Atmos. Chem. Phys. Discuss., 12, C5826–C5829, 2012
www.atmos-chem-phys-discuss.net/12/C5826/2012/

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 #2

Received and published: 16 August 2012

General Comments:

This paper investigates the sources of subvisible cirrus identified by CALIPSO observations in the tropical upper troposphere by examining the interaction of back trajectories with aerosols and convective activity. The authors found no noticeable impact from Nitric Acid Trihydrate crystals or higher aerosol concentrations after volcanic eruptions or biomass burning, though the volcanic eruptions that occurred during the time of study led to relatively small increases in tropical stratospheric SO2. Many (37-65%) of the trajectories from SVC over Africa intersect with convection within the previous 5 days, leading to the authors' conclusion that subvisible cirrus are formed by the same processes as other cirrus and are not fundamentally different besides their small optical depths.

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Interactive Discussion

Discussion Paper

The trajectory analysis is a nice contribution to the currently open question of how thin cirrus near the tropopause are formed. In particular, this study provides evidence that some fraction of the optically thinnest cirrus may be formed by convective detrainment, contrary to earlier suggestions that seemed to indicate that the thinnest "laminar" cirrus were created by in situ ice nucleation, while cirrus from convective detrainment were less uniform in shape and optically thicker.

I think the strongest evidence given in the study is the analysis of the trajectories with the ISCCP brightness temperature data to determine convective interaction. Though trajectory calculations always have high uncertainties due to lack of observational data and atmospheric turbulence, the trajectory calculation method used in this study is thorough, including using the most recent reanalysis data, examining temperature histories, and comparing to the highest resolution observations available for this sort of analysis. The number of trajectories (500 trajectories from only 57 SVC) is small to make robust conclusions, and is perhaps more of an extended case study than a statistical picture of tropical SVC.

I recommend the paper for publication after the authors address the following specific concerns:

1. The conclusions for the interaction between trajectories and convection are based on one season (JJA) for one region, yet we know that SVC amounts and possibly their origins vary regionally and seasonally. The results would be much stronger if they included additional trajectory calculations for other time periods. At the very least, authors need to clearly identify this regional/seasonal limitation in the abstract and conclusions when quoting that 37-65% of trajectories interact with convection. I also found myself wondering why the authors chose JJA when their earlier analysis showed more trajectories over Africa in DJF?

2. Limiting analysis of trajectories to those with coherent temperature variance is a reasonable decision that will weed out inconclusive trajectory calculations, but some

investigation is needed to determine whether this selects a representative sample of the SVC. In addition to any impact of meteorological conditions, I am wondering if this criterion is more likely to select small SVC since those trajectories will start closer together and be less likely to diverge with time.

3. It may also be useful to discuss these recent papers in interpreting the results of this study: a. Wang and Dessler (2012) "Analysis of cirrus in the tropical tropopause layer from CALIPSO and MLS data: A water perspective" JGR, doi:10.1029/2011JD016442– the study's findings that the fraction of cirrus formed by convection was greater at the tropopause than lower in the upper troposphere support the authors conclusions. b. Virts et al (2010) "Tropical Tropopause Transition Layer Cirrus as Represented by CALIPSO Lidar Observations" JAS, DOI: 10.1175/2010JAS3412.1. This study shows higher correlations between temperature variations and cirrus than between convection and cirrus in the upper troposphere, suggesting formation by in situ ice nucleation as a result of Kelvin waves.

4. I find the distinction between "external processes" of cirrus formation and convective influence to be confusing. Where does in situ ice nucleation initiated by temperature fluctuations due to Kelvin waves discussed by Virts et al. (2010) fit? That is, presumably external processes are injections of possible ice nuclei that cause cirrus to form, but it is also possible that a change in temperature will cause ice to nucleate on existing aerosol.

Technical corrections:

1. 14876, Line 12: change to "In order to simplify"

2. 14881, Line 8: change to "accounted for by models"

3. 14884, Line 3: change to "As time goes back, temperature variance"

4. 14890, Line 18: change to "bring a significant number of particles"

5. 14895, Line 19: change to "possible correlation between an increase"

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6. 14896, Line 25-26: “Which ice nuclei are statistically significant for SVC formation” (this is confusing and should be changed)

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

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Interactive Comment