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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "On the origin of subvisible cirrus clouds in the tropical upper troposphere" *by* M. Reverdy et al.

**Anonymous Referee #1**

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Review of "On the origin of subvisible cirrus clouds in the tropical upper troposphere" by Reverdy et al. (2012)

After nearly 6 years of continuous global observations, the CALIPSO lidar has provided unprecedented details about the vertical structure of cloud and aerosol layers in the atmosphere. Among others, one particular strength of CALIPSO is to provide observations of the macrophysical and microphysical properties of a particular class of ultra-thin clouds, which populates the tropical transition layer (TTL), called "Sub-Visible Cirrus" (SVC). Since they are known to affect the radiative budget of the atmosphere as well as controlling the entrance of water vapor in the stratosphere, it is very important to improve our understandings of their formation. In that regard, this study aims to answer questions related to the origin of SVC in the tropical upper troposphere. Several



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atmospheric processes are discussed including: i) The role of local aerosol enhancement from volcanoes and biomass burning, which can supply the upper troposphere in aerosols, ii) The inclusion of NAT particles and iii) the view of SVC as a natural extension of deep convection.

The methods used to investigate the importance of those different mechanisms are interesting but relatively poorly and superficially explored and should be improved before a possible publication. Therefore, I would recommend a major revision of the manuscript.

In general, figures need improvements by increasing the size of characters.

Major Comments:

1- PSC inclusion

The authors keep a large degree of speculation on the importance of PSC as a possible class of SVC without solid scientific arguments. Is the 3.4% of SVC1 that represents approximately 10% of the total SVC population statistically significant? PSC-like SVC would represent 0.34% of the total SVC observed by CALIPSO during the 2006-2008 period. To me, the paragraph about PSC gives too much place to this controversial problem and does not bring solid elements to support it.

2- Local increase of aerosol loading

The discussion related to the importance of aerosol enhancement (volcanic eruptions and biomass burning) as a source of ice nuclei for SVC formation is poorly explored. First, the authors need to differentiate more clearly observed increase of aerosol in the TTL that could be inferred from CALIOP (Vernier et al., 2011c) and those, which are hypothetic. The signatures of two volcanoes in the TTL could be observed after Tavurvur and Jebel-Al-tair eruptions during the falls 2006 and 2008. It seems that other eruptions (Nyiragongo and Hawaii volcanoes) were to weak to influence the TTL aerosol loading. In addition, the influence of biomass burning is also very poorly explored. I



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would suggest using CO from the Microwave Limb Sounder onboard Aura as possible tracer of soot particles to explore this more specifically. I strongly encourage the authors to revisit this part with more solid scientific material.

2- Influence of convection

The authors have inferred from this part that 37 to 65 % of SVC seem to be a direct extension of deep convection reaching the TTL. However, those numbers are limited to a particular class of SVC (temperature variance below 4 K, less than 5 days) in a particular region (Africa) and during a particular season (DJF). How those numbers are representative of the entire population of SVC ? Those numbers are generalized in the abstract as if it could be applied for all SVC in the TTL. The authors don't bring a solid justification for that. Thus, I would recommend to investigate this problem globally and not only around Africa.

More specific comments:

Section 2.

- L8 : "which document the vertical distribution of atmospheric composition.." You may want to change "atmospheric composition" by "aerosol and cloud layers" - Fig.2 : Please increase significantly the size of characters.

Section 3.

- Fig.4 : increase size of characters - Please clarify sect.3.2 14884/ L15 "The associated. . ." - Fig 6. Increase size of characters' - Please clarify L15 "Over 10 days (not shown), the number of C1 SVC more than doubles .." : double relative to what ? - SVC selection: the variance criteria used to select a coherent population of SVC restricts the study to only around 10% of SVC. This may create artificial bias and may not be representative of all tropical SVC (as discussed 14885 L-9).

Section 4.



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- 4.2 " statement of the first sentence is incorrect. The largest C1 SVC populations are in Africa and Asia in JJA and not in the "Pacific" - The volcanic plume, which resulted from the Tavurvur eruption, may contribute to the cluster of points with quasi-null depolarization (fig.8/bottom) in addition to Soufriere Hill volcanic aerosols.

Section 5. Discussion

- PSC inclusion :

Is the 3.4% of 10% of the total SVC population (∼0.3%) statistically significant to attribute their formation to PSC inclusion ? To me, the paragraph gives too much place to this controversial problem and does not bring solid elements.

- Effect of local increase of aerosol:

Not that aerosol may also change could microphysics and not only cloud cover.

You need to differentiate here volcanic eruptions, which resulted in an enhancement of aerosols in the TTL from those without impact. This is highly speculative to say that volcanic plume, not reaching the TT,L may have an indirect effect on SVC through their transport by convection. L25-28 14889 paragraph is very speculative.

Eg. Nyiragongo does not appear to have injected volcanic materials at levels where SVC can be observed (Vernier et al., 2011a). Figure 12 does not bring specific information and should be taken out.

- In addition, Soufriere Hills volcanic plume is located above 19 km and doesn't show evidence of sedimentation in the TTL but is seen to be transported by the Brewer-Dobson circulation in the lower stratosphere. Therefore, if aerosols are not in the TTL, they will not affect SVC formation. I don't think that fig.14 bring relevant information relative to the plume height not already published (Carn et al. 2008, Vernier et al., 2009).

Again the impact of biomass burning is very speculative and should be analyzed in



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details but not simply with a “brief look”. Instead of NO2, CO would be a better tracer of biomass burning. A suggestion would be to use CO from MLS Aura to analyze how CO in the TTL could be correlated with a change in SVC cover or microphysical properties.

In conclusion, the analysis of the impact of aerosol enhancement presented in this section is very weak and speculative. It should be seriously improved before the paper could be published.

- Effect of deep convection:

The effect of deep convection on the SVC population is limited to a small proportion of SVC over Africa. A more complete analysis in the tropics needs to be performed to generalize the numbers presented in the abstract.

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Interactive comment on Atmos. Chem. Phys. Discuss., 12, 14875, 2012.