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Atmospheric Measurement Techniques Discussions

Interactive comment on "Cirrus crystal fall velocity estimates using the Match method with ground-based lidars: a first case study" *by* D. Dionisi et al.

Anonymous Referee #1

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This paper describes lidar measurements of a cirrus cloud made at two observatories one in France, the other in Italy. By carefully selecting a case where the streamlines in the upper troposphere connect the two sites, they look at the difference in the cloud profile, and from this estimate the sedimentation rate of the crystals.

This paper is well written, and what they have done is clearly explained. As far as I'm aware this approach has not been tried before, and is therefore of interest. However, after reading the paper I wasn't at all convinced that the technique actually works. Nor was it entirely clear to me why this method is necessary, in an era of Doppler radars

and lidars. So that's why I recommend major revisions for the manuscript - I feel both of these issues need to be addressed in the paper.

Main comments:

1. Section 4.3:

From looking at the backscatter profiles you determine that the "BSR mass centre" has shifted down by 200 metres. From this shift, the time taken for a parcel of air to advect from one lidar site to the other, and the model isentropic shift (100m upwards) you infer the ice particles have fallen for effectively 300 metres relative to the air mass in which they are embedded, and hence their terminal velocity in still air would be approximately 1.5 cm/s.

The error due to the range resolution of the lidars is useful - however I think this error actually applies *twice* - once at each lidar site, so potentially the height error is 150m which is three-quarters of the observed change in height, and an error of 50% in the derived fall speed.

The other source of error, which is not considered in the paper at present, is any uncertainty in the model-derived vertical air motion. Can you put a figure on this? This could be a significant source of error - if the model is out by 1cm/s then the derived fall speeds would be essentially meaningless. So this really needs to be addressed in the paper.

2. Section 1

The other question that was in my mind as I was reading this paper was "why use this approach?". Doppler radars and lidars do exist, and can measure the vertical velocity of ice particles in clouds. So what advantage (or potential advantage) does this match technique have? This should be spelled out at the start if possible.

3. Backscatter plots. The time-height cross sections don't look particularly similar, and clearly have quite a bit of variability in their structure. You do mention this, and

speculate sedimentation has led to an evolution of the cloud microphysical profile. The other option I suppose is mesoscale fluctuations in the dynamics - some people think gravity waves are very important for these kinds of clouds. Either way, this variability and/or microphysical evolution is going to affect your sedimentation rate estimates which assume the cloud structure is frozen for 6 hours. Can you quantify or in any way try and estimate what effect this is going to have? What happens if you perform the match technique over slightly different sections of the time series - do you get the same results?

Other comments:

Abstract line 1 - notation seems inconsistent here, using v_r rather than v_s line 14 - "the analysis through lidar primarily parameters" - can you rephrase this?

Section 1, page 5789, line 26 - say satellite instruments are "nearly blind" for a "large part" of cirrus cloud population. Can you be more specific here.

Section 1, page 5791, line 9 - say range of cirrus crystal velocities is 0.1-10cm/s. Can you provide a reference for this? I think it rather depends on what you define as "cirrus". Note this range is also inconsistent hereas in the first paragraph of section 1 you mention Jakob who uses a range of 10-200cm/s.

Section 4, page 5797, lines 15-18 - maybe delete this paragraph, repetitive of previous material

page 5799, line 8 - I wasn't clear here if top height was determined from lidar or sonde?

section 4.3 paragraph 1 - I think it would be useful here to clearly note in the text that the points of interest are the parts marked at the very right hand side of the graph - this will help the reader get their bearings (otherwise it seems like there are much more dramatic changes in the back history than are actually relevant to the match analysis)

page 5804, line 3 "(radius < 5 microns)" - but you estimated radius of $\sim$ 10 microns (stated in previous paragraph)?

Other questions:

Are there any geostationary images which might be used to show the Ci layer propagating between the sites.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 5787, 2012.