UNIVERSITY OF OSLO

Faculty of Mathematics and Natural Sciences

Midterm exam in GEF2610 – Introduction to Physical Oceanography
Day of exam: Friday 13 Oct. 2017
Exam hours: 1430-1530
This examination paper consists of 2 pages (including this).
Appendices:
Permitted materials: None

Make sure that your copy of this examination paper is complete before answering.

Problem 1: Air-sea fluxes

a) Briefly describe the four types of heat fluxes we can have between atmosphere and ocean. (2 points)

b) The bulk parametrizations for both types of turbulent heat fluxes have the wind speed incorporated in them. Why is this? (2 points)

c) Fluxes of actual salts through the sea surface are extremely small. What type of air-sea fluxes is it that instead impact the salinity of the ocean, and how? (2 points)

Problem 2: Stratification, potential energy and the equation of state

a) What do we mean by vertically stable and unstable water columns? What happens during vertical convection? (2 points)

b) Explain, by help of a drawing, why we can have a fluid which is vertically stable but from which we can still extract potential energy by a certain rearrangement of water parcels. In other words, explain what we mean by the term 'slantwise convection'. (2 points)

c) What is the difference between in situ temperature (the temperature we actually measure) and potential (or conservative) temperature? (2 points)

Problem 3: Observations

a) What is a CTD instrument and what does it measure? Salinity is not measured directly by this instrument. How is salinity deduced (from what the instruments can measure)? (2 points)

b) Name at least two ways in which we can obtain Eulerian (fixed position) observations of the ocean velocity field? How can we obtain Lagrangian observations of the velocity field? (2 points)
c) Explain how satellite observations of sea surface height can be used to deduce surface velocities. What do we call such velocities? (2 points)

Problem 4: The Coriolis acceleration and geostrophy

a) Explain the Coriolis acceleration. Use the example of two friends who are sitting on a rotating disk while trying to throw a ball to each other. (2 points)

b) What is the geostrophic balance and under what temporal and lateral scales does it hold (here you could introduce the Rossby numbers)? Write down the geostrophic equations. (2 points)

c) The sea surface height in the North Pacific Ocean increases from south to north by 0.5 m over a distance of 1000 km. The kinematic pressure at $z = 0$ is approximately $p/\rho_0 = g\eta$, where g is the gravitational accelleration and η is the sea surface height (above $z = 0$). Assume that $g = 10$ ms^{-2} and that the Coriolis parameter is $f = 10^{-4}$ s^{-1} . What are the geostrophic surface currents (their strength and direction)? (2 points)