The System for Integrated Modeling of the Atmosphere (SIMA) Project Charter

1. Project Purpose

The System for Integrated Modeling of the Atmosphere (SIMA) is a unified community atmospheric modeling framework intended for use in the Community Earth System Model (CESM) and other ESMs. SIMA enables multiple model configurations for applications spanning time horizons from minutes to centuries and from local (e.g., km-scale) to global scales, including atmospheric forecasts and projections of the atmospheric state and composition from the surface to the thermosphere. For example, the CESM Scientific Steering Committee or its Working Groups, or the MUSICA (Multi-Scale Infrastructure for Chemistry Modeling) leadership, can decide which configurations of SIMA to use for different CESM-related applications or atmospheric chemistry applications. The SIMA project will coordinate with the entity's leadership to ensure that desired configurations are included following the expectations of model development that will be part of SIMA.

2. Objectives

The overall objective of this project is to advance the atmospheric modeling framework (SIMA) to:

- Deliver infrastructure than enables simulation of atmospheric processes and atmospheric interactions with other components of the coupled Earth system from the surface to the ionosphere and across scales from storm-resolving weather to decadal climate applications;
- Enhance atmospheric and earth-system modeling applications for frontier-science problems at the intersections of climate, weather, atmospheric chemistry, and/or geospace disciplines;
- Move NCAR's atmosphere modeling ecosystem from several models to a single atmosphere modeling system for use in CESM and potentially other ESMs;
- Develop greater accessibility for internal and external users, and build a framework to address cross-disciplinary research questions not currently being addressed by the community.

Beyond SIMA, skillful and lightweight coupling is necessary between the Earth system components, such as to the ocean, terrestrial and cryosphere systems, along with chemistry and human systems through factors including emissions. This coupling infrastructure remains an important area to support as needed to ensure the success of SIMA.

The SIMA tool development is multi-pronged to pursue the science priorities of the labs and community projects such as CESM and MUSICA as represented by the four scientific and technical co-leads; climate, weather, chemistry, and geospace. All four of these development areas are well-aligned with NCAR's Strategic Goals and Institutional Objectives outlined in the current NCAR Strategic Plan and Implementation Plan, respectively.

3. Expected Outcomes

Looking ahead, SIMA will demand targeted development activities to meet system requirements. Yet, with limited available resources, tasks will need to be prioritized and sequenced accordingly. Prioritization will be achieved by identifying requirements for:

- Target science objectives;
- Necessary core development to serve across applications;
- Sustainable and forward-looking software design and development taking into account the rapidly changing and evolving hardware and infrastructure ecosystem;
- Expanding use and usability of the broader SIMA framework based on community input.

Target science objectives will follow from an internal solicitation process aimed at cultivating leadership by early career NCAR staff. The intent of the internal solicitation approach is to entice early career staff to exercise SIMA and to prioritize associated capability development to pursue emerging science opportunities. The solicitation will be developed by the SIMA steering committee, with advice from the external advisory committee, to provide high level guidance on science priorities to drive development of SIMA while also advancing Center priorities. Selection of specific science proposals will be done through internal review and in a cooperative process with the SIMA scientific and technical co-leads as safeguards against feasibility and readiness of the system to meet associated requirements and development goals.

Additional requirements can arise from the co-lead team to deliver core system functionality that extends across applications. Requirements can also emerge from the community through guidance originating from the external advisory committee or from community engagement workshops.

Development activities to achieve the above requirements should then be prioritized and executed following a Project Execution Plan (PEP).

Successful implementation of this project will result in the following outcomes:

- A flexible atmospheric modeling framework that can function within CESM and other ESMs that enables cutting edge science applications that extend beyond existing capabilities;
- User support through documentation and direct assistance to facilitate successful use of SIMA for supported applications;
- Modern software development approach;
- An open approach for community contributions to the SIMA project;
- Scalable, portable, and high performance code that works on current and future HPC and cloud platforms.

4. Project Team and Advisory Committees

The SIMA team will develop a PEP for clarifying scope, scheduling for completing system requirements, budget tracking, performance monitoring and reporting, along with change management procedures. This activity follows from the adoption of this charter, selection of science drivers from the internal solicitation process, and development of requirements for core system functionality and requirements drawn from community engagement activities.

The SIMA Lead will ensure routine reporting on milestones, activities, and progress toward meeting requirements to the project manager and steering committee:

- At least semi-annual engagement with an external advisory team and annual community meetings to acquire community input on software development needs and user support requirements;
- Annually updated timeline and milestones (employ a 'rolling wave' approach);
- Frequent reporting (e.g., quarterly) on progress to enable external communication through the steering committee.

Fiscal allocations will be decided by the SIMA steering committee to ensure alignment with the project strategic priorities and goals.

4.1. Key Roles and Responsibilities

The guiding principles for the SIMA team participants are as follows:

- Responsibly guide development of the SIMA framework to meet the needs of current and future researchers within NCAR and the broader community;
- Develop in coordination across the Center to facilitate wide use of the innovations of SIMA within NCAR's atmospheric modeling ecosystem;
- Foster growth of a broad user community for SIMA capabilities both internally and externally, in collaboration and coordination with existing communities such as those of MPAS, CESM, CEDAR, and MUSICA;
- Contribute toward broadening participation and expanding access to NCAR capabilities.

The specific roles for SIMA team members will be further developed in the PEP. Broad roles and responsibilities follow in Table 1. Notably, the SIMA team encompasses all of the key roles below.

The principle of SIMA is to build interoperability while maintaining the foundational capabilities of CESM and other frameworks within NCAR's modeling ecosystem. SIMA Co-Leads are responsible for promoting this philosophy. If there are concerns within the SIMA project that require conflict resolution, the SIMA Lead and Co-Leads will address the issue and escalate to the SIMA Steering Committee, as appropriate.

Concerns that emerge between SIMA and other entities, such as CESM, will be addressed in a collaborative spirit. The SIMA Lead and the other entity's leadership (e.g., CESM Chief Scientist) will be charged to resolve the issue. If further discussion is warranted, then the SIMA

Scientific and Technical Leads group will try to resolve the issue with the steering committee of the other entity. In the rare instance that a resolution has not been reached via either of these methods, then the NCAR Director will have the final authority, in consultation with the NCAR Executive Committee, to make a decision and inform the relevant NSF program managers, as necessary.

Table 1. Key roles.

Participant	**Role(s)**
NCAR Director and Deputy Director	NCAR deputy and NCAR director have overarching authority and responsibility. Appoint the steering committee.
SIMA Steering Committee (SSC)	This steering committee provides project oversight and fiscal authority over the SIMA project. Inaugural membership will include five lab directors, or their management designee, with expertise across Earth system science and computational science, representing the partnering labs of CGD, HAO, ACOM, MMM, and CISL, along with a sixth member providing representation from the NCAR Director's Office. Additional responsibilities include appointing the SIMA Lead, supporting in-kind contributions to SIMA project activities, holding staff participants accountable, and guiding SIMA development toward Center and community priorities such as through the internal science solicitation focus and selection. The SIMA steering committee appoints a chair to organize meetings, lead communications to external stakeholders, and ensure progress on the project. The SIMA steering committee, in their role of oversight and fiscal authority, has general responsibility for decision-making.
NCAR Lab Associate Directors	Committed to co-sponsoring specific developments and resources to deliver capabilities needed to ensure the success of the SIMA project. Mechanisms to achieve co-sponsorship will be agreed upon and set by the SIMA steering committee.
SIMA Lead	Appointed by the SIMA steering committee for three year terms (rotating position). Primary point of contact who reports directly to the SIMA steering committee and oversees the SIMA co-leads. Provides day-to-day project coordination and delivery of requirements-driven development in coordination with stakeholders and with assistance from SIMA project management support. Responsible for executing the PEP and following PEP procedures. Implements the Center vision provided by the steering committee. Ensures community engagement. Develops and provides routine reporting to meet internal, sponsor, and community requirements. The SIMA Lead may or may not be a

	SIMA scientific and technical Co-lead.
SIMA Scientific and Technical Co-leads	Appointed by the SIMA steering committee. Delivers subject matter expertise toward the development of project priorities and defines resource allocation needs for SIMA development to meet science objectives. The latter will be in the form of requirements and associated program development activities as outlined in the PEP under the direction of the SIMA Lead. Provide day-to-day operational authority to coordinate and ensure timely execution of development tasks tied to fulfilling system and project requirements. Helps coordinate staff efforts who are developing SIMA. Communicates and engages with the internal and external community, including CESM leadership, to identify development needs and requirements. *Placeholder (structure still being defined): The SIMA Scientific and Technical Co-leads includes a software engineer (SE) who represents a leadership structure of multiple SEs across NCAR to ensure expertise in the direction and coordination for the design and implementation of SIMA Milestones.*
SIMA project management lead	Provides coordination and support for the execution of the PEP for SIMA. Reports to the SIMA steering committee. This will be accomplished by tracking the execution of development activities toward meeting system requirements and monitoring fiscal aspects of the project to ensure on time and within budget execution of the project tasks. Aids the SIMA Lead in development of quarterly and annual project reports.
External advisory committee	Contributes guidance on SIMA priorities and objectives to the NCAR SIMA team; aids in identifying appropriate requirements and prioritization for SIMA development activities, bringing together perspectives from multiple disciplines in one discussion. Evaluates project evolution and recommends opportunities to engage the community.

Other stakeholders for the successful execution of the SIMA project, in addition to those key roles already noted above, include community members, other NCAR staff members, and NSF among their provision of general oversight of NCAR priorities.

6. Risks and Opportunities

Project risks will be managed by first assessing the risk impact and likelihood. Weighted scores derived using the risk register will then drive mitigation efforts to appropriately reduce risk to the project. The SIMA Lead, along with the project team, will monitor project risk mitigation activities

and risk status and will review and update the project risk register on a quarterly basis to capture all current risk status information. An initially identified set of risks and potential mitigation efforts are provided in the SIMA Risk Register.

7. High Level Requirements

Completion of the SIMA project will enable:

- Advances in core aspects of SIMA that lead to greater functionality and support for core atmospheric science applications (weather, climate, chemistry, geospace);
- Enhanced use and usability of the SIMA framework for applications within CESM and other ESMs with development prioritized by science needs;
- Demonstration of high visibility applications identified by early career staff;
- Enhanced internal and external user interest in SIMA developments.

8. Timeframe Requirements

The SIMA project, at the time of the initial charter release, is anticipated to be in place for about 3 years. An extension of the term will be considered toward the end of this period if warranted and funds remain.

9. Terms and Definitions

CAM - Community Atmospheric Model
CESM - Community Earth System Model
ESM - Earth System Model
MPAS - Model for Prediction Across Scales
NCAR - National Center for Atmospheric Research
NSF - National Science Foundation
PEP - Project Execution Plan
SIMA - System for Integrated Modeling of the Atmosphere

10. Charter Version History

Version #	**Revision Description**	**Revision Date**
1.0	Initial release of charter	7/22/2022
2.0	Updates from Dave Lawrence, Glen Romine, Gokhan Danabasoglu, and Mary Barth to address synergies with CESM. Also updated with edits from Rich Neale, Julio Bacmeister, and Peter Lauritzen (all CGD representatives).	11/11/2022, 11/18/2022, 12/20/2022
3.0	Updated to reflect TBD software engineer leadership structure and include suggestions from the NCAR Director.	1/5/2023, 1/25/2023

4.0	Updated to include edits from the CESM Advisory Board (CESM CAB).	3/7/2023