We thank the Anonymous Referee #2 for his/her positive comments about our work, and suggested revisions that will allow us to improve:

• *"The Hilbert transform should be better motivated. What can be achieved? Why does it give an amplitude and a phase? What are its limitations? A brief overview of how the Hilbert transform works would also be helpful to potential readers not acquainted to this method. I understand that the authors may not want to lengthen the article, but the latter could be given as first section of the supplementary material. Something as short and clear as Pikowsky et al., 2002, Appendix A.2.1, would greatly benefit the reader."*

Authors' response: Our motivation to use of Hilbert transform (HT) is that it has been demonstrated useful to analyse and to characterise oscillating signals of different kinds, but to the best of our knowledge, it has not yet been used to investigate changes in surface air temperature data. We have performed a first analysis in Zappala et al (2016) where we detected well defined spatial patterns in Hilbert magnitudes, and our motivation here is to determine how these patterns have changed over the last three decades. In our manuscript we have briefly commented the main limitation of HT: the difficulty in dealing with signals without a sufficiently narrow band of frequency.

In a revised version of the manuscript we will be happy to extend the introduction to describe in more detail the motivation of our study, as well as the limitations of the Hilbert approach. Moreover, we agree with the reviewer that adding a section in the Supporting Information to explain the basics of HT will be very helpful to the readers.

• *"Regarding the interpretation of the blue and red spots in Fig. 2, please discuss the quality of the reanalysis in these regions. In particular, the blue spot in the Arctic is in a region for which there is little constraints from satellites on the re- analysis."*

Authors' response: We thank the reviewer for pointing out this issue. Actually, our way to deal with possible problems with the quality of the reanalysis has been to consider two different datasets (ERA-Interim and NCEP-DOE Reanalysis 2) and compare the results. We show in Section 3 of the Supporting Information that the blue spot is in the same position in the two datasets. While this could be considered a confirmation of a genuine amplitude change, it could also be an artifact in the two reanalysis, due to the same constraints from satellites. In a revised version of the manuscript we will be happy to discuss this point.

Regarding the technical comments:

p.2, l.32: what is meant by "detrended"? The climatology is kept, while the long term trend is removed? How is this done?

Authors' response: First of all, from the raw SAT time series, we calculate the linear regression, to find the long term linear shift of temperature. Then, we subtract this linear trend from the SAT series. We do this because, to analyse the oscillation of the series, we don't want the center of oscillation to shift in time.

p.3, l.4: what is meant by "unwrapping the phase"?

Authors' response: To calculate the phase from x and y we use the arctan function. If we keep into account the sings of x and y, we get phase values in the domain $[-\pi, \pi]$. So, basically, the time series of phase has jumps from π to - π. By "unwrapping the phase" we just mean to eliminate these jumps (with a standard matlab function), to obtain a series which values are not limited to the domain [-π, π].

p.3, l.6: how the 5% where chosen? Are the results robust to this choice?

Authors' response: We analysed the results of our HT algorithm over synthetic series generated by us (with known amplitude and frequency). In this way, we could compare the results given by HT with the true values of frequency and amplitude. As known by previous studies, near the two extremes of the series we found differences between HT results and the true values. We chose the value of 5% as a security threshold, because in all the tests it was sufficient to eliminate the parts of the series where HT gives significant deviations from the true amplitude and frequency values.

p.3, l.7: exactly reconstructs xj , but for extreme realizations, right?

Authors' response: We performed extensive tests and found that, in all sites, x(t) and A(t) cosφ(t) are exactly equal at each time "t", except when "t" is too close to the extremes of the time series (i.e., except a few initial and final values), which were disregarded from the analysis (the 5% explained in the previous point). In a revised version, we will be happy to describe in the detail the calculations, and include a comparison between the original SAT time series, x(t), and the series obtained from the HT, A(t) cosφ(t).

*p.3, l.30: That the results are robust to the threshold is convincing enough. However, why make the threshold based on the standard deviation and not perform a fully non-parametric test by choosing a significance tolerance, say alpha = 0:05 and consider as significant all values larger than (1 –alpha /2) * 100% of surrogate realizations?*

Authors' response: We thank the reviewer for this suggestion and we will add this non-parametric test in the revised version of the manuscript.

p.4, l.11: Please, be more precise regarding what is meant by "fast oscillations".

Authors' response: Since we just meant "amplitude of oscillations", in a revised version we will remove the world "fast".

Finally, the reviewer is absolutely right about the typo and the numbering of Figure 2 of Supporting Information, and we will correct these mistakes in a revised version.