Atmos. Chem. Phys. Discuss., 9, C2079–C2082, 2009
www.atmos-chem-phys-discuss.net/9/C2079/2009/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Generation of free convection due to changes of the local circulation system" *by* R. Eigenmann et al.

Anonymous Referee #1

Received and published: 22 June 2009

This work uses results of an observational campaign to make meteorological measurements in Alpine terrain. The diurnal variation of mean and turbulent quantities in valley flows are described with particular emphasis placed on the variation in turbulence regimes during the morning and evening reversals in valley wind directions.

The paper is an addition to the body of turbulence measurements in mountainous terrain and merits publication provided significant changes are made to meet the comments detailed below.

There are two general criticisms which should be attended to. The first is that there appears to be some misconception regarding the free convection regime in the boundary layer. The impression throughout is given that free convection is a regime that *only* appears in the boundary layer when the surface wind speed drops to near zero and

that suddenly large convective elements develop with a potential to generate cumulonimbus etc when this point is reached. In fact, on flat terrain, at all moderate wind speeds, provided there is a positive heat flux, there is always free convection going on somewhere in the boundary layer. The point about zero wind speed is that only then does the free convection regime reach down to the surface. In this case, individual convective circulations may be more closely related to individual ground sources. In surface layer theory for flat terrain, free convection occurs for any wind speed at all heights above the Monin –Obukhov level L. The criterion used for free convection, i.e. that z/L exceeds unity simply means that the sonic (at height z) is positioned above the level L and so is within the free convection layer which, however, will rise above the sonic at higher wind speeds (or lower heat fluxes). The fact that free convection and coherent convection elements are ubiquitous in the boundary layer is shown by its use for soaring flight. Glider pilots use coherent convective elements (thermals) in the boundary layer for long soaring flights in wind speeds greater than those measured here. The main point is that as the wind speed increases, the thermals become 'broken up' at lower levels (i.e. the free convection level rises) and the pilot has to be launched to (and maintain) a height greater than this free convection level to enable a soaring flight to be made. Even if the wind speed is so great (or the heat flux so small) that convection is mechanically driven throughout most of the boundary layer, clouds will still develop at the top of the layer with their own coherent circulations. Now, circumstances may be very different over complex terrain (in which case concepts like u*, L etc might be irrelevant) but if this is so, the case needs to be argued.

The second criticism of the paper as it stands is that it is not concisely written – there is a large amount of material that is not very relevant to the main study, particularly in the initial sections and this becomes tedious to the reader, detracting from an appreciation of the results.

Comments on the individual sections are as follows:

The abstract almost gives the impression that the point of the paper is to show that free convection occurs in zero wind speeds – it should be made clearer that the point is to measure the variation in turbulence quantities during the transition as the free convection level drops below that of the anemometer – and also to give empirical data relating to the valley wind reversals. The term 'wind speed collapse' rather over-dramatises the fact that the wind speed drops to zero.

Section 1 The introduction is excessively long – it should be reduced to a very few relevant sentences.

Section 2.1 A brief mention of the COPS campaign is all that is necessary.

Section 2.2 Again there is too much detail of the site set-up. Only the sonic anemometer description is really necessary. Is figure 1 really necessary?

Section 2.3 It is good to know that a serious effort was put into quality control but again this section is far too detailed and long. Is Figure 2 really necessary?

Section 2.4 As above. However Figure 3 actually shows some results

Section 3.1 Again, is so much detail really necessary to understanding the results? Is Figure 4 really necessary? It is good to know that you have checked the energy balance, but I would have thought a simple sentence saying this would suffice – Figure 5 is not really necessary.

Section 3.2 This is the first really relevant section. My general comment at the start applies here – it may well be that the thermally driven valley wind circulations produce a burst of cloud when they initiate, but is this somehow related to the level terrain concept of free convection reaching down to the surface? Might it perhaps rather be the result of excess moisture trapped in the stable valley air overnight being released?

Some of the main results are in Figure 7, but the plots are far too small for study – if the unnecessary Figures 1, 2, 4 and 5 are removed, there will be more room to expand the plots of Figure 7 (and Figure 12 – see below) Figure 8 is relevant but shows that there are large scale circulations throughout the period – they are not particularly limited to

the period when the wind speed changes. Figure 9 is also relevant.

My general remarks at the start apply with regard to the lack of any evidence from satellite photography that there was any cloud formation observed at the time of valley wind direction reversal. The radar evidence shown in figure 10 is far from convincing.

Section 3.3 Another important section. In fact Figure 11 is one of the really significant results of the experiment. It shows not only the frequency of valley wind thermal circulations throughout the observing period (results over several years would be very valuable) but also the periods of light winds during reversal and the times relative to sunrise and sunset. It is striking that the reversals occur at around the times that morning and evening transition occur over flat terrain (i.e. around two hours after sunrise for morning transition and two hours before sunset for evening transition). Perhaps the authors would like to discuss this coincidence – or even relate it to numerical modelling studies.

Figure 12 is also a very relevant result and it would be worth enlarging the individual plots as with Figure 7.

Section 4 The conclusions. These are very relevant but my general comments at the start regarding free convection apply here. You really must explain why you think there is something special about the free convection regime momentarily reaching down to the level of your sonic and why you do not expect large convection elements possibly with related clouds at other times (and which are clearly visible in figure 8 at other times)

As mentioned above, there may be other possible reasons related to trapped humidity for clouds to form at the time of morning valley wind reversal.

You should also explain why the satellite photography (mentioned in section 3.3) does not show any strong cloud formation at the time of valley wind reversal.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 11367, 2009.