

Sea level change from satellite altimetry and tide gauges in the Baltic Sea*

Josef Cherniawsky¹

Remko Scharoo²

Oleg Nikitin³

Evgueni Kulikov⁴

¹Institute of Ocean Sciences, Fisheries and Oceans Canada

²Alimetrics LLC, Washington, DC, USA

³State Oceanographic Institute, Moscow, Russia

⁴Shirshov Institute of Oceanology, Moscow, Russia

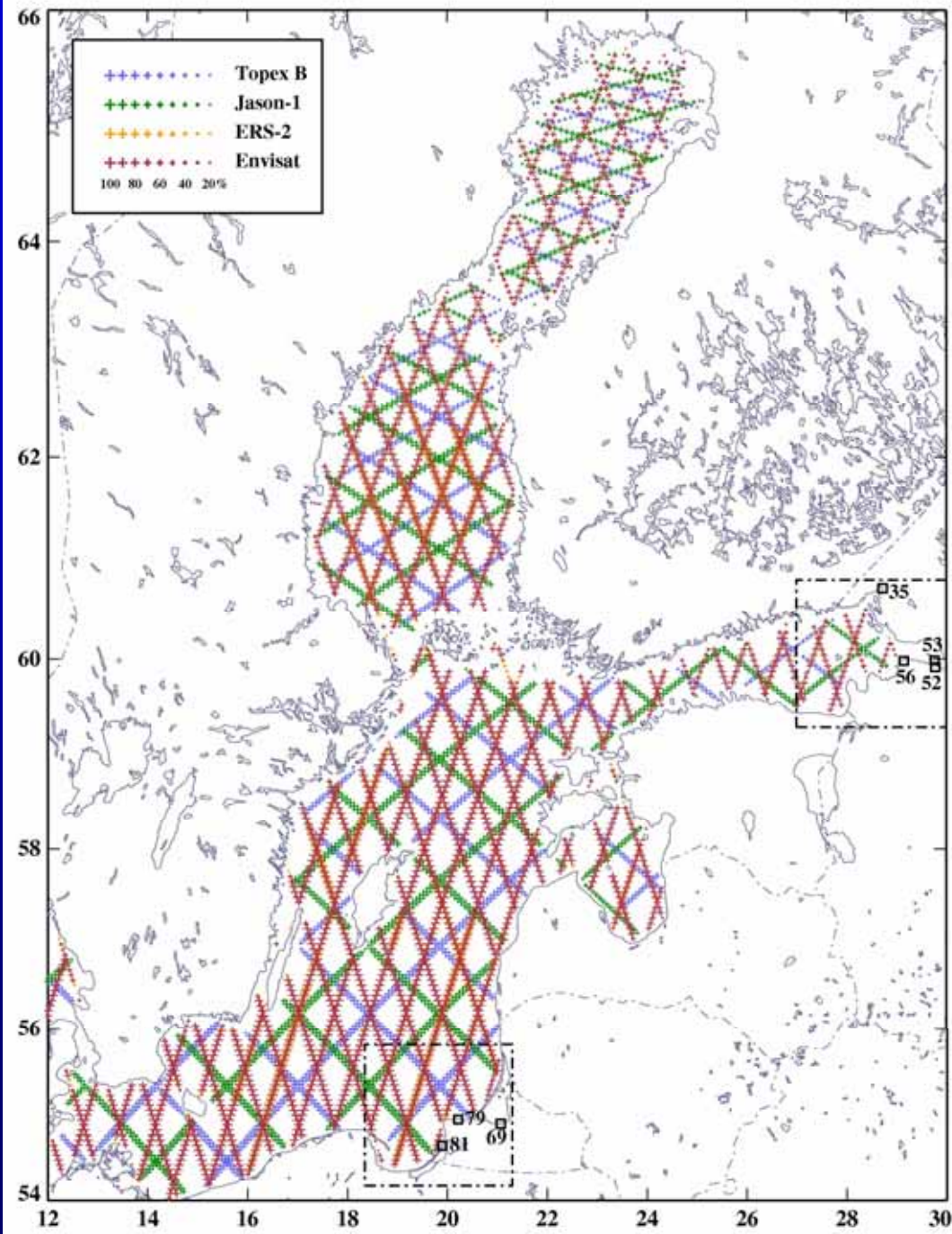
*This research is carried out as part of the NATO Science for Peace project
“Flood Risk Analysis for the Gulf of Finland and St. Petersburg”

Altimeter	Phase	Time	Cycles	Passes	Records
GEOSAT	A	31 Mar 1985 - 30 Sep 1986	001 - 025		
	B	08 Nov 1986 - 30 Dec 1989	026 - 093		
	D	31 Mar 1985 - 01 Oct 1986	001 - 025	61153	104397577
ERS-1	A	01 Aug 1991 - 14 Dec 1991	001 - 046		
	B	14 Dec 1991 - 25 Mar 1992	047 - 081		
	C	14 Apr 1992 - 20 Dec 1993	083 - 101		
	D	24 Dec 1993 - 10 Apr 1994	103 - 138		
	E	10 Apr 1994 - 28 Sep 1994	139 - 140		
	F	28 Sep 1994 - 21 Mar 1995	141 - 143		
	G	24 Mar 1995 - 02 Jun 1996	144 - 156	47806	83291704
TOPEX	A	25 Sep 1992 - 11 Aug 2002	001 - 364		
	B	20 Sep 2002 - 08 Oct 2005	369 - 481		
	N	11 Aug 2002 - 20 Sep 2002	365 - 368	111960	264208514
POSEIDON	A	01 Oct 1992 - 12 Jul 2002	001 - 361	7472	15718917
ERS-2	A	29 Apr 1995 - 30 Mar 2008	000 - 135	120772	157782887
GFO-1	A	07 Jan 2000 - 12 Apr 2008	037 - 213	78435	146106159
JASON-1	A	15 Jan 2002 - 07 May 2008	001 - 233	57876	124449980
ENVISAT1	B	24 Sep 2002 - 08 May 2008	009 - 068	55537	144645209
Total				541011	1040600947

RADS data availability on May 11, 2008

<http://rads.tudelft.nl/rads/status.shtml>

(using IOS mirror site)



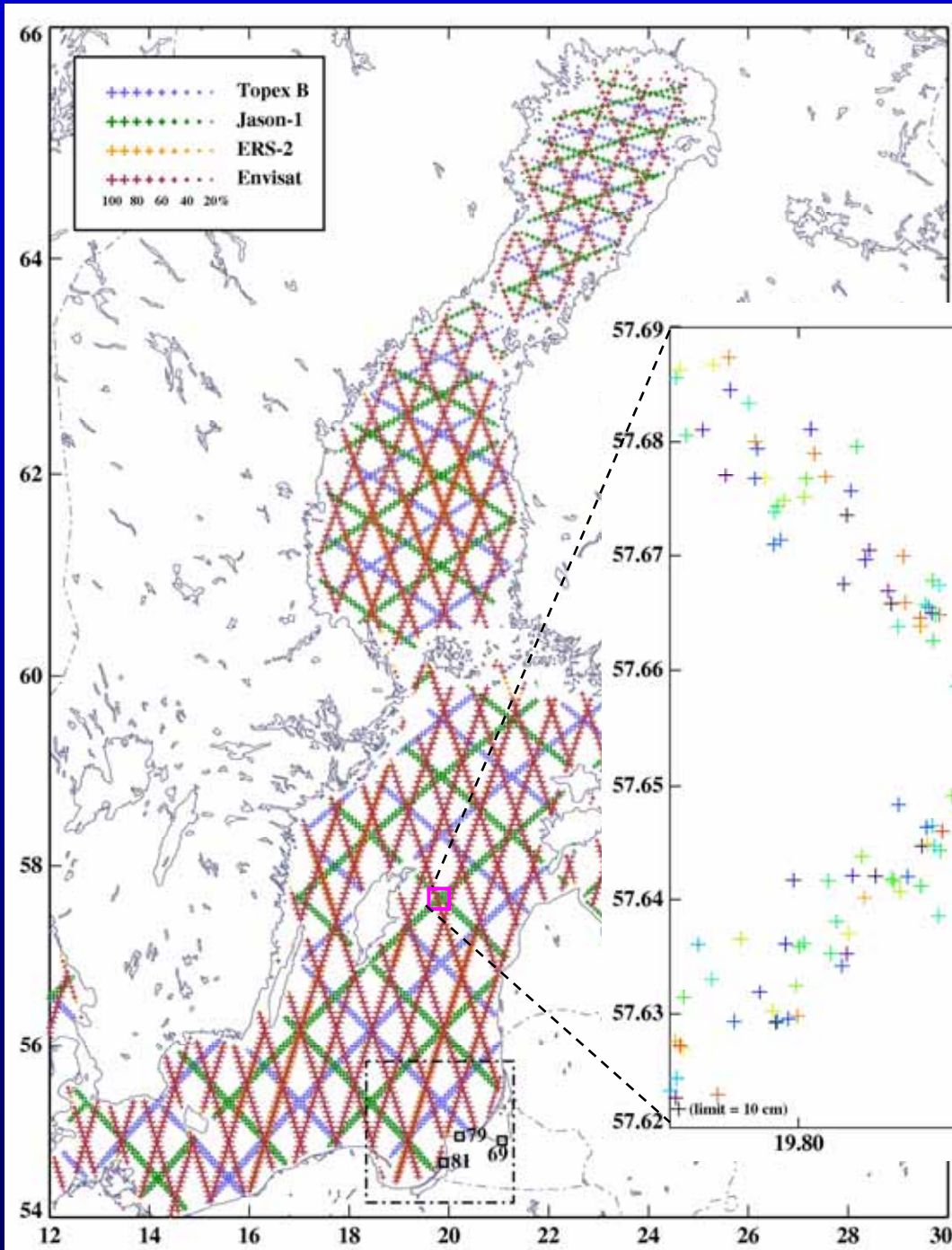
Data coverage (%)

Topex-B

Jason-1

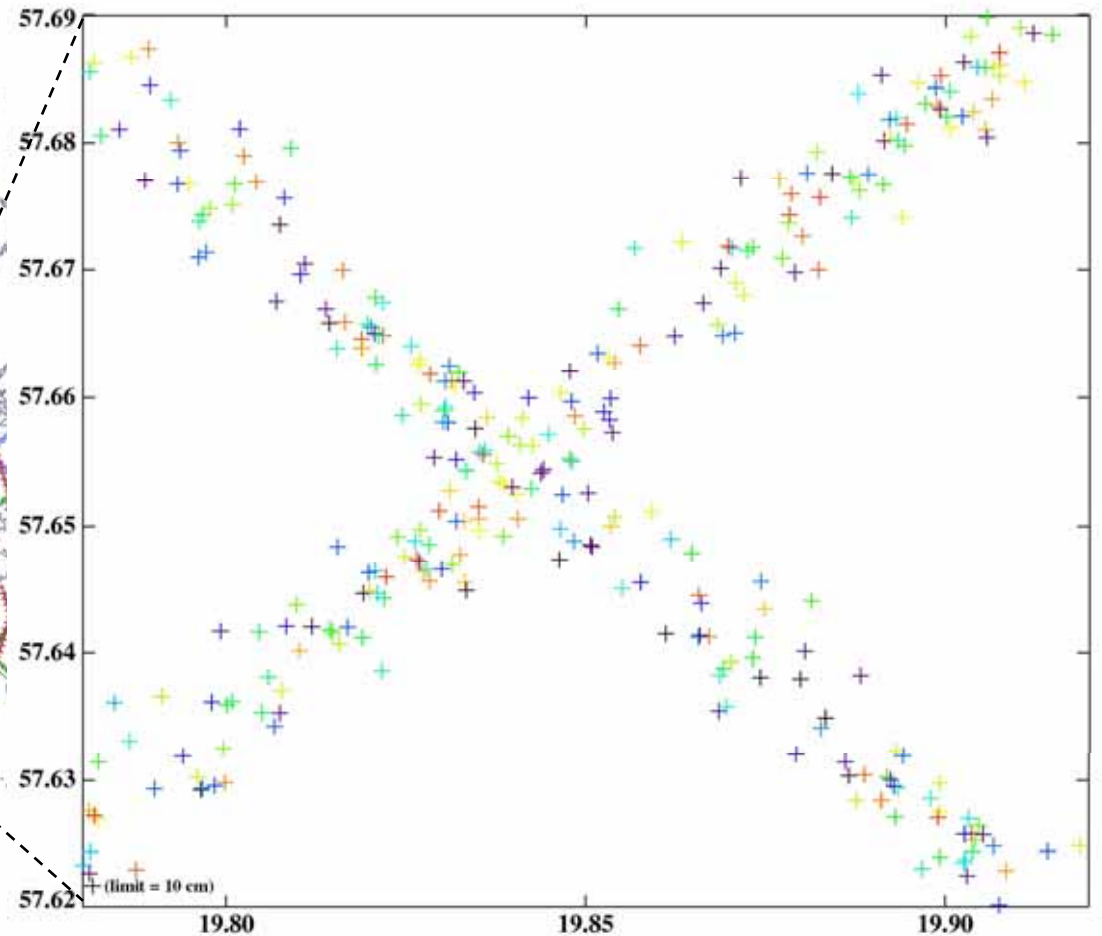
ERS-2

Envisat-1



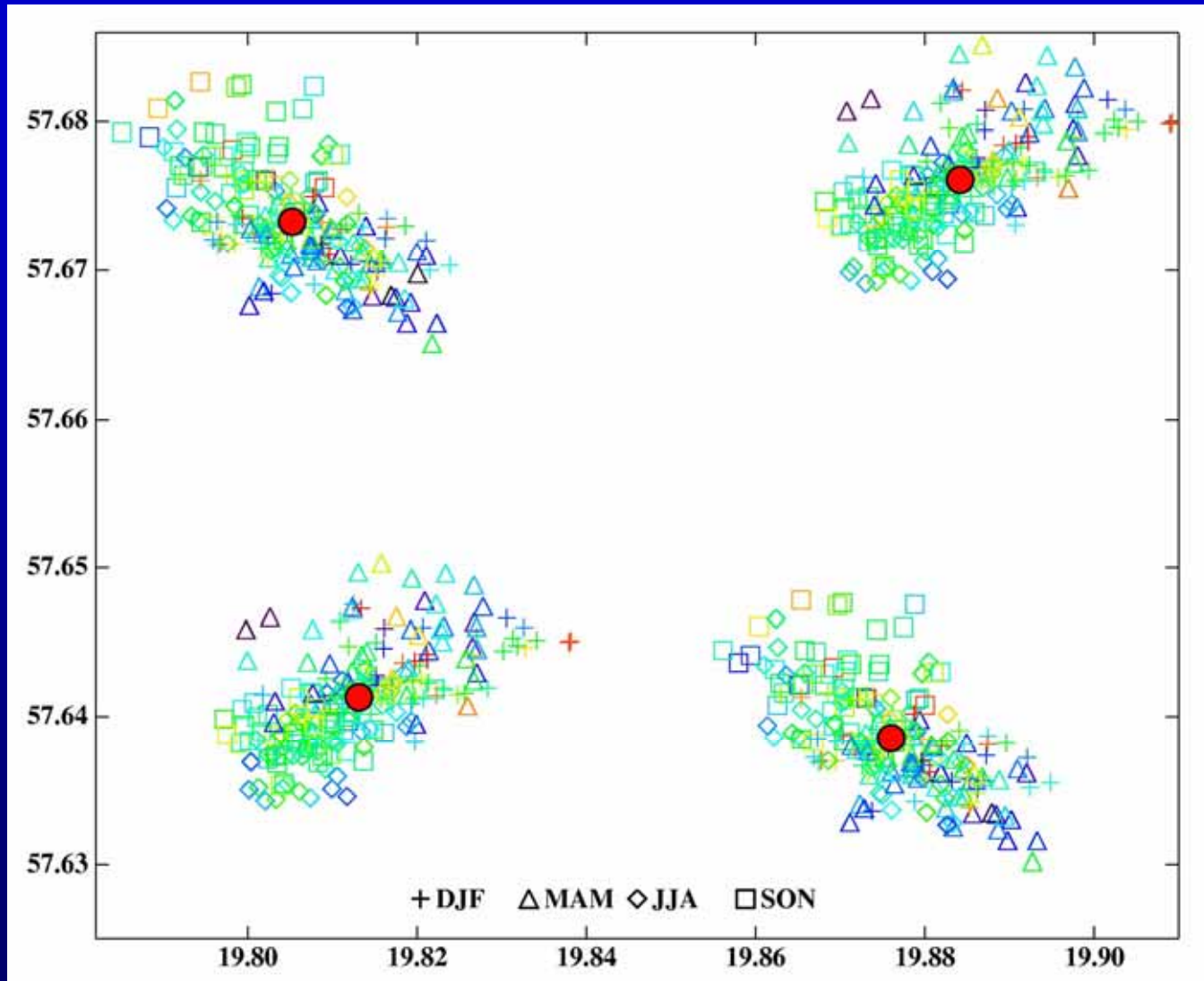
RADS data are not collocated

example of a Jason-1 crossover
east of Gotland Island

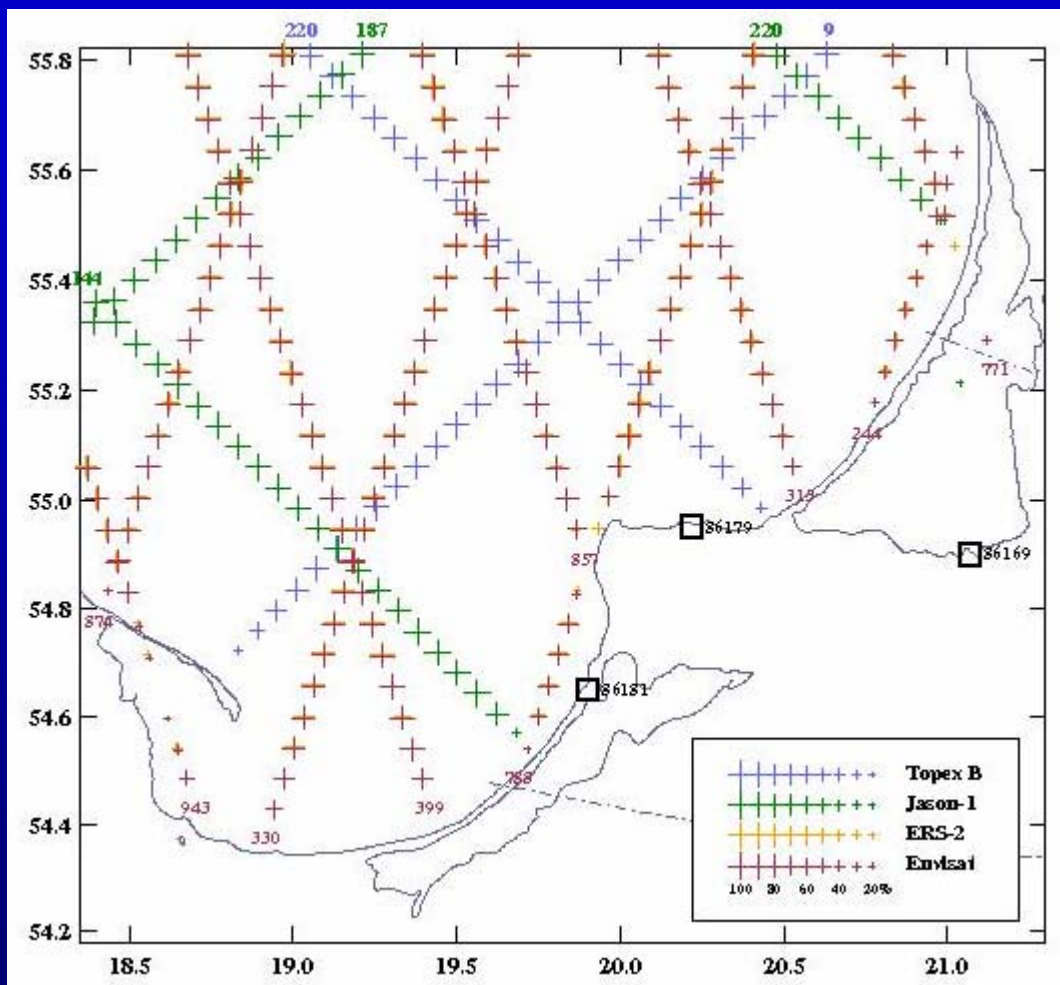


only values < 10 cm are shown

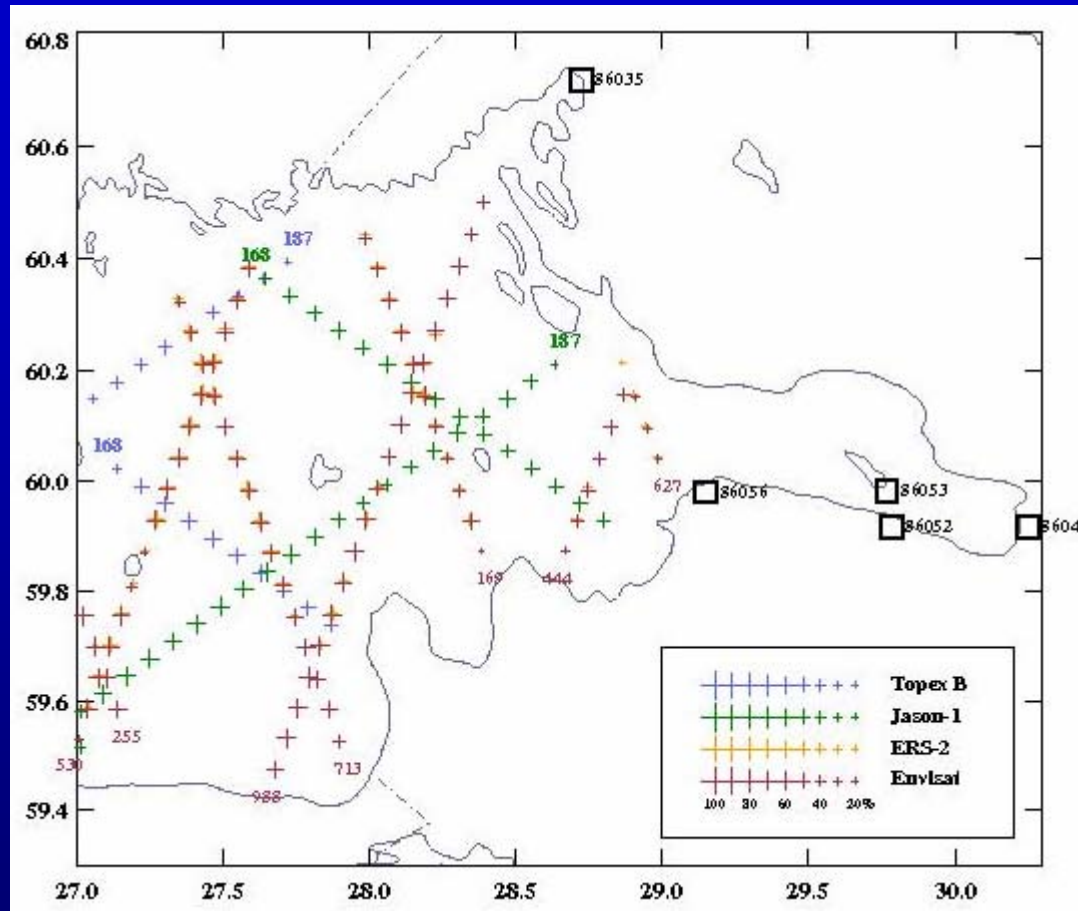
An ad-hoc “1-sec collocation” scheme near Jason-1 track crossover east of Gotland Island



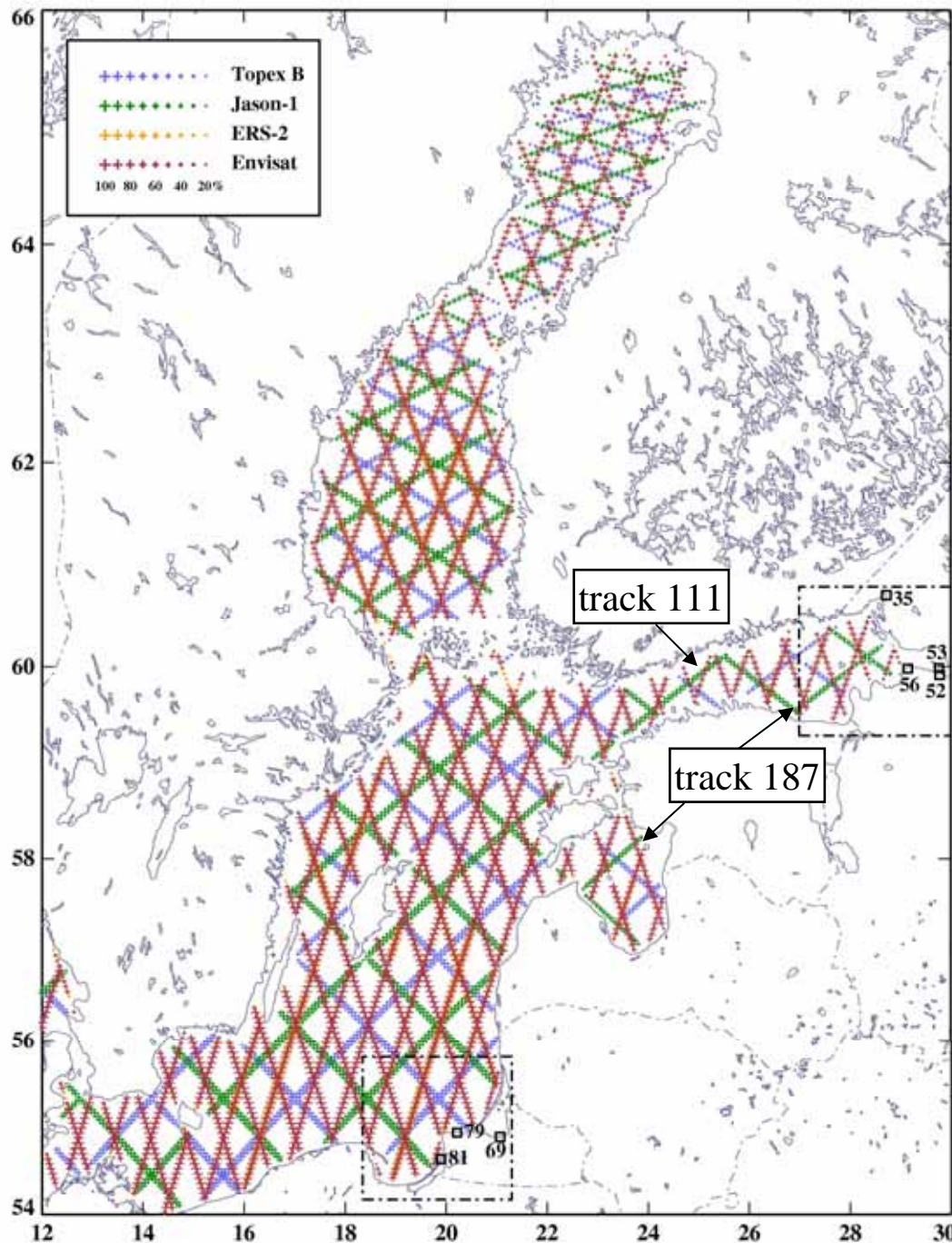
Collocated tracks and Russian tide gauge stations in Kaliningrad area



Collocated tracks and Russian tide gauge stations in eastern Gulf of Finland and near Gulf of Neva

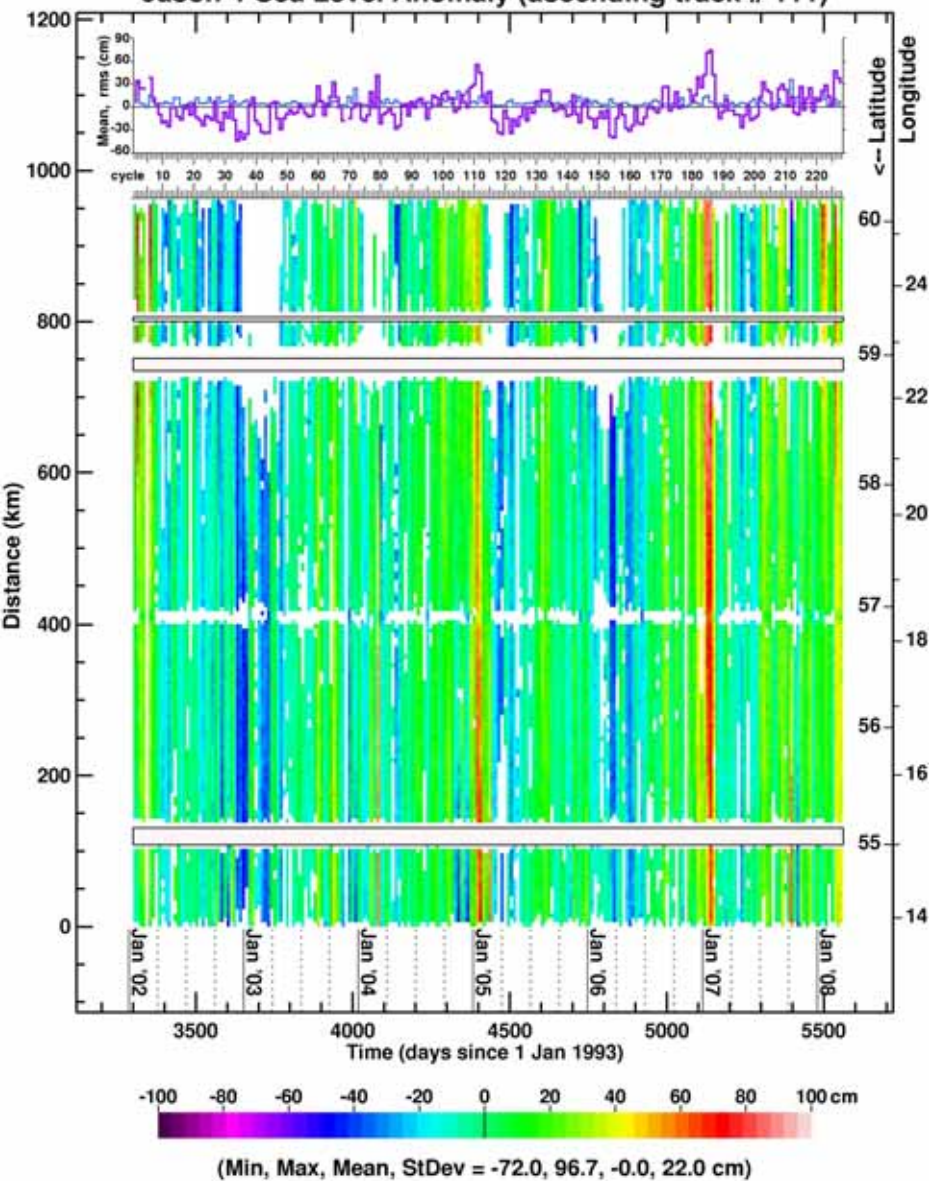


What about
storm surges?

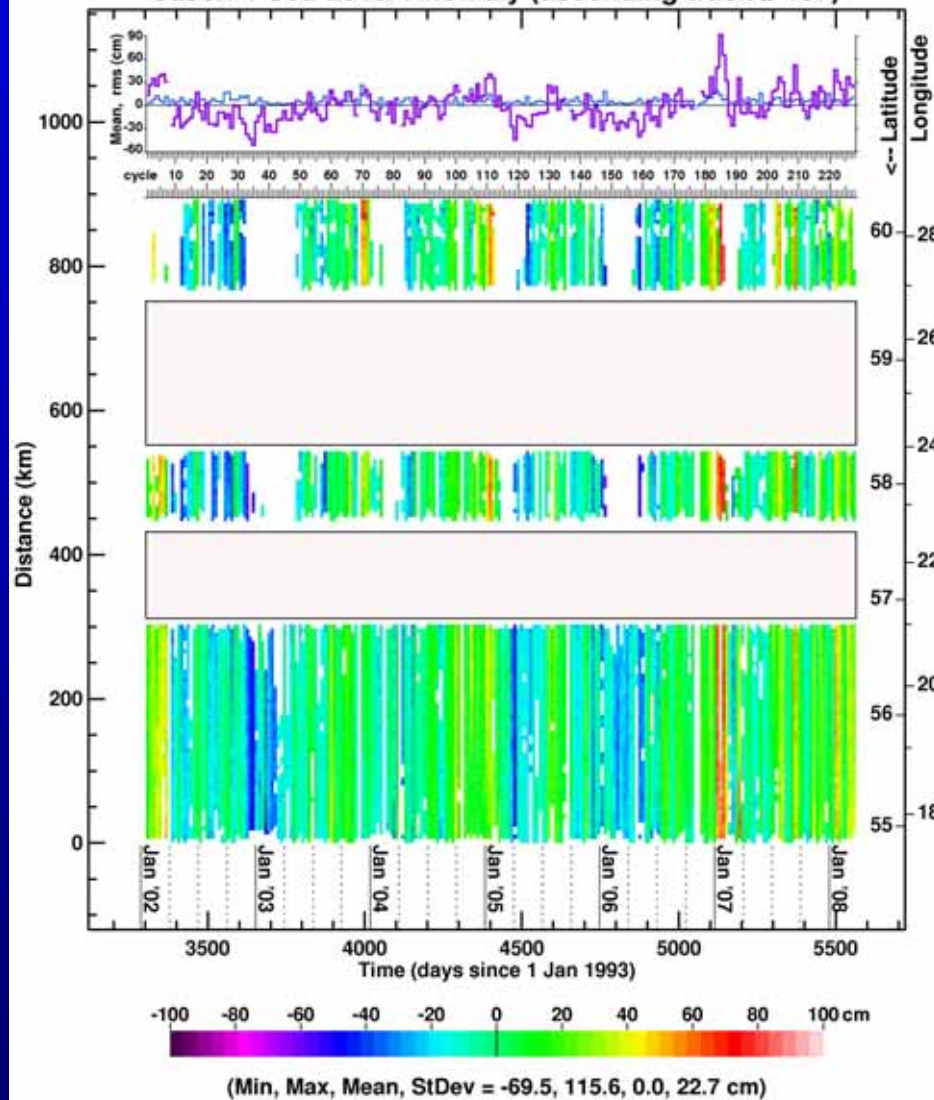


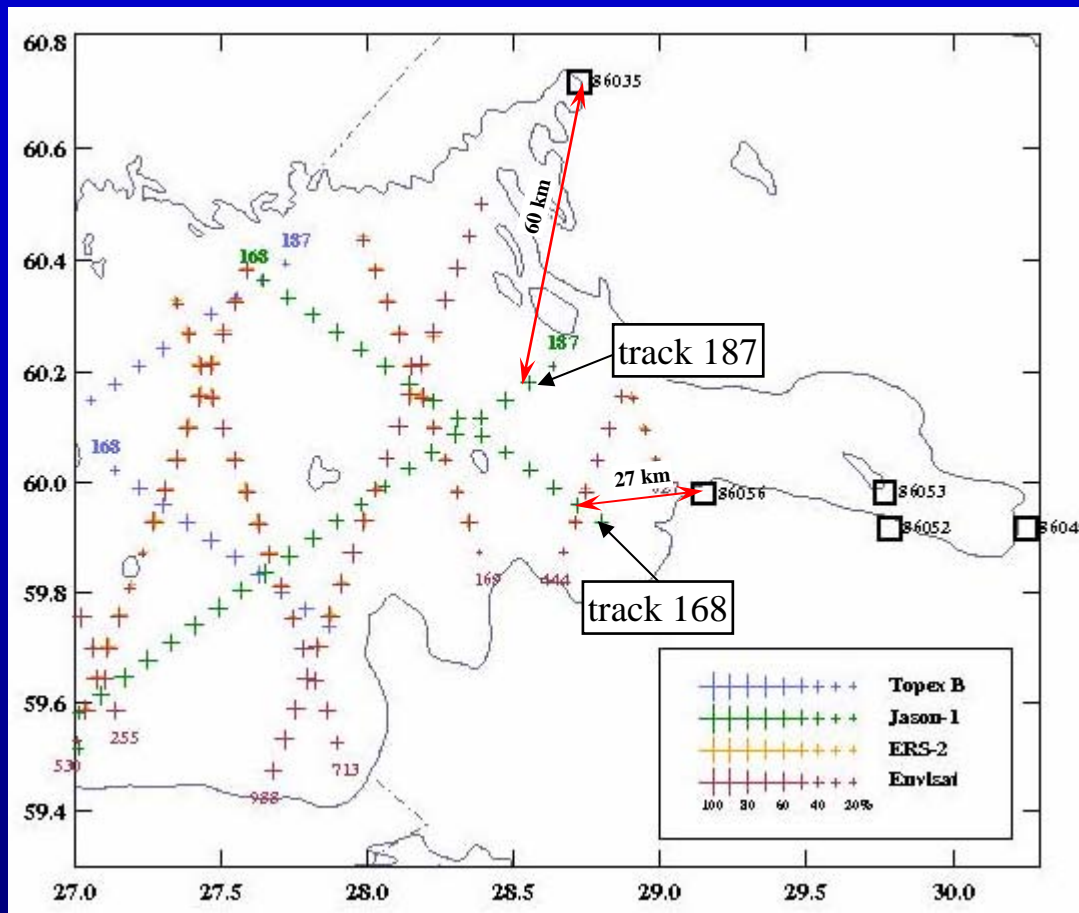
6 years of
Jason-1 anomalies
along tracks
111 and 187
(next slide)

Jason-1 Sea Level Anomaly (ascending track # 111)



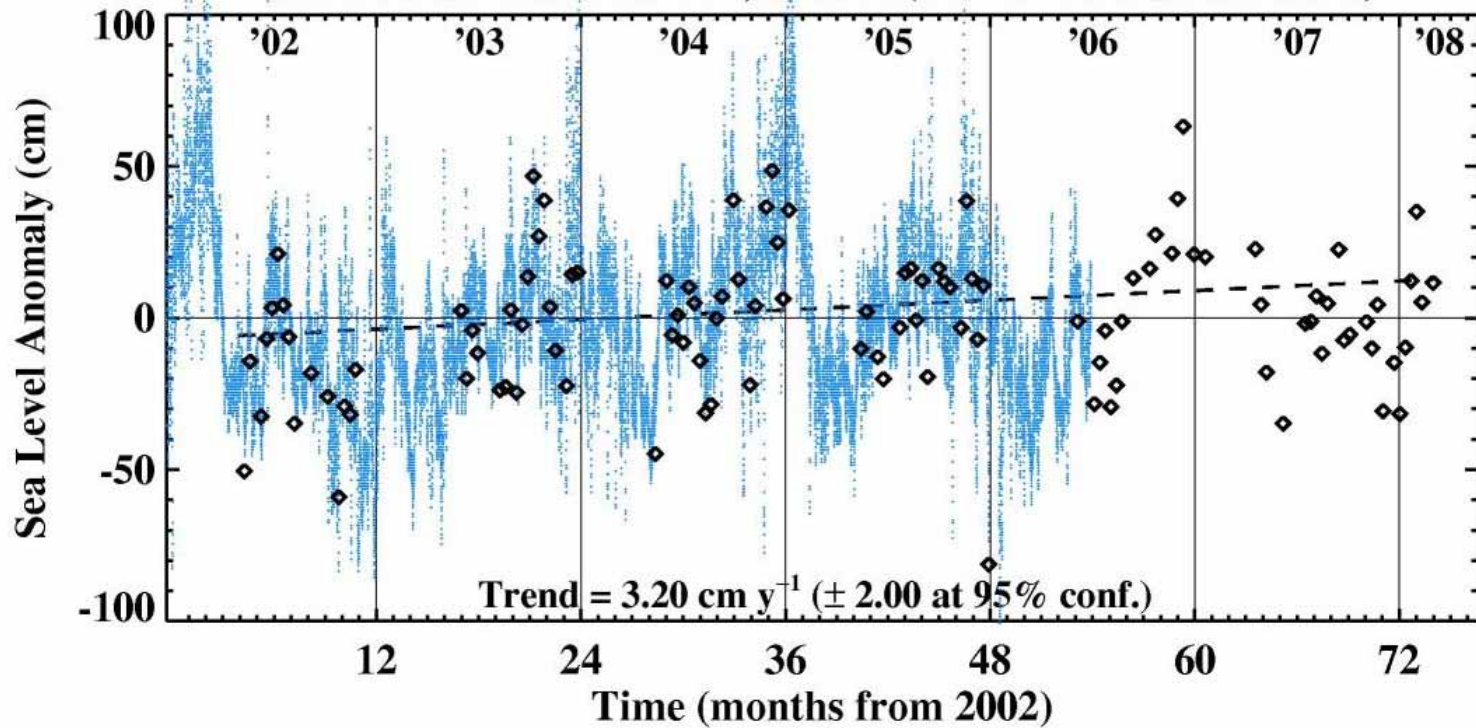
Jason-1 Sea Level Anomaly (ascending track # 187)



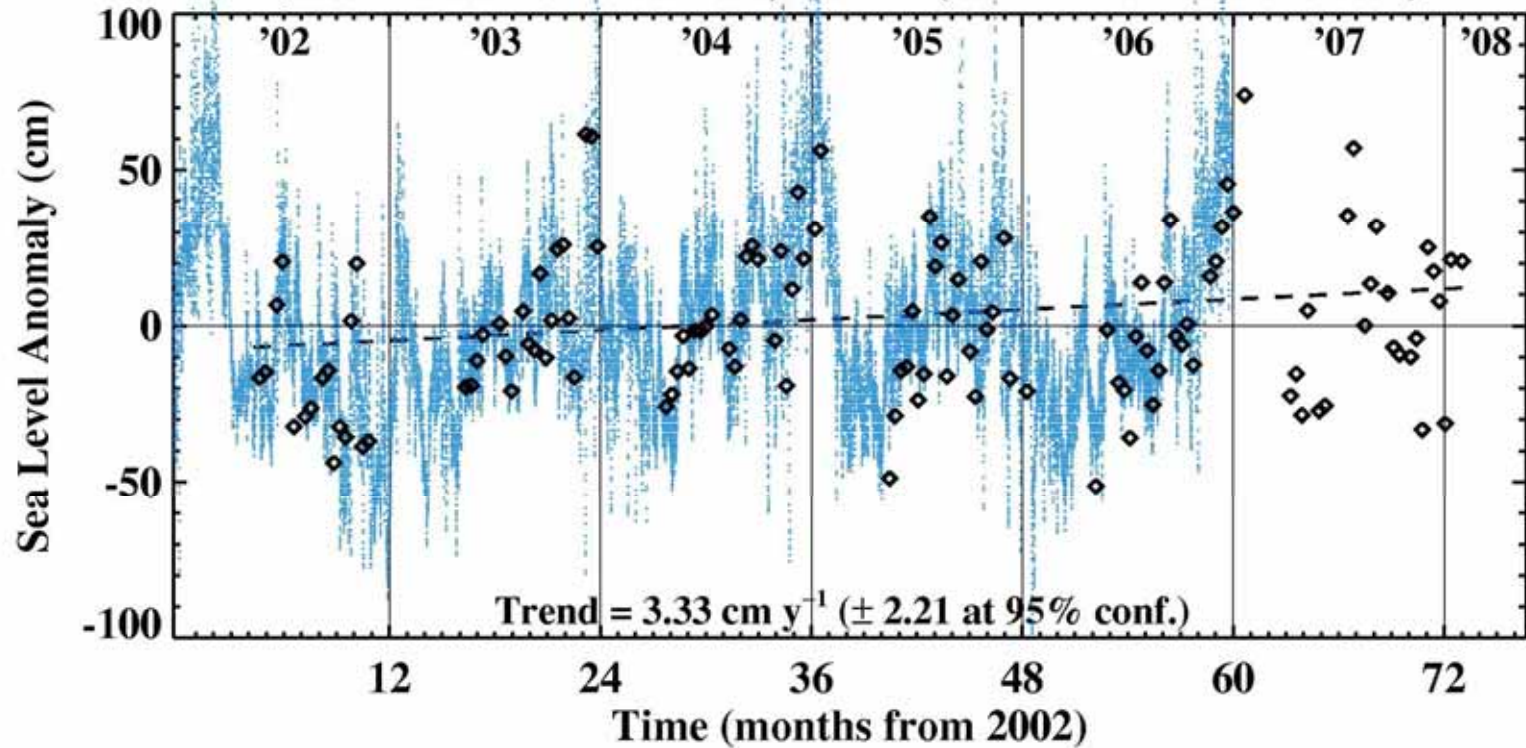


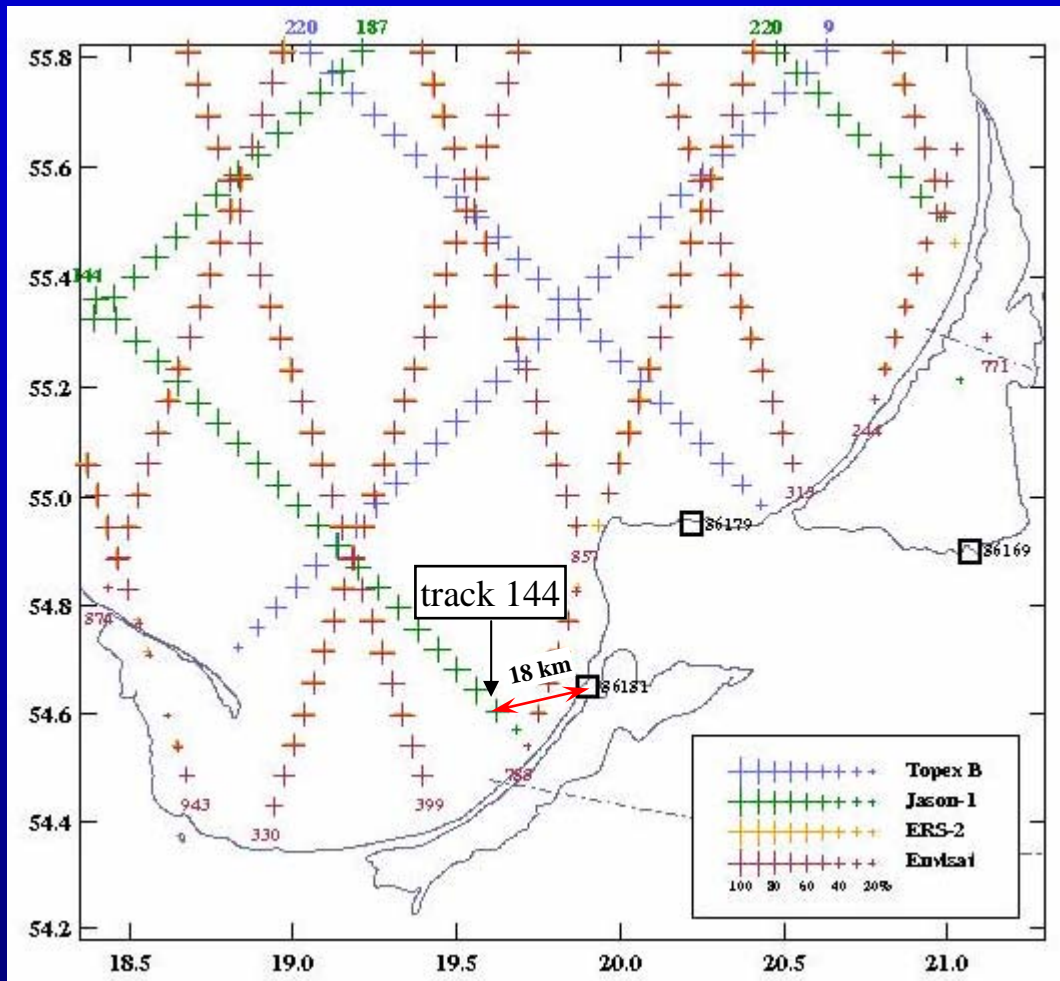
6-year time series at Jason-1 locations near 2 EGF coastal stations
(next 2 slides)

Jason-1 track 168 at 59.929N, 28.800E (27.0 km from station 86056)



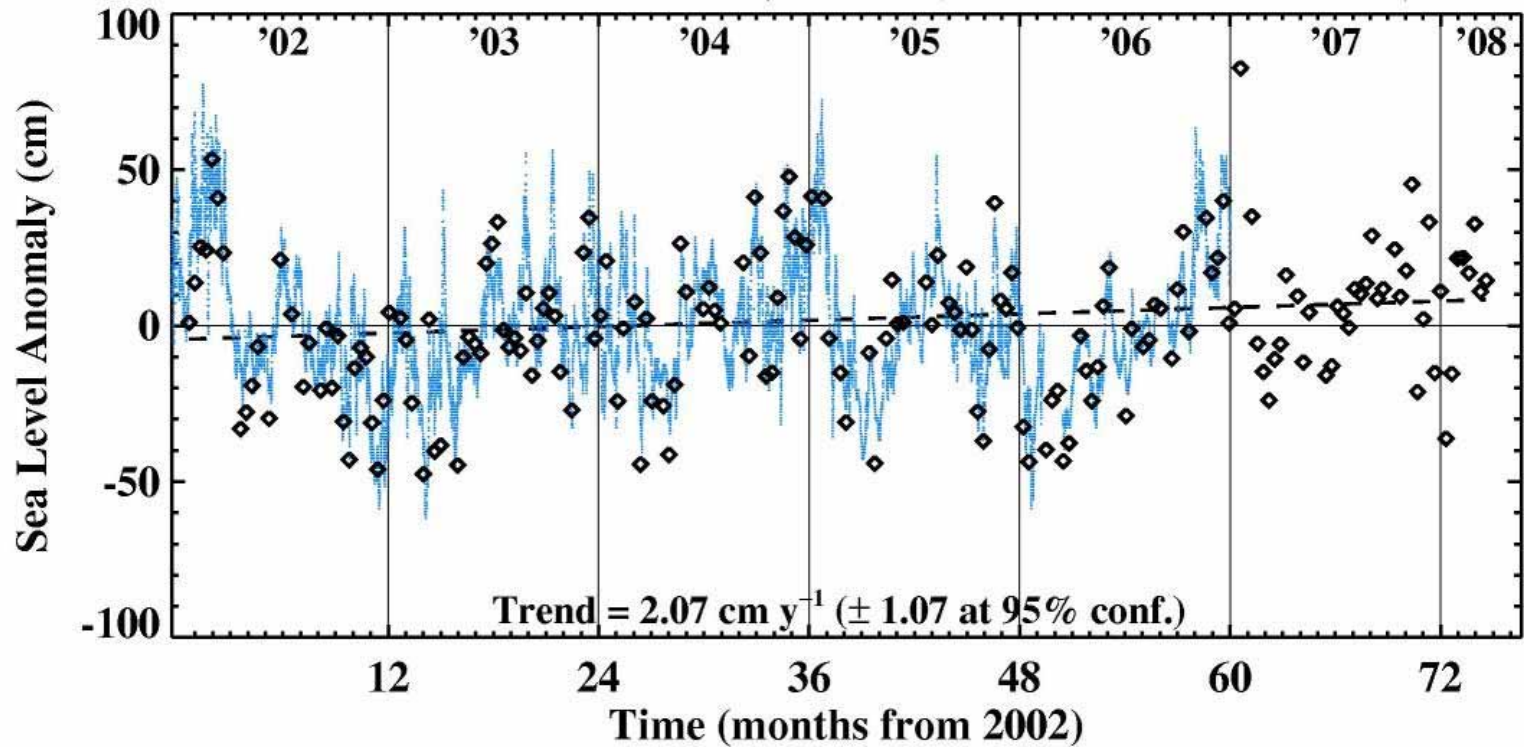
Jason-1 track 187 at 60.180N, 28.551E (60.4 km from station 86035)





6-year time series at a Jason-1 location near a coastal station in Kaliningrad region (next slide)

Jason-1 track 144 at 54.605N, 19.622E (18.5 km from station 86181)



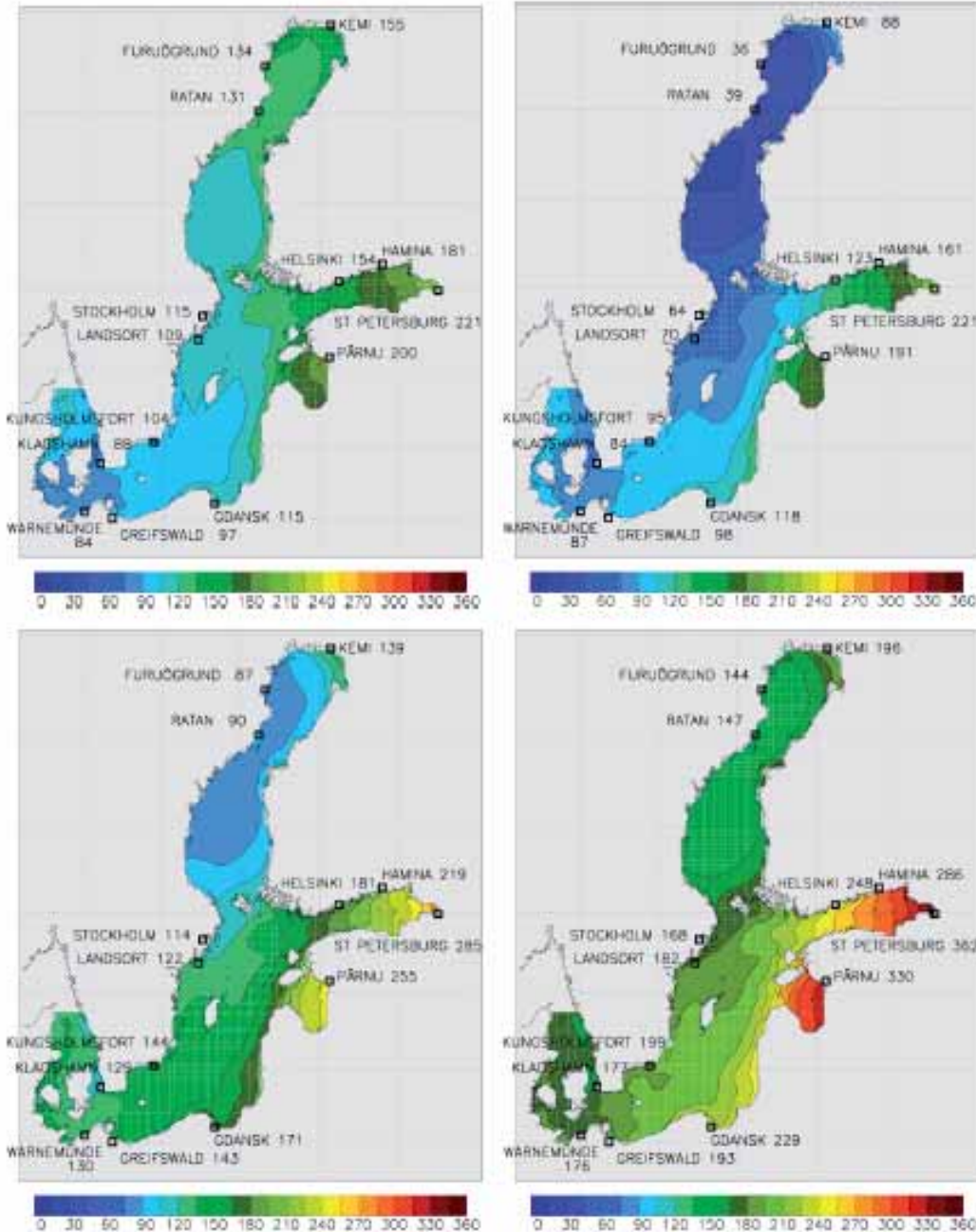
Scenarios from a coupled model (RCAO) simulated 100-year changes in maximum sea levels.

Upper-left: present climate.

Upper-right: “low-case” scenario of global mean SL rise of 9 cm.

Lower-left: “ensemble average” scenario of mean SL rise of 48 cm.

Lower-right: “high case” scenario of mean SL rise of 88 cm.



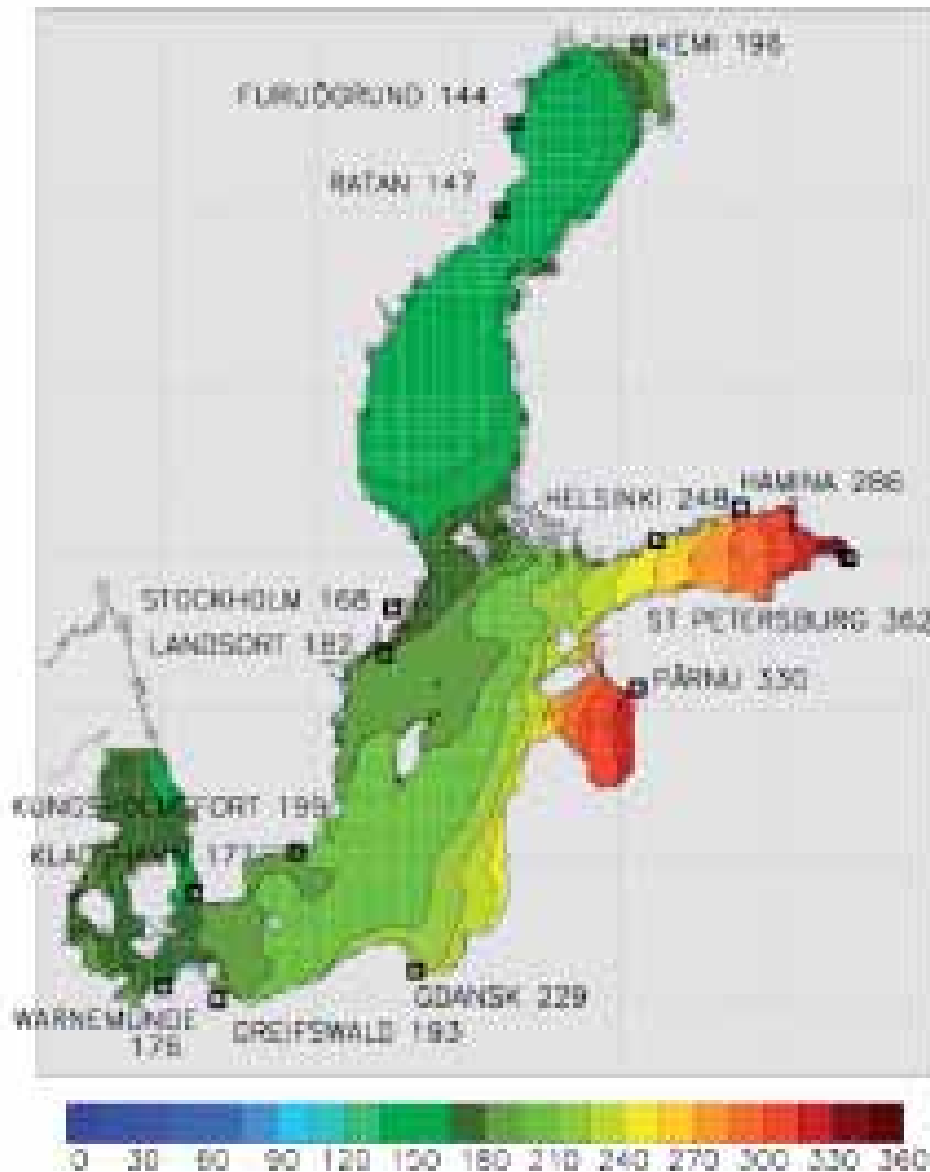
(from H.E. Markus Meier, *New Scenario Simulations for the Baltic Sea*. BALTEX Newsletter, Dec. 2005, pp 5-7.)

The “high case” scenario:

Global mean SL rise of
88 cm over 100 years

Gdansk: 2.3 cm yr⁻¹
Pärnu: 3.3 cm yr⁻¹
Hamina: 2.9 cm yr⁻¹
St. Petersburg: 3.6 cm yr⁻¹

How tall are the gates
in the SPB flood
protection barrier?



Conclusions:

- Four satellite altimeters (Jason-1, Envisat, ERS-2 and Topex-B) provide a relatively dense observation network of up-to-date sea level in Baltic Sea.
- An ad-hoc “1-sec collocation” scheme was used to tie each alongtrack altimeter position to same location at each cycle for time series and statistics.
- Time-distance plots of alongtrack Jason-1 sea levels (2002-2008) exhibit large scale signatures of past storm surges, though due to the 10-day repeat cycle, these plots are not likely to capture peak amplitudes of flooding events.
- Plots of coastal station and nearby Jason altimeter sea level timeseries show a good agreement between the two very different observing systems.
- The 6-year long (2002-2008) Jason-1 data show a surprisingly large sea level rise of about 3.2 cm/year in Eastern Gulf of Finland, and about 2.1 cm/year in southeastern Baltic Sea (Kaliningrad region).
- Work is in progress to ascertain that altimeter-derived rates are consistent with those from coastal stations and to compute sea level statistics in Baltic Sea.