| **AdOc 2013 GEOL4060/5060 Exercise 7**<br>**Eddy Viscosity, Turbulence, Waves** | Name:<br>Id: |
|---|---|

*Issued 8Apr2013; Due at beginning of 15Apr2013 session. Give short answers, but please show your thinking. The relations that you need are in lecture PPT's and also at the bottom of the sheet.*

**Q1. Wind stress** A persistent wind blows over an open ocean location at 50 knots (measured at 10m above sealevel).

(i) Using this diagram of $C_D$ estimate the shear stress, then near-surface Eddy Viscosity of the area.

(ii) Apply the Ekman relations to estimate the Ekman drift and transport.

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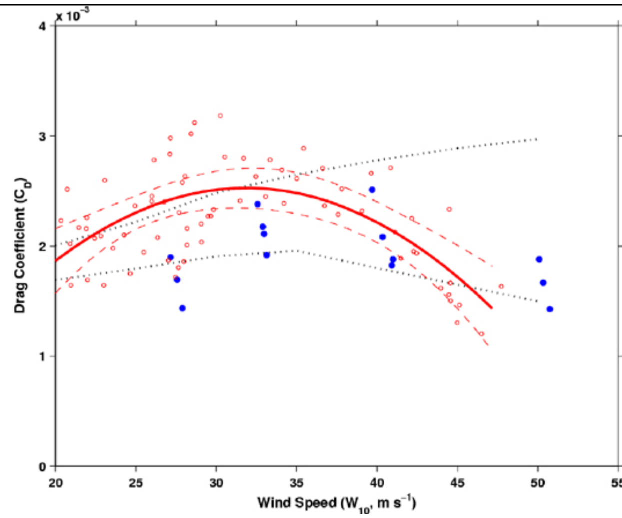
A i:

A ii:




| **Q2. General knowledge** | |
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| i. Is there a type of an Ekman effect near the seabed ? Why ? | |
| ii. List the different types of waves we have encountered in this course. In what scenarios did they occur ? | |
| iii. What is the Reynold's number and (thereby) the ambient flow state for:<br>a. Tuna at full speed ?<br>b. Jellyfish ?<br>c. Feeding barnacle cirri ? | |
| iv. If a set of deep ocean waves runs into a current going in (i) the opposite (ii) same direction, what changes happen to the waves ? | |

Q3. Using the list provided below as inputs, and formulae from lectures, calculate:

a. Kolmogorov length scale for the various situations, then

b. Turbulent Kinetic Energies (TKE) at the jellyfish (10cm) scale ?

| *Arctic (0˚C)*<br>• *Breaking waves ε ~1.E-3* | |
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| | |
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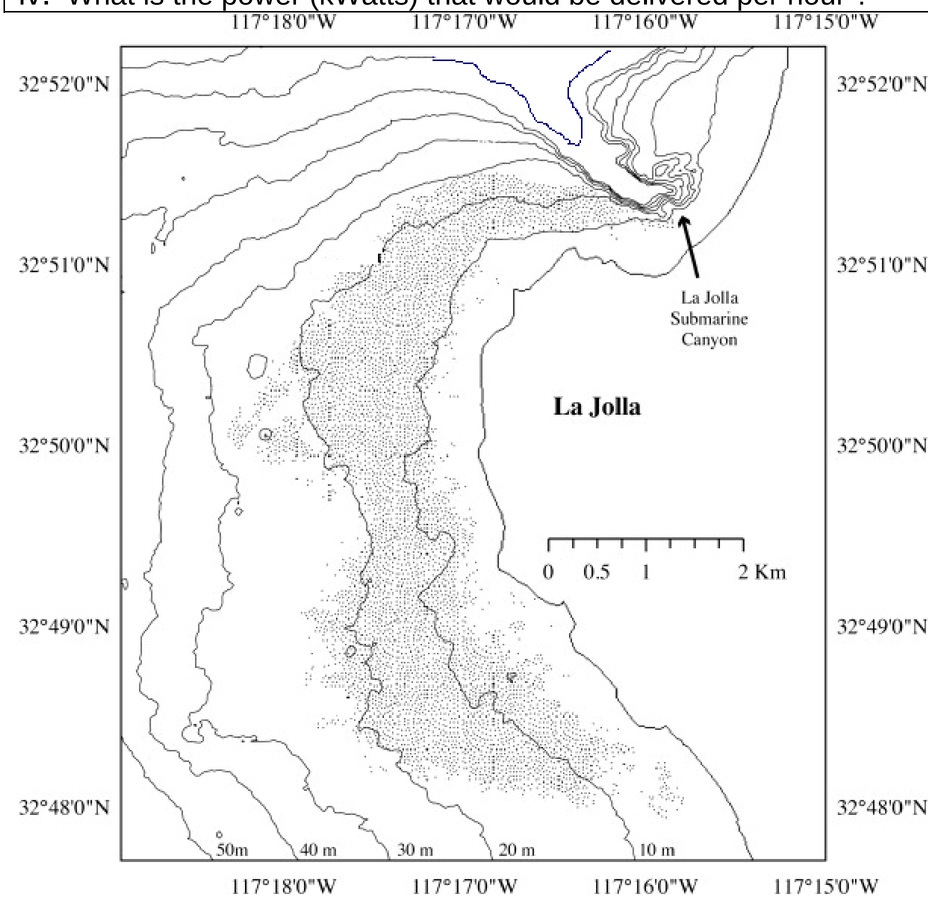
| • *Current shear ε ~1.E-5*<br>*Tropical (25˚C)*<br>• *Beneath thermocline ε ~1.E-10*<br>• *Current shear ε ~1.E-5* | |

Q4. A train of deep-water ocean waves of 6 secs period arrives from the WNW at this coastline.

i. At what locations (water depth contours) will the waves transition from deep-water waves, and then to shallow water waves ?
ii. Using Snell's law, calculate a raypath for the waves as they pass onto 3 different sectors of the shelf and coastline.
iii. At 1m wave height beating on the shore, what will the wave energy (Joules) be delivered per meter of coastline where your raypaths strike ?
iv. What is the power (kWatts) that would be delivered per hour ?




1 bar=$10^5$ N/m$^2$; 1 Newton (N) is the force of Earth's gravity on a mass of ~0.1 kg (i.e., 1/9.81 kg); P=ρgz;

F=fmu; f=2 Ω sin(Φ); Ω=$7.292 \times 10^{-5}$ rad/s; F=Ma; $\frac{dP}{dX} = \rho g \tan(\theta)$; $Re = \frac{\rho V D}{\mu}$ dimensionless;

$E(k) = C\epsilon^{2/3}k^{-5/3}$; $l_k = \eta = \left(\frac{\nu^3}{\epsilon}\right)^{1/4}$

Dynamic viscosity (mu, μ) - 0 °C: $1.88 \times 10^{-3}$ Pa s ; 20 °C: $1.08 \times 10^{-3}$ Pa s

Kinematic viscosity, (nu, ν) - 0 °C: $1.83 \times 10^{-6}$ m$^2$ s$^{-1}$ ; 20 °C: $1.05 \times 10{-6}$ m$^2$ s$^{-1}$

end