PRACTICAL E1. ESTIMATION OF AOUR FROM AOU AND TRACER-AGE

Background. During a cruise in the South Atlantic Ocean from 45 to 9º S along 9ºW (Figure E1a), water samples for dissolved oxygen and CFC-11 determination were collected in the core of the Antarctic Intermediate Water (AAIW), from 400 db at 45ºS to 800 db at 9ºS, every 30 nautical miles. The attached Excel file (database.xlsx) contains those data, together with relevant ancillary information.

Dissolved oxygen determinations were converted into Apparent Oxygen Utilisation (AOU) values applying the equation AOU = O_{2sat} (S, T) – O_2 and CFC11 determinations were converted into CFC11-age values using the equation pF = C / F (S, T) to find the year when each sample was last in equilibrium with the atmosphere and compare it with the year when the samples were collected to obtain the CFC11-age (Figure E1b).

Questions:

1) Calculate the aOUR along the core of AAIW from the direct linear regression of AOU vs CFC11-age. Comment on the y-intercept and slope of this relationship.
2) Calculate the aOUR independent of water mass mixing along the core of AAIW. Comment on the water mass mixing independent AOU/age slope as compared with the previous estimate.

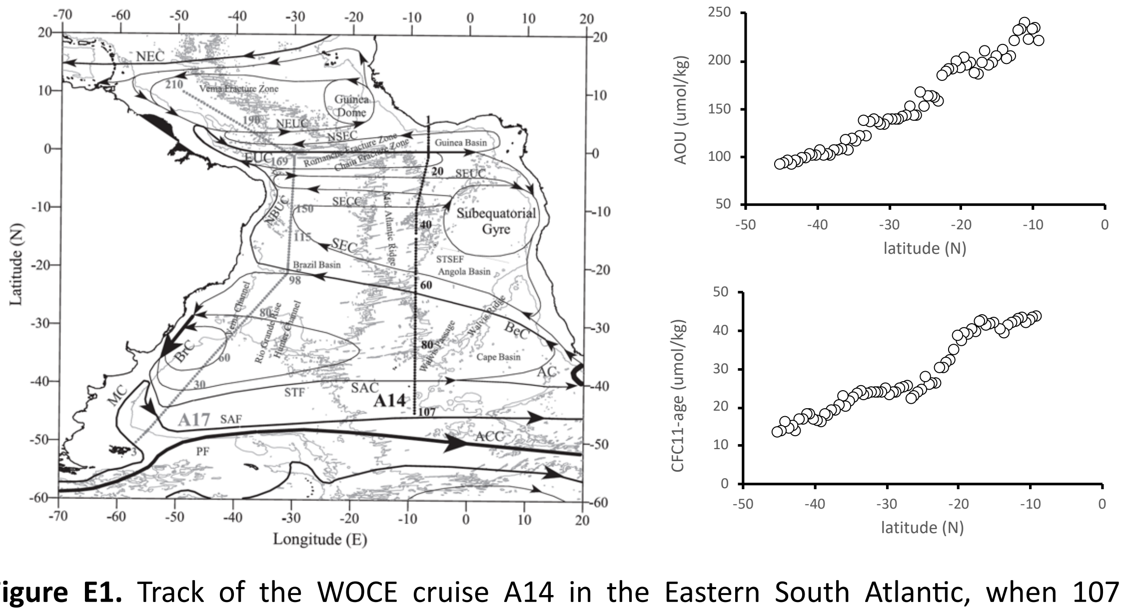

Figure E1. Track of the WOCE cruise A14 in the Eastern South Atlantic, when 107 hydrographic stations were occupied, separated about 30 nautical miles (a); and latitudinal evolution of apparent oxygen utilisation (AOU) and CFC11 age along the core of the Antarctic Intermediate Water (AAIW) (b)

PRACTICAL E2. ESTIMATION OF OUR FROM MASS BALANCES

Background. A hydrographic box has been defined in the Northeast Atlantic Ocean, South of the Canary Islands (red square in Figure E2.1a). The box is crossed by some of the major currents of the North Atlantic: Canary Current, Mauritanian Current and North Equatorial Current, which transports water masses with contrasting oxygen levels. The box is at the interface between the highly productive Eastern Boundary Upwelling System (EBUE) of the Canary Current and the adjacent North Atlantic oligotrophic gyre. It is also at the boundary between the subtropical and tropical waters of the North Atlantic, separated by the Cape Verde Front (dashed line in Figure E2.1a).

An inverse box model was applied to obtain the average horizonal advection transports (in Sv) presented in Figure E2.1b for the epi- (0 – 150 db) and mesopelagic (150 – 1500 db) layers. Transports in/out of the layers through the Northern, Western, Southern and Eastern sides of the box are reported. Vertical advection transports are calculated applying volume conservation. Vertical turbulent diffusion transports are calculated with a parameterization that depends primarily on the water column stability (Brunt-Väiäsälä frequency).

Questions.

1) Calculate the vertical advection transport to the mesopelagic layer (**Qv_{Z3}**)
2) Calculate the residence time of water in the epi- (**τ_1**) and mesopelagic (**τ_2**) layers. Comment on the results obtained.

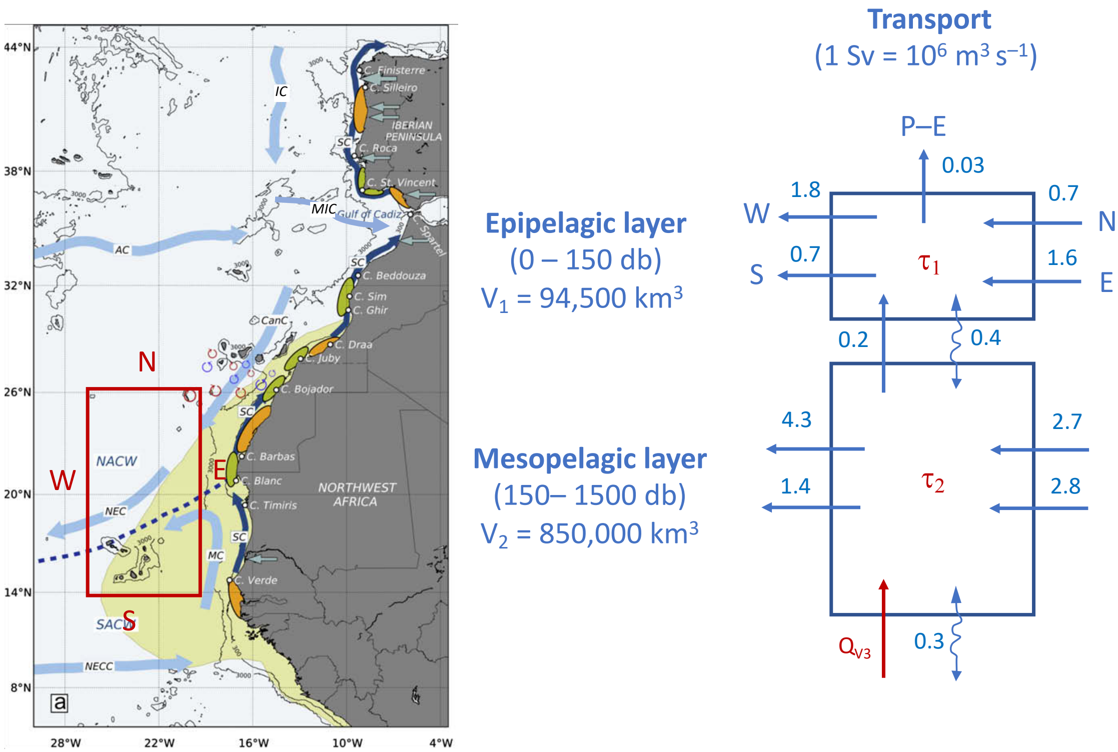

Figure E2.1. Hydrographic box at the boundary between the highly productive coastal upwelling of NW Africa and the oligotrophic subtropical gyre (a), horizontal and vertical advection and turbulent diffusion flows in the epi- and mesopelagic layers of the hydrographic box. The Precipitation minus Evaporation (P – E) balance is also show.

Background. Seasonal average concentrations of dissolved oxygen (in mmol m^{-3}) at each side (Northern, Western, Southern and Eastern) of the box and the horizontal surface areas between layers were taken for the World Ocean Atlas and reported in Figure E2.2a. For the case of the turbulent diffusion flux, the dissolved oxygen immediately above and below the horizontal surface areas between layers are also shown.

The dissolved oxygen fluxes (Figure E2.2b) are obtained multiplying the water transports (Figure E2.1b) by the dissolved oxygen concentrations (Figure E2.2a).

Questions:

1) Comment on the dissolved oxygen concentrations transported by the different water flows.
2) Calculate the unknowns (?) in Figure E2.2b and estimate the Net Ecosystem Production of dissolved oxygen in the epipelagic layer (NEP_1) and the mesopelagic (NEP_2) layer. Comment on the results obtained.

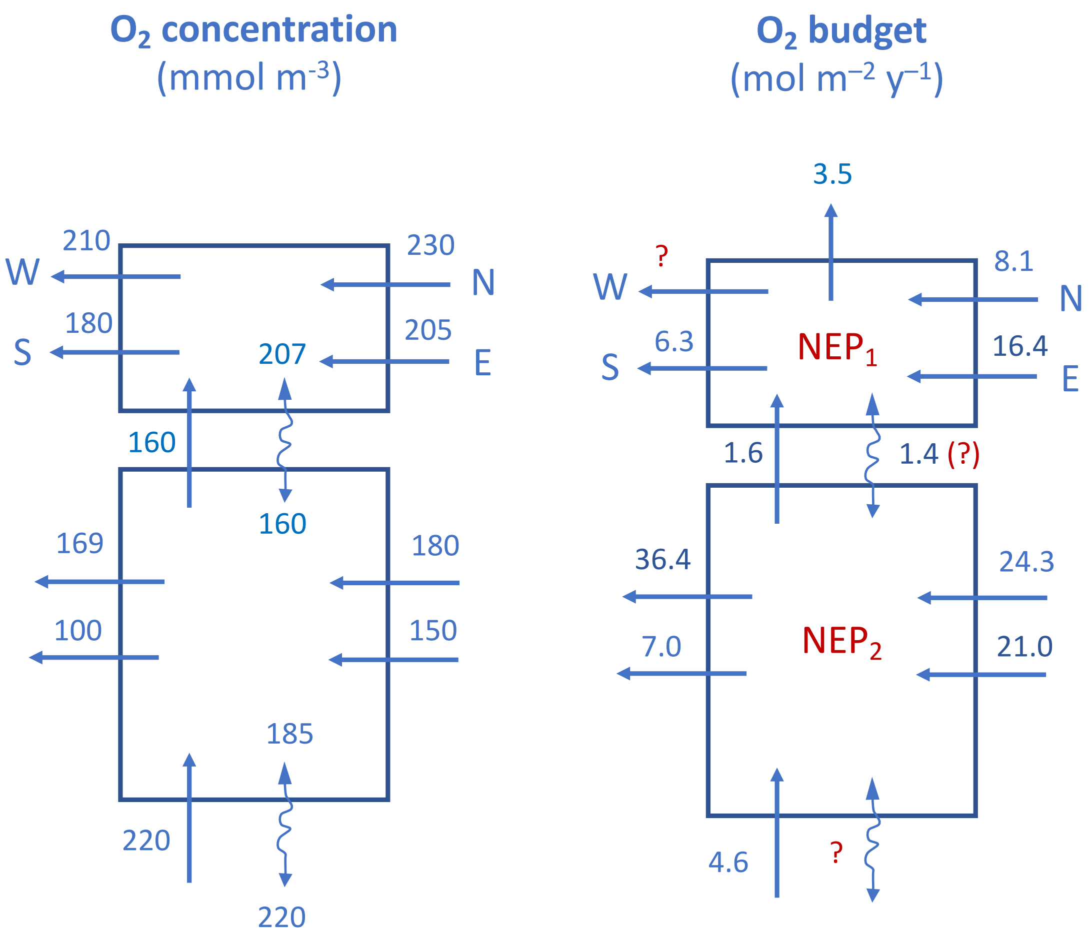

Figure E2.2. Dissolved oxygen concentrations associated to each transport in/out of the epi- and mesopelagic layers (a) and dissolved oxygen budget for the epi- and mesopelagic layer of the box. The diffusion of O_2 from the atmosphere to the epipelagic layer in panel b has been calculated from the piston velocity of dissolved oxygen (dependent on wind intensity) and the seasonal apparent oxygen utilisation of the epipelagic layer.