We would like to thank the referee for her/his comments that we address in the following.

The manuscript describes the diurnal variability of hydrogen peroxide and its precursors presented as median values averaged for the whole campaign for five different locations in Europe spanning southerly (Spain and Cyprus) to northerly (Finland) field sites. The median diurnal variability is proposed to be a robust signature representative for a 'typical' pattern during the campaigns.

Based on these data hydrogen peroxide budgets are calculated from photochemical production, photochemical loss and dry deposition loss. Photochemical production is linked to the main H2O2 production pathway via recombination of HO2 radicals, chemical loss through reaction with OH radicals and photolysis while dry deposition is deduced from periods with constant mixing rations but still measurable production. Dry deposition losses than should be equal to production. HO2 and OH radicals were measured as well during the campaigns. As the production of H2O2 is a fast reaction from atmospheric radicals it's production term should thus basically follow the HO2 mixing ratios. The procedure to derive dry deposition loss rates requires also a constant mixed boundary layer as well as low impact from horizontal transport with probably different composition.

General comments

The manuscript is rather difficult to read even for somebody who is familiar with atmospheric chemistry. While the chemistry introduction is state of the art, see also Tremmel et al (1993) (there also vertical profiles of H2O2 in the planetary boundary layer and free troposphere) the description of the meteorological parameters controlling the composition of air masses investigated is marginal. Only for the HUMPPA campaign in Finland a more detailed meteorological description is available. However, it's necessary to consult an additional paper. This paper includes also the vertical structure of the atmosphere which is important for both, the production term of H2O2 during the morning hours between sunrise and noon as well as for the afternoon hours deposition calculation.

We regret that the referee considers the paper hard to read, and plan to do a better job to outline the purpose of the paper properly. Please note that we do not intend to model the H2O2 mixing ratios at different sites. This has been done e.g. in Crowley et al. (2018) using a box model for the HUMPPA campaign. Instead, we analyze the rate change of H2O2 mixing ratios in the early morning and during the night, using measured mixing ratios of precursors and photolysis rates associated with fast local photochemistry. This analysis only marginally depends on the local meteorology (with respect to temperature, pressure, relative humidity or wind speed). We agree with the referee though that the absolute level of H2O2 will strongly depend on the air mass history and thus on the synoptic meteorology. However, we feel that such an analysis is beyond the scope of our study. The relevant meteorological information necessary to evaluate Eq. 1, in particular the variation in boundary layer height, is presented in the paper, and we will scrutinize if this is well-balanced among the different campaign descriptions. Information in particular on air mass history, however, is not necessary to calculate local net production rates of H2O2.

Meteorological data given in the companion paper for CYPHEX are marginal. For the campaign HOPE, that's especially low in H2O2 mixing ratios no measurements of the MBL and no meteorological data are available at all.

More details on the meteorology for CYPHEX can be found in Meusel et al., 2016 (doi:10.5194/acp-16-14475-2016) or Hüser et al., 2017 (doi:10.5194/acp-17-10955-2017). Since no publication on HOPE meteorology has been published so far, we will summarize the meteorology for the different campaigns in a revised version of the manuscript by including this information into Chapter 2.1 (Campaigns, observations sites and meteorology).

The diurnal patterns presented are only contained in the supplement. Besides varying vertical axis units the time axis is plotted as UTC. This is basically a good way to plot a diurnal cycle, however, given the varying local time it makes a comparison of the different campaign data more difficult.

In order to compare different diurnal cycles, we included either the local solar zenith angle (Figure 2) or the JNO2 photolysis rate (supplement). We consider this more accurate than using local time, which is sensitive to the season and generally does not follows local insolation that drives the chemistry.

As three of the five stations (PARADE, HOPE and CYPHEX) are located either on mountain tops or in hilly terrain it is not clear, whether the assumptions made about a single vertical column over the filed site without only marginal impact of additional horizontal transport and depth of the nocturnal boundary layer are valid. These field sites are during the day subject to significant upslope winds and even in low elevation above the site horizontal wind speeds may increase strongly. Also the nocturnal in- version layer is often far below the elevation of the field site. This is addressed in the manuscript, but it's significance is not discussed.

As mentioned above, here we only calculate the rate of change of H2O2 during the morning hours based on local sources and sinks, i.e. photochemistry and dry deposition. Based on the local production and loss, we deduce the amount of transported hydrogen peroxide that is necessary to explain the observed increase in H2O2. Transport according to Eq. 1 includes both vertical and horizontal advection. Nevertheless, considering that a regular pattern with increasing mixing ratios from sunrise to noon is observed at all cites, it is more likely that vertical transport is responsible for the positive transport, since horizontal gradients are generally small while vertical gradients can be rather large (e.g. Klippel et al., 2011).

The data base is better for the HUMPPA campaign in Finland, however, the meteorological description of the campaign by Williams et al (2011) indicates that the summer 2010 was extraordinary hot in Finland and not representative for a 'typical' summer, making the results for HUMPPA less comparable to the other campaigns.

As mentioned in Williams et al., only the first half of the campaign was

exceptionally hot. Furthermore, this should not affect the comparability of HUMPPA to the other campaigns. Higher temperatures will most probably lead to higher emissions of biogenic compounds. Whether this will results in higher or lower values of HOx and thus H2O2 net production is interesting, though hard to say and beyond the scope of this study.

In summary I would recommend to consider publication after major revisions including a detailed meteorological chapter and a clear argumentation that even at the mountain stations the procedures to derive production and loss are valid. Looking at figure 2, it's obvious that hydrogen peroxide mixing ratios in Cyprus and at the Hohenpeißenberg are clearly out of phase to solar radiation and probably horizontal advection plays a major role although the chemistry is rather fast.

As mentioned above we do not exclude transport as a process to change H2O2 concentrations. Quite the contrary, we use fast local photochemistry and dry deposition to estimate chemical processes in order to estimate the contribution of transport. Due to the fact that the effect of transport is always positive, it is more likely that it is associated with a region were H2O2 mixing ratios are systematically higher, which points to a dominant contribution from vertical transport.

What is the time scale of the horizontal advection of the marine airmasses mentioned on page 13, compare to the time scale of advection of air masses at other mountain sites?

This depends on the horizontal wind speed, which is comparable (2 – 6 m/s) at all mountain sites.

Missing mixing height data for the day and the nocturnal inversion can be obtained for example from HYSPLIT. They agree relatively well with the HUMPPA measurements. Contained also in HYSPLIT is the information of rain during the transport. This is important for example for Föhn conditions where H2O2 mixing ratios are reduced due to washout shortly before arrival at the HPB observatory.

As mentioned above the air mass history will mainly affect the absolute values of the H2O2 mixing ratio and to a much lesser extent the rate of change. Since the analysis performed here is based on observed species, the advantage of using additional HYSPLIT data is marginal and will not help our production/loss analysis.

Tremmel, H.G., Junkermann, W. Slemr, F., and Platt, U., The Distribution of Hydrogen Peroxide in the Lower Troposphere over the Northeastern U.S. during Late Summer 1988, Journal of Geophysical Research, Vol. 98, 1083-1099, 1993

Minor comments

A statement about the detection limit of the method would be helpful, AERO-LASER claims < 100 ppt, but without mentioning whether this is 1 or 3 sigma.

DOMINO, PARADE and HOPE mixing rations are often very close to this level.

The detection limit of the instrument is mentioned on page 5 line 6 as being of the order of 25 pptv (1 sigma). It is determined from the reproducibility of zero air measurements during the individual campaigns.

The argument, that the mixing layer depth cannot be used for the CYPHEX campaign on page 11, line 5-6 also holds for the HOPE campaign.

We may miss the point of the referee. While nocturnal H2O2 mixing ratios show no systematic decrease during CYPHEX, a clear negative trend can be identified during HOPE indicating a first order loss process.

The figures in the supplement are hardly readable. The paper is not understandably without these supplementary figures.

In a revised version of the manuscript we will provide larger and clearer figures.

A figure illustrating graphically the budget calculations would be helpful.

Results of the budget calculations are summarized in Figure 6.

Typing errors

Page 5, lines 30 /31, Meteorologie Consult instead of Metorologie Consult

Page 11, line 27 and 29. With an uncertainty of +- 100 % it's unreasonable to estimate a deposition velocity within the percent accuracy.

Page 12. Line 32 morning instead of mourning

We will correct the typing errors in a revised manuscript.