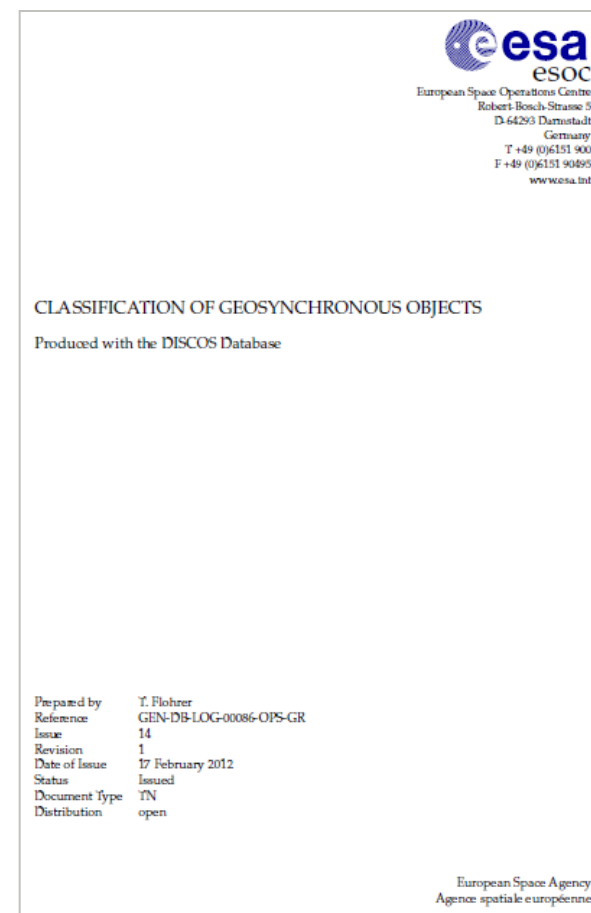


# ESA Classification of Geosynchronous Objects Issue 14

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- Yearly issue (~Feb)
- Based on TLE information by USSTRATCOM in ESA's DISCOS database
- And on orbital data resulting from a wide collaboration:
  - Keldysh Institute of Applied Mathematics of the Russian Academy of Sciences (KIAM RAS)
  - International scientific observation facilities network (ISON) coordinated by KIAM RAS
  - Astronomical Institute of the University of Bern, Switzerland, partner of ISON
  - Joint Italian-Russian telescope FIRST at Collepardo, Italy
  - Telescope Fabra ROA Montsec (TFRM), Spain
- Most of 'Unidentified objects' correlated thanks to the excellent work of satellite analysts and amateur observers
- Distribution via email: request your copy from [tim.flohrer@esa.int](mailto:tim.flohrer@esa.int)

- Content
  - List of geosynchronous objects
  - Table 1: Objects with Two-Line-Element data
    - C1: E-W and N-S control
    - C2: only E-W control
    - D: Drifter
    - L1: (libration around Eastern stable point)
    - L2: (libration around Western stable point)
    - L3: (libration around both stable points)
  - Table 2: Objects without Two-Line-Element data
    - C1: E-W and N-S control
    - C2: only E-W control
    - D: Drifter
    - L1: (libration around Eastern stable point)
    - L2: (libration around Western stable point)
    - L3: (libration around both stable points)
    - UI: Unidentified objects
    - UC: Uncontrolled objects
    - UU: Uncontrolled uncatalogued objects
  - Table 3: I: Objects in a highly inclined orbit (>25deg)
  - Table 4: Objects of indeterminate status
  - Figures
  - Summary



- GEO definition:
  - $e < 0.2$ ,  $i < 70^{\circ}$ ,  $0.9 < n < 1.1 \text{ rev/d}$  (→ - 2500km .. +3150km)
- 1307 objects known
- 1234 with recent orbital data, 1069 with TLEs, as of 31 December 2011:
  - 406 C (280 C1)
  - 629 D
  - 172 L
  - 8 highly inclined (6 before 2011, 2 additional in 2011)
  - 8 uncontrolled with no recent orbital elements available
  - 66 uncatalogued objects, associated with a launch
  - 18 not classified

# Changes in 2011 (1)



- 34 new objects (32 payloads and 2 rocket bodies) launched into or near GEO in 2011
- 1 object launched in 2010 (10039A, USA 214 (AEHF SV-1)) reached GEO in 2011
- At least 14 spacecraft reached end of life
- 10 reorbited more than 250 km above GEO (compliant with the IADC reorbiting guidelines):
  - TDRS 4 (89021B, USA, 457 km × 562 km)
  - Meteosat 6 (93073B, EUMETSAT, 347 km × 384 km)
  - PAS 2 (94040A, USA, 274 km × 337 km)
  - Intelsat VII F-5 (95013A, INTELSAT, 287 km × 450 km)
  - PAS 3R (96002A, USA, 287 km × 385 km)
  - Echostar 4 (98028A, USA, 329 km × 417 km)
  - GOES 11 (00022A, USA, 340 km × 355 km)
  - Beidou (00069A, China, 308 km × 465 km)
  - BSAT-2a (01011B, Japan, 313 km × 340 km)
  - Estrela do Sul 1 (Telstar 14) (04001A, Brazil, 384 km × 434 km)
- 2 spacecraft without TLE data available were apparently reorbited in 2011 (compliant):
  - USA 39 (DSP F14) (89046A, USA, 400 km × 425 km),
  - USA 158 (GeoLITE) (01020A, USA, 325 km × 490 km).

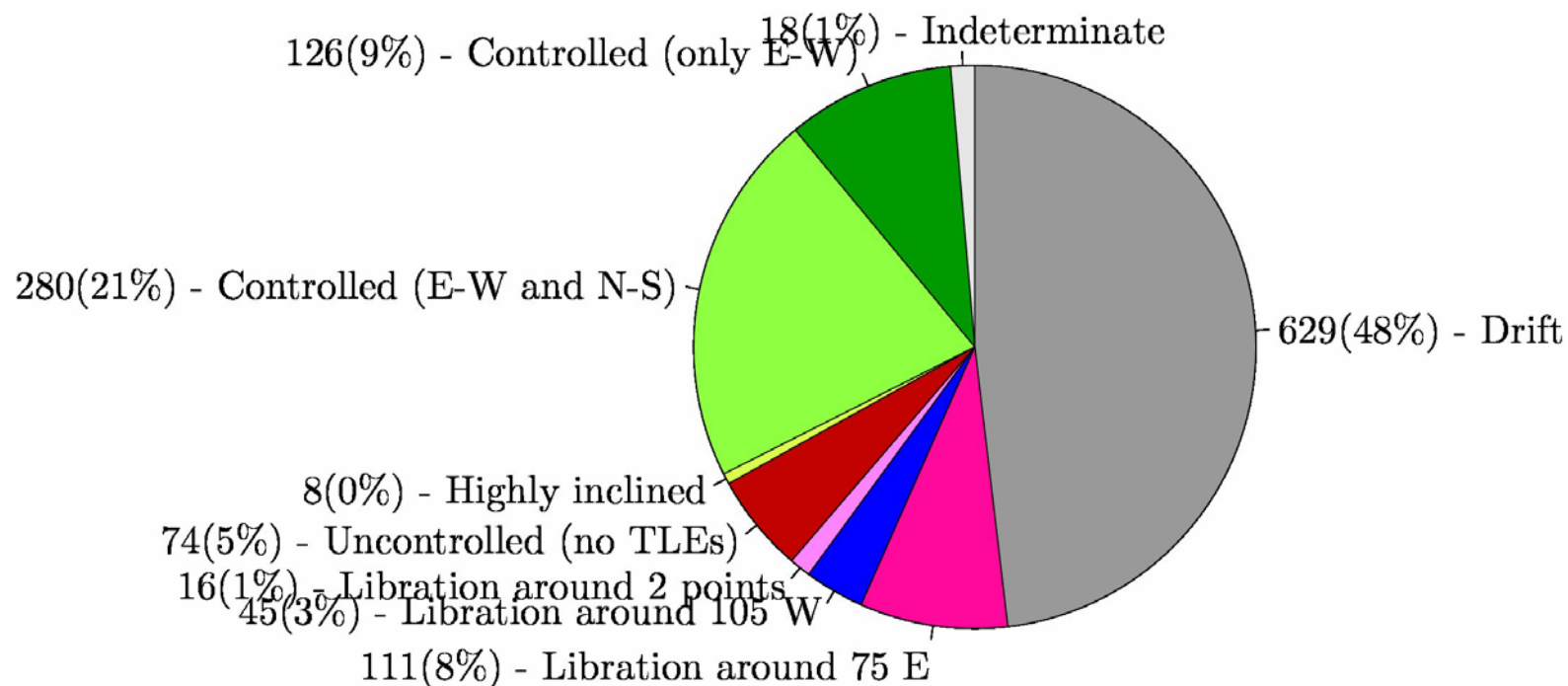
# Changes in 2011 (2)



- 1 spacecraft reorbited below the GEO, which is also compliant:
  - Hot Bird 3 (97049A, EUTELSAT, -705 km × -510 km)
- 3 spacecraft reorbited too low:
  - Intelsat VI F-1 (91075A, INTELSAT, 177 km × 208 km)
  - Beidou 1B (00082A, China, 141 km × 433 km)
  - GSAT-2 (03018A, India, 103 km × 135 km)
- 1 spacecraft seems to be abandoned (L1):
  - Beidou DW2 (Compass G2) (09018A, China)
- Indeterminate status of Cosmos-2240 (08033A, Russia) (L1-type orbit, but it is not passive)
- Indeterminate status of Raduga-1 (04010A, Russia) (L1-type orbit, end-of-life unclear)
- Galaxy 15 (05041A) changed status from L2 back to C1
- Perigee drop by about 20 km of drifter GOES-10 (97019A) around September 15, 2011 (decommissioned in 2009 and no known energy source remained on-board)

## Classification of geosynchronous objects

Status: 04-JAN-12

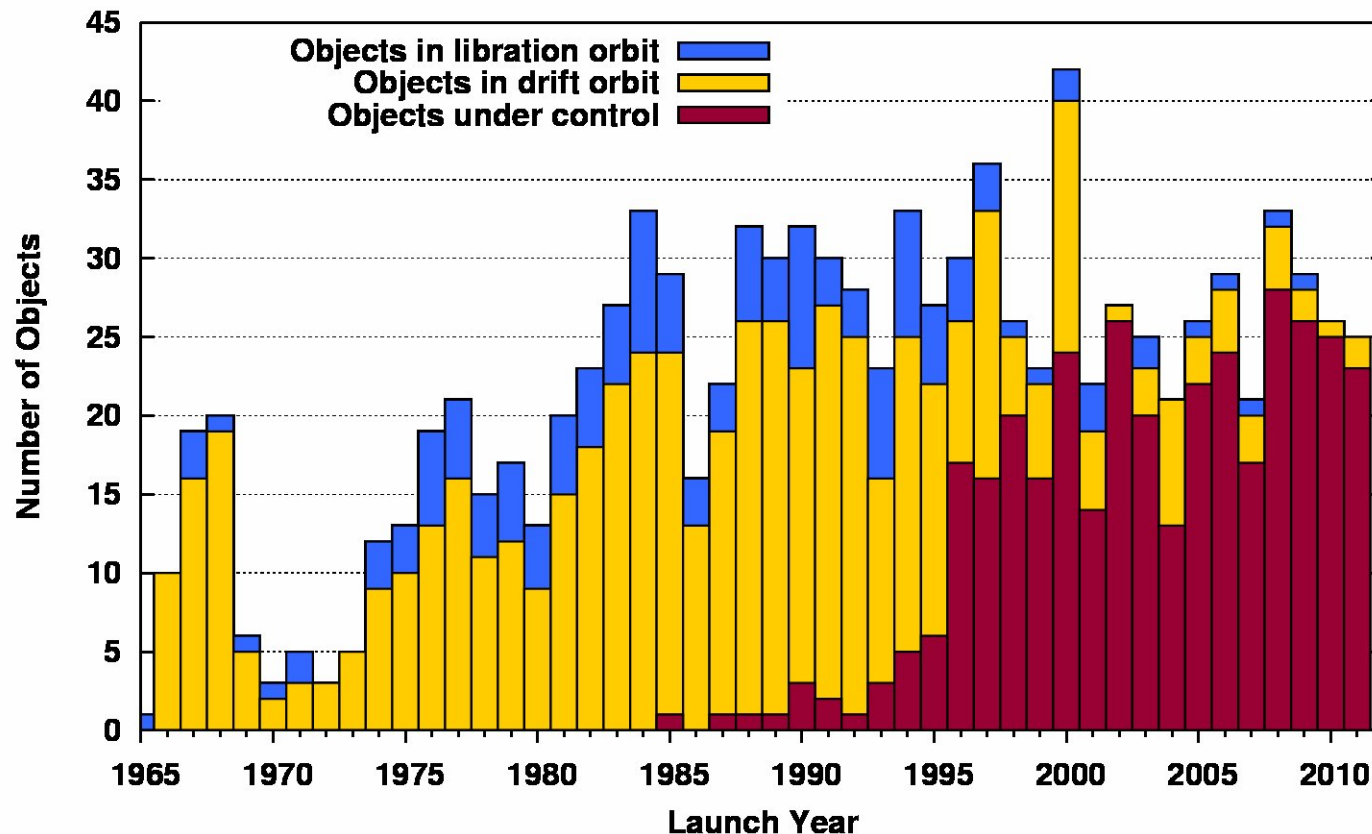


# Status as function of launch year (TLE only)



## Classification of geosynchronous objects

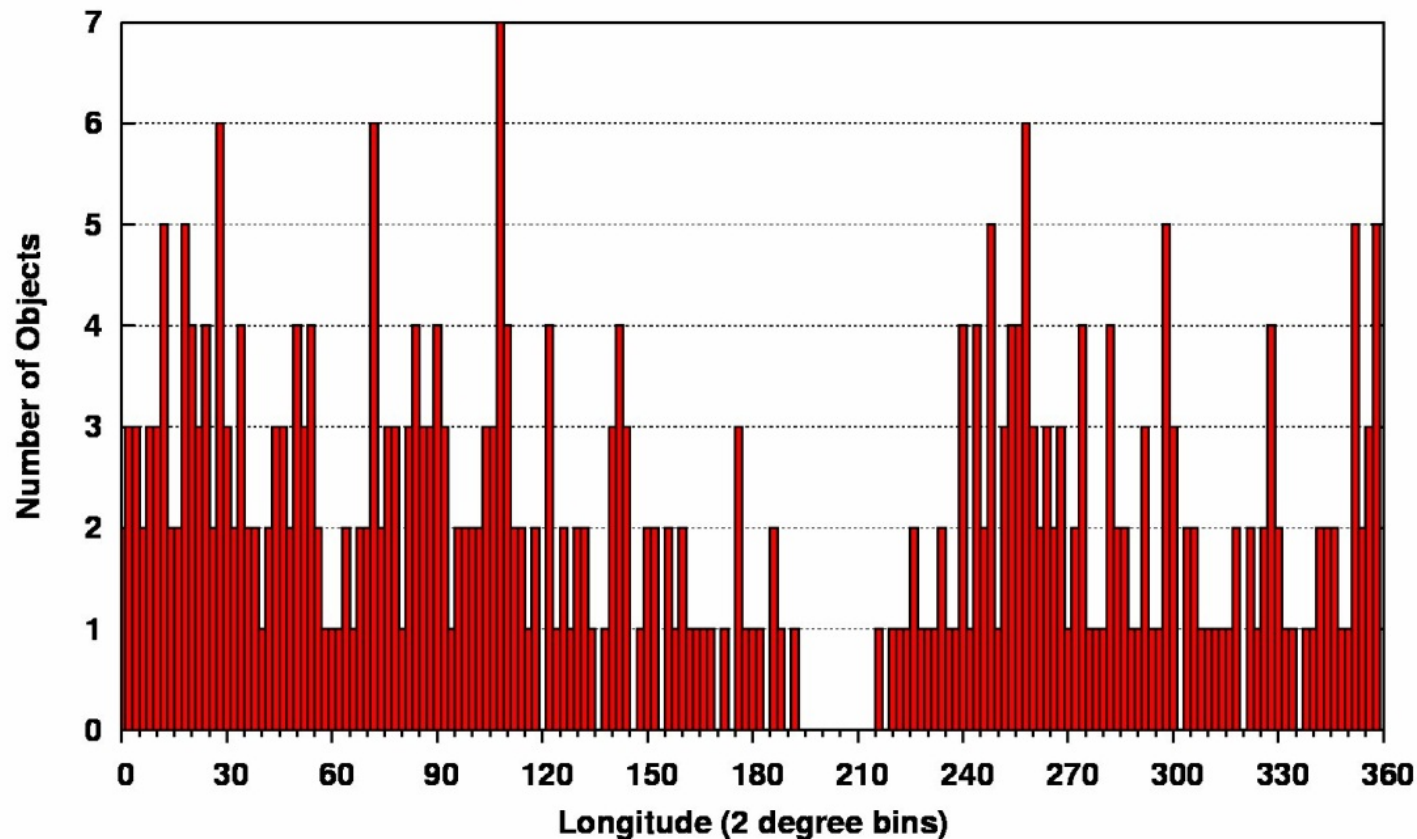
(Objects with recently updated TLEs)  
Status: 04-JAN-12





## Geosynchronous satellites under control

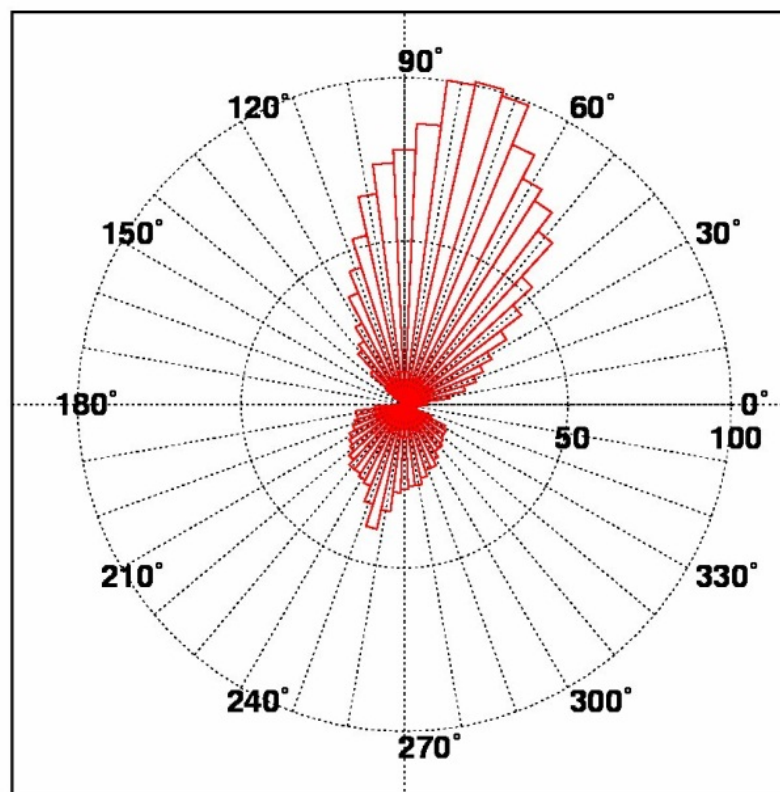
Distribution of longitude  
Status: 04-JAN-12



# Distribution of librating objects (TLE only)

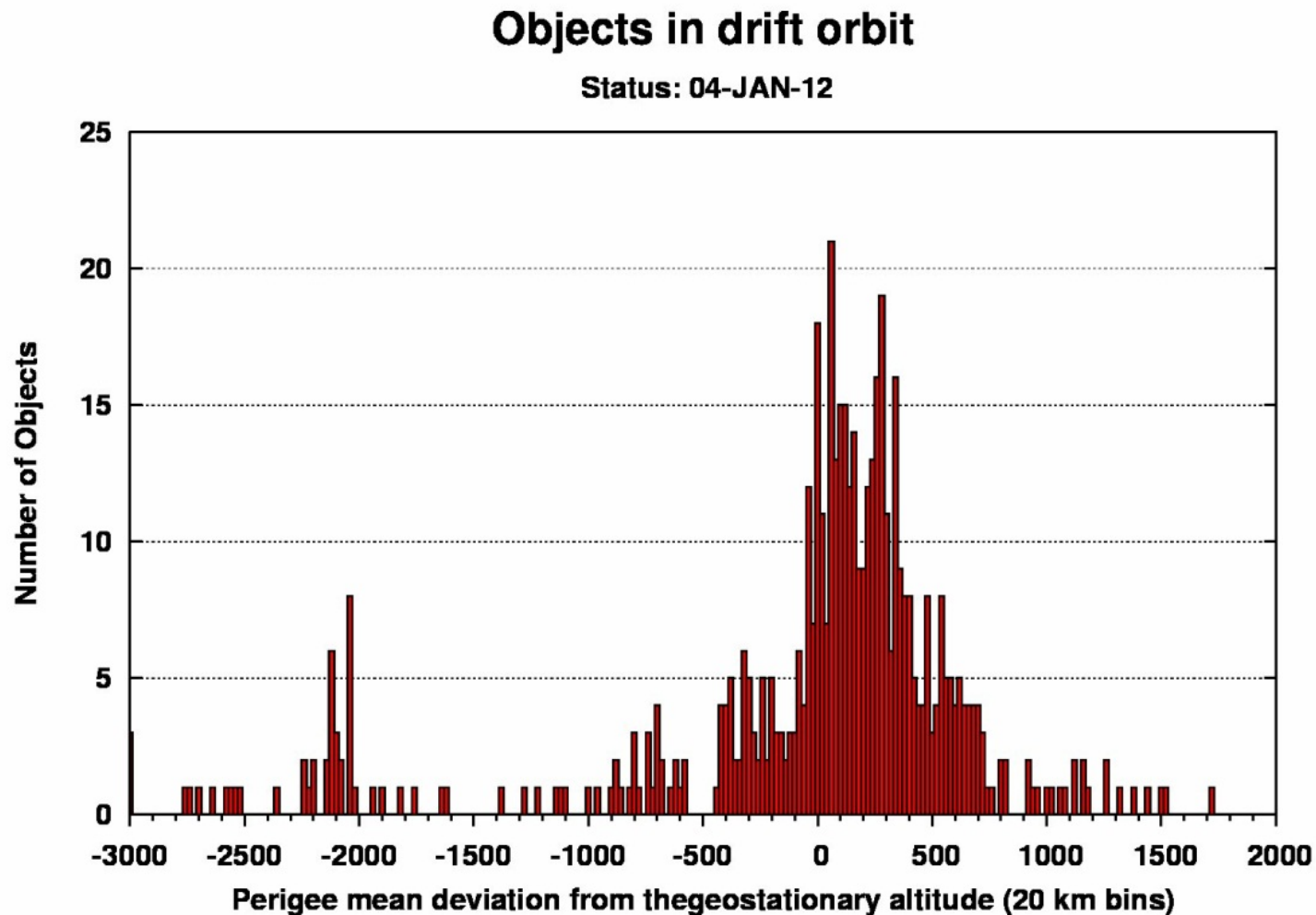
## Objects in libration orbit

Status: 04-JAN-12



**RADIUS: Number of objects**  
**ANGLE: longitude (5 deg bins)**

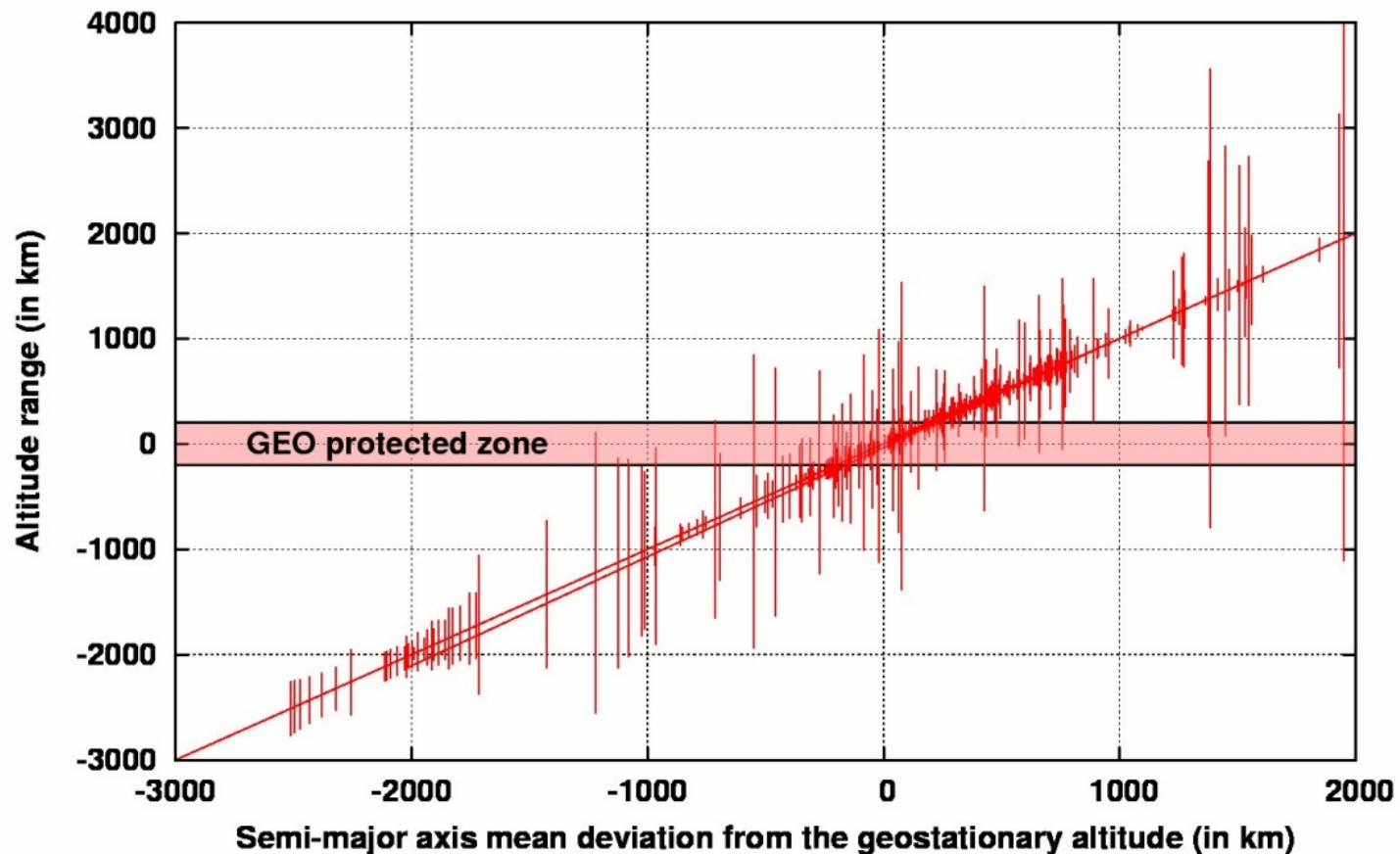
# Distribution of drifters (TLE only)



# Distribution of drifters (TLE only)

## Objects in drift orbit

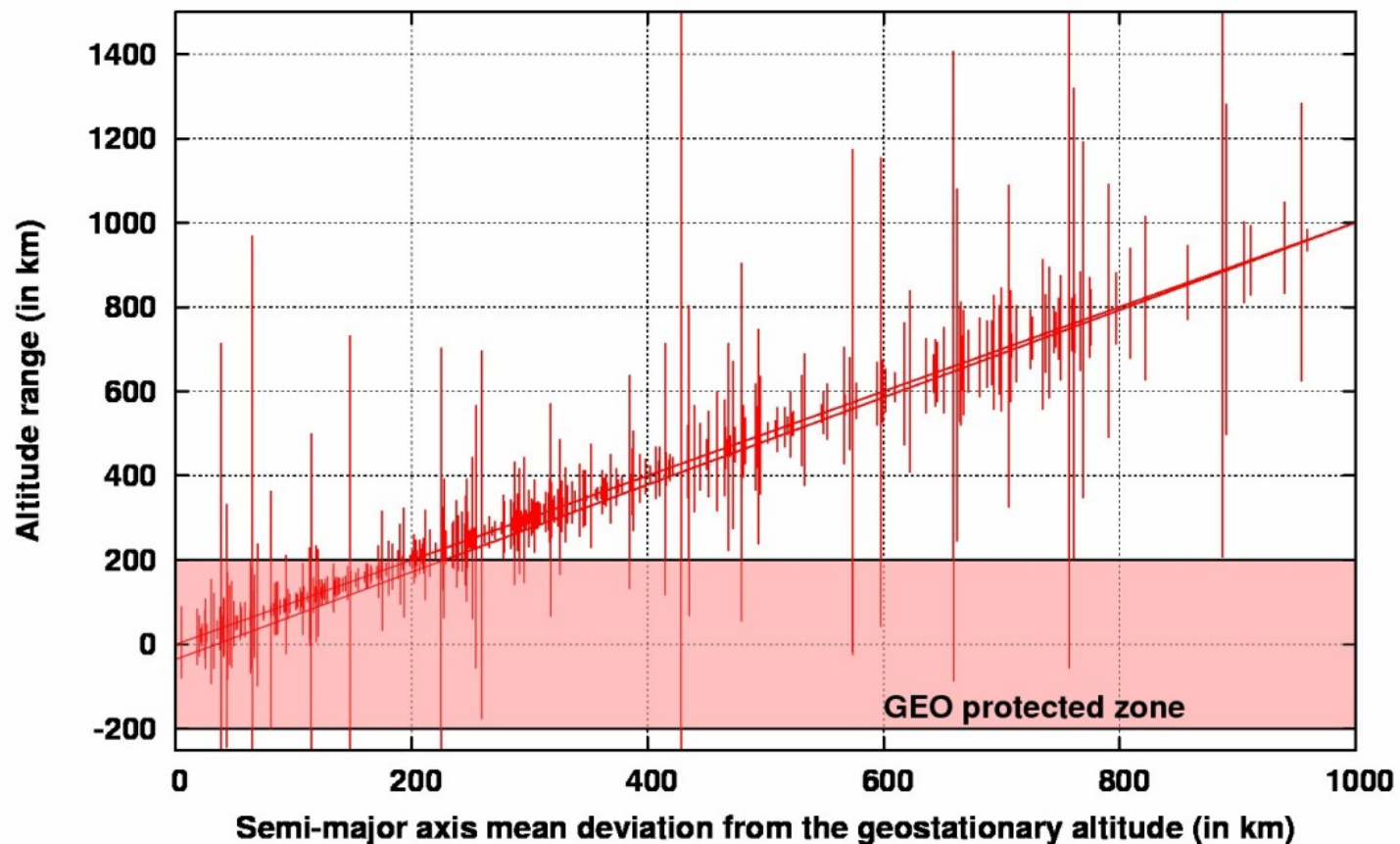
Status: 04-JAN-12



# Distribution of drifters (TLE only)

## Objects in drift orbit

Status: 04-JAN-12



# End-of-life statistics

	99	00	01*	02	03	04	05	06	07	08	09	10	11	Σ
L1	5	3	5	1	-	2	1	2	1	2	3	3	1?	<b>26</b>
L2	1	1	2	1	1	1	1	1	-	1	-	-	-	<b>10</b>
L3	-	2	-	-	-	-	1	-	-	1	-	-	-	<b>4</b>
D	4	2	6	5	7	5	5	7	1	1	6	4	2	<b>51</b>
OK	5	3	2	4	8	5	11	9	11	6	12	11	13	<b>89</b>
Σ	15	11	15	11	16	13	19	19	13	11	21	18	16	<b>180</b>

\*ATS3 corrected in 2011 (C → L2)

# ESA efforts on LEO classification from TLE data (1)



## Background:

- Idea for yearly reports raised during IADC 29
- Implementation efforts at ESA (side activity) in the area of:
  - Automated manoeuvre detection
  - Extension of ESA's DISCOS database
  - Elaboration of evaluation criteria

## Motivation:

- Establish an annual “LEO” report next to the annual “GEO” report
- Provide the grounds for an inter-agency understanding on the status of LEO missions
- Verify assumptions taking in WG2 on the current “business as usual”

## Status:

- Draft for IADC review discussed in WG4

# ESA efforts on LEO classification from TLE data (2)



- Upper stages tend to comply better than payloads
- GTO and SSO type of orbits seem to suffer equally from non-compliances
- Performance in critical regions [800km-1000km] is poor
- Payloads tend to comply where it is “easy” to comply (< 400km altitude)
- On the order of 40t of mass remain in space longer than “allowed”
- The assumption of 90% compliance taken in many simulations is optimistic
- Working on:
  - Manual review of results (manoeuvre detection, lifetime estimation) and proper documentation of assumptions
  - Review within WG4, reflection of mission related objects and debris



- ESA prepares a classification report on the GEO annually
- >1300 objects known in GEO, 1234 with recent orbital data, 1069 with TLEs
- Better compliance with end-of-life GEO disposal guidelines can be observed (from ~30% to >50% now)
- But: 14 years after the IADC guidelines were established, there are still satellites that were not or could not be properly reorbited