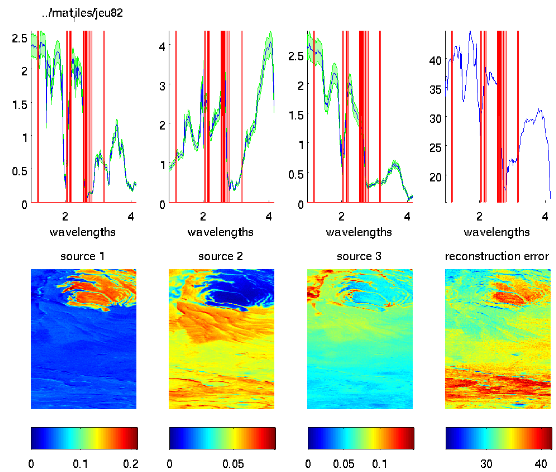

Fig. 4. Estimation of 3 sources of the entire OMEGA image 41_1 with BPSS using a preprocessing step of pixel selection using the convex hull method. The first and third source are clearly identified as CO_2 and H_2O ices (see fig. 3) with a correlation coefficient of 0.953 and 0.940 (see run OMEGA-7 of Table IV-B3c). The spatial abundances is well estimated regarding the WAVANGLET classification method [39], [48]. The second source is identified as dust with a lower correlation coefficient (0.372).

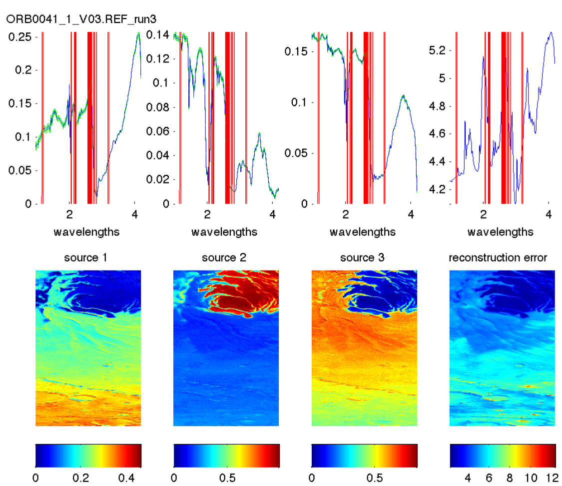

Fig. 5. Estimation of 3 sources of the entire OMEGA image 41_1 with BPSS without pixel selection. The second source is clearly identified as CO_2 ice (see fig. 3) with a correlation coefficient of 0.957 (see run OMEGA-5 of Table IV-B3c). The first and third sources are identified to dust and water ice with lower correlation coefficients of 0.555 and 0.773. The spatial abundances of water ice is not well estimated regarding the WAVANGLET classification method [39].

Figure 6 summarizes the following results in a schematic form.

1) The TO, for both BPSS and BPSS2, allows one to decrease the computation times by a factor of 1.5, without altering the accuracy of the results. Memory consumption has also been reduced by a significant factor. With such unambiguous advantages, the TO versions of BPSS and BPSS2 can be rather used than the original implementations.
2) Trivially, results obtained for linear artificial dataset (with uniform abundance distributions identical for each endmember with abundances until 100%) have demonstrated that the sources estimated by the TO strategy is equivalent to the CHO strategy (for instance: runs BPSS-1 to BPSS-2 in Table IV-A3g and runs BPSS2-1 to BPSS2-2 in Table IV). In this case, pixel selection is still relevant to reduce the computation time about 50 times (Table II).
3) Results obtained for artificial dataset with uniform abundance distributions and identical cutoffs for all endmembers have shown that the estimation of the sources is less accurate when a pixel selection (CHO) has been performed (runs BPSS-3 to BPSS-6 in Table IV-A3g and runs BPSS2-3 to BPSS2-6 in Table IV). In this case, despite 50 times shorter computation times, using pixel selection as a preprocessing step seems to be inadequate.
4) For OMEGA data, the computation time reduction due to CHO has been around 100 (Table V). Abundance distributions can be significantly unbalanced (some endmembers are significantly less present in the scene). In that case, pixel selection by convex hull (CHO) is a way to overcome the bias caused by the overwhelming endmembers. This has been supported by the results obtained for the synthetic dataset of linear mixture using unbalanced uniform distribution.
5) BPSS2 seems to better estimate the sources in the artificial dataset but not in the real case. This is probably due to non-linearity or non-Gaussian noise effect.
6) The method BPSS2 appears to be very robust to Gaussian noise, as shown by the results obtained on synthetic dataset, even with 100 times actual OMEGA noise.
7) Sometimes, some sources have been well estimated but anti-correlated with the real spectra. This behavior has been interpreted to be due to linear dependent endmembers. In that case, spectra built by a linear combination of all sources except the considered source already contain spectral signatures of the considered source. The last source is then anti-correlated with the corresponding endmember to decrease his contribution. This behavior has to be studied in further details because it is clearly a limitation of blind source separation.

In the future, the choice of the number of sources, which is an input in the current implementation, should be automated to allow one batch processing without human intervention. A methodology of pixel selection for use across dataset should also be established to enables integration of source separation techniques into larger systems and aim at the generation of catalogs and maps.

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