Frequency of Close Earth Approaches by Near-Earth Objects

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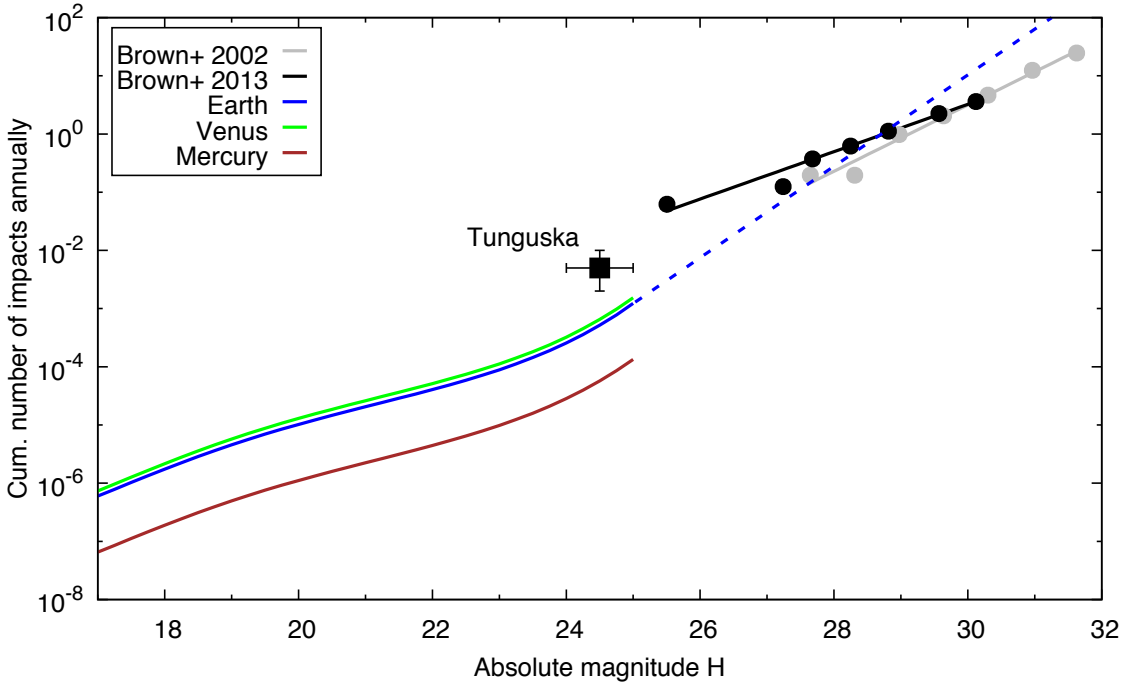
Building on

Granvik, Morbidelli, Jedicke, Bolin, Bottke, Beshore, Vokrouhlicky, Nesvorny, Michel, 2018. “Debiased orbit and absolute-magnitude distributions for near-Earth objects”, Icarus 312, 181–207.

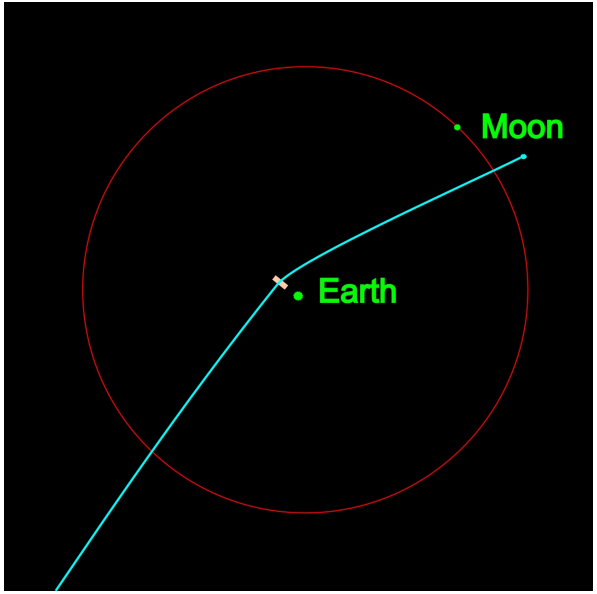
Predicted rate of impacts on the inner planets and comparison with bolides



Granvik+ (2018)

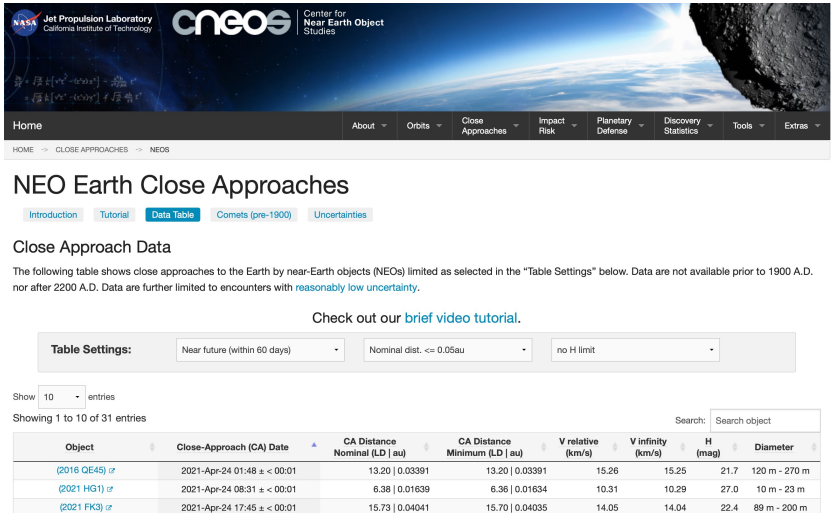
What is the frequency of encounters such as that by Apophis in 2029?

- Apophis has H≈19.1 and closest geocentric distance in 2029 is 0.00025 au.
- Frequency of Apophis-like encounters is once per 1000 yr according to casual statements – unclear where this number comes from.
- Frequency of Apophis-like encounters is once per 6500 yr according to Granvik+ (2018).

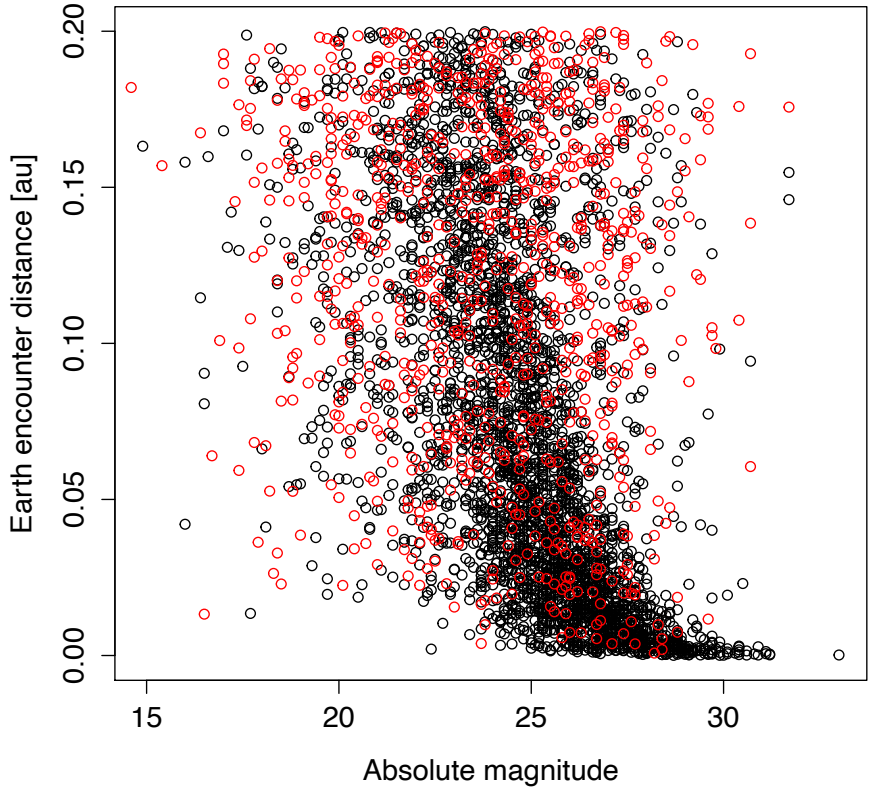


Can we rely on the Granvik+ (2018) prediction in terms of impact and close-encounter rates?

- The impact frequency in the size range of observed bolides appears to be in reasonable agreement with model prediction.
- A direct verification of the impact frequency for larger objects is, of course, impossible because impacts are rare and there is no observational data.
- We can make a direct comparison between the predicted and observed rate of close encounters, but need to use a reasonably unbiased sample to avoid being misled by observational biases.

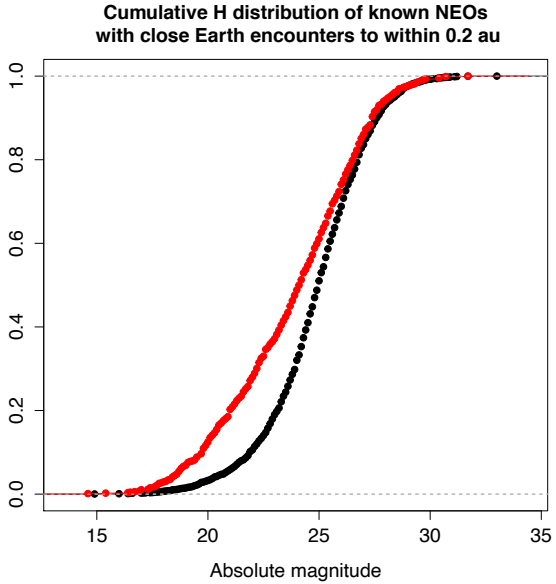


Close encounter data 2021-04-15 ± 1yr from CNEOS

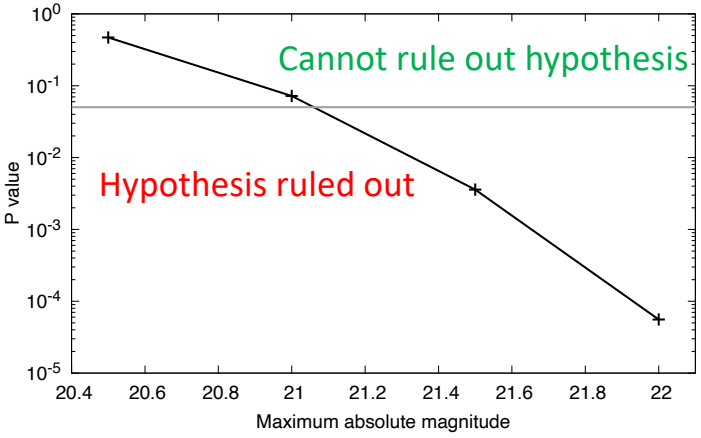


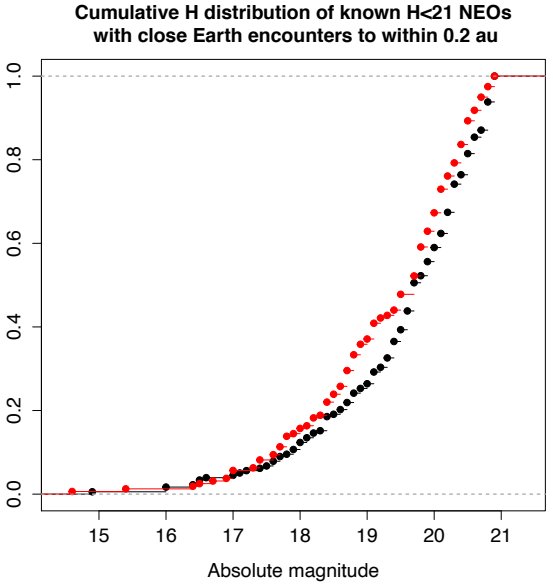
Past year (“observed”)
Next year (“predicted”)

Unbiased close encounter data 2021-04-15 ± 1yr

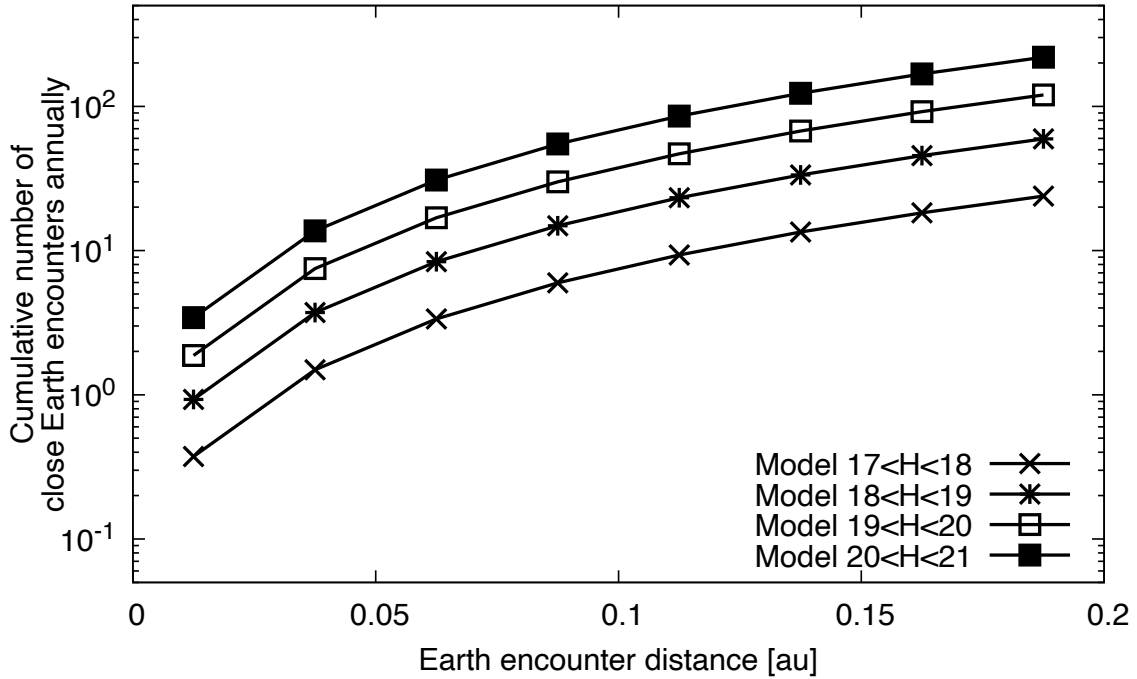


Null hypothesis for AD test:
Samples are drawn from
the same distribution

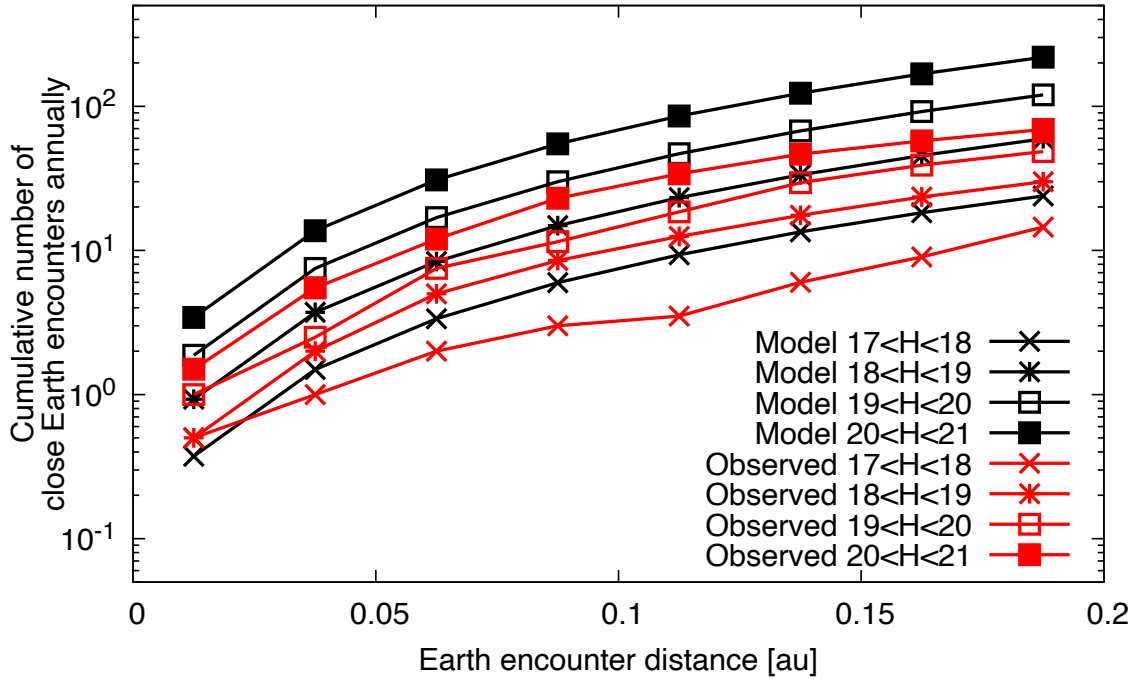




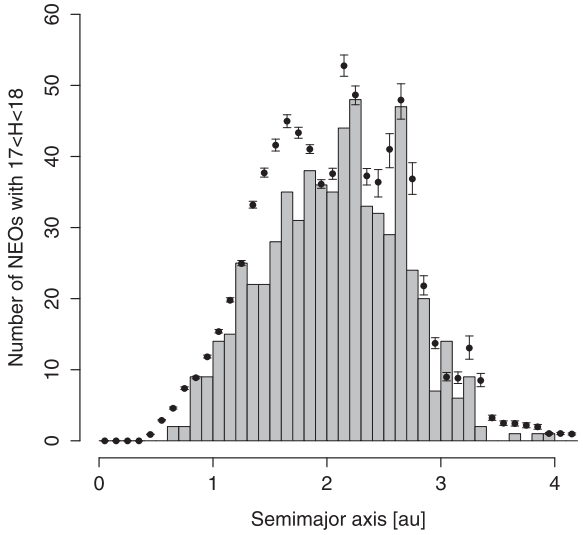
Model prediction for frequency of close encounters by large NEOs

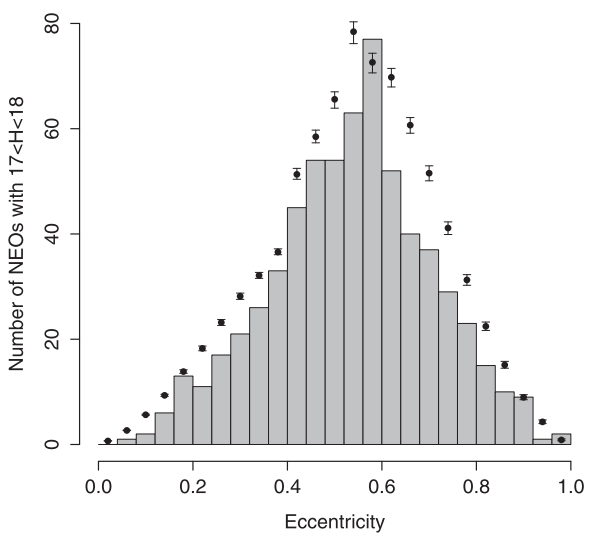


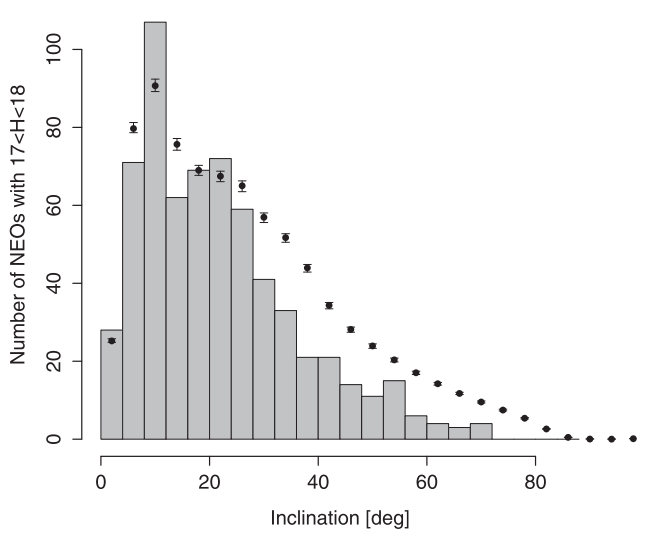
Predicted frequency of close encounters is factor of few higher than observed frequency



Completeness of the 17<H<18 NEO inventory in 2018







Granvik+ (2018)

Conclusions

- The observed frequency of close encounters for Apophis-scale objects is a factor of a few lower than the model predicts.
- The Apophis encounter in 2029 thus appears to be a once-in-20,000-yr event.
- The root cause for the disagreement between theory and observations is still not understood, but observational biases may be part of the explanation, in particular for smaller NEOs.