Creation of a Statistical Ensemble for Tropical Cyclone Intensity Prediction

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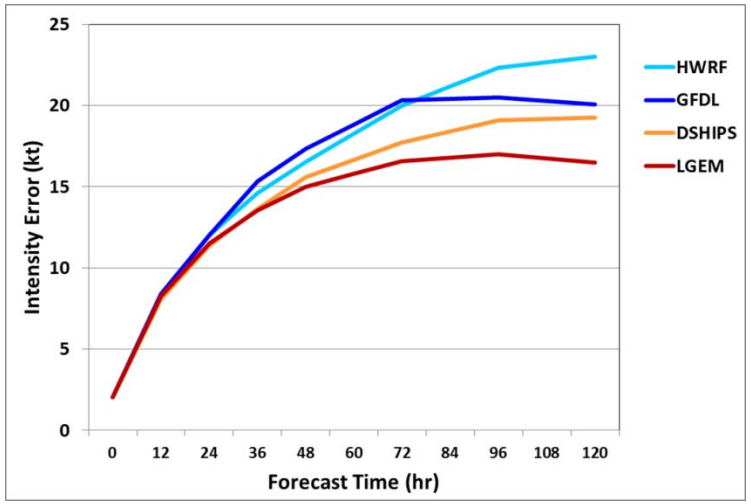
Motivation for Statistical Ensemble

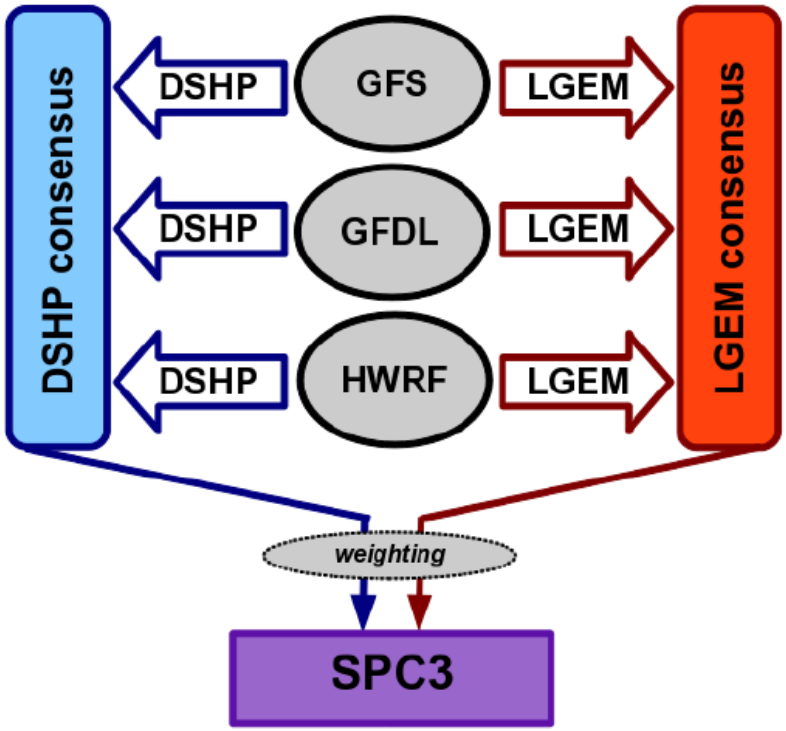
- Statistical SHIPS and LGEM models are competitive with dynamical models
- Current input includes single track (NHC official) and global model (NCEP/GFS)
- JTWC experience with STIPS shows improvements with multiple inputs
- Run time nearly trivial



Atlantic Operational Intensity Model Errors 2007-2011

SPICE (Statistical Prediction of Intensity from a Consensus Ensemble)

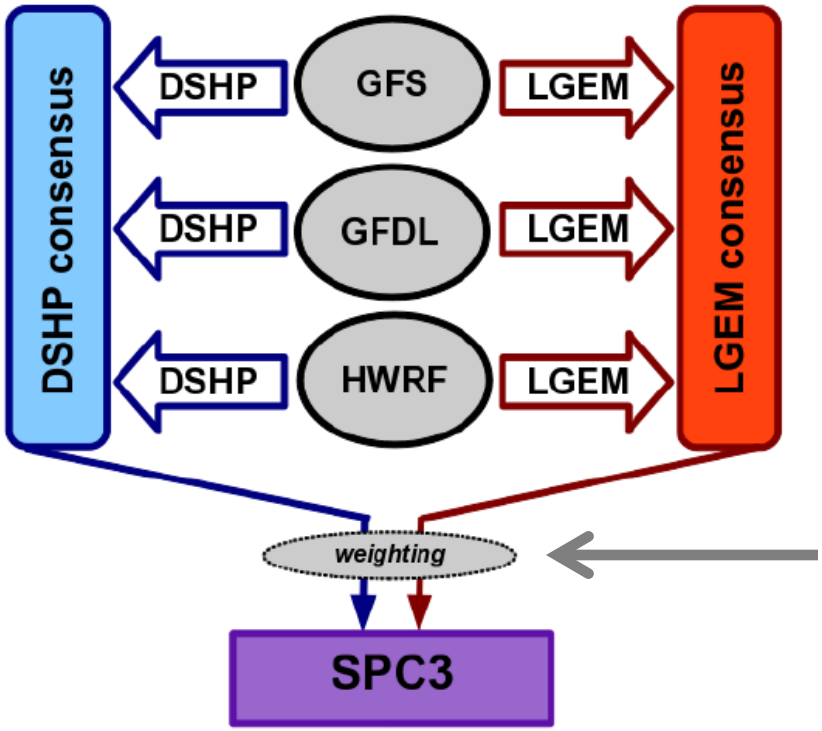
Model Configuration for Consensus



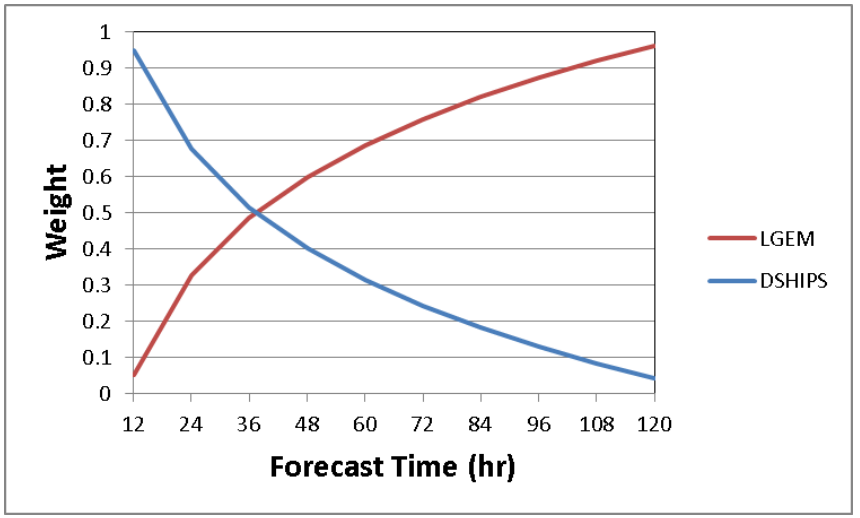
- SPICE forecasts TC intensity using a combination of parameters from:
  - Current TC intensity and trend
  - Current TC GOES IR
  - TC track and large-scale environment from GFS, GFDL, and HWRF models
- These parameters are used to run Decay-SHIPS and LGEM based off each dynamical model
- The forecasts are combined into two unweighted consensus forecasts, one each for DSHIPS and LGEM
- The two consensus are combined into the weighted SPC3 forecast

SPICE (Statistical Prediction of Intensity from a Consensus Ensemble)

Model Configuration for Consensus



DSHIPS and LGEM Weights for Consensus



Weights determined empirically from 2008-2010 Atlantic and East Pacific sample

SPICE Input – Model Diagnostic Files

* HWRF 2011091018 *
* AL14 MARIA *

STORM DATA

NTIME 022 DELTAT 006

TIME	(HR)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
LAT	(DEG)	17.5	18.3	19.0	20.1	21.0	21.7	22.2	22.8	23.4	23.9	24.3	24.9	25.7	26.6	27.8	29.3	30.8	32.4	34.1	36.0	38.2	40.9
LON	(DEG)	298.1	297.3	296.7	296.1	295.6	294.9	294.4	294.0	293.4	292.7	292.1	291.8	291.4	291.3	291.1	291.1	291.2	291.7	292.4	293.8	295.9	299.0
MAXWIND	(KT)	41	45	41	42	44	49	52	56	63	71	76	83	83	93	91	93	92	91	95	99	98	91
RMW	(KM)	164	142	152	147	132	89	48	49	51	38	41	41	46	52	52	53	56	59	64	67	66	74
MIN_SLP	(MB)	1006	1005	1003	1004	1001	997	990	987	979	970	962	956	951	951	945	945	942	942	943	946	946	951
SHR_MAG	(KT)	18	19	19	20	18	17	16	16	16	14	11	12	17	20	22	25	28	27	26	32	39	44
SHR_DIR	(DEG)	237	229	235	244	246	248	260	246	254	253	246	227	221	223	209	190	180	183	180	180	189	202
STM_SPD	(KT)	11	9	12	10	10	7	7	8	8	7	7	9	9	12	15	15	17	18	22	28	36	9999
STM_HDG	(DEG)	316	321	333	333	317	317	328	317	308	306	336	336	354	352	0	3	15	19	31	37	42	9999
SST	(10C)	294	291	291	291	290	292	291	290	290	289	288	285	285	284	283	282	278	275	273	275	258	250
OHC	(KJ/CM2)	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
TPW	(MM)	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999	9999
LAND	(KM)	412	316	264	275	324	368	413	478	529	538	551	604	680	776	906	941	837	780	775	730	601	453
850TANG	(10M/S)	104	108	107	102	109	116	114	117	122	130	134	142	148	154	151	157	168	170	170	177	177	180
850VORT	(/S)	18	15	8	-1	3	9	5	2	11	19	16	26	49	66	61	68	80	77	72	91	98	113
200DVRG	(/S)	90	61	34	48	71	64	50	39	39	31	29	29	57	48	62	77	107	106	105	138	145	137

SOUNDING DATA

NLEV 020 SURF 1000 0950 0900 0850 0800 0750 0700 0650 0600 0550 0500 0450 0400 0350 0300 0250 0200 0150 0100

TIME	(HR)	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
T_SURF	(10C)	287	286	286	285	284	284	284	283	283	282	282	281	280	279	277	274	271	267	261	249	233	209
R_SURF	(%)	79	79	79	79	78	78	78	78	78	78	78	78	78	79	79	78	78	78	78	78	76	74
P_SURF	(MB)	1012	1013	1013	1015	1015	1016	1015	1017	1014	1016	1013	1014	1012	1013	1010	1011	1009	1010	1008	1009	1008	1009
U_SURF	(10KT)	-117	-121	-121	-112	-105	-102	-85	-85	-85	-82	-68	-65	-68	-75	-59	-37	-13	-2	39	60	85	106
V_SURF	(10KT)	11	-5	13	17	19	9	28	12	22	15	29	19	23	26	35	25	26	31	48	30	24	26
T_1000	(10C)	277	277	274	270	269	269	266	264	266	267	266	265	268	269	267	265	265	264	257	242	229	210
R_1000	(%)	73	73	75	77	78	79	80	81	81	81	81	81	80	79	79	78	76	75	78	80	80	81
Z_1000	(DM)	11	12	11	13	13	14	13	15	12	14	11	13	10	11	9	10	8	9	7	8	7	7
U_1000	(10KT)	-141	-143	-142	-132	-124	-122	-101	-102	-101	-99	-81	-78	-80	-89	-68	-43	-14	-1	45	70	96	121
V_1000	(10KT)	14	-5	17	23	24	13	35	17	27	19	35	25	29	34	44	32	32	40	58	39	32	35
T_0950	(10C)	235	235	232	228	228	227	225	223	225	226	225	224	226	227	226	224	224	223	217	204	192	175

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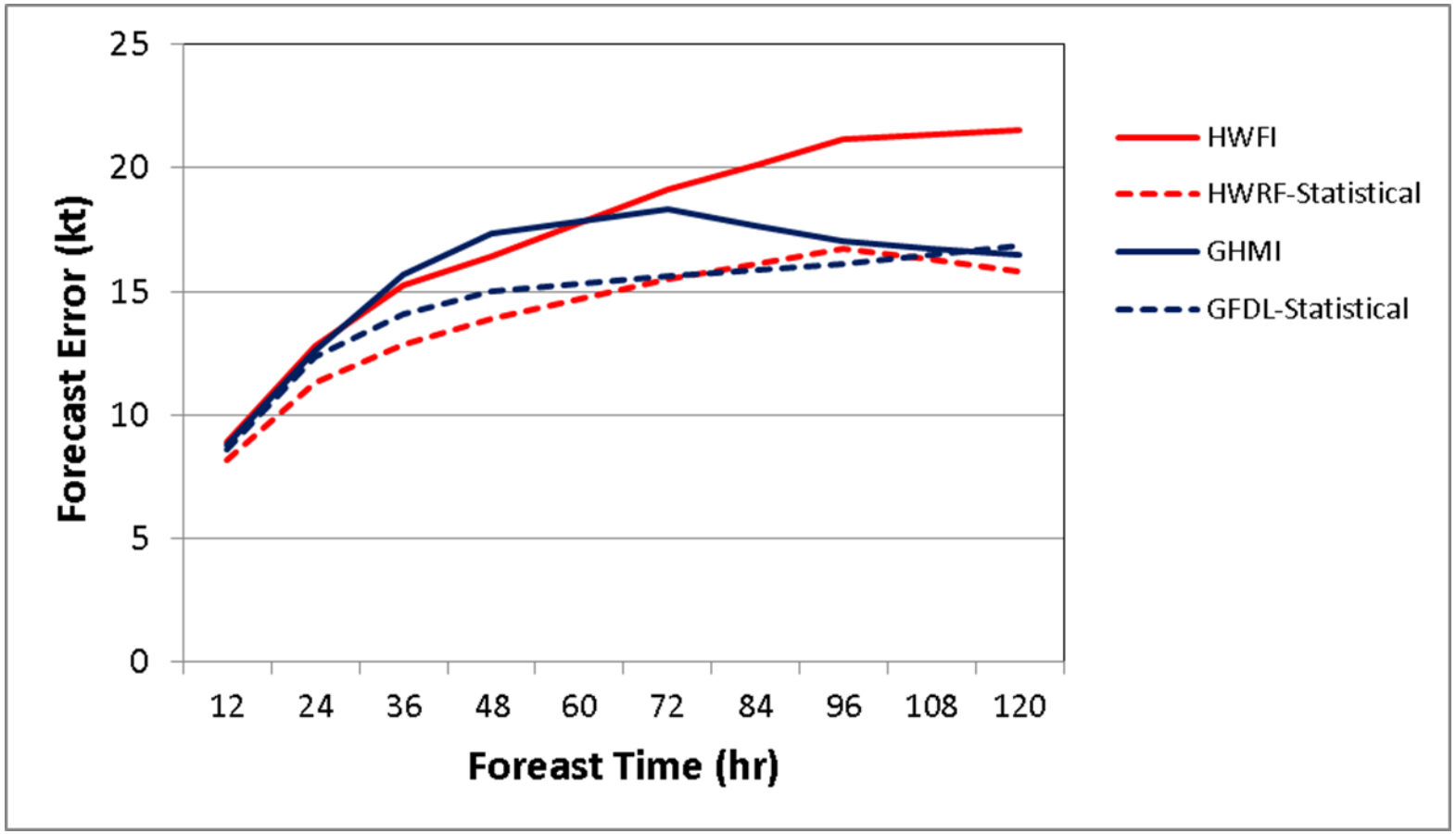
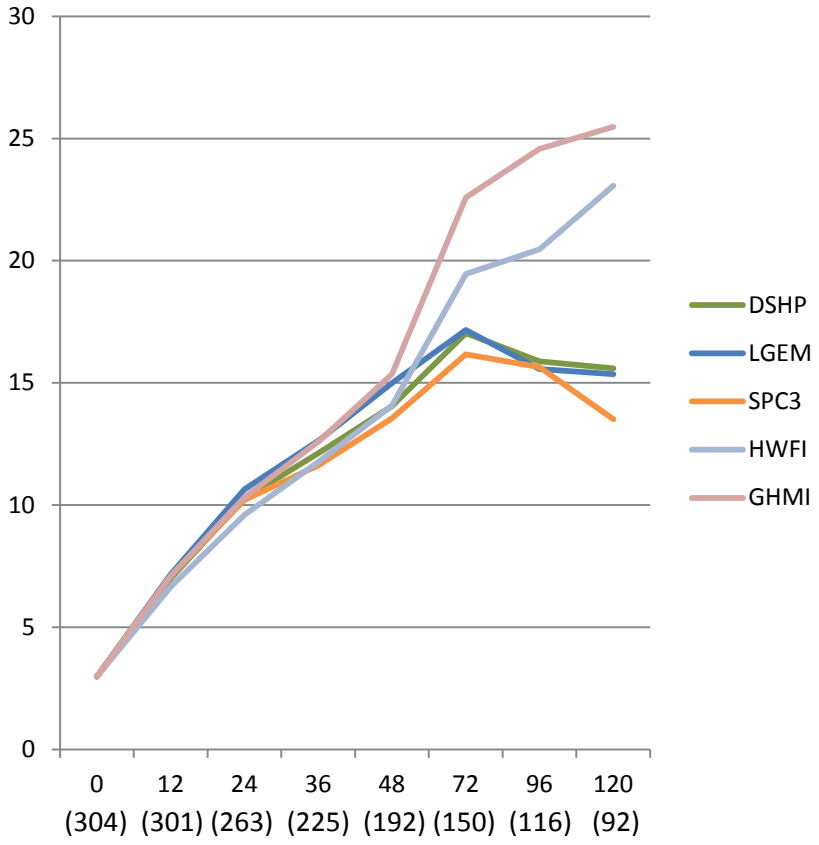
2008-2010 Retrospective Runs for HFIP Stream 1.5 Implementation

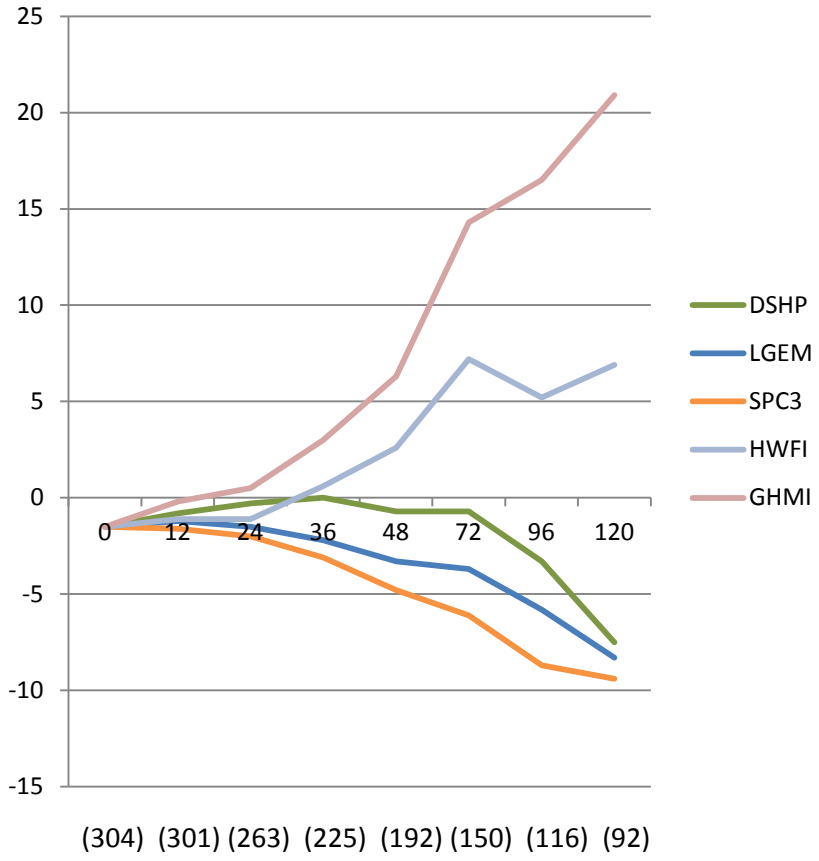


Results from 2011 Atlantic Season

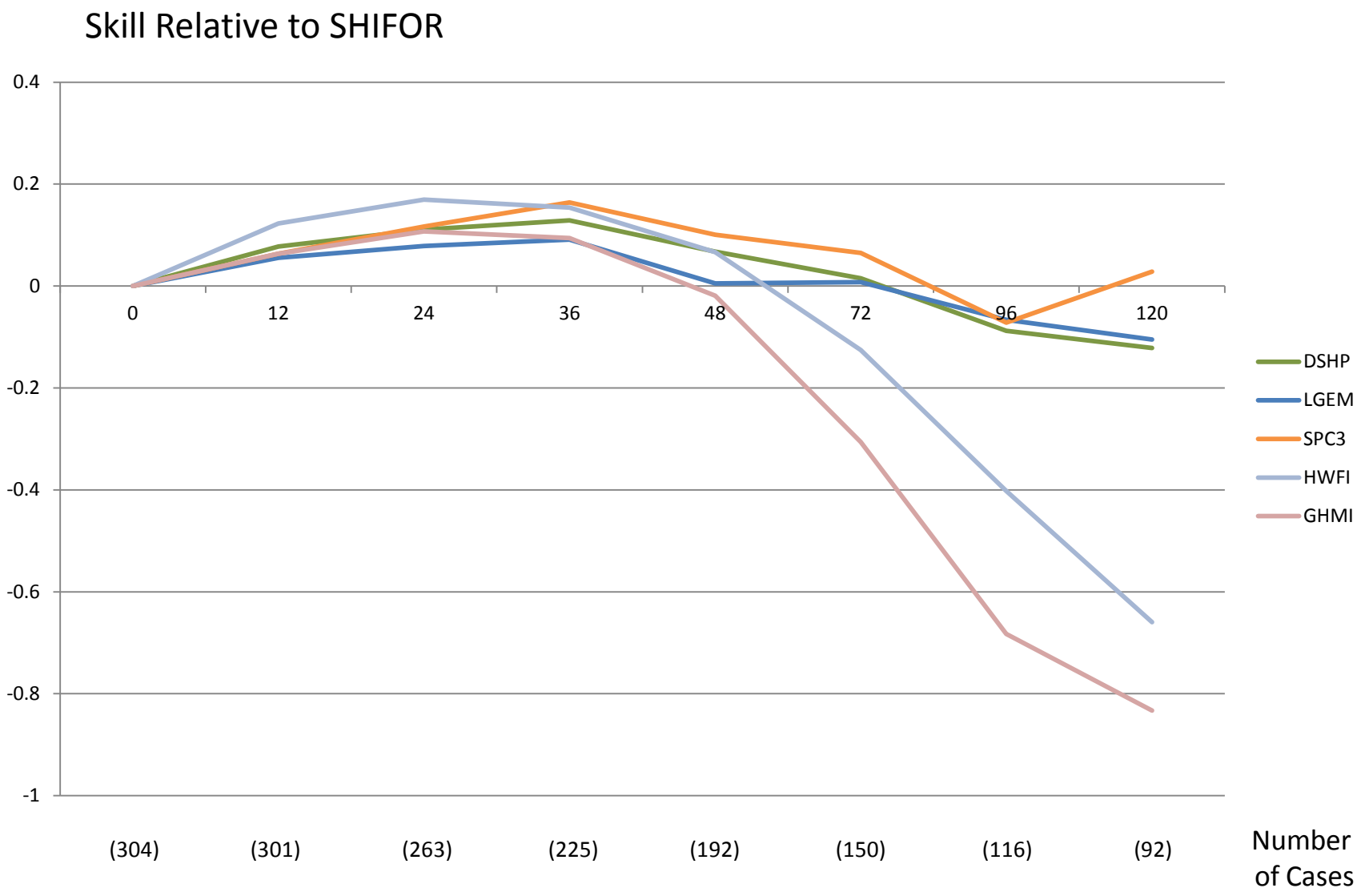
Average Intensity Error (kt)



Average Intensity Bias (kt)



Results from 2011 Atlantic Season



Results from 2011 Atlantic Season

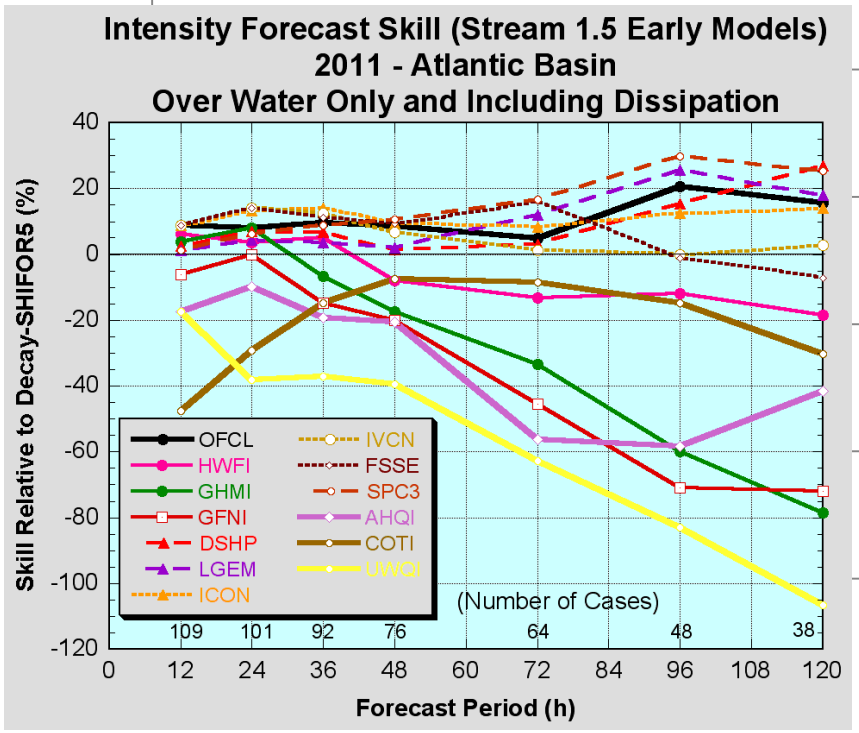
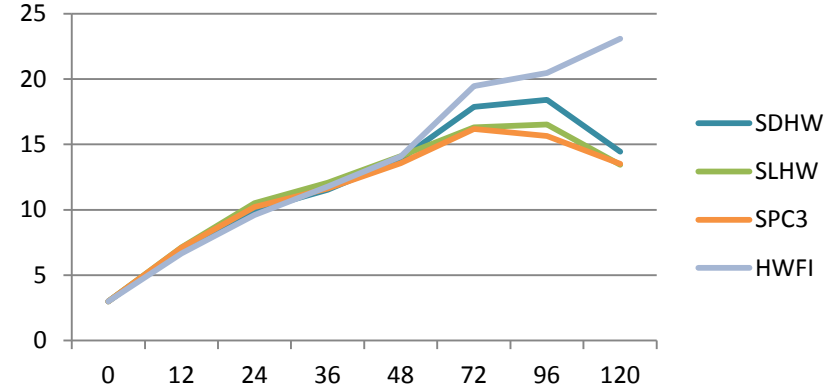
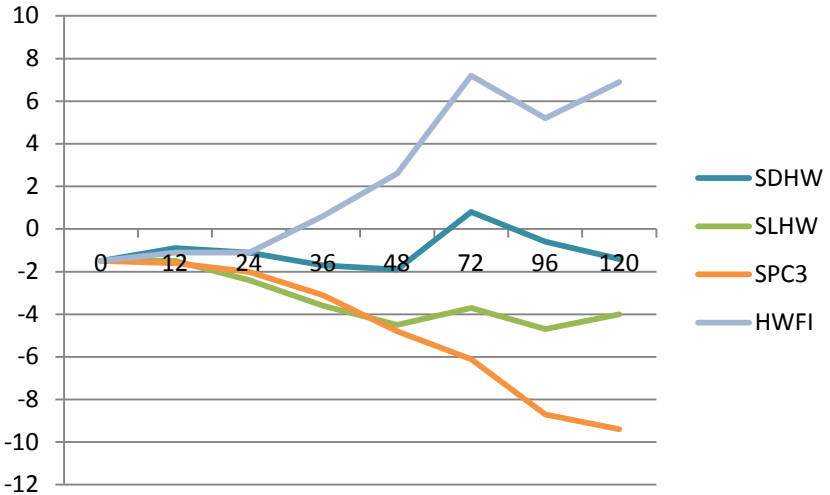


Figure courtesy of James Franklin

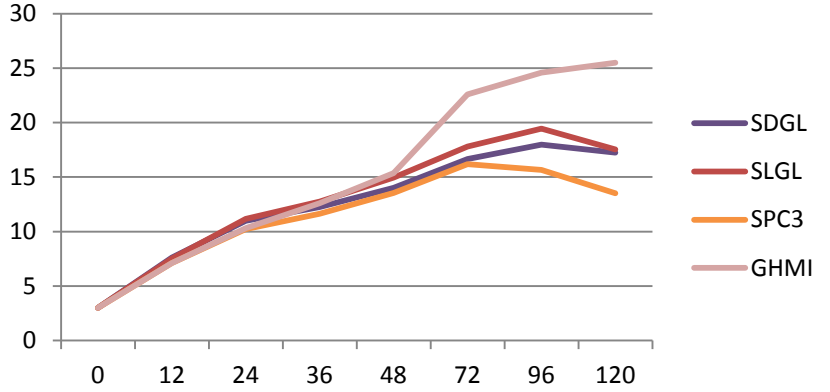
Results from 2011 Atlantic Season

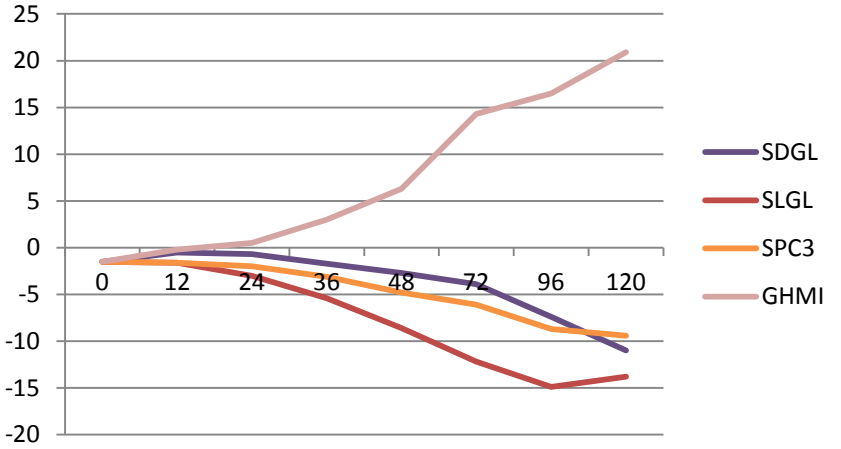
HWRF



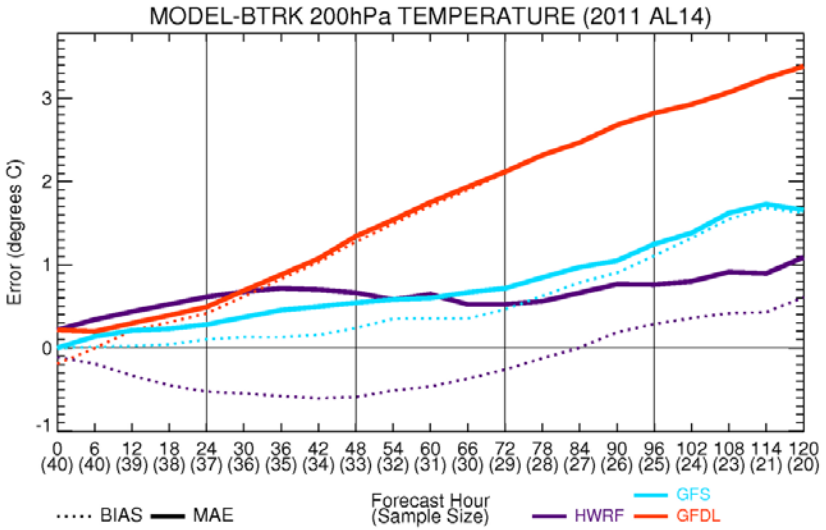


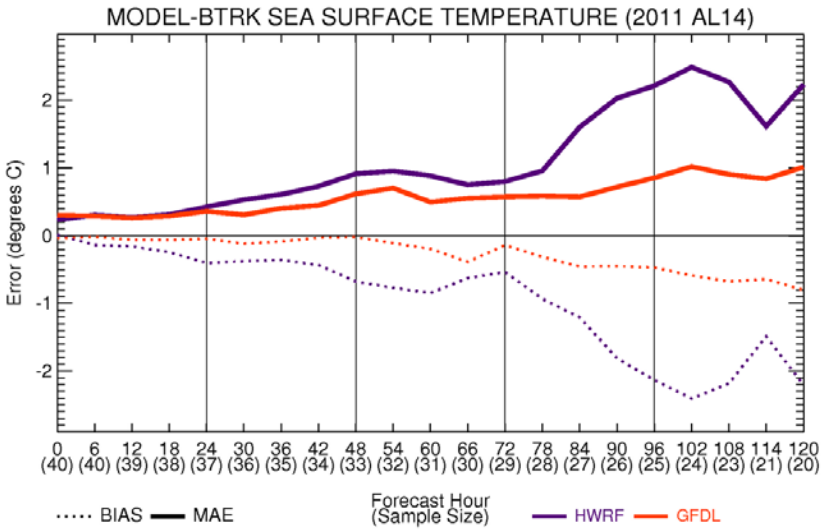
GFDL



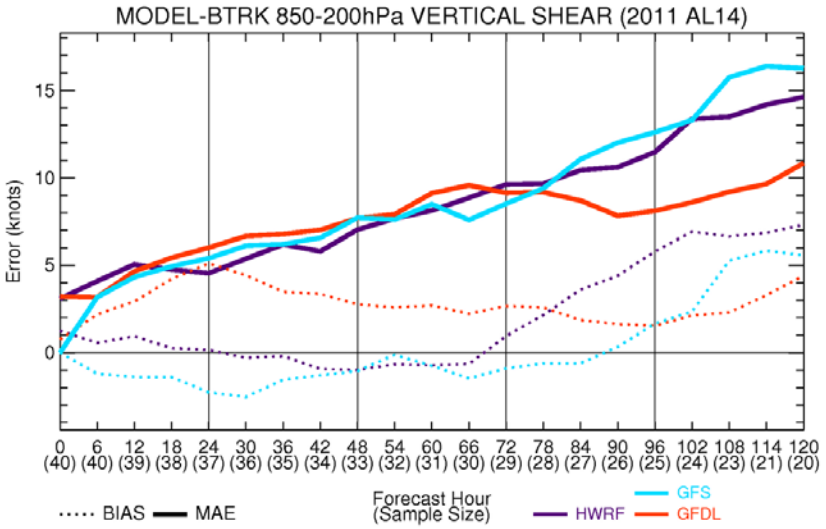


Results from 2011 Atlantic Season: Model Diagnostic Files





Hurricane Maria (2011)
case study



Preliminary Conclusions

- Statistical Ensemble (SPICE) had better error statistics than SHIPS and LGEM in 2011 real time tests
- SPICE model components had lower errors than parent dynamical models (GFDL, HWRF)
- Limited storm development in 2011 may have favored SPICE model
  - Confirmation from additional tests needed

Plans for 2012 Season

- In 2012 we'll run two separate versions of SPICE in HFIP Stream 1.5:
  - The first version will be based of the 2011 SPICE model, with the possible inclusion of COAMPS-TC
  - The second version will include HFIP global model ensembles
- Testing is currently underway in preparation for the HFIP retrospective runs of the 2009-2011 seasons