Book: Dynamical Oceanography
Author: Dijkstra, H. A.; email: H.A.Dijkstra@uu.nl
Chapter: 12, Exercise: 12.1: Ocean-atmosphere interaction
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Assume that the temperature in the eastern Pacific (in the NINO3 region) increases by 1° C.

a. Use Fig. 12.5 and information in section 2.1 such as (2.1) to determine the amplitude response of the zonal wind stress τ_*^x *caused by a SST (NINO3) anomaly.*

From Fig. 12.5 we see that a pseudostress maximum of about 10 $\mathrm{m}^2/(\mathrm{s}^2\mathrm{K})$ is generated. According to (2.1) this gives a zonal wind stress anomaly

$$\Delta\tau_*^x \sim 10 C_D \rho_a = 0.012 \text{ Pa}$$

Assume that the wind-stress anomaly is purely zonal, i.e., $\tau^y = 0$.

b. Calculate the amplitude of the equatorial upwelling anomaly w_{E*} *caused by the zonal wind-stress anomaly.*

From the expression (12.9), we can calculate w_{E*} at the equator as

$$w_{E*} = \frac{\beta_0 \Delta\tau_*^x}{\rho a_s^2}$$

With $a_s = 5 \times 10^{-6}$ s^{-1}, it follows that $w_{E*} \sim 0.66$ m/day.

c. Calculate the amplitude of the thermocline anomaly h_{e*} *in the west Pacific caused by the zonal wind-stress anomaly.*

Here we use (11.80) for $x_* = 0$m, which gives

$$h_{e*} = \frac{\Delta\tau_*^x L}{3\rho H g'}$$

With $g'H = 4$ $\mathrm{m}^2\mathrm{s}^{-2}$ and $L = 10^7$ m, we find $h_{e*} \sim 10$ m.