RCM Multi-Look Complex (MLC) Product Type – Additional Information

Since September 2021, the MLC product type is available for RCM ScanSAR modes. It is an alternative to the Single-Look Complex (SLC) product type for Compact Polarimetry (CP) applications. Compared to SLC, the product manipulation is simplified by the mosaicking of the various ScanSAR bursts into a single image of the covariance matrix elements. Also, the volume is considerably reduced by multi-looking as part of the SLC to MLC conversion, while preserving the polarimetric phase information useful for several applications. Like SLC, MLC data are georeferenced and provided in slant range geometry. This product type is not intended for interferometry, for which SLC is recommended.

Table 1: Comparison of image product volumes for SLC and MLC (dual/compact-pol)

RCM Beam Mode	Number of Looks for MLC (rg x az)	MLC approx. volume per square scene 16-bit option [GB]	MLC approx. volume per square scene 32-bit option [GB]	SLC approx. volume per square scene 16-bit option [GB]	SLC approx. volume per square scene 32-bit option [GB]
Medium Resolution 30m	2 x 2	0.4	0.8	2.4	4.7
Medium Resolution 50m	4 x 1	1.1	2.1	7.5	15.0
Medium Resolution 50m High Incidence (swath E)	4 x 1	0.4	0.8	0.9	2.0
Low Resolution 100m	6 x 1	0.7	1.5	10.2	20.4
Low Noise	3 x 2	0.3	0.7	3.1	6.2
Ship Detection*	5 x 1	4.1	8.2	27.4	54.9

**Approximate volume per square scene is given for comparison purpose only. For Ship Detection Mode, the longest scene is shorter than square in the current implementation, so the indicated volume would not be reached in practice.*

Although the MLC format supports both dual Co-/Cross-Polarization (HH-HV and VV-VH) and CP, its usefulness is mainly for CP at this time, since the polarimetric phase of the dual Co-/Cross-Polarization products is currently not calibrated. The RCM CP is using a Right-Circular polarization on transmit (denoted "C" in the product files) and linear H and V on receive. The covariance matrix elements provided in the *imagery* folder of MLC products therefore consist in two real diagonal elements $|CH|^2$ and $|CV|^2$ and a complex off-diagonal element XC = CH**conj*(CV), where *conj* is the complex conjugate. In the following, we will refer to those elements, based on their matrix position, as *C*11, *C*22 and *C*12, respectively.

Information on how to obtain the calibrated values from the digital numbers in the image files is detailed in the RCM Image Product Format Definition. For the complex off-diagonal element *C*12, the focus in that document is on the amplitude values, without directive for the phase scaling. We therefore provide here additional information on this specific complex element of the MLC product. In order to convert the digital number (*DN*) of a given range sample to a calibrated value for all three covariance channels (*C*11, *C*22 and *C*12), the digital number is first squared, then divided by the gains value (*A*) corresponding to the range sample. For the complex element *C*12, the complex value is constructed from the real and imaginary *DN* layers (*XC_band0* + *j XC_band1*), then squared.

$$calibrated\ value = DN^2/A$$

For *C*11 and *C*22, the calibrated value is a real number representing power and is one of sigma-nought, beta-nought, or gamma, depending on the selected Look-Up Table (LUT). For *C*12, the calibrated value is a complex number representing the non-normalized coherence value between CH and CV. The modulus of that complex number is the coherence amplitude while its phase refers to the relative phase between CH and CV. The square operation on the complex number is equivalent to multiplying by 2 the phase of the complex digital number, that is, the *C*12 phase is equal to 2*arg(*complex_DN*). The phase is unchanged by the application of the calibration gains. The gain values *A* can be found in the LUT *.xml* files provided in the *calibration* sub-folder of the image product.