

# How connected is the solar atmosphere?

By

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team website → <https://www.unige.ch/sml/>

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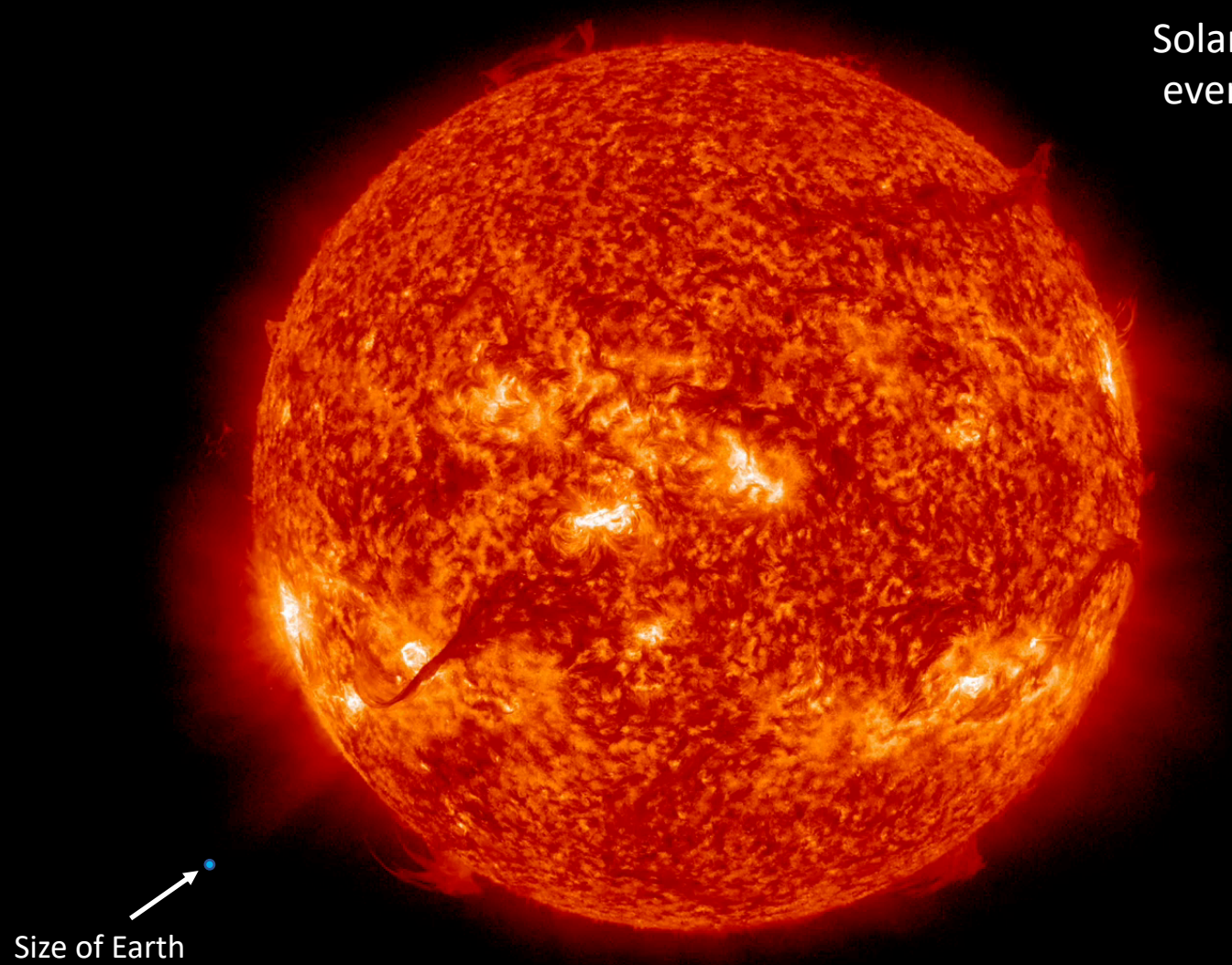
The university of Geneva



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## Introduction: Solar Flares

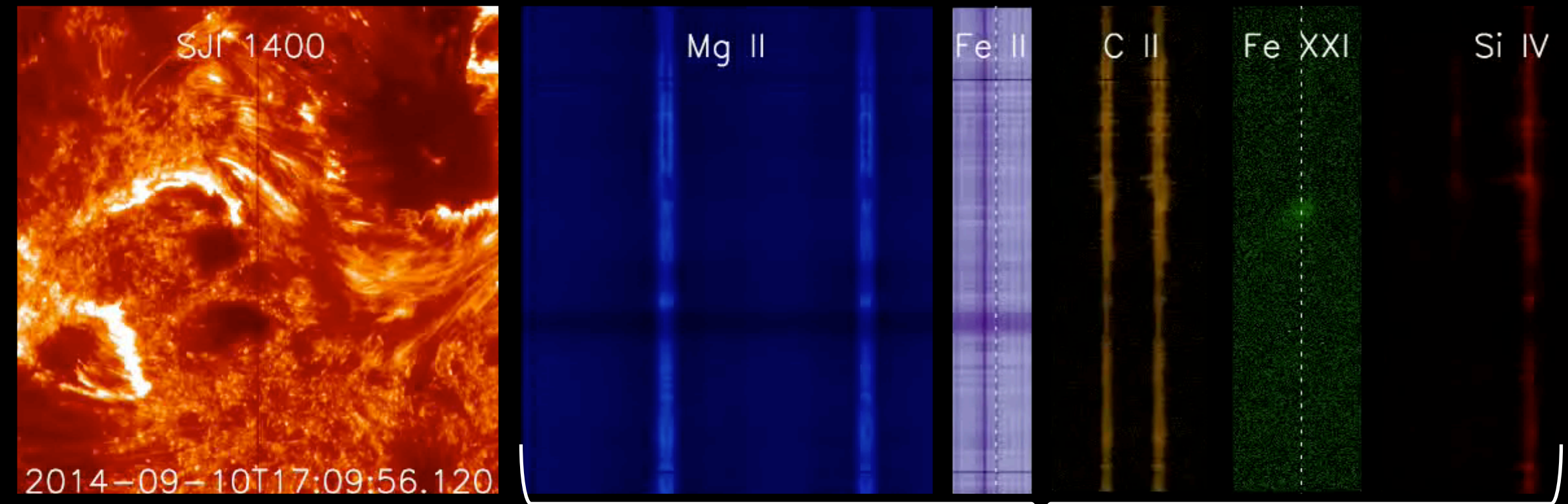


Solar flares are the most energetic events in our solar system

The complex magnetic field of the Sun powers solar flares

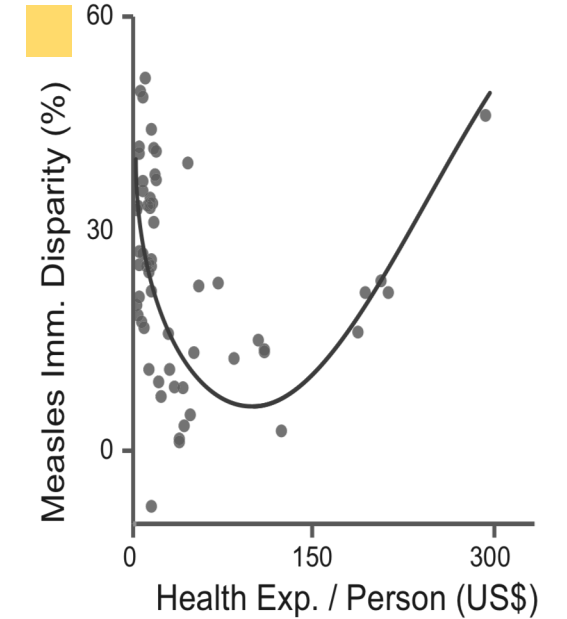
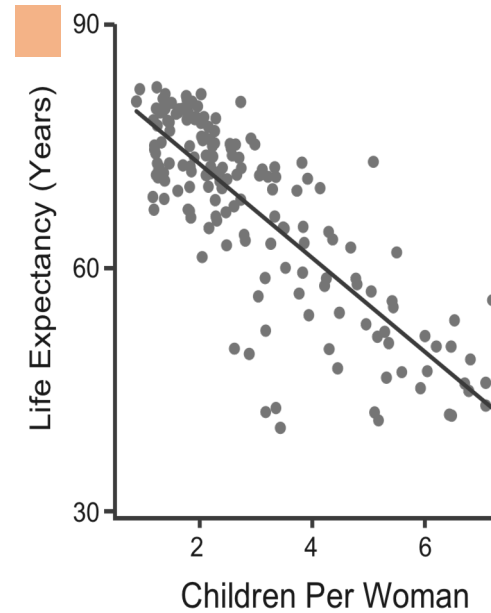
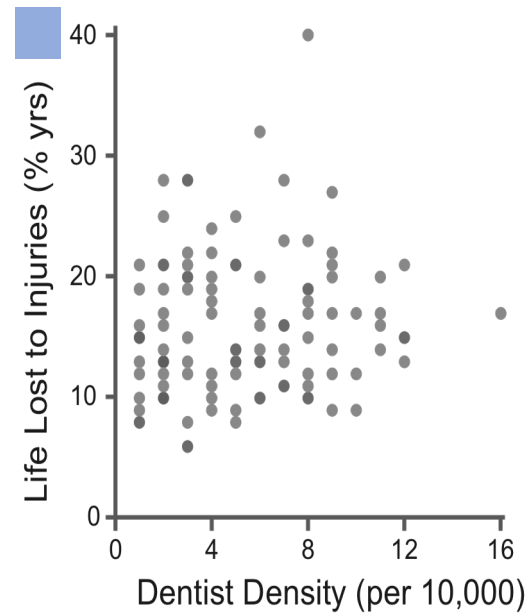
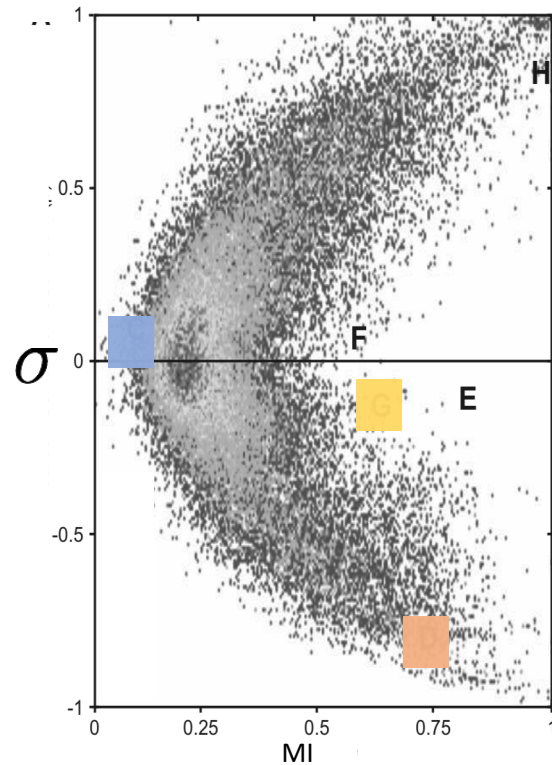
AIA 304 - 2012/08/31 - 18:26:31Z

# Introduction: Generic problem of multiple data sets (IRIS)



- How are the data correlated?
- Can you predict one data type based on another?
  - ↳ Implications for modeling

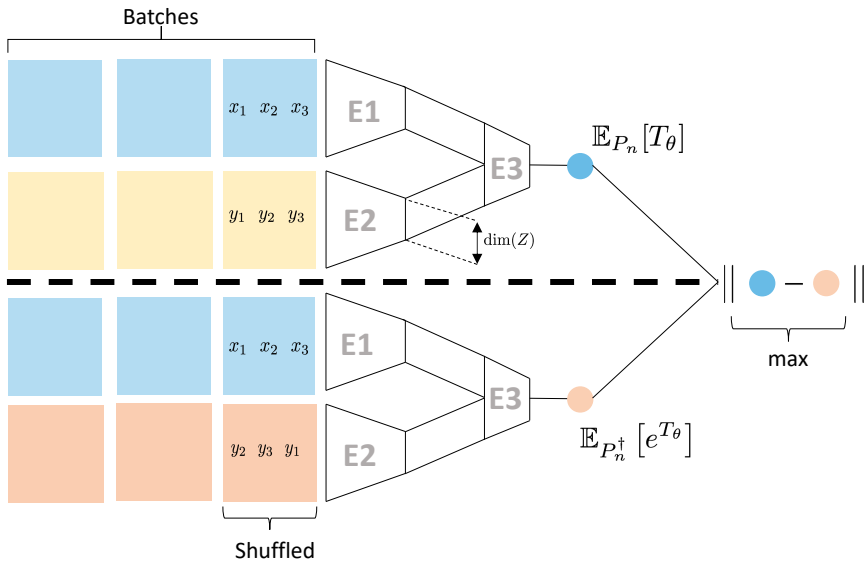
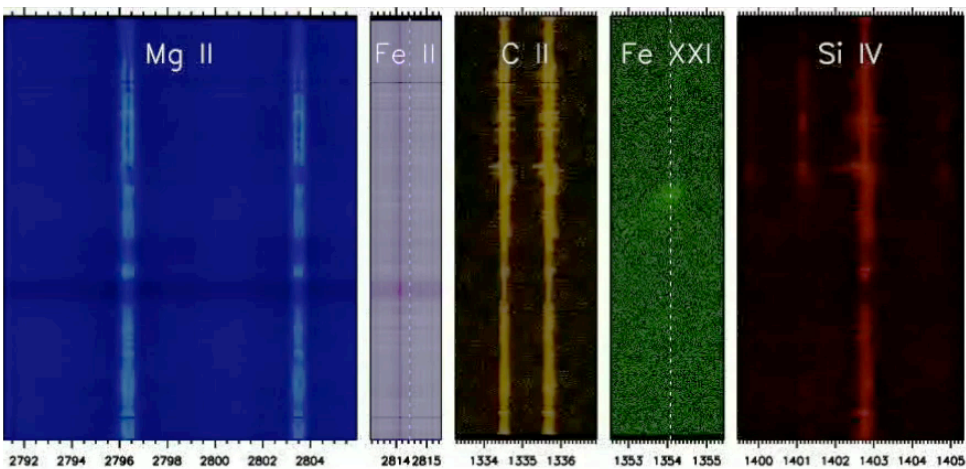




David Reshef 2011 WHO data set

$$\text{Corr}(X; Y) \subseteq MI(X; Y)$$

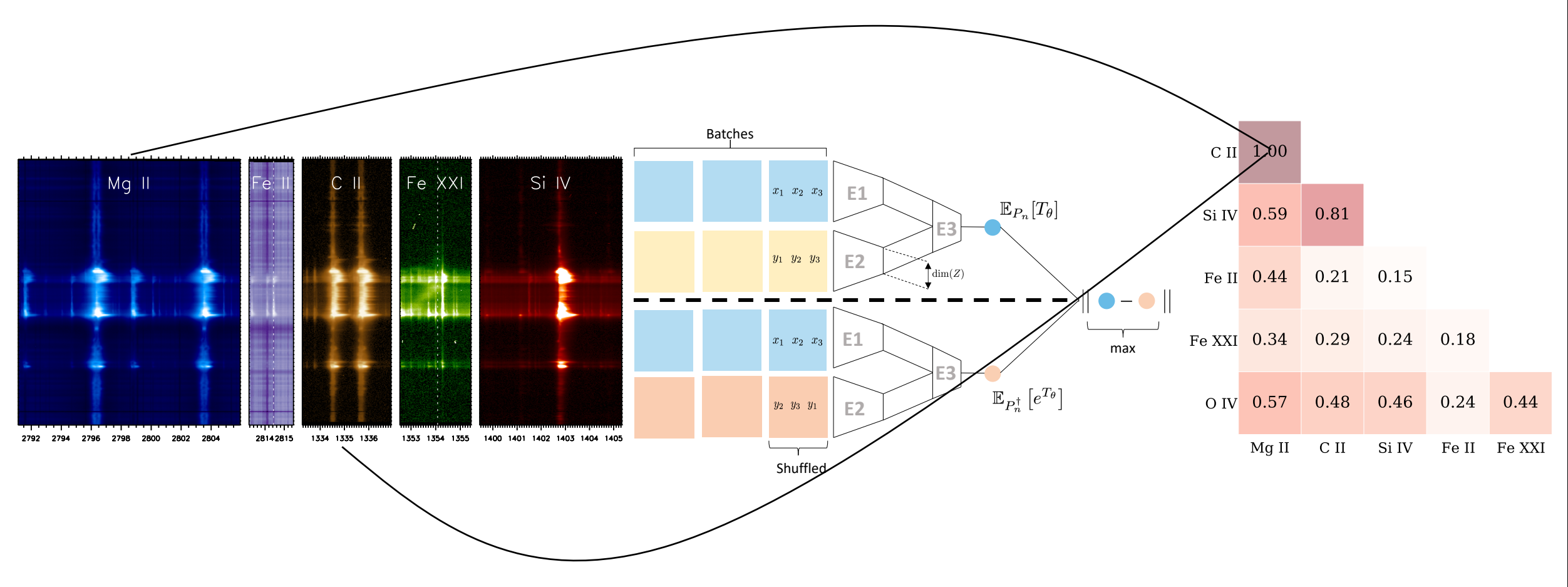




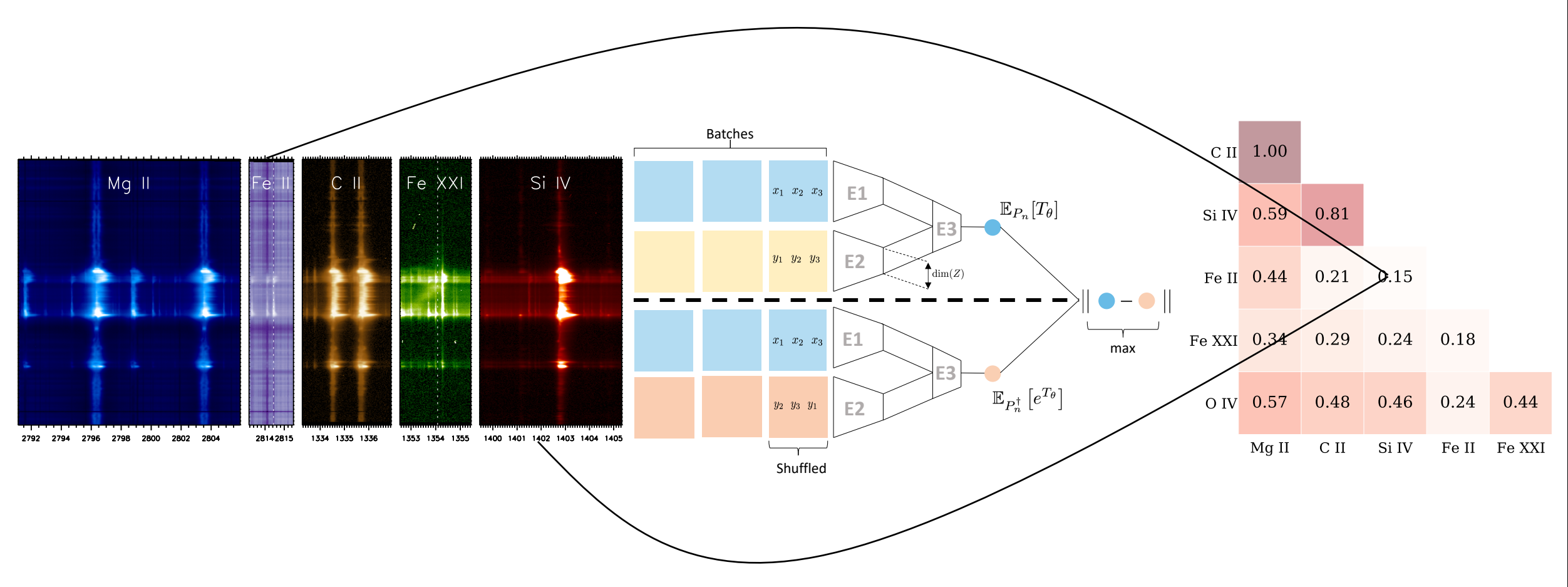
C II	1.00				
Si IV	0.59	0.81			
Fe II	0.44	0.21	0.15		
Fe XXI	0.34	0.29	0.24	0.18	
O IV	0.57	0.48	0.46	0.24	0.44
	Mg II	C II	Si IV	Fe II	Fe XXI

B. Panos, L. Kleint, and S. Voloshynovskiy, 2021, ApJ, 912, 121

Automatically calculate the MI between lines, results make sense



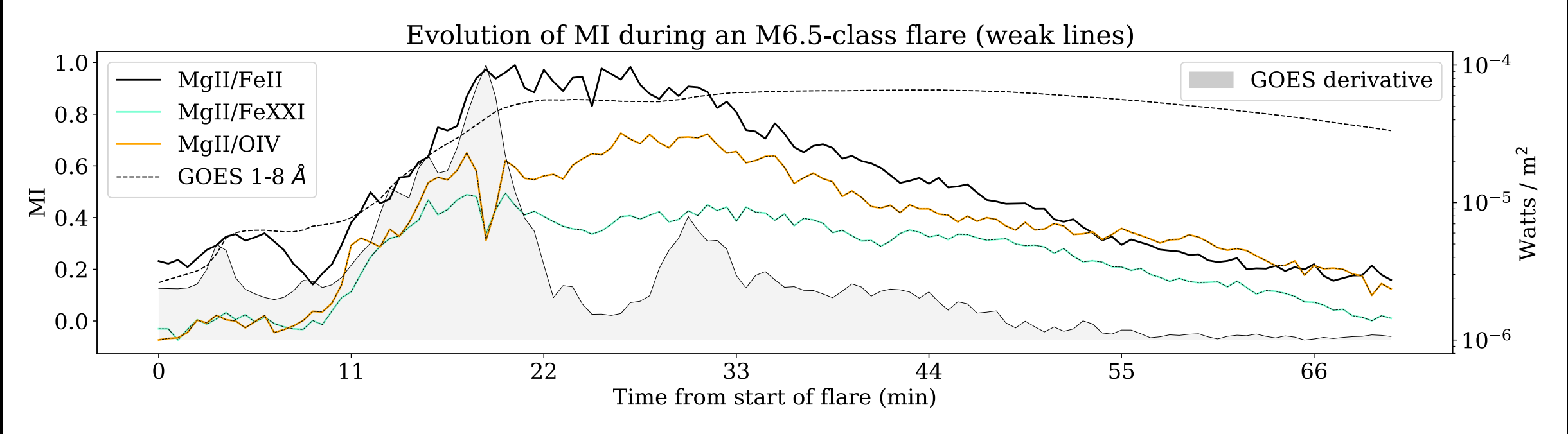
Automatically calculate the MI between lines, results make sense



Automatically calculate the MI between lines, results make sense

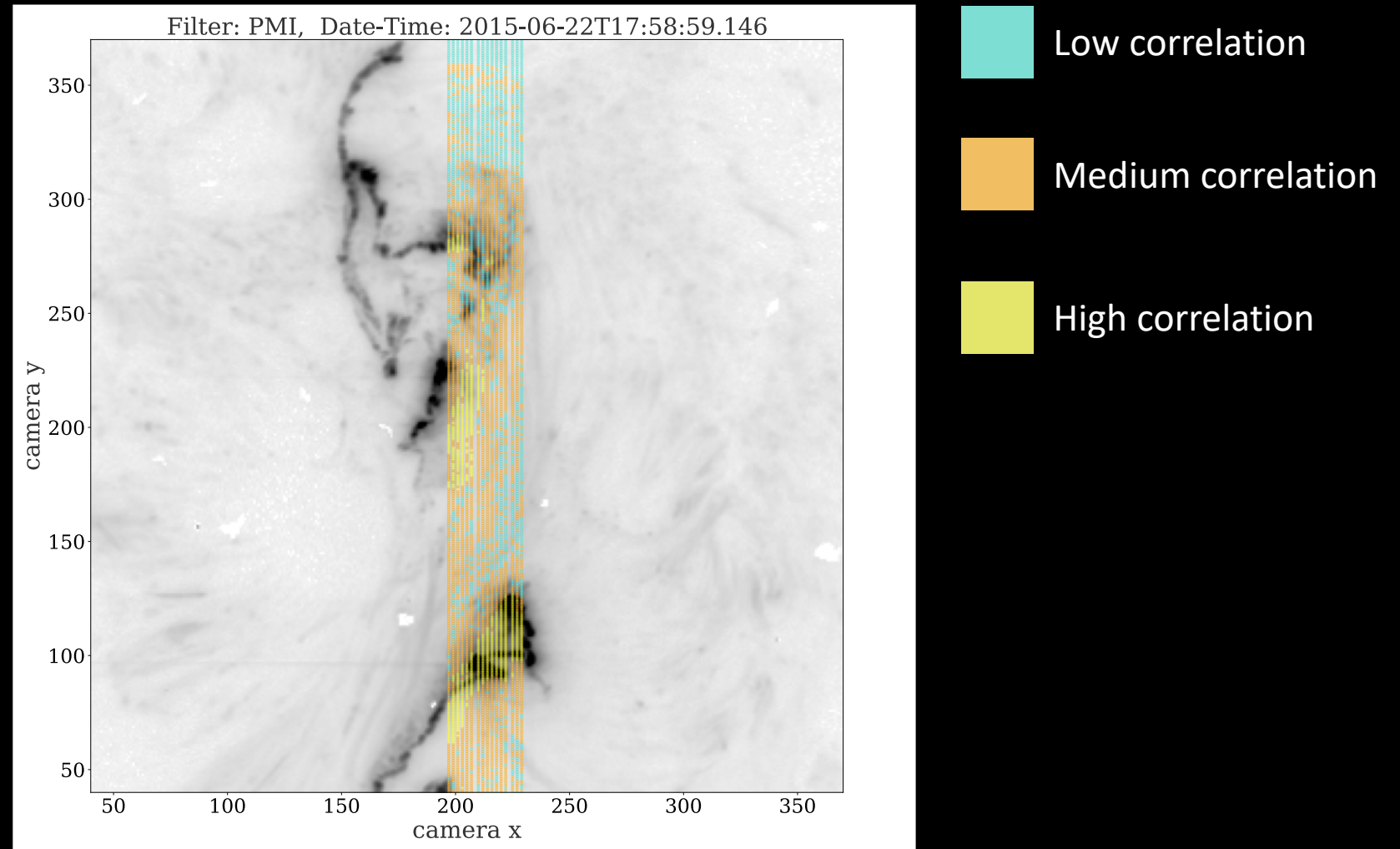


Time

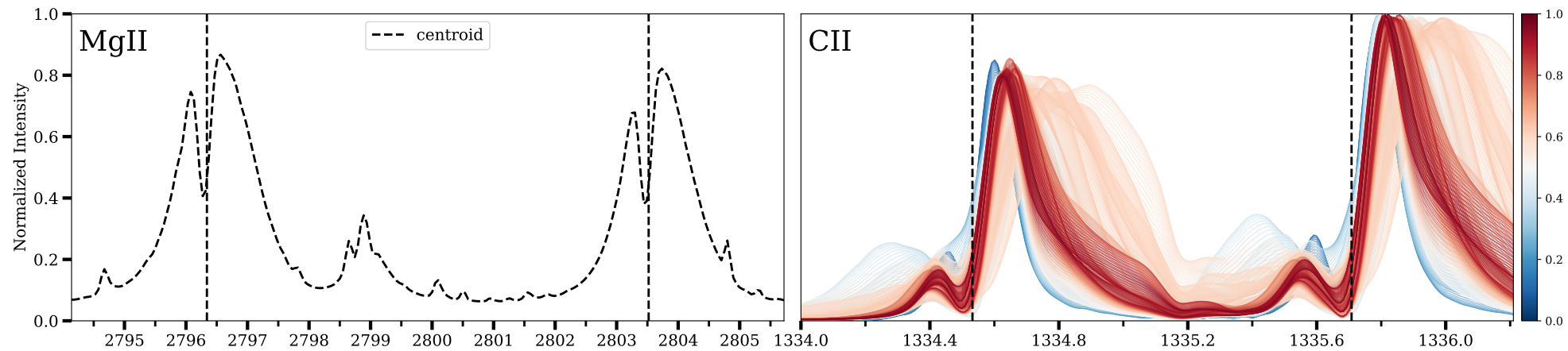


The atmosphere becomes more connected as the flare becomes stronger

## Space



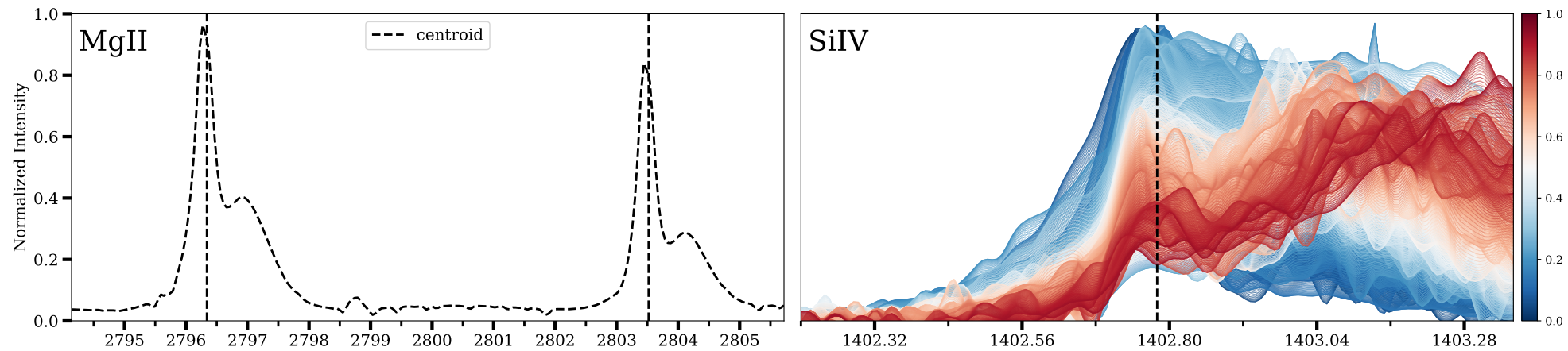
The atmosphere is more connected over flare ribbons, where most of the energy is deposited



B. Panos and L. Kleint, 2021, ApJ, 915, 77

Change input and target freely





B. Panos and L. Kleint, 2021, ApJ, 915, 77

Change input and target freely

1. Mutual information (MI) measures both linear and non-linear correlations and is superior to covariance
2. You can use a neural network called a mutual information neural estimator to automatically calculate the M
3. Machine learning allows for the efficient analysis of multifaceted large volume data sets