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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Small-scale transport structures in the Arctic winter 2009/2010" *by* C. Kalicinsky et al.

Anonymous Referee #3

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The paper presents airborne remote-sensing CRISTA-NF observations of three trace gases in the UTLS region during a reasearch flight into the Arctic polar vortex on March 2 2010. The scientific focus of the paper is threefold: first, to highlight the capability of CRISTA-NF observations and retrieval algorithms to detect and derive fine-scale structures in the lower stratosphere. Second, the observations are employed to verify model simulations by CLaMS. Third, the CLAMS simulations are applied to derive the origin of the observed airmasses and to describe the mixing in some qualitative way.

Generally, the paper is well written, it contains a presentation of observations with novel spatial resolution, and, therefore, it is certainly suited for publication in ACP. However, I would recommend to revise the paper in some aspects:

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Discussion Paper

(1) Analysis of the mixing: The paper can be improved signficantly, if the analysis of the mixing at the vortex edge is considered from a quantitative perspective.

(2) The writing style could be advanced by applying more specific statements. This holds for the whole paper. Some examples are given below.

Specific Comments:

Title: - the title doesn't reflect the height region of observations - "small-scale transport structures" is a rather vague, perhaps for some readers even misleading term; just say what you are talking about in the paper: observations of filaments at the vortex edge and the corresponding mixing - time period is not really necessary in the title

Abstract: - I would suggest to use a more specific style; there are some imprecisions as:

o " .. observed altitude range .. ": not specified before o " .. show several structures ..": more specific as the observations certainly don't show the polar vortex but only portions of it etc.

This sentence at lines 10/11 is kind of typical of some formulations throughout the paper: you mix observations with interpretations from a model. I would recommend to differentiate clearly what is observed and what is simulated and what is the conclusion from both and additional arguments.

o line 12: "The situation ...": more specific which situation you are refering to o line 16: ".. very small-scale structures ..": more specific which part of the spectrum you are refering to o line 17: " .. use a model concept utilising artificial .." sounds strange to me; why not only ".. use artificial tracers .."??

I could continue to go through the text like this but I'm sure the authors can improve the respective parts of the manuscript by themselves.

1 Introduction

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- page 3, lines 6-11: It is not clear to me why this sentence is necessary; the link to the sentences before and after could be clearer

- page 3, line 23: "successfully flown" probably better: "successfully employed"

- page 4, line 8: not clear here, what is meant by "passive tracer concept"

2 CRISTA-NF observations

- page 4, last line: for which distance does the vertical sampling of 250 m hold?

- page 5, first line: resolve symbols lambda and Delta lambda.

3 CLaMS simulations

- page 6, line 14: what is a "dynamically adaptive grid" for a Lagrangian model? Explain briefly!

4 Flight path and meteorological situation

- page 8, lines 21-25: It is interesting, and probably not surprising, that CI is always ever low at the end of the measurement, i.e. at low altitudes. Does this occurence of tropospheric clouds correspond to exisiting satellite observations?

- page 9, lines 3-5: o correct spelling: European Centre for Medium-Range Weather Forecasts o What kind of reanalysis data were used? o It would be very helpful for the interpretation of the results to mention here that the flight on March 2 2010 took place after a major warming happened in the stratosphere in late January and that the vortex broke into two lobes in early February. So, the vortex was already quite disturbed and it was not as coherent and isolated as before the warming. It might be instructive to show a horizontal plot of the mPV at an isentropic surface together with the flight path to illuminate the situation and the mixing processes discussed in the paper.

o Fig 2: Are the enhanced mPV values near 10 km altitude the sign of the tropopause? A similar plot of the squared Brunt-Väisälä frequency calculated from ECMWF data

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could shed some light on this question.

5 CRISTA-NF retrieval results

-page 10, lines 24/25: I don't see the "steep gradient" in the CFC-11 values. It looks rather as a gradual transition not like a "mixing barrier". However, I have no comparison of these values for a vortex in its undisturbed evolution phase. So, a more quantitative assessment would be beneficial!

- page 11, line 20-25: Again: no reference is established to the history of the polar vortex including the sudden stratospheric warming!

I know that this issue is discussed later in Section 6.2 on the air mass origin but for an early understanding of the dynamics and the associated mixing processes, I recommend to shift a general overview of the vortex evolution into Section 4.

6 Comparison to CLaMS and air mass origin

- page 16, line 24: "the polar vortex was very stable after 15 January" This is not true as the vortex was first displaced and afterwards broken end of January and begin of February. What you probably mean is that the air inside the observed vortex lobe wasn't much impacted by mixing of outside vortex air, right?!

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 10463, 2013.