Role of drizzle and mesoscale organization in determining cloud characteristics

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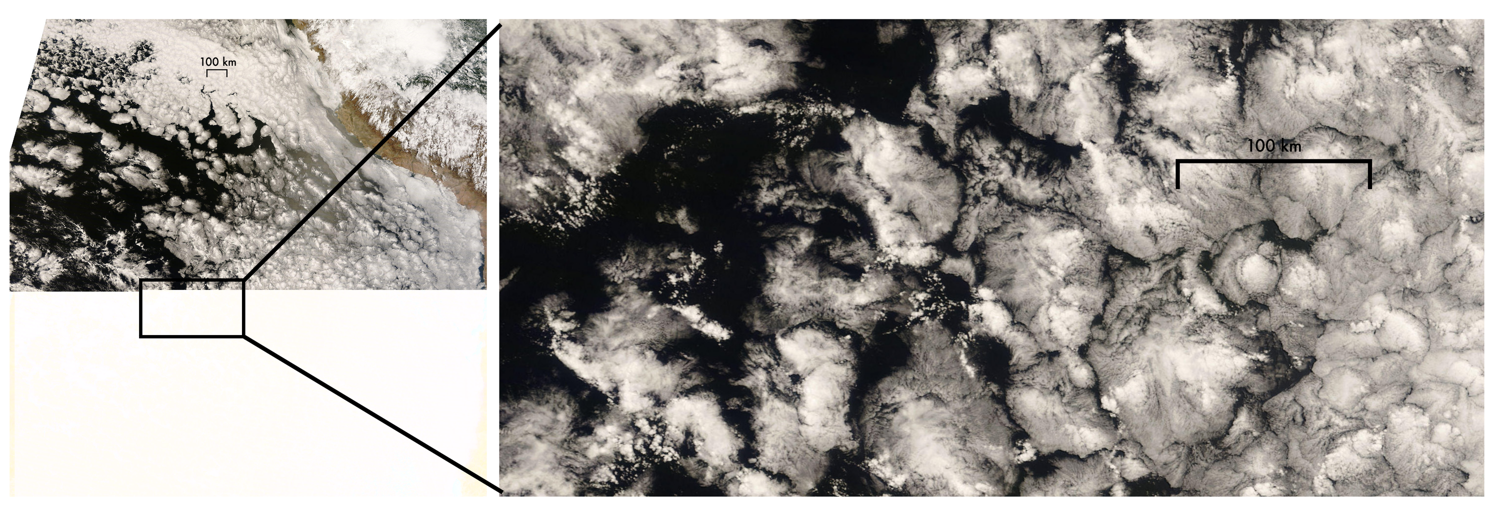
Background

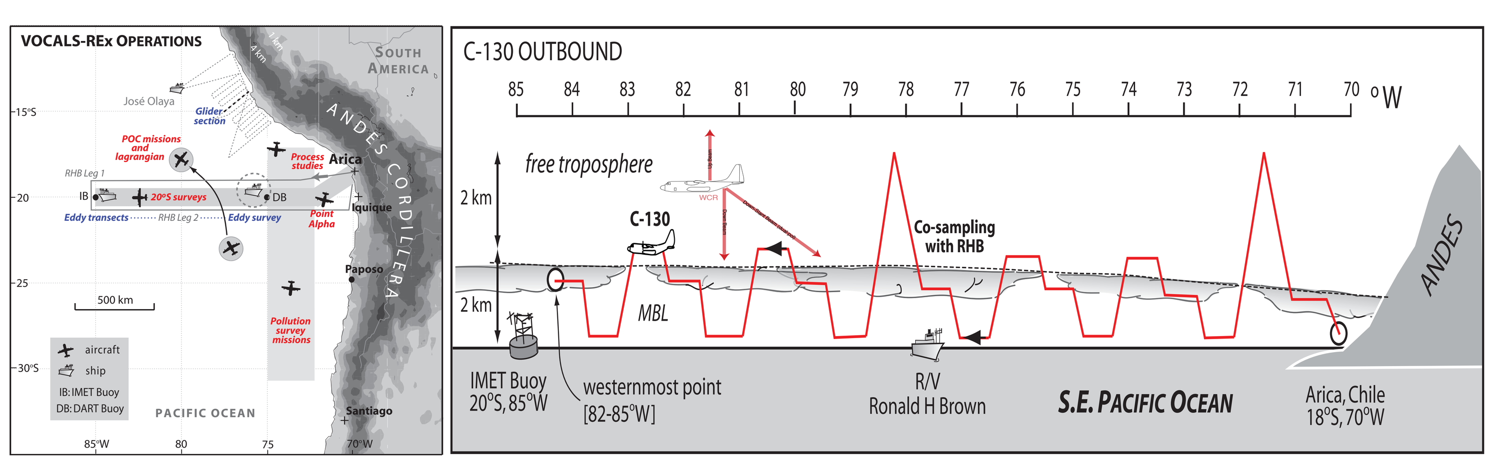
The VOCALS (VAMOS Ocean Cloud Atmosphere Land Study) Regional Experiment took place during October and November of 2008 in the South-Eastern Pacific (SEP) off the Chilean coast. The SEP region is home to a large, semi-permanent area of stratocumulus, within which there are clear signatures of embedded mesoscale organization and drizzle. These signatures become more pronounced in the deeper boundary layer further to the West.

Both observations and models indicate these mesoscale organizational features play an important role in stratocumulus cloud properties and the development of open cellular convection both in their contribution to cloud-radiation interactions and impact on precipitation rate and drizzle processes. As mesoscale organization and convection is the most common form of organization in the SEP region, understanding the modulation of cloud properties and structure in the stratocumulus deck by mesoscale organization is critical in understanding the large scale radiation and precipitation impacts.

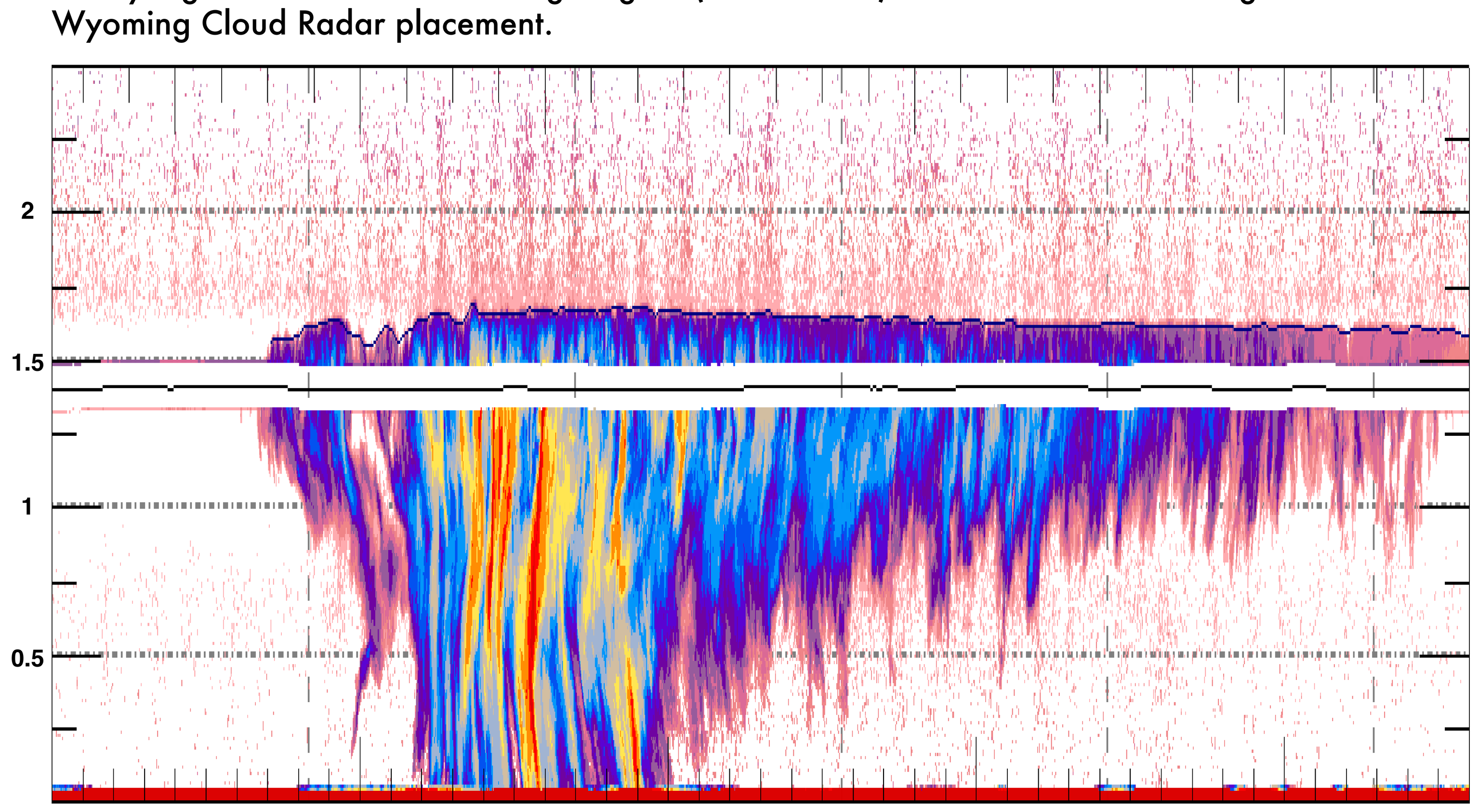
Here we examine individual mesoscale features (`drizzle-cells') to better understand their structure and behavior. Data was collected onboard the NSF/NCAR C130 aircraft. Flight legs were conducted above, in and below cloud. Data from the WCR/WCL Integrated Data Set, along with the C130 1Hz data files are used.



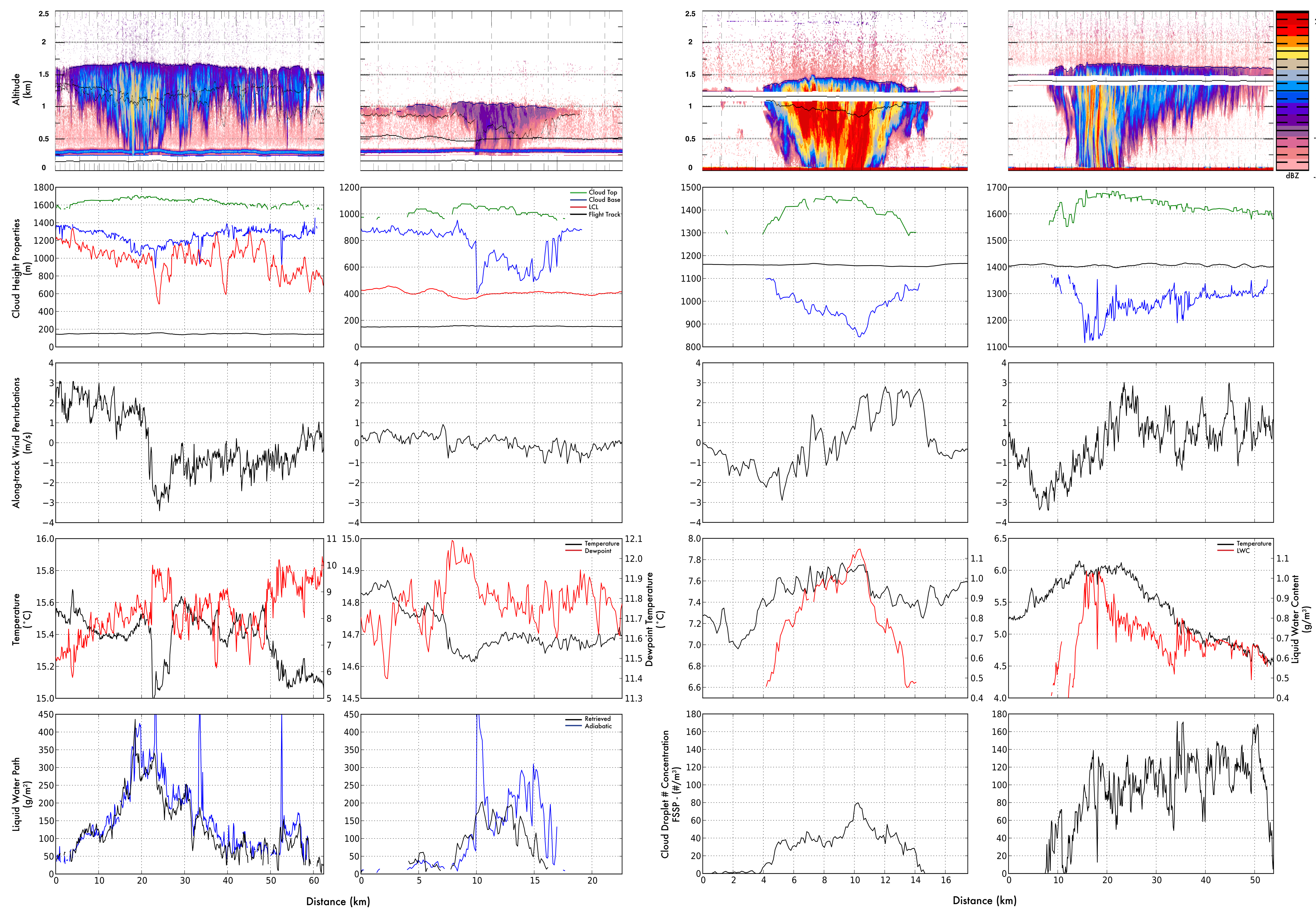
MODIS image showing the typical structure of the SEP stratocumulus deck. Spatial variability of mesoscale organization in this region varies from several kilometers to hundreds of kilometers.



Schematic of the VOCALS REx study region (top left) outlining the observational strategy. 20°S survey flights are detailed in the right figure (Wood 2011) with C-130 detailed diagram of the Wyoming Cloud Radar placement.



Sub-Cloud Legs / In-Cloud Legs



Cell selection from research flight 7. This cell was located at 23.34°S, 80.09°W and was sampled from a deep layer of stratocumulus clouds.

Cell selection from research flight 11. This cell was located at 29.79°S, 75.00°W. This cell was sampled closer to the coast than the left cell and was shallower and less active.

Cell selection from reasearch flight 6. This flight was a `POC' flight, which sampled pockets of open cellular convection. This cell was located at 18.14°S, 79.95°W.

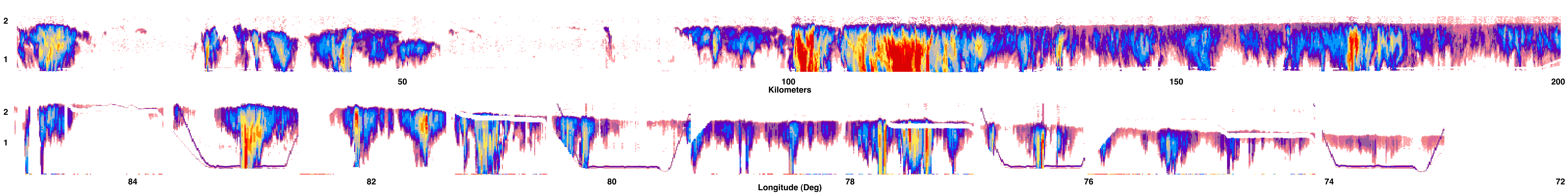
Cell selection from research flight 8. This cell was located at 22.33°S, 80.06°W. This cell is more stratiform than the POC cell.

Analysis and Discussion

In the multi panel plots above, several properties of well behaved drizzle cells are plotted for both in-cloud and sub-cloud legs. The sub-cloud legs show evidence of lower level convergence feeding into the cell, while the in-cloud legs show evidence of divergent flow along the flight track. Moistening of the sub-cloud layer is somewhat evident in the traces of temperature and dewpoint. In-cloud legs show liquid water content maxima in the center of the cell, tapering off towards the cell edges. This is also apparent in cloud droplet number concentration. Liquid water paths in the sub-cloud legs are consistent with liquid water paths from MODIS.

The long plots below demonstrate the variable and complex nature of the SEP region. Individual, isolated cells are present along with cells embedded in stratiform cloud formations. The top panel is a view of a single flight leg, while the bottom panel shows an entire 20°S flight. The panel on the left shows a blown up view of research flight 8 (top right, above). Color and height units are the same as above.

To better understand how these individual mesoscale features influence and modulate the SEP stratocumulus deck, future research will involve the compilation of many cells. Statistical methods will be used to investigate the variation of these cell properties both within and between individual cells. From this analysis, we hope to better understand the variability of stratocumulus cloud properties resulting from variability in embedded mesoscale features, and thus begin to understand how the SEP stratocumulus deck is modulated by mesoscale organization.



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