The Ekman Current Observed From Drifters In The Northeast Pacific

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Ekman Model

- Ekman wind-driven current model,

$$-fv = \frac{du}{dz}\left(K_z \frac{du}{dz}\right)$$

$$fu = \frac{dv}{dz}\left(K_z \frac{dv}{dz}\right)$$

- Solution,

$$\vec{u} = \frac{\tau H}{\sqrt{2}K_z} e^{z/H} e^{-i\theta}$$

Where $\theta = (z/H + \pi/4)$

Ekman Model

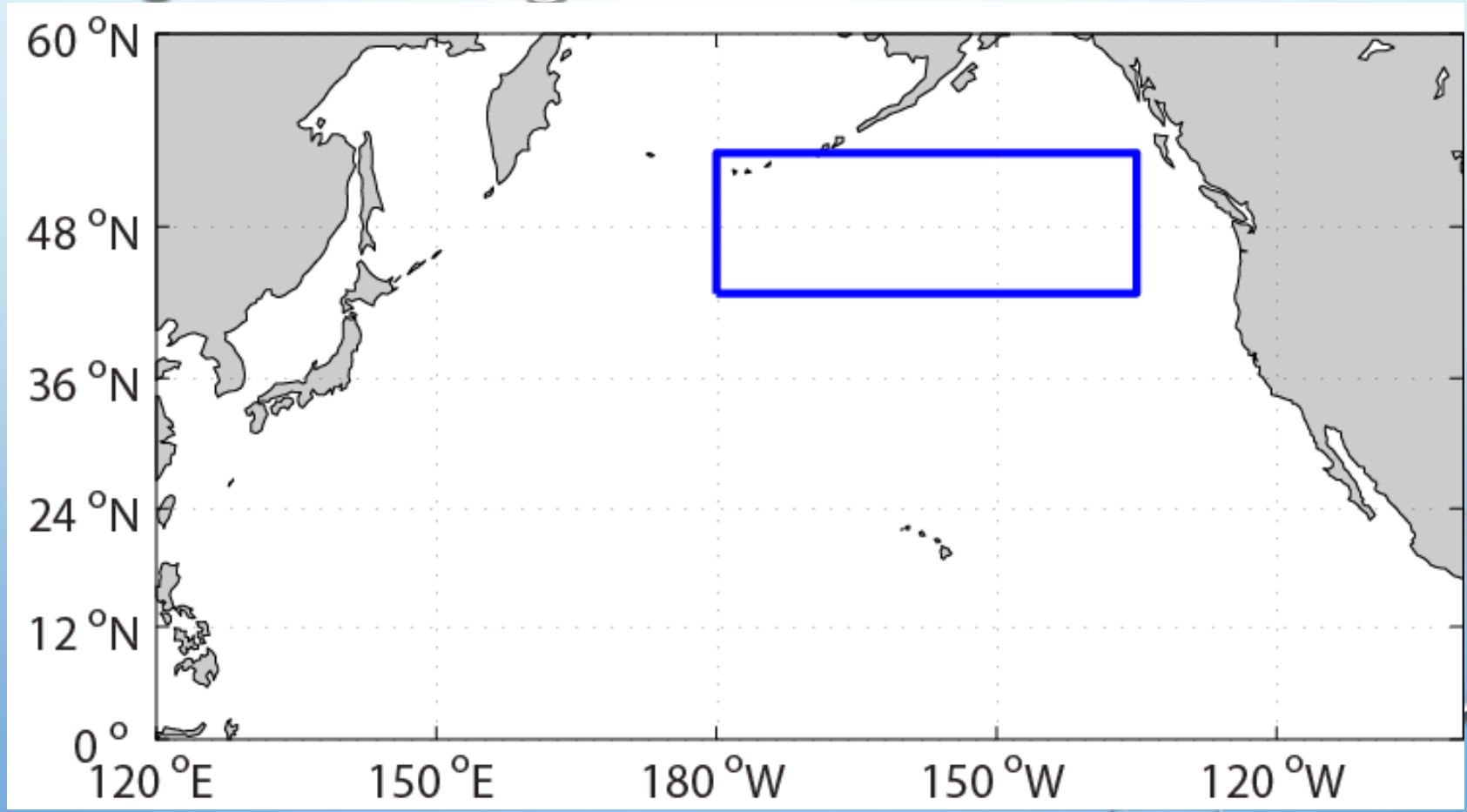
- Here Ekman Layer Depth

$$\mathrm{H} = \left(\frac{2K_z}{f}\right)^{1/2}$$

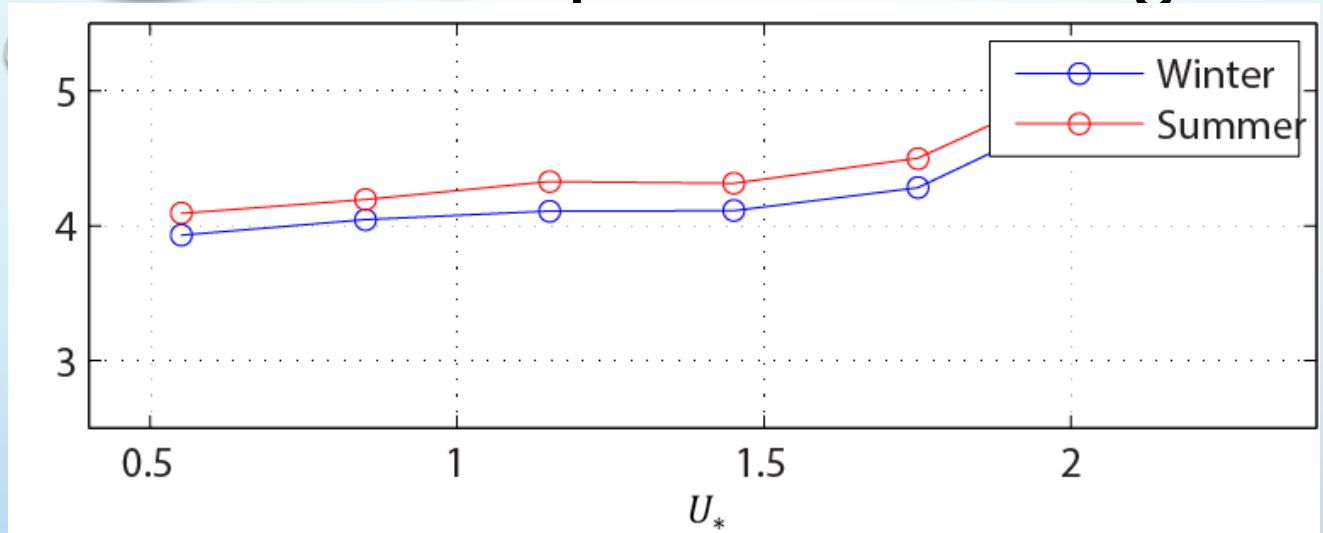
- H is also depend on τ, i.e. eddy viscosity coefficient K_z depends on wind stress.
- Angle at 15m becomes smaller with stronger wind,

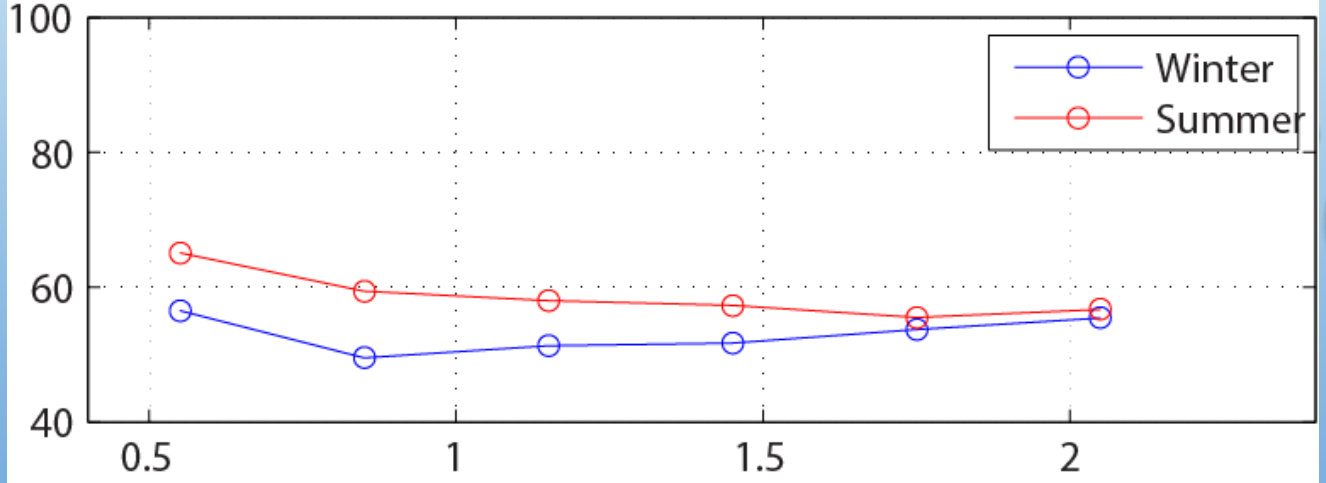
Ekman Spiral $\theta = ({}^{z}/_{H} + {}^{\pi}/_{4})$, and angle increases with depth.

Observation Area – Strong Westerlies, Weak Eddy Activity



Observed Amplitude and Angle



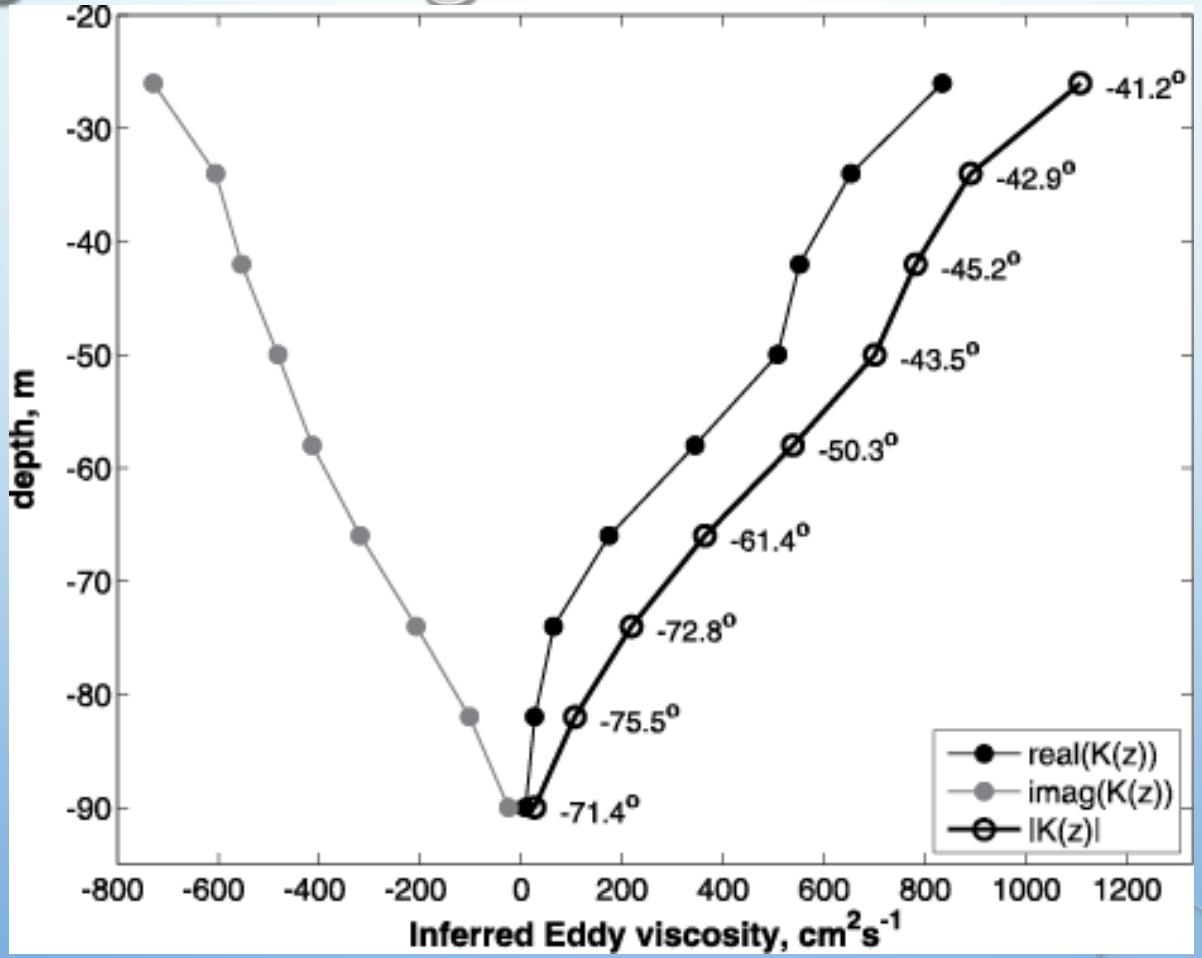


Observations Indicate

1. Angle is not depend upon wind stress!
2. Amplitude $\sim U_*^{1.05}$ Ralph and Niiler (1999)
3. Seasonal difference!

U_*

From Lenn and Cherskin (2009)
Rotating eddy viscosity with depth



EKMAN MODEL WITH ROTATING EDDY VISCOSITY

1. Ekman wind-driven current model in complex domain (Lenn and Cherskin),

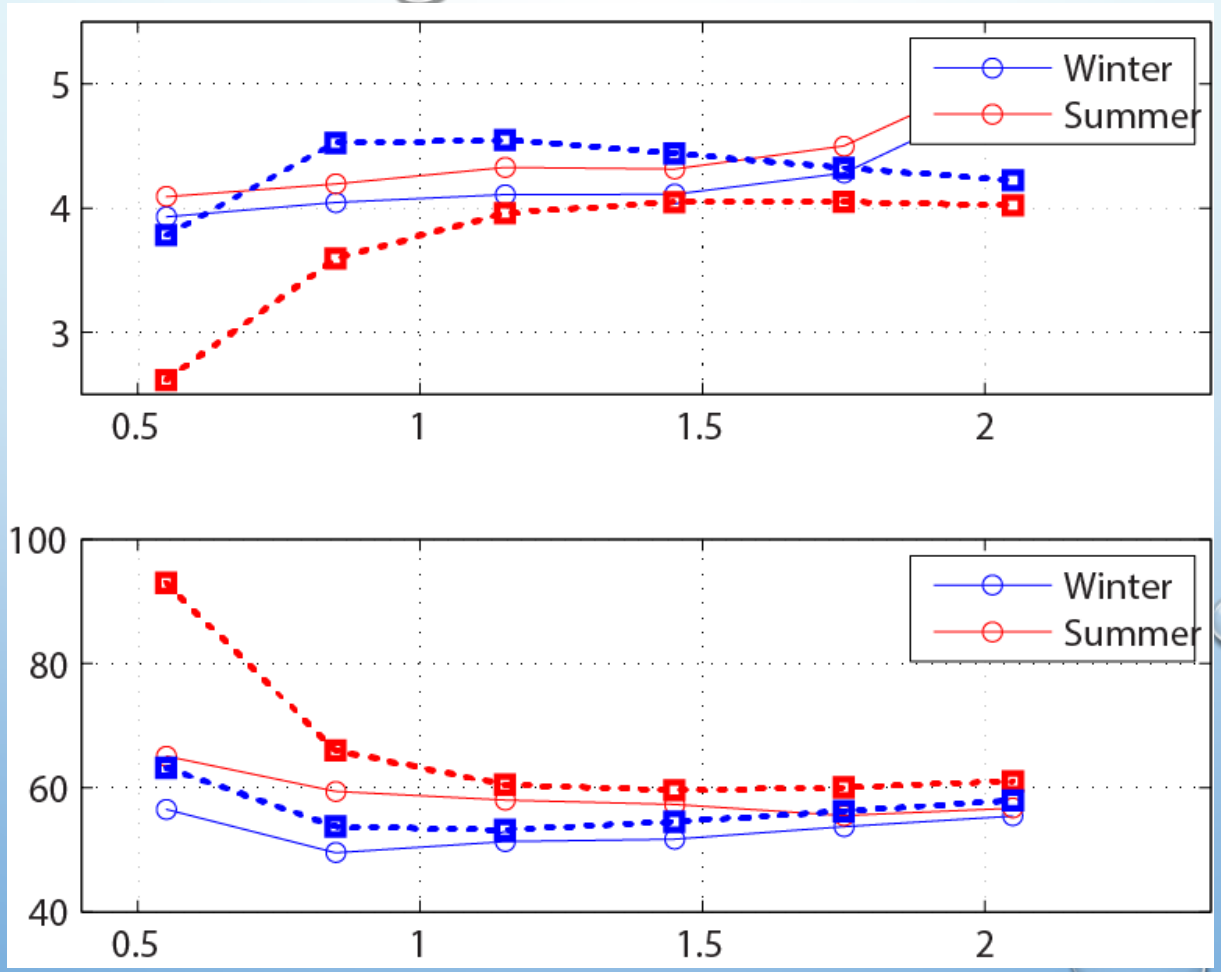
$$if[u+iv]=a[\partial^2 iv/\partial^2 z]+c[\partial^2 u/\partial^2 z]$$

2. *a* and *c* become real number, the correct model for rotating eddy viscosity is

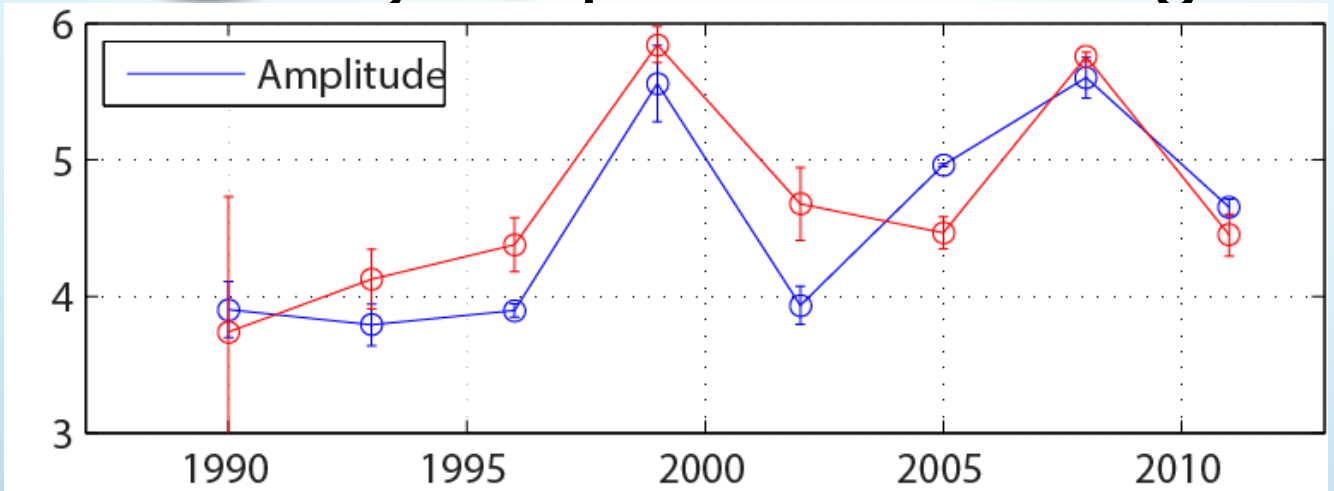
$$f[u+iv]=\partial/\partial z\left\{(a(z)e^{i\theta})[\partial\ (u+iv)/\partial\ z]\right\}$$

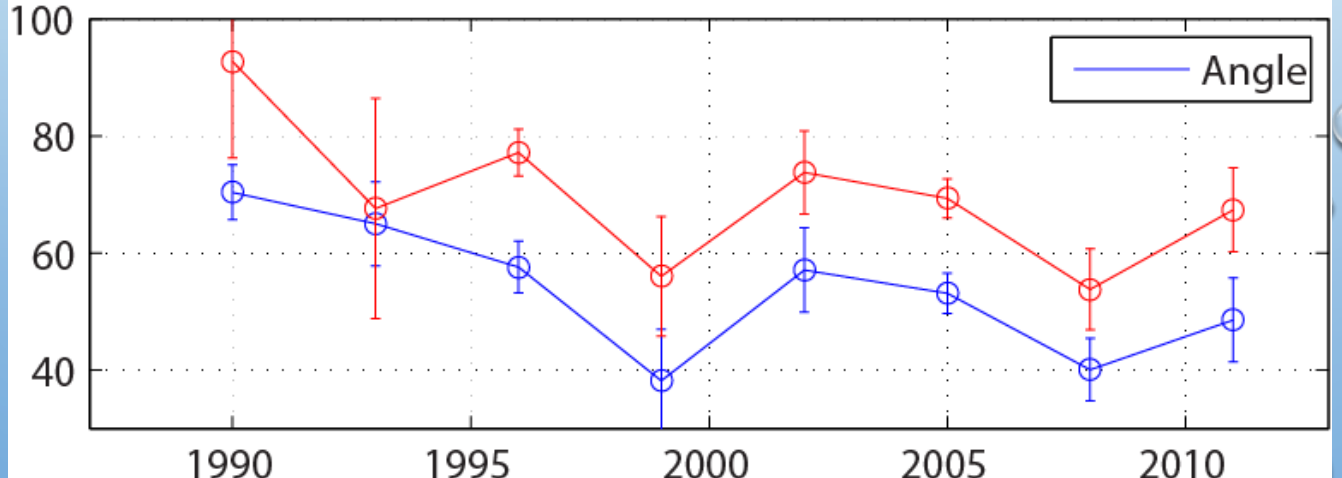
3. The model can be solved numerically using Matlab solver

Rotating eddy viscosity with depth



Yearly Amplitude And Angle





Observation and Model Indicate

1. Eddy viscosity has direction, strong wind -> downwind direction (~30°) and weak wind -> cross wind direction (~80°)
2. Model indicates mean drogue depth may be shallow in winter.

Verification of Model Needs

1. Mean drogue depth in winter may be shallower than 15m by collapsing drogue.
2. Drogue status recheck before 2002.
3. Drifter with pressure gauge is planned for measuring drogue depth in high wave state.