Subseasonal to Seasonal (S2S) Prediction

Presented by
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S2S prediction is a frontier but remains challenging

**S2S: 10 days to one season**

Multiagency and international efforts:

1) WWRP/WCRP S2S project

2) SubX (Participation in the NOAA/MAPP S2S Task Force)

- Falling into the time range of ‘the Weather Act’ in 2017 (hours~2 years)
Subseasonal TC prediction

FLOR-DPC
(Double-Plume Convection Scheme)

Two-week TC genesis prediction

Initialization: Nudging U, V, T, SLP and SST (11 y)

Jiang et al., J. Clim. 2018; Xiang et al., MWR 2015

Running a model in forecast mode provides important verification of the newly developed convection scheme (DPC)

HiRAM

Monthly total hurricane activity

Blue: Uniform
Pink: Nested

30% of TCs can be skillfully predicted with 1-2 week lead time

Gao et al., GRL 2019

Seasonal hurricane prediction skill: $r = 0.88$ (Chen and Lin 2013)

Geophysical Fluid Dynamics Laboratory Review
October 29-31, 2019
Week 3-4 prediction of wintertime temperature

FLOR-DPC

ECMWF

The dots denote the region with the correlation skill significant at the 5% significance level

Xiang et al., GRL 2019
Predictability sources: 1) MJO

3 weeks after MJO phase 3

Observation

Sat & H500

Shading: temperature
Contours: H500

3-week lead forecast

Sat & H500

Xiang et al., GRL 2019

MJO prediction skill

Xiang et al., J. Clim., 2015

27 days

GFDL

Operational S2S models


27 days
Predictability sources: 2) Stratospheric impact

One of the most predictable modes for t2m (NAO)

Shading: t2m
Contours: correlation with H500

Stratospheric Polar Vortex

Xiang et al., GRL 2019

Stratospheric Polar Vortex

from initial condition
Future Plans

GFDD S2S Forecast System

SHiELD
(25km)
Mixed Layer Ocean
Atmosphere/land DA
Nudging SST

SPEAR
(50km)
MOM6
Ocean DA
Nudging atmosphere

Goal: Improving our understanding and prediction skill of S2S prediction

Prediction Study
(temperature, precipitation, MJO, TC, sea ice, atmospheric river, even tornado……)

Process-level Study
(model resolution/bias, land initialization, air-sea coupling, snow cover, stratosphere, ……)

Geophysical Fluid Dynamics Laboratory Review
October 29-31, 2019
MJO simulations in SHiELD and SPEAR

Lag–longitude diagram of intraseasonal precipitation anomalies (10S-10N)

Obs

Note that CM2.1 and CM3 have poor MJO simulations (Kim et al. 2009; Donner et al. 2011)
Nested configuration of SHiELD improves MJO prediction

16km global uniform vs 4km over Maritime Continent

Starting from MJO phase 2 & 3

During DYNAMO period (2011-12)

--- Kun Gao’s poster
S2S prediction is still at its infancy and developing stage!

- Lack of understanding of predictability sources
- Intrinsic model errors
- Imperfect initial conditions (land, sea ice ...)
- No standard metrics
- High computational costs

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Summary

• We have made progress in S2S prediction using the previous generation of GFDL models (FLOR-DPC, HiRAM): TC, MJO, temperature and predictability sources.

• Newly developed S2S prediction system (SHiELD and SPEAR) combines weather and climate perspective.

• Running a model in forecast mode provides important verification of a newly developed scheme, providing feedback to guide model development.