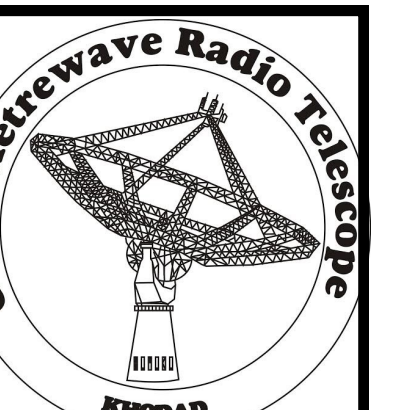# REAL TIME AIRCRAFT MONITORING ABOVE THE GMRT ARRAY

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Abstract: GMRT observatory being close to two intentional airports namely Mumbai and Pune cities, one domestic airport at Shridi, and two national and international flying routes passing near the GMRT observatory, the ATC signals produce strong interferences to GMRT observatory in certain RF bands of observation. The upgraded GMRT operates in the 150MHz to 1500MHz frequency band and the majority of the ATC signals fall within the observing frequency band of GMRT. On an average 500-600 flights were seen in 24 hours over 60kms radius of GMRT array. Some of the domestic and international flights fly over GMRT antenna array and it is necessary to monitor the flight movement and onboard transmission signals used for navigation.

ADS-B has been installed at the GMRT observatory to closely monitor the flight movement within the 60kms radial distance from the center of the GMRT array antenna. Using GMRT antenna beam direction during the observation and the real time database of flights flying in the 60km radius, a more precise measurement of ATC signals with reference to the class of flights, received RF power levels, flight direction and distance from the nearest GMRT antenna is studied along with RFI monitoring system at the observatory. This paper will talk about a real time monitoring program which has been developed to record flight name, flight number, altitude and speed of the flight and the amount of time spent by the flight within 60kms radius from center of the array antenna.

Based on the altitude and location of overflying planes the landing flights are identified. A cronjob does the recording for 24 X 7, records the flights data continuously and daily reports are being generated. A simultaneous RF spectrum is independently recorded using Discone antenna setup. The recorded RF spectrum will help in flagging the ATC interference in the observed data during analysis. Figure1 and 2 show the flight path and data recorded with the setup.
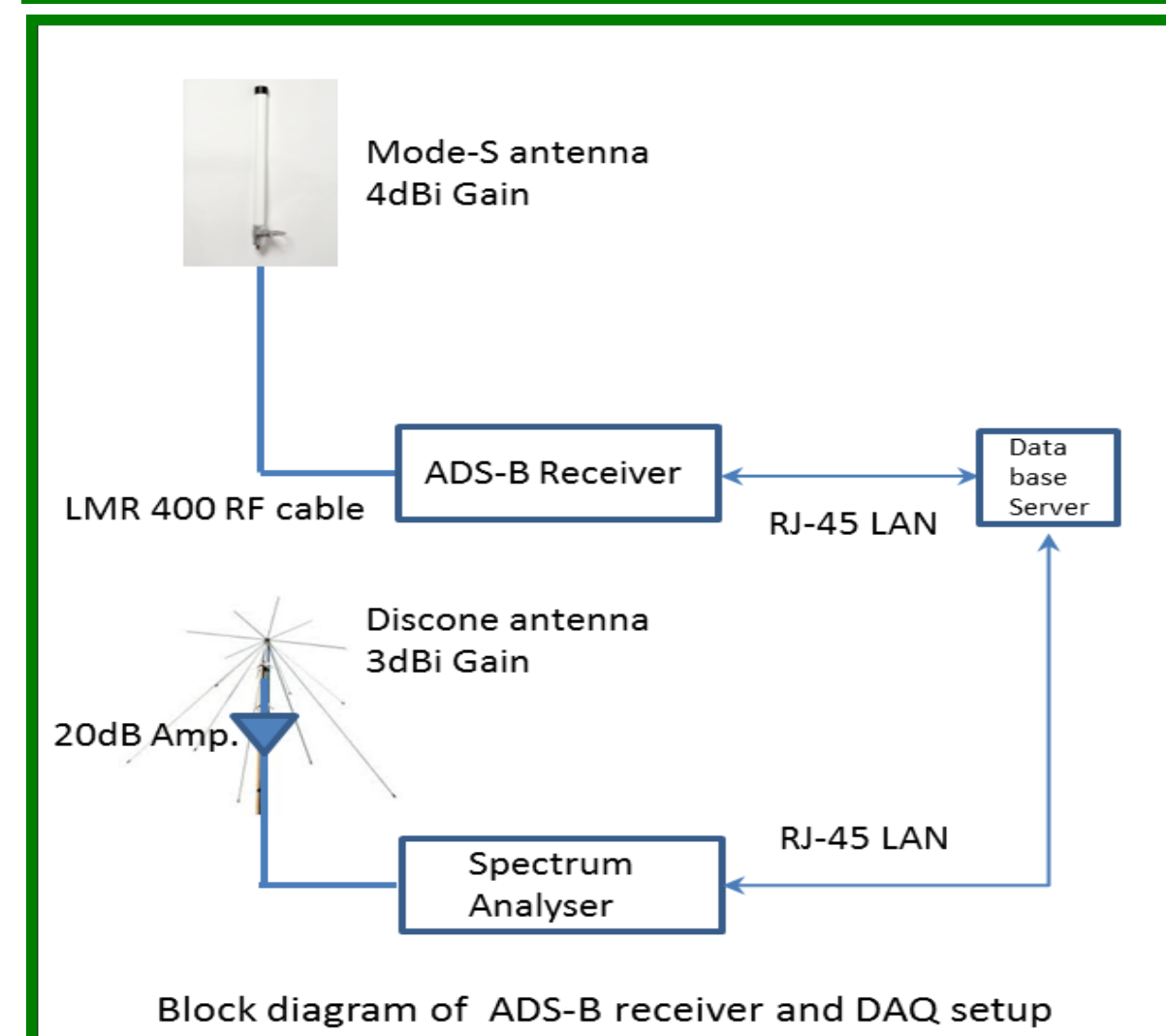
Database management and daily reports generation:

Image 6: Radial distance of flight from GMRT Observatory— 5km to 60km

Image 7: Time duration of flights seen within 60km radius in minutes

Image 8: Altitude of flights in km recorded within 60km radius

Image3: GMRT Observatory and nearest Airport are shown in blue color star—Mumbai– 125km, Pune – 59km and Shirdi-76km, Nearest ATC route for domestic flights is at 40km distance and International ATC flight route is at 60kms distance from the center of the GMRT Observatory.

Figure 1. Data Block of an ADS-B message

Message Structure : An ADS-B frame is 112 bits long and consists of five main parts, shown above

DF (5)	CA (3)	ICAO (24)	ME (56)	PI (24)

Image1 : Block diagram of ADS-B receiver and Discone antenna DAQ system

Flight Radar 24 Receiver system installed at the GMRT observatory

Image 4: Real time Graphical User Interface (GUI) : Flight monitoring above GMRT array antennas. The data is being recorded for the flights which enters the 60km circle are displayed on the screen and the flights that exist 60km circle are removed from the display. The right hand corner display shows flight name, distance and amount of time present lin the 60 km radius of GMRT observatory.

Air Traffic Control Frequency	Band Designation	GMRT RF Observation Band	GMRT antenna Beam width
75 MHz	NAV-AID (Marker Beacons)		
108-118 MHz	LOS, VOR (Very High Frequency Omnidirectional Range), ILS Localizer	120-240MHz	5°
118-137 MHz	VHF Air & Ground Communications		
328.6 - 335.4 MHz	ILS Glide Slope	250-500MHz	1.5°
1030 & 1090 MHz	Air Traffic Control Radar Beacon, Mode S, TCAS		
962 to 1213 MHz	DME (Distance Measuring Equipment)	1000-1450MHz	0.5°
1215 – 1400 MHz	Air Route Surveillance Radar, GPS and GLONASS L1		

ATC Frequencies observed inside the GMRT observation bands

Bit	No. Of bits	Abbreviation	Information	Type Code	Data frame content
1–5	5	DF	Downlink Format	1–4	Aircraft identification
6–8	3	CA	Transponder capability	5–8	Surface position
9–32	24	ICAO	ICAO aircraft address	9–18	Airborne position (w/Baro Altitude)
33–88	56	ME	Message, extended squitter	19	Airborne velocities
				20–22	Airborne position (w/GNSS Height)
				23–27	Reserved
(33–37)	(5)	(TC)	(Type code)	28	Aircraft status
				29	Target state and status information
89–112	24	PI	Parity/Interrogator ID	31	Aircraft operation status

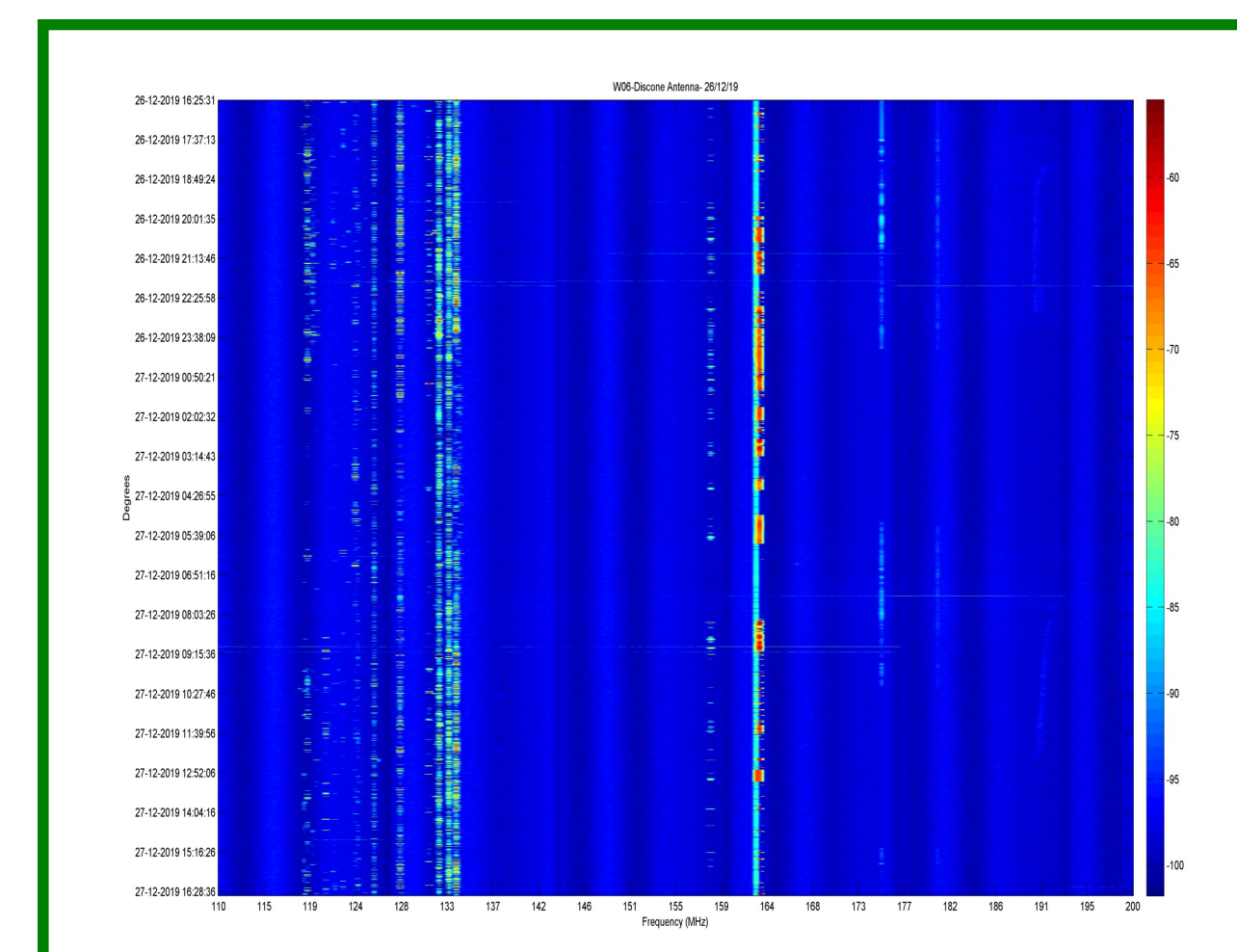**Details of message structure of 112 bits shown in table 1 and table2**

Image2: 24 hours of data recorded using Discone antenna setup (110-200MHz) showing ATC signal, Police wireless and terrestrial TV transmission signal.
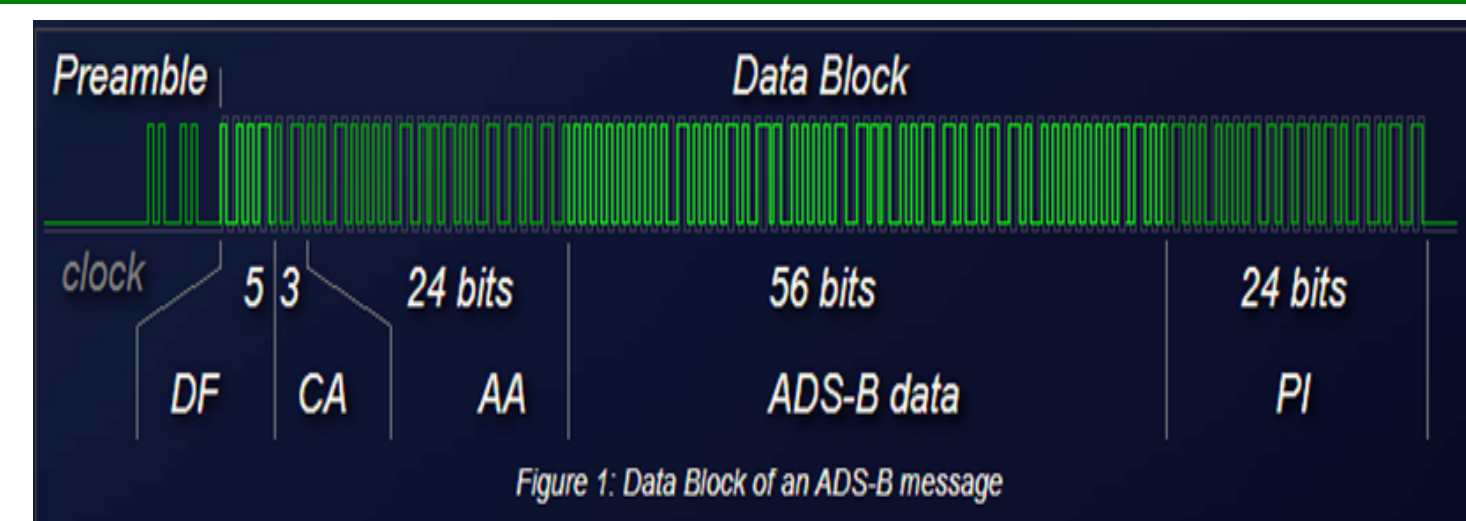

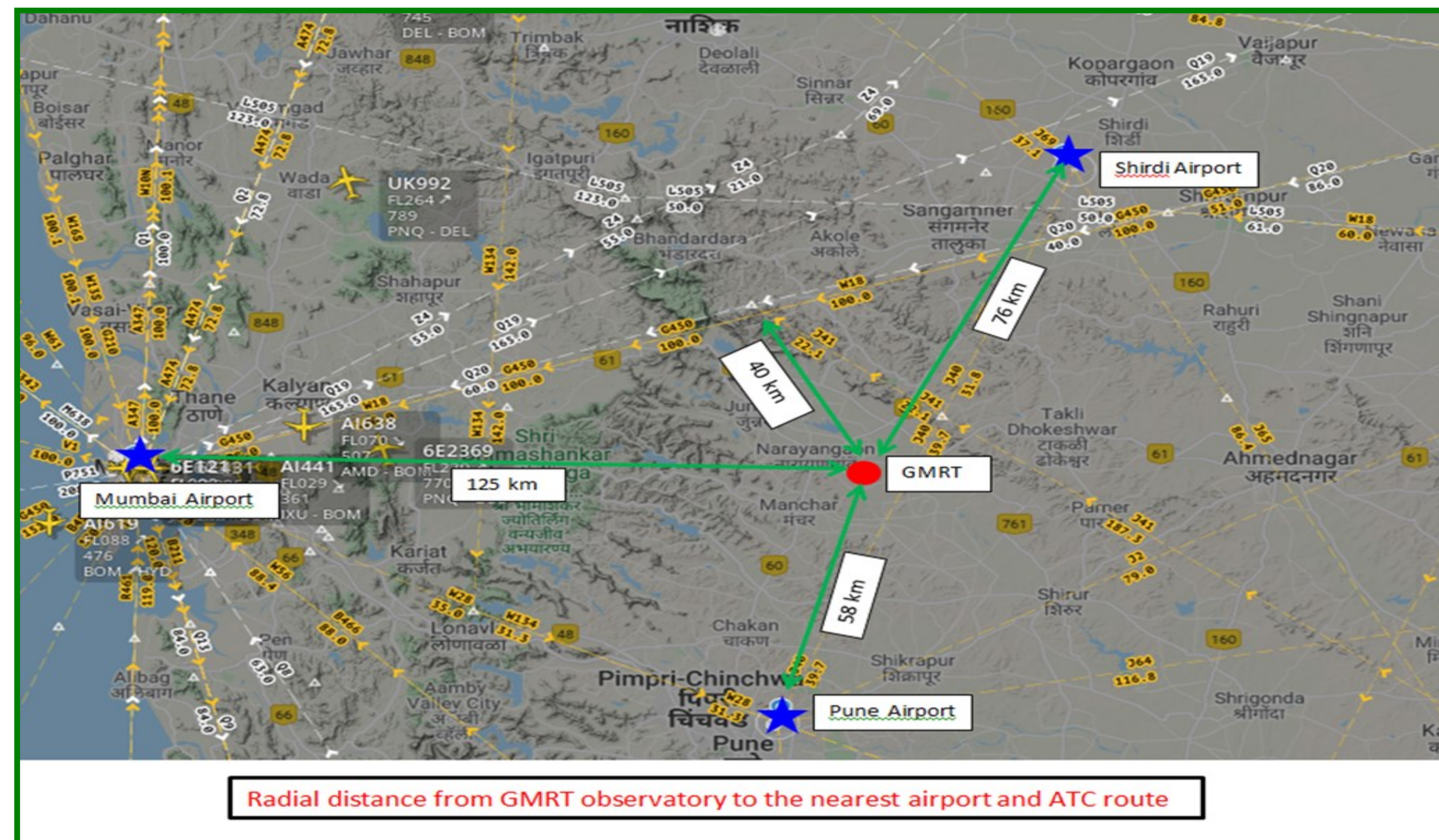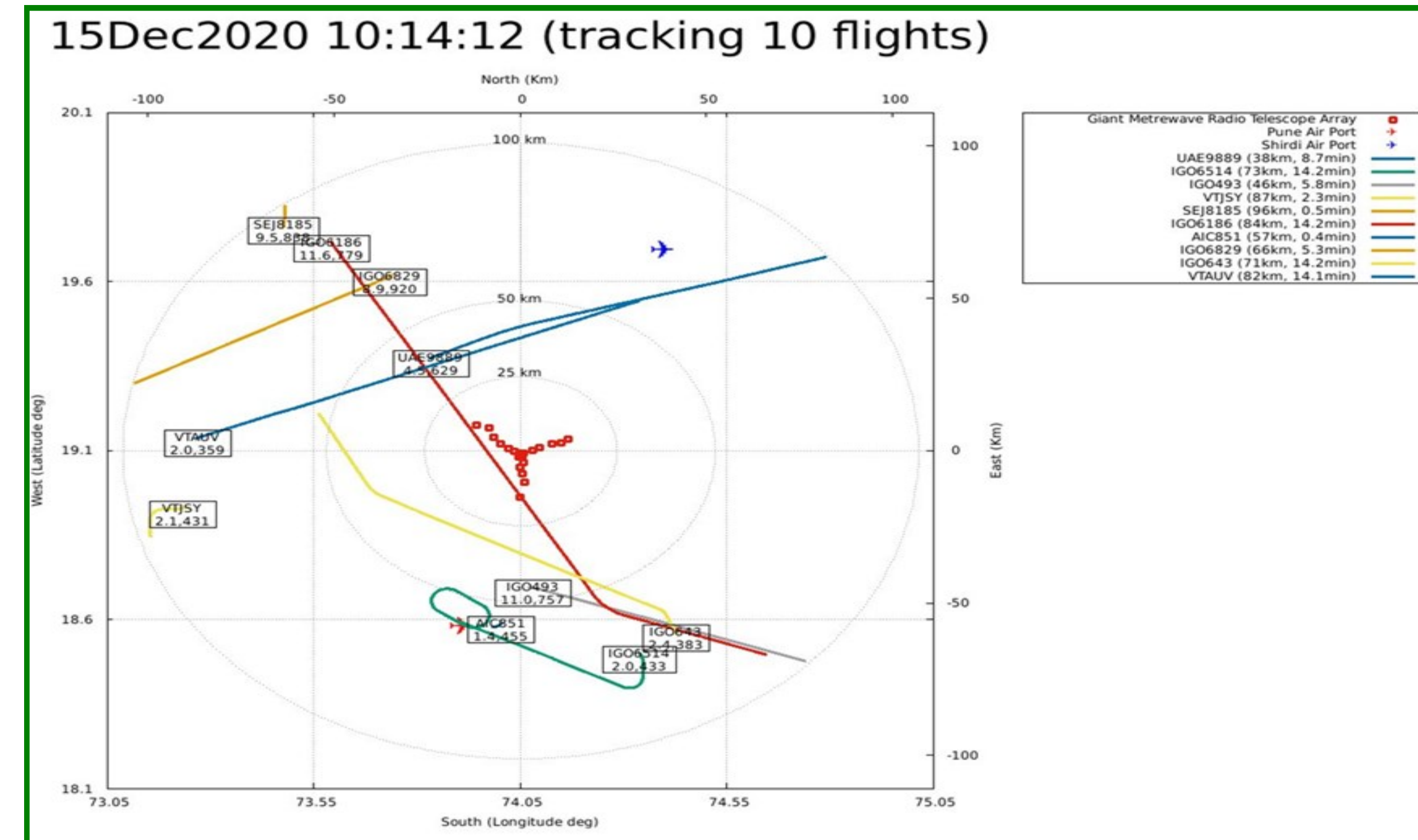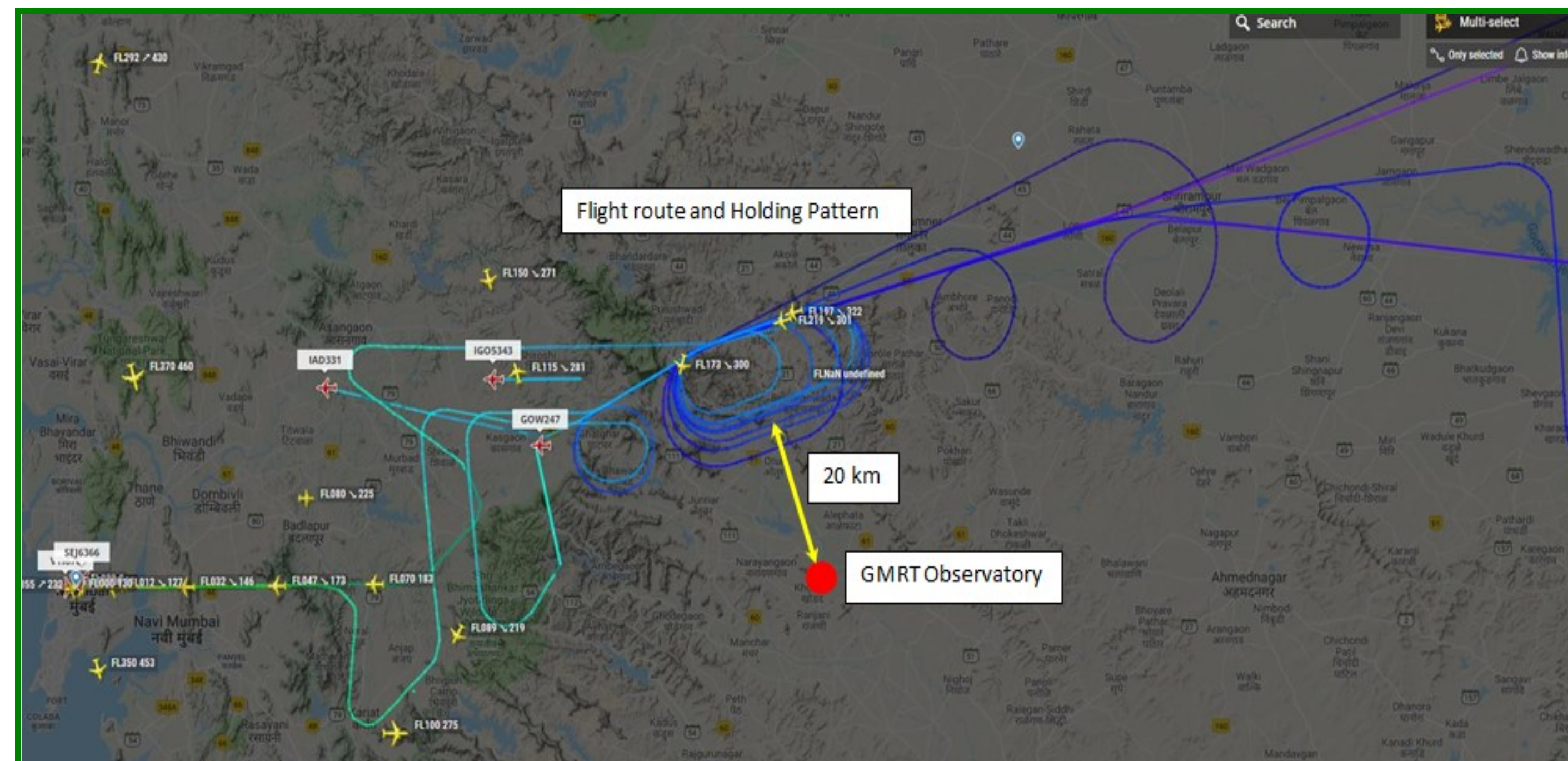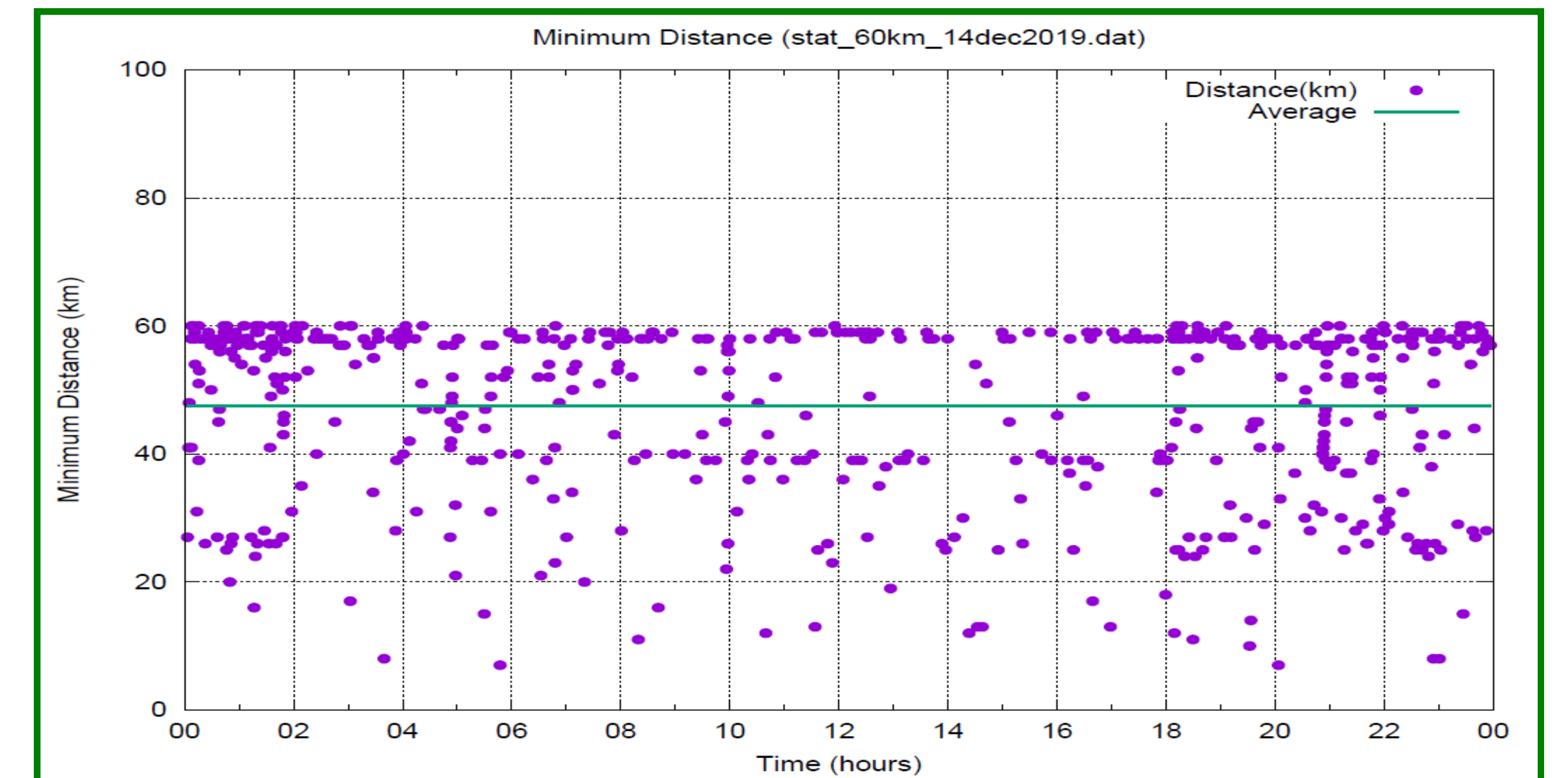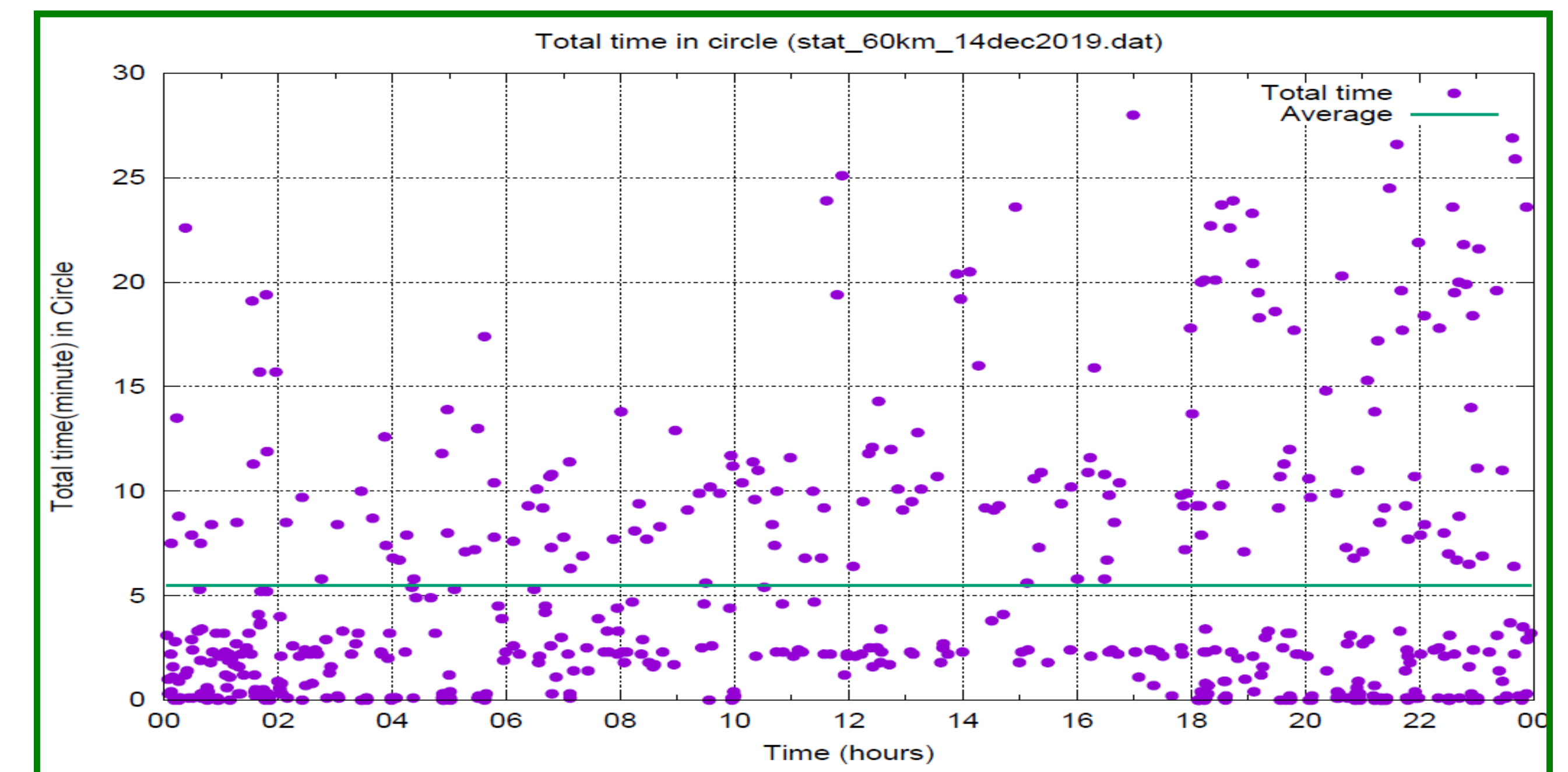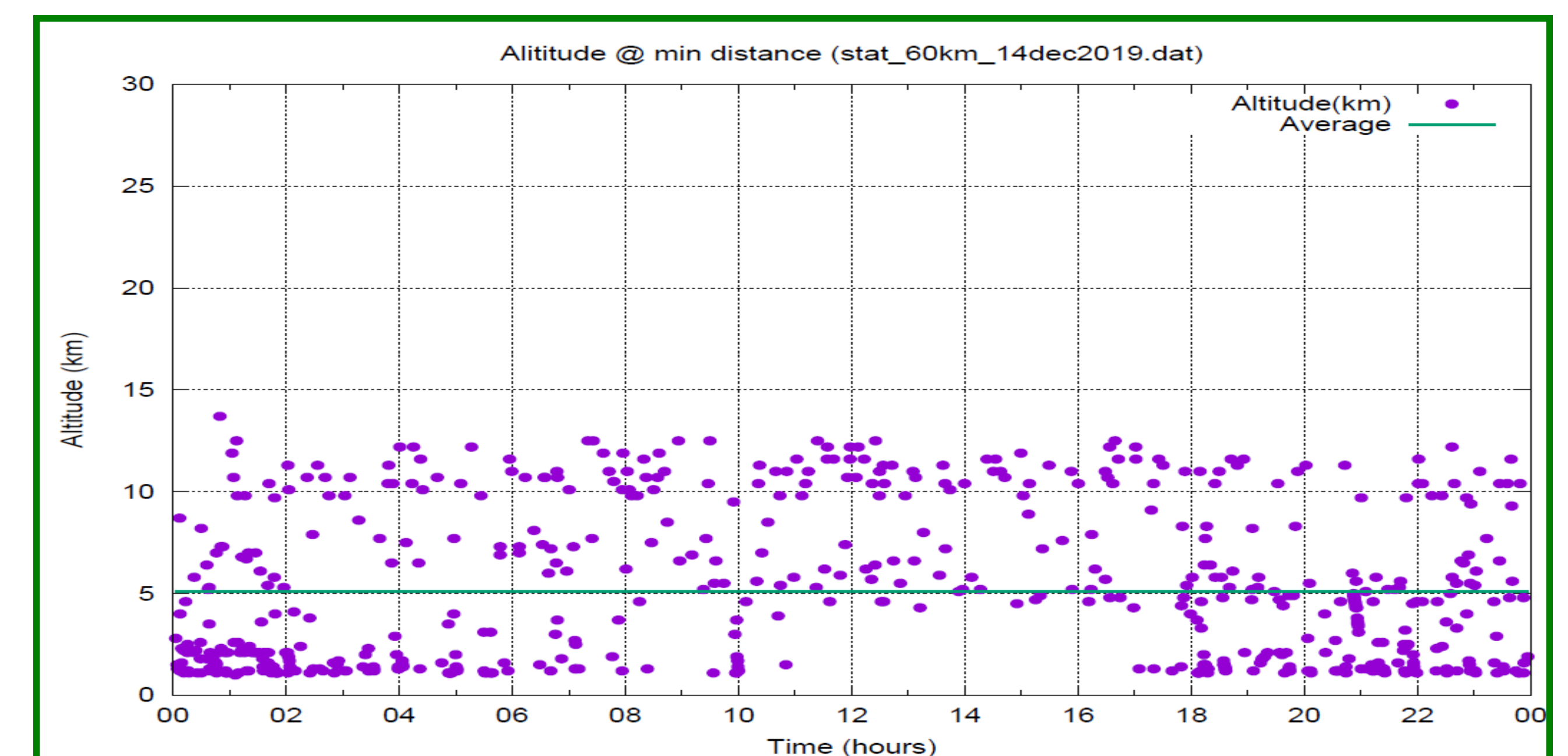**Image2a: Estimated visibility of flights duration ,distance and angle of the GMRT antenna.**

Image 5: ATC flight route and holding pattern seen near GMRT observatory

- Conclusion :
- GMRT observatory has three airports within 125km radius.
- On an average 580 no of flights per day fly within 60km radius of the GMRT.
- These flights fly at an altitude from 2kms to 12kms.
- Frequencies used by ATC cause interference to the GMRT observation band of 120-240MHz, 250-500MHz and 1000-1450MHz band.
- Based on present facility of satellite prediction and alarm generation , a similar facility of the real time monitoring and prediction of flight with alarm raising to flag GMRT data during observation is being implemented.