Atmos. Chem. Phys. Discuss., 6, S3987–S3991, 2006
www.atmos-chem-phys-discuss.net/6/S3987/2006/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Defintion of "banner clouds" based on time lapse movies" *by* J. H. Schween et al.

Anonymous Referee #2

Received and published: 23 October 2006

Definition of "banner clouds" based on time lapse movies by J. H. Schween et al.

General comments:

Banner clouds are a rare and scientifically less documented atmospheric phenomenon. Therefore, the authors try to develop a scientifically sound definition of banner clouds. A short review of the existing theories leading to banner cloud formation is presented. One major outcome of the paper is that the banner cloud phenomenon seems not to be restricted to peaked mountains as initially postulated but can also be observed at sharp mountain ridges. Five criteria are found to be essential for the classification of banner clouds. The authors show sequences of time-lapse movies to test their definition of banner clouds and to distinguish banner clouds from similar phenomenons such as

cap clouds and blowing snow. The weakness of the paper is that the authors fail to extend the reader's knowledge in any significant and scientific way except that, as already mentioned, banner cloud formation may not be restricted to the leeward side of peaked mountains. Some of the arguments which are brought up are of speculative nature and do not provide the reader with more scientific insight. Thus, the paper would benefit a lot if the authors would provide additional observational data such as wind measurements or vertical soundings to get an idea what the ambient synoptic-scale atmospheric state is and to increase the reader's confidence on the necessary ingredients for banner cloud formation.

Specific comments:

Introduction:

Although only a limited number of publications are dealing with banner clouds the book of R. A. Houze (1993) could be cited as a further reference. Houze (1993) gives a very brief overview of the flow dynamics associated with the leeward circulation which is thought to be necessary for banner cloud formation.

Existing theories:

1.Since the formation of banner clouds is associated with the flow over and around a mountain range some of the fundamental conceptual studies dealing with that could be discussed here. E.g. the paper of R. B. Smith (1989) and especially the studies of Smolarkiewicz and Rotunno (1989) and Olaffson and Bougeault (1996) which address the issue of low Froude number flow and the formation of lee vortices. 2.The possibility of banner clouds forming similar to a mixing fog is ruled out as being not very plausible. However, it may still be a valid argument if one considers that the snow cover and partly glaciated areas on Mount Zugspitze may cool and moisten the airstream coming from the Zugspitzplatt through latent heat fluxes between the ice surface and the ambient air. The mountain range serves as a barrier and separates the "coldpool" on Zugspitzplatt from the air in the north. When the air flows over the mountain crest

ACPD
6, S3987–S3991, 2006

EGU

into the coldpool a banner cloud may form similar to a mixing fog. 3.Considering the three arguments which are brought up for explaining the upwelling on the leeward side of the mountain a further aspect (which could be questioned here) may be the role of local valley circulations which could contribute to the leeward convergence and the upwelling in a similar way. So far, it has not been shown that local valley winds do not contribute to banner cloud formation.

Orography at Mount Zugspitze:

In order to get a more detailed 3D picture of the banner clouds a further interesting point would be to see the banner clouds also from below and to get an idea what the vertical extent is. Does the leeward circulation extend completely down to the valley or is it rather confined to the area directly beneath the mountain crest? This could give additional information about the underlying mechanisms. A camera mounted on the valley bottom could have provided this information.

Definition of “banner clouds”:

1.A slight change in the formulation of I. could reduce the definition to only three points. Thus, I would suggest to replace statement I with: “A banner cloud is an isolated cloud which occurs exclusively on the leeward side of the mountain...”.

2.Definition IV involves a theoretical concept which, so far, has not been proven to be neither necessary nor sufficient and, hence, should not be part of the definition.

Examples:

5.1 A typical banner cloud:

line 13 (... turnover time...): Could you clarify the argument concerning the lee vortex a bit more. Which lee vortex do you mean and how did you determine the turnover time?

line 16 (...updraft...): Based on the movie we could belief that the winds are strong enough to cause an updraft on the leeward side. However, wind measurements would

ACPD
6, S3987–S3991, 2006

EGU

give us confidence. What is the role of wind shear in this case?

5.3 Transition from a banner cloud to a convective cumulus cloud:

line 10 (Towards the end...): The 11 UTC radiosonde from Munich shows a very strong inversion between 700 hPa and 600 hPa for this specific day which does not favor convection too much. I would suspect that either local upslope winds or Kelvin-Helmholtz instabilities are perturbing the banner cloud. From this point of view I would still admit this sequence as a banner cloud although perturbations occur.

5.5 Not a banner cloud:

Although the leeward banner cloud and the windward clouds are temporarily connected one may argue that the formation mechanism of the different cloud types is physically different and that the perturbations are solely due to advection. Hence, my argumentation would focus rather on the advection of clouds into the field of the banner cloud than to disapprove the occurrence of the banner cloud itself.

5.6 Transition from a convective cumulus cloud to a banner cloud:

I suggest to split up this subsection into two parts one dealing with the “convective cumulus cloud” and the second dealing with blowing snow. The 11 UTC radiosonde from Munich suggests winds up to 60km/h between the levels 850hPa and 700hPa and even higher wind speeds are evident from the 23 UTC radiosonde. So, this would probably support the blowing snow argument but, again, local measurements would be more convincing. However, this example is from January 7th 16.00 CET which basically means that the elevation of the sun is very low in this case. This fact could explain the high illumination of the cloud and the fact that there is a considerable amount of forward scattering as could be expected from Mie-theory which does not rule out the possibility of small cloud droplets or ice crystals. The fact that the “cloud” is very transparent, just tells us that the total water content is low similar to what we know from fractus-type clouds.

ACPD

6, S3987–S3991, 2006

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 9995, 2006.

ACPD

6, S3987–S3991, 2006

Interactive Comment

EGU