Goals	Science Goal	Current Use Case/Application
Climate	Understand the mechanisms that lead to interdecadal, interannual, and seasonal variability in Earth's climate. What are the mechanisms (high-res, chemistry, interaction with surface, hydrology) that we can't do but are relevant?	100 km century scale coupled earth system simulations. Moving to 0.25˚ (Globally uniform)
	Apply this modeling system to estimate the past and likely future of Earth's environment	Multi-century to millennial scale coupled earth system modeling
Weather-climate	Understand the capability of weather model physics to perform on climate scales and vice versa Satisfy climate and weather metrics simultaneously	Exercise weather models and climate models on the same framework and targets
Weather	Provide a flexible weather simulation tool for the community that enables construction of forecasts, as well as a research and development capability	● Global 15 km 10 day initialized forecasts. ● Regional/Global Convection resolving (3km) high impact weather simulations (5 days)

	Improved weather and air quality (AQ) prediction via improved data assimilation capabilities for model initialization	• Initialize land models and run forecasts • Initialize atmospheric composition and run AQ forecasts
	Key phenomena: Hurricane Prediction, Convective Weather Prediction, Antarctic Prediction, AQ prediction	Regionally-refined models for ocean basins, Antarctic, urban regions High-res campaign-focused chemistry simulations (FRAPPE, KORUS, SOAS, ...)
Geospace	Improve forecasting of space weather hazards and their impacts on the Earth, people, and technology	Initialized whole atmosphere experiments
	Characterize and evaluate the impact of solar variability and climate change on the coupled terrestrial and space climates.	Multi-century to millennial scale coupled whole earth system modeling
Frontiers		
Mesoscale Processes: Coupled	• Subseasonal to Seasonal (S2S) prediction: including global scale phenomenon such as ENSO, QBO, MJO, Monsoons and their effects and coupling to atmospheric composition • Land-Atmosphere Interactions	Global ensemble coupled (with assimilation) prediction system for S2S applications. [Detail? What does that mean? Resolution?]

	● Tropical Cyclones and Other extreme events (Convection) ● Chemistry-Atmosphere interactions (volcanoes, fires, urban emissions)	Convection resolving (3km atm, 1/12th deg ocean) high impact weather simulations with a coupled system. Stepping stone is a small region. Goal is global. Running as a prediction system (initialized forecasts). E.g. Daily forecast system, and also research mode. Coupling to higher resolution (1km) land, approach 250m hydrology (used in national water model). Atmospheric boundary layer blending heights. Represent Regional scale @ 3km but with global scale impacts. [Scale and locations where people live: need emissions responding to climate/weather]: Critical is resolving the first 50m of the atmosphere, interaction with land (canopy)

Climate impacts	• Regional climate extremes • Extreme weather and air quality phenomena under climate change • Surface hydrology • Better able to study and represent phenomena	Statistics of high impact weather @ 3km under different climate regimes/scenarios with Earth system model. Ensembles. [Argument for being around 10km for tropical cyclones]. [Pace current global weather simulations at 10-15km for coupled climate prediction.]
Unified Earth System	• chemistry (?) • coupled earth system modeling	
	• How does tropospheric weather drive space weather variability? • Forecasting the whole atmosphere response to extreme space weather events	• Ground-to-space simulations with regionally-refined global model • High-resolution simulations coupled to a magnetosphere
Simulation Frontiers	• Develop and coordinate ‘unified’ (and convergent) physics that works across scales,	A modeling framework that is easy for the community to use for problems at different scales. Small scale problems run on a

	and encourage its development with community partners ● Multi-scale (weather to climate) validation and evaluation tools ● Robust common frameworks for more efficient computation, development and testing ● Education and training to grow user base and educate next generation of forecasters and scientists	university cluster. Also easy to develop internally and externally. Evaluation tools in a common framework that the community can add to. Robust user base that serves community needs