Radar Observations in Drizzle Cell Transitions from the VOCALS Field Campaign

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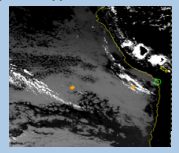
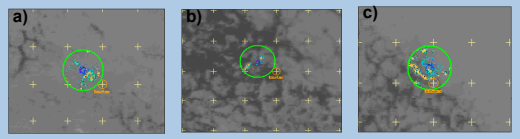
Introduction and Location

- Goal: examine changes in drizzle cell structures across transitions.
- Marine stratocumulus drizzle is poorly represented in global climate models.
- VOCALS (VAMOS Ocean Cloud Atmosphere Land Study) field campaign (October 21st to November 10th, 2008) used ship-based radar observations in order to study stratocumulus clouds and drizzle off the Chilean coast.
- Drizzle events were analyzed using blob detection by identifying contiguous regions above a threshold (Comstock et al. (2007)).

The VOCALS campaign took place off the coast of Chile in the Southeast Pacific region in South America.



Classification and Methods



Figures 1a-c show the differences in cloud structures based on infrared satellite imagery: figure 1a shows a closed-cellular structure within the radar region (depicted as the green circle) while (b) and (c) are open-cellular and transitional regions respectively.

- Closed-cellular clouds are clouds classified as unbroken, while open-cellular clouds are classified as broken.
- Transition periods occur when clouds evolve from closed to open or open to closed.
- Discrete drizzle cells were defined as contiguous areas larger than eight pixels with reflectivity greater than 5 dBZ.

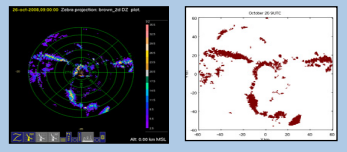
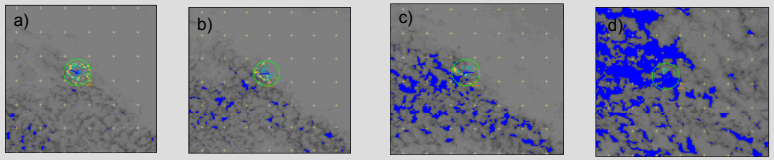


Figure 2a depicts the radar-observed reflectivity intensity. Figure 2b shows the same image using the drizzle cell criteria.

Data and Analysis

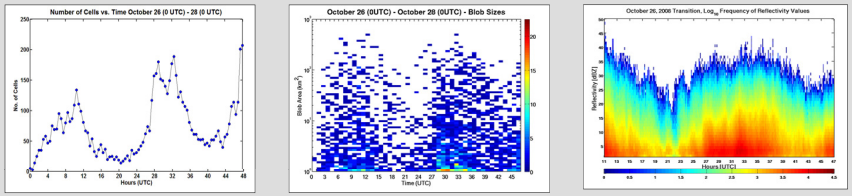


October 26: Image 3a shows a period shortly before the transition begins; this would be classified as closed-cellular. Images 3b – c show an evolution of the transition. At 3b, the clouds are breaking up and there is a clear line between broken and unbroken cloud structures. At 3c, the clouds continue to break up at the southwestern half of the domain. Figure 3d shows the primarily broken clouds.

Transition 1 October 26

Transition times: 11:15UTC – 18:30 UTC, 22:45 – 25 UTC, 31:15 – 35:45 UTC

Broken → unbroken → broken → unbroken → broken → unbroken

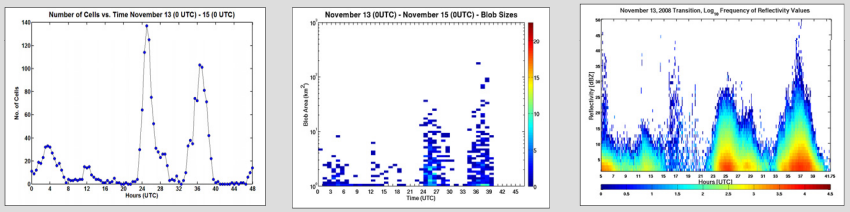


For October 26, there is a transitional period that begins near 11 UTC and another transition that begins on the 27th of October near 7 UTC (hour 31 on the graphs) which correspond to peaks in the plots.

Transition 2: November 13

Transition times: 16:45UTC – 20:30 UTC, 28:30 – 32:15 UTC

Unbroken → broken → clear

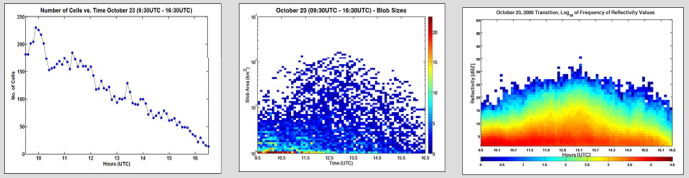


In the November case, the transitional periods show low values for the cell count and cell area, but have a tendency towards higher values of reflectivity. This is due to a few small cells of high reflectivity. The transition from 16:45 UTC to 20:30 UTC is a transition from unbroken to broken.

Transition 3: October 23

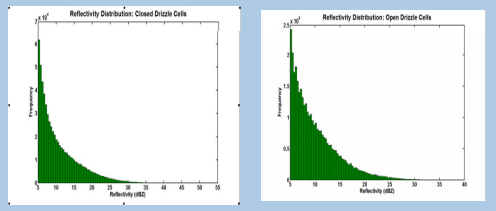
Transition time: 10UTC – 15:45 UTC

Unbroken → broken



The October 23 transition had the maximum number of cells at the beginning of the transition, while cell area and cell size reached a maximum at the middle of the transition.

Data and Analysis (continued)



- The distribution of reflectivity for open-cellular and closed-cellular shows that drizzle associated with closed-cellular cloud structures covers larger area for each reflectivity value and extends to higher reflectivity values compared to open-cellular clouds.

Conclusions

- The October 23 transition had more than 40 times more drizzle cells at the beginning of the transition than at the end.
- There is more and stronger drizzle in closed-cellular drizzle as compared to open-cellular periods.
- During the October 26-27 and November 13-14 transition periods cell area, cell count, and reflectivity were all positively correlated and reached their respective maxima at the same times.
- The transition on October 23 differed in that cell count peaked at the start of the transition and then declined. In contrast, the time series for cell area and reflectivity distribution were positively correlated and had maximum values near the middle of the transition period.

Acknowledgements

I would like to thank Matthew Miller and the Clouds and Precipitation Processes and Patterns Group