Figure 2: Series of heatmaps showing the penetration depth (as a percent of ice shell thickness) in a large variety of simulated scenarios (compared to Figure 1). Each row represents a unique ice shell thickness, and each column represents the attenuation model used for penetration depth calculation. The x along each heatmap denotes the scenario regolith thermal conductivity(W/mK), and the y axis along each heat map shows regolith depth(m).

Figure 2 demonstrates observable trends across more parameter combinations than in Figure 1. Each cell represents a single simulation (equivalent to one line graph in Figure 1), with the value inside displaying the amount of material the radar penetrated in the simulation as a percent of the total simulation depth. The bolded labels along the vertical axis of the figure describe the ice shell thickness of every simulation (either 5 km ice shell thickness, 21 km, or 25 km) in that row of heatmaps. The bolded labels at the top of the figure describe which columns used which attenuation model.

A few predominant trends become apparent when viewing these heat maps. The first notable trend is that every combination of simulated material attributes always has a lower depth penetration percentage in the high-loss attenuation model compared to low-loss. The second trend is that generally, the more regolith added to the surface and the less conductive that regolith is the less radar penetration.

However, a trend reversal occurs in poor thermal regolith conductivity cases. This trend is observable in all but the 35 km low-loss heat maps. In the lowest conductivity case, as we move from 0 regolith thickness to 100 and 250 meters of regolith, the usual trend occurs of less penetration with more material and less conductivity. However, between 250 and 700 meters, the trend reverses. Suddenly, the radar penetrates less in the scenarios with very low conductivity and high regolith depth compared to the lower regolith scenarios. This trend is less acute with large ice shell thicknesses. [insert explanation of why this occurs.

NOTE – as an explanation here, I copied what Tina said in Slack as an explanation. I think it explains the trend reversal well, but it needs to be refined here for the sake of the manuscript.

For moderate conductivities and thicknesses, the usual trend is that the temperature at the ice-regolith interface increases with increasing reg thickness. This effect is so pronounced that it outweighs the effects thicker regoliths have on colder temperatures compared to thinner regoliths.

However, for these very low conductivities and rather large thicknesses (that we investigate here), this effect of increasing ice-regolith interface temperature with increasing reg thickness is minor. For all thickness cases, the temperature at the ice-regolith interface is almost the same. Thus, the lower temperatures within the regolith play a role, leading to less attenuation for increasing thickness.