

Shocks, Solitons and Turbulence Unit

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FY2023 marks the launch of The Tree Pulse Network with multiple prototypes and test sites.

Abstract

The Shocks, Solitons and Turbulence (S2T) Unit focuses primarily on energy redistribution across space-time by linear and nonlinear wave phenomena with applications in ocean-atmosphere and land-atmosphere interactions.

In FY2023 the unit focused mainly on (i) communicating and developing further its ocean-atmosphere model for long-wave isentropic waves, which is relevant to tsunamis associated with explosive volcanic eruptions; (ii) developing a network of sensors to measure diurnal tree pulses associated with active and passive water dynamics in tree stems.

1. Staff

- Emile Touber, Associate Professor
- Prabal Negi, Postdoctoral Researcher
- Adel Rodriguez, Postdoctoral Researcher
- Stephen Winn, Postdoctoral Researcher
- Andre Krichikov, Technician
- Roman Mukhin, Technician
- Saori Chappell, Research Unit Administrator

2. Collaborations

Nothing to report

3. Activities and Findings

Blue Planet

In FY2022 we developed a model capable of predicting most tsunami waves around the globe in the 24 hours following an explosive volcanic eruption by properly accounting for the two-way coupling between the ocean and the atmosphere. In this approach, the atmosphere was treated as a single compressible layer with a rigid upper boundary. In FY2023 we invested time advertising this result (see below) and developing the model further to account for multiple layers in the atmosphere, including the ionosphere. Coupling multiple layers consistently is challenging but is now complete and we shall communicate our findings in FY2024.

Green Planet

This year we launched the Tree Pulse Network (see <https://treepulse.network>). Its aim is to monitor over a long period of time (hopefully decades) the daily cycles associated with water transport in tree stems, across various forest structures and environments. We currently focus on delivering scalable, robust, upgradable and relatively cheap sensors we can then deploy worldwide and operate remotely. To this end we launched a pilot program across over a dozen sites in Japan, US and Europe. In parallel we are working on dynamical models to interpret the data to be collected. Ultimately, we want to understand how water is mobilized by forest ecosystems to quantify the role they play in Earth's energy budget and predict how they could adapt to environmental changes.

4. Publications

4.1 Journals

1. Miyahara H., Kusano K., Kataoka R., Shima S., Touber E. Response of high-altitude clouds to the galactic cosmic ray cycles in tropical regions. *Frontiers in Earth Science*, doi: 10.3389/feart.2023.1157753 (2023).

4.2 Books and other one-time publications

1. Selected press coverage of our work on the 2022 Tonga event:

- Nikkei <https://www.nikkei.com/article/DGXZQOUC041ZD0U3A900C200000/>
- United Nations Office for Disaster Risk Reduction <https://www.preventionweb.net/news/new-model-provides-real-time-more-accurate-prediction-tsunami-wave-patterns>
- Phys.org <https://phys.org/news/2023-09-real-time-accurate-tsunami-patterns.html>
- Run-up comparison on NOAA website <https://www.ncei.noaa.gov/products/natural-hazards/tsunamis-earthquakes-volcanoes/tsunamis/recent-significant-events> (click on "2022 January 15: Tonga Tsunami Event")

2. Tree pulse data:

Some of the tree pulse measurements are made available to the public here: <https://treepulse.network>

4.3 Oral and Poster Presentations

1. Winn S.D., Toubert E., Sarmiento A.F. Long-wave isentropic ocean-atmosphere dynamics: providing faster-than-real-time, predictive modelling of the 2022 Hunga Tonga event, *Poster Presentation*, AGU Annual Meeting 2023, San Francisco, USA, 11-15 December (2023), doi: 10.22541/essoar.170144104.45628386/v1
2. Winn S.D. Long-wave isentropic ocean-atmosphere dynamics: addressing a blind spot in tsunami warning systems. *Seminar Series*, Imperial College London, UK, 22 May / University of Southampton, UK, 23 May / Delft University of Technology, Netherlands, 24 May / Ecole Nationale Supérieure d'Arts et Métiers, France, 09 May (2023). <https://youtu.be/VxkPtKAdD5Q?si=Pffa8ogoAPRkW7mC>

5. Intellectual Property Rights and Other Specific Achievements

Nothing to report

6. Meetings and Events

Nothing to report

7. Other

Nothing to report.