4th International Workshop on Waves, Storm Surges and Coastal Hazards

Incorporating the 18th International Waves Workshop



The Rising Threat of Southern Ocean Swells to the Pacific Coastal Communities of the Americas

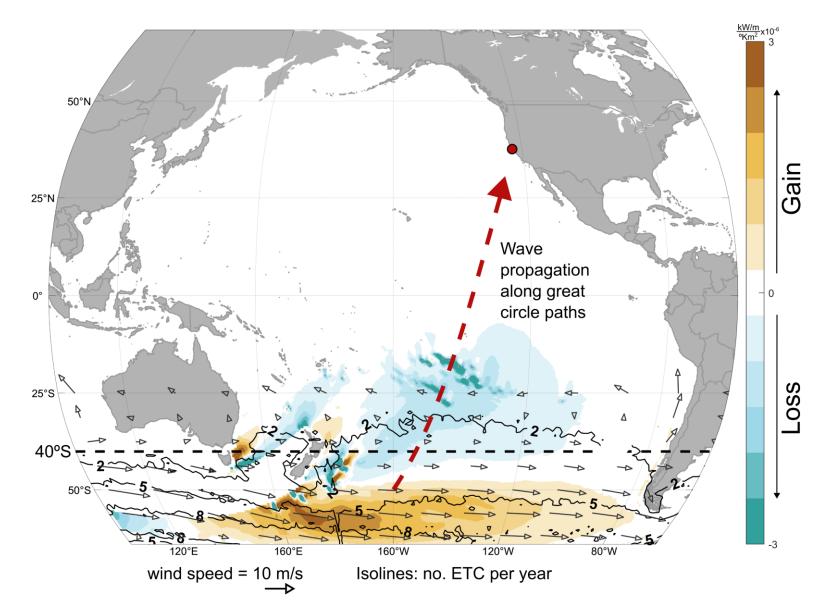
<u>Hector Lobeto (lobetoh@unican.es),</u> Melisa Menendez, Alvaro Semedo, Iñigo J. Losada, Gil Lemos

Incorporating the 18th International Waves Workshop

- 1. Context
- 2. Data
- 3. Method
- 4. Results
- 5. Conclusions

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Southern Ocean swells are generated in the extra-tropical region of the Southern Hemisphere, radiating to every ocean basins and reaching very distant coasts, even in the Northern hemisphere.





Southern Ocean swells **pose significant threats** to many coastal region **globally**, including low-lying **islands** and continental margins.

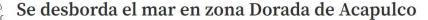
♠ Escuchar

News reports



Mar de fondo: las otras ocasiones en las que las olas del mar han arrasado y provocado daños en las costas de Guatemala

El fenómeno conocido como mar de fondo que arrasó en el Pacífico va había ocurrido en otras ocasiones en C



Protección Civil dice que es un fenómeno cíclico conocido como mar de fondo que provoca fuertes oleajes, por lo cual exhorta a la población y a bañistas a tomar precauciones.







Mié, 21/06/2006

a la población

Europa Press

La marejada que azota las costas del Pacífico desde el domingo ha causado importantes pérdidas materiales en Guatemala, El Salvador, Ni PERÚ:

inundaron, y evacuaciones d registraron heridos ni muert

afectado por las grandes ola Oleajes anómalos produjeron daños en la infraestructura de playas de Ica, Arequipa y Tacna

La Dirección General de Capitanías y Guardacostas (Dicapi) precisó que actualmente hay nueve puertos cerrados debido a los oleajes anómalos en Arequipa.





Scientific publications



Distant-Source Swells Cause Coastal Inundation on Fiji's Coral Coast

Moritz Wandres^{1*}, Jérôme Aucan², Antonio Espejo¹, Naomi Jackson¹, Antoine De Ramon N'Yeurt³ and Hervé Damlamian¹

Coastal flooding in the Maldives: an assessment of historic events and their implications

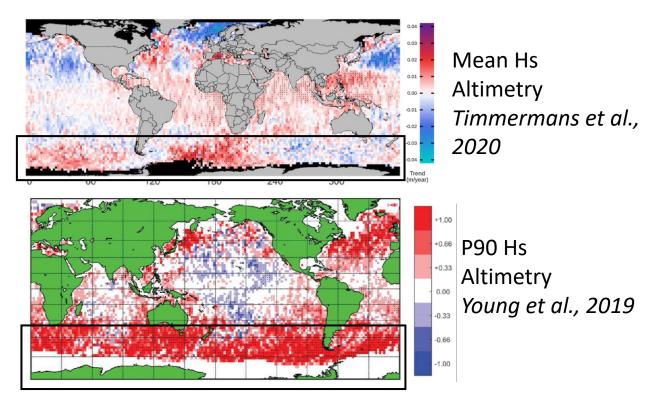
Matthew Wadey^{1,2} · Sally Brown¹ · Robert J. Nicholls¹ · Ivan Haigh^{3,4}

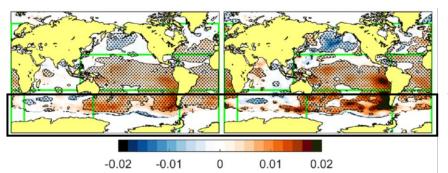
Coastline variability of several Latin American cities alongside Pacific Ocean due to the unusual "Sea Swell" events of 2015

P. Godwyn-Paulson · M. P. Jonathan . Francisco Reyes Hernandez · G. Muthusankar · C. Lakshumanan



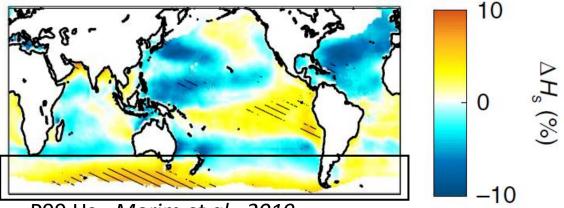
Positive trends in wave height in in the Southern Ocean in recent decades.



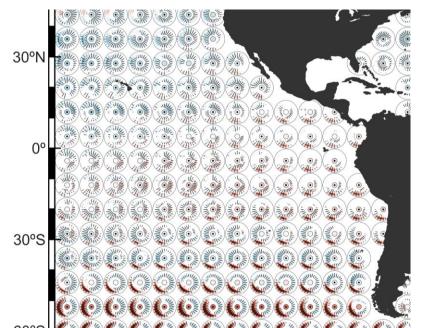


P50/P90 Hs Hindcast *Erikson et al., 2022*

Positive changes in wave height in in the Southern Ocean by the end of the century.



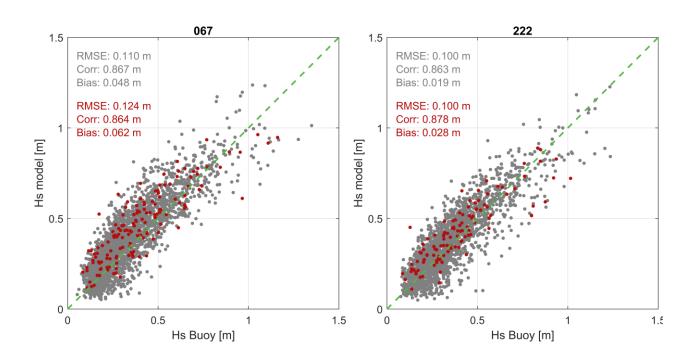
P99 Hs - Morim et al., 2019



Lobeto et al., 2022

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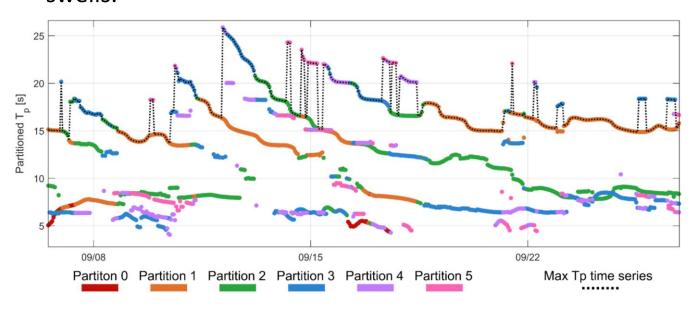
- **Hindcast** data developed with WaveWatch III (**ERA5** forcings).
- Period 1979-2023 (45 years).
- Six spectral partitions (1 wind sea + 5 swells).
- Data at 22 coastal target locations.
- Validation against spectral buoys.







- Swell events are identified by analyzing the decrease in Tp at the coastal location.
- Swell origins determined rom the relation between Tp slope and distance travelled by swells.



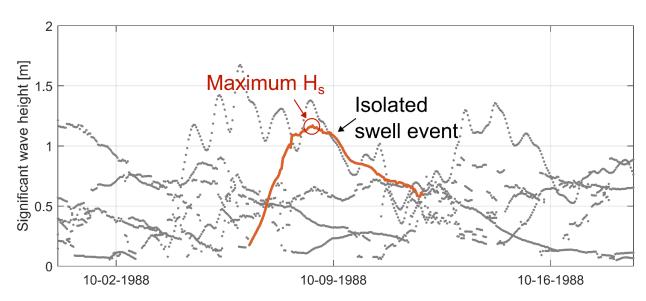


- All partitions are analyzed jointly.
- Each arriving **swell** is **not** consistently represented by the **same partition** over time.

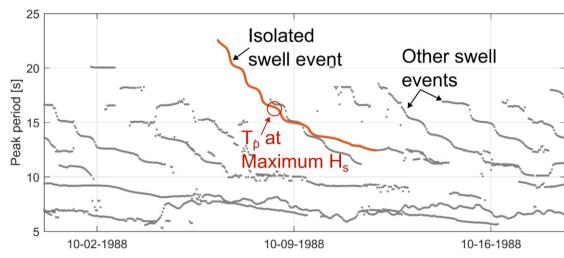
Partitioned data **filtered by direction.**

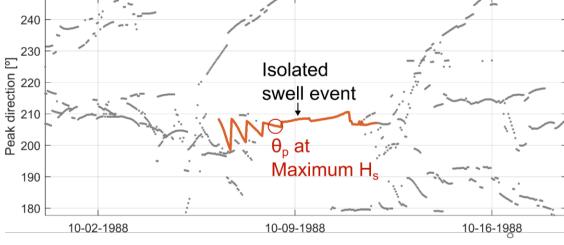


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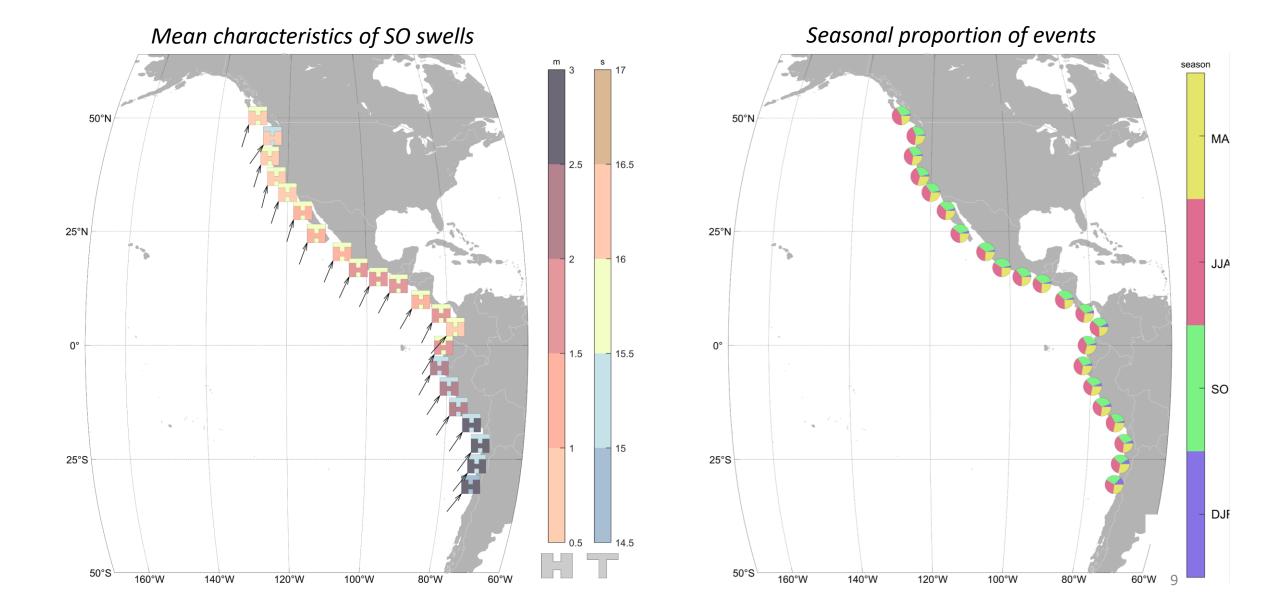


 The 20 most powerful Southern Ocean swell events per year are selected and analyzed.









50°S

140°W

120°W

100°W

80°W

60°W

160°W

140°W

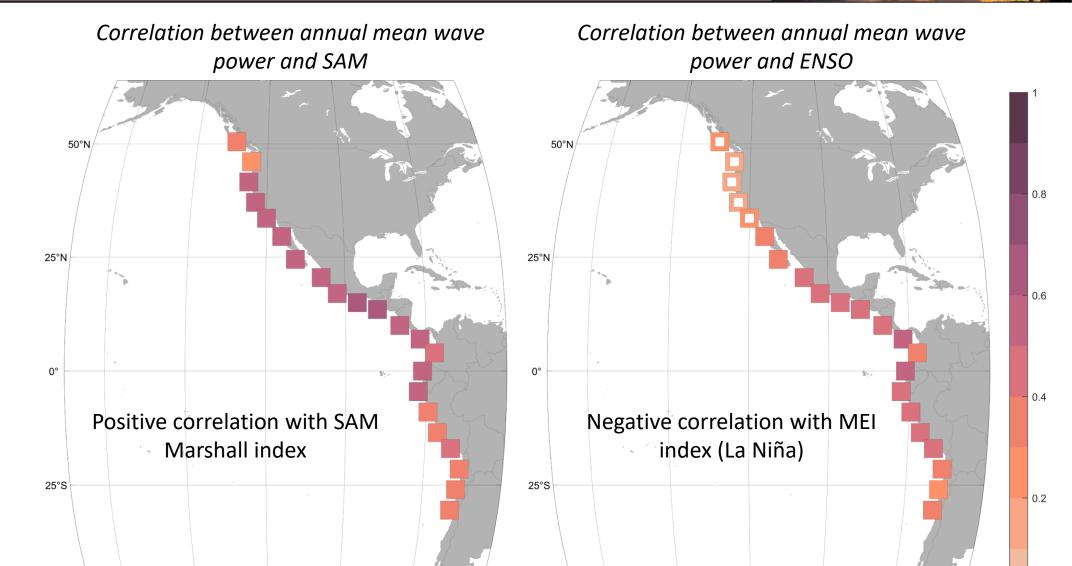
120°W

100°W

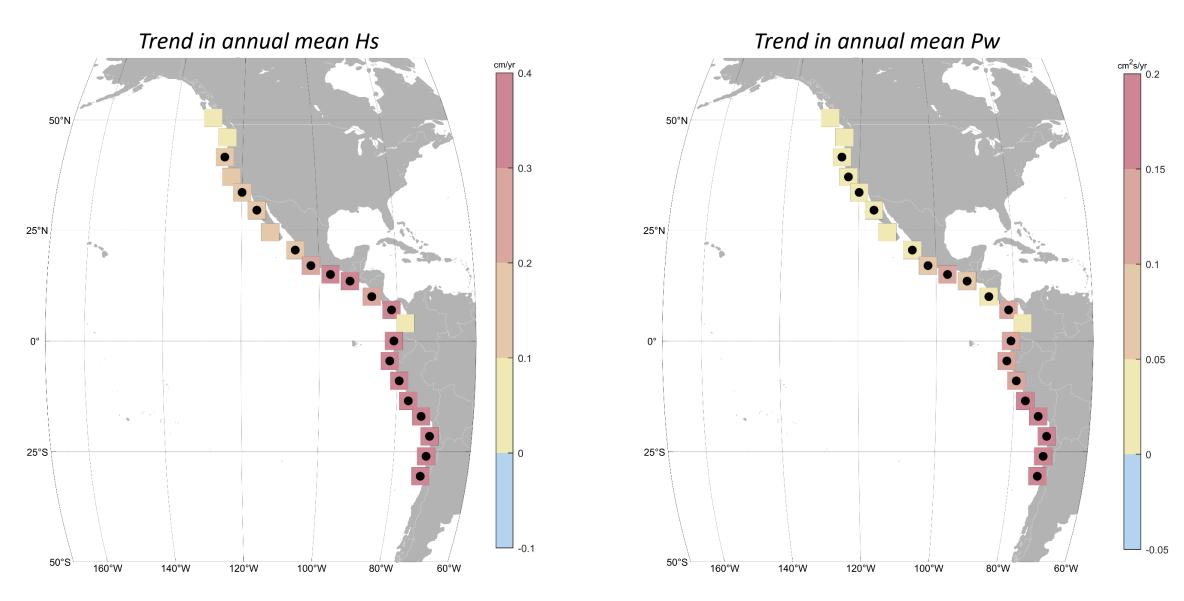
80°W

60°W



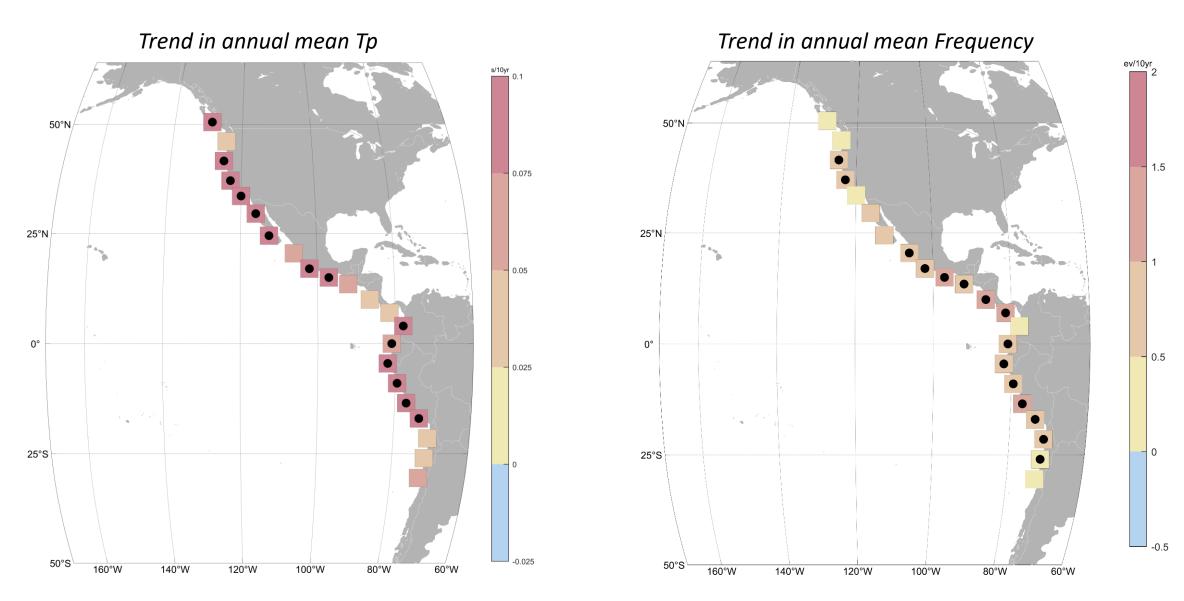






*Black dots indicate statistical significance at the 90% confidence level.





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- The use of spectral partitions facilitates the isolation of Southern Ocean swells and, consequently, their detailed study.
- There is a strong relationship between the power of these events and the positive phase of the SAM.
- In **recent decades**, there has been a **significant increase** in the wave height, period, power, and frequency of occurrence of Southern Ocean swells.
- Overlooking these events may lead to severe consequences, given their importance and growing threat.
- This problem is expected to affect multiple continental coastlines and islands worldwide.



Hector Lobeto, Melisa Menendez, Alvaro Semedo, Iñigo J. Losada, Gil Lemos. 2025. **Southern Ocean swells pose a significant and growing threat to the Pacific coast of the Americas**. Nature Communications. **Under review**.

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Thank you! Questions?