Towards a …

Seamless System for Prediction and Earth System Research

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Seamless System for Prediction and Earth System Research

- Benefits from unifying predictions & projections across time scales (weather to multidecada)
- GFDL has already made substantial progress in this direction
- CM2.1 developed for projections; was basis for seasonal to decadal prediction system, leading to FLOR (operational NMME) and HIFLOR (research-only) prediction models
- Accelerated push towards next-generation "seamless" weather to climate prediction system
- Leveraging off FV3, NGGPS, AM4 and MOM6 development efforts

Special thanks to SJ Lin, M. Zhao, M. Harrison, A. Adcroft, R. Hallberg

Seamless System for Prediction and Earth System Research

Tradeoffs:

Model speed, resolution, comprehensiveness,
and the ability to run large ensembles.

➔ *A system is needed, not a single model.*

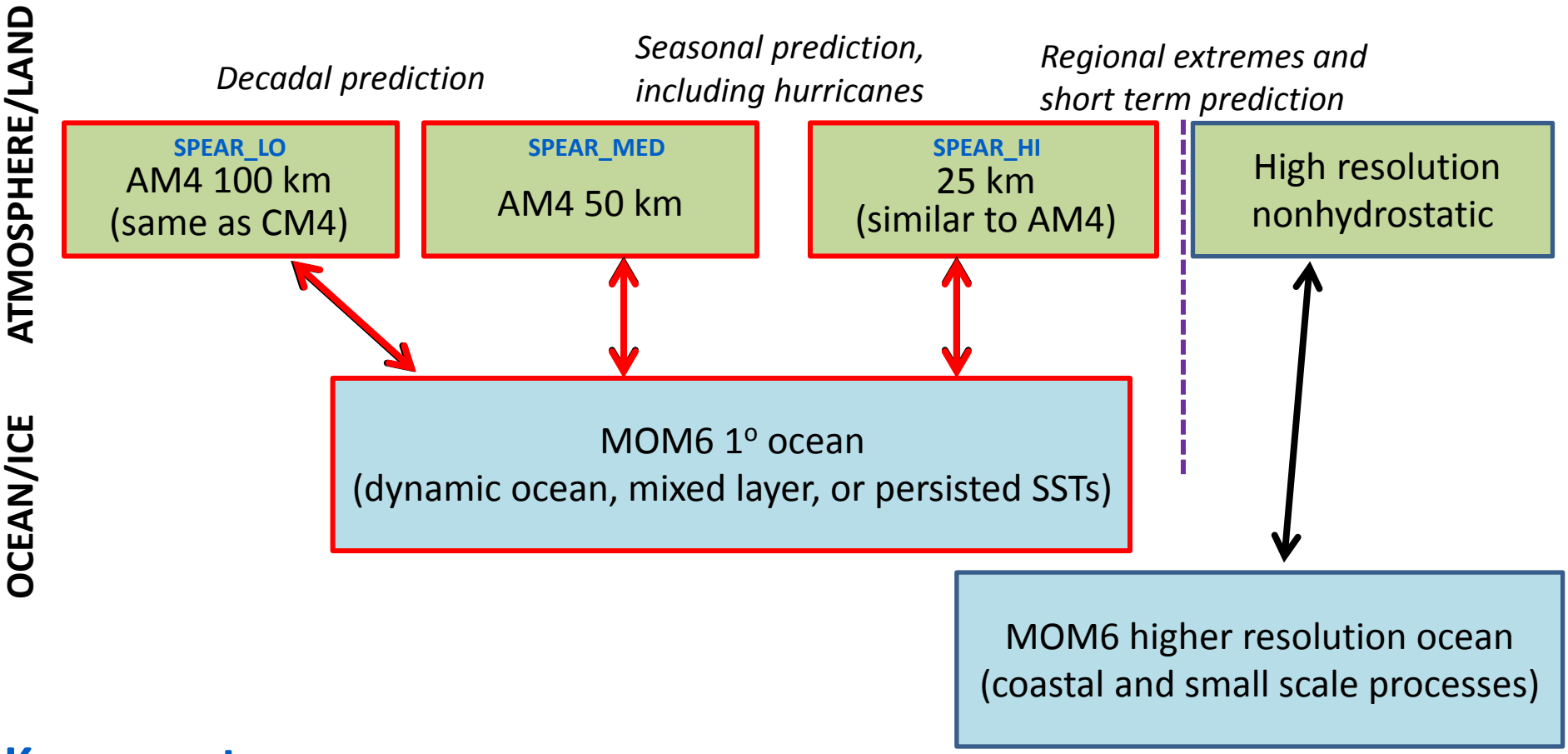
Philosophy:

Flexibility to optimize for multiple purposes

Targets for seamless system:

- Prediction: weather to seasonal to decadal
- Decadal and multidecadal projections
  - *Regional extremes, tropical and extratropical storms*
  - *North American water resources, including droughts and floods*
- Scientifically sound risk assessment in support of resilience

Seamless System for Prediction and EArth System Research "SPEAR"



Key aspects:

(a) Improved models may lead to improved predictions and projections across time scales

(b) Initialization system is crucial – will require considerable additional investment

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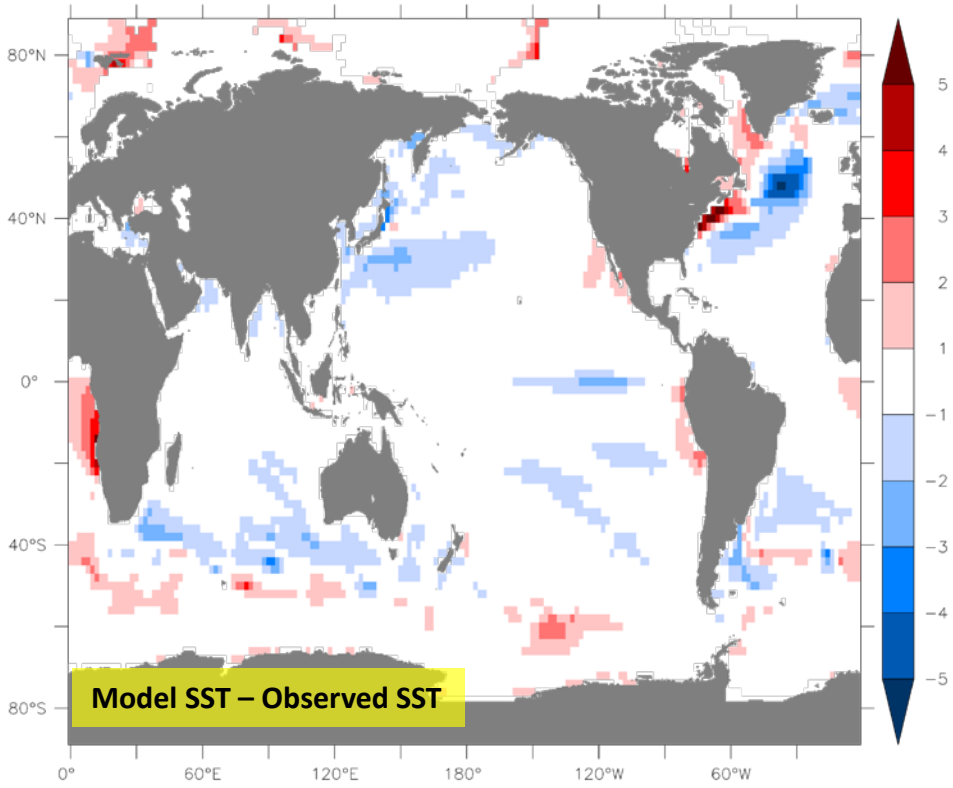
SPEAR_LO (100 km atmosphere, 1º ocean)

Root Mean Square Error (RMS) for SST = 0.86



Low SST error due to:

- Improved AM4 atmosphere, esp radiation
- MOM6 (hybrid vertical coordinates and upper ocean mixing)

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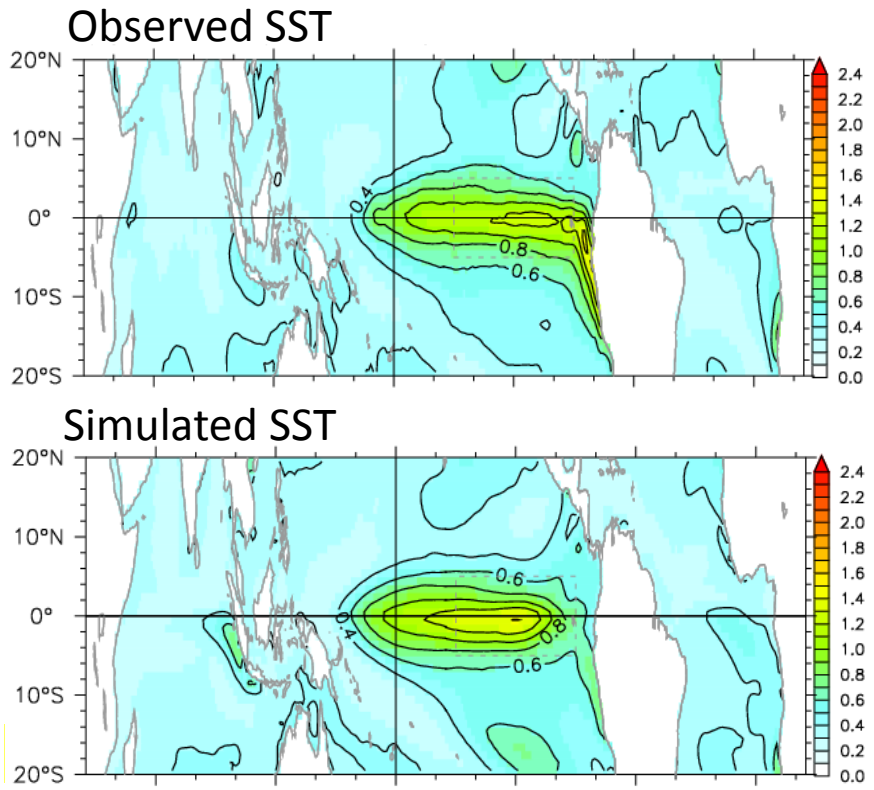
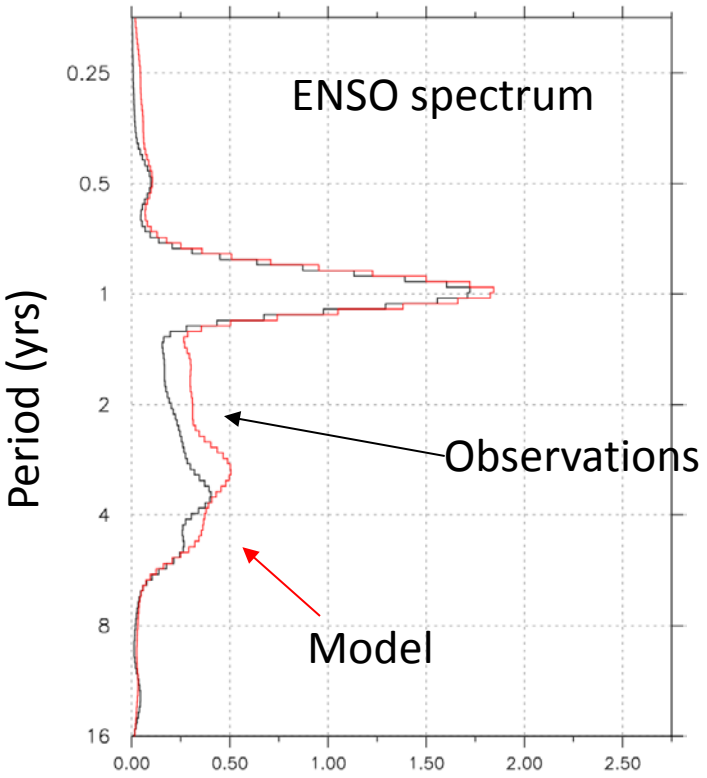
SPEAR_LO (100 km atmosphere, 1º ocean)

- Despite relatively coarse ocean resolution, SST bias pattern and ENSO are encouraging.
- The low computational cost (12 times less expensive than CM4) makes this an attractive prediction tool, used together with SPEAR_MED (50 km atmosphere) and SPEAR_HI (25 km atmosphere).





Courtesy of Andrew Wittenberg

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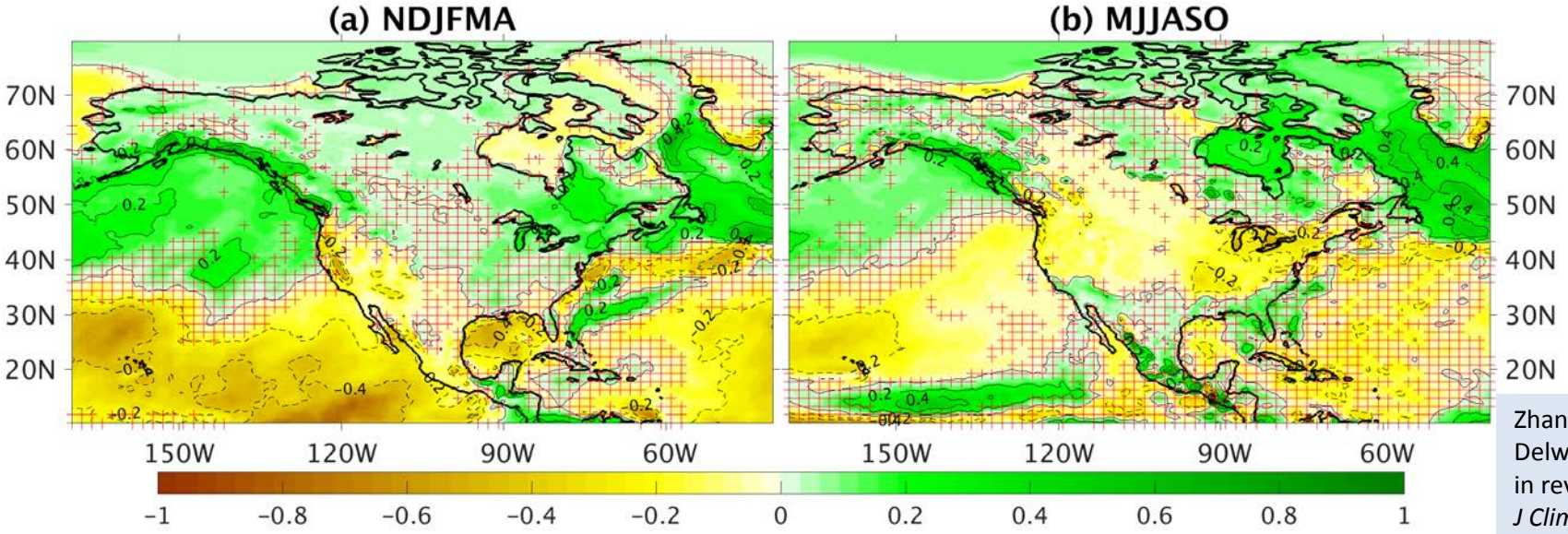
Key goal: **Probabilistic assessment of decadal-scale changes in weather extremes over North America**

- *Precipitation extremes and water resources, especially over North America*
- *Impacts of changing tropical and extratropical storms*
- *Snowpack and western water resources*

Example: Change in P-E (for decade of 2030s) using large ensembles of projections with FLOR



Zhang and Delworth, 2017, in revision, *J Climate*

Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change

Karin van der Wiel[1,2], Sarah B. Kapnick[2], Geert Jan van Oldenborgh[3], Kirien Whan[3], Sjoukje Philip[3], Gabriel A. Vecchi[2], Roop K. Singh[4], Julie Arrighi[4], and Heidi Cullen[5]

Hydrology and Earth System Sciences, 14 Feb, 2017

Weakening of the North American monsoon with global warming

Salvatore Pascale, William R. Boos, Simona Bordoni, Thomas L. Delworth, Sarah B. Kapnick, Hiroyuki Murakami, Gabriel A. Vecchi & Wei Zhang

Nature Climate Change, 9 Oct, 2017