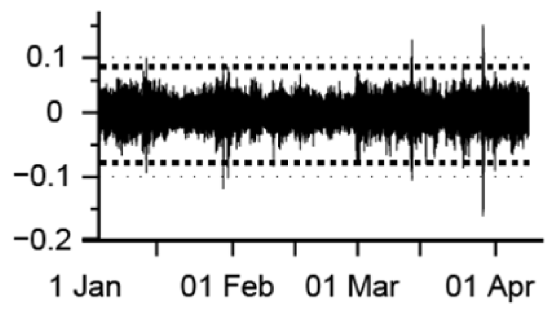
What is a meteotsunami?

A simple definition:

- 'Looks like an earthquake tsunami, but it's not!
- Elevated wave activity caused by amplification of the inverted barometer effect.

Identifying a wave event as a 'meteotsunami' is difficult as around 99% of energy within the tsunami frequency band (2 mins –2 hours) is related to meteorological forcing. Literature suggests events with a wave height exceeding 4σ be classified as meteotsunamis.

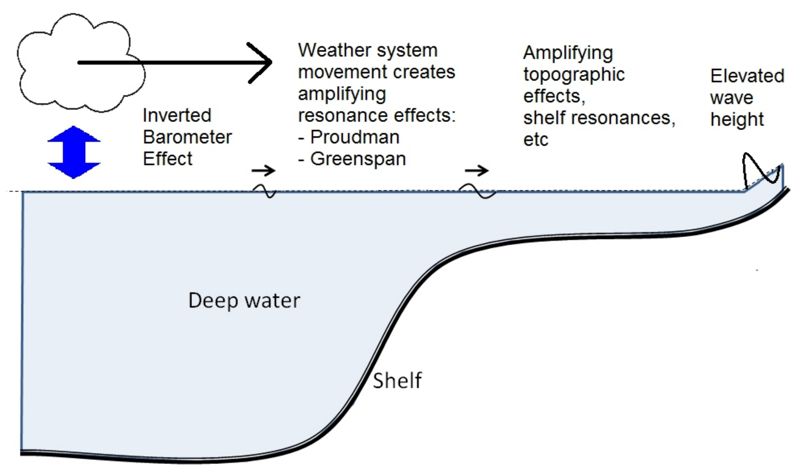


To overcome these difficulties, this research sought to identify events by the occurrence of amplifying mechanisms.

Some mechanisms involved

Typical amplifying mechanisms for a meteotsunami are:

- **Proudman Resonance:** where a pressure system moves at a similar speed and direction to the free wave it propagates
- **Greenspan Resonance:** where a pressure system moves at a similar speed and direction to a coastally trapped wave
- **Topographic effects:** e.g. harbour seiching, topographic funnelling, shoaling, continental shelf resonance



Some interesting examples

Frequenting Western Australia

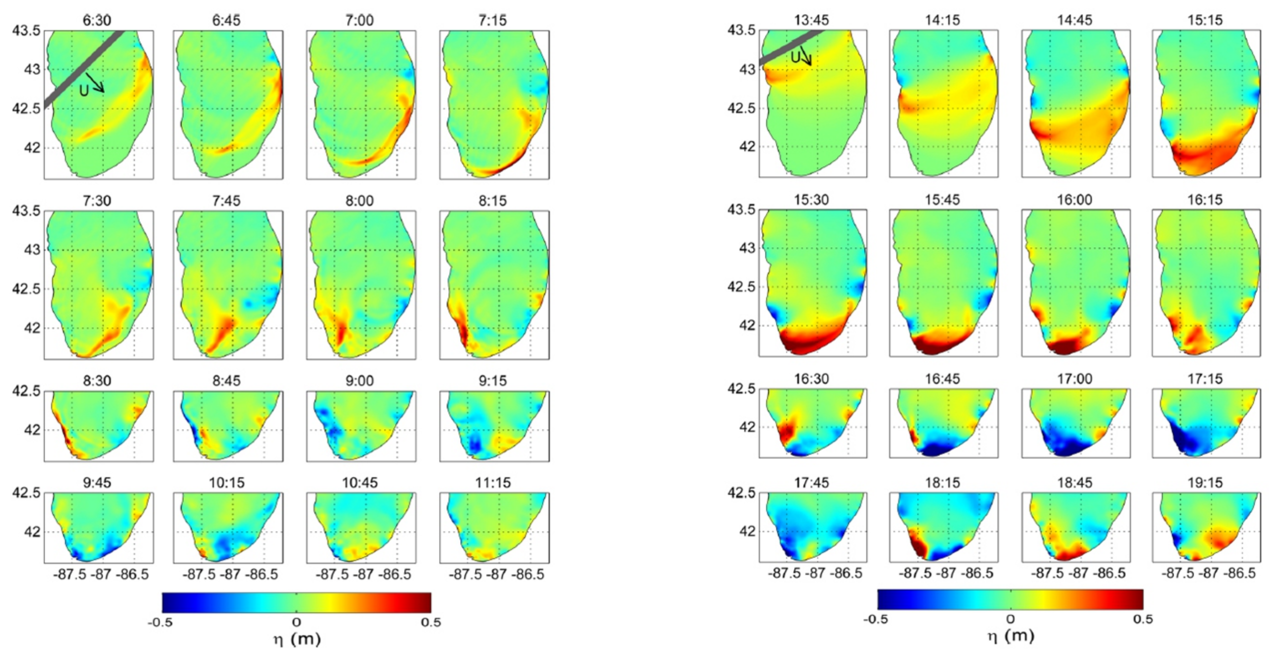
Research led by Professor Charitha Pattiaratchi at University of WA identified 25 meteotsunami events occurring in WA during 2014, including an event which caused a container ship to break its moorings and cause damage to the rail bridge in Fremantle Harbour.

Pattiaratchi, CB et al. *2015, Are Meteotsunamis an underrated hazard?*

Chicago 1954

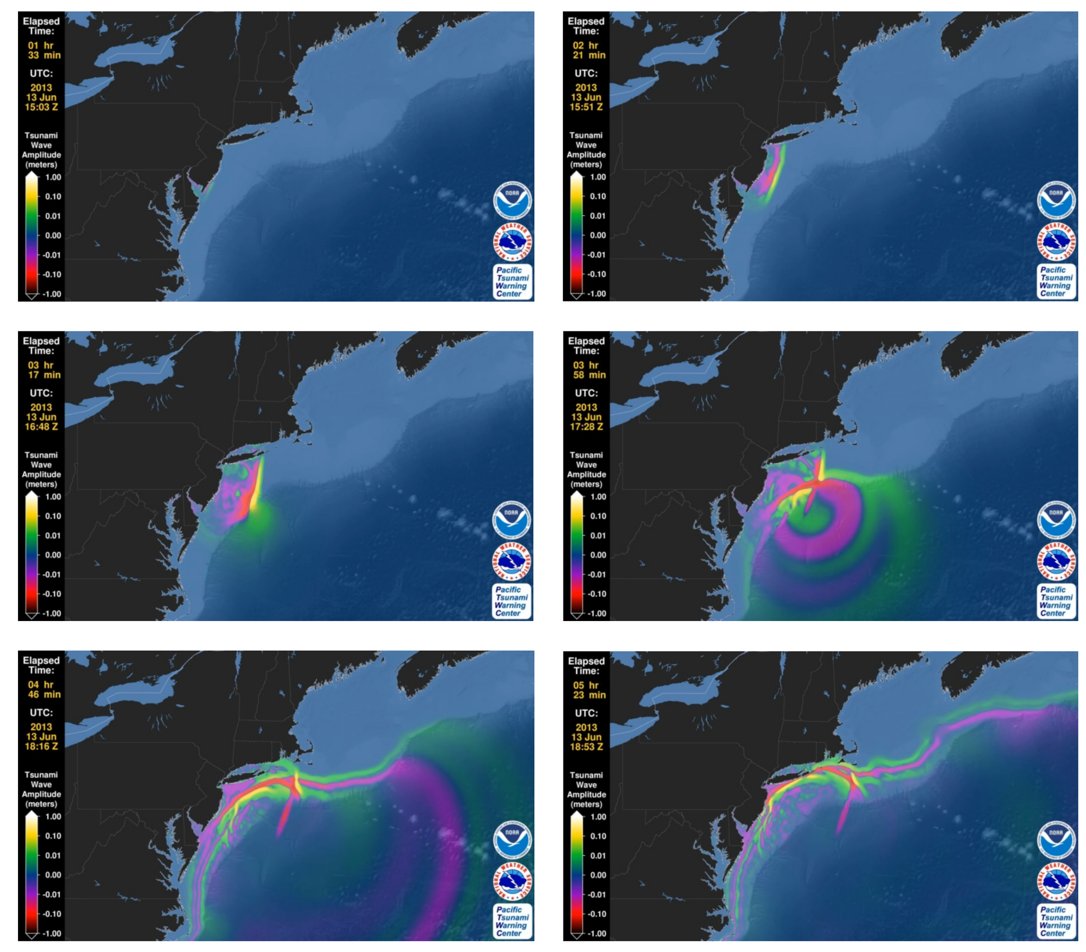
June 26 1954
Proudman resonance occurred as a squall passed over Lake Michigan, the reflected wave struck Chicago where a 3m wave was reported and 7 lives were lost.

July 6 1954
Greenspan resonance occurred with the squall passing more perpendicularly to the shore. A max height of 1.25m was recorded and less damage occurred, with the city being better prepared.



Bechle et al. 2014, *The Lake Michigan meteotsunami of 1954 revisited*

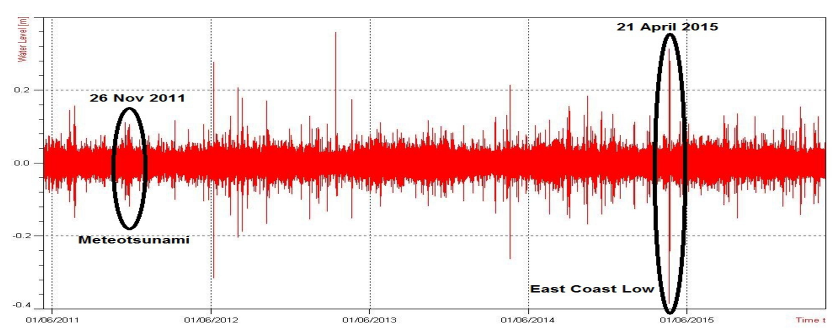
USA East Coast meteotsunami reflected at shelf edge



Bailey et al. 2014, *An Examination of the June 2013 East Coast Meteotsunami Captured by NOAA Observing Systems*

Developing a method to identify meteotsunamis

A method for identifying meteotsunami events is developed for occurrences at Sydney in 2013.

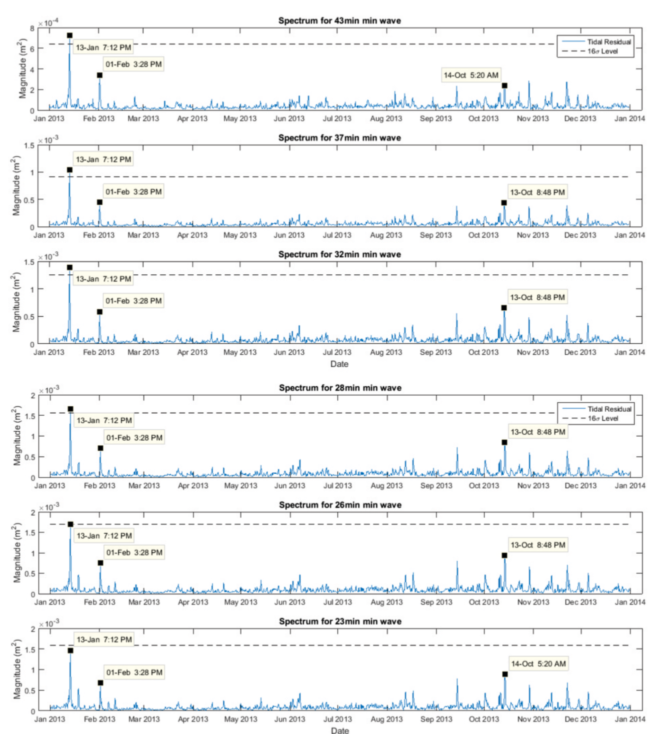


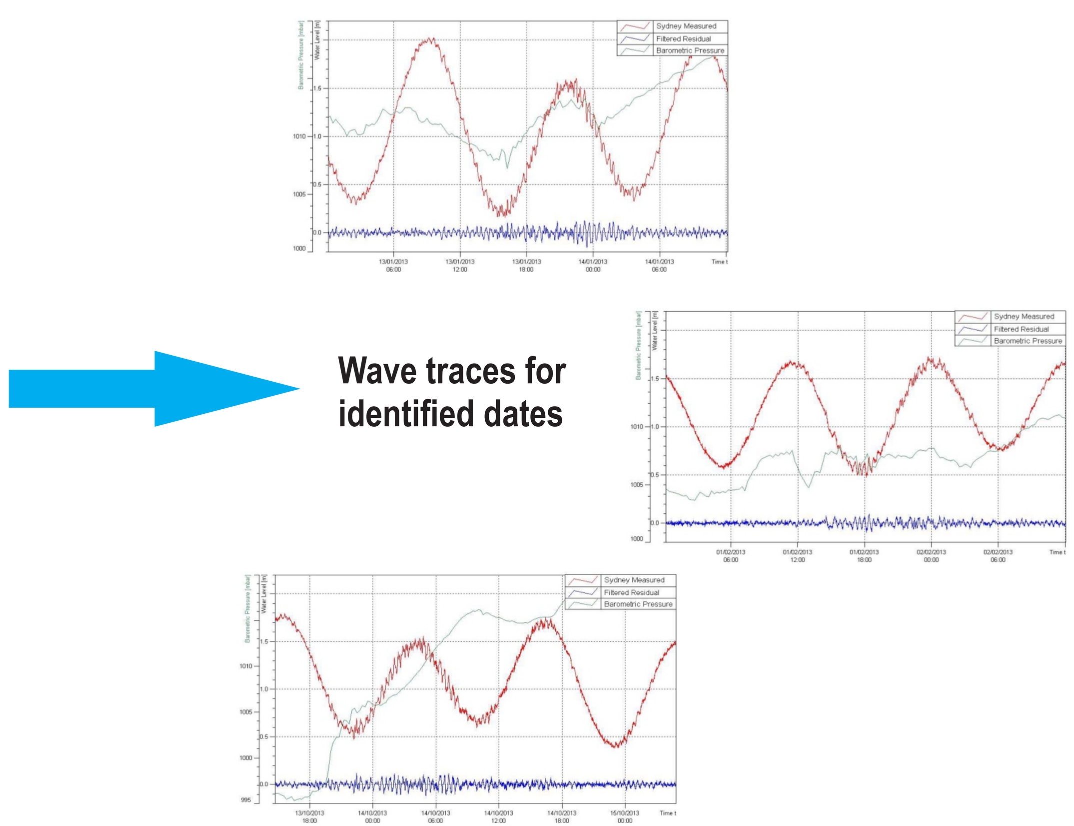
ECLs create difficulties in identification

Fourier Analysis Methodology

Occurrence of East Coast Lows creates difficulty in identifying NSW meteotsunamis using a 4σ wave height threshold. Fourier analysis is used to detect dates with elevated energy within the meteotsunami wave bands.

High energy dates

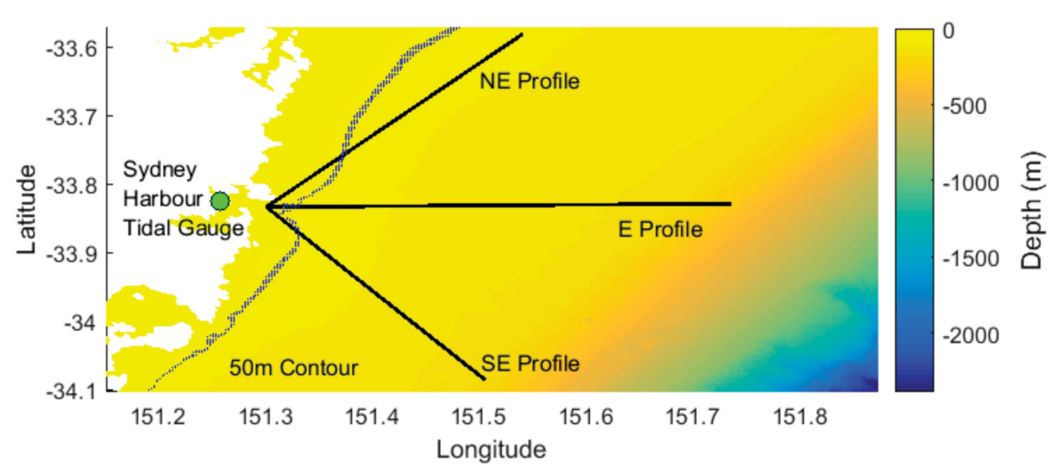




Exploring theoretical methodologies

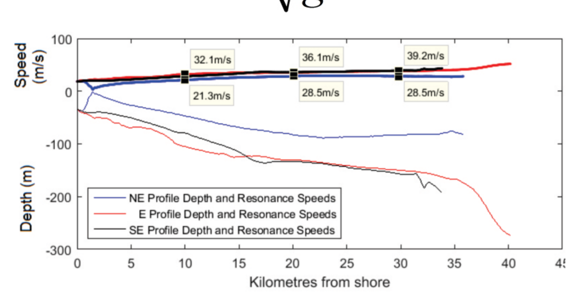
Understanding theoretical resonance conditions could allow causative barometric conditions to be detected and possibly forecast.

Theoretical resonance conditions for Sydney were calculated by constructing onshore and longshore bathymetric profiles.



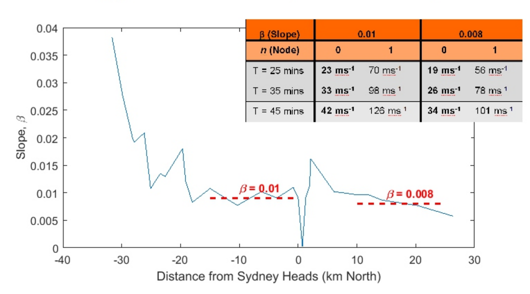
Proudman Resonance Conditions

$$c = \sqrt{gh}$$

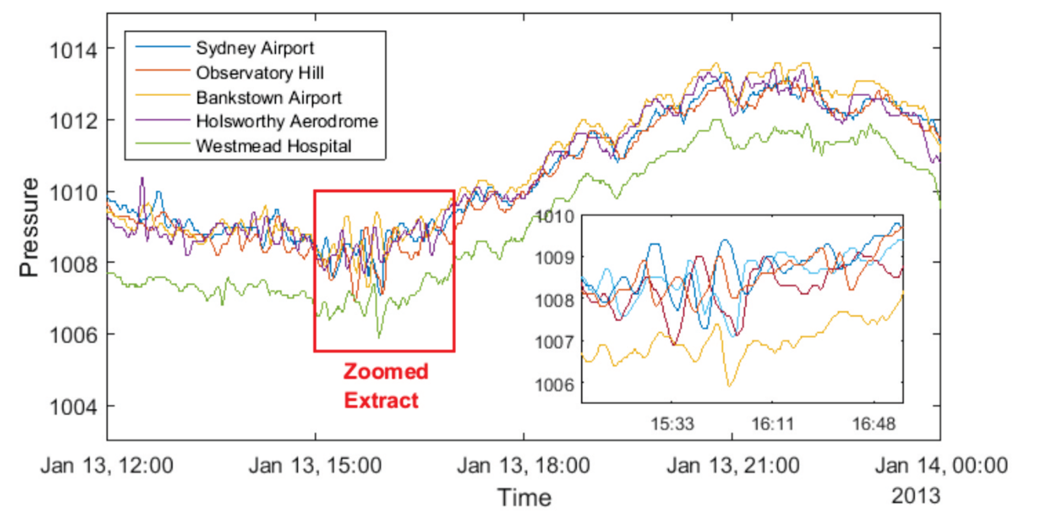


Greenspan Resonance Conditions

$$c_{edge} = gT\tan(\beta(2n+1))$$



Barometric conditions producing resonance were then sought to be identified in data. Below is the barometric data for January 13. It is apparent that the data is inadequate for the analysis.



NSW GOVERNMENT | Public Works
Manly Hydraulics Laboratory

Research undertaken by Ben Blumberg, Rob Jacobs and Indra Jayewardene,

with acknowledgement to Andy Taylor of BoM

Conclusions

- High spatial and temporal resolution bathymetry data would extend modelling and predictive capabilities.
- High resolution water level recording within NSW lakes and estuaries would improve monitoring, modelling, and predictive capabilities by allowing detection of shorter period wave energy.