

Report on the weather conditions at the Durban Harbor on the 10 of October 2017

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## Summary

Weather definitions are found in Chapter 1. The weather system that affected Durban on the 10 of October 2017 was the result of the interaction of an upper air cut-off low system and a low-pressure system situated near Durban. The cut off low affected most of South Africa from the 9 to the 11 of October and slowly moved from west to east. The low-pressure system seems to have been generated on the 10. The low-pressure system brought moist air from the ocean further fueling the cut off low and associated thunderstorms in energy and moisture at the surface leading to severe thunderstorm gale force wind and flood inland in numerous locations of South Africa. The low-pressure system is seen in chapter 5 on the SAWS synoptic weather chart off Durban and marked with a "L". Typical low-pressure systems affecting South Africa are cut off low, cold front, coastal low and mesoscale convective system. The cut-off low is a well-known low-pressure system that occurs several times a year in South Africa. The cut-off trajectory was relatively well forecasted at the country scale. The cut off low is seen in blue on the 500 mb geopotential height chart GFS hindcast and forecast on the 9, 10 and 11 of October 2017 (Chapter 6). On the 8 of October 2017 a severe weather warning was broadcasted by the South African Weather Service (SAWS) with severe thunderstorms and strong winds forecasted for Gauteng and Central KwaZulu-Natal (Chapter 4). Heavy rain was forecasted for South KwaZulu-Natal on that warning (the Port of Durban falls within this geographic area). The only warning concerning wind speed given by South African Weather service was a warning of strong winds meaning winds above 80 km/h could occur. SAWS defines a severe thunderstorm when hail diameter is superior to 19mm diameter, it rains 50 mm in 24 hours and wind gust is superior to > 80 km/h. For a tornado wind gust should be superior to 90 km/h. Maximum wind gust of 175 km/h and 5-minute average maximum wind speed of 115 km/h were recorded during the storm in the harbor from Westerly to Southerly direction. A severe thunderstorm can be accompanied with wind gusts stronger than 80-100 km/h, tornadoes, hail and heavy rainfall but not will not necessarily happen for the everywhere region it is forecasted. It is just a warning it could happen. I have not seen the weather forecast issued on the 9 of October but it seems that only heavy rainfall and strong wind was forecasted on the 9 of October 2017 for the 10 of October for South KwaZulu-Natal. Only SAWS can issue severe weather warning and it is illegal to broadcast a severe weather warning as per Section 30A of the South African Weather Services Amendment Act of 2013. This is why the CSIR only provides real time information of wind speed measurement. In chapter 2, The analysis of the 4 Durban harbor anemometers plus the Port Shepstone and the Tugela anemometer which form part of the Integrated Port Operation Support System (IPOSS) provide useful information on what happened on 10 of October 2017 and how often such wind speed was recorded at the Harbor since their establishment 6 years ago by the CSIR (Chapter 2 and 3). All Durban harbor anemometers have recorded their maximum mean hourly rainfall as 5-minute average and maximum gust the day of the Great Storm on the 10 of October 2017 at around 10 am (out of 43800 hourly record). It is interesting to note that the anemometer at Port Shepstone (30°44'31.40"S Latitude and 30°27'31.66"E Longitude and Tugela River (29°13'21.06"S Latitude and 31°30'15.35"E Longitude) did not record their maximum hourly wind and gust on the 10 of October 2017. The historical record consists of hourly mean, maximum gust speed and time of maximum gust while the 10 of October 2017 data record consists of 5 minutes mean wind speed and maximum gust of the last 5 minutes. The 10 October wind speed

seems to be an outlier in the climatology of the distribution of wind speed and direction for hourly average wind speed and maximum gust shown in Chapter 3. Otherwise it seems that beside the storm of 10 10 2017 that is seen as the highest average wind or gust in all graph of Chapter 3 and with maximum average or gust occurring in various southerly direction depending on location (South , South West , West-South-West and West) other wind direction that are experienced during strong wind also occurs mainly from the North East and also from the West. It is clear from the analysis of the 5 minutes wind record shown in Chapter 2 that the wind accelerated very quickly at around 09:30 am on 10 October 2017 and reached very high wind speeds with maximum at 10:00 am on 10 October 2017 decreasing gradually within the next hour quickly to the same speed it started from. Strong wind was experienced from a westerly direction to a Southerly direction (Chapter 2). This indicates wind speed associated to a squall line, or a severe thunderstorm or even a tornado. I do not think it is possible to forecast the exact location of such extreme events at the scale of a harbor for instance. The absence of radar used by the SAWS would have prevented the SAWS from following that squall line or severe thunderstorm in real time as well as its trajectory. It is also virtually impossible to forecast the exact path of a tornado, a squall line or a severe thunderstorm at the scale of the harbor. It is possible to do it at the scale of a region or a country. Therefore, the SAWS has a network of radar to follow severe thunderstorm in real time and warn the public of its possible trajectory. This is done to warn an airport of an incoming thunderstorm. The wind anemometer at Port Shepstone did not record the extreme wind event but very strong wind was recorded at Tugela at 13:30 pm. It is also interesting to note that the wind speed was not as strong at the SA navy base with max gust difference of 50 km/h between Durmarine and Navy base. This is due to difference in height of measurement and location as building and orography can generate such difference noted in speed and direction within the various anemometer. The climatology of wind speed and direction reflect such difference but outline the storm of the 10 10 2017 as an outlier in the distribution of speed and wind presented in chapter 3.

## **1 Definition**

The following definitions are based and copied from the American Meteorological Society glossary and World Authority in Weather, Climate and Ocean Related Science definition. In italics are South Africa Weather Service definitions.

### **Low pressure system**

(Sometimes called depression.) In meteorology, an "area of low pressure," referring to a minimum of atmospheric pressure in two dimensions (closed isobars) on a constant-height chart or a minimum of height (closed contours) on a constant-pressure chart. A low-pressure system is, on a synoptic chart, always associated with cyclonic circulation.

*Cold Front and Cut off low are typical South African weather systems*

### **Thunderstorm**

In general, a local storm, invariably produced by a cumulonimbus cloud and always accompanied by lightning and thunder, usually with strong gusts of wind, heavy rain, and sometimes with hail. It is usually of short duration, seldom over two hours for any one storm. A thunderstorm is a consequence of atmospheric instability and constitutes, loosely, an overturning of air layers to achieve a more stable density stratification. A strong convective updraft is a distinguishing feature of this storm in its early phases. A strong downdraft in a column of precipitation marks its dissipating stages.

### **Squall line**

A line of active deep moist convection frequently associated with thunder, either continuous or with breaks, including contiguous precipitation areas.

A strong wind characterized by a sudden onset, a duration of the order of minutes, and then a rather sudden decrease in speed.

In nautical use, a severe local storm considered, that is, winds and cloud mass and (if any) precipitation, thunder and lightning.

### **Cut-off low**

A cold low that has grown out of a trough and become displaced out of the basic westerly current and lies equatorward of this current.

### **Cold low**

At a given level in the atmosphere, any low that is generally characterized by colder air near its center than around its periphery; the opposite of a warm low.

A significant case of a cold low is that of a cut-off low, characterized by a completely isolated pool of cold air within its vortex.

## 2 Wind record during the storm on the 10 10 2017

To be drawn

Figure 1: Top: 20-minute mean wind speed(black) and maximum wind gust(blue). Bottom: wind direction on 10 10 2017 at DB2013 Windnet Port CONTROL, Durban Harbor.

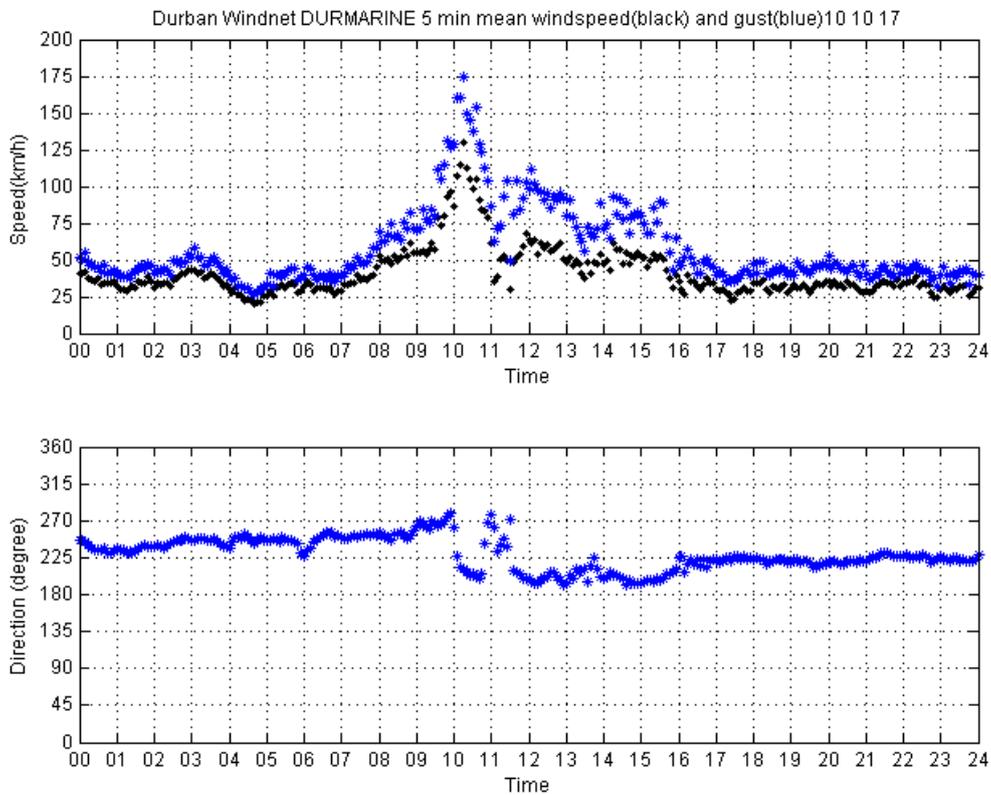


Figure 2: Top: 5-minute mean wind speed(black) and maximum wind gust(blue). Bottom: wind direction on 10 10 2017 at D101 Windnet Durmarine Building, Durban Harbor.

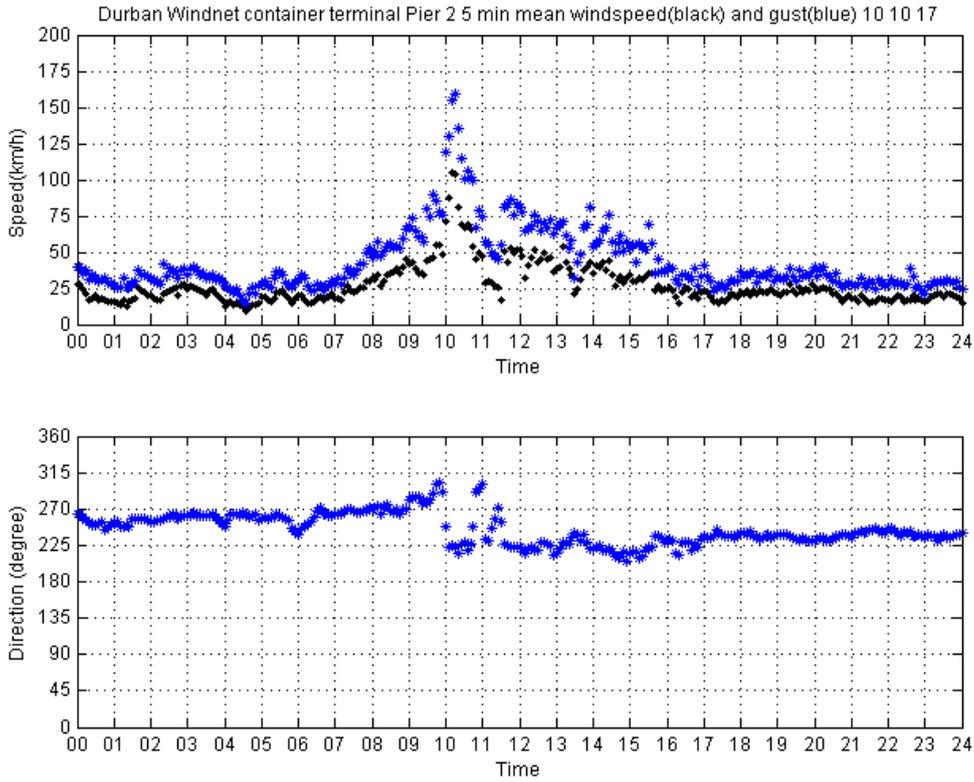


Figure 3. Top: 5-minute mean wind speed (black) and maximum wind gust (blue). Bottom: wind direction on 10 10 2017 at D201 Windnet Container terminal PIER 2, Durban Harbor

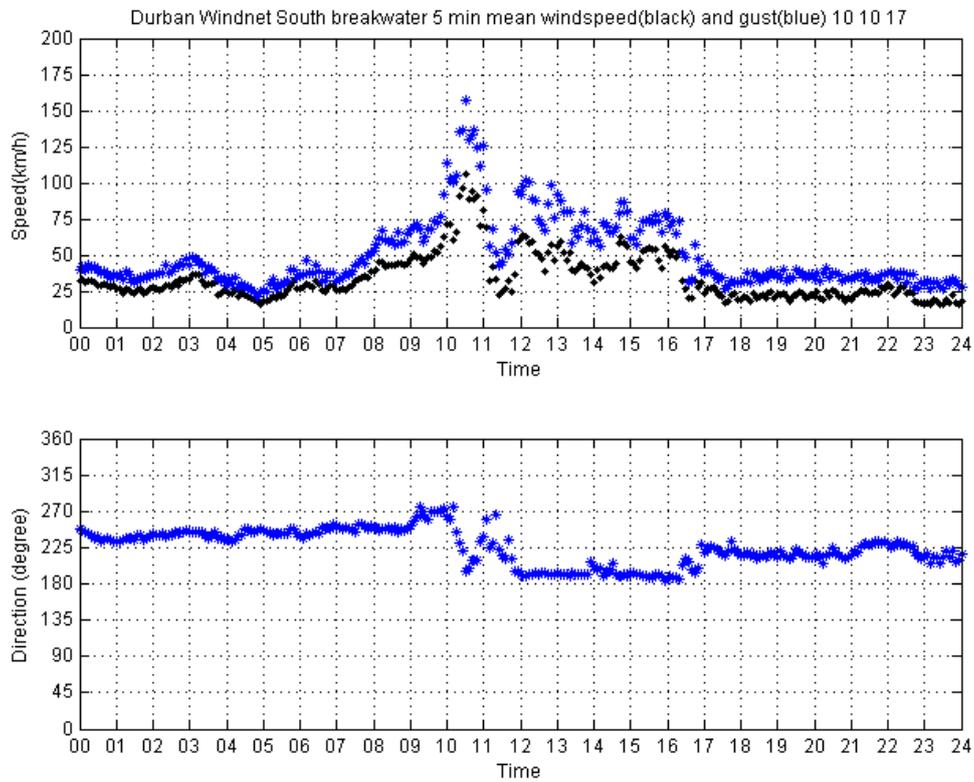


Figure 4. Top: 5-minute mean wind speed(black) and maximum wind(blue) gust. Bottom: wind direction on 10 10 2017 at D401 Windnet South Breakwater, Durban Harbor.

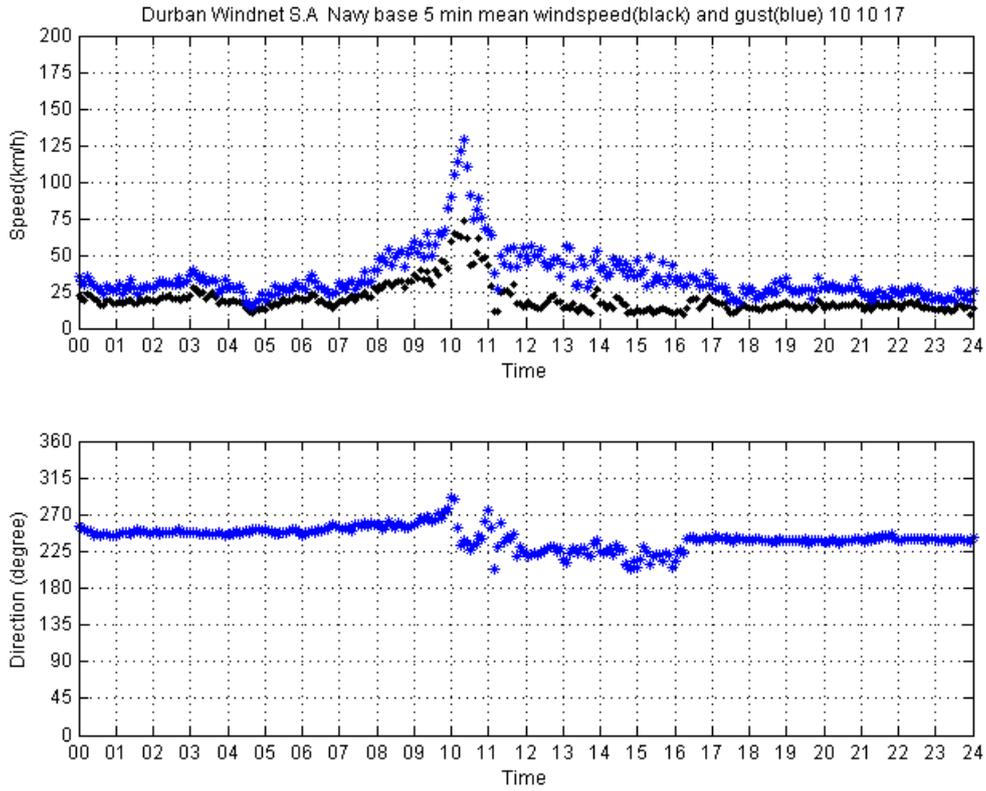


Figure 5. Top: 5-minute mean wind speed (black) and maximum wind gust (blue). Bottom: wind direction on 10 10 2017 at D301 Windnet Navy Base, Durban Harbor

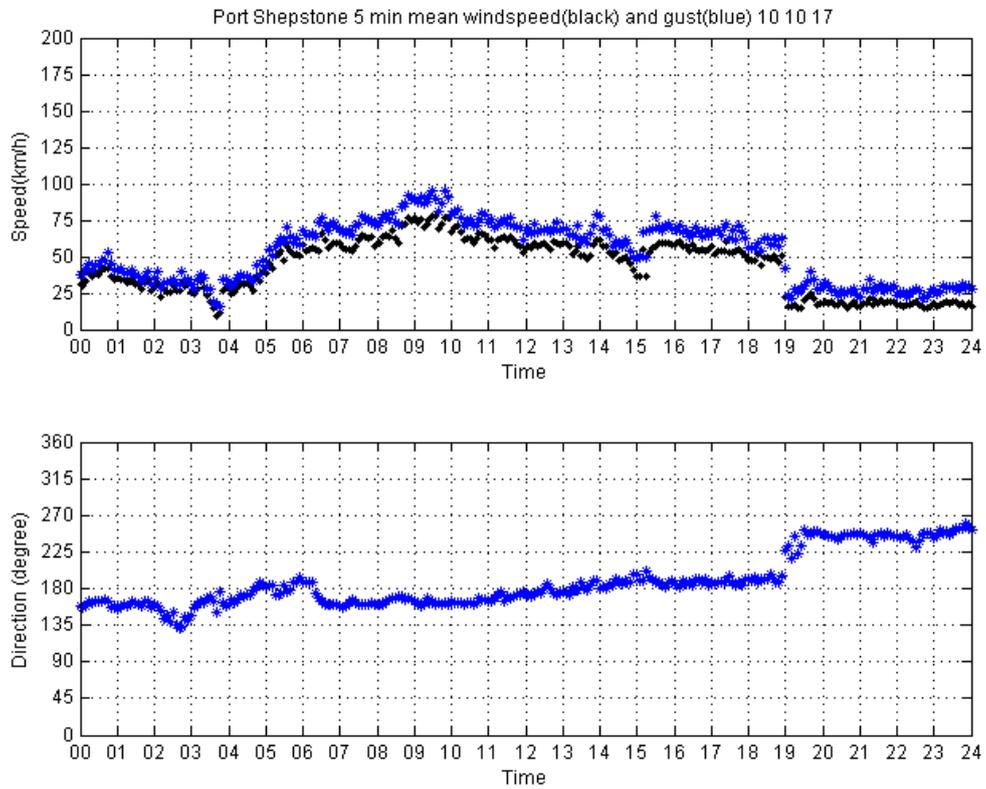


Figure 6. Top: 5-minute mean wind speed (black) and maximum wind gust (blue). Bottom: wind direction on 10 10 2017 at D501 Windnet Port Shepstone.

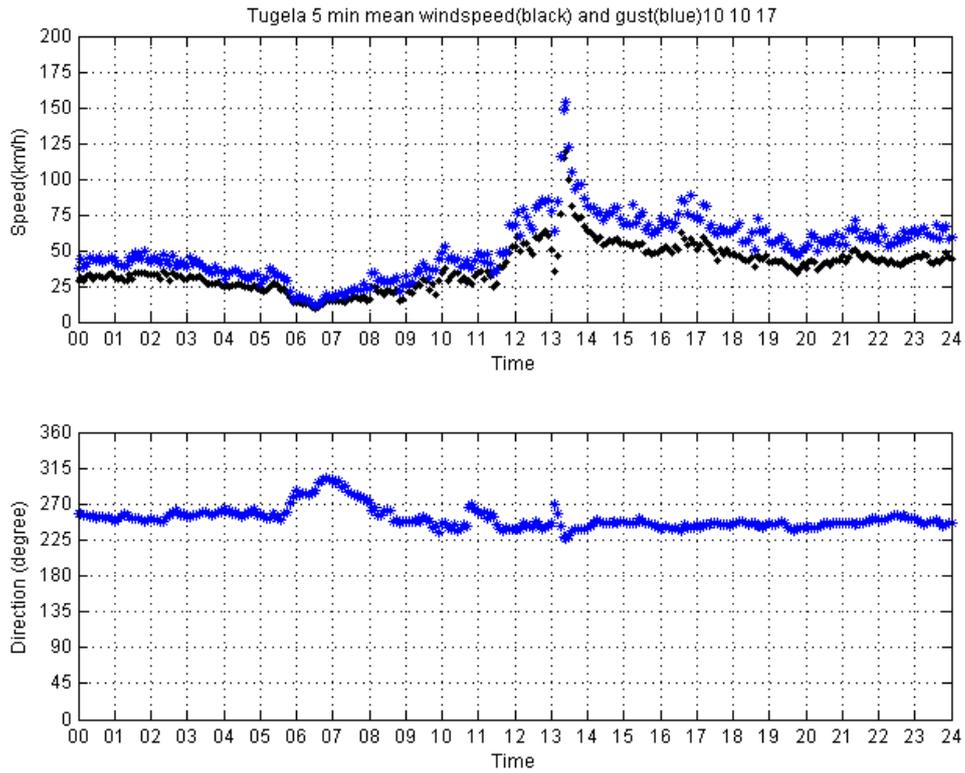


Figure 7. Top: 5-minute mean wind speed (black) and maximum wind gust (blue). Bottom: wind direction on 10 10 2017 at D601 Windnet Tugela Rivermouth lighthouse.

### 3 Wind climatology at the weather stations

*Warning: please note that the climatology of station db103 Durban Port control is based on 20 minutes average while the rest is based on hourly average. This affects the occurrence of events presented and calculated below. I need to recalculate the station Db103 Durban Port hourly for better comparison. It is a very useful station and because it is quite high it represents better the weather that the other station that are very close to the ground and could be shadowed or distorted by building. I also plan to do such wind rose for the 10 of October 2017. Mathieu Rouault 04/04/2019*

#### 3.1 Hourly wind speed

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	1.383	0.746	1.208	0.737	0.588	0.585	0.612	0.610	0.724	0.726	0.812	1.606	1.882	1.351	1.657	2.335	17.561
11.25-22.5	2.357	2.649	4.182	1.506	0.940	0.657	0.755	1.128	1.814	2.722	4.741	8.752	4.945	1.143	0.628	0.750	39.669
22.5-33.75	1.077	3.216	5.999	1.242	0.242	0.149	0.144	0.447	1.368	3.148	5.358	1.729	0.245	0.029	0.013	0.028	24.434
33.75-45.0	0.227	1.462	5.382	0.757	0.059	0.032	0.028	0.095	0.619	1.705	1.614	0.137	0.022	0.002	0.007	0.003	12.152
45-56.25	0.014	0.535	2.924	0.397	0.048	0.004	0.004	0.015	0.146	0.529	0.223	0.005	0.001	0.001	0.002	0.003	4.851
56.25-67.5	0.007	0.133	0.723	0.110	0.007	0.001	0.004		0.001	0.038	0.024			0.001	0.001		1.050
67.5-78.75		0.026	0.134	0.017	0.002	0.001	0.001			0.004	0.001						0.187
78.75-90		0.001	0.003									0.001					0.004
90-101.25												0.001					0.001
Σ	5.064	8.768	20.557	4.766	1.887	1.428	1.548	2.295	4.672	8.873	12.771	12.231	7.095	2.527	2.308	3.119	99.908

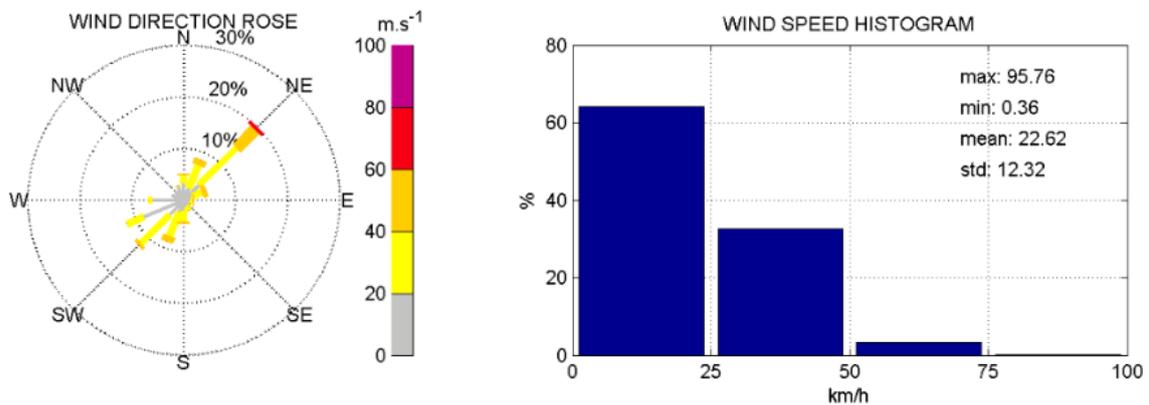


Figure 8: DB103 DURBAN PORT CONTROL 2. HEIGHT: 80. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	3.363	3.268	1.622	1.179	0.799	0.693	0.907	0.945	1.044	1.423	4.881	4.260	1.593	1.047	1.465	2.328	30.817
11.25-22.5	8.578	11.422	3.585	2.160	1.036	0.582	1.102	1.310	2.861	3.352	6.767	3.421	0.542	0.071	0.230	0.551	43.570
22.5-33.75	5.485	4.899	1.666	0.573	0.080	0.053	0.049	0.299	3.074	4.647	3.768	0.254	0.020	0.009	0.018	0.009	19.902
33.75-45.0	0.020	0.308	0.259	0.062	0.004	0.002	0.004	0.015	1.155	2.381	0.684	0.046				0.004	4.946
45-56.25			0.007			0.002	0.002		0.139	0.436	0.080	0.015					0.682
56.25-67.5									0.009	0.038	0.002						0.049
67.5-78.75										0.004			0.002				0.007
78.75-90																	0.000
90-101.25											0.002						0.002
Σ	8.446	19.897	7.138	3.974	1.918	1.332	2.065	2.569	8.282	12.281	16.184	7.997	2.157	1.126	1.713	2.892	99.973

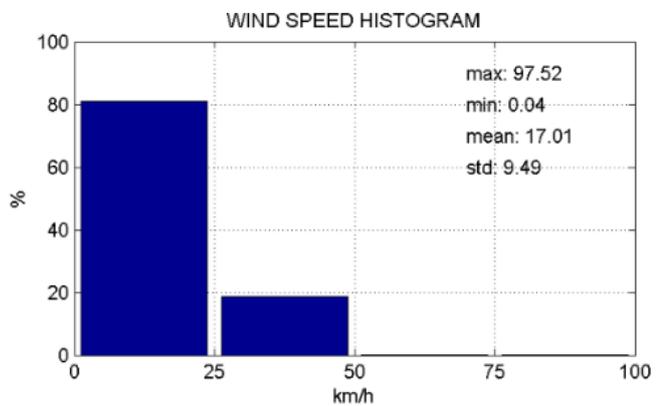
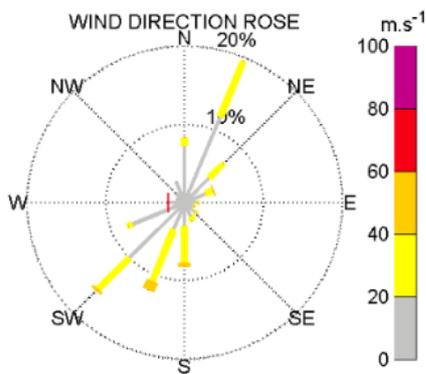


Figure 9: D101 DURBAN WINDNET DURMARINE BUILDING. HEIGHT: 5.0. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	2.018	2.059	2.141	3.190	2.013	1.252	1.633	1.038	1.529	3.830	7.115	6.447	3.908	3.800	2.247	1.438	45.658
11.25-22.5	5.394	3.090	5.013	4.230	2.046	1.856	1.825	0.532	1.347	3.744	5.595	1.998	1.622	1.983	0.577	0.147	36.000
22.5-33.75	5.004	0.385	4.983	1.927	0.329	2.026	0.363	0.009	0.117	2.154	1.953	0.221	0.947	0.240	0.054	0.004	15.716
33.75-45		0.009	1.107	0.489	0.017	0.389	0.087	0.002		0.160	0.167	0.004	0.052	0.006	0.009	0.002	2.500
45-56.25			0.080	0.017		0.009	0.004				0.006			0.002			0.119
56.25-67.5																	0.000
67.5-78.75												0.002					0.002
78.75-90																	0.000
90-101.25																	0.000
Σ	2.416	5.543	13.324	9.853	4.405	5.532	3.912	1.581	2.993	9.888	14.836	8.672	6.529	6.032	2.887	1.592	99.996

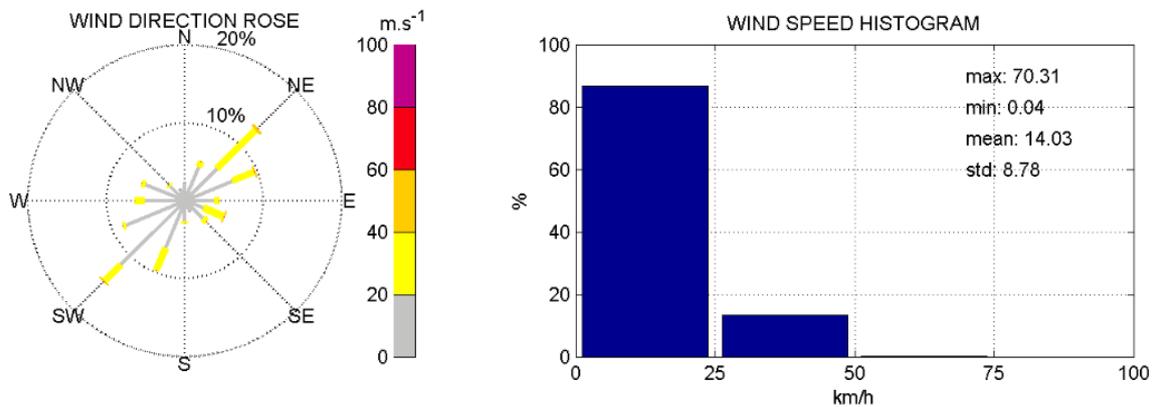


Figure 10: D201 DB WINDNET Container Terminal PIER 2 HEIGHT: 2.5. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	1.769	0.978	0.930	0.721	0.743	0.691	0.706	0.737	0.769	1.719	3.950	2.442	1.189	1.182	1.312	1.143	20.981
11.25-22.5	3.265	3.629	1.982	1.193	0.741	0.774	1.102	1.819	2.903	6.312	8.441	1.992	0.304	0.584	1.806	2.021	39.867
22.5-33.75	3.454	5.271	2.147	0.426	0.115	0.135	0.248	1.095	4.587	4.209	1.067	0.078	0.004	0.013	0.026	0.315	24.190
33.75-45.147	3.889	1.803	0.137	0.030	0.035	0.035	0.278	3.127	0.734	0.169	0.007	0.002	0.002	0.004	0.026	0.026	11.427
45-56.25	0.146	1.169	0.584	0.022	0.011	0.011	0.002	0.033	1.110	0.054	0.002	0.002	0.002	0.004	0.013	0.013	3.166
56.25-67.5		0.187	0.056			0.002			0.096	0.007							0.348
67.5-78.75									0.011								0.011
78.75-90											0.002						0.002
90-101.25																	0.000
Σ	11.781	15.123	7.503	2.499	1.640	1.647	2.092	3.961	12.602	13.035	13.632	4.522	1.501	1.782	3.153	3.518	99.991

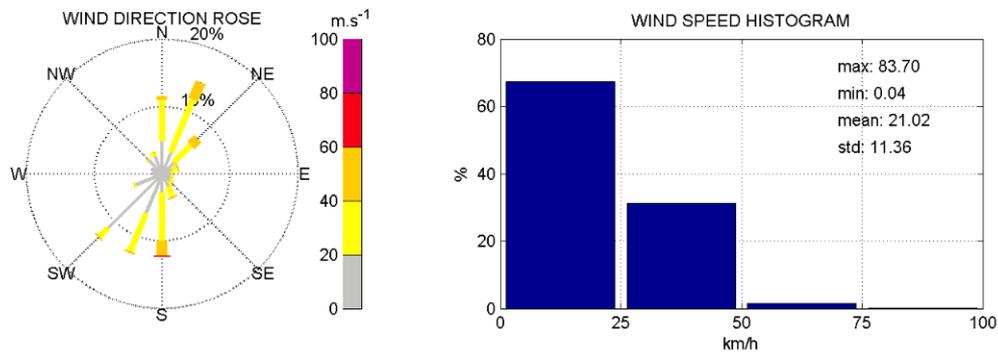


Figure 11: D401 DB WINDNET DURBAN SOUTHERN Breakwater. HEIGHT: 3.0. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	2.297	2.388	1.929	1.620	1.079	1.172	1.159	1.700	2.692	8.206	17.503	10.397	1.186	0.952	1.489	1.899	57.666
11.25-22.5	5.705	6.656	5.010	2.489	0.742	0.943	0.895	1.150	1.081	0.524	3.536	2.673	0.025	0.027	0.233	0.778	30.469
22.5-33.75	5.480	2.751	4.735	1.248	0.091	0.032	0.002	0.006	0.004		0.013	0.080		0.002	0.008	0.013	9.466
33.75-45		0.273	1.493	0.408	0.025	0.004							0.002		0.002	0.002	2.210
45-56.25		0.004	0.087	0.042								0.002					0.135
56.25-67.5				0.004													0.004
67.5-78.75																	0.000
78.75-90																	0.000
90-101.25																	0.000
Σ	6.482	12.072	13.254	5.812	1.937	2.151	2.056	2.857	3.777	8.730	21.052	13.152	1.214	0.981	1.732	2.692	99.951

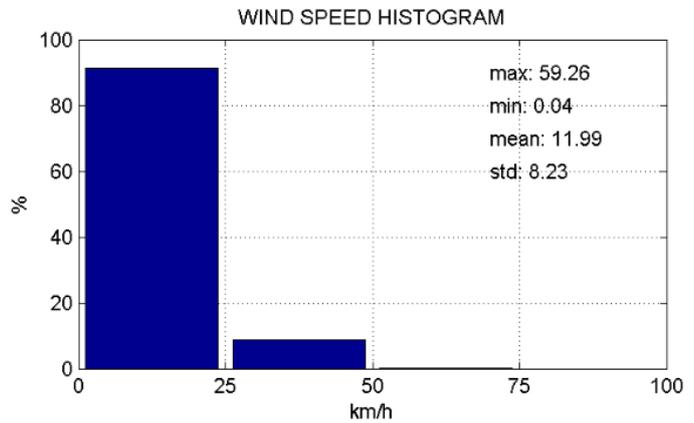
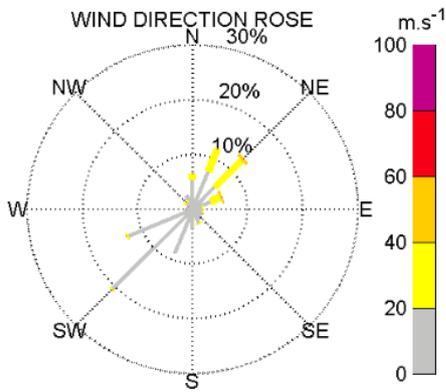


Figure 12: D301 DB WINDNET S.A NAVY BASE HEIGHT: 3.0. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	2.672	1.083	0.636	0.608	0.556	0.595	0.623	0.571	0.523	0.702	1.473	2.448	2.574	2.755	3.873	5.903	27.597
11.25-22.5	5.974	3.010	2.657	1.253	0.612	0.410	0.549	0.894	1.467	2.600	5.589	4.209	1.138	2.825	3.180	6.474	40.841
22.5-33.75	4.423	4.098	3.682	0.312	0.076	0.059	0.116	0.272	1.469	3.937	2.563	0.248	0.007	0.074	0.052	0.089	17.477
33.75-45.0	0.031	2.834	2.991	0.078	0.031	0.022	0.013	0.057	0.752	2.701	0.392	0.004	0.002				9.907
45-56.25	0.002	1.112	0.963	0.022	0.009	0.026	0.002	0.017	0.196	1.247	0.046						3.642
56.25-67.5	0.002	0.113	0.057	0.004	0.009		0.002	0.007	0.041	0.253							0.488
67.5-78.75				0.002			0.002	0.004	0.002	0.017							0.028
78.75-90									0.002								0.002
90-101.25									0.002								0.002
Σ	7.104	12.250	10.986	2.280	1.293	1.112	1.308	1.822	4.453	11.459	10.064	6.910	3.721	5.654	7.106	12.466	99.985

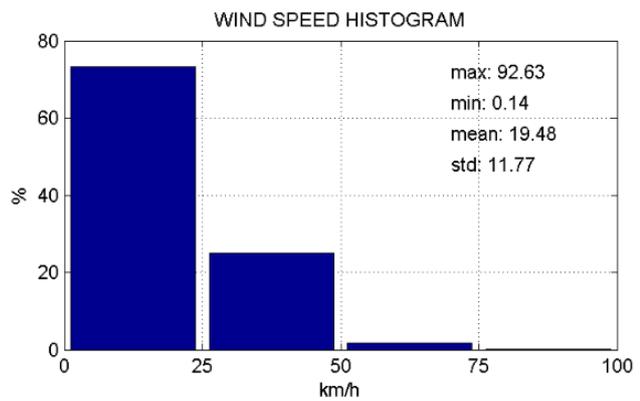
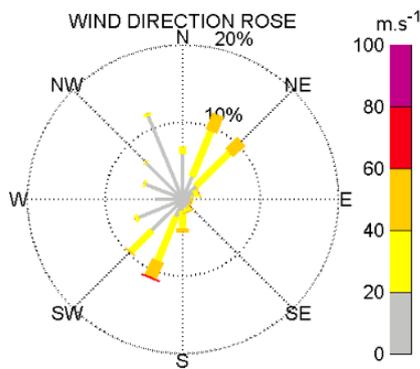


Figure 13: D501 DB WINDNET PORT SHEPSTONE. HEIGHT: 15.0. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-11.25	5.978	0.620	1.367	0.906	0.691	0.622	0.540	0.465	0.579	0.587	0.636	0.919	1.884	2.456	1.207	0.161	19.618
11.25-22.5	3.055	1.315	5.112	3.176	1.609	0.923	0.589	0.641	1.153	1.777	2.074	2.570	4.079	5.643	2.339	0.195	37.250
22.5-33.75	0.612	0.302	4.445	4.346	1.168	0.205	0.080	0.132	0.711	1.847	3.673	3.363	1.014	0.262	0.069		22.229
33.75-45	0.080	0.057	1.347	2.982	0.581	0.019	0.009	0.026	0.271	1.509	3.676	1.374	0.106	0.003			12.039
45-56.25	0.004		0.369	1.739	0.261	0.009	0.007	0.007	0.065	0.906	2.185	0.530	0.022				6.103
56.25-67.5	0.001		0.067	0.555	0.071				0.007	0.385	0.928	0.170					2.183
67.5-78.75			0.001	0.031	0.002			0.001	0.001	0.072	0.292	0.029					0.428
78.75-90									0.011	0.083	0.003						0.098
90-101.25									0.012	0.021							0.033
Σ	10.731	2.294	12.708	13.733	4.382	1.779	1.226	1.272	2.786	7.103	13.567	8.957	7.105	8.364	3.616	0.356	99.980

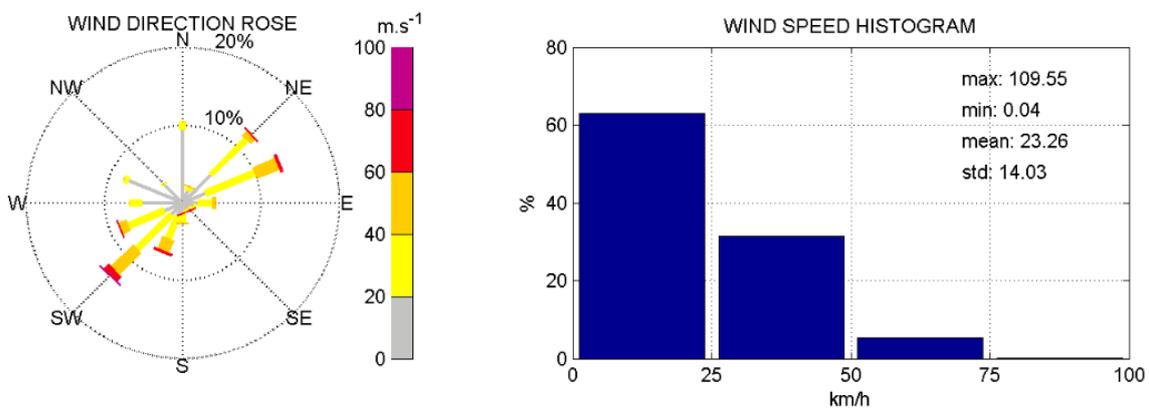


Figure 14: D601 DB TUGELA RIVER LIGHTHOUSE. Height 22 m. Wind climatology from February 2013 to August 2018 based on hourly average. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

## 2.2 Hourly wind gust

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	2.449	1.741	2.785	1.382	1.075	0.934	0.970	1.118	1.427	1.419	1.655	4.881	4.919	2.242	2.093	2.743	33.831
20-40	2.381	5.198	8.878	2.134	0.700	0.461	0.534	1.051	2.358	4.320	6.091	6.425	2.100	0.276	0.201	0.363	43.470
40-60	0.223	1.641	6.986	0.983	0.098	0.029	0.038	0.123	0.838	2.480	4.054	0.845	0.067	0.007	0.010	0.008	18.431
60-80	0.012	0.186	1.780	0.253	0.010	0.003	0.004	0.002	0.048	0.602	0.898	0.075	0.008		0.004	0.005	3.891
80-100	0.001	0.002	0.126	0.015	0.004	0.001	0.001		0.001	0.048	0.068	0.004					0.272
100-120			0.001	0.001						0.003	0.005		0.001	0.001			0.012
120-140																	0.000
140-160												0.001		0.001			0.002
160-180																	0.000
Σ	5.064	8.768	20.557	4.767	1.887	1.428	1.548	2.295	4.672	8.873	12.771	12.231	7.095	2.527	2.308	3.119	99.908

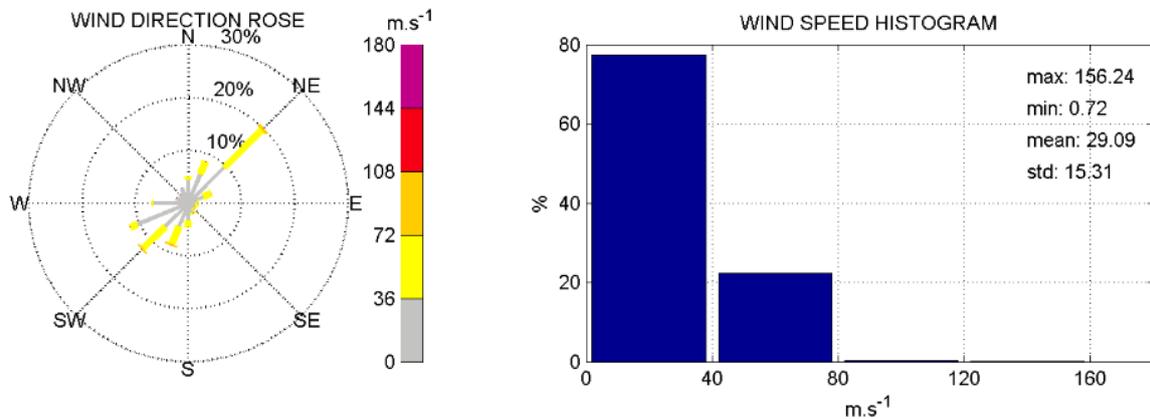


Figure 15: DB103 DURBAN PORT CONTROL 2. HEIGHT: 80. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	3.144	3.018	1.620	1.252	0.724	0.549	0.823	0.859	0.881	1.255	5.441	5.021	1.644	1.009	1.334	2.292	30.865
20-40	4.691	11.524	3.651	2.277	1.122	0.728	1.193	1.494	3.321	3.381	7.138	2.770	0.496	0.104	0.350	0.575	44.814
40-60	0.575	4.932	1.651	0.423	0.064	0.049	0.042	0.201	2.947	4.799	3.038	0.159	0.013	0.007	0.024	0.011	18.937
60-80	0.031	0.416	0.217	0.022	0.009	0.004	0.004	0.011	0.989	2.343	0.516	0.042	0.002	0.007	0.004	0.013	4.631
80-100	0.004	0.007				0.002	0.002	0.004	0.137	0.462	0.046	0.004					0.670
100-120									0.009	0.038	0.002						0.049
120-140									0.002				0.002				0.004
140-160																	0.000
160-180											0.002						0.002
Σ	8.446	19.897	7.138	3.974	1.918	1.332	2.064	2.569	8.284	12.281	16.184	7.997	2.157	1.126	1.713	2.892	99.973

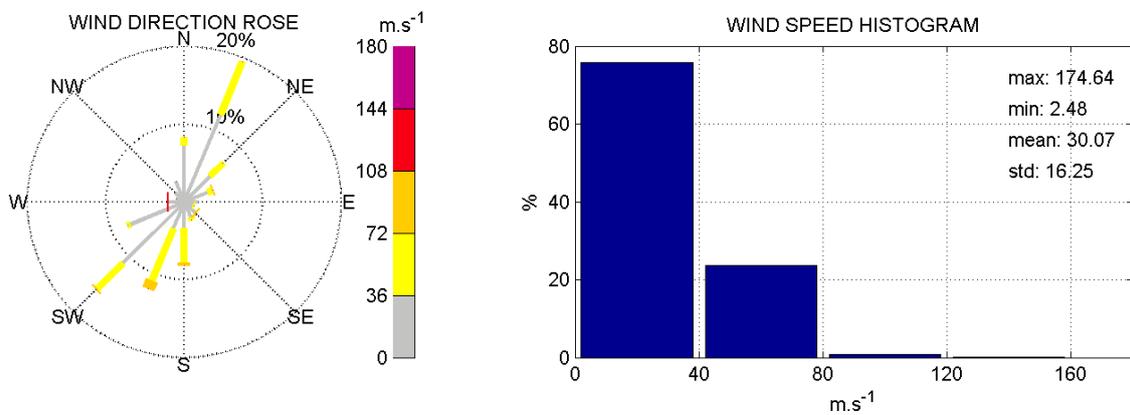


Figure 16: D101 DURBAN WINDNET DURMAR BUILDING. HEIGHT: 5.0. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	2.009	2.074	2.325	4.053	1.957	1.163	1.881	0.889	1.179	3.315	5.802	5.733	3.653	3.302	2.217	1.395	42.946
20-40	0.389	3.162	6.669	4.444	2.165	2.775	1.806	0.666	1.615	3.555	6.261	2.584	1.533	2.150	0.599	0.184	40.556
40-60	0.015	0.298	4.063	1.265	0.279	1.529	0.208	0.024	0.190	2.595	2.470	0.342	1.157	0.554	0.061	0.009	15.058
60-80	0.002	0.009	0.264	0.089	0.004	0.065	0.013	0.002	0.009	0.407	0.296	0.011	0.175	0.024	0.011	0.004	1.384
80-100			0.002	0.002			0.004			0.015	0.006		0.013				0.043
100-120											0.004			0.002			0.006
120-140																	0.000
140-160												0.002					0.002
160-180																	0.000
Σ	2.416	5.543	13.323	9.853	4.405	5.532	3.912	1.581	2.993	9.887	14.839	8.672	6.531	6.031	2.887	1.592	99.996

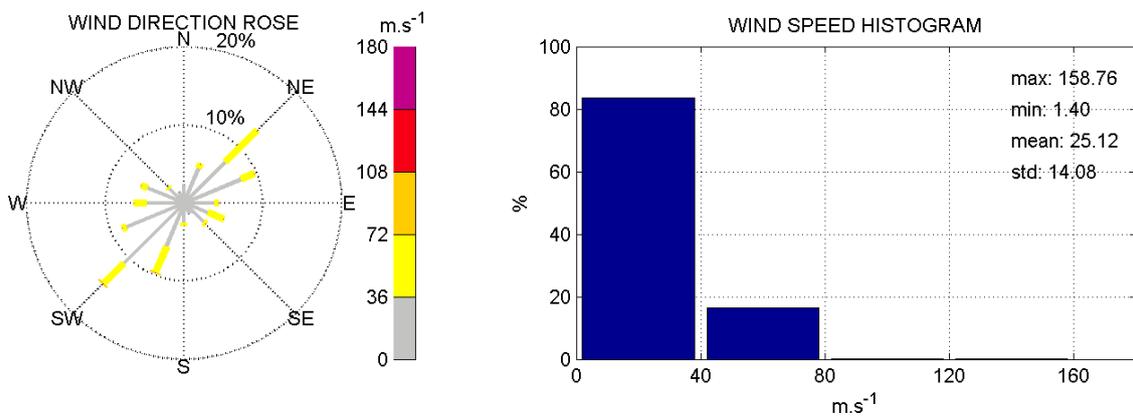


Figure 17: D201 DB WINDNET CONT TERMI PIER 2 HEIGHT: 2.5. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	2.272	1.526	1.361	0.960	0.980	0.962	0.941	1.110	0.939	1.669	6.574	3.401	1.290	1.426	2.007	1.669	29.086
20-40	6.962	6.962	3.180	1.329	0.579	0.600	1.030	2.248	4.203	6.164	6.063	1.060	0.204	0.340	1.131	1.734	43.788
40-60	2.360	5.536	2.482	0.191	0.076	0.082	0.119	0.555	5.042	4.214	0.887	0.061	0.013	0.020	0.015	0.106	21.757
60-80	0.176	1.040	0.455	0.020	0.009	0.007	0.004	0.050	2.120	0.860	0.080	0.007	0.002		0.011	0.020	4.860
80-100	0.004	0.035	0.020			0.002		0.002	0.286	0.111	0.007	0.002					0.468
100-120		0.002							0.017	0.007			0.002				0.028
120-140									0.002								0.002
140-160											0.002						0.002
160-180																	0.000
Σ	11.774	15.101	7.497	2.499	1.643	1.654	2.094	3.964	12.606	13.027	13.612	4.530	1.511	1.786	3.165	3.529	99.991

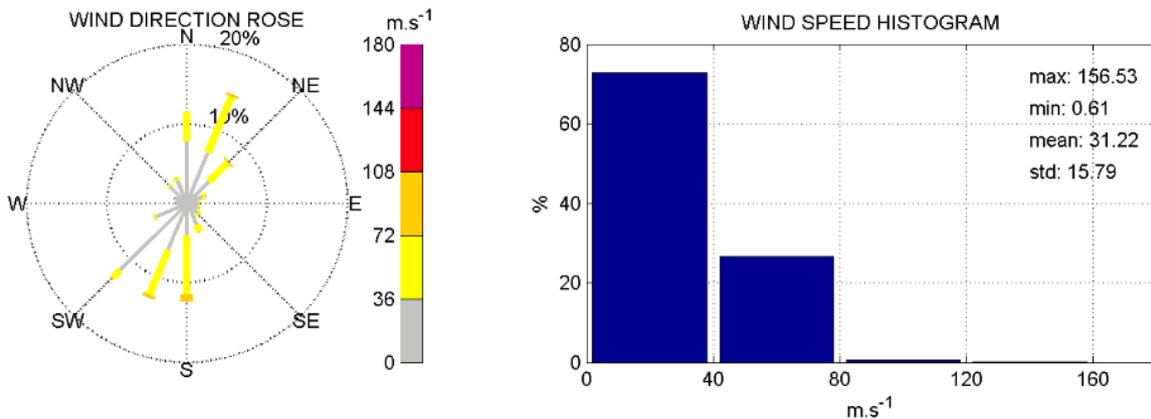


Figure 18: D401 DB WINDNET DUR SOUTHERN BW. HEIGHT: 3.0. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	2.178	2.535	2.444	1.986	1.043	1.106	0.865	0.981	0.905	3.935	9.903	8.822	1.129	0.926	1.548	1.884	42.191
20-40	3.937	7.536	6.881	3.045	0.804	1.009	1.161	1.791	2.271	3.654	9.535	4.075	0.080	0.051	0.167	0.780	46.777
40-60	0.355	1.903	3.673	0.730	0.085	0.032	0.027	0.087	0.594	1.106	1.567	0.254	0.002	0.004	0.011	0.023	10.453
60-80	0.011	0.087	0.254	0.044	0.006	0.002	0.002	0.002	0.011	0.032	0.040	0.002			0.006	0.004	0.503
80-100		0.008		0.006		0.002					0.004		0.002				0.023
100-120										0.002							0.002
120-140												0.002					0.002
140-160																	0.000
160-180																	0.000
Σ	6.481	12.070	13.252	5.811	1.937	2.151	2.055	2.861	3.781	8.729	21.049	13.155	1.214	0.981	1.732	2.692	99.951

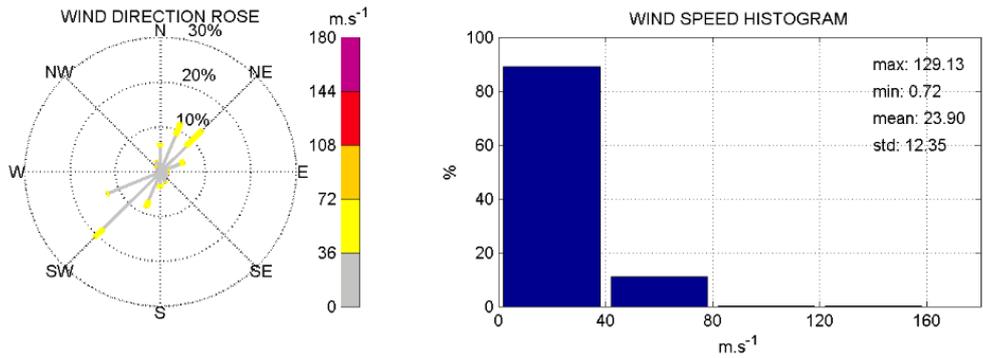


Figure 19: D301 DB WINDNET S.A NAVY BASE HEIGHT: 3.0. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	2.562	1.155	1.028	0.859	0.769	0.700	0.793	0.756	0.767	0.801	1.174	2.020	2.335	3.397	4.845	8.667	32.628
20-40	4.016	4.593	5.209	1.279	0.471	0.362	0.493	0.925	2.268	4.078	5.385	4.342	1.305	2.129	2.076	3.582	42.513
40-60	0.458	5.321	4.115	0.150	0.058	0.071	0.058	0.141	1.202	4.580	2.887	0.441	0.036	0.092	0.144	0.118	19.872
60-80	0.043	1.052	0.527	0.013	0.013	0.026	0.004	0.026	0.218	1.763	0.536	0.062	0.009	0.004	0.030	0.032	4.357
80-100	0.009	0.021	0.013	0.006	0.006			0.011	0.024	0.246	0.071	0.013	0.002		0.002	0.011	0.435
100-120	0.002		0.002	0.002	0.002		0.004			0.006	0.004	0.002	0.002	0.004	0.002	0.011	0.045
120-140	0.002						0.002		0.002	0.009	0.002	0.002	0.002	0.004		0.006	0.032
140-160		0.002			0.002				0.004	0.002			0.004	0.002		0.004	0.021
160-180			0.002				0.002			0.002				0.002		0.004	0.015
Σ	7.092	12.145	10.897	2.309	1.322	1.159	1.356	1.859	4.485	11.488	10.059	6.882	3.695	5.636	7.099	12.435	99.919

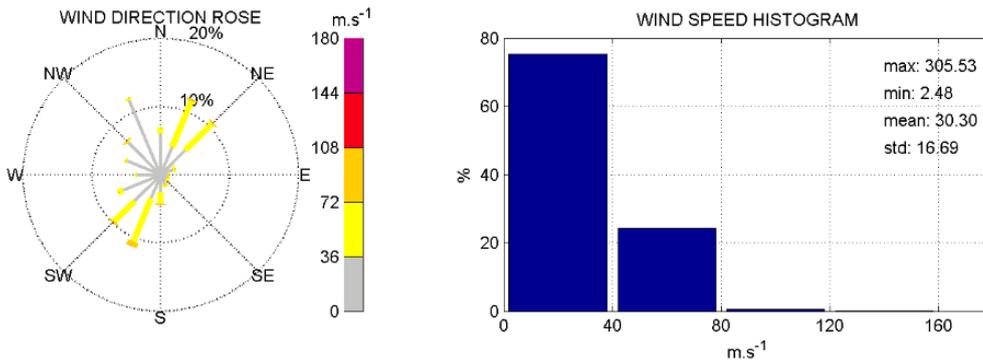


Figure 20: D501 DB WINDNET PORT SHEPSTONE. HEIGHT: 15.0. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

JOINT DISTRIBUTION OF SPEED AND DIRECTION

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Σ
0-20	6.938	1.025	2.216	1.659	1.174	0.971	0.777	0.707	0.933	1.046	0.949	1.164	3.184	5.849	2.744	0.311	31.647
20-40	3.283	1.085	7.092	6.066	2.186	0.764	0.421	0.511	1.392	2.727	4.000	4.046	3.517	2.488	0.870	0.045	40.494
40-60	0.470	0.172	2.954	4.543	0.826	0.033	0.020	0.045	0.390	2.101	5.114	2.803	0.357	0.024	0.002		19.853
60-80	0.030	0.013	0.442	1.412	0.189	0.012	0.007	0.008	0.067	0.967	2.589	0.766	0.045	0.003			6.549
80-100	0.006		0.004	0.052	0.007		0.001		0.003	0.229	0.748	0.167	0.003				1.220
100-120	0.003							0.001		0.026	0.144	0.010					0.184
120-140	0.001			0.001					0.001	0.008	0.027						0.037
140-160											0.005	0.001					0.006
160-180																	0.000
Σ	10.731	2.294	12.708	13.733	4.382	1.779	1.226	1.272	2.786	7.105	13.576	8.957	7.105	8.364	3.616	0.356	99.990

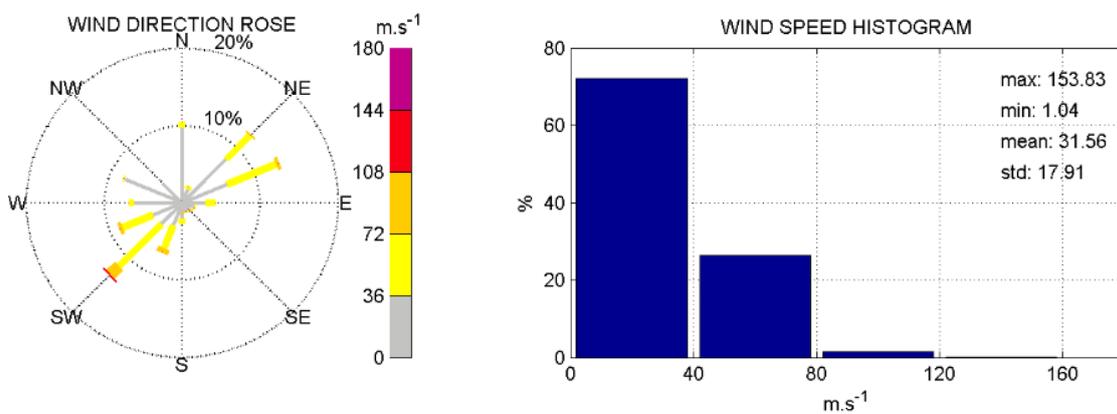


Figure 21: D601 DB TUGELA RIVER LIGHT HOUSE. Height 22 m. Wind gust climatology from February 2013 to August 2018 based on hourly maximum. Top: distribution of wind speed and direction. Wind speed categories are defined in the first column and wind direction in the first row. Data is in in percentage. Last row and last column are the total percentage of occurrence per category of direction and speed respectively. Bottom left: Wind rose. Bottom right Wind histogram. Std mean standard deviation. SW wind direction means wind comes from South West. 0.001 % represent roughly 30 minutes.

## 4 South Africa Weather Service warnings



Please be advised about the following for 09 October 2017  
Provinces affected: All



**ADVISORY:**

- Intense cut-off low system expected to affect the eastern parts of the Western Cape, south-eastern Northern Cape, Eastern Cape and Kwa-Zulu Natal on **Monday**, but only the Eastern Cape and Kwa-Zulu Natal on **Tuesday**.  
The public and small stock farmers are advised that:
  - Very cold conditions expected over the high lying areas of the Eastern Cape and south-eastern Northern Cape on **Monday** spreading to the south-western high lying areas of Kwa-Zulu Natal on **Tuesday**.
  - Light snowfalls expected on the high ground of the Eastern Cape, north-eastern high ground of the Western Cape on **Monday** spreading to the south-western high ground of Kwa-Zulu Natal on **Tuesday**.

**WATCH:**

- Severe thunderstorms expected in places over the eastern parts of the North-West, eastern parts of the Free State, northern and central parts of Kwa-Zulu Natal, in places in Gauteng, Limpopo and Mpumalanga.
- Heavy rain expected in the eastern coastal areas of the Eden District of the Western Cape in the **morning** and the eastern parts of the Eastern Cape spreading to the southern parts of Kwa-Zulu Natal on **Tuesday**.
- Disruptive snowfalls expected over the southern Drakensberg of the Eastern Cape on **Tuesday**.

Figure 22: 8 of October SAWS 2017 warning



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**South African Weather Service**

9 October 2017 · 🌐

⋮

Warning:9 Oct 2017Severe TS obs over Ga-Moloi + Glen Cowie move to Steelport and Burgersfort area-damaging winds, heavy downpours+large hail

👍 20 11 Shares

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WATCH: Severe Thunderstorms Watch 09/10/17 - 11h00 09/10/17 23h00 with possible hail and strong winds expected over the north-eastern parts of the Free State today (09/10/2017).

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**South African Weather Service**

9 October 2017 · 🌐

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Warning:9 Oct 2017 Severe thunderstorms observed over western parts of KZN moving south-east. Possibility of Hail, Strong Wind Gusts + Heavy Downpours.

👍 🤔 17 6 Shares

Figure 23: 9 of October 2017 warning

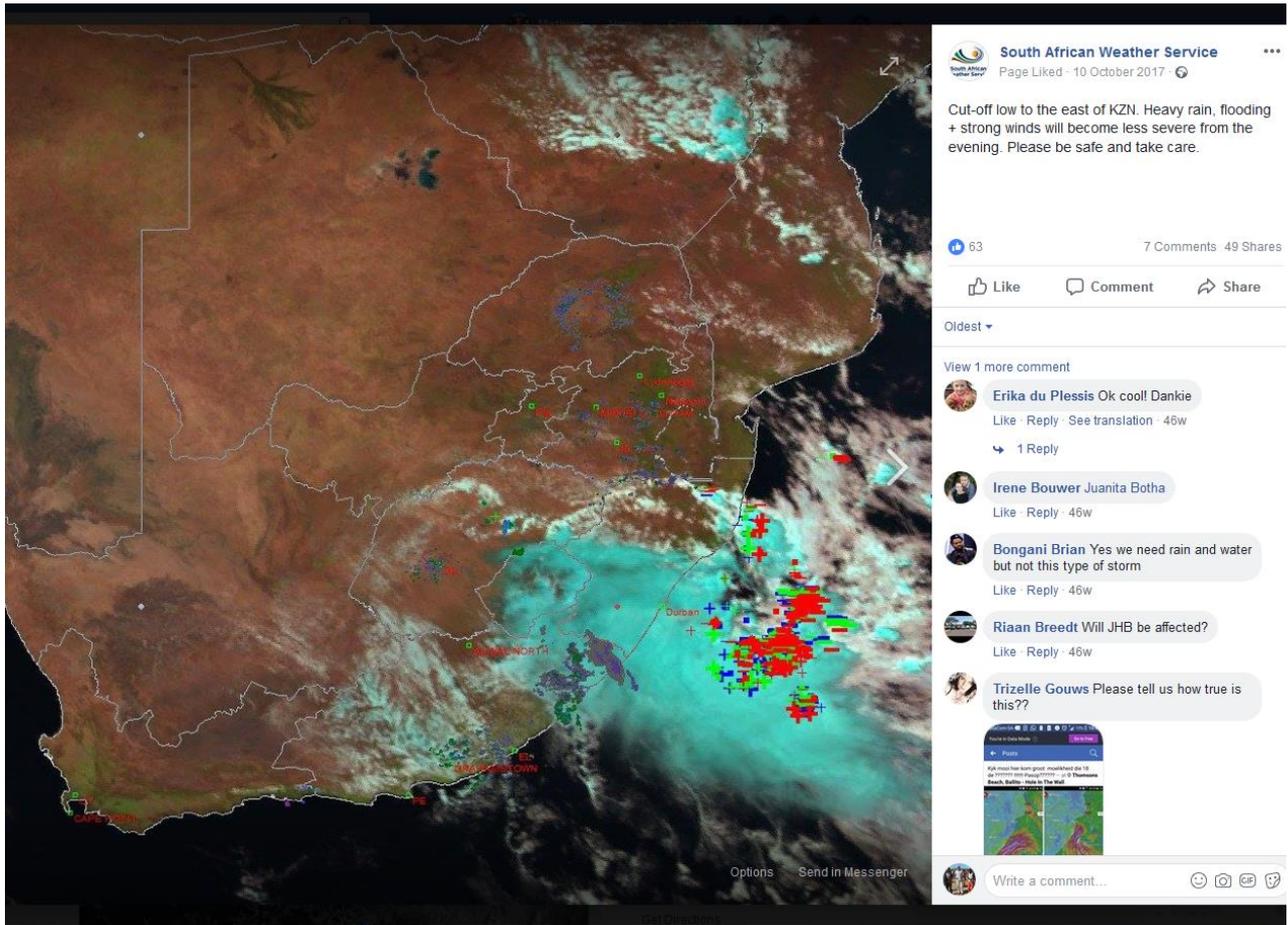


Figure 24: 10 of October SAWS satellite image and warning

# 5 Surface synoptic weather chart from the South African Weather service

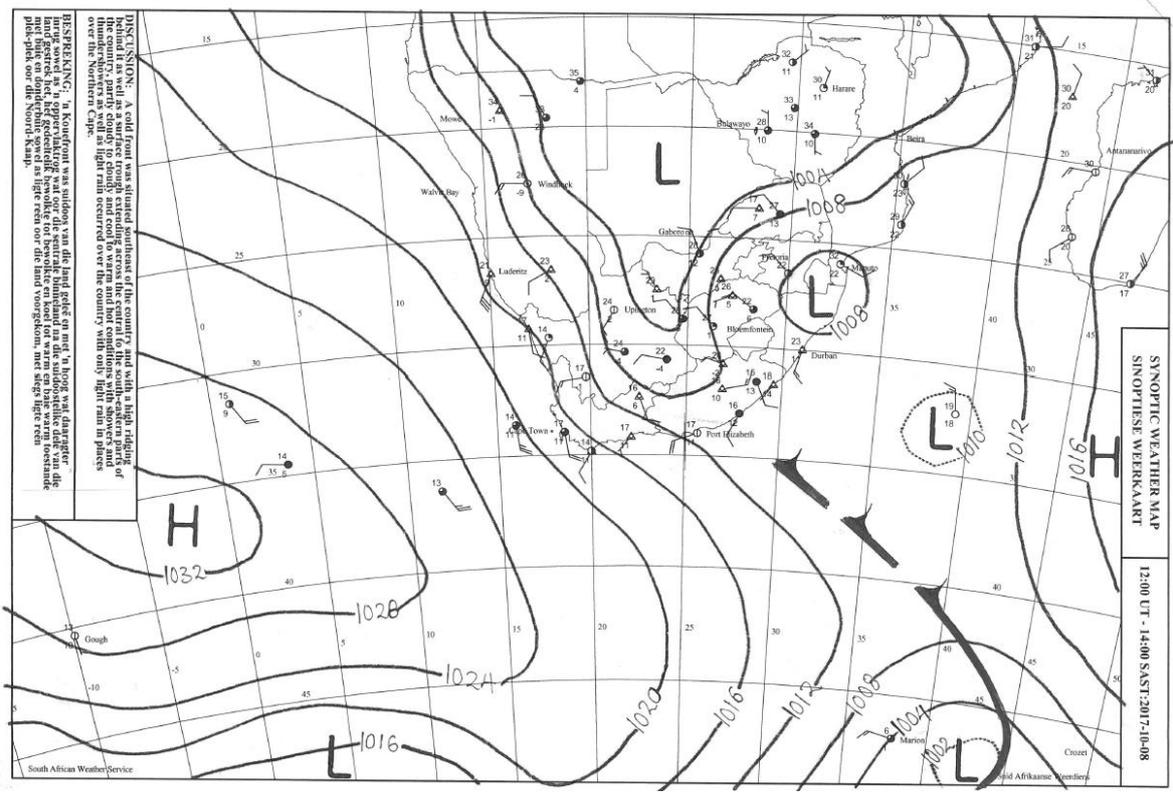
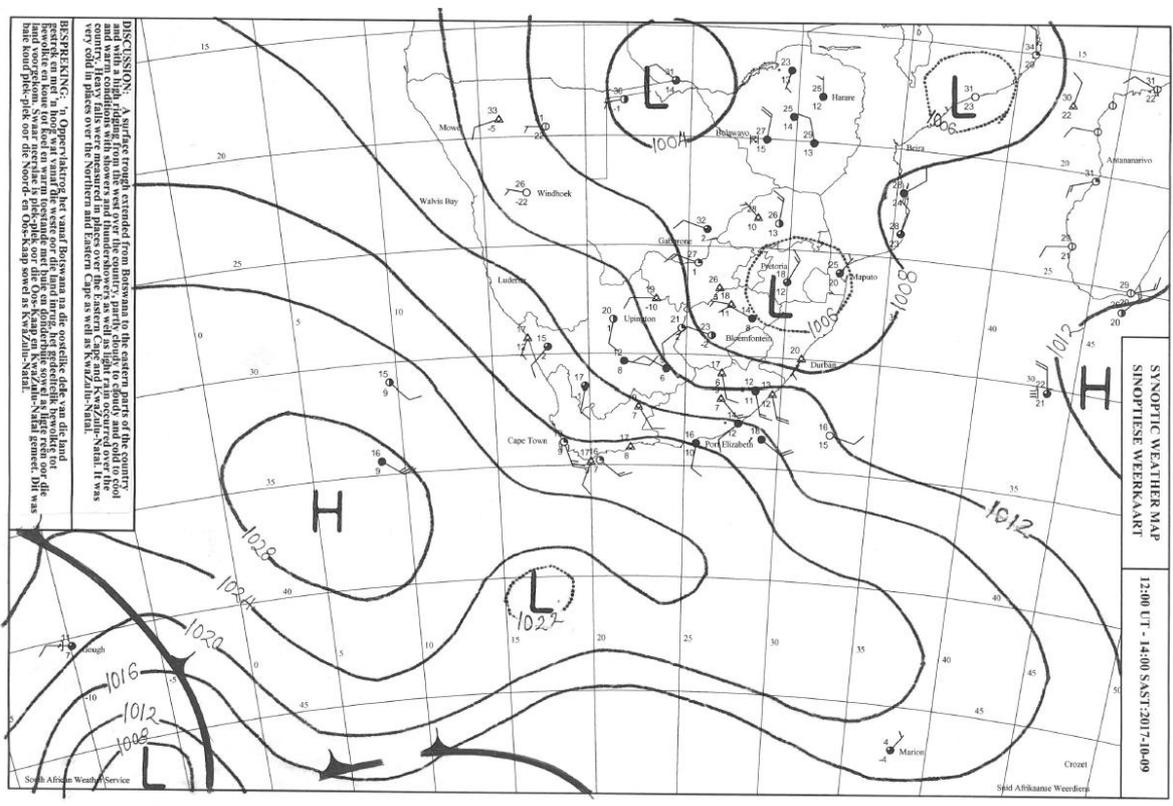


Figure 25: SAWS historical synoptic chart and summary 1400 SAST 8 10 2017





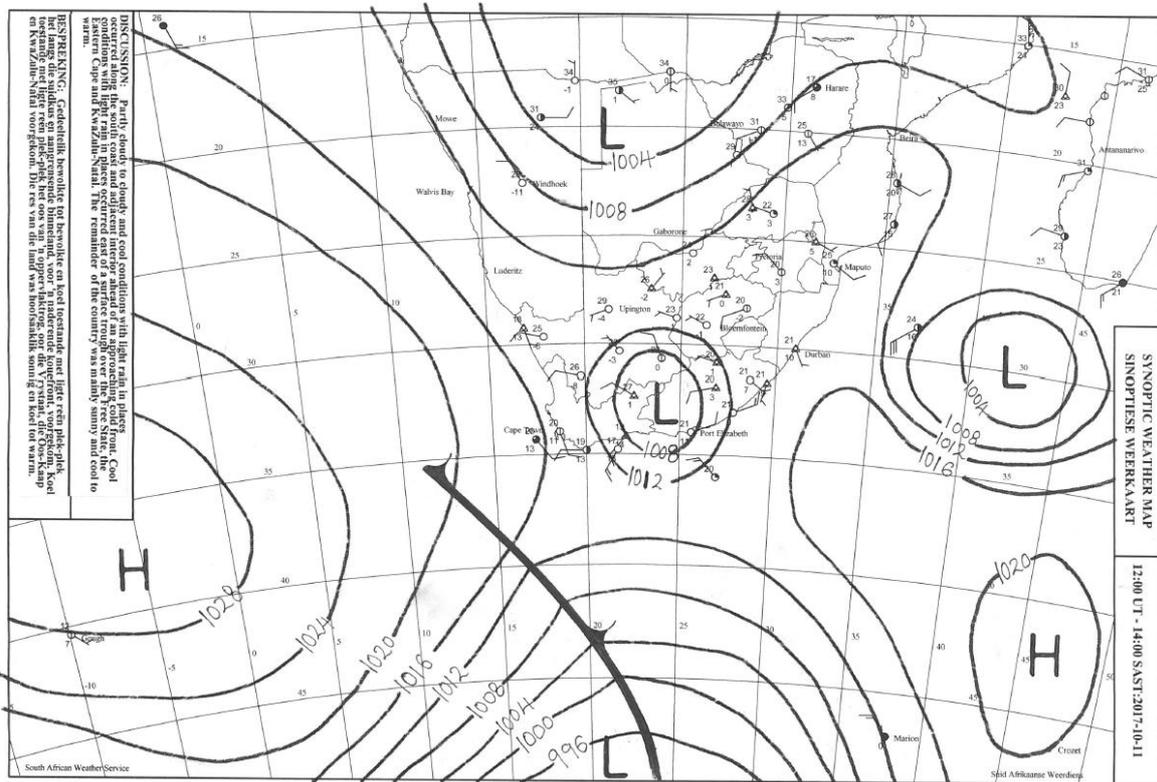


Figure 28: SAWS historical synoptic chart and summary 1400 SAST 11 10 2017

## **6 Weather charts, hindcast and forecast from the Global Forecast System**

### **6.1 Interpretation of charts**

#### **500mb Geopotential Height and Vorticity**

Black contours indicate the geopotential height of the 500 millibar surface, in tens of meters. Low geopotential height (compared to other locations at the same latitude) indicates the presence of a storm or trough at mid-troposphere levels. Relatively high geopotential height indicates a ridge, and quiescent weather. The color shaded contours indicate vorticity at 500 millibars: Red for positive vorticity, blue for negative. Positive vorticity indicates counterclockwise rotation of the winds, and/or lateral shear of the wind with stronger flow to the right of the direction of flow. Negative vorticity indicates clockwise rotation of the winds, and/or lateral shear of the wind with stronger flow to the left of the direction of flow. Positive (or negative in the Southern Hemisphere) vorticity at 500 millibars is associated with cyclones or storms at upper levels and will tend to coincide with troughs in the geopotential height field. Negative (positive in SH) vorticity is associated with calm weather and will tend to coincide with ridges in the geopotential height field.

#### **Sea Level Pressure and 1000-500mb Thickness**

The colored contour lines indicate sea level pressure in millibars. High pressure is red, low pressure in green or blue. Only the last 2 digits shown -- sea level pressure is usually around 1000 millibars, so add 1000 to values in the range of 00-50 and add 900 to values in the range of 50-98. Low sea level pressure indicates cyclones or storms near the surface of the earth. High sea level pressure indicates calm weather. The shaded contours indicate the vertical distance, or thickness, between the 1000 millibar surface and the 500 millibar surface, measured in tens of meters. Since air behaves nearly as an ideal gas, and vertical distance is proportional to volume over a specified surface area, the thickness between two pressure levels is proportional to the mean temperature of the air between those levels. Thus, low values of thickness mean relatively cold air. The 540 line is highlighted in black, since this line is often used as a rule of thumb to indicate the division between rain and snow for low terrain. When there is precipitation where the thickness is below 540dam, it is generally snow. If the thickness is above 540dam, it is usually rain (or sleet if the air next to the surface is below freezing).

#### **Vertical Velocity or Precipitation**

The vertical velocity at 700mb (in mb/hr) is shown instead of accumulated precipitation for the analysis. Negative values indicate ascending air, and positive values denote sinking air. Ascending motion is associated with cloudiness and rain. Large negative values of vertical velocity correspond to areas of heavy rainfall if moisture is available. The remaining forecast panels indicate 12 or 24 hour accumulated precipitation, measured in millimeters. The total is the amount of rainfall forecast during the 12 or 24 hours immediately preceding the verification time in the lower left-hand corner of the map. The with the 540-thickness line and the 0 °C

isotherm at 850mb can give a good indication of the dividing line between snow and rain.

### 850mb Temperature, Humidity and Winds

Colored contour lines indicate the air temperature at the 850 millibar level, in degrees Celsius. The 0 °C contour is highlighted, as this is also often used as a divider between rain and snow. The green shading indicates the relative humidity percentage at the 850 millibar level. High values indicate the availability of moisture. When areas of large upward vertical velocity are co-located with high moisture availability, heavy rainfall will likely occur. The streamlines indicate the wind flow. Advection of moisture by the wind can be inferred by noticing the direction and rate at which moist areas appear to be blown. Similarly, temperature advection can be inferred by noticing whether the wind is blowing cold air toward a warm region, or warm air toward a cold region.

### 6.2 500 mb charts

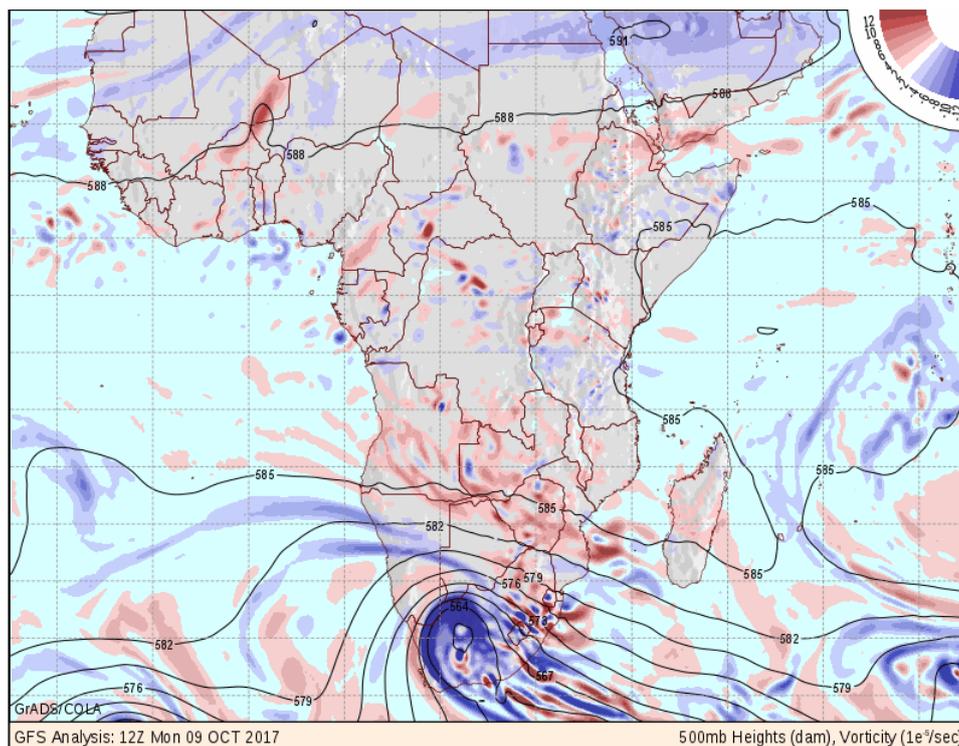


Figure 29: 09 10 2017 12 PM GFS analysis of 500 mb geopotential heights and vorticity. Blue show the extend of the cut off low.

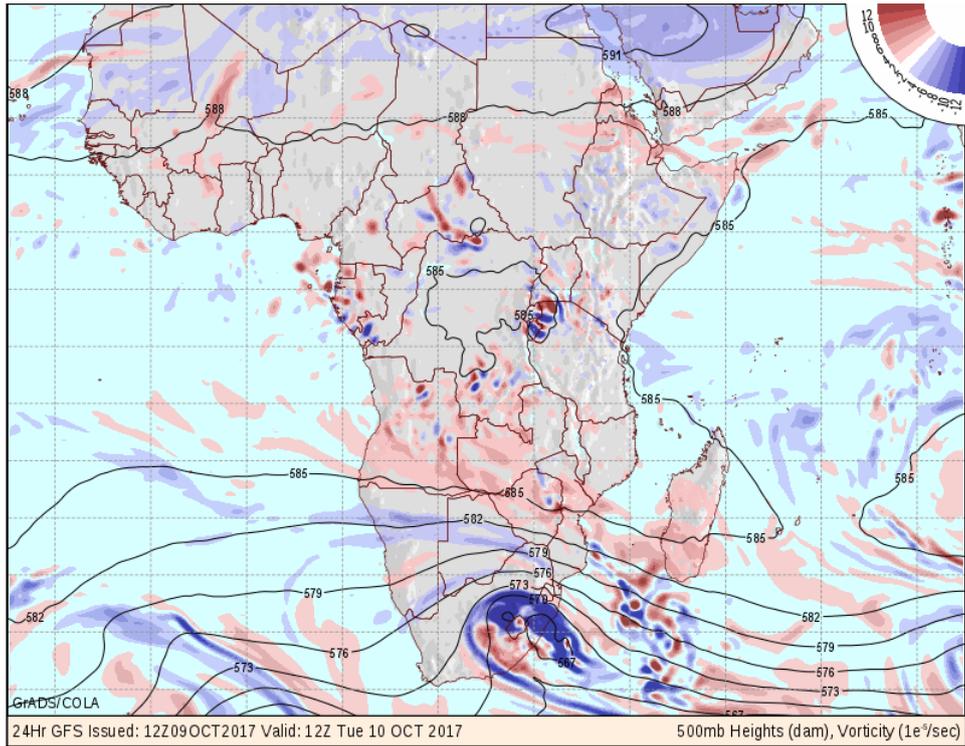


Figure 30: 10 10 2017 12 PM forecast done on 9 10 2017 of 500 mb geopotential heights and vorticity. Blue show the extend of the cut off low.

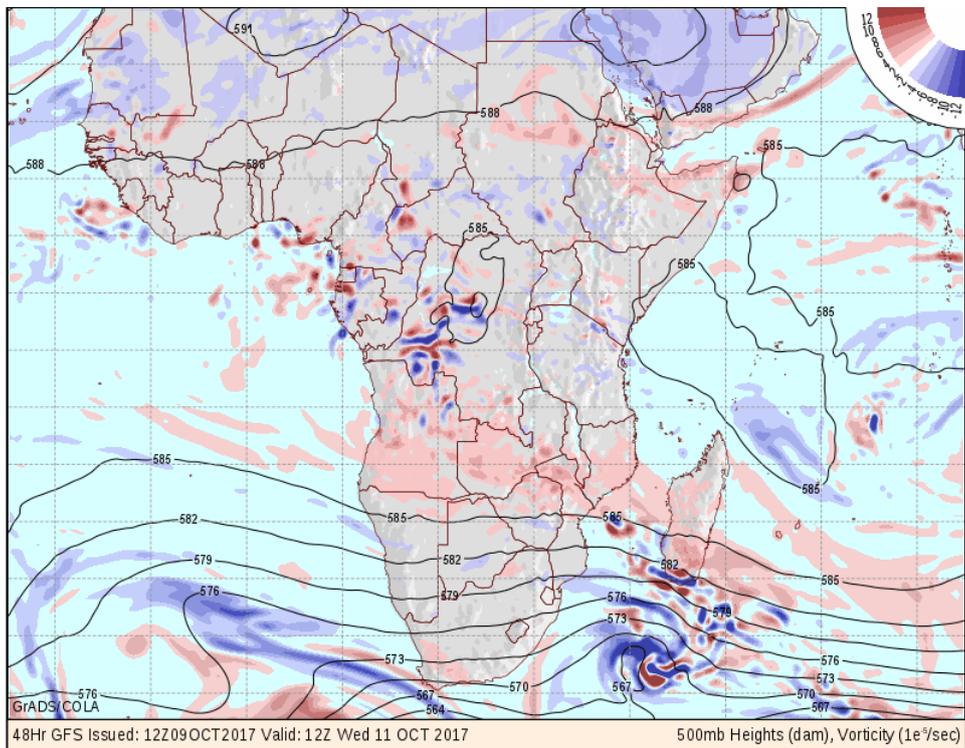


Figure 31: 11 10 2017 12 PM forecast done on 9 10 2017 of 500 mb geopotential heights and vorticity. Blue show the cut off low moving east at sea.

### 6.3 Sea level pressure charts

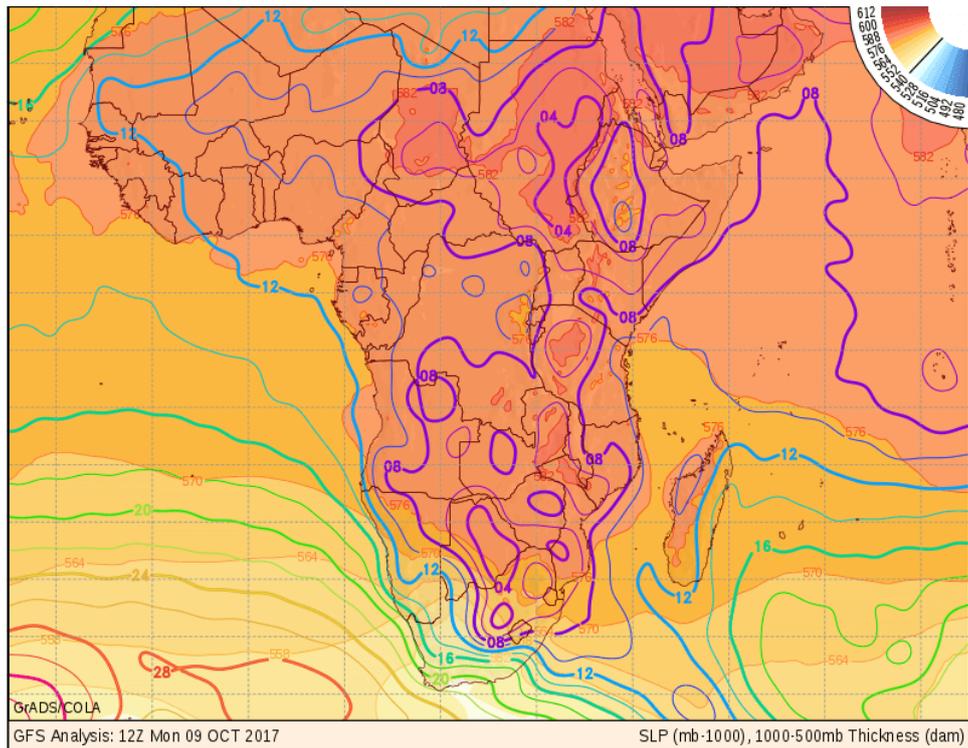


Figure 32: 09 10 2017 12 PM GFS analysis of surface level pressure.

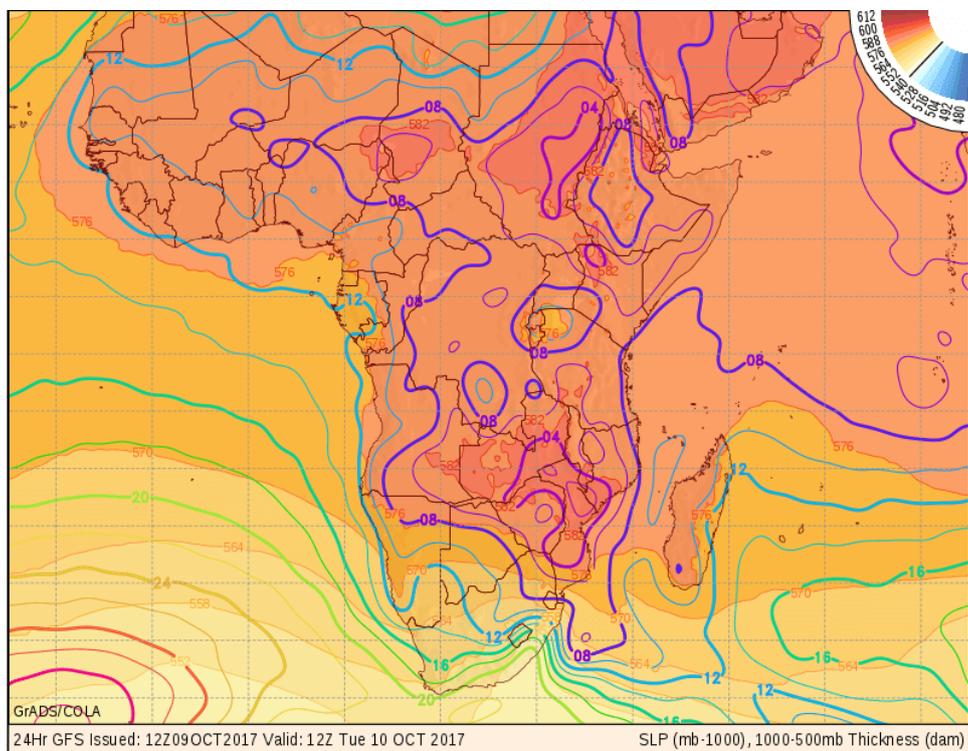


Figure 33: 10 10 2017 12 PM forecast done on 9 10 2017 of surface level pressure 500 mb geopotential heights and vorticity. Purple line shows the extend of the small surface low pressure system.

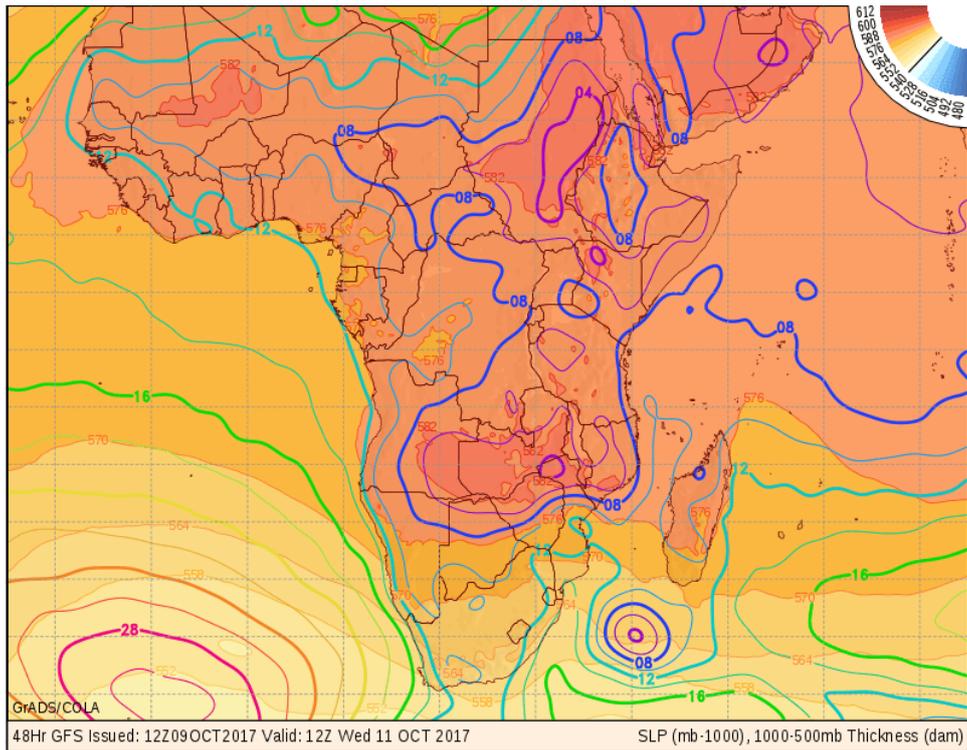


Figure 34: 11 10 2017 12 PM forecast done on 9 10 2017 of surface level pressure 500 mb geopotential heights and vorticity. Purple line shows the surface low pressure moving eastwards.

### 6.4 Precipitation charts

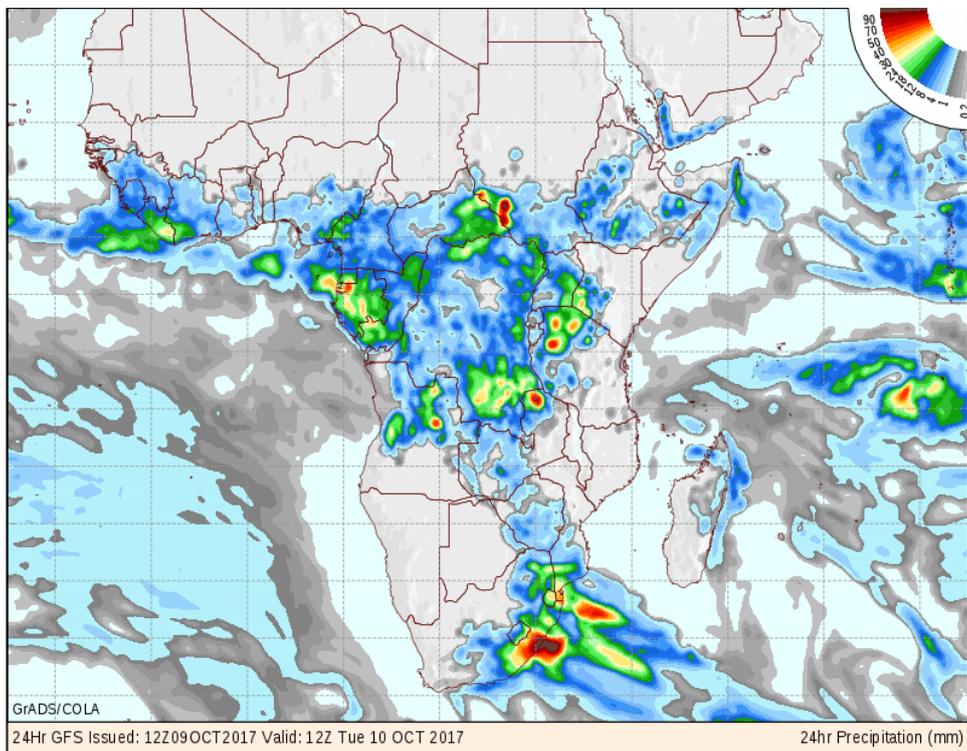


Figure 35: cumulative 9 10 2017 12 PM to 10 10 2017 12 PM forecast of precipitation done on 9 10 2017.

### 6.5 500 mb charts

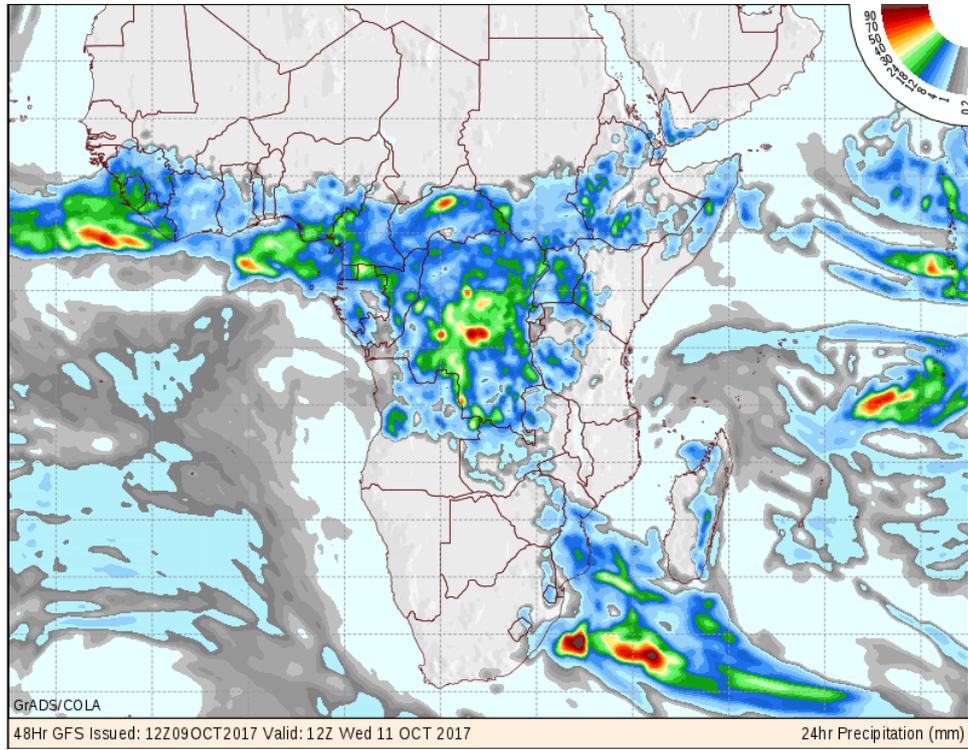


Figure 36: cumulative 10 10 2017 12 PM to 11 10 2017 12 PM forecast of precipitation done on 9 10 2017.