

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 pursued 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.