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Climate of the Past Discussions

Interactive comment on "Anthropogenic effects on subsurface temperature in Bangkok" *by* M. Taniguchi

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This m/s addresses the effect of anthropogenic heating by large cities. It presents new subsurface temperature data from the metropolitan area of Bangkok which reflect - in a complex manner - this heat island effect. The data is new and the approach innovative.

As with all new approaches every new answer produces new questions. Some of them are addressed already in the other reviewers' comments. These need to be worked out in more detail in this m/s but also in future work.

My comments address two specific points: (1) Temperature was measured in boreholes of 10 cm - 30 cm diameter and the author claims that thermal free convection does not occur here and can be neglected. Free convection effects were studied in detail in the past by Diment (Geophysics, 32(4), 720-726, 1967) and Gretener (Geo-

physics,32(4), 727-738, 1967). In most boreholes with diameters of 10 cm or more free convection was observed with amplitudes between several mK and 80 mK. A critical gradient can be given for the onset of free thermal convection as a function of absolute temperature, gravity, several material properties (such as thermal expansion, viscosity, thermal diffusivity, spec. heat capacity) and geometric properties of the borehole (such as diameter). For a borehole diameter of 13 cm, Gretener arrives at a critical temperature gradient as little as 1 K/km for water at 43 °C. Since temperature is in the numerator of the corresponding expression, lower temperatures, as measured in Bangkok, yield accordingly even lower values. In view of this, I am almost certain, that there is free convection in the boreholes measured in Bangkok. This effect is often overlooked when a borehole is logged a a certain speed. In point-by-point measurements the oscillations can be easily observed with periods varying from several minutes to even hours, depending on borehole diameter. I suggest the author inspects the data again in view of the critical gradients for the onset of free convection and discusses possible amplitudes. A certain roughness in the logs may serve as an indicator. I feel this effect needs to be discussed in sufficient detail in order to warrant further discussion of small temperature deviations ("0.1 °C apart from the steady-state profile).

(2) This leads to my second point: The author calculates theoretical vertical temperature profiles allowing for vertical heat advection by groundwater flow. Here again, a discussion of the effect of regional flow systems (which are not vertical everywhere) on the observed temperatures is necessary, in particular becaus the author defines as a criterion for the influence of the urban heating effect a 100 mK deviation of the measured profile from the theoretical prediction. Incidentally, the original wording for the criterion ("the depth apart by 0.1 °C from the steady thermal gradient") is a bit awkward and prone to misunderstanding. Maybe it can be rephrased to make it more simple and easier to understand. At any rate, this approach really requires a discussion of errors. These may be induced by variations in soil properties and Darcy flow rates plugged into equation (1), but also by free thermal convection effects which were observed in holes of 15 cm and 25 cm diameter with amplitudes as large as 80 mK by

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Gretener (1967).

All in all, I think this interesting approach merits additional work invested in the discussion of data quality and sources and size of errors. In a revised form, the m/s would be of interest to a much larger group of readers.

Interactive comment on Clim. Past Discuss., 2, 831, 2006.