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

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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.”
GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama

FY 2004 SCIENTIFIC AND TECHNICAL REPORTS,
ARTICLES, PAPERS, AND PRESENTATIONS

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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.

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.

TM—2004–213170 May 2004

A heat pipe–cooled reactor coupled to a Brayton cycle is currently under consideration for nuclear electric propulsion or as a planetary surface power source. In this system, power is transferred from the heat pipes to the Brayton gas via a heat exchanger attached to the heat pipes. This Technical Memorandum (TM) discusses the fluid, thermal, and structural analyses that were performed in support of the design of the heat exchanger to be tested in the Safe, Affordable Fission Engine experimental program at Marshall Space Flight Center. A companion paper, “Mechanical Design and Fabrication of a SAFE–100 Heat Exchanger for use in NASA’s Advanced Propulsion Thermal-Hydraulic Simulator,” presents the fabrication issues and prototyping studies that, together with these analyses, led to the development of this heat exchanger. An important consideration throughout the design development of the heat exchanger was its capability to be used for higher power and temperature applications. This TM also discusses this aspect of the design and presents designs for specific applications under consideration.

TM—2004–213172 May 2004
Evaluation of Training Samples Manually Welded With the Universal Handtool in a Space Simulation Chamber.


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.

TM—2004–213174 May 2004

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.

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.

The NASA Barrel-Shaped Asymmetrical Capacitor (NACAP) has been extensively tested at NASA Marshall Space Flight Center and the National Space Science and Technology Center. Trichel pulse emission was first discovered here. The NACAP is a magnetohydrodynamic device for electric propulsion. In air it requires no onboard propellant nor any moving parts. No performance was observed in hard vacuum. The next step shall be optimizing the technology for future applications.

The Geostationary Operational Environmental Satellite (GOES) Product Generation System (GPGS) is introduced and described. GPGS is a set of computer programs developed and maintained at the Global Hydrology and Climate Center and is designed to generate meteorological data products using visible and infrared measurements from the GOES-East Imager and Sounder instruments. The products that are produced by GPGS are skin temperature, total precipitable water, cloud top pressure, cloud albedo, surface albedo, and surface insulation. A robust cloud mask is also generated. The retrieval methodology for each product is described to include algorithm descriptions and required inputs and outputs for the programs. Validation is supplied where applicable.
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.

TP—2003–212927

November 2003


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.

TP—2003–212929

November 2003


A mechanism is presented for the nucleation of diamond in the combustion flame environment. A series of six experiments and two associated simulations provide results from which the mechanism was derived. A substantial portion of the prior literature was reviewed and the data and conclusions from the previous experimenters were found to support the proposed mechanism. The nucleation mechanism builds on the work of previous researchers but presents an approach to nucleation in a detail and direction not fully presented heretofore. This work identifies the gas phase as the controlling environment for the initial formulation steps leading to nucleation. The development mechanism explains some of the difficulty which has been found in producing single crystal epitaxial films.

An experiment which modified the initial gas phase precursor using methane and carbon monoxide is presented. Addition of methane into the precursor gases was found to be responsible for pillaring of the films. Atomic force microscopy surface roughness data provided a reasonable look at suppression of nucleation by carbon monoxide. Surface finish data was taken on crystals which were open to the nucleation environment and generally parallel to the substrate surface. These surfaces were measured as an independent measure of the instantaneous nucleation environment. A gas flow and substrate experiment changed the conditions on the surface of the sample by increasing the gas flow rate while remaining on a consistent point of the atomic constituent diagram, and by changing the carbide potential of the substrate. Two tip modification experiments looked at the behavior of gas phase nucleation by modifying the shape and behavior of the flame plasma in which the diamond nucleation is suspected to occur. Diamond nucleation and growth was additionally examined using a high-velocity oxygen fuel gun and C$_2$H$_6$ as the fuel gas phase precursor with addition of carbon monoxide gas or addition of liquid toluene.
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.

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).

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—2004–213338


The objective is to develop an improved space solar cell radiation response analysis capability and to produce a computer modeling tool which implements the analysis. This was accomplished through analysis of solar cell flight data taken on the Microelectronics and Photonics Test Bed experiment. This effort specifically addresses issues related to rapid technological change in the area of solar cells for space applications in order to enhance system performance, decrease risk, and reduce cost for future missions.

TP—2004–213339


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 \(<0.1 \text{rd(S)}/\text{s}\) compared to similar transistors irradiated at dose rates \(>1 \text{rd(S)}/\text{s}\). 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 shutdowns, 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 Environment 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. Subsystems 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 yield an accurate prediction of the observed charging under a wide variety of conditions.

Fortran statements were developed that are required for the NUMIT runs to work with this kind of data from space. In addition to developing the Fortran for NUMIT, simple correlations between the IDM pulsing history and the space radiation were observed because we now have a better characterization of the space radiation.

The study showed that: (1) the new methods for measurement of charge storage and conduction in insulators provide the correct values to use for prediction of charging and pulsing in space; (2) the methods in NUMIT that worked well for time durations less than hours now work well for durations of months; (3) an average spectrum such as AE8 is probably not a good guide for predicting pulsing in space— one must take time dependence into account in order to understand insulator pulsing; and (4) the old method for predicting pulse rates in space that was based on the CRRES data could be improved to include dependencies on material parameters.

For the 39th consecutive year, the NASA Faculty Fellowship Program (NFFP) was conducted at Marshall Space Flight Center. The program was sponsored by NASA Headquarters, Washington, DC, and operated under contract by The University of Alabama in Huntsville. In addition, promotion and applications are managed by the American Society for Engineering Education (ASEE) and assessment is completed by Universities Space Research Association (USRA). The nominal starting and finishing dates for the 10-week program were May 27 through August 1, 2003. The primary objectives of the NASA Faculty Fellowship Program are to: (1) Increase the quality and quantity of research collaborations between NASA and the academic community that contribute to NASA’s research objectives; (2) provide research opportunities for college and university faculty that serve to enrich their knowledge base; (3) involve students in cutting-edge science and engineering challenges related to NASA’s strategic enterprises, while providing exposure to the methods and practices of real-world research; (4) enhance faculty pedagogy and facilitate interdisciplinary networking; (5) encourage collaborative research and technology transfer with other Government agencies and the private sector; and (6) establish an effective education and outreach activity to foster greater awareness of this program.
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ELSNER, R.F. SD50
GLADSTONE, G.R. Southwest Research Institute
RAMSAY, G. Mullard Space Science Laboratory
RODRIGUEZ, P.R. XMM-Newton SOC
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
GOODMAN, S.J. SD60

BUECHLER, D.E. UAH
GOODMAN, S.J. SD60
LA CASSE, K. SD60
BLAKESLEE, R.J. SD60
DARDEN, C. SD60

BURNS, H. ED31
ALBYN, K. ED31
EDWARDS, D.L. ED31
BOOTHE, R. ED31
FINCHUM, C. ED31
FINCKENOR, M. ED31


BURNS, L. Raytheon
DECKER, R. ED44


CAMPBELL, J.W. FD02
PHIPPS, C. Photonics Associates
SMALLEY, L. UAH
REILLY, J. Northeast Science & Technology
BOCCIO, D. SUNY


CANNING, F.X. ISR
WINET, E. ISR
ICE, B. ISR
MELCHER, C. ISR
PESAVENTO, P. ISR
HOLMES, A. ISR
BUTLER, C. ISR
COLE, J. TD40
CAMPBELL, J. TD40


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


CANNING, F.X. ISR
WINET, E. ISR
ICE, B. ISR
MELCHER, C. ISR
PESAVENTO, P. ISR
HOLMES, A. ISR
BUTLER, C. ISR
COLE, J. TD40
CAMPBELL, J. TD40


CARRASQUILLO, R.L. FD21
BAGDIGIAN, B. FD21
PERRY, J.L. FD21
LEWIS, J.


CARRASQUILLO, R.L. FD21
CLOUD, D. Hamilton Sundstrand
BEDARD, J. Hamilton Sundstrand


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. FD02
DAY, G. Boeing Phantom Works


CARRINGTON, C.K. FD02
HOWELL, J.T. FD02
DAY, G. Boeing Phantom Works


CARTER, L. FD21
TATARA, J.D. FD21
MASON, R. FD21
O’CONNOR, E. FD21
BEDARD, J. FD21


CASIANO, M.J. TD63
ZOLADZ, T.F. TD63


CATALINA, A.V. BAE/SD46
STEFANESCU, D.M. University of Alabama
SEN, S. SD46


CECIL, D.J. UAH
LAFONTAINE, F.J. Raytheon ITSS
HOOD, R.E. SD60
BLAKESLEE, R.J. SD60
MACH, D.M. UAH
HEYSFIELD, G. Goddard Space Flight Center


CHANG, H. UAH
SMITH, D.D. SD46


CHANG, J. Purple Mountain Observatory

CHICHESTER, W.K.H. Max Planck Institute
ADAMS, J.H. SD50
AHN, H.S. University of Maryland
BASHINDZHAGYAN, G.L. Moscow State University
CHRISTL, M.J. SD50
FAZELY, A.R. Southern University
GANEL, O. University of Maryland
ET AL.

CHANG, S.-W. SD50
GALLAGHER, D.L. SD50
SPANN, J.F. SD50
MENDE, S. SD50
GREENWALD, R. SD50
NEWELL, P.T. SD50

CHAUVERS, G. TD40
CHANG-DIAZ, F. Johnson Space Center

CHAUVERS, G. TD40
CHANG-DIAZ, F. Johnson Space Center
BREIZMAN, B. University of Texas
BENGSTON, R. University of Texas

CHEN, F. SD60
KISSEL, D.E. SD60
WEST, L.T. SD60
RICKMAN, D. SD60
LUVALL, J.C. SD60
ADKINS, W. SD60

CHERNOV, A.A. SD46
RASHKOVICH, L.N. SD46
VEKILOV, P.G. SD46

CHERNOV, A.A. SD46
RASHKOVICH, L.N. SD46
VEKILOV, P.G. SD46
DE YOREO, J.J. SD46

CHOU, S.-H. SD60
LAPENTA, W.M. SD60
JEDLOVEC, G.J. SD60
MCCARTY, W. UAH
MECIKALSKI, J.R. UAH

CHOWDHURY, D.P. SD50

CHOWDHURY, D.P. SD50
BALASUBRAMANIAM, K.S. National Solar Observatory
SUEMATSU, Y. National Astronomical Observatory

CHOWDHURY, D.P. SD50
MOORE, R.L. SD50

CHOWDHURY, D.P. SD50
MOORE, R.L. SD50
FALCONER, D.A. SD50
POJOGA, S. Prairie View A&M University
KRUCKER, S. University of California
UDDIN, W. Aryabhata Research Institute

CHOWDHURY, D.P. SD50
STERLING, A.C. SD50
MOORE, R.L. SD50
YURCHYSHYN, V. Big Bear Solar Observatory
CHRISTIAN, H.J. SD60

CHRISTIAN, H.J. SD60

CHRISTL, M.J. SD50

CISSOM, R.D. FD32
WATSON, K. AREs Corporation

CISZAK, E.M. SD46
DOMINIAK, P.M. SD46

CLAYTON, L. ED25

CLINTON, JR., R.G. SD40

CLINTON, JR., R.G. SD40
SEMMES, E.B. SD41
COOK, M.B. SD30
WARGO, M.J. NASA Headquarters
MARZWELL, N.I. Jet Propulsion Laboratory

CLINTON, JR., R.G. SD40
SEMMES, E.B. SD40
SCHLAGHECK, R.A. SD40
BASSLER, J.A. SD40
COOK, M.B. SD40
WARGO, M.J. NASA Headquarters
SANDERS, G.B. Johnson Space Center
MARZWELL, N.I. Jet Propulsion Laboratory

COFFEY, V.N. SD50
CHANDLER, M.O. SD50
SINGH, N. UAH
MILLER, J. UAH
MOORE, T.E. Goddard Space Flight Center

COOK, S.A. NP01
MORRIS, C.E.K. NP01
TYSON, R.W. NP01

COOKE, W.J. Morgan Research Corporation
MOSER, D. Morgan Research Corporation
SUGGS, R.M. ED44

CORDER, E.L. ED12
BRISCOE, J.M. ED12

CORDER, E.L. ED12
BRISCOE, J.M. ED12

CRAVEN, P.D. SD50
MOORE, T.E. SD50
GALLAGHER, D.L. SD50
Thermal N+ in the Inner Magnetosphere—Abstract Only. For presentation at the American Geophysical Union 2004

CRUZ, A. SD46
BORS, K. SD46
JANSEN, H. SD46
RICHMOND, R.C. SD46


CRUZEN, C. FD32
DYER, S. FD33


CUNTZ, M. University at Texas/Arlington
SUSS, S.T. SD50


CUNTZ, M. SD50
SUSS, S.T. SD50


CURRERI, P.A. SD46
SIBILLE, L. BAE Systems


DARROUZET, F. Belgian Institute
LEMAIRE, J.F. Belgian Institute
DECREAUX, E. Universite d’Oreleans
DE KEYSER, J. Belgian Institute
MASSON, A. Research and Scientific
GALLAGHER, D.L. SD50
SANTOLIK, O. MMF, Prague
TROTIGNON, J.G. Universite d’Oreleans
RAUCH, J.L. Universite d’Oreleans
ET AL.


DAVIS, R.N. University of Alabama
POLITES, M.E. University of Maryland
TREVINO, L.C. ED10


DAVIS, S.E. ED36
ENGEL, C.D. ED36
RICHARDSON, E.R. ED36


DECKER, R.K. ED44
LEACH, R. ED44


DECKER, R.K. ED44
LEACH, R. Morgan Research Corporation/ED44


DETKOVA, E.N. Institute of Microbiology
PIKUTA, E.V. SD50
HOOVER, R.B. SD50


DOBSON, C. TD40
HRBUD, I. Purdue University


ELSNER, R.F. SD50
RAMSEY, B.D. SD50
WAITE, JR., J.H. University of Michigan
REHAK, P. BNL
JOHNSON, R.E. University of Virginia
COOPER, J.F. Raytheon
SWARTZ, D.A. USRA


ELSNER, R.F. SD50
RAMSEY, B.D. SD50
WAITE, JR., J.H. University of Michigan
REHAK, P. Brookhaven National Laboratory
JOHNSON, R.E. University of Virginia
COOPER, J.F. Raytheon
SWARTZ, D.A. USRA/SD50


EMBERSON, C.W. Western Michigan University
LAM, S.-N. Louisiana State University
QUATTROCHI, D.A. SD60


EMRICH, W.J. TD40
HAWK, C.W. UAH


ENG, R. SD72
STAHL, P. SD72
HOGUE, W. SD72
HADAWAY, J. UAH

Poco Graphite Inc. SuperSi 0.25m Mirror Cryogenic Test Result—Abstract Only. For presentation at the Mirror Technology Days, Huntsville, AL, August 17–19, 2004.

ENGBERG, R.C. ED27
OUI, T.K. UAH


ENGELHAUPT, D. UAH
RAMSEY, B.D. SD50


ESTES, H. ED17


EVANS, S.W. ED44


EVANS, S.W. ED44
STALLWORTH, R. ED23
STELLINGWERF, R.F. Stellingwerf Consulting


FALCONER, D.A. SD50
MOORE, R.L. SD50
GARY, G.A. SD50


FALCONER, D.A. UAH/SD50
MOORE, R.L. SD50
GARY, G.A. SD50
BALASUBRAMANIAN, S. UAH/SD50

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
ELAM, S.K. TD61
HICKS, E.D. Jacobs Sverdrup
SANDERS, T.M. TD72
LONDON III, J.R. TD70
MAYNE, A.W. TRW (Retired)
CHRISTENSEN, D.L. Lockheed Martin


FERGUSON, C.K. SD22
ABUSHAGUR, M. SD22
ENGLISH, J.M. SD22
NORDIN, G.P. SD22

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

FISHERMAN, 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
MAJDALANI, J. University of Tennessee


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
BRASUNAS, J.C. Goddard Space Flight Center
ET AL.


FLASAR, F.M. Goddard Space Flight Center
KUNDE, V.G. University of Maryland
ACHTERBERG, R.K. Science Systems & Applications
CONRATH, B.J. Cornell University
SIMON-MILLER, A.A. Goddard Space Flight Center
NIXON, C.A. University of Maryland
GIERASCH, P.J. Cornell University
ROMANI, P.N. Goddard Space Flight Center
ABBAS, M.M. SD50
ET AL.


FISHERMAN, G. J. SD50


FOX, N.J. SD50
GOLDBERG, R. SD50
BARNES, R.J. SD50
SIGWARTH, J.B. SD50
BEISSER, K.B. SD50
MOORE, T.E. SD50
HOFFMAN, R.A. SD50
RUSSELL, C.T. SD50
SPANN, J.F. SD50
ET AL.


FULLER, K.A. UAH
SMITH, D.D. SD46

FUSS, T. University of Missouri-Rolla
RAY, C.S. SD46
LESHER, C.E. University of California-Davis
DAY, D.E. University of Missouri-Rolla

Crystallization of an Li$_2$O-SiO$_2$ Glass Under High Hydrostatic Pressures—Abstract Only. For presentation at the 106th Annual Meeting of the American Ceramic Society, Indianapolis, IN, April 18–21, 2004.

GALLAGHER, D.L. SD50


GALLAGHER, D.L. SD50


GALLAGHER, D.L. SD50


GALLAGHER, D.L. SD50
ADRIAN, M.L. SD50
LIEMOHN, M.W. SD50


GALLAGHER, D.L. SD50
KHAZANOVA, G.V. SD50


GARBE, G. TD05
MONTGOMERY IV, E.E. TD05
HEATON, A.F. TD05
VAN SANT, J.T. GSFC
CAMPBELL, B.A. GSFC

WILLIAMS, R. TD64

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. SD50

MOORE, R.L. SD50


GATLIN, P.N. SD60
GOODMAN, S.J. SD60


GERMANY, G. UAH
SPANN, J.F. SD50
DEVERAPALLI, C. UAH
HUNG, C.-C. Southern Polytechnic State University


GEVEDEN, R.D. DD01


GILLIES, D.C. SD40


GOGUS, E. SD50
FINGER, M.H. SD50

PATEL, S.K. SD50
RUPEN, M. SD50
SWANK, J.H. SD50
MARKWARDT, C.B. SD50
VANDERKLIS, M. SD50

GOLDMAN, A. SD46
KELTON, K.F. SD46
ROGERS, J.R. SD46

GONZALEZ, J.E. Santa Clara University
LUVALL, J. SD60
RICKMAN, D. SD60
COMARAZAMY, D.E. SD60
PICON, A. SD60

GOODMAN, D.D. TD62

GOODMAN, S.J. SD60
BLAKESLEE, R.J. SD60
CHRISTIAN, H. SD60
KOSHAK, W. SD60
BAILEY, J.C. Global Hydrology & Climate Center
HALL, J. Global Hydrology & Climate Center
MCCAUL, E. Global Hydrology & Climate Center
BUCHLER, D.E. Global Hydrology & Climate Center
DARDEN, C. NSSTC
ET AL.

GORTI, S. SD46
FORSYTHE, E.L. BAE Systems
PUSEY, M.L. SD46

GOODMAN, S.J. SD60
BLAKESLEE, R.J. SD60
CHRISTIAN, H. SD60
KOSHAK, W. SD60
BAILEY, J.C. Global Hydrology & Climate Center
HALL, J. Global Hydrology & Climate Center
MCCAUL, E. Global Hydrology & Climate Center
BUCHLER, D.E. Global Hydrology & Climate Center
DARDEN, C. NSSTC
ET AL.

GOLDMAN, A. SD46
KELTON, K.F. SD46
ROGERS, J.R. SD46

GONZALEZ, J.E. Santa Clara University
LUVALL, J. SD60
RICKMAN, D. SD60
COMARAZAMY, D.E. SD60
PICON, A. SD60


GOODMAN, D.D. TD62

GOODMAN, H.M. SD60
REGNER, K. UAH
CONOVER, H. UAH
ASHCROFT, P. Remote Sensing Systems
WENTZ, F. Remote Sensing Systems
CONWAY, D. UAH
LOBL, E. UAH
BEAUMONT, B. UAH
HAWKINS, L. UAH
JONES, S. UAH


GOODMAN, S.J. SD60

The LATEST Project: Operational Assessment of Total Lightning Data in the U.S.—Abstract Only. For presenta-

GORTI, S. SD46
FORSYTHE, E.L. BAE Systems
PUSEY, M.L. SD46

GORTI, S. SD46
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FORSYTHE, E.L. BAE Systems
PUSEY, M.L. SD46


GOSTOWSKI, R. TD40

Isothermal Calorimetric Observations of the Effect of Welding on Compatibility of Stainless Steels With High-Test

GOSTOWSKI, R. TD40

GREGG, M.W. ED22

GREGG, M.W. ED22

GREGORY, D.A. UAH
HERRNS, K.A. SD70

GREINER, J.C. Max Planck Institute
KLOSE, S. Thuringer Landesstern.
REINSCH, K. Universits-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
PALAZZI, E. Istituto di Astrofisica
ET AL.

GRUGEL, R.N. SD46

GRUGEL, R.N. SD46
ANILKUMAR, A.V. SD46
LEE, C.P. SD46

GRUGEL, R.N. SD46
LUZ, P. SD46
SMITH, A. SD46
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SEN, S. SD46
ANILKUMAR, A.V. SD46

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O’DELL, S.L. SD50
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SMITHERS, M. SD50

GUBAREV, M. SD50
RAMSEY, B.D. SD50
APPLE, J. SD50

GUBAREV, M. SD50


HEATON, A.F. TD54

HEFNER, K. FD03

HENDERSON, S.J. U.S. Military Academy
HAMILTON, G.S. ED42

HENLEY, M.W. Boeing/Phantom Works
HOWELL, J.T. FD02

HEREFORD, J. Murray State University
GWALTNEY, D. ED17

HEREFORD, J. Murray State University
GWALTNEY, D. ED17

HERREN, K.A. SD71
LIN, J. UAH
COHEN, T. UAH
PAKHOMOV, A.V. UAH
THOMPSON, M.S. Information Systems, Inc.

HOLLADAY, J.B. FD24
DAY, G. Boeing
GILL, L. Carleton Technologies

HOLLERMAN, W. University of Louisiana
ALBARDO, T. University of Louisiana
LENTZ, M. University of Louisiana
EDWARDS, D.L. ED31
HUBBS, W.S. ED31
SEMMEL, C.L. Qualis Corporation

HOLT, J.M. ED25
CLANTON, S.E. Jacobs Sverdrup

HOOD, R.E. SD60
BLAKESLEE, R.J. SD60
CECIL, D.J. UAH
LAFONTAINE, F.J. Raytheon ITSS
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
PIKUTA, E.V. SD50
WICKRAMASINGHE, N.C. Cardiff Center
WALLIS, M.K. Cardiff Center


HOOVER, R.B. SD50
ROZANOV, A.Y. Paleontological Institute


HU, Z.W. SD46
HOLMES, A. SD46
THOMAS, B.R. SD46
CHERNOV, A.A. SD46
CHU, Y.S. Argonne National Laboratory
LAI, B. Argonne National Laboratory

X-Ray Microscopic Characterization of Protein Crystals—Abstract Only. For presentation at the 10th International

HULCHER, A.B. ED34

HULCHER, A.B. ED34

HUTCHENS, C. FD21
GRAVES, R. Allied

HYERS, R.W. University of Massachusetts
BRADSHAW, R.C. University of Massachusetts
ROGERS, J.R. SD46
RATHZ, T.J. UAH
LEE, G.W. Washington University
GANGOPADHYAY, A.K. Washington University
KELTON, K.F. Washington University

HYERS, R.W. University of Massachusetts
BRADSHAW, R.C. University of Massachusetts
ROGERS, J.R. SD46
RATHZ, T.J. UAH
LEE, G.W. Washington University
KELTON, K.F. Washington University
GANGOPADHYAY, A.K. Washington University

IRWIN, D.E. SD60

IRWIN, D.E. SD60
SEVER, T.L. SD60
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HARDIN, D. UAH

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DAVIS, E. FD42

JAAP, J. FD42
MAXWELL, T. FD42

JACOBSON, D. XP01

JACOBSON, D. XP01

JEDLOVEC, G.J. SD60
Use of MODIS/AIRS Direct Broadcast Data for Short Term Weather Forecasting—Abstract Only. For presentation at the

JEDLOVEC, G.J. SD60
HAINES, S. UAH
SUGGS, R.J. SD60
BRADSHAW, T. NWS Forecast Office
BURKS, J. NWS Forecast Office


JOHNSON, D.L. ED44
VAUGHAN, W.W. UAH
KELLER, V.W. ED44


JOHNSON, D.L. ED44
VAUGHAN, W.W. UAH
KELLER, V.W. ED44


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


JUSTUS, C.G. Morgan Research Corporation/ED44
DUVALL, A.L. Morgan Research Corporation/ED44
KELLER, V.W. ED44


JUSTUS, C.G. Morgan Research Corporation/ED44
DUVALL, A.L. Morgan Research Corporation/ED44
KELLER, V.W. ED44


JUSTUS, C.G. Morgan Research Corporation/ED44
DUVALL, A.L. Morgan Research Corporation/ED44
KELLER, V.W. ED44


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

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization/Location</th>
<th>Title</th>
<th>Location/Date</th>
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</thead>
<tbody>
<tr>
<td>KAKAR, R.</td>
<td>NASA Headquarters</td>
<td>KHAZANOV, G.V.</td>
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<tr>
<td>GOODMAN, H.M.</td>
<td>SD60</td>
<td>GALLAGHER, D.L.</td>
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<td>HOOD, R.E.</td>
<td>SD60</td>
<td>SPANN, J.F.</td>
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<td>GUILLORY, A.R.</td>
<td>SD60</td>
<td>SINGH, N.</td>
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<td>KAUFFMAN, B.</td>
<td>ED03</td>
<td>KHAZANOV, G.V.</td>
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<td>HARDAGE, D.</td>
<td>ED03</td>
<td>LIEMOHN, M.W.</td>
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<td>MINOR, J.</td>
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<td>RIDLEY, A.J.</td>
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<td>KEYS, A.S.</td>
<td>SD50</td>
<td>KHAZANOV, G.V.</td>
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<tr>
<td>CROW, R.W.</td>
<td>Sensing Strategies, Inc.</td>
<td>SINGH, N.</td>
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<tr>
<td>ASHLEY, P.R.</td>
<td>U.S. Army Aviation</td>
<td>GAMAYUNOV, K.V.</td>
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<tr>
<td>NELSON, JR., T.R.</td>
<td>Air Force Laboratory, SNDD</td>
<td>KRIVORUTSKY, E.N.</td>
<td></td>
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<tr>
<td>PARKER, J.H.</td>
<td>Air Force Laboratory, SNJT</td>
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<tr>
<td>BEECHER, E.A.</td>
<td>Air Force Laboratory, SNJT</td>
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<td>KHAZANOV, G.V.</td>
<td>SD50</td>
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<td>KRIVORUTSKY, E.N.</td>
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<td>KIESSLING, E.</td>
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Sodium Heat Pipe Module Processing for the SAFE-100
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Flourescent Approaches to High Throughput Crystallalogy—
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Meridional Variations of $\text{C}_2\text{H}_4$ and $\text{C}_2\text{H}_6$ in Jupiter’s Atmosphere From Cassini CIRS Infrared Spectra—Abstract Only. For publication in Icarus, 2004.

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