

Intrinsic Dimensionality in Combined Visible to Thermal Infrared Imagery

Insight into the Information Richness of the SBG Observable

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Complimentary wavelength ranges

	VisNIR (0.4 – 1um)	SWIR (1-2.5um)	TIR (8-12um)
Ecology	Health Greenness Species Foliar traits	Species Foliar traits	ET Temperature
Minerology	Hematite	Clays Chlorite Mica Sulphates Hydroxides	Silica Feldspar Carbonates Sulphates Phosphates
Air/Gas		Water vapor Carbon dioxide Methane Aerosol loading Pollutants	Methane Sulphur dioxide Ammonia Hydrogen Sulphide Nitrogen dioxide

Intrinsic Dimensionality

$$\text{Image} \rightarrow X = S + \Delta \leftarrow \text{Noise}$$

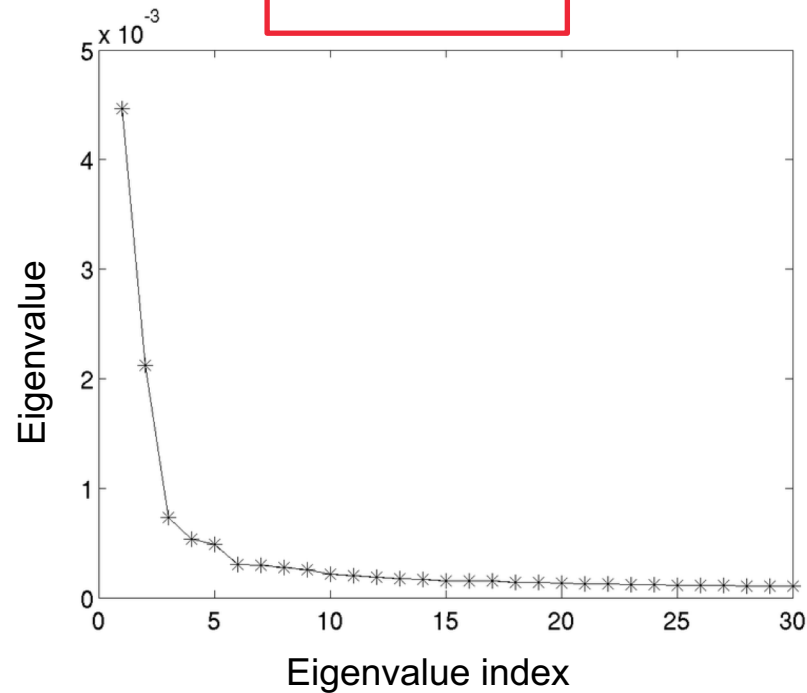
Signal

(Assuming centered and scaled data)

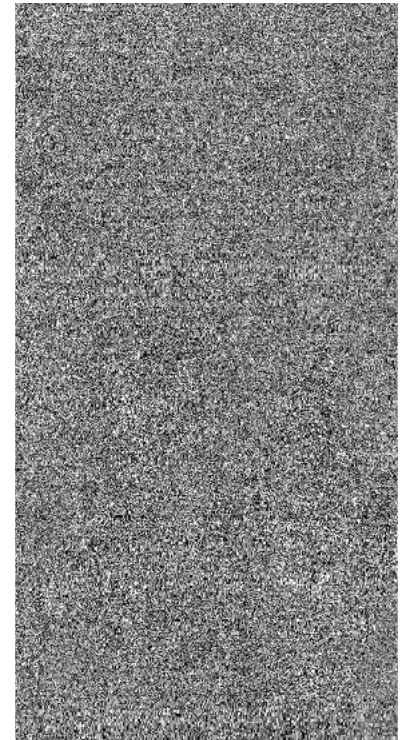
Principal component K



$$X X^T$$



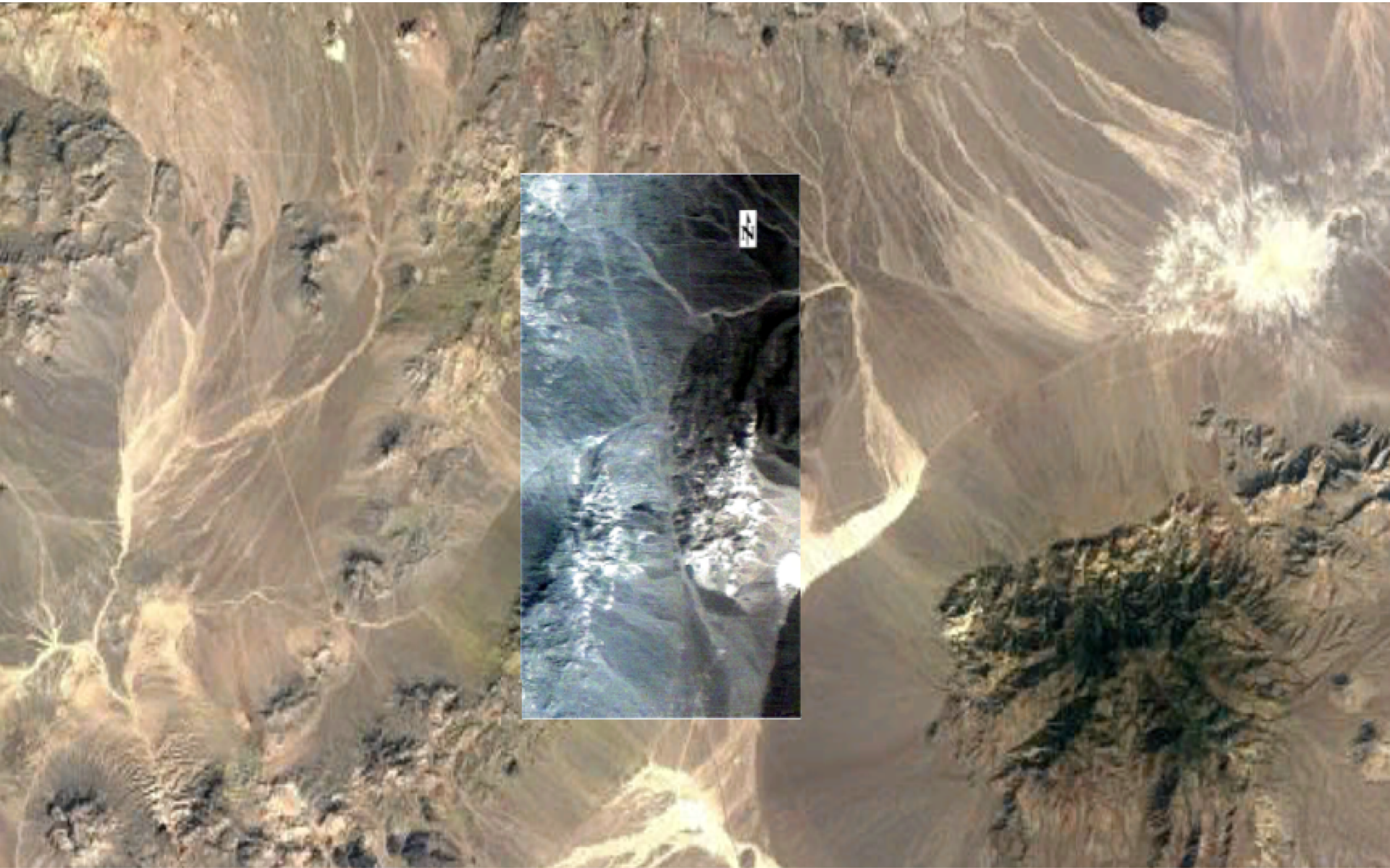
Principal component K+1

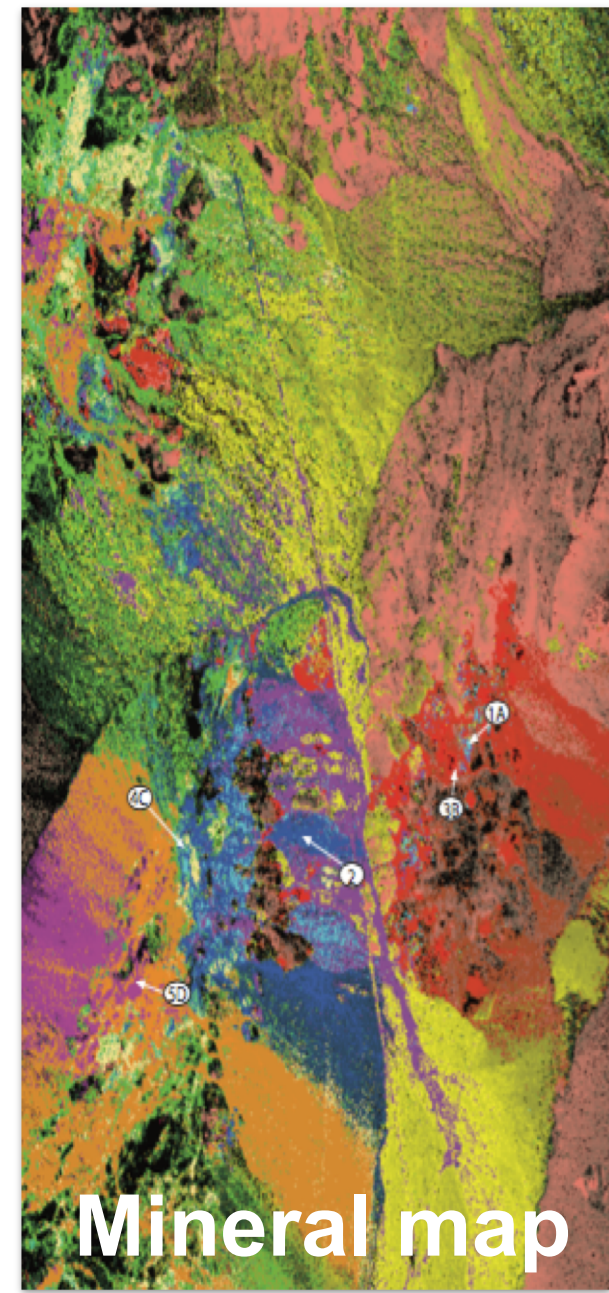
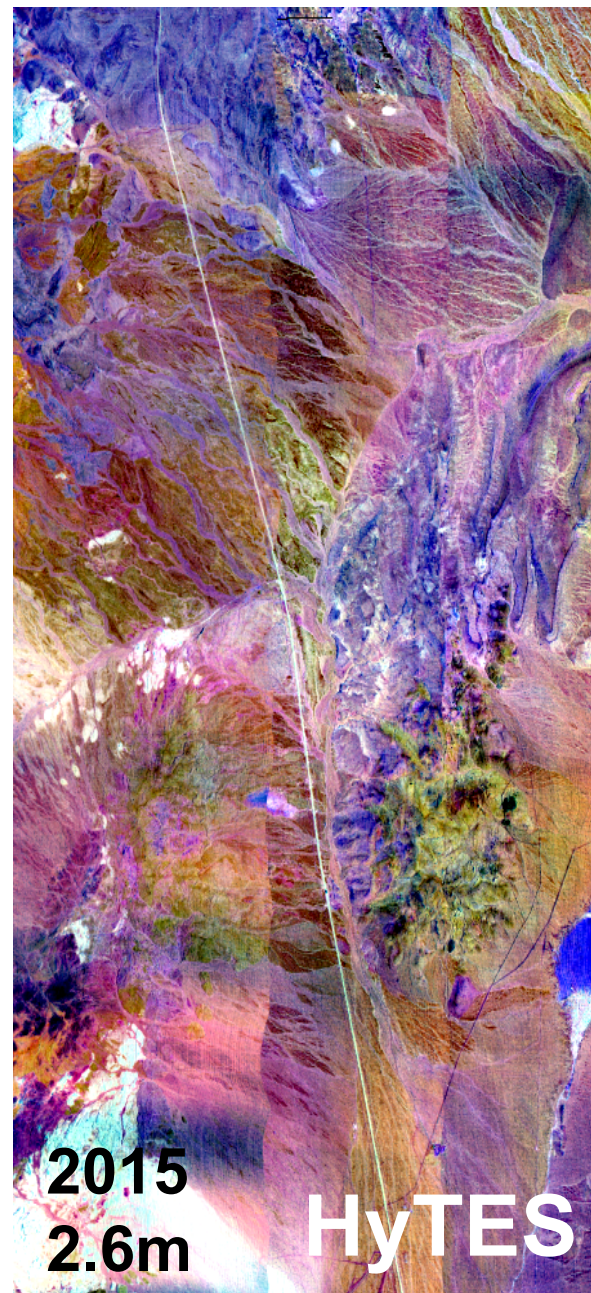
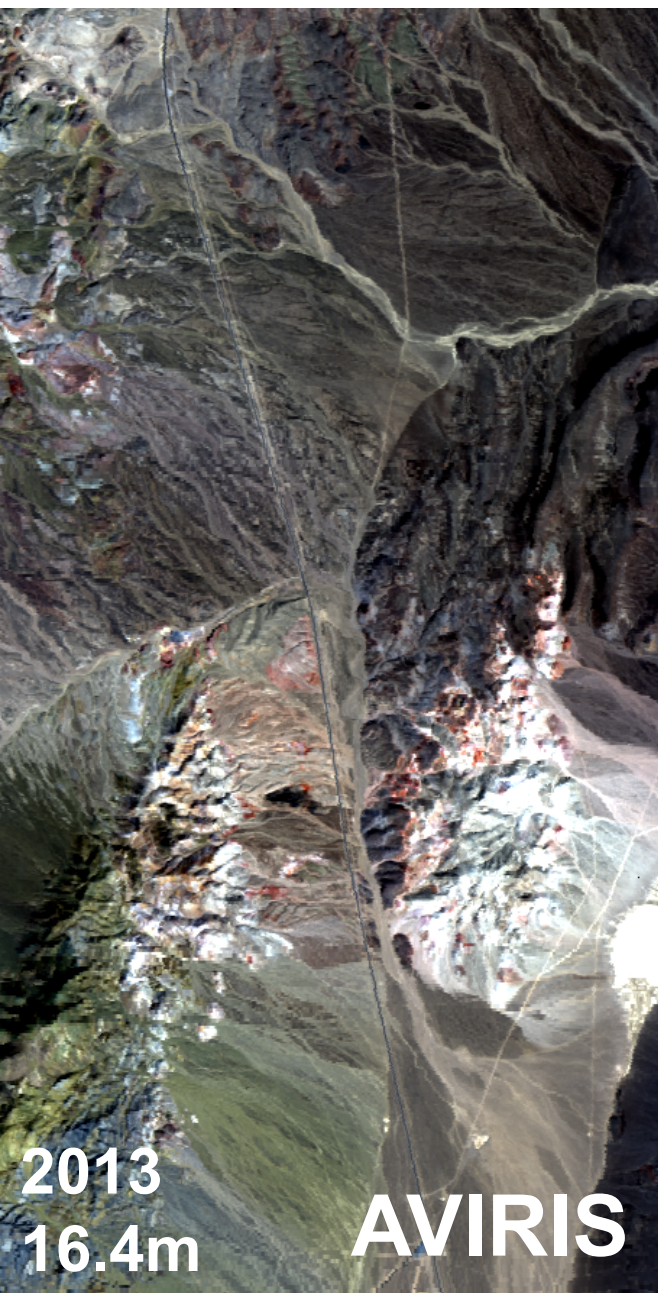


Random Matrix Theory



Cuprite

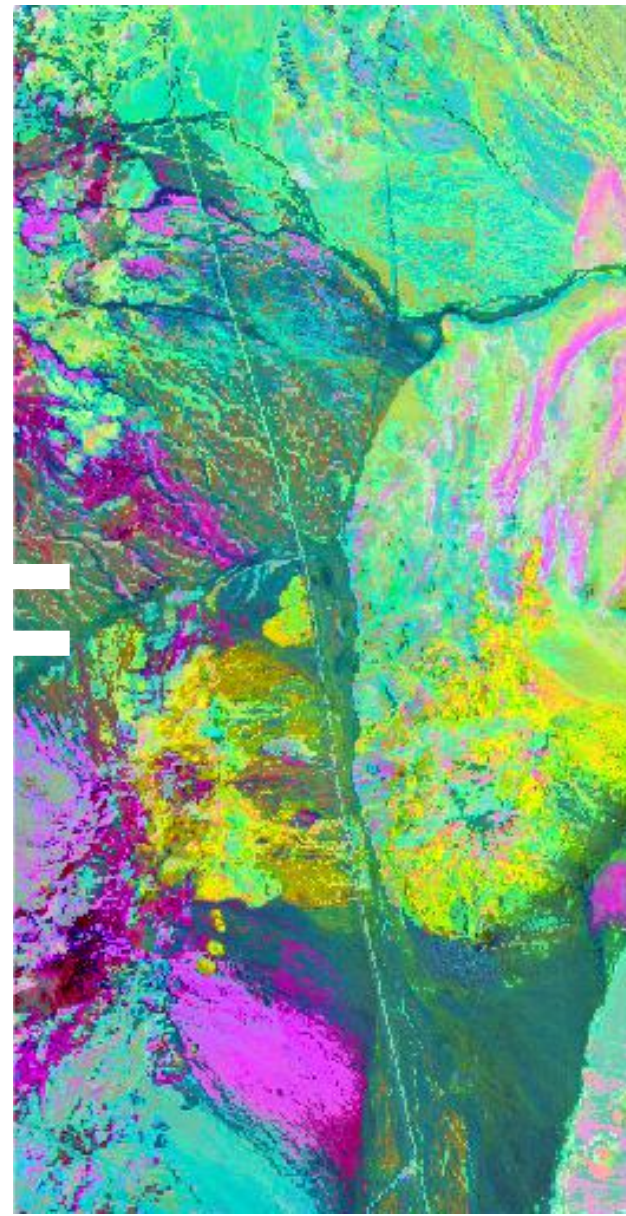
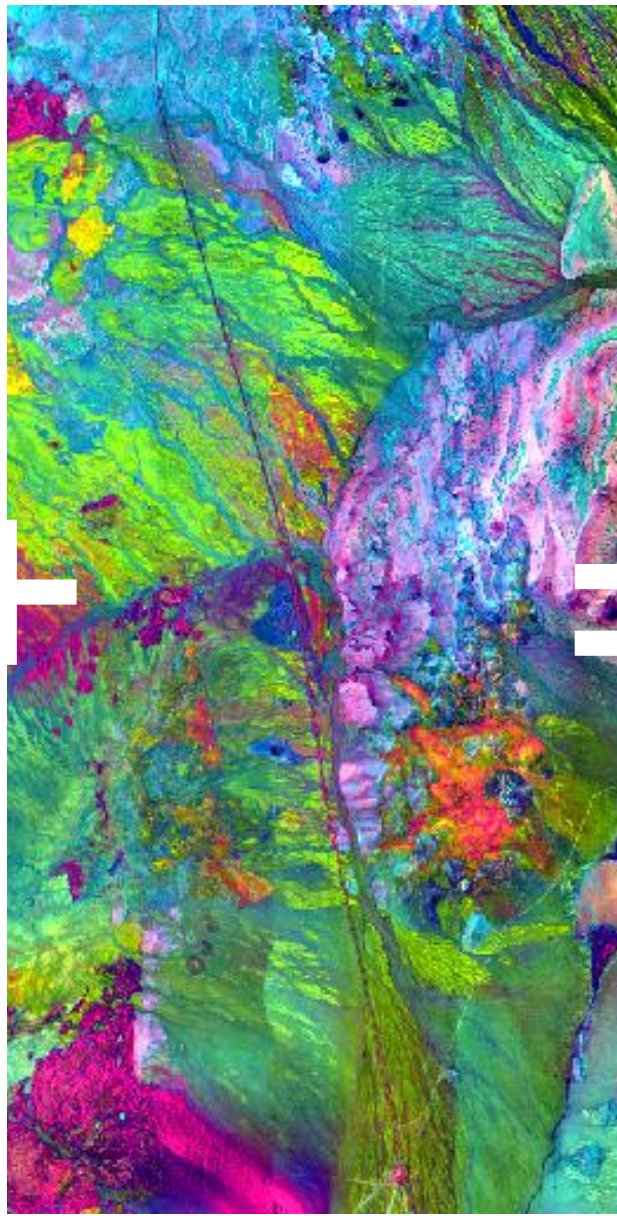
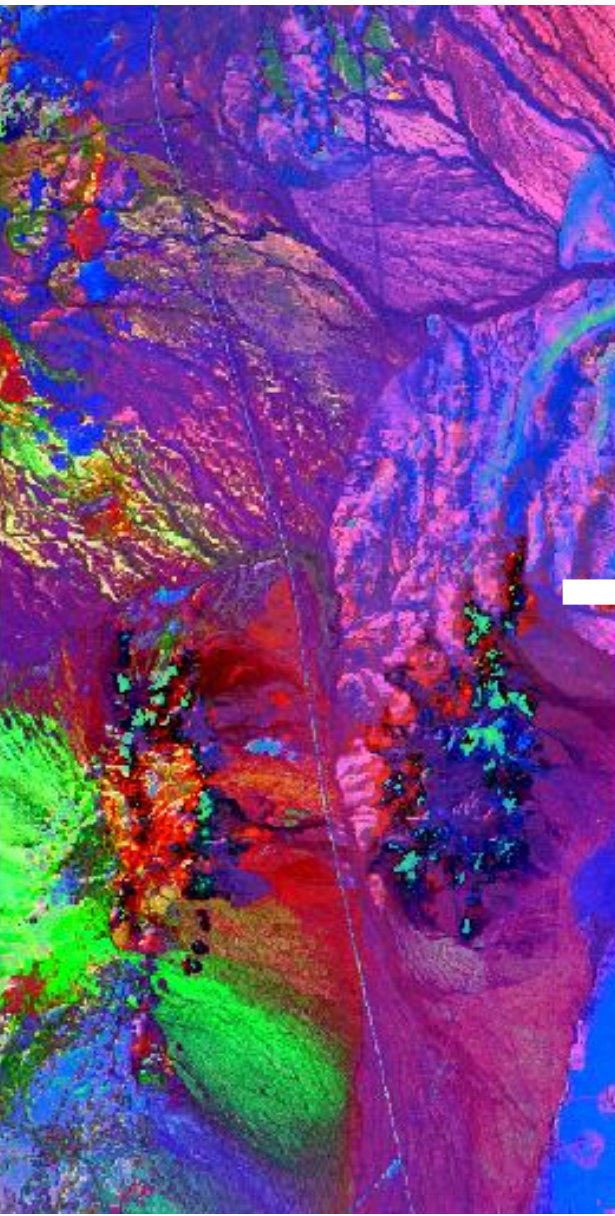




Intrinsic Dimensionality

Scene	Number of channels	Intrinsic Dimensionality
AVIRIS	224	24
HyTES	202	20
Combined (scaled)	426	38

- The VSWIR and TIR spectral channels are almost entirely orthogonal/complementary



Mauna Loa

Hawaii Campaign

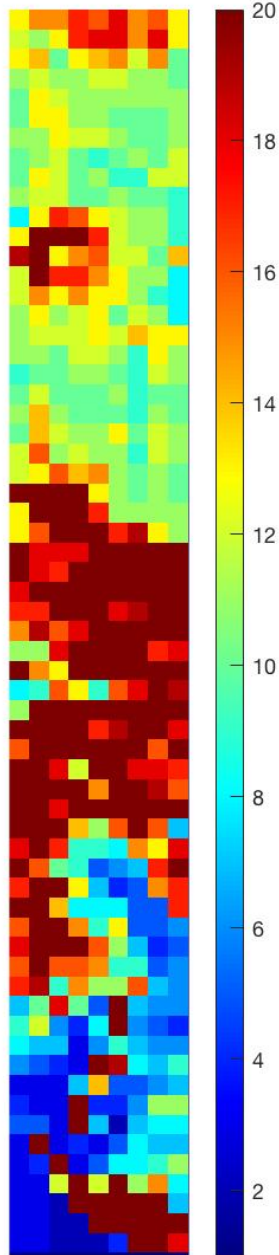
Jan-Feb 2018

ER-2, 13.6m

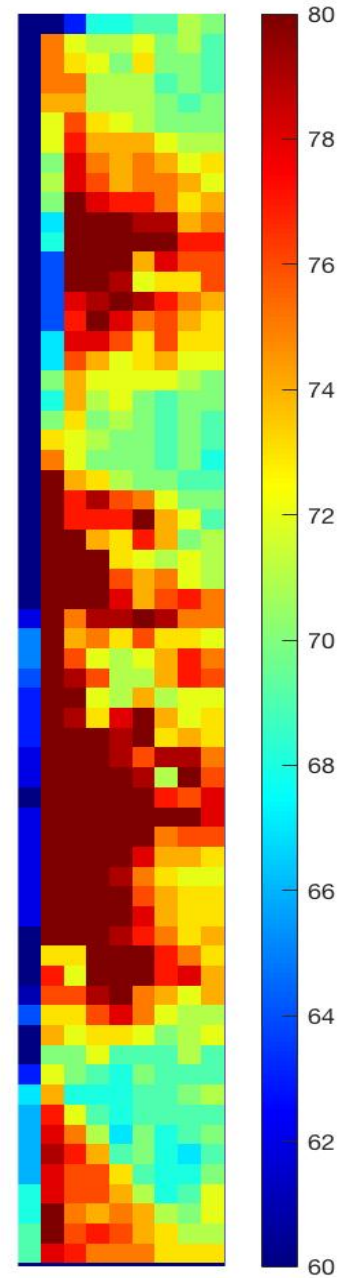




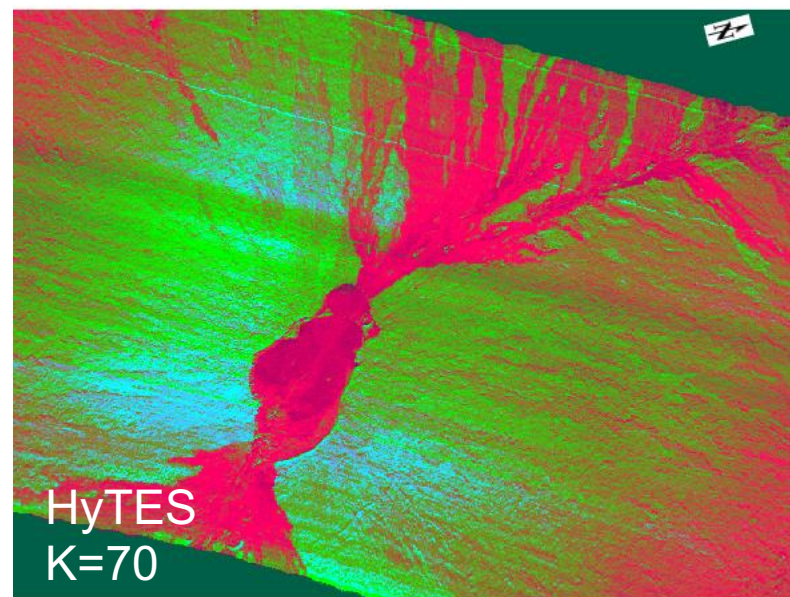
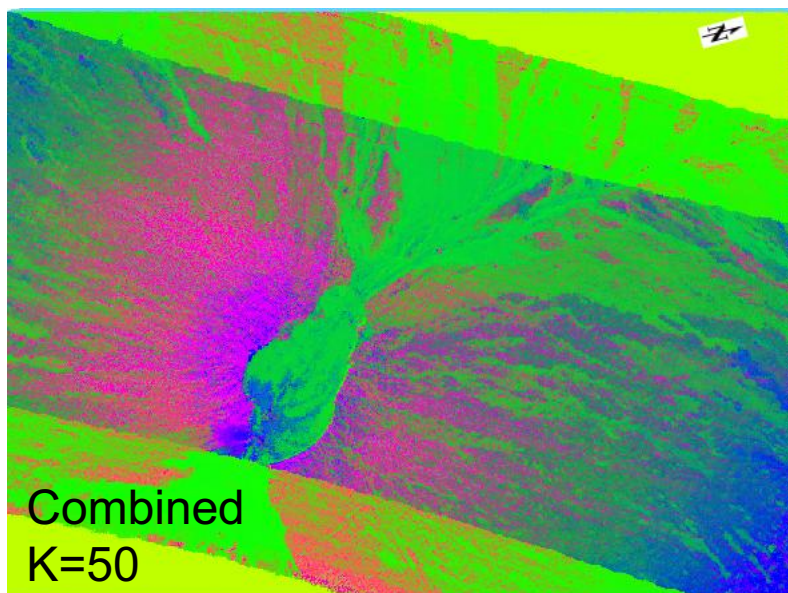
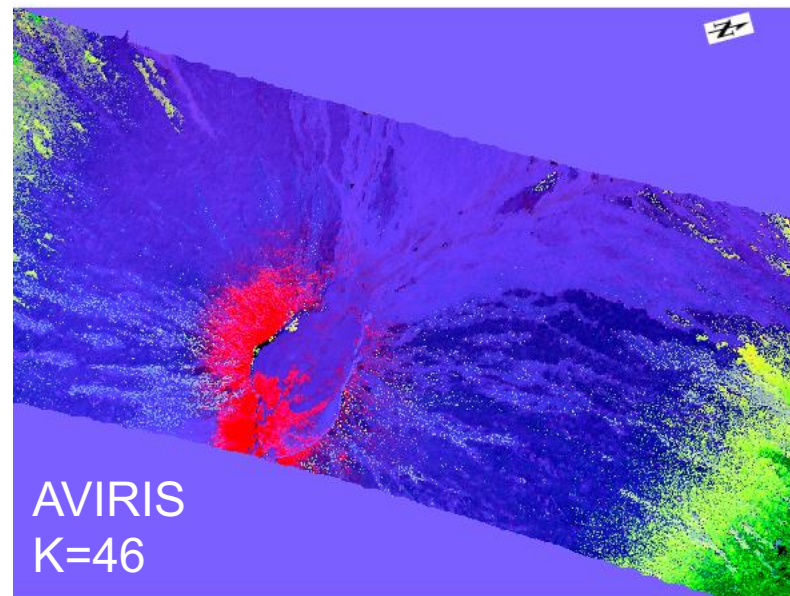
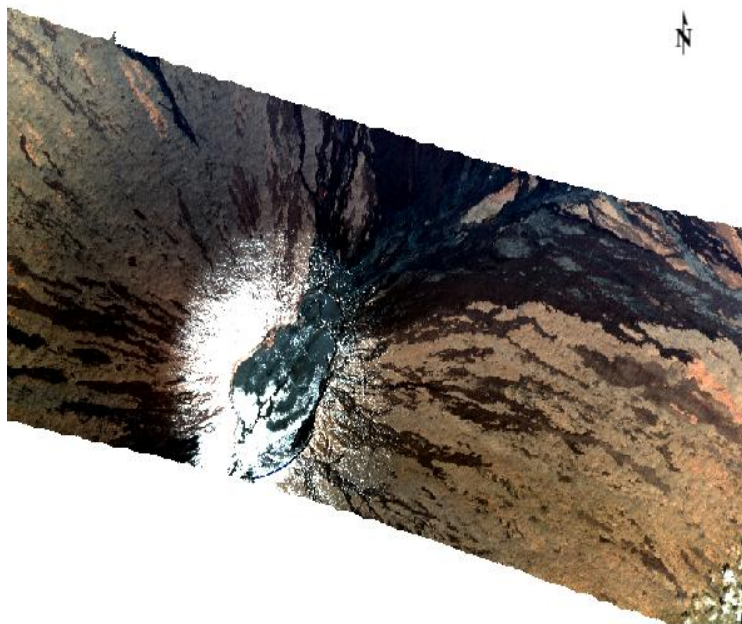
16 Aug 2018

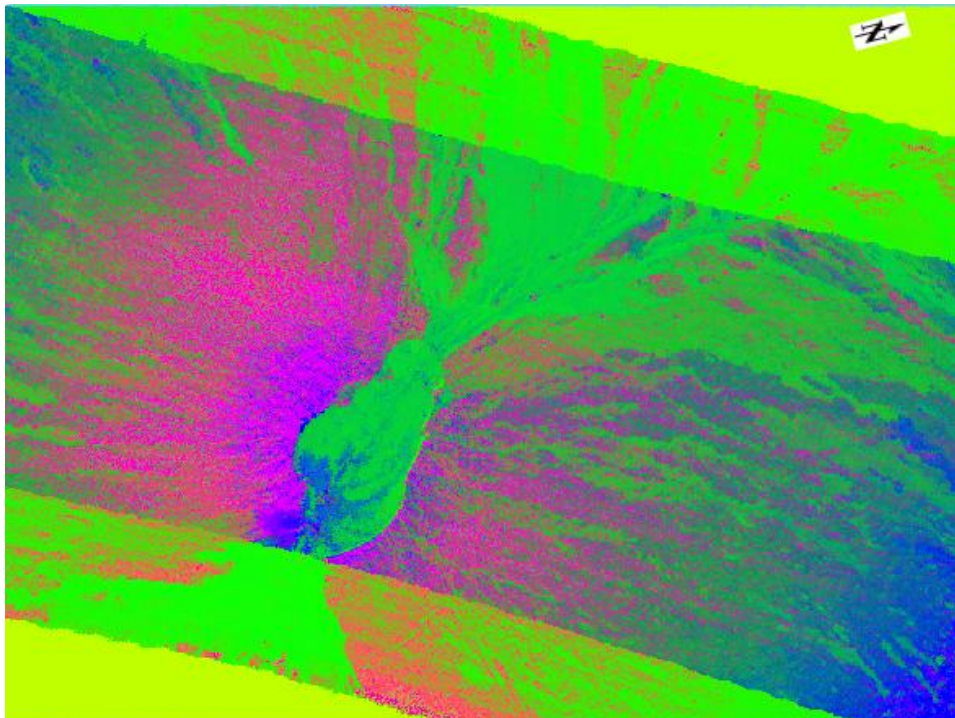


AVIRIS refl
K=68



HyTES emis
K=88





Volcanic scenes are often noisy due to unexpected emissions. Here, the combination of VSWIR and TIR has allowed for a better noise model, and so more real classes are detected.

After removal of redundant spectral classes:

Sensor	Original ID	ID after pruning
AVIRIS	46	26
HyTES	70	3
Combined	50	46

Summary

- VSWIR and TIR spectral ranges each have advantages in measuring SBG observables
- In some cases, information content of VSWIR and TIR is almost orthogonal
- Contemporaneous measurement of the full wavelength range has the highest information content.



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