Two New Multi-Spectral Composite Satellite Products and their Use by NWS Alaska Region in Aviation Forecasting

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Introduction

Using an approach originally developed at the European Organization for the Exploration of Meteorological Satellites (EUMETSAT), the Short-Term Prediction Research and Transition (SPoRT) Center has worked with the Geographic Information Network of Alaska (GINA) at the University of Alaska to generate two multi-spectral composite, or "RGB," products by combining several Moderate-Resolution Imaging Spectroradiometer (MODIS) and Visible Infrared Imaging Radiometer Suite (VIIRS) channels into single images. The raw MODIS and VIIRS data are received via direct broadcast by GINA, and the resulting multi-spectral composite imagery is distributed in near real time for use by the National Weather Service (NWS) in Alaska. The RGB Nighttime Microphysics and RGB 24hr Microphysics products highlight the presence of low clouds and fog which can negatively impact aviation and the general public, particularly in areas of complex terrain.

Ideally, these new MODIS and VIIRS products will provide value beyond the capabilities of traditional satellite imagery such as the infrared channel differencing "fog product." It is also hoped that these products will be of particular use in Alaska due to the comparatively high frequency of coverage from the MODIS and VIIRS instruments at higher latitudes, and because coverage from other in-situ data such as surface observations and weather radars is quite limited over much of Alaska.

SPoRT's RGB Nighttime Microphysics product was delivered to the NWS in Alaska and formally assessed by NWS meteorologists in real time and under actual operational conditions during the winter of 2013/2014; a similar assessment was conducted for both the Nighttime and 24hr Microphysics RGBs in the winter of 2014/2015. Some results of these assessments are presented, along with an outline for future plans for these RGB microphysics products.

Two RGBs, Two Purposes

The Nighttime and 24hr Microphysics RGBs build upon the traditional 11µm-3.9µm channel differencing "fog product." As shown in table 1, this channel differencing is used as the green component of the Nighttime Microphysics RGB. The Nighttime RGB then adds additional information in the red and blue components to provide more detail and subtlety. The Nighttime Microphysics RGB from April 1, 2015, 4:01am AKDT is shown in figure 1. The yellow-green colors within the white circle indicate patchy lower stratus clouds, and such clouds were reported by surface weather observations.

One shortcoming of the 11µm-3.9µm channel differencing method, and of any product (such as the Nighttime Microphysics RGB) that incorporates this channel differencing, is its lack of utility during the daytime, as the 3.9µm wavelength is influenced by both solar reflectance and radiance, and therefore the relationship of the differencing changes due to reflectance. The 24hr Microphysics RGB is an attempt to mitigate this problem by substituting the 8.7µm wavelength (which is not influenced by reflected shortwave radiation) for the 3.9µm wavelength. Figure 2 is from the same time as figure 1, but shows the 24hr Microphysics product. Figure 3 is a Nighttime Microphysics RGB when half the image is illuminated by sunlight and half the image is in darkness and shows the limitations of the 3.9µm wavelength.

Color	Band(s)	Physically Relates to…	Small contribution to composite means…	Large contribution to composite means…
Red	12.0µm – 10.8µm	Optical Depth	Thin clouds	Thick clouds
Green	10.8µm – 3.9µm	Particle phase and size	Ice particles, or bare ground	Water clouds with small particles
Blue	10.8µm	Temperature of surface	Cold surface	Warm surface

Table 1: Composition of the Nighttime Microphysics Product

Color	Band(s)	Physically Relates to…	Small contribution to composite means…	Large contribution to composite means…
Red	12.0µm – 10.8µm	Optical Depth	Thin clouds	Thick clouds
Green	10.8µm – 8.7µm	Particle phase and size	Ice particles, or bare ground	Water clouds with small particles
Blue	10.8µm	Temperature of surface	Cold surface	Warm surface

Table 2: Composition of the 24hr Microphysics Product. The only difference between the two RGBs is in the green channel, with the 24hr RGB using the 8.7µm wavelength rather than 3.9µm.

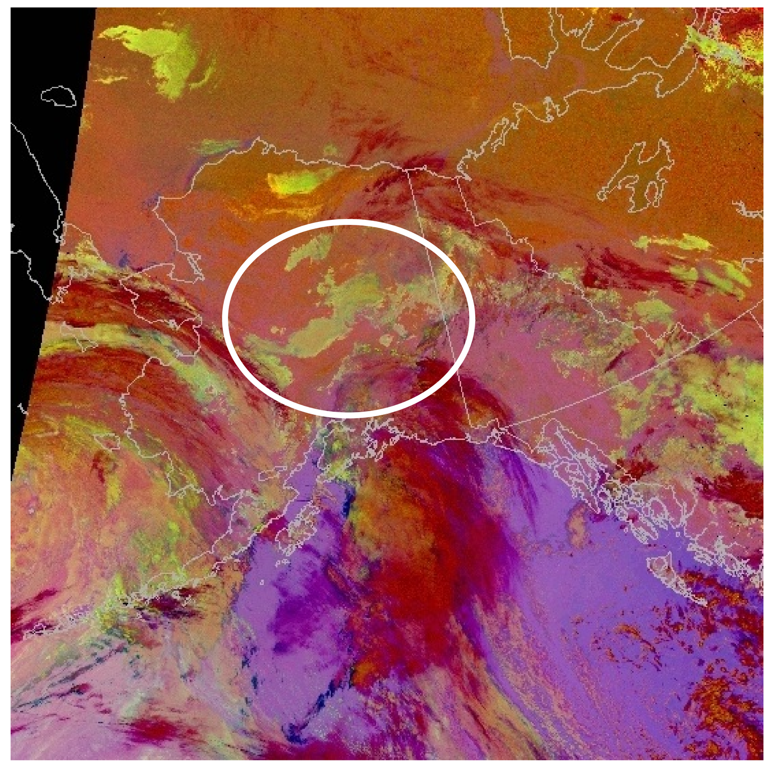

Figure 1: VIIRS-based Nighttime Microphysics RGB, April 5, 2015 at 1201 UTC, 4:01am AKDT.

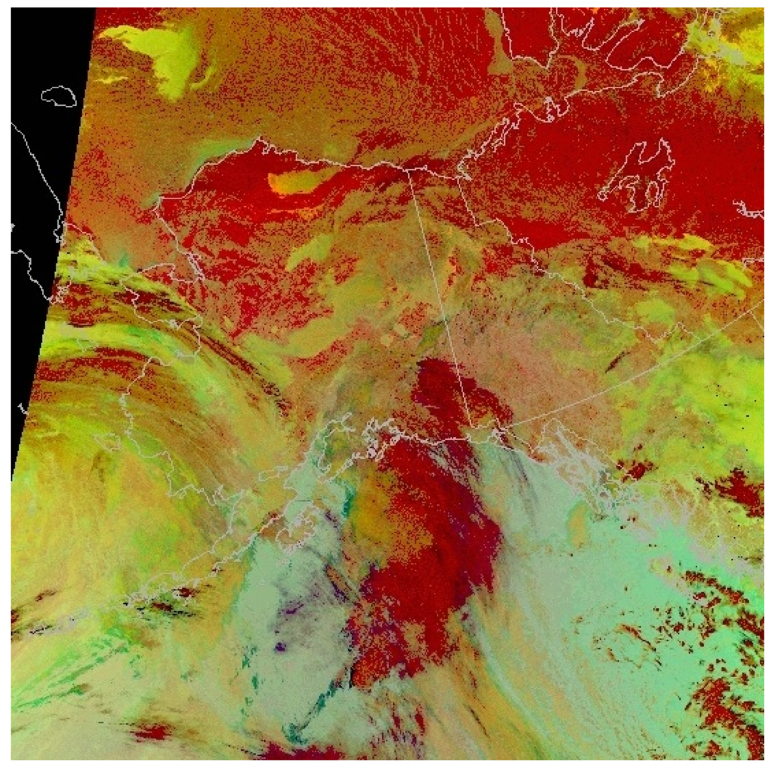

Figure 2: VIIRS-based 24hr Microphysics RGB, April 5, 2015 at 1201 UTC, 4:01am AKDT.

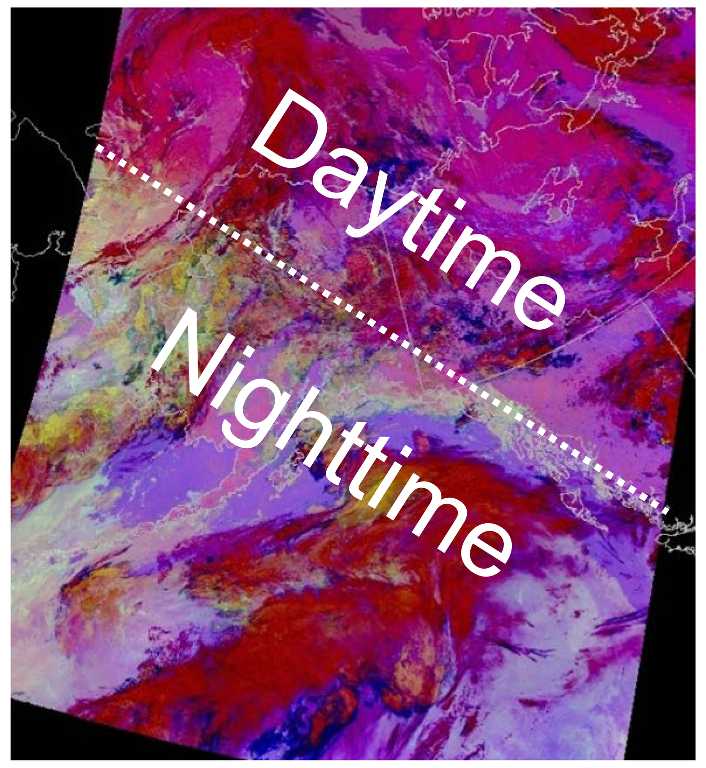

Figure 3: VIIRS-based Nighttime Microphysics RGB, July 17, 2014 at 1217 UTC, 4:17am AKDT.

Results of the Winter 2015 Assessment

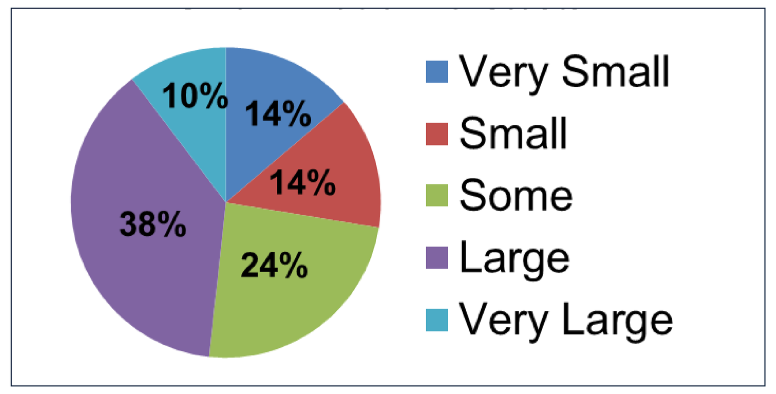

Figure 4: Survey results concerning impact of the Nighttime Microphysics RGB on aviation forecasts

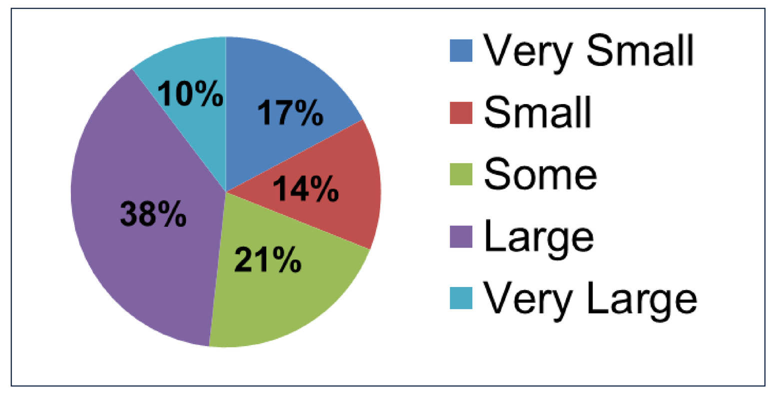

Figure 5: Survey results concerning impact of the 24hr Microphysics RGB on aviation forecasts

The Nighttime Microphysics RGB was assessed by forecasters at NWS field offices in Alaska during the winter of 2013-2014. Building upon the 2013-2014 assessment and the familiarity NWS forecasters were developing with RGBs, both the Nighttime and 24hr Microphysics RGBs were then assessed in January and February 2015.

One component of the winter 2015 assessment was a web-based form hosted by SPoRT where NWS forecasters rated the RGBs' performance in the real-time operational environment. NWS forecasters at Juneau, Anchorage, and Fairbanks completed 29 such forms. As shown in figures 5 and 6, survey results indicated that the Nighttime and 24hr RGBs added at least some value to aviation forecasting in 72% and 69% of cases, respectively. For both RGBs, the most common response was to report a "large impact" on the forecast process.

A number of NWS meteorologists remarked that both RGBs fit well into their forecast methodologies when combined with other datasets such as surface observations, web cams, and output from numerical models, and that the RGBs augmented the utility of, but did not replace, other satellite products. Both products were applied in support of forecasting for aviation and the general public, particularly when the "problem of the day" was assessing the presence, or the absence, of low stratus and fog.

Forecasters' comments generally revealed a preference for the Nighttime Microphysics RGB over the 24hr Microphysics RGB at night. The look of the 24hr product was occasionally described as comparatively "washed out," a characteristic that made finding subtle details difficult. This preference is not surprising, as the 24hr Microphysics product was developed with the motivation of mitigating the shortcomings of the Nighttime product during the day, and the 2015 assessment took place during a period of predominant darkness in Alaska.

Plans for the summer of 2015

SPoRT and GINA will facilitate another assessment of the 24hr Microphysics RGB by the NWS in Alaska during the summer of 2015. One goal is to learn how much value the 24hr Microphysics RGB offers forecasters during the long Alaskan days when the Nighttime Microphysics and traditional channel differencing products are of less use. Additionally, anticipating advances in infrastructure at both GINA and the NWS, "client-side production" of these RGBs at NWS field offices will be explored, with the hope that the resulting products will offer finer spatial resolution and deeper bit depth.

Data Cited and Acknowledgment

Background image is the MODIS-based Nighttime Microphysics RGB from 0737 UTC April 1, 2015 made from data received at GINA via direct broadcast and posted online at http://weather.msfc.nasa.gov/sport/

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