

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-966

Volkmar Wirth (Referee)

Referee comment on "The formation and composition of the Mount Everest plume in winter" by Edward E. Hindman and Scott Lindstrom, Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-966-RC1>, 2022

The current paper investigates the occurrence and origin of plumes in the lee of major mountain peaks in the Himalayas. The authors combine satellite imagery from a few episodes with temperature and humidity data at a station close to Mt Everest. They conclude that most of the observed plumes are, indeed, cases of so-called banner clouds, meaning they have been generated by condensation of water vapor in an ascending air stream in the lee of the mountain (rather than just snow being blown off the summit).

The method to analyze the meteorological situation is straightforward: the authors compute the lifting condensation level (LCL) from temperature and moisture data at the observational site, and then check whether the LCL is below or above the summit of the respective mountain. If the LCL is below the summit, they hypothesize that one should expect a banner cloud to occur. Comparing this "expectation" with observations from satellite images indicates good agreement. This then allows the authors to conclude that the plumes observed on the satellite images are, indeed, real banner clouds.

This is the first study of its kind that I am aware of, and I think it is worth a publication in a science journal. My only criticism is that the spatial resolution of the satellite imagery is marginally low for the intended purpose: for me as a reader it required occasionally quite a bit of imagination to see what the authors see. Yet, the movies improve upon this issue, as the non-stationarity of (even a poorly resolved) feature in these movies allows one to more or less clearly identify the presence of a plume.

Below I have two major issues as well as a number of minor issues. My remarks are meant to help to produce a revised version.

Volkmar Wirth

Major issues:

I think it would be best to be explicit and honest about the low resolution of the satellite imagery. I.e, you best are honest and admit that the resolution is marginal, but (in particular in combination with the animations) just about sufficient to draw the conclusions that you want to draw. In your introduction you state that your results are "conclusive" (as opposed to earlier results); in my view this is somewhat overstated. To be sure, you add some circumstantial evidence, but this is not extremely convincing to me owing to the low resolution of the satellite imagery.

Also, I suggest that you systematically distinguish between the concept of a plume and the concept of a banner cloud. For me, a plume is anything that you see in the lee of a steep and high mountain (including snow blown off the mountain top). By contrast, a banner cloud is a plume that has been generated through condensation of moisture in an upwelling airstream in the immediate lee of the mountain.

Minor issues:

The movies: It would be good if you could provide movie-captions for all the movies.

Movie 1: it would be good to know how local time evolves as the movie passes by; is it possible to include a little clock running with the movie accordingly? Or to give at least the time span (beginning and end time) covered by the movie.

The satellite movies are very coarse resolution. Is there a possibility to post-process them in order to more clearly focus on what you want to show? (Maybe not, indeed, because nothing beats the pattern recognition skills of the human brain.)

Table 1: I think it would be better to provide wind speed in m/s rather than knots.

Line 48: Sentence unclear to me.

Line 62: See our paper Prestel and Wirth (2016) where we elucidate the conditions under which one would expect a banner cloud to occur (steep mountain, weak stratification).

Line 68: what resolution are these satellite images? Is it good enough to well resolve the cloud?

Line 79: which model? More details!

Line 82: "Hence....": do you want to imply that banner clouds occur only on pyramid-shaped mountains?

Line 96: What do you mean by "initial composition" here? (It becomes clear somewhat later....). Can you exclude the possibility that these clouds are mixed-phase clouds?

Fig. 4: Make the Tephigrams larger, they are important!

Fig. 6: There seems to be a problem/mismatch between the yellow caption inside the image and the added caption below the image in the bottom row left and middle column.

Line 146 ff: I found it hard to verify the description/interpretation that you provide in the text when viewing the images.

Line 164: 4C? Do you mean 4 degrees Celsius?

Line 181/182: Haven't you said something very similar a few lines earlier?

Line 204: What do you mean if you mention a "Jet stream.... embedded in a trough...."?

Figure 7: What do you want to clarify by showing this sequence of maps? Is the evolution important? Could you show just one panel as representative for the entire episode?

Figure 9: Apparently, upward is not northward in these satellite images. Please notify the

reader in the figure caption accordingly. Also, it would be nice if you could somehow indicate the northward direction on these satellite images.

Line 228: Am I supposed to see that shadow in the satellite image?

Line 231/232: For me this is hard to see on the satellite image.

Line 244: The difference between sharp and fuzzy is hard for me to see on the satellite image.

Line 259: here you could specifically point to their Fig. 5b, which explicitly shows the diurnal cycle at Mt Zugspitze.

Line 290: "... Presented evidence...", well, rather weak evidence, essentially based on the interpretation of a very low-resolution satellite image.

Line 295: "... expect the plumes to form ..." not clear whether I understand the logic behind this argument.

References:

Prestel, I., and V. Wirth, 2016: What flow conditions are conducive to banner cloud formation? *J. Atmos. Sci.*, 73, 2385–2402.