GINA

ALASKA DIRECT BROADCAST QUICK GUIDES

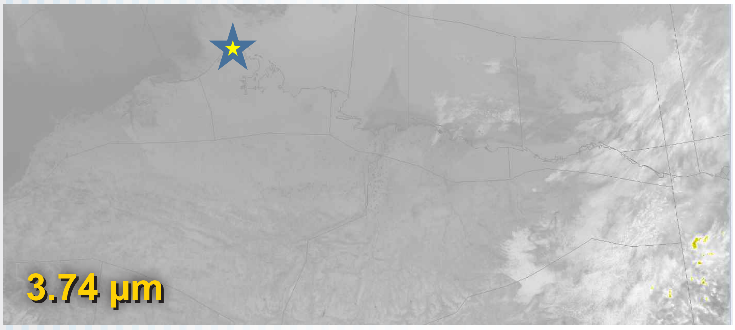
The 3.74 µm "Fog and Fire" Band

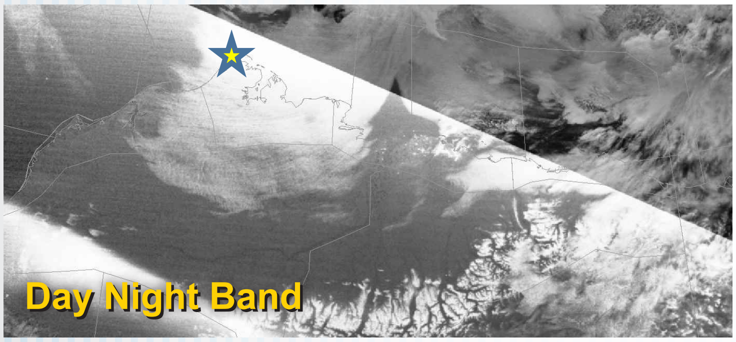
OVERVIEW

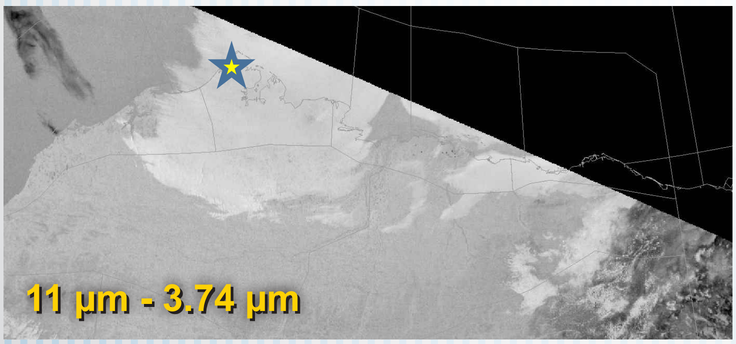
The 3.74 µm channel is in the mid-wave portion of the infrared spectrum and has utility in identifying areas of fog and low stratus when combined with longwave infrared imagery and also in identifying wildfires when used as a stand-alone image.

FINDING FOG WITH THE 3.74 µm CHANNEL

The three images below are from a VIIRS pass at 1128Z on September 3, 2015, over Alaska's North Slope; a star has been placed over Barrow for reference. At 1127Z WSO Barrow took a SPECI observation indicating a ceiling of 300 ft vertical visibility and ¾ mile visibility in mist. The stand-alone 3.74 µm image at top does not offer enough contrast or detail to allow an accurate analysis of the stratus and fog. The low clouds appear much more distinct in the Day Night Band image at middle. Note the sharp line running across the Day Night Band from the upper left to the middle right of the image—the area northeast of this line is illuminated by daylight, and consequently a different processing scheme must be used in that area. At bottom is the traditional "fog product" highlighting the difference in brightness temperatures between the 11 µm longwave IR and the 3.74 µm channel, and here the low clouds and fog are easier to identify.







The channel differencing approach (bottom image) works because liquid water cloud droplets, even super-cooled droplets, exhibit different emissivity at 11 µm and 3.74 µm. Areas with large differences in brightness temperature in this product are thus assumed to be covered by low stratus or fog.

Weaknesses of the channel differencing product include vulnerability to blockage by higher clouds above the stratus and fog, as well as a restriction to the hours of darkness. Note how the fog product at bottom includes no data over the area covered by sunshine in the Day Night Band. The 3.74 µm channel, while still being in the infrared, is of a short enough wavelength that any sunshine reflecting off of clouds overwhelms the emissivity signal at 3.74 µm, with the result that the channel differencing is overly noisy and unusable during daylight hours.

ADDITIONAL REFERENCES

- Blog entry from CIRA about 3.74 µm and other wavelengths used to detect fires in Alaska: http://rammb.cira.colostate.edu/projects/alaska/ blog/index.php/uncategorized/the-land-of-10000-fires/
- Quick guides to channels on the GOES-R Advanced Baseline Imager (ABI). ABI Band 7 is centered at 3.9 µm http://www.goes-r.gov/education/ABI-bands-quick-info.html
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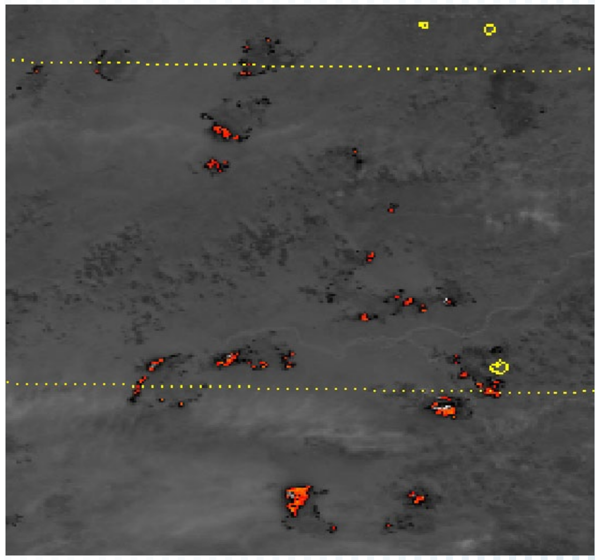
THE HEAT IS ON

The 3.74 μm wavelength is sensitive to the temperatures at which wildfires burn and can be used as a stand-alone image to identify active fires. This functionality is not dependent on the presence or absence of incoming shortwave radiation from the sun, so is valid both day and night. However, the 3.74 μm channel cannot see through thick clouds. While the 3.74 μm channel is a great tool for identifying areas of active burning, it does not depict the smoke from wildfires well.



The VIIRS I4 band zoomed over wildfires in Alaska's Interior, 2209Z July 4, 2015 .

FIRE WORKS ON THE FOURTH OF JULY

At right is the VIIRS I4 3.74 μm band over Alaska's Interior at 2209Z July 4, 2015, a period of aggressive wildfire behavior. Wildfires are assigned colors from red to orange to yellow with increasing temperature and intensity; areas without wildfire are colored various shades of gray. However, the 3.74 μm channel has a weakness: it saturates in cases of particularly hot temperatures. In such cases, the imagery can suffer from "fold over" such that the hot cores of the fires actually appear very cool in the 3.74 μm imagery; this caveat is conceptually similar to "range folding" in 88D velocity data under conditions of extreme wind. The VIIRS M13 4.0 μm channel has a coarser spatial resolution than the VIIRS I bands (750 m versus 375 m), but the M13 can detect fire temperatures without suffering from the I4's "fold over" problem and thus depicts the temperatures of the cores of the hottest fires more accurately.

(Images provided by Dr. Curtis Seaman of CIRA.)

Satellite(s)	Instrument	Band Name	Wavelength	Resolution at NADIR
Suomi NPP	VIIRS	I4	3.74 μm	375 m
Terra and Aqua	MODIS	20	3.75 μm	1000 m
POES and METOP	AVHRR	3b (available only during nighttime)	3.74 μm	1100 m

Table showing the various satellites that carry instruments generating imagery at (roughly) 3.74 μm. Note how the spatial resolution of the MODIS channels has changed from 250 m at nadir for the 0.64 μm channel up to 1000 m for the 3.75 μm channel. Across this same spectral range, the resolutions of the VIIRS I bands and AVHRR bands have remained constant at 375 m and 1100 m, respectively.

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