Submission J-STSP-ECARR-00173-2025
Supplementary Materials

1 Empirical link exclusion–SAD

This scatter plot shows the source separation performance (measured using SAD) in function of the exclusion level of the sources, for 50000 random realizations (5 sources, uniform exclusion values in $[0\%, 50\%]$, random source matrices of given exclusion, random orthogonal mixing matrices).

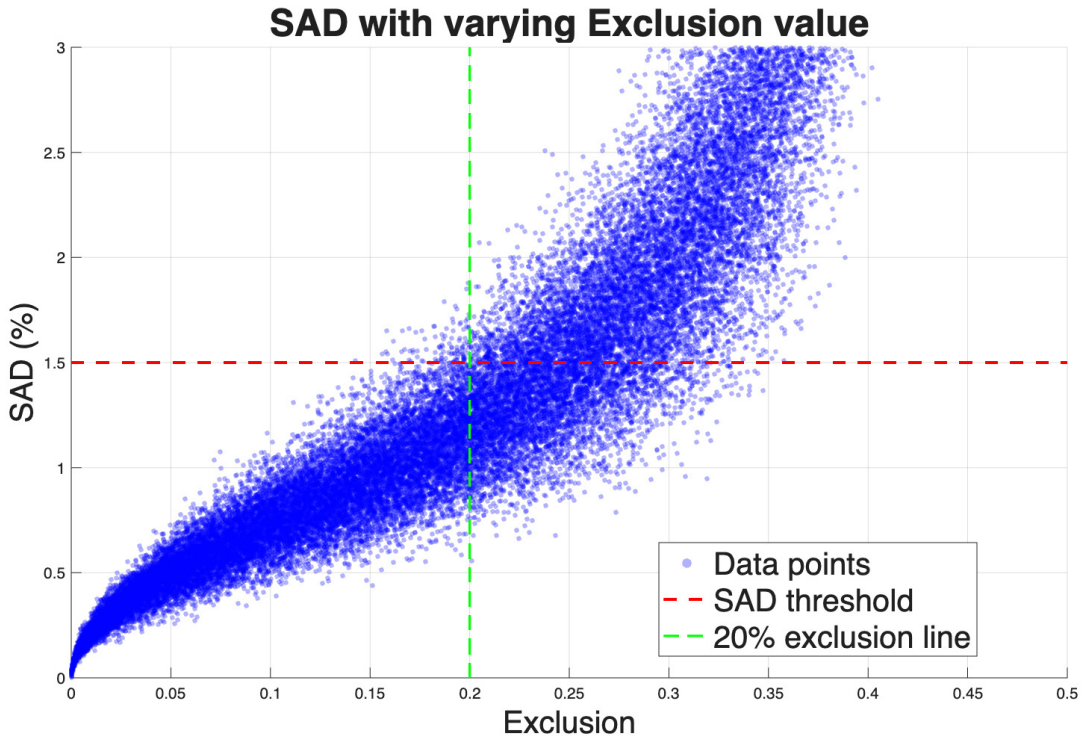

Figure 1: WEP optimization results for different values of the exclusion of the source matrix. This validates empirically the statement that, when the exclusion is smaller than 20%, minimizing the exclusion results in accurate source separation (SAD $\lesssim 1.5\%$).

2 Unmixing standard datasets

2.1 Quantitative performance comparison

Table 1: RMSE_S($\times 10^{-2}$)

Data	Source	VCA-FCLS	PLMM	NMF-QMV	HISUN	MiSiCNet	DFFN	SWC-Net	WEP+
Apex	1	22.93	18.54	18.14	17.16	**16.05**	43.18	21.89	17.65
	2	**9.72**	10.31	24.69	24.80	15.77	34.58	23.65	10.64
	3	11.64	15.53	24.87	25.21	12.41	**11.96**	20.5	17.23
	4	12.75	12.06	38.41	38.05	18.07	26.97	17.23	**9.11**
	Overall	15.15	14.46	27.54	27.35	15.71	26.58	20.95	**14.18**
JasperRidge	1	16.76	23.65	20.39	15.01	9.60	**9.21**	16.37	10.87
	2	8.01	26.45	18.37	19.61	11.42	**7.70**	15.86	7.72
	3	28.01	47.28	14.65	12.76	22.13	11.66	17.58	**9.20**
	4	24.86	47.89	12.45	11.25	24.93	50.45	16.49	**10.33**
	Overall	20.90	38.04	16.76	14.99	18.26	26.58	16.59	**9.61**
Moffett	1	3.41	3.43	5.46	7.39	6.87	18.38	28.22	**2.69**
	2	**5.53**	5.54	6.57	7.83	11.77	9.81	18.15	9.99
	3	2.52	2.50	**2.26**	2.80	12.32	13.23	20.7	12.35
	Overall	**4.03**	4.03	5.10	6.42	10.61	14.25	22.76	9.30
Samson	1	25.66	25.66	25.05	23.47	17.38	14.72	**5.08**	17.49
	2	18.21	18.72	25.66	26.96	18.32	8.52	**3.36**	12.83
	3	34.89	35.32	38.94	38.88	30.42	27.95	**3.23**	24.85
	Overall	27.12	27.42	30.56	30.49	22.83	18.89	**3.98**	19.04
Urban	1	28.84	31.21	26.59	34.60	27.64	**16.75**	18.69	20.59
	2	50.11	46.33	36.92	54.88	40.31	14.27	25.35	**13.42**
	3	39.03	32.06	32.23	34.65	25.06	16.57	13.39	**7.55**
	4	17.90	25.77	19.82	19.09	12.89	33.82	**12.13**	14.98
	Overall	36.01	34.69	29.59	38.00	28.21	21.81	18.16	**14.88**
WDC	1	37.68	38.00	35.91	39.78	41.65	54.22	44.17	**22.00**
	2	32.25	32.13	27.31	32.16	**12.73**	39.61	24.81	31.43
	3	25.19	27.46	32.65	25.27	**14.11**	61.63	22.68	29.99
	4	8.54	9.02	8.62	**4.40**	32.66	58.26	31.46	5.57
	5	32.69	31.44	35.51	39.55	12.74	63.90	22.24	**4.02**
	6	10.17	11.92	9.98	16.37	11.72	21.02	14.2	**5.57**
	Overall	26.89	27.21	27.50	29.17	24.02	52.00	28.19	**22.02**

Table 2: SAD($\times 10^{-2}$)

Data	Source	VCA-FCLS	PLMM	NMF-QMV	HISUN	MiSiCNet	DFFN	SWC-Net	WEP+
Apex	1	69.15	112.40	40.03	34.22	**10.63**	76.52	50.67	11.01
	2	26.44	29.86	27.10	12.26	**7.97**	46.99	20.04	11.89
	3	11.05	10.84	17.53	**10.60**	8.91	14.17	34.07	16.16
	4	51.76	41.64	129.99	114.80	31.13	4.72	**4.31**	109.45
	Overall	39.60	48.69	53.66	42.96	**14.66**	35.60	27.27	37.13
JasperRidge	1	26.49	50.55	28.59	16.83	4.34	13.55	13.18	**2.18**
	2	25.42	45.23	147.38	10.59	29.01	14.28	**7.74**	8.46
	3	22.63	83.02	17.23	13.86	**6.62**	14.29	11.74	17.05
	4	53.60	18.58	4.97	9.91	32.96	**3.29**	11.96	4.49
	Overall	32.03	49.34	49.54	12.79	18.23	11.34	11.15	**8.05**
Moffett	1	22.55	16.13	54.40	148.64	12.55	16.52	**12.42**	18.36
	2	3.54	4.36	4.21	4.35	5.94	3.44	**2.88**	5.65
	3	**0.00**	1.86	2.17	2.44	16.88	4.90	2.20	27.57
	Overall	8.70	7.45	20.26	51.81	11.79	8.29	**5.83**	17.19
Samson	1	2.07	2.91	3.52	4.90	0.79	1.21	**0.47**	3.01
	2	4.95	5.53	7.74	7.77	1.85	3.54	**1.74**	4.35
	3	12.99	24.28	149.29	126.09	19.8	5.60	**1.33**	15.13
	Overall	6.67	10.91	53.52	46.25	7.48	3.45	**1.18**	7.50
Urban	1	20.95	**8.04**	30.78	16.79	13.04	19.83	11.20	10.46
	2	33.39	34.18	14.54	7.16	70.59	14.10	21.11	**4.10**
	3	17.84	24.49	20.16	30.60	10.53	10.60	9.62	**4.92**
	4	72.21	73.16	**8.88**	49.85	18.15	36.74	29.83	10.59
	Overall	36.10	34.97	18.59	26.10	28.08	20.32	17.94	**7.52**
WDC	1	20.11	20.48	19.78	26.16	10.69	75.01	16.39	**6.46**
	2	30.54	34.03	45.24	37.57	8.98	32.75	20.36	**5.10**
	3	21.85	23.77	73.46	50.33	**7.25**	21.73	34.53	20.53
	4	**3.43**	22.36	20.53	14.83	53.73	32.22	55.95	6.93
	5	7.94	11.61	13.93	5.07	8.21	**3.69**	5.66	10.20
	6	21.94	19.74	6.09	9.19	**4.99**	11.07	6.82	34.82
	Overall	17.64	22.00	29.84	23.86	15.64	29.41	23.29	**14.01**

Table 3: Time

Data	VCA-FCLS	PLMM	NMF-QMV	HISUN	MiSiCNet	DFFN	SWC-Net	WEP+
Apex	1.62	29.80	17.10	3.25	16.08	56.88	9.34	**1.26**
JasperRidge	1.40	38.40	14.30	3.11	12.75	37.72	5.58	**0.84**
Moffett	0.32	2.77	4.37	2.16	11.59	16.92	4.47	**0.21**
Samson	**0.57**	12.32	12.48	2.75	12.08	32.46	7.11	**0.57**
Urban	10.55	93.53	278.12	24.64	44.58	559.03	28.53	**8.15**
WDC	17.82	87.82	383.52	34.64	45.28	429.71	30.20	**14.17**

2.2 Visual performance comparison

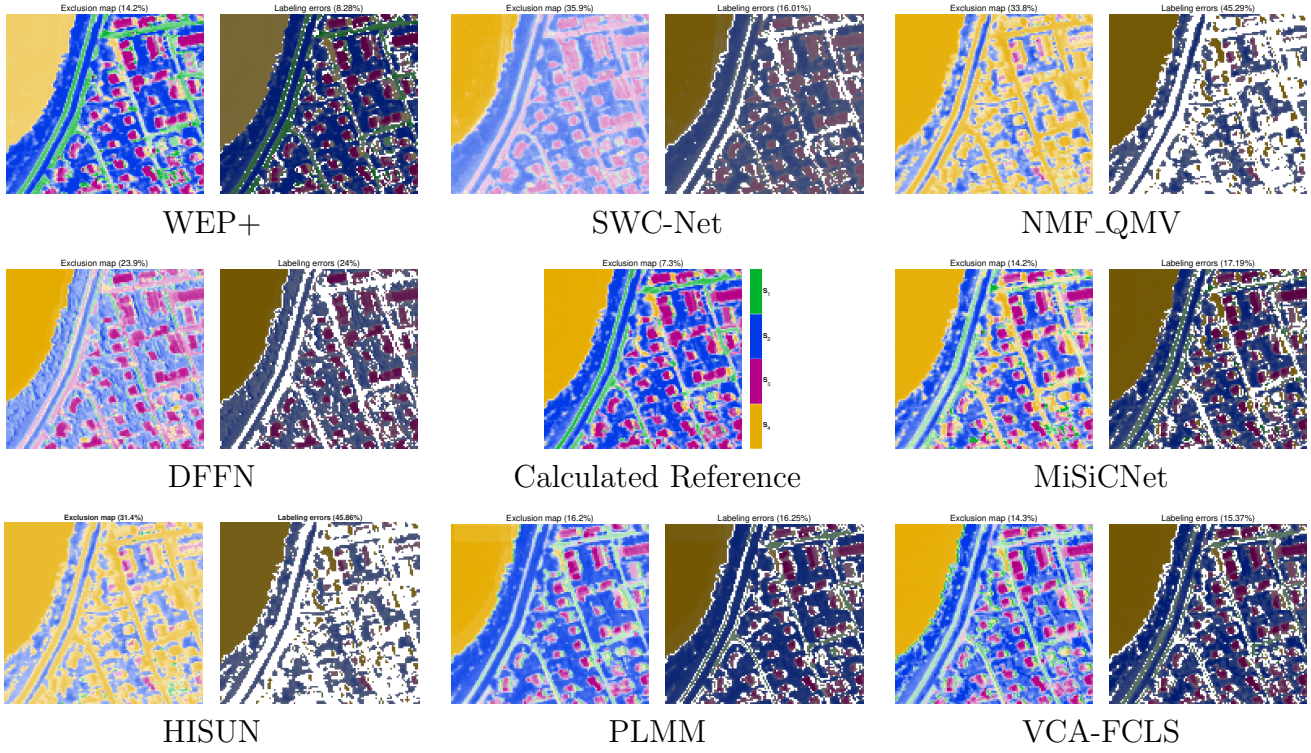

Figure 2: Exclusion maps obtained by WEP+ and other algorithms on the Apex data (calculated reference shown for comparison): see Table for more details.

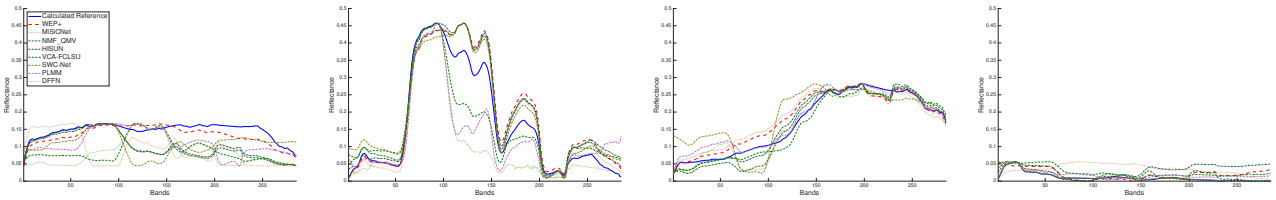

Figure 3: Spectral endmembers calculated by WEP+ and other algorithms on the Apex data.

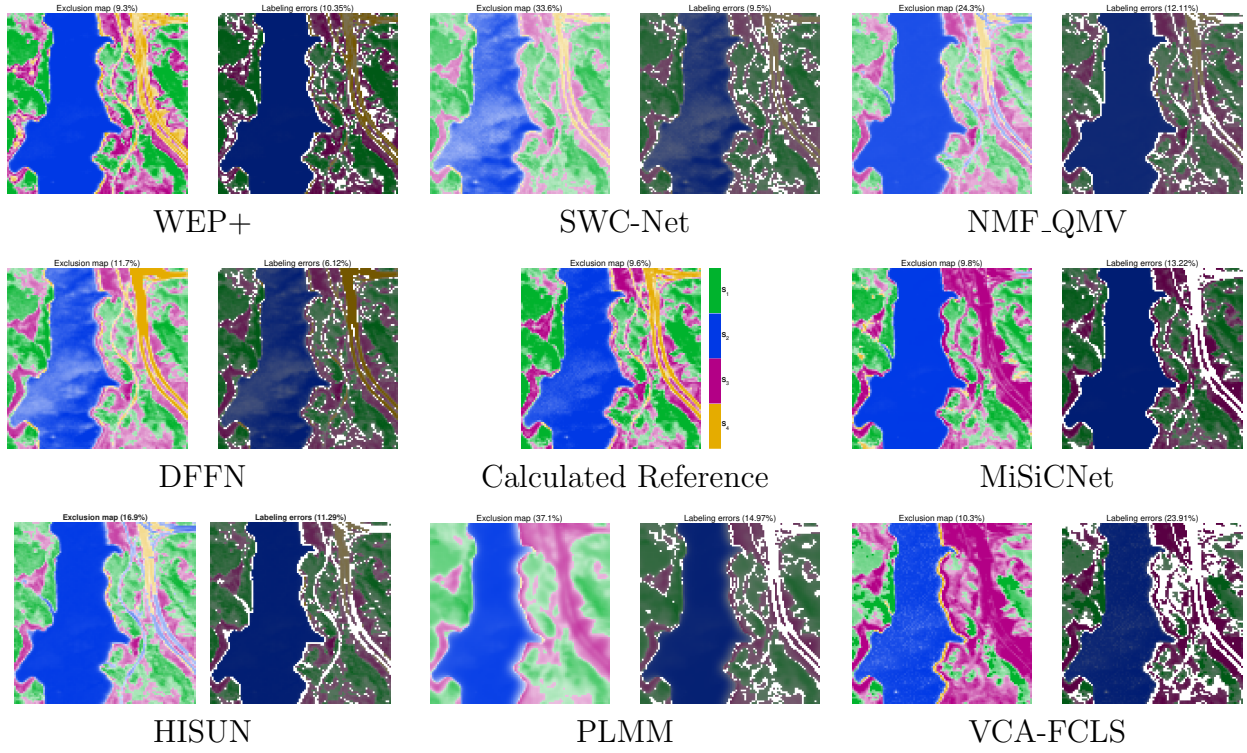

Figure 4: Exclusion maps obtained by WEP+ and other algorithms on the Jasper Ridge data (calculated reference shown for comparison): see Table for more details.

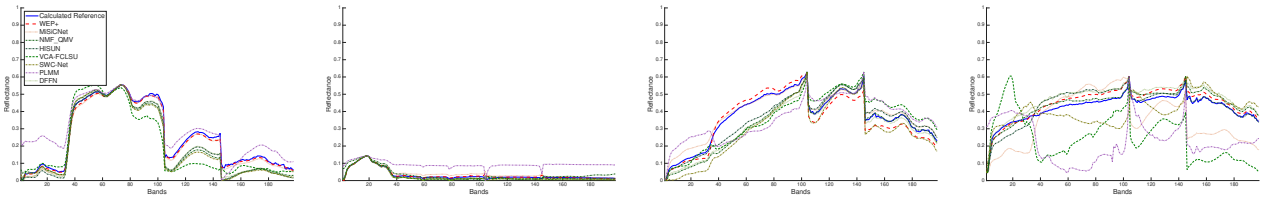

Figure 5: Spectral endmembers calculated by WEP+ and other algorithms on the Jasper Ridge data.

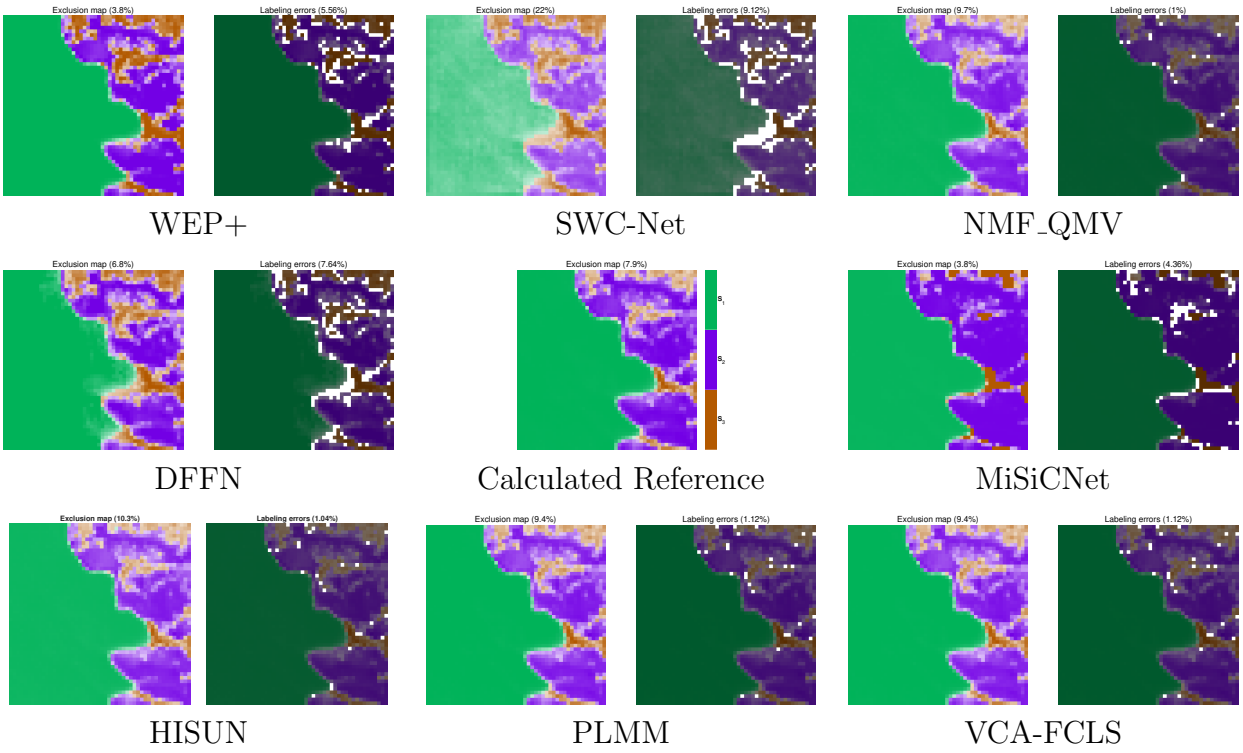

Figure 6: Exclusion maps obtained by WEP+ and other algorithms on the Moffett data (calculated reference shown for comparison): see Table for more details.

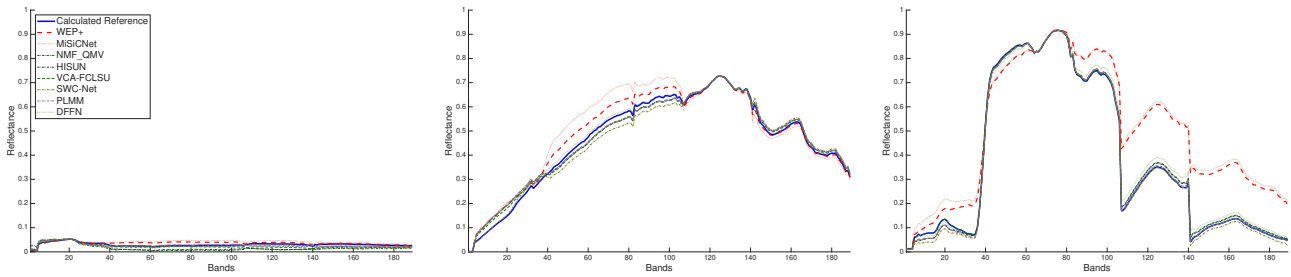

Figure 7: Spectral endmembers calculated by WEP+ and other algorithms on the Moffett data.

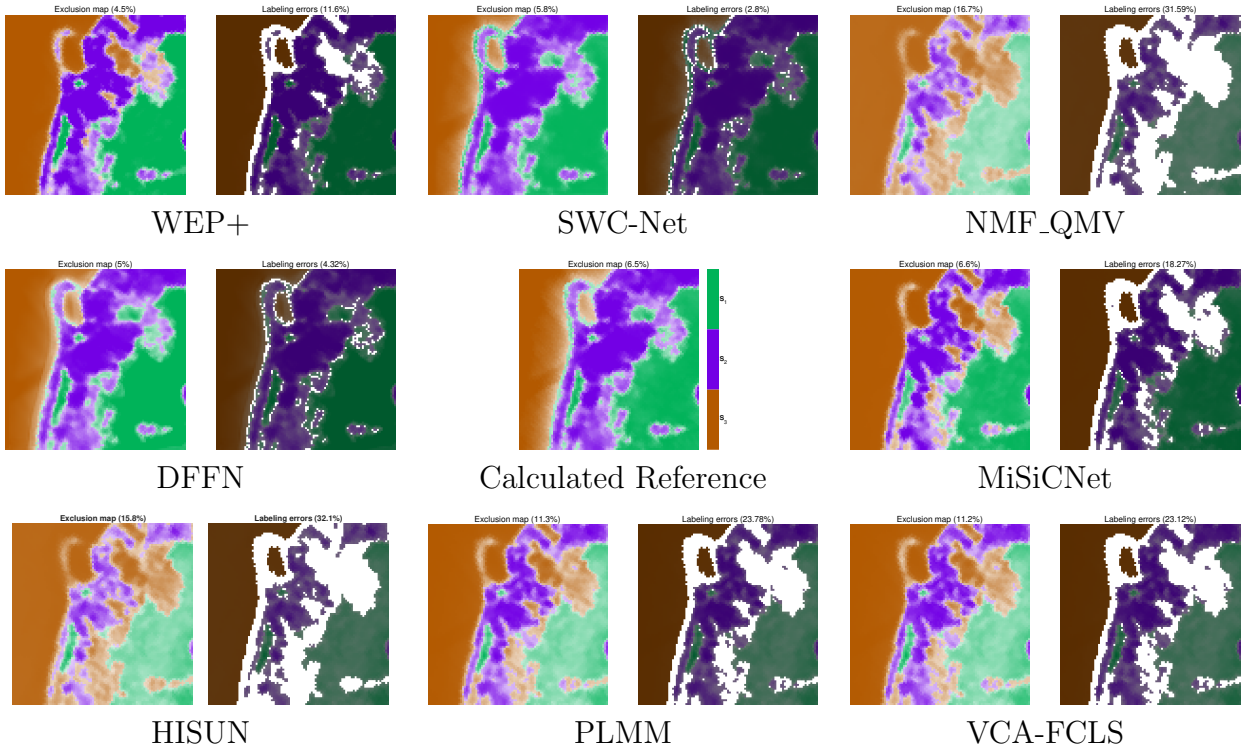

Figure 8: Exclusion maps obtained by WEP+ and other algorithms on the Samson data (calculated reference shown for comparison): see Table for more details.

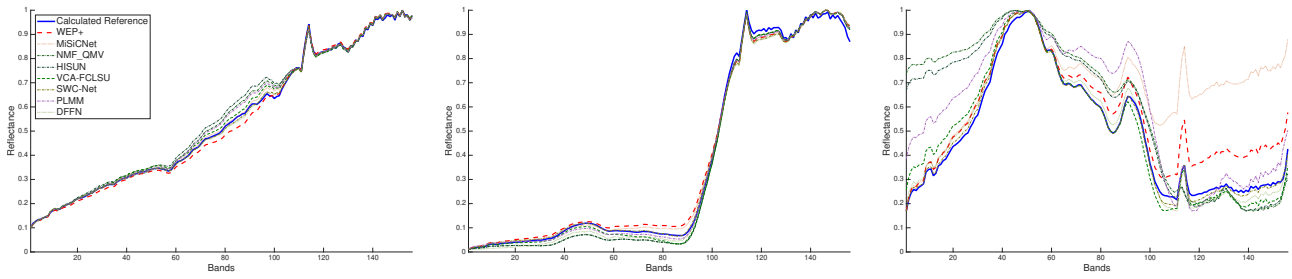

Figure 9: Spectral endmembers calculated by WEP+ and other algorithms on the Samson data.

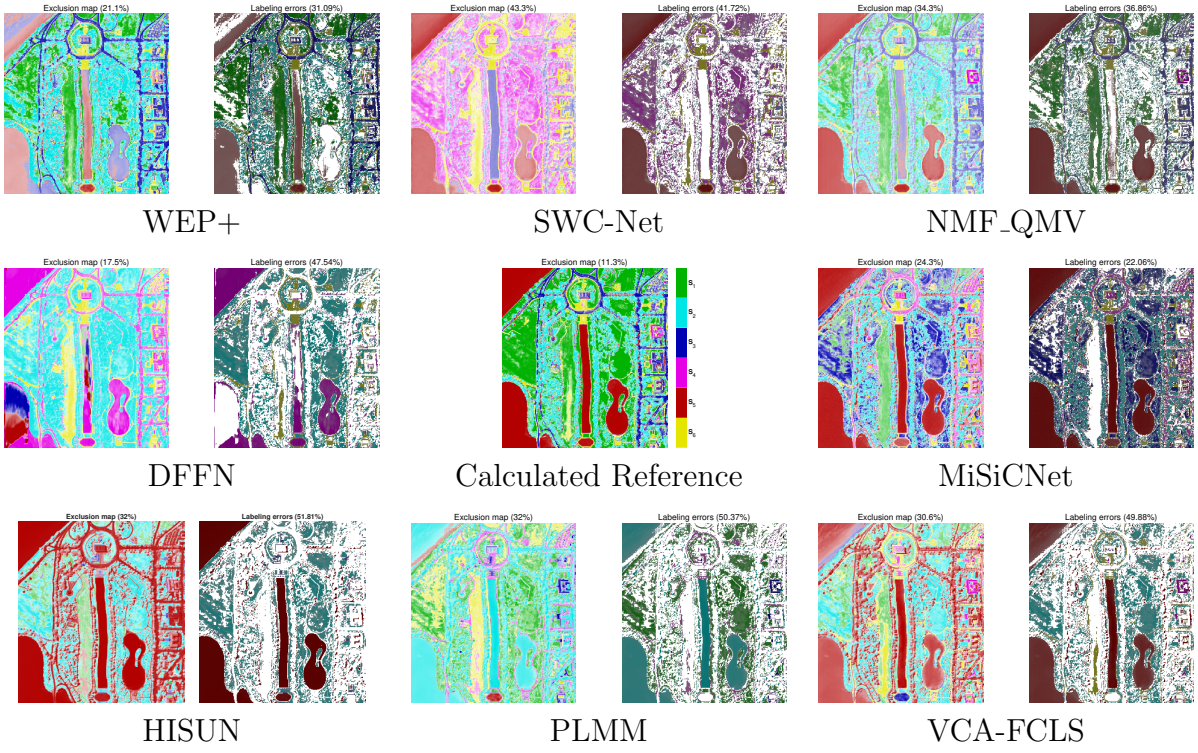

Figure 10: Exclusion maps obtained by WEP+ and other algorithms on the WDC data (calculated reference shown for comparison): see Table for more details.

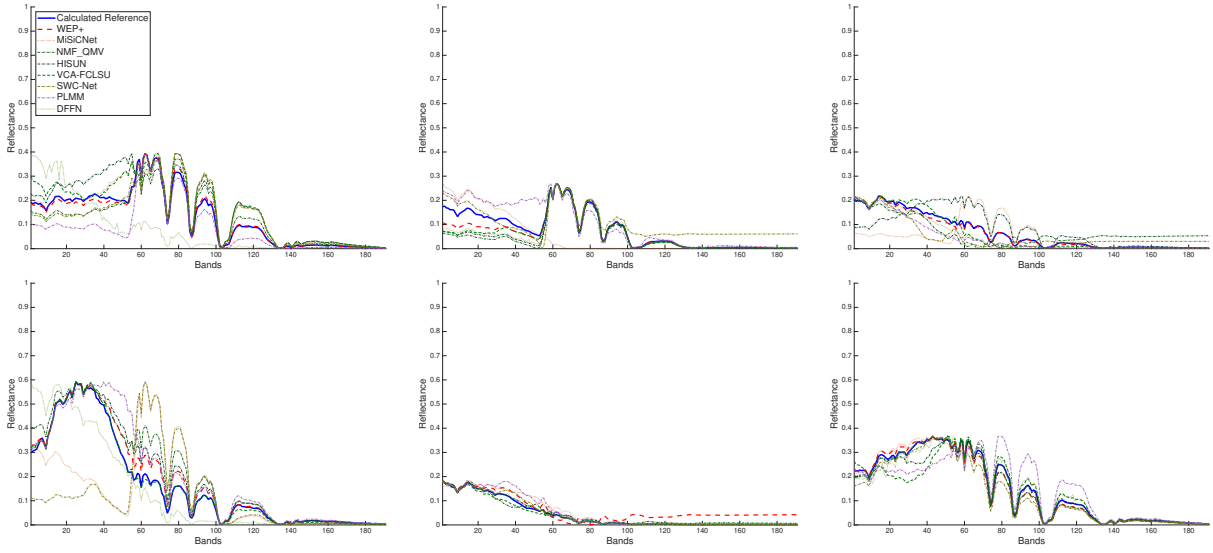

Figure 11: Spectral endmembers calculated by WEP+ and other algorithms on the WDC data.