System for Integrated Modeling of the Atmosphere (SIMA)

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A. Gettelman, B. Skamarock, M. Barth, H. Liu

SIMA Leadership Group

NCAR
NATIONAL CENTER FOR ATMOSPHERIC RESEARCH

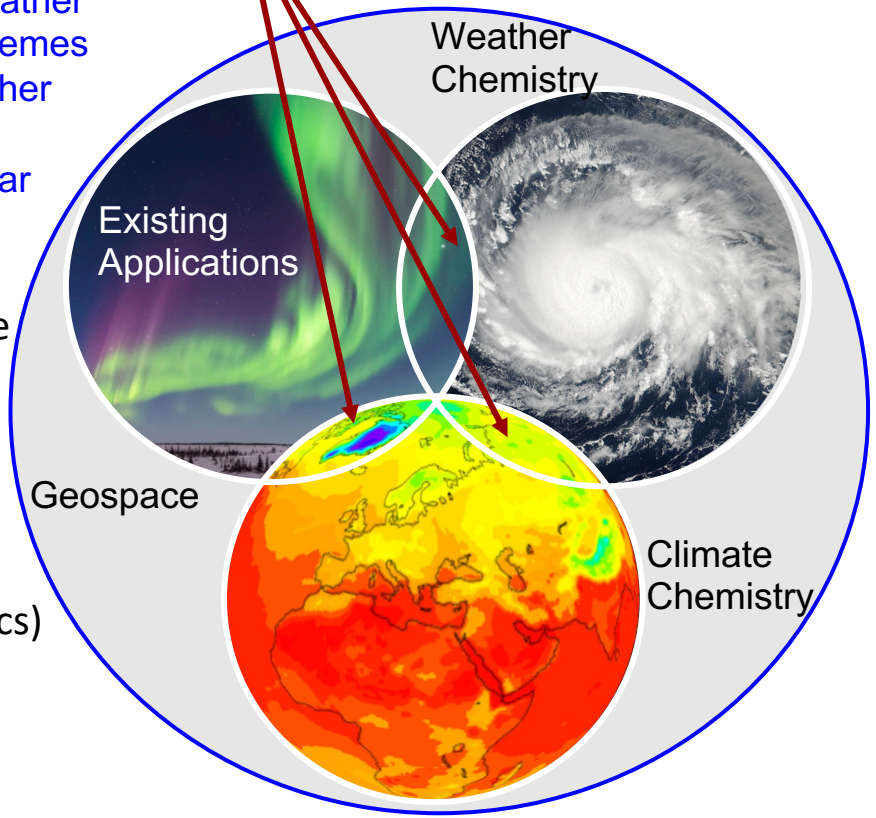
NSF

System for Integrated Modeling-Atmosphere (SIMA)

SIMA is composed of common atmospheric model components & infrastructure

SIMA Frontier Applications

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



SIMA Vision

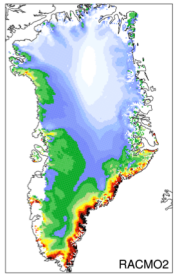
- Encompass Climate, Weather, Chemistry & Geospace
- Prediction (Initialized and Forecast) capabilities
- Complement & extend existing applications (CESM/WRF/MPAS)
- Shared infrastructure for efficiency
- Common atmospheric components (dynamics, physics)
- Includes education, observations, evaluation, computation

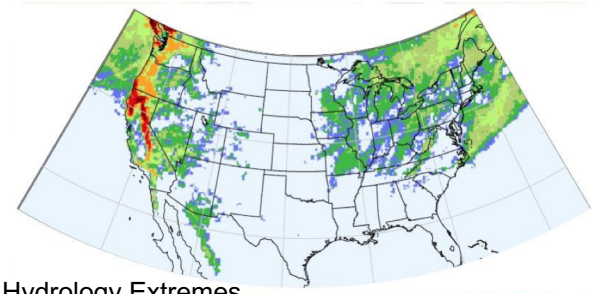
Frontier Science Goals

Map to specific applications

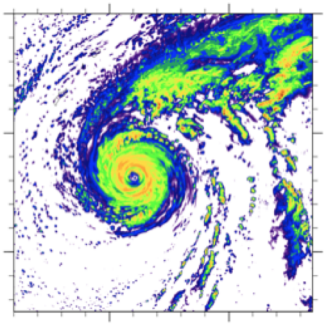
- Coupled Simulations at the Weather Scale
  - Tropical cyclones, Extreme convection
- Extreme weather under climate change
  - Extreme heat and precipitation, Hydrologic cycle extremes
- Polar Processes and Prediction
- Integrated Geospace modeling
- Regional/Urban Air Quality

Polar

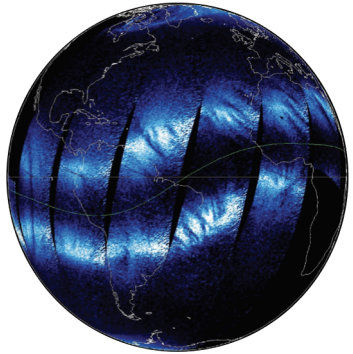




Hydrology Extremes

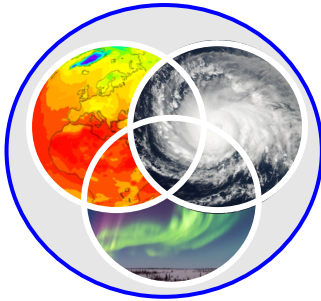


Tropical Cyclones



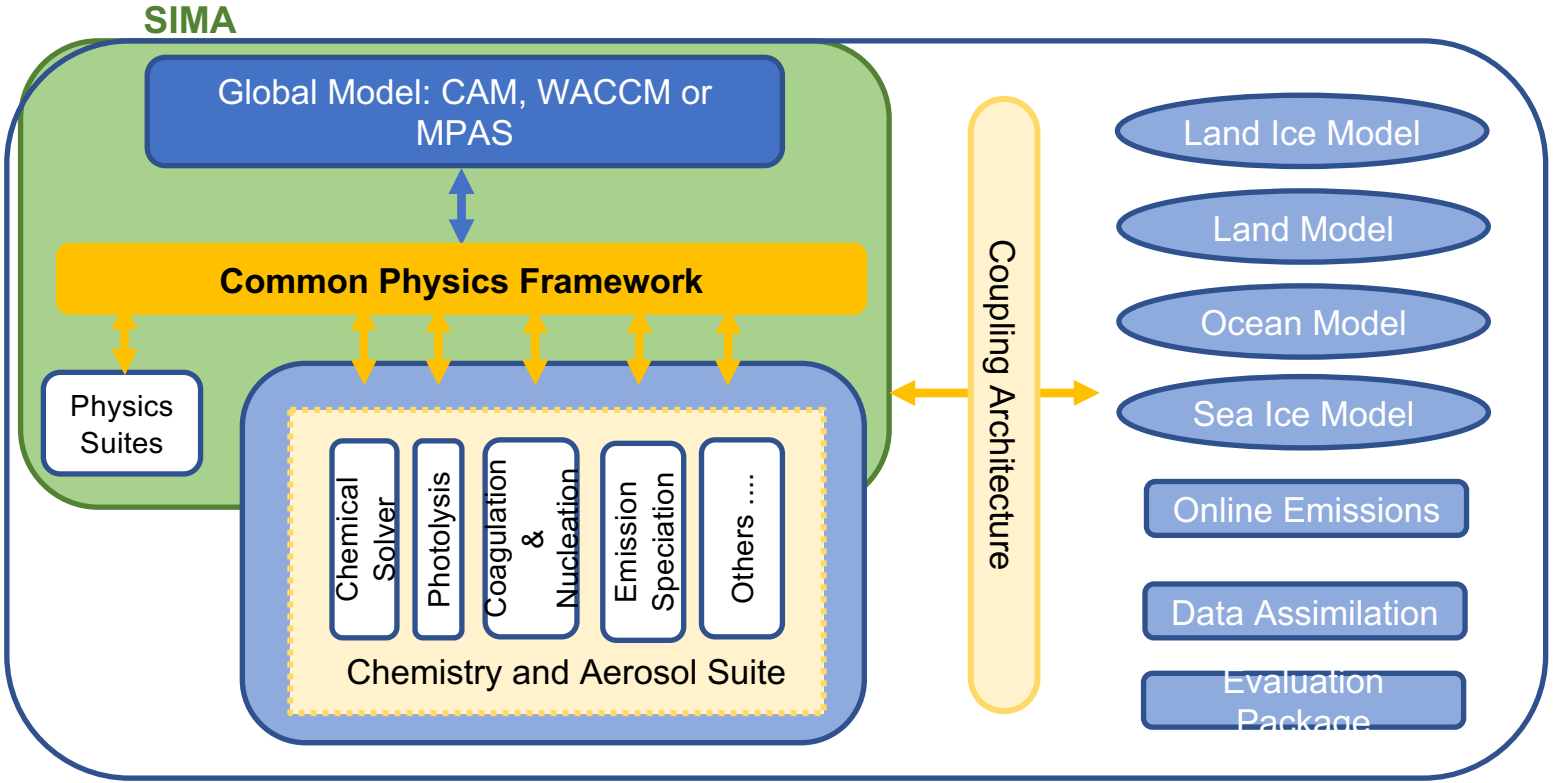
Space Weather

Current Efforts and Short-term Plans

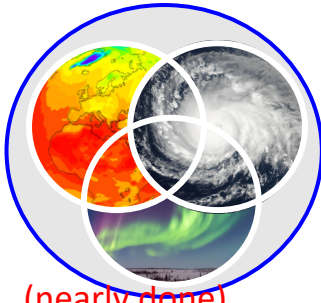


- Create a version 0 of SIMA (proof of concept)
  - Details in final slide
- Engage entire* community at workshop
  - 2-day workshop during 2-6 March week
  - Expect ~80 people, invitations and applications
  - Goal: Define SIMA effort for Weather, Climate, Geospace, and Chemistry applications
- Develop SIMA version 1
  - Refine SIMA v1 definition based on outcomes of workshop
  - Aim to have SIMA v1 by end of 2020

*Weather, Climate, Geospace, and Chemistry communities


SIMA
Global Model: CAM, WACCM or MPAS
Common Physics Framework
Physics Suites
Chemical Solver
Photolysis
Coagulation & Nucleation
Emission Speciation
Others ....
Chemistry and Aerosol Suite
Coupling Architecture
Land Ice Model
Land Model
Ocean Model
Sea Ice Model
Online Emissions
Data Assimilation
Evaluation Package

SIMA v0 Progress (goal to have v0 ready for workshop)

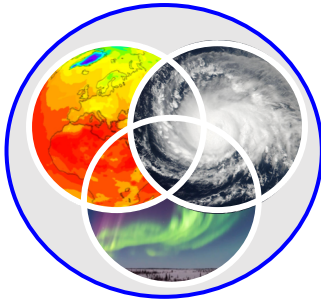


(Status)

- Common infrastructure
  - Common Physics Framework (CPF) initial version available
  - Suite of WRF physics parameterization becoming compliant with CPF (nearly done)
  - MICM code is compliant with current version of CPF
- Common Dynamical cores
  - MPAS dynamical core in CAM → non-hydrostatic dynamics and ability to couple with ocean model for tropical cyclone studies (Done; testing simple cases; address scaling issues)
- Releasing CAM SE regionally-refined grid meshes for CONUS and Polar regions to community
- Unified Chemistry (MICM/MUSICA)
  - Full tropospheric chemistry mechanism with CPF compliant code (MusicBox)
  - Test of MICM code in CAM without use of CPF (In progress)
  - CAM-Chem SE with regional refinement mature simulations (2013, forecasts) (Simulations complete; forecasts will occur once emissions are updated)
- Regridding scheme to connect atmosphere grid to ionosphere grid (Done; modify DyCore next)

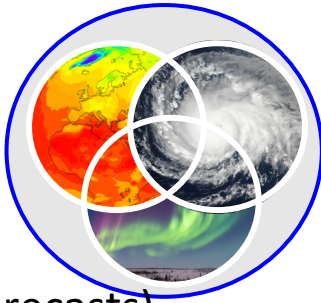
Extras

SIMA v0 – all items



- Weather
  - Suite of WRF physics parameterization becoming compliant with CPF
  - MPAS dynamical core in CAM – conduct null core test
  - Update CAM-MPAS to v7.0 MPAS
- Climate
  - Release CAM SE with regionally refined grid meshes for CONUS and Polar regions
  - Conduct CAM-MPAS (non-hydrostatic) for idealized cases
  - Test CPF in a simple model
  - Produce a prototype of CAM running with CPF
- Geospace
  - Regridding scheme to connect atmosphere grid to ionosphere grid
  - High resolution ionospheric modules using WACCM-X
  - Modify SE dynamical core for thermosphere

SIMA v0 – continued



- Chemistry
  - CAM-Chem SE with regional refinement mature simulations (2013, forecasts)
  - Full tropospheric chemistry mechanism with CPF compliant code (MusicBox)
  - Test of MICM code in CAM without use of CPF
  - Offline emission tool released to the community for regionally-refined grids
  - Translator for KPP files to JSON format (will provide guidance only because each mechanism contains its own unique set of KPP description)

  - Produce CAM SE version that is well tuned
  - Produce WACCM SE updating gravity wave parameterization and QBO
  - Produce SE RR emissions over CONUS
  - Evaluation of CAM-Chem SE RR runs with monitoring stations, aircraft field experiments, and satellite data as well as WRF simulations