

## ***Interactive comment on “Sensing Hadley cell with space lidar” by W. Sun and B. Lin***

### **Anonymous Referee #2**

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Global climate models predict a poleward expansion of the tropics in response to greenhouse forcing. The authors propose that direct observation of optically thin cirrus by satellite lidar can be used to define the location of the tropical edge, and that long-term satellite observations could be used to monitor the poleward expansion. While presenting an intriguing idea, the paper does not have sufficient content and requires major revisions to merit publication.

I am in general agreement with the other reviewer that the paper requires more detail and more justification of the proposed idea. The presentation and discussion is quite brief. The discussion does not seem to reflect our current understanding of tropical cirrus or the TTL. Nothing has been cited from the substantial amount of research conducted over the last decade on the distribution and processes involving TTL cirrus.

Specific comments:

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1) Line 11: ‘optically thin clouds cover 50% of the globe’ – define what is meant by ‘optically thin’. The rest of this paragraph appears to be talking about subvisible cirrus, with optical depths typically less than 0.03. The global coverage of this subvisible cirrus is likely much less than 50% because they occur much more frequently in the tropics than at higher latitudes.

2) Line 18: It is not clear what is meant by ‘common clouds’: convective clouds or just clouds detectable by passive sensors. This should be clarified.

3) Line 19 states that ‘super-thin cirrus’ is a direct tracer of the Hadley circulation, but the argument is rather weak. The paper needs to demonstrate that this super-thin cirrus is a tracer of the Hadley circulation, rather than just an indicator of tropopause height – which in itself seems a useful signature for expansion of the tropics\*. The paper seems to be saying that these super-thin cirrus clouds are a better tracer of Hadley circulation than optically thicker cirrus. This point needs much more discussion. How would Figure 3 change if only cirrus with optical depth greater than 0.3 were used?

\* The paper by Fu, Hu, and Yang (GRL, 2007, doi:10.1029/2007GL030099) is particularly relevant to this point.

4) Line 28: The criteria for selecting FOVs with super-thin clouds seem rather preliminary and arbitrary. If there is a need to rely only on super-thin clouds occurring in otherwise clear sky, this should be discussed. This section requires more detail: a description of what the CCCM dataset is, the different measurement geometries of CERES, MODIS, and CALIOP, etc..

5) Figure 3: some other indicator of the Hadley circulation should be shown to support the statement that “super-thin clouds well correlate with the Hadley cells.”

6) Causes of the differences between Figure 3 and Figure 4 should be discussed. Numerous papers comparing cloud detection from CALIOP and MODIS have been published.

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7) The other reviewer raises a valid point regarding sensitivity differences with future lidar instruments. I doubt this is an insurmountable problem, but the manuscript would benefit from some discussion on this point as detection of tropical expansion requires observations spanning decades which necessarily must come from different instruments. The issue of night vs. day detection sensitivity is discussed in Winker et al. (JTech, 2009).

8) Finally, none of the conclusions listed in Section 4 are supported by the results presented here:

“the extent of the Hadley cell could reliably be estimated” – this could be true, but it has not been demonstrated by comparisons with other measures of the Hadley circulation.

“super thin clouds trace the moisture flow in the general circulations” – there is no support for this statement in the manuscript. A substantial amount of work has been done in the last few years, much of it using CALIOP data, on the mechanisms which form and sustain TTL cirrus. This claim should be discussed in the context of this recent work.

“Through consecutive multi-year measurements . . . a good estimation of the expansion of the Hadley cell could be obtained.” Multiple years of CALIOP data are available. The interannual variability of these cloud statistics should be studied to see whether the year-year signals are consistent, and to characterize the natural interannual variability of this signature of the tropical edge.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 16599, 2011.

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