Performance of hi-res GFS-based NOAA models v ECMWF

2013 HFIP summer demo – LANT/EPAC

Mike Fiorino
NOAA ESRL Boulder CO
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ATCF ID	Model	Resolution (3n+1 rule)	Comments
AVNO	GFS T574L64	23 km	GFS baseline
FIM9	FIM G9L64	15 km	2011 GFS physics, dynamical core improves
HWRF	HWRF	27:9:3 km	GFS IC/BC – highest res NOAA model
GE00	GFS SL T1148L64	11 km	experimental semi-lagrangian version of GFS2013 run at ESRL
EDET	ECMWF HRES T1279L137	10 km	IFS cycle 38r2 (25 JUN 13) increased vertical res; sfc drag; shallow cu…

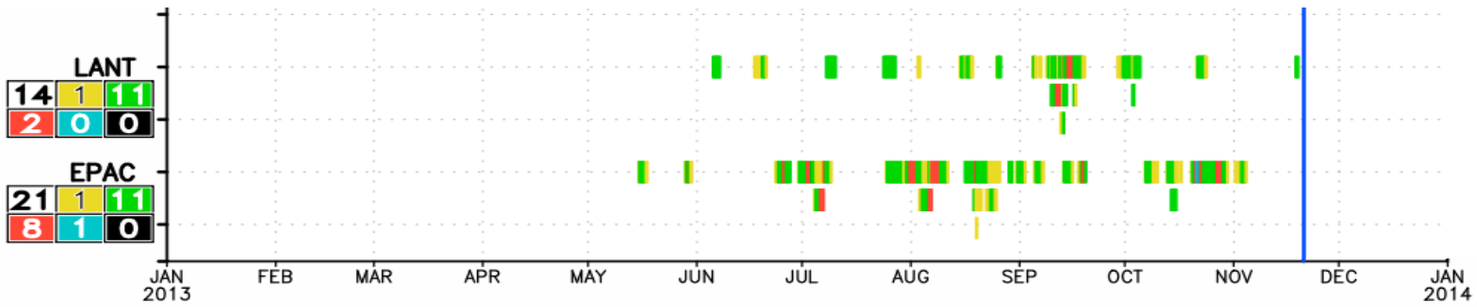
Prelims and NBs

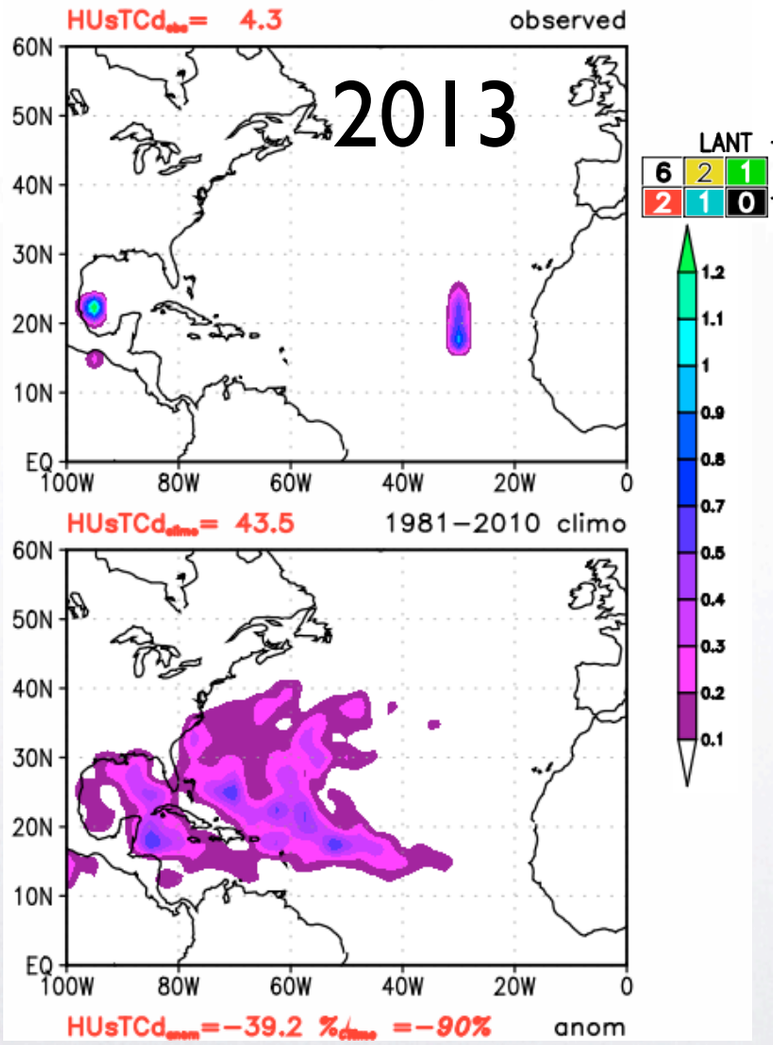
- verify against *working best track* using NHC/JTWC rules – if it's a *TC* (!= LO/WV/PT…) – *verify*
  - no special treatment of model and/or best track positions over land
- EDET comes from ECMWF (tigge or bufr)
  - ECWMF tracker using *full res fields* – has a few issues
  - *intensity* forecasts have *less bias* compared to trackers using 1deg fields (e.g., EMX)
- tracking for GFS/FIM9/GFS-SL uses *0.5 deg global fields* – will not completely resolve model TC intensity
- emphasize *model* performance vice performance as a *forecast aid*
  - will not compare to OFCL or other 'late' aids such as TVCN
- homogeneous comps – every 12 h vice 06 h because HRES runs *00/12UTC*
  - 12-h run separation ~ e-folding time for run-to-run error correlation
- *forecast error* = 'track error' = great-circle distance between forecast and verifying position (Charlie Neumann)

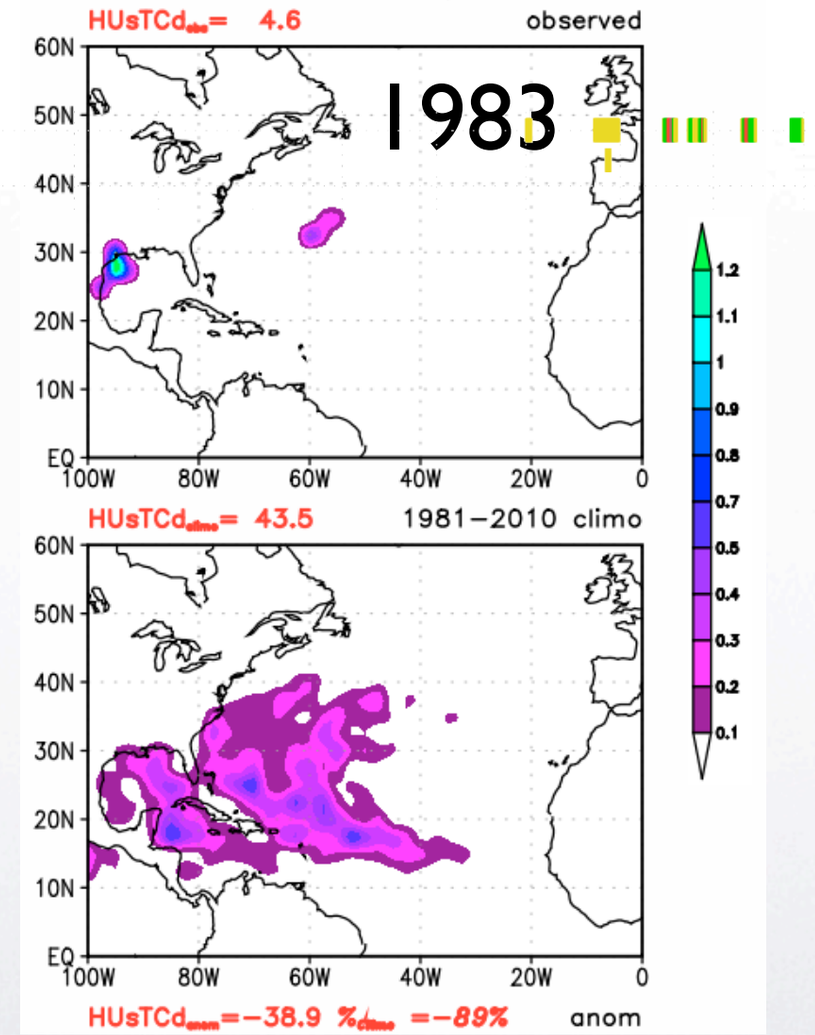
review of the EPAC/LANT season

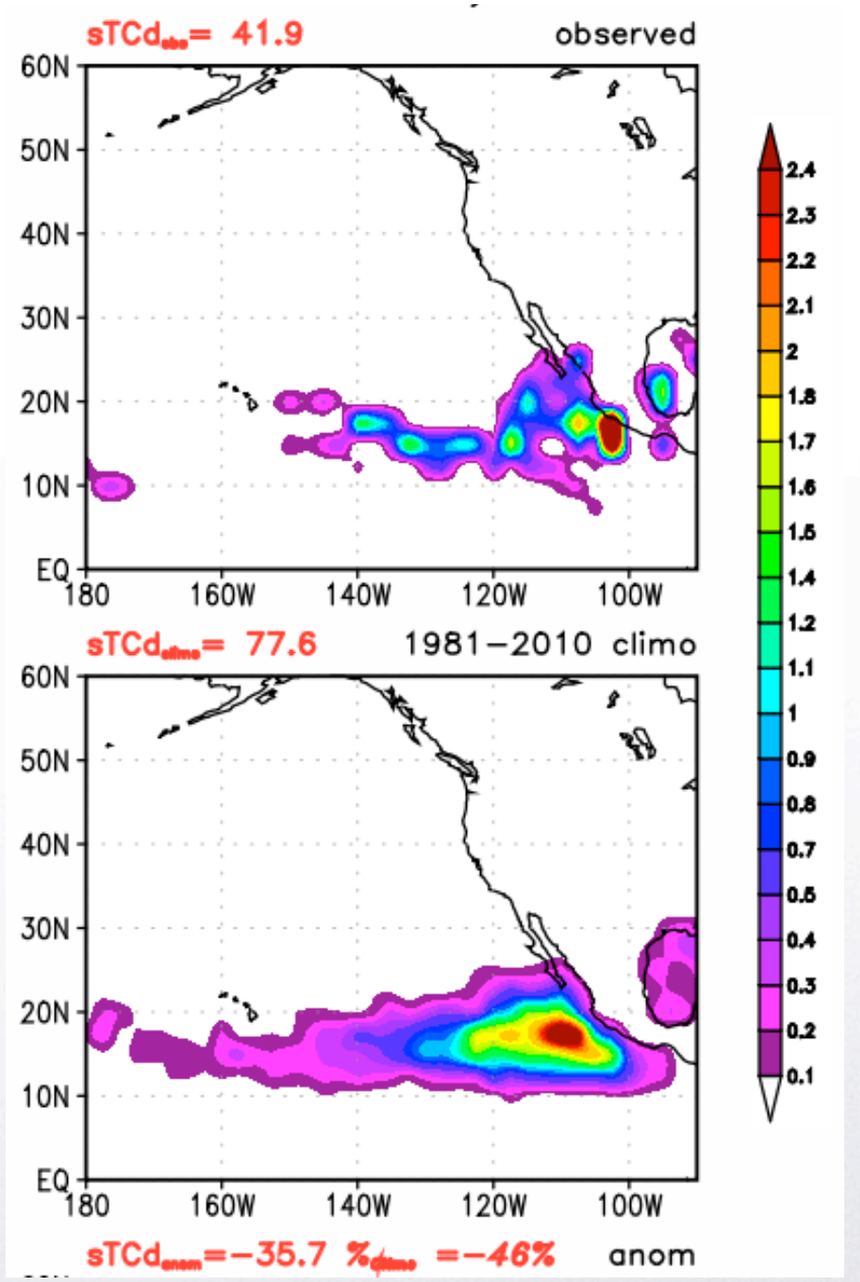
http://ruc.noaa.gov/hfip/tcact

LANT: lowest Hurricane ACE in last 48 years…EPAC: -46% below average ACE



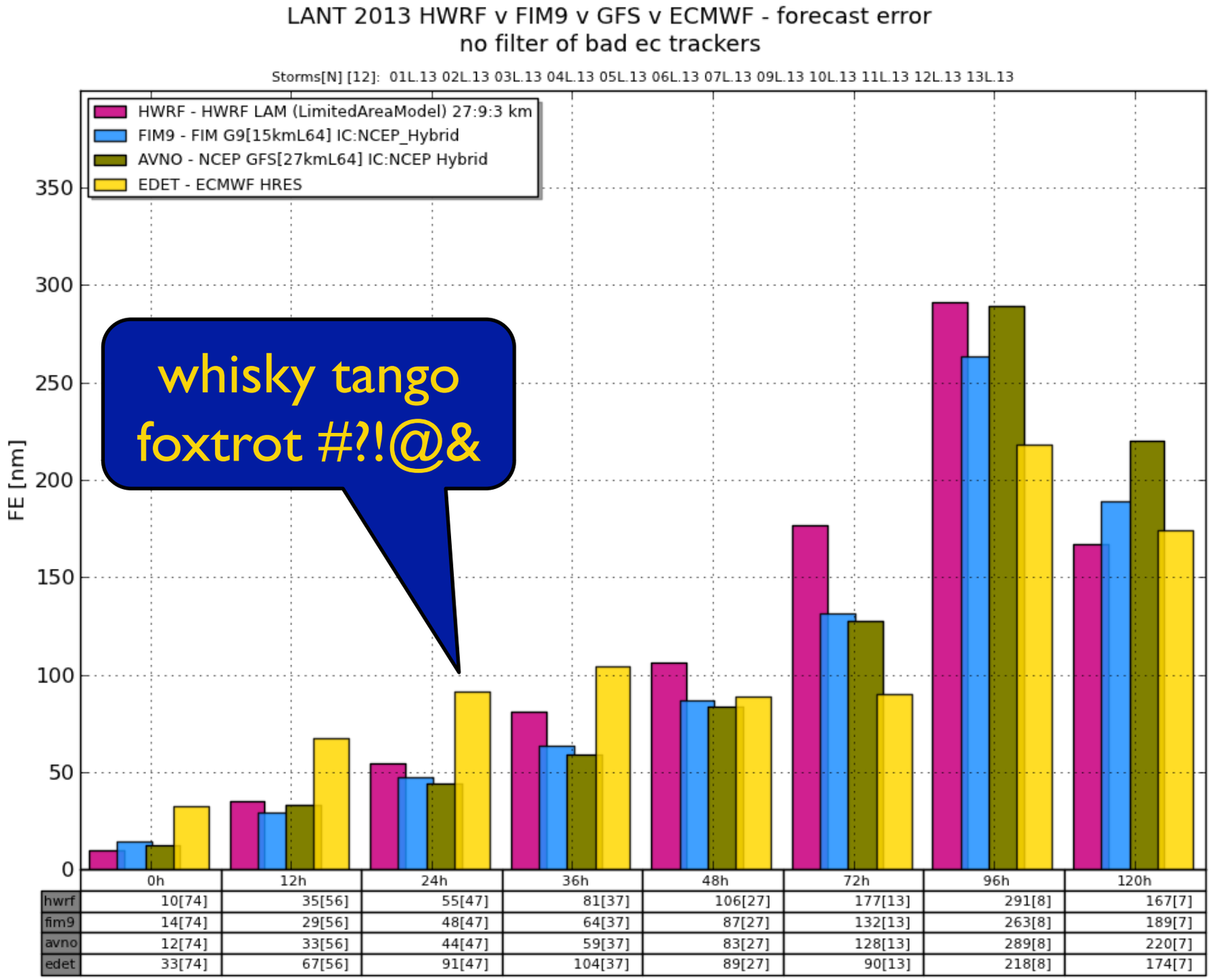






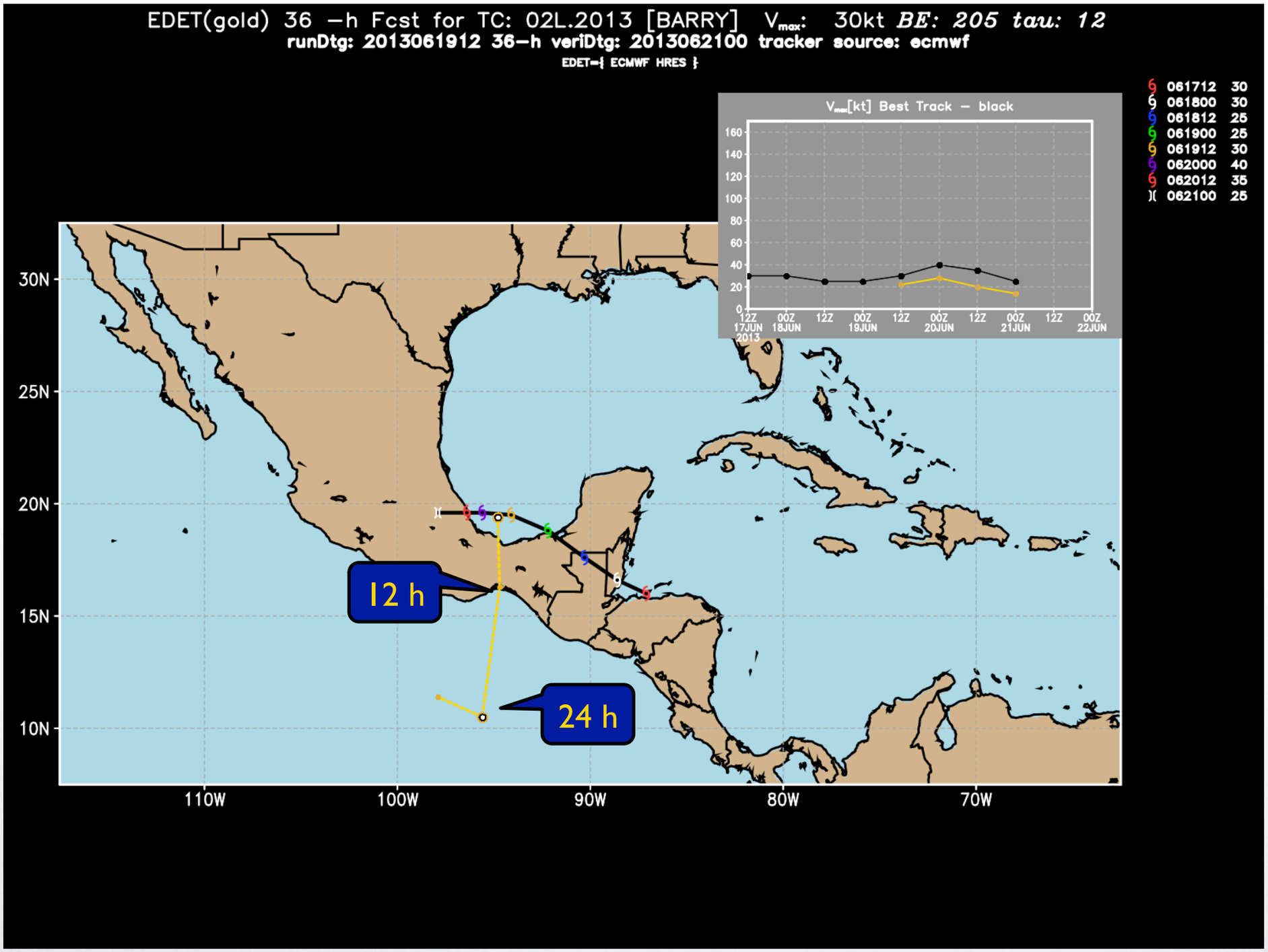
weak activity in LANT makes stats less meaningful…

LANT 2013 – forecast error



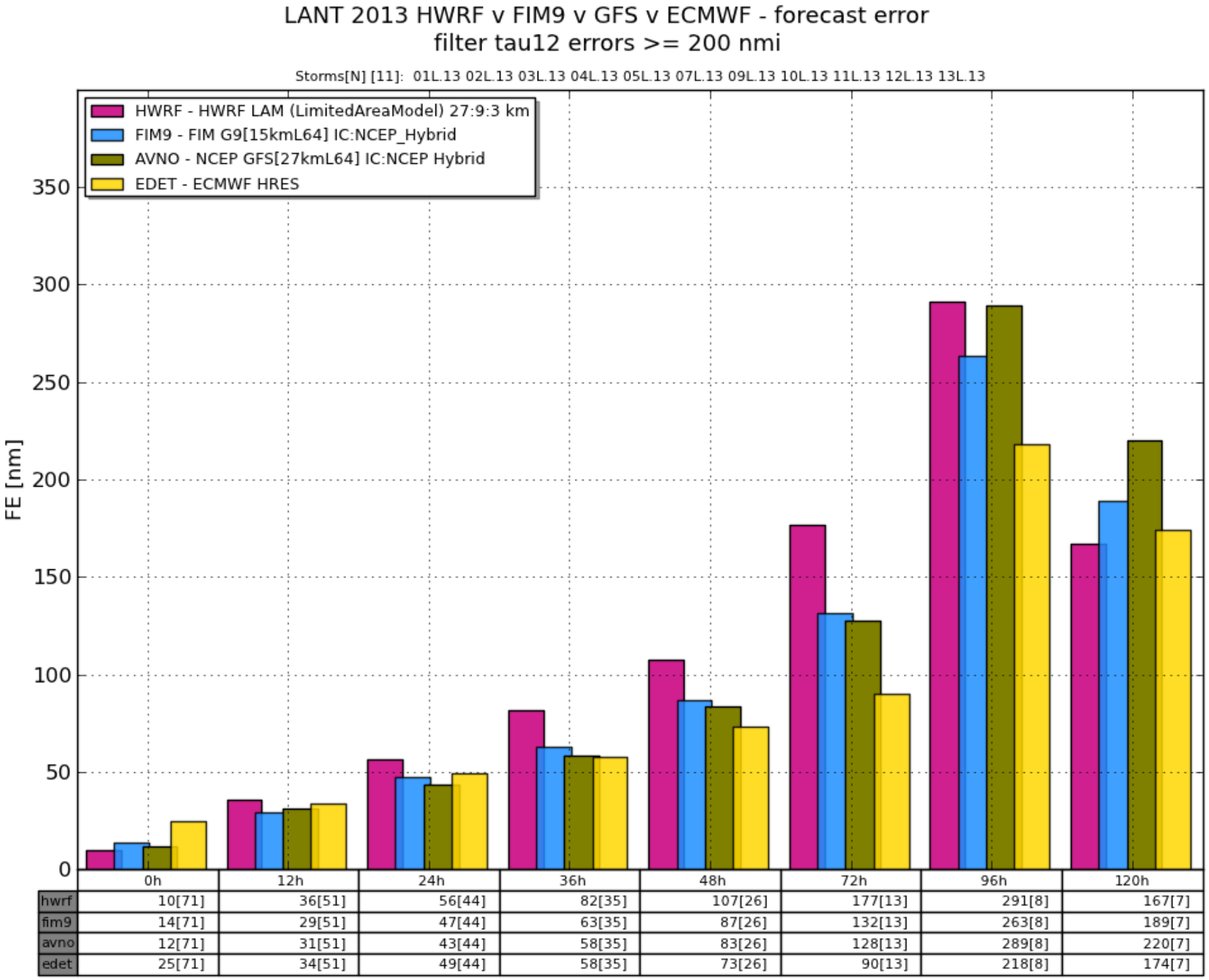
	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	10[74]	35[56]	55[47]	81[37]	106[27]	177[13]	291[8]	167[7]
fim9	14[74]	29[56]	48[47]	64[37]	87[27]	132[13]	263[8]	189[7]
avno	12[74]	33[56]	44[47]	59[37]	83[27]	128[13]	289[8]	220[7]
edet	33[74]	67[56]	91[47]	104[37]	89[27]	90[13]	218[8]	174[7]

ECMWF tracker issues…



- storms: 02L, 06L, 09L
- ok initial position
- 24-h forecast position in EPAC
- probably a bad first guess for 12-h position…
- added switch to toss cases with big 12-h errors

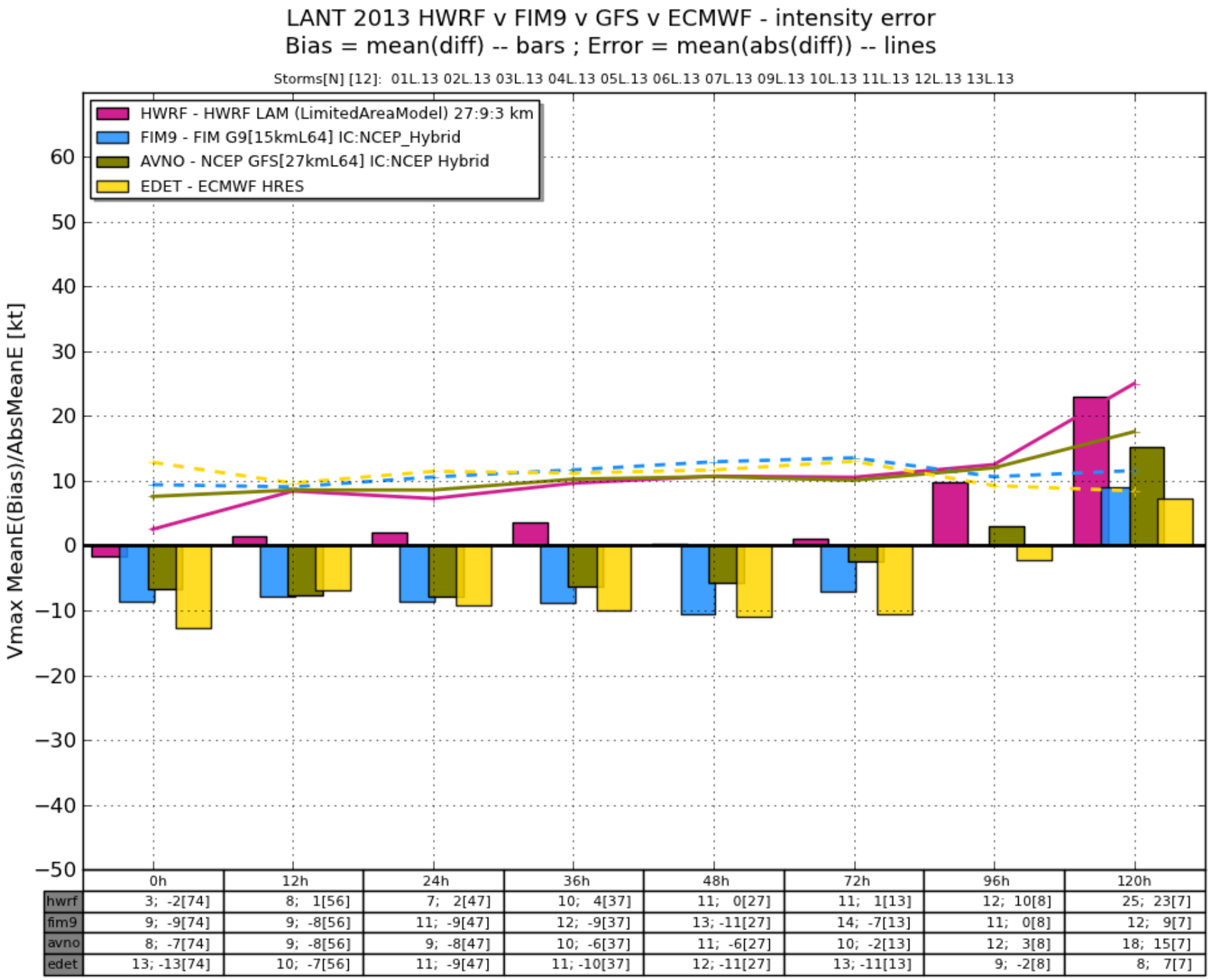
LANT 2013 – forecast error



	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	10[71]	36[51]	56[44]	82[35]	107[26]	177[13]	291[8]	167[7]
fim9	14[71]	29[51]	47[44]	63[35]	87[26]	132[13]	263[8]	189[7]
avno	12[71]	31[51]	43[44]	58[35]	83[26]	128[13]	289[8]	220[7]
edet	25[71]	34[51]	49[44]	58[35]	73[26]	90[13]	218[8]	174[7]

- mean errors for taus 96 & 120 h are not related to basin-wide errors (= 09L)
- from taus 36-72 h ECMWF has slower error growth
- HWRF low initial position error, but higher error growth
- FIM9 ~ AVNO

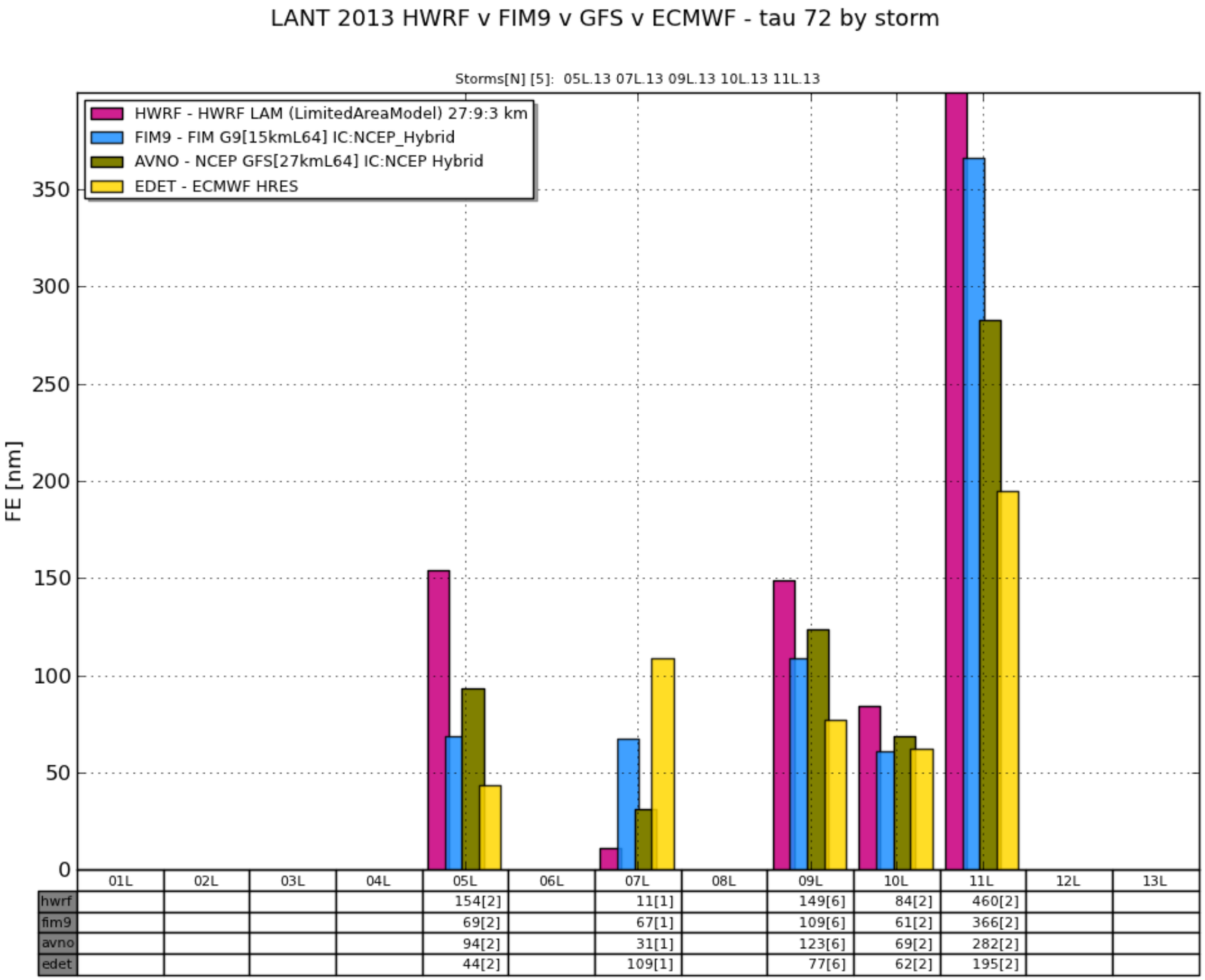
LANT 2013 – intensity error



	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	3; -2[74]	8; 1[56]	7; 2[47]	10; 4[37]	11; 0[27]	11; 1[13]	12; 10[8]	25; 23[7]
fim9	9; -9[74]	9; -8[56]	11; -9[47]	12; -9[37]	13; -11[27]	14; -7[13]	11; 0[8]	12; 9[7]
avno	8; -7[74]	9; -8[56]	9; -8[47]	10; -6[37]	11; -6[27]	10; -2[13]	12; 3[8]	18; 15[7]
edet	13; -13[74]	10; -7[56]	11; -9[47]	11; -10[37]	12; -11[27]	13; -11[13]	9; -2[8]	8; 7[7]

- ECMWF has highest initial error; HWRF almost none!
- very low mean abs errors (~10 kt)
- mean abs error ~ mean error (bias)
- from taus 36-72 h ECMWF has slower error growth
- HWRF low initial position error, but higher error growth
- FIM9 ~ AVNO, but higher initial intensity error

LANT 2013 – tau 72 forecast error by storm

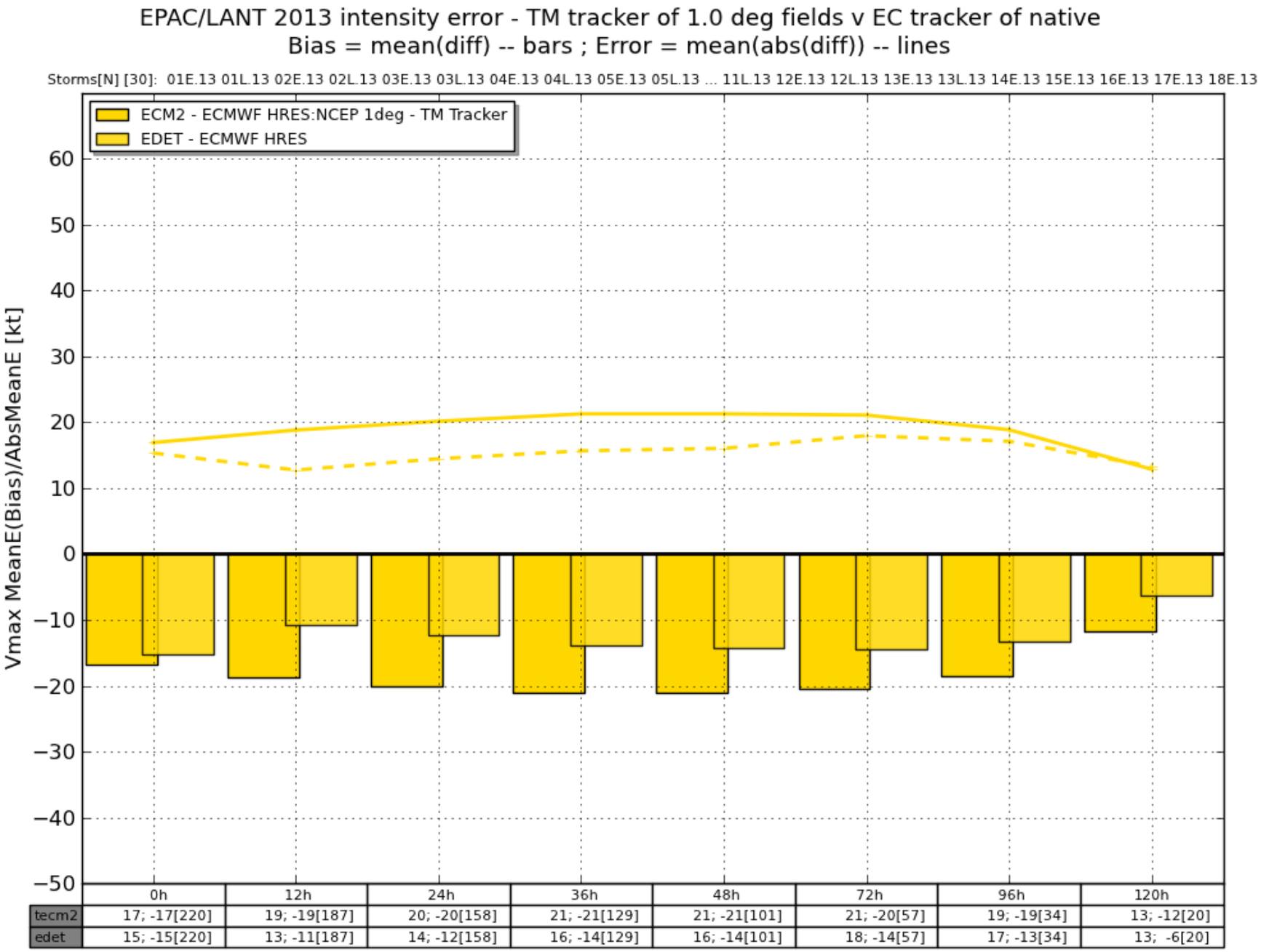


	01L	02L	03L	04L	05L	06L	07L	08L	09L	10L	11L	12L	13L
hwrf					154[2]		11[1]		149[6]	84[2]	460[2]		
fim9					69[2]		67[1]		109[6]	61[2]	366[2]		
avno					94[2]		31[1]		123[6]	69[2]	282[2]		
edet					44[2]		109[1]		77[6]	62[2]	195[2]		

- 09L (HUMBERTO) most cases
- ECMWF has lower error for all storms except 07L (GABRIELLE – one case)
- HWRF problems with 05L, 09L, 11L

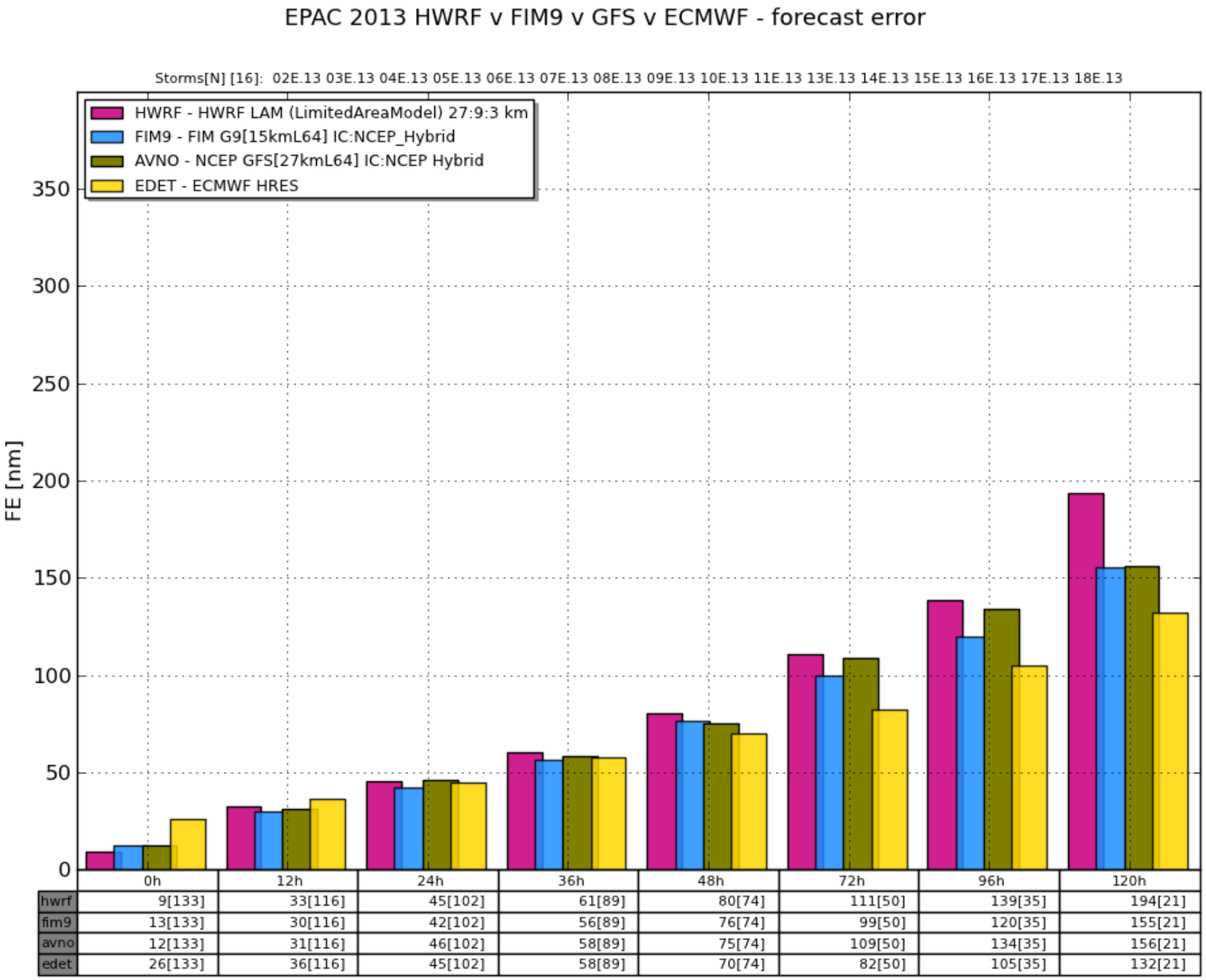
EPAC/LANT 2013 – ECMWF intensity errors

affect of grid resolution on intensity



- TM tracker uses 1.0 deg grids; ECMWF tracker ~ 15 km grids
- initial intensity bias similar…
- but decreases in time using full/native grids in the ECMWF tracker ~ 30-60%
- improving model intensity may come from initial storms becoming smaller during the forecast

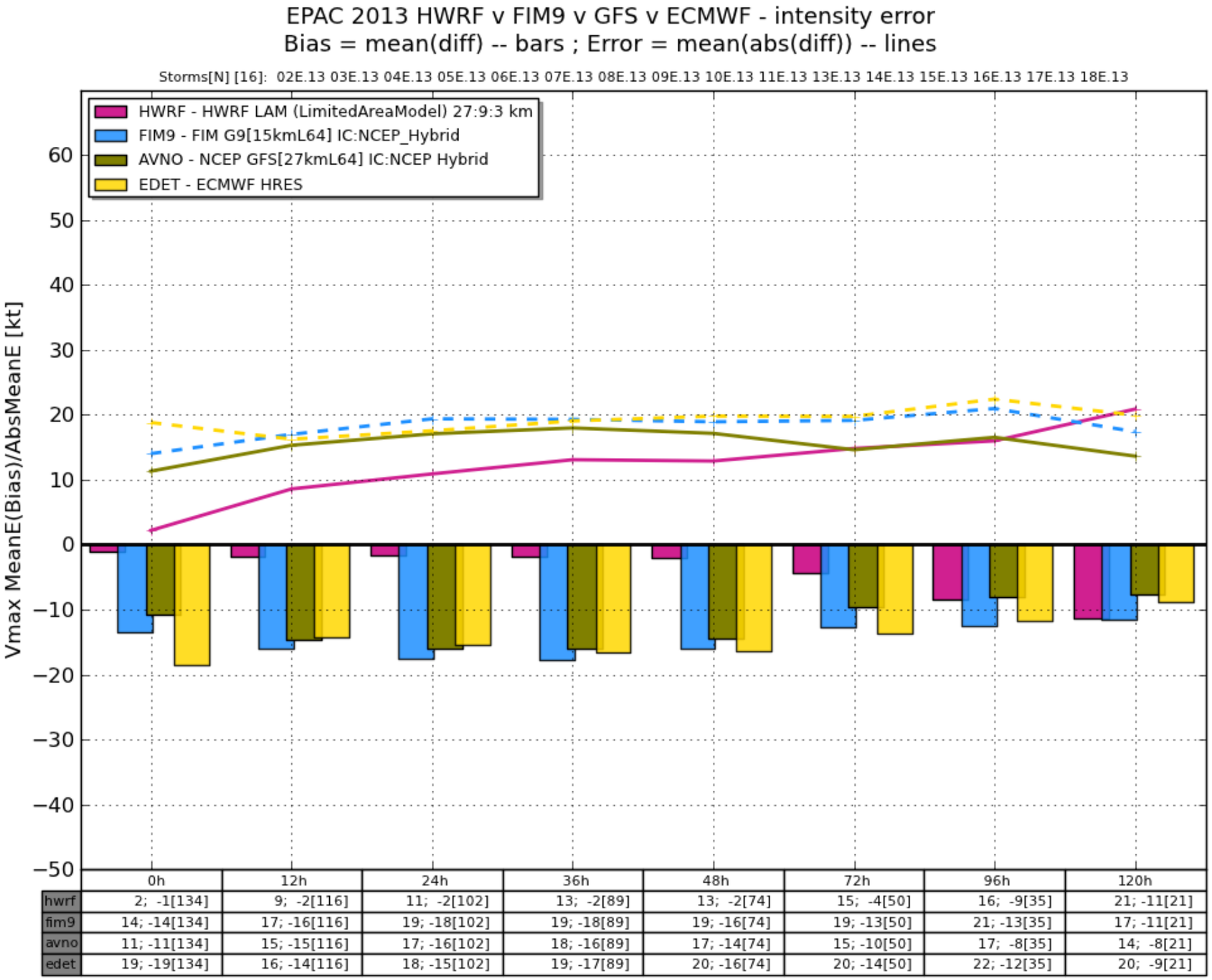
EPAC 2013 – forecast error



	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	9[133]	33[116]	45[102]	61[89]	80[74]	111[50]	139[35]	194[21]
fim9	13[133]	30[116]	42[102]	56[89]	76[74]	99[50]	120[35]	155[21]
avno	12[133]	31[116]	46[102]	58[89]	75[74]	109[50]	134[35]	156[21]
edet	26[133]	36[116]	45[102]	58[89]	70[74]	82[50]	105[35]	132[21]

- ECMWF still the gold standard…
- HWRF low initial position error, but higher error growth
- FIM9 >~ GFS – a good year for FIM in EPAC

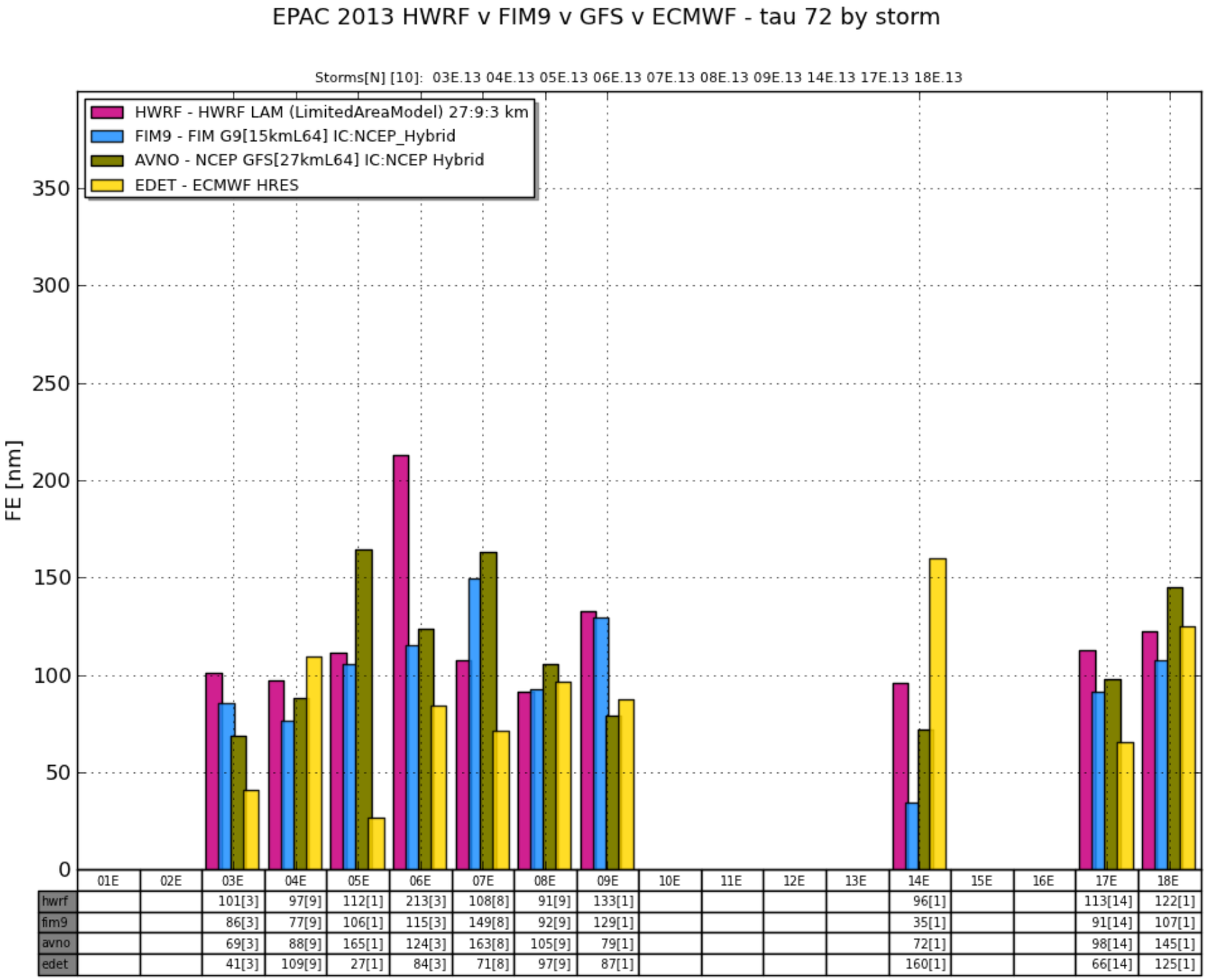
EPAC 2013 – intensity error



	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	2; -1[134]	9; -2[116]	11; -2[102]	13; -2[89]	13; -2[74]	15; -4[50]	16; -9[35]	21; -11[21]
fim9	14; -14[134]	17; -16[116]	19; -18[102]	19; -18[89]	19; -16[74]	19; -13[50]	21; -13[35]	17; -11[21]
avno	11; -11[134]	15; -15[116]	17; -16[102]	18; -16[89]	17; -14[74]	15; -10[50]	17; -8[35]	14; -8[21]
edet	19; -19[134]	16; -14[116]	18; -15[102]	19; -17[89]	20; -16[74]	20; -14[50]	22; -12[35]	20; -9[21]

- as in the LANT, ECMWF has highest initial intensity error
- HWRF very low initial intensity error, small bias taus 0-72 h, very good mean abs errors
- FIM9 has larger negative bias v GFS

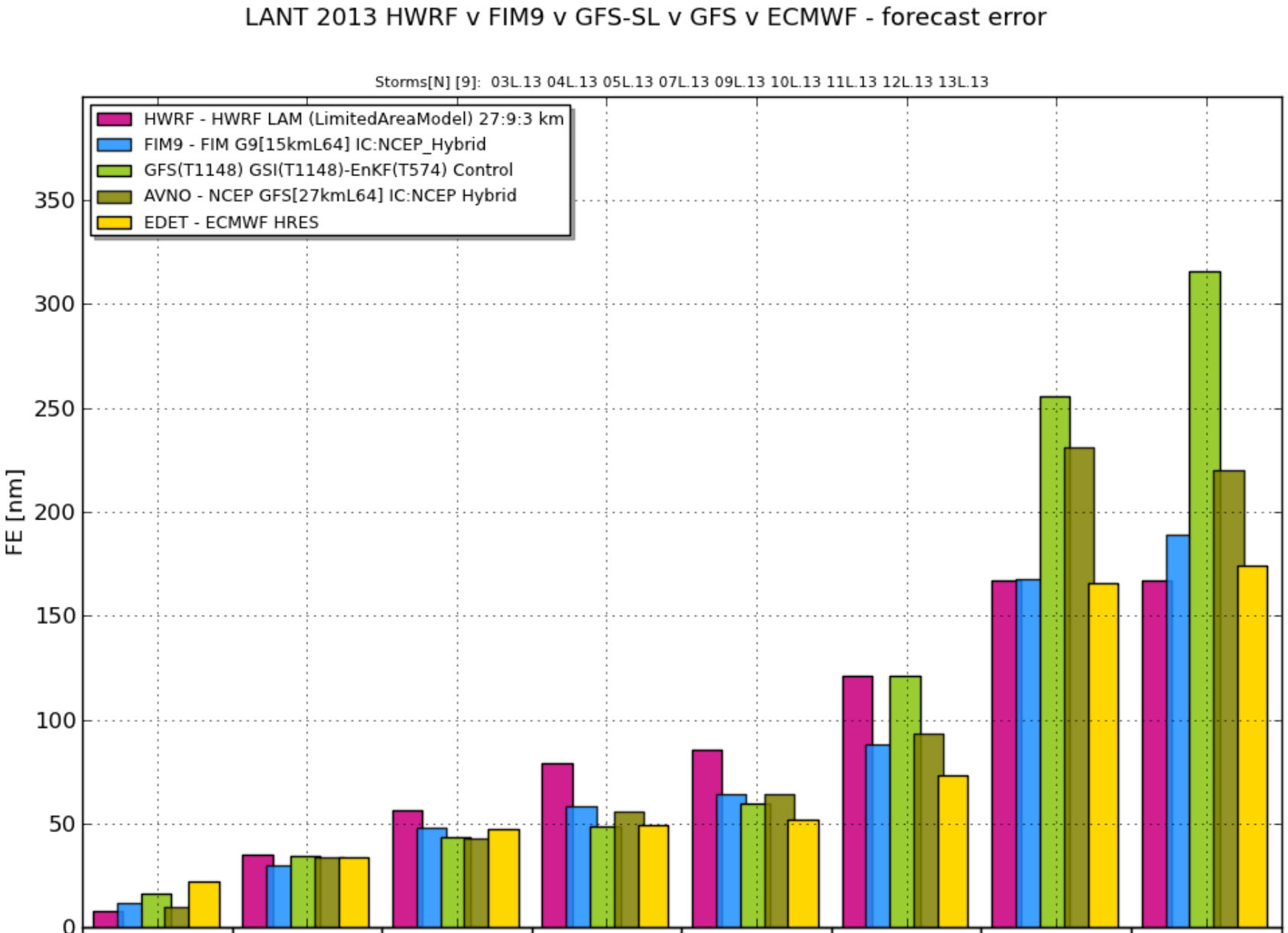
EPAC 2013 – tau 72 forecast error by storm



	01E	02E	03E	04E	05E	06E	07E	08E	09E	10E	11E	12E	13E	14E	15E	16E	17E	18E
hwrf			101[3]	97[9]	112[1]	213[3]	108[8]	91[9]	133[1]					96[1]			113[14]	122[1]
fim9			86[3]	77[9]	106[1]	115[3]	149[8]	92[9]	129[1]					35[1]			91[14]	107[1]
avno			69[3]	88[9]	165[1]	124[3]	163[8]	105[9]	79[1]					72[1]			98[14]	145[1]
edet			41[3]	109[9]	27[1]	84[3]	71[8]	97[9]	87[1]					160[1]			66[14]	125[1]

- largest contribution to 72-h mean error:
  - 04E (DALILA)
  - 07E (GIL)
  - 08E (HENRIETTE)
  - ***17E (RAYMOND)***
- ECMWF > all
  - 06E,07E, 17E,
- FIM9 > GFS
  - 04E, 07E, 08E, 17E

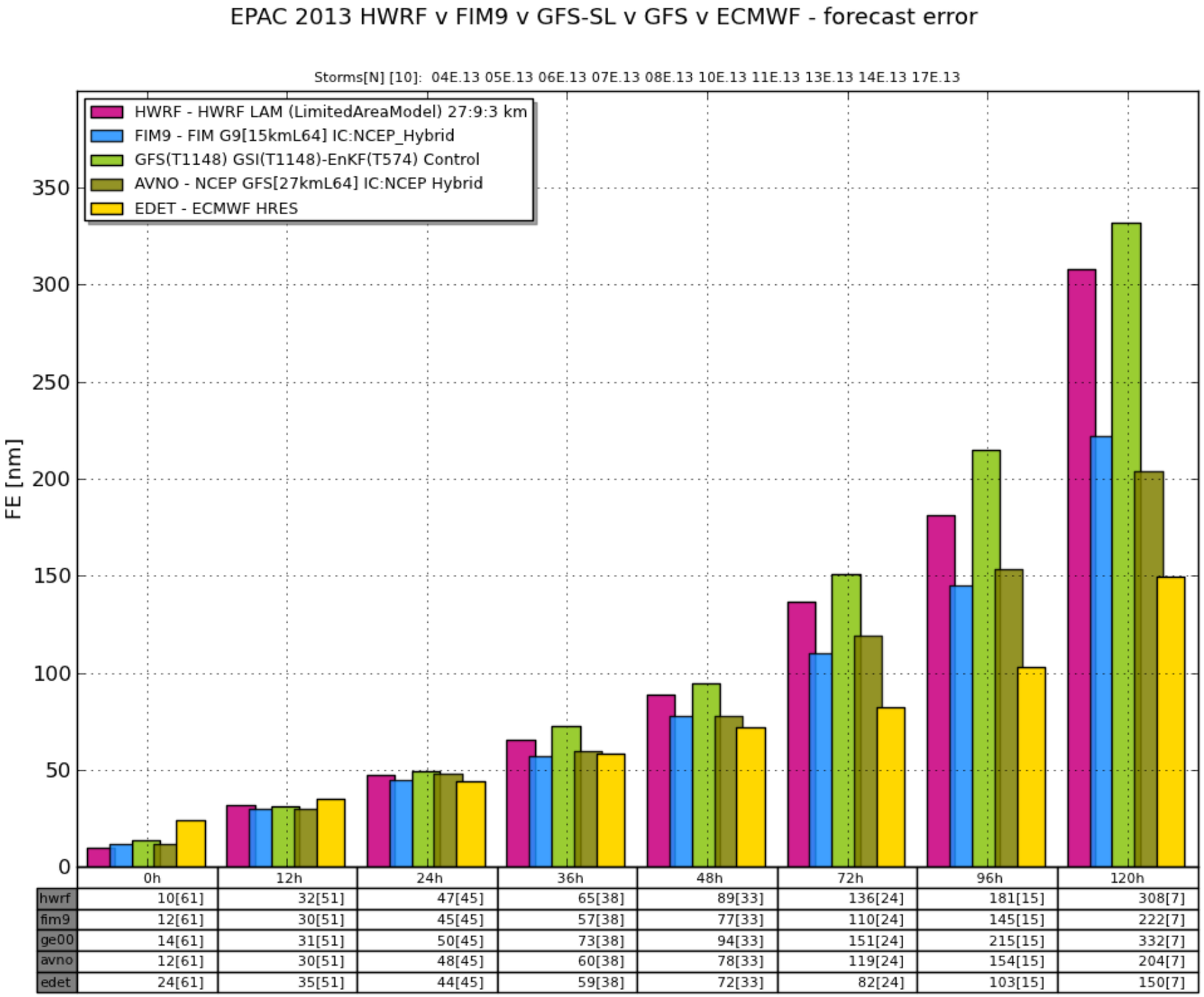
LANT 2013 – forecast error – add GFS-SL



	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	8[42]	35[33]	56[29]	79[24]	86[18]	121[10]	167[6]	167[7]
fim9	12[42]	30[33]	48[29]	58[24]	64[18]	88[10]	168[6]	189[7]
ge00	16[42]	34[33]	44[29]	49[24]	60[18]	121[10]	255[6]	316[7]
avno	10[42]	34[33]	43[29]	56[24]	64[18]	93[10]	231[6]	220[7]
edet	22[42]	34[33]	47[29]	50[24]	52[18]	73[10]	166[6]	174[7]

- fewer cases because of GFS-SL
- GFS-SL has higher initial position error
- GFS-SL ~ GFS 0-48 h but large error growth >= 72 h

EPAC 2013 – forecast error – add GFS-SL

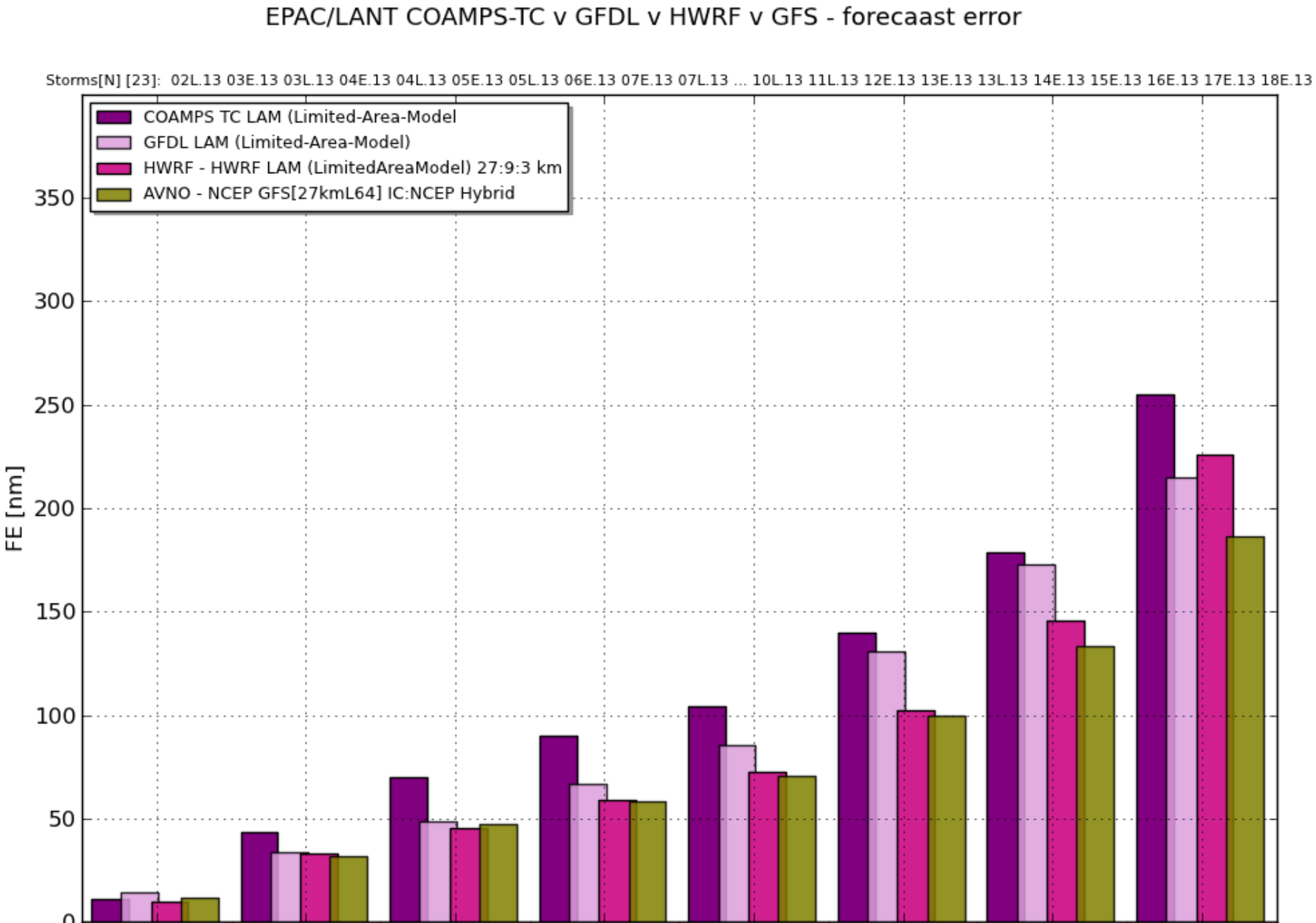


	0h	12h	24h	36h	48h	72h	96h	120h
hwrf	10[61]	32[51]	47[45]	65[38]	89[33]	136[24]	181[15]	308[7]
fim9	12[61]	30[51]	45[45]	57[38]	77[33]	110[24]	145[15]	222[7]
ge00	14[61]	31[51]	50[45]	73[38]	94[33]	151[24]	215[15]	332[7]
avno	12[61]	30[51]	48[45]	60[38]	78[33]	119[24]	154[15]	204[7]
edet	24[61]	35[51]	44[45]	59[38]	72[33]	82[24]	103[15]	150[7]

- fewer cases because of GFS-SL – 6 storms before the 1 AUG 13 start of the demo
- GFS-SL has greatest error growth
- ECMWF lowest error growth for tau >= 36h
- GFS-SL in WPAC even worse…

other GFS-based models: COAMPS-TC, GFDL

EPAC/LANT



	0h	12h	24h	36h	48h	72h	96h	120h
cotc	11[166]	43[151]	70[128]	90[109]	104[89]	140[54]	179[41]	255[27]
gfdl	15[166]	34[151]	49[128]	67[109]	86[89]	131[54]	173[41]	215[27]
hwrf	10[166]	33[151]	46[128]	59[109]	73[89]	102[54]	146[41]	226[27]
avno	12[166]	32[151]	47[128]	58[109]	71[89]	99[54]	133[41]	186[27]

- limited # of COTC runs in NHC adecks
- HWRF closer to GFS

Takeaways

- LANT 2013 stats cannot be indicative of model errors in general
  - need to dig into individual cases to understand if errors are systematic
- HWRF has very low initial position and intensity errors
  - vortex initialization recovers almost all of the Tcvitals
- FIM9 had a good year v GFS
- resolution not a sufficient condition for TC prediction success
  - COAMPS-TC v GFDL v HWRF v GFS-SL
- doubling the resolution of the GFS degraded TC performance
  - consistent with experience at ECMWF – need to 'adapt' physics to new resolution