

Open Source Models Toolset for VLEO Aerospace Systems Simulation

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Abstract

Simulations are a way to test systems design, improve performance and reduce the cost. To be more accurate some mathematical models need to be updated to reflect changes in the real component that is being modeled or to add new available information. The Scilab/Xcos simulation environment provides a free, open source tool to implement the disturbance blocks and design graphical models to carry out simulations. It is a useful tool to design VLEO aerospace systems and provides a way to update or add new models. In this poster, we present the results of implementing blocks with this tool for atmospheric and geomagnetic models.

Keywords: VLEO, aerospace, atmospheric model, magnetic model, disturbances, model design, satellite simulation, open source.

1. Introduction

Simulations are very important in aerospace in order to predict all the possible scenarios, avoid any failure and reduce costs. Simulations are typically used through various stages of a project, from the design to the tests of the whole system.

Xcos is an open source graphical tool to design models using functional blocks. It provides a palette of basic blocks that can be used to create a diagram. Figure 1 shows the graphical interface with the design of a system to model the orbit of a satellite.

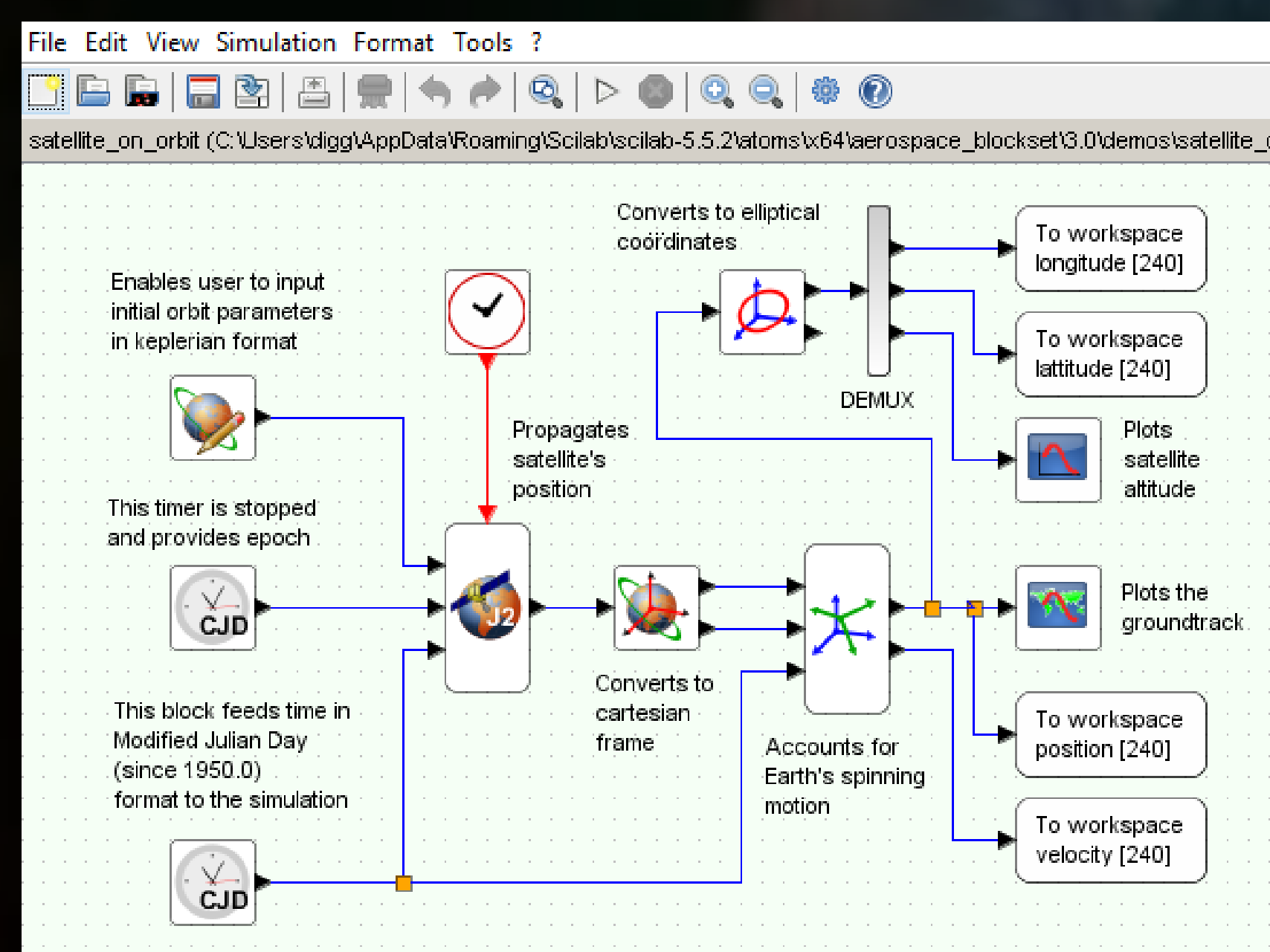


Figure 1: Xcos graphical user interface

It is very important to use components that accurately model the behaviour of a real system in order to get simulation results that are closer to the real values. Thus a flexible tool that can add new models that are more accurate is a requirement.

2. Implementation of model blocks

Xcos allows the creation of functional blocks with source code in C, C++ or Fortran. This functionality let us extend the palette of blocks available in the tool and add any block required for simulating VLEO environment conditions and all the disturbances that affect a satellite flying in low orbits.

C source code is integrated in new functional blocks implementing an interface. The new block runs the source code to perform the required operation using the implemented interface. Figure 2 illustrates the process to run external c code in a new block in Xcos.

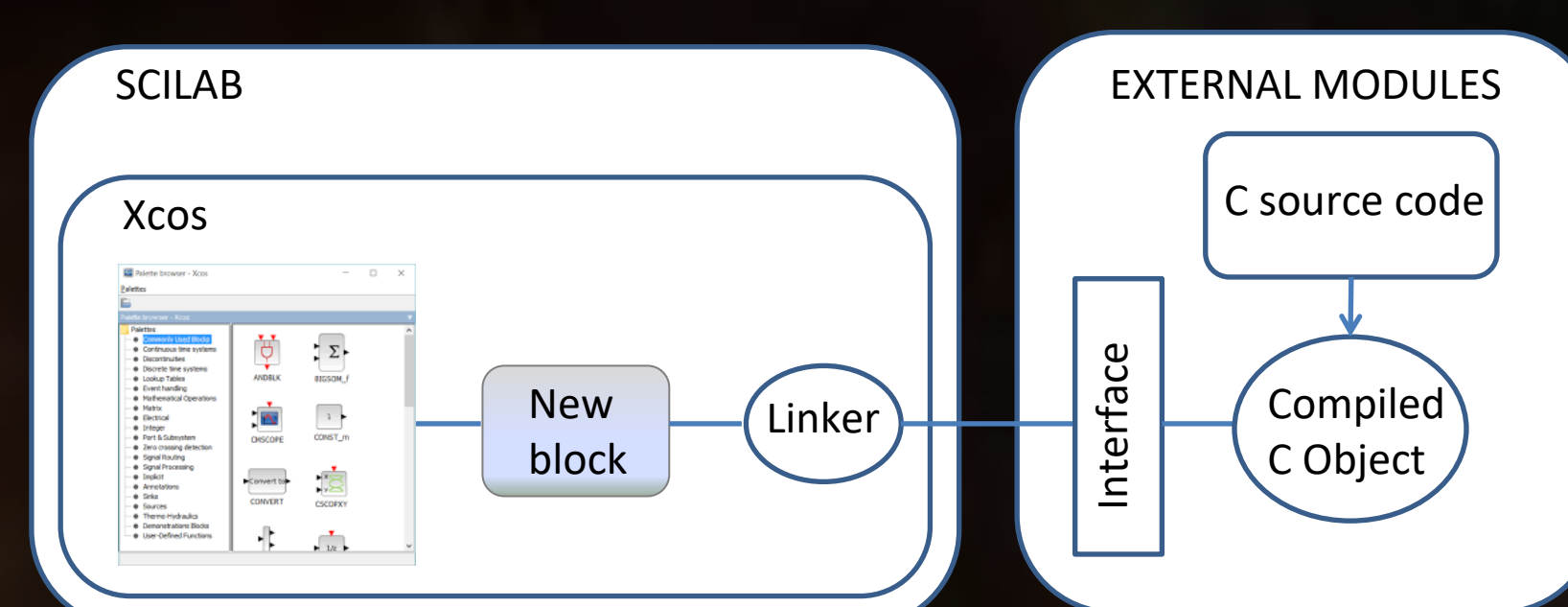


Figure 2: C source code integration in Xcos

There are several forces and torques which act on the spacecraft in VLEO. In this environment perturbations due to interaction with the residual atmosphere are significant. Magnetic field generated by Earth must be considered due to the importance for the operation of magnetometer sensors and magneto-torquer actuators.

The atmospheric density and the magnetic field are determined by using the atmospheric model NRLMSISE-00 [1] and the International Geomagnetic Reference Field (IGRF-12) [2]. The source code of this models was integrated in the blocks illustrated in figure 3.

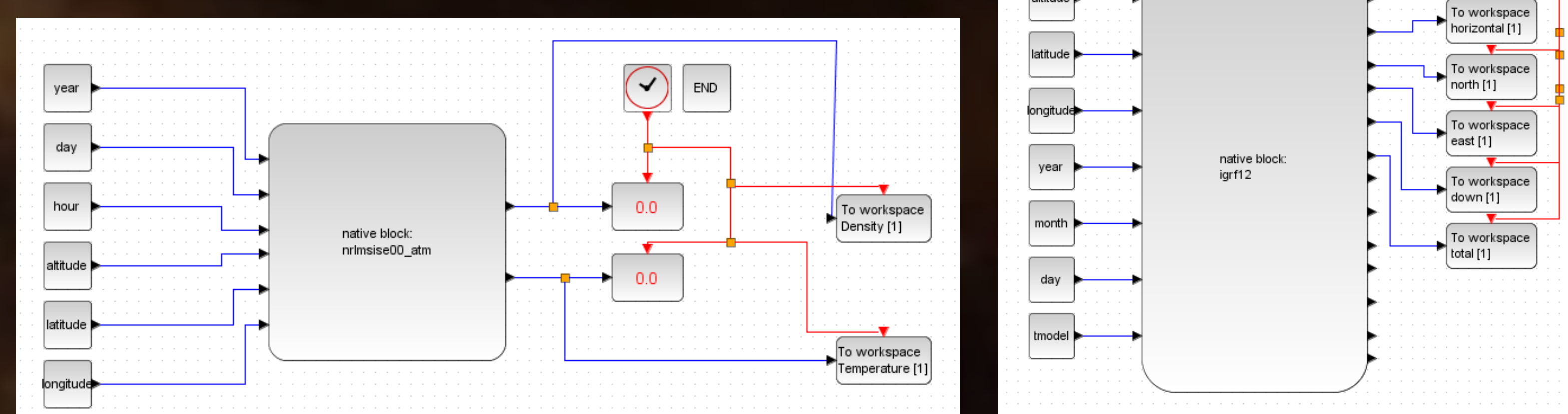


Figure 3: Blocks of the atmospheric and magnetic field models

3. Results

The blocks implemented for each model were used to calculate the density of the atmosphere and the magnetic field at an altitude of 300 km. The following figures show the maps with the results.

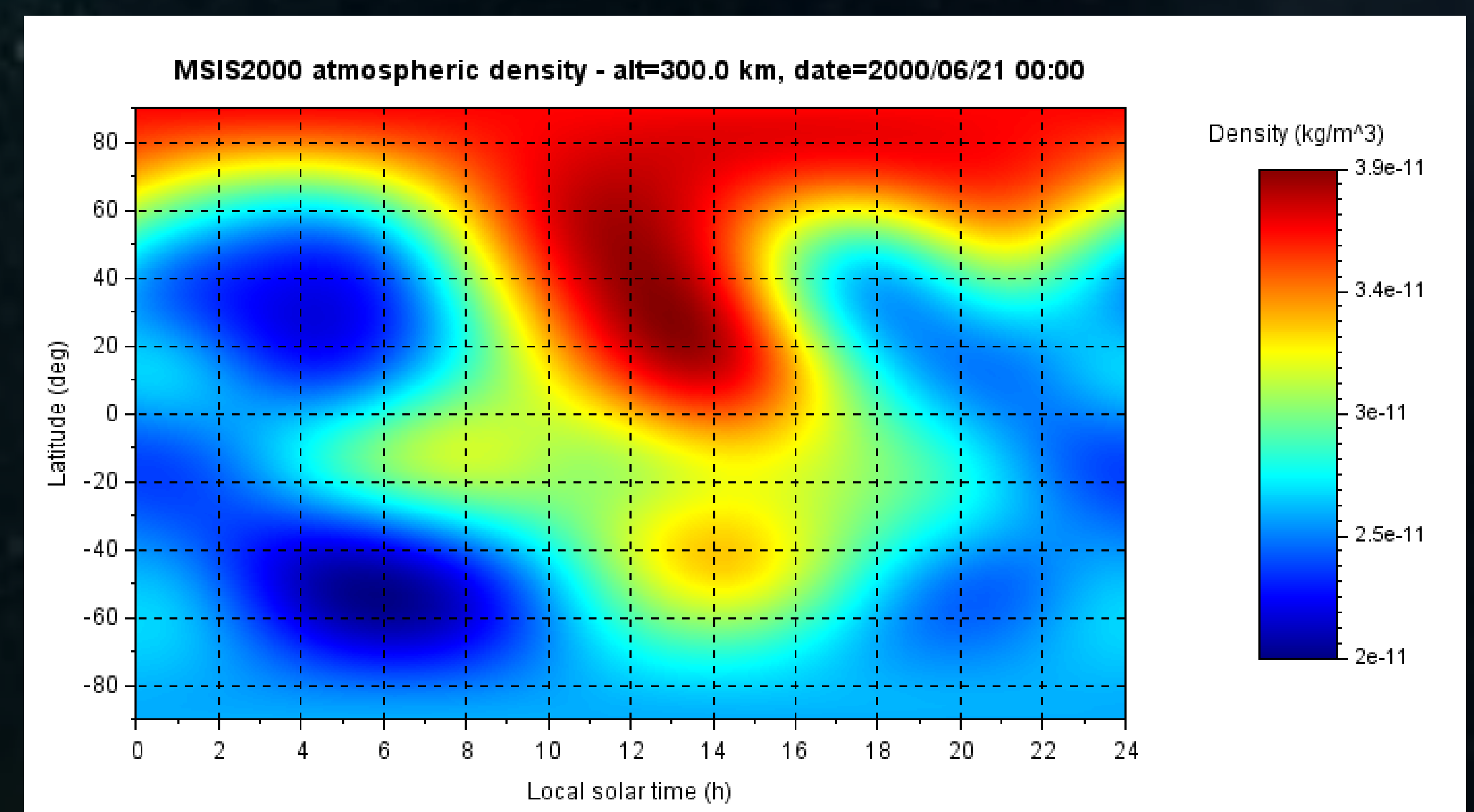


Figure 4: Atmospheric density

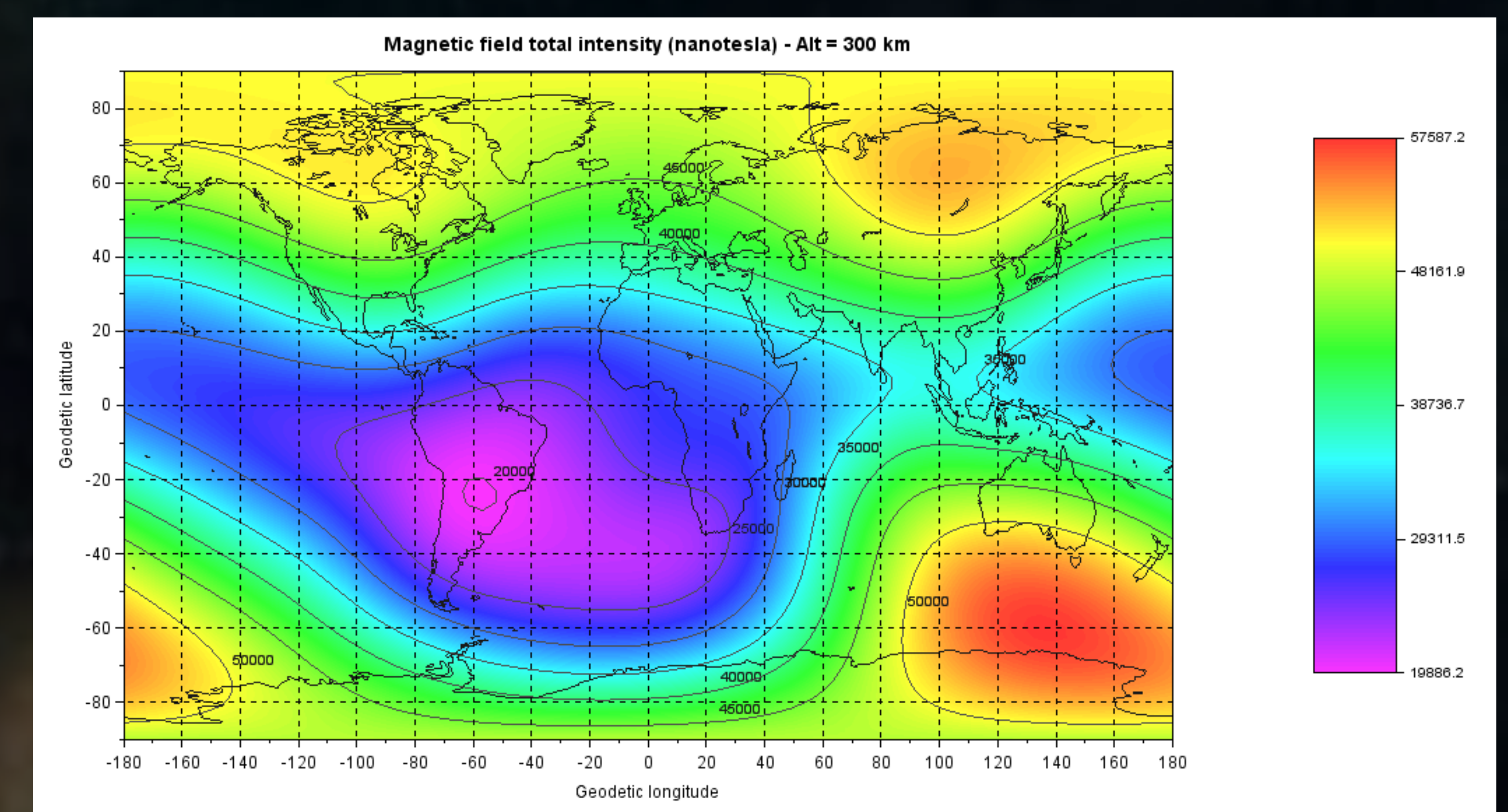


Figure 5: Geomagnetic field

4. Conclusions

The available open source software tools allowed us to implement the atmospheric and geomagnetic models in blocks that can be used to model the disturbance forces in the design of the attitude and orbit control system. These models were tested in order to check their functionality. The work carried out reveals that the set of blocks available can be extended to create a tool set with all the required functions to model a VLEO spacecraft system.

6. References

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