Responses to the Reviewer 2

The present manuscript describes in detail a new experimental technique developed for measuring total OH reactivity. The instrument is compact and can easily be deployed in field campaigns. The compact size has benefits compared to currently used instruments and will possibly become a standard instrument, also for long-term measurements.

The paper is very well written, with many details on the instrumental design and the validation. I have no major remarks, only a few minor comments that might improve the manuscript:

We thank the reviewer for the thoughtful and thorough reviews. Point-by-point responses to the comments are attached below. We have made corresponding modifications, and these changes are marked in the revised manuscript.

1. Line 67: There has been another intercomparison campaign between CRM and LP-LIF technique, which you might want to cite for completeness: Hansen et al., Intercomparison of the Comparative Reactivity Method (CRM) and Pump-Probe technique for measuring total OH reactivity in an urban environment, AMT 8, 4243 (2015)

We added the work and revised the description in the manuscript.

> Several intercomparisons of the techniques and instruments mentioned above have been conducted. Zannoni et al. (2015) reported a field intercomparison of two CRM instruments in the Mediterranan basin. Hansen et al. (2015) carried out an intercomparison between the CRM and LP-LIF techniques in an urban environment. The series of intercomparison experiments conducted in the SAPHIR simulation chamber at Forschungszentrum Jülich involved all types of existing methods and nine instruments from around the world (Fuchs et al., 2017).

2. Line 113: demodulated
3. Line 123: spots ARE arrangeD
4. Line 135: consistsING
5. Line 145: undergoesING
6. Line 156: below than 79.2
7. Line 169: several

We made the modifications based on Suggestions 2 to 12.

13. Figure 5: It would be more convenient to define as time 0 the time when the photolysis laser is triggered.

Yes, time zero is commonly defined as the point at which laser photolysis is triggered, such as the time sequence in LP-LIF instrument. But in our system, as shown in the following figure, timing is started from the data acquisition to record first 30-ms data points to evaluate noise level and perform rapid background subtraction to obtain clear OH spectral signal for determining the operating current of the laser.
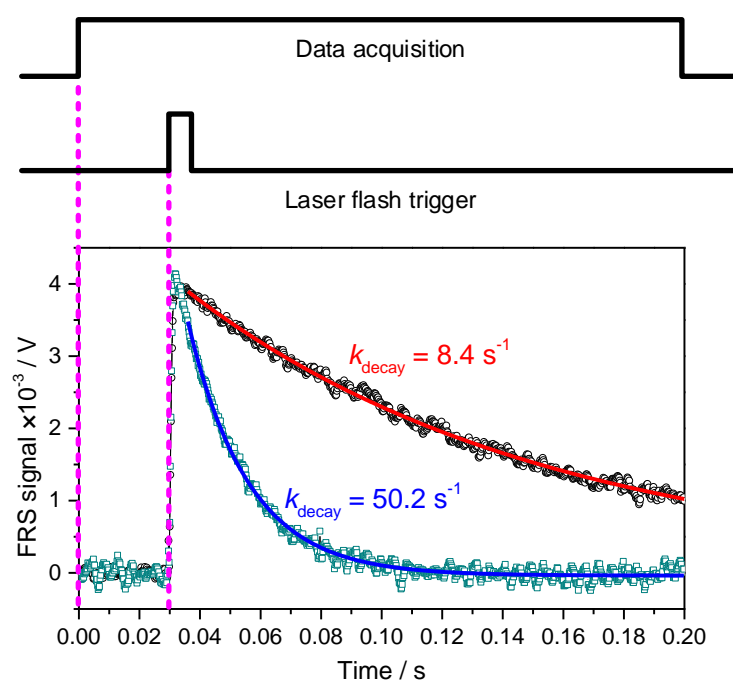

Fig.1: Time sequence of the developed portable LP-FRS instrument

14. Line 290: You consider that the remaining around 80% of the k_{zero} is due to reaction with impurities?

Yes, the impurities in additional zero flow and water are considered as the major contribution to the instrument zero.

15. Figure 7: How k$_{OH}$ can be negative? I guess you removed the overall average value (5.2s^{-1}?) from each individual value? Please specify.

Yes, the measurement is the correction value after being processed with instrument zero and dilution, as described in Eq.7 of $k'_{OH} = f \times (k_{decay} - k_{zero})$. We added the description in the manuscript.

> To assess the measurement precision of the LP-FRS instrument, an Allan deviation analysis was conducted on time series of zero air measurements. <u>The measured values were processed by subtracting the instrument zero.</u>

16. Line 299: with A total a

Done.

17. Line 300: Can you confirm that the measurement precision is already converted to atmospheric conditions, ie. that the precision of the measurement itself is 5 times better?

Yes, we confirm the precision is converted to atmospheric conditions. The measured values in Fig.7 were processed with the instrument zero and the dilution factor.

18. Line 302: improved

Done.

19. Figure 8: same question: how can k$_{OH}$ be negative? And what is the mean value of 0.2 s^{-1}?

The measured values have been processed by subtracting the instrument zero. The value of 0.2 s^{-1} reflects the relatively stability of multiple long interval measurements, without any significant measurement drift.

20. Line 329: (RH) concentration
21. Line 376: missing reactivity of

Done. We made the modifications based on Suggestions 20 to 21.

22. Finally, some more information on energy consumption, total weight, and also an indication on the cost of the instrument could be interesting to the reader.

We added the information at appropriate locations in the revised manuscript.

Revision in Introduction:

The time-resolved LP-FRS is a novel technique that employs a mid-infrared semiconductor diode laser (with much cheaper commercial price than the typical dye laser system and good stability) as the probe laser for k_{OH}' measurement, making the technique both cost-effective and simple to operate (Wei et al., 2020).

Revision in Sec.2:

Optical components from both systems are integrated into a single unitary box, with all communications and gas tubes connected to designated interfaces. The optical box has dimensions of 130 cm × 40 cm × 35 cm and a total weight of ~ 90 kg. The instrument's total operation power consumption is ~ 3 kW. These factors make the developed LP-FRS instrument both cost-effective and portable for field applications.