The effect of asymmetric surface topography on dust dynamics on airless bodies

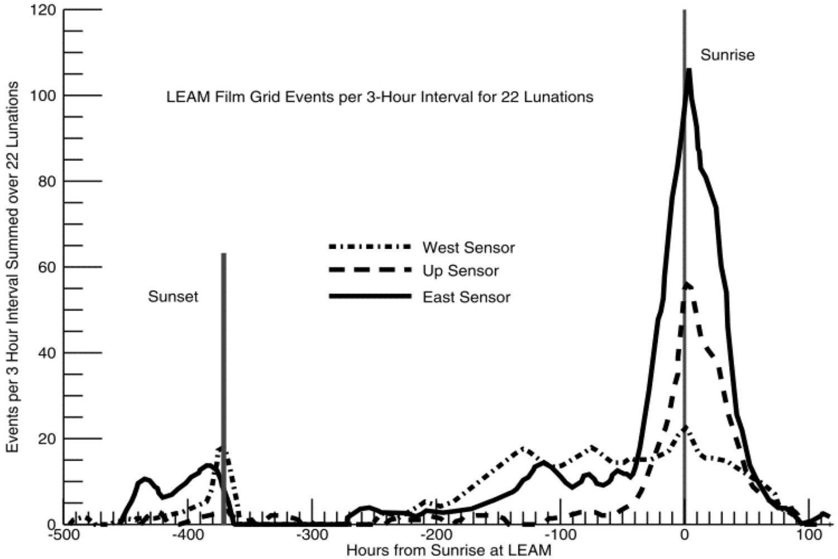
M. Piquette[1,3] and M. Horányi[2,3]

[1]Dept. of Astrophysical and Planetary Science, University of Colorado, Boulder CO

[2]Dept. of Physics, University of Colorado, Boulder CO

[3]Laboratory of Atmospheric and Space Physics, University of Colorado, Boulder CO

Motivation – dusty plasma



LEAM measurements indicating higher dust activity near the terminator, (O. Berg *et al*., Geo. Res. Lett., **1**, 1974)

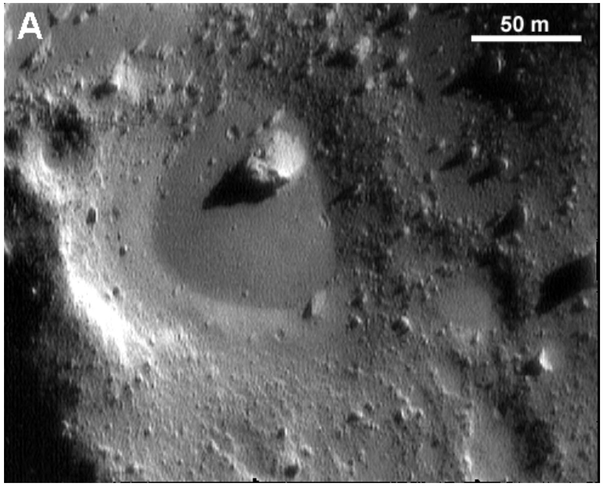
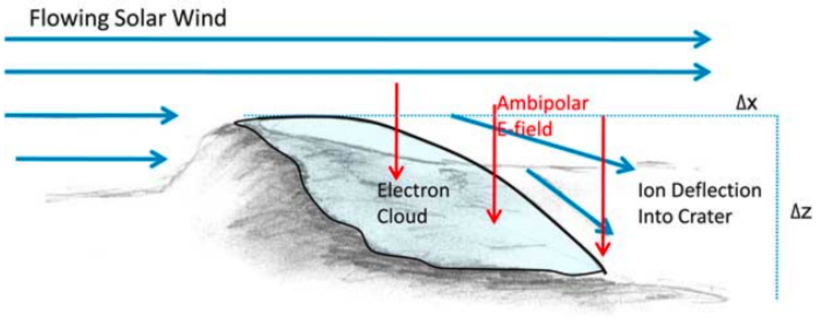
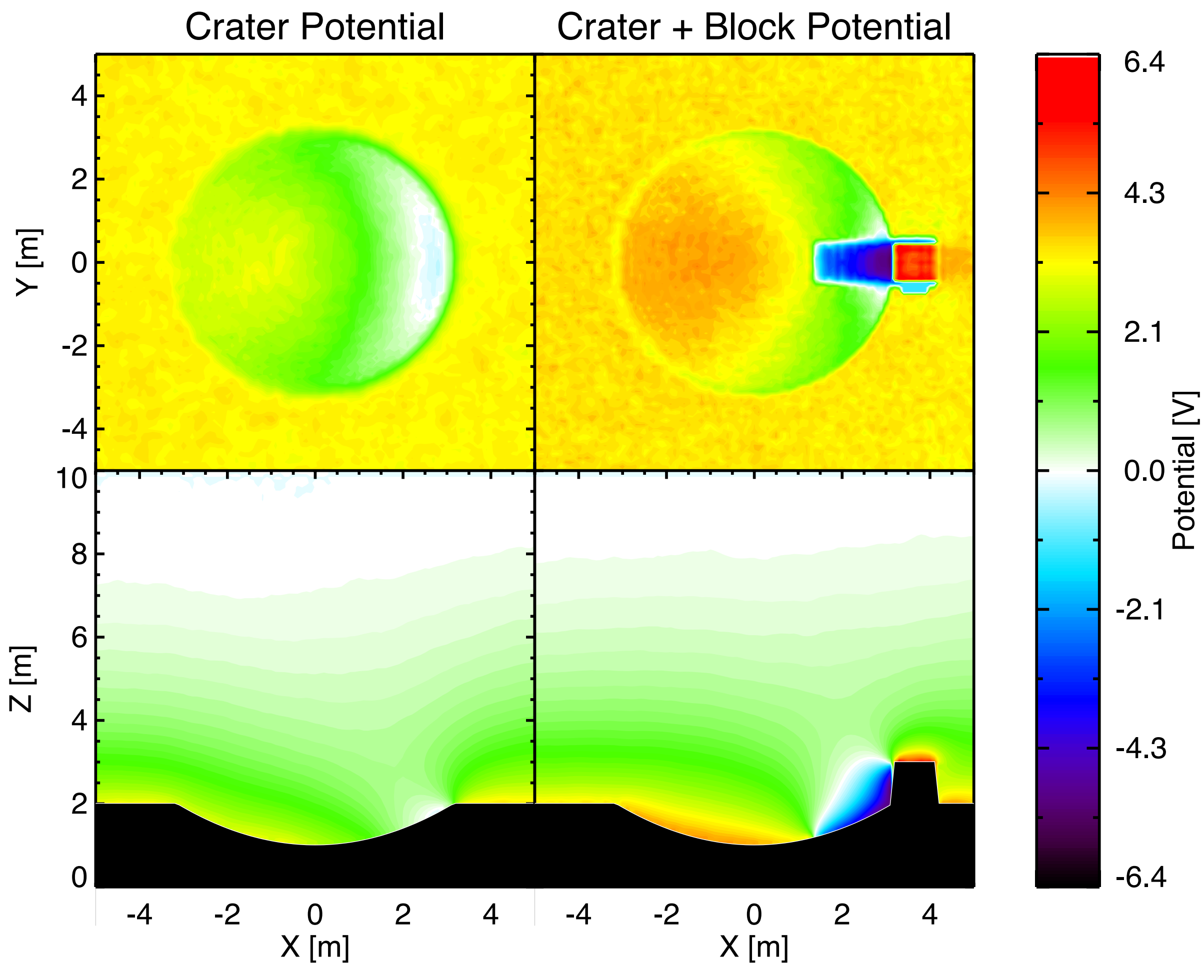


Image of dust pond on Eros 433, (J. Veverka *et al.*, Science, **292**, 2001)



Topography can develop complex plasma environments, (Farrell, W. M, et al., J. Geophys. Res., **115**, 2010)

PIC model



Solar wind:

$n = 1 \times 10^7$ 1/m^3

$v_{drift} = 4.5 \times 10^5$ m/s

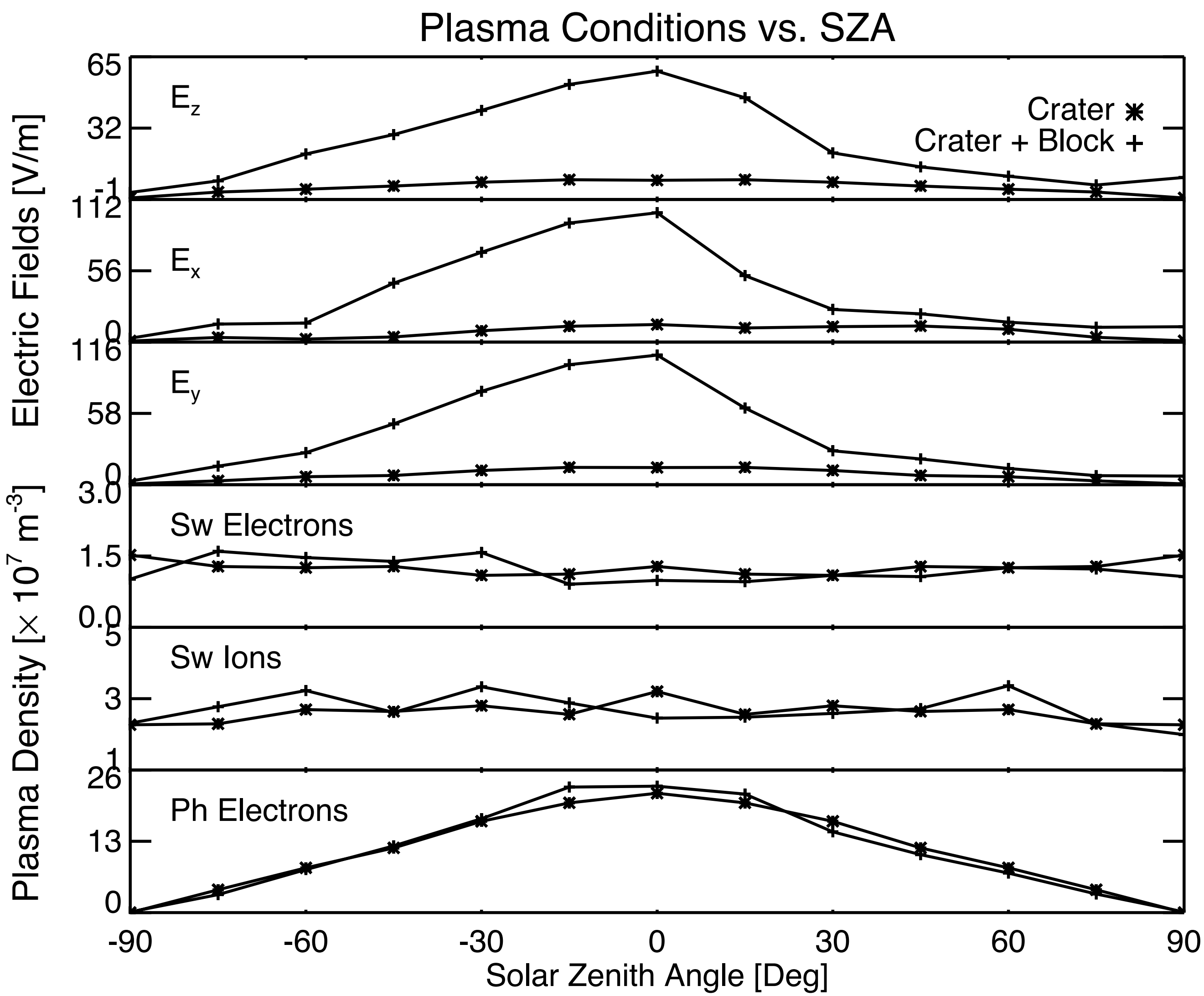
E = 10 eV

Photoelectrons:

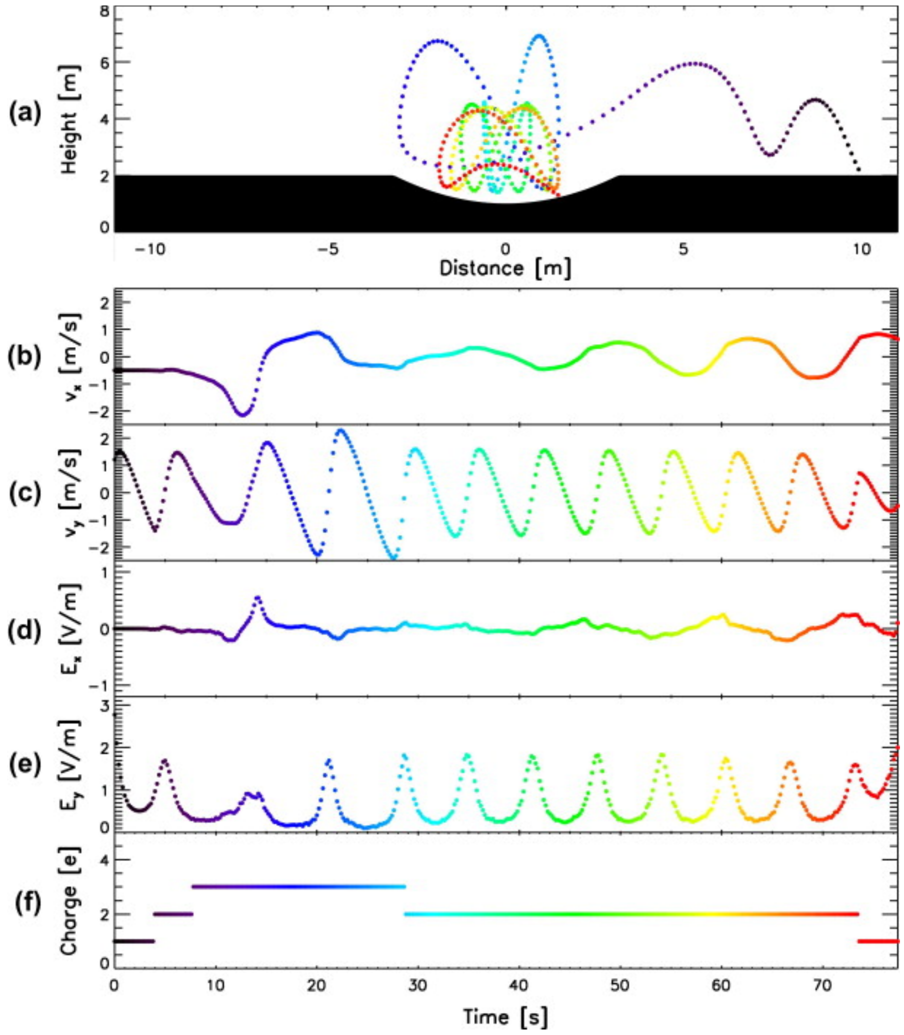
$I = 4.5 \times 10^{-6}$ μA/m^2

E = 2.2 eV

Results – plasma conditions

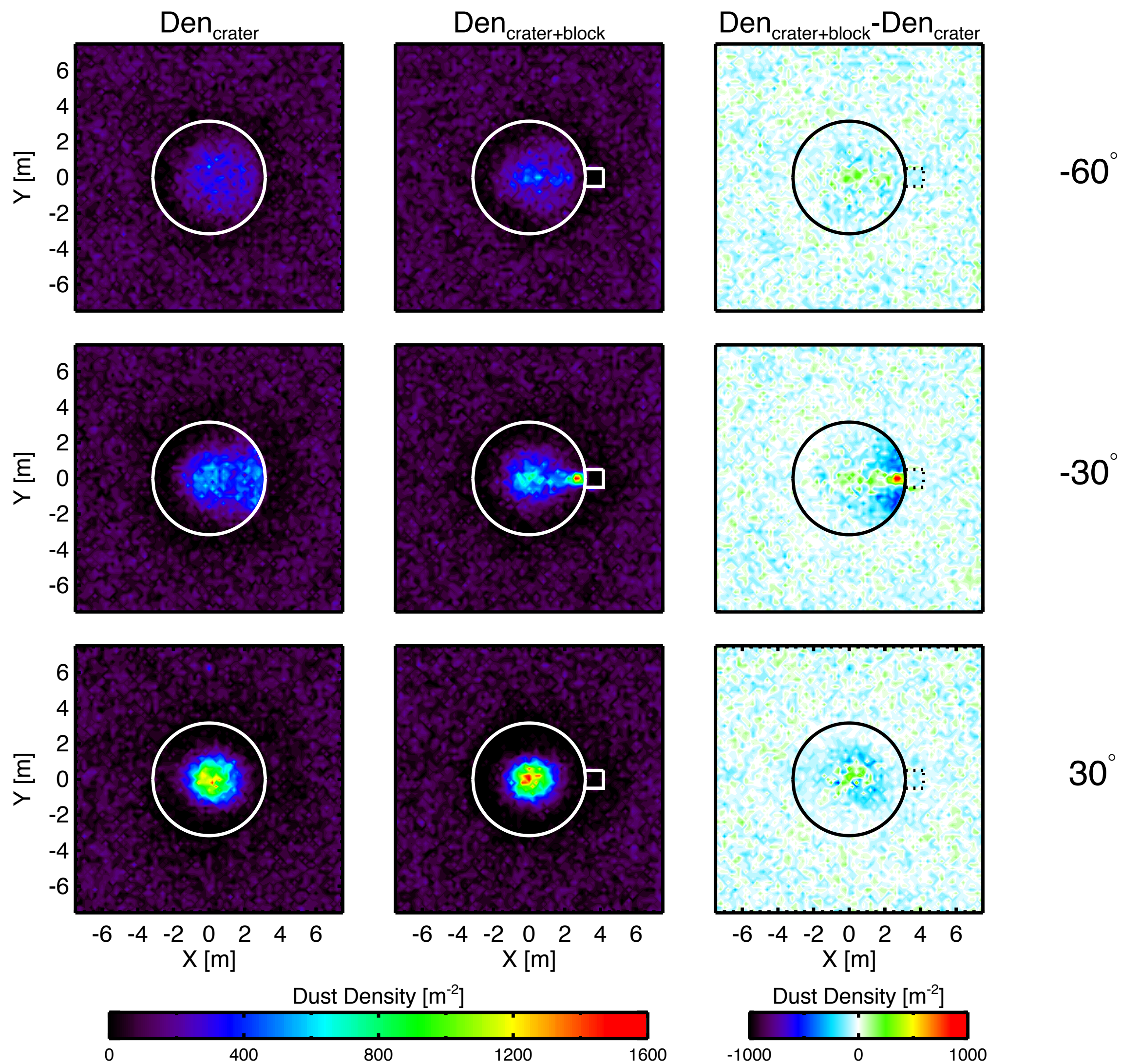


Dust tracing code

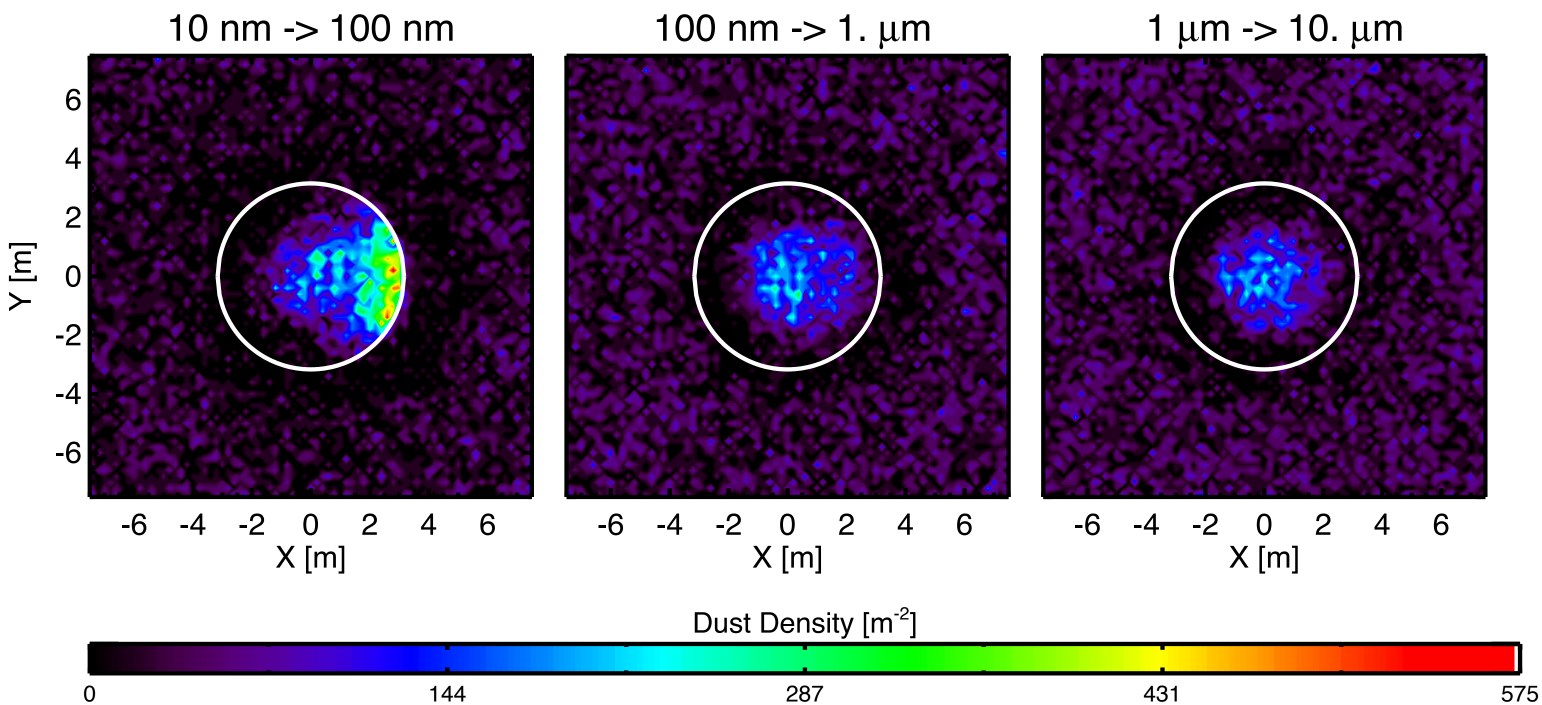


Poppe, A.R., Piquette, M., Likhanskii, A., Horanyi, M., 2012, Icarus.

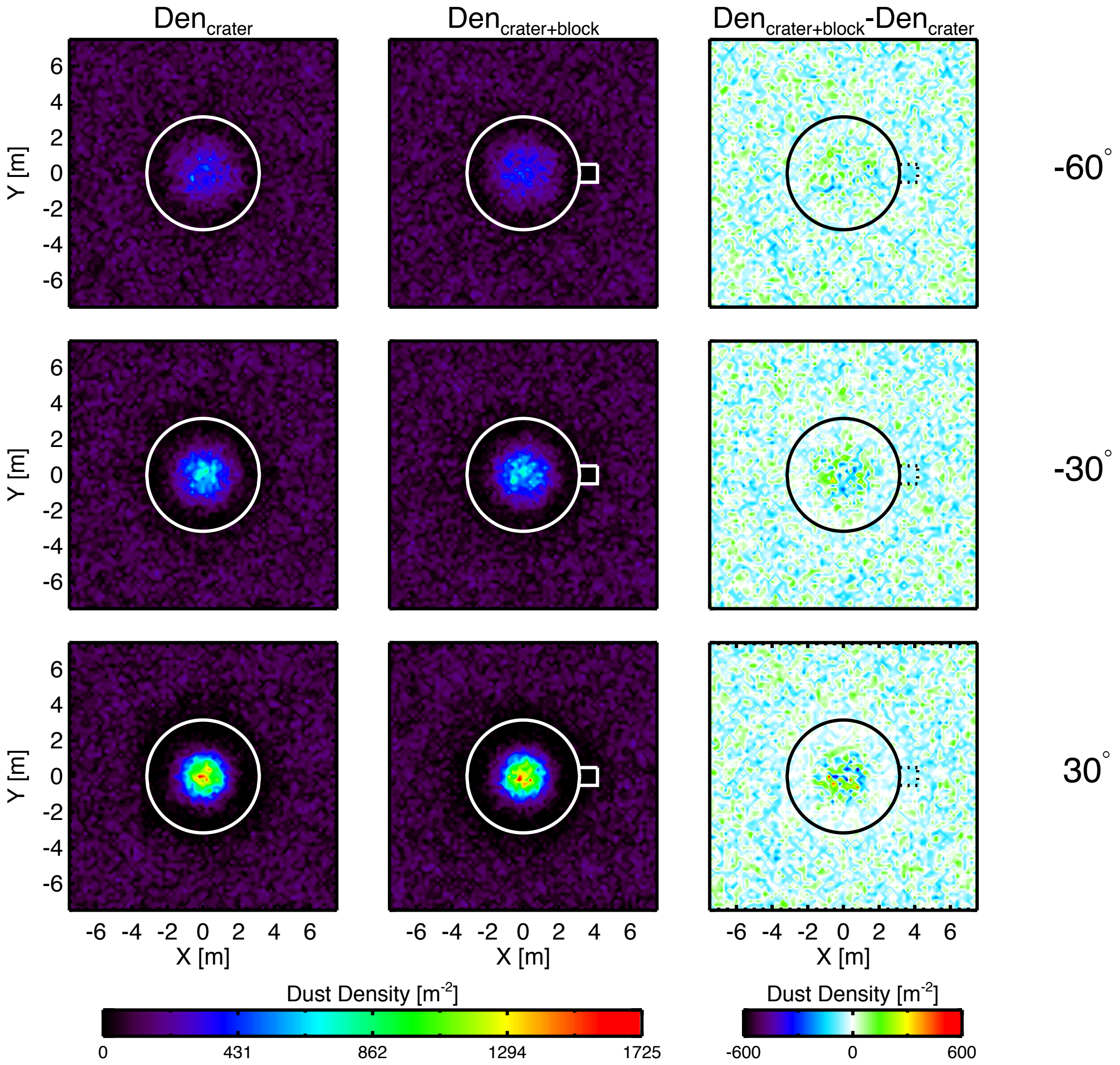
Results – surface dust density (retain charge)



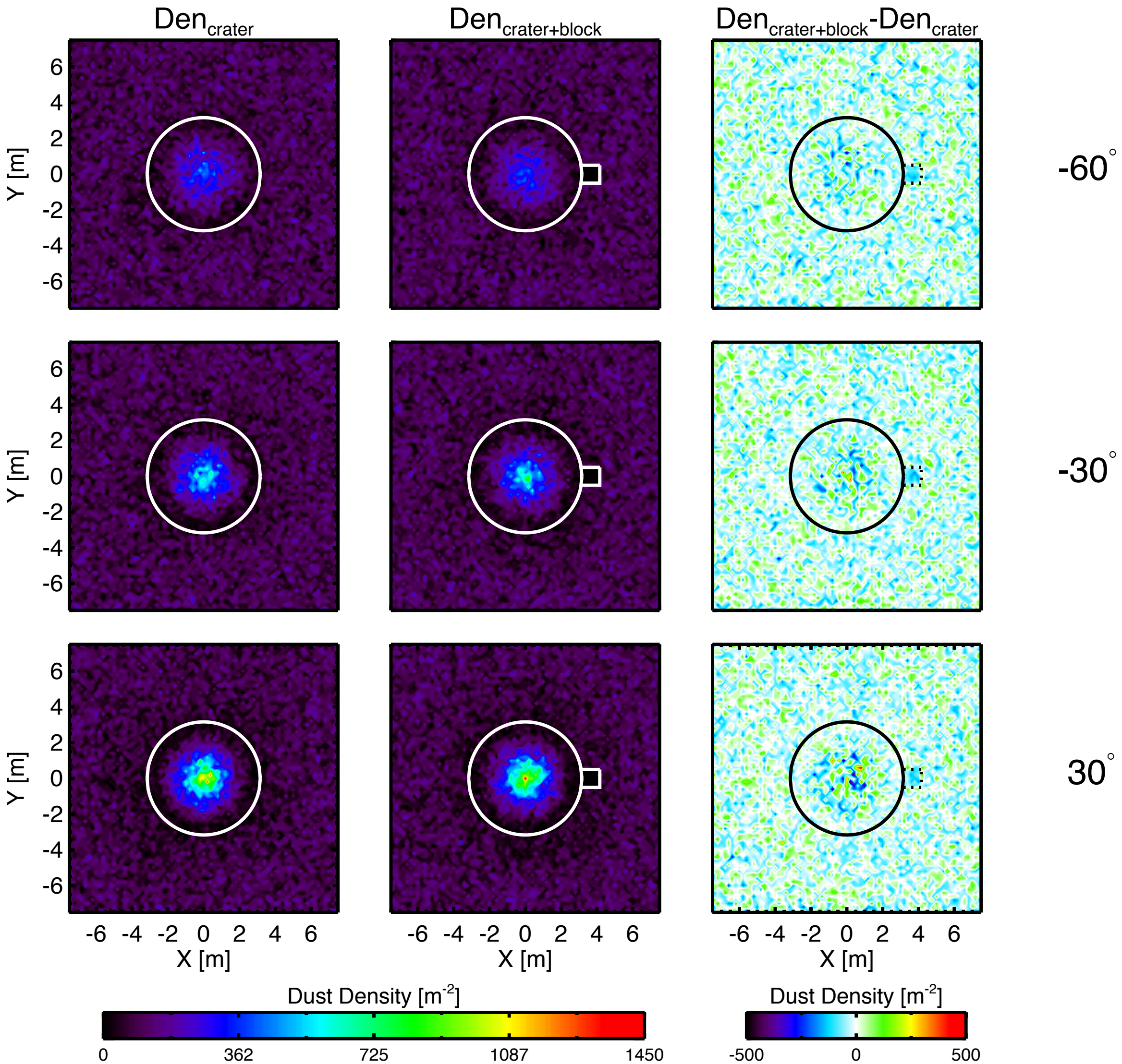
Results – vs. size



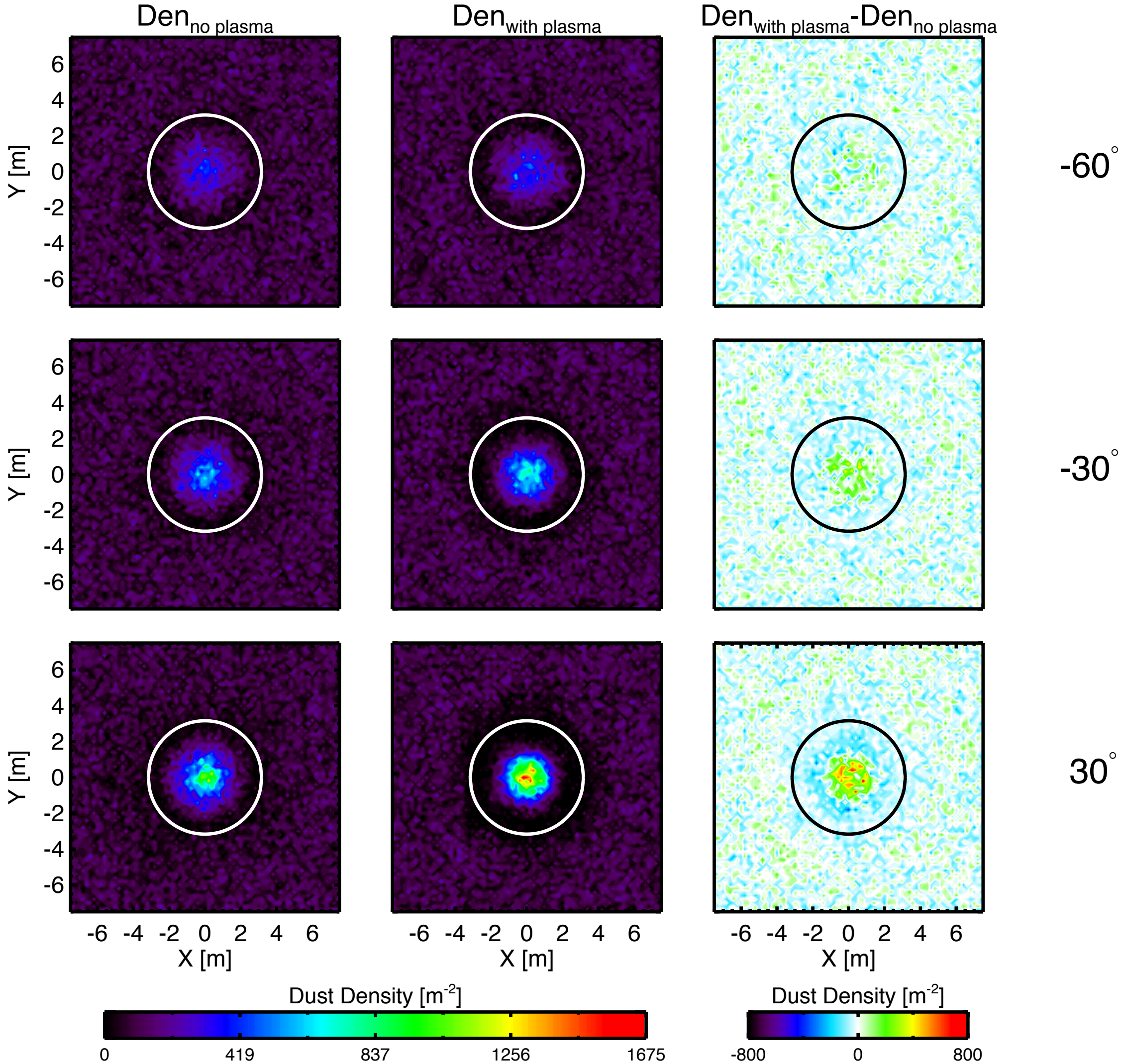
Results – surface density (lose charge)



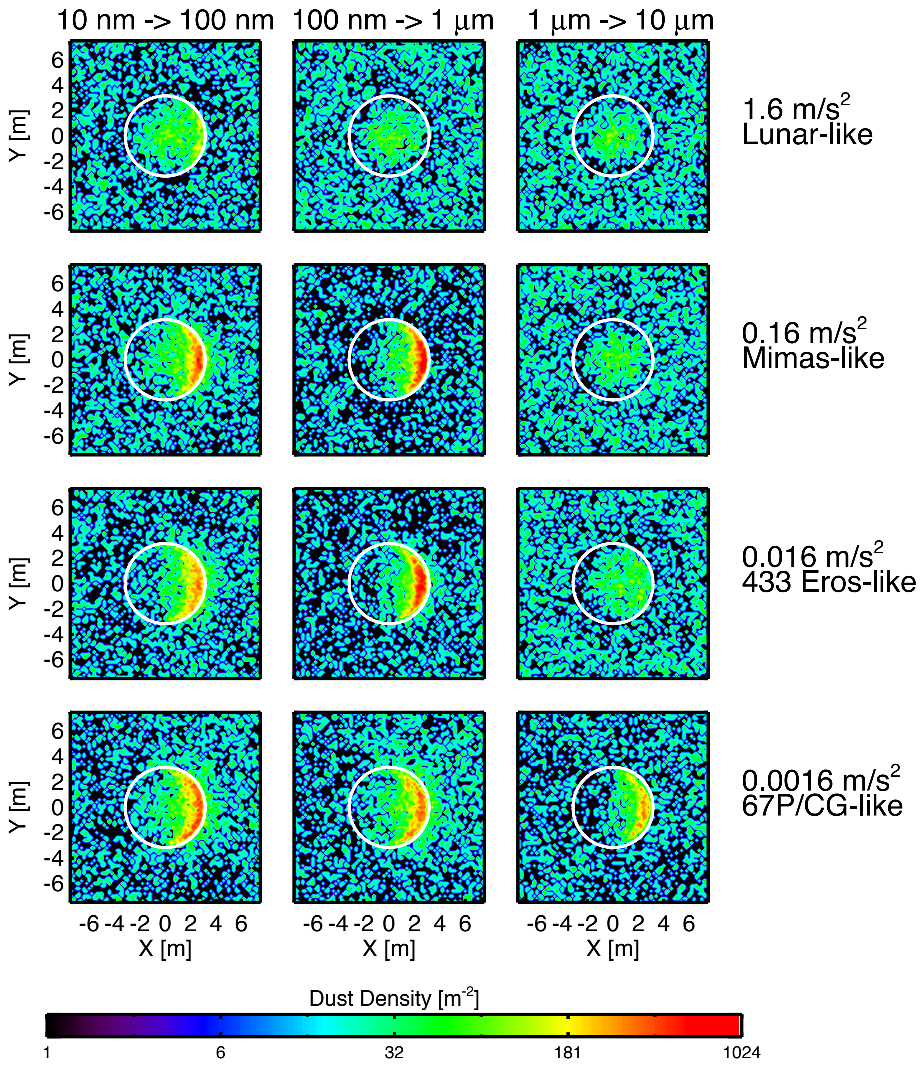
Results – surface density (no charge)



Results – charge vs. uncharged



Results – reduced gravity

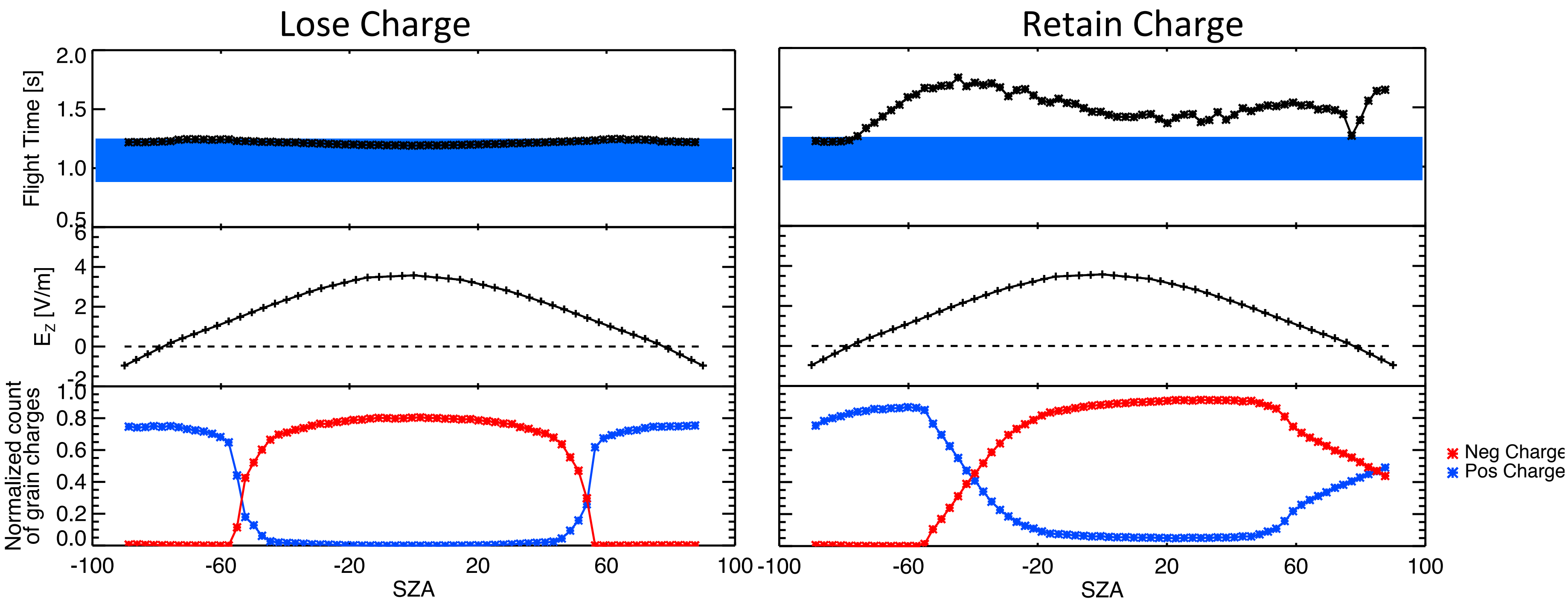


Conclusions

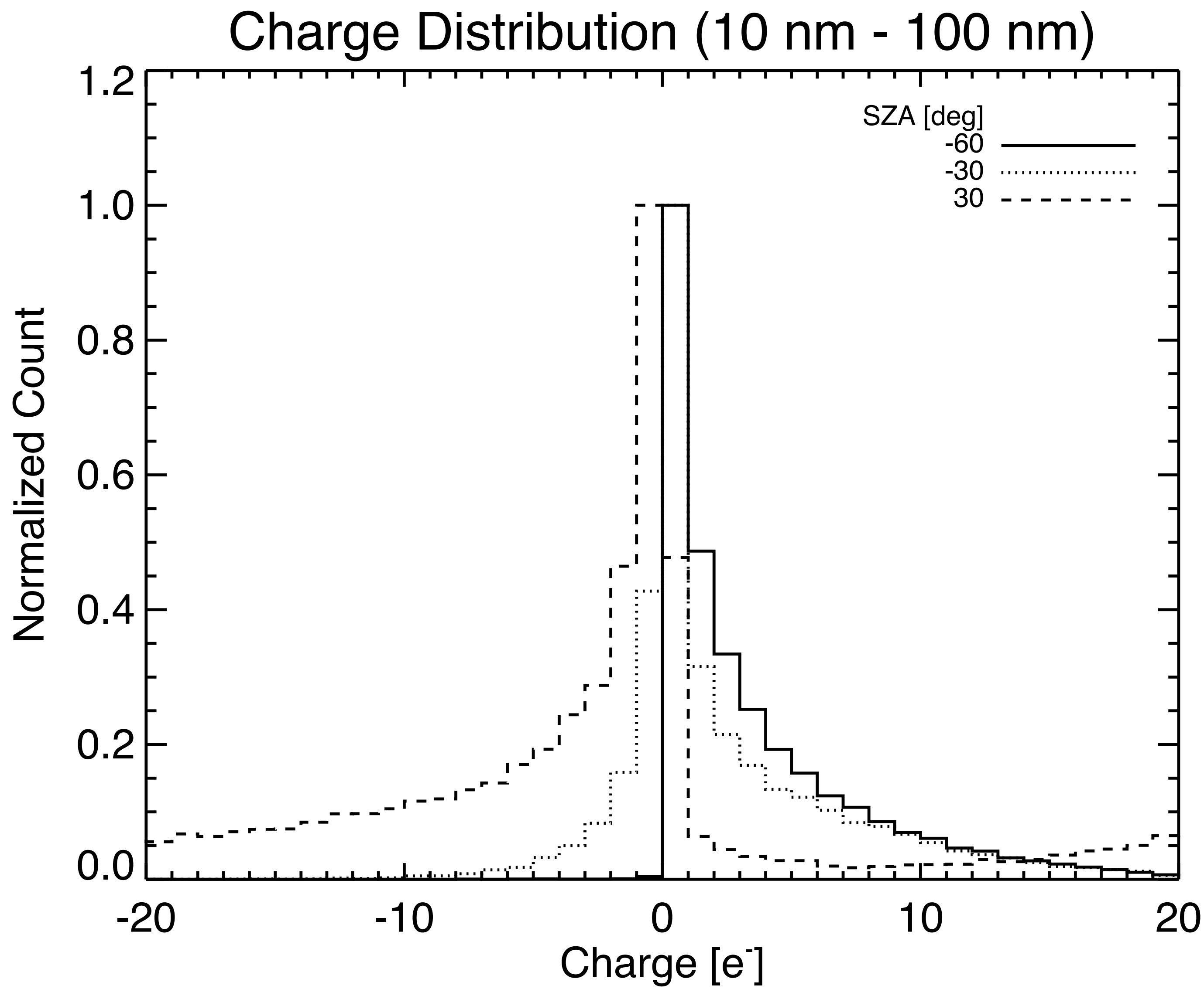
- Changes to topography on the order of the plasma Debye length are able to drastically change the surface charge density resulting in an order of magnitude increase in electric field strength.
- Plasma densities above the surface however were little affected by the topographic change.
- Dust behavior was dependent on how grains charge is handled.
  - In general, dust is transported to topographic relief due to both electrostatic and geometric influences.
  - Significant transport to transient shadow regions, in lunar gravity, is only present for smaller (10 – 100 nm) dust grains that retain charge.
  - **The effects of asymmetric topographies on the scale of a spacecraft has little affect on bulk transport in the range of 10 nm – 10 μm.**
- Reduced gravity leads to more efficient dust transport and dust activity above the surface

- Extra slides

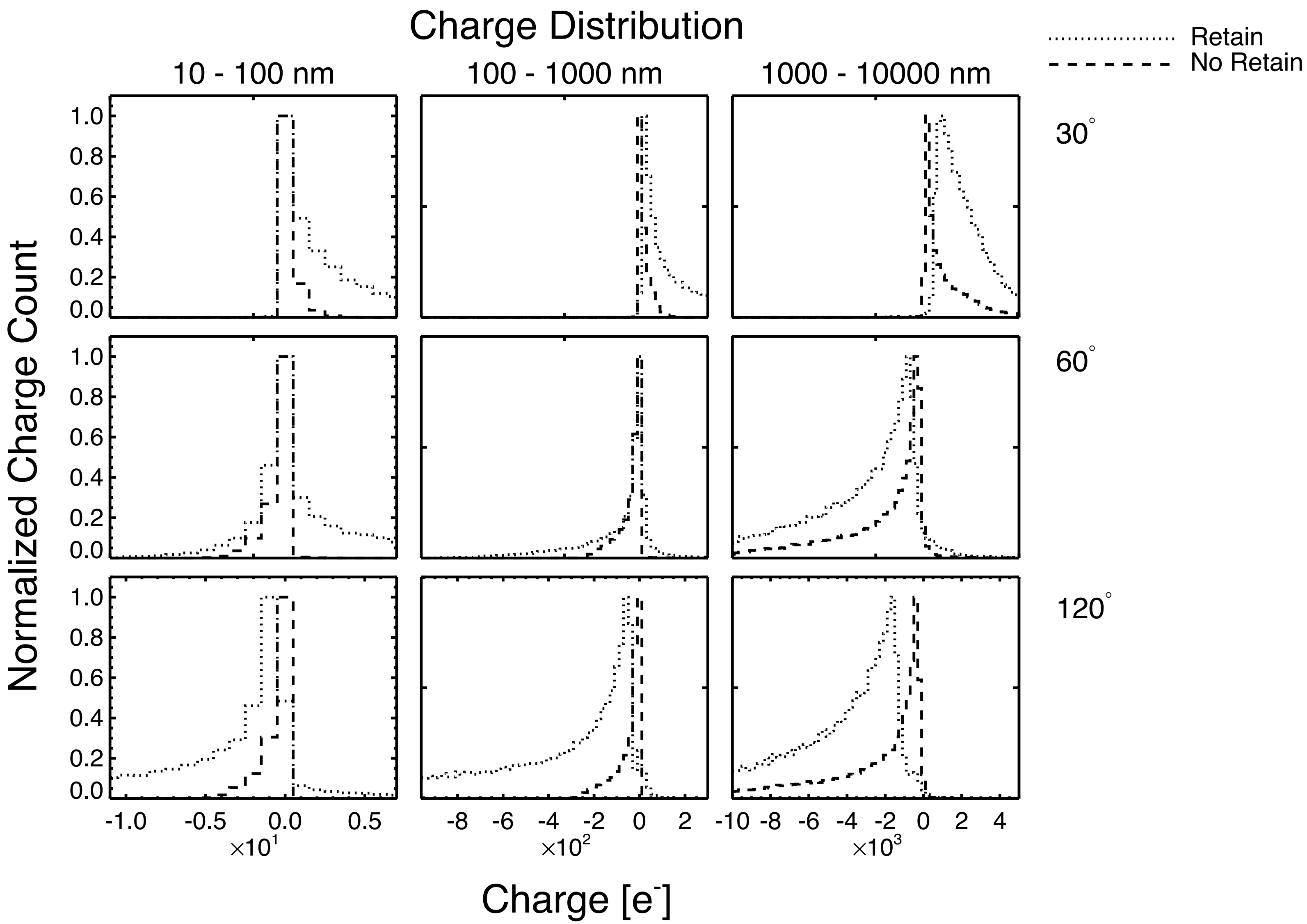
Time of flight – lunar gravity



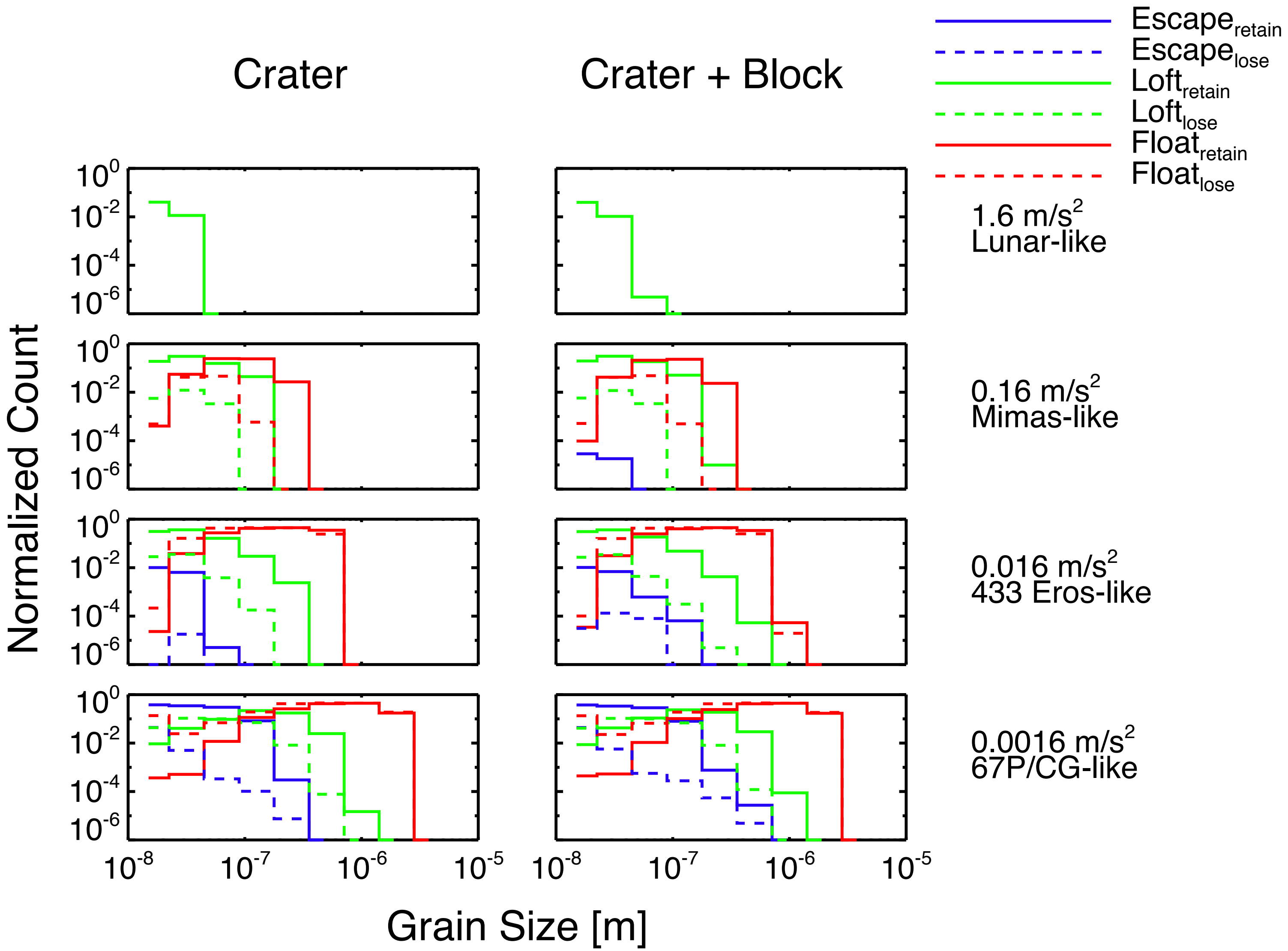
dust charge evolution, grains that retain charge



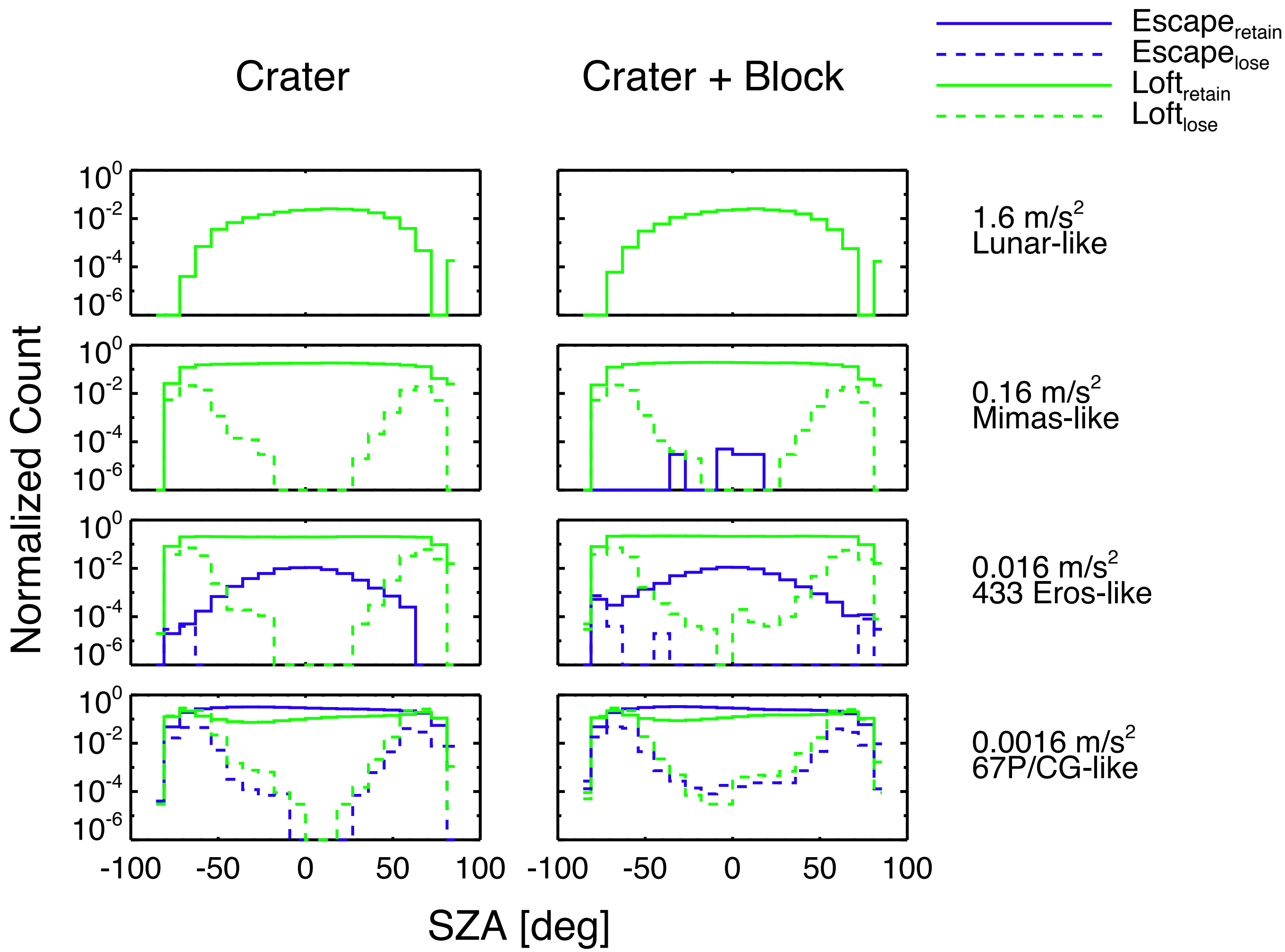
dust charging – retain vs. lose charge



Reduced gravity – particle size



Reduced gravity - time



Reduced gravity – loft height