SIO 115 Homework 6 (due Friday 3rd March): Glaciers and ice sheets

Please write your answers on a separate sheet with your name clearly written at the top. You will be graded on your writing style as well as the content of your answer. Please be careful with units and significant figures.

1. *Glacier hypsometry (shape) and ELA*. Consider two hypothetical glaciers named Alpha and Beta. These glaciers have the same total area, the same constant surface slope, the same terminus elevation (and longitudinal position, x) and the same balance with elevation. Each glacier spans (from the head to the terminus) $-L/2 \le x \le L/2$, where L is the total length of the glacier. Thus, we can assume that the balance varies with *x: b = b(x) = -G x*, where *G* is the balance gradient. Here, *G = G(x)*, but we can relate it to *z* due to the constant slope. Let W_0 be the width of the glacier at x = *0*, and let the taper of the sides be *m*, where *m* is positive for Beta Glacier and negative for Alpha Glacier. You can then write $W(x) = mx + W_0$.

(i) Solve for the AAR on a glacier given *m*. Remember this involves simply taking the ratio of the area of the accumulation area to the total area (you need to first write down a simple integral for the area). Hints: first figure out where the ELA is; your integration limits are –L/2 to L/2. [2]

(ii) Given that *m = 0* for a straight sided glacier, what is the AAR? [2]

(iii) What happens to the AAR given a + and – taper (*m*)? [2]

(iv) If you fix the AAR at 0.5, what happens to the ELA? How does this compare with what you already know about the location of the ELA? [2]

2. *Ice shelf mass balance:* (i) What two ablation processes are important components of the mass balance of Antarctic ice shelves, that are not important for mountain glaciers? [2]

(ii) Explain qualitatively how the "ice pump" in the ocean cavity underneath an ice shelf works (Mode-1 basal melting), and what mass loss and gain processes it leads to. A diagram might help. [4]

(iii) What mass loss process has been attributed to the rapid collapse of some Antarctic ice shelves? How does this happen? Where has this happened? [4]