Photo Courtesy: Christian Stiegler

A Greenhouse Gas Emissions Scientist with the National Institute of Water and Atmospheric Research (NIWA), Dr Christian Stiegler is a pākehā scientist focussed on climate change. Born in Austria, Christian is relatively new to Aotearoa, having moved to the country in October 2023. In conversation with NZASE science communicator, Sneha Pillai, Christian shares his journey and learnings as a micrometeorologist.

BORN

Born in 1985 in central Austria, Christian grew up on a farm, an hour's drive from Salzburg. "My parents are farmers. We had a lot of animals around cows, sheep, cats, and chickens. Growing up, my brother and I had plenty of entertainment at our farm."

SCHOOLS AND SUBJECTS

"The school system in Austria is a bit different compared to New Zealand," says Christian. After completing secondary level at the age of 14, students choose the type of school they want to go to – a vocational-technical track or a university preparatory track. "I chose the university track and studied languages (French and English) and economics. So, no major science subjects. But I had studied physics, biology and chemistry as part of my general education in school."

HOW HE GOT INTO SCIENCE

"There was no specific event or trigger as such. However, I had always been curious about our natural world and wanting to know more about what's happening out there," says Christian.

TRAINING AND JOBS

Though Christian had not picked any science subjects in his post-secondary education track, Christian's curiosity about the natural world around him inspired him to study environmental systems sciences and physical geography for his bachelor's and master's at the University of Graz in Austria. For his PhD, Christian went to Lund University in Sweden, with his thesis focussing on climate change in the Arctic.

Before going for his university studies, Christian took a gap year in which he enrolled for civilian services in Austria. He worked as a paramedic with the Red Cross during this time.

FIELDS OF SCIENCE

Micrometeorology focusses on the interaction between vegetation and the atmosphere's lowermost layer, the troposphere. It helps measure greenhouse gas emissions. Micrometeorologists study the exchange of heat, momentum, and mass (greenhouse gases), from the scale of vegetation canopies up to several kilometres.

RESEARCH EXAMPLES

In his PhD, Christian focussed on climate change in the Arctic, specifically exploring how Arctic ecosystems respond to temperature increases and weather patterns. One of his studies focussed on how differences in snow accumulation impact an Arctic ecosystem. “We had one year with quite extreme snowfall and snow accumulation. And then the following year we had very little snow accumulation. Naturally, the year with higher snowfall delayed the onset of the spring season, so vegetation had less time to grow and develop and that had impacts on the food chain. So, animals find less food because the landscape is still snow-covered. And then the year after where there was just a little snow accumulated, there was a lack of water. Basically, Arctic ecosystems are desert ecosystems and winter snowfalls play an important role in their hydrology. That year was a dry year with a huge impact on vegetation.”

Christian with his colleagues during fieldwork in Indonesia. Courtesy: Christian Stiegler

Christian also did a postdoc in Central Germany at the University of Göttingen, focussing on the impacts of land transformation in Indonesia. "Here, I studied the greenhouse gas balance of an oil palm plantation. We measured the exchange of greenhouse gases at a specific plantation using eddy covariance technique. The technique is based on high-frequency measurements of wind speed and atmospheric greenhouse gas concentrations,” says Christian.

The study focussed on quantifying carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) fluxes but also, how does the change in landscape from forest ecosystems to these intensely managed plantations impact the landscape in general and the people? It was quite an interdisciplinary project while I was looking at the greenhouse gas balance of this specific oil plantation, my colleagues, for example, focussed on the impact of the land transformation on the biodiversity from ground bacteria to birds and spiders, and the local people and social aspects."

In New Zealand, Christian's research is focussed on greenhouse gas emissions and fluxes, focussing on the New Zealand agricultural system. “It’s mainly focussed on quantifying and studying greenhouse gas emissions from different sources to help develop mitigation strategies." Climate change mitigation involves actions to reduce or prevent greenhouse gas emissions from human activities.

HOW HE FINDS THINGS OUT

Fieldwork studies and field experiments are integral to Christian’s work. “The actual research method depends on the research question. But we have different sets of instruments that we use for metereological measurements. For example, NIWA has a nationwide network of meteorological stations that we can use, but we also have different sensors that can be used to quantify greenhouse gas emissions and fluxes. We have also recently started using drones to quantify emissions."

"Thinking through how to mitigate the effects of climate change and also, how we adapt, is important, because, well, we're running out of time."

The drone (unmanned aerial vehicle (UAV)) and an electric vehicle (EV), equipped with scientific measurement equipment is used to measure atmospheric methane (CH_4) and ethane (C_2H_6) concentrations, and wind speed and wind direction to monitor small-scale emission plumes of CH_4, e.g. from cattle, sheep or wastewater treatment plants. The wind sensors sit on top of the UAV and EV attached to a metal pole. One gas sensor is attached to the base of the UAV and another gas sensor is on the backseat of the EV. A small tube, with a particle filter inlet attached next

Christian at field work in New Zealand with the drone and EV. Courtesy: NIWA

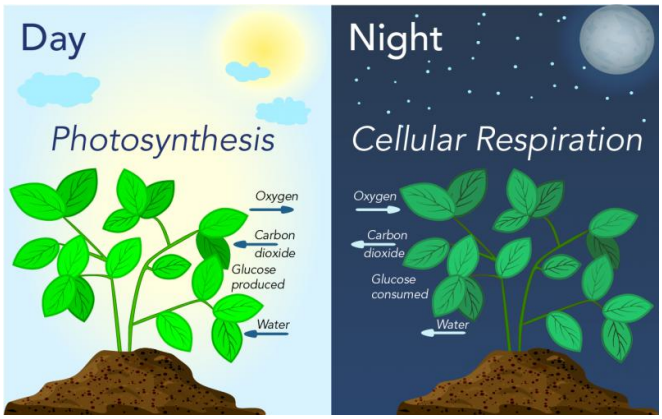
to the wind sensor, is connected to the gas sensor and a pump inside the gas sensor pumps air from the filter inlet to the gas sensor. "I use a laptop to download the wind and CH_4 concentration data. With the EV, we monitor CH_4 emission plumes near the ground surface while we use the UAV to detect CH_4 emission plumes at levels up to 120m above ground. The collected data helps us to quantify small-scale CH_4 emissions from different sources and to develop CH_4 emissions mitigation strategies," explains Christian.

Another tool that micrometeorologists use is a portable CO_2 chamber system. "With this system, we can measure plant photosynthesis and CO_2 exchange at small-scale levels. Here, for example, I measured CO_2 exchange of plants and mosses in a subarctic wetland in northern Sweden. The system consists of a transparent chamber and a CO_2 sensor, connected via tubing. Plant photosynthesis and CO_2 exchange

Christian measuring plant photosynthesis and carbon dioxide (CO2) exchange, using a portable CO2 chamber system. Courtesy: Christian Stiegler

are measured by placing the chamber over the vegetation, making sure that the chamber is completely sealed. The CO_2 sensor monitors the CO_2 concentration inside the closed chamber. Plant photosynthesis causes a decrease of CO_2 concentration inside the chamber. By monitoring the change in CO_2 concentration over time, we can we can quantify how much CO_2 has been removed from the atmosphere and absorbed by the plant via photosynthesis.

Plants need sunlight for photosynthesis. If there is no sun- or daylight, i.e. during night, plants do not absorb CO_2. However, plants and soil bacteria constantly respire CO_2 but during the day plant CO_2 absorption via photosynthesis exceeds plant and soil CO_2 respiration. Plant and soil respiration can be measured by simulating night (or dark) conditions, e.g. by covering the chamber with a black or dark-coloured coat. "If we repeat our measurement and simulate night conditions, we will see an increase in



CO_2 exchange is when CO_2 enters the plant during the day and leaves the plant at night. Courtesy: Let's Talk Science

CO_2 concentration inside the chamber over time and we can derive a CO_2 flux and quantify how much CO_2 and carbon has been respired by the plant and soil. Chamber-based measurements of plant photosynthesis and CO_2 respiration are a simple and quick way to study the CO_2 balance of a specific vegetation type," explains Christian.

CO_2 exchange is the process by which plants (or an ecosystem) absorb and release CO_2 while CO_2 balance is the plant's (or ecosystem's) net result of CO_2 uptake and release.

MĀTAURANGA MĀORI

"We have an upcoming wānanga where we aim to exchange knowledge and explore collaboration with

the local Māori community, and that's because they have a unique connection with nature, including the weather systems. I think the Western civilization has lost its connection with nature to some extent. We enjoy nature and we harvest the products of nature, but sometimes I feel we're a bit disconnected. When engaging with Maori traditions and Maori knowledge, their connection to nature is evident."

WHAT HE LIKES ABOUT SCIENCE

Christian with his NIWA colleagues at a work site. Courtesy: NIWA

"There are so many challenges out there in the natural world. I mean, climate change and climate change mitigation are hot topics and everyone has an opinion about it. But it's hard to find the right solutions. Thinking through how to mitigate the effects of climate change and also, how we adapt, is important, because, well, we're running out of time. We can already see its consequences with extreme weather events increasing. That's what drives me – the need to find better solutions."

RELEVANT LINKS

Christian's Articles

Two years with extreme and little snowfall: effects on energy partitioning and surface energy exchange in a high-Arctic tundra ecosystem (2016).
Retrieved from https://tc.copernicus.org/articles/10/1395/2016/

Flooding and land use change in Jambi Province, Sumatra: integrating local knowledge and scientific inquiry (2020).
Retrieved from https://www.researchgate.net/publication/ 343903215_Flooding_and_land_use_change_in_Jambi_Province_Sumatra_integrating_local_knowledge_and_scientific_inquiry

Learning Resources

Measuring gases using eddy covariance: Retrieved from Science Learning Hub
https://www.sciencelearn.org.nz/resources/2629-measuring-gases-using-eddy-covariance

NIWA SCIENCE AND TECHNOLOGY FAIRS 2024

Check for details about your local fair by following one of the links below.

NIWA Auckland Science & Technology Fair: 29-31 August

NIWA South and East Auckland Science & Technology Fair: 23 August

NIWA Wellington Science & Technology Fair: 28-31 August

NIWA Canterbury - Westland Science & Technology Fair: 21-22 September

Ngā Kupu
Āhuarangi: climate
Aotūroa: natural world
Huarere: weather
Raupapa kame: food chain
Source: Te Aka Māori Dictionary