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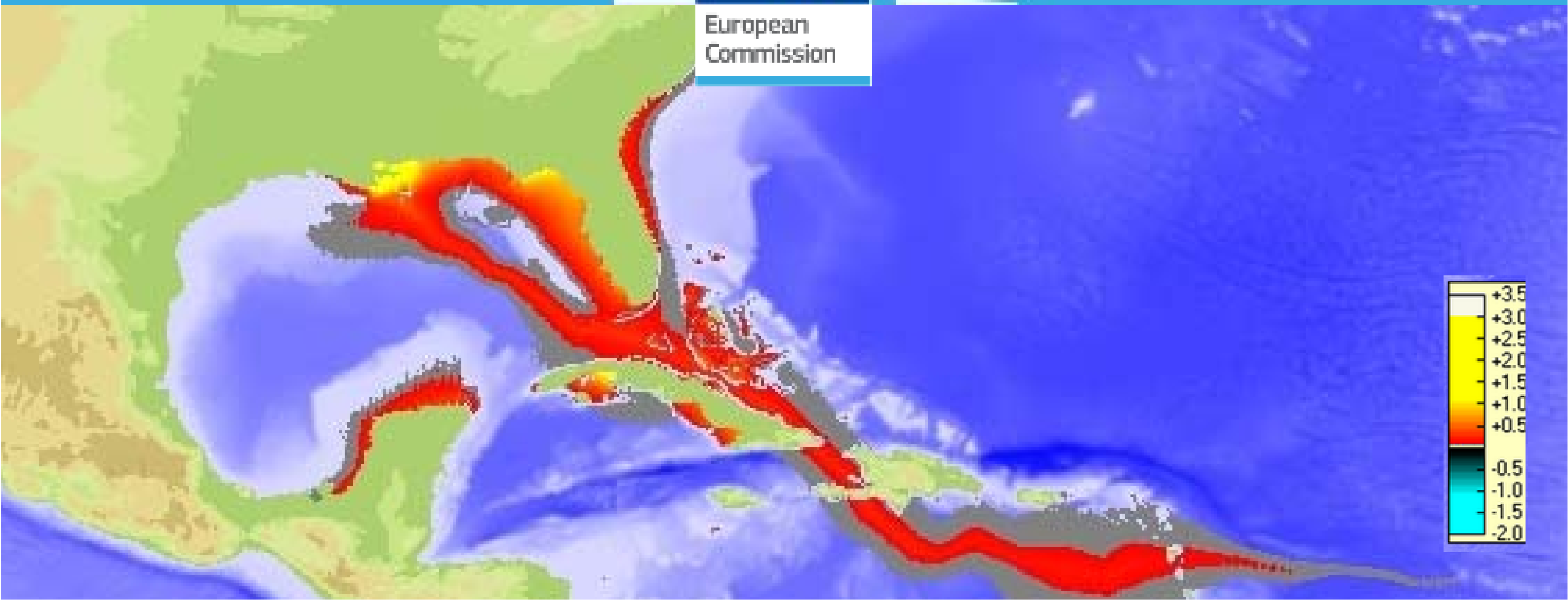

JRC TECHNICAL REPORTS

Tropical Cyclone ISAAC

USA, August 2012

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2012

Report EUR 25657 EN

Joint Research Centre

European Commission
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This publication is a Reference Report by the Joint Research Centre of the European Commission.

JRC77878

EUR 25657 EN

ISBN 978-92-79-27982-9 (pdf)
ISBN 978-92-79-27983-6 (print)

ISSN 1831-9424 (online)
ISSN 1018-5593 (print)

doi:10.2788/72586

Luxembourg: Publications Office of the European Union, 2012

Printed in Italy

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1. EXECUTIVE SUMMARY

Tropical Cyclone ISAAC, after causing damage and deaths in Haiti, moved towards the coast of SE Louisiana (USA), where it made two landfalls as a Hurricane of Category 1 (with max 1-min sustained winds of 130 km/h): first at 23:45 UTC on 28 Aug 2012 in Plaquemines Parish just SW of the mouth of the Mississippi River, second at 07:15 UTC on Aug 29 near Port Fourchon (about 90 km SSW of New Orleans). After the second landfall, it started moving inland in SE Louisiana, passing W of New Orleans on Aug 29 afternoon/evening (UTC), weakening into a tropical storm, then late on Aug 30 into a tropical depression.

During its path Tropical Cyclone ISAAC affected the southern parts of Louisiana, Mississippi and Alabama with heavy rainfall, strong winds and storm surge, causing flooding, power outages, damage to property and killing at least 7 people. According to media reports, most of this damage has been caused by heavy rains and storm surge. Plaquemines parish was the area worst hit by flooding due to ISAAC. In St. John's parish, on Aug 30, 3000 people were evacuated to escape flooding caused by waters from Lake Pontchartrain overflowing barriers. According to FEMA, as of Aug 30, there were around 6,000 people in shelters. Early on Aug 31 there were still around 800,000 people without power across Arkansas, Alabama, Louisiana and Mississippi.

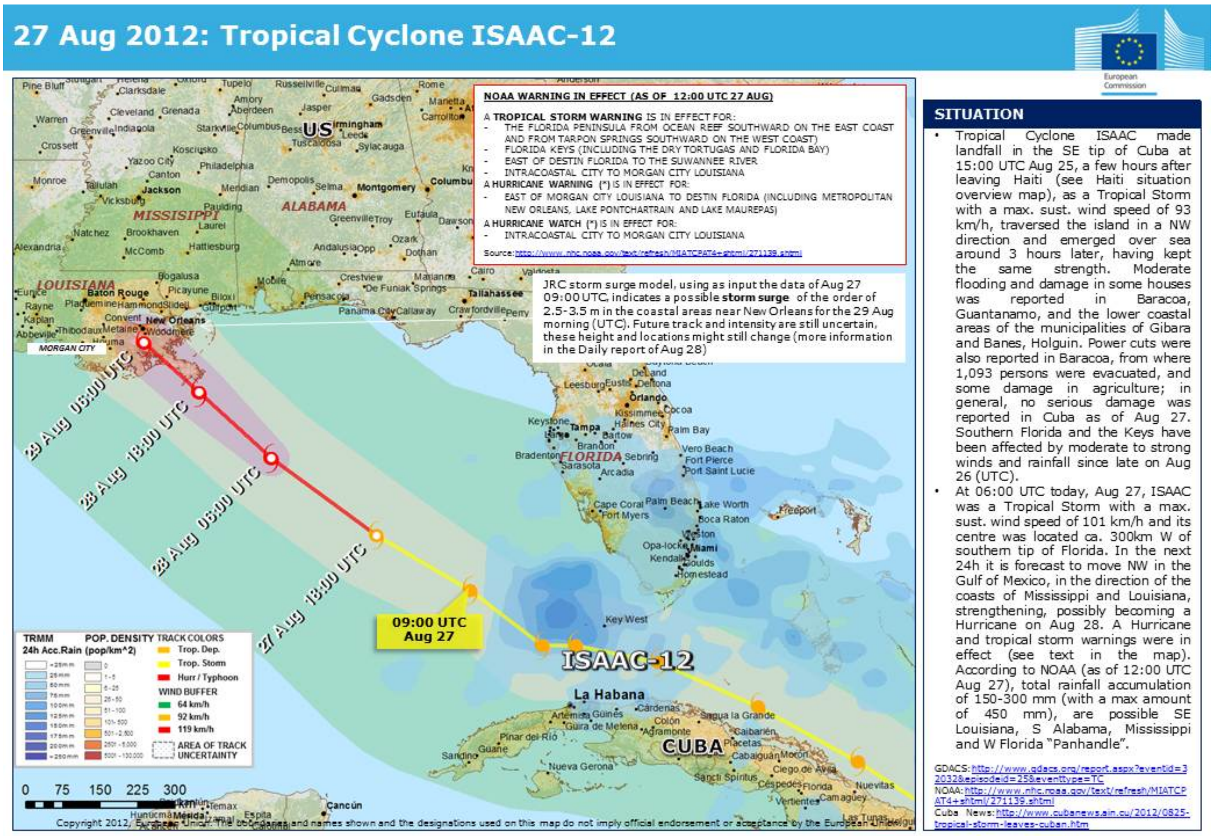


Figure 1 – Forecast (as of 09:00 UTC 27 Aug 2012) of Trajectory of Tropical Cyclone ISAAC in the USA. Source: JRC daily report, 27 August 2012, prepared by the Joint Research Centre for the Monitoring and Information Centre of DG ECHO

The Joint Research Centre (JRC) followed the event through the information automatically collected and analysed in the Global Disasters Alerts and Coordination System (GDACS). GDACS classification, for TC ISAAC in the USA, was: Green for the wind impact, Orange for rain impact and Red for storm surge impact. On 27 August 2012, JRC storm surge model indicated a possible storm surge in the order of 2.5-3.5m for Aug 29 morning (UTC) in the coastal area E-SE of New Orleans, Louisiana (see Figure 1). Observations in Shell Beach (Louisiana) showed a max sea level increase of about 3.3 m at 05:00 UTC on Aug 29 and in Bay Waveland Yacht Club (Mississippi) an increase of 2.2 m at 14:14 UTC on Aug 29. This report analyses and discusses the GDACS automatic impact assessments and compares the JRC *HyFlux2* deterministic storm surge forecasts with the probabilistic forecasts provided by NOAA.

2. ALERTS AND WARNINGS

2.1. GDACS - Event alert

Tropical Cyclones have three dangerous effects: heavy rain, strong winds and storm surge. In order to estimate the area and the population affected by a cyclone, all the three types of physical impacts must be taken into account. GDACS alert levels are based on the risk formula factors, cyclone's wind speed (hazard), population affected, and vulnerability of the affected country. Tropical Cyclone data for ISAAC used in GDACS were provided by PDC and elaborated by JRC (see Vernaccini et al. 2007). These data, for the Tropical Cyclones in the Atlantic Ocean, are based on NOAA advisories data. Hereafter, these bulletins will be called NOAA advisories.

According to media and FEMA reports, most of the damage caused by Hurricane ISAAC was due to heavy rain and storm surge. GDACS Alerts for these effects were Orange and Red.

The GDACS classification was

- Green Alert for wind impact in USA
- Orange Alert for rain impact in USA
- Red Alert for storm surge in USA

The impact of all the three effects were analysed as shown below. All the alerts based on the advisories 39 for ISAAC, are shown in Figure 2; blue boxes indicate the cases analysed in the next sections. The advisory during the landfall[1] is shown in red.

[1] Second landfall landfall in SW Lousiana occurred on Aug 29 at 07:15 UTC. Hereafter the term "landfall" will be used to indicate the second landfall.

NOAA first landfall: http://www.nhc.noaa.gov/archive/2012/al09/al092012.posest.08282356.shtml?

NOAA second landfall: http://www.nhc.noaa.gov/archive/2012/al09/al092012.posest.08290803.shtml?

Previous advisories

For accessing reports of previous advisories, please click on the advisory number in the table below.

Advisory	Alert color	Date	Category	Maximum sustained wind speed (km/h)	Population affected by cyclone winds (>120km/h)	Affected countries	Date added
1		8/21/2012 9:00:00 AM	Category 2	175	No people affected	Dominican Republic, Guadeloupe, Martinique, Antigua and Barbuda, Saint Kitts and Nevis, Montserrat, Puerto Rico, Virgin Islands, U.S.	21/08/2012 11:14
2		8/21/2012 3:00:00 PM	Category 2	167	No people affected	Dominican Republic, Guadeloupe, Martinique, Antigua and Barbuda, Saint Kitts and Nevis, Montserrat, Puerto Rico, Virgin Islands, U.S.	21/08/2012 17:15
3		8/21/2012 9:00:00 PM	Category 1	138	No people affected	Haiti, Dominican Republic, Guadeloupe, Antigua and Barbuda, Saint Kitts and Nevis, Montserrat, Puerto Rico, Virgin Islands, U.S.	21/08/2012 23:15
4		8/22/2012 3:00:00 AM	Category 1	130	No people affected	Dominican Republic, Haiti, Guadeloupe, Antigua and Barbuda, Saint Kitts and Nevis, Montserrat, Puerto Rico, Virgin Islands, U.S.	22/08/2012 05:15
5		8/22/2012 9:00:00 AM	Category 1	148	4.8 million	Cuba, United States, Haiti, Dominican Republic	22/08/2012 16:10
6		8/22/2012 3:00:00 PM	Category 1	138	No people affected	Cuba, Dominican Republic, Haiti, United States, Bahamas, Guadeloupe, Antigua and Barbuda, Saint Kitts and Nevis, Montserrat, Puerto Rico, Virgin Islands, U.S.	22/08/2012 17:20
7		8/22/2012 9:00:00 PM	Category 1	130	No people affected	Cuba, Dominican Republic, Haiti, United States, Bahamas, Guadeloupe, Martinique, Antigua and Barbuda, Saint Kitts and Nevis, Montserrat, Puerto Rico	22/08/2012 23:17
8		8/23/2012 3:00:00 AM	Category 1	130	3.7 million	Haiti, Dominican Republic	23/08/2012 05:15
9		8/23/2012 9:00:00 AM	Category 1	130	3.4 million	Haiti, Dominican Republic	23/08/2012 11:51
10		8/23/2012 3:00:00 PM	Category 1	138	1.1 million	Haiti	23/08/2012 17:49
11		8/23/2012 9:00:00 PM	Category 1	138	No people affected	Cuba, Dominican Republic, Haiti, United States, Jamaica, Bahamas, Puerto Rico	23/08/2012 23:17
12		8/24/2012 3:00:00 AM	Category 1	148	No people affected	United States, Cuba, Dominican Republic, Haiti, Jamaica, Bahamas, Puerto Rico	24/08/2012 05:17
13		8/24/2012 9:00:00 AM	Category 1	138	No people affected	United States, Cuba, Dominican Republic, Haiti, Jamaica, Bahamas	24/08/2012 11:17
14		8/24/2012 3:00:00 PM	Category 1	130	No people affected	United States, Cuba, Dominican Republic, Haiti, Jamaica, Bahamas	24/08/2012 17:18
15		8/24/2012 9:00:00 PM	Category 1	138	No people affected	Cuba, Dominican Republic, Haiti, United States, Jamaica, Bahamas	25/08/2012 00:47
16		8/25/2012 3:00:00 AM	Category 1	148	No people affected	United States, Cuba, Dominican Republic, Haiti, Turks and Caicos Islands, Jamaica, Bahamas	25/08/2012 05:17
17		8/25/2012 9:00:00 AM	Category 1	148	750 thousand	United States	25/08/2012 11:17
18		8/25/2012 3:00:00 PM	Category 2	158	980 thousand	United States	25/08/2012 17:17
19		8/25/2012 9:00:00 PM	Category 2	158	480 thousand	United States	25/08/2012 23:17
20		8/26/2012 3:00:00 AM	Category 2	167	360 thousand	United States	26/08/2012 05:17
21		8/26/2012 9:00:00 AM	Category 2	167	760 thousand	United States	26/08/2012 11:16
22		8/26/2012 3:00:00 PM	Category 2	167	700 thousand	United States	26/08/2012 17:22
23		8/26/2012 9:00:00 PM	Category 2	158	1.1 million	United States	26/08/2012 23:18
24		8/27/2012 3:00:00 AM	Category 2	158	1.4 million	United States	27/08/2012 05:16
25		8/27/2012 9:00:00 AM	Category 1	148	820 thousand	United States	27/08/2012 11:16
26		8/27/2012 3:00:00 PM	Category 1	148	1.7 million	United States	27/08/2012 17:20
27		8/27/2012 9:00:00 PM	Category 2	158	1.8 million	United States	27/08/2012 23:20
28		8/28/2012 3:00:00 AM	Category 1	148	980 thousand	United States	28/08/2012 05:50
29		8/28/2012 9:00:00 AM	Category 1	138	890 thousand	United States	28/08/2012 11:17
30		8/28/2012 3:00:00 PM	Category 1	130	870 thousand	United States	28/08/2012 17:27
31		8/28/2012 9:00:00 PM	Category 1	130	2 million	United States	28/08/2012 23:55
32		8/29/2012 3:00:00 AM	Category 1	130	2.2 million	United States LANDFALL	29/08/2012 05:20
33		8/29/2012 9:00:00 AM	Category 1	130	1.8 million	United States	29/08/2012 11:46
34		8/29/2012 3:00:00 PM	Category 1	121	1.7 million	United States	29/08/2012 17:18
35		8/29/2012 9:00:00 PM	Tropical storm	111	1.6 million	United States	29/08/2012 23:19
36		8/30/2012 3:00:00 AM	Tropical storm	93	1.6 million	United States	30/08/2012 05:17
37		8/30/2012 9:00:00 AM	Tropical storm	74	1.6 million	United States	30/08/2012 11:19
38		8/30/2012 3:00:00 PM	Tropical storm	64	1.6 million	United States	30/08/2012 17:18
39		8/30/2012 9:00:00 PM	Tropical depression	56	1.6 million		30/08/2012 23:20

Figure 2 - GDACS Alerts for Tropical Cyclone ISAAC (GDACS), as of Advisory 39. Blue boxes indicate the cases analysed. Red box shows the advisory during the landfall.

2.2. NOAA NHC Warnings

National Oceanic and Atmospheric Administration (NOAA) Tropical Storm and Hurricane Warnings were in effect before and after ISAAC's landfall (on Aug 29) for its potential effects. The image below, from NOAA, shows the locations where landfall occurred and the Warnings and Watch in effect (as of Advisory 33, 09:00 UTC Aug 29)

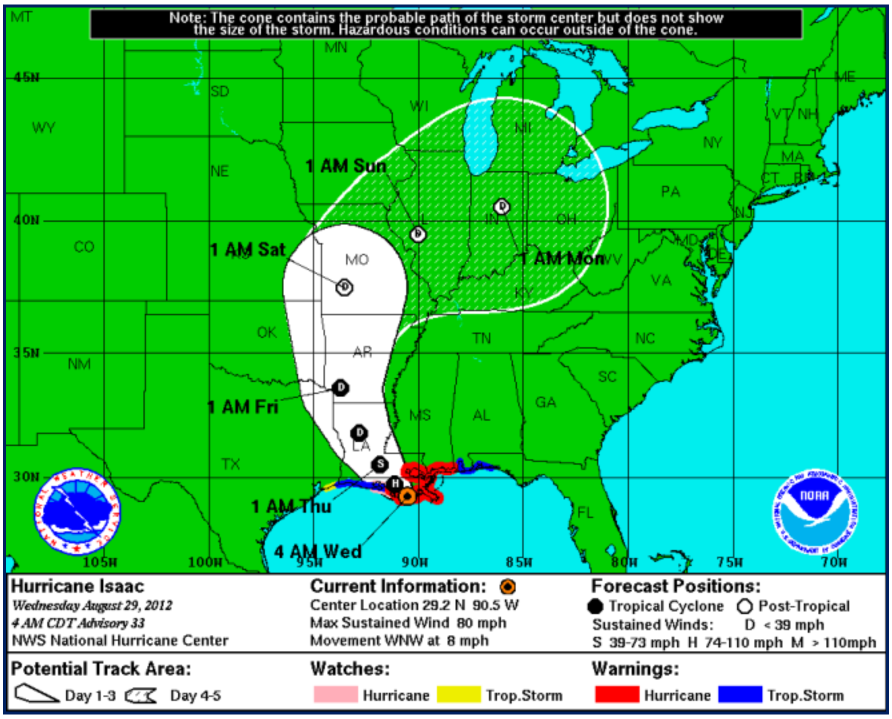


Figure 3 - Coastal Watches/Warnings and 5-Day Forecast Cone for Storm Center (NOAA, as of Adv. 33). Source: http://www.nhc.noaa.gov/archive/2012/graphics/al09/loop_5NLW.shtml

3. AFFECTED AREA AND POPULATION

ISAAC killed 7 people in the USA and affected the southern parts of Louisiana, Mississippi and Alabama with heavy rainfall, strong winds and storm surge, causing flooding, power outages, damage to property. Plaquemines parish (red area in Figure 1) was the area worst hit by flooding due to ISAAC, with water of up to 3.5 m reported in some parts; a levee in the east bank portion of this parish was overrun on Aug 29, causing flooding. In St. John's parish, on Aug 30, 3000 people were evacuated to escape flooding caused by waters from Lake Pontchartrain overflowing barriers. According to FEMA, as of Aug 30, there were around 6,000 people in shelters. Early on Aug 31 there were still around 800,000 people without power across Arkansas, Alabama, Louisiana and Mississippi. According to media reports, most of this damage has been caused by heavy rains and storm surge.

The population affected by "hurricane force winds" (> 120 km/h), estimated by GDACS (based on the High winds impact) was 1.3 million people, as of Aug 29 15:00 UTC (see Figure 5).

The impacts of winds, rain and storm surge are shown in the next Section.

4. IMPACT ASSESSMENT

4.1. Wind Impact

Tropical Cyclone ISAAC made two landfalls in south-eastern Louisiana as a Category 1 Hurricane with a max 1-min sustained wind speed of 130 km/h: at 23:34 UTC on Aug 28 it made the first landfall in Plaquemines Parish[2], just SW of the mouth of the Mississippi, then it moved again over water towards the coast of SE Louisiana and made a second landfall near Port Fourchon (ca. 90 km SSW of New Orleans) around 07:15 UTC on Aug 29. The second landfall occurred 7 years after the landfall of Hurricane KATRINA, in almost the same area. A comparison between the two Hurricanes is shown in Annex 1.

After the second landfall (hereafter indicated only as landfall) ISAAC started moving inland in SE Louisiana, passing W of New Orleans on Aug 29 afternoon/evening (UTC). Over land it weakened into a tropical storm on Aug 29 evening (UTC). The reconstructed wind field (during "landfall-time") for TC ISAAC is shown in Figure 4. The red area represents the area where the winds could reach 64 knots, orange area 50 knots, green area 35 knots. ISAAC affected parts of SE Louisiana with "hurricane force winds" (Red Area) as shown in Figure 4.

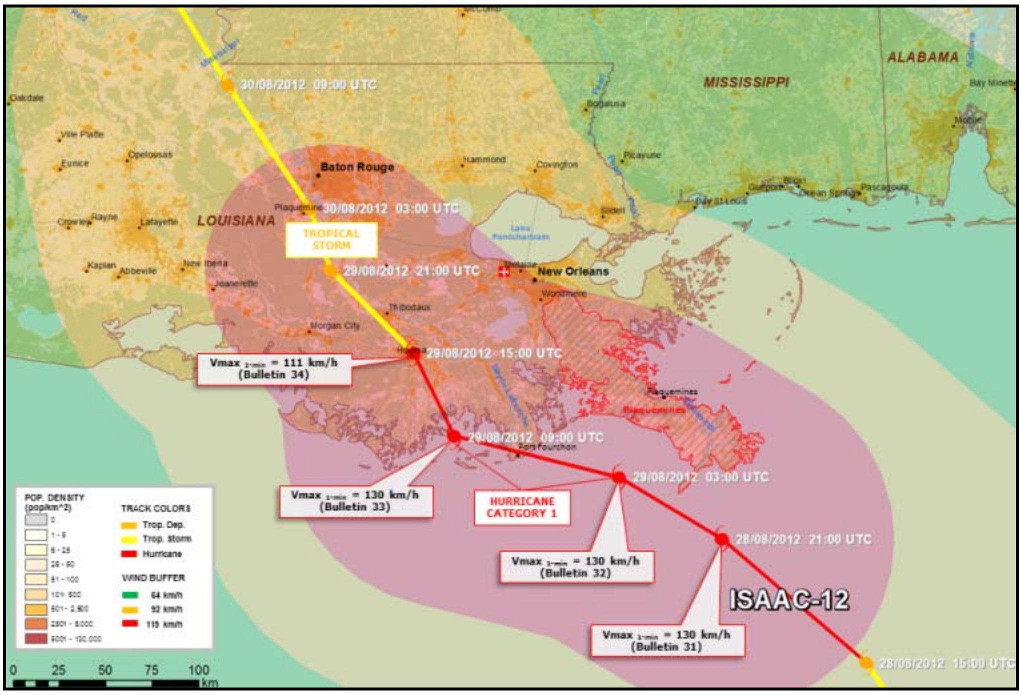


Figure 4 - ISAAC wind field

The GDACS alert levels are based on the risk formula factors, cyclone's wind speed (hazard), population affected, and vulnerability of the affected country (see Vernaccini et al., 2007). GDACS issued a Green alert (for High winds[3]) for this event, when the center of ISAAC (as a Hurricane of Category 1) moved over SE Louisiana on Aug 28-29.

According to the data of 09:00 UTC Aug 29, 1.3 million people could be affected by wind speeds of Hurricane strength (>120 km/h). The event time line and population affected is shown in Figure 4 (the storm evolution is shown in the table and the wind evolution also in the figure below; the alert levels and population estimates are related to the area from a point to the next).

[2] First landfall was in the south-eastern tip of Plaquemines Parish (however the track line is not over land)

[3] The vulnerability of the USA is Low

Event time line

The storm evolution is shown in the table below. Alert levels and population estimates are related to the area from a point to the next.

Advisory	Alert color	Date (UTC)	Category	Wind speed	Wind gusts	Population affected by cyclone winds (>120km/h)	Location (lon, lat)
25		8/27/2012 9:00:00 AM	Tropical storm	**101 km/h** (63 mph)	121 km/h (75 mph)	no people	-84.2, 25.2
26		8/27/2012 3:00:00 PM	Tropical storm	**101 km/h** (63 mph)	121 km/h (75 mph)	no people	-85.3, 26.1
27		8/27/2012 9:00:00 PM	Tropical storm	**111 km/h** (69 mph)	138 km/h (86 mph)	no people	-86.2, 26.4
28		8/28/2012 3:00:00 AM	Tropical storm	**111 km/h** (69 mph)	138 km/h (86 mph)	no people	-87, 27.1
29		8/28/2012 9:00:00 AM	Tropical storm	**111 km/h** (69 mph)	138 km/h (86 mph)	no people	-88.1, 27.5
30		8/28/2012 3:00:00 PM	Tropical storm	**111 km/h** (69 mph)	138 km/h (86 mph)	4500 people	-88.5, 28.1
31		8/28/2012 9:00:00 PM	Category 1	**130 km/h** (81 mph)	158 km/h (98 mph)	33000 people	-89.2, 28.7
32		8/29/2012 3:00:00 AM	Category 1	**130 km/h** (81 mph)	158 km/h (98 mph)	660000 people	-89.7, 29
33		8/29/2012 9:00:00 AM	Category 1	**130 km/h** (81 mph)	158 km/h (98 mph)	860000 people	-90.5, 29.2
34		8/29/2012 3:00:00 PM	Category 1	**121 km/h** (75 mph)	148 km/h (92 mph)	1.3 million people	-90.7, 29.6
35		8/29/2012 9:00:00 PM	Tropical storm	**111 km/h** (69 mph)	138 km/h (86 mph)	no people	-91.1, 30
36		8/30/2012 3:00:00 AM	Tropical storm	**93 km/h** (58 mph)	111 km/h (69 mph)	no people	-91.2, 30.3
37		8/30/2012 9:00:00 AM	Tropical storm	**74 km/h** (46 mph)	93 km/h (58 mph)	no people	-91.6, 30.9
38		8/30/2012 3:00:00 PM	Tropical storm	**64 km/h** (40 mph)	93 km/h (58 mph)	no people	-92.1, 31.7
39		8/30/2012 9:00:00 PM	Tropical depression	**56 km/h** (35 mph)	74 km/h (46 mph)	no people	-92.6, 32.7
39		8/31/2012 6:00:00 AM	Tropical depression	**47 km/h** (29 mph)	64 km/h (40 mph)	no people	-93, 34
39		8/31/2012 6:00:00 PM	Tropical depression	**37 km/h** (23 mph)	56 km/h (35 mph)	no people	-93.2, 36
39		9/1/2012 6:00:00 AM	Tropical depression	**37 km/h** (23 mph)	56 km/h (35 mph)	no people	-92.7, 37.7
39		9/1/2012 6:00:00 PM	Tropical depression	**37 km/h** (23 mph)	56 km/h (35 mph)	no people	-91.5, 38.6
39		9/2/2012 6:00:00 PM	Tropical depression	**27 km/h** (17 mph)	47 km/h (29 mph)	no people	-88.5, 39.5
39		9/3/2012 6:00:00 PM	Tropical depression	**27 km/h** (17 mph)	47 km/h (29 mph)	no people	-85.5, 39.5
39		9/4/2012 6:00:00 PM	Tropical depression	**27 km/h** (17 mph)	47 km/h (29 mph)	no people	-82.5, 38.5

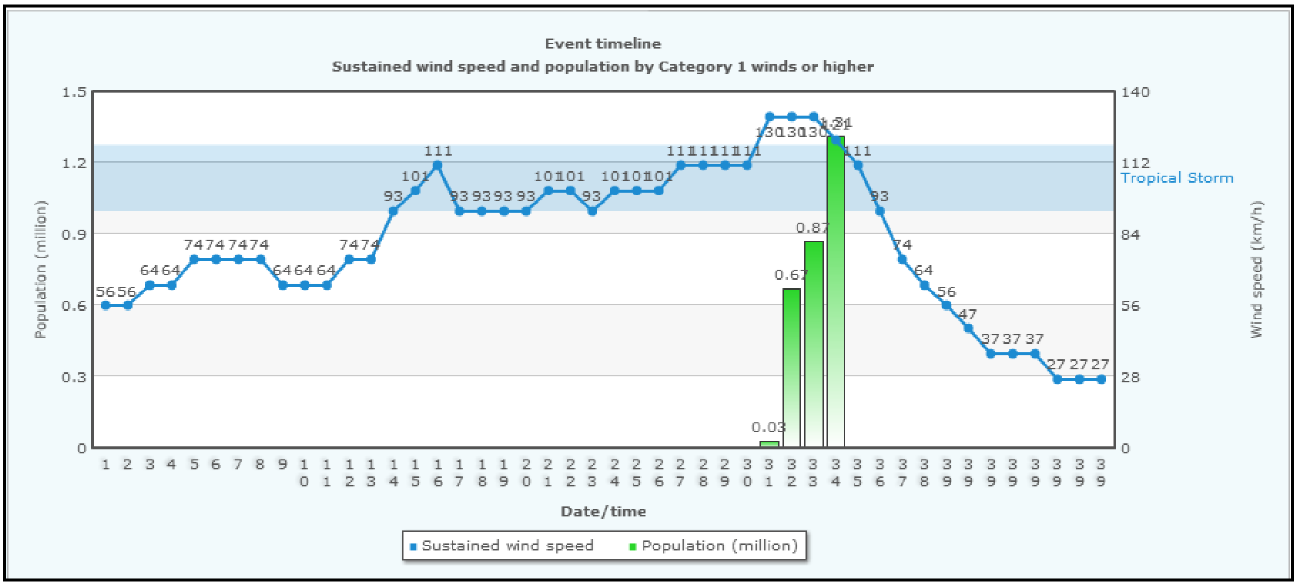


Figure 5 - GDACS Event time line (storm evolution is shown in the table, the wind evolution also in the figure below the table). Alert levels and population estimates are related to the area from a point to the next.

4.2. Rainfall impact

Tropical Cyclone ISAAC caused heavy rainfall in parts of south-eastern USA along its path, in particular in southeastern Florida, southeastern Louisiana, southeastern Mississippi and western Alabama. Its center passed south of Florida on Aug 27 and moved towards Mississippi, reaching the coast on Aug 29, then moved inland and late on Aug 30 it started dissipating (last Advisory was available on Aug 30 21:00 UTC). Therefore the analysis of the rains in this reports covers the period Aug 27-30.

Currently, GDACS uses the Ensemble Tropical Rainfall Potential" (eTRaP) accumulation data for its alert model (more information in Ebert et al., 2009). The GDACS model for the rain impact is simple, and sets alert levels based on total accumulation on land:

- Green when the total rain is below 200mm;
- Orange between 200mm and 500mm;
- Red above 500mm.

For ISAAC in the USA, the GDACS alert level was Orange (the total accumulation reached values between 300 and 350 mm). NOAA eTRaP accumulation rainfall is shown in Figure 6 and in Table 1. According to NASA[4]: "the highest totals of rain over the period Aug 27-Sept 05 were in southeast Louisiana, southeast Mississippi, western Alabama, and in southeast Florida with totals anywhere from 120 mm to upwards of 320 mm. Locally, New Orleans reported up to 500 mm of rain". NASA "Tropical Rainfall Measuring Mission" (TRMM) accumulation rainfall due to the passage of ISAAC is shown in Figure 7. According to NOAA observational data, over the period Aug 27-31, ca.260 mm of rain has been recorded in two stations near New Orleans (see Table 2).

Date (UTC)	Maximum rain rate (mm/6h)	Maximum rain rate (mm/h)
30/08/2012 12:00	114	19
30/08/2012 00:00	147	25
29/08/2012 18:00	177	30
29/08/2012 12:00	177	30
29/08/2012 06:00	175	29
29/08/2012 00:00	243	41
28/08/2012 18:00	271	45
28/08/2012 06:00	257	43
28/08/2012 00:00	185	31
27/08/2012 18:00	177	30
27/08/2012 06:00	133	22
27/08/2012 00:00	122	20
26/08/2012 18:00	118	20
26/08/2012 12:00	153	26
26/08/2012 06:00	151	25
26/08/2012 00:00	147	25
25/08/2012 18:00	143	24
25/08/2012 12:00	131	22
25/08/2012 06:00	185	31
25/08/2012 00:00	187	31
24/08/2012 18:00	189	32
24/08/2012 12:00	193	32
24/08/2012 06:00	191	32
24/08/2012 00:00	191	32
23/08/2012 18:00	193	32
23/08/2012 12:00	191	32
23/08/2012 06:00	169	28
23/08/2012 00:00	131	22
22/08/2012 18:00	128	21
22/08/2012 12:00	128	21
22/08/2012 06:00	128	21
22/08/2012 00:00	64	11
21/08/2012 18:00	68	11
21/08/2012 12:00	96	16

Table 1 - ISAAC rainfall statistics: Maximum accumulation over time, as well as countries affected by rainfall over 100mm (maximum accumulation does not necessarily fall over land in the country).

[4] http://www.nasa.gov/mission_pages/hurricanes/archives/2012/h2012_Isaac.html

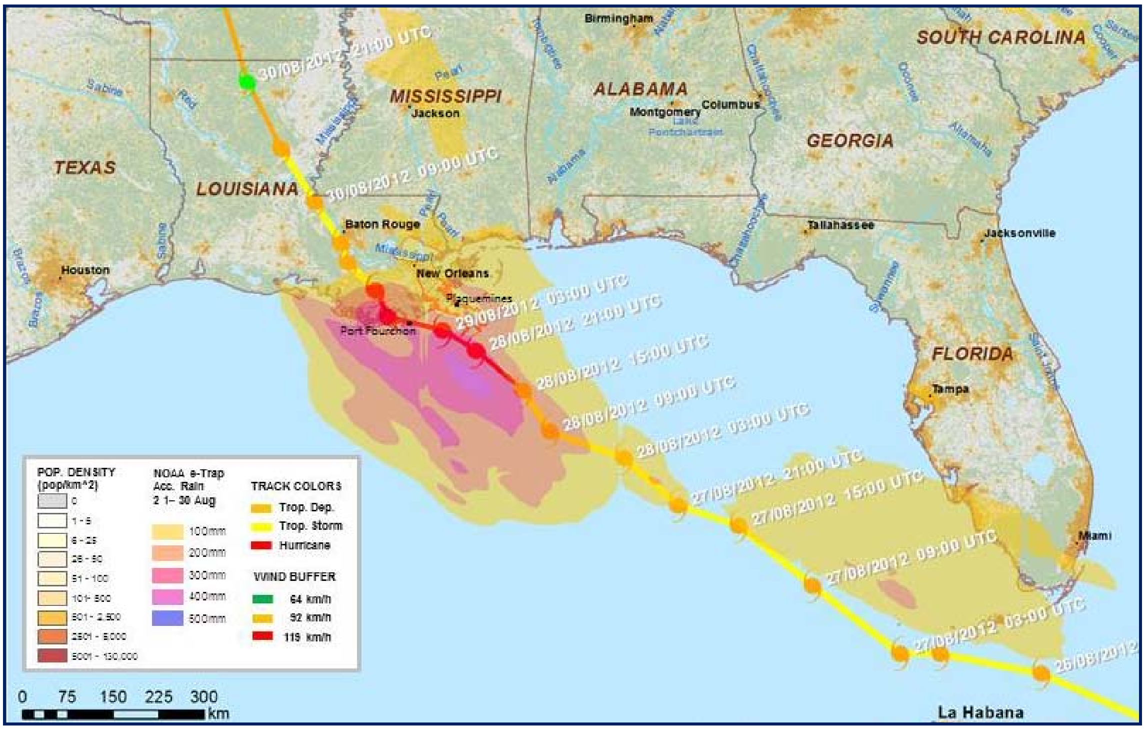


Figure 6 - NOAA eTRaP accumulation rainfall (GDACS)

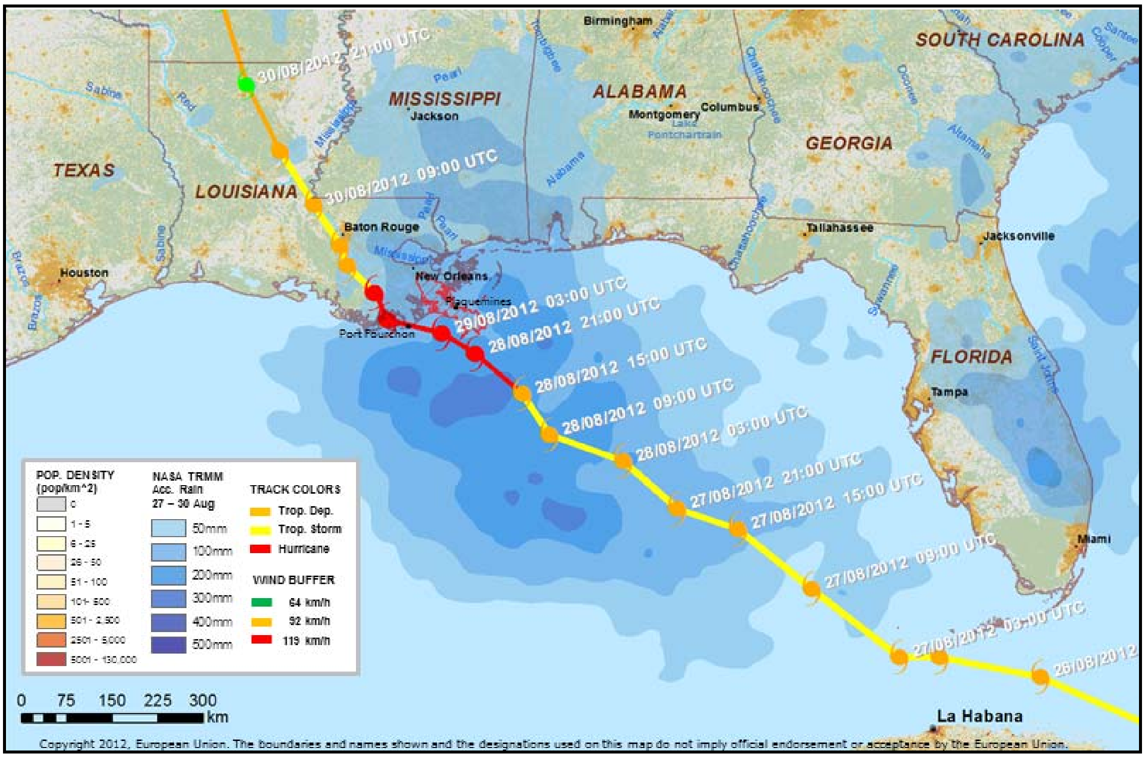
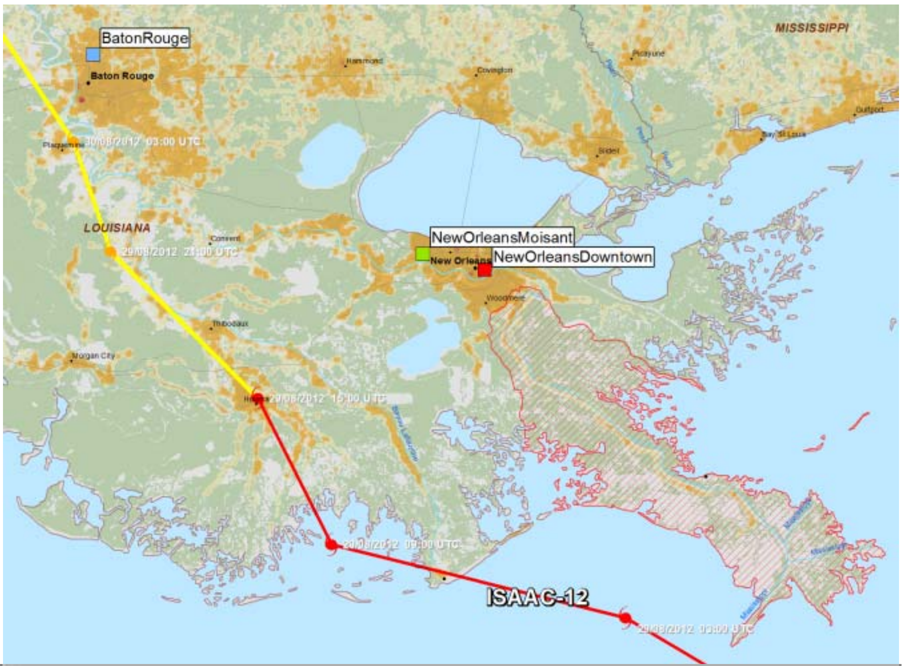


Figure 7 - ISAAC track and NASA/TRMM accumulation rainfall over the period 27 - 30 Aug.

Station	Latitude	Longitude	Accumulated Rain 27-31 Aug 2012
Baton Rouge	30.537°	- 91.147°	127 mm
New Orleans / Downtown (*)	29.950°	- 90.083°	265 mm
New Orleans/M oisant	29.993°	- 90.251°	261 mm



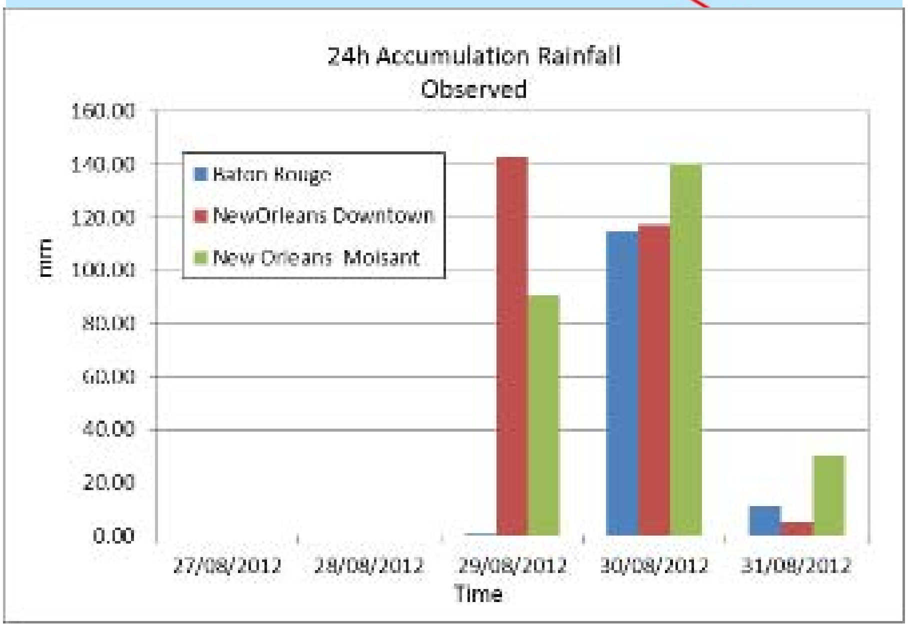


Table 2 - NOAA Rainfall data (27-31 Aug). The table above shows the accumulation over the period 27-31 Aug, the map in the middle shows the locations of the stations and the figure in the middle the 24h accumulation rainfall.(source: http://gis.ncdc.noaa.gov/map/cdo/?thm=themePrecip)
(*) 24h Accumulation Rainfall in New Orleans Downtown were not available for 27-28 Aug.

4.3. Storm surge impact

Storm surge is an abnormal rise of water above the predicted astronomical tides, generated by strong winds and by a drop in the atmospheric pressure. The wind friction and pressure gradient generate long waves that can be modelled by the shallow water equations. Since 2004, the JRC has developed experience in tsunami early warning system (Annunziato, 2007) and inundation modelling using HyFlux2 code, which solves the shallow water equations by a finite volume method (Franchello, 2008; Franchello, 2010). Therefore the JRC has introduced the atmospheric forcing in the shallow water equations, solved by HyFlux2 code, to simulate the storm surge phenomena (Probst and Franchello, 2012), see next Section.

The GDACS alert levels are based on the maximum storm surge height:

- Green when the storm surge is below 1.5m;
- Orange when the storm surge is between 1.5m and 3m;
- Red when the storm surge is above 3m.

GDACS alert level for Tropical Cyclone ISAAC was RED in the US (see Table 3).

4.3.1. Model description

The atmospheric forcing - wind friction and pressure gradient - has been included in the shallow water equations solved by HyFlux2 code. The Holland parametric model (Holland, 1980; Holland et al. 2010) is used to infer this forcing and uses it into the source terms of the shallow water equations. This model develops an idealized representation of the Tropical Cyclone (TC), based on a few key parameters (named hereafter Holland parameters): track, maximum wind speed (V_{max}) or minimum central pressure (P_c), and the radius of maximum wind (R_{max}). The method solves simplified equations and therefore is very efficient and widely used in storm surge modelling (see Harper et al., 2001). The Holland's parameters are not globally available; therefore the JRC has developed a Monte Carlo method to obtain the required parameters using the data available in the cyclones bulletins provided by the NOAA or by the Joint Typhoon Warning Centre (JTWC)[5], through the Pacific Disaster Centre (PDC). This method used as input the coordinates of TC centre (Latitude and Longitude), the maximum velocity V_{max} and wind radii at each quadrant[6]. JRC storm surge calculations for ISAAC are presented in Section 4.3.2.

Other than JRC storm surge model, several other storm surge models are used to predict the Tropical Cyclone impact (see Harper et al, 2001). In the Atlantic basins, the Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model is used by NOAA (see Section 4.3.3).

JRC uses a deterministic approach to obtain the storm surge impact, other Centres uses a probabilistic approach. NOAA NHC Storm Surge Product Decision Support Wedge uses three different approaches to utilize available storm surge data for decision support (see NOAA NHC slosh web site). In Section 4.3.3 the NOAA NHC probabilistic Storm Surge (p-surge) product, based upon an ensemble of SLOSH model runs using the current official hurricane advisory, are compared with the JRC storm surge model calculations.

[5] In the Atlantic basin NOAA data are used.

[6] The wind radii represent the maximum radial extent – in nautical miles - of winds reaching 34, 50, and 64 knots in each quadrant (NE, SE, SW, and NW).

4.3.2. JRC Calculations

The calculation has been performed using PDC-NOAA bulletins[7], which include the analysis (time 0) and the forecasts. An automatic procedure submits a simulation when a new bulletin is available. The initial conditions of the simulation are taken from the results at time 0 of the previous bulletin, i.e., at time -6 hour if a bulletin is delivered every 6 hours. A forecast of 72 hour is performed. The published results are related from past to current bulletins. The final calculated heights and maps published in GDACS are reported below.

Locations affected by Storm surge (15 of 1474)
Calculation based on advisory number 38 of 30 Aug 2012 15:00:00.
(Simulation using 2 minute resolution)

Date	Name	Country	Storm surge height (m)
29 Aug 2012 09:00:00	Chef Menteur	United States	3.1m
29 Aug 2012 09:00:00	Martello Castle	United States	3.1m
30 Aug 2012 17:00:00	Little Woods	United States	3.1m
29 Aug 2012 09:00:00	Greens Ditch	United States	2.7m
29 Aug 2012 09:00:00	Lake Catherine	United States	2.7m
29 Aug 2012 09:00:00	Yscloskey	United States	2.6m
29 Aug 2012 20:00:00	Kenner	United States	2.6m
29 Aug 2012 09:00:00	White Kitchen	United States	2.5m
29 Aug 2012 09:00:00	Jackson Landing	United States	2.5m
29 Aug 2012 09:00:00	Riolets	United States	2.5m
29 Aug 2012 09:00:00	Pearlington	United States	2.4m
29 Aug 2012 09:00:00	Ansley	United States	2.4m
31 Aug 2012 00:00:00	Lee	United States	2.4m
29 Aug 2012 03:00:00	Saint Malo	United States	2.3m

Table 3 - List of locations affected by a storm surge greater than 2.3m (calculations based on NOAA Adv. 38)

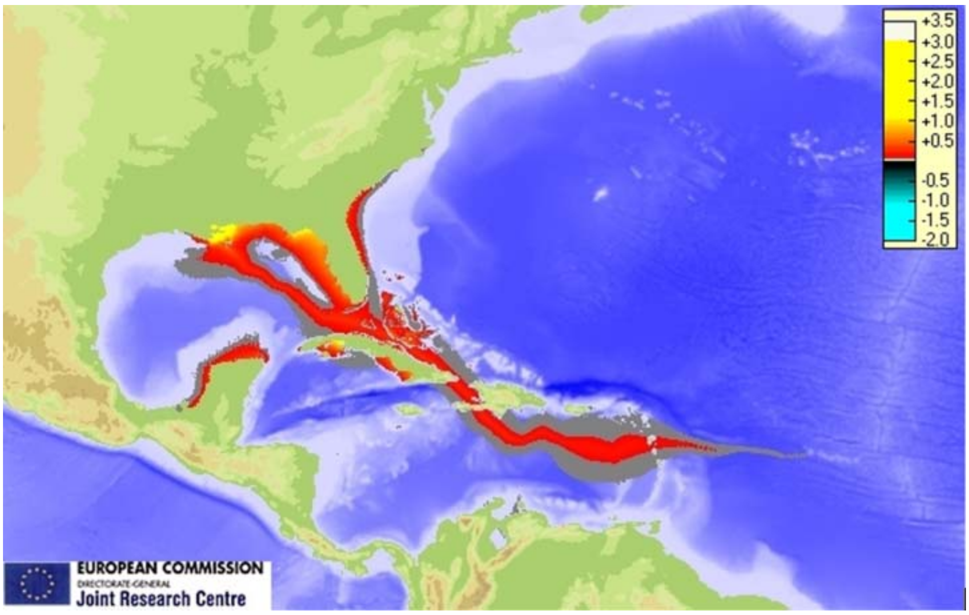


Figure 8- Maximum sea level above normal tide simulated by HyFlux2 (using as input data of Adv. 38)

[7] Tropical Cyclone developed in the Atlantic Ocean. In this basin, the bulletins, provided by PDC, are based on NOAA advisories data. Hereafter, these bulletins will be named NOAA bulletins/advisories.

The JRC storm surge calculations based on the advisories available two and one days before the landfall[8], few hours before landfall and after the landfall are presented below. The Advisories used for each "cases" analysed are the following:

a) *FORECAST: 2 days before landfall (Aug 27 09:00 UTC, **Adv. 25**)*
b) *FORECAST: 1 day before landfall (Aug 28 09:00 UTC, **Adv. 29**)*
c) *FORECAST: few hours before the second landfall (Aug 29 03:00 UTC, **Adv. 32**)*
d) *POST-ANAYLIS: more than 1 day after the landfall (Aug 30 15:00 UTC, **Adv. 38**)*

The calculations are compared with the tidal gauges measures. In the next Section the calculations will also compared with the NOAA Storm surge probabilities.

a) *FORECAST: Calculation 2 days before landfall*

TC ISAAC at 09:00 UTC Aug 27 (Adv. 25), was a Tropical Storm with a 1-min sustained maximum wind speed of 101 km/h and its centre was located ca. 300 km W of southern tip of Florida. It was moving NW in the Gulf of Mexico, in the direction of the coasts of Mississippi and Louisiana, strengthening (see Figure 9). JRC storm surge model, using as input data the Advisories 25 of 27 August, indicates a possible storm surge in the order of 2.5-3.8 m in the coastal areas near New Orleans for 29 Aug between 04:00-06:00 UTC (see Table 4, Figure 10).

Locations affected by Storm surge (15 of 1547)
Calculation based on advisory number 25 of 27 Aug 2012 09:00:00.
(Simulation using 2 minute resolution)

Date	Name	Country	Storm surge height (m)
29 Aug 2012 05:00:00	Little Woods		3.8m
29 Aug 2012 06:00:00	Martello Castle		3.8m
29 Aug 2012 06:00:00	Chef Menteur		3.7m
29 Aug 2012 05:00:00	Huntington Park		3.6m
29 Aug 2012 06:00:00	Camp Leroy Johnson		3.4m
29 Aug 2012 06:00:00	Gentilly Terrace		3.3m
29 Aug 2012 06:00:00	Lake Catherine		3.3m
29 Aug 2012 06:00:00	White Kitchen		3.2m
29 Aug 2012 06:00:00	Riolets		3.1m
29 Aug 2012 05:00:00	Alluvial City		3.1m
29 Aug 2012 06:00:00	Pearlington		3.0m
29 Aug 2012 06:00:00	Jackson Landing		3.0m
29 Aug 2012 04:00:00	Hopedale		2.9m
29 Aug 2012 06:00:00	Ansley		2.9m

Table 4 - List of locations affected by a storm surge greater than 2.8m (calculations based on NOAA Adv. 25)

[8] ISAAC made two landfalls: first at 23:45 UTC on Aug 28 in Plaquemines Parish, second at 07:15 UTC on Aug 29 near Port Fourchon. Hereafter the landfall term is used to indicate the second landfall.

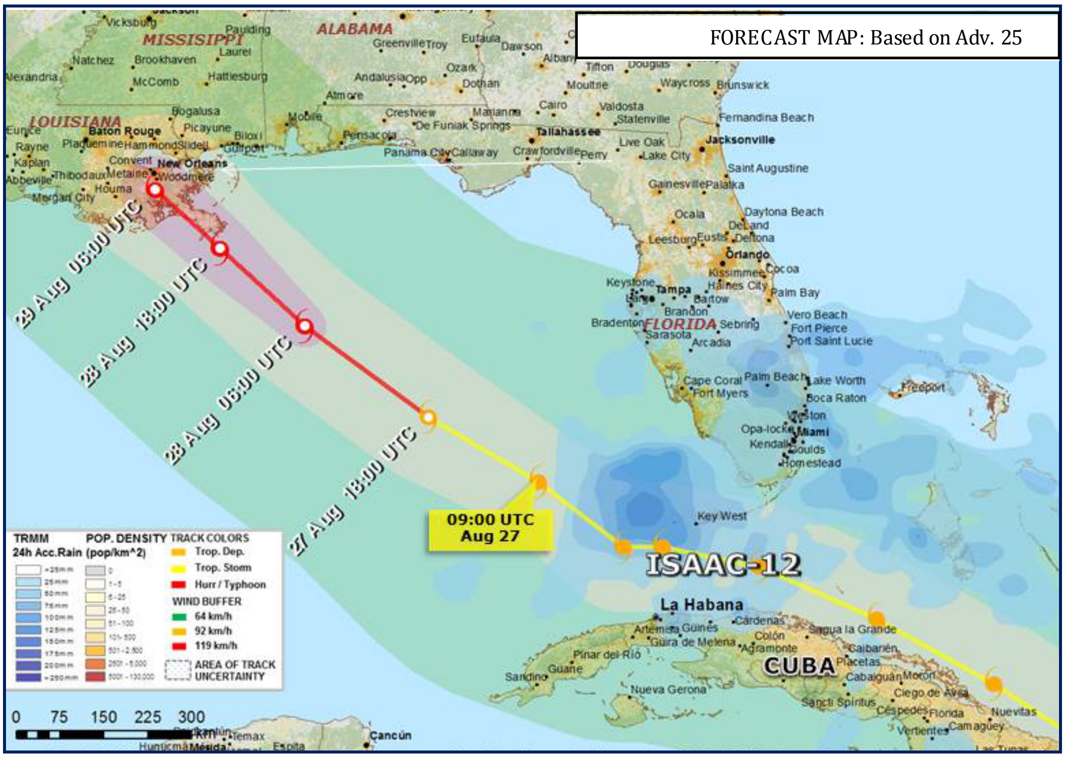


Figure 9 - ISAAC forecast track (using data of Adv. 25)

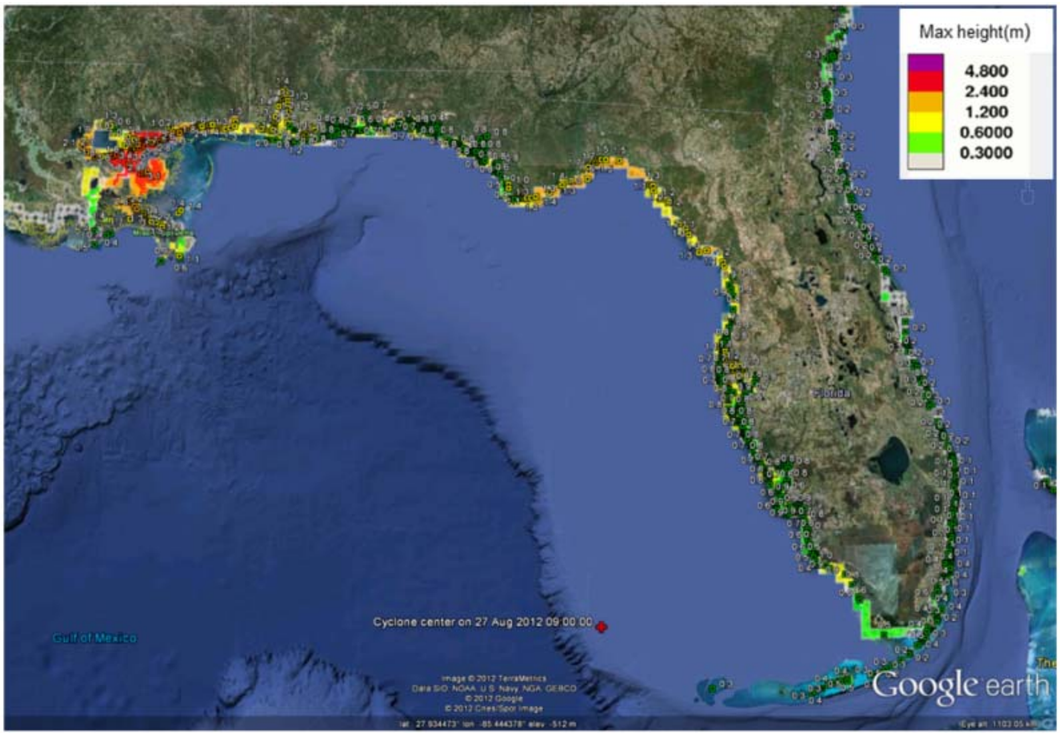


Figure 10 - JRC inundation height calculation (Based on the data of Adv. 25).

b) <u>FORECAST: Calculation 1 day before landfall</u>

The center of ISAAC at 09:00 UTC Aug 28 (Adv. 29) was located around 200 Km SSE of the mouth of the Mississippi River. According to the data of Adv. 29, its center was forecast to reach the Mississippi Delta River on Aug 28 evening (UTC) and pass close to New Orleans on Aug 29 morning/afternoon (UTC), see Figure 11. The calculations, using as input the data of Adv. 29 of 28 August, indicated a possible storm surge in the order of 2.5 to 3.5 m for Aug 29 early morning (4:00 to 6:00 UTC) in the coastal area E-SE of New Orleans (see Figure 12).

Locations affected by Storm surge (15 of 1526)
Calculation based on advisory number 29 of 28 Aug 2012 09:00:00.
(Simulation using 2 minute resolution)

Date	Name	Country	Storm surge height (m)
30 Aug 2012 00:00:00	Little Woods		3.6m
29 Aug 2012 07:00:00	Martello Castle		3.5m
29 Aug 2012 08:00:00	Chef Menteur		3.5m
30 Aug 2012 00:00:00	Lee		3.3m
30 Aug 2012 00:00:00	Camp Leroy Johnson		3.2m
29 Aug 2012 08:00:00	Greens Ditch		3.1m
29 Aug 2012 09:00:00	White Kitchen		3.0m
29 Aug 2012 07:00:00	Lake Catherine		3.0m
29 Aug 2012 09:00:00	Pearlington		2.9m
29 Aug 2012 06:00:00	Yscloskey		2.9m
29 Aug 2012 08:00:00	Riolets		2.9m
29 Aug 2012 13:00:00	Ruddock		2.8m
29 Aug 2012 12:00:00	Kenner		2.8m
29 Aug 2012 12:00:00	Frenier		2.8m

Table 5 - List of locations affected by a storm surge greater than 2.7m (calculations based on NOAA Adv. 29)

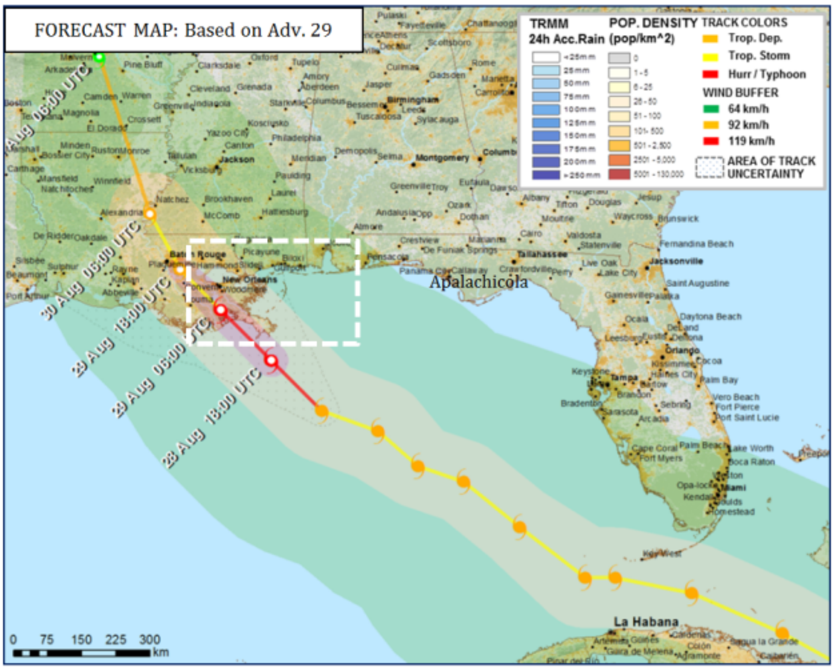


Figure 11 - Map of Forecast track of ISAAC, based on the data of Adv. 29

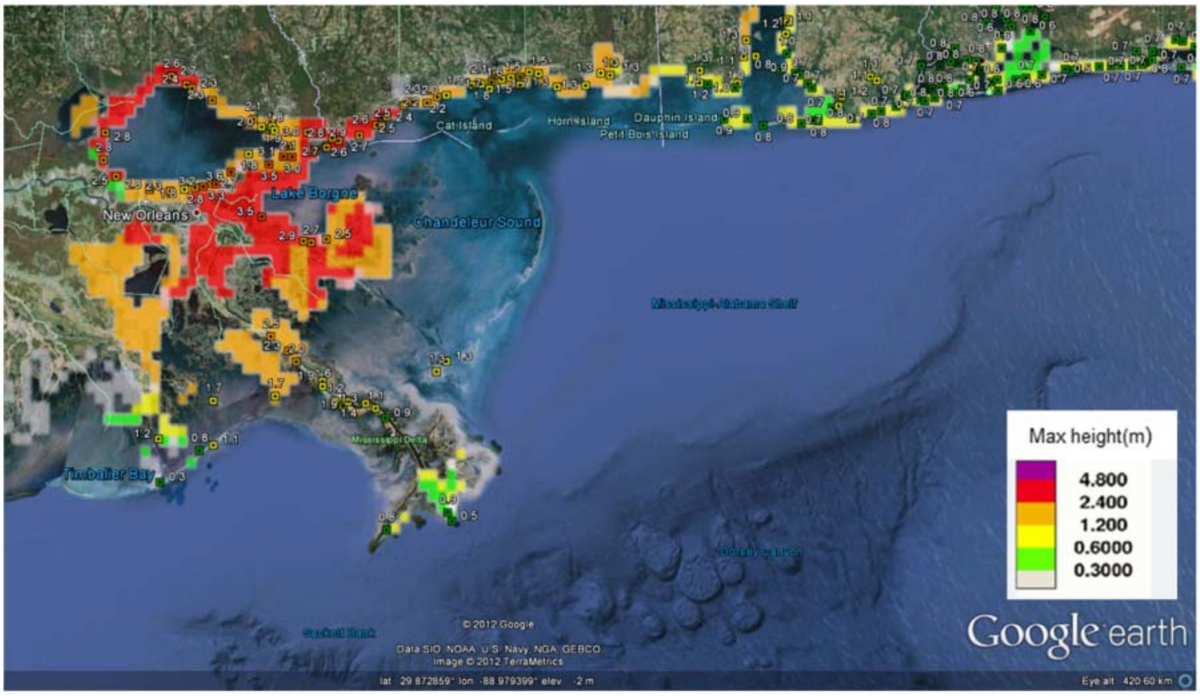


Figure 12 - JRC Inundation height calculation (Based on the data of Adv. 29)

Sea Level Measurements

The maximum sea level above normal tide simulated by HyFlux2, using as input the data of Adv. 29, was compared with the observations of 5 buoys (see Figure 14). The colours in the squares in Figure 13 correspond to the colours of the calculated values in Figure 14. The measured values are always in purple. The agreement was good for all the quantities. The highest measured sea level increase (1 day before landfall), of about 1m, was occurring in Apalachicola, Florida. The maximum expected height, in the measured locations was about 2m in Bay Waveland Yacht Club. **These comparisons allowed to confirm that the accuracy of the storm surge forecasts performed for this Tropical Cyclone were height, therefore the inundation height map presented in** Figure 12 **might be used, in this case, for evacuation with high confidence.**

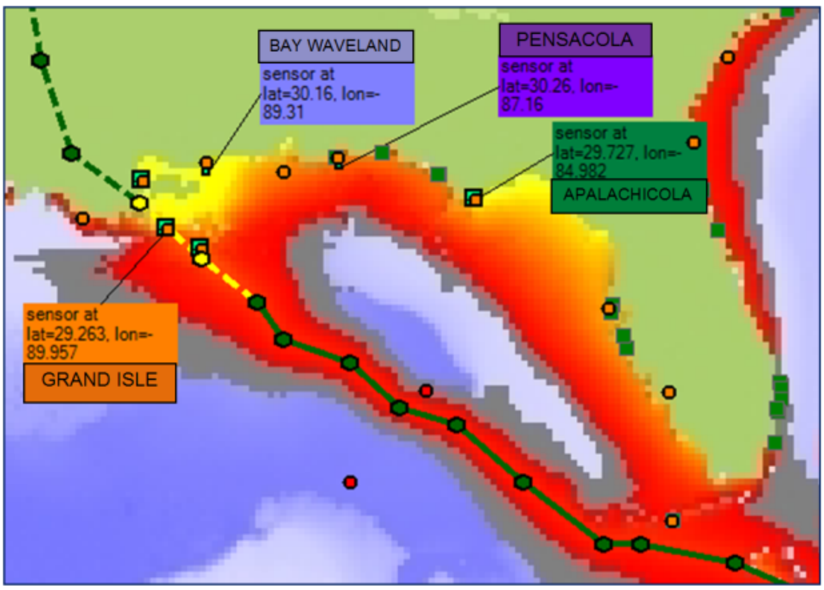
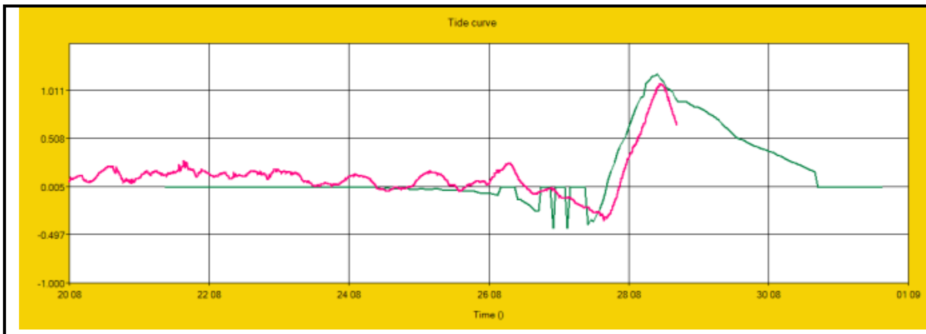
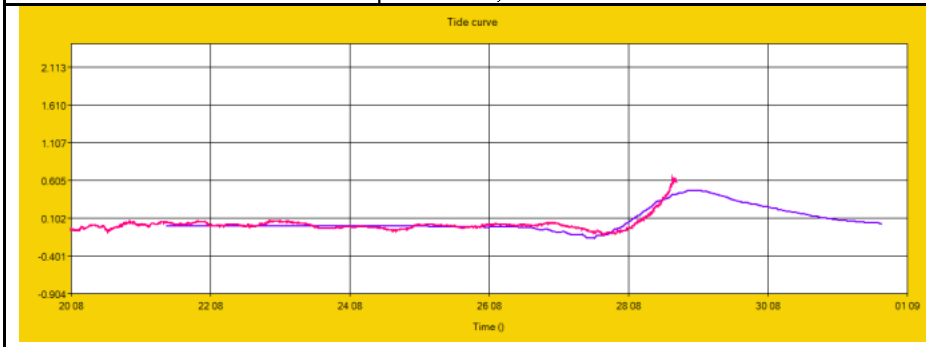


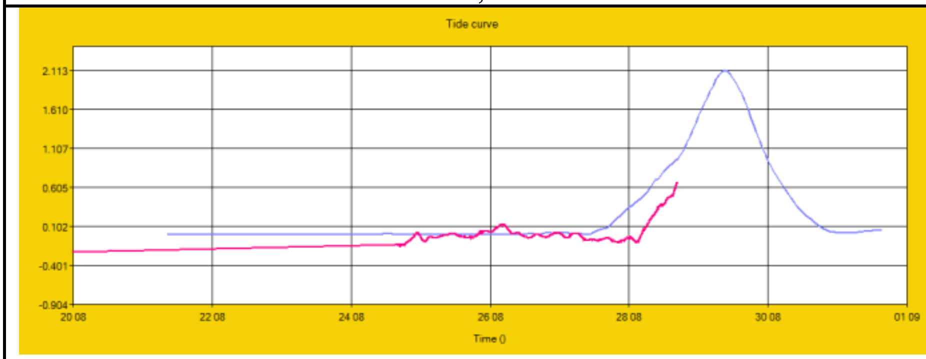
Figure 13 - Maximum sea level above the normal tide calculated using as input the data of Adv. 29. The colours in the squares correspond to the colours of the calculated values in the plots below. Green line track indicates tropical storm status, yellow hurricane status; dotted line corresponds to forecast data.



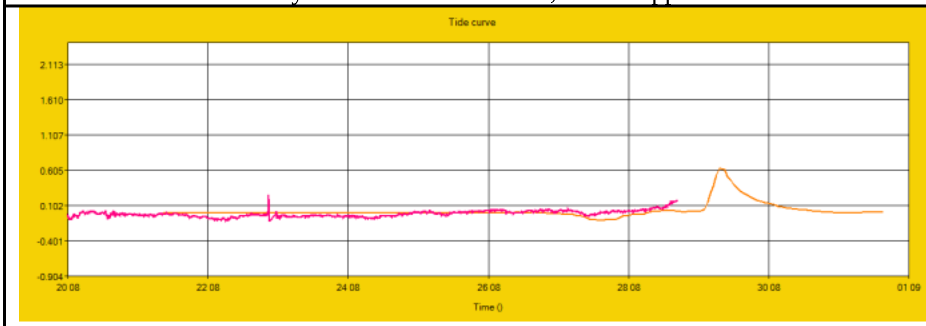
Apalachi cola, Florida



Pensacola, Florida



Bay Waveland Yacht Club, Mississippi



Grand Isle, Louisiana

Figure 14 - Comparison between calculations and observations. Purple curve is the sea level (measured level-predicted tide), the other colors-curves are the calculations (using as input data of Adv. 29). The colors in the squares in Figure 13 are corresponding to the colors of the calculated values in these plots.

c) <u>FORECAST: few hours before the landfall</u>

Tropical Cyclone ISAAC made the first landfall in Plaquemines Parish, just SW of the mouth of the Mississippi, at 23:34 UTC on Aug 28 with a max sustained wind speed of 130 km/h; after the first landfall it moved again over water towards the coast of SE Louisiana. At 03:00 UTC on Aug 29 (Adv. 32), it was a hurricane of category 1 (with max sust. wind speed of 130 km/h) and its center was located about 50 km E-SE of Port Fourchon, Louisiana, where it made the second landfall few hours later (at around 07:15 UTC).

The JRC calculations, using as input the data of Adv. 32, indicated a possible storm surge in the order of 2.5 to 3.5m for Aug 29 between 08:00 and 15:00 UTC in the coastal area E-SE of New Orleans (see Figure 15 and Table 1).

Sea Level Measurements:

In Figure 15 JRC calculations (blue line), using as input the data of Adv. 29, are compared with the observations (purple line, measured level– predicted tide) in Bay Waveland Yacht Club. **Observations confirm the good agreement with the calculations, as at been pointed out one day before the landfall.**

NOAA National Ocean Service Tide Gauge Observations: at 04:00 UTC Aug 29, a storm surge of 3.3m was reported at Shell Beach in Louisiana and 2.1 m was observed in Waveland, Mississippi. At this time (04:00 UTC) the water level was still increasing.

Locations affected by Storm surge (15 of 1536)
Calculation based on advisory number 32 of 29 Aug 2012 03:00:00.
(Simulation using 2 minute resolution)

Date	Name	Country	Storm surge height (m)
30 Aug 2012 08:00:00	Little Woods		3.5m
29 Aug 2012 10:00:00	Chef Menteur		3.5m
29 Aug 2012 10:00:00	Martello Castle		3.4m
29 Aug 2012 18:00:00	Kenner		3.2m
30 Aug 2012 15:00:00	Lee		3.2m
30 Aug 2012 15:00:00	Camp Leroy Johnson		3.0m
29 Aug 2012 12:00:00	Greens Ditch		3.0m
29 Aug 2012 12:00:00	White Kitchen		2.9m
29 Aug 2012 10:00:00	Lake Catherine		2.9m
29 Aug 2012 12:00:00	Pearlington		2.8m
30 Aug 2012 15:00:00	Metairie		2.8m
29 Aug 2012 09:00:00	Yscloskey		2.8m
29 Aug 2012 11:00:00	Riolets		2.8m
30 Aug 2012 15:00:00	Lake Terrace		2.7m

Table 6 - List of locations affected by a storm surge greater than 2.6m (Adv. 32)

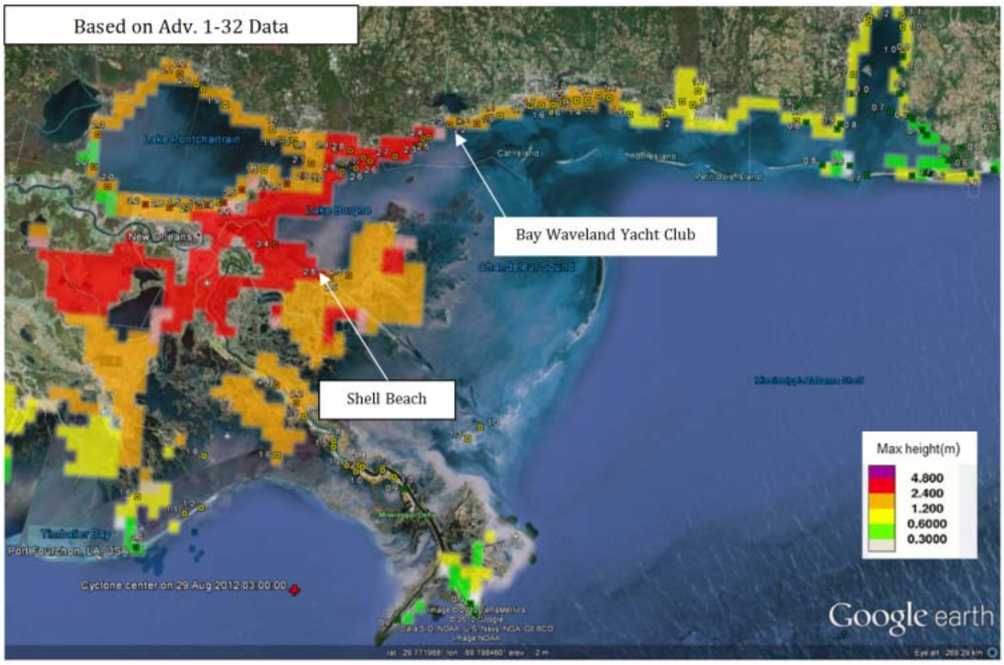


Figure 15 – JRC Inundation height calculation (using as input the data of Adv. 32).

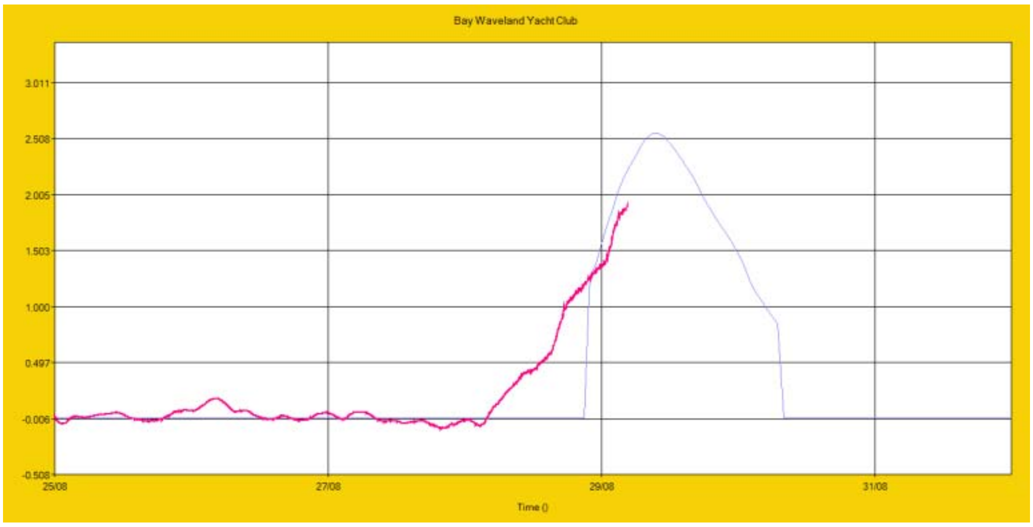


Figure 16 - Blue curve is the calculation and the purple curve is the sea level (measured level – predicted tide) in Bay Waveland Yacht Club

d) POST-ANALYSIS: Calculation after landfall

Tropical Cyclone ISAAC, after the landfall in SE Louisiana on Aug 29, moved NW over Louisiana, passing W of New Orleans on Aug 29 afternoon/evening (UTC), weakening into a tropical storm, then late on Aug 30 into a tropical depression.

The max of storm surge in the areas E-SE of New Orleans (i.e. Shell Beach) was observed few hours after the landfall on Aug 29 (morning, UTC), while in the areas NE of this city (i.e. Bay Waveland) in the afternoon. JRC storm surge calculations, using as input the data of the bulletins after the landfall (Adv. 38, Aug 30 15:00 UTC), estimated a possible storm surge in the order of 2-3m in the coastal area E of New Orleans for Aug 29 morning (around 09:00 UTC). JRC calculations are shown in Table 7 and Figure 17.

Sea Level Measurements:

In Figure 19 JRC calculations (blue line) are compared with the observations (purple line, measured level– predicted tide). Periodical oscillations of the measured-predicted tide are due to the coarse method used to evaluate the predicted tide. The tide gauge in East Bank provided measurements that first deviate from the calculations and then stops. In Pilot Station East tide gauge the predicted values are lower than the measured: better accuracy is realised in tide gauges that are located in protected areas.

Final observations confirm the good agreement with the calculations.

Locations affected by Storm surge (15 of 1474)
Calculation based on advisory number 38 of 30 Aug 2012 15:00:00.
(Simulation using 2 minute resolution)

Date	Name	Country	Storm surge height (m)
29 Aug 2012 09:00:00	Chef Menteur	United States	3.1m
29 Aug 2012 09:00:00	Martello Castle	United States	3.1m
30 Aug 2012 17:00:00	Little Woods	United States	3.1m
29 Aug 2012 09:00:00	Greens Ditch	United States	2.7m
29 Aug 2012 09:00:00	Lake Catherine	United States	2.7m
29 Aug 2012 09:00:00	Yscloskey	United States	2.6m
29 Aug 2012 20:00:00	Kenner	United States	2.6m
29 Aug 2012 09:00:00	White Kitchen	United States	2.5m
29 Aug 2012 09:00:00	Jackson Landing	United States	2.5m
29 Aug 2012 09:00:00	Riolets	United States	2.5m
29 Aug 2012 09:00:00	Pearlington	United States	2.4m
29 Aug 2012 09:00:00	Ansley	United States	2.4m
31 Aug 2012 00:00:00	Lee	United States	2.4m
29 Aug 2012 03:00:00	Saint Malo	United States	2.3m

Table 7 - List of locations affected by a storm surge greater than 2.3m (calculations based on Adv. 38)

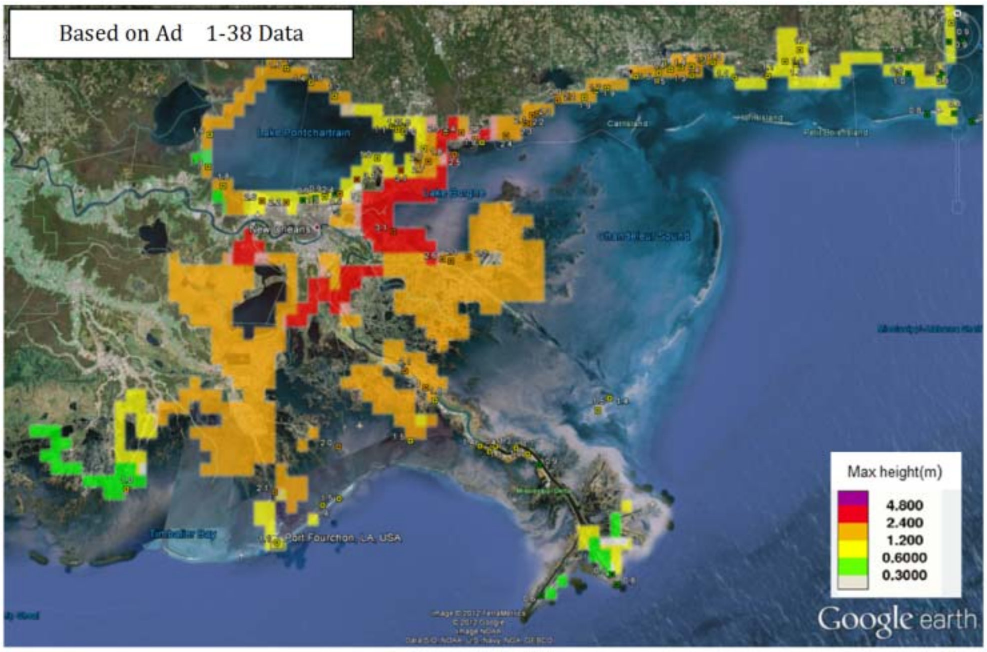


Figure 17 - JRC Inundation height calculation (using as input the data of Adv. 38)

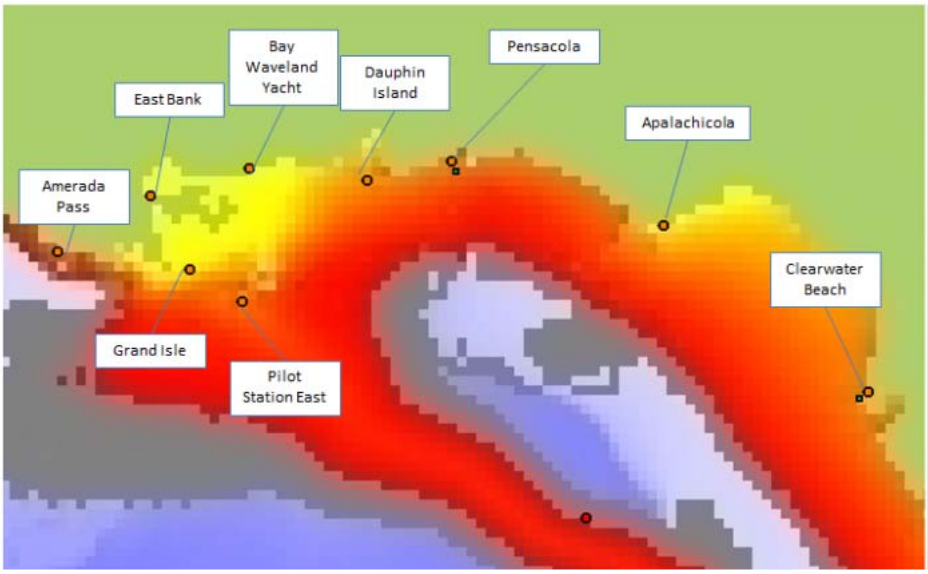
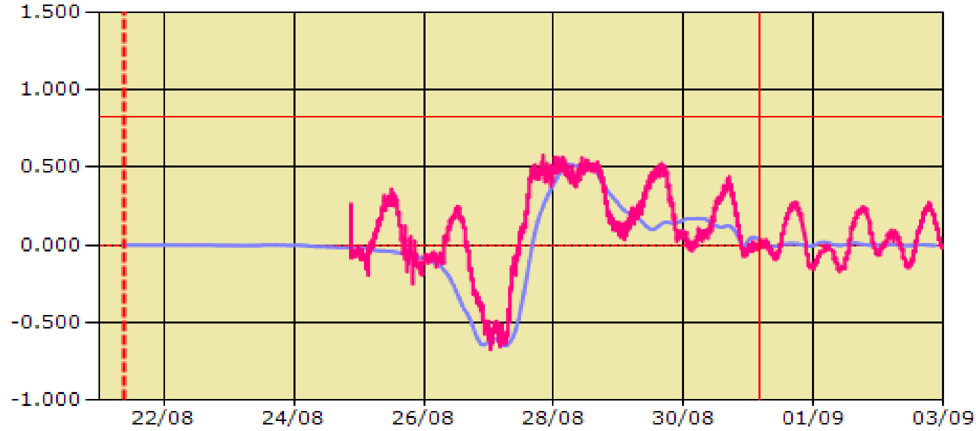
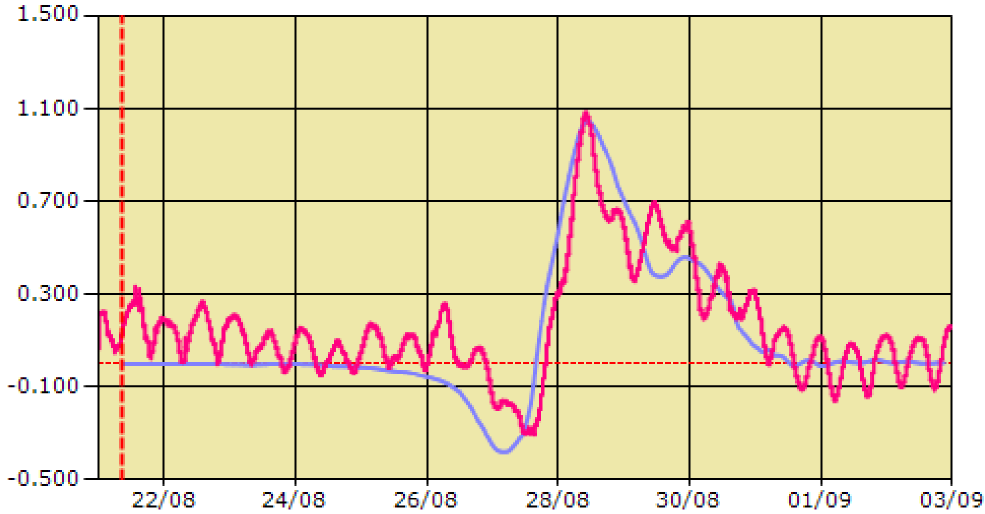


Figure 18 - Maximum sea level above the normal tide calculated using as input the data of Adv. 38. Circles: tide gauge locations.

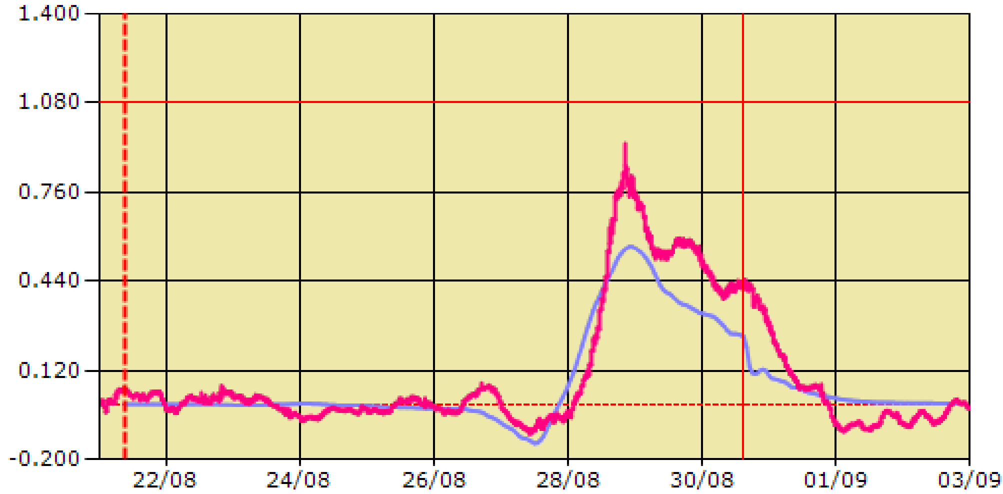
Clearwater Beach



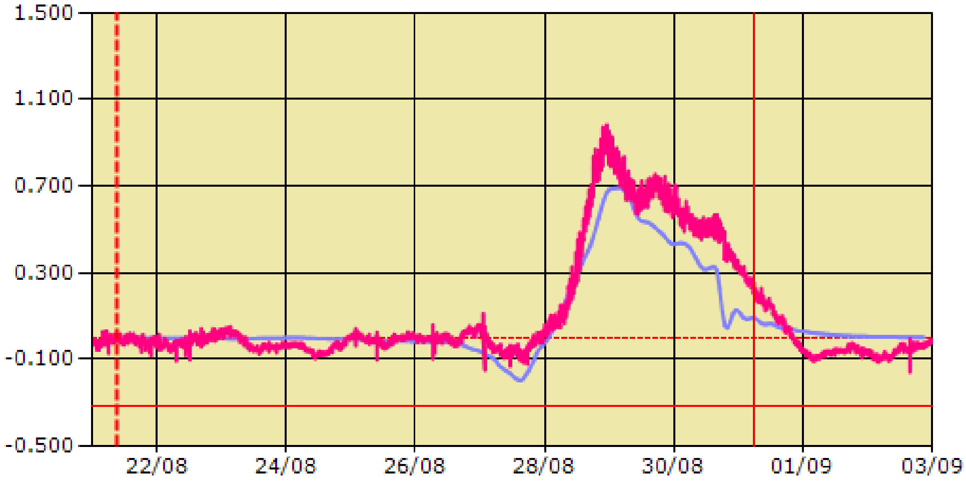
Apalachiola



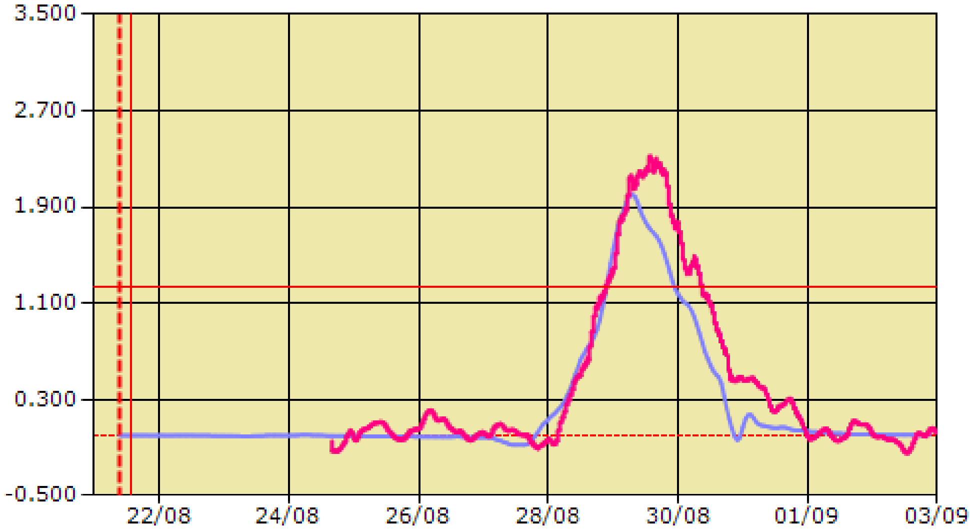
Pensacola



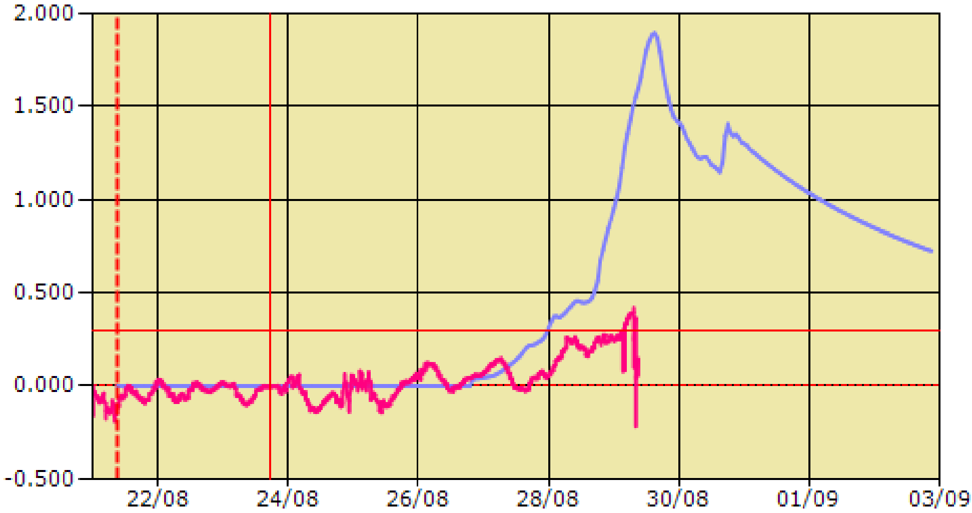
Dauphine Island



Bay Waveland Yacht Club



East Bank



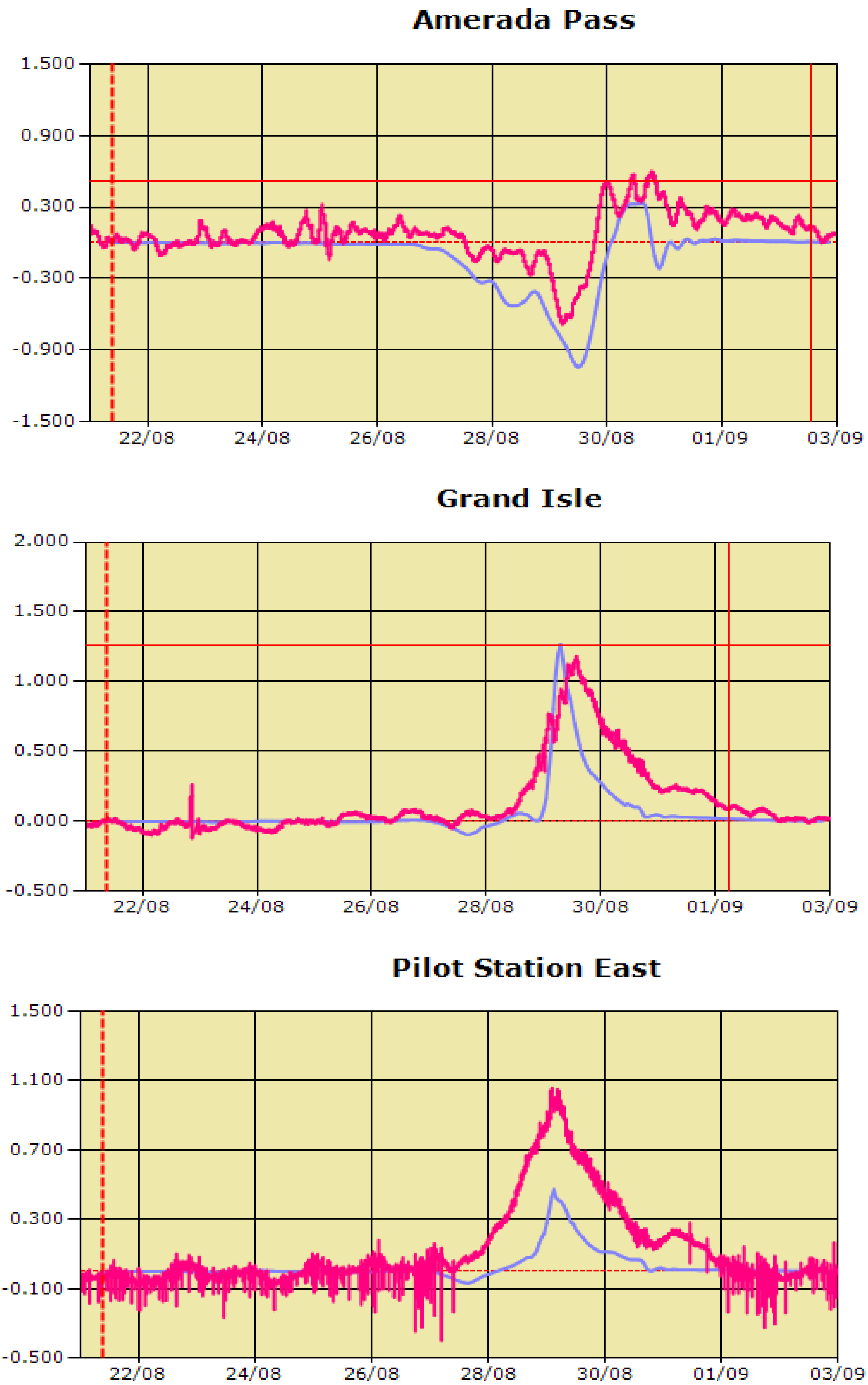


Figure 19 - Comparison between calculations and observations. Purple curve is the sea level (measured level-predicted tide) while the blue curves are the calculations (using as input data of Adv. 38). See Figure 18 for the the tide gauge locations.

4.3.3. Comparisons between JRC calculations and NOAA Storm Surge Probabilities products

JRC uses a deterministic approach to obtain the storm surge impact while other Centres use a probabilistic approach. In this Section the NOAA NHC probabilistic Storm Surge (P-surge)[9] product is compared with the JRC *HyFlux2* deterministic storm surge calculations. The P-surge product is developed by the Meteorological Development Laboratory (MDL) of the National Weather Service (NWS), in cooperation with the NHC. The Tropical Cyclone storm surge probabilities (2-25 feet) graphics show the overall chance that a storm surge greater than a specific height - between 2 and 25 feet - will occur at each individual location on the map during the forecast period indicated. These graphics are based upon an ensemble of Sea, Lake, and Overland Surge from Hurricanes (SLOSH) model runs using the current official tropical cyclones advisories data.

SLOSH Model is a computer code developed by Federal Emergency Management Agency (FEMA), United States Army Corps of Engineers and by the National Weather Service to define flood-prone areas for evacuation planning. It is run by the NOAA National Hurricane Centre to estimate storm surge heights and winds resulting from historical, hypothetical, or predicted hurricanes. SLOSH model solves the depth-integrated shallow water equations using a finite difference solution and a polar or elliptical/hyperbolic grid type (depending on the specific coastal area called basin[10]). SLOSH uses a simplified, parametric wind and pressure model, which required as input the radius Rmax and the pressure difference between the center of the storm and the ambient pressure (Deltap) over time, derived from NHC's advisory data. More information on SLOSH model can be found in Jelesnianski et al. (1992), Glahn et al. (2009), Dube et al. (2010), on the NOAA NHC SLOSH website[11] and FEMA website[12].

Since the errors in the input provided to SLOSH far exceed the error in the model, a probabilistic approach for the inputs seemed appropriate (see Harper et al, 2001). The probabilistic hurricane storm surge (P-surge) model[13] was developed to calculate the probability of storm surge from an ensemble of forecasts. The approach is, instead of using a single run of the model based on the current NHC hurricane forecast, to use an ensemble of hypothetical storms based on both the current NHC hurricane forecast and combinations of error distributions derived from historic NHC advisories, to estimate the probability of storm surge.

The comparisons of the JRC deterministic calculations with the NOAA probabilistic P-surge products are shown below. For the three analysed Advisories, the maximum water height forecasted by the JRC model is quite stable in value (from 2.5 m to 3.5 m) and spatial distribution. The NOAA forecasted probabilities - for a maximum water height exceedance of 2.4 m - increase from about 20-30% (2 days before landfall) to 70-90% (few hours before landfall) while the spatial distribution of the forecasted probabilities is stable like for the JRC calculations.

[9] NOAA NHC Storm Surge Product Decision Support Wedge uses three different approaches (deterministic, probabilistic, composite) to utilizing available storm surge data for decision support (see NOAA NHC SLOSH web site: http://www.nhc.noaa.gov/ssurge/ssurge_slosh.shtml).

[10] The areas covered by SLOSH are: U.S. East Coast, Gulf of Mexico, parts of Hawaii, Guam, Puerto Rico, Virgin Islands, various basins in China and India.

[11] http://www.nhc.noaa.gov/HAW2/english/surge/slosh.shtml

[12] http://www.fema.gov/hazard/hurricane/index.shtm

[13] http://www.nws.noaa.gov/mdl/psurge/archive.php

The different behaviour between the two methods should be investigated: it seems that the evaluated probabilities are too low or not consistent with the improvements in the accuracy of the recent tropical cyclones forecast tracks.

a) Comparison with NOAA Storm Surge Probability of Advisory 25.

JRC storm surge model, using as input the data of Adv. 25 (09:00 UTC Aug 27, ca. 2 days before landfall), estimated a max height of the order of 2.5-3.8m for Aug 29 mornings, UTC (see Figure 20). On Aug 27 at 09:00 UTC, the NOAA storm surge probabilities of a storm surge higher than 8 feet (2.4m) in the coastal area near New Orleans was in the order of 10-30% (see Figure 21).

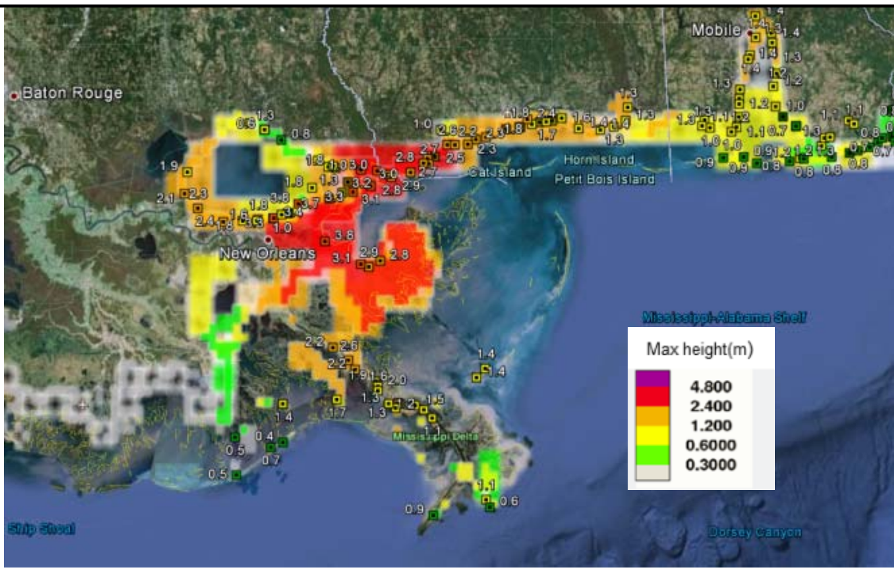


Figure 20 - JRC Inundation height calculation (Based on the data of Adv. 25)

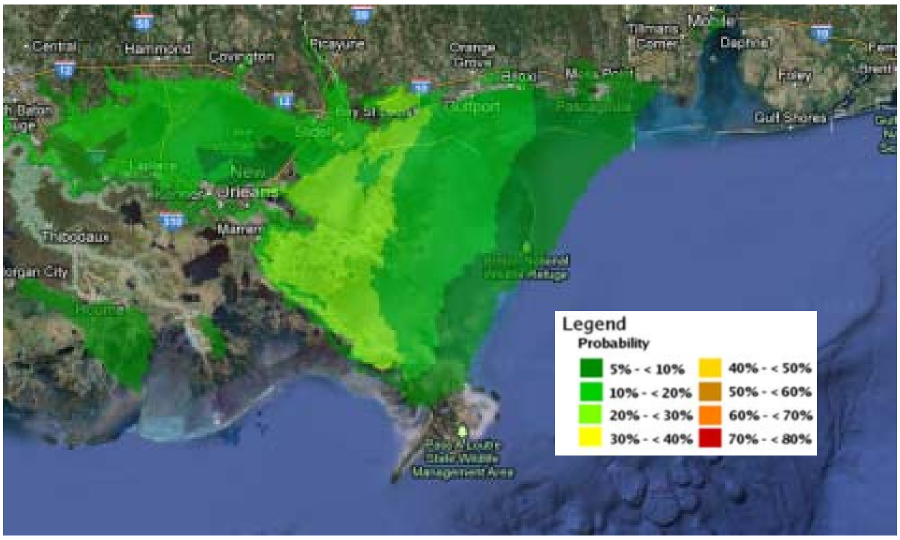


Figure 21 – NOAA storm surge probabilities (Adv. 25). Chance of Storm Surge >= 8 feet (2.4m)[14]. Valid from 05 AM EDT Aug 27 to 10 AM EDT Aug 30.

[14] Source: http://www.nws.noaa.gov/mdl/psurge/archive.php?S=Isaac2012adv25&Ty=gt8&Th=8&Z=

b) Comparison with NOAA Storm Surge Probabilities of Advisory 29

On Aug 20 at 09:00 UTC (about 1 day before the second landfall), the NOAA storm surge probabilities of a storm surge higher than 8 feet (2.4m) in the coastal E of New Orleans was in the order of 20% to 60% (see Figure 23); in this area JRC storm surge model estimated a max height of the order of 2.5-3.5m (see Figure 22).

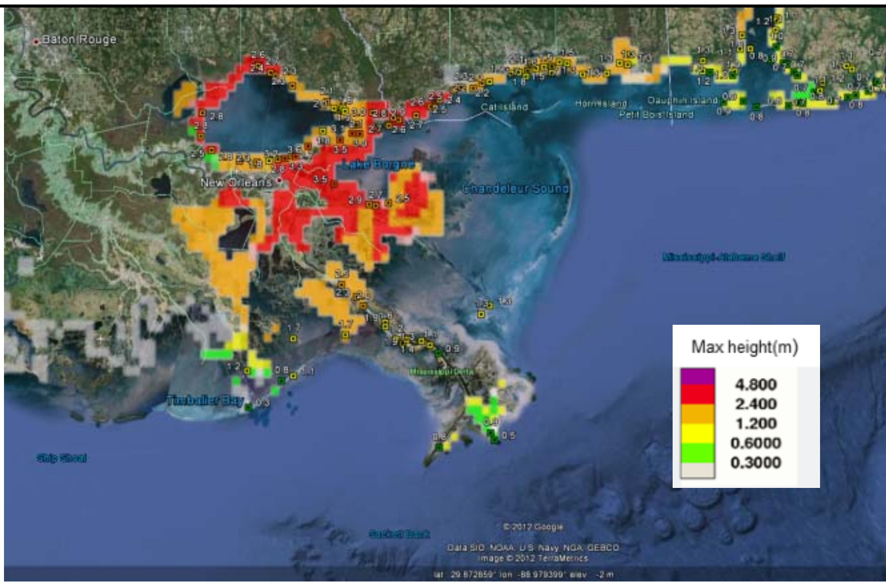


Figure 22 - JRC Inundation height calculation (Based on the data of Adv. 29)

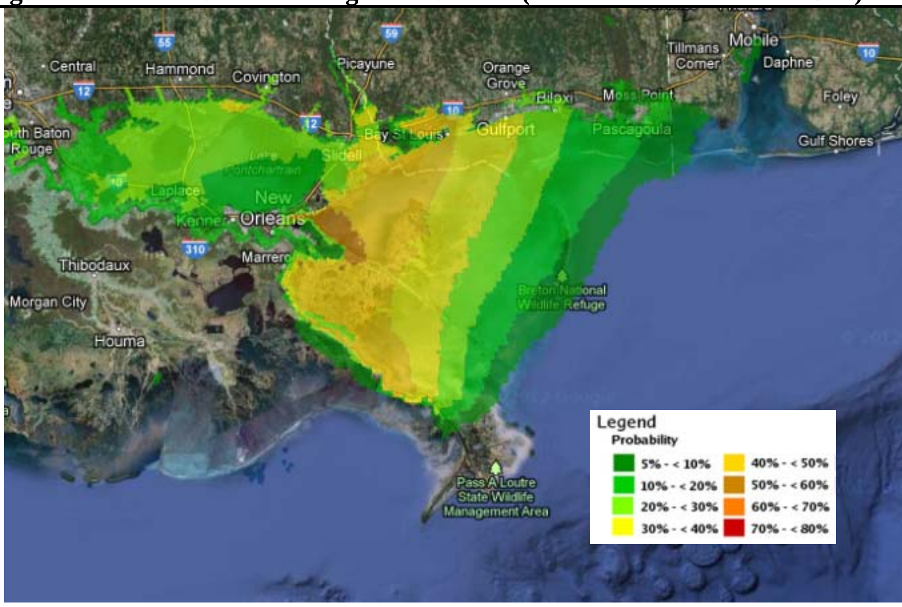


Figure 23 – NOAA storm surge probabilities (as of Adv. 29). Chance of Storm Surge >= 8 feet (2.4m)[15]

[15] Source: http://www.nws.noaa.gov/mdl/psurge/archive.php?S=Isaac2012adv29&Ty=gt8&Th=8&Z=

c) Comparison with NOAA Storm Surge Probabilities of Advisory 32

Few hours before the second landfall (Aug 29 03:00 UTC, Adv. 32) the JRC storm surge model estimated a max height of the order of 2.5-3.5m (see Figure 24). The NOAA storm surge probabilities (as of Adv. 32) of a storm surge higher than 8 feet (2.4m) in the coastal areas near New Orleans was 70-90% in the area SE of New Orleans with a max of 90-100% in a small area near New Orleans (see Figure 25).

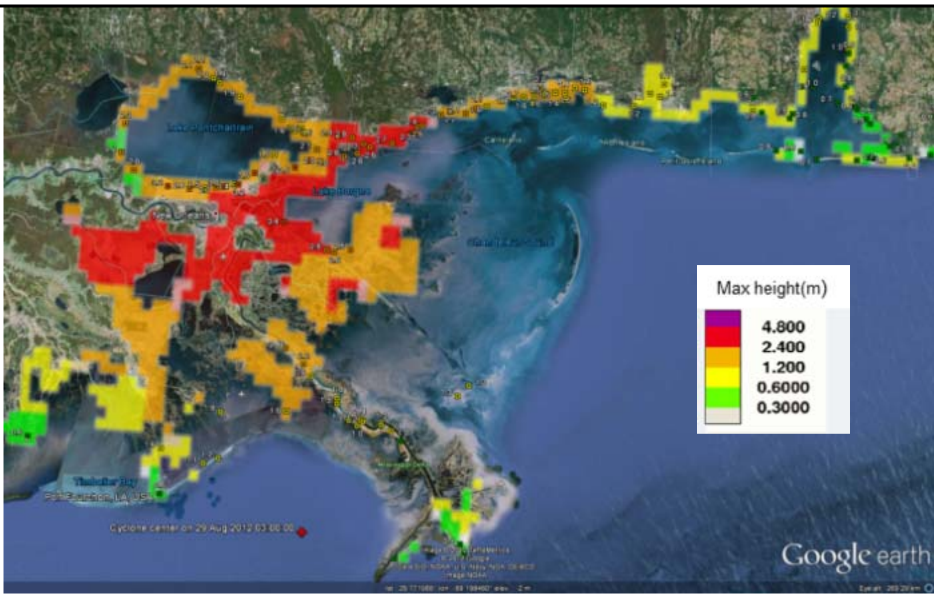


Figure 24 - JRC Inundation height calculation (Based on the data of Adv. 32)

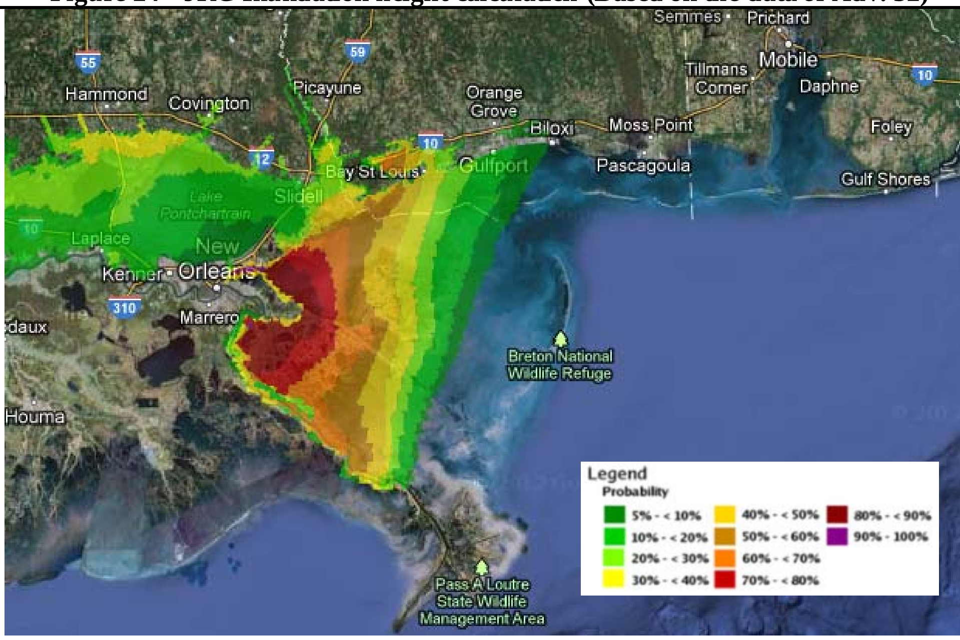


Figure 25 – NOAA storm surge probabilities (as of Adv. 32). Chance of Storm Surge >=8 feet (2.4m)[16]

[16] Source: http://www.nws.noaa.gov/mdl/psurge/archive.php?S=Isaac2012adv32&Ty=gt8&Th=8&Z=

5. CONCLUSIONS

JRC has developed GDACS, an early warning system created to alert the humanitarian community about potential disasters which are under development. Tropical cyclones are some of the most damaging events, affecting the coastal population with three dangerous effects: strong wind, heavy rain and storm surge. GDACS classification, for TC ISAAC in the USA, was: Green for the wind impact, Orange for rain impact and Red for storm surge impact.

On 27 August 2012, 2 days before landfall, JRC storm surge model indicated a possible storm surge in the order of 2.5-3.5m for Aug 29 morning (UTC) in the coastal area E-SE of New Orleans, Louisiana. Observations on the tidal gauges, 1 day before and after the landfall, confirmed the forecast values and allowed to publish the inundation height map with high confidence.

This report analyses and discusses the GDACS automatic impact assessments (more detailed for storm surge effect) and compares the JRC HyFlux2 deterministic storm surge forecasts with the probabilistic forecasts provided by NOAA P-surge product. For the three analysed Advisories, the maximum water height forecast by the JRC model is quite stable in value and spatial distribution. The NOAA forecast probabilities increase with time while the spatial distribution of the forecasted probabilities is stable as in the JRC calculations. The different behaviour between the two methods should be investigated: it seems that the evaluated probabilities are too low or not consistent with the improvements in the accuracy of the recent tropical cyclones forecast tracks.

Overall, the GDACS models performed well, providing alert levels for all hazard components, that should be validated with more field observations.

The method adopted to evaluate the forecast of the storm surge impact – comparison of the calculated sea level with online tidal gauges measurement – should continue and validated case by case.

ANNEX 1 – Track of ISAAC (2012) – KATRINA (2005)

Hurricane ISAAC (2005) made landfall 7 years later Hurricane KATRINA (2005) on Aug 29, in almost the same area. Isaac reached the coast as a much weaker Category 1 hurricane (before it was a tropical storm), instead Katrina made landfall as a more powerful Category 3 hurricane (previously was an extremely powerful Hurricane of Category 5)[17]. The track and categories of both hurricanes are shown in Figure 26.

Hurricane Katrina was one of the most damaging Tropical Cyclone disasters in the history of the US, causing fatalities and damage in several regions (S Florida, Gulf of Mexico, Louisiana and Mississippi, Georgia and Alabama), killing 1836 people, most in Louisiana.

It formed over the Bahamas on 23 August 2005 and crossed southern Florida entering in the Gulf of Mexico, and began strengthening rapidly, reaching Category 5 on Saffir-Simpson Scale, with a maximum wind of 277 km/h, it to Category 3 and on 29 Aug 2005 it made landfall in Louisiana (near Buras), then a landfall near Louisiana/Mississippi border. Strong winds and an elevated pressure drop created an extreme storm surge (8.4m was observed in St. Louis Bay Mississippi). Most of the damage caused by KATRINA had due to a secondary effect of this surge: the surge caused a rise of the level of Lake Pontchartrain, straining the levee system protecting New Orleans; several of the levees and floodwalls were overtopped and/or breached at different times on the day of landfall, causing flooding.

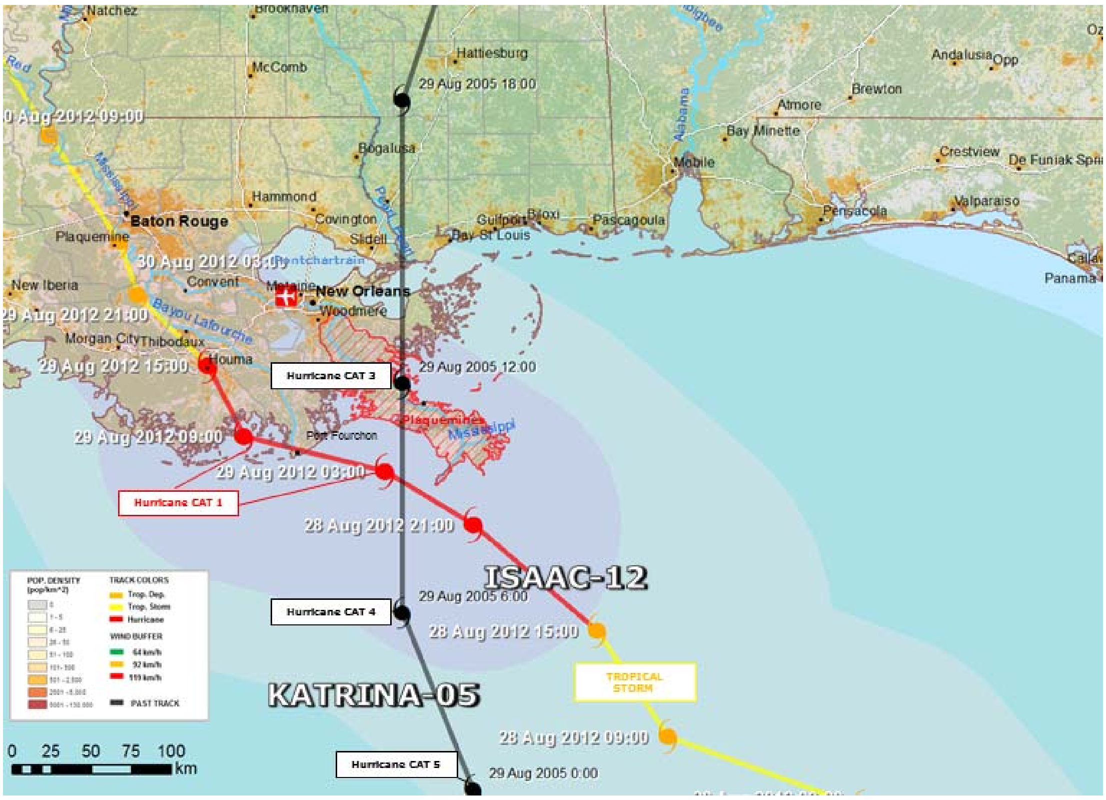


Figure 26 - Track and wind speed of hurricane KATRINA (2005) and ISAAC (2012)

[17] Sustained wind speed (Saffir-Simpson Hurr. Wind Scale): Cat 1 (119-153 km/h), Cat 2 (154-177 km/h), Cat 3 (178-208 km/h), Cat 4 (209-251 km/h), Cat 5 (> 251 km/h)

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NOAA NHC SLOSH website: http://www.nhc.noaa.gov/HAW2/english/surge/slosh.shtml

FEMA website: http://www.fema.gov/hazard/hurricane/index.shtm.

European Commission
EUR 25657 EN – Joint Research Centre – Institute for the Protection and Security of the Citizen

Title: Tropical Cyclone ISAAC. USA, August 2012

Authors: Pamela Probst, Giovanni Franchello, Alessandro Annunziato, Tom De Groeve, Ioannis Andredakis

Luxembourg: Publications Office of the European Union

2012 – 35 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print)

ISBN 978-92-79-27982-9 (pdf)
ISBN 978-92-79-27983-6 (print)

doi:10.2788/72586

Abstract

Tropical Cyclone ISAAC, after causing damage and deaths in Haiti, moved towards the coast of SE Louisiana (USA), where it made two landfalls. After the second landfall, it started moving inland in SE Louisiana, passing W of New Orleans on Aug 29 afternoon/evening (UTC), weakening into a tropical storm, then late on Aug 30 became a tropical depression. Tropical Cyclone ISAAC affected the southern parts of Louisiana, Mississippi and Alabama with heavy rainfall, strong winds and storm surge, causing flooding, power outages, damage to property and, according to media report, killing at least 7 people. Most of this damage has been caused by heavy rains and storm surge.
The Joint Research Centre (JRC) followed the event through the information automatically collected and analysed in the Global Disasters Alerts and Coordination System (GDACS). GDACS classification, for TC ISAAC in the USA, was: Green for the wind impact, Orange for rain impact and Red for storm surge impact.
On 27 August 2012, 2 days before the landfall, the JRC *HyFlux2* storm surge model indicated a possible storm surge in the order of 2.5-3.5m for Aug 29 morning (UTC) in the coastal area E-SE of New Orleans, Louisiana Online observations and NOAA reports confirmed the forecasts. This report analyses and discusses the GDACS automatic impact assessments and compares the JRC *HyFlux2* deterministic storm surge forecasts with the probabilistic forecasts provided by NOAA.

LB-NA-25657-EN-N

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ISBN 978-92-79-27982-9

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