GEF 2610
ON F/F TRYGVE BRAARUD
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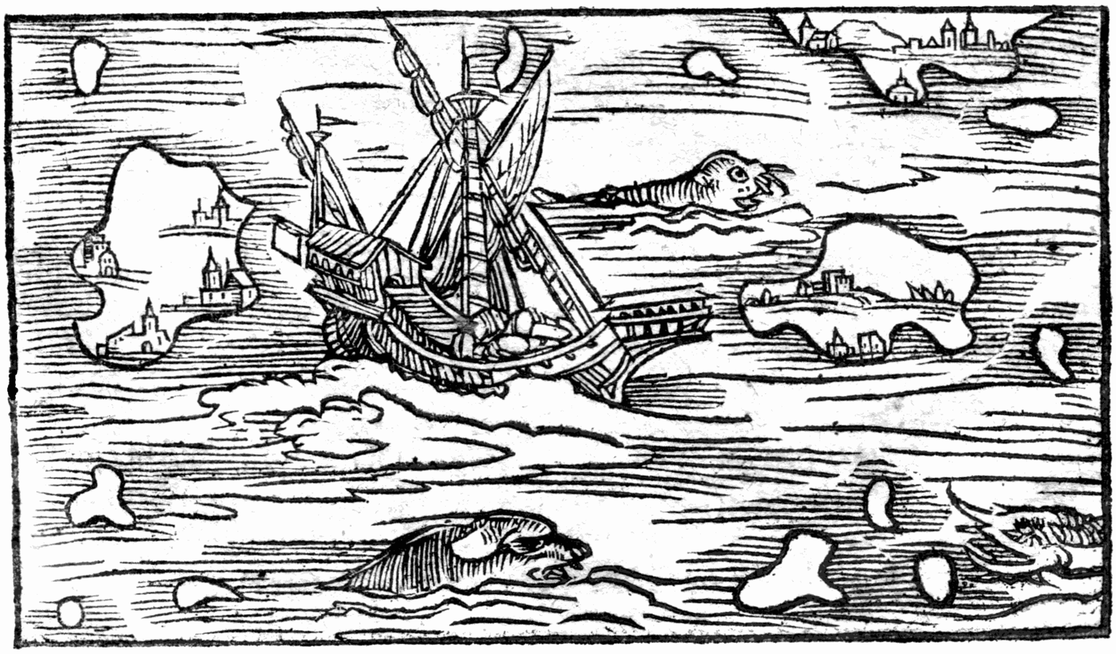
Program, analysis and presentation of results



Program for the day

The purpose of the cruise is to make the students acquainted with some basic observational techniques and to learn some more about air-sea fluxes and fjord circulation and hydrography from their own measurements.

We will collect hydrographic measurements (salinity, temperature, pressure) at three different stations, likely at *Malmøykalven* (in Bekkelagsbassenget), *Oksvaldflua* (close to Nesodden) and *Geitholmen* (in Lysakerfjorden). The hydrography will be collected with the ship's *conductivity, temperature and depth (CTD)* sensor. The lowering of the CTD will be done by the ship's crew, but students will be involved with the data collection.

We will also make estimates of some air-sea energy ("heat") fluxes. For this we will need to collect: air and sea surface temperature, air humidity, incident irradiance, cloudiness and wind speed. Wave height, and general weather conditions will also be noted. Some of these quantities are displayed on the bridge and on the screen in the laboratory. The Secchi disk depth will also be observed and noted.

In addition, we will meet up with representatives from Nortek who will demonstrate and deploy an ADCP to measure vertical profiles of currents.

Analysis and reporting

Each student will make his/her own cruise report. The report shall contain:

- A brief repetition of the purpose of the cruise and measurement program.
- A brief description of the vessel, the equipment used and the sampling procedure we used.
- A description of stations visited, including exact position and time.
- Analysis/calculations.
- A brief discussion of the results, including an assessment of possible errors.

Specific observations and analyses

1) Hydrography

The CTD measurements from all stations shall be presented in graphs as vertical profiles and as TS diagrams. The observations shall then be discussed, both individually (What characterizes the vertical stratification? Does the stratification give sign of what is expected from an estuary?) and in relation to the other stations (To what extent do we observe contrasting conditions?). If one station is repeated you should compare and discuss the time evolution of hydrography at that station.

Calculate from the CTD recordings the hydrostatic pressure at 30 m depth at *both* of the stations Malmøykalven and Geitholmen. Estimate the total density as 1000 + *sigma-t* [kg m^{-3}], where *sigma-t* is taken from the CTD data. Use g = 9.81 m s^{-2}. If we assume *hydrostatic balance*, what is the pressure difference at 30 m depth? If the sea surface itself is completely horizontal, which way will the current flow? In order to compensate for the pressure difference at 30 m depth, so that there is no pressure difference at depth, what would the sea level difference have to be between the two stations?

2) Air-sea heat fluxes

In our study here we will make estimates of air-sea heat fluxes from 1) shortwave and 2) longwave radiation and, in addition, from 3) heat conduction (sensible heat fluxes).

Shortwave radiation

The quanta irradiance, or photosynthecially active radiation (PAR), is measured as the number of light quanta per unit time per area, and for our instrument this is reported in units of [μmol s^{-1} m^{-2}]. When we want to calculate the heat effect of the irradiance, it is better to express it in energy flux units, i.e. in [W m^{-2}]. The incident shortwave irradiance Q_s in energy flux units just beneath the surface can be obtained from the PAR value Q_q by multiplying it with the empirical factor

$$0.5\ (\mathrm{W\ m^{-2}})/(\mathrm{\mu mol\ m^{-2}\ s^{-1}}).$$

Observe shortwave radiation at the sea surface and report this in W m^{-2}

Longwave radiation

Stefan-Boltzmann's formula for longwave radiation (the one involving temperature to the fourth power) is seldom used in practice. Instead, a *practical* formula for the *net received* longwave (infrared) radiation at the surface of the sea is

$$Q_b \approx -\left(143 - 0.9\ T_w - 0.46\ e_a\right)\left(1 - 0.1\ C\right)\left[W\ m^{-2}\right]$$

where T_w is the sea surface temperature measured in ºC, e_a is the relative humidity of the air measured in %, and C is the cloudiness measured in the unit of oktas. Usually Q_b will be negative and thus represent a *loss*.

What is Q_b at the time of observation? How many Joules are lost diurnally from one square meter of water surface, based on the sea surface temperature, the relative air humidity and the cloudiness, provided these quantities remain constant?

Turbulent sensible heat flux

The heat gain of the sea due to heat conduction can be approximated by

$$Q_h \approx -1.88\ V\ \left(T_w - T_a\right)\left[W\ m^{-2}\right]$$

where V is wind velocity in m s^{-1}, T_w is again the sea surface temperature in ºC, and T_a is the air temperature in ºC. If $T_w > T_a$, Q_h will be negative and represent a loss.

What is Q_h at the time of observation?

Heat budget

Using your measured heat fluxes and assuming that other heat transport terms (what are these?) are small, assess whether the surface waters in the fjord are warmed or cooled during our cruise. If one station is repeated (e.g. Oksvaldflua), you should average the heat budget made for those two sets of observations and then compare the result with the measured temperature difference (from the CTD data) between observation 1 and 2.

Instruments

-The CTD is manufactured by Sea-Bird Electronics and the model is SBE911*plus*.
-The quanta irradiance meter is model LI-189 for the recordings in air.
-The Secchi disk is a standard disk of unknown origin.