Coupling Between Oceanic Upwelling and Cloud-Aerosol Properties at the AMF Point Reyes Site

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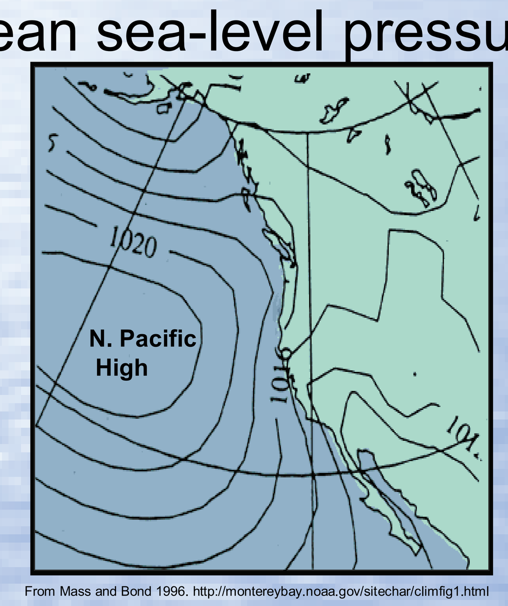
ARM Atmospheric Radiation Measurement

Upwelling SST to Atmosphere

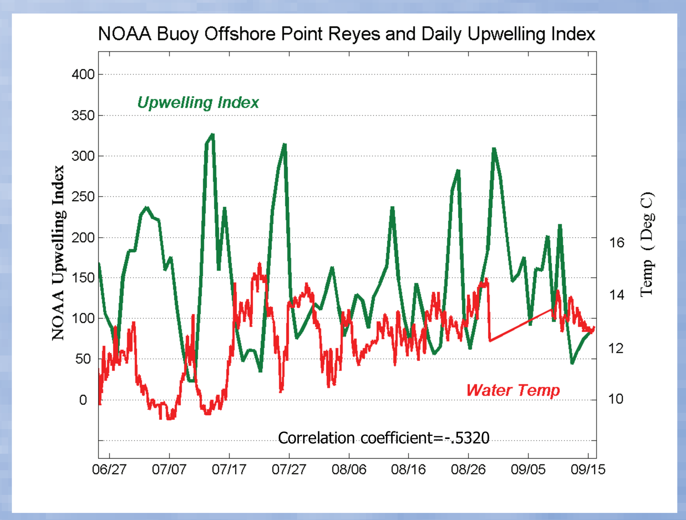
Introduction

Ground based observations from the MASRAD, Pt. Reyes AMF July 1-Sept 15, 2005 indicate a relationship between coastal marine stratus cloud properties, boundary layer cloud condensation nuclei and the upwelling of cool oceanic waters measured at an offshore NOAA buoy.

Mean sea-level pressure

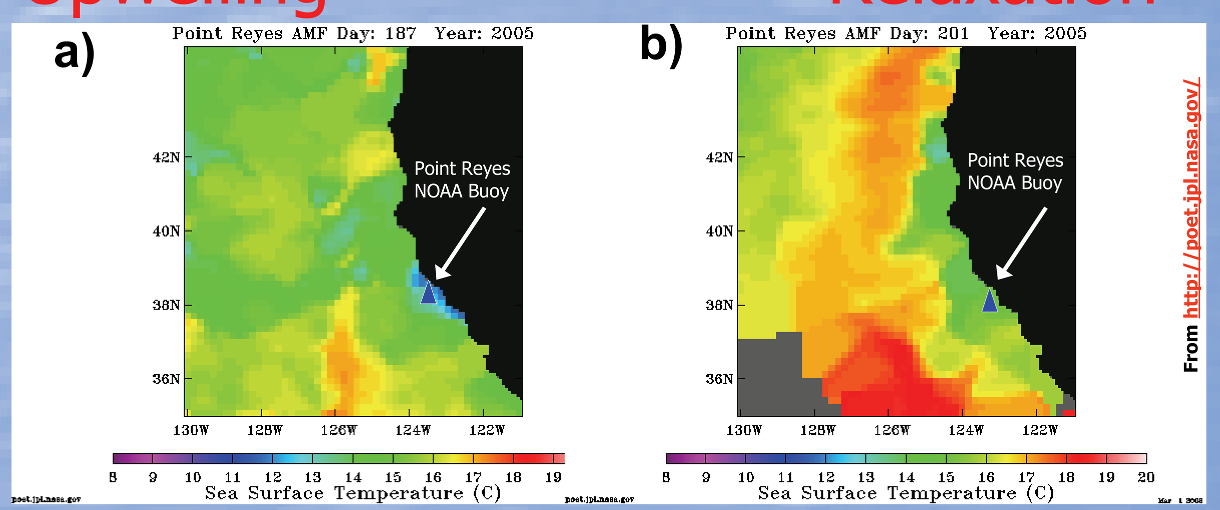


Wind fields generated by the N. Pacific High drive coastal upwelling.

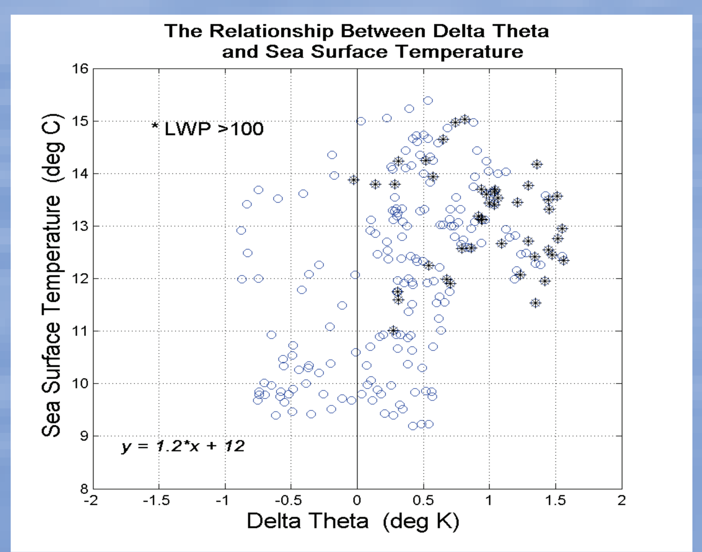


Sea Surface Temperature (SST) at NOAA buoy reflects cyclic upwelling processes.

Upwelling — Relaxation



NAVOCEANO MC-SST weekly nighttime composite
a) July 6 during an upwelling event.
b) July 20 during a relaxation of upwelling

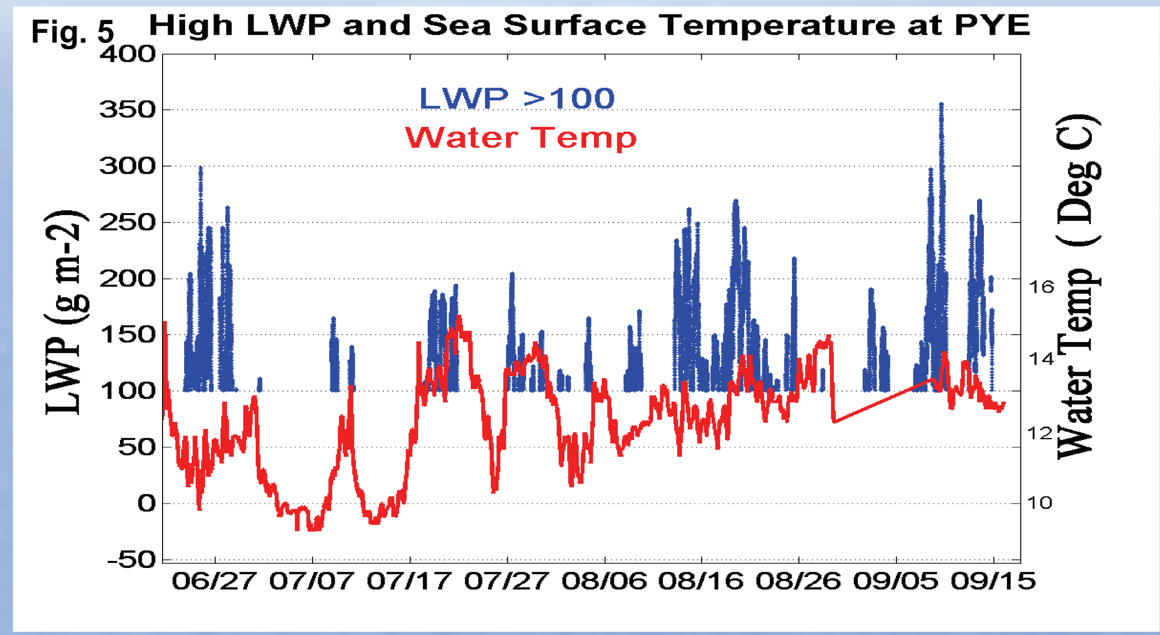


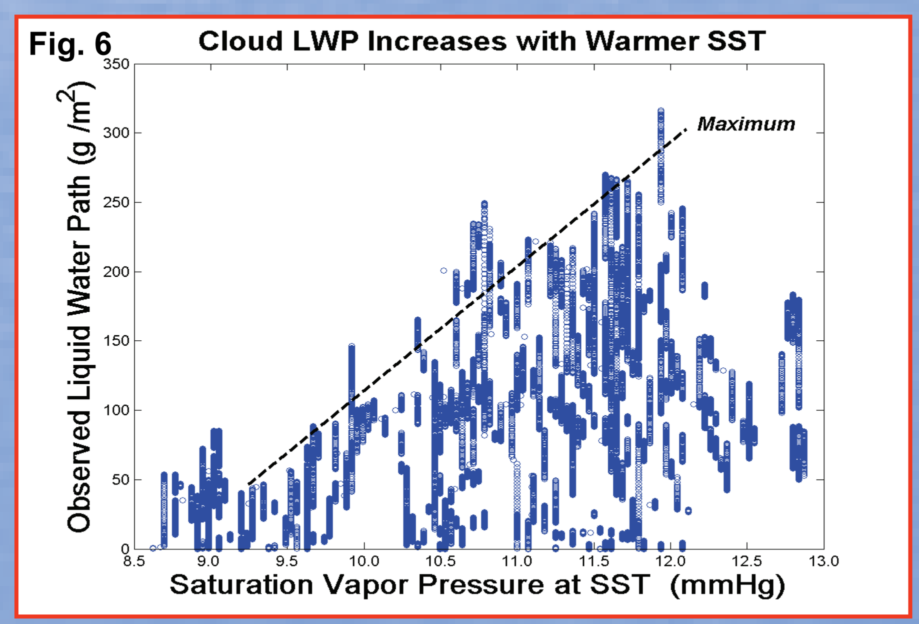
$$\Delta\theta = \theta(0.9\, z_i) - \theta(0.1\, z_i)$$

z_i = inversion height

A small positive Delta Theta indicates a stable, well mixed marine boundary layer when liquid water path is high (> 100 gm^{-2}).

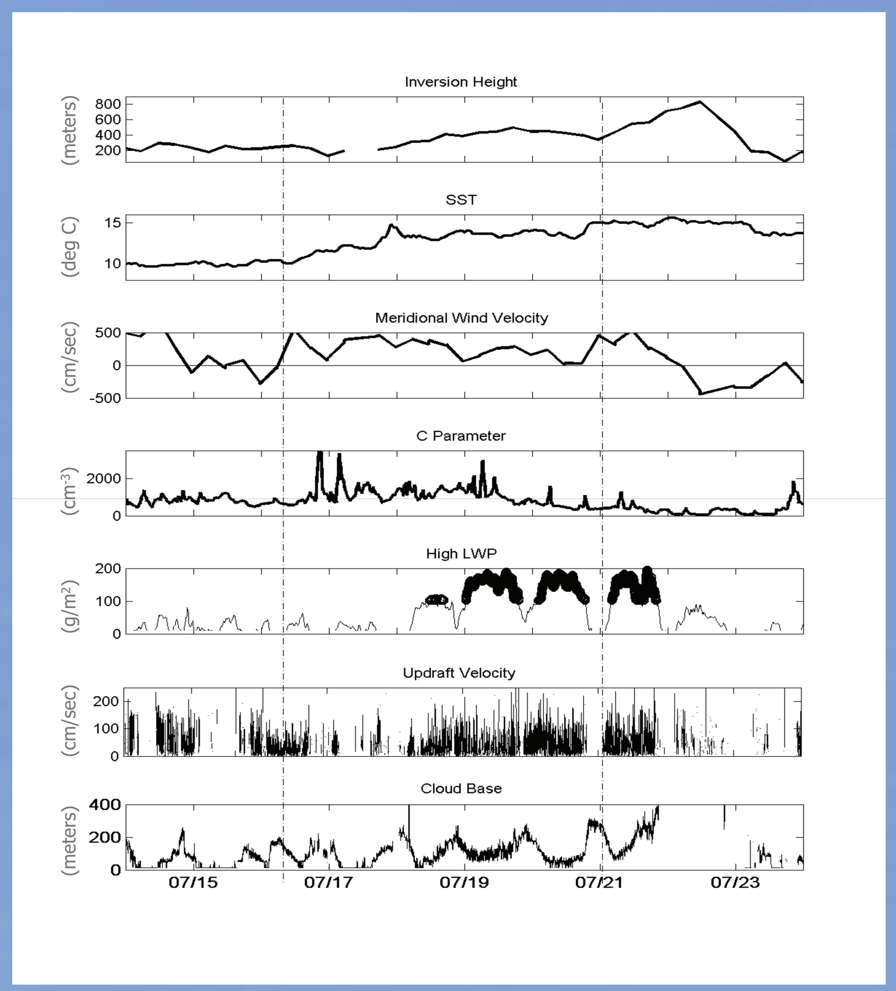
Atmosphere to Cloud





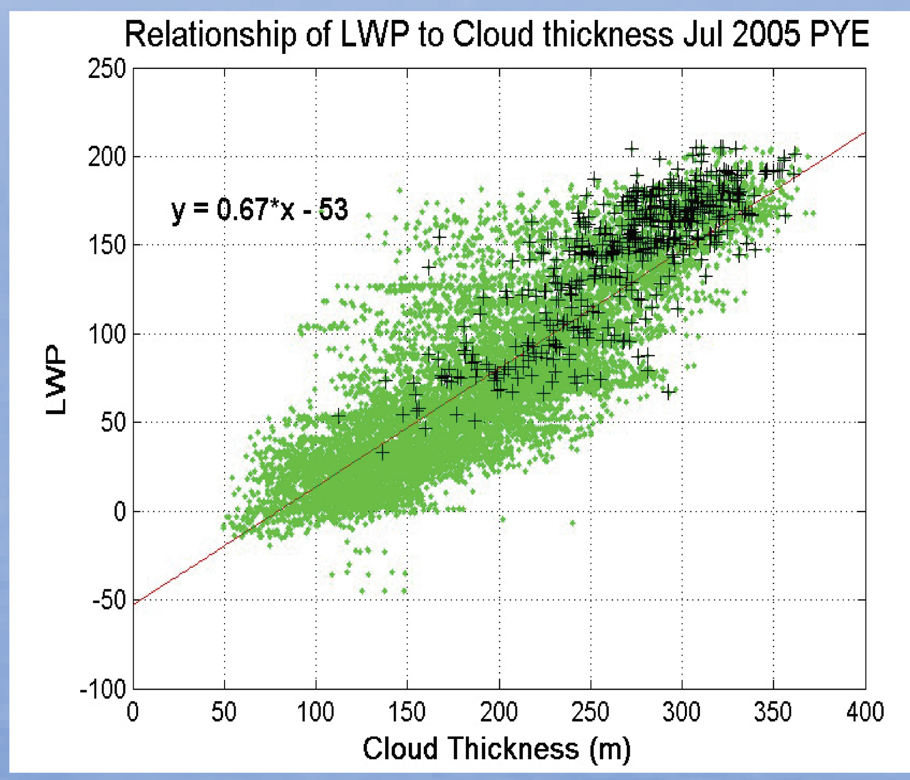
Results

Coastal sea surface temperatures are observed to correlate well with nearby ground measurements of cloud LWP (fig. 5). The nighttime calculated Saturation Vapor Pressure can predict the maximum cloud LWP (fig. 6).



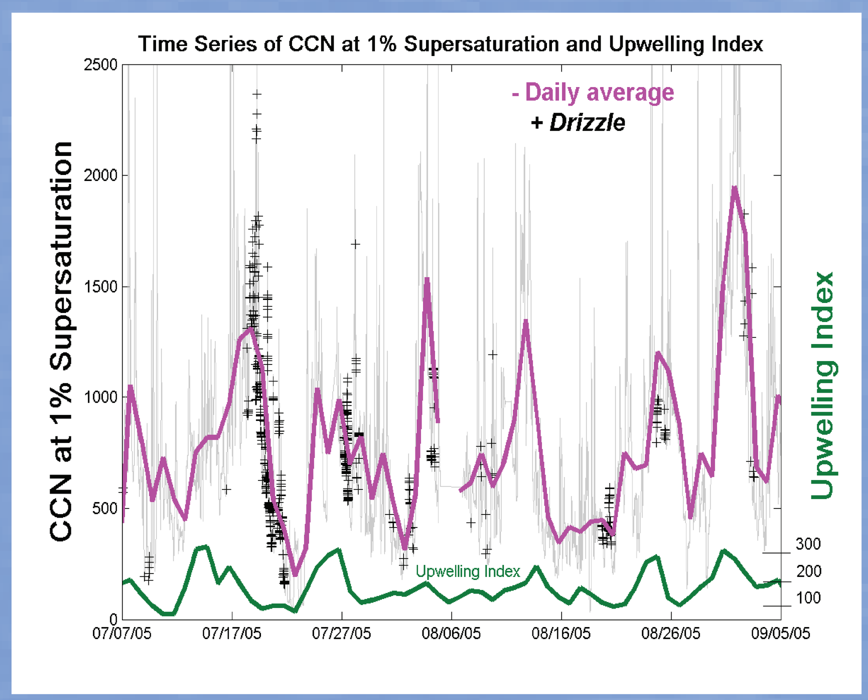
Measurements of one full cycle of upwelling and relaxation taken at Pt. Reyes AMF from July 15 - 23.

Cloud Drizzle to CCN



Ground based measurements of Cloud LWP increases with cloud thickness. Drizzle (+ marker) occurs more often in high LWP clouds.

The C parameter (CCN at 1% Supersaturation) decreases during radar identified drizzle times and relaxation of upwelling (low index) offshore.



Conclusion

Coastal marine stratus clouds increase in thickness as the underlying sea surface temperature rises. This suggests a transfer of moisture and heat to the marine boundary layer. The subsequent increase in drizzle from thick clouds contributes to the removal of CCN in the boundary layer.

Acknowledgements

NAVOCEANO MCSST data were obtained through the online PO.DAAC Ocean ESIP Tool (POET) at the Physical Oceanography Distributed Active Archive Center (PO.DAAC), NASA Jet Propulsion Laboratory, Pasadena, CA. http://podaac.jpl.nasa.gov/poet

SST buoy data were obtained through NOAA's National Data Buoy Center web site http://www.ndbc.noaa.gov/

Daily Upwelling Index is produced by the NOAA Pacific Fisheries Environmental Laboratory using estimates of Ekman transport. Available at http://www.pfeg.noaa.gov/products/PFEL/modeled/indices/upwelling/