Report of the Implementation Committee for the Institute for Mathematics Applied to Geosciences (IMAGe)

1 Introduction and Overview

This report summarizes planning for a new Institute at the National Center for Atmospheric Research (NCAR), the Institute for Mathematics Applied to Geosciences (IMAGe). IMAGe will coordinate the application of mathematics and statistics to the geosciences and motivate new research in the mathematical sciences derived from grand challenge problems from geophysics and related environmental sciences. IMAGe will be built from three existing and successful groups at NCAR: the Data Assimilation Initiative (DAI), the Geophysical Turbulence Program (GTP) and the Geophysical Statistics Project (GSP) and the creation of IMAGe will serve to support and to interlink these programs. IMAGe will also provide the substrate to broaden the mathematical activity at NCAR through additional sections in IMAGe and alliances with other mathematics centers and programs.

Implementation committee members are: Jeffrey Anderson (DAI), Joanne Dunnebecke (RAP), Barbara Hansford (ASP), Richard Loft (SCD), Mitchell Moncrieff (MMM), Doug Nychka (GSP), Annick Pouquet (GTP), Mark Rast (HAO). The implementation committee is comprised of both scientists and administrators and also has representatives from the groups that will form IMAGe.

1.1 IMAGe Mission Statement

The Institute for Mathematics Applied to Geosciences (IMAGe) exists to foster, enhance and sustain strong collaborations between the geoscience and mathematical science communities and to become a center of excellence for these communities.

IMAGe will bring together mathematical scientists and geoscientists from the U.S. and abroad to facilitate contacts and to disseminate knowledge through:

- research workshops, tutorials and schools;
- visitor, fellowship, senior under-graduate, graduate and post-doctoral programs;
- long-term focused research activities of joint interest;
- and the creation of innovative targeted software that is open source and developed in concert with the geoscience and mathematical science communities.

The Institute supports the NCAR and UCAR scientific programs by engaging and coordinating cross-divisional/cross-laboratory grand challenge science from a fundamental and mathematical perspective. It also helps identify the need for, and accelerate the development of advanced mathematical, computational, conceptual and statistical methods within the NCAR/UCAR community, with emphasis on multi-scale phenomena, model/data fusion, stochasticity and uncertainty.

1.2 Implementation Summary

The consensus of the committee was that IMAGe presents unique opportunities for the science and outreach programs at NCAR. Some key aspects of the implementation plan are given below.

Phasing. The committee recommends that the IMAGe implementation have two distinct phases: an integration of existing groups (DAI, GTP and GSP) and then a second phase that involves adding new groups and a more aggressive external program.

Scientific mission. Although IMAGe will emphasize a mathematical perspective, the committee was concerned that the Institute participate in scientific programs that are central to NCAR's strategic science plan. Moreover, this focus should remain strong as external and thematic activities are added to the Institute's scope. To begin to address these concerns, the implementation plan includes a mini-retreat among current IMAGe members and associated scientists. The goal is to develop a science plan so that at the creation of the Institute there will be substantive links to other NCAR divisions and laboratories.

Focused Research Theme. With suitable resources IMAGe will conduct a yearly outreach program, also known as the Theme-of-the-Year (TOY), that focuses the attention of the mathematical community on specific problems in the geosciences. This program will be coordinated by a visiting Theme Director and will involve a network of university groups and mathematical centers as partners. A pilot program on data assimilation is being pursued in 2004-2005.

Leadership. IMAGe will have a Director on a term appointment, a Theme Director, who is a senior visitor responsible for thematic programs, and an Institute steering committee, composed of the director, theme director and section leaders.

Oversight. An internal scientific board will be drawn largely from NCAR scientists and an external advisory board will consist of representatives from NSF mathematics centers, research laboratories and relevant university groups. In both cases the boards will actively engage in planning, selection and maintenance of scientific and educational programs in IMAGe.

Administrative support. The scope and diversity of IMAGe relative to other NCAR units led the committee to recommend that an administrator and at least one administrative assistant be dedicated to the Institute. The administrative functions, however, should not duplicate those at the laboratory level and the Institute will coordinate planning of administrative functions with the Computing and Information Systems Laboratory (CISL).

IMAGe scientific staff. The initial groups forming IMAGe will consist of 25–30 members including scientists, support staff, students and visitors. In addition, it is expected that several scientists will have joint appointments with IMAGe and another NCAR scientific divisions.

Space. In the short-term, IMAGe members need to be collocated with scientific divisions with which they already have strong collaborations. Proximity to the Laboratory Associate Directors office and the Scientific Computing Division is also desirable as IMAGe is formed. Longer-term recommendations are to collocate IMAGe personnel with long- and short-term Institute visitors and to provide ample space for meetings and seminars.

Computing. An appraisal of IMAGe computing activities indicates a need for an increase in computing resources based on the progress of ongoing projects. This can be accomplished through a combination of increased GAUs and computing on PC clusters. Another important component of computing support is adequate staff to assist with visitors and workshops.

2 Committee Activities

2.1 Charge to the committee

Develop an implementation plan for IMAGe including a mission statement, long- and short-term goals, an integration plan for cross-cutting collaborations within and outside NCAR, a phased scientific staffing plan, support staff and space requirements.

2.2 Process

- A realignment subcommittee, chaired by Annick Pouquet met in Fall, 2003 and produced a draft plan for IMAGe. This first report included contributions from many individuals beyond the subsequent implementation committee members.
- Pouquet, Winter and Nychka visited NSF and the North Carolina Mathematics Center (SAMSI) in January 2004. Pouquet visited the UCLA Mathematics Center in February 2004.
- The IMAGe Reorganization Committee met approximately six times and members contributed written materials on different aspects of the implementation plan.
- Additional meetings were held among IMAGe scientists and with the Deputy Director to refine aspects of the implementation.
- A working web page (www.cgd.ucar.edu/stats/IMAGe) has been used as a common site for committee materials.

2.3 Plan Outline

The implementation plan developed by the committee is presented in the remainder of this report. And is divided into the following sections.

- A time line for implementation (Section 3)
- A roster of scientific staff (Section 4) and job descriptions for administrative support positions (Appendix B)
- Survey of computing needs (Section 5)
- Appraisal of space needs (Section 6)
- A Charter containing broad goals and delineating roles of the director, IMAGe sections, external programs and advisory panels (Appendix A)

3 IMAGe timeline for implementation

The timeline in this section focuses on the near-term consolidation of the initial sections into IMAGe. The retreat and workshop planned for Fall 2004 will facilitate planning over a longer period.

2004

June

Data Assimilation (DA) Theme-of-the-Year begins with sponsorship of a student team at IPAM
Constitute external advisory board
Appoint Institute Director

July
IMAGe brochure completed
Public version of IMAGe web page completed
Integrate IMAGe space needs with NCAR short- and long-range space planning
August
Finalize plans for DA theme, select Theme Director and visitors.
Advertise (or identify) administrative staff.
Initiate IMAGe Joint Appointments
September
Begin planning integration of support functions with SCD and SICL
Mini-retreat for drafting a unified IMAGe scientific plan
October
Setup IMAGe front office with some collaborative and visitor space
Create IMAGe account codes and a Institute budget
Workshop/external advisory board meeting to initiate IMAGe network and to identify potential Focused Research Themes
Transition of computer support directly under Institute
Planning for 2006 Theme
November
IMAGe budget planning
Planning for external support
Visit to NSF mathematics and geomathematics programs

2005

January
Joint workshop at IPAM connected with DA theme
February
Joint workshop at SAMSI connected with DA theme
June
IMAGe Data Assimilation summer school
August
Short-term collocation for IMAGe
Advertise for Director (funding permitting)

4 Organizational outline for IMAGe

The organizational structure of IMAGe is summarized in Figure 1 and the next two sections list the initial composition of IMAGe and increases in staff related to development of a Theme-of-the-Year and additional sections. These rosters are also used to determine space needs.

4.1 Initial configuration

Institute office:
Director
Administrator
Administrative Assistant

IMAGe Sections:

Geophysical Turbulence Program (GTP)

Annick Pouquet (S4)
Aime Fournier (PS)
Duane Rosenberg (SE)
Pablo Mininni (PD)
Jay Sukhatme (ASP PD)
Alekakis Alessandros (ASP PD)
Wilfred Thompson (GRA)
Jonathan Graham (GRA)

Geophysical Statistics Project (GSP)

Doug Nychka (S4)
Tim Hoar (AS) 50% (50% DAI)
Reinhard Furrer (PD)
Uli Schneider (PD)
Dorin Drignei (PD)
Curtis Storley (GRA)
Dan Cooley (GRA)

GSP Joint Appointments

Claudia Tebaldi (PS) 50% (50% ISSE/RAP)
Rick Katz (S4) 50% (50% ISSE)
Steve Sain (AfS) 20% (80% CU-Denver)
Thomas Lee (AfS) 20% (80% CSU)

GSP Visiting program

3-5 visiting faculty for 1-1.5 months (June/July)
2-4 visiting students for 1-1.5 months (June/July)

Data Assimilation Initiative (DAI)

Jeff Anderson (S3)
Kevin Rader (AS)
Hui Liu (PS)
Alain Caya (PS)
Dale Barker 50%
Tomoko Matsuo (PD) (50% GSP)
DA/GSP post doc

DAI Affiliates

Chris Snyder (S3) 17%
Joe Tribbia (S4) 17%

IMAGe Affiliates

Steve Thomas (S3)
Natasha Flyer (S1)

PS=Project Scientist, SE=Software Engineer, PD=Postdoctoral visiting scientist, AfS=Affiliate Scientist (e.g. regularly visiting faculty), Graduate research assistant (e.g., PhD Student)

4.2 Elaboration of initial Institute

Focused Research Theme (TOY)
Theme Director (senior visitor)
Long-term Theme visitors
- 1 senior visitor
- 1-2 postdocs
- 1-2 graduate students.

Short-term visitors
- 2-3

Additional IMAGe Sections
- 1-2 scientists (may include IMAGe Director)
- 1-2 postdocs

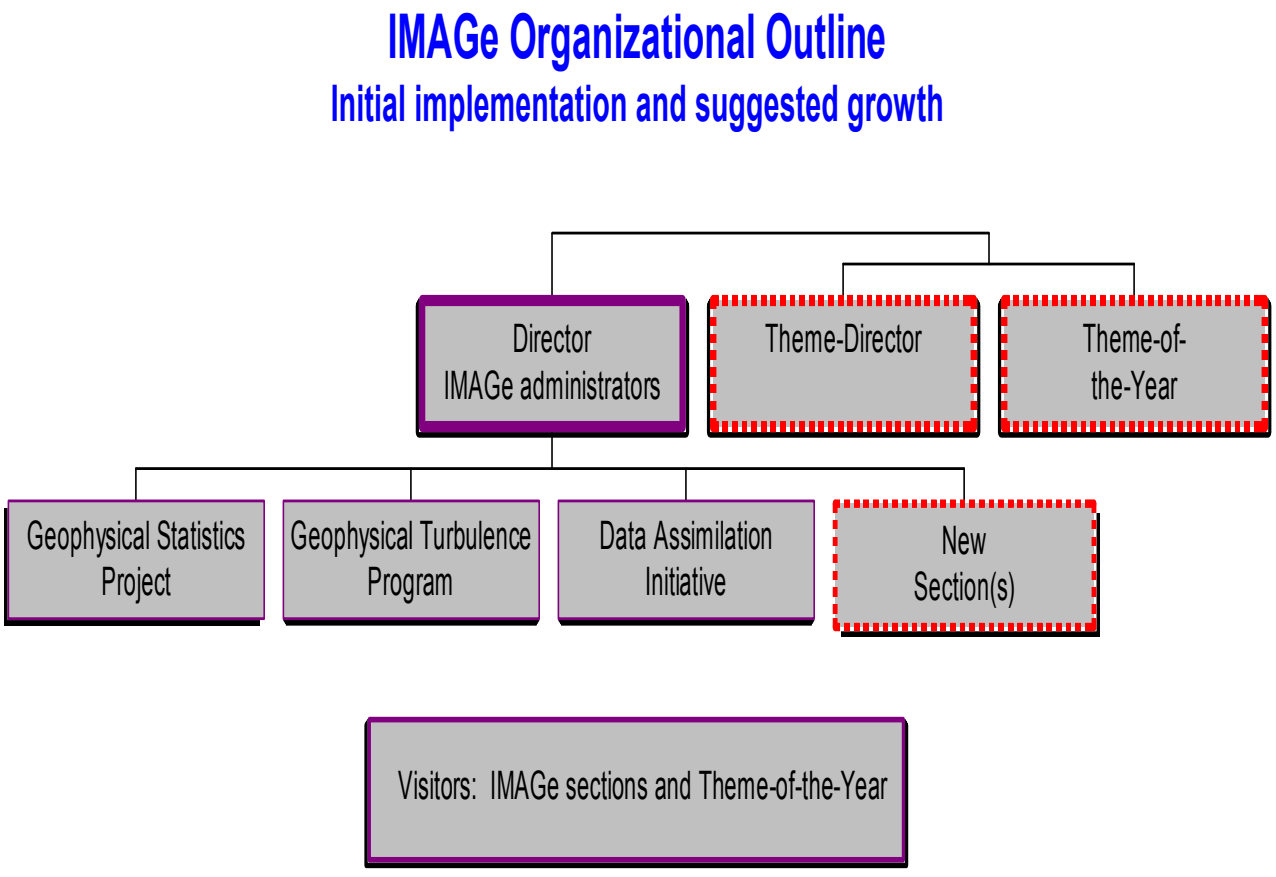

Figure 1.

5. IMAGe Computing Assessment

This section provides the planning information needed to determine information systems support and computing needs.

Representatives of the three founding groups of IMAGe (GTP, DAI and GSP) were each given an IT questionnaire to fill out. This questionnaire sought to identify the general types of hardware and software used by these groups; identify the type and amount of IT support needed; obtain data on current supercomputing resource requirements as well as anticipated supercomputing needs for 2005.

5.1 IMAGe Software Requirements

Third Party Software Tools. The three groups make use of a number of third party software tools that are worth noting. GTP uses the DOE parallel packages Zoltan and Chaco. GSP heavily uses R, an interactive statistics language. All groups make extensive use of Matlab, which can be moderately expensive to support on an individual license basis. IDL is used for visualization by GTP, other groups use NCL. The groups typically use NetCDF and HDF5 standard storage formats. Other libraries used include BLAS and FFTW.

Model Applications. At present, DAI is running three large realistic atmospheric models: MMM's WRF model, CGD's CAM model, and the National Weather Service's Operational Global Forecast System. In addition, DAI is running several more idealized but still large atmospheric models. The ensemble data assimilation methodology requires running a large number of model integrations in parallel. GTP has developed an adaptive grid, spectral element model, GASPaR, for turbulence simulation and is also using some pseudospectral models for MHD simulation.

5.2 IMAGe Hardware Requirements

Staff Desktop Systems. Desktop systems in use in the three groups are typical mixture of Sun workstations, generic Linux IA-32 systems (generally running RedHat 9.0) as well as a few Windows XP and MacOSX systems. Support for desktops across the three groups varies: ACD supports GTP systems, CGD supplies support for the DAI and GSP groups, along with some self-administration of desktops systems. Recent security issues at NCAR have made it clear that the prospect of continued self-administration of desktop systems is problematic. Linux systems, for example, require hardware and software expertise to configure properly with the appropriate drivers for graphics and wireless cards. It is therefore prudent to assess the unified and centralized support requirements for the 25-30 desktops envisioned by IMAGe. For the number of staff in these three groups, SCD desktop professionals contacted for this report estimate that 0.5 FTE of support is required for the desktop systems. If desktop support is currently coming from CGD, then it must be supplied by IMAGe itself or, failing that, within SISL, by SCD desktop administrators, which does not exist.

Visitor Systems. IMAGe will eventually have a large number of short and long-term visitors associated with its many workshops and collaboration. Visitors also bring a number of special security and support issues, particularly in the area of LAN and Wi-Fi networking. Adequate numbers of secure network connections must be provisioned in IMAGe work areas. Staff must be available to assign and manage guest accounts and troubleshoot problems with short response times. A fully realized visitor program for IMAGe may require an additional 0.5 FTE system administrator to support.

Servers. The three groups combined have several small multiprocessor systems. DAI has a dual Xeon system in CGD (dart) and GSP has a dual Xeon system with a 245 GB attached level 5 RAID (*ghotiol*) and a dual processor Sun Ultra-60 with 16 GB of memory (*nightingale*) both located in CGD. GTP is part owner of an SGI visualization system, located in SCD.

Administration overhead of these multiple small shared memory systems could be reduced by consolidating them into a single larger shared memory server system. This new system could be configured to satisfy all of the current and anticipated functional server requirements of IMAGe over the next two years, i.e., to serve as a data analysis and possible visualization engine, as a CVS repository server, with the appropriate memory, processing power and disk space to support IMAGe's compute and data intensive large memory workload. The administrative time saved could be better redirected at supporting the staff and visitor desktop support issues sited above. This consolidation would have to be coordinated with the CGD and MMM divisions, and would require IT funds in the range of $50-100k, depending on the specific requirements.

Supercomputing. All three groups are heavily invested in Linux cluster computing. DAI uses a 22 processor Linux cluster system (*ocotillo*) located in MMM, DAI has put substantial funds into the CGD Linux cluster (*bangkok*). DAI is also a user of another CGD cluster (*anchorage*). The computing and investment relationships of DAI and GSP are the result of the historical collocation of DAI and GSP within CGD. The groups computational needs within IMAGe and SISL would necessarily change these usage and investment patterns over time. One logical solution is that the IMAGe Linux synthesizing cluster requirements be refactored with its overall supercomputing requirements and then integrated with the computer acquisition and allocation policies and priorities of SISL. Again, this approach would save system administration costs, which could be better spent elsewhere.

Supercomputing Resource Requirements. The supercomputing resource requirements are imprecise due to the unavailability of detailed accounting statistics. Nevertheless some clear patterns emerge from the responses from the three groups on these questions. All three IMAGe groups make heavy use of Linux cluster systems. Perhaps not surprisingly, GTP seemed to consume the largest amount of supercomputing resources by a wide margin, followed by DAI, with GSP a distant third. However, the trend for GSP is to make greater use of scientific supercomputing resources as it becomes integrated in larger NCAR projects. The data provided was converted from CPU-hours to GAU's using the following assumptions. It is assumed that one bluesky CPU-hr equals 0.24 GAU's. The computational power of a Linux (Xeon) processor was estimated to be equal to roughly half of an IBM 1.3 Ghz Power-4. These assumptions allowed for the normalization of the data provided to bluesky GAU's for Table 1 and Table 2.

Table 1. Current supercomputer resource requirements (GAU/yr) of the IMAGe component groups.

Supercomputing System	GTP	GSP	DAI	Totals
Linux-clusters	18250	600	5250	24100
IBM-bluesky	5000	755	0	5755
Totals	23250	1355	5250	29885

Table 2. 2005 supercomputer resource requirements (CPU-hrs/month) of the IMAGe component groups.

	GTP	GSP	DAI	TOTALs
Linux-clusters	109500	600	50000	120600
IBM-bluesky	30000	755	0	30750
Totals	139500	1355	50000	151355

The results for 2005 are strongly influenced by a dramatic increase in usage by GTP, based upon the user base for GTP codes currently in development increasing by a factor of six in 2005. DAI is now entering a more mature phase of activity in which it will need to perform regular assimilation experiments with a variety of large models. These assimilations require running many integrations of large models. In order for DAI to build collaborations with partners both inside and outside of NCAR, a large increase in computational resources, by at least a factor of five during 2005, will be required. Requirements for computing will continue to grow during subsequent years as more applications are developed with collaborators.

6 Preliminary analysis of space needs for IMAGe

6.1 Efficient continuation of existing activities

IMAGe's existing activities require a centralized location for administrative staff as well as space for existing scientific and technical staff of GSP, GTP and DAI. It is also important that IMAGe be co-located with some of the science divisions (CGD, MMM, ESIG, HAO, ACD) with which there are strong and on going projects. Collocation with respect to the SICL Associate Director's office will also be desirable in coordinating administrative functions.

In addition, IMAGe would need one or more shared offices at the location(s) hosting the other scientific divisions. This 'satellite' space would have to be configured so that workstations, phones, etc. could be easily changed for a particular member of IMAGe. In addition, some amount of 'paper' storage for books and filing would also be needed at each satellite location.

Rough totals for number of offices and other space:

1. Scientist 4 / Director (3)
2. Scientist 3 (1)
3. PS / AS / SE (6)
4. Admins (2)
5. Postdocs (7)
6. Graduate students (5)
7. Joint appts. / affiliates (2+)
8. Faculty visitors (2 permanent, 3 for summer)
9. Student visitors (space for 4)
10. Meeting rooms (2)
11. Common space (1)

6.2 Requirements for enhanced activities

Enhanced activities would include establishing a Theme-of-the-Year program and possibly adding an additional ongoing activity. It is difficult to assess the space needs of a new activity without additional guidance, but a rough estimate is a need for four additional offices.

Theme-of-the-Year activity:

- IMAGe Director (Sci. 4)
- TOY administrator
- Theme coordinator (Visiting scientist)
- Software engineers (2)
- Space for long-term theme visitors (4)
- Space for short-term theme visitors for workshops (20)
- Space for computer lab facilities for theme visitors (or proximity to an existing computational lab facility and priority for use; probably need 30+ seats with workstations or comparable capability to network this many laptops)
- Computing system admins (2)
- Computing space in shared SISL facility for servers

Totals for enhanced activities:

1. Senior visiting scientist (1)
2. Admin (1)
3. SE / system admins (4)
4. Long-term visitors (4)
5. Short-term visitors (20)
6. Computer lab (30 seats)

IMAGe sections in Applied Mathematics

- Scientist (1-2) (may include future IMAGe Director)
- Post doc (1-2)

Appendix A

Charter for the Institute for Mathematics Applied to Geosciences at the National Center for Atmospheric Research

Preamble

This charter describes an Institute at the National Center for Atmospheric Research (NCAR), the Institute for Mathematics Applied to Geosciences (IMAGe). IMAGe will coordinate the application of mathematics and statistics to the geosciences and will motivate new research in the mathematical sciences based on grand challenge problems from geophysics and related environmental sciences. A primary intent of this charter is to insure that IMAGe in its initial form and through future expansion will remain focused on vital geosciences research.

This Institute will build upon three existing groups at NCAR: the Data Assimilation Initiative (DAI), the Geophysical Turbulence Program (GTP) and the Geophysical Statistics Project (GSP) and will support and nurture these programs. IMAGe will also provide the structure to broaden the mathematical activity at NCAR through collaborative projects, affiliated scientists, additional IMAGe sections and alliances with other mathematics centers and programs. Accordingly, the implementation of this charter has two parts: the immediate consolidation of DAI, GTP and GSP into a distinct Institute and a more deliberate broadening of IMAGe to fulfill its long-term vision.

1.1 Vision Statement

IMAGe brings mathematical and conceptual tools to bear on fundamental problems in the geosciences and aims to be a center of activity and an integrator for the mathematical and geophysical communities. This is achieved through internal collaborations among NCAR divisions, institutes and UCAR programs and through an external network of mathematics centers, university groups and government laboratories. IMAGe activities will emphasize the grand scientific challenges that are faced in understanding the Earth system and the subsequent enrichment of the mathematical sciences achieved by tackling such problems. Based on this vision, the Institute posits a broad definition of applied mathematics including statistics, probability, scientific computation, algorithm development and machine learning, along with more traditional disciplines based on differential equations and mathematical physics.

1.2 Mission Statement

The Institute for Mathematics Applied to Geosciences, (IMAGe) exists to foster, enhance and sustain strong collaborations between the geoscience and mathematical science communities and to become a center of excellence for these communities.

IMAGe will bring together mathematical scientists and geoscientists from the U.S. and abroad to facilitate contacts and to disseminate knowledge through:

- research workshops, tutorials and schools;
- visitor, fellowship, senior under-graduate, graduate and post-doctoral programs;
- long-term focused research activities of joint interest;
- and the creation of innovative focused software that is open source and developed in concert with the geoscience and mathematical science communities.

The Institute supports NCAR and UCAR scientific programs by engaging and coordinating cross-divisional/cross-laboratory grand challenge science from a fundamental and mathematical perspective. It also helps identify the need for, and accelerate the development of advanced mathematical, computational, conceptual and statistical methods within the NCAR/UCAR community, with emphasis on multi-scale phenomena, model/data fusion, stochasticity and uncertainty.

1.3 Provenance

The initial ideas for IMAGe were developed through a sub-committee of the NCAR Realignment Committee chaired initially by Larry Winter (NCAR Directorate) and subsequently by Annick Pouquet (GTP/ASP). The other members were: Jeff Anderson (DAI), Tom Bogdan (HAO), Jim Curry (Applied Mathematics Department, CU), Natasha Flyer (SCD), Doug Nychka (GSP), Piotr Smolarkiewicz (MMM), Steve Thomas (SCD), Joe Tribbia (CGD), and Wes Wilson (RAP).

Based on the work from this subcommittee IMAGe became part of the NCAR reorganization plan and a committee was formed to create an implementation plan. Implementation committee members were: Barbara Hansford (ASP), Doug Nychka (GSP), Jeffrey Anderson (DAI), Joanne Dunnebecke (RAP), Mark Rast (HAO), Mitchell Moncrieff (MMM), Annick Pouquet (GTP), Richard Loft (SCD).

2 Organizational Structure

2.1 Institute

IMAGe will be an NCAR Institute and is at the similar organizational level as that of traditional NCAR divisions. An Institute is understood to be a research and education group whose relevance depends on substantive collaboration with more than one NCAR science division or laboratory. Although cross-divisional collaboration and synergy is to be expected throughout NCAR, for an Institute it is a defining attribute. IMAGe is administratively placed in the Computational and Information Sciences Laboratory (CISL).

2.2 Sections

IMAGe will be composed of sections. The founding sections are DAI, GTP and GSP and the longer term goals of IMAGe include adding other sections. Any decision to augment IMAGe will include consultation with the internal scientific board (Section 4) to insure relevance to NCAR programs and the external advisory board (Section 4) to assess benefits to external collaborations.

2.3 Institute members

The Institute will be composed of a variety of members depending on the level of support and affiliation.

- *IMAGe staff:* Permanent members of IMAGe sections.
- *Joint Appointments:* Scientists at NCAR where part of their support is from IMAGe. Typically these would be members contributing directly to IMAGe projects, to Theme activities or with the IMAGe network members. A joint appointment includes the expectation of administrative and facilities support from the Institute but need not be permanent.

- *Affiliates:* Scientists at NCAR who have significant collaborations with IMAGe related projects but who do not receive salary through IMAGe.
- *Institute Fellows:* Researchers outside of NCAR with significant involvement in IMAGe activities. Typically IMAGe will support regular visits of a Fellow to NCAR over a prescribed period, not necessarily in conjunction with Focused Theme (Section 3.3) programs

2.4 External network

Intrinsic to IMAGe is the formation of a network of mathematical centers and other related research and educational groups that will provide a national and international scope. Initially the network is expected to include:

- Institute for Pure and Applied Mathematics (IPAM), UCLA
- Statistics and Applied Mathematical Sciences Institute (SAMSI), North Carolina
- Center for Atmosphere Ocean Science (CAOS), NYU

Within the network IMAGe will assume a leadership role in maintaining a scientific framework and context for mathematical modeling and analysis methods. IMAGe will engage shorter mathematical programs sponsored by network members as part of longer term scientific collaborations and programs. The Focused Research Themes (Section 3.3) supported by IMAGe will be in coordination with the network members, NCAR laboratories and UCAR programs.

2.5 Leadership

Director: The Institute will be led by a director on a term appointment with four major roles:

1) to represent IMAGe to the NCAR Directorate and coordinate activities with other NCAR divisions and laboratories,
2) to represent IMAGe to the university and research communities and to be responsible for the maintenance of the Focused Research Theme program,
3) to coordinate a broad scientific agenda and its ensuing budget.
4) to supervise the administrative staff of IMAGe.

Section Leaders: The leaders of IMAGe sections will manage the section's research, programs and projects, and develop the strategic plans for their sections and coordinate these plans within IMAGe, with other groups at NCAR and with external partners. Section leaders will take responsibility for the IMAGe sections being substantively engaged with the scientific program at NCAR.

Theme Director: The theme director will be responsible for the management and success of the Focused Research Theme. It is anticipated that in most cases this individual will be a distinguished researcher from a UCAR university, a national laboratory or an equivalent international research center. The theme director will be appointed by the NCAR Directorate under advisement by the IMAGe director and the external advisory board.

Steering Committee: An IMAGe steering committee will provide coherence to the activities of the different sections in IMAGe. It will be composed of the heads of each section, the Theme Director and the Director of the Institute. This committee will meet regularly and will set priorities for IMAGe. Responsibility of the steering committee includes Institute planning and organization, personnel decisions, pursuing outside funding, and resource allocation. Although the Director will have primary responsibility for setting the agenda for the steering committee, it is expected that the committee itself will provide substantial guidance and administrative support to the Director.

2.6 Visitor Program

It is expected that the IMAGe will have an active visitor program that is coordinated with the current Focused Research Theme (Section 3.3) and the activities of the Institute's sections. An important component of the visitor program is an IMAGe seminar series that seeks to integrate visitors into the broader activities of the Institute. This will be achieved through regular seminars that are often introductory and tutorial and include participation of all IMAGe sections.

3 Institute Activities

3.1 Role within NCAR

IMAGe will network extensively with research efforts undertaken within the NCAR. Within the Computational and Information Systems Laboratory, IMAGe will complement work in the Computational Science section and in particular, the Numerical Modeling Group. Based on the flexibility and broad application of mathematical and statistical tools it is expected that IMAGe can maintain a collaborative presence in all NCAR laboratories. Such connections will anchor the contributions of IMAGe to geophysical and related problems and will insure that the Institute remains an integral part of NCAR research and outreach. The IMAGe internal scientific board (Section 4) will serve to evaluate and to foster this role.

3.2 Sectional Research

IMAGe will be a balance between research pursed by individual scientists and staff in the IMAGe sections and broad collaboration outside of NCAR. This is based on the principle that for IMAGe to pursue integration of geophysical research and training on a national or international scale, the members must themselves be experts in disciplines related to IMAGe projects. The founding sections already have strong integrative research and service roles within NCAR, and IMAGe must necessarily support these activities. In general, sectional research will be guided by an Institute strategic plan that draws on the NCAR scientific plan, the particular mission and vision for IMAGe, recommendation of the advisory boards for the sections, the IMAGe internal scientific board (see Section 4) and an annual Institute retreat.

3.3 Focused Research Theme

A cornerstone of IMAGe's support of the mathematical science community is the coordination of mathematical and statistical research and education on a challenging area drawn from the geosciences. Ideally, the theme will provoke a synergy between a scientific problem and mathematics: the application of advanced mathematical models and tools will result in substantive advances in an area of the geosciences. In a complementary fashion, the focus on specific geophysical problems will motivate new mathematics and the need for novel mathematical tools. Typically IMAGe will adopt one theme per year and so this program is will also be referred to as the Theme-of-the-Year (TOY). A theme can either be an area drawn from the mathematical sciences with broad application, such as data assimilation, or a scientific topic that may entrain one or more areas of mathematics and statistics. Not all of the theme activities need be located at NCAR and it is expected that most themes will be distributed among one or more members of the external network members. However, themes that have substantial participation by IMAGe will also map onto the broader NCAR scientific and educational plans.

Some broad criteria for theme selection include:

1) Geophysical problems that have broad impact across the Earth System.
2) Scientific applications that have the potential to generate new and perhaps unanticipated mathematical results or suggest the need for new mathematical tools.
3) Themes where some local mathematical expertise is represented in IMAGe either through staff, NCAR affiliates or long-term visitors.
4) Scientific themes that leverage local scientific expertise at NCAR and are aligned with the NCAR strategic science plan.
5) Coincident interest with one or more external research centers or groups.

3.4 Education and Outreach

Beyond the structured activities such as the Focused Research Theme, the IMAGe will have a significant and sustained training and outreach component. Outreach will range from co-developing educational materials with university partners that have wide dissemination to more informal and tutorial events targeted largely to the NCAR community. IMAGe members will be encouraged to visit and, when appropriate, participate in network members programs.

4 Oversight and Reporting

- *Sectional advisory boards:* Due to the uniqueness of the IMAGe sections it is anticipated that each will be prescribed to have its own external scientific advisory board. The reports of these boards will be coordinated into an annual document with the intent of reducing the need for a formal program review by an Institute level panel.
- *IMAGe external board:* The IMAGe external board will be composed of representatives from mathematics centers, government laboratories and other relevant university groups and will focus on Focused Research Theme selection and other external activities. This board is the main entity to coordinate the IMAGe network and will be convened at least once a year. The current theme director is an *ex officio* member of the board. This group will set research themes, coordinate and plan collaboration among the network institutions and will contribute to the final reports for the research themes. Although it is expected that IMAGe members may play a leading role in proposals to the board it is also expected that substantial decision making will derive from the participation of all the board members.
- *Internal scientific board:* An internal advisory panel will be formed drawn largely from NCAR scientists that provide broad representation of the NCAR science divisions and laboratories. This panel should not only track existing IMAGe activities, but also be engaged in planning, selection and maintenance of scientific and educational programs in IMAGe.
- *Policy oversight:* IMAGe will not have a separate policy advisory board but will rely on policy guidance through the board convened for its Laboratory.

Appendix B

Descriptions of IMAGe administrative positions.

POSITION DESCRIPTION: IMAGe ADMINISTRATOR

Employee Name _____ Date_____

Position Title ___Administrator II _____ Div/Prog and Group ___IMAGe _____

Reports To:____Director of IMAGe_____

Basic Function of Job:
This is a full-time, exempt position that oversees and provides administrative functions for IMAGe.

Duties: Describe the primary work to be performed. List duties starting with those duties taking the greatest percent of time.	% of Time
Develop annual and long-range budgets for the Institute. Monitor spending and compliance with budget policies and procedures.	30
Coordinate the development, review and submission of proposals for new funds.	15
Oversee and administer workshops, seminar series and visitor programs. Administrative advisor to scientific staff on logistics, organization, advertising and implementation processes.	15
Oversee handling and disposition of application and selection processes for postdoctoral fellows, graduate fellows, workshop attendees, and visitors. Analyze appropriate databases characterizing these applicants, for statistical purposes in year-end reports.	10
Support or supervise scientific support (e.g., manuscript preparation, proposal preparation, travel arrangements, publications charges, etc.) for scientists and Director. Coordinate the preparation of the Annual Scientific Report, the Program Plan, and other required documents for the program.	10
Represent the program on committees and contribute to other institutional functions. Negotiate space and property use within the programs and, as the program representative, among NCAR groups.	10
Supervise and hire other administrative and support personnel, and guide their development through performance appraisals, recommend salaries, and training activities. Coordinate the process of selecting, mentoring, and reviewing joint appointments with staff and their home divisions.	10
The above statements describe the primary work being performed. Additional tasks may be assigned from time to time.	

DECISION MAKING&PROBLEM SOLVING - i.e., types of problems that are solved independently

Develops and recommends IMAGe salaried and non-salaried budget component distribution, coordinating with science divisions as necessary. Requires extensive knowledge of program goals and needs. Administrator has full latitude and responsibility to decide most efficient means of using annual funds.

Analyzes annual targets and recommends new equipment purchases based on expected system replacements and considering new staff research requirements. Negotiates joint appointments and logistics with other division administrators independently.

Works with postdocs to request special work arrangements consistent with policy, but accommodating research/personal leave needs (including leaves of absence to pursue research opportunities and reduced FTE appointments for maternity/personal leave).

Develops space administration to accommodate visitors' needs and aid institution in temporary availability.

KNOWLEDGE/SKILLS/ABILITIES

Demonstrated skill in developing and monitoring budgets. Extensive knowledge of cost accounting system budget methodologies and reporting requirements.	E
Demonstrated skill in reviewing and monitoring contracts and grants for compliance with NCAR, NSF and sponsored requirements	E
Advanced skill in workshop and visitor program budgeting, planning, implementation and coordination	E
Demonstrated knowledge of the principles and practices of personnel administration	FW
Knowledge of purchasing and subcontracting policies and procedures and constructed Asset development techniques	FW
Skill in statistical analysis for program accounting and visitor program competition processes	FW
Skill in leading group discussions and presentations in Director's absence	FW/E
Excellent written communication skills to collect, organize and draft reports such as Periodic program reviews, ASR, program plans, etc.	E
Skill in supervising non-exempt staff and preparing ads, requests for staff, interviewing and hiring new staff when necessary	E

EDUCATION & EXPERIENCE

Bachelor's degree in relevant academic discipline, plus at least three years' relevant administrative experience or an equivalent combination of education and experience.

OTHER REQUIREMENTS:
Supervisory Responsibilities
Directs work of all administrative staff within Institute

SUPERVISOR SIGNATURE: _____ EXTENSION:_____

DIVISION/PROGRAM
DIRECTOR SIGNATURE: _____ EXTENSION:_____

POSITION DESCRIPTION: IMAGe ASSISTANT ADMINISTRATOR

Employee Name _____ Date_____

Position Title ___Administrative Assistant III _____ Div/Prog and Group ___IMAGe _____

Reports To:____Institute Administrator_____

Basic Function of Job:
This is a full-time, non-exempt position that provides administrative support for IMAGe

Duties: Describe the primary work to be performed. List duties starting with those duties taking the greatest percent of time.	% of Time
Provides administrative support for Institute staff: makes travel arrangements; sets up internal and advisory board meetings; handles logistics for workshops and schools; schedules meeting maker appts., orders supplies, assists in creating presentations; writes letters and memos for own and others' signature; coordinates and compiles reports; assists with proposal preparation and submission to Budget and Planning, updates and extends web site, facilitates seminar arrangements	60
Prepares paperwork (e.g., offer letters, visitor authorization and organization paperwork) for visitors and joint appointments; sets up offices and coordinates moves as needed and handles general visitor-related issues	20
Assists the Administrator with monthly reporting and account reconciliation, preparing salary and expenditure transfer forms as needed; makes credit card purchases and monitors account; generates check requests and purchase requisitions	20
The above statements describe the primary work being performed. Additional tasks may be assigned from time to time.	

DECISION MAKING&PROBLEM SOLVING - i.e., types of problems that are solved independently
Routinely makes decisions regarding prioritization of tasks; travel arrangements; meeting coordination; graphics design/layout and web postings. Conducts research and makes recommendations regarding purchase/lease of office equipment. Receives work from a large and diverse group located at different sites and must determine how best to satisfy sometimes-conflicting needs. Discretion, good judgment, creativity, humor, and the ability to think clearly under pressure are needed. Creativity is frequently used in designing and creating graphics materials and web postings/on-line application forms to effectively convey information.

KNOWLEDGE/SKILLS/ABILITIES	
Advanced knowledge of word processing, database, spreadsheet, and graphics applications	FW/E
Web site maintenance and editing	FW/E
Skill in working in a networked computing environment	FW
Advanced knowledge of travel logistics, planning and procedures	FW
Advanced knowledge of writing and English skills	FW
Knowledge of basic accounting principles and practices	G/FW
Knowledge of the Bi-Tech and Data Warehouse accounting system	FW
Knowledge of institutional policies and procedures, particularly in the areas of finance and travel, and ability to apply them	FW
Ability to compose general correspondence and proofread documents	FW
Effective oral and written communication skills	FW
Ability to prioritize tasks	FW
Skill in working effectively both independently and as part of a team	FW
Skill in relating to people	FW

EDUCATION & EXPERIENCE

High school degree or equivalent, and at least four years' relevant experience; or equivalent combination of education and experience, experience in writing in diverse environment with large flux of people.

OTHER REQUIREMENTS:

Supervisory Responsibilities
Exercised: May direct the work of lower-level administrative staff
Received: Receives general supervision from the Institute Administrator

SUPERVISOR SIGNATURE: _____ EXTENSION:_____

DIVISION/PROGRAM
DIRECTOR SIGNATURE: _____ EXTENSION:_____