Sonic Boom Energy from Atmospheric Models

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Goals and Objectives

•Predict the energy and period generated by re-entry of the Spectral Interpretation, Resource Identification, and Security – Regolith Explorer (OSIRIS-REx) sample return capsule (SRC)

•Used atmospheric specifications from the 1976 NASA U.S. Standard Atmosphere, NRL Ground-to-Space (G2S), and fifth-generation European Centre for Medium-Range Weather Forecasts atmospheric reanalysis (ECMWF ERA5) for estimations

Introduction

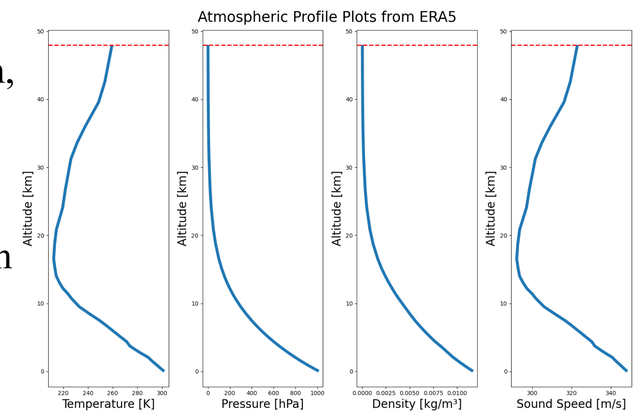
•On 24 September 2023 ~14:52 UTC, the OSIRIS-REx capsule containing samples from asteroid Bennu entered Earth at hypersonic speed, landing in Utah Test and Training Range

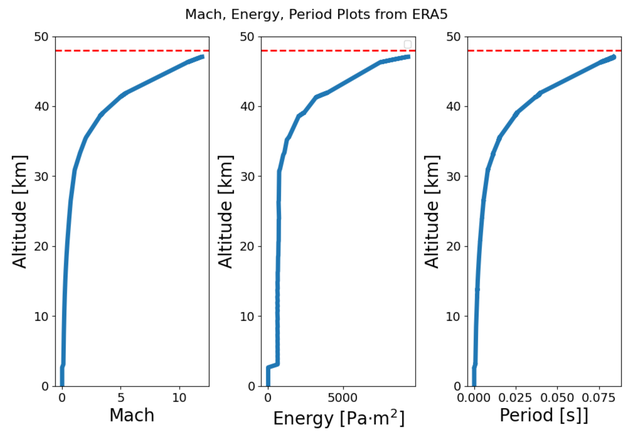
•A sample return mission has not landed in the USA since Stardust (in 2006)

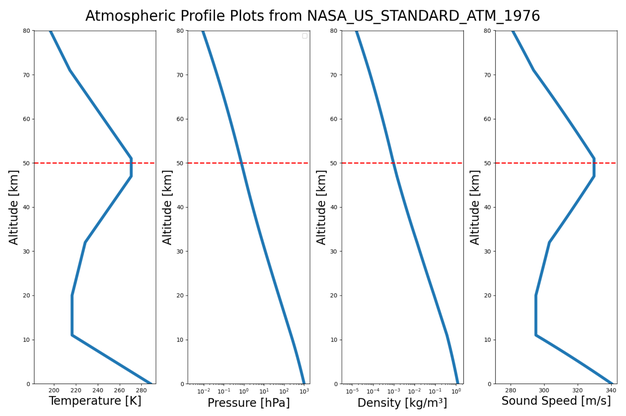
•The SRC entry produced sonic booms during the hypersonic and supersonic stages (Mach >1)

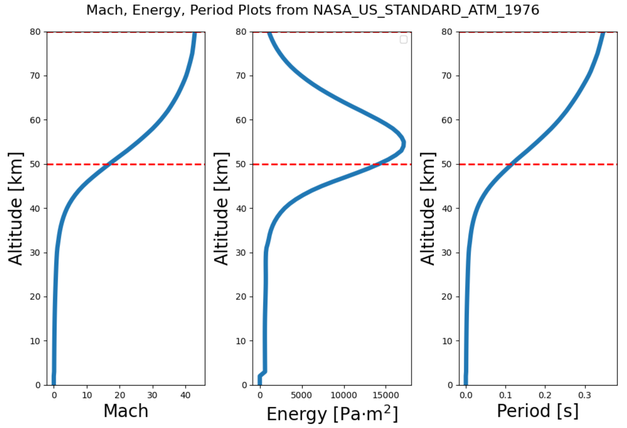
•Figures show atmospheric profiles from the three different specifications mentioned above and estimation of the energy per unit length and sonic boom duration over the entry flight altitude

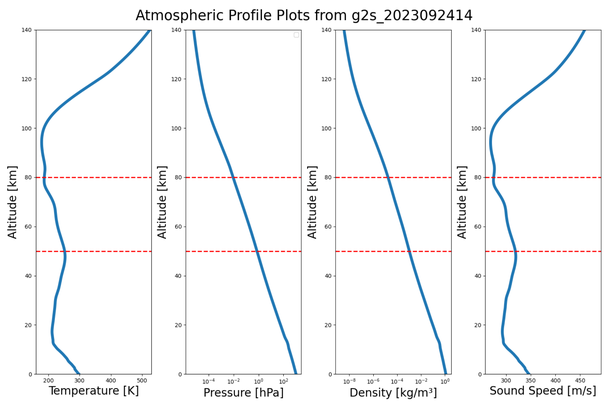
Results

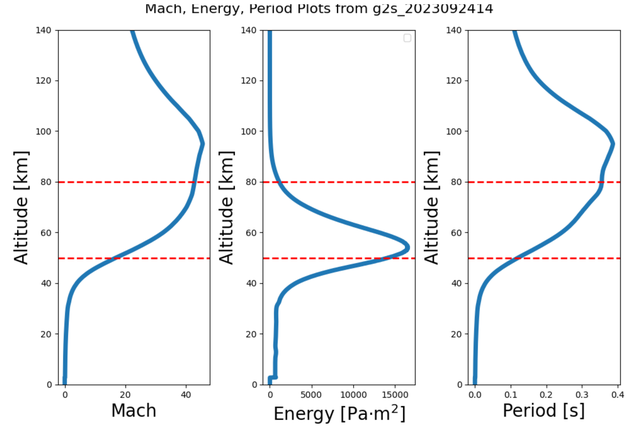












Methods

• We used the predicted trajectory (courtesy of NASA) with the atmospheric specifications to predict the energy and duration of the signal

Conclusions

The SRC enters the atmosphere at hypersonic (Mach ≧ 5), transitioning to supersonic (5 > Mach > 1) and subsonic (Mach < 1) until it lands

•NASA U.S. Standard Atmosphere, and GS2 show the peak energy and period. ERA5 only provides data up to ~50km, which limits the amount useful information

•The largest predicted energy release from the SRC was ~ 54.2 km (near the stratopause) over the trajectory.

•The largest signal period can only be seen from G2S, where the peak is at below 100 km altitude (mesosphere/ionosphere region)

Discussion

•The three different models provided consistent atmospheric profiles and predictions.

Next Step

•Use final trajectory data to compare with predicted results.

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