Reviewer 2:

The authors present a commendable collaborative effort in integrating daily aggregated in-situ R_{eco} measurements from air warming experiments consisting of control plots and warmed plots with open top chambers at 64 Arctic and alpine tundra sites across 12 countries. The dataset spans from 2000 to 2024 and has decent coverage of circumpolar Arctic ecosystems, making it a robust resource for spatial and temporal studies. The dataset has strong potential to contribute to collaboration across nations and research teams in current and emerging studies, allowing for reliable model comparison and leading to a scalable synthesis of Arctic warming and responses in R_{eco}, and becoming a useful resource to further our understanding and identify knowledge gaps of Arctic ecosystems and biogeochemical cycling. Therefore, I think this dataset is fitting for Earth System Science Data and is a meaningful contribution to the literature. However, I found that the future directions of the manuscript were lacking, and I think the authors could be more explicit in mentioning their next steps, as well as mentioning how they will streamline the process of maintaining the database for future data integration and cross-collaboration.

Overall, the manuscript was easy to follow and is well-written. I found that I was able to have a solid understanding of what the database is and its utility. Accessing the database took me some time, but once I had downloaded all the files from Zenodo and had tinkered with them in R, I was able to view them. I appreciate the authors' organization of the datasets and files, as well as the detailed information provided in the supplementary materials. I think TundraFlux is an impressive and valuable resource, and I appreciate it being an open-access dataset.

Response: We thank the reviewer for their positive assessment of the TundraFlux Database and for recognizing its potential to support synthesis studies, model evaluation, and international collaboration. We also appreciate the reviewer's suggestion to provide more detail on future directions and long-term database development. In response, we have expanded the discussion of future perspectives to more explicitly outline planned database growth, including the incorporation of additional flux variables (methane and nitrous oxide) and experimental treatments, integration with complementary databases and synthesis efforts, and continued community-driven data contributions **(L377-395)**.

Below, I have made some line-by-line suggestions for the authors to consider:

Supplementary:

S1: I really liked the inclusion of the start year for each of the sites for the warming experiments. I think it would be helpful to include a column for the end year as well here, or within the same column for the start year, and change it to provide the beginning and end year (e.g., Start – End warming)

Response: We are glad to hear the reviewer found the inclusion of the start year of the warming experiments useful. We agree that the duration of prior warming can be an important factor, as it may influence plant and microbial community composition and thereby affect R_{eco}. However, to our knowledge all the warming treatments included here are still ongoing and therefore do not have a defined end year. We asked for this information specifically in the data collection phase and no dataset provided an end year for their warming treatment. For this reason, an end date is generally not applicable, and we have chosen to report only the start year.

ITEX_biomass_method_protocol: The inclusion of this document is a nice addition and a helpful resource for the database. However, it looks like the links included in the document do not work for reviewer access and received a “404 file not found” error.

Response: Thank you for letting us know. We have now revised the document to include only the relevant information: the protocol for plant height measurements. We have also updated the link to the ITEX manual.

Main Text

1. **Introduction**

Line 119: Might want to consider including a definition for permafrost (e.g., soil that remains consecutively frozen for at least 2 years)

Response: We agree and added a definition of permafrost in **L117-121**, where it now reads:

”*The Arctic and alpine tundra biome stores one-third of global soil organic carbon, which is nearly twice the atmospheric carbon pool (Schuur et al., 2015), much of it locked in permafrost (i.e., soil that remains consecutively frozen for at least 2 years), organic-rich mineral soils, and peat (Gorham, 1991; Hugelius et al., 2020; Park et al., 2025; Schuur et al., 2022; Tarnocai et al., 2009; Zimov et al., 2006).*”

1. **Description and structure**

Lines 158-164: adding a line or two in this paragraph to mention that warming alters tundra ecosystems in the increasing frequency of thermokarst activity (geomorphology impacts), which may also contribute to R_{eco}. Some references below:

https://www.nature.com/articles/ncomms13043

https://www.nature.com/articles/s41467-019-09314-7

https://ecoss.nau.edu/wp-content/uploads/2016/05/Vogel_et_al-2009-Journal_of_Geophysical_Research-_Solid_Earth_1978-2012.pdf

https://www.researchgate.net/publication/281261197_Permafrost_collapse_alters_soil_carbon_stocks_respiration_CH4_and_N2O_in_upland_tundra

Response: We acknowledge geomorphological disturbance (thermokarst/permafrost collapse) as an additional warming pathway influencing tundra carbon dynamics and potentially ecosystem respiration (Reco), and have added a corresponding sentence, which now reads:

“Warming alters tundra ecosystems through a suite of interacting biotic and abiotic pathways, including changes in vegetation composition (Bjorkman et al., 2020; Collins et al., 2021; García

Criado et al., 2025; Wilson and Nilsson, 2009), plant productivity (Hollesen et al., 2015; Myers-Smith et al., 2019), microbial activity (Frossard et al., 2021), decomposition rates (Sarneel et al., 2020; Schwieger et al., 2025), nutrient cycling (Weedon et al., 2012), growing season length (Barichivich et al., 2013; Collins et al., 2021; Myers-Smith et al., 2019; Oberbauer et al., 1998), and snow-mediated microclimate conditions (Morgner et al., 2010; Pattison and Welker, 2014; Rixen et al., 2022), as well as increased thermokarst activity and permafrost degradation, which can strongly alter soil structure and carbon availability and thereby contribute to ecosystem respiration (Reco) (Abbott and Jones, 2015; Lewkowicz and Way, 2019; Olefeldt et al., 2016; Vogel et al., 2009).” **(L164-171)**

Line 210: This could be a user error on my end, but when opening the Tundra_flux_daily_v1 in my version of R, I see 76 variables instead of 74. Could it be a typo here?

Response: That is indeed a typo and we corrected it.

Lines 258-259: You may want to double-check to make sure the DOI works for others to access Zenodo. Additionally, having a direct link here to the dataset would be helpful to readers. Maybe this can be included in the DOI display name?

Response: The dataset will be made publicly available through Zenodo upon acceptance of the manuscript in *Earth System Science Data*. At present, the DOI is reserved but not yet active, and will become fully accessible once the publication is accepted. We will ensure that the final published version includes a working direct link to the dataset.

Applications of the TundraFlux database

Lines 274-275: I appreciate the authors' efforts in including shoulder season observations in the database.

Response: We agree that these measurements are important for improving our understanding of ecosystem respiration outside the growing season, which remains comparatively underrepresented in current datasets.

1. **Future Directions**

Lines 369-379: Would including other variables be considered for future directions in addition to what is already included in the database? For example, the tundra type or landform (thaw slumps, peatlands, coastal, etc.) for each of the sites would be interesting and helpful for future studies. Additionally, mentioning other potential methods that can be incorporated into, for example, the integration of field-based observations and remotely sensed observations?

Response: We thank the reviewer for this suggestion. We already include several of the proposed future directions in the manuscript, on **L377-395**. Specifically, we outline plans to incorporate additional flux variables such as methane, nitrous oxide, NEE, and GPP **(L377-378)**, as well as additional experimental manipulations such as snow fence and experiments **(L379-384)**. We also explicitly discuss integration with other major tundra synthesis efforts and databases.

We agree that additional metadata layers, such as tundra type, landform classification (e.g., peatlands, thaw slumps, coastal systems), and potential links to remotely sensed products, would be highly valuable for future syntheses. These are indeed important directions for improving cross-site comparability and scaling. We therefore added a sentence in the discussion highlighting these as longer-term opportunities for database development. It reads as follows:

"*In recent years, remote sensing using unmanned aerial vehicles (UAVs) and satellites has advanced significantly, providing an opportunity to quantify landscape heterogeneity in the tundra biome at high spatio-temporal resolutions (Assmann et al., 2020; Myers-Smith et al., 2020). With this data, it is possible to bridge the gap between the TundraFlux plot-scale field measurements and large-scale remote sensing mapping products. In addition, we will incorporate remote sensing-derived metadata, such as tundra type and landform classification (e.g., peatlands, thaw slumps and coastal systems), as well as other derived products (Niittynen, 2026; Virkkala et al., 2024; Wagner and Hugelius, 2026), into future syntheses. Finally, we aim to link the TundraFlux Database with other available databases on terrestrial carbon fluxes (Table S1), including the Tundra Trait Team database (Bjorkman et al., 2018), the Manipulation Experiments Synthesis Initiative (MESI; Van Sundert et al., 2023), COSORE (Bond-Lamberty et al., 2020), and the ABCflux database (Leffler et al., 2025; Virkkala et al., 2022). Although integration remains challenging due to differences in data formats, identifiers, and metadata standards, establishing common protocols will be crucial to advance syntheses across databases.*" **(L385-395)**