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Reconstructions of Circulation in the Northeastern Pacific and Western North America since 1500 A.D.: Relation to Precipitation and Fire Conditions in California

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A reconstruction of the position of the North Pacific Jet Stream (NPJ) in wintertime over the past 500 years is. Reconstruction of NPJ behavior is driven by an analog process that employs existing paleoclimate field reconstructions of winter temperature, summer precipitation and summer soil moisture from western North America to select climate model states in millennial climate simulations that are closest to the field reconstructions. The skill of the reconstruction method is tested against the 20CR meteorological reanalysis. All three types of proxy sets individually contribute to the skill in the reconstruction of the winter atmospheric circulation. The NPJ reconstruction is also evaluated in relation to dry and wet extremes in California and extremes of Sierra Nevada fire activity. Results indicate that fire and precipitation extremes are both closely linked with NPJ winter position, with characteristic wet/low fire and dry/high fire NPJ spatial features in the northeastern Pacific adjacent to western North America. The meridional profiles of zonal wind at 200 hPa height can be classified according to winters belonging to dry and wet hydrological years and also according to summers with high or low fire activity. This classification indicates that in wet years and low-fire years the jet stream is more intense, more zonally oriented with peak winds occurring at lower latitudes. The opposite configuration occurs in dry, high-fire, years, with a more meandering jet stream peaking at higher latitudes.
These features are in turn evaluated in future climate model scenarios using directly comparable transient integrations that cover the past millennium, the instrumental period, and the 21st century. Relatively wet/low fire regional conditions are reasonably possible in the later 21st century under a high greenhouse gas forcing regime (RCP 8.5), even though temperatures rise significantly. The implication of this combination of conditions in the Sierra Nevada is that more winter precipitation will occur as rain instead of snow due to rising temperatures, even if overall precipitation actually increases. Reduced snowpack moisture into late spring and summer would generally be associated with drier soil conditions during the summer and early fall "fire season", which would co-occur with higher temperatures. Changes of this kind will mean that the dynamically-driven NPJ influence on precursor climate conditions for fire which has existed for the several centuries included in this study will be to a significant degree superseded by the direct thermodynamic energy-balance influence of increasing temperatures.