1B-1: Verification of global and regional model forecasts for tropical cyclones affected Vietnam from 2012-2016

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Contents

- Numerical weather products (NWP) at the National Hydro-Meteorological Services in Vietnam (NHMS)
- NWP and tropical cyclone (TC) forecast
- Verification for TCs from 2012-2016
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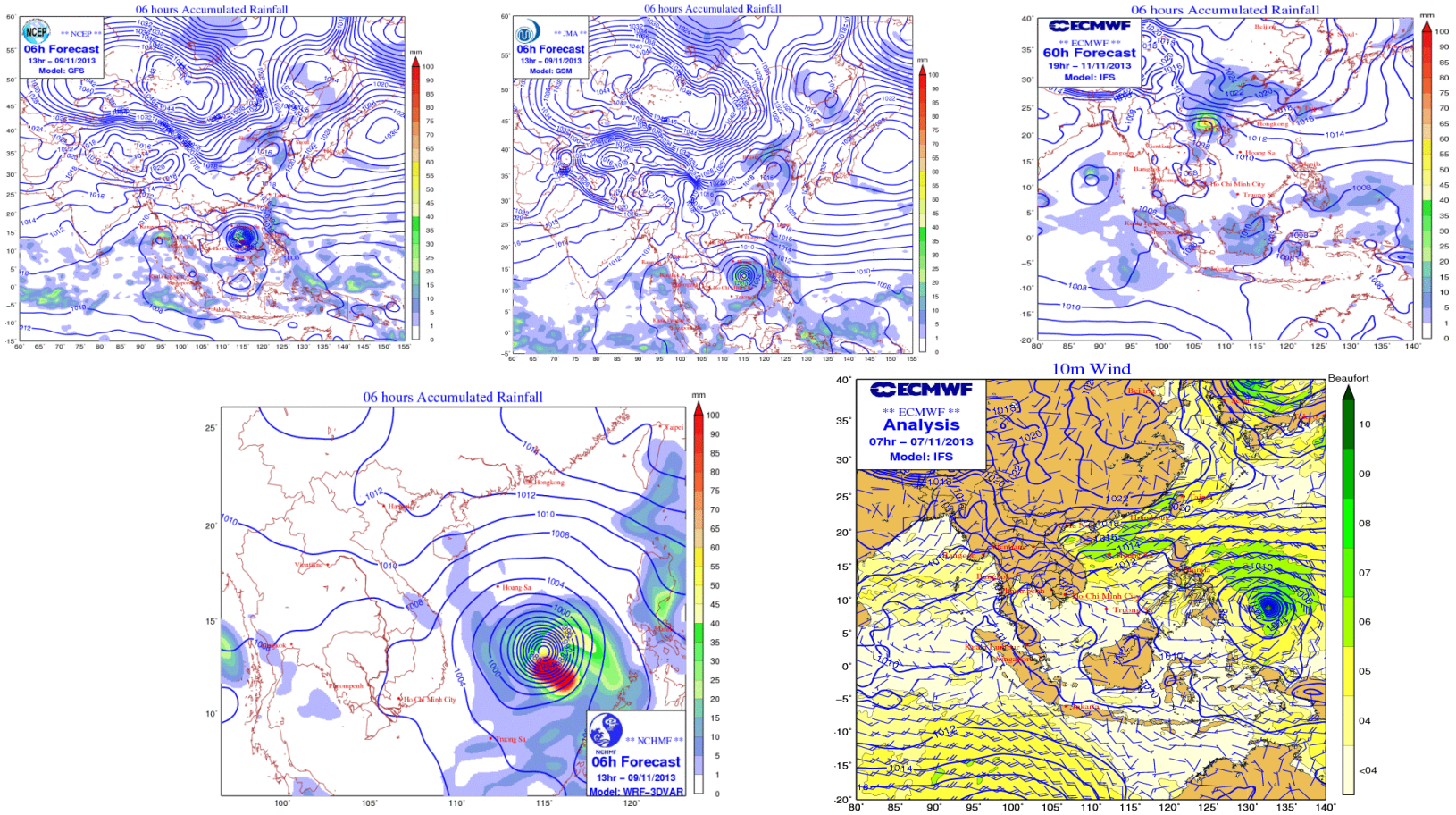
NWP at National Hydro-Meteorological Services in Vietnam

- Global forecast systems
  - The Japanese Global Spectral Model (GSM), 4 cycles/day, 0.5 degree horizontal resolution
  - The NOAA Global Forecast System (GFS) , 4 cycles/day, 0.5 degree horizontal resolution
  - The Integrated Forecasting System (IFS) from European Centre for Medium-Range Weather Forecasts (ECMWF) , 2 cycles/day, 9km-14km horizontal resolution

NWP at National Hydro-Meteorological Services in Vietnam

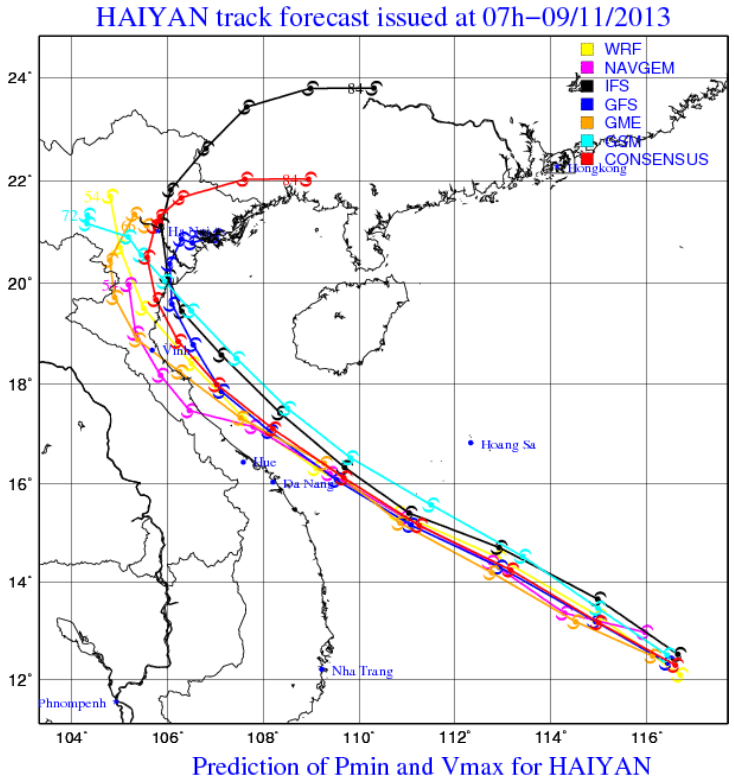
- Regional forecast systems
  - The National Center for Atmospheric Research (NCAR, US) Advanced research of Weather Research and Forecasting model (WRF-ARW), 0.125 degree horizontal resolution
  - WRF-GFS and WRF-GSM take boundary conditions from GFS and GSM respectively

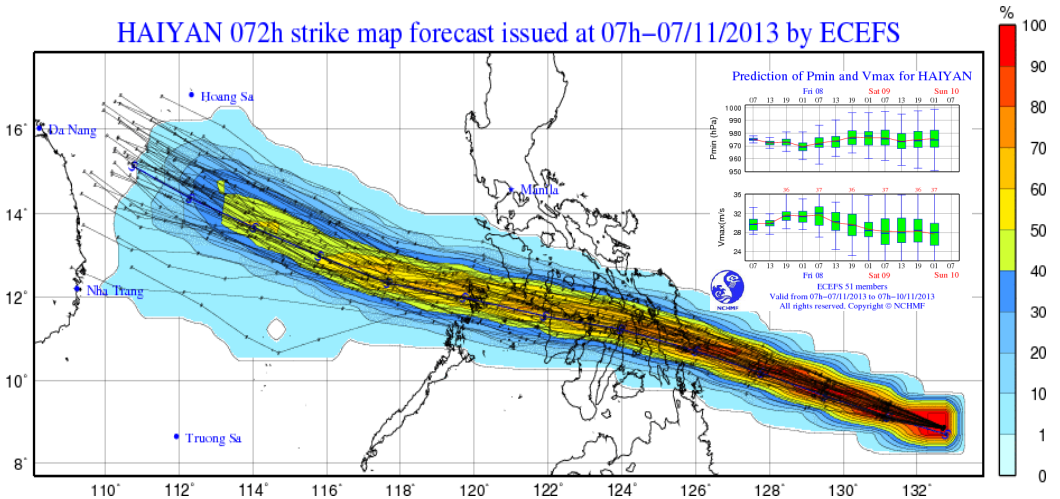
NWP and tropical cyclone forecast

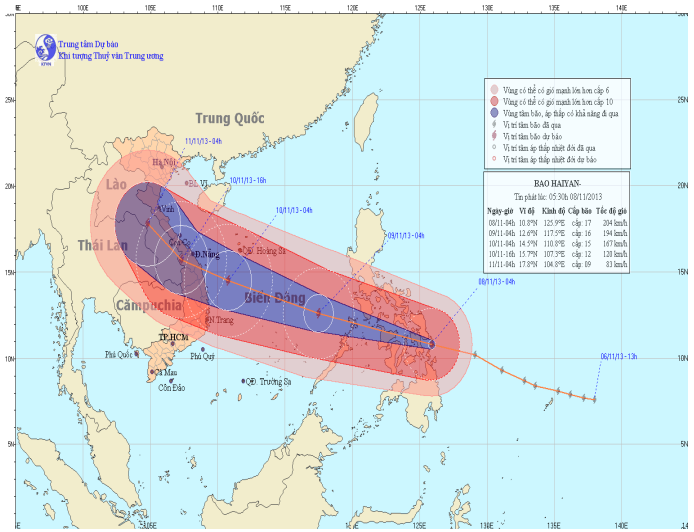


Sea surface pressure and 6h acc. Rainfall forecast for Haiyan TC, 2013

NWP and tropical cyclone forecast (cont.)





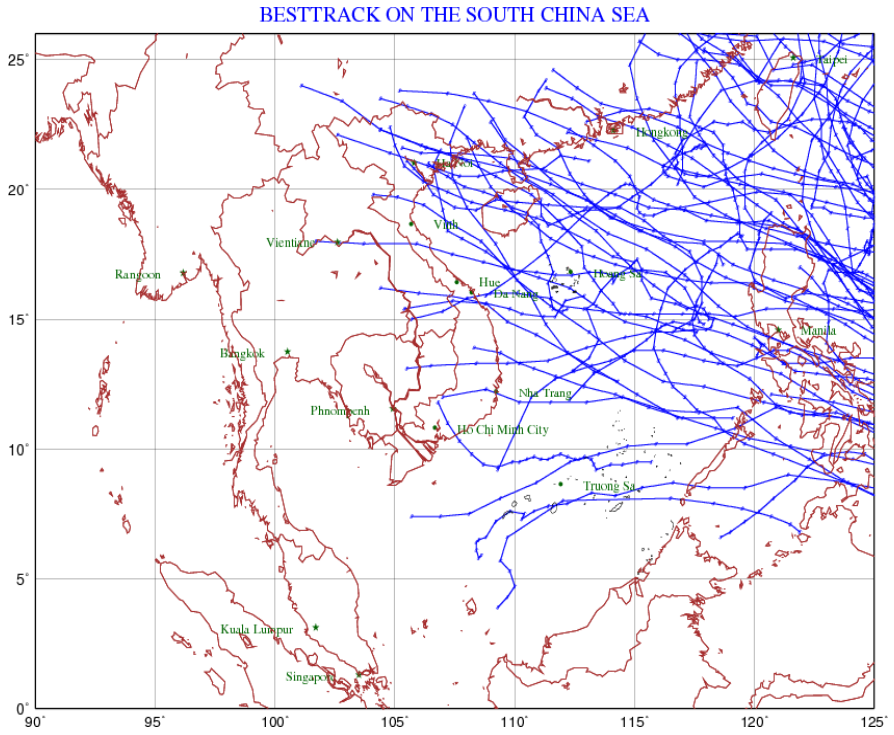


Track Forecast of NHMS valid at
21Z 07 Nov 2013

TC Tracking algorithm

- First guess for center positions from JTWC/RMSC or previous forecast steps.
- Downhill simplex method for finding minimum position from geo-potential fields at 850 and 700 hPa levels and pressure mean sea level
- Multi-checking with u,v wind components, tangential wind and gradient of geo-potential at 850hPa level

Deterministic verification for TC affected Vietnam from 2012-2016



	TC name	Start forecast cycle	End forecast cycle
2012	TALIM	2012061800	2012061900
	DOKSURI	2012062800	2012062900
	VICENTE	2012072012	2012072400
	KAI-TAK	2012081500	2012081700
	TEMBIN	2012082312	2012082612
	GAEMI	2012092900	2012100512
	SON-TINH	2012102412	2012102800
	BOPHA	2012120500	2012120800
	WUKONG	2012122700	2012122800
2013	SONAMU	2013010312	2013010412
	BEBINCA	2013062100	2013062212
	RUMBIA	2013070100	2013070100
	CIMARON	2013071712	
	JEBI	2013073100	2013080212
	MANGKHUT	2013080612	2013080700
	UTOR	2013081112	2013081412
	USAGI	2013092012	2013092200
	WUTIP	2013092712	2013093000
	NARI	2013101112	2013101412
	KROSA	2013103100	2013110312
	HAIYAN	2013110812	2013110912
2014	HAGIBIS	2014061412	
	RAMMASUN	2014071512	2014071900
	KALMAEGI	2014091400	2014091612
	FUNG-WONG	2014091900	
	SINLAKU	2014112800	2014112812
	HAGUPIT	2014120812	2014121100
	JANGMI	2014123012	2014123100
2015	KUJIRA	2015062100	2015062312
	LINFA	2015070500	2015070812
	VAMCO	2015091400	
	DUJUAN	2015092800	
	MUJIGAE	2015100200	2015100400
	MELOR	2015121500	
2016	NEPARTAK	2016070712	2016070800
	MIRINAE	2016072612	
	NIDA	2016073100	2016080112
	DIANMU	2016081800	2016081812
	MERANTI	2016091312	
	AERE	2016100600	2016100900
	SARIKA	2016101512	2016101800
	HAIMA	2016101912	2016102012
	TOKAGE	2016112500	2016112700
	NOCK-TEN	2016122600	2016122700

Deterministic verification for TC affected Vietnam from 2012-2016

- 45 TCs from 2012-2016:
  - 179 forecast cycles from GFS, GSM and IFS models (24h, 48h and 72h forecast ranges)
  - 108 forecast cycles from WRF-GFS and WRF-GSM models (24h and 48h forecast ranges)
- Best track data from Joint Typhoon Warning Center – JTWC, US
- The track forecast error: the distance between a cyclone's forecast position and the best track position at the forecast verification time or the direct positional error (DPE)
- The intensity forecast error (Vmax):
  - the absolute value of the difference between the forecast and best track maximum 10-meter wind at the forecast verifying time
  - Mean errors for bias estimation

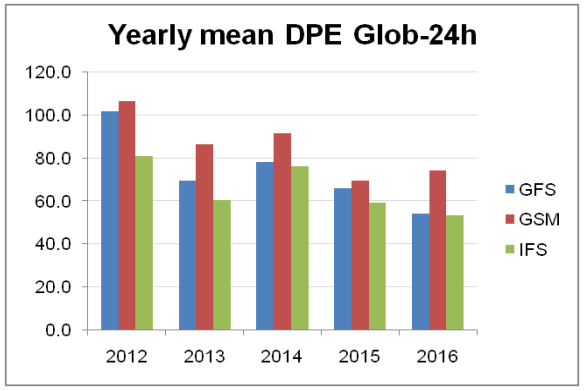
Performances of global models

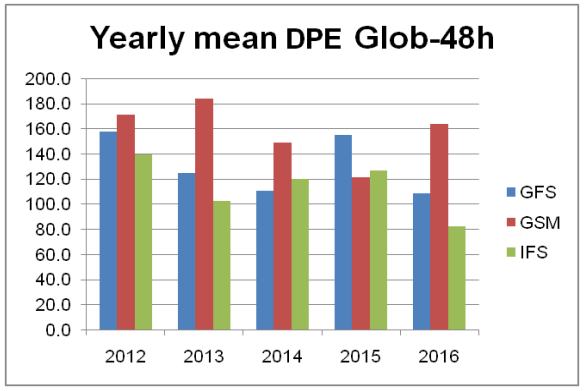
	Mean DPE 24h			Mean Err Vmax 24h		
	GFS	GSM	IFS	GFS	GSM	IFS
2012	101,7	106,6	80,8	8,3	10,6	9,0
2013	69,4	86,4	60,4	8,9	12,5	10,8
2014	78,2	91,5	76,1	9,4	14,3	10,4
2015	65,9	69,4	59,1	7,6	7,7	7,1
2016	53,9	74,2	53,2	6,5	7,9	7,5

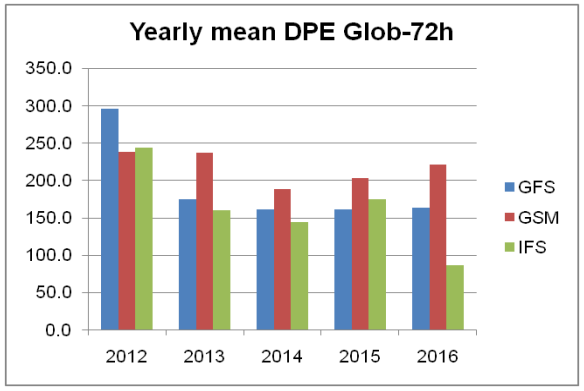
	Mean DPE 48h			Mean Err Vmax 48h		
	GFS	GSM	IFS	GFS	GSM	IFS
2012	157,7	171,2	139,4	8,5	12,1	10,2
2013	124,9	184,0	102,6	10,3	13,0	10,9
2014	110,3	148,9	119,8	10,6	13,6	12,6
2015	155,0	121,5	126,6	10,0	10,6	10,4
2016	108,4	163,9	82,4	5,9	7,4	7,9

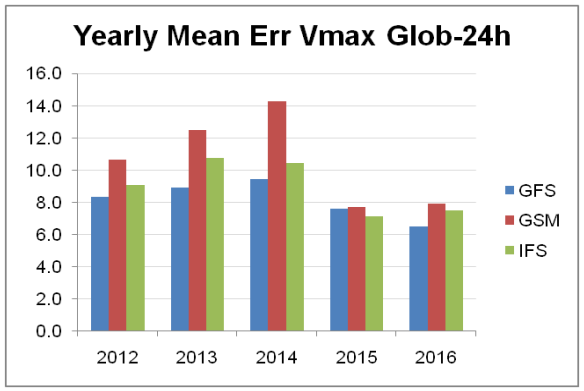
	Mean DPE 72h			Mean Err Vmax 72h		
	GFS	GSM	IFS	GFS	GSM	IFS
2012	295,3	237,7	243,5	10,1	16,5	12,5
2013	174,2	236,6	160,0	9,8	11,4	10,5
2014	161,4	188,4	143,7	10,0	12,9	13,4
2015	160,3	202,7	174,7	11,5	9,3	12,3
2016	163,5	220,8	86,2	8,1	10,6	5,6

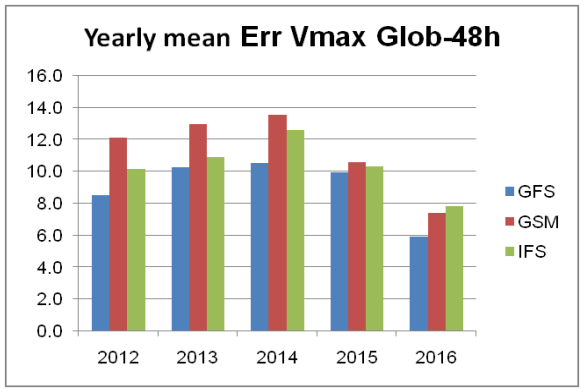
Performances of global models

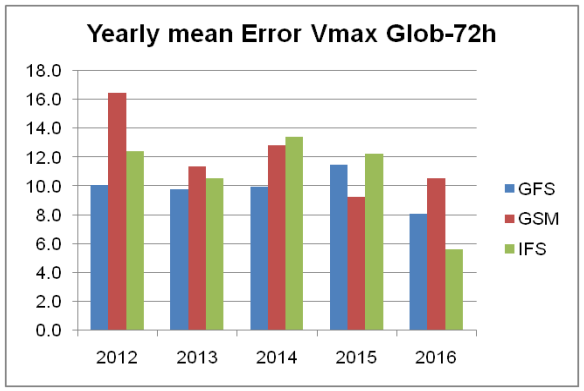




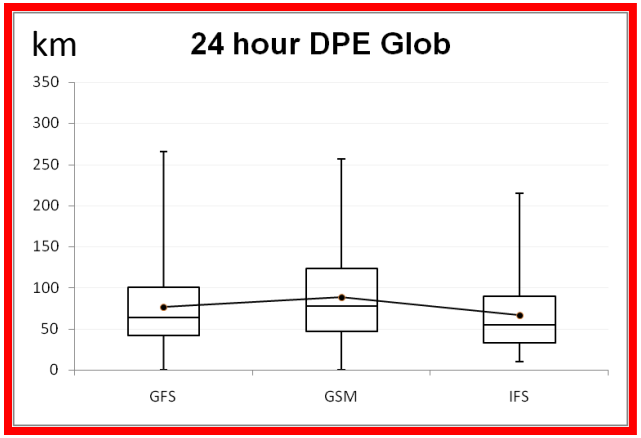




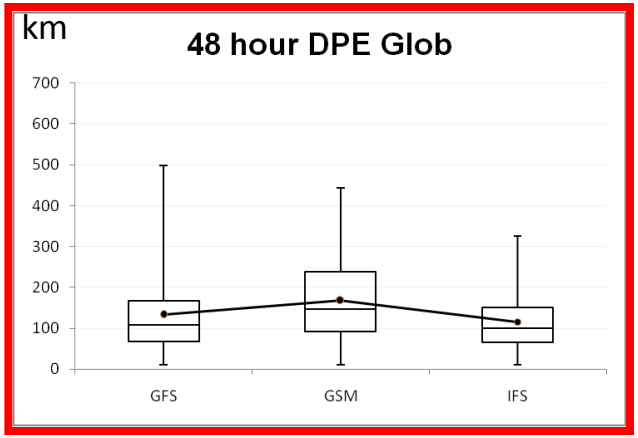


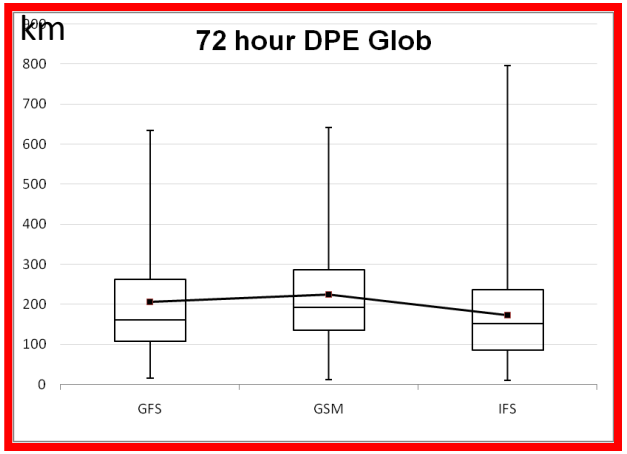


Performances of global models: track errors



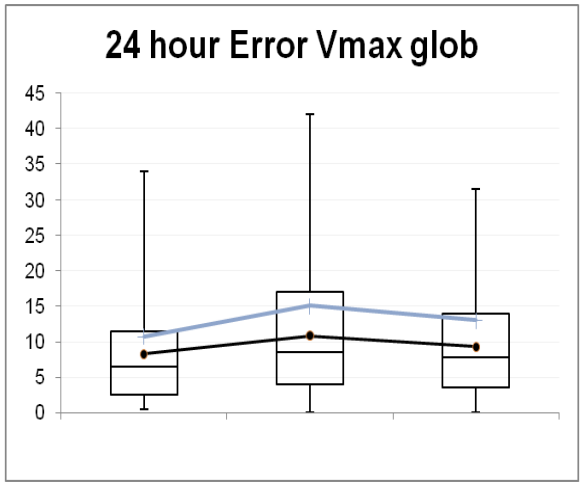
24h ~ 75 km (IFS, GFS, GSM)
48h ~ 140 km (IFS, GFS, GSM)
72h ~ 190 km (IFS, GFS, GSM)

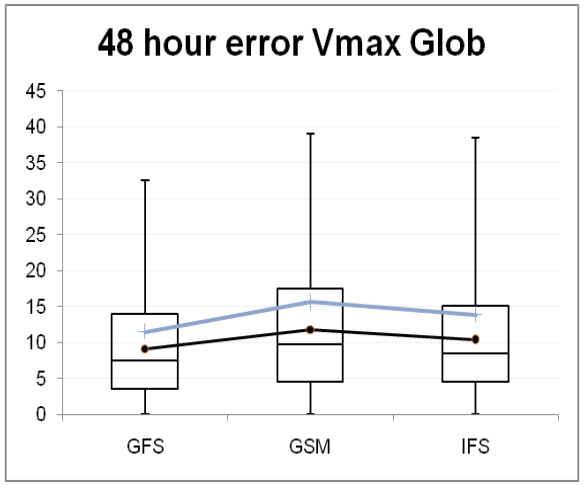


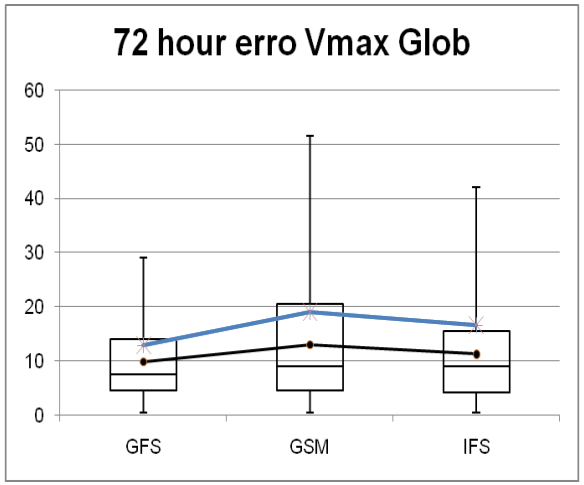


Dot line: mean errors
Box: min, max, 25%, 50% and 75%

Performances of global models: intensity errors



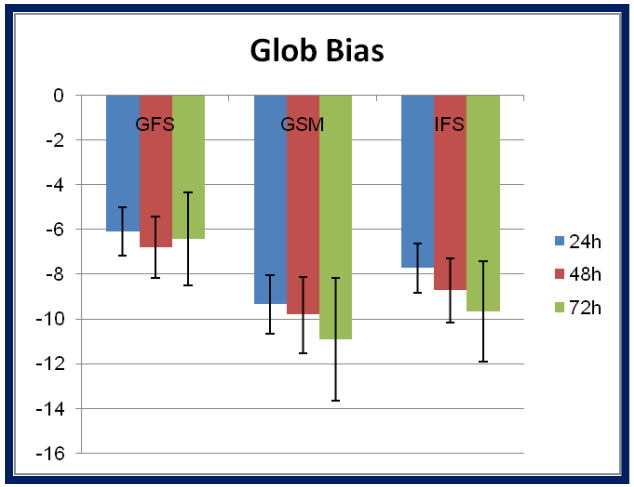




24h ~ 9.2 m/s (GFS, IFS, GSM)
48h ~ 10.3 m/s (GFS, IFS, GSM)
72h ~ 10.9 m/s (GFS, IFS, GSM)

Vmax > 24.4 m/s

24h ~ 12.8 m/s (GFS, IFS, GSM)
48h ~ 13.6 m/s (GFS, IFS, GSM)
72h ~ 16.1 m/s (GFS, IFS, GSM)

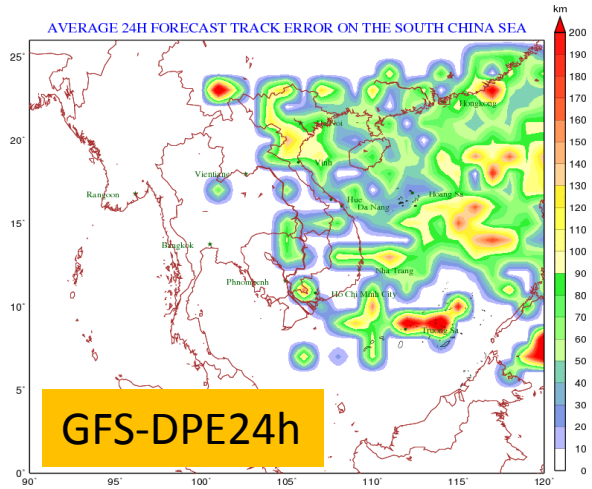


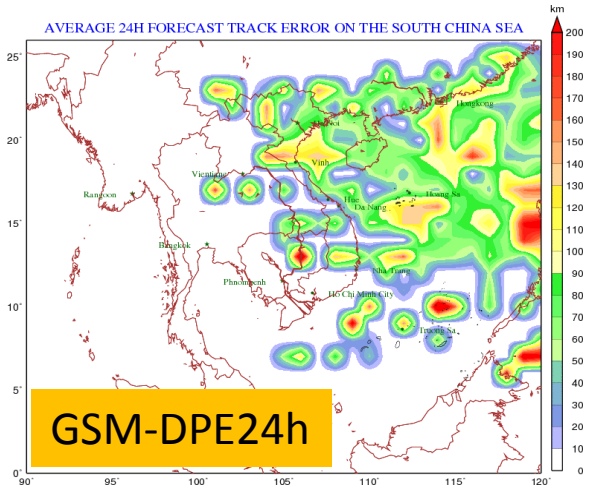
Black dot line: mean errors

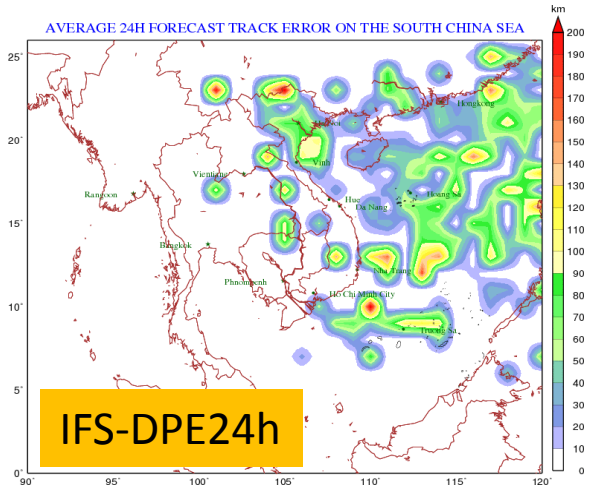
Blue dot line: mean errors for Vmax > 24.4 m/s

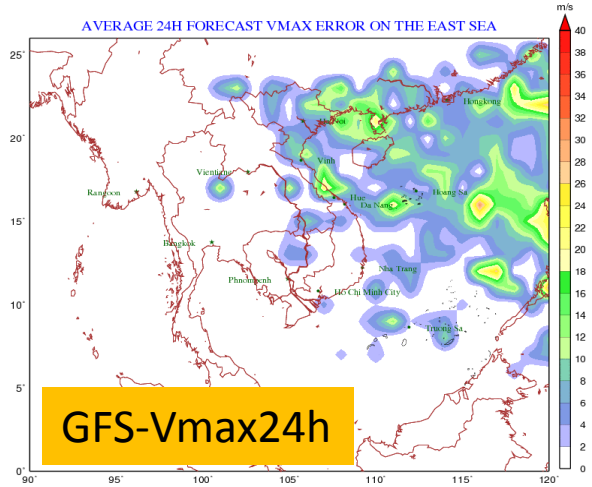
Box: min, max, 25%, 50% and 75%

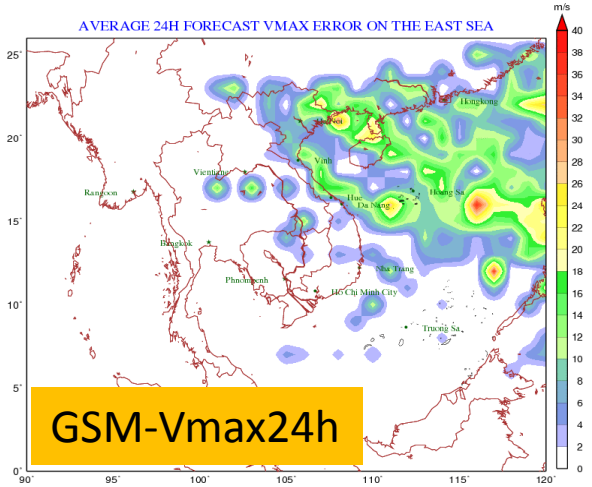
Performances of global models: spatial distribution

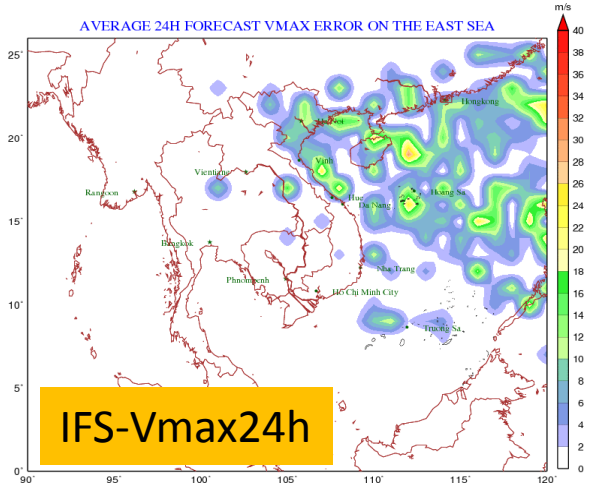




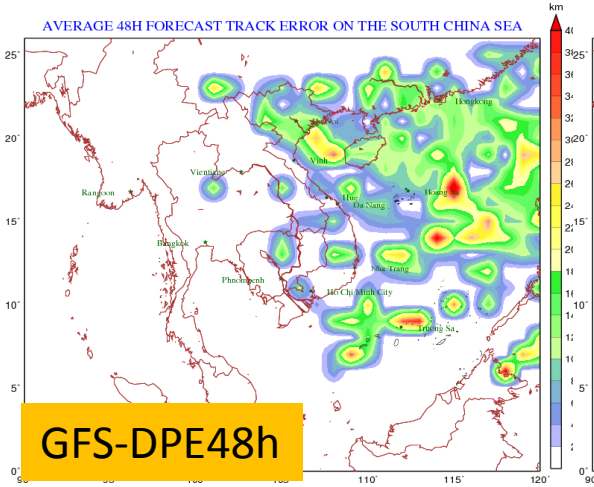


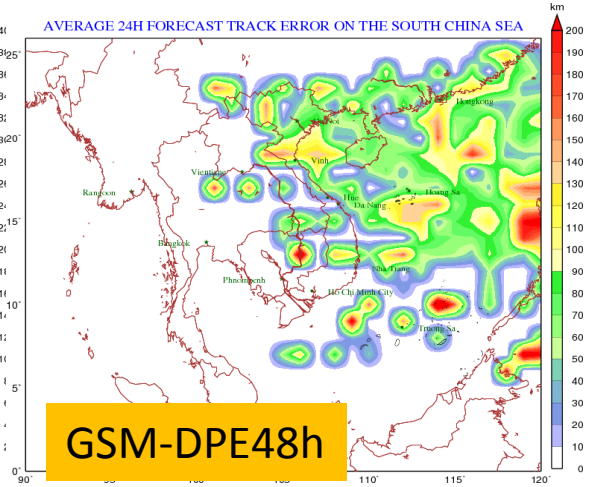


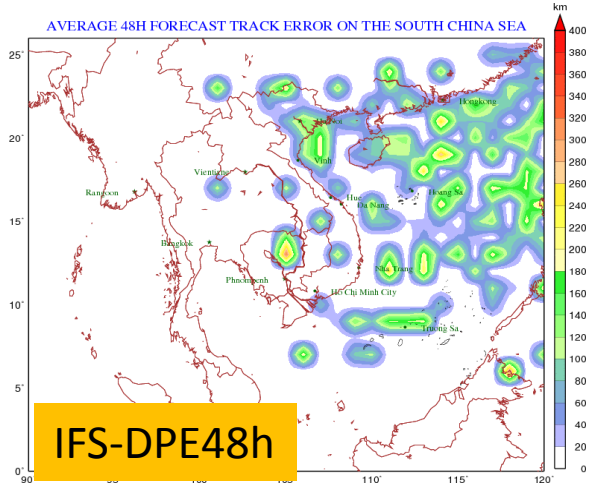


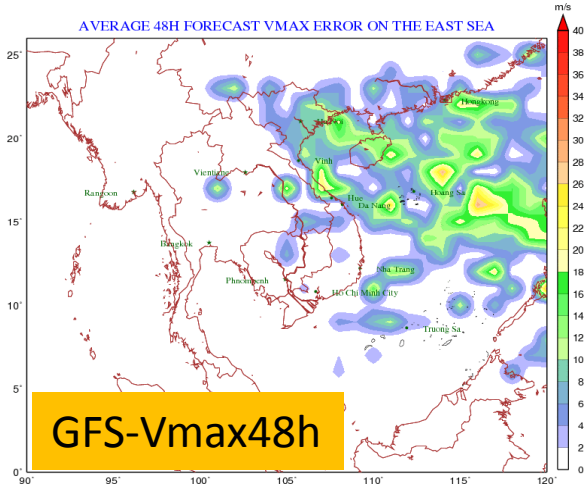


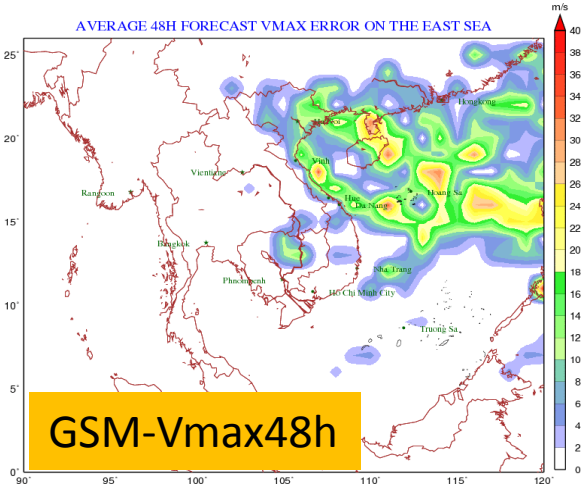
Performances of global models: spatial distribution

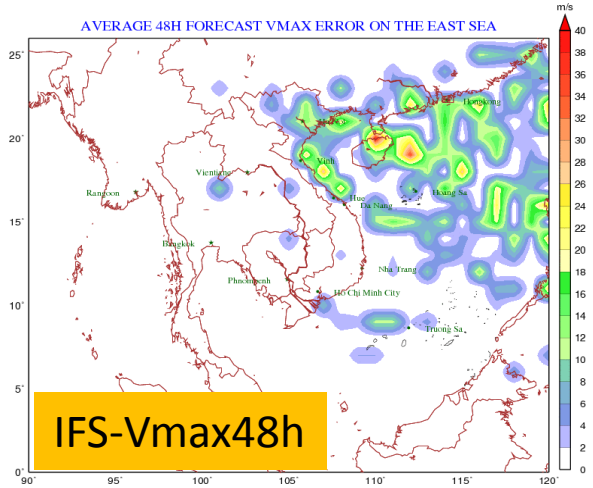




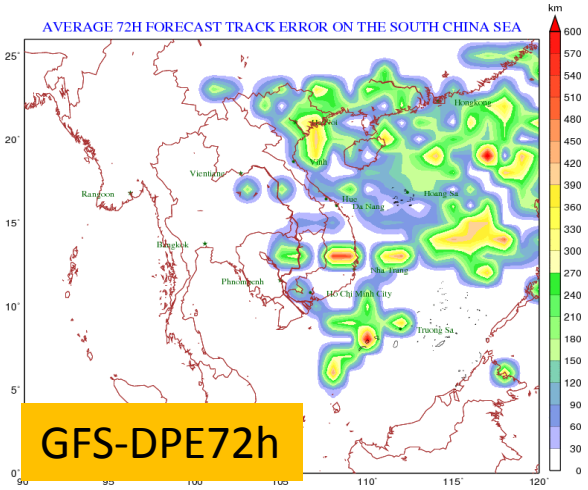


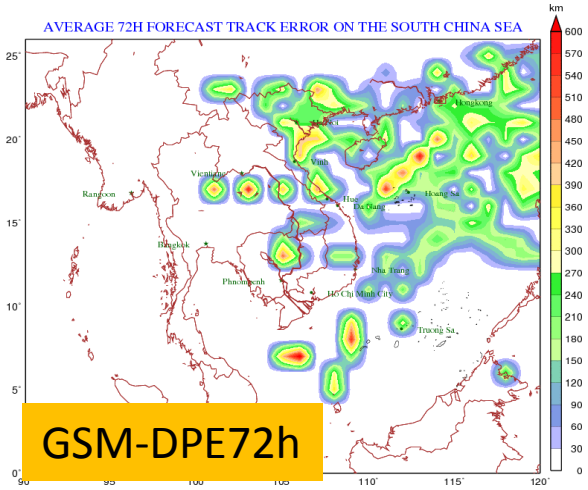


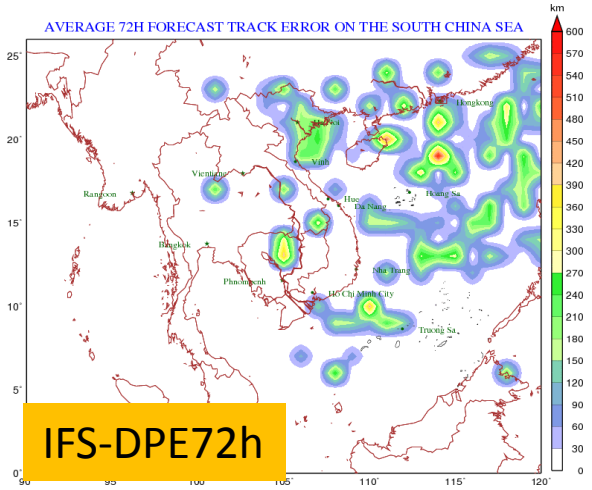


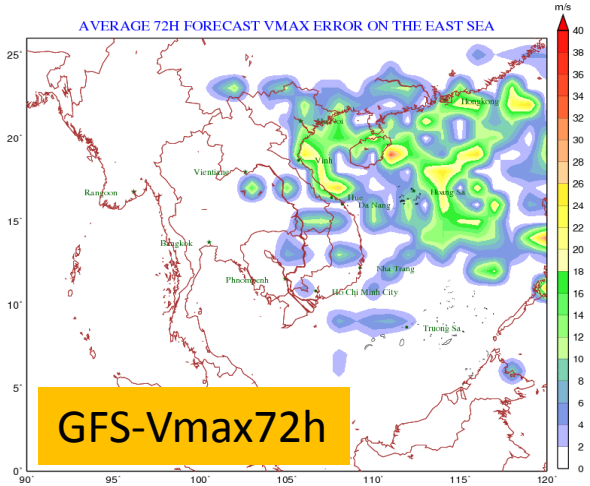


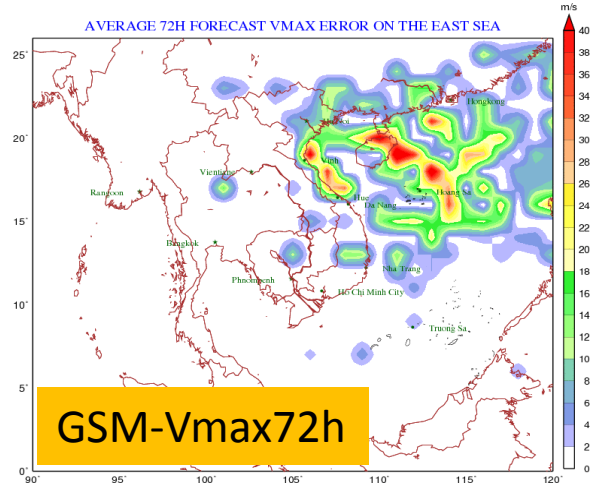
Performances of global models: spatial distribution

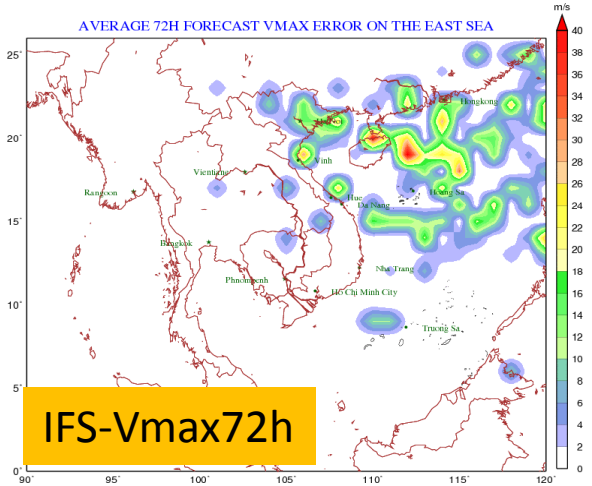






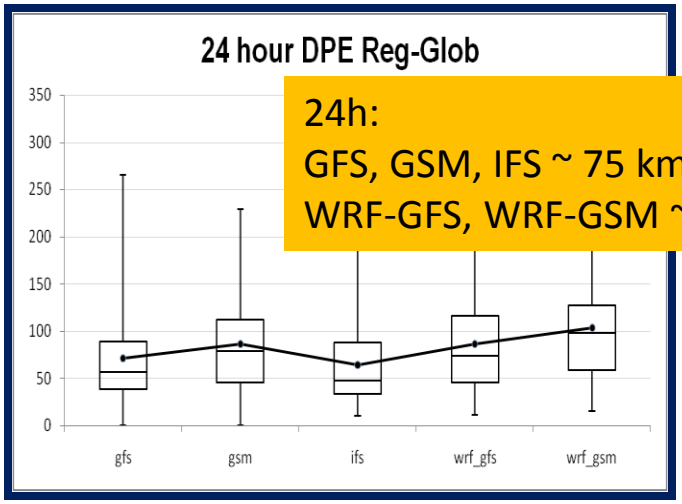






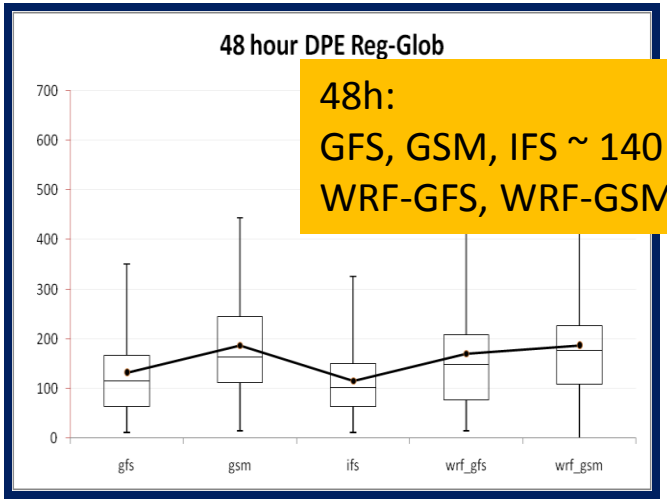
Comparison of regional models vs. global models: track errors

Mean DPE 24h Reg vs. Glob					
	GFS	GSM	IFS	WRF_GFS	WRF_GSM
2012	89,6	101,4	80,1	85,1	110,0
2013	71,5	88,2	61,3	83,0	103,6
2014	79,5	96,2	79,3	84,4	104,7
2015	65,8	72,0	60,9	135,7	160,6
2016	55,0	72,9	50,3	70,2	66,1



24h:
GFS, GSM, IFS ~ 75 km
WRF-GFS, WRF-GSM ~ 100km

Mean DPE 48h Reg vs. Glob					
	GFS	GSM	IFS	WRF_GFS	WRF_GSM
2012	119,3	186,7	144,1	130,4	157,9
2013	140,7	209,4	102,5	195,9	207,9
2014	102,1	145,4	126,8	115,6	163,1
2015	176,3	153,3	134,7	287,5	273,3
2016	116,0	201,0	88,0	109,8	107,0

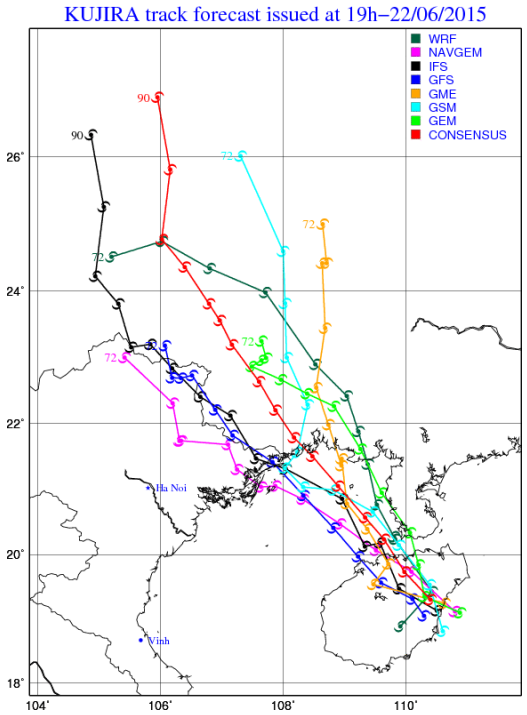


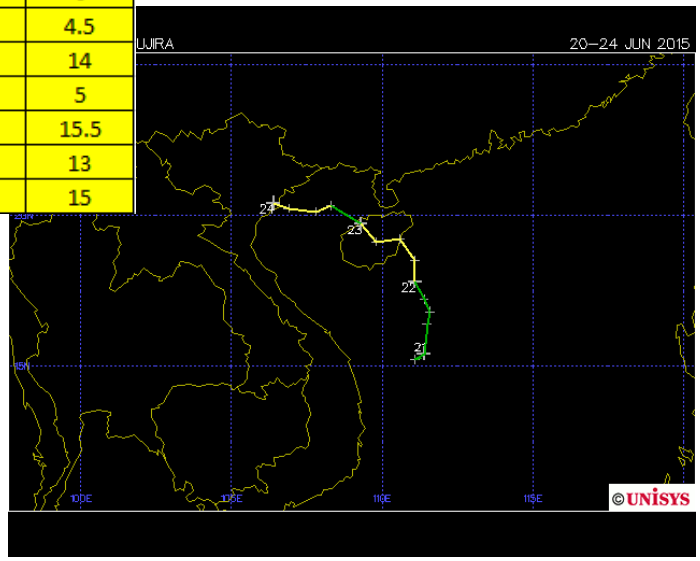
48h:
GFS, GSM, IFS ~ 140 km
WRF-GFS, WRF-GSM ~ 170 km

Track and intensity errors for 2015

Reg-Glob		gfs	gsm	ifs	wrf_gfs	wrf_gsm	gfs	gsm	ifs	wrf_gfs	wrf_gsm
name		error24					error_vmax24				
KUJIRA	2015062100	101.14	33.61	33.63	185.95	190.82	8.5	7.5	5	6	6
KUJIRA	2015062112	107.47	38.59	10.51	168.54	114.43	5.5	3	5	2.5	4
KUJIRA	2015062200	104.09	80.46	78.73	203.5	232.92	2.5	1	2	4	1
KUJIRA	2015062212	99.64	137.1	145.05	203.34	314.07	1	1	1.5	1.5	3.5
KUJIRA	2015062300	59.36	78.53	108.36	249.82	254.7	3.5	5	4.5	4.5	8
KUJIRA	2015062312	44.48	99.6	78.54	227.64	251	1.5	0.5	3.5	2	1.5
VAMCO	2015091400	78.58	69.69	101.05	108.76	108.76	2.5	2	1.5	1	0
MUJIGAE	2015100200	63.31	74.67	47.73	73.86	161.85	2.5	10.5	7	5	10.5
MUJIGAE	2015100212	53.59	39.41	11.12	76.63	53.56	2	12	8	3	7
MUJIGAE	2015100300	11.12	0	11.12	45.68	55.6	15.5	20.5	24	12.5	16
MUJIGAE	2015100312	55.6	78.52	38.13	73.52	15.17	17.5	17	20	19.5	17.5
MELOR	2015121500	11.12	133.71	66.72	11.12	174.23	6	8	4	1.5	2.5

Reg-Glob	gfs	gsm	ifs	wrf_gfs	wrf_gsm	gfs	gsm	ifs	wrf_gfs	wrf_gsm
name	error48					error_vmax48				
KUJIRA	292.88	104.09	94.9	438.48	394.33	3	1	0.5	0.5	0
KUJIRA	348.54	228.81	142.36	412.17	507.16	6.5	0.5	0	3.5	4.5
KUJIRA	210.77	153.9	252.38	490.65	389.26	9.5	7	8.5	12.5	14
KUJIRA	143.1	252.23	158.73	447.23	368.25	0	3	0.5	3	5
MUJIGAE	53.43	53.27	30.49	72.96	165.69	19	30	22.5	9.5	15.5
MUJIGAE	61.48	112.67	102.91	113.3	65.82	11	21.5	12.5	17	13
MUJIGAE	124.02	168.05	160.97	37.8	22.24	12	17	14	14	15





Comparison of regional models vs. global models: intensity errors

Mean Err Vmax 24h Reg vs. Glob

	GFS	GSM	IFS	WRF_GFS	WRF_GSM
2012	12,1	15,7	12,6	10,9	11,3
2013	9,0	12,7	10,9	7,7	10,0
2014	10,0	15,3	10,7	9,7	13,2
2015	5,7	7,3	7,2	5,3	6,5
2016	6,1	8,0	6,7	4,6	4,2

24h:

GFS, GSM, IFS ~ 10 m/s

WRF-GFS, WRF-GSM ~ 8.3 m/s

48h:

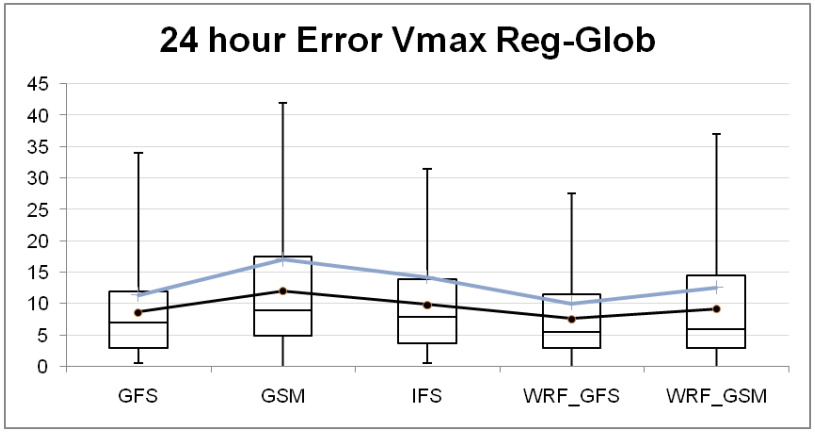
GFS, GSM, IFS ~ 11.4 m/s

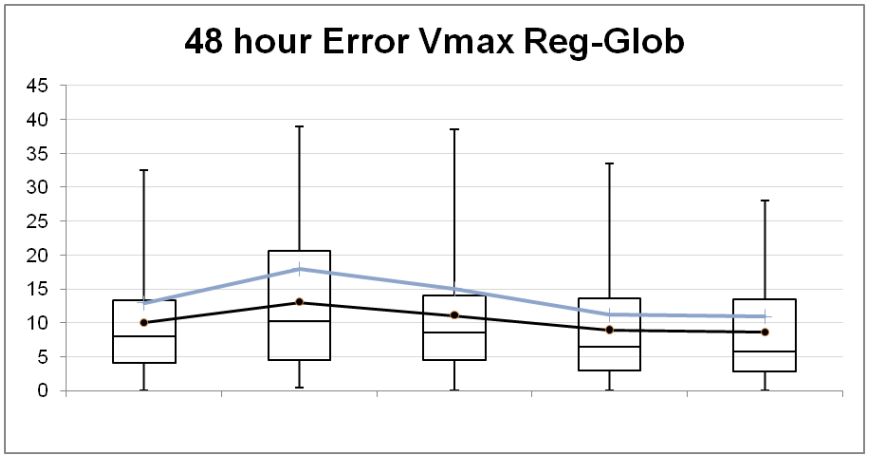
WRF-GFS, WRF-GSM ~ 9.2 m/s

Mean Err Vmax 48h Reg vs. Glob

	GFS	GSM	IFS	WRF_GFS	WRF_GSM
2012	16,1	21,5	17,7	16,8	15,4
2013	9,2	11,8	10,1	7,1	6,8
2014	11,8	14,6	13,4	11,2	10,7
2015	8,7	11,4	8,4	8,6	9,6
2016	4,3	6,7	6,1	3,1	3,1

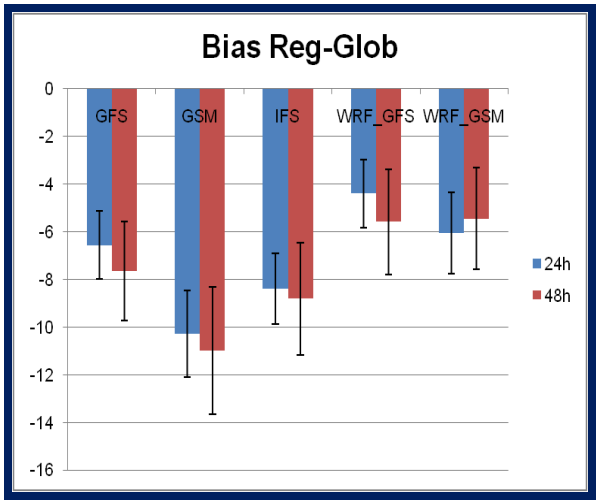
Comparison of regional models vs. global models: intensity errors





Vmax > 24.4 m/s

24h:
GFS, IFS, GSM ~ 14.2 m/s
WRF-GFS, WRF-GSM ~ 11.2 m/s
48h:
GFS, IFS, GSM ~ 15.3 m/s
WRF-GSM, WRF-GFS ~ 11.0 m/s



Black dot line: mean errors
Blue dot line: mean errors for Vmax > 24.4 m/s
Box: min, max, 25%, 50% and 75%

Remarked conclusions

- Global systems:
  - IFS shows the best forecast of track at 24h, 48h and 72h and most confident compared to GFS and GSM
  - GFS has lowest intensity error compare to GSM and IFS at 24h, 48h and 72h
  - Almost intensity forecast from global models is under estimation (minus bias)
- Regional systems:
  - There is no improvement of track forecast from regional system compare to global system at 24h and 48h forecast ranges
  - Regional systems can significantly reduce both intensity forecast error and bias at 24h and 48h forecast ranges

Thank you very much