

Verification of Tropical Cyclone Genesis Prediction in a Suite of Operational Global Numerical Weather Prediction Models



Mike Fiorino

`michael.fiorino@noaa.gov`

Commander, United States Navy (retired)

B.S. ('75 PSU), M.S. ('78 PSU), Ph.D. ('87 NPS) all in Meteorology

NOAA ESRL Boulder CO

5 March 2014

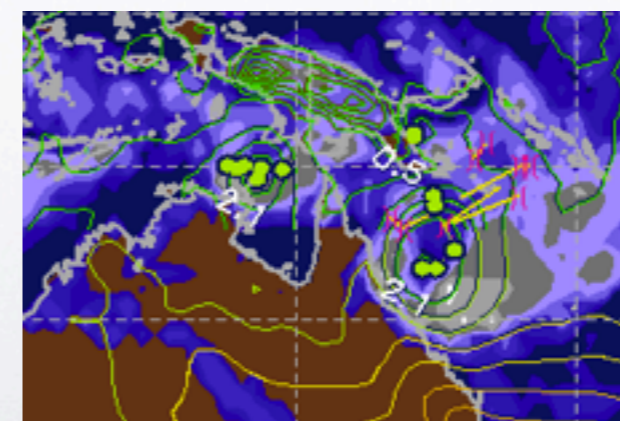
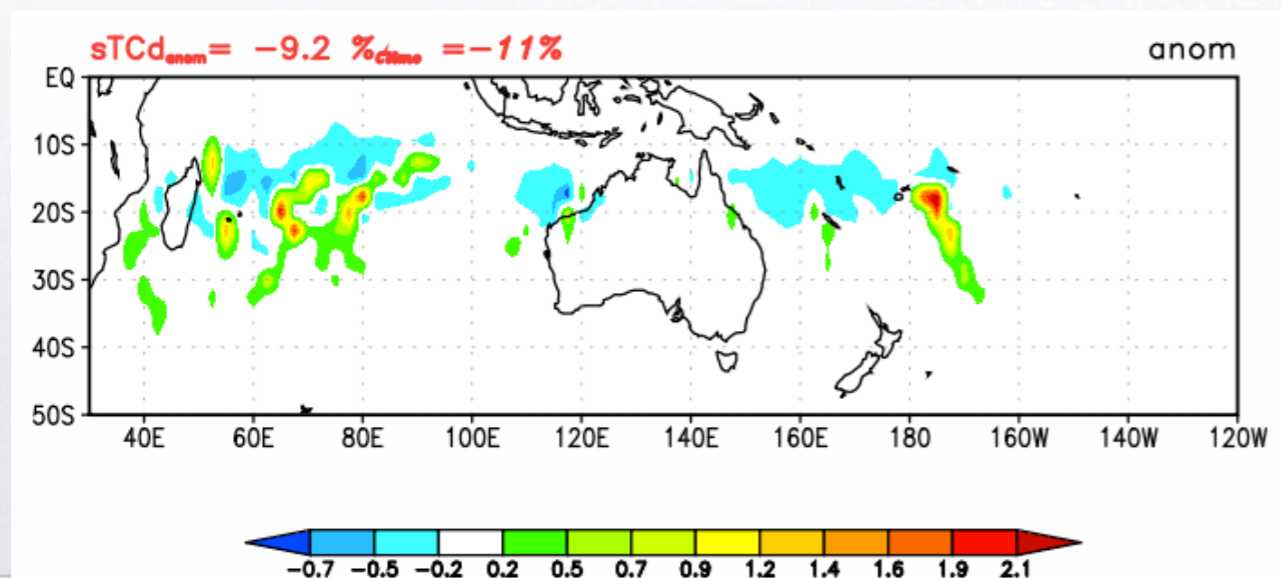
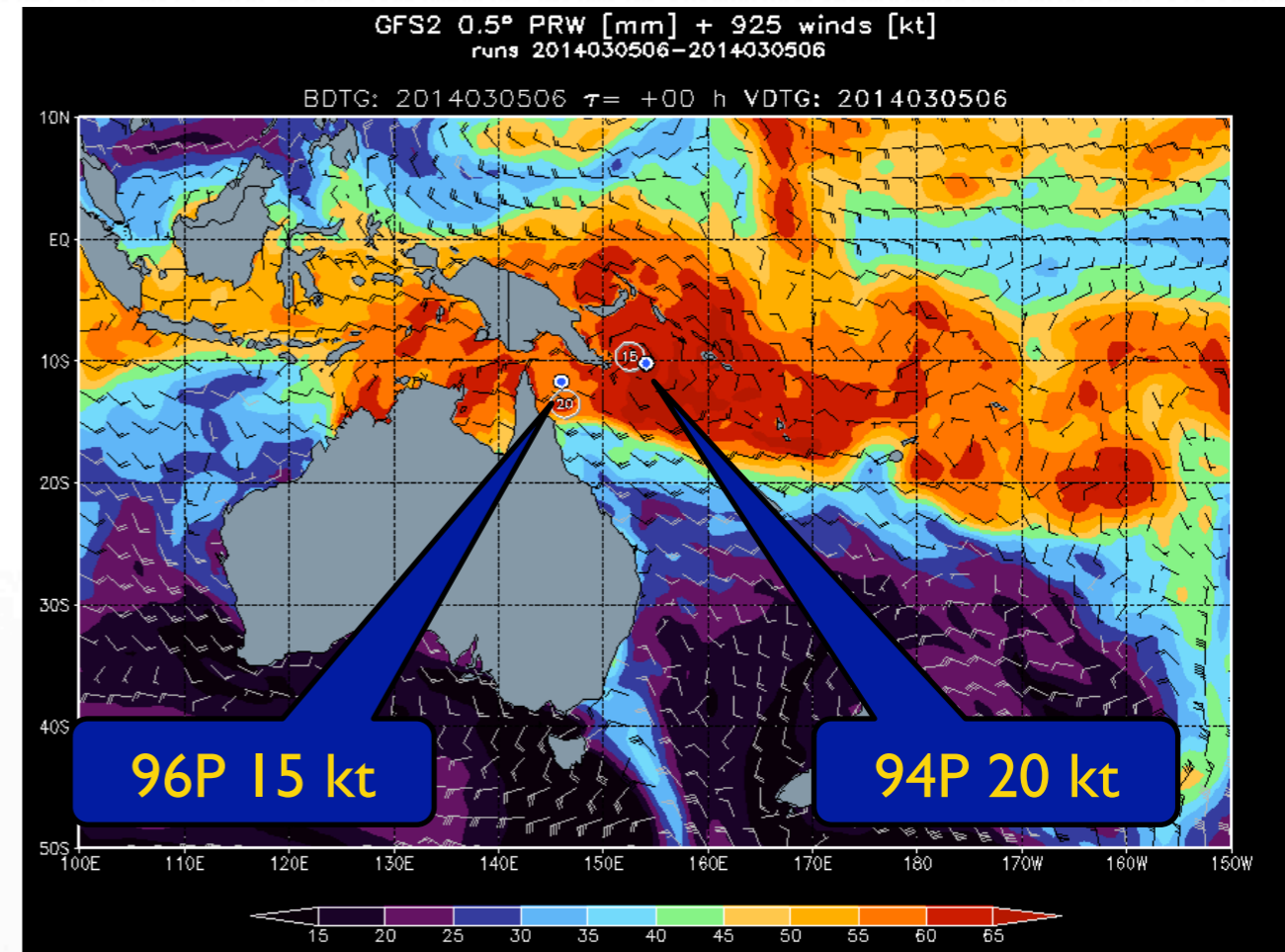
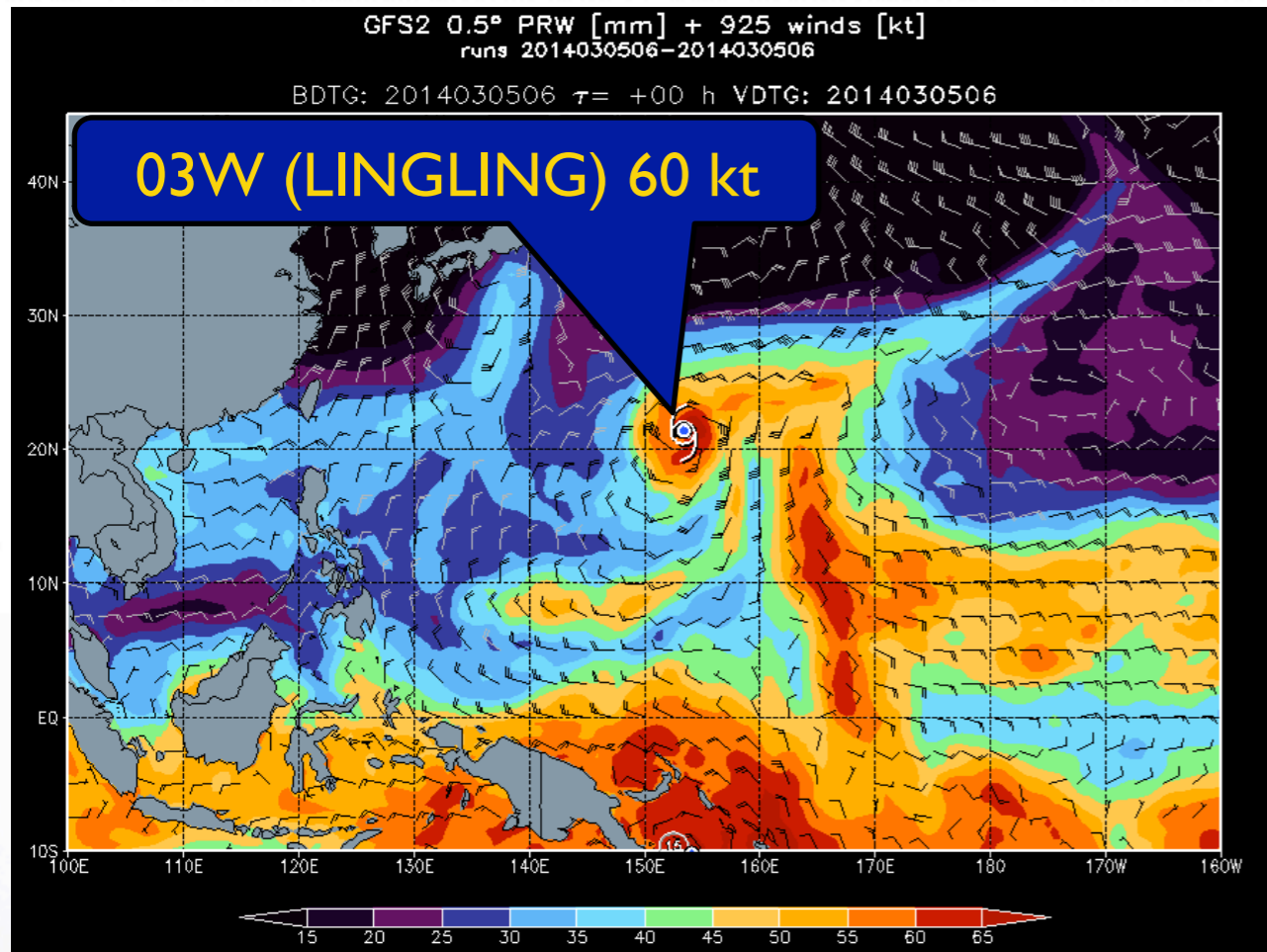


- R2O v O2R
 - JTWC/FNMOC: STY Abbey 1983 – PhD dissertation on the nonlinear dynamics of beta gyres
 - NHC: potential of global models to forecast TC genesis
- TCgen2 and the TC menagerie
- HFIP 2013 demo v 2010 demo – verification in LANT/EPAC/WPAC
- Prospects for accurate model TC genesis forecasts...are very good

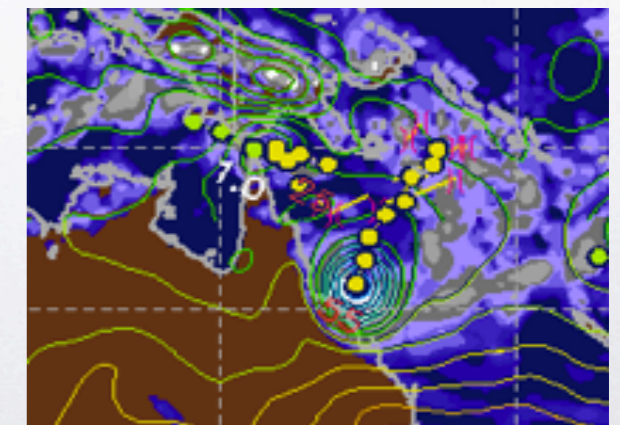
METCON 2014030506

03W, 94P, 96P

slide 2



ECMWF HRES D+3



NCEP GFS D+3

TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



...maybe those d!*#%ng models are pretty good after all...

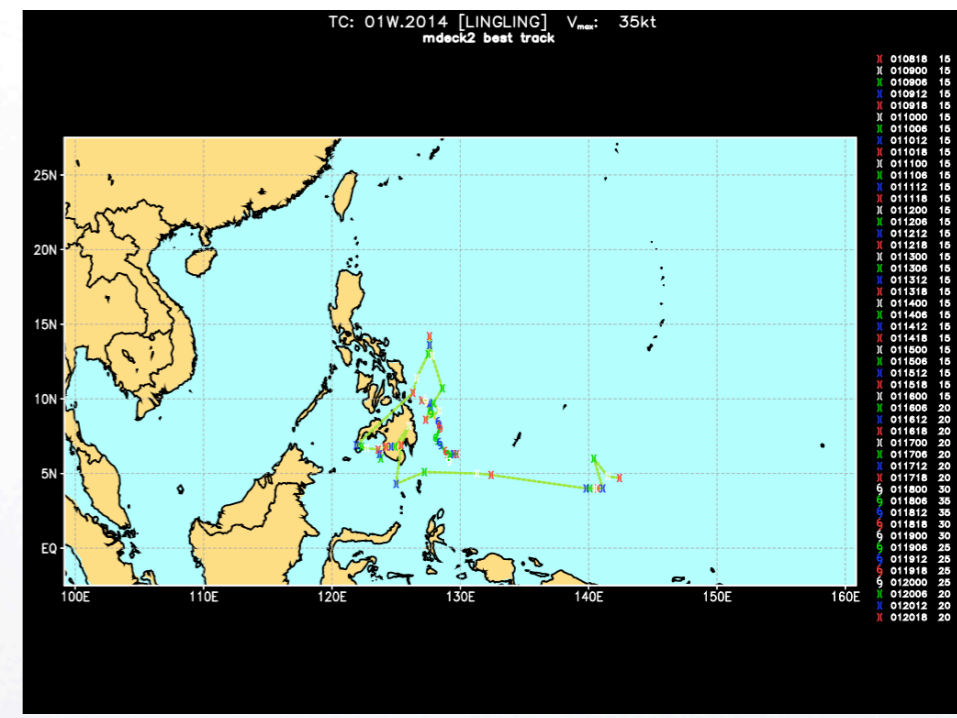
01W.2014 (LINGLING)

slide 3

"The models are getting downright phenomenal in their skill and usefulness. Several days ago, the NVG and GFS began picking-up on 91W making it to the Philippines, and these two models have been (somewhat) consistent in track and timing ever since."

Mark Lander, UofGuam in an email to tstorm.org list on 2014010909

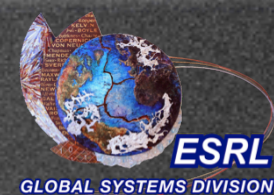
2014010818	A1W.2014	015	----	4.7	142.4E	---	---	303.1	11.9	B	NT	NW	---	1/38	lf: 0.00									
2014010900	A1W.2014	015	----	4.8	141.5E	---	---	303.1	11.9	B	NT	NW	---	2/38	lf: 0.00									
2014010906	A1W.2014	015	----	6.0	140.4E	---	---	303.1	11.9	B	NT	NW	---	3/38	lf: 0.00									
2014010912	A1W.2014	015	----	4.0	141.1E	---	---	206.5	4.5	B	NT	NW	---	4/38	lf: 0.00									
.																								
2014011706*	A1W.2014	020	1007	9.7	127.9E	---	---	230.0	2.0	C	DB	NW	---	35/38	lf: 0.00	INVEST	<***Genesis							
2014011712*	A1W.2014	020	1007	9.7	127.6E	---	---	255.0	2.0	C	DB	NW	---	36/38	lf: 0.00	INVEST	<***Genesis							
2014011718*	A1W.2014	020	1005	9.9	127.0E	---	---	280.0	4.0	C	DB	NW	---	37/38	lf: 0.00	INVEST	<***Genesis							
2014011800*	A1W.2014	030	1000	9.9	127.3E	---	---	304.1	1.8	B	TD	NW	---	38/38	lf: 0.00		<***Genesis							
2014011806*	01W.2014	035	996	8.9	127.8E	---	---	156.3	4.9	B	TS	WN	TJM	20/30	lf: 0.00	LINGLING	<***Genesis							
2014011812*	01W.2014	035	996	8.4	128.3E	---	---	138.1	7.4	B	TS	WN	TJM	21/30	lf: 0.00	LINGLING	<***Genesis							
.																								
2014011918	01W.2014	025	1004	6.6	128.7E	---	---	140.4	3.9	B	TD	WN	SJB	26/30	lf: 0.00	LINGLING								
2014012000	01W.2014	025	1008	6.3	129.0E	---	---	135.2	4.2	B	TD	NW	---	27/30	lf: 0.00	LINGLING								
2014012006	01W.2014	020	1004	6.3	129.2E	---	---	121.1	2.9	B	TD	NW	---	28/30	lf: 0.00	LINGLING								
2014012012	01W.2014	020	1004	6.3	129.5E	---	---	90.0	2.5	B	TD	NW	---	29/30	lf: 0.00	LINGLING								
2014012018	01W.2014	020	1007	6.3	129.7E	---	---	90.0	2.5	B	TD	NW	---	30/30	lf: 0.00									
2014 01W	TS	LINGLING	:	35	:	3.2;	7.2	:	8.9	127.9	:	010818<->012018	:	6.3<->11.9	:	126.3<->129.7	:	0.8	:	0.1	:	0:	0:	0:
tG:222	9X:	91W	1st:	011800																				



- 01W.2014 was 91W for 222 h before JTWC issued 1st warning
- similar to observations of the NHC specialists 2006-2008 that if the big three models (GFS/ECMWF/UKMO) forecast the formation of a cyclone, then...



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



main ingredients of TCgen2

<http://ruc.noaa.gov/hfip/tcgen> (password protected, .com excluded) slide 4

- **TIM's (TCs In Models) cyclone tracker**
 - ▶ tracker mode – track cyclones from an initial position in the initial conditions (*a priori*)
 - ▶ genesis mode – find and track cyclones *during* the integration (*a posteriori*)
 - ▶ measure of model cyclone strength – scaled Tropical Depression days (sTDd)
- **Genesis definition**
 - ▶ 30-h period around the first advisory(NHC)/warning(JTWC) to give models running at 00/12 UTC three chances to forecast genesis
- **TC demographics of ?TCs and spuricanes**
- **Scheme to match model cyclones (genesis & tracker) to real ?TCs**
 - ▶ compare positions of ?TCs to model TCs within a 24-h window before the forecast time
 - ▶ a bit of an accounting nightmare...
- **Weather maps + model diagnostics**
 - ▶ sanity check the tracker and matching scheme ; synoptic evaluation
 - ▶ basin-wide, over-ocean precipitation + ratio of convective/total precip



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



pTCs, TCs, mTCs, aTCs and the **SPURICANE** the TC menagerie

slide 5

Type	Naming	Features
TC	01-50 numbered TCs 01W.2014 TC #1 in WESTPAC in 2014	tropical cyclone as analyzed by JTWC/NHC ATCF TC designations: TD, TS, TY, HU, STY, [SD, SS] ATCF non-TC designations: PT, XT, ET
pTC	9X or INVEST systems 94S.2014 – the landphoon over eastern OZ	pre/potential TC as analyzed by JTWC/NHC ATCF designations: LO, DB, WV
mTC	TGNNNN NN or 9X	model cyclone from a tracker
aTC	TGNNNN	initial mTC that the model maintains for ≥ 24 h
SPURICANE	TGNNNN	<ol style="list-style-type: none"> I. mTC that <u>cannot be associated</u> with a TC, pTC, aTC II. mTC <u>associated</u> with a <u>dissipated</u> ?TC



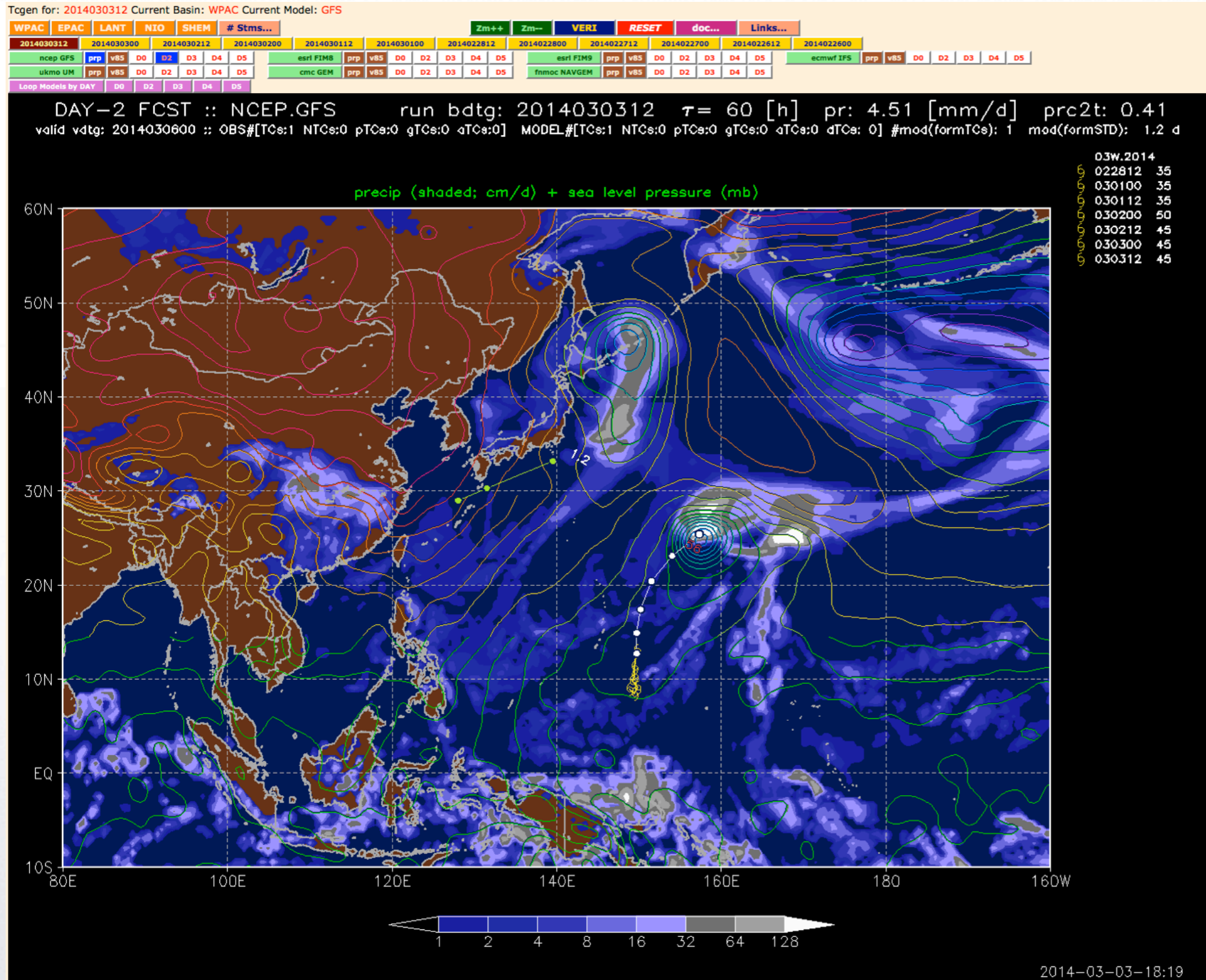
TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – front page – FCST mode – forecast

<http://ruc.noaa.gov/hfip/tcgen>

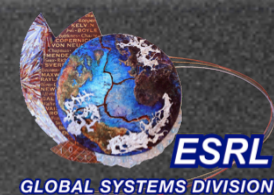
slide 6



- 7 models
 - ▶ GFS (27 kmL64)
 - ▶ FIM8 (30kmL64), FIM9 (15kmL64)
 - ▶ ECMWF HRES (16 kmL137)
 - ▶ UKMO (30 kmL70)
 - ▶ NAVGEML42 (37 kmL52)
 - ▶ CMC-GDPS (33 kmL79)
- +12 h model forecast for consistency with forecast e.g, day+2 (D2) uses 60 h model forecast
- tropical ocean-only precip stats for model diagnostics...
- model and observed ? TCs
- FCST (forecast) & VERI (verification) modes
- single model or loop mode



TC genesis in a suite of global models
 Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – two WxMAP2 product: thermo (precip)

<http://ruc.noaa.gov/hfip/tcgen>

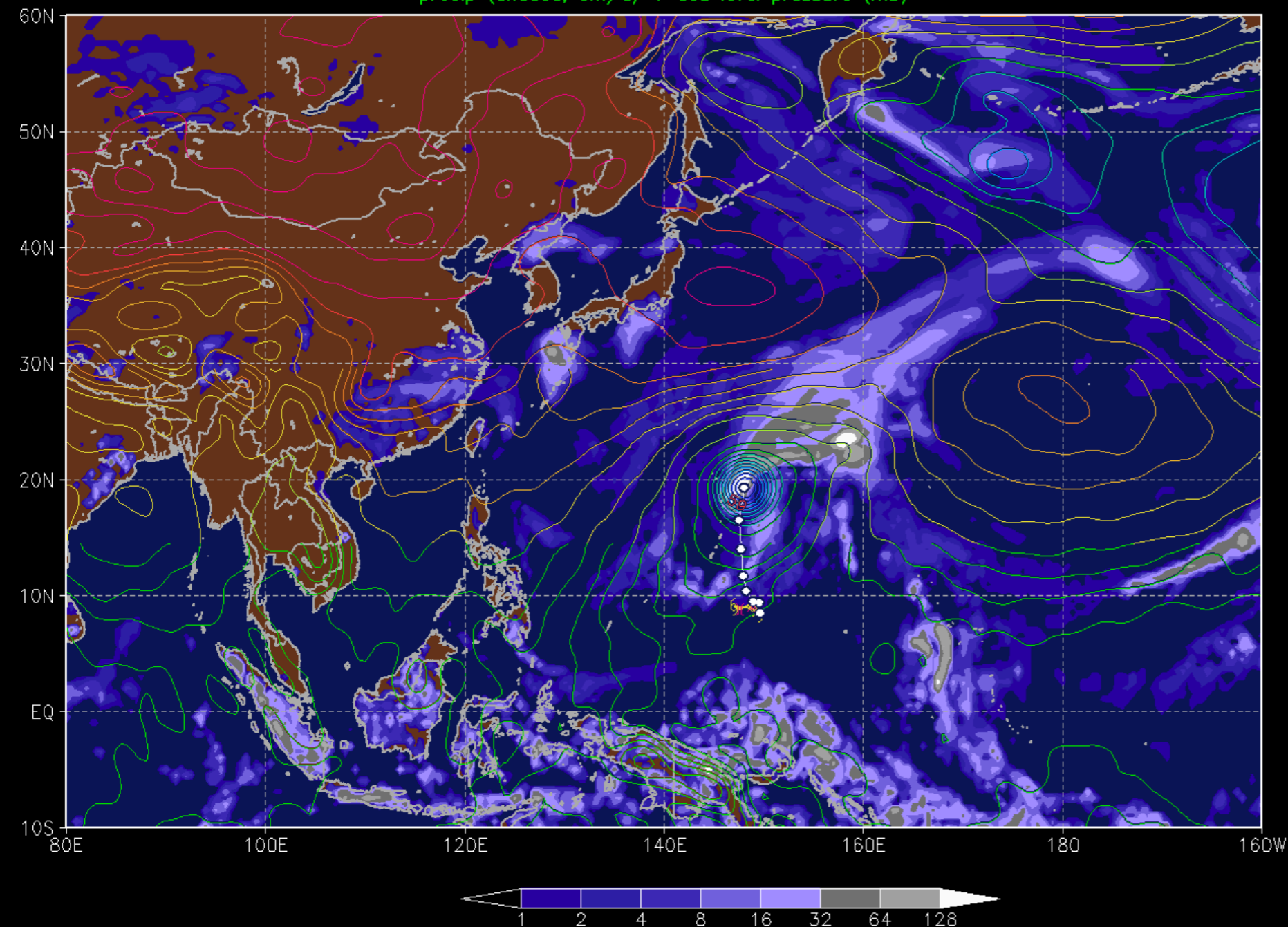
slide 7

DAY-3 FCST :: NCEP.GFS run bdtg: 2014030100 $\tau = 84$ [h] pr: 4.36 [mm/d] prc2t: 0.55
valid vdtg: 2014030412 :: OBS#[TCs:1 NTCs:0 pTCs:0 gTCs:0 aTCs:0] MODEL#[TCs:1 NTCs:0 pTCs:0 gTCs:0 aTCs:0 dTCs:0] #mod(formTCs): 0 mod(formSTD): 0.0 d

precip (shaded; cm/d) + sea level pressure (mb)

03W.2014	
(	022600 20
(	022612 20
(	022700 20
(	022712 20
(	022800 25
(	022812 35
(	030100 35

- thermo (precip) and mass (sea-level pressure)
- D3 forecast (tau 84) for 03W verifying today (030412)



2014-03-01-06:19



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – two WxMAP2 products: dynamical (NHC 850 McAdie chart)

<http://ruc.noaa.gov/hfip/tcgen>

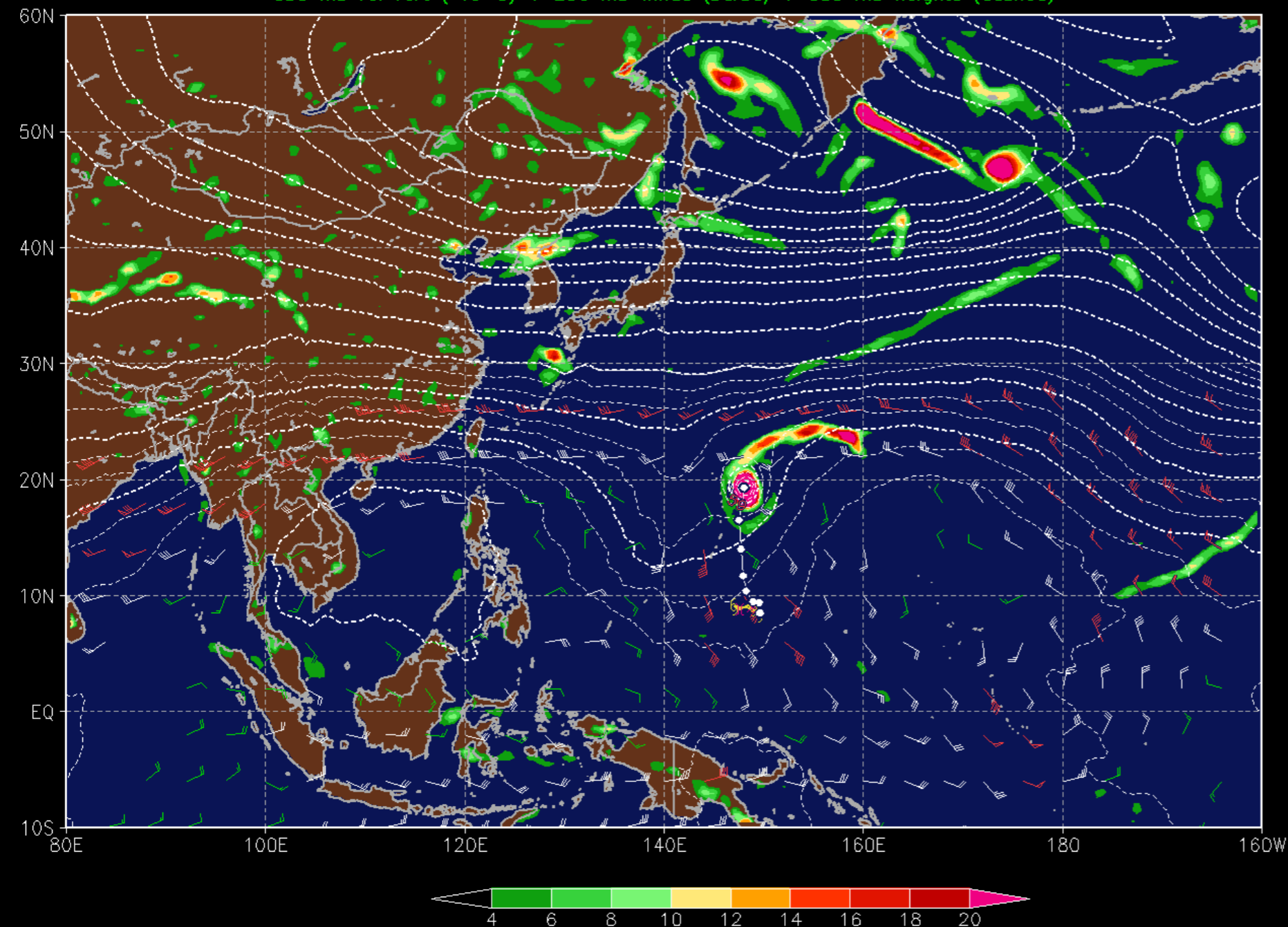
slide 8

DAY-3 FCST :: NCEP.GFS run bdtg: 2014030100 $\tau = 84$ [h] pr: 4.36 [mm/d] prc2t: 0.55
valid vdtg: 2014030412 :: OBS#[TCs:1 NTCs:0 pTCs:0 gTCs:0 aTCs:0] MODEL#[TCs:1 NTCs:0 pTCs:0 gTCs:0 aTCs:0 dTCs:0] #mod(formTCs): 0 mod(formSTD): 0.0 d

850 mb rel vort ($\times 1e-5$) + 200 mb winds (barbs) + 500 mb heights (dashed)

03W.2014	
(	022600 20
(	022612 20
(	022700 20
(	022712 20
(	022800 25
(	022812 35
(	030100 35

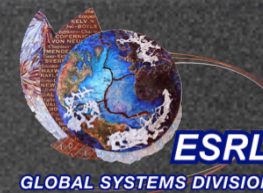
- dynamics – 850 mb relative vorticity
- mass – 500 mb heights – STR & breaks
- dynamics – 200 mb wind – shear



2014-03-01-06:19



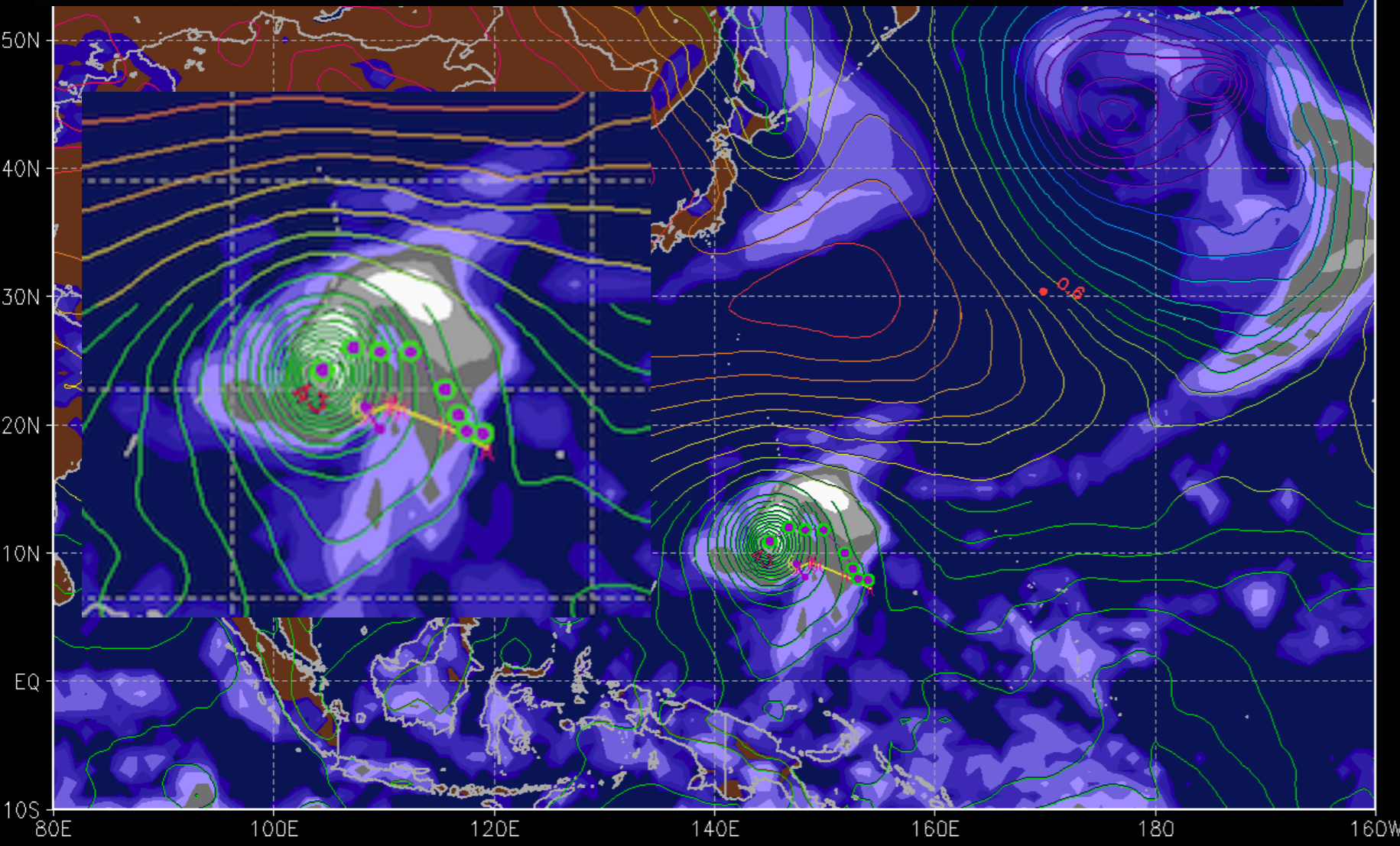
TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



DAY-5 VERI :: CMC.GEM valid vdtg: 2014022800 $\tau=132$ [h] pr: 4.97 [mm/d] prc2t: N/A
 run bdtg: 2014022212 :: OBS#[TCs:1 NTCs:0 pTCs:0 gTCs:1 aTCs:0] MODEL#[TCs:0 NTCs:0 pTCs:0 gTCs:1 aTCs:0] #mod(spurTCs): 1 mod(spurSTD): 0.6 d

OBS#[TCs:1 NTCs:0 pTCs:0 gTCs:1 aTCs:0]
 MODEL#[TCs:0 NTCs:0 pTCs:0 gTCs:1 aTCs:0]

03W.2014	
(	022500 15
(	022512 15
(	022600 20
(	022612 20
(	022700 20
(	022712 20
Ⓞ	022800 25

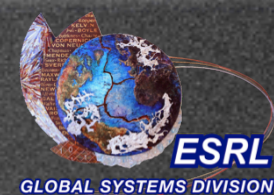


- first JTWC warning for 03W on 2014022800 – genesis
- CMC mTC located ‘near enough’ to 03W to be declared a ‘hit’ of genesis forecast $V_{max}=43$ kt
- spurricane on top of tropical band

2014-02-28-06:29



TC genesis in a suite of global models
 Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – VERI mode – spuricanes class I & 2 – NCEP GFS D+2 forecast

<http://ruc.noaa.gov/hfip/tcgen>

slide 10

DAY-2 VERI :: NCEP.GFS valid vdtg: 2014030312 $\tau = 60$ [h] pr: 5.08 [mm/d] prc2t: 0.92
 run bdtg: 2014030100 :: OBS#[TCs:1 NTCs:0 pTCs:1 gTCs:0 aTCs:0] MODEL#[TCs:1 NTCs:0 pTCs:1 gTCs:0 aTCs:0 dTCs:1] #mod(spurTCs): 7 mod(spurSTD): 2.6 d

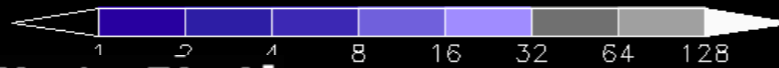
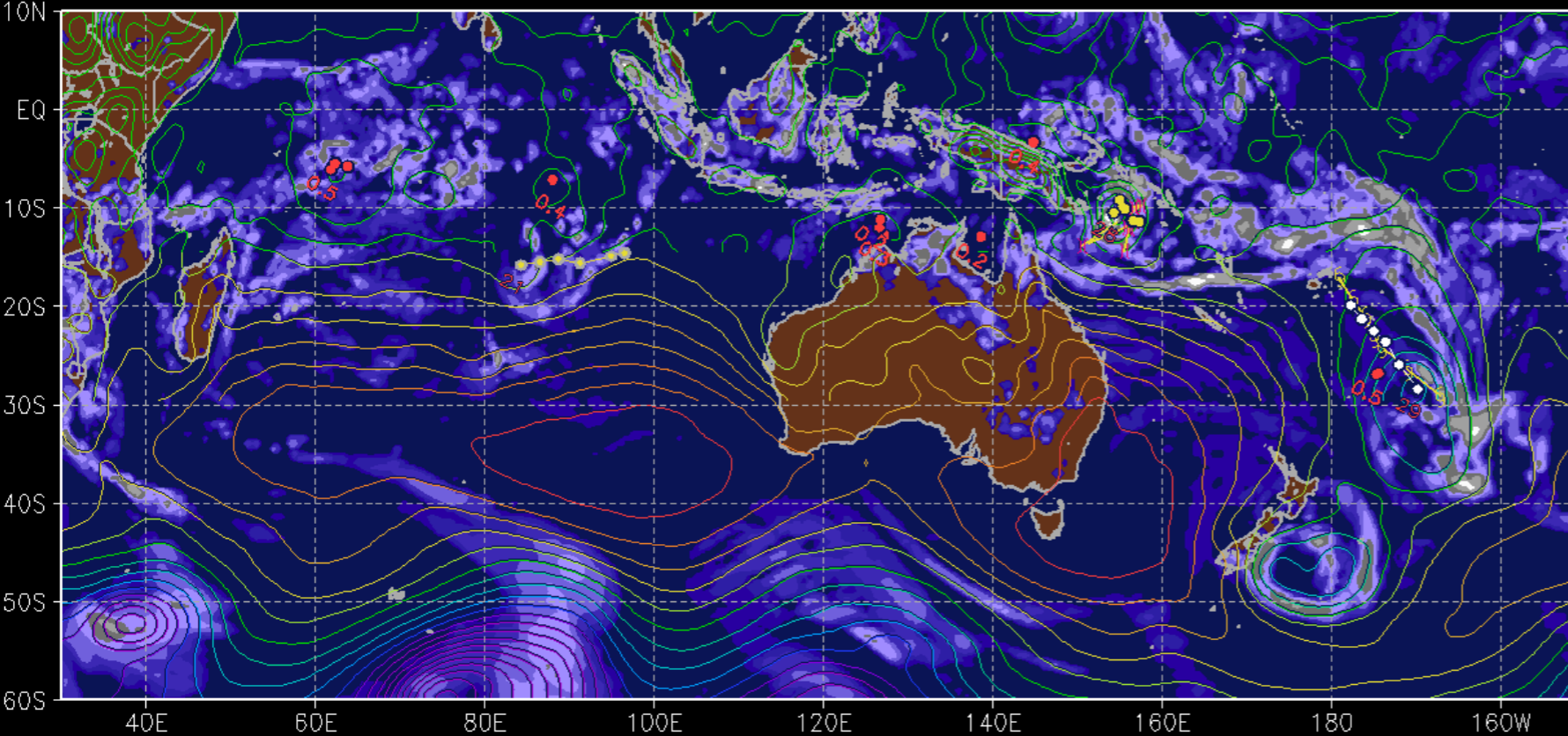
pr: 5.08 [mm/d] prc2t: 0.92
 pr: 5.62 [mm/d] prc2t: 0.64

GFS
 FIM9

16P.2014
 022812 35
 030100 35
 030112 45
 030200 45
 030212 45
 030300 50
 030312 45

94P.2014
 022812 15
 030100 15
 030112 20
 030200 20
 030212 20
 030300 20
 030312 20

precip (shaded; cm/d) + sea level pressure (mb)



OBS#[TCs:1 NTCs:0 pTCs:1 gTCs:0 aTCs:0]

MODEL#[TCs:1 NTCs:0 pTCs:1 gTCs:0 aTCs:0 dTCs:1] #mod(spurTCs): 7 mod(spurSTD): 2.6 d

2014-03-03-18:20

- GFS correctly forecasts both TC 16P and pTC 96P
- 7 class I spuricanes but sTDd ≤ 0.5 d
- model maintained a TC that dissipated – class II spurricane



TC genesis in a suite of global models
 Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – seasonal verification – LANT 2013 – D+2 & D+5

<http://ruc.noaa.gov/hfip/tcgen>

slide 11

TCgen Stats :: **Gentau: 60 [h]** Basin: LANT Year: 2013 Models: CMC.GEM, ECMWF.IFS, ESRL.FIM, NCEP.GFS, FNMOC.NAVGEM, ESRL.FIM9, UKMO.UM

Storm	CMC.GEM	ECMWF.IFS	ESRL.FIM	NCEP.GFS	FNMOC.NAVGEM	ESRL.FIM9	UKMO.UM	
01L.2013 [TS 055 kt] ANDREA	3/ 3.1	3/ 2.0	2/ 1.1	2/ 1.7	0/----	2/ 1.5	2/ 1.9	86
02L.2013 [TS 040 kt] BARRY	0/----	0/----	1/ 0.4	0/----	0/----	1/ 0.5	0/----	29
03L.2013 [TS 055 kt] CHANTAL	0/----	0/----	0/----	0/----	0/----	0/----	0/----	----
04L.2013 [TS 055 kt] GABRIELIAN	3/ 1.4	1/ 0.9	1/ 0.5	2/ 1.0	2/ 0.6	1/ 0.5	1/ 0.3	100
05L.2013 [TS 055 kt] JERRY	1/ 0.3	1/ 0.3	1/ 0.5	1/ 0.5	1/ 0.4	0/----	1/ 0.3	86
06L.2013 [TS 055 kt] NERNAND	0/----	0/----	0/----	0/----	1/ 0.9	0/----	0/----	14
07L.2013 [TS 050 kt] GABRIELLE	3/ 2.6	3/ 1.5	3/ 2.0	3/ 2.3	3/ 1.8	2/ 1.6	3/ 2.0	100
08L.2013 [TD 030 kt] EIGHT	0/----	2/ 0.6	0/----	3/ 1.7	0/----	0/----	0/----	29
09L.2013 [HU1 075 kt] HUMBERTO	2/ 0.6	3/ 1.3	2/ 1.3	2/ 1.3	0/----	2/ 1.0	2/ 1.2	86
10L.2013 [HU1 075 kt] INGRID	1/ 0.5	3/ 0.9	2/ 1.1	2/ 0.6	2/ 1.0	3/ 1.6	1/ 0.4	100
11L.2013 [TS 045 kt] JERRY	0/----	0/----	1/ 0.5	0/----	0/----	1/ 0.6	0/----	29
12L.2013 [TS 055 kt] KAREN	0/----	1/ 0.3	1/ 1.0	1/ 0.7	3/ 1.8	-1/----	2/ 0.8	83
13L.2013 [TS 045 kt] LORENZO	0/----	1/ 0.3	0/----	0/----	1/ 0.7	0/----	0/----	29
14L.2013 [TS 055 kt] MELISSA	3/ 4.0	2/ 2.4	2/ 2.6	2/ 2.6	2/ 2.4	2/ 2.6	2/ 2.2	100
bottomline by model	50	71	71	64	57	62	57	

D+2

box color	key
-1/----	no model run
0/----	0 forecasts of genesis
1/ 0.5	1 of 3 forecast verified
2/ 1.5	2/3 forecasts verified
3/ 3.6	3/3 forecasts verified
----	0%
14	< 25 %
29	25 >= % < 75
83	>= 75

TCgen Stats :: **Gentau: 132 [h]** Basin: LANT Year: 2013 Models: CMC.GEM, ECMWF.IFS, ESRL.FIM, NCEP.GFS, FNMOC.NAVGEM, ESRL.FIM9, UKMO.UM

Storm	CMC.GEM	ECMWF.IFS	ESRL.FIM	NCEP.GFS	FNMOC.NAVGEM	ESRL.FIM9	UKMO.UM	
01L.2013 [TS 055 kt] ANDREA	3/ 3.0	3/ 1.6	1/ 0.3	3/ 2.2	1/ 0.2	1/ 0.7	0/----	86
02L.2013 [TS 040 kt] BARRY	2/ 0.6	2/ 0.8	3/ 0.9	1/ 0.4	0/----	3/ 1.0	1/ 0.7	86
03L.2013 [TS 055 kt] CHANTAL	0/----	0/----	0/----	0/----	0/----	0/----	0/----	----
04L.2013 [TS 055 kt] GABRIELIAN	2/ 0.8	0/----	0/----	1/ 0.4	0/----	0/----	0/----	29
05L.2013 [TS 055 kt] JERRY	0/----	0/----	0/----	3/ 1.2	0/----	1/ 0.5	0/----	29
06L.2013 [TS 055 kt] NERNAND	0/----	1/ 0.4	0/----	1/ 0.4	0/----	0/----	0/----	29
07L.2013 [TS 050 kt] GABRIELLE	3/ 3.7	2/ 0.7	1/ 0.5	2/ 1.5	2/ 1.1	0/----	3/ 2.0	86
08L.2013 [TD 030 kt] EIGHT	0/----	0/----	0/----	2/ 0.7	1/ 0.5	0/----	0/----	29
09L.2013 [HU1 075 kt] HUMBERTO	3/ 1.9	3/ 1.3	0/----	2/ 1.6	1/ 0.2	2/ 1.5	3/ 1.5	86
10L.2013 [HU1 075 kt] INGRID	0/----	1/ 0.3	0/----	3/ 1.5	0/----	0/----	0/----	29
11L.2013 [TS 045 kt] JERRY	2/ 2.4	0/----	0/----	0/----	3/ 1.7	0/----	0/----	29
12L.2013 [TS 055 kt] KAREN	2/ 1.4	1/ 0.2	2/ 2.3	2/ 1.5	0/----	-1/----	1/ 0.5	83
13L.2013 [TS 045 kt] LORENZO	3/ 3.0	0/----	0/----	0/----	0/----	0/----	0/----	14
14L.2013 [TS 055 kt] MELISSA	3/ 3.6	2/ 1.7	2/ 2.5	2/ 2.0	2/ 2.0	2/ 1.7	2/ 1.9	100
bottomline by model	64	57	36	79	43	38	36	

D+5



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – seasonal verification – WPAC 2013 – D+2 & D+5

<http://ruc.noaa.gov/hfip/tcgen>

slide 12

TCgen Stats :: **Gentau: 60 [h]** Basin: **WPAC** Year: **2013** Models: **CMC.GEM, ECMWF.IFS, ESRL.FIM, NCEP.GFS, FNMOC.NAVGEM, ESRL.FIM9, UKMO.UM**

n Stats :: **Gentau: 132 [h]** Basin: **WPAC** Year: **2013** Models: **CMC.GEM, ECMWF.IFS, ESRL.FIM, NCEP.GFS, FNMOC.NAVGEM, .FIM9, UKMO.UM**

Storm	CMC.GEM	ECMWF.IFS	ESRL.FIM	NCEP.GFS	FNMOC.NAVGEM	ESRL.FIM9	UKMO.UM		Storm	CMC.GEM	ECMWF.IFS	ESRL.FIM	NCEP.GFS	FNMOC.NAVGEM	ESRL.FIM9	UKMO.UM	
01W.2013 [TS 045 kt] SONAMU	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	----	2013 [TS 045 kt] SONAMU	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	----
02W.2013 [TD 025 kt] SHANSHAN	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	----	2013 [TD 025 kt] SHANSHAN	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	----
03W.2013 [TS 055 kt] YAGI	3/ 3.6	0/----	3/ 2.5	3/ 2.6	1/ 0.3	3/ 2.6	2/ 1.0	86	2013 [TS 055 kt] YAGI	3/ 3.9	0/----	2/ 1.5	3/ 3.5	3/ 2.1	2/ 1.4	0/----	71
04W.2013 [TS 035 kt] LEEPI	3/ 3.1	3/ 1.8	3/ 2.4	3/ 2.5	3/ 1.6	3/ 2.5	3/ 2.4	100	2013 [TS 035 kt] LEEPI	1/ 1.4	1/ 0.2	3/ 3.0	1/ 0.5	3/ 2.1	3/ 1.9	0/----	86
05W.2013 [TS 035 kt] BEBINCA	2/ 1.7	1/ 0.9	3/ 3.1	3/ 2.0	3/ 1.4	3/ 3.1	2/ 1.3	100	2013 [TS 035 kt] BEBINCA	1/ 0.5	1/ 0.5	0/----	3/ 2.7	3/ 2.6	1/ 0.5	1/ 1.1	86
06W.2013 [HU1 065 kt] RUMBIA	3/ 1.8	3/ 1.7	3/ 1.8	3/ 1.3	3/ 1.8	2/ 1.1	3/ 0.9	100	2013 [HU1 065 kt] RUMBIA	2/ 1.1	3/ 1.3	1/ 0.5	3/ 1.7	3/ 1.4	2/ 1.0	3/ 1.7	100
07W.2013 [HU4 125 kt] SOULIK	3/ 3.7	3/ 1.4	1/ 0.4	1/ 0.4	0/----	1/ 0.5	2/ 1.2	86	2013 [HU4 125 kt] SOULIK	3/ 3.3	0/----	0/----	0/----	3/ 2.2	0/----	1/ 0.3	43
08W.2013 [TS 040 kt] CIMARON	3/ 3.0	3/ 2.8	3/ 3.8	3/ 3.9	3/ 3.1	3/ 2.1	3/ 2.8	100	2013 [TS 040 kt] CIMARON	3/ 5.8	3/ 6.1	3/ 7.8	3/ 8.0	3/ 5.9	1/ 0.5	3/ 4.2	100
09W.2013 [TS 060 kt] JEBI	3/ 1.6	3/ 1.5	2/ 2.1	3/ 2.6	3/ 2.3	3/ 2.0	3/ 1.5	100	2013 [TS 060 kt] JEBI	3/ 4.0	1/ 0.3	1/ 0.9	2/ 0.8	0/----	2/ 1.4	2/ 0.7	86
10W.2013 [TS 040 kt] MANGKHUT	3/ 2.9	3/ 2.6	3/ 2.9	3/ 2.6	3/ 2.9	2/ 1.4	3/ 2.0	100	2013 [TS 040 kt] MANGKHUT	2/ 3.1	2/ 2.0	3/ 3.4	3/ 3.2	2/ 1.5	2/ 2.5	3/ 2.7	100
11W.2013 [HU4 130 kt] UTOR	1/ 0.2	2/ 0.6	1/ 0.3	2/ 0.7	1/ 0.4	-1/----	2/ 0.7	100	2013 [HU4 130 kt] UTOR	3/ 1.6	3/ 1.1	1/ 0.9	0/----	3/ 1.9	-1/----	3/ 1.2	83
12W.2013 [HU1 075 kt] TRAMI	3/ 2.5	3/ 1.5	3/ 2.2	3/ 1.9	3/ 1.8	2/ 1.6	3/ 0.8	100	2013 [HU1 075 kt] TRAMI	3/ 4.0	1/ 0.5	3/ 3.6	3/ 3.9	2/ 0.9	1/ 0.7	1/ 0.4	100
13W.2013 [TD 025 kt] THIRTEEN	3/ 2.5	3/ 1.5	3/ 2.2	3/ 1.9	3/ 1.8	2/ 1.6	3/ 0.8	100	2013 [TD 025 kt] THIRTEEN	3/ 4.0	1/ 0.5	3/ 3.6	3/ 3.9	2/ 0.9	1/ 0.7	1/ 0.4	100
14W.2013 [TS 055 kt] KONG-REY	3/ 3.5	2/ 1.6	3/ 3.7	3/ 3.5	3/ 2.0	2/ 2.5	2/ 1.8	100	2013 [TS 055 kt] KONG-REY	3/ 2.8	2/ 0.4	0/----	0/----	3/ 1.0	0/----	2/ 1.5	57
15W.2013 [TS 050 kt] TORAJI	3/ 2.3	3/ 2.6	3/ 3.0	3/ 3.7	3/ 1.5	3/ 1.9	3/ 2.5	100	2013 [TS 050 kt] TORAJI	3/ 4.5	3/ 3.2	2/ 1.4	3/ 2.5	3/ 2.4	3/ 2.2	3/ 1.9	100
16W.2013 [TS 060 kt] MAN-YI	3/ 4.2	3/ 2.2	3/ 4.0	3/ 3.5	3/ 2.3	2/ 2.8	3/ 1.6	100	2013 [TS 060 kt] MAN-YI	3/ 2.8	1/ 0.2	2/ 2.0	3/ 1.4	3/ 1.9	2/ 1.3	1/ 0.3	100
17W.2013 [HU5 140 kt] USAGI	3/ 3.7	3/ 1.8	3/ 3.0	3/ 2.7	3/ 1.5	3/ 3.0	2/ 0.8	100	2013 [HU5 140 kt] USAGI	2/ 1.2	0/----	2/ 3.6	2/ 3.5	3/ 2.5	0/----	2/ 2.0	71
18W.2013 [TD 025 kt] EIGHTEEN	3/ 3.1	3/ 2.3	3/ 2.6	3/ 2.0	3/ 2.2	3/ 2.7	3/ 2.4	100	2013 [TD 025 kt] EIGHTEEN	3/ 3.0	3/ 1.9	3/ 2.9	3/ 1.5	2/ 1.0	3/ 2.9	3/ 1.8	100
19W.2013 [HU2 090 kt] PABUK	2/ 3.2	3/ 3.1	2/ 3.4	2/ 3.0	1/ 1.3	2/ 4.0	2/ 2.4	100	2013 [HU2 090 kt] PABUK	3/ 4.0	3/ 2.4	2/ 2.4	3/ 2.2	2/ 1.5	1/ 1.2	2/ 1.4	100
20W.2013 [HU2 090 kt] WUTIP	3/ 2.7	3/ 2.3	3/ 2.5	3/ 2.3	3/ 2.2	2/ 2.0	3/ 2.2	100	2013 [HU2 090 kt] WUTIP	3/ 4.0	3/ 3.8	1/ 1.2	3/ 3.1	3/ 4.7	0/----	3/ 3.1	86
21W.2013 [TS 035 kt] SEPAT	3/ 3.4	3/ 2.7	3/ 3.3	3/ 2.9	3/ 2.7	2/ 2.3	3/ 2.7	100	2013 [TS 035 kt] SEPAT	3/ 4.3	3/ 1.6	3/ 3.7	3/ 2.1	3/ 2.5	2/ 2.6	2/ 1.3	100
22W.2013 [HU2 090 kt] FITOW	3/ 3.4	3/ 2.7	3/ 3.3	3/ 2.9	3/ 2.7	2/ 2.3	3/ 2.7	100	2013 [HU2 090 kt] FITOW	3/ 4.3	3/ 1.6	3/ 3.7	3/ 2.1	3/ 2.5	2/ 2.6	2/ 1.3	100
23W.2013 [HU4 125 kt] DANAS	2/ 1.6	2/ 1.3	3/ 2.3	3/ 2.0	3/ 1.6	1/ 0.8	3/ 1.4	100	2013 [HU4 125 kt] DANAS	2/ 2.8	2/ 1.7	2/ 1.2	3/ 2.8	3/ 1.4	1/ 0.6	2/ 0.9	100
24W.2013 [HU3 105 kt] NARI	0/----	1/ 1.4	1/ 1.3	1/ 1.3	1/ 0.9	0/----	1/ 1.1	71	2013 [HU3 105 kt] NARI	3/ 4.3	2/ 2.4	3/ 5.3	3/ 4.2	1/ 1.5	1/ 0.4	3/ 4.1	100
25W.2013 [HU4 115 kt] WIPHA	2/ 1.1	3/ 2.1	3/ 3.2	3/ 3.0	3/ 2.3	2/ 2.0	3/ 2.4	100	2013 [HU4 115 kt] WIPHA	3/ 4.4	3/ 1.6	0/----	2/ 2.3	2/ 1.8	2/ 3.2	3/ 1.8	86
26W.2013 [HU5 140 kt] FRANCISCO	2/ 1.5	2/ 1.4	1/ 0.3	1/ 0.6	3/ 0.8	0/----	1/ 0.6	86	2013 [HU5 140 kt] FRANCISCO	0/----	0/----	0/----	0/----	1/ 0.5	0/----	0/----	14
27W.2013 [TD 025 kt] TWENTYSEVE	2/ 1.8	1/ 0.7	2/ 2.0	3/ 2.6	1/ 0.7	1/ 0.9	0/----	86	2013 [TD 025 kt] TWENTYSEVE	2/ 2.6	0/----	1/ 1.0	1/ 1.0	0/----	2/ 1.6	0/----	57
28W.2013 [HU5 140 kt] LEKIMA	3/ 1.8	3/ 2.3	3/ 2.6	3/ 2.0	2/ 1.6	2/ 1.8	3/ 2.2	100	2013 [HU5 140 kt] LEKIMA	2/ 1.8	3/ 2.0	3/ 2.5	3/ 1.9	3/ 2.4	2/ 1.9	2/ 1.5	100
29W.2013 [HU3 100 kt] KROSA	3/ 2.8	3/ 2.4	3/ 3.2	3/ 2.5	3/ 2.2	0/----	3/ 1.9	86	2013 [HU3 100 kt] KROSA	1/ 1.8	1/ 2.2	3/ 7.2	3/ 7.2	3/ 7.0	0/----	1/ 0.3	86
30W.2013 [TS 035 kt] THIRTY	3/ 2.4	3/ 2.1	3/ 2.4	3/ 2.4	1/ 0.7	1/ 0.8	3/ 2.1	100	2013 [TS 035 kt] THIRTY	1/ 1.3	2/ 0.7	2/ 1.4	3/ 1.7	2/ 0.5	1/ 0.9	3/ 1.9	100
31W.2013 [HU5 170 kt] HAIYAN	2/ 1.6	3/ 1.6	3/ 2.0	3/ 2.0	1/ 0.7	1/ 0.8	3/ 2.1	100	2013 [HU5 170 kt] HAIYAN	1/ 1.3	2/ 0.7	2/ 1.4	3/ 1.7	2/ 0.5	1/ 0.9	3/ 1.9	100
32W.2013 [TD 025 kt] PODUL	3/ 3.5	2/ 1.8	2/ 2.2	2/ 2.7	2/ 2.3	1/ 1.2	2/ 1.9	100	2013 [TD 025 kt] PODUL	3/ 3.6	2/ 1.1	2/ 2.7	2/ 3.0	2/ 2.3	1/ 1.6	2/ 1.9	100
33W.2013 [TD 030 kt] THIRTYTHRE	1/ 0.4	0/----	0/----	1/ 0.4	1/ 0.8	1/ 0.4	0/----	57	2013 [TD 030 kt] THIRTYTHRE	3/ 3.0	0/----	2/ 1.8	0/----	3/ 3.5	1/ 0.9	2/ 1.5	71
bottomline by model	97	94	97	100	97	90	94		bottomline by model	97	81	84	84	94	80	87	

box color	key
-1/----	no model run
0/----	0 forecasts of genesis
1/ 0.5	1 of 3 forecast verified
2/ 1.5	2/3 forecasts verified
3/ 3.6	3/3 forecasts verified
----	0%
14	< 25 %
29	25 >= % < 75
83	>= 75



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



TCgen2 – seasonal verification – LANT 2010 v WPAC 2013 D+5

<http://ruc.noaa.gov/hfip/tcgen>

slide 13

TCgen Stats :: **Gentau: 120 [h]** Basin: **LANT** Year: **2010** Models: **CMC, ECM, FIM, GFS, NGP, UKM**

Storm	CMC	ECM	FIM	GFS	NGP	UKM	
01L.2010 [HU2 085 kt] ALEX	2/ 2.9	3/ 3.7	1/ 2.2	0/----	3/ 9.9	0/----	67
02L.2010 [TD 030 kt] TWO	2/ 1.6	1/ 0.2	0/----	0/----	0/----	0/----	33
03L.2010 [TS 035 kt] BONNIE	0/----	0/----	0/----	0/----	0/----	0/----	----
04L.2010 [TS 050 kt] COLIN	3/ 7.3	1/ 1.5	1/ 1.1	1/ 0.5	1/ 2.3	2/ 4.0	100
05L.2010 [TD 030 kt] FIVE	2/ 7.6	0/----	2/ 1.9	3/ 7.8	2/ 3.7	0/----	67
06L.2010 [HU4 115 kt] DANIELLE	3/ 2.7	4/ 6.7	1/ 3.0	1/ 0.8	3/ 2.1	2/ 1.6	100
07L.2010 [HU4 120 kt] EARL	1/ 0.3	1/ 0.9	0/----	1/ 0.3	1/ 0.2	0/----	67
08L.2010 [TS 055 kt] FIONA	1/ 0.8	3/ 4.2	0/----	2/ 2.4	3/ 3.3	1/ 0.6	83
09L.2010 [TS 035 kt] GASTON	2/ 2.8	2/ 1.2	4/ 3.2	2/ 1.5	2/ 0.9	4/ 2.0	100
10L.2010 [TS 055 kt] HERMINE	1/ 1.1	0/----	1/ 2.6	1/ 0.6	0/----	0/----	17
11L.2010 [HU4 135 kt] IGOR	1/ 0.4	3/ 3.8	3/ 5.8	3/ 4.0	1/ 0.4	2/ 0.9	100
12L.2010 [HU4 115 kt] JULIA	0/----	0/----	0/----	0/----	0/----	0/----	----
13L.2010 [HU3 105 kt] KARL	3/ 2.6	3/ 9.0	3/ 4.2	3/ 3.1	3/ 3.1	3/ 5.6	100
14L.2010 [HU1 070 kt] LISA	2/ 2.9	1/ 4.1	2/ 6.2	2/ 3.8	0/----	1/ 2.4	83
15L.2010 [TS 050 kt] MATTHEW	4/ 6.5	5/ 9.3	5/ 27.4	5/ 10.1	5/ 12.0	5/ 12.9	100
16L.2010 [TS 035 kt] NICOLE	1/ 0.8	1/ 0.6	1/ 2.8	1/ 1.4	1/ 0.2	0/----	----
17L.2010 [HU1 075 kt] OTTO	3/ 7.0	3/ 8.0	3/ 10.5	3/ 4.5	3/ 6.9	2/ 7.6	100
18L.2010 [HU2 090 kt] PAULA	1/ 2.5	1/ 0.6	1/ 3.3	1/ 1.3	1/ 2.1	1/ 2.8	----
19L.2010 [HU1 080 kt] RICHARD	3/ 11.6	3/ 0.8	3/ 15.9	3/ 6.8	2/ 3.7	3/ 4.0	100
20L.2010 [HU1 065 kt] SHARY	4/ 15.8	2/ 8.0	2/ 13.2	2/ 9.2	2/ 4.8	1/ 0.4	100
21L.2010 [HU2 085 kt] TOMAS	0/----	2/ 4.4	2/ 6.4	2/ 1.2	2/ 2.0	0/----	67
bottomline by model	75	75	70	70	70	55	

TCgen Stats :: **Gentau: 132 [h]** Basin: **WPAC** Year: **2013** Models: **CMC.GEM, ECMWF.IFS, ESRL.FIM, NCEP.GFS, FNMOC.NAVGEM, ESRL.FIM9, UKMO.UM**

Storm	CMC.GEM	ECMWF.IFS	ESRL.FIM	NCEP.GFS	FNMOC.NAVGEM	ESRL.FIM9	UKMO.UM	
1W.2013 [TS 045 kt] SONAMU	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	----
2W.2013 [TD 025 kt] SHANSHAN	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	-1/----	----
3W.2013 [TS 055 kt] YAGI	3/ 3.9	0/----	2/ 1.5	3/ 3.5	3/ 2.1	2/ 1.4	0/----	71
4W.2013 [TS 035 kt] LEEPI	1/ 1.4	1/ 0.2	3/ 3.0	1/ 0.5	3/ 2.1	3/ 1.9	0/----	86
5W.2013 [TS 035 kt] BEBINCA	1/ 0.5	1/ 0.5	0/----	3/ 2.7	3/ 2.6	1/ 0.5	1/ 1.1	86
6W.2013 [HU1 065 kt] RUMBIA	2/ 1.1	3/ 1.3	1/ 0.5	3/ 1.7	3/ 1.4	2/ 1.0	3/ 1.7	100
7W.2013 [HU4 125 kt] SOULIK	3/ 3.3	0/----	0/----	0/----	3/ 2.2	0/----	1/ 0.3	43
8W.2013 [TS 040 kt] CIMARON	3/ 5.8	3/ 6.1	3/ 7.8	3/ 8.0	3/ 5.9	1/ 0.5	3/ 4.2	100
9W.2013 [TS 060 kt] JEBI	3/ 4.0	1/ 0.3	1/ 0.9	2/ 0.8	0/----	2/ 1.4	2/ 0.7	86
10W.2013 [TS 040 kt] MANGKHUT	2/ 3.1	2/ 2.0	3/ 3.4	3/ 3.2	2/ 1.5	2/ 2.5	3/ 2.7	100
11W.2013 [HU4 130 kt] UTOR	3/ 1.6	3/ 1.1	1/ 0.9	0/----	3/ 1.9	-1/----	3/ 1.2	83
12W.2013 [HU1 075 kt] TRAMI	3/ 4.0	1/ 0.5	3/ 3.6	3/ 3.9	2/ 0.9	1/ 0.7	1/ 0.4	100
13W.2013 [TD 025 kt] THIRTEEN	3/ 4.0	1/ 0.5	3/ 3.6	3/ 3.9	2/ 0.9	1/ 0.7	1/ 0.4	100
14W.2013 [TS 055 kt] KONG-REY	3/ 2.8	2/ 0.4	0/----	0/----	3/ 1.0	0/----	2/ 1.5	57
15W.2013 [TS 050 kt] TORAJI	3/ 4.5	3/ 3.2	2/ 1.4	3/ 2.5	3/ 2.4	3/ 2.2	3/ 1.9	100
16W.2013 [TS 060 kt] MAN-YI	3/ 2.8	1/ 0.2	2/ 2.0	3/ 1.4	3/ 1.9	2/ 1.3	1/ 0.3	100
17W.2013 [HU5 140 kt] USAGI	2/ 1.2	0/----	2/ 3.6	2/ 3.5	3/ 2.5	0/----	2/ 2.0	71
18W.2013 [TD 025 kt] EIGHTEEN	3/ 3.0	3/ 1.9	3/ 2.9	3/ 1.5	2/ 1.0	3/ 2.9	3/ 1.8	100
19W.2013 [HU2 090 kt] PABUK	3/ 4.0	3/ 2.4	2/ 2.4	3/ 2.2	2/ 1.5	1/ 1.2	2/ 1.4	100
20W.2013 [HU2 090 kt] WUTIP	3/ 4.0	3/ 3.8	1/ 1.2	3/ 3.1	3/ 4.7	0/----	3/ 3.1	86
21W.2013 [TS 035 kt] SEPAT	3/ 4.3	3/ 1.6	3/ 3.7	3/ 2.1	3/ 2.5	2/ 2.6	2/ 1.3	100
22W.2013 [HU2 090 kt] FITOW	3/ 4.3	3/ 1.6	3/ 3.7	3/ 2.1	3/ 2.5	2/ 2.6	2/ 1.3	100
23W.2013 [HU4 125 kt] DANAS	2/ 2.8	2/ 1.7	2/ 1.2	3/ 2.8	3/ 1.4	1/ 0.6	2/ 0.9	100
24W.2013 [HU3 105 kt] NARI	3/ 4.3	2/ 2.4	3/ 5.3	3/ 4.2	1/ 1.5	1/ 0.4	3/ 4.1	100
25W.2013 [HU4 115 kt] WIPHA	3/ 4.4	3/ 1.6	0/----	2/ 2.3	2/ 1.8	2/ 3.2	3/ 1.8	86
26W.2013 [HU5 140 kt] FRANCISCO	0/----	0/----	0/----	0/----	1/ 0.5	0/----	0/----	14
27W.2013 [TD 025 kt] TWENTYSEVE	2/ 2.6	0/----	1/ 1.0	1/ 1.0	0/----	2/ 1.6	0/----	57
28W.2013 [HU5 140 kt] LEKIMA	2/ 1.8	3/ 2.0	3/ 2.5	3/ 1.9	3/ 2.4	2/ 1.9	2/ 1.5	100
29W.2013 [HU3 100 kt] KROSA	1/ 1.8	1/ 2.2	3/ 7.2	3/ 7.2	3/ 7.0	0/----	1/ 0.3	86
30W.2013 [TS 035 kt] THIRTY	1/ 1.3	2/ 0.7	2/ 1.4	3/ 1.7	2/ 0.5	1/ 0.9	3/ 1.9	100
31W.2013 [HU5 170 kt] HAIYAN	1/ 1.3	2/ 0.7	2/ 1.4	3/ 1.7	2/ 0.5	1/ 0.9	3/ 1.9	100
32W.2013 [TD 025 kt] PODUL	3/ 3.6	2/ 1.1	2/ 2.7	2/ 3.0	2/ 2.3	1/ 1.6	2/ 1.9	100
33W.2013 [TD 030 kt] THIRTYTHRE	3/ 3.0	0/----	2/ 1.8	0/----	3/ 3.5	1/ 0.9	2/ 1.5	71
bottomline by model	97	81	84	84	94	80	87	

box color	key
-1/----	no model run
0/----	0 forecasts of genesis
1/ 0.5	1 of 3 forecast verified
2/ 1.5	2/3 forecasts verified
3/ 3.6	3/3 forecasts verified
----	0%
14	< 25 %
29	25 >= % < 75
83	>= 75



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305



Takeaways

slide 14

- TCgen2 was developed based on NHC operations (O2R)
- FCST mode consistent with NHC operations, e.g., use 60 h model solution for D+2 forecast
- VERI mode to see how the models are doing in real time, based on a detailed comparison of model v observed (NHC/JTWC-analyzed) TCs
- in WPAC/EPAC 2013 models had 100% correct genesis forecasts at D+2 reduces to ~80% at D+5
- LANT 2013 genesis forecasts much less skillful, perhaps because the season had the lowest hurricane ACE in the last 48 years...
- comparison of active-basin genesis at D+5 between 2010 (TCgen1) and 2013 shows some improvement in model skill



TC genesis in a suite of global models
Mike Fiorino ESRL – IHC 68 20140305

