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Interactive comment on "Earth's surface heat flux" *by* J. H. Davies and D. R. Davies

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This paper presents the most recent estimate of the Earth's total surface heat flux. It is a useful addition for those interested in the heat loss from the Earth. Heat flow measurements are essential for estimating the contributions from the different sources of heat within the Earth and our planet's thermal history.

This work builds on previous estimates of the Earth's heat loss derived from heat flow measurements in the oceans and continents. Some previous studies are by Lee and Uyeda (1965), Williams and Von Herzen (1974), Pollack et al. (1993), and Jaupart et al. (2007). The estimated heat loss value of 46.64 +/- 2 TW in this paper is about 5% higher than Pollack et al. (1993). Compared to previous studies some of the main differences here are a larger heat flow data set (about 55% more measurements), use of a recent global geological map (from 2000) to examine the relationship between age

and heat flow in the continents, GIS (Geographical Information Science) techniques, and new estimates of heat flow from glacially-covered continental areas. Compared to Pollack et al., the higher heat flux in this study appears to come from three main factors, a slightly higher heat flux from the continents, higher estimated heat flow from currently glaciated continents, and 1 TW added for flux from oceanic hotspots in crust less than about 65 million years.

For the oceanic crust, two different approaches are used to determine the heat loss. For young crust (here less than about 65 million years) the expected values for conduction-only reference models with age are used since the measured heat flow is typically less than expected due to hydrothermal heat loss. For older oceanic crust, the observed heat flow data are used. The choice of adding 1 TW for hotspot activity in young oceanic crust is puzzling. It is about 4% of the total expected heat flux from young crust. Also, heat flow measurements in hotspot regions typically do not have higher values compared to that expected for its crustal age, except perhaps for a few sites on or near the volcanic features (e.g. Stein and Von Herzen, 2007). For the continental crust, the calculated heat flux is a combination of geology, age, and average measured heat flow in regions.

The paper is mostly well written and easy to read. However, it was sometimes difficult to follow the relatively detailed analysis of how the estimated heat flux varied for different regions depending on different assumptions plus how the estimates here compared to values from previous studies. For example, it was unclear how the heat flux estimates for glacial Antarctica compared to values from Pollack et al. and Jaupart et al. studies. The associated tables are confusing.

Some other concerns included the following.

1) For Parsons and Sclater (1977) the expected heat flow in younger oceanic crust is given as 430 mW m^{-2} /square root of age in million years in this paper. However, in Sclater et al. (1980) the value is 473 (not 430).

2) In the results section, second paragraph: The differences in the expected heat flow with age from the reference models of Parsons and Sclater (1977) and Stein and Stein (1992) are not exclusively due to different temperatures at the base of the plate. A reference curve is computed by finding the best-fitting values of model parameters (including basal temperature, plate thickness, thermal conductivity and coefficient of thermal expansion) for observed heat flow and depth data with age. Thus, for a different basal temperature and the same data, different best-fitting values for the other parameters can be determined to produce essentially the same heat flow with age reference curve. Also these two studies used different data sets.

3) Hopefully the final figures (especially 1, 3, 9, and 10) will be larger than shown in the manuscript. In figure 1 the data from Pollack et al. (1993) should be shown in one color and the new data should be shown in a different color.

References:

Jaupart, C., Labrosse, S., and Mareschal, J.-C., Temperatures, heat and energy in the mantle of the Earth, *in* Bercovici, D. (ed.), *Treatise on Geophysics*, Vol. 7, Mantle Convection, Elsevier, 253-303, 2007.

Lee, W. H. K., and Uyeda, S., Review of heat flow data, *in* Lee, W.H.K. (ed), *Terrestrial heat flow*, Geophys. Mono. 8, 87-190, American Geophysical Union, Washington, D.C., 1965.

Parsons, B., and Sclater, J. G., An analysis of the variation of ocean floor bathymetry and heat flow with age, *J. Geophys. Res., 82*, 803-827, 1977.

Pollack, H. N., Hurter, S. J., and Johnston, J. R., Heat loss from the earth's interior: analysis of the global data set, *Rev. Geophys., 31*, 267-280, 1993.

Sclater, J., Jaupart, C., and Galson, D., The heat flow through oceanic and continental crust and the heat loss of the Earth, *Rev. Geophys. Space Phys., 18*, 269-311, 1980.

Stein, C. and Stein, S., A model for the global variation in oceanic depth and heat flow with lithospheric age, *Nature, 359,* 123-128, 1992.

Stein, C.A., and Von Herzen, R. P., Potential effects of hydrothermal circulation and magmatism on heat flow at hotspot swells, *in* Foulger, G. R., and Jurdy, D. M. (eds.), *Plates, Plumes, and Planetary Processes*, Geol. Soc. Am. Sp. Paper. 430, 261-274, doi: 10.1130/2007.2430(13), 2007.

Williams, D. L. and Von Herzen, R. P., Heat loss from the earth: New estimate, *Geology, 2*, 327-328, 1974.

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