

Adriatic meteotsunamis: a review and future research directions

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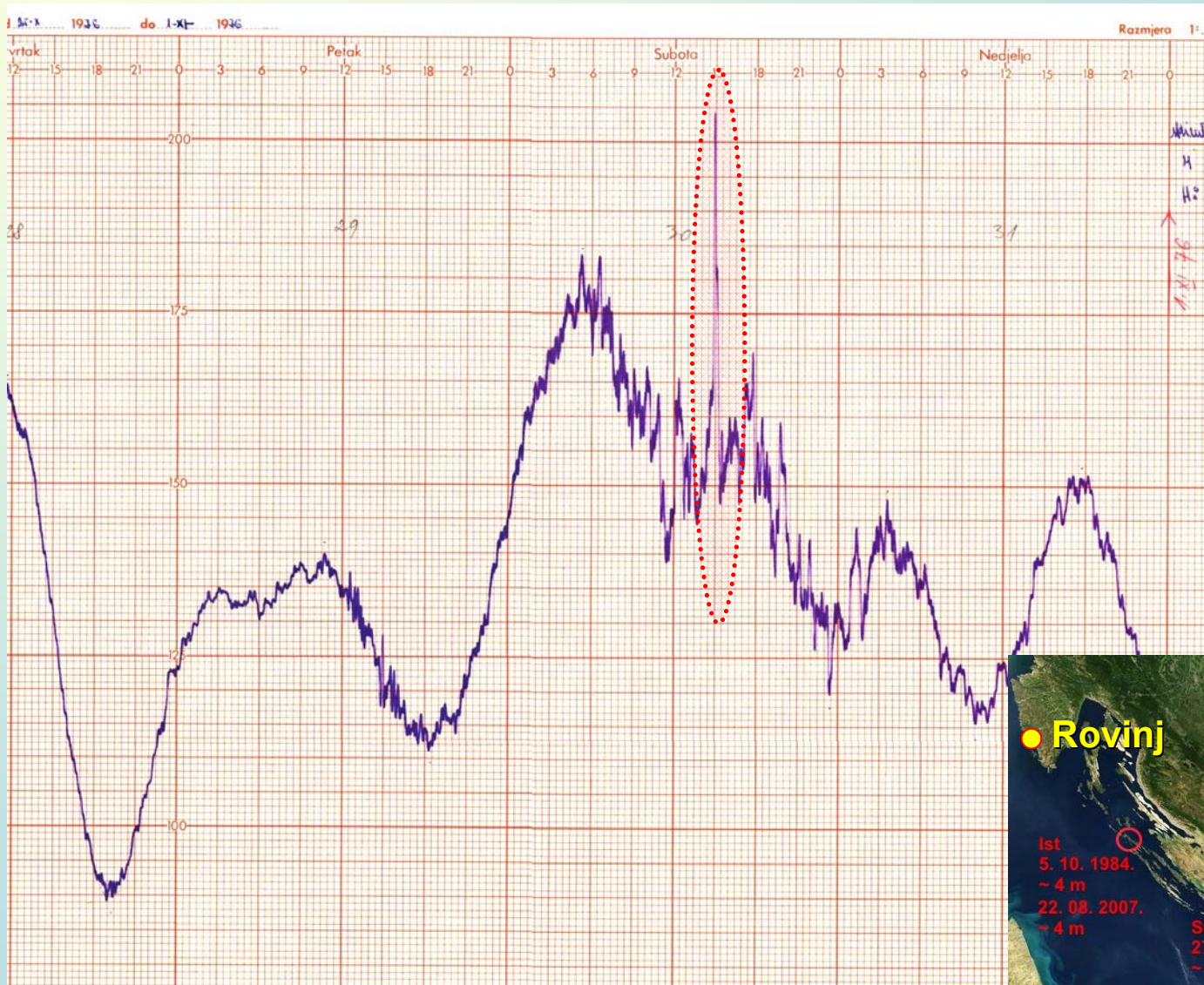


An overview of meteotsunami events
Present knowledge on generation and dynamics
Future research pathways

The story begins with an overview of recent meteotsunami events ...

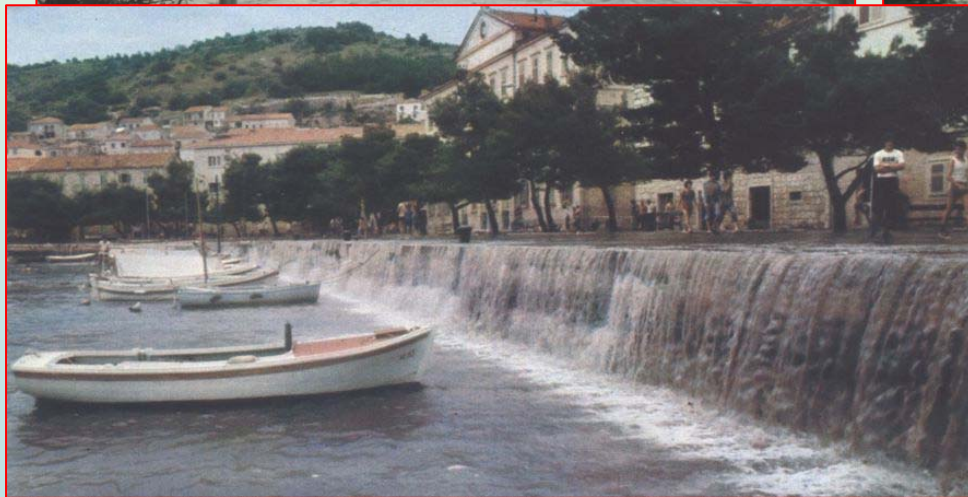
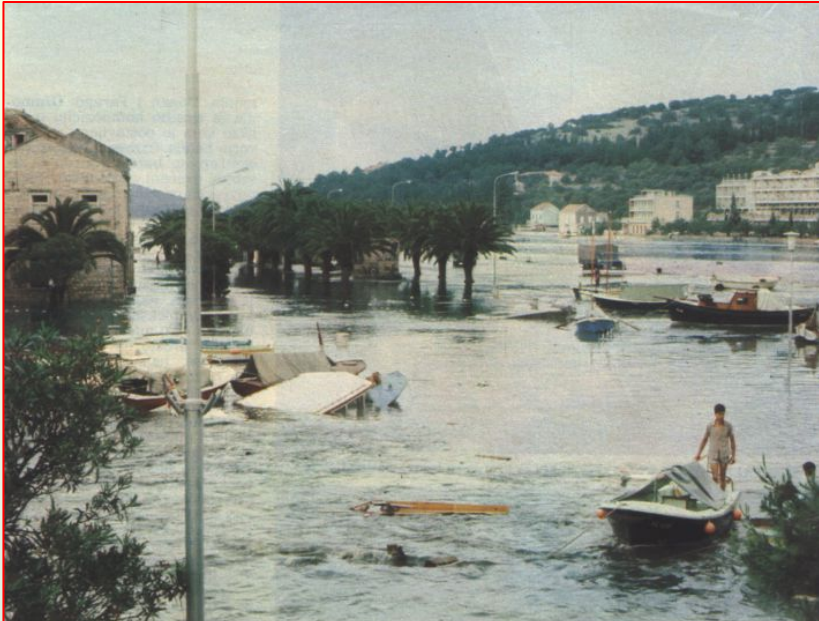


... but can we treat this record as a meteotsunami?



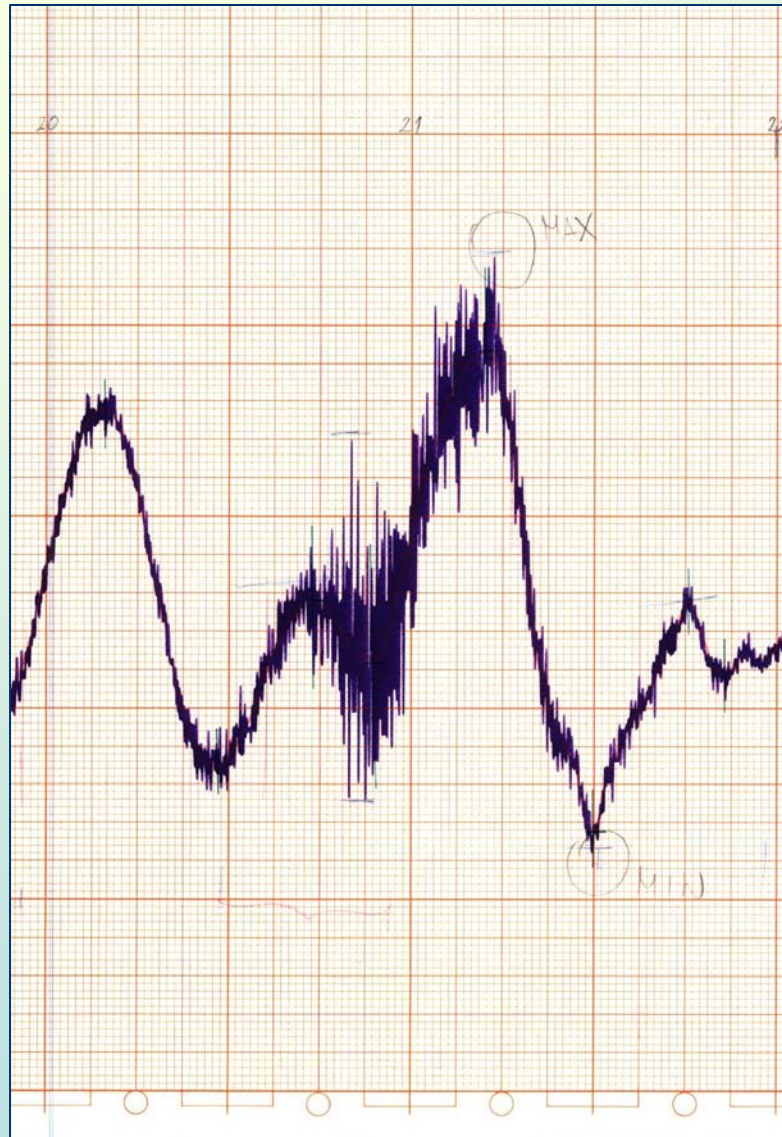
Vela Luka, 21.06.1978.

Overview



tide gauge at Split, 21.06.1978.

Overview



ITALIAN TSUNAMI CATALOGUE version 2

Code:	63	Date Information				Date:
Reliability:	2	Year:	Month:	Day:	Time (hh:mm:ss)	Reliability:
		1978	6	21		

Region Information

Subregion: Central Adriatic Map

Short Description: Extended flooding and damage

Tsunami Information

Max Runup: 800

Intensity: 4

Magnitude:

Source Information

Cause: UN

Intensity: Focal Depth: Longitude: Latitude:

Magnitude: VEI: Reliability:

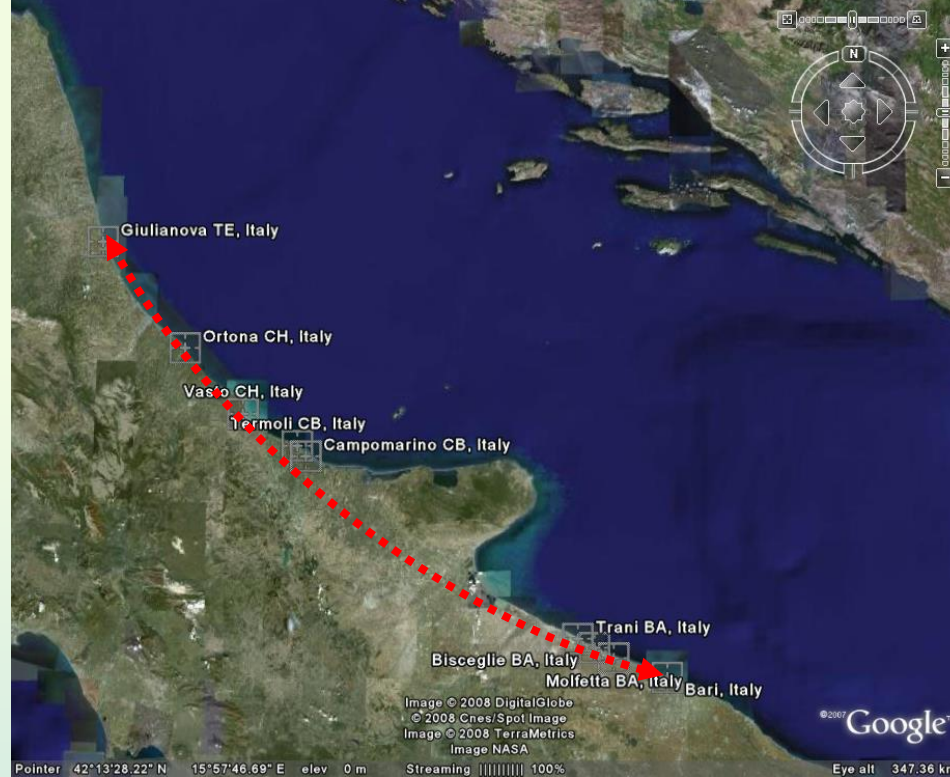
Remarks:

Description: Event date from Bedosti (r159). Runup value from contemporary newspapers (Anonymous r220;r222). Tsunami reliability and intensity from Tinti (r248).

Order by

Extraction References Images Statistics False Events Search

Overview



On June 21 some **anomalous coastal oscillations** of the sea along the central Adriatic coast between **Giulianova and Bisceglie**. No earthquakes recorded to justify the anomalous event. Bedosti (r159) hypothesises that a possible cause is a submarine landslide beneath the 200 m isobath more or less between Termoli and Vasto.

The following information is taken from Bedosti (r159).

The oscillations **period was about 10-15 minutes**.

At **Giulianova** the sea withdrew by about 50 m at **11h 59m am** and it came back 6 min later surpassing the normal level by **about 60 cm**. Oscillations repeated many times with period of 15 min and amplitude of 60 cm in the harbour until 5:30 pm.

At **Ortona** only one oscillation observed, starting at **11:30 am** with a withdrawal of 15 m. The water came back at 12:00.

At **Bisceglie** the sea withdrew by 2-3 m at **6:30 am** and then flooded the beach by 200 m. The maximum height was **50 cm**. Two fishing boats broke their mooring.

At **Molfetta** at **5:00 am** 10 m of withdrawal. The period was 5 min.

Anomalous oscillations also observed at **Fossacesia, Vasto, Termoli, Campomarino and Trani** at different times.

At **Termoli** the sea withdrew by tens of metres leaving the harbour dried and then violently came back; some swimmers referred that **the sea water suddenly became cold** and immediately after became also turbulent and strongly agitated (Anonymous, r220).

At **Bari** the sea water suddenly withdrew many times leaving the seafloor dried; some moored ships in the harbour went aground and **some fish was found on the beach** (Anonymous, r220;r221).

Anonymous (r220) quotes the opinion of Prof. Mosetti that suggests the occurrence of a submarine landslide in the Adriatic sea.

subota, 28.6.2003.

novosti

teme dana

ekonomija

sport

kultura

mozaik

crna kronika

dalmacija

split

županija

zadar

šibenik

dubrovnik

bih

sd magazin

pomet

feljton

kolumne

osmrtnice

zadnje vijesti

impresum

prometni vodič

kretanje brodova

mali oglasi

kontakt

linkovi

arhiv

e-mail adresar

Mail oglasnik Turizam Franjka Marketing Grafika djelatnost Stripovi

online
the **MONITOR**

THE ONLINE MONITOR
I VAŠE NAM JE MIŠLJENJE VAŽNO!

novosti

U STAROME GRADU
URUŠENO 60 METARA ZIDA I POPLAVLJENI BROJNI OBJEKTI

Plimni val nosio sve pred sobom

STARIGRAD — Veliki plimni val što je u petak ujutro, nešto poslije šest sati, zapljusnuo starogradsku rivu, pa čak i šire područje parka Vorba, žiteljima je ovoga drevnoga grada nanio iznimno velike štete. Očevici tvrde da su mjesto zapljusnula zapravo dva vala: prvi nešto manji, a potom veći visine oko 1,30 m, koji je nosio sve pred sobom. Automobilima, kontejnerima, stolovima i stolicama more se poigravalo kao s igračkama, tako da će oko saniranja posljedica biti doista puno posla.

Od Viska Haladića, gradonačelnika Staroga Grada, doznajemo da su mnogi ugostiteljski lokali, trgovine, prostorije Turističke zajednice, pa i obiteljske kuće, doslovno poplavljeni. More je tako ugrozilo ne samo predjelo oko rive, što se znalo događati godinama, nego i Trg Naime, tamo je povukao gotovo 60 metra, nakon čega kaže on, mora poduzeća Stari Grada.

Gradonačelnik će



PREDSED
REPUB
MESIĆ
POSJE
"KAME
Što bi
civiliza
Grci za
kamer

DODIJE
TURIST
KOJA S
PRIPRE
GOSTI
Opatija
Labin najbolji domaćini
predsezona

NA SUBENJU
SLOBODANU
MILOŠEVIĆU SVJEDOČIO

e
uaciji
enika

Overview



Ist, 22.08.2007.

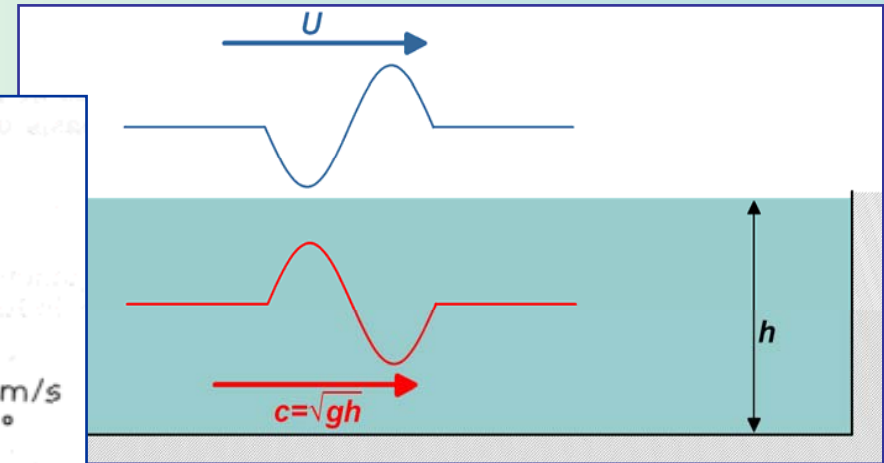
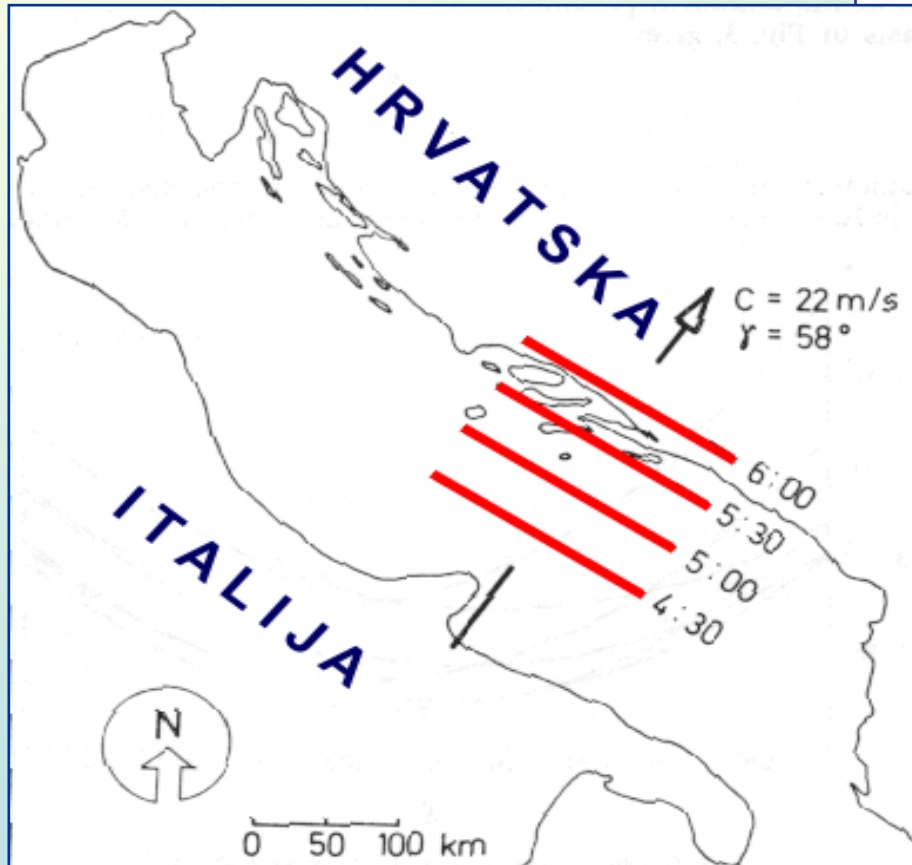


Research papers

- **Hodžić, M., 1979/1980.** Occurrences of exceptional sea-level oscillations in the Vela Luka Bay, *Priroda*, 68 (2-3), 52-53 (in Croatian).
- **Orlić, M., 1980.** About a possible occurrence of the Proudman resonance in the Adriatic, *Thalassia Jugoslavica*, 16(1), 79–88, 1980.
- **Vilibić, I., Domijan, N., Orlić, M., Leder, N., Pasarić, M., 2004.** Resonant coupling of a traveling air-pressure disturbance with the east Adriatic coastal waters. *Journal of Geophysical Research – Oceans*, 109, C10001, doi:10.1029/2004JC002279.
- **Vilibić, I., 2005.** Numerical study of the Middle Adriatic coastal waters sensitivity to the various air pressure travelling disturbances. *Annales Geophysicae*, 23, 3569-3578.
- **Vilibić, I., Mihanović, H., 2005.** Resonance in Ploče Harbour (Adriatic Sea). *Acta Adriatica*, 46 (2), 125-136.
- **Vilibić, I., Domijan, N., Čupić, S., 2005.** Wind versus air pressure seiche triggering in the Middle Adriatic coastal waters. *Journal of Marine Systems*, 57, 189-200.
- **Vilibić, I., Beg Paklar, G., 2006.** High-frequency atmospherically-induced oscillations in the middle Adriatic coastal area, *Annales Geophysicae*, 24, 2759-2771.
- **Monserat, S., Vilibić, I., Rabinovich, A.B., 2006.** Meteotsunamis: atmospherically induced destructive ocean waves in the tsunami frequency band. *Natural Hazards and Earth System Sciences*, 6, 1035-1051.
- **Belušić, D., Grisogono, B., Bencetić Klaić, Z., 2007.** Atmospheric origin of the devastating coupled air-sea event in the east Adriatic, *Journal of Geophysical Research – Atmosphere*, 112, doi:10.1029/2006JD008204.
- **Vilibić, I., 2008.** Numerical simulations of the Proudman resonance. *Continental Shelf Research*, 28, 574-581.

Vela Luka, 21.06.1978.

The source

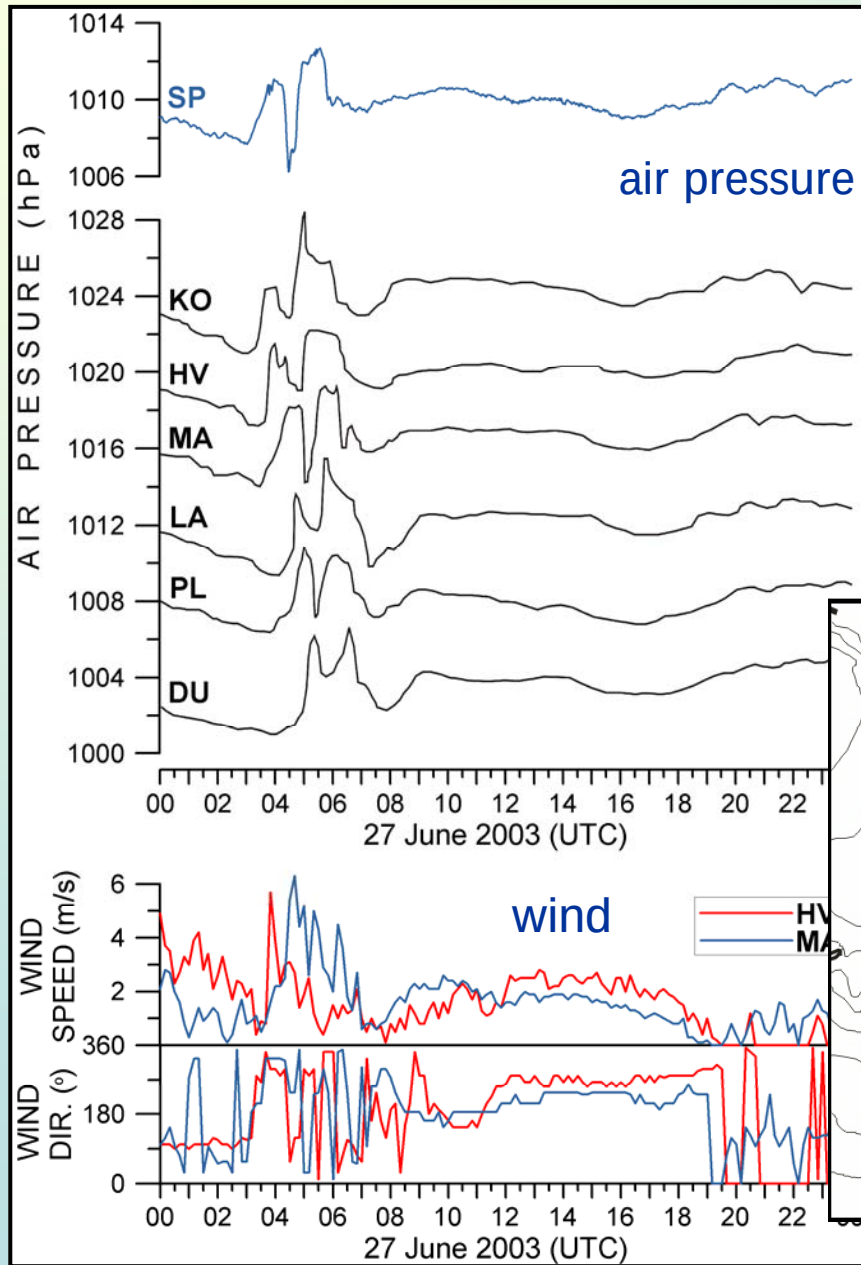


Orlić, 1980

Yap, Proudman resonance
can occur at 50 m depth ...

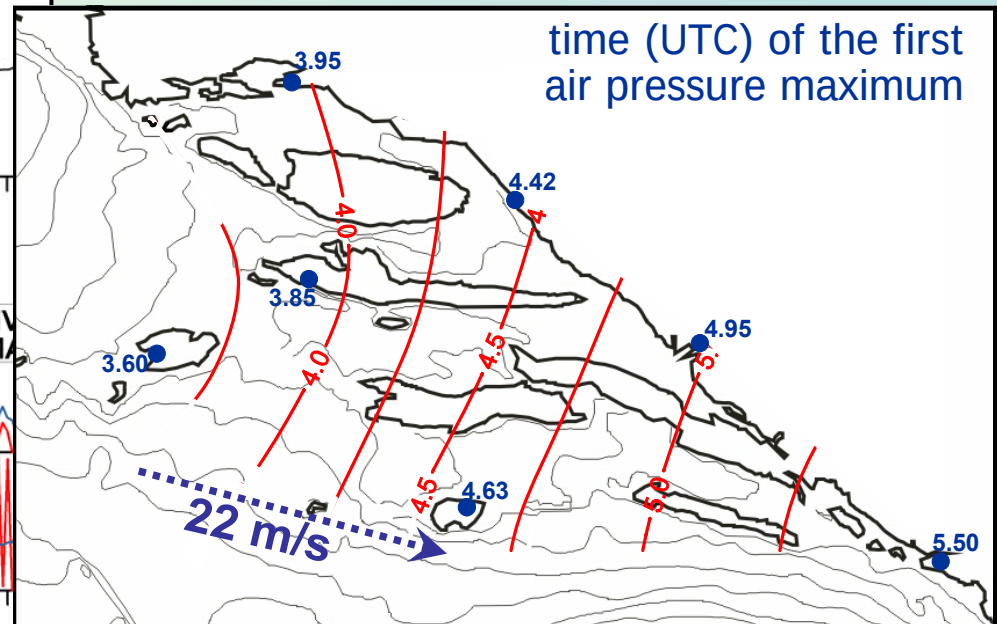
Stari Grad, Mali Ston, 27.06.2003.

The source



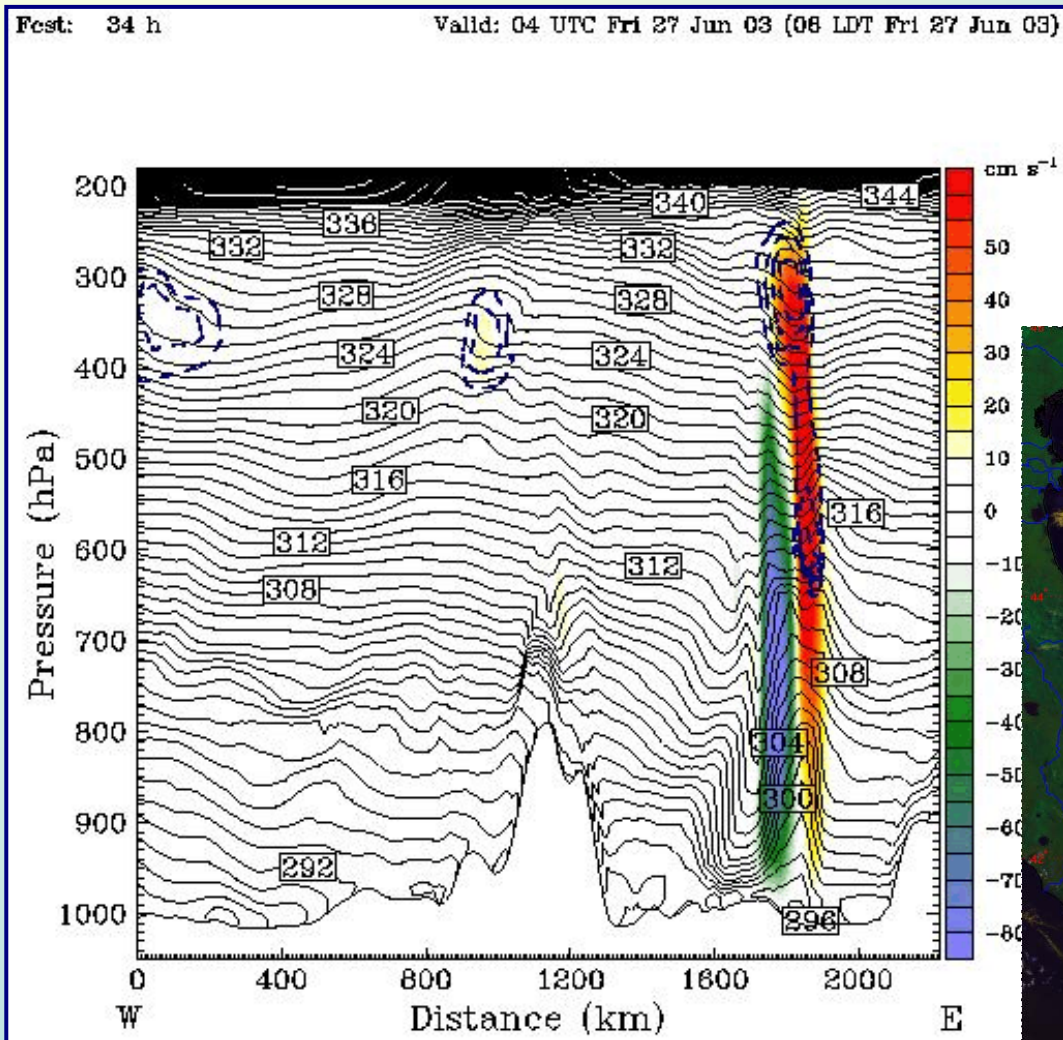
... also here ...

Vilibić et al., 2004

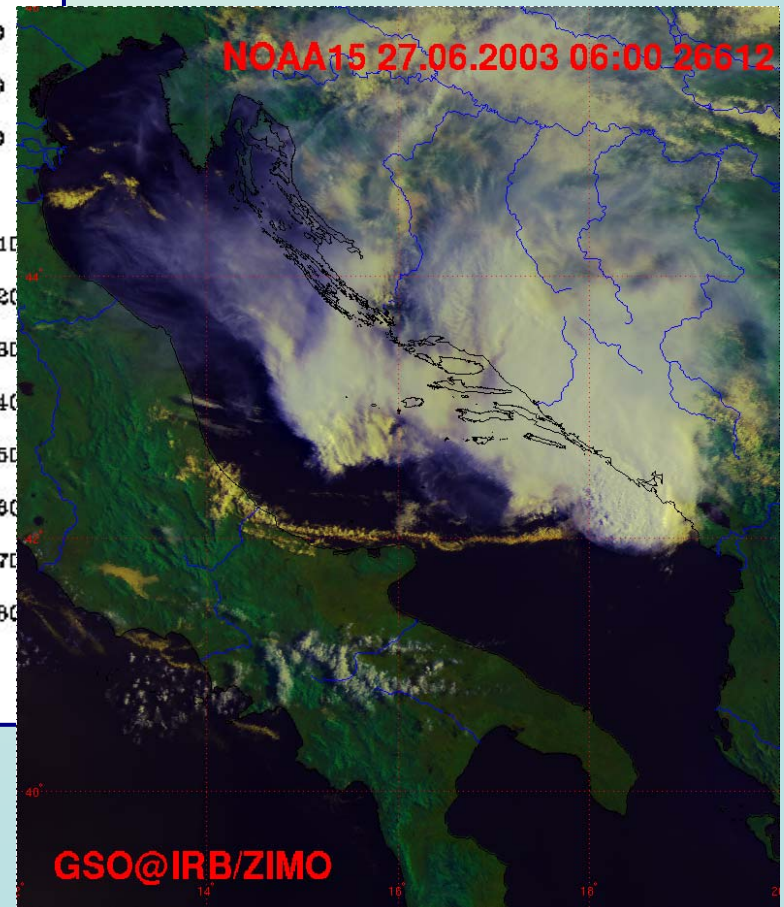


Stari Grad, Mali Ston, 27.06.2003.

The source



Belušić et al., 2007

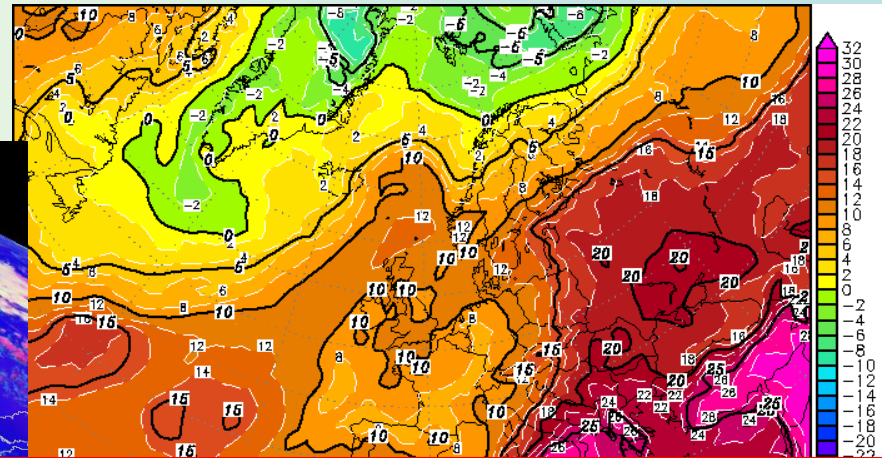
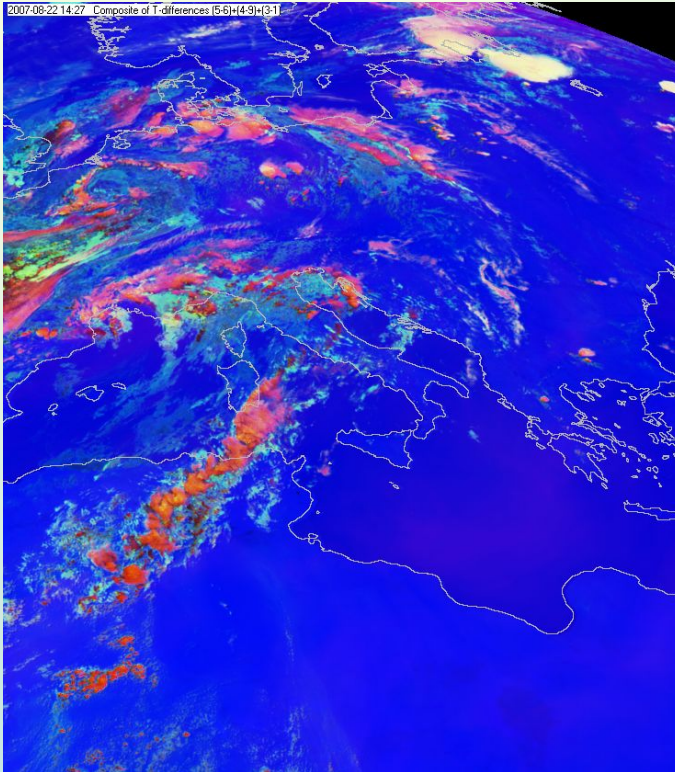


... generated by wave-CISK ...

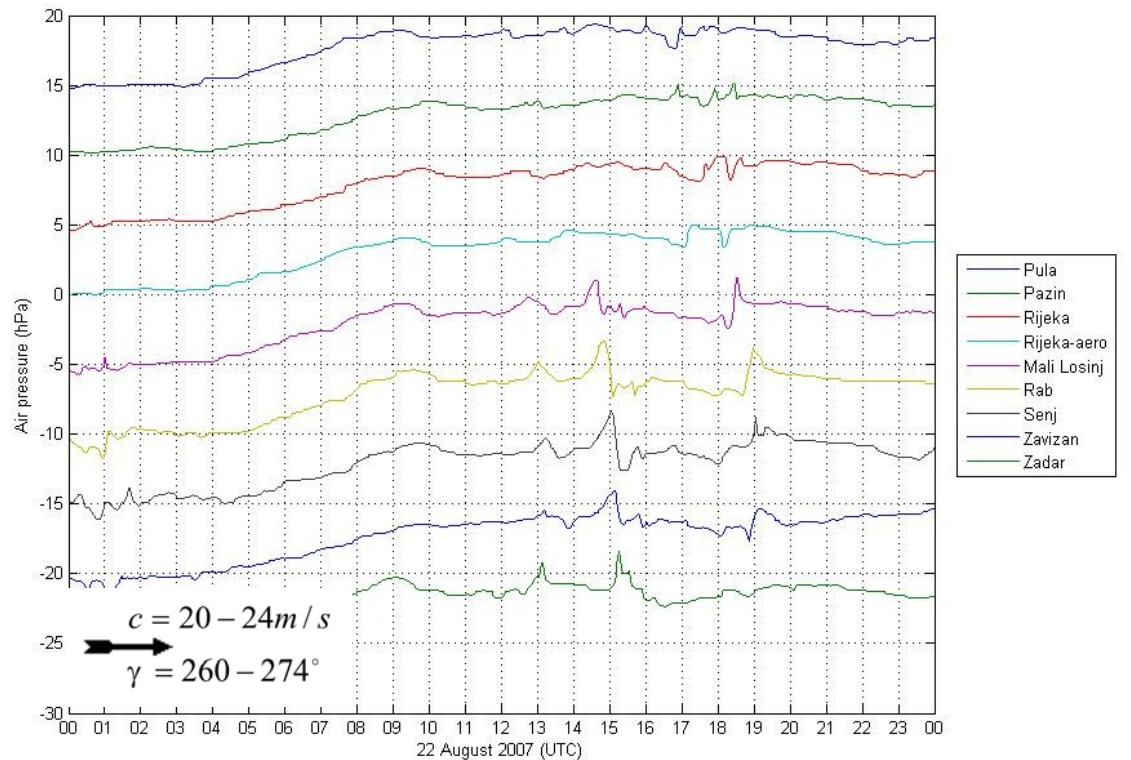
Ist, 22.08.2007.

The source

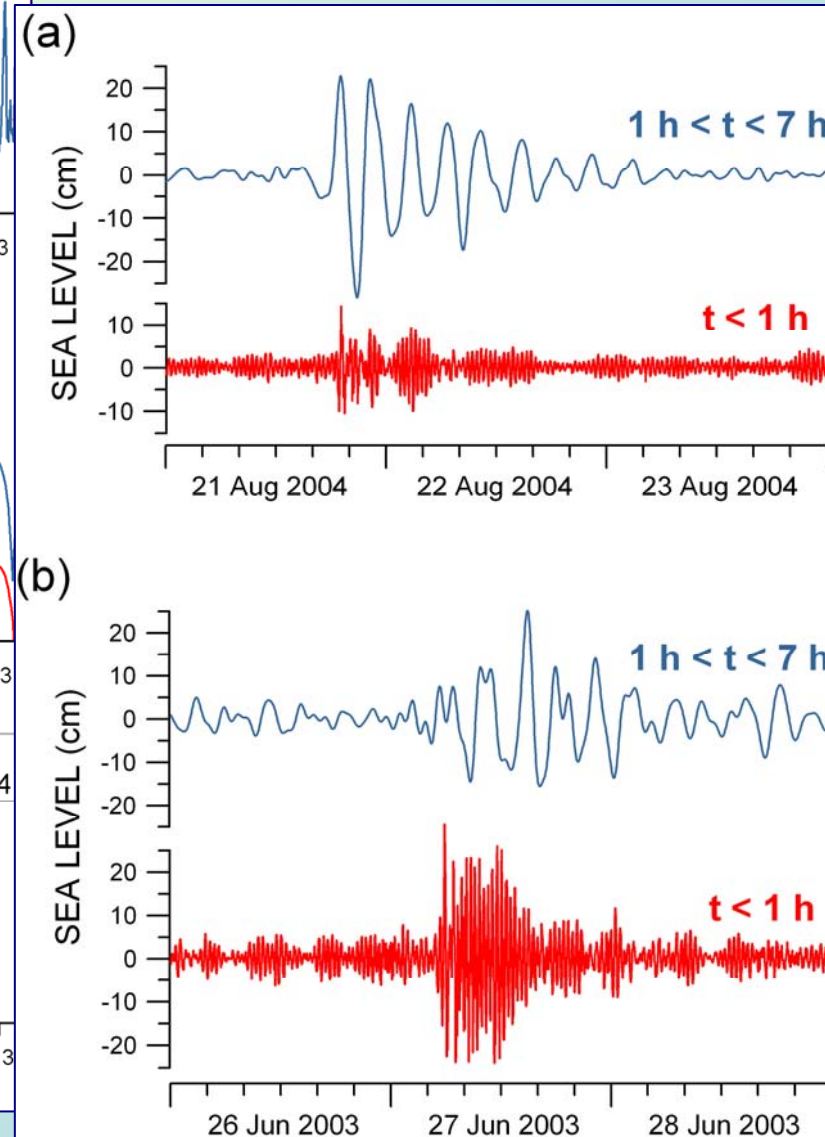
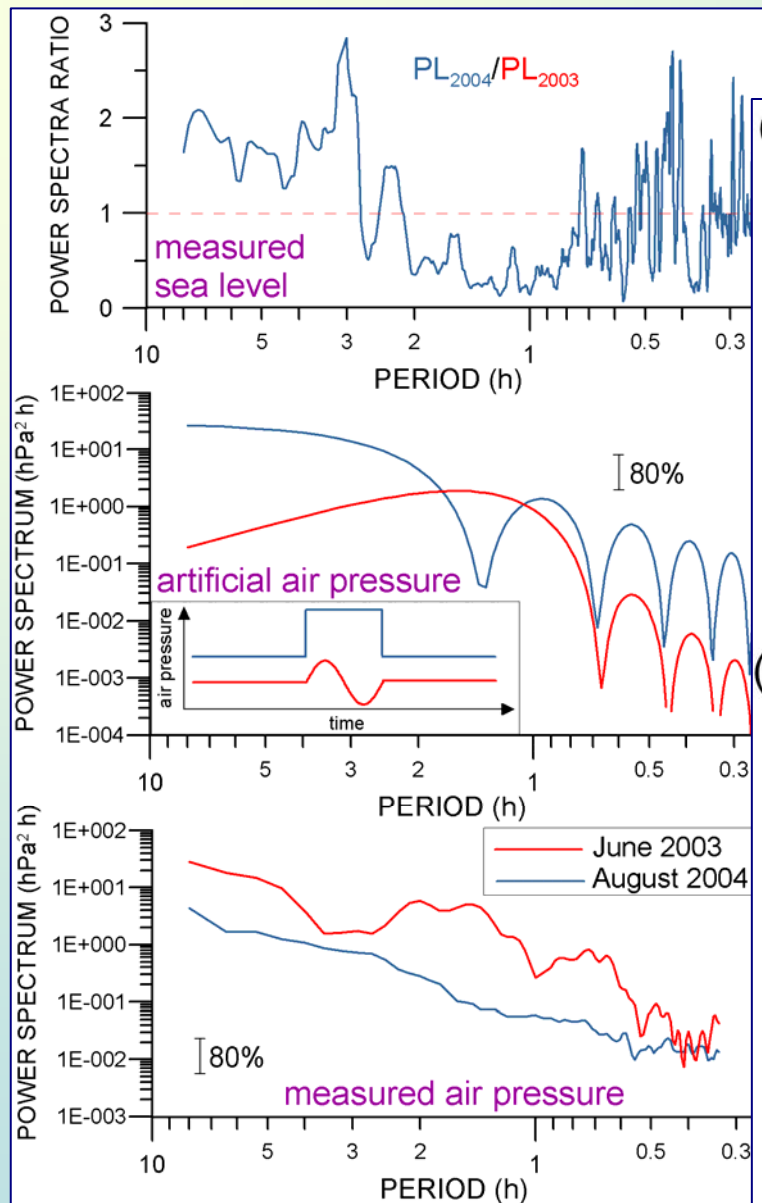
Šepić et al., work in progress.



... or by ducted
gravity wave ...



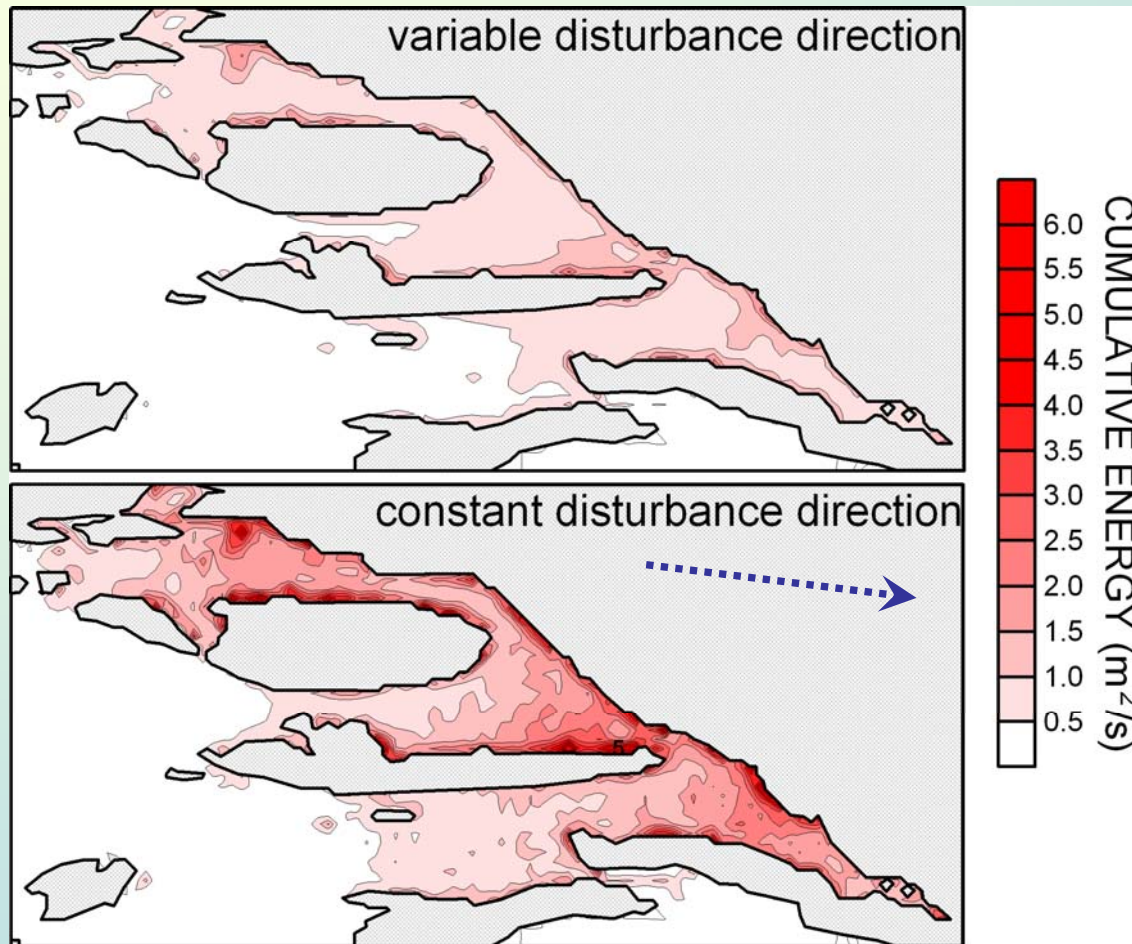
The source



Vilibić et al., 2005

... where a small changes in energy content may significantly change the sea response.

Vilibić and Beg Paklar, 2006

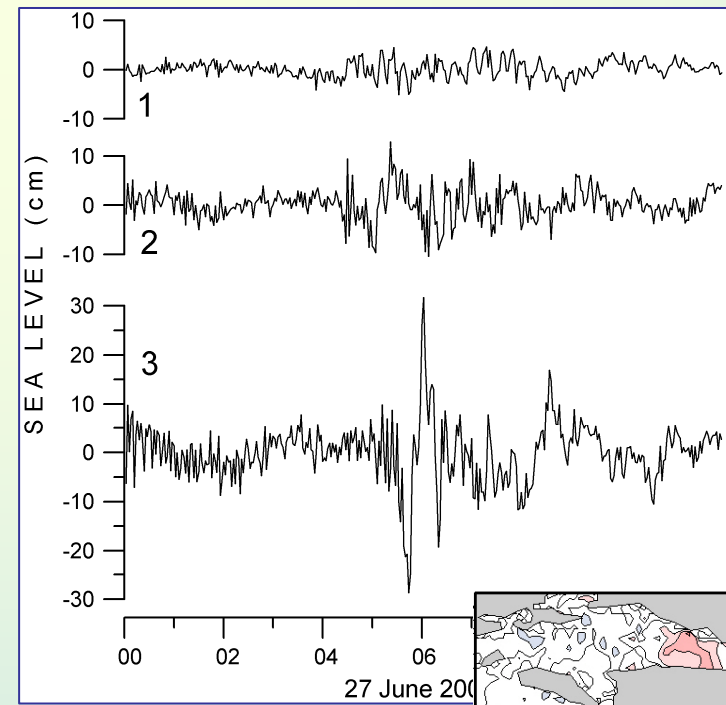


**But, what about middle Adriatic islands?
Do they affect the generation of the ocean waves?
Are other than Proudman resonance occurring there?**

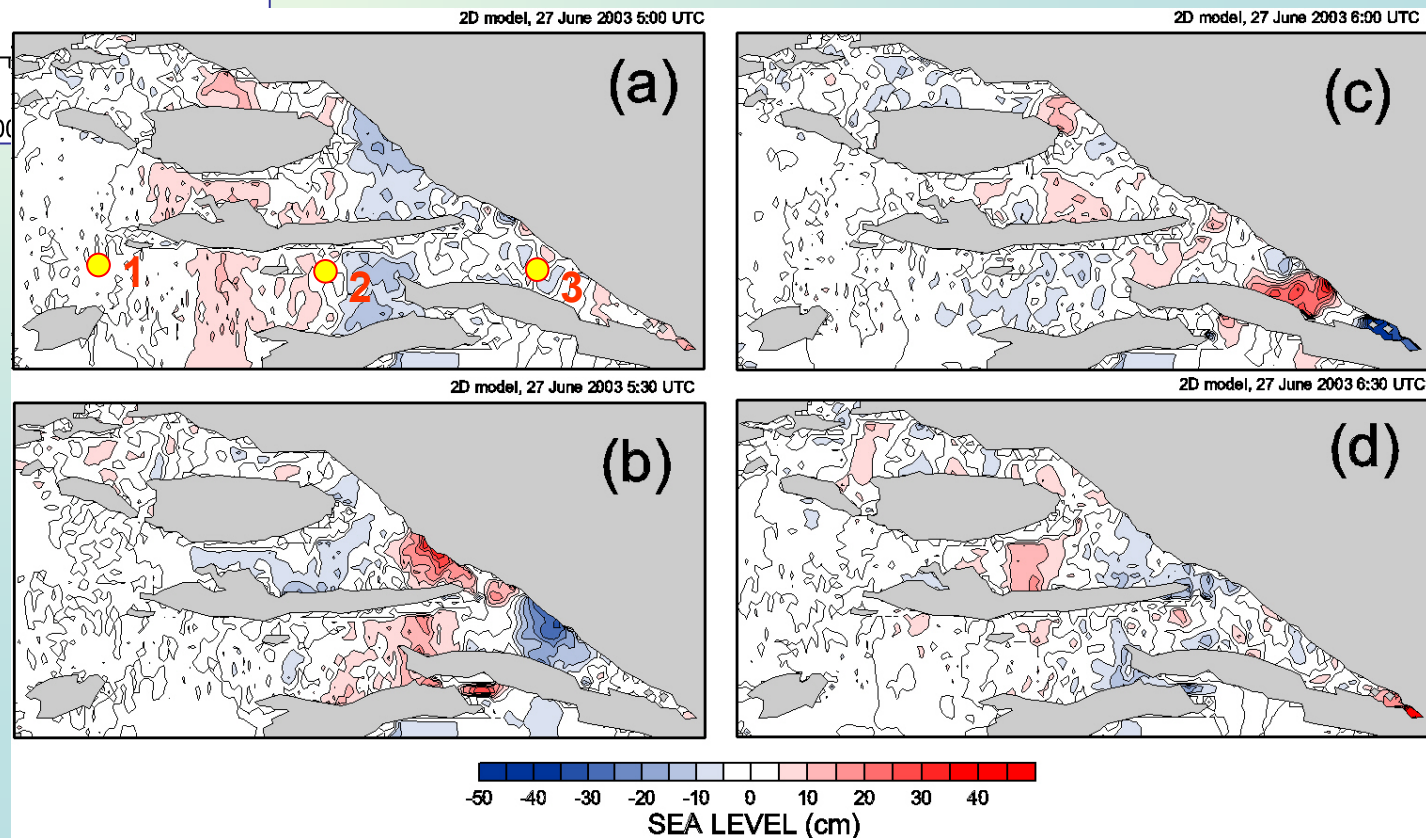
Generation

At least we know that the Proudman resonance is occurring ...

Vilibić et al., 2004



Vilibić, 2008

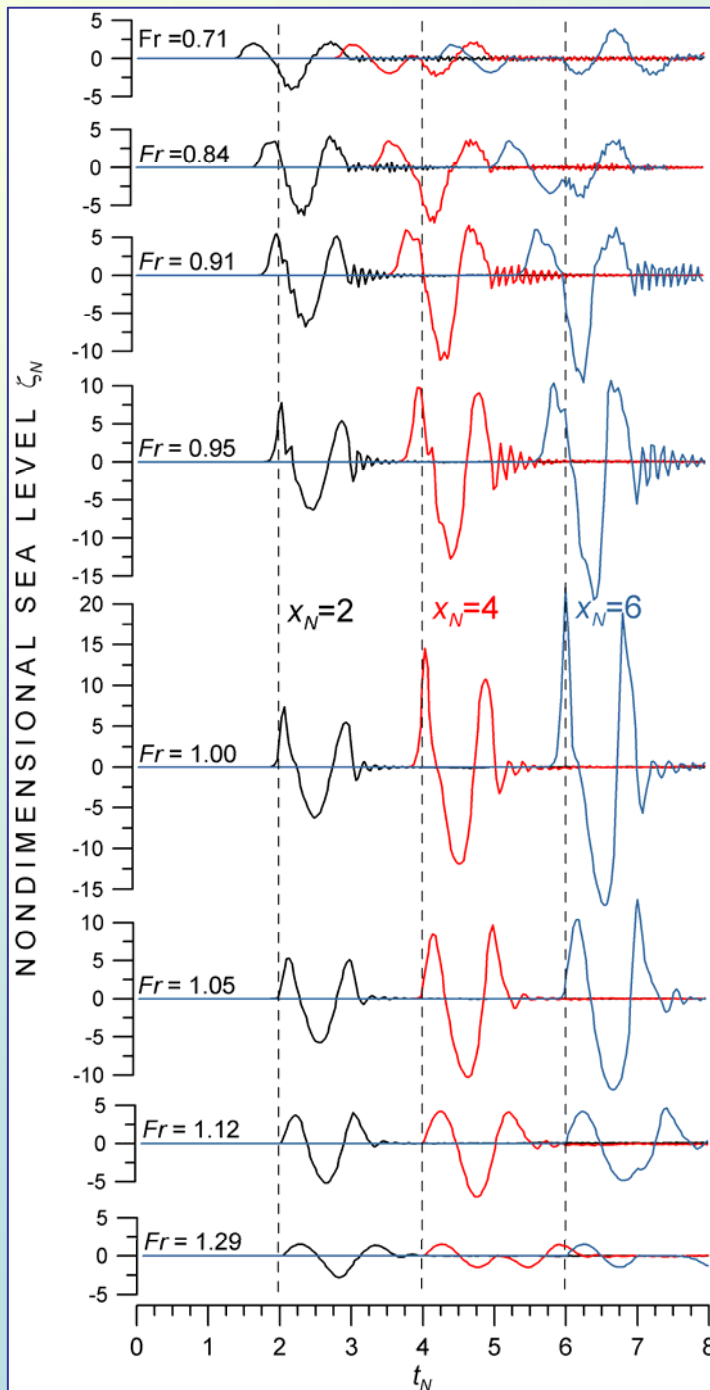
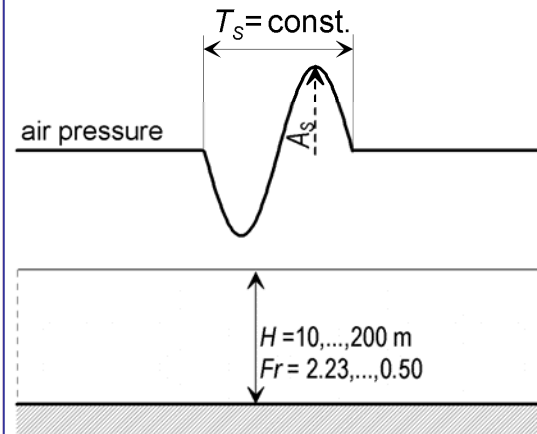


Generation

$$Fr = \frac{U}{\sqrt{gH}}$$

R1 exercise

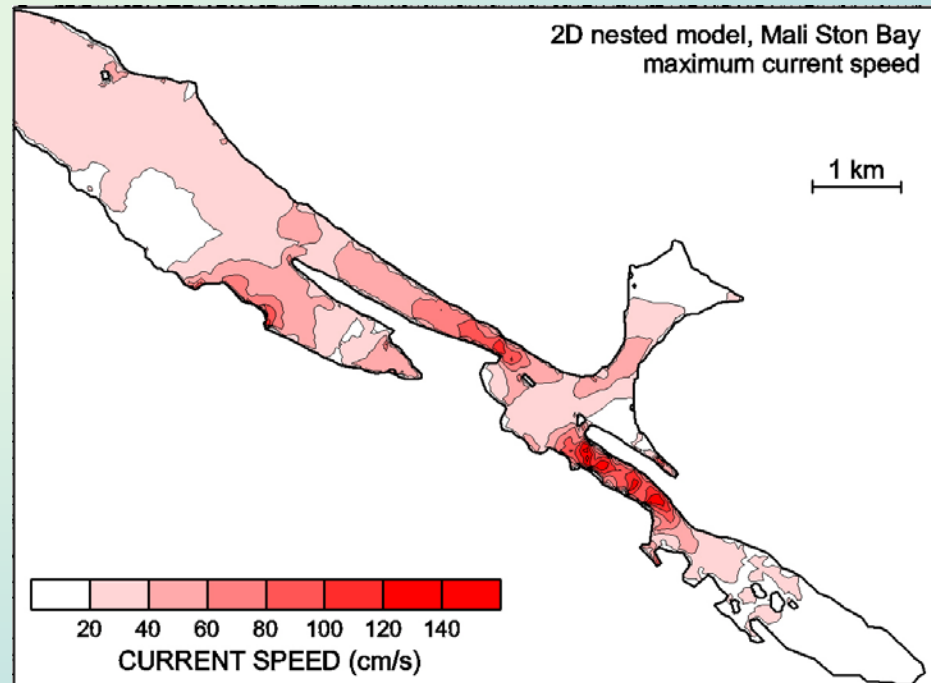
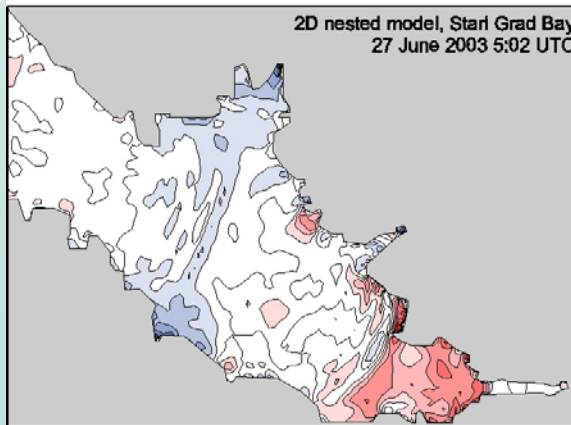
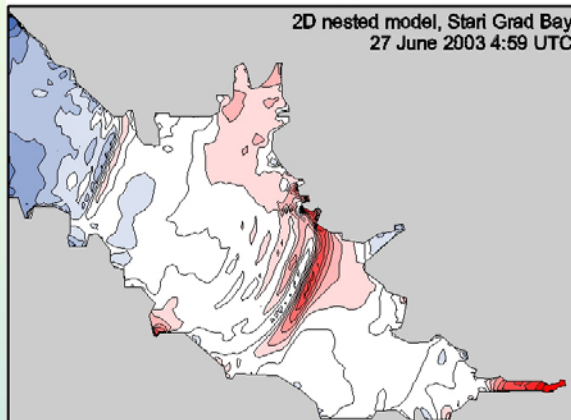
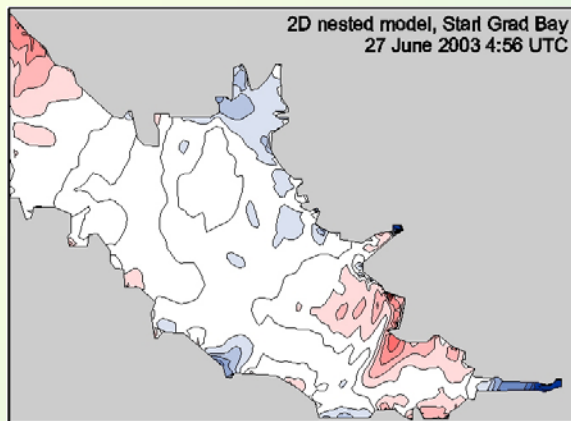
disturbance direction
 $U = \text{const.} = 22.15 \text{ m/s}$



... being very sensitive to
the bathymetry changes.

Coastal dynamics

Vilibić et al., 2004



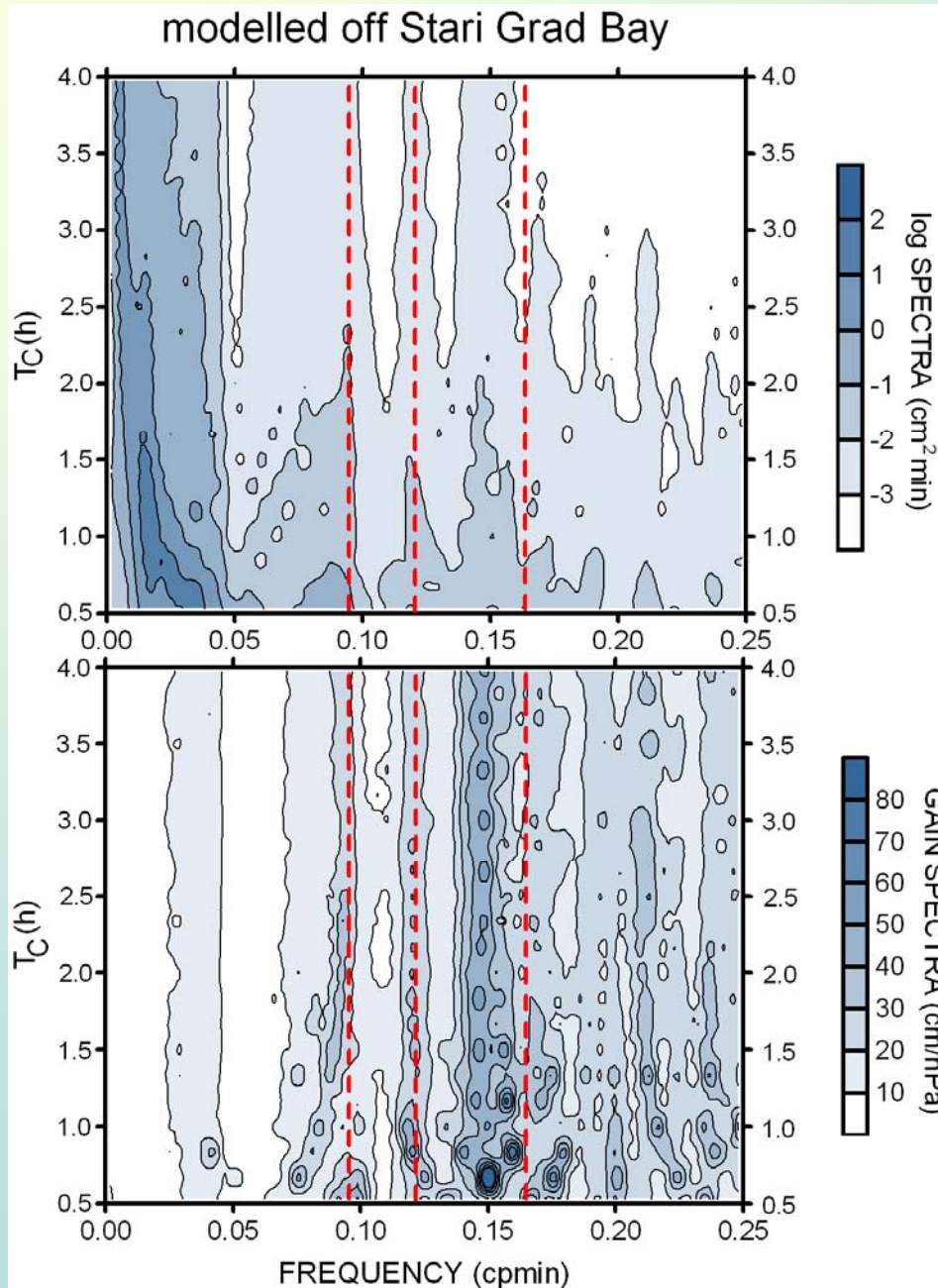
**They may attack the bays and
harbours severely by additional
amplification through the
harbour resonance ...**

Coastal dynamics



... but the arrival of the waves may be a bit strange ...

Coastal dynamics



... maybe being amplified through coupling with the outer basin free modes.

Ok, what we do get?

The source of the Adriatic meteotsunamis are in atmosphere ...

... being in the form of travelling wave-CISK or ducted gravity wave ...

... causing resonant transfer of energy towards the sea (Proudman resonance) ...

... amplifying topographically in front of the affected areas ...

... but they reach destructive levels inside the well-shaped bays and harbours (Široka Bay, Vela Luka, Stari Grad and Mali Ston Bays).

What we did not (or could not) get?

We need non-standard meteorological measurements (air pressure) of high resolution (1 min or less), 10 min is not enough ...

... and permanent high-resolution sea level measurements at hot spots – its installation is a preconditioning for successful meteotsunami research!

Atmospheric mesoscale models are still not capturing properly intensity and time-space characteristics of the disturbances ...

... also ocean models, which need high-resolution bathymetry (also coastal elevation maps)!

Then we will be able to proceed with long-term monitoring and research studies, proper verification of the models, impact assessment studies, eventual protection and mitigation measures, and finally effective meteotsunami warning system.