Attachment 1: 1st Year Progress Report for NAG5-13435

Date:	19 February 2004
To:	Dr. James C. Dodge, Program Manager
From:	Dr. James J. Simpson, Principal Investigator
Subject:	1st year Progress Report for "New Retrieval Algorithms for Geophysical Products from GLI and MODIS Data"
NASA Grant #:	NAG5-13435
Performance Period:	1 February 2003 – 1 March 2004
Progress Report Due Date:	1 March 2004
CC:	M. Crosser, J. Davis, M. Nelson, A. Dunbar, J. Simpson

Dear Jim:

Below is the 1st year progress report for NAG5-13435 "New Retrieval Algorithms for Geophysical Products from GLI and MODIS Data". Activity on this project has been coordinated with our NASA DB project NAG5-9604. For your convenience, this report has six sections and an Appendix. Sections I - III discuss specific activities undertaken during the past year to analyze/use MODIS data. Section IV formally states our intention to no longer pursue any research using JAXA's (formerly NASDA's) GLI instrument which catastrophically failed very early after launch (also see the Appendix). Section V provides some indications of directions for second year activities based on our January 2004 telephone discussions and email exchanges. A brief summary is given in Section VI.

SECTION I: MODIS DATA PREPARATION ON BEOWULF SYSTEM

A large and comprehensive MODIS data set was obtained from the NASA Goddard DAAC. Software available to the DAAC makes the browsing, ordering and subsequent delivery of MODIS data to the user more difficult and time-consuming than either anticipated or one would like. Below, a brief overview of their process is provided.

1. We used three different web-based search/order schemes for MODIS data available via GSFC. Problems were found with all three. Steve Kemper and his group made/are making numerous changes/fixes to their software systems to render them more user-friendly and more precise (*e.g.*, search area etc.) based on our experience/feedback to Steve's group. This process took a long time – about six months! The good news is that other potential users of MODIS data will benefit from our experience and interactions with Steve's group because of his group's corrective actions taken in light of our experience and suggestions.

2. Steve and his group got us all the data. This took about five months.

3. Then, we matched data requested from GSFC with data actually received. We developed a list of missing files. Our request, coupled with the way MODIS data are archived at Goddard, requires that lots of files be collected from different parts of the GSFC archive for a single scene. One needs all components requested.

4. The method of copying requested data to tape by GSFC is such that not all files associated with a given scene are stored either sequentially or on the same DLT. Our Beowulf system, PIPE, was used to sort a lot of this out and develop a statistical sample sufficient to

evaluate MODIS noise characterization/mitigation. **This is a work in progress. See Section II below for details.**

SECTION II: STATISTICAL NOISE REDUCTION IN MODIS DATA

A. MODIS Data: Noise Model

MODIS data have horizontal striping and multiplicative vertical noise (Figure 1a). Depending upon image resolution, horizontal stripes occur at periods of 10, 20, or 40 pixels. Vertical noise has a period of 2 pixels regardless of resolution. Some noise is band specific.

Use of MODIS 1.6 μm data is emphasized; they are especially relevant for the intended products. The 20-pixel periodic horizontal stripes are statistically different from neighboring pixels and cause distinct noise peaks centered at normalized frequencies: (0, 0.1k), where k is an integer, $1 \leq |k| \leq 10$, of the two-dimensional Fast Fourier Transform (FFT) of the data (Figure 1b). Because the stripes are not constant valued and due to spectral leakage, noise creeps out vertically and horizontally from these peaks. This results in symmetric "bars" of noise running down the vertical frequency axis towards the DC component (center peak in Figure 1b). The noise bar extends vertically beyond the normalized fundamental noise frequency of 0.1 toward the DC component. MODIS data with 1 km and 250 m resolution exhibit the same behavior except the number of noise peaks is halved or doubled, respectively.

Vertical multiplicative noise of periodicity two (*e.g.*, the first column is multiplied by k and the second by l, $l \neq |k|$) is equivalent to the convolution of the FFT of the original image with a scaled Kronecker delta at (0,0) and another scaled Kronecker delta at the horizontal Nyquist frequency. The vertical noise (every other column in a MODIS band) is thought to be an artifact associated with the more complicated optical train of the MODIS instrument compared to earlier and simpler instruments (*e.g.*, AVHRR, FY-1C). Thus, periodic horizontal striping, coupled with the vertical noise, exhibits additional noise structure at $(-1,\nu)$ corresponding to a shift of the noise at $(0,\nu)$ in the normalized frequency spectrum (Figure 1b). More spectral leakage occurs for reasons similar to those cited above. This results in vertical symmetric bars of noise running down the left and right sides of the image's spectra. A conceptual model of both components of noise is given in Figure 1c.

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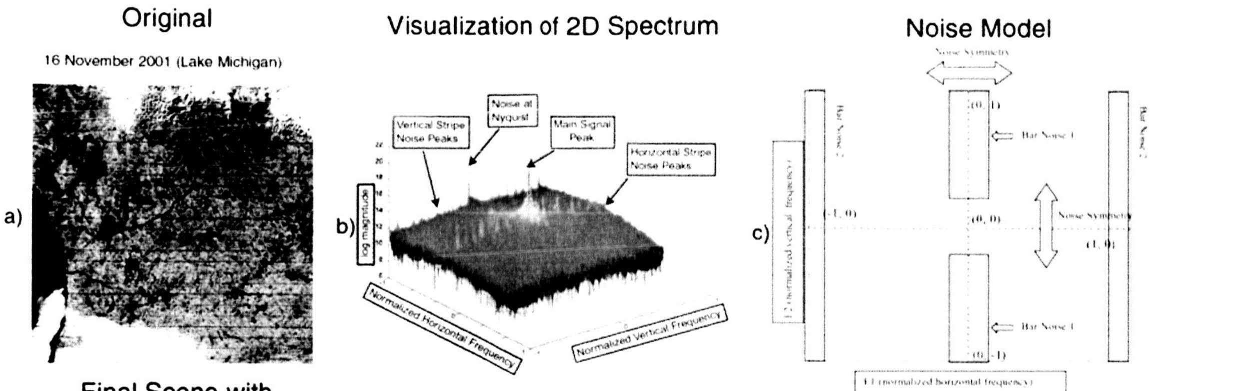

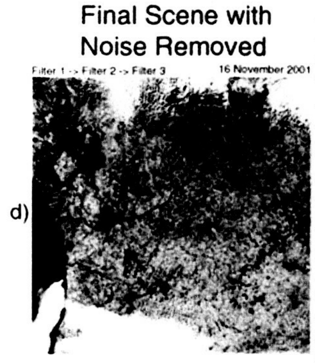

Fig. 1: a) A MODIS 1.6 μm data subsection, b) A three-dimensional diagram of the two-dimensional image spectrum of the data in panel a. The origin (0,0) is at the center of this spectral plot. It corresponds to the DC component in the scene. The major signal is in a small radial area near the origin. The line parallel to the normalized vertical frequency axis and furthest from it contains Nyquist aliasing and other components that produce the vertical striping. The line passing through (0, 0) and perpendicular to the normalized horizontal frequency axis contains noise peaks associated with the horizontal stripes. As one approaches the origin on this line, noise peaks and signal can overlap, c) Conceptual model of 2-dimensional noise in the spectrum of MODIS data. Bar Noise 1 corresponds to the horizontal striping in the time domain. Bar Noise 2 corresponds to the vertical multiplicative noise in the time domain. d) Final image after noise removal. **Note, the vertical noise in panel a is difficult to see due to image reduction, but is visible in the spectrum (panel b).**

B. Signal Correction Using Finite Impulse Response (FIR) and other Spatial Domain Filters – Significant Potential for Improved MODIS Products

A set of two-dimensional Finite Impulse Response (FIR) filters corrects the noise. The multiplicative vertical noise is addressed by Filters 1 and 2. Filter 1 is a "low pass" filter with nulls placed at the left and right vertical edges of the spectra. Filter 2 applies a null to (1,0) and the horizontal Nyquist frequency. This is needed because observations show that the noise peaks at (±1,0) are orders of magnitude larger than the other noise peaks along the left and right edges of the spectra. The horizontal striping is addressed by Filter 3 which nulls out noise peaks running vertically down the center of the spectra. The noise corrected scene (Figure 1d) now can be used for analysis. If not corrected, cloud/sea ice/snow analyses are compromised.

In addition, two feature space domain noise correction filters also have been developed. Hereafter, they are referred to as methods 2 and 3. These filters have advantages/disadvantages relative to the FIR filter design identified above as solution 1. Figure 2 shows a very preliminary intercomparison of the three possible solutions. Figure 2a shows the original noise-contaminated MODIS data (band 21). Figure 2b-2d show the three noise removal techniques: b) FIR filter; c) feature space filter model 1; and d) feature space domain model 2. Figures 3 and 4 are analogous to Figure 2 but show MODIS band 20 and band 29, respectively. Collectively, they show different attributes of the three current prototype designs. See figure captions for details.

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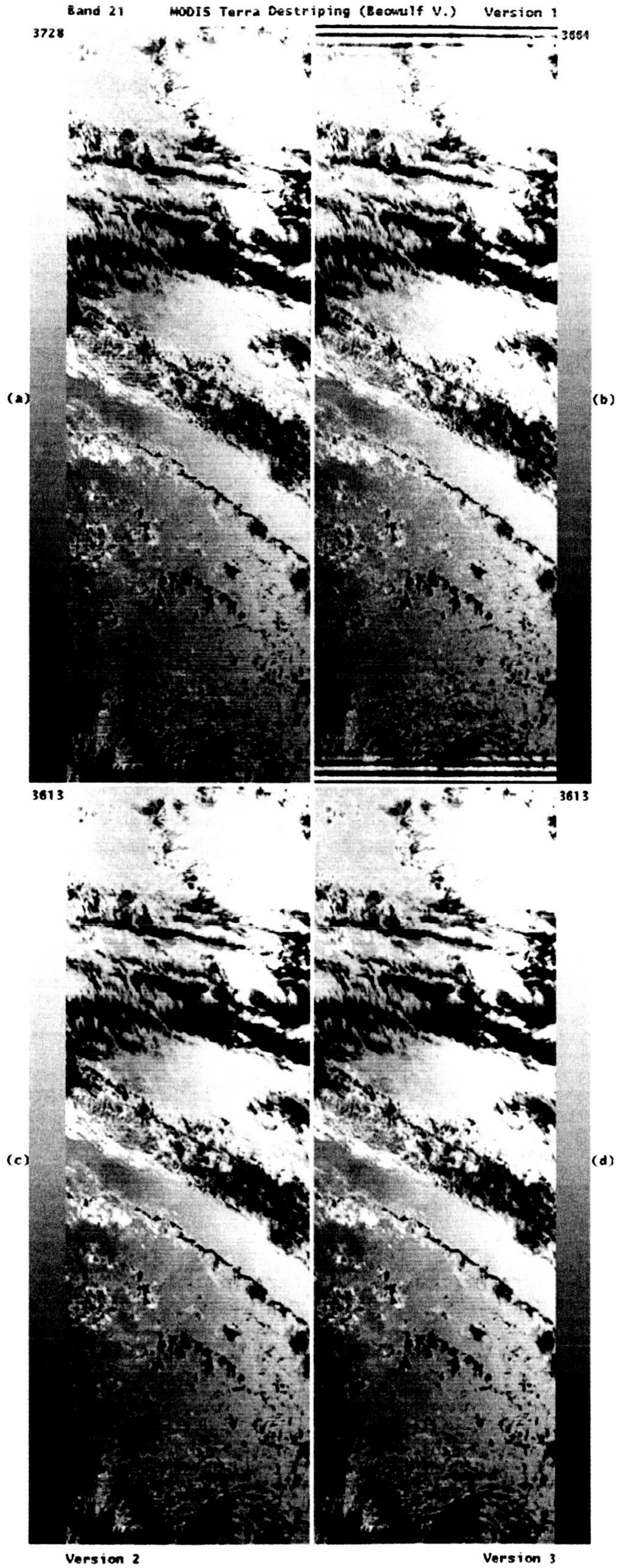

Figure 2: 1KM A2001318.2210 Band21

Figure 2:

a) Full MODIS level 1b pass (band 20) received from Goddard Space Flight Center's MODIS DAAC. This pass was destriped (removing both horizontal and vertical components of noise) using three different prototype noise correction schemes on our Beowulf system, PIPE. PIPE was developed as part of the MODIS Direct Broadcast project.

b) Results from method 1 (FIR-based) remove the stripes but leave artifacts at the beginning and end of a scene due to edge effects (reflection) and the order of the FIR filter. These are intrinsic attributes of a FIR filter design.

Panels c and d show results obtained using spatial domain filters (methods 2 and 3, respectively). Edge effects are absent but in this case the noise reduction isn't as good as that achieved with method 1.

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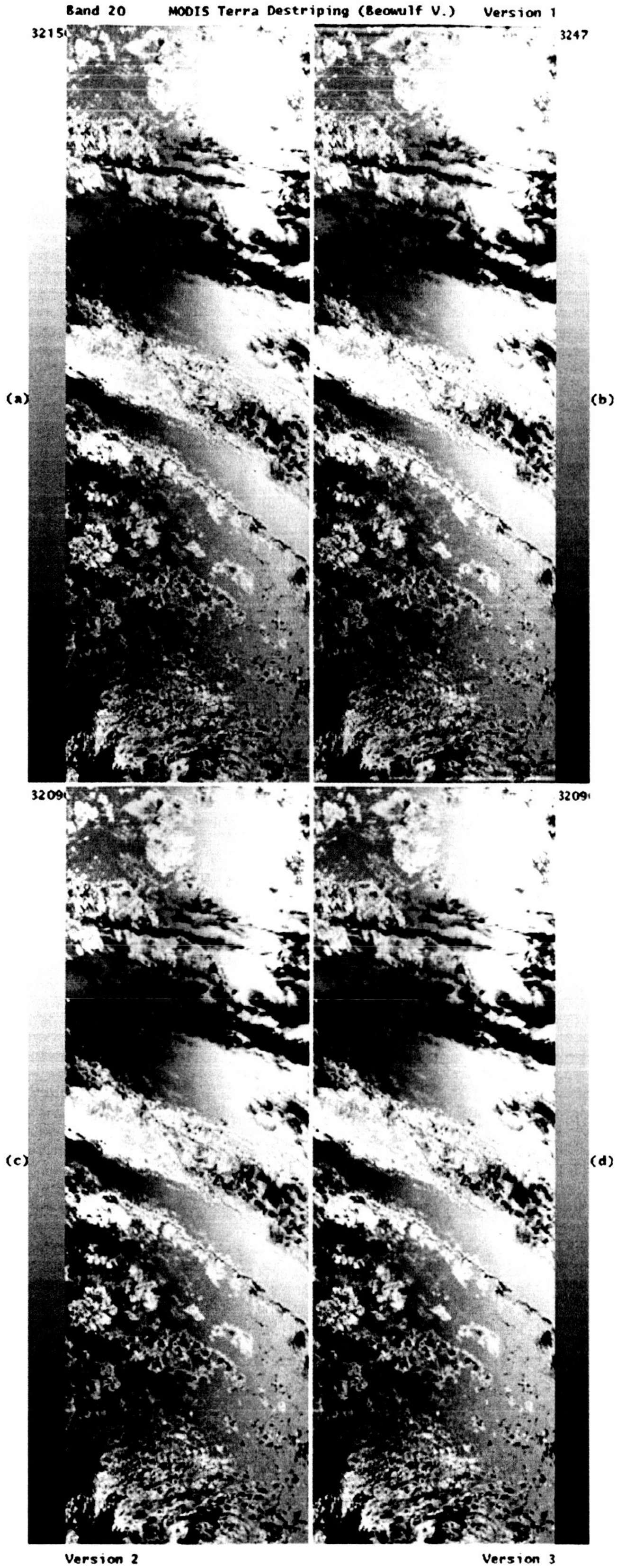

Figure 3:
Analogous to Figure 2 except for band 20. The level of noise in the data is less than that shown in Figure 2. All methods are reasonably successful. Edge effects in the FIR-based approach (panel b) are reduced compared to those in Figure 2. The spatial domain methods (panels c and d) do a reasonably good job at noise reduction but aren't quite as good as that achieved with the FIR design (based on statistically computed measures not shown). The areas marked in orange are bad data flagged in the original GSFC DAAC data files.

Figure 3: 1KM A2002009 Band20

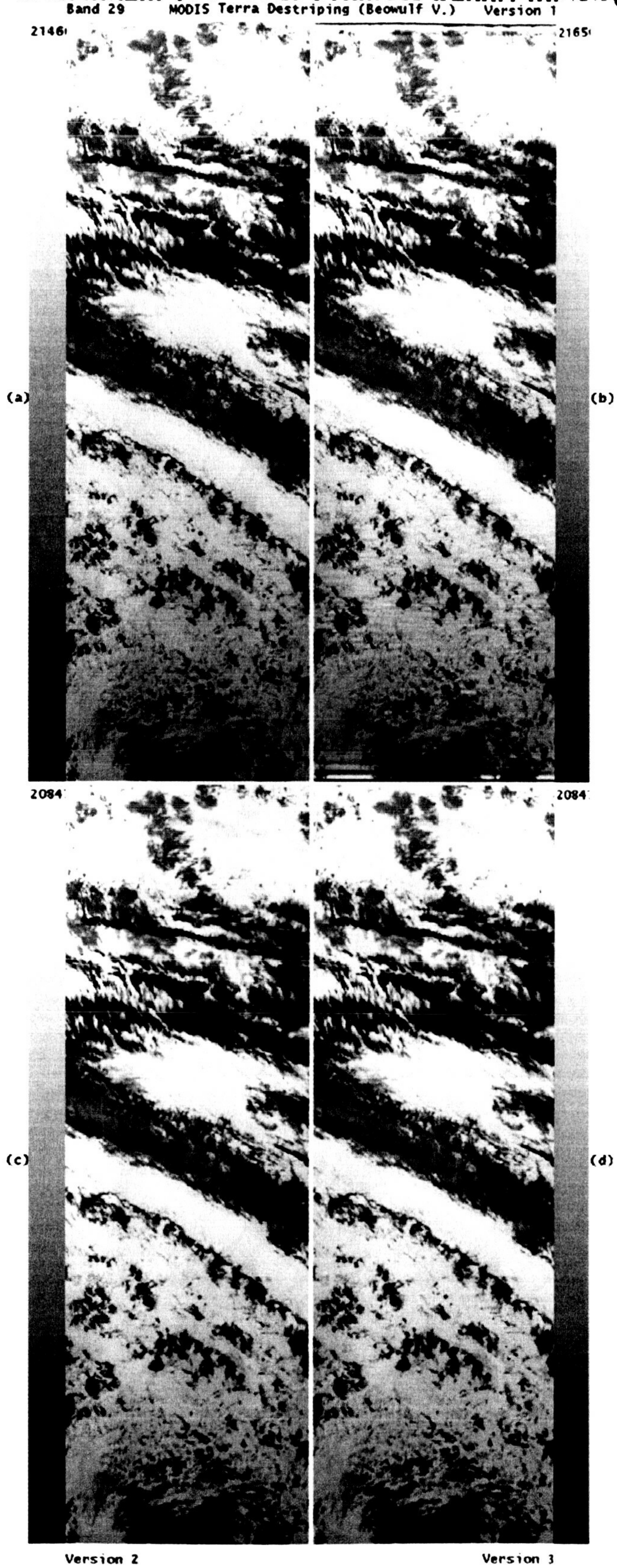

Figure 4: 1KM A2001318.2210 Band29

Figure 4:
Analogous to Figure 2, except for band 29. Here the spatial domain methods (panels c and d) produce fully equivalent results to those of the FIR-based method (panel b). And, edge effects, inherent in FIR filter design (panel b), are absent.

These examples (Figures 2-4) show that noise in MODIS data has a self-consistent form but its strength can vary from scene to scene. This is very analogous to the various noise levels found in mid-infrared channel 3 data taken with the AVHRR instrument. Our expectation is that the particular noise reduction method chosen will be determined based on the application.

There also is a GSFC-induced time dependency to the noise and its level (signal to noise ratio). This occurs because GSFC often adjusts the calibration lookup tables (LUTs). Others (*e.g.*, Liam Gumley) also noted this at the November 2003 Hawaii DB meeting. The necessary, frequent adjustment of the LUTs is a solid indicator that either the characteristics of the composite sensors on MODIS are changing and/or the basic calibration process used to develop the LUTs has large residual error.

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SECTION III: USE OF MODIS 250M VISIBLE DATA IN AN OPERATION FORECASTING APPLICATION

A. 20-21 September 2003 Resuspended Katmai Ash Event

Katmai National Park, located on the Alaska Peninsula, is one of the most active volcanic regions in the world (Fierstein and Hildreth, 2001). There are eight volcanoes in the Park that are know as the Katmai cluster: Snowy Mountain, Mount Griggs, Mount Katmai, Mount Martin, Trident Volcano, Novarupta Volcano, Mount Mageik and Alagogshak (Figure 5). These volcanoes form a 25 km long line of contiguous stratovolcanoes on the drainage divide of the Alaska Peninsula. Typical elevations of these volcanoes range from 1,830 to 2,320 m. Major eruptions from these volcanoes have deposited volcanic ash in the Katmai region at least 15 times in the past 10,000 years. The 1912 Novarupta eruption, the largest of the 20th century, produced at least 17 km^3 of ash fall deposits and 11 km^3 of ash flow (pumiceous pyroclastic flow) in about 60 hours (Hildreth, 1983). The Novarupta vent is located on the north foot of Trident volcano. This 1912 eruption is virtually unique among major historical eruptions in that it generated a large volume ash flow that all came to rest on land. The ash flow moved like a sheet northwestward from Novarupta and formed the Valley of Ten Thousand Smokes which covers an area of about 120 km^2 (Figure 6). The thickness of the ash in the Valley varies up to about 250 m in depth. Griggs, Katmai, Trident and Mageik partially surround the head of the flat floored Valley (Figure 5) which still remains largely vegetation free (Hildreth, 1987). There have been other occasions when volcanic ash (and some dust) from the surface of the Valley of Ten Thousand Smokes was entrained/transported by strong winds after several dry days and subsequently observed as a cloud by visitors at Brooks Camp, about 50 km northwest of the Valley. However, on 20-21 September 2003, weather satellite imagery suggests strong winds entrained and lifted ash from the surface of the Valley of Ten Thousand Smokes to high in the atmosphere (> 1670 m). This event appears to be much larger than any previously reported event: the length of the cloud extends in excess of 230 km from the source and the downstream cloud exhibits both a south and an eastward component (Figure 7). Commercial and civilian aviation were impacted because the resuspended ash intersected major airline routes (See FAA Pilot Reports).

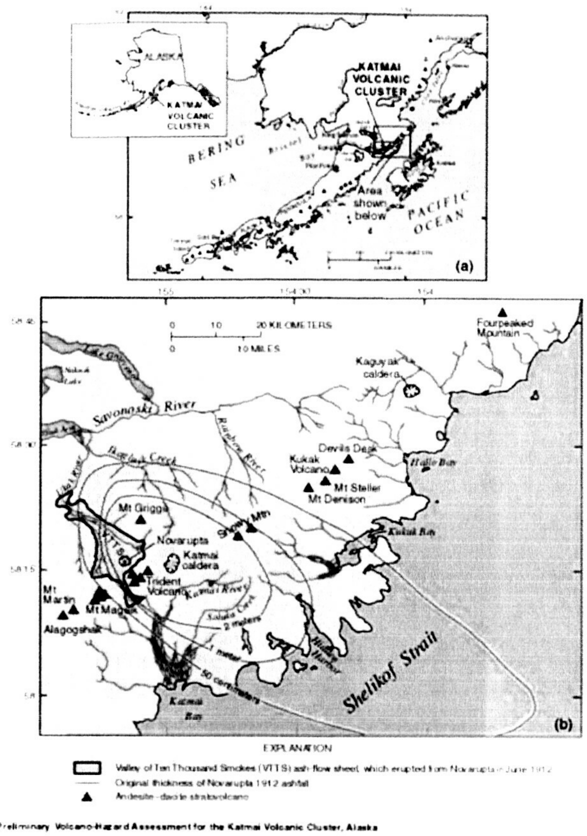


Figure 5: a) Location of Katmai Volcanic Cluster on the Alaskan Peninsula. b) Ash fall (red contours) from the 1912 Novarupta eruption. Figure from Fierstein and Hildreth (2000). Reproduced here courtesy of J. Fierstein.

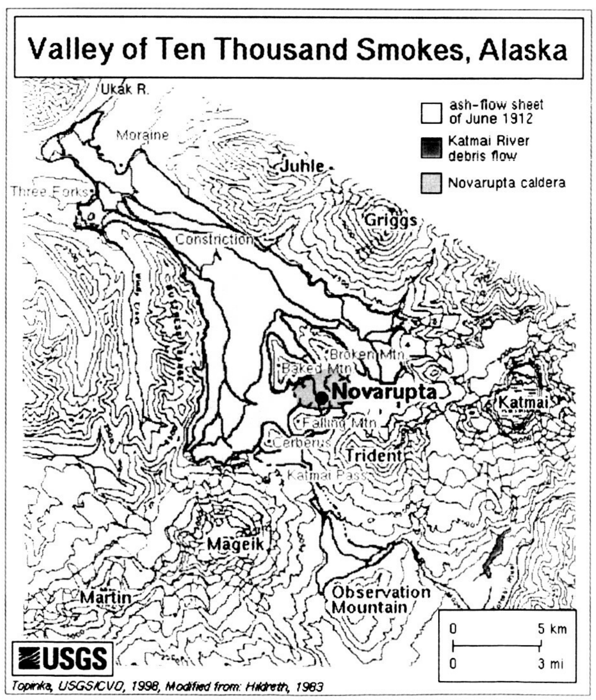


Figure 6: Valley of Ten Thousand Smokes ash flow sheet (yellow), which erupted from Novarupta in June, 1912 overlaid on local topography. Figure provided courtesy of U.S. Geological Survey.

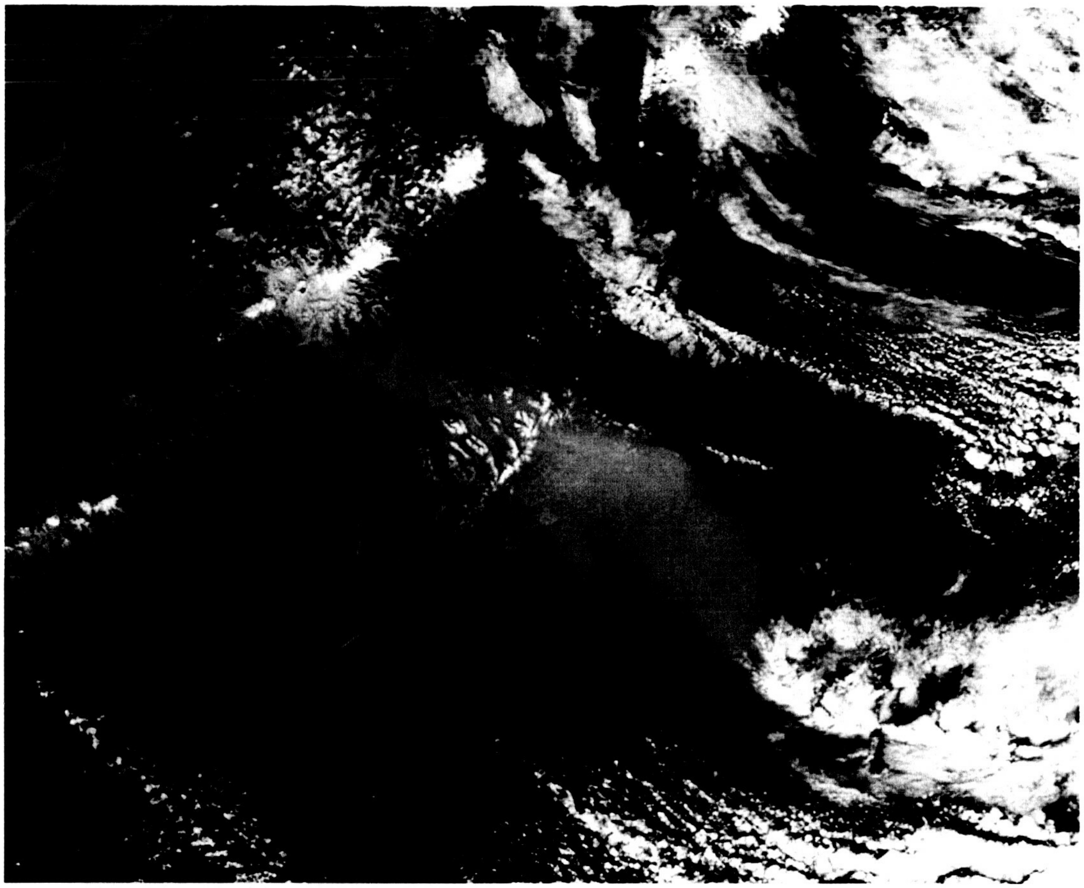
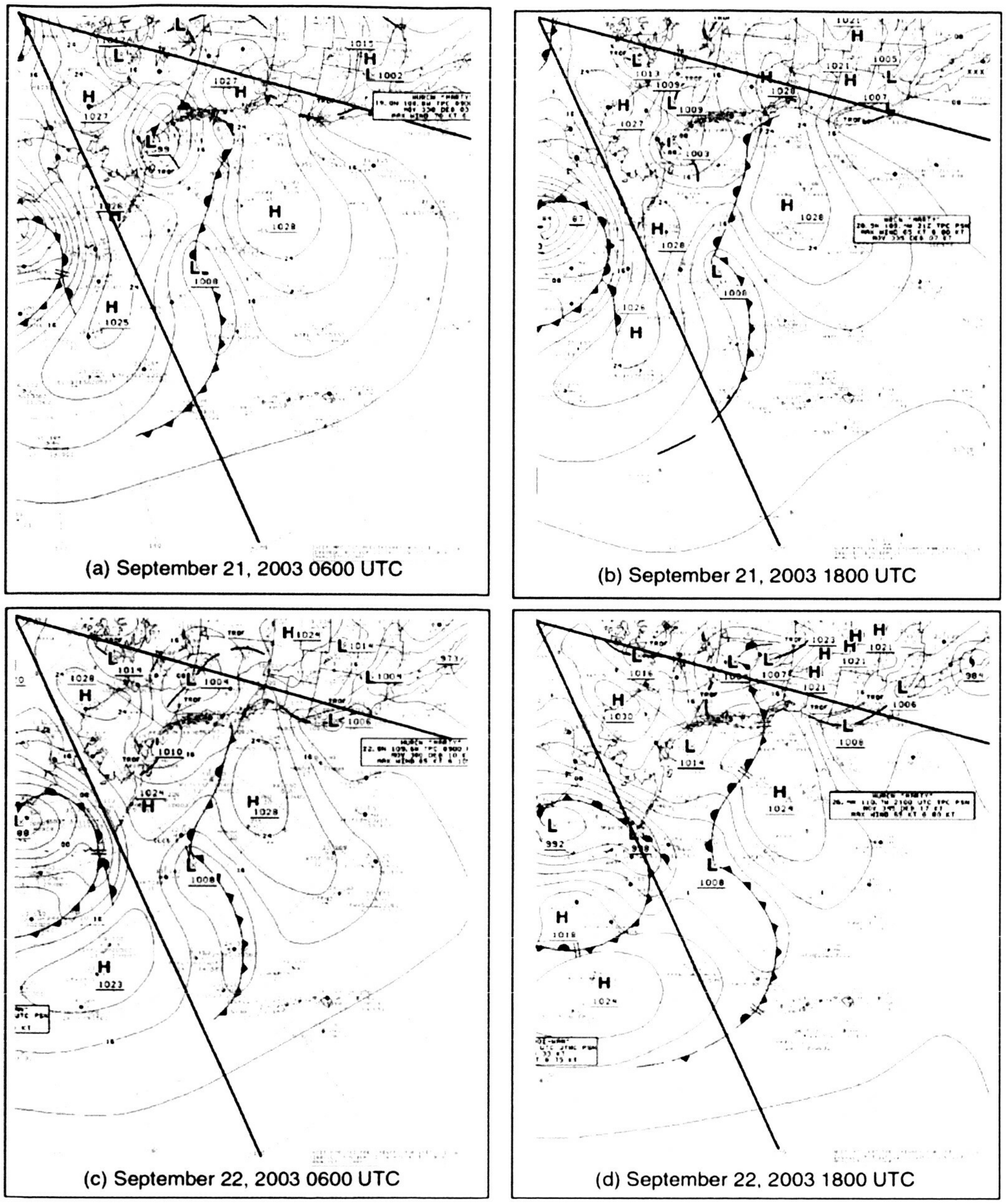


Figure 7: Resuspended ash cloud extending from Katmai over Kodiak Island into the Gulf of Alaska as seen in MODIS 250m visible data on 21 September, 2003.

An analysis of the large-scale patterns in the National Centers for Environmental Protection (NCEP) sea level pressure charts during the 20-21 September ash cloud event shows: 1) a weakening quasi-stationary cyclonic center located just south of Prince William Sound in the Gulf of Alaska (992 mb at 0000 UTC 21 September (not shown) to 1010 mb at 0600 UTC 22 September; and 2) two anticyclonic centers (1024- 28 mb), one in the Bering Sea and the other on the Alaskan North Slope (Figure 8). This pressure field produced northwest surface winds over the Katmai area during the entire resuspended ash cloud event. Examination of the 850 mb wind and temperature analysis from the NCEP Eta numerical prediction model for 1200 UTC September 21, shows the extent of 30 kt (15.4 ms^{-1}) winds (Figure 9). For the flying community, large-scale winds 20 kt (10.3 ms^{-1}) or greater are the criteria for classifying the wind as strong in mountainous areas (Carney *et al.*, 2000).



(a) September 21, 2003 0600 UTC

(b) September 21, 2003 1800 UTC

(c) September 22, 2003 0600 UTC

(d) September 22, 2003 1800 UTC

Figure 8: NCEP North Pacific surface analyses for dates and time indicated. Highlighted wedge shows area of interest.

The wind speeds observed in the radiosonde soundings from King Salmon appear too weak to produce the dynamic vertical forcing necessary to lift the relic volcanic ash well into the atmosphere (> 1670 m). However, there are several important factors that likely had a strong local influence on the winds that lifted the relic ash into the atmosphere: 1) The Katmai cluster and the Valley of Ten Thousand Smokes are located in very complex terrain (Figure 6); and 2) there are numerous mountains interspersed with valleys, channels, and gaps through the mountain barrier. In addition, the sounding at King Salmon shows that the lower troposphere is very stable, except below 850 mb where the atmosphere is super adiabatic. In this case, the synoptic-scale pressure gradient of stable flow is both nearly perpendicular to the mountain barrier with its channels and gaps, and is in phase with local pressure-driven channeling and any stable wave formation induced by barrier flow over the mountains. With the presence of the low level super adiabatic lapse rate and a strong subsidence inversion to reflect the wave downward, we have factors that can contribute to acceleration of downslope winds that would entrain and lift the relic volcanic ash from the ground and form the ash cloud observed on 21-22 September 2003 (Figure 7).

Figure 9: NCEP Eta 850 mb wind forecast chart for Alaska area 0000 UTC 22 September, 2003.

We postulate that winds over the mountains and through the channels and gaps that surround the Valley of Ten Thousand Smokes accelerated because of the factors discussed above. The Alaska Marine Ferry Tustumena (call sign WNGW) at 57.9E N and 154.3E W (just offshore of the Katmai cluster in Shelikof Strait) reported a surface wind of 39 kt (21.8 ms^{-1}), about double the speed of the wind observed upstream of the Katmai area.

A synthetic aperture radar (SAR) image of derived surface winds from the RADARSAT satellite was obtained for the coastal waters off the Katmai area at 0342 UTC, 22 September (Figure 10). See Monaldo (2000) for details of SAR derived winds. The SAR image shows strong surface winds both north and south of Kodiak Island blowing from the Alaska Peninsula. A ship observation at 0000 UTC, 22 September from the Tustumena at 58.8° N and 152.1° W confirms that the surface winds at the northern tip of Kodiak were 37 kt (19.0ms^{-1}) in good agreement with the SAR image. A unique feature in the SAR image is the zone of little or no winds that extend from the Katmai coast across Kodiak Island and into the Gulf of Alaska. This zone is a "shadow" of the resuspended volcanic ash cloud at that time. It appears that the ash cloud was sufficiently dense to attenuate the SAR signal from the RADARSAT satellite so that no surface winds below it could be measured.

This study is a work in progress. Validation data for satellite retrievals, additional analyses, and high spatial resolution (2km) numerical modeling using a regional RAMS model, specifically developed for this part of Alaska, will be done in year 2 of this study. Modeling will be done in collaboration with a colleague from the University of Alaska, Anchorage campus (Dr. Peter Olssen).

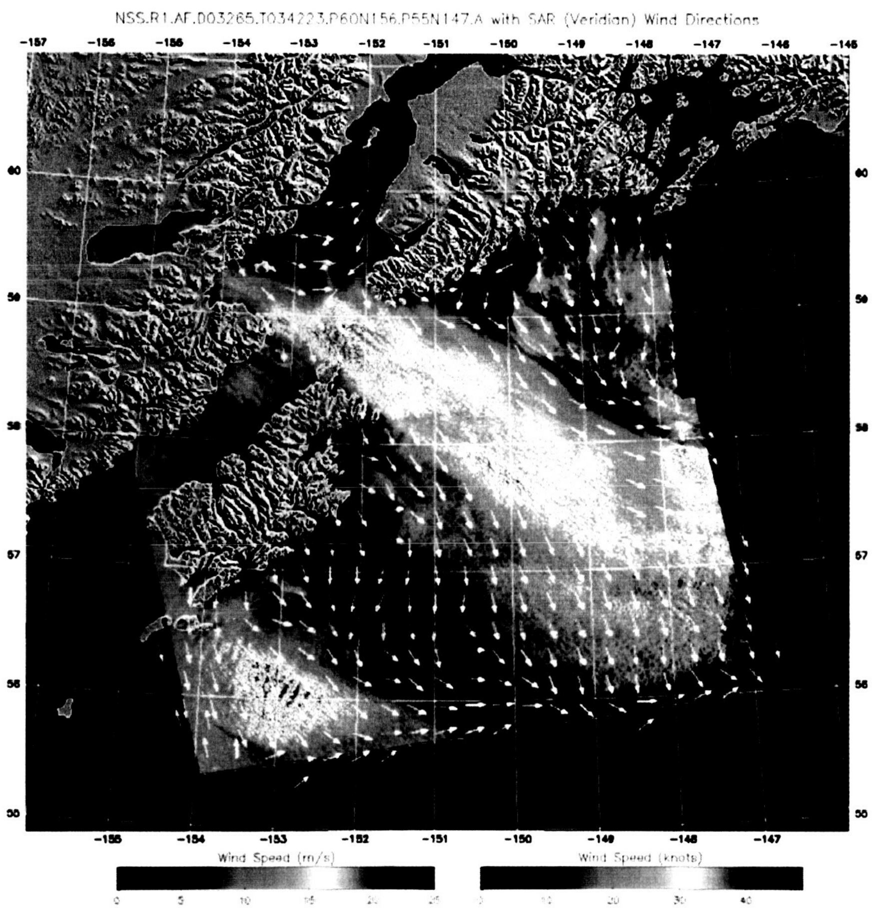


Figure 10: Derived synthetic aperture radar surface wind image for Alaska Peninsula/Kodiak coastal area for 0342 UTC, 22 Sept., 2003

B. References cited

Carmey, T. Q., Bedard, A. J., Broun, J. M., McGimley, J., Lindholm, T., and Kraus, M. J. (2000). Hazardous Mountain Winds and their Visual Indicators. Federal Aviation Administration, AC00-57, 91pp.

Fierstein, J. and Hildreth, W. (2001). Preliminary volcano-hazard assessment for the Katmai volcanic cluster, Alaska. U.S. Geological Survey Rept. 00-489, 50 pp.
Hildreth, W. (1983). The compositionally zoned eruption of 1912 in the Valley of Ten Thousand Smokes, Katmai National Park, Alaska. *J. Volcan. Geotherm Res.*, 18, 1-56
Hildreth, W. (1987). New perspectives on the eruption of the 1912 in the Valley of Ten Thousand Smokes, Katmai National Park, Alaska. *Bulletin of Volcan.*, 49, 680-693.
Monaldo, F. (2000). The Alaska SAR demonstration and near-realtime synthetic aperture radar winds. *John Hopkins APL Technical Digest*, 21, 75-79.

SECTION IV: EVALUATION OF GLI DATA

This 1st year progress report also formalizes my intention to eliminate further analysis of data from Japan's ADEOS-II Global Imager (GLI) instrument. As per our earlier discussion/emails in January, 2004, the basis for my decision is twofold: 1) ADEOS-II's GLI failed catastrophically in October, 2003 and subsequent efforts to render the satellite operative were unsuccessful (see Letter from JAXA (formerly NASDA) to ADEOS-II/GLI PIs in the Appendix to this report); and 2) GLI data have all the problems associated with MODIS data plus some additional severe limitations (*e.g.*, a decision by NASDA prior to launch to detune the gains on a suite of visible/near-infrared bands on GLI in order to correct for saturation in a few bands). Some GLI scientists (myself included) argued against this course of action because, based on our Arctic experience with Chinese FY-1C data, it became clear that reducing gains on visible to near-infrared channels definitely compromises cryospheric applications under important low light conditions (*e.g.*, thawing of sea ice in early spring; formation of sea ice in early fall). Thus, GLI data are compromised during the two most critical phases of the Arctic sea ice cycle. Finally, given the short record of GLI data potentially available, it seems imprudent to tackle additional data qualify issues *vis-à-vis* MODIS, when the payoff will be very limited.

SECTION V: SECOND YEAR ACTIVITIES

During the remaining year of this project we will pursue the following activities:

1. Continue the statistical evaluation of the three prototype noise reduction methods using the statistically representative data set built on the Beowulf system, PIPE, using MODIS data supplied by the Goddard DAAC.

2. Implement refinements of the three prototype noise correction designs based on the results obtained from 1 above. Additional runs will be performed on the Beowulf system as needed. A MODIS noise reduction manuscript also will be submitted.

3. Complete the Katmai relic volcanic dust resuspension event. *In situ* validation and a numerical simulation using a 2km resolution RAMS model, specifically adapted to this region of Alaska, are envisioned as part of this analysis. Modeling efforts will be done in collaboration with Dr. Peter Olssen, University of Alaska, Anchorage campus. Dr. Gary Hufford, U.S. National Weather Service, will provide operational issues/responses to this type of event, which appear to be increasingly more common. A scientific paper will be submitted for publication.

4. Complete an analysis of Alaskan climate/biogeography/sea ice feedback loops. A scientific paper will be submitted for publication.

5. Assuming items 1and 2 are successful and sufficient time/funds are available, we will then start development on a MODIS cloud mask. Some special emphasis may be placed on cloud/sea ice separation due to our intrinsic interest in cryospheric problems.

SECTION VI: SUMMARY

The decision to terminate all work on ADEOS-II's GLI data seems most prudent given the recent failure of the instrument. Moreover, its data have additional problems (*e.g.*, reduced gain setting in visible channel amplifiers) which make the data of very marginal use for the intended cryospheric/atmospheric analyses originally intended. This strategy has the added advantage that all remaining efforts in the second and final year of this project can be directed to MODIS data analyses and related studies.

Our intended goals during the second and final year of this effort are well defined. However, as per our earlier telephone/email discussions, large uncertainties remain in the State of California's budget for the '04/'05 fiscal year which starts 1 July 2004. Moreover, the state's budget process is highly volatile and unpredictable. Budget-related circumstances could arise which might interfere with the plans developed herein. Nonetheless, our intention is to produce the best possible outcomes during this second and final year of effort, consistent with the available resources.

Let me know if you need any additional material or have any unanswered questions.

Once again, thanks for your support, not only on this project but on various other projects over the years.

Best Regards,
Jim Simpson

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Appendix: Letter from JAXA, dated November 5, 2003.
Subject: Failure of ADEOS-II.

03/JAXA/AEO No.1031003
November 5, 2003

JAXA
Japan Aerospace Exploration Agency

Earth Observation Operation of Midori-II
(Advanced Earth Observing Satellite-II, ADEOS-II)

Dr. SIMPSON, James J.
The Regents of the University of California,
University of California San Diego
Contract and Administration 0210, 9500 Gilman Drive,
San Diego, CA, 92093-0210

Dear Sir:

It is with profound regret that I must formally notify you that, on October 31, 2003, JAXA determined that the likelihood of restoring Midori-II to operation is extremely low.

JAXA has been investigating the possibility of restoring the Midori-II observations after an anomaly was detected in the satellite on October 25. However, as a result of our careful investigation, pains-taking analysis, and inability to re-establish any communications with the satellite, we now think it is impossible for the Midori-II satellite to start observing the Earth again.

We would like to express our sincere apology to all Midori-II users and parties who can no longer pursue their activities due to this unfortunate anomaly.

Please be assured that we will continue to send commands to the satellite and to investigate its condition in the hopes of clarifying the cause of the anomaly and preventing its recurrence in future satellite programs. Furthermore, we will send you a report of the anomaly in the most timely manner possible after completion of the investigation.

In order to minimize the potential impact of this unexpected loss, we will strive diligently to provide users of Midori-II with as much of the data acquired by the satellite in its nine-month operation period as possible. We also promise to work closely with you to identify creative ways in which we might continue our cooperation.

Sincerely,

Fumio Otsuki
Director
Earth Ovservation Research and Application Center (EORC)
Japan Aerospace Exploration Agency (JAXA)

Attachment 2: Email from Dr. Jim Dodge in Response to 1st Progress Report for NAG5-13435 and Final Reports for Two Other NASA Grants.

Subject: **Re: Summary of Reports/Papers provided to you for NAG5-9604, NAG5-9721 and NAG5-13435**
Date: Mon, 21 Jun 2004 14:36:32 -0400
From: James Dodge <James.C.Dodge@nasa.gov>
To: Jim Simpson <jsimpson@ucsd.edu>, Jim Dodge <jim.dodge@hq.nasa.gov>, Nancy Wilson <wilson@siomail.ucsd.edu>, Marian Crosser <crosser@siomail.ucsd.edu>, Ann Dunbar <adunbar@coast.ucsd.edu>, Jennifer Davis <jdavis@ucsd.edu>, Jim Simpson <jsimpson@ucsd.edu>
References:
1

Thanks, Jim. Duly noted. I've placed a copy of this list in you folder. You have been one of my most productive and diligent researchers, and I believe that a number of significant scientific advances were completed under you scientific direction. I hope to see you next month on my drive down the West coast. Have a good summer.

Jim D.

At 10:08 AM 6/21/2004 -0700, Jim Simpson wrote:
>Hi Jim:
> This email summarizes the various reports and manuscripts sent to you
>via email/FTP over the past several months. They relate to one or more
>of the NASA grants referenced above for which you are program manager.
>
>1. Final Report for NAG5-9604, "A Regional Real-Time Interactive
>GIS-based Computational
> Environment for NASA's Direct Broadcast Program". Submitted to NASA,
>May, 2004.
> Project ended May 31, 2004.
>
>2. Final report for NAG5-9721, "A Physically based Approach to the
>Construction of a Climate
> Quality SST Record from Complimentary Space Borne Sensors:
>Application to Diurnal SST".
> Submitted to NASA, June, 2004. Project Finished, ends June 30, 2004.
>
>3. First Year Progress Report for NAG5-13435, "New Research Retrieval
>Algorithms for
> Geophysical Products for the GLI and MODIS Data". Submitted to NASA,
>February, 2004.
> First year activities ended March 31, 2004.
>

Attachment 2: Email from Dr. Jim Dodge in Response to 1st Progress Report for NAG5-13435 and Final Reports for Two Other NASA Grants.

>Many papers have resulted from these studies. Some have already appeared
>in the literature and reprints were sent to you as they appeared. These
>papers are not cited below. Updates on additional papers resulting for
>this work and which are still in the process of review/publication are
>given below.
>
>1. " Resuspension of Volcanic Ash and Dust from Katmai: Still and
>Aviation Hazard." D.
> Hadley, G.L. Hufford, and J.J. Simpson, Weather and Forecasting, in
>press.
>
>2. The Parallel Image Processing Environment (PIPE): Automated
>Parallelization of Satellite
> Data Analyses", James J. Simpson , Timothy J. McIntire, Jared S.
>Berg and James C. Dodge.
> Revised and resubmitted to Remote Sensing of the Environment.
>
>3. "Comparing Maps of Mean Monthly Surface Temperature and Precipitation
>for Alaska and
> Adjacent Areas of Canada Produced by Two Different Methods", James
>J. Simpson, Gary L.
> Hufford, Chris Daly, Jared S. Berg, and Michael D. Fleming. Revised
>and resubmitted to
> Artic.
>
>4. "Analysis of Along Track Scanning Radiometer -2 (ATSR-2) Data for
>Clouds, Glint and Sea
> Surface Temperature Using Neural Networks", James J. Simpson, Yueh
>Lung (Ben) Tsou,
> Andrew Schmidt, Timothy McIntire, and Andrew Harris. Is in review by
>the various co-
> authors, to be submitted to Remote Sensing of the Environment this
>summer.
>
>Thanks again for all your help over the years. Hope the eyelid surgery
>goes well. Have a great summer.
>
>Cheers,
>Jim

****
Currently:

Dr. James C. Dodge
Research Division
Office of Earth Science

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FAX (202)358-2770
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After July 2, 2004:

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