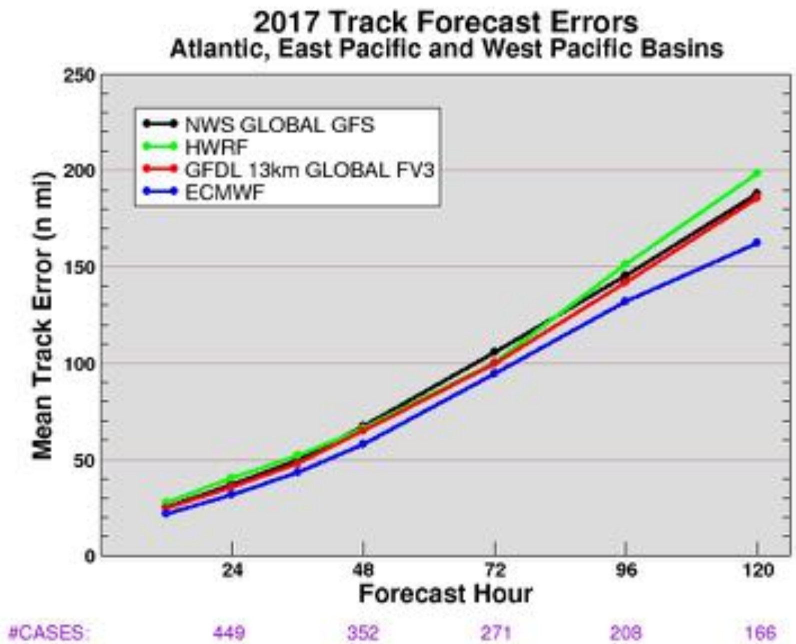
Weather-to-Decadal Timescales:

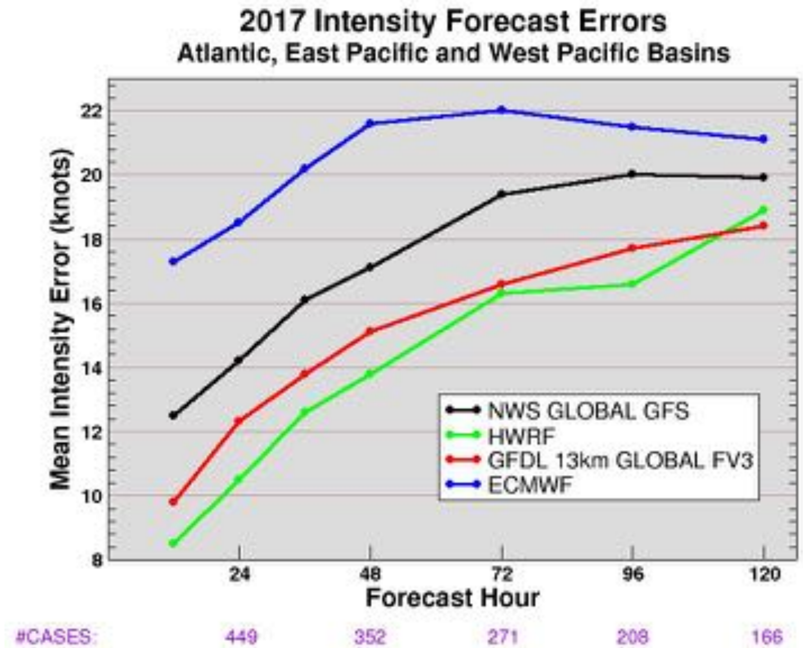
Enhancing Modeling for Predictions

V. Ramaswamy

Geophysical Fluid Dynamics Laboratory

2017 Atlantic/Pacific TCs





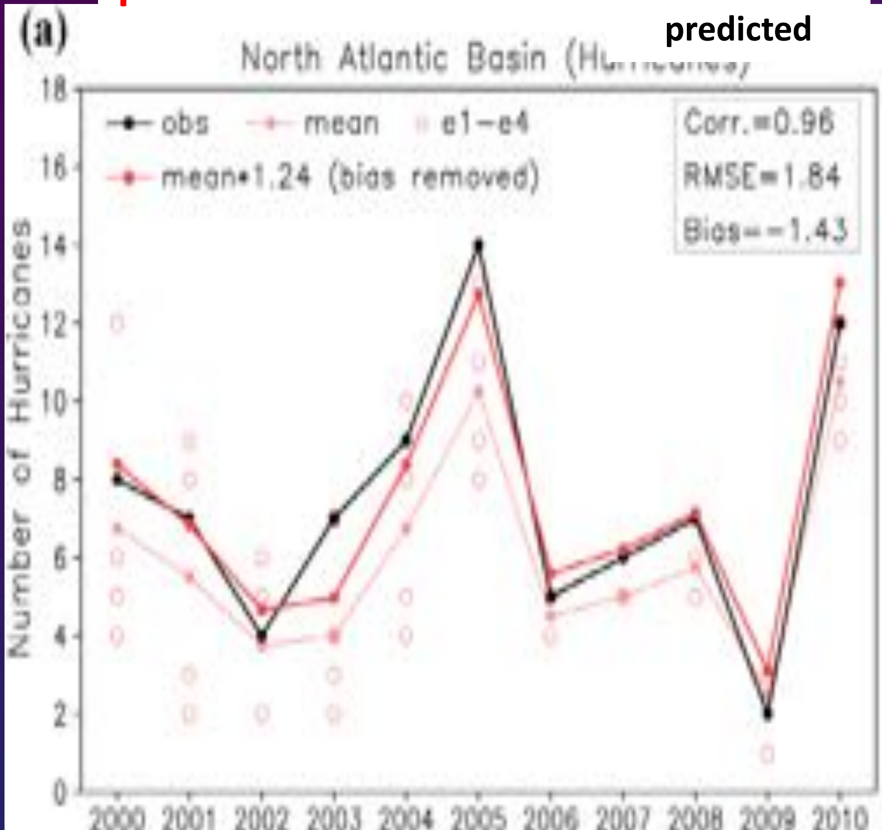
Modest improvement in track. **BIG** improvement in intensity!!

Courtesy J.-H. Chen and Morris Bender

SEASONAL, SUBSEASONAL PREDICTION: 25-KM HIRAM

Observed Hurricanes
Model seasonal prediction

96%
variance predicted

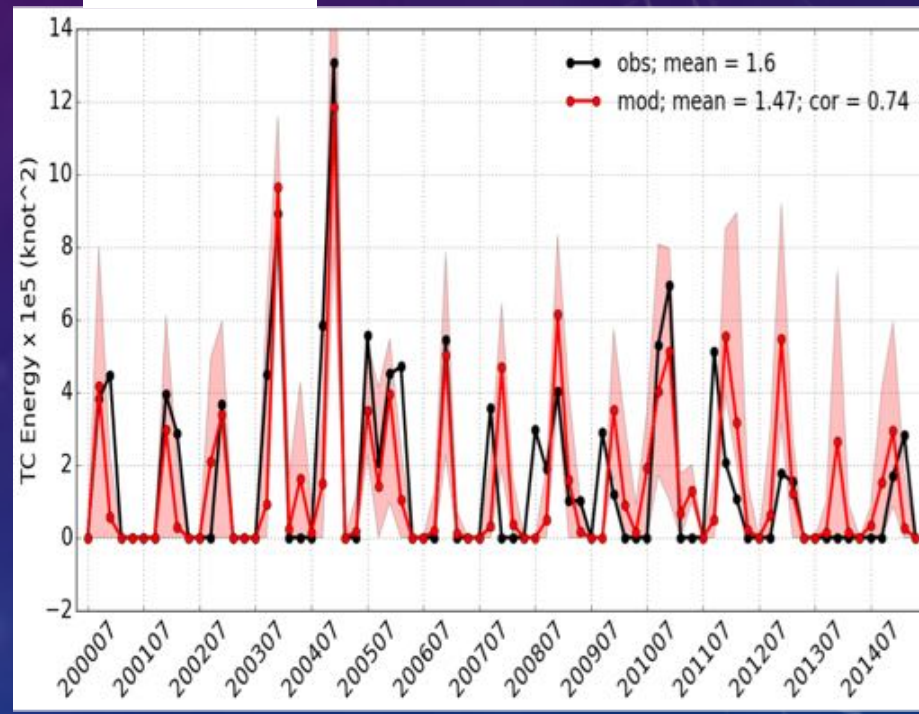


Chen & Lin (2011)

Seasonal Atlantic **Hurricane** Predictions

74%
variance predicted

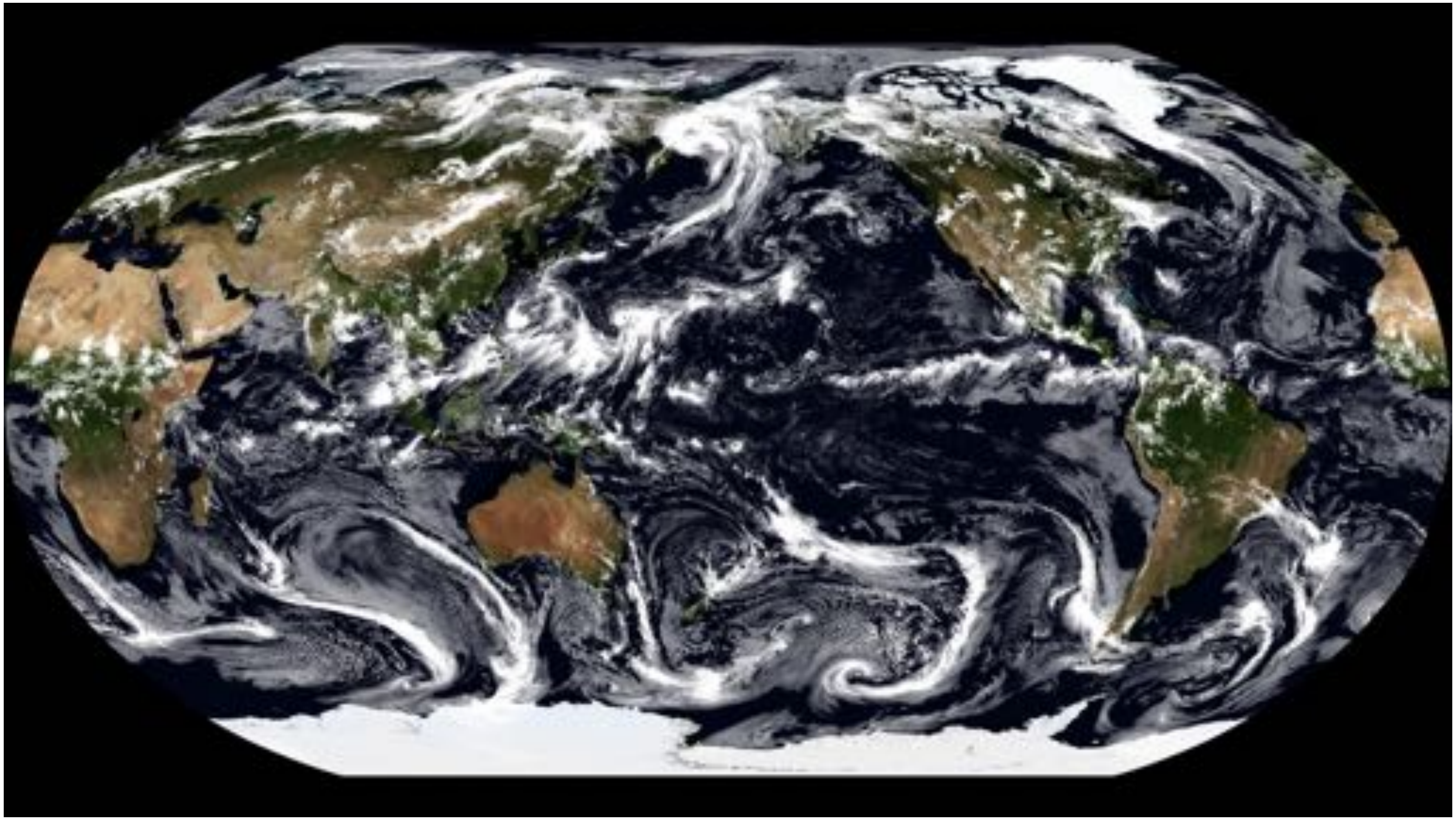
Observed Hurricanes
Model subseasonal prediction



Subseasonal (harder!) Atlantic **Major hurricane** Predictions

Courtesy: S. J. Lin

fvGFS global cloud-resolving simulation



Experimental 10-day forecast; 3-km (c3072); fvGFS init 1 Aug 2016

- FV3 has powered global cloud-scale models at GFDL and NASA for 10+ years
- 8.5 mins/day with ~110K cores: in reach of current computing systems
- Participating in DYAMOND intercomparison (w/ NICAM, ICON, GEOS)

Courtesy: S. J. Lin and X. Chen

GFDL Research on Seasonal to Multi-year Prediction Systems

Models used for research and experimental predictions:

[Cat 4/5 hurricanes, Western US precipitation and snowpack, Arctic sea-ice, winter storms,……]

1. CM2.1 – Low res atmos (200 km), low res ocean (100 km) (developed circa 2004)

2. FLOR – Medium res atmos (50 km), low res ocean (100 km) (assembled circa 2012)

3. HIFLOR – High res atmos (25 km), low res ocean (100 km) (assembled circa 2014)

- CM2.1 and FLOR are run each month for the North American Multi-Model Ensemble (NMME)

- Output provided to the NHC and CPC to inform their seasonal outlooks

- Ocean reanalysis also provided to NOAA

Key point: Prediction systems are made possible through harvesting the fruits of decades long research on MODEL DEVELOPMENT and INITIALIZATION SYSTEMS.

Atmospheric initial conditions important for successfully predicting 2015-16 winter precipitation: FLOR Model

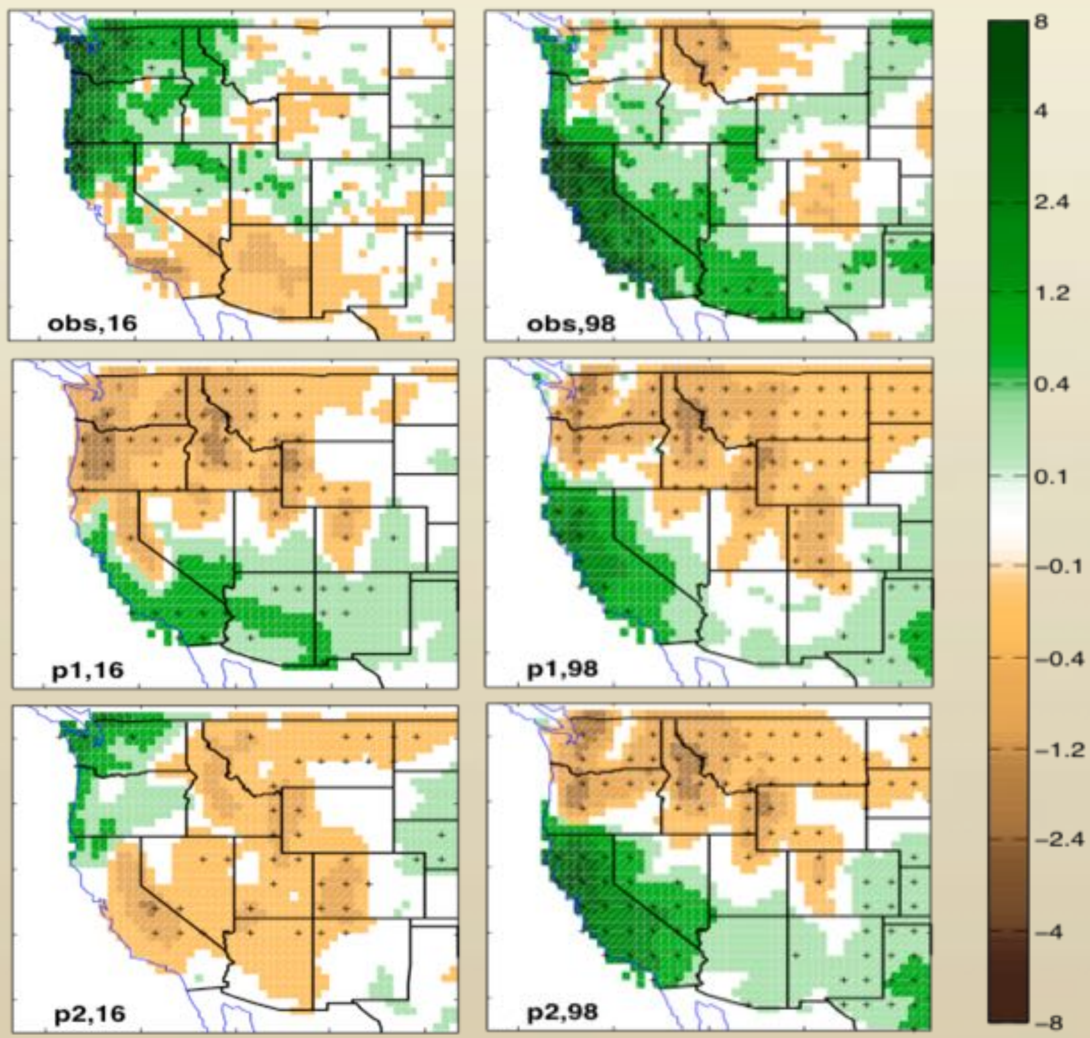
DJF 2015-16

DJF 1997-98

Observed precipitation anomaly

Prediction using only ocean initial conditions

Prediction using ocean and atmos initial conditions



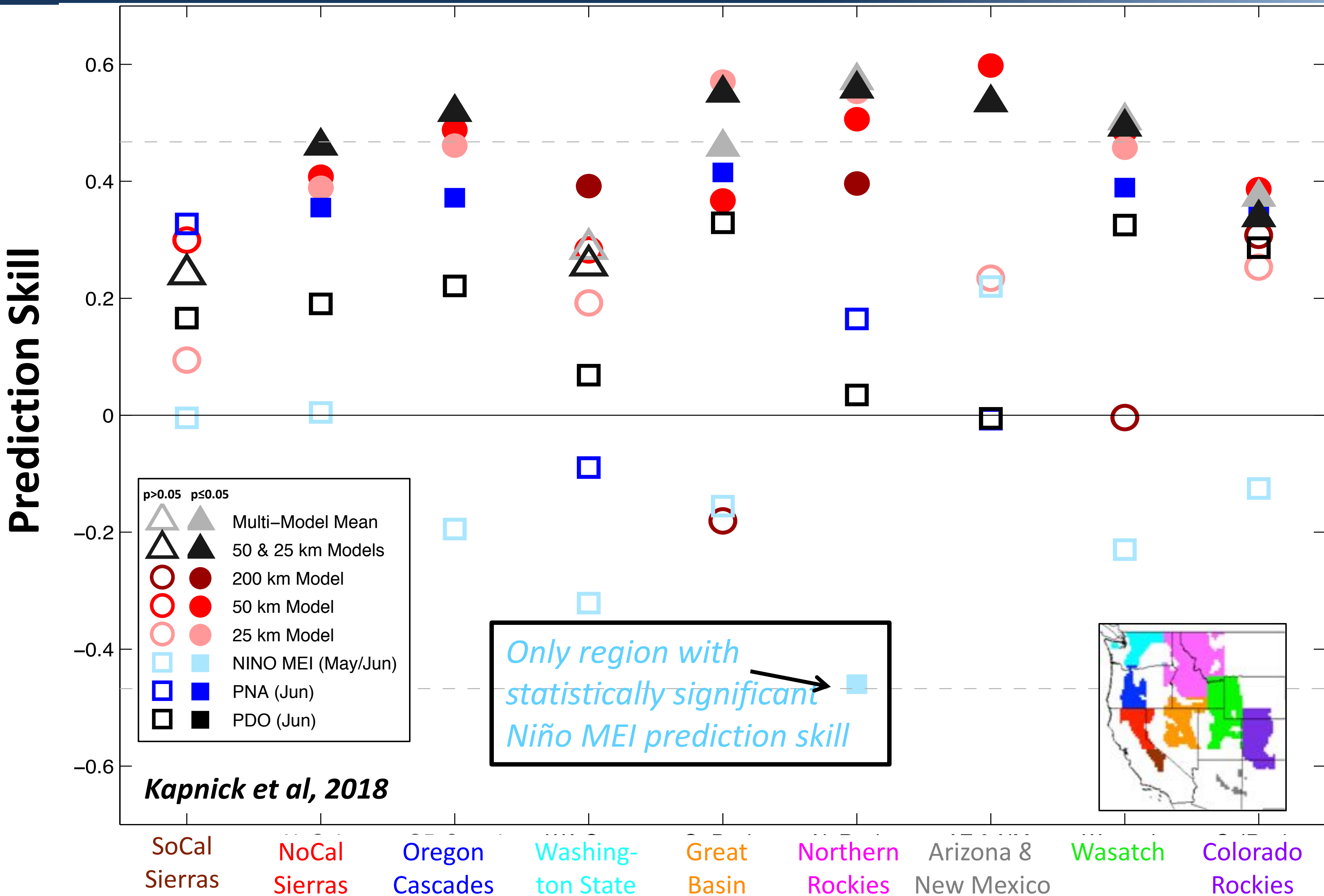
Conclusions:

➔ *For 97-98, ocean initial conditions are dominant*

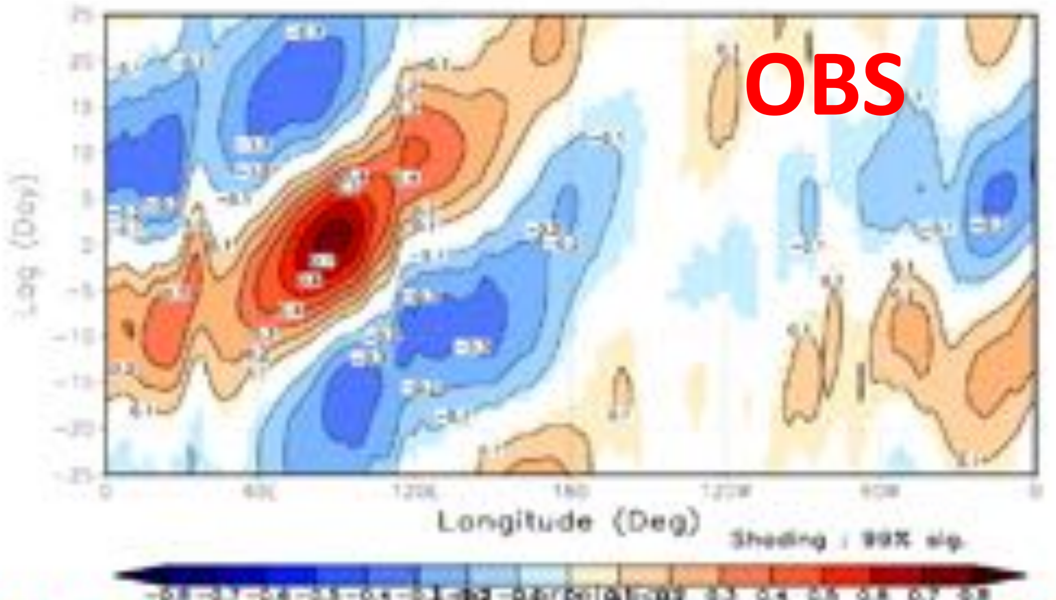
➔ *For 15-16, atmos initial conditions play important role*

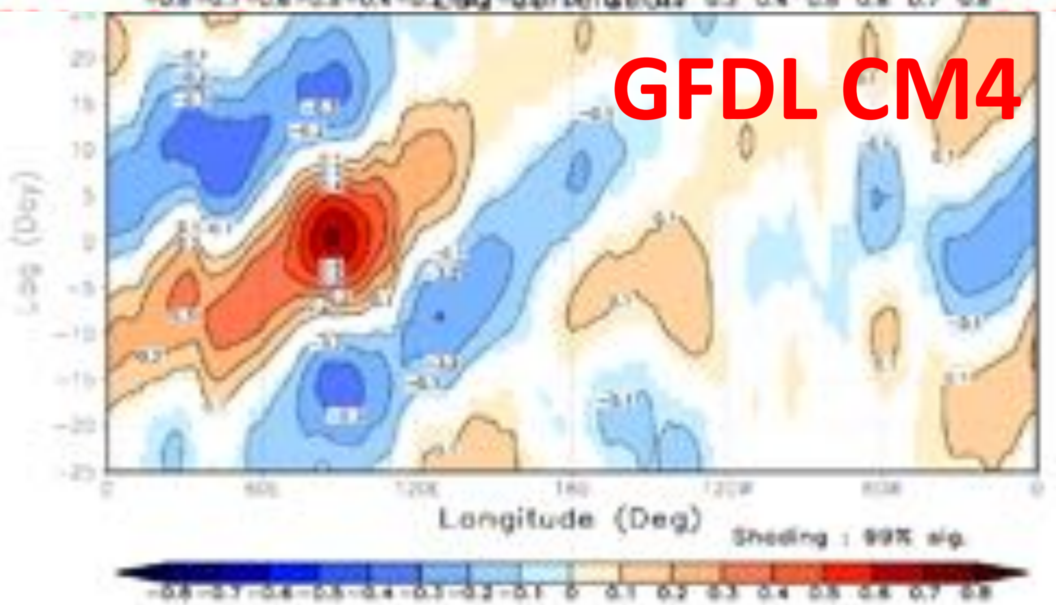
Yang et al. (2018, Clim. Dyn.)

Skill in predicting March snowpack from previous July obs



NEW Generation of NOAA/ GFDL Models: (AM4, CM4) MJO Eastward Propagation and Comparative Metrics





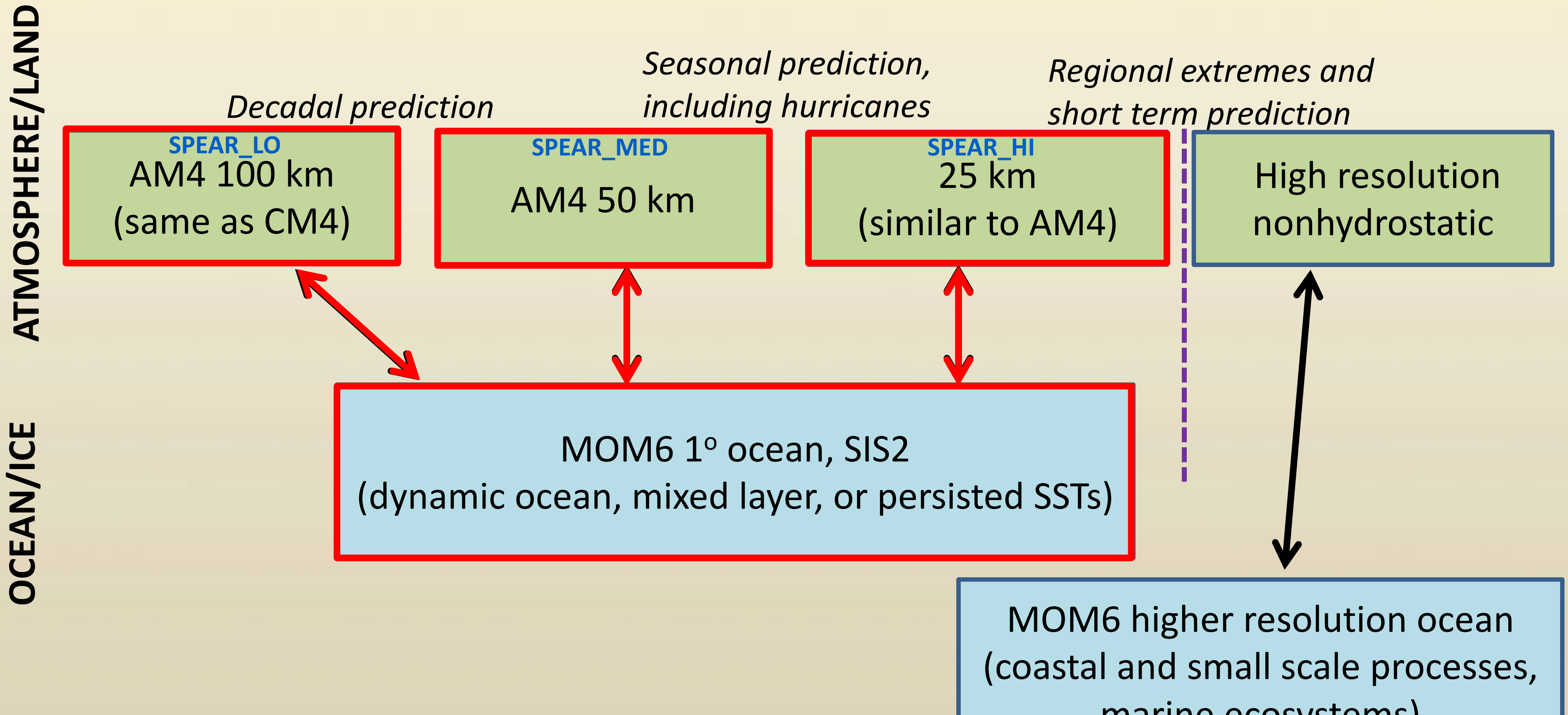
AMIP RMSE Comparison (SST cpld)

Model	CM2	CM3	CM4
SST	1.2	1.1	0.83
OLR	7.21	8.56	4.27
TOA SW	12.59	11.26	7.70
Precip	1.13	1.02	0.86
NH DJF SLP	19.4	19.2	18.4
Zonal wind	1.95	1.85	0.94

AM4: Zhao et al., (JAMES, in press)

Towards a Seamless System for Prediction and EArth System Research
"SPEAR"

… building from AM4/LM4 and MOM6/SIS2



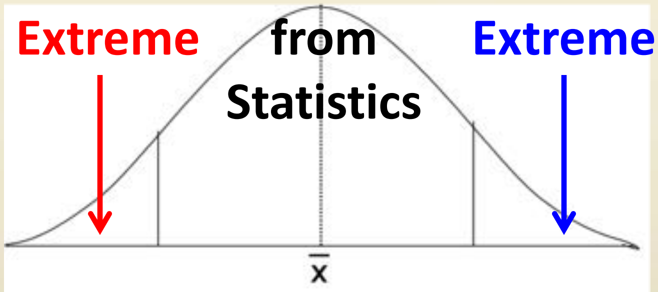
Key aspects:

- Improved models may lead to improved predictions and projections across time scales
- Initialization system is crucial – will require considerable additional investment
- Physical model for prediction, potential to include other Earth System components

Beyond the traditional definition of extremes: things that matter

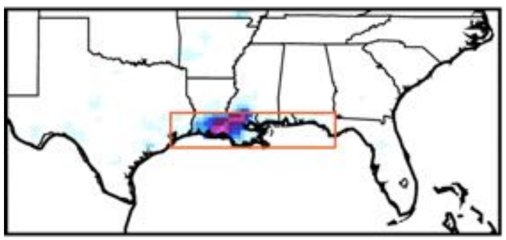
van der Wiel et al. 2017a,b; Pascale et al. 2016; Janoski et al., in prep

Traditional Definition from Statistics

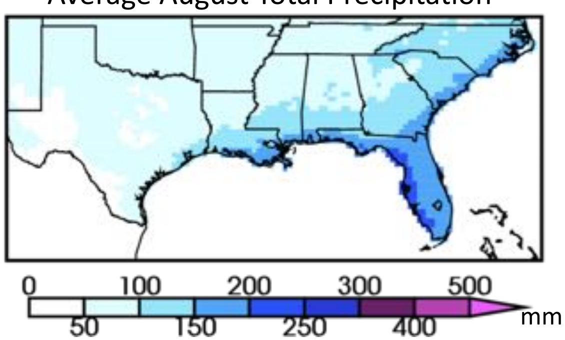


12-14 Aug 2016: Rainfall Extreme Louisiana

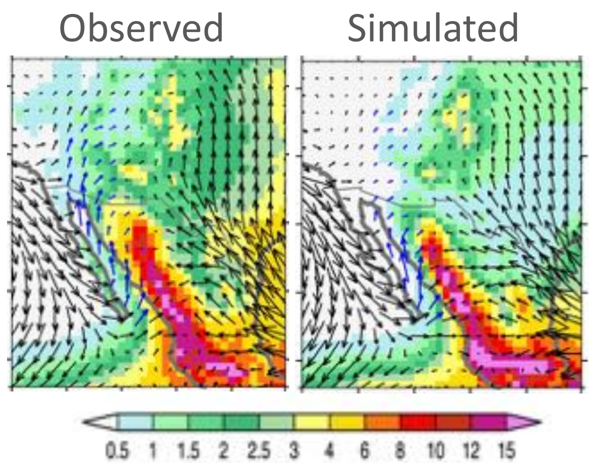
Total Rainfall 12-14 Aug; max = 535mm



Average August Total Precipitation

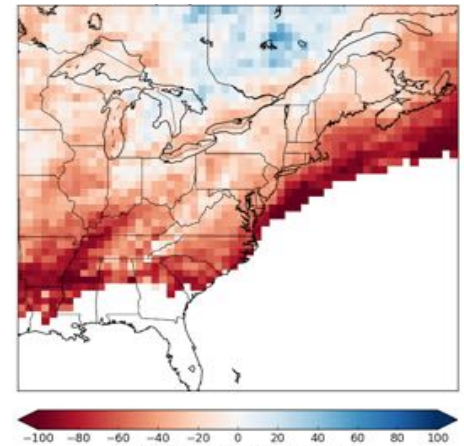


North American Monsoon



Precipitation today (mm/day June-Sept)

East Coast High Wind/Snow Events



% Future Change over 70 years

"Mild" or Tourism Weather