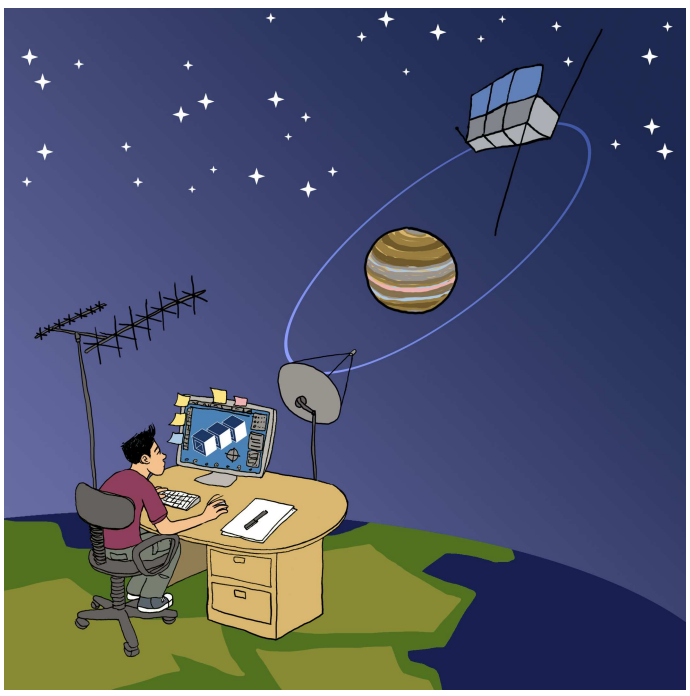

DOCKS for space mission free 3D-design prototyping

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After revolutionizing the access to space, the CubeSat technology also changes the paradigm for deep space missions. New tools are needed and C²ERES is developing DOCKS as free Python software, that includes all necessary tools to quickly generate data of a space mission. Data are simulated to output to VTS, a free CNES 3D-engine for space data. DOCKS' modules cover:

- Orbits, with a multi-body and complex shapes deep space propagator
- Attitudes and quick design of pointing strategies (tracking, inertial pointing, spin)
- Datalink to estimate the cumulative data volume downloaded
- Power, to size and check the electric power system you need
- Integration of satellite model in 3DS

"DOCKS": Design and Operations Cross-checKing Services

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Propagator to Deep Space

DOCKS' Propagator includes 2 méthodes:

- The famous Runge-Kutta 4
- Runge-Kutta-Fehlberg 45 (RKF45)

RKF45 allows a flexible integration time-step. It is necessary in contexts like a highly elliptical orbit or a planetary body flyby. Also the user can select multiple known bodies in the environment or add his/her own gravitational complex models (e.g. non-spherical shapes for proximity operations). The Propagator was intensively tested in Keplerian and non-Keplerian cases.

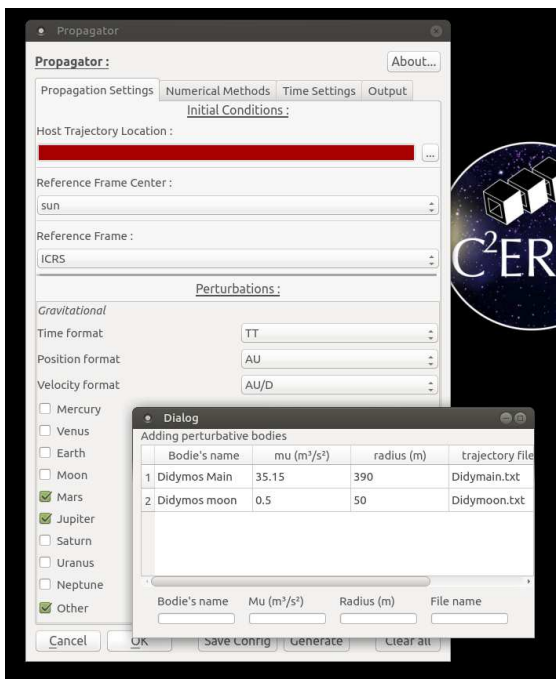

Fig. 1: Example of the propagator GUI.

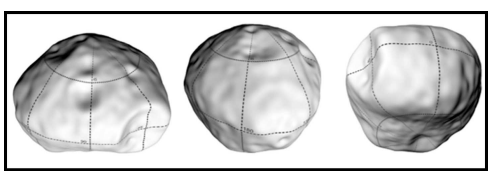

Fig.2: spherical harmonics of Phobos can be coded from a scientific model, e.g. Willner & al., 2014, Phobos' shape and topography model

A Collaborative Project

DOCKS is a collaborative endeavour: C²ERES has developed and maintained DOCKS and now expects the scientific community and the open source community to take part in it. Scientists can add their own complex-shape gravitational models in Python the way they want: we provide the interface requirements and it is up to you to model an asteroid with spherical harmonics, multiple-part body or density models. Scientists are also invited to intensively double-check the results with their own work to report any discrepancies. The open source community can evaluate the use of DOCKS, suggest or develop new features. We welcome this feedback and provide support to this aim.

Modules will be released progressively within a fully modular architecture

The next release will upgrade the Propagator. Then a full module for Keplerian trajectories will be published ("Easy trajectory" module). A preparatory release for both modules Datalink and Power is in preparation to deal with intervisibility functions and possible eclipses, gathered within a new library. Datalink module is intended to estimate the realistic cumulated data volume that is feasible in a mission. The Power module would cross-check the right sizing of an Electric Power system with assumptions of solar array design, battery aging, trajectory, orientations and platform modes.

DOCKS is meant to work with separate stand-alone modules or with the same modules fully integrated, i.e. "docked", within a common upper-module that generates a 3D-displayable project for VTS (CNES' free software for 3D-visualization). Also all modules and libraries can be launched in command line to adapt to the user's own tools.

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