Analysis of synoptic conditions during VOCALS-REx

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GOES-10 VISIBLE IMAGE AND DETAIL

THE meteorology in the maritime area of the southeastern tropical Pacific (SEP) is governed by the subtropical high which represents the descending branch of the Hadley-Walker circulation of the south Pacific. As such, it interacts with the ENSO (Toniazzo 2009).

The area is characterised by extensive Sc cover, capped by a strong (~15-20 K) inversion separating the cool, moist PBL from the dry, super-adiabatic free troposphere (FT). The Sc reflect about 70% of solar radiation, giving a significant negative contribution to the global heat budget. Far from uniform, the Sc cover displays significant variability, both temporal and spatial. Drizzle and aerosol processes and μ -scale organisation are thought to be important, especially in connection with nearly-clear "pockets of open cells"



2. Overview of VOCALS-REx

An intensive observations campaign aimed at the study of the physical and dynamical proprties of the lower atmopshere and the upper ocean in the SEP, the cloud/aerosol physics of the Sc, and their relation with the circulation, was conducted in October and November 2008 by a consortium of US, Chilean, Peruvian, and UK research institutions. It was mainly based in the north-Chilean city of Arica (18S, 71W) and involved a total of 5 research aircraft and 2 research vessels. Measurements included radiosonde/dropsonde profiles, C- and W-band radar and lidar (up- and down-looking) reflectivities, extensive particle sampling for aerosol and cloud-droplet characterisation, ship CTDs, and floats. Particular focus was put on sampling the zonal strip along 20S, where multi-annual dataset are available from two instrumented buoys deployed at 75W and 85W.





3. The average circulation and forecast models

The mean flow is dominated by the zonal subtropical jet aloft, and radiatively induced mid-tropospheric subsidence that is accompanied by poleward flow aloft and equatorward flow in the PBL. The anticyclone is broadly confined to the PBL, below the inversion, while Sverdrup balance regulates the meridional flow in the FT.



Zonal transects

Near the orography, the diurnal land-sea and mountain breeze systems are associated with a mean convection cell which locally reverses the low-level zonal flow and with a southerly jet in the PBL near the coast.

Away from the coast, the circulation is we represented by the UK Met Office 40km g operational reanalysis and 24h forecasts, which we mainly based the current analys The model captures the synoptic variability and diurnal cycle in cloud cover away fro the coastal region as shown from satellite observations.

1. The Sc area of the SE tropical

Climatology and circulation of the **South-East Pacific** GOUTH AMER

In this paper, we document the synoptic meteorology observed in the SEP during the VOCALS-REx observations campaing, and we analyse the relationship between Sc cover and the circulation on the SEP on synoptic spatio-temporal scales.

VOCALS-REX October - November 2008



The NOAA research vessel servicing these buoys, the R.H.Brown, extended its annual cruise to allow the profiling of oceanic eddies, thought to crucially affect air-sea fluxes and oceanic advection, and the continuous radara/lidar sampling of the PBL and the cloud base. Also, 4 radiosonde balloons a day where deployed throughout the cruise.

73 5W-72 5W Oct-Nov 20

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80.5W-79.5W Oct-Nov 2008

Period 1	200HPg (PH: 15–31 0kt
Period 2	200HPo GPH; S-12 Nov
	200hPd GPH: 19-30 Nov

Period 3



Period 1



5. PBL-top characteristics, cloud cover and synoptic controls



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References

Toniazzo T., 2009, "Climate variability in the southeastern tropical Pacific and its relation with ENSO: a GCM study", Climate Dynamics, accepted

The EPIC 2001 Sc study, BAMS, Dec 2004

"Synoptic and large-scale conditions during **VOCALS-REx**", in preparation by the authors of this poster

The large-scale flow in the three periods

4. General large-scale conditions and observed regimes

Three different regimes during 15 Oct – 30 Nov:

- first half of October are similar
- 13-16 Nov
- component

Between these phases conditions are characterised by the evolution and dissipation of synoptically forced, coastal cut-off lows, peaking in 1 Nov and 15 Nov. Other occurrences of CLs are during 22-25 Oct and later during 30/11-2/12. The first is extremely strong, as shown later.

Strength of the anticyclone and SEP teleconnections

In October, the surface flow was exceptionally strong, with a deeper-than-normal anticyclone.

The anomaly was associated with a equivalent barotropic height anomaly, with a zonal-mean dipole signature across the subpolar jet stream. The anomalous meridional distribution of zonal-mean zonal momentum suggests role for eddy transport in setting up and maintaining these conditions.

Preceding that, the rotational

flow displayed a wave-like anomaly pattern with apparent origin in the West Pacific. Consistently, this was accompanied by convective activity (as indicated by low OLR) and strengthened divergent circulation.



← Both in the model and in the observations, over spatial scales \geq 1000 km and temporal scales of a few days, Sc cover is inversely correlated with the height of the inversion. In the spatial average, optically thicker cloud tends to be geometrically thinner; and a lower, stronger inversion is found in coincidence with warmer conditions in the FT. These relationship can be understood in terms of the basic dynamical constraints on the baroclinic circulation of the anticyclone, and the properties of the moist entrainment process at the cloud-top that mediates it (Toniazzo et al., 2009, in preparation).

The action of moist entrainment can be seen clearly in R.H.Brown's radiosonde ascents, which show a homogeneisation of wet-bulb potentital termperature leading to a higher, weaker inversion and reduces cloud. As a result, the inversion height and cloud cover inversely correlate with the local tropospheric geopotential height. The correlation pattern is strongly suggestive of extratropical anomalies, consistently with the day-to-day phenomenology observed in VOCALS-REx; and the latter appears to be related with wave-like perturbations excited from the tropical areas of deep convection, consistently with analysis of both observational products (see above) and of climate models (e.g. Toniazzo 2009).



Large, fast excursions in inversion height, prominent in Period I, correspond to dynamically forced (i.e. isoentropic) anomalies in midtropospheric subsidence.

1)15-31 Oct: strong surface anticyclone, unstable subtropical jet; conditions in the

2) 3-12 Nov: mid-tropospheric anticyclone, zonal steady jet; terminated by cut-off low

3) 17-30 Nov: weak surface anticyclone; steady, strong flow aloft with poleward



