Very positive about this product! Remarkable compilation addressing a most-urgent topic. I will definitely recommend for publication in ESSD but I need to recommend changes that, in my estimation, strengthen and clarify the manuscript for many readers. Apologies for long list.

First, I address cross-cutting issues. Later, I address technical changes in each section.

1) Manuscript seems way too long. 1330 lines from start of title to end of acknowledgements/ financials in this version, compared to 1150 in previous version (von Schuckmann et al. 2020). Nearly 16% increase? Not good for authors nor for ESSD. We might expect a percent or two, from additional relevant materials, but offset substantially by the fact that authors will not need to repeat here what they already described (in detail) in previous version. Many specific comments related to length follow but - overall - possible to easily reduce by $\geq$ 20%? Readers do not want or need to wander through so much material. We want crisp sharp accurate restatement and update of EEI! Tricky balancing act: you want this one to stand alone, conveying accurate info for any new reader, but you also want to not repeat here background material from v1. See several shortening suggestions under technical comments.

2) For this reader, way too much GCOS advocacy! I write as a big fan of GCOS, recognizing that WMO dismissed or chased away good people. I endorse every concern about GCOS, but these concerns do not belong in ESSD! One strategy: mention (one sentence) relevant ECVs in each land, ocean, ice, atmosphere section, then summarize concerns in sentence or two of conclusions/recommendations? At a minimum, and assuming time is short, end with a clear simple sentence of concern?

3) Likewise, for this reader, way too much IPCC content? Readers will know (will have participated in) AR5 or AR6 or both, plus SR. EEI stands on its own! IPCC will cite it, not the other way around. Use IPCC citations sparingly, remove all IPCC quotes. These do not contribute to crisp sharp update of EEI.

4) Settle on standard common definitions of time periods.

Confusion begins in abstract (line 90: 2006-2020 does not constitute a decade),
continues around line 157 (here you bounce between 1971-2018 and 2010-2018),
emerges again at line 315 (era of Argo floats starts in 2000 but references not until 2016 or 2019?),
again at line 340 (near-global coverage of Argo floats by 2005 but you already said this slightly differently at lines 318, 319),
at line 391 (legend to Fig 3 where you define 1960-2020 as historical, 1993-2020 as altimeter, and 2006-2020 as recent [= Argo?], likewise and expanded at line 412),
at line 421 (25 years for historical [!!??] and altimetric and 15 years [not = decadal!] for Argo),
at line 453 (Table 1, in which 1971-2020 emerges again),
at lines 482 and 490 (introduces 1990 as boundary for deep OHC except at line 495 you use 1993),
at line 512 atmosphere (now using 1980 to 2020),
line 561 (still AHC, now back-extended 1980 to 1960),
line 574 (talking about coverage periods of reanalysis products including specifically ERA-5),
line 582 (RO and RS products 2002-2020 and 1996-2000 respectively),
line 618 (Fig 4, all panels using 1960-2020),
line 645 (Fig 5, now using time periods 1993-2020, 2001-2020 and 2006-2020 without categorization but as anomalies from 1961-2000?),
lines 656 and following and line 672 (still for AHC, settled on 1993-2020, 2001-2020 and 2006-2020?),
line 718 (now referencing ERA-Interim rather than ERA-5?),
line 728 (Fig 6, land [continental?] Heat content 1960-2020,

line 790 (Fig 7, heat to melt ice, now using 1979 [first satellite measurements of sea ice?] to 2020),
at line 899 (specifying temporal coverage of satellite products 1980-2011 and 2011-2020),
line 934 (total heat gain cryosphere now 1971-2020),
line 954 (total heat inventory 1971-2020 but summary Fig 8 at line 964 clearly shows 1960-2020 and references to 1960),
line 1014 (now three periods 1985-2020, 1993-2020 and 2006-2020,
lines 1037, 1038 (now 2006-2020 represent a GCOS golden age where earlier we had those years as Argo "golden age",
lines 1089 and following (concluding at 1971-2020 and "recent era" 2006-2020),
line 1130 (Fig 10 overview appropriately references in fig legend but now covering 1955-2020), and
line 1139 (excellent Fig 11 now back to 2006-2020 and 1971-2020).

Substantial effort to compile this list. We would not want to burden readers with same task, but they will need a clear summary! If composite inventory ends up covering 1971-2020 and 2006-2020, then same period should flow down to all individual components? But manuscript started with 1960-2020, 1993-2020 and 2006-2020? Authors need to provide guidance for readers to get from starting time periods to concluding time periods? Not clear at present!

Given ocean dominance of global heat inventory, adopt ocean time periods throughout? However, recognizing different sources, reanalyses available for some components for some time periods, major role of satellite products for other components, etc., authors may not agree (or, have time to agree) on common time periods? If not, readers need a table or graphic somewhere to show major overlap periods. And, from abstract to conclusion, clear statement by authors of which time periods the inventory will cover and why. Even for a knowledgeable reader, this seems confusing at best. Help the readers with explicit clarification? Perhaps a time (multiple) line chart with observational emphasis periods for each component with final inventory periods super-imposed? Readers deserve some help, graphic or otherwise, to sort these multiple time periods.

5) At many locations throughout text authors make reference to prior version; good! But (and thinking ahead) should authors in this version start a table to explicitly list and track changes/ improvements from prior version? Perhaps not so important for v2 but by v4 or v5 you would need such a list/table?

List of technical changes / questions:

Line 80, abstract: Rewrite this after you made / considered all other changes, including shortening and removals? Needs work …. Present confusion about rates (W/m2/decade) vs imbalance amounts. Too much advocacy, particularly wrt GCOS?

Line 90: as noted, 2006-2020 does not constitute a decade.

Check punctuation marks in 'et al.' Mostly correct but occasionally (e.g. line 96) not.

Line 105, Introduction: Too much IPCC and GCOS text here. Start introduction instead at line 139 or even at line 163. Good place to save space by citing v1 as much as possible/ reasonable?

Line 167: Forster et al reference represents your primary much-used IPCC WG1 Energy Budget chapter; you know this but readers may not. On first use of Forster citation, label it as AR6 WG1 Energy Budget paper so that, in subsequent use of Forster et al. readers will (we hope) recognize it as the WG1 reference? E.g. here (or at line 142) use 'as itemized in energy chapter

of AR6 WG1 (Forster et al., 2022)'. (Or something similar, authors will know best what they want.)

Lines 189-192: Good statement, basic motivation of this product. This (or something similar) should appear in abstract?

Line 195, Figure 1: Nice graphic but not needed, not useful, in this data description. Only four numbers here, without reference to time period. All numbers repeated multiple times in subsequent text, tables, figures. Save this one for poster or presentation? Not useful here.

Line 214: Cheng et al. 2022. But, you have two Cheng et al. 2022 listed in reference, one in J. Climate and one under review at Nature. Not sure how Copernicus deals with papers in review but authors will need to specify via 2022a, 2022b?

Line 225: Permafrost warming / degradation does not only lead to ground subsidence. Might also lead to fracturing, ponding, heaves, erosion, etc. Better to say here: leads to disruptive changes in ground morphology?

Line 232: here you reference recent AR6 WG2 report (and cite as IPCC product). Something like this should also appear back at line 142 or 167? Need consistency in how you report AR6 chapters, e.g by author name or by IPCC chapter?

Line 239 and following: This bulleted list is new to this version. Good summary, but high redundancy with preceding text? This reader finds the list useful, so perhaps scrub overall introduction to ensure minimal redundancy with this list.

Lines 275 to 287: Good outline! Here, add explicit note (including, perhaps, a Table) of changes from prior version (see comment #5 above)? Note that outline includes discussion of future evolution of GCOS as a topic for the end conclusions / recommendations. Appropriate here (there) as opposed to too much discussion throughout introduction.

Line 291 and following: A lot of this text on history of ocean observations repeats almost verbatim what you wrote already in v1. Cite that version for all historical recounting; save this version for accurate detailed summary of current best data sources? Too much credit given here to GCOS, who basically passively benefited from Argos? Better to not engage in that discussion here?

Line 302: Introducing IQuOD here, new to this version (could have been listed in change table, comment #5) but not yet a community-wide standard. Hopeful, with notable goals, but not yet widely adopted? Only at V0.1? Many other versions of ocean thermodynamic data sets in play, e.g. GLODAP (much used and cited in ESSD); CLIVAR colleagues will know this field. Present status of IQuOD not clear to this reader, not needed here? Could list IQuOD as hopeful new QC product in conclusions/recommendations? Fits in category of promotion rather than of detailed data description? Same for ocean mass data: mention in Conclusions/Recommendations as future enhancement?

Line 315: Argo represents a remarkable community technology and data achievement. Credit GCOS for establishing ocean heat ECV and for advocating open access but, technically, GCOS did not initiate Argo system? E.g Argo system web pages may reference one or two ECV but carry few or no references to GCOS? Some overlap (post-project) in personnel but otherwise independent? Much of this discussion of ocean data developments could be cited from v1, rather than reproducing here?

Line 372: Figure 2, excellent essential graphic, Uncertainty ranges, all nominally 2-sigma, appear much larger here than in v1? Due to different (more recent) climatology: 2005-2020 rather than 2005 to 2017 used previously? With different prior climatology period, would current anomaly uncertainties grow larger or smaller? No discussion or explanation provided? Note that here reader encounters three time periods with most recent (2006-2020) called "golden Argo era" (re: comment #4 above).

Line 419: Trend analysis using LOWESS also new to this version (again, which Cheng et al. 2022?), this change could have been listed in change table?

Line 454, Table 1: Extra significant figure(s) in many numbers of this version compared to prior version? Not consistent with wider uncertainty ranges? No explanation? A consequence of LOWESS?

Line 501, Section 3: Discussion of tropospheric thickening coupled with stratospheric cooling and shrinking represents another addition to this version. Good, but would also deserve mention in a 'changes' table?

Line 525 and following: Much of this is identical to v1 but most readers will need to have these equations and this explanation at hand. No changes.

Line 552: ECMWF-IFS, 2015 - this reference not defined!

Line 560: Additional changes described here that one could / should list in a 'changes' table? Changes include different treatment of JRA products, different use of radiosonde and radio-occultation products, drop the MSU, etc. All positive, but list them so readers will know! AHC figure (Figure 4) much improved in this version!

Line 670: Strongly agree with sentiment in this paragraph but I worry about the term "at an unprecedented rate". Unprecedented compared to what? To other components of the EEI? To undefined past time periods? Readers will need context here; I suspect you might need to change wording.

Line 687 and many following lines in Section 4: Readers will appreciate and eventually read and use the many Cuesta-Valero references but - for the moment - most of those references remain submitted only. I suspect, as for other publishers, Copernicus does not allow 'submitted' references? Although many of the Cuesta-Valero references carry delineating characters (e.g. 2002a, 2020b, etc.) in the text, the same references remain very inconsistently referenced in the formal list. Need some serious fixes here.

Line 713: "generated using various global ground datasets" not detailed enough for a data journal? You want to provide information sufficient so that readers can duplicate your outcomes,

Line 718: the CSIRO land modeling effort relies on ERA-Interim where elsewhere (e.g. atmosphere) authors specifically chose ERA-5. Reconcile if possible?

Line 750 and following: Confusing. Outcomes here use same input data as in v1 but produce the same patterns? In next sentence, similar outcomes derive from differences in processes? Awkward at best, most readers will need revision and clarification.

Line 767 and previous: Perhaps explain the term "continental" as it differs from 'terrestrial'? Readers may not understand the distinction and will not yet have access to Cuesta-Valero papers.

Line 782: Northern Hemisphere seasonal snow cover on land has a pretty good time series. Snow on ice (glaciers or sea ice) remains very difficult to quantify.

Line 793: Reader encounters 95CI where earlier we saw 2-sigma. Similar uncertainty range but two different statistical naming conventions? Assumes normal distribution of random errors?

Line 802: As for prior equations, this equation should carry an ID number?

Line 936: Strange punctuation around the von Schuckmann citation?

Line 955: obtained, obtained? Please revise.

Lines 960, 961: “challenging to be quantified with respect to gaps in the observing system”? Not sure what the authors intend here?

Lines 975 to 977: clear statement here of EEI over 1971 to 2020 and 2006 to 2020. Please extend this clarity back to the abstract?

Line 999: Awkward as written. Need caution - I agree. Perhaps: “Rate of heat accumulation across the Earth system’? Needs slight revision. Citation punctuation problems throughout the paragraph. Authors handled this point more accurately and more gracefully in v1.

Line 1019: very helpful figure with good explanation of time periods but we must regard 2006-2020 as the ‘Argo golden era’ as the author did in prior descriptions rather than a ‘GCOS’ golden age? GCOS itself general does not identify specific periods as ‘golden ages’?

Line 1023: The opening phrase of this sentence, referencing GCOS, seems irrelevant to the remaining content of this paragraph.

Line 1036 and following paragraph: Readers will not understand in this paragraph whether authors refer to generic global climate observations or to formal GCOS organization. If authors intend to add expressions of concern about GCOS with reinforcing statements about GCOS ECVs (for example) in their Conclusion / Recommendation section which follows (as this reviewer recommends) then this paragraph should refer more to the generic need for careful time series of precise observations with perhaps a final point about coordination by GCOS proper in the final sentence?

Line 1059 and following: Provision of separate files for ocean, atmosphere, land and ice components seems useful and appropriate, with 5th file reporting the composite energy budget. This reader does not understand (and, does not remember reading a reason) why permafrost data exists in a separate file? Earlier we read about data held at DKRZ, presumably under DOI. Those long-term files will replace these short term Handle-labelled files? Someone, presumably at Copernicus, will ensure that transition? This reader notes that clicking on links results in error but that copy/paste of full Handle ID works. Registration barrier imposed by WDCC at DKRZ (similar to v1) approved by ESSD?

Line 1084: Sentence beginning “Moreover, this study succeeded to improve” reads as awkward and run-on. Authors can do much better.

Line 1100: Paragraph about Glasgow outcomes not relevant and not useful to most readers. Delete. Issue of including EEI in global stocktake addressed quite well in following paragraph.

Line 1130: Figure 10, new to this version. Utility / information content not clear to this reader? If authors and/or editors intend to keep this graphic, it needs substantial revision (even for final downloaded version) to make it readable / legible. May remind many readers of a similar temporal evolution of sea level projections figure but without similar information impact. Combination of EEI total with OHC, while understandable, also adds confusion? Not a useful addition from the perspective of this reader.

Line 1139: Figure 11 (formerly, Fig 8), excellent, comprehensive, a fine graphic take-home summary. Legend in prior version referenced needed CO2 reductions, not included here; I leave that one to authors.

The following paragraphs, outlining needs and recommendation for most (atmosphere, land, ice) component, seem helpful. This reader misses (and, authors miss a great opportunity to promote) an equivalent conclusion / recommendation focused on ocean? No shortage of ocean observation issues raised earlier; most of those would fit very well here! If authors wanted to delineate 'official' recommendations, those could start at line 1255.

To this point, authors have NOT made a valid case for extending data records back in time, e.g. for delineating trends over longer time periods. In view of recent satellite and Argo observations, continuity seems far more important for this effort than rescue?

In view of this reader, authors provide compelling informed attention to generic observation system (e.g. including international and research systems beyond WMO or GCOS). As stated earlier, GCOS proper needs attention and support but this product must not and should not serve as GCOS advocacy. We might wish for slight clarity and refinement of final sentences but - for this reader - those provide adequate GCOS attention in this manuscript.