9 March 2016
Meteorological Satellite Center
Japan Meteorological Agency

# Quality improvement of Himawari-8 observation data

On 9 March 2016, JMA updated the Himawari-8 ground processing system to improve Himawari-8 image quality in Himawari Standard Data (HSD) and related products. The update covered:

1) Implementation of coherent noise reduction processing
2) Improvement of band-to-band co-registration processing for infrared bands
3) Improvement of resampling processing
4) Bug fix for HSD header information

Note: The data format was not affected by this change.

## 1) Implementation of coherent noise reduction processing

The downlinked AHI imagery contains some coherent noise due to the operating configuration. It is most significant in band 7 but is present to some degree in all bands. This results in north-south stripes in low radiance portions of the images, such as cloud-free ocean in the visible and near-infrared bands, deep convective cloud in infrared bands and deep space in all bands. A noise reduction process for band 7 was applied on 18 June 2015 before the start of Himawari-8 operation (02:00 UTC on 7 July 2015). The process was also applied to a number of bands in which noise is efficiently reduced (1, 2, 4, 5, 6, 10, 11, 12, 13, 14 and 15) at 05:00 UTC on 9 March 2016. The algorithm corrects periodic noise identified in deep-space observation data using a Fourier transform.

Figure 1 shows the reflectivity of band-4 observation over the ocean at 00:20 UTC on 25 November 2015. Figure 1 (A) features a nominal color palette (i.e., black and white on a color scale from 0 to 1). Figure 1 (B) is similar to Fig. 1 (A), but focuses on the low reflectivity range (i.e., the minimum and maximum reflectivities are changed from 0 and 1 to 0.005 and 0.03). Figure 1 (C) shows the image resulting from application of the noise reduction process to Fig. 1 (B). It can be seen that the significant striping observed in the latter is effectively reduced.

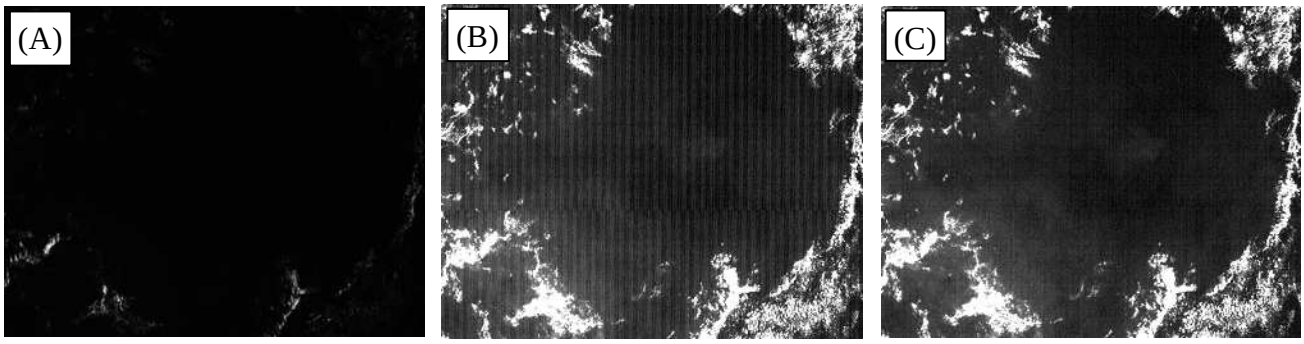


Fig. 1. (A) Reflectivity of band-4 (0.86 μm) observation at 00:20 UTC on 25 November 2015 with a nominal color palette (i.e., black and white on a color scale from 0 to 1). (B) As per (A), but with the minimum and maximum reflectivities changed from 0 and 1 to 0.005 and 0.03. (C) As per (B), but with the noise reduction process applied.

## 2) Improvement of band-to-band co-registration processing for infrared bands

Band-to-band co-registration errors involve relative misalignment between sensor bands. To combat this, a new co-registration process was applied to infrared bands 7, 8, 9, 10, 11, 12 and 15 at 05:00 UTC on 9 March 2016.

Figure 2 shows the co-registration error of band 11 with respect to band 13 observation estimated using a pattern-matching approach with common features such as coastline and cloud edge observed via the two bands. Figures 2 (A) and (B) represent errors before and after the improvement of the process, respectively. In the old and new processes, the co-registration correction amount is determined using pattern matching analysis based on calculation of cross-correlation. In the new process, the correction derived in the current observation cycle is simply applied to data in the next observation cycle for each swath. In the old process for band 7, the correction amount is optimized using sensor temperature information derived from in-orbit testing. As correction for bands 8 to 16 in the old process is also based on observation data obtained during in-orbit testing, this process may not be applicable to data for all seasons. The co-registration mismatch was reduced from 0.27 pixels (approx. 540 m) to 0.01 pixels (approx. 20 m) on the HSD 2 km resolution band after application of the new process (Fig. 2). In addition, the new band-to-band co-registration process includes a parameter change and a few minor bug fixes for ground processing software. These changes also help to alleviate the co-registration mismatch. Table 1 shows band-to-band co-registration errors of all infrared bands with respect to band-13 observation validated by observation at 15:10 UTC on 17 November 2015. Most errors for infrared bands are significantly reduced by the new process, which will also be applied to bands 1, 2, 3, 4, 5, 6, 14 and 16 in the future.

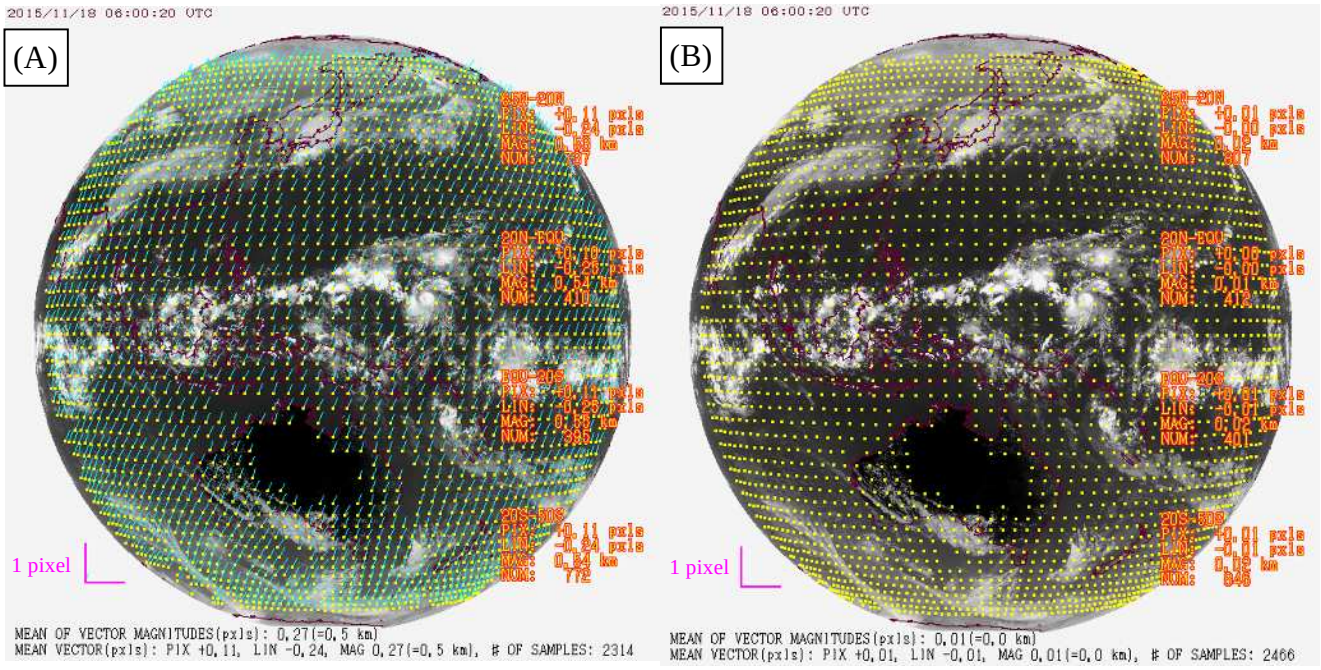


Fig. 2. (A) Band-to-band co-registration errors of band 11 with respect to band-13 observation at 06:10 UTC on 18 November 2015. (B) As per (A), but with the new processing applied. Yellow dots show validation points, and light-blue segments with yellow dots represent the direction and length of the misalignment to be corrected.

Table 1: Band-to-band co-registration errors of infrared bands (7, 8, 9, 10, 11, 12 and 15) with respect to band-13 observation at 15:10 UTC on 17 November 2015. “Before” and “After” values represent errors for co-registration before and after the application of the process, and are expressed as pixel sizes. One pixel corresponds to a distance of 2 km at the sub-satellite point. The update was applied at 05:00 UTC on 9 March 2016.

| Band | 7 | 8 | 9 | 10 | 11 | 12 | 15 |
|---|---|---|---|---|---|---|---|
| Before | 0.11 | 0.13 | 0.22 | 0.24 | 0.30 | 0.16 | 0.09 |
| After | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.01 |

### 3) Improvement of resampling processing

The resampling process was modified to address the issue of unnatural spotted pixels in band-to-band differential imagery. The modification was applied to all AHI bands at 02:00 UTC on 9 March 2016.

Figure 3 (A) shows a pre-modification color composite image[1]. Some unnatural dark pixels appear on the edge of clouds due to both inadequate resampling and band-to-band co-registration error (the latter is described in Section 2). The post-modification image in Fig. 3 (B) shows few such pixels. The correction of band-to-band co-registration error also contributed to this improvement.

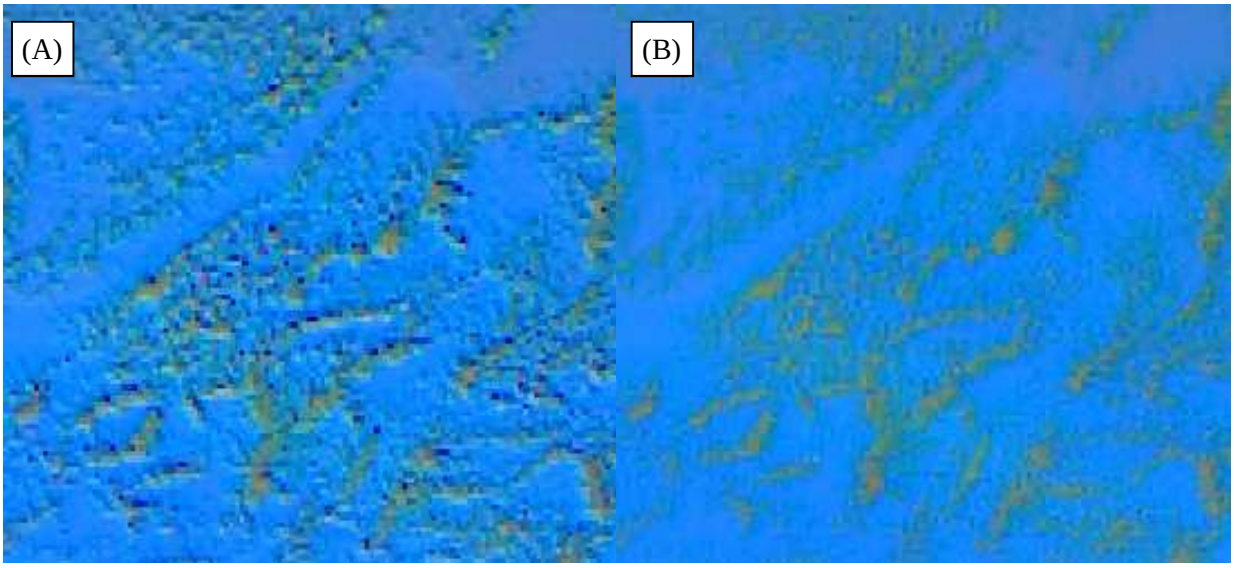


Fig. 3. (A) Dust RGB color composite image taken over the Pacific Ocean at 00:10 UTC on 9 December 2015. (B) As per (A), but with the modified resampling process applied.

[1]: This is a Dust RGB composite image used for detection of yellow sand and volcanic ash. Its three primary-color components are based on the difference between bands 15 and band 13 (red), that between bands 13 and 11 (green), and band 13 (blue).

### 4) Bug fix for HSD header information

A) Bug fix regarding operation flag for maneuver information

The HSD header has an operation flag for maneuver information contained the 5th bit of Quality Flag 1 (Basic Information Block 15) [2]. South-north station keeping maneuver information was appropriately stored in the operation flag, but east-west station keeping maneuver information was not. This bug was fixed on 9 March 2016. The next east-west station keeping maneuver is scheduled for 17 March 2016.

Table 2: 5th bit of Basic Information Block 15

| Status | Before bug fix | After bug fix |
|---|---|---|
| East-west station keeping maneuver | 0: not maneuvering | 1: maneuvering |
| South-north station keeping maneuver | 1: maneuvering | 1: maneuvering |

B) Bug fix regarding line number for observation time information

The line number indicating starting line numbers for each scan swath was not stored properly in Observation Time Information Block 4 in the HSD header[2] for Full Disk and Japan Area data. This bug was fixed at 02:00 UTC on 9 March 2016.

[2] Reference : Himawari-8/9 Himawari Standard Data User's Guide Version 1.2
http://www.data.jma.go.jp/mscweb/en/himawari89/space_segment/hsd_sample/HS_D_users_guide_en_v12.pdf