12.1 Spatial Binning

Spatial binning algorithm is performed on each level 2 scene (generated by each orbit tilt segment) in order to calculate level 2 data. Binning is performed to pixels for which binning is permitted by referring to level 2QF (Quality Flag).

x_{ij} is assumed as an observation value for which variable j of pixel i can take and LON (i) and LAT(i) are longitude and latitude of center of pixel i. (longitude and latitude are calculated by using a latitude and longitude conversion coefficient.) By these coordinate systems, index number b of Bin is determined by the relationship mentioned before (refer to the previous page).

First, the following process is performed for each pixel each time.

In case of ocean color related geophysical parameter, natural logarithm is calculated for each variable j and the following parameters are added.

$$\mathrm{SUMX}\ (b, j) = \mathrm{SUMX}\ (b, j) + \mathrm{LOGX} \qquad (12.1\text{-}1)$$

$$\mathrm{SUMXX}\ (b, j) = \mathrm{SUMXX}\ (b, j) + \mathrm{LOGX*LOGX} \qquad (12.1\text{-}2)$$

In case of vegetation index and sea surface temperature, geophysical parameters are used as is without taking any logarithm.

$$\mathrm{SUMX}\ (b, j) = \mathrm{SUMX}\ (b, j) + \mathrm{LOG} \qquad (12.1\text{-}1)'$$

$$\mathrm{SUMXX}\ (b, j) = \mathrm{SUMXX}\ (b, j) + \mathrm{LOGX*LOGX} \qquad (12.1\text{-}2)'$$

Moreover, number of pixels contributing to the sum of Bin b is incremented.

$$N\ (n) = N\ (b) + 1 \qquad (12.1\text{-}3)$$

In order to indicate that Bin b has data in a binary variables, 1 is set.

$$\mathrm{NSEG}\ (b) = 1 \qquad (12.1\text{-}4)$$

Next, after processing all the effective pixel data from this orbit tilt segment,. sum weights of each Bin is calculated:

$$W(b) = \sqrt{N(b)} \qquad (12.1\text{-}5)$$

And weights are added to the sum of variables as follows.

$$\mathrm{SUMX}(b, j) = \frac{\mathrm{SUMX}(b, j)}{W(b)} \qquad (12.1\text{-}6)$$

$$\mathrm{SUMXX}(b, j) = \frac{\mathrm{SUMXX}(b, j)}{W(b)} \quad (12.1\text{-}7)$$

Lastly, 32 bit number TT (b) (time tag) is defined for each Bin. This figure is used to show temporal distribution of data at the stage of temporal binning mentioned in the next section. For spatial binning algorithms, all the bits for TT(b) is 0 except for the cases where 1 is set in the lowest bit to show there is data in Bin b.

Outputs from spatial binning algorithm are spatial statistical parameters of each bin, which are : b, N (b), NSEG (b), w (b), TT (b), and SUMX (b,j) and SUMXX (b, j), a pair of the sum for which weights are added for each variation j.

12.2 Time Binning

The temporal binning algorithm converts spatial statistical quantities into further statistic quantities in temporal areas. Sampling domain for Bins are day, week, month or a year. Time t is correlated to each set of spatial statistical quantities output from spatial algorithm at time t is input to Temporal binning algorithm, this input is indexed with time t such as (N (b)t, NSEG (b)t, W(b)t, TT(b)t, and SUMX(b,j)t , and SUMXXl(b,j) t are those with weights. The following process is performed on each Bin in a time series.

If N (b)t > 0, (that is Bin has data), sums in temporal area to each j; are incremented as follows:

SUMX(b,j) = SUMX(b,j) + SUMX(b,j)t (12.2-1)
SUMXX(b,j) = SUMXX(b,j) + SUMXX(b,j)t (12.2-2)

Further, the number of pixels that contributes to the sum are counted up as follows:

N (b) = N(b) + N(b)t (12.2-3)

Number of spatial Bin scene : segment) that contribute to the sum are as follows.

NSEG (b) = NSEG(b) + NSEG(b)t (12.2-4)

Sum of weights are calculated as follows.

W (b) = W(b) + W(b)t (12.2-5)

In order to reflect that data exists at time t, the appropriate bit of temporal distribution variation TT(b) , is set to 1. That is, in case of a day product, 1 bit is equivalent to 1 orbit, when there is revolution data, 1 is placed for the first bit (LSB), when data exists, 1 is placed in the second bit. The rest follows the same. In case of week product, one bit is equivalent to one day and for moon product, one bit is equivalent to two days and for year product a bit is equivalent to one month. In either case, smaller temporal segment uses the lower bit.

Output form temporal binning algorithm, data to each Bin: b, N (b), NSEG (b), W (b), TT (b) and a per of sums weights are added to each variation j and SUMX (b,j) and SUMXX (b, j).

Output from temporal a SUM(b,j) has the same format as input. Binning product of a day is used for input to temporal binning algorithm in order to generate month by month product. Year product is generated by input of week product.

W (b), TT (b) and a pair of sums to which weights are added to each variation j and SUMM (b, j).

12.3 Binned Map Projection

Level 3 Binned map product is generated by performing map projection for level 3 binned product. In a map projection, the entire globe is divided into a grid of 4096 x 2048 of equal latitude and longitude intervals. Grid data is set to Bin data which latitude and longitude belong. (NN method)

That is, latitude and longitude of grid of image address (i, j) are as follows.

$$\lambda_i = \left[\lambda_0 + \frac{2\pi}{4096}(i - 2047.5) \right] \quad (i = 0 \cdots 4095)$$

(12.3-1)

$$\phi_j = \frac{\pi}{2048}(1023.5 - j) \qquad (j = 0 \cdots 2047)$$

Where λ_0 is longitude of image center. ([ ] indicates ranging to ±180°)

In case of water color related product, in order to estimate average of physical quantities from Bin statistic quantities, the following procedures are used.

First, bias correction coefficient F is calculated.

If W (b) > Nseg (b),

$$F = \frac{W(b) \cdot W(b)}{W(b) \cdot W(b) - NSEG(b)} \qquad (12.3\text{-}2)$$

If not, F = 1.

Next, average and distribution of natural logarithm of each variation Xj are calculated as follows.

$$m = \frac{WUMX(b, j)}{W(b)} \qquad (12.3\text{-}3)$$

$$s^2 = F \cdot \left(\frac{SUMXX(b, j)}{W(b)} - m \cdot m \right) \qquad (12.3\text{-}4)$$

Estimated values to Xj at Bin b by MLE estimation index is as follows.

$$\overline{X}(b, j) = \exp\left(m + s^2 / 2\right) \qquad (12.3\text{-}5)$$

This is used.

The following equation is used for vegetation index and surface temperature.

$$\overline{X}(b, j) = \frac{SUMX(b, j)}{W(b)} \qquad (12.3\text{-}6)$$