Ocean Predict

SYMPOSIUM OP'24

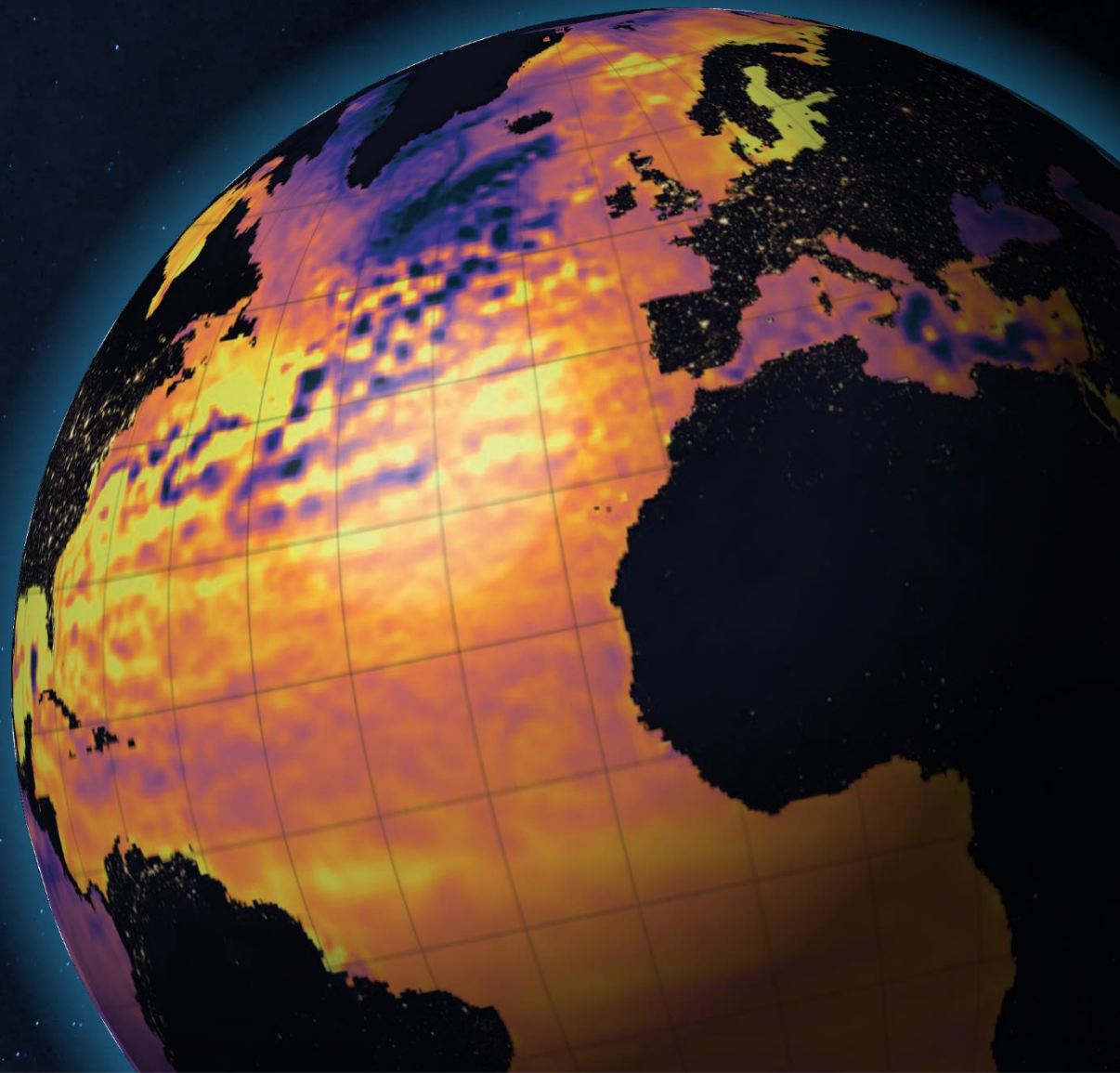
In partnership with unesco Intergovernmental Oceanographic Commission

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

A seasonal to interannual ensemble climate prediction system

Yunfei ZHANG, Ziqing ZU, Qian ZHOU

National Marine Environmental Forecasting Center



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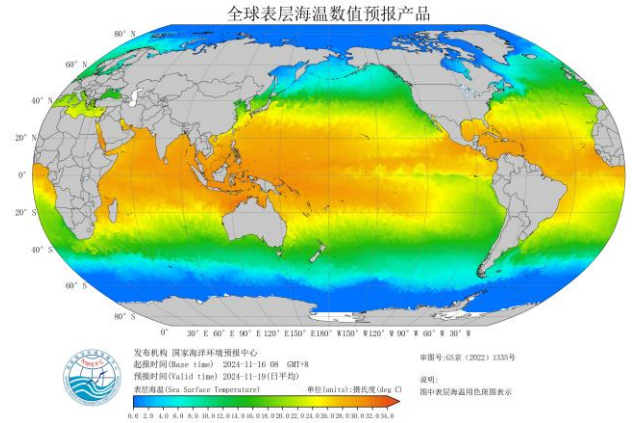
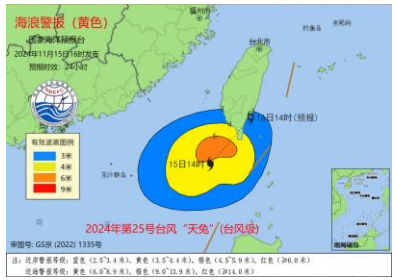
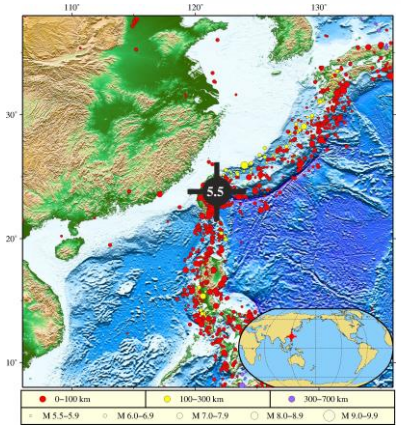
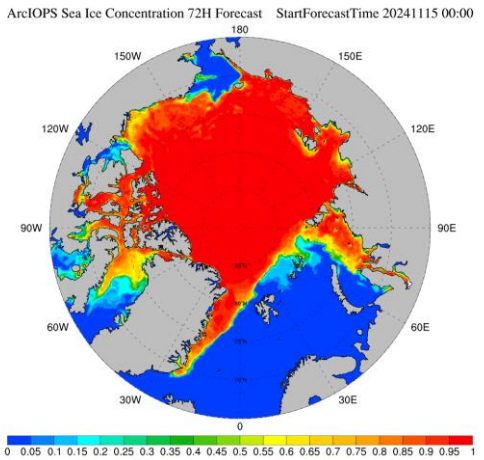
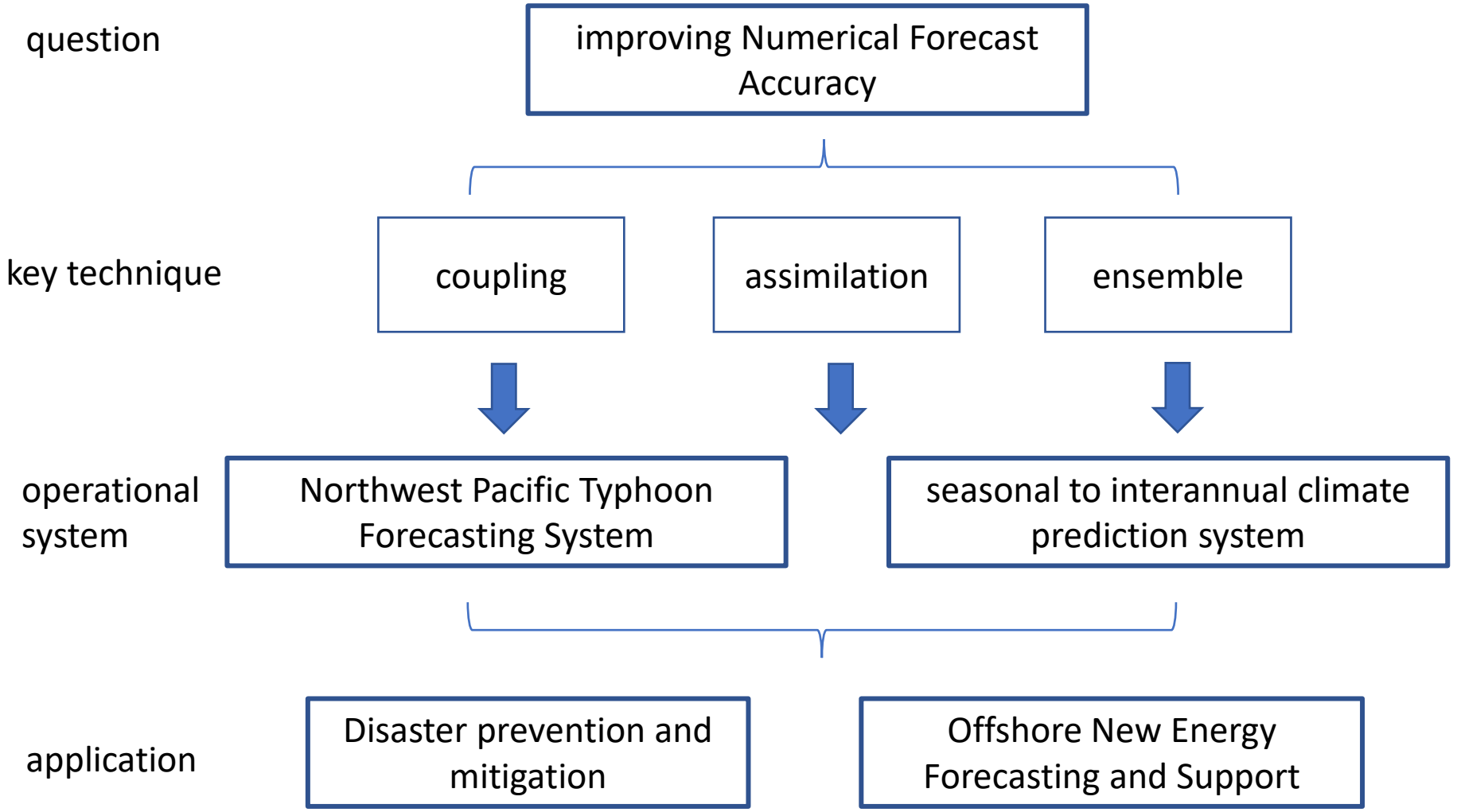








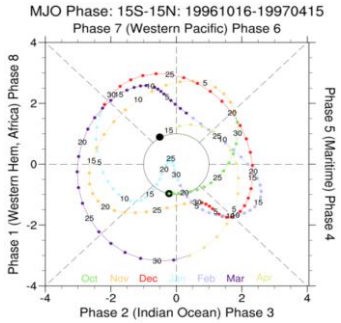
Ocean-Atmosphere Interaction Research Group



Introduction

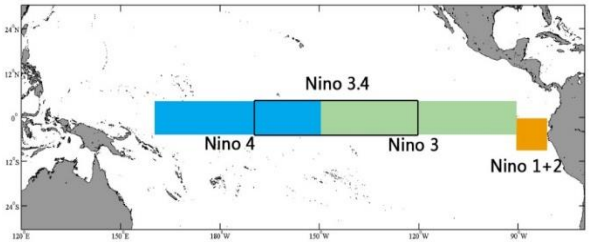
subseasonal → annual → interannual

MJO



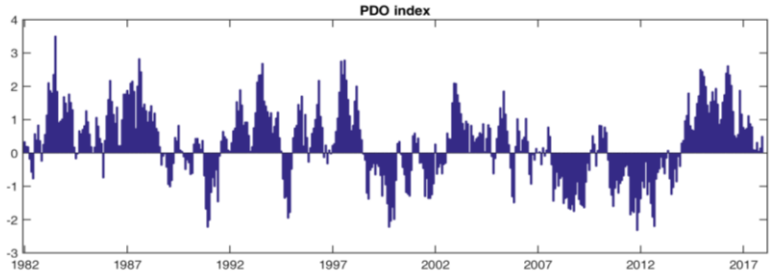
typhoon

ENSO



flood

PDO



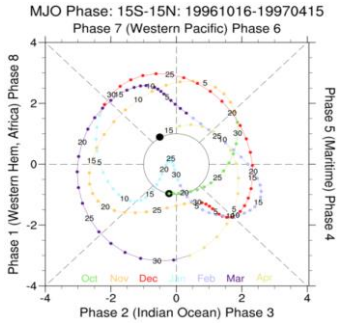
drought

wildfire

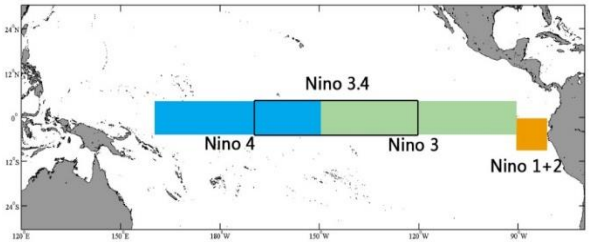
Introduction

subseasonal → annual → interannual

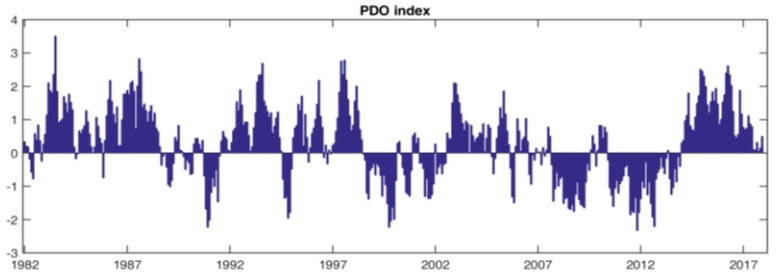
MJO



ENSO



PDO



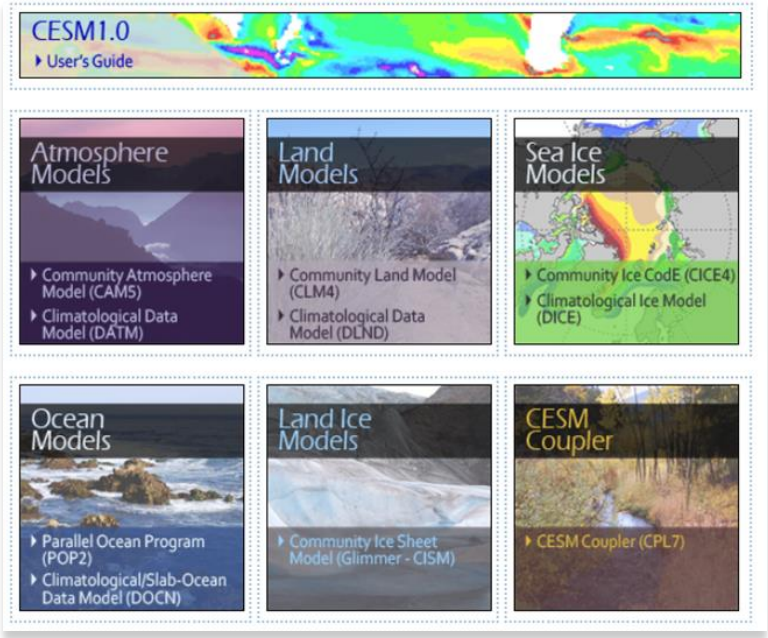
Seemless Prediction across Timescales

- Efficiencies in model development
- Unified physical parameterzation on all time-scales

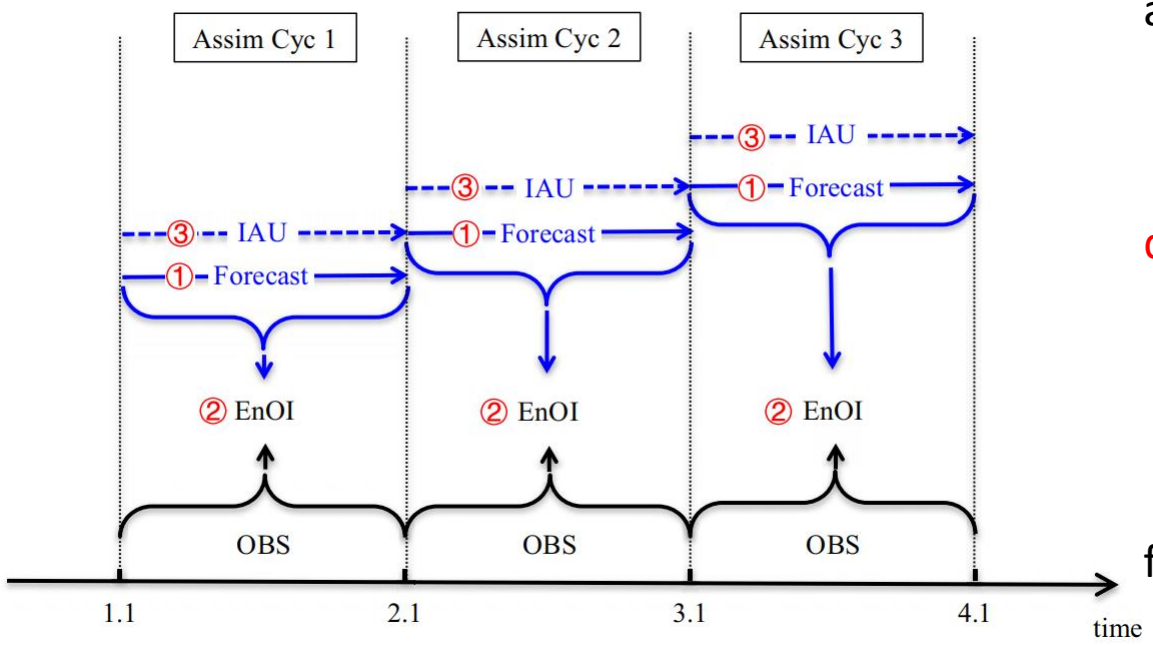
Model and Method

- Data assimilation
  - Ensemble optimal interpolation (EnOI) for ocean
  - Nudging for atmosphere
- Ensemble
  - Sea surface temperature perturbations
  - Climate singular vector analysis
  - Conditional nonlinear optimal perturbation methods

CESM1.2.1 f09_g16
atmosphere： 0.9°× 1.25°， 26 level
ocean： gx1v6, 1.1°×(0.54 ~ 1 °)， 60 level



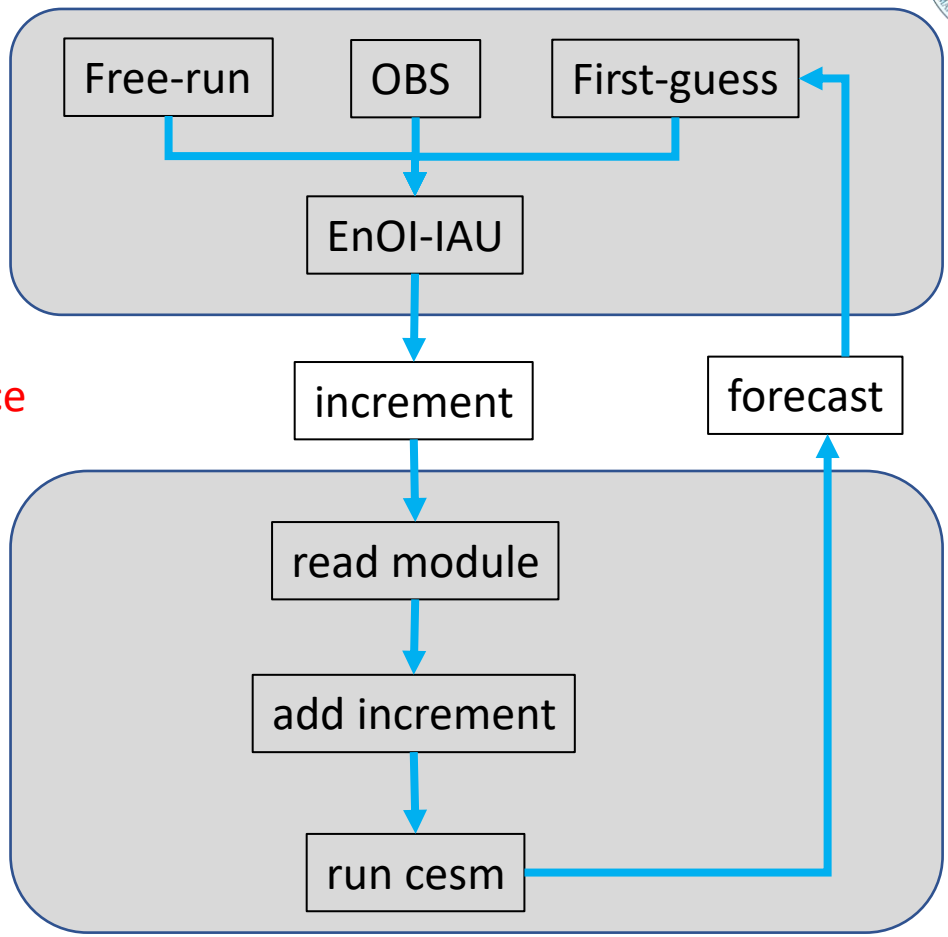
EnOI-IAU



assimilation

data interface

forecast



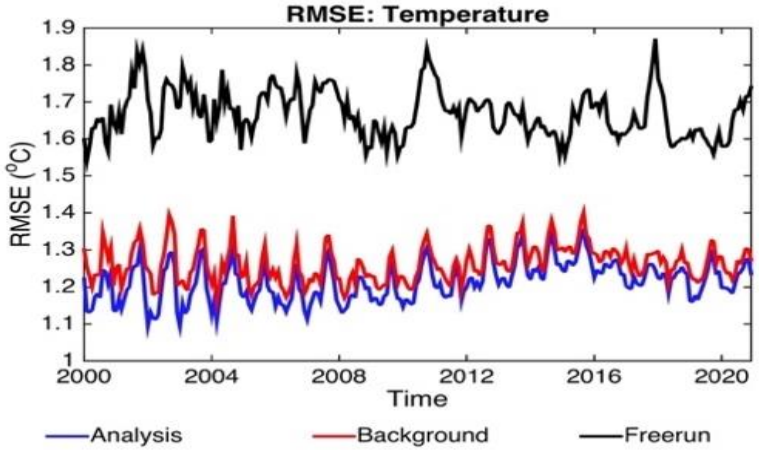
Wu, B., Zhou, T., & Zheng, F. (2018). EnOI-IAU initialization scheme designed for decadal climate prediction system IAP-DecPreS. Journal of Advances in Modeling Earth Systems, 10, 342–356

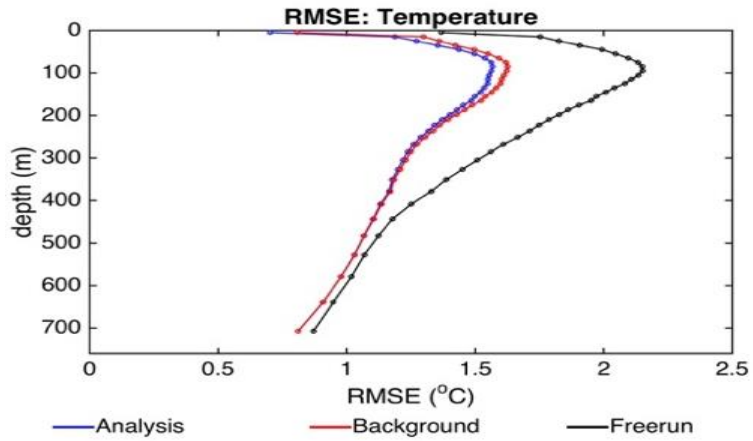
EnOI-IAU

Assimilated Data

- SST
- SLA
- ARGO

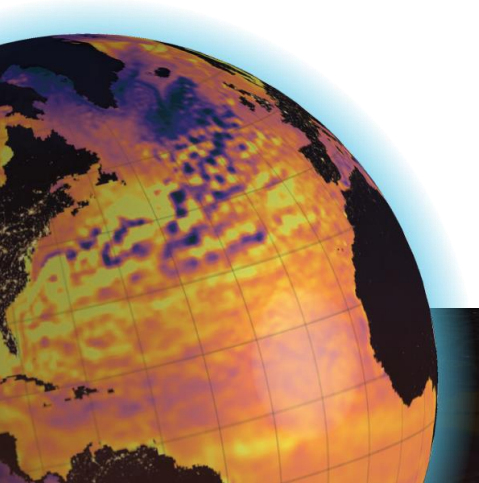
Validation





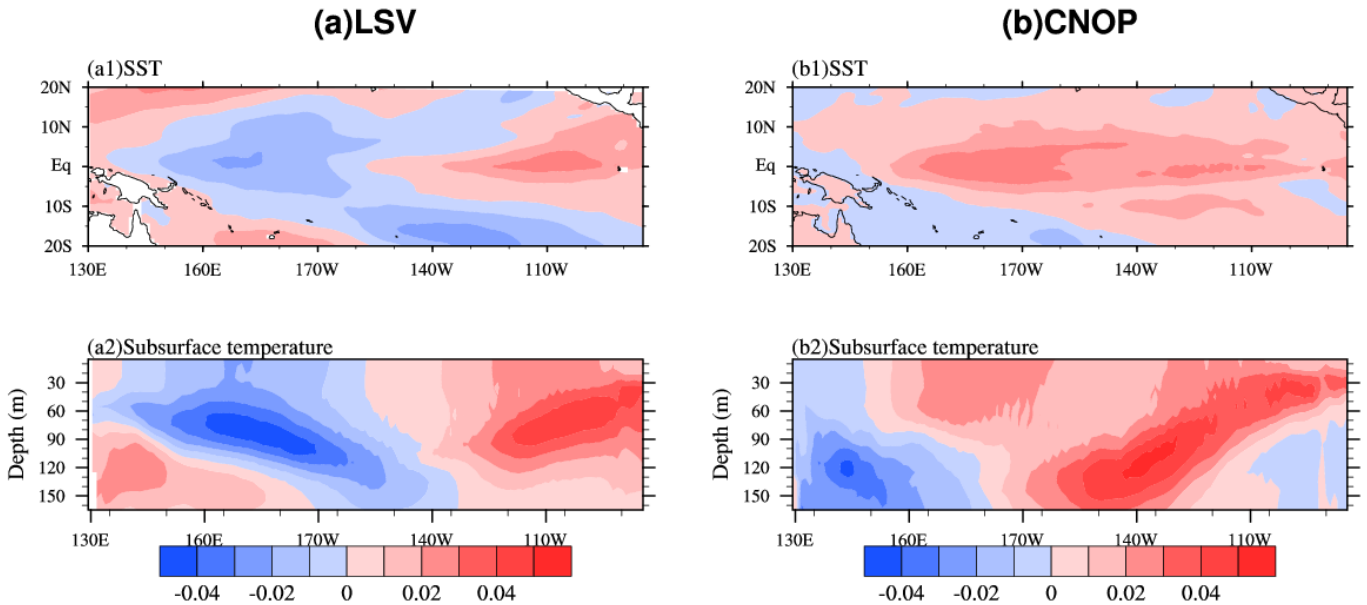
Nudging

- import nudging module from CAM6
- ERA5 or EC data to CAM
  - horizontal interpolation
  - pressure to hybrid interpolation
  - hydrostatic correction
- Nudging U, V, T, Q



Ensemble

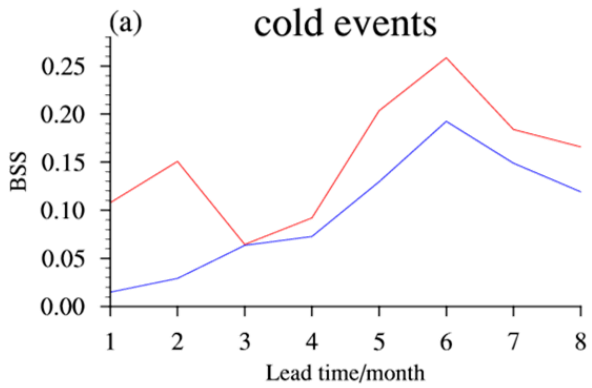
- sea surface temperature perturbations
  - climate singular vector (Kleeman et al. 2003; Tang et al. 2006)
  - conditional nonlinear optimal perturbation methods （Wang and Tan, 2010; Chen et al. 2015; Chen et al. 2021）

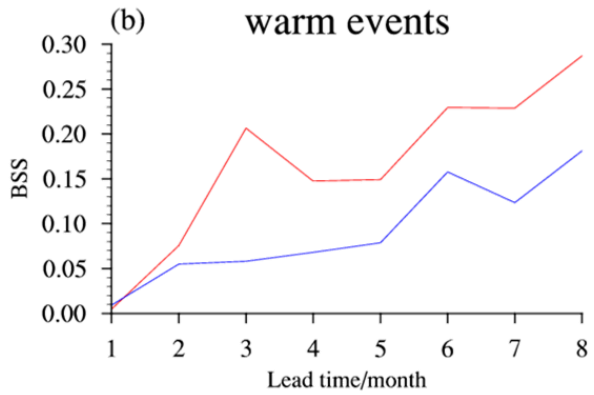


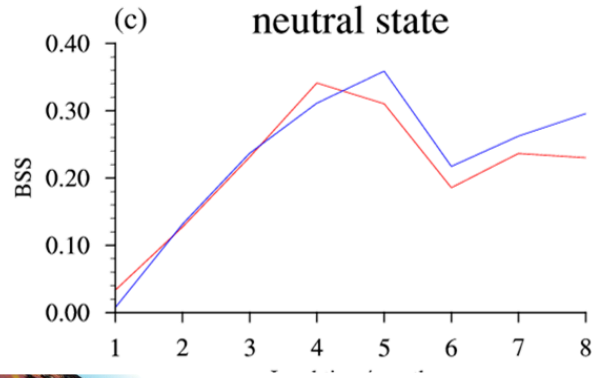
Zhou, Q., L. Chen, W. Duan, X. Wang, Z. Zu, X. Li, S. Zhang, and Y. Zhang, 2021: Using Conditional Nonlinear Optimal Perturbation to Generate Initial Perturbations in ENSO Ensemble Forecasts. Wea. Forecasting, 36, 2101–2111

Ensemble

$$\text{ratio } \lambda = \frac{RMSE}{Spread}$$

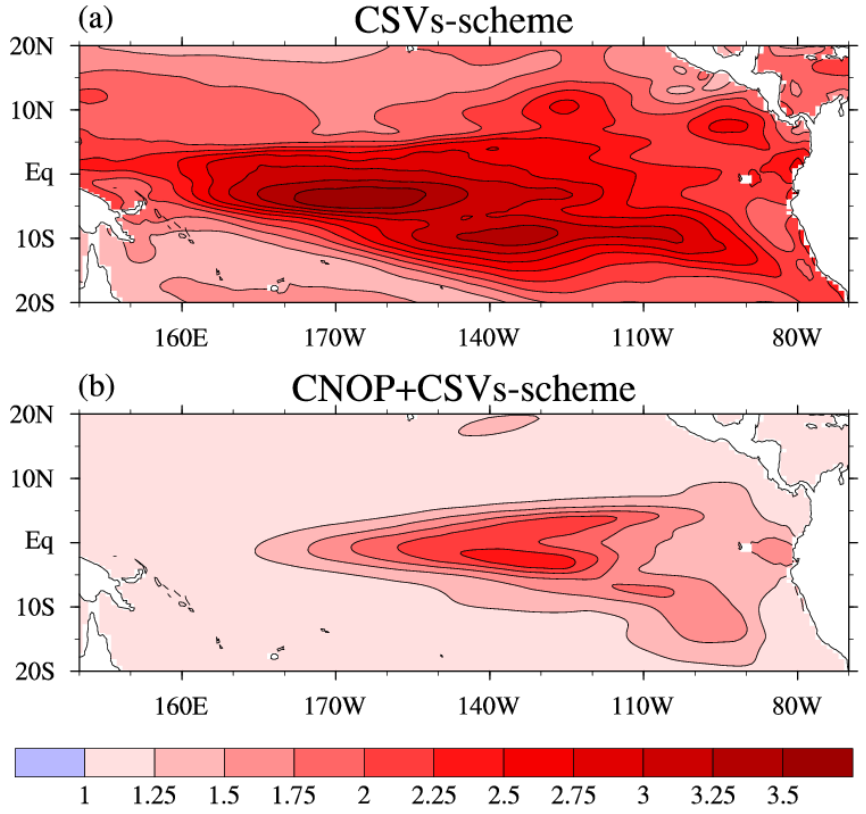






CSVs

CNOP+CSVs



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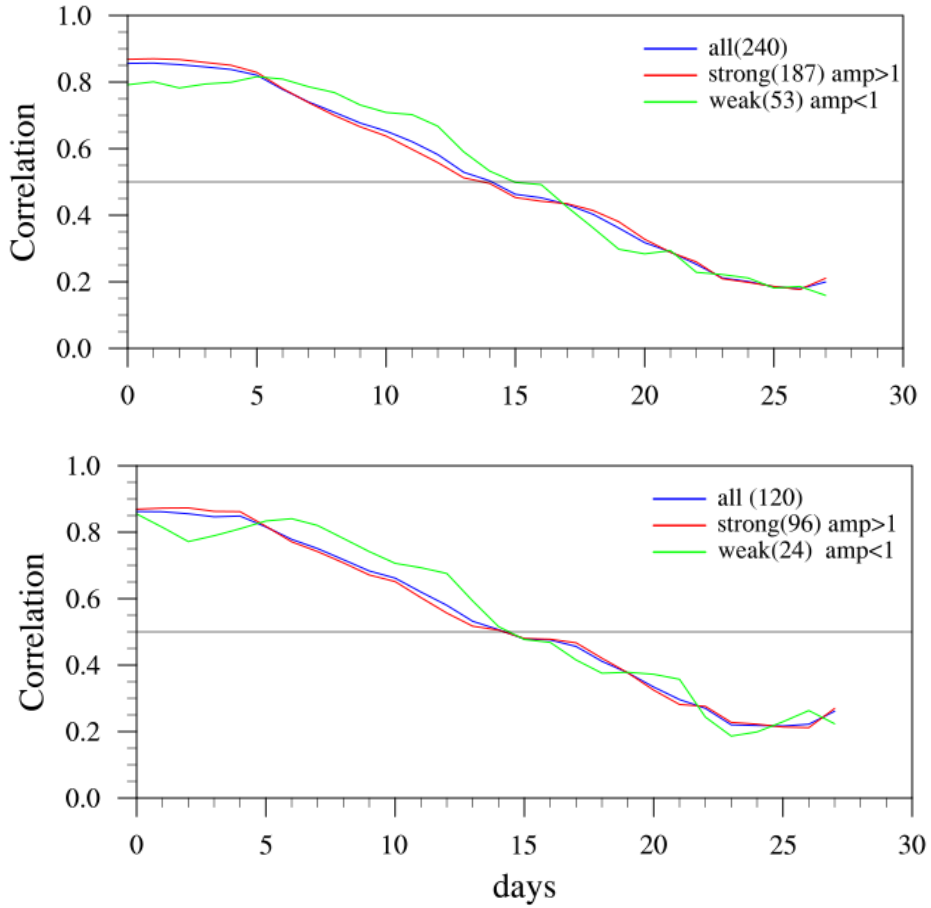
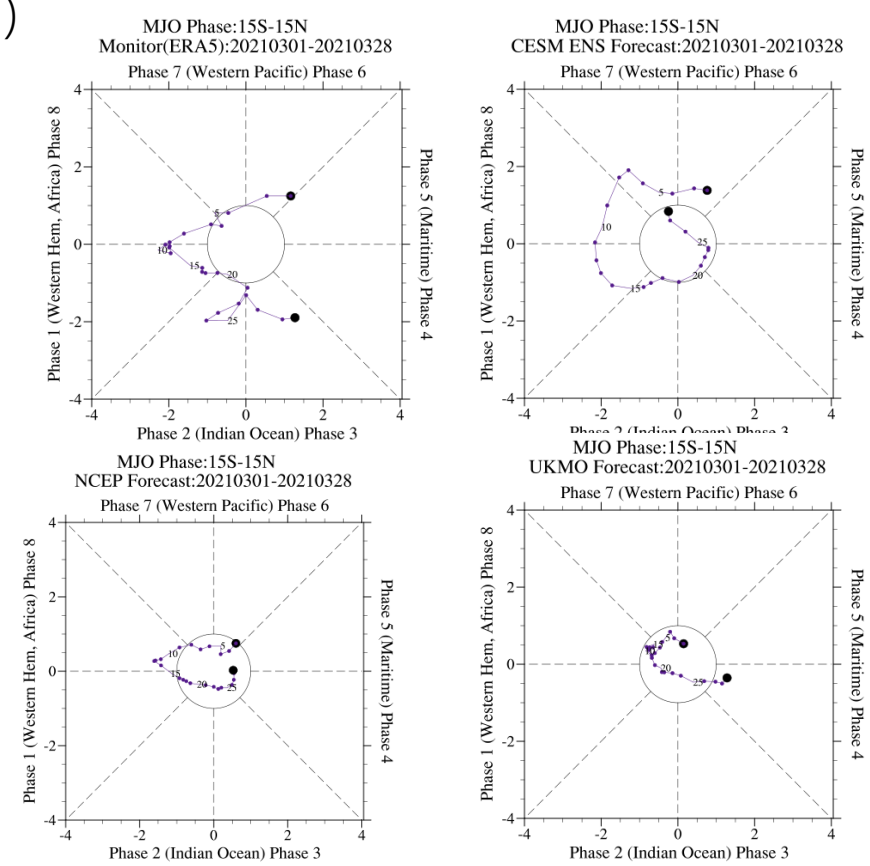
Validation

MJO RMM index （Wheeler,2004）



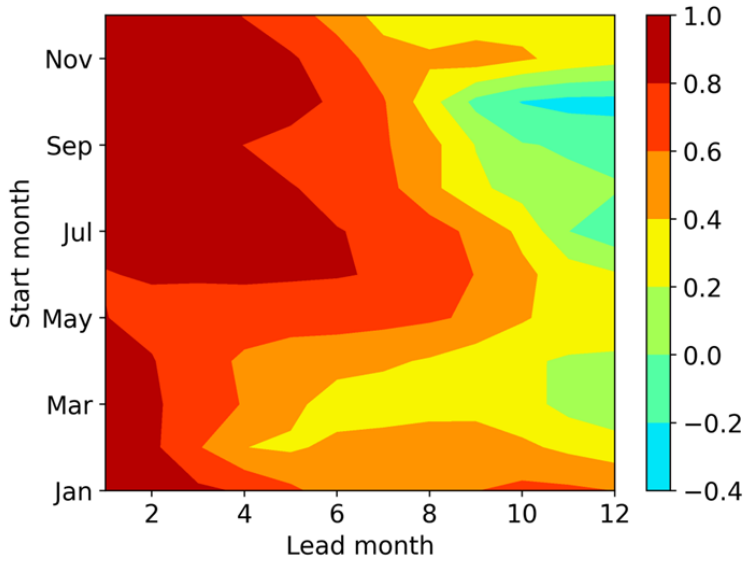
hindcast 2001-2020



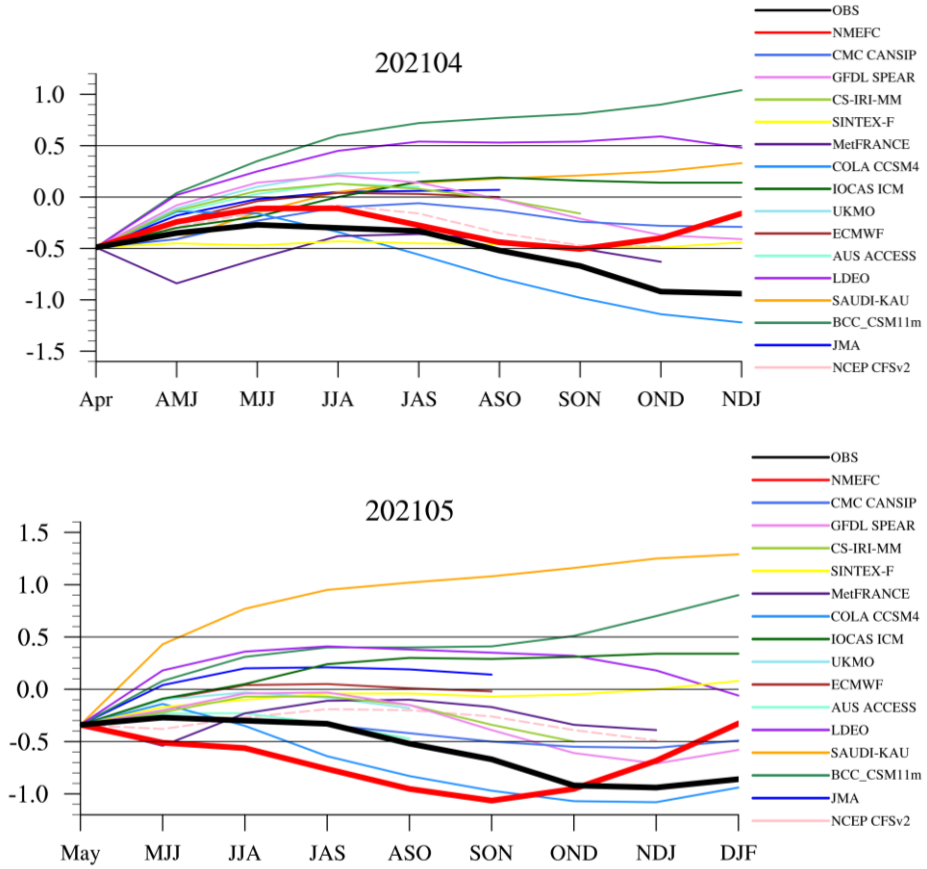
forecast

Validation

ENSO Niño 3.4 index



hindcast 2001-2020

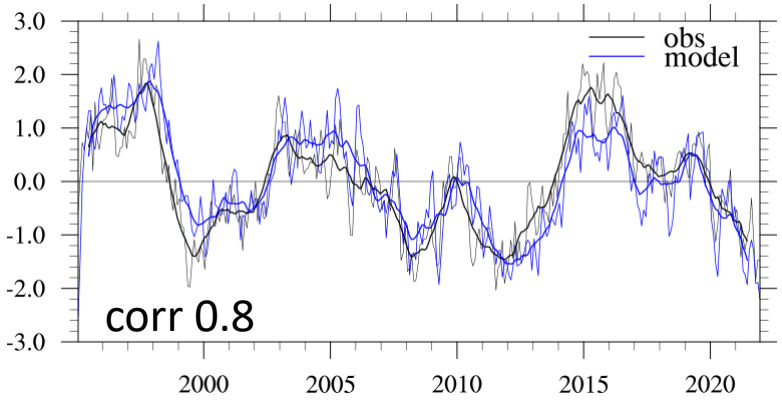


forecast

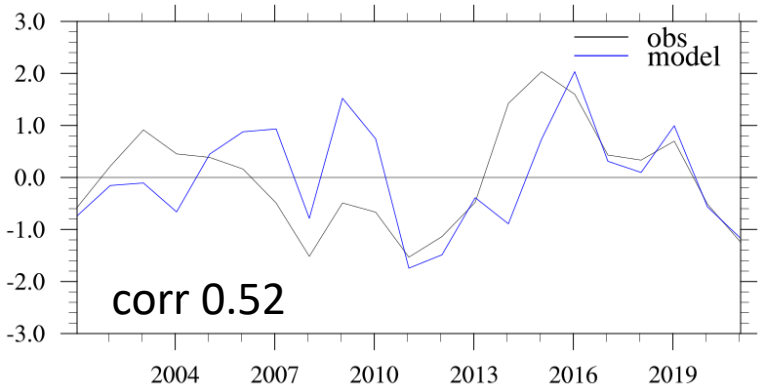
Validation

PDO index (Wen, 2012)

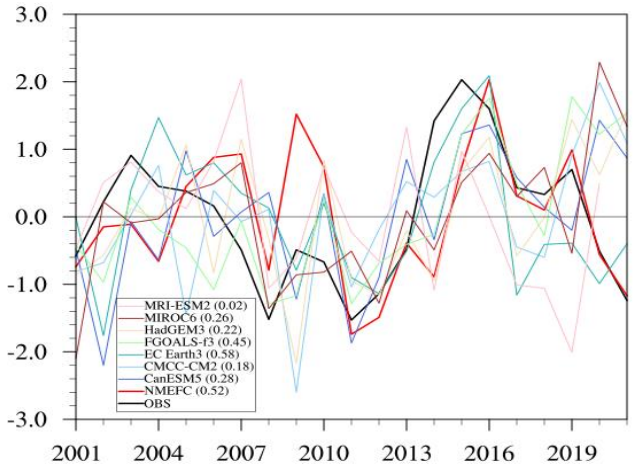
simulation

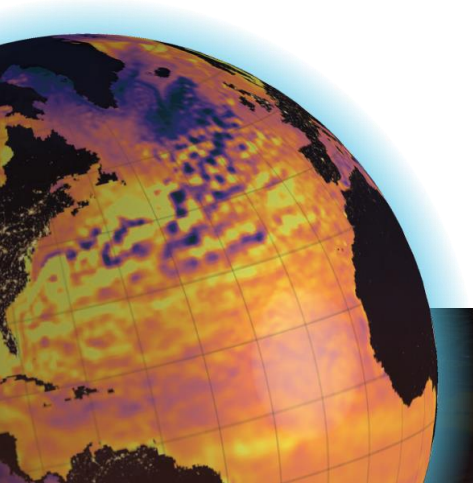


hindcast (1year lead)



DCPP





Ocean Predict

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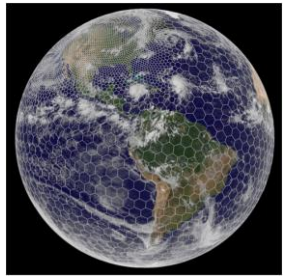
New generation climate model by NMEFC

Future



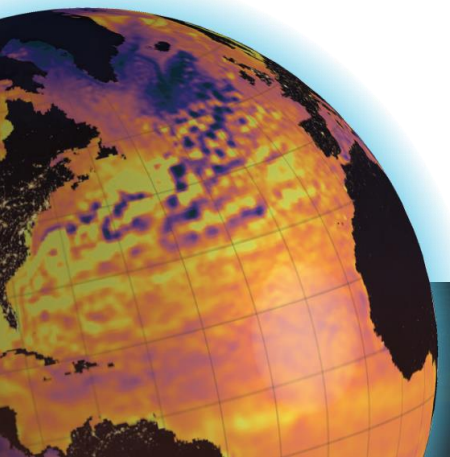
C-Coupler3

Mass Conservation Ocean Model

MOM aCOM

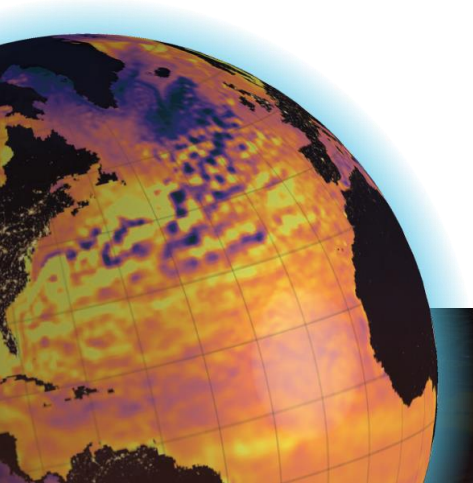
FVWAM

Finite Volume Wave Model



Conclusion

- A seasonal to interannual ensemble climate prediction system was developed,
  - ensemble optimal interpolation (EnOI) technique for ocean data assimilation
  - nudging data assimilation for atmosphere data assimilation
  - sea surface temperature perturbations which climate singular vector analysis and conditional nonlinear optimal perturbation methods
- The system accurately predicted the 2021 La Niña event with a five-month lead time
- Madden–Julian Oscillation (MJO) up to 14 days in advance
- successfully anticipated the transition to a negative phase of the Pacific Decadal Oscillation (PDO) one year prior to its 2020 occurrence



European Commission

Copernicus Marine Service

EU4oceanobs
INTERNATIONAL OCEAN GOVERNANCE
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MERCATOR OCEAN INTERNATIONAL

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Met Office

NERSC

Australian Government
Bureau of Meteorology

Canada