



Decomposition of Inelastic and Elastic Components of Total Subsidence for Model Calibration Evaluation

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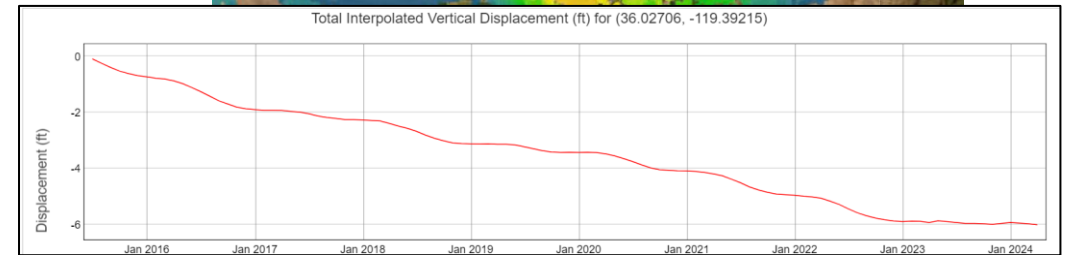
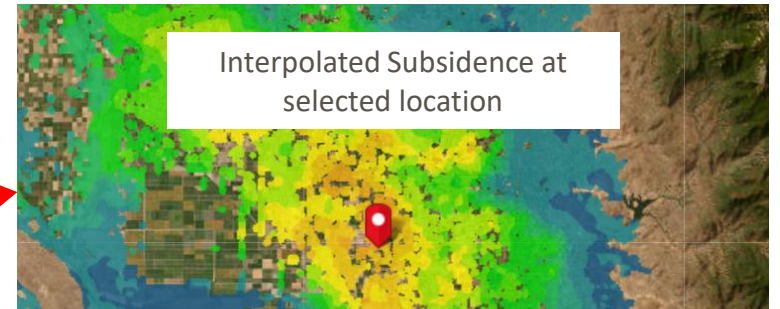
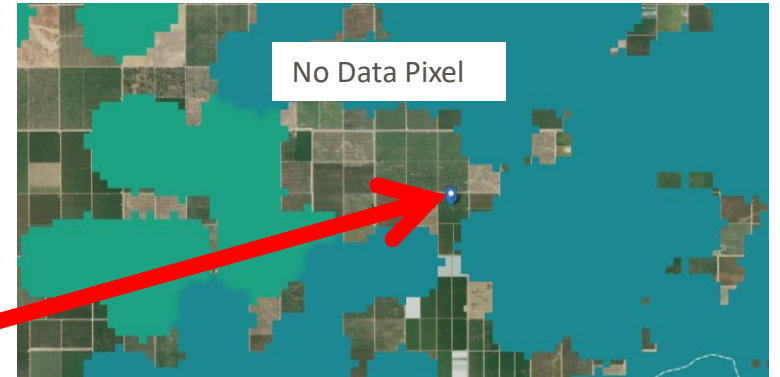
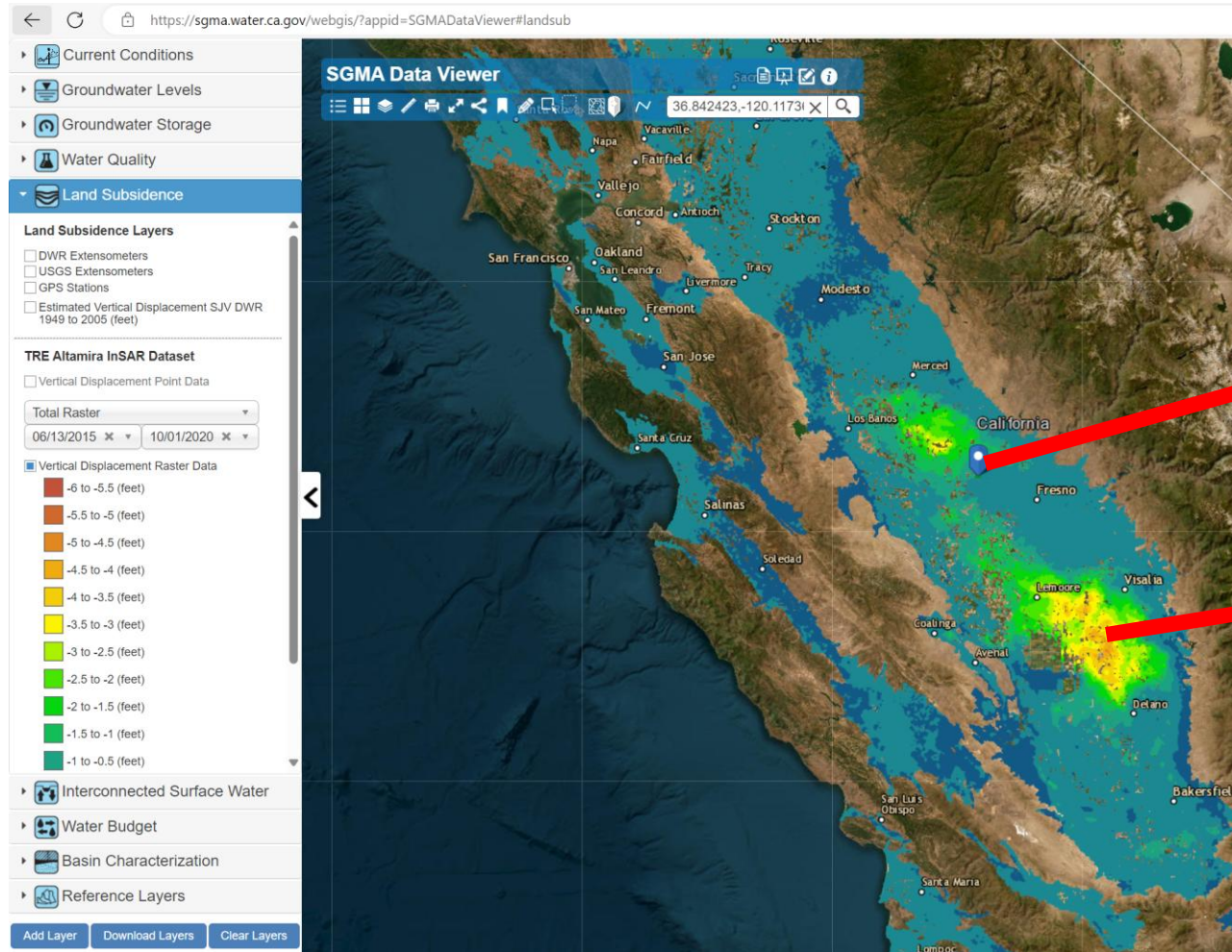
**California Water & Environmental Modeling Forum
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Outline

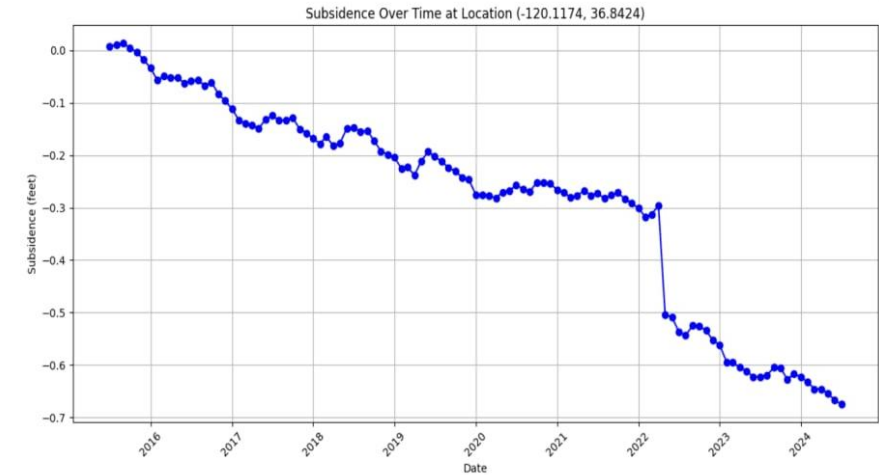
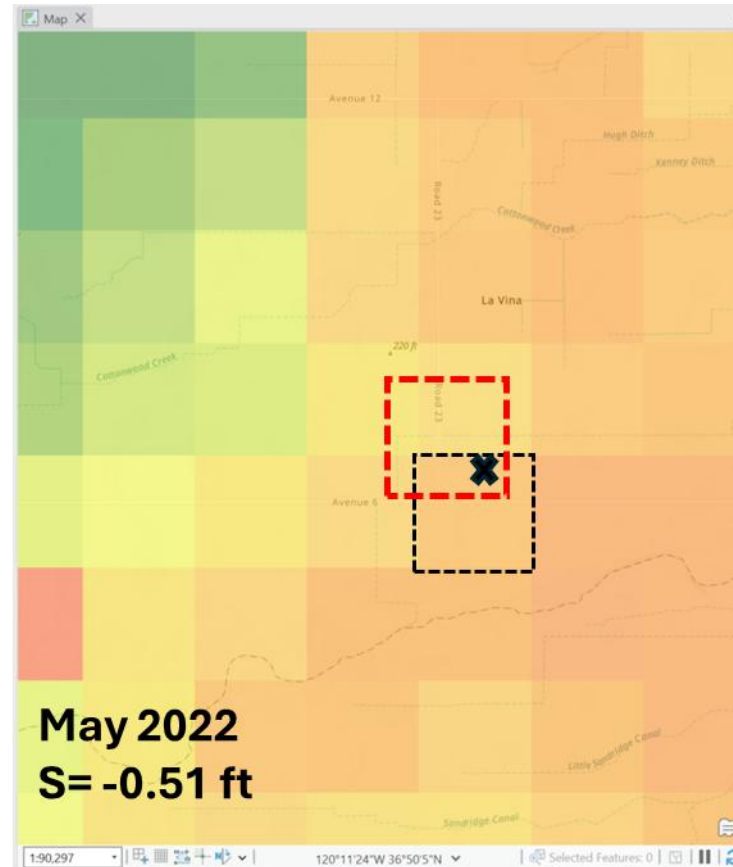
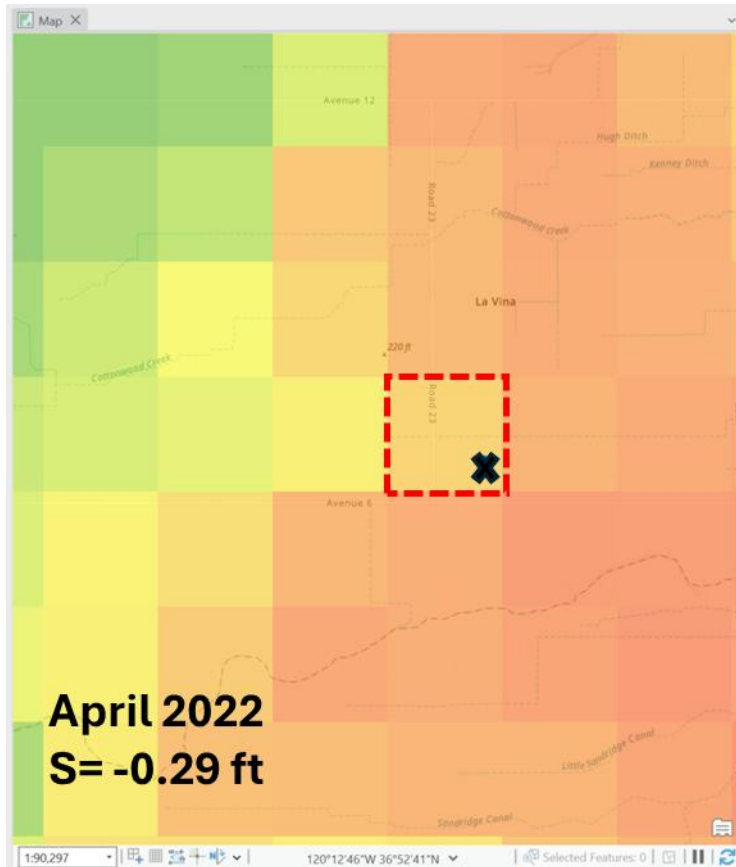
- SGMA InSAR Data
- Principal vs Independent Components Analysis
- Truncate Data Temporally to Avoid Artefacts
- Truncate Data Spatially to Known Subsidence 'bowls'
- Model Calibration Evaluation
- Conclusions

InSAR Total Subsidence Spatial and Temporal Data coverage can vary for each month, subsidence values are interpolated



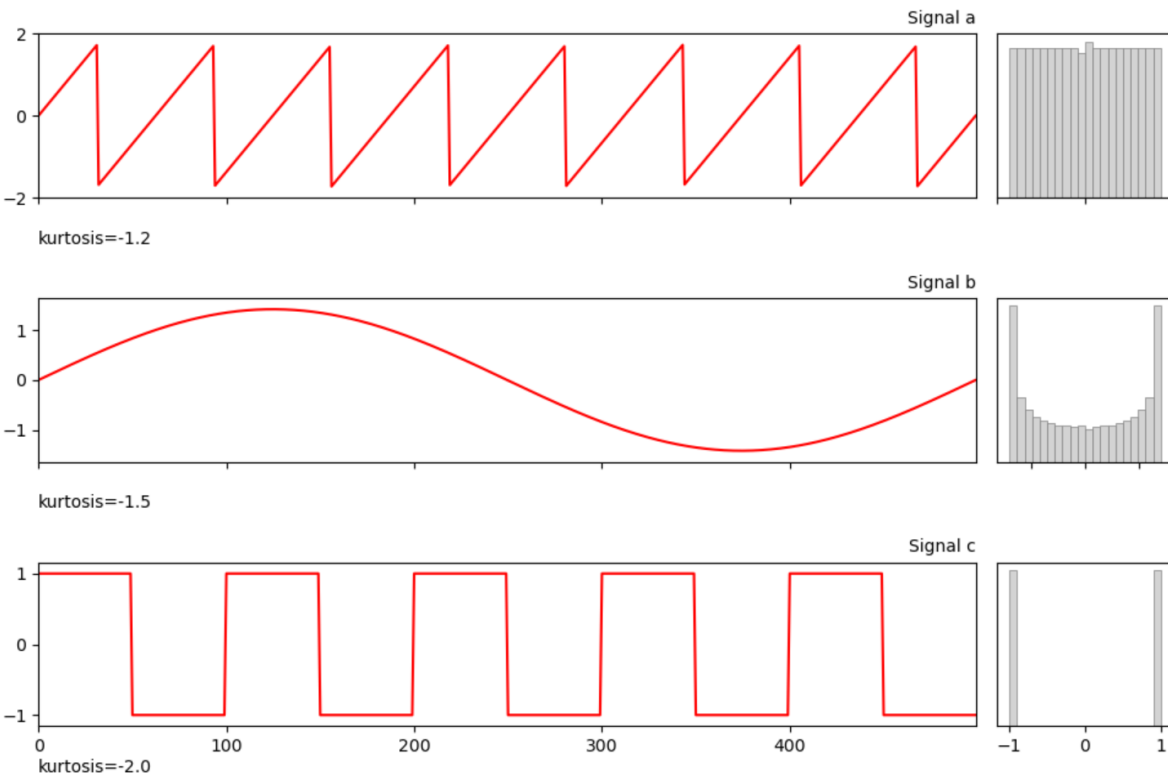
Pixel offsets in original InSAR raster data

Interpolation artefacts cause sudden jump in timeseries

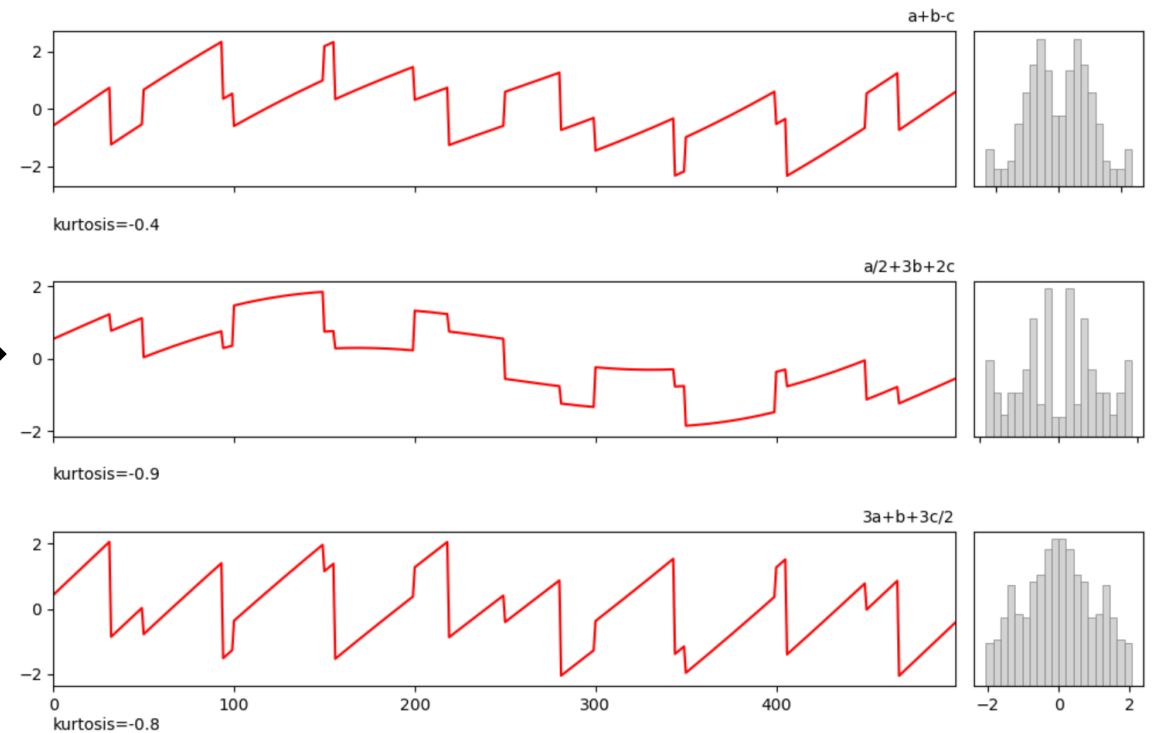


Independent Component Analysis is not a dimension reduction method like Principal Component Analysis

Input Signals

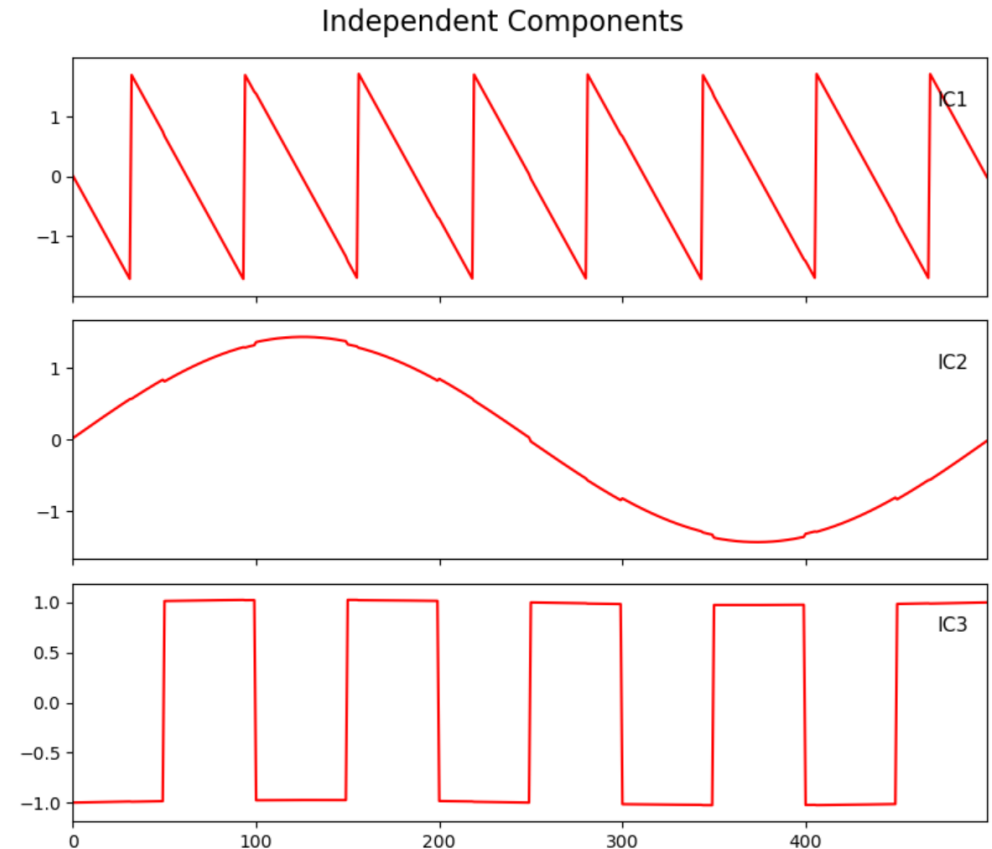
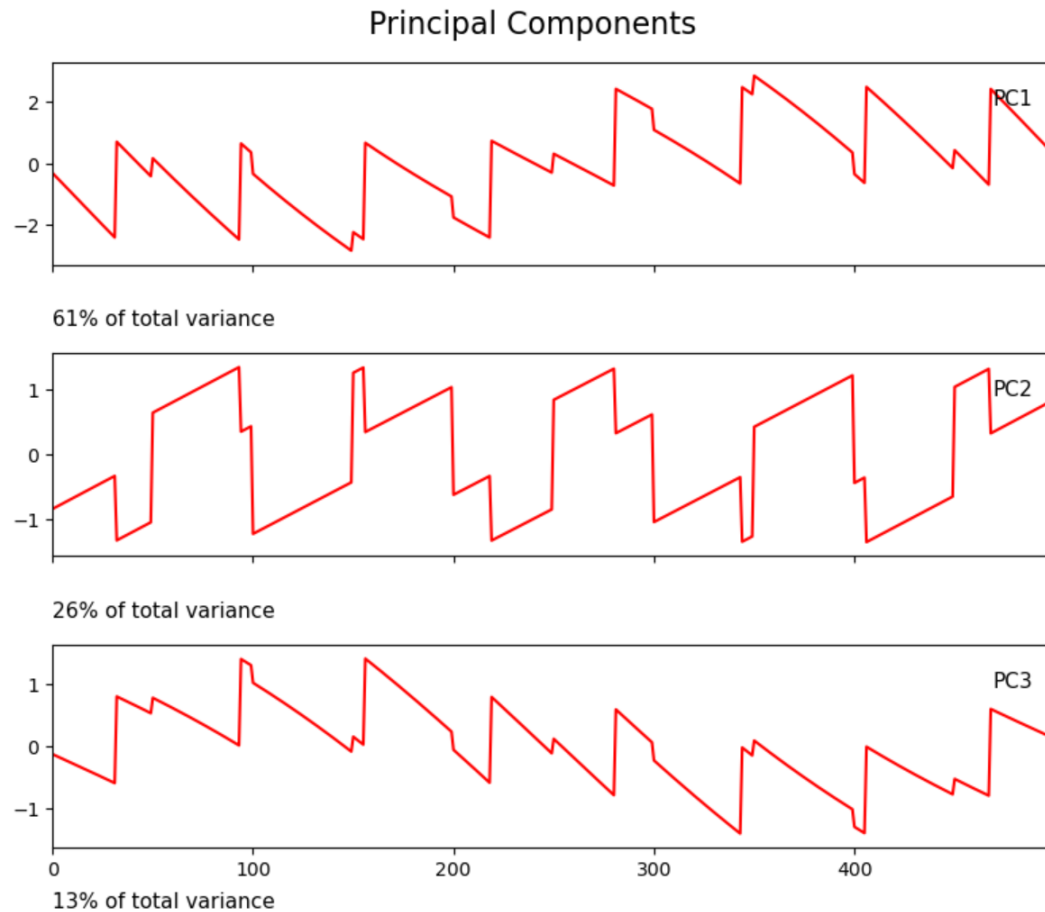


Mixed Signals



No eigenvalues, or ordering of variance unlike PCA

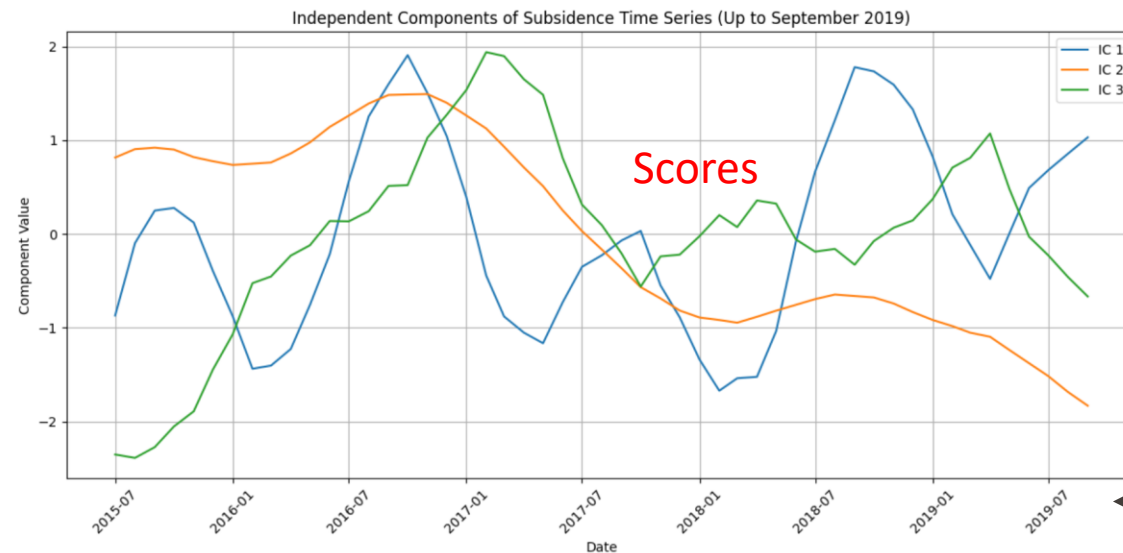
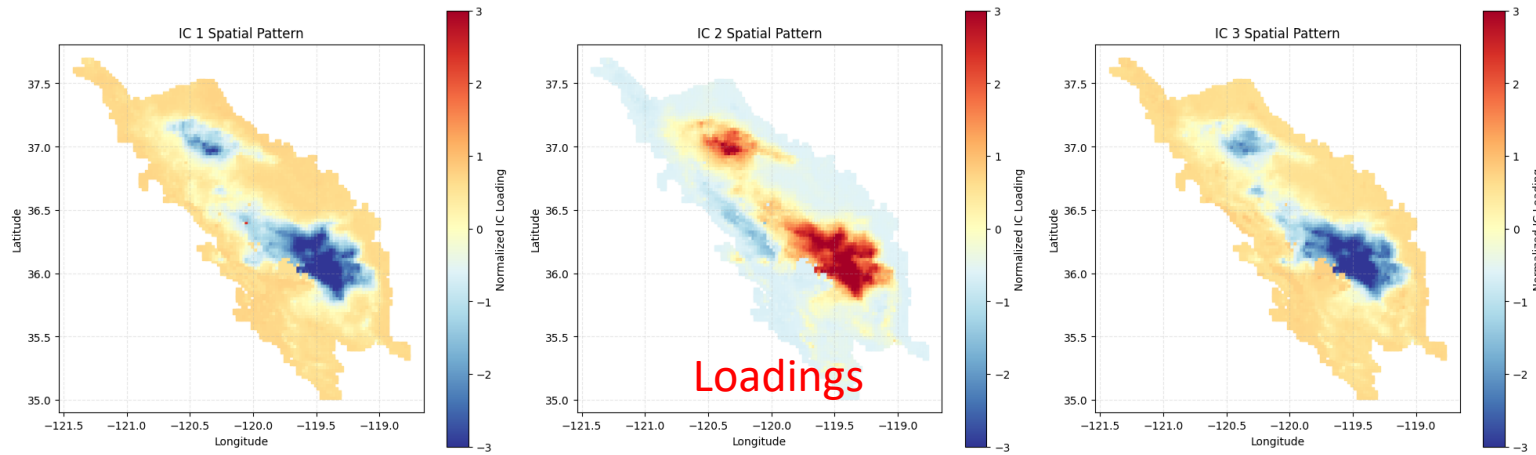
Resolved independent components need not be orthogonal



Linear mixing model for both techniques

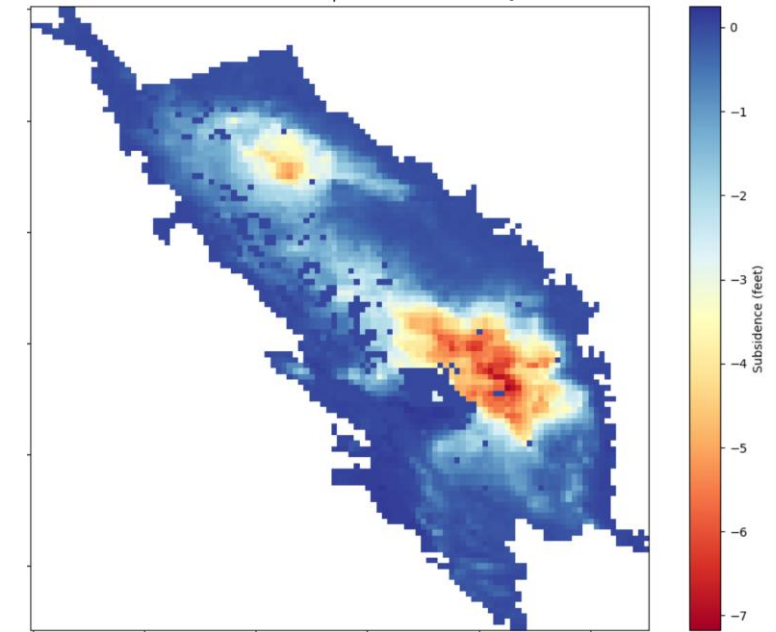
$$\mathbf{X} = \mathbf{A}\mathbf{S}$$
$$\mathbf{X} = \sum_k a_k s_k$$

Does ICA reveal any patterns?



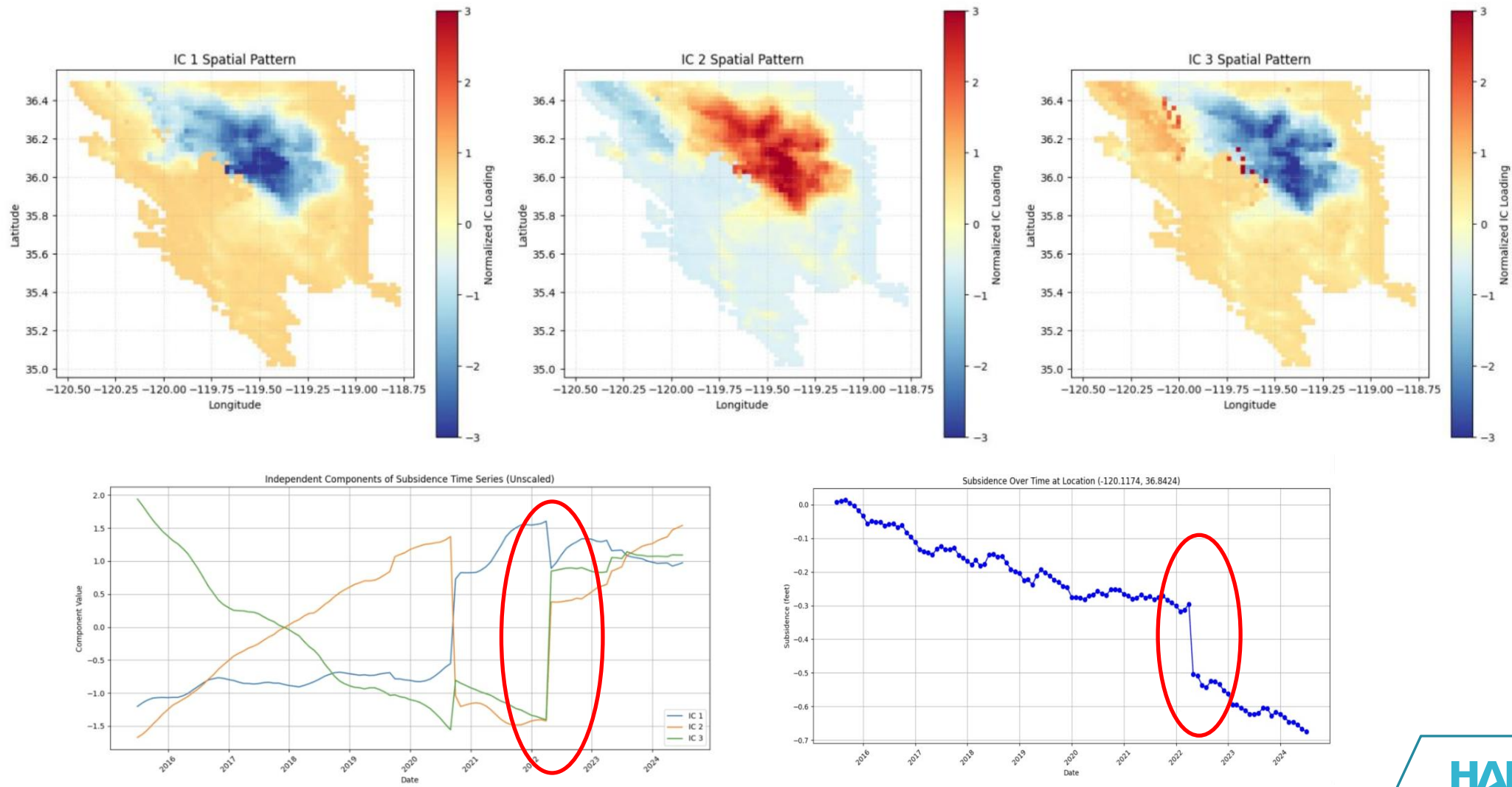
← Why limit to 2019?

Total Subsidence 7/2024

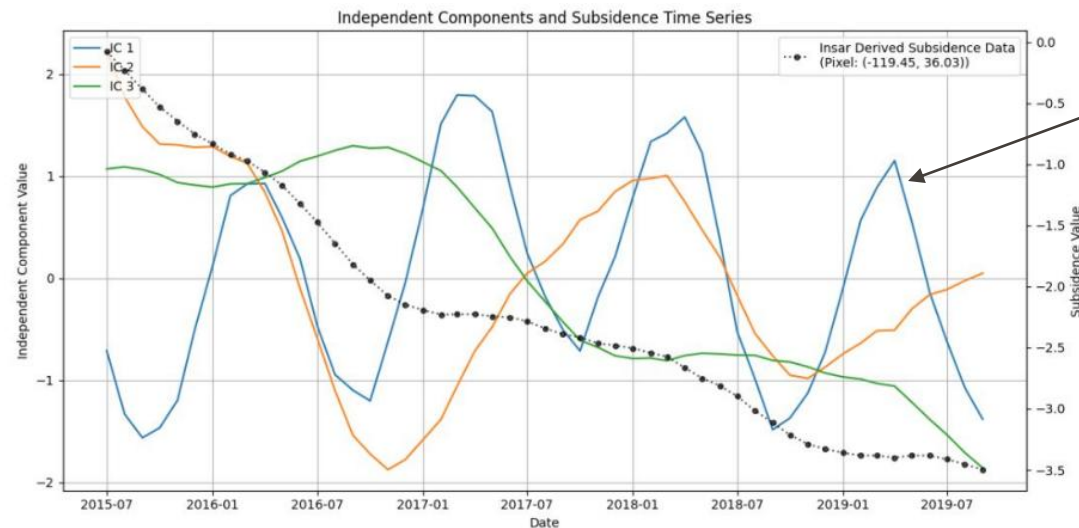
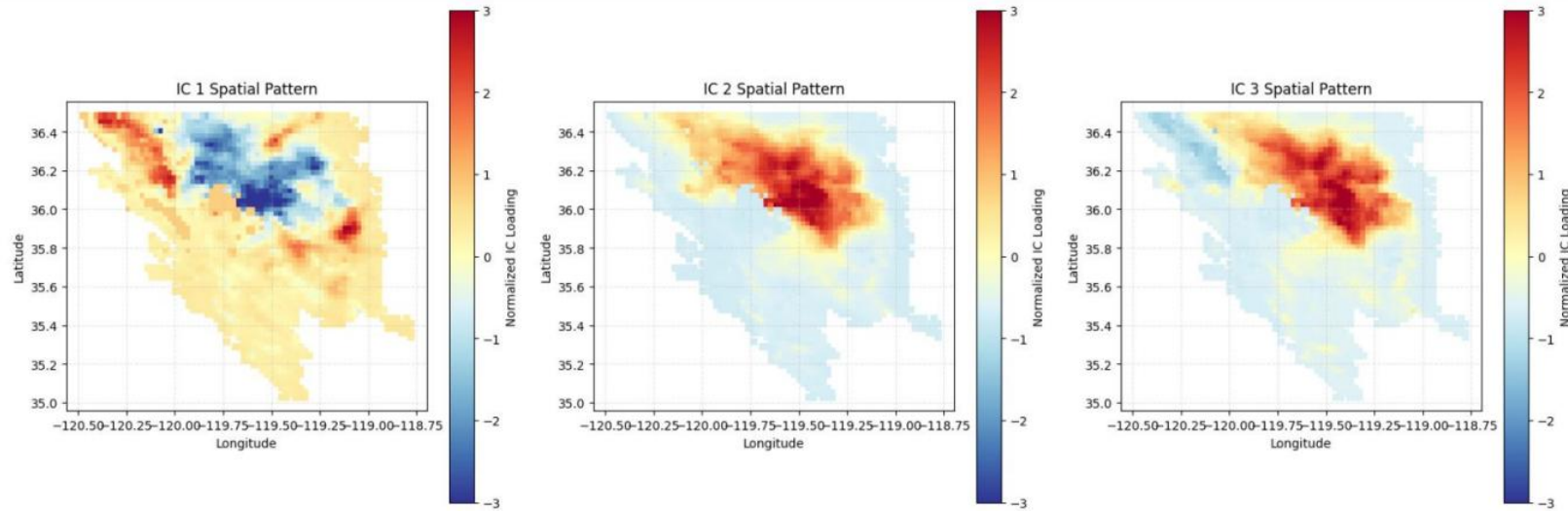


$$Sub_t \times p = T_t \times n S_n \times p$$

Applying ICA to InSAR data reveals interpolation artefacts

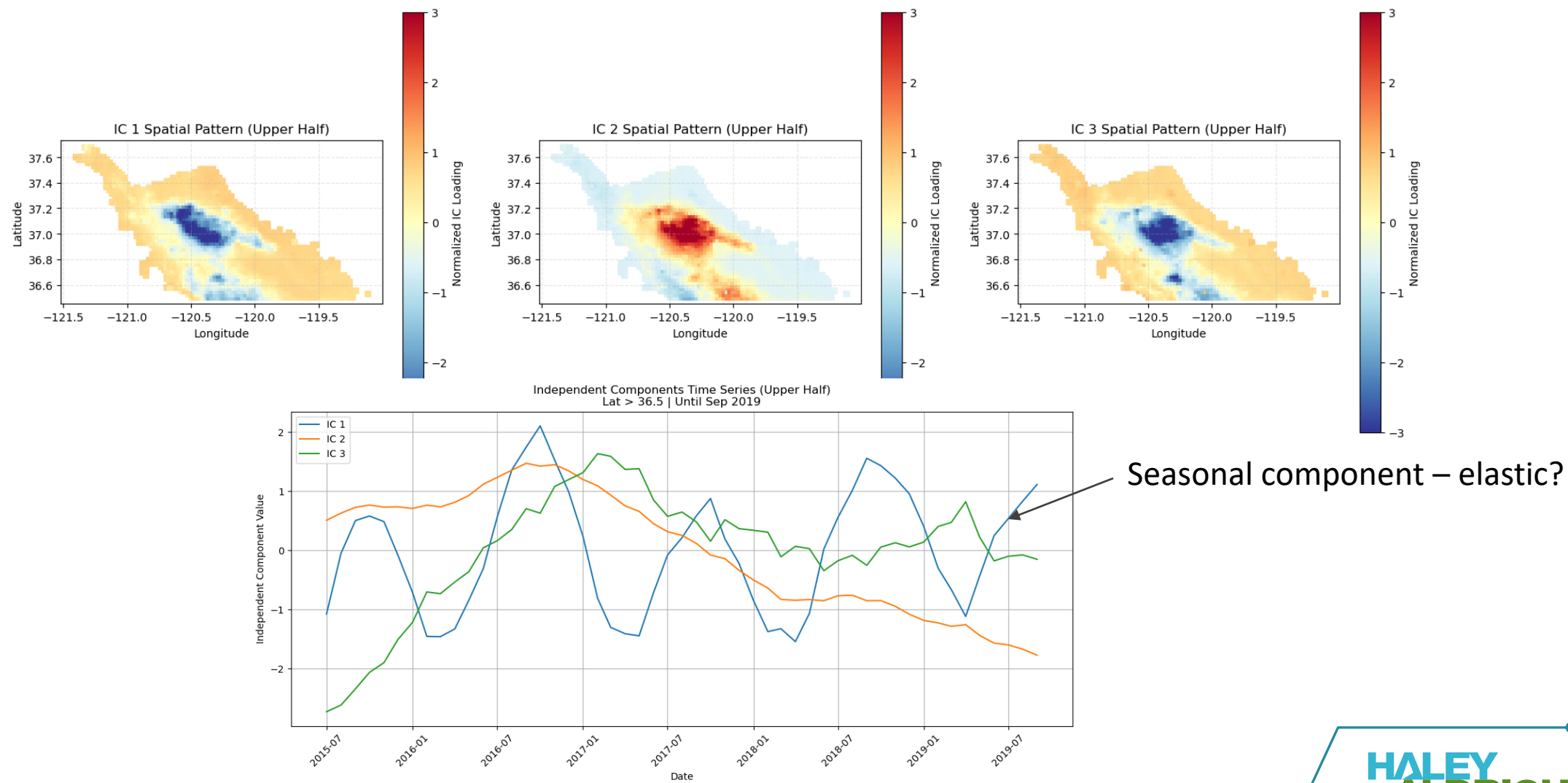


Spatial and Temporal Truncation Reveals Seasonal Patterns

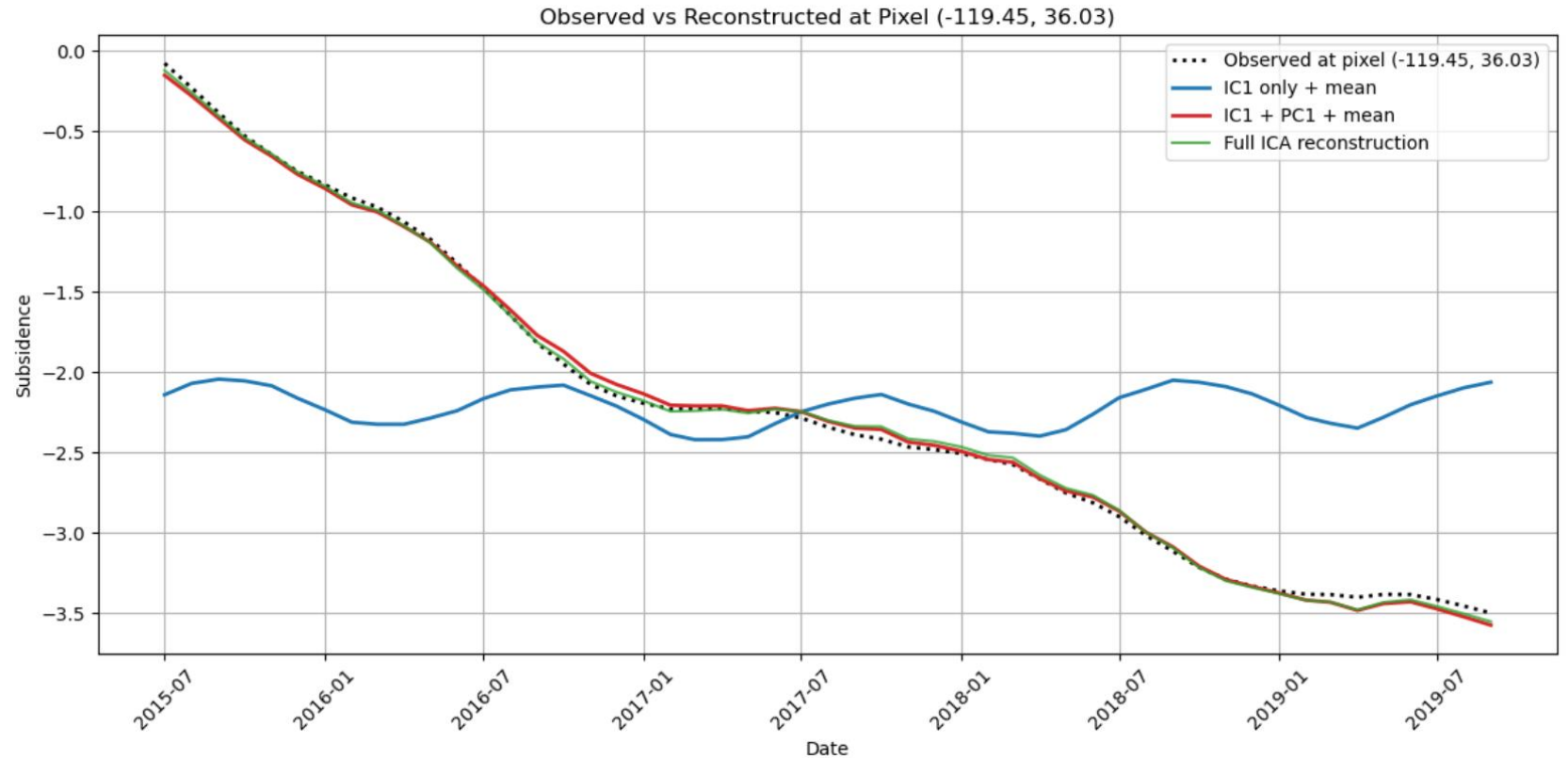
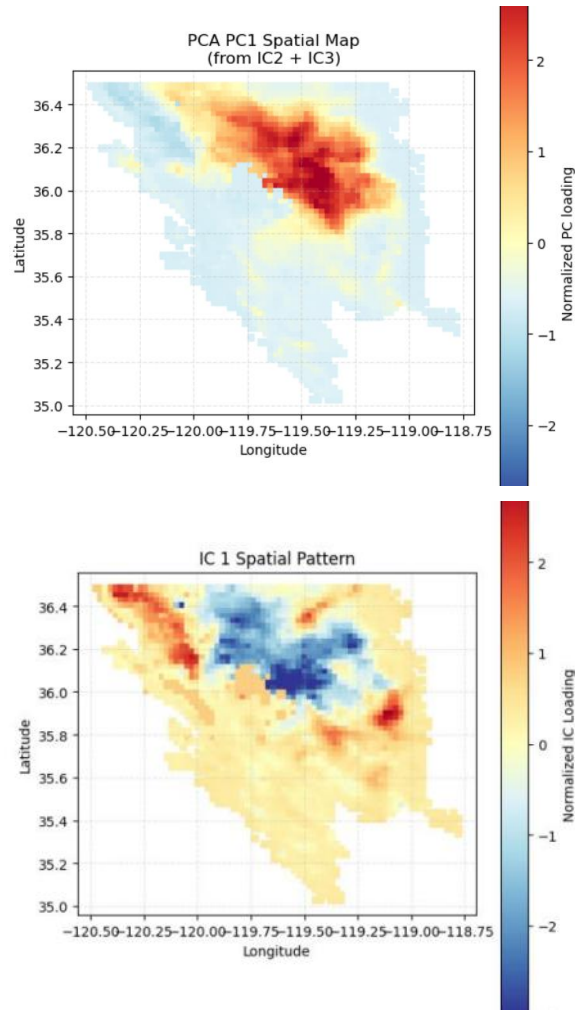


Seasonal component – elastic?

Spatial and Temporal Truncation Reveals Seasonal Patterns

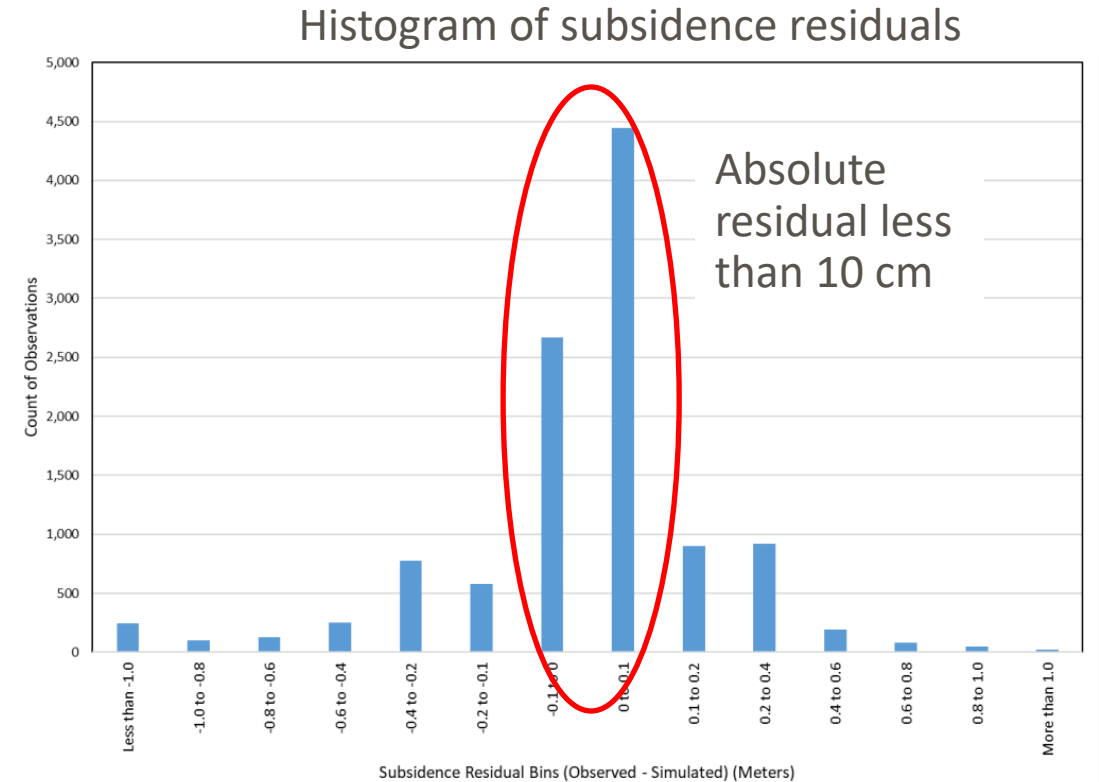


Combining the remaining two independent components can reveal the inelastic component



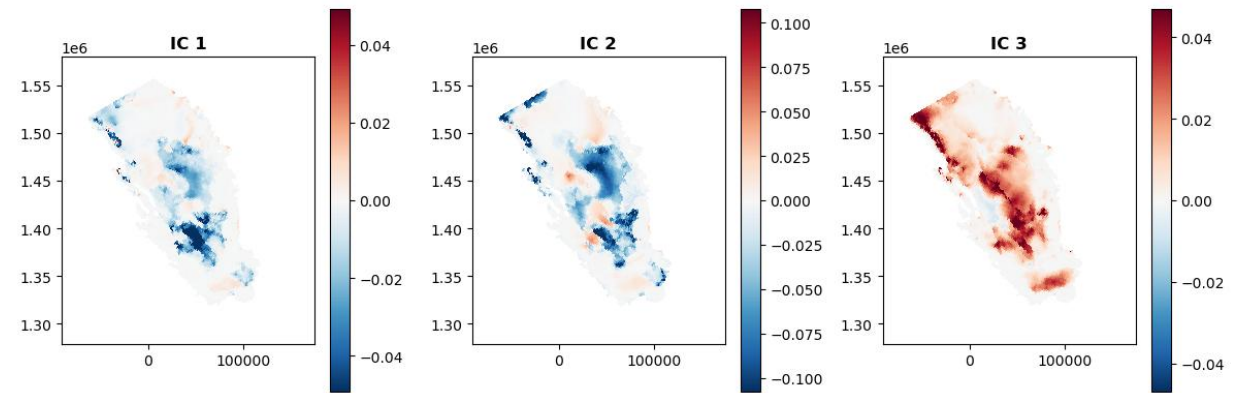
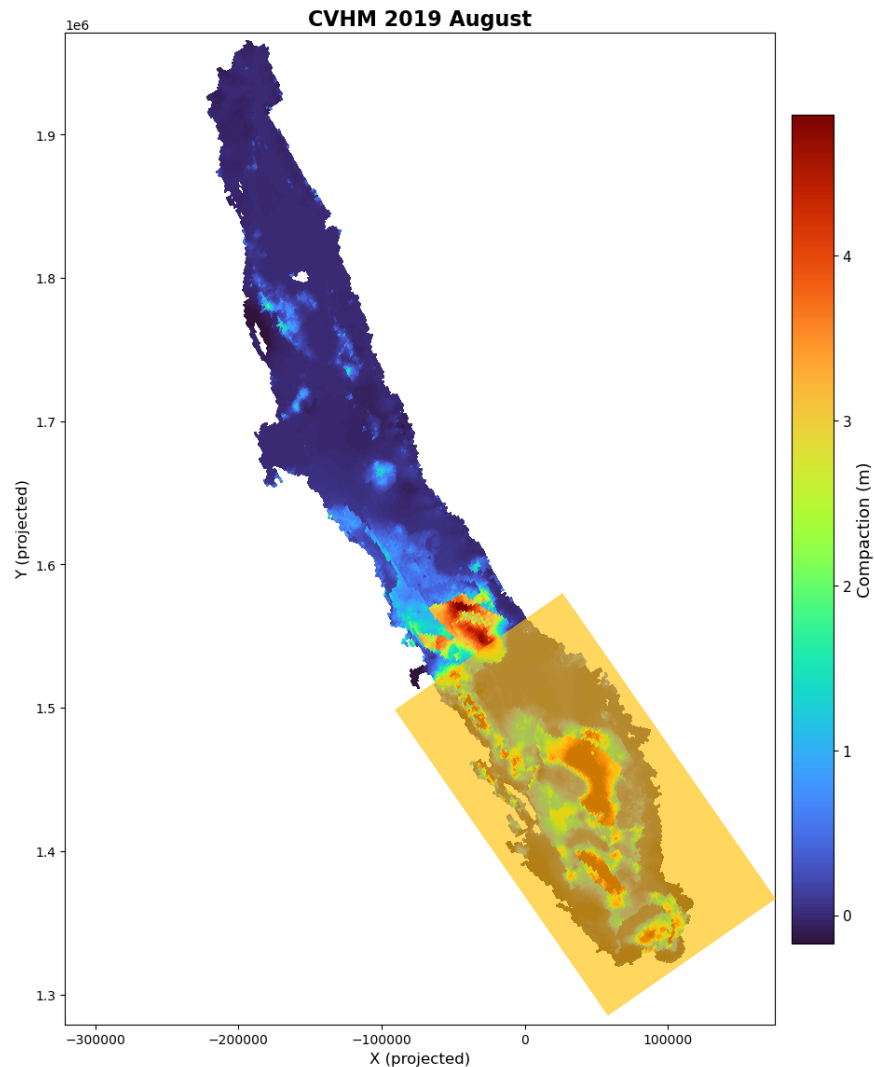
CVHM2 is well calibrated to diverse datasets

- SUB package simulates elastic & inelastic compaction
- Total of 362,254 observations
- 922 subsidence observations 'sites'
 - Extensometers (20), Continuous GPS (27)
 - SAR (2003-2010, 2013-2016)

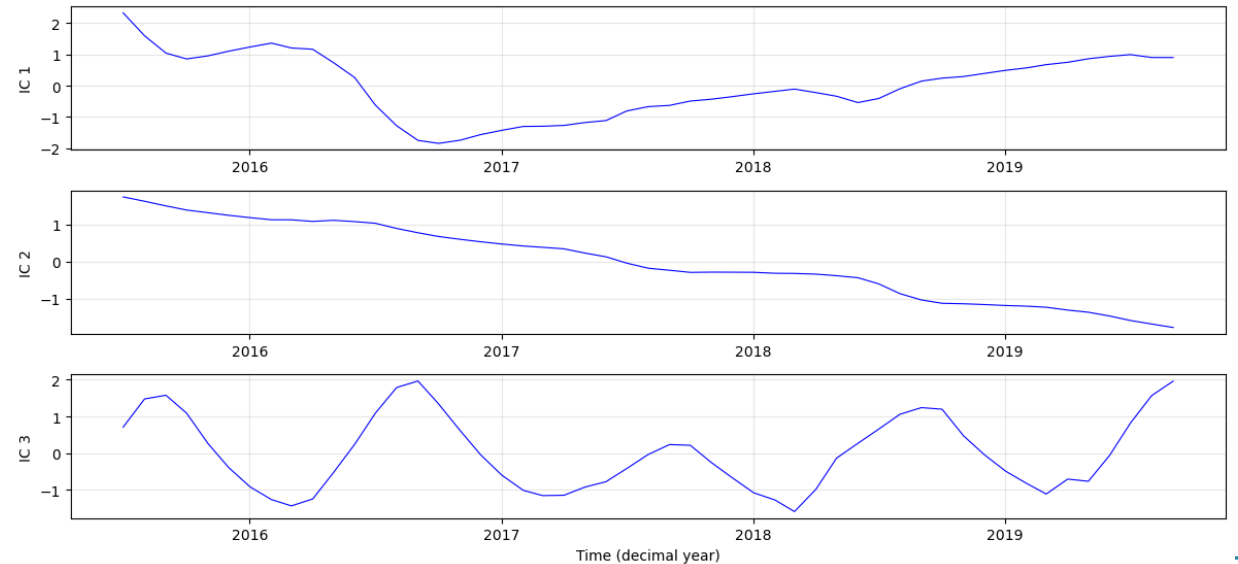


From Faunt et al (2024)

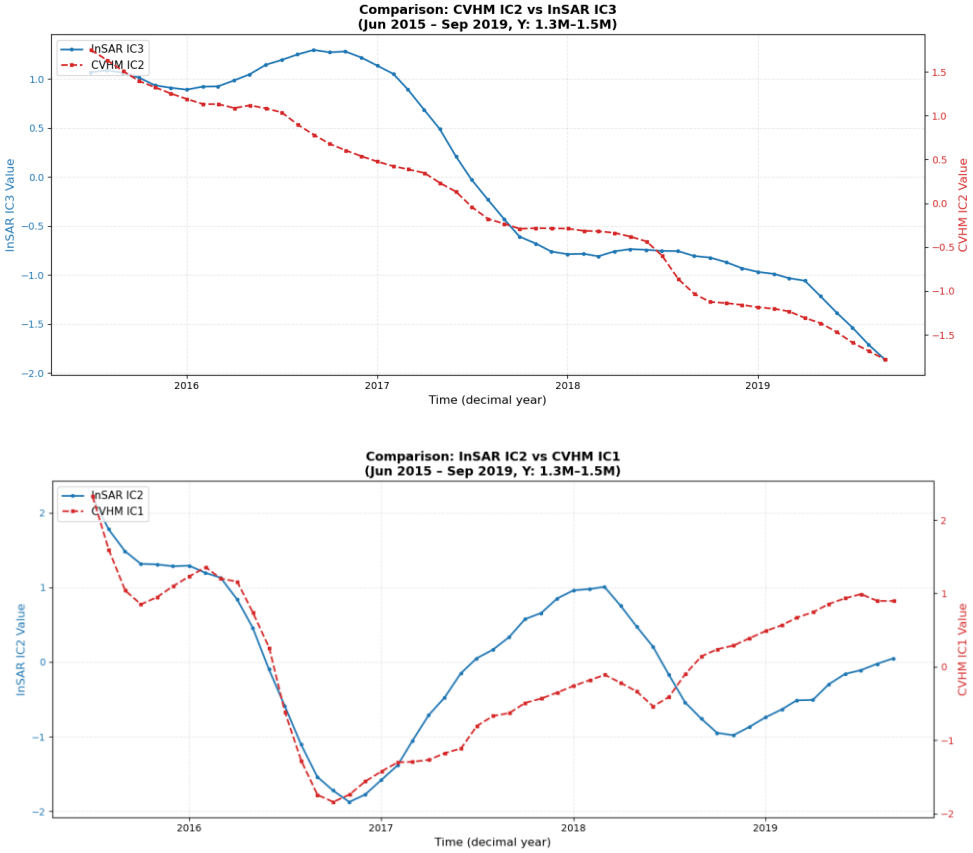
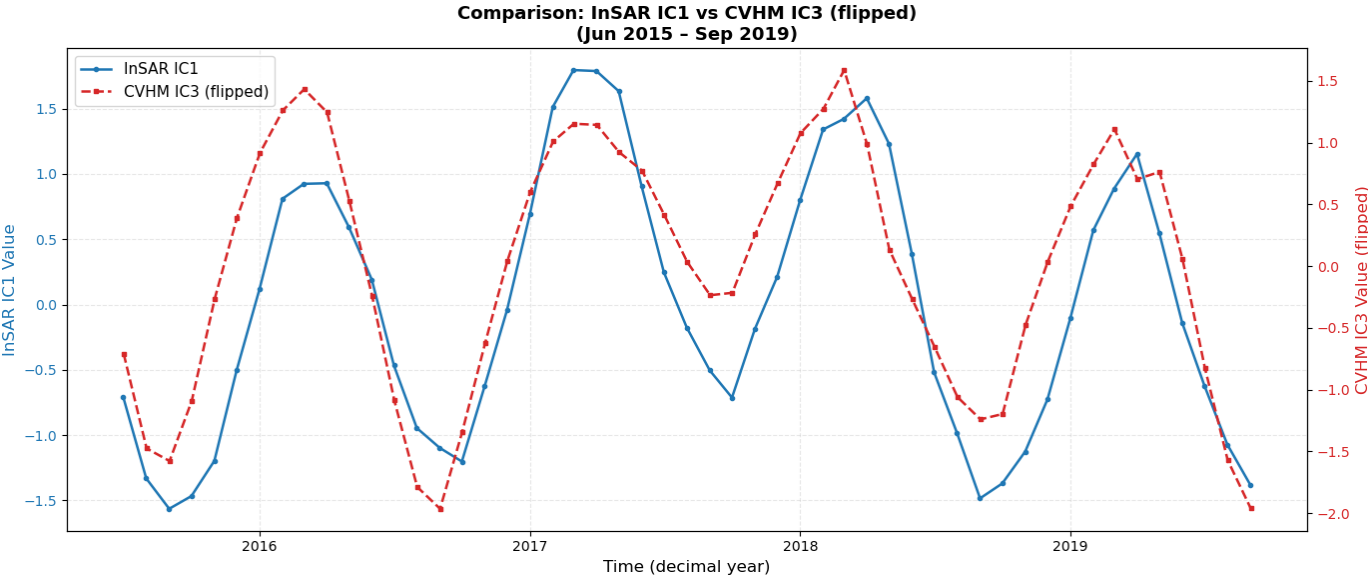
ICA can be used to evaluate CVHM2 modeled subsidence



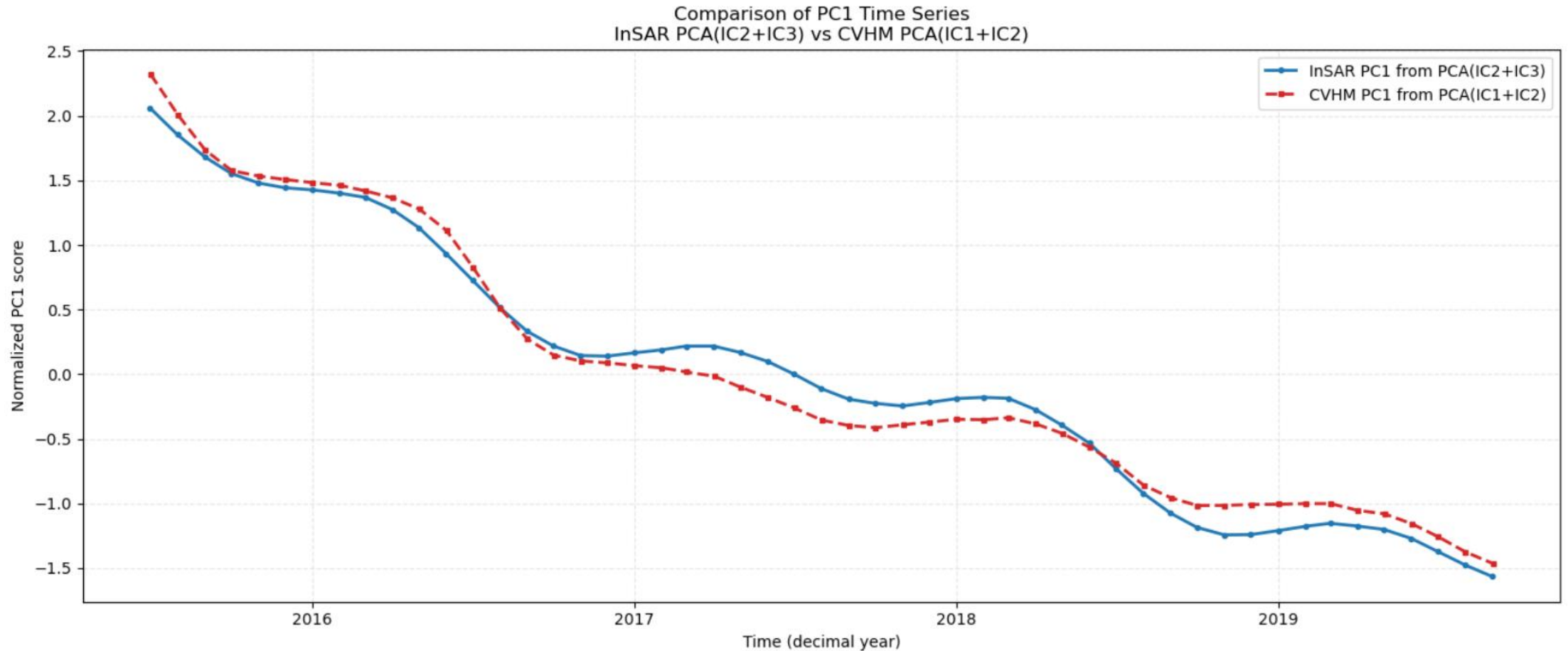
CVHM ICA Temporal (3 Comp) - Jun 2015 to Sep 2019, Y: 1.3M-1.5M



CVHM2 Compares well with InSAR seasonal component

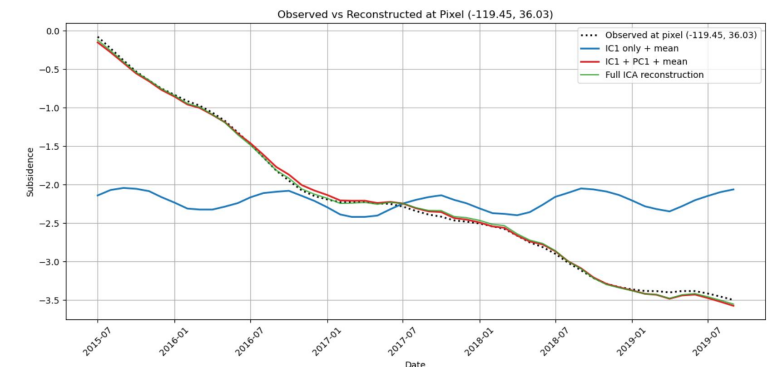
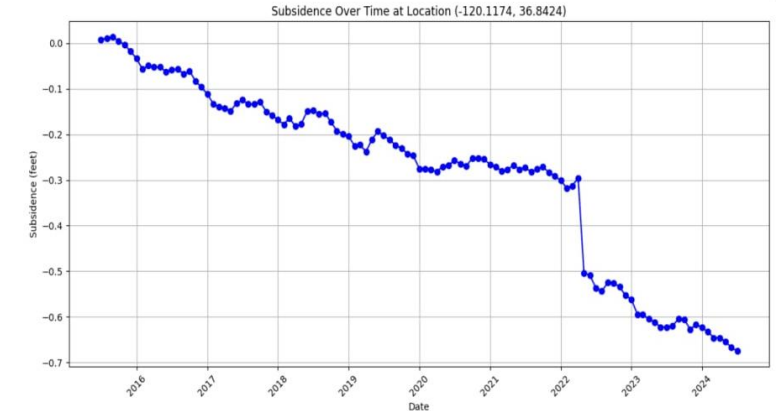


CVHM2 combined non-elastic component also compares very well with InSAR



Conclusions and Future Directions

- Independent components analysis of InSAR data effective tool to 'catch' interpolation artefacts
- Spatial truncation compartmentalizing major areas of subsidence reveals seasonal patterns
- ICA provides spatial estimates of seasonal elastic compaction
- Temporal loadings can be ideal targets for *meta-model calibration*

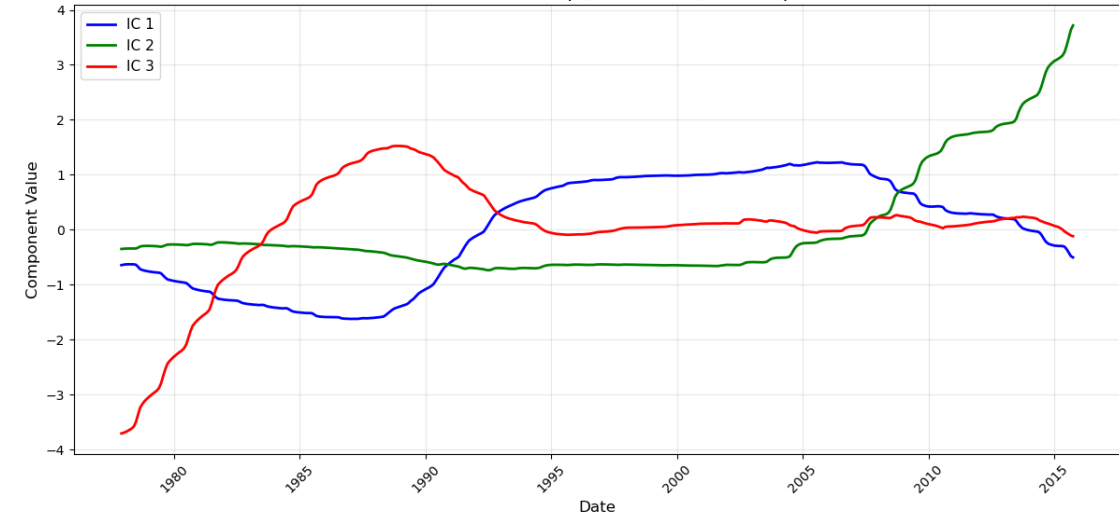


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ICA Time Series - Half Map (5111 nodes) - 3 Components



Thank You

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