Table 2. List of the EnMAP observations coordinated with MAJIS team during the EGA.

Coverage area	Latitude (°)	Longitude (°)	Datatake ID	Time difference with MAJIS (hour)	Swath length (km)
Great Nicobar	7.084	93.865	0000088492	−40.615	360
Cambodia	11.569	105.307	0000088809	6.531	450
Ocean-1	19.879	129.280	0000088808	4.755	300
Ocean-2	~~22.514~~	~~139.981~~	0000088675	−21.428	450
Ocean-3	~~23.261~~	~~163.828~~	~~0000088660~~	1.299	300
~~Ocean-3~~	~~23.195~~	~~−175.060~~	~~0000088779~~		
Big Island Hawaii	18.738	−155.774	0000088777	−5.383	360

along the spectrum, with signals reduced by factors of up to 100 in strong absorption bands.

As mentioned in Sect. 2.2, high resolution observations in the Jupiter system will be performed with an integration time of 100 ms, so that the SNR performance for the Earth observations at high incidence in 11 ms (with nominal spatial and spectral sampling) is representative of what can be expected for high resolution observations with nominal sampling during the science phase of MAJIS.

The readout noise (RON) of the 1 MHz readout mode at the H1RG pixel$_{18\,\mu m}$ level is $\sim 30\,e^-$ (Langevin et al., 2024). The noise (then the SNR) can be assessed for H1RG pixel$_{18\,\mu m}$ by combining the shot noise and the RON, then dividing it by 2 for MAJIS data element with nominal sampling (2×2 H1RG pixel$_{18\,\mu m}$). The results for the most relevant EGA observation are shown in Fig. 8. The signal collected by MAJIS data elements ranged from a few $10\,e^-$ in deep absorption bands up to $250\,000\,e^-$ (clouds near 1000 nm). Figure 8 shows that, except in very deep absorption bands, the SNR for high resolution observations in the Jupiter system will range from good (~ 50) to very good (~ 100) and excellent (~ 500) even without stacking. In the crossover range (2280 to 2370 nm), the best SNR will be obtained with the IR channel. It is important to note that on-board stacking will be applied on most science data as a result of de-spiking strategies (Langevin et al., 2020) or when long repetition times are available (7.8 s for the orbit phase at an altitude of 5100 km over Ganymede). As an example, the most frequently used Jupiter observation mode ("disk scan") averages 8 out of 12 independent samplings into a MAJIS data element, improving by a factor of 3 the SNR as displayed in Fig. 8 for representative Earth spectra. This estimate is consistent with previous radiometric modeling (Poulet et al., 2024b; Royer et al., 2025). For regional mapping of Ganymede, the SNR will exceed 1000 over a large part of the wavelength range due to longer integration time. Additional stacking can be considered on ground for further improving the SNR to detect very weak signals (rings, exospheres) or absorption bands.

3.2 Impact of the compression

The very large dynamic range of signal levels for a single acquisition raises a major challenge for the MAJIS data compression strategy. It implements reversible compression after shifting the DN levels to the right by 0 to 7 (Poulet et al., 2024b). This reduces the number of bits required for coding each value. Specifically, this procedure saves 1 bit/data per step as long as only noise bits are shifted out of the signal in DN. However, a shift by 1 to 7 multiplies the quantization noise ($\sim 1.2\,e^-$ for the data as acquired) by 2 to 128, so that implementing a large shift to a relatively low signal increases the total noise. Data compression with a single value of the shift parameter for the full data cube would have been either very ineffective or very penalizing for spectral ranges with lower signal. Therefore, a specific shift can be selected by TC for up to 16 spectral bands per channel so as to adjust the level of shift to the signal level, maintaining the quantization noise at a lower level than the physical noise (Poulet et al., 2024b). For the EGA, a shift of 0 (reversible compression) was applied to all spectral bands (8 per channel for the EGA), leading to an average data volume of 6.43 bits per datum after compression (already a significant reduction from the 16 bits before compression). An optimum set of shifts, as will be applied during the JUICE science phase, would have reduced the data volume to 3.5 bits per datum. As shown in the right panel of Fig. 8, the SNR (which is good to excellent) is reduced by at most a factor 1.1 except in the deepest absorption bands. This is definitely a small price to pay for nearly doubling the number of observations which can be implemented within the MAJIS data volume allocation.

3.3 Browse validation

For observations with selective downlink, two files are produced by MAJIS: a nominal data file with the full spatial and spectral resolution, and a "browse" file. LEGA data provided the opportunity to validate the browse production during the LEGA by checking that the browse dataset is correctly extracted on-board from the nominal dataset, and that a more effective compression scheme does not negatively impact the relevance of the browse dataset for selection on the basis of