**Ocean Data: Observations, Analysis, Synthesis and Communication**

EOSC 595F 104, 2022W2

**Course Learning Goals:**

By the end of this course, students will be able to:

* Understand the fundamental elements of robust ocean data collection (*e.g.* sensor calibration, drift correction, quantification of reproducibility and uncertainty)
* Apply basic approaches to data cleaning, filtering and quality-control)
* Select and employ appropriate tools to analyze and visualize relevant ocean data sets
* Explore the interface between ocean data and numerical models
* Demonstrate how ocean observations and models can be used to inform decision making and policy

Lectures will be held on Tuesday from 9:30 – 10:30 AM (Vancouver time)**\*\***

Tutorials will be held on Fridays from 9:00 – 11:00 AM (except for Sept. 29, in lieu of Sept. 30)

**\*\*Note:** The time difference between Canada and Chile will change twice during this course. In Canada, the clocks go back by 1 hour on Nov 7, while in Chile the clocks go forward by 1 hour on Sept. 4.

**PART 1: Making Measurements**

**Week 1** – Overview of ocean data (Tortell et al.) **Sept. 6 and 9**

Introduce the key ocean variables, what they tell you, why are they fundamental and important to measure and what kind of data records currently exist

Tutorial / Assignment (Heagy): Reading and writing different data formats, with a focus on NetCDF. Introduce tools in python, Matlab, R, *etc*. Description of self-describing formats, extraction of variables and data attributes, some basic data selection, plotting functions.

**Week 2** – In situ ocean sensors (Tortell and Hamme) **Sept. 13 and 16**

More detailed (‘nuts and bolts’) information about how we actually measure things in the ocean, with a focus on some of the key variables discussed in week 1.

Tutorial / Assignment: (Hamme / Tortell). Analysis, calibration, and time-lag exploration of glider O2 data.

**Week 3** – Home-made (DIY) sensors (Emmanuel Boss) **Sept. 20 and 23**

Introduce students to the range of cheap DIY approaches to measuring ocean variables and the ethos of open source collaboration.

Tutorial / Assignment: Have this past year’s PRODIGY students present their DIY projects from the Quadra Island field school to give students an idea of what they might do during the field school in Chile. Provide some overview of sampling opportunities at the Chilean field station (We will ask Samuel Hormazabal to join the discussion).

**Week 4** – Satellite-based sensors (Scott) **Sept. 27 and 29** (note, special Thurs. tutorial)

Either focus on sea ice or SST. Describe the basic properties of the measurements and how physically-meaningful quantities are derived from raw data.

Tutorial / Assignment: Extraction and simple process of sea ice (or SST) data.

**PART 2: Data Analysis and modelling**

**Week 5** – Data cleaning / outlier detection (Ng) **Oct. 4 and 7**

Provide some basic information on outlier detection methods and computation.

Tutorial / Assignment: Working with a dataset already presented in the class (*e.g.* glider based O2 or possibly salinity) to apply some of the methods presented in the lecture to automatically detect and remove outliers.

**Week 6** – Spatial analysis (Salibian-Barrera) **Oct. 11 and 14**

Spatial analysis / objective mapping / interpolation. Mapping data from distinct observations with differential sampling coverage. Interesting problems revolve around data coverage, and the spatial and temporal scales of variability. Possible data sets include satellite data or Argo float data - especially temperature and salinity, which are well sampled.

**Week 7** – Time series analysis and filtering (Bostock) **Oct. 18 and 21**

Seismograms as time series, seismic “signals” (earthquakes) vs “noise” (ocean currents, wind-driven ocean-surface waves), time vs frequency domains and the Fourier Transform. Butterworth filters. Arrival-time-based earthquake location and seismogenic plate boundary faults offshore B.C.

Tutorial / Assignment: Application of time-domain filtering to earthquake seismograms from stations of the ONC underwater cabled observatory to allow arrival time estimation of P and S-waves. Use of S-P times to estimate earthquake-station distances and triangulation for epicentral location.

**Week 8** – Power spectral analysis of time-series (Klymak). **Oct. 25 and 28**

What is signal and what is noise? Focus on identifying signals at different frequencies using multiple data sets.

Tutorial / Assignment: TBD, but ideally using a data set that has been previously introduced in the course.

**Week 9** – Observation – model synergies (Allen) **Nov. 1 and 4**

How do models and observations work together?

Tutorial / Assignment: Focussing on examining variables that have been previously discussed in previous weeks (likely S and T), use observations to validate model output from the Salish Sea (<https://salishsea.eos.ubc.ca/nemo/>).

**PART 3: Communication of ocean data**

**Week 10**– Data visualization (Perin) **Nov. 15 and 18**

Overview of some key principles of data visualization.

Tutorial / Assignment. Working with different data sets of sufficient complexity (e.g. possibly 3d glider data), students will design and critique different visualizations.

**Week 11** – Sonification Workshop – (Chris Chafe, Stanford University, *confirmed*) **Nov. 22 and 25**

Principles and applications of sonification to represent data through musical tones.

Tutorial / Assignment: create a sonification of a data set of interest. (For an example from last year’s class, see: <https://www.essoar.org/cms/asset/5a7c0c35-a046-46b0-a2ca-4b5814d861ba/mov_ssa_sequence_audio.mp4>)

**Week 12** – Data-informed action and policy for marine Geo Hazards and fisheries / aquaculture management (Tiegan Hobbes, NR Can and Laura Biannucci, Kerra Shaw, DFO) **Nov. 29 and Dec. 2**

How are ocean data sets uses to inform risk assessment and appropriate mitigation actions and policies? Case students will be presented on seismic hazards and fisheries / aquaculture management.

Tutorial / Assignment: No Assignment this week – maybe prep for following week’s assignment / presentation.

**Week 13** – Field school discussion and student project presentations. **Dec. 6 and 9**

Tutorial / Assignment: Student presentations (we will invite this past year’s cohort to attend and provide feedback).