Contributions of SLR to the Success of Satellite Altimeter Missions

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Overview

Satellites

- TOPEX/Poseidon (NASA/CNES): 1992-
- ERS-2 (ESA): 1995-
- GFO (US Navy): 1998-
- Jason-1 (NASA/CNES): 2001-
- Envisat (ESA): 2002-

Applications

- Gravity field improvement
- Global large-scale and meso-scale ocean circulation
- Ocean topography and marine geophysics
- Sea level rise
- Ice sheet topography mapping and change

- First of series of multi-disciplinary environmental satellites
- Payload includes:
  - Radar Altimeter (wind, wave, sea height)
  - Microwave Radiometer (wet tropospheric content)
  - Synthetic Aperture Radar
    (land use and displacement)
  - Wind Scatterometer (wind field)
  - Along-Track Scanning Radiometer
    (surface temperature)
  - Precise Range And Range-rate Equipment (PRARE, orbit determ.)
- PRARE failed soon after launch
- Precise orbits (4–5 cm radial) achieved with SLR and altimeter tracking data
- Science mission saved by SLR community

ERS-1 spotted by SPOT4
ERS-2 (ESA): 21 Apr 1995 - present

- Successor of ERS-1, with improved payload:
  - PRARE fully redundant design
  - Global Ozone Monitoring Experiment
- PRARE still operational
- PRARE ground-segment degrades
- Delay in PRARE data delivery
- Precise orbits (4–5 cm radial) achieved with SLR and altimeter tracking data
- SAR interferometry also demands precise orbits (mainly cross-track)
- Operational use of altimeter data secured by SLR community

ERS-2 at ESTEC
ERS-2 Near-realtime Orbit Determination

- Every day, 9:00 UTC
- Download ERS-2 SLR data from CDDIS and EDC
- Download ERS-2 altimeter data from NOAA
- Generate orbit for previous and current day
- Last days’ orbit to update altimeter data; prediction is starting point for next day
- Running 4 years, nearly without intervention

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Vertical scale: sea height anomaly with respect to long-term mean
Colour: temperature anomaly with respect to long-term mean
Izmit (Turkey) Earthquake, 17 Aug 1999

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Antarctic Elevation Change 1992-1996

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8

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Results from different satellites are similar
Results from different time periods are dissimilar
TOPEX/Poseidon: 10 Aug 1992 - present

- Dedicated high-precision altimeter satellite
- Dual-frequency altimeter for ionosphere measurement
- Orbit determination by GPS, DORIS and SLR
- Inefficient LRR array
- Less dependent on SLR, yet receives most SLR tracking
- Radial orbit precision: 1-2 cm

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During design, LRR array (identical to Jason-1) added at the eleventh hour.

Launched on 10 Feb 1998, but only operational since 29 Nov 2000.

None of the GPS receivers worked properly without interfering with the altimeter.

SLR community saved the science mission, though Navy operators appear satisfied with S-band tracking.

Precise orbit determination (after gravity field tuning) gives radial orbit error of about 5-7 cm.
Jason-1 (NASA/CNES): 17 Dec 2001 - present

- Successor of TOPEX/Poseidon
- GPS, DORIS tracking systems and small LRR array
- DORIS tracking system seems to suffer from radiation
- Unusually high measurement residuals at Southern latitudes
- Does SLR need to save another altimeter mission?
Envisat: SLR Tracking (Cycle 7)

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SLR passes, May 1 - October 1, 2002

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Most passes of altimeter satellites

Monument Peak  12980
Yarragadee     12537
Herstmonceux   11540

Most passes of altimeter satellites on a single day

Graz          27   (1 Oct 2002)
Zimmerwald    21   (28 Jul 2002)
Orroral Valley 19  (7 Sep 1998)

First to track altimeter satellites

ERS-1  Grasse  17 Jul 1991 20:29  (launch + 18:35)
TOPEX Herstmonceux 10 Aug 1992 23:36  (launch + 00:28)
ERS-2  Riga    24 Apr 1995 18:50  (launch + 17:04)
GFO    Fort Davis  22 Apr 1998 02:56  (launch + 43d)
Jason-1 Greenbelt 19 Dec 2001 09:30  (launch + 12d)
Envisat Riga       10 Apr 2002 19:28  (launch + 41d)