GOBESHONA 4

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Building local climate knowledge

Forcing ocean model with atmospheric model outputs to simulate storm surge in the Bangladesh coast

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Background

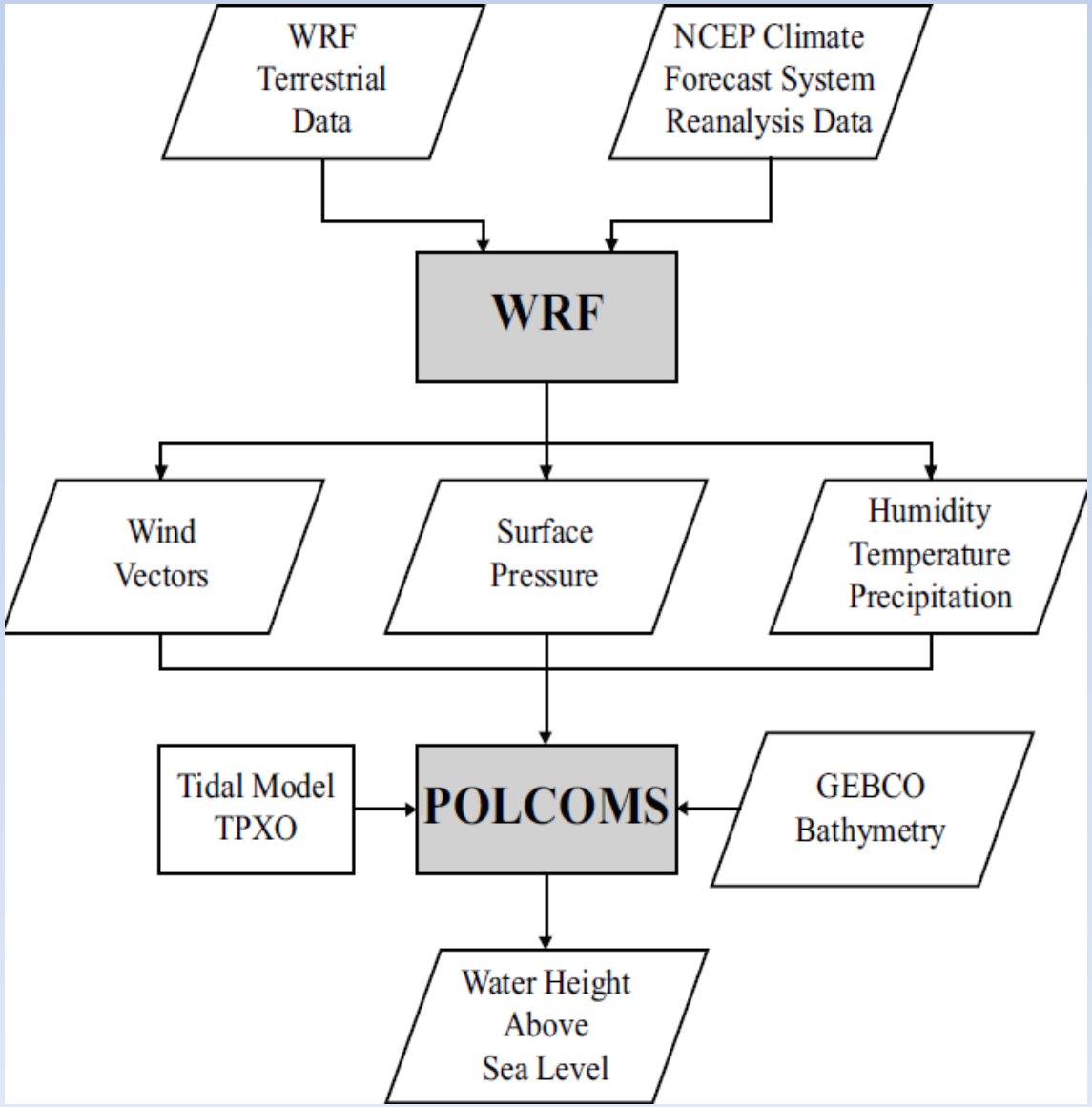
- Storm surge is a major problem for Bangladesh
- Recent observations show that there are reasons for concern
- Possibly decreasing in the mean, move towards a substantial intensification
- Reliable forecasts of storm surge are of utmost importance for coastal areas
- Great potential to inflict loss of life and property.
- Small improvement in modeling can save many lives

Background

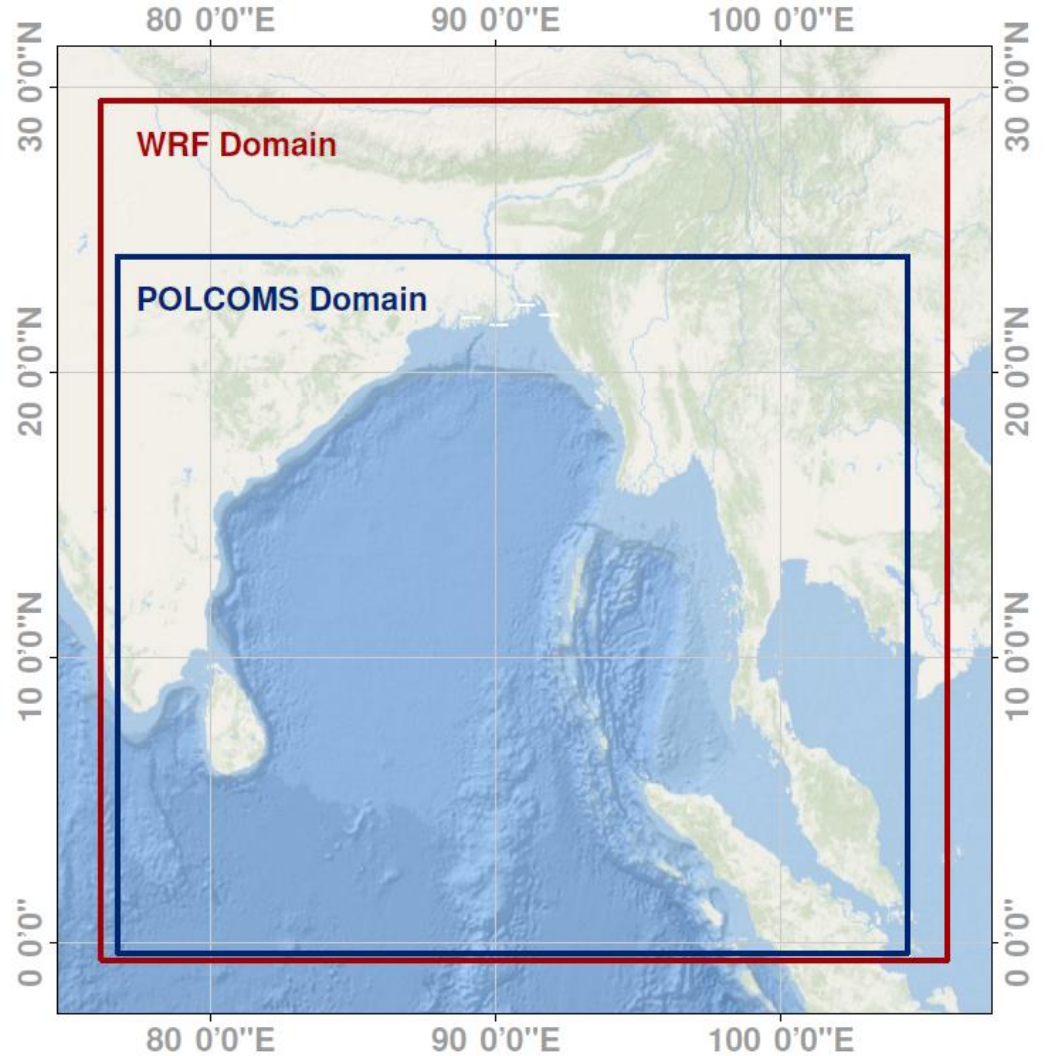
- Two forcing fields generating storm surge
- Many crucial aspects of coupling are still to be explored and defined
- Accurate representation of wind forcing and mean sea level pressure is important
- Recent model development efforts tended to include more modeling components
- Models are getting higher resolution in time and space,
- investigated the ability of a state-of-the-art ocean-atmosphere coupled model (one way coupling)

Model Schematic

- Advanced Research Weather Research and Forecasting model (WRF)
- Proudman Oceanographic Laboratory Coastal Ocean Modeling System (POLCOMS)
- One way coupling - the outputs from the atmospheric model were used to drive the ocean models



Model Domains



WRF Domain

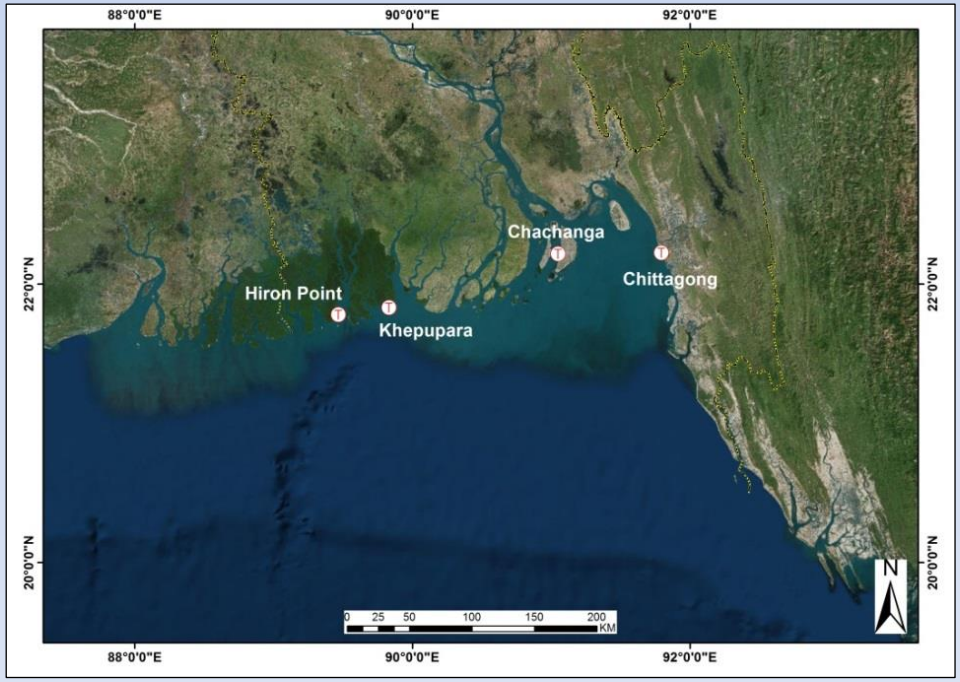
- 12 km resolution grid spacing
- 277 x 294 grid points

POLCOMS Domain

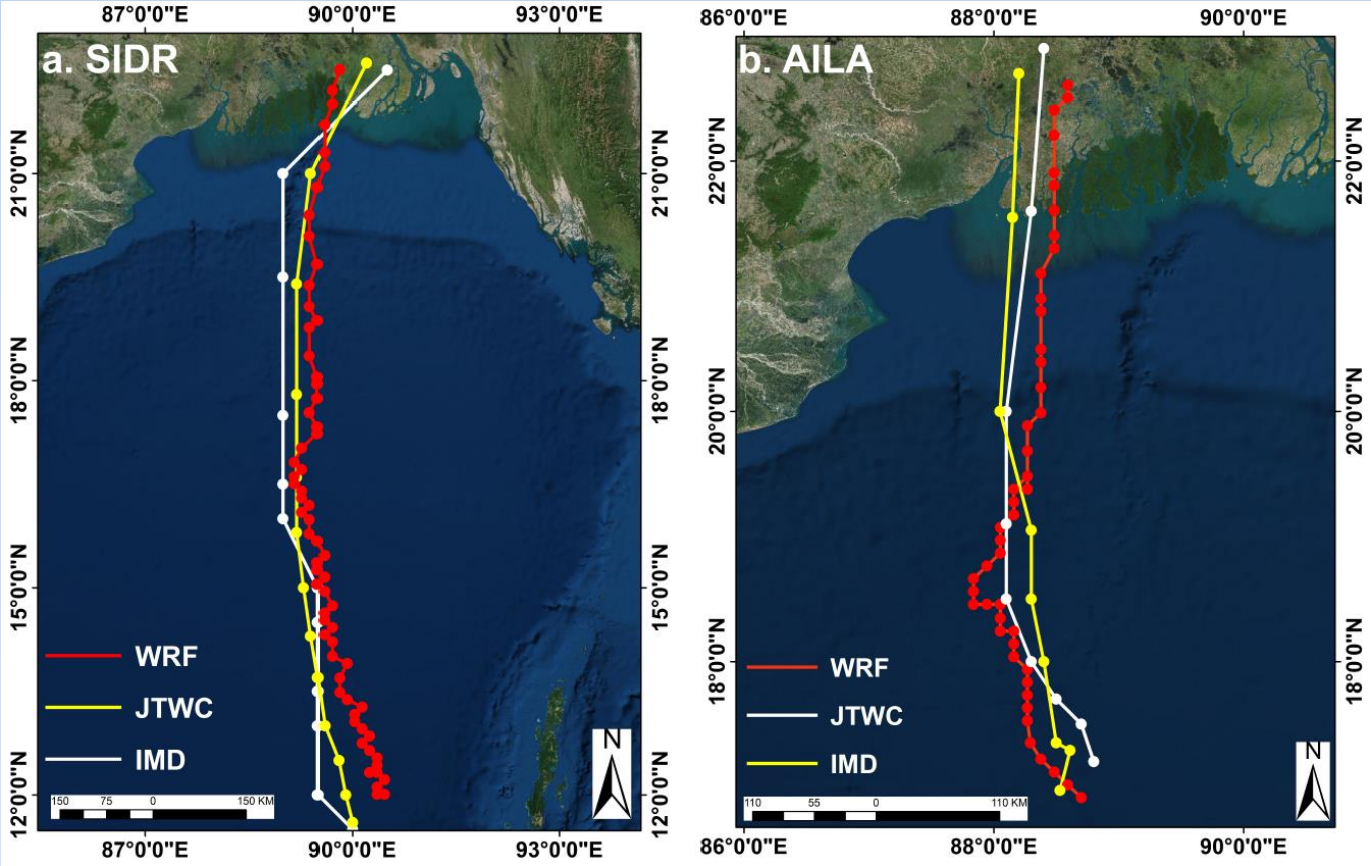
- 1° in longitude and latitude
- about 11 km e spatial resolution
- 200 km offshore from the shelf break.

Observation data for model validation

- JTWC and IMD estimation from International Best Track Archive for Climate Stewardship (IBTrACS). Basic cyclone data at every 6-h interval
- Hourly tide gauge data from Bangladesh Inland Water Transport Authority (BIWTA).
- Water level data of Chittagong station were obtained from University of Hawaii Sea Level Center

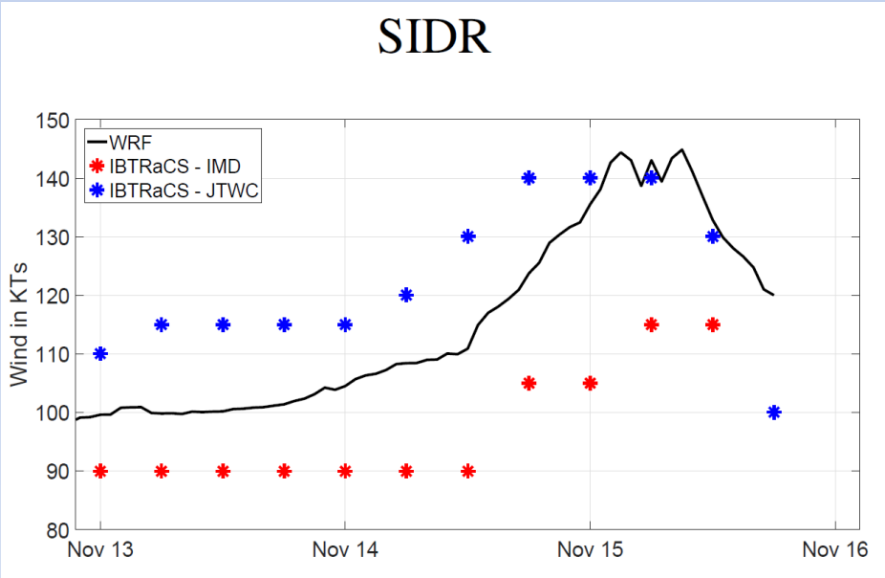


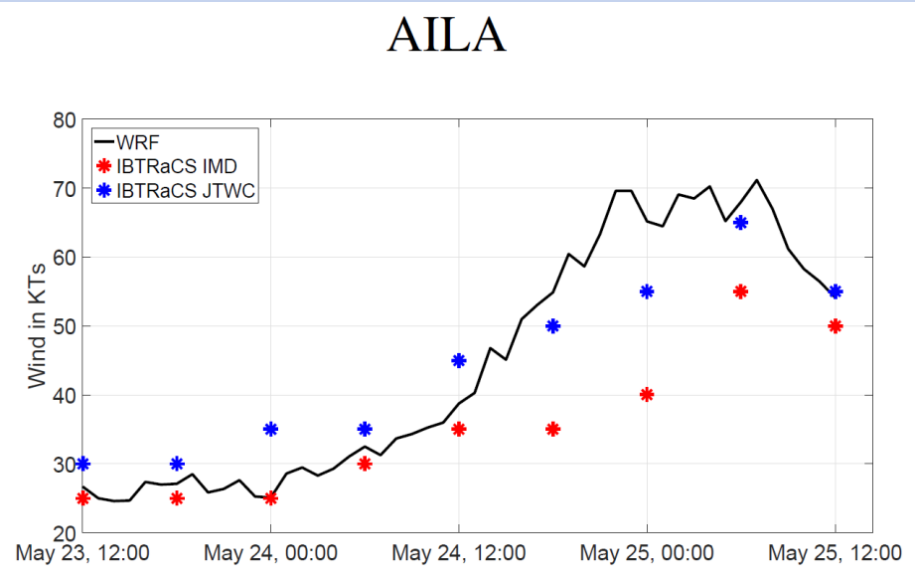
WRF Results: Cyclone Track



- The model simulated track of SIDR showed a track displacement error of about 45 km with JTWC, and about 62 km with IMD during landfall.
- The model simulated track of AILA showed a maximum track displacement error of about 28 km with JTWC, and about 42 km with IMD.

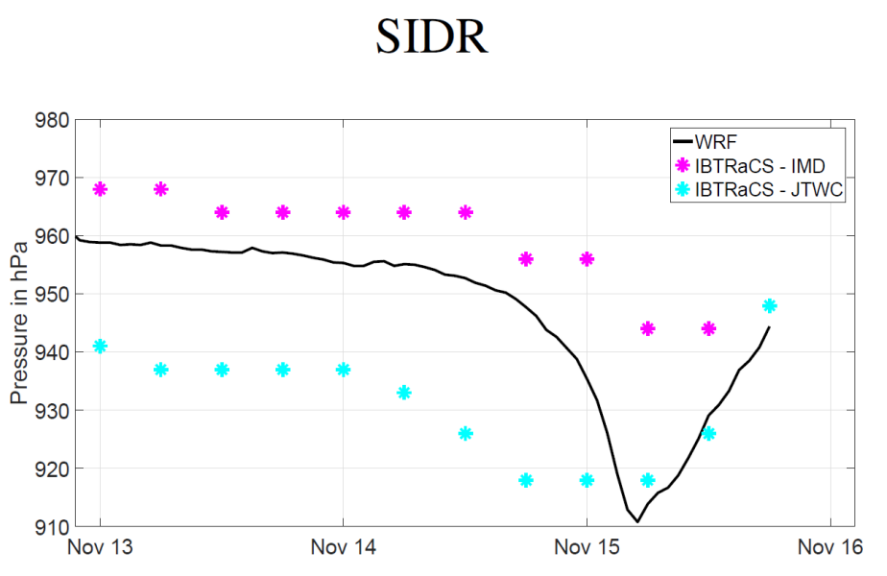
WRF Results: Maximum Sustain Wind (MSW)

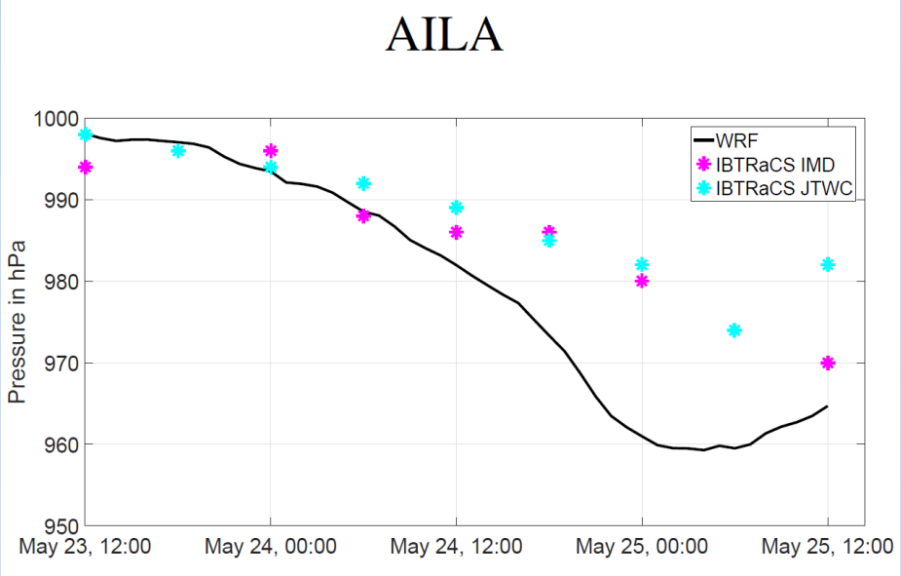




	R2		RMSE (KTs)		P-bias (%)	
	IMD	JTWC	IMD	JTWC	IMD	JTWC
SIDR	0.92	0.84	7.06	10.10	22.97	-6.47
AILA	0.89	0.76	5.53	8.15	-0.57	-0.41

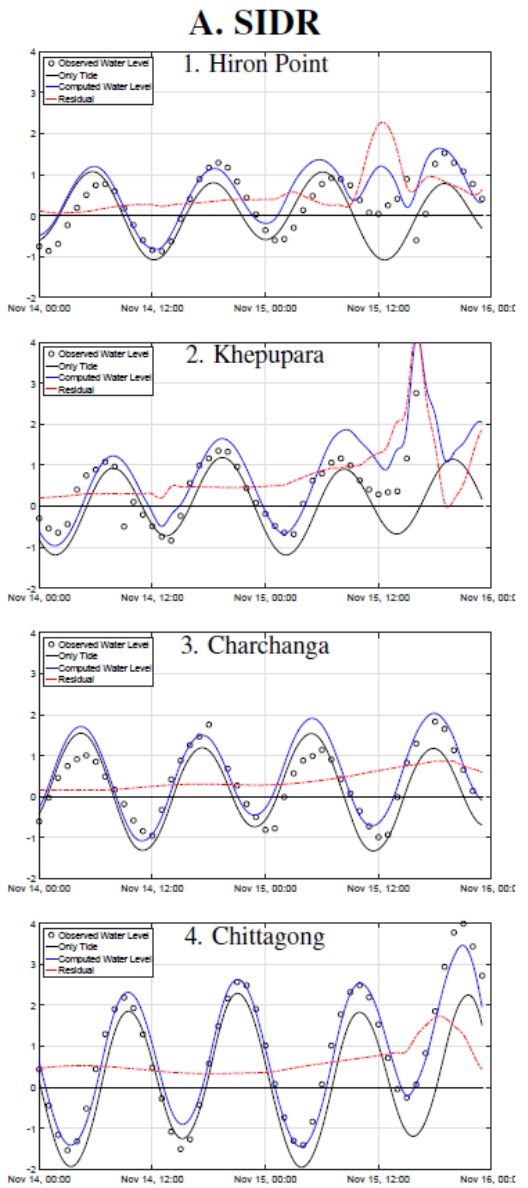
WRF Results
Minimum Sea Level Pressure (MSLP)





	R2		RMSE (hPa)		P-bias (%)	
	IMD	JTWC	IMD	JTWC	IMD	JTWC
SIDR	0.57	0.76	9.23	12.50	-1.84	1.11
AILA	0.89	0.76	5.53	8.15	0.576	3.656

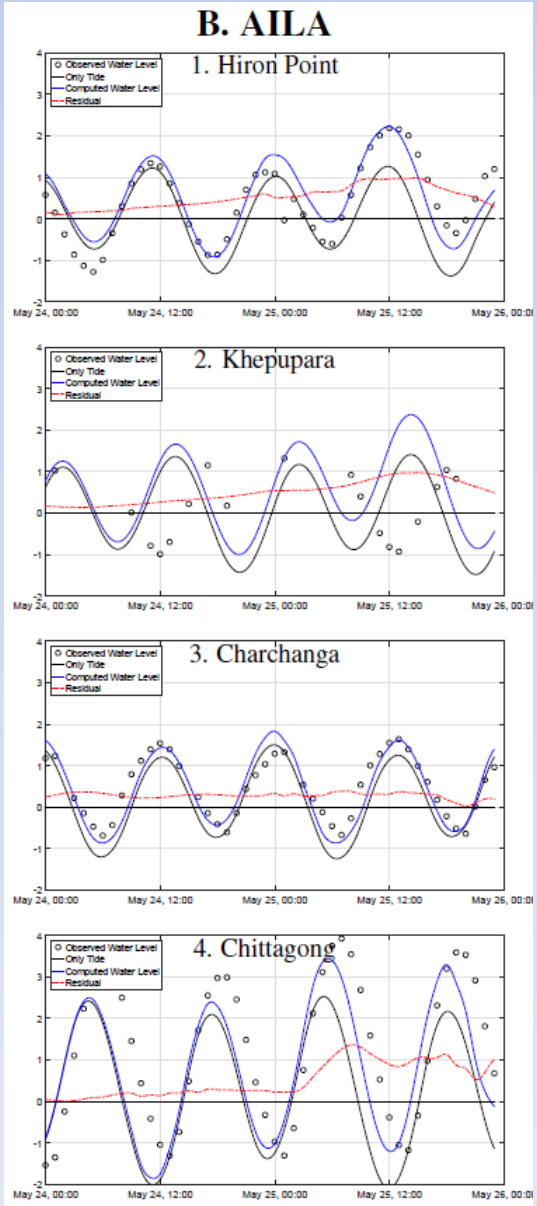
POLCOMS Results
Water Level During Cyclone SIDR



Tide Gauge Station	R^2	RMSE (m)	p-bias (%)
Hiron Point	0.64	0.42	34.32
Khepupara	0.66	0.45	29.90
Charchanga	0.84	0.32	24.11
Chittagong	0.97	0.28	19.35

- maximum water levels are fairly well reproduced
- surge is reduced by the tide–surge interaction during low tide

POLCOMS Results
Water Level During Cyclone AILA



Tide Gauge Station	R^2	RMSE (m)	p-bias (%)
Hiron Point	0.62	0.58	47.61
Khepupara	–	–	–
Charchanga	0.87	0.2672	–20.39
Chittagong	0.98	0.21	–18.39

- a significant phase difference in the surge characteristics
- Interaction of tide and surge are less in comparison with those of the cyclone SIDR
- The Sundarbans poses a major challenge to determine the extent of surge residuals

POLCOMS Results

- The model is found to reproduce surge elevation with a relatively good accuracy, although errors still exist.
- The most important contribution is the integration of real time weather data to the ocean models
- Skill is gained through forcing the ocean model with wind and pressure fields from atmospheric model.
- Large tide-surge interactions are evidenced by the model
- Tides need to be computed explicitly and accurately in storm surge models

Areas of improvement

- availability of up-to-date accurate data on the elevation and condition of embankments
- improved and high resolution bathymetric data should be used to ensure
- Considering wave setup in storm surge models
- other mechanisms such as changes in wind direction and intensity due to topographic effects

Conclusion

- Future model-development work should focus on developing a two-way coupling
- This coupled modeling system is a useful test bed for the sensitivity of a model ocean to meteorological forcings.
- This system now has potential to generate future work on the air–sea interface and feedbacks from ocean to atmosphere
- Better available topographic and bathymetric data is an essential prerequisite
- Public authorities should thus take urgently the necessary measures to make sure that the best topographic and bathymetric data are made available for the scientific community.

Thanks for your kind attention

"meteorologists considered the ocean as a wet surface, oceanographers considered the atmosphere as a place where wind blows"
- Prof. Erik Mollo-Christensen

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