Does the Problem Matter?

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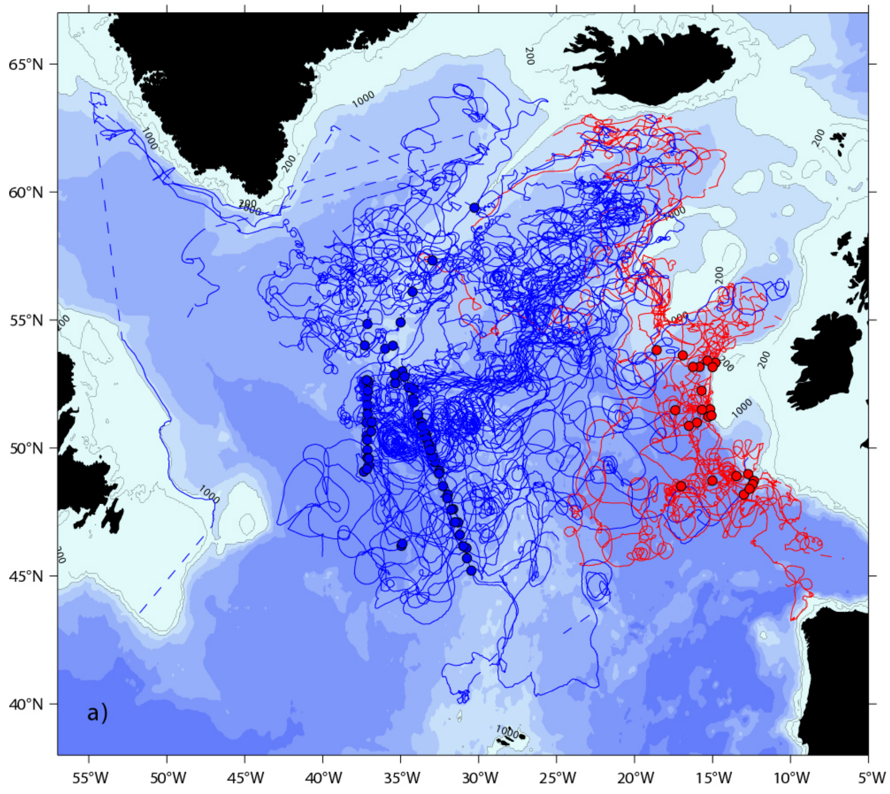
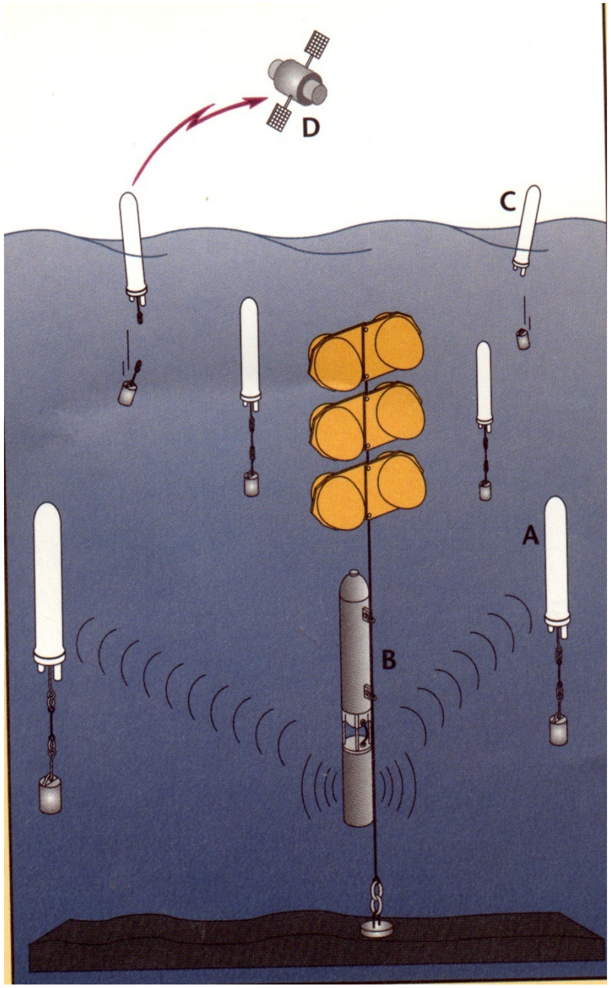
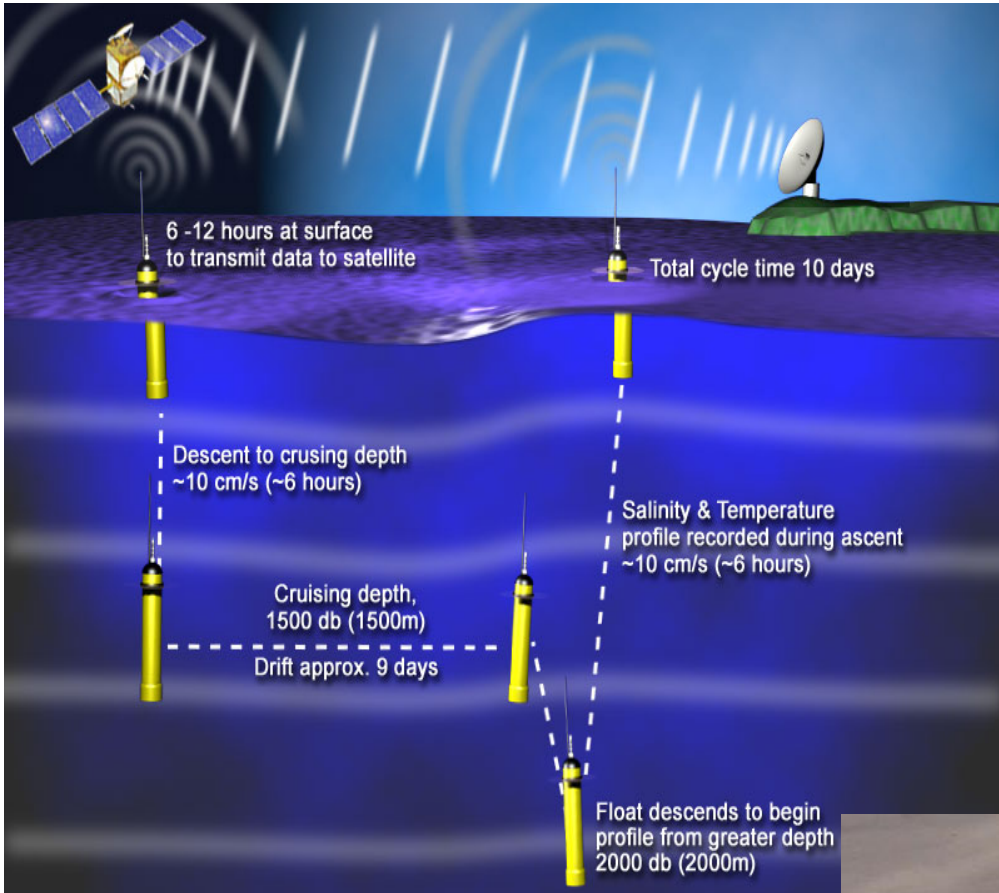
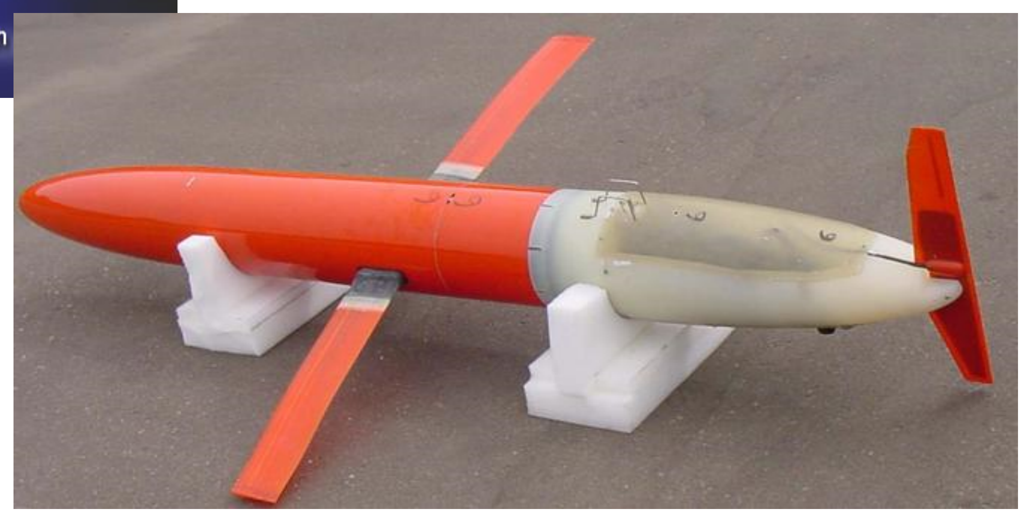
Using data from the tracks of Lagrangian instruments






6 -12 hours at surface
to transmit data to satellite
Total cycle time 10 days
Descent to crusing depth
~10 cm/s (~6 hours)
Salinity & Temperature
profile recorded during ascent
~10 cm/s (~6 hours)
Cruising depth,
1500 db (1500m)
Drift approx. 9 days
Float descends to begin
profile from greater depth
2000 db (2000m)



Augmented system

Append equations for drifters (floats)

$$\mathbf{x} = \begin{pmatrix} \mathbf{x}_F \\ \mathbf{x}_D \end{pmatrix} \quad \text{-- augmented state vector}$$

$$\frac{d\mathbf{x}_F^{\mathrm{f}}}{dt} = M_F(\mathbf{x}_F^{\mathrm{f}}, t) \quad \text{-- flow equations}$$

$$\frac{d\mathbf{x}_D^{\mathrm{f}}}{dt} = M_D(\mathbf{x}_D^{\mathrm{f}}, \mathbf{x}_F^{\mathrm{f}}, t) \quad \text{-- tracer advection equation}$$

Apply filtering to augmented system

Ide, Jones and Kuznetsov (2002)

Salman's Idea

$$\frac{d\mathbf{x}_F^{\mathrm{f}}}{dt} = M_F(\mathbf{x}_F^{\mathrm{f}}, t)$$

$$\frac{d\mathbf{x}_D^{\mathrm{f}}}{dt} = M_D(\mathbf{x}_D^{\mathrm{f}}, \mathbf{x}_F^{\mathrm{f}}, t)$$

Treat flow and tracer variables by different filtering methods

Salman: particle filtering on flow and full Fokker-Planck on tracers

$\Downarrow$

Modified idea: EnKF on flow and particle filtering on tracers

Parameter Estimation

Lorenz 96 (40 variable model):

$$\dot{x}_i = (x_{i+1} - x_{i-2})x_{i-1} - x_i + F$$

Problem: estimate forcing from state observations

Context: augment with equation for forcing

$$\boxed{\begin{aligned} \dot{x}_i &= (x_{i+1} - x_{i-2})x_{i-1} - x_i + F \\ \dot{F} &= 0 \end{aligned}}$$

Common Structure

Lagrangian DA	Parameter Estimation
$U_t = F(U)$	$X_t = F(X,P)$
$x_t = G_U(x)$	$P_t = 0$

$$X_{t+1} = M(X_t)$$

$$Y_{t+1} = N(Y_t)$$

Dimensions		
HIGH	U	X
LOW	x	P

Basic idea

HIGH → EnKF

LOW → Particle

One metric for a successful filter: how infrequent can we make the obs times and still have the filter converge?