ALLEGATO 15.1

Sea climate and propagation

ANNEX 4: SEA CLIMATE AND PROPAGATION

BASIC PROJECT FOR THE NEW MARITIME LOADING TERMINAL FOR LIQUIFIED NATURAL GAS (LNG) IN THE PORT OF TARANTO

ITALY

ANNEX 4: SEA CLIMATE AND PROPAGATION

MAIN INDEX

TABLE INDEX

FIGURE INDEX

BASIC PROJECT FOR THE NEW MARITIME LOADING TERMINAL FOR LIQUIFIED NATURAL GAS (LNG) IN THE PORT OF TARANTO

ITALY

ANNEX 4: SEA CLIMATE AND PROPAGATION

1. OBJECTIVE OF THIS STUDY

The objective is to study the features defining the sea climate and meteorology in the area where the maritime loading terminal for LNG in Taranto (Italy) will be located. This study is essential, both to determine the operability level of the terminal and to determine the calculation values for each one of the environmental actions possibly affecting structure stability and functionality.

Bearing this objective in mind, the analysis of the sea climate will include the characterisation of the Mean and Extreme regimes of surge in deep waters, according to the data requested by ALATEC for this purpose. Based on such deep water regimes, and after having made some test batteries to measure surge propagation first, we will be able to define the features of the Mean and Extreme Maritime Climates at the terminal.

The analysis of the sea climate at the site includes also the determination of the Mean and Extreme wind regimes, which are relevant factors in the operability analysis of the maritime access of the terminal, as well as the characterisation of other environmental factors such as currents, fog and sea levels.

2. LOCATION OF THE AREA UNDER STUDY

The following figure shows the navigational chart of the coast of the Gulf of Taranto, where the exact location of the LNG terminal is marked with the folowwings.

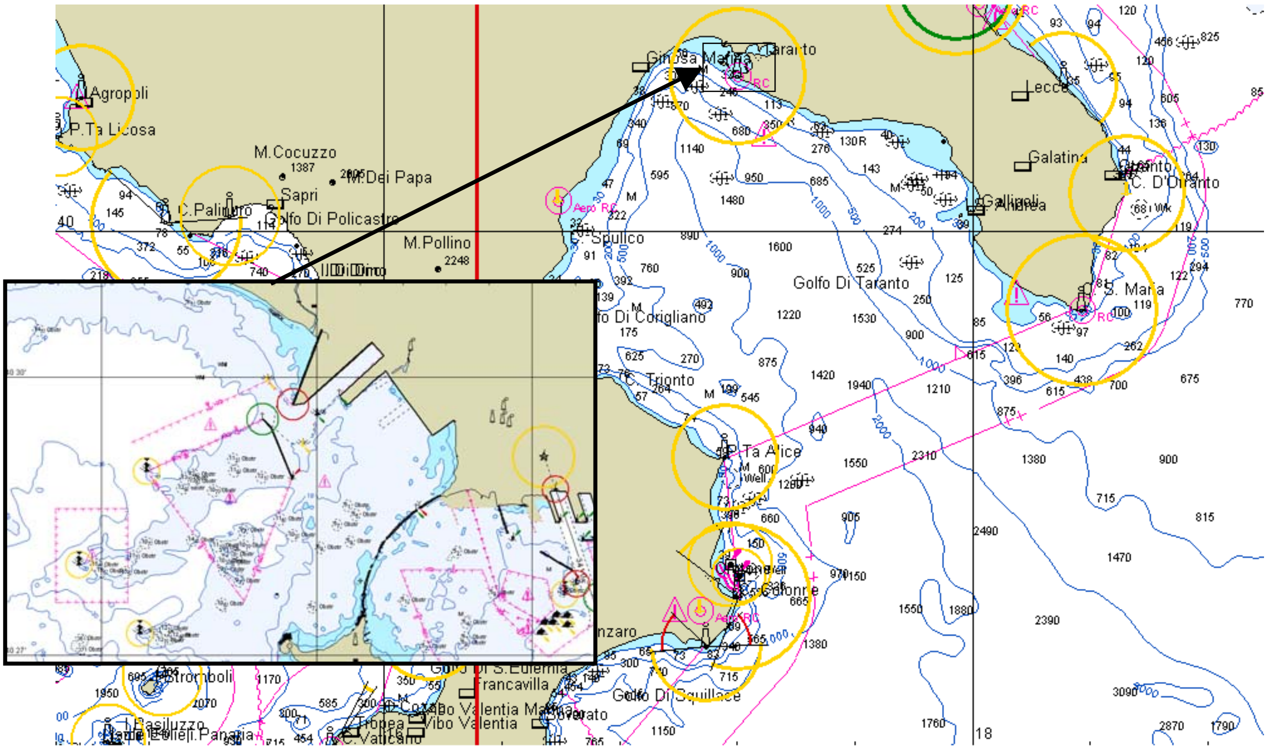


Figure 1. Navigational Chart of the Gulf of Taranto and details of the area

The port of Taranto is in the following equatorial coordinates

CHARACTERISTICS	STUDY AREA
Longitude	17º 10' E
Latitude	40º 10' N

Table 1. Location of the study area

3. CHARACTERISATION OF SURGE

3.1. DATA SOURCES

The data available to carry out the analysis of surge in the area of the Project have been obtained from the Meteo-Sea Study undertaken by MEDEA ENGINEERING S.A. for the “Progetto Preliminare Terminale di Ricezione e Rigassificazione Gas Naturale Liquefatto (GNL). Taranto” and other surge data that ALATEC requested from the U.K. METEOROLOGICAL OFFICE for a certain point at deep water within the area under study.

- **Data from the Meteo-Sea Study**

The Meteo-Sea Study of the “Progetto Preliminare Terminale di Ricezione e Rigassificazione Gas Naturale Liquefatto (GNL). Taranto” by MEDEA ENGINEERING S.A includes the following surge data:

-Continuous registration of surge from 1951 to 1996 for sectors SE and SSE.

-Extreme values for wave height and period for sectors Sciroco, Mezzogiorno and Libeccio and their associated return periods for a point near the coast of Crotone, obtained from the “Rete Ondametrica Nazionale”.

- **Data from the U.K. Meteorological Office**

In order to establish the features of the surge regimes at the area, data were requested from the U.K. METEOROLOGICAL OFFICE, which has provided ALATEC with a continuous registration of data on simultaneous wind and surge in deep waters throughout a period of four years. The “Global Wave Model” used by the UKMO represents the sea conditions based on atmospheric data (barometric chart), thus providing in a 60km spacing grid data on wave height (sea and swell), as well as the origin direction, measured in 6-hour intervals until November 2002, when the intervals were reduced to 3 hours.

3.2. SURGE IN DEEP WATERS

3.2.1. MEAN SURGE REGIME

In order to establish the features of the mean surge regime in deep waters, we used the data provided by the U.K. METEOROLOGICAL OFFICE to ALATEC. Therefore, we are based on a continuous registration (every 6 or 3 hours) of surge (sea and swell) in deep waters throughout the last 4 years (from 2001 to 2004), a period that is long enough to establish the features of the mean climate.

The following figure shows the location of the point of measurement. Its geographical coordinates are: 40º N, 17,54º E.

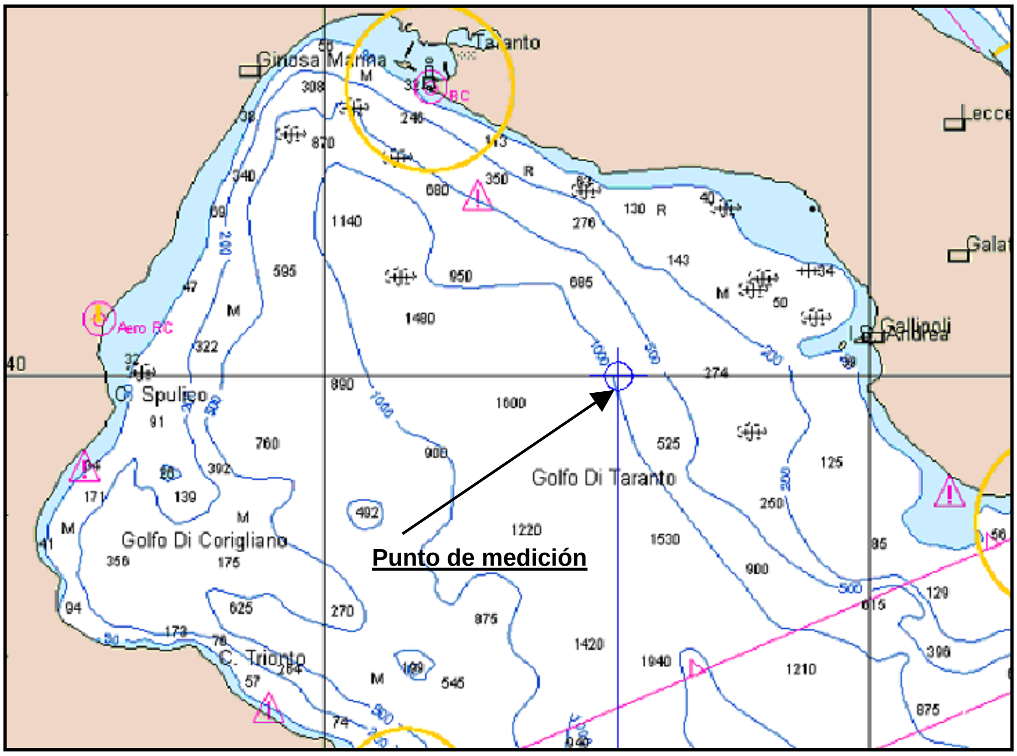


Figure 2. Position of the point of measurement

The following tables show the number of registries and frequencies (for wave height and direction) obtained from the continuous surge registration provided by the UKMO. For this purpose, wave heights that are equal or below 0.2 m have been considered as “calm”.

DIRECCIÓN		Hs (m)											TOTAL
		CALMAS	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	
N	**0**	155	208	201	39	6	0	0	0	0	0	0	**609**
NNE	**22.5**	105	115	72	14	1	0	0	0	0	0	0	**307**
NE	**45**	68	50	27	4	0	0	0	0	0	0	0	**149**
ENE	**67.5**	77	25	8	1	1	0	0	0	0	0	0	**112**
E	**90**	53	21	4	2	0	0	0	0	0	0	0	**80**
ESE	**112.5**	60	41	12	8	0	0	0	0	0	0	0	**121**
SE	**135**	168	265	166	144	83	64	51	25	9	1	0	**976**
SSE	**157.5**	112	315	484	321	178	109	48	17	10	5	2	**1601**
S	**180**	255	482	471	133	21	6	6	0	0	0	0	**1374**
SSW	**202.5**	81	201	136	16	2	1	0	0	0	0	0	**437**
SW	**225**	58	168	110	9	4	0	0	0	0	0	0	**349**
WSW	**247.5**	35	122	52	4	0	0	0	0	0	0	0	**213**
W	**270**	46	86	38	2	1	0	0	0	0	0	0	**173**
WNW	**292.5**	78	76	23	1	0	0	0	0	0	0	0	**178**
NW	**315**	137	171	83	8	2	0	0	0	0	0	0	**401**
NNW	**337.5**	170	291	244	50	9	1	0	0	0	0	0	**765**
TOTAL	**1658**	**2637**	**2131**	**756**	**308**	**181**	**105**	**42**	**19**	**6**	**2**	**7845**	**TOTAL**

Table 2. Number of registries per height and direction

DIRECCIÓN		Hs (m)											TOTAL
		CALMAS	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	
N	**0**	1.976	2.651	2.562	0.497	0.076	0.000	0.000	0.000	0.000	0.000	0.000	**7.763**
NNE	**22.5**	1.338	1.466	0.918	0.178	0.013	0.000	0.000	0.000	0.000	0.000	0.000	**3.913**
NE	**45**	0.867	0.637	0.344	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.899**
ENE	**67.5**	0.982	0.319	0.102	0.013	0.013	0.000	0.000	0.000	0.000	0.000	0.000	**1.428**
E	**90**	0.676	0.268	0.051	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.020**
ESE	**112.5**	0.765	0.523	0.153	0.102	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.542**
SE	**135**	2.141	3.378	2.116	1.836	1.058	0.816	0.650	0.319	0.115	0.013	0.000	**12.441**
SSE	**157.5**	1.428	4.015	6.170	4.092	2.269	1.389	0.612	0.217	0.127	0.064	0.025	**20.408**
S	**180**	3.250	6.144	6.004	1.695	0.268	0.076	0.076	0.000	0.000	0.000	0.000	**17.514**
SSW	**202.5**	1.033	2.562	1.734	0.204	0.025	0.013	0.000	0.000	0.000	0.000	0.000	**5.570**
SW	**225**	0.739	2.141	1.402	0.115	0.051	0.000	0.000	0.000	0.000	0.000	0.000	**4.449**
WSW	**247.5**	0.446	1.555	0.663	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**2.715**
W	**270**	0.586	1.096	0.484	0.025	0.013	0.000	0.000	0.000	0.000	0.000	0.000	**2.205**
WNW	**292.5**	0.994	0.969	0.293	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**2.269**
NW	**315**	1.746	2.180	1.058	0.102	0.025	0.000	0.000	0.000	0.000	0.000	0.000	**5.112**
NNW	**337.5**	2.167	3.709	3.110	0.637	0.115	0.013	0.000	0.000	0.000	0.000	0.000	**9.751**
TOTAL		**21.134**	**33.614**	**27.164**	**9.637**	**3.926**	**2.307**	**1.338**	**0.535**	**0.242**	**0.076**	**0.025**	**100**

Table 3. Frequencies per height and direction

Surge in deep waters is that coming from sectors **SSE, S** and **SE**. Adding up all three frequencies we can see that they cover 50.4% of the time. These three types of surge are also very energetic and likely to reach the terminal under study, so they will be the main sectors to take into consideration in the study of propagation from deep waters to the terminal.

Based on previous tables we have represented the surge compass card defining the mean surge climate in deep waters:

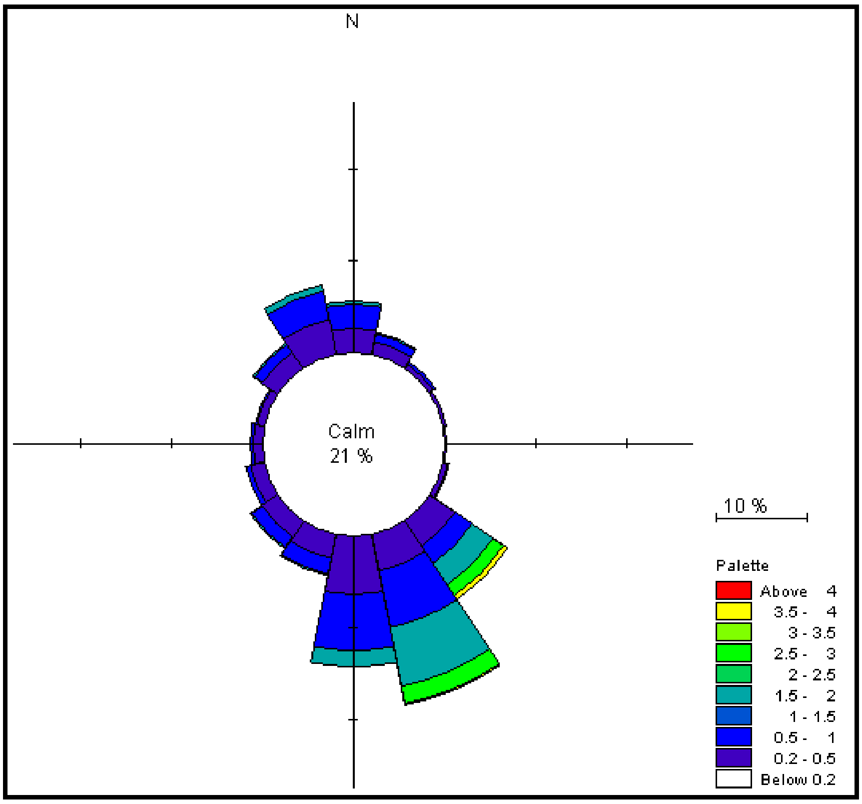


Figure 3. Surge compass card in deep waters

Hence, the highest frequency corresponds to surge from the sector between 146.25º and 168.75º in relation to the North (SSE sector), covering 20.41% of the time. This may be considered as the main sector as it holds most of the surge energy and even reaches waves up to 5 m high.

The following table shows the mean direction regime of the wave height in deep waters, expressed as the percentage of possibility over 1.

DIRECCIÓN		**Hs** (m)										
		CALMAS	**0.5**	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**4.5**	**5.0**
N	**0.0**	0.0198	0.0463	0.0728	0.0778	0.0785	0.0785	0.0785	0.0785	0.0785	0.0785	0.0785
NNE	**22.5**	0.0134	0.0280	0.0372	0.0390	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391	0.0391
NE	**45.0**	0.0087	0.0150	0.0185	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190	0.0190
ENE	**67.5**	0.0098	0.0130	0.0140	0.0142	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143	0.0143
E	**90.0**	0.0068	0.0094	0.0099	0.0102	0.0102	0.0102	0.0102	0.0102	0.0102	0.0102	0.0102
ESE	**112.5**	0.0077	0.0129	0.0144	0.0154	0.0154	0.0154	0.0154	0.0154	0.0154	0.0154	0.0154
SE	**135.0**	0.0214	0.0552	0.0763	0.0947	0.1053	0.1134	0.1199	0.1231	0.1243	0.1244	0.1244
SSE	**157.5**	0.0143	0.0544	0.1161	0.1570	0.1797	0.1936	0.1997	0.2019	0.2032	0.2038	0.2041
S	**180.0**	0.0325	0.0939	0.1540	0.1709	0.1736	0.1744	0.1751	0.1751	0.1751	0.1751	0.1751
SSW	**202.5**	0.0103	0.0360	0.0533	0.0553	0.0556	0.0557	0.0557	0.0557	0.0557	0.0557	0.0557
SW	**225.0**	0.0074	0.0288	0.0428	0.0440	0.0445	0.0445	0.0445	0.0445	0.0445	0.0445	0.0445
WSW	**247.5**	0.0045	0.0200	0.0266	0.0271	0.0271	0.0271	0.0271	0.0271	0.0271	0.0271	0.0271
W	**270.0**	0.0059	0.0168	0.0217	0.0219	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220	0.0220
WNW	**292.5**	0.0099	0.0196	0.0226	0.0227	0.0227	0.0227	0.0227	0.0227	0.0227	0.0227	0.0227
NW	**315.0**	0.0175	0.0393	0.0498	0.0509	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511	0.0511
NNW	**337.5**	0.0217	0.0588	0.0899	0.0962	0.0974	0.0975	0.0975	0.0975	0.0975	0.0975	0.0975
TOTAL		**0.2113**	**0.5475**	**0.8200**	**0.9164**	**0.9556**	**1.9343**	**0.9921**	**0.9974**	**0.9999**	**1.0000**	**1.0000**

Table 4. Mean Direction regime of surge in deep waters

Based on the previous table we can make a graphical representation of the mean scalar regime of surge in deep waters, as follows:

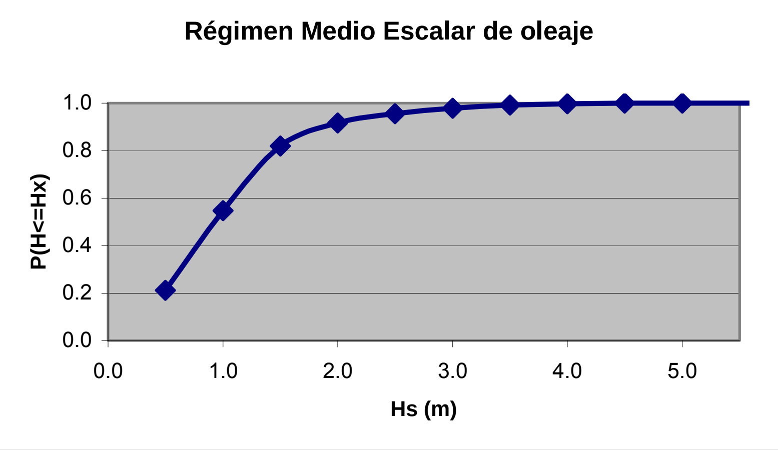


Figure 4. Mean scalar regime of surge in deep waters

In order to state the complete features of the mean regime of surge, we are also showing the tables of the number of registries and appearance, per top period and direction, obtained from the continuous registration of surge provided by the UKMO

DIRECCIÓN		**Tp (seg)**											**TOTAL**
		3.5	**4.0**	**4.5**	**5.0**	**5.5**	**6.0**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	
N	**0**	402	154	37	16	0	0	0	0	0	0	0	**609**
NNE	**22.5**	232	53	18	4	0	0	0	0	0	0	0	**307**
NE	**45**	121	19	8	1	0	0	0	0	0	0	0	**149**
ENE	**67.5**	99	8	3	0	2	0	0	0	0	0	0	**112**
E	**90**	72	3	2	3	0	0	0	0	0	0	0	**80**
ESE	**112.5**	83	22	8	4	4	0	0	0	0	0	0	**121**
SE	**135**	167	216	176	124	96	87	53	37	15	4	1	**976**
SSE	**157.5**	287	299	215	238	212	169	86	57	26	12	0	**1601**
S	**180**	422	391	274	116	66	54	27	16	4	4	0	**1374**
SSW	**202.5**	298	100	31	5	2	1	0	0	0	0	0	**437**
SW	**225**	262	60	19	7	1	0	0	0	0	0	0	**349**
WSW	**247.5**	166	40	3	3	1	0	0	0	0	0	0	**213**
W	**270**	138	30	4	1	0	0	0	0	0	0	0	**173**
WNW	**292.5**	156	21	1	0	0	0	0	0	0	0	0	**178**
NW	**315**	324	59	13	3	2	0	0	0	0	0	0	**401**
NNW	**337.5**	508	189	52	14	2	0	0	0	0	0	0	**765**
TOTAL		**3737**	**1664**	**864**	**539**	**388**	**311**	**166**	**110**	**45**	**20**	**1**	**7845**

Table 5. Number of registries per top period and direction

DIRECCIÓN		Tp (seg)											TOTAL
		3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	
N	**0**	5.124	1.963	0.472	0.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**7.763**
NNE	**22.5**	2.957	0.676	0.229	0.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**3.913**
NE	**45**	1.542	0.242	0.102	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.899**
ENE	**67.5**	1.262	0.102	0.038	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	**1.428**
E	**90**	0.918	0.038	0.025	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**1.020**
ESE	**112.5**	1.058	0.280	0.102	0.051	0.051	0.000	0.000	0.000	0.000	0.000	0.000	**1.542**
SE	**135**	2.129	2.753	2.243	1.581	1.224	1.109	0.676	0.472	0.191	0.051	0.013	**12.441**
SSE	**157.5**	3.658	3.811	2.741	3.034	2.702	2.154	1.096	0.727	0.331	0.153	0.000	**20.408**
S	**180**	5.379	4.984	3.493	1.479	0.841	0.688	0.344	0.204	0.051	0.051	0.000	**17.514**
SSW	**202.5**	3.799	1.275	0.395	0.064	0.025	0.013	0.000	0.000	0.000	0.000	0.000	**5.570**
SW	**225**	3.340	0.765	0.242	0.089	0.013	0.000	0.000	0.000	0.000	0.000	0.000	**4.449**
WSW	**247.5**	2.116	0.510	0.038	0.038	0.013	0.000	0.000	0.000	0.000	0.000	0.000	**2.715**
W	**270**	1.759	0.382	0.051	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**2.205**
WNW	**292.5**	1.989	0.268	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	**2.269**
NW	**315**	4.130	0.752	0.166	0.038	0.025	0.000	0.000	0.000	0.000	0.000	0.000	**5.112**
NNW	**337.5**	6.475	2.409	0.663	0.178	0.025	0.000	0.000	0.000	0.000	0.000	0.000	**9.751**
TOTAL		**47.635**	**21.211**	**11.013**	**6.871**	**4.946**	**3.964**	**2.116**	**1.402**	**0.574**	**0.255**	**0.013**	**100**

Table 6. : Frequencies per top period and direction

According to the previous table, the most frequent top periods are those below 3.5 sec, and surge with top periods over 8 sec. is not very likely to appear.

The following tables show the Hs-Tp relation in number of registries and frequency of appearance in deep waters obtained from the continuous surge registration provided by the UKMO

Hs (m)	Tp (seg)											TOTAL
	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	
CALMAS	1406	171	52	24	4	1	0	0	0	0	0	**1658**
0,5	2007	308	186	75	26	22	10	3	0	0	0	**2637**
1	324	1173	336	137	82	45	15	8	10	1	0	**2131**
1.5	0	12	290	209	115	72	36	19	3	0	0	**756**
2	0	0	0	94	111	55	28	16	3	0	1	**308**
2.5	0	0	0	0	50	91	23	9	3	5	0	**181**
3	0	0	0	0	0	25	46	20	7	7	0	**105**
3.5	0	0	0	0	0	0	8	25	8	1	0	**42**
4	0	0	0	0	0	0	0	10	9	0	0	**19**
4.5	0	0	0	0	0	0	0	0	2	4	0	**6**
5	0	0	0	0	0	0	0	0	0	2	0	**2**
TOTAL	**2331**	**1493**	**812**	**515**	**384**	**310**	**166**	**110**	**45**	**20**	**1**	**7845**

Table 7. Hs-Tp relation table. Number of registries

Hs (m)	Tp (seg)											TOTAL
	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	
CALMAS	17.92	2.18	0.66	0.31	0.05	0.01	0	0	0	0	0	**21.134**
0,5	25.58	3.926	2.37	0.96	0.33	0.28	0.13	0.04	0	0	0	**33.614**
1	4.13	14.95	4.28	1.75	1.05	0.57	0.19	0.1	0.13	0	0	**27.164**
1.5	0	0.153	3.7	2.66	1.47	0.92	0.46	0.24	0.04	0	0	**9.6367**
2	0	0	0	1.2	1.41	0.7	0.36	0.2	0.04	0	0.01	**3.9261**
2.5	0	0	0	0	0.64	1.16	0.29	0.11	0.04	0.1	0	**2.3072**
3	0	0	0	0	0	0.32	0.59	0.25	0.09	0.1	0	**1.3384**
3.5	0	0	0	0	0	0	0.1	0.32	0.1	0	0	**0.5354**
4	0	0	0	0	0	0	0	0.13	0.11	0	0	**0.2422**
4.5	0	0	0	0	0	0	0	0	0.03	0.1	0	**0.0765**
5	0	0	0	0	0	0	0	0	0	0	0	**0.0255**
TOTAL	**47.64**	**21.21**	**11**	**6.87**	**4.95**	**3.96**	**2.12**	**1.4**	**0.57**	**0.3**	**0.01**	**100**

Table 8. Hs-Tp relation table. Frequencies

Relevant low heights, in a rate from 0.5 m to 1 m, are associated to a low top period, around 4 sec, whereas the highest numbers, from 3.5 m to 4 m, are associated to higher top periods, around 7 sec.

The following figure is the histogram representation of Hs- Tp:

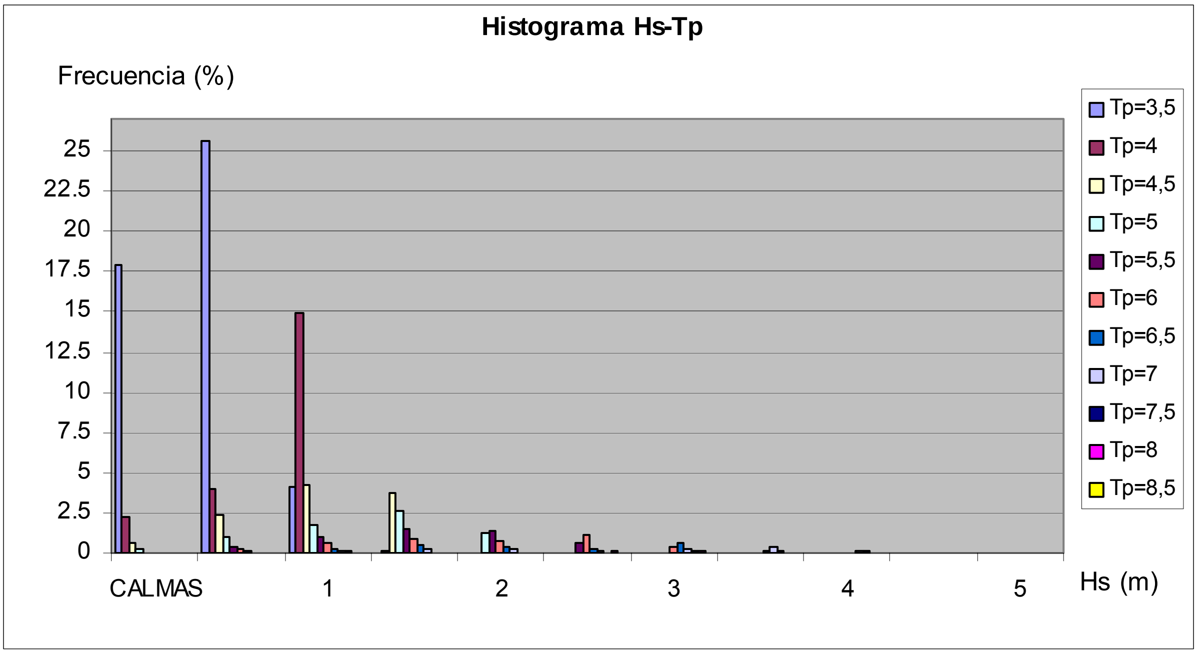


Figure 5. Hs-Tp histogram

In accordance with the previous histogram, the highest frequency corresponds to surge with wave heights 0.5 m or lower, with an associated top period of 3.5 sec, which appears approximately 25% of the time, whereas waves over 4 m, with top periods over 7 sec, have very low frequency.

3.2.2. EXTREME SURGE REGIME

3.2.2.1. EXTREME SCALAR REGIME

In order to determine the extreme scalar regime of the wave height, we have used the Extreme Value Method based on continuous surge data obtained from the UKMO.

We can focus on the modelling of extreme or maximum values of a certain variable from different points of view. The method used here is known as POT (peak over threshold) or Relative Maximum Value Method, whose basic ideas and principles are stated next, in order to enable the interpretation of the results obtained.

This method is based on extracting from the registered time series the individual storms, which are not interdependent due to proximity in time, surpassing a significant wave height in the time peak, and uses as a sample the series of values reached by the significant wave height at the peak of each selected time period. The starting off point of the extreme model used consists of a time period stating the significant evolution of the wave height throughout time, and from which we can select the relative maximum values or peaks surpassing a certain risk limit or limit height (H_c.)

However, to make this analysis valid we need an additional condition: the peaks must be far enough from each other so as to guarantee their independence. In other words, out of all the peaks surpassing the H_c level we must only choose those that, on one hand, are the highest or most representatives of their period, and, on the other, are far enough from each other so as to be considered independent. The minimum time lapse between the different peaks to consider them independent varies from one series to the other and depends on the average duration of the weather conditions that usually lead to extreme surge conditions.

The group of maximum relative values surpassing a certain limit and forming a sample of independent values will be known as extreme values or extreme population.

Once the group of extreme values has been chosen, the next step is to adjust such values to a probability distribution function. Such distribution, represented by F_e (x/H_c), will result in the probability rate there is for an independent peak surpassing the H_c level to reach an equal or lower magnitude than x, so F_e (x/H_c) represents a conditioned probability.

Based on practical situations we have observed that the extreme values of the surge series adjust quite well (through the method of the square minimums) to the Weibull triparametric distribution, which are used to establish the theoretical frequencies assigned to each of the data belonging to the extreme sample of the Gringorten formulation.

The Weibull triparametric distribution function is expressed as follows:

$$F_e(x) = 1 - \exp\left(-\left(\frac{x-\alpha}{\beta}\right)^{\gamma}\right)$$

Parameters α, β and γ are respectively known as the centering, scale and form parameters. Based on this distribution using the previously defined extreme sample (P'), the annual non-excedence probability of an H_i value is obtained using the following expression:

$$P(H \le Hi) = 1 - \lambda\left[1 - P'(H \le Hi)\right]$$

Where λ is the mean number of storms a year.

Therefore, the return period in years will be:

$$T(Hi) = \frac{1}{\lambda\left[1 - P'(H \le Hi)\right]}$$

In this particular case we have defined 2.00 m as the wave limit value, thus obtaining an extreme sample comprising 54 independent values, which correspond to the maximum wave heights for each storm. Those storms more than 12 hours apart have been considered as independent storms.

Using the previously described extreme sample, we have adjusted it to a Weibull triparametric distribution function, resulting in the following centering, scale and form parameters:

α= 2.275
β= 0.711
γ= 1.011

Based on such aspects, the extreme wave height in deep waters for the return period defined in the Annex “Calculation and Design Basis” (475 years) is 8.36 m for the central dead reckoning.

Provided that the data used are obtained from a registration measurement that is too short to obtain an extreme regime (4 years), bearing in mind the extreme regime data stated in the Meteo-Sea Study made by MEDEA ENGINEERING S.A, as well as estimations of the extreme wave height obtained with the SPM (Shore Protection Manual 1984) method for the provision of wind surge in deep waters, we believe it is advisable to consider the extreme wave height associated to a confidence interval of 95%, thus obtaining a relevant wave height of 9.50 m for the return period of 475 years.

3.2.2.2. EXTREME DIRECTIVITY REGIME

In order to determine the extreme directivity regime of the surge, it is defined based on the extreme scalar regime, by multiplying the wave height corresponding to the defined return period by a Kα directivity coefficient, which is different for each direction.

The Kα coefficients corresponding to each direction are established based on the approximate relation between the extreme wave heights in the directions or directivity sectors where they may appear. For each direction, the Kα coefficient is defined as the quotient of the wave height associated to that direction and the maximum wave height. Therefore, coefficient 1 is assigned to the direction showing the highest associated wave height.

Provided that most of the available information deals with the intermediate climate, Kα values will be defined based on mean wave height direction regimes, in accordance with 2 procedures:

Method 1: Based on this mean wave height regime resulting from the adjustment of the data in the intermediate-high area (or upper end) of the initial sample, each direction is associated to the mean value of wave heights with annual exceeding values between 1% and 0.1% (probability 0.99 and 0.999 of the regime) in each one of the annual mean regimes corresponding to each directivity sector.

Method 2: Based on the wave Height/Direction table, each direction is associated to the mean wave heights which have exceeded from 5% to 0.5% the number of times the corresponding sector has been observed.

Provided that the values obtained in both approaches are similar, we have used a value of Kα that is considerably similar to the mean value of the coefficients obtained through both of the previously described methods.

Hence, we can consider the extreme scalar regime as associated to the strictest direction/s (Kα = 1) resulting in a wave height associated to a return period corresponding to other directions, by multiplying the wave height corresponding to such return period provided by the extreme scalar regime by the corresponding directivity coefficient.

The adjustment of the mean wave height regime data has been made using a biparametric Weibull distribution function, thus obtaining the wave heights associated to the non-excedence probabilities required in each method.

DIRECCIÓN		**Método 1**				**Método 2**				**$K\alpha$ medio**
		Altura asociada a excedencia de		**H media**	**$K\alpha_1$**	**Altura asociada a excedencia de**		**H media**	**$K\alpha2$**	
		1.00%	**0.10%**			**5.00%**	**0.50%**			
		0.99	**0.999**			**0.95**	**0.995**			
N	**0.0**	1.28	1.60	1.44	0.38	1.02	1.38	1.20	0.40	0.39
NNE	**22.5**	1.18	1.50	1.34	0.35	0.91	1.28	1.09	0.37	0.36
NE	**45.0**	0.94	1.17	1.06	0.28	0.75	1.02	0.88	0.30	0.29
ENE	**67.5**	1.02	1.48	1.25	0.33	0.69	1.16	0.93	0.31	0.32
E	**90.0**	0.85	1.13	0.99	0.26	0.62	0.93	0.78	0.26	0.26
ESE	**112.5**	0.98	1.24	1.11	0.29	0.76	1.06	0.91	0.30	0.30
SE	**135.0**	3.23	4.42	3.82	1.00	2.32	3.60	2.96	0.99	0.99
SSE	**157.5**	3.24	4.26	3.75	0.98	2.42	3.56	2.99	1.00	0.99
S	**180.0**	1.78	2.37	2.07	0.54	1.32	1.96	1.64	0.55	0.55
SSW	**202.5**	1.38	1.82	1.60	0.42	1.03	1.52	1.27	0.43	0.42
SW	**225.0**	1.24	1.57	1.40	0.37	0.96	1.34	1.15	0.38	0.38
WSW	**247.5**	0.95	1.16	1.05	0.28	0.77	1.02	0.90	0.30	0.29
W	**270.0**	1.12	1.47	1.30	0.34	0.84	1.23	1.04	0.35	0.34
WNW	**292.5**	0.84	1.07	0.96	0.25	0.66	0.92	0.79	0.26	0.26
NW	**315.0**	1.13	1.48	1.31	0.34	0.85	1.24	1.05	0.35	0.35
NNW	**337.5**	1.44	1.86	1.65	0.43	1.10	1.57	1.34	0.45	0.44

Table 9. Directivity coefficients

Where the maximum wave height for a return period of 475 years is 9.50 m, as mentioned in the previous section, the maximum directivity wave heights associated to that return period will be obtained by multiplying that maximum height by the directivity coefficients shown in the previous table.

DIRECCIÓN		Kα	H (m)
N	**0.0**	0.39	3.70
NNE	**22.5**	0.36	3.40
NE	**45.0**	0.29	2.72
ENE	**67.5**	0.32	3.03
E	**90.0**	0.26	2.46
ESE	**112.5**	0.30	2.82
SE	**135.0**	0.99	9.45
SSE	**157.5**	0.99	9.41
S	**180.0**	0.55	5.18
SSW	**202.5**	0.42	4.01
SW	**225.0**	0.38	3.57
WSW	**247.5**	0.29	2.73
W	**270.0**	0.34	3.25
WNW	**292.5**	0.26	2.43
NW	**315.0**	0.35	3.28
NNW	**337.5**	0.44	4.17

Table 10. Height of the extreme directivity wave, T=475 years

According to this table, the maximum height of an extreme wave is for section SE, where its value is 9.45 m.

3.3. SURGE AT THE TERMINAL

The following sections summarise the studies on surge propagation from the UKMO data source in deep waters to the location of the LNG terminal.

Based on the surge features in deep waters described in previous sections, we have made the necessary propagations to determine the wave height and surge approximation direction, both for the mean and the extreme regimes, in the berthing area at the terminal in project.

3.3.1. STUDY ON SURGE PROPAGATION, MEAN REGIME

3.3.1.1. DESCRIPTION OF THE NUMERIC SURGE MODEL

Once the Sea Climate has been studied in deep waters, we will carry out a propagation of surge until the area under study by using the MIKE21-PMS model.

ALATEC provides several surge propagation models that are suitable for each case under study, depending on its particular features. We suggest using module PMS included in the MIKE 21 set, made by the Danish Hydraulics Institute and described as follows.

The MIKE-21 PMS module is a refraction-diffraction linear module based on a parabolic approximation to the elliptic equation of the mild slope. The model considers that the refraction and shoaling effects are due to variation in depth, diffraction throughout the perpendicular following the main direction of surge, and dissipation of wave energy caused by friction with the bed and breaking caused by surge. The model also considers the effect of frequency and directivity dispersion using linear overlapping. The parabolic equation is solved using the Crank-Nicholson finite-difference scheme.

Basic output data for the model are integral wave parameters such as the quadratic mean of the wave height, the maximum period and the mean wave direction. Other output data that can be obtained from the model are radiation tensions and instant superficial elevations.

Therefore, it is a Module for the parabolic calculation of surge in mild slopes. It can be used for any type of dredging and is able to represent the phenomena of shoaling, refraction, loss due to friction with the bed, breaking, forward dispersion and partial diffraction.

3.3.1.2. PROPAGATION METHODOLOGY FOR THE MEAN REGIME

Each representative surge of the mean climate that - due to its direction - is quite likely to reach the area under study has been propagated. Such types of surge are characterised by mean direction parameters, a significant wave height and top period (sector, Hs, Tp). Once each case has been propagated, the resulting table has been represented with a compass card describing the mean regime at the area in question.

Propagation has been made at a mean level and is said in the description of the sea climate in the area to reach 0.42 m above BMVE.

For the propagation we have only taken into consideration a type of surge that could reach the LNG loading terminal; that is to say, surge that at the point of measurement of the UKMO comes from directions SE, SSE, S and SSW. In addition to this, due to the low frequency of certain wave heights, we will not carry out propagation for all of them. The following table shows the directions and wave heights propagated, as well as their frequency, considering that the types of surge to be propagated constitute 100% of the sample.

DIRECCIÓN		Hs (m)							TOTAL
		0.5	**1.0**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	
SE	**135º**	7.025	4.401	3.818	2.200	1.697	1.352	0.928	**21.421**
SSE	**157.5º**	8.351	12.831	8.510	4.719	2.890	1.273	0.901	**39.475**
S	**180º**	12.778	12.487	3.526	0.875	--	--	--	**29.666**
SSW	**202.5º**	5.329	3.606	0.504	--	--	--	--	**9.438**
TOTAL		**33.484**	**33.324**	**16.357**	**7.794**	**4.586**	**2.625**	**1.829**	**100.000**

Table 11. Heights and directions to be propagated

The top period (Tp) associated to each wave height (Hs), has been selected in accordance with the (Hs/Tp) meeting point, obtained from UKMO data and it figures in the description of the mean surge regime in deep waters. The top periods associated to each wave height propagated are shown in the following table:

	Hs (m)						
	0.5	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**
Tp (seg)	3.5	4.0	5.0	5.5	6.0	6.5	7.0

Table 12. Top periods associated to the wave heights propagated

Provided that the numeric model requires surge to come in from the left, we must prepare the necessary bathymetry grids to propagate the directions needed.

For propagation in the mean regime we have used 3 rectangular bathymetry grids to propagate surge from sectors SE, SSE, S and SSW.

For the first three sectors (SE, SSE and S) grid orientation will remain the same; that is to say, grids whose main direction is SSE - NNW, then creating surge rolling ± 22.5º in relation to the main direction of the grid in order to simulate the surge from the two sectors that do not coincide with the main grid direction (SE and S).

For the SSW sector we will use a grid with a different orientation than those grids used for the propagation of surge coming from the other three sectors. Its main direction will be
SSW- NNE.

To simulate the different top periods to be propagated we will use grids with different spatial discretisation and different dimensions, ensuring that the lines generating surge are located in deep waters and that the grid knit is within the suitable interval for each period.

The following tables show which grid has been used for each propagation, as well as the features of the three grids used.

Dirección		Hs (m)	Tp (seg)	Malla empleada
SE	**135º**	0.5	3.5	1
		1	4	
		1.5	5	
		2	5.5	
		2.5	6	2
		3	6.5	
		3.5	7	
SSE	**157.5º**	0.5	3.5	1
		1	4	
		1.5	5	
		2	5.5	
		2.5	6	2
		3	6.5	
		3.5	7	
S	**180º**	0.5	3.5	1
		1	4	
		1.5	5	
		2	5.5	
SSW	**202.5º**	0.5	3.5	3
		1	4	
		1.5	5	

Table 13. Grids used

Malla	Orientación	Paso (m)	Dimensiones (m)	Prof. Límite A.P. (m)
1	SSE-NNW	7.5	24375x12750	24
2	SSE-NNW	11	24376x12760	39
3	SSW-NNE	7.5	13500x10125	24

Table 14. Grid features

The following figures represent the three rectangular grids used.

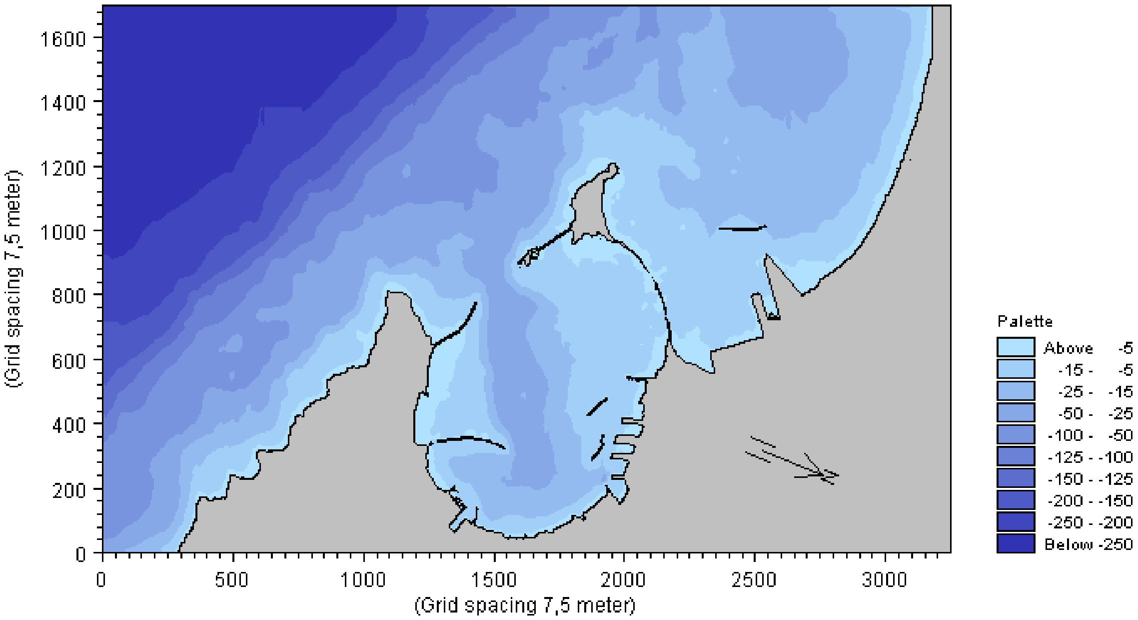


Figure 6. Grid 1. Knit 7.5 m. Orientation SSE-NNW

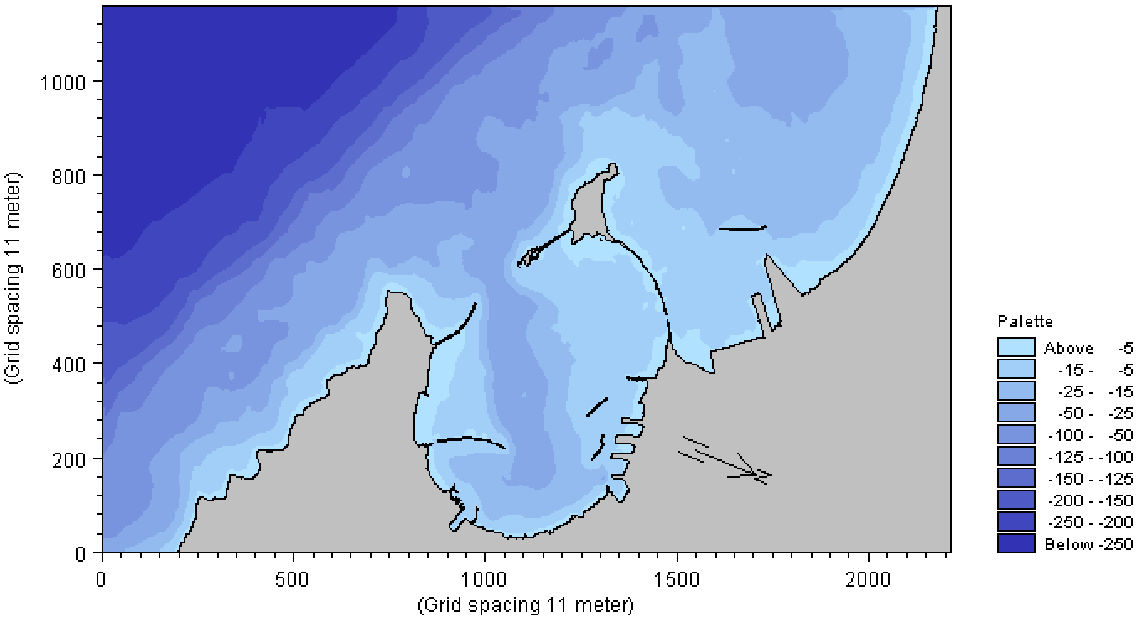


Figure 7. Grid 2. Knit 11 m. Orientation SSE-NNW

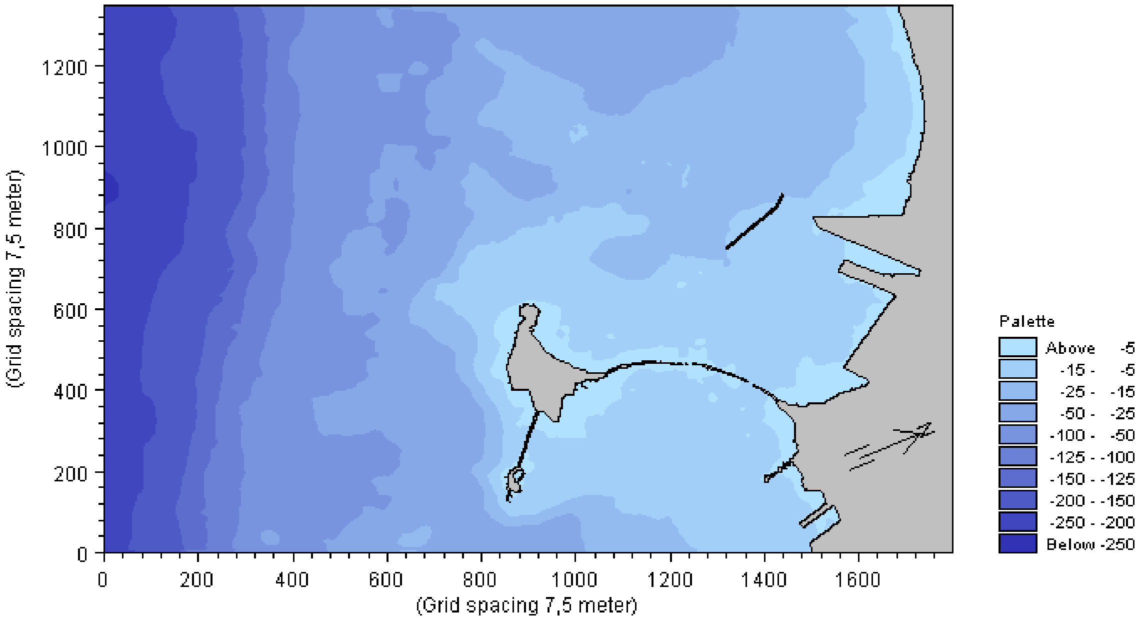


Figure 8. Grid 3. Knit 7.5 m. Orientation SSW-NNE

3.3.1.3. RESULTS OF PROPAGATION

The figures corresponding to simulations made using MIKE 21-PMS are stated in **Appendix I: "Surge propagation figures"**. Based on such tests we have obtained the table of propagated surge, the surge compass card at the terminal and the corresponding propagation coefficients.

The transformation experienced by surge propagated from deep waters up to the terminal, both in wave height and in incidence direction, are shown in the following table:

AGUAS PROFUNDAS									TERMINAL
Dir		Hs (m)							
		0.5	1	1.5	2	2.5	3	3.5	
SE	**135º**	0.036	0.096	0.103	0.092	0.082	0.092	0.204	**H (m)**
		164.63	171.97	172.29	185.04	170.53	181.25	193.66	**Dir**
		SSE	S	S	S	S	S	SSW	
SSE	**157.5º**	0.116	0.192	0.193	0.229	0.214	0.199	0.331	**H (m)**
		163.47	167.86	174.59	182.06	171.49	173.83	188.68	**Dir**
		SSE	SSE	S	S	S	S	S	
S	**180º**	0.071	0.132	0.275	0.405	--	--	--	**H (m)**
		163.10	166.81	172.31	181.36	--	--	--	**Dir**
		SSE	SSE	S	S	--	--	--	
SSW	**202.5º**	0.162	0.394	0.886	--	--	--	--	**H (m)**
		213.67	217.91	230.22	--	--	--	--	**Dir**
		SSW	SW	SW	--	--	--	--	

Table 15. Surge transformation

The type of surge that in deep waters comes from the **SE** sector experiences an important decrease in height, so its propagation coefficients will be very low. This is the direction experiencing the strongest refraction due to the location of the terminal. Surge rolls S, thus proving that the most energetic surge is the one that rolls the most and reaches the terminal heading SSW. The least energetic surge also moves S, although does not roll as much, so it reaches the terminal heading SSE.

Surge from the **SSE** appears at the terminal with a decrease in height lower than SE surge, so its propagation coefficients will be higher. The rolling experienced by this surge from deep waters up to the terminal is heading S. Less energetic surge rolls 10ºS, so it reaches the terminal heading the same direction (SSE) whereas the most energetic surge rolls 20º - 30º, and reaches the terminal heading S.

Surge coming at the measuring point from the **S** section reduces its height in a similar way as surge from the SSE. The change in direction in less energetic surge in this sector is made turning 10º E, and appears at the terminal heading SSE. The most energetic surge hardly experiences any variation in its direction, so it reaches the terminal heading the same direction as it did in deep waters.

Lastly, surge that in deep waters comes from the **SSW**, is, obviously, the one experiencing the smallest change in height. This surge rolls W when approaching the area being studied and the most energetic surge can even roll up to28º, thus changing direction to the SW.

Therefore, frequency of the surge propagated up to the terminal is shown in the following table:

Dirección		**Hs (m)**										**TOTAL**
		0.05	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	
SSE	**157.5º**	7.025	12.778	33.669	--	--	--	--	--	--	--	**53.472**
S	**180º**	--	9.650	13.601	11.135	0.901	0.875	--	--	--	--	**36.162**
SSW	**202.5º**	--	--	5.329	0.928	--	--	--	--	--	--	**6.257**
SW	**225º**	--	--	--	--	3.606	--	--	--	--	0.504	**3.606**
TOTAL		**7.025**	**22.43**	**52.599**	**12.06**	**4.507**	**0.875**	**0**	**0**	**0**	**0.504**	**100**

Table 16. Frequency of surge presentation at the terminal

The table shows that the main surge at the terminal comes from the SSE, and the maximum wave height is 0.9 m, even if its frequency of presentation is very low (0.8 days a year).

Surge at the terminal can be graphically represented through the following compass card:

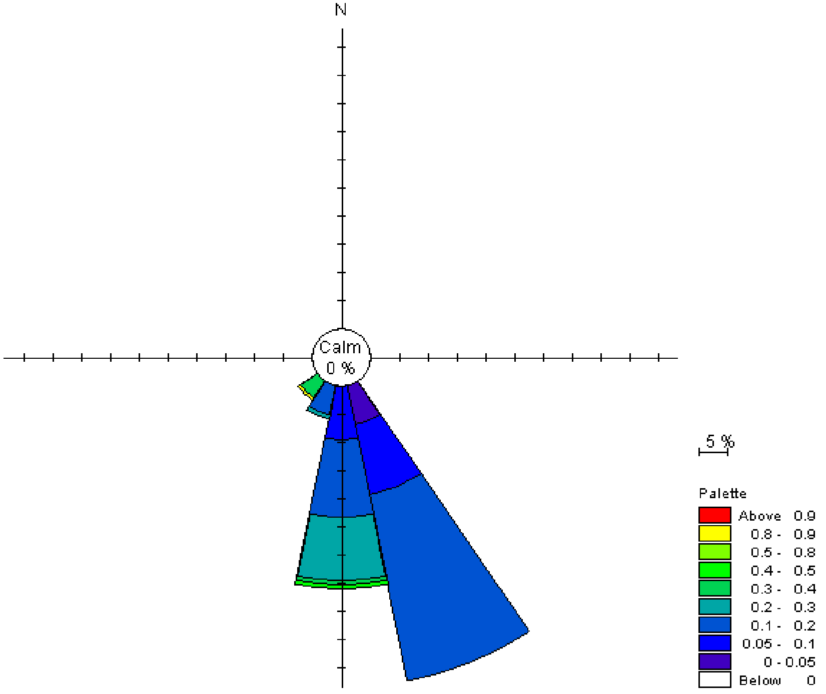


Figure 9. Terminal surge compass card

To see the transformation experienced by surge from deep waters up to the berthing point at the LNG terminal, we will now show a figure showing both compass cards: the card of already propagated surge in deep waters and the card of surge at the terminal.

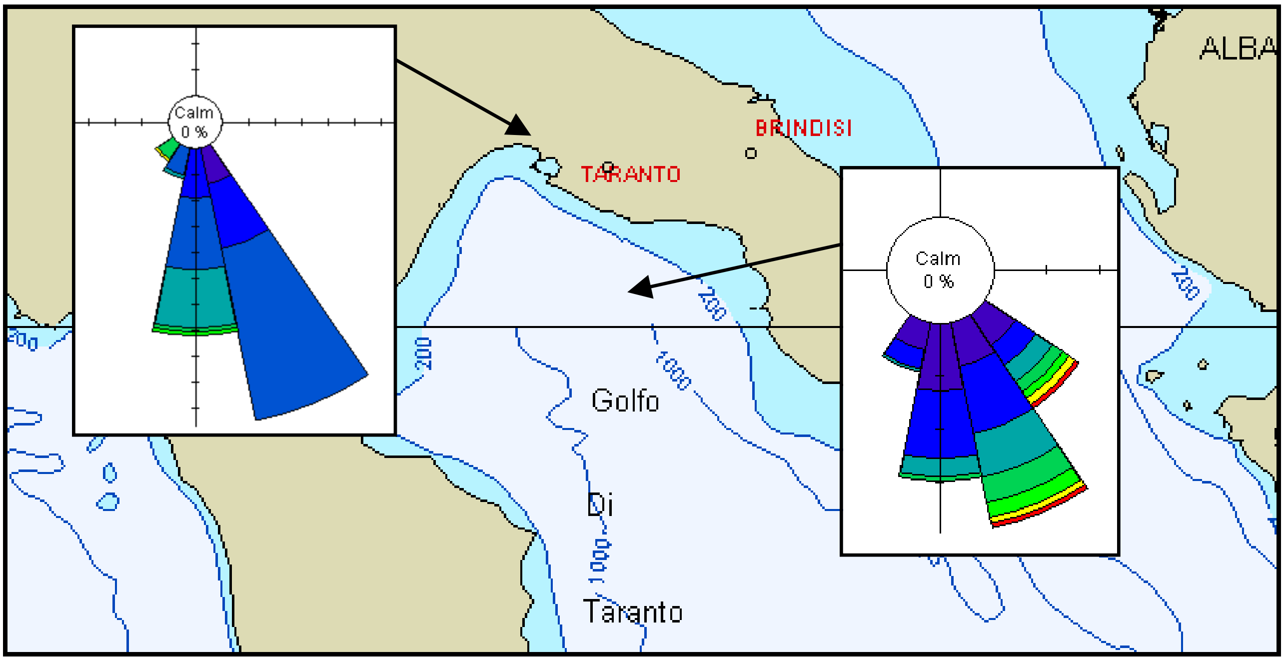


Figure 10. Surge compass cards in deep waters and at the terminal

3.3.1.4. PROPAGATION COEFICIENTS

To analyse the transformation experienced by the wave height in propagation from deep waters up to the terminal, we will now show a summary table stating all the heights of propagated waves and the propagation coefficients obtained for tested surge.

Dir Aguas Profundas	Ho (m)	Hp (m)	Kp	Tp (seg)
SE	0.5	0.036	0.0729	3.5
	1	0.096	0.0960	4
	1.5	0.103	0.0689	5
	2	0.092	0.0459	5.5
	2.5	0.082	0.0329	6
	3	0.092	0.0306	6.5
	3.5	0.204	0.0584	7
SSE	0.5	0.116	0.2315	3.5
	1	0.192	0.1920	4
	1.5	0.193	0.1289	5
	2	0.229	0.1145	5.5
	2.5	0.214	0.0857	6
	3	0.199	0.0665	6.5
	3.5	0.331	0.0945	7
S	0.5	0.071	0.1426	3.5
	1	0.132	0.1322	4
	1.5	0.275	0.1831	5
	2	0.405	0.2024	5.5
SSW	0.5	0.162	0.3236	3.5
	1	0.394	0.3942	4
	1.5	0.886	0.5907	5

Table 17. Propagation coefficients

The previous table shows that the maximum significant wave height obtained at the terminal is 0.88 m (from the SW) and corresponds to a height of 1.5 m and SSW direction in deep waters.

Based on the previous table we can obtain mean propagation coefficients for each of the directions propagated from deep waters.

Dir. Aguas Profundas		Kp (medio)
SE	**135º**	0.0579
SSE	**157.5º**	0.1305
S	**180º**	0.1651
SSW	**202.5º**	0.4362

Table 18. Direction propagation coefficients

The surge sector, which in deep waters experiences a greater variation of height in its propagation up to the terminal, comes from the SE, where the wave height at the terminal is approx. 5.79% of the wave height in deep waters. On the other hand, the sector with the lowest decrease in wave height is the SSW, where the wave height at the terminal is a mean 43.62% of the height in deep waters.

3.3.2. STUDY OF SURGE PROPAGATION, EXTREME REGIME

3.3.2.1. DESCRIPTION OF THE NUMERIC SURGE MODEL

Once the Sea Climate in deep waters has been studied, we will carry out a propagation of surge up to the area under study, by using the MIKE21-PMS model.

The propagation model used for the extreme regime is the same used for the study of propagation of surge in the previously described mean regime.

3.3.2.2. METHODOLOGY OF PROPAGATION IN THE EXTREME REGIME

We have propagated each one of the types pf surge representing the extreme climate which are likely to reach the area under study due to their direction. Such surge is characterised by the parameters of mean direction, significant wave height and top period (sector, Hs, Tp).

Propagation has been made at a mean level, as said in the description of the sea climate of the area, and is located 0.42 m above BMVE.

We have only taken into consideration for propagation those types of surge likely to reach the LNG terminal, that is to say, surge that in deep waters comes from SE, SSE, S and SSW.

The wave heights propagated correspond to the directivity extreme regime that was previously calculated for each of the directions subject to propagation. The following table shows the directions to be propagated with the corresponding wave heights and associated top periods.

Dirección		**Hs** (m)	**Tp** (seg)
SE	**135º**	9.45	10.4
SSE	**157.5º**	9.41	10.4
S	**180º**	5.18	8.1
SSW	**202.5º**	4.01	7.3

Table 19. Directions, heights and periods to be propagated

The top period (Tp) associated to each of the wave heights (Hs) has been calculated based on the linear relation between the radix of the wave height and the top period calculated from the extreme sample obtained in accordance with what has been established in the P.O.T. method.

Provided that the numeric model requires surge to come in from the left, we must prepare the bathymetry grids to propagate the directions needed.

For propagation in the extreme regime we have used 3 rectangular bathymetry grids to propagate surge from sectors SE, SSE, S and SSW.

For the first three (SE, SSE and S) grid orientation will remain the same; that is to say, grids whose main direction is SSE - NNW, then creating surge rolling ± 22.5º in relation to the main direction of the grid in order to simulate the surge from the two sectors that do not coincide with the main grid direction (SE and S).

For the SSW sector we will use a grid with a different orientation than those grids used for the propagation of surge coming from the other three sectors. Its main direction will be SSW-NNE.

To simulate the different top periods to be propagated we will use grids with different spatial discretisation and different dimensions, ensuring that the lines generating surge are located in deep waters and that the grid knit is within the suitable interval for each period.

The following tables show which grid has been used for each propagation, as well as the features of the three grids used.

Dirección		Hs (m)	Tp (seg)	Malla empleada
SE	**135º**	9.45	10.4	4
SSE	**157.5º**	9.41	10.4	4
S	**180º**	5.18	8.1	5
SSW	**202.5º**	4.01	7.3	6

Table 20. Grids used

Malla	Orientación	Paso (m)	Dimensiones (m)	Prof. Límite A.P. (m)
4	SSE-NNW	33	28710x13200	84
5	SSE-NNW	20	28000x14000	51
6	SSW-NNE	16	13504x10128	42

Table 21. Grid features

The following figures represent the three rectangular grids used.

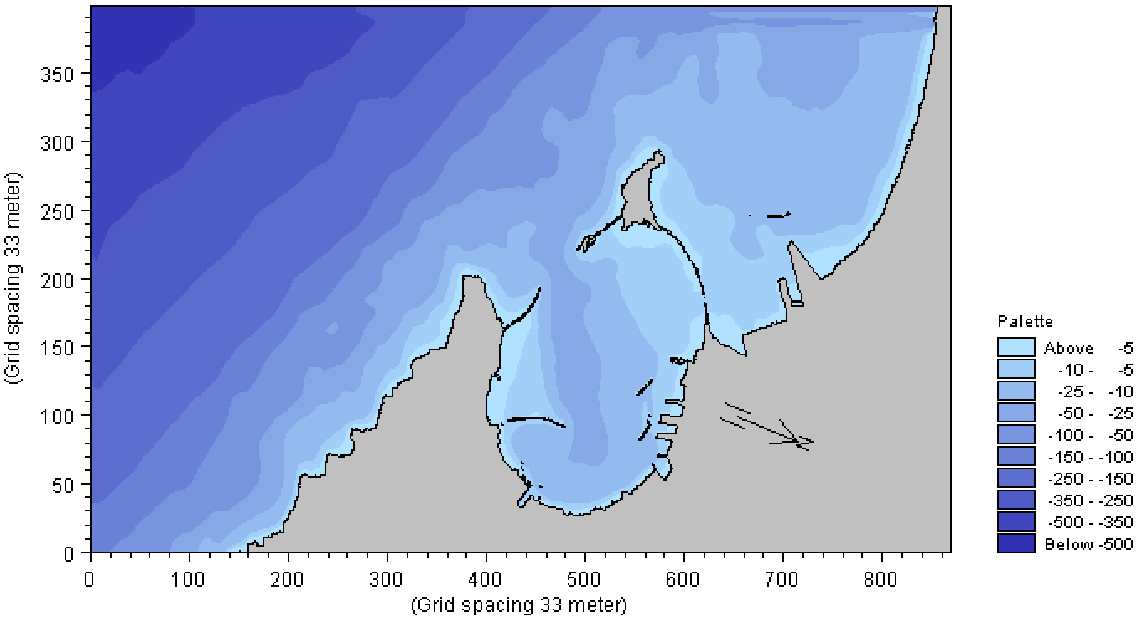


Figure 11. Grid 4. Knit 30 m. Orientation SSE-NNW

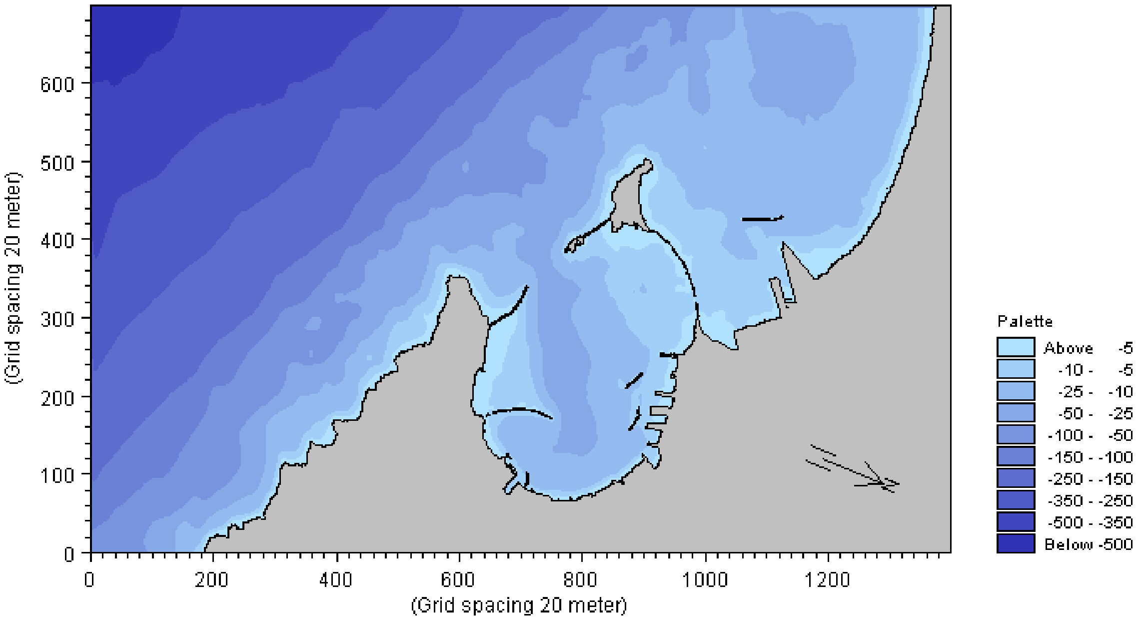


Figure 12. Grid 5. Knit 20 m. Orientation SSE-NNW

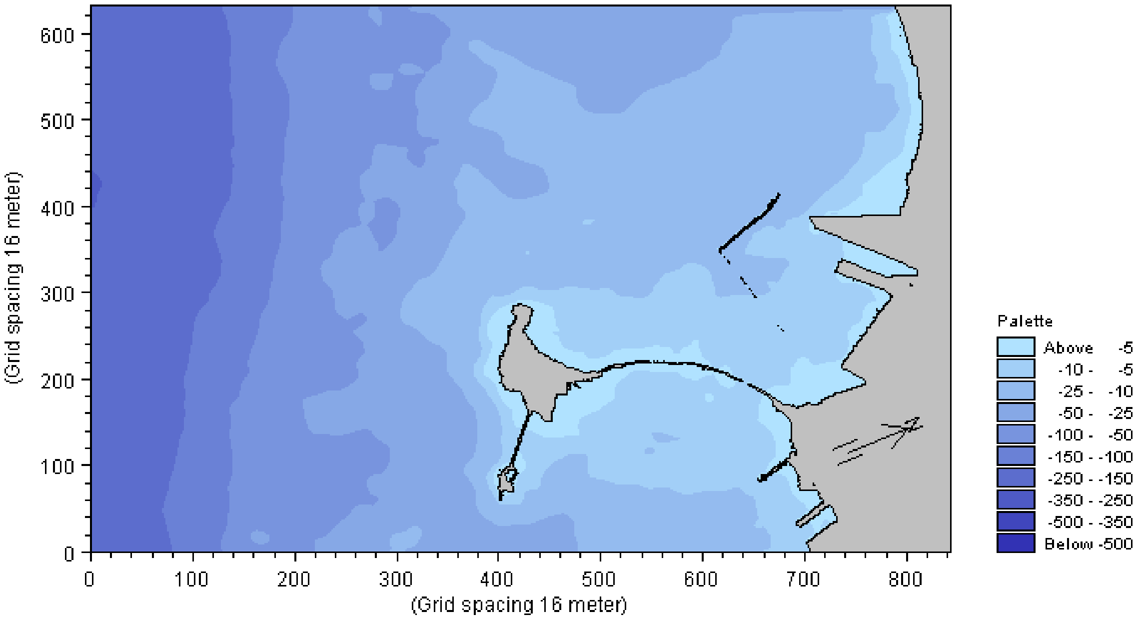


Figure 13. Grid 6. Knit 16 m. Orientation SSW-NNE

3.3.2.3. RESULTS OF PROPAGATION

The figures corresponding to simulations made using MIKE 21-PMS are stated in **Appendix I: “Surge propagation figures”**. Based on such tests we have obtained the table of propagated surge and the corresponding propagation coefficients.

The transformation experienced by surge propagated from deep waters up to the terminal, both in wave height and in incidence direction, is shown in the following table:

Dirección Aguas Profundas		**Terminal**	
SE	**135º**	0.278	**H** (m)
		164.17	**Dir**
		SSE	
SSE	**157.5º**	0.376	**H** (m)
		165.61	**Dir**
		SSE	
S	**180º**	0.481	**H** (m)
		169.34	**Dir**
		S	
SSW	**202.5º**	2.463	**H** (m)
		226.27	**Dir**
		SW	

Table 22. Surge transformation

The type of surge that in deep waters comes from the **SE** sector, experiences an important decrease in height. This is the direction experiencing in deep waters the highest wave height and top period, even if after propagation it reaches the terminal with heights lower than the rest of the sectors propagated due to the location of the terminal. This surge rolls S and reaches the terminal heading SSE.

Surge from the **SSE** appears at the terminal with a decrease in height lower than SE surge, so its propagation coefficients will be higher. The rolling experienced by this surge from deep waters up to the terminal is heading S and is very low, so it maintains its propagation direction.

Surge coming from the **S** experiences a smaller reduction of height than surge from the SSE. The change in direction of this surge in less energetic surge is made turning 10º E, and appears at the terminal heading S.

Lastly, surge coming from the **SSW** in deep waters is, obviously, the one experiencing the smallest change in height. This surge rolls W when approaching the area being studied and thus changes direction to the SW upon reaching the terminal.

3.3.2.4. PROPAGATION COEFFICIENTS

To analyse the transformation experienced by the wave height in propagation from deep waters up to the terminal, we will now show a summary table stating all the heights of propagated waves and the propagation coefficients obtained for tested surge.

Dirección Aguas Profundas	Ho (m)	Hp (m)	Kp	Tp (seg)
SE	9.45	0.278	0.0294	10.4
SSE	9.41	0.376	0.0399	10.4
S	5.18	0.481	0.0929	8.1
SSW	4.01	2.463	0.6142	7.3

Table 23. Propagation coefficients

The previous table shows that the maximum significant wave height in extreme regime obtained at the terminal is 2.46 m (from the SW) and corresponds to a height of 4.01 m and SSW direction in deep waters.

4. CHARACTERISATION OF WIND

4.1. DATA SOURCES

The data available to carry out the analysis of wind intensity in the area of the project have been obtained from the Meteo-Sea Study undertaken by MEDEA ENGINEERING S.A. for the “Progetto Preliminare Terminale di Ricezione e Rigassificazione Gas Naturale Liquefatto (GNL). Taranto” and other data on continuous wind registration and surge in deep waters that ALATEC requested from the U.K. METEOROLOGICAL OFFICE.

- **Data from the Meteo-Sea Study**

The Meteo-Sea Study of the “Progetto Preliminare Terminale di Ricezione e Rigassificazione Gas Naturale Liquefatto (GNL). Taranto” by MEDEA ENGINEERING S.A includes the following wind data:

-Annual and seasonal frequency of wind speed per directions, based on data obtained from the Metrological and Geophysical Observatory of Taranto.

-Annual frequency of wind at a 10m height per directions obtained from the data of the Meteorological Station of Taranto (1951-1977).

- **Data from the U.K. Meteorological Office**

In order to establish the features of the wind regimes at the area, data were requested from the U.K. METEOROLOGICAL OFFICE, which has provided ALATEC with a continuous registration of data on simultaneous wind and surge in deep waters throughout a period of four years. The “Global Wave Model” used by the UKMO represents the sea conditions based on atmospheric data (barometric chart), thus providing in a 60 km spacing grid data on wave height (sea and swell), as well as the origin direction. It was measured in 6-hour intervals until November 2002, when the intervals were reduced to 3 hours.

4.2. MEAN WIND REGIME

In order to characterise the mean wind regime, we have used as a source the data provided by the U.K. METEOROLOGICAL OFFICE to ALATEC. We are based then on a continuous registration (every 6 or 3 hours) of speed and direction of the wind throughout the last 4 years (from 2001 to 2004), which is a long enough period to characterise the mean climate.

The following figure shows the location of the point of measurement, whose geographical coordinates are: 40ºN, 17,54ºE.

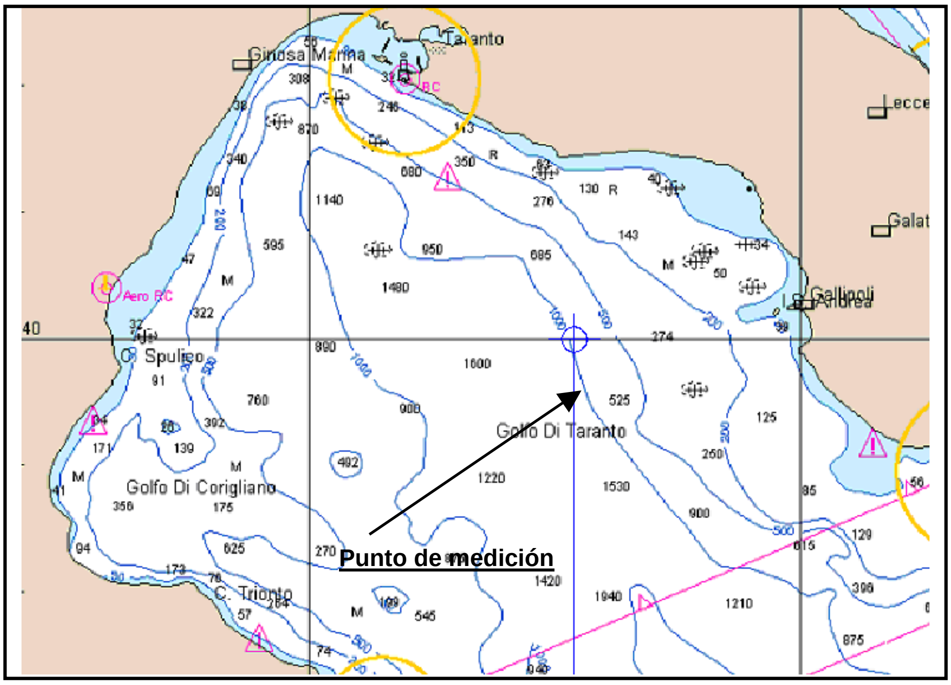


Figure 14. Location of the point of measurement

We are now going to present the tables showing the number of registries and the frequency, per wind speed and direction, obtained from the UKMO continuous registration.

DIRECCIÓN		**Vv** (m/seg)									**TOTAL**
		1	**3**	**5**	**7**	**9**	**11**	**13**	**15**	**17**	
N	**0º**	13	216	264	205	103	56	17	2	0	**876**
NNE	**22.5º**	19	158	144	77	58	21	3	0	0	**480**
NE	**45º**	16	141	129	49	21	6	0	0	0	**362**
ENE	**67.5º**	20	123	87	25	5	2	0	0	0	**262**
E	**90º**	13	108	45	17	8	1	0	0	0	**192**
ESE	**112.5º**	13	125	65	21	25	11	0	0	0	**260**
SE	**135º**	14	135	116	54	31	24	0	0	0	**374**
SSE	**157.5º**	15	155	199	114	112	71	11	3	0	**680**
S	**180º**	12	201	283	195	112	35	6	0	0	**844**
SSW	**202.5º**	14	149	232	170	46	5	3	0	0	**619**
SW	**225º**	15	129	221	138	44	6	2	0	0	**555**
WSW	**247.5º**	15	113	119	51	22	9	1	0	0	**330**
W	**270º**	15	117	79	34	11	0	0	0	0	**256**
WNW	**292.5º**	16	136	77	25	12	1	0	0	0	**267**
NW	**315º**	12	183	221	84	24	4	3	1	0	**532**
NNW	**337.5º**	20	227	366	225	76	28	13	0	1	**956**
TOTAL		**242**	**2416**	**2647**	**1484**	**710**	**280**	**59**	**6**	**1**	**7845**

Table 24. Number of registries per speed and direction

DIRECCIÓN		Vv (m/seg)									TOTAL
		1	3	5	7	9	11	13	15	17	
N	**0º**	0.166	2.753	3.365	2.613	1.313	0.714	0.217	0.025	0.000	**11.166**
NNE	**22.5º**	0.242	2.014	1.836	0.982	0.739	0.268	0.038	0.000	0.000	**6.119**
NE	**45º**	0.204	1.797	1.644	0.625	0.268	0.076	0.000	0.000	0.000	**4.614**
ENE	**67.5º**	0.255	1.568	1.109	0.319	0.064	0.025	0.000	0.000	0.000	**3.340**
E	**90º**	0.166	1.377	0.574	0.217	0.102	0.013	0.000	0.000	0.000	**2.447**
ESE	**112.5º**	0.166	1.593	0.829	0.268	0.319	0.140	0.000	0.000	0.000	**3.314**
SE	**135º**	0.178	1.721	1.479	0.688	0.395	0.306	0.000	0.000	0.000	**4.767**
SSE	**157.5º**	0.191	1.976	2.537	1.453	1.428	0.905	0.140	0.038	0.000	**8.668**
S	**180º**	0.153	2.562	3.607	2.486	1.428	0.446	0.076	0.000	0.000	**10.758**
SSW	**202.5º**	0.178	1.899	2.957	2.167	0.586	0.064	0.038	0.000	0.000	**7.890**
SW	**225º**	0.191	1.644	2.817	1.759	0.561	0.076	0.025	0.000	0.000	**7.075**
WSW	**247.5º**	0.191	1.440	1.517	0.650	0.280	0.115	0.013	0.000	0.000	**4.207**
W	**270º**	0.191	1.491	1.007	0.433	0.140	0.000	0.000	0.000	0.000	**3.263**
WNW	**292.5º**	0.204	1.734	0.982	0.319	0.153	0.013	0.000	0.000	0.000	**3.403**
NW	**315º**	0.153	2.333	2.817	1.071	0.306	0.051	0.038	0.013	0.000	**6.781**
NNW	**337.5º**	0.255	2.894	4.665	2.868	0.969	0.357	0.166	0.000	0.013	**12.186**
TOTAL		**3.085**	**30.797**	**33.741**	**18.917**	**9.050**	**3.569**	**0.752**	**0.076**	**0.013**	**100**

Table 25. Frequency per speed and direction

Based on the previous tables we have represented the wind compass card, which defines the mean wind climate at the point of measurement.

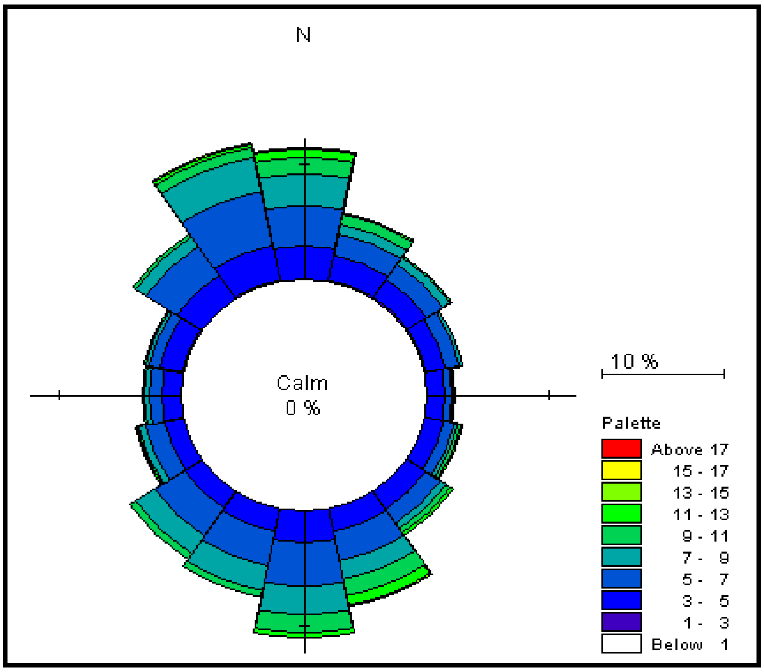


Figure 15. Wind compass card, UKMO point of measurement

As we can see in the table of frequency of presentation and the card, there is no predominant wind direction, although E and W winds are not very frequent. Regarding wind speed, we can see that 65% of the time it is in a 1 to 5 m/sec. interval.

The following table presents a summary of the mean wind directivity regime, expressed in the non-excedence percentage over 1.

DIRECCIÓN		**Vv** (m/seg)								
		1	**3**	**5**	**7**	**9**	**11**	**13**	**15**	**17**
N	**0º**	0.0017	0.0292	0.0628	0.0890	0.1021	0.1092	0.1114	0.1117	0.1117
NNE	**22.5º**	0.0024	0.0226	0.0409	0.0507	0.0581	0.0608	0.0612	0.0612	0.0612
NE	**45º**	0.0020	0.0200	0.0365	0.0427	0.0454	0.0461	0.0461	0.0461	0.0461
ENE	**67.5º**	0.0025	0.0182	0.0293	0.0325	0.0331	0.0334	0.0334	0.0334	0.0334
E	**90º**	0.0017	0.0154	0.0212	0.0233	0.0243	0.0245	0.0245	0.0245	0.0245
ESE	**112.5º**	0.0017	0.0176	0.0259	0.0286	0.0317	0.0331	0.0331	0.0331	0.0331
SE	**135º**	0.0018	0.0190	0.0338	0.0407	0.0446	0.0477	0.0477	0.0477	0.0477
SSE	**157.5º**	0.0019	0.0217	0.0470	0.0616	0.0758	0.0849	0.0863	0.0867	0.0867
S	**180º**	0.0015	0.0272	0.0632	0.0881	0.1024	0.1068	0.1076	0.1076	0.1076
SSW	**202.5º**	0.0018	0.0208	0.0504	0.0720	0.0779	0.0785	0.0789	0.0789	0.0789
SW	**225º**	0.0019	0.0184	0.0465	0.0641	0.0697	0.0705	0.0707	0.0707	0.0707
WSW	**247.5º**	0.0019	0.0163	0.0315	0.0380	0.0408	0.0419	0.0421	0.0421	0.0421
W	**270º**	0.0019	0.0168	0.0269	0.0312	0.0326	0.0326	0.0326	0.0326	0.0326
WNW	**292.5º**	0.0020	0.0194	0.0292	0.0324	0.0339	0.0340	0.0340	0.0340	0.0340
NW	**315º**	0.0015	0.0249	0.0530	0.0637	0.0668	0.0673	0.0677	0.0678	0.0678
NNW	**337.5º**	0.0025	0.0315	0.0781	0.1068	0.1165	0.1201	0.1217	0.1217	0.1219
TOTAL		**0.031**	**0.339**	**0.676**	**0.865**	**0.956**	**0.992**	**0.999**	**1.000**	**1.000**

Table 26. Mean Directivity Regime of Wind in deep waters

From the previous table we can make a graphical representation of the mean scalar regime of wind speed as it is shown in the following graph:

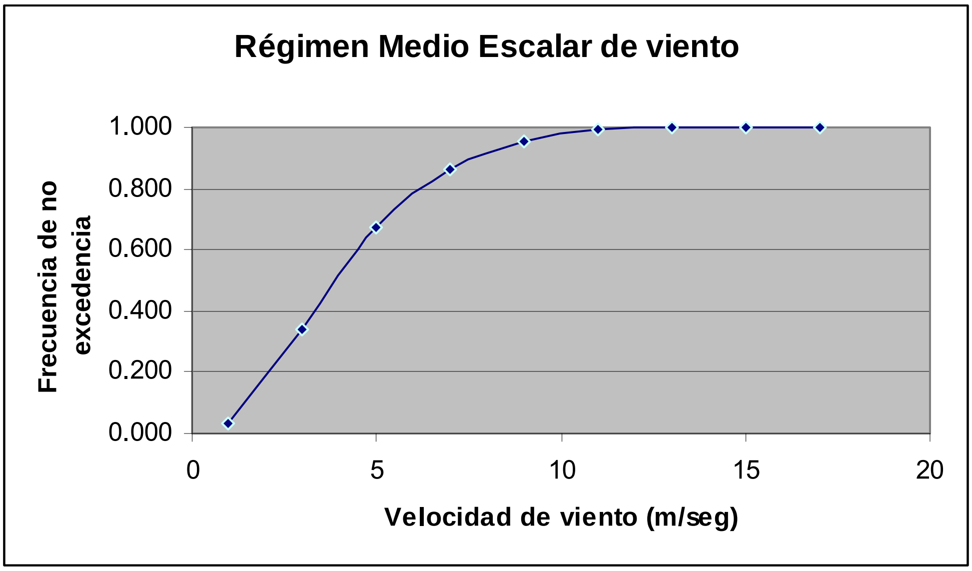


Figure 16. Mean Scalar Wind Regime at the UKMO point of measurement.

4.3. EXTREME WIND REGIME

4.3.1. SCALAR REGIME

In order to determine the extreme scalar regime of wind speed, we have used the Extreme Value Method based on continuous wind data obtained from the UKMO, as we did earlier to determine the extreme scalar regime of wave height.

We can focus on the modelling of extreme or maximum values of a certain variable from different points of view. The method used here is known as POT (peak over threshold) or Method of Relative Maximum Values, whose basic ideas and principles are stated next, in order to enable the interpretation of the results obtained.

This method is based on extracting from the registered time series those individual storms, which are not interdependent due to proximity in time, surpassing a significant wave height in the time peak, and uses as a sample the series of values reached by the significant wave height in the peak of each selected time period. The starting off point of the extreme model used consists of a time period stating the evolution of the wind speed that is significant throughout time, and from which we can select the relative maximum values or peaks surpassing a certain risk limit or limit speed (V_c.)

However, to make this analysis valid we need an additional condition: the peaks must be far enough from each other so as to guarantee their independence. In other words, out of all the peaks surpassing the V_c level we must only choose those that are, on one hand, the highest of their period, and, on the other, are far enough from each other so as to be considered independent. The minimum time lapse between periods to consider them independent varies from one series to another and depends on the average duration of the weather conditions that usually lead to extreme wind.

The group of maximum relative values surpassing a certain limit and forming a sample of independent values will be known as extreme values or extreme population.

Once a group of extreme values has been chosen, the next step is to adjust such values to a probability distribution function. Such distribution, represented by F_e (x/H_c), will result in the probability rate that an independent peak surpassing the H_c level to reach an equal or lower magnitude than x, so F_e (x/H_c) represents a conditioned probability.

Based on practical situations we have observed that the extreme values of the wind series adjust quite well (through the method of the square minimums) to the Weibull triparametric distribution, used to establish the theoretical frequencies assigned to each of the data belonging to the extreme sample of the Gringorten formulation.

The Weibull triparametric distribution function is expressed as follows:

$$F_e(x) = 1 - \exp\left(-\left(\frac{x-\alpha}{\beta}\right)^{\gamma}\right)$$

Parameters α, β and γ are respectively known as the centering, scale and form parameters.

Based on this distribution using the previously defined extreme simple (P'), the annual probability of an V_i value of non-excedence is obtained using the following expression:

$$P(V \leq Vi) = 1 - \lambda\left[1 - P'(V \leq Vi)\right]$$

Where λ is the mean number of storms a year.

Therefore, the return period in years will be:

$$T(Hi) = \frac{1}{\lambda\left[1 - P'(V \leq Vi)\right]}$$

In this particular case we have defined 9.5 m/sec. as the speed limit wind value, thus obtaining an extreme sample comprising 72 independent values, which correspond to the maximum wind speeds for each storm. Those storms more than 12 hours apart have been considered as independent storms.

Using the previously described extreme simple, we have adjusted it to a Weibull triparametric distribution function, resulting in the following centering, scale and form parameters:

α= 9.853

β= 1.61

γ= 0.866

Based on such aspects, the extreme wind speed for the return period defined in the Annex “Calculation and Design Basis” (475 years) is 23.82 m/sec. for the central dead reckoning.

Provided that the data used are obtained from a registration measurement that is too short to obtain an extreme regime (4 years), we believe it is advisable to consider the extreme wind speed associated to the confidence interval of 95%, thus obtaining a wind speed of 24.94 m/sec. for the return period of 475 years.

4.3.2. DIRECTIVITY REGIME

In order to determine the extreme direction regime of the wind, it is defined based on the extreme scalar regime, by multiplying the wind speed corresponding to the defined return period by a Kα directivity coefficient, which is different for each direction.

The Kα coefficients corresponding to each direction are established based on the approximate relation between the extreme wind speeds in the directions or directivity sectors where they may appear. For each direction, the Kα coefficient is defined as the quotient of the wind speed associated to that direction and the maximum wind speed. Therefore, coefficient 1 is assigned to the direction showing the highest associated speed.

Provided that most of the available information deals with the intermediate climate, $K\alpha$ values will be defined based on mean wind speed direction regimes, in accordance with 2 procedures:

Method 1: Based on this mean wind speed regime resulting from the adjustment of the data in the intermediate-high area (or upper end) of the initial sample, each direction is associated to the mean value of wave height with annual exceeding values between 1% and 0.1% (probability 0.99 and 0.999 of the regime) in each one of the annual mean regimes corresponding to each directivity sector.

Method 2: Based on the wind Speed/Direction table, each direction is associated to the mean wind speeds which have exceeded from 5% to 0.5% the number of times the corresponding sector has been observed.

Provided that the values obtained in both approaches show similar results, we have used a value of $K\alpha$ that is considerably similar to the mean value of the coefficients obtained through both of the previously described methods.

Hence, we can consider the extreme scalar regime as associated to the strictest direction/s ($K\alpha = 1$), resulting in a wind speed associated to a return period corresponding to other directions, by multiplying the wind speed corresponding to such return period provided by the extreme scalar regime by the corresponding directivity coefficient.

DIRECCIÓN		**Método 1**				**Método 2**				**$K\alpha$ medio**
		Velocidad asociada a excedencia de		**Vv media**	**$K\alpha_1$**	**Velocidad asociada a excedencia de**		**Vv media**	**$K\alpha 2$**	
		1.00%	**0.10%**			**5.00%**	**0.50%**			
		0.99	**0.999**			**0.95**	**0.995**			
N	**0.0**	10.93	13.02	11.98	0.95	9.08	11.62	10.35	0.96	**0.96**
NNE	**22.5**	9.78	11.87	10.82	0.86	7.96	10.46	9.21	0.85	**0.86**
NE	**45.0**	8.16	9.81	8.99	0.72	6.72	8.70	7.71	0.72	**0.72**
ENE	**67.5**	7.48	9.15	8.31	0.66	6.04	8.02	7.03	0.65	**0.66**
E	**90.0**	7.47	9.12	8.30	0.66	6.05	8.01	7.03	0.65	**0.66**
ESE	**112.5**	8.62	10.50	9.56	0.76	6.99	9.23	8.11	0.75	**0.76**
SE	**135.0**	9.02	10.86	9.94	0.79	7.41	9.62	8.52	0.79	**0.79**
SSE	**157.5**	11.41	13.72	12.57	1.00	9.38	12.16	10.77	1.00	**1.00**
S	**180.0**	9.79	11.51	10.65	0.85	8.25	10.35	9.30	0.86	**0.86**
SSW	**202.5**	9.22	10.91	10.06	0.80	7.71	9.77	8.74	0.81	**0.81**
SW	**225.0**	9.22	10.96	10.09	0.80	7.68	9.79	8.73	0.81	**0.81**
WSW	**247.5**	0.47	0.58	0.53	0.04	0.39	0.51	0.45	0.04	**0.04**
W	**270.0**	6.92	8.27	7.60	0.60	5.73	7.36	6.55	0.61	**0.61**
WNW	**292.5**	7.50	9.09	8.30	0.66	6.12	8.02	7.07	0.66	**0.66**
NW	**315.0**	9.56	11.48	10.52	0.84	7.87	10.18	9.03	0.84	**0.84**
NNW	**337.5**	10.85	13.06	11.95	0.95	8.92	11.57	10.24	0.95	**0.95**

Table 27. Directivity coefficients

Where the maximum wind speed for a return period of 475 years of 24.94 m/sec., as mentioned in the previous sections, the maximum directivity wind speeds associated to that return period will be obtained by multiplying that maximum speed by the directivity coefficients shown in the previous table.

DIRECCIÓN		Kα	$V_{v,10\ mín}$ (m/seg)
N	**0.0**	0.96	23.86
NNE	**22.5**	0.86	21.40
NE	**45.0**	0.72	17.84
ENE	**67.5**	0.66	16.39
E	**90.0**	0.66	16.37
ESE	**112.5**	0.76	18.87
SE	**135.0**	0.79	19.72
SSE	**157.5**	1.00	24.94
S	**180.0**	0.86	21.33
SSW	**202.5**	0.81	20.10
SW	**225.0**	0.81	20.12
WSW	**247.5**	0.04	1.04
W	**270.0**	0.61	15.11
WNW	**292.5**	0.66	16.42
NW	**315.0**	0.84	20.88
NNW	**337.5**	0.95	23.72

Table 28. Speed of the extreme directivity wind, T=475 years

According to this table, the maximum value of extreme wind is for section SE, where it reaches 24.94 m/sec.

5. CURRENTS

In accordance with the information included in the Meteo-Sea Study made by MEDEA ENGINEERING S.A. for the “Progetto Preliminare Terminale di Ricezione e Rigassificazione Gas Naturale Liquefatto (GNL). Taranto” regarding the currents expected at the site, we may only expect superficial current speeds of a certain relevance in those associated with strong S, N and NE winds. These winds generally produce in the area under study currents heading E and SE with magnitudes between 0.05 and 0.20 m/s.

The following figures, which have been taken from the previously mentioned study, show the meteorological current in the different seasons.

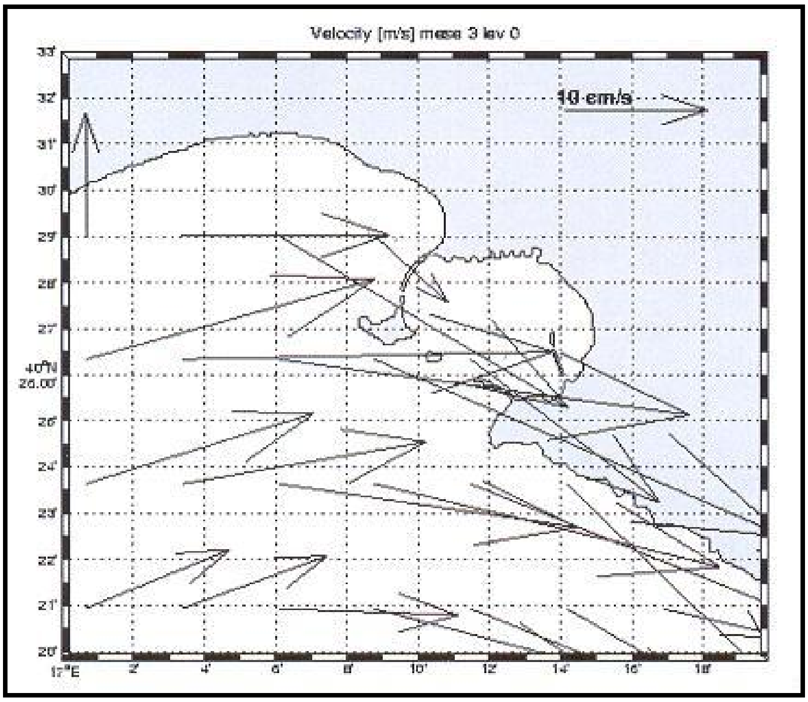


Figure 17. Superficial meteorological current for March

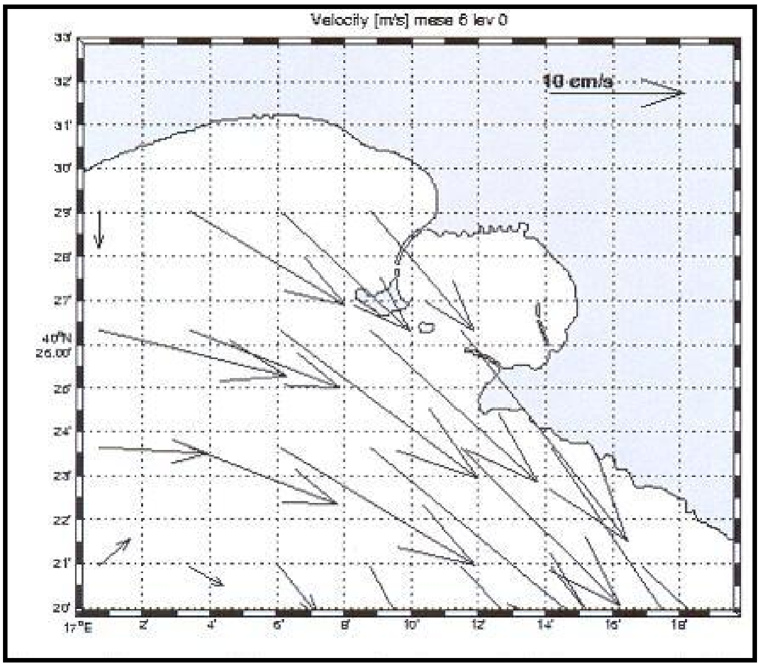


Figure 18. Superficial meteorological current for June

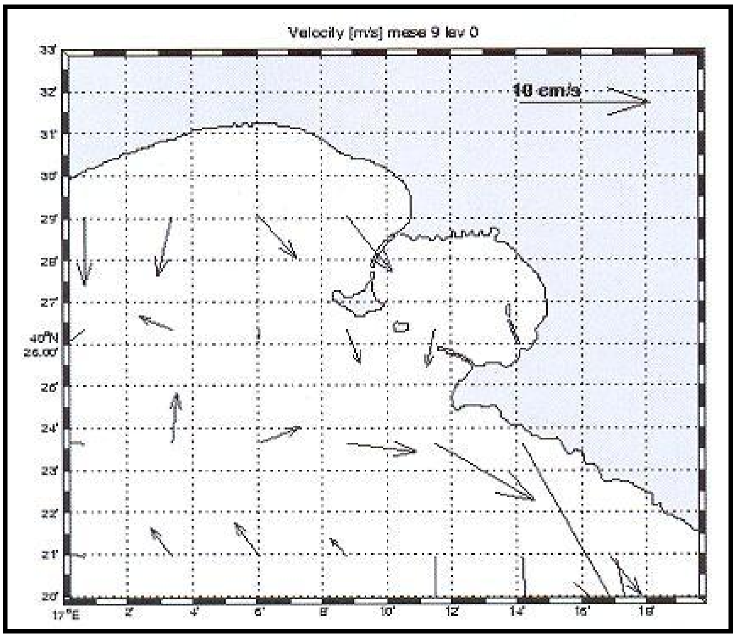


Figure 19. Superficial meteorological current for September

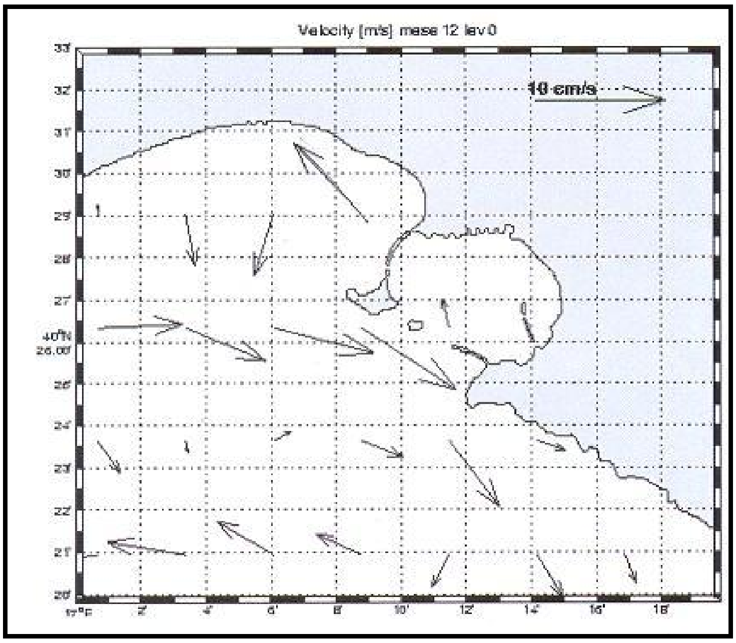


Figure 20. Superficial meteorological current for December

In the Meteo – Sea study we have obtained the current speed profiles for two points near the site of the terminal. Maximum and minimum values of the current in the whole depth of the profile for points 1 and 2 located in that area (as shown in the following figure), are stated in the following tables:

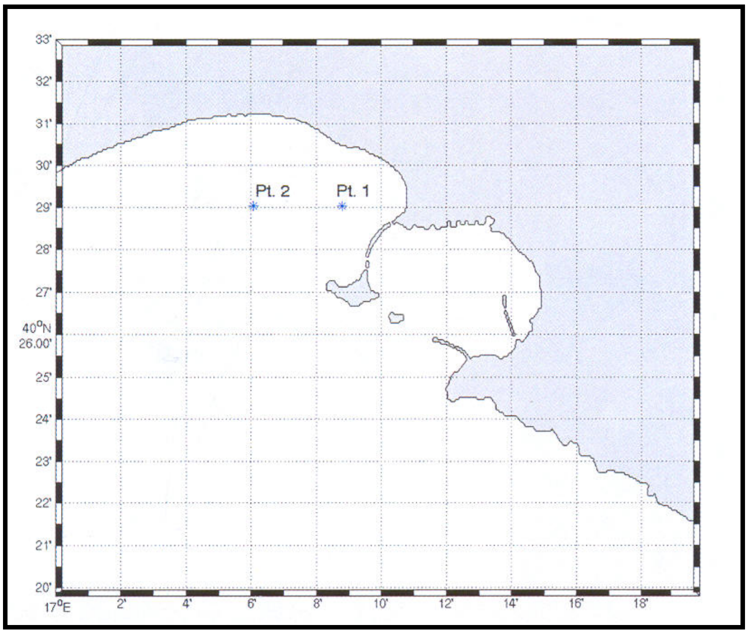


Figure 21. Points of measurement of the profile of current speeds.

Temperatura (ºC)		**Salinidad** (psu)		**Velocidad de Corriente** (cm/seg)	
Min	Máx	Mín	Máx	Mín	Máx
14	23	38.17	38.6	0.8	20

Table 29. Maximum and minimum values of current speed at Point 1

Temperatura (ºC)		**Salinidad** (psu)		**Velocidad de Corriente** (cm/seg)	
Min	Máx	Mín	Máx	Mín	Máx
14	22	38.15	38.58	0.3	24

Table 30. Maximum and minimum values of current speed at Point 2

6. FOG

Information available regarding foggy days when visibility is below 100 m is not at the Port of Taranto but in nearby areas, although according to data on the Port of Taranto, S and E winds bring fog to the port.

To obtain the number of foggy days at the Gulf of Taranto we have determined the mean value of foggy days corresponding to places nearby Taranto.

The present statistical study covers a period of 20 years (1980 to 1999) and shows the number of foggy days for each season, stating the maximum value in the year when they happened. A “foggy day” is “any day when, at a longer or shorter period of the day, visibility is reduced by over 1 Km”.

Stazione	Media	Max	Anno
Bari	3.5	8	1990
Brindisi	15.2	30	1990
S.M.Leuca	10.6	17	1995
ºPotenza	11.7	16	1990/91
Crotone	8.9	20	1986
Valor medio aplicable a Taranto	10	16	

Table 31. Number of foggy days, period 1980-1999

In accordance with the mean number of foggy days for Taranto, there are approximately 10 days a year when visibility is below 1000 m at the site. This represents a gross annual 2%. Bearing in mind a mean persistence of fog of 50% during daytime the mean percentage of daytime when visibility is below 1000 m would be an annual 1.0%. The maximum number of foggy days expected is 16, which means, applying the percentage of persistence during daytime, a 4.5% percentage.

7. TIDES

The maximum values of the sea level are the result of the combination of astronomical tide and the variation of the climate conditions.

Astronomical tide in Taranto is semi-daily (12h 20min. period) with two high tides and two low tides a day and various amplitudes. The maximum positive and negative unevenness has been proved during the sizygy stage, reaching a value of 0.13 m and -0.11 in relation to the mean sea level (amplitude tidal range:24cm).

The difference in level due to atmospheric pressure variation is estimated between +0.33 m and -0.27 m in relation to the mean sea level.

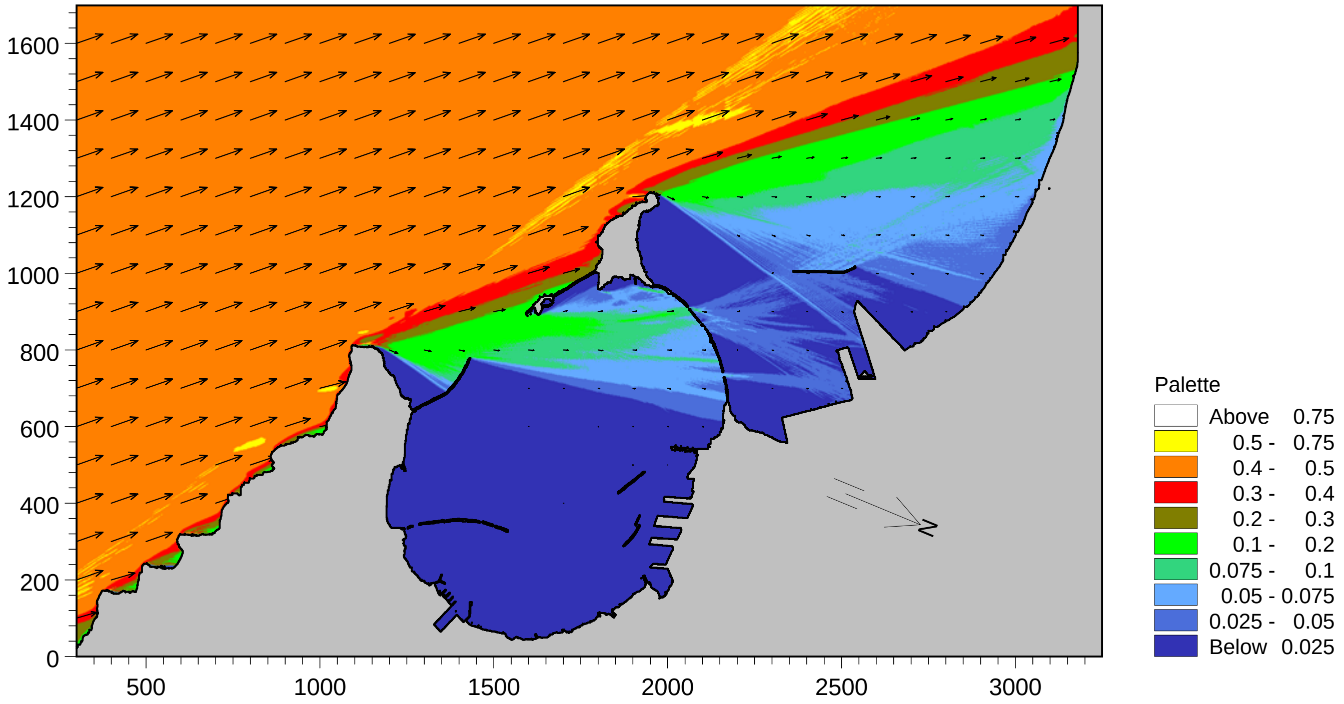
The contribution of wind to the elevation of the level is ± 0,04. Therefore, there are certain expected maximum increases and decreases of +0,50 and -0,42 m respectively in relation to the mean sea level, with a maximum amplitude of level variation of 0.92 m

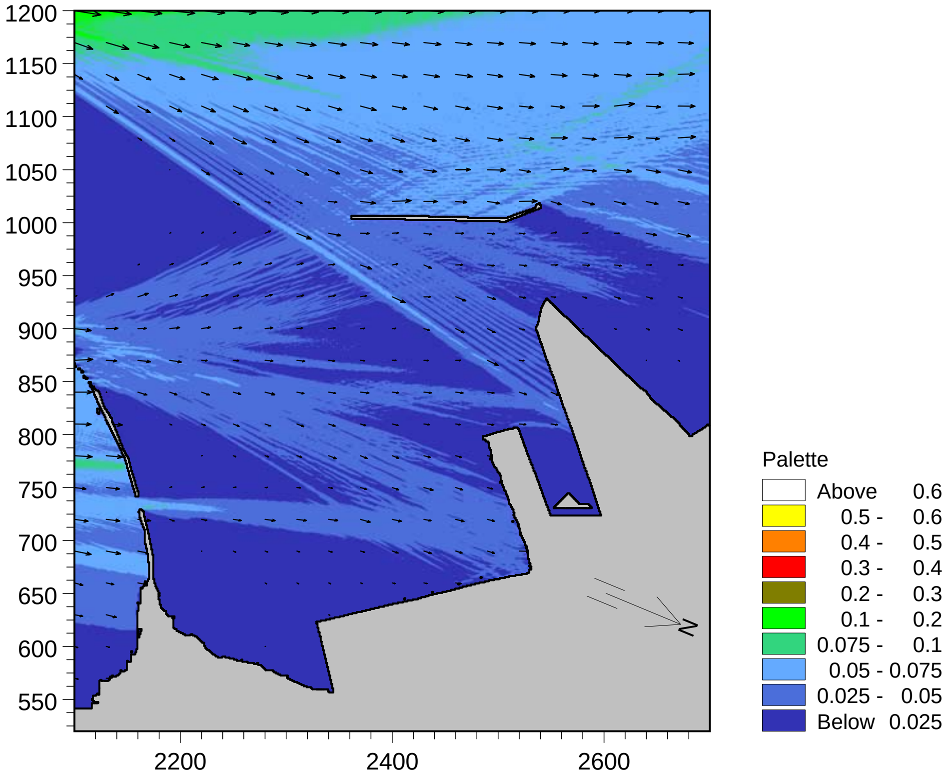
The mean sea level in Taranto is 0.25 cm below IGM=0.

APPENDIX 1: FIGURES OF SURGE PROPAGATION

alatec
ingenieros consultores
y arquitectos

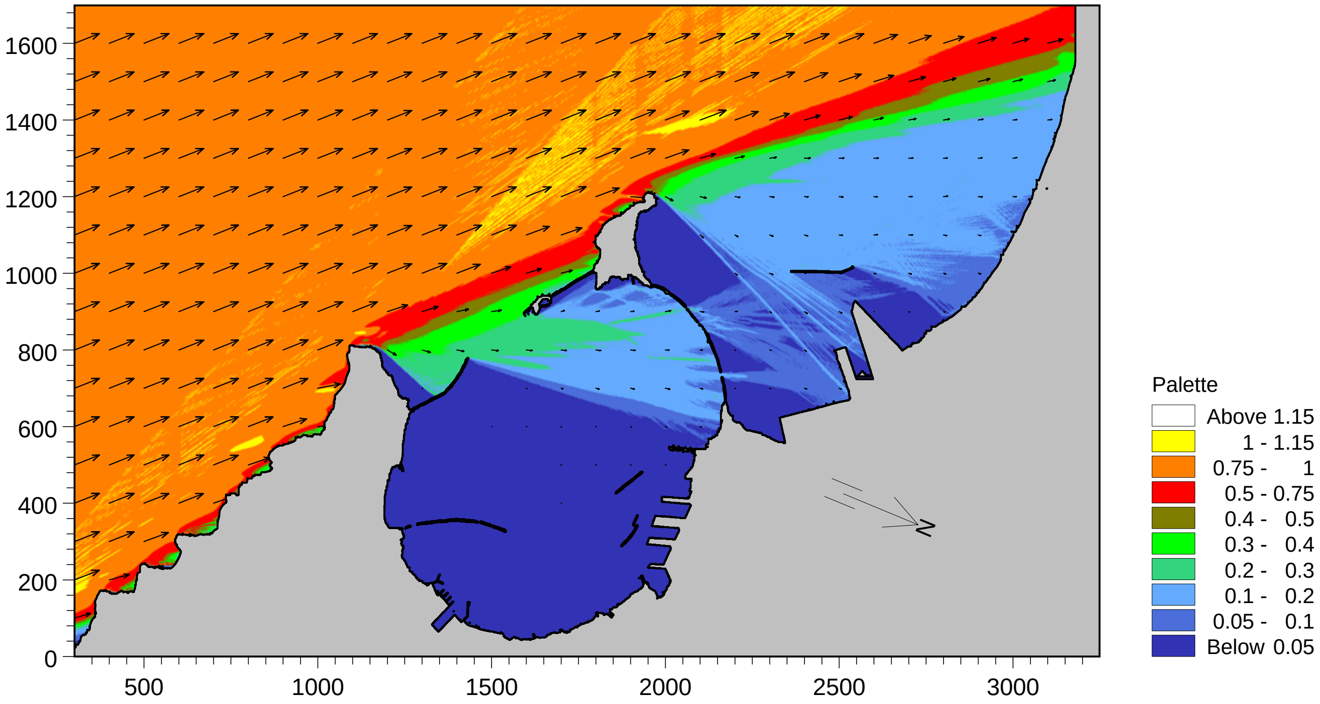
Client: GAS NATURAL			MIKEZero
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SE, Hs= 0,5m, Tp= 3,5s	Drawing no. 1
	Init:		

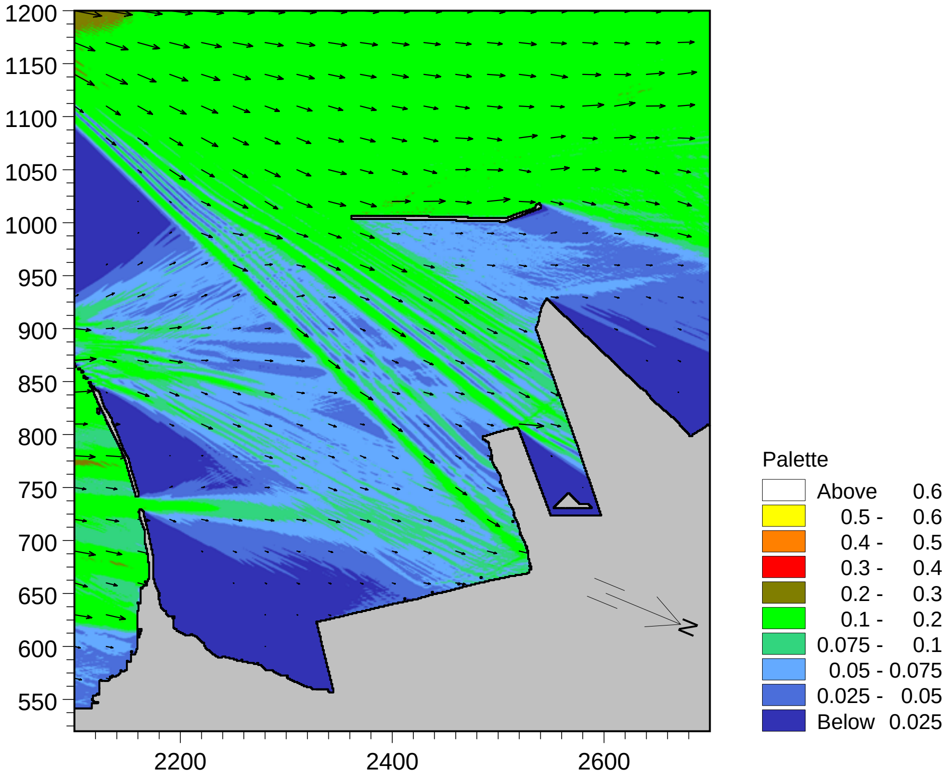




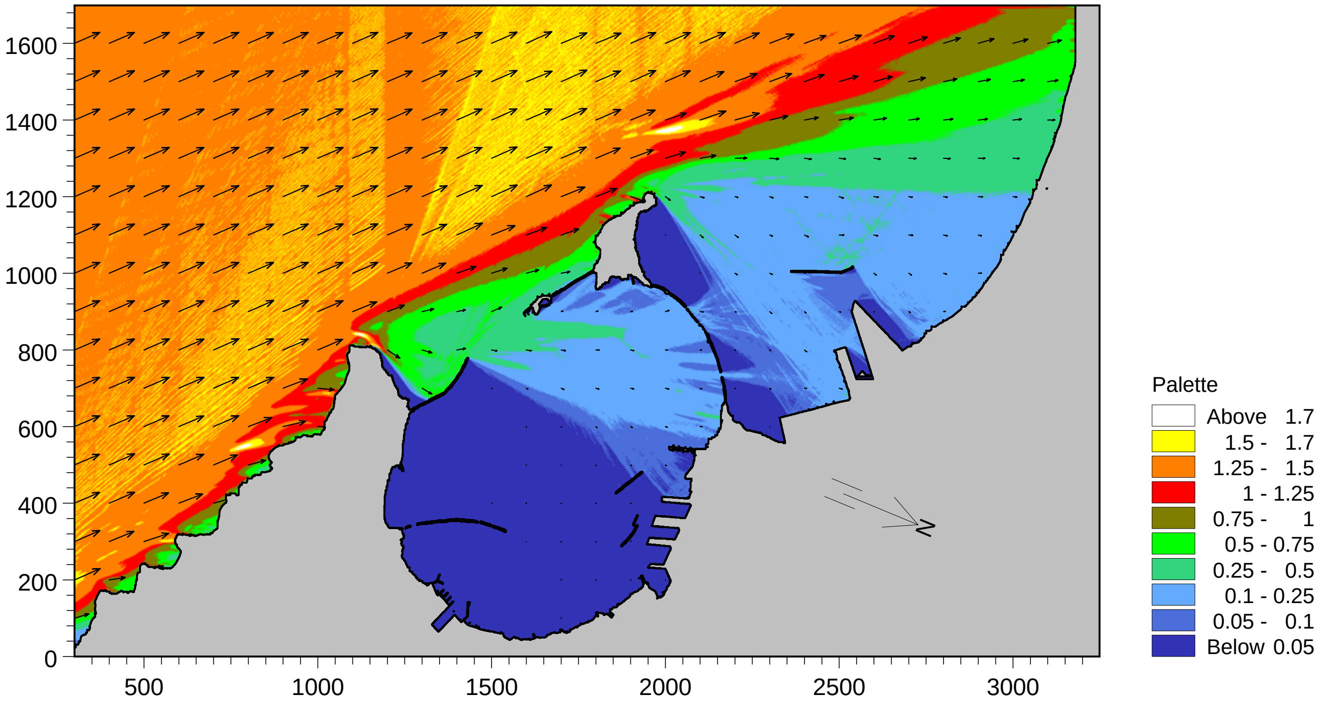
alatec
ingenieros consultores
y arquitectos

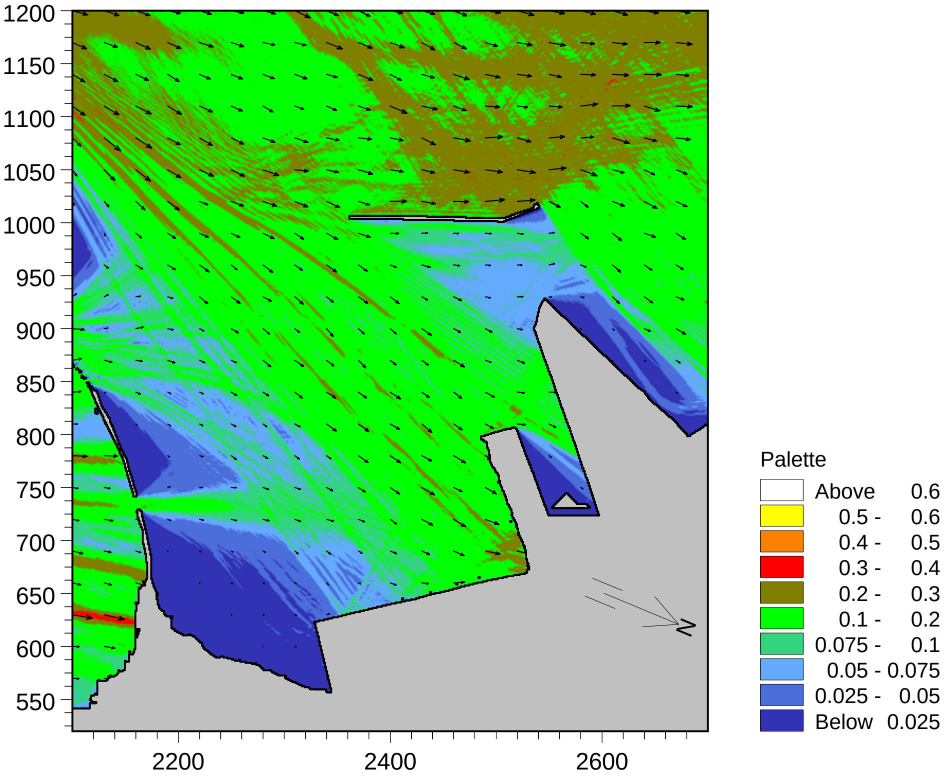
Client: GAS NATURAL			
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SE, Hs= 1m, Tp= 4s	Drawing no. 2
	Init:		





alatec ingenieros consultores y arquitectos	Client: GAS NATURAL Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)		MIKEZero
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SE, Hs= 1,5m, Tp= 5s	Drawing no. 3
	Init:		





alatec
ingenieros consultores
y arquitectos

Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

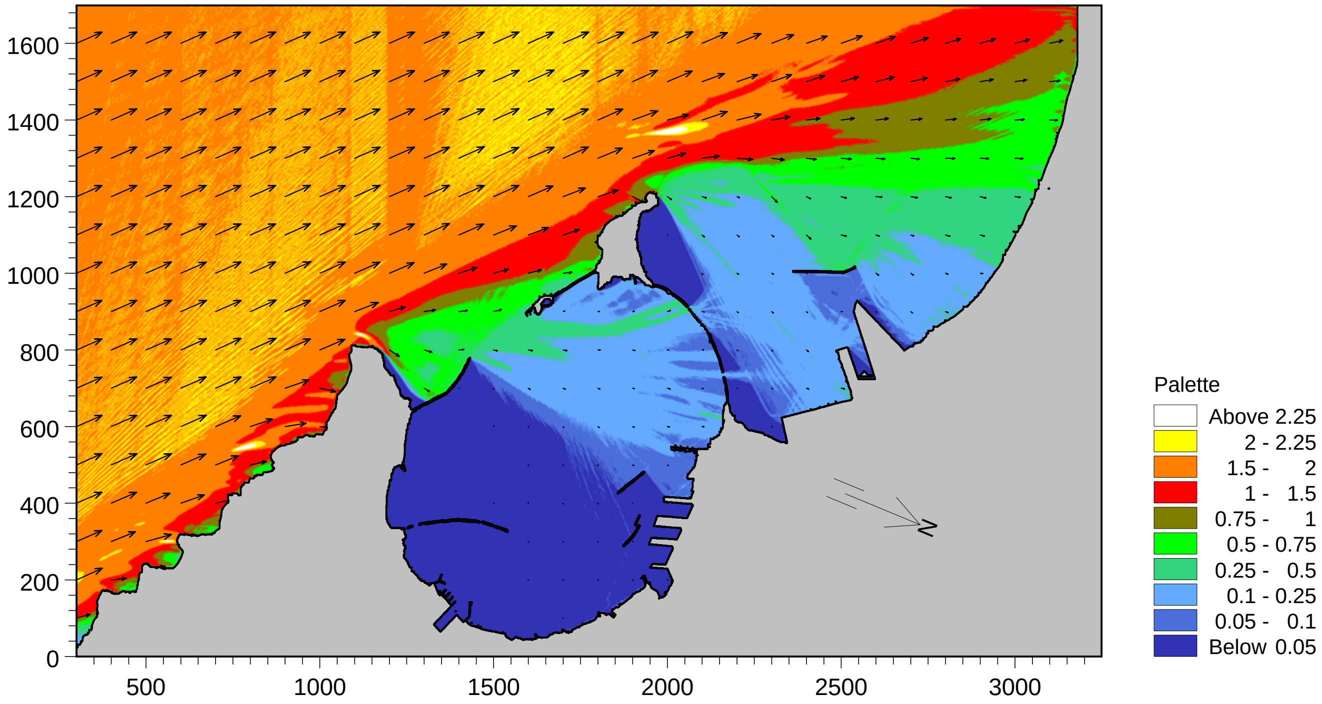
NIVEL MEDIO

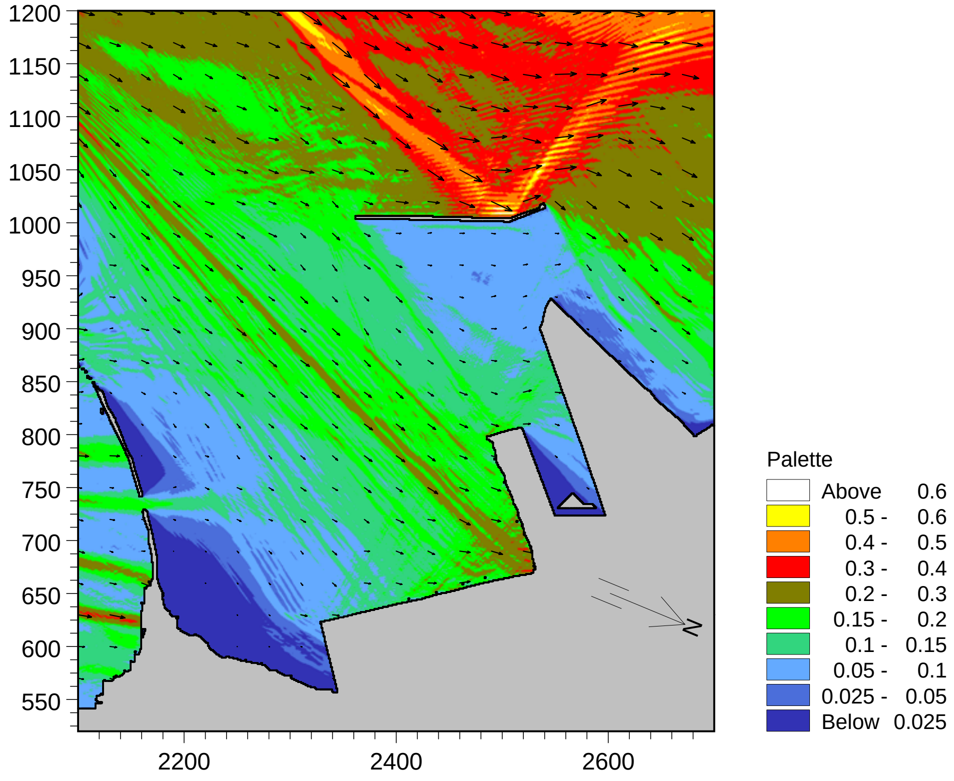
Date:
Enero 2005

Init:

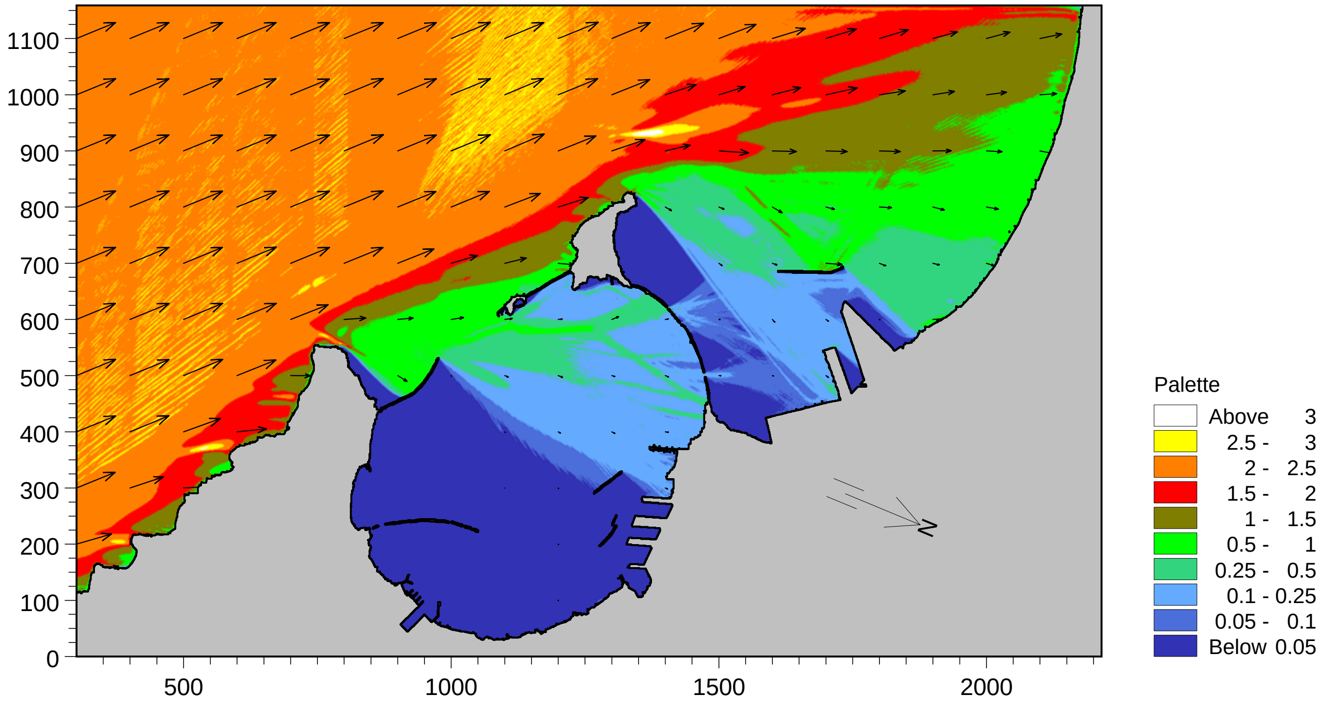
PROPAGACION
SE, Hs= 2m, Tp= 5,5s

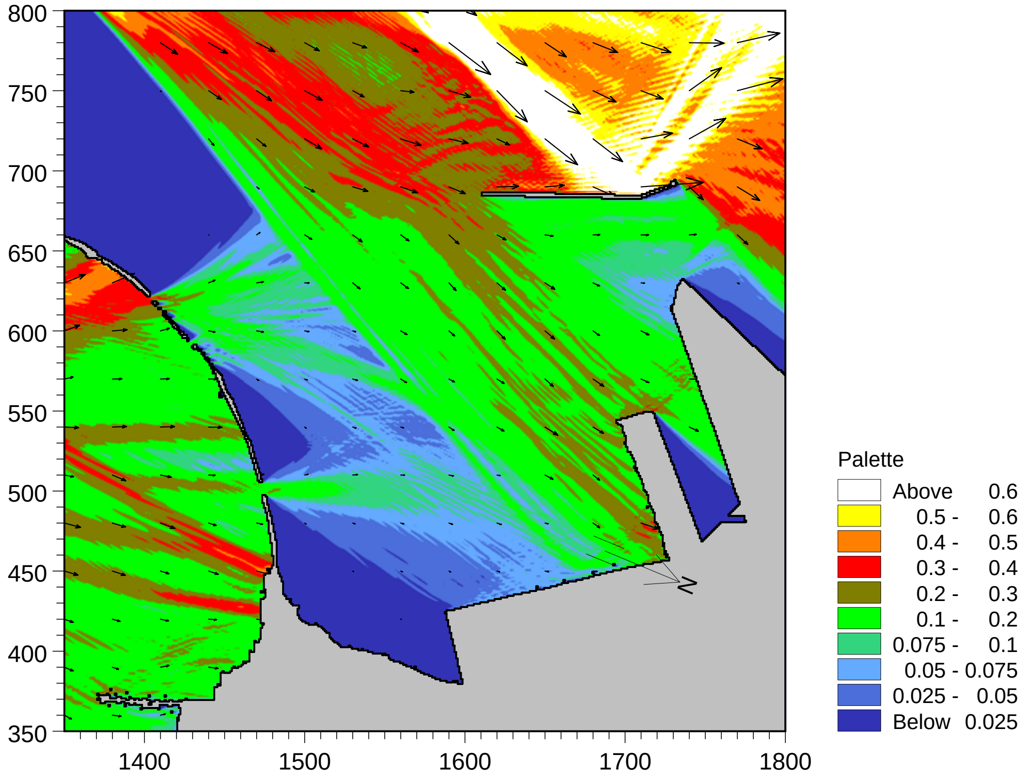
Drawing no.
4





alatec ingenieros consultores y arquitectos		Client: GAS NATURAL Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)	MIKEZero
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SE, Hs= 2,5m, Tp= 6s	Drawing no. 5
	Init:		





alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL

Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

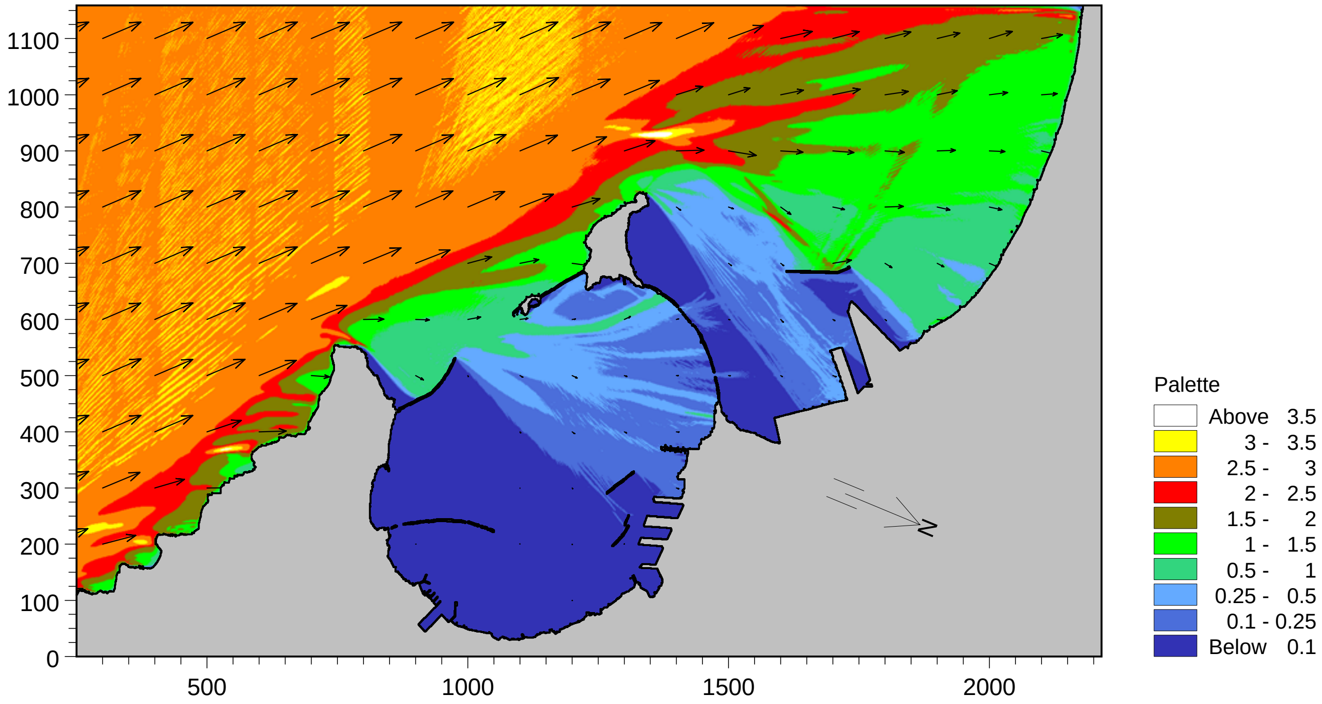
NIVEL MEDIO

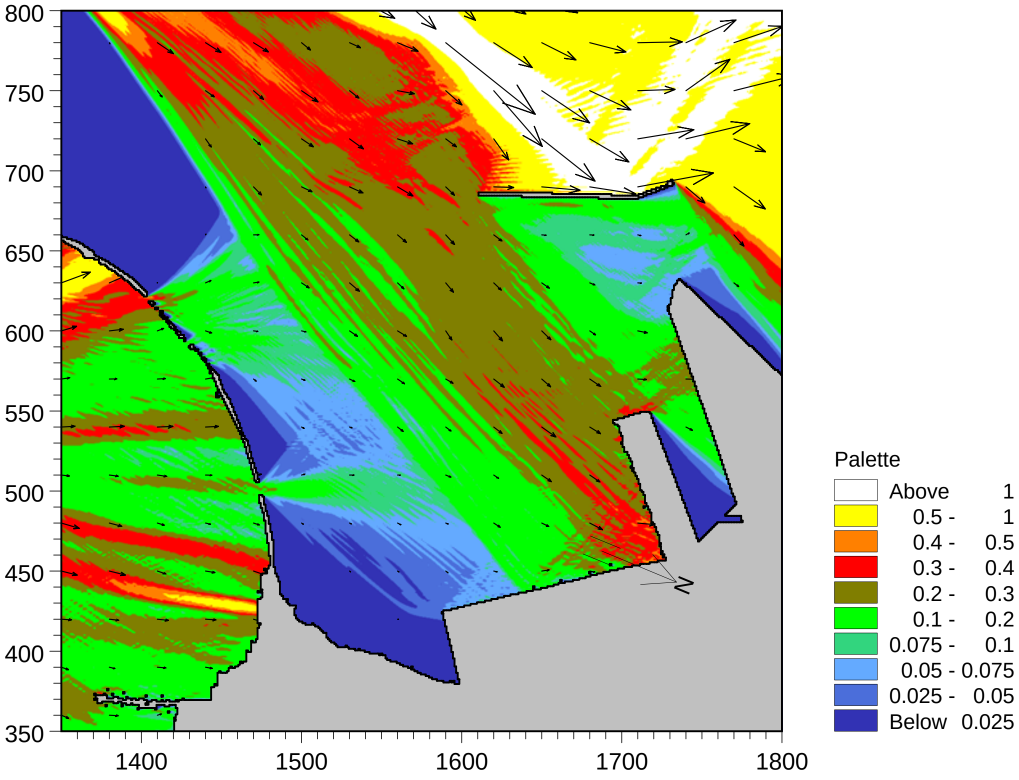
Date: Enero 2005

Init:

PROPAGACION
SE, Hs= 3m, Tp= 6,5s

Drawing no. 6





alatec ingenieros consultores y arquitectos

Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

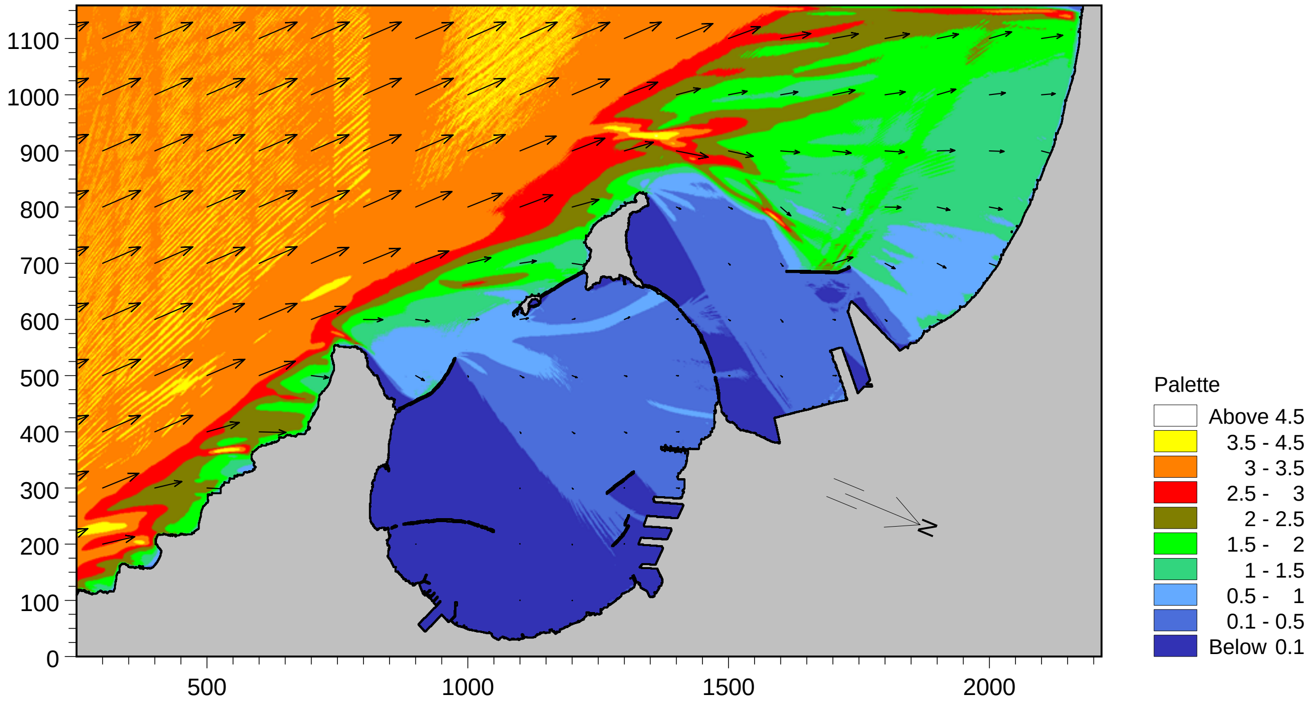
NIVEL MEDIO

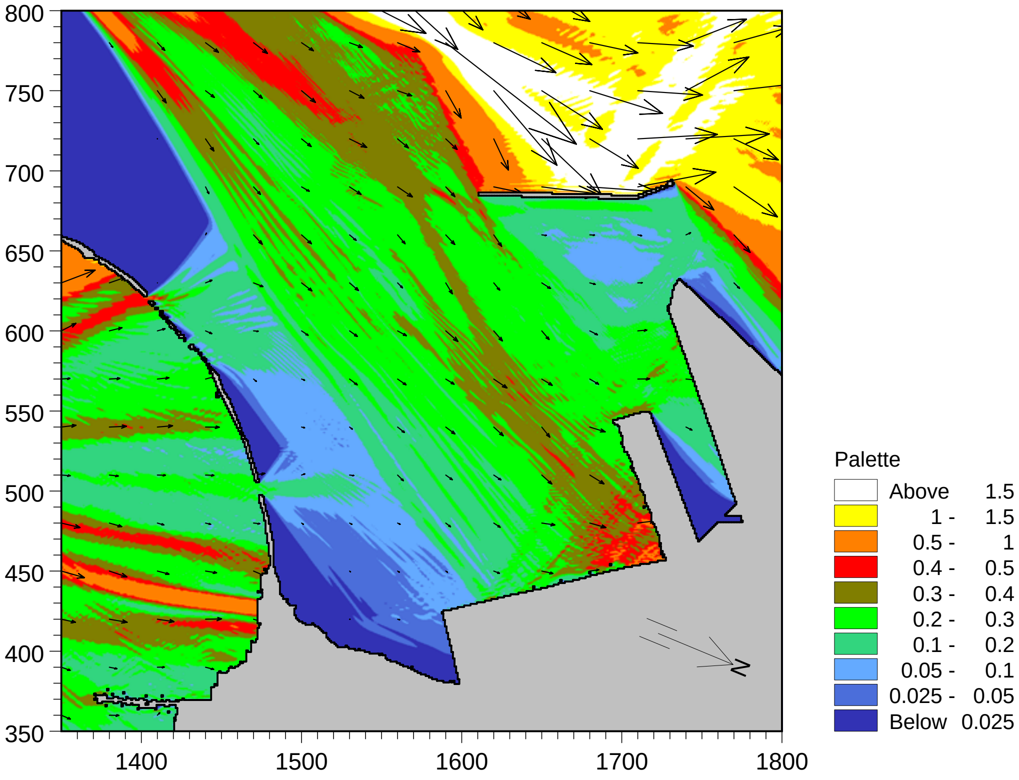
Date:
Enero 2005

Init:

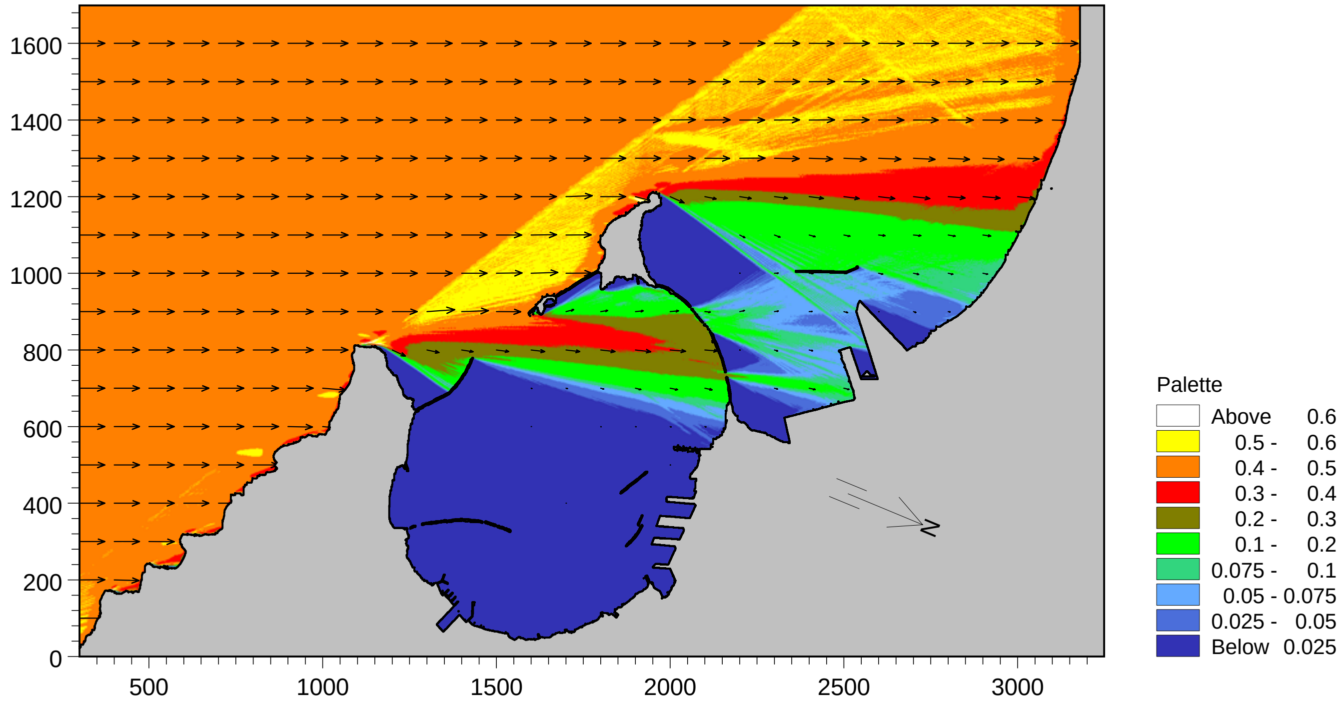
PROPAGACION
SE, Hs= 3,5m, Tp= 7s

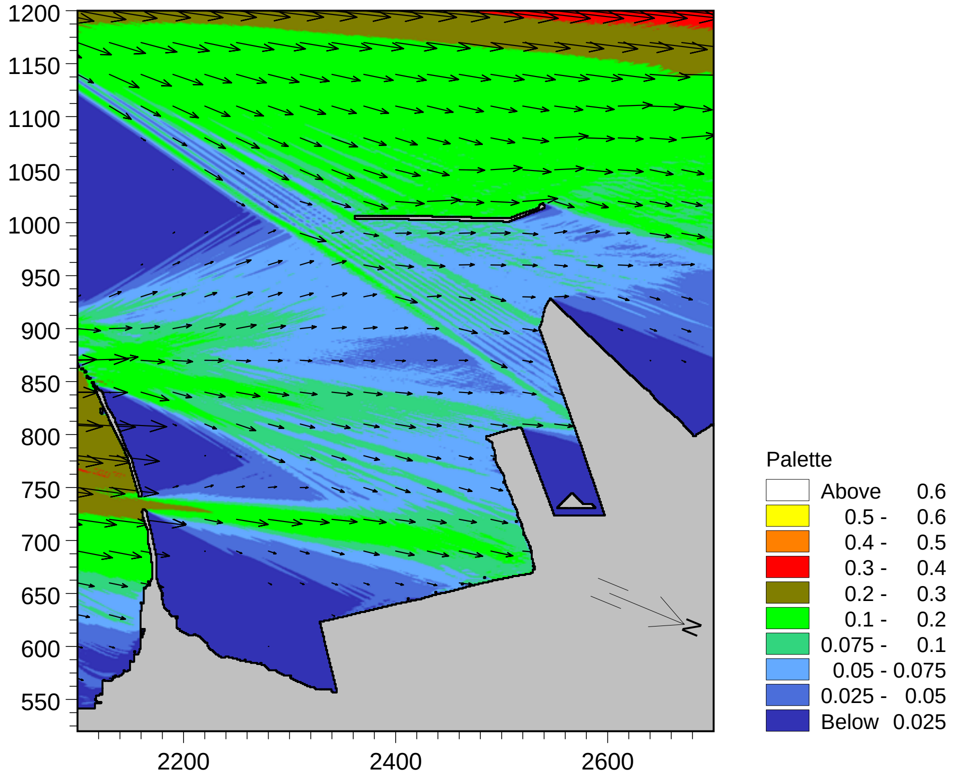
Drawing no.
7





alatec ingenieros consultores y arquitectos		Client: GAS NATURAL Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)	MIKEZero
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSE, Hs= 0.5m, Tp= 3,5s	Drawing no. 8
	Init:		





alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL

Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

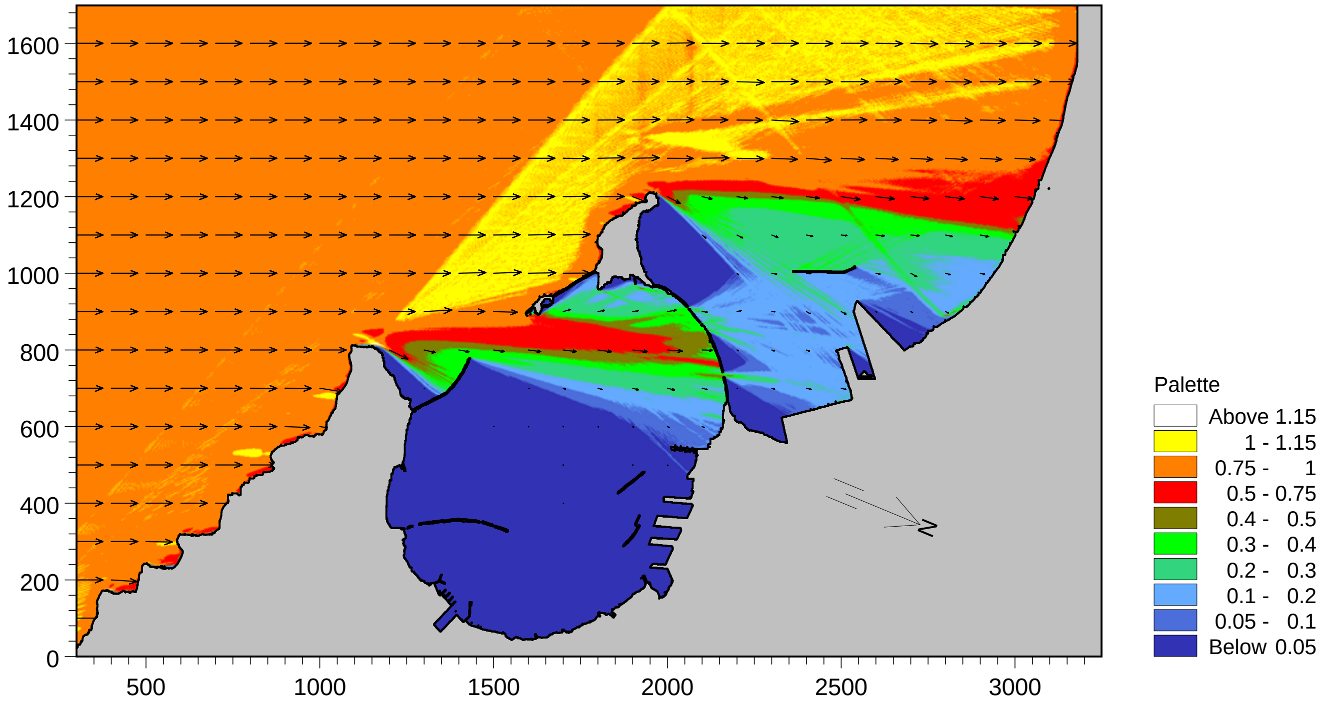
NIVEL MEDIO

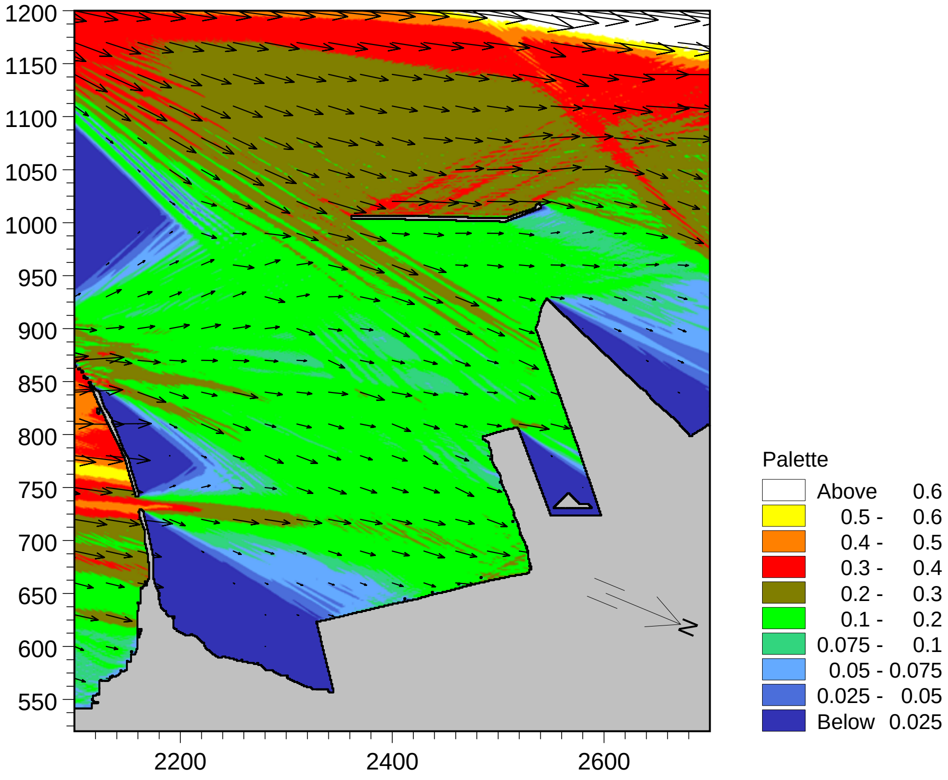
Date: Enero 2005

Init:

PROPAGACION
SSE, Hs= 1m, Tp= 4s

Drawing no. 9

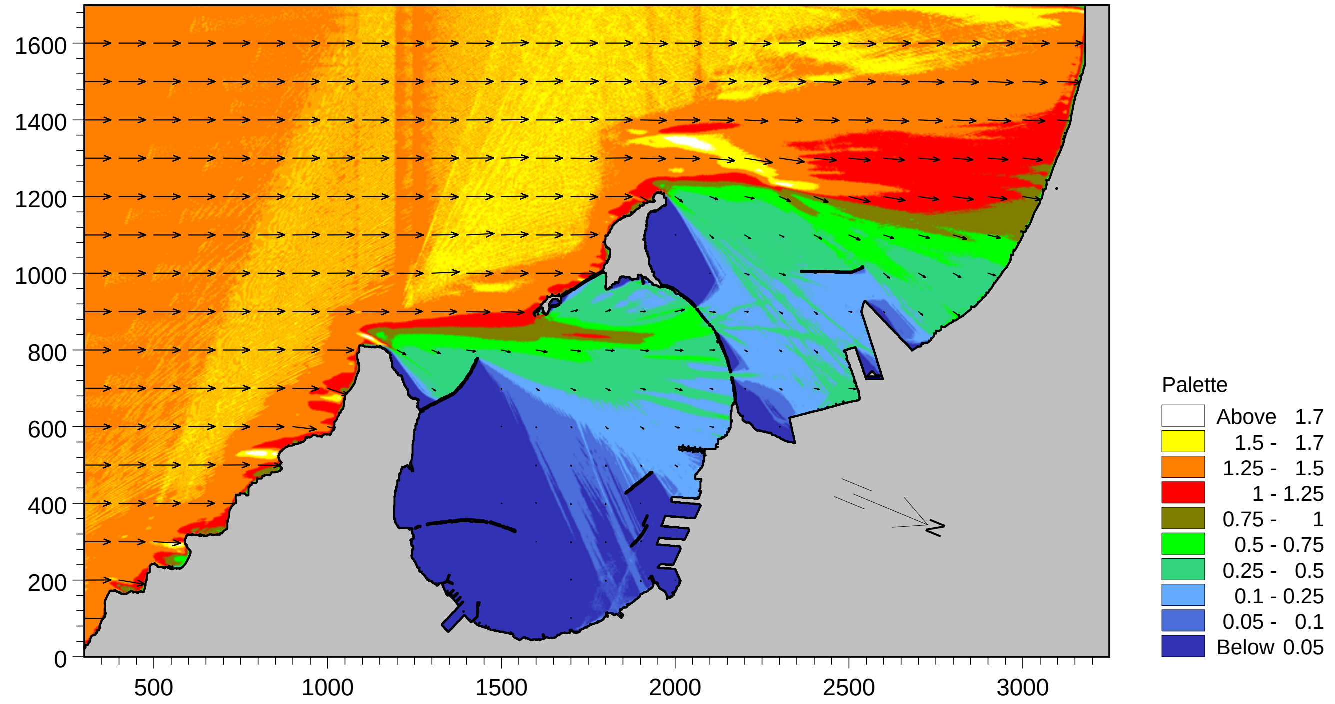


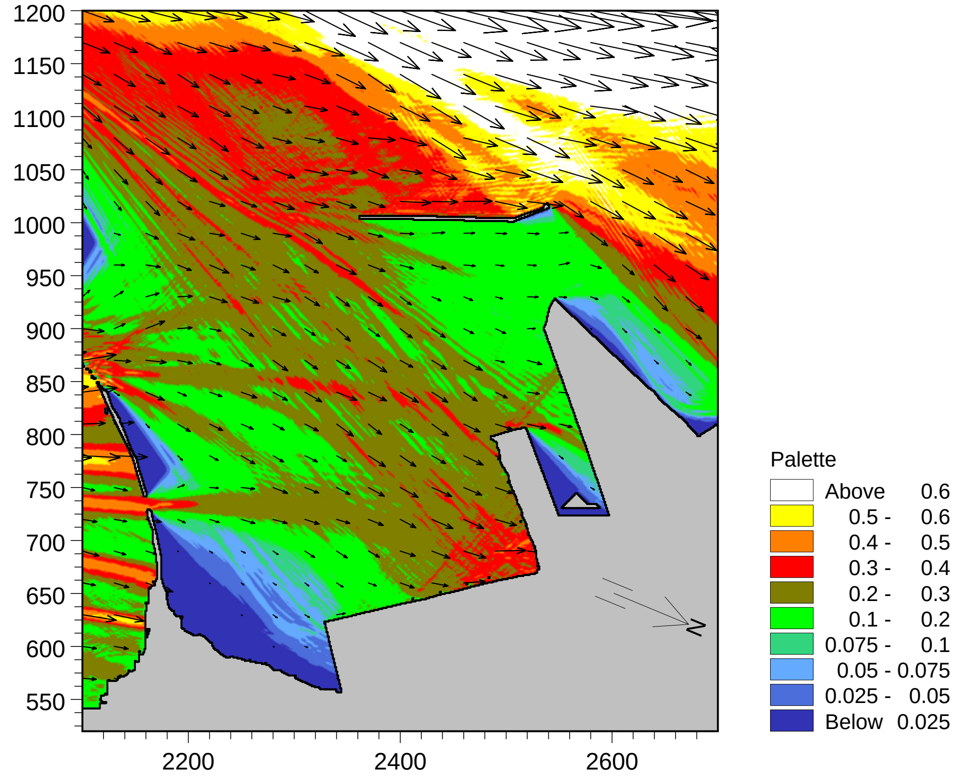


alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL			
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSE, Hs= 1,5m, Tp= 5s	Drawing no. 10
	Init:		

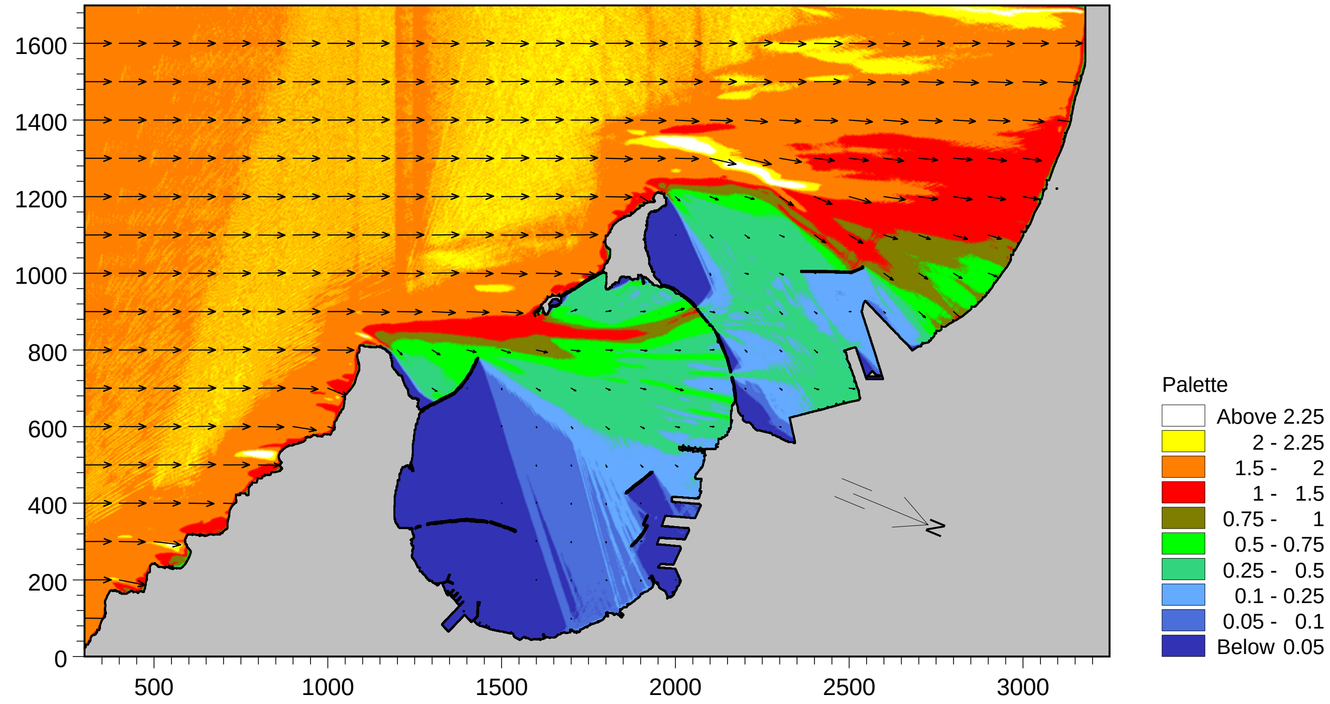
MIKEZero

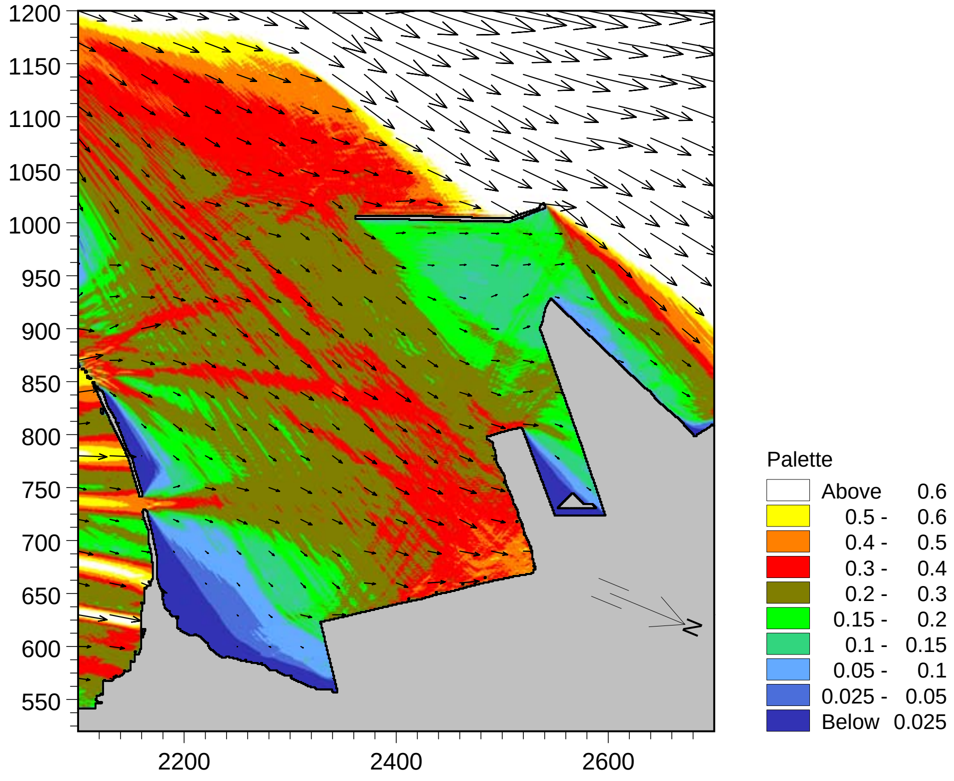




alatec
ingenieros consultores
y arquitectos

	Client: GAS NATURAL		
	Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)		MIKEZero
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSE, Hs= 2m, Tp= 5,5s	Drawing no. 11
	Init:		





alatec
ingenieros consultores
y arquitectos

Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

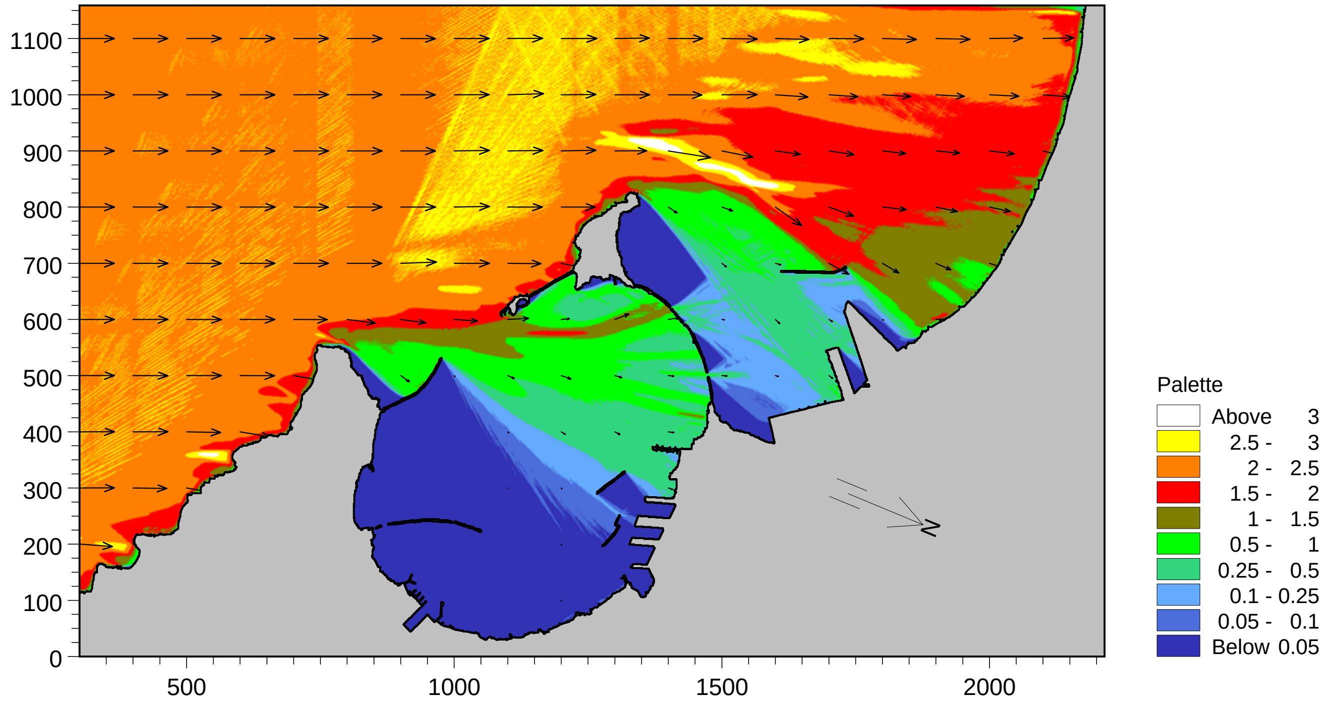
NIVEL MEDIO

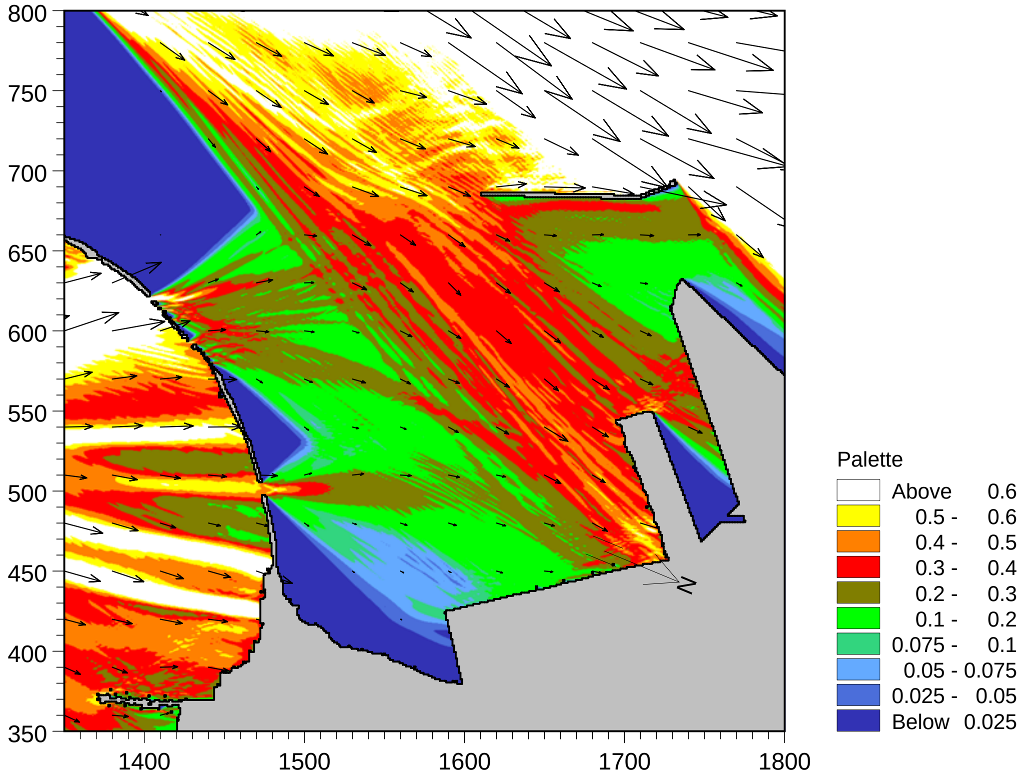
Date:
Enero 2005

Init:

PROPAGACION
SSE, Hs= 2,5m, Tp= 6s

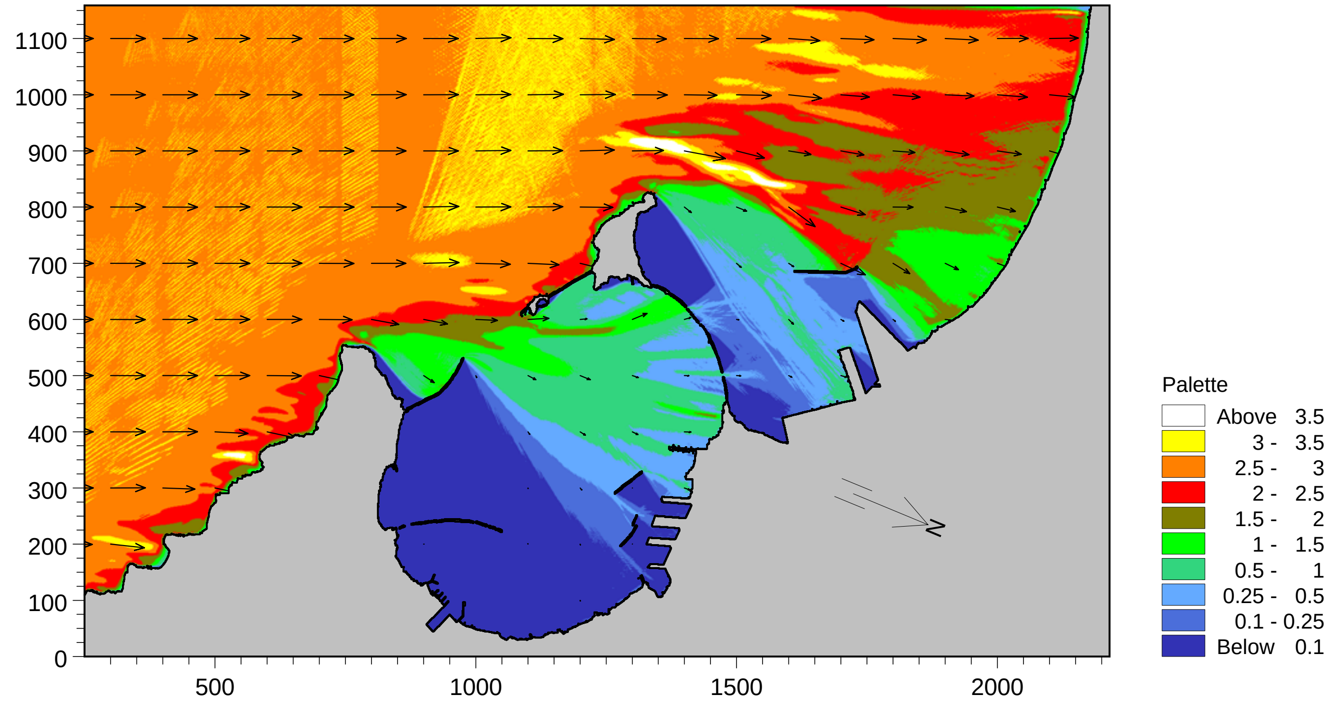
Drawing no.
12

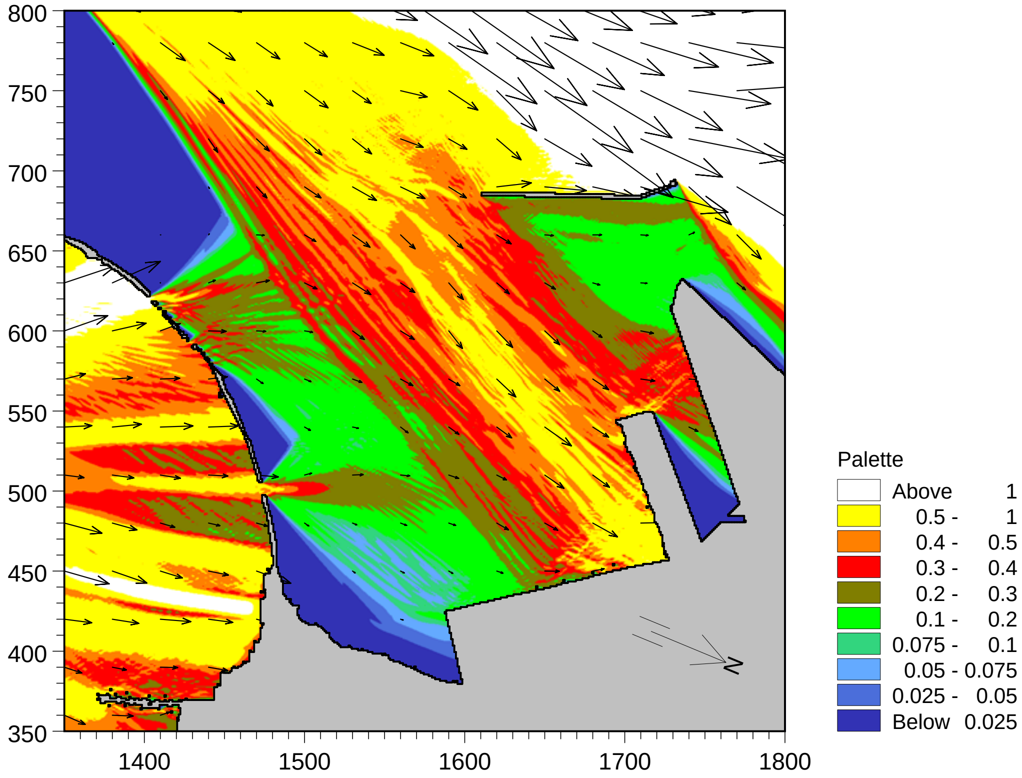




alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL			
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSE, Hs= 3m, Tp= 6,5s	Drawing no. 13
	Init:		

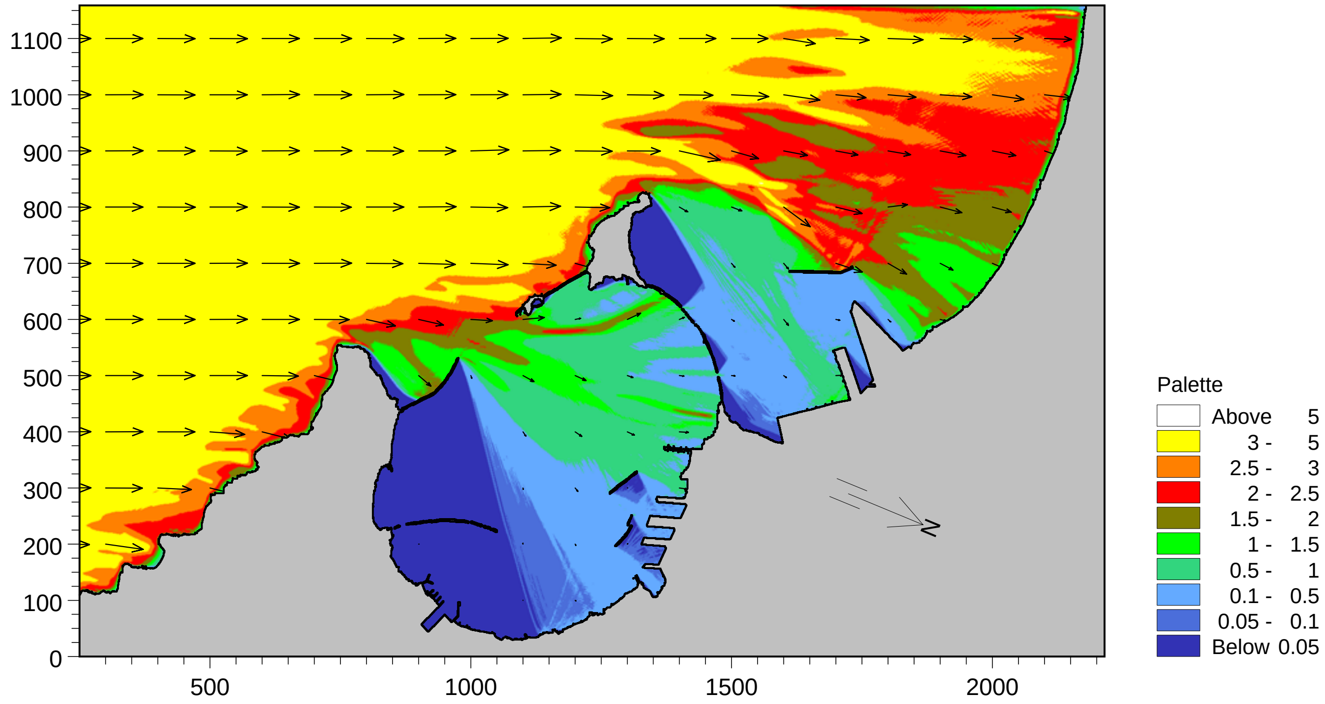


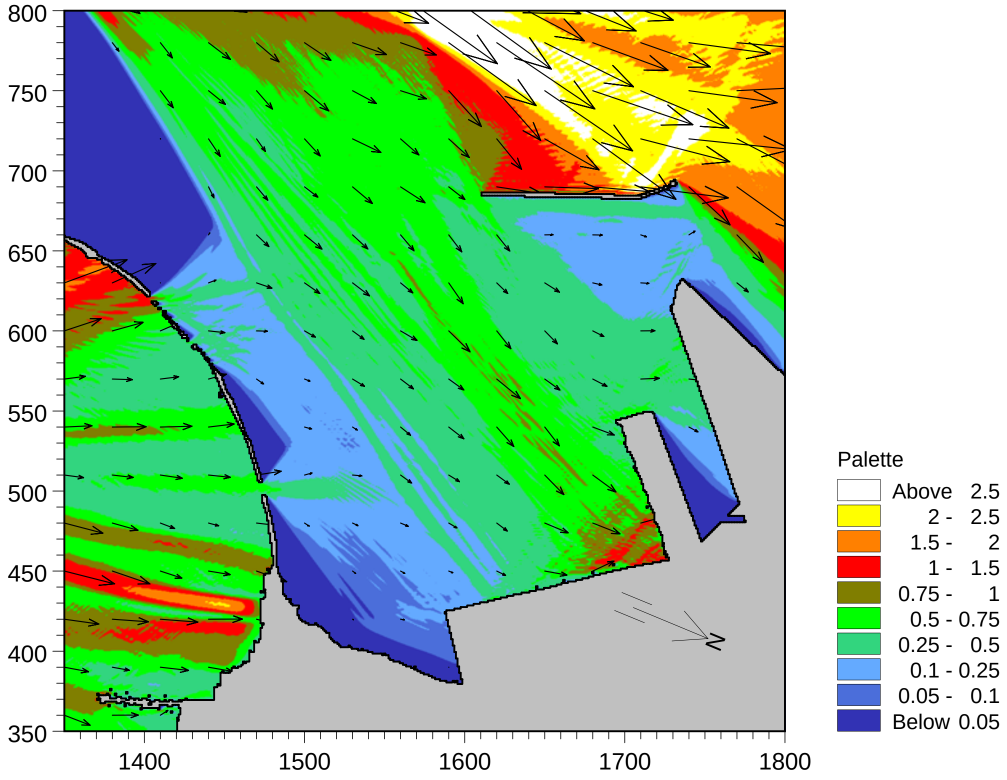


alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)
MIKEZero

NIVEL MEDIO
Date: Enero 2005
Init:
PROPAGACION
SSE, Hs= 3,5m, Tp= 7s
Drawing no. 14





alatec
ingenieros consultores
y arquitectos

Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKE Zero

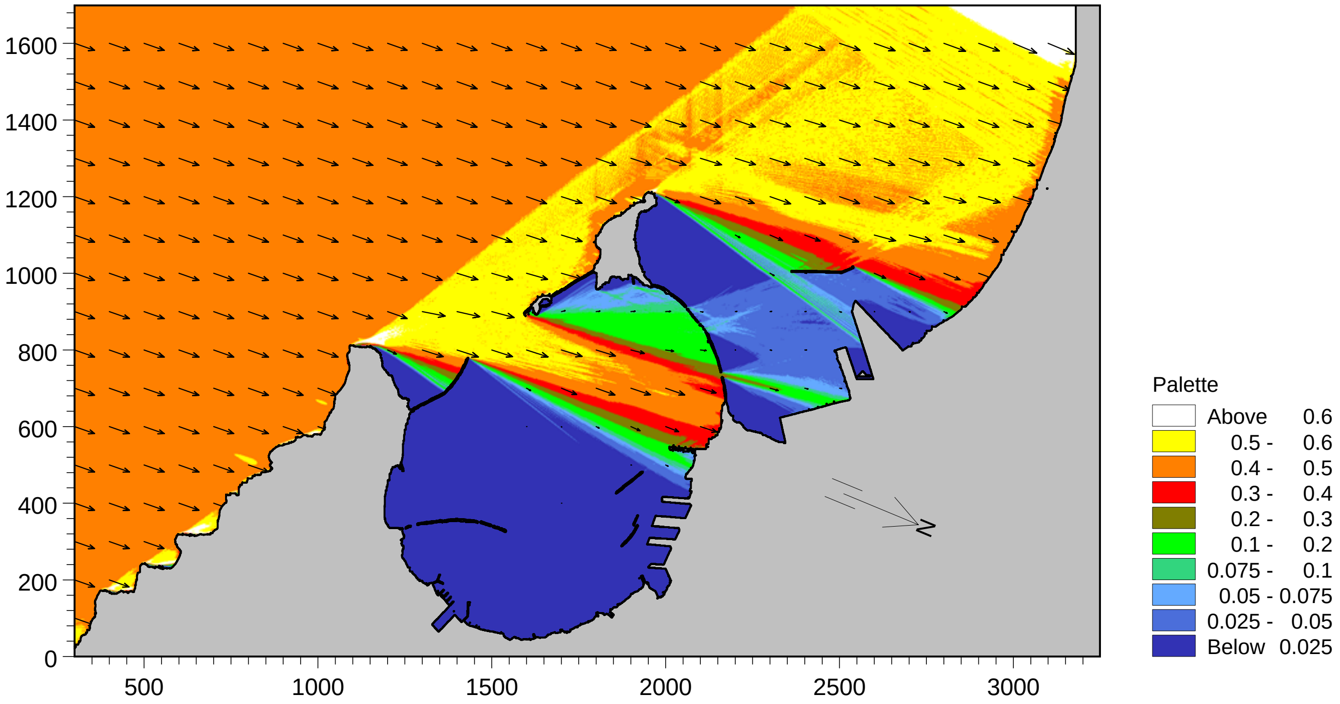
NIVEL MEDIO

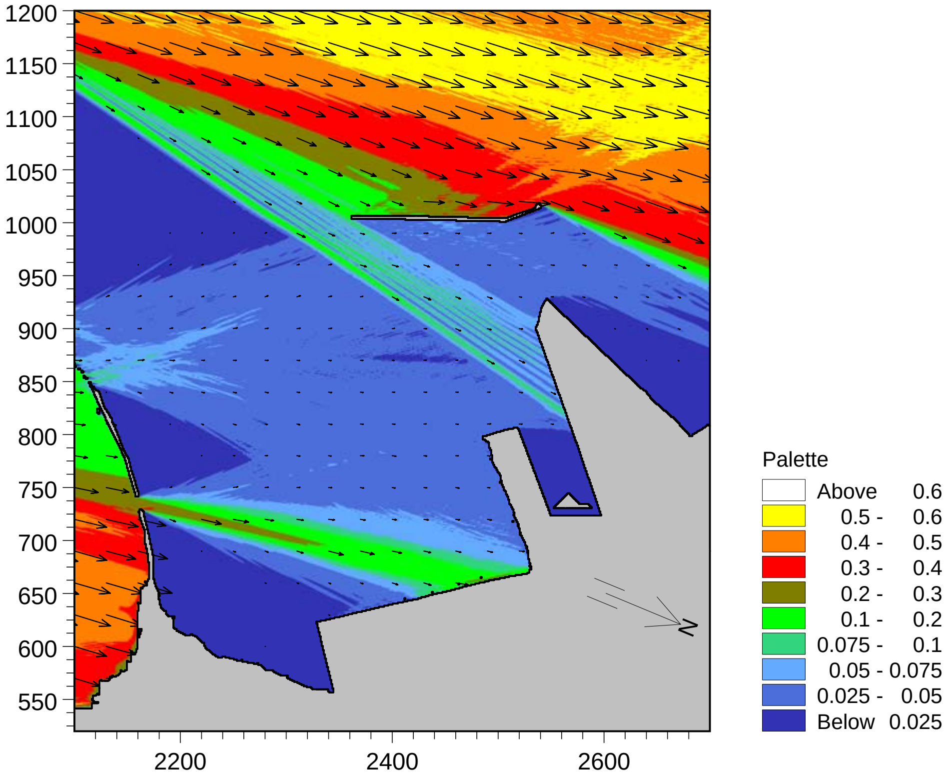
Date:
Enero 2005

Init:

PROPAGACION
S, Hs= 0.5m, Tp= 3,5s

Drawing no.
15

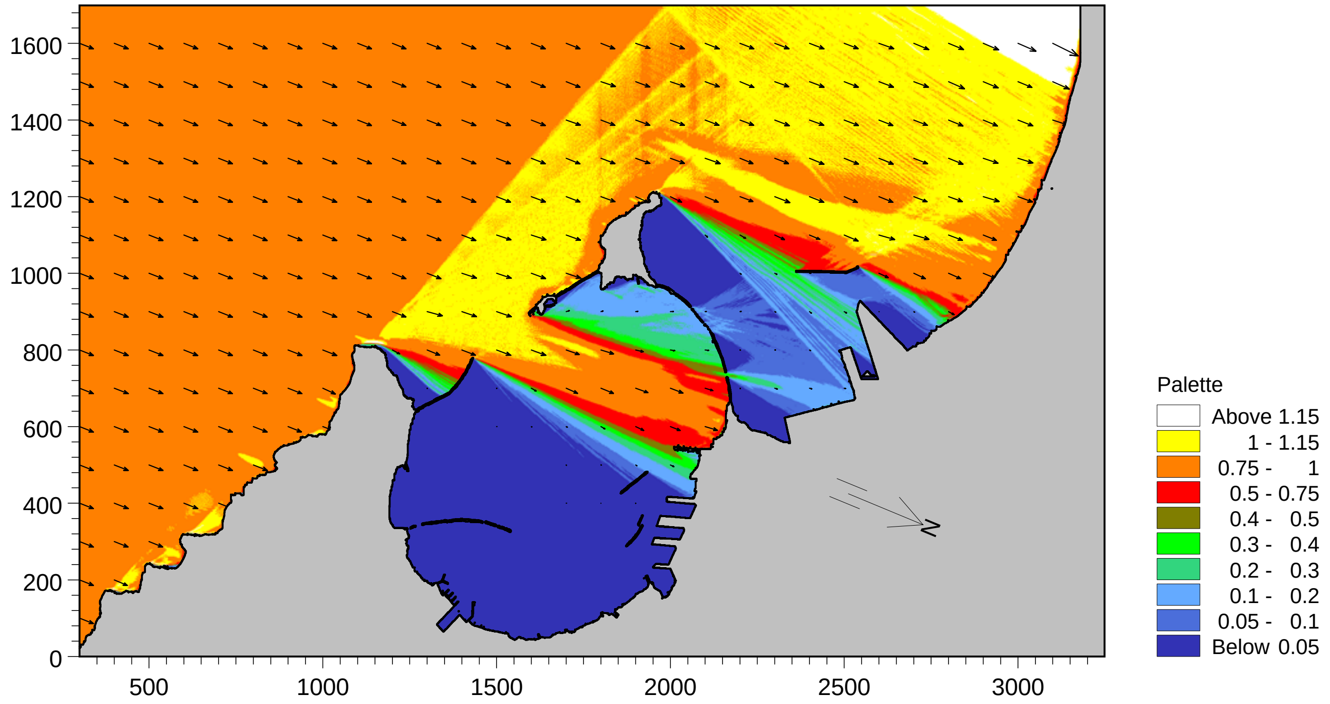


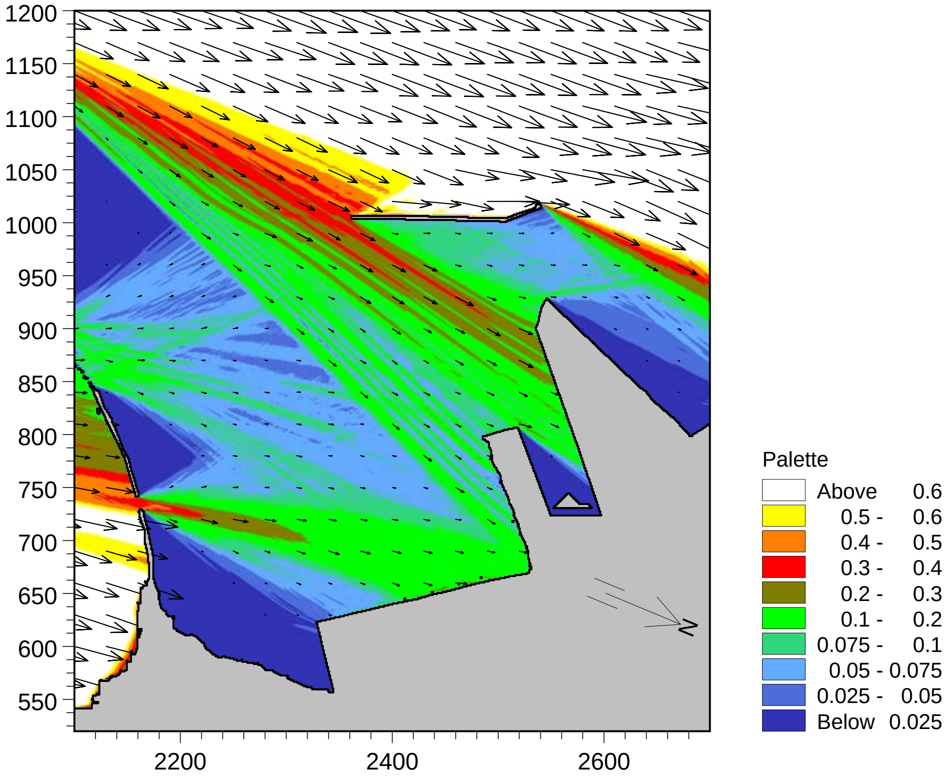


alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL			
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION S, Hs= 1m, Tp= 4s	Drawing no. 16
	Init:		

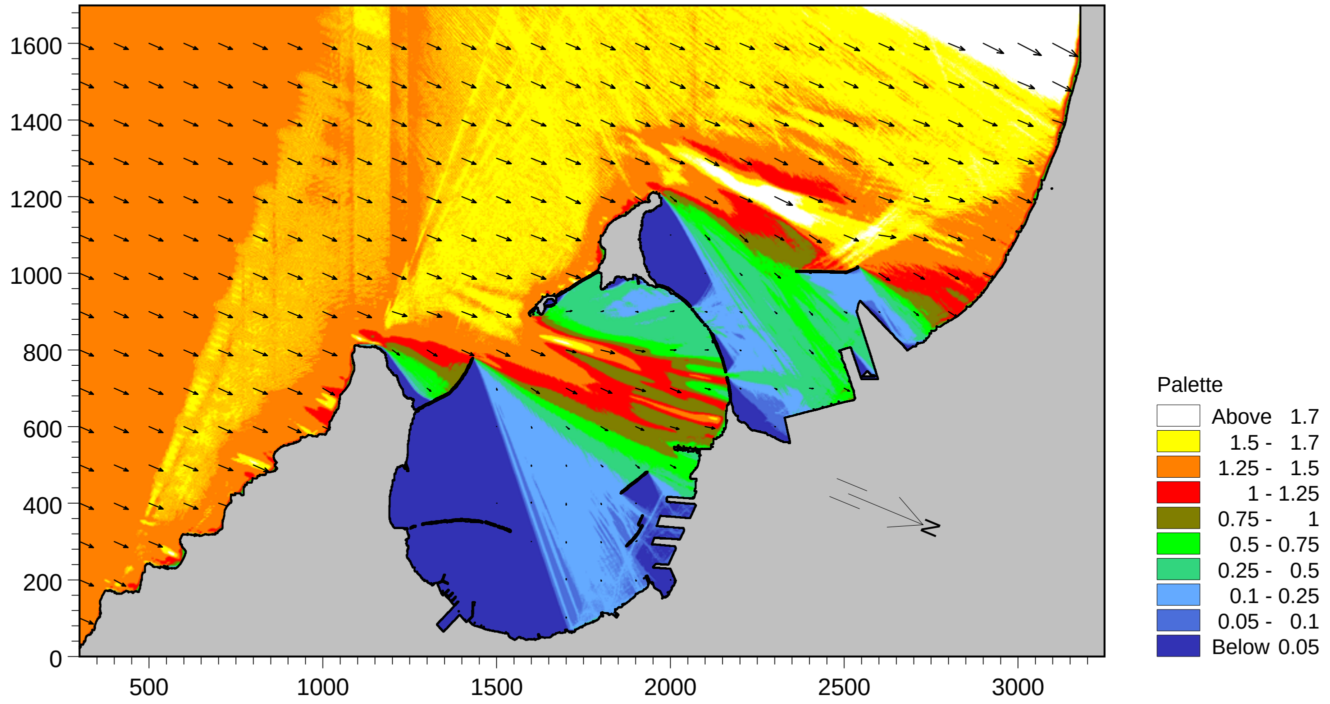
MIKEZero

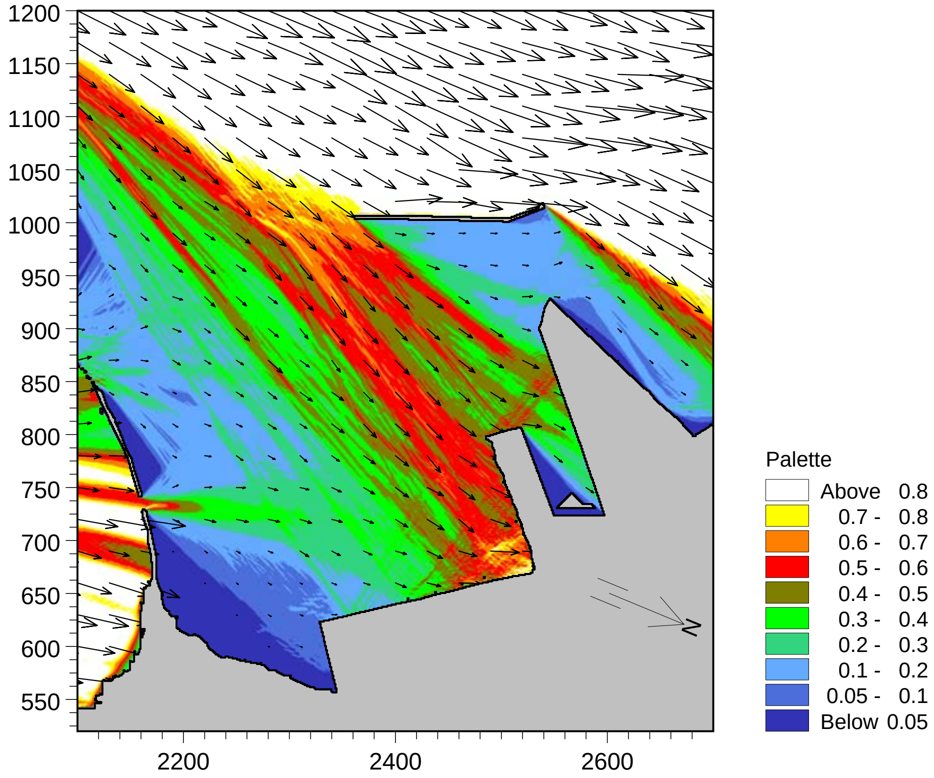




alatec
ingenieros consultores
y arquitectos

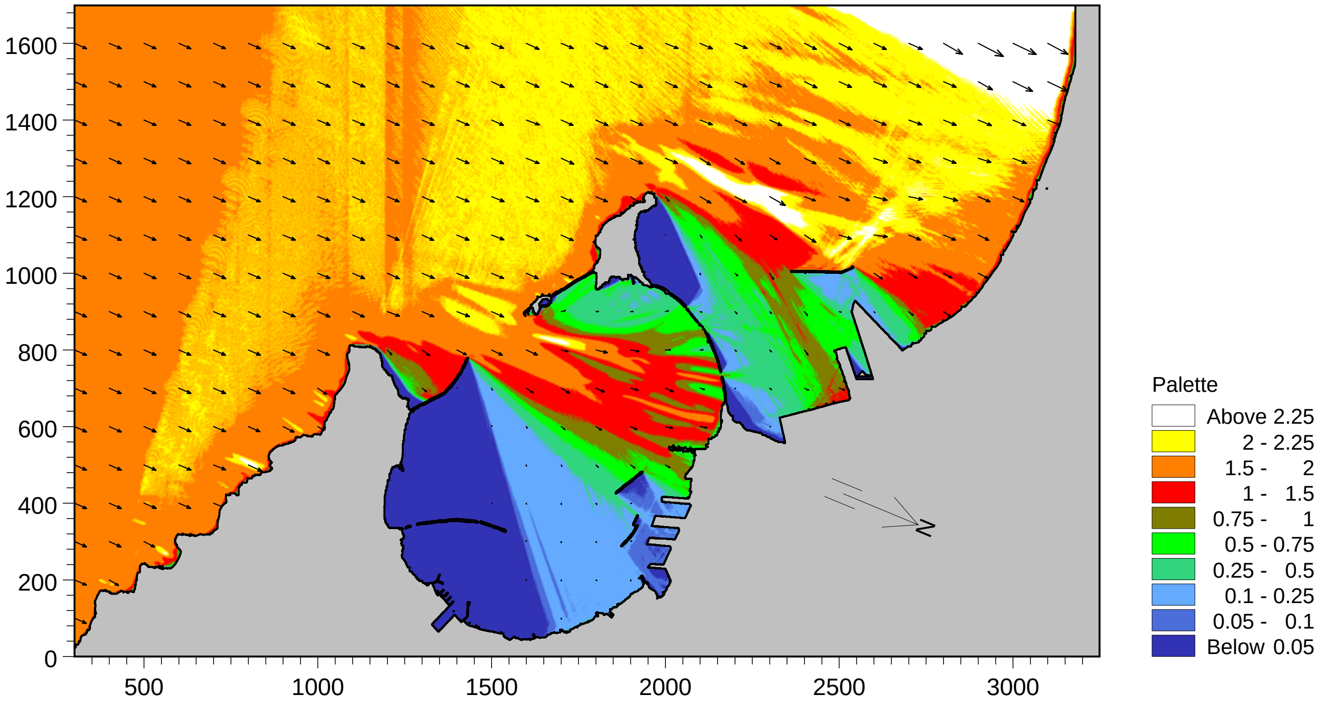
Client: GAS NATURAL			MIKEZero
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION S, Hs= 1,5m, Tp= 5s	Drawing no. 17
	Init:		

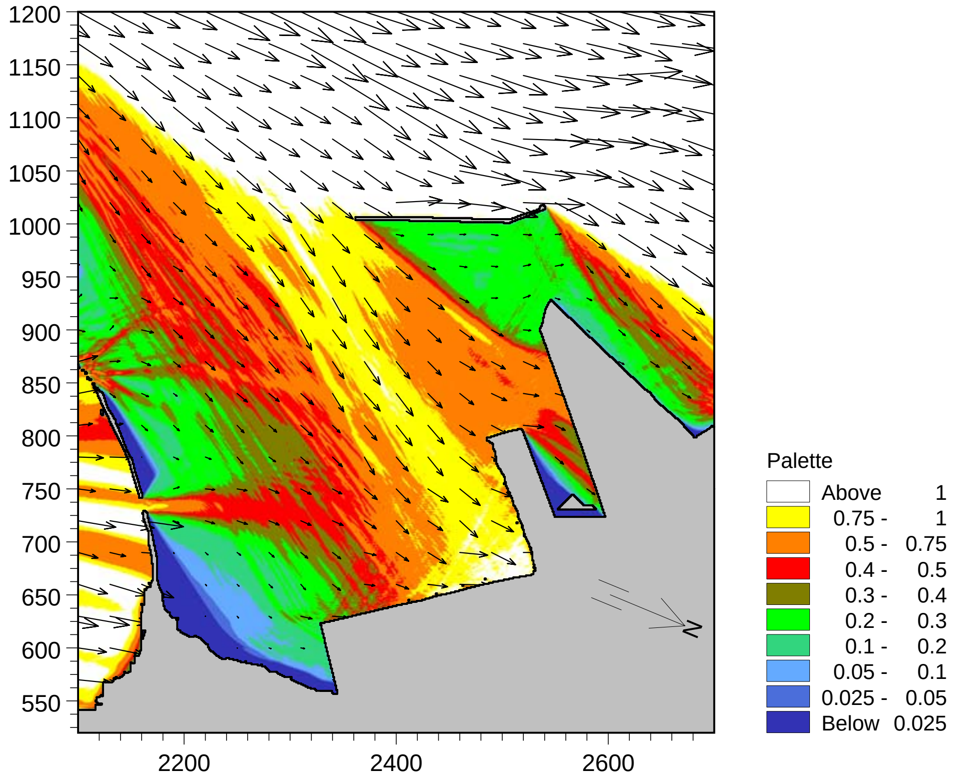




alatec
ingenieros consultores
y arquitectos

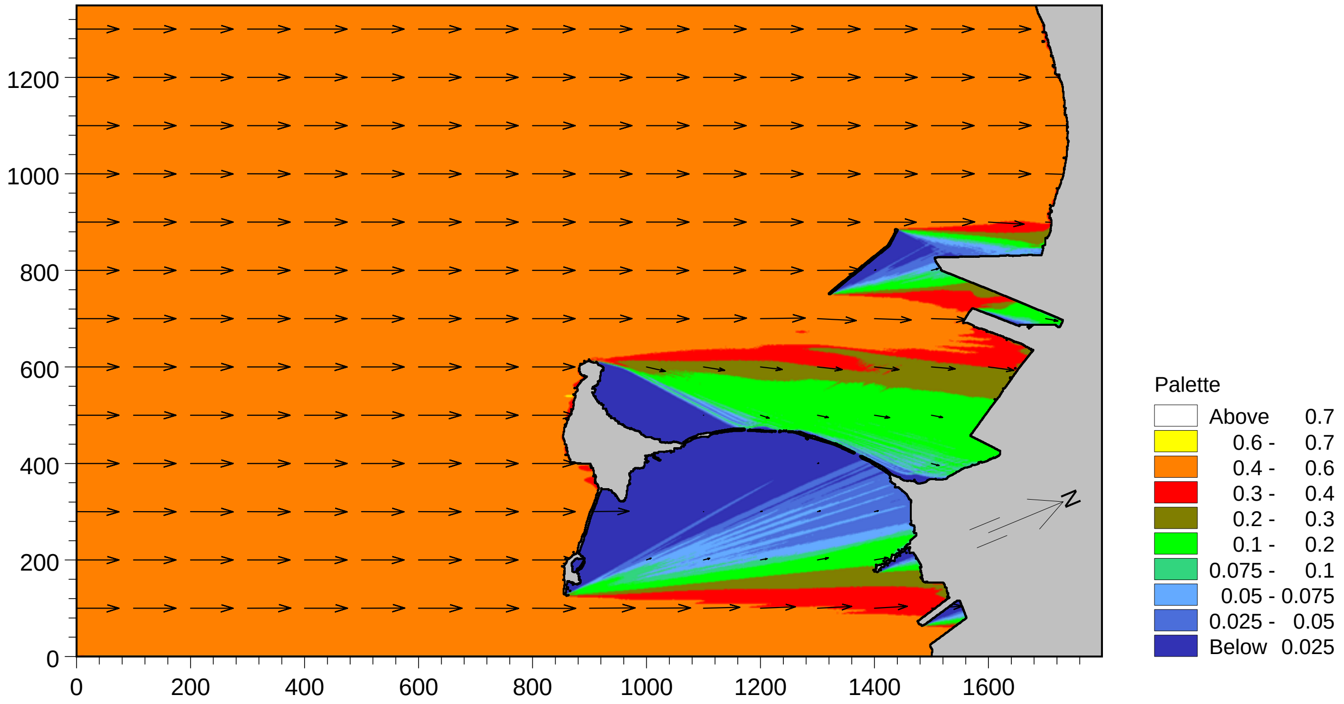
		Client: GAS NATURAL	MIKE Zero
		Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)	
NIVEL MEDIO	Date: Enero 2005	PROPAGACION S, Hs= 2m, Tp= 5,5s	Drawing no. 18
	Init:		

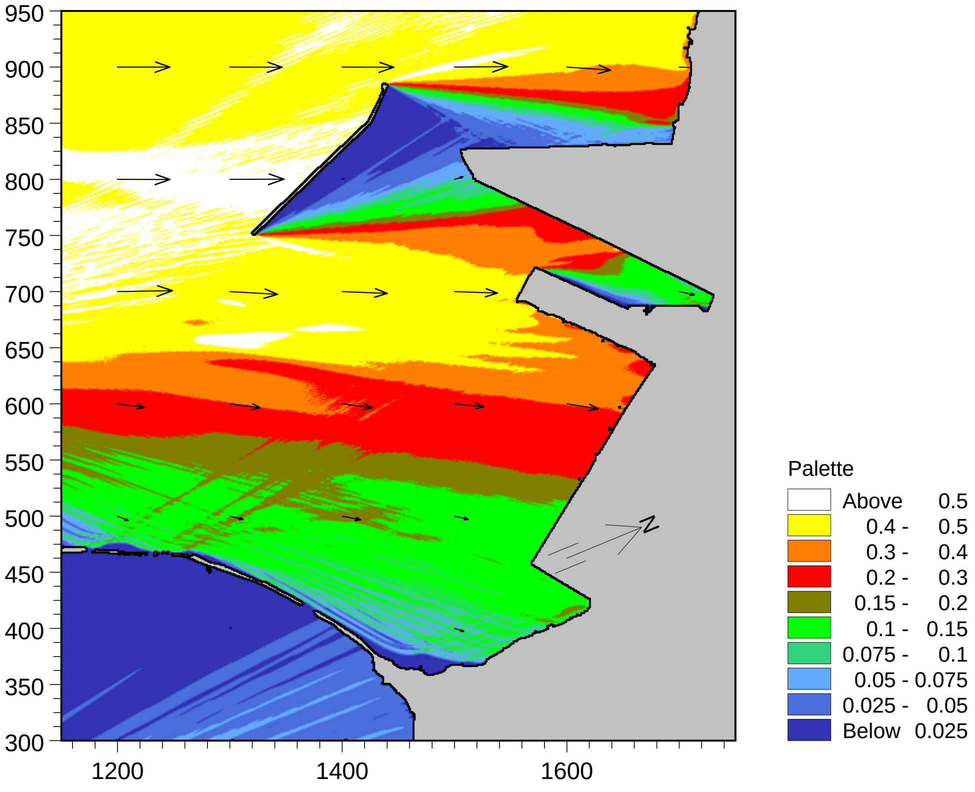




alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL			
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSW, Hs= 0.5m, Tp= 3,5s	Drawing no. 19
	Init:		





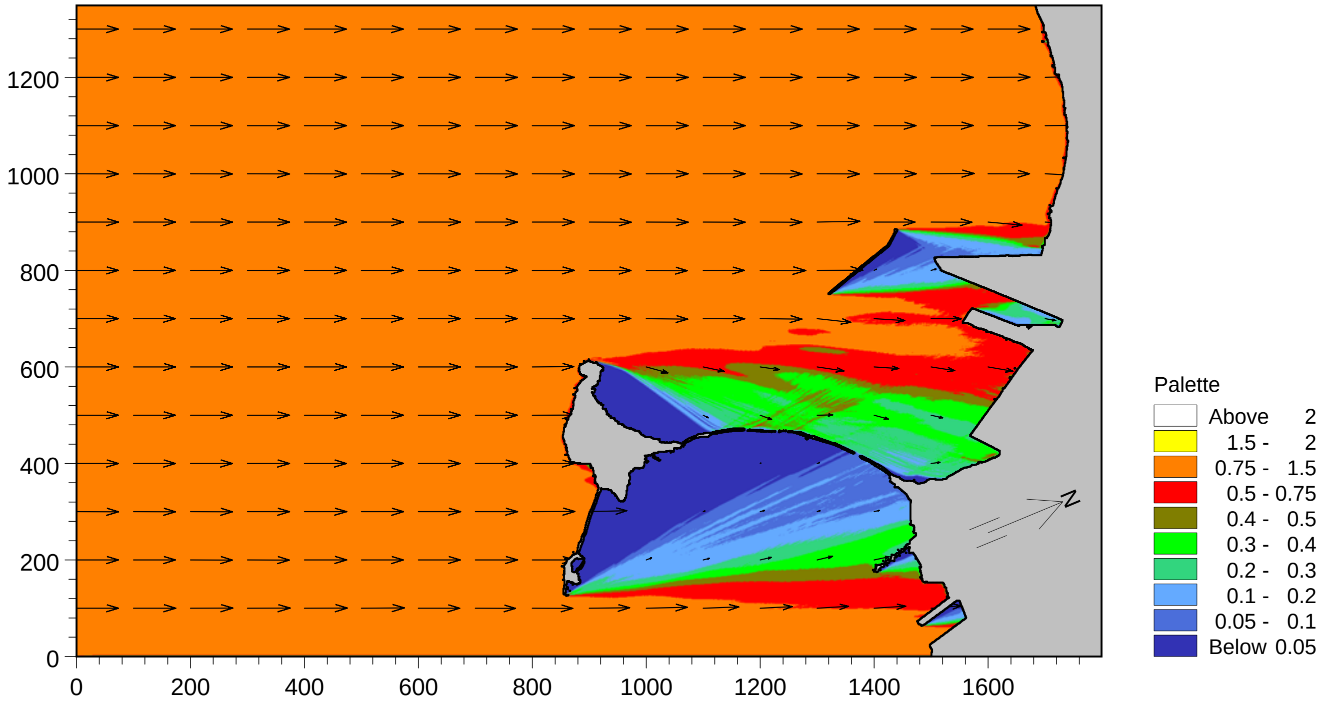
alatec
ingenieros consultores
y arquitectos

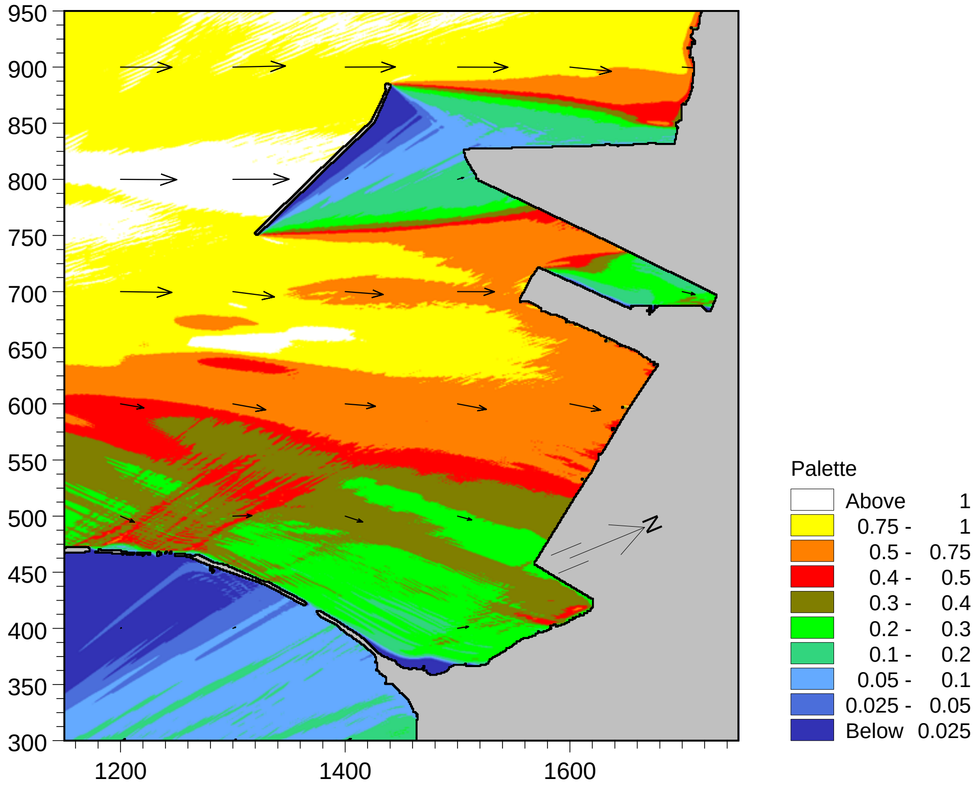
Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSW, Hs= 1m, Tp= 4s	Drawing no. 20
	Init:		





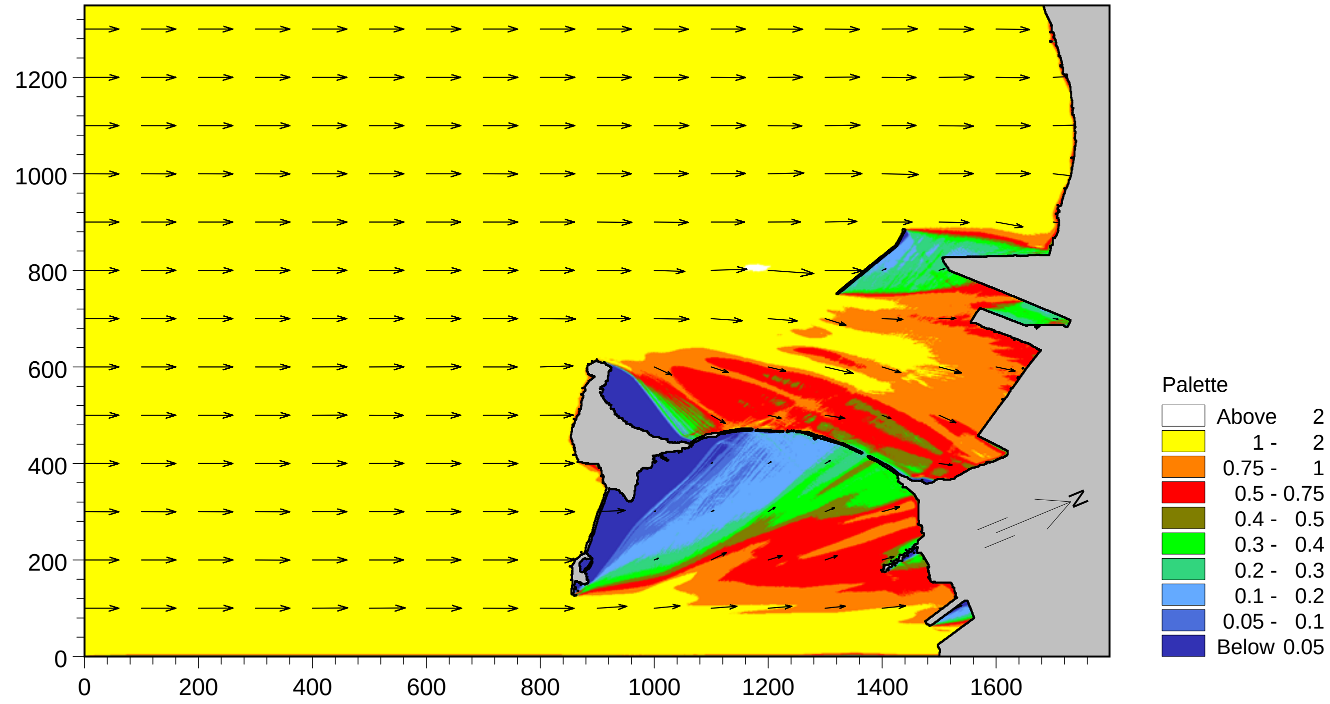
alatec
ingenieros consultores
y arquitectos

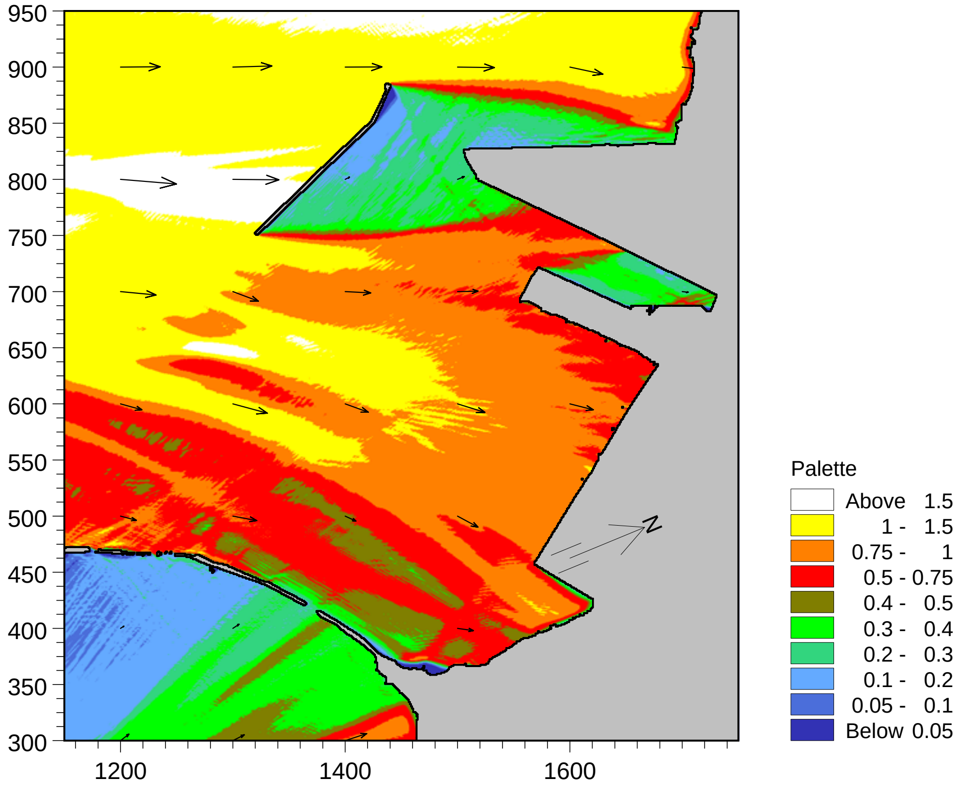
Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

NIVEL MEDIO	Date: Enero 2005	PROPAGACION SSW, Hs= 1,5m, Tp= 5s	Drawing no. 21
	Init:		





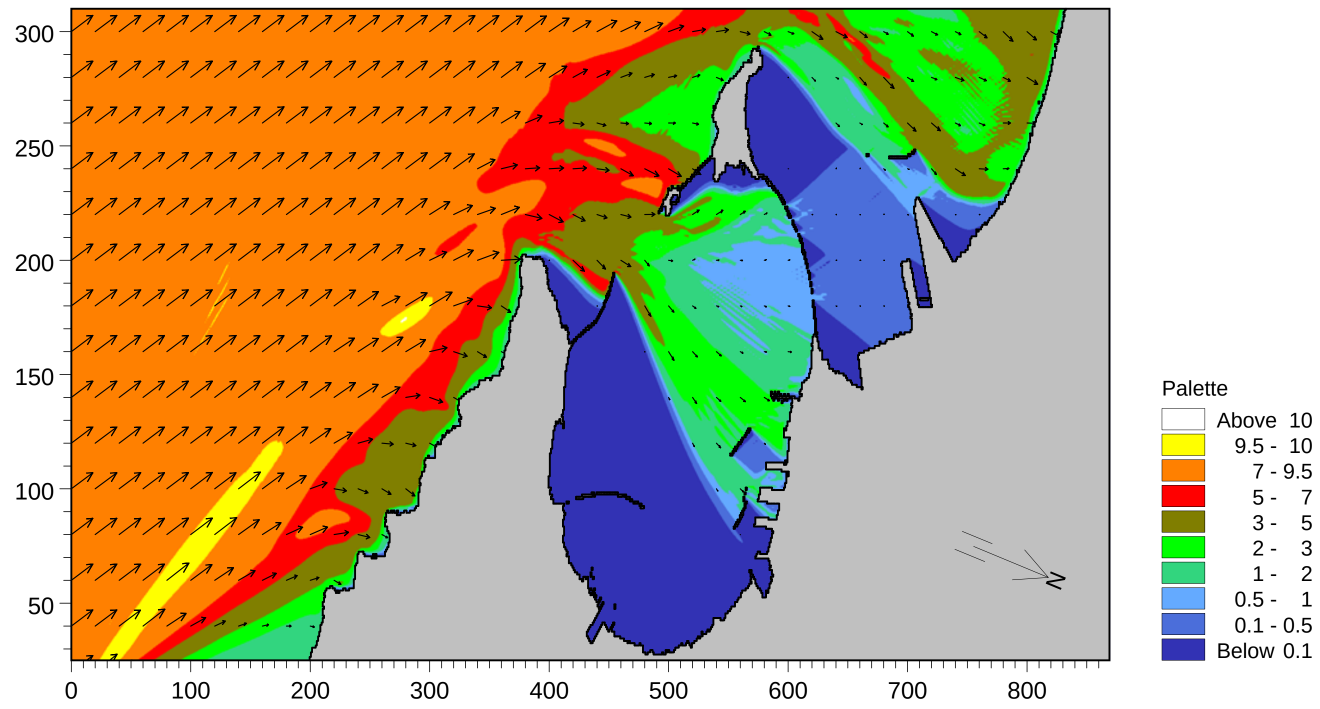
alatec
ingenieros consultores
y arquitectos

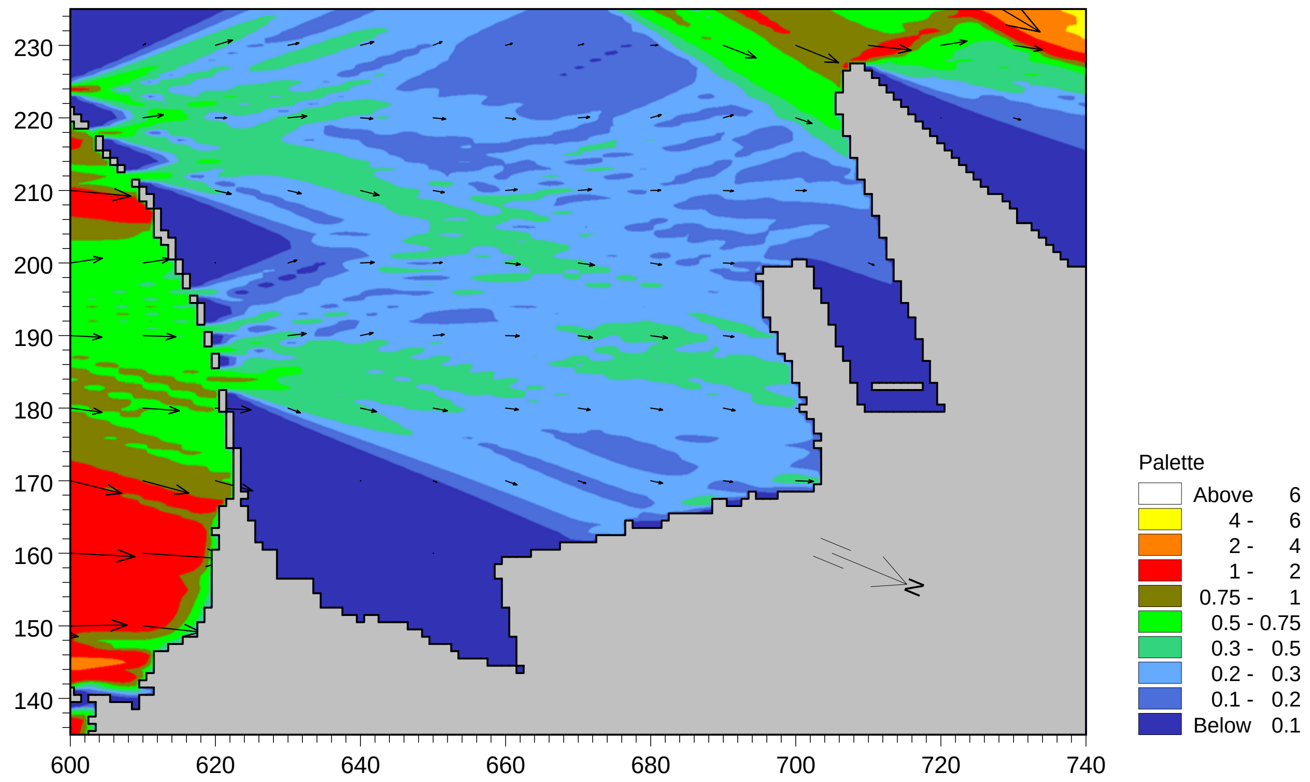
Client: GAS NATURAL

Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

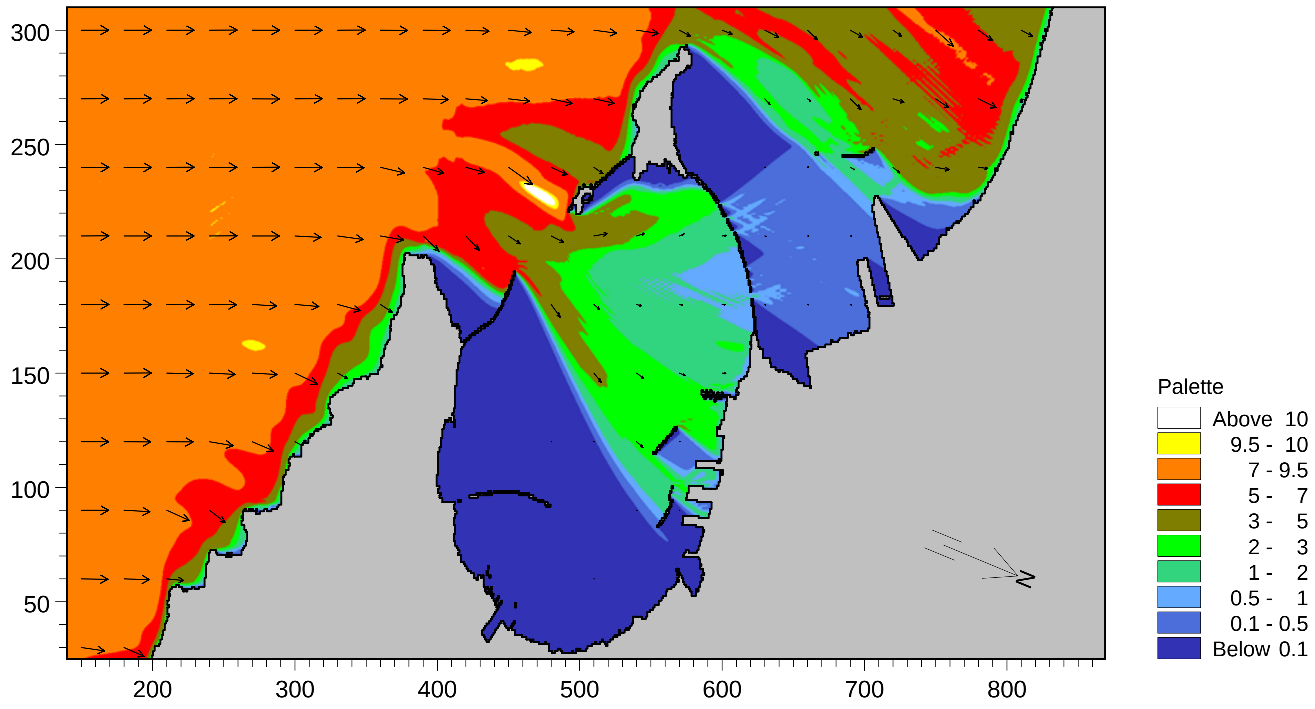
NIVEL MEDIO	Date: Enero 2005	PROPAGACION RÉGIMEN EXTREMAL SE, Hs= 9,45m, Tp= 10,4s	Drawing no. 22
	Init:		

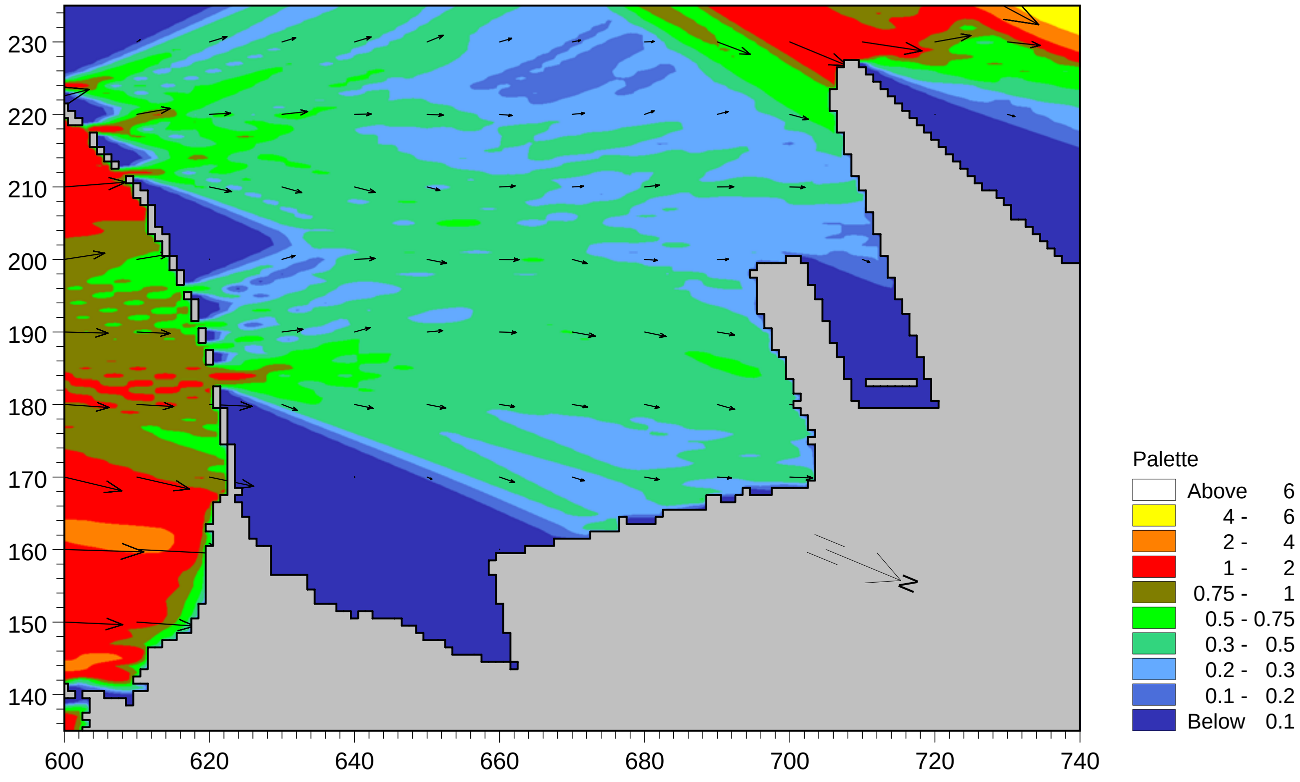




alatec
ingenieros consultores
y arquitectos

Client: GAS NATURAL			MIKEZero
Project: TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)			
NIVEL MEDIO	Date: Enero 2005	PROPAGACION RÉGIMEN EXTREMAL SSE, Hs= 9,41m, Tp= 10,4s	Drawing no. 23
	Init:		



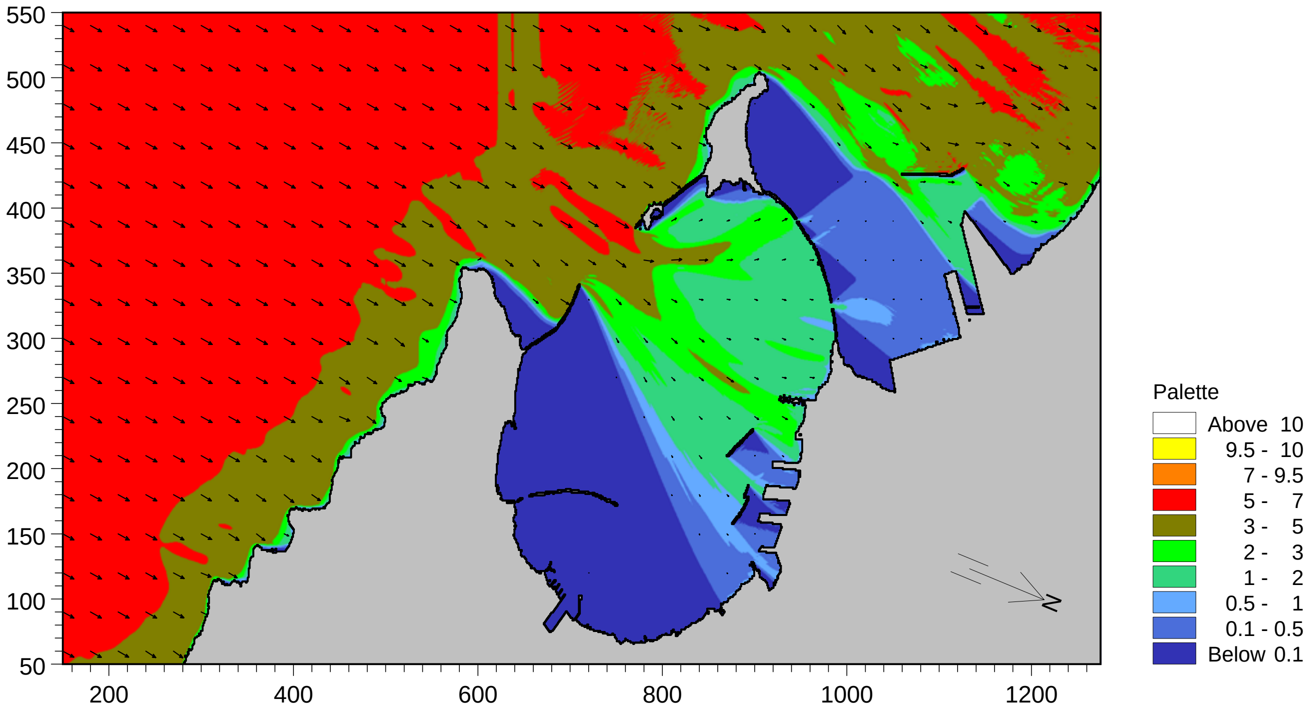


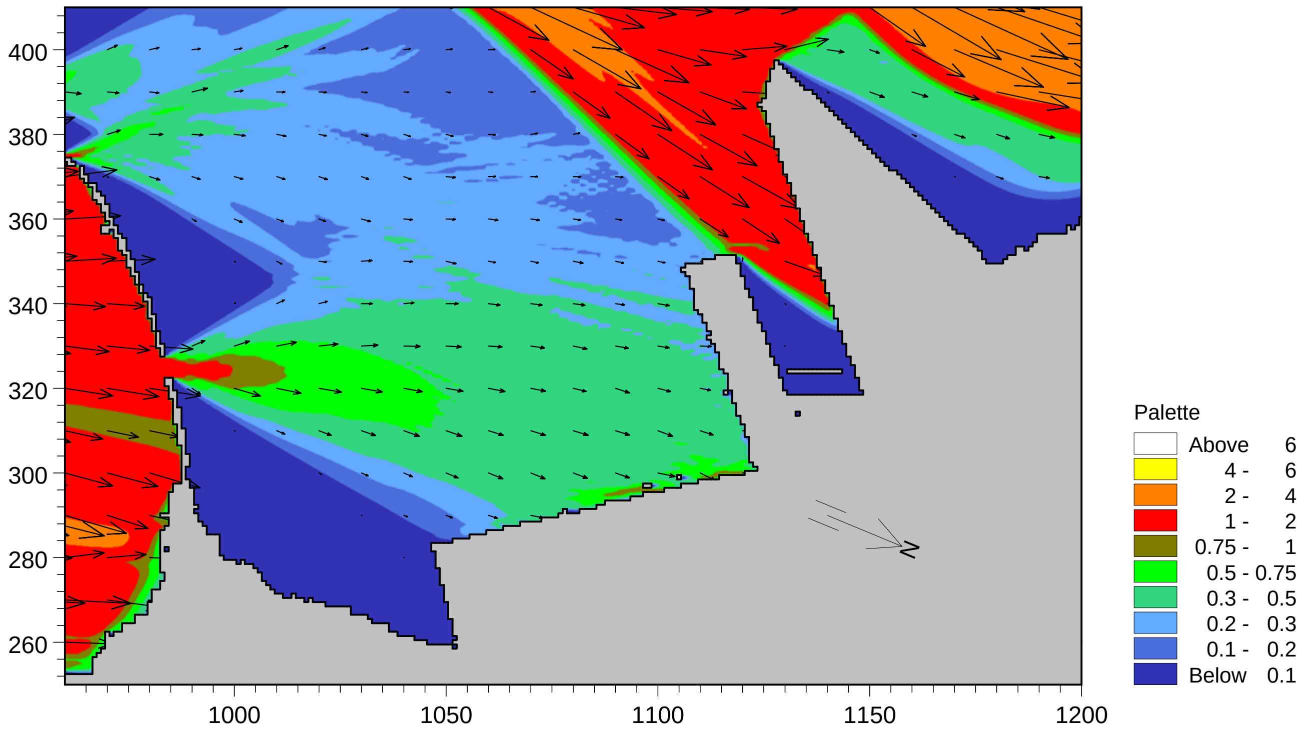
alatec
ingenieros consultores
y arquitectos

Client:	GAS NATURAL
Project:	TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

MIKEZero

NIVEL MEDIO	Date: Enero 2005	PROPAGACION RÉGIMEN EXTREMAL S, Hs= 5,18m, Tp= 8,1s	Drawing no. 24
	Init:		





alatec
ingenieros consultores
y arquitectos

Client:
GAS NATURAL

Project:
TERMINAL REGASIFICACIÓN, TARANTO (ITALIA)

NIVEL MEDIO

Date:
Enero 2005

Init:

PROPAGACION RÉGIMEN EXTREMAL
SSW, Hs= 4,01m, Tp= 7,3s

Drawing no.
25