System for Integrated Modeling of the Atmosphere

SIMA

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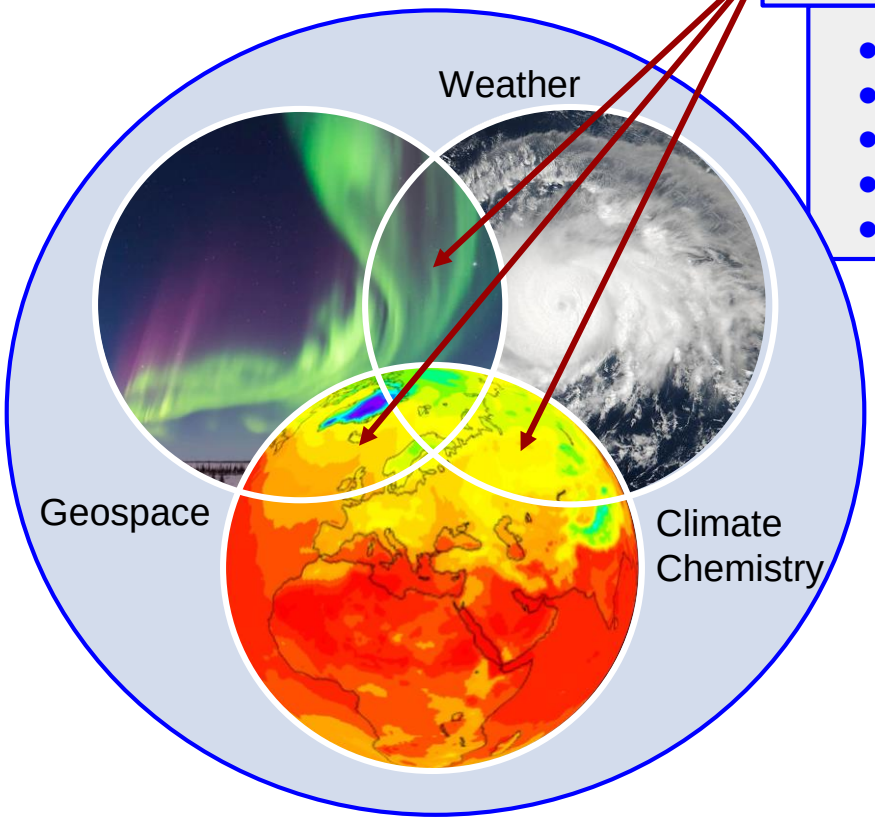
System for Integrated Modeling-Atmosphere (SIMA)

SIMA is composed of common atmospheric model components & infrastructure

- Dynamical cores
- Physics/Chemistry
- Initialization
- Diagnostics
- Coupled System



SIMA Frontier Applications

- Coupled Weather
- Climate Extremes
- Space Weather
- Air Pollution
- Coupled Polar

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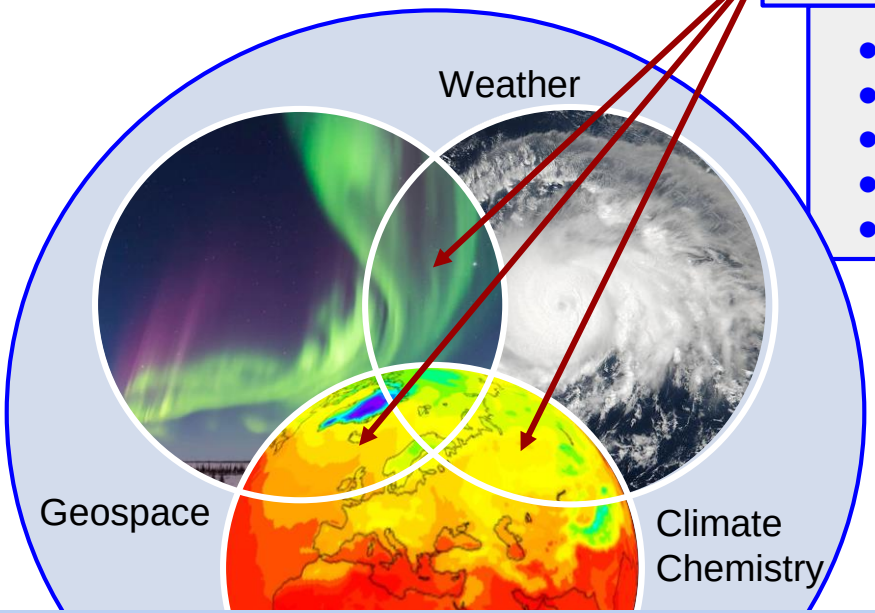

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SIMA is not a new model. Its configurations will utilize existing atmospheric model components in addition to new components as they become available. These configurations will reproduce existing capabilities and provide new capabilities.

Why SIMA: Community Interests and External Recommendations

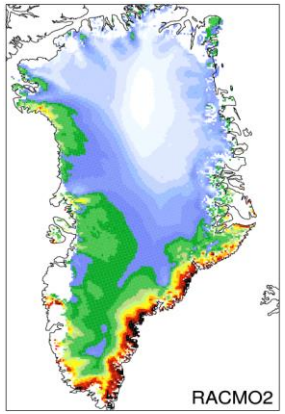
- NSF 2016 SVTs recommended that NCAR unify its modeling, particularly weather and climate
- CESM research community needs to have improvements on ability to include new science (physics) in the Community Atmosphere Model (CAM)
- Chemistry community desires unification of its various chemistry models
- WRF/MPAS community desires supported coupled (atmosphere-ocean) capability for high-resolution simulations
- Global air quality research requires local urban-scale resolution with global transport
- Geospace community needs access to full atmosphere (including deep dynamical core and magnetosphere) capability

Why SIMA: Benefits of Unification

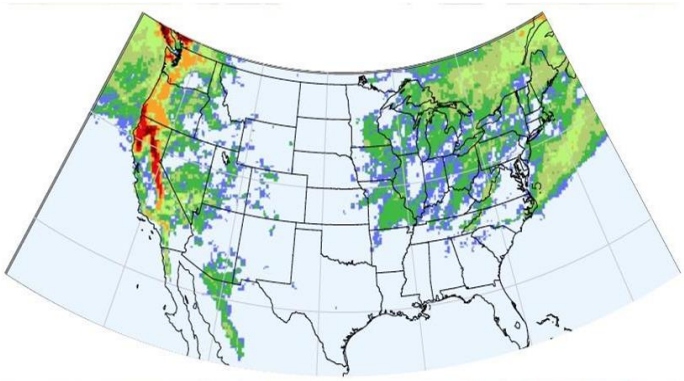
- Infrastructure and atmospheric model components
  - Reduce duplication of efforts across communities
  - Allow climate, weather, geospace and chemistry communities to collaborate and share innovations
  - Provide modeling capability that transitions smoothly across space and time scales
  - Permit new science for the research community
  - Ease the burden of implementing new technology
  - Allow capitalization on next-generation HPC technology

Frontier Science Goals for SIMA

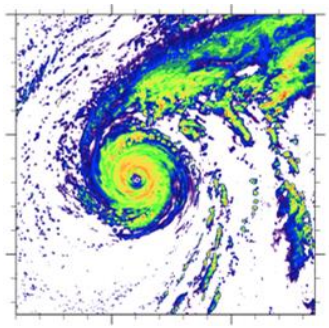
- Coupled Simulations at the Weather Scale
  - Tropical cyclones, Extreme convection, Urban pollution
- Extreme weather under climate conditions
  - Extreme heat and precipitation, extreme weather under climate change, air quality
- Polar Processes and Prediction
- Integrated Geospace modeling
- Regional/Urban Air Quality



Polar

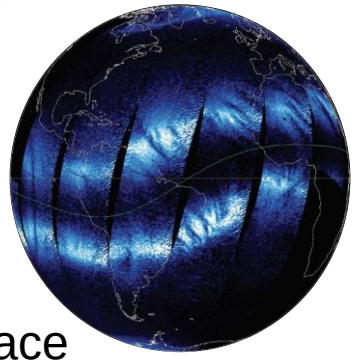


Hydrology Extremes



Tropical Cyclones

Air Quality



Space Weather

SIMA Path Forward: Near-Term Strategy

- Conduct development to enable science demonstrations and feasibility assessment
- Work with NWSC-3 effort to ensure consistency between SIMA infrastructure and future computing architecture
- Communicate with our constituents at upcoming meetings
  - MUSICA (unified chemistry)
  - WRF/MPAS Workshop
  - CESM Workshop
- SIMA Community workshop
  - Geospace, weather, chemistry, climate, hydrology, and HPC
  - Identify how various existing communities can collaborate
  - Intended to enhance, not compete with, existing governance

Current Impediments

- Dynamical core
  - CAM-6 does not include a nonhydrostatic dycore
  - A true deep atmosphere dycore does not exist
  - Chemistry modeling redundancy
- Code infrastructure
  - Lack of physics modularity in CAM
  - CAM parallelization layout has significant weak- and strong-scaling constraints.
- Coupling
  - Weather community has no well supported coupled (atmos/ocean/land/ice) research system
  - Insufficient coupling capability to MHD
- Climate, weather and geospace communities have not traditionally worked closely together, but need to in order to have physical parameterizations that are usable across communities

Tasks Underway To Quantify Feasibility

(Through CY 2019)

- Including MPAS in CESM (single version from single GitHUB repository)
- Model Independent Chemistry Module
- Common Physics Framework (CPF), compatible with NOAA CCPP
- Evaluating solutions to CAM physics scalability

❖ All these are proceeding slowly given resource limitations and the need to support current systems