFO to begin ingesting the SPoRT Geo/LEO hybrid product (activity was completed by June 30, 2013), 2) completing issues related to display of SST product for ice desk (completed by July 31, 2013), and 3) establish a virtual machine capability for the production of products in Alaska using GINA direct broadcast data (ongoing). The latter will significantly reduce the latency of SPoRT products used by Alaska WFOs.

# SPoRT visits Alaska

As a follow-up to the OCONUS meeting, Kevin Fuell and Matt Smith spent a few days in August at each of the three Alaska WFOs. Their first stop was Anchorage where they spent time with several forecasters, showing them SPoRT's RGB and Geo/LEO hybrid products available in AWIPS. They spoke with RFC personnel to discuss how SPoRT could help with hydrological forecast problems. The NASA Land Information System (LIS) may be used over Alaska to provide a better initialization for groundwater, latent heat flux, and snow water equivalent (SWE), to name a few (see Proposed LIS Activities with UAF). They also spoke with Kathleen Cole at the Alaska Ice Desk about how to best provide SPoRT's composite Sea Surface Temperature product (see SPoRT SST's at the Alaska Ice Desk).


Kevin and Matt next travelled to Fairbanks, where they first met with staff members at GINA (Geographic Information Network of Alaska) at the University of Alaska Fairbanks. They discussed possible collaborations with faculty members Dr. Jessica Cherry and Dr. Jiang Zhu about hydrologic modeling opportunities (see Proposed LIS Activities with UAF). The group also discussed how we could work together to improve the speed of delivery of SPoRT's current MODIS- and VIIRS-based products by generating them in Alaska. GINA offered 'virtual machines' (VM) for product generation using data from their local Direct Broadcast receiving stations. A VM is a software implementation of a computer that executes code just like a physical machine. These new VMs with local data sources will significantly reduce product delivery times. (Update: SPoRT's preparation work with these GINA-supplied Virtual Machines is almost complete. Data should be flowing by December.) Going forward, SPoRT and GINA plan to meet regularly to collaborate on efforts to improve data availability and AWIPS I/II display capabilities– especially with AWIPS II changes expected soon.

Kevin and Matt met with the forecasters at the Fairbanks WFO, once again discussing the RGB and Hybrid products as well as having discussions about the QPE and LPW product suites that were being evaluated at that time. Interaction with local staff on these issues was very insightful to their needs in areas of hydrology, aviation, and fire weather.

Kevin and Matt's last stop was the WFO in Juneau where they were able to visit the office on 3 consecutive days to reach a wide audience. Once again, busy forecasters found some time for them to talk about the forecast issues that could potentially be improved with these products. One-on-one training sessions on QPE and LPW were conducted as well as discussions of LPW derivative products such as an anomaly or percent of total for LPW. In addition, there was high interest in RGB imagery from MODIS and VIIRS for aviation forecast challenges, and Kevin left them a "Quick Guide" to the Nighttime Microphysics RGB. Lastly, the Alaska trip wouldn't have been quite complete without the kindness of forecaster Joel Curtis taking them on a whale-watching trip. It, too, was a success.

# Proposed LIS activities with the University of Alaska Fairbanks

During the trip, SPoRT team members also visited with scientists at the Geophysical Information Network of Alaska (GINA) at the University of Alaska Fairbanks (UAF) to brainstorm potential collaborative opportunities in the area of modeling and data assimilation. Specifically, both groups have an interest in applying the NASA Land Information System (LIS) to improve forecast operations in two key areas: (1) monitoring soil moisture for summer fire weather operations, and (2) improving the depiction of Spring and Summer snow melt and runoff for hydrologic models. Both of these areas could benefit operations at the Alaska NWS WFOs, as well as the Alaska River Forecast Center (RFC).

For fire weather applications, the LIS would run the Noah land surface model (LSM) over Alaska initially with a simple baseline configuration that uses climatology green vegetation fraction (GVF) and atmospheric input forcing from the Global Data Assimilation System (GDAS). The initial goal would be to provide the baseline LIS output to the WFOs and RFC for assessment within AWIPS II.

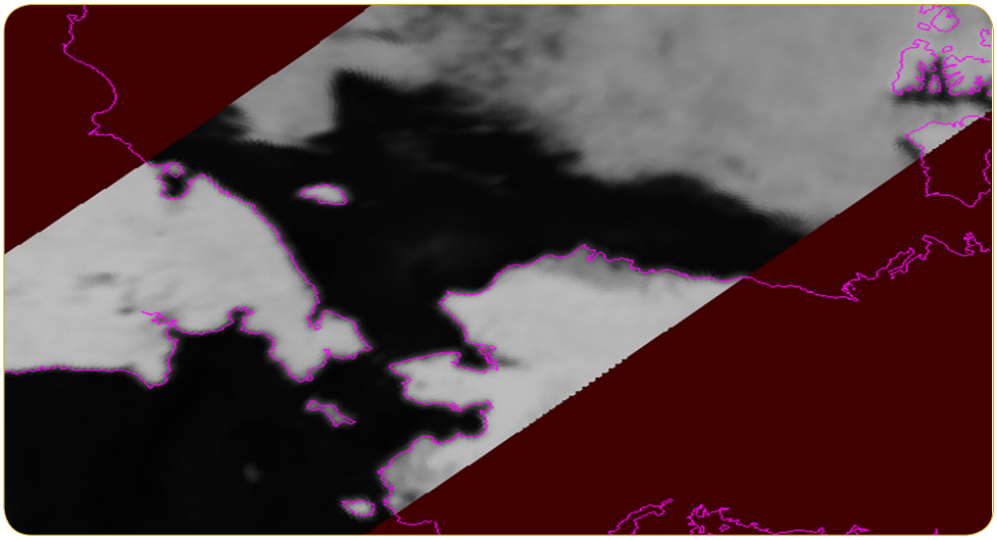
Future refinement of the baseline LIS configuration could involve incorporating the real-time GVF product produced by National Environmental Satellite, Data, and Information Service (NESDIS), which is derived from VIIRS. The NESDIS VIIRS GVF product is updated daily on a global domain with 4-km resolution. The incorporation of real-time GVF data has been shown to improve the representation of sensible and latent heat fluxes into the atmosphere and to the corresponding evolution of the soil moisture field during the warm season months. Monitoring real-time changes in the coverage of healthy vegetation can also help assess fire weather potential. Additionally, soil moisture data could be assimilated within LIS from sources such as the Soil Moisture Ocean Salinity, Global Change Observation Mission (GCOM), and future Soil Moisture Active Passive missions, in order to improve soil moisture depiction over Alaska during the summer. Areas of lower soil moisture and/or vegetation coverage can lead to greater sensible heating, lower relative humidity, and a higher fire weather risk.

A SPoRT-UAF collaboration in research area (2) is contingent upon a better understanding of the role and extent of NOAA's National Operational Hydrologic Remote Sensing Center (NOHRSC) operations in Alaska, in order to define data assimilation activities that could complement work already being done by NOHRSC. Currently, NOHRSC generates LIS output of snow information over Alaska using the Noah and Community Land Model LSMs, driven by atmospheric input from GDAS and the North American Mesoscale model. Future collaborative activities could involve the assimilation in LIS of MODIS/VIIRS fractional snow cover and/or retrieved snow-water equivalent fields from microwave satellite sensors such as the GCOM Advanced Microwave Scanning Radiometer-2 or the Suomi-NPP Advanced Technology Microwave Sounder. In addition, simulated precipitation from the High Resolution Rapid Refresh in Alaska model could provide a higher-resolution depiction of orographic precipitation compared to GDAS precipitation, and subsequently improve the LIS integrated snow water equivalent fields in areas of complex terrain.

# Passive Microwave Products

There are a number of passive microwave instruments on current polar orbiting satellites. Data from these instruments can be used to derive many geophysical products. These products include snow cover, snow depth, snow water equivalent, snowfall rate, sea ice cover, and sea ice temperature to name a few. With the relatively large number of satellite overpasses over high latitude locations, these products and others may be of operational use.

The products are generally at much lower resolution than most other standard products, available on scales of 5 – 40 kilometers or more depending on the product. Also, they vary in accuracy from highly scientific to merely qualitative, varying from product-to-product. Despite this, in many cases an estimate can be very valuable. One example is shown depicting a qualitative view of virtually cloud-free sea ice coverage over the southern Arctic Ocean



north of Alaska on 06 September 2013 at about 1420 UTC using a 10.7 GHz channel from AMSR2 (traveling NE-to-SW) and remapping it onto stereographic projection with a resolution of 5 km. The black color represents ice free ocean; the various shades of gray-to-white represent a mixture of water and sea ice (or land), with the amount of sea ice (or land) increasing with brightness. With many overpasses per day, the sea ice coverage and movement could be monitored.

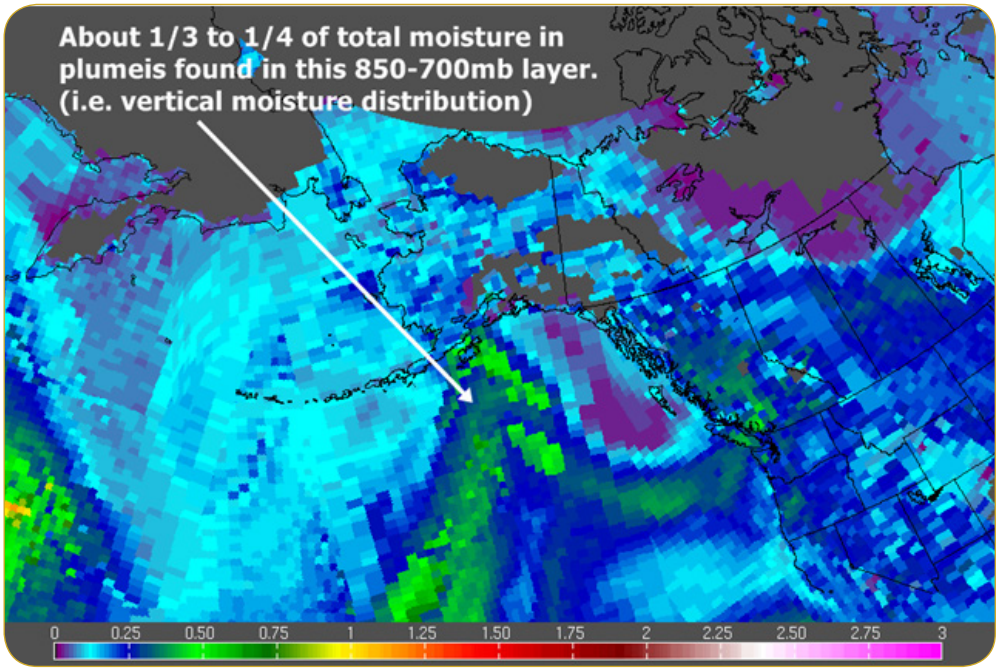
# Assessment of GOES-R QPE by NESDIS

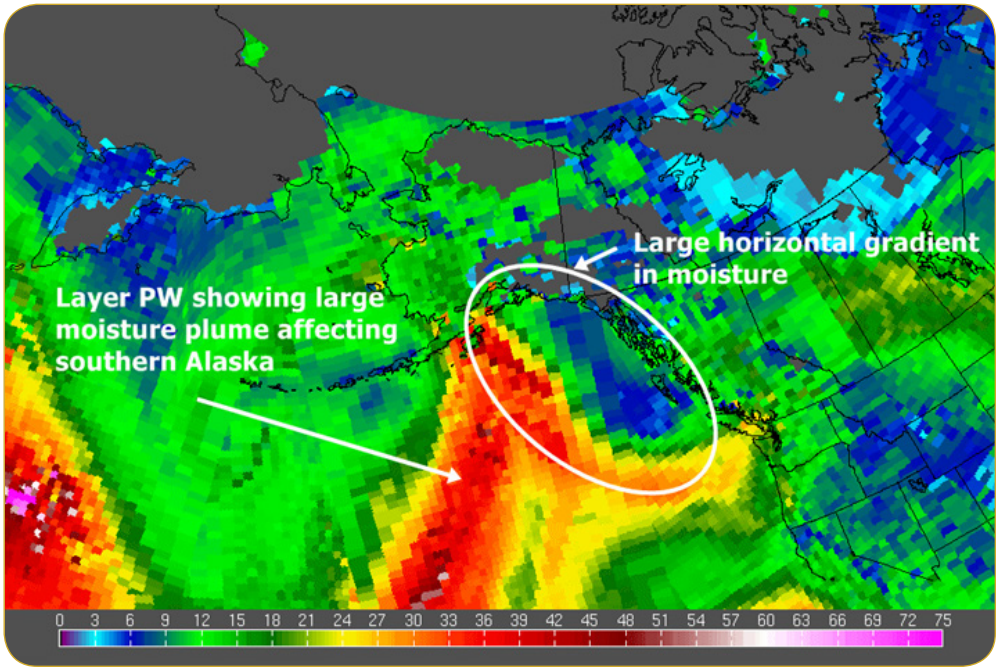
NESDIS GOES-R QPE is a quantitative precipitation estimation algorithm that combines GOES IR and microwave data from various satellites. This past July-September it was assessed at all three forecast offices in AK and at the Alaska-Pacific River Forecast Center (and simultaneously evaluated at San Jaun, Puerto Rico WFO for comparison) to evaluate its strengths and weaknesses at high latitudes and in the terrain offered in those locations. Of the AK participants, 35 evaluation forms were submitted by 12 different forecasters from these 4 offices, in addition to discussions via email with the product developer, Bob Kuligowski, which will benefit the product's development as we approach the GOES-R era.

The assessment of NESDIS GOES-R QPE coincided with SPoRT WFO visits to AK partners. This allowed individual training opportunities for the forecasters and allowed the SPoRT team to see how GOES-R QPE is being utilized in operations and on decision support systems at each office. The site visits also seemed to help improve participation and feedback for the assessment.

# Assessment of Layered Precipitable Water (LPW) by CIRA

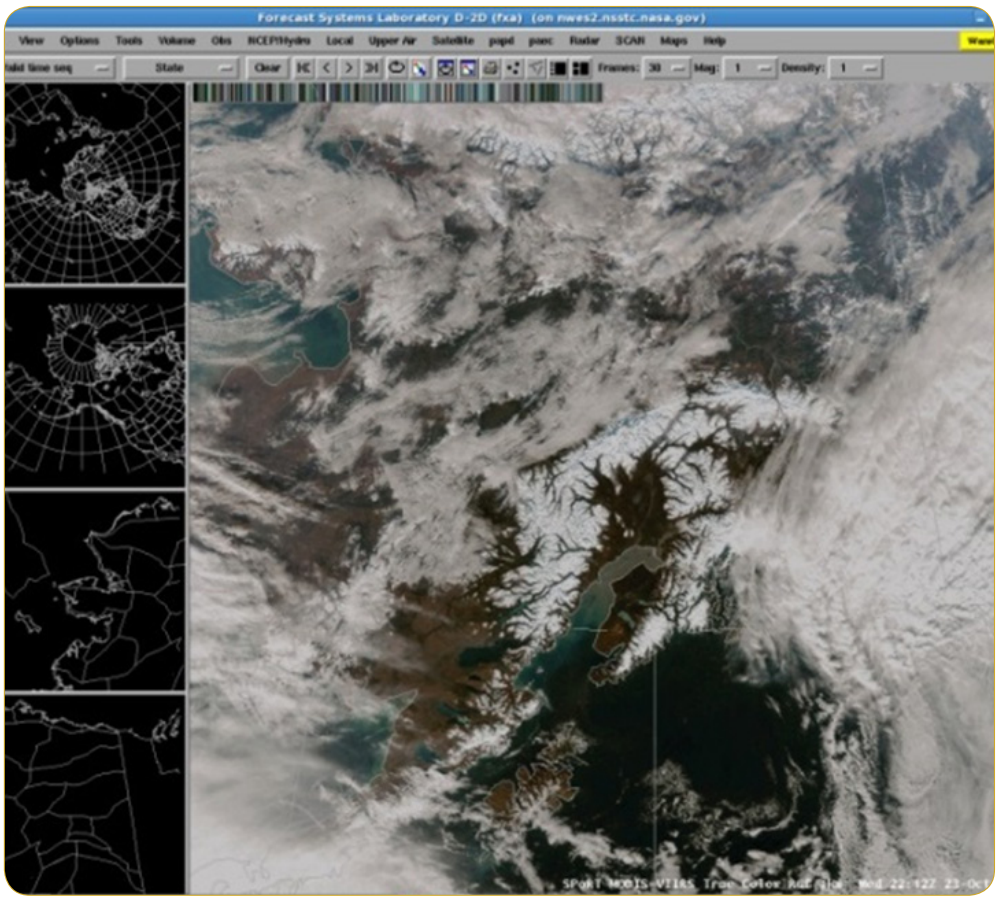
The LPW product suite developed by Dr. Stan Kidder and John Forsythe of CIRA is a composite of water vapor retrievals for multiple layers using microwave sensors on polar orbiting satellites (NOAA-18, NOAA-19, Metop-A and DMSP F-18), mapped to a 16-km grid. The use of microwave data provides an advantage over infrared soundings that need a cloud-free view to see low-level moisture. The NASA Atmospheric Infrared Sounder (AIRS) on Aqua is used to augment the microwave retrievals in cloud free layers and has the advantage that it will retrieve moisture information over snow-covered land areas, which often is the case in winter for Alaska. The LPW fills the gaps left by traditional point observations (e.g. radiosondes) and infrared channels focused only on upper level moisture. Like the CIRA Blended TPW product, LPW uses similar satellites; however, the resulting LPW products are layers of precipitable water verse a column total (see Figures for comparison). The applications of LPW include diagnosis of vertical moisture distribution, wide spatial coverage over data void areas and hence detailed analysis of moisture gradients, as well as an independent data set for comparison to NWP model moisture. Initial evaluation of LPW occurred by Alaska and other OCONUS users from July 15 – September 15. Input is being used to create the next version of the product to help users better compare it to NWP models and other point datasets.



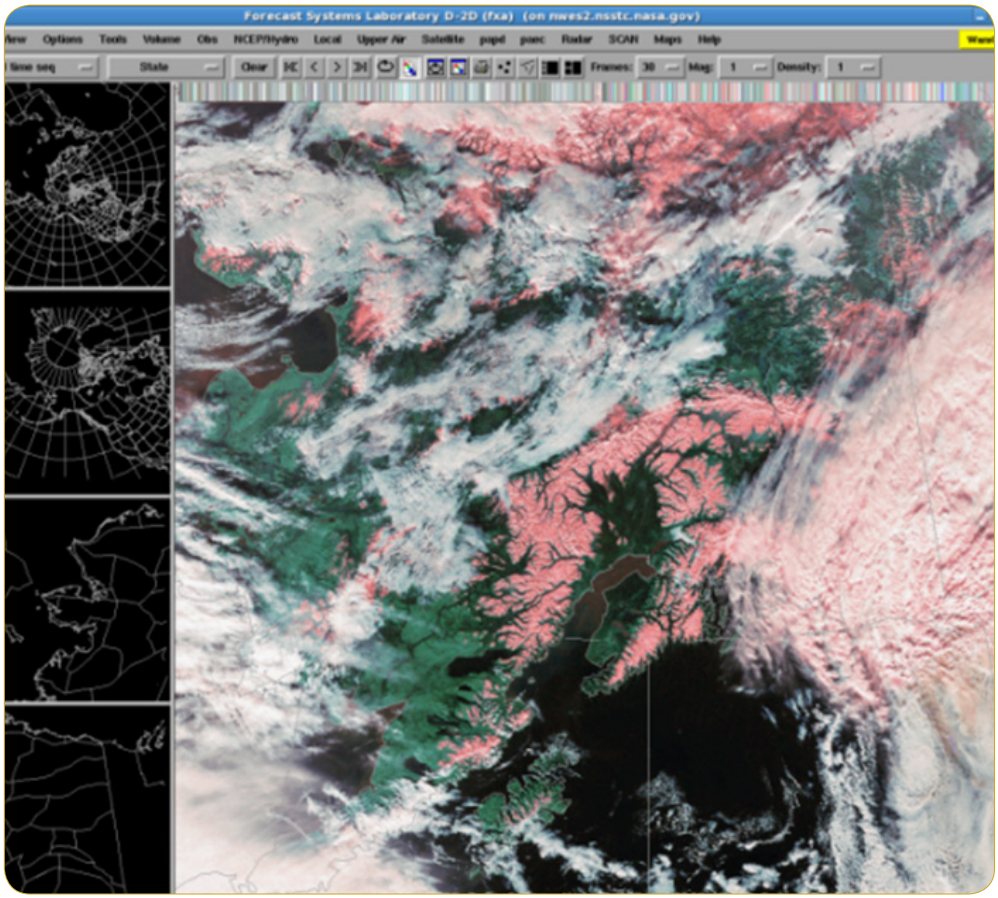
# RGB Imagery

There are many composite red, green, blue (RGB) imagery products currently available for Alaska users via instruments such as MODIS and VIIRS. The value of RGB imagery is the ability to incorporate multiple infrared or visible channels within the same satellite image. The “True Color” image below gives the sense that one is looking at the earth from space. For true color imagery three visible channels are used to create what your eyes would see, hence, the clouds appear white, the land features are in greens and browns, and the oceans are in a deep blue or aqua color.

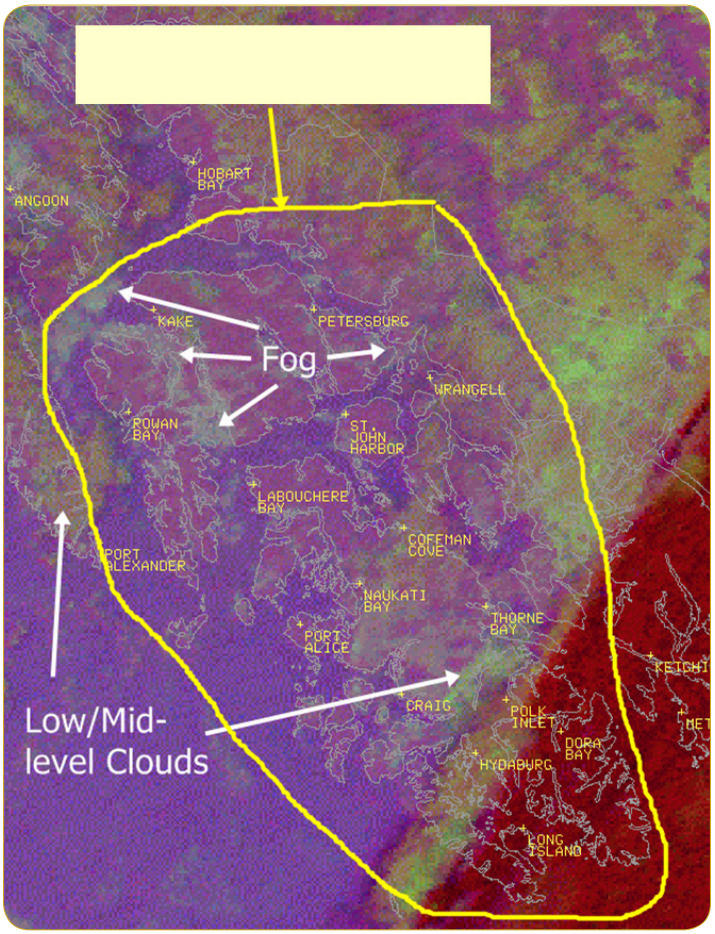



Taking this concept a step further, a combination of visible and infrared channels is used to create RGBs where the colors are less intuitive, but provide even greater value. The Snow-Cloud RGB for the same time as the True Color RGB shows bare ground in aqua, clouds in white or pink, and snow on the ground as red. The Snow-Cloud RGB helps to differentiate clouds and snow cover in a scene and has been used to monitor snow melt as applied to hydrology forecasts.

The previous examples use a single channel in each of the RGB color components available from NASA-NOAA polar-orbiting instruments. However, EUMETSAT product developers have created a “best practices” suite of RGB imagery from their experiences with the SEVIRI instrument on the MeteoSat Second Generation (MSG) geostationary satellite. These standardized RGBs often use channel differences as one of the color components. For example, the familiar 11-3.9μm difference imagery often used to identify low clouds and fog is just one of the color components to the Nighttime Microphysics RGB product. SPoRT is providing this and other best-practices RGBs from both MODIS and VIIRS and these are available within the AWIPS/D-2d Satellite menu.



In the Nighttime Microphysics RGB example shown below, fog is more easily identified from other low and mid-level cloud features within the narrow channels of southeast Alaska. SPoRT is evaluating the use of this RGB imagery for Aviation and Cloud Analysis as part of its GOES-R and JPSS Proving Ground Activities. NWS users in the Southern Region as well as parts of the Rocky Mountain Front Range have found value in the ability of the RGB to provide information on the cloud type and physical characteristics to enhance aviation forecasts. SPoRT plans to conduct a similar evaluation with NWS Alaska forecasters in December/January (2013/14). Training for the Nighttime Microphysics Imagery is available in the form of a "micro-lesson" (8-minute module) as well as a Quick Guide for use directly within the operations area.




## SPoRT Products at Alaska WFOs

SPoRT has been providing Alaska WFOs with at least a few products for more than three years, beginning with the composite Sea Surface Temperature product (accompanied by a latency product). For about the last two years, SPoRT has provided WindSat data received through NRL-Monterrey. Those data are inserted into AWIPS I as if they are from the QuikSCAT instrument since AWIPS I code has been virtually frozen. Since this summer SPoRT has delivered the NESDIS (GOES-based) Quantitative Precipitation Estimate and CIRA's Layered Total Precipitable Water products. Also begun this past summer was the suite of RGB products for MODIS and VIIRS swaths:

- Air Mass (using CrIS water vapor)
- Dust
- True Color
- Snow-Cloud Differentiation
- Nighttime Microphysics
- Day-Night Band Radiance
- Day-Night Band Reflectance

and the Geo/LEO Hybrid product suite:

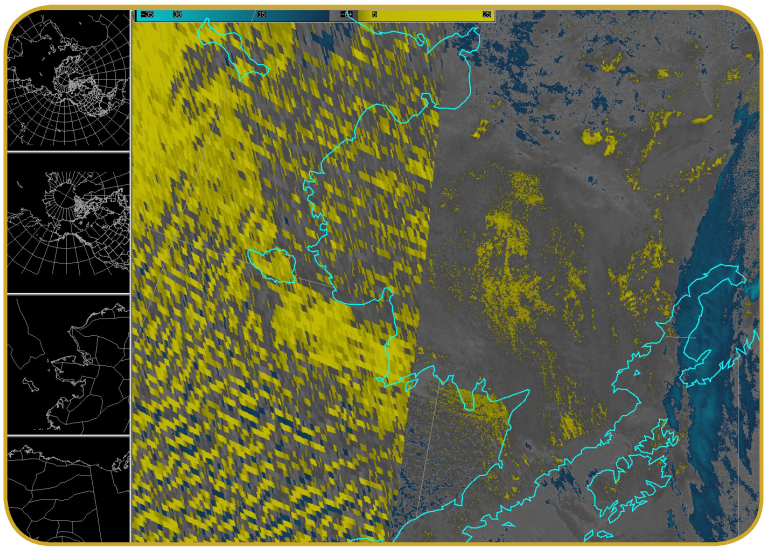
- Visible
- Longwave IR
- Shortwave IR
- Spectral Difference (with LEO Nighttime Microphysics)
- Water Vapor (with LEO Air Mass [MODIS-only])

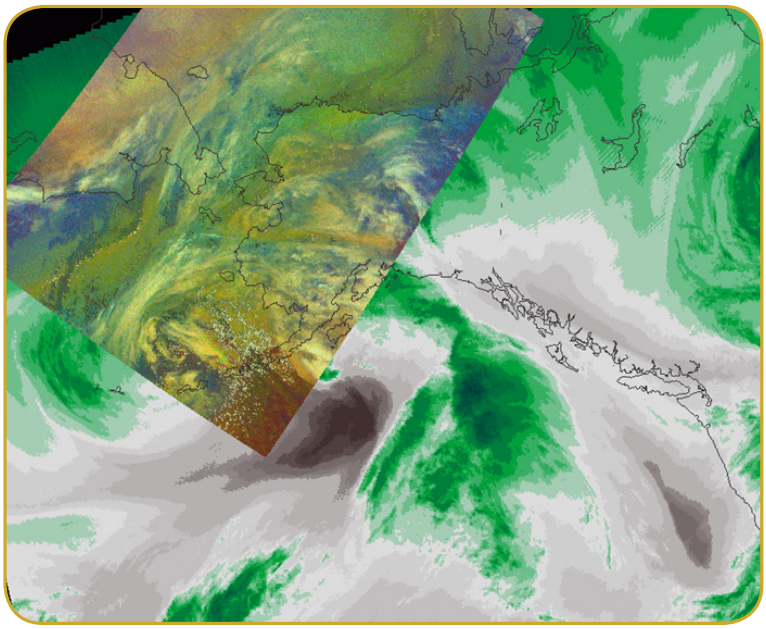
Most of these SPoRT data are available (at a reduced resolution) on the SPoRT website.

The first product evaluation with Alaska WFOs was with WindSat data in the fall of 2011. There have been two other Alaska evaluations — both this past summer: QPE and LPW.

# Geo/LEO Hybrid

For 3 years SPoRT has been creating the Geo/LEO Hybrid products - combining the best of both geostationary and polar-orbiting (low-earth orbit) platform data. The foundation of the Alaska version of the product is the 15-min frequency GOES-15 (GOES-West) imagery. SPoRT uses the visible, shortwave- and long-wave-infrared, and water vapor channels. These images provide animation capabilities and continuity of rapidly changing conditions. Unfortunately, especially at high latitudes, the effective resolution is considerably reduced — compared to the equatorial resolutions of 1km visible and 4km IR. In far Northern reaches of Alaska, GOES imagery is almost useless. The SPoRT Hybrid products help to solve this problem. The Hybrid product simply inserts higher resolution polar-orbiting MODIS (from Terra and Aqua platforms) and VIIRS (from Suomi-NPP) into the GOES images, when available. The result is an animation sequence where cloud motion or changing surface features which were poorly detected become clear. Then, in one of the images, polar-orbiting data clearly shows cloud and surface features (This image shows a VIIRS swath ascending northwestward on the right half of the image.) It's like finally putting on your reading glasses! Along with the Visible, SWIR, LWIR, and Water Vapor channels, SPoRT generates two RGB Hybrid products: (1) the basic spectral difference (11μm – 3.9μm) 'fog' product with GOES data –inserting the Nighttime Microphysics RGB swath data when available and (2) the GOES Water Vapor channel – inserting the Air Mass RGB swath data when available (This is for MODIS data only, since VIIRS does not have a water vapor channel.) SPoRT plans to enhance this product in the coming months by adding other polar-orbiting instruments, like AVHRR.





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