EnvSeis Newsletter
Summer 2024

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2.1 Stefania Ursica (GFZ Potsdam, Germany)

Update on the recent progress of my research involving an alpine catchment and La Reunion study sites. This brief report outlines the key advancements in my understanding and analyses.

AI Automatic Seismic Pipeline In the past few months, I've been focused on advancing a more unconventional approach to detecting and predicting events through automatic pipelines. This method revolves around identifying, classifying, locating, and predicting seismic activities, applying these techniques to exotic seismic catalogs. By strategically selecting event locations and volumes, I aim to refine this system for practical applications in diverse geophysical contexts.

Climate Study with Rain Radar Data in Alpine Zone Simultaneously, I have delved into the analysis of rain radar data, exploring both near-field and far-field solutions. This research ties into a tilting experiment involving radar,which captured valuable data, including a hailstorm recorded at GFZ building's rooftop.This dataset provides insights and is part of a broader initiative aimed at deploying this technology in an Alpine catchment. The objective is to integrate this radar data with seismic observations to better understand landscape dynamics in this rapidly changing environment.

La Reunion Seismic Deployment I have been preparing for two upcoming fieldwork expeditions to La Réunion this autumn, focusing on installing seismic stations on the dormant Piton des Neiges volcano. This effort, within the constraints of a protected area, needs authorizations and permits, as well as special equipment preparations to deal with a cyclonic climate regime. The goal is to enhance our understanding of landscape evolution in a tropical environment characterized by steep environmental gradients. By carefully choosing station locations, we aim to monitor and model a wide array of surface and subsurface processes such as landslides, rockfalls, debris flows, sediment transport, and groundwater dynamics.

The strategic design of this seismic network is essential to fill existing gaps in the regional monitoring systems. By optimizing the placement of stations, I plan to improve the resolution of seismic data, particularly in remote and difficult-to-access areas. Collaborating with various institutions such as OSU, Meteo France, Reunion University, IPIGP, this project will deepen our understanding of the intricate relationships between climatic, geomorphological, and hydrological processes in a dynamic landscape.

2.2 Sibashish Dash (GFZ Potsdam, Germany)

2.3 Aiswarya Padmadas (BGU, Beersheba, Israel)

I have been quite busy since the last newsletter, working on a new concept aimed at focusing on seismic signals from a specific region where other instruments are deployed. This approach involves dividing the overall system into sub-arrays, each tuned to a particular frequency range. These sub-arrays interact to produce a combined beam that targets the location where the other instruments are placed. After designing a parameterized setup for nodes, I selected an optimal configuration from an astonishing 3.45e19 possible combinations. This geometry is scheduled for deployment in Arroyos de Los Pinos, New Mexico, later this month. Figure 1 illustrates the beam pattern for a sub-array at 7 Hz.

In addition, I recently spent two weeks with my team on a site visit in Austria, where I would like to extend special thanks to Dr. Helmut Habersack, Dr. Rolf Ridler, Sabrina Schwarz, Lukas Unger and Chiara Girardelli. During our visit, I had the opportunity to analyze seismic data from two of the 14 bedload monitoring sites across the country. The first site was the Venter Ache River in Vent, Austria, an alpine river with a catchment area extending into Switzerland and Italy. We hiked up to the catchment area to gain insights into the region's stability. Figure 2 shows the catchment area of the stream. Additionally, we conducted bedload sampling at this site.

The second site was the Drau River in Dellach, Austria, a 40-meter-wide alpine river equipped with 20 geophones placed at regular intervals, three slot samplers, a LiDAR, and one seismic node. We encountered some challenges with the sampler, as it got stuck and required hydraulic assistance to be lifted (Figure 3). Bedload sampling was also conducted at this location.

Our lab experiment at the Institute of Hydraulic Engineering and River Research (IWA) at the University of Natural Resources and Life Sciences, Vienna (BOKU), was particularly engaging. We conducted a three-hour experiment using ECM to determine the different frequency ranges it can operate within flume conditions. The experiment involved several other instruments, including a laser reader to measure the 2-D velocity of the flow based on water turbidity. We also took discharge measurements at the inlet and used colored pebbles of varying sizes to observe their movement (unfortunately, the pebbles did not move much). Figure 4 provides a view of the ECM placement, colored pebbles, and approaching water.

Looking ahead, I am excited about the upcoming data from Arroyos de Los Pinos after deployment, and the samples collected from the Austrian sites are currently being dried and sieved. Once that data is tabulated, I will be able to correlate it with other datasets, such as seismic signals, plate geophone data, and water discharge and level measurements.

2.4 Guilherme de Melo (GEOMAR Kiel, Germany)

2.5 Sophia Laporte (Umea University, Sweden)

I am about to start my 6-month secondment in Grenoble, where I will carry out a flume experiment related to river-ice. This summer, I attended a workshop on experimental hydraulics in Strasbourg where I learned more about flume experiments and various measurements techniques which I will be using, such as Ultrasonic Doppler Velocimetry. Last spring, I also attended the second EnvSeis workshop in Milan with the other ESRs where we presented our work, engaged in interesting discussions around our projects and completed a course about seismic theory. Furthermore, I recently finished my second summer field campaign where my field assistant and I successfully collected seismic, topographic, photographic and hydraulic data on both studied river sites (Mjellejohka in Abisko and Säravån near Umeå). Now I have 1 whole year of data to dive into!

2.6 Selina Wetter (IPGP Paris, France)

For the past two months, I've been focused on manually verifying the events that were classified as Glacial Earthquakes (GEQ). This process has taken much longer than expected and, while it can be a bit tedious, it's crucial for ensuring accurate results.

As of now, I have identified approximately 700-800 GEQ events per year for the past several years, with a similar number of events still categorized as uncertain. The next phase of my research involves completing the manual review and proceeding with the localization of these events. The localization process presents potential challenges, as many of the events are only detectable on one or two seismic stations, likely due to their smaller amplitude compared to the events in the merged catalogue by Tsai and Ekström (2007), Veitch and Nettles (2012), and Olsen and Nettles (2017).

2.7 Juliane Starke (ISTerre, Grenoble, France)

Juliane spent a lot of time conducting fieldwork this summer. An active acoustic monitoring system was installed successfully to monitor the daily changes in sonic velocity of the rock cliff she is investigating. A dataset of more than 3 weeks was recorded. Now she will try to verify the quality of the dataset and try to relate the velocity changes to the results of the numerical simulations and the resonance frequency changes. All these values should give an estimation of the mechanical state of the cliff, which changes with the daily temperature changes.

2.8 Samidha V. Revankar (IGE, Grenoble, France)

Continuing my work with the 2019 Severaisse data, I am now looking at Beamforming outputs over different ranges of frequencies. These include the low frequency turbulence induced seismic signals and high frequency bedload induced signals. I am awaiting to decipher interesting physics through frequency - velocity - Beamformer amplitude relations. Further, in the coming months I plan to perform the flume experiments and also do some field experiments at the Severaisse site.

2.9 Amandine Missana (NTNU, Trondheim, Norway)

The data collection campaign in Northern Norway using geophones is coming to an end. The geophones were installed in late April, with the goal to record the seasonal acceleration in spring/summer of the rock slides that we are studying. The broadbands will stay in place one more year in order to obtain more data and to learn more about the use of broadbands for rock slide monitoring.

2.10 Gwendal Leger (University of Sevilla, Spain)

Since the last newsletter, I traveled twice: to Paris and to Bilbao. In Paris I worked with Anne Mangeney, Enrique Nieto and Gladys Narbona on relevant test cases for my model, and on what I would present at the CEDYA (Congress of Differential Equations And Applications), which took place in Bilbao. There I managed to finish writing the program implementing the hydrostatic model of submarine avalanches and presented it. It was my first time presenting my work formally to other mathematicians, and it was an interesting exercise by forcing me to take a step back and look at the broader picture of my work.

I have now started to work on the non-hydrostatic model, where we consider the vertical velocity and a non-constant pressure. This model will present mainly two advantages that will make it more precise. The first one is that the results will depend less on the shape of the arbitrary fixed interface, because the velocity will be two-dimensional (horizontal and vertical), thus being less affected by the change of angle occurring through said interface. The second is that it will allow wave to disperse. Dispersion is a very important phenomenon, in which the velocity of a wave depends on its wavelength, to take into account to accurately represent gravital waves, in particular tsunamis.

On the figures, we can see a comparison of simulation results obtained with the same initial conditions (Fig. 1) but with different choices of arbitrary fixed interfaces (dashed blue line): a ”curvy” shape following the bottom (Fig. 1, top-right), a ”flat” (horizontal) shape (Fig. 1, top-left) and a ”slope” shape (Fig. 1, bottom-left). We can see that at t = 10 (Fig. 2) the avalanche profiles (red line) differ, and that the average discharge profiles (Fig. 2, bottom-right) are very different. This illustrates the behaviour of the multilayer hydrostatic model when there is a rotation of coordinates, that hopefully will affect less results with the non-hydrostatic model.

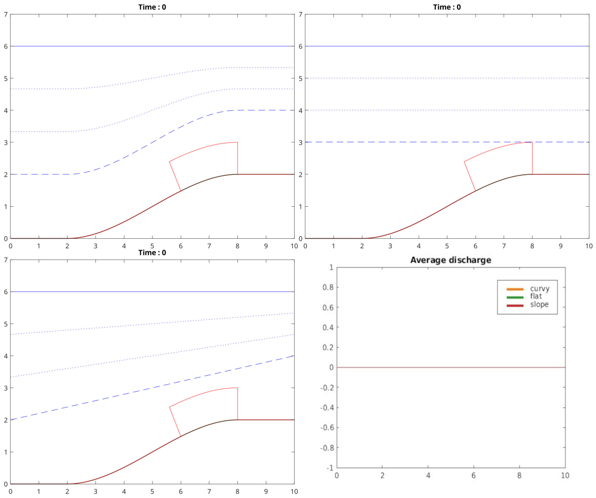

Figure 1: Caption

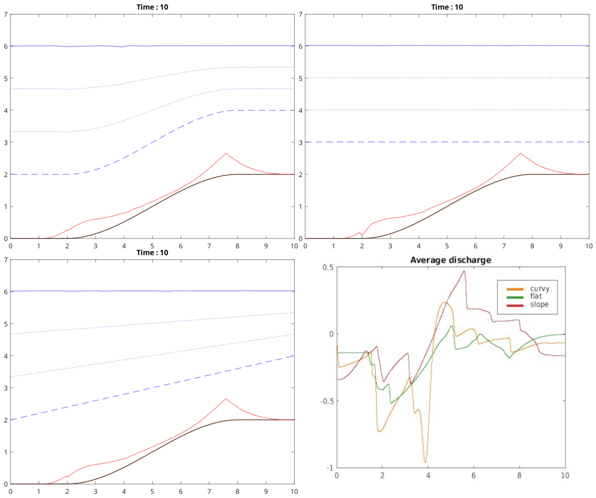

Figure 2: Caption

2.11 Eva Wolf (Uni Lausanne, Switzerland)

In the past three months, I've been going through a very intense period of fieldwork. We had planned to work several weeks on different measurements on Glacier d'Otemma, Val de Bagne, Valais (Switzerland). In July, we initiated a pre-study on the glacier surface using a grid of 3 component seismic nodes. Analysing the source locations of certain frequency bands related to turbulent flow, we attempted to find the location of the subglacial channel underneath the ice. Two weeks later, we started the big field campaign to do DAS measurements of the surface and to drill to (hopefully) the subglacial channel. The weather was unstable throughout the first week, which gave us some delay in employing the fiber optic cable on the glacier surface. It was tricky to couple the cable with the ice surface, as the cable melting into the ice would have needed more solar radiation. We helped ourselves by fixing the cable with stones in place. In the second week, the cable naturally melted itself into the ice more, as we hoped for. On the first weekend, unfortunately our team caught a virus, which is why we had to rest in Cabane de Chanrion for a few days. By the end of the second week, we were back in good health and finally able to let the Interrogator run for an entire night. This gave us the chance to also capture the seismic noise of the glacier at the coldest point of the night, at 6am, where we can probably get a lot clearer picture of the subglacial river, as the surface melt processes stop. After this recording, we started the second aim of the project: To drill to where we expect the subglacial channel to be. As Glacier d'Otemma is still up to 150m deep at elevation 2700, where we chose to work, we needed a big hot water ice drill, set up out of several components, such as pressure generator, heater, whinch, electricity generator and several more. To move these machines on the glacier surface required a lot of wo(man)power and time. On Tuesday of the third week, we were finally able to run the drill and to drill 130m down the glacier. At a depth of 90m, water filled borehole suddenly drained. We connected to some englacial channel or moulin crossing our borehole (still to be exactly determined). After reaching a depth of 130m, we couldn't get any deeper – nor could we get the drill up again. We assume that due to the slight bend of the hole, the drill head was hardly able to move up again. Working under really strong forces, one part of the winch collapsed. We had to set up an alternative construction to pull up the 130m tube, which thanks to amazing teamwork with my colleagues was possible just in time before it got dark. After the ice drill was not working anymore, we continued to work with the one good hole that we got. We investigated the hole with a camera, finding the hole filled with water at around 90m depth. This confirmed our assumption of not having hit the subglacial channel, unfortunately, but some kind of drainage channel going through the ice core. The day after, we installed a fiber optic cable down the borehole and did measurements on it. This was just in time before we had to start to clean up. Just before typing this newsletter article, we finished to tidy up all the equipment which was needed to run this project. Soon, after some rest, we are going to have a look at the fibre optic and node recordings which we took and hope to improve our analysis of the location of the subglacial river, as well as work on the structure of the glacier and other events related to it, such as icequakes.

2.12 Jiahui Kang (WSL, Zurich, Switzerland)

With the completion of our first project on the automatic detection of rock-slope failures using Distributed Acoustic Sensing (DAS) at Brienz, our next focus is on analyzing the dynamics of the major collapse that occurred during the night of June 15-16, 2023. By combining seismometer data provided by GFZ with DAS data, we aim to retrieve the force history of the event using forward modeling and inversion techniques.

In parallel, we are working on a second project that investigates regional shallow landslides in the Napf-Emmental region using environmental seismology techniques, such as ambient noise analysis. The study area, near the village of Wasen, spans elevations from 600 to 1404 meters above sea level (a.s.l.) and is particularly susceptible to shallow landslides due to its steep terrain and high soil moisture levels.

Since 2019, soil moisture—specifically volumetric soil water content and soil water potential—has been measured at six locations in the Napf region. We have also deployed a 400-meter fibre-optic cable between 840 m and 940 m a.s.l., connected to a Silixa iDAS interrogation unit with a 400 Hz sampling rate and a 1-meter spatial sampling interval (Fig. 3). DAS data were recorded from July to September 2023, during which no landslides occurred. This research aims to identify potential slow-moving processes during precipitation events and to understand the influence of rainfall and soil moisture on the subsurface structure over the two-month period.

2.13 Nicolas De Pinho Dias (IPGP, Paris, France)

In the previous episode, I succeeded in recovering experimental results with my simulations of iceberg capsize. Since, this was the first step of my PhD, it is now time to write down everything and publish. It is such an interesting exercise ! Writing made me realize how far I can push certain aspects of my study. Even though this paper will mainly deal with the numerical methods, I wanted to give a glimpse of what an application on a field scale case looks like. Hopefully, the paper will be submitted in early July. As a teaser, I present you one of the figures: It is a snapshot from a simulation of a documented iceberg calving event [Van Dongen 201]. In colors, you can see the flow velocity magnitude in the symmetry plan (y=0) and on the bottom of the fjord (slip condition). The glacier wall (x=0) is here represented with the mesh used in the numerical model. Purple and green dots are the location of wave gauges placed to capture a possible tsunami wave.

Also, improvement in the process make preparation of simulations more efficient now. This will allows us to emulate more realistic configurations and prepare a database of diverse quantities (forces, pressure, velocities...) for various iceberg sizes and shapes.

Attending my first EGU conference in April was a great opportunity to meet and discuss with other scientists as well as to present my work.

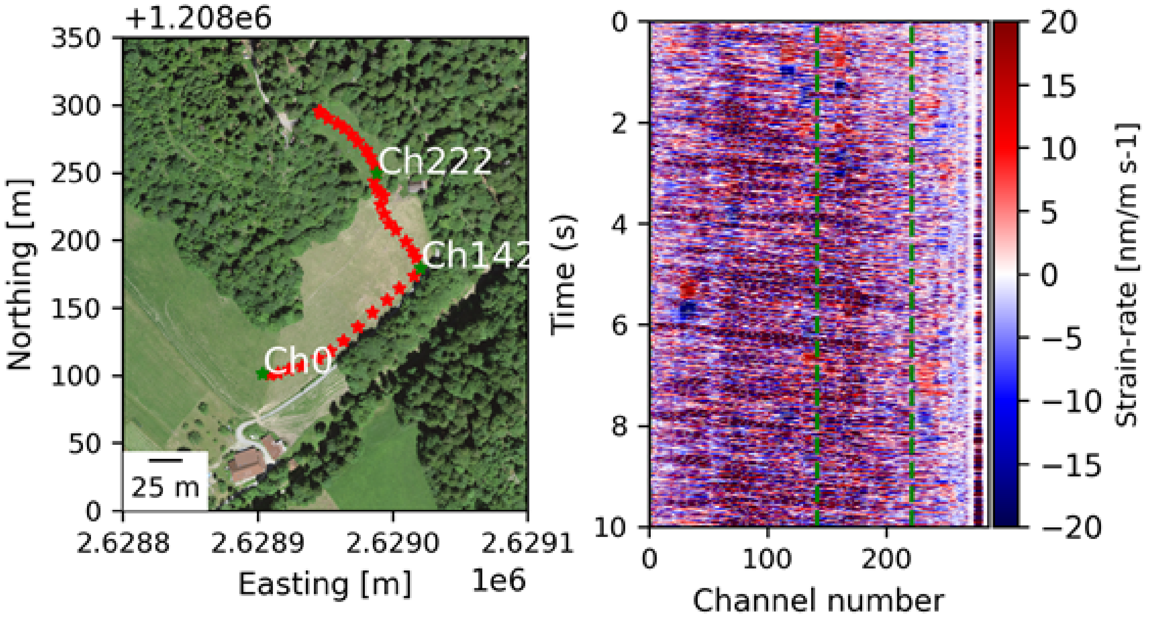

Figure 3: Site and DAS data overview. The steep slope at Emmental runs from northwest to southeast. The first section of the fiber-optic cable from Ch0 to Ch142 is perpendicular to the slope while the remaining section after Ch142 is parallel to the steep slope.

References

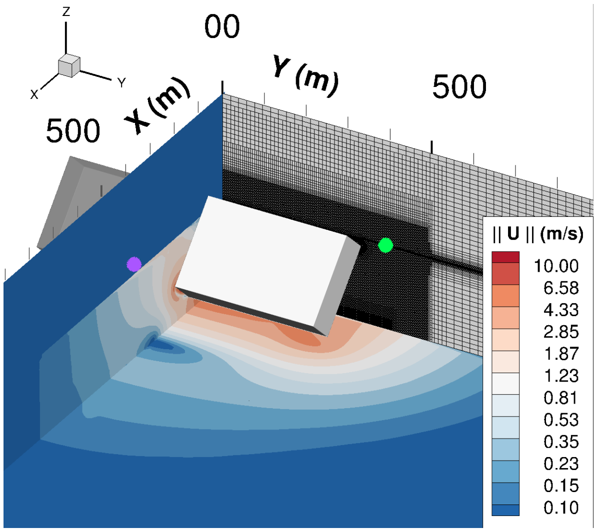
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Figure 4: