Responses to Referee #1:

We thank the reviewer for his valuable and very contructive comments*:*

Comment:

This paper is a solid case study of the impact of vertically propagating mountain waves on the dynamics and the distribution of trace gases in the upper troposphere/lower stratosphere (UTLS) region. It combines in-situ airborne observations and numerical modelling. A successful application of a novel, recently published numerical approach (nesting of a LES-type model into a mesoscale weather prediction and research model) demonstrates the huge potential for future analyses of aircraft data.

In the study, the appearance of small-scale instabilities due to Kelvin-Helmholtz instabilities is deduced convincingly. Furthermore, the fluctuations of trace gases as O3 and CO are discussed and their variability is explained.

Altogether, the paper is well written and logically structured. There are only minor comments, otherwise, the paper can be accepted.

Minor comments:

Comment:

The discussion in section 6 never mentioned the term "tropopause" (surprinsingly for a paper on the UTLS, it appears only 5 times in the text). I believe, it is a known fact that the observed vertical gradients of O3 and CO are a signature of the tropopause. Can a PV-diagnostic as computed from the model results help to classify the observed air masses as being located in the above/below the actual tropopause??

Answer:

We agree with the comment of the Referee. The tropopause is now discussed in Section 6. It is true that PV can be used to identify the tropopause. In our case we found that the tropopause is better defined by the jump in stability (N). We now superimposed in Fig. 21 (Fig. 18 in the new version) the profile of the stability as a function of theta calculated from the model results. The jump in N2 is found at 330 K. This level also coincides with the level where O3 and CO have high vertical gradients. The potential temperature measured by the aircraft during the leg studied is above 330K, which suggests that the air sampled during this leg of the flight was located in the lower stratosphere.

GENERAL

Comment:

page 8: what is the meaning of ARW in WRF-ARW?

Answer:

ARW means Advanced Research WRF. This is added.

Comment:

page 12 lines 7/8: try to avoid qualitative statements as "The observed and simulated profiles are in good agreement." This says nothing; specify the min/max or the mean standard deviations! See also page 18, line 12, page 21, line 11.

Answer:

We removed the statement "The observed and simulated profiles are in good agreement" everywhere. We now specify the min/max when comparing observations and simulations for Figs.6-7 (Fig.1c-f in the new version), and we specify the correlation when comparing the observed and reconstructed variations of O3 and CO.

Comment:
page 12, last paragraph: could you estimate if the vertical profiles of the Scorer parameter would allow for trapped waves and support your findings in such a way by predictions from linear theory?!
Answer:
Yes, thank you for your suggestion. We did estimate the vertical profile of the Scorer parameter from the model result, and we included it in the revised version (Fig. 6 in the new version). This profile shows a strong decrease between 5 km and 8 km which allows for trapped waves formation, and therefore supports our findings.

Comment:
page 16, 1st paragraph: "The short-wavelength co-spectrum peak is not present at lower levels; this confirms that these short-wavelike fluctuations do not originate at mid- and upper-tropospheric levels." I don't understand the logic of this sentence. Isn't it just the opposite you want to conclude??
Answer:
We changed this sentence: "*The short-wavelength co-spectrum peak is not present at lower levels; this confirms that these short-wavelike fluctuations do not originate from the ground.*"

Comment:
page 19: here, I expect a more physical discussion about the sampling in different air masses related to the tropopause.
Answer:
We added more physical discussion about the sampling in different air masses related to the tropopause. We estimated the level of the tropopause from the microscale simulations. We define the tropopause by the jump in the Brunt Vaisala frequency (N). We superimposed the average profile of the stability as a function of potential temperature obtained from the model simulations to the averaged curves of O3 and CO. This profile shows a strong jump in the value of the stability at the vertical level of 330 K. This level also coincides with the level where the vertical gradient of O3 and CO increases, indicating that the tropopause is located around 330 K. The air masses sampled by the aircraft during the leg of the flight studied in this paper have potential temperature values above 330 K. This suggests that most of the air masses sampled were located above the tropopause.

Comment:
page 19, line 10: "In an other hand" = "On the other hand" ?? Also on page 20, line 27.
Answer:
Changed everywhere

Comment:
page 19, line 22: delete one of both "negative"
Answer:
Deleted

Comment:
page 20, line 20. Capital letter in Looking
Answer:
Changed

Comment:
Use SI units and their abbreviations ("h" instead of "hrs" and so on)
Answer:
"hrs" replaced by "h"

FIGURES

Comment:
There are 21 figures, some of them could be omitted (e.g. Fig. 1 or Fig 10), some could be combined (Figs 2 and 6,7). Generally, the quality is good. However, the readability of Fig. 18 could be enhanced by using different colors for the aircraft observations instead of dashed lines.
Answer:
Fig. 1 and Fig. 10 are omitted. Figs. 2, 6 and 7 are combined in Fig.1. Fig. 18 (Fig.15 in the revised version) is enhanced by using solid curve with red color coding for the aircraft observations instead of dashed lines.

REFERENCES

Comment
- typing errors in Moustaoui et al. 2010 (Grubisic), Plougonven et al. 2008 (Plougonven)
Answer:
Typing errors corrected

Comment:
not cited in the text:
Dornbrack, A.: Turbulent mixing by breaking gravity waves, J. Fluid Mech., 375, 113-141, 1998.
Wicker, L. J. and Skamarock, W. C.: Time splitting methods for elastic models using forward time schemes, Mon. Wea. Rev., 130, 2088-2097, 2002.

Answer:
The reference "Dornbrack, 1998" is now cited. There was a typo in the text "Dornbrack et al., 1999" is replaced by "Dornbrack, 1998". The reference to "Wicker and Skamarock" is removed from the list of references.

Comment:
not resolved in the reference list:
Fritts and Alexander, 2003 Dornbrack et al., 1999
Answer:
"Dornbrack et al., 1999" replaced by Dornbrack, 1998", and Fritts and Alexander, 2003 is added to the list of references.