Contributions of SLR to the Success of Satellite Altimeter Missions

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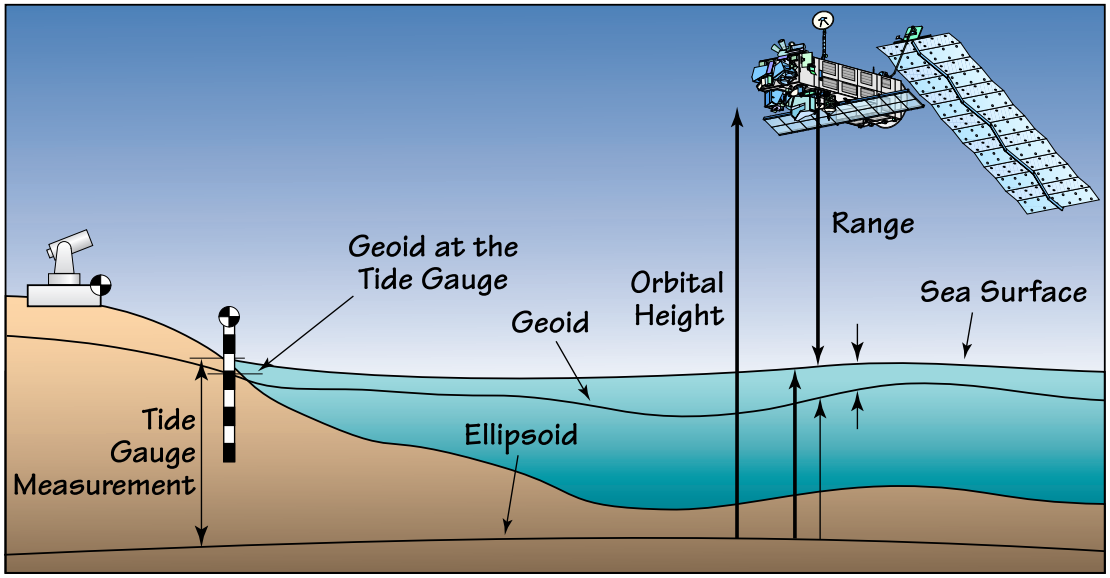
Overview

Satellites

- ERS-1 (ESA): 1991-2000
- TOPEX/Poseidon (NASA/CNES): 1992-
- ERS-2 (ESA): 1995-
- GFO (US Navy): 1998-
- Jason-1 (NASA/CNES): 2001-
- Envisat (ESA): 2002-

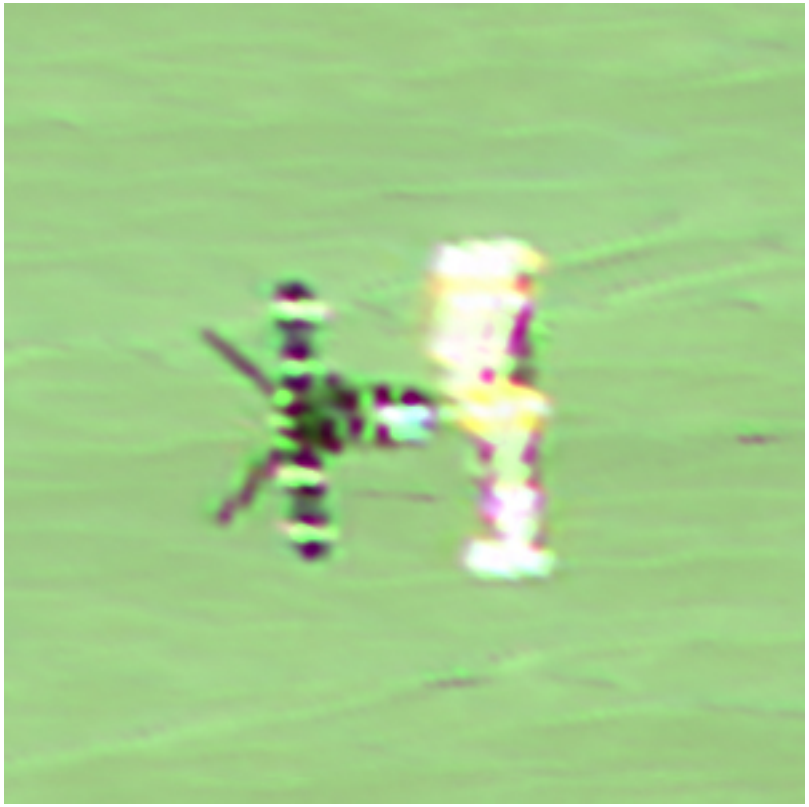


Applications

- 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

ERS-1 (ESA): 17 Jul 1991 - 10 Mar 2000

- 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

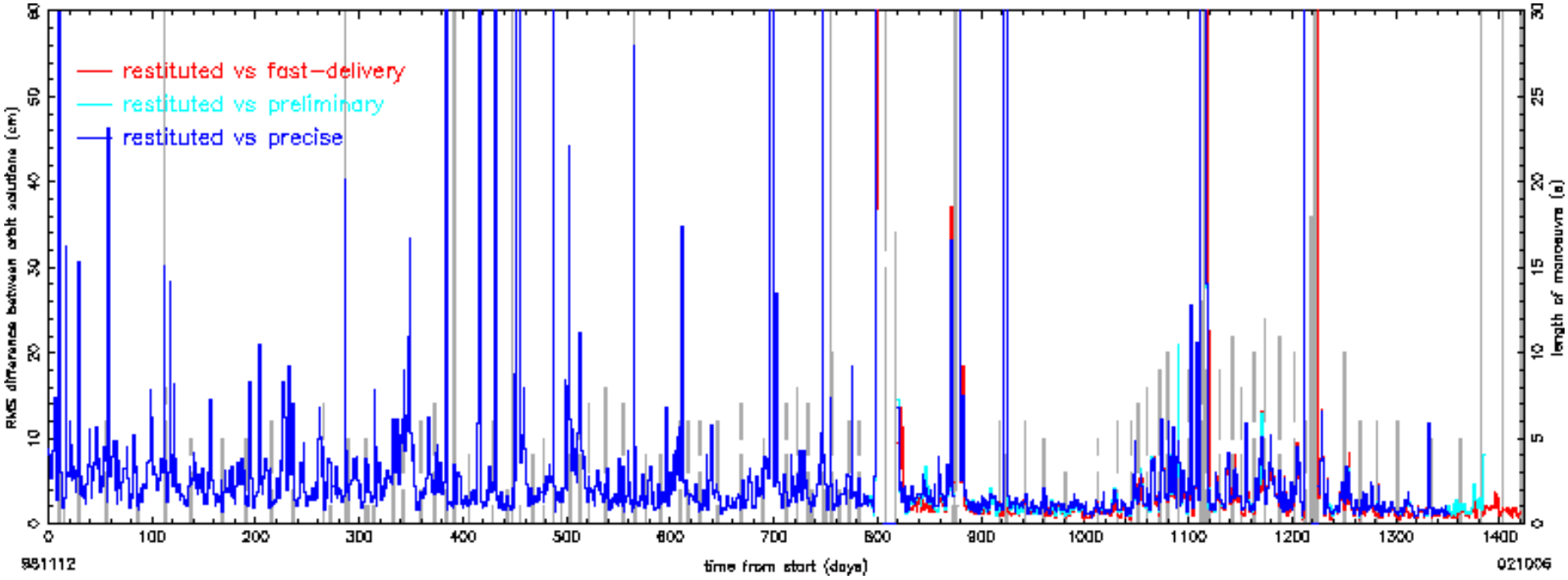
- Successor of ERS-1, with improved payload:
  - PRARE fully redundant design
  - Global Ozone Monitoring Experiment
- PRARE still operational
- PRARE ground-segment degrades
- Delay in PRARE data delivery
- Precise orbits (4–5 cm radial) achieved with SLR and altimeter tracking data
- SAR interferometry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

ERS-2 at ESTEC

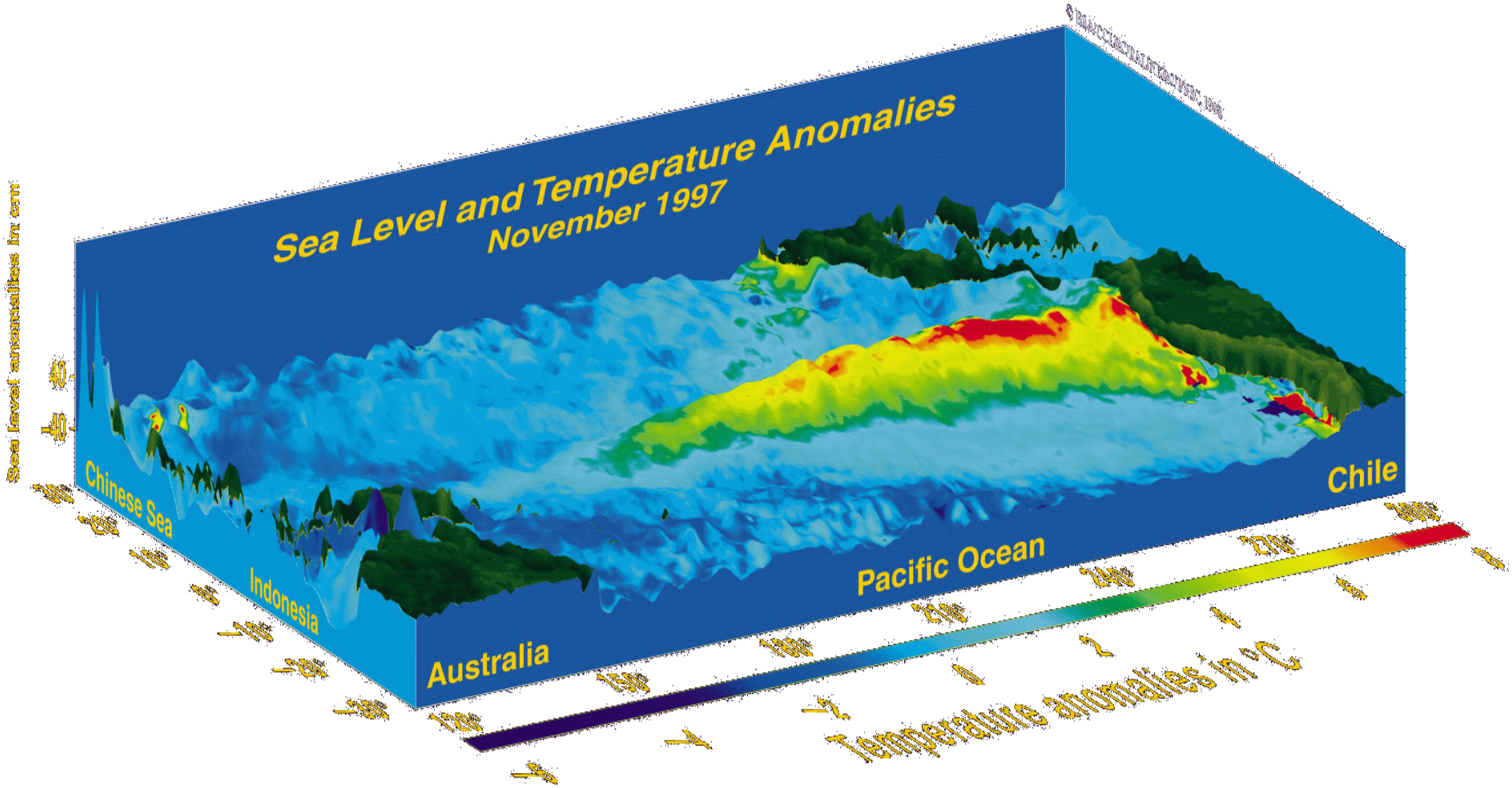
PRARE Network at Largest Extent (1998)

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

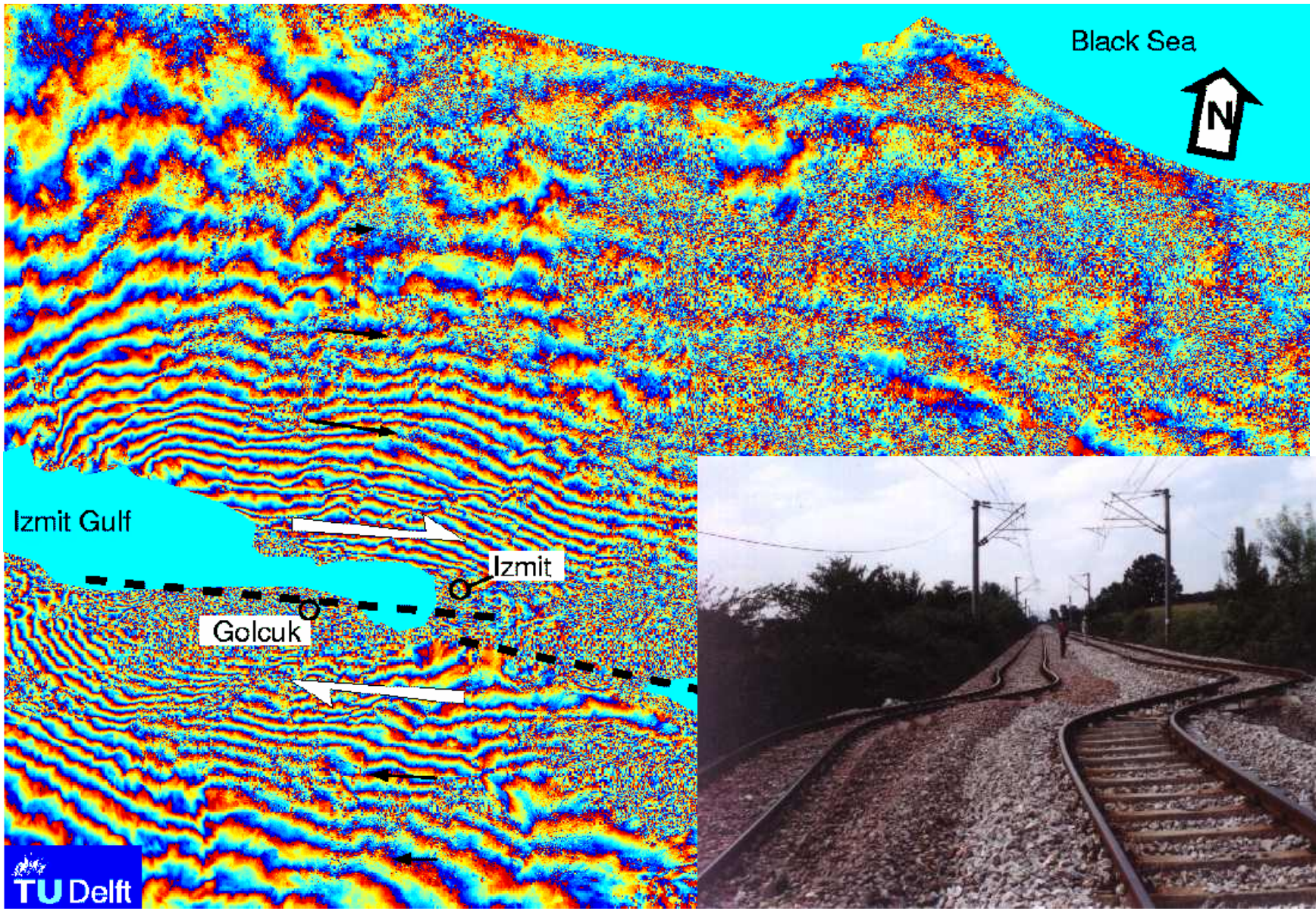


El Niño 1997-1998 Event

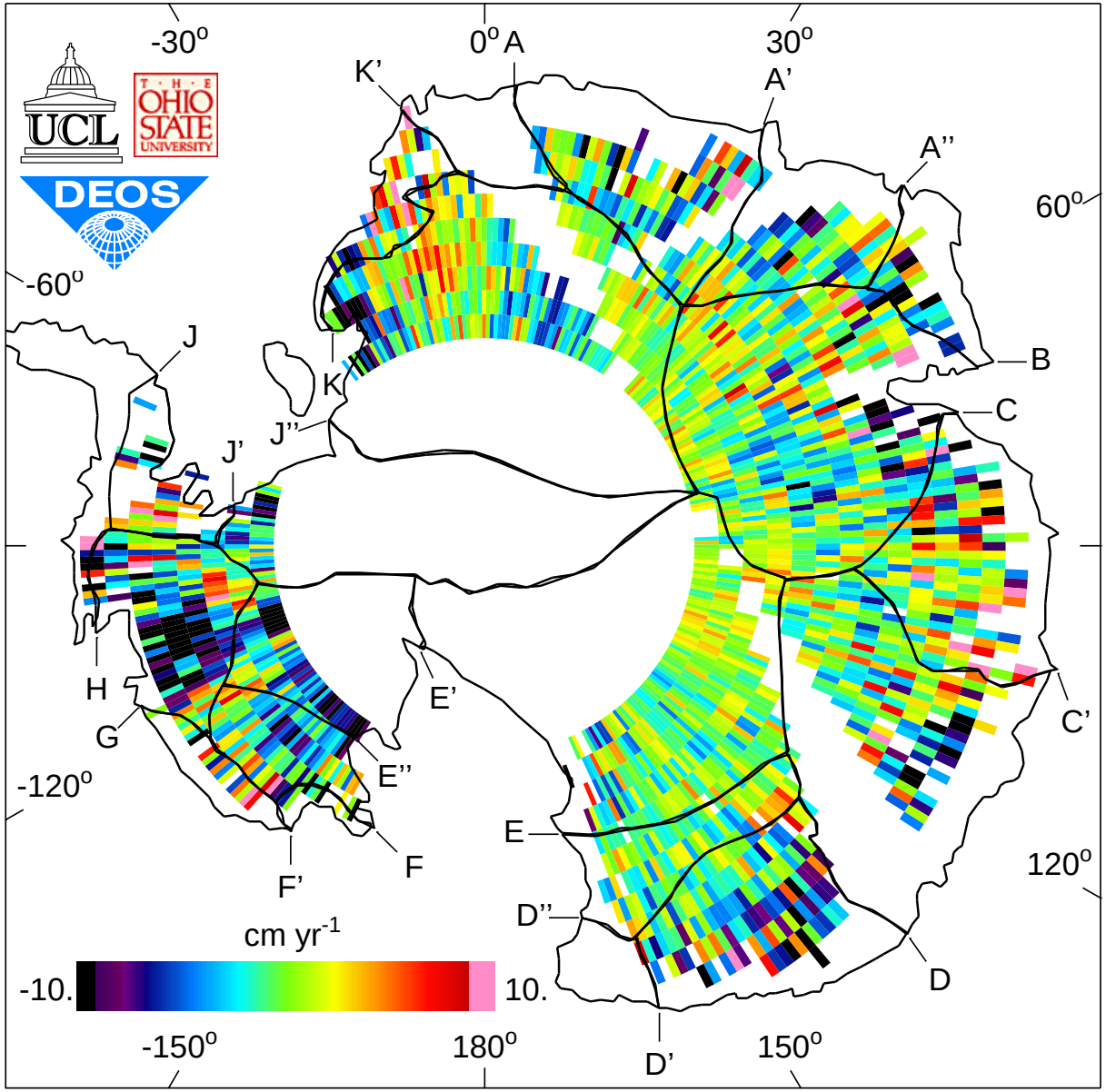


- Vertical scale: sea height anomaly with respect to long-term mean
- Colour: temperature anomaly with respect to long-term mean

Izmit (Turkey) Earthquake, 17 Aug 1999

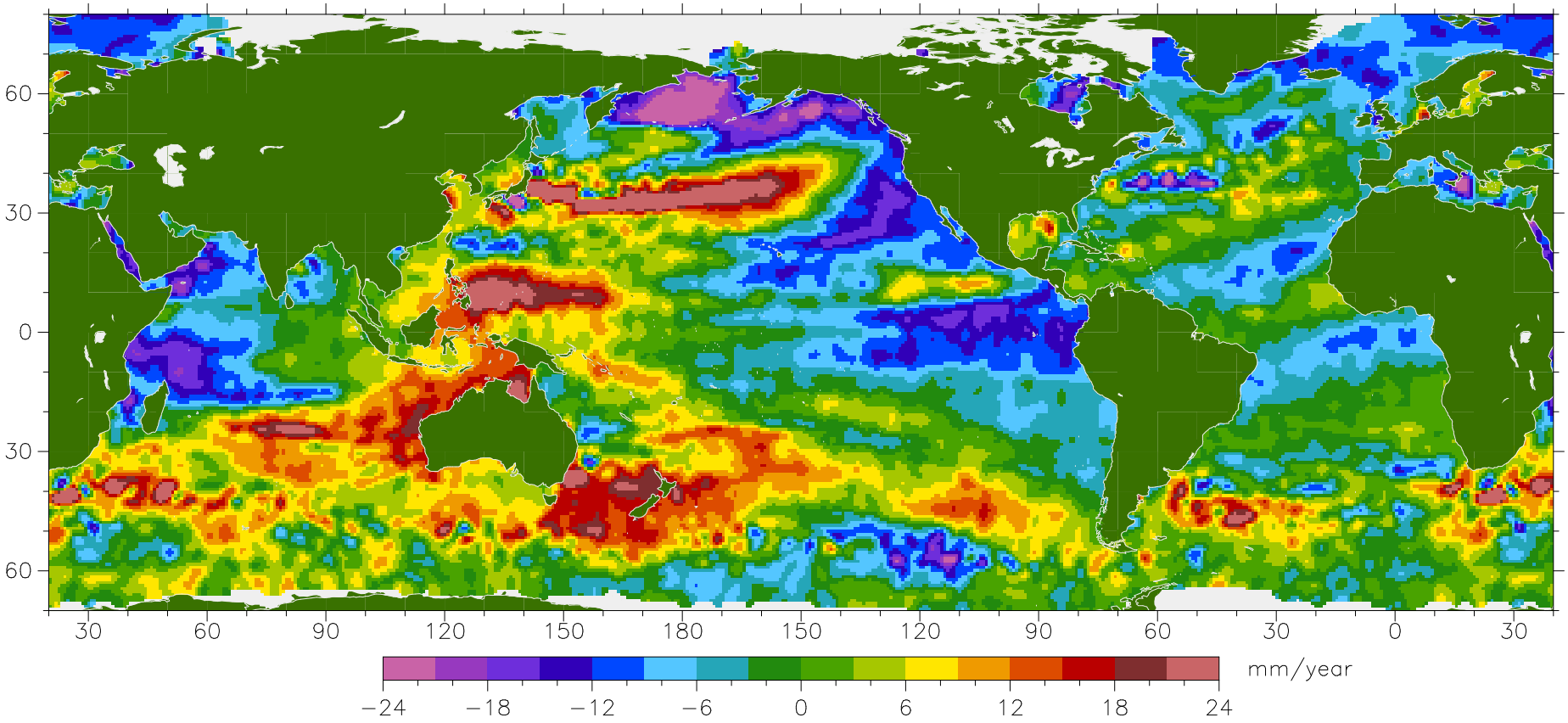


Antarctic Elevation Change 1992-1996



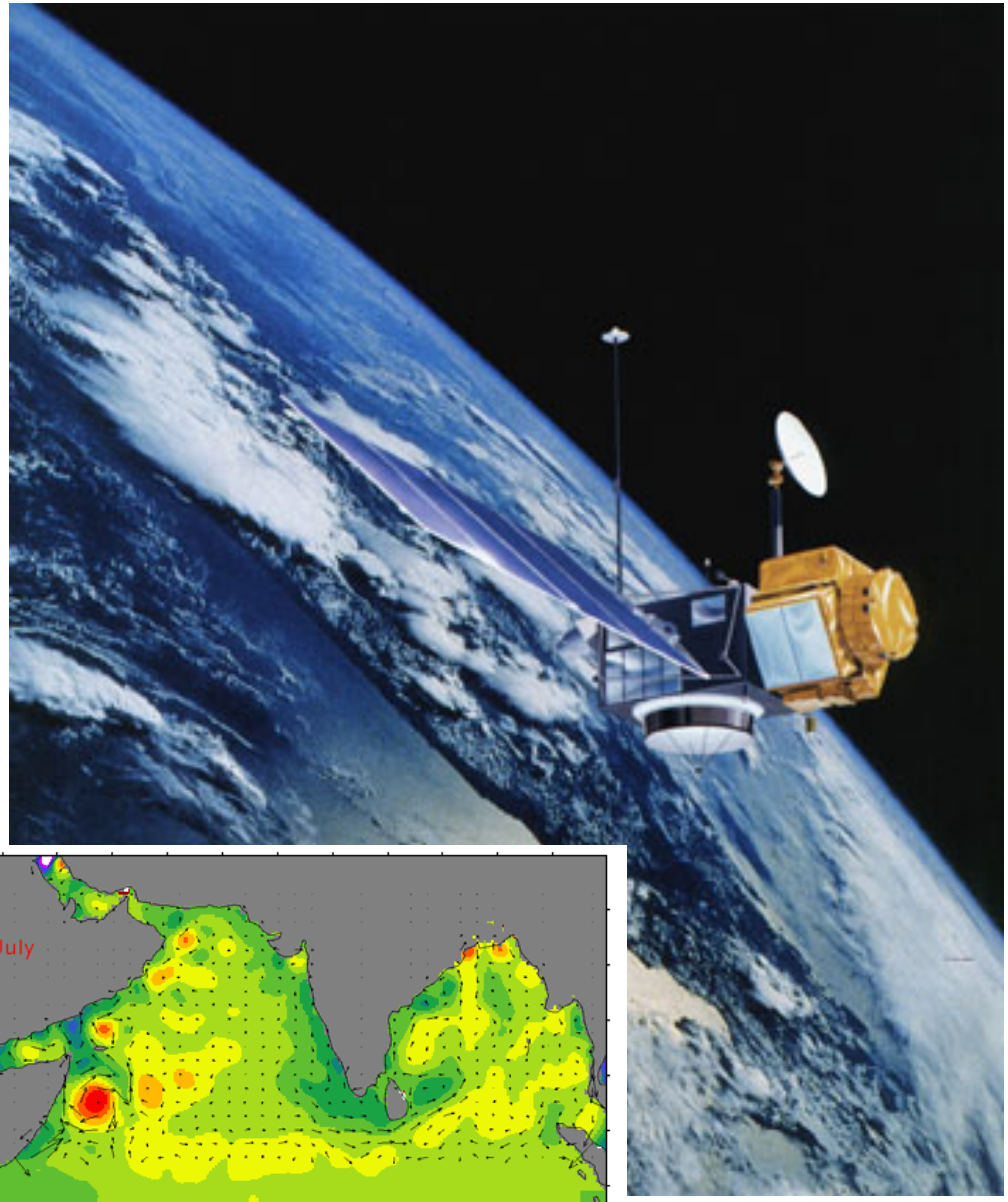
Sea level change (May 1995 - June 2002)

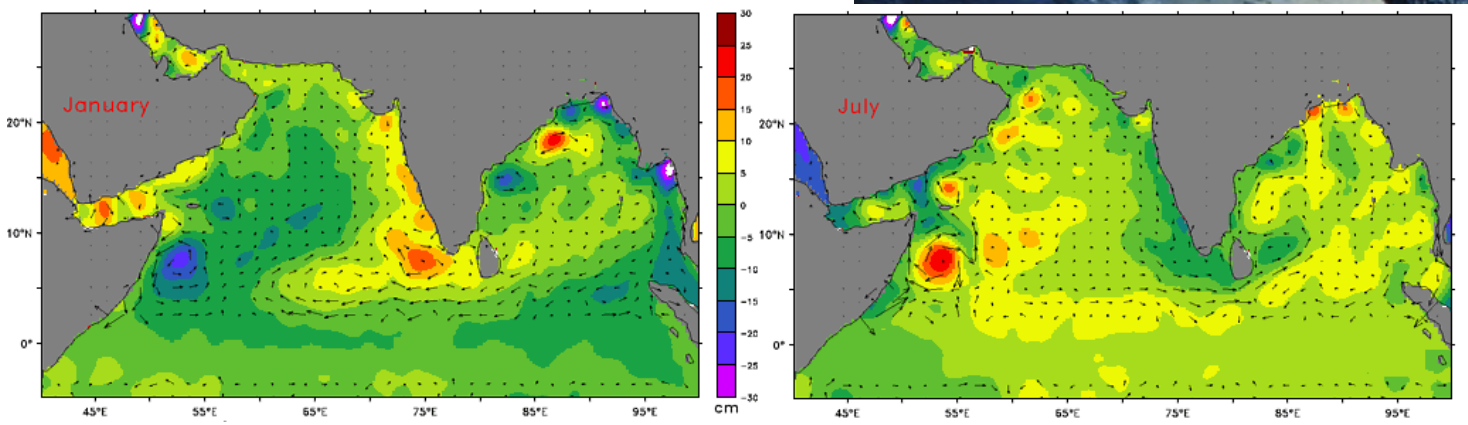
- Results from different satellites are similar
- Results from different time periods are dissimilar



TOPEX/Poseidon: 10 Aug 1992 - present

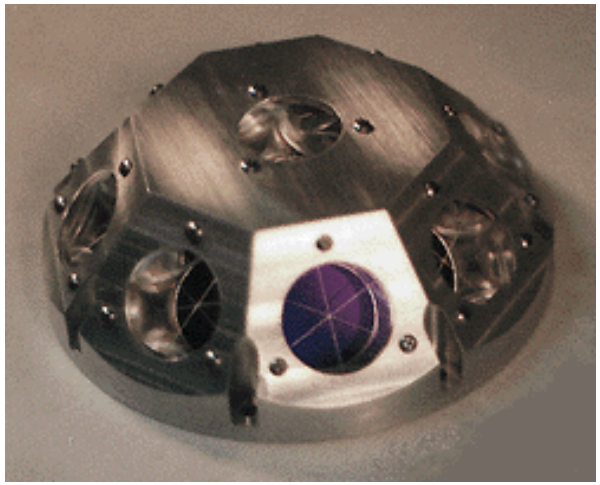
- Dedicated high-precision altimeter satellite
- Dual-frequency altimeter for ionosphere measurement)
- Orbit determination by GPS, DORIS and SLR
- Inefficient LRR array
- Less dependent on SLR, yet receives most SLR tracking
- Radial orbit precision: 1-2 cm

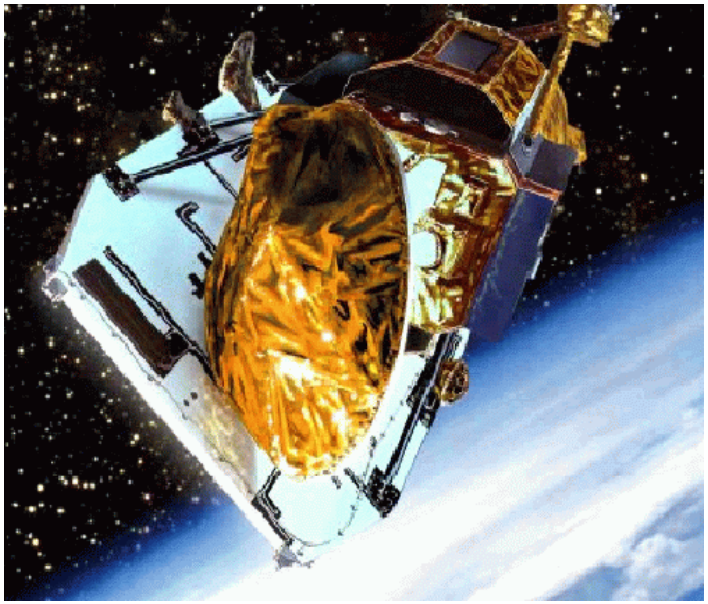




GFO (US Navy): 10 Feb 1998 - present

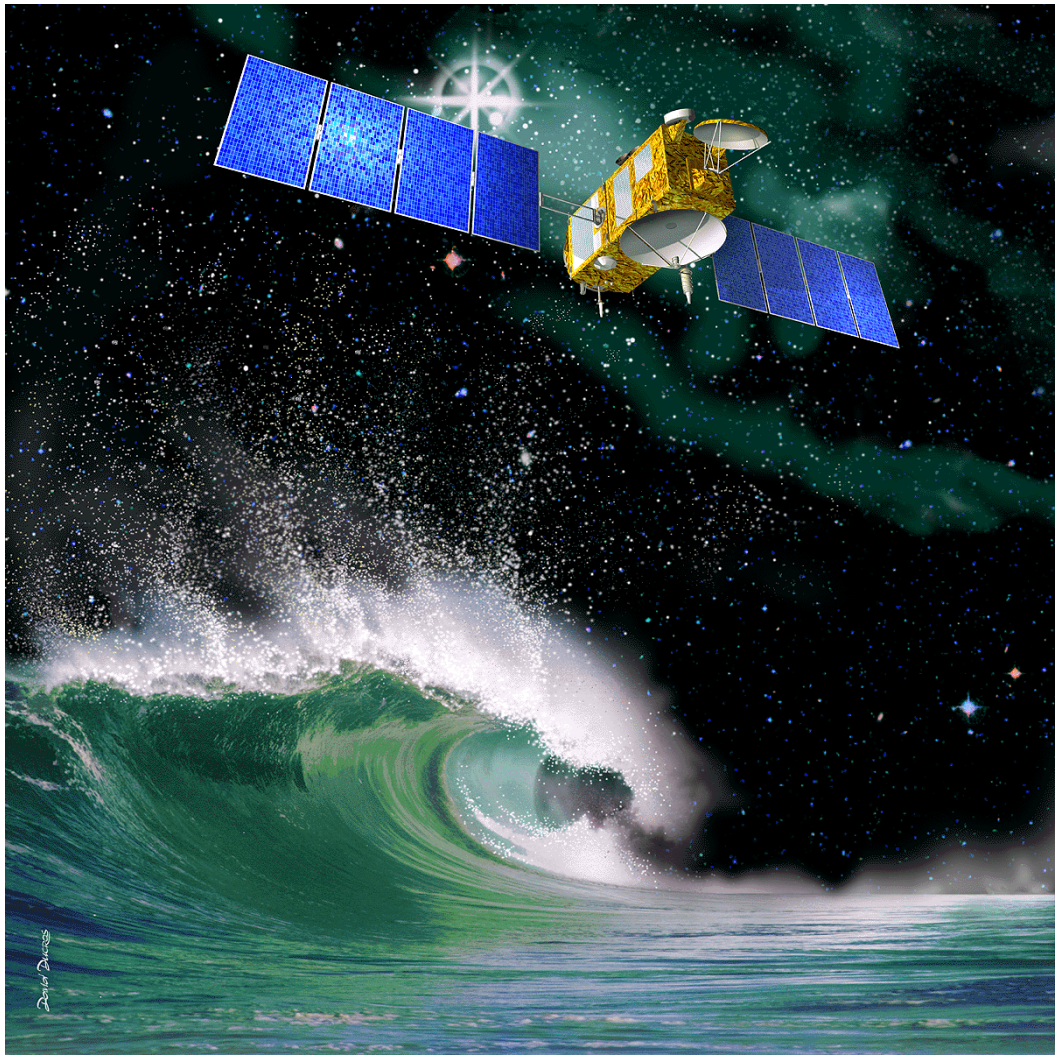
- During design, LRR array (identical to Jason-1) added at the eleventh hour
- Launched on 10 Feb 1998, but only *operational* since 29 Nov 2000
- None of the GPS receivers worked properly without interfering with the altimeter
- SLR community saved the science mission, though Navy operators appear satisfied with S-band tracking
- Precise orbit determination (after gravity field tuning) gives radial orbit error of about 5-7 cm



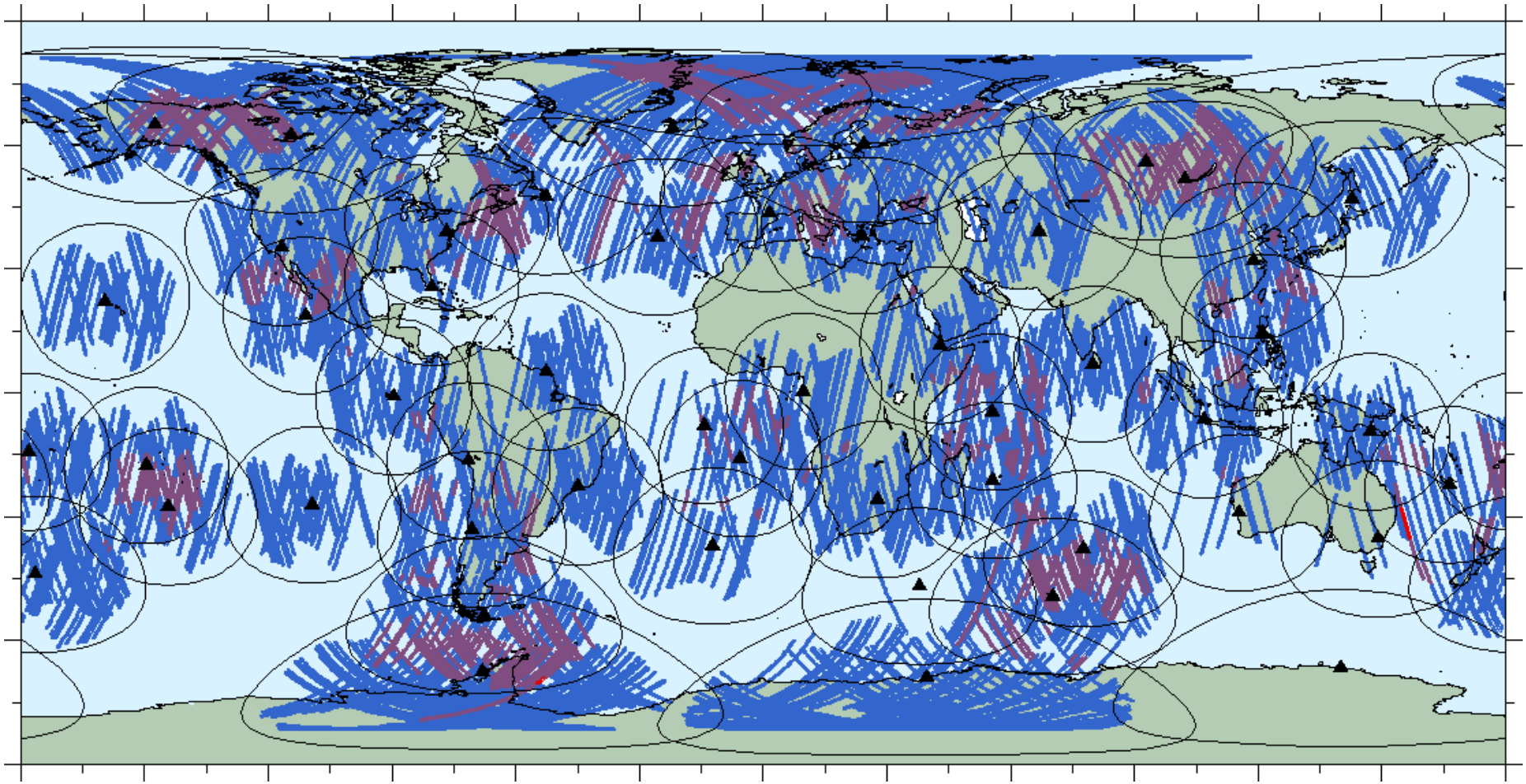


Jason-1 (NASA/CNES): 17 Dec 2001 - present

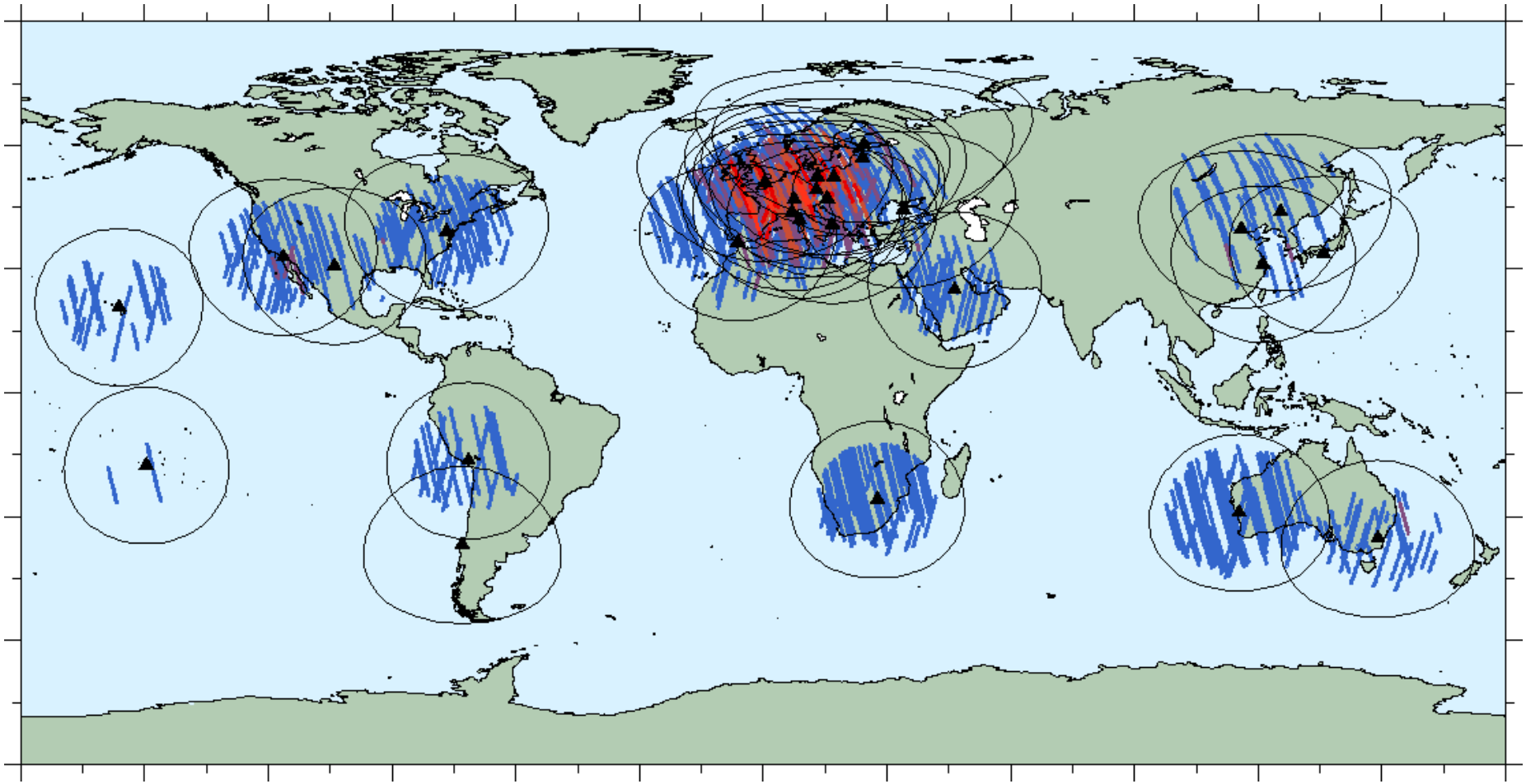
- Successor of TOPEX/Poseidon
- GPS, DORIS tracking systems and small LRR array
- DORIS tracking system seems to suffer from radiation
- Unusually high measurement residuals at Southern latitudes
- Does SLR need to save another altimeter mission?



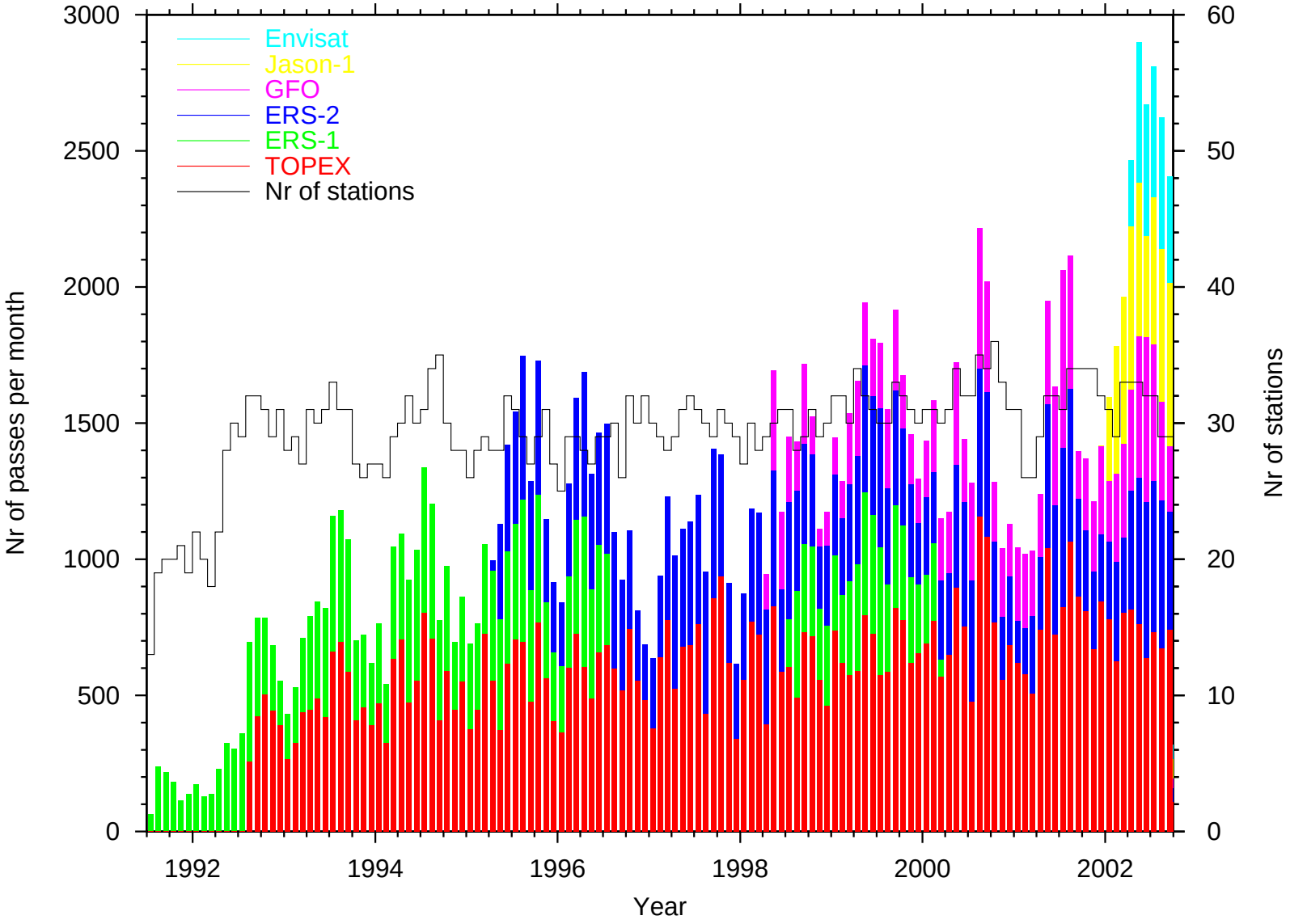
Envisat: DORIS Tracking (Cycle 7)



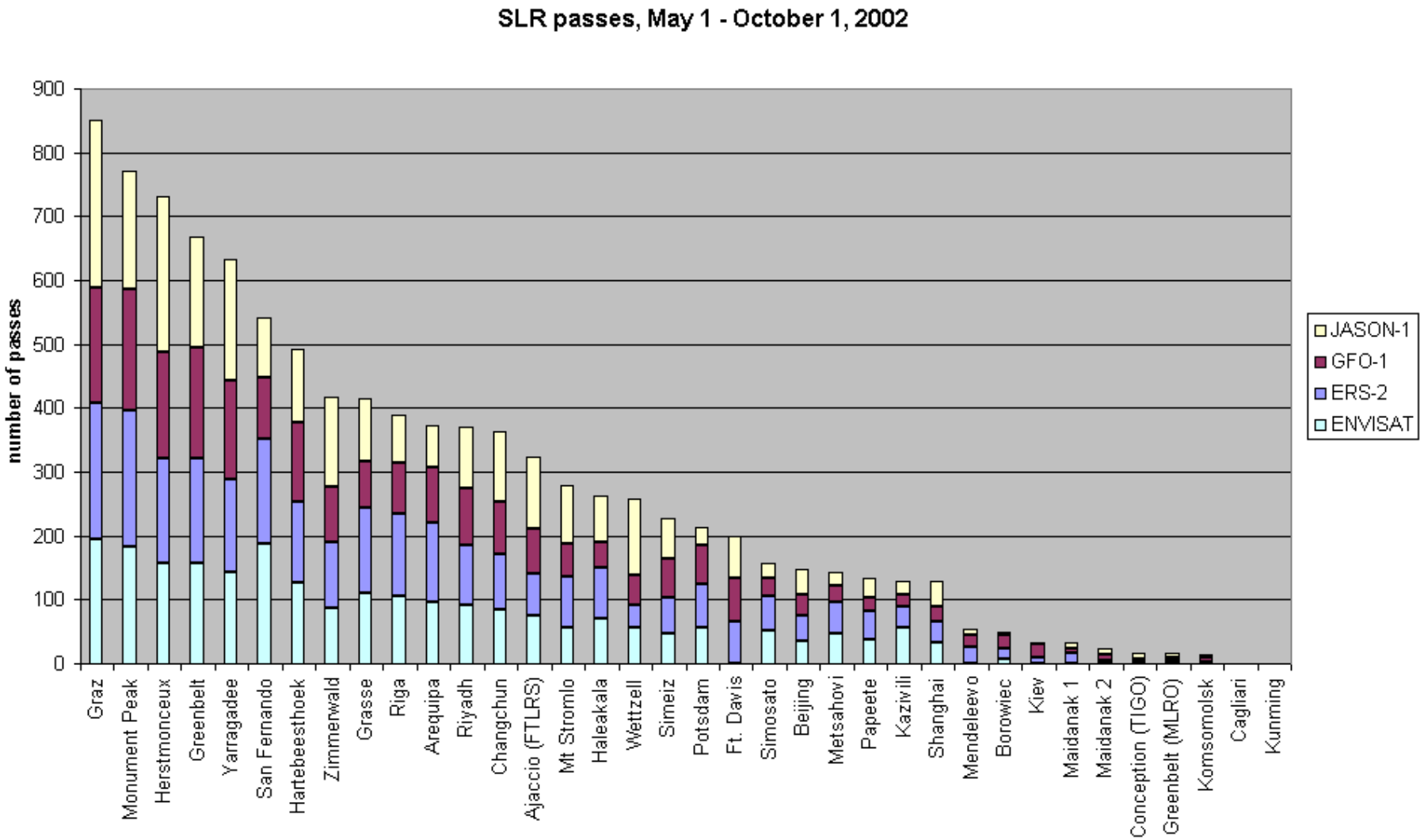
Envisat: SLR Tracking (Cycle 7)



Altimeter Satellite Tracking 1991-2002



Altimeter Satellite Tracking May-Sep 2002



Special Achievements (Jul 1991 - Oct 2002)

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)