

# **IGSO Operation and De-orbit Area**

**VS.**

# **GSO Protected Region**

Mari Yuzawa Gotoh  
**MITSUBISHI ELECTRIC CORPORATION**

Nov.5-9.2018

**ICG**  
(International Committee on GNSS)

## Contents

1. Purpose --- P.3
2. IGSO operation orbit vs. GSO --- P.4
3. IGSO De-orbit vs. GSO and Other IGSO --- P.11
4. Conclusion --- P.25

## 1. Purpose

This material

- proposes the current possible issues of IGSO orbit and
- initiates a discussion to seek the most appropriate solutions for IGSO.

## 2. IGSO operation orbit vs. GSO

- IGSO interference time increases as the inclination and the eccentricity become lower.
- The longitude deviations are longer than GSO.

Table 1-1

Fig.	IGSO	Inclination [deg]	Eccentricity	Interference time [hr]	longitude deviation [deg]
1-3	QZSS	36	0.75	0.9	2.6
1-4	QZSS	47	0.75	0.9	4.4
1-5	BeiDou	54	0	4.9	15.2
1-6	NAVIC	29	0	8.6	6.6

## 2. IGSO operation orbit vs. GSO

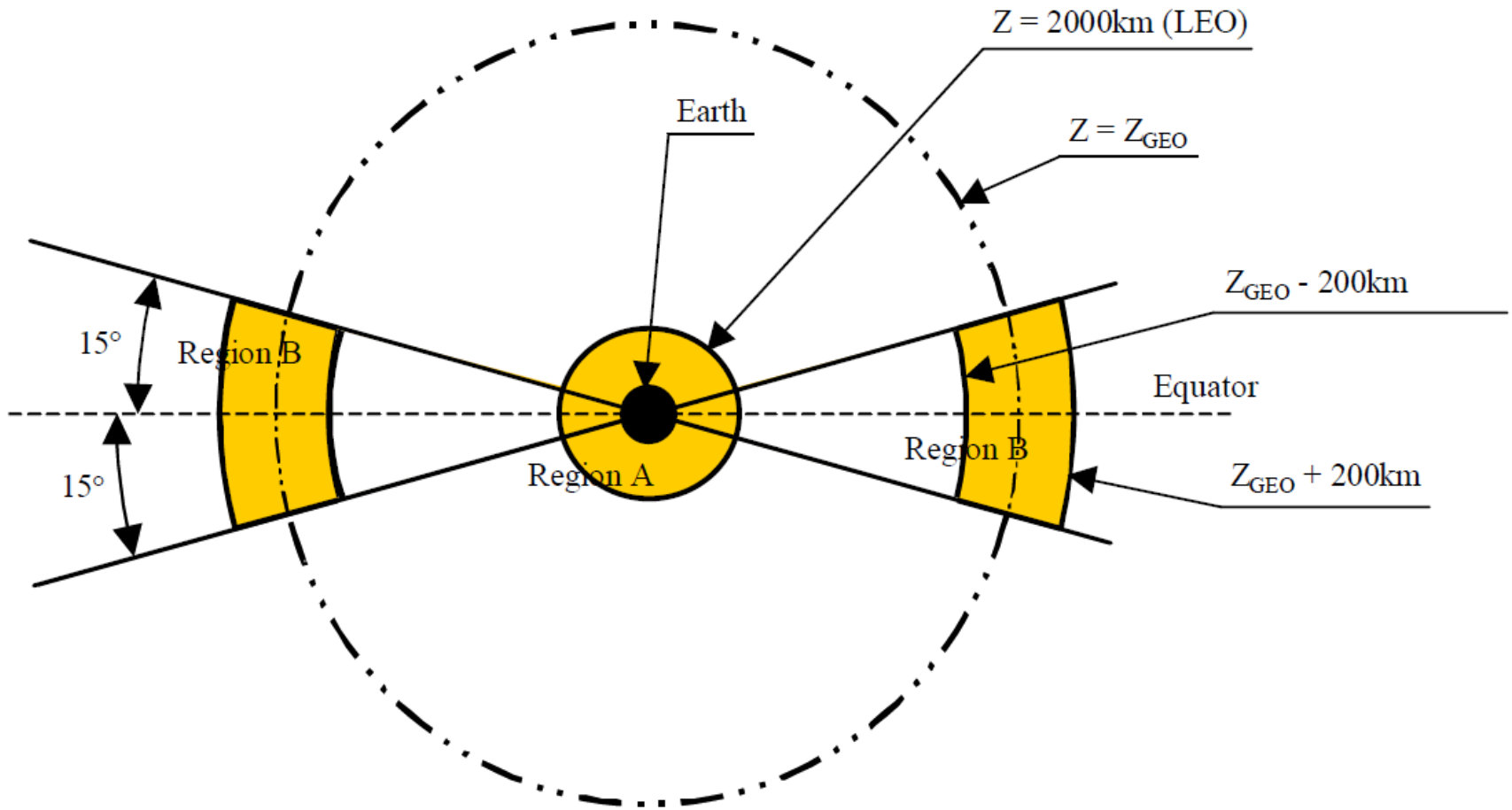


Fig.1-1 Cross section of GEO and LEO protected regions

## 2. IGSO operation orbit vs. GSO

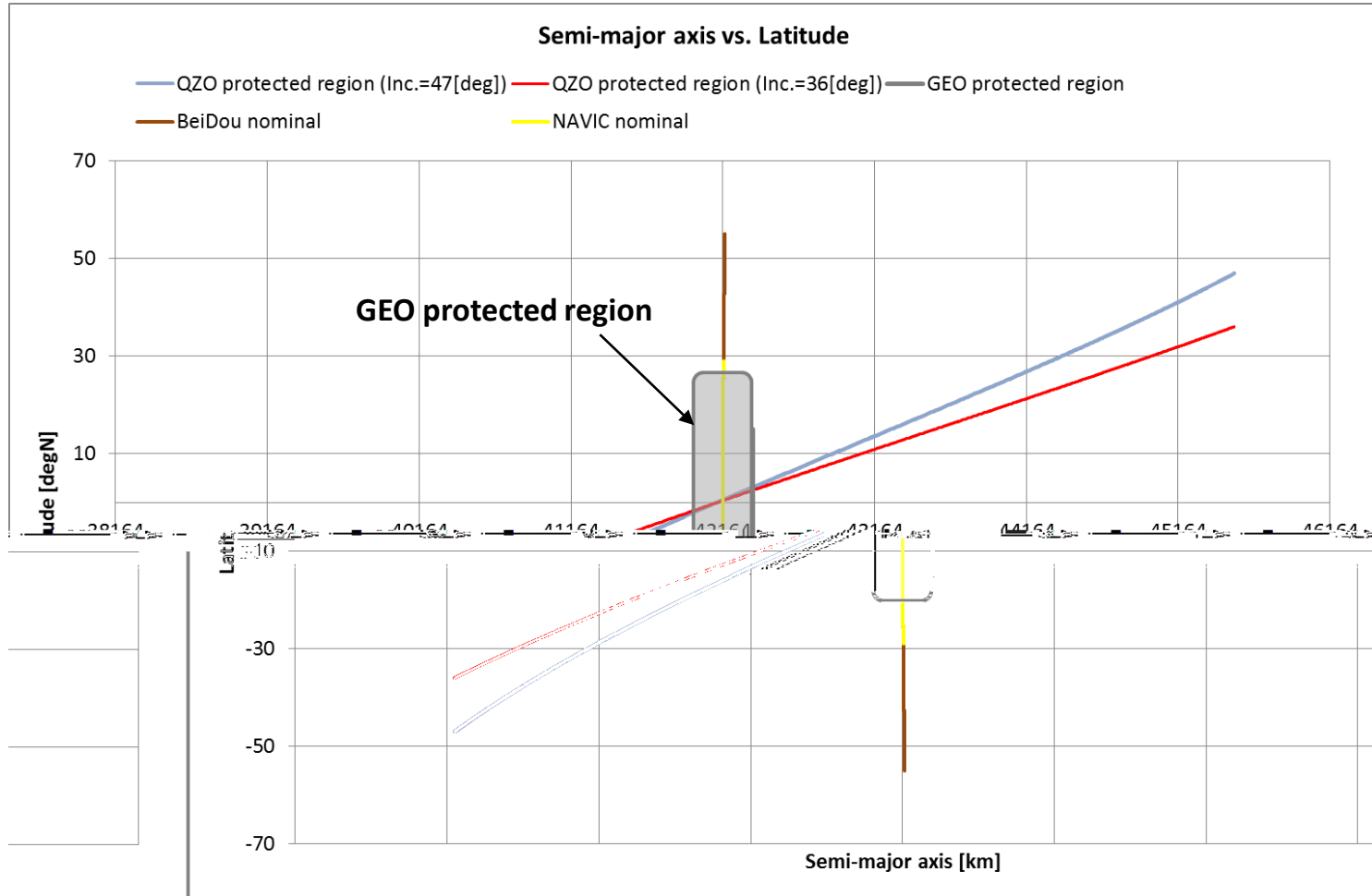
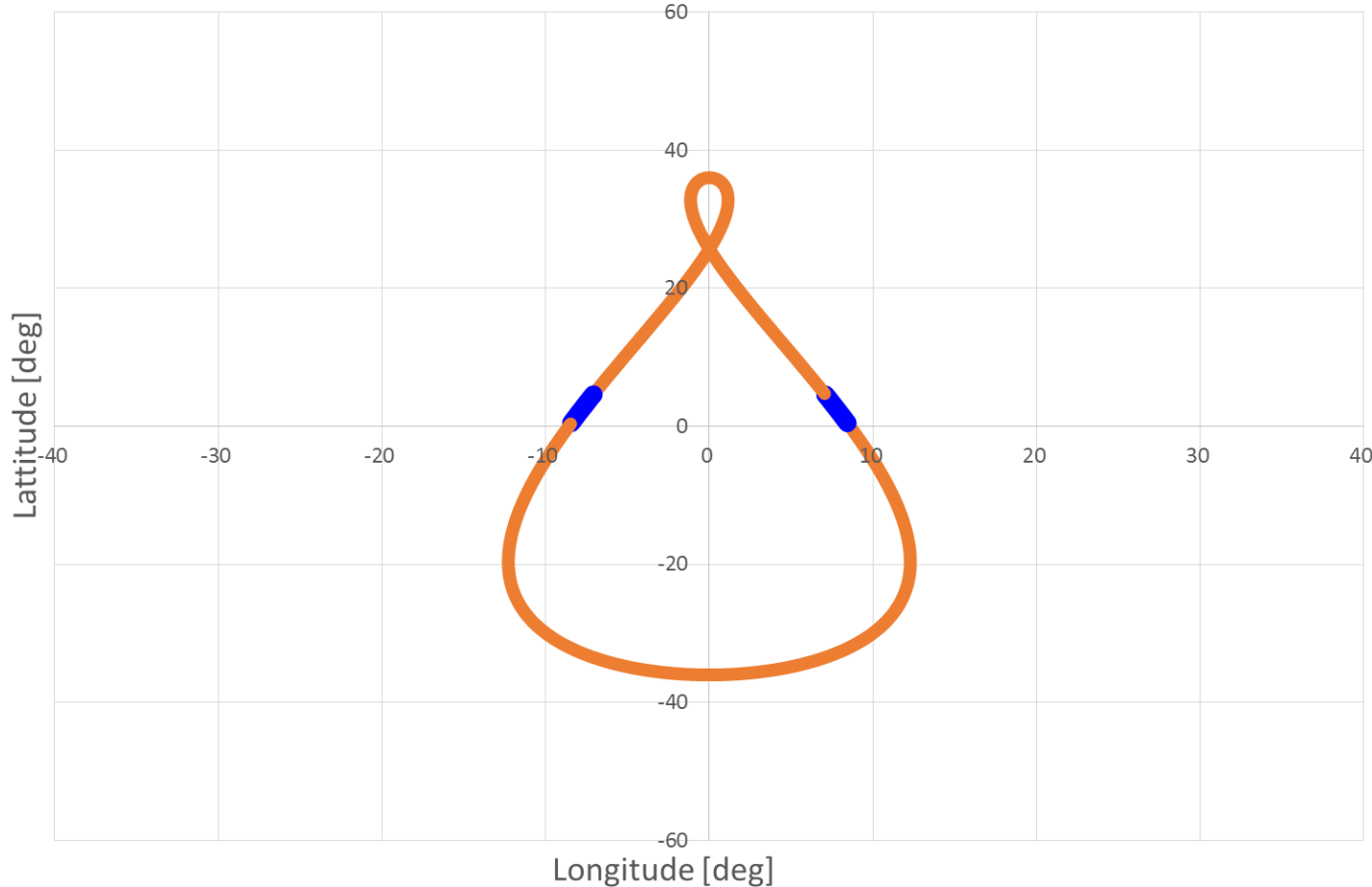


Fig.1-2 Representative Orbit Semi-major [km] vs Latitude [deg]

## 2. IGSO operation orbit vs. GSO

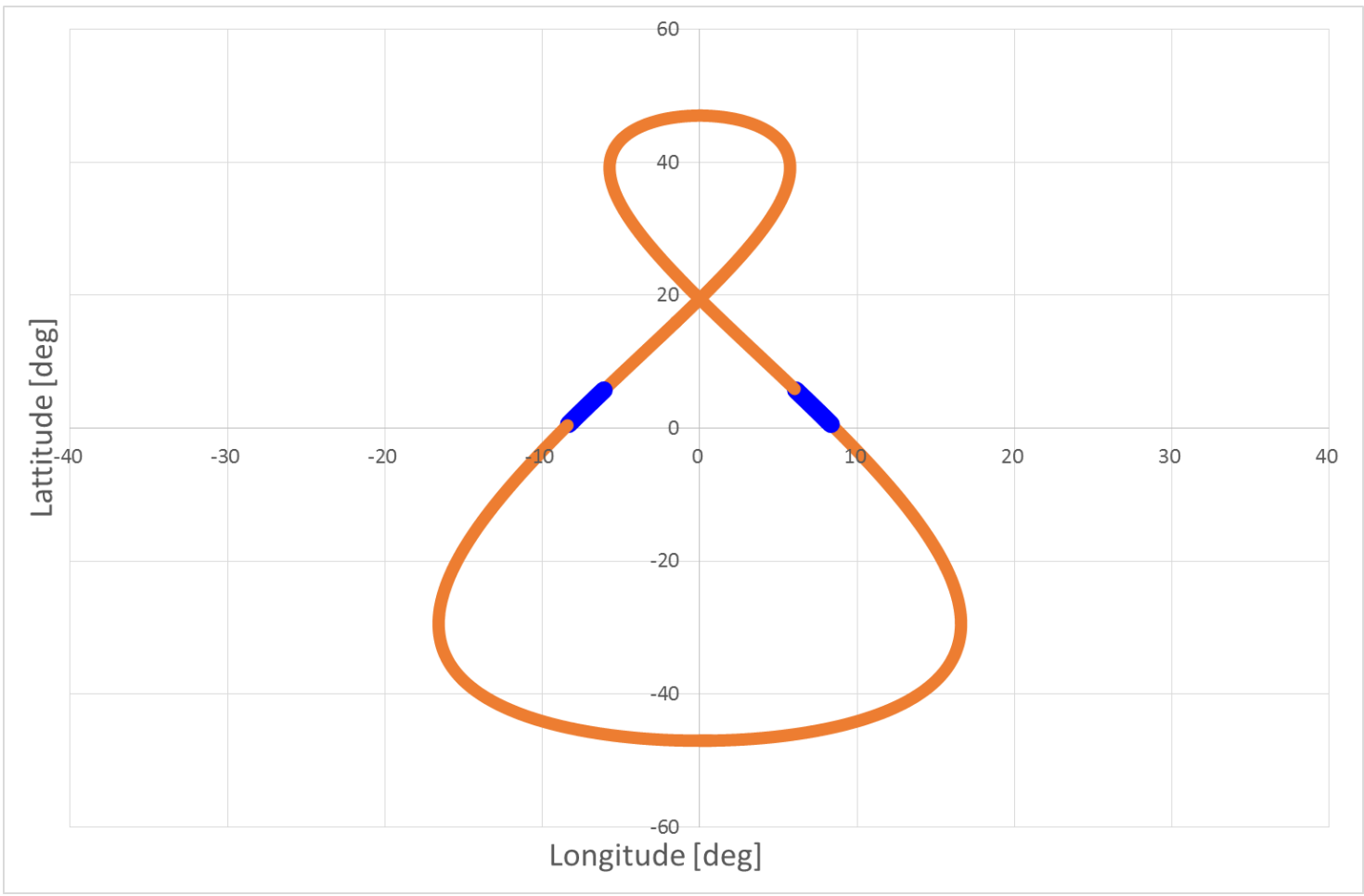


**Blue :**  
interference time is 0.9 [hr]

**Orange :**  
not interference time is 23.1 [hr]

Fig.1-3 Longitude [deg] vs Latitude [deg] QZS (Inc : 36 [deg] )

## 2. IGSO operation orbit vs. GSO



**Blue:**  
 interference time is 0.9 [hr]

**Orange:**  
 not interference time is 23.1 [hr]

Fig.1-4 Longitude [deg] vs Latitude [deg] QZS (Inc : 47 [deg] )



## 2. IGSO operation orbit vs. GSO

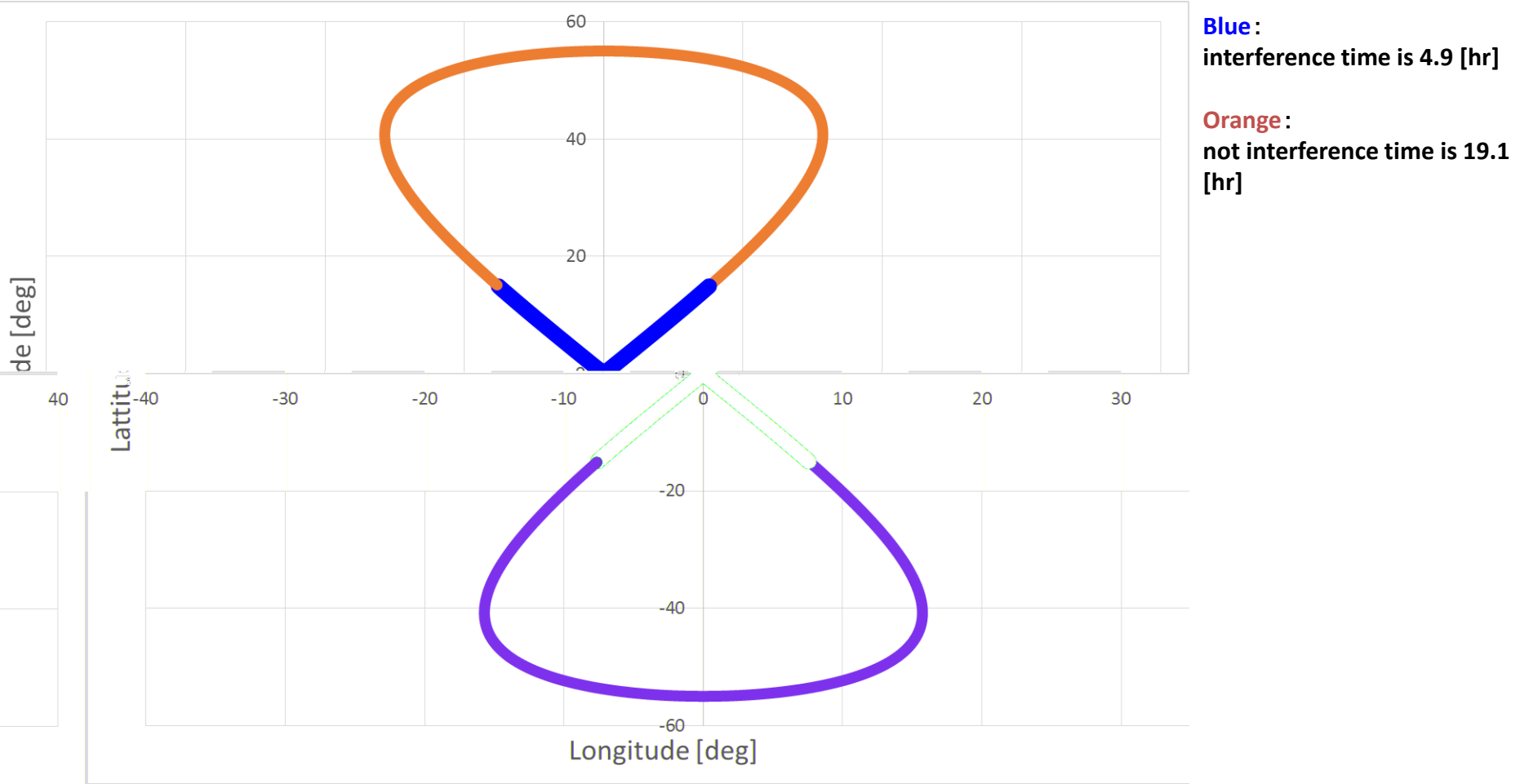
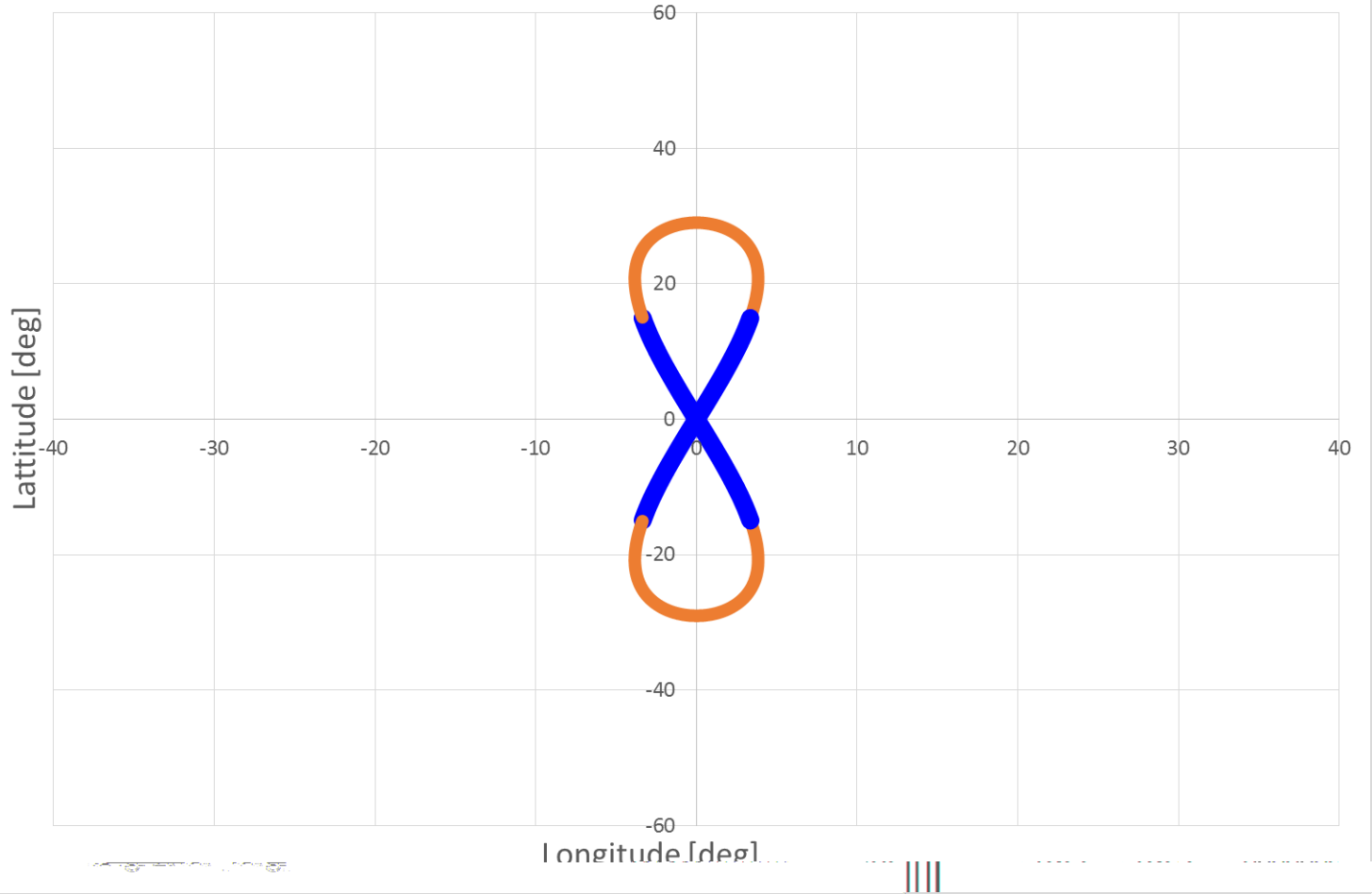


Fig.1-5 Longitude [deg] vs Latitude [deg] BeiDou (Inc : 55 [deg] )

## 2. IGSO operation orbit vs. GSO



**Blue:**  
 interference time is 8.6 [hr]

**Orange:**  
 not interference time is 15.4 [hr]

Fig.1-6 Longitude [deg] vs Latitude [deg] NAVIC (Inc : 29 [deg] )

### 3. IGSO De-orbit vs. GSO and Other IGSO

QZSS's de-orbit parameters are actual numbers as these satellites are currently in orbit.

As for BeiDou and NAVIC, assumed de-orbit parameters are used. These assumptions are referring open papers.

## 3. IGSO De-orbit vs. GSO and Other IGSO

Figure	IGSO	De-orbit height [km]	RAAN [deg]	Inclination [deg]
1-7	QZSS-QZO	3600	0-360	36-47
1-8	QZSS-GEO	1920		0.05
1-9	BeiDou	350	189	54
1-10	BeiDou	350	69	54
1-11	BeiDou	350	309	54
1-12	BeiDou	1000	69	54
1-13	NAVIC	350	70	29
1-14	NAVIC	350	190	29
1-15	NAVIC	350	310	29
1-16	NAVIC	2000	310	29

## 3. IGSO De-orbit vs. GSO and Other IGSO

Key parameters of IGSO de-orbit are the height, RAAN and inclination.

- De-orbit perturbed area increases as the inclination decreases.
- The possibility of interfering into GEO region decreases as the height fo de-orbit increases.
- The area of de-orbit perturbation depends on initial RAAN.

## 3. IGSO De-orbit vs. GSO and Other IGSO

### Table 1-3 Interference Summary

Figure	IGSO	De-orbit height [km]	RAAN [deg]	Inclination [deg]	Interference in			
					protected region	Operation region		
						GSO	BeiDou	NAVIC
1-7	QZSS-QZO	3600	0-360	36-47	No	No	No	No
1-8	QZSS-GEO	1920		0.05				
1-9	BeiDou	350	189	54	Yes	Yes	Yes	Yes
1-10		350	69	54	Yes	Yes	Yes	Yes
1-11		350	309	54	Yes	Yes	Yes	Yes
1-12		1000	69	54	Yes	Yes	Yes	Yes
1-13	NAVIC	350	70	29	No	No	No	Yes
1-14		350	190	29	No	No	No	Yes
1-15		350	310	29	No	No	No	Yes
1-16		2000	310	29	No	No	No	Yes

## 3. IGSO De-orbit vs. GSO and Other IGSO

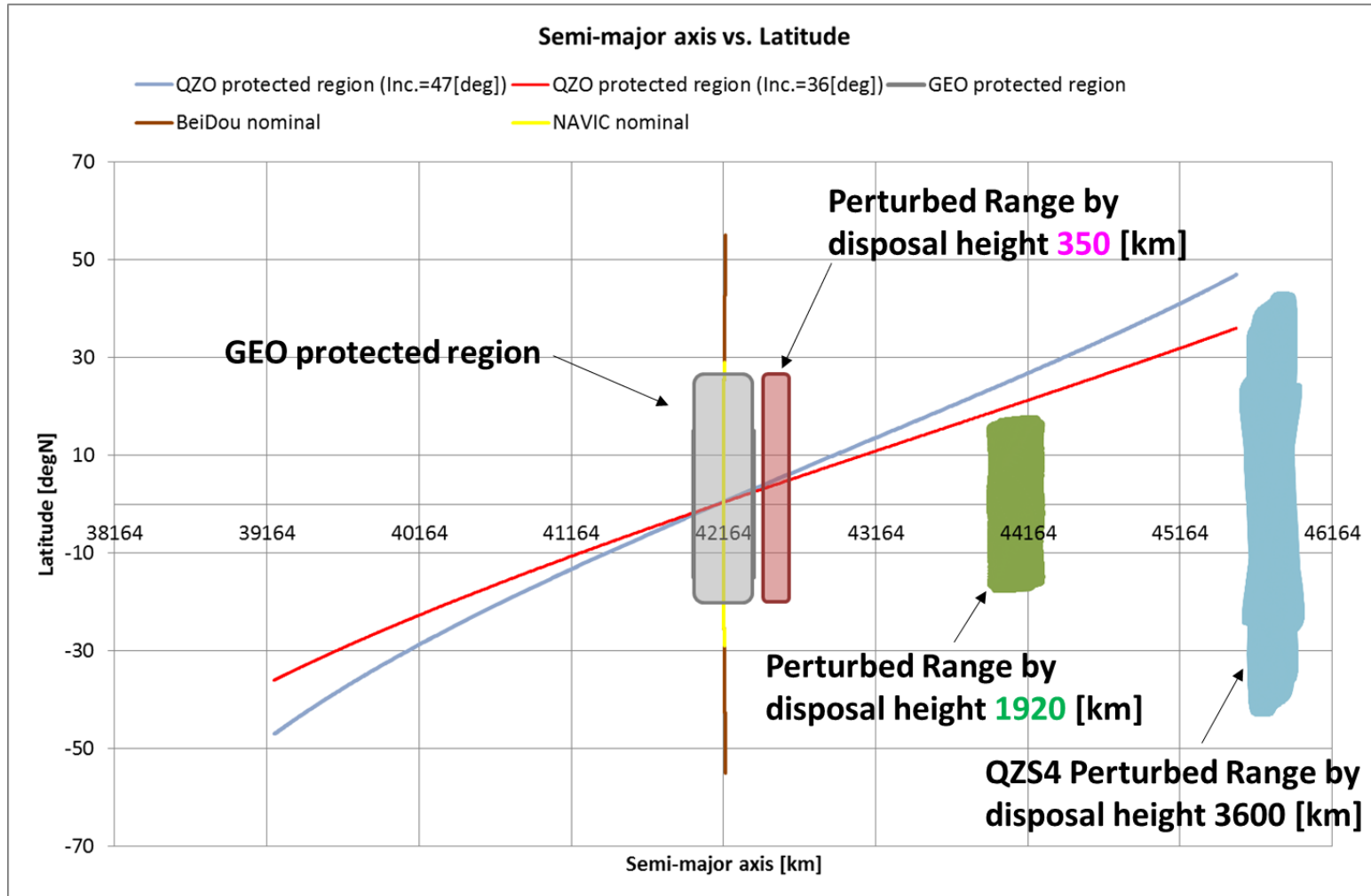


Fig.1-7 QZS4 Disposal Orbit Height 3600km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

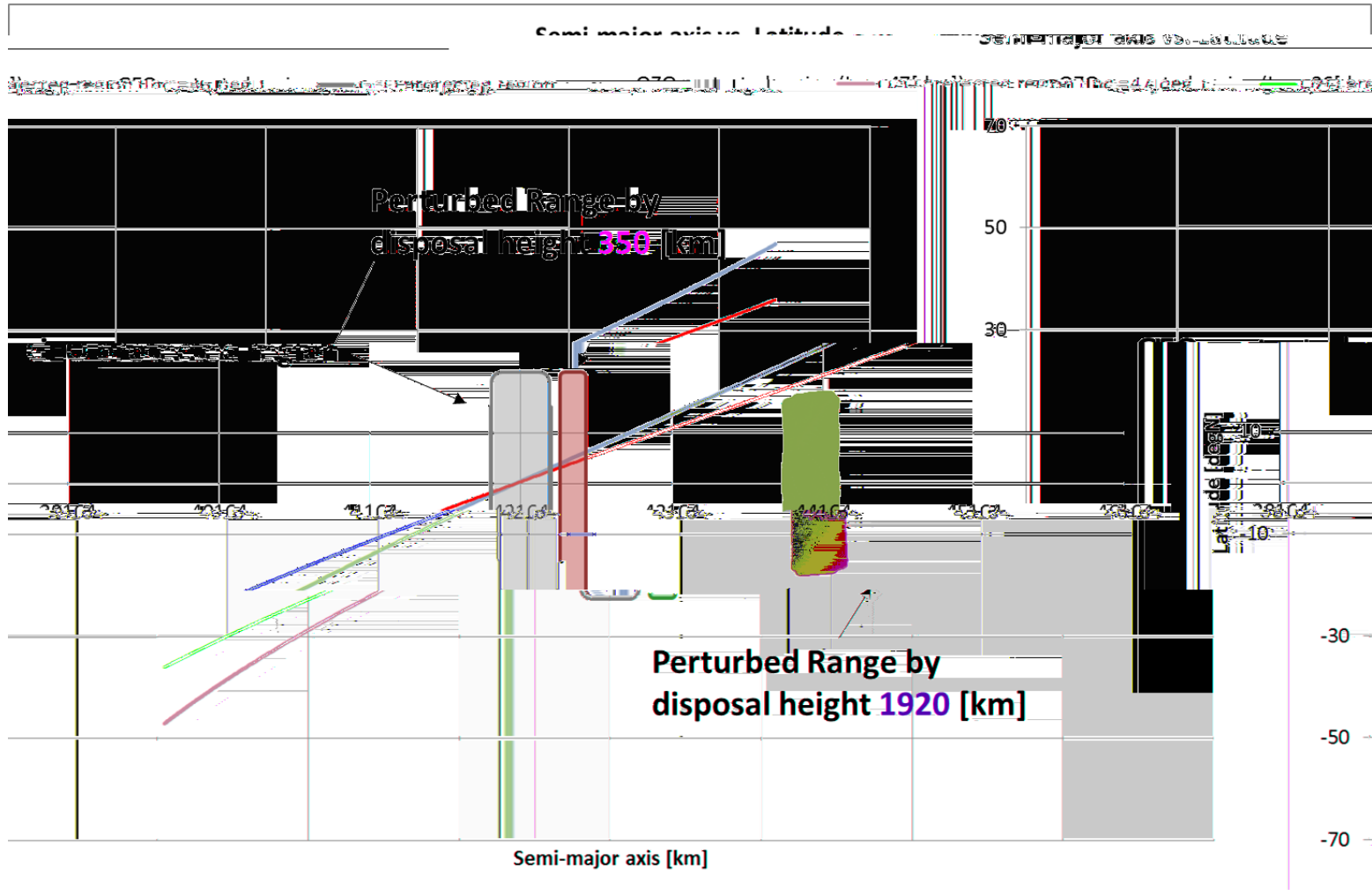


Fig.1-8 GEO Disposal Orbit Height 1920km  
 and Perturbed Range during 100 years



## 3. IGSO De-orbit vs. GSO and Other IGSO

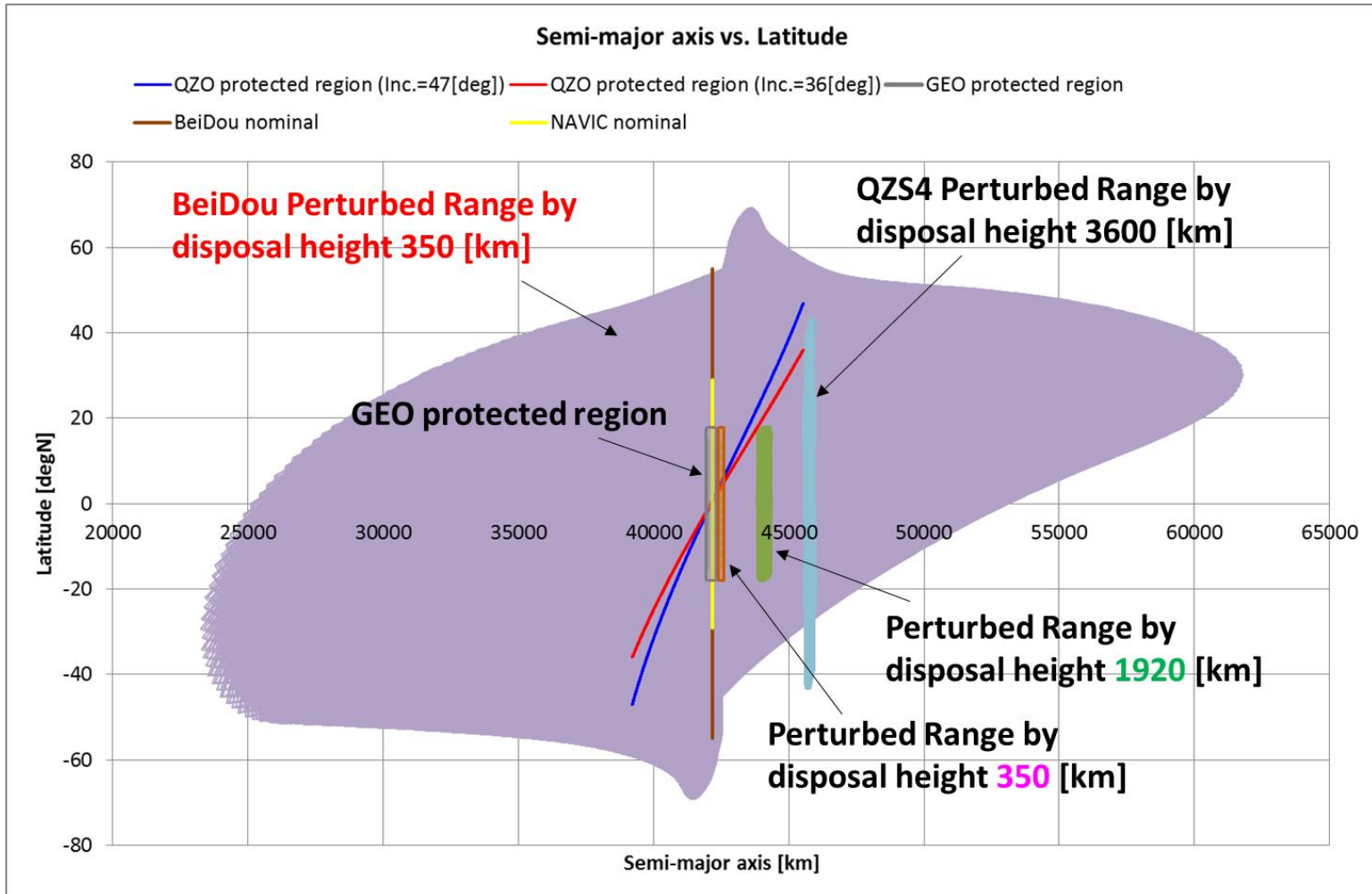


Fig.1-9 BeiDou Disposal Orbit Height 350km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

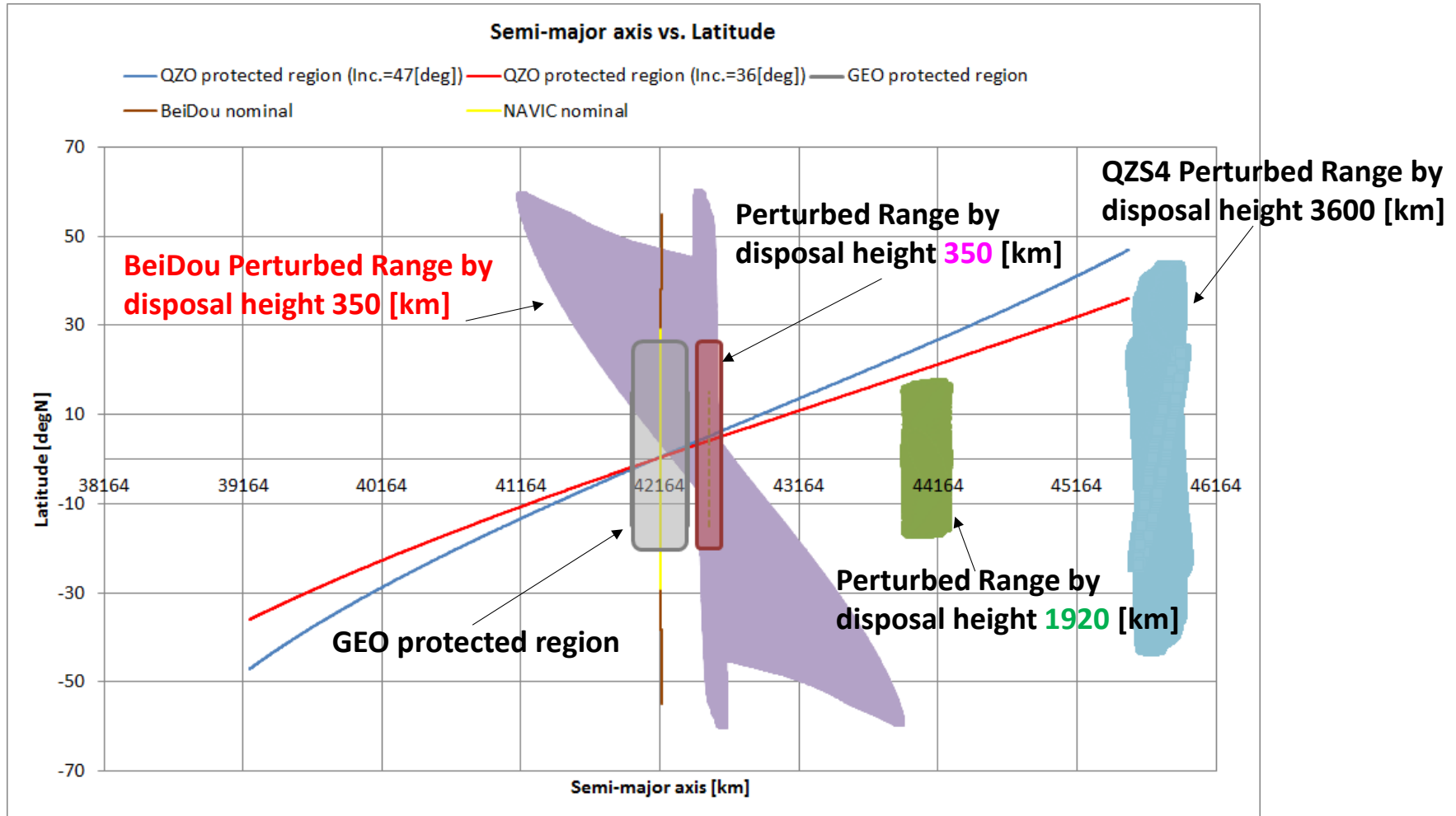


Fig.1-10 BeiDou Disposal Orbit Height 350km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

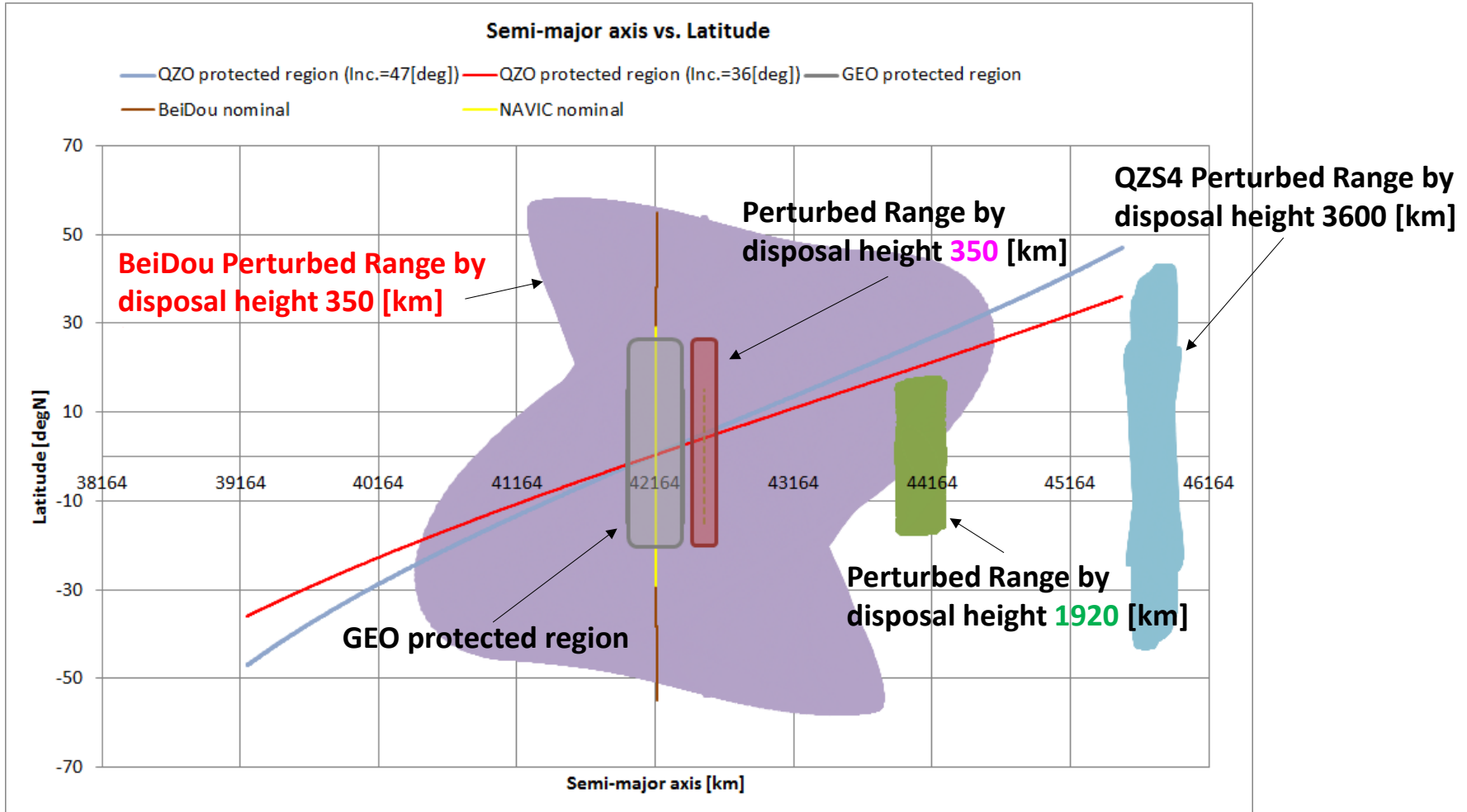


Fig.1-11 BeiDou Disposal Orbit Height 350km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

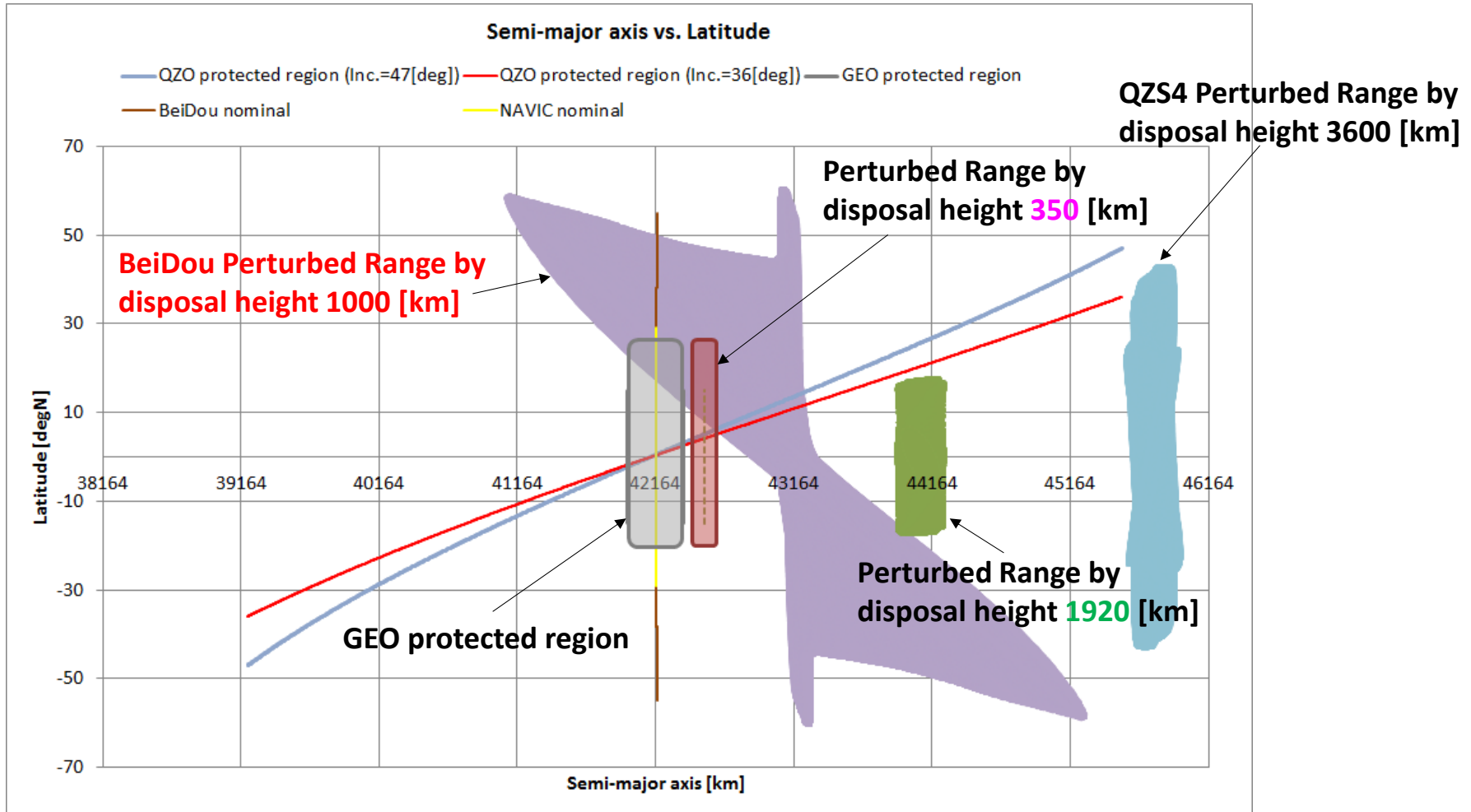


Fig.1-12 BeiDou Disposal Orbit Height 1000km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

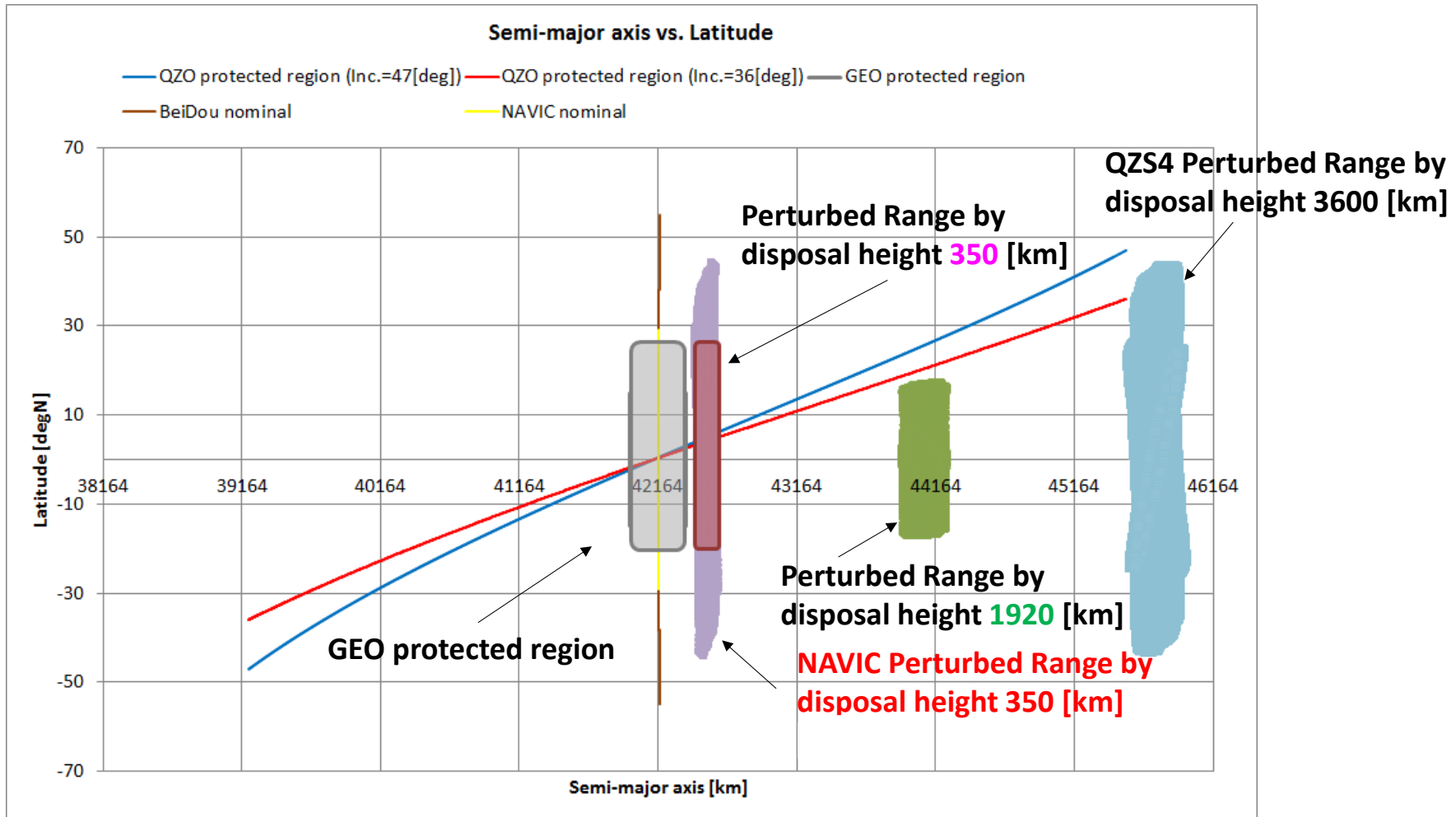


Fig.1-13 NAVIC Disposal Orbit Height 350km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

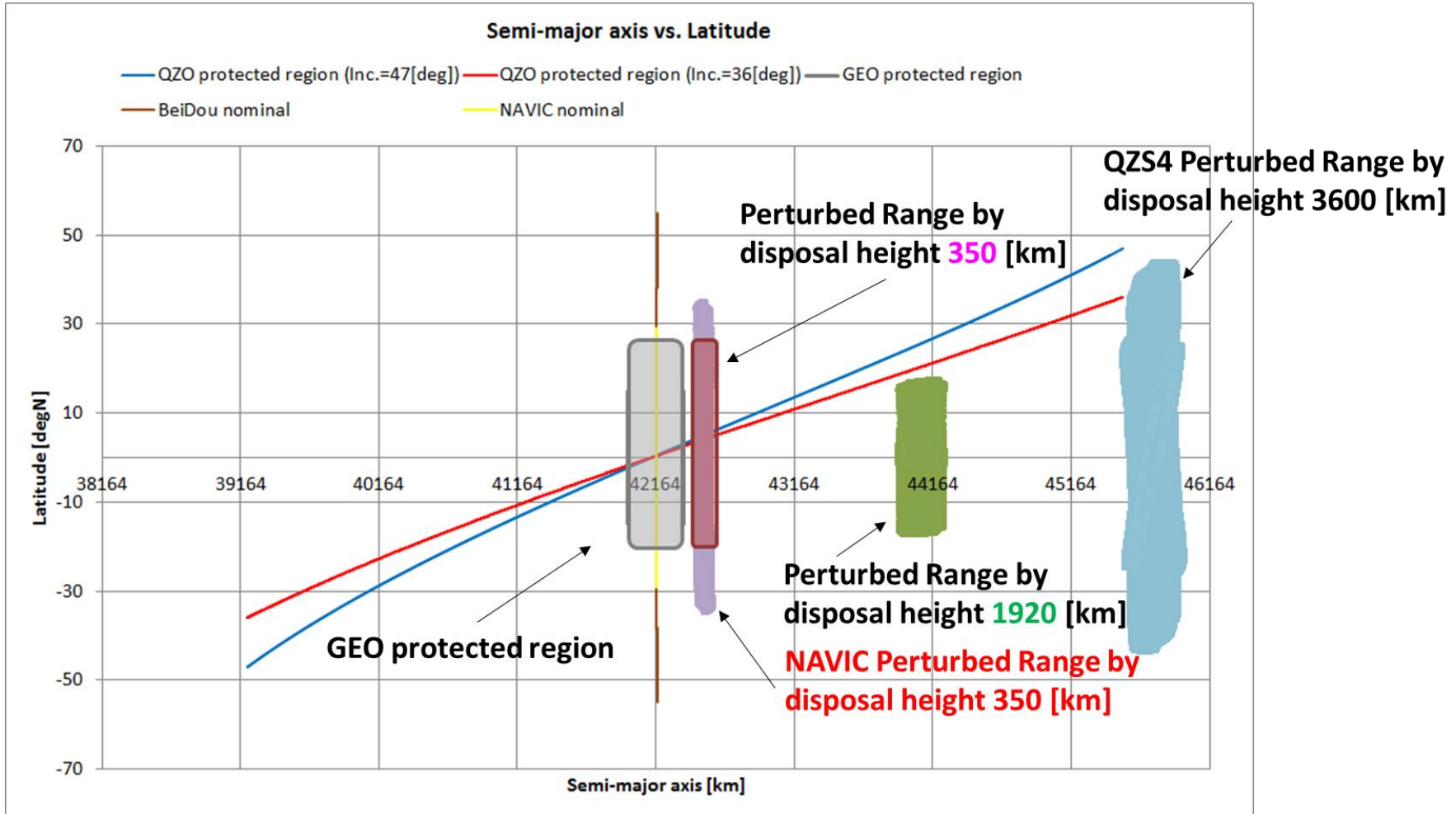


Fig.1-14 NAVIC Disposal Orbit Height 350km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

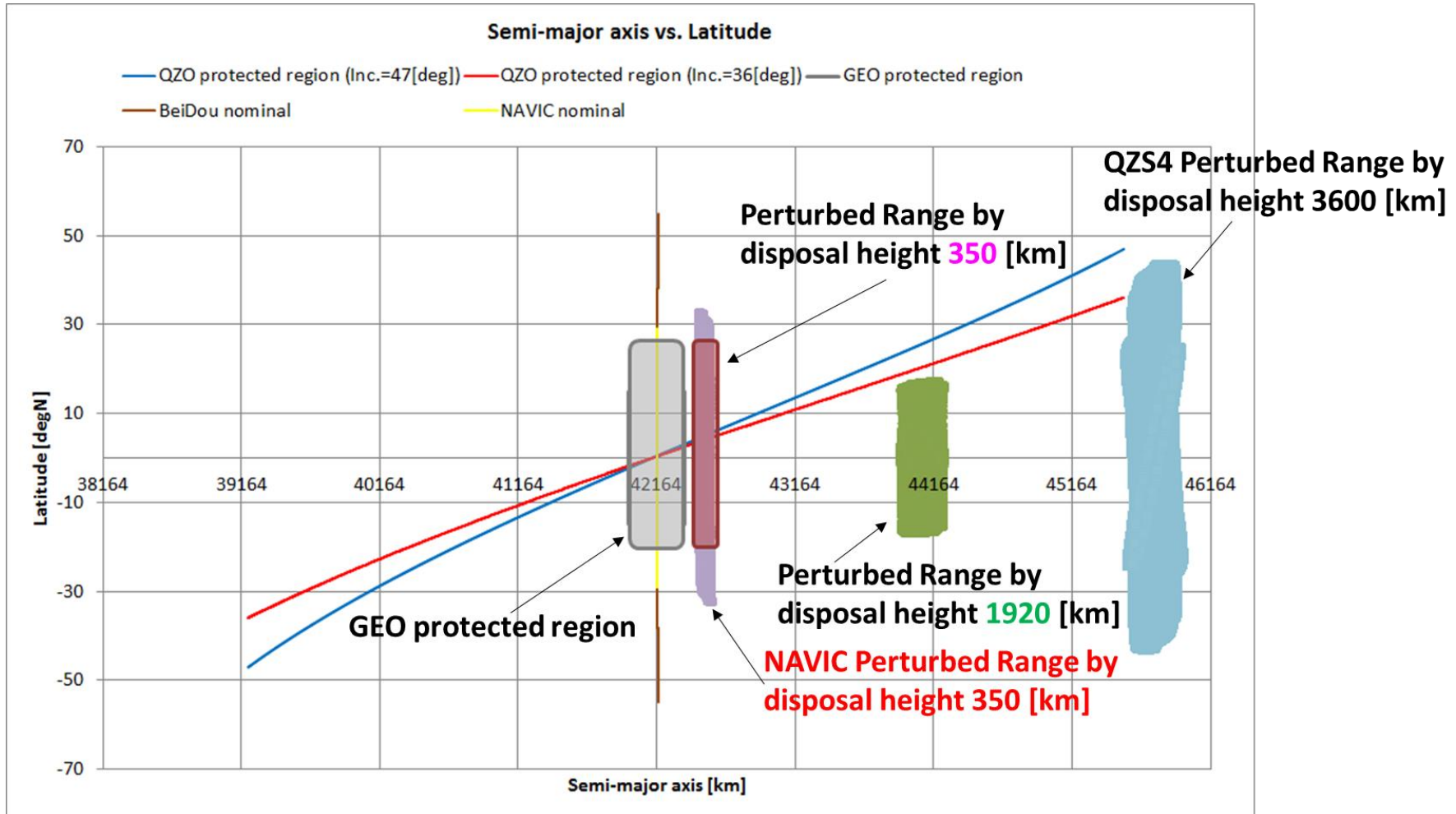


Fig.1-15 NAVIC Disposal Orbit Height 350km and Perturbed Range during 100 years

## 3. IGSO De-orbit vs. GSO and Other IGSO

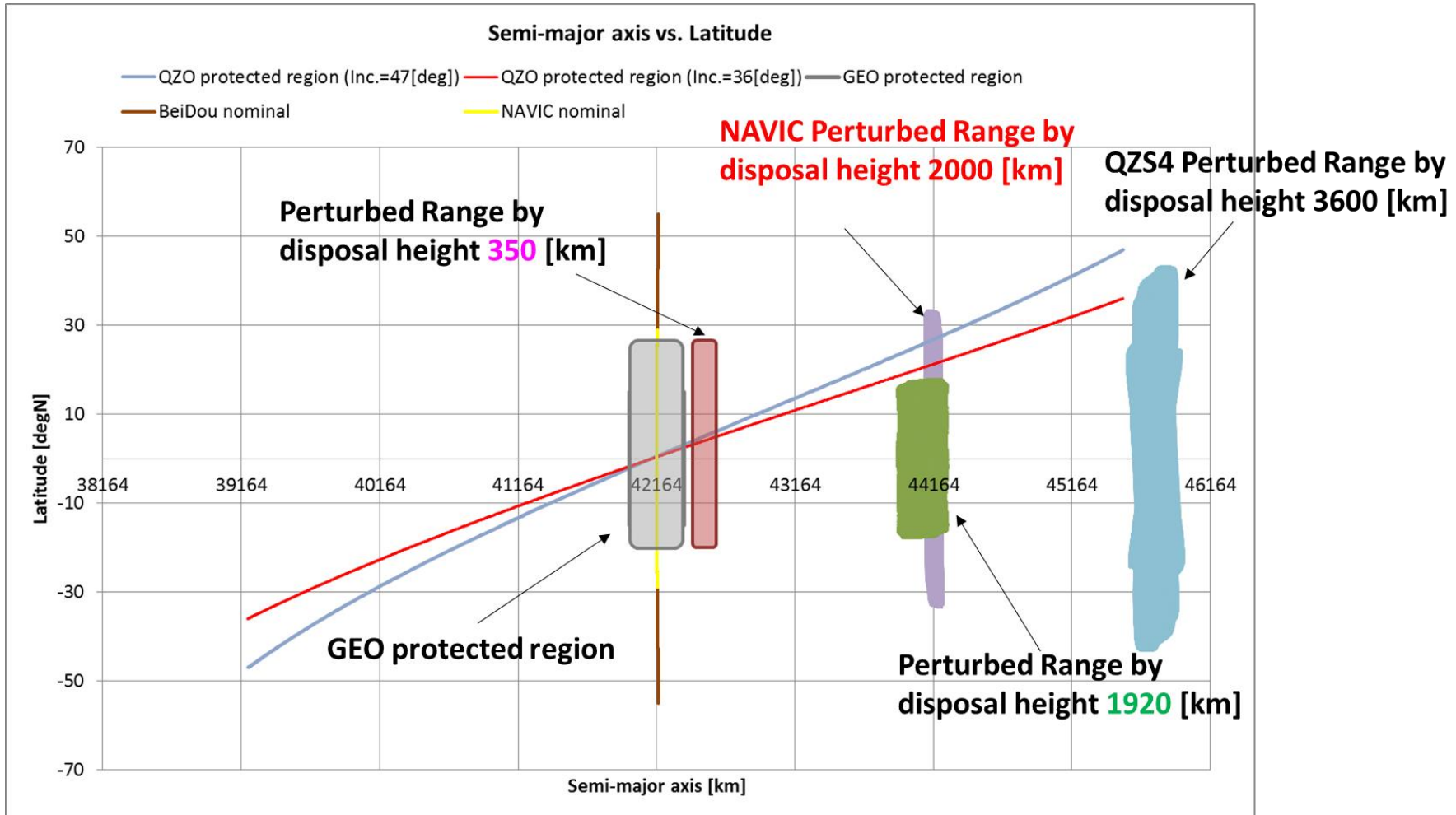


Fig.1-16 NAVIC Disposal Orbit Height 2000km and Perturbed Range during 100 years



## 4. Conclusion

### On operation orbit

- it is recommended to open the orbit information
- check minimum distance frequently
- and decrease the collision possibility

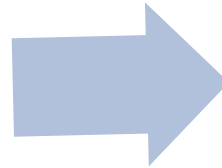
## 4. Conclusion

### Regarding the disposal orbit

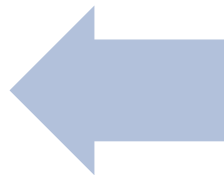
- Achieve the de-orbit not to encroach onto GSO region
- If it cannot achieve the de-orbit, open the disposal orbit to notify the possibility of interference to other satellites

## 4. Conclusion

For sustainable operation in GEO vicinity, **create a data base** of IGSO operation and disposal orbits



Most importantly, **establish a forum** to discuss issues and methods to coordination



-END-

Thank you so much for your attention.