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FY 2004 Scientific and Technical Reports, Articles, Papers, and Presentations

Compiled by
B.A. Fowler
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FOREWORD

In accordance with the NASA Space Act of 1958, the George C. Marshall Space Flight Center (MSFC) has provided for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof.

Since July 1, 1960, when MSFC was organized, the reporting of scientific and engineering information has been considered a prime responsibility of the Center. Our credo has been that “research and development work is valuable, but only if its results can be communicated and made understandable to others.”
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During zero-gravity orbital cryogenic propulsion operations, a thermodynamic vent system (TVS) concept is expected to maintain tank pressure control without propellant resettling. In this case, a longitudinal spray bar mixer system, coupled with a Joule-Thompson (J-T) valve and heat exchanger, was evaluated in a series of TVS tests using the 18-m³ multipurpose hydrogen test bed. Tests performed at fill levels of 90, 50, and 25 percent, coupled with heat tank leaks of about 20 and 50 W, successfully demonstrated tank pressure control within a 7-kPa band. Based on limited testing, the presence of helium constrained the energy exchange between the gaseous and liquid hydrogen (LH₂) during the mixing cycles. A transient analytical model, formulated to characterize TVS performance, was used to correlate the test data. During self-pressurization cycles following tank lockup, the model predicted faster pressure rise rates than were measured; however, once the system entered the cyclic self-pressurization/mixing/venting operational mode, the modeled and measured data were quite similar. During a special test at the 25-percent fill level, the J-T valve was allowed to remain open and successfully reduced the bulk LH₂ saturation pressure from 133 to 70 kPa in 188 min.


Successful development of space fission systems will require an extensive program of affordable and realistic testing. In addition to tests related to design/development of the fission system, realistic testing of the actual flight unit must also be performed. At the power levels under consideration (3–300 kW electric power), almost all technical issues are thermal or stress related and will not be strongly affected by the radiation environment. These issues can be resolved more thoroughly, less expensively, and in a more timely fashion with nonnuclear testing, provided it is prototypic of the system in question. This approach was used for the safe, affordable fission engine test article development program and accomplished via cooperative efforts with Department of Energy labs, industry, universities, and other NASA Centers. This Technical Memorandum covers the analysis, testing, and data reduction of a 30-kW simulated reactor as well as an end-to-end demonstrator, including a power conversion system and an electric propulsion engine, the first of its kind in the United States.


Documentation of the internal science research at the Biological and Physical Space Research Laboratory as presented in a review to Dr. Ann Whitaker, MSFC Science Director, in July 2002. These presentations have been revised and updated as appropriate for this report. The report documents flight and ground experiments in microgravity materials science and biotechnology science and space radiation. All of the work described includes significant scientific contributions by internal scientists (usually as principal or co-investigator on the research grant). Much of the research is in collaboration with external scientists. All the funding was provided as the result of competitive proposals evaluated by internal or external peer review processes. The external flight and ground research that our laboratory supports for the NASA program will be reviewed in a separate report.


This Technical Memorandum (TM) presents formal NASA technical reports, papers published in technical journals, and presentations by MSFC personnel in FY 2002. It also includes papers of MSFC contractors.

After being announced in STAR, all NASA series reports may be obtained from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

The information in this TM may be of value to the scientific and engineering community in determining what information has been published and what is available.


The purpose of this research effort was to (1) provide a concise and well-defined property profile of current and developing composite materials using thermal and chemical characterization techniques and (2) optimize analytical testing requirements of materials. This effort applied a diverse array of methodologies to ascertain composite material properties.
Often, a single method or technique will provide useful, but nonetheless incomplete, information on material composition and/or behavior. To more completely understand and predict material properties, a broad-based analytical approach is required. By developing a database of information comprised of both thermal and chemical properties, material behavior under varying conditions may be better understood. This is even more important in the aerospace community, where new composite materials and those in the development stage have little reference data. For example, Fourier transform infrared (FTIR) spectroscopy spectral databases available for identification of vapor phase spectra, such as those generated during experiments, generally refer to well-defined chemical compounds. Because this method renders a unique thermal decomposition spectral pattern, even larger, more diverse databases, such as those found in solid and liquid phase FTIR spectroscopy libraries, cannot be used. By combining this and other available methodologies, a database specifically for new materials and materials being developed at Marshall Space Flight Center can be generated. In addition, characterizing materials using this approach will be extremely useful in the verification of materials and identification of anomalies in NASA-wide investigations.


The international space welding experiment was designed to evaluate the universal handtool (UHT) functions as a welding, brazing, coating, and cutting tool for in-space operations. The UHT is an electron beam welding system developed by the Paton Welding Institute (PWI), Kiev, Ukraine, and operated at 8 kV with up to 1 kW of power. In preparation for conducting the space welding experiment, cosmonauts were trained to properly operate the UHT and correctly process samples.

This Technical Memorandum presents the results of the destructive and nondestructive evaluation of the training samples made in Russia in 1998. It was concluded that acceptable welds can be made with the UHT despite the constraints imposed by a space suit. The lap joint fillet weld configuration was more suitable than the butt joint configuration for operators with limited welding experience. The tube braze joint configuration designed by the PWI was easily brazed in a repeatable manner.

A laser space calibration experiment is considered using the 12-J, 15-Hz high-performance CO₂ laser surveillance sensor (HI-CLASS) system on the 3.67-m aperture advanced electro-optics system (AEOS). The objectives are to provide accurate range and signature measurements of orbiting calibration spheres, demonstrate high-resolution tracking capability of small objects, and precision drag determination for low-Earth orbit (LEO). Ancillary benefits include calibrating radar and optical sites, completing satellite conjunction analyses, supporting orbital perturbation analyses, and comparing radar and optical signatures. A global positioning system (GPS), laser beacon instrumented microsatellite about 25 cm in diameter will be deployed from a Space Shuttle Hitchhiker canister or other suitable launch means. Orbiting in LEO, the microsatellite will pass over AEOS on the average of two times per 24-hr period. An onboard orbit propagator will activate the GPS unit and a visible laser beacon at the appropriate times. The HI-CLASS AEOS will detect the microsatellite as it rises above the horizon, using Space Command-generated acquisition vectors. GPS data will be transmitted to the ground providing independent on-orbit, submeter accuracy location information for the microsatellite.
A unique foam/multilayer insulation (MLI) combination concept for orbital cryogenic storage was experimentally evaluated using a large-scale hydrogen tank. The foam substrate insulates for ground-hold periods and enables a gaseous nitrogen purge as opposed to helium. The MLI, designed for an on-orbit storage period for 45 days, includes several unique features including a variable layer density and larger but fewer perforations for venting during ascent to orbit. Test results with liquid hydrogen indicated that the MLI weight or tank heat leak is reduced by about half in comparison with standard MLI. The focus of this effort is on analytical modeling of the variable density MLI (VD-MLI) on-orbit performance. The foam/VD-MLI model is considered to have five segments. The first segment represents the optional foam layer. The second, third, and fourth segments represent three different MLI layer densities. The last segment is an environmental boundary or shroud that surrounds the last MLI layer. Two approaches are considered: a variable density MLI modeled layer by layer and a semiempirical model or “modified Lockheed equation.” Results from the two models were very comparable and were within 5–8 percent of the measured data at the 300 K boundary condition.

The solid rocket booster uses hydraulic pumps fabricated from cast C355 aluminum alloy, with 17–4 PH stainless steel pump port caps. Corrosion-resistant steel, MS51830 CA204L self-locking screw inserts are installed into C355 pump housings, with A286 stainless steel fasteners installed into the insert to secure the pump port cap to the housings. In the past, pump port cap fasteners were installed to a torque of 33 Nm (300 in-lb). However, the structural analyses used a significantly higher nut factor than indicated during tests conducted by Boeing Space Systems. When the torque values were reassessed using Boeing’s nut factor, the fastener preload had a factor of safety of <1, with potential for overloading the joint. This paper describes how behavior was determined for a preloaded joint with a steel bolt threaded into steel inserts in aluminum parts. Finite element models were compared with test results. For all initial bolt preloads, bolt loads increased as external applied loads increased. For higher initial bolt preloads, less load was transferred into the bolt, due to external applied loading. Lower torque limits were established for pump port cap fasteners and additional limits were placed on insert axial deformation under operating conditions after seating the insert with an initial preload.
and a timeline for each are presented. The sensor and test facility are discussed briefly. A new test stand was also developed. A table establishing sensor bias and spot size growth for several ranges is detailed along with testing anomalies.

**TM—2004–213394**

September 2004


This Technical Memorandum (TM) lists the significant publications and presentations of the Science Directorate during the period January 1–December 31, 2003. Entries in the main part of the TM are categorized according to NASA Reports (arranged by report number), Open Literature and Presentations (arranged alphabetically by title). Most of the articles listed under Open Literature have appeared in refereed professional journals, books, monographs, or conference proceedings. Although many published abstracts are eventually expanded into full papers for publication in scientific and technical journals, they are often sufficiently comprehensive to include the significant results of the research reported. Therefore, published abstracts are listed separately in a subsection under Open Literature. Questions or requests for additional information about the entries in this TM should be directed to Dr. A.F. Whitaker (SD01; 544–2481) or to one of the authors.
During fiscal year 2002, a team of engineers from TD30/Advanced Concepts and TD40/Propulsion Research Center embarked on a study of potential crewed missions to the outer solar system. This study was conducted under the auspices of the Revolutionary Aerospace Systems Concepts activity administered by Langley Research Center (LaRC). The Marshall Space Flight Center (MSFC) team interacted heavily with teams from other Centers, including Glenn Research Center, LaRC, Jet Propulsion Laboratory, and Johnson Space Center. The MSFC team generated five concept missions for this project. The concept missions use a variety of technologies, including magnetized target fusion (MTF), magnetoplasmadynamic thrusters, solid core reactors, and molten salt reactors in various combinations. This Technical Publication (TP) reviews these five concepts and the methods used to generate them. The analytical methods used are described for all significant disciplines and subsystems. The propulsion and power technologies selected for each vehicle are reviewed in detail. The MSFC team also expended considerable effort refining the MTF concept for use with this mission. The results from this effort are also contained within this TP. Finally, the lessons learned from this activity are summarized in the conclusions section.

A simple method for monitoring the nearness and size of conventional cycle maximum for an ongoing sunspot cycle is examined. The method uses the observed maximum daily value and the maximum monthly mean value of international sunspot number and the maximum value of the 2-mo moving average of monthly mean sunspot number to effect the estimation. For cycle 23, a maximum daily value of 246, a maximum monthly mean of 170.1, and a maximum 2-mo moving average of 148.9 were each observed in July 2000. Taken together, these values strongly suggest that conventional maximum amplitude for cycle 23 would be ≈124.5, occurring near July 2002 ± 5 mo, very close to the now well-established conventional maximum amplitude and occurrence date for cycle 23 — 120.8 in April 2000.
given of a Marshall Space Flight Center-led study intended to develop and assess various candidate systems for protection of the Earth against NEOs. Details of analytical tools, trajectory tools, and a tool that was created to model both the undeflected inbound path of an NEO as well as the modified, postdeflection path are given. A representative selection of these possible options was modeled and evaluated. It is hoped that this study will raise the level of attention about this very real threat and also demonstrate that successful defense is both possible and practicable, provided appropriate steps are taken.

TP—2004–213143 April 2004
Plasma Sail Concept Fundamentals. G.V. Khazanov, P. Delamere,* K. Kabin,** and T.J. Linde***. Space Science Department, Science Directorate, *University of Colorado, **University of Alberta, and ***The University of Chicago.

The mini-magnetospheric plasma propulsion (M2P2) device, originally proposed by Winglee et al., predicts that a 15-km standoff distance (or 20-km cross-sectional dimension) of the magnetic bubble will provide for sufficient momentum transfer from the solar wind to accelerate a spacecraft to unprecedented speeds of 50–80 km/s after an acceleration period of ≈3 mo. Such velocities will enable travel out of the solar system in a period of ≈7 yr—almost an order of magnitude improvement over present chemical-based propulsion systems. However, for the parameters of the simulation of Winglee et al., a fluid model for the interaction of M2P2 with the solar wind is not valid. It is assumed in the magnetohydrodynamic (MHD) fluid model, normally applied to planetary magnetospheres, that the characteristic scale size is much greater than the Larmor radius and ion skin depth of the solar wind. In the case of M2P2, the size of the magnetic bubble is actually less than or comparable to the scale of these characteristic parameters. Therefore, a kinetic approach, which addresses the small-scale physical mechanisms, must be used. A two-component approach to determining a preliminary estimate of the momentum transfer to the plasma sail has been adopted. The first component is a self-consistent MHD simulation of the small-scale expansion phase of the magnetic bubble. The fluid treatment is valid to roughly 5 km from the source and the steady-state MHD solution at the 5 km boundary was then used as initial conditions for the hybrid simulation. The hybrid simulations showed that the forces delivered to the innermost regions of the plasma sail are considerably (≈10 times) smaller than the MHD counterpart, are dominated by the magnetic field pressure gradient, and are directed primarily in the transverse direction.

TP—2004–213173 May 2004

The theoretical performance of diagonal conducting wall crossed-field accelerators is examined on the basis of an infinite segmentation assumption using a cross-plane averaged generalized Ohm’s law for a partially ionized gas, including ion slip. The desired accelerator performance relationships are derived from the cross-plane averaged Ohm’s law by imposing appropriate configuration and loading constraints. A current-dependent effective voltage drop model is also incorporated to account for cold-wall boundary layer effects, including gasdynamic variations, discharge constriction, and electrode falls. Definition of dimensionless electric fields and current densities leads to the construction of graphical performance diagrams, which further illuminate the rudimentary behavior of crossed-field accelerator operation.

TP—2004–213281 June 2004

On the basis of the maximum amplitude-early rise correlation, cycle 23 could have been predicted to be about the size of the mean cycle as early as 12 mo following cycle minimum. Indeed, estimates for the size of cycle 23 throughout its rise consistently suggested a maximum amplitude that would not differ appreciably from the mean cycle, contrary to predictions based on precursor information. Because cycle 23’s average slope during the rising portion of the solar cycle measured 2.4, computed as the difference between the conventional maximum (120.8) and minimum (8) amplitudes divided by the ascent duration in months (47), statistically speaking, it should be a cycle of shorter period. Hence, conventional sunspot minimum for cycle 24 should occur before December 2006, probably near July 2006 (±4 mo). However, if cycle 23 proves to be a statistical outlier, then conventional sunspot minimum for cycle 24 would be delayed until after July 2007, probably near December 2007 (±4 mo). In anticipation of cycle 24, a chart and table are provided for easy monitoring of the nearness and size of its maximum amplitude once onset has occurred (with respect to the mean cycle and using the updated maximum amplitude-early rise relationship).

TP—2004–213284 June 2004

From early in the Shuttle program, the National Aeronautics and Space Administration has modeled hydrogen chloride (HCl) release by burning solid propellant in the solid rocket boosters. In 1998, the United States Air Force 45th Space Wing
instituted more stringent launch commit criteria (LCC) for the Titan and Delta vehicles and proposed that the same LCC be applied to the Shuttle to enhance safety of onsite visitors and offsite public. Two types of health and safety standards were applicable: (1) Expected casualties and risk and (2) air quality emergency response.

This study addresses the issues using the U.S. Environmental Protection Agency-recommended model, CALPUFF. Results were compared to those produced by the USAF model, REEDM, developed for projecting air quality from nominal launches. Model performance was also evaluated against results of a Kennedy Space Center-sponsored study at the Los Alamos National Laboratory (LANL) using a computer-intensive, wildfire model.

CALPUFF and the LANL model are capable of multipuff modeling of multiple sources. REEDM is a single-source, single-puff model. This study revealed significant deficiencies in REEDM when applied to the catastrophic failure problem. CALPUFF results indicate that, if a Shuttle abort were to occur over land, serious levels of HCl exposure could occur out to distances of at least 10 km, sufficient range to include major onsite visitor viewing areas. A preliminary survey of mitigation alternatives indicates cost-effective measures could be implemented that are sufficiently protective. Recent safety initiatives in response to the Columbia Accident Investigation Board report are not reflected here.

TP—2004–213339 August 2004

This effort is a detailed analysis of existing microelectronics and photonics test bed satellite data from one experiment, the bipolar test board, looking to improve our understanding of the enhanced low dose rate sensitivity (ELDRS) phenomenon. Over the past several years, extensive total dose irradiations of bipolar devices have demonstrated that many of these devices exhibited ELDRS. In sensitive bipolar transistors, ELDRS produced enhanced degradation of base current, resulting in enhanced gain degradation at dose rates <0.1 rd(Si)/s compared to similar transistors irradiated at dose rates >1 rd(Si)/s. This Technical Publication provides updated information about the test devices, the in-flight experiment, and both flight-and ground-based observations. Flight data are presented for the past 5 yr of the mission. These data are compared to ground-based data taken on devices from the same date code lots. Information about temperature fluctuations, power shut-downs, and other variables encountered during the space flight are documented.
The next millennium challenges us to produce innovative materials, processes, manufacturing, and environmental technologies that meet low-cost aerospace transportation needs while maintaining U.S. leadership. The pursuit of advanced aerospace materials, manufacturing processes, and environmental technologies supports the development of safer, operational, next-generation, reusable, and expendable aeronautical and space vehicle systems. The Aerospace Materials, Processes, and Environmental Technology Conference provided a forum for manufacturing, environmental, materials, and processes engineers, scientists, and managers to describe, review, and critically assess advances in these key technology areas.

Continued constrained budgets and growing interests in the industrialization and development of space requires NASA to seize every opportunity for assuring the maximum return on space infrastructure investments. This workshop provided an excellent forum for reviewing, evaluating, and updating pertinent strategic planning, identifying advanced concepts and high-risk/high-leverage research and technology requirements, developing strategies and roadmaps, and establishing approaches, methodologies, modeling, and tools for facilitating the commercial development of space and supporting diverse exploration and scientific missions. Also, the workshop addressed important topic areas including revolutionary space systems requiring investments in innovative advanced technologies; achieving transformational space operations through the insertion of new technologies; revolutionary science in space through advanced systems and new technologies enabling experiments to go anytime to any location; and, innovative and ambitious concepts and approaches essential for promoting advancements in space transportation. Details concerning the workshop process, structure, and results are contained in the ensuing report.

The 8th Spacecraft Charging Technology Conference was held in Huntsville, Alabama, October 20–24, 2003. Hosted by NASA's Space Environments and Effects (SEE) Program and co-sponsored by the Air Force Research Laboratory (AFRL) and the European Space Agency (ESA), the 2003 conference saw attendance from eleven countries with over 65 oral papers and 18 poster papers in the areas of Plasma Propulsion and Tethers, Ground Testing Techniques, Interactions of Spacecraft and Systems With the Natural and Induced Plasma Environment, Materials Characterizations, Models and Computer Simulation, Environment Specifications, Current Collection and Plasma Probes in Space Plasmas, and On-Orbit Investigations. A round-table discussion of international standards regarding electrostatic discharge (ESD) testing was also held with the promise of continued discussions in the off years and an official continuation at the next conference.

NASA is constantly searching for new ideas and approaches yielding opportunities for assuring maximum returns on space infrastructure investments. Perhaps the idea of transformational innovation in developing space systems is long overdue. However, the concept of utilizing modular space system designs combined with stepping-stone development processes has merit and promises to return several times the original investment since each new space system or component is not treated as a unique and/or discrete design and development challenge. New space systems can be planned and designed so that each builds on the technology of previous systems and provides capabilities to support future advanced systems. Sub-systems can be designed to use common modular components and achieve economies of scale, production, and operation. Standards, interoperability, and “plug and play” capabilities, when implemented vigorously and consistently, will result in systems that can be upgraded effectively with new technologies. This workshop explored many building-block approaches via way of example across a broad spectrum of technology discipline areas for potentially transforming space systems and inspiring future innovation. Details describing the workshop structure, process, and results are contained in this Conference Publication.
An improved specification of the plasma environment has been developed for use in modeling spacecraft charging. It was developed by statistically analyzing a large part of the LANL Magnetospheric Plasma Analyzer (MPA) data set for ion and electron spectral signature correlation with spacecraft charging, including anisotropies. The objective is to identify a relatively simple characterization of the full particle distribution that yields an accurate prediction of the observed charging under a wide variety of conditions.

CR—2004–213227  June 2004

This effort analyzed the low-energy deposition Pulse Height Analyzer (PHA) data from the Combined Release and Radiation Effects Satellite (CRRES). The high-energy deposition data had been previously analyzed and shown to be in agreement with spallation reactions predicted by the Clemson University Proton Interactions in Devices (CUPID) simulation model and existing environmental and orbit positioning models (AP-8 with USAF B-L coordinates). The scope of this project was to develop and improve the CUPID model by increasing its range to lower incident particle energies, and to expand the modeling to include contributions from elastic interactions. Before making changes, it was necessary to identify experimental data suitable for benchmarking the codes; then, the models to the CRRES PHA data could be applied. It was also planned to test the model against available low-energy proton or neutron SEU data obtained with mono-energetic beams.

CR—2004–213228  June 2004

One can truly predict the charging and pulsing in space over a year’s time using only the physics that worked for periods of an hour and less in prior publications. All portions of the task were achieved, including the optional portion of determining a value for conductivity that best fit the data.
ABBAS, M.M. SD50
CRAVEN, P.D. SD50
SPANN, J.F. SD50
TANKOSIC, D. UAH
LECLAIR, A. UAH
GALLAGHER, D.L. SD50


ADAMS, J.H. SD50


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CHANG, J. Max Planck Institute
CHRISTL, M.J. SD50
FAZELY, A.R. Southern University
GANEL, O. University of Maryland
ET AL.


ALBYN, K. Edward Cheer
EDWARDS, D.L. ED31


ALBN, K. ED31
ALRED, J. Boeing Space Station

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<th>Affiliation</th>
<th>Title</th>
<th>Conference/Meeting Details</th>
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BECKER, W. Max Planck Institute
WEISSKOPF, M.C. SD50
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ET AL.


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TENNANT, A.F. SD50
JESSNER, A. Max Planck Institute
ZHANG, S.N. SD50/UAH


BENEFIELD, M.P.J. TD05
BELCHER, J.A. TD05


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TINKER, M.L. ED21


BENFORD, A. University of Texas Pan Am
TINKER, M.L. ED20


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REID, R.S.  TD40

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SORIA, R.  Mullard Space Science Laboratory
WAITE, JR., J.H.  University of Michigan

BROWN, A.M.  ED19
MCGHEE, D.S.  ED21

BUECHLER, D.E.  UAH
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PHIPPS, C. Photonics Associates
SMALLEY, L. UAH
REILLY, J. Northeast Science & Technology
BOCCIO, D. SUNY


CANFIELD, S. Tennessee Technological University
BEARD III, J.W. Tennessee Technological University
PEDDIESON, J. Tennessee Technological University
EWING, A. Ewing Research
GARBE, G. TD05


CANNING, F.X. ISR
WINET, E. ISR
ICE, B. ISR
MELCHER, C. ISR
PESAVENTO, P. ISR
HOLMES, A. ISR
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CARDELINO, H. Spellman College
CARDELINO, C.A. Georgia Institute of Technology
MOORE, C.E. SD46
DIETZ, N. Georgia State University
MCCALL, S.D. Spellman College
BACHMANN, K. North Carolina State University


CARPENTER, P.K. SD46
ARMSTRONG, J. SD46


CARPENTER, P.K. SD46
ARMSTRONG, J. NIST

Improvements in Electron-Probe Microanalysis: Applications to Terrestrial, Extraterrestrial, and Space-Grown

CARRASQUILLO, R.L. BAGDIGIAN, B. PERRY, J.L. LEWIS, J.

CARRASQUILLO, R.L. CLOUD, D. BEDARD, J.

CARRIER, M. ZOU, X. LAPENTA, W.M. JEDLOVEC, G.J.
Assessing the Usefulness of AIRS Radiance Observations in a 4D-Var Assimilation Scheme Using the Penn State/NCAR Mesoscale Model Version 5 (MM5) and a Stand Alone Radiative Transfer Algorithm (SARTA)—Abstract Only. For presentation at the 13th Conference on Satellite Meteorology and Oceanography, Norfolk, VA, September 20–24, 2004.

CARRINGTON, C.K. DAY, G.

CARRINGTON, C.K. HOWELL, J.T. DAY, G.

CARTER, L. TATAR, J.D. MASON, R.

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CARRASQUILLO, R.L. CLOUD, D. Hamilton Sundstrand
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CARRIER, M. Florida State University
ZOU, X. Florida State University
LAPENTA, W.M. SD60
JEDLOVEC, G.J. SD60
Assessing the Usefulness of AIRS Radiance Observations in a 4D-Var Assimilation Scheme Using the Penn State/NCAR Mesoscale Model Version 5 (MM5) and a Stand Alone Radiative Transfer Algorithm (SARTA)—Abstract Only. For presentation at the 13th Conference on Satellite Meteorology and Oceanography, Norfolk, VA, September 20–24, 2004.

CARRINGTON, C.K. Boeing Phantom Works
DAY, G.

CARRINGTON, C.K. Boeing Phantom Works
DAY, G.
F AZELY, A.R. Southern University
GANEL, O. University of Maryland


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GALLAGHER, D.L. SD50
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MENDE, S. SD50
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BALASUBRAMANIAM, K.S. National Solar Observatory
SUEMATSU, Y. National Astronomical Observatory


CHOUHARY, D.P. SD50
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POJOGA, S. Prairie View A&M University
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KRUCKER, S. University of California
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CHOUHARY, D.P. SD50
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CISZAK, E.M. SD46
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COFFEE, V.N. SD50
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TYSON, R.W. NP01

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MOUSER, D. Morgan Research Corporation
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CUNTZ, M. University at Texas/Arlington
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CURRERI, P.A. SD46
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LEMAIRE, J.F. Belgian Institute
DECREAU, E. Universite d’ Orleans
DE KEYSER, J. Belgian Institute
MASSON, A. Research and Scientific
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Forecasting Coronal Mass Ejections From Magnetograms—Abstract Only. For presentation at the Living With a Star Workshop, Boulder, CO, March 23–26, 2004;

FARR, R.A. TD72
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HICKS, E.D. Jacobs Sverdrup
SANDERS, T.M. TD72
LONDON III, J.R. TD70
MAYNE, A.W. TRW (Retired)
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NORDIN, G.P. SD22

Design and Analysis of a MEMS Miro-Translation Stage With Indefinite Travel—Abstract Only. For presentation at the Nanospace 2003, Galveston, TX, February 2004.

FISHMAN, G.J. SD50

The Mystery of Gamma-Ray Bursts—Abstract Only. For presentation at the Rice University Space Exploration Series, Houston, TX, March 22, 2004.

FLANDRO, G.A. University of Tennessee
MAJIDALANI, J. University of Tennessee
SIMS, J.D. TD07


FLASAR, F.M. Goddard Space Flight Center
KUNDE, V.G. University of Maryland
ABBAS, M.M. SD50
ACHTERBERG, R.K. Science Systems & Applications
ADE, P. University of Cardiff
BARUCCI, A. Observatoire de Paris
BEZARD, B. Observatoire de Paris
BJORAKER, G.L. Goddard Space Flight Center
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Overview of MSFC’s Applied Fluid Dynamics Analysis Group Activities—Presentation. For presentation at the MSFC Spring Fluid Workshop, MSFC, AL, April 13, 2004.

GARY, G.A.  

GALLAGHER, D.L.  

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The LATEST Project: Operational Assessment of Total Lightning Data in the U.S.—Abstract Only. For presenta- 
tion at and publication in Proceedings of the 18th International Lightning Detection Conference, Helsinki, Finland, June 7–9, 2004.

GOODMAN, S.J.  
BLAKESLEE, R.J.  
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Kinetic Roughening Transition and Energetics of Tetragonal Lysozyme Crystal Growth—Abstract Only. For presentation at the 10th International Conference on the Crystallization of Biological Macromolecules (ICCBM10), Beijing, China, June 5–8, 2004.

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HERREN, K.A. SD70

GREINER, J.C. Max Planck Institute
KLOSE, S. Thuringer Landesstern.
REINSCH, K. Universitaats-Sternwarte
SCHMID, H.M. Institut fur Astronomie
SARI, R. California Institute of Technology
HARTMANN, D.H. Clemson University
KOUVELIOTOU, C. SD50
RAU, A. Max Planck Institute
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Spatially Varying Spectrally Thresholds for MODIS Cloud 
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Simulation Based Acquisition for NASA’s Office of 
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JONES, R.E. TD54  
Advanced Guidance and Control for Hypersonics and Space 
Access—Final Paper. For presentation at the JANNAF 

HANSON, J.M. TD54  
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Test Results for Entry Guidance Methods for Reusable 
Launch Vehicles—Final Paper. For presentation at the 42nd 
AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, 

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HATHAWAY, D.H. SD50  
Recent Progress in Understanding the Sun’s Magnetic 
Dynamo—Abstract Only. For presentation at Vanderbilt 
University—Public Lecture, Nashville, TN, April 8, 
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HATHAWAY, D.H. SD50  
Modern Solar Mysteries—Abstract Only. For presentation 
at Vanderbilt University—Public Lecture, Nashville, TN, 
April 8, 2004.

HATHAWAY, D.H. SD50  
What the Long-Term Sunspot Record Tells Us About Space 
Climate—Abstract Only. For presentation at the First 
International Symposium on Space Weather, Oulu, Finland, 

HATHAWAY, D.H. SD50  
Flows in the Solar Convection Zone—Abstract Only. For presentation at the 35th COSPAR Scientific Assembly, Paris, 

HATHAWAY, D.H. SD50  
How Large-Scale Flows in the Solar Convection Zone May 
Influence Solar Activity—Abstract Only. For presentation 
at the NSO Workshop No. 22 Large-Scale Structures and 
Their Role in Solar Activity, Sunspot, NM, October 18–22, 
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MEYER, P.J. SD50  
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NANDY, D. Montana State University  
WILSON, R.M. SD50  
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HEATON, A.F. TD54

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DAVIDSON, G. Northrop Grumman

HENDERSON, S.J. U.S. Military Academy
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HENLEY, M.W. Boeing/Phantom Works
HOWELL, J.T. FD02

HEREFORD, J. Murray State University
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HOLLADAY, J.B. FD24
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HOLLERMAN, W. University of Louisiana
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HONG, Y.-S. SD46/BAE Systems
ADAMEK, D.H. SD46/AZ Technology
BRIDGE, K. SD46/UAH
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CECIL, D.J. UAH
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HEYSFIELD, G. Goddard Space Flight Center
MARKS, F. NOAA Hurricane Research Division

HOOD, R.E. SD60
KAKAR, R. NASA Headquarters
Early Results of the NASA Convection and Moisture Experiment (CAMEX)—Abstract Only. For presentation at the 58th Interdepartmental Hurricane Conference, Charleston, SC, February 29–March 5, 2004.

HOOVER, R.B. SD50
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HU, Z.W. SD46
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LAI, B. Argonne National Laboratory

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JUSTUS, C.G. Computer Sciences Corporation
DUVALL, A.L. Computer Sciences Corporation
KELLER, V.W. ED44

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<th>Title</th>
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VRBA, F.J.  

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PATEL, S.K. SD50
LEVAN, A. University of Leicester
BLANDFORD, R. Kavli Inst. for Particle Astrophysics and Cosmology
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WEISSKOPF, M.C. SD50
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