

Sea-level observations in the North Adriatic Sea during the 18th century



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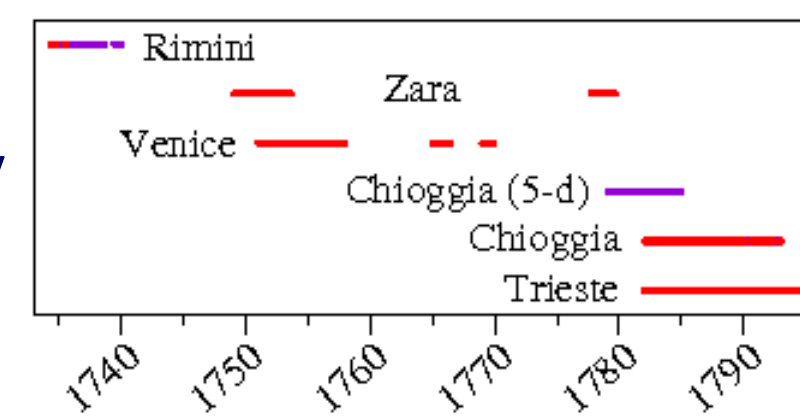


We present a collection of sea-level observations performed in Rimini, Zara, Venice, Chioggia and Trieste, in the North Adriatic, during the second half of the 18th century. Except for Chioggia, whose data are published, the other observations appear as manuscripts. Some information is available about the observation times or frequencies, vertical references and units, as summarized in the Table. No information on bathymetry.

Only in Chioggia the astronomical tide is adequately sampled. In the other stations, to obtain approximate monthly Mean Sea Level, the means from the observed data are normalized to 24-hour means using modern observations taking into account the actual sampling patterns.

Only macroscopic errors have been corrected. Highly suspicious data have been excluded from elaborations.

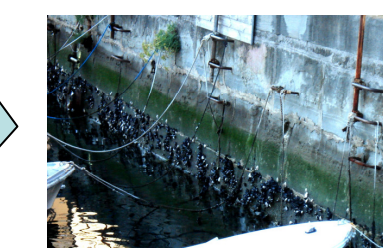
Data availability
 $<50\%$ $\geq 50\%$



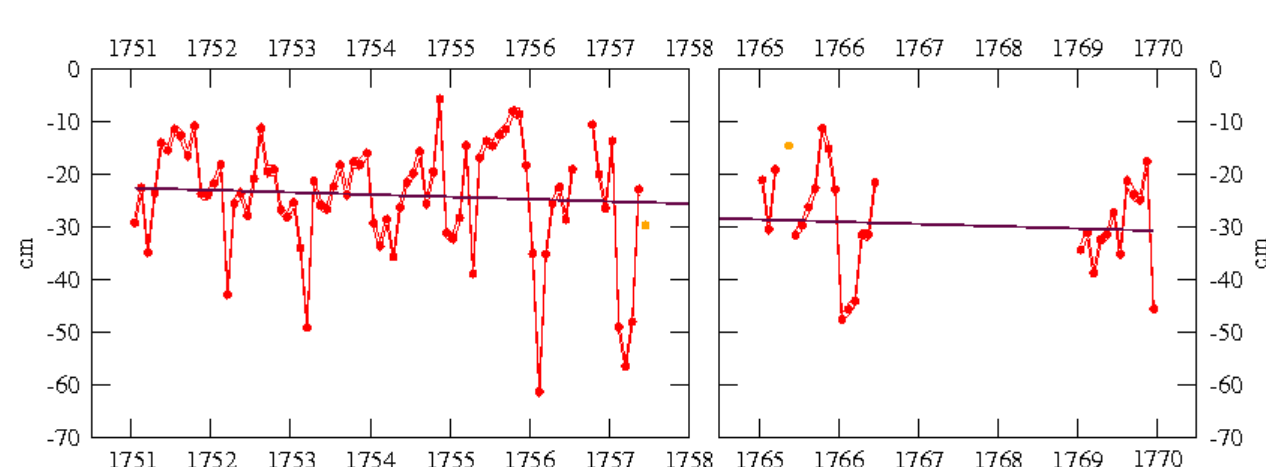
Location	Period	Observation frequency	Vertical Reference	Unit
Rimini	1734-40	Irregular (unusable)	Sea floor(?)	Rimini foot = 45.19 cm
Zara	1749-53	1/day, usu. at 9-13(*)	Sea floor	Venice foot = 34.77 cm
Venice	1751-69	Daily highest and lowest	Comune Marino	Venice foot = 34.77 cm
Zara	1777-79	2/day, usu. at 6-8(*) and 17-19(*)	Sea floor	Venice foot = 34.77 cm
Chioggia	1779-84	5-day MHW, usu. 2/month	Sea floor	Venice foot = 34.77 cm
Chioggia	1782-92	Daily highs and lows	Sea floor	Venice foot = 34.77 cm
Trieste	1782-94	At least 2/day at 7 and 16(*)	Algae belt	Paris foot = 32.48 cm

(*) UTC+1 time

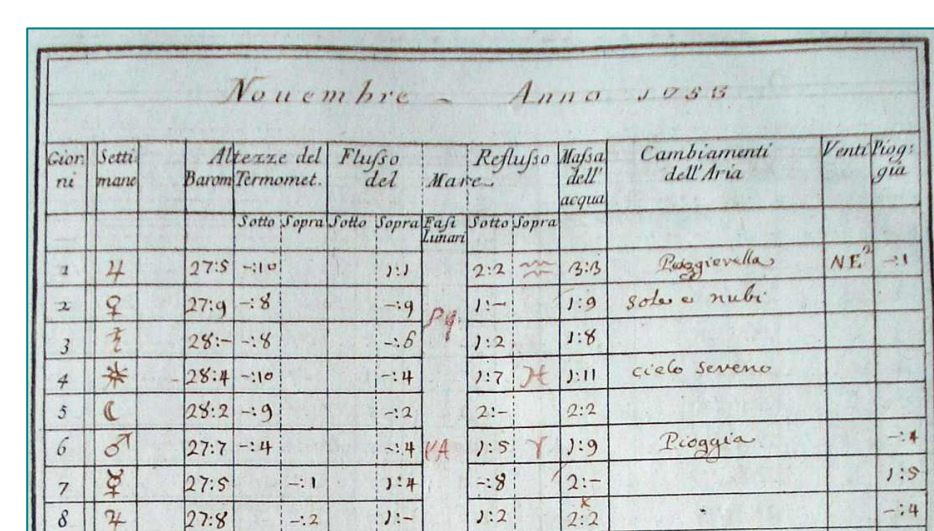
Local time was "hora italica" (day start 30' after sunset) everywhere except in Trieste (day start at midnight).



VENICE Tommaso Temanza - 1751-1757, 1765-1766, 1769
 (INAF, Astronomical Observatory old archive, Padua)

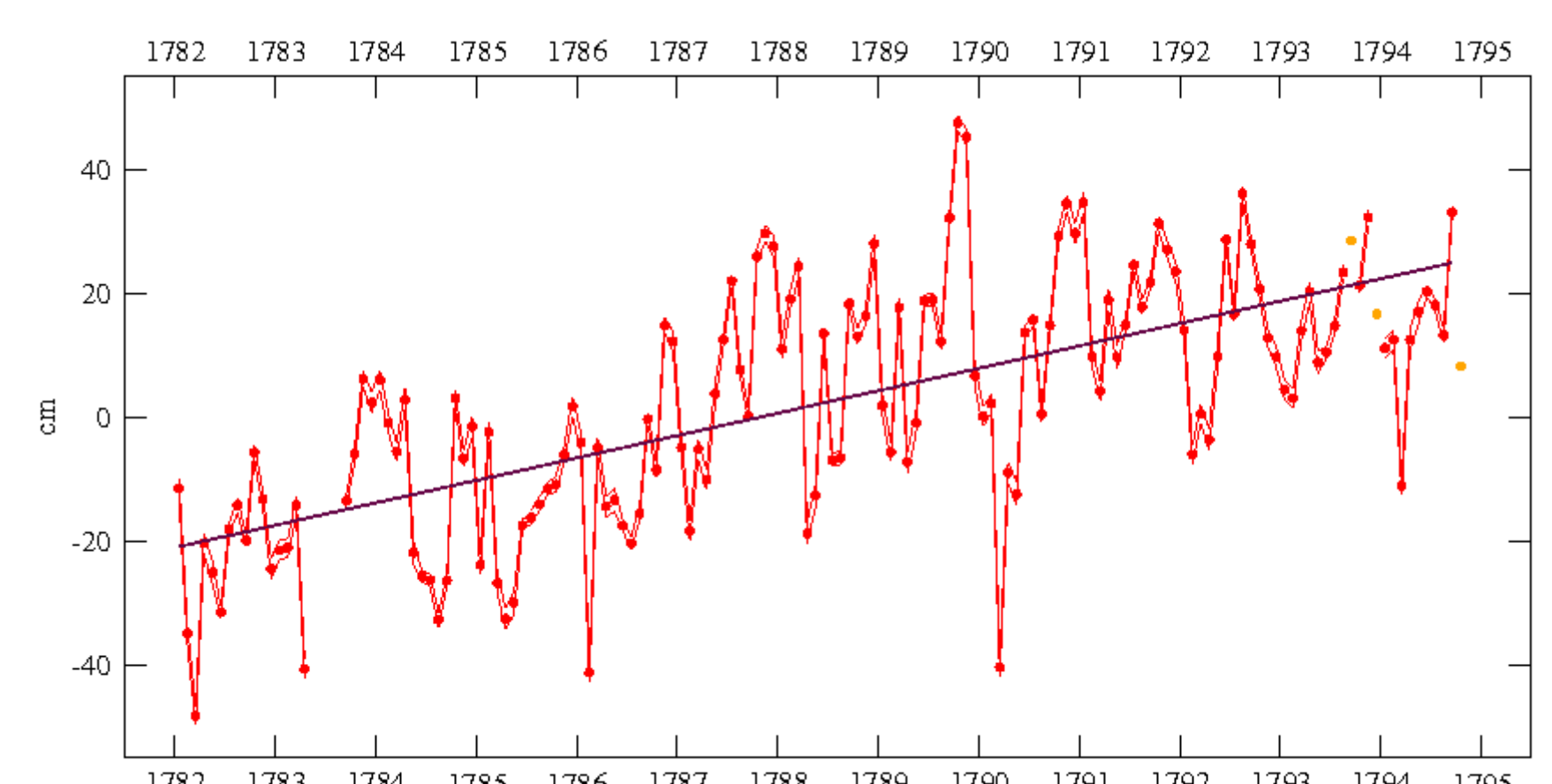
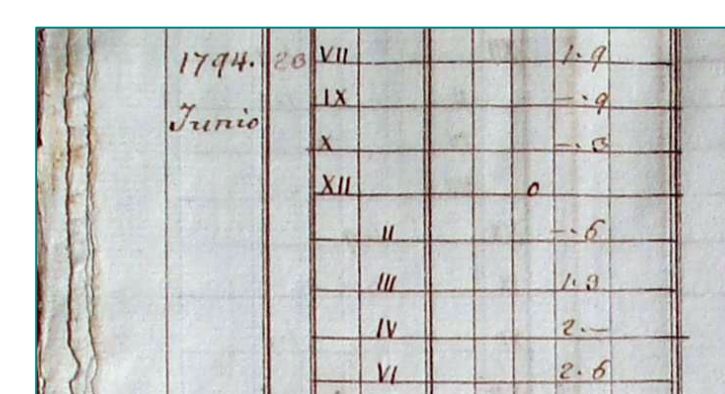


1751-1769
 From highest and lowest tide
 normalized to MSL using 1940-2009 data
 Monthly error ≈ 1 cm
 Trend: -4.8 ± 2.2 mm/y

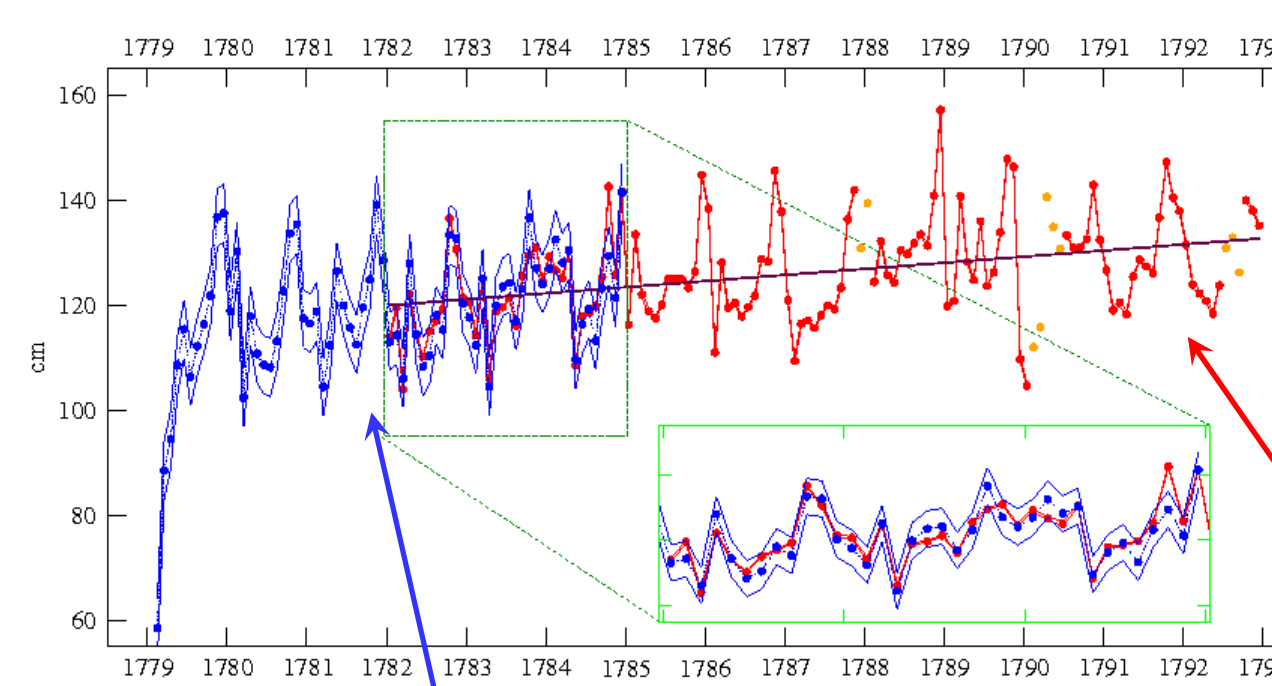


TRIESTE Leonardo Vordoni - 1782-1794
 (INAF, Astronomical Observatory old archive, Padua)

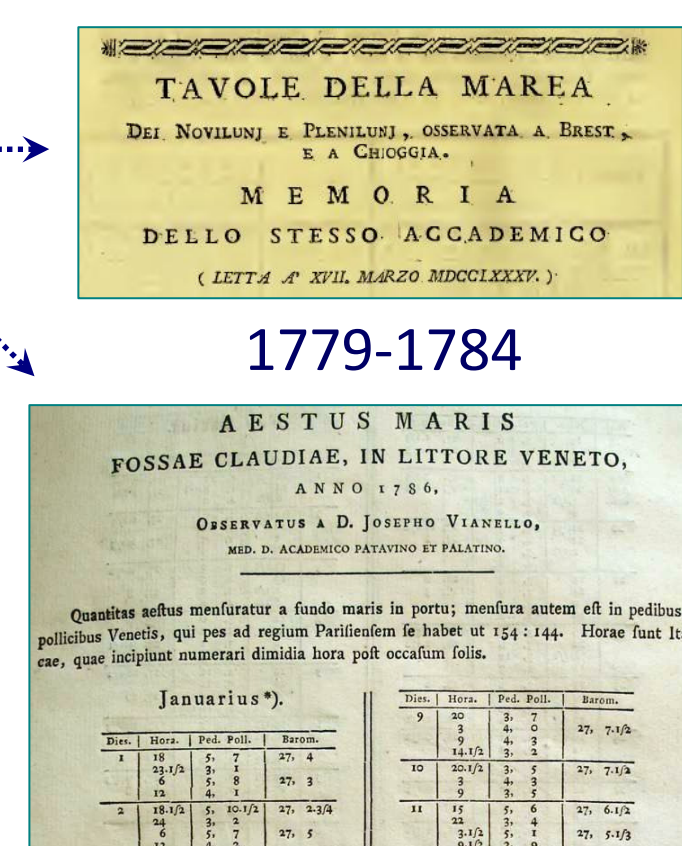
1782-1794
 From 2 daily observations
 normalized to MSL using 1939-2012 data
 Monthly error $\approx 1-2$ cm
 Trend: 42.2 ± 6.5 mm/y



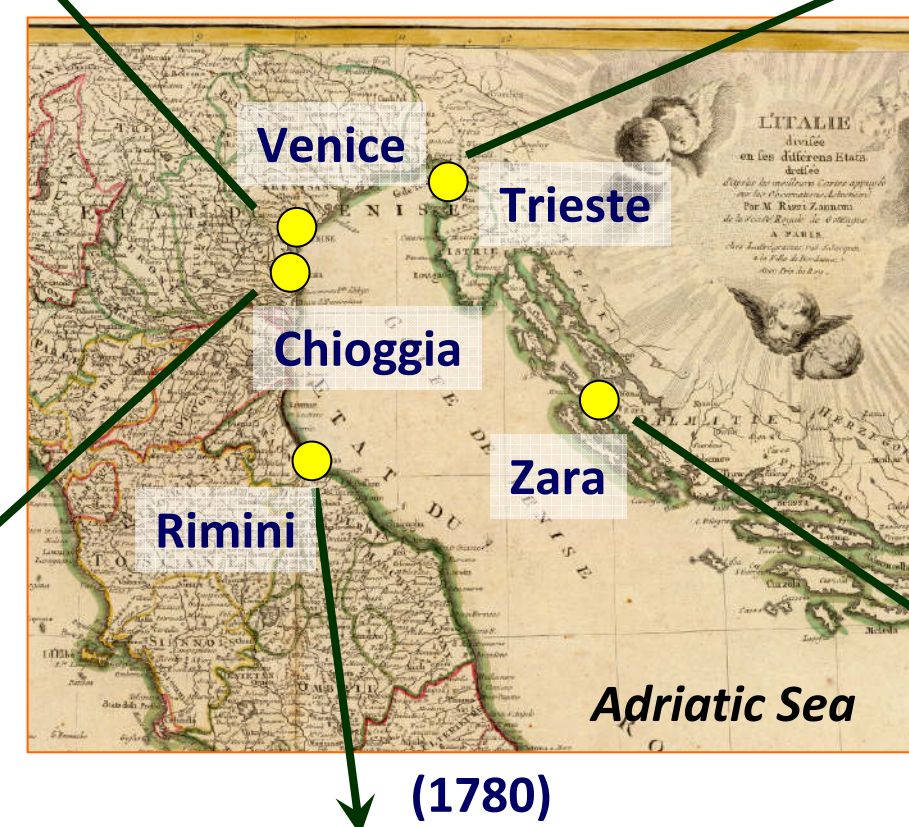
CHIOGGIA Giuseppe Vianelli
 (Saggi Accad. Padova, v. 2, 1789
 Ephem. Meteor. Soc. Palatinae, v. 2-12, 1784-1795)



1779-1784 ($<50\%$ data available)
 MHW normalized to MTL in 1782-1784
 then to MSL as in 1782-1792
 Monthly error ≈ 5.5 cm

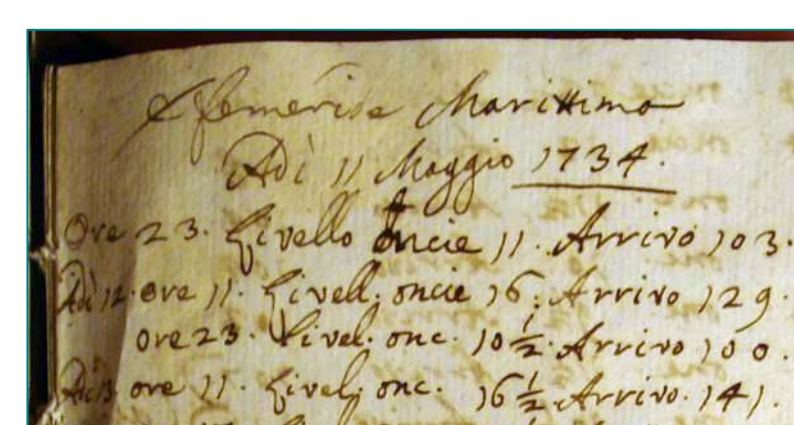


1782-1792
 MTL normalized to MSL
 using 1989-2012 data
 Monthly error < 1 cm
 Trend: 12.3 ± 3.8 mm/y



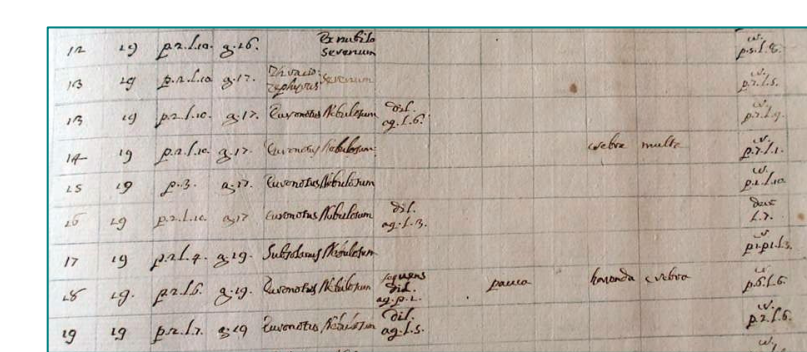
(1780)

RIMINI

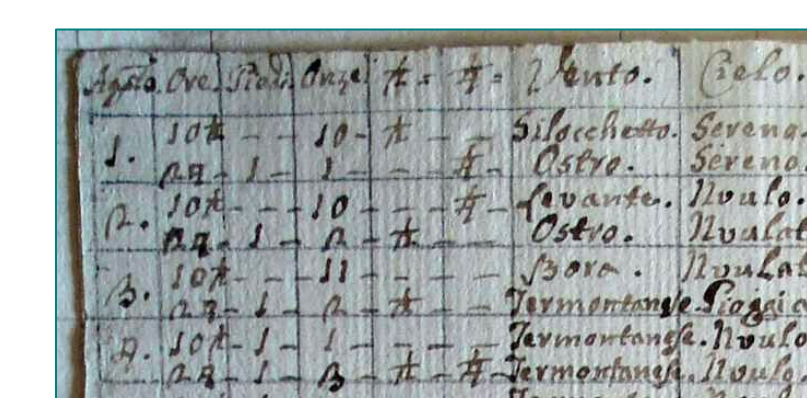


Giovanni Bianchi - 1734-1740
 (Gambalunga library, Rimini)

ZARA
 (INAF, Astronomical Observatory
 old archive, Padua)

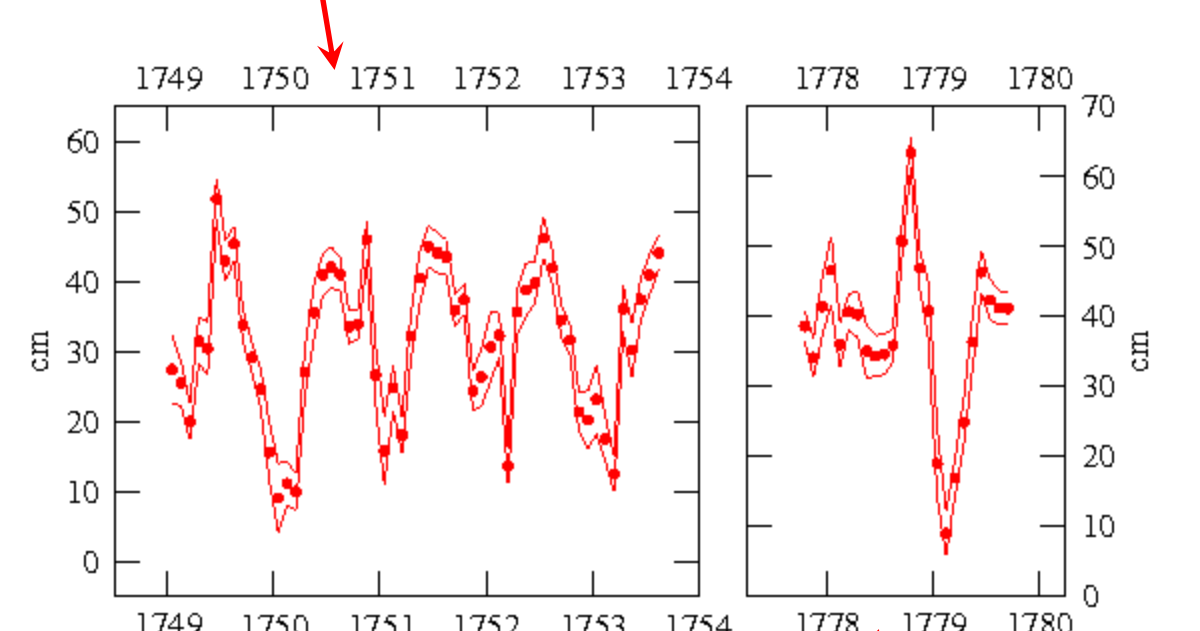


? Danieli - 1749-1753



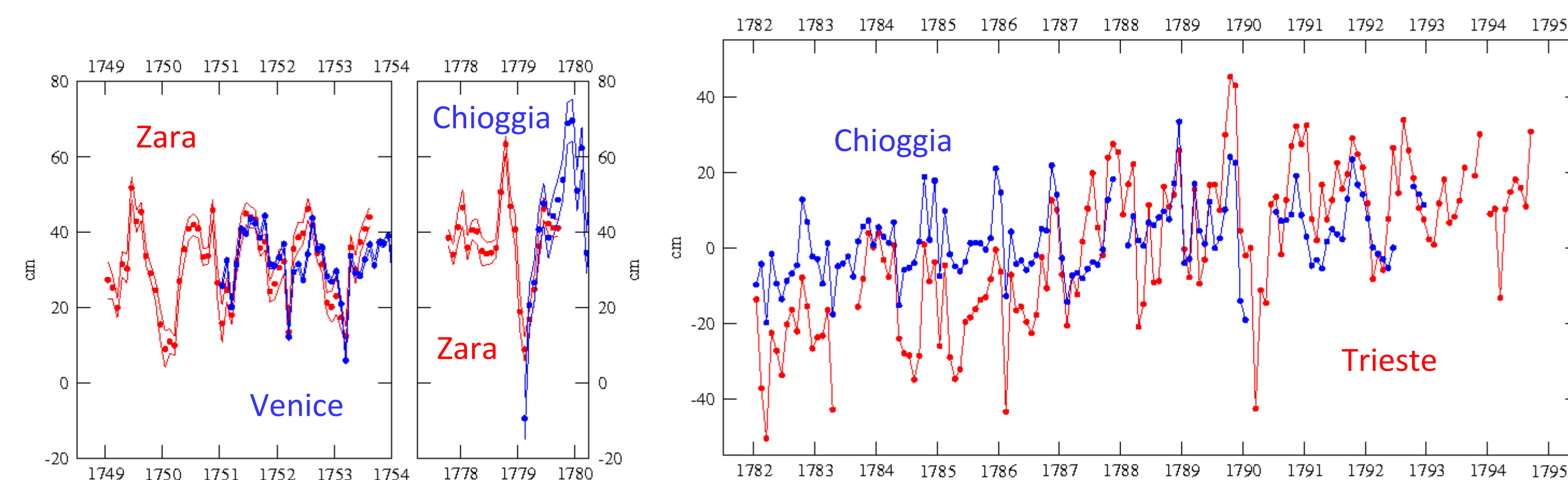
Simeone Fattovich - 1777-1779

1749-1753
 From 1 daily observation
 normalized to MSL using 1994-2005 data
 Monthly error ≈ 4 cm

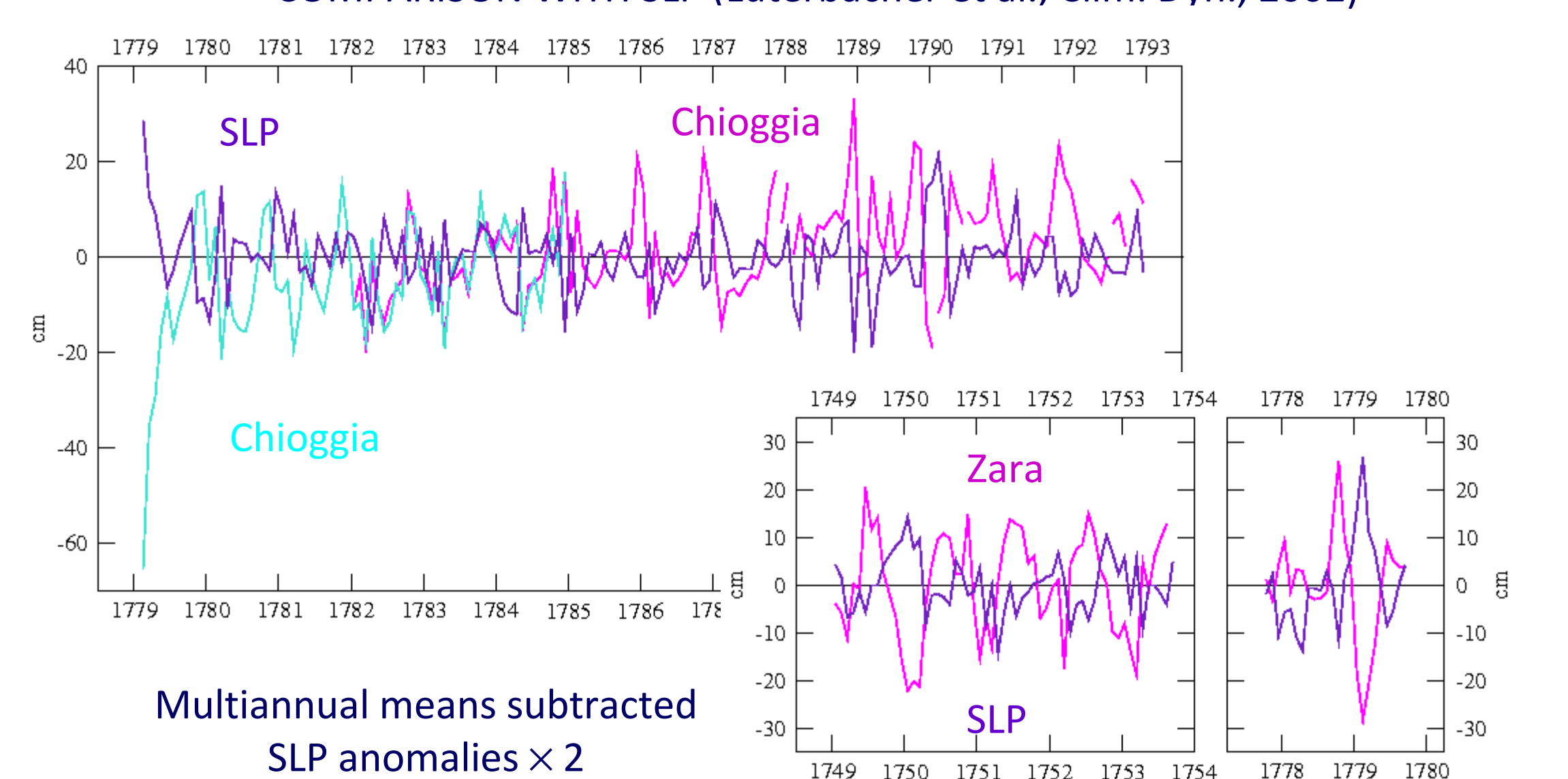


1777-1779
 From 2 daily observations
 normalized to MSL using 1994-2005 data
 Monthly error ≈ 2 cm

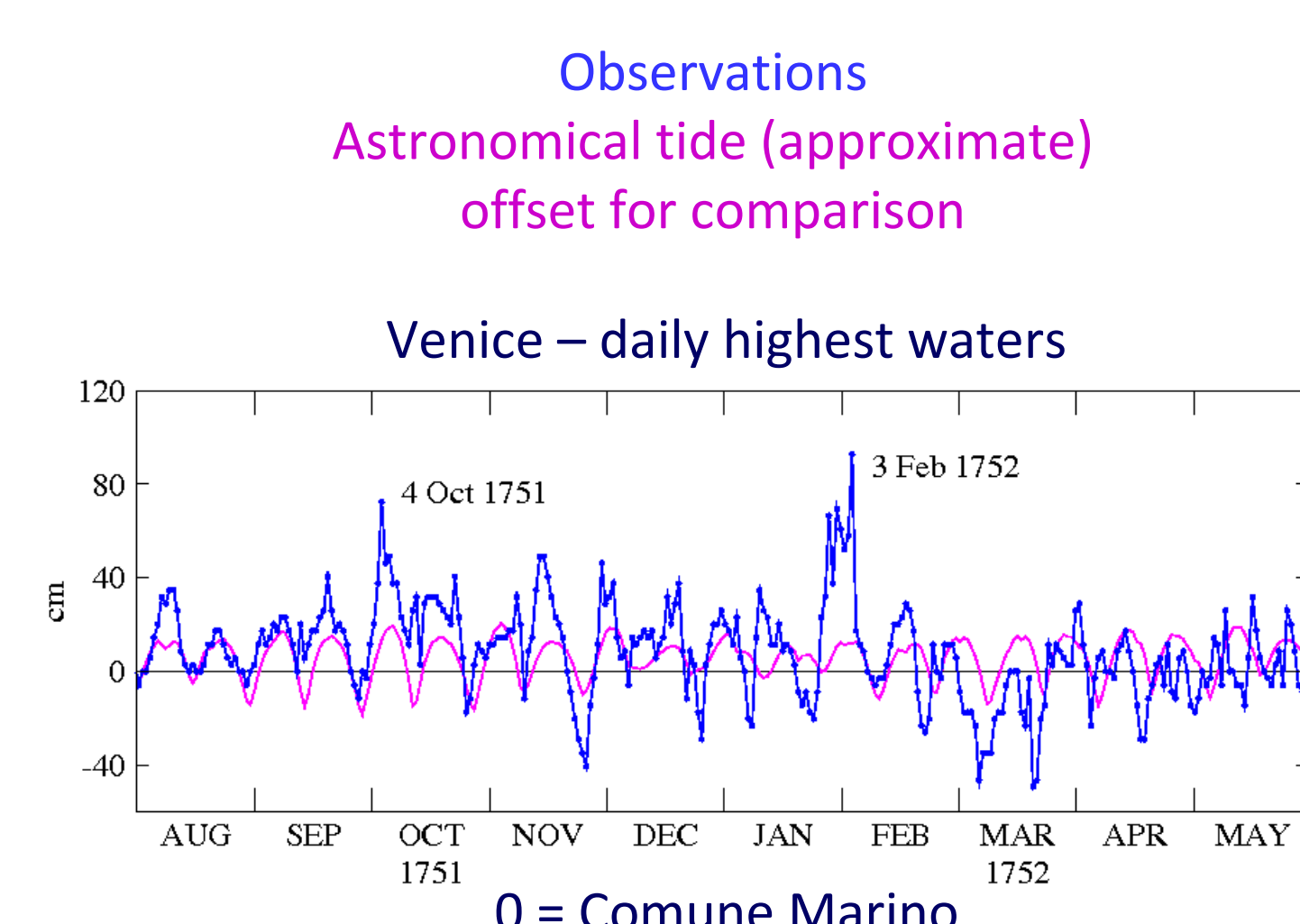
COMPARISON OF OBSERVATIONS OF DIFFERENT SITES



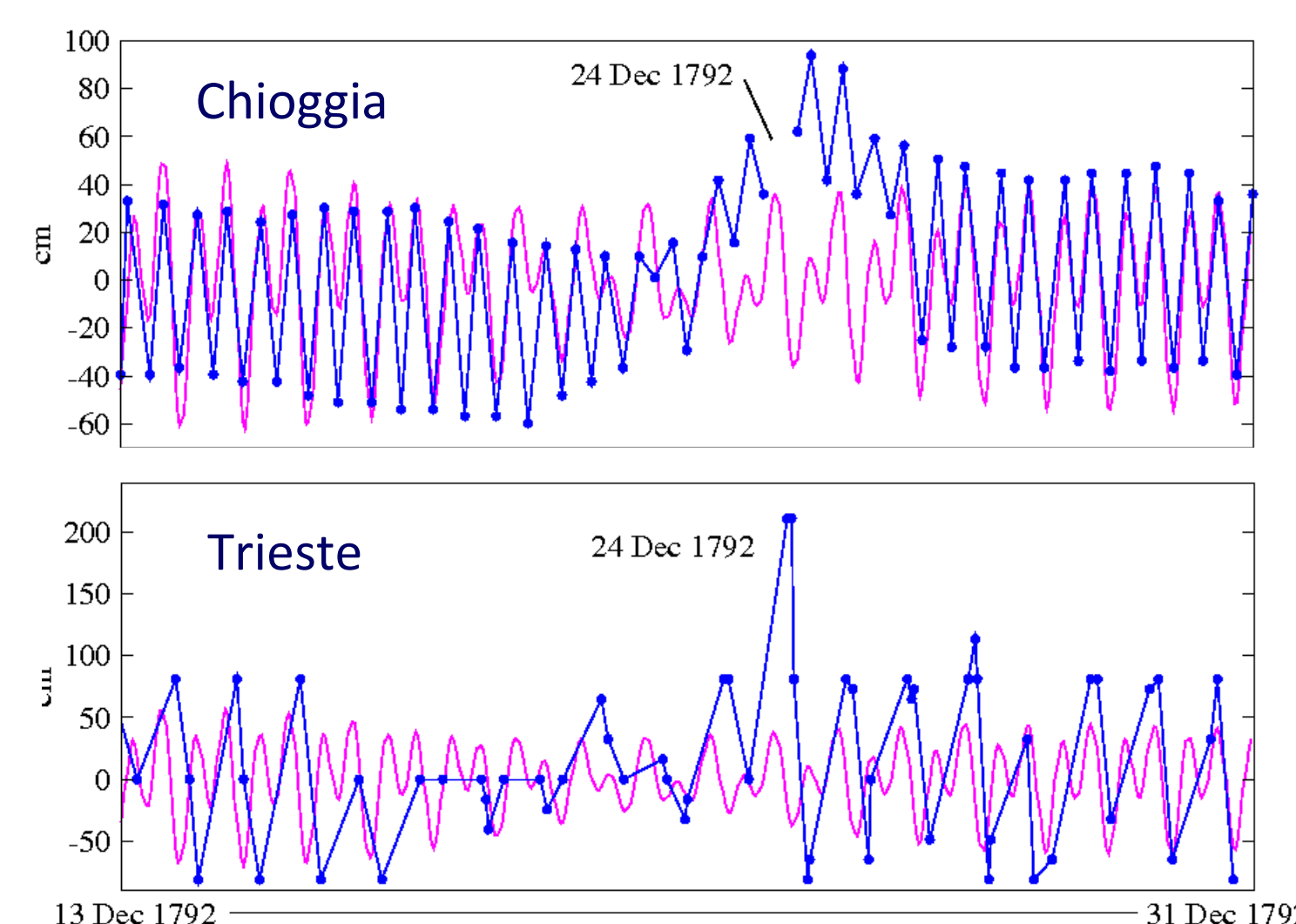
COMPARISON WITH SLP (Luterbacher et al., Clim. Dyn., 2002)



EXTREME EVENTS (STORM SURGES)



24 Dec 1792 – Remarkable flood in Venice



SOME REMARKS

Main problems

- The large linear trends at Chioggia and, particularly, Trieste are probably due to abnormal vertical motions of the sites.
- The information on vertical references does not allow to connect these data with modern observations.
- No information is available about possible influence of wind waves.

Results

- The time series of monthly means from different sites are generally consistent with each other on the seasonal and interannual time scales.
- Monthly sea level and pressure anomalies show the inverse barometer effect.
- Sea level variability on the synoptic scale is well visible at Chioggia and Venice.