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Interactive comment on "Evidences of thin cirrus clouds in the stratosphere at mid-latitudes" *by* P. Keckhut et al.

P. Keckhut et al.

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We found that all the minor comments were valuable and so have been taken into account in the new version, as suggested by the referees.

The main comments provided by the referees and the Dr Juckes share some common aspects and hence can be grouped into 3 main points: 1/ The number of cases analyzed and the reasons for presenting this particular case 2/ The significance of the cloud in the backscattering lidar profile 3/ The discussion about the cloud formation

The text has been modified accordingly. 2 figures have been modified in the new manuscript.

1/ The analysis of the dynamical tropopause has been performed over the 27 nights of cirrus detection, but only 5 cirrus layers were found to be completely in the stratosphere (bottom cloud altitude above the tropopause). 2 cases were very significantly above the tropopause (>2 km). The case we focus on is the highest with respect to the tropopause (2,7 km above the tropopause). It also presents an anomaly in the PV profile that is a bit clearer than for the other case. We choose to analyse the best case because the presence of cirrus in the mid-latitude stratosphere is not well documented or established and so we have tried to push the analysis as far as possible with the tools available. 10 years of data are available and we are starting a climatology study. However, to our best knowledge, no cirrus was ever observed and reported as high into the mid-latitude stratosphere as this one. It seems to us interesting for the scientific community to report first this case with a detailed trajectory analyses that permit to conclude that thin cirrus can appear sporadically (for a ground observer) in the stratosphere because thin filaments of subtropical moist tropopause air are transported quasi-isentropically into the stratosphere above mid-latitude observation sites. The few additional climatological information about the other cases analyzed has been added in section 3.

2/ The discussion of the significance of the detection has been improved in the manuscript by adding the noise level and the threshold limit in the figure 2. The cirrus signature is relatively weak, rather close to the detection threshold. We concentrated our analysis on the highest cirrus layer(13,5-13,9 km). However, some other cirrus layers can be identified at the same time at lower altitude and still in the stratosphere. This is in good agreement with the PV structures that extend lower down below the targeted cirrus layer . The PV anomaly presents a larger extension as shown in figure 3. The stratospheric filament had an horizontal thickness estimated at less than 100 km from Fig.4 and crossed France in clearly less than 12 hours (see Fig. 5) which explains the short duration of the cirrus detection compared to the several hours of observation available. This is quite different with common cirrus that exhibit larger horizontal extensions and so longer detection time over a single lidar location. As a result, the traditional temporal representation is not very useful in our case. The text has

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been amended and more explanations are provided. Because the cloud signature is weak compare to the noise level, we agree, as suggested by one referee, that the term “evidence” is probably overoptimistic, and we suggest to modify the title and change “evidences” into a more the appropriate word “indications”.

3/ Cloud formation In accordance with the comments of the reviewer and Dr Juckes, we have improved this part by modifying two figures. The first one is figure 4. We had initially represented two Mimosa plots corresponding to the top and bottom level of the cloud. Now we propose to include two Mimosa plots at the same cloud altitude for the day of detection over OHP and 2 days before detection. This two plots allow to estimate the displacement of the laminae structure and to compare it with its horizontal thickness. The second plot corresponds to figure 5. We propose to add the evolution of the air parcels potential temperature as suggested by Dr Juckes. This plot shows very clearly the adiabatic nature of the transport, at least in the advection-dispersion simulation. Some comments and a reference related to these two figures have been added.

Most of the changes concern the figures and 5 over 6 have been improved. Figure 1: axis titles Figure 2: threshold limits Figure 4: change two altitudes plot by two plots at different times Figure 5: Add the back trajectory particles at different times before the observation Figure 6: Add one panel concerning the evolution of the potential temperature

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Interactive comment on Atmos. Chem. Phys. Discuss., 5, 4037, 2005.