Degradation of GPS Navigation Performance in the oceanic airspace in Fukuoka FIR

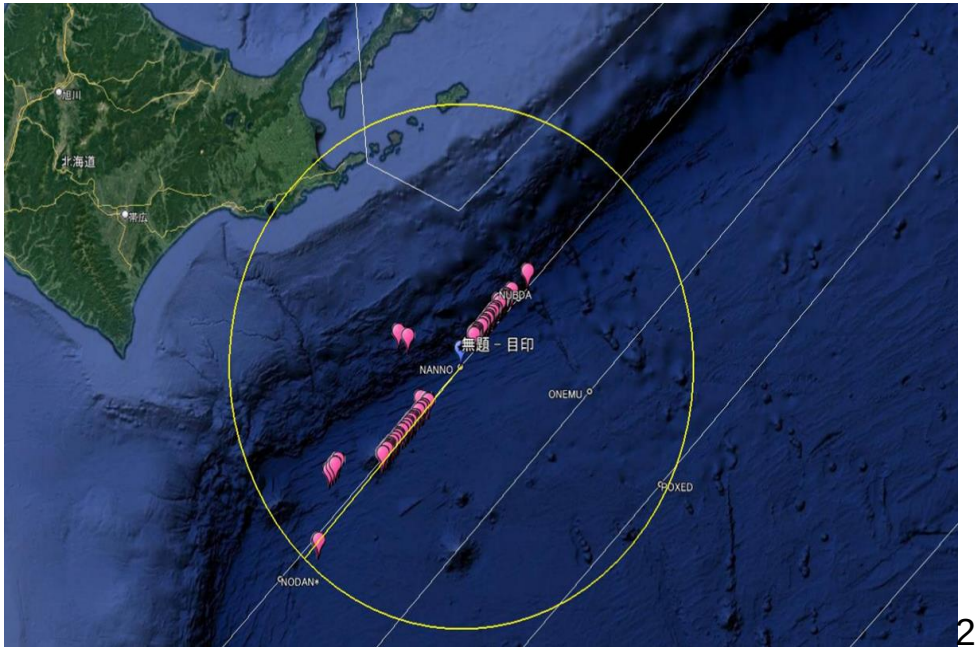
May 2022

Network Performance Assessment Center (NPAC)
Japan Civil Aviation Bureau

OVERVIEW

- On September 23th, 2021, TOPS (ATC oceanic Control System) detected that the FOM (*) level, which is a navigation performance index used in ADS-C application, had declined on the oceanic airways in the southeastern offshore of Hokkaido region. And at the same time, aircrafts reported that EICAS Advisory Message “ADS-B OUT” also were occurred.
- NPAC investigated the events.

*FOM (Figure of Merit Value): FOM figure can be confirmed as one of the ADS-C figures on the TOPS monitor screen, and it usually keeps 5 to 7. But at the event timing the figure became 4 and alerted.



【GPS navigation performance degradation Area】

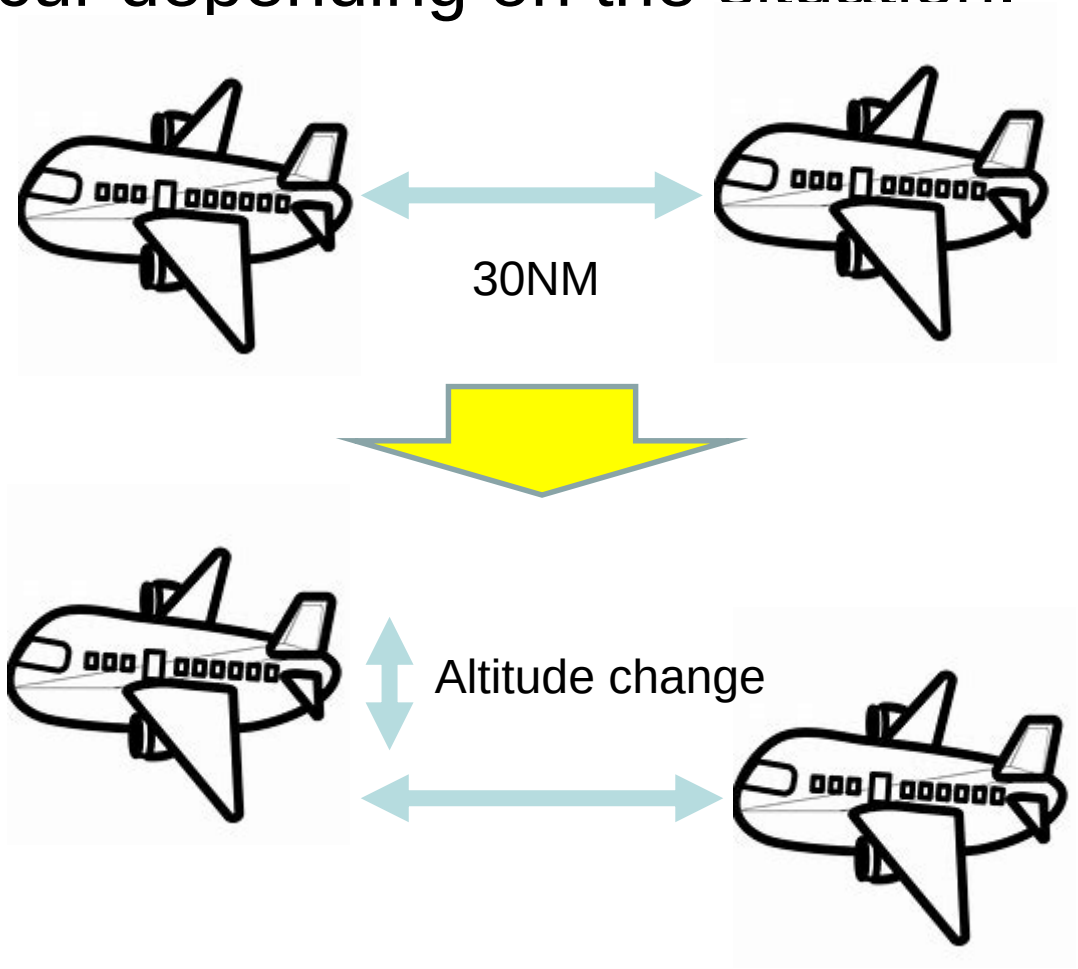
F O M Value

- Although the ATC separation using ADS-C can be applied up to the FOM value 4, the TOPS alerts at the FOM value 4 to warn to prepare the lack of separation. Therefore, the condition of FOM value 4 does not mean to immediately move to conventional way.

FOM	Position Accuracy	
0	**Complete loss of Navigation Function**	
～	～	
4	4NM Or less	
5	1NM Or less	NORMAL
6	0.25NM Or less	
7	0.05NM Or less	

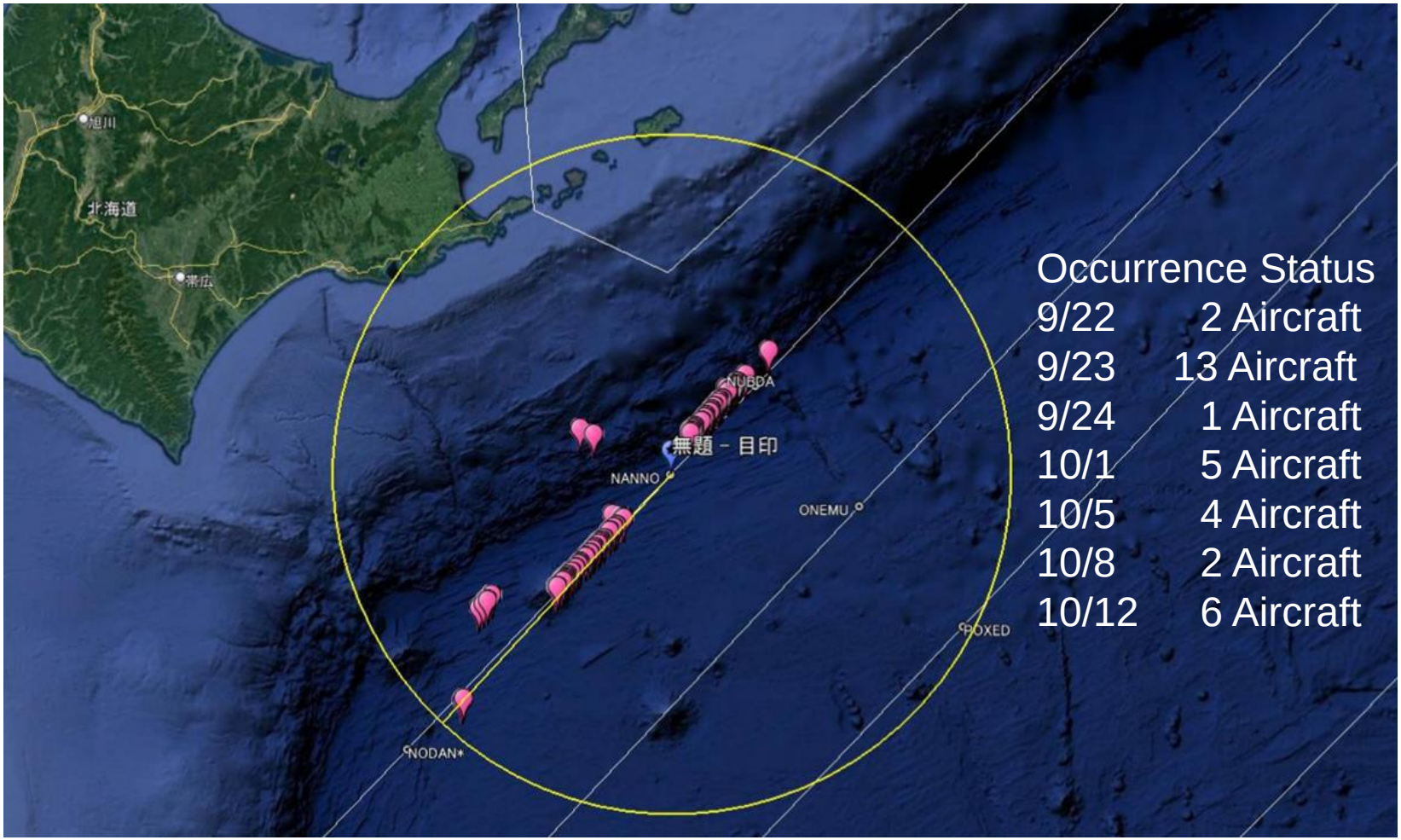
IMPACT of Lower FOM on Air Traffic Control

- There is no immediate effect, but altitude changes may occur depending on the situation.



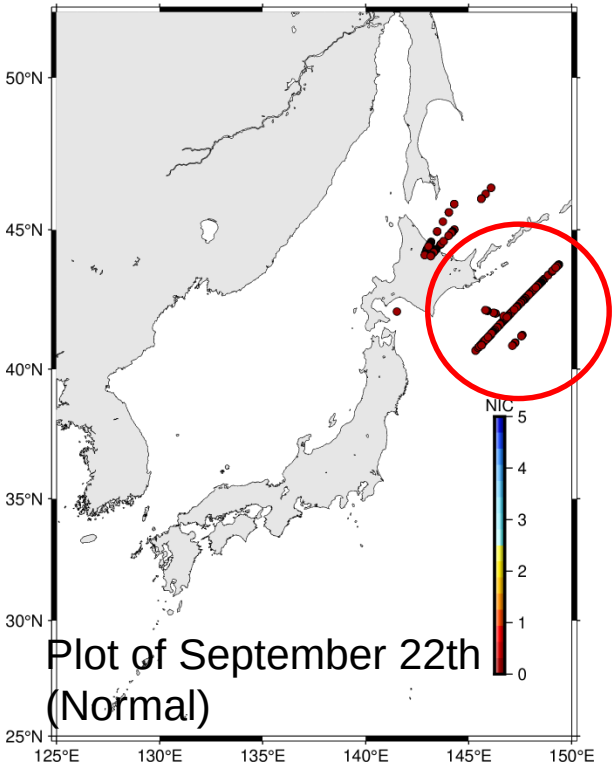
NPAC Research （ADS-C）

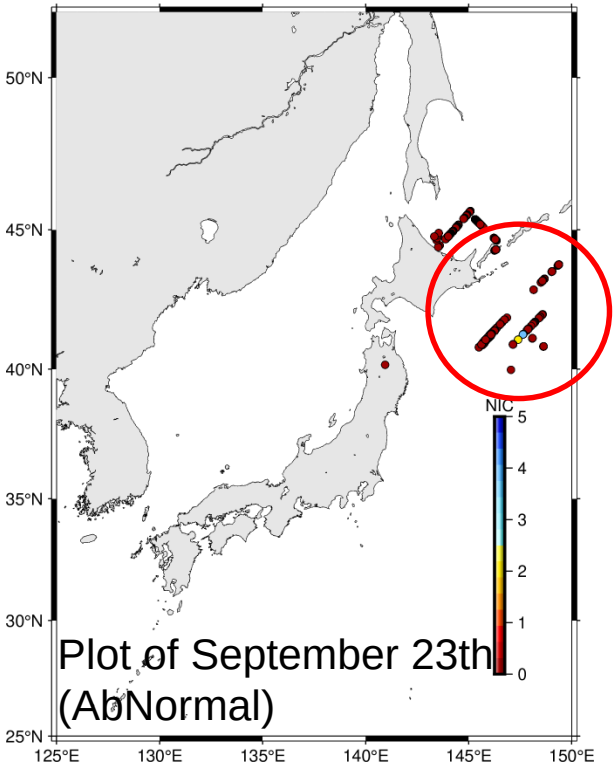
・NPAC plotted the latitude and longitude of the FOM anomaly reported aircrafts on a map and confirmed that it was concentrated in a specific area on NOPAC (R220).



NPAC Research （ADS-B）

- NPAC analyzed the ADS-B signals, which were received at the nearest Kushiro ADS-B Rx site.
- NPAC confirmed that the index of NIC / NAC value were decreased and furthermore there were some area where the location information was missing.

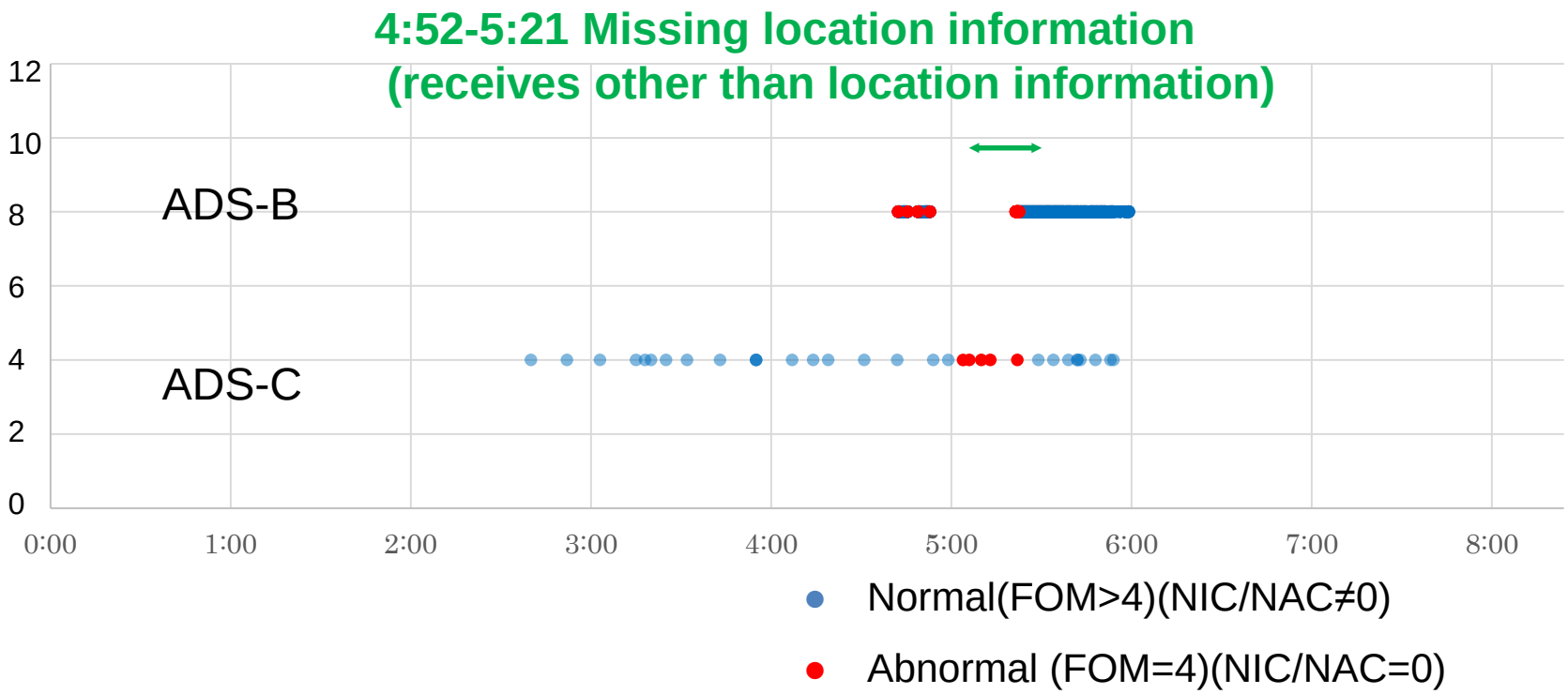




ADS-B signal received results on the oceanic airways

NPAC Research （Comparison of ADS-C and ADS-B）

- NPAC compared the ADS-C and ADS-B and confirmed that there is a correlation between the signal deterioration of FOM and the lack of position information of ADS-B.

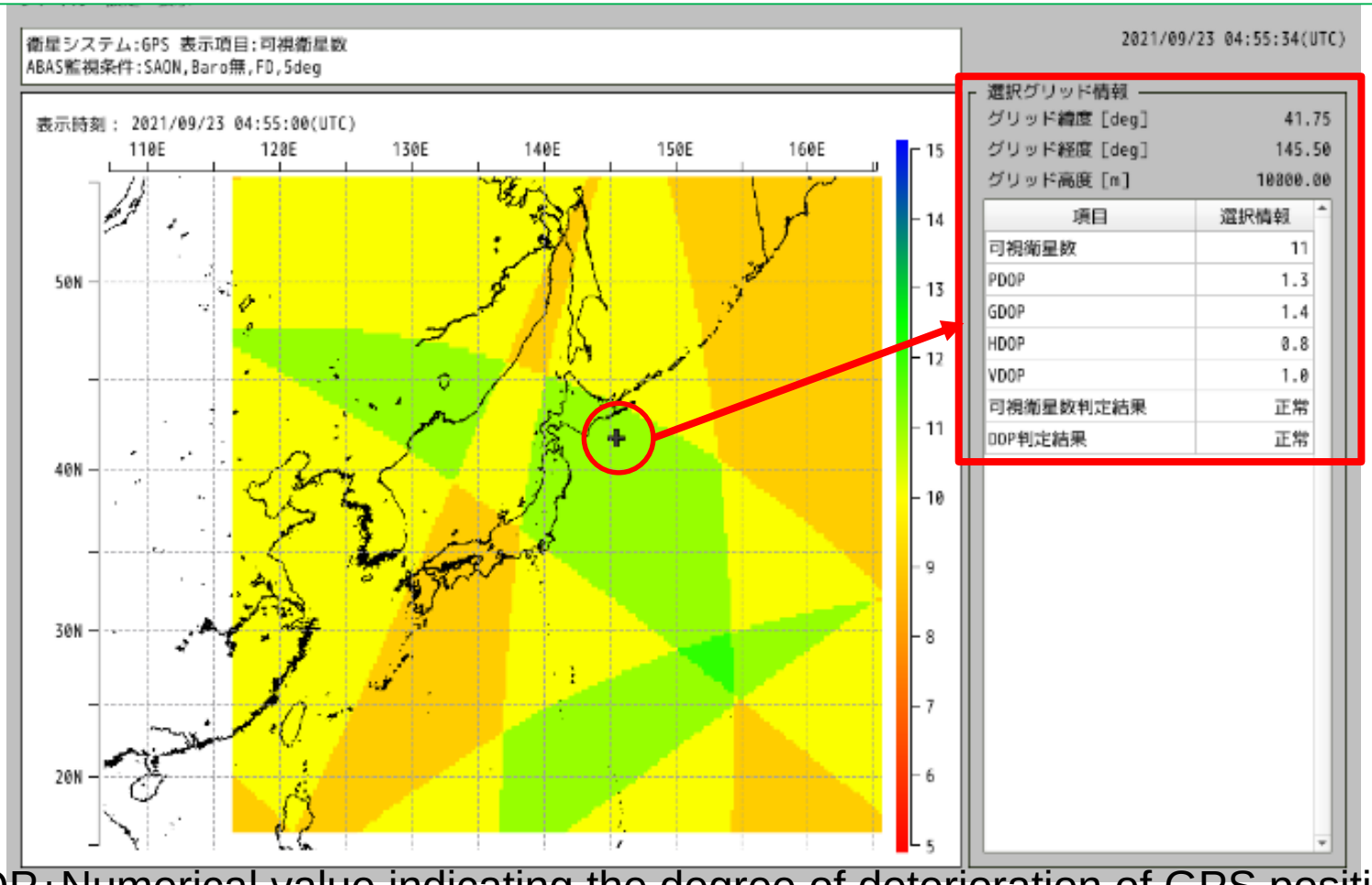


*The NIC (Navigation Integrity Category) value and the NAC (Navigation Accuracy Category) value are indicators of the accuracy of the position information broadcasted by the aircraft, and the larger index is better.

NPAC Research （GPS）

- Using GNSS monitoring System NPAC confirmed that GPS status, satellite placement, and DOP were good condition.

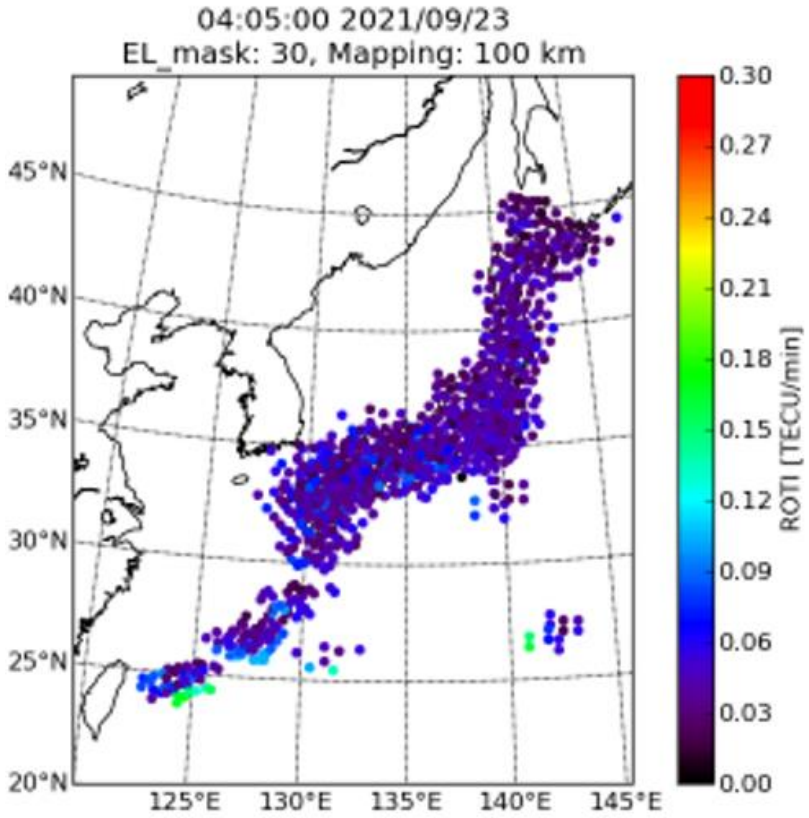
Number of visible satellites and DOP information at the time of occurrence



*DOP：Numerical value indicating the degree of deterioration of GPS positioning accuracy. The smaller the value, the higher the accuracy.

NPAC Research （Space Weather）

- NPAC confirmed that there were no magnetic storms or radio bursts.
- Electronic Navigation Research Institute(ENRI) advised NPAC that the possibility of radio wave interference should be considered.



Electron Density Disturbance Index(ROTI)
（from Space Weather Prediction Center）

Cooperation with Other Ministries

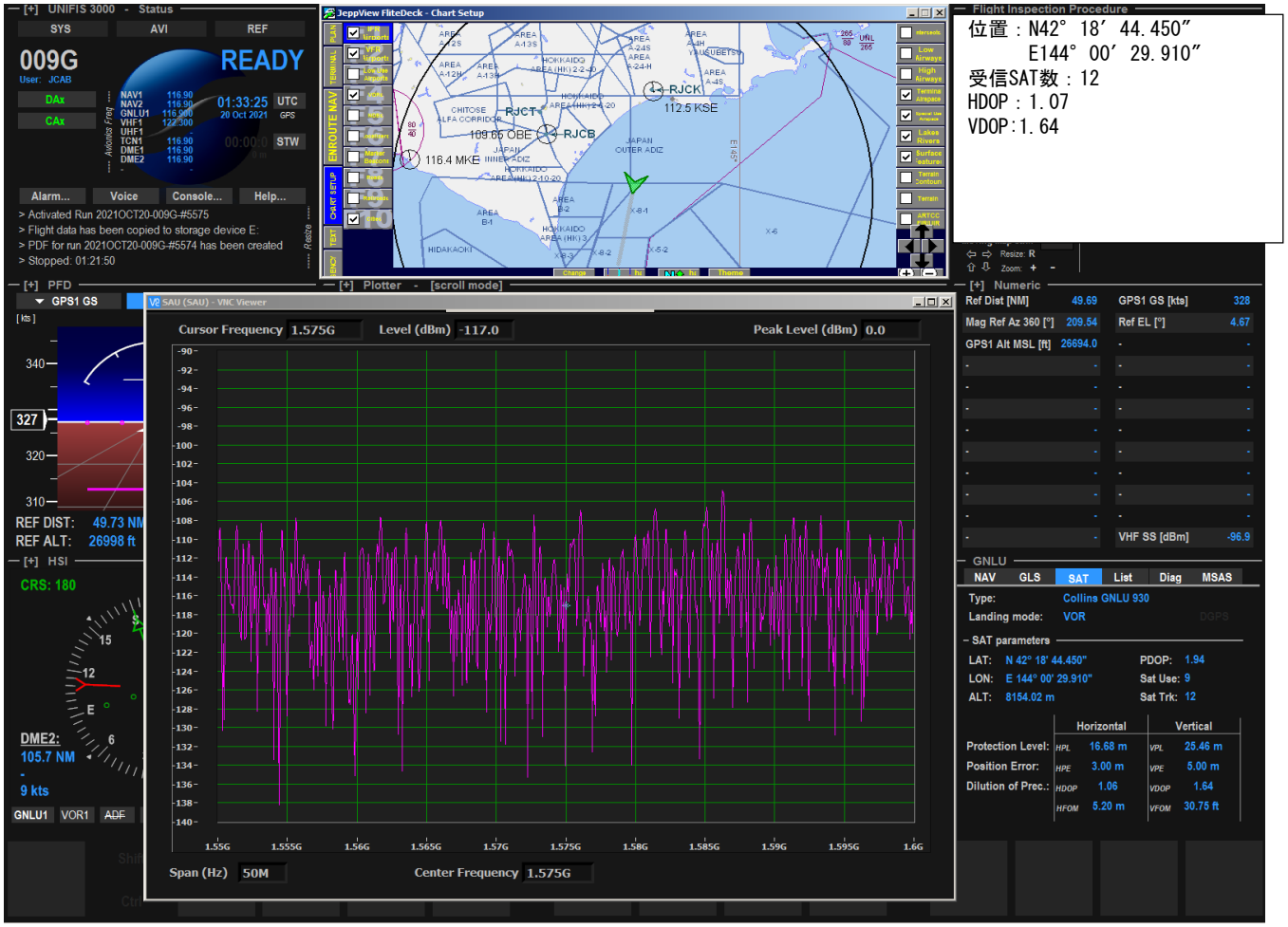
- NPAC provided information to other ministries and agencies in consideration of the possibility of radio wave interference.
- Regional Bureau of Telecommunications confirmed with the radio wave monitoring system (DEURAS) that No noise was found on land.
- A helicopter belonging to the Japan Coast Guard confirmed GPS reception failure at Kushiro offshore.

Hokkaido Regional Bureau of Telecommunications
Radio Monitoring System

Japanese Coast Guard helicopter
from the HP.

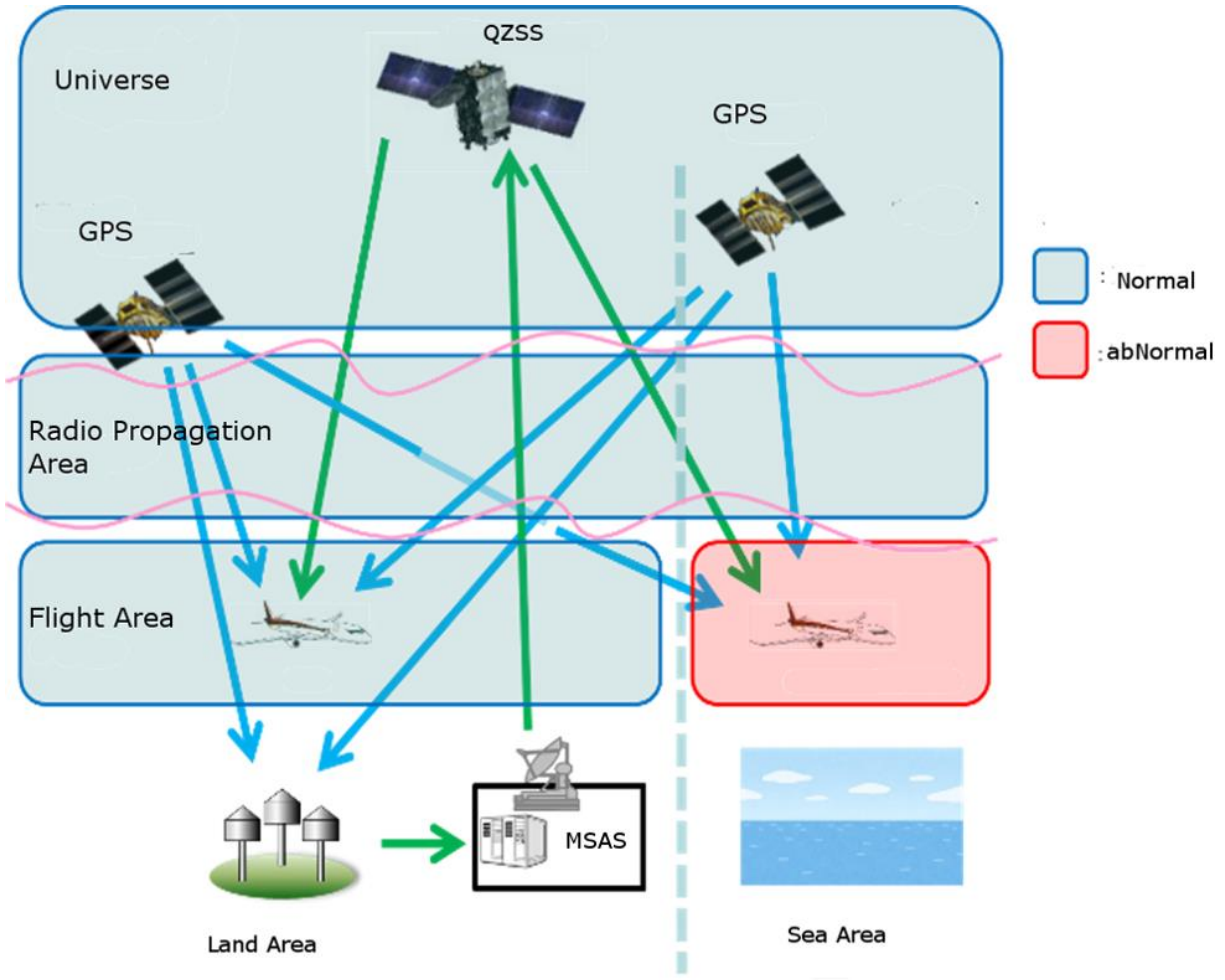
Confirmation by Flight Inspection Plane

- NPAC requested Flight inspection group to check the GPS signal.
- The disturbance of L1 GPS signal was not occurred and GPS reception failure was not confirmed.



NPAC Monitoring System and Scope

- NPAC can monitor only around installed receiver stations within the entire space area, the entire radio wave propagation area, and the land area within the Fukuoka FIR.
- NPAC cannot monitor in oceanic flight areas.
- Since the events occurred in oceanic flight areas, NPAC could not confirm any signal environmental errs such as spurious.



NOTAM Issued

- This situation often occurred after September 23.
- JCAB issued the following NOTAM from October 14th, and extended NOTAM until November 30th.

NEW

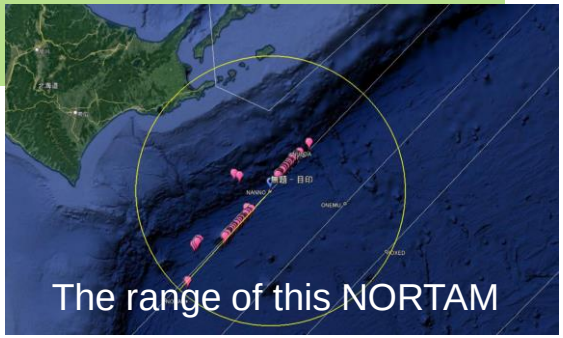
(6366/21 NOTAMN
Q)RJJJ/QGWXX/IV/NBO/E/000/999/4155N14652E100
A)RJJJ B)2110141000 C)2110241459
E)GPS POSITION ACCURACY MAY BE REDUCED WITHIN A 100NM RADIUS CENTERED ON NANNO ON THE FUKUOKA FIR.)

GPS reception accuracy within a 100NM radius centered on NANNO on the Fukuoka FIR may decrease.

REVISE

(6586/21 NOTAMR 6366/21
Q)RJJJ/QGWXX/IV/NBO/E/000/999/4155N14652E100
A)RJJJ B)2110221257 C)2111301459EST
E)GPS POSITION ACCURACY MAY BE REDUCED WITHIN A 100NM RADIUS CENTERED ON 415457.90N 1465133.04E
NANNO ON THE FUKUOKA FIR.)

Added latitude and longitude of NANNO


The range of this NORTAM

Afterwards

- After November 1st, there was no recurrence of the event that the FOM decreased in the same airspace, so the cancellation NOTAM was issued on November 30th.

SUMMARY

- The cause of this event could not be identified.

- After the NOTAM cancellation, data security work continues in case of recurrence.
- In case of similar cases, NPAC will work to solve the problem while sharing information with affiliated companies and other ministries and agencies.

Arigato