COMPARISON BETWEEN LINEAR AND NONLINEAR SPECTRAL UNMIXING OF HYPERSPECTRAL DATA

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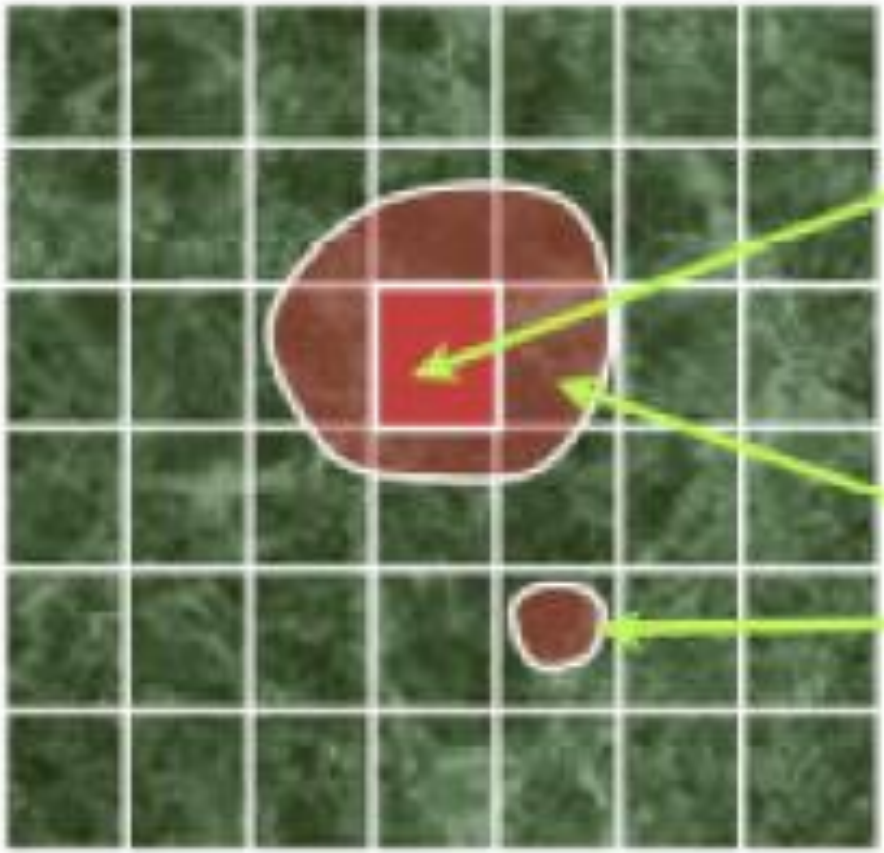
Mixed Pixels

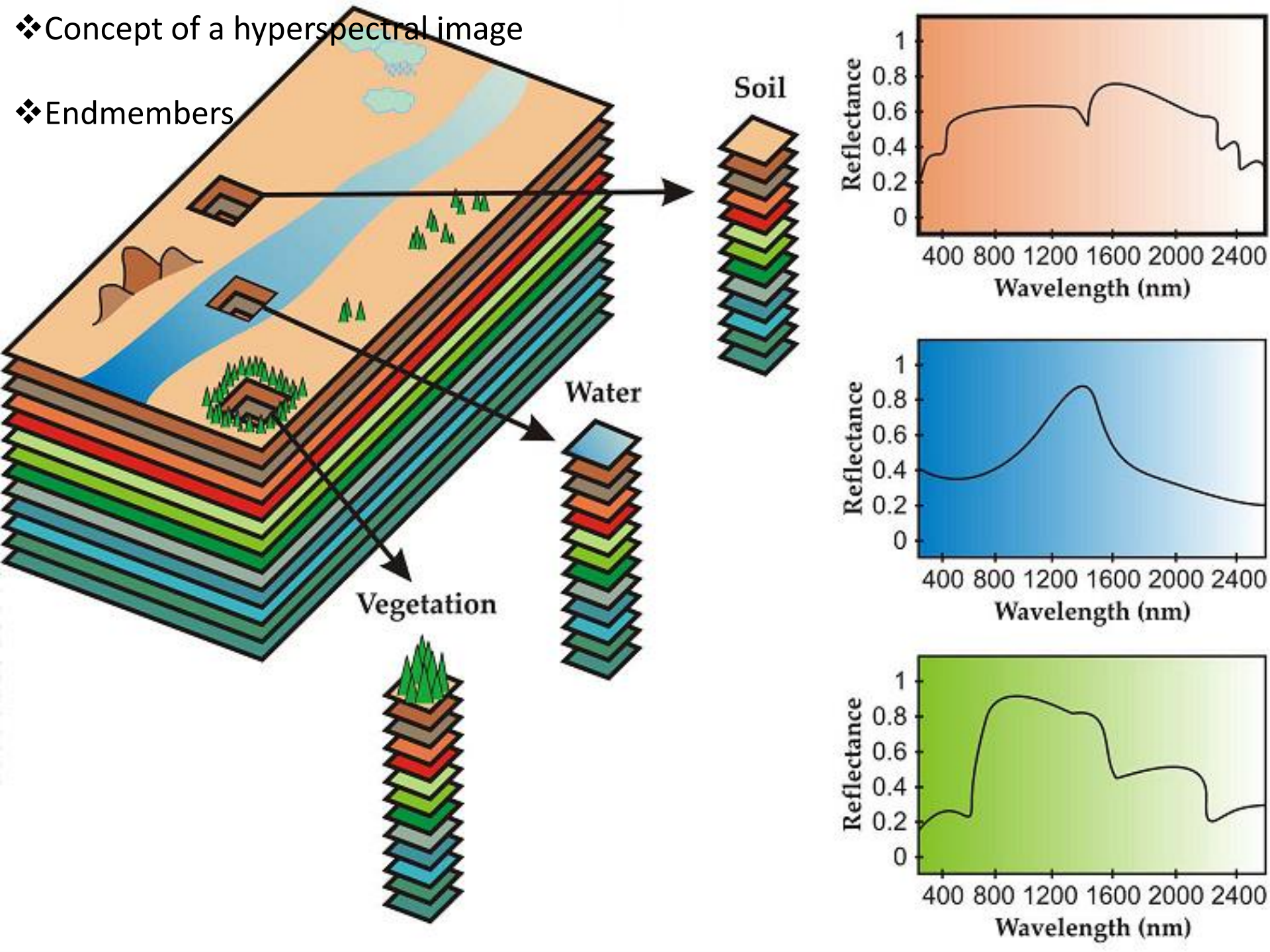


Full-pixel target

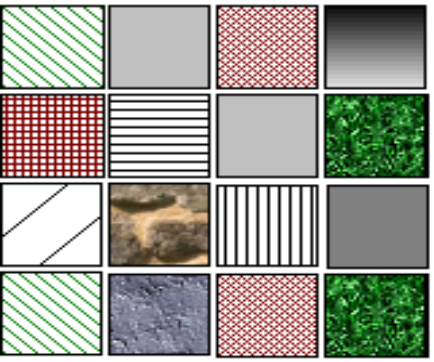
Sub-pixel targets

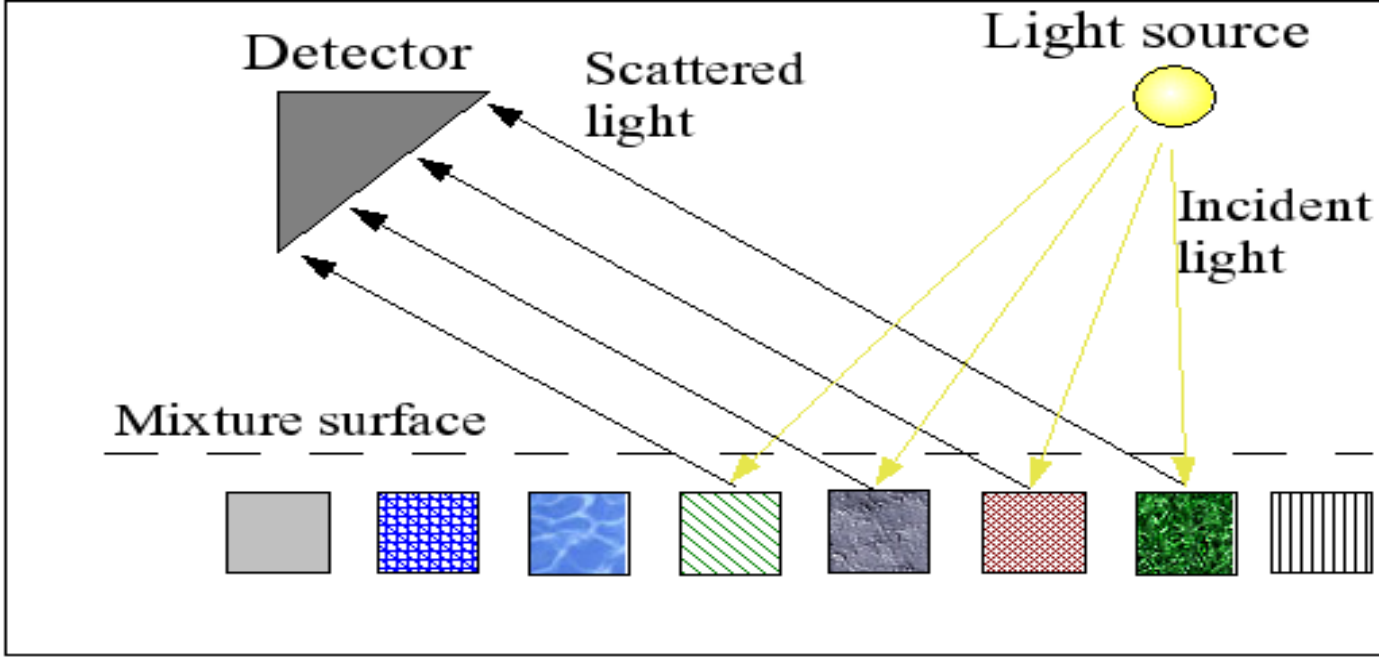
❖Concept of a hyperspectral image

❖Endmembers

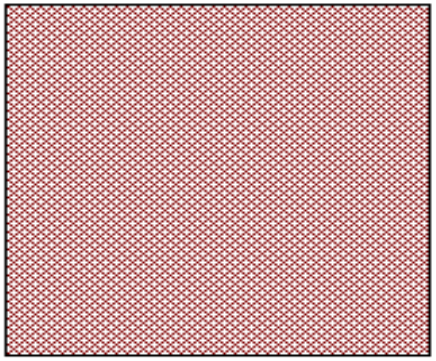


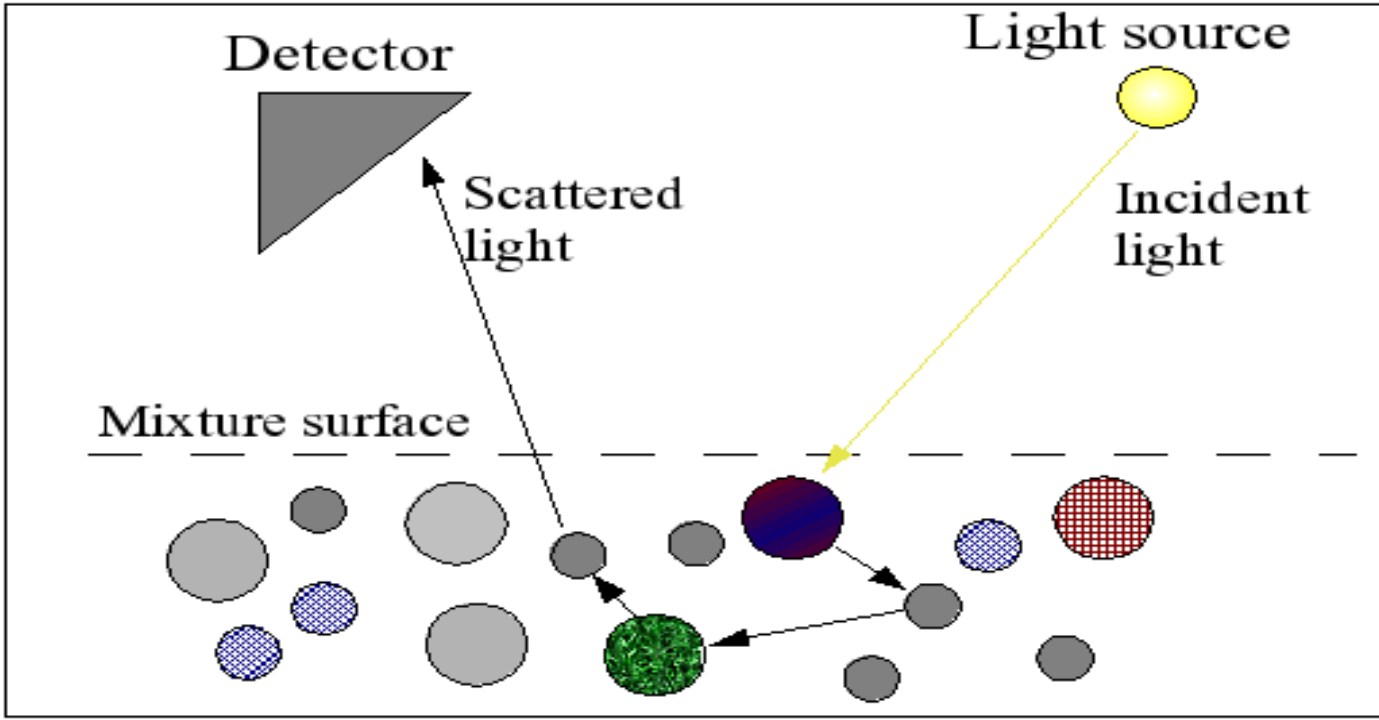
Linear mixture



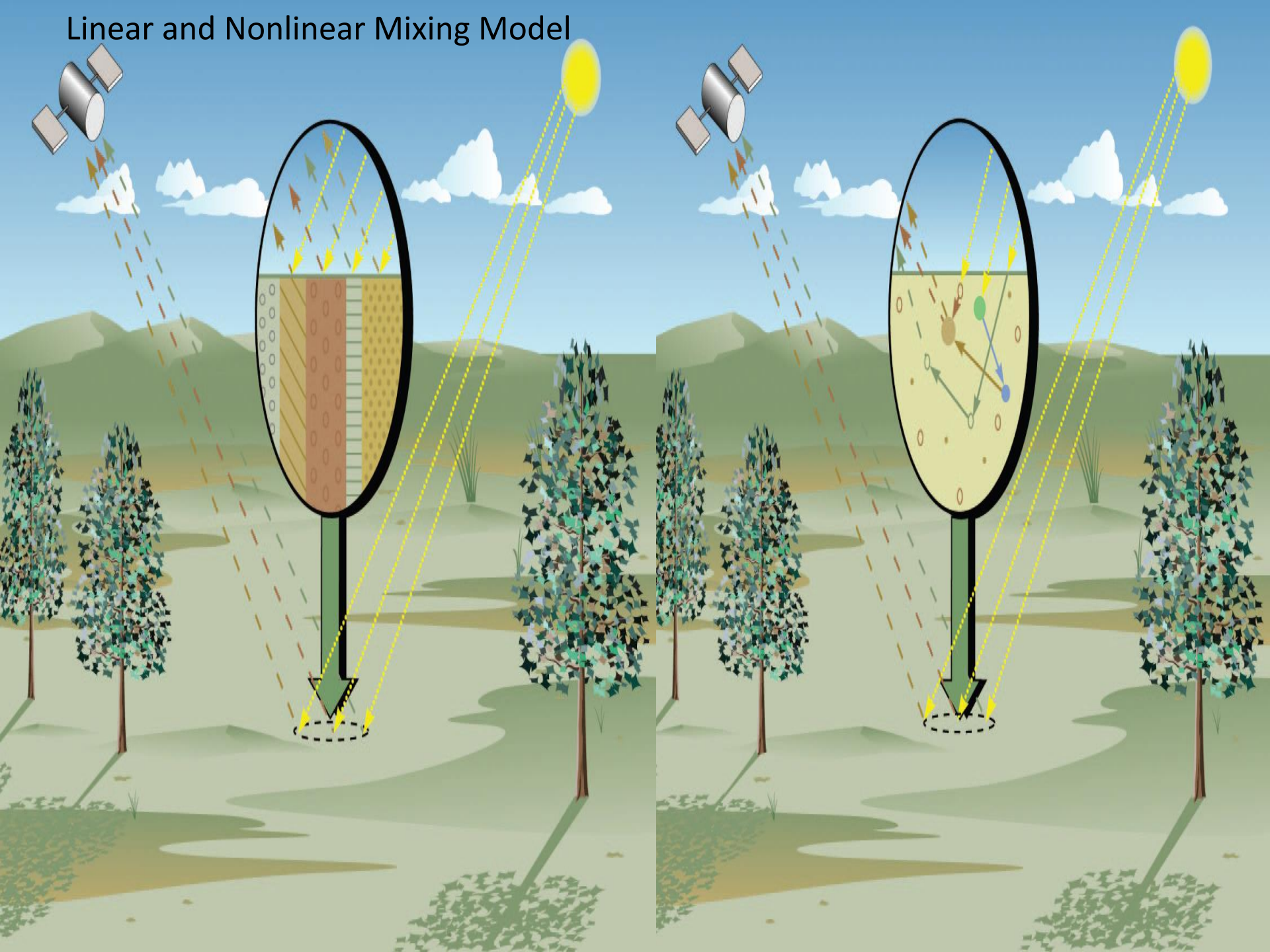


Intimate mixture





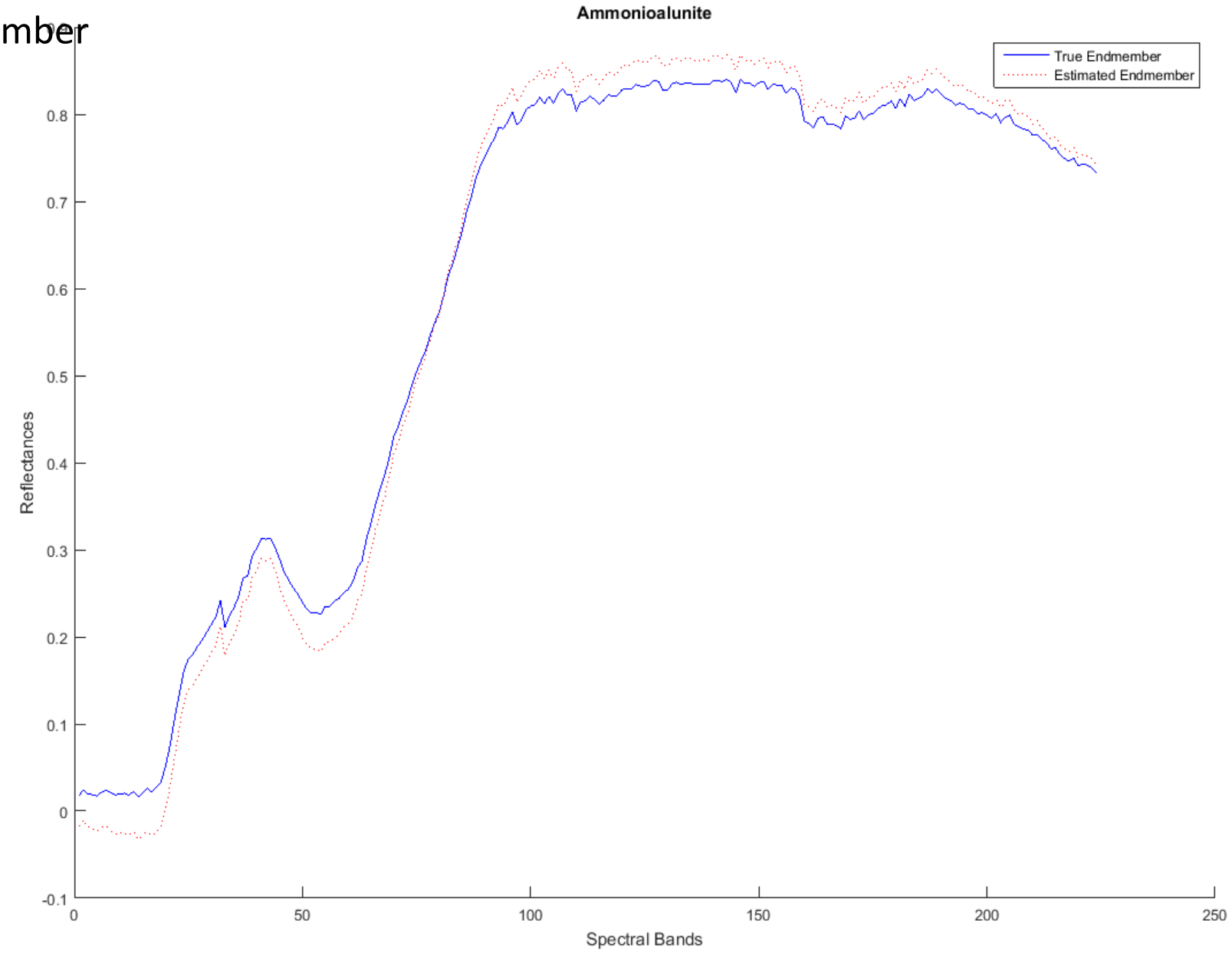
Linear and Nonlinear Mixing Model



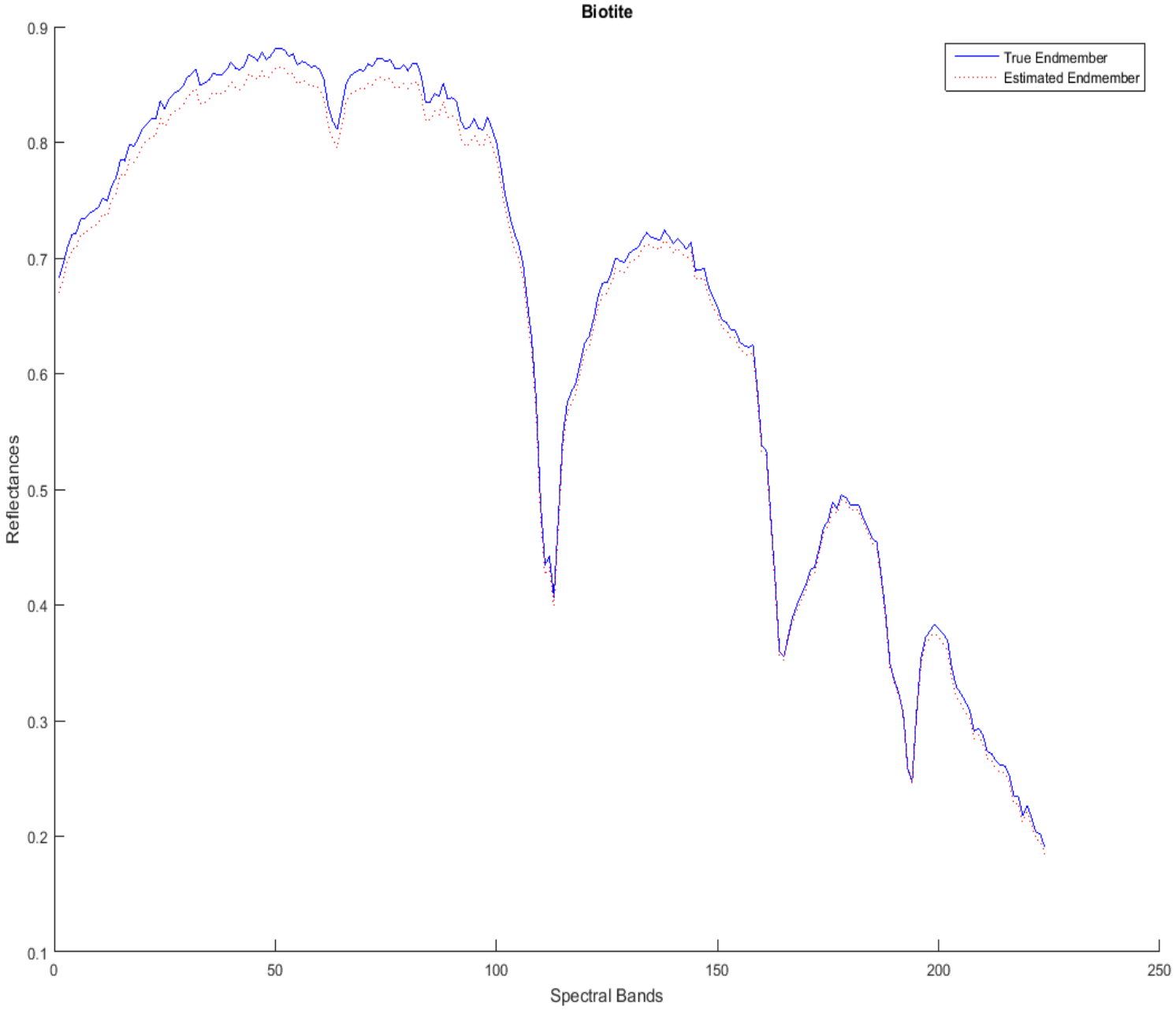
Comparison

- Vertex Component Analysis (VCA)
- Minimum Volume Simplex Analysis (MVSA)
- Generalized Bilinear Model (GBM)
- Polynomial Post Nonlinear Mixing Model (PPNMM)

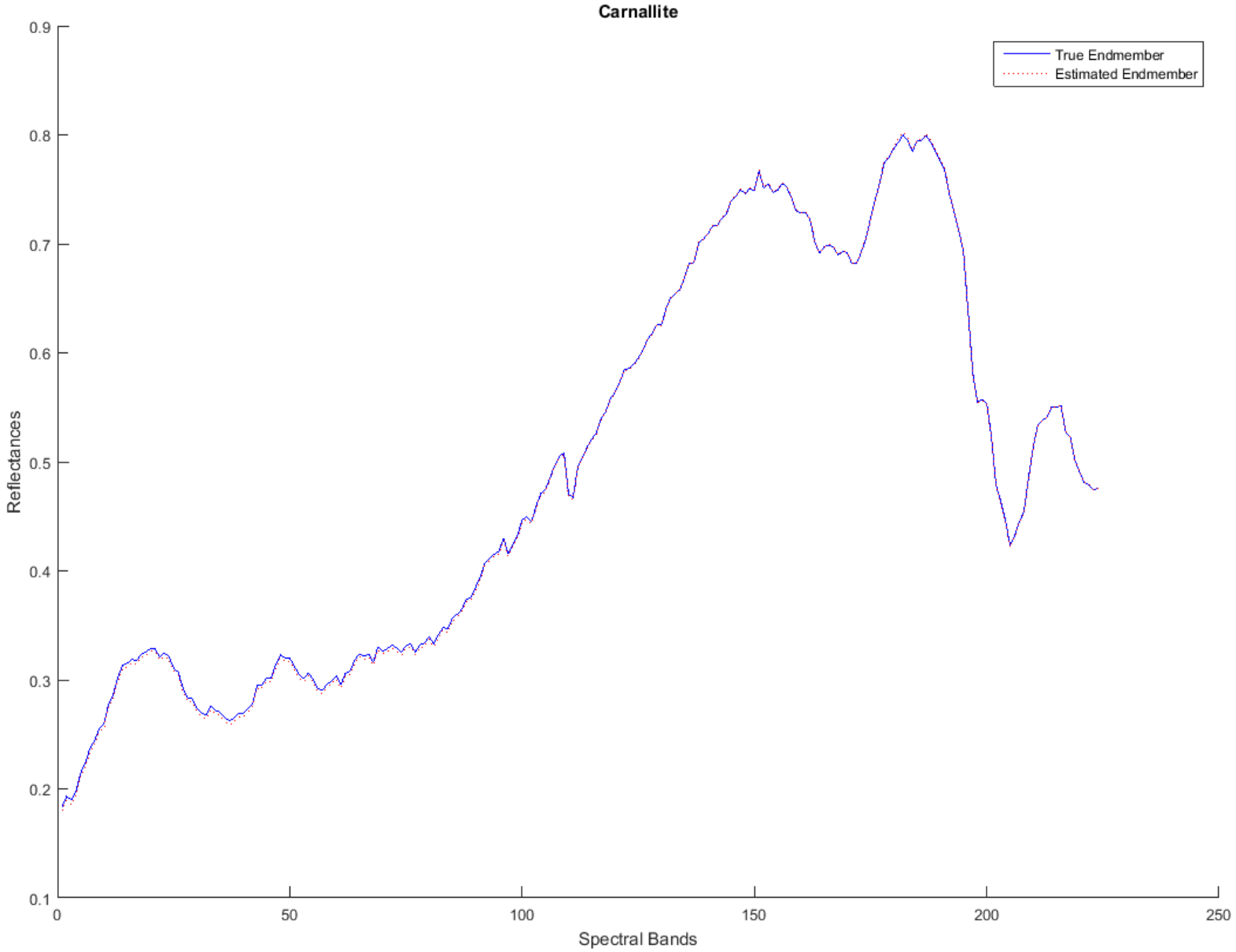
❖Plot of true and estimated member



Plot of true and estimated member



Plot of true and estimated member



Assessment Method

$$RMSE = \sqrt{\frac{1}{nR}\sum_{p=1}^{n} \| a(p) - \hat{a}(p) \|^2}$$

Results

ALGORITHM	SNR (10dB)	COMP TIME (s)	SNR (30dB)	COMP TIME (s)	SNR (50dB)	COMP TIME (s)
VCA	0.1933	0.110	0.0952	0.120	0.0808	0.110
MVSA	0.1804	0.550	0.0096	0.500	0.0028	0.990
GBM	3.1126 ($*10^{-2}$)	1.678	2.7233 ($*10^{-2}$)	1.431	2.500 ($*10^{-2}$)	1.130
PPNMM	4.333 ($*10^{-2}$)	1.254	3.706 ($*10^{-2}$)	1.101	3.005 ($*10^{-2}$)	1.100

Conclusions

- Nonlinear models out performs the linear models in the presence of high SNR

- The nonlinear models are computationally expensive compared to the linear method .

- The nonlinear models are robust against noise with different SNR level

References

Keshava N and J. F. Mustard. Spectral unmixing. *IEEE Signal Process. Mag, vol.19(no.1):44{57, 2002.*

Duran O and Petrou M. Mixed pixel classification in remote sensing – literature survey. *Technical report, School of electronics and Physical Science, University of Surrey, Guildford,* GU2 7XH, United Kingdom, 2004.

Olga Duran and Maria Petrou. Robust endmember extraction in the presence of anomalies. *Geoscience and Remote Sensing, IEEE Transactions on, 49(6):1986-1996, 2011*.

Somers, B., Cools, K., Delalieux, S., Stuckens, J., Van der Zande, D., Verstraeten, W.W. and Coppin, P., 2009. Nonlinear hyperspectral mixture analysis for tree cover estimates in orchards. *Remote Sensing of Environment*, *113*(6), pp.1183-1193.

Nascimento, J.M. and Dias, J.M.B., 2005. Vertex component analysis: A fast algorithm to unmix hyperspectral data. *Geoscience and Remote Sensing, IEEE Transactions on*, *43*(4), pp.898-910.

Thank you and…

Questions