1 Added sentence and paragraph at the end of "Introduction"

With the help of data from the UK Met Office operational forecasts of the relevant period (Abel et al. 2010), here we attempt to synthesise and complement this information and provide a tentative interpretation for the link between Sc cloud cover and the circulation in the SEP. To that aim, this paper is structured in several inter-dependent sections, in an order meant to provide a context for each part of the meteorological analysis we conducted. We summarise them here to provide a guide to the reader.

Section 2 describes the data used in the analysis. Section 3 provides a description of the mean circulation and the associated typical meteorological conditions for the area of of the subtropical anticyclone of the south-Pacific and the area of study. Section 4 focusses on the specific region and period that was sampled during VOCALS-REx, with specific attention to the cloud cover and to the circulation and tracer advection in the lower troposphere and the MBL. This is the part most closely relevant for VOCALS-REx operations and is descriptive in nature, with a nearly day-to-day assessment of the meteorology. Section 5 discusses results from our analysis regarding the relationships between synoptic and larger-scale conditions and the state of the MBL and of the cloud cover. It complements the similar discussion provided by Rahn and Garreaud (2010), which was based on a regional-model (WRF) integration forced with reanalysis at the boundaries. Our treatment differs in that it uses operational analysis/forecast data and attempts a connection with the large-scale circulation. Section 6 moves on to describe the large-scale circulation and its likely drivers for the relevant period of time. Section 7 puts that circulation in a climatological context, identifying features which could be regarded as anomalous in the year 2008 in comparison with average seasonal conditions in the last few decades, and therefore provide further guidance to identify the potential drivers for conditions in the SEP during VOCALS-REx. Section 8 briefly touches on the mean diurnal variations of the circulation in the SEP, highlighting the connection with regional features of the circulation off the coast of South America, in order to complement the findings of the previous sections with information relevant for the specific temporal sampling of VOCALS-REx missions, which by necessity include a sub-diurnal component, discussed in other work (Rahn and Garreaud 2010b, Zuidema et al. 2010), in an attempt, again, to offer a broad spatio-temporal view of that component. Finally, Section 9 briefly summarizes and draws conclusions.

2 Text in Section 5 for the discussion around Figure 14. This replaces the last paragraph in Section 5, starting with "In addition".

The response of the inversion height to synoptic forcing has a signature on the surface circulation. The evolution of meteorological parameters at the surface, within the region 90W-80W, 25S-15S, is shown in Figure 14. Panel (a) in the Figure shows the evolution of the pressure difference between the surface and the lower free-troposphere. This is seen to partly match (with a correlation coefficient of 0.66 for 61 points) the pressure variations that might be expected from changes in the inversion height alone (blue line), when e.g. a thickening of the MBL in response to free-tropospheric cooling results in the replacement of a layer of warm free-tropospheric air with cool MBL air. This contribution is important in October during phases of synoptically forced circulation anomalies. From the beginning of November onward, although the correlation with the MBL depth remains large, he contribution from free-tropospheric temperatures variations (green line) is dominant. The sum of these two contributions is shown in the red line, which still neglects variations in surface temperature. It may be seen that such approximation is acceptable until mid-November. A different estimator for the thermal wind maybe obtained directly from the variations in free-tropospheric wet-bulb potential temperature, which reflects both the temperatures changes in the lower free-troposphere, and the associated inversion-height anomalies. These give an approximate relationship between the anomalies that can be written as $p' \simeq -2\,(\theta_w'/\mathrm{K})$ hPa where the primes indicate departures from the time mean, and appropriate values, diagnosed from the operational analyses ($\Delta\theta$ =10 K; θ=300 K; $\partial_z\theta_w$=1.5$\cdot$10^{-3} K/m), are substituted for the time-mean quantities. This estimator is shown as the pink line in Figure 14(a). Although its correlation with the actual pressure anomalies is very high (c =-0.89 for 61 DOF), it may be noted that it does not perform well in the first part of October, when the adjustment of the inversion to a zero wet-bulb potential temperature jump is incomplete.

Increased surface pressure ($p' > 0$) tends to also correspond to larger surface pressure gradients and thus wind speed. This results in a good correlation of the surface wind speed with the (baroclinic) surface pressure departures from the mean (c =0.54 for 61 DOF) and a marginally significant one with the free-tropospheric wet-bulb potential temperature departures themselves (c =-0.34). Much of the changes in wind-speed are attributable to the meridional component (c =0.80), as can be seen in Figure 14(b). Presumably because of the addition association between meridional wind and the circulation anomalies highlighted in Figure 11 this wind component is well-correlated directly with the free-tropospheric potential temperature. Changes in surface-wind direction (green line in Figure 14(b)) seem erratic, but remain small, with departures generally less than 10^o from the mean of 143^o. The surface wind-speed directly affects air-sea fluxes, and the general weakening of the winds in the second half of November, visible in Figure 14(b), is accompanied by weaker sensible and latent surface heat fluxes. In this part of the period under study, the MBL is affected by a comparatively slow but significant warming of the SSTs.

The air surface temperature undergoes large oscillations in October, becomes fairly stationary between the end of October and the beginning of November, and rises markedly in the second half of November (panel (c)). The slow evolution largely tracks the SSTs, while the faster oscillations track the changes in atmospheric temperature advection (cyan line in panel (d)). In the last period, cold MBL advection is reduced, along with a reduction in the meridional wind (panel (b)) and the meridional SST gradient south of 25S (not shown). The temperature of the air raises to approach that of the underlying ocean, leading to a suppression in latent heat cooling (green line in panel (d)), which together with the increase in surface solar irradiation (orange line) contribute to the raise in local SSTs. Thus, in late November 2008, the large-scale forcing, with weaker surface wind and large-scale subsidence, combined with the response of regional surface meteorology, to lead a reduction of the stability of the MBL and favour conditions for day-time cloud break-up.

3 Added paragraph at end of “Conclusions”

Our treatment and discussion of the meteorology of VOCALS-REx neglects the mesoscale circulations and air-mass conditions that have been observed to affect the cloud-cover in the SEP. This limitation pertains, in particular, to conditions within a few hundreds of Km of the south-American coast, and to the observed occurrences of so-called “pockets of open cells” (POCs) where Sc cells develop into shallow-cumulus systems and cloud-cover is dramatically reduced. Such features are poorly represented, or entirely absent, in models of the global circulation, due to the complexity and small spatial scales of the terrain in one case, and to likely interactions between the mesoscale dynamics and cloud microphysical and precipitation processes in the other. Given that our discussion focusses on the specific conditions encountered during October-November 2008, a discussion of these features in a statistical sense would exceed to the scope of this work, and we feel it more appropriate to leave such discussion to papers that will include outcomes from research into the relevant meteorological processes which is currently underway. Even ignoring such important features, however, we have shown that on spatio-temporal scales of a few hundreds of Km and a few days, and bigger, many of the characteristics of the meteorology in the SEP are associated with synoptic and planetary-scale circulations that affect that area of the world.

4 Figure 14 and its caption (note that graphics is unchanged).

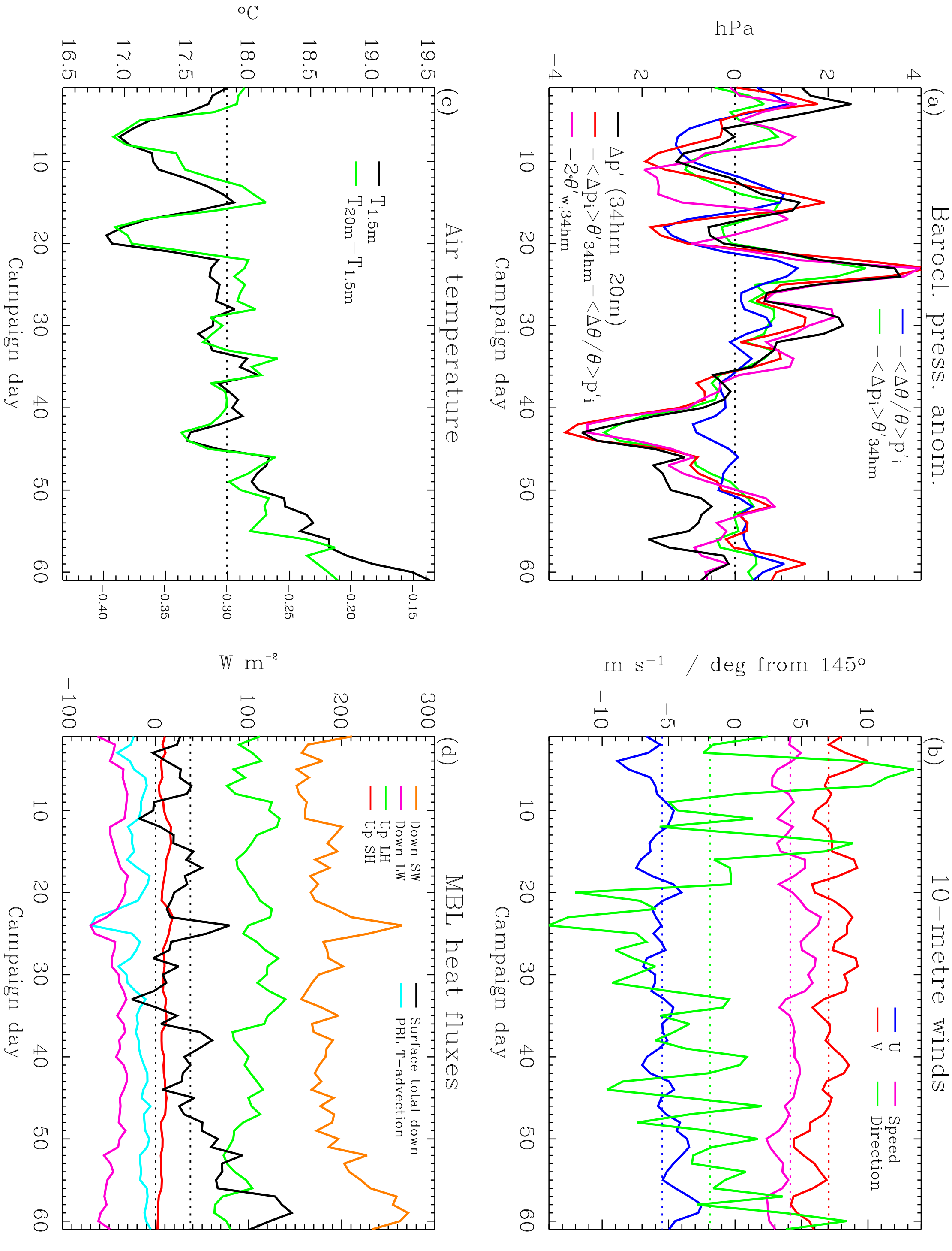

Figure 14: *(Previous page)* Daily average MBL quantities diagnosed from the UKMO global operational model for the area 90W-80W, 25S-15S in the period October-November 2008. Day 1 corresponds to 1 October. (a): Pressure difference between 20 metres and 3400 metres (black line) and estimators that neglect surface temperature variations. The blue and the green lines represent contributions from the changes in inversion height and from free-tropospheric temperature changes, respectively. Primes indicate that the time-averages over the period of interest have been subtracted from the relevant quantity. (b): 10-metre wind components, wind-speed and wind direction. (c): 1.5-metre air temperature (black line, scale on the left-hand side of the panel) and difference between 20-metre and 1.5-metre air temperatures (green line, scale on the right-hand side of the panel), surface air temperature depression and (d): heat fluxes at the surface, split into radiative and material components, as indicated in the panel. The total downward heat flux is shows in the black solid line. Also shown is the horizontal atmospheric temperature advection, integrated over the depth of the MBL and expressed in $\mathrm{W/m^2}$, in the cyan or light-blue line.