

Interactive comment on “The effect of temperature and salinity on the stable hydrogen isotopic composition of long chain alkenones produced by *Emiliana huxleyi* and *Gephyrocapsa oceanica*” by S. Schouten et al.

S. Schouten et al.

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We appreciate the positive comments by the referee’s on our paper and that both find the paper acceptable for publication upon minor changes. Below we respond to their comments and to that of the editor in more detail:

Referee 1 (Alex Sessions): 1. We will extend the description of the way the cultures were grown and when they were harvested in the revised version. 2. We will add the following sentence at the end of the discussion of our revised version: “Therefore the method for analysis of hydrogen isotopic fractionation described by Sessions and Hayes (2005) does not apply here as this assumes a constant fractionation factor.” 3. Admittedly we did not test the relationship between growth rate and isotopic frac-

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tionation and we are grateful that the referee pointed this out. Unexpectedly for us there is a significant negative correlation between growth rate and alfa. This will now be described in the revised version and a figure (2c) has been added to demonstrate this. In fact, the best correlations are now obtained by plotting alfa against salinity divided by growth rate (new figure 2d). This has led us to propose a theoretical model of isotopic fractionation of hydrogen in the algal cells which potentially can explain this phenomenon. However, as the model needs further rigorous development we only have briefly described it. As growth rate has now been found to have an impact on the fractionation we severely toned down our conclusion that the measurement of delta D of alkenones can be a valuable paleosalinity proxy in the revised version. 4. Based on the finding described in comment 3 and the literature suggested by the referee we now propose an alternative mechanism for the observed fractionation in the revised version.

Suggested minor corrections will be made in the revised manuscript.

Referee 2 (L. Beaufort): We will try to make the text easier to follow in the revised version though we do not want to repeat too much from the literature where these equations are taken from as this would make it even harder to read.

Effect of temperature: We only cultured the species at 2 (*G. oceanica*) or 3 (*E. huxleyi*) different temperatures. To get the best view of the effect of temperature we plotted only the data with similar salinities. *G. oceanica* was not plotted as only 2 different culture temperatures were used. The scatter observed in Fig. 2a can actually now be explained by growth rates: the alfa is usually lower at 15°C compared to 10 and 21°C. This is because our *E. huxleyi* culture has a growth optimum at this temperature and since we now found that growth rate is negatively correlated with alfa (see comment 3, reviewer 1) this results in lower alfa for experiments at 15°C.

Diversity of alkenone-producers: The referee is correct in that there are multiple species of Noelarabdaceae and that they may produce different hydrogen isotopic fractionation patterns. As will be stated in the revised manuscript field verification of

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the isotopic fractionation patterns of alkenone-producing organisms is needed to test if the culture results are generally applicable.

Alternative approach discussion: This part will be removed in the revised manuscript.

Editor (Jean Pierre Gattuso): We will provide more details on the salinity measurements in the revised version. Regarding the units for salinity, we refer to Pilson (Pilson 1998) which provides a good overview of the historical use of the different units. Salinity has been defined as the weight in grams of the dissolved inorganic matter in one kilogram of seawater after all the bromide and iodide have been replaced by the equivalent amount of chloride and all carbonate converted to oxide (Knudsen 1902). It used to be determined by chlorinity titration and was reported in ‰. However, since about 1960, so-called “salinometers”, based on comparative measurements of conductivity almost completely replaced the titration method. This new method could not determine absolute salinity but was extremely accurate by using the ratio of the conductivities of a sample and a standard. Initially, standard seawater produced by the Standard Seawater Service, generally adjusted to a chlorinity of 19.374 (salinity, $S = 35.000$) was used (or some other standards traceable to this). When the precision of the conductivity method revealed that variations in the ratios of some major (and even minor) ions led to differences in the conductivity-to-chlorinity relationship in samples from different localities (and even between different batches of Wormley Water), a precisely defined solution of KCl in pure water (whose conductivity was equal to that of standard seawater at a chlorinity of 19.374, which by definition has a salinity of $S = 35.00$) was recommended. This was termed the “Practical Salinity Scale” (PSS). Further careful measurements lead to the “Practical Salinity Scale 1978” (PSS 1978). Since salinity as measured by conductivity is actually calculated from a ratio of two conductivities, it should be considered a dimensionless number. However, since the actual conductivity ratio (exactly 1 at $S = 35$) is multiplied by the factor 35 to bring the numerical values into accord with the original definition and usage, and this factor of 35 might be considered as 35 g of salt in one kilogram of seawater, it might still be appropriate to use the

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unit designation as ′. To distinguish salinities on the PSS 1978 from earlier salinities, it has been suggested that salinities on the PSS 1978 could be designated in “practical salinity units” or PSU. The bottom line is that salinities can be reported in ′, as a dimensionless number or in PSU (with a specification somewhere in the paper that salinity is determined according to PSS1978). We have chosen PSU, in agreement with common usage.

Pilson, M. E. Q. (1998). An introduction to the chemistry of the sea. Upper Saddle River, New Jersey, Prentice-Hall, Inc. Simon & Schuster / A Viacom Company. 431p.

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