Anthropogenically forced increase in acidification extreme conditions in the Northeast Pacific ocean modulated by climate modes

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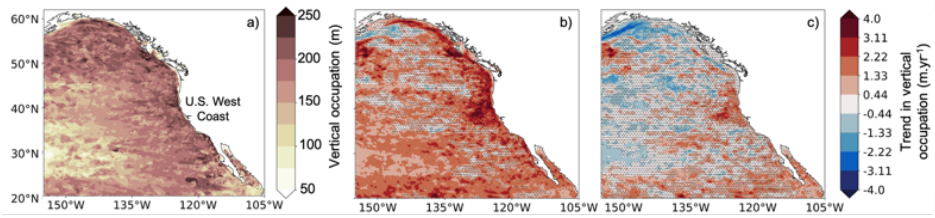
The ocean acidifies as it takes up anthropogenic carbon from the atmosphere. While mean changes in ocean carbonate chemistry have been widely studied, little is known about the trends and interannual to decadal variability of episodic high acidity extreme events. Understanding the temporal variability of such extreme events is crucial to investigate their potential predictability. Using a regional ocean model coupled to a biogeochemical-ecosystem model (ROMS-BEC) we found that acidification extreme events increase from 1984 through 2019 in the upper 250 m of the Northeast Pacific, mostly due to rising atmospheric CO2 concentration. The increase is enhanced in the highly productive California Current System (CCS) by changes in upwelling strength. Our study further reveals that El Niño-Southern Oscillation (ENSO) and the North Pacific Gyre Oscillation (NPGO) modulate the long-term trends in acidification extreme events, especially in the southern and central parts of the CCS. La Niña (El Niño) increases (decreases) the amount of extreme conditions experienced by the region. Similarly, the positive (negative) phase of NPGO is associated with more (less) extreme conditions. These results offer potential for predicting unusual acidity stress ahead of time in some regions of the Northeast Pacific ocean, such as the CCS.



Maps of (a) the maximum vertical occupation by acidifition extreme conditions on any given day between 1984 and 2019 in the upper 250 m of the Northeast Pacific ocean and long-term trends in the yearly maximum vertical occupation for (b) a hindcast and (c) a simulation with linearly de-trended atmospheric CO2 forcing. The California Current System refered to in the abstract is located along the U.S. West Coast.