IADC Re-Entry Prediction Campaigns

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Presentation Outline

- terms of reference of the Inter-Agency Space Debris Coordination Committee (IADC)
- concept of IADC re-entry prediction campaigns
- example of the EAS re-entry
- summary and conclusions

IADC Terms of Reference

- purpose:
  - exchange information on space debris research activities between members, to facilitate opportunities for cooperation in space debris research
  - review progress of cooperative activities
  - identify space debris mitigation options
- membership:
  - ASI, BNSC, CNES, CNSA, DLR, ESA, ISRO, JAXA, NASA, NSAU, ROSCOSMOS
- structure:
  - members are national or international space agencies that perform space activities and actively contribute to space debris research
  - the work program is governed by a steering group and performed in 4 working groups (measurements, environment & database, protection, mitigation)
  - IADC technical meetings are held annually
  - as part of their terms-of-reference, IADC fosters the exchange of data on potentially hazardous re-entry objects

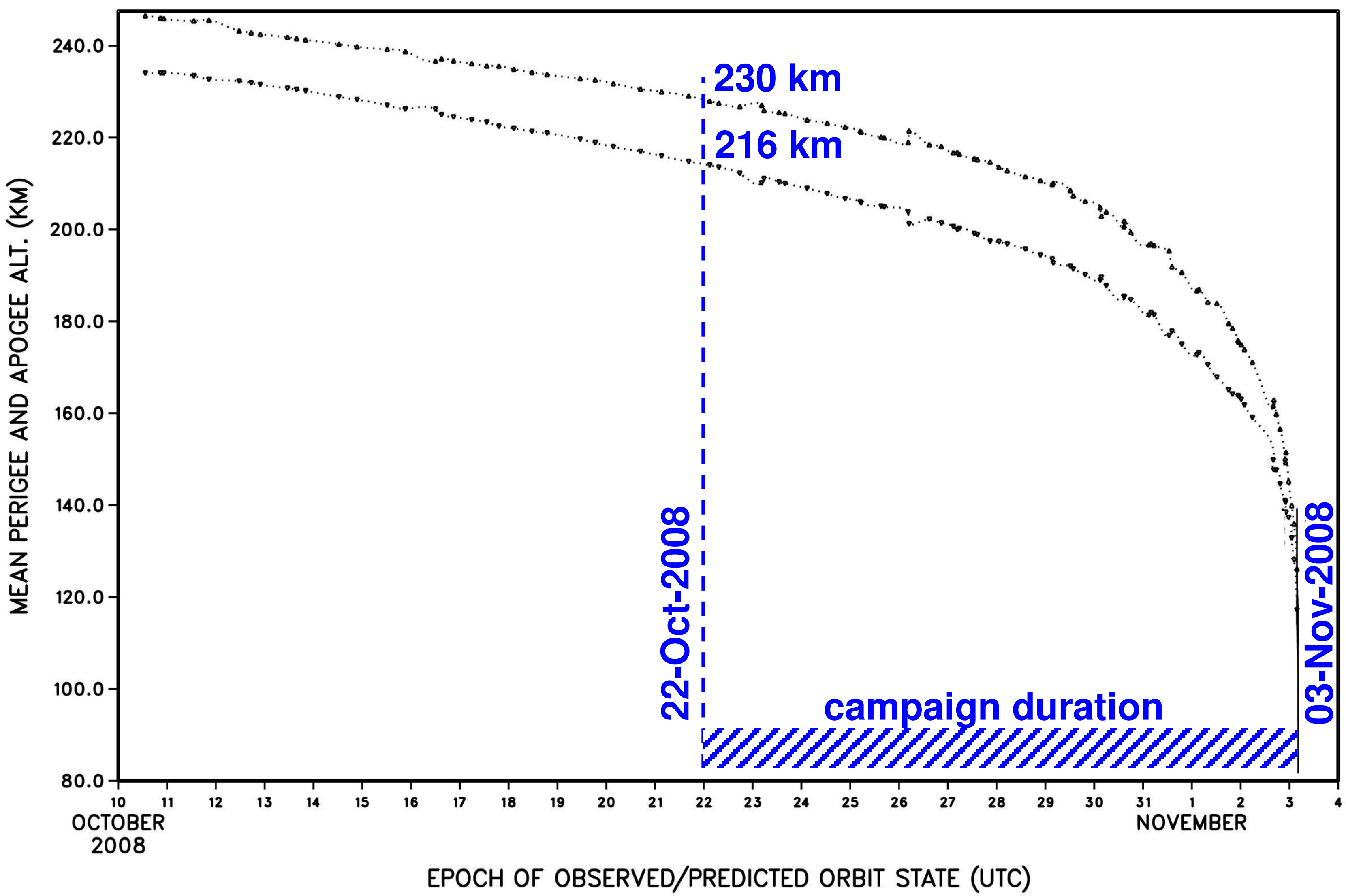
IADC Data Exchange on Re-Entry Risk Objects

- history:
  - the risk potential of re-entries was recognized at the occasion of Cosmos 954 (Jan. 1978), Skylab (July 1979), and Salyut 7 (Feb. 1991)
  - an initial, limited IADC data exchange was realized for the Cosmos 398 re-entry (Dec. 1995); a more formalized data exchange was later implemented for the re-entry of the Chinese FSW-1-5 capsule (March 1996)
  - in 1997 plans were adopted to develop a web-based IADC Re-Entry Events Database to facilitate the exchange of information on a re-entry object, on its orbit, and on its predicted re-entry time and location; this database is hosted by the European Space Operations Centre of ESA; it is operational since 1998
- re-entry risk object qualification criteria:
  - the object or parts of it may survive to cause potential significant damage, or
  - the entry event may cause radioactive contamination
- past IADC re-entry prediction campaigns:
  - Inspektor (D, 1998), GFZ-1 (D, 1999), Soyuz stage (RU, 2000), Vostok stage (RU, 2002), Cosmos 389 (RU, 2003), Cosmos 2332 (RU, 2005), Coronas F (RU, 2005), Cosmos 1025 (RU, 2007), Delta-2 stage (USA, 2007), EAS (USA, 2008)

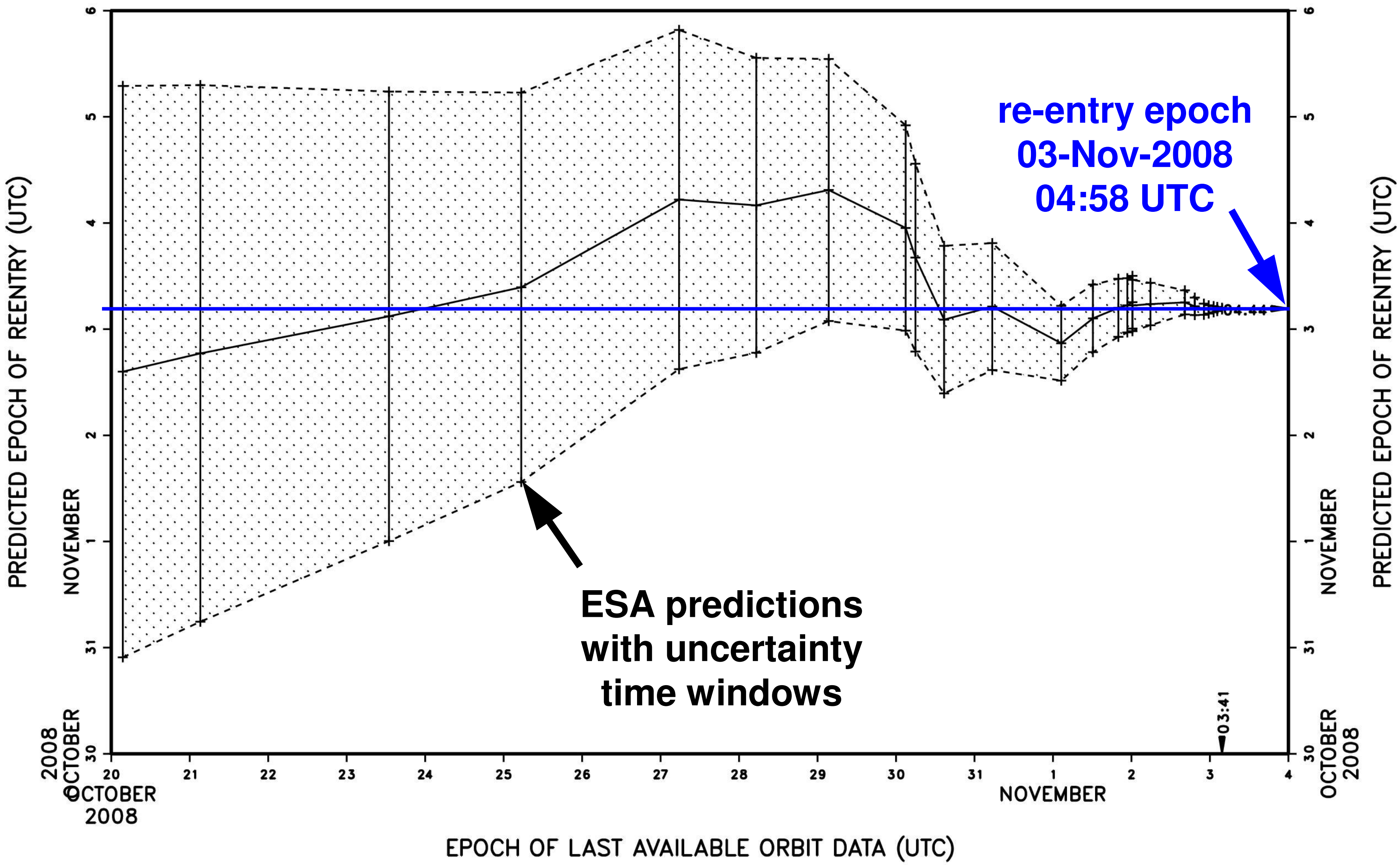
Re-Entry Test Object EAS

- Early Ammonia Servicer EAS (1998-067BA, #31928)
- launched on STS-105 on Aug. 10, 2001, and installed on ISS truss P-6
- jettisoned from ISS on July 23, 2007, during an extra-vehicular activity
- mass: 640 kg; dimensions: 2.5 m × 1.2 m × 1.7 m
- orbit at campaign start on Oct. 22, 2008: 216 km × 230 km at 51.64° inclination

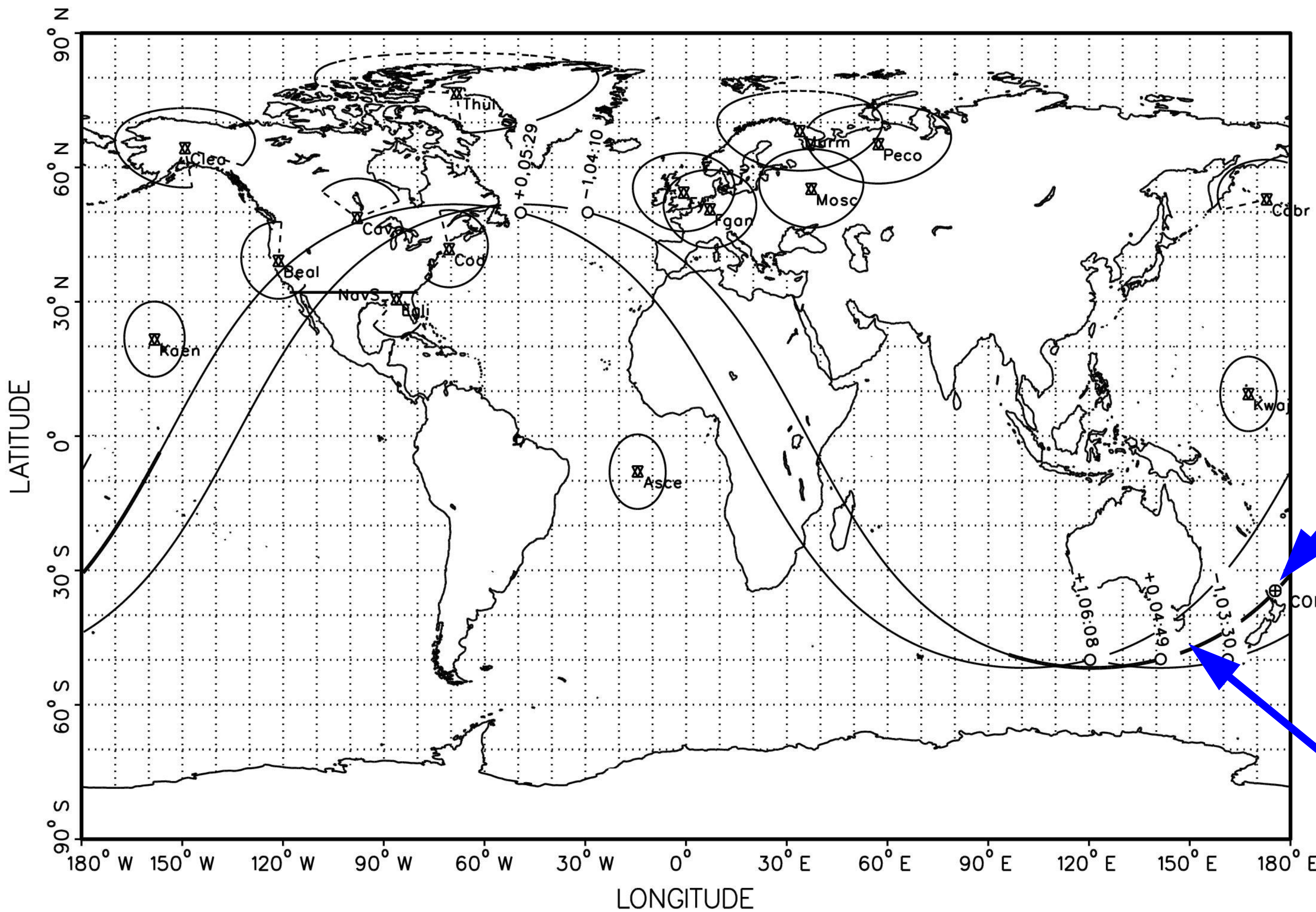
Altitude Decay of EAS



Re-Entry Time Window of EAS



Re-Entry Ground Track of EAS



"impact" location

35°S, 176°E

"80 km alt." location

48°S, 151°E

EAS Campaign Summary

	All Predictions		Last 48h Predictions	
Agency	Count	Error Δt (%)	Count	Error Δt (%)
ASI	24	5.76	11	8.53
BNSC	9	18.89	5	9.18
CNES	12	5.96	4	7.92
CNSA	20	7.35	11	4.85
DLR	16	9.06	7	6.79
ESA	20	8.50	12	7.75
ISRO	28	7.30	13	8.20
JAXA	7	4.28	-	-
NASA	7	6.51	4	6.37
ROSCOSMOS	27	5.54	13	5.30
total	170		80	

- pass of 80 km altitude interface at 04:51 UTC on Nov. 3, 2008 (SSN information)
- assessed ground impact at time 04:58 UTC, and location 35°S and 176°E
- IADC re-entry database statistics: 6^d13^h total log-on time of 10 IADC Members; 170 predictions and 160 orbit determinations were entered

Conclusions

- 10 IADC re-entry prediction test campaigns have been performed since 1998, at a mean rate of 1 per year
- the Web-based IADC Re-Entry Events Database has proven to be a valuable tool for the timely exchange of technical information required to perform reliable re-entry predictions of potentially hazardous space objects
- due to the near real-time availability of orbit data from space surveillance systems or individual sensors of IADC members, the re-entry prediction accuracy is generally better than ± 15% of the remaining orbital lifetime (i.e. generally better than ± 13 min, one orbit prior to re-entry)
- the improved prediction accuracy due to data sharing facilitates more efficient risk control in the case of high-risk re-entry events; however, predictions of the final impact zone remain difficult, mainly due to limitations in the atmosphere models and satellite drag models