

Modeling the meteoroid environment far from the ecliptic plane

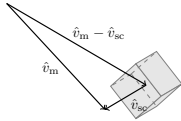
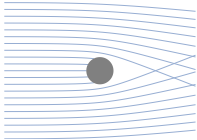
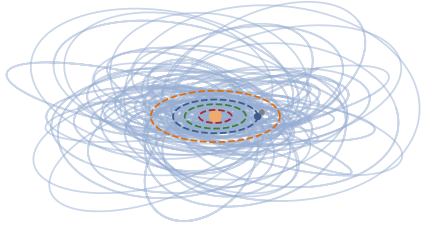
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MEM describes the sporadic component of the meteoroid environment.



Meteoroid models primarily consist of populations of meteoroid orbits.

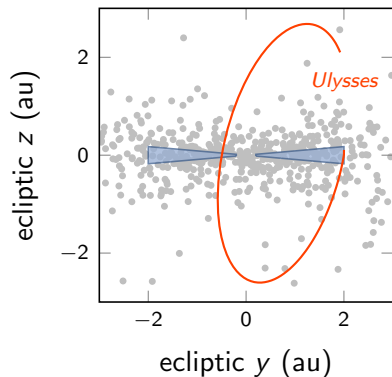
The gravity and size of the Earth and Moon affect the local environment, and the spacecraft's motion factors in to the apparent velocity of the meteoroids it encounters.

NASA's Meteoroid Engineering Model (MEM) describes the resulting environment relative to a given spacecraft trajectory.

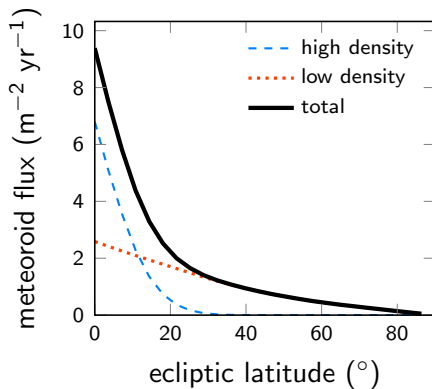
All versions of MEM to date assume that the spacecraft lies near the ecliptic plane (simplifies the math and decreases run time).

MEM 3.1-alpha is a new version that captures the drop in meteoroid flux as you move away from the ecliptic.

The near-ecliptic assumption is fine for most, but not all, spacecraft:

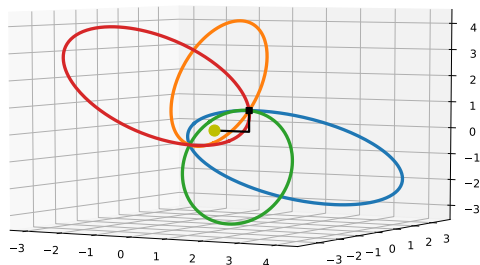
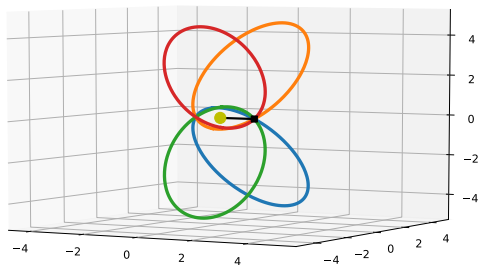


Spacecraft far from the ecliptic should encounter a lower flux:



The apparent directionality also changes with ecliptic latitude.

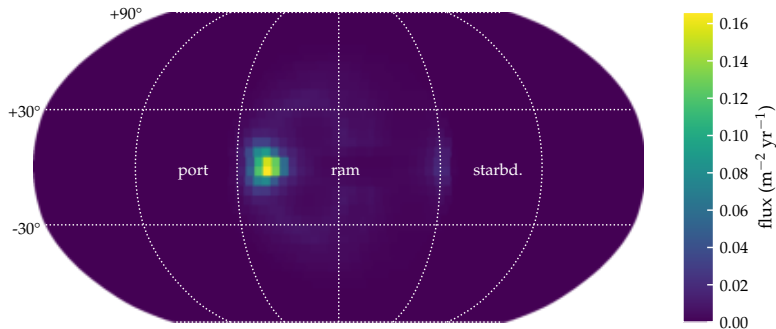
For a given a , e , and i , there are 4 sets of orbit angles that allow the orbit to intersect a given point (provided that i is large enough).



At out-of-ecliptic locations, the apparent directionality is of course no longer symmetric about the ecliptic.

What does the environment look like near the ecliptic?

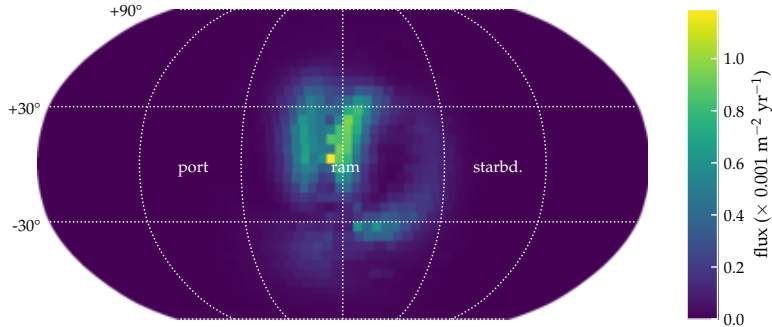
Here's the meteoroid flux encountered by *Ulysses* on its way to Jupiter:
heliocentric distance of 1.33 au, less than 2° from the ecliptic



Note the strong contribution from the helion meteoroid source between port and ram.

What does the environment look like far from the ecliptic?

Here's the meteoroid flux encountered by *Ulysses* after the Jupiter fly-by: heliocentric distance of 1.8 au, nearly 70° south of the ecliptic



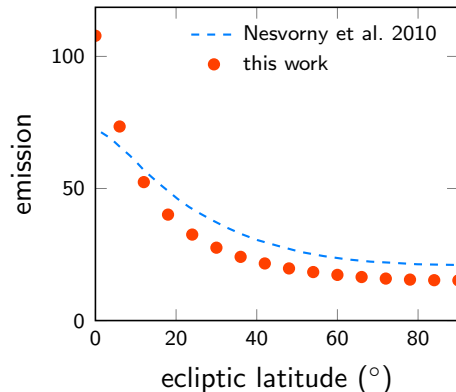
The helion source has disappeared, the overall flux is much lower (check the scale), and the flux is dominated by high-inclination “toroidal” meteoroids.

Modeled infrared emissions bear some similarity to observations, but are not a close match.

When we simulate $25\text{ }\mu\text{m}$ emission from particles (a la Nesvorný et al. 2010), the result qualitatively resembles ZC observations.

However, our profile is steeper than observed.

Results are preliminary and subject to change.



Summary

We've developed a new version of our meteoroid environment model (MEM 3.1-alpha) that can handle out-of-ecliptic spacecraft or observer locations.

This version of the code is important for modeling the hazardous particle flux encountered by solar observation missions. Without it, the risk is overestimated and the directionality is wrong.

MEM 3.1-alpha is also better for scientific applications, such as modeling impacts on asteroids with inclined orbits.

Validation against observations is ongoing.