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The CTBTO's Report on Missing Malaysian Airlines Flight MH 370: An Analysis (what it really means)

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Summary:

On March 11, the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) issued its report related to the international search mission of the lost Malaysian Airlines Flight MH 370. The report summarized the results of infrasound waves registered at the International Data Center (IDC) in Vienna. Signals were generated by infrasound sensors of the International Monitoring Station (IMS), located in the area of Malaysia, on the day the plane vanished.

Two days after the disappearance of the plane, prior to the release of the report, the CTBTO Executive Secretary Lassina Zerbo mentioned the possibility of infrasound detection at the United Nations noon press briefing on 10 March 2014 in response to a question. He explained that infrasound sensors would be the best technology to detect and record an explosion or crash of the missing plane if that explosion occurred near the station at a range less than 100 Km or the explosion is at a level or amplitude that it could be detected.

IMS infrasound stations routinely detect commercial planes within range while they are taking off and landing from local airports, notes the report. Airplane accidents may be detected by the IMS infrasound system depending on the geographical situation of the area under consideration and closest certified and operational stations from the predicted and matching plane's flight directions.

Caveats:

The report outlined three major site-specific and regional circumstances that influence the sensor performance and station likelihood of recording related signals that could be helpful in investigating plane accidents. First, commercial planes in normal flight conditions are usually detected by IMS infrasound stations only at close range, within about 100 km from stations, states the report. A few incidents involving planes have been registered in the past. For example,

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the crash of a FedEx cargo plane at Narita International Airport, Japan, in March 2009 was detected and recorded by IMS infrasound stations located within a few tens to a few hundreds of kilometres. The crash of two F16 military aircraft at an air show in Belgium, in 2003, was detected in a similar way. Second, the only reported commercial plane that could be tracked over large distances across the Atlantic with an infrasound station was the Concorde as it was travelling at supersonic speed, says the report. The Concorde was discontinued 10 years ago. Thus, it is unlikely that stations beyond 100 Km can register infrasound signals from a commercial plane like MH 370.

Third, for a plane incident to be detected at regional or global distances from stations, as in the case of the missing Boeing 777, it could mean that the plane crashed, exploded or disintegrated. The report indicated that the processing of the infrasound data from the seven closest IMS stations did not provide a clue linked to a crash or explosion of the plane. The report was greeted with hysterical headlines, stating it most certainly confirmed the plane did not explode or crash. However, it would likely not be possible to draw any definitive conclusion based on remote infrasound recordings alone, cautions the report. A discussion of the CTBTO's findings follows. The significance of the findings depends on a combination of factors, including the geography of Malaysia, the distribution of IMS infrasound stations in the region, IDC automatic bulletin reviews, and infrasound propagation status. First, what is known about the flight?

Plane Mystery:

There are many questions yet to be answered about this mystery. Some of them will take months or years to determine, others may never be answered satisfactorily. However, there's known information already in the public domain to answer basic questions about first 40 minutes of the flight. Malaysian Airlines Flight MH 370 Boeing 777 carrying 227 passengers and 12 crew took off from Kuala Lumpur airport, Malaysia, on Saturday 8 March at 00:41 A.M. (Friday 7 March at 16:41 GMT), when it disappeared from flight control radars. It was flying north, over the Gulf of Thailand, towards Vietnam en route to Beijing, China, when its transponder, which allows air traffic controllers to identify and track the airplane, ceased communicating at 01:21 A.M. (17:21 GMT), between Malaysian and Vietnamese airspace, According to the BBC (http://www.bbc.com/news/world-asia-26503141). The last reported location is 200 km north of Kuala Lumpur (source: Flight Aware). Figure 1 is a summary of the situation.

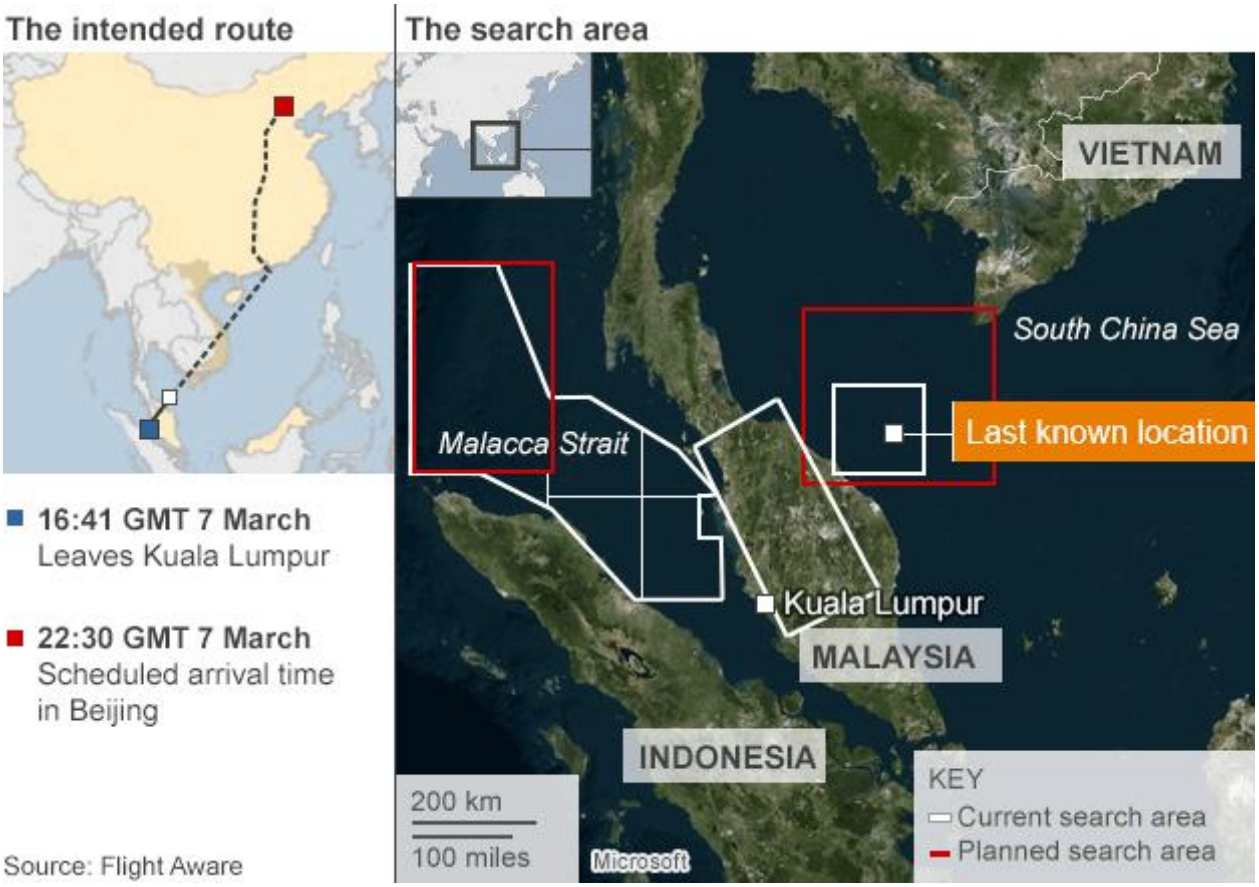


Figure 1: BBC summary of the situation for missing flight MH 370. –Credits: BBC

Topographical Challenges:

According to the report, the topography of Kuala Lumpur and the ranges of certified instruments from the predicted flight route exhibit weak detection capabilities. Although the IMS stations are using state-of-the-art meteorological models and background noise levels, the report elaborates on how the geographical situation of Kuala Lumpur is not favorable for the detection of infrasound signals over long distances that result in the low performance of the system. According to the report, the closest certified infrasound station that could have recorded signals from the plane was found to be located 1700 km away from the southern part of the predicted flight path. That station is recognized by treaty code IS06 in the Cocos Islands, a territory of Australia, located in the Indian Ocean. The station is southwest of Christmas Island and approximately midway between Australia and Sri Lanka. It is, therefore, unlikely that the station IS06 could have detected signals from the flying Malaysian plane as its distance from the flight path was found to be several hundred beyond 100 Km, below which infrasound sensors usually detect commercial planes in normal flight.

The report adds that in the northern part of the flight path, the next two closest stations that could potentially record signals related to the plane are in China but under construction. The installation of the 2 Chinese stations, IS15 in Beijing and IS16 in Kunming, are still to be completed. The report points out that the next closest certified stations are at ranges over 3500 km. Again, it is unlikely that those stations would perform well to identify the plane crash, explosion or disintegration along the flight's route. Moreover, the infrasound atmospheric propagation in regions like Malaysia close to the Equator is often complex given the relatively quiet upper atmospheric winds. As earlier mentioned, this implies that long distance infrasound wave propagation is less favorable than at higher and lower latitudes. Consequently, the report concluded that the performance of the station at the closest IMS in Cocos Island exhibits relatively fair to weak detection capabilities. One cannot, therefore, rule out the possibility that the plane might have exploded, crashed or landed on the water. Figure 2 is a google map of IMS infrasound network around Malaysia. The blue dot on land mass is Kuala Lumpur airport and the green dots on scattered all over are infrasound stations.

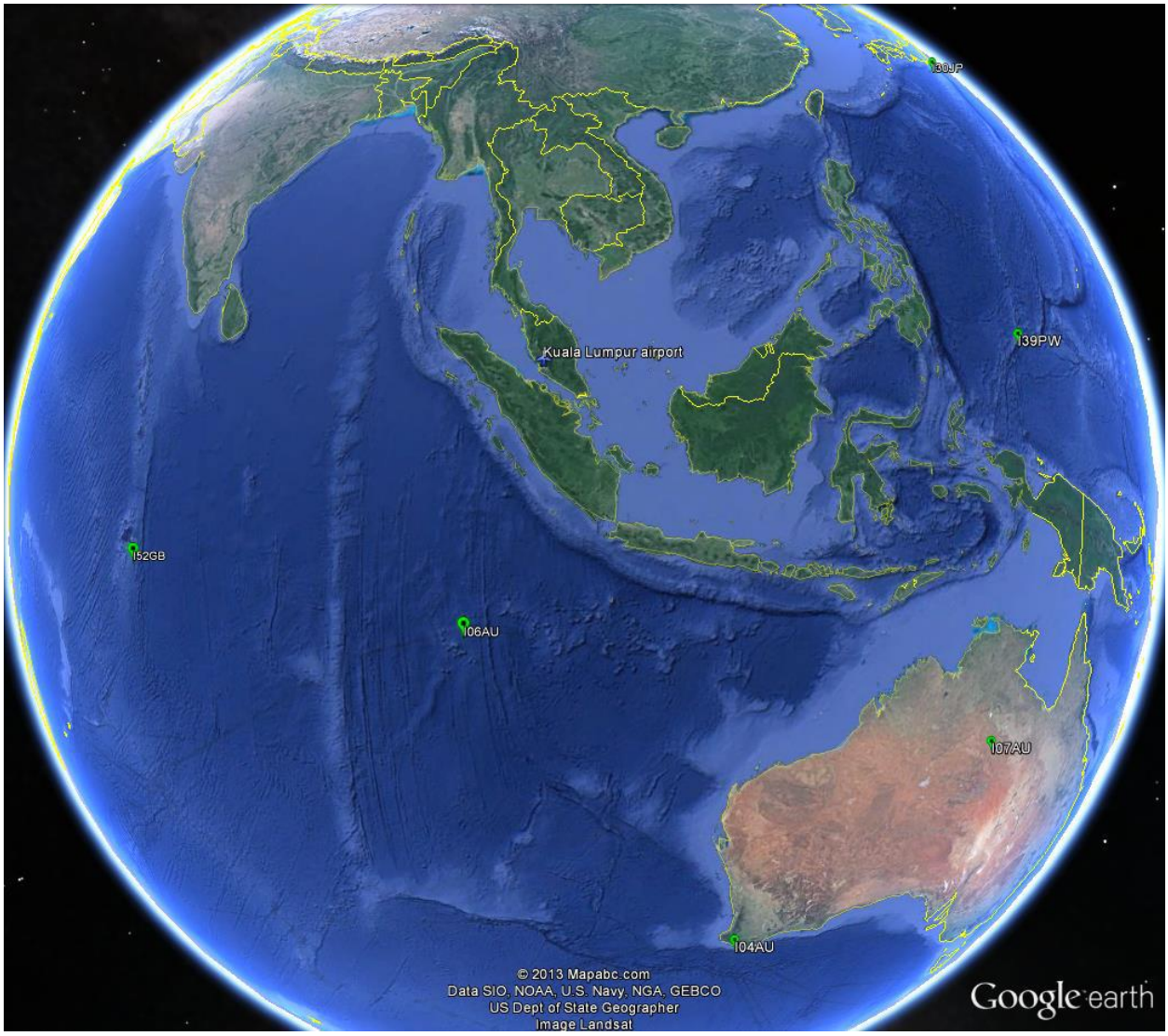


Figure 2: Situation of IMS infrasound network around Malaysia. -Credits: CTBTO

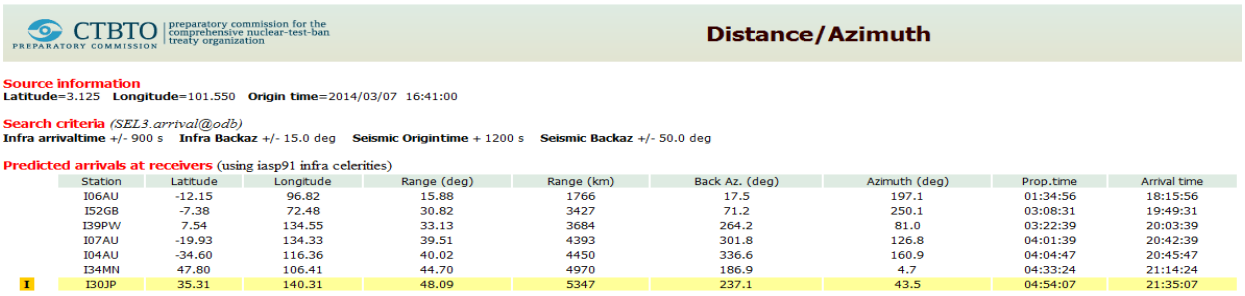
Distance Impact:

The report states that the closest certified IMS networked infrasound stations to the predicted trajectory of the Malaysian Flight MH 370 on March 8 from Kuala Lumpur to Beijing exceeds 1600 Km. The only station within 2000 Km, in the area around Kuala Lumpur, Malaysia, is station ISO6, located at Cocos Islands in Australia. The two next close stations are located about 3500 km away from the flight path. One is the IS52 at Diego Garcia, an Island in the Indian Ocean, a territory of the UK. The other is and the IS39 in Palau, an island country located in the western Pacific Ocean. Other stations in the area are located in Australia and beyond 4300 km -IS04 in Shannon and IS07 in Warramunga. The subsequent two close stations that may help to identify the whereabouts of flight MH 370 are located beyond 5000 Km with reference to the closest point on the predicted flight path. They are IS34 at Songino in Mongolia and IS30 at Isumi in Japan.

Automatic Bulletin Reviews Finding:

Five of the closest stations that were found to be located within 5000 Km did not provide any detection or trace of signals related to the missing flight MH 370. The closest stations to the predicted and matching route of the flight were identified to be ISO6, Cocos Islands, Australia; IS52, Diego Garcia, UK; IS39, Palau; IS04, Shannon, Australia; IS07, Warramunga, Australia. CTBTO reviewed the IDC automatic bulletins (SEL3) and found no event that could be matched to the plane within the first 15 minutes of flight along the predicted and matching directions.

However, when bulletins from the closest seven stations, with reference to points long the predicted path of MH 370 were reviewed, only one station, IS3 at Isumo in Japan, located at over 5300 km showed detections possibly originating from the Malaysian and Vietnamese area. CTBTO analysts closely examined REBs of March 7, when the plane disappeared from flight control radars. It appeared that the azimuth of those detections were rather common. The agency concluded that the detections could be related to one of two activities. On the one hand, the activity could have originated from well-known active volcanoes in Japan – Sakura-jima in Kyushu and Suwanose-jima in the Tanegashima islands, according to the report. On the other hand, the activity could have originated from a microbarom-like activity in the sea, south-west of that IS3 station. Microbaroms are pulses of atmospheric infrasound emitted by ocean surface waves.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Distance/Azimuth

Source information
Latitude=3.125 **Longitude**=101.550 **Origin time**=2014/03/07 16:41:00

Search criteria *(SEL3.arrival@odb)*
Infra arrivaltime +/- 900 s **Infra Backaz** +/- 15.0 deg **Seismic Origintime** + 1200 s **Seismic Backaz** +/- 50.0 deg

Predicted arrivals at receivers (using iasp91 infra celerities)

	Station	Latitude	Longitude	Range (deg)	Range (km)	Back Az. (deg)	Azimuth (deg)	Prop.time	Arrival time
	I06AU	-12.15	96.82	15.88	1766	17.5	197.1	01:34:56	18:15:56
	I52GB	-7.38	72.48	30.82	3427	71.2	250.1	03:08:31	19:49:31
	I39PW	7.54	134.55	33.13	3684	264.2	81.0	03:22:39	20:03:39
	I07AU	-19.93	134.33	39.51	4393	301.8	126.8	04:01:39	20:42:39
	I04AU	-34.60	116.36	40.02	4450	336.6	160.9	04:04:47	20:45:47
	I34MN	47.80	106.41	44.70	4970	186.9	4.7	04:33:24	21:14:24
I	I30JP	35.31	140.31	48.09	5347	237.1	43.5	04:54:07	21:35:07

Figure 3: Infrasound tool for searching event matching arrivals in IDC bulletins. The source is Kuala Lumpur airport at the time of take-off and the receivers are all stations within 50 degrees. –Credits: CTBTO

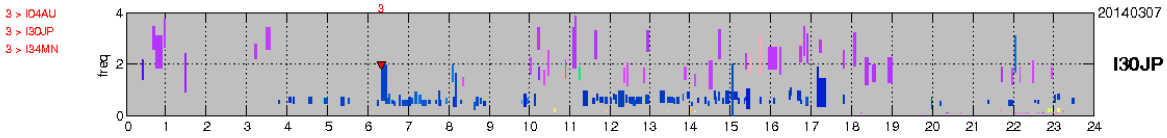

Figure 4: Daily IDC bulletins for IS30 (Japan) station showing detections from Kyushu volcanoes (dark blue) mixed with microbaroms (dark to light blue) and local activity in the bay of Tokyo (purple). –Credits: CTBTO

The IDC Review Event Bulletin (REB) is the bulletin listing events built from waveform data that have been reviewed by a human analyst, according to the CTBTO. Put another way, it is a "data product" of the IDC in which the seismic analysis has undergone careful study by CTBTO experts. The analyst uses the Standard Event List 3 (SEL3) as the basis to correct erroneously identified natural and man-made events that are systematically included in the REB. The REB was an integral and critical part of data collection that was used to identify and locate the position of the nuclear test declared by the Democratic People's Republic of Korea (DPRK) on Monday, 25 May 2009. REB study benefitted from sufficient seismic data that was registered by 61 Infrasound stations. CTBTO Member States received the results of the REB review within less than 48 hours of the event that ensured data transparency and connectedness around the world. The evaluation helped in reducing the error ellipse and the event's location was found with certainty of about +/- 10 Km. The REB review is helpful in homing in on the event site, if the event has been detected and recorded by the IMS infrasound sensors in nearby stations. The site of the Malaysian Flight MH 370 could be found in the same way, if at least one station registered a related event.

Propagation Issue:

IMS infrasound sensor performance, in addition to investigating station by station if traces of signal could be found, is another useful indicator on the station that have a higher likelihood of recording associated signals. A summary of the station performance was produced by using an infrasound threshold monitoring software (DTK-NetPerf), which combines the station background noise computed by IDC and the atmospheric characteristics in the stratosphere for the projected flight duration of the vanished Malaysian plane MH 370. Continuous threshold monitoring is a technique for using a seismic system to monitor a geographical area continuously in time. The method provides, at a given confidence level, continuous assessment of the upper magnitude limit of potential seismic events that might have occurred in the target area.

The CTBTO report states that the Malaysia – Vietnam region exhibited rather fair to poor IMS infrasound system performances for the day of March 7. There are a few possible reasons to suggesting that poor performance. First, the closest station IS06 is 1700 Km away from the predicted and matching direction of MH 370. However, commercial planes in normal flight conditions are usually detected by IMS infrasound stations only at close range, within about 100 km from stations. Second, there was relatively high level of infrasound noise at that station. In general, stations that are located on islands, such as the IS06 in Cocos Islands, are subjected to strong winds that produce high noise levels.

Third, wind shift impacts the long propagation of infrasound signals that will, in turn, contribute to the poor performance of the IMS Infrasound stations. The CTBTO report states that the processed results of the continuous infrasound threshold monitoring for IS06 station on March 7, showed Kuala Lumpur farthest away from the Equatorial wind shift between southern and northern hemisphere. Wind shift is a change in wind direction of 45 degrees or more in less than 15 minutes with sustained wind speeds of 5 m/s (10 knots) or more throughout the wind shift. The area located at the edge of Equatorial wind shift, like Kuala Lumpur, is usually not favorable for long propagation of infrasound waves.

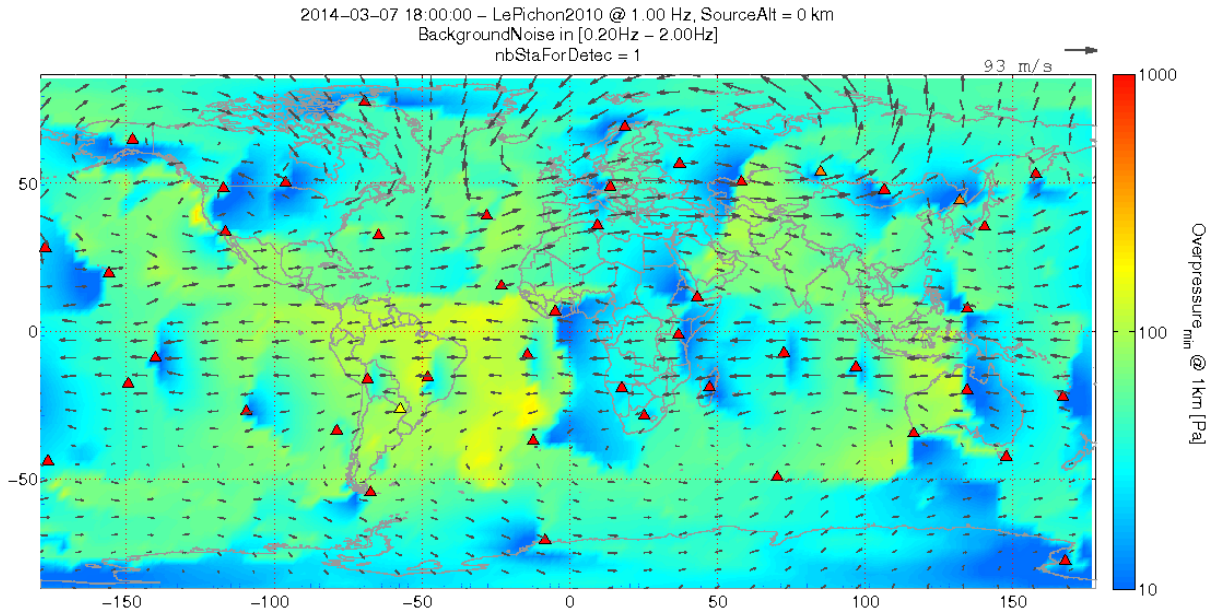

Figure 5: infrasound threshold monitoring results with DTK-Netperf for Friday.
–Credits: CTBTO

Finding:

As of March 30, the processing of the IMS infrasound data at the IDC in Vienna did not provide a clue whether the lost Malaysian Airlines Flight MH 370 could have landed or crashed. However, it would likely not be possible to draw any definitive conclusion that the missing plane neither exploded in the air nor crashed on land or water based on the results of an analysis of the remote IMS infrasound recordings alone.

At a March 14 press conference, Zerbo encouraged scientists in CTBTO Member States around the world to study IDC data carefully and add value with their national technical means and any other means to help the continuing search for the missing plane.

CTBT Background:

On September 10, 1996, The United Nations General Assembly adopted the Comprehensive Nuclear-Test-Ban Treaty (CTBT), prohibiting nuclear explosions worldwide, in all environments. The treaty calls for a global verification system, including a network of 321 monitoring stations distributed around the globe, data communications system, international data center (IDC), and on-site inspections, to verify compliance. As a central element of the CTBT verification mechanism, the IDC collects, processes and analyses monitoring data and presents results as lists of events and bulletins to Member States.

Infrasound monitoring is one of the four technologies used by the International Monitoring System (IMS) to verify compliance with the CTBT. Atmospheric and shallow underground nuclear explosions can create infrasound, acoustic waves with very low frequencies below the frequency band audible to the human ear that can be detected by infrasound sensors. Infrasound is also produced by a variety of natural and man-made sources: exploding volcanoes, earthquakes, meteors, storms and auroras in the natural world; nuclear, mining and large chemical explosions, as well as aircraft and rocket launches in the man-made arena. Infrasound technology has considerable potential for civil and scientific applications, not least in disaster prevention or mitigation.

As of March 7, 47 infrasound stations for the IMS system have been installed and are transmitting data to the IDC. When fully operational, this system will consist of 60 array stations situated strategically in 35 countries around the world. In Africa, certified and operational stations are IS17 at Dimbokro in Cote d'Ivoire, IS19 at Dijibouti in Djibouti, IS32 at Nairobi Kenya, IS33 at Antananarivo in Madagascar, IS35 at Tsumeb in Namibia, IS47 at Boshof in South Africa, IS48 at Kesra in Tunisia. IS12 is planned for construction at Bangui in the Central African Republic. Infrasound stations relay data continuously 24 hours a day and seven days a week in real time to the International Data Centre (IDC) in Vienna. Once received, data are analyzed and data products are transmitted via satellite to the CTBTO Member States.

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