

# MUSICA update for all WG leaders

Andrew Conley, Seb Eastham, Steve Goldhaber, Louisa Emmons, Claire Granier, Marc Guevara, Bernard Aumont, Kelley Barsanti, John Orlando, Jerome Fast, Alma Hodzic, Xiaohong Liu, Mary Barth, Karen Rosenlof, Allison Steiner, Nick Davis, Lorenzo Palvani, John Plane, Ave Arellano, Ben Gaubert, Daven Henze, Simone Tilmes

## and Steering/Advisory Group(s)

Gabi Pfister, Arlene Fiore, Georg Grell, Daniel Jacob, Daniel Marsh, Elizabeth Barnes, Larry Horowitz, Katie Lundquist, Vincent-Henri Peuch

1. Update on activities between May 2019 and now
2. Ongoing and Future Activities
3. Discussion Items

November 2020

# Outcomes of MUSICA Kickoff Meeting from May 2019

## Created 7 working groups

1. Model Architecture (Leads: Andrew Conley, Seb Eastham, Steve Goldhaber)
2. Emissions & Deposition (Leads: Louisa Emmons, Claire Granier, Marc Guevara)
3. Chemical Schemes (Leads: Bernard Aumont, Kelley Barsanti, John Orlando)
4. Aerosols (Leads: Jerome Fast, Alma Hodzic, Xiaohong Liu)
5. Physics, Transport, Subgrid (Leads: Mary Barth, Karen Rosenlof, Allison Steiner)
6. Whole Atmosphere (Leads: Nick Davis, Lorenzo Palvani, John Plane)
7. Evaluation & Data Assimilation (Leads: Ave Arellano, Ben Gaubert, Daven Henze, Simone Tilmes)

## Wrote a MUSICA vision paper that is published in BAMS

- Pfister and 26 co-authors (2020) – [just published](#)

Little things that have been done:

- Enhanced the [MUSICA website](#)
- Created a logo
- Created a general email list called [musica-info@ucar.edu](mailto:musica-info@ucar.edu)
- Created an inquiry form to ask questions, receive news updates, request code as a friendly user

**MUSICA**

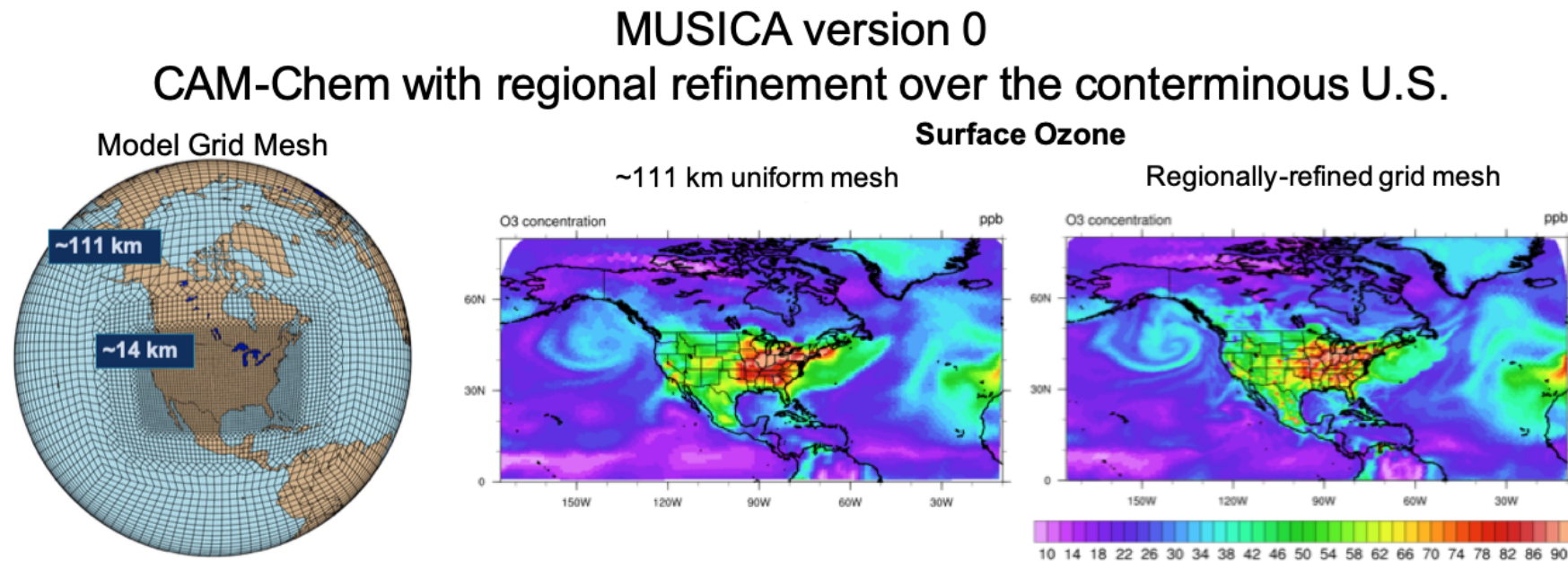
Multiscale Infrastructure for  
Chemistry and Aerosols

## Currently developing a MUSICA Implementation Plan

- Leads of each WG were asked to write a plan to outline issues and give tasks of what needs to be done
  - Science perspective
  - WG leads have written these
  - Currently should be shared with WG members to get feedback
  - Some WGs are adding members; suggestions welcomed
- Next steps
  - Outline software engineering plan to make each WG implementation plan happen
  - Bring together individual WG plans into one overall MUSICA implementation plan

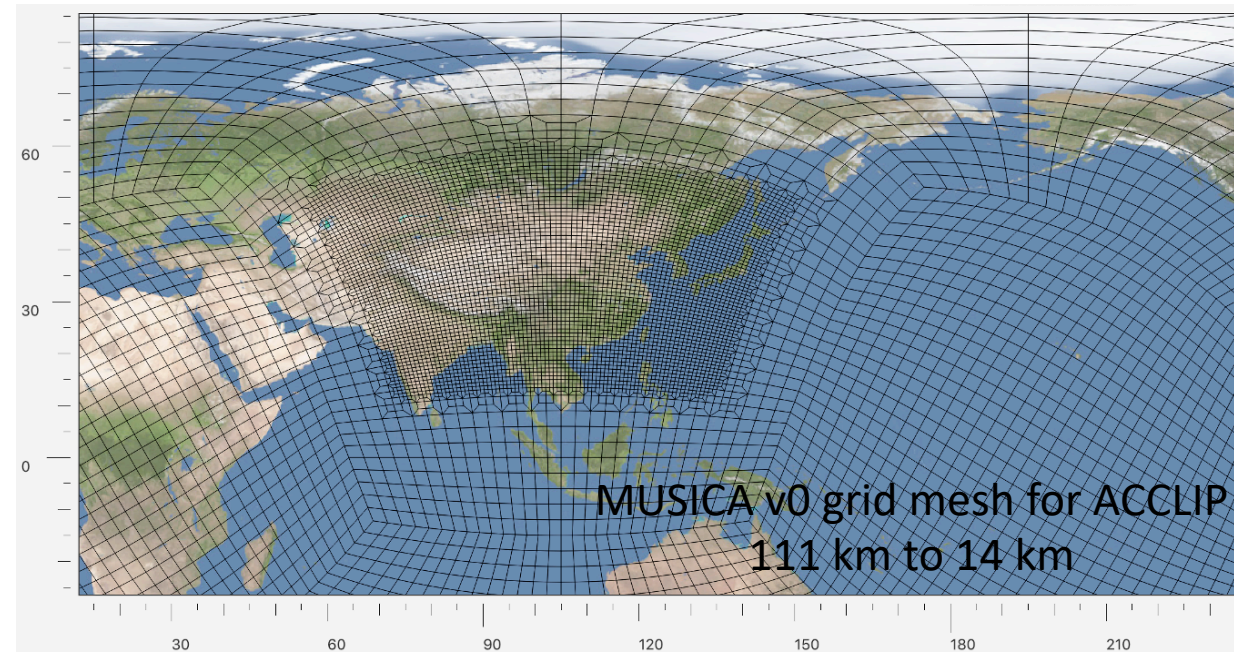
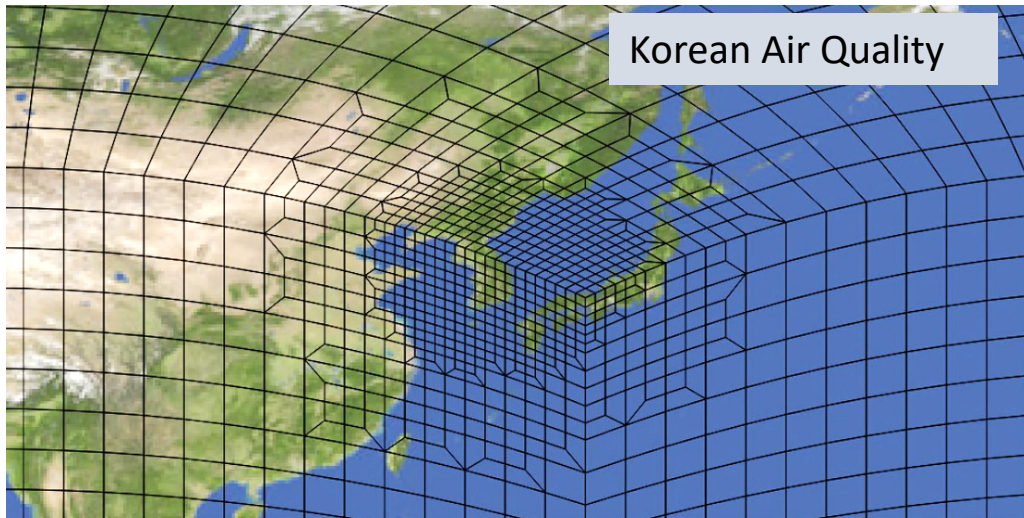
# Past Model Developments

- MUSICA version 0 released as a compset of CESM2.2.0
  - Information at <https://www2.acom.ucar.edu/sections/musicav0>
  - Includes offline emission tools for regridding to an unstructured grid
  - Tutorial for MUSICA v0 will be a mini-series of instruction sessions this winter



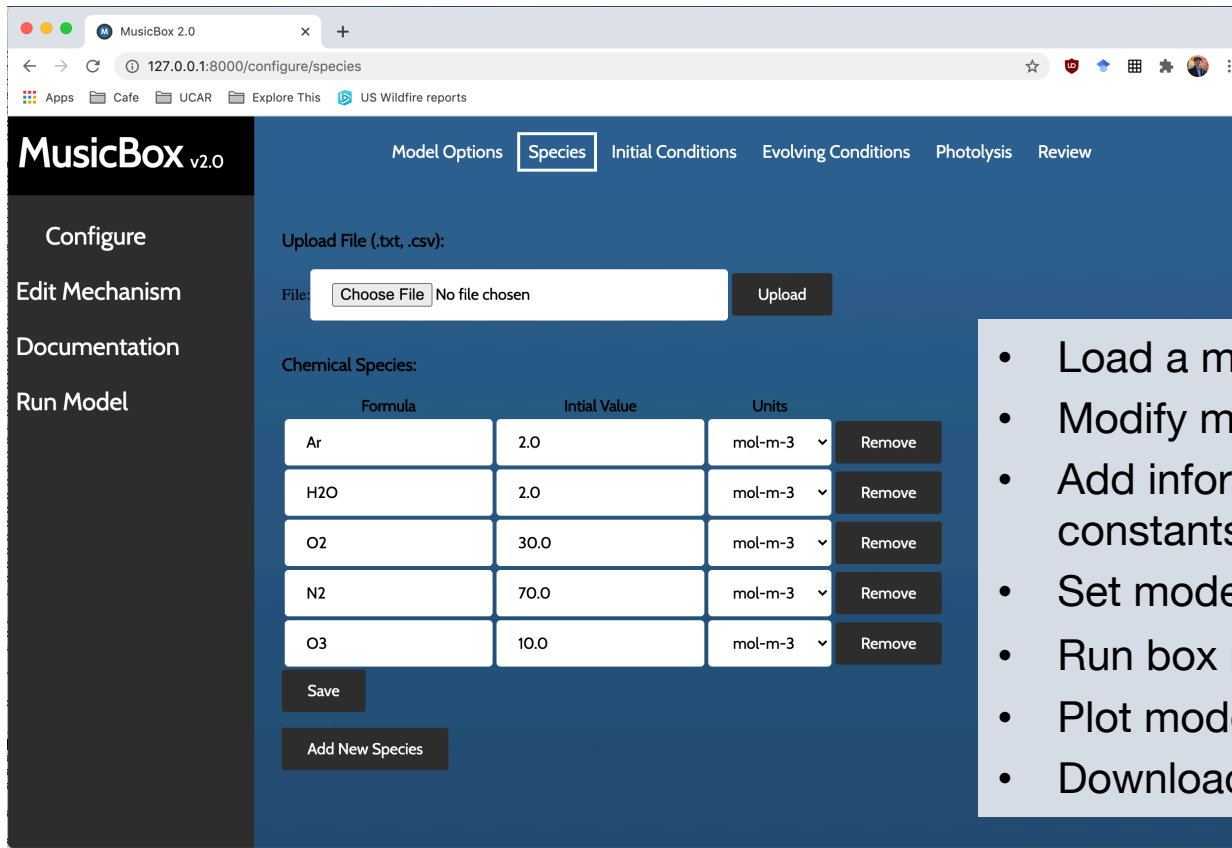
## Future MUSICA V0 Applications

- Biomass Burning over North America in context of FIREX-AQ and WE-CAN
- Korean Air Quality
- Asian Summer Monsoon Chemical and Climate Impact Project (ACCLIP)



# Ongoing Model Developments

- Model Independent Chemistry Module and MusicBox
  - Information at <https://www2.acom.ucar.edu/sections/musica-projects>
  - Tutorial for MICM/MusicBox will be later this winter



The screenshot shows the MusicBox v2.0 web interface. The browser address bar displays "127.0.0.1:8000/configure/species". The page has a dark blue header with navigation tabs: "Model Options", "Species" (selected), "Initial Conditions", "Evolving Conditions", "Photolysis", and "Review". On the left, a sidebar contains "Configure", "Edit Mechanism", "Documentation", and "Run Model". The main content area includes an "Upload File (.txt, .csv):" section with a "Choose File" button and an "Upload" button. Below is a "Chemical Species:" table with columns for "Formula", "Initial Value", and "Units".

Formula	Initial Value	Units	
Ar	2.0	mol-m-3	Remove
H2O	2.0	mol-m-3	Remove
O2	30.0	mol-m-3	Remove
N2	70.0	mol-m-3	Remove
O3	10.0	mol-m-3	Remove

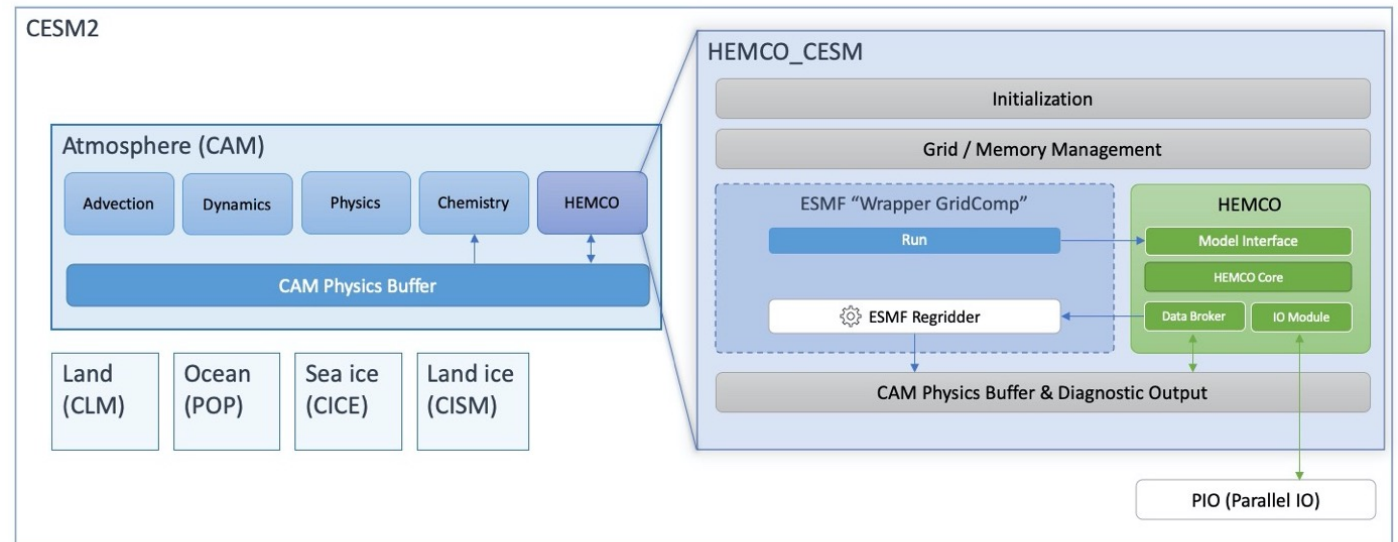
Buttons for "Save" and "Add New Species" are located at the bottom of the table.

- Load a mechanism file
- Modify mechanism (species, reactions, etc.)
- Add information about species (e.g., Henry's Law constants), document reactions (references)
- Set model conditions (initial, time-varying)
- Run box model
- Plot model results (compare 2 mechanisms)
- Download results

# Ongoing Model Developments

- Integrating GEOS-Chem as a chemical module in CESM
  - Information at <http://acmg.seas.harvard.edu/research.html#esmf>
  - Develop interface between GEOS-Chem and CESM
  - Develop HEMCO as a stand-alone tool to serve emissions in CESM
  - Implement GEOS-Chem in SIMA

## HEMCO-CESM Architecture



D. Jacob, S. Eastham, L. Emmons

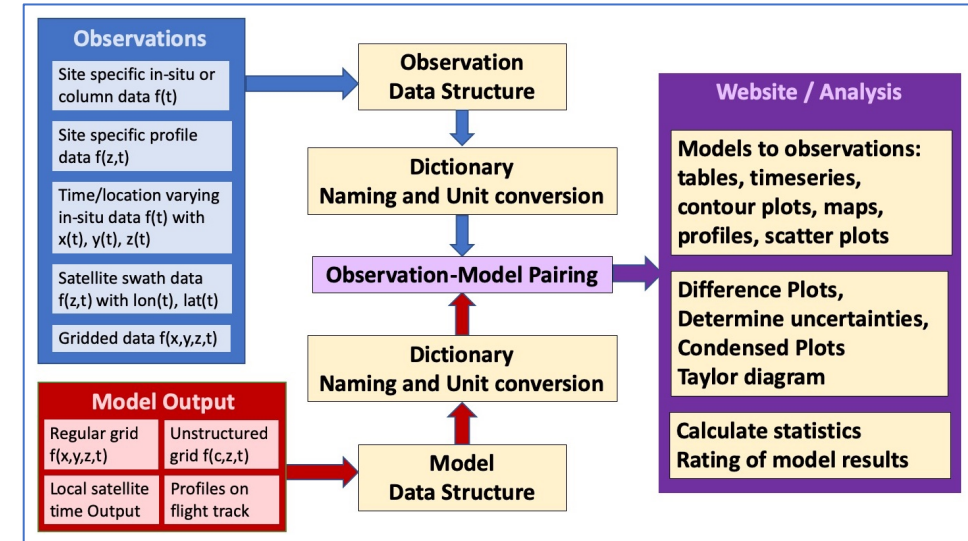
T. Fritz, H. Lin, L. Lundgren, and others



# Future Model Developments

## 1. MELODIES: Model Evaluation using Observations, Diagnostics and Experiments Software

- PI: Emmons; co-Is: Gaubert, Tilmes, Pfister, Worden, Arellano, and G. Chen
- NSF/Earthcube grant recently awarded
- Community input discussion coming soon

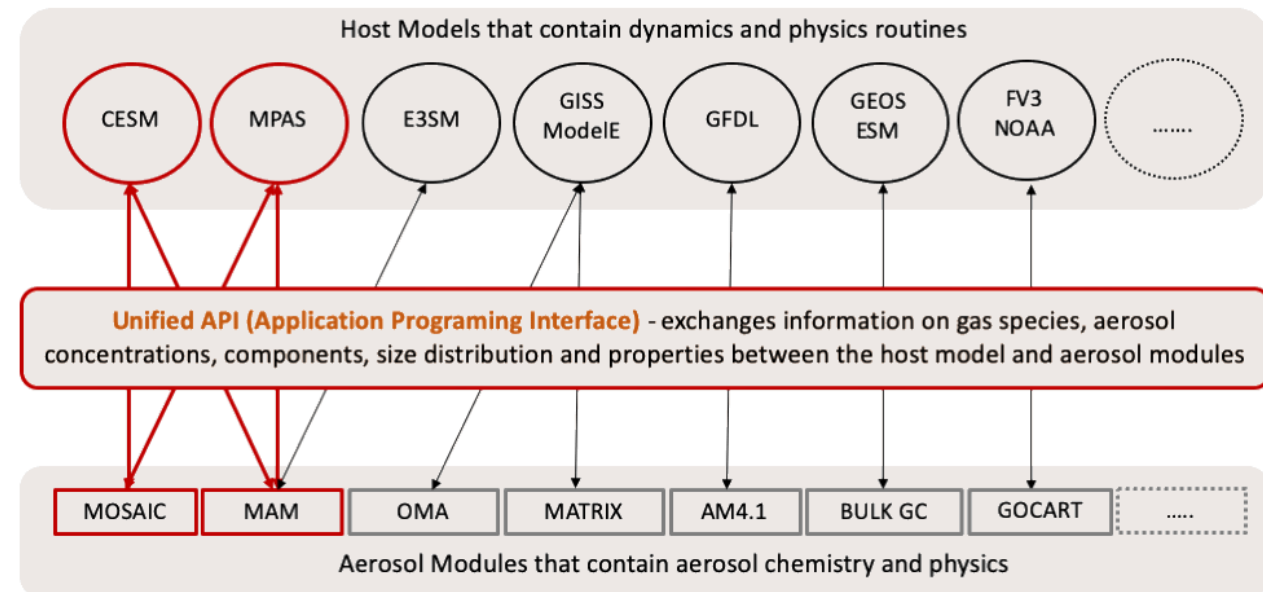


## 2. Implementation of modified reaction rates due to incomplete mixing in a grid box

- Part of the NCAR Boundary Layer Reinvestment Project (PI: Ned Patton)

# Other Updates

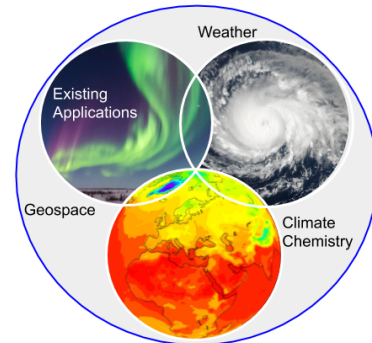
- MUSICAL – Leveraging MUSICA to generalize aerosol modeling
  - Facilitating the interchange of aerosol–chemistry models across atmospheric models MUSICAL (E3SM, GISS, GEOS-Chem, GFDL)
  - White paper drafted and being brought to attention of funding agencies
  - Participants: modelers from NCAR, PNNL, NASA/GISS, GEOS-Chem, NOAA/GFDL, TAMU, Cornell, U. Illinois.



NCAR-wide:

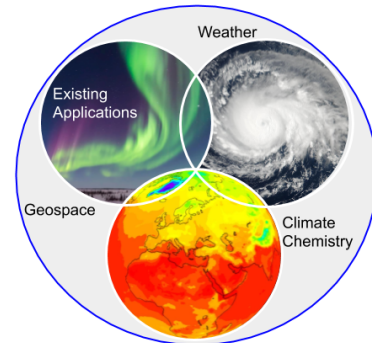
## SIMA: System for Integrated Modeling of the Atmosphere

- SIMA is an effort to unify infrastructure of NCAR models
  - MUSICA is connected to SIMA for the NCAR modeling
- SIMA will enable frontier science questions to be addressed, e.g.
  - Predictability of tropical convection and tropical cyclone formation
  - Extreme events needing high resolution modeled for climate scales
  - Processes affecting Greenland Ice Sheet
  - Effect of multi-scale processes on space weather
  - Biomass burning effects on air quality, weather, and climate
- A unified infrastructure
  - More efficient use of development, maintenance, and support resources
  - Improve ability to respond to new computational platforms



## SIMA Update [SIMA wiki page](#)

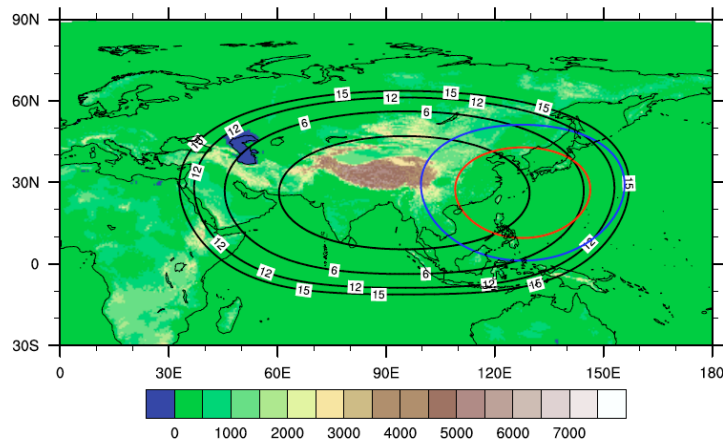
- SIMA version 0 (2019-2020 activities)
  - Chemistry: MUSICA v0 with offline emission tool; MICM/MusicBox; test MICM in CAM
  - Geospace: SE dycore for thermosphere; regriding to geomagnetic grid; couple WACCM-X to ionosphere model; couple GAMERA to WACCM-X
  - Polar: create and release CAM SE with high-res grid over pole
  - Weather/Climate: modified a WRF/MPAS physics suite to be CCPP compliant; modifying MPAS dycore to be CCPP compliant; placing MPAS dycore in CAM and testing for Use Cases
- SIMA Workshop (June/July 2020)
  - Develop vision and Use Case Examples
  - [SIMA Vision Statement](#) updated and currently under review by NSF



## SIMA Next Steps [SIMA wiki page](#)

- We are identifying a SIMA configuration(s) to develop in next year
- One possible goal: MPAS coupled with ocean model with refined grid over East Asia to evaluate with PRECIP and ACCLIP field campaign data; tracers or small MICM chemistry mechanism would be part of this configuration

MPAS grid mesh for ACCLIP  
15 km to 3 km

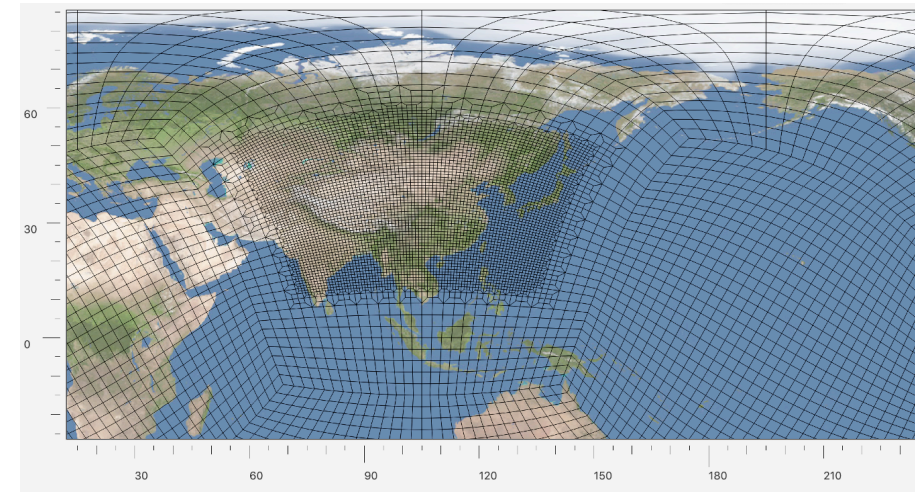


MPAS grid mesh for PRECIP  
15 km to 3 km



CONTOUR FROM 4 TO 14 BY 2

MUSICA v0 grid mesh for ACCLIP  
111 km to 14 km



## Discussion Items

- Are there other model development efforts?
- Working Group Membership
- Implementation Plan Planning – i.e., how should we proceed?