ISSM: Ice Sheet System Model

NASA's Jet Propulsion Laboratory, Pasadena, California

In order to have the capability to use satellite data from its own missions to inform future sea-level rise projections, JPL needed a full-fledged ice-sheet/ice-shelf flow model, capable of modeling the mass balance of Antarctica and Greenland into the near future. ISSM was developed with such a goal in mind, as a massively parallelized, multi-purpose finite-element framework dedicated to ice-sheet modeling.

ISSM features unstructured meshes (Tri in 2D, and Penta in 3D) along with corresponding finite elements for both types of meshes. Each finite element can carry out diagnostic, prognostic, transient, thermal 3D, surface, and bed slope simulations. Anisotropic meshing enables adaptation of meshes to a certain metric, and the 2D Shelfy-Stream, 3D Blatter/Pattyn, and 3D Full-Stokes formulations capture the bulk of the ice-flow physics. These elements can be coupled together, based on the Arlequin method, so that on a large scale model such as Antarctica, each type of finite element is used in the most efficient manner.

For each finite element referenced above, ISSM implements an adjoint. This adjoint can be used to carry out model inversions of unknown model parameters, typically ice rheology and basal drag at the ice/bedrock interface, using a metric such as the observed InSAR surface velocity. This data assimilation capability is crucial to allow spinning up of ice flow models using available satellite data.

ISSM relies on the PETSc library for its vectors, matrices, and solvers. This allows ISSM to run efficiently on any parallel platform, whether shared or distrib-
uted. It can run on the largest clusters, and is fully scalable. This allows ISSM to tackle models the size of continents. ISSM is embedded into MATLAB and Python, both open scientific platforms. This improves its outreach within the science community. It is entirely written in C/C++, which gives it flexibility in its design, and the power/speed that C/C++ allows. ISSM is svn (subversion) hosted, on a JPL repository, to facilitate its development and maintenance.

ISSM can also model propagation of rifts using contact mechanics and mesh splitting, and can interface to the Dakota software. To carry out sensitivity analysis, mesh partitioning algorithms are available, based on the Scotch, Chaco, and Metis partitioners that ensure equal area mesh partitions can be done, which are then usable for sampling and local reliability methods.

This work was done by Eric Larour and John E. Schiermier of Caltech, and Helene Seroussi and Mathieu Marlinghem of Ecole Centrale Paris for NASA’s Jet Propulsion Laboratory. For more information, see http://issm.jpl.nasa.gov/.

This software is available for commercial licensing. Please contact Dan Broderick at Daniel.F.Broderick@jpl.nasa.gov. Refer to NPO-48164.

Automated Loads Analysis System (ATLAS)
Lyndon B. Johnson Space Center, Houston, Texas

ATLAS is a generalized solution that can be used for launch vehicles. ATLAS is used to produce modal transient analysis and quasi-static analysis results (i.e., accelerations, displacements, and forces) for the payload math models on a specific Shuttle Transport System (STS) flight using the shuttle math model and associated forcing functions. This innovation solves the problem of coupling of payload math models into a shuttle math model. It performs a transient loads analysis simulating liftoff, landing, and all flight events between liftoff and landing.

ATLAS utilizes efficient and numerically stable algorithms available in MSC/NASTRAN.

This work was done by Stephen Gardner, Scot Freer, and Patrick O’Reilly of The Boeing Company for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24987-1

Integrated Main Propulsion System Performance Reconstruction Process/Models
Lyndon B. Johnson Space Center, Houston, Texas

The Integrated Main Propulsion System (MPS) Performance Reconstruction process provides the MPS post-flight data files needed for post-flight reporting to the project integration management and key customers to verify flight performance. This process/model was used as the baseline for the currently ongoing Space Launch System (SLS) work.

The process utilizes several methodologies, including multiple software programs, to model integrated propulsion system performance through space shuttle ascent. It is used to evaluate integrated propulsion systems, including propellant tanks, feed systems, rocket engine, and pressurization systems performance throughout ascent based on flight pressure and temperature data. The latest revision incorporates new methods based on main engine power balance model updates to model higher mixture ratio operation at lower engine power levels.

This work was done by Eduardo Lopez, Katie Elliott, Steven Snell, and Michael Evans of The Boeing Company for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-25066-1

Phoenix Telemetry Processor
NASA’s Jet Propulsion Laboratory, Pasadena, California

Phxtelemproc is a C/C++ based telemetry processing program that processes SFDU telemetry packets from the Telemetry Data System (TDS). It generates Experiment Data Records (EDRs) for several instruments including surface stereo imager (SSI); robotic arm camera (RAC); robotic arm (RA); microscopy, electrochemistry, and conductivity analyzer (MEGA); and the optical microscope (OM). It processes both uncompressed and compressed telemetry, and incorporates unique subroutines for the following compression algorithms: JPEG Arithmetic, JPEG Huffman, Rice, LUT3, RA, and SX4.

This program was in the critical path for the daily command cycle of the