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Atmospheric Measurement Techniques Discussions

Interactive comment on "The evolution of AMULSE (Atmospheric Measurements by Ultra-Light Spectrometer) and its interest in atmospheric applications. Results of the Atmospheric Profiles Of GreenhousE gasEs (APOGEE) weather balloon release campaign for satellite retrieval validation" *by* Lilian Joly et al.

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Review#2

The evolution of AMULSE (Atmospheric Measurements by Ultra-Light Spectrometer) and its interest in atmospheric applications. Results of the Atmospheric Profiles Of

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Discussion paper

GreenhousE gasEs (APOGEE) weather balloon release campaign for satellite retrieval validation

Anonymous Referee #2

Received and published: 3 January 2020

Thank you very much for your interest in our work. I warmly thank the Reviewer for his valuable comments which enabled us to improve this article.

General Comments

1) This paper should be reconsidered after major revisions.

2) There are sections of the paper that focus solely on IASI analysis and then shoehorn in the fact that the analysis was also done with CrIS. It would be beneficial to add more details on the analysis done with CrIS. A couple of the sections that need more information are mentioned in the specific comments.

3) There are many grammatical mistakes throughout that need fixing. I compiled a list of the ones I found but there are certainly more.

4) Overall, the structure of the paper is good.

Specific comments

1) Many acronyms are used without being spelled out in the abstract (CNRM, AMULSE, APOGEE, IASI, CrIS, NWP, RRTOVRTTOV, MOCAGE, CAMS)

Added

2) P8. Figure 2: What does the % of H2O represent?

We changed the unit to be more explicit, we put it in ppmv (parts per million by volume).

3) P11. Line 3: The photo synthesis phenomenon enriching CO2 should have a reference

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3) In section 5.1.3 and 5.2.2, the authors should add more information on CrIS. CrIS seems to be mentioned off handwhile all of the analysis is done with IASI.

4) In equation 1 in section 5.1.5 exp should be rewritten as either exp(O3) or O3=ln(.....). The superscript simul could also be shortened to just sim.

EXP means Âń experiment Âż for example, EXPO3 means experiment for ozone case, etc.

Technical corrections

P1. Line 5-6: I recommend splitting this into two sentences. Maybe “The plug and play instrument is compact, robust, cost-effective, and autonomous. The instrument also has a low power consumption and is non-intrusive.”

Corrected

P2. Line 7-8: rewrite to “The climate of the earth is currently changing quickly. Recently, evidence has accumulated showing that this climate change is directly related to human activities.” Line 9: change “involve” to “create” Line 10: change “of” to “on”Line 10: remove “on Earth” Line 20: remove “the” before CH4

All Corrected

Line 22: change “many informations” to “information” Line 25: Define the RRTOV RTTOV acronym

Corrected

P4. Line 26: change “meters”’ to “meters” Line 27: change “lots of preparations” to “a lot of preparation”

Corrected

P5. Line 2: change “This specificity of the balloons, to be able to access the pofiles,” to“The balloons’ ability to access the profiles”

Corrected

P6. Line 9: close the parentheses Line10: change “The spectrometer weights is lower than” to “The spectrometer weighs lessthan” Line 13: change “send various datas” to “sends various data” Line 14: computerfixed 400m in relation to what? Line 15: capitalize AMULSE Line 23: change “at” to “a”change “about” to “for” Line 25: capitalize AMULSE

Corrected

P7. Figure 1: capitalize AMULSE,remove “of (a) CO2,(b) CH4 and (c) H2O” P9. Line 3: replace “the” with “our” Line 9:change “balloon” to “balloons” Line 10: add period at the need of this sentence Line 18:change “Balloon” to “The balloon” Line 20: change “Balloon” to “The balloon” Line 20: change “cutted” to “cut” Line 29: make hypothesis plural

P11. Move the table 2 captiondown a line Line 6-7: change “prospects for 2020 is to make water vapour measure-ments by laser diode spectrometry to have a better accuracy” to “goals for 2020 is tomake water vapour measurements by laser diode spectrometry more accurate”

Corrected

P12.Line 6: change “a prior” to “a priori”

Corrected P13. Line 15,19,20, and 21: Either use commas or no separation between the thousand and hundred place in numbers instead of decimal points. (i.e. 1,000 or 1000)

Corrected

P16. Need to fix decimal points on this page as well. Line 4 and 5: what does “rp” mean Why did CO2 and CH4 become italicized midway throughthis page

decimal point and italicized corrected. "rp" is the abbreviation for respectively, which I

replace here by "resp.".

P17. Figure 9: If “,rp” stands for reference profiles you need a better way of conveying this Line 5: add “to” between “CO2” and “have”

In the same way Âń rp Âż means Âń respectively Âż

P18. Line 8: change “validate to “verify” and remove “essentially”

Corrected

P19. Line 5: Remove“of the”

Corrected

P20. Line 13: add space to “be retrieved” Line 14: change “. Which” to “, which” Line 25: Remove “of” add the start of the sentence. I do not think “restitutions” is the right word here.

Corrected

P22. Last 2 lines: Remove italics on chemical names

Corrected

P23. Figure 12panel d: change “radiosondage” to “radiosonde”

Corrected

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2019-335, 2019.

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Discussion paper

The development of the Atmospheric Measurements by Ultra-Light Spectrometer (AMULSE) greenhouse gas profiling system and its interest in atmospheric applications

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Abstract.

We report in this paper the development of an embedded ultralight spectrometer (< 3 kg) based on tuneable diode laser absorption spectroscopy (with a sampling rate of 24 Hz) in the mid-infrared spectral region. This instrument is dedicated to in-situ measurements of the vertical profile concentrations of three main greenhouse gases: carbon dioxide (CO_2), methane (CH_4) and water vapour (H_2O) via standard weather and tethered balloons. The plug and play instrument is compact, robust, cost-effective, and autonomous. The instrument also has a low power consumption and is non-intrusive.

It was first calibrated during an *in situ* experiment on an ICOS (Integrated Carbon Observation System) site for several days, then used in a two experiments with several balloon flights up to 30 km altitude in the Reims-France in 2017-2018 in collaboration with Météo-France/CNRM Centre National de Recherches Météorologiques.

This paper shows the valuable interest of the data measured by AMULSE (Atmospheric Measurements by UltraLight SpEctrometer) instrument during the APOGEE (Atmospheric Profiles Of GreenhousE gasEs) measurement experiment, specifically for the vertical profiles of CO_2 and CH_4, which remain very sparse. We have carried out several experiments showing that the measured profiles have several applications: for the validation of simulations of infrared satellite observations, for evaluating the quality of chemical profiles from Chemistry Transport Models (CTM) and for evaluating the quality of retrieved chemical profiles from the assimilation of infrared satellite observations. The results show that the simulations of infrared satellite observations from IASI (Infrared Atmospheric Sounding Interferometer) and CrIS (Cross-Track Infrared Sounder) instruments performed in operational mode for Numerical Weather Prediction (NWP) by the Radiative Transfer Model (RTM) RTTOV (Radiative Transfer for TIROS Operational Vertical sounder) are of good quality. We also show that the MOCAGE (MOdèle de Chimie Atmosphérique à Grande Échelle) and CAMS (Copernicus Atmospheric Monitoring Service) CTMs modeled ozone profiles fairly accurately and that the CAMS CTM represents the methane in the troposphere well compared to MOCAGE. Fi-

Fig. 1.