



➤ Ionospheric Simulation System for Satellite Observations and Global Assimilative Model Experiments — ISOGAME

Modeling helps develop improved systems to study the ionosphere.

NASA's Jet Propulsion Laboratory, Pasadena, California

Modeling and imaging the Earth's ionosphere as well as understanding its structures, inhomogeneities, and disturbances is a key part of NASA's Heliophysics Directorate science roadmap. This invention provides a design tool for scientific missions focused on the ionosphere. It is a scientifically important and technologically challenging task to assess the impact of a new observation system quantitatively on our capability of imaging and modeling the ionosphere. This question is often raised whenever a new satellite system is proposed, a new type of data is emerging, or a new modeling technique is developed. An example is the proposed COSMIC-Follow-On mission (COSMIC stands for Constellation Observing System for Meteorology, Ionosphere, and Climate). The proposed constellation would be part of a new observation system with more low-Earth orbiters tracking more radio occultation signals broadcast by Global Navigation Satellite System (GNSS) than those offered by the current GPS and COSMIC observation system.

A simulation system was developed to fulfill this task. The system is composed of a suite of software that combines the Global Assimilative Ionospheric Model (GAIM) including first-principles and empirical ionospheric models, a multiple-dipole geomagnetic field model, data assimilation modules, observation simulator, visualization software, and orbit design, simulation, and optimization software.

The software system can assess the improvements to GAIM that assimilate data collected using a concerned observing system. The GNSS observation system, for instance, consists of the GNSS constellations that transmit L-band radio signals, low-Earth orbiting GNSS receiver constellations, and ground-based GNSS receiver networks. The satellites and ground networks can be designed with an existing, or any, distribution to meet user requirements, such as achieving global coverage with uniformly distributed observations. Under this system, an empirical ionospheric model or the GAIM physics model simulates a nominal or disturbed ionosphere for a

specific experiment. The observation simulator uses the designed observing scenario (LEO constellations and ground-based receiver networks) to simulate total electron content (TEC) observations along receiver-transmitter radio links. An Observation System Simulation Experiment (OSSE) can then be conducted by assimilating the synthetic observations into GAIM to quantitatively assess the degree of improvement of modeled ionospheric specifications under the observing scenario. The model that is used for data assimilation assessment can differ substantially from the model that is used to simulate the observations. Visualization software is used to examine and analyze the assimilating model's performance.

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This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47626.

➤ Airborne Tomographic Swath Ice Sounding Processing System

This program enables 2D ice thickness measurement.

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Glaciers and ice sheets modulate global sea level by storing water deposited as snow on the surface, and discharging water back into the ocean through melting. Their physical state can be characterized in terms of their mass balance and dynamics. To estimate the current ice mass balance, and to predict future changes in the motion of the Greenland and Antarctic ice sheets, it is necessary to know the ice sheet thickness and the physical conditions of the ice sheet surface and bed. This information is required at fine res-

olution and over extensive portions of the ice sheets.

The ice sheet has two major interfaces: the upper surface interface, between the air and the snow or ice; and the basal interface, between the ice and bedrock or subglacial water. In between, there are internal layers that originate from slight density changes or ancient volcanic deposits. Due to the broad antenna pattern of the sounding radar system, each image resolution cell will contain signals from the left and from the right of the antenna array, and originating from the

surface and from the bed. To resolve these signals and to achieve swath sounding capability, an array of receiving antennas in the cross track direction is used. A tomographic algorithm has been developed to take raw data collected by a multiple-channel synthetic aperture sounding radar system over a polar ice sheet and convert those data into two-dimensional (2D) ice thickness measurements. Prior to this work, conventional processing techniques only provided one-dimensional ice thickness measurements along profiles.