

(Ultra-) High Resolution and Regionally-Refined Modeling: Survey Results

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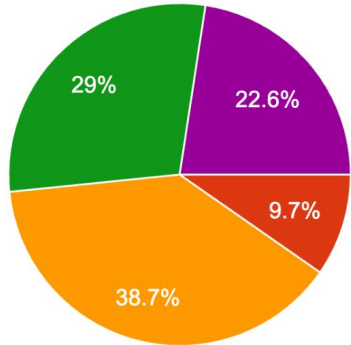


Outline

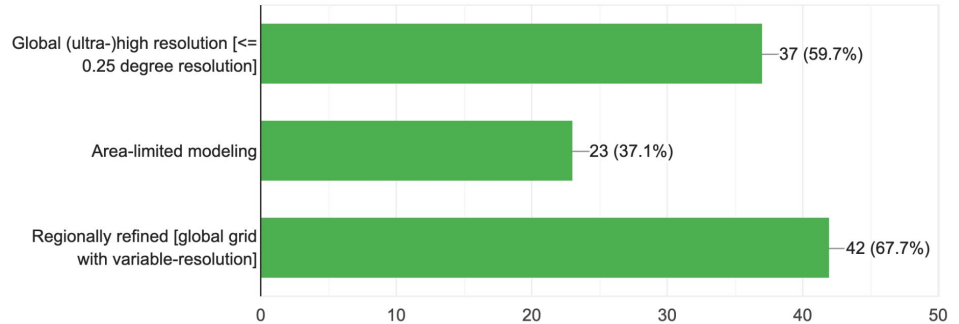
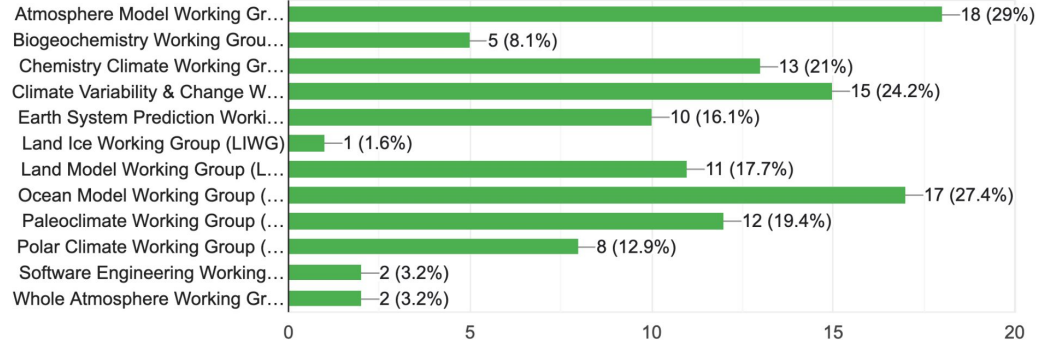
- General overview
- (Ultra-) High-resolution modeling stats
- Variable-resolution modeling stats
- Area-limited modeling stats
- Venn Diagrams for benefits and shortcomings to all 3
- Community resources and needs
- Discussion & Discussion Questions

General Overview

N = 62 responses total



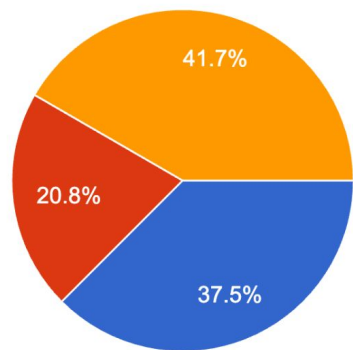
- Undergraduate Student
- Graduate Student
- Early Career Scientist (within 10 years of your highest degree)
- Mid Career Scientist
- Senior Scientist



(Ultra-) High-resolution modeling [$\leq 0.25^\circ$]

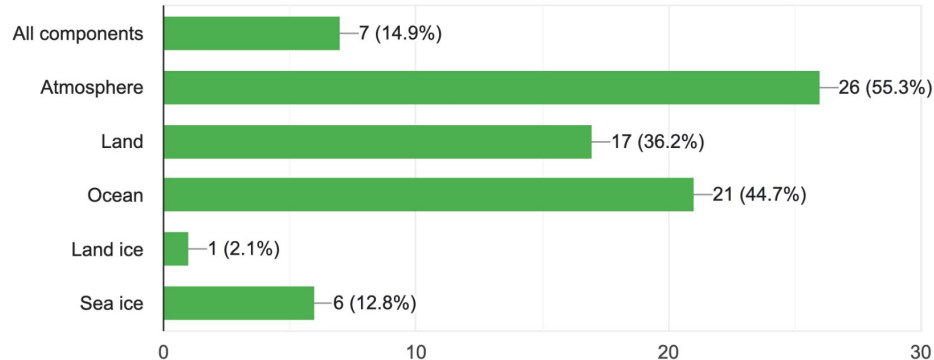
How long have you worked with (ultra-)high resolution?

48 responses



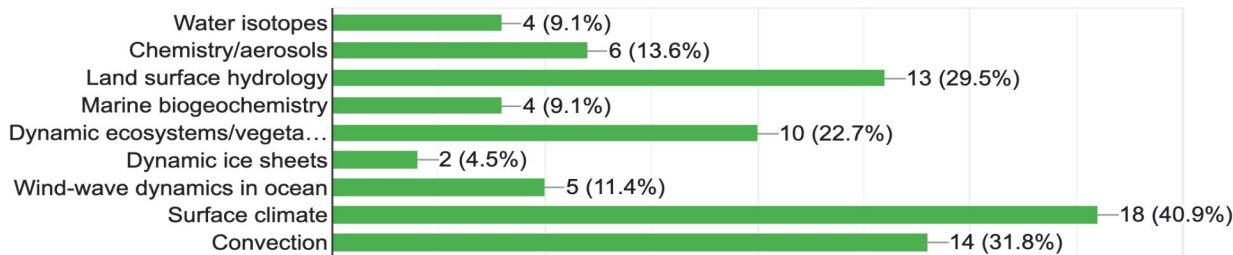
- Not started yet
- Less than 1 year
- More than 1 year

Other: *polar lows, weather extremes, AMOC, air-sea-ice interaction, ocean eddies & currents*



What (ultra-)high resolution modeling capabilities are you working with or are interested in working with? Please fill in any that are missing.

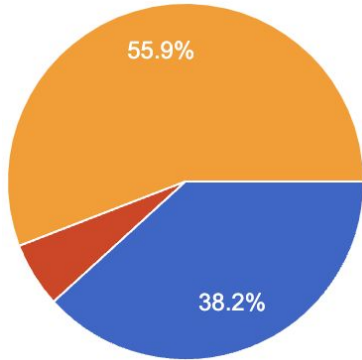
44 responses



Area-limited modeling

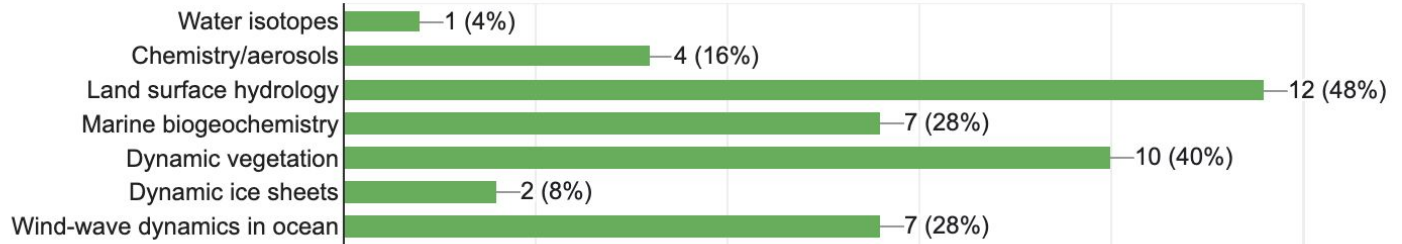
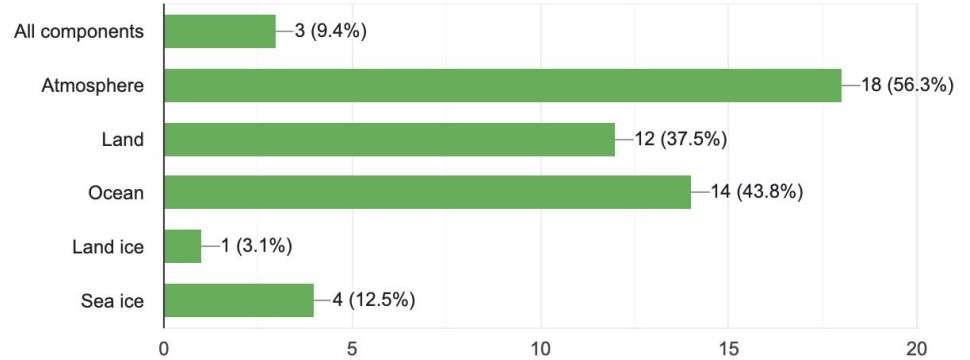
How long have you worked with area-limited models?

34 responses



- Not started yet
- Less than 1 year
- More than 1 year

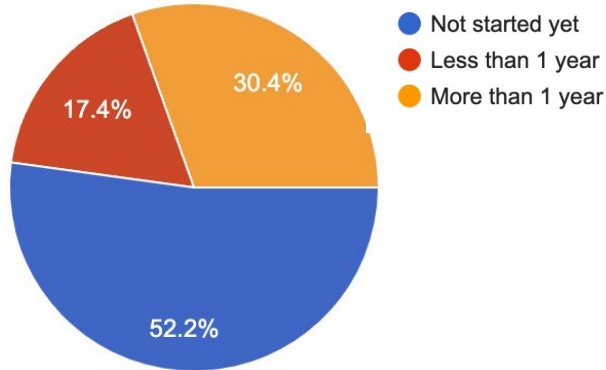
Other: clouds & turbulence, ocean eddies & currents, coastal impacts, surface climate



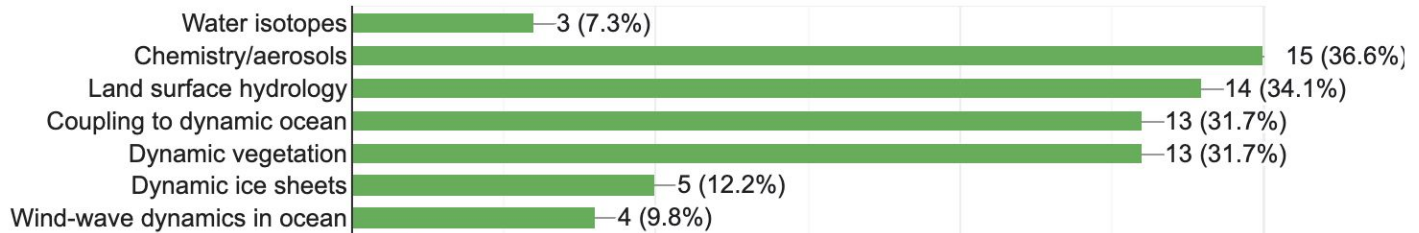
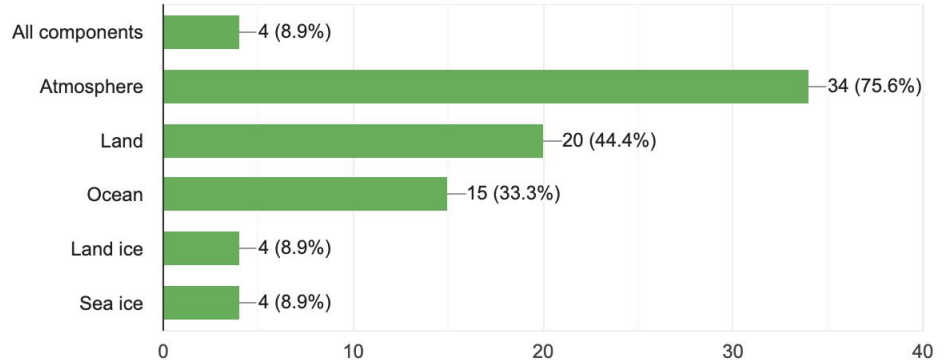
Global Grid with Regional Refinement

How long have you worked with variable-resolution modeling?

46 responses



Other: clouds, surface climate, convection, biogeochemistry



Common Processes

- Processes & features produced by high land surface heterogeneity (e.g., topography, vegetation, urban areas)
- Hydroclimate extremes (e.g. atmospheric rivers)
- Cloud processes
- Atmospheric chemistry and aerosols
- Ecosystems
- Air-sea-ice interactions
- Convection
- Gravity waves
- Surface turbulent fluxes
- Eddies & ocean currents
- Thermohaline circulation
- Marine heatwaves

What are the Main Benefits

**Global
(ultra-)high
resolution**

Explicitly resolve
traditionally-parameterized
processes globally

Fully-coupled Earth
system capability at hi-res

Two-way interaction
large-scale climate &
mesoscale

Improve many processes
compared to traditional
lo-res simulations

Resolve scales closer
to obs. & community
impacts

Capture regional hi-res
with physically consistent
lo-res global model

More rapid development
and testing

Achieve higher resolution
in region of interest than
global simulations

Cheap compared to
global simulations

Cheap compared
to global hi-res
simulations

Can focus resources
on region of interest

**Global with
regional-refinement**

Area-limited

What are the Main Shortcomings

**Global
(ultra-)high
resolution**

Compared to other modeling...
most expensive, shortest,
fewer simulations

Largest data volume

Less accessible at the
moment

Long development
and testing cycles

Scale-dependence of many
parameterizations is
uncertain

Losing information between
outer lo-res domain and
inner hi-res domain

Artifacts from
refinement region

**Global with
regional-refinement**

Area-limited

Lack two-way interaction
with global climate

Global model biases
superimposed on regional model
biases

Need inputs at
boundaries of model
domain

Compared to traditional lo-res
simulations...

More expensive, shorter, fewer

Generating resolution
specific input files can
be challenging

Useful Resources & Community Needs

Common resources:

- CISM Forum
- CISM Python lectures
- MUSICAv0 tutorial
- AMWG, CCWG, OMWG, ACOM members

Other resources:

- Python: dask, xarray, xgcm, pangeo
- DRAKKAR and Mercator for NEMO
- Meeting people at WCRP & internal NCAR meetings

Common needs:

- More comprehensive online technical documentation and outreach to empower community and reduce reliance on individual expert support
- Scripts for post-processing data
- More distributed resources (ultra-high)
- More software engineering support

Other needs:

- Extension of CISM Tutorial dedicated to high-res
- VR-CISM2 Workshop

Discussion Questions

- Q1: Do you have any additional questions/thoughts about the survey and/or session talks? Did we capture the Venn diagram content correctly?
- Q2: Do you feel that you are using the right tool for your research question considering the computational expense?
- Q3: Which of these configurations should be supported by CESM, and how could we overcome their challenges?