

# 201708 - Tropical cyclone - Harvey

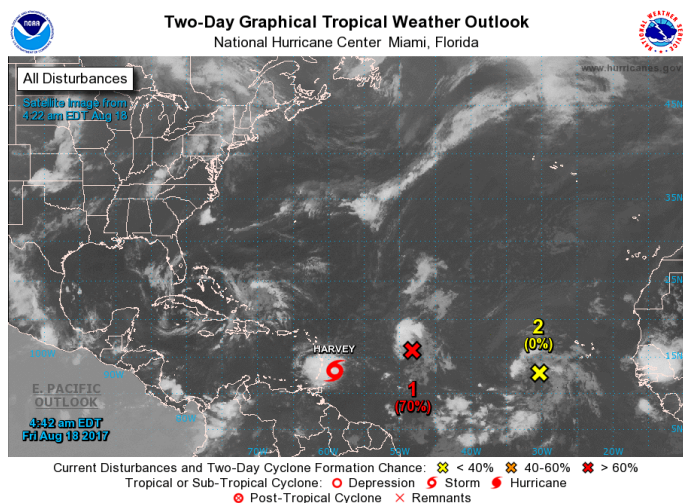
Status: Finalised Material from: Linus, Esti, Ivan

## 1. Impact

Early on 26 August tropical cyclone Harvey made landfall on the TEXas coast between Corpus Cristi and Rockport. Later the cyclone became stationary for 3 days (check) and a huge amount of rainfall fell over the region (locally more than 1000 mm) and caused massive floodings in e.g Houston. *We do not yet know the final result from the cyclone.*

## 2. Description of the event

The cyclone formed on 18 August from a disturbance east of the West Indies. The cyclone later made landfall on Yucatan on 22 August. After entering the Gulf of Mexico the cyclone re-intensified. The cyclone made its second landfall on the Texas coast on 26 August.

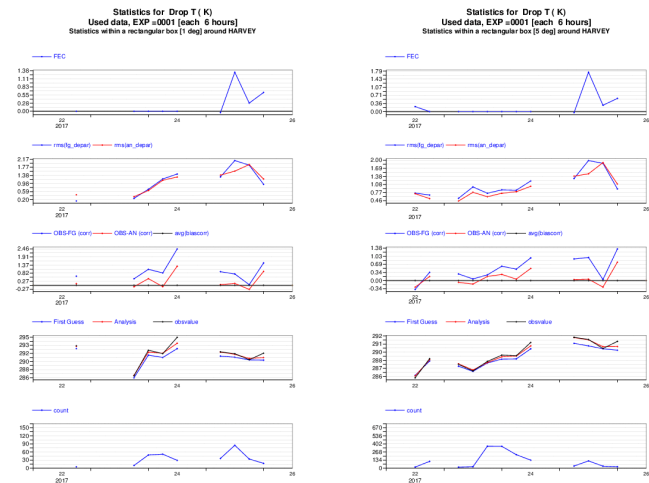


The plot below shows the precipitation totals over Texas (to be added).

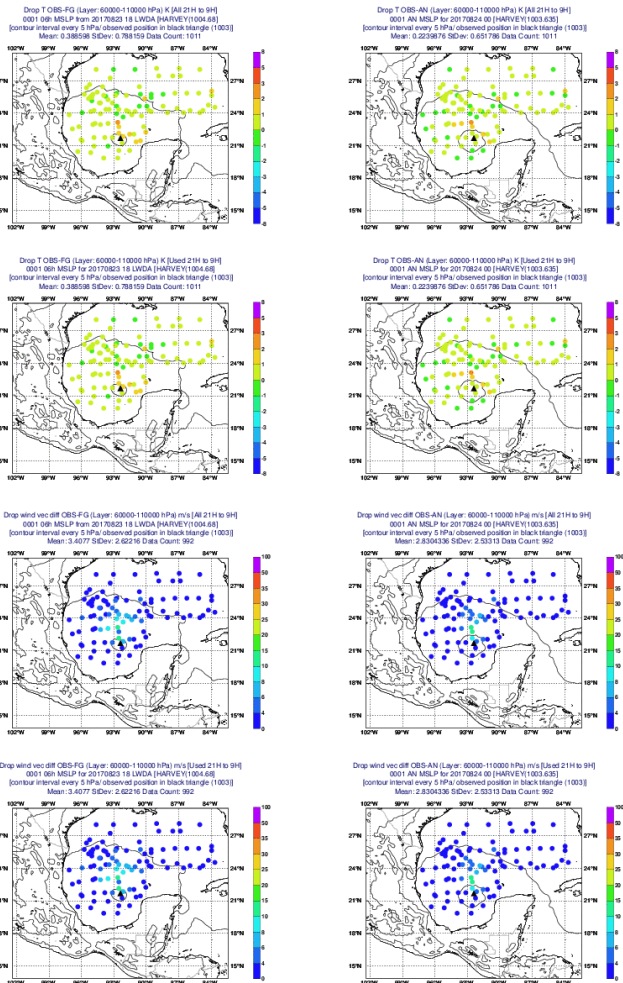
## 3. Predictability

### 3.1 Data assimilation

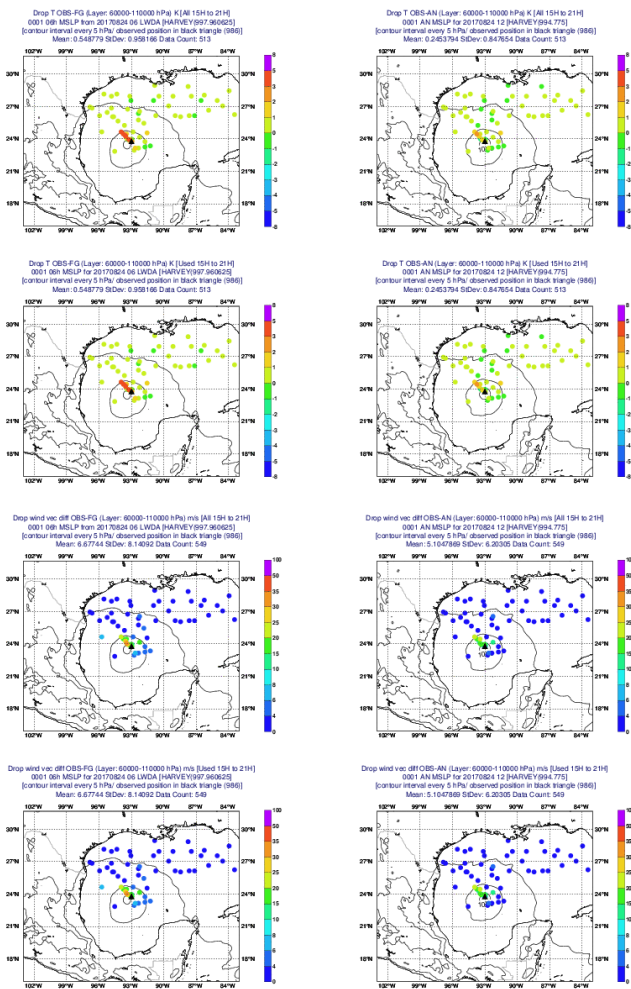
The plots below shows observation statistics for temperature from dropsondes along the path of Harvey within 1 degree (left) and 5 degrees (right).



The plots below shows the observation statistics for dropsondes for temperature (left) and wind vector (right) for 24 August 00z, when the Global Hawk mission dropped a lot of sondes.

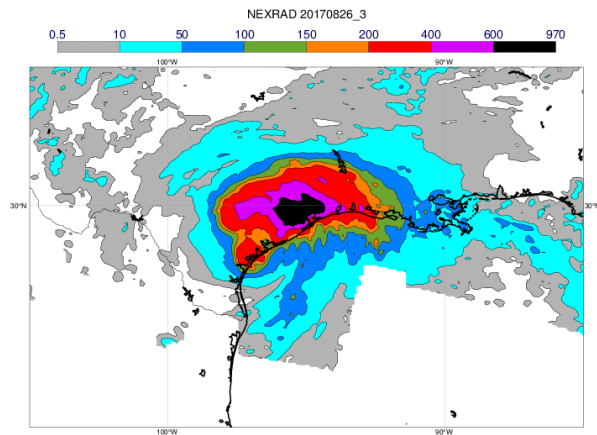


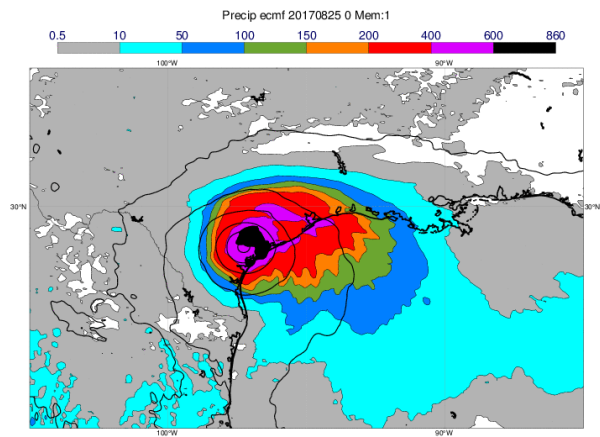
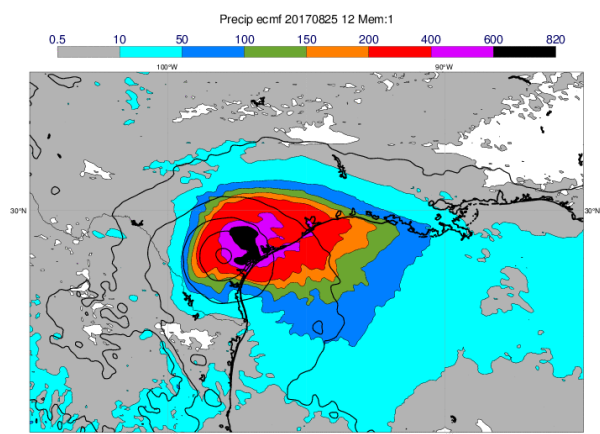
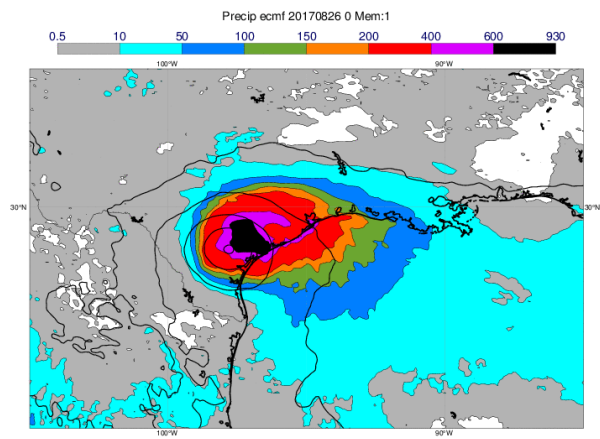
The plots below show the same as above but for 24 August 12z.

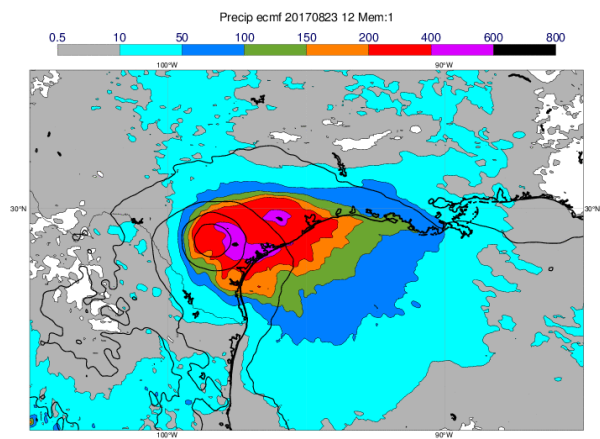
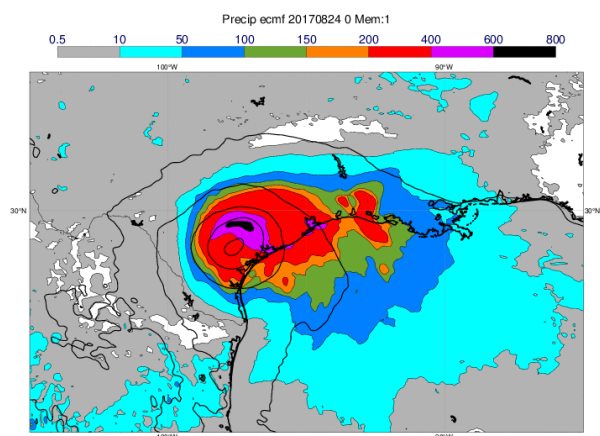
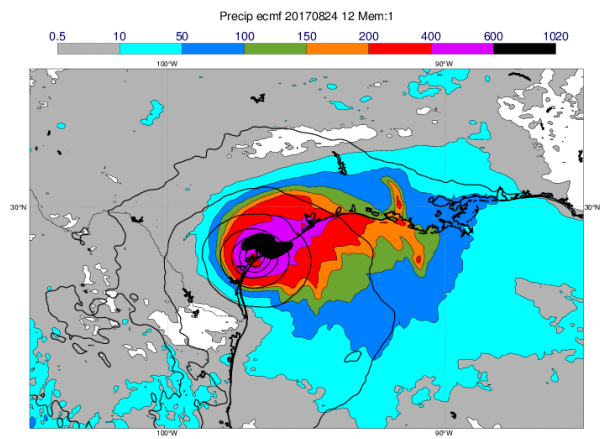


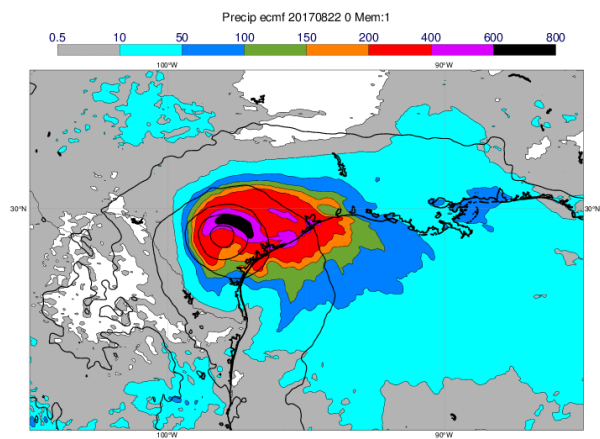
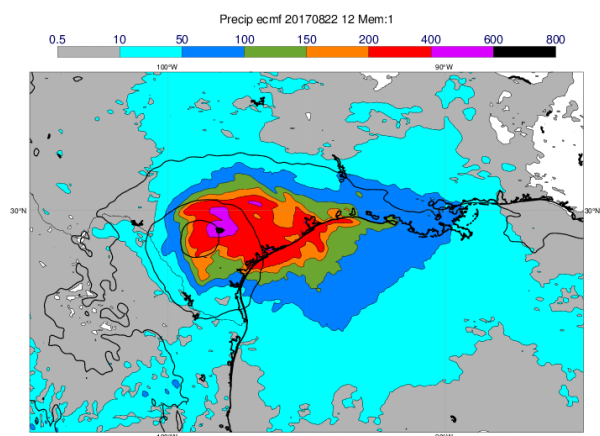
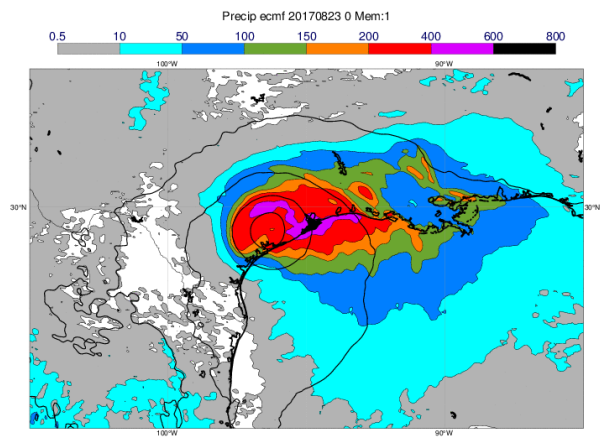
### 3.2 HRES

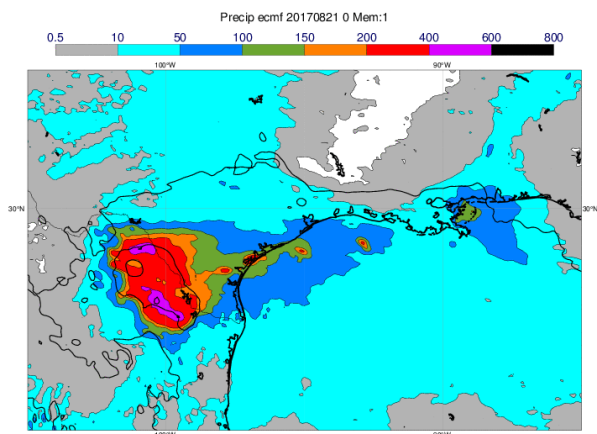
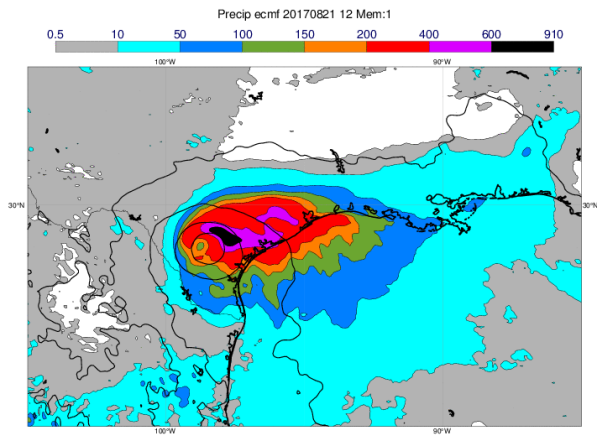
The series of plots below shows 3-day accumulated precipitation (26 August 00z to 29 August 00z) and MSLP valid 27 August 12z from HRES forecasts. The first plot is the accumulation from NEXRAD for the same period.



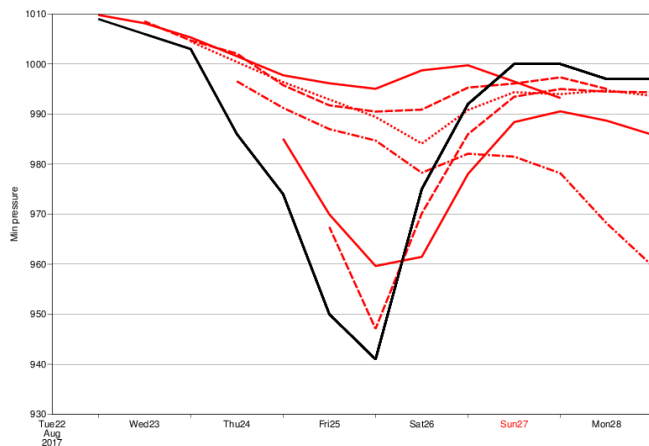








The plot below shows the evolution of the central pressure in Best Track (black) and HRES forecasts with different initial times. The forecasts before 25 August missed the rapid intensification the day before landfall. Also note how the forecast from 24 August 12z kept the intensity for a long time, probably because the cyclone stalled closer to the coast as seen above.

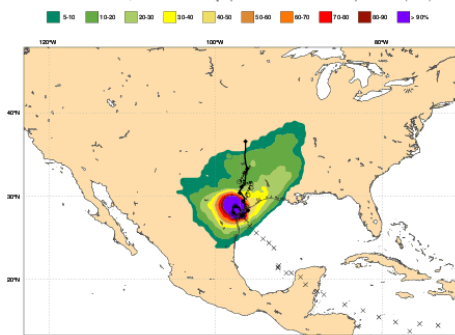


### 3.3 ENS

The plots below show the tropical cyclone product for TC Harvey.

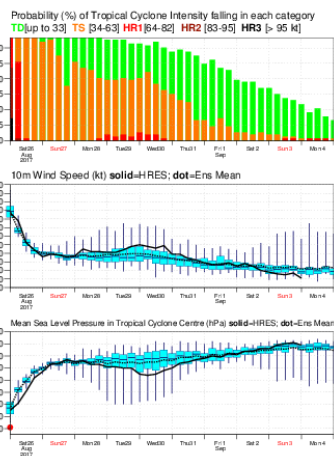


Date 20170826 00 UTC @ECMWF  
Probability that **HARVEY** will pass within 120 km radius during the next 240 hours  
tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) **941** ]

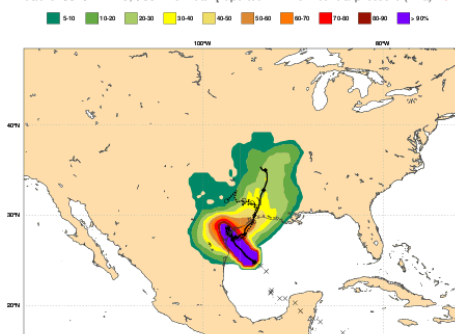


List of ensemble members numbers forecast Tropical Cyclone  
Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[>95 k]

MEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
MEMBER	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
MEMBER	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
MEMBER	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
MEMBER	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250
MEMBER	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
MEMBER	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350
MEMBER	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400
MEMBER	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450
MEMBER	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
MEMBER	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550
MEMBER	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
MEMBER	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650
MEMBER	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
MEMBER	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750
MEMBER	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
MEMBER	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850
MEMBER	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
MEMBER	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950
MEMBER	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000



Date 20170825 00 UTC @ECMWF  
Probability that **HARVEY** will pass within 120 km radius during the next 240 hours  
tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) **974** ]



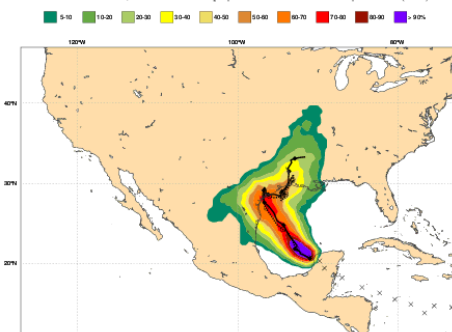
List of ensemble members numbers forecast Tropical Cyclone  
Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[>95 k]

MEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
MEMBER	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
MEMBER	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
MEMBER	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200
MEMBER	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250
MEMBER	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300
MEMBER	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350
MEMBER	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400
MEMBER	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450
MEMBER	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
MEMBER	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550
MEMBER	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
MEMBER	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650
MEMBER	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700
MEMBER	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750
MEMBER	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800
MEMBER	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850
MEMBER	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900
MEMBER	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950
MEMBER	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000



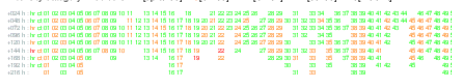
Date 20170823 00 UTC @ECMWF

Probability that **HARVEY** will pass within 120 km radius during the next 240 hours  
tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) 1009 ]



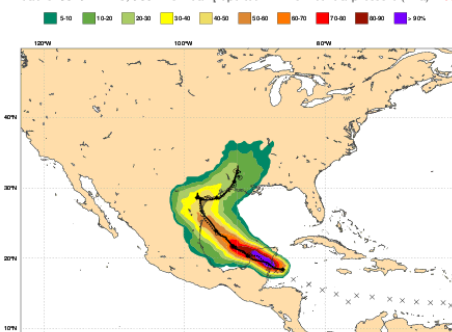
List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] HR3[> 95 k]



Date 20170822 00 UTC @ECMWF

Probability that **HARVEY** will pass within 120 km radius during the next 240 hours  
tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) 1008 ]



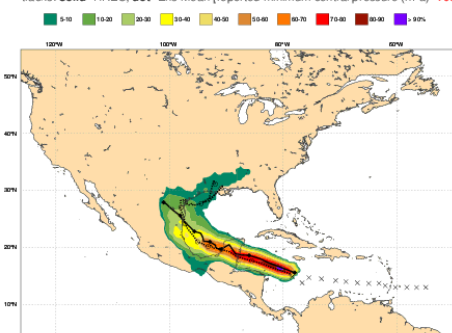
List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] HR3[> 95 k]



Date 20170821 00 UTC @ECMWF

Probability that **HARVEY** will pass within 120 km radius during the next 240 hours  
tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) 1007 ]



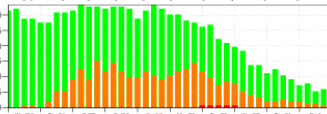
List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: TD[up to 33] TS[34-63] HR1[64-82] HR2[83-95] HR3[> 95 k]

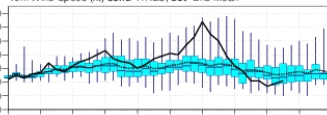


Probability (%) of Tropical Cyclone Intensity falling in each category

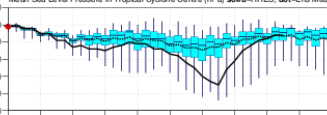
TD[up to 33] TS [34-63] HR1 [64-82] HR2 [83-95] HR3 [ > 95 k]



10m Wind Speed (kt) solid=HRES; dot=Ens Mean

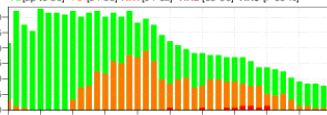


Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean

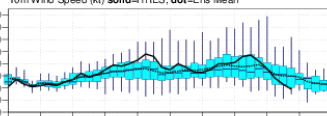


Probability (%) of Tropical Cyclone Intensity falling in each category

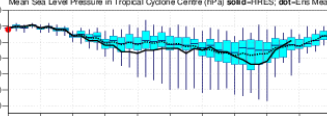
TD[up to 33] TS [34-63] HR1 [64-82] HR2 [83-95] HR3 [ > 95 k]



10m Wind Speed (kt) solid=HRES; dot=Ens Mean

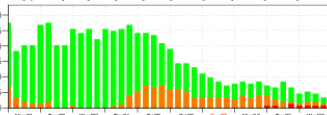


Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean

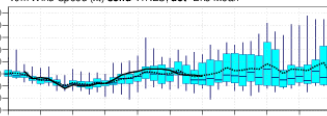


Probability (%) of Tropical Cyclone Intensity falling in each category

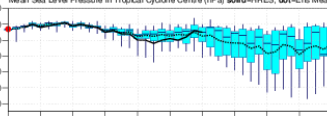
TD[up to 33] TS [34-63] HR1 [64-82] HR2 [83-95] HR3 [ > 95 k]



10m Wind Speed (kt) solid=HRES; dot=Ens Mean



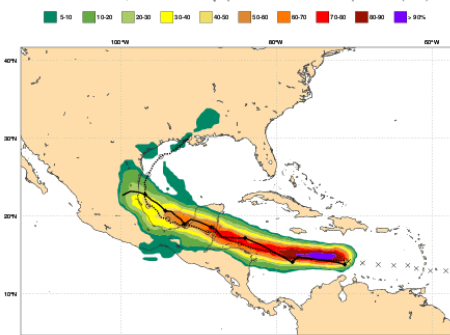
Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) solid=HRES; dot=Ens Mean



Date 20170820 00 UTC @ECMWF

Probability that **HARVEY** will pass within 120 km radius during the next 240 hours

tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) 1005]



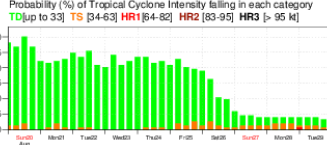
List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 k]

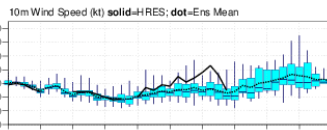
MEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
MEMBER	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Probability (%) of Tropical Cyclone Intensity falling in each category

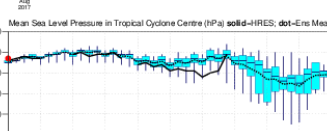
**TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 k]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



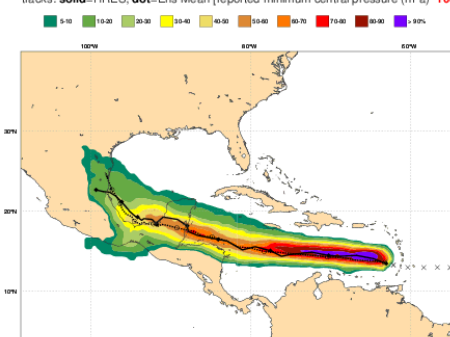
Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



Date 20170819 00 UTC @ECMWF

Probability that **HARVEY** will pass within 120 km radius during the next 240 hours

tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) 1005]



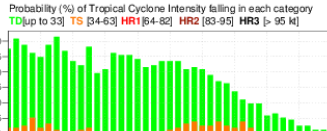
List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 k]

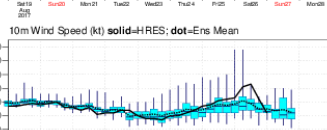
MEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
MEMBER	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Probability (%) of Tropical Cyclone Intensity falling in each category

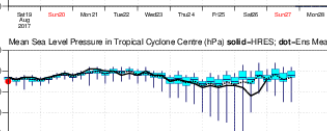
**TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 k]



10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



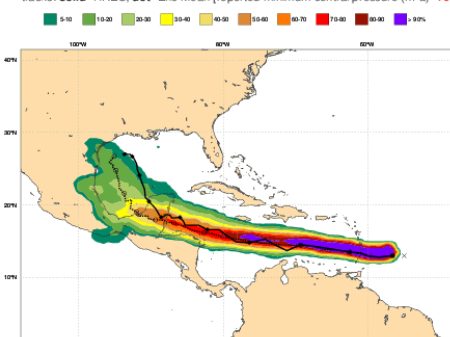
Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



Date 20170818 00 UTC @ECMWF

Probability that **HARVEY** will pass within 120 km radius during the next 240 hours

tracks: **solid**=HRES; **dot**=Ens Mean [reported minimum central pressure (hPa) 1005]



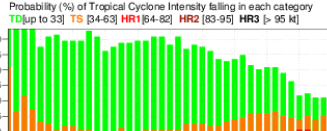
List of ensemble members numbers forecast Tropical Cyclone

Intensity category in colours: **TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 k]

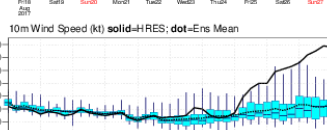
MEMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
MEMBER	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

Probability (%) of Tropical Cyclone Intensity falling in each category

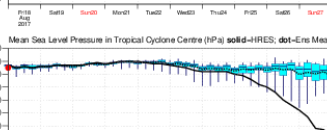
**TD**[up to 33] **TS**[34-63] **HR1**[64-82] **HR2**[83-95] **HR3**[> 95 k]



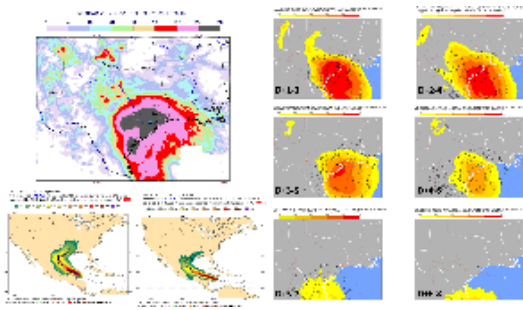
10m Wind Speed (kt) **solid**=HRES; **dot**=Ens Mean



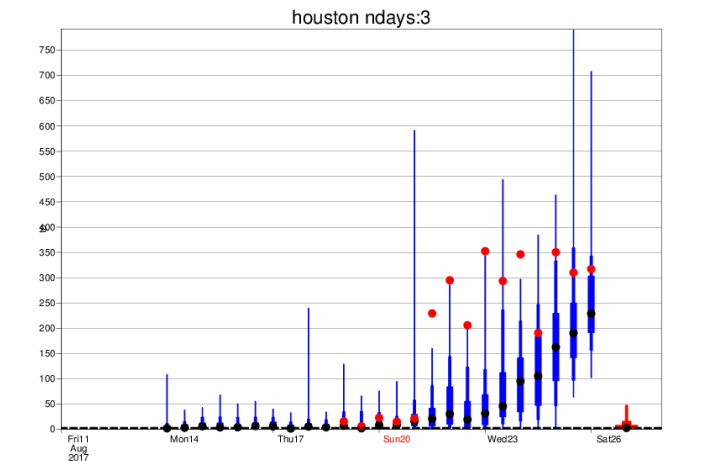
Mean Sea Level Pressure in Tropical Cyclone Centre (hPa) **solid**=HRES; **dot**=Ens Mean



The figure below includes 3-day EFI and the precipitation from NEXRAD, valid 25 August 00z to 28 August 00z..



The plot below shows the ensemble evolution for 72-hour precipitation for Houston 26-29 August. The ensemble distribution is shown in blue box-and-whisker and HRES in red dot. The model climate is shown in red box-and-whisker positioned on 26 August.



### 3.4 Monthly forecasts

### 3.5 Comparison with other centres

## 4. Experience from general performance/other cases

## 5. Good and bad aspects of the forecasts for the event

- Good early prediction of the risk for the cyclone to move into Gulf of Mexico
- The forecasts picked up the risk the risk for heavy rainfall around Houston (especially HRES) around 21-22 August (4 days before the landfall). HRES generated more than 1000 mm/72h locally.
- The forecasts did not predicted the rapid intensification before it started. However, RI is well known to be unpredictable, and I do know how much we should expect from a global model here.

## 6. Additional material