Heat Production and Neutrino Luminosity in different Earth reservoirs

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1. Given the mass and abundances of the heat producing elements (K, Th & U) calculate the heat production (in TW) in the 9 different reservoirs identified in the accompanying Excel spreadsheet:
    a. Continental Sediments
    b. Upper Continental Crust
    c. Middle Continental Crust
    d. Lower Continental Crust
    e. Continental Lithospheric Mantle
    f. Oceanic Sediments
    g. Oceanic Crust
    h. Depleted Mantle
    i. Enriched Mantle

    For extra credit, propagate the uncertainties in your results assuming ±3% for mass and ±10% for abundances of K, Th & U.
2. Calculate the neutrino flux (neutrino/cm^2/s) and luminosity (neutrino/s) for the Earth and its reservoirs. The neutrino flux calculation will be calculated in terms of a "Geological response factor" (G_{rf}) . The G_{rf} values given here will be for Jinping, our latest estimate. The following equations relate the various contributors to the Earth's geoneutrino luminosity:

$$\phi(\vec{r}) = \langle P_{ee} \rangle \varepsilon_{\bar{\nu}_e} \iiint \frac{A(\vec{r}')\rho(\vec{r}')}{4\pi|\vec{r} - \vec{r}'|^2} \mathrm{d}\vec{r}'$$

Neutrino flux	ϕ
Survival probability	$\langle P_{ee} \rangle$
Conversion factor	ϕ
Abundances (kg/kg)	A
Density	ρ
Distance with respect to detector	$\vec{r}$
Production rate	$\varepsilon_{\nu e}$

The Production rate ($\varepsilon_{\nu e}$) accounts for the isotopic proportion, the Avogadro number and the number of antineutrinos generated in the decay scheme:

$$\varepsilon_{\bar{\nu}_e} = \frac{X N_A \lambda n_{\bar{\nu}_e}}{\mu}$$

Natural isotopic proportion	X
Atomic weight	μ
# of antineutrinos per decay chain	$n_{\bar{\nu}_e}$
Decay constant	λ
Avogadro number	N_A

One can reduce further the above equation by calculating a geological response factor (G_{rf}) for each layer in the Earth:

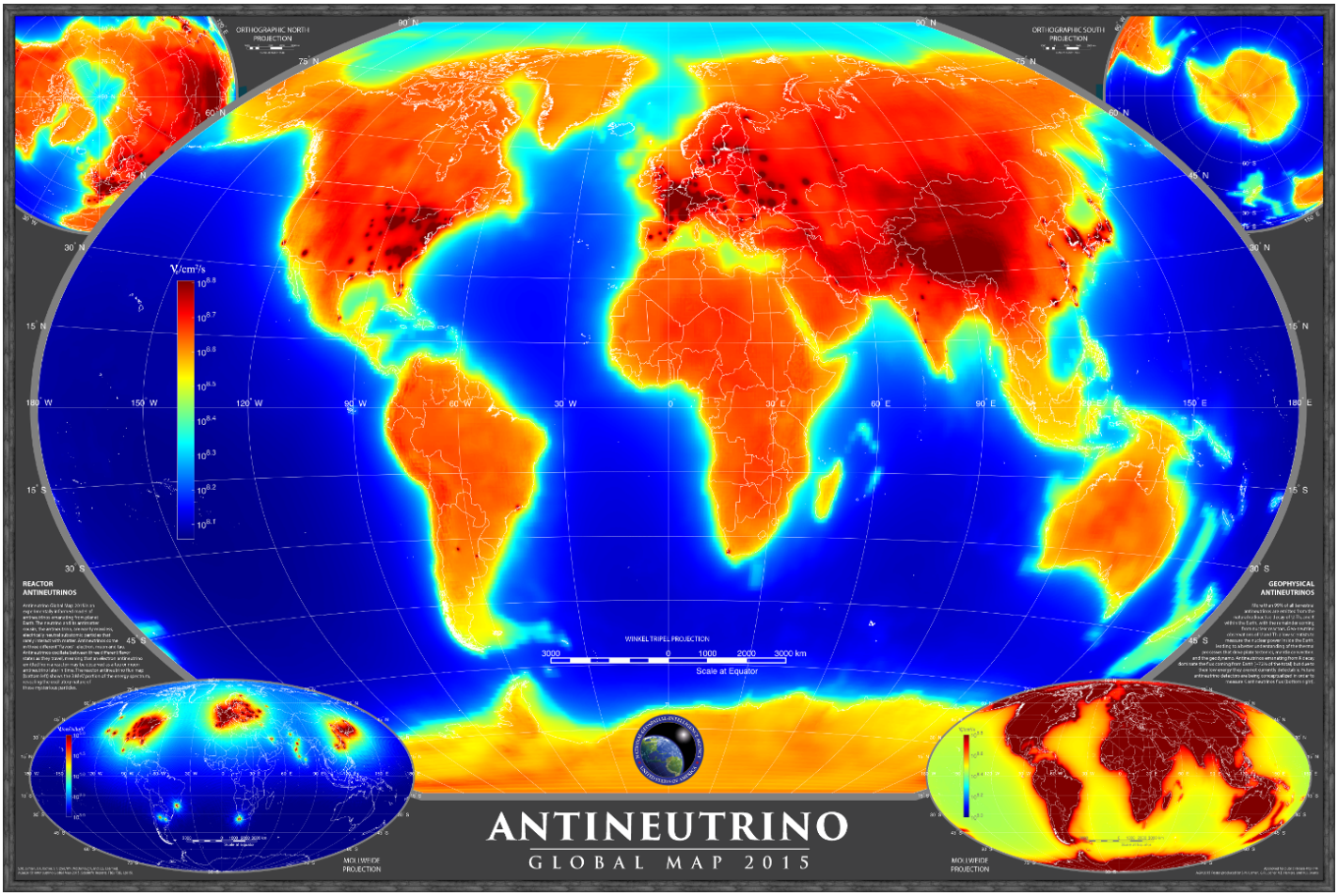
$$\phi(\vec{r}) = \langle P_{ee} \rangle \varepsilon_{\bar{\nu}_e} A\, G_{\mathrm{rf}}(\vec{r})$$

The geological response factor (G_{rf} in kg/m^2) for each layer in the Earth is:

$$G_{\mathrm{rf}}(\vec{r}) = \iiint \frac{\rho(\vec{r}')}{4\pi|\vec{r} - \vec{r}'|^2} \mathrm{d}\vec{r}'$$

3. Calculate the fraction of neutrino flux and luminosity for Earth reservoirs.

Present surface flux map was published 2015 (AGM: Antineutrino Global Map, *Usman et al.*):



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