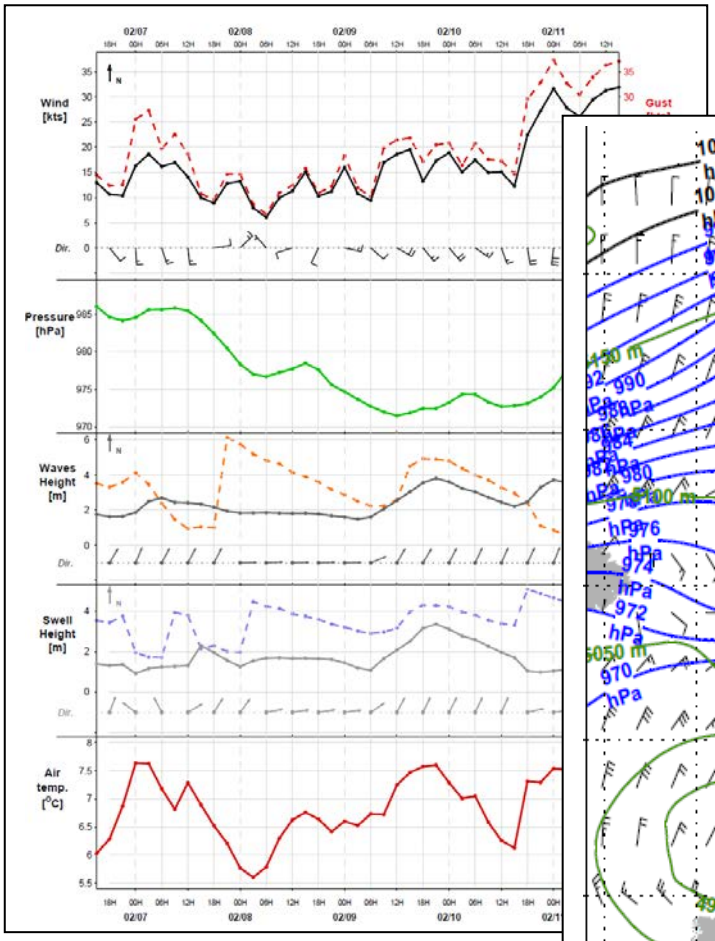
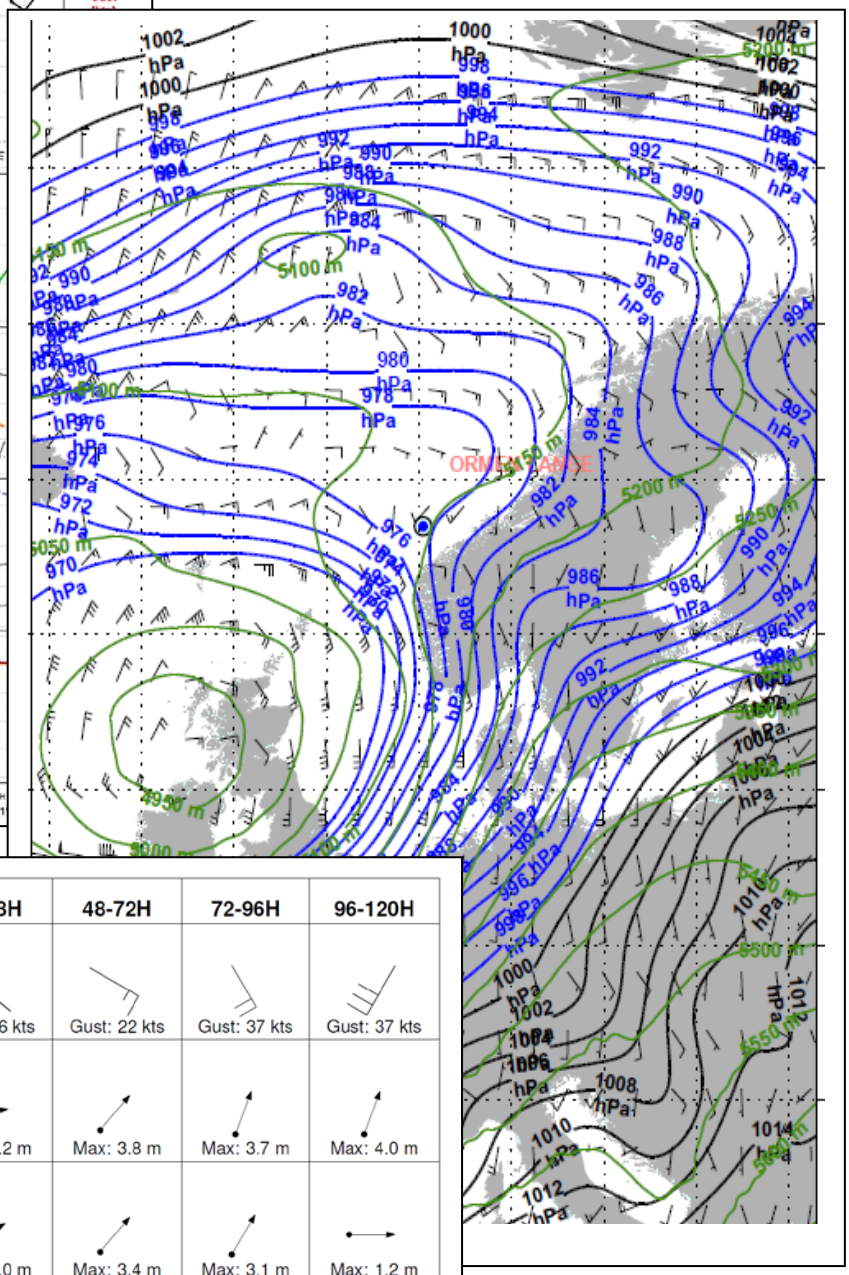
SAT-OCEAN'S SCOPE OF WORK
WEATHER FORECAST SERVICE





FORECAST	0-24H	24-48H	48-72H	72-96H	96-120H
Wind (Average)	Gust: 27 kts	Gust: 16 kts	Gust: 22 kts	Gust: 37 kts	Gust: 37 kts
Waves (Mean dir.)	Max: 2.7 m	Max: 2.2 m	Max: 3.8 m	Max: 3.7 m	Max: 4.0 m
Swell (Mean dir.)	Max: 2.3 m	Max: 2.0 m	Max: 3.4 m	Max: 3.1 m	Max: 1.2 m
Pres. (Trend)	986 hPa	982 to 978 hPa	976 to 972 hPa	973 hPa	977 to 989 hPa

1. Daily weather bulletins

1.1 Introduction

1.1.1 Corporate overview

SAT-OCEAN is a leading provider of Metocean services, bringing similar services in waves & currents forecasting to those routinely expected for winds and weather. Our technologies, relying on a combination of advanced modeling and an individualized understanding of local phenomena, have been proven world-wide since 2001.

Building on this expertise, SAT-OCEAN can provide a dedicated weather & metocean service.

As part of our real-time forecasting services for offshore operations, we can deliver:

- Wind and waves forecast;
- Local ocean current forecast;
- Daily weather bulletins.

1.1.2 Recent forecasting projects

Customer	Location	Project
Shell	Offshore Brazil	Assistance to drilling operations
Major oil operator	Offshore East Africa	Assistance to drilling operations
Major oil operator	Indian Ocean	Rig move optimization
IOC	Africa	Oil spill monitoring
Perenco	Offshore Congo	Platform installation
Drilling contractor	South Africa	Assistance to drilling operations
Cable laying company	Angola	Pipe lay for LNG project
Shell	Sarawak	4D seismic survey
Drilling contractor	Indian & Atlantic Oceans	Rig move
CGG	North Sea	4D seismic survey

1.2 SAT-OCEAN technology

1.2.1 Winds technology

SAT-OCEAN provides high quality analyzed satellite wind data for up to 20 years long. We provide longer time series by combining these data with lower resolution dataset based on all the historical data available worldwide and meteorological numerical models. Besides these long-term times series, SAT-OCEAN includes in its daily reports up to 9-days wind forecast data, together with our waves and ocean currents. The winds are either used as direct information or to force our ocean

current and wave models. In addition, SAT-OCEAN has built an oil spill drift forecast system based on these winds and on our currents.

Our winds are based on NCEP 1/2° global winds and Wave Watch 3 improved winds. We then calibrate the global winds with satellites scatterometers to improve the accuracy. Our winds are accurate to within 90-95% depending on the region and period of time.

1.2.2 Waves technology

SAT-OCEAN's wave forecasting system is based on the combination of altimetry satellite data and the Wavewatch III numerical model. The altimetry satellite data is assimilated into the numerical model to improve the results.

A first baseline (1^{o}) global model is being run daily from D-5 to D+7 and covers the entire ocean domain, and a first nesting procedure is applied to a higher-resolution area ($1/4^{o}$). A 1/16°, very high resolution run is then being performed, nested in the $1/4^{o}$, targeting the area of concern.

The governing equations of the Wavewatch III wave model include refraction and straining of the wave field due to temporal and spatial variations of the mean water depth and of the mean current (tides, surges etc.), when applicable. Parameterizations of physical processes (source terms) include wave growth and decay due to the actions of wind, nonlinear resonant interactions, dissipation (whitecapping) and bottom friction.

Wave propagation is considered to be linear. Relevant nonlinear effects such as resonant interactions are, therefore, included in the source terms (physics).

1.2.3 Ocean currents technology

SAT-OCEAN ocean currents real time forecast system is based on the computation of satellite sea temperature, wind and altimetric data. From raw data measured by a combination of several satellite sensors, we apply our own quality control, calibration and merging methods to obtain cloud-free data. With this set of daily sea surface temperature (SST) & sea surface height (SSH), we deduce 3D temperature and salinity which are then assimilated in our ocean circulation model. The ocean circulation model is also forced with high resolution winds.

SAT-OCEAN brings a significant methodology innovation in its use of the ocean current model by giving very little freedom to the model. We are very close to performing an inversion of our forcing data, and we ensure that the “data” drives the model. Another way to present this is to say that we fit ocean currents to high quality satellite data, rather than obtaining current "data" from a model.

A baseline ($1/8^{o}$) global model is being run daily from D-5 to D+7 and covers the entire ocean domain. Then, a high resolution (1/32° equivalent to about 3.5 km) configuration of the model covers the target areas. The runs encompass 34 layers, with an about 10-layer sampling of the thermocline and a 1-hour output time step. The values obtained represent the currents down to the smallest time scales encompassed in the forcing and assimilated data, from 1 to 6 hours.

Being based on a full 3D ocean forecasting, this approach allows us to deliver on a worldwide basis the full absolute ocean current, including geostrophic large and mesoscale currents, thermohaline circulation, tides, inertial currents...SAT-OCEAN's ocean current forecast span the 5 upcoming days and are being updated daily (up to hourly if required).

2. Weather forecast

2.1 Service description

On a daily or twice daily basis, SAT-OCEAN sends to a prescribed diffusion list a full weather bulletin by email. The pdf document covers all the key weather parameters.

Deliverables include:

- A forecast overview table
- Table of atmospheric forecasted data :
    - Wind speed and direction at 10 & 50 m
    - Gust
    - Wind sea (Hs)
    - Swell (Hs, Tp and Dp)
    - Waves (Hs, Tp, Dp and Hmax)
    - Air temperature
    - Visibility
    - Rainfall
    - Cloud cover
- Maps of 10-meter and 50-meter wind magnitude and direction, atmospheric pressure and 500hPa height at nowcast
- Same wind/pressure/500hPa for nowcast and 5 days +
- Weather time series
- When applicable : Cyclone Warning Bulletin

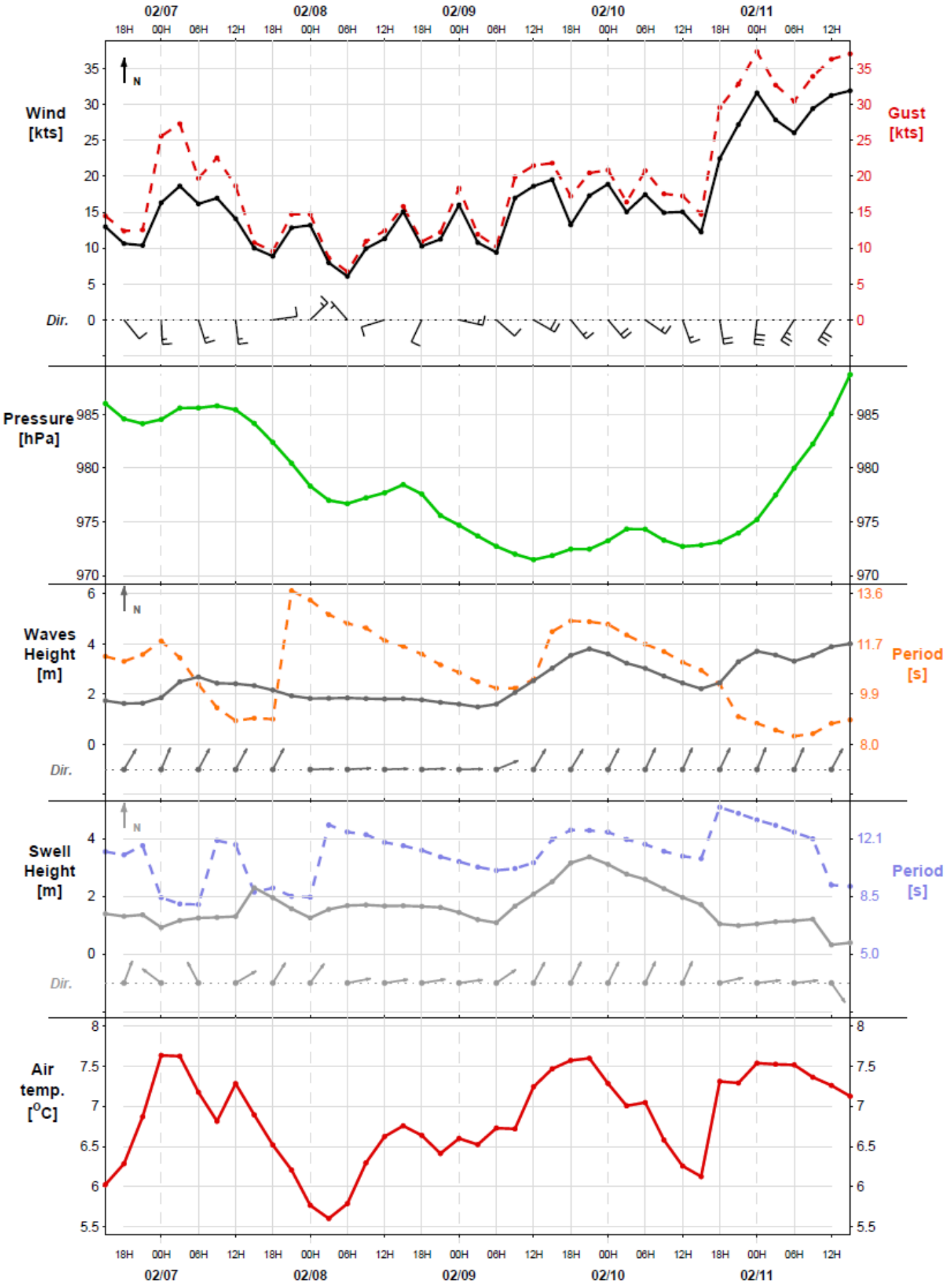
2.2 Weather Bulletin deliverables

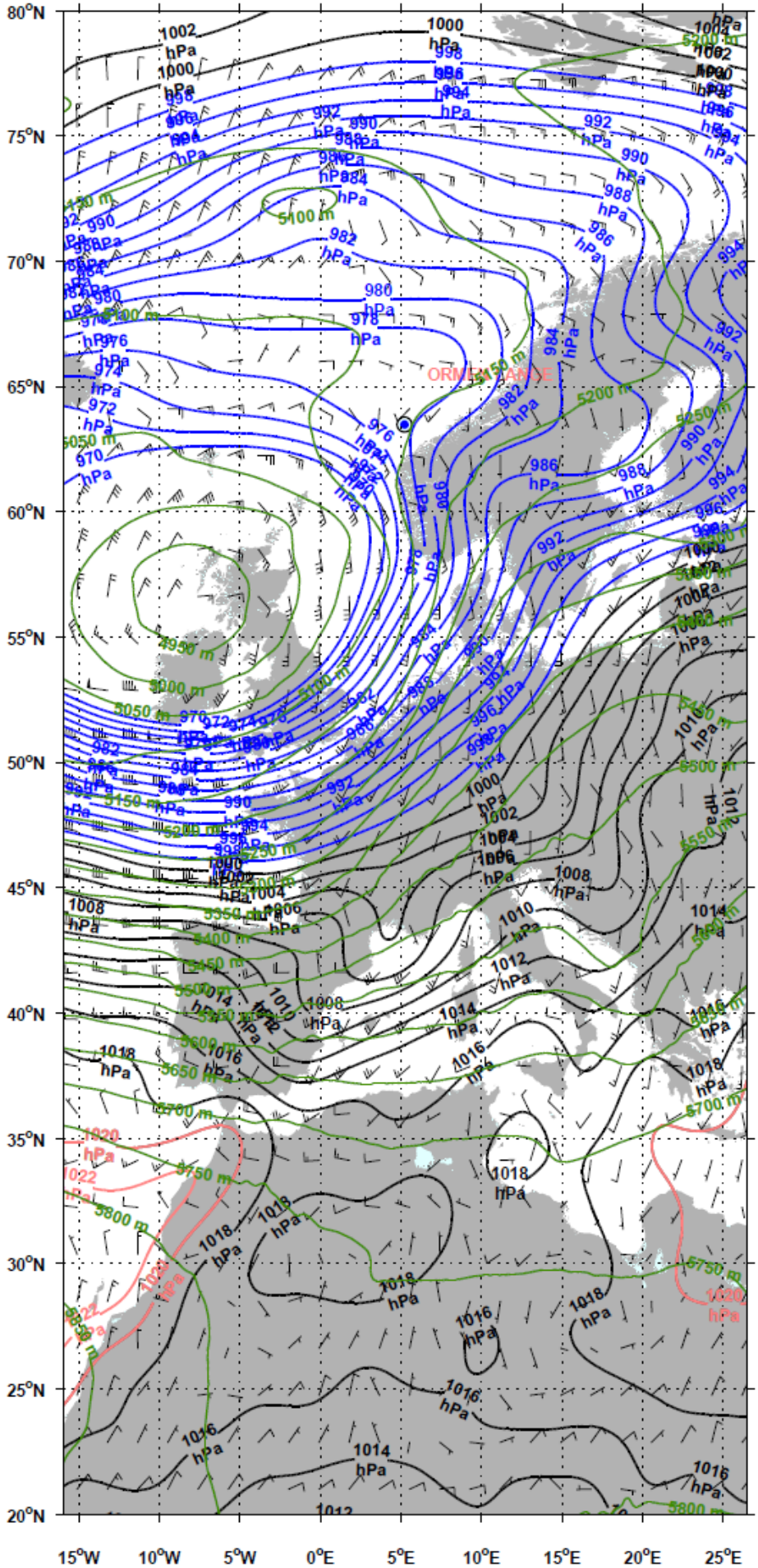
FORECAST	0-24H	24-48H	48-72H	72-96H	96-120H
Wind — Average	Gust: 27 kts	Gust: 16 kts	Gust: 22 kts	Gust: 37 kts	Gust: 37 kts
Waves — Mean dir.	Max: 2.7 m	Max: 2.2 m	Max: 3.8 m	Max: 3.7 m	Max: 4.0 m
Swell — Mean dir.	Max: 2.3 m	Max: 2.0 m	Max: 3.4 m	Max: 3.1 m	Max: 1.2 m
Pres. — Trend	986 hPa	982 to 978 hPa	976 to 972 hPa	973 hPa	977 to 989 hPa

CONVENTIONS - Winds and waves are given in ”meteorological” convention (”coming from”).

WIND, WAVES & AIR TEMP. FORECAST AT LOCATION

DATE	TIME [UTC]	WIND					WIND SEA	SWELL			WAVES				AIR TEMP	VIS	RAINFALL	CLOUD COVER		
		10M		50M		GUST	Hs	Hs	Tp	Dp	Hs	Tp	Dp	Hmax		10m		Low	Mid	High
		SPD [KTS]	DIR	SPD [KTS]	DIR	[KTS]	[M]	[M]	[S]		[M]	[S]		[M]	[°C]	[NM]	[MM/3HR]	[%]	[%]	[%]
FEB.06	15	13	99	14	108	14	1.0	1.4	11	201	1.7	11	211	3.1	6.0	10.5	0.0	0	16	100
	18	11	141	14	146	12	1.0	1.3	11	201	1.6	11	211	2.9	6.3	10.5	0.0	0	46	99
	21	10	190	13	184	13	0.9	1.4	12	200	1.6	11	208	3.0	6.9	9.3	0.3	26	58	44
FEB.07	00	16	177	11	139	26	1.6	0.9	8	127	1.9	12	203	3.4	7.6	9.8	0.3	60	58	0
	03	19	180	17	167	27	2.2	1.2	8	120	2.5	11	206	4.5	7.6	10.0	0.0	65	1	1
	06	16	163	17	152	20	2.4	1.2	8	152	2.7	10	208	4.8	7.2	9.0	0.0	81	3	15
	09	17	171	18	175	23	2.1	1.3	12	237	2.4	9	208	4.4	6.8	7.9	1.6	96	80	34
	12	14	174	15	163	19	2.0	1.3	12	239	2.4	9	208	4.3	7.3	9.4	0.0	29	8	57
	15	10	132	12	158	11	0.4	2.3	9	208	2.3	9	208	4.2	6.9	9.7	0.0	1	1	69
	18	9	82	10	83	10	0.9	2.0	9	212	2.2	9	207	3.9	6.5	10.7	0.0	1	41	79
	21	13	56	14	59	15	1.1	1.6	9	211	1.9	14	267	3.5	6.2	10.8	0.0	1	90	84
FEB.08	00	13	46	14	48	15	1.3	1.3	8	216	1.8	13	269	3.3	5.8	10.8	0.0	0	86	99
	03	8	21	7	20	9	1.0	1.5	13	259	1.8	13	266	3.3	5.6	10.8	0.0	0	36	72
	06	6	319	5	199	7	0.8	1.7	12	259	1.8	12	267	3.3	5.8	10.8	0.0	0	11	79
	09	10	281	10	277	11	0.7	1.7	12	260	1.8	12	269	3.3	6.3	10.8	0.0	9	71	83
	12	11	253	13	246	12	0.7	1.7	12	261	1.8	12	268	3.2	6.6	9.8	0.0	34	36	11
	15	15	223	2	167	16	0.7	1.7	12	261	1.8	12	270	3.3	6.8	10.1	0.0	32	2	34
	18	10	206	8	178	11	0.6	1.6	11	261	1.8	11	268	3.2	6.6	10.4	0.0	1	4	67
	21	11	98	6	152	12	0.4	1.6	11	258	1.7	11	270	3.0	6.4	10.6	0.0	0	42	90
FEB.09	00	16	103	8	124	18	0.7	1.4	11	262	1.6	11	269	2.9	6.6	9.2	0.1	5	93	97
	03	11	140	12	131	12	0.9	1.2	10	268	1.5	10	268	2.7	6.5	9.0	0.3	45	98	94
	06	9	132	12	114	10	1.2	1.1	10	236	1.6	10	248	2.9	6.7	9.9	0.0	0	91	64
	09	17	104	14	122	20	1.2	1.7	10	208	2.1	10	220	3.7	6.7	10.6	0.0	1	75	22
	12	19	120	20	121	21	1.4	2.1	11	208	2.5	10	211	4.6	7.2	10.6	0.0	4	62	70
	15	20	133	21	131	22	1.7	2.5	12	208	3.0	12	214	5.5	7.5	9.5	0.4	30	88	86
	18	13	141	17	156	17	1.6	3.2	13	206	3.5	13	211	6.4	7.6	8.4	0.4	56	100	99
	21	17	121	20	124	20	1.8	3.4	13	207	3.8	13	209	6.8	7.6	8.9	0.0	0	54	94
FEB.10	00	19	139	25	150	21	1.8	3.1	12	207	3.6	12	207	6.5	7.3	8.5	0.4	18	71	86
	03	15	126	20	138	16	1.7	2.8	12	205	3.2	12	205	5.8	7.0	8.0	0.4	17	98	99
	06	17	125	10	120	21	1.6	2.6	12	205	3.0	12	205	5.4	7.0	8.3	0.1	3	99	99
	09	15	127	15	107	18	1.5	2.3	11	205	2.7	11	205	4.9	6.6	8.4	0.4	80	95	83
	12	15	160	12	139	17	1.5	2.0	11	204	2.4	11	204	4.4	6.3	9.6	0.0	9	63	49
	15	12	178	21	158	15	1.4	1.7	11	206	2.2	11	205	4.0	6.1	9.1	1.2	36	88	56
	18	22	171	26	172	30	2.2	1.0	14	257	2.5	10	205	4.4	7.3	9.0	1.4	94	87	67
	21	27	172	27	164	33	3.1	1.0	14	261	3.3	9	204	5.9	7.3	8.0	0.4	97	36	47
FEB.11	00	32	187	35	188	37	3.6	1.0	13	263	3.7	9	202	6.7	7.5	7.8	0.1	54	6	47
	03	28	207	34	201	33	3.4	1.1	13	263	3.6	9	201	6.4	7.5	7.8	1.3	11	0	46
	06	26	212	22	219	30	3.1	1.1	12	264	3.3	8	203	6.0	7.5	8.1	0.9	30	12	62
	09	29	208	38	208	34	3.3	1.2	12	264	3.5	8	206	6.4	7.4	8.1	1.5	8	30	62
	12	31	213	39	214	36	3.9	0.3	9	325	3.9	9	208	7.0	7.3	8.3	2.1	15	10	70
	15	32	218	20	239	37	4.0	0.4	9	319	4.0	9	214	7.2	7.1	8.1	2.3	12	68	89


02/07
02/08
02/09
02/10
02/11
18H 00H 06H 12H
Wind [kts]
Gust [kts]
Dir.
Pressure [hPa]
Waves Height [m]
Period [s]
Swell Height [m]
Air temp. [°C]
N


80°N
75°N
70°N
65°N
60°N
55°N
50°N
45°N
40°N
35°N
30°N
25°N
20°N
15°W
10°W
5°W
0°E
5°E
10°E
15°E
20°E
25°E
ORMEN LANGE

2.3 Cyclone Warning Bulletin deliverables (when applicable)

TROPICAL CYCLONE INFORMATION ON DEC. 20 AT 06H00 [UTC]

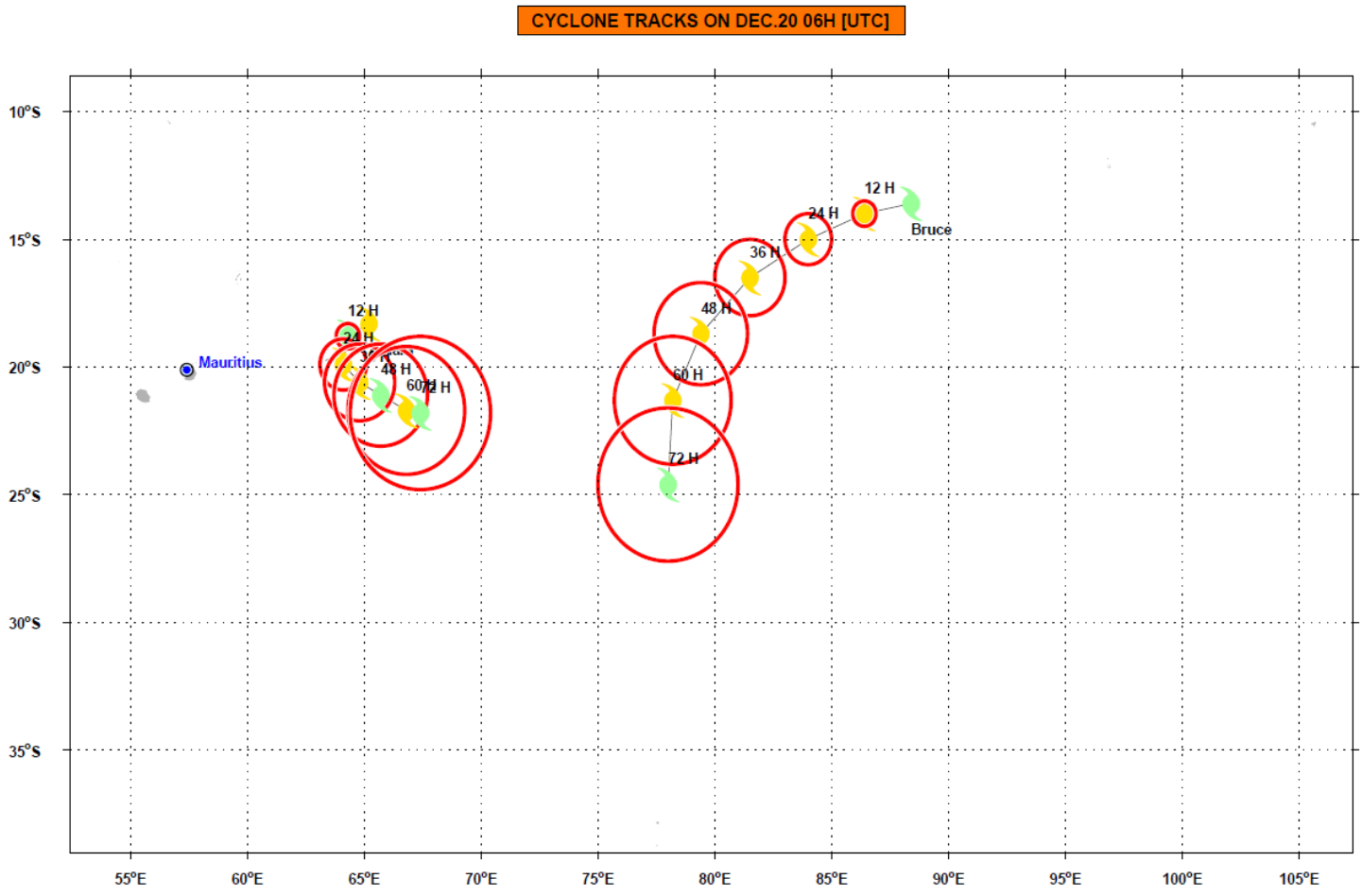
NAME	AMARA	BRUCE
AREA	South Indian	South Indian
CATEGORY	Category 1	Tropical Storm
POSITION AT 06H00 [UTC]	065°12'00"E 18°18'00"S	088°24'00"E 13°35'60"S
DIRECTION & SPEED	SW 6 kts	SW 11 kts
MINIMUM PRESSURE	992 hPa	990 hPa
MAXIMUN WIND	74 kts	61 kts
DISTANCE FROM VESSEL	455 NM	1822 NM

SAFFIR-SIMPSON HURRICANE WIND SCALE

CATEGORY	Tropical Depression	Tropical Storm	Category 1	Category 2	Category 3	Category 4	Category 5
WIND SPEED	$\leq$ 34 kts	35 - 63 kts	64 - 82 kts	83 - 95 kts	96 - 112 kts	113 - 136 kts	$\geq$ 137 kts
ABBREVIATION	TD	TS	1	2	3	4	5
SYMBOL							

FORECAST ALONG "CYCLONE AMARA" TRACK

DATE	TIME [UTC]	POSITION		MIN PRESSURE [hPa]	MAX WIND [KTS]	CATEGORY
		LONGITUDE[°]	LATITUDE [°]			
DEC.20	06	065°12'00"E	18°18'00"S	992	74	1
	12	064°42'00"E	18°36'00"S	991	65	1
	18	064°17'60"E	18°48'00"S	994	61	TS
DEC.21	00	064°00'00"E	19°18'00"S	991	58	TS
	06	064°05'60"E	19°53'60"S	993	67	1
	12	064°17'60"E	20°11'60"S	991	64	1
	18	064°47'60"E	20°36'00"S	994	64	1
DEC.22	00	065°12'00"E	20°48'00"S	991	57	TS
	06	065°42'00"E	21°06'00"S	994	51	TS
	12	066°24'00"E	21°30'00"S	992	55	TS
	18	066°47'60"E	21°41'60"S	993	68	1
DEC.23	00	067°05'60"E	21°41'60"S	992	59	TS
	06	067°24'00"E	21°48'00"S	996	40	TS
	12	067°42'00"E	21°48'00"S	996	38	TS
	18	068°00'00"E	21°30'00"S	1000	35	TS
DEC.24	00	068°30'00"E	21°36'00"S	1000	31	TD
	06	068°47'60"E	21°48'00"S	1003	27	TD
	12	069°17'60"E	22°11'60"S	1002	27	TD
	18	069°17'60"E	22°11'60"S	1005	27	TD
DEC.25	00	069°00'00"E	22°23'60"S	1005	27	TD
	06	068°42'00"E	22°30'00"S	1007	29	TD


CYCLONE TRACKS ON DEC.20 06H [UTC]
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15°S
20°S
25°S
30°S
35°S
55°E
60°E
65°E
70°E
75°E
80°E
85°E
90°E
95°E
100°E
105°E
Mauritius
12 H
24 H
36 H
48 H
60 H
72 H
Bruce