Author response in red font, original editor/reviewer comments in black font.

The study examines precipitation, snowfall, and surface temperature characteristics associated with 4 atmospheric river (AR) cases impacting California as simulated in the Simple Cloud Resolving E3SM (Energy Exascale Earth System Model) Atmosphere Model (SCREAM) with selected regionally refined grid mesh (RRM) configurations. Sensitivity of the results to the RRM horizontal resolution (3.25 km, 1.6 km, and 800 m) and upstream extent of the RRM domain is evaluated against both high-resolution gridded data sets and single-station time series. Generally, SCREAM is able to capture the fine-scale regional distributions of AR-related precipitation over California. However, the model systematically overestimates precipitation over upwind and higher-elevation areas, and underestimates precipitation on leeward sides of mountain ranges. SCREAM also tends to overestimate storm-total snowfall and mean surface temperatures during the AR events. Overall, it is found that precipitation and temperature distributions exhibit only modest sensitivity to RRM resolution. Although somewhat greater improvement is seen for the largest RRM domain extent due to better representation of large-scale meteorological patterns that guide the ARs, the authors assert that the required RRM domain expansion no longer achieves the intended computational cost savings.

I found the modeling approach and scientific assessment to be both clear and informative. The detail of the model evaluation was appropriate given the fairly large number of simulations conducted and AR cases examined.

A key finding of the paper, in my view, is the relative insensitivity of storm-total precipitation to model horizontal grid resolution in the range from 3.25 km to 800 m. This finding also highlights the current horizontal resolution limit of evaluation data sets (4 km for daily surface precipitation, and 25 km for ERA5 atmospheric fields). At such fine scales, the need would arise to start evaluating models against single meteorological stations, as the authors have done here.

Findings related to the RRM domain extent are also novel. The authors note that SCREAM is initialized with ERA5 but allowed to evolve freely thereafter. In my opinion, initializing the model 24 hours (or 18 or 30 hours, based on sensitivity tests) is perhaps a “low bar” to assess model performance, though I suppose longer lead times might result in a drift of the large-scale meteorological solution such that evaluation of AR impacts could become complicated. I view the paper’s findings mostly as an examination of AR impacts from simulations in which the large-scale meteorological patterns are quasi-prescribed, given the short lead time.

The authors thank the reviewer for their thoughtful and thorough review. We have revised the manuscript accordingly. Please see our responses for each relevant point below.

Specific comments:

L26-28: Rutz et al. (2014, https://doi.org/10.1175/MWR-D-13-00168.1) displays one of the earliest and nicest maps of AR contributions to total cool-season precipitation (their Fig. 8). Consider adding this reference here.

Done.

L49-51: Can a reference to these modeling improvement be added here?

The Caldwell et al. (2021) is the appropriate reference here; which was cited in the preceding and following sentences.

L94-97: "SCREAMv0 used a prescribed-aerosol version of E3SM's modal aerosol model, however in this work we use a version of SCREAM that prescribes both cloud-condensation nuclei number and aerosol radiative properties from an E3SMv2 simulation. This is known as Simple Prescribed Aerosol (SPA) and will be incorporated into SCREAMv1." Do the authors think that this simplification, especially the prescribed CCN, could potentially be contributing to the "eagerness" of SCREAM to overestimate precipitation on the upwind side of mountain ranges?

This is a good point. While it is unclear to us if this could be a contributing factor, this is something that could be explored via sensitivity studies (as alluded to in the conclusions) with this configuration.

Figs. 2 and 3: In future depictions of RRMs, it is recommended to recreate the plot formatting like the right panel in Fig. 1 so that land masses and coastlines are visible.

We thank the reviewer for this suggestion and we agree this would be better to do.

L159: "most locations" is too vague

Agreed. Changed to "in addition to widespread reports of damaging winds in excess of 27 m/s that resulted in extensive power outages"

L163-164: ERA5 and IVT should be defined here, as it's their first usage.

Done.

L169-170: D4 drought classification should be referenced.

Done.

L214-216: Three references on the large-scale meteorological patterns that precede west coast (of U.S.) AR landfalls:

References have been cited.

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Benedict, J. J., Clement, A. C., & Medeiros, B. (2019). Atmospheric blocking and other large-scale precursor patterns of landfalling atmospheric rivers in the North Pacific: A CESM2 study. Journal of Geophysical Research: Atmospheres, 124, 11,330–11,353. https://doi.org/10.1029/2019JD030790

Zhou, Y., & Kim, H. (2019). Impact of Distinct Origin Locations on the Life Cycles of Landfalling Atmospheric Rivers Over the U.S. West Coast. Journal of Geophysical Research: Atmospheres, 124, 11,897–11,909. https://doi.org/10.1029/2019JD031218

Carrera, M. L., Higgins, R. W., & Kousky, V. E. (2004). Downstream weather impacts associated with atmospheric blocking over the northeast Pacific. Journal of Climate, 17(24), 4823–4839. https://doi.org/10.1175/jcli-3237.1

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L248-249: SNOTEL and Cooperative Observer Program should be referenced.

Done.

L273-274: It would be helpful to clarify how “bias” is calculated, as well as what spatial domain is used in the calculations for Fig. 5. The author’s use of “statewide” in L276 leads me to believe that the entire state of California is being used as the spatial domain for evaluation, but this should be more clearly stated.

Yes, this desperately needed to be clarified. We have added the following passage: “We note that all skill scores presented are statewide, using only the model columns and points for SCREAM and PRISM that fall within California. These are determined by a mask file generated from a California shapefile.”

A map containing locations (mountain ranges, counties) highlighted in the text should be added to help readers not familiar with California geography.

Great suggestion. We have added Figure three which includes the geographic points of interest in addition to the locations of the SNOTEL evaluation sites (suggested by reviewer 1). We have added the following text to the document:

"For convenience, we have included Figure~\ref{CAref}, which shows the locations of various California geographic features, various points of interest, and evaluation sites that are frequently mentioned throughout this paper when discussing the cases and results."

In Figs. 12 and 13, what temporal resolutions are used for SCREAM and ERA5 to evaluate maximum IVT? This should be noted in the L428 paragraph.

We have added the sentence: We note that the temporal resolution of ERA5 is coarser (3 hours) compared to the 1-hour resolution used in the SCREAM analysis.

L486-494: It would greatly benefit the paper to add references to specific figures when summarizing the key findings.

Good idea, done.

L511: At the end of this paragraph, it might be good to add a sentence noting that model evaluation at sub-kilometer scales is challenged by the availability of observations needed to evaluate the simulations… though I suppose a comparison to a single station would be appropriate in some cases.

We have added the sentence: "However, we acknowledge the added challenge of evaluating sub-kilometer scale models due to the lack of available high-resolution observations."

Technical Corrections:

All technical corrections have been addressed. Thank you for the careful check!

L2: E3SM should be defined.

L42: "generation…have" —> "generation…has"

L62: "Winter Hydroclimate" need not be capitalized.

L73-74: "resolution is increased to 1.6 km": It would be better to state something like "resolution is increased from 3 km to 1.6 km…"

L77: “5 km though, that work” —> “5 km, though that work”

The Fig. 1 caption seems to be missing one or more words.

Fig. 2 caption: Should be “ne32”, not “ne21”.

L135: Missing period at end of sentence.

L171: ; —> ,

L215: “set up” (verb) —> “setup” (noun)

L232: letting —> allowing

L281-283: Remove “Though”, add comma after “scores”, and change semicolon to comma. Also, “grids and there can be implications” —> “grids. There can be implications…”

L310: ; —> ,

L388: models —> model’s

L401: Should be Fig. 10, not Fig. 3.

L402: “though” —> “though they”

L403: Lakes —> Lake

L405: ; —> ,

L425: ; —> ,

L455: ; —> ,

L495: “The aforementioned positive precipitation bias seen in our simulations of 10 to 33%, is far less…” — please change to: “The aforementioned positive precipitation bias of 10-33% seen in our simulations is far less…”

L498: Remove semicolon

L505: “SCREAM’s resolution” —> “SCREAM’s muted resolution”…?