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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Increase in the Frequency of Tropical Deep Convective Clouds with Global Warming" *by* Hartmut H. Aumann et al.

Anonymous Referee #1

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General comments.

This paper concludes that the frequency of DCC will increase in the future climate. This is based on the onset of DCC SST correlated with SST, based on today's inter-annual varability. They used the CMIP climate models to determine the SST change between current and future climate periods. There is also some information provided to the predicted rainfall rate of future DCC. However, the rainfall rate information did not make it into the conclusions or in the abstract. Anytime predictions are made about future climate many assumptions need to be made. The authors primary assumption is to use today's SST inter-annual variability and modeled future SST change to make this prediction. I believe the paper is worthy of publication as one path to get to the frequency of DCC in future climate, the basis of which can be used in future papers on the topic, as more climate change studies and data becomes available.

Specific comments.

I believe the authors have tried to focus this paper more about the assumptions and predictions than about the procedures used. All of the methodology seems to be in appendices and are very succinct and in my opinion lacking some detail. However, more elaboration could help bolster these assumptions, especially section 3.2. I had to read the section several times to see how a DCC SST onset and DCC frequency were tied together.

I found the DCC rainfall rate results in appendix A and C distracted from the intent of the paper. It was not used to determine the increase in frequency of DCC in future climate. It almost seems as an afterthought, while writing the paper. The topic of DCC rainfall rates in future climates is a paper in itself. I also found it odd that none of the rainfall rate information made it into the abstract or conclusions.

This study uses DCC results found over tropical oceans. There is a considerable frequency of DCC found over tropical land. Is the frequency of DCC found over ocean and land correlated in either current or future climates?

Line 51 I am not convinced that the DCC data groups are uncorrelated. I do not agree that the even and odd days from the same year are uncorrelated. Fig. 2 clearly shows that. The even and odd points are located very closely together. Also, the year to year variations could be auto-correlated. In line 271 you state that the even and odd days should provide the same PDF shape.

Fig. 2. This plot uses the inter-annual variability to correlate the onset of convection with SST. The period between 2003 and 2016 were very quiet climate years, except for the 2016 El Nino event. I am sure the El Nino 2016 even and odd day values have a SST ∼299.7 in Fig. 2. Without the year 2016, the slope of the line would be very different. In other words, if the years of 2003 to 2015 were used the conclusions would be different. Would the results look different for 30 years, with volcanic events, and other large El Nino years? For a study that predicts future climate, you have

to assume that today's climate variability can be extrapolated in the future. Today's climate variability is driven by short term climate variability such as the ENSO cycle. This data is the critical information to estimate the increase in DCC frequency. Here are 2 arguments that need to be given some thought.

1) There have been papers that address that inter-annual cloud feedbacks are larger than long-term feedbacks. Zhou, C.,ÂăM. D. Zelinka,ÂăA. E. Dessler, andÂăS. A. KleinÂă(2015),ÂăThe relationship between interannual and long-term cloud feedbacks,ÂăGeophys. Res. Lett.,Âă42,Âă10,463–10,469, doi:10.1002/2015GL066698.

2) Recently studies have pointed out that SST changes is not a very good at predicting inter-annual TOA flux changes, the correlations when using modeled and observed are very weak. Using the 500 hPa tropical temperatures correlations are much greater. (Trenberth, Murphy and Spencer)

Fig. 3. The two SST frequencies of the current and future climates do not look like the SST frequency in Fig. 1. The peak of the current climate is 300K and the future climate is 303K. The peak of fig. 1 using RTGSST SSTs is $\sim$302K. Is it a matter of resolution, 0.25° versus 2.5K?

Fig. C1 Why is there no current climate peak plateau or warm temperature drop off in the rain rate compared with the future climate?

Technical Corrections.

Line 29. I am assuming that the DCC frequency was based on the AIRS footprint (12 km) resolution. DCC smaller than 12-km are not counted. How well does this method separate the anvil or core blow off, which will have a constant temperature, from the convective core? What gives you the confidence that only the DCC cores are identified in the DCC frequency study.

Line 47. I appreciate the author stating the data used in the acknowledgements. Still information is lacking what product and version was used for this analysis. Here it

just states that DCC identified AIRS is collocated with RTGSST (is there a version number?), which is on a 0.25° grid. Was the AIRS (12 km) convolved into the 0.25° resolution data? Or was the RTGSST convolved into the AIRS footprint resolution? What product of AIRS was used and what version of AIRS?

Line 47. I assume that a BT threshold temperature of 210K was used, since that was stated in line 31. Could that threshold be stated again in line 47. The acknowledgement then states this data is publicly available as a product.

Line 55 add "all-sky tropical ocean" in between observed and distribution of the SST for clarity.

Line 248 Can the AMSR-E product name and version number be stated in the text. This is also a 0.25° gridded product as was the RTGSST. Again, was the AIRS footprint data also mapped into 0.25° gridded regions?

Line 270 Fig. A1. I believe should be Fig. 1

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