Meteorological conditions in the south-east Pacific area and large-scale and synoptic forcing during leg 2 of the VOCALS 2008 cruise on the NOAA research vessel R.H.Brown

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During leg 2 of the VOCALS cruise with the NOAA research vessel R.H.Brown between 9 November and 2 December, observations were carried out on the relationship between the local conditions and the synoptic-scale meteorology. For the latter, we made use of data from the VOCALS field catalogue (http://catalog.eol.ucar.edu/vocals/index.ht

It was noted that the general conditions of the Sc cloud field are to some extent predictable on the basis of the synoptic scale flow alone. Some operational models, such as the UK Met Office Unified Model, show some skill in their forecasts of the cloud cover and of the cloud liquid water if considering changes in their general pattern. However, allowances need to be made for model biases. For example, the UKMO Unified Model tends to overproduce cloud, especially within a few hunderd of km from the coast, where it also fails to generate the diurnal clearing.

It has however turned out to be useful to compare the synoptic-scale flow above the cloud top inversion (generally between 850 and 800 hPa), for which reanalysis and forecasts are reliable and consistent between different forecast times and between different models, with the satellite images in the visible band, and reason on the tendencies for the next day. In general terms, there appears to be a significant relationship between lofting implied by the quasi-geostrophic flow in the free troposphere (for example from PV conservation and vorticity advection) and cloud cover, in the sense of decreasing cloud cover with increased lofting. The resulting cloud field

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Figure 1: Photograph taken in the morning of 15 November (near 11UTC) looking north-east from the deck of the R.H.Brown.

appears affected by the combination from such tendencies and the advection with the mean south-south-easterly PBL winds.

In the Figure we show an example of such relationship between synoptic-scale flow and cloud field. It refers to the evolution over a day between November 14 and 15, when a coastally-trapped sub-synoptic low formed in the vicinity of the ship (which was downstream of the low, near 19.5S, 76W). The cloud field on 15 November appeared both thin, non-drizzling, and characterised by regular features extending over tens of km. Figure 2 shows a comparison between the Sc cloud cover and the synoptic flow at 500 hPa. On the 14th, cloud-free areas appear in the south-east of the satellite image which correspond with the north-east side of the 500hPa cyclone where quasi-geotrophic lofting can be expected. In the area of quasi-geostrophic subsidence to the north-west the cloud cover persists. Further to the north, the liquid water part (not shown) was high and an region of "open cells" appears north of 20S. The evolution of this cloud field into the following day is broadly consistent with mean PBL-wind advection to the north-west, but the area of clearing moves eastward together with the cyclone aloft, and it intensifies near the coast.

Although the details of the cloud field depend on the microphysics and on the history of the air-mass, and cannot be understood from synoptic conditions, the relatively good match between the pressure velocity in the

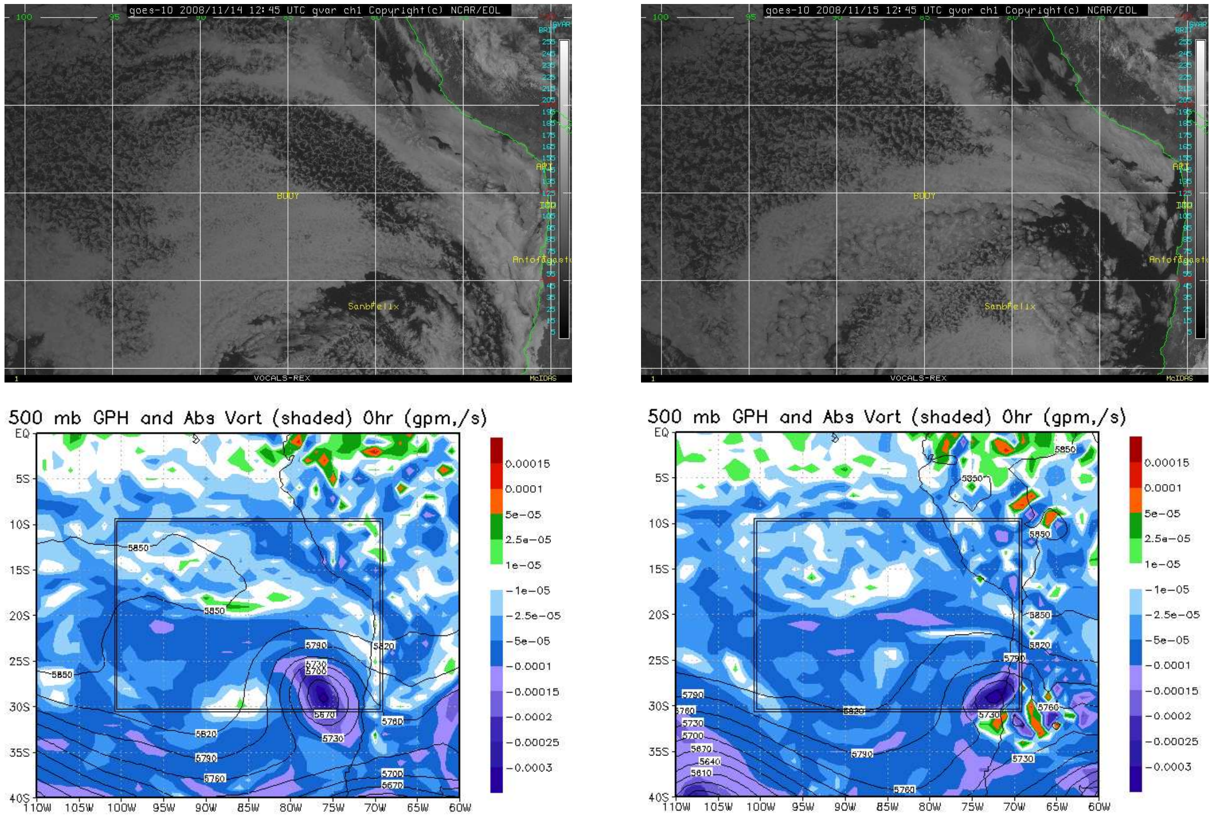

Figure 2: Visible (channel 1) images of the GOES satellite over the VOCALS region (panel at the top) and model reanalysis fields of 500hPa geopotential height (lower panels, contour lines) and absolute vorticity (lower panels, colour coding) for the days of 14 November and 15 November 2008. The validity time of the satellite images is 12.45 UTC, those of the model fields is 12.00 UTC. The rectangles in the model fields show the field-of-view of the satellite images. The reanalysis fields are from the NCEP GFS 40km model. Images from the VOCALS field catalogue.

reanalysis fields and the features visible in the satellite and in-situ observations of cloud cover noted above are remarkable in that the GFS model produces nearly no cloud whatsoever. This implies not only that cloud respond to synoptic forcing at leading order, but also that, over short time leads, the synoptic-scale flow is not significantly altered by the presence of cloud. This might help explaining why some forecast models, such as the UKMO Unified Model and the ECMWF model, can produce realistic-looking cloud fields and relatively accurate forecasts even with their simple representation of cloud microphysical processes.