

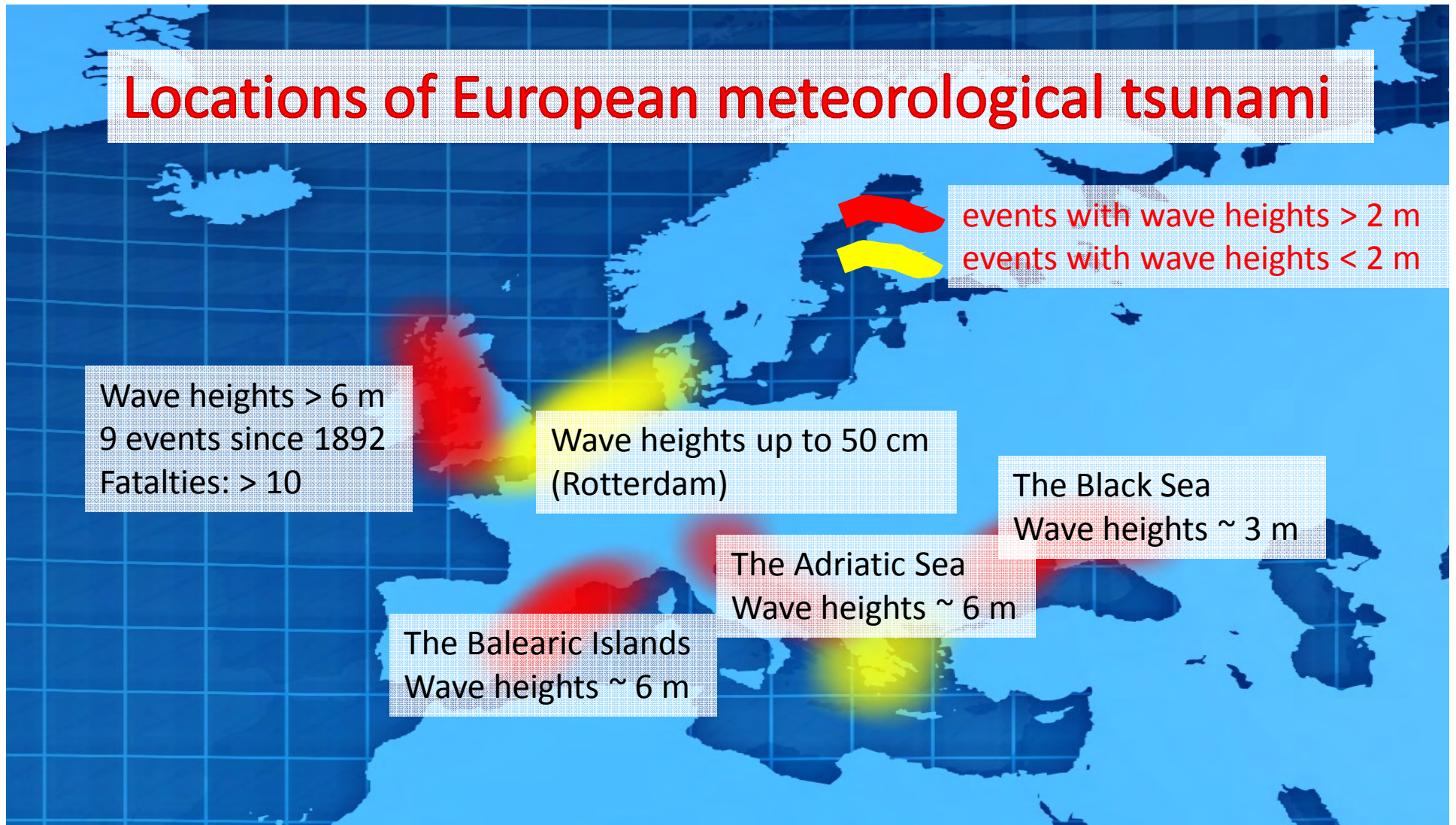


Extreme meteorological tsunamis

and their environmental impact

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Locations of European meteorological tsunami



The Adriatic meteorological tsunamis



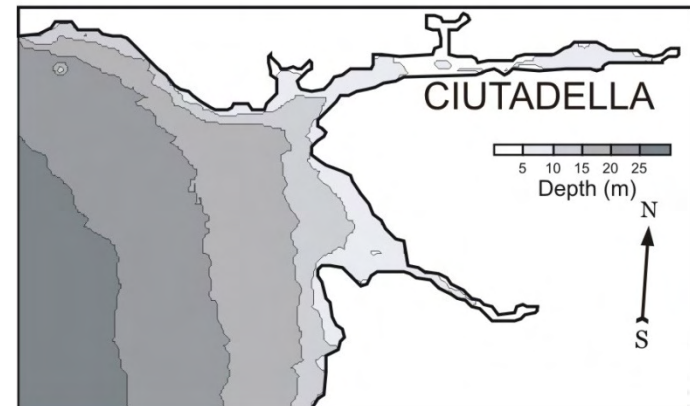
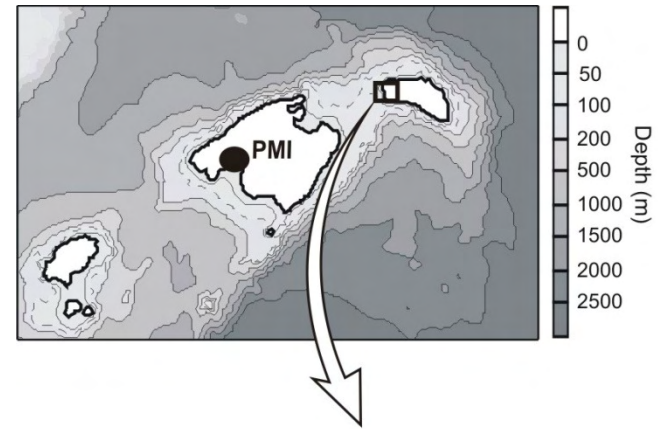
Vela Luka meteorological tsunami of 21 June 1978

- Sea level rising 3 m in 10 minutes
- Sea level dropping 6 m in next 10 minutes



The Balearic Islands meteotsunami of 15 June 2006

- Ciutadella port on Menorca Island
- Wave heights up to 6 m
- Great damage

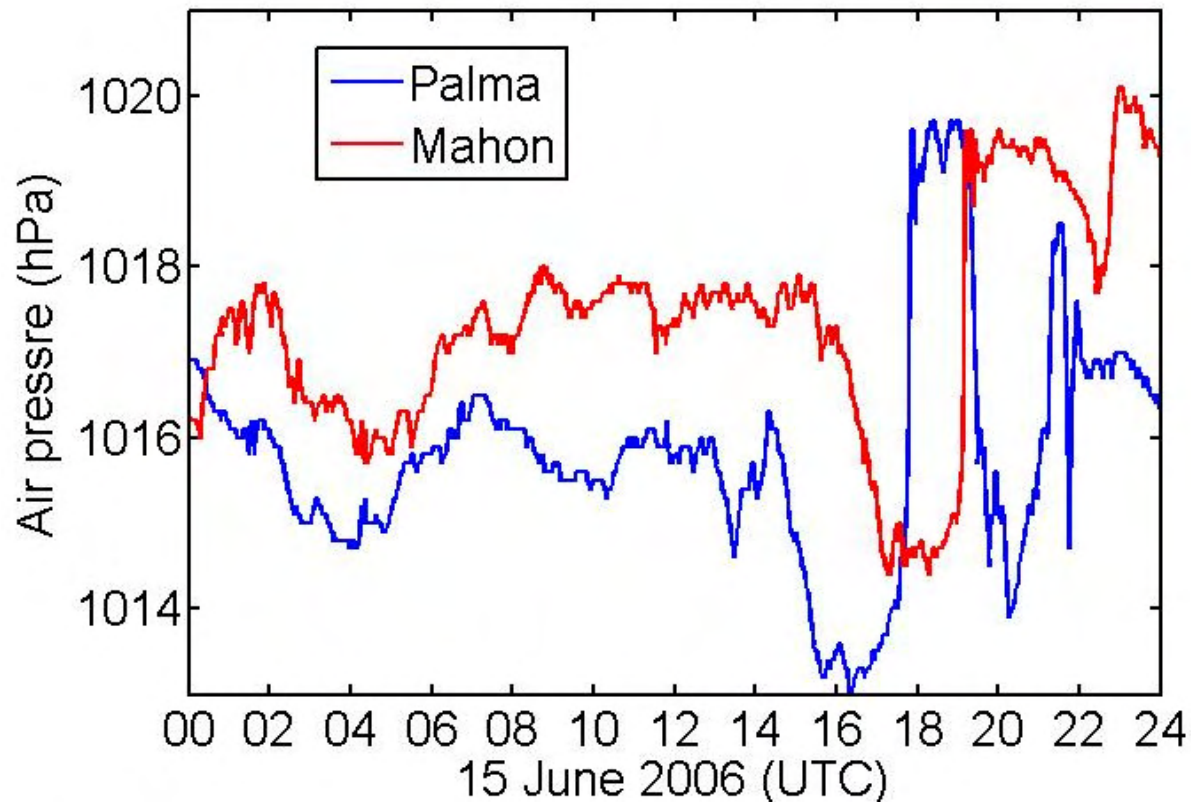


The Balearic Islands meteotsunami of 15 June 2006

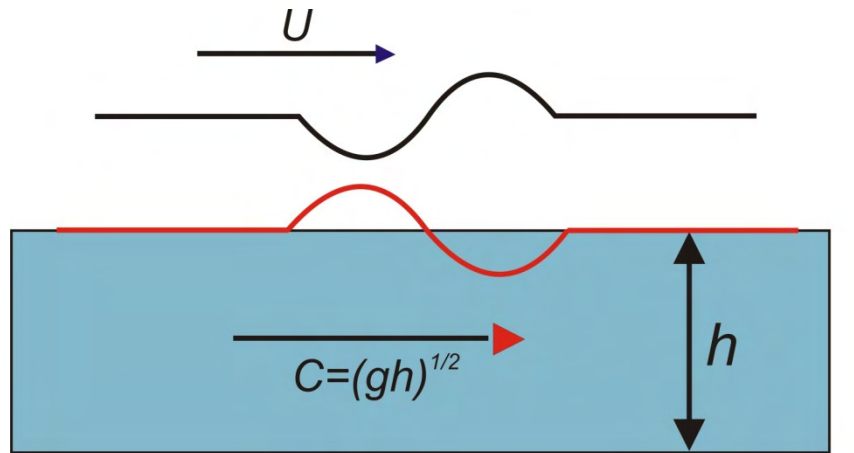


The Balearic Islands meteotsunami of 15 June 2006

- Cause of the meteotsunami: sudden air pressure change.



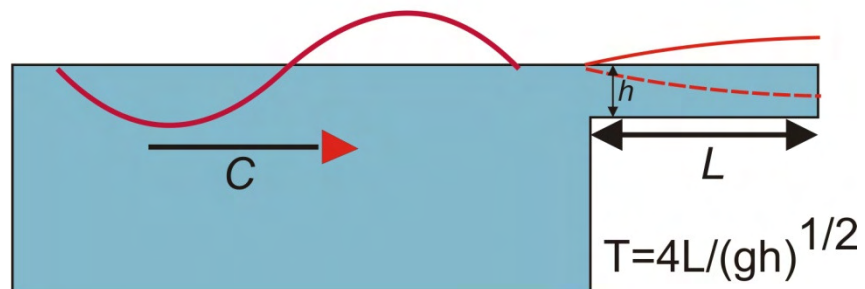
Meteorological tsunami generation mechanism



Proudman resonance:

resonant transfer of energy from moving air pressure disturbance to barotropic sea waves.

Several resonances needed!



Harbour resonance:

resonant transfer of energy from open sea waves to eigen-oscillations (seiches) of harbour

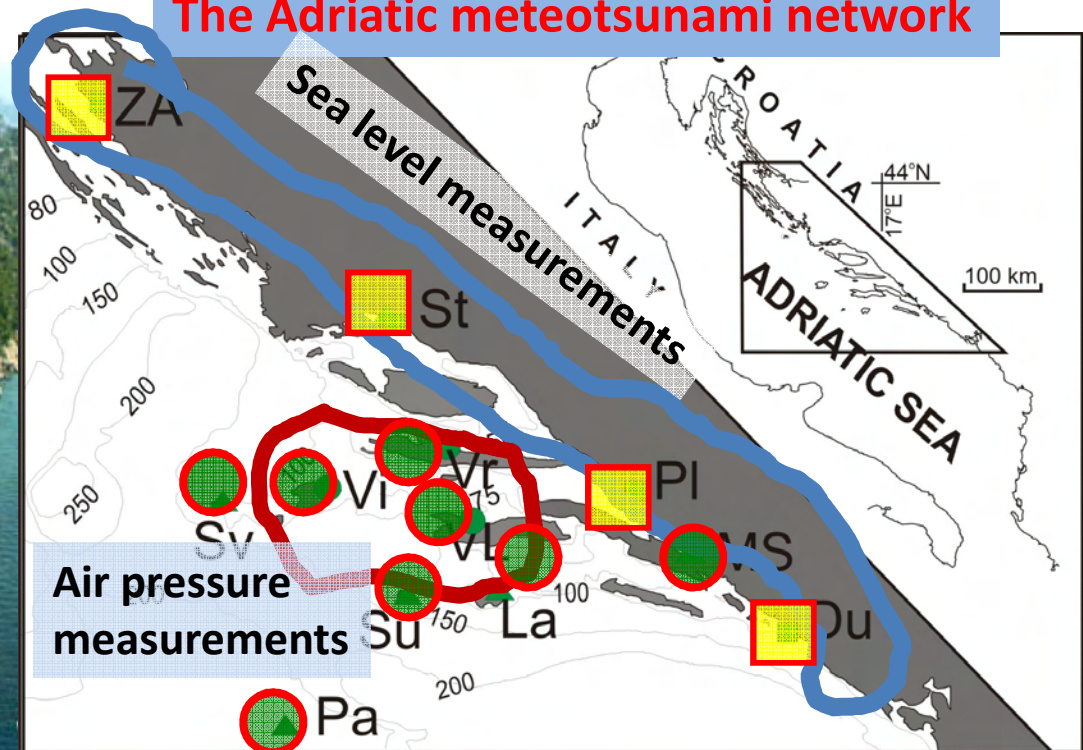
Interest in two things (aside from research):

- How to assess meteotsunami danger & **create efficient warning system?**
- How will future meteorological tsunamis be **affected by climate change?**

Meteotsunami warning system

An efficient warning system can be created!

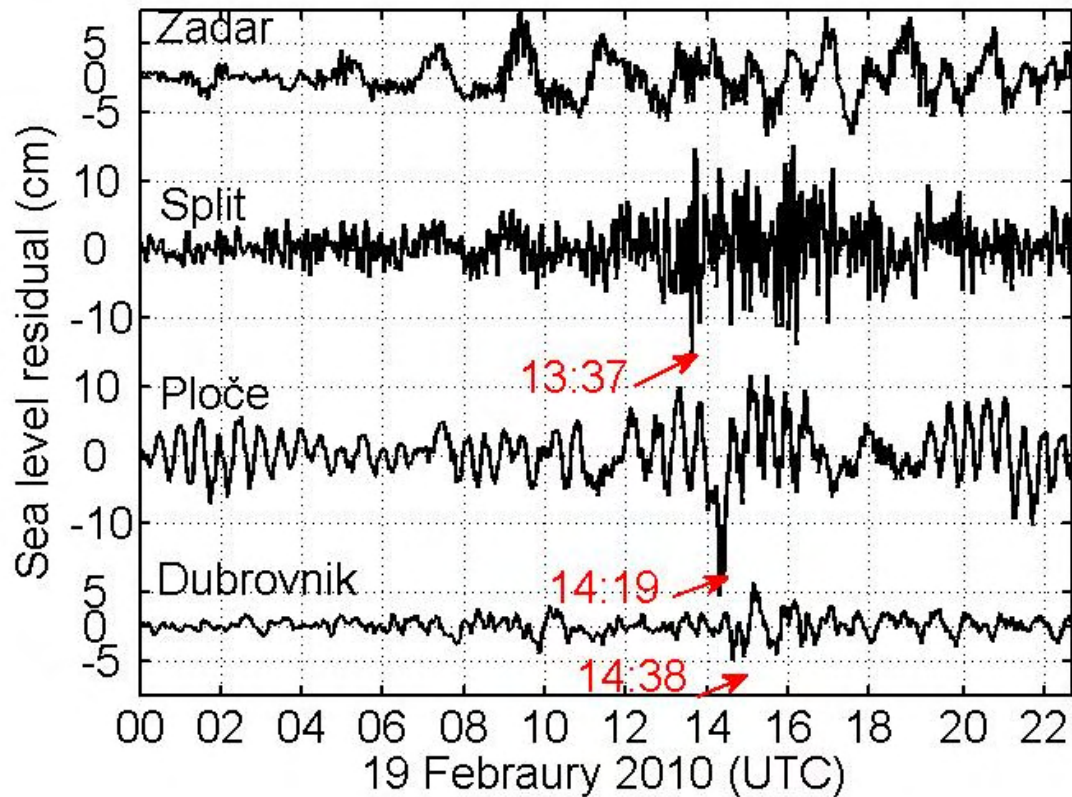
The Adriatic meteotsunami network



Meteotsunami decision matrix... Stari Grad Harbour

| Pressure tendency (hPa/5 min) | Velocity (m/s) | Direction (°) | Meteotsunami danger |
|-------------------------------|--------------------|------------------------|-----------------------------|
| > 2.0 | [21-23] | [270-290] | Large meteotsunami possible |
| > 2.0 | [21-23] | [235-270] or [290-325] | Moderate |
| > 2.0 | [17-21] or [23-27] | [270-290] | Moderate |
| [1.0 – 2.0] | [21-23] | [270-290] | Moderate |
| > 2.0 | [17-21] or [23-27] | [235-270] or [290-325] | Low |
| [1.0 – 2.0] | [21-23] | [235-270] or [290-325] | Low |
| [1.0– 2.0] | [17-21] or [23-27] | [270-290] | Low |
| [1.0 – 2.0] | [17-21] or [23-27] | [235-270] or [290-325] | Very low |

The Adriatic meteotsunami warning system

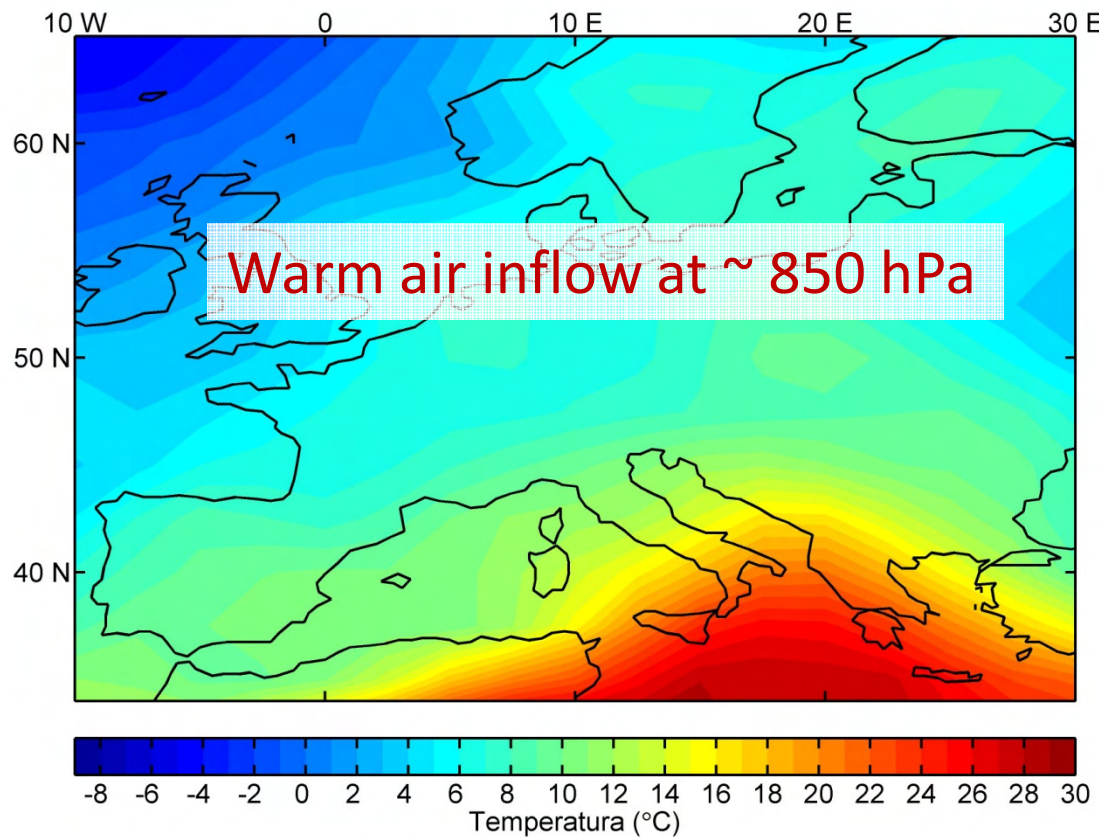


Meteotsunamis under climate change

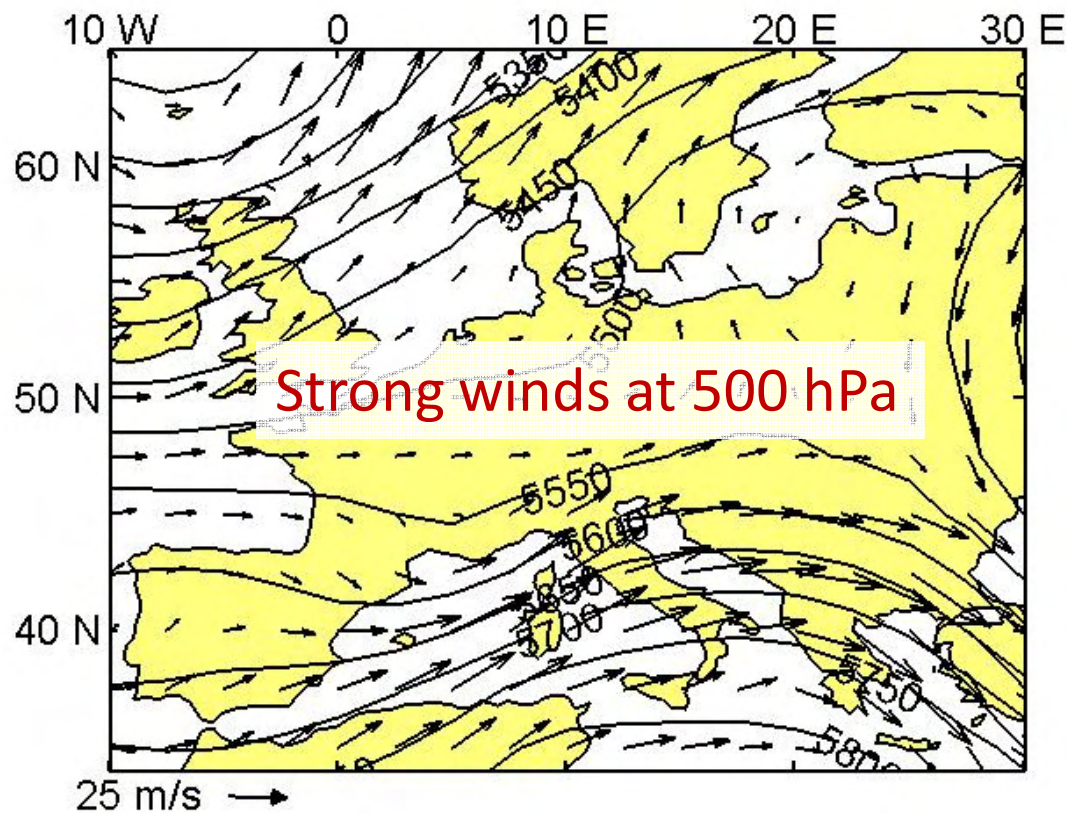
- Can meteotsunamis be modelled?
 - Individual events can be modelled (in atmosphere and in the sea separately)
- Can meteotsunamis be modelled with global or regional climate models? **No!** Inappropriate temporal and spatial scales.
 - However... Perhaps statistical downscaling of synoptic conditions is an answer...

Typical atmospheric conditions during the Mediterranean meteotsunamis

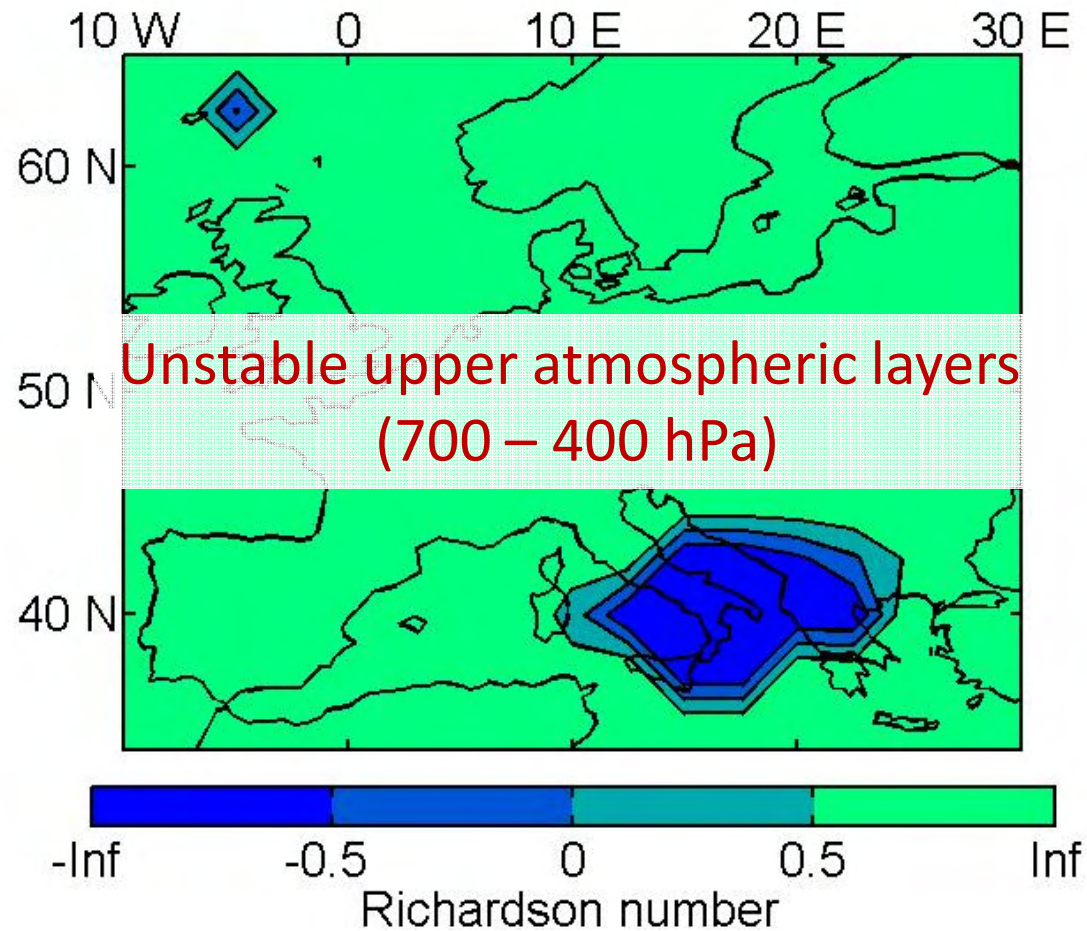
- Meteotsunami, Vela Luka, 21 June 1978



Typical atmospheric conditions during the Mediterranean meteotsunamis



Typical atmospheric conditions during the Mediterranean meteotsunamis



A world map is centered on the slide, rendered in a light blue color. The map is overlaid on a dark blue background that features a grid of lighter blue lines, representing latitude and longitude. The map shows the continents of North America, South America, Europe, Africa, Asia, and Australia.

Thank you for your attention!

Questions?