RPC File Format for Cartosat-1

RPCs give the relation between ground and image coordinates. The ground coordinates ranges for latitude is **[-90, +90]**, longitude is **[0,360]** degrees and height in meters. The following section gives the description of meaning of each parameter provided in RPC file.

Each scanline number can be expressed as a function of ground coordinates in terms of ratio of cubic polynomials. The constant term in the denominator is taken as 1. So for a given scanline number, we have

$$s = \frac{P_1(X,Y,Z)}{P_2(X,Y,Z)}$$

where,

$$\begin{aligned} P_1(X,Y,Z) &= a_1 + a_2Y + a_3X + a_4Z + a_5YX + a_6YZ + a_7XZ + a_8Y^2 + a_9X^2 \\ &\quad + a_{10}Z^2 + a_{11}XYZ + a_{12}Y^3 + a_{13}YX^2 + a_{14}YZ^2 + a_{15}Y^2X + a_{16}X^3 + a_{17}XZ^2 \\ &\quad + a_{18}Y^2Z + a_{19}X^2Z + a_{20}Z^3 \end{aligned}$$

$$\begin{aligned} P_2(X,Y,Z) &= b_1 + b_2Y + b_3X + b_4Z + b_5YX + b_6YZ + b_7XZ + b_8Y^2 + b_9X^2 \\ &\quad + b_{10}Z^2 + b_{11}XYZ + b_{12}Y^3 + b_{13}YX^2 + b_{14}YZ^2 + b_{15}Y^2X + b_{16}X^3 + b_{17}XZ^2 \\ &\quad + b_{18}Y^2Z + b_{19}X^2Z + b_{20}Z^3 \end{aligned}$$

$$b_1 = 1$$

Similarly each pixel number can also be expressed as a function of ground coordinates in terms of ratio of cubic polynomials. Here also we take the constant term in the denominator as 1. So for a given pixel number, we have

$$p = \frac{P_3(X,Y,Z)}{P_4(X,Y,Z)}$$

where,

$$\begin{aligned} P_3(X,Y,Z) &= c_1 + c_2Y + c_3X + c_4Z + c_5YX + c_6YZ + c_7XZ + c_8Y^2 + c_9X^2 \\ &\quad + c_{10}Z^2 + c_{11}XYZ + c_{12}Y^3 + c_{13}YX^2 + c_{14}YZ^2 + c_{15}Y^2X + c_{16}X^3 + c_{17}XZ^2 \\ &\quad + c_{18}Y^2Z + c_{19}X^2Z + c_{20}Z^3 \end{aligned}$$

$$\begin{aligned} P_4(X,Y,Z) &= d_1 + d_2Y + d_3X + d_4Z + d_5YX + d_6YZ + d_7XZ + d_8Y^2 + d_9X^2 \\ &\quad + d_{10}Z^2 + d_{11}XYZ + d_{12}Y^3 + d_{13}YX^2 + d_{14}YZ^2 + d_{15}Y^2X + d_{16}X^3 + d_{17}XZ^2 \\ &\quad + d_{18}Y^2Z + d_{19}X^2Z + d_{20}Z^3 \end{aligned}$$

$$d_1 = 1$$

X, Y, Z are the normalized object space coordinates i.e normalized latitude, longitude and height respectively. s and p are the normalized scanline number and pixel number between (-1,+1). The normalization of the coordinates can be done as follows

$$X=\left(\phi-O_{\phi}\right)/S_{\phi},\ Y=\left(\lambda-O_{\lambda}\right)/S_{\lambda},\ Z=\left(h-O_{h}\right)/S_{h},$$

$$s=\left(S-O_{s}\right)/S_{s},\ p=\left(P-O_{p}\right)/S_{p}$$

$O_{\phi},O_{\lambda},O_{h},O_{s},O_{p}$ are the mean values for latitude, longitude, height, scanline number and pixel number respectively while $S_{\phi},S_{\lambda},S_{h},S_{s},S_{p}$ are the scale factor values for latitude, longitude, height, scanline number and pixel number respectively. The above values are filled in RPC file as follows

LINE_OFF: O_{s} pixels
SAMP_OFF: O_{p} pixels
LAT_OFF: O_{ϕ} degrees
LONG_OFF: O_{λ} degrees
HEIGHT_OFF: O_{h} meters
LINE_SCALE: S_{s} pixels
SAMP_SCALE: S_{p} pixels
LAT_SCALE: S_{ϕ} degrees
LONG_SCALE: S_{λ} degrees
HEIGHT_SCALE: S_{h} meters
LINE_NUM_COEFF_1: a_{1}
LINE_NUM_COEFF_2: a_{2}
LINE_NUM_COEFF_3: a_{3}
LINE_NUM_COEFF_4: a_{4}
LINE_NUM_COEFF_5: a_{5}
LINE_NUM_COEFF_6: a_{6}
LINE_NUM_COEFF_7: a_{7}
LINE_NUM_COEFF_8: a_{8}
LINE_NUM_COEFF_9: a_{9}
LINE_NUM_COEFF_10: a_{10}
LINE_NUM_COEFF_11: a_{11}
LINE_NUM_COEFF_12: a_{12}
LINE_NUM_COEFF_13: a_{13}
LINE_NUM_COEFF_14: a_{14}

LINE_NUM_COEFF_15: a_{15}
LINE_NUM_COEFF_16: a_{16}
LINE_NUM_COEFF_17: a_{17}
LINE_NUM_COEFF_18: a_{18}
LINE_NUM_COEFF_19: a_{19}
LINE_NUM_COEFF_20: a_{20}
LINE_DEN_COEFF_1: b_1
LINE_DEN_COEFF_2: b_2
LINE_DEN_COEFF_3: b_3
LINE_DEN_COEFF_4: b_4
LINE_DEN_COEFF_5: b_5
LINE_DEN_COEFF_6: b_6
LINE_DEN_COEFF_7: b_7
LINE_DEN_COEFF_8: b_8
LINE_DEN_COEFF_9: b_9
LINE_DEN_COEFF_10: b_{10}
LINE_DEN_COEFF_11: b_{11}
LINE_DEN_COEFF_12: b_{12}
LINE_DEN_COEFF_13: b_{13}
LINE_DEN_COEFF_14: b_{14}
LINE_DEN_COEFF_15: b_{15}
LINE_DEN_COEFF_16: b_{16}
LINE_DEN_COEFF_17: b_{17}
LINE_DEN_COEFF_18: b_{18}
LINE_DEN_COEFF_19: b_{19}
LINE_DEN_COEFF_20: b_{20}
SAMP_NUM_COEFF_1: c_1
SAMP_NUM_COEFF_2: c_2
SAMP_NUM_COEFF_3: c_3
SAMP_NUM_COEFF_4: c_4
SAMP_NUM_COEFF_5: c_5
SAMP_NUM_COEFF_6: c_6
SAMP_NUM_COEFF_7: c_7
SAMP_NUM_COEFF_8: c_8
SAMP_NUM_COEFF_9: c_9
SAMP_NUM_COEFF_10: c_{10}

SAMP_NUM_COEFF_11: c_{11}
SAMP_NUM_COEFF_12: c_{12}
SAMP_NUM_COEFF_13: c_{13}
SAMP_NUM_COEFF_14: c_{14}
SAMP_NUM_COEFF_15: c_{15}
SAMP_NUM_COEFF_16: c_{16}
SAMP_NUM_COEFF_17: c_{17}
SAMP_NUM_COEFF_18: c_{18}
SAMP_NUM_COEFF_19: c_{19}
SAMP_NUM_COEFF_20: c_{20}
SAMP_DEN_COEFF_1: d_{1}
SAMP_DEN_COEFF_2: d_{2}
SAMP_DEN_COEFF_3: d_{3}
SAMP_DEN_COEFF_4: d_{4}
SAMP_DEN_COEFF_5: d_{5}
SAMP_DEN_COEFF_6: d_{6}
SAMP_DEN_COEFF_7: d_{7}
SAMP_DEN_COEFF_8: d_{8}
SAMP_DEN_COEFF_9: d_{9}
SAMP_DEN_COEFF_10: d_{10}
SAMP_DEN_COEFF_11: d_{11}
SAMP_DEN_COEFF_12: d_{12}
SAMP_DEN_COEFF_13: d_{13}
SAMP_DEN_COEFF_14: d_{14}
SAMP_DEN_COEFF_15: d_{15}
SAMP_DEN_COEFF_16: d_{16}
SAMP_DEN_COEFF_17: d_{17}
SAMP_DEN_COEFF_18: d_{18}
SAMP_DEN_COEFF_19: d_{19}
SAMP_DEN_COEFF_20: d_{20}