The effect of climate change on high elevation ecosystems and freshwater resources in Hawai‘i
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Project Summary
This ongoing project aims to assess the sensitivity of the upper limit of the cloud forest (forest line) and adjacent shrubland and grassland to El Niño-induced drought.

Statewide rainfall through time: As part of this project, statewide trends in monthly, annual, and seasonal rainfall were calculated and mapped to show the regions in the state that have been experiencing the most severe changes since 1920. Results showed drying trends across every island, with the largest trends found in the Kona region of Hawai‘i Island during dry season months (May-October). The highest elevation areas were found to have the greatest relative losses in rainfall (percent per decade), particularly in dry season months. A running trend analysis revealed that most of the drying trends in Hawai‘i were a result of a few, very dry years at the end of the record. The exception was in Kona, where downward trends have been persistent through time.

Rainfall during El Niño and La Niña: Large-scale natural climate variability has a large influence on rainfall in Hawai‘i, particularly the El Niño-Southern Oscillation (ENSO): El Niño events tend to produce dry winter conditions over Hawai‘i and La Niña events produce wetter than average conditions. ENSO plays an important role in ecosystem dynamics at the forest line, and El Niño-induced drought events are likely the driving factor of the forest line position. We have completed a composite analysis of rainfall during El Niño and La Niña events to determine the strength of the rainfall anomalies during each phase. The spatial details of these teleconnections are now available for strong, moderate and weak events since 1920. Understanding the magnitude of the change in rainfall associated with an El Niño event of certain strength will help with water resources planning and management for future ENSO events.

Forest response during drought: High elevation forests serve as some of the last remaining habitat for native Hawaiian birds, and it is projected that climate change will be detrimental to bird abundances. Montane cloud forest ecosystems also produce high watershed yields which support water resource needs downstream, making these vulnerable ecosystems extremely hydrologically important. To better understand this important ecosystem, we are focusing on the forest line region of windward Haleakalā, Maui, located between 2000 and 2200 m elevation. The entire region is largely disturbance-free, with the exception of some non-native ungulate and non-native plant invasions. This protected “natural” treeline is an ideal place to study the impacts of natural climate variability on high elevation ecosystems. Using remotely-sensed vegetation index (VI) data from 2000 to 2015 derived from the MODIS satellite, we can detect the responses of the forest and adjacent shrubland and grassland to climatic extremes (such as the 2009-2010 El Niño event). The VI anomalies during drought events will be modeled with corresponding climate data to assess spatiotemporal patterns and drivers during drought. Climate data will be obtained from the Little HaleNet network, which is made up of 12 climate stations that bracket the forest line in three east-west transects (Fig. 1, 2 & 3). Understanding how these ecosystems respond to natural climate variability will be important for future water resource planning and management as well as preservation of native ecosystems and habitats.
Fig. 1: WorldView-2 imagery of the forest line area of Haleakalā, Maui with Little HaleNet station locations shown in yellow.

Fig. 2: Dr. Shelley Crausbay performing maintenance on a Little HaleNet climate station in the cloud forest.

Fig. 3: Abby Frazier conducting fieldwork near Kalapawili Ridge, Haleakalā, east Maui.