Suomi NPP VIIRS
Near Constant Contrast (NCC) Imagery

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Unique features of VIIRS, as compared with its predecessors

- Finer spatial resolution for all bands (down to 375 m)
- Finer spatial resolution at swath edge in particular
- Wider (3000 km) swath, leaving no gaps between adjacent orbits
- DNB / NCC enables visible light imagery under all natural and artificial illumination conditions
See next image for comparison of spatial resolution at swath edge (within white circles)
VIIRS vs. MODIS spatial resolution at swath edge
(blowup of images within white circles in previous slide)

VIIRS – ~1.5 km @ swath edge
(M-band 750 m @ nadir)

MODIS – ~5 km @ swath edge
(1 km @ nadir)

Note that these images are not of the same clouds.
See next slide for comparison of spatial resolution at swath edge (within white circles)
VIIRS vs. AVHRR spatial resolution at swath edge
(blowup of images within white circles in previous slide)

VIIRS – 1.5 km @ swath edge
(M-band 750 m @ nadir)

AVHRR – 5.5 km @ swath edge
(LAC 1.1 km @ nadir)

Note that these images are not of the same clouds, but are from similar scan angles.
Land (vegetated or not) and cloud
Ice, water, and cloud
Better resolution at swath edge

a) MODIS (Edge of Scan)

b) VIIRS (Edge of Scan)
# VIIRS Environmental Data Record (EDR)s

Bands highlighted in **pale yellow** are specifically-required Imagery EDRs. **Other Imagery EDRs** are highlighted in **grey**.

<table>
<thead>
<tr>
<th>VIIRS Band</th>
<th>Central Wavelength (µm)</th>
<th>Wavelength Range (µm)</th>
<th>Band Explanation</th>
<th>Spatial Resolution (m) at nadir</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>0.412</td>
<td>0.402 - 0.422</td>
<td>Visible</td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td>0.445</td>
<td>0.436 - 0.454</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M3</strong></td>
<td>0.488</td>
<td>0.478 - 0.488</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M4</strong></td>
<td>0.555</td>
<td>0.545 - 0.565</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M5 (B)</strong></td>
<td>0.672</td>
<td>0.662 - 0.682</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M6</td>
<td>0.746</td>
<td>0.739 - 0.754</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M7 (G)</strong></td>
<td>0.865</td>
<td>0.846 - 0.885</td>
<td>Near IR</td>
<td></td>
</tr>
<tr>
<td>M8</td>
<td>1.240</td>
<td>1.23 - 1.25</td>
<td></td>
<td>750 m</td>
</tr>
<tr>
<td><strong>M9</strong></td>
<td>1.378</td>
<td>1.371 - 1.386</td>
<td>Shortwave IR</td>
<td></td>
</tr>
<tr>
<td>M10 (R)</td>
<td>1.61</td>
<td>1.58 - 1.64</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M11</strong></td>
<td>2.25</td>
<td>2.23 - 2.28</td>
<td>Medium-wave IR</td>
<td></td>
</tr>
<tr>
<td><strong>M12</strong></td>
<td>2.45</td>
<td>2.4 - 2.45</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M13</strong></td>
<td>4.05</td>
<td>3.97 - 4.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M14</strong></td>
<td>8.55</td>
<td>8.4 - 8.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>M15</strong></td>
<td>10.763</td>
<td>10.26 - 11.26</td>
<td>Longwave IR</td>
<td></td>
</tr>
<tr>
<td><strong>M16</strong></td>
<td>12.013</td>
<td>11.54 - 12.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNB</td>
<td>0.7</td>
<td>0.5 - 0.9</td>
<td>Visible</td>
<td>750 m across full scan</td>
</tr>
<tr>
<td><strong>I1 (B)</strong></td>
<td>0.64</td>
<td>0.6 - 0.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I2 (G)</strong></td>
<td>0.865</td>
<td>0.85 - 0.88</td>
<td>Near IR</td>
<td></td>
</tr>
<tr>
<td><strong>I3 (R)</strong></td>
<td>1.61</td>
<td>1.58 - 1.64</td>
<td>Shortwave IR</td>
<td></td>
</tr>
<tr>
<td><strong>I4</strong></td>
<td>3.74</td>
<td>3.55 - 3.93</td>
<td>Medium-wave IR</td>
<td></td>
</tr>
<tr>
<td><strong>I5</strong></td>
<td>11.45</td>
<td>10.5 - 12.4</td>
<td>Longwave IR</td>
<td></td>
</tr>
</tbody>
</table>
Sensor Data Record (SDR) to Environmental Data Record (EDR)

- **Ground Track Mercator (GTM)** remapping software.
  - GTM is a *remapping* of the data, but the same radiances/reflectances for Non-NCC bands only.
- For NCC imagery there is additional radiance processing.
**NCC (EDR) vs. DNB (SDR)**

- What are the differences?

<table>
<thead>
<tr>
<th>Product</th>
<th>xDR</th>
<th>Units</th>
<th>Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>DNB</td>
<td>SDR</td>
<td>Radiances</td>
<td>Raw</td>
</tr>
<tr>
<td>NCC</td>
<td>EDR</td>
<td>Pseudo-albedos</td>
<td>GTM</td>
</tr>
</tbody>
</table>

- Which is better?
- Answer: Depends on the usage!
Near Constant Contrast (NCC) Product

Example of NCC performance for a day/night terminator (non-lunar) case. NCC extends constant contrast into the twilight portion of the granule swath.

Cross-terminator DNB SDR (top) versus NCC Imagery EDR (bottom)
Artifacts in the DNB SDR are inherited by the NCC Imagery EDR. Before August 2013 the most significant of these was a stray light issue with the DNB on the dark side of the terminator. The DNB SDR algorithm was adjusted to correct for this error in August 2013. The impact on the NCC Imagery EDR was profound. The removal of the stray light is evident in the bottom image, taken from the granule over the upper Midwest of the United States on 9 August 2013. As a reference, Lake Michigan may be seen in the middle of the granule.
The NCC Imagery EDR is produced under all solar and lunar illumination conditions, including cases where there is no illumination from either the sun or moon (i.e. new moon phase). The DNB is sensitive enough that air glow is sufficient to create an image, although such an image appears quite noisy. Here is an example of NCC Imagery at night when the moon was below the horizon. The example is Super Typhoon Phailin taken on the night of 10 October 2013. The typhoon, along with convective elements and its eye, are evident despite the extremely low levels of radiance present in the DNB spectrum. This is, in essence, the “worst case” scenario for NCC Imagery. As lunar illumination increases, the SNR improves and the noisiness in the DNB SDR decreases, with subsequent benefits to the NCC Imagery EDR.
Multi-sensor imagery sequence over the Puyehue-Cordón Caulle volcanic chain in Chile during an ongoing eruption

a) Aqua MODIS on 12 December 2011 at 1810 UTC, b) VIIRS DNB on 13 December at 0510 UTC for the inset box region of (a), and c) Aqua MODIS on 13 December at 1850 UTC.
DNB image of lightning from thunderstorms over Colombia and Venezuela taken 0644 UTC, 10 May 2012

Lightning strikes are identified by the red arrows. At the time this image was taken, the moon was approximately 80% full.
Mostly cloud-free DNB image over the U.S. Upper Midwest, 3 September 2012 at 0839 UTC

Note the lights from major cities, as well as a large cluster of oil flare signatures in northwestern North Dakota from the recently-developed Bakken formation.
Auroras in the DNB

Aurora Borealis over Saskatchewan, Canada on 9 March 2012, visible during a full moon!

Aurora Australis over Antarctica on 15 September 2012, during a new moon.
VIIRS DNB image, 1219 UTC, 7 October 2013

Note
Aurora (as well as stray light), Prudhoe Bay lights, and Veniaminof volcano on Aleutian Islands
Animations of DNB/NCC Imagery
Animation of VIIRS NCC images of the Pine Island Glacier, 7-18 November 2013
Animation of VIIRS NCC images of icebergs, 20-26 December 2013
Animation of VIIRS DNB images from 19-20 October 2013. The North Pole is located at the center of the image. Light from the ship carrying the 2014 Winter Olympic torch is visible.
Animation of selected VIIRS DNB images from 30 October to 2 November 2013. Images courtesy William Straka III (CIMSS).
DNB/NCC Imagery in combination with non-NCC Imagery
~ 100 km difference between exposed low-level circulation center as denoted by VIIRS DNB and the sheared higher level convection further to the SE. Image courtesy of NRL-Monterrey.
3-color R/G/B (DNB/SWA/LWIR) @ day
### 3-color/RGB combinations

<table>
<thead>
<tr>
<th></th>
<th>Red</th>
<th>Green</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>I01/Visible</td>
<td>SW Albedo</td>
<td>LWIR</td>
</tr>
<tr>
<td>Day - alternative</td>
<td>DNB/NCC</td>
<td>SW Albedo</td>
<td>LWIR</td>
</tr>
<tr>
<td>Night</td>
<td>DNB/NCC</td>
<td>SW Albedo</td>
<td>LWIR</td>
</tr>
</tbody>
</table>

### 3-color/RGB product explanation

<table>
<thead>
<tr>
<th>Color</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>White/off-white</td>
<td>Low-clouds/stratus/fog</td>
</tr>
<tr>
<td>Green</td>
<td>Clear/land surfaces</td>
</tr>
<tr>
<td>Magenta-purple</td>
<td>Ice clouds</td>
</tr>
<tr>
<td>Magenta-red</td>
<td>Snow covered ground</td>
</tr>
<tr>
<td>Blue</td>
<td>Water surfaces</td>
</tr>
</tbody>
</table>
3-color R/G/B (DNB/SWA/LWIR) @ night
VIIRS Imagery outreach at RAMMB/CIRA

• VIIRS Imagery and image products outreach:
  – VIIRS Imagery and Visualization Team Blog
    (http://rammb.cira.colostate.edu/projects/npp/blog/)
  – Seeing the Light: VIIRS in the Arctic
    (http://rammb.cira.colostate.edu/projects/alaska/blog/)
  – Suomi NPP VIIRS Online (including direct-broadcast imagery)
    (http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp)

• NRL-Monterey uses of VIIRS:
  – VIIRS Cal/Val
    http://www.nrlmry.navy.mil/VIIRS.html
Summary

• VIIRS EDR Imagery (including NCC Imagery has reached the Validation 3 maturity stage in January 2014.
• Feedback is still requested from users.
• NCC will continue as unique imagery on JPSS-1 and 2!
• Our only major concern is data latency for non-direct-broadcast users (~6 hours).

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