Current Status of Cloud Properties from VIIRS on JPSS-1 for CERES

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Outline

• J1-VIIRS Introduction & Data used for this work
• Reflectance and brightness temperature comparisons between J1-VIIRS & NPP-VIIRS
• Pixel level examples, NPP-VIIRS vs J1-VIIRS
• Global maps and stats, NPP-VIIRS vs J1-VIIRS
• Summary & Future Plans
• J1 was launched on November 18, 2017

• J1 was renamed NOAA-20 after launch

• J1 carries 5 Instruments:
  - VIIRS
  - CERES
  - ATMS
  - CrIS
  - OMPS

• CERES analyzes VIIRS data to derive cloud properties
NPP-VIIRS

Polar Orbital Satellite
Altitude: 824 km
Period: 1.7 hr (101.44 min)
Inclination: 98.7 degree
Ground track: 20 km repeat accuracy at equator with 16 days repeat cycle
Each scan: 3040 km wide x 12 km
M band: 16 detectors
I band: 32 detectors

J1-VIIRS

Same
Polar Orbital Satellite
Period: 1.7 hr (101.44 min)
Altitude: 824 km
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Ground track: 20 km repeat accuracy at equator with 16 days repeat cycle
Each scan: 3040 km wide x 12 km
M band: 16 detectors
I band: 32 detectors

J1 leads NPP by 50.75 min.
Examples of J1 and NPP orbits
May 2018, day 22

Hour 7

Hour 7, same hour
Examples of J1 and NPP tracks

201805 day 22

Hour 7

Hour 7, same hour

Hour 8, an hour later
Data

- J1, the first data date was April 11, 2018

- For this work:
  - J1-VIIRS, May 2018
  - NPP-VIIRS, May 2018
  - Aqua-MODIS, May 2018
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Conditions for matching pixels from J1-VIIRS and NPP-VIIRS

- Time within half hour
- Solar zenith angles within 5°
- View zenith angles within 5°
- Azimuth angles within 7.5°
- 5 min grid box
Day

Night

Number of matched pixels

May 2018
May 2018

- J1-VIIRS: 7-8% higher than NPP
Reflectance 1.6 µm, Daytime

- J1-VIIRS: 13-14% lower than NPP

May 2018

Intercept: 0.000000
Slope: 0.865589
Mean PY-PX: -0.0325618
Stdev PY-PX: 0.0861059
Total Counts: 8558819
Reflectance 2.25 \( \mu m \), Daytime

- J1-VIIRS: 10% lower than NPP

May 2018
• J1-VIIRS: 4% lower than NPP
Brightness Temperature, Daytime

J1-VIIRS

- Total Count: 8603561
- Intercept: 0.000000
- Slope: 0.998313
- Mean PY-PX: 0.0968430
- Stdev PY-PX: 6.505000

NPP-VIIRS

- Total Count: 8603561
- Intercept: 0.000000
- Slope: 1.00036
- Mean PY-PX: 0.0308831
- Stdev PY-PX: 3.58446

May 2018

- 3.74 µm
- 8.55 µm
- 10.76 µm
- 12.01 µm
Brightness Temperature, Nighttime

May 2018

J1-VIIRS

Total Count

NPP-VIIRS

Brightness Temperature

3.74 µm

8.55 µm

10.76 µm

12.01 µm

Total Count
J1 and NPP matching areas are over polar regions

To see comparisons for non-polar regions:

- Match NPP with Aqua to find the relationship between Aqua and NPP
- Match J1 with Aqua, using relationship of Aqua and NPP → J1 vs NPP
Number of matched counts from NPP and Aqua

20180503 day time

Number of matched counts from J1 and Aqua

20180515 day time
Reflectance 0.6 $\mu$m, Daytime

May 3rd, 2018

NPP .vs. Aqua

<table>
<thead>
<tr>
<th>J1 .vs. Aqua</th>
</tr>
</thead>
</table>

| J1 .vs. NPP |

NPP agrees with Aqua well

J1 ~ 8% higher than Aqua

J1 ~ 7-8% higher than NPP
Brightness Temperature 3.74 μm, Night time

May 3rd, 2018

NPP vs. Aqua

J1 vs. Aqua

J1 vs. NPP

NPP cutoff ~ 210 K

J1 cutoff ~ 210 K
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May 18, 2018, Over Russia
Cloud Fraction Difference (J1 – NPP), May 2018

Cloud Fraction (J1 – NPP) (%)

<table>
<thead>
<tr>
<th></th>
<th>Ocean</th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>-1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Night</td>
<td>-0.03</td>
<td>-1.0</td>
</tr>
</tbody>
</table>
Ice Cloud Optical Depth Difference (J1 – NPP), May 2018, Day

- J1 ice tau is ~ 5 larger than NPP globally
- Due to J1 0.6 μm ref 7-8% too high
• J1 water tau is ~ 3 larger than NPP globally
• Due to J1 0.6 \( \mu \text{m} \) ref 7-8% too high
Cloud Effective Height Difference (J1 – NPP) (km), May 2018

### Day Time

<table>
<thead>
<tr>
<th></th>
<th>Ice</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-polar</td>
<td>-0.39</td>
<td>-0.19</td>
</tr>
<tr>
<td>polar</td>
<td>-0.13</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

### Night Time

<table>
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<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-polar</td>
<td>-0.04</td>
<td>-0.00</td>
</tr>
<tr>
<td>polar</td>
<td>0.04</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

- Regional differences exist
- Essentially no differences globally
Particle Size Difference \((\text{J1} - \text{NPP})\) (\(\mu\text{m}\)), May 2018, Day

J1 re: 1 – 1.5 \(\mu\text{m}\) larger than NPP
Summary

- **J1 Solar channels:**
  - 0.6 $\mu$m $\rightarrow$ 8% higher than NPP
  - 1.6 $\mu$m $\rightarrow$ 13-14% lower than NPP
  - 2.25 $\mu$m $\rightarrow$ 10% lower than NPP
  - 1.24 $\mu$m $\rightarrow$ 4% lower than NPP.

- **J1 Thermal channels are quite consistent with NPP**

- Calibrate both J1 and NPP with Aqua respectively to have a better coverage.

- With current J1-VIIRS,
  - clouds 1.3% lower than NPP over ocean and 1.7% higher
  - tau is 5-8 higher than NPP
  - clouds height consistent with NPP
  - re $\sim$ 1-1.5 $\mu$m larger than NPP
Future Plan

- J1 Solar Channels Calibrations

- After calibration, repeat the same process. Hopefully the inconsistency issues in cloud properties will be resolved

- Deliver one PGE to run both NPP-VIIRS and J1-VIIRS.