Complete force (momentum) balance with rotation

Three equations:

Horizontal (x) (west-east)

acceleration + advection + Coriolis =

pressure gradient force + viscous term

Horizontal (y) (south-north)

acceleration + advection + Coriolis =

pressure gradient force + viscous term

Vertical (z) (down-up)

acceleration +advection (+ neglected very small Coriolis) =

pressure gradient force + effective gravity

(including centrifugal force) + viscous term

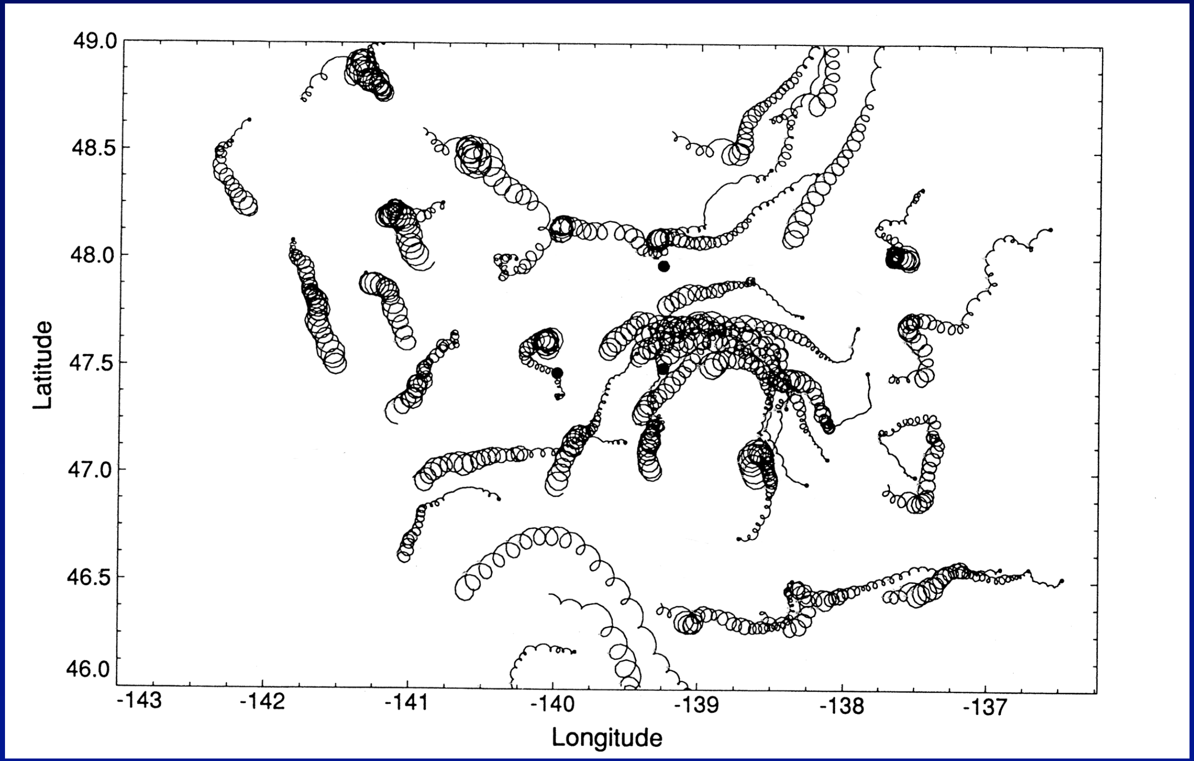
Final equations of motion (momentum equations in Cartesian coordinates)

x: $\partial u/\partial t + u\,\partial u/\partial x + v\,\partial u/\partial y + w\,\partial u/\partial z - fv =$
$- (1/\rho)\partial p/\partial x + \partial/\partial x(A_H \partial u/\partial x) +$
$\partial/\partial y(A_H \partial u/\partial y) + \partial/\partial z(A_V \partial u/\partial z)$ (7.11a)

y: $\partial v/\partial t + u\,\partial v/\partial x + v\,\partial v/\partial y + w\,\partial v/\partial z + fu =$
$- (1/\rho)\partial p/\partial y + \partial/\partial x(A_H \partial v/\partial x) +$
$\partial/\partial y(A_H \partial v/\partial y) + \partial/\partial z(A_V \partial v/\partial z)$ (7.11b)

z: $\partial w/\partial t + u\,\partial w/\partial x + v\,\partial w/\partial y + w\,\partial w/\partial z$ (+ neglected small Coriolis) =
$- (1/\rho)\partial p/\partial z - g + \partial/\partial x(A_H \partial w/\partial x) +$
$\partial/\partial y(A_H \partial w/\partial y) + \partial/\partial z(A_V \partial w/\partial z)$ (7.11c)

Coriolis in action in the ocean: Observations of Inertial Currents



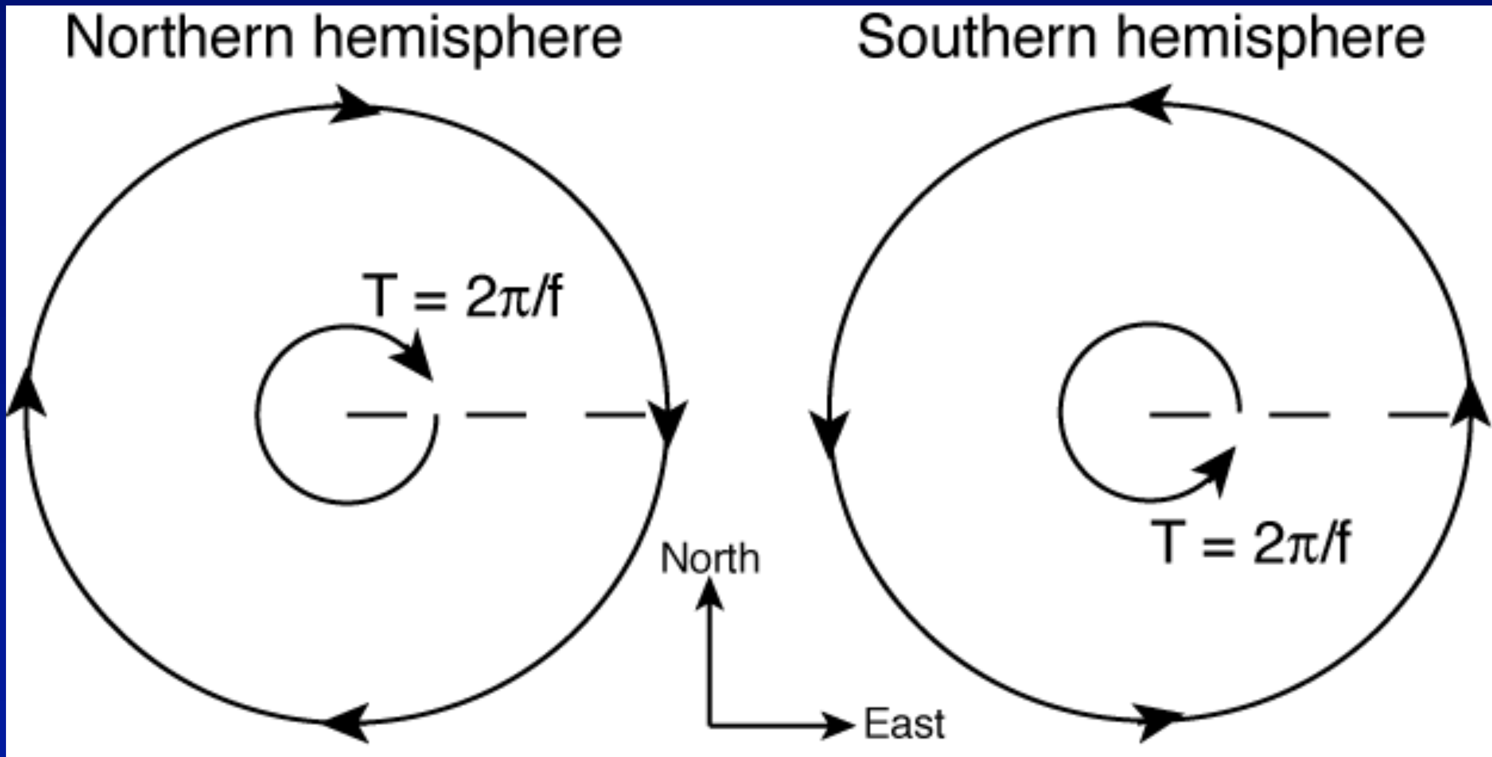
D'Asaro et al. (1995)

DPO Fig. 7.4

- Surface drifters in the Gulf of Alaska during and after a storm.
- Note the corkscrews - drifters start off with clockwise motion, which gets weaker as the motion is damped (friction)

Inertial currents

Balance of Coriolis and acceleration terms: push the water and it turns to the right (NH), in circles



DPO Fig. S7.8a

Inertial currents: force balance

Three APPROXIMATE equations:

Horizontal (x) (west-east)

acceleration + Coriolis = 0

Horizontal (y) (south-north)

acceleration + Coriolis = 0

Vertical (z) (down-up) (NOT IMPORTANT) (hydrostatic)

0 = pressure gradient force + effective gravity

That is:

x: $\partial u/\partial t - fv = 0$

y: $\partial v/\partial t + fu = 0$

1/2d/dt(u*u+v*v)=R