

Multispectral Analysis of Land Surface Reflectance Time-Series for Clustering Change Events

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Introduction:

- Satellite image time-series for monitoring Earth system change (land surface reflectance)
- Harmonic models for sequentially extracting seasonal parameters with Particle Filtering
- state vector: $x_{b,k} = [\mu_{b,k}, \alpha_{b,k}, \varphi_{b,k}, \omega_{b,k}]$ (mean, amplitude, phase, frequency at k in band b)
- **Multispectral behavior at change point**

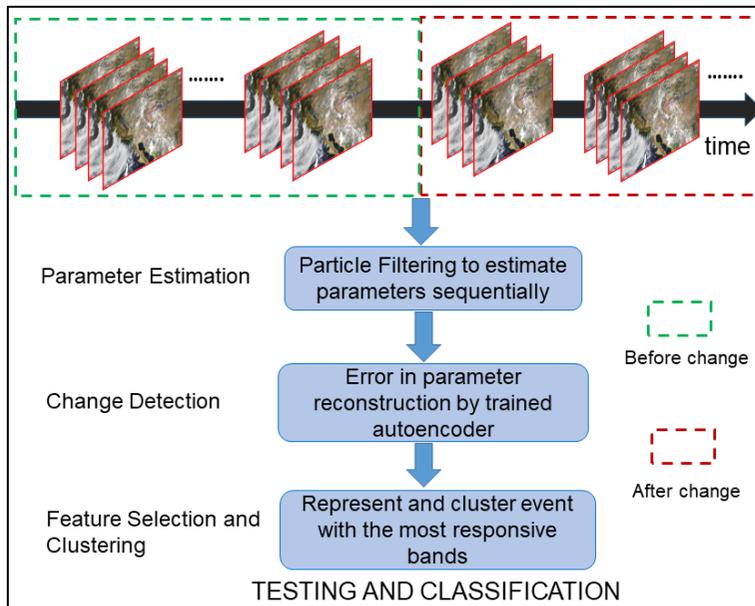
Methodology:

Dataset: MODIS land surface reflectance (7 bands, 8 days, 500 m)

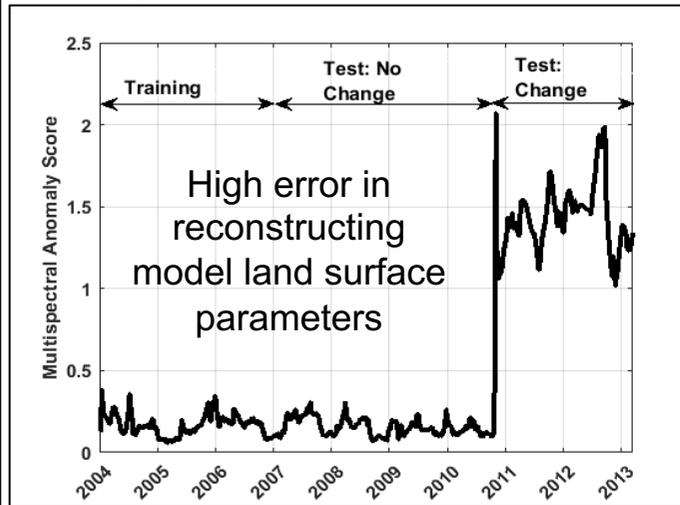
Pixel time-series of regions over 16 years

Change Events: forest fire, drought, flood (coastal wetland, agricultural area), coastal land gain

Training: pre-change spectra of land surface reflectance time series across all bands to learn expected spectral reflectance model using autoencoders



Change Detection:



Sequentially Estimated reflectance: $(x_{b,k})$
Reconstructed reflectance: $(x'_{b,k})$

Anomaly Score:

$$A_k = \sum_{b=1}^B |x'_{b,k} - x_{b,k}|$$

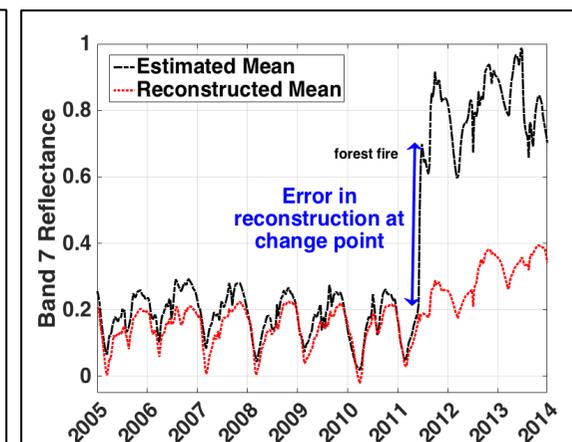
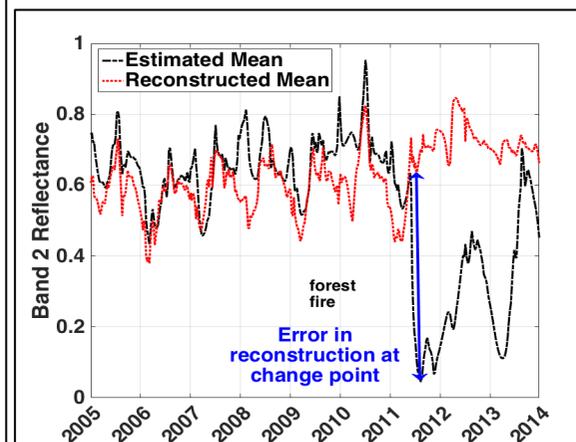
Interpretability of Reconstruction Errors:

$$(x'_{b,k} - x_{b,k}) > 0$$

Time-series (at k in band b) **decreases** due to change

$$(x'_{b,k} - x_{b,k}) < 0$$

Time-series (at k in band b) **increases** due to change

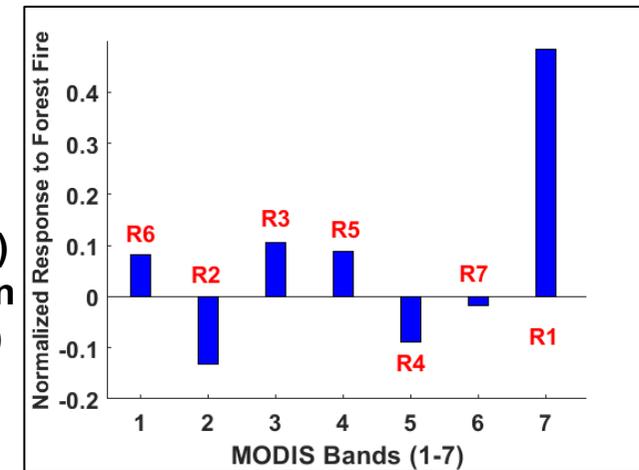


Reconstruction error over time for forest fire in NIR and SWIR

Change Signatures:

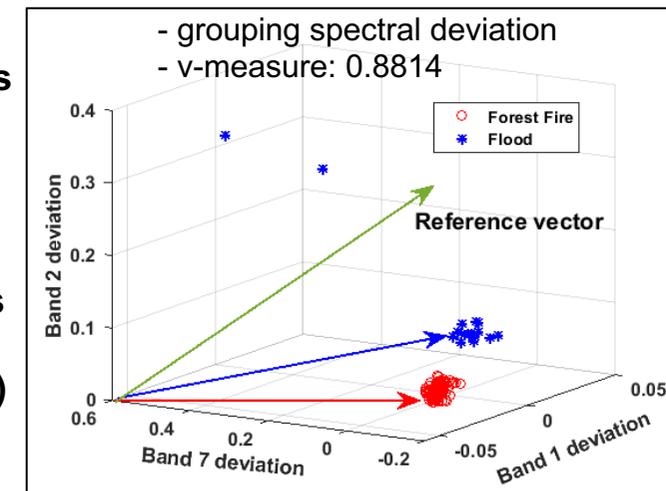
Similarity with NDVI:

- Increase in band 1 (Red)
- Decrease in band 2 (NIR)



Clustering:

Uniqueness of change vector of different events (deviations of change signatures)



Conclusion and Future Work:

- Unique signature of each event from deviations
- extension to more regions, hyperspectral data

References:

1. S. Chakraborty, et al. "Time-varying modeling of land cover change dynamics due to forest fires." *IEEE JSTARS*, 11.6 (2018).
2. S.Chakraborty, A.Papandreou-Suppappola, P.R.Christensen, "Class Separability of Land Cover Change Events from Multispectral Satellite Image Time-Series." *AGUFM 2019*: IN43A-05.