AA2014-2

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

JAPAN AIRLINES CO., LTD.

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May 30, 2014

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board and with Annex 13 to the Convention on International Civil Aviation is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

Norihiro Goto
Chairman,
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

PASSENGER INJURY BY THE SHAKING OF THE AIRCRAFT
JAPAN AIRLINES CO., LTD.
BOEING 767-300, JA610J (JAPAN)
AT AN ALTITUDE OF APPROX. 36,000 FT
ABOVE FUJINOMIYA CITY, SHIZUOKA PREFECTURE
NOVEMBER 26, 2012 AT 14:54 JAPAN STANDARD TIME

April 25, 2014
Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Keiji Tanaka

1. PROCESS AND PROGRESS OF THE INVESTIGATION

On November 27, 2012, the Japan Transport Safety Board designated an investigator-in-charge and two investigators to investigate this accident. An accredited representative of the United States of America, as the State of Design and Manufacture of the aircraft involved in this accident, participated in the investigation. Comments from parties relevant to the cause of the accident and the relevant State were invited.

2. FACTUAL INFORMATION

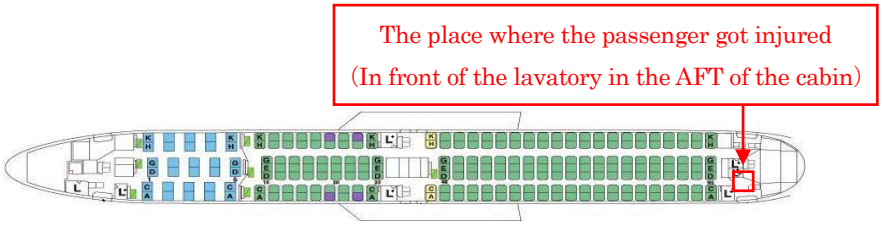
2.1 History of the Flight

The history of the flight is summarized as below, based on the data from digital flight data recorder (DFDR) and the statements of the pilot in command (PIC), the first officer (FO), flight attendants (FAs) and an injured passenger.

On November 26, 2012 at 14:28 Japan Standard Time (JST, UTC+9), a Boeing 767-300, registered JA610J, operated by Japan Airlines Co., Ltd. as flight 877, took off from Narita International Airport (Japan) for Shanghai Pudong International Airport (the People's Republic of China) with a total of 171 people on board : the PIC, the FO, 10 FAs and 159 passengers.

The PIC took the left seat as the PM (pilot monitoring : pilot mainly in charge of duties other than flying) and the FO was the PF (pilot flying : pilot mainly in charge of flying).

When reaching a cruising altitude of 36,000 ft, the aircraft was flying in the thin clouds. The PIC instructed all FAs over the interphone to serve passengers with extra care for a while against a little shaking ahead, and

	then around 14:45, the PIC turned off the seatbelt sign. The FAs started to prepare for in-flight services and several passengers left their seats for using the lavatories. In the pre-flight briefing, the PIC had already confirmed the Transverse Band[*1] on the meteorological satellite imagery (infrared imagery[*2]) as of 12:00 and other weather information, and planned earlier descent around westward area of Osaka to avoid it. The aircraft encountered the severe turbulence at an altitude of 36,000 ft over Fujinomiya City, Shizuoka Prefecture around 14:54, following some fluctuations in VSI (Vertical Speed Indicator). Until then, the aircraft had flown in a smooth and steady condition at that altitude and the on-board weather radar had not identified any active radar images. At the moment of shaking, the DFDR recorded the significant changes of vertical acceleration (deceleration to +0.7 G one second after acceleration to +1.9 G). The FO immediately turned on the seatbelt sign and started to descend to evade further turbulences. After the rough-air condition settled down and the seatbelt sign was turned off, a passenger told a FA that he had tried to maintain his posture and sprained his right ankle as the aircraft shook severely just after he came out of the AFT lavatory. The aircraft landed at Shanghai Pudong International Airport at 17:49 and the injured passenger was transported to the hospital for diagnosis, where fracture of his ankle was identified. The accident occurred around 14:54 at an altitude of about 36,000 ft over Fujinomiya City, Shizuoka Prefecture (Latitude 35°12'24" N and Longitude 138°34'25" E). No PIREPs[*3] were reported about turbulence at nearby airspace where the accident occurred around that time. (See Figures 1 and 2) 
2.2 Injuries to Persons	Serious injury: One Passenger Male, Age 35
2.3 Damage	None
2.4 Personnel Information	PIC Male, Age 55 Airline transport pilot certificate (Airplane) Type rating for Boeing 767 May 16, 1994 Class 1 aviation medical certificate Validity: Until August 31, 2013 Total flight time 16,048 hr 32 min. Total flight time on the type of aircraft 10,247 hr 41 min. FO Male, Age 36 Commercial pilot certificate (Airplane) February 26, 2003 Type rating for Boeing 767 November 5, 2004

	Instrument flight certificate October 9, 2003 Class 1 aviation medical certificate Validity: Until April 29, 2013 Total flight time 5,240 hr 56 min. Total flight time on the type of aircraft 4,953 hr 30 min.
2.5 Airplane Information	(1) Type: Boeing 767-300 (Serial number: 33846, Date of manufacture: September 1, 2004) Certificate of airworthiness: No. 2009-128 Category of airworthiness: Airplane, Transport T Total time in service: 31,730 hr 53 min. (2) It is estimated that the weight and the position of center of gravity of the aircraft were each within the allowable ranges when the accident occurred. (3) The aircraft was equipped with a DFDR and a cockpit voice recorder (CVR), but the CVR data recorded at the time of the accident was overwritten and not retained due to time spent in confirming the accident.
2.6 Meteorological Information	(1) General Weather Conditions According to the Asia-Pacific surface weather chart as of November 26, 2012 at 09:00, a deep trough covered over Japan and the low-pressure system (Low) with front located around the Shikoku region, which was gaining strength as moving east. This Low reached the Tokai region at 15:00, whose rainy areas was spreading widely from eastern to northern Japan. On the Asia-Pacific isobaric chart at 300 hPa as of November 26, 2012 at 09:00, the two strong wind bands associated with Jet streams blew over Japan. The one in the south was blowing from central China, passing through western Japan and the area close to the turbulence spot where the aircraft encountered severe turbulence, continuing to blow towards the Pacific Ocean. (2) Meteorological Satellite Imagery (Infrared Imagery) On the meteorological satellite imagery (infrared imagery) as of November 26, 2012 at 15:00, the high-level clouds with top height of 38,000 ft, relating with the southern Jet stream on the Asia-Pacific isobaric chart at 300 hPa, formed Transverse Band implying the possibility of turbulence, which lay down from China through western Japan toward the turbulence spot. Observing the developing phase of this Transverse Band along with time went by, obscure Bulge[*4]could be found at 12:00. However, at 13:00, it was identified from the Kyushu region to the Kinki region It moved toward the Chubu region through the Shikoku region at 14:00, and it reached the Kanto region through the Kinki region at 15:00. The shape of the Bulge as of 15:00 swelled and built up the curvature on its northern edge and it became clear at the turbulence spot. Those development of the Bulge indicated large inflow of humid warm air-mass from the south, which accompanied the cyclogenesis at ground-level.

	(3) Hourly Analysis Chart (cross-section drawing along 140°E longitude) On the hourly analysis chart (cross-section drawing along 140°E longitude) as of November 26, 2012 at 15:00, there were southern strong wind areas over eastern Japan which appeared in the Asia-Pacific Isobaric Chart at 300 hPa. Strong wind areas were shown at 35,000 ft and 40,000 ft in the vicinity of the Jet stream axis (the central axis of the Jet stream). There were two significant Vertical Wind Shear (VWS*5) areas, which implicated the atmospheric disturbance. One appeared around 38,000 ft where Transverse Band was formed, and the other appeared in the upper-level frontal zone just below Jet stream axis of 35,000ft. However, there were not any VWS areas close to the turbulence spot. Observing the hourly analysis charts from 13:00 to 15:00 along with time went by, there was no definite change in the strong wind bands. However, the air-mass below the Jet stream axis was gradually turning bigger in the temperature gradient and at 15:00, the analyzed VWS areas were becoming narrow and the upper-level frontal zone was getting clear and distinct. (See Figures 3, 4, 5 and 6)

*1 "Transverse Band" is striped lines of clouds that form perpendicular to the air flow and one of the cloud patterns implying the turbulence. It is said to be a visualized symbol of developing Kelvin-Helmholtz wave (a wave generated at the boundary surface where two atmosphere layers in different densities flow horizontally in different velocities) which is regarded as a cause of clear air turbulence.

*2 "Infrared imagery" is one of the satellite observations which capture infrared radiation emitted by cloud. It shows cloud with low temperature in a high altitude as white. Cloud such as well-developed tall Cumulo Nimbus or thin high-level Cirrus on a sunny day are also shown up as white.

*3 "PIREP : Pilot Report" is a report that pilots send to the ATC organization when they encountered adverse weather conditions which disturb the aircraft operation. PIREP includes C-PIREP (: Common PIREP) which contains light turbulence information and so on shared among Japan Civil Aviation Bureau and major Japanese air carriers.

*4 "Bulge" is a phenomenon, in which frontal cloud areas swell into cold air-mass. It consists of high-level clouds formed by an active warm air advection into the front of low pressure system in its way. Bulge increases its curve when the advection of the warm air goes stronger.

*5 "Vertical Wind Shears : VWS" is a difference between the upper layers wind and lower's one, converted into the difference per 1,000ft, for the wind direction and velocity at locations obtained through wind analysis. In response to altitude change, the more wind direction or velocity or both of them vary, the bigger VWS value becomes.

3. ANALYSIS

3.1 Involvement of Weather	Yes
3.2 Involvement of Pilots	None
3.3 Involvement of Airplane	None
3.4 Analysis of Findings	(1) In view of the history of the flight, it is highly probable that the severe turbulence corresponded to the significant change of the vertical acceleration recorded on the DFDR data. Due to this significant change of the vertical acceleration, it is highly probable that one of the passengers who had been away from his seat lost his body's balance in front of the AFT lavatory, and injured the right foot seriously. (2) Around the time when the aircraft encountered severe turbulence, the

	developing Low with front stayed in the Tokai region. In the upper-level, Transverse Band which was generated along with the Jet stream was moving eastward. Bulge was formed in the north edge of Transverse Band and covered the turbulence spot. It is highly probable that, associated with the development of the ground-level Low, the strong southerly warm wind flowed into front of the Low in its direction of movement and this warm air flow caused to enhance the horizontal temperature gradient in the upper-level frontal zone. As a result, it is probable that the wind velocity in the vicinity of the Jet stream axis grew bigger in specific areas and the turbulence spot contained the possible large VWS in temporally and spatially limited narrow range. (3) It is probable that the aircraft encountered the severe turbulence caused by large VWS formed in a temporally and spatially limited narrow range, which made the aircraft shake severely, though VWS was not identified in the hourly analysis chart in spite of the fact that the turbulence spot was located in the vicinity of the jet stream axis. (4) The large VWS in the vicinity of the Jet stream axis that was seemed to occur at the turbulence spot (where the aircraft had flown) was not corresponded to the upper-level frontal zone or Transverse Band. Therefore, it was probable that the prediction of the occurrence of the turbulence was difficult. It is hoped that the prediction accuracy regarding detection of the turbulence areas will advance in the future through the progress in research and development of analysis technology in the field of aviation meteorology.

4. PROBABLE CAUSES

It is highly probable that this accident occurred because the aircraft encountered the turbulence and was shaken at the cruising altitude of 36,000 ft. This shaking caused one of the passengers who had been away from his seat to lose his body's balance and to sustain serious injuries.

It is probable that the turbulence the aircraft encountered was caused by the large VWS formed in a temporally and spatially limited narrow range due to the strong southerly warm wind which flowed into the developing front side of the Low.

See Figure 1: Estimated flight route
See Figure 2: DFDR Records
See Figure 3: Asia-Pacific Surface Weather Chart
See Figure 4: Asia-Pacific Isobaric Chart at 300 hPa
See Figure 5: Meteorological Satellite Imagery (Infrared Imagery)
See Figure 6: Hourly Analysis Chart

Figure 1 Estimated flight route

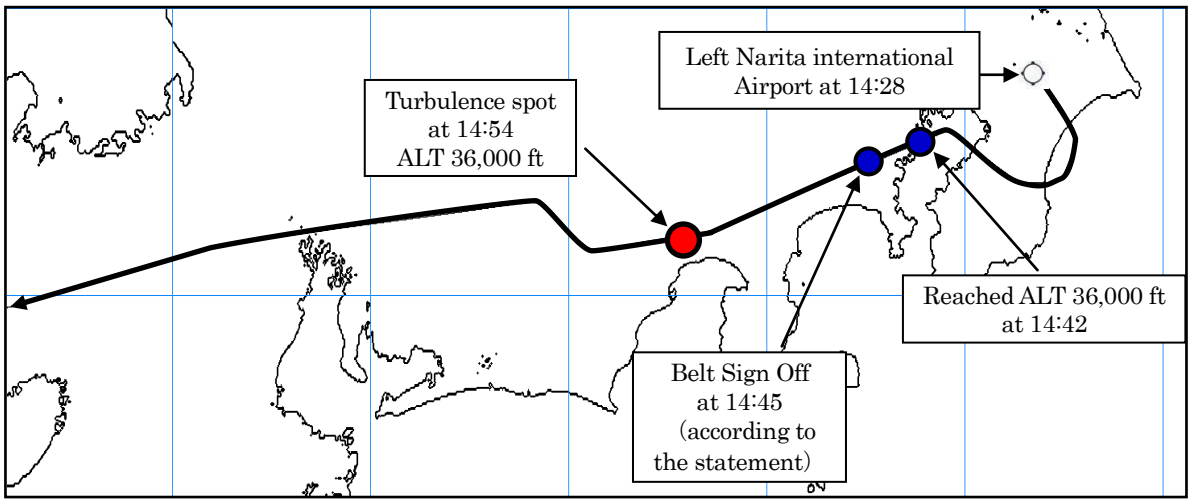


Figure 2 DFDR Records

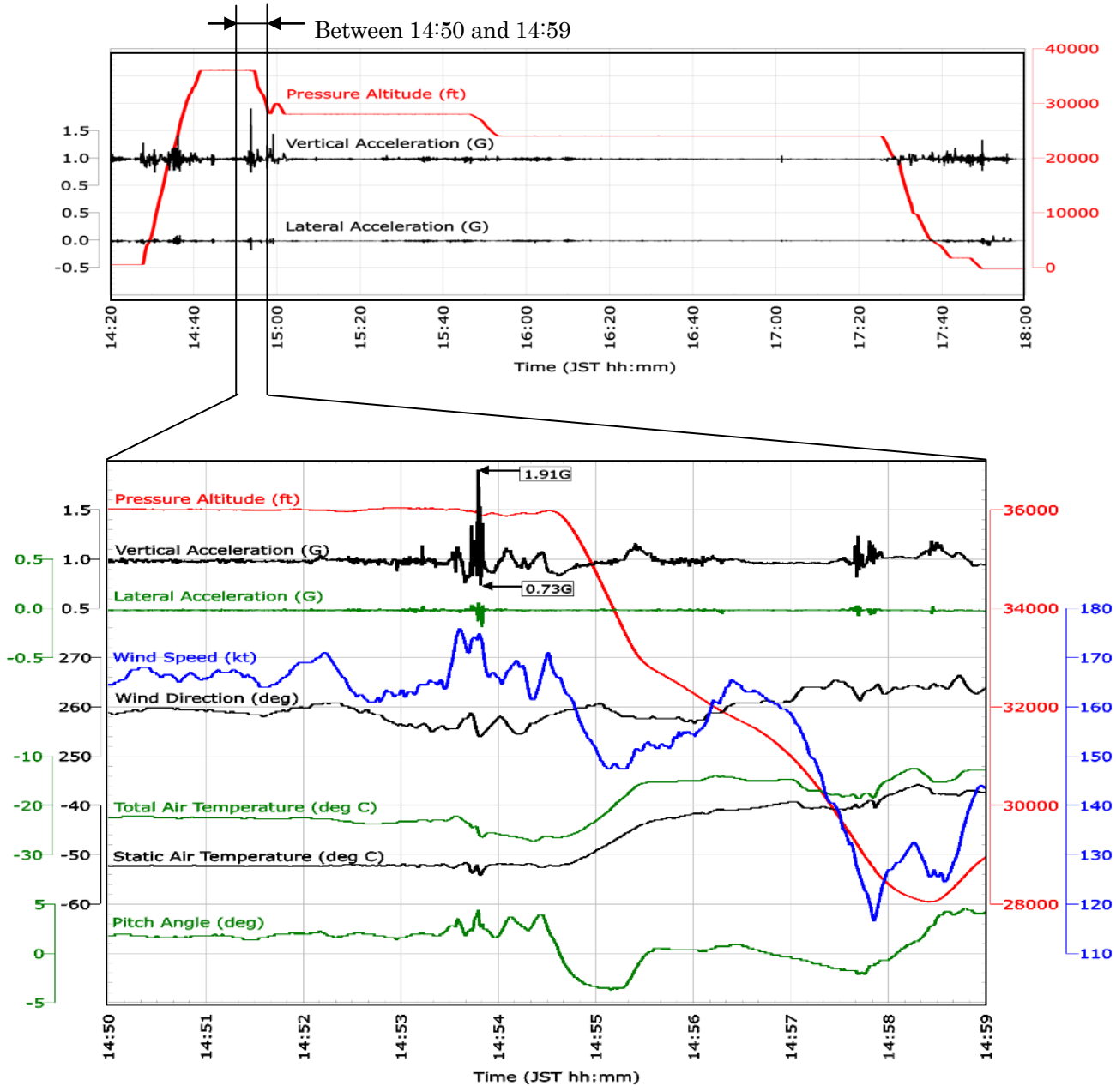


Figure 3 Asia-Pacific Surface Weather Chart (As of Nov. 26, 2012 at 09:00)

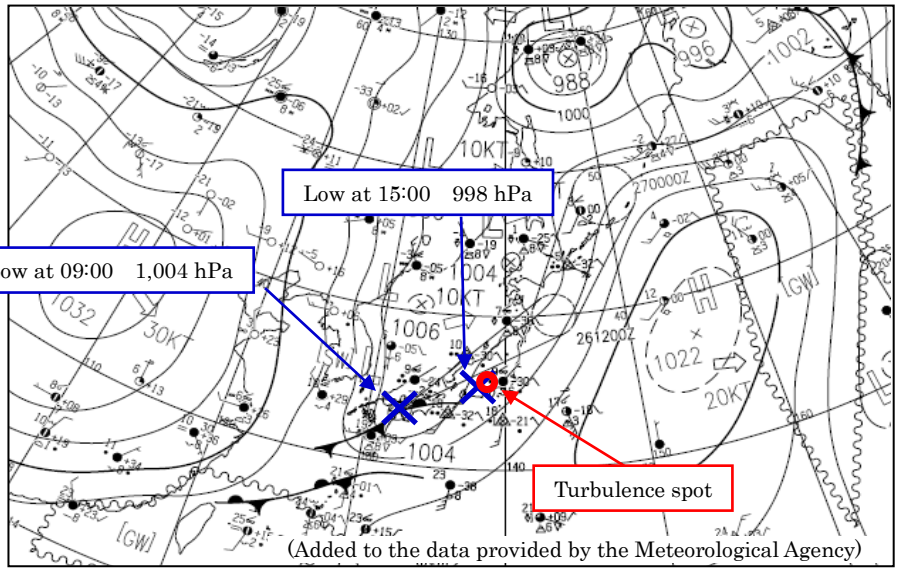


Figure 4 Asia-Pacific Isobaric Chart at 300hPa (As of Nov. 26, 2012 at 09:00)

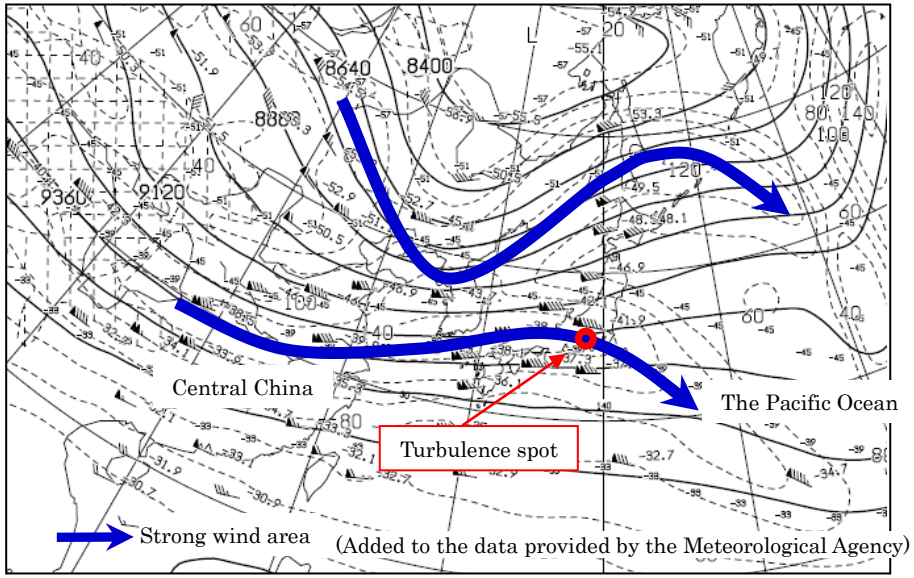


Figure 5 Meteorological Satellite Imagery (Infrared Imagery)
(As of Nov. 26, 2012 at 15:00)

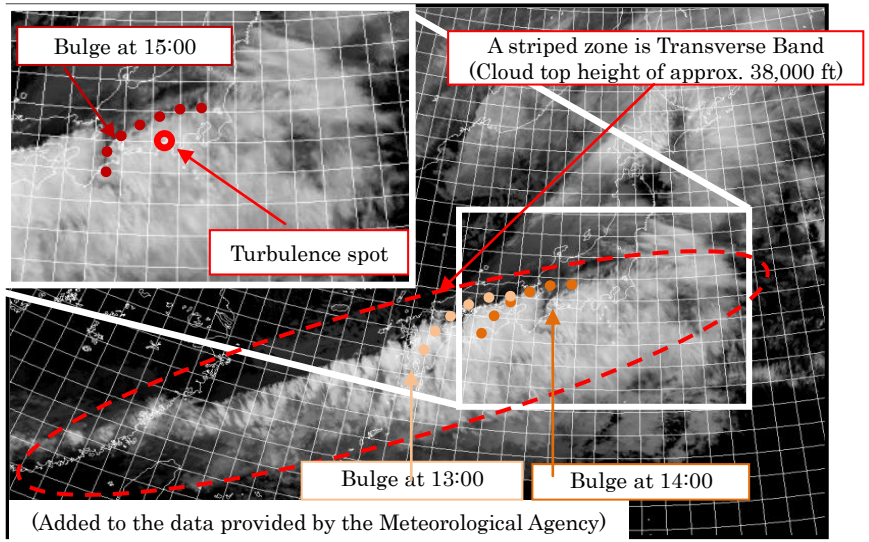


Figure 6 Hourly Analysis Chart (As of Nov. 26, 2012 at 15:00)