Comparison of directional wave spectrum hindcast to the buoy data measured near the typhoon path

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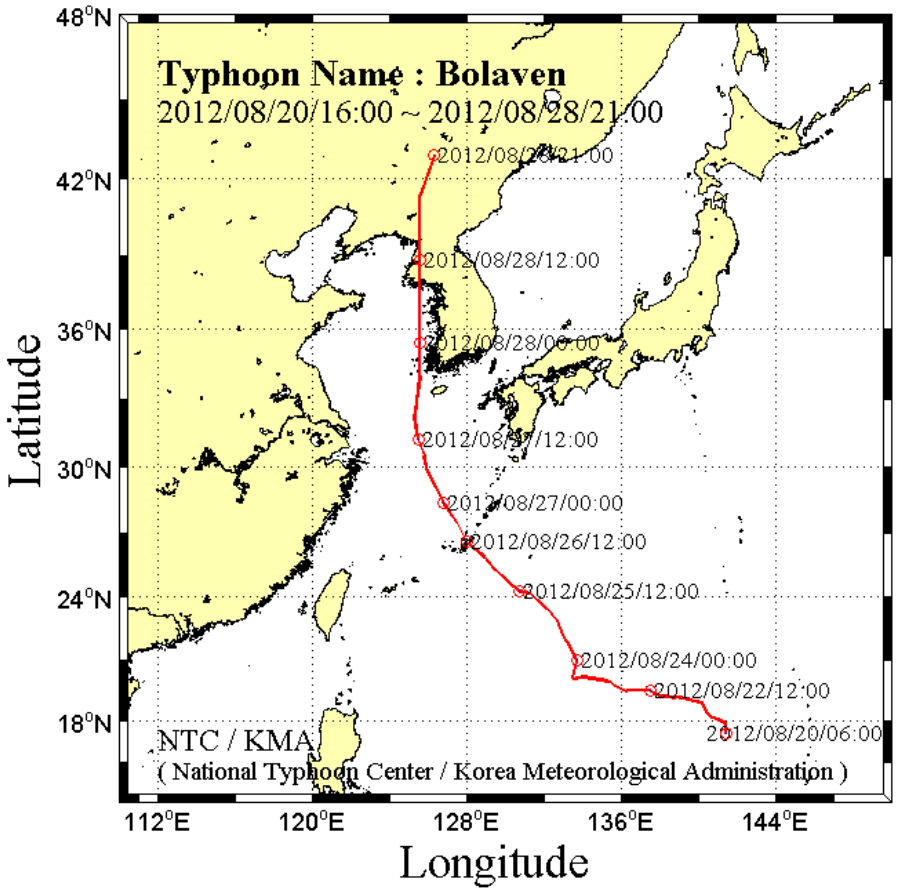
Contents

Background(1)

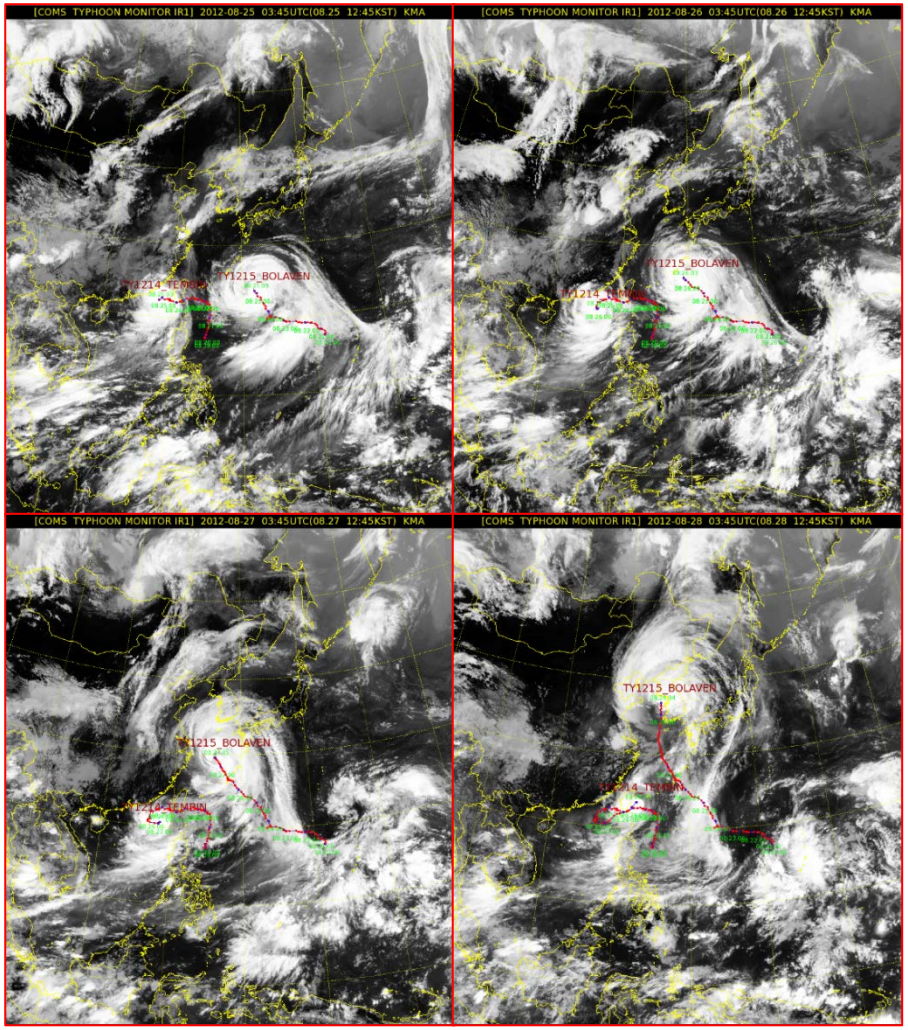
1. Typhoon Bolaven(1215)(TYB_category 3) generated record breaking waves and damaged several ports severely. The central pressure and maximum wind velocity reached up to 910h and 51.8 m/s, respectively. It is the most powerful typhoon which passed the Yellow Sea with casualties of 15 and property damages of over 700 million dollars.

Typhoon Bolaven Path and Satellite Images

TYB Path



Satellite Images(COMS)

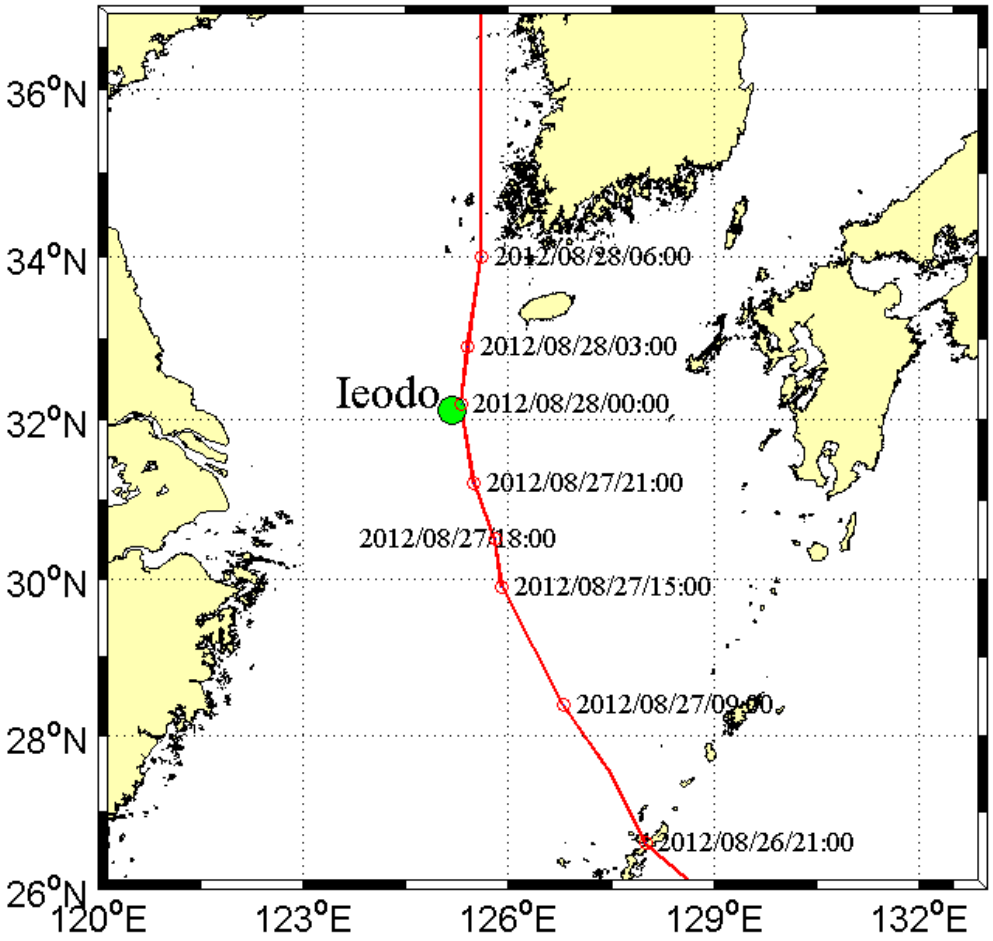


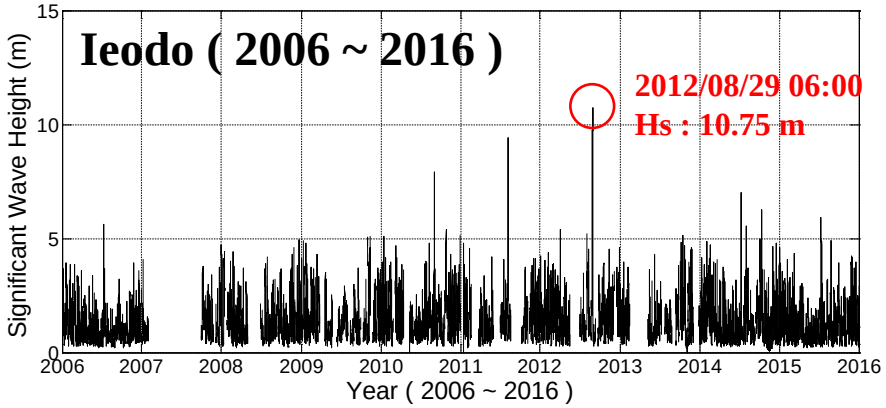
NTC / KMA (National Typhoon Center / Korea Meteorological Administration)

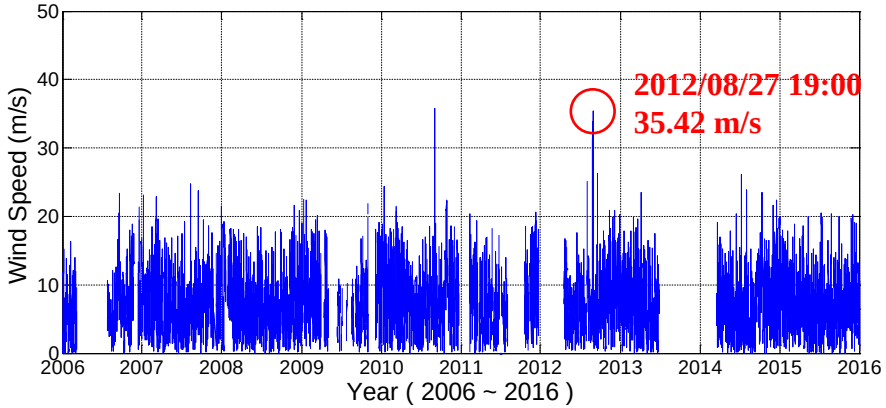
Typhoon Bolaven Wind & Wave

IEODO Ocean Station data for 10 years.

Hs =10.75 m Wind velocity= 35.42 m/sec







Damages by Typhoon Bolaven

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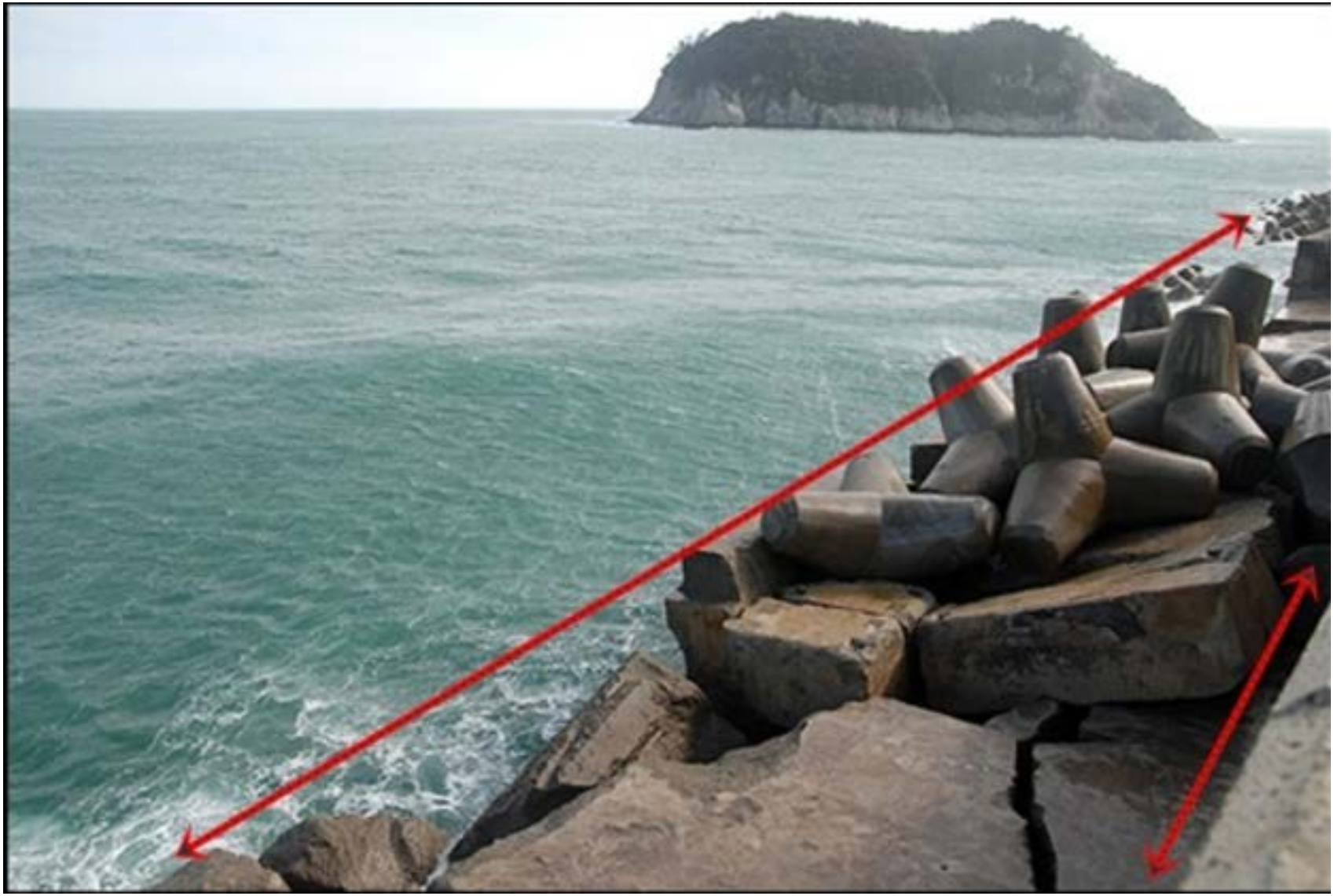
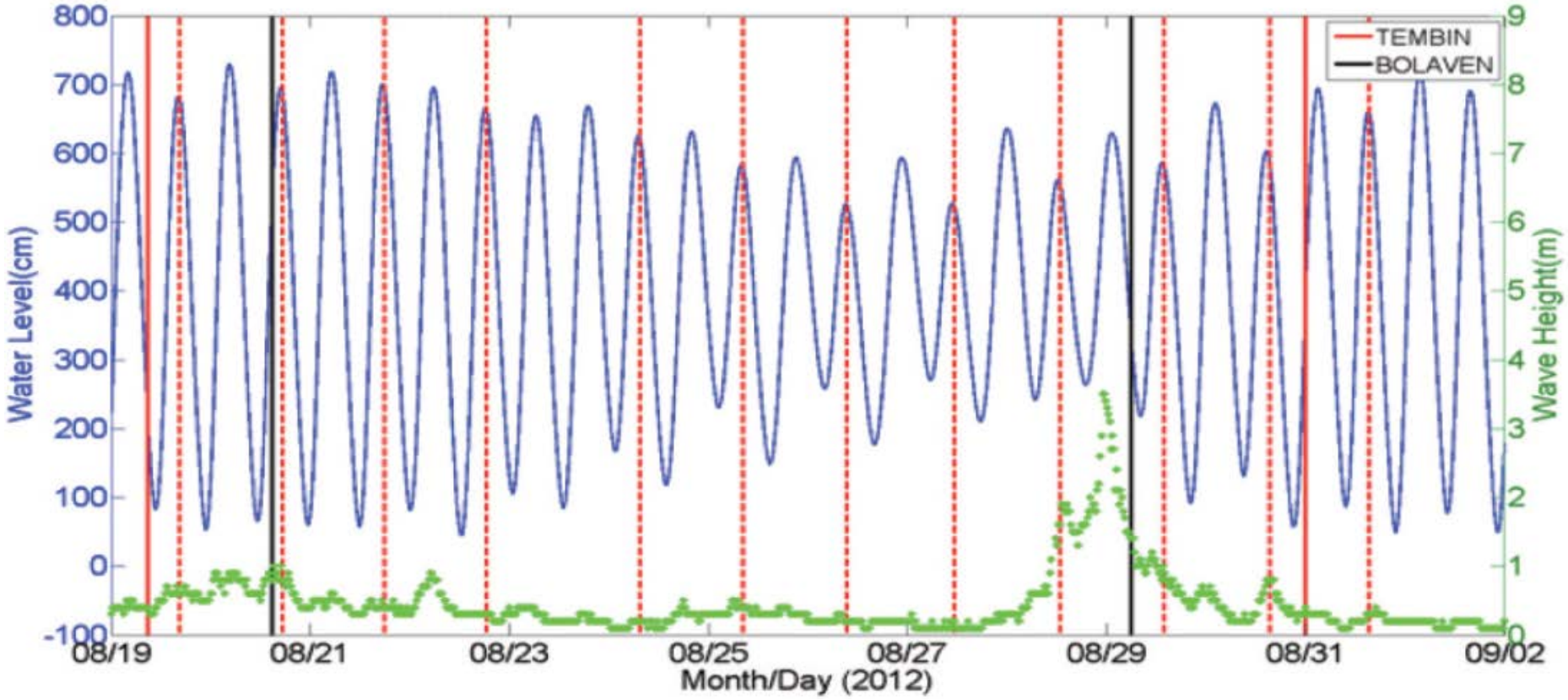


Damages by Typhoon Bolaven

Storm Surge by Typhoon Bolaven ?



Background(2)

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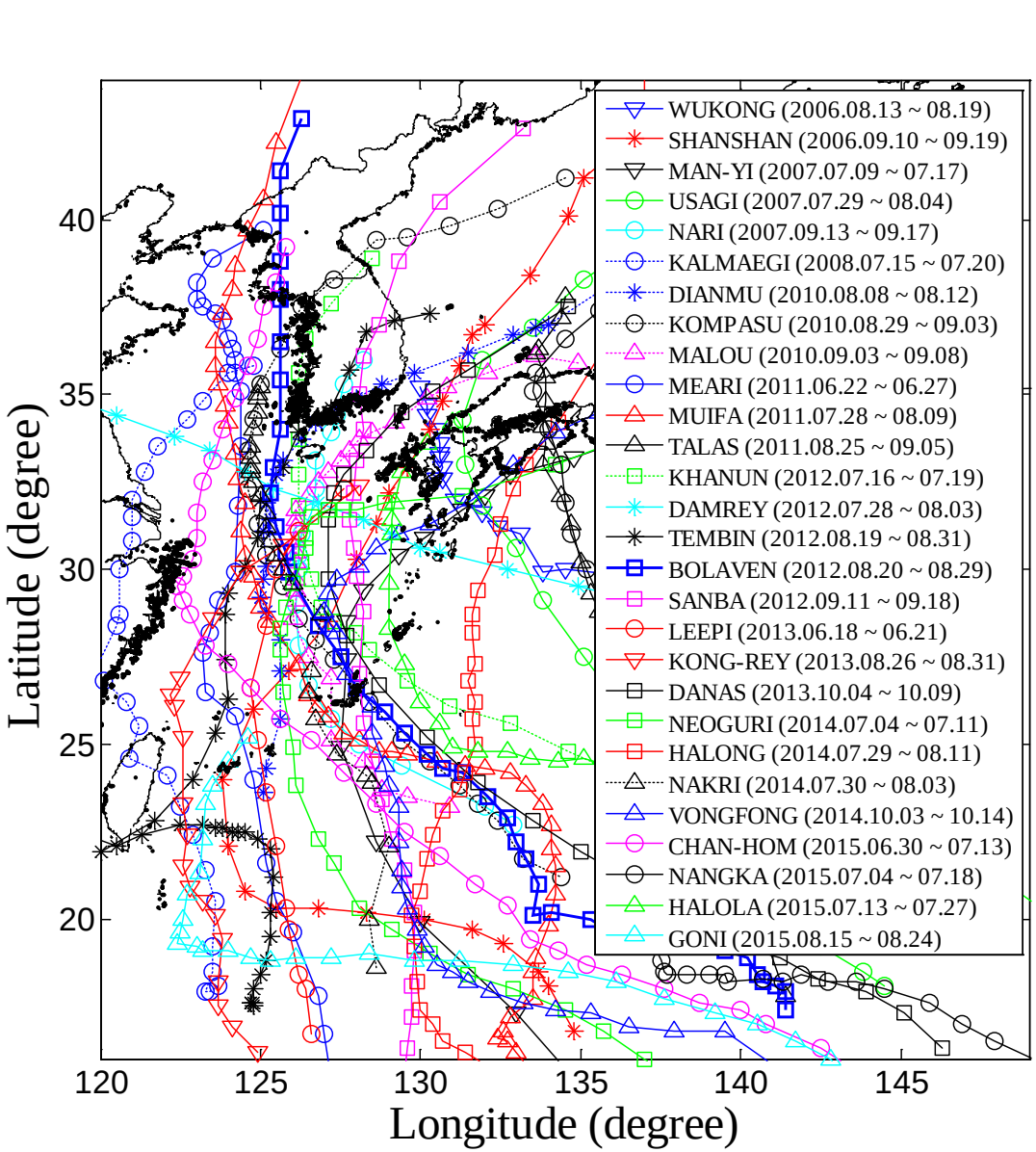
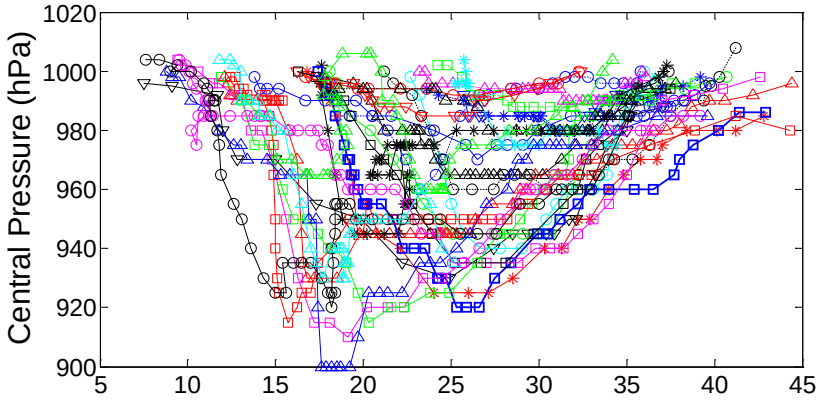
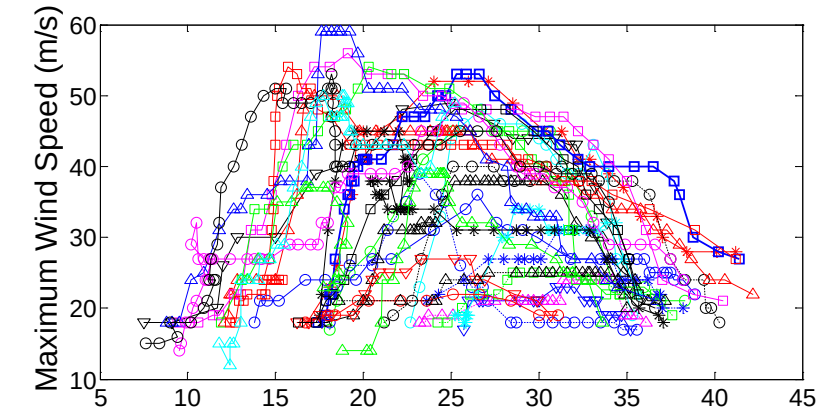
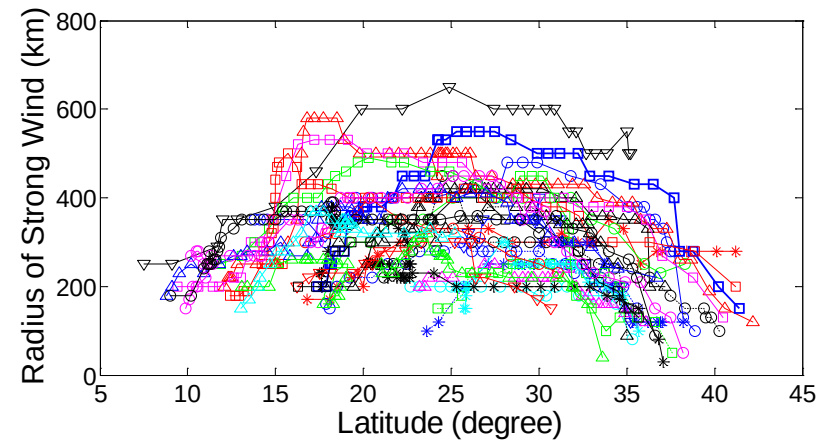
2. TYB generated extreme waves (Hmax=20.7m) and also high waves for long duration. The reason of this extreme case is considered by “dynamic fetch effect” but needs to be analyzed with more data.

Typhoon Bolaven Characteristics (1)









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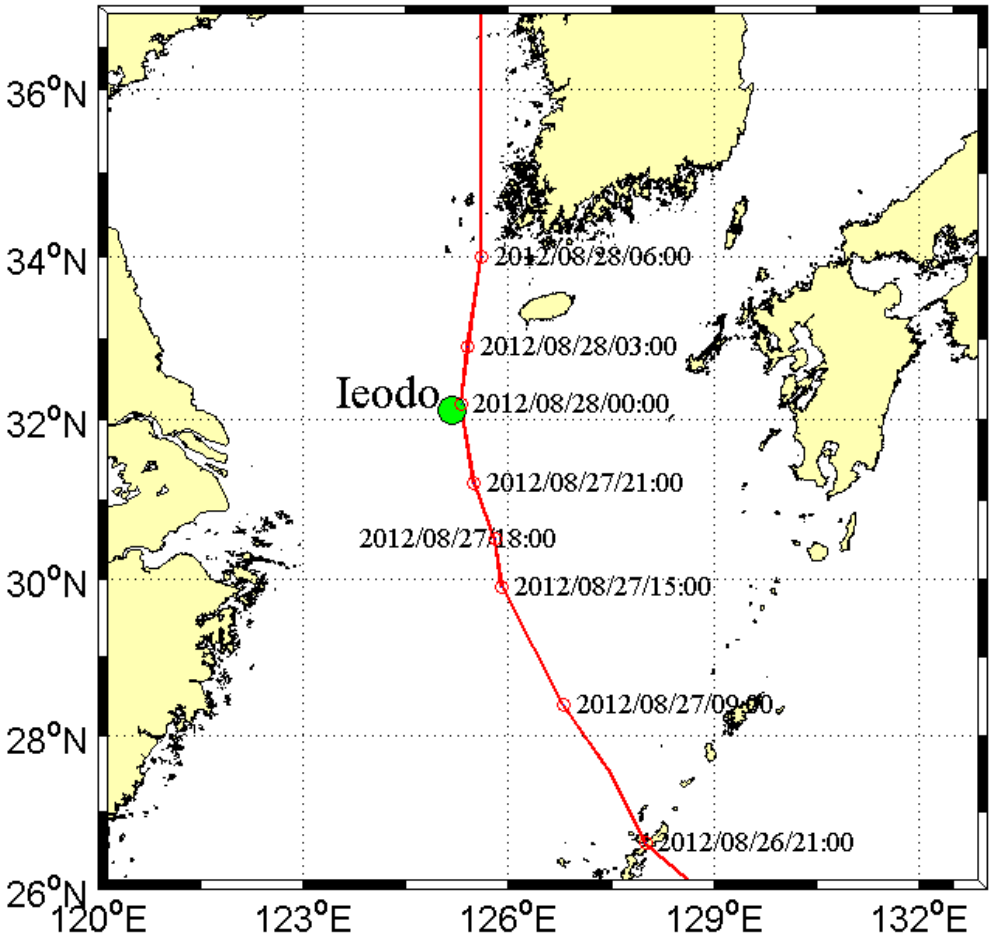

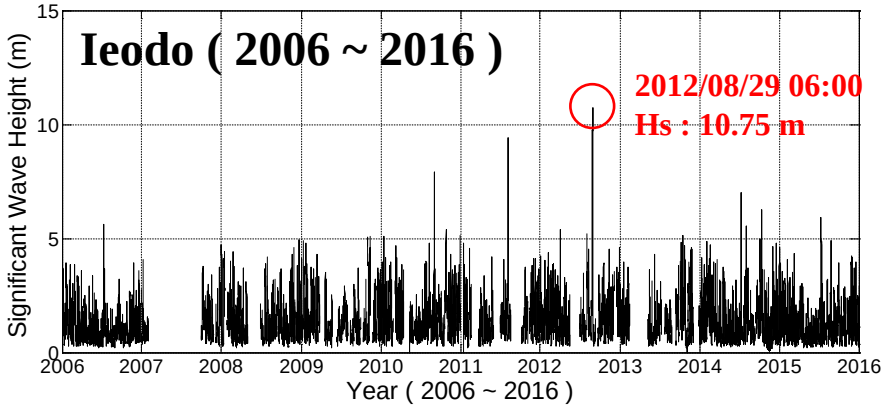

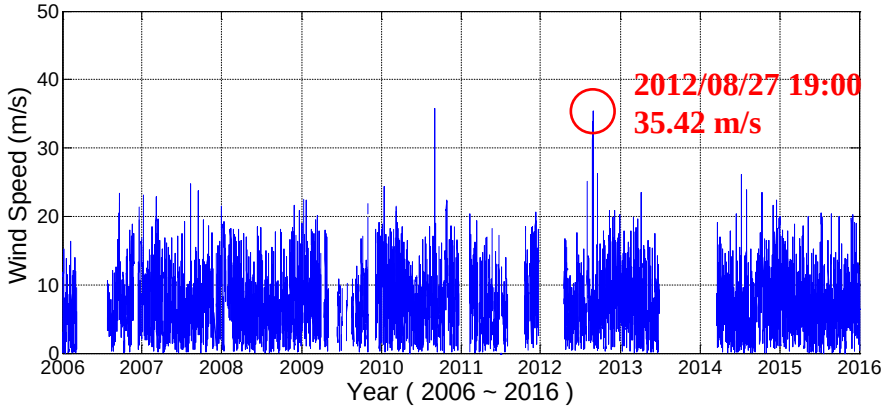

Background(3)

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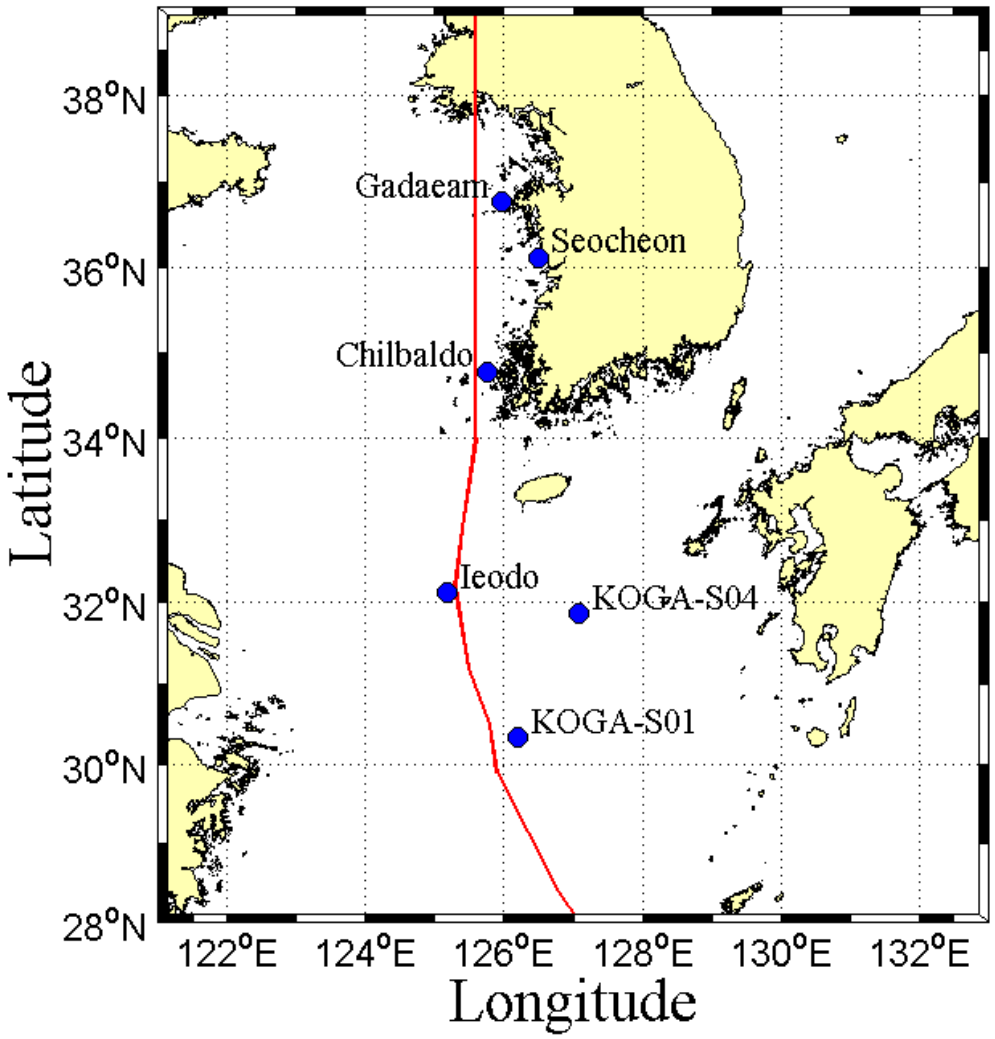
2. TYB generated extreme waves (Hmax=20.7m) and also high waves for long duration. The reason of this extreme case is considered by “dynamic fetch effect” but needs to be analyzed with more data.

3. Typhoon wind and wave fields are very complicate and good example to check the model performance. The numerical wave prediction model needs to be tested with more wave data, specially in terms of directional spectrum.

Wave Observation Sites



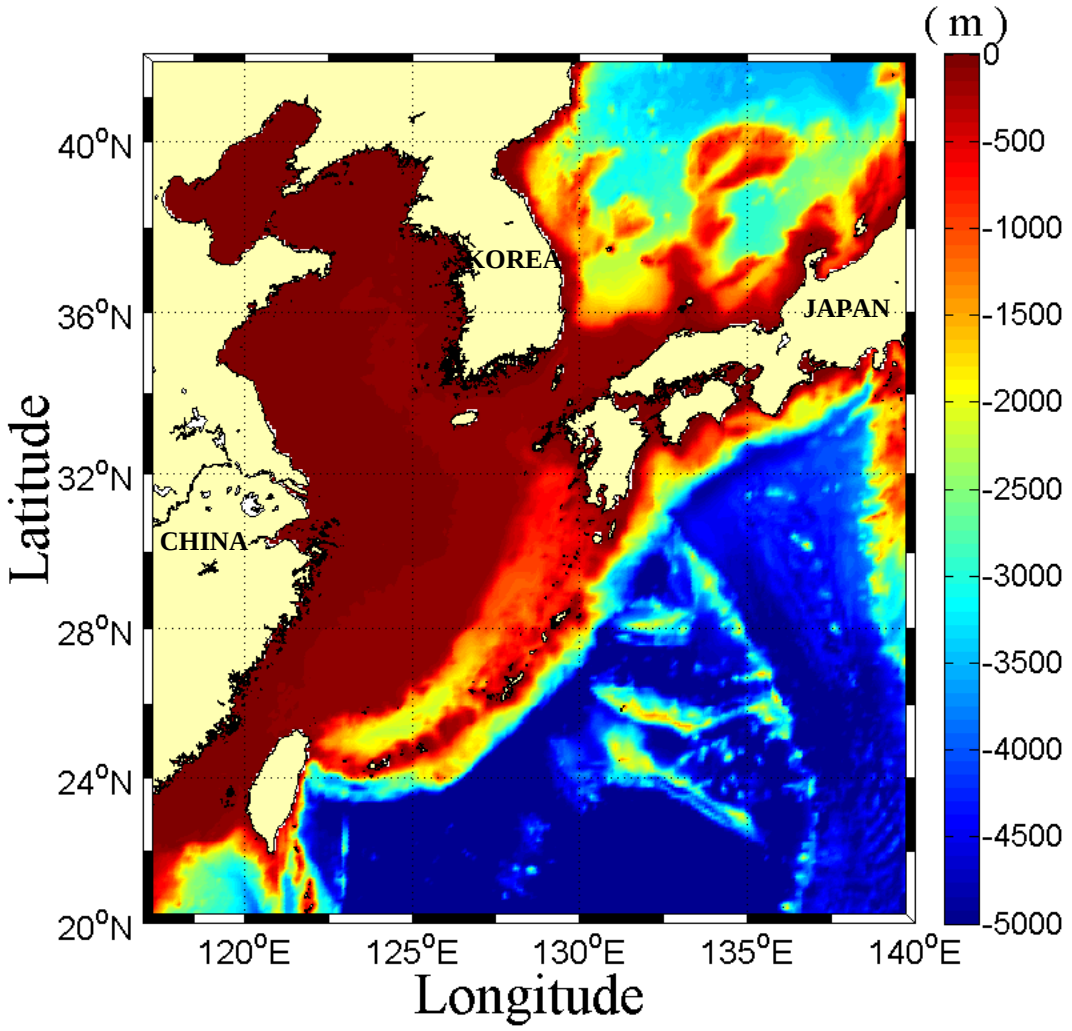
Wave Directional Spectrum

- KOGA-S01(33.4 km)
- KOGA-S04(160.6 km)
- IEODO

Significant Wave Height

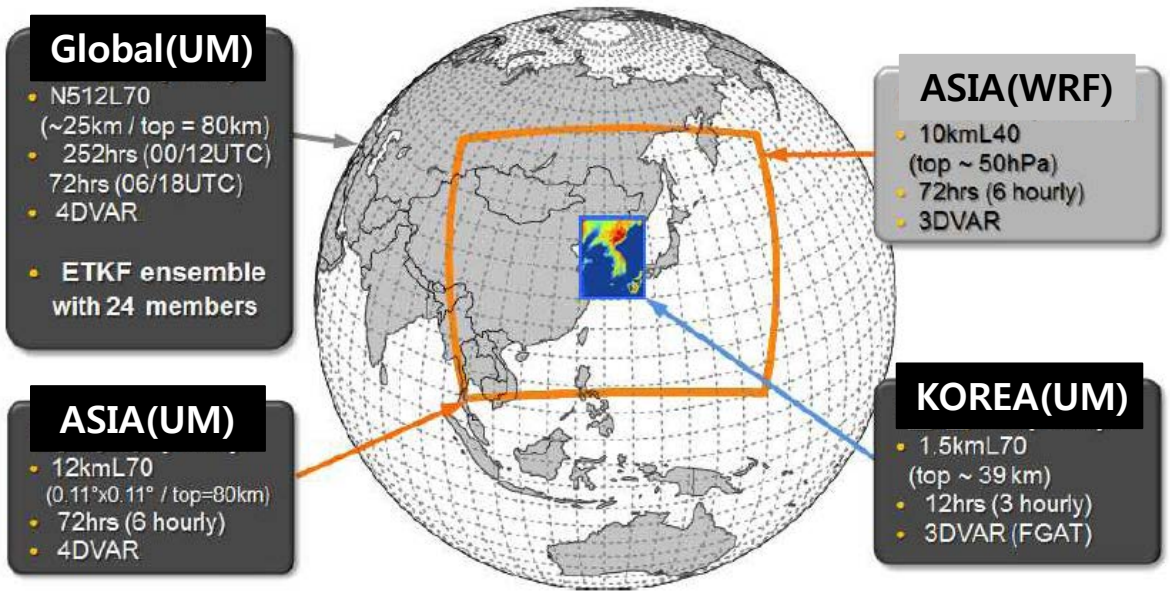
- Chilbaldo
- Seocheon
- Gadaeam

WAVEWATCH3(Depth and Grids)



- WAVEWATCH3 (v 4.18)
- Modeling area
  latitude 18˚N~52.5˚N , longitude 115˚E~147˚E
- Grid information
  · Unstructured Grid
  · Nodes : 121,292
  · Elements : 214,597
- Grid resolution
  · Max : 200 km
  · Min : 100 m
- Spherical coordinate
- Depth Data : ETOPO1

KMA UM Wind Data



- KMA UM(Unified Model) Wind Data

· **RDAPS(Regional Data Assimilation and Prediction System)**

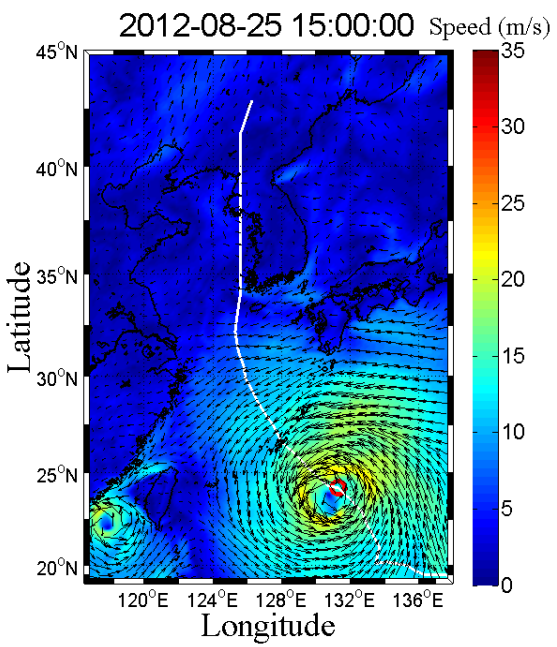
· **Spatial Resolution : 12 km (0.11°), 419 x 491 grids.**

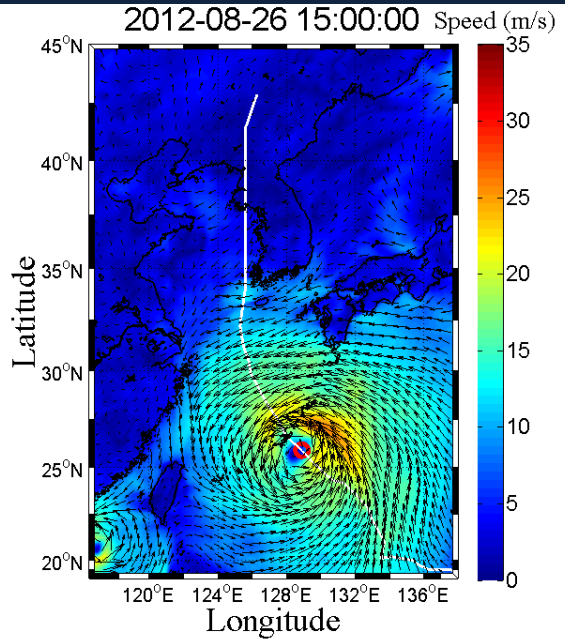
· **Temporal Resolution : 3 hour, 4 times/day(00, 06, 12, 18UTC), 72 hour prediction**

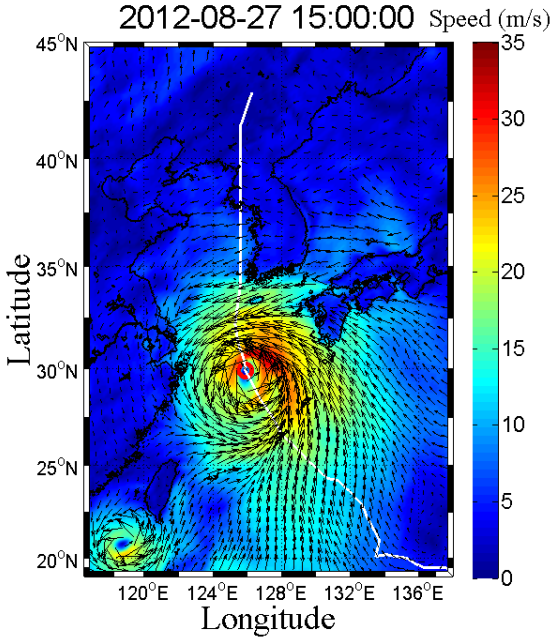
- WW3 Wind Data

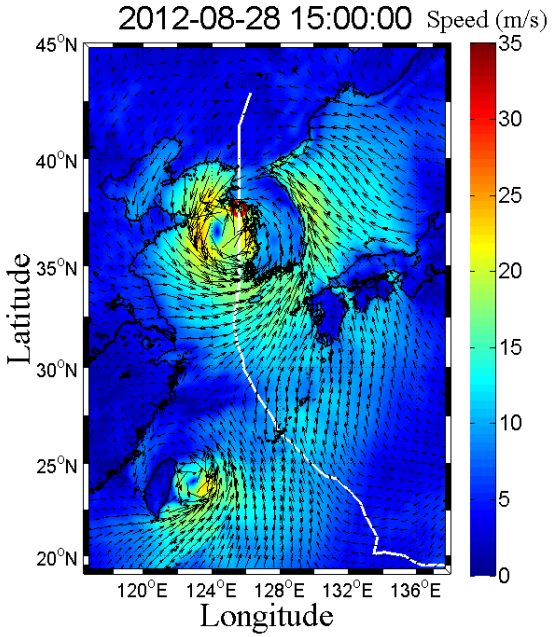
- 10m Sea Wind Data(U, V), 6 hour Resolution

UM Wind Field Data(RDAPS)

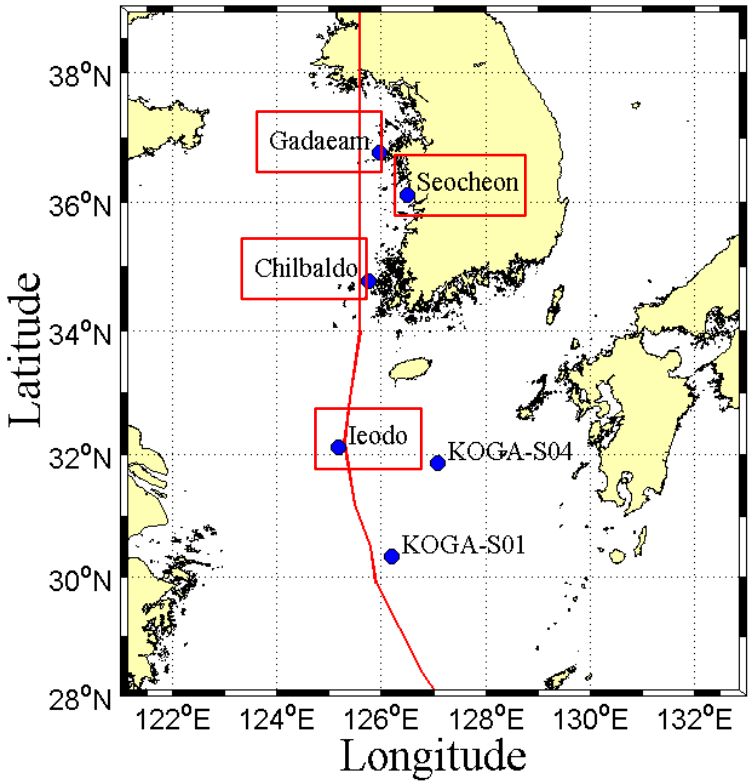


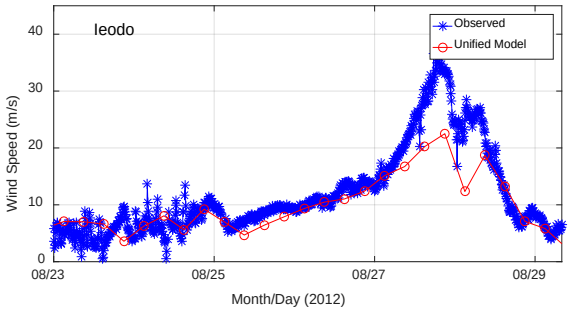


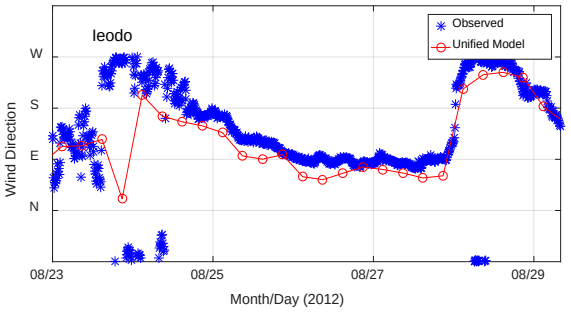


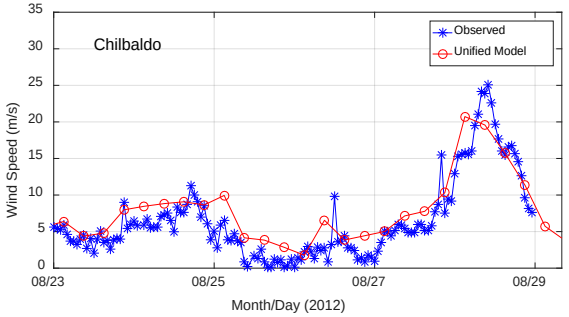


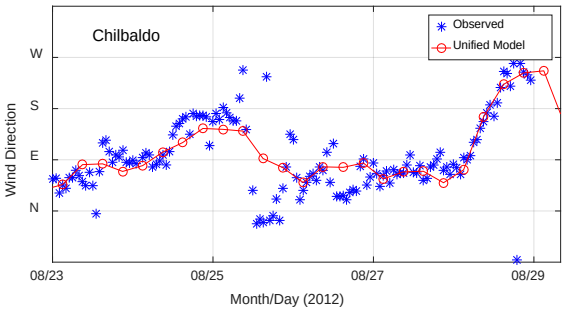
Comparison of UM Wind with Observation Data

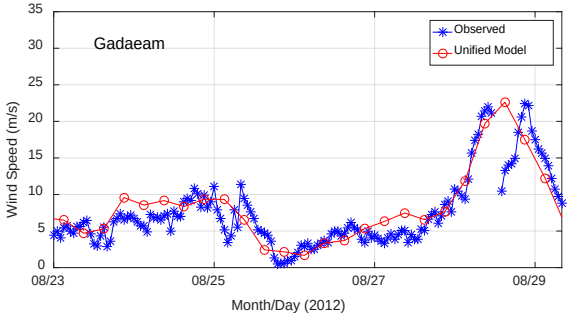


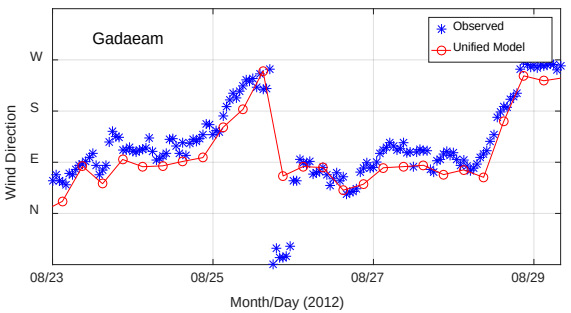


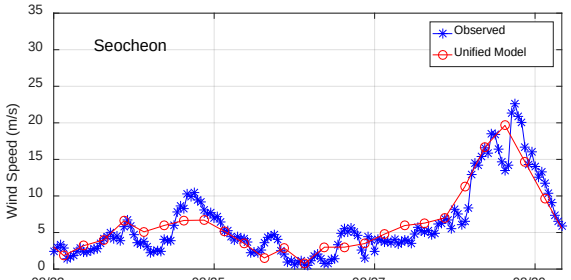


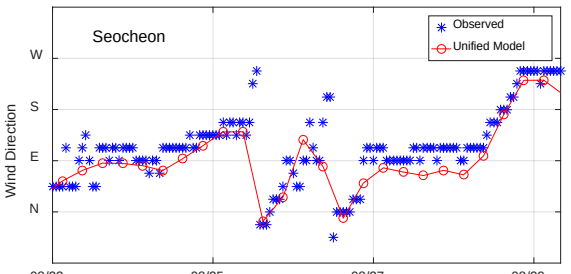




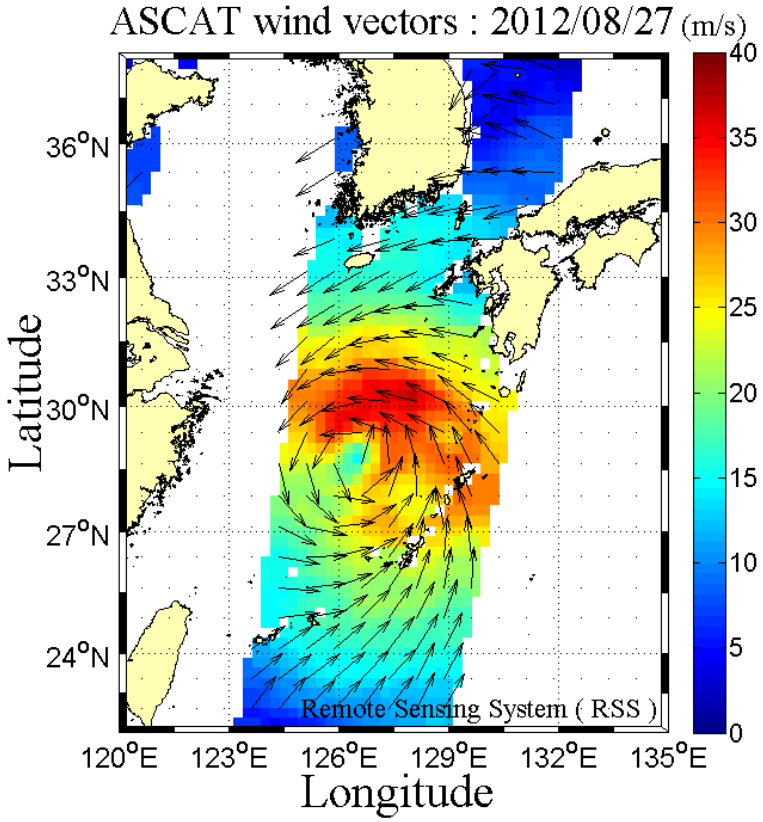


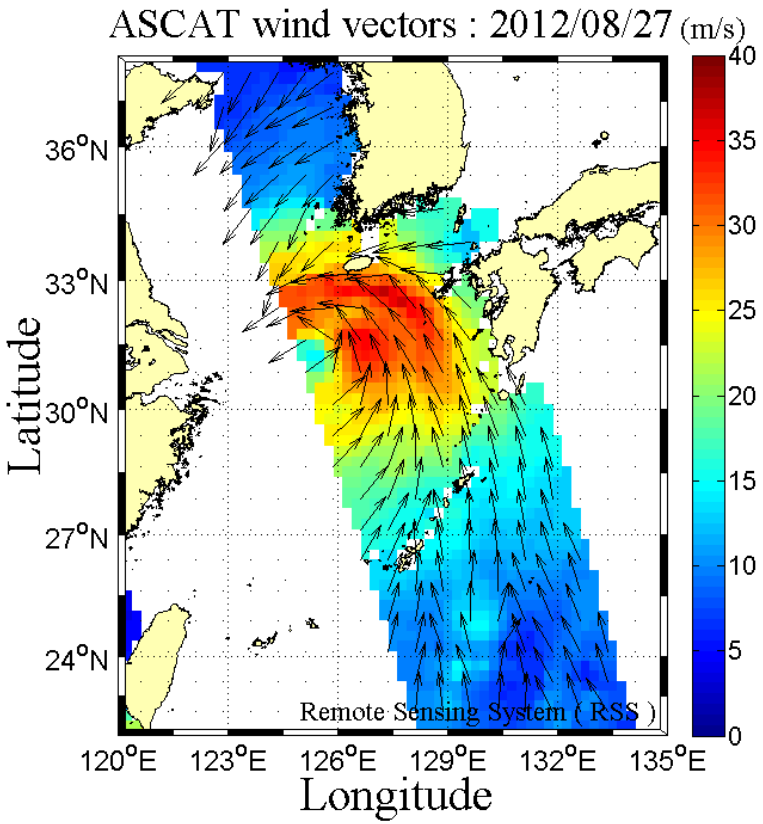






ASCAT Wind Fields(Eumersat MetOp-A)





morning passes (~09:30 local time),

09:54 (KST),

evening passes (~21:30 local time)

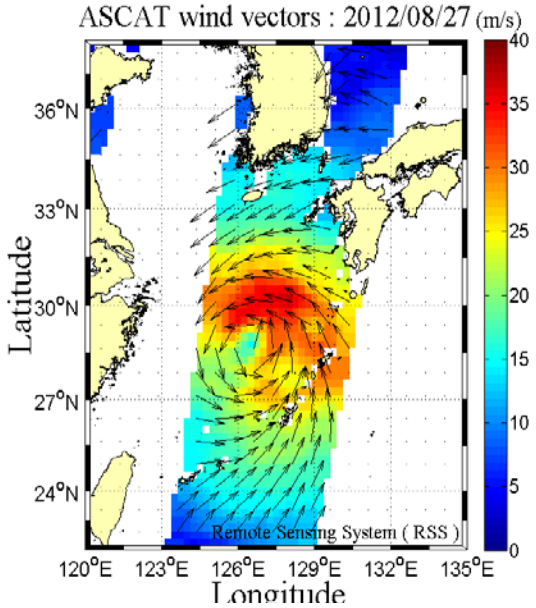
21:06 (KST)

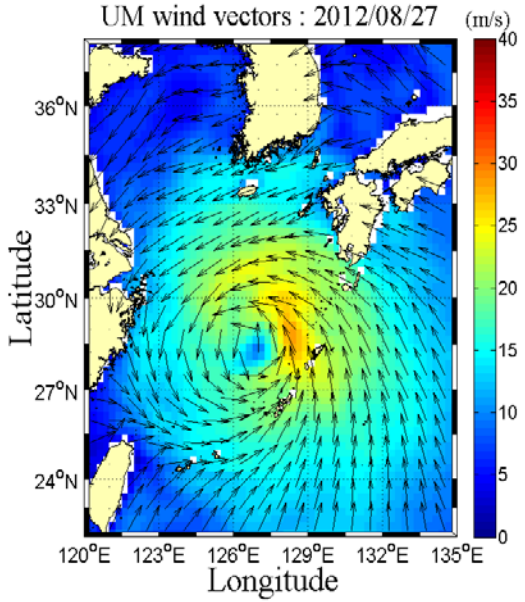
27th August 2012

ASCAT Wind *vs* UM Wind

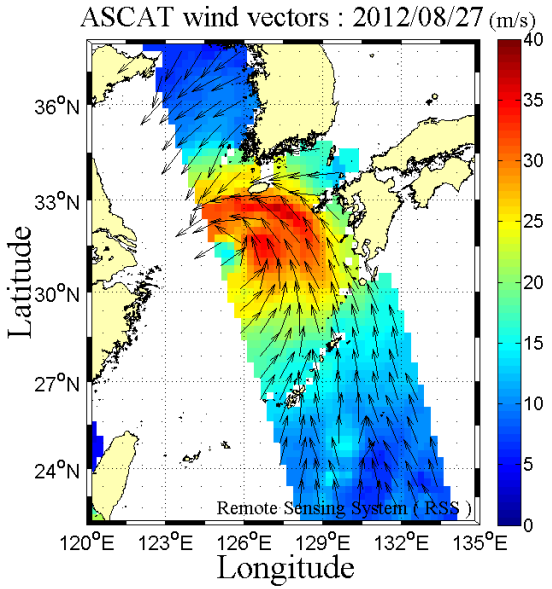
2012/08/27

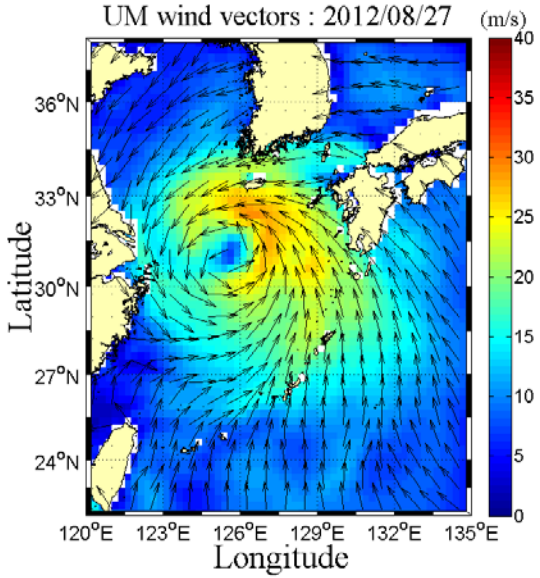
09:54





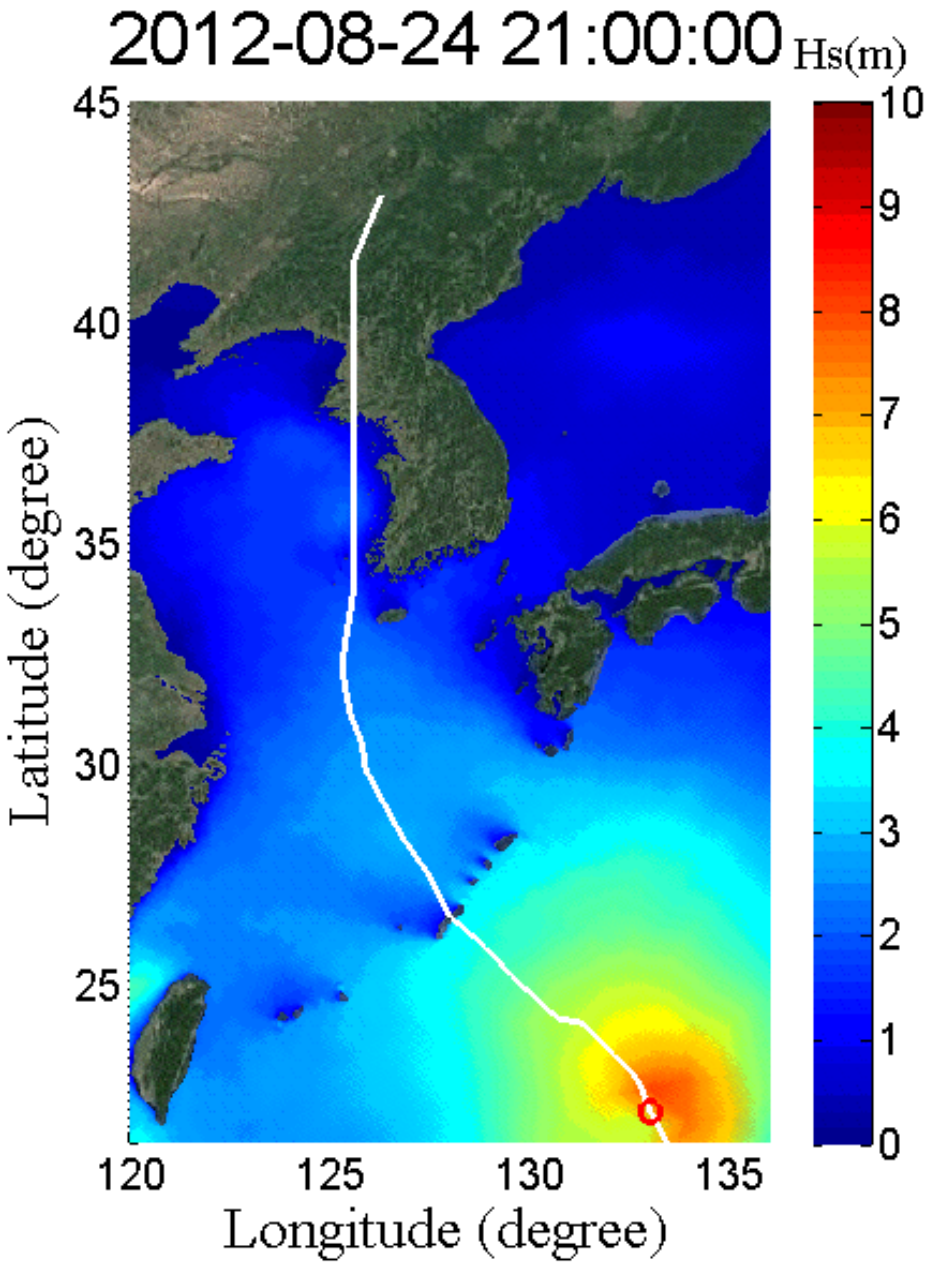
- **2012/08/27**
- **21:06**





Wave Fields Simulation (1)

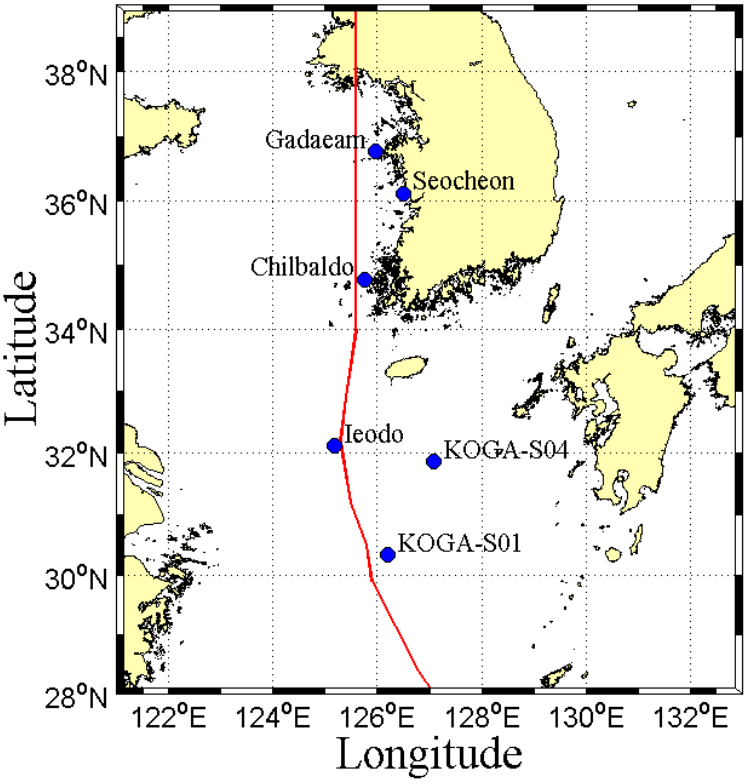
WW3
(RDAPS/UM)

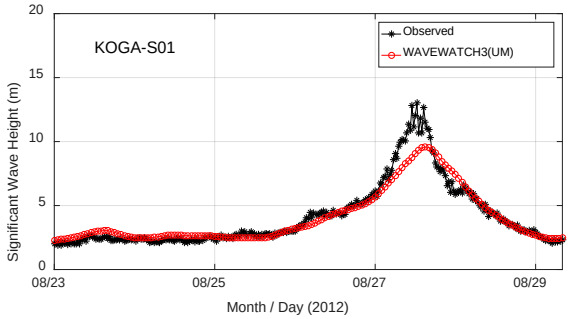


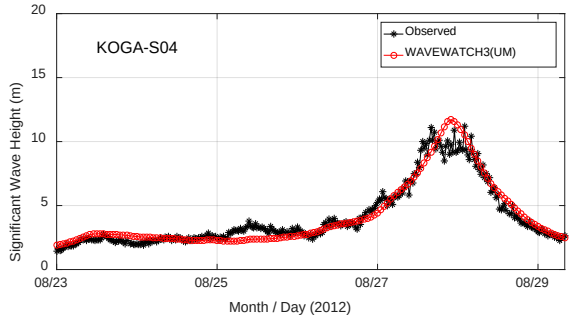
- **High waves are generated on the right side of the TYB translation direction.**

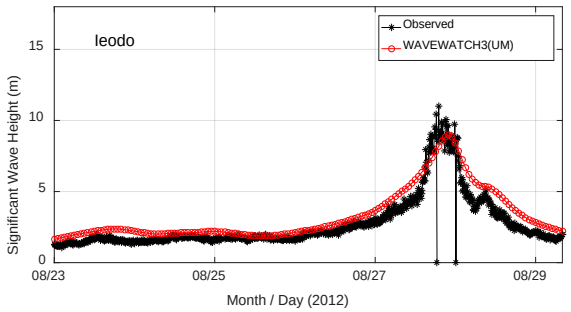
- **From 27th to 28th in August 2012, higher than 10 m Hs was generated along the TYB track.**

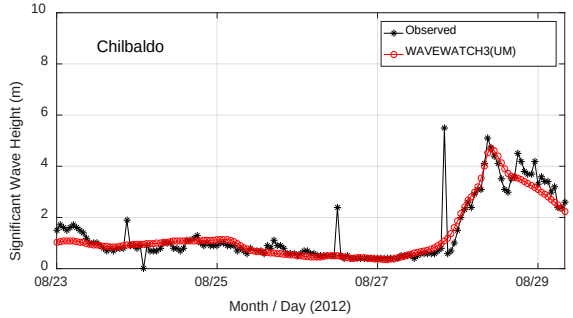
Comparison of WW3 with Observation

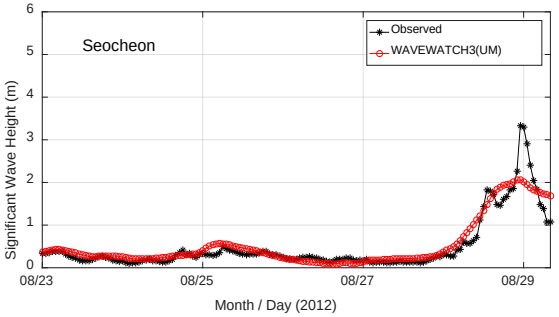


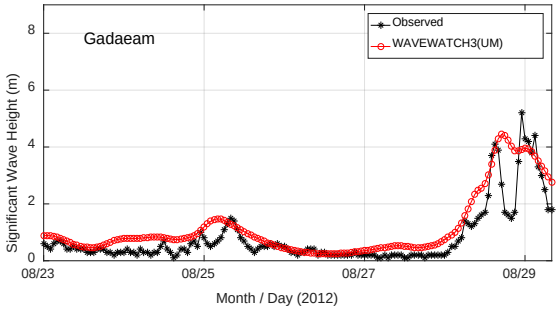




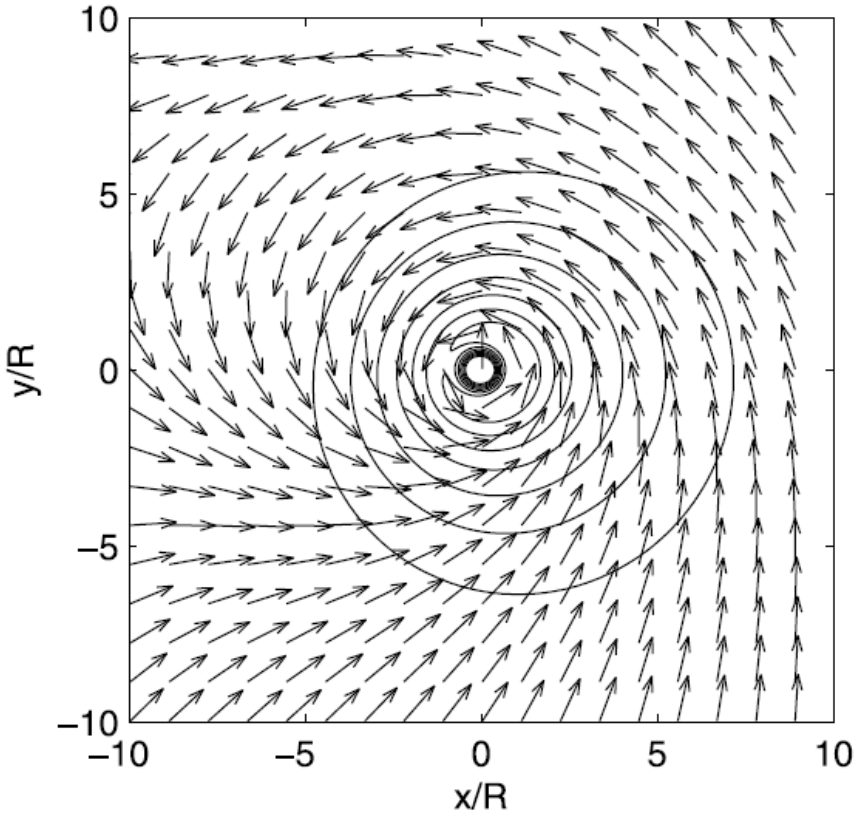




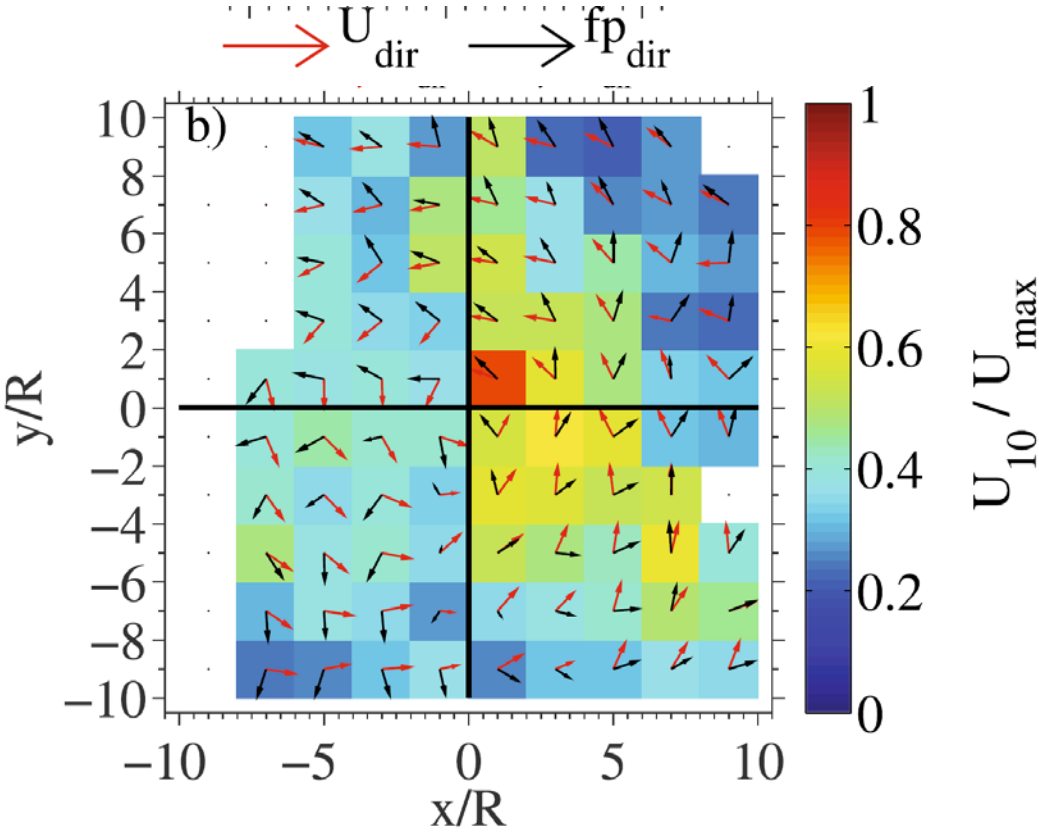




Review of Typhoon Wind and Wave Fields

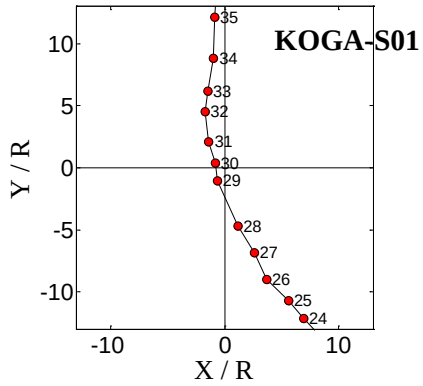


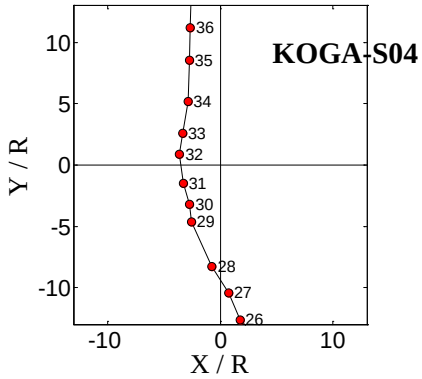
Typical typhoon wind field in the Northern Hemisphere (Young, 2006, JGR)

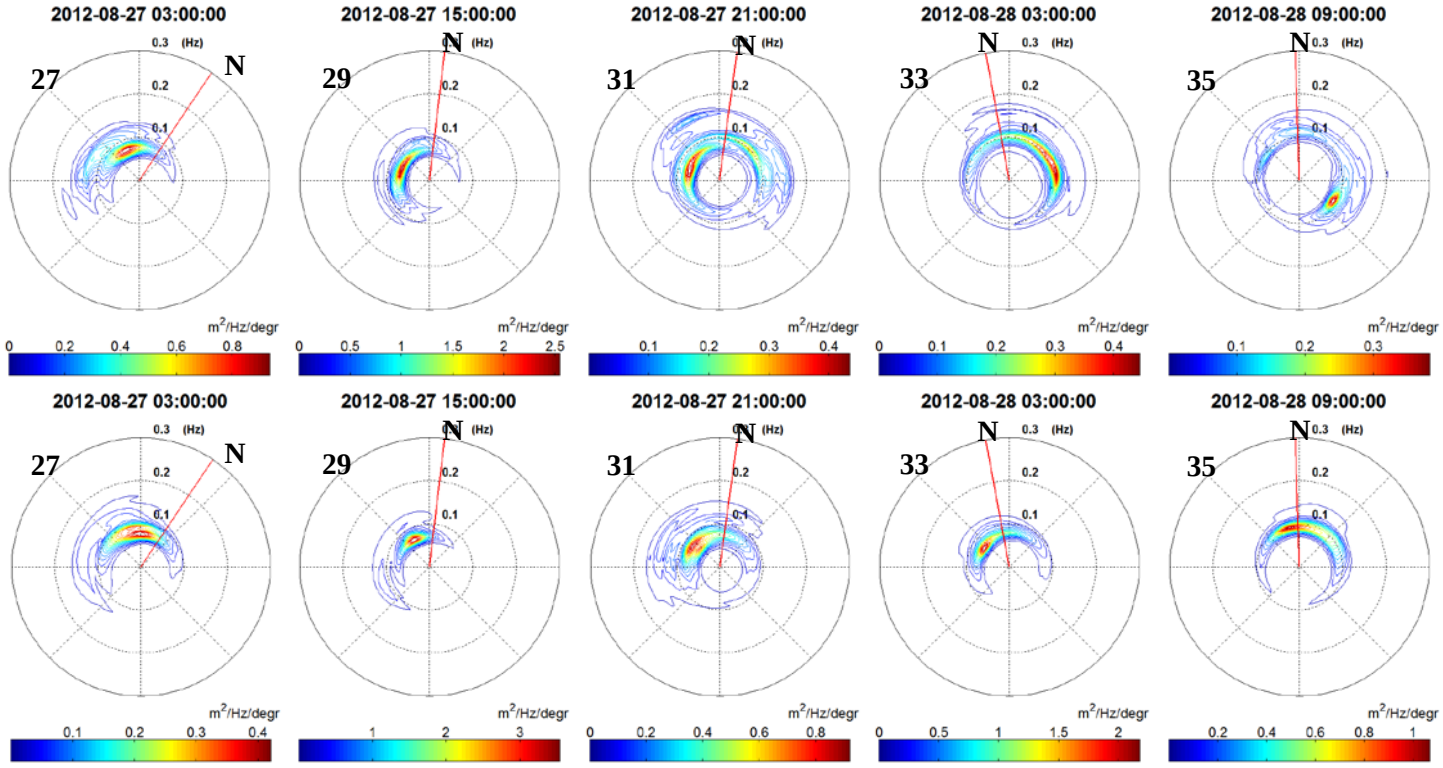


Spatial structure of directional wave spectra in hurricanes (Esquivel-Trava et al., 2015, Ocean Dynamics)

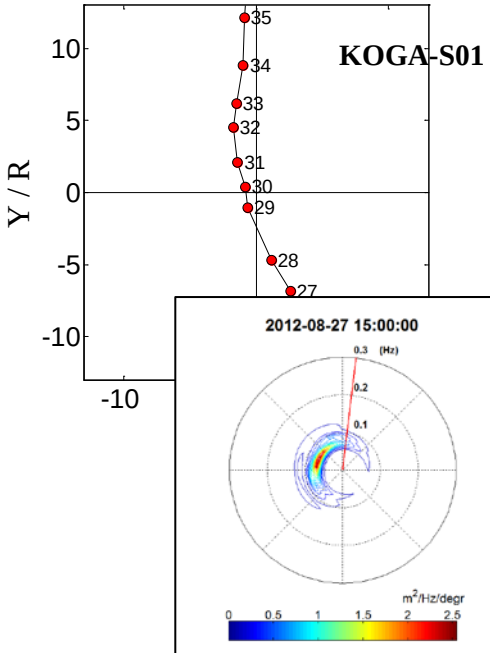
Wave Directional Spectrum Changes(Observed)

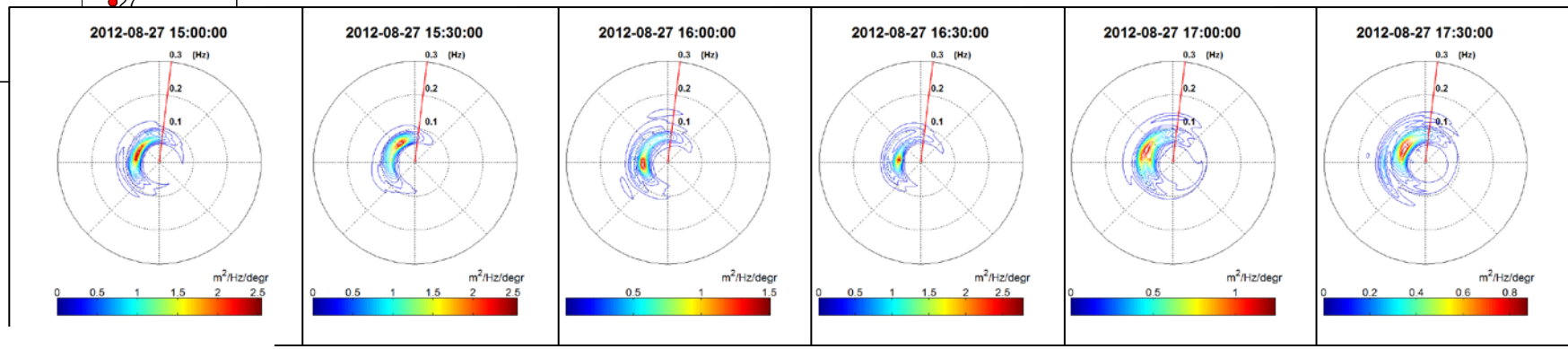


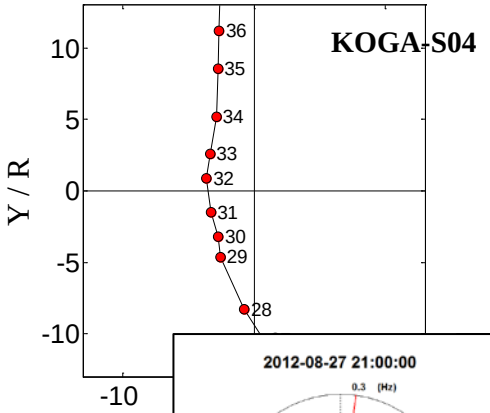


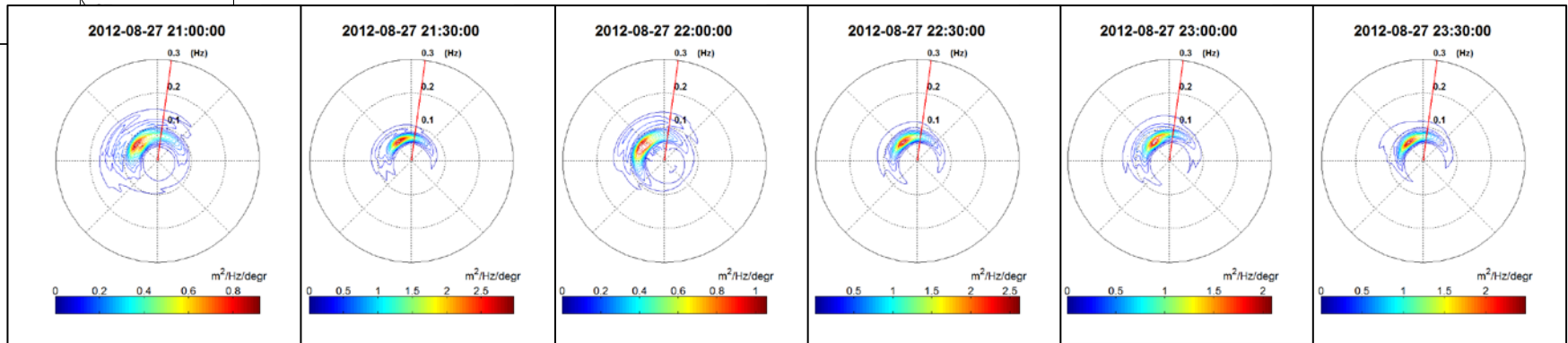


Wave Directional Spectrum Changes

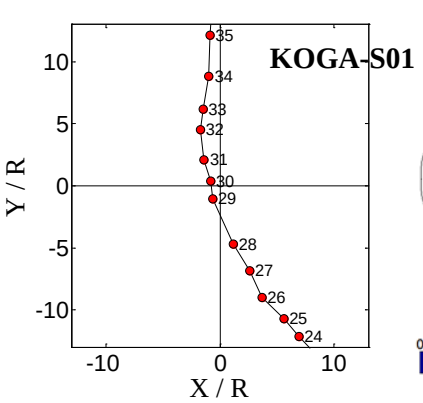


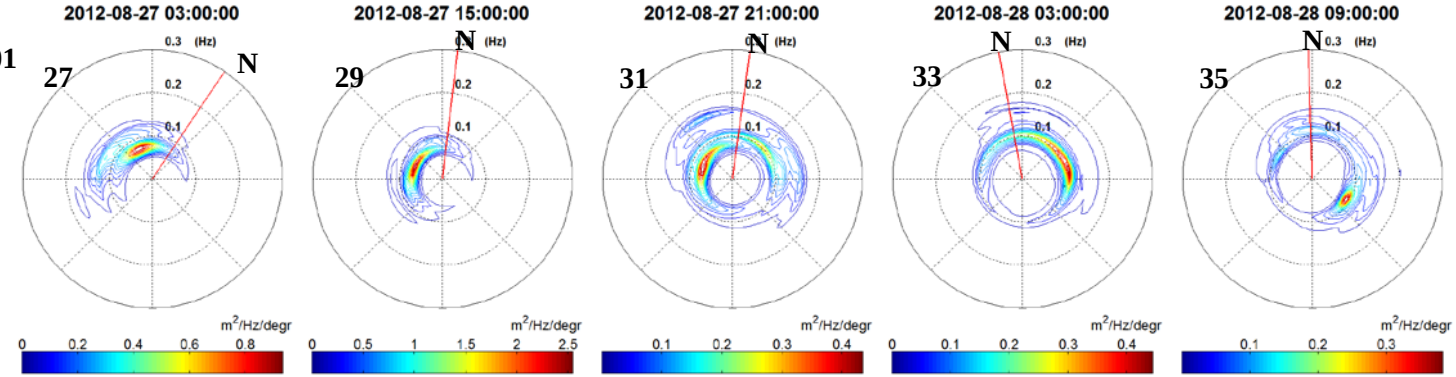




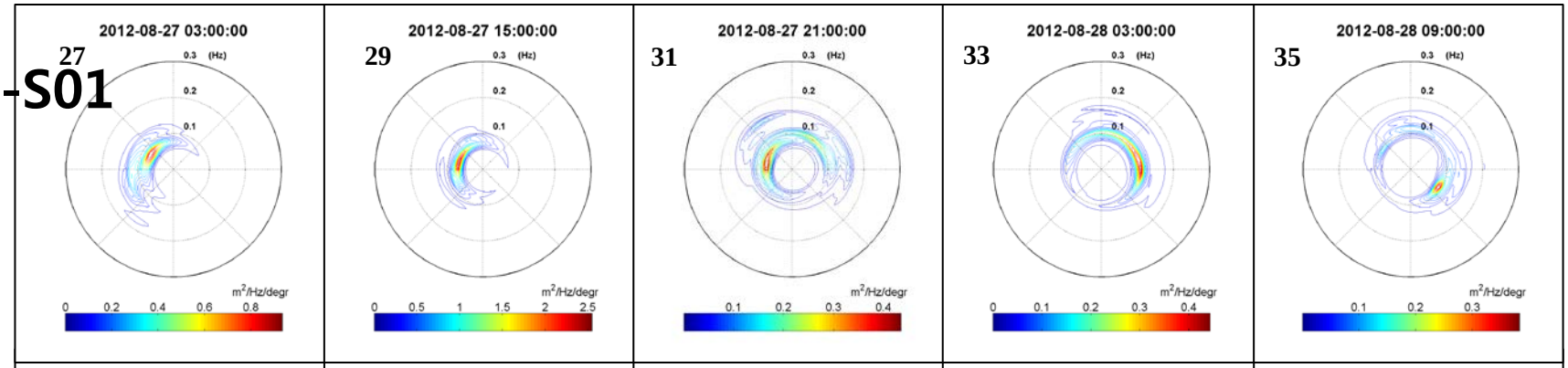


Comparison of Directional Spectrum(WW3 *vs* S01)

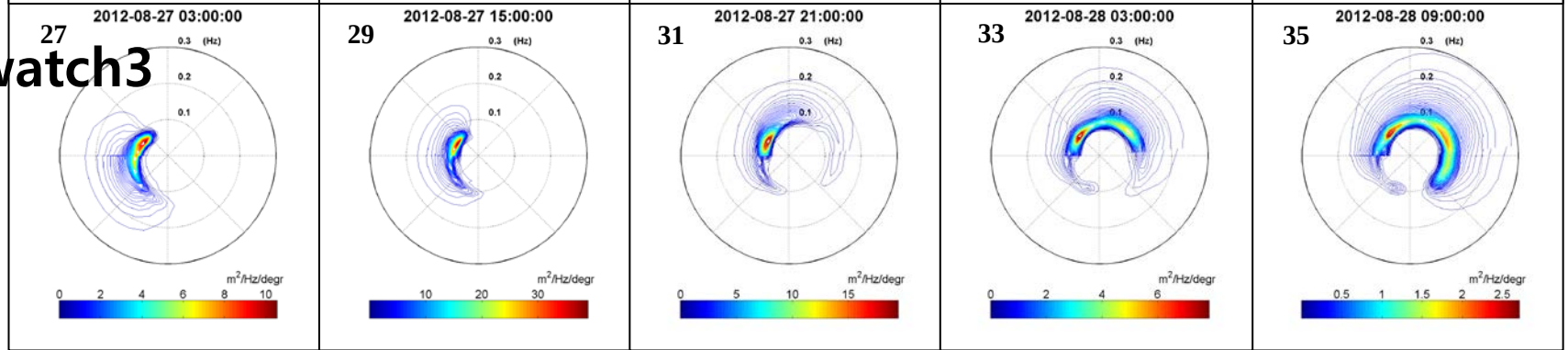




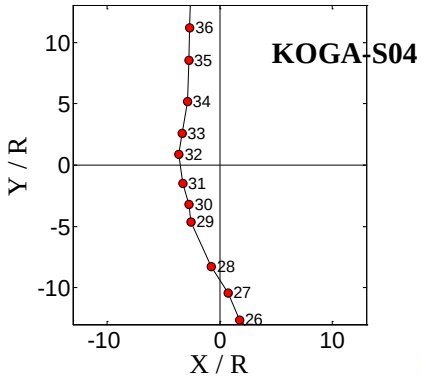
KOGA-S01

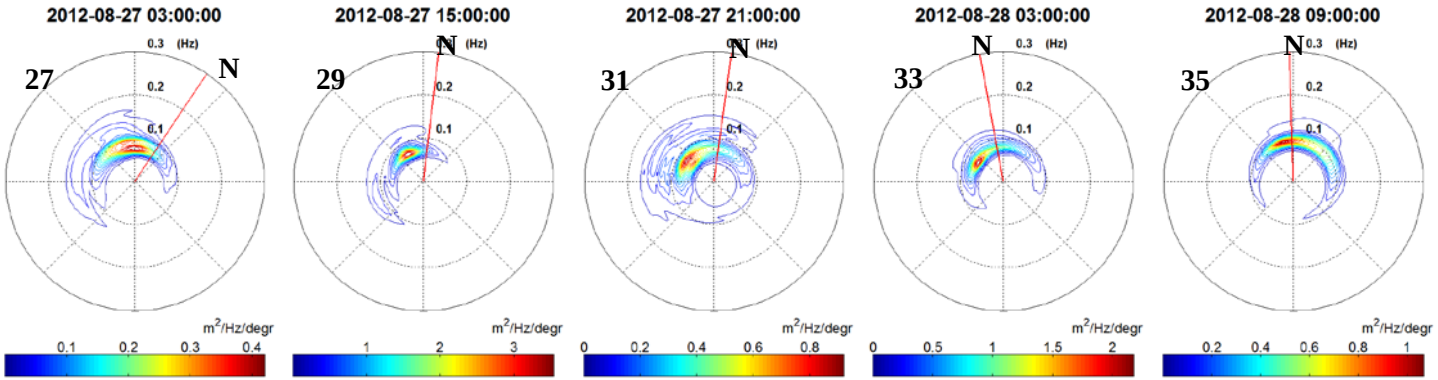


wavewatch3

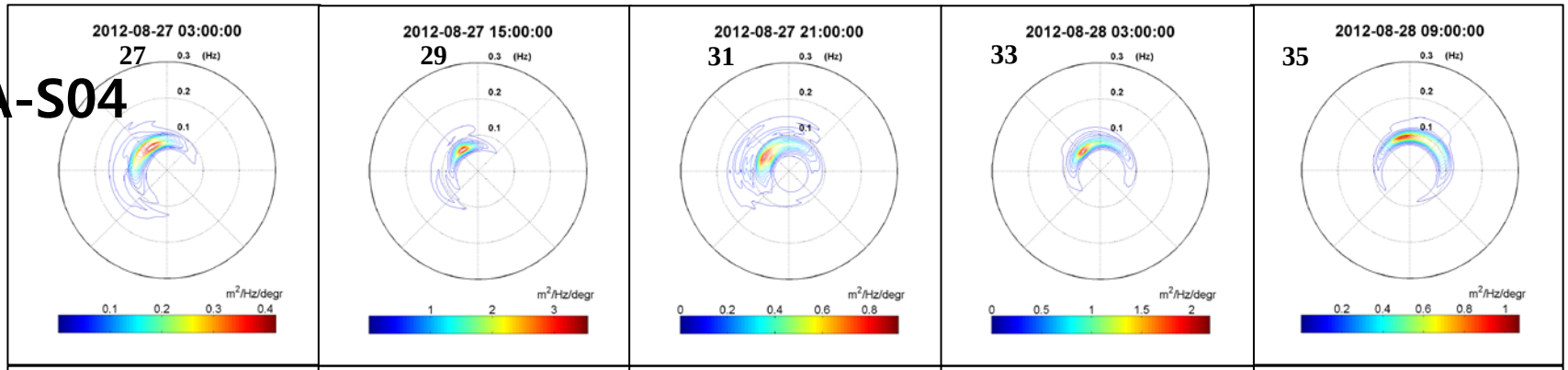


Comparison of Directional Spectrum(WW3 *vs* S04)

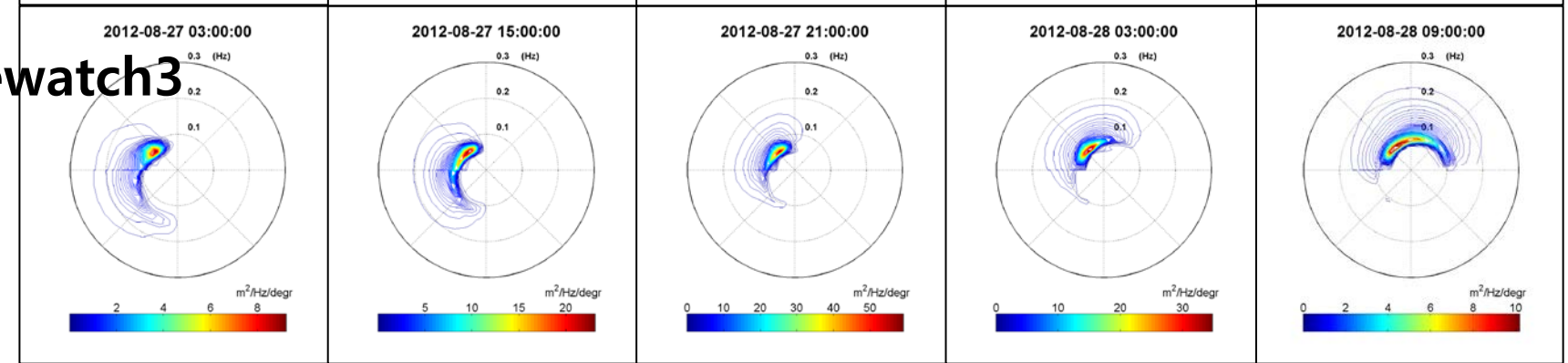




KOGA-S04



wavewatch3



Summary and Next Steps(1)

1. Up to now, directional wave spectrum data observed at two buoys near the TYB path clearly do not show the dynamic fetch effects. Need more analysis using normalization in terms of TYB speed, Cg, Rmax , relative location from the TYB center and wave growth

Summary and Next Steps(2)

2. Comparison of WW3 and observed data shows reasonably good agreement in time series of Hs. Underestimation of Hs near the TYB path seems to be originated from underestimation of UM wind.

3. The calculated directional spectrum is similar to buoy data near the TYB center but shows differences at far point from the center

4. Same analysis of model results using normalization is needed for comparison to buoy data.

THANK YOU!!

Questions & Comments