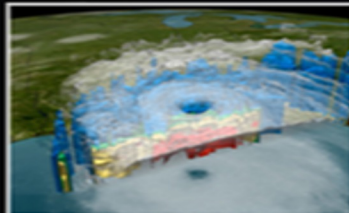
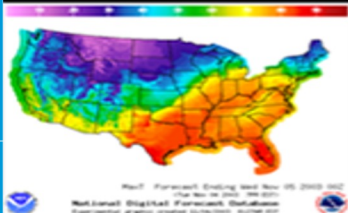
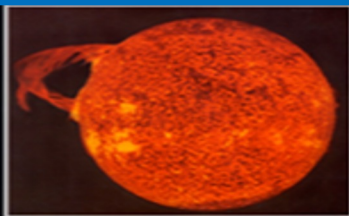
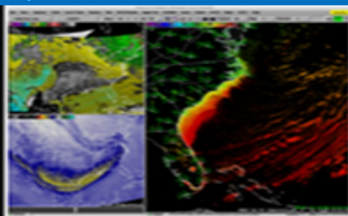


**NOAA**  
National  
Weather  
Service

# NoahMP Operational Transition Overview at NOAA/EMC

Noah-MP Workshop, June 3, 2024

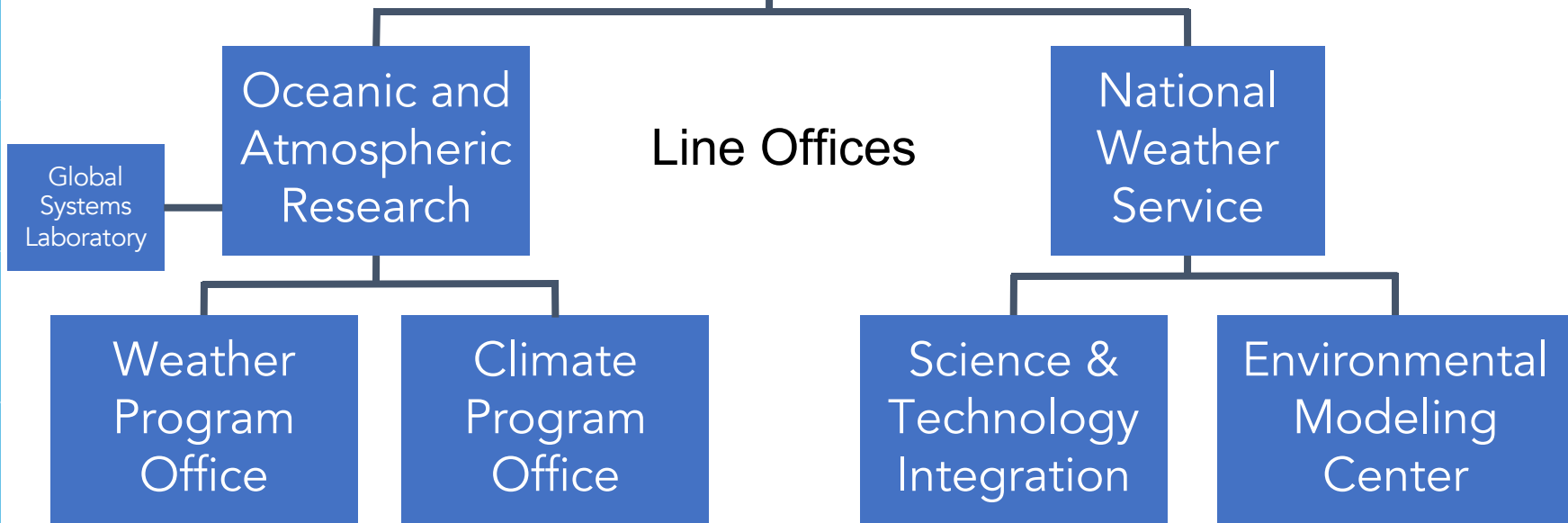
Michael Barlage, NOAA Environmental Modeling Center  
 Acknowledgements: EMC Land Team (Weizhong Zheng, Helin Wei, Zhichang Guo, Rongqian Yang); Lydia Stefanova (EMC); Ufuk Turuncoglu (NCAR); Clara Draper (NOAA PSL)



# NOAA Organization Chart



## Line Offices





# Unified Forecast System



- Unified Forecast System (UFS)
  - community-based, coupled, comprehensive Earth modeling system
  - the source system for NOAA's operational numerical weather prediction.
- The UFS is organized around applications, each having a forecast target, spanning local to global domains and predictive time scales from sub-hourly to seasonal.
- Application Teams (subset)
  - Short-Range Weather (SRW): Atmospheric (**and land**) behavior from less than an hour to several days
  - Medium-Range Weather (MRW): Atmospheric (**and land**) behavior out to about two weeks
  - Subseasonal-to-Seasonal (S2S): Atmospheric and ocean (**and land**) behavior from about two weeks to about one year
- Working Groups: Chemistry, DA, Dynamics, Ensembles, Marine, Physics, Post-Proc, **LAND**





# Inaugural UFS Land Working Group



Brent Lofgren (NOAA/GLERL)

Trey Flowers (NOAA/NWC)

Clara Draper (NOAA/PSL/CIRES)

Andy Fox (JCSDA)

Sujay Kumar (NASA/HSL)

Paul Dirmeyer (GMU)

Joe Santanello (NASA/HSL)

Elena Shevliakova (NOAA/GFDL)

David Lawrence (NCAR/CGD)

Tanya Smirnova (NOAA/GSL/CIRES)

Guo-Yue Niu (U. Arizona)

Fei Chen (NCAR/RAL)

Zong-Liang Yang (UT-Austin)

Xiwu Zhan (NOAA/NESDIS)

Maoyi Huang (NWS/OSTI)

Michael Ek (NCAR/DTC) – Co-Lead

Michael Barlage (NOAA/EMC) – Co-Lead



Hydrology



Land Data Assimilation



Land-Atmo Interactions



Climate Development



NWP Development



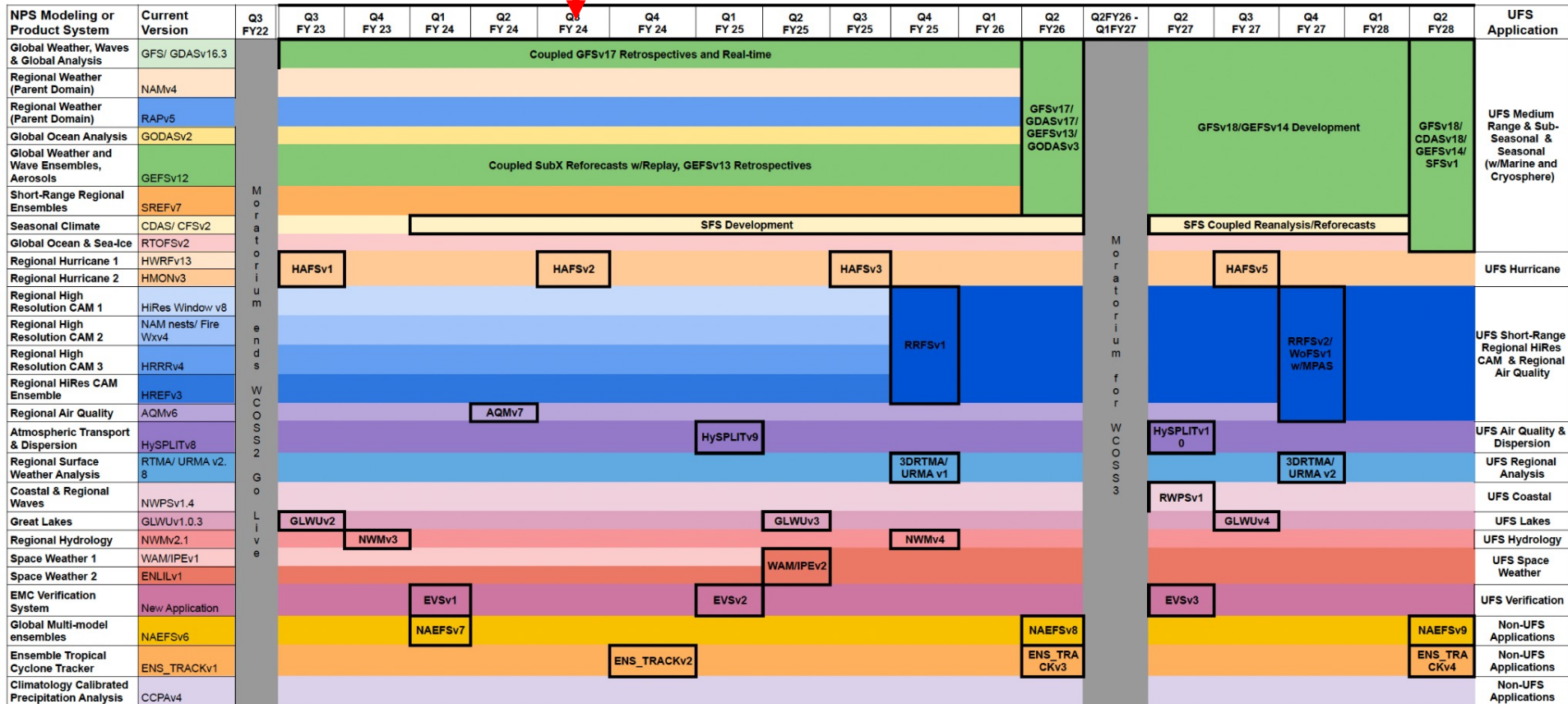
Land Satellite Data

**Get involved in UFS Land!**



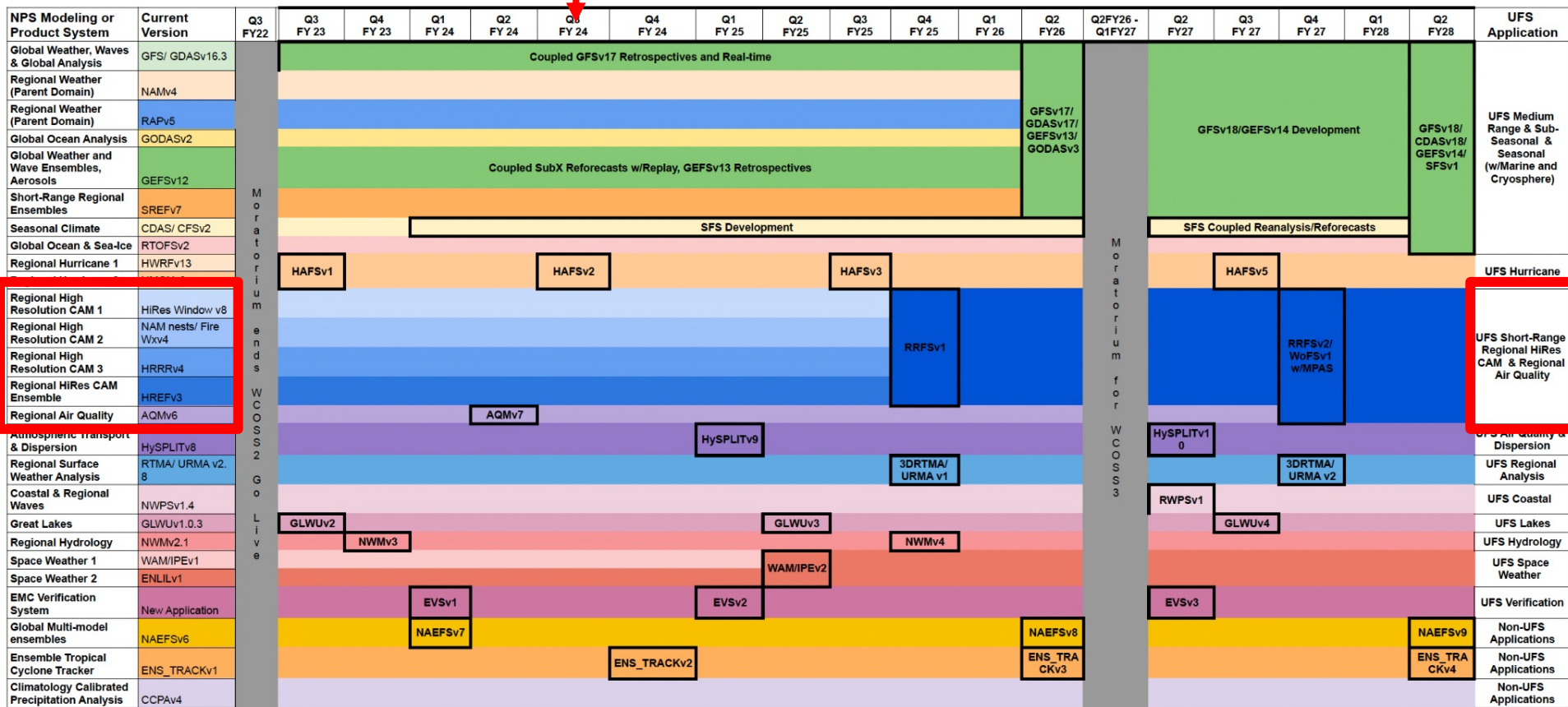


# The Rainbow Chart: NOAA Unified Modeling





# The Rainbow Chart: NOAA Unified Modeling



# Rapid Refresh Forecast System (RRFS)

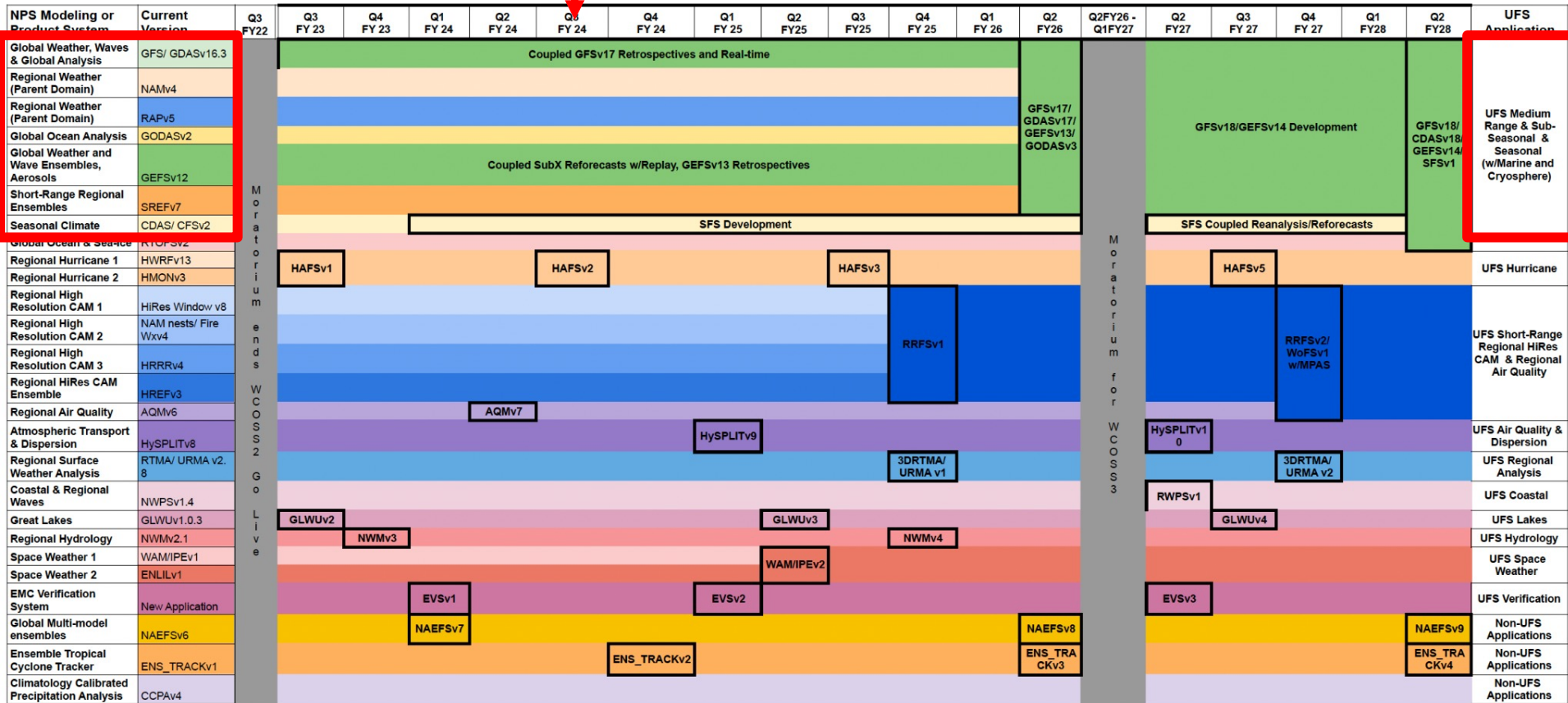
- Current Operational Model
  - Multiple: HRRR, RAP, NAM, NAM nest
  - Land model: RUC, Noah
  - 1.5km, 3km, 12km
  - Last update: some back to 2017
- Developmental Model
  - RRFSv1 planned 2025Q2 (science freeze)
  - Land model: RUC (NoahMP v2)
  - North America 3km
  - Hourly forecast to 18 hours (60 hours 4x per day - 10 ensemble members)
- Priorities: process level evaluation of water and energy diurnal cycles, parameter optimization, initialization strategies, human influences: urban, irrigation/agricultural, water management, chemistry-relevant physics/properties



RRFSv1 Computational Domain



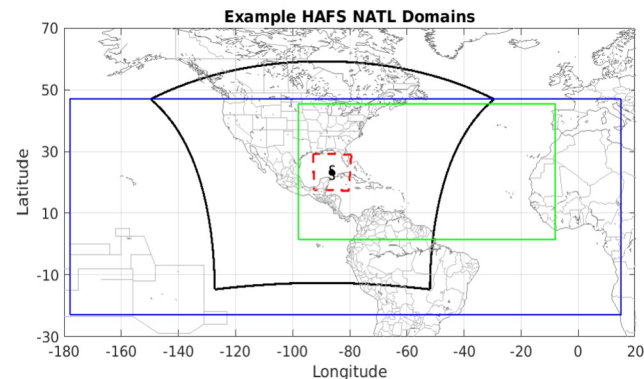
# The Rainbow Chart: NOAA Unified Modeling





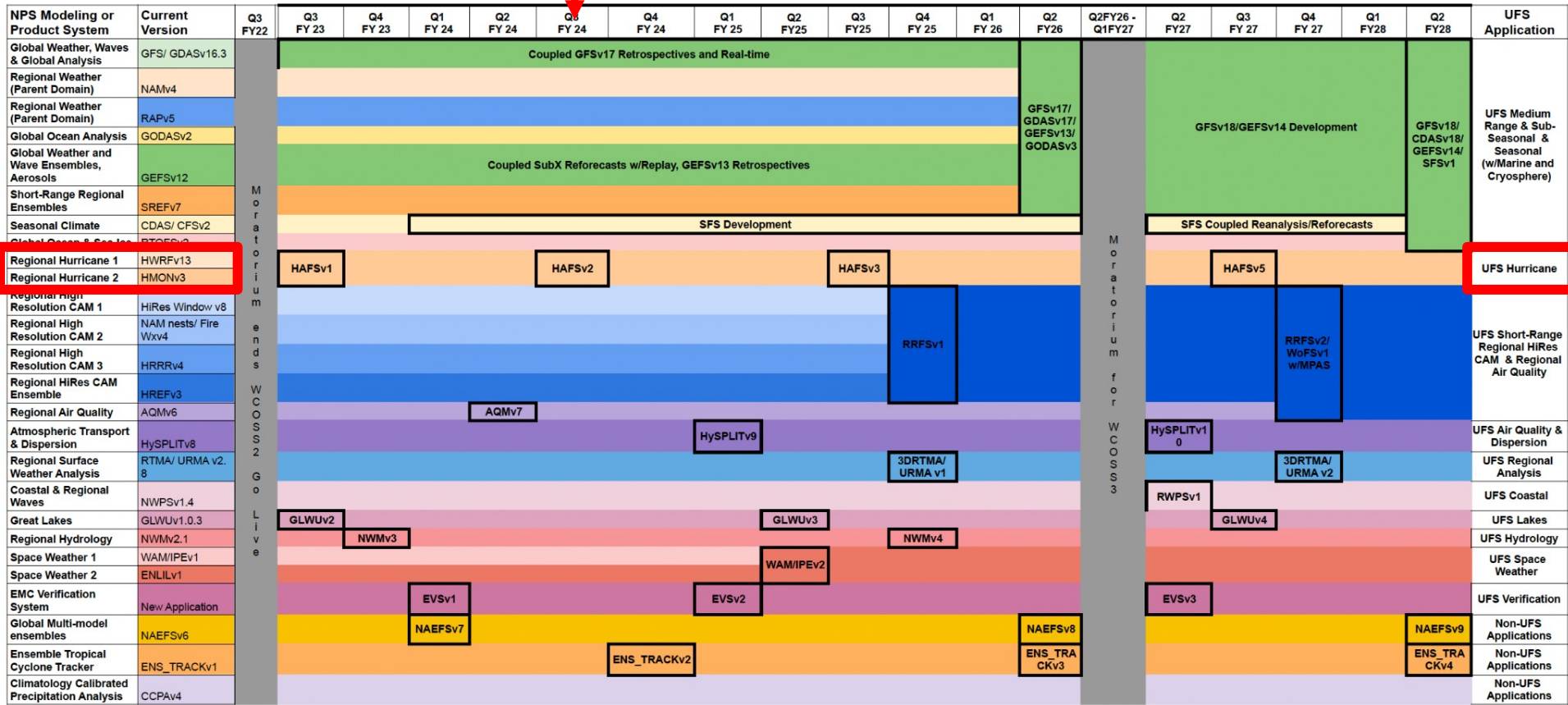
# Hurricane Analysis and Forecasting System (HAFS)

- Current Operational Model
  - HAFSv1 became operational June 27, 2023
  - Land model: Noah
- Developmental Model
  - HAFSv2 planned ~July 2024
  - Land model: Noah
- Land development concerns
  - HAFS is a nested configuration of GFS
  - Cold start from GFS land states - moving nests
  - To maintain land model consistency transition to a new land model will have to wait until GFS is upgraded
- Priorities: landfall precipitation, inundation, water cycle connections





# The Rainbow Chart: NOAA Unified Modeling



# Seasonal Forecast System (SFS)

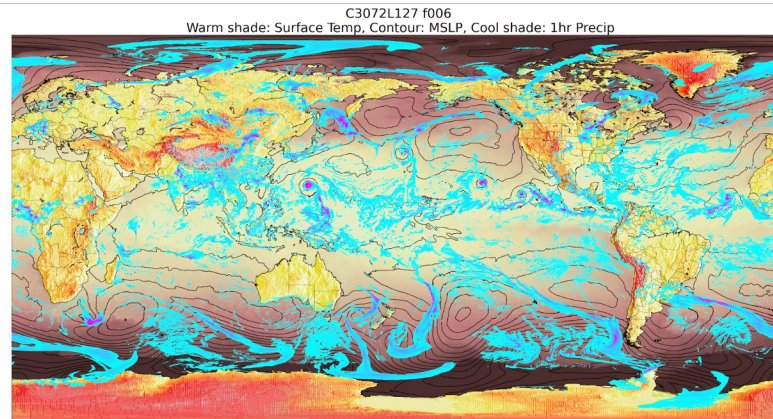
- Current Operational Model

- CFSv2 operational ~2011
- Land model: Noah
- ~1° global spectral model
- Forecast length: 9 months

- Developmental Model

- SFSv1 planned transition in ~FY28
- Land model: NoahMP
- UFS C192(~50km), 21 ensemble members
- Forecast length: 1 year

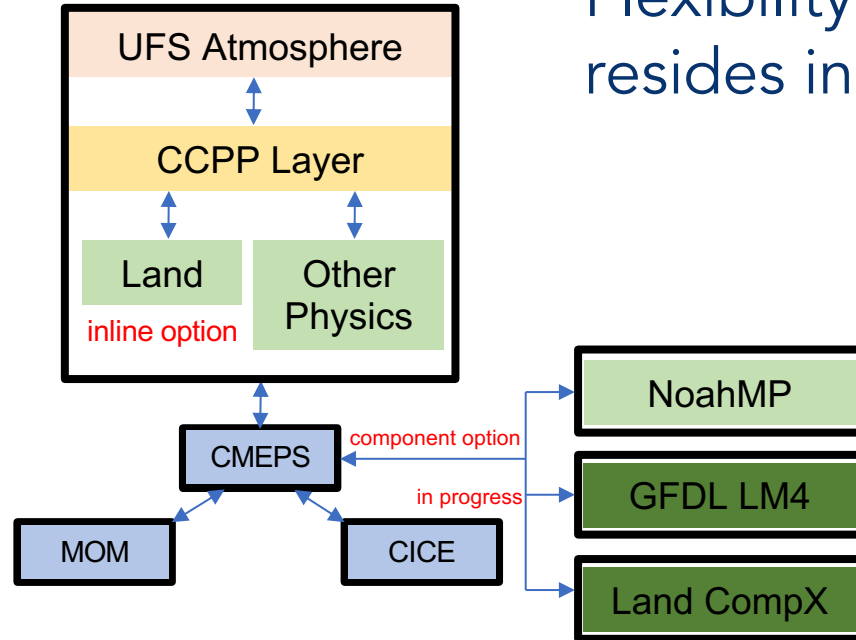
- Priorities: plant hydraulics, snow, groundwater, irrigation; prognostic vegetation phenology including agricultural; extreme weather precursors



# Global Forecast System (GFS/GEFS)

- Current Operational Model
  - GFSv16/GEFSv12 operational March 2021/Sept 2020
  - Land model: Noah
  - C768 (13km), 16 days; C384 (25km), 16 days (35 days 1x per day)
- Developmental Model
  - GFSv17/GEFSv13 planned for FY26Q1
  - Land model: NoahMP
  - C1152 (9km); C384 (25km) 30 members to 35 days
- Priorities: superset of short-range and seasonal priorities

# UFS Land – Infrastructure



Flexibility on where the land model resides in the system

- inline with the atmosphere
  - advantage: faster physics/coupling
  - single column model
- as a separate component
  - advantage: land model testing within a well-designed framework (i.e., with a data atmosphere)
  - advantage: evaluating fluxes across interface

Land = CCPP land models

Land = component land models, including lakes, routing, etc.

# Global Evaluation Prototypes

- Prototypes (PT 1-8, completed)

Coupled Model: Atm (C384) - Ocean ( $\frac{1}{4}$  tripolar) - Ice ( $\frac{1}{4}$  tripolar) - Wave ( $\frac{1}{6}$  tripolar)

April 1, 2011 – March 15, 2018, cold start forecasts at 00Z cycle 1<sup>st</sup> and 15<sup>th</sup> of month, 35 day forecast (168 total forecasts)

- HR1-2 (completed)

Coupled Model: Atm (C768) - Ocean ( $\frac{1}{4}$  tripolar) - Ice ( $\frac{1}{4}$  tripolar) - Wave ( $\frac{1}{6}$  tripolar)

Summer: June 1– Aug. 30, 2020, cold start forecasts at 00Z cycle every 3 days, 16 day forecast

Winter: Dec. 03, 2019 – Feb. 26, 2020, cold start forecasts at 00Z cycle every 3 days, 16 day forecast

Hurricane: July 20, 2020 – Nov 20th, 2020, cold start forecasts at 00Z cycle everyday, 7 day forecast

- HR3 - +C1152 atmosphere/land, completed

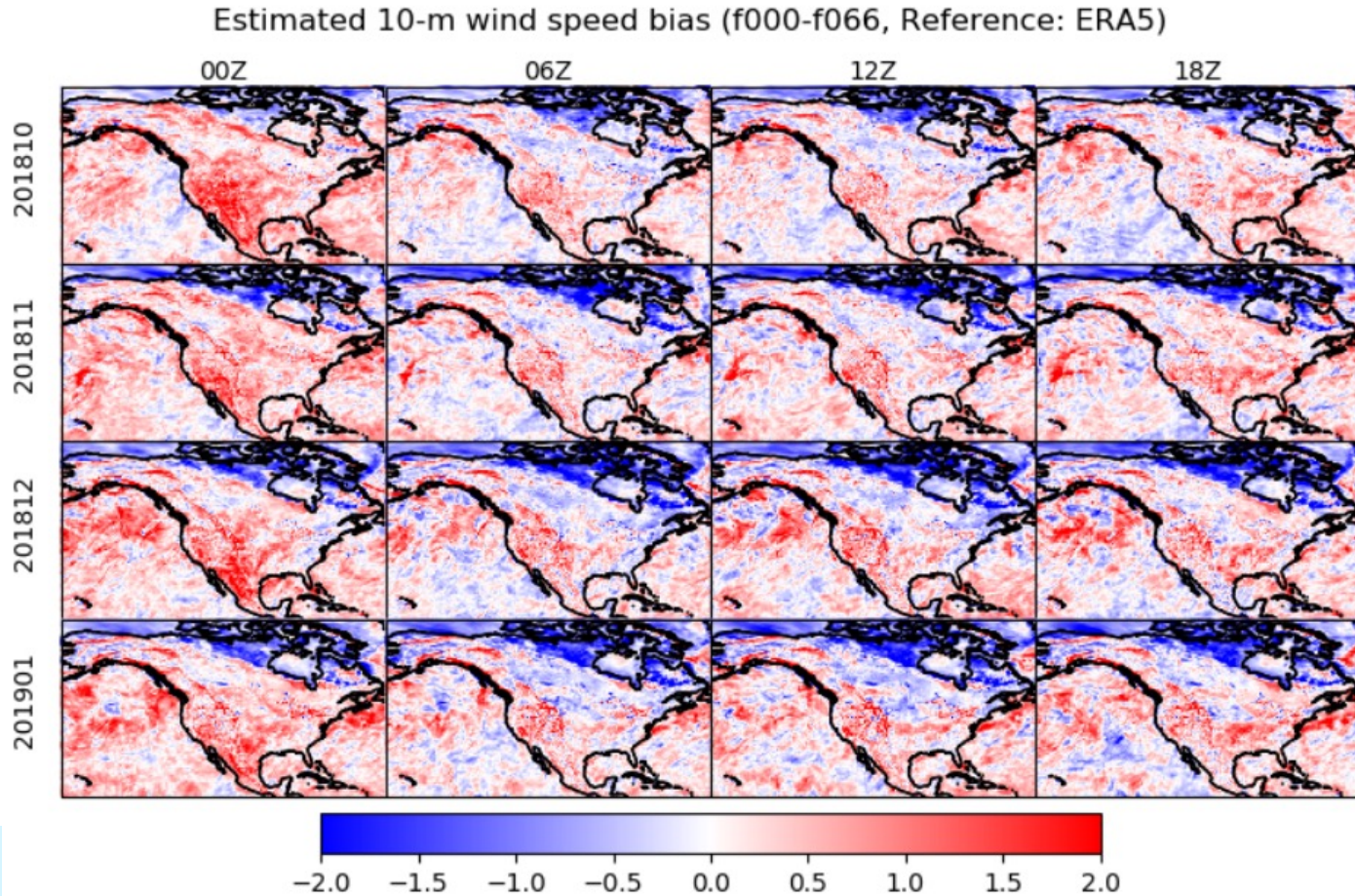
- HR4 - cycled DA

- Data stored on NCAR /glade/derecho/scratch/barlage



# Wind Evaluation in Prototypes

- Comparison of ensemble prototypes wind speed compared to ERA5 shows land high bias especially at 00Z





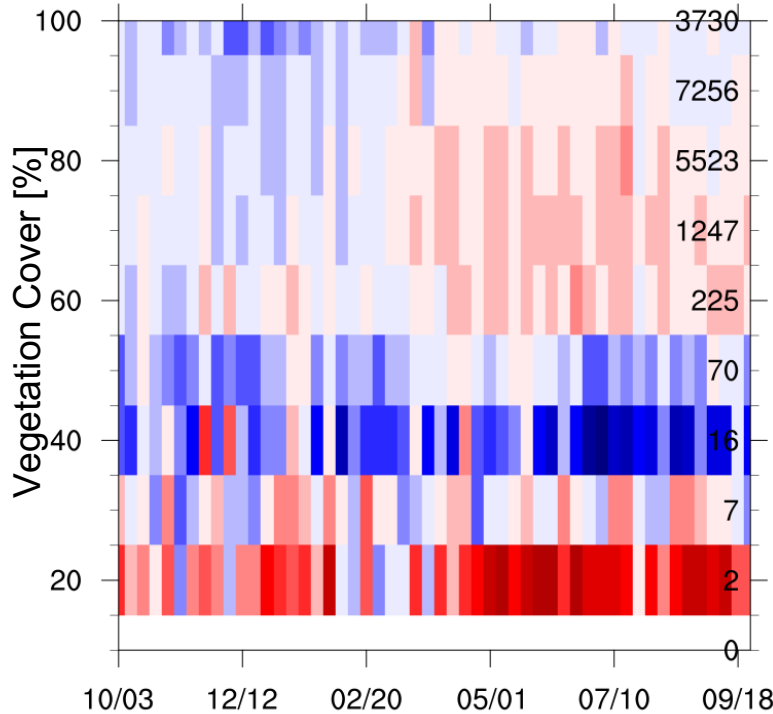
# Wind Evaluation in Prototypes



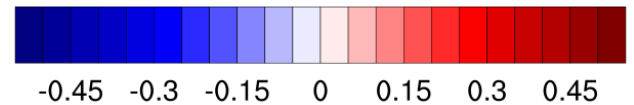
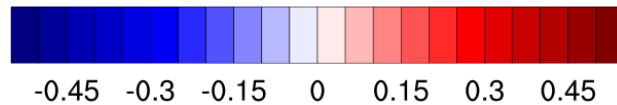
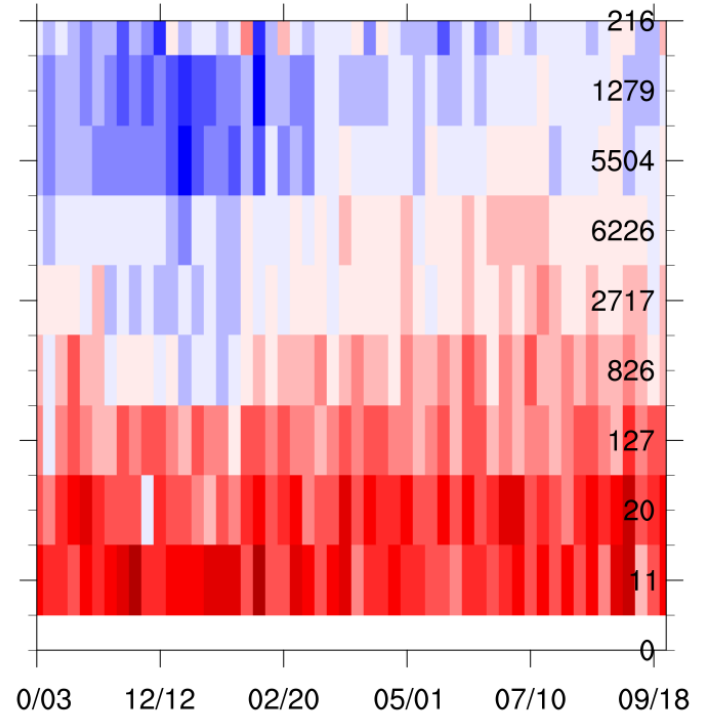
- Convert to local time
- Plot bias ratio as a function of time and vegetation cover



### Mixed Forest Zone: 30N



### Evergreen Needleleaf Forest Zone: 30N







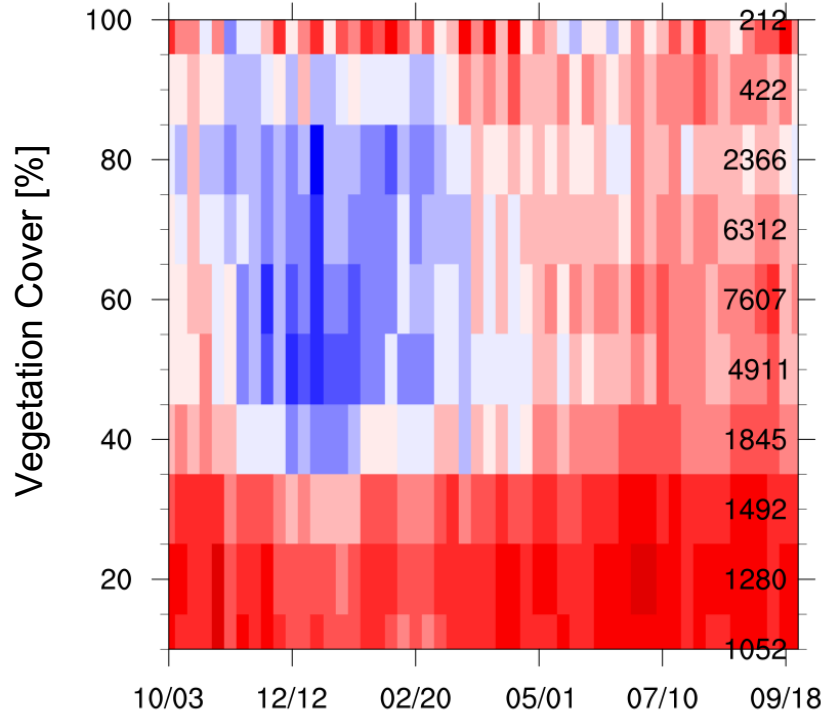
# Wind Evaluation in Prototypes



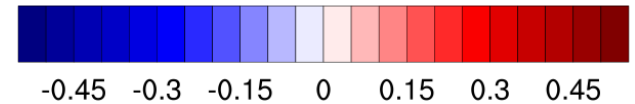
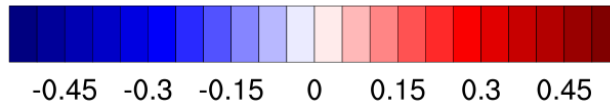
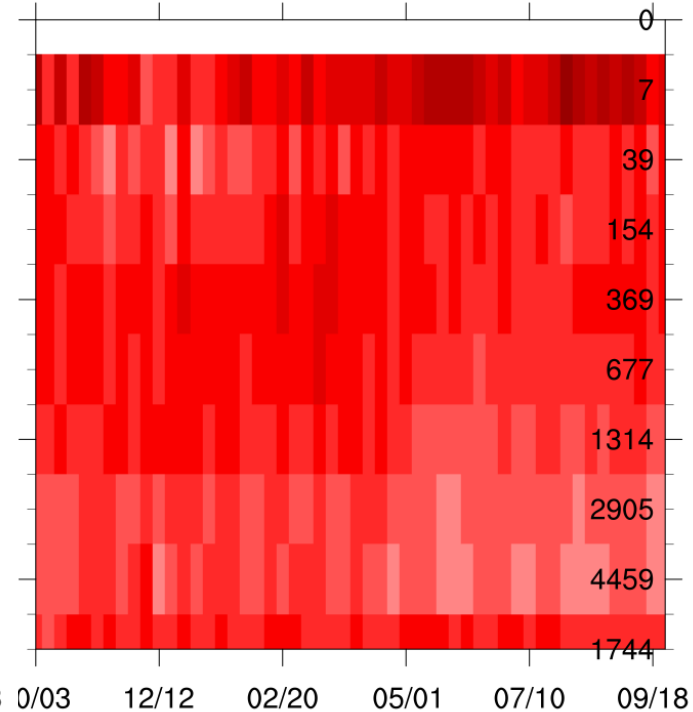
- Convert to local time
- Plot bias ratio as a function of time and vegetation cover



Open Shrub Zone: 30N



Open Shrub Zone: EQ





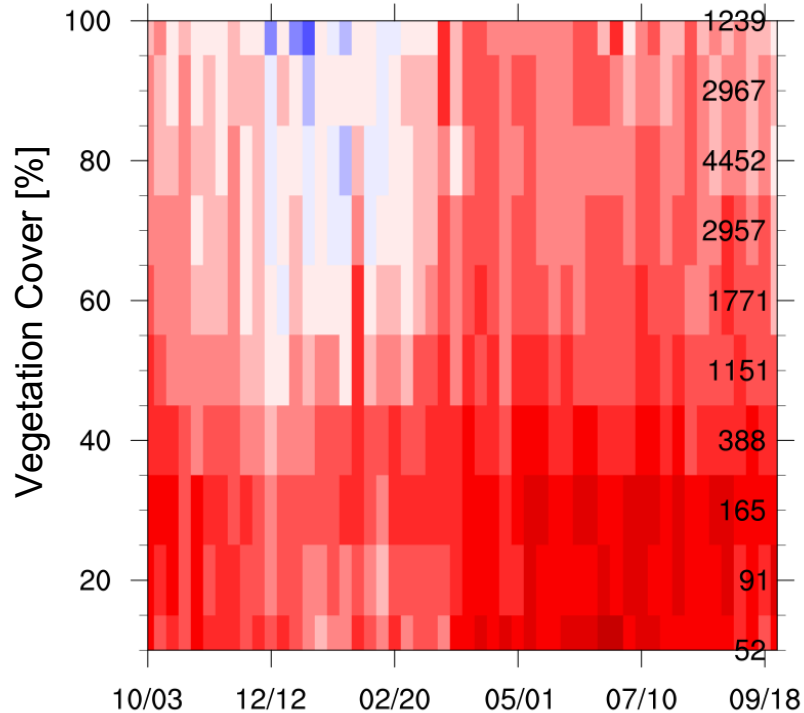
# Wind Evaluation in Prototypes



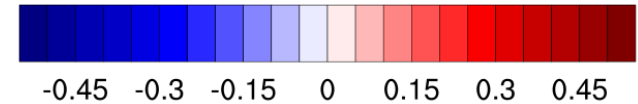
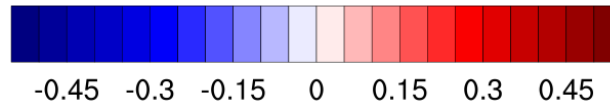
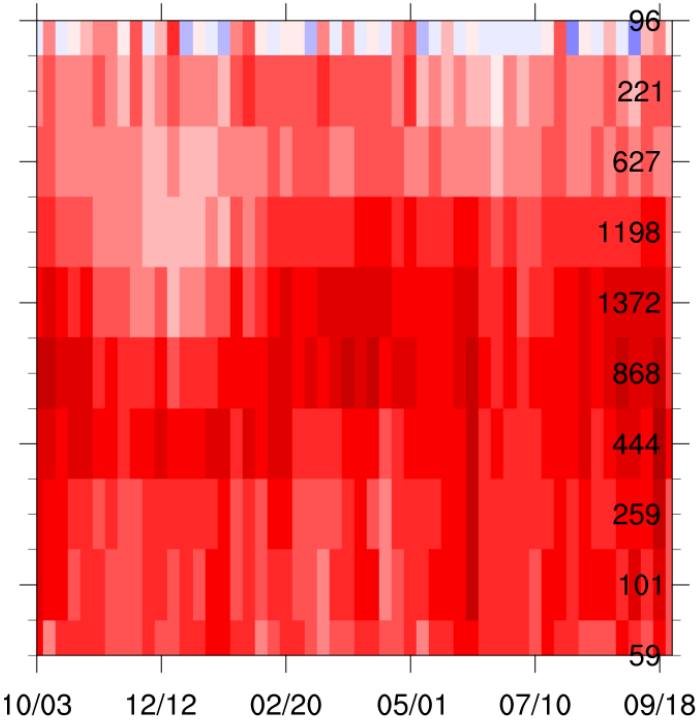
- Convert to local time
- Plot bias ratio as a function of time and vegetation cover



Cropland Zone: 30N



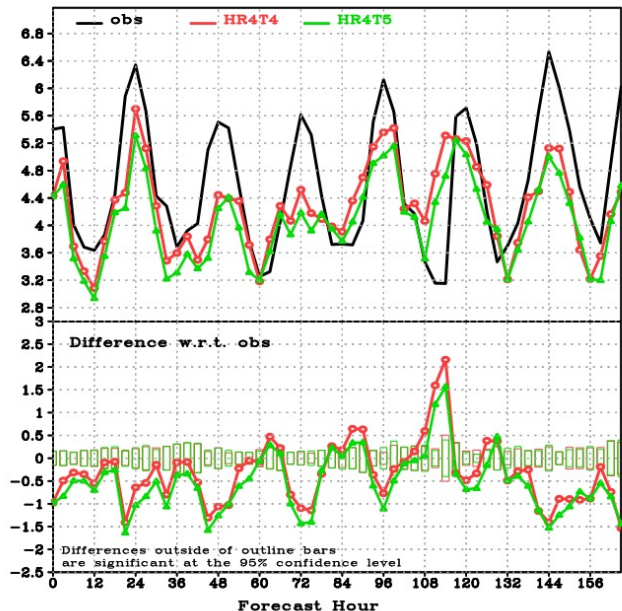
Cropland Zone: EQ



# Wind Evaluation in Prototypes

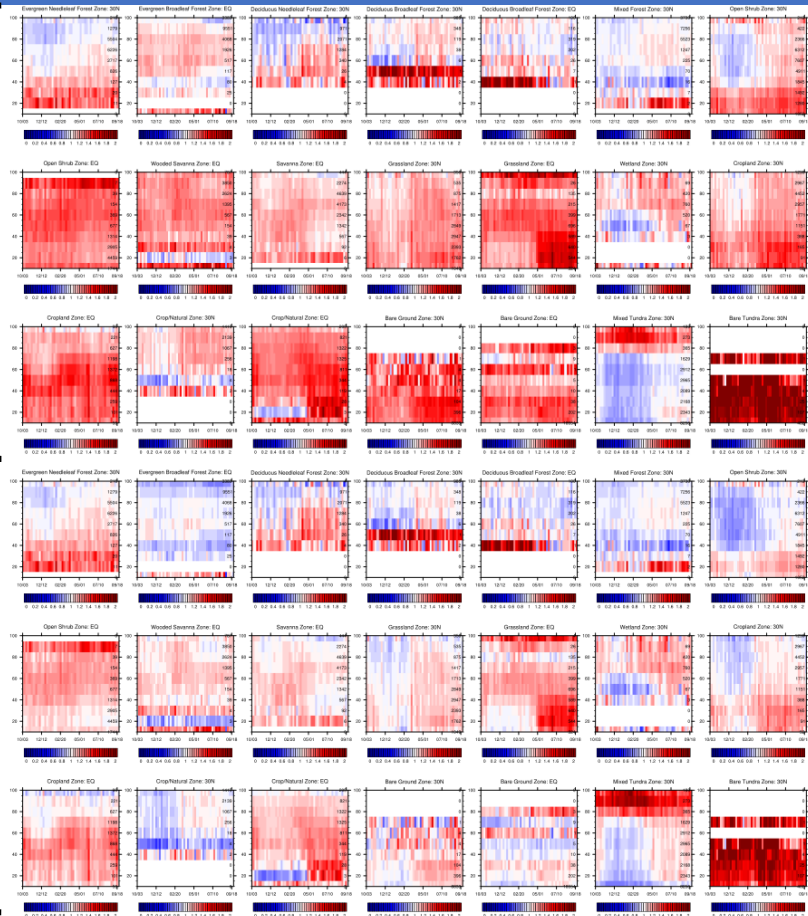
- Modified roughness length makes the simulations worse compared to site observation data

ND SFC, Barren or Sparsely Vegetated, 00Z Cycle, 20200601-20200827 Me



Default Roughness

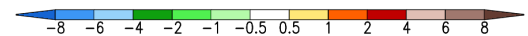
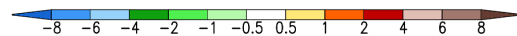
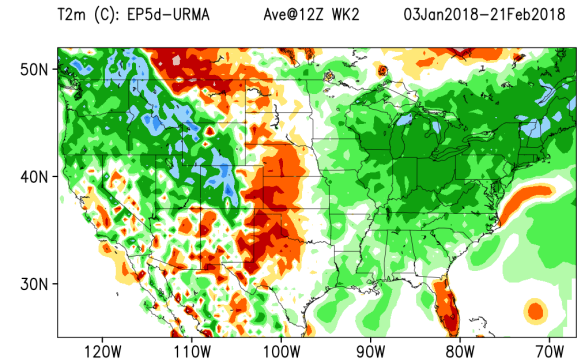
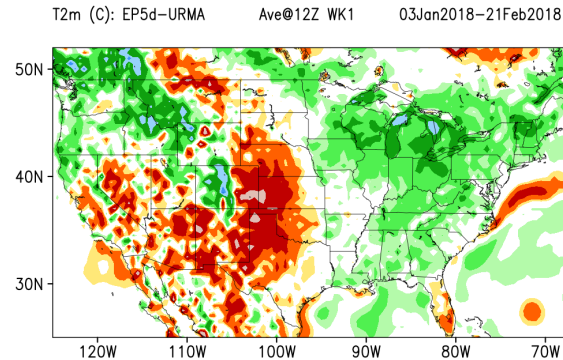
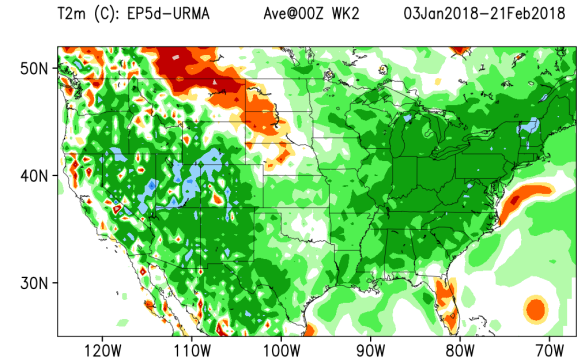
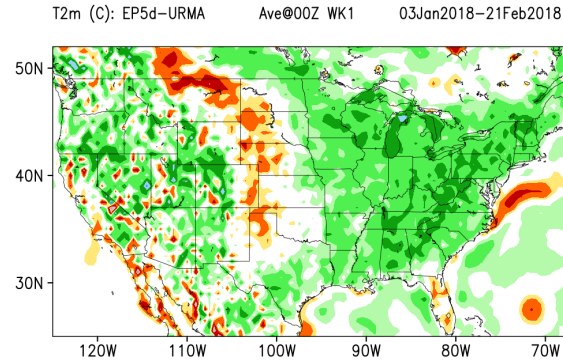
Modified Roughness





# Temperature Evaluation in Prototypes

- Low temperature bias both day and night that grows with time

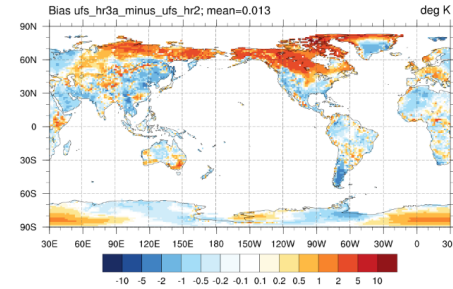
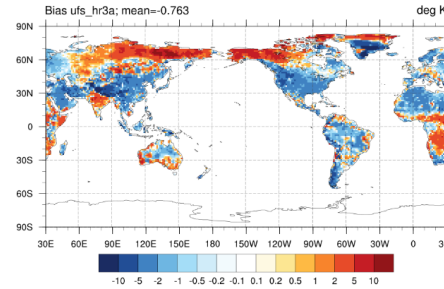
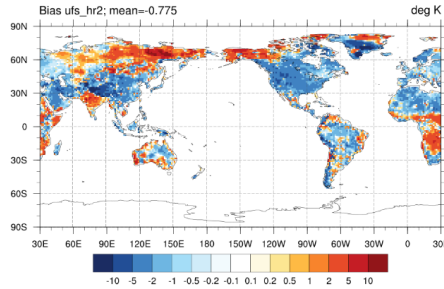




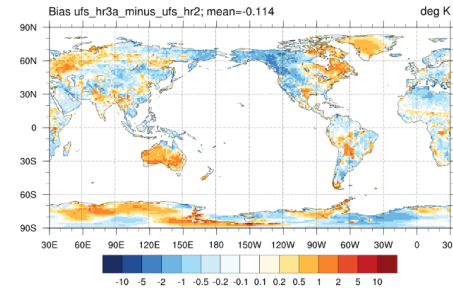
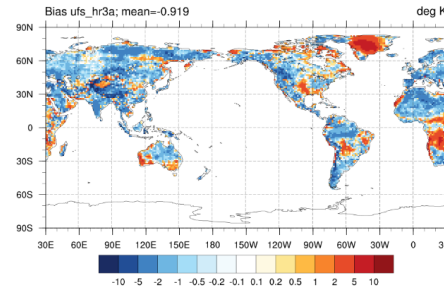
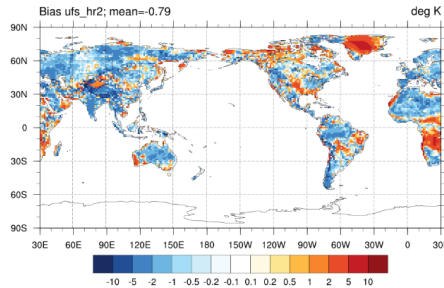
# Temperature Evaluation in Prototypes

- Low temperature bias both day and night that grows with time

t2max vs t2max\_CPC, DJF, day 8 - day 15, 29 ICs



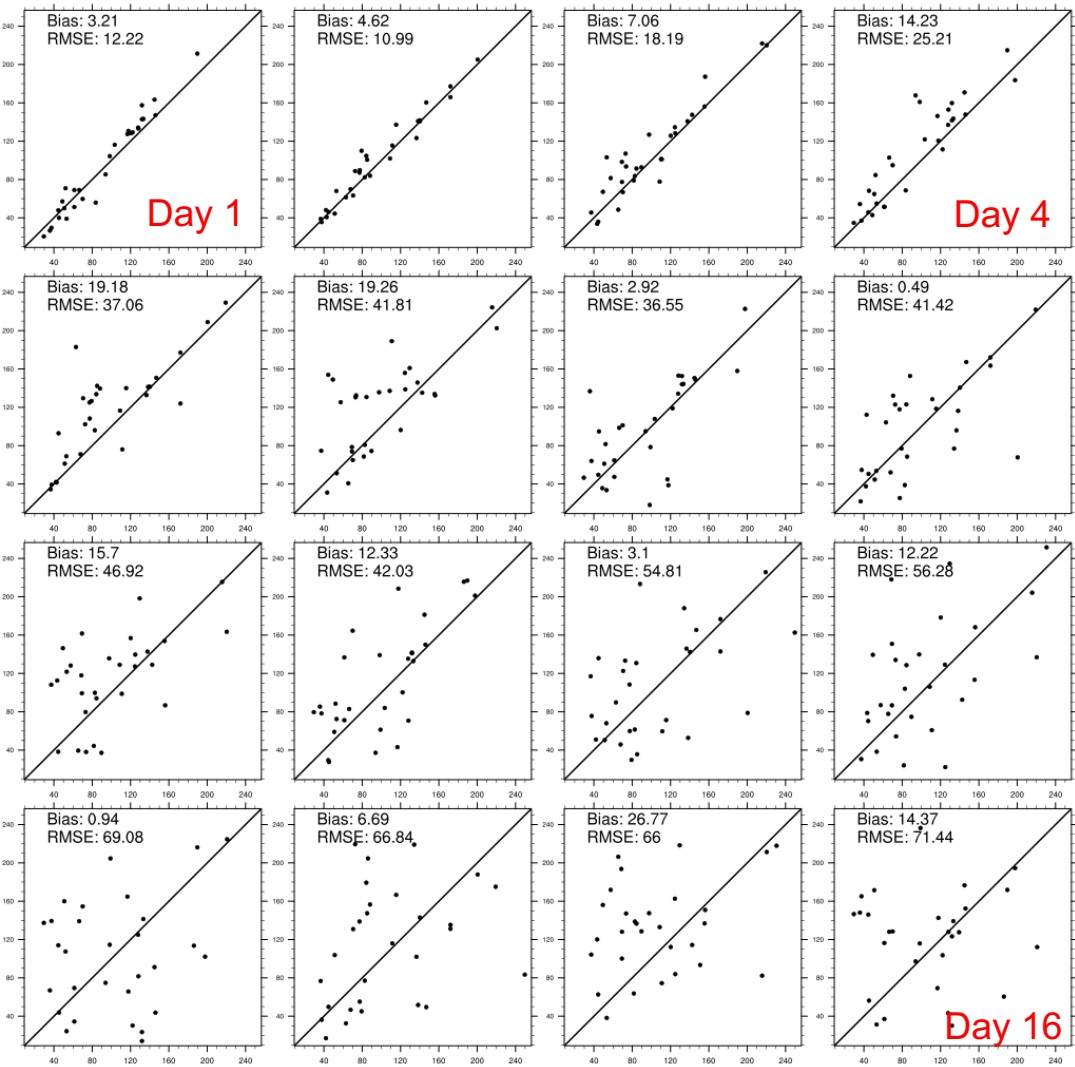
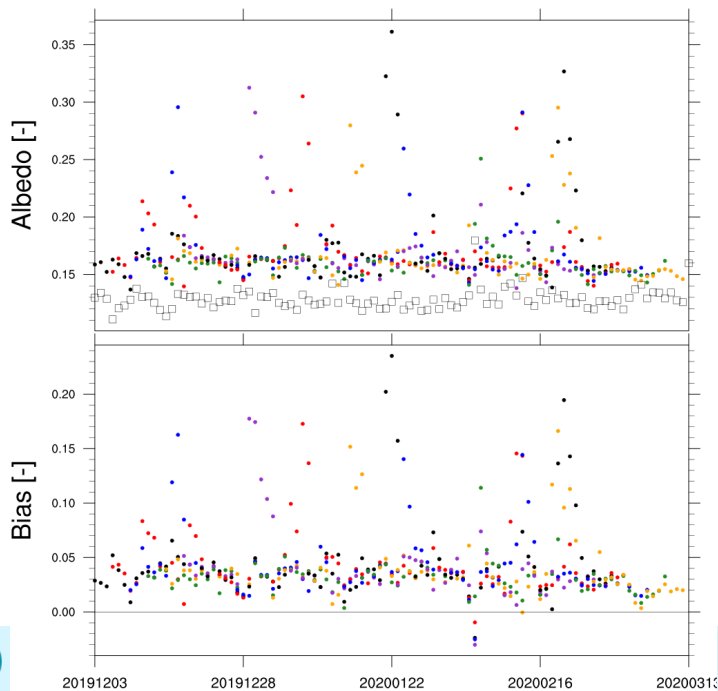
t2max vs t2max\_CPC, JJA, day 8 - day 15, 31 ICs





# CERES Radiation

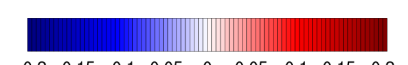
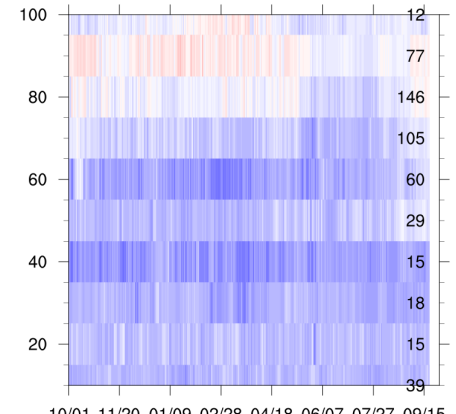
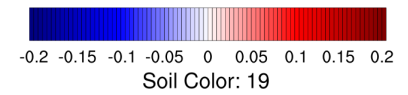
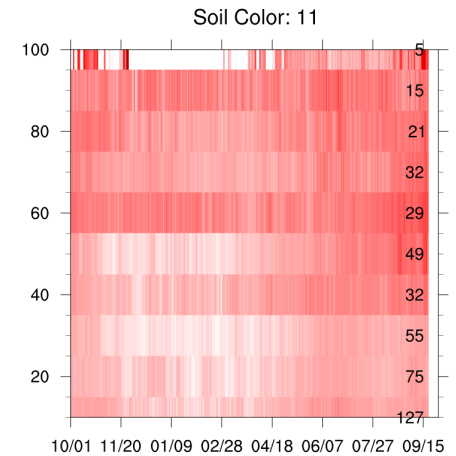
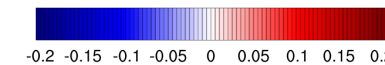
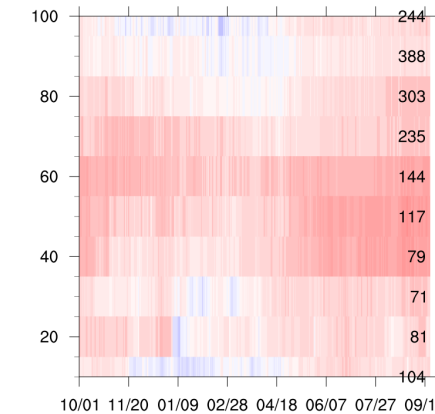
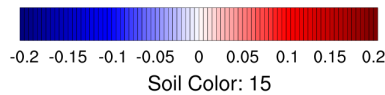
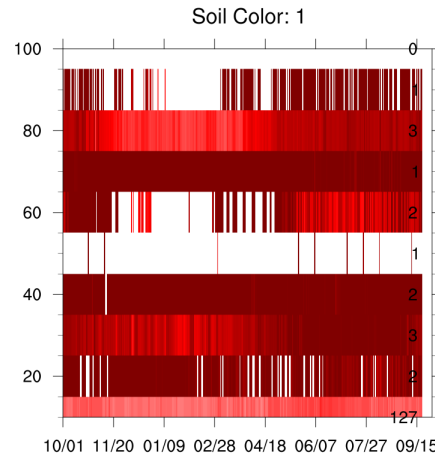
- Shortwave down small high bias on Day 1 that grows with forecast length





# CERES Radiation

- Albedo bias has a clear relationship with CLM soil color category
- Brighter soils tend to be too bright and darker soils tend to be too dark
- This could be due to how soil color was defined in CLM and the tile structure of Noah-MP





# CERES Radiation



- Mask where CERES and model have snow and where CERES water fraction > 5%



- Several vegetation types have interesting vegetation cover and seasonal dependence



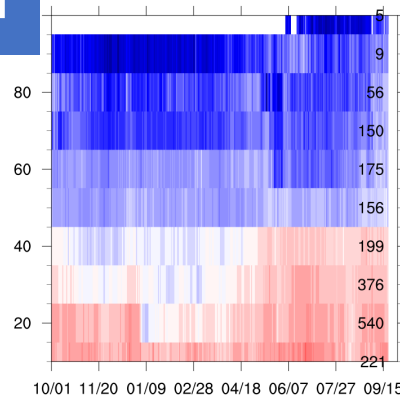
- Grassland, cropland and crop/natural stand out with very high albedo bias

- Strange values in table

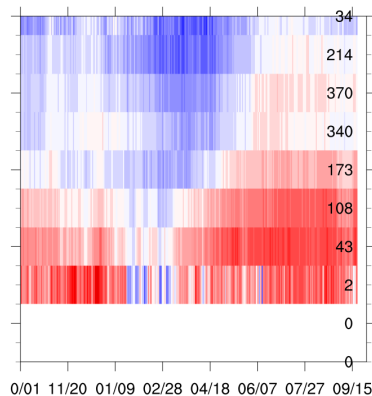
baseline	
xl	-0.3
rhol_vis	0.11
rhol_nir	0.58
rhos_vis	0.36
rhos_nir	0.58
taul_vis	0.07
taul_nir	0.25
taus_vis	0.22
taus_nir	0.38

C3 grass	-0.3	0.11	0.35	0.31	0.53	0.05	0.34	0.12	0.25
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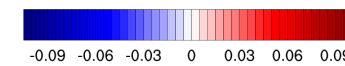
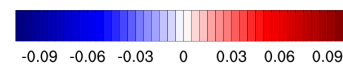
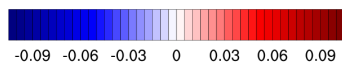
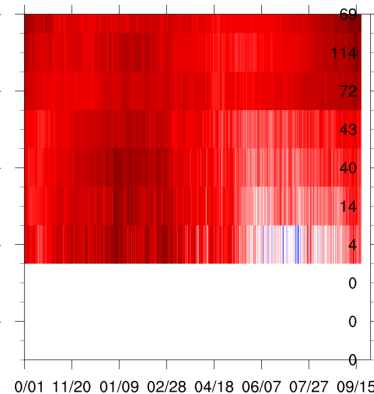
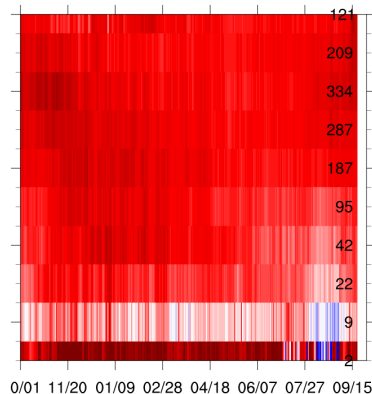
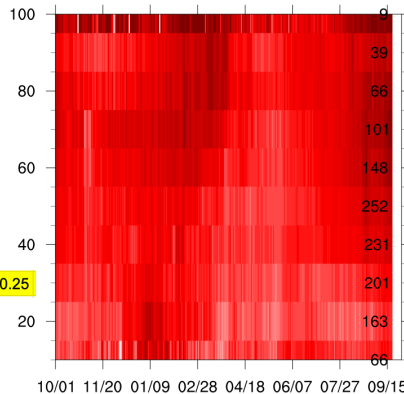
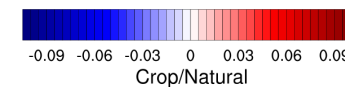
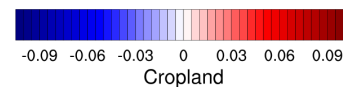
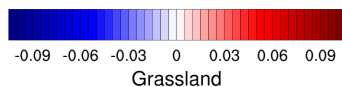
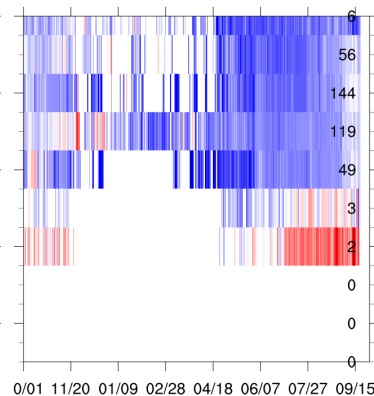
Open Shrub



Savanna



Evergreen Needleleaf Forest

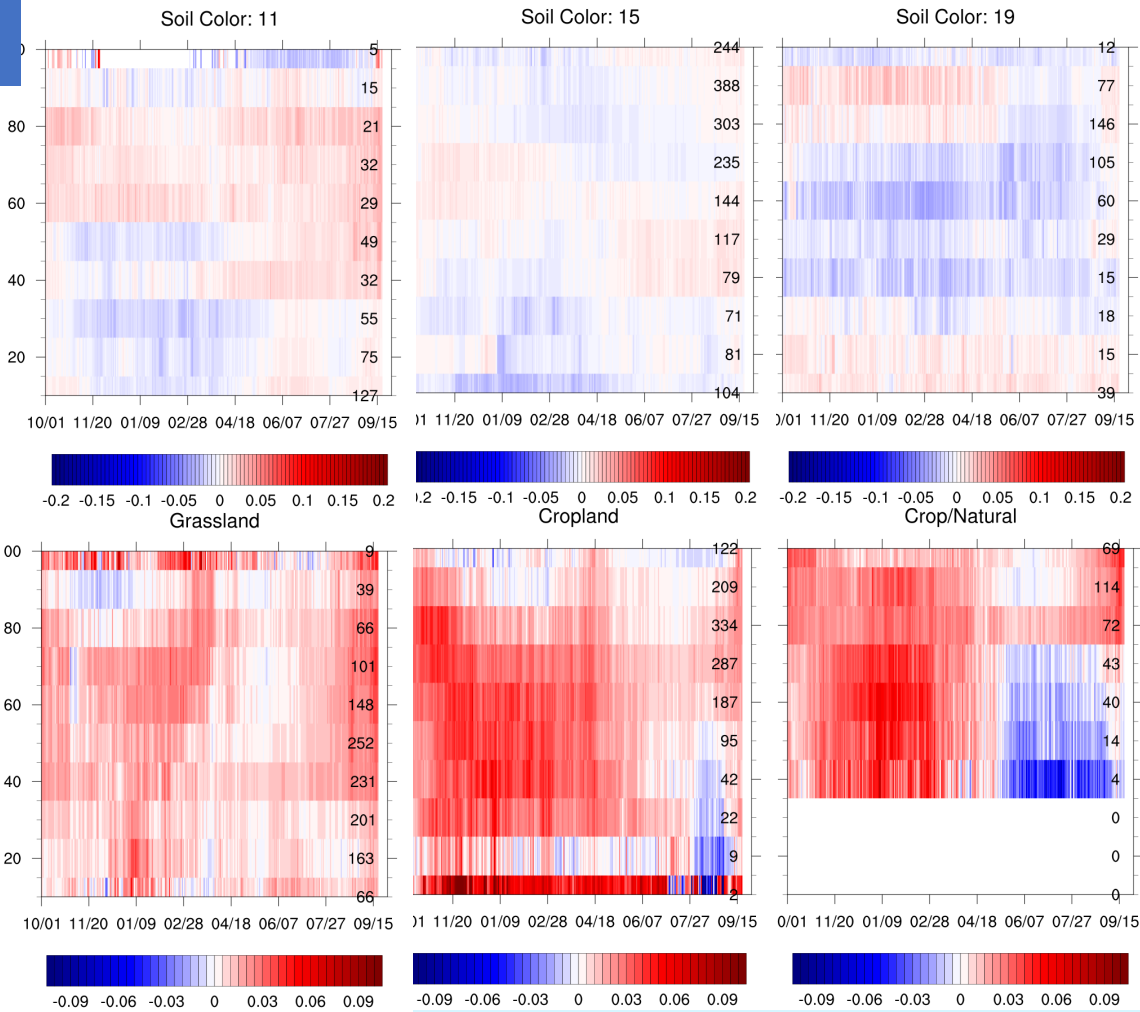






# CERES Radiation

- Modifying soil color and fixing table values can improve a lot of the albedo bias
- There are still seasonal biases that need to be addressed through parameter adjustments specific to Noah-MP





# Current Plans



- Development of Noah-MP
  - Global Forecast System is in final stages
  - Regional and Seasonal Systems are just beginning (Hurricane as well)
- Still some fundamental things to look at in Noah-MP
  - Seasonal and vegetation dependence on model bias
  - Diagnostic fields
  - Consistency of flux solution method
  - Ground heat flux (diffusion solution)
- @NOAA: More direct linkage to NCAR noahmp repository
- @UFS: Get involved with UFS-Land

