SAP 1.3 "Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change"

Public Comment Period: 14 April through 29 May 2008.

PUBLIC Reviewers

NOAA Research Council

The Research Council, as part of its major project oversight duties for the Climate Change Science Program (CCSP), was asked to review the draft report for CCSP Synthesis and Assessment Product 1.3: **Reanalysis of Historical Climate Data for Key Atmospheric Features: Implications for Attribution of Causes of Observed Change.** The Research Council Executive Secretary sent the document to all Research Council members and to additional NOAA scientists who were identified for their expertise to review the document. Following are the consolidated Research Council comments. These comments do not necessarily represent official NOAA viewpoints, since these have not been vetted throughout the whole agency. Do not consider these comments as part of the official government review on SAP 1.3.

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GENERAL COMMENT

The authors of CCSP Synthesis and Assessment Product 1.3 thank the NOAA Research Council and NOAA scientists for reviewing the draft report and for providing their comments. The comments are shown below in plain text. The responses from the author team are shown in blue.

NOAA Research Council general comment

1. The report identifies many problems with Reanalysis which seems to bring into question its worth. Additional description of the benefits may be in order.

Response: Throughout the Report we have identified both strengths and weaknesses of current reanalysis products. For example, the Abstract states that reanalysis data play a crucial role in a broad range of climate research problems, particularly in addressing variations and changes in large-scale atmospheric circulation features and helping to identify the physical mechanisms that produce high-impact climate anomalies. To emphasize this point and help address the review comment, we have added a figure in chapter 1 that shows a recent history of publication citations related to climate reanalyses, which provides one illustration of how extensively reanalyses are used in climate research. The Abstract also states that reanalysis data play a critical role in assessing the

ability of climate models to simulate the mean climate and its variations, and in identifying fundamental errors in the physical processes that create climate model biases. We believe these are major benefits. The Executive Summary further emphasizes benefits of reanalyses, with the first three bullets on primary results and findings emphasizing the crucial integrating role of reanalyses in a global climate observing system, among other major benefits. The concluding sentences of this section again stress the value of reanalyses, and are followed by recommendations that would further increase their value in the future. The statements in the Abstract and Executive Summary are based on findings discussed in much more detail in the report itself. In short, we believe that this assessment, while identifying potential deficiencies of reanalysis products, also appropriately recognizes their enormous scientific and practical benefits, and recommends additional steps that would further increase the value of future reanalyses.

SPECIFIC PUBLIC COMMENTS

NOAA Research Council

Chapter 2

1. Chapter: 2.5.2 Page 128 Line 0: The Climate Forecast System (CFS) is mentioned in Box 2.3, but without reference. The appropriate reference was noted in Chapter 2.4, Page 302, Line 10. Include reference in Box 2.3 if necessarily under CCSP standard formatting.

Response: The CFS reference (Saha et al. 2006) is now cited in Box 2.3.

2. Chapter: 2.1.2 Page 51 Line 13-23: This paragraph draws a false distinction between statistical analyses and dynamic reanalysis (as a justification for the latter). The references given in this section indicate that statistical analysis are *(sic)* done for surface (or more generally interface (SST)) variables. No one has done a statistical 500mb height (or 200mb wind) analysis in decades. The true distinction appears to be surface and interface variables (SST, T2m, Prate) versus free atmospheric variables, rather than the analysis method. Reanalysis has not been shown to add value for the surface/interface where none of the advantages (consistency among variables, advection and interpolation) apply trivially.

Response: We believe that a major reason no one has done a statistical analysis in decades of primary atmospheric circulation variables, e.g., like 500 hPa height and 200 hPa wind fields, as stated in the question, as well as numerous other critical climate fields is that physical/dynamical constraints obtained by using the dynamical models in the analysis method lead to superior, internally consistent estimates for such fields, which is precisely the point of this paragraph. For these variables, analyses obtained by combining observations within sophisticated atmospheric dynamical models through the process of data assimilation are now the "gold standard" to the point of being taken for granted, as implied in the last sentence of this question (i.e., discounting the numerous advantages). Text was changed to clarify the distinction, and a pertinent reference was added.

3. Chapter: 2.1.3 Page 58 Line 20-22: Climate analysis is said to be different fundamentally from weather Reanalysis in that data throughout the evolution (i.e. also future data) can be used. Such an assertion would be bolstered by referencing those who have actually done this for any reanalysis. Moreover, with reference to Saha et al (2006), the short-term climate prediction effort, one cannot use future data in those initial conditions either, and for the same reason as weather prediction and therefore we wonder under what context would the use of future data be permissible.

Response: The text already notes that, since the current systems have evolved from weather prediction, the potential of a climate analysis that uses future data to constrain system evolution is yet to be realized. The CFSRR effort referenced is tied to operational seasonal-to-interannual predictions, so it has the same limitations as short-range numerical weather prediction (i.e., with respect to use of future data).

4. Chapter: 2.1.3 Page 59 Line 14: The use of Reanalysis for SI forecasts is not possible when using future data as it is not available in real time. While it may be true that the analysis improves when using future data, this course of action may not be the best. The property of time symmetry, which is questioned here, is highlighted as "especially desirable" on p154 (Appendix 2.A).

Response: The comment again refers to reanalysis to support operational seasonal-to-interannual forecast applications. This is one application, but there are many reanalysis applications beyond supporting operational S-I forecasts. No changes made.

5. Chapter: 2.2.1 Page 66 Line 14-18: While we agree with the assertion that the model deviates from nature's path because model and data are imperfect, how about the butterfly effect? Data is necessary even for a perfect model and perfect data (perfect only to machine precision).

Response: We agree that, because of the chaotic nature of the system, even very small errors will tend to grow over time (in practice, errors are well above machine precision). To address this comment, the following sentence was added: "We should note that even with a perfect model and nearly perfect observations the model would still deviate from nature's path because of the chaotic nature of the atmosphere so that even very small errors grow rapidly to impact the model forecast."

6. Chapter: 2.2.2 Page 68 Line 9: CMIP is the free-running mode that better resembles nature and therefore we disagree with the authors promoting AMIP as free running mode for the model

Response: No changes. AMIP-style runs have been and continue to be very useful for simulating various aspects of atmospheric behavior. There are extensive examples in the literature demonstrating the great value of AMIP-style runs.

7. Chapter: 2.2.2 Page 70 Line 12-14: The last sentence in section 2.2.2 suggests verifying a model against the Reanalysis, even though that particular section is about validation of the analysis by some means. The discussion appears circular.

Response: No changes made. This section is about the use of reanalysis data in understanding climate forcing and determining the veracity of climate models, not in evaluating the quality of the reanalysis data itself. As stated above, with respect to certain features, e.g., atmospheric circulation features in mid- and high-latitudes, reanalysis fields are often the "gold standard", and therefore have considerable value in evaluating the veracity of climate models used for other purposes, including climate predictions and projections.

Other Specific Comments:

1. A paper by Fan and Van den Dool (2008) makes extensive comparisons between Reanalysis (ERA40, R1, and R2) and stand-alone Cressman analysis of monthly surface air temperature (T2m) beyond only where trends are concerned. The Reanalyses have much common error against observation of T2m, especially in the tropics and in mountainous areas (Fan, Y., and H. van den Dool (2008), A global monthly land surface air temperature analysis for 1948—present, J. Geophys. Res., 113, D01103, doi:10.1029/2007JD008470.)

Response: This reference was added on page 51, line 17.