

Review of the paper “Effects of atmospheric dynamics and aerosols on the thermodynamic phase of cold clouds” by Jiming Li et al.

I appreciate that the authors rewrite their introduction to get rid of plagiarism and put effort to even improve it. They also better describe the observations and the method used to produce the SLFs. However, I still have major concerns about the manuscript - developed below -, which should be treated before considering publication.

Validity of the results

I found their results not consistent with previously published material using CALIPSO-GOCCP. In Cesana et al. (2015) Fig. 5 bottom right, the ratio of ice to liquid+ice (i.e., 1-SLF) is shown as a function of the temperature and the latitude. At -10°C it is quite constant regardless of the latitude and the value ranges between 60 and 80%. In Cesana and Chepfer (2013) Fig. 7b, the global average of the ratio of ice to ice+liq is represented as a function of the temperature for different latitudinal bands and again, for -10°C , the SLF is higher than 70% for all regions.

I could not reproduce the author's results although I used their formula and the CALIPSO-GOCCP monthly data. I finally figured out that was because they used day + night time data. As mentioned in Cesana and Chepfer (2013), Cesana et al (2015,2016), daytime data are noisier because of solar contamination – which particularly affect the perpendicular laser channel – and should not be used for statistical analysis. It affects even more overly bright regions such as stratocumulus regions that reflect a lot of incoming solar light (even more in the tropics).

I enclosed below my results using the authors' formula $\text{SLF} = \text{cltemp_liq} / (\text{cltemp_liq} + \text{cltemp_ice})$ for night and daytime CALIPSO-GOCCP 2007-2015 monthly data, on separate figures.

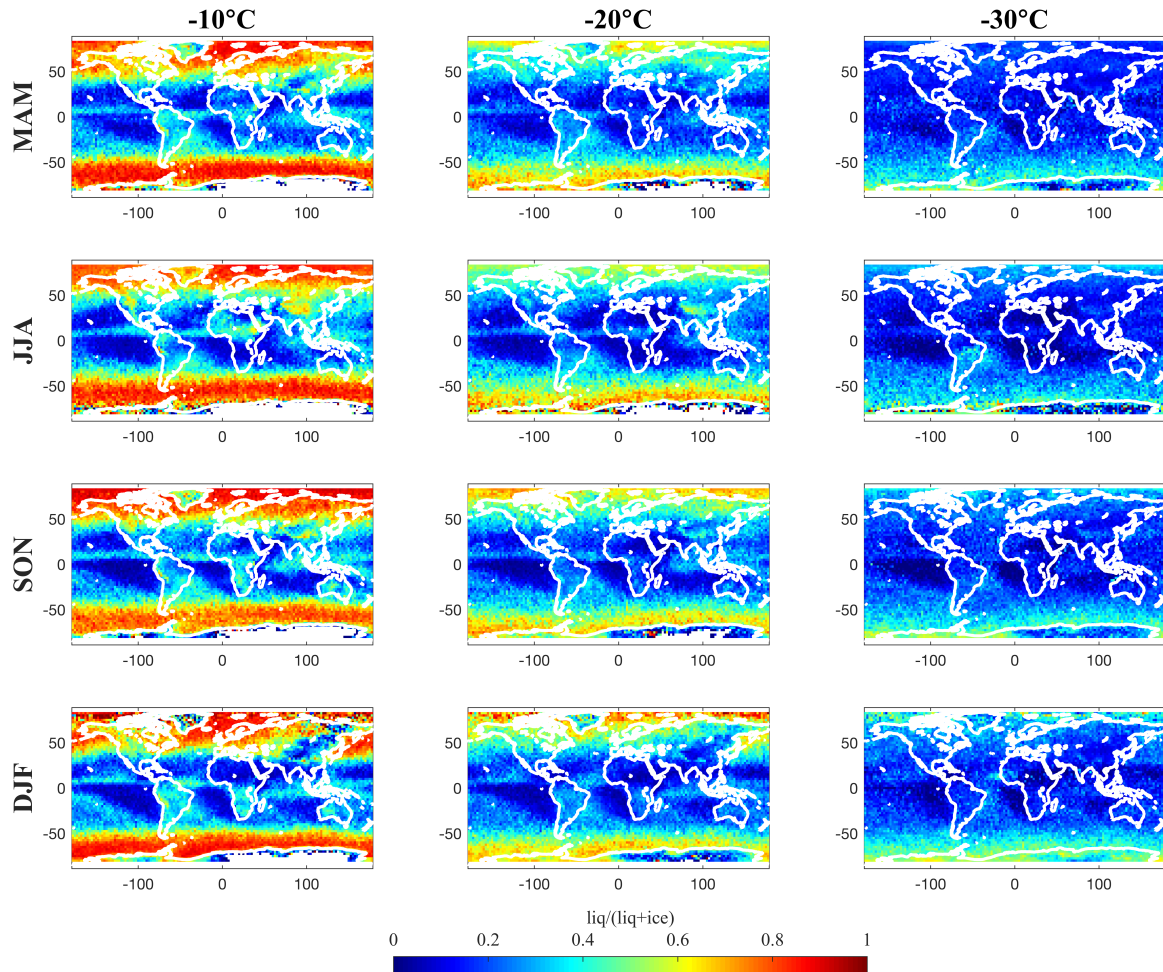


Figure 1: Seasonal variation of the Cloud Phase Ratio ($\text{liq}/(\text{liq}+\text{ice})$) for different isotherm (-10, -20 and -30°C, from the left to the right) using daytime GOCCP monthly data (2007-2015)

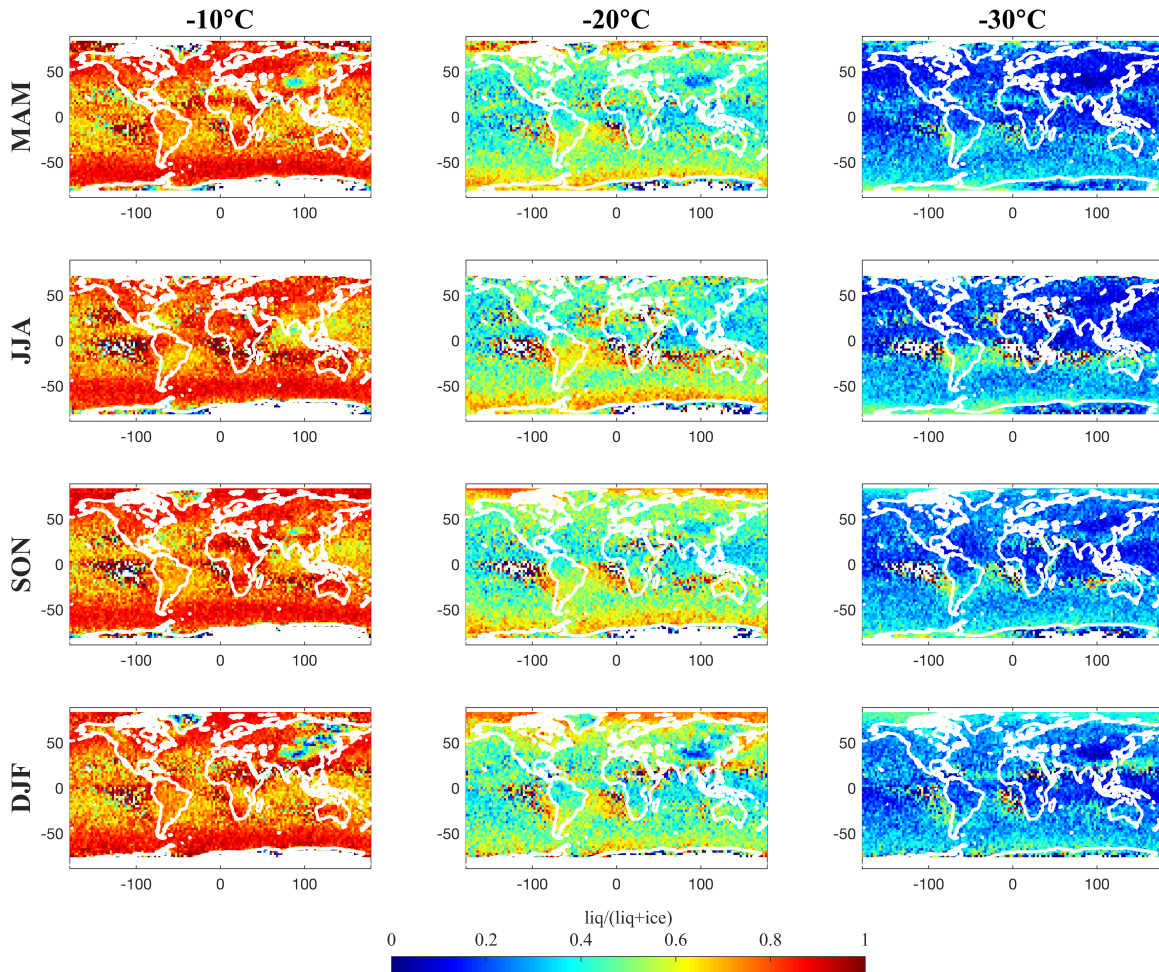


Figure 2: Seasonal variation of the Cloud Phase Ratio ($liq/(liq+ice)$) for different isotherm (-10, -20 and -30°C, from the left to the right) using nighttime GOCCP monthly data (2007-2015)

As you can see, results are quite different, especially over subsidence regime regions. I suggest the authors start over again using nighttime only data.

As the rest of the study is based on the calculation of the SLF, it completely questions the validity of the following results; this could explain why the authors found that higher large-scale vertical velocity and relative humidity promote the fraction of supercooled liquid at very low temperatures, which is in disagreement with Cesana et al (2015) results, who used the same CALIPSO-GOCCP and ERAi data.

Large-scale vs. in-cloud

There is a confusion between large-scale and in-cloud meteorological parameters. Large-scale velocity gives an information about the gridbox averaged vertical velocity and thus the type of cloud regime to expect. Yet it does not mean the in cloud vertical velocity is necessarily very large and the authors also reference papers that used in-cloud updrafts velocity rather than large-scale vertical velocity without mentioning it. They should clear make the distinction in the manuscript.

Introduction

While the authors substantially re-wrote the introduction – and it is a good thing-, they still don't really explain why they want to focus on the relation aerosol – phase other than it wasn't done before. They could reduce it by skipping most of the second paragraph for example - why do you focus on water vapor and size and shape of ice crystal whereas you don't investigate this at all in your study? – and add more detail about why they want to focus on aerosol – phase relation.

Minor comments

Line 79 and 84: the use of the word important is not appropriate here. Please consider reformulating.

Line 92 92: Redundant use of also and addition/additionally

Line 105: dominates?

Line 112 – 116: This is confused: content of ice in ice clouds? Discrepant?

Line 126 I would rather say detailed than accurate.

Line 126: Define the CALIPSO acronym

Line 136 – 141: This is not correct. Cesana et al. (2015) analyzed what you called here cloud phase changes (the cloud phase transition) at global scale in obs and models.
Similar comment for line 468

Line 139 What is systematic studies?

Line 171: for single scattering only. Otherwise liquid droplets also produce cross polarization - because of multiple scattering issues – but relatively less than ice crystals. “Spherical particles typically do not”

Line 181 differences **between** the observations ... outputs are **mostly** attributed . Indeed, Line 182 Cesana et al., 2015 do not use the lidar simulator. You might reference Cesana and Chepfer 2012 instead and add e.g. because they are many other papers out there that use the lidar simulator.

Line 192 (e.g. Chepfer et al., 2013)

Line 194 further classifies

Line 224 231: The impact of the oriented ice crystals on the mixed phase cloud retrievals is negligible after the lidar tilt (late 2007) [Cesana et al., 2016].

Line 301: “are” should not be here.

Line 325 334: Do you mean anti-correlated? So you expect to have fewer SCF in regions of large values of aerosol such as the mid-lat? Yet mid-lat regions are known to be the regions where mixed-phase clouds form.

Line 417: Seasonal variations at high latitude imply that only daytime or nighttime data were used, which might explain why different correlations are found at mid-lat (using both day and nighttime data no matter the season) and high lat.

Line 430: Again, Cesana et al (2015) mentioned the large-scale vertical velocity whereas West et al (2014) the subgrid, which is different. Although an increase of the LWP does not say anything about the mixed-phase clouds.

The rest of the paper is very difficult to interpret as the variation of SCF cannot be trusted.

I won't comment the results section as I believe the results are incorrect.