

Interactive  
Comment

## ***Interactive comment on “On the relationship between Arctic ice clouds and polluted air masses over the north slope of Alaska in April 2008” by C. Jouan et al.***

**C. Jouan et al.**

jouan.caroline6@gmail.com

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We have taken comments and/or suggestions given in this review (see attached file). We hope to have addressed all points so to significantly improve the paper.

To follow the corrections, please refer to the corrected manuscript entitled "CJouan\_ACP\_2ndsubmit\_FigIncluded\_Corrections\_Highlighted.doc".

- Paragraphs in blue were added. - Paragraphs in green have been removed. - Paragraphs in orange were displaced.

1. The authors should clearly explain, what are their new results worthwhile for publication  
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lishing compared to other cited studies, e. g. Jouan et al. (2012).

We modified the introduction to more clearly explain the main results of Jouan et al. (2012) (Lines 61-87), and the objectives of the new article (Lines 190-195). A new paragraph (Lines 88-118) was added to make the transition between the results obtained in Jouan et al. (2012), and the objectives of the new article.

We have removed an entire paragraph in the discussion that was out of the topic : Lines 712-762. Then the results are much better defined in Discussion and Conclusion.

2. The paper needs a stronger science focus, is too long and difficult to read. Especially chapter 5 needs a clearer focus with respect to the key topic of the manuscript.

The key topic of the manuscript is : An investigation of the origin of the air masses in which the ISDAC TIC-1/2A (1 April 2008) and TIC-2B form (15 April 2008), identified in Jouan et al (2012), to verify the hypothesis regarding the potential link between acidified mineral dust and TIC-2B, considering information gathered from the ARCTAS and ISDAC field experiments and trajectory analyses. An

We have removed all paragraphs that brought no new information to the initial key topic of the manuscript, which are : Lines 64-72; Lines 75-78; Lines 130-137; Lines 161-166; Lines 176-189; Line 216-229; Line 261-265; Line 283-285; Lines 342-345; Lines 407-410; Lines 569-573; Lines 625-629; Lines 698-706.

We added a clearer focus with respect to the key topic of the manuscript in chapter 5. We explained that observations taken during ISDAC were not complete on the aerosol properties in all TICs identified in Jouan et al. (2012). This is why this paper proposes an alternative approach to determine the potential acidity of the studied air masses based on trajectory tools associated with OMI/CALIPSO satellite data. Lines 451-470.

3. The presented results are not convincing enough to confirm the hypothesis. Only 2 flight segments and one layer of cloud data is selected to highlight the above mentioned hypothesis. Therefore much more in-situ data are required.

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Before analyzing the properties of aerosols in TIC clouds, it was necessary to make a detailed analysis of the cloud microphysical and thermodynamic properties observed. This allowed to focus on two case studies (Jouan et al., 2012). In this new article, we take these two case studies for a detailed analysis of the nature and properties of the aerosol upstream TIC clouds.

These detailed analyses are not trivial and require to take into account a lot of data (cloud and aerosol airborne and satellite data).

We agree with the reviewer that these two case studies are not enough to confirm the hypothesis but nevertheless, these results represent an essential and important first step to relate previous modeling, remote sensing and laboratory studies with TICs cloud in-situ observations.

We added the following paragraph in Discussion, Lines 814-820 : “ The overall results of the synoptic situation (Jouan et al., 2012), the in-situ characterization of the cloud properties (Jouan et al., 2012) as well as sources, transport of air masses and analysis of the nature and properties of aerosols upstream the TICs, show favorable conditions to the involvement of acidification of aerosols in the formation of the TICs-2B-F21. But without representative in-situ information on the initial concentration of ice nuclei and chemical composition we cannot fully validate this hypothesis. This should be one of the topics for further field experiments. ”

We modified the following paragraph in Conclusion, Lines 854-857 : “ These results and the analysis of aerosol moistening strongly support the hypothesis that acidic coating on IN are could be at the origin of the formation of TIC-2B. However, other studies are needed to confirm this hypothesis, in particular dedicated campaigns to investigate the link between acid-coated aerosols and TIC-2B clouds. “

4. The difference in the 2 selected data sets TIC-2B and TIC-1/2A is relatively small and therefore not really convincing to underline the hypothesis.

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We respectfully do not agree. The differences in the 2 selected data sets TIC-2B and TIC-1/2A in terms of in-situ thermodynamic and microphysical properties (Nic, Rei, RH<sub>ice</sub>) are important between the two clouds (Jouan et al., 2012). In this new article, we showed that air masses in which the two clouds form are characterized by distinct sources of aerosols with relatively pure mineral particles in TIC-1/2A and mineral particles with a high proportion of pollutants in TIC-2B. The OMI observations indicate that concentration of SO<sub>2</sub> in air masses forming the TIC-2B are larger than in air masses forming the TIC-1/2A. Airborne measurements confirm a high acidity of the air masses near the TIC-2B.

5. The authors argue with indirect arguments using satellite data, but a combined analysis of the in-situ data showing the aerosol acidity would be more convincing.

We do agree with the reviewer. But unfortunately, observations taken during ISDAC were not complete on the aerosol properties in all TICs identified in Jouan et al. (2012). The aerosol chemical composition was therefore missing. That's why this paper proposes an alternative approach to determine the potential acidity of the studied air masses based on trajectory tools associated with OMI/CALIPSO satellite data.

We added the following paragraph Lines 453-470 : “ During the ISDAC field experiment, the National Research Council of Canada (NRC) Convair-580 was equipped with 41 instruments including aerosol sensors. The aerosol number concentration (Na) was measured with a CPC-3775 ( $> 0.004 \mu\text{m}$ ) and a PCASP ( $0.12\text{-}3 \mu\text{m}$ ) probes. Note that data from the CPC-3775 were valid for lower altitudes only ( $< 3.5 \text{ km}$  above mean sea level) due to instrument limitation. Data from the PCASP were missing for the studied flight F21. A single mass spectrometer (SPLAT-II) measuring the concentration and chemical composition of aerosols (Zelenyuk et al, 2010) and a continuous flow diffusion chamber (CFDC) measuring the IN concentration were also available in the aircraft. Unfortunately, the CFDC was not functional for flights prior to April 8th, 2008 (including Flight 8-15) and aerosol chemical composition from SPLAT-II for studied flights F9 and F21 were not available at the beginning of the analysis (Alla Ze-

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lenyuk, personal communication). To compensate this lack of in-situ aerosol observations, this paper proposes an alternative approach to determine the potential acidity of the studied air masses. Results are discussed examining the CALIPSO satellite tracks, which intersect the back-trajectories in the region away from the TICs layers observed by the aircraft and/or satellites to analyze aerosol occurrence and optical properties. The objective is to investigate in depth the link between TIC-2B formation and acidified mineral dust using a lagrangian approach as previously developed by Adam de Villiers et al. (2010b). “

6. There is a clear need for confirming the established hypothesis in a chemical transport model or regional climate model with interactive chemistry. Simple trajectory calculations are not enough.

The objective of the study is to provide as much evidence on a potential link between acidification of aerosols and TIC-2B formation from laboratory, airborne and satellite observations, for the case studied, without the use of a model. In a second step, it is our plan to confirm the hypothesis using a chemical transport model. This will require quantification of particle sources, which will raise further questions.

The combination of trajectory tools (FLEXPART) and satellite data is an effective method to identify long-range pollution tracks to the Arctic (OMI) and to analyze aerosol occurrence and optical properties examining the CALIPSO satellite tracks, which intersect the back-trajectories in the region away from the TICs layers observed by the aircraft.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/13/C7073/2013/acpd-13-C7073-2013-supplement.zip>

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