NATIONAL HURRICANE CENTER
TROPICAL CYCLONE REPORT

TROPICAL STORM SONIA
(EP182013)
1 – 4 November 2013

Todd B. Kimberlain
National Hurricane Center
8 January 2013

MODIS IMAGE OF TROPICAL STORM SONIA AT 1810 UTC 3 NOVEMBER 2013. IMAGE COURTESY OF NASA.

Sonia was a late-season tropical storm that formed well southwest of Manzanillo, Mexico. The weak storm moved northeastward and made a rare November landfall in the Mexican state of Sinaloa, causing some flooding.

Tropical Storm SONIA

1 – 4 NOVEMBER 2013

SYNOPTIC HISTORY

A well-defined active phase of the Madden-Julian Oscillation (MJO) moved eastward from the central Pacific around the beginning of the last week in October. The arrival of the MJO over the eastern North Pacific basin during the last few days of the month likely caused the development of a very broad low-level cyclonic circulation that spanned almost 15° of longitude south and west of mainland Mexico. A tropical wave several hundred miles south of Acapulco was moving slowly westward within this cyclonic gyre late on 26 October, producing some deep convection. This disturbance was convectively dormant for a couple of days, but deep convection re-developed on 29 October after the passage of the MJO. The convection triggered the development of a trough of low pressure that lifted slowly northward between a mid-level ridge over the Gulf of Mexico and a deep mid- to upper-level trough digging over the western United States. Under easterly shear, deep convection formed west of a broad surface circulation on 30 October, but the convection was intermittent and not well organized. Although the convection became more persistent and better organized during the next couple of days, the circulation did not become better defined until early on 1 November. A European Space Agency's Advanced Scatterometer (ASCAT) pass around 0600 UTC that day indicated that a well-defined circulation had developed, marking the formation of a tropical depression about 280 n mi southwest of Manzanillo, Mexico. The "best track" chart of the cyclone's path is given in Fig. 1, with the wind and pressure histories shown in Figs. 2 and 3, respectively. The best track positions and intensities are listed in Table 1[1].

The depression gradually turned west-northwestward over the next day or so and moved a little faster in response to a weak mid-level ridge building to the northeast of the cyclone. Little change in strength occurred during this time, with the circulation consisting of multiple swirls and deep convection displaced west of the center due to shear. A second mid- to upper-level trough digging into the western United States caused the track of the depression to turn northward early on 3 November around the time that a significant burst of deep convection was forming northwest of the center. An 0420 UTC ASCAT pass suggested that the depression became a tropical storm around 0000 UTC.

Sonia turned northeastward and accelerated, reaching a peak intensity of 40 kt while passing just south of the southern tip of the Baja California peninsula. Southwesterly shear increased, causing a separation to develop between the low- and mid-level centers, and this separation increased significantly by the time Sonia reached the coast. Despite the shear, Sonia maintained tropical storm strength through landfall near El Dorado in the state of Sinaloa

---

[1] A digital record of the complete best track, including wind radii, can be found on line at ftp://ftp.nhc.noaa.gov/atcf. Data for the current year's storms are located in the *btk* directory, while previous years' data are located in the *archive* directory.

around 0500 UTC 4 November. The cyclone moved inland and quickly weakened to a tropical depression, and dissipated within a few hours over the high terrain of the Sierra Madre Occidental mountain range.

METEOROLOGICAL STATISTICS

Observations in Sonia (Figs. 2 and 3) include subjective satellite-based Dvorak technique intensity estimates from the Tropical Analysis and Forecast Branch (TAFB) and the Satellite Analysis Branch (SAB), and objective Advanced Dvorak Technique (ADT) estimates from the Cooperative Institute for Meteorological Satellite Studies/University of Wisconsin-Madison. Data and imagery from NOAA polar-orbiting satellites including the Advanced Microwave Sounding Unit (AMSU), the NASA Tropical Rainfall Measuring Mission (TRMM), the ASCAT, and Defense Meteorological Satellite Program (DMSP) satellites, among others, were also useful in constructing the best track of Sonia.

The estimated 40-kt peak intensity of Sonia is based on a blend of Dvorak satellite classifications of T2.5 and T3.0 at 1200 and 0000 UTC 4 November.

There were no ship reports of winds of tropical storm force associated with Sonia, and no surface observations from land stations near the path of the storm are available.

Sonia is only the third eastern North Pacific tropical storm to make landfall during the month of November in the era of continuous satellite coverage (1966 – present).

CASUALTY AND DAMAGE STATISTICS

Sonia apparently caused two direct deaths[2]. According to a media report, the Sinaloan State Civil Defense identified a fisherman as being missing at sea. No further information regarding his whereabouts has come to light since that report. The Mexican Civil Defense also reported a casualty in the state of Nayarit as a result of a lightning strike.

There were a few reports of flooding associated with heavy rains from Sonia in Mazatlan and Culiacan, which prompted the evacuation of around 1,000 people. Heavy rains caused the water to rise as high as 5 ft (1.5 m) in Mazatlan, and the highway linking the capital Culiacan to the city of Navolato was closed due to flooding.

---

[2] Deaths occurring as a direct result of the forces of the tropical cyclone are referred to as "direct" deaths. These would include those persons who drowned in storm surge, rough seas, rip currents, and freshwater floods. Direct deaths also include casualties resulting from lightning and wind-related events (e.g., collapsing structures). Deaths occurring from such factors as heart attacks, house fires, electrocutions from downed power lines, vehicle accidents on wet roads, etc., are considered indirect" deaths.

FORECAST AND WARNING CRITIQUE

The genesis of Sonia was reasonably well forecast in the short range. The system from which Sonia formed was introduced into the 48-h Tropical Weather Outlook 54 h prior to genesis, and the genesis potential was raised to the medium category (30 to 50%) just 12 h later. The system was then given a high chance of formation (greater than 50%) 18 h before tropical cyclone formation. The same system was introduced into the extended-range outlook 138 h prior to genesis with a low probability (20% or less) of formation, and the genesis potential was raised to the medium category 30 h later. The 5-day genesis probability was increased to a high chance 42 h prior to tropical cyclone formation.

A verification of NHC official track forecasts for Sonia is given in Table 2a. Official forecast track errors were greater than the mean official errors for the previous 5-yr period at all times, except at 36 h. Difficulty in pinpointing the initial position and estimating the initial motion of the cyclone early in its lifecycle likely led to the greater errors at 12 h and 24 h. Cross-track errors were quite low, with official forecasts correctly capturing the landfall location with a high degree of accuracy. The greater official errors at longer lead times are attributed to along-track error; the first few official forecasts called for landfall about 24 h later than what occurred. A homogeneous comparison of the official track errors with selected guidance models is given in Table 2b. The Canadian model (CMCI) outperformed the official forecasts through 36, and the GFSI did so at 36 h and 48 h. Otherwise, the multi-model consensus (TVCE) forecast errors were generally comparable to those of the official forecast.

A verification of NHC official intensity forecasts for Sonia is given in Table 3a. Official forecast intensity errors were lower than the mean official errors for the previous 5-yr period at all forecast times. Official intensity forecasts correctly predicted that little intensification would occur as a result of the poor inner core structure and center definition of the cyclone as well as the marginally conducive environment in which it was embedded. A homogeneous comparison of the official intensity errors with selected guidance models is given in Table 3b. The official forecast bested almost all of the intensity guidance at all times through 48 h.

Watches and warnings associated with Sonia are given in Table 4.

Table 1.   Best track of Tropical Storm Sonia, 1-4 November 2013.

Date/Time (UTC)	Latitude (°N)	Longitude (°W)	Pressure (mb)	Wind Speed (kt)	Stage
01 / 0600	16.0	107.9	1007	30	tropical depression
01 / 1200	16.3	108.0	1006	30	"
01 / 1800	16.6	108.1	1006	30	"
02 / 0000	16.9	108.3	1006	30	"
02 / 0600	17.1	108.6	1006	30	"
02 / 1200	17.3	109.0	1006	30	"
02 / 1800	17.4	109.5	1006	30	"
03 / 0000	17.8	110.0	1005	35	tropical storm
03 / 0600	18.5	110.2	1004	35	"
03 / 1200	19.5	110.0	1003	40	"
03 / 1800	20.9	109.3	1002	40	"
04 / 0000	22.7	108.4	1003	40	"
04 / 0500	24.4	107.6	1004	35	"
04 / 0600	24.6	107.5	1007	25	tropical depression
04 / 1200					dissipated
03 / 1200	19.5	110.0	1003	40	maximum wind
03 / 1800	20.9	109.3	1002	40	minimum pressure
04 / 0500	24.4	107.6	1004	35	Landfall near El Dorado, Sonora, Mexico

Table 2a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) track forecast errors (n mi) for Tropical Storm Sonia, 1-4 November, 2013. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	35.8	49.4	**57.2**	78.9	176.5		
OCD5	63.5	128.9	174.8	171.7	201.0		
Forecasts	11	9	7	5	1		
OFCL (2008-12)	27.0	43.1	57.8	71.9	101.7		
OCD5 (2008-12)	37.4	73.0	114.9	158.3	238.4		

Table 2b.   Homogeneous comparison of selected track forecast guidance models (in n mi) for Tropical Storm Sonia, 1-4 November 2013. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 2a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	35.8	49.4	57.2	78.9	176.5		
OCD5	63.5	128.9	174.8	171.7	201.0		
GFSI	46.7	54.7	**49.6**	**68.4**	229.4		
GHMI	42.3	65.1	79.5	156.2	267.9		
HWFI	42.5	71.9	92.3	105.6	**68.4**		
EMXI	44.7	65.0	75.1	88.6	**173.2**		
CMCI	**32.4**	**41.4**	**35.6**	81.1	254.5		
TVCE	37.1	52.2	57.2	**78.0**	184.9		
AEMI	46.8	60.0	62.0	88.2	**142.6**		
LBAR	41.5	66.3	82.4	93.1	**34.2**		
BAMS	44.6	63.7	71.1	86.6	231.5		
BAMM	43.2	63.3	92.6	96.2	**60.7**		
BAMD	50.3	77.7	105.3	111.8	**114.6**		
Forecasts	11	9	7	5	1		

Table 3a.   NHC official (OFCL) and climatology-persistence skill baseline (OCD5) intensity forecast errors (kt) for Tropical Storm Sonia, 1-4 November 2013. Mean errors for the previous 5-yr period are shown for comparison. Official errors that are smaller than the 5-yr means are shown in boldface type.

	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	**1.8**	**5.0**	**5.7**	**3.0**	**10.0**		
OCD5	4.0	6.3	5.7	8.4	6.0		
Forecasts	11	9	7	5	1		
OFCL (2008-12)	6.3	10.5	13.4	14.5	15.3		
OCD5 (2008-12)	7.6	12.5	16.5	18.8	20.4		

Table 3b.   Homogeneous comparison of selected intensity forecast guidance models (in kt) for Tropical Storm Sonia, 1-4 November 2013. Errors smaller than the NHC official forecast are shown in boldface type. The number of official forecasts shown here will generally be smaller than that shown in Table 3a due to the homogeneity requirement.

Model ID	Forecast Period (h)						
	12	24	36	48	72	96	120
OFCL	1.8	5.0	5.7	3.0	10.0		
OCD5	4.0	6.3	5.7	8.4	**6.0**		
HWFI	6.2	9.1	6.4	6.4	**4.0**		
GHMI	6.4	10.4	15.6	9.4	**2.0**		
DSHP	4.3	5.4	**5.6**	4.4	**8.0**		
LGEM	4.3	6.1	6.0	6.6	**7.0**		
IVCN	4.7	6.8	6.9	4.6	**4.0**		
Forecasts	11	9	7	5	1		

Table 4.   Watch and warning summary for Tropical Storm Sonia, 1-4 November 2013.

Date/Time (UTC)	Action	Location
2 / 2100	Tropical Storm Watch issued	Topolobampo to La Cruz
3 / 0900	Tropical Storm Watch modified to	Topolobampo to Altata
3 / 0900	Tropical Storm Warning issued	Mazatlan to Altata
4 / 0900	Tropical Storm Watch discontinued	All
4 / 0900	Tropical Storm Warning discontinued	All
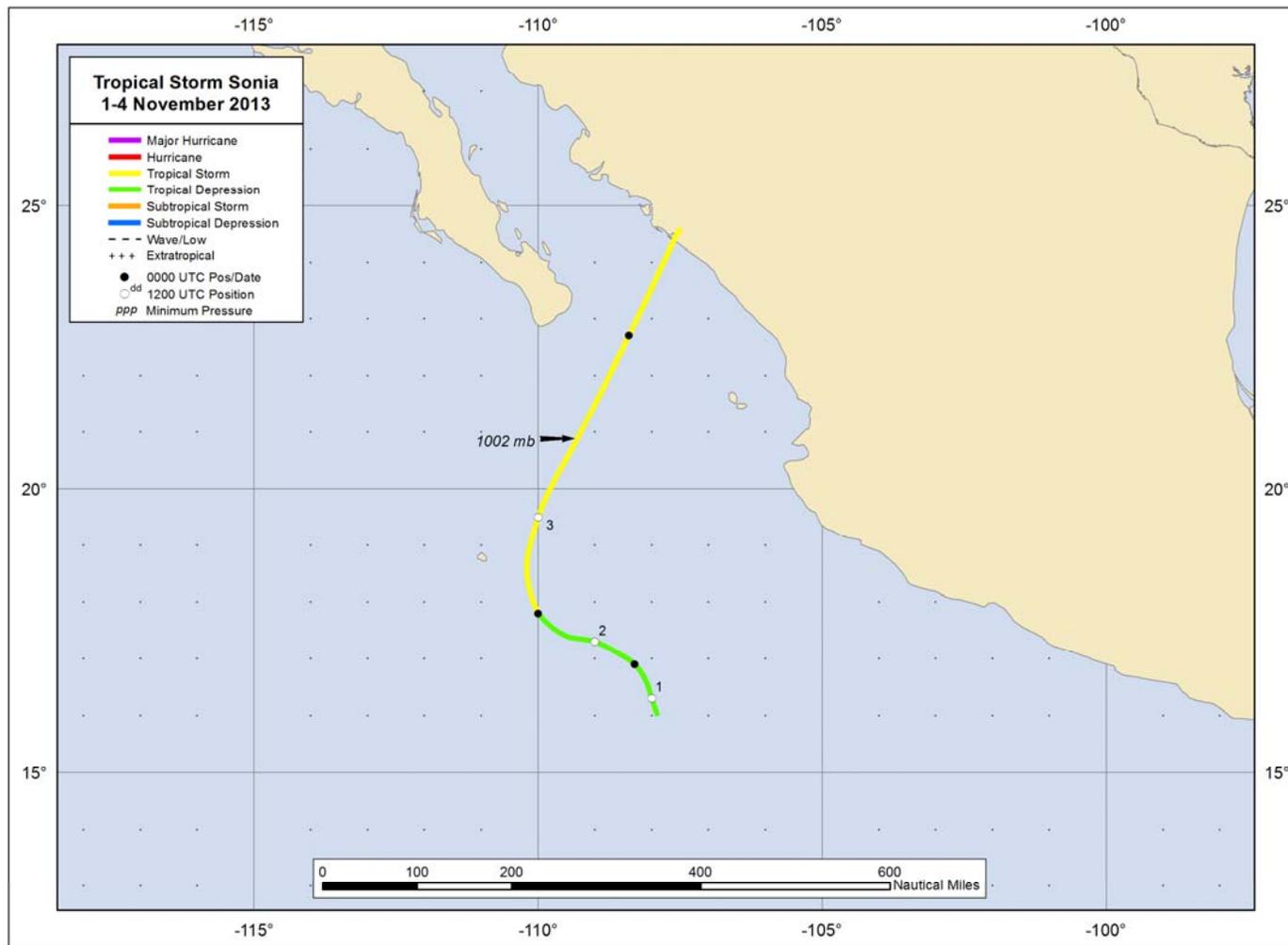
Figure 1.   Best track positions for Tropical Storm Sonia, 1-4 November 2013.
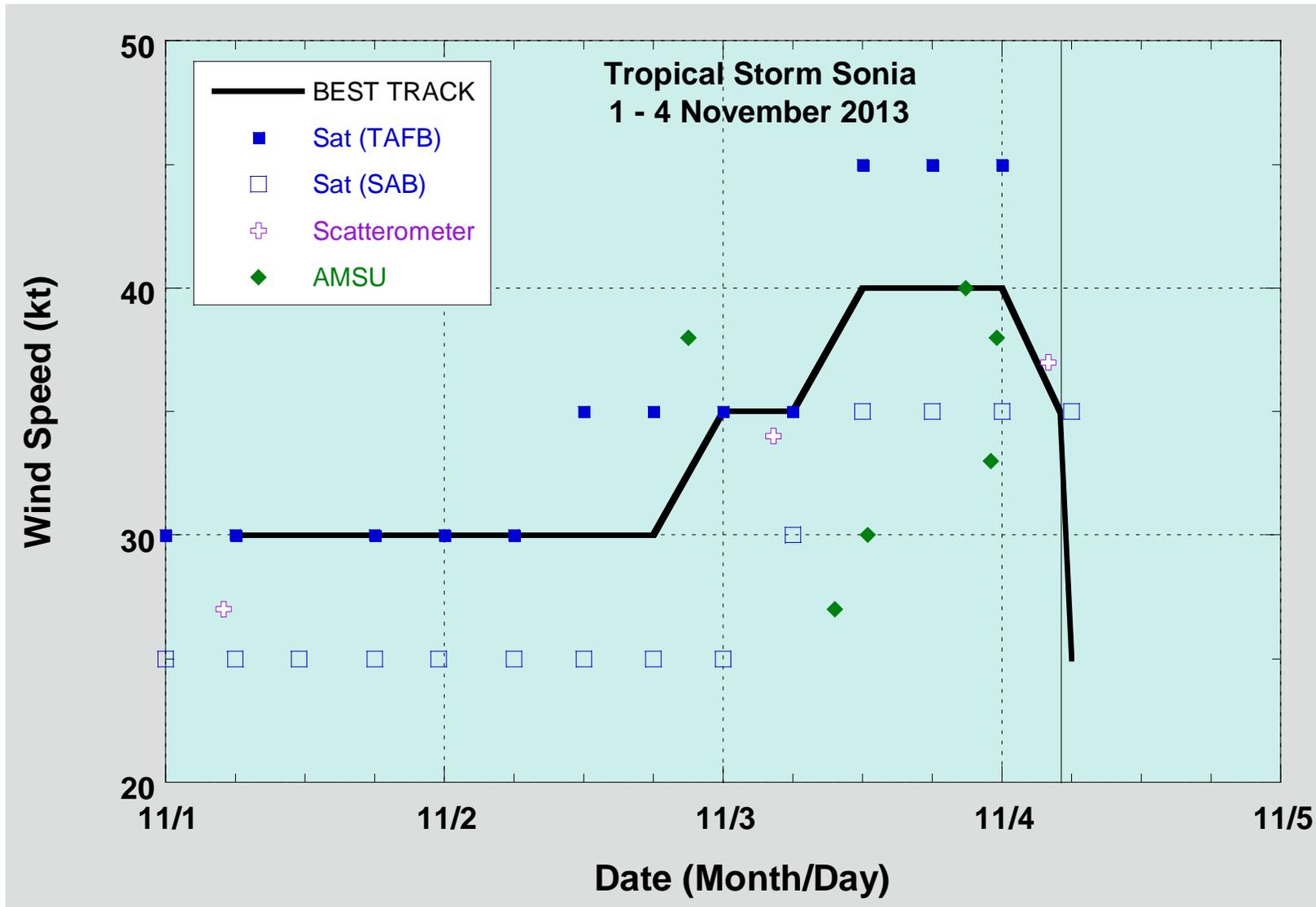
Figure 2.   Selected wind observations and best track maximum sustained surface wind speed curve for Tropical Storm Sonia, 1-4 November 2013. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.
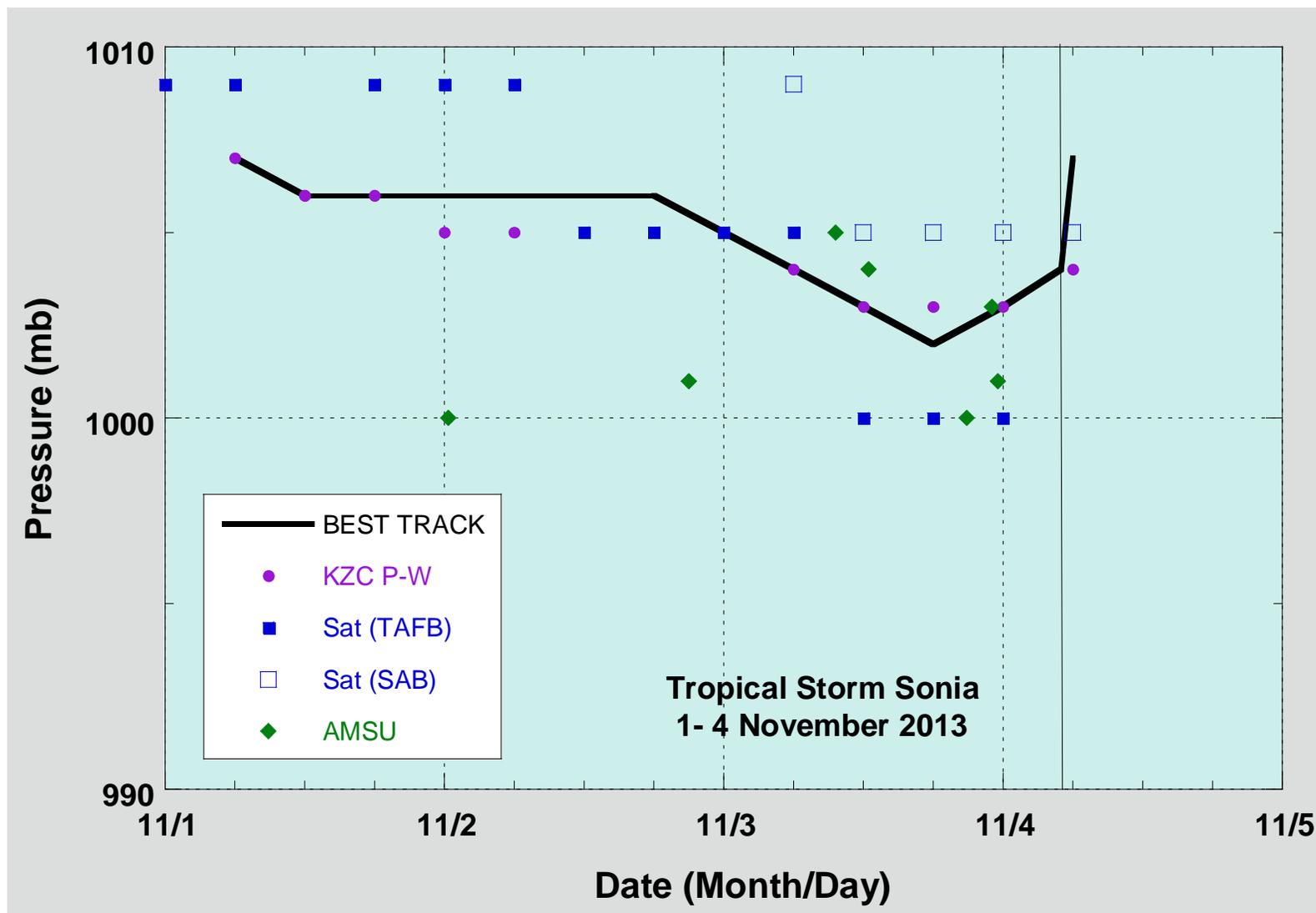
Figure 3.   Selected pressure observations and best track minimum central pressure curve for Tropical Storm Sonia, 1-4 November 2013. AMSU intensity estimates are from the Cooperative Institute for Meteorological Satellite Studies technique. KZC P-W refers to pressure estimates derived using the Knaff-Zehr-Courtney pressure-wind relationship. Dashed vertical lines correspond to 0000 UTC, and solid vertical lines correspond to landfalls.
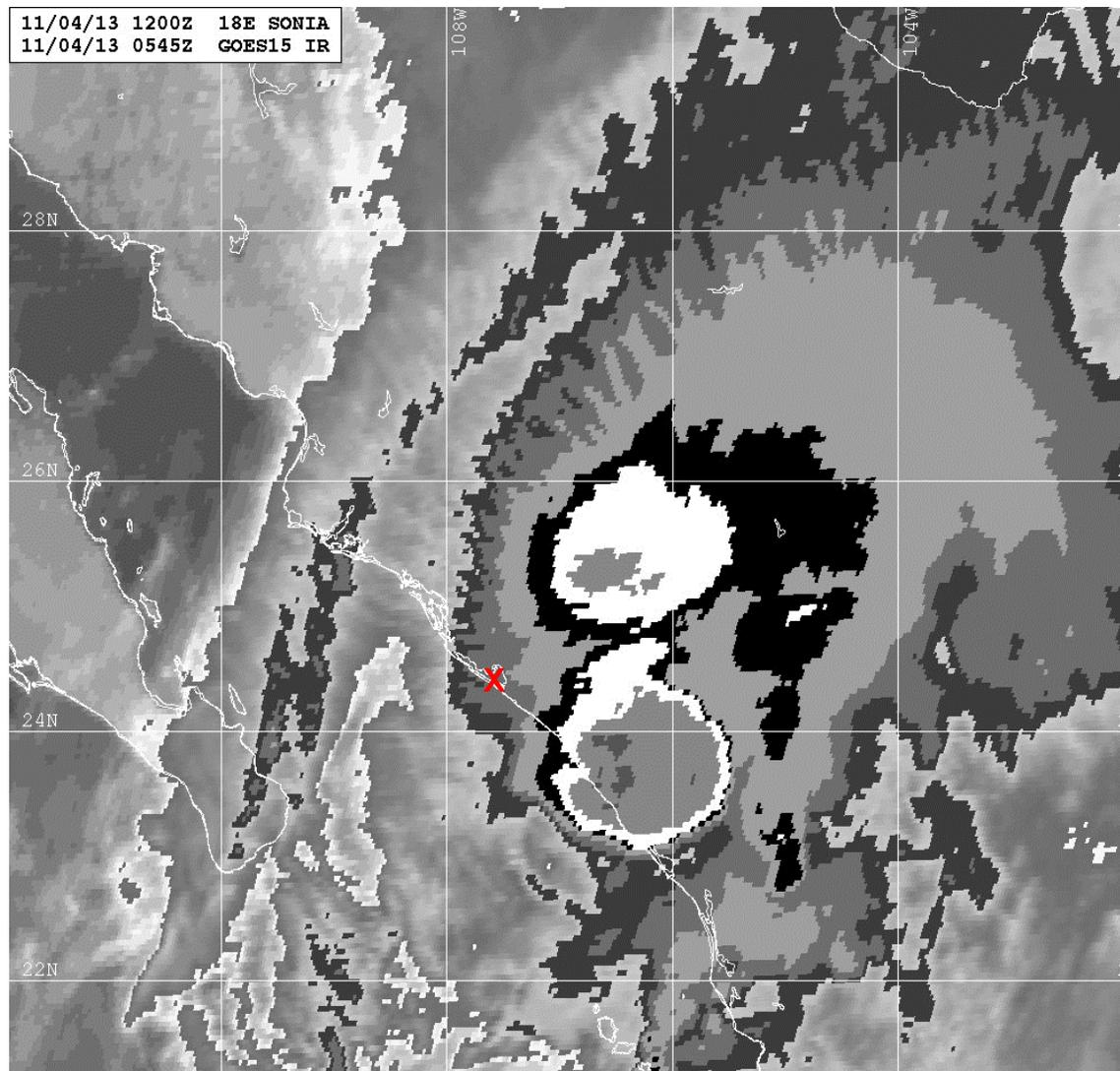
Figure 4.   GOES-15 infrared satellite image at 0545 UTC 4 November 2013, showing Tropical Storm Sonia around the time of landfall along the coast of Sonora in northwestern Mexico. The symbol X indicates the center of Sonia. Image courtesy of the Naval Research Lab.