Why is the SO₂ RGB Important?
Sulfur dioxide (SO₂) is a gas commonly released into the atmosphere during volcanic eruptions. In high concentrations it is toxic to humans and has considerable environmental effects, including volcanic smog, acid rain, and is harmful to vegetation downwind of the eruption. The SO₂ RGB product can be used to detect and monitor large sulfur dioxide emissions from volcanoes, as well industrial facilities such as power plants.

SO₂ RGB Recipe

<table>
<thead>
<tr>
<th>Color</th>
<th>Band / Band Diff. (µm)</th>
<th>Min to Max Gamma</th>
<th>Physically Relates to...</th>
<th>Small contribution to pixel indicates...</th>
<th>Large Contribution to pixel indicates...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>6.95 – 7.34 Ch 9 – Ch 10</td>
<td>-4.0 to 2.0 °C 1</td>
<td>Vertical water vapor difference, presence of SO₂</td>
<td>Low-levels, relatively drier atmosphere</td>
<td>SO₂ is present in mid- and high-levels of the atmosphere</td>
</tr>
<tr>
<td>Green</td>
<td>10.35 – 8.50 Ch 13 – Ch 11</td>
<td>-4.0 to 5.0 °C 1</td>
<td>Moisture, stability, particle size and phase, presence of ash and SO₂</td>
<td>Small crystal ice cloud</td>
<td>Low- and mid-level cloud, volcanic ash and/or SO₂</td>
</tr>
<tr>
<td>Blue</td>
<td>10.35 Ch 13</td>
<td>-30.1 to 29.8 °C 1</td>
<td>Cloud top or surface temperature</td>
<td>Mid- and high-levels in the atmosphere</td>
<td>Surface or low-levels in the atmosphere</td>
</tr>
</tbody>
</table>

Impact on Operations

Detection of sulfur dioxide:
Stronger absorption of SO₂ is found in Band 10 (7.34 µm, a Water Vapor channel) and weaker SO₂ absorption is found in Band 11 (8.50 µm, an Infrared channel). These bands are differenced with similar water vapor and infrared channels in the red and green components respectively to highlight the presence of SO₂.

Limitations

Distinguishing SO₂ from ash and water vapor: Volcanic eruptions are often composed of ash and a mixture of gases, including water vapor and SO₂. Distinguishing the components can be a challenge, and water vapor can mask the ash and aerosol signals.

Low-level clouds: In the RGB, the light green color of low-level SO₂ is a similar color to that of low-level cloud.

Upper-level clouds: Thick opaque upper-level clouds can mask the SO₂ signal below.

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RGB Interpretation

1. Upper-level SO\textsubscript{2} cold background (orange)
2. Upper-level SO\textsubscript{2} warm background (light yellow)
3. Low-level SO\textsubscript{2} (light green)
4. Low- and mid-level cloud (green)
5. Convective clouds (tan)
6. Thin, high level cloud (dark blue)
7. Ocean/land surface (light blue)

Note: colors may vary diurnally, seasonally, and latitudinally

Comparison to Ash RGB and 10.35 µm Infrared:
The SO\textsubscript{2} RGB is a modified version of the Ash RGB recipe, tuned to better detect sulfur dioxide emissions. For the RED component, in place of the longwave difference in the Ash RGB, band 10 is differenced to take advantage of the strong SO\textsubscript{2} absorption region near 7.34 µm. For the GREEN component, similar channels are used in both RGBs but with different ranges, to take advantage of the lesser SO\textsubscript{2} absorption region near 8.50 µm. The BLUE component is the same for both RGBs.

The three images below are from the eruption of the Aoba Volcano shown above, but a few hours later at 0250 UTC, 6 April 2018. In the SO\textsubscript{2} RGB, SO\textsubscript{2} over (cold) cloud is orange, while SO\textsubscript{2} over (warm) ocean is white; in the Ash RGB, SO\textsubscript{2} is aqua green over ocean; in the IR 10.35 µm imagery, SO\textsubscript{2} is not discernable.

RGB Color Guide

This RGB composite was developed by the Japan Meteorological Agency (JMA) for Himawari-8. Interpretation is still under investigation.