



MASTS Postdoctoral and Early Career Researcher Exchange (PECRE) Fellowship - Final report

Fellow : Sozic Garnier, Strathclyde University

Project Title : Optimal-detail circulation models for fjords and sea lochs

Host : Michael Schmidt, Long Live The Kings, Seattle USA

Dates : From the 17th of February 2018 to the 3rd of April 2018

Aim of the exchange :

The aim of the exchange was to improve and test with a first case study a new optimal and realistic circulation model for fjords and sea lochs that can run over a multi-decadal timescale. This intermediate model provides an interesting alternative to the classic 3D high resolution models but computationally slow like ROMS, and the simple box models that are fast to execute but provide poor details.

To test this intermediate approach for modelling, the first case study that has been chosen is the Puget Sound, a fjord near Seattle in USA. Within the Salish Sea, the inland sea that encompasses the Puget Sound, wild salmon population has dramatically declined for the last 50 years. However, no significant changes have been observed on the near Pacific coast, this suggests that the problem lies within the Salish sea itself. One hypothesis is that variations in circulation and water properties have impacted plankton production and therefore indirectly altered salmons through their food-web. The developed model provides an interesting tool to investigate these possible long-term changes in circulation and water properties of the Puget Sound due to regional climate variabilities.

Scientific output resulting from the exchange :

During my visit in Seattle I had the opportunity to meet the American research community working on the Salish sea project (from Long Live The Kings, the NOAA federal agency, the University of Washington and the Washington State Department of Ecology). In particular, Michael Schmidt, deputy director Long Live The Kings helped to organize a meeting at the NOAA facility where I could engage with them and present an update of my work. We could discuss about the available data I can use to validate my model and we also exchanged about the different applications they would be interested to use the model for. For instance, testing the assumption for circulation changes in the Puget Sound, but also studying in details the impact of each mechanistic process occurring within the fjord (impact of river discharge vs wind stress vs tides) and looking at climate change prediction.

With Parker MacCready from the University of Washington I worked on improving the numerical model. We reviewed together the theory and assumptions used in the circulation model and added modifications in order to improve the physical accuracy of the simulation. Some of these changes still have to be implemented. Even though, we also considered how to validate the model and we explored ideas to improve model optimization in case of future need.

The exchange also gave me the opportunity to meet Eric Salathe who got me access to his database of dynamically downscaled climate projections for the Pacific Northwest which provides wind time series from 1950 to nowadays with 12 km resolution and 6h timestep for the Puget Sound region. These data will be useful to study seasonal timing and magnitude of the mixing in the surface layer. Indeed before the exchange, I came to the conclusion that the mixing in the surface layer is mainly due to the tides, but also up to 40% due to the wind. This observation suggests that if the timing and magnitude of the wind experience inter-annual variations, the mixing in the surface layer might also be affected. As mixing is an important factor (among others) for primary production, it seems that changes in wind-mixing can indirectly degrade salmon food-web. Therefore it is important to analyse wind time series for the last 50 years to look for long-term alteration in the wind seasonal timing and the occurrence of extreme events.

Other outputs :

- I joined a weekly group meeting with the team that works with Parker MacCready, we were all presenting our work and sharing the problem we came across during the last week.
- I had the chance to join a cruise on the Puget Sound and helped to sample zooplankton using a vertical net and a bongo net.
- I presented a poster at the Ocean Science Meeting in Portland USA before the exchange. It was my first international conference and a good occasion to get feedback on my work.
- I presented a poster at the Salish Sea Ecosystem conference in Seattle USA after the Exchange. The conference was a great opportunity to have an overview of the late research done in the Salish sea and advertise my model to the research community.
- I saw for the first time the estuary I am working on and could realise the complexity and vastness of the Salish Sea.

Award Size and expenditure :

The non-profitable association Long Live The Kings funding was used along with the MASTS PECRE grant to support travel, accommodation and living costs during the exchange in Seattle.

(a) MASTS PECRE grant

Flight : £375
Living costs : £810
Accommodation : £1300
Subtotal : £2485

(b) Long Live The Kings funding

Flight : £375
Living costs : £800
Subtotal : £1175