

# NCAR Unified Community Atmosphere Modeling Roadmap

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On behalf of the *Singletrack Steering Group*



*Singletrack* is currently an NCAR group (60+ total) developing this roadmap

## Singletrack Purpose

Develop a strategic vision and roadmap to unify and improve community atmospheric modeling efforts across NCAR

- Intent: a Unified *Community* Atmosphere Model in the Earth System Model

## Singletrack Goals

- Unify Weather (WRF, MPAS), Climate, Geospace (CAM-->WACCMX) applications
- Enable future ‘frontier’ science across scales: Weather-Climate Interface
- Engage the weather/climate/geospace community in this effort

*Singletrack’s purpose and goals are aligned with recommendations from the Jan 2018 NCAR advisory panel and 2017 NSF Site Visit Team (SVT)*

## *What is a unified atmosphere model?*

A minimal set of interoperable components: dynamical cores, physical parameterizations, chemical models, etc, with compatible or identical infrastructure (e.g. coupling, I/O, testing). These components cover the primary applications for the climate, weather and geospace communities.

Over time, we expect to evolve towards fewer components covering more applications.

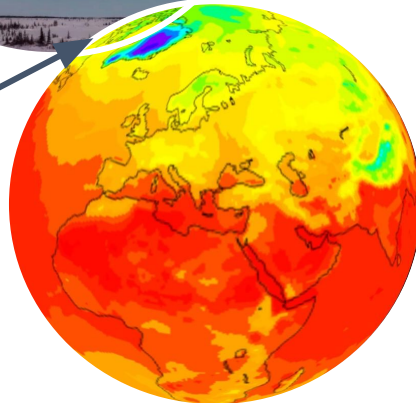
# Current Community Atmosphere Models

Existing Applications

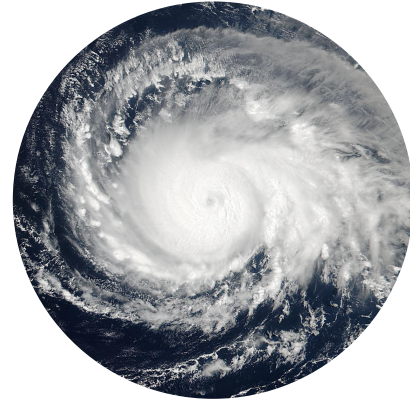
Geospace (TIE-GCM)



WACCM-X



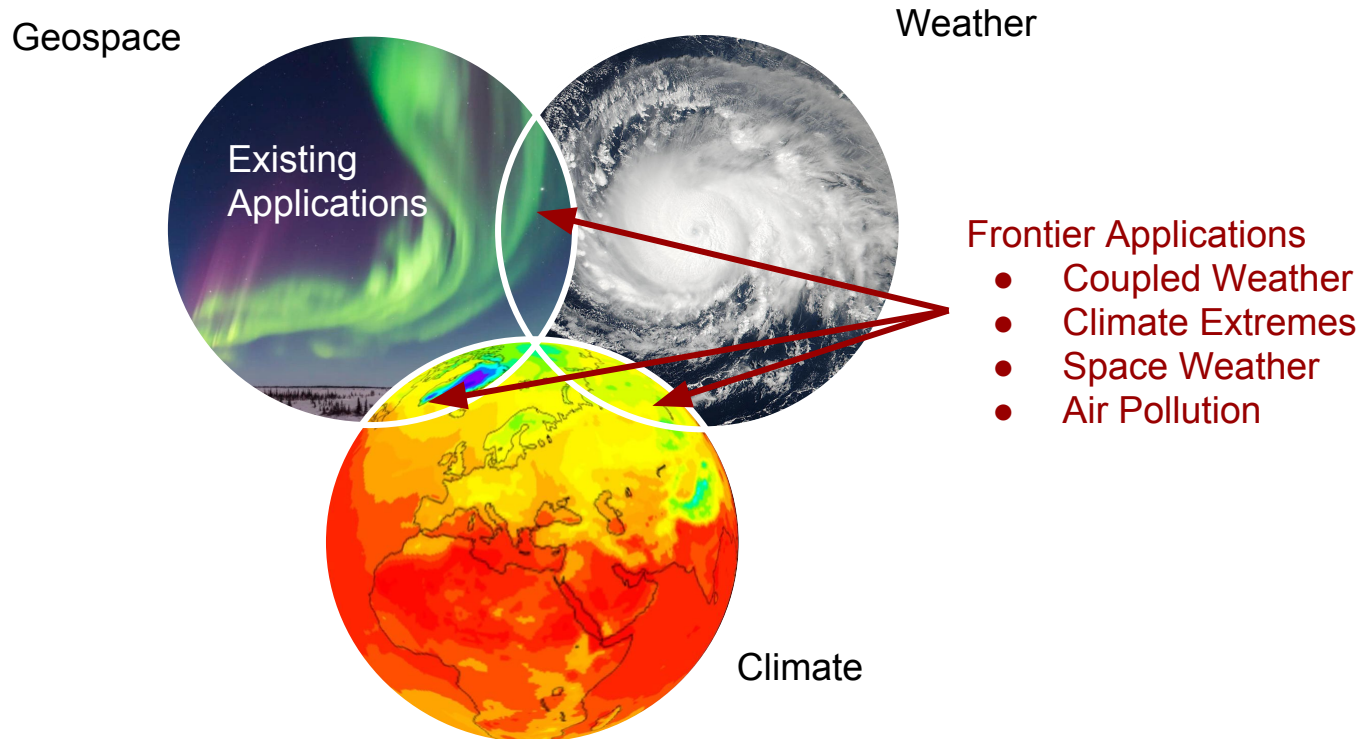
Weather (WRF & MPAS)



Climate (CAM)

# Singletrack Vision

Support Existing and Frontier Applications

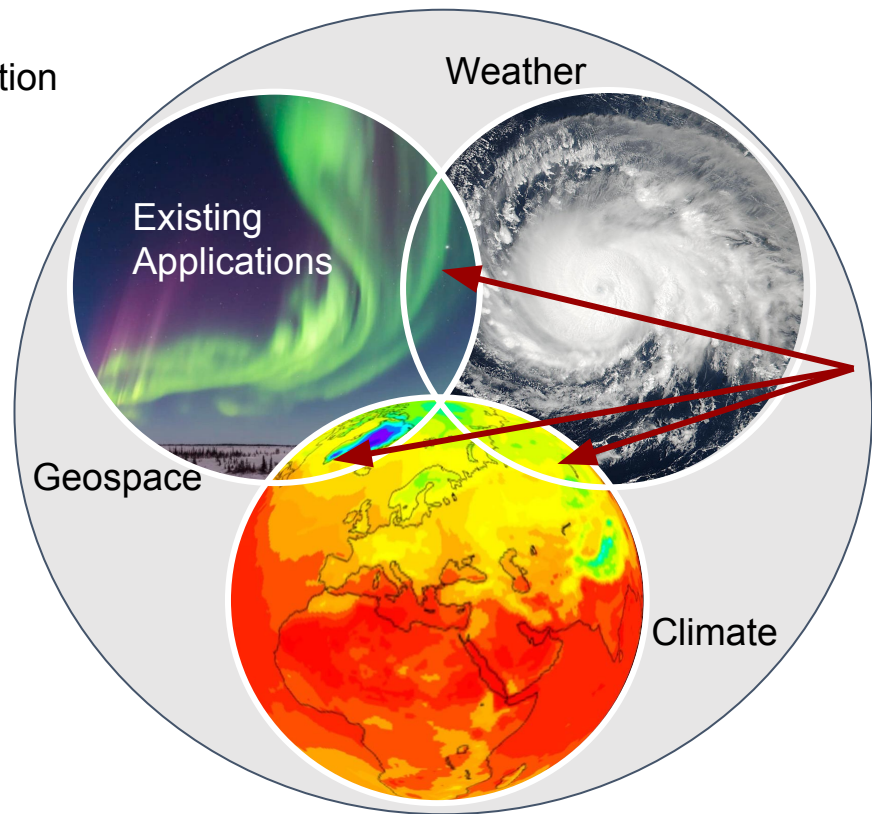


# Singletrack Vision

Support Existing and Frontier Applications

## Unified Infrastructure

- Initialization/Prediction
- Diagnostics
- Coupling in ESMs
- Small to Exascale
- Usability



## Frontier Applications

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

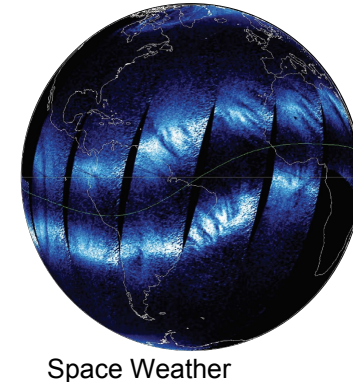
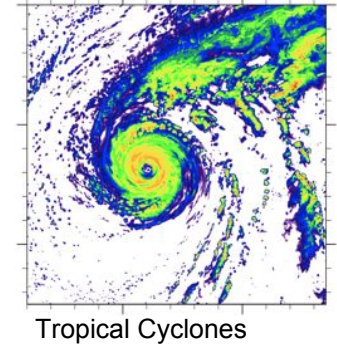
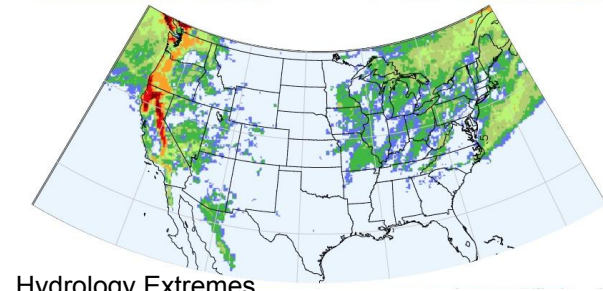
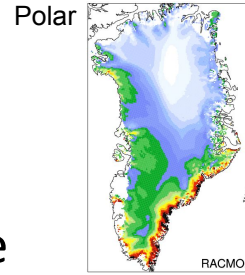
# Unified modeling and existing applications

- Existing *Science Goals and Applications* will be supported
- Singletrack developments meet atmospheric needs in WRF/CESM Strategic Plans
- WRF/MPAS: support forecast and weather science
  - WRF is NOT going away unless all applications can be met
  - Singletrack will enable better testing/portability of physics
- CESM: singletrack can be the atmosphere model for CESM3
  - Existing climate applications supported
  - No change in CESM Governance
  - Improved testing and traceability with portable physics

# Frontier Science Goals

Map to specific applications

- 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 Prediction
- Integrated Geospace modeling
- Subseasonal to Seasonal (S2S) to Decadal Prediction
  - Intra-seasonal (MJO), And interannual (ENSO)
- An Atmospheric Model in the coupled system
  - Land - Atmosphere Interactions
  - Unified chemistry





# Singletrack Applications

Application Examples and Configurations

<b>Topic</b>	<b>Example Application</b>	<b>Configuration</b>
Weather	Tropical Cyclones	3km refined mesh, coupled ocean, forecasts
Climate	Hydrologic Extremes	3km refined mesh, forecast and climate simulations
Polar	Arctic Prediction	5km refined mesh, coupled ocean, land, sea ice, land ice. Forecast and climate simulations
Geospace	Space Weather Prediction	10km global atmosphere to the ionosphere, forecast.
Chemistry	Urban/Regional Air Quality Prediction	Urban: <1km regional forecast. Regional: 4km refined global mesh, climate and forecast

# Singletrack: a *community* atmosphere model

- ❖ Community Engagement in Planning, Definition, Applications
- ❖ Improved usability for focused problems (regional weather, idealized)
- ❖ Common interfaces/infrastructure to aid community development
- ❖ Diagnostic tools to incorporate observations & facilitate analysis
- ❖ Education/Training/Tutorial Components
  - New science areas for early career scientists
  - New model developments
- ❖ Community Governance: Weather & Climate components

# Singletrack: Timeline

Past, **Present**, Future

- Jan-February: Organized, developed science goals, requirements
- March: Development of specific application examples
- April: feedback from NCAR stakeholders
- May: develop vision/applications
- May: Develop roadmap ideas (Define Tasks/Resources)
- June: Discussions with NSF
- June: Solid vision/plan draft presented at WRF/CESM meetings
- **July: Incorporate feedback, aim for 'release' of a draft plan**

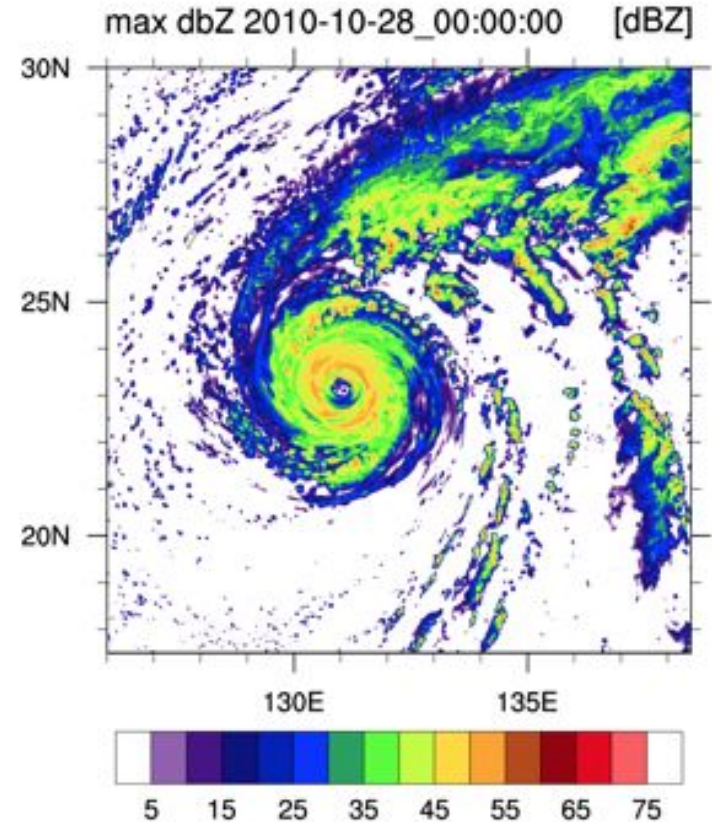
# Extra: Applications Details

# Applications: Weather

## Tropical Cyclones

Simulate coupled weather phenomena in a coupled system at high (<5km) resolution. Example: tropical cyclones.

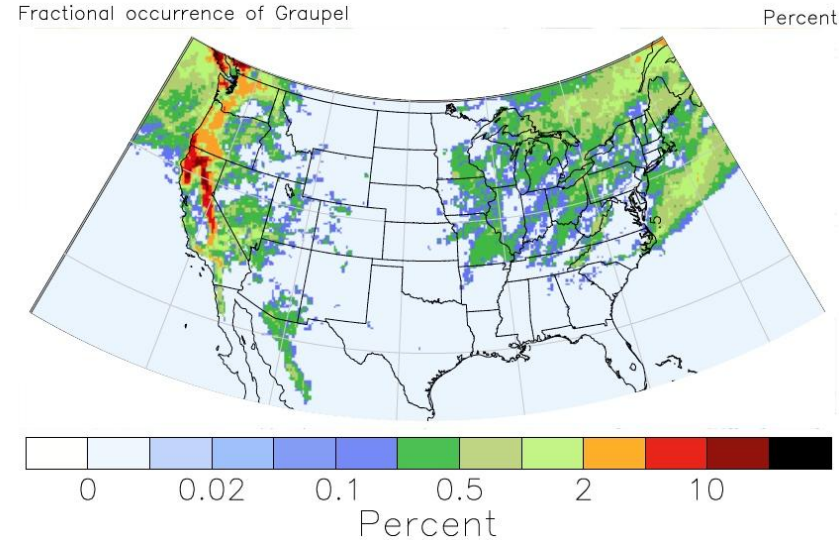
Also applies to MCS (convection) and S2S sub-seasonal prediction (MJO)



# Applications: Climate Hydrological Extremes

Simulate high impact weather extremes in a coupled system at high (< 5km) resolution. Example: occurrence of graupel (extreme precipitation) in a 14km global model

Also applies to floods, hydrology, droughts (up to seasonal). Prediction as well as climatologies of extreme hydrological events

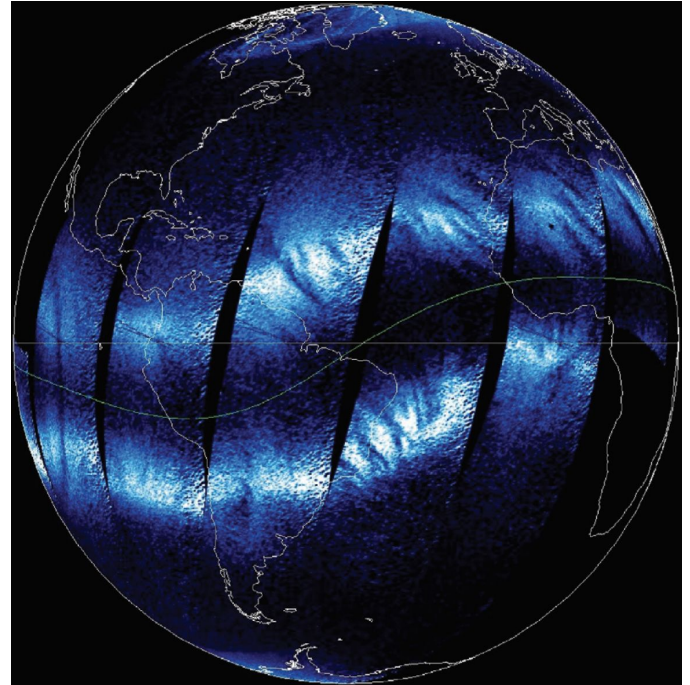


# Applications: Geospace

## Space Weather Prediction

Simulate forced events in the upper atmosphere that affect human systems and climate. Example: Ionospheric plasma bubbles that disrupt radio waves (Communication, navigation)

Couple specialized geospace models on different grids to a deep atmosphere model



# Applications: Chemistry

- Represent air quality in urban regions
- Interactions between atmospheric chemistry, weather and climate

Requires chemical modeling at fine horizontal (< 5km) and vertical (multiple layers in the urban canopy) resolution within a global modeling system.

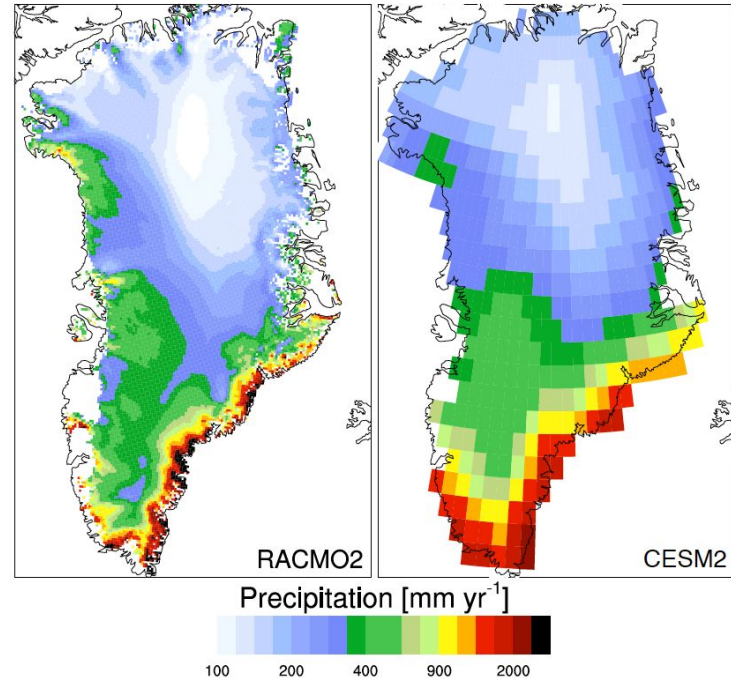


Delhi, March 2018



# Applications: Polar

- Simulate evolution of the Arctic environment
- Requires high resolution, but also a coupled system (especially to the cryosphere and ocean)
- Seasonal to Sub-seasonal (S2S) scale, but also Decadal scale



Target applications: 5km refined mesh forecast, 10-25km climate simulations. Coupled ocean, land, sea ice, land ice.

# Singletrack Topical Areas

## Initial Topics

- Dynamical Core
- Physical Parameterizations
- Data Assimilation
- Infrastructure

## Phase 2 Topics

- Diagnostics/Observations
- Governance
- Education/Training/Tutorials