Extended-range TC Forecast Experiments

Tim Li

University of Hawaii
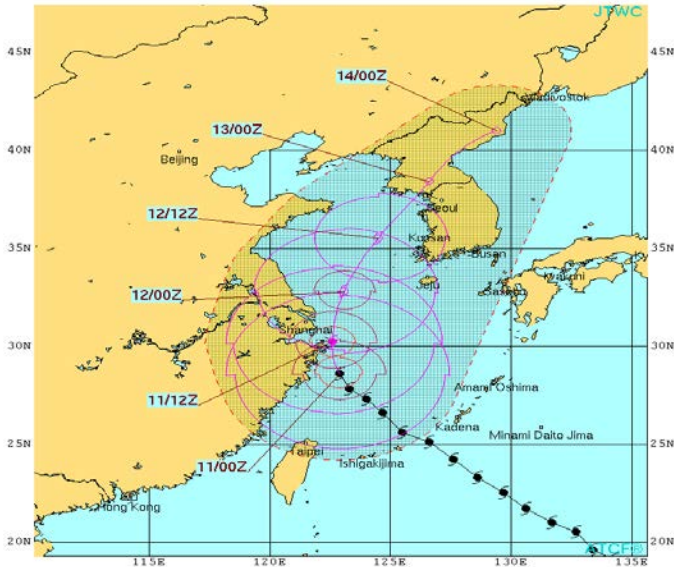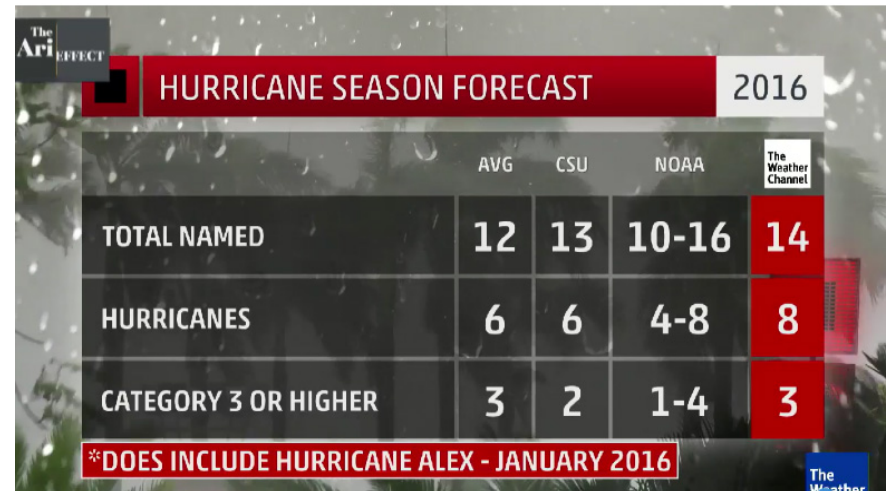
March 14-16, 2017
2017 TCORF/IHC Conference, Miami, FL

Current Status of Operational TC Forecast

Medium-range (up to 5 days)
(Initial condition)

Seasonal outlook (seasonal TC count)
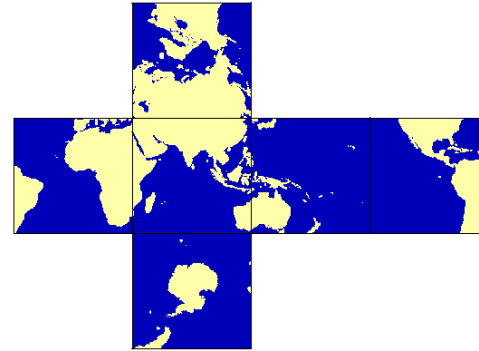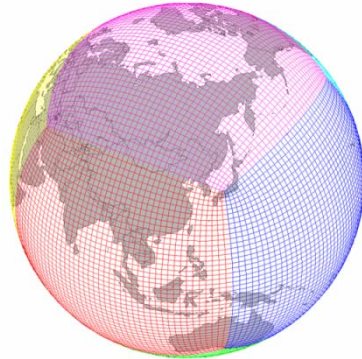(SST, QBO, PDO, AMO, etc)

Extended-range (5-30 days, beyond weather scale) forecast
  ~ still in experimental mode

Possible predictability sources: Madden-Julian Oscillation, CCEWs, SST, etc.

GFDL High-Resolution Atmosphere Model (HiRAM)

- Designed for resolution between 1– 50 km, with non-hydrostatic **finite-volume dynamical core** on the **cubed-sphere** (S.-J. Lin)

- A "**6-category cloud micro-physics**" with high-order vertical sub-grid reconstruction allowing vertically & horizontally sub-grid cloud formation

- A "**Double-Plume**" convective parameterization scheme (Bretherton scheme modified by Ming Zhao at GFDL)

- **Coupled** with MOM5 **OGCM**

Beyond weather scale prediction of Hurricane Sandy and Super Typhoon Haiyan

Sandy (Oct 2012)

Genesis on Oct 22, landfall on Oct 29

Haiyan (Nov 2013)

Genesis on Nov 4, landfall on Nov 7

Methodology

Initial Condition:
Nudging (U, V, SLP, HGT, Temperature + SST) toward NCEP FNL

TC tracker:
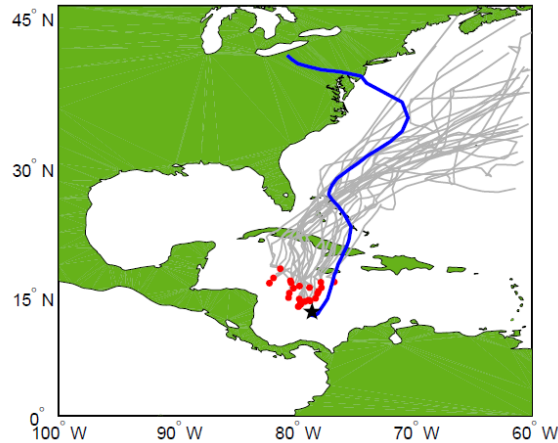 Lucas Harris's simply tracker

Definition of 'correct' forecast range:
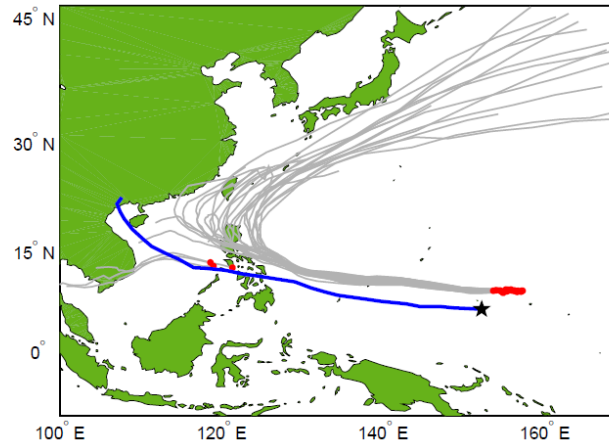Genesis during one day before and after the observed genesis (a 3-day window) within radius of 1000 km

24 ensemble forecast members each day
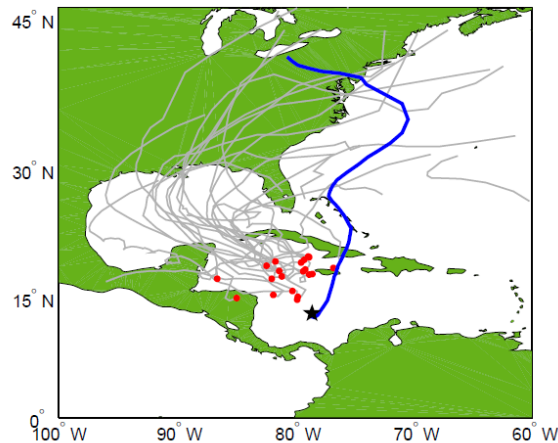
Genesis forecast of Sandy & Haiyan

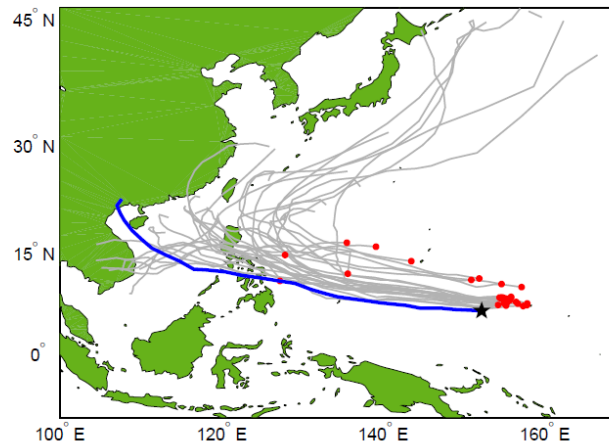a) 5−day lead forecast for Sandy genesis

b) 10−day lead forecast for Sandy genesis

c) 5−day lead forecast for Haiyan genesis
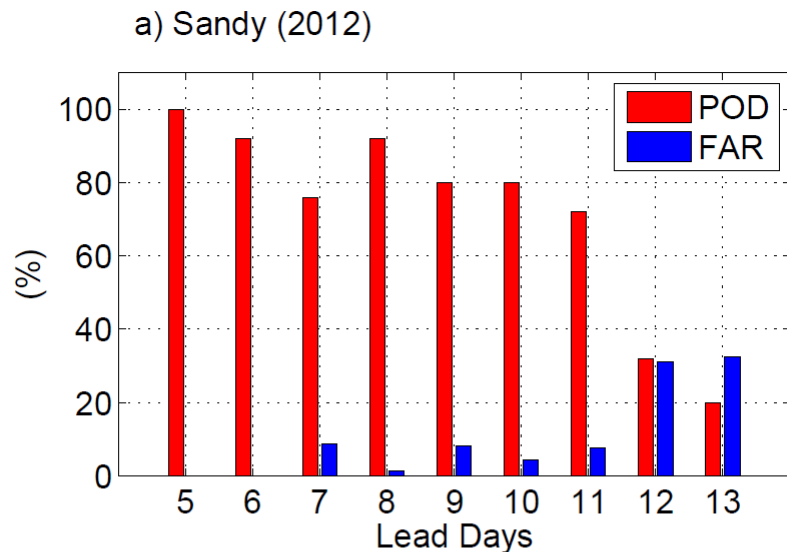
d) 10−day lead forecast for Haiyan genesis

Blue lines represent observed TC track.

Grey lines denote predicted tracks.

Black stars denote observed genesis location.

Red dots denote predicted genesis locations from 24 ensample members.

Sandy and Haiyan genesis is predictable at a lead time of 11 days

a) Sandy (2012)

b) Haiyan (2013)

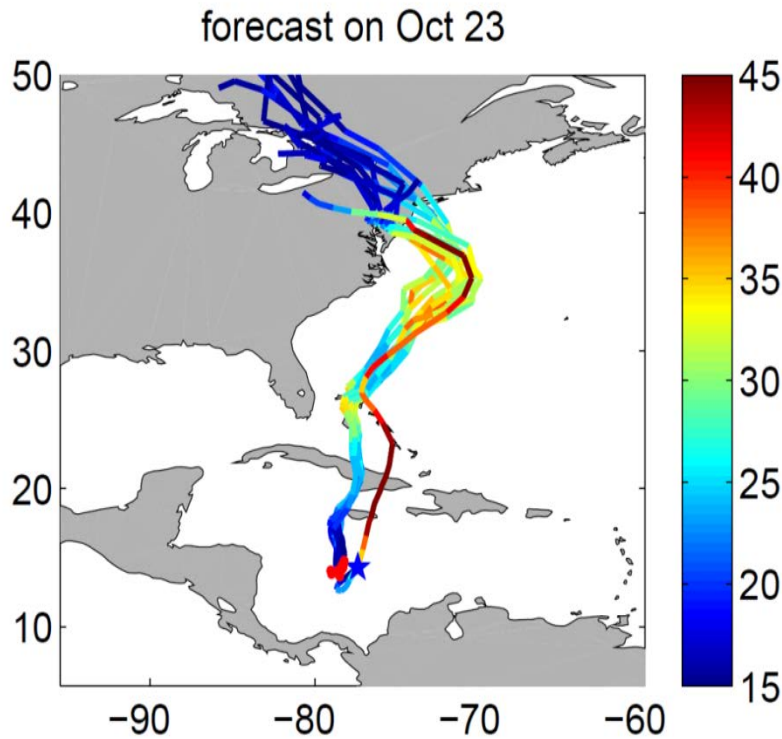Red: possibility of detection (POD)
Blue: false alarm ratio (FAR)

The 'correct' prediction is counted by the cyclogenesis within a 3-day window within 1000 km radius.

The false alarm is counted by cyclone numbers 5 days before and 5 days after the 'correct' prediction window within 1000 km radius of circle.
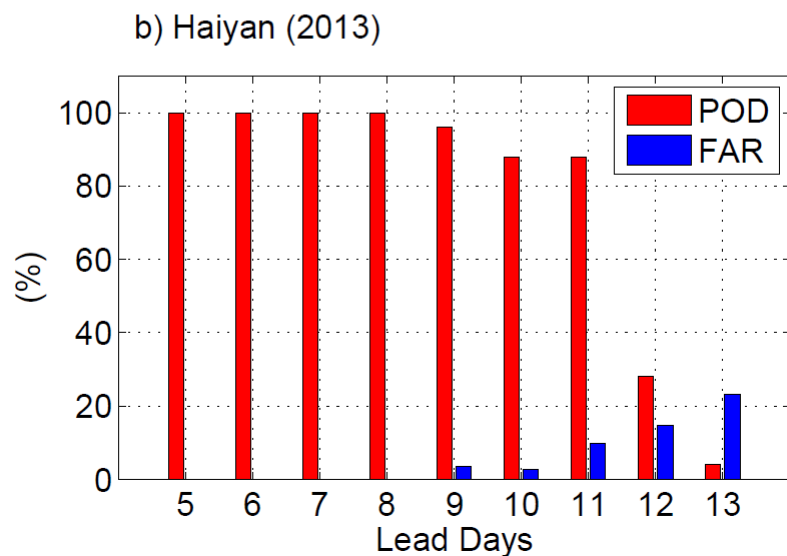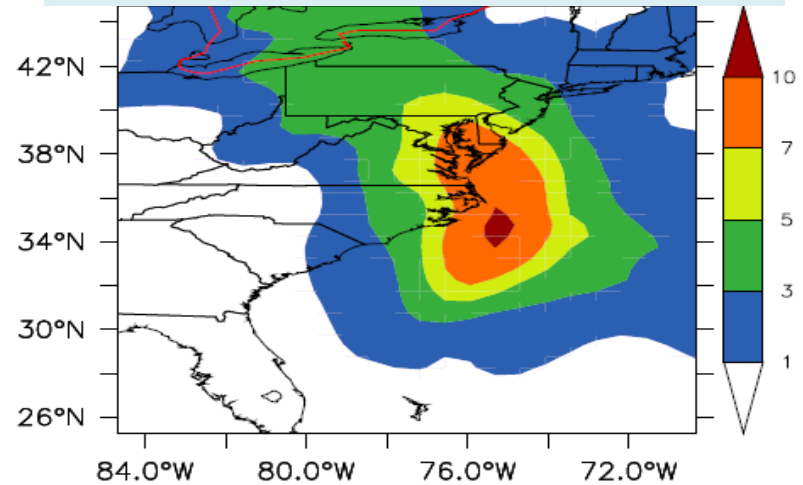
➔ POD is above 70% for both Sandy and Haiyan for 5- to 11- day lead.
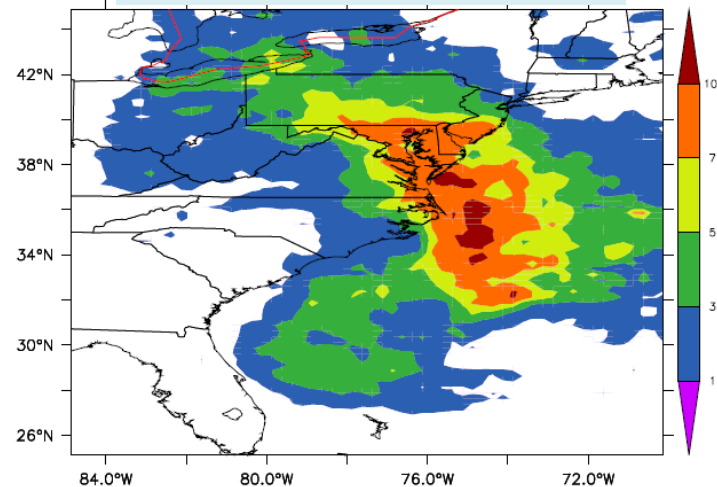
Track forecast of Sandy

forecast on Oct 23

Forecasted precipitation (7-day lead)

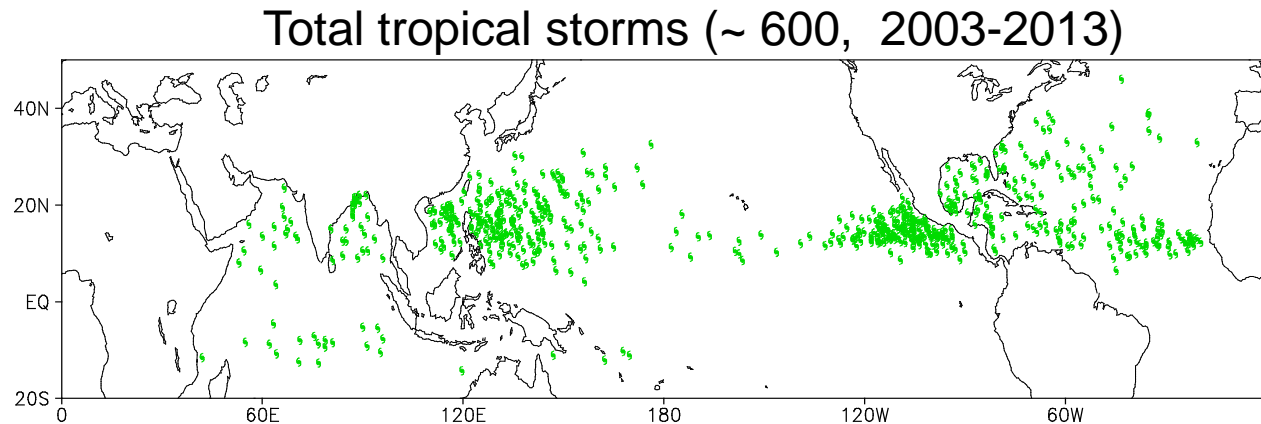Observational validation

Track forecast of Sandy on Oct 23. Landfall time: Oct 29, 2012

Extended-range Predictability of TC genesis – Multi-year hindcasts

- 6 times each month (1st, 6th , 11st, 16th, 21st , 26th) Jun-Nov, **2003-2013**
- 12 ensemble members (00Z, 02Z, …., 22Z)
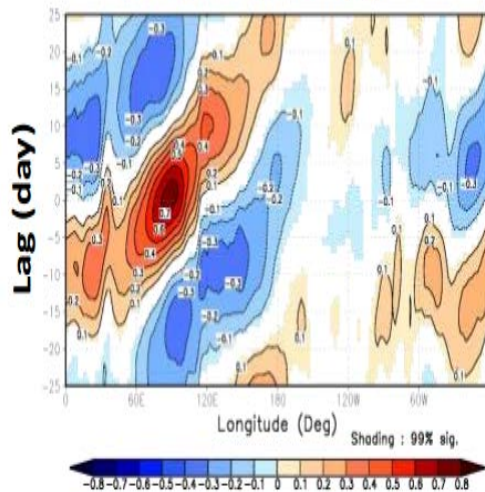- 30-day forecast

Total tropical storms (~ 600, 2003-2013)

Good prediction skill: week 1 forecast skill > 65% ; or week 2 forecast skill > 50%

Tropical Storms with higher prediction skill (~ 30%)
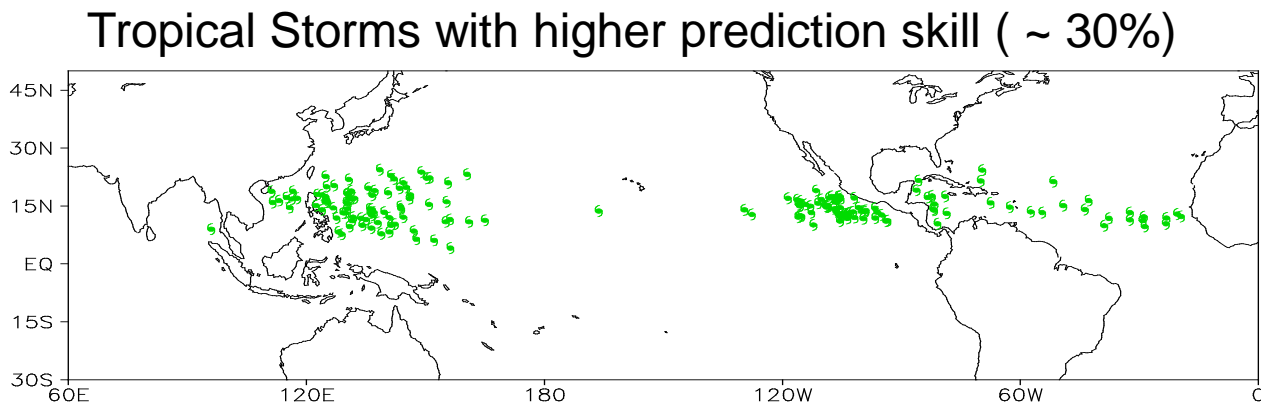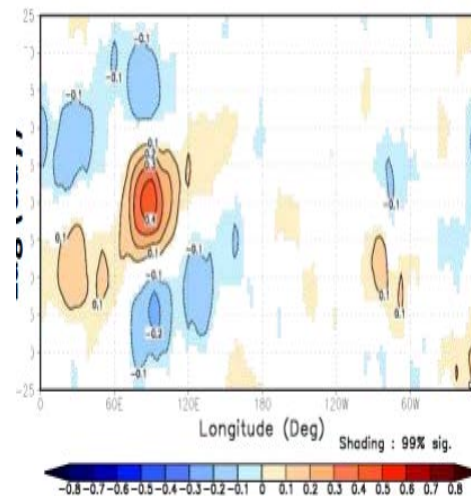
Take Home Message

- **Extended-range TC forecast is possible** if a model is capable of forecasting circulation changes associated with **MJO**.
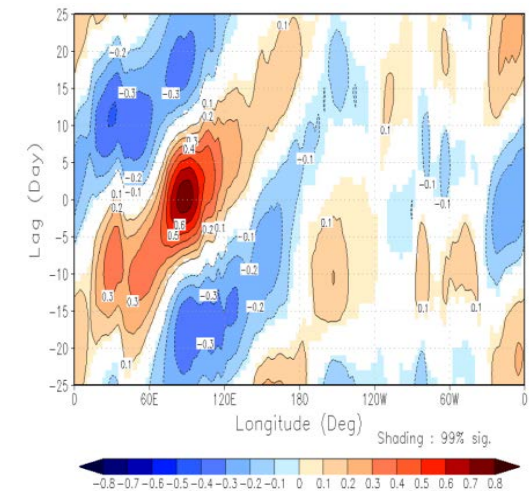
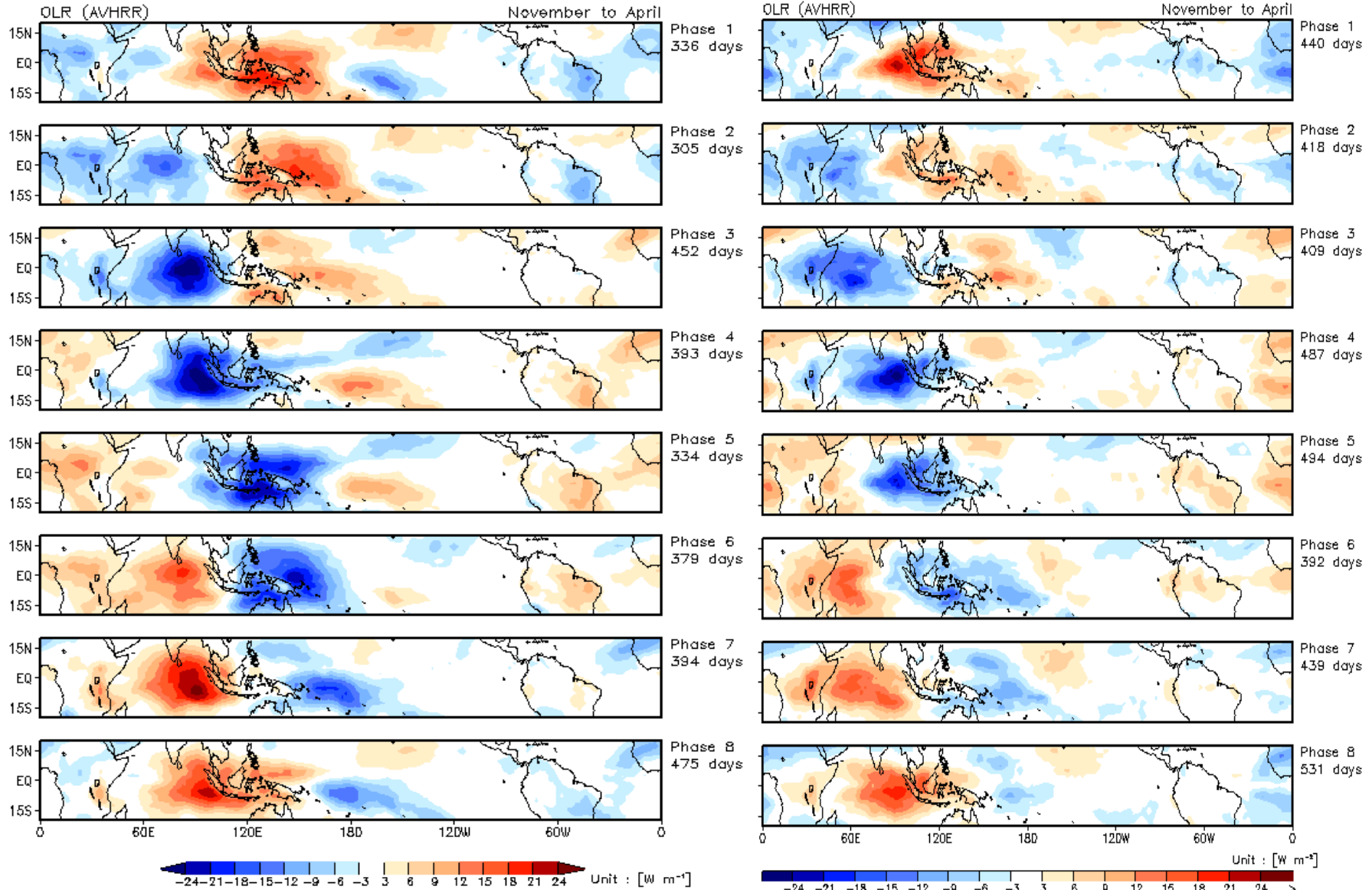OLR (AVHRR, Nov-Apr)

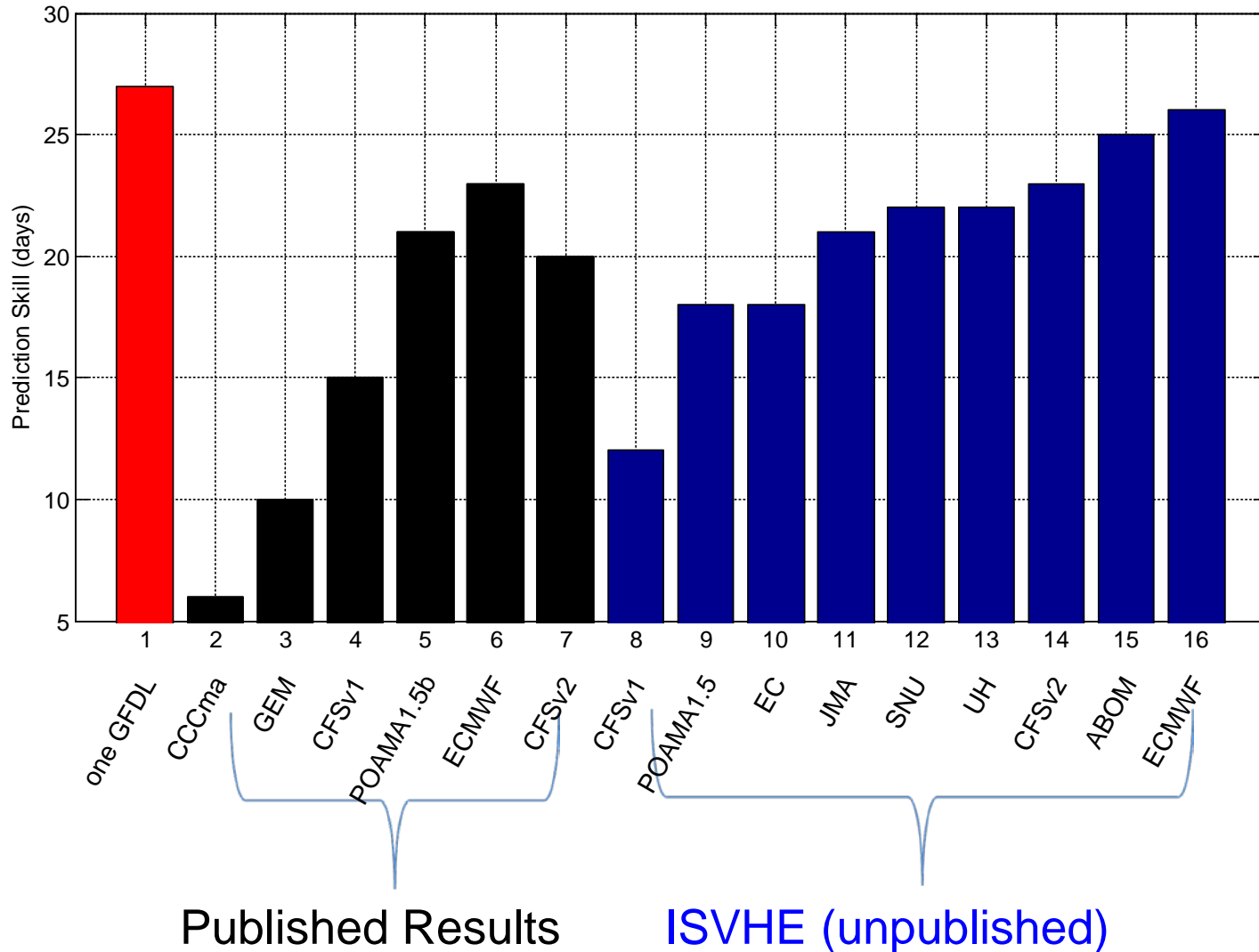HiRAM (Shallow Conv. Only)

HiRAM (Double Plume)

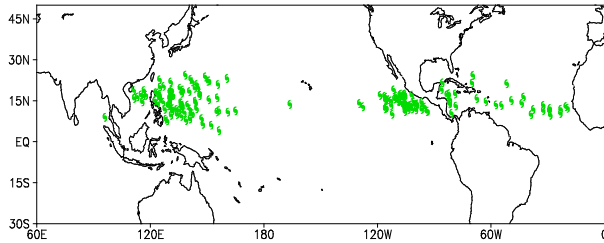# Composite of OLR anomaly in boreal winter

MJO Skill Comparison (10-yr Hindcast)

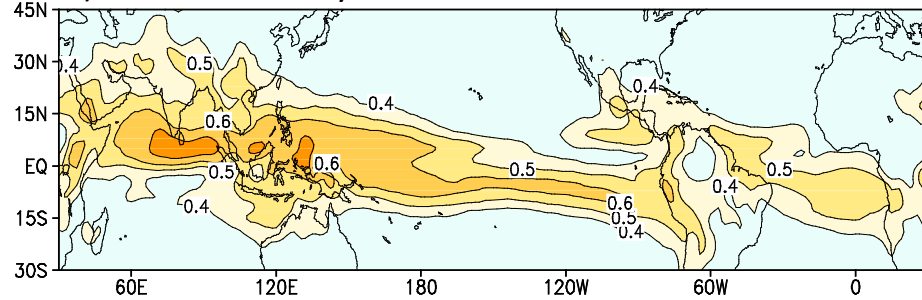# Correlation between Forecasted and Observed Large-scale Fields at Week-2 (day 8-14)

TCs with high prediction skill
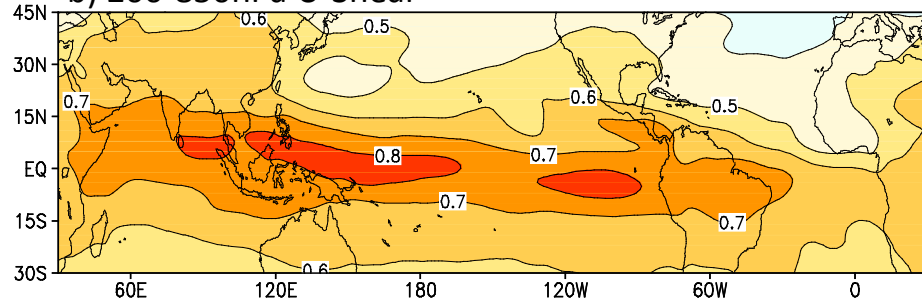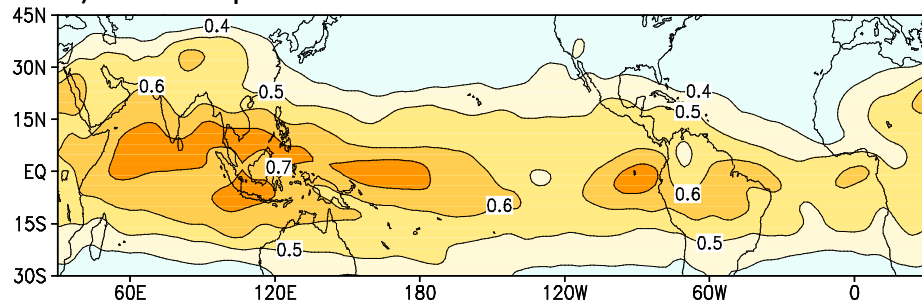
Correlation between week-2 forecasted and observed large-scale circulation fields is in a range of 0.4 ~ 0.8 in most parts of TC basins.

a) 850hPa Vorticity

b) 200-850hPa U-Shear

c) 500hPa q