Effects of drought conditions on CO_2 flux in semi-arid chaparral ecosystems

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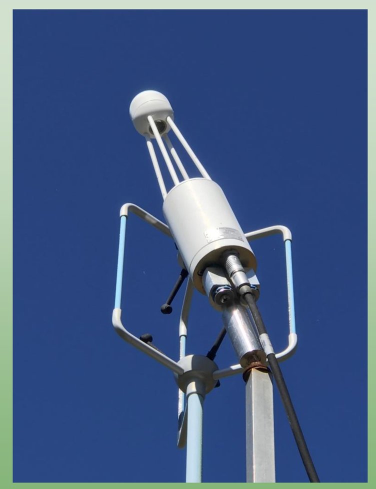
Research Summary

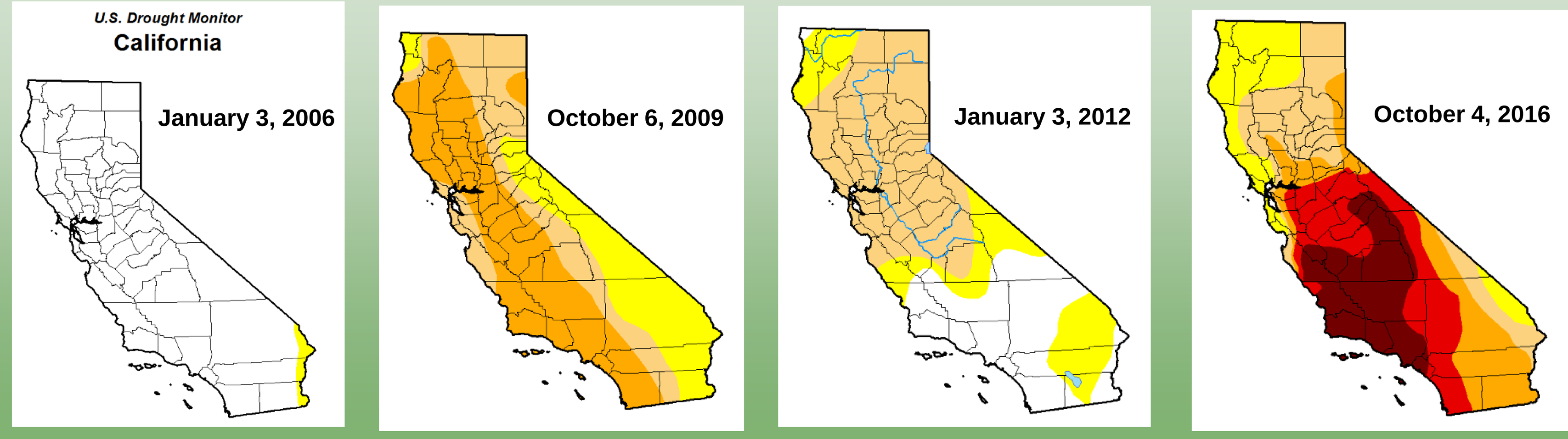
As global atmospheric carbon dioxide (CO_2) increases due to human activity, it is vital that we create measures to reduce levels of CO_2 in the atmosphere. Carbon flux in semi-arid shrublands has rarely been studied using eddy covariance techniques. Semi-arid shrublands, especially old-growth shrub ecosystems, could mitigate the rising levels of CO_2 in the atmosphere. Under normal weather conditions, such ecosystems can become carbon sinks ultimately absorbing the excess levels of carbon in the atmosphere. However, as global temperatures change due to human activity, precipitation patterns are likely to change resulting in an increase in drought events. As the prevalence of drought events increase in semi-arid shrubland ecosystems, gaining a better understanding of how these ecosystems act under non-normal weather conditions is key. In this study, eddy covariance measurements of the net ecosystem exchange (NEE) of CO_2 over a 14-year period were analyzed for three Mediterranean-type chamise (*Adenostoma fasciculatum*)-dominated chaparral stands in Southern California. Findings from this study may suggest a shift in the carbon source-sink dynamics of these semi-arid chaparral ecosystems.

Methods

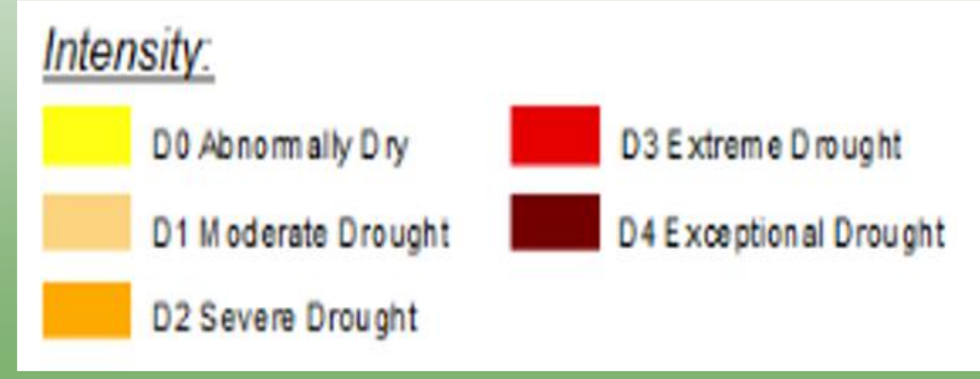


- CO_2 and water vapor fluctuations were measured using a 10 Hz open-path gas analyzer.
- Half-hourly mean CO_2 and water vapor fluxes were calculated as the covariance between the CO_2/H_2O mixing ratio and vertical wind speed using the postprocessing software EddyPro.
- A 3-dimensional sonic anemometer was used to measure wind speed, wind direction, and temperature at 10 Hz.

California's Drought History



Recent Severe Drought Years: 2006 to 2010 and 2012 to 2017



Old Stand Eddy Covariance Tower

Stand History

- AmeriFlux: US-SO2
- Located at Sky Oaks Field Station in Southern California.
- In 2003, the chaparral stand was 158 years old.
- In July 2003, a natural wildfire burned areas that included the Old Stand tower.

Young Stand Eddy Covariance Tower

Stand History

- AmeriFlux: US-SO3
- Located at Sky Oaks Field Station in Southern California.
- In 2003, the chaparral stand was 11 years old.
- In July 2003, a natural wildfire burned areas that included the Young Stand tower.

New Stand Eddy Covariance Tower

Stand History

- AmeriFlux: US-SO4
- Located at Sky Oaks Field Station in Southern California.
- Chaparral stand is about 172 years old.

Old Stand Eddy Covariance Tower

Figure 1. Average seasonal net ecosystem exchange (NEE), precipitation (mm), and soil moisture between depths of 0 and 40cm during the years of 2006 to 2018 collected by the Old Stand Eddy Covariance Tower in Southern California. Winter season (November 1st to February 28th), growing season (March 1st to June 30th), dry season (July 1st to October 31st).

Young Stand Eddy Covariance Tower

Figure 2. Average seasonal net ecosystem exchange (NEE), precipitation (mm), and soil moisture between depths of 0 and 40cm during the years of 2006 to 2018 collected by the Young Stand Eddy Covariance Tower in Southern California. Winter season (November 1st to February 28th), growing season (March 1st to June 30th), dry season (July 1st to October 31st).

New Stand Eddy Covariance Tower

Figure 3. Average seasonal net ecosystem exchange (NEE), precipitation (mm), and soil moisture between depths of 0 and 40cm during the years of 2004 to 2018 collected by the New Stand Eddy Covariance Tower in Southern California. Winter season (November 1st to February 28th), growing season (March 1st to June 30th), dry season (July 1st to October 31st).

Preliminary Results & Conclusions

One average low levels of precipitation and soil moisture can cause these experimental chaparral stands to switch from a carbon sink to a carbon source.

Carbon Source:

- Rate of soil decomposition and respiration (carbon sources) outweigh the rate of photosynthesis (carbon sink).

Carbon Sink:

- Normal weather conditions
- High atmospheric CO_2 can increase photosynthesis rates, decrease respiration, and relieve nutrient stress.

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