
**Spatial and temporal
localization of enhanced
chromospheric 3-minute
oscillations before, during, and
after the 2011-February-15 X2.2
flare**

Laurel Farris

Department of
Astronomy

New Mexico State
University

2018 SDO Workshop



Introduction

Summary of main points

- **Motivation**

- Recent literature: changes in power of chromospheric 3-minute oscillations associated with flares
 - Depleted power in $H\alpha$
(Monsue, T., Hill, F., & Stassun, K. G. 2016, AJ, 152, 81)
 - Enhanced power in SDO/EVE in $Ly\alpha$, Ly-cont
(Milligan, R. O., Fleck, B., Ireland, J., Fletcher, L., & Dennis, B. R. 2017, ArXiv e-prints.)

- **Objective**

- Use spatially resolved data from AIA and HMI to investigate the *spatial* and *temporal* variations in the chromospheric 3-minute oscillations before, during, and after a flare.

- **Conclusions**

- Spatial distribution supports injection of energy by non-thermal particles

Chromospheric 3-minute oscillations

Observations

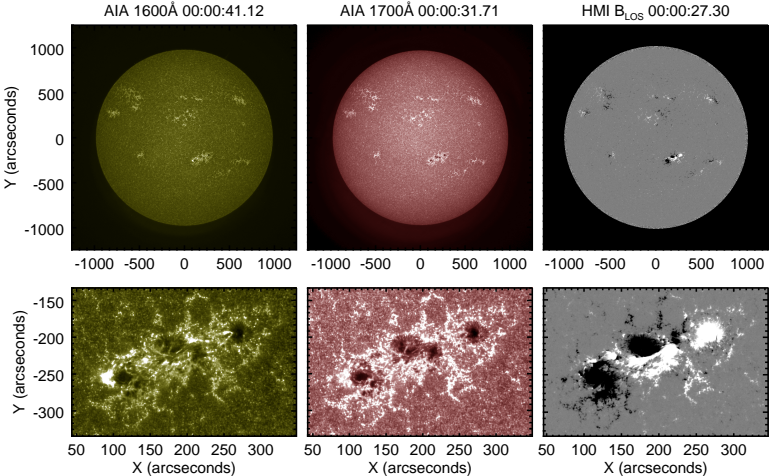
1. Intensity: “umbral flashes” every 3 minutes
2. Velocity: 5-10 km s⁻¹

Interpretation

1. Upward-propagating slow magnetoacoustic waves with frequency greater than acoustic cutoff: $\nu > \nu_0$
 $\nu_0 \approx 5.6$ mHz
2. ν_0 = natural frequency at which chromosphere responds to a disturbance

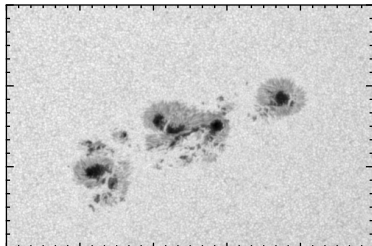
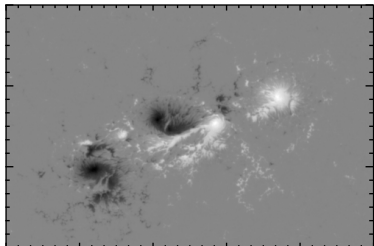
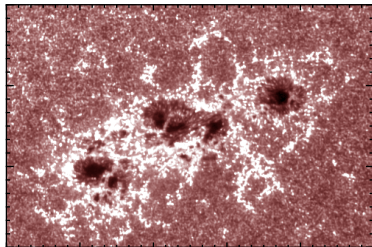
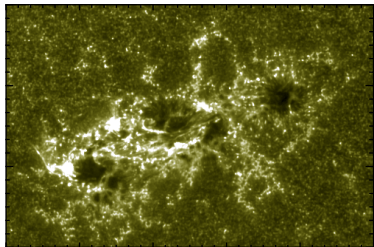
NOAA AR 11158

15 February 2011



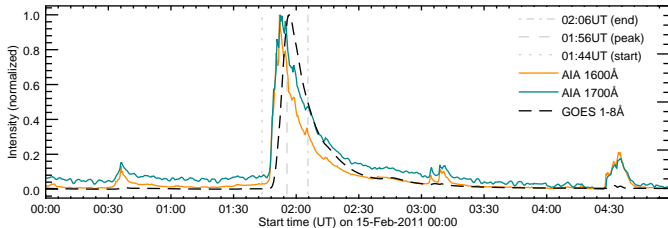
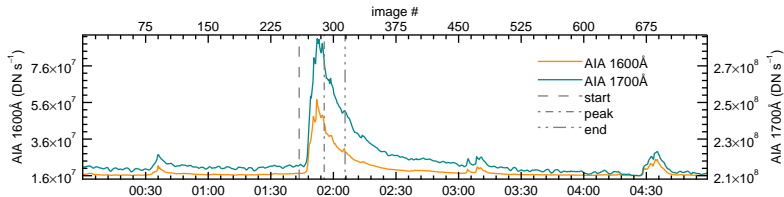
NOAA AR 11158

15 February 2011



X2.2 flare

15 February 2011

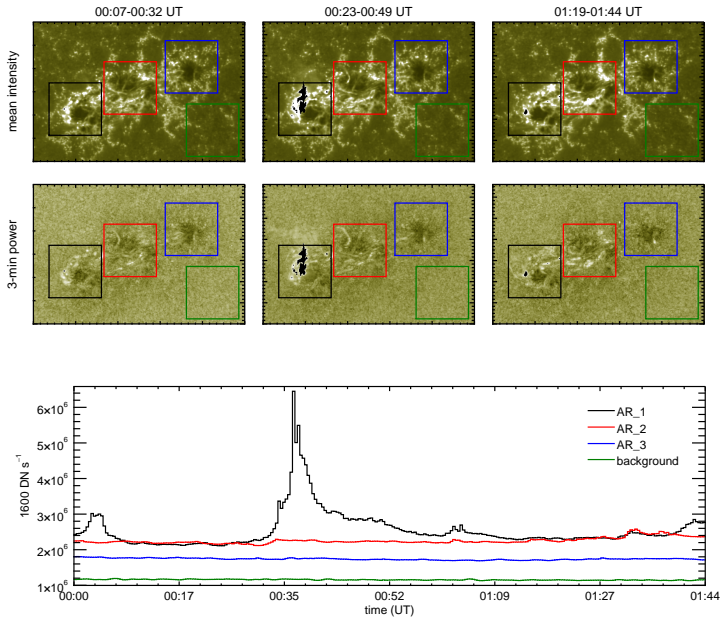


Wed Aug 22 20:00:03 2018

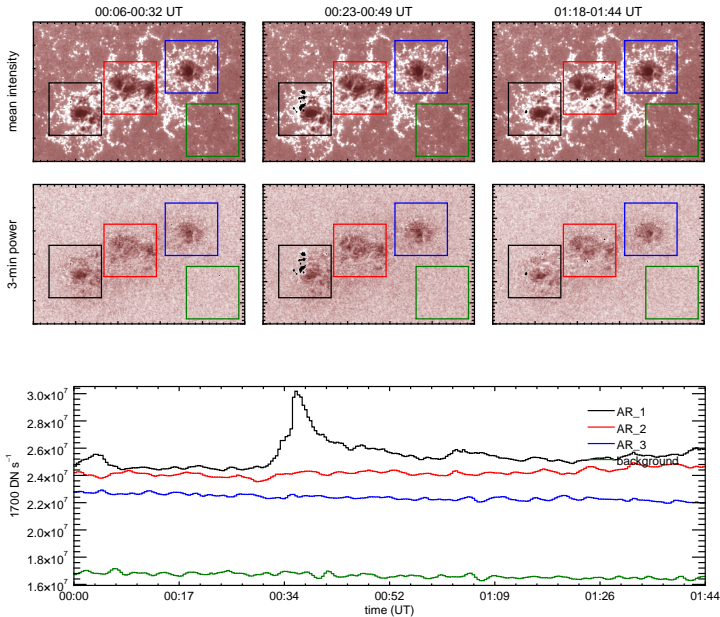
Part 1: 3-minute oscillations in space

- Apply FFT individually to each pixel through time.
- time segment length $T = 64$ frames (~ 26.5 minutes).
- frequency resolution $d\nu = 0.6$ mHz.
- Average power within frequency bandpass $\Delta\nu = 1$ mHz
→ 3-minute power.

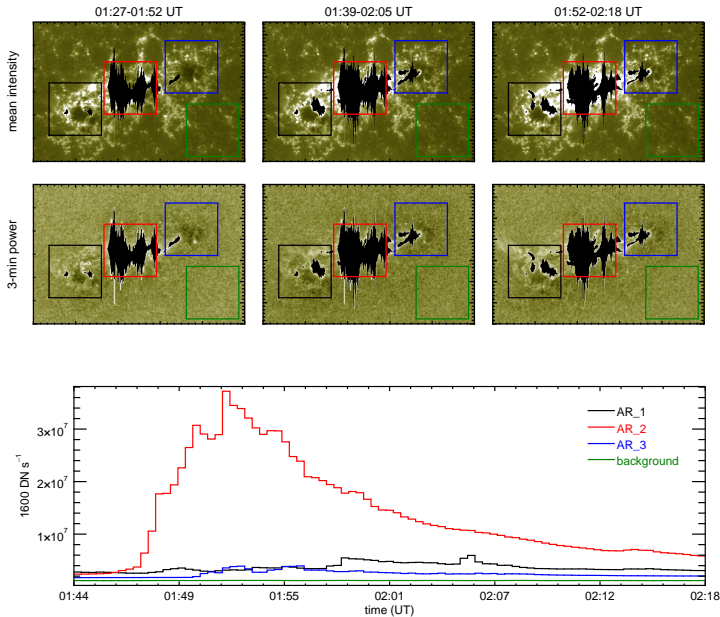
AIA 1600Å pre-flare



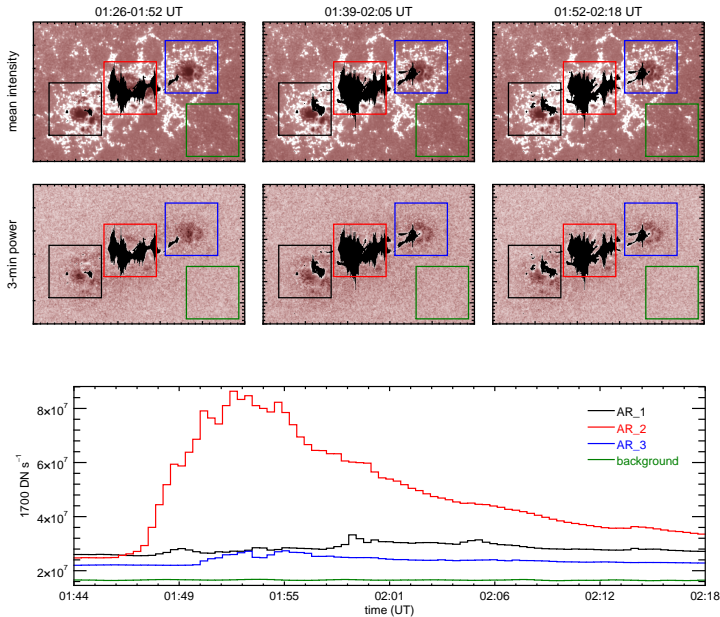
AIA 1700Å pre-flare



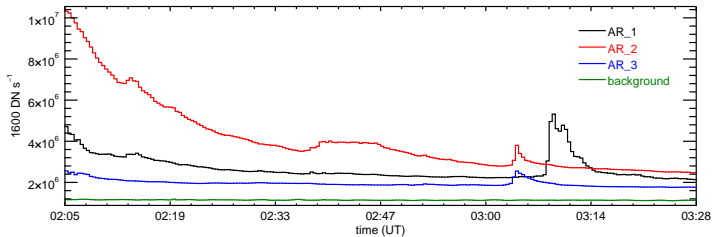
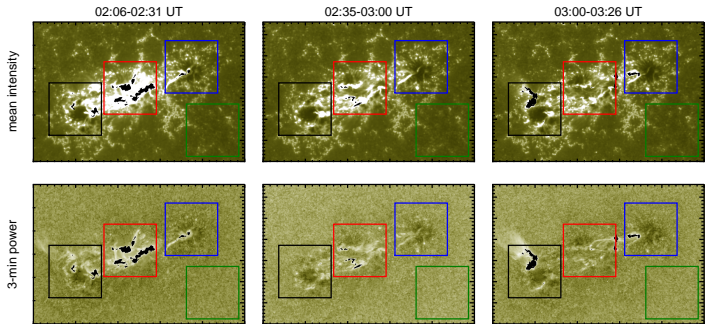
AIA 1600Å X2.2 flare



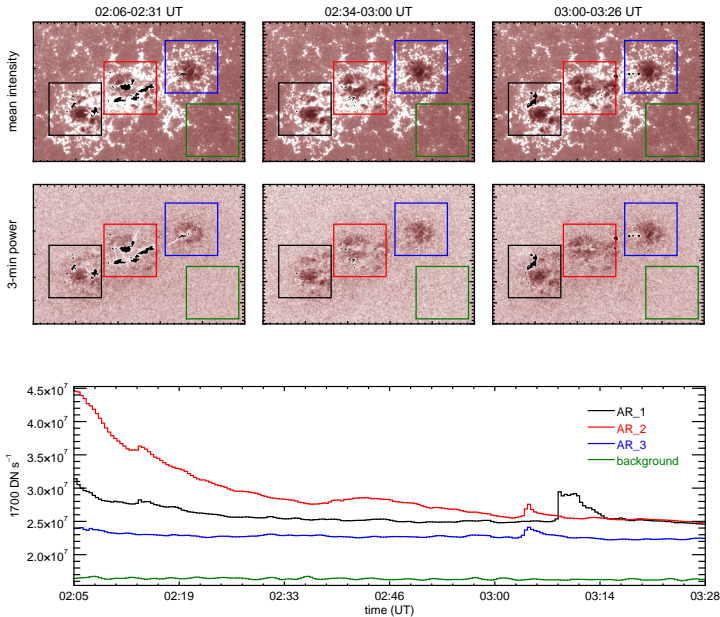
AIA 1700Å X2.2 flare



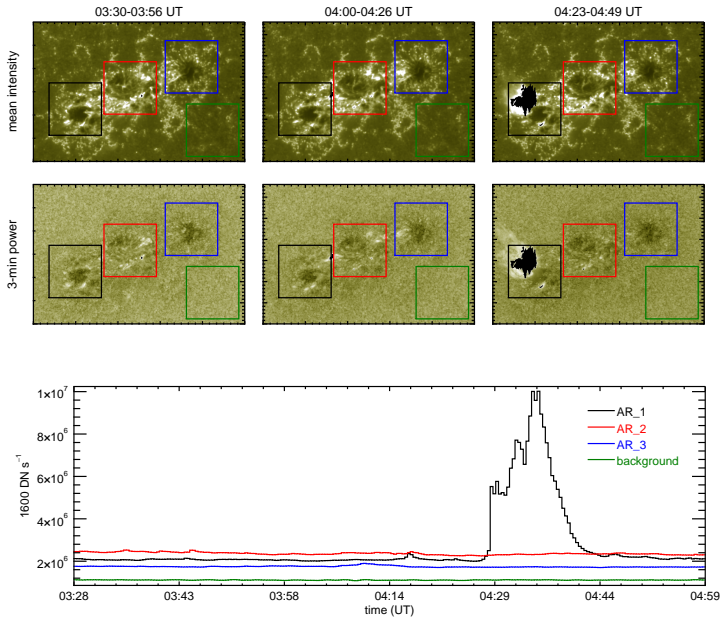
AIA 1600Å post-flare



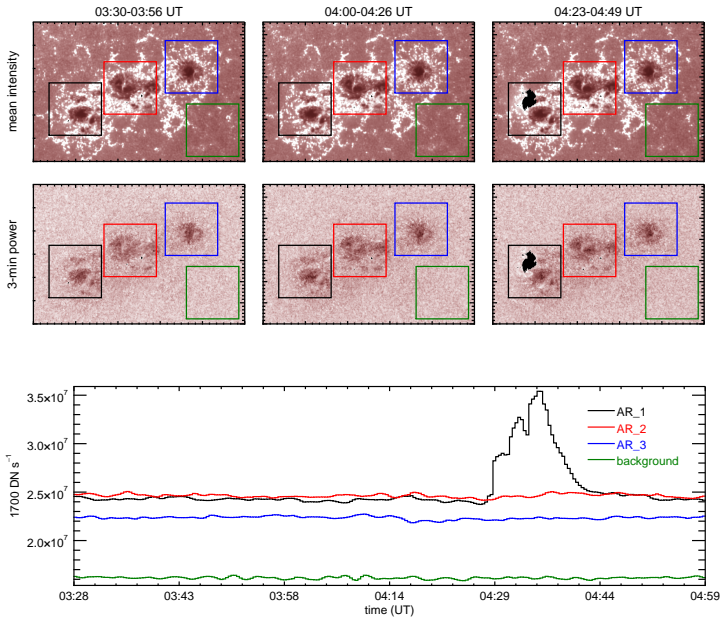
AIA 1700Å post-flare



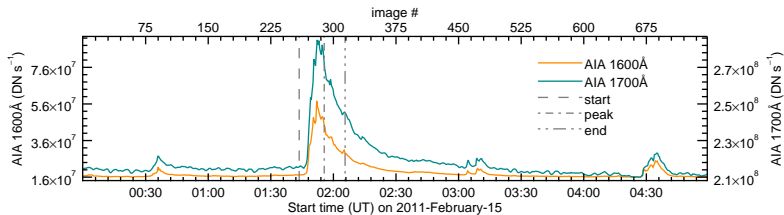
AIA 1600Å post-flare



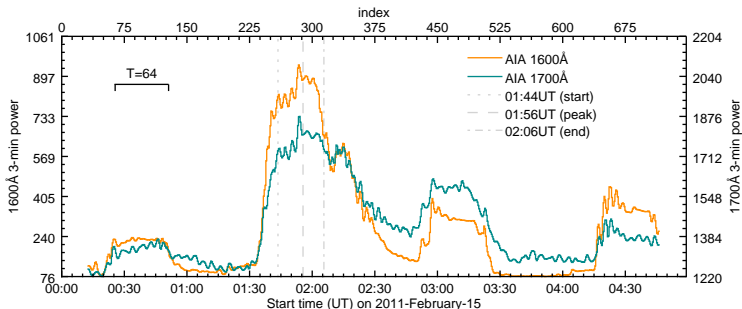
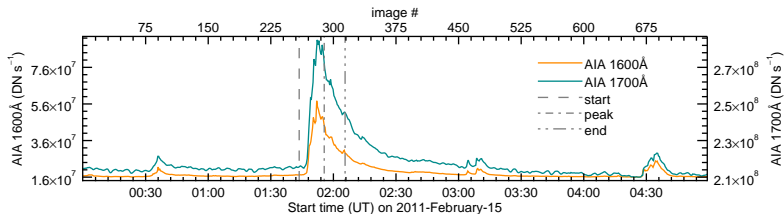
AIA 1700Å post-flare



Time evolution of 3-minute power



Time evolution of 3-minute power



Summary

Conclusions

1. Enhancement location coincides with excess emission, supporting theory of response to energy injection.

Future work

- Wavelet analysis to improve temporal resolution
- Analyze spectroscopic data provided by the *Interface Region Imaging Spectrometer (IRIS)*
- Multi-flare studies

Acknowledgments

Collaborators

Dr. R. T. James McAteer - Advisor (NMSU)

Dr. Jack Ireland (GSFC)

Funding

2018-10-29

- Notes go here