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Are paleoceanographic and paleoatmospheric temperature anomalies related to each other via the air-water heat capacity ratio?

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Various paleoclimatic records (e.g., GISP) show that, during anomalous climatic periods such as Heinrich events, the atmospheric temperature anomalies are roughly four (4) times the corresponding oceanic anomalies. The tracing of glaciers' snow line suggest that, at times, this 1:4 relationship is also satisfied in the tropics (Porter 2001). This striking ratio has been so far ignored by paleoclimatologists probably because most assumed that it is accidental. We argue that the above ratio is not accidental but rather results from the air-water heat capacity ratio (kilogram-per-kilogram). We use a simple model involving Ekman layers dynamics and a simple ocean-atmosphere heat exchange process.

We assume that the heat exchange between the ocean and the air takes place within the Ekman layers of the two fluids, i.e., within an atmospheric Ekman layer situated on top of an oceanic Ekman layer. Both layers are subject to the same stress implying that the *mass* transport in the two layers is the same. We further employ the not-so-easily-justified assumption that the wind stress curl is small so that there is no significant Ekman pumping.

These are combined with a heat budget equation which doesn't involve the specification of any bulk measured formulas. The outcome is a statement that, when the ocean and the atmosphere exchange heat (and the wind stress curl is small), the temperature difference between the incoming and outgoing oceanic and atmospheric temperatures are related via the heat capacity ratio. Application of a simple perturbation scheme to this scenario shows that this approximately 1:4 ratio is the *maximum* ratio between the *anomalies*.