Cometary Interaction with Martian Atmosphere

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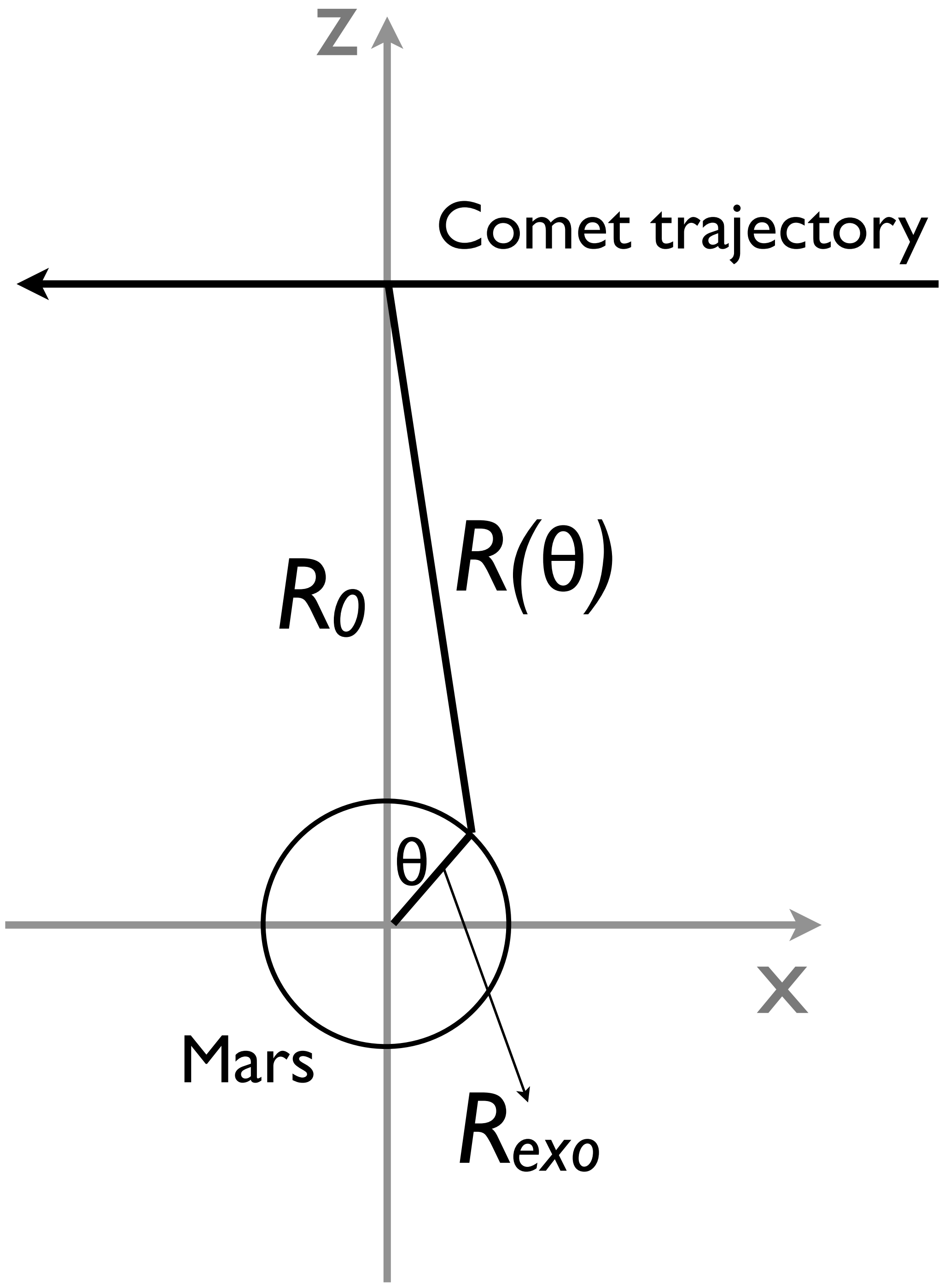
O Sputtering from Comet

- Assume neutral O dissociated from H_2O outgassing from comet, while incident flux decay with R^{-2}
- O precipitates with cometary speed (v_c) = 56 km/s ⇒ Energy of O = 262 eV
- Calculate the sputtering effects with O source rate (Q_c) = 10^{28} s^{-1} at (R_0) = 169,500 km ⇒ Scale the results to other Q_c and R_0

Precipitation rates



- At closest approach:

$$F_0 = \int_0^{\pi}\int_0^{\pi} \frac{Q_c}{[R(\theta)]^2} R_{exo}^2 \sin\theta \, d\theta \, d\phi$$

where

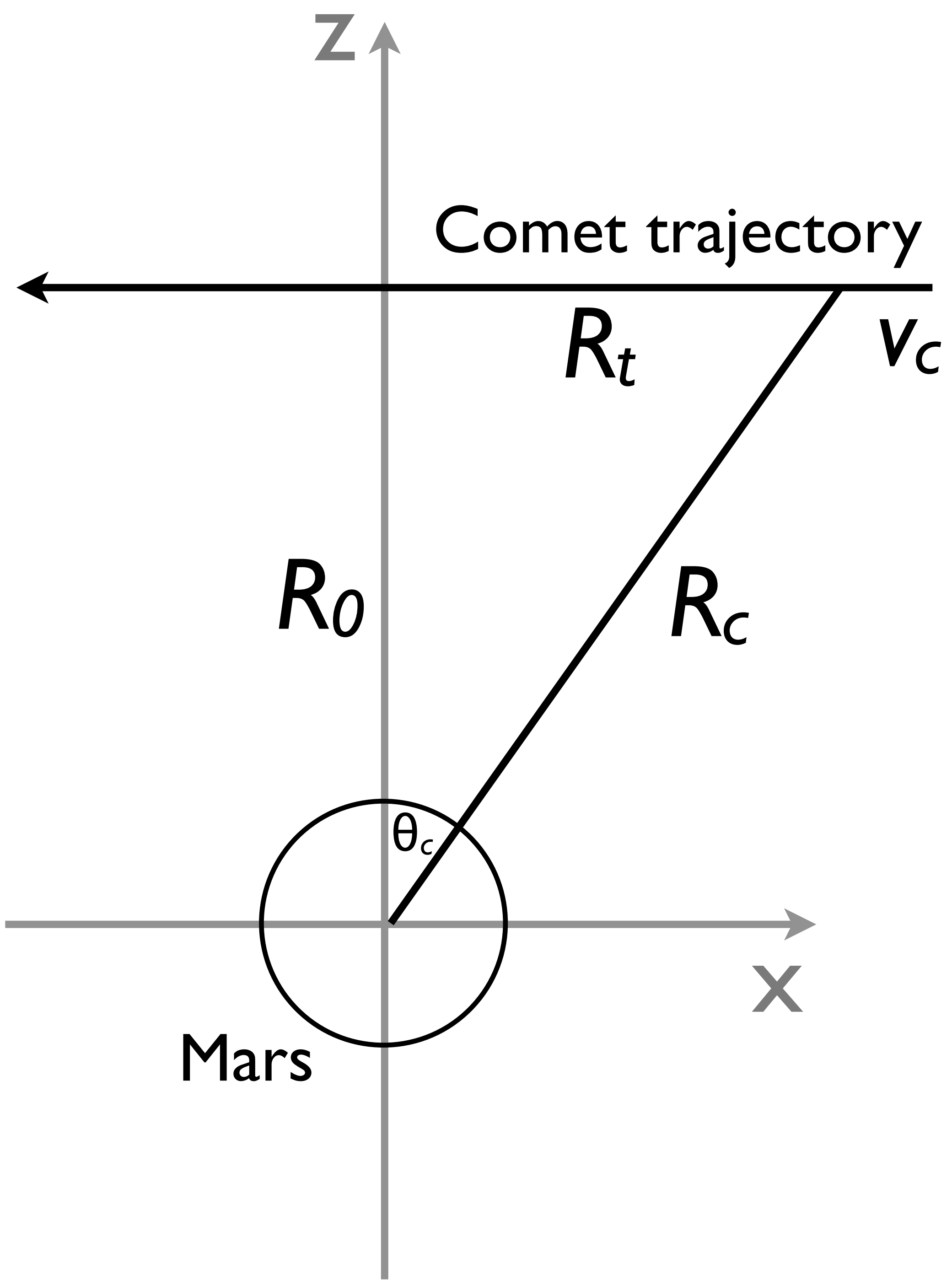
$$[R(\theta)]^2 = R_{exo}^2 (x^2 - 2x\cos\theta + 1)$$

$$x = \frac{R_0}{R_{exo}}$$

$$R_{exo} = R_M + h_{exo}$$

$$\Rightarrow \qquad F_0 \propto R_0^{-2}$$

Integrate along trajectory



- Assume simplified trajectory with constant speed of (v_c) ⇒ Integrate precipitation rate from infinity

$$F_{\text{int}} = \int_{t_c}^{\infty} F(R,t)\,dt$$

with

$$F(R,t) = F_0 \frac{R_0}{[R_c(t)]^2}$$

$$t = R_t / v_c$$

$$R_c = R_0 \sec\theta_c$$

$$R_t = R_0 \tan\theta_c$$

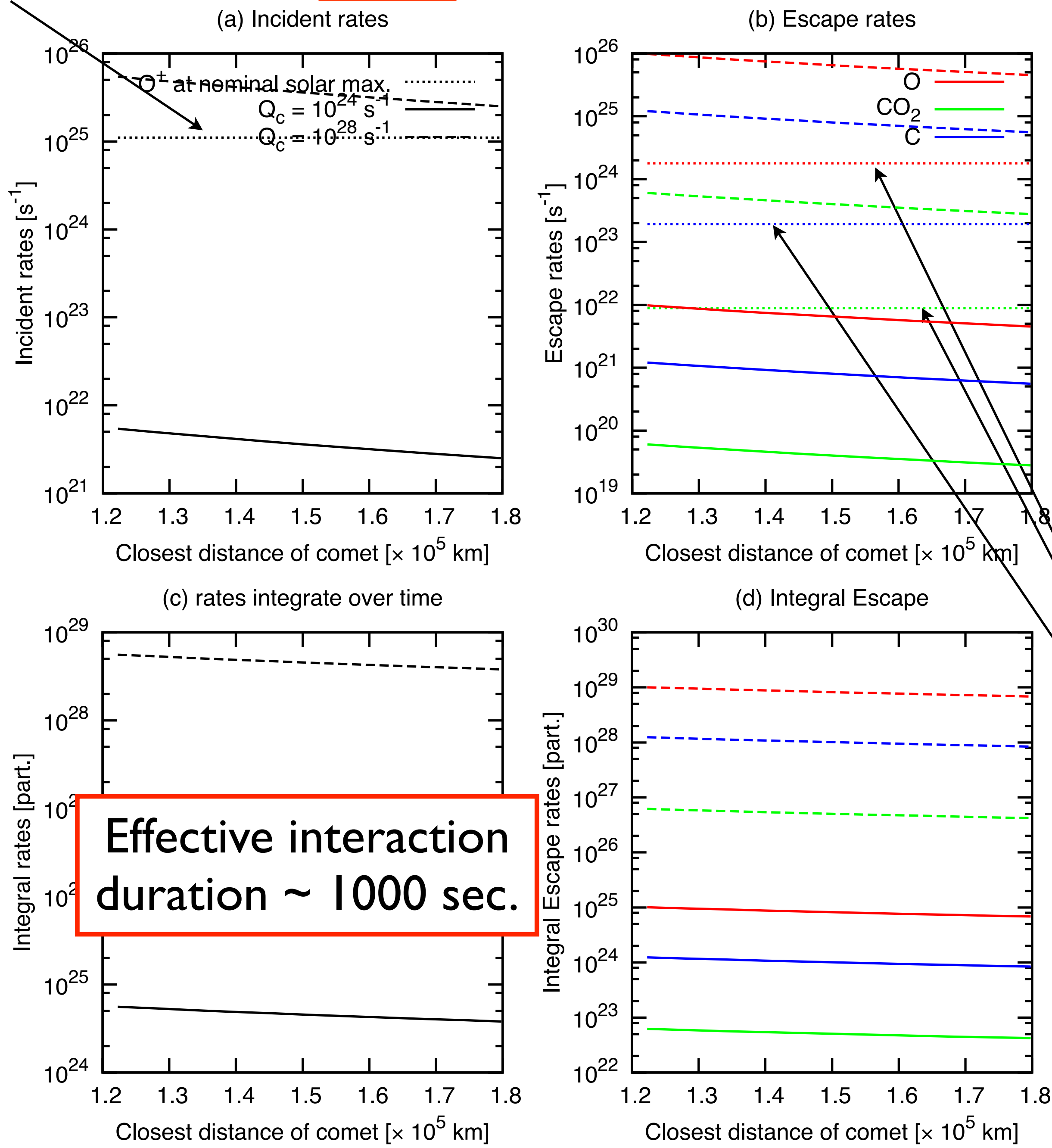
$$\Rightarrow \quad F_{\text{int}} = \frac{1}{2} F_0 \left(\frac{R_0}{v_c}\right) \propto R_0^{-1}$$

Cometary precipitation

Pick-up O^+ precipitation rate at nominal solar max. (Fang et al., 2013; Wang et al., 2013).
Averaged incident energy = 60 eV

F_0

F_{int}



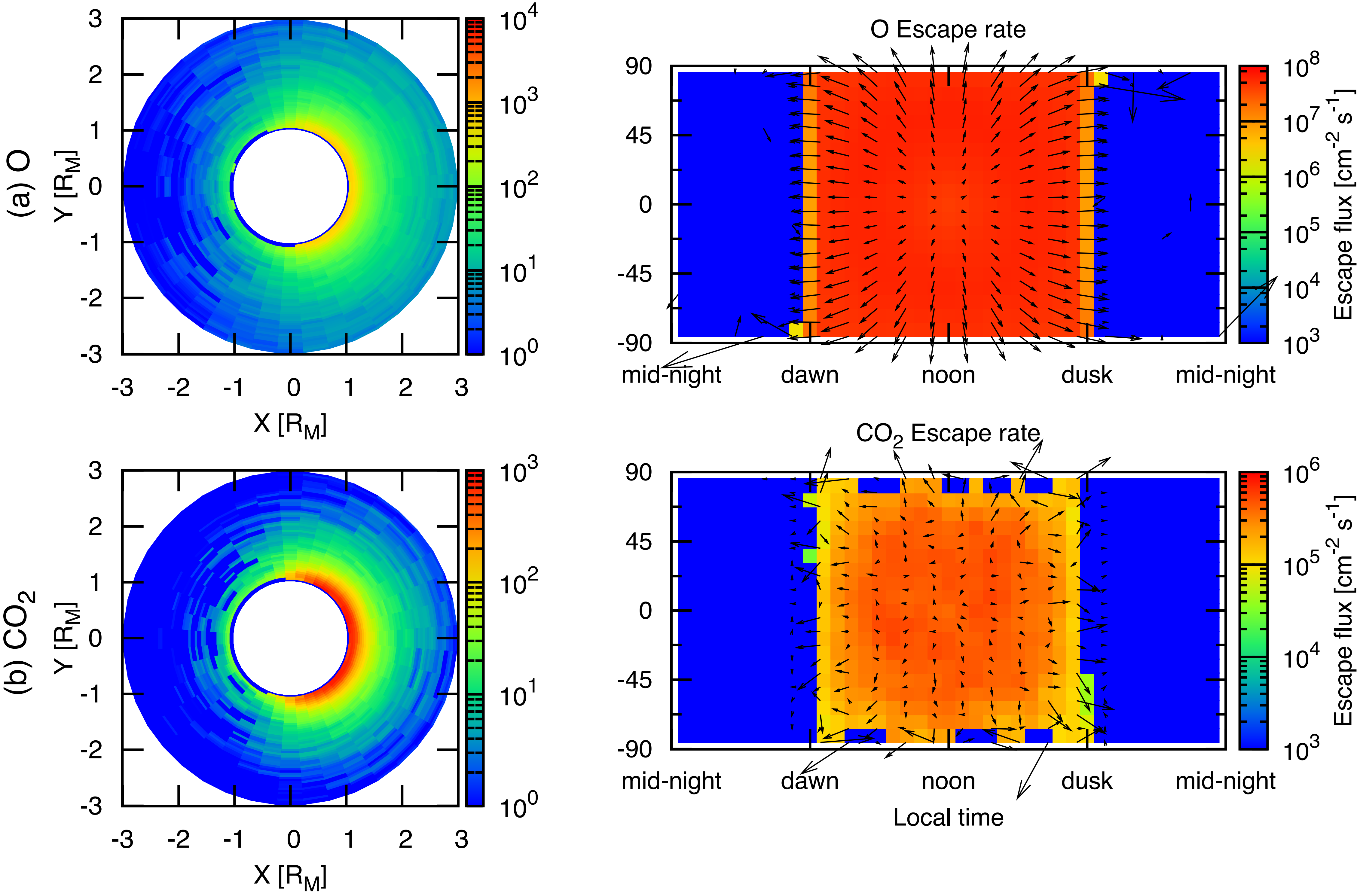
- Scale escape rates from simulated escape yields ⇒

[O, CO_2, C] = [180%, 1%, 22%]

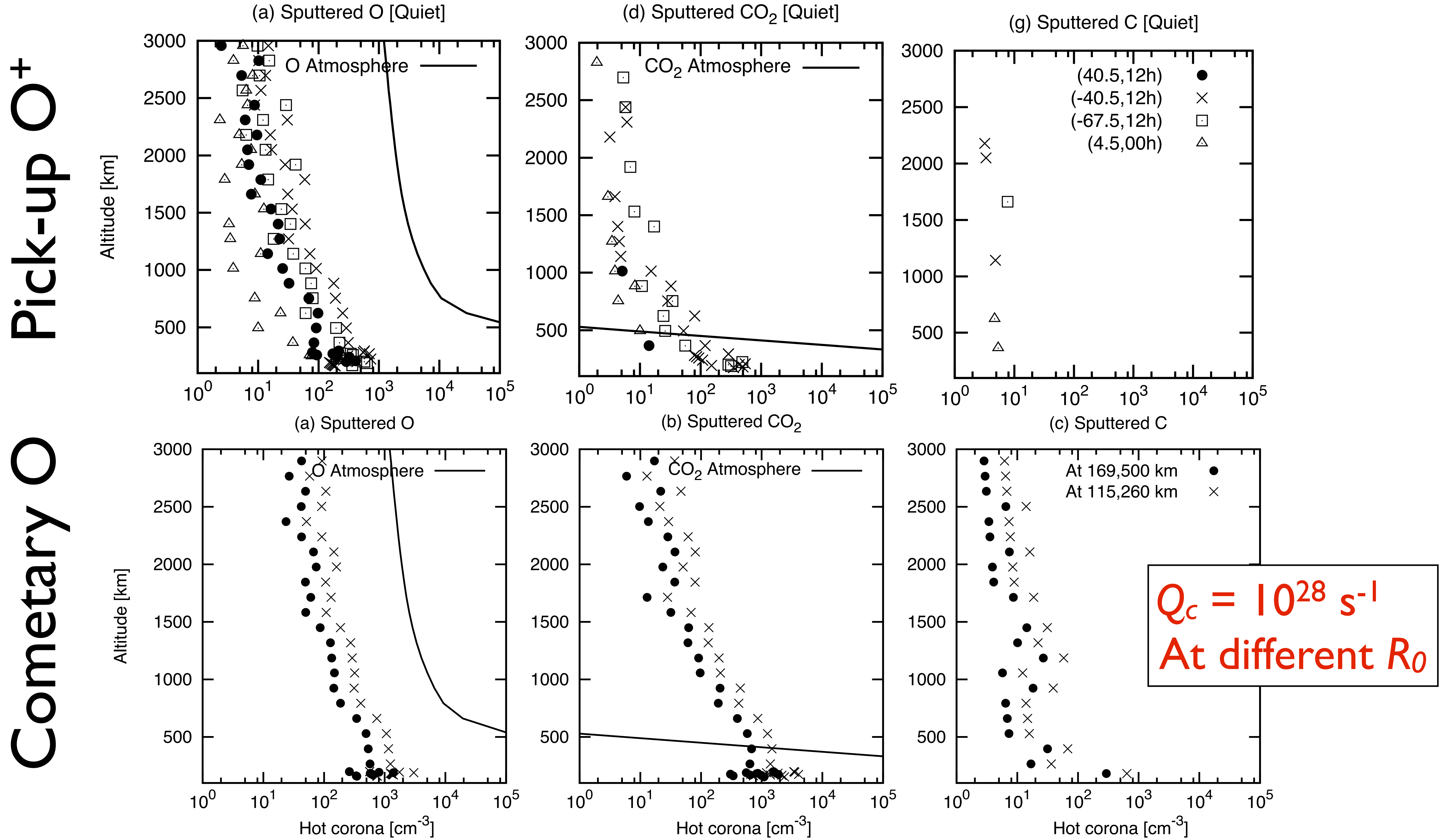
c.f. with pick-up O^+

[O, CO_2, C] = [16%, 0.08%, 2%]

$Q_c = 10^{28}\ s^{-1}$ at R_0 = 169,500 km



Hot corona



⇒ If $Q_c \approx 10^{28}$ s^{-1}, cometary O sputtered CO_2 hot corona may be detectable at $R_0 <$ 169,500 km.