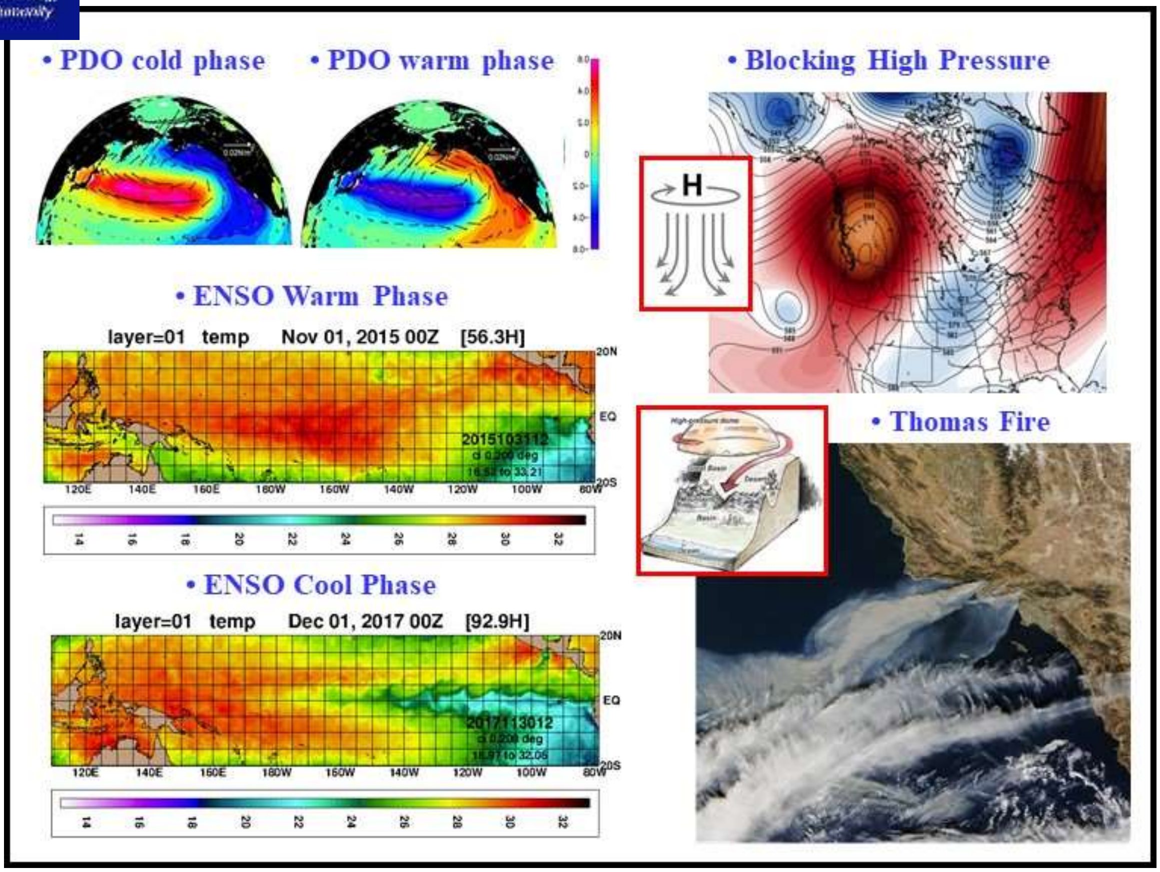

Ocean Oscillations, Blocking High Pressure Systems and Downslope Winds: Explaining the California Drought/Fire Cycle

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California weather conditions have always alternated between flood and drought. Most of the rainfall comes from winter storms that form in the Gulf of Alaska and move south along the coast. Under the right conditions, so called 'atmospheric rivers' form and substantial additional rainfall is produced as a relatively narrow band of moist air flows in from the Pacific Ocean. The source of the water is of course evaporation from the ocean surface. This depends on the wind speed and the ocean surface temperature. There is no requirement for an exact energy balance at the ocean surface between the solar heating and the wind driven cooling. This leads to the formation of natural ocean oscillations that produce quasi-periodic changes in ocean temperature. In the Pacific Ocean there are two main oscillations. There is the El Nino Southern Oscillation (ENSO) in the central equatorial Pacific Ocean with a period in the 3-to-7-year range and the Pacific Decadal Oscillation (PDO) in the N. Pacific Ocean with periods in the 10 to 25 and 50-to-70-year range. The PDO influences the ocean surface temperature in the Gulf of Alaska which determines the amount of moisture that can be carried south by the winter storms. The ENSO influences the temperatures in the equatorial Pacific Ocean that determine the location and magnitude of the atmospheric rivers. The detailed ocean weather interactions are complex.

In addition, in S. California there is a natural transition between on-shore and off-shore flow. On shore flow is associated with cooler ocean temperatures and higher humidity. Offshore flow is associated with higher temperatures and lower humidity. This is usually associated with a high-pressure dome inland. There is a natural down flow of dry air at the center of the high-pressure dome that is heated by compression. In addition, as air flows from the inland desert plateau to the coast it is heated as it descends to lower altitudes. This produces the dry, hot, downslope winds known in California as Santa Ana or diablo winds. These conditions lead to rapid drying of the vegetation and a high fire risk.

Over the past 100 years or so, the atmospheric concentration of CO_2 has increased by approximately 120 parts per million (ppm) from 280 to 400 ppm. The current annual average rate of increase in the CO_2 concentration is near 2.4 ppm per year. Radiative transfer calculations show that the 120 ppm increase in CO_2 has produced an increase in the downward long wave infrared (LWIR) flux from the lower troposphere to the surface of approximately 2 W m^{-2}. The current rate of increase in the LWIR flux is near 0.034 W m^{-2} per year. These changes in flux are too small to have any effect on ocean oscillations, high pressure dome formation or downslope winds. There has been no significant change in S. California rainfall levels over the last 100 years. Tree ring analysis shows that California has seen both wetter and drier periods over the last 1200 years. California will continue to see floods, droughts and fires. Short term variations should not be used to predict long term trends.

Speaker: Roy Clark

Roy Clark received his MA in chemistry from Oxford University and his Ph.D. in chemical physics from Sussex University (UK; 1976). He has over 40 years of experience in new product and process development with emphasis on optical and spectroscopic measurements in adverse environments. He has integrated complex optical diagnostic systems into high energy laser and hypersonic combustion test facilities. His spectroscopic experience extends from 200 nm to 200 cm^{-1} including work with circular and linearly polarized light. One of his technical interests is time-based metrology using optical sensors, such as the use of thermographic phosphor fluorescence decay time to measure temperature. He has worked at large and small companies in S. California including Rockwell, Boeing, Physical Optics Corporation, and Hughey and Phillips. He has also provided consulting services for optical systems development. He has 13 technical and scientific publications and 8 US Patents. Roy has been an IEEE member for 14 years.

Roy began his own research on climate change in 2007. His particular interest is the determination of the surface temperature from first principles using the time dependent flux terms. He has published several technical articles in this area and wrote the book '*The Dynamic Greenhouse Effect*'.

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