Astro 342 Fall 2006 Homework #5

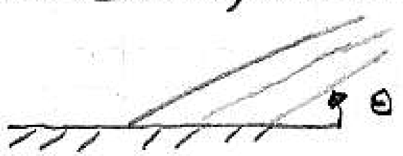
Hartmann, Ch 10, Prob 1

(a) see p. 271-2

(b) two reasons:
1. they are all old and worn away via regolith modification processes (micrometeorite erosion, etc.)
2. highly fluid lava flows dominated on the moon

3

Hartmann, Ch 10, Prob 13 (Extra credit)



☉ $A_L = 0.4$ $\epsilon = 0.5$

$a = 1.524$; at perihelion, $r = (1-e) \times 1.524 = 1.382$

Flux in is reduced by a factor of $\sin\theta$ in addition to the atmospheric absorption of 50%

So the equation for the equilibrium temperature should be used in a modified form:

(a)
$$T_{eq} = \left(\frac{F_{sun} \sin\theta \cdot 0.5}{r_{au}^2} \frac{(1-0.4)}{\cancel{4} \times 0.5 \times \sigma} \right)^{1/4}$$

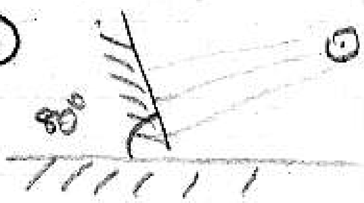
no factor of 4, looking locally (see p. 297)

$$= \left(\frac{1360 \sin(10^\circ)\, 0.5}{(1.382)^2} \frac{0.6}{0.5\sigma} \right)^{1/4} = 190.2\,K$$

note: we're ignoring day/night cycles!

2

(b)



now, the only change is $\theta = 90^\circ$

$$T_{eq} = \left[\frac{\sin(90^\circ)}{\sin(10^\circ)} \right]^{1/4} \times 190.2 = 294.61\,K$$

(c) Temperature swings will be greater on the cliff near CO_2 sublimation perhaps leading to some mechanical weathering in addition to wind erosion being greater...

Chapter 7, Prob. 5

Parent body large enough to be differentiated; iron-like bodies from core, silicate-rich from mantle/crust.

Chapter 7, Prob. 21

$A_b = 0.7$, $\epsilon = 0.2$

(a) @ $R = a_{Jupiter} = 5.203$ au

$$T_{eq} = \left(\frac{1360}{(5.203)^2} \frac{(1-0.7)}{4 \times 0.2 \times \sigma} \right)^{1/4} = 135.0\text{ K}$$

(b)

$$(273)^4 = \left(\frac{1360}{r_{au}^2} \cdot \frac{0.3}{0.8\sigma} \right); \quad r_{au}^2 = \frac{1360}{(273)^4} \cdot \frac{0.3}{0.8\sigma}$$

$r = 1.2725$ a.u

Chapter 7, Prob 22

$A_b = 0.03$, $\epsilon = 0.2$

(a) $T_{eq} = 135.0\text{K} \left(\frac{0.97}{0.30} \right)^{1/4} = 181.0\text{ K}$

(b) $\left(\frac{r}{1.2725} \right)^2 = \frac{0.97}{0.3}$; $r = 2.2882$ au

dPL 10.14

Perihelion = 1 au
aphelion = 15 au

$2a = 16$ au

$a = 8$ au

(a)

$$\frac{P^2}{(8)^3} = 1$$

$$P^2 = 2^9$$

$$P = 2^{4.5} = 22.63\ y$$

(b) • Sublimation for $P/10 = 2.263\ y$ per orbit

- $r \sim 1.5$ au for sublimation interval
- $\rho = 1.0\ g\,cm^{-3}$; 1 H_2O Molecule $\approx 18\ m_H \approx 2.99 \times 10^{-23} g$
- $Q = \frac{1.2 \times 10^{18}\,\pi R^2}{r_{au}^2}$ molecules / sec

How many meters of ice lost per orbit?

$$m_{H_2O}\, Q \cdot t = \frac{1.2 \times 10^{18}\,\pi R^2}{(1.5)^2} \times 2.99 \times 10^{-23} \cdot 2.263\,y \cdot 3.16 \times 10^{7}\,s/yr$$

$$= 1.14 \times 10^{3}\,\pi R^2 \text{ g / orbit lost}$$

Volume lost = area × radius lost $= 4\pi R^2 \Delta R$

Mass lost = $1\,g/cm^3 \cdot 4\pi R^2 \Delta R$

so $4 \pi R^2 \Delta R = 1.140 \times 10^3 \pi R^2$

$$\Delta R = \frac{1.140 \times 10^3\,cm}{4} = 2.85\ m \text{ lost}$$