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GLOBAL ULTRAVIOLET IMAGING PROCESSING FOR THE
GGS POLAR VISIBLE IMAGING SYSTEM (VIS)

ANNUAL PERFORMANCE REPORT

1 October 1996 - 30 September 1997

NAG5-3328

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July 1997

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Iowa City, Iowa 52242-1479

GLOBAL ULTRAVIOLET IMAGING PROCESSING FOR THE
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VIS Earth Camera Operations

The Visible Imaging System (VIS) on Polar spacecraft of the NASA Goddard Space Flight Center was launched into orbit about Earth on February 24, 1996. Since shortly after launch, the Earth Camera subsystem of the VIS has been operated nearly continuously to acquire far ultraviolet, global images of Earth and its northern and southern auroral ovals. The only exceptions to this continuous imaging occurred for approximately 10 days at the times of the Polar spacecraft re-orientation maneuvers in October, 1996 and April, 1997. Since launch, approximately 525,000 images have been acquired with the VIS Earth Camera.

The VIS instrument operational health continues to be excellent. Since launch, all systems have operated nominally with all voltages, currents, and temperatures remaining at nominal values. In addition, the sensitivity of the Earth Camera to ultraviolet light has remained constant throughout the operation period. Revised flight software was uploaded to the VIS in order to compensate for the spacecraft wobble. This is accomplished by electronic shuttering of the sensor in synchronization with the 6-second period of the wobble, thus recovering the original spatial resolution obtainable with the VIS Earth Camera. In addition, software patches were uploaded to make the VIS immune to signal dropouts that occur in the sliprings of the despun platform mechanism. These changes have worked very well. The VIS and in particular the VIS Earth Camera is fully operational and will continue to acquire global auroral images as the sun progresses toward solar maximum conditions after the turn of the century.

Summary of Significant Scientific Accomplishments

Images acquired with the VIS Earth Camera have led to significant accomplishments. Studies of substorm onset and development using multiple spacecraft and ground stations have begun. Initial results have been presented at meetings and the first publications have been accepted. Significant progress has been made in the understanding of the theta aurora phenomena by combining images from the VIS Earth Camera and the particle data from the Hydra instrument on the Polar satellite. Movies showing the dynamics of the auroral oval have been processed from the images acquired by the Earth Camera of VIS. In particular, the VIS Earth Camera movie of the auroral oval response to the January 6-11, 1997 Coronal Mass Ejection (CME) has been used to show the impact of the CME on Earth's magnetosphere. VIS Earth Camera images have also been used for comparison to the Energetic Neutral Particle Images of the Magnetosphere obtained with the CEPPAD instrument on the Polar spacecraft. The VIS Earth Camera acquired far ultraviolet images

of the comet Hale-Bopp in order to measure the oxygen content of the cometary coma. This can then be related to the total water production from the comet. Analysis of these images is ongoing. Finally, the VIS Earth Camera has been used to confirm the existence of atmospheric holes first observed with the ultraviolet imaging photometer on the Dynamics Explorer-1 spacecraft more than a decade ago. These atmospheric holes have been associated with the impact of small comets into Earth's upper atmosphere at a global rate of 5 to 20 per minute. In addition, the VIS Earth Camera has captured for the first time the disintegration of a small fraction of these small comets at high altitudes. These disintegrated small comets leave a tell-tale dashed trail of resonantly scattered ultraviolet emission from the atomic oxygen liberated from the water molecules.

Data Processing and Distribution

In addition to normal daily processing of the VIS Earth Camera Images since launch, the VIS imaging team has special processed 79 requests for data by 21 investigators. To date, all image data requests have been serviced. The data distribution has generally been in 4 forms.

- 1) Fully processed images (level 2 data) in final display format (e.g. GIF)
- 2) Movies created by combining the stills of the fully processed images and converting to NTSC, PAL, or other formats.
- 3) Level 2 processed images distributed via FTP or CD-ROM.
- 4) Level 1 processed image data requested and distributed to Co-investigators.

The table below includes the listing of requested data, requesters, and institutions whose data requests were satisfied during the period of performance.

In addition to the data distributed as a result of data requests, the images from the Near Real Time contacts have been automatically processed and placed online with accessibility from the World Wide Web (WWW). To date approximately 110,000 images have been served to the scientific community and the public.

Development of software to produce CDFs for Key Parameter data, level 1 data, and level 2 data is in the late testing stages and will be released within the next few months. Testing of the Key Parameter software on the CDHF computer is slated to begin next month and release should follow quickly. In addition, IDL based viewers that can be transported to any computer platform running the IDL software have been developed to make the CDFs immediately accessible to all of the ISTP community.

Presentations and Papers

The accompanying tables list the publications and presentations that have included the use of the VIS Earth Camera image data. In summary to date 10 papers have been submitted for publication and 24 presentations have been given at large number of national and international conferences. Many additional presentations utilizing image data acquired with the VIS Earth Camera have been given for which members of the VIS imaging

investigation team have not been co-authors. These presentations have not been included in the table of presentations.

Publications

1. Frank, L. A., J. B. Sigwarth, J. D. Craven, J. P. Cravens, J. S. Dolan, M. R. Dvorsky, P. K. Hardebeck, J. D. Harvey and D. Muller, The Visible Imaging System (VIS) for the Polar Spacecraft, Space Sci. Rev., **71**, 297-328, 1995.
2. Pulkkinen, T. I., D. N. Baker, N. E. Turner, H. J. Singer, L. A. Frank, J. B. Sigwarth, J. Scudder, R. Anderson, S. Kokubun, R. Nakamura, T. Mukai, J. B. Blake, C. T. Russell, H. Kawano, F. Mozer and J. A. Slavin, Solar Wind-Magnetosphere Coupling During an Isolated Substorm Event: A Multispacecraft ISTP Study, Geophys. Res. Lett., **24**, 983-986, 1997.
3. Frank, L. A. and J. B. Sigwarth, Detection of Atomic Oxygen Trails of Small Comets in the Vicinity of Earth, accepted for publication, Geophys. Res. Lett., 1997.
4. Frank, L. A. and J. B. Sigwarth, Transient Decreases of Earth's Far-Ultraviolet Dayglow, accepted for publication, Geophys. Res. Lett., 1997.
5. Frank, L. A. and J. B. Sigwarth, Simultaneous Observations of Transient Decreases of Earth's Far-Ultraviolet Dayglow With Two Cameras on the Polar Spacecraft, accepted for publication, Geophys. Res. Lett., 1997.
6. Frank, L. A. and J. B. Sigwarth, Trails of OH Emissions From Small Comets in the Vicinity of Earth, accepted for publication, Geophys. Res. Lett., 1997.
7. Pulkkinen, T. I., D. N. Baker, L. A. Frank, J. B. Sigwarth, H. J. Opgenoorth, R. Greenwald, E. Friis-Christensen, T. Mukai, R. Nakamura and H. Singer, Two Substorm Intensifications Compared: Onset, Expansion, and Global Consequences, submitted to J. Geophys. Res., 1997.
8. Whipple, E. C., J. S. Halekas, J. D. Scudder, W. R. Paterson, L. A. Frank, R. B. Sheldon, N. C. Maynard, D. R. Weimer, C. T. Russell, K. Tsuruda, H. Hayakawa and T. Yamamoto, Identification of Magnetospheric Particles that Travel Between Spacecraft, and Their Use to Help Obtain Magnetospheric Potential Distributions, accepted for publication, J. Geophys. Res., 1997.
9. Chang, S.-W., J. D. Scudder, J. B. Sigwarth, L. A. Frank, N. C. Maynard, W. J. Burke, W. K. Peterson, E. G. Shelley, R. Friedel, J. B. Blake, R. A. Greenwald, R. P. Lepping, G. J. Sofko, J.-P. Villain and M. Lester, A Comparison of a Model for the Theta Aurora with Observations from Polar, Wind and SuperDARN, submitted to J. Geophys. Res., 1997.

10. Frank, L. A. and J. B. Sigwarth, On the Influx of Small Comets into Earth's Atmosphere, submitted to Proceedings SPIE's 1997 International Symposium on Instruments, Methods, and Missions for the Investigation of Extraterrestrial Microorganisms, San Diego, California, 27 July–1 August 1997.

Abstracts/Presentations

1. Frank, L. A., J. B. Sigwarth, J. D. Craven, C.-I. Meng, T. L. Killeen and W. E. Sharp, Global Views of Earth and its Auroras with the Visible Imaging System (VIS) on the Polar Spacecraft, 31st Scientific Assembly of COSPAR, Birmingham, United Kingdom, p. 175, 14–21 July 1996.
2. Sigwarth, J. B., L. A. Frank, J. D. Craven, C.-I. Meng, G. K. Parks, T. L. Killeen and W. E. Sharp, Images of Earth's Auroras From the Visible Imaging System (VIS) for the POLAR Spacecraft, presented at the 1st Alfven Conference, Kiruna, Sweden, 9–13 September 1996.
3. Frank, L. A., J. B. Sigwarth, J. D. Craven, C.-I. Meng, G. K. Parks, T. L. Killeen and W. E. Sharp, Images of Earth's Auroras From the Visible Imaging System (VIS) for the POLAR Spacecraft, 1996 Huntsville Workshop on "Encounter Between Global Observations and Models in the ISTP ERA," Guntersville, Alabama, p. 15, 15–20 September 1996.
4. Frank, L. A., W. R. Paterson, J. B. Sigwarth, S. Kokubun, T. Yamamoto, R. P. Lepping and K. W. Ogilvie, Plasma Dynamics in Earth's Magnetotail, Chapman Conference on "The Earth's Magnetotail: New Perspectives," Kanazawa, Japan, p. 43, 5–9 November 1996.
5. Reeves, G. D., M. G. Henderson, M. F. Thomsen, R. D. Belian, H. J. Singer, G. K. Parks, L. A. Frank and R. P. Lin, Periodic Oscillations Seen in the Inner Plasmasheet Following a Substorm on May 10, 1996: Coordinated ISTP Observations, Chapman Conference on "The Earth's Magnetotail: New Perspectives," Kanazawa, Japan, p. 35, 5–9 November 1996.
6. Chenette, D. L., J. D. Tobin, L. A. Frank, J. B. Sigwarth, G. K. Parks and M. J. Brittnacher, Simultaneous Narrow-band UV, Broad-band UV, and X-ray Imaging of the Aurora, and Auroral Energetics on 27 May 1996, EOS, 77(46), 618, 1996.
7. Craven, J. D., T. J. Immel, L. A. Frank, J. B. Sigwarth, C.-I. Meng, G. K. Parks, T. L. Killeen, W. E. Sharp and R. P. Lepping, FUV Observations of the Active Aurora and Correlated Perturbations to Thermospheric Composition as Seen With the Visible Imaging System on the POLAR Spacecraft, EOS, 77(46), 620, 1996.
8. Frank, L. A., J. B. Sigwarth, W. R. Paterson, S. Kokubun, T. Yamamoto, K. W. Ogilvie and R. P. Lepping, An Initial Substorm Study: Global Auroral Images From POLAR, In-Situ Plasma Sheet Observations From GEOTAIL, and the Solar Wind Input From WIND, EOS, 77(46), 618, 1996.

9. Kauristie, K., T. I. Pulkkinen, D. N. Baker, N. Turner, L. A. Frank, J. B. Sigwarth, H. Singer, T. A. Fritz, J. B. Blake, G. D. Reeves, S. Kokubun, R. Nakamura and C. T. Russell, Multispacecraft Study of Solar Wind – Magnetosphere Coupling During an Isolated Substorm Event, EOS, 77(46), 640, 1996.
10. Pulkkinen, T. I., D. N. Baker, L. A. Frank, J. B. Sigwarth, S. G. Kanekal and T. Onsager, Particle Precipitation Boundaries and UV Oval Images Compared: Geomagnetically Quiet Times, EOS, 77(46), 623, 1996.
11. Raeder, J., J. Berchem, M. Ashour-Abdalla, L. A. Frank, W. R. Paterson, K. L. Ackerson, S. Kokubun, T. Yamamoto and R. P. Lepping, Global MHD Simulation of the May 19/20, 1996 Substorm Event and Comparisons with ISTP/GGS Observations, EOS, 77(46), 639, 1996.
12. Reeves, G. D., M. G. Henderson, M. F. Thomsen, R. D. Belian, H. J. Singer, G. K. Parks, L. A. Frank and R. P. Lin, Periodic Oscillations Seen in the Inner Plasmasheet Following a Substorm on May 10, 1996: Coordinated ISTP Observations, EOS, 77(46), 613, 1996.
13. Sigwarth, J. B. and L. A. Frank, Images of Earth's Auroras From the Visible Imaging System (VIS) for the POLAR Spacecraft, EOS, 77(46), 623, 1996.
14. Anderson, R. R., D. A. Gurnett, J. D. Scudder, L. A. Frank, J. B. Sigwarth, H. Matsumoto, K. Hashimoto, H. Kojima, Y. Kasaba, M. L. Kaiser, G. Rostoker, J.-L. Bougeret, J.-L. Steinberg, I. Nagano, H. J. Singer and T. G. Onsager, GEOTAIL, WIND, POLAR, CANOPUS, and ISTP Associated Geosynchronous Satellite Observations of Substorms Following the January 1997 CME Event, EOS, 78(17), 283, 1997.
15. Chang, S.-W., J. D. Scudder, L. A. Frank, J. B. Sigwarth, J. B. Blake, R. Friedel, E. G. Shelley, W. K. Peterson, R. A. Greenwald and R. P. Lepping, Polar Spacecraft Views of the Transpolar Arcs in Theta Auroras, EOS, 78(17), 277, 1997.
16. Craven, J. D., T. J. Immel, H. C. Stenbaek-Nielsen, T. J. Hallinan, L. A. Frank, J. B. Sigwarth, C. A. Cattell, C. W. Carlson, J. P. McFadden, R. E. Ergun and R. C. Elphic, Simultaneous Observations of the Global and Local Aurora With Spacecraft, Aircraft and From the Ground in the POLAR and FAST Missions, EOS, 78(17), 275, 1997.
17. Frank, L. A. and J. B. Sigwarth, Atmospheric Holes and Small Comets, EOS, 78(17), 279, 1997.
18. Pickett, J. S., R. R. Anderson, L. A. Frank, D. A. Gurnett, W. R. Paterson, J. D. Scudder, J. B. Sigwarth, B. T. Tsurutani, C. M. Ho, G. S. Lakhina, W. K. Peterson, E. G. Shelley, C. T. Russell, G. K. Parks, M. J. Brittnacher, H. Matsumoto, K. Hashimoto, I. Nagano, S. Kokubun and T. Yamamoto, Correlative Magnetopause Boundary Layer Observations, EOS, 78(17), 291, 1997.

19. Pulkkinen, T. I., D. N. Baker, N. Turner, L. A. Frank, J. B. Sigwarth, H. Singer, G. D. Reeves, J. B. Blake, T. Mukai, S. Kokubun and R. Nakamura, Two Substorm Intensifications Compared: Onset, Expansion and Global Consequences, EOS, 78(17), 309, 1997.
20. Sigwarth, J. B. and L. A. Frank, Imaging of the Northern Auroral Oval With the Visible Imaging System on the Polar Spacecraft, EOS, 78(17), 297, 1997.
21. Tagirov, V., V. Arinen, D. G. Sibeck, C. I. Meng, L. A. Frank and G. Parks, Coordinated Ground and Satellite Observations of Substorm Onset, EOS, 78(17), 280, 1997.
22. Tung, Y.-K., C. W. Carlson, R. E. Ergun, J. P. McFadden, F. S. Mozer, W. K. Peterson, D. M. Klumpar, E. G. Shelley, L. Tang, E. Moebius, L. M. Kistler, C. A. Kletzing, L. A. Frank, J. B. Sigwarth, C. A. Cattell, J. R. Wygant, J. D. Craven and R. P. Lepping, Observations of the Dawn Side Polar Cap at Three Altitudes From Polar and FAST, EOS, 78(17), 280, 1997.
23. Sigwarth, J. B. and L. A. Frank, Imaging of the Northern Auroral Oval with the Visible Imaging System on the Polar Spacecraft, presented at the International Symposium on Solar-Terrestrial Coupling Processes, Paros, Greece, 23-27 June 1997.
24. Frank, L. A., On the Influx of Small Comets into Earth's Atmosphere, presented at SPIE's 1997 International Symposium on Instruments, Methods, and Missions for the Investigation of Extraterrestrial Microorganisms, San Diego, California, 27 July-1 August 1997.
25. Frank, L. A., W. R. Paterson, J. B. Sigwarth, S. Kokubun and T. Yamamoto, Simultaneous Observations of the Auroral Oval With the Polar Spacecraft and of Plasma Sheet Dynamics With the Geotail Spacecraft, to be presented at the 8th Scientific Assembly of International Association of Geomagnetism and Aeronomy (IAGA), Uppsala, Sweden, 4-15 August 1997.
26. Pickett, J. S., R. R. Anderson, L. A. Frank, D. A. Gurnett, W. R. Paterson, J. D. Scudder, B. T. Tsurutani, C. M. Ho, G. S. Lakhina, W. K. Peterson, E. G. Shelley, C. T. Russell, H. Matsumoto, K. Hashimoto, I. Nagano, S. Kokubun and T. Yamamoto, Wave-Particle Interactions in the Polar Cap and Magnetopause Boundary Layers: An ISTP POLAR/GEOTAIL Correlative Study, to be presented at the 8th Scientific Assembly of International Association of Geomagnetism and Aeronomy (IAGA), Uppsala, Sweden, 4-15 August 1997.
27. Pulkkinen, T. I., D. N. Baker, L. A. Frank, J. B. Sigwarth, S. G. Kanekal and T. Onsager, Effects of the Sun to the Earth's Particle Environment: Particle Precipitation Boundaries and UV Oval Images Compared, to be presented at the 8th Scientific Assembly of International Association of Geomagnetism and Aeronomy (IAGA), Uppsala, Sweden, 4-15 August 1997.

28. Sigwarth, J. B. and L. A. Frank, Imaging of the Northern Auroral Oval With the Visible Imaging System on the Polar Spacecraft, to be presented at the 8th Scientific Assembly of International Association of Geomagnetism and Aeronomy (IAGA), Uppsala, Sweden, 4–15 August 1997.
29. Syrjasuo, M. T., T. I. Pulkkinen, K. Kauristie, A. Viljanen, R. J. Pellinen, J. D. Craven, L. A. Frank and J. B. Sigwarth, Comparison of Ground-Based and Satellite Images of Discrete Auroras, to be presented at the 8th Scientific Assembly of International Association of Geomagnetism and Aeronomy (IAGA), Uppsala, Sweden, 4–15 August 1997.
30. Tung, Y.-K., C. W. Carlson, R. E. Ergun, J. P. McFadden, F. S. Mozer, W. K. Peterson, D. M. Klumpp, C. A. Kletzing, L. A. Frank, J. B. Sigwarth, C. A. Cattell, J. D. Craven and R. P. Lepping, Observations of the Dawn Side Polar Cap at Three Altitudes From Polar and FAST, to be presented at the 8th Scientific Assembly of International Association of Geomagnetism and Aeronomy (IAGA), Uppsala, Sweden, 4–15 August 1997.
31. Pulkkinen, T. I., D. N. Baker, L. A. Frank, J. B. Sigwarth, S. G. Kanekal and T. Onsager, Effects of the Sun to the Earth's Particle Environment: Particle Precipitation Boundaries and UV Oval Images Compared, to be presented at the conference Toward Solar Max 2001: The Present Achievements and Future Opportunities of ISTP and GEM, Yosemite, California, 10–13 February 1998.

POLAR VISIBLE IMAGING INVESTIGATION -- EARTH CAMERA NAG5-3328
PROCESSED DATA PROVIDED 10/01/96--7/25/97

Year	Day	Requested By	Institution/Organization
1996	85	Dr. Jean-Louis Bougeret	Observatoire Pairs Meudon, France
1996	85	Dr. Lev M. Zelenyi	Russian Academy of Science, Space Research Institute, Moscow
1996	97	Mr. Jon Storey	University of Leicester, United Kingdom
1996	100	Mr. Jon Storey	University of Leicester, United Kingdom
1996	120	Dr. Nelson Maynard	Mission Research Corporation, New Hampshire
1996	121	Dr. Nicola Fox	NASA/Goddard Space Flight Center
1996	126	Dr. Tuija I. Pulkkinen	University of Colorado
1996	128	Dr. Shen-Wu Chang	University of Iowa
1996	128	Dr. Tuija I. Pulkkinen	University of Colorado
1996	129	Dr. Nelson Maynard	Mission Research Corporation, New Hampshire
1996	130	Dr. Tuija I. Pulkkinen	University of Colorado
1996	132	Dr. Tuija I. Pulkkinen	University of Colorado
1996	134	Dr. Tuija I. Pulkkinen	University of Colorado
1996	136	Dr. Shen-Wu Chang	University of Iowa
1996	136	Dr. Tuija I. Pulkkinen	University of Colorado
1996	140	Dr. Mark Lester	University of Leicester, United Kingdom
1996	149	Dr. Alan Rodger	British Antarctic Survey, Cambridge, England
1996	150	Dr. Shen-Wu Chang	University of Iowa
1996	158	Dr. Harlan Spence	Boston University
1996	192	Dr. Martin Wuest	Southwest Research Institute
1996	240	Kirsten Lorentzen	University of Washington
1996	241	Kirsten Lorentzen	University of Washington
1996	243	Dr. Jean-Louis Bougeret	Observatoire Pairs Meudon, France
1996	243	Dr. Lev M. Zelenyi	Russian Academy of Science, Space Research Institute, Moscow
1996	250	Dr. Shen-Wu Chang	Auburn University
1996	254	Dr. Ennio Sanchez	SRI International, Menlo Park, CA
1996	261	Dr. Shen-Wu Chang	University of Iowa
1996	271	Dr. John Craven	University of Alaska, Fairbanks
1996	306	Dr. Shen-Wu Chang	University of Iowa
1996	310	Dr. Shen-Wu Chang	University of Iowa
1996	320	Dr. William K. Peterson	Lockheed Space Science Lab., Palto Alta, CA
1996	320	Yeh-Kai Tung	University of California, Berkeley
1996	344	Dr. D. Sibeck	Johns Hopkins University, APL
1996	348	Dr. William K. Peterson	Lockheed Space Science Lab., Palto Alta, CA
1996	348	Yeh-Kai Tung	University of California, Berkeley

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Year	Day	Requested By	Institution/Organization
1996	354	Dr. William K. Peterson	Lockheed Space Science Lab., Palto Alta, CA
1996	354	Yeh-Kai Tung	University of California, Berkeley
1996	366	Dr. John Craven	University of Alaska, Fairbanks
1997	1	Dr. John Craven	University of Alaska, Fairbanks
1997	3	Jolene Pickett	University of Iowa
1997	6	Dr. Nelson Maynard	Mission Research Corporation, New Hampshire
1997	9	Jolene Pickett	University of Iowa
1997	10	Dr. Nicola Fox	NASA/Goddard Space Flight Center
1997	10	Dr. Qian Wu	University of Michigan
1997	11	Dr. Nicola Fox	NASA/Goddard Space Flight Center
1997	12	Dr. Roger R. Anderson	University of Iowa
1997	12	Dr. Nelson Maynard	Mission Research Corporation, New Hampshire
1997	18	Dr. John Craven	University of Alaska, Fairbanks
1997	23	Dr. John Craven	University of Alaska, Fairbanks
1997	27	Dr. John Craven	University of Alaska, Fairbanks
1997	27	Dr. William K. Peterson	Lockheed Space Science Lab., Palto Alta, CA
1997	27	Yeh-Kai Tung	University of California, Berkeley
1997	28	Dr. John Craven	University of Alaska, Fairbanks
1997	31	Dr. John Craven	University of Alaska, Fairbanks
1997	32	Dr. John Craven	University of Alaska, Fairbanks
1997	33	Dr. John Craven	University of Alaska, Fairbanks
1997	34	Dr. John Craven	University of Alaska, Fairbanks
1997	35	Dr. John Craven	University of Alaska, Fairbanks
1997	36	Dr. John Craven	University of Alaska, Fairbanks
1997	37	Dr. John Craven	University of Alaska, Fairbanks
1997	38	Dr. John Craven	University of Alaska, Fairbanks
1997	39	Dr. John Craven	University of Alaska, Fairbanks
1997	40	Dr. John Craven	University of Alaska, Fairbanks
1997	41	Dr. John Craven	University of Alaska, Fairbanks
1997	42	Dr. John Craven	University of Alaska, Fairbanks
1997	43	Jolene Pickett	University of Iowa
1997	44	Dr. John Craven	University of Alaska, Fairbanks
1997	45	Dr. John Craven	University of Alaska, Fairbanks
1997	46	Dr. John Craven	University of Alaska, Fairbanks
1997	47	Dr. John Craven	University of Alaska, Fairbanks

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Year	Day	Requested By	Institution/Organization
1997	56	Dr. John Craven	University of Alaska, Fairbanks
1997	73	Dr. John Craven	University of Alaska, Fairbanks
1997	74	Dr. John Craven	University of Alaska, Fairbanks
1997	74	Dr. R. Niciejewski	U. of Michigan Space Physics Research Laboratory
1997	84	Dr. John Craven	University of Alaska, Fairbanks
1997	85	Dr. John Craven	University of Alaska, Fairbanks
1997	94	Dr. John Craven	University of Alaska, Fairbanks
1997	95	Dr. John Craven	University of Alaska, Fairbanks
1997	150	Dr. Nelson Maynard	Mission Research Corporation, New Hampshire