Comments on the manuscript
Temporal Stratification in Climate Science: …
by
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The manuscript by Mazza aims at providing a structured narrative review to synthesize multi-disciplinary evidence in order to clarify the temporal and ontological foundations of the term "climate". To this end, three nested domains are distinguished: meteorological variability, sub-climatic oscillations, and long-term climate regimes. This hierarchical framework is supposed to provide a useful basis for interpreting recent climate trends within the broader temporal structure of the Earth system.

I am afraid that the narrative review does not achieve its goal, nor does it add any new insight compared to the concepts proposed in classical papers and textbooks on this topic by, for example, Hasselmann (1976) or Peixoto and Oort (1993) or Saltzman (2002). The narrative review also fails to acknowledge the meanwhile commonly accepted definition of "climate in a narrow sense", i.e., the meteorological definition of climate in terms of weather statistics, and "climate in a wider sense", i.e., climate in terms of state and statistics of a system which includes atmosphere, ocean, ice and land interacting via fluxes of momentum, energy, matter, and carbon, as put forward by the IPCC already in (2001), for example.

The narrative review tends to diffuse the physical concept of a (climate) system: the system includes all processes which a study focuses at, being separated from processes outside the boundaries of the system which affect the system but are not affected by the system - as clearly outlined in the textbook on the Physics of Climate by Peixoto and Oort (1993). According to Peixoto and Oort (1993), the definition of a system depends on the scope of the research which also implies a dependence on timescales. For the study of short-term climate variability on a decadal timescale, for example, some components of the climate system like ice sheets could be considered as outside of the system and hence could be taken as prescribed boundary condition. Most important, no inter-action between the system and the world outside of the system beyond boundaries is allowed. In contrast, the new concept outlined in this study does allow for an interaction between externally driven boundary conditions and internally mediated feedback processes (the present manuscript line 116/7). This lack of separation of processes hinders, rather than promotes, our physical understanding of climate variability.

Hasselmann (1976) separated the „coupled ocean-atmosphere-cryosphere-land system … divided into a rapidly varying "weather" system (essentially the atmosphere) and a slowly responding "climate" system (the ocean, cryosphere, land vegetation, etc.)". Thereby he was able to explain the slow changes of climate „as the integral response to continuous random excitation by short period "weather" disturbances." Saltzman (2002) also used the concept of gaps in the variance spectrum of climate change (see for example Figure 1-2 in his text book) separating the scales of "tectonic average" from "climatic average" from "synoptic average" – which interestingly resembles the three scales of temporal stratification proposed in the present study. The concept of spectral gaps was useful for constructing efficient paleoclimate models in which the fast components of the climate system could be parameterized in terms of some noise acting on the slower components of the climate system. See also the overview paper by Ganopolski (2024) – mentioned in the list of references, but missing in the text - who extensively uses climate models of intermediate complexity which are based on the concept of climate gaps.

But do these spectral gaps really exist and, thus, is a temporal stratification still useful? Climate variability exists on all time scales, from seasonal and interannual to multi-millennial, and climatic processes are intimately coupled, so that understanding variability at any one timescale requires some understanding of the whole spectrum. For example, vegetation interacts with the other

climate system components on timescales of minutes to multi-centuries via biophysical, biogeochemical and biogeographical processes. Instead of being separated by a spectral gap, low- and high-frequency surface temperature responses appear to be of nearly equal magnitude at centennial timescales (e.g., Huybers and Curry, 2006) which interestingly is the timescale at which the effects of global warming become prominent. It would thus be misleading to view the recent climate trend as just reflecting atmospheric and oceanic variability operating over decadal and centennial timescales (as stated in line 232-233). Of course, for predicting seasonal changes of the atmosphere and ocean the dynamics of glacial – interglacial cycles can safely be ignored. But the current state of the atmosphere-ocean system and its stability cannot be understood without understanding the development of Holocene climate variability, as the stability of the atmosphere-ocean system to external perturbation, like volcanic forcing or anthropogenic greenhouse gas emission, and the emergence of abrupt changes or so-called tipping points strongly depends on the climate state and its evolution. Consistently, climate modeling, specifically paleoclimate modeling, aims at bridging, not separating, timescales. Current comprehensive paleoclimate models describe the interaction of as many climate components as computationally feasible running from weather to glacial – interglacial cycles (e.g., Duque-Villegas et al., 2025; Mikolajewicz et al., 2025).
In summary, I very much regret to conclude that the new concept of temporal stratification does not add new value to existing classical definitions of climate. Moreover, the new concept fails to acknowledge the state-of-the-art of climate physics which aims at bridging, not separating, time domains.

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