Summary of the paper

This paper explores profiling Doppler lidar data of a Sc-capped boundary layer over two days at a coastal site in western Ireland. It also uses reflectivity data from a 35 GHz cloud radar. It does not use surface nor radiosonde data. The period of interest is synoptically quiescent, following the passage of a cold front. This study emphases profiles of vertical velocity moments (the mean, the variance, the skewness). Also computed are the rate of TKE dissipation and cut-off wavelength of the inertial subrange. The main conclusion is that the cloud layer generally is decoupled from the surface, except when negative buoyancy due to cloud-top radiative cooling is strong enough for parcels to mix down to the surface. This conclusion is based solely on the change in w skewness: w skewness tends to be negative in a mixed layer driven by negative buoyancy, and positive when positively convective (superadiabatic).

Summary of the evaluation

The paper's background is succinct and straightforward, the methodology is sound, and the synoptics of the intensive observation period is adequately described. I question the validity of the interpretation of BL vertical structure based on turbulence-scale Doppler lidar kinematic data, especially given the lack of thermodynamic data. Below, I make some suggestions that may corroborate or contradict this interpretation. This probably requires more than a major revision, and certainly would fundamentally alter the paper.

Major comments

While the basis for this conclusion is correct, the paper does not exclude other factors that may explain the change in w skewness. I see this as the main weakness in this paper. I am especially skeptical because the Doppler lidar wind speed profiles (Fig. 4) do not show any shear layer corresponding with the "decoupling height" (the height of the interface between surface-based and cloud-driven mixing), and because the lidar backscatter power (Fig. 5a) does not show an aerosol layer corresponding with the same stable layer.

The main remedy I suggest is to use proximity temperature and humidity profiles (e.g., from radiosondes) to show the decoupling, and the evolution of the decoupling height. It would be very nice to quantify decoupling strength at the interface. This would be the nail that seals the case, but presumably, such data are not available. In that case the paper will be much weaker, but some venues can be explored to seek further evidence. Six possible venues are listed below.

1. Explore the flow field relative to the terrain near Mace Head, which appears to be close to a cliff overlooking the ocean. As the wind speed decreases around t=18 hrs in Fig. 4, there may be a shallow layer of offshore or drainage flow. Fig. 4 could be reproduced for wind direction. Changes in wind direction can produce changes flow relative to the terrain and changes in stability, and thus in vertical velocity moments.
2. It is not clear how the decoupling height diagnosed from the profiles of w skewness. The w skewness field based on 30 min intervals is quite noisy (Fig. 5d). It often changes sign over the full depth of the BL from one instance to the next. The velocity uncertainty increases with decreasing SNR or power, which is quite obvious from a comparison between Fig. 5a and d. It would be good to see whether the pattern becomes more crisp (or vanishes) under different velocity QC, processing, and averaging periods.

3. Repeatability is always useful. This is a case study of a 24-36 hr period. Do the same relations apply in other fair-weather Sc-topped BL conditions?
4. Much can be learned from the variation of w power spectral density with height across the interface. If the paper's main conclusion is correct, then one can expect a minimum in TKE near the decoupling height, simply because of distance from the TKE generation regions, i.e. the cloud top layer and the surface. This is unlikely to be the case, because TKE and turbulence dissipation rate tend to strongly correlate, and the computed turbulence dissipation rate (Fig. 5e) does not appear to have a minimum near the decoupling height (Fig. 6), although the time axes do not match so it is difficult to compare the two Figs.
5. Cloud-top driven mixing (or cloud top entrainment instability) has been shown to be active in various Sc environments (see review by Woods 2012). It is only hypothesized to be active in this case. Profiling Doppler radar data within the drizzle layer should reveal the presence of vertical velocity turbulence. I believe these data are available.
6. Decoupling strength can be estimated from the difference in potential temperature at the surface and that at cloud base. The latter may be available from a zenith infrared thermometer. If not, then the difference between the lidar-determined cloud base height and surface-based LCL is a good measure of decoupling strength, although it will not give the decoupling height.

Minor comments

- The theory in Eqns 1-6 is sound but the text does not specify the value chosen for the variable mu.
- Table 1: add units to range resolution (m)
- Fig. 1: please use real data to make the point. The power spectral density curve shown is physically impossible.
- It is not quite correct to use "time (hours UTC)" in the abscissa title of most figures. One option is to use "time since 00 UTC on 24 Feb 2012 (hours)"
- Fig. 6: The black region is NOT the cloud layer. Rather, it is the drizzle layer, which often extends below cloud base. A Ka-band radar can only detect drizzle-size drops (e.g., Fox and Illingworth 1997).
- The evaluation of upper wavelength of the inertial subrange (lamda_o) in Figs. 6 and 7 is done at three heights within the BL, whose depth is based on the radar profiles (cloud echo top). These heights cut across the decoupling height. If indeed the surface-driven layer clearly is decoupled from the cloud-driven above, it would be more interesting to characterize lamda_o in this two respective layers.

References

Fox, N. I., and A. J. Illingworth, 1997: The retrieval of stratocumulus cloud properties by ground-based cloud radar, *J. Appl. Meteor.*, **36**, 485-492.
Wood, R., 2012: Stratocumulus Clouds. *Mon. Wea. Rev.*, **140**, 2373–2423.