Betacast-ing: Tools for initialized case studies in CESM (and E3SM?)

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AMWG winter meeting
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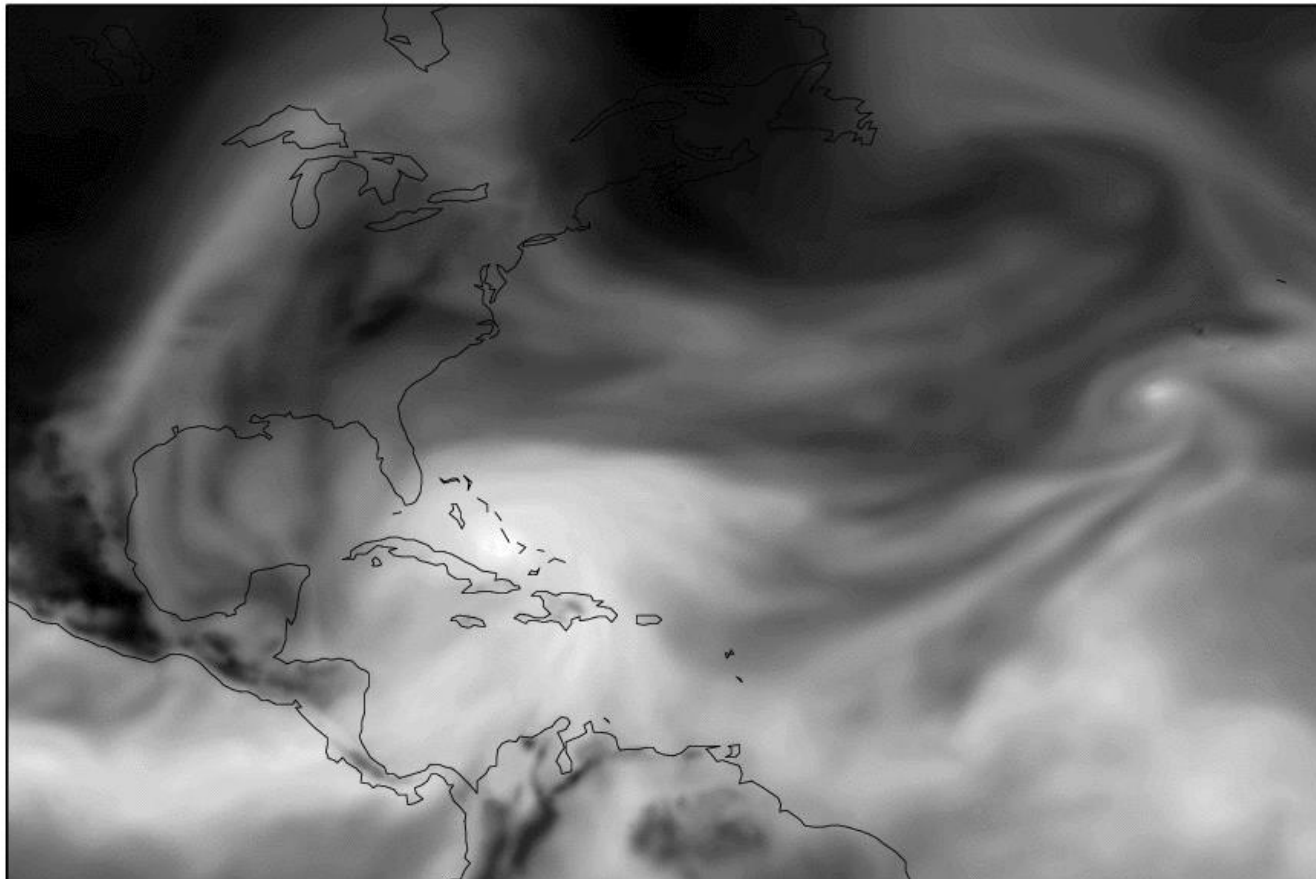
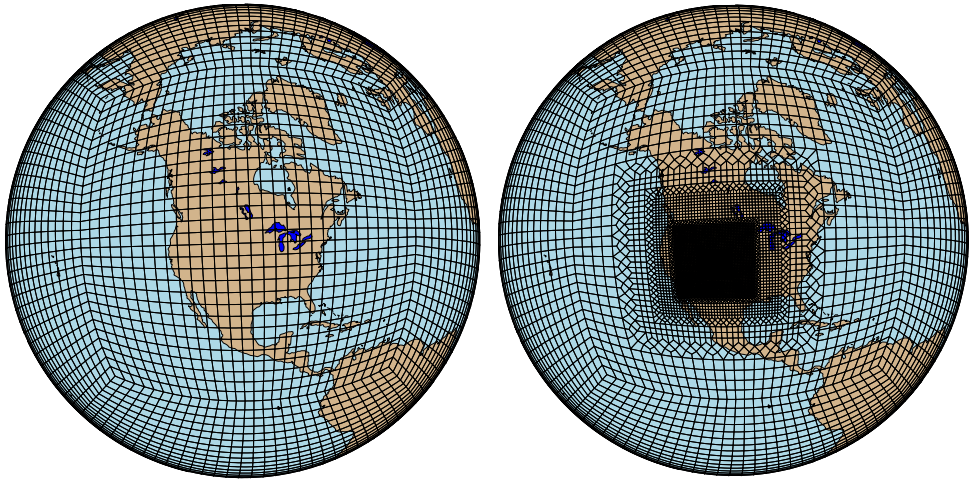
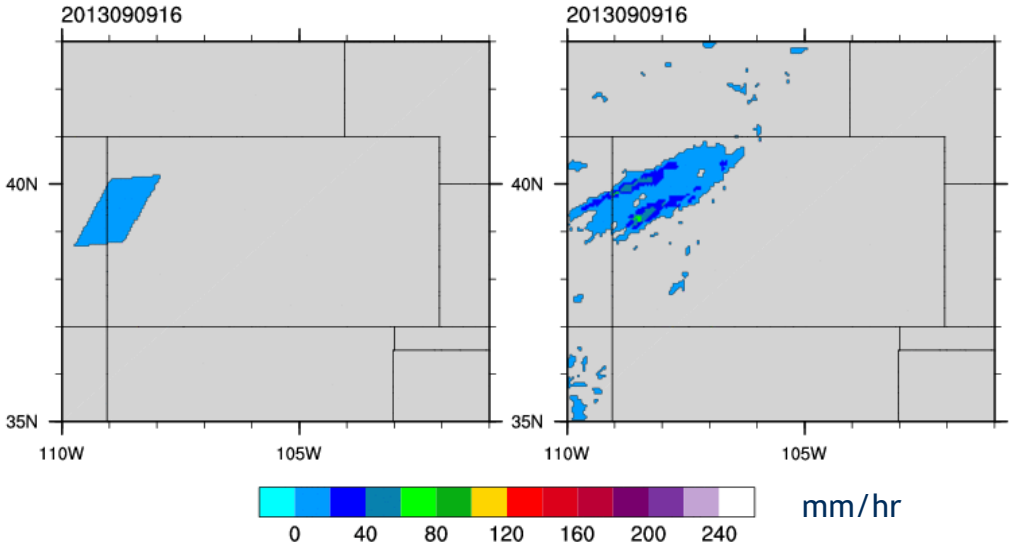


What am I referring to?

- "Initialized?"
- Using CESM (or E3SM) to run **short (<10 days) deterministic-like simulations**
- No explicit focus on s2S and beyond (atmospheric predictability timescales)





CESM hindcast of Colorado Floods, 2013

Motivator? Weather/climate paradigm

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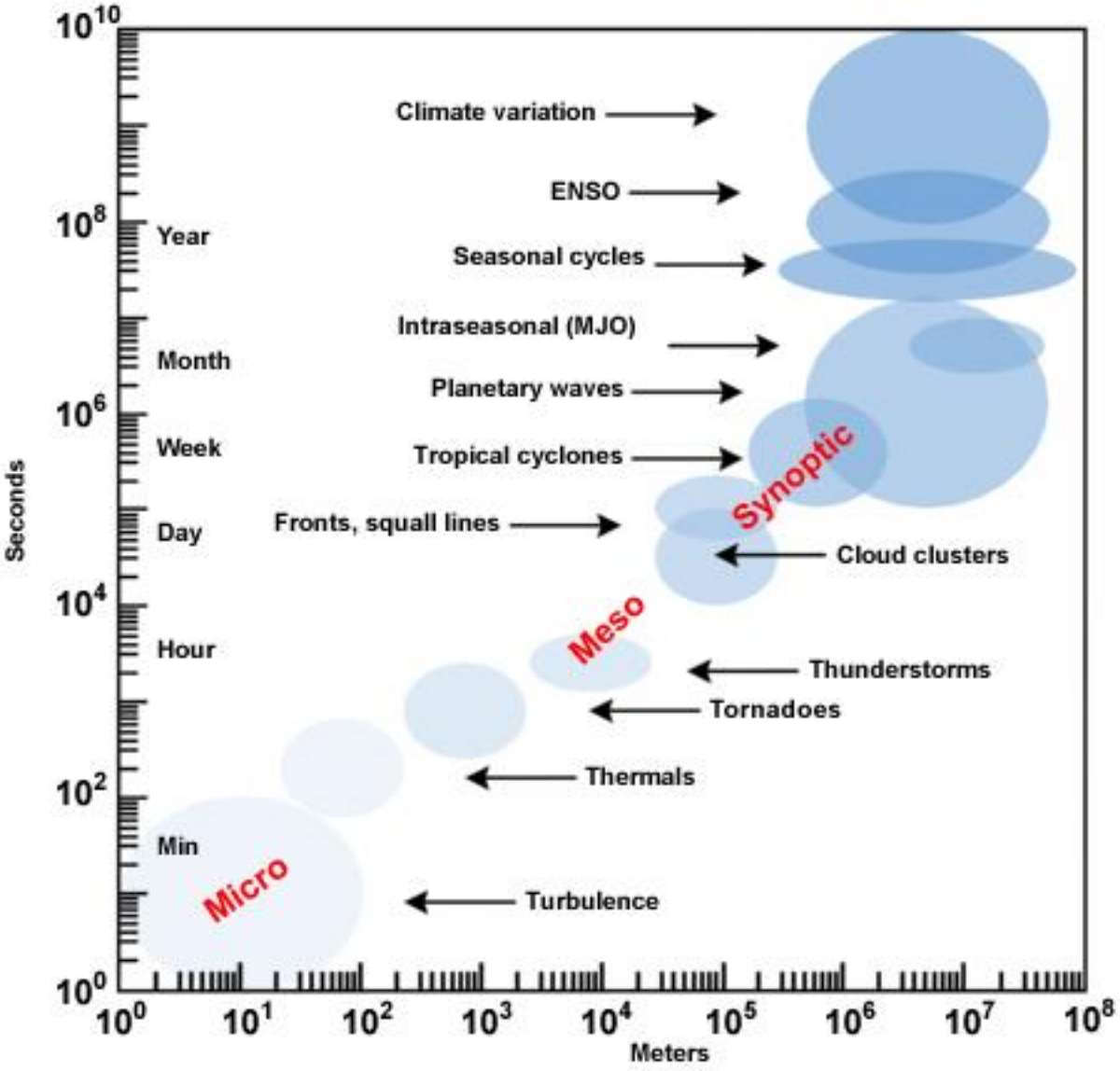
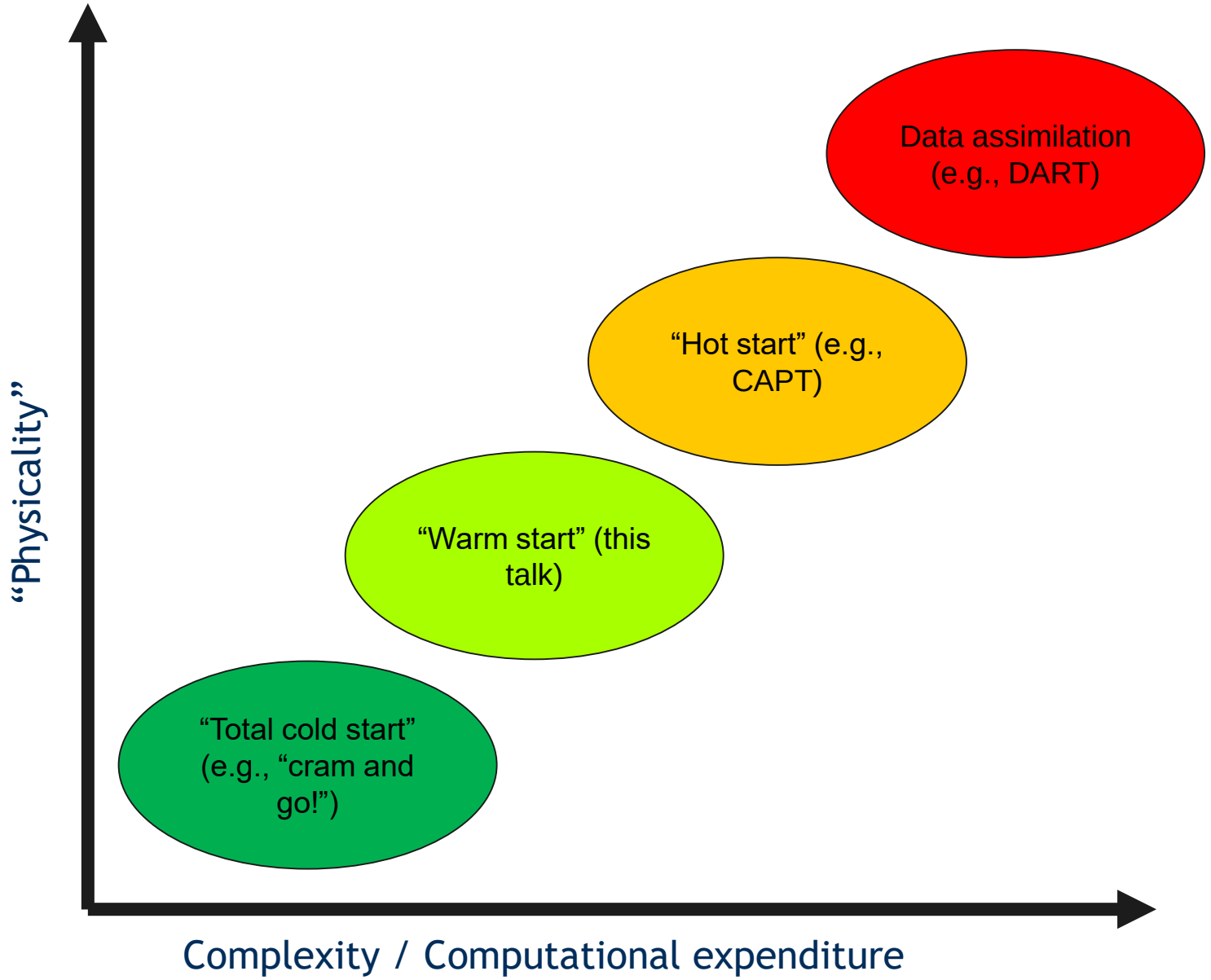


- **Fundamentally no difference between a "weather" or "climate" model**
- Challenges
  - Scale-aware physics
  - Efficient dynamics

Hierarchy of initialized prediction



What are CESM "Betacasts?"

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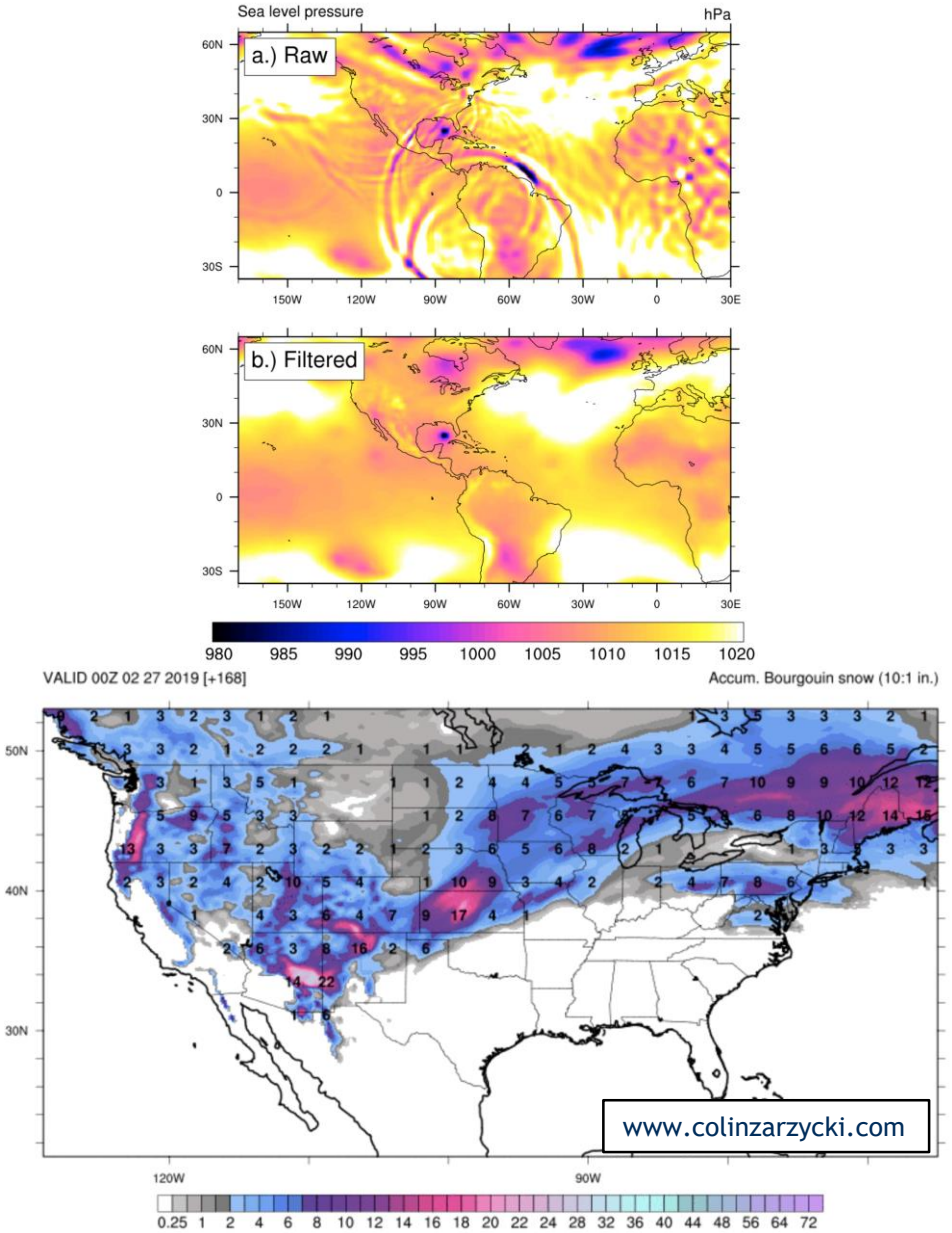
- **"Betacast" = Beta Forecast**
- Bash/NCL* wrappers that automatically...
  1. Pull re/analysis data
  2. Map data correctly (inc. unstructured grids)
  3. Configure CESM case to run in "hindcast" mode
  4. (*opt*) forward DFI – (primarily SE)
  5. (*opt*) post-process (e.g., storm tracking/plotting)



* "Pivoting?"

What are CESM "Betacasts?"

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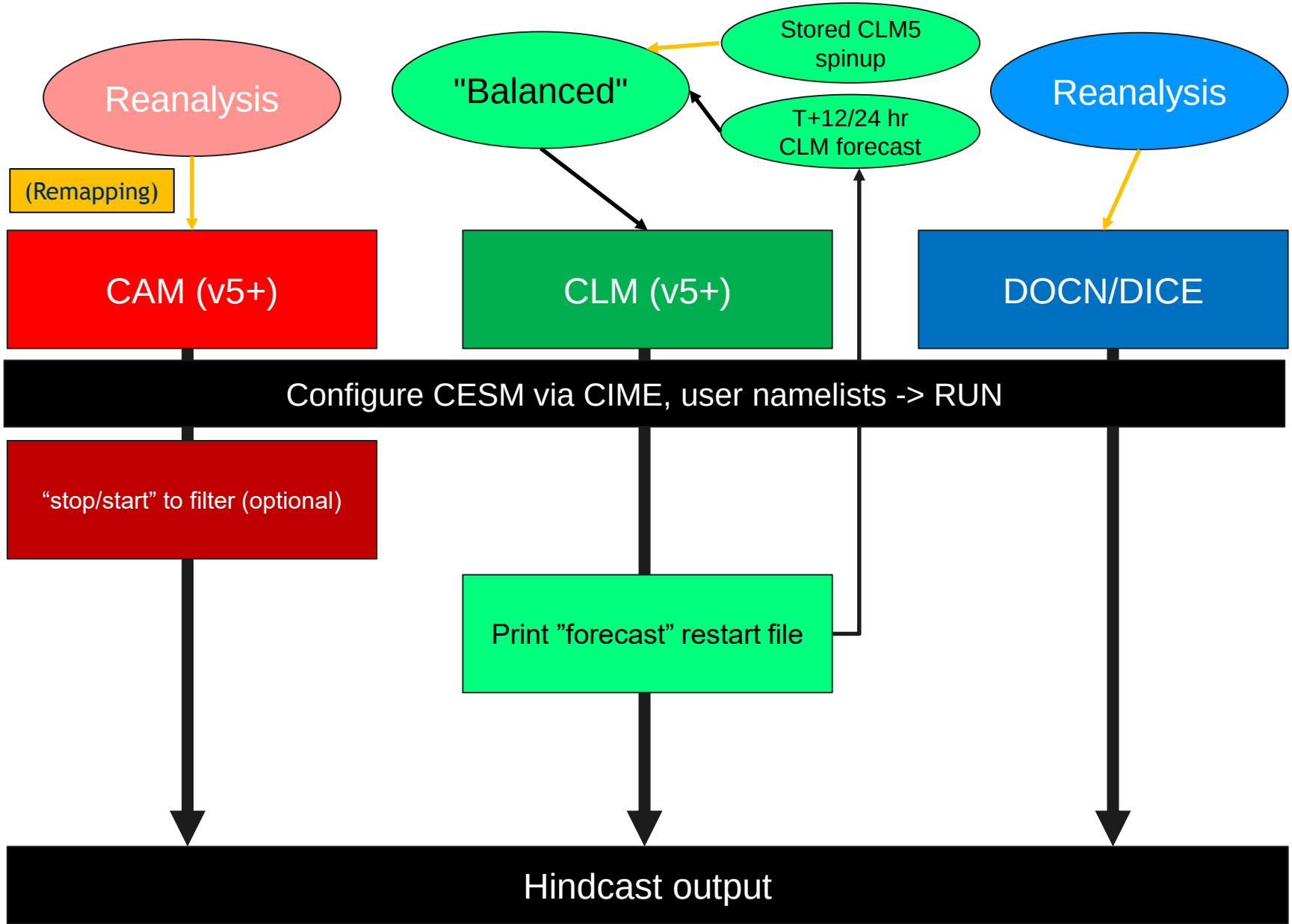

What are CESM "Betacasts?"

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- Pros:
  - Fast (if mapping files generated & CESM compset built, can be running within an hour)
  - Simple (mechanics are straightforward)
  - Skillful (bulk Z500 + TC forecasts "in the ballpark")
  - Namelist/case-based (phys-perturbed ensembles, etc.)
- Cons:
  - No "true" land initialization (no DA or interp. obs)
  - No interactive ocean capability (slab ocean OK!)
  - All physics tendencies start at "0"
  - No increments/etc.

What are CESM "Betacasts?"

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https://github.com/zarzycki/betacast

v0.1?

- Ideally a "bridge" (SIMA?)
- Available, quasi-polished (grad students using!) but not bulletproof, ex: relies on some data-specific routines (IANASE!)
- Currently wraps around CIME -> transferable to other models (e.g., E3SM, NorESM) (?)

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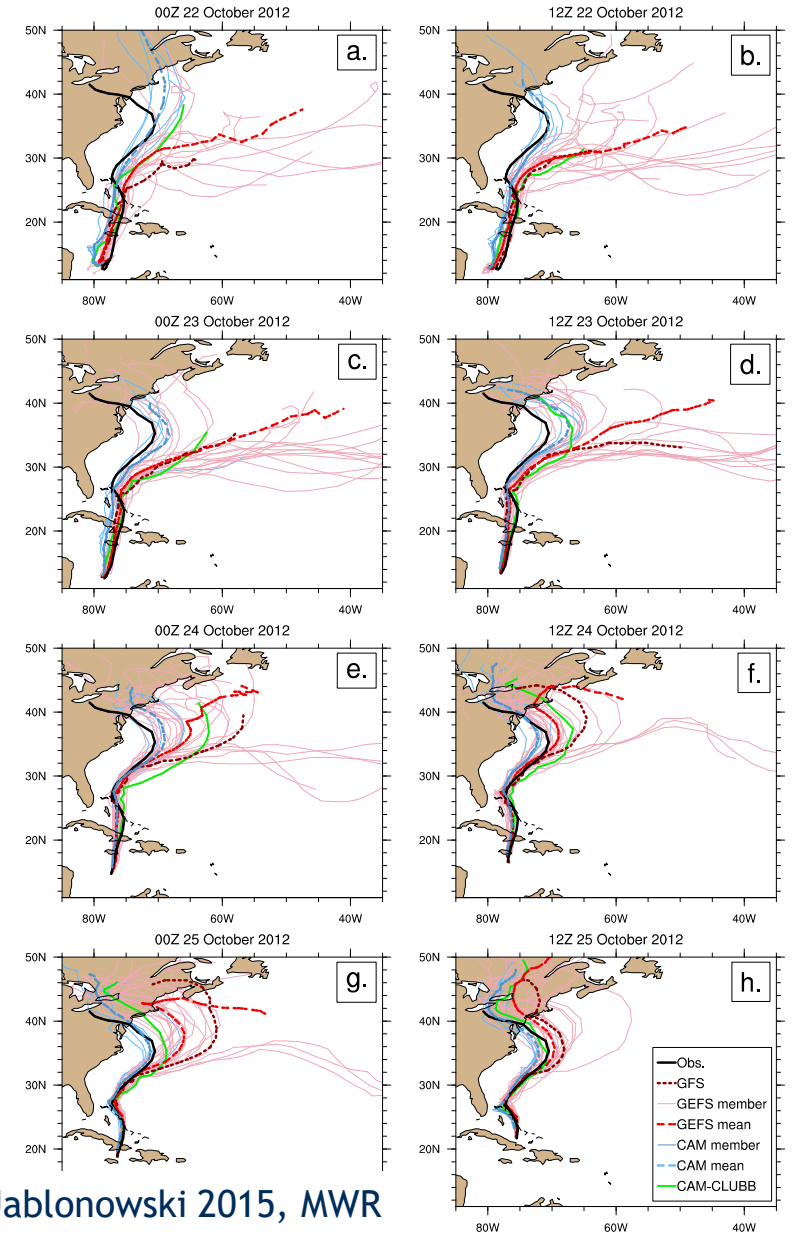
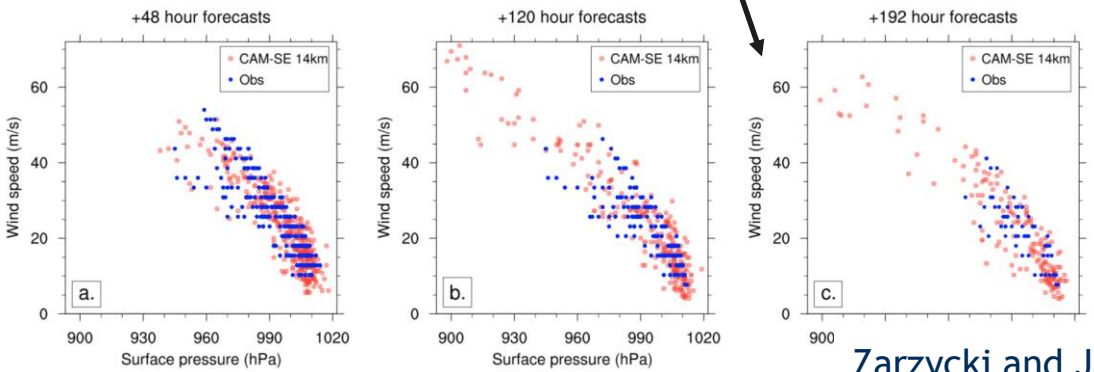
```
### GFS analysis avai
### CFSR analysis ava
### Use NOAAOI unless running real-time
# 1 = GFS analysis, 2 = ERA-interim, 3 = CFSR
  atmDataType = 1

# 1 = GDAS, 2 = ERA, 3 = NOAAOI
  sstDataType = 1

# 32 -> CAM5.5 physics, 30 -> CAM5 physics, 26 -> CAM
  numLevels = 30

#forecast length (in days)
  numdays = 7

#true/false, needs to be lowercase
  doFilter = true

#if true, exits after filter (generates init data)
  filterOnly = false

  numHoursSEStart = 3
  filterHourLength = 6
  filtTcut = 6

# Add perturbations from climate forcing run -- right
  add_perturbs = false
  add_noise = false

# is there a user_nl_clm_presave file?
  preSavedCLMuserNL = true

  land_spinup = false

# Case name
  casename = forecast_conus_30_x8_CAM5_L30
```

Science facilitated by technique

- Tropical cyclone (TC) work
  - Validated VR-CAM-SE core
  - Model physics can ***dramatically*** impact TC trajectory
  - Hinted that while CAM5 physics at 0.25^{O} gets TC intensity "*right*" climatologically, it is likely not for the "*best dynamical reasons*"





Zarzycki and Jablonowski 2015, MWR

Science facilitated by technique

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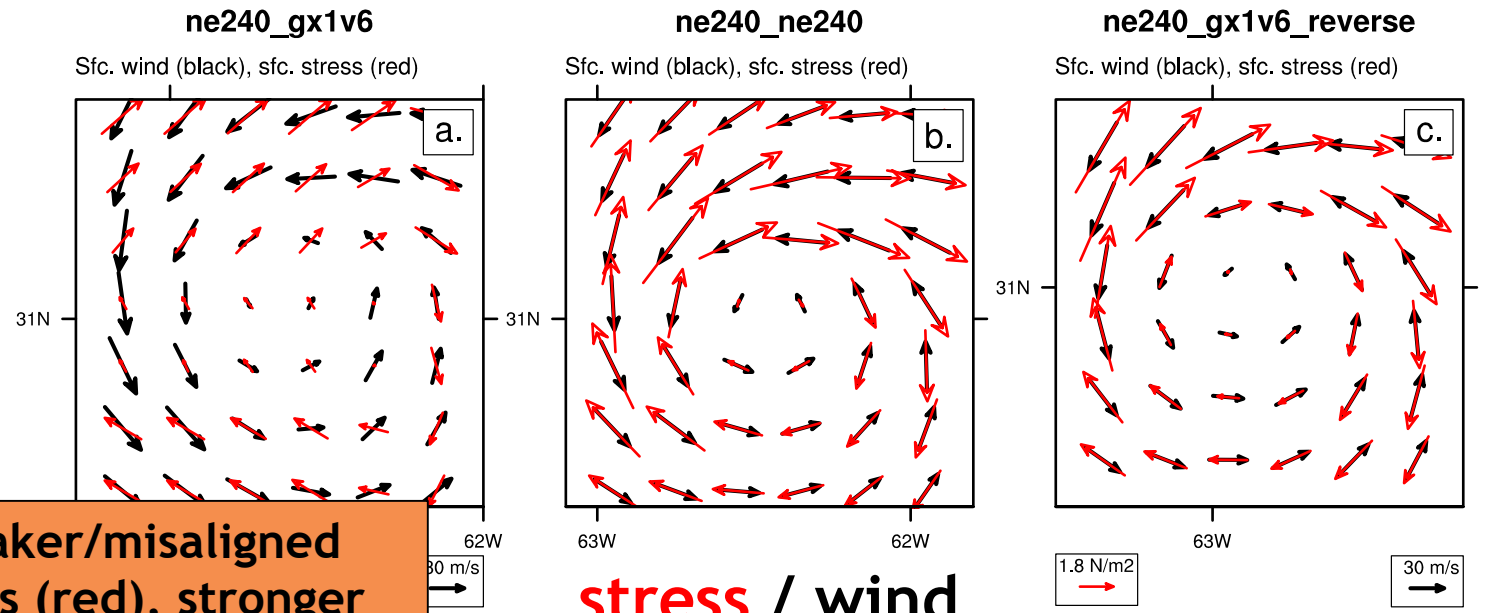
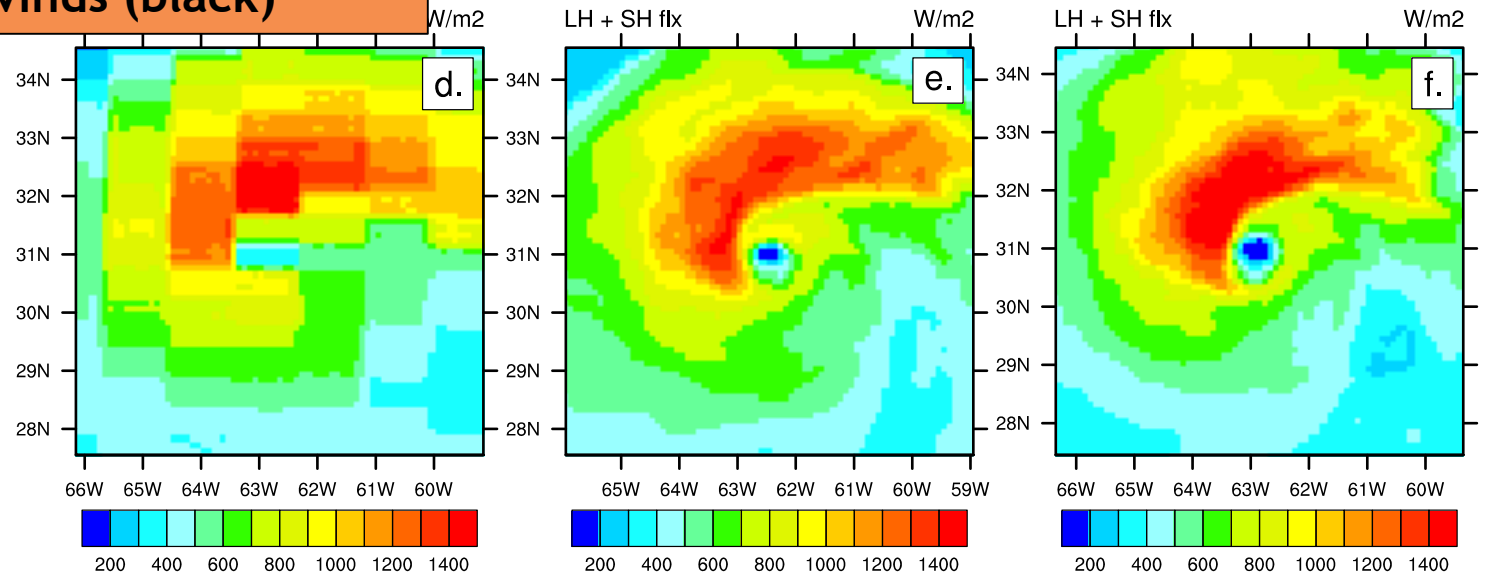


Weaker/misaligned stress (red), stronger winds (black)

stress / wind



Zarzycki et al., 2016, GMD

Science facilitated by technique

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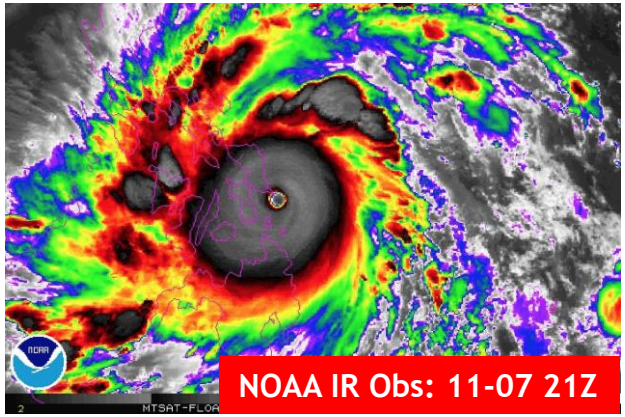

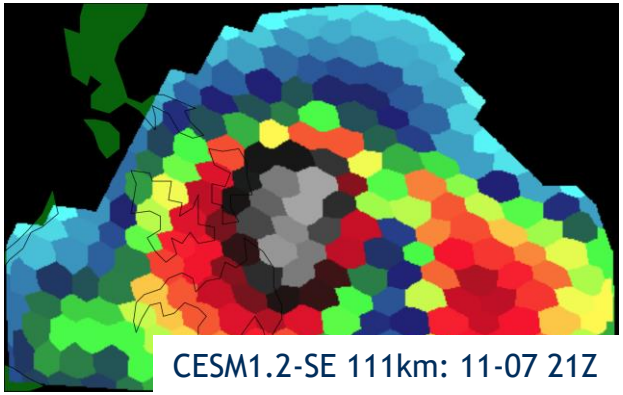

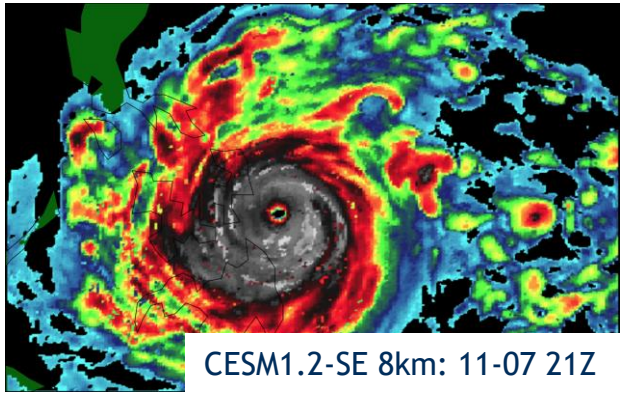

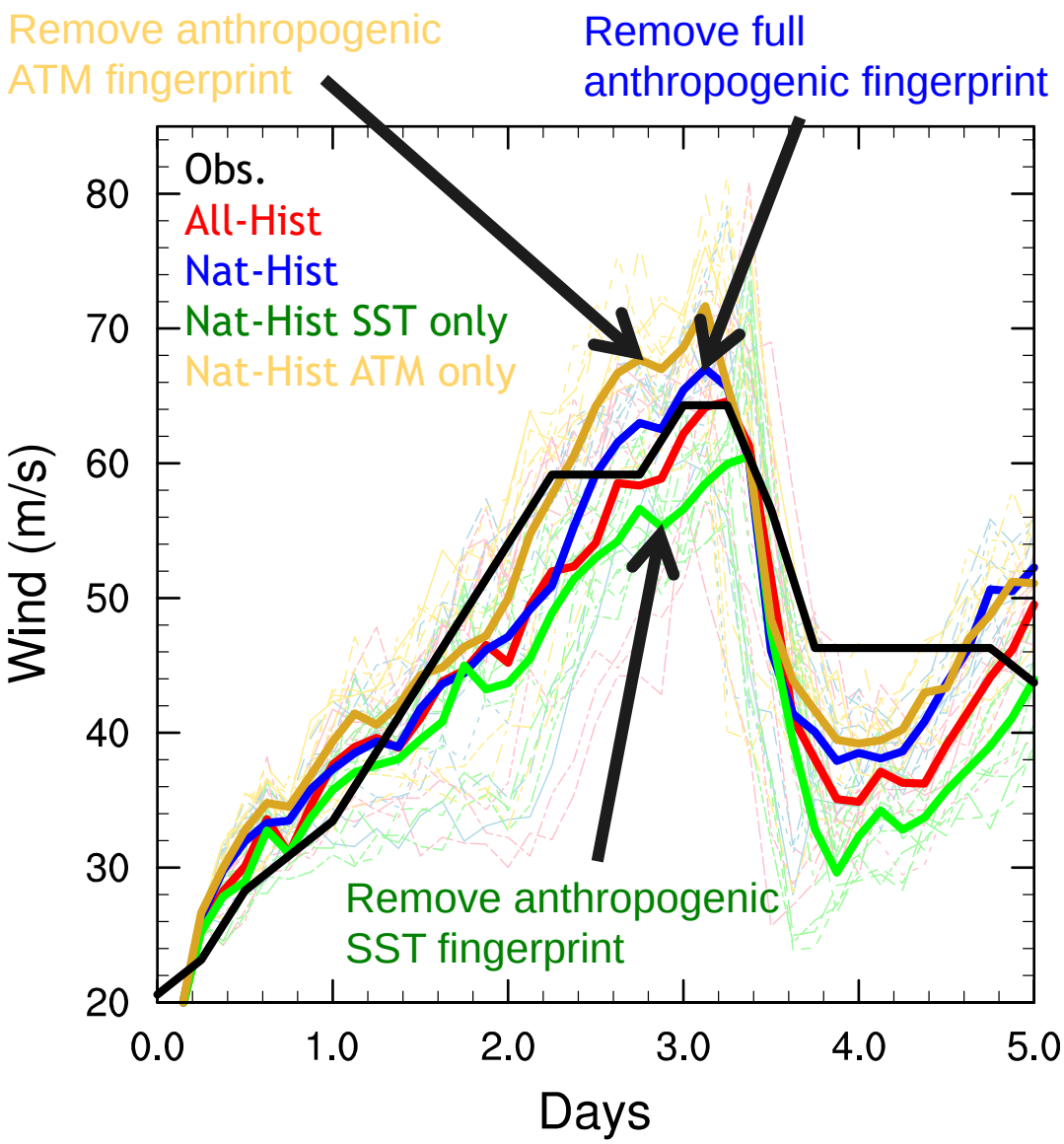

Wehner, Zarzycki, and Patriciola 2019

Science facilitated by technique

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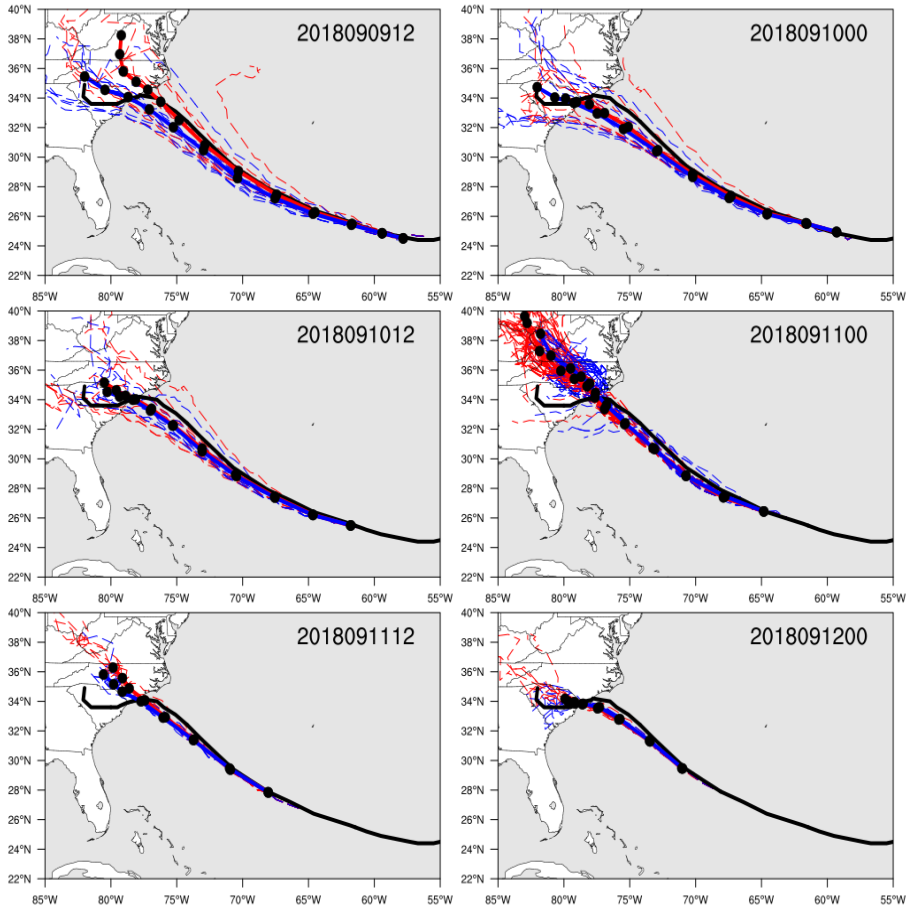
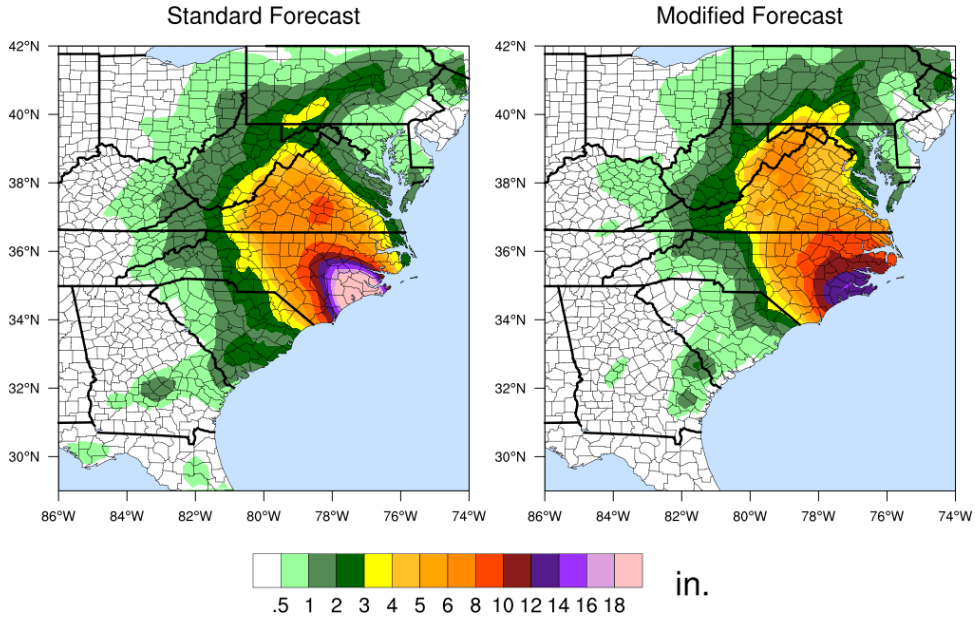
- Real-time detection and attribution of Hurricane Florence
- Marginal intensity signal from climate change but ~30% more rainfall
- Insanely small sample size, but CAM5 outperformed all global guidance for Florence!





Stony Brook University

Reed, Stansfield, Wehner, Zarzycki, in review, Science Advances

Initialization: the "big picture?"

- **Need focused investment developing "easy-to-use" initialization tools...**
  - Init in CAM currently "wild west" (outside of CAPT)
- From AMWG's perspective...
  - Address fast-evolving errors (clouds, precip, coupling, etc.)
  - Dycore evaluation (e.g., FV3 vs. MPAS vs. SE at 3km)
  - New parameterization development (Grell-Freitas, MG3, etc.)
- From the external/university community's perspective...
  - Case studies (particularly with non-local teleconnections, strong synoptic influences, etc.)
  - "In-ensemble" downscaling
  - Reduced computing load (postdoc allocation, university clusters, etc.)
  - Educational (ex: modeling classes)