Review of Penaud et al "Hydrological processes affecting the subtropical NE Atlantic...."

General comments

This study presents a compilation of transfer function estimates of past sea surface temperature for a 3-core north to south transect for the Gulf of Cadiz, with some new insights into changes in surface productivity in the same region. It is interesting work, and worthy of being published in Biogeosciences. I am not convinced the authors have taken quite the correct line with this paper, and I really feel it would be a stronger contribution if they altered their approach along the lines I outline below. However, I do feel that this paper is publishable once these comments have been taken into account.

Major comments

1) **Inadequate quantitative analysis:** The analysis of differences between SST estimates is handled verbally, rather than fully quantitatively. I really feel this part of the manuscript would benefit from being altered to form a quantitative assessment about how important these differences are. I am very surprised to see no form of binary plot or correlation analysis between these different lines of evidence, and also no quantitative comparison of the correlation between various SST estimates and $\delta^{18}O_{pf}$ (suitably detrended for sea level). Wiggles are nice, but they are not the only way to represent this data!

The key here is to *quantitatively* identify whether one of the methods is providing a really different output to the rest, or whether one time interval is particularly problematic. Consequently, it will be necessary to perform a sequence of these binary tests for whole data sets and for time periods thought to have effectively "constant" (i.e. variability < estimate error) climate, such as the LGM and the Younger Dryas. This will yield a potentially large number of figures, so the authors will need to be selective which ones they present and how they present them (a multi-panel figure might be the most effective way). To some extent the multi-parameter data can be assessed using some kind of confirmatory principal component analysis - if there is an overriding similarity between the data the analysis should show one enormously strong eigenvector, which will effectively be the "real" SST.

I would also strongly recommend comparison of their averaged LGM output with recently published compilations from MARGO and PMIP / PMIP2. This would place their findings better into the regional context, and also help them contribute to ongoing efforts in model-data comparison. Several papers showing MARGO time-slice data could be used to source the information (e.g. (Waelbroeck et al. 2009) and although the Gulf of Cadiz is on the edge of their regions of interest, (Kageyama et al. 2006) and (Otto-Bliesner et al. 2009) provide appropriate model data for comparison. The various means and variances for the LGM temperature anomaly from the authors data could be compared to the model output in a similar method to that used in figure 6 from (Kageyama et al. 2006).

2) **Is the MARGO "MAT" actually the ANN?** It is worth double checking this point, as most MARGO foraminiferal SST maps are built on the newer ANN method!

3) **Planktic foraminiferal MAT temperatures ≠ SST:** The idea that the foraminifera may be generating colder temperatures than the dinocysts because they were dwelling deeper in the water column confused me. I could understand this if the data were a geochemical measurement that was

set at the depth of calcification, but assemblage proxies are calibrated to SST **not** to *in situ* T. Surely, this mechanism is impossible for this data! Even if the assemblage at time X did comprise solely taxa dwelling below the surface layer, this would also be the case for the analog assemblage linked to it via the MAT analysis and the analog assemblage data would still be linked to the surface water characteristics via the calibration, which is common for all sites. I simply do not believe this explanation, and I suggest the authors try again to explain this anomaly! Maybe one / all of the methods are inherently biased (or not very good!)?

4) **The title:** The most important parts of this study are 1) the assessment of the performance of the SST estimation methodologies, 2) the new insights into temperature changes observed in this key region during the last 30ka and 3) the claimed proof of the concept of a hydrological front in the Gulf of Cadiz during the LGM and other moderately cold periods. Given this, the title is a little vague! I would recommend altering it to something similar to "Assessment of Sea Surface Temperature changes in the Gulf of Cadiz during the last 30ka, and implications for glacial changes in regional hydrography".

Minor Comment

I do apologise for the self-citation, but given the focus of much of this MS on the last 2 Heinrich Events, I think a contribution to this problem I published last year could be useful (Rogerson et al. 2010). I also identified the strong north-south temperature gradient during certain times, and not during other times.

Kageyama M, Laine A, Abe-Ouchi A, Braconnot P, Cortijo E, Crucifix M, de Vernal A, Guiot J, Hewitt CD, Kitoh A, Kucera M, Marti O, Ohgaito R, Otto-Bliesner B, Peltier WR, Rosell-Mele A, Vettoretti G, Weber SL, Yu Y, Members MP (2006) Last Glacial Maximum temperatures over the North Atlantic, Europe and western Siberia: a comparison between PMIP models, MARGO sea-surface temperatures and pollen-based reconstructions. Quaternary Science Reviews 25 (17-18):2082-2102. doi:10.1016/j.quascirev.2006.02.010

Otto-Bliesner BL, Schneider R, Brady EC, Kucera M, Abe-Ouchi A, Bard E, Braconnot P, Crucifix M, Hewitt CD, Kageyama M, Marti O, Paul A, Rosell-Mele A, Waelbroeck C, Weber SL, Weinelt M, Yu Y (2009) A comparison of PMIP2 model simulations and the MARGO proxy reconstruction for tropical sea surface temperatures at last glacial maximum. Clim Dyn 32 (6):799-815. doi:10.1007/s00382-008-0509-0

Rogerson M, Colmenero-Hidalgo E, Levine RC, Rohling EJ, Voelker AHL, Bigg GR, Schönfeld J, Cacho I, Sierro FJ, Löwemark L, Reguera MI, deAbreu L, Garrick K (2010) Enhanced Mediterranean-Atlantic Exchange During Atlantic Freshening Phases. . Geochemistry Geophysics Geosystems 11:DOI: 10.1029/2009GC002931

Waelbroeck C, Paul A, Kucera M, Rosell-Melee A, Weinelt M, Schneider R, Mix AC, Abelmann A, Armand L, Bard E, Barker S, Barrows TT, Benway H, Cacho I, Chen MT, Cortijo E, Crosta X, de Vernal A, Dokken T, Duprat J, Elderfield H, Eynaud F, Gersonde R, Hayes A, Henry M, Hillaire-Marcel C, Huang CC, Jansen E, Juggins S, Kallel N, Kiefer T, Kienast M, Labeyrie L, Leclaire H, Londeix L, Mangin S, Matthiessen J, Marret F, Meland M, Morey AE, Mulitza S, Pflaumann U, Pisias NG, Radi T, Rochon A, Rohling EJ, Sbaffi L, Schafer-Neth C, Solignac S, Spero H, Tachikawa K, Turon JL (2009) Constraints on the magnitude and patterns of ocean cooling at the Last Glacial Maximum. Nature Geoscience 2 (2):127-132. doi:10.1038/ngeo411