Studies of variability in fire count in Indonesia: Effects of ENSO and MJO phase

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Abstract

Tropical biomass burning has long been recognized as a major source of trace gases and aerosols to the troposphere. In this study, we focus on burning in Southeast Asia, which is heavily impacted by human activities and climate. In this region, prior studies have shown that interannual variability in fires is closely linked to drought, which in turn is tied to the warm-phase ENSO (El Niño-Southern Oscillation) conditions. We show that year-to-year variability in satellite-detected fire counts in Indonesia from 1995-2010, as reported by the ATSR World Fire Atlas, is strongly tied to the interannual variations in both the NOAA Multivariate ENSO Index (MEI) and the Southern Oscillation Index (SOI). Similar findings were derived for Vietnam, Malaysia, and the Philippines. At shorter timescales, month-to-month variations in fire counts in Indonesia were strongly related to phases of the Madden-Julian Oscillation (MJO) that are associated with below-average rainfall in this region. Our results confirm that not only anthropogenic land-clearing activities, but regional climate influences, have strong impacts on the number and timing of biomass burning events observed by satellite in Southeast Asia.

Data sets and Method

A) ENSO anomalies Correlations:

The ENSO indexes are reported monthly so we used the monthly fire count data. For each year, we found total fire counts from July (year 1) – June (year 2), to be consistent with the ENSO cycle. We computed the average MEI or SOI over the same July-June time period. Finally, we SUBTRACTED linear trends over the years of data (1995-2010) for both data sets. This gives us ANOMALY ("adjusted") plots that we can use for comparison.

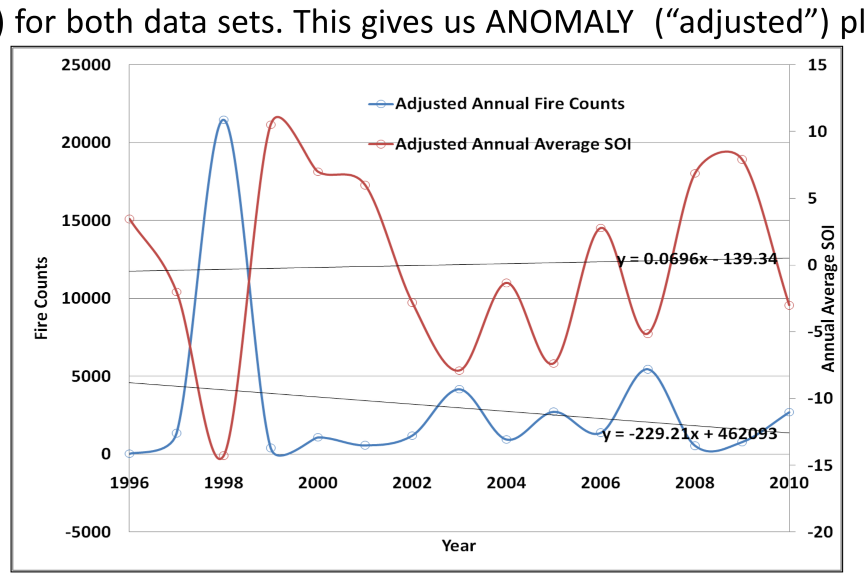


FIGURE 1: Example of the linear trends subtraction to compute ENSO and fire counts anomalies.

B) MJO phases correlation:

Because the MJO varies on much shorter timescales than do ENSO-related indices, we use **daily** (rather than monthly) values for this part of our work. The phase is related to variables defined by Wheeler and Hendon (RMM1 and RMM2). We used daily values of the phase available from http://cawcr.gov.au/staff/mwheeler/maproom/RMM/RMM1RMM2.74toRealtime.txt. Also, discrete values of the fire counts for each region are available (time and location of each hot spot), but these data needed to be specially processed into a file of daily fire counts for each region. Because this processing was time-consuming, we chose seven years (2002-2008) for initial investigation, to examine whether any relationships exist between the data sets, and confined our analyses to Indonesia.

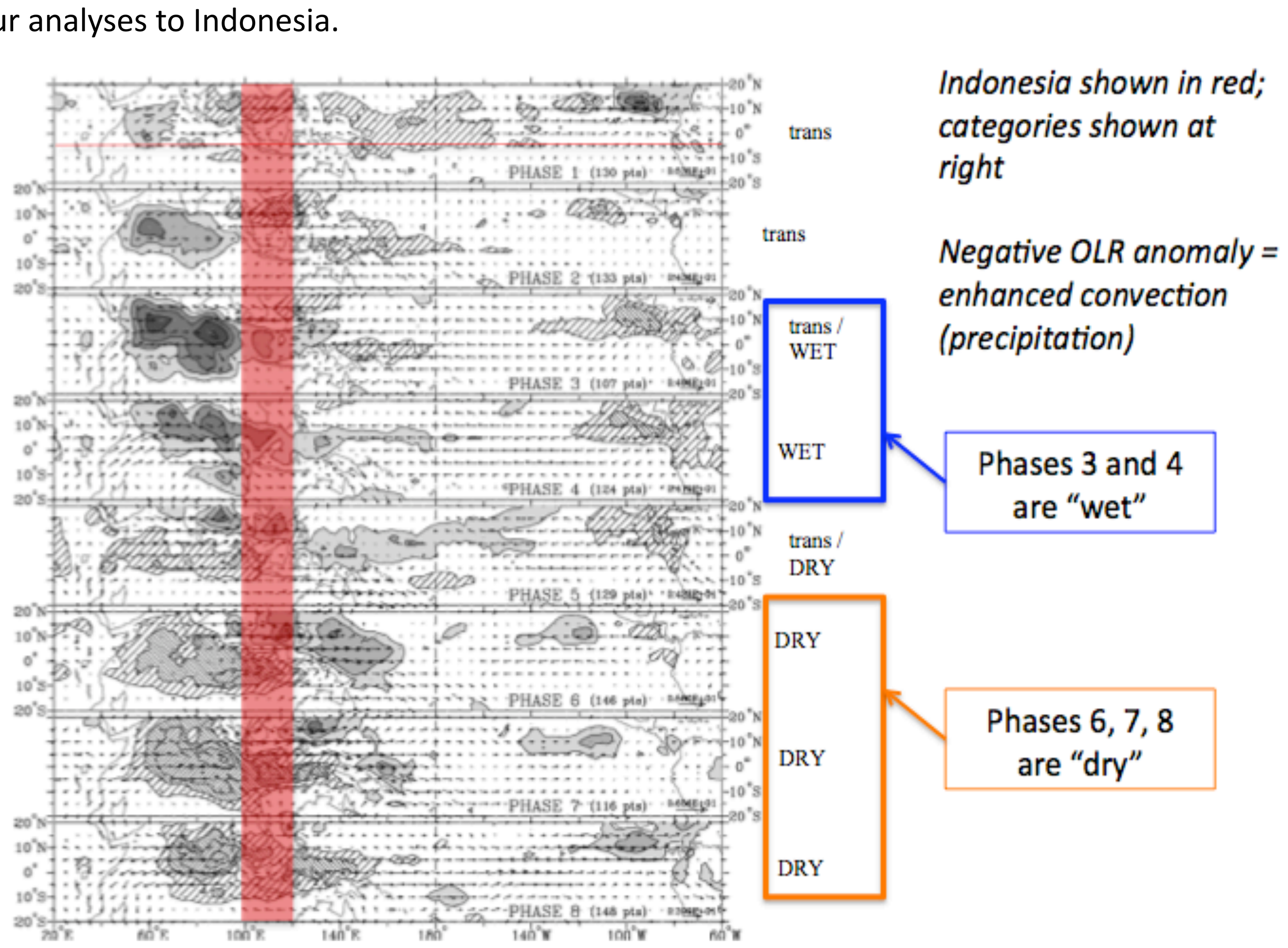


FIGURE 2: MJO phases and their effect on Indonesia.

Results

A) ENSO anomalies correlation with fire counts:

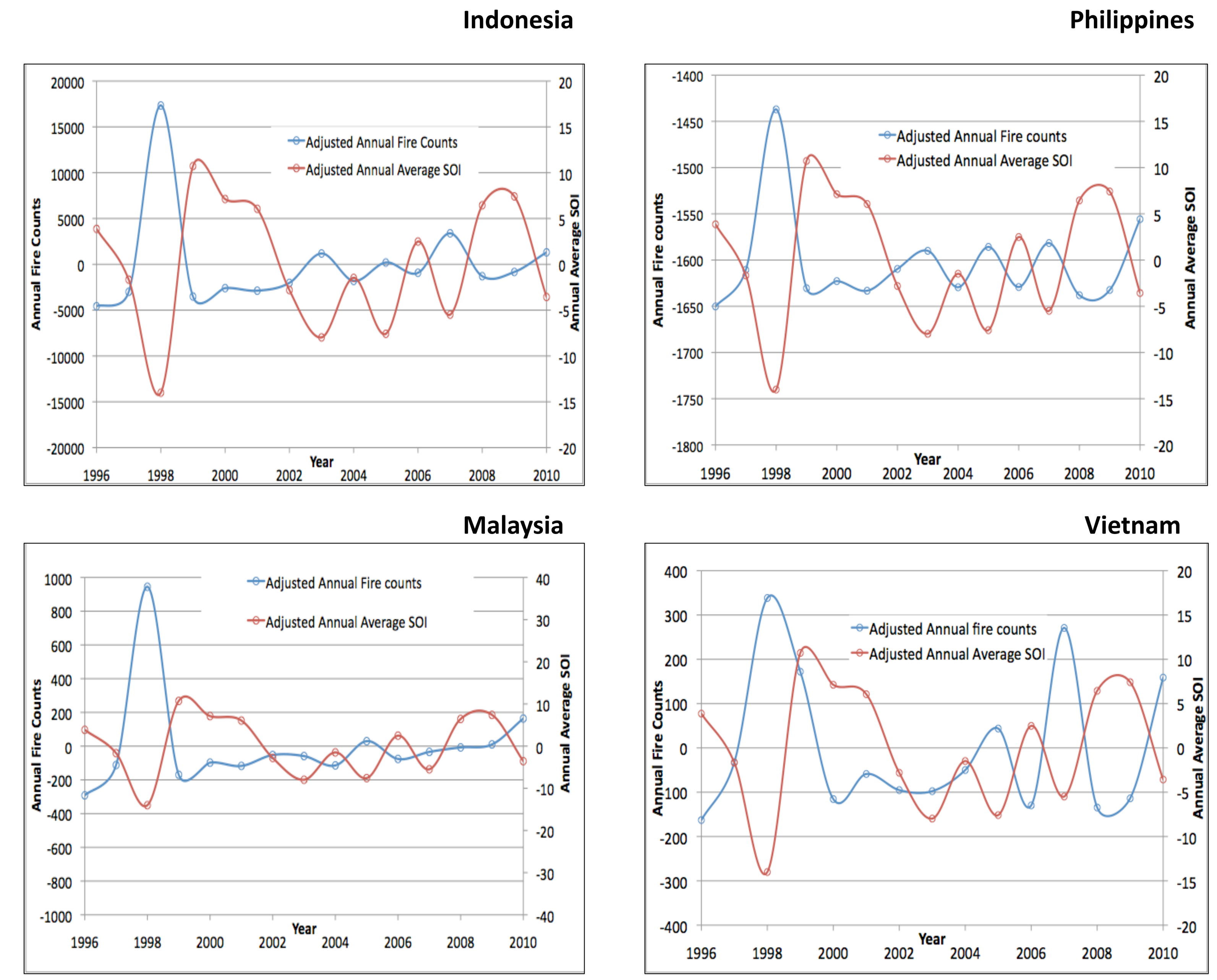


FIGURE 3: SOI correlation with Fire Counts on some regions of South Asia. Negative Values of the SOI means the presence of El Niño-Southern Oscillation.

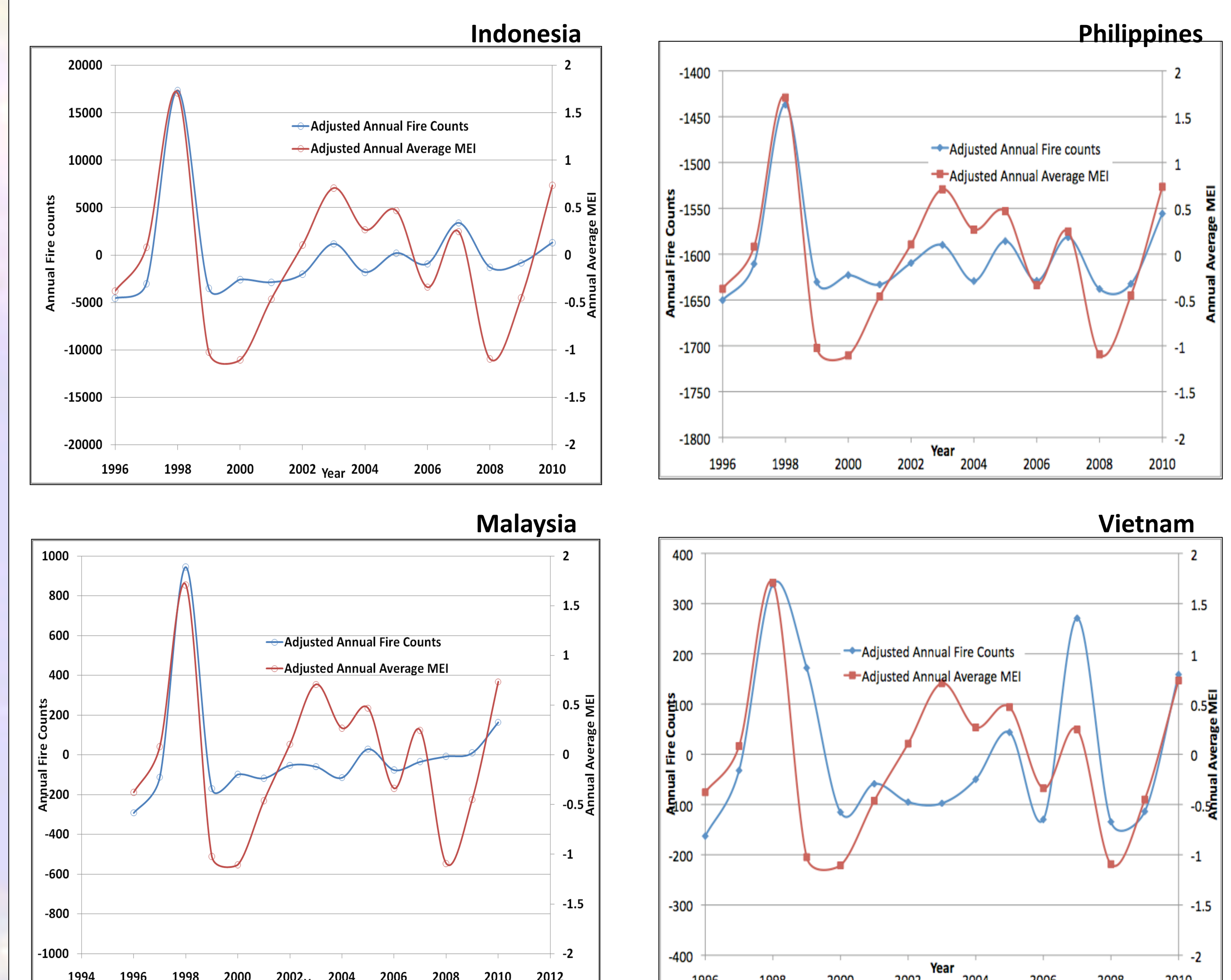
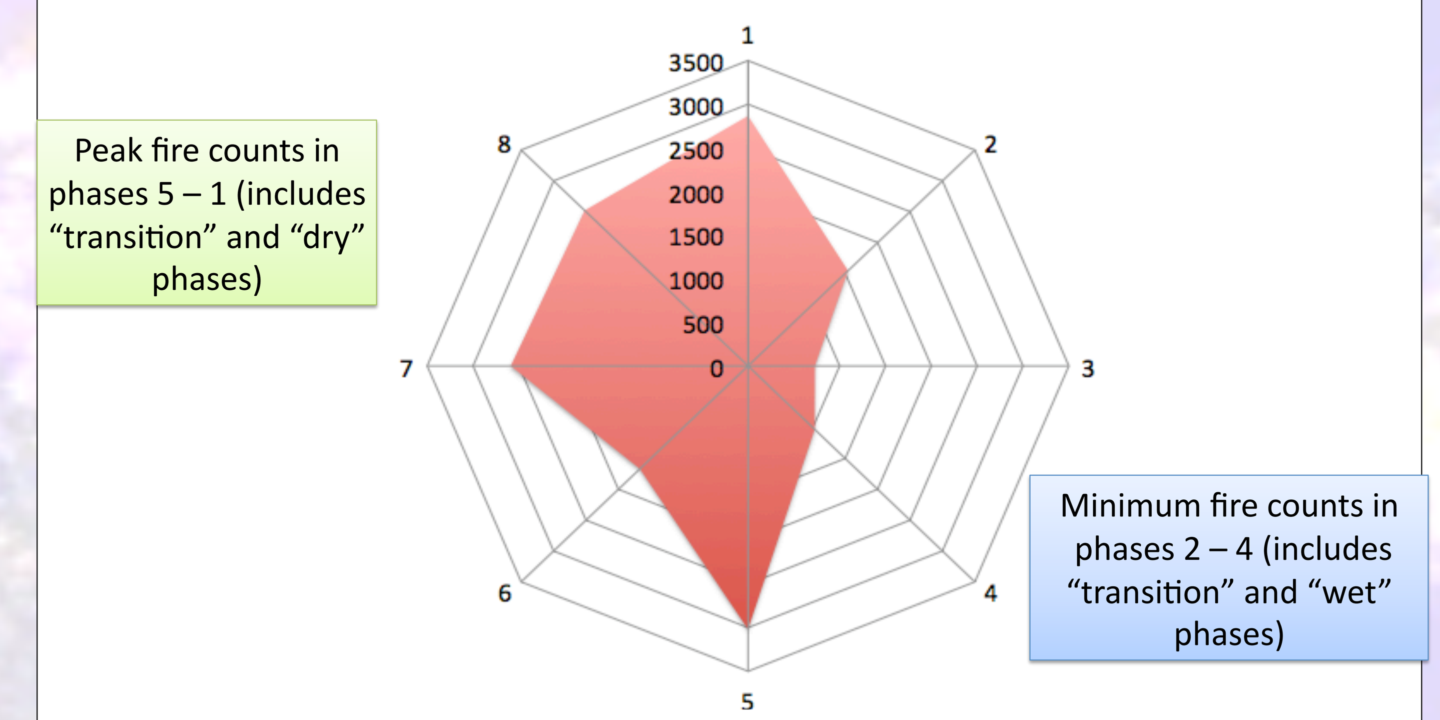


FIGURE 4: MEI correlation with the Fire Counts on some regions of South Asia. Positive Values of the MEI means the presence of El Niño-Southern Oscillation.

Strong relationships seen between satellite "hot spot" and ENSO anomalies for all locations studied

Results (Cont.)

B) MJO Correlations:



FUGURE 5: Fire Counts on each MJO phase during 2002-2008.

Conclusion

We found a strong relationship between the SOI and satellite-derived fire counts, and MEI and satellite-derived fire counts for the SE Asia locations considered. These have a strong influence on **interannual** variability in fires. This relationship is expected because when El Niño is present, a decrease in cloud formation over Indonesia occurs, often associated with drought. Certain phases of the MJO are also strongly associated with decreased rainfall and dry conditions in Indonesia. Therefore, we expected to see fire counts increase during those phases, and our findings thus far are consistent with this expectation. These have a strong influence on **month-to-month variability** in fires within the "fire season". MJO and ENSO are not completely independent, so further relationships may exist that can be explored with these data sets. Should also process more years of data to ensure this signal is robust

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Acknowledgements

- The following websites for the data sets:
  - An All-season Real-time Multivariate MJO Index: http://cawcr.gov.au/staff/mwheeler/maproom/RMM/index.htm.
  - ASTR-World Fire Atlas. *European Space Agency*: http://wfaa-dat.esrin.esa.int/.
  - Climate Prediction center. *National Weather Services*: http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml.
  - Southern Oscillation Index. *Australian Government: Bureau of Meteorology*: http://www.bom.gov.au/climate/current/soihtm1.shtml.
- This work has been supported by the National Science Foundation Science and Technology Center for Multi-Scale Modeling of Atmospheric Processes, managed by Colorado State University under cooperative agreement No. ATM-0425247.