GOES IR Channel to Channel Co-Registration Correction Implementation and GVAR changes

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The GOES IR Channel to Channel Co-Registration Correction Program has been implemented with SPS 10.4 version. This program currently makes the corrections for GOES13, as the study shows that the co-registration error could be as large as 1.0 pixel along the East/West direction for the images between channel 2 and 4, while smaller co-registration error found along the North/South direction. The corrections are made based a co-registration table, which are calculated by an offline software. The study found that the channel 4 images for GOES13 are more aligned with the visible channel image. Therefore, the correction is made by shifting GOES13 channel 2 images so that it is aligned with the images in channel 4. The evaluation of the resampled channel 2 images found that shifting the channel 2 image with the fractional shifts through the image resampling degrades the overall strength of the fire pixels. Thus, integer shift are made for the channel images. In particular, if the co-registration errors are larger than 0.5 pixel, the channel 2 images will be shifted by 1 pixel. If the co-registration error is less than 0.5 pixel, no correction will be made.

The evaluation of GOES 14 images also found large co-registration error along the East/West directions between channel 2 and 4 images, which requires the correction by the GOES ground system. However, it has not been determined the images on which channel that need to be corrected. If the channel 4 images for GOES 14 need to be resampled, the fractional shifts through the image resampling will be made for a more accurate correction, otherwise, the integer shift will be made for the channel 2 images.

We found that the co-registration errors for GOES 15 are small, therefore, no correction will be made.

The image resampling status word will be added to the GVAR block 0 to show the resampling enable/disable status, in which channel the image data being resampled, and the resampling parameter. The detail of the image resampling status word and its location in the GVAR block 0 is shown in Table 1. The detailed information on the layout of GVAR block 0 can be found in GOES Interface Document 504-02[1]. The image resampling status word is located at the word 261-262 right after the straylight status word in the GVAR block 0. The most significant bit is the co-registration error correction enable/disable bit. The bit 14 identifies the image data in which channel is shifted. Since the correction is only applied to the images in either channel 2 or channel 4, only one bit is sufficient to identify which of these two channels is being corrected. This parameter is static for a given satellite, but might be different for different satellites; therefore, it will be added to the SPS database. The bit 13 is the execution status bit to indicate if the IR image is resampled. The integer in bit 0-12 represents the resampling parameter used in the image resampling, and it is related the co-registration error δ by

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[1] See http://www.osd.noaa.gov/GVAR_Downloads/gvar_downloads.html for the GVAR Interface Document 504-02.

$$I_{0-12} = INT(1000(\delta + 2.0)), \qquad [1]$$

assuming that the co-registration error is generally within the range of -2.0 to 2.0 pixels so that the integer I_{0-12} has the range from 0 to 4000.

The co-registration error δ is defined as the images in channel 4 relative to those in channel 2. If the images in channel 4 are corrected, the co-registration error δ is the same as the shift parameter used in the image resampling. There will be an overall negative sign if the images in channel 2 are corrected. The shift parameter δ^2 for the channel 2 images is related to the co-registration error δ by

$$\delta^2 = -\begin{cases} 1 & \text{if } \delta \geq 0.5 \\ 0 & \text{if } -0.5 < \delta < 0.5 \\ -1 & \text{if } \delta \leq -0.5 \end{cases} \qquad [2]$$

For GOES 13, the data shows that the shifting parameter δ^2 has the value -1 or 0.

Table 1 Proposed GVAR Block 0 with the image resampling status word. Refer to Table 3-6 in GOES Interface Document 504-02 for complete information

Words	Name	Description
2	SPSID	SPS Identity: a binary number identifying the source SPS which formatted the GVAR data stream. Values 1–9 are assigned to SPS1–SPS9, respectively.
….	….	
251-258	CIFST	Current Imager Frame Start Time. CDA time tag - 8 words formatted in same manner as defined for words 23-150.
259-260	SLC_STATUS	The Straylight Status
261–262	RES_STATUS	IR Channel Resampling status word, the bit zero is defined as the least significant bit (LSB) of the word 262. The status bits are defined below: **Bit**　　**Value**　　　　**Condition** 0-12　　　　　　　Resampling parameter, Related to the co-registration error value by INT(1000*(δ+2.0)) 13　　=　　0　　The image is shifted. 13　　=　　1　　The image is not shifted. 14　　=　　0　　The images in channel 2 are shifted. 14　　=　　1　　The images in channel 4 are shifted. 15　　=　　1　　The image co-registration error correction is enabled. 15　　=　　0　　The image co-registration error correction is disabled.