General comments

The authors present a thorough evaluation of land-atmosphere (L-A) coupling and its influence on subseasonal-to-seasonal (S2S) predictability, specifically focusing on surface air temperature (T2m). They assess the coupling processes by calculating correlations that capture the interactions between land conditions and surface fluxes, as well as between surface fluxes and the overlying atmosphere or boundary layer. The study analyzes 414 forecast dates using Version 2 of NASA's advanced GEOS S2S analysis and forecast system, with comparisons to ERA5 and MERRA2 reanalyses. The authors effectively emphasize the importance of understanding L-A coupling strength for enhancing forecast skill, especially for "forecasts of opportunity" across the continetal U.S.

Your study provides valuable insights into the role of strong L-A coupling for enhancing surface air temperature prediction on subseasonal-to-seasonal timescales. One area that could enrich this research further would be an exploration of how this coupling influences the predictability of specific extreme events, such as heatwaves and soil moisture droughts, or their compound occurrences. Understanding these interactions could provide additional context for the societal and ecological impacts of such events and improve risk management strategies. Do you see potential in integrating analyses of compound heatwave-drought events with your L-A coupling framework to advance this aspect?

Below, I offer several suggestions to strengthen the paper.

Specefic Comments

Title
The current title, "The role of land-atmosphere coupling in subseasonal surface air temperature prediction," could be refined to better reflect the study's specific focus. I suggest including the geographic focus and indicating the use of the GEOS-S2S-2 model and reanalysis data for increased specificity.

Introduction

1. The introduction could benefit from integrating recent studies that highlight how the development of compound drought-heatwave events is influenced by distinct land-atmosphere (L-A) coupling behaviors associated with water and energy limitation regimes in various U.S. regions. For instance, the work by Yoon et al. (2024) emphasizes how L-A coupling significantly shaped the 2022 compound drought-heatwave events in the contiguous United States (CONUS). Incorporating these findings could provide context on how specific L-A coupling dynamics contribute to such extreme events and enhance the relevance of your study's focus on prediction skill. This perspective would enrich the discussion by linking L-A coupling to practical forecasting challenges and implications.

Data and Methods

1. **Geographical Focus**: While the study seems to focus on the continental U.S., explicitly stating this in the Data and Methods section would help clarify the study's regional scope for readers.
2. **Model and Data Source Clarity**: The authors use the NASA GEOS-S2S model from 1999 to 2022 and compare its outputs to ERA5 and MERRA2 reanalyses. It would be beneficial if the authors could specify the strengths and limitations of each reanalysis data source in the context of L-A coupling.
3. **Forecast Initialization Skill (Lines 52-54)**: The paper emphasizes forecasts of coupling components rather than initialization. Including a brief analysis of GEOS-S2S forecast skill compared to reanalysis data specifically for weeks 3-4 could be valuable for readers assessing the model's performance.
4. **Order Consistency**: In the Methods section, the authors first introduce the Anomaly Correlation Coefficient (ACC) before discussing L-A coupling metrics. However, this order is not followed in the Results section. For consistency and readability, aligning the order in both sections would be beneficial.

Results

1. **Figure 1 (a-c)**: The spatial similarity between GEOS-S2S and the two reanalyses is noteworthy. Expanding on these similarities in the discussion would strengthen the analysis and provide further context for the comparison.
2. **Figure 2 (d-e)**: The correlation between latent heat flux (LH) and surface skin temperature (TS) appears stronger in ERA5 than in GEOS-S2S in the western U.S. Providing an explanation for this difference could offer insights into the model's performance in capturing regional variations.
3. **Figure 2 (g-i)**: The spatial pattern for the correlation between LH and LCLd in GEOS-S2S appears more similar to that of MERRA2. The authors could address the inconsistencies observed when comparing GEOS-S2S with the two reanalyses in Figures 2(d-e) and (g-i) to enhance the interpretation of these results.

Summary and Discussion

1. **Multimodel Comparison**: While the study provides useful insights based on the GEOS-S2S model, the results could be more generalizable if tested across multiple models. I agree with the authors' suggestion for a multimodel intercomparison using S2S project data or SubX data, which could broaden the understanding of L-A coupling impacts across diverse geographical and seasonal contexts.

2. **Biases in Seasonal Models**: The authors mention the presence of systematic warm and dry biases in certain seasonal prediction models over the central U.S. (e.g., Klein et al., 2006; Ardilouze et al., 2019). Expanding the discussion on how these biases may impact L-A coupling strength and forecast skill could provide additional context and depth.

3. **Ensemble Size and Forecast Frequency**: Previous studies indicate that increasing forecast frequency can enhance S2S forecast accuracy. Similarly, expanding ensemble size may better capture subtle shifts in forecast probabilities (e.g., see ECMWF newsletter 173). Including a discussion on the potential impacts of ensemble size and forecast frequency would add depth and highlight possible avenues for future studies.

4. **Incorporating Examples of Extreme Events:** Integrating specific examples, such as the 2011 Southern Plains Drought and Heatwave, the 2012 Central U.S. Drought and Heatwave, and the 2020–2022 Western U.S. Megadrought and associated heatwaves, would contextualize the role of L-A coupling dynamics in extreme events. These cases illustrate the compound impacts of heat and drought and how L-A coupling can amplify such conditions. Addressing these examples could enhance the relevance of the study by connecting findings to real-world events. Additionally, discussing these interactions in the 'Discussion and Conclusions' section would provide insights into how future research could explore these dynamics to improve forecasting for compound events.

References

Vitart, F., Balmaseda, M. A., Ferranti, L., & Fuentes, M. (2022). The Next Extended-Range Configuration for IFS Cycle 48r1. *ECMWF Newsletter*, no. 173 (Autumn 2022). Retrieved from https://www.ecmwf.int/en/newsletter/173/news/next-extended-range-configuration-ifs-cycle-48r1.

Yoon, D., Chen, J. H., & Seo, E. (2024). Contribution of land-atmosphere coupling in 2022 CONUS compound drought-heatwave events and implications for forecasting. *Weather and Climate Extremes*, *46*, 100722.https://doi.org/10.1016/j.wace.2024.100722.