

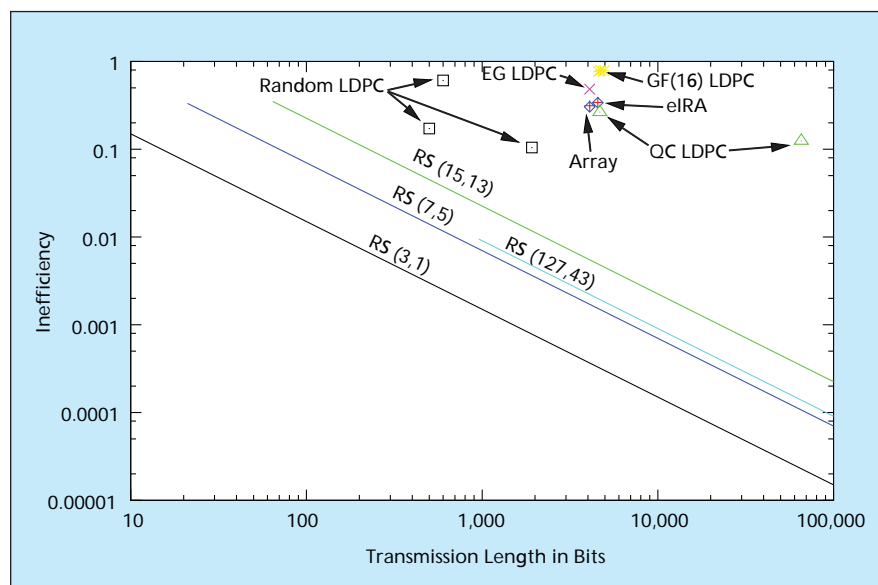
Optimal Codes for the Burst Erasure Channel

This approach offers lower decoding complexity with better burst erasure protection.

NASA's Jet Propulsion Laboratory, Pasadena, California

Deep space communications over noisy channels lead to certain packets that are not decodable. These packets leave gaps, or bursts of erasures, in the data stream. Burst erasure correcting codes overcome this problem. These are forward erasure correcting codes that allow one to recover the missing gaps of data. Much of the recent work on this topic concentrated on Low-Density Parity-Check (LDPC) codes. These are more complicated to encode and decode than Single Parity Check (SPC) codes or Reed-Solomon (RS) codes, and so far have not been able to achieve the theoretical limit for burst erasure protection.

A block interleaved maximum distance separable (MDS) code (e.g., an SPC or RS code) offers near-optimal burst erasure protection, in the sense that no other scheme of equal total transmission length and code rate could improve the guaranteed correctable burst erasure length by more than one symbol. The optimality does not depend on the length of the code, i.e., a short MDS code block interleaved to a given length would perform as well as a longer MDS code interleaved to the same overall length. As a result, this approach offers lower decoding complexity with better burst erasure protection compared to other recent designs for the burst erasure channel (e.g., LDPC codes). A limitation of the design is its lack of robustness to channels that have impairments



The Inefficiency of Interleaved RS Codes is compared with other listed codes.

other than burst erasures (e.g., additive white Gaussian noise), making its application best suited for correcting data erasures in layers above the physical layer. The efficiency of a burst erasure code is the length of its burst erasure correction capability divided by the theoretical upper limit on this length. The inefficiency is one minus the efficiency. The illustration compares the inefficiency of interleaved RS codes to Quasi-Cyclic (QC) LDPC codes, Euclidean Geometry (EG) LDPC codes, extended Irregular Repeat Accumulate (eIRA) codes, array

codes, and random LDPC codes previously proposed for burst erasure protection. As can be seen, the simple interleaved RS codes have substantially lower inefficiency over a wide range of transmission lengths.

This work was done by Jon Hamkins of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaofflce@jpl.nasa.gov.

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-46903.

Phenological Parameters Estimation Tool

NASA's Jet Propulsion Laboratory, Pasadena, California

The Phenological Parameters Estimation Tool (PPET) is a set of algorithms implemented in MATLAB that estimates key vegetative phenological parameters. For a given year, the PPET software package takes in temporally processed vegetation index data (3D spatio-temporal arrays) generated by the time series product tool (TSPT) and outputs spatial grids (2D arrays) of vegetation phenological parameters. As a precursor to PPET, the TSPT uses quality information for each pixel of each date to remove bad or suspect data, and then interpo-

lates and digitally fills data voids in the time series to produce a continuous, smoothed vegetation index product. During processing, the TSPT displays NDVI (Normalized Difference Vegetation Index) time series plots and images from the temporally processed pixels. Both the TSPT and PPET currently use moderate resolution imaging spectroradiometer (MODIS) satellite multispectral data as a default, but each software package is modifiable and could be used with any high-temporal-rate remote sensing data collection system that is ca-

pable of producing vegetation indices.

Raw MODIS data from the Aqua and Terra satellites is processed using the TSPT to generate a filtered time series data product. The PPET then uses the TSPT output to generate phenological parameters for desired locations. PPET output data tiles are mosaicked into a Conterminous United States (CONUS) data layer using ERDAS IMAGINE, or equivalent software package. Mosaics of the vegetation phenology data products are then reprojected to the desired map projection using ERDAS IMAGINE.

The TSPT software can temporally process a variety of MODIS multispectral data products on a per-pixel basis. Generally, the TSPT runs on one user-specified kind of MODIS data product to generate a given time series data product. The TSPT can process output from the MODIS Re-projection Tool (MRT) as input, or can directly convert MODIS Hierarchical Data Format (HDF) sinusoidal gridded data to BSQ input files.

Unlike other known vegetation phenological parameter estimation software, the PPET produces not only common phenological parameters, but also real-time and custom parameters without *a priori* assumptions about the shape of the phenological cycle. Common phe-

nological parameters, like those produced in PPET, are associated with the annual vegetation growth cycle. They quantitatively describe vegetative states related to annual cyclical growing seasons, such as green-up, maturity, senescence, and dormancy by analyzing the temporal shape of given vegetation index time series. The real-time phenological and custom parameters are formed from a cumulative sum (integral) produced at a fixed temporal interval. In addition, cumulative vegetation index and time-specific/pest-specific phenological parameters can be designed to optimize the detection of vegetation damage from specific pests and diseases. These problem-specific, phenological parameters have the potential to

be integrated into near real-time, predictive surveillance systems (i.e. early warning systems) and, with improved vegetative state information, could assist decision makers in making intelligent vegetation and associated land resource management choices.

This work was done by Rodney D. McKelip of Stennis Space Center; Kenton W. Ross, Joseph P. Spruce, James C. Smoot, and Robert E. Ryan of Science Systems and Applications, Inc.; Gerald E. Gasser of Lockheed Martin; and Donald L. Prados and Ronald D. Vaughan of Computer Sciences Corp.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager at Stennis Space Center (228) 688-1929. SSC-00321

XMbodyinfo

NASA's Jet Propulsion Laboratory, Pasadena, California

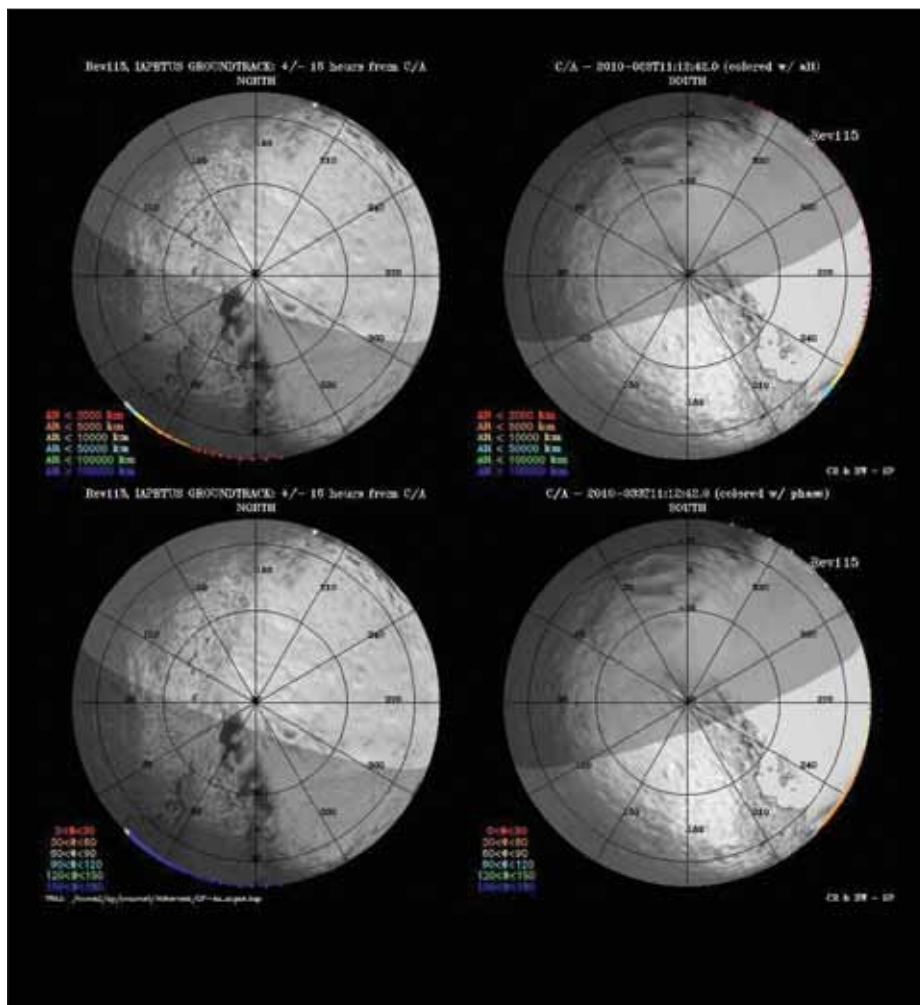
XMbodyinfo was designed to evaluate potential reference trajectories, providing a proficient way to assess the quality of all satellite body flybys for a Cassini type mission tour. It is autonomous and will generate a variety of ORS (optical remote sensing) and FPW (fields, particles, and waves) plots that aid in the evaluation, qualification, selection, and improvement of a potential tour (see figure).

XMbodyinfo attempts to streamline the tour design process. More specifically, it attempts to streamline the approval process, interaction, and subsequent iteration that must occur between the tour designers and the science teams during the design and development of a tour.

It can quickly produce various geometry plots and ground tracks for Saturnian satellite flybys when given an input trajectory, a C/A (closest approach) time in SCET (Spacecraft Event Time), and a flyby label. All instrument teams and science disciplines used this tool extensively to aid in the selection of Cassini's extended mission tour.

This work was done by Chris Roumeliotis and Bradford D. Wallis of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-46482.



Individual Flyby Groundtrack Plot is color coded with altitude and phase angle (polar projection). This is one of a number of plots provided by XMbodyinfo.