Potential Sources of Oceanic Predictability

Arun Kumar
Climate Prediction Center/NOAA
arun.kumar@noaa.gov
Oceanic variability on different time-scales

- Tidal
- Weekly
  - Mesoscale eddies
  - Tropical instability waves
- Seasonal-to-interannual
  - El Niño–Southern Oscillation (ENSO)
  - Indian Ocean Dipole (IOD)
- Decadal
  - Pacific Decadal Oscillation (PDO)/Inderdecadal Pacific Oscillation (IPO)
  - Atlantic Multi-decadal Oscillation (AMO)
- Centennial
  - Thermohaline
  - Trends due changes in external forcings
Seasonal-to-Interannual - ENSO

El Niño Episode Sea Surface Temperatures
Departure from average in degrees Celsius
Dec 1982 - Feb 1983

La Niña Episode Sea Surface Temperatures
Departure from average in degrees Celsius
Dec 1998 - Feb 1999

Sea Surface Temperature Anomaly

Historical NINO3.4 Sea Surface Temperature Anomaly

ENSO Index

El Niño

La Niña
Seasonal-to-Interannual - IOD

Sea Surface Temperature Anomaly
November 1997

Indian Ocean Dipole Mode Indices
(3 Month-Running-Mean)

IOD Indices
Decadal - PDO

Pacific Decadal Oscillation

Sea Surface Temperature Anomaly (shading)

Standardized PDO (9 Month Running Mean)
Decadal - AMO

Sea Surface Temperature Anomaly

AMO Index
Centennial

Sea Surface Temperature (basin averages)
Predictability

• **Predictability**: From the knowledge of the current state of the ocean, our ability to anticipate its future evolution → Prediction skill

• **Sources of predictability**
  – Persistence of anomalies
  – Horizontal propagation of anomalies (Ocean dynamics: e.g., propagation of oceanic waves; advection;...)
  – Coupled air-sea interactions
  – Oceanic teleconnections (via atmospheric bridge)
Persistence time-scale

Time-scale in weeks when autocorrelation drops to 0.5
Prediction skill due to persistence

Skill in predicting monthly mean SSTs based on persistence of initial anomalies
Prediction skill using initialized dynamical models
Seasonal

CFSv2 Correlation SST
Initial month: Jul 1982–2009

Skill in predicting seasonal mean SSTs
Source: Persistence + Ocean Dynamics + Coupled interactions
Prediction skill using initialized dynamical models
Seasonal

Gain in skill beyond persistence
Predictability due to oceanic teleconnections (mediated via atmospheric bridge)
Prediction skill using initialized dynamical models

Decadal

- Source schematics

Additional skill due to ocean initialization

Doblas-Reyes et al. (2013, Nature Comm.)
Summary

• Oceanic variability exists on various time-scales

• There are various sources of oceanic predictability (persistence, ocean dynamics, couple air-sea interaction etc.) that allow us to anticipate the future evolution of the current state of ocean anomalies

• There is demonstrable skill in prediction oceanic anomalies on various time-scales, however, skill has regional variations