Analysis of Diurnal Trends in Stratocumulus Drizzle from the VOCALS Field Campaign

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Introduction

•The Southeast Pacific deck of stratocumulus clouds is one of several stratocumulus regions which form off the west coast of continents.

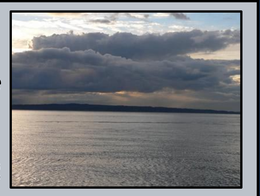

Figure 1. Photographic example of a marine stratocumulus cloud.

•These regions of clouds reflect incoming radiation, producing a net cooling effect on the climate.

•Since global climate models poorly represent such regions, the response of stratocumulus to changing climate conditions remains uncertain.

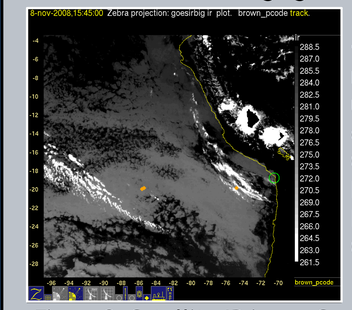

Figure 2. Satellite IR image Southeast Pacific deck of stratocumulus, off the coast of Chile.

•We examine diurnal trends in marine stratocumulus drizzle utilizing information obtained during the 2008 VAMOS Ocean Cloud Atmosphere Land Study Regional Experiment (VOCALS-REx), which took place from October 21 to November 30 2008.

Data and Methods

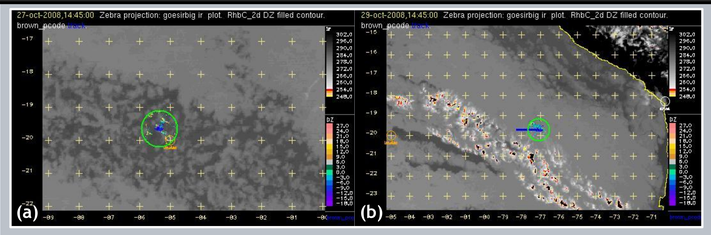

Figure 3. Two satellite images that show different IR conditions. These are (a) open and (b) closed cellular structures. The green circle shows area were the ship radar data were obtained.

• Cloud structure satellite infrared (IR) images were classified as either closed cellular, open cellular or transitional.

• Closed cellular were those images in which cloud coverage was unbroken.

• Open cellular were those in which clouds were broken.

• Reflectivity values obtained from ship-based radar data were classified as:

a. weak drizzle (< 20 dBZ),
b. intermediate drizzle (>20 dBZ)
c. strong drizzle (>20 dBZ and an area coverage of at least 40 pixels).

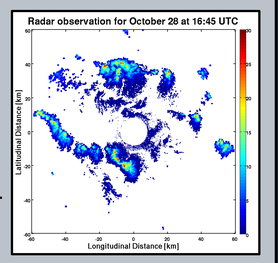

Figure 4. Radar reflectivity from October 26, 2008 at 16:45 UTC.

Analysis of overall daily trends and behaviors for the 2008 VOCALS-Rex

Data from the first leg of VOCALS expedition (October 21-November 3, 2008)

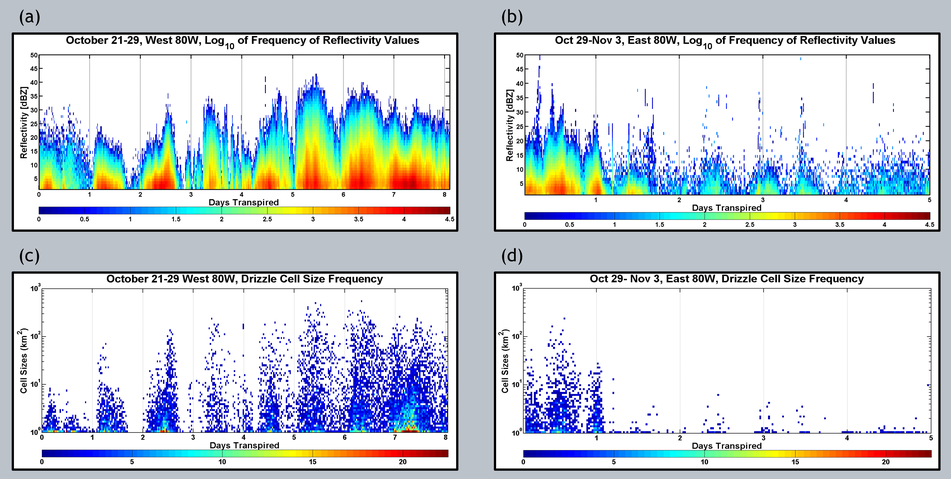

Figure 5. Plots show the frequency and intensity of reflectivity values as a function of time that the ship was (a) west and (b) east of 80 degrees west . The color bar depicts the log_{10} of frequency. Plots (c) and (d) show time series of contiguous drizzle cell size (y-axis, logarithmically scaled) and the number of cells (color bar).

• There is a more appreciable diurnal cycle in reflectivity and cell size and number when the ship was west of 80 W. This pattern looks less defined in cell size and number east of 80 W(in which the ship was approaching the Chilean coastline).

Data from portion of second leg of VOCALS expedition (November 10-26, 2008)

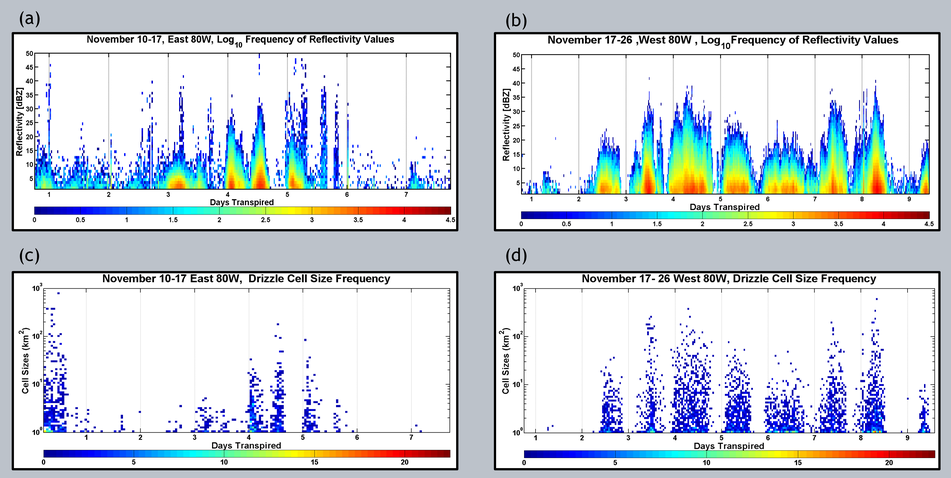

Figure 6. Reflectivity and drizzle cell time series for portion of the second leg of the VOCALS field campaign.

• As was previously observed, diurnal cycles close to the Chilean coast are not well defined. When comparing (a) with (b) it is observed that the expected diurnal cycle returns when the ship gets further west, with peaks close to local sunrise and gaps closer to local sunset.

Comparing open and closed cellular diurnal cycles

Comparison of open cellular cycles and closed cellular cycles

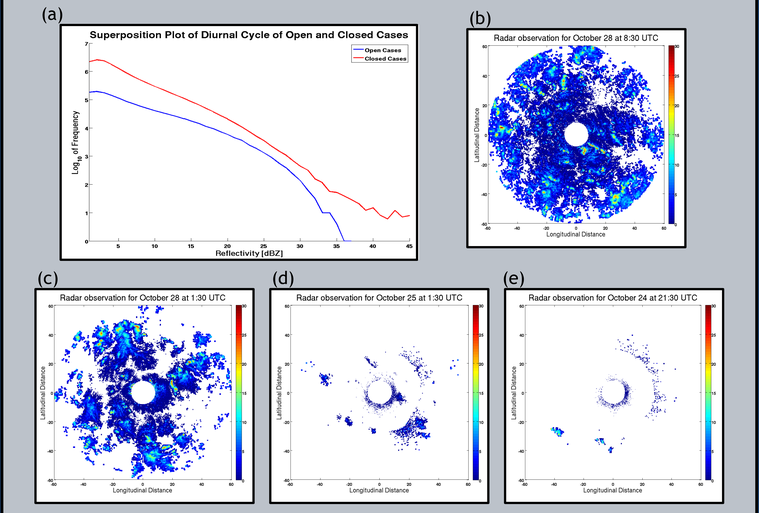

Figure 7. Comparison of open and closed cases for October 24,25,28 and 29. (a) Log_{10} frequency of reflectivity values as a function of intensity. Radar images (b) and (c) are closed cases, (d) and (e) are open cases.

Conclusions

•The diurnal cycle in the Southeast Pacific stratocumulus deck greatly affects the area coverage and intensity of drizzle.

•Strongest drizzle cases occur near sunrise at local time, with reflectivity values as high as 40 dBZ and a radar area coverage ranging from 18-55%

•Minimum reflectivity values occur close to the local sunset, with reflectivity values usually below 25 dBZ and a radar area coverage ranging from 0-11%.

•A weakening of the diurnal cycle is depicted as the ship gets close to the coast. This area is more affected by the local climate of the Chilean coastline, and we do not see the dominance of stratocumulus clouds that we normally see further west.

•For the October 24-29 period, drizzle in closed cells covers more area for each reflectivity value and extends to higher values compared to open cells.

Acknowledgements

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