WGNE intercomparison of Tropical Cyclone Track forecast, 2011

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5-9 Nov. 2012, Toulouse

WGNE-28

VERIFICATION OF GLOBAL MODELS

History of the Project

- 1991 : commencement with three centers: ECMWF, UKMO and JMA. The verification area was only western North Pacific.
- 1994 : CMC joined.
- 1999 : Verification for the North Atlantic started.
- 2000 : DWD joined. Verification for the eastern North Pacific started.
- 2002 : Verification for 2 Southern Hemispheric regions, north Indian Ocean and the Central Pacific started.
- 2003 : NCEP and BoM joined. A website for this intercomparison project was launched.
- 2004 : Meteo-France and CMA joined.
- 2006 : CPTEC and NRL joined.
- 2011 : KMA joined. CMA came back.

2012: 11 NWP centers participated in the project.
〔BOM CMA CMC DWD ECMWF JMA KMA France NCEP NRL UKMO 〕

Specification of Data

NWP centers	Participate Year	Bogus data	Horizontal Res. of provided data	Model Res. as of 2011
BoM	2003	-	1.25x0.833	80kmL50
CMA	2004	used	1.25x1.25	T_L639L60
CMC	1994	-	1.0x1.0	33km L60
DWD	2000	-	0.36x0.36(2010) 0.25x0.25(2011)	30kmL60
ECMWF	1991	-	0.25x0.25(2010) 0.125x0.125(2011)	T_L1279L91
JMA	1991	used in WNP	0.5x0.5(2010) 0.125x0.125(2011)	T_L959L60
KMA	2011	used	1.25x1.25	40kmL50→ 25kmL70(23 May ~)
France	2004	used*	0.5x0.5	T_L798C2.4L70
NCEP	2003	used in rare case	1.0x1.0	T574 L64
NRL**	2006	used	1.0x1.0	T239L30
UKMO	1991	used	0.3515x0.2345	25kmL70

* except for South Pacific and north Indian-Ocean

**Data from July 2011 to October 2011 are almost missing.

Method of TC verification using MSLP

TCs to be verified

TCs which intensity reached tropical storm (TS) with the maximum sustained wind of 34 knots or stronger are set as targets for this verification. The tropical depression (TD) stage of the targeted TCs is also included in this verification. However, the TCs which stayed at TD level all through their life are excluded.

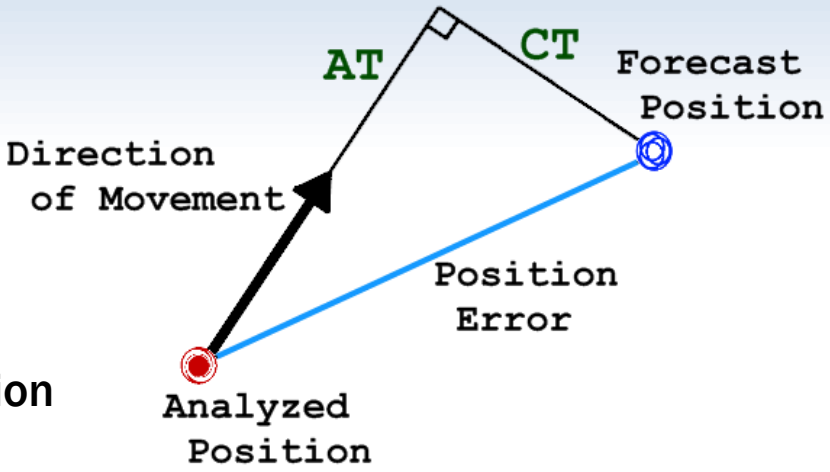
1. Tracking Method

local pressure minimum;

a) First position (FT +0hr) : search from the best track position
b) Second position (FT +12hr) : search from the first position
c) Third and after (FT +24hr~) : search from estimated position from the latest two positions

(all position searched within 500km radius)

2. Verification Method



- **Position Error〔km〕**

  The distance between
  the best-track (analyzed) position
  and the forecast position.

- **Along Track – Cross Track bias**

  AT(along-track)-bias : The bias in the direction of TC movement

  CT(cross-track)-bias : The bias in the rectangular direction of TC movement

- **Detection Rate〔%〕**

  Detection Rate (t) = A(t)/ B(t)

A(t) : *The number of forecast events in which a TC is analyzed at forecast time t on the condition that a NWP model continuously expresses the TC until the forecast time t.*

B(t) : *The number of forecast events in which a TC is analyzed at forecast time t.*

TC Verification

TC tracks on 2011 season

Northern-Hemisphere [2011/01/01 to 2011/12/31]

Southern-Hemisphere [2010/09/01 to 2011/08/31]

Number of TCs , [best-track data provider]

21 western North-Pacific [RSMC Tokyo]

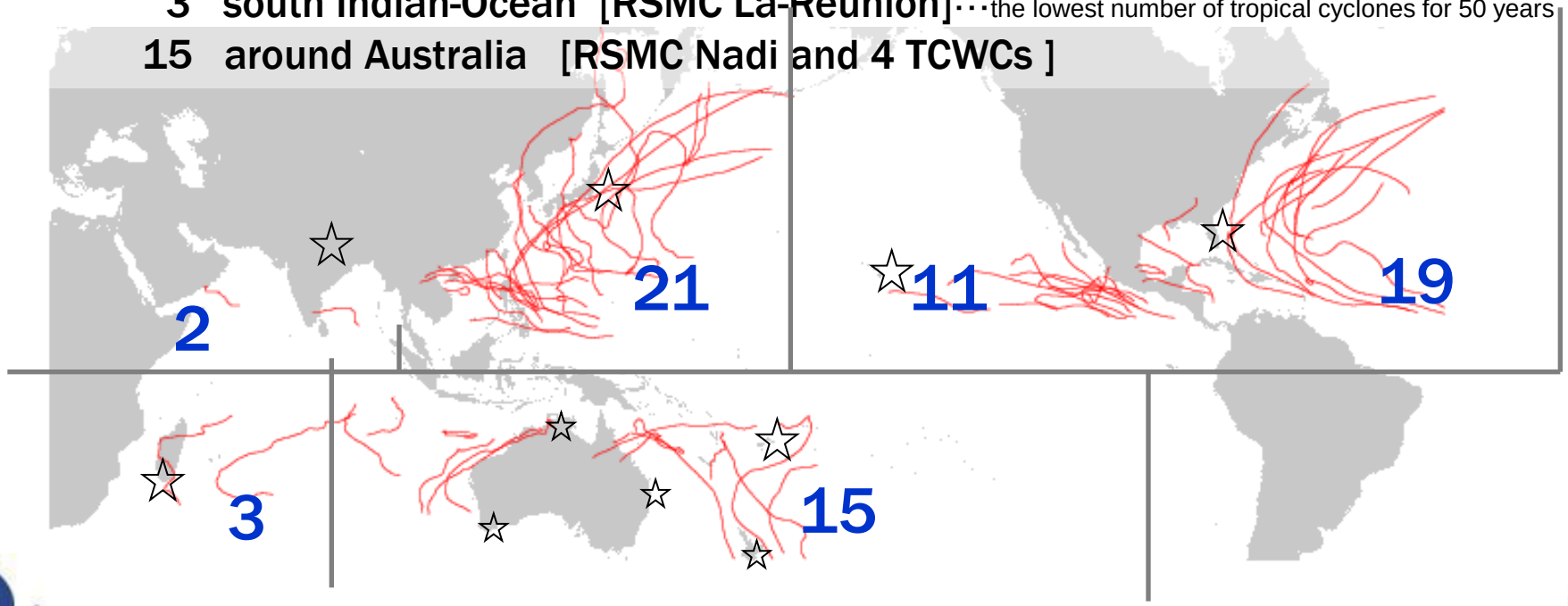
11 eastern North-Pacific (including Central-Pacific) [RSMC Miami, Honolulu]

19 North Atlantic [RSMC Miami]

2 north Indian-Ocean [RSMC New-Delhi]

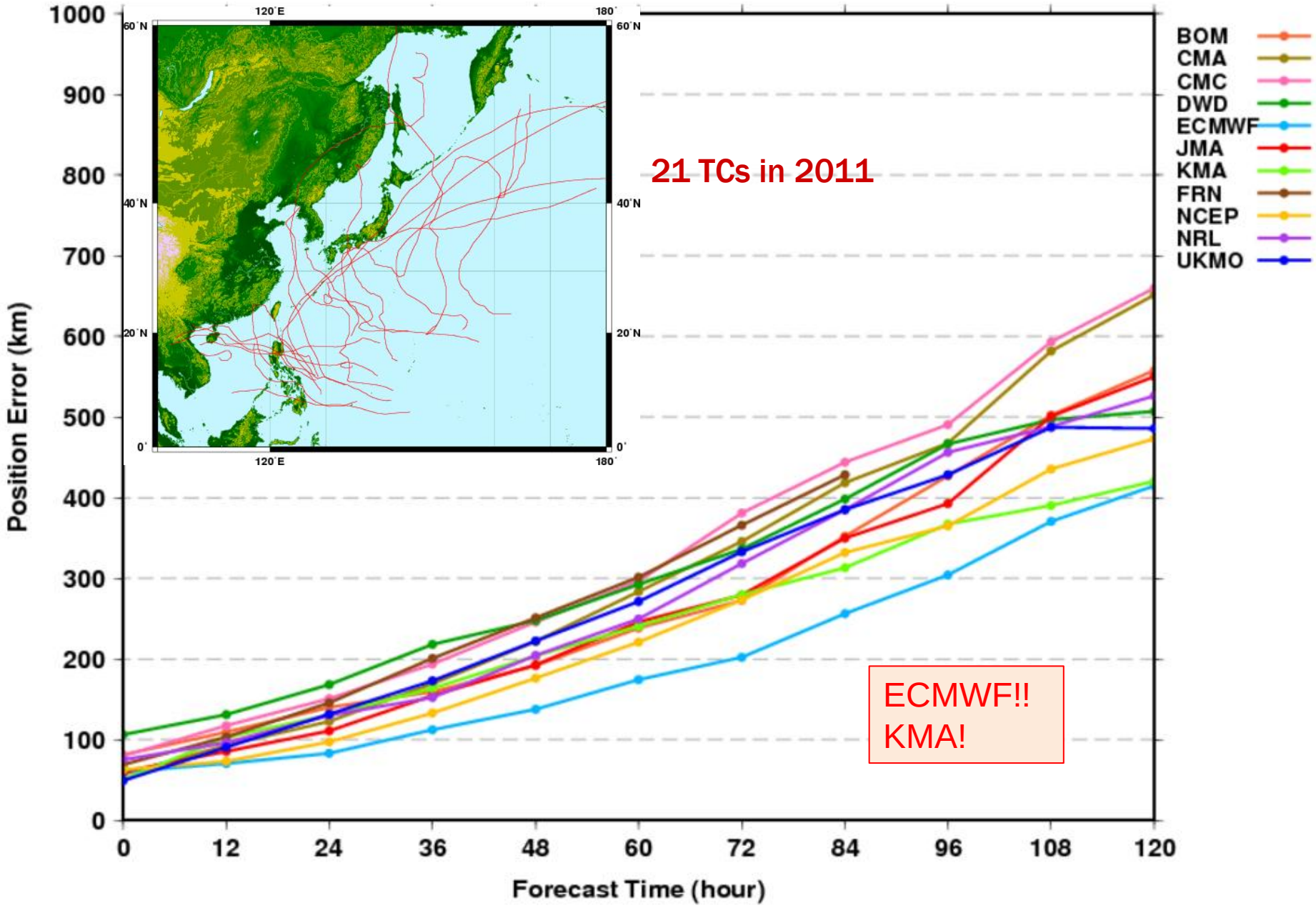
3 south Indian-Ocean [RSMC La-Reunion]…the lowest number of tropical cyclones for 50 years

15 around Australia [RSMC Nadi and 4 TCWCs]

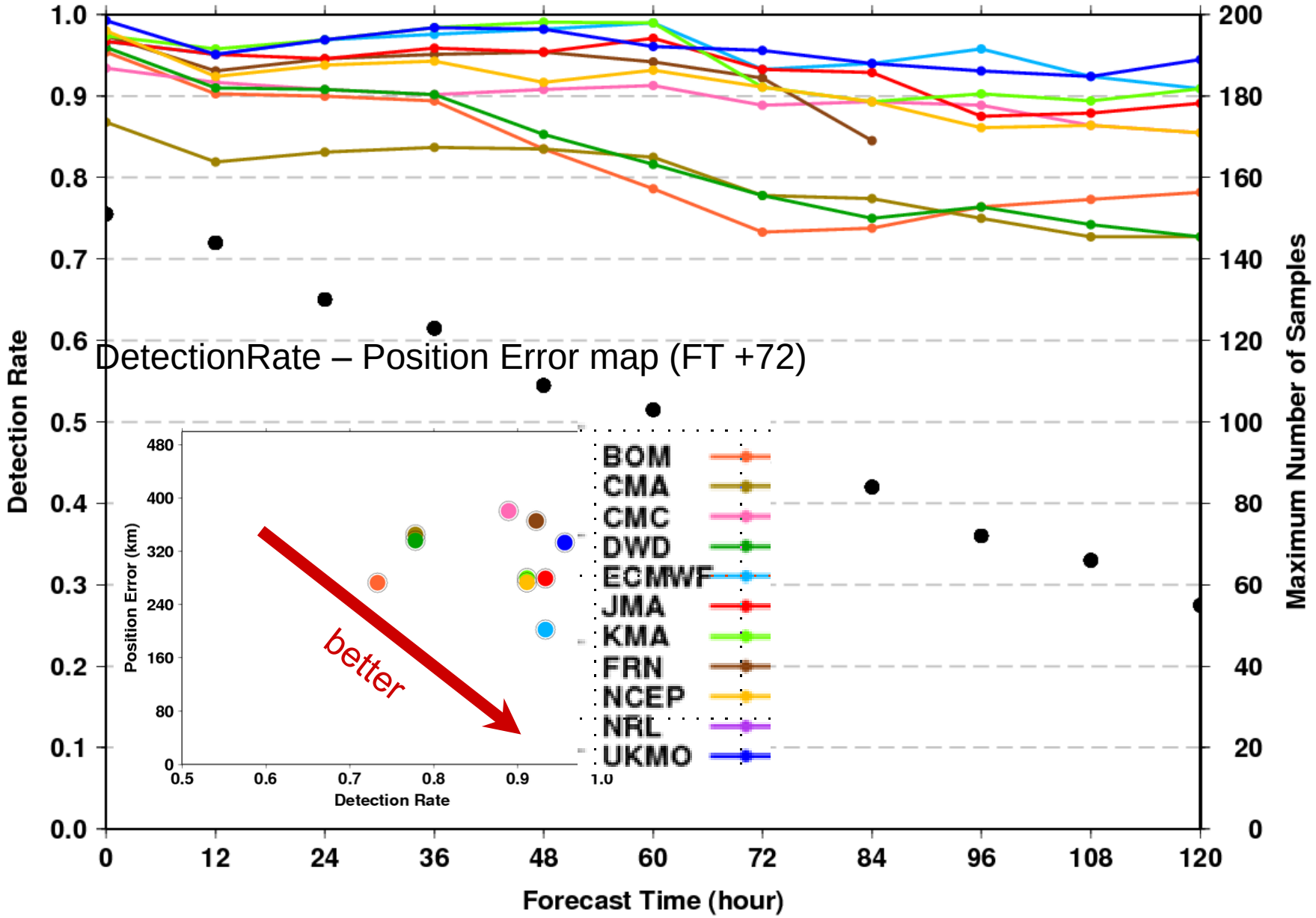


(Except for Errol and Bune
13 typhoons was actually verified)

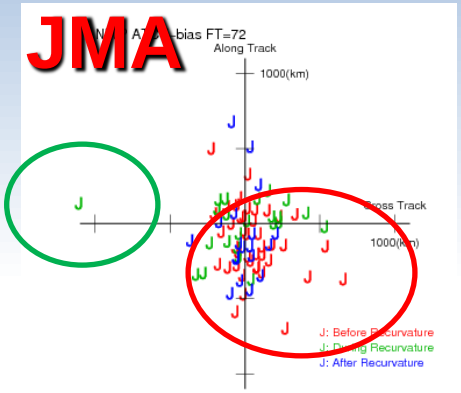
(a) western North-Pacific (WNP) domain Position Error

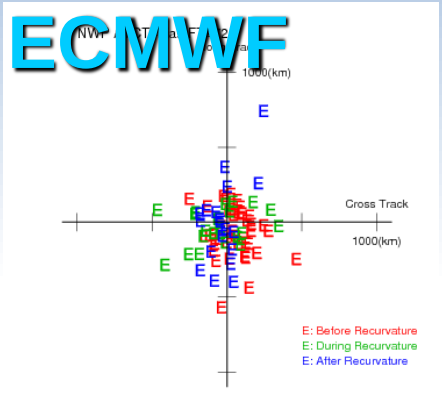


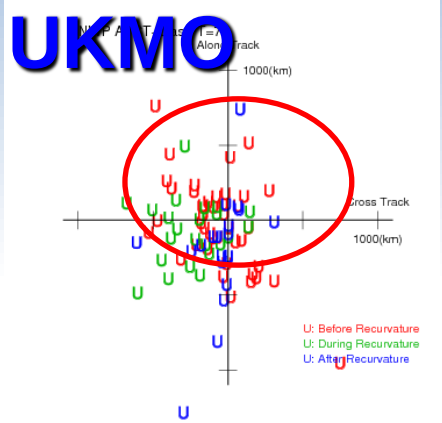
(a) WNP domain Detection Rate

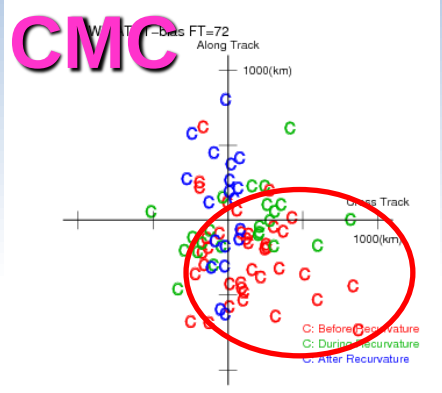


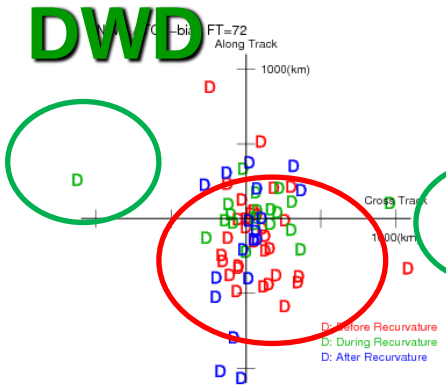
(a) WNP domain AT-CT bias map (FT +72)

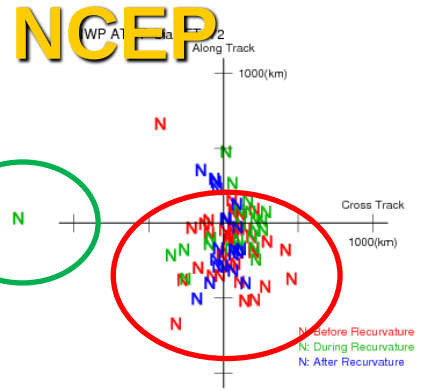


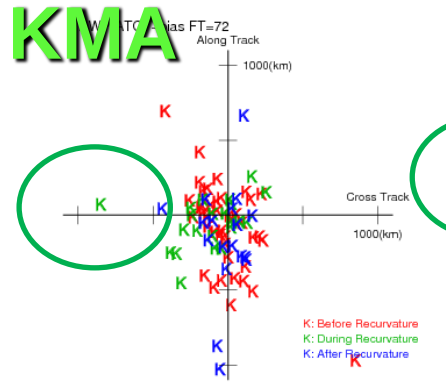


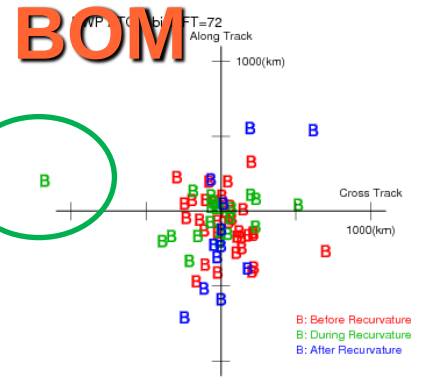


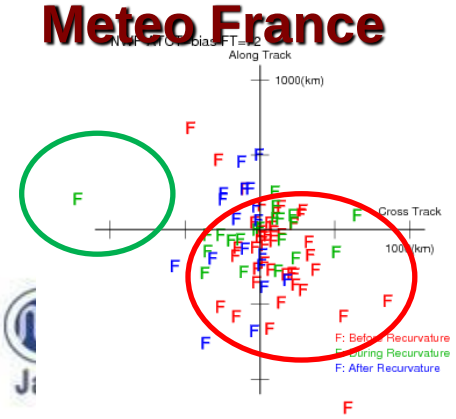


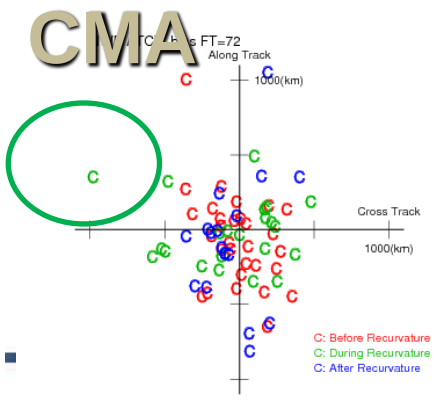












Scatter diagram of TC positions at 72 hour forecast.

Red : Before recurvature

Green : During recurvature

Blue : After recurvature

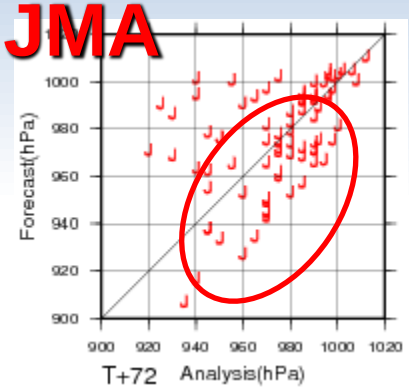
Y-axis represents position errors in Along Track (AT) direction

and X-axis does that in Cross Track (CT) direction.

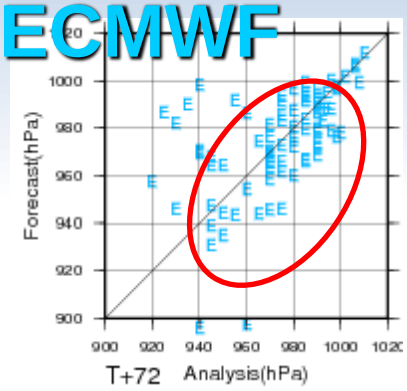
Unit: km

(a) WNP domain Central Pressure scatter diagram (FT +72)

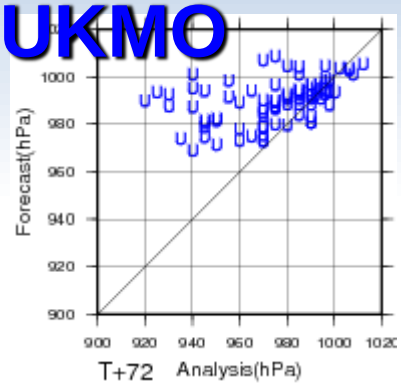
JMA



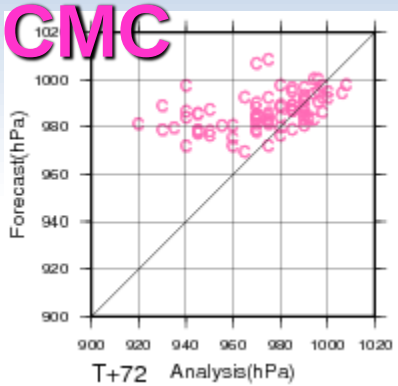
ECMWF



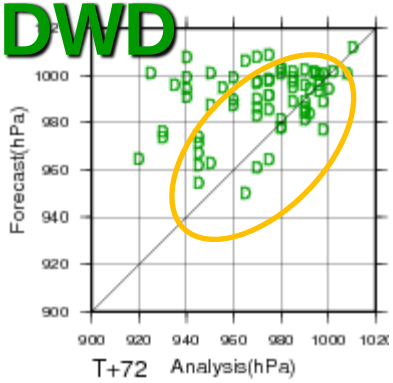
UKMO



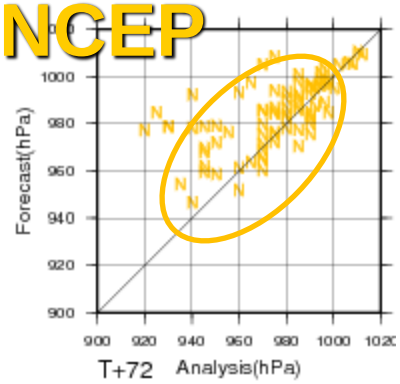
CMC



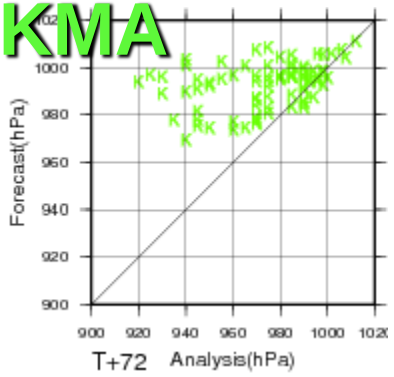
DWD



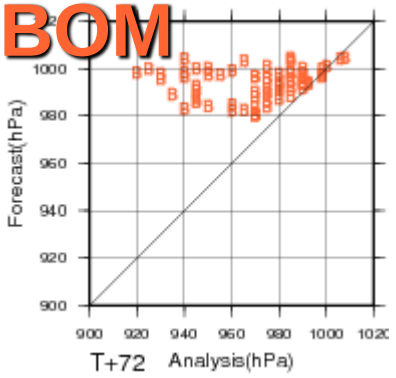
NCEP



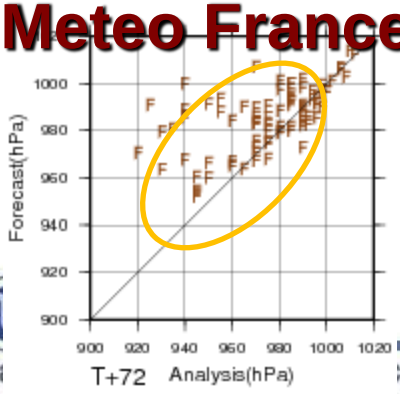
KMA



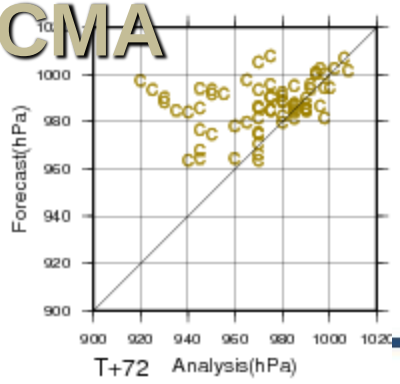
BOM



Meteo France



CMA

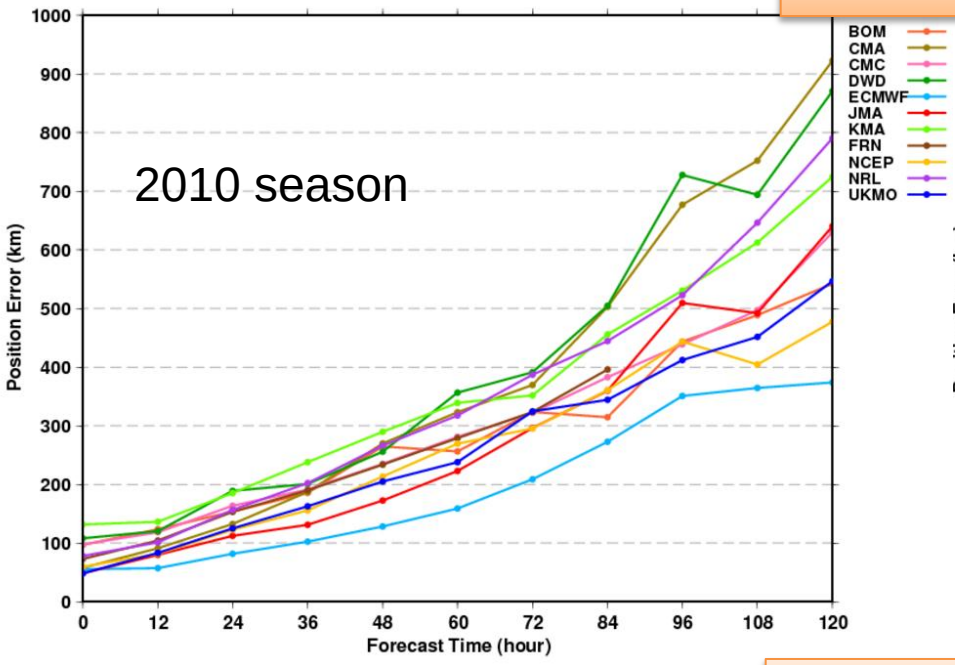


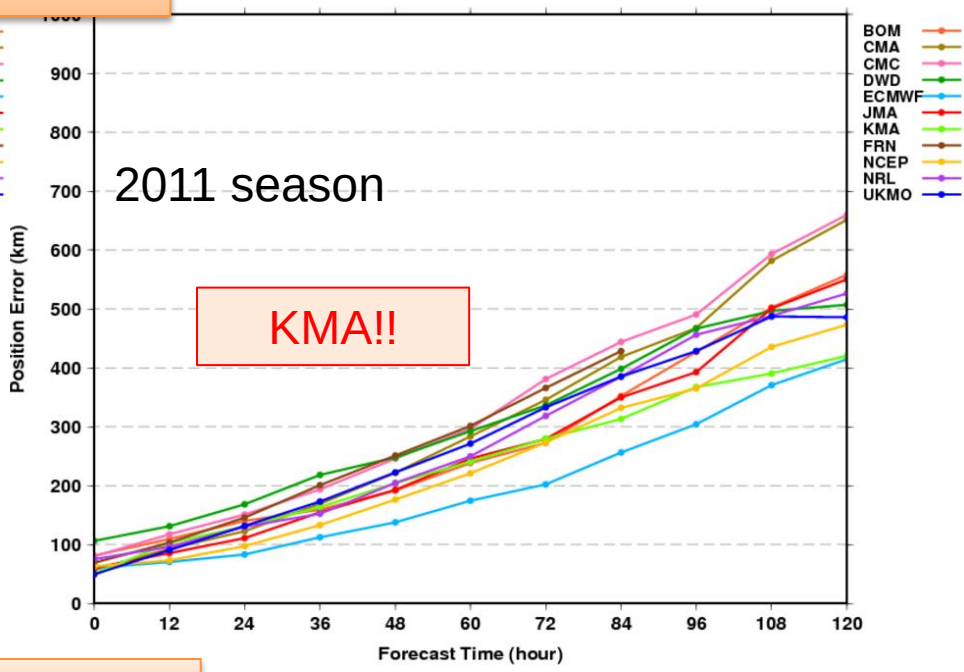
Scatter diagram of central pressure at 72 hour forecast.

Y-axis represents central pressure of forecast and X-axis does that of analysis.

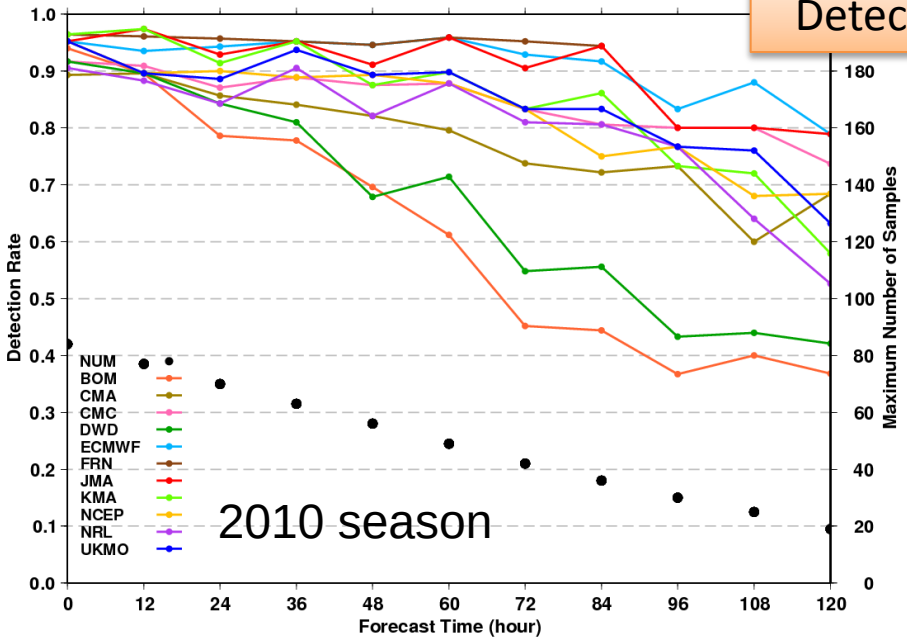
Unit: hPa

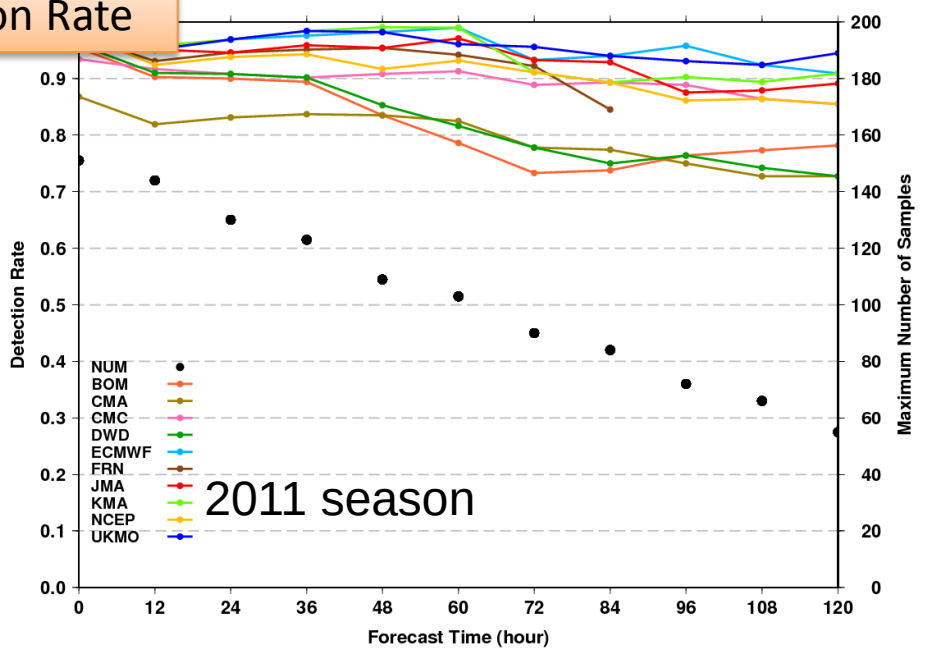
Position Error



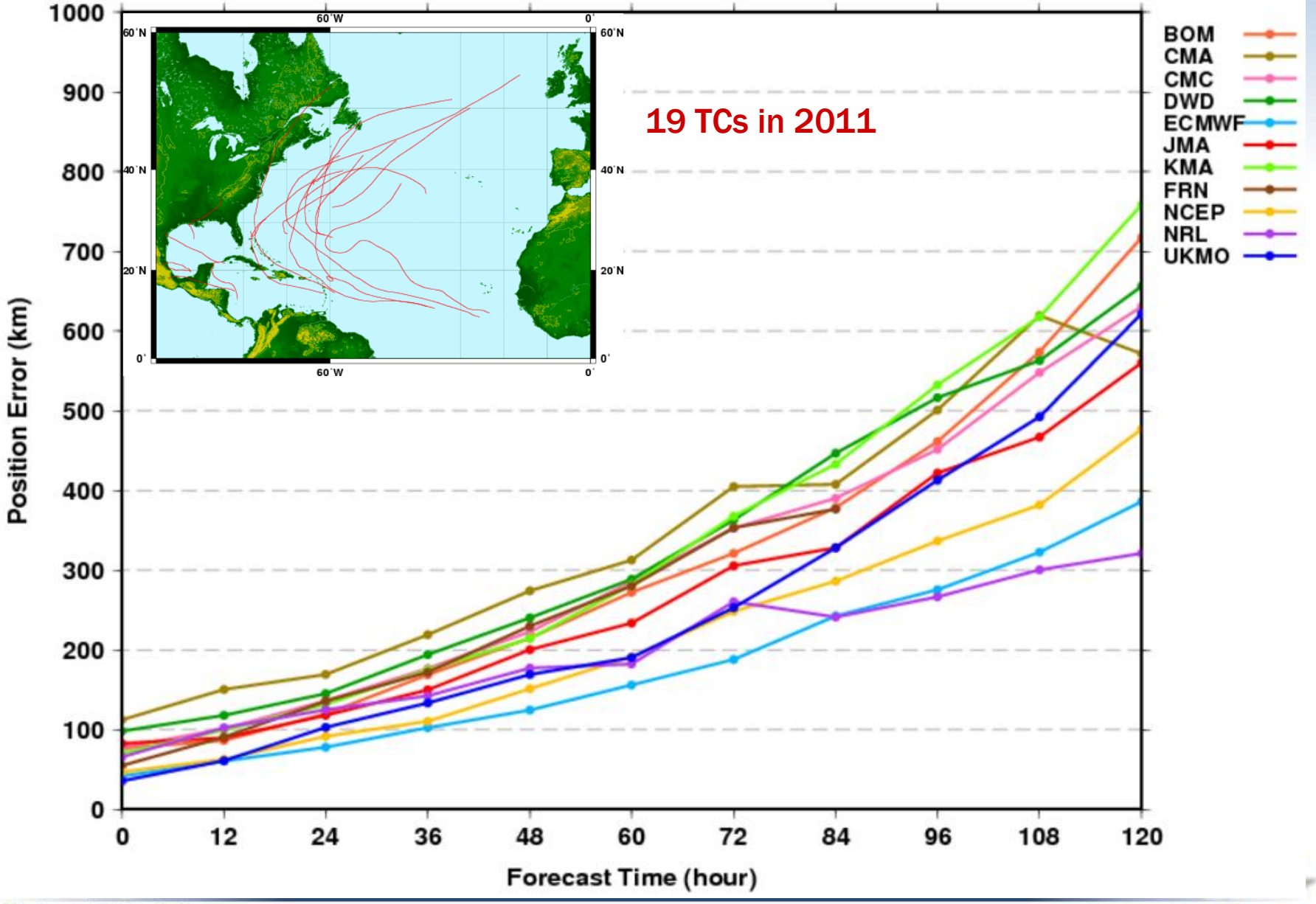


Detection Rate

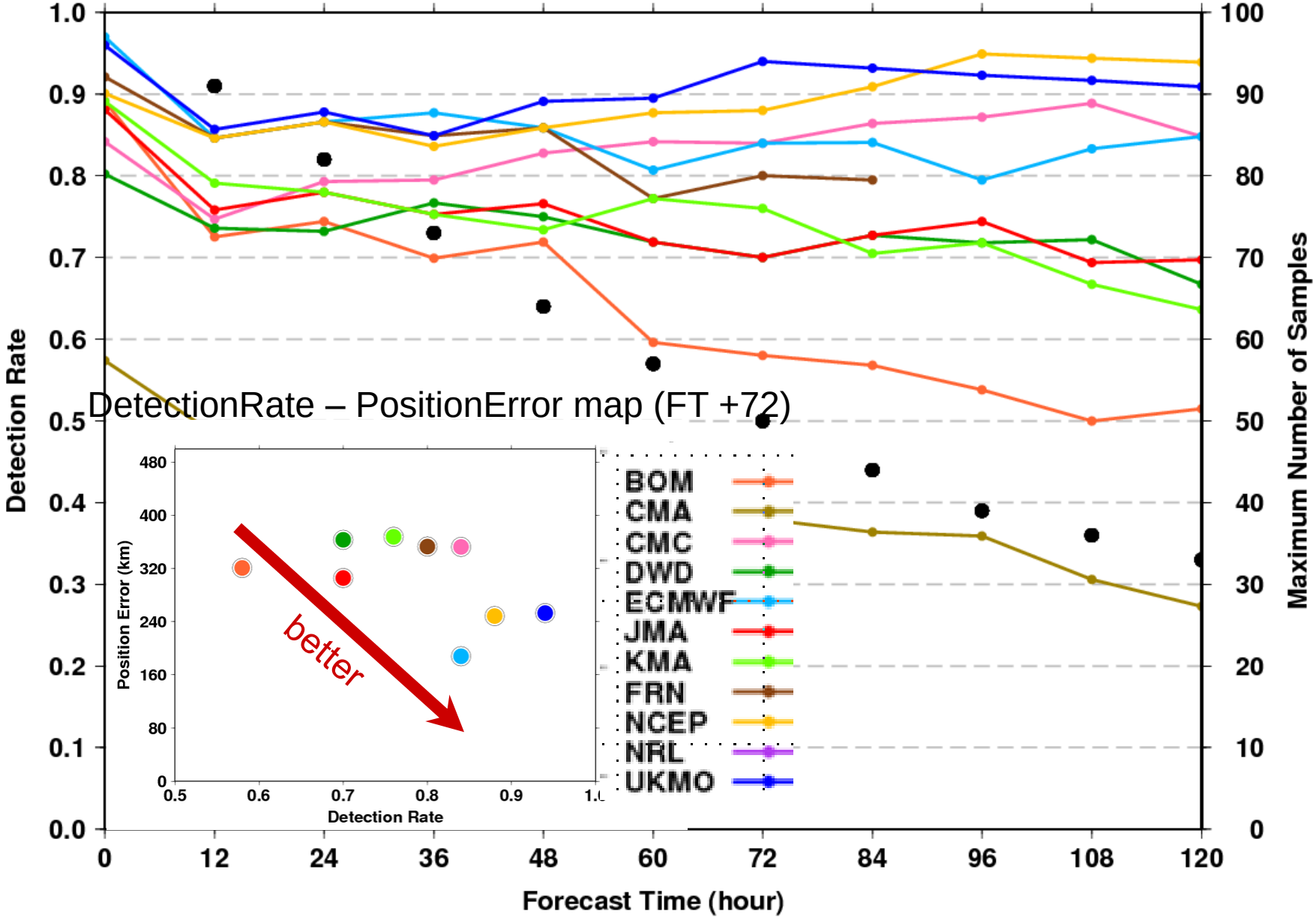




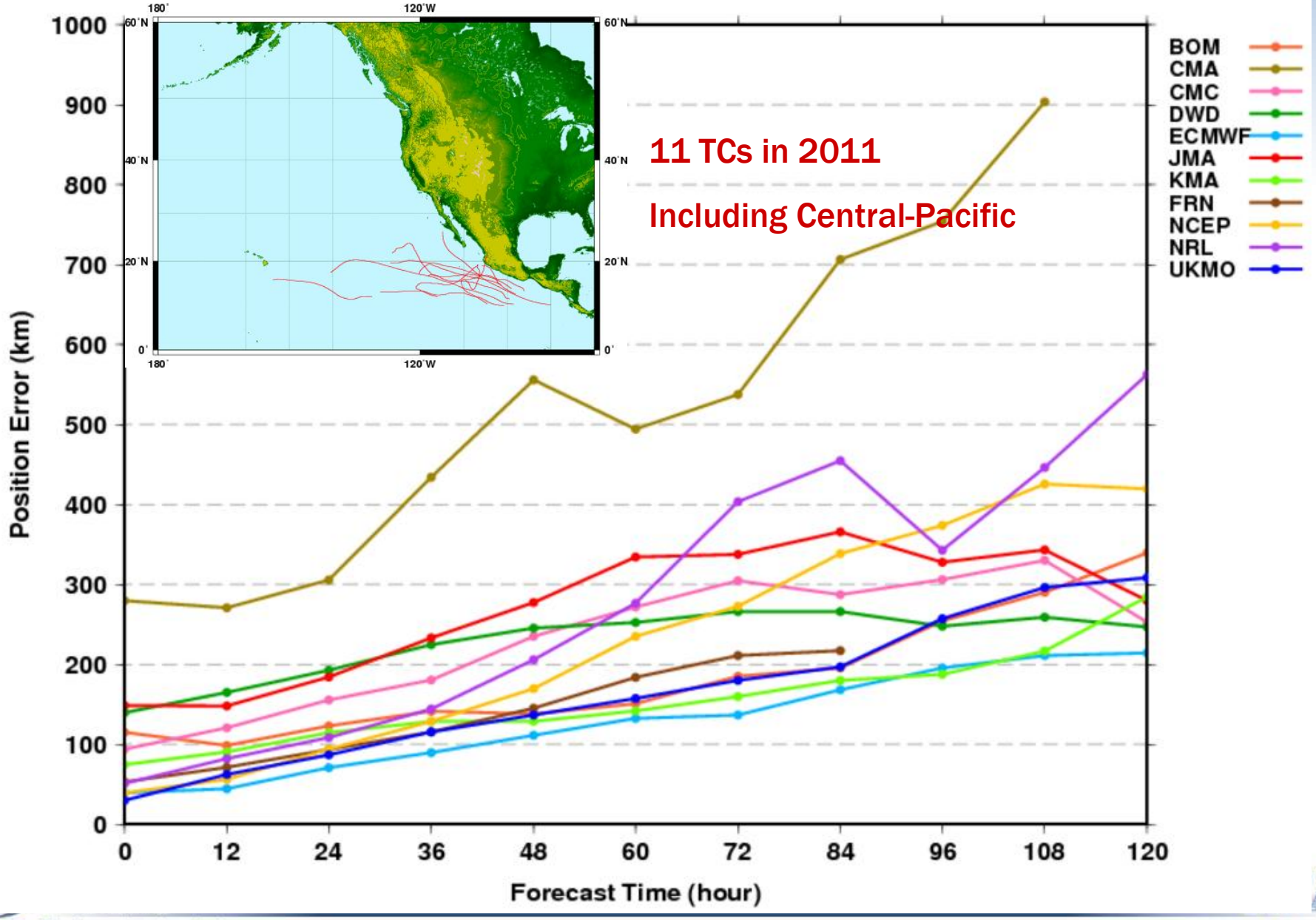
(b) North-Atlantic (NAT) domain Position Error



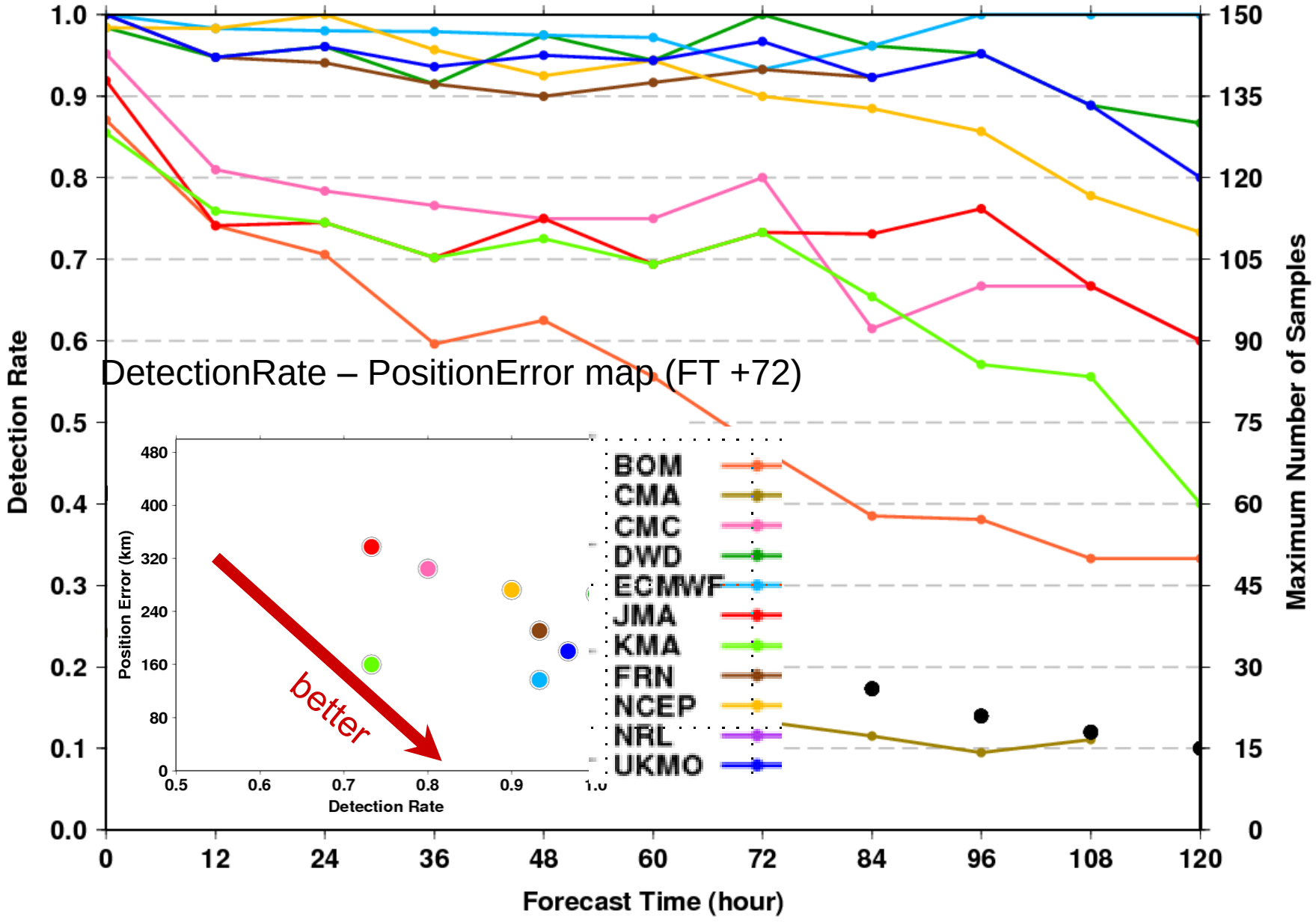
(b) NAT domain Detection Rate



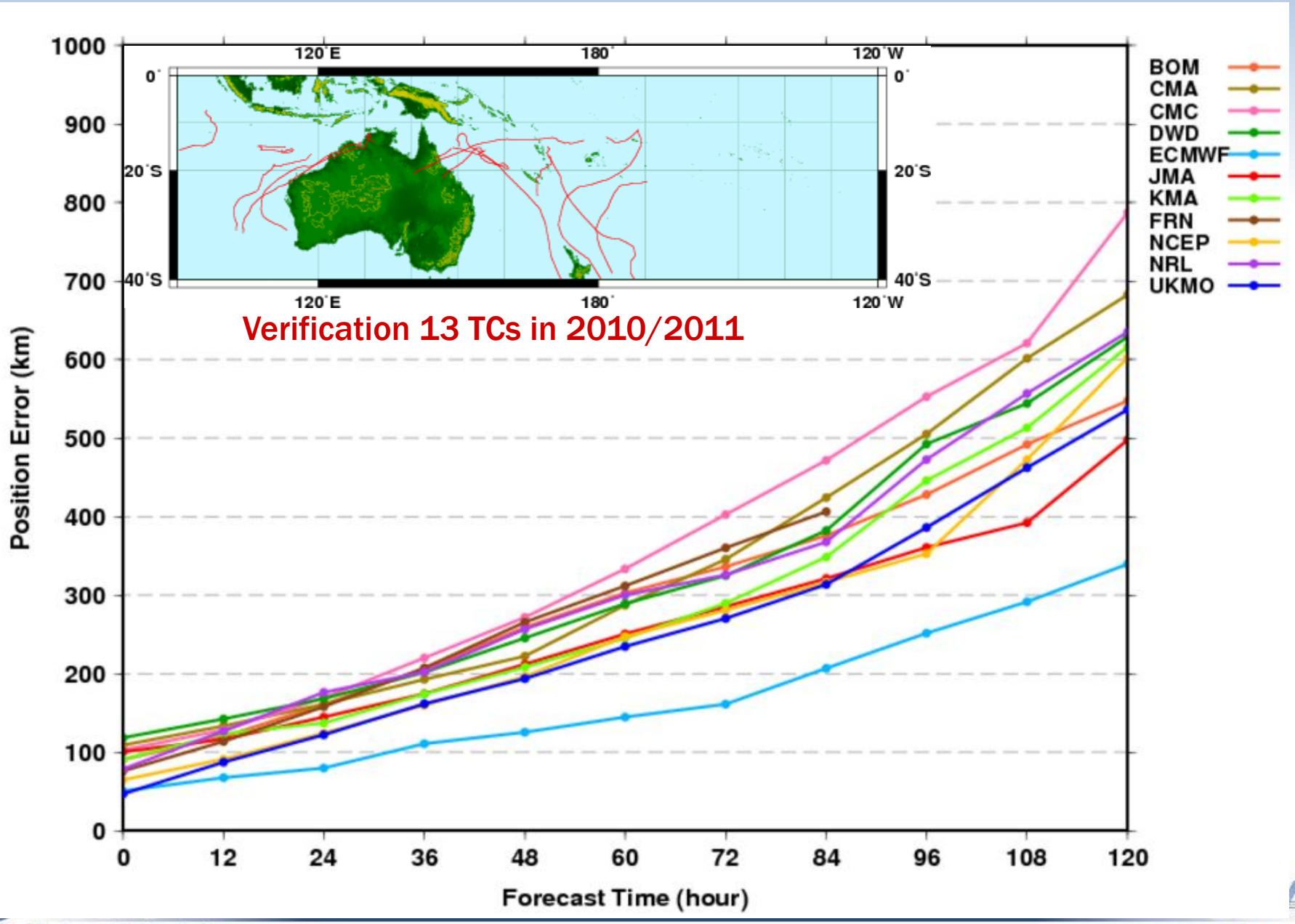
(c) eastern North-Pacific (ENP) domain Position Error



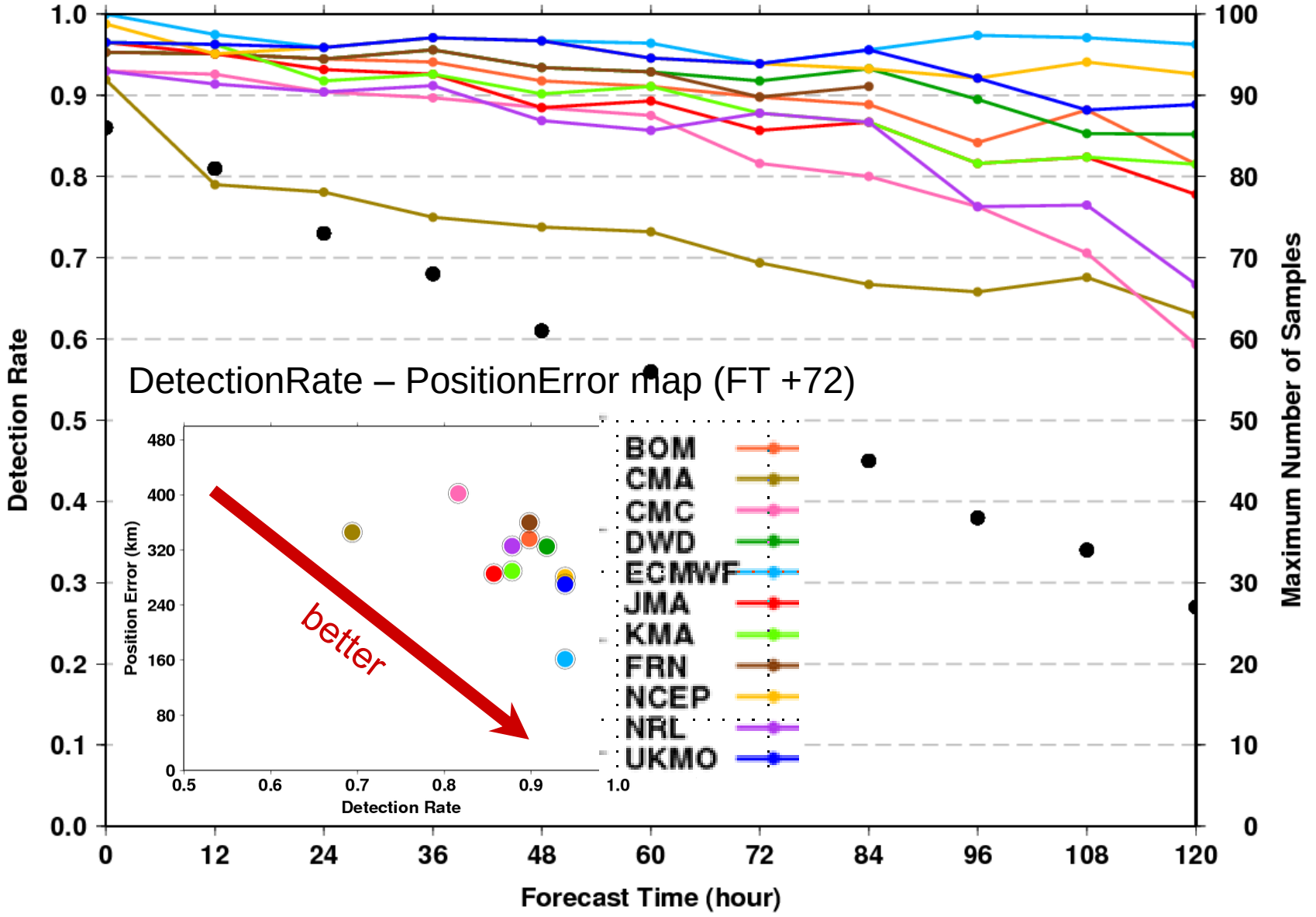
(c) ENP domain Detection Rate



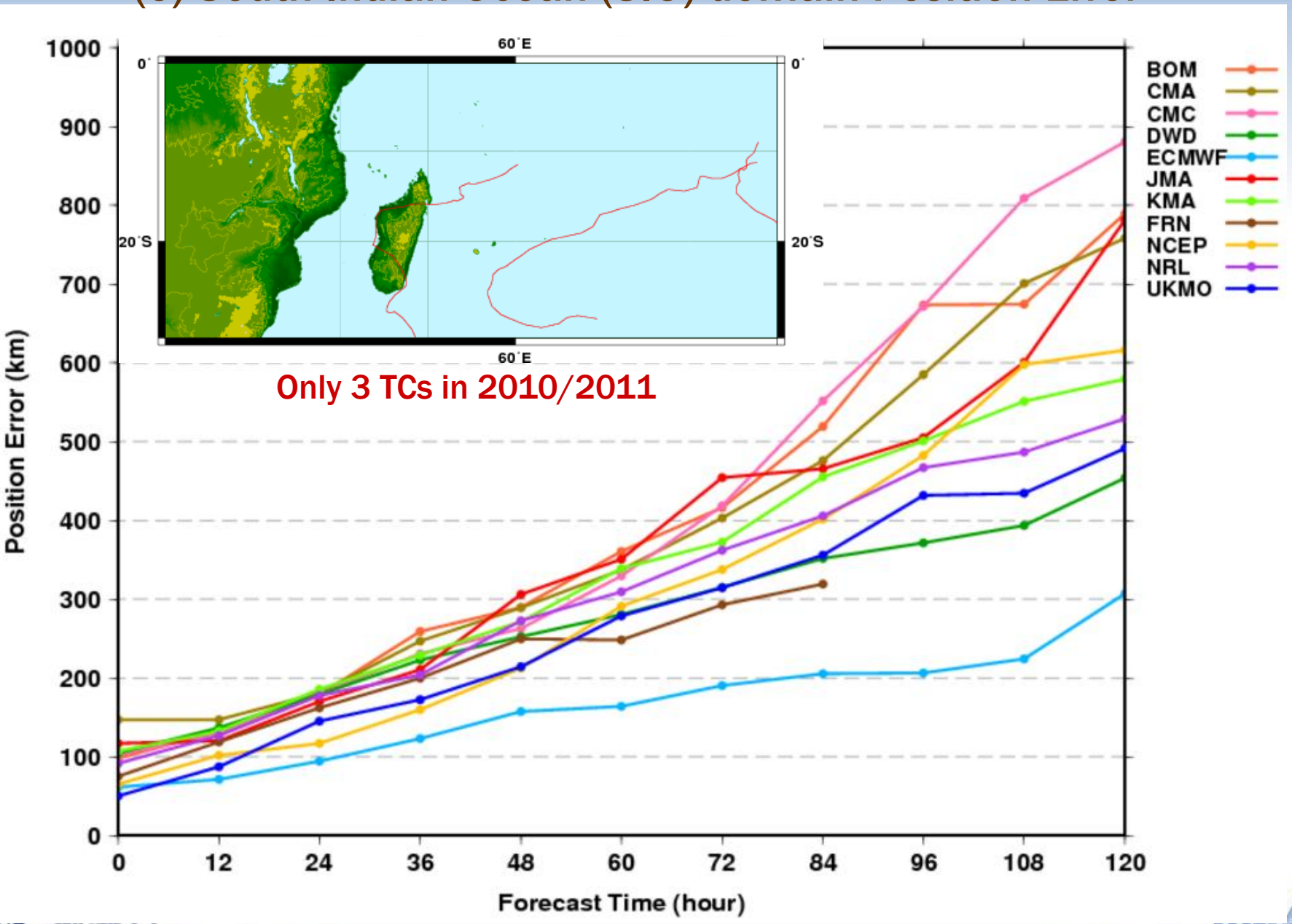
(d) “around Australia” (AUR) domain Position Error



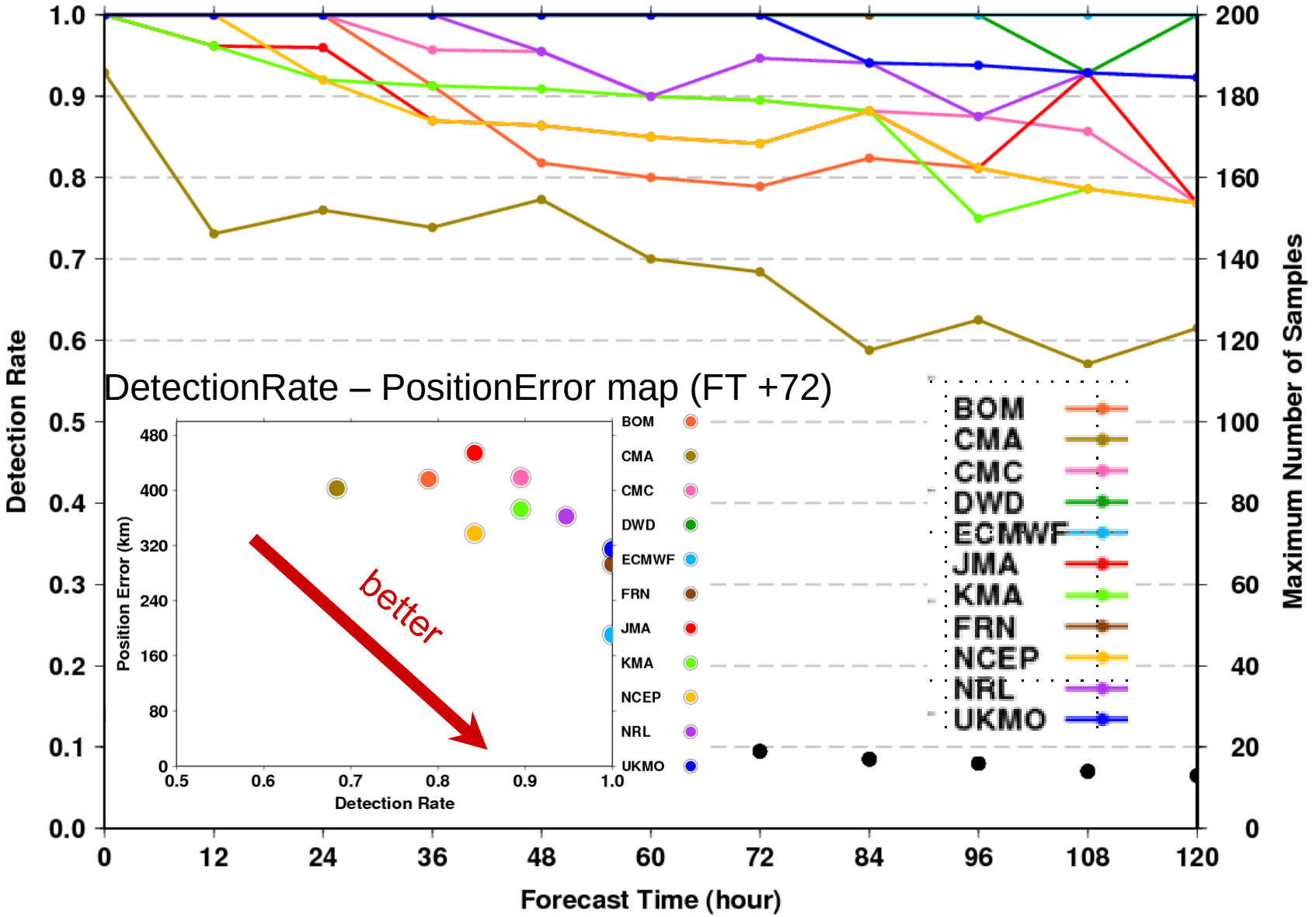
(d) AUR domain Detection Rate



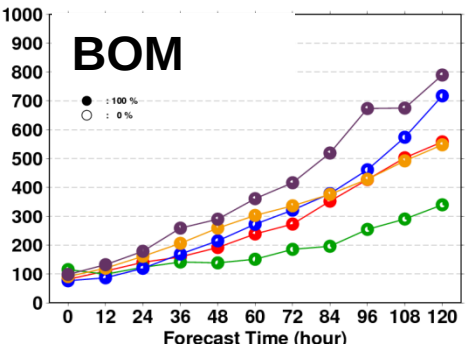
(e) South Indian Ocean (SIO) domain Position Error

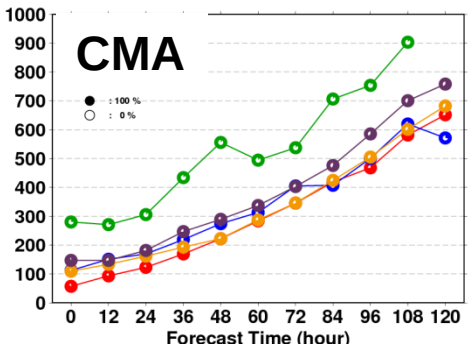


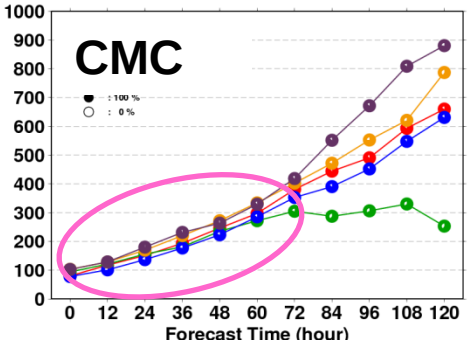
(e) SIO domain Detection Rate

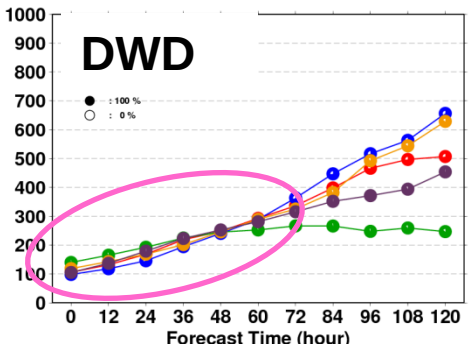


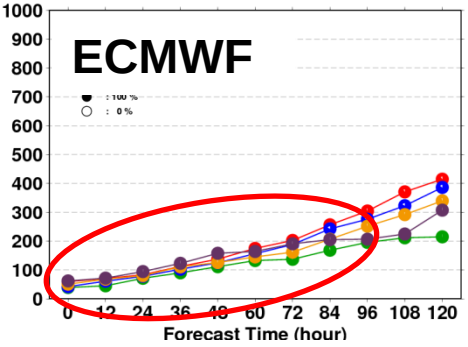
visualization with “pie-chart”

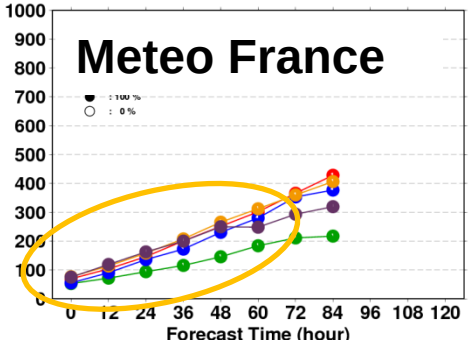


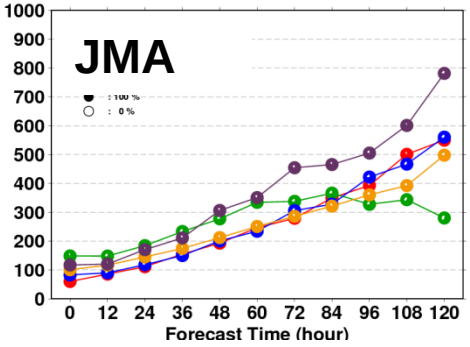


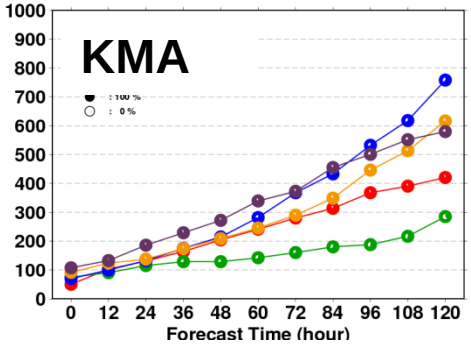


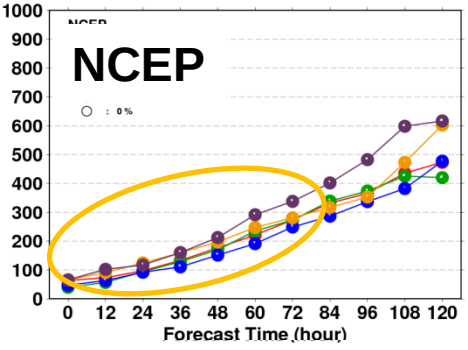


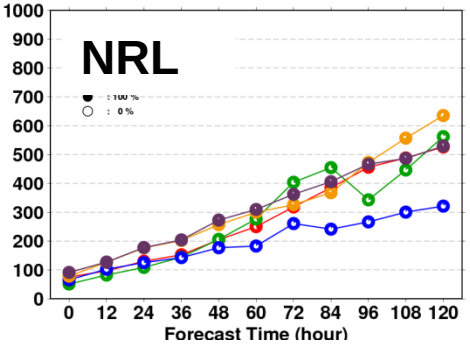


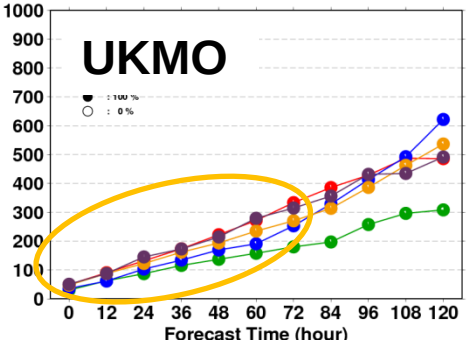






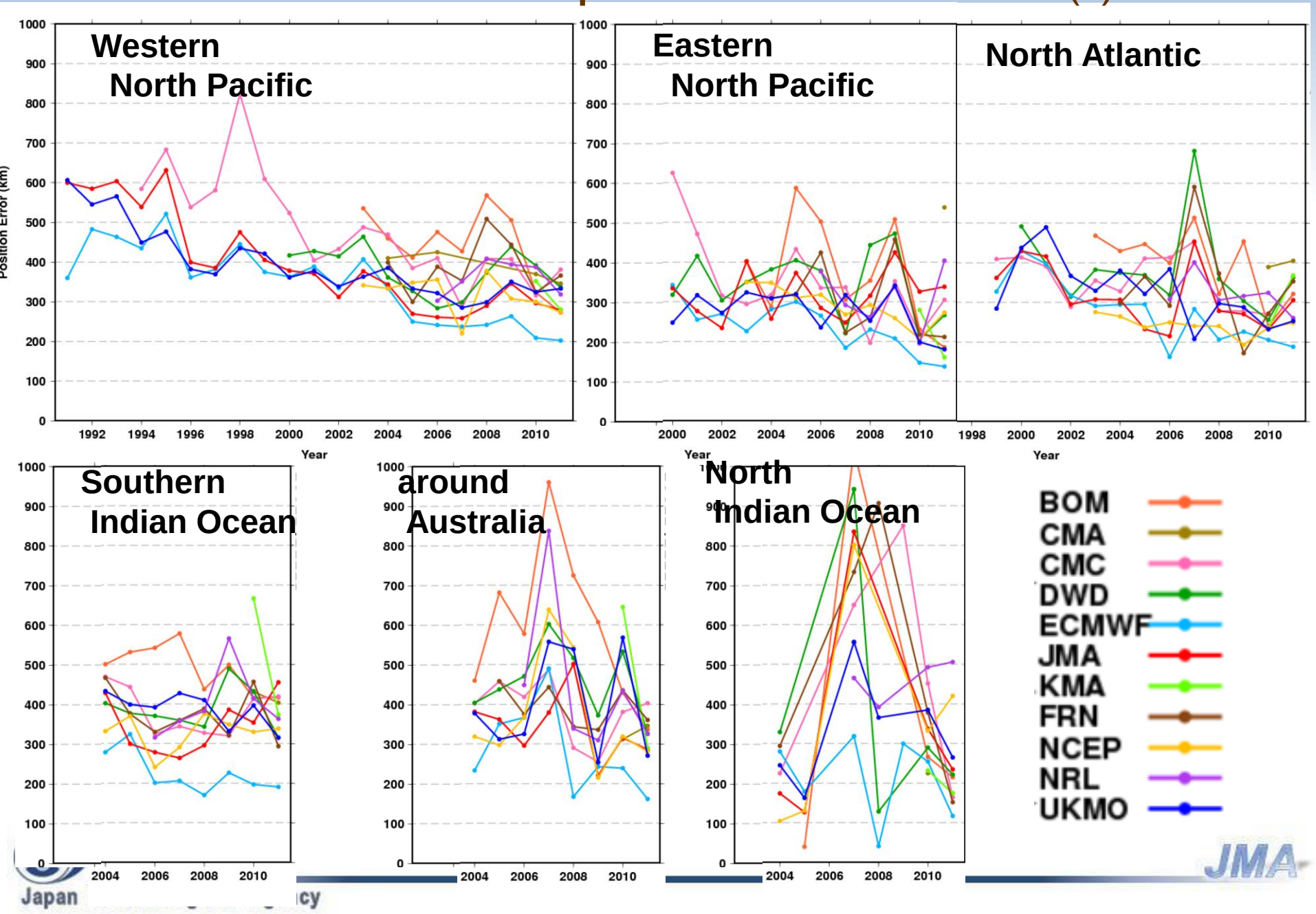






western North-Pacific
eastern North-Pacific
North-Atlantic
around Australia
Southern Indian Ocean
detection rate
● : 100 %
○ : 0 %

transition of FT+72 position error over decade(s)



ADDITIONAL VERIFICATION

Verification of Regional Models

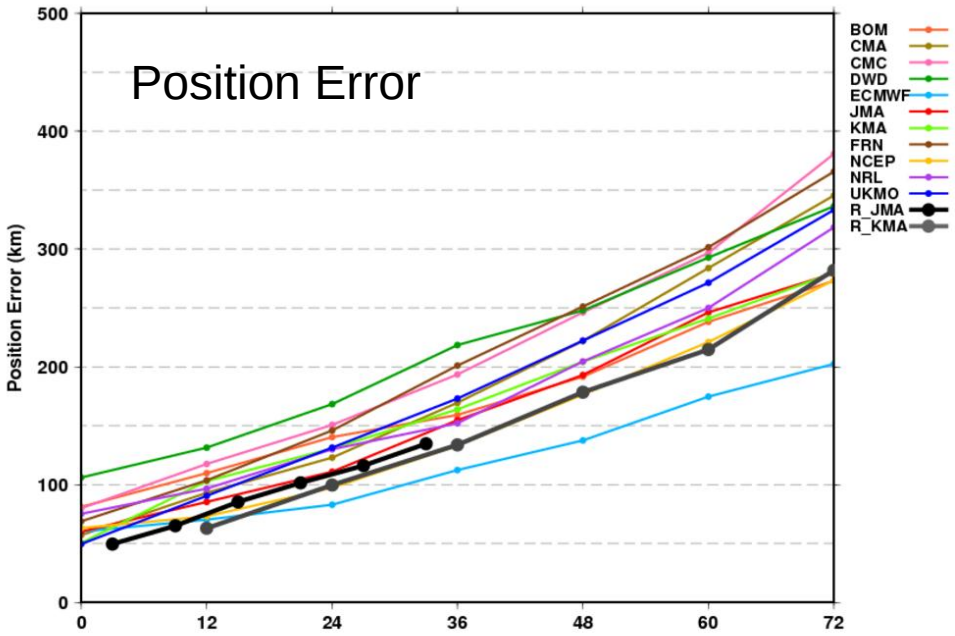
Specification of Data of Regional Models

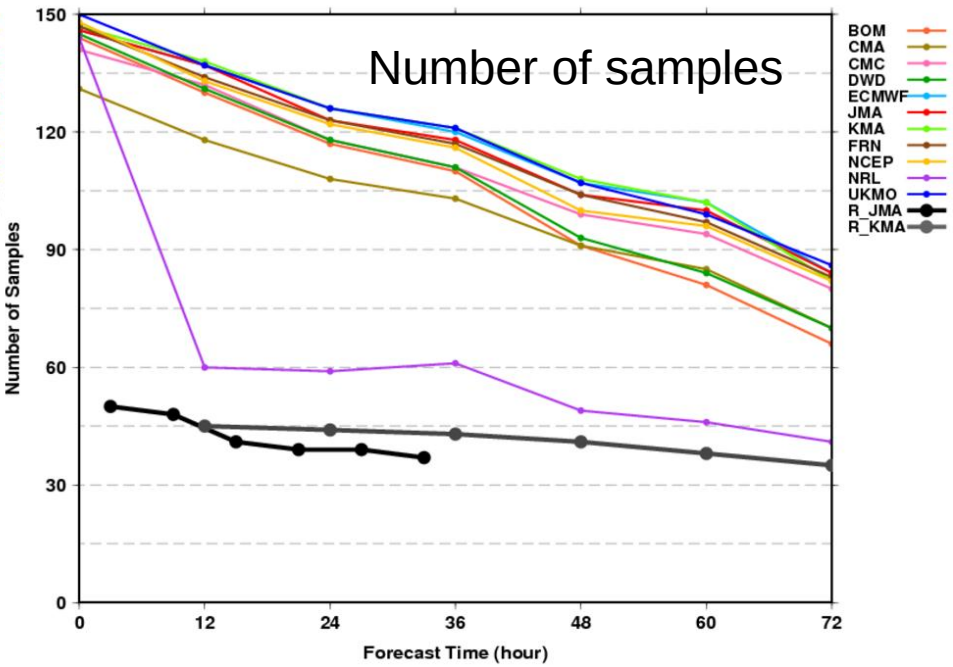
NWP centers	Name of Model	Verification Region	Bogus data	Model Res. as of 2011
JMA	MSM	WNP*	Used	5kmL50
KMA	Unified Model	WNP (north to 20N west to 140E)	Used	12kmL70
France	Aladin-Reunion	SIO (31E-88.5E 32S-0)	Used	8kmL70
NCEP	HWRF	NAT,ENP	Used**	inner 9km outer 27km L42

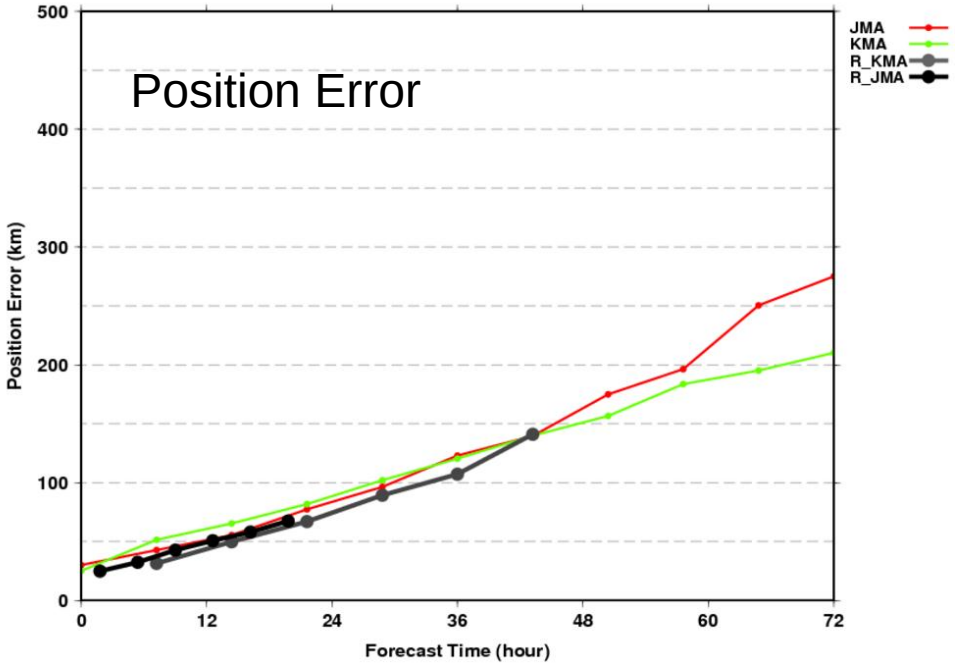
*Region of MSM

**change vortex initialization procedure 24 May 2011

NWP Domain – Position Error and Number of samples







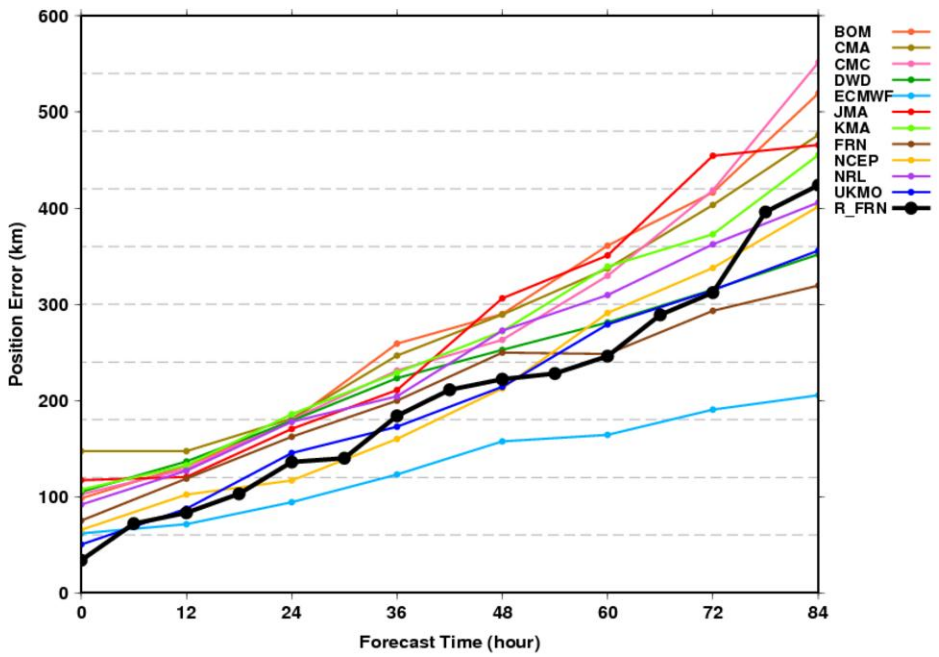
Regional Model：JMA,KMA

The forecast data from 15UTC initial are used in R_JMA. (target:T1101,T1102,T1105,T1106,T1109,T1111-T1116)

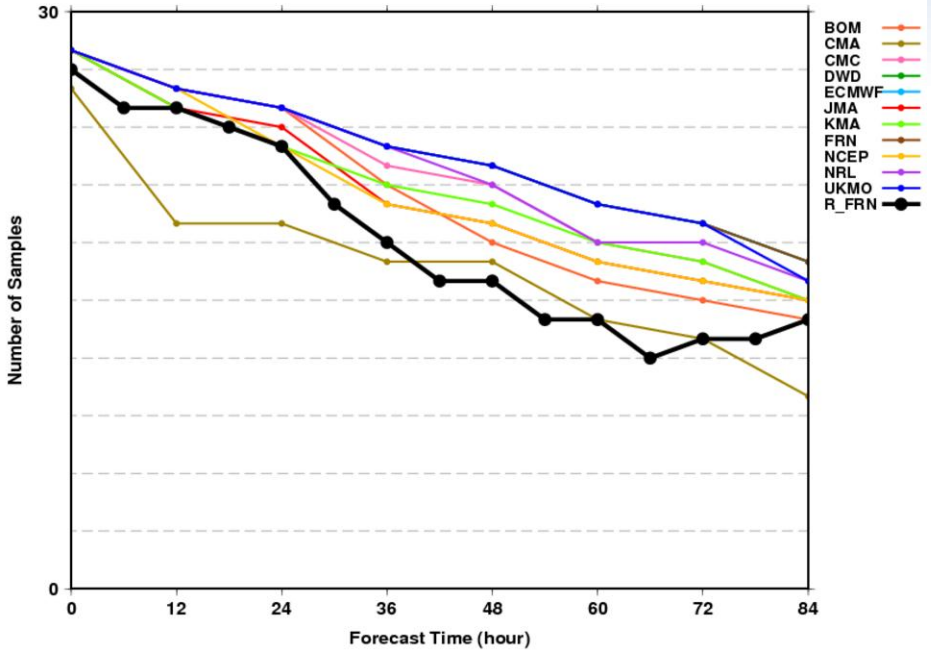
The verification area of R_KMA (Unified Model 12kmL70) is north to 20N and west to 140E.

SIO Domain – Position Error and Number of samples

Position Error



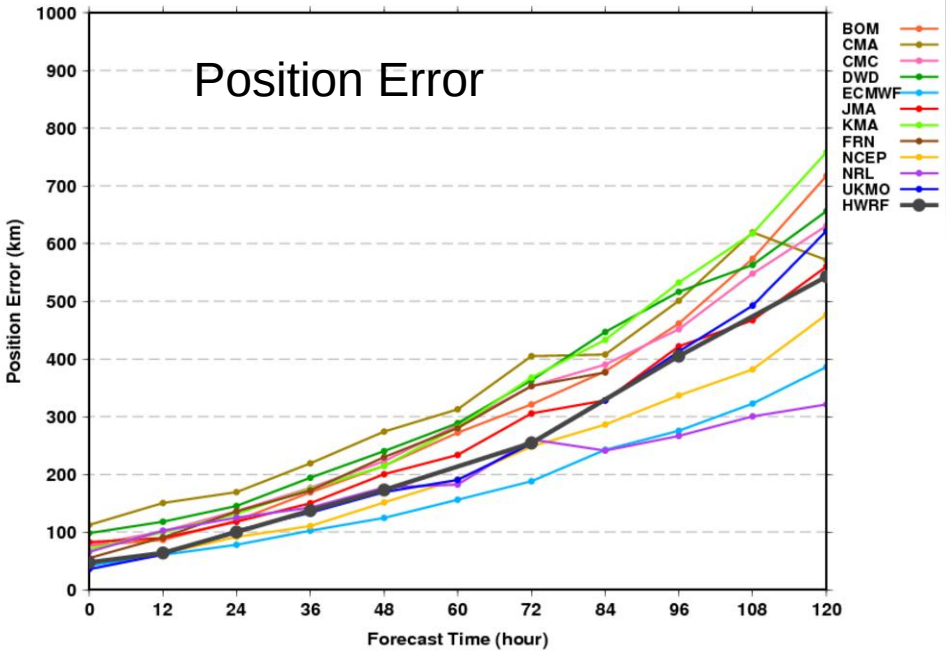
Number of samples

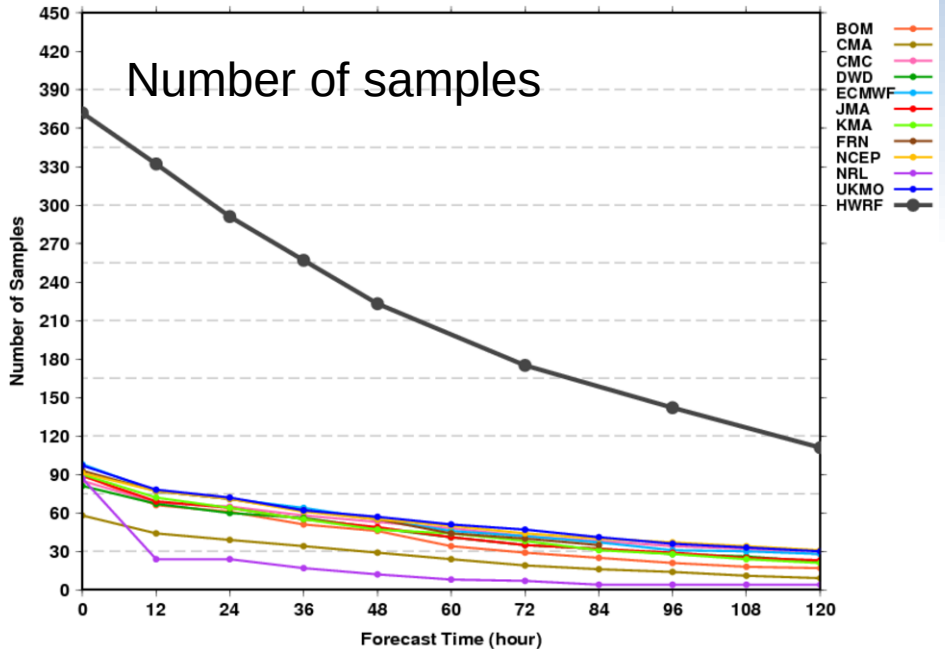


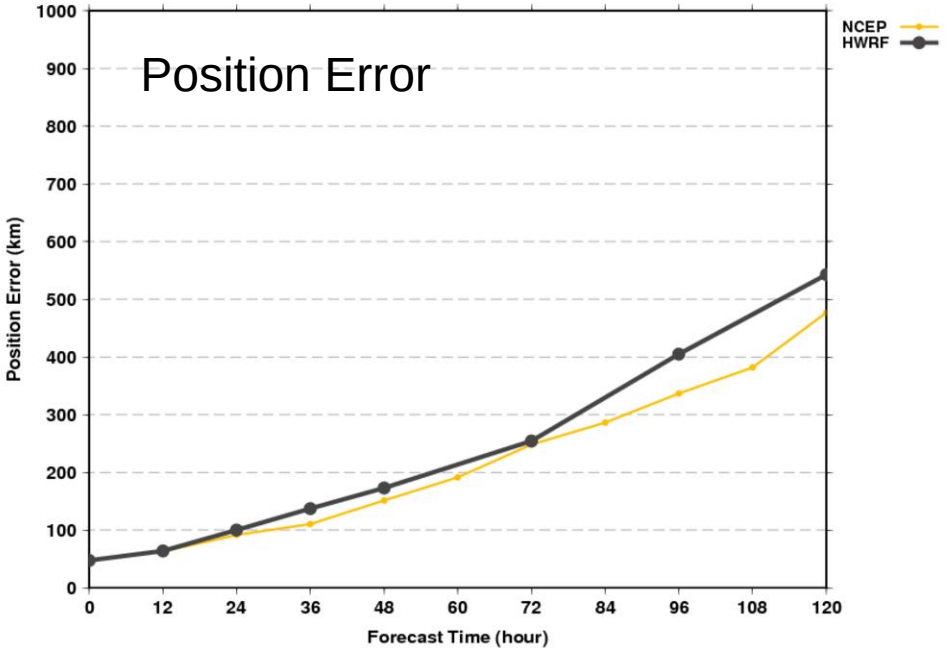
Regional Model：FRN

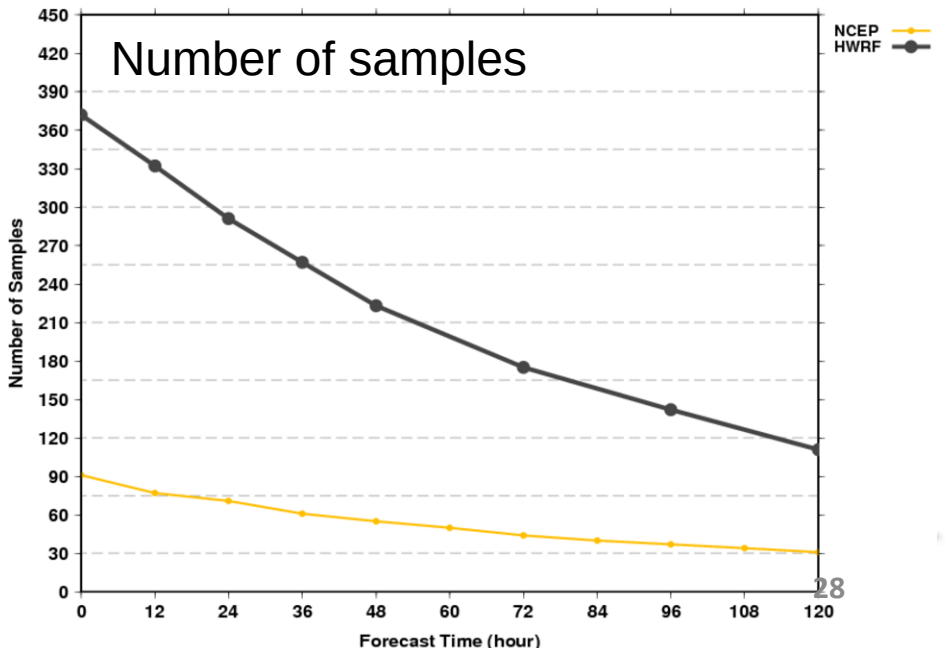
The verification area of R-FRN (8kmL70 bogus used) is Southwestern Indian Ocean.

NAT Domain – Position Error and Number of samples

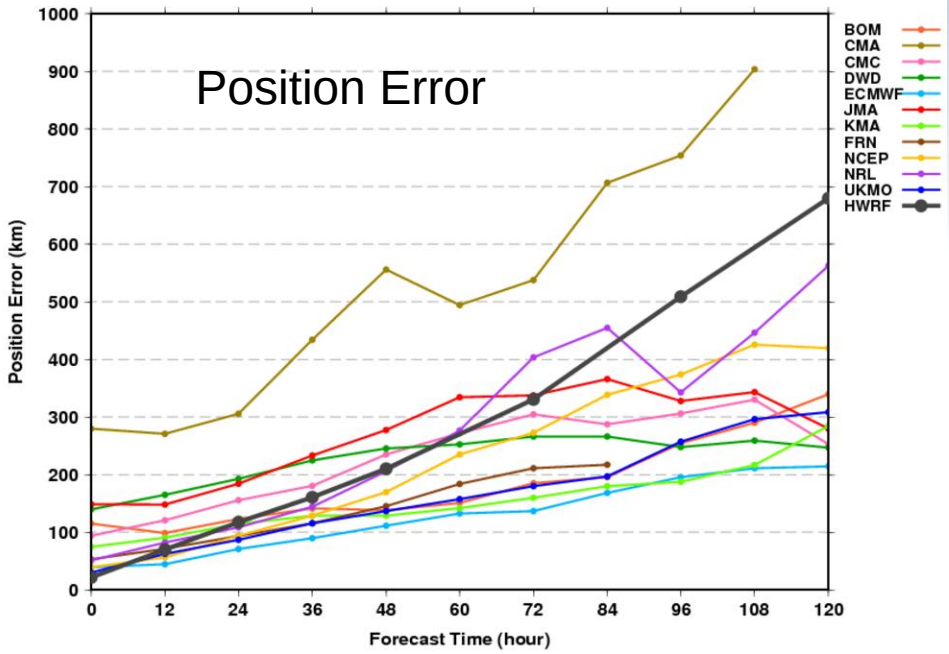


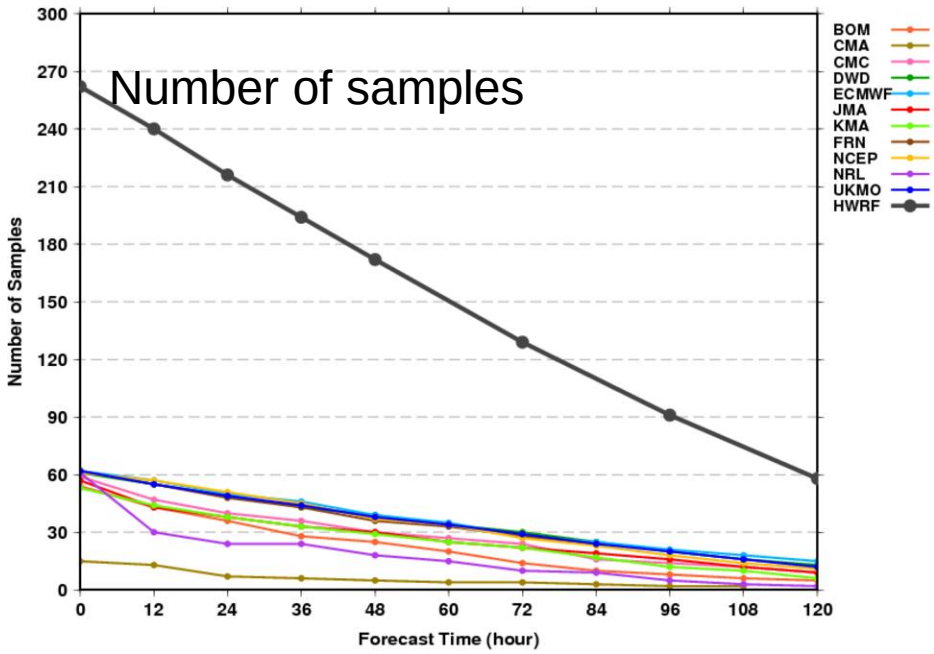


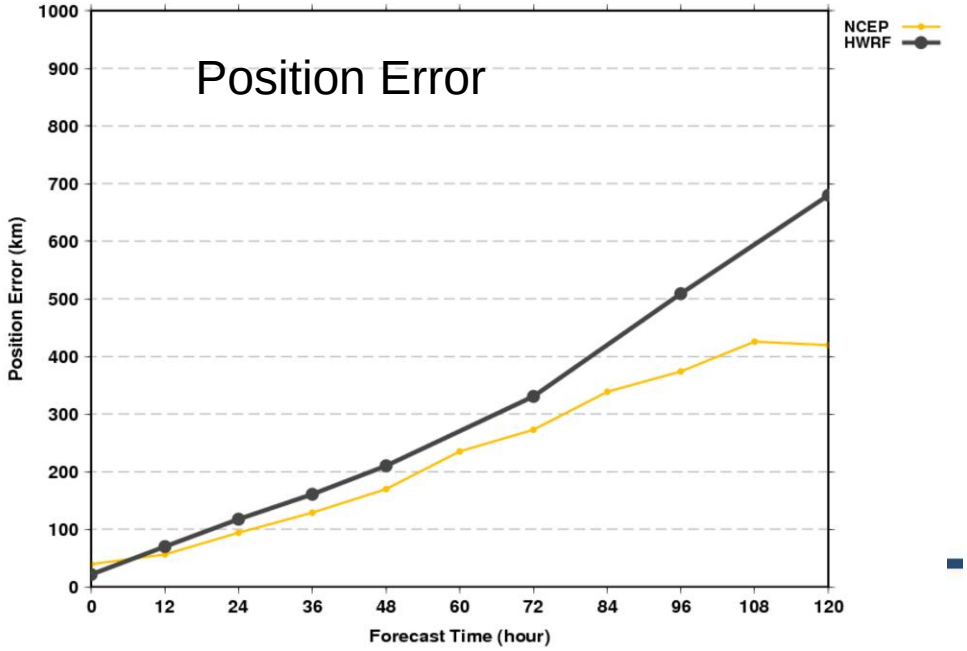


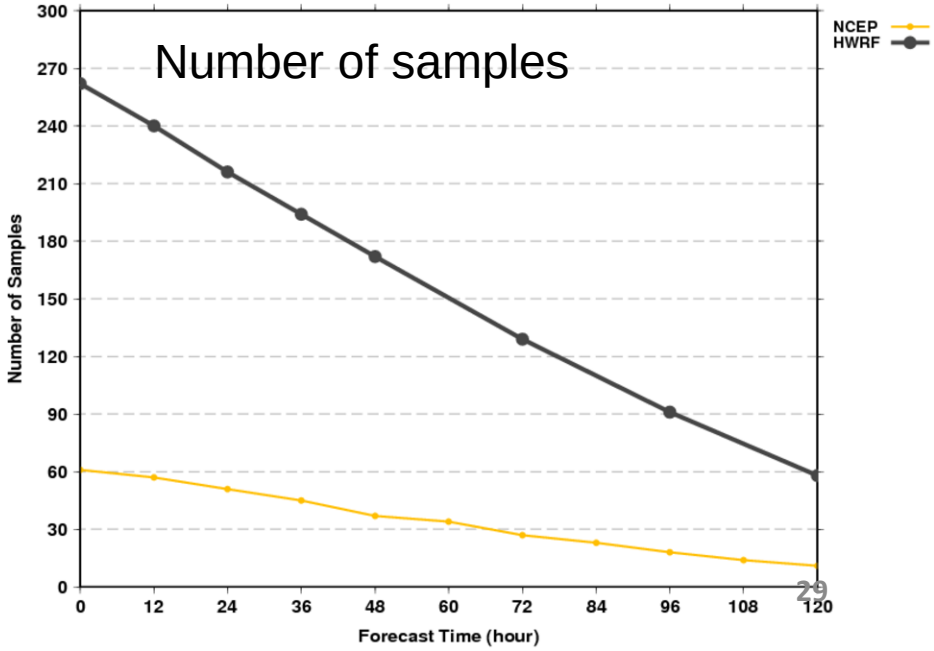


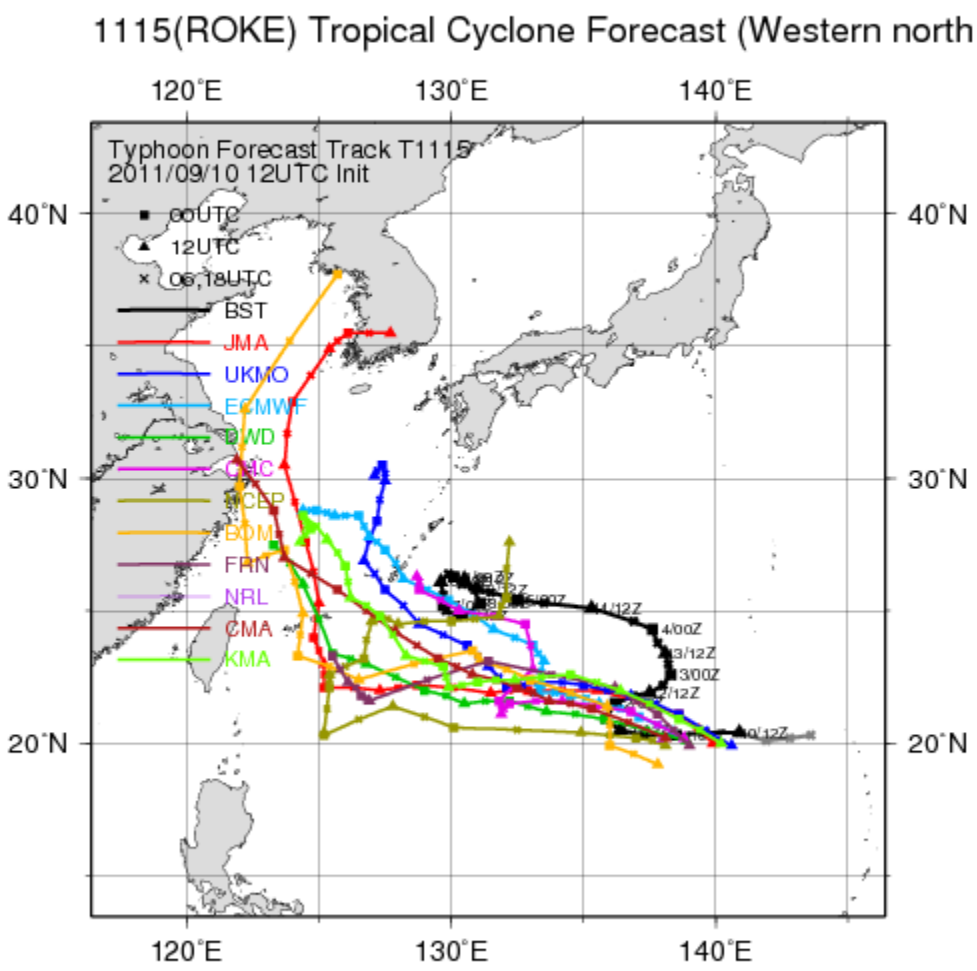
ENP Domain – Position Error and Number of samples

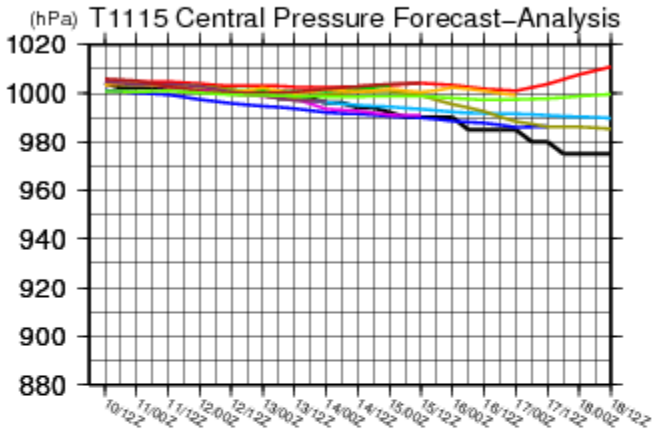


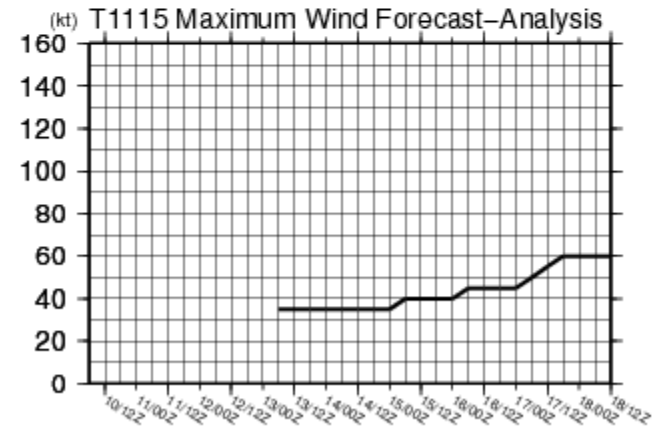












Almost Centter forecasts

Summary

- KMA made great advances in 2011.
- ECNWF is progressing steadily.
- Slow biases in before-recurvature stage are observed in all models except for ECMWF and UM family (UKMO, KMA and BoM).

- Regional version of Unified Model at KMA performs well in WNP.