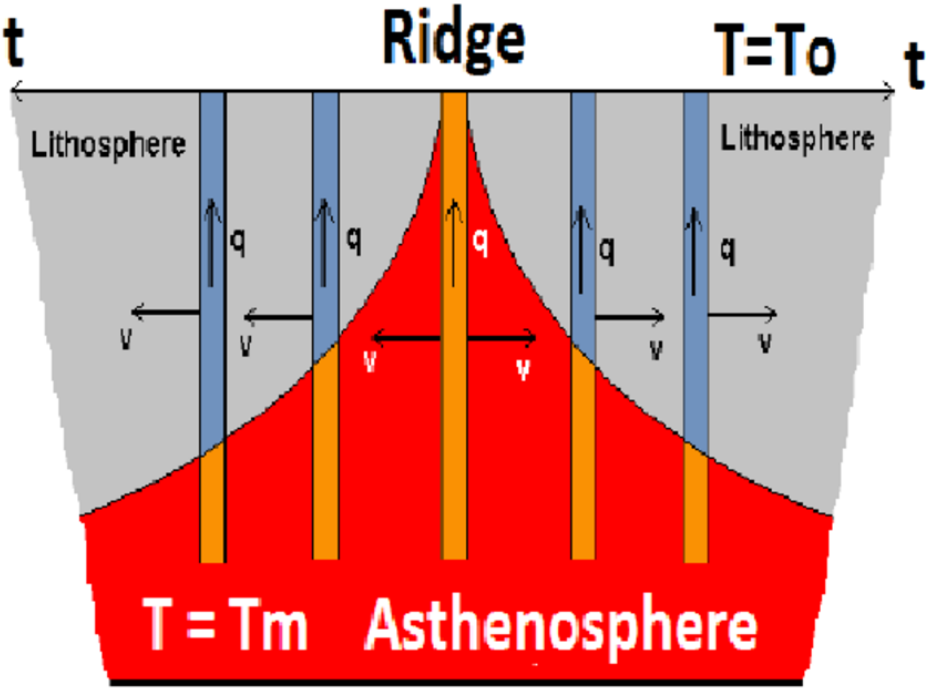
Half-space Cooling Model Test

This test calculates the simplified half-space cooling model as it applies to oceanic lithosphere. This model assumes oceanic lithosphere is created at a fixed boundary, in this instance the start of the array, and has a temperature equal to that of the mantle. The upper boundary of the lithosphere is depth 0 and the temperature at this boundary is also 0. This simplified model ignores horizontal conductive heat transport, latent heat, and compaction, and the lithosphere is allowed to cool to unlimited depth.

The equation to solve for temperature as a function of depth and age is as follows from Stein and Stein, 2005.

$$T(t, z) = T_m \operatorname{erf}\left(z(4\kappa t)^{-1/2}\right)$$

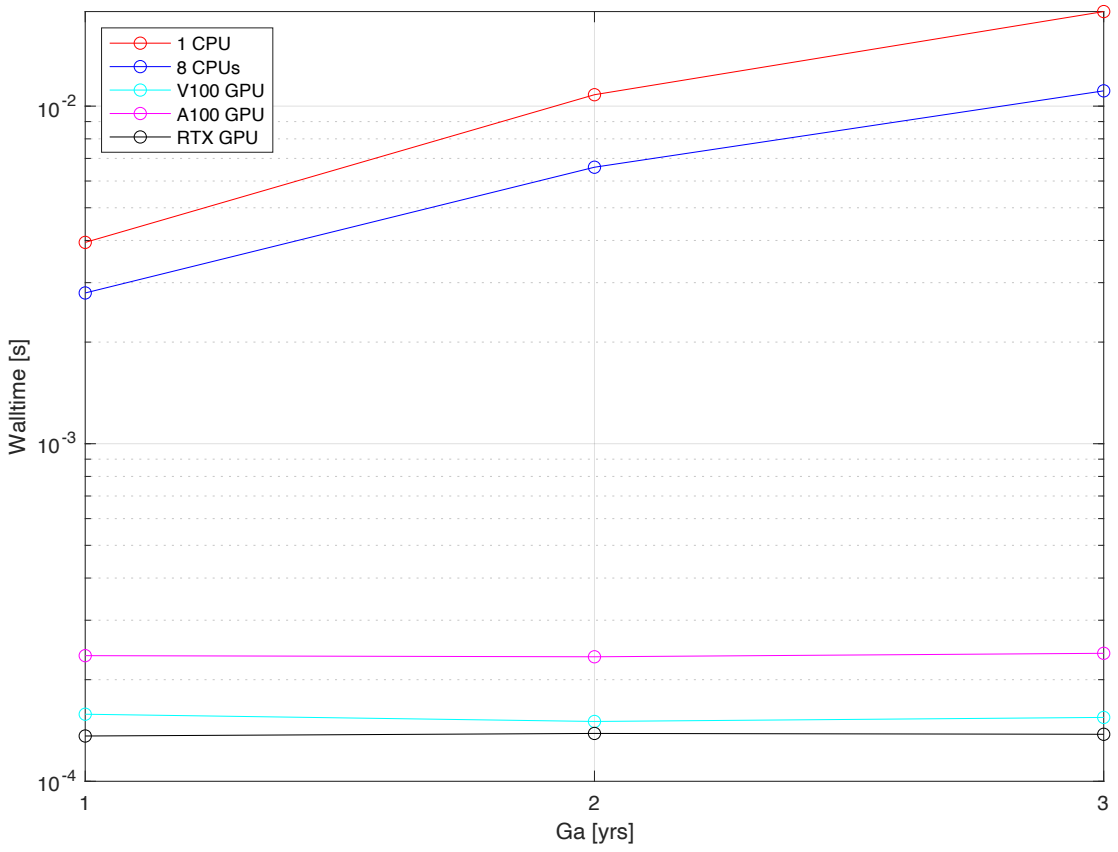
A schematic of half-space cooling in the lithosphere is below from Cardoso and Hamza, 2011. The model follows the shape of an error function as the lithosphere increases in age and moves away from the ridge.



In this test, the temperature of the lithosphere as a function of depth and age is populated into a DynamicRaggedDownArray. The array will be populated down until the temperature of the lithosphere has reached the mantle temperature and then moves on to the next age. The test outputs the depth to the mantle every 1 Ma and the run time.

Performance Portability using MATAR and Kokkos

This test was conducted on serial and parallel CPUs and three kinds of GPUs (Tesla_V100, NVIDIA_A100, and Quadro_RTX_8000) with increasing size of the problem. In this case, increasing the age of the plate that the cooling is computed for, and the y axis is total wall time in seconds.



References

Cardoso, R.R. and Hamza, V.M., 2011. Finite Half pace model of oceanic lithosphere. *Horizons in Earth Science Research, edited by: Veress, B. and Szigethy, J*, *11*, pp.375-395.

Stein, C.A. and Stein, S., 1992. A model for the global variation in oceanic depth and heat flow with lithospheric age. *Nature*, *359*(6391), pp.123-129.