First of all, we would like to sincerely thank Reviewer 2 for the interest in this study and the very constructive comments and suggestions on our manuscript. We carefully considered each point. Please find below our responses and related changes (highlighted in red).

General comments

This manuscript presents a database of soil and vegetation parameters and variables collected during a two year field campaign over an agricultural test site in Thuringia, Germany. The authors describe in great detail which parameters were measured and how and provide some outlook for potential uses of the database.

General comments:
Generally, the paper is well written and provides a thorough overview of the contents and generation of the database and as such represents a useful resource for potential users of the database. My main concern is the science merit (or lack thereof) of this paper. While a thorough description of the database and field campaign is certainly useful, I think that by itself it is more appropriate for a data documentation or technical memorandum rather than a scientific article. That being said, the authors do mention that several satellite images are available for the study period and domain and that the database is meant to validate land data assimilation systems. So one option would be to include a short comparison of the collected in situ measurements against the satellite or data assimilation estimates as a short illustration for potential applications. In such a comparison, the authors could also try to show how the combination of a large number of parameters and a high temporal resolution (compared to other in situ datasets as indicated in the text) helps to better validate the satellite or data assimilation products.

Answer:

Thank you for this suggestion. We completely agree that the next step is to demonstrate the added value of the large number of parameters and the high temporal resolution. However, we believe that this is beyond the scope of this manuscript. At the moment, we are working on the implementation of realistic prior information in EO-LDAS using the presented data from the Gebesee test site (information has been added to the manuscript at page 13, line 22). We intend to quantify the (expected) uncertainty reduction that can be achieved using different prior information. This requires at least a clarification of the operating principles of EO-LDAS, an explanation on the stratification of the dataset into training and validation data, a methodological description on the generation of prior information and a sound presentation and discussion of the results. We think that this information would better fit into a separate manuscript that is currently in preparation.

The aim of this manuscript submitted to Earth System Science Data (ESSD) is the presentation of the ground reference database including a detailed description of the study design and methods. We are confident that this manuscript, in combination with the database, will stimulate further research on the vegetation monitoring with data assimilation systems and satellite-aided retrieval models. We think that this is in accordance with the foci of ESSD, i.e., articles that "may pertain to the planning, instrumentation, and execution of experiments or collection of data. Any interpretation of data is outside the scope of regular articles" (https://www.earth-system-science-data.net/about/manuscript_types.html).

Changes in manuscript:

Page 13, line 22. Added and modified text: "The database will be used to implement realistic prior information into EO-LDAS and to assess the effects on the accuracy of derived vegetation parameter values."

Specific comments

(1) Abstract

In the abstract, it might make sense to add a qualifier that the data collected during the field campaign are mostly focused on supporting the validation of data products based on visible and (near-) infrared satellite observations.

Answer:

We will add this information to the abstract.

Changes in manuscript:

Page 1, line 15. Modified text: "Here, we describe the acquisition of a comprehensive ground reference database which was created to test and validate the recently developed Earth Observation Land Data Assimilation System (EO-LDAS) and products derived from remote sensing observations in the visible and infrared range."

(2) Introduction

P. 1 Ll. 36-37: Could you please include half a sentence or so on what temporal resolution is 'sufficiently high'. That is, what are the temporal scales on which the collected plant and soil parameters typically change in the study domain?

Answer:

We will rephrase the first and second paragraph of the introduction. Indeed, data assimilation (DA) systems, such as EO-LDAS, can be run without any observations. In this case, the result will resemble the prior information implemented in the DA system. Adding data from observations reduces the uncertainty in derived vegetation parameters. The more observations are available the lower the expected uncertainty. Speaking of a "sufficiently high temporal resolution" is therefore misleading.

With respect to the set-up of EO-LDAS, a high temporal resolution is required for the set-up of detailed prior information regarding seasonal variations of vegetation parameters. The high temporal resolution might not be mandatory for satellite-aided retrieval models in general. Therefore, we will refer only to EO-LDAS in the first two paragraphs. The potential of the database for retrieval models will be first mentioned in the last paragraph of the introduction.

Changes in manuscript:

Page 1, line 23-25. Rephrased text that builds the first paragraph of the introduction: "Ground reference data are required for the set-up and validation of land data assimilation systems that enable large-scale monitoring of crop properties with Earth Observation data (Lillesand et al., 2008). The recently developed Earth Observation Land Data Assimilation System (EO-LDAS; Lewis et al., 2012) represents a weak-constraint variational land data assimilation system that relies on radiative transfer models describing the interaction of photons with canopy, leaves and soil. EO-LDAS can be used in two different modes. In the forward mode, the surface reflectance of vegetated areas can be simulated in the visible and infrared domain for a given set of soil and vegetation parameters. In the inverse mode, Earth Observation data are interpreted in terms of soil and vegetation parameters, while prior information is introduced to diminish the uncertainty of retrieved parameters (cf. Chernetskiy et al., 2017)."

Page 1, line 26-30. Text remains the same, but builds now the second paragraph of the introduction.

Page 1, line 31-37. Builds now the third paragraph of the introduction. Rephrased text of line 34-37: "While the acquisition of all these datasets is well aligned with specific project aims, none of the aforementioned datasets meets the requirements for comprehensive testing and validation of EO-LDAS. For the validation of the inverse mode, ground reference data must be available for various soil and vegetation parameters represented in EO-LDAS, while the set-up of detailed prior information on seasonal parameter variations necessitates a high temporal resolution. In addition, hyperspectral measurements are required for an in-depth validation of the forward mode."

Page 2, line 1-7. Builds now the fourth paragraph of the introduction. Rephrased text of line 1-3: "Here, we present a comprehensive ground reference database for the set-up, test and validation of EO-LDAS, that may be also used in combination with satellite-aided retrieval models."

Page 14, line 29. Added reference: Chernetskiy, M., Gómez-Dans, J., Gobron, N., Morgan, O., Lewis, P., Truckenbrodt, S., and Schmullius, C.: Estimation of FAPAR over Croplands Using MISR Data and the Earth Observation Land Data Assimilation System (EO-LDAS), Remote Sensing 9, 30 pp., doi:10.3390/rs9070656, 2017.

(3) 4.1.2 Fractional vegetation cover and proportion of senescent material

P.4 ll. 11-12: Does this mean 10 images per species per ESU? How did you deal with the mixed crop ESU?

Answer:

The visual inspection of 300 pixels per image is rather elaborative. Therefore, we decided to determine the bias and precision of FVC and PSM for only one ESU per species. We will rephrase the sentence for clarification.

For each ESU, ≥10 images (i.e., ≥3000 pixels) were analyzed. The exact number of analyzed images is indicated in the database (doi: 10.1594/PANGAEA.874144).

For the mixed-crop ESU 430-2, we analyzed 17 images in total that were taken at the SSP00, SSP08, SSP12 and SSP16 all of which were cultivated by spring wheat in 2013.

Changes in manuscript:

Page 4, line 11-12. Rephrased text: "Bias and precision of *FVC* and *PSM* were assessed separately for each species based on one arbitrarily selected ESU from which ≥ 10 images were analyzed."

(4) 4.2.1 Chlorophyll content

P.6 ll. 39-40: Could you please indicate in the text what potential causes for this increased afternoon bias are?

Answer:

The SPAD-502Plus determines the transmissivity of an object (e.g., a leaf) at wavelengths of 650 and 940 nm. Electromagnetic waves at these wavelengths can be affected by Rayleigh and Mie scattering. Thus, a bias could be potentially caused by an increasing contamination of the sensor field (e.g., by dust, aerosols, pollen) during the field working day (although the SPAD-502Plus partially corrects for contamination (Markwell et al., 1995; doi: 10.1007/bf00032301)). The increase by 0.4 units is, however, negligible as the manufacturer indicates an uncertainty of ± 3.0 units for the reference value of the SPAD-502Plus reading checker. Therefore, we will delete the information of increasing values throughout the field working day and state the uncertainty of the reference value instead.

Changes in manuscript:

Page 6, line 38-40. Modified text: "Biases range from –1.5 to 1.2 with a median of –0.1 which is below the tolerance of ±3.0 indicated by the manufacturer. The 1σ errors varies between 0.1 and 0.7 with a median of 0.1."

(5) 4.3 Soil moisture

P.7 ll.29-30: Could you please indicate the reason for the increased number of measurements in the potato field? Is an increased heterogeneity expected in a potato field?

Answer:

A high small-scale soil moisture variability is to be expected on potato fields with high values on the furrow bottom and low values on the furrow ridge (Robinson, 1999). We will add this information to the text.

Changes in manuscript:

Page 7, line 29-32. A high small-scale soil moisture variability is to be expected on potato fields with high values on the furrow bottom and low values on the furrow ridge (Robinson, 1999). Thus, five measurements were performed per examined SSP: one in the middle of the furrow ridge centered between neighboring plants and two additional measurements on each side, i.e., one measurement in the middle of the slope and another one at the bottom of the furrow, respectively.

Page 17, line 24. Added reference: Robinson, D.: A comparison of soil-water distribution under ridge and bed cultivated potatoes, Agr. Water Manage. 42 189–204, doi:10.1016/S0378-3774(99)00031-1, 1999.

Technical Corrections

P. 1 l. 9: Replace 'elaborated' with 'developed'.

Answer:

We changed it to 'created' since 'developed' is used again in the same sentence.

Changes in manuscript:

Page 1, line 9. Modified text: "Here, we describe the acquisition of a comprehensive ground reference database which was created to test and validate the recently developed Earth Observation Land Data Assimilation System (EO-LDAS)."

P. 1 l. 16: Please change to '… are available'.

Answer:

Will be changed accordingly.

Changes in manuscript:

Page 1, line 16. Modified text: ""

In situ data collected less than 1 day apart from satellite acquisitions (RapidEye, SPOT5, Landsat-7 and -8) with a cloud coverage ≤ 25 % are available for 10 and 16 days in 2013 and 2014, respectively.

P. 1 l. 17: Replace 'In the article, …' with 'Here' or 'In this study …'

Answer:

Will be changed to 'Here'.

Changes in manuscript:

Page 1, line 17-18. Modified text: "Here, the experimental design of the field campaigns, and methods employed in the determination of all parameters are described in detail."

P. 1 l. 19: Change to 'These data will contribute … .'

Answer:

Will be changed accordingly.

Changes in manuscript:

Page 1, line 19. Modified text: "These data will contribute to a further development of crop monitoring methods based on remote sensing techniques."

P. 1 l. 23: I would suggest removing the 'other', since data assimilation systems are not quite the same as retrieval models.

Answer:

We agree. As part of the rephrasing of the first paragraph of the introduction (see above: Specific comments, (2) Introduction), the phrase 'and other retrieval models' was removed.

Changes in manuscript:

Page 1, line 23. Modified text: "Ground reference data are required for the set-up and validation of land data assimilation systems that enable large-scale monitoring of crop properties with Earth Observation data (Lillesand et al., 2008)."

P. 2 l.1: please change 'elaborated' to 'developed'

Answer:

As part of the rephrasing of the last paragraph of the introduction (see above: Specific comments, (2) Introduction), the phrase 'that has been originally elaborated' was removed.

Changes in manuscript:

Page 2, line 1. Modified text: "Here, we present a comprehensive ground reference database for the set-up, test and validation of EO-LDAS, that may be also used in combination with satellite-aided retrieval models."

P.2 l.3: Same comment as above that retrieval algorithms and data assimilation systems are not quite the same.

Answer:

As part of the rephrasing of the last paragraph of the introduction (see above: Specific comments, (2) Introduction), the word 'other' was replaced by 'satellite-aided'.

In addition, we will remove the word 'other' in the title.

Changes in manuscript:

Page 2, line 3. Modified text: "Here, we present a comprehensive ground reference database for the set-up, test and validation of EO-LDAS, that may be also used in combination with satellite-aided retrieval models."

Page 1, line 1-3. Modified title: "Seasonal evolution of soil and plant parameters on the agricultural Gebesee test site: a database for the set-up and validation of EO-LDAS and satellite-aided retrieval models"

P.2 l. 23: Maybe better 'An eddy covariance flux tower in the center of field 430 has been operated since 200.'

Answer:

Will be changed accordingly. As part of the recommended restructuring of chapter 2 by Reviewer 1, the sentence will be shifted to the end of the paragraph.

Changes in manuscript:

Page 2, line 23. Modified text: "An eddy covariance flux tower is operated in the center of field 430 since 2000 (MPI BGC, 2015)."

P.2 l.28: Please change to '… data for winter rape …'

Answer:

Will be changed accordingly. In addition, we will also change "of" into "for" on page 8, line 32.

Changes in manuscript:

Page 2, line 28. Modified text: "In addition, data for winter rape and sugar beet were gathered in 2014 (Table 1)."

Page 8, line 32. Modified text: "(1) extraction of the acquisition time from the metadata for each hyperspectral measurement;"

P.4 l.34: Please change to 'oriented'

Answer:

Will be changed accordingly.

Changes in manuscript:

Page 4, line 34. Modified text: "The sensor lens was covered with a 45° view cap with the field of view (FOV) oriented parallel and orthogonal to the planting rows […]."

P.5 l.7: Please change to '… were taken at a distance of …'

Answer:

Will be changed accordingly.

Changes in manuscript:

Page 5, line 7. Modified text: "DHPs were taken at a distance of approximately 1 m from the ESU diagonal to prevent an influence of the disturbed canopy architecture."

P.5 l. 22: Please change to 'border'.

Answer:

We will correct the spelling.

Changes in manuscript:

Page 5, line 22. Modified text: "Afterwards, circular areas of interest were extracted with a radius equal to the minimal distance between the optical center (Baret, 2004) and the border of the image."

P.5 l.22: Please change to 'The circular area of interest corresponds to …'

Answer:

Will be changed accordingly.

Changes in manuscript:

Page 5, line 22. Modified text: "The circular area of interest corresponds to a view angle of 42.5° and 37.5° for the upward and downward photos, respectively."

P.5 l. 26: Please change to '… on each day of field work …'

Answer:

Will be changed accordingly. In addition, we will also change "at" into "on" on page 7, line 14.

Changes in manuscript:

Page 5, line 26. Modified text: "Starting in June 2013, at least one of the two methods was employed on each day of field work."

Page 7, line 14. Modified text: "Fresh mass (m_{fresh}) was determined on the same day."

P.7 l.33: Is this once per week per ESU?

Answer:

Yes, the gravimetric soil moisture was determined once per ESU on each field working day (will be changed accordingly for clarification).

Changes in manuscript:

Page 7, line 33. Modified text: "The gravimetric soil moisture was determined once per ESU on each field working day."

P.10 l.36: Could you please spell out 'cv.' And remove the full stop? It is a bit confusing to read this otherwise.

Answer:

Will be changed accordingly.

Changes in manuscript:

Page 10, line 36. Modified text: "In Fig. 4, time series of soil moisture, plant height and proportion of senescent material on ESUs cultivated with spring wheat cultivar Taifun are compared with mean monthly temperature and monthly rainfall."