Synopsis of Real ELT Incident in Alberta, Canada

Slide Presentation to Cospas-Sarsat
Joint Committee 26th Meeting
(of document JC-26/Inf.30)

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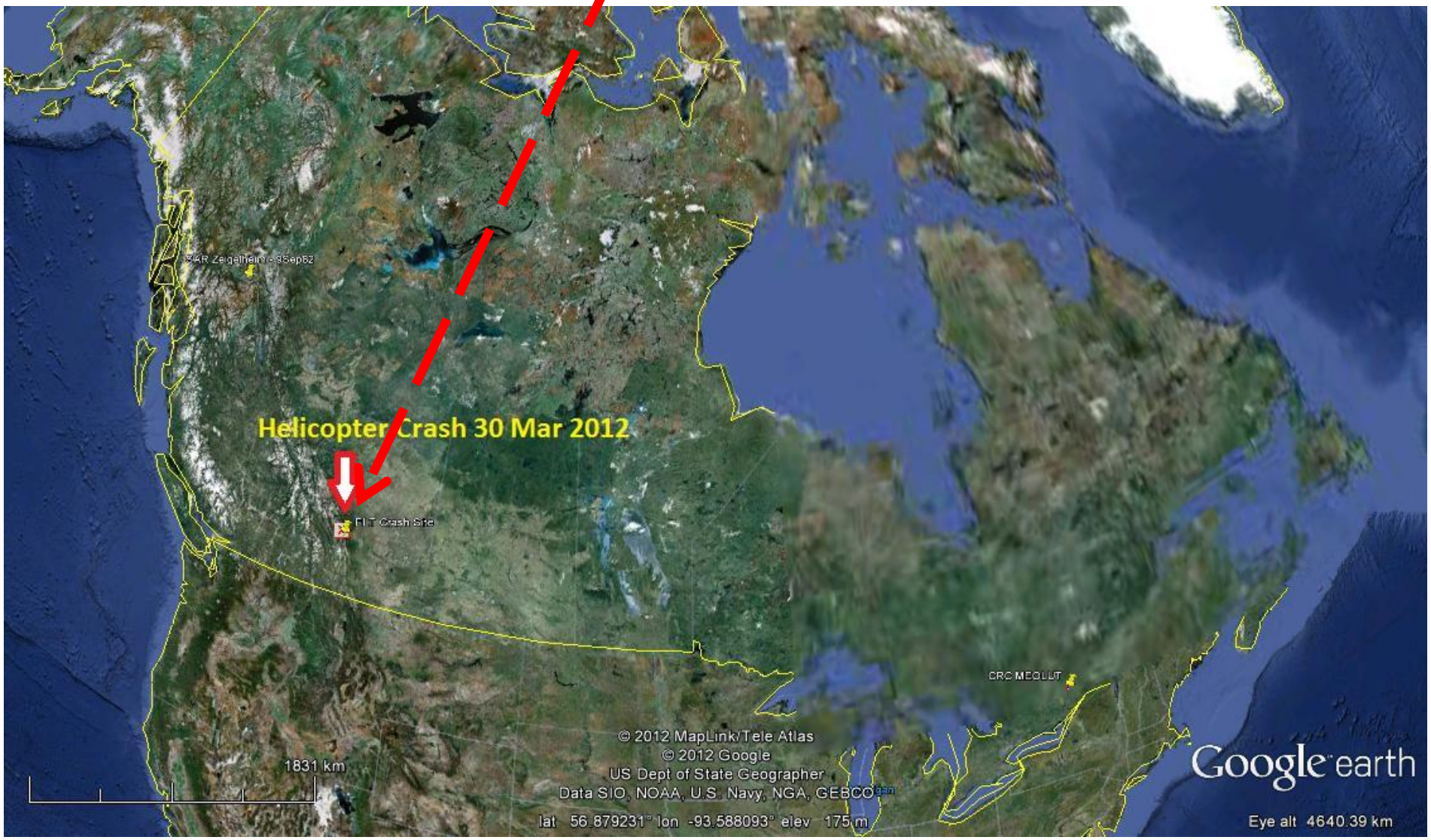
Real ELT Incident in Alberta, Canada

- Sightseeing helicopter on a scenic tour in the Rocky Mountains -30 Mar 2012
- 5 persons on board (pilot & 4 tourists)
- Helicopter crashed in mountains in Western Canada (near Canmore, Alberta, about 80 km West of Calgary)
- ELT signals received by Cospas-Sarsat LEOSAR provided RCC first & only alert
- This is a subsequent analysis of alerts from LEO, GEO & MEOSAR systems
- MEOSAR system not yet operational, so not being monitored in real-time
- photo credits: TSB, KMH & K-country Rescue

Helicopter Crashed in Mountains in Western Canada



Media Article-1

Pilot killed in Calgary chopper crash named

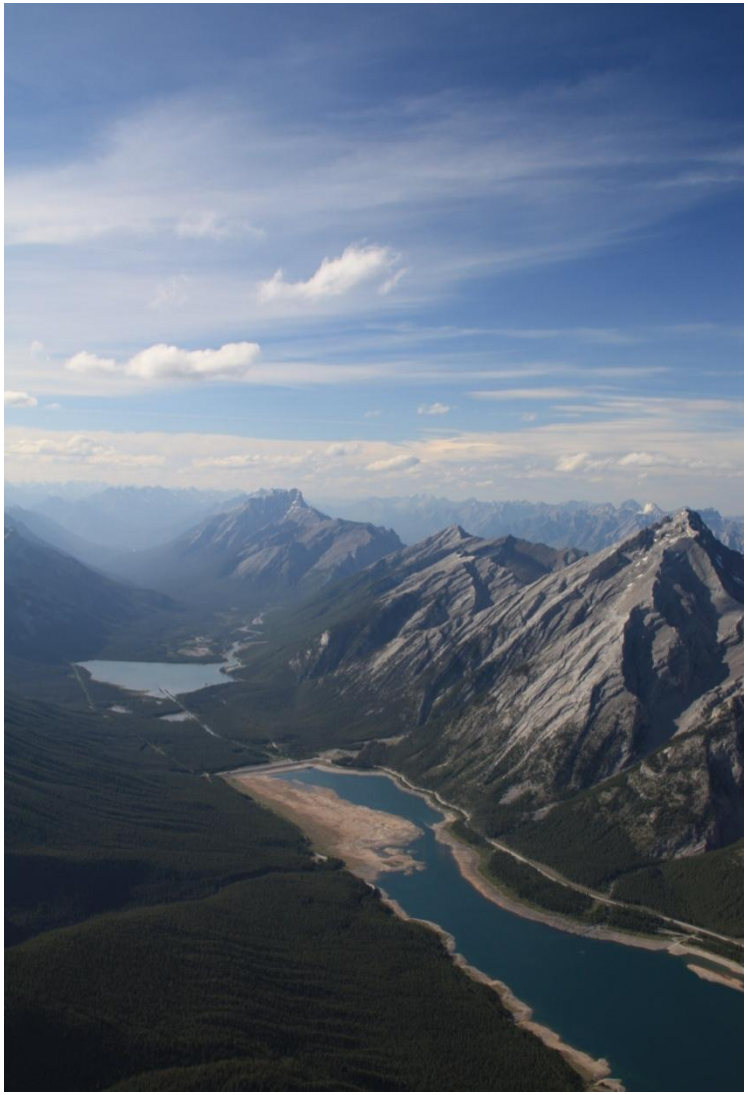
The pilot killed when a sightseeing helicopter went down Friday, just west of Calgary, has been identified as Matthew Goodine, 28, of British Columbia. His hometown was not immediately made available. The chopper crashed during a scenic tour near Grotto Mountain, in the Canmore area. All four passengers, believed to be tourists from outside the country, received non-life-threatening injuries. "We do know there was four tourists on board, as well as the pilot," said RCMP Sgt. Patricia Neely. "What went wrong, when and how, that's yet to be determined." A STARS air ambulance team assisted in attempts to save the pilot's life, but the patient died before the workers could load him into the air ambulance. The helicopter, operated by Kananaskis Mountain Helicopters and flown by Kananaskis Heli Tours, crashed shortly before noon.

Media Article - 2

- "...It crashed at 10:30 a.m. *(1630 UTC)* on Friday but Canmore RCMP did not find out about it until about 1 p.m. *(1900 UTC)*
- The survivors suffered only minor injuries and were treated and released from hospital. Goodine died before arriving at hospital....."
- 4 survivors (tourists) and 1 fatality (pilot)

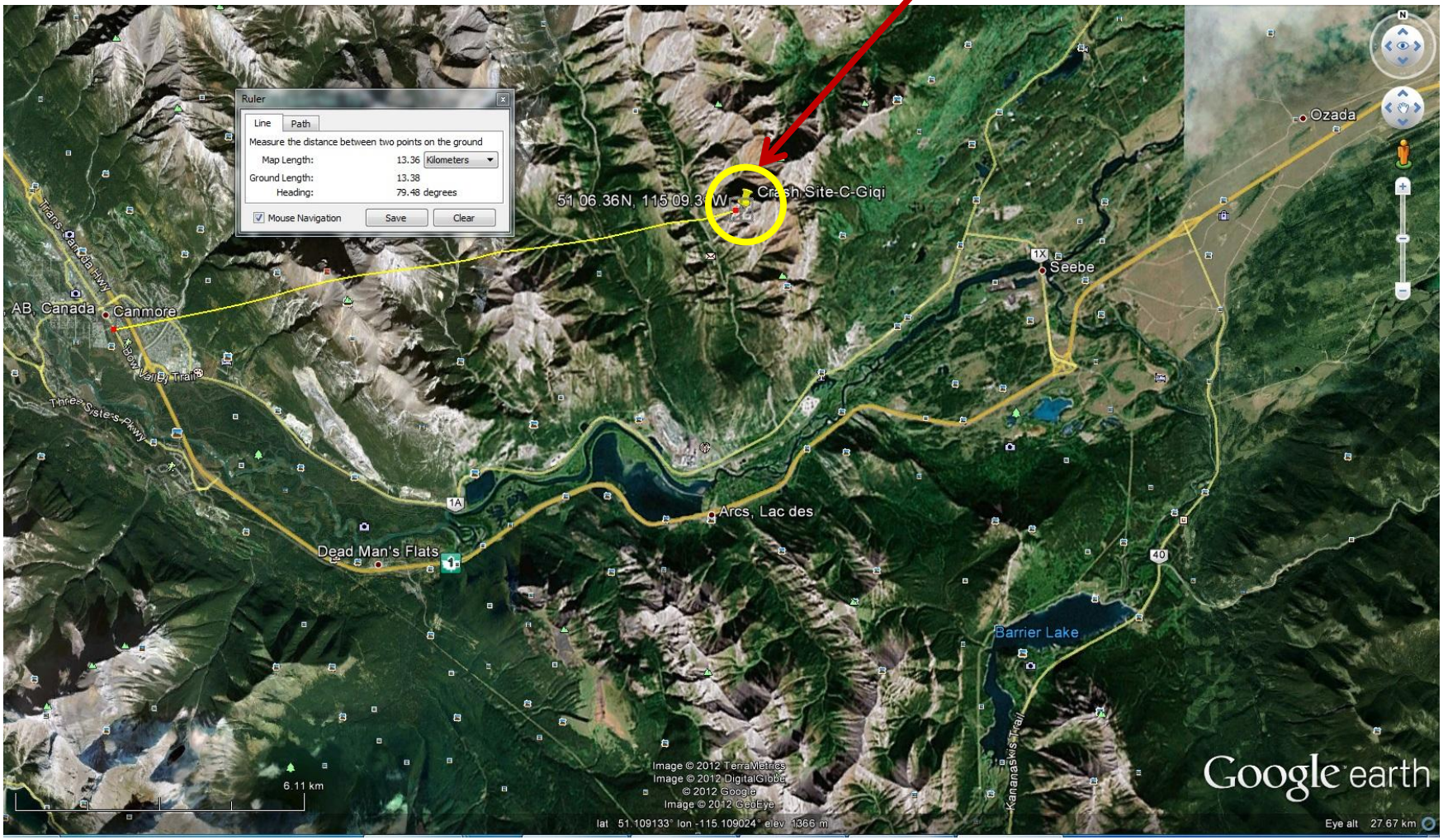
Rugged Terrain in Rocky Mountains

Rugged Terrain in Rocky Mountains



ELT activated soon after crash

- Actual Location: 51 06.36N, 115 09.31W (=51.106 N, 115.155W) (13 km from Canmore, Alberta)

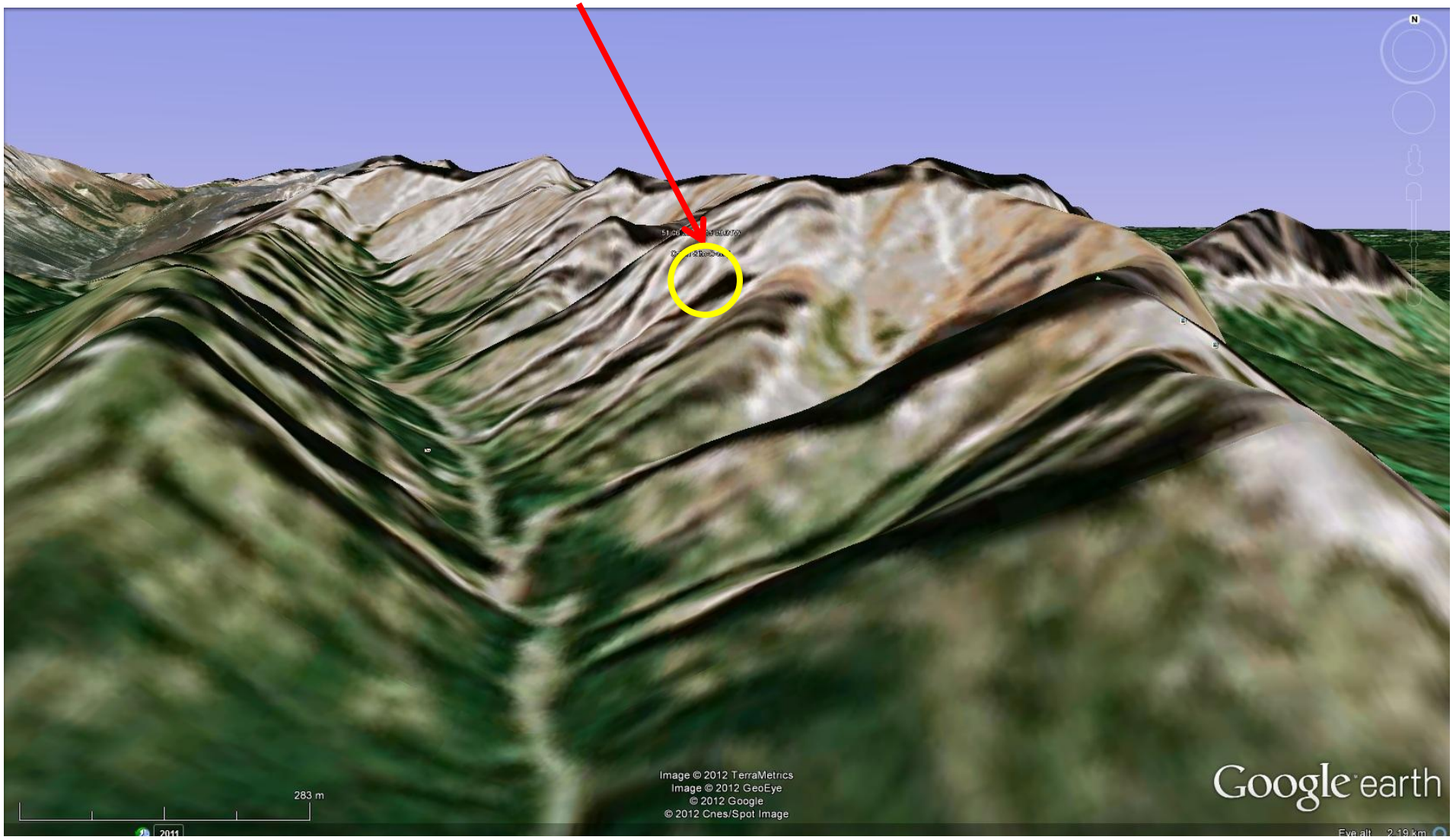


Rugged Terrain- Top view

approx crash site

Rugged Terrain- Side view

approx crash site on side of 800m high mountain on East and West



Flying north in Jura Creek Valley towards crash site

mountain peaks rise ~800 m (2,500 ft) above the valley

(photo credits: TSB, KMH and K-country Rescue team)

Approaching crash site

Crash site in centre ravine

Crash site in centre ravine

Helicopter body and broken-off tail section / tail rotor

Helicopter body and broken-off tail section / tail rotor

Helicopter body and broken-off tail section / tail rotor

Crashed Helicopter - and ELT still transmitted to C-S satellites for 24 hr (ELT rod antenna horizontal above snow)

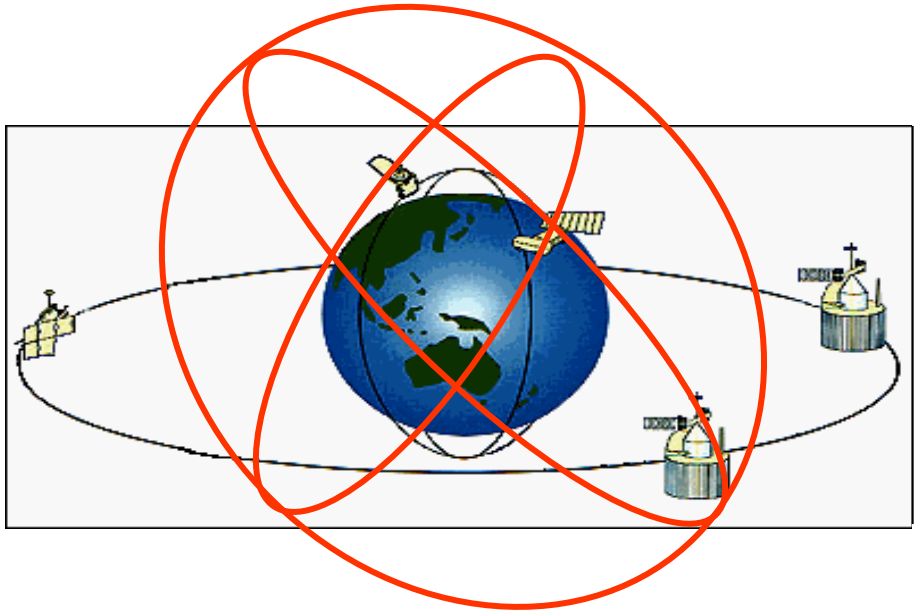
Crashed Helicopter on steep slope - ELT antenna laying horizontally just above snow

Wreckage in laboratory a week later -

ELT rod antenna still intact and ELT removed for further investigation

3 Different Satellite Systems for SAR

- **LEOSAR** (Low Earth Orbiting satellites in polar orbit, 1,000 km up)
- **GEOSAR** (Geostationary satellites over Equator, 36,000 km up)
- **MEOSAR** (Medium Earth Orbit satellites, 20,000 km up)



- Cospas-Sarsat system received ELT signal and decoded the data

Decode of ELT Signal Received – 24-bit AC Address

406 MHz Decode Program (Version 3.1)

53C6F80C6BA0178C76381362453CAD 15 Hexadecimal

ITEM	BITS	
Message format: short format	25	0
Protocol: User	26	1
Country code: 316 - **Canada**	27-36	010011
User type: Serial User	37-39	011
Serial Type: ELT with Aircraft 24-bit Address	40-42	011
Cospas-Sarsat Certificate Number in bits 74-83: Yes	43	1
24-bit Aircraft ID: 12608349 or in hexidecimal C0635D	44-67	110000
Number of Additional ELTs: 0	68-73	000000
C/S Number or National Use (bit 43 refers): 188	74-83	001011
Aux radio device: 121.5 MHz	84-85	01

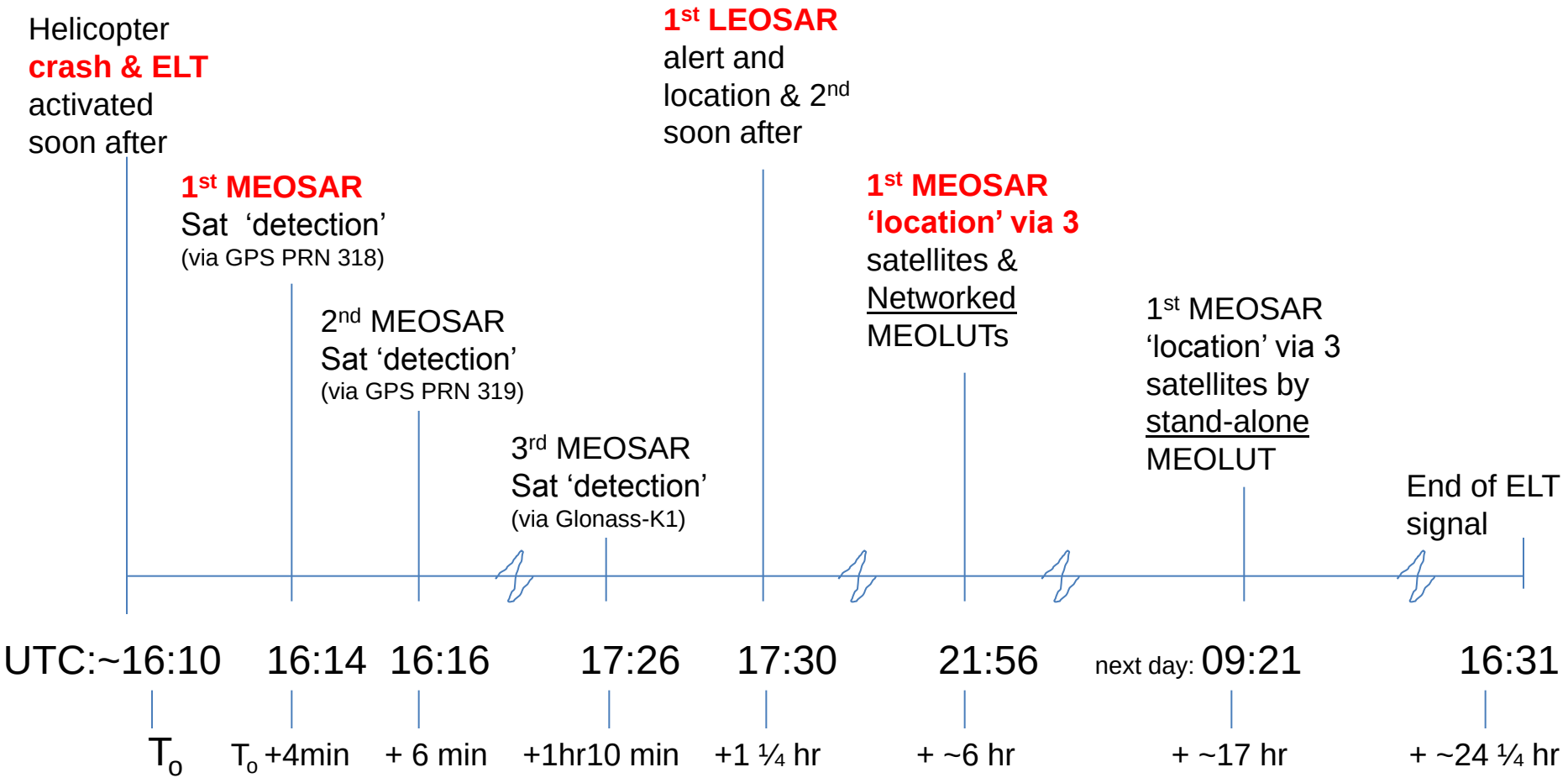
Information from ELT Signal Received

- Short Message (so no GNSS location encoded)
- Country Code 316=Canada
- ELT with 24-bit Aircraft Address (identifies specific aircraft # 12608349)
- C/S Type Approval Certificate No 188 (and from C/S data, this is Artex ELT model ME406 (probably HM version) and pictures from Artex website show:

Overview of Satellite Alerts from ELT signal

(30-31 Mar 2012, Day 90 & 91))

(with only a partial MEOSAR constellation)

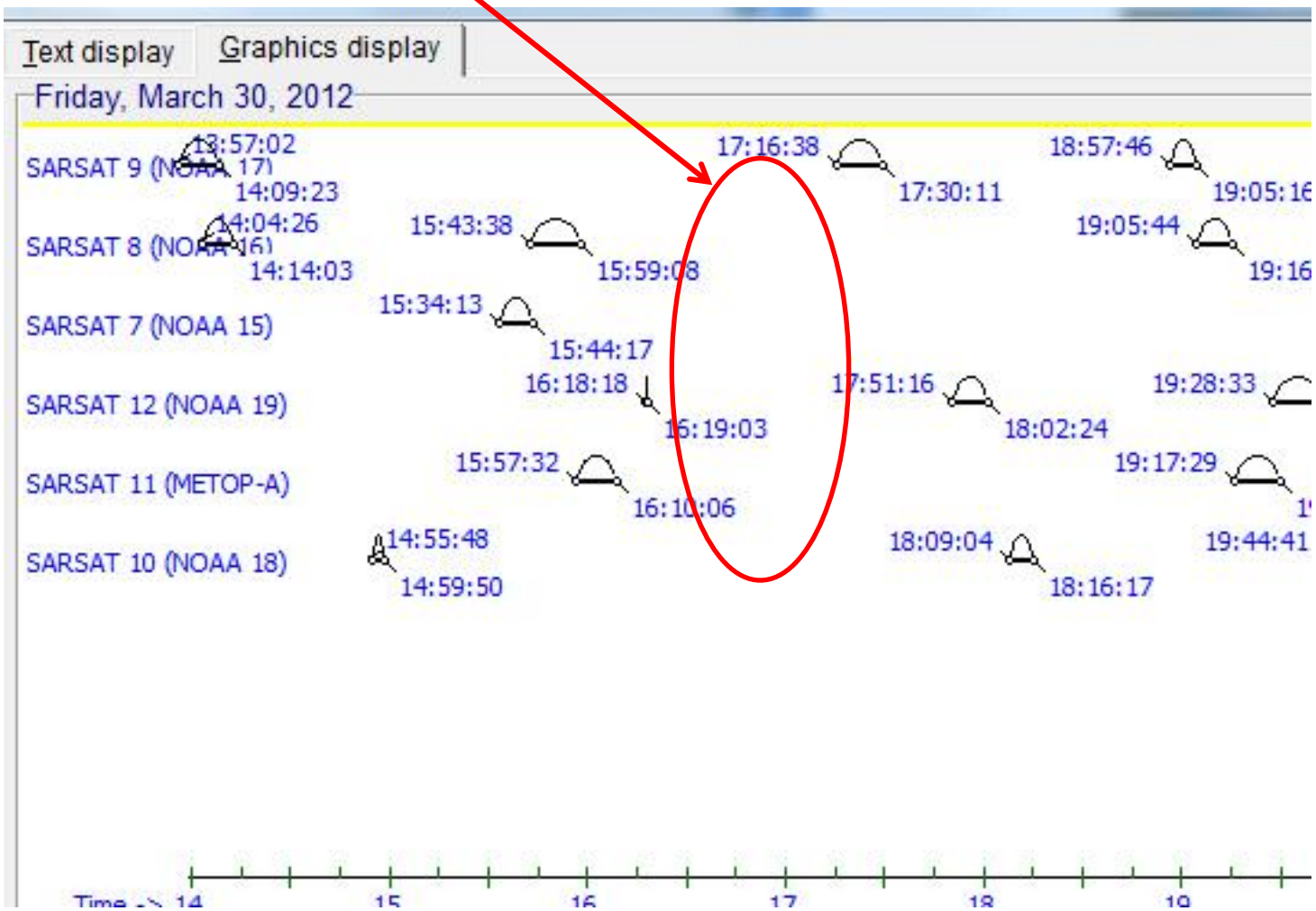


Summary of Satellite Alerts from ELT signal
(on Fri 30 Mar 2012, Day 90)

- **LEOSAR**
  - Started providing ELT locations 1 ¼ hr (at 17:30 UTC) after crash
  - TCA of first LEO sat was 17:23 & second at 17:32 and ambiguity resolved)
  - Location accuracy within 2 km
  - SARR and SARP locations continued over 24 hour period of ELT operation
- **GEOSAR**
  - No detections at all from GOES-East or GOES-West
- **MEOSAR**
  - First received a burst from ELT at 16:14 UTC producing an 'unlocated' alert (received at Hawaii MEOLUT, then other MEOLUTs)
  - Very approx locations started being computed by Canada MEOLUT ½ hr later (16:46), using Doppler freq data from France via 1 MEO Sat
  - later TOA/FOA data from France, Turkey & Brazil MEOLUTs via Network

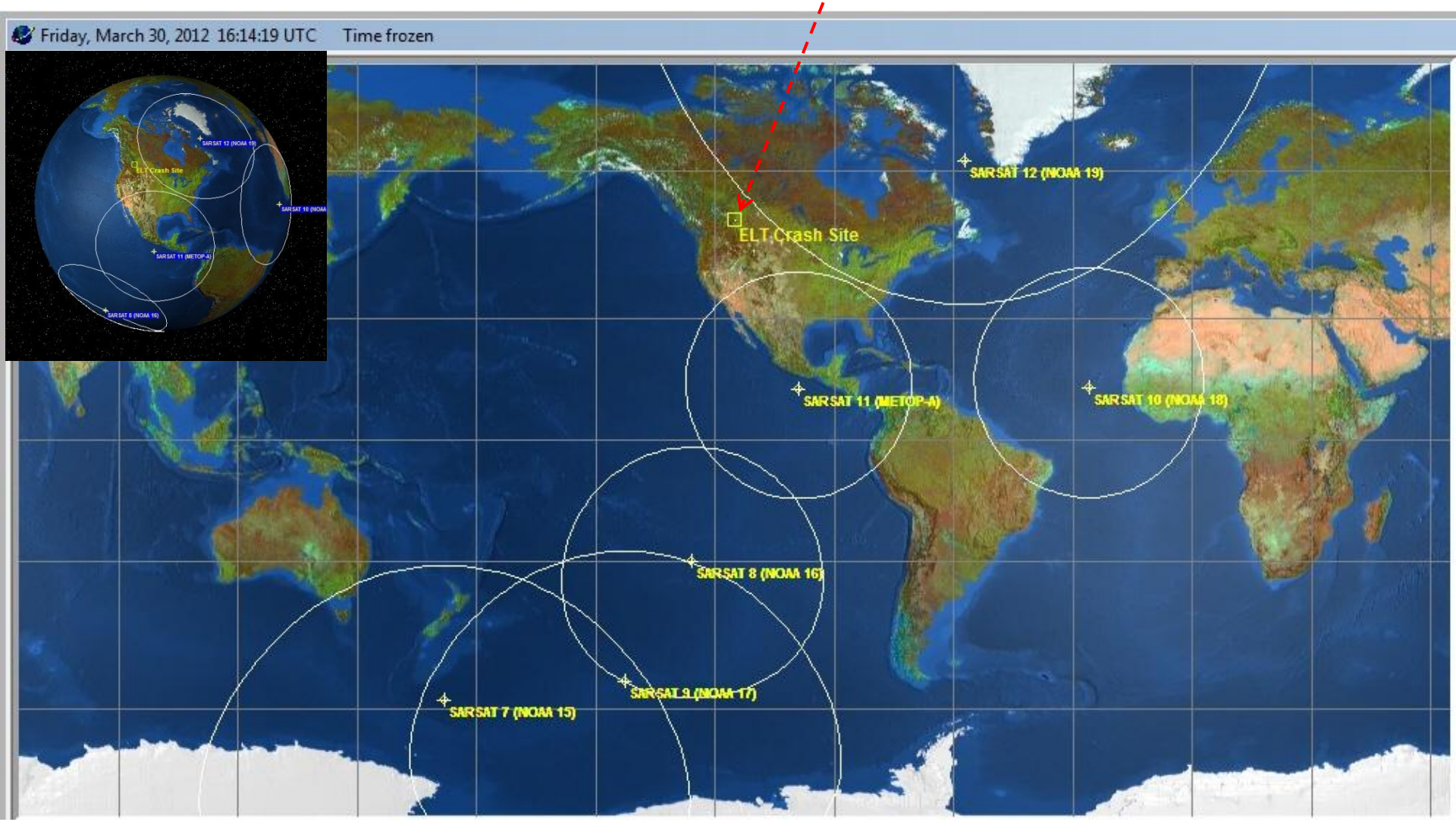
LEOSAR Satellite Pass Timeline

showing NO LEO satellite coverage in that area until 1 1/4 hours after crash



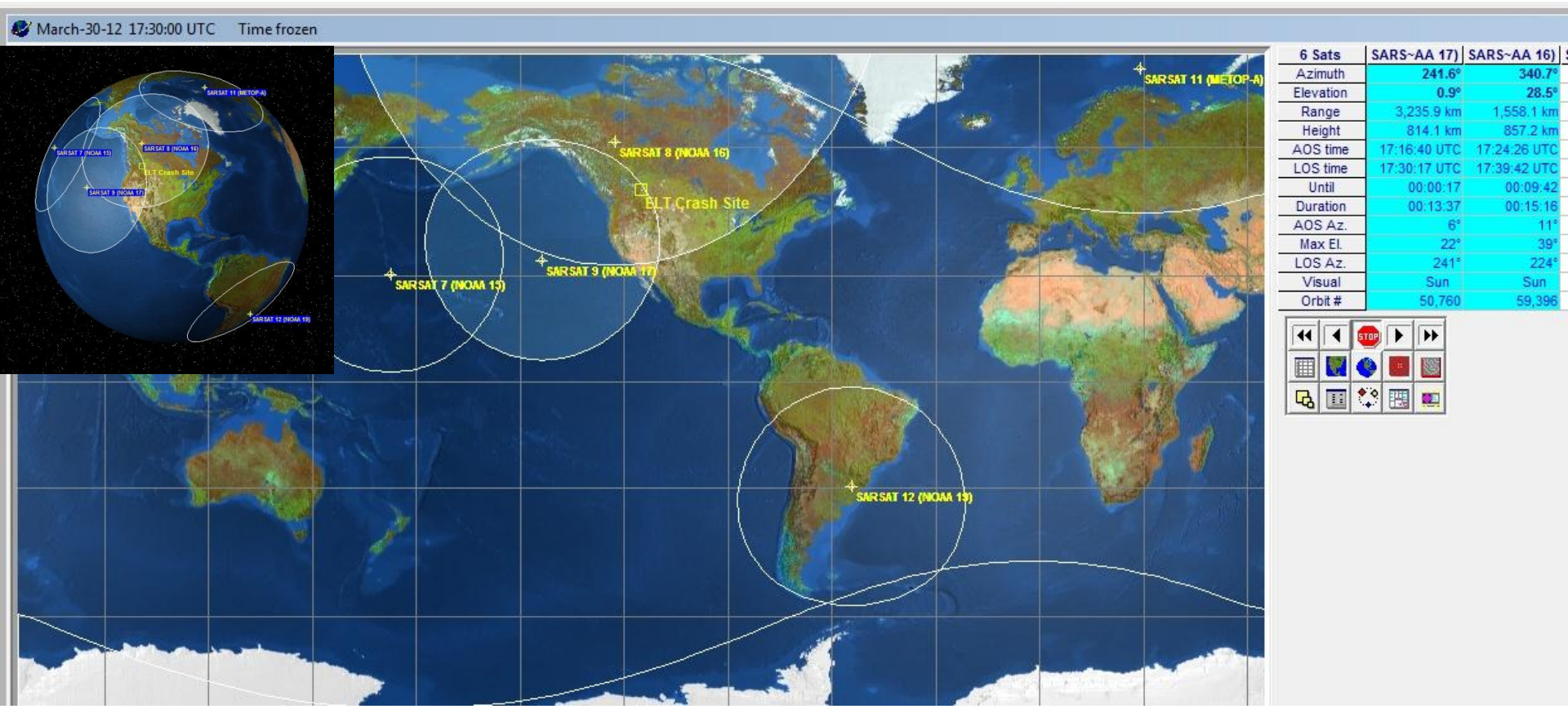
LEOSAR Satellite Footprints at 16:14

- None of the 6 LEOSAR satellites in view of ELT site at time of crash or MEO detection

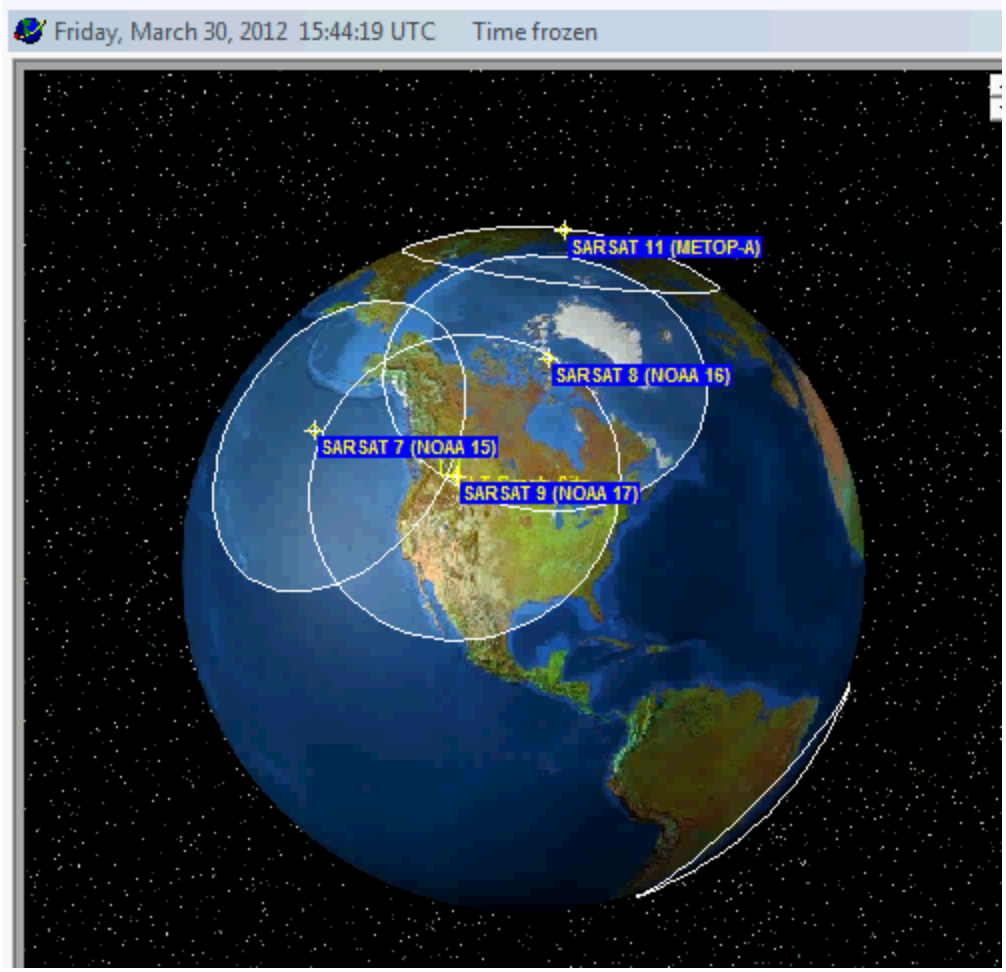


LEOSAR Satellite Footprints 1 1/4 hours later (at 17:30)

- 1 1/4 hours later, 2 of the 6 LEOSAR satellites now in view of ELT crash site
- LEOSAR alerts and locations were produced soon after these satellite passes



LEOSAR Satellite Footprints over 3 hours



LEOSAR System

- The LEOSAR system provided the RCC the first, and only, operational alert of this real ELT distress incident (MEOSAR not yet operational and not being continually monitored in real-time)

- LEOSAR alerts and/or locations were produced on about 26 passes during the 24 period the ELT operated

- On each LEO pass, ELT signals were typically received for only about 3-5 minutes (full range was 1 to 7 minutes), during mid-pass, while satellite was at high enough Elevation angle to be above mountains

- So typically only about 3-5 minutes of Doppler curve was produced

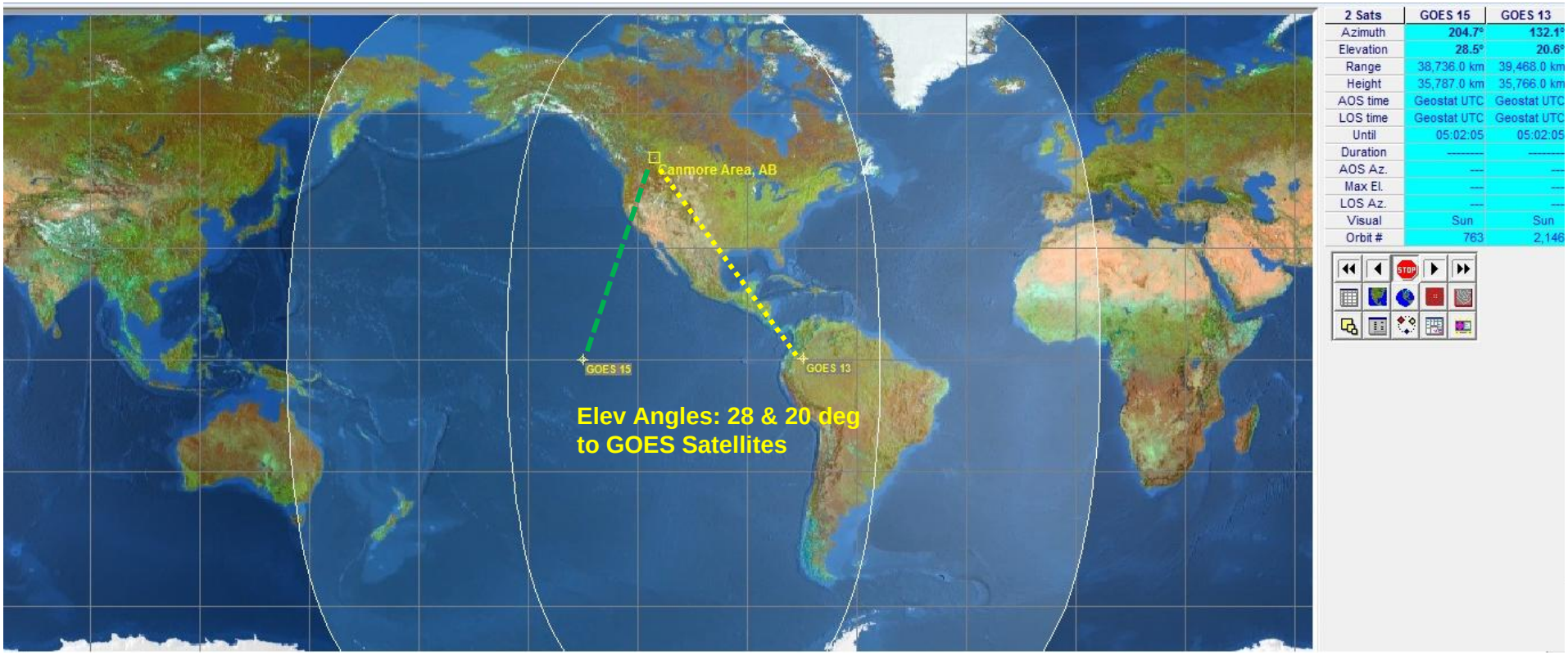
- Most ELT bursts were reliably received when LEO sat was in line-of-sight (nearly 100 % detection rate when in line-of-sight)

LEOSAR SARP Received Power Levels

- SARP memory was analyzed for all ELT bursts received
- ELT received Power level at SARP was typically -120 to -130 dBm, but ranged from -109 to -140 dBm
- Some passes received only 1 ELT burst, at very weak level (probably when LEO sat was at gap in mountains)
- When LEO satellites were at similar Azimuth and Elevation angles as GEOSAR satellites, no ELT signals were received (probably blocked by mountains)

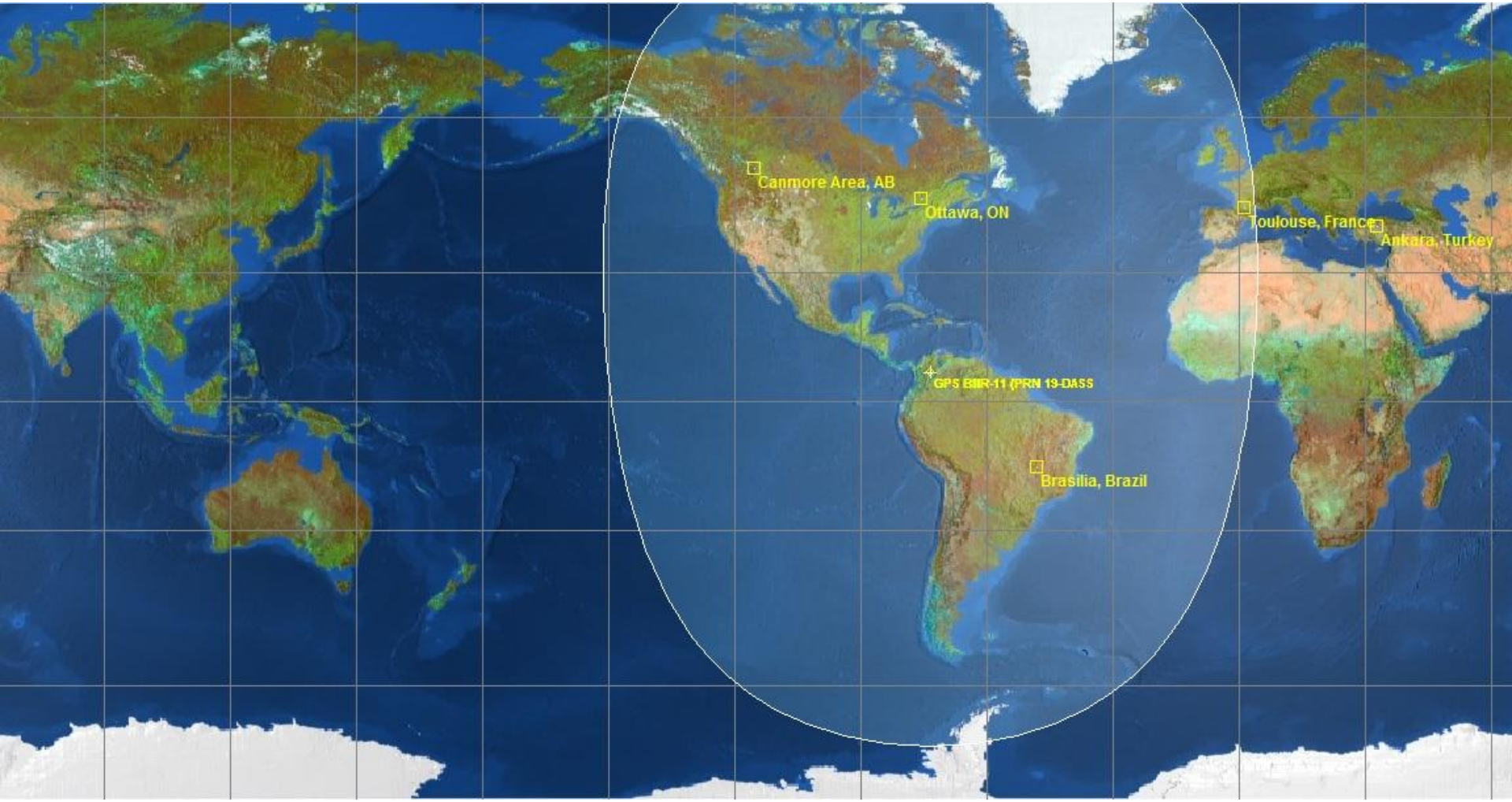
GEOSAR Satellite Footprints

- NO Detections received from either GOES-East or -West satellites
- At 28 and 20 degree elevation angle at crash site
- Line-of-sight to GEOSAR satellites <u>probably blocked by mountains</u>

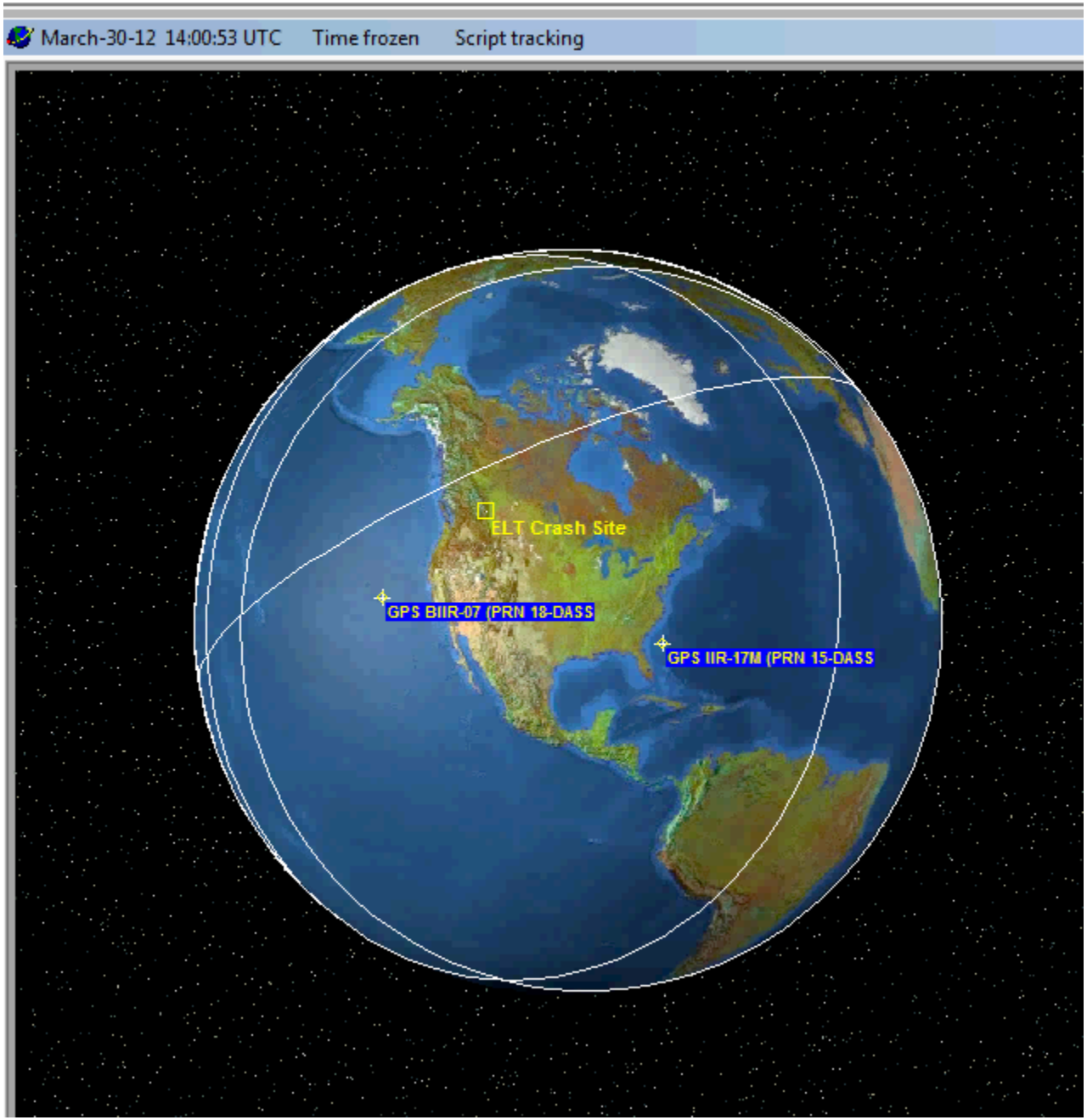


MEOSAR Satellite Footprint

almost as large as GEOSAR, and slowly moving, so various look angles to satellites



MEOSAR Satellite Footprints over 5 hours



TOA/FOA Data Received Automatically from MEOLUT Network between Canada, Brazil, Toulouse & Turkey

- Far away MEOLUTs provided data from crash site

(Brazil 9800 km away, Toulouse 7800 km, and Turkey 9200 km)

Sequence of MEOSAR "Detections"
(on Fri 30 Mar 2012, Day 90)

- CRC's MEO tracking antennas turned off for maintenance & upgrades, but MEOLUT Processor & Network still operating and Honeywell Ottawa Antenna connected
- First several bursts received via 2 MEO Satellites giving 'unlocated' alerts:
  - Hawaii MEOLUT via GPS PRN 318, then 319
  - France MEOLUT via GPS PRN 318
- ELT bursts were only detected sporadically, even when MEO satellite was in line-of-sight (much less than 100 % detection rate, since signals probably near processing threshold)

- TOA/FOA data came automatically from MEOLUTs in France & Honeywell Ottawa to Canada's MEOLUT at 16:20 UTC

Sequence of MEOSAR "Locations"
(on Fri 30 Mar 2012, Day 90)

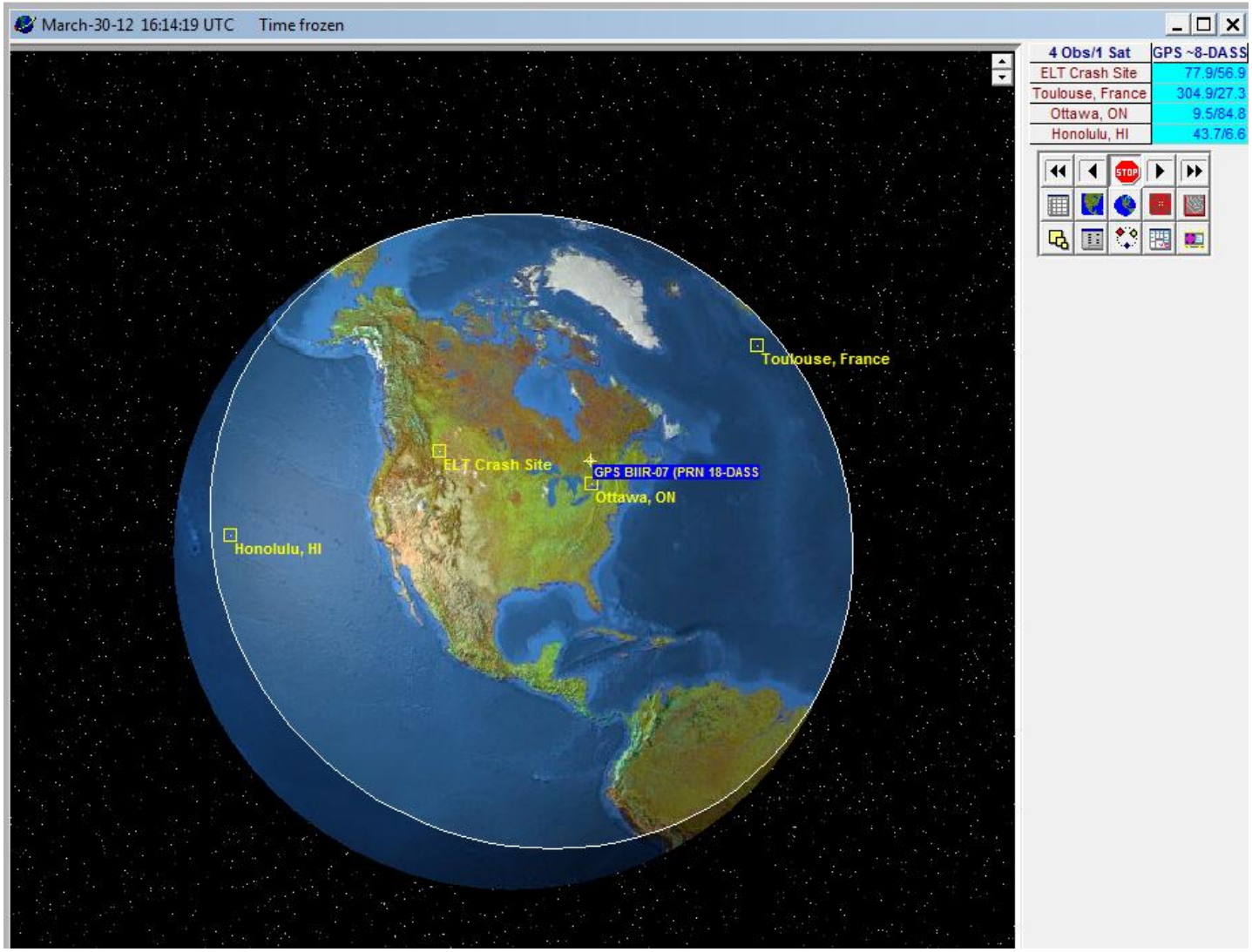
- Additional TOA/FOA data arrived via Network every few minutes
- Initial locations computed using "Doppler shift" data from only that 1 MEO Sat (poor locations with 200-300 km error),
- Location computations updated each 10 min (16:36, 16:46, 16:56, 17:06, 17:16 etc...) still using "Doppler shift" data from only that 1 MEO Sat (note: Hawaii MEOLUT data was not put into MEOLUT Network)
- An hour later (at 17:26) a 2nd MEO satellite -- Glonass-K1 (#501) in view of crash site and TOA/FOA data received from Turkey MEOLUT
- A few hours later, 3rd & 4th satellites came into view (PRN 323 & 316) and eventually data was also received from Brazil MEOLUT
- MEOSAR system required 6 hr before detections via 3 MEO satellites available (at 22:16), and then accurate MEO locations were computed
- MEO Locations continued over 24 hr period of ELT operation

Hawaii MEOSAR Data from USA
(on Fri and Sat 30-31 Mar 2012, Day 90 & 91)

- Hawaii MEOLUT was under test, so data for case study was subsequently provided by USA by e- mail
- It showed a first ELT burst received at 16:14 via GPS (PRN 318), with 3 successive bursts till 16:16
- Then many bursts were received via another GPS (PRN 319), which was being tracked by Hawaii, but was not in view of any other MEOLUTs and data was not fed into Network
- ELT Independent Locations were computed by Hawaii MEOLUT the next day at 09:21 (17 hr after crash) when 3 MEO satellites were in view of ELT & Hawaii MEOLUT
- If those early detections from the Hawaii MEOLUT had been provided to the MEOLUT network, Canada MEOLUT could have computed accurate MEO locations within 1 hr of the crash, rather than taking 6 hr, illustrating the benefits of MEOLUT networking

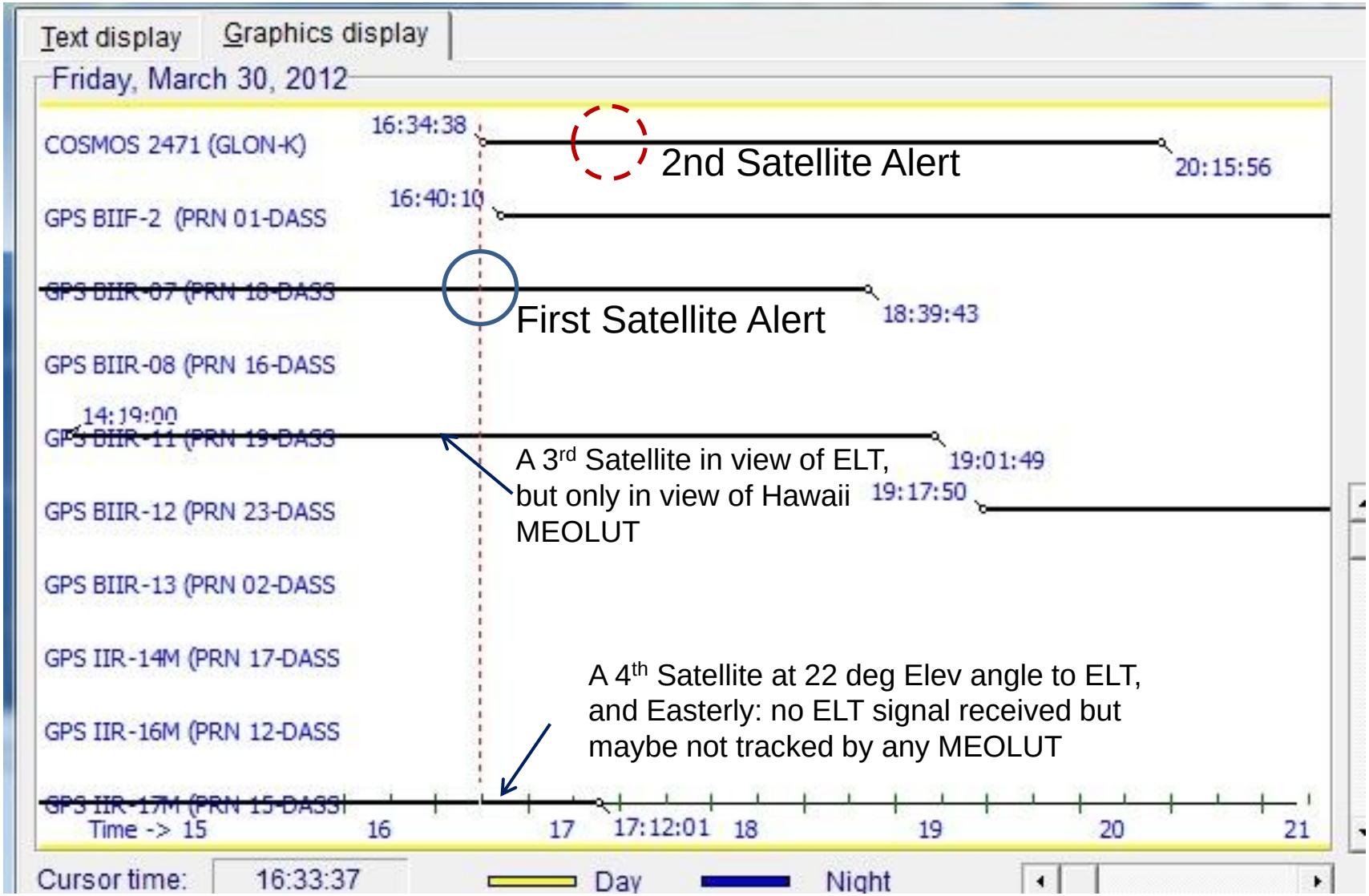
1 MEOSAR Satellite (PRN 318) at 16:14

in view of ELT when 1st burst was received providing 'unlocated' alert while being tracked by Hawaii, Ottawa (Honeywell) and France MEOLUTs



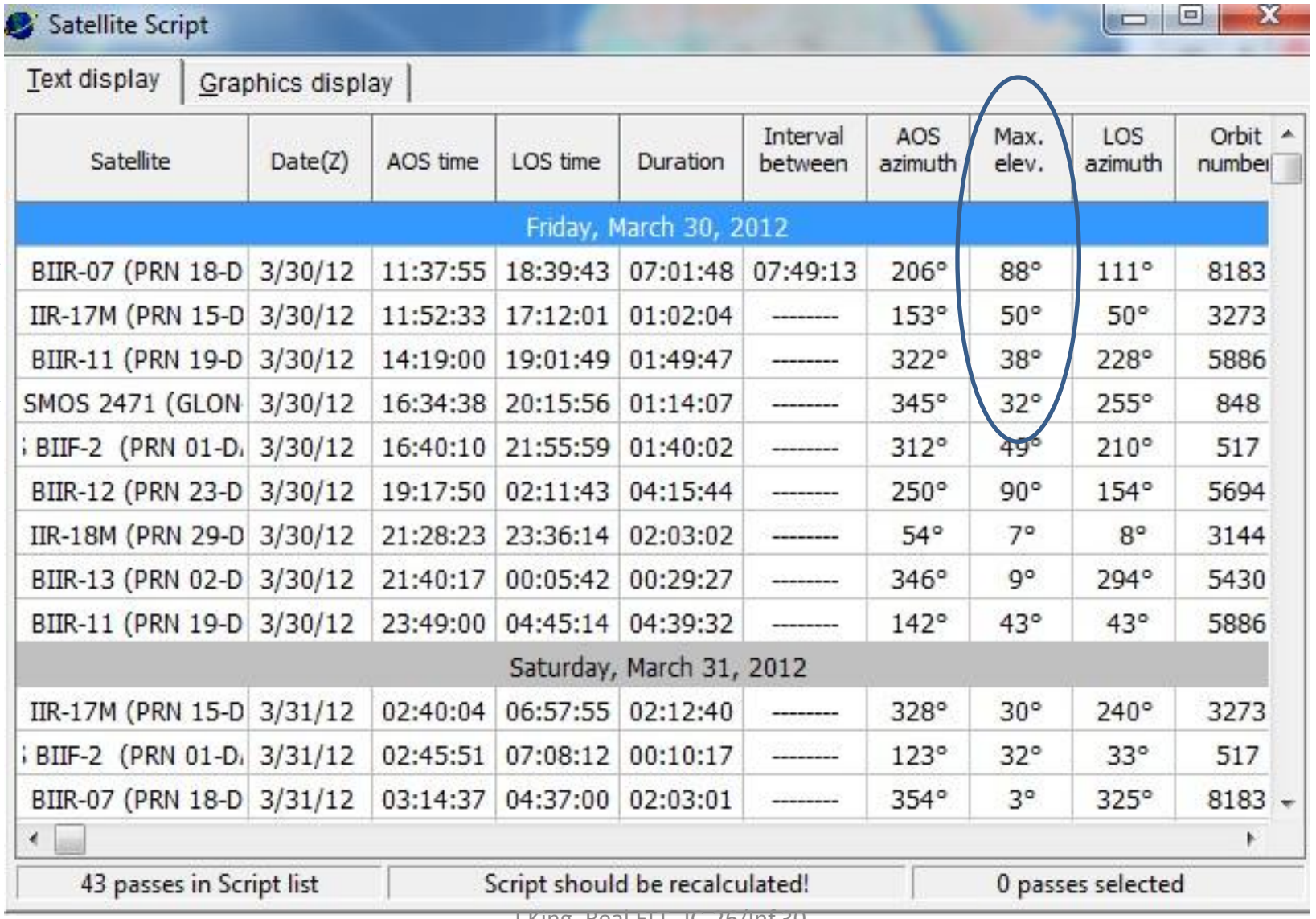
MEOSAR Satellite Pass Timeline

for all passes visible at ELT crash site



MEOSAR Satellite Pass Schedule

for all passes visible at ELT crash site



Satellite Script

Text display | Graphics display

Satellite	Date(Z)	AOS time	LOS time	Duration	Interval between	AOS azimuth	Max. elev.	LOS azimuth	Orbit numbe
Friday, March 30, 2012									
BIIR-07 (PRN 18-D	3/30/12	11:37:55	18:39:43	07:01:48	07:49:13	206°	88°	111°	8183
IIR-17M (PRN 15-D	3/30/12	11:52:33	17:12:01	01:02:04	--------	153°	50°	50°	3273
BIIR-11 (PRN 19-D	3/30/12	14:19:00	19:01:49	01:49:47	--------	322°	38°	228°	5886
SMOS 2471 (GLON	3/30/12	16:34:38	20:15:56	01:14:07	--------	345°	32°	255°	848
BIIF-2 (PRN 01-D	3/30/12	16:40:10	21:55:59	01:40:02	--------	312°	49°	210°	517
BIIR-12 (PRN 23-D	3/30/12	19:17:50	02:11:43	04:15:44	--------	250°	90°	154°	5694
IIR-18M (PRN 29-D	3/30/12	21:28:23	23:36:14	02:03:02	--------	54°	7°	8°	3144
BIIR-13 (PRN 02-D	3/30/12	21:40:17	00:05:42	00:29:27	--------	346°	9°	294°	5430
BIIR-11 (PRN 19-D	3/30/12	23:49:00	04:45:14	04:39:32	--------	142°	43°	43°	5886
Saturday, March 31, 2012									
IIR-17M (PRN 15-D	3/31/12	02:40:04	06:57:55	02:12:40	--------	328°	30°	240°	3273
BIIF-2 (PRN 01-D	3/31/12	02:45:51	07:08:12	00:10:17	--------	123°	32°	33°	517
BIIR-07 (PRN 18-D	3/31/12	03:14:37	04:37:00	02:03:01	--------	354°	3°	325°	8183

43 passes in Script list | Script should be recalculated! | 0 passes selected

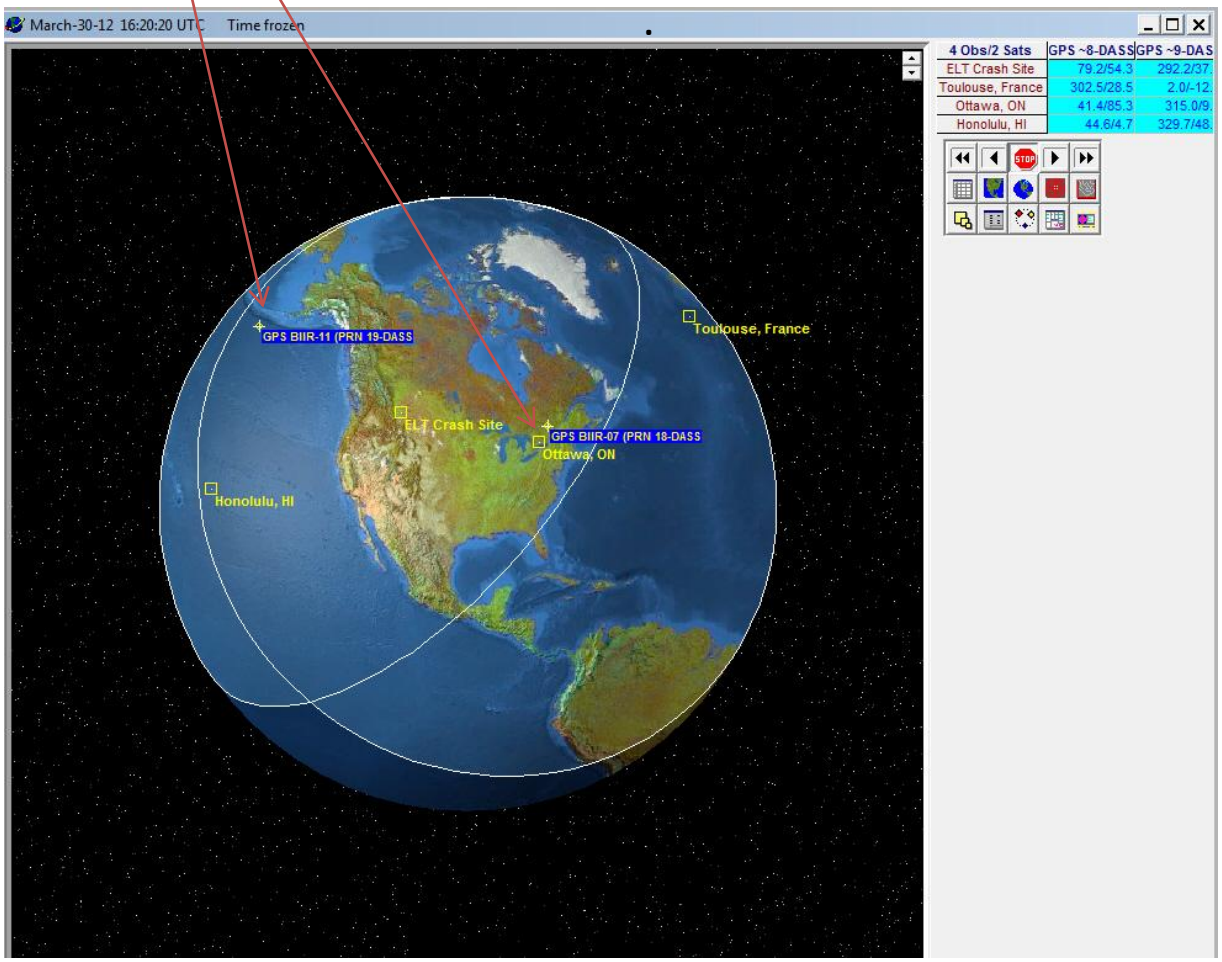
2 MEOSAR Satellite Footprints at 16:20

2 MEO satellites in view of ELT crash site and being tracked:

GPS PRN 318 being tracked by Ottawa, Toulouse & Hawaii MEOLUTs

GPS PRN 319 being tracked only by Hawaii MEOLUT .

Another GPS (PRN 315) was also in range of ELT, but at lower Elev and maybe not tracked

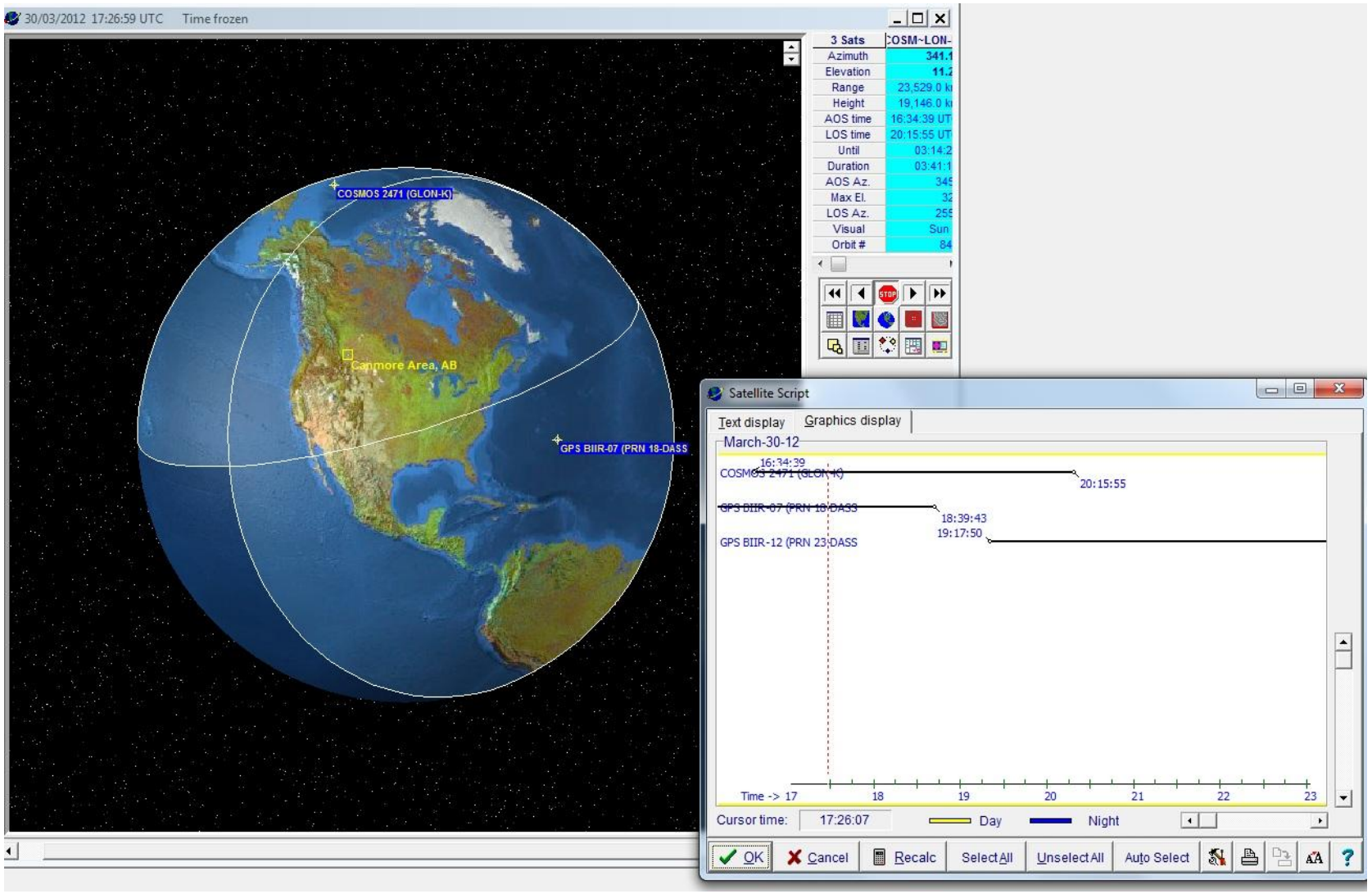


3 MEOSAR Satellite Footprints at 17:26

- Three MEOs now in view of ELT site (all below 28 deg elevation) including:
- GPS PRN #318 being tracked by France MEOLUT
- Glonass-K #501 being tracked by Turkey MEOLUT
- GPS PRN #319 over Pacific Ocean being tracked by Hawaii, but not in view of other MEOLUTs in Network

2 MEOSAR Satellite Footprints at 17:26

GPS PRN 318 (Ottawa & Toulouse) and Glonass-K1 (Turkey MEOLUT)



Summary of Preliminary Findings for this Real Distress Case

- Even today's partial MEOSAR system provided:
  - the first alert and ELT ID code (unlocated alert)
  - Approx locations computed within 1 hour using only 2 MEO satellites
  - Good locations computed 6 hours later (using 3 MEO satellites), but could have been done after 1 hour if Hawaii data were in MEOLUT Network
  - ELT signals were relayed via S-band (DASS-GPS) & L-band (Glonass) satellites
  - C/No from ELT about 34 to 35 dBHz for 24 hours
  - MEOSAR burst detection rates are noticeably lower than LEOSAR
- LEOSAR locations computed 1 ¼ hr after crash (waiting for satellites to be in view)
- GEOSAR system never detected beacon (ELT signal probably blocked by mountains)
- ELT transmitted 1700 bursts over 24 hours of operation

Conclusions from this Real Distress Case

- MEOLUT Network was instrumental, as MEOLUTs 8,000 to 9,000 km away provided key data
- ELT message contained 24-bit Aircraft address, even early unlocated alert would have been beneficial to SAR
- Further analysis could still be done (e.g. location accuracies vs number & geometry of MEO sats, received signal levels via LEO SARP & MEO, etc)
- Thanks to Participants (Brazil, France, Turkey, USA, & CMCC, JRCC) TSB, KMH & K-country rescue team for data, information & photos
- Potential benefits of future MEOSAR system look very promising