Algorithm Theoretical Basis Document

GCOM-C/SGLI Level-3 Spatial Binning (G5A)

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Contents

1. Introduction

1.1 Objectives

The objective of the G5A algorithm is to take spatial statistics of SGLI Level-2 (L2) daily geophysical variable (GV) products reducing the spatial resolution to 1/24 deg. (land, cryosphere, and ocean) or 1/12 deg. (atmosphere).

1.2 Development strategy

The G5A algorithm is designed to use a same program code for taking statistics of all GVs in order to make the maintenance of the code simple. Basically the output of the G5A processing contains the same statistics variables except for the case of snow and ice cover extent (SICE) and cloud type (CLTYPE) in cloud properties (CLPR) product (see next sub-section). The SICE and CLTYPE are flag products and the statistical outputs of these two GVs are customized so that the number of snow/ice cover observation or cloud type within each bin with a spatial resolution of 1/24 deg. for SICE and 1/12 deg. for CLTYPE is counted. Finally, to make the addition or deletion of GVs quite easy, the GV names of the statistical targets are defined in an external text file so that the change could be made without compiling the code.

1.3 Processing targets and outputs

Processing targets of the L2 GV statistics are all SGLI products for land, cryosphere, ocean, and atmosphere. Input and output variables are summarized in Table 1.

Table. 1 List of the target products, GVs, and output types of the G5A processing

Input Product ID	Long Name	Geophysical Variables (GVs)	Output Product ID	Output Variables*1
RSRF	Land surface reflectance	Rs_VN01 Rs_VN02 Rs_VN03 Rs_VN04 Rs_VN05 Rs_VN06 Rs_VN07 Rs_VN08 Rs_VN09 Rs_VN10 Rs_VN11 Rs_SW01 Rs_SW02	**RV01** **RV02** **RV03** **RV04** **RV05** **RV06** **RV07** **RV08** **RV09** **RV10** **RV11** **RS01** **RS02**	AVE, RMS, N_{used}, N_{input}, MIN, MAX, Date, QA_flag

		Rs_SW03 Rs_SW04 Rs_TI01 Rs_TI02 Rs_VN08P Rs_VN11P Rs_PI01 Rs_PI02 Sensor_azimuth*3 Sensor_zenith Solar_azimuth*3 Solar_zenith Sensor_azimuth_PL*3 Sensor_zenith_PL Solar_azimuth_PL*3 Solar_zenith_PL Sensor_azimuth_IR*3 Sensor_zenith_IR Solar_azimuth*3 Solar_zenith	**RS03** **RS04** **RT01** **RT02** **RN08** **RN11** **RP01** **RP02** **GEOV** **GEOP** **GEOI**	
VGI_	Vegetation index	NDVI EVI SDI	**NDVI** **EVI_** **SDI_**	Same as above
LAI_	Leaf area index	LAI FAPAR	**LAI_** **FPAR**	Same as above
AGB_	Above-ground biomass	AGB VRI	**AGB_** **VRI_**	Same as above
LST_	Land surface temperature	LST	**LST_**	Same as above
SIPR	Snow and ice physical properties	SGSL SIST	**SGSL** **SIST**	Same as above
SICE	Snow and ice cover extent	SICE	**SICE**	N_{snow1}, N_{snow2}, N_{snow3}, N_{used}, N_{input}, Date, QA_flag
CLPR	Cloud properties	CLTYPE	**CFRX*2**	N_{cfrx}*2, N_{used}, N_{input}, Date, QA_flag
		CLTT	**CLTT**	AVE, RMS,

		CLTH CLOT_W CLER_W CLOT_I	**CLTH** **COTW** **CERW** **COTI**	N_{used}, N_{input}, MIN, MAX, Date, QA_flag
ARNP	Aerosol properties by NP	AROT_ocean AROT_land ARAE_ocean ARAE_land	**AOTO** **AOTL** **AAEO** **AAEL**	Same as above
ARPL	Aerosol properties by PL	AROT_pol_land ARAE_pol_land ARSSA_pol_land	**AOTP** **AAEP** **ASSA**	Same as above
SSTD	Sea surface temperature (Day)	SST	**SST__**	Same as above
SSTN	Sea surface temperature (Night)	SST	**SST_**	Same as above
NWLR	Normalized water leaving radiance, aerosol parameters and photosynthetically available radiation	PAR NWLR_380 NWLR_412 NWLR_443 NWLR_490 NWLR_530 NWLR_565 NWLR_670 TAUA_670 TAUA_865	**PAR_** **L380** **L412** **L443** **L490** **L530** **L565** **L670** **T670** **T865**	Same as above
IWPR	In-water properties	CHLA TSM CDOM	**CHLA** **TSM_** **CDOM**	Same as above

*1 AVE: Average of valid GV data, RMS: Root Mean Square of valid GV data, N_{used}: Number of valid GV data actually used in the statistics, N_{input}: Number of input GV data, Min: Minimum of valid GV data, Max: Maximum of valid GV data, Date: Dates of the SGLI observations during the 8-day or 1-month interval period, QA_flag: Flag for quality assurance information, N_{snow1}: Number of snow or ice cover, N_{snow2}: Number of snow with vegetation or bare ice, N_{snow3}: Number of melting snow

*2 Output of CLTYPE statistics in the descending orbit is cloud fractions for individual cloud types. The "CFRX" and "cfrx" denotes the cloud fraction of type "x" which is the ID number of the ISCCP cloud classification. For example, in case of "cirrus cloud" the ISCCP ID is "1" and thus the output variable named as "Ncfr1" is stored in the output file with product ID of "CFR1". In the ascending orbit cloud fraction is estimated for three layer of High, Middle, and Low, the results of which are stored in "CFRH or cfrh", "CFRM or cfrm", and "CFRL or cfrlh", respectively. In addition, cloud fraction considering all the cloud types are also calculated and generated with the ID of "CFRA" and "cfra".

*3 Sensor and Solar azimuth angles are firstly converted to absolute relative azimuth angle (araz) defined as araz = | sensor_azimuth – 180.0 – solar_azimuth | and then its statistics (AVE, RMS, MAX, MIN) are calculated and stored in the output file.

Basically (except for the case of flag products (SICE and CLTYPE)) the statistics variables taken and stored in the output files are the eight values or flag shown in Table1. When processing the flag products, the statistics of Ave, RMS, Min, and Max are not taken. Instead, only snow/ice or cloud counts are stored in the output file.

2. Theoretical Description

2.1 Processing flow

Figure 1 indicate the flow of the G5A L2 GV statistics processing. Spatial coverage and resolution of input files can differ depending on the observation fields. That is, for the processing of land and cryosphere products, the input files are the L2 daily tile GV products with spatial resolution of 250m/1km (land) and 1km (cryosphere). For the atmosphere, the L2 daily global-bin GV files with a resolution of 1/24 deg. are the input. For ocean products, L2 scene GV products with spatial resolution of 1km can be inputs. The output of G5A processing contains daily spatial statistics of GV(s) which are stored in one dimensional array in the output file. The number of output files depends on the GV contents in the input file. In case that an input file contains multiple GVs, the G5A process generates output files for every GVs separately (except for the cases of geometry data in RSRF). For example, the "VGI_" product contains three GVs of NDVI, EVI and SDI as shown in Table 1. The outputs of the G5A processing for VGI_ are three files with the following product IDs, i.e., NDVI, EVI_, and SDI_.

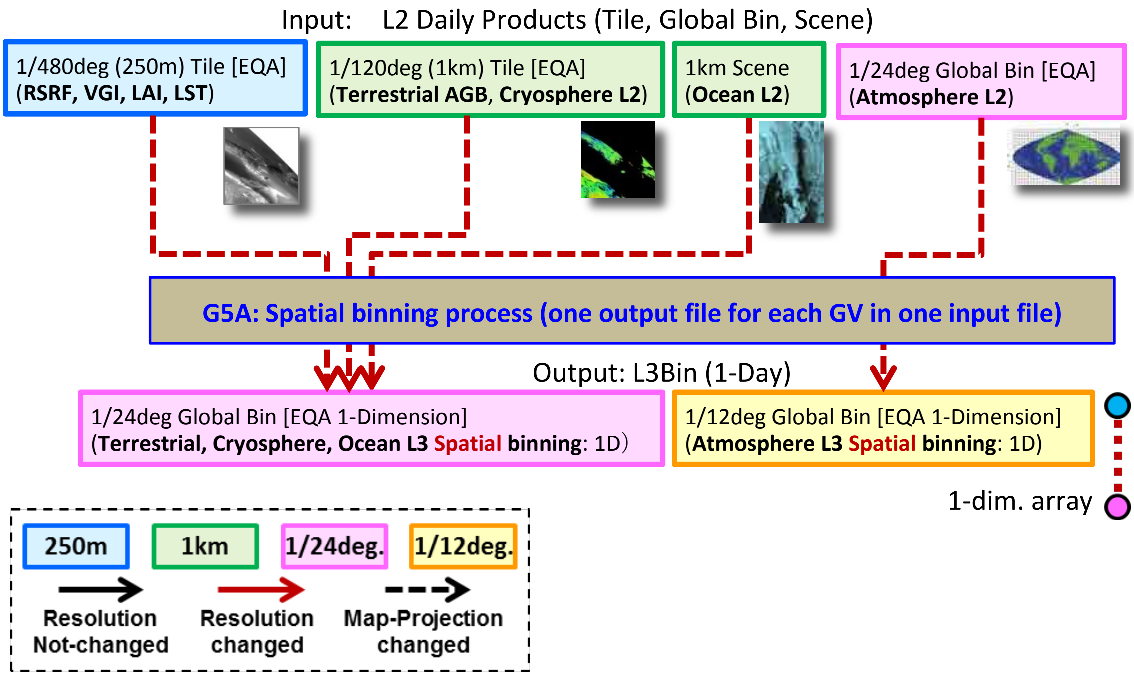


Fig. 1 Flow of the G5A L2 GV statistics processing

2.2 Definition of the statistics

Equations for calculating “AVE” and “RMS” are the followings;

$$\text{AVE} = \frac{1}{n}\sum_i xi$$

$$\text{RMS} = \sqrt{\frac{1}{n}\left(\sum_i xi^2\right)}$$

Where n is the total number of observation days with valid GVs, xi is the daily value of a GV to be processed.

“N_{used}” is the number of valid GV data actually used in the statistics, whereas “N_{input}” is the number of all the input GV data.

“MIN” and “MAX” are the minimum and maximum of valid GVs data during the temporal interval.

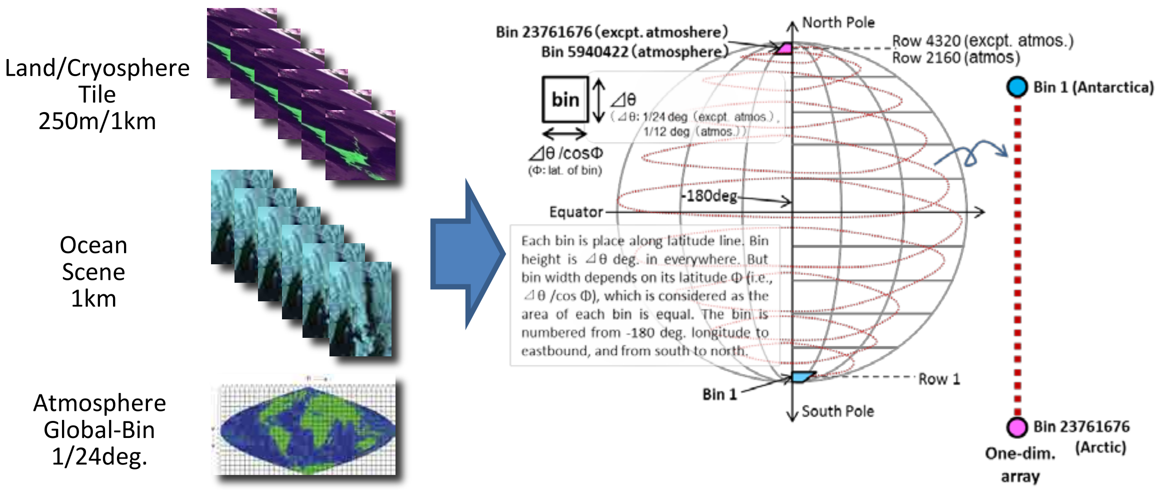
“Date” is an 8-bit value storing the dates of SGLI observations used in the statistics calculation. However, always “1” is stored in this L3Bin-Daily product.

2.3 QA process

“QA_flag” currently stores flags for discriminating land and water. In future update, QA information for GVs will be included.

2.4. Sample images

Because the output statistics variables are stored in one-dimensional array, the output results cannot be visualized as images. The output one-dimensional array of G5A (and G6A) is projected to the equirectangular (EQR) map projection (and polar stereographic projection only for cryosphere products) in the G7A processing. Figure 2 illustrate the definition of the one-dimensional array of the G5A output.



Input: L2 Daily GVs   Output: L3 Daily Spatial Binned GVs

Fig. 2 Input and output of the G5A processing.

3. Current status and remaining issues of the G5A code implementation

The G5A process works well without system errors. Processing speed and memory size are also within the expectations except for the cases of parts of ocean scene processing. Remaining tasks are the implementation of the QA_flag for the output of quality assurance information and the further speeding up of the ocean scene processing.