# Control of active floating sensors

EE291 Class Project

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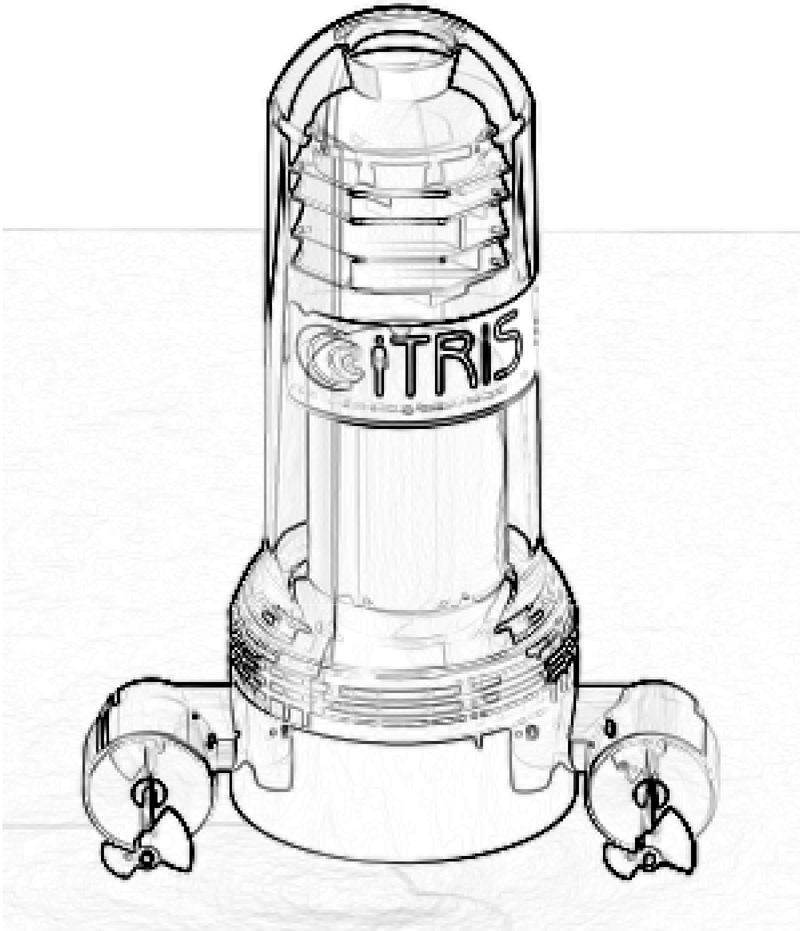
# The Floating Sensor Project

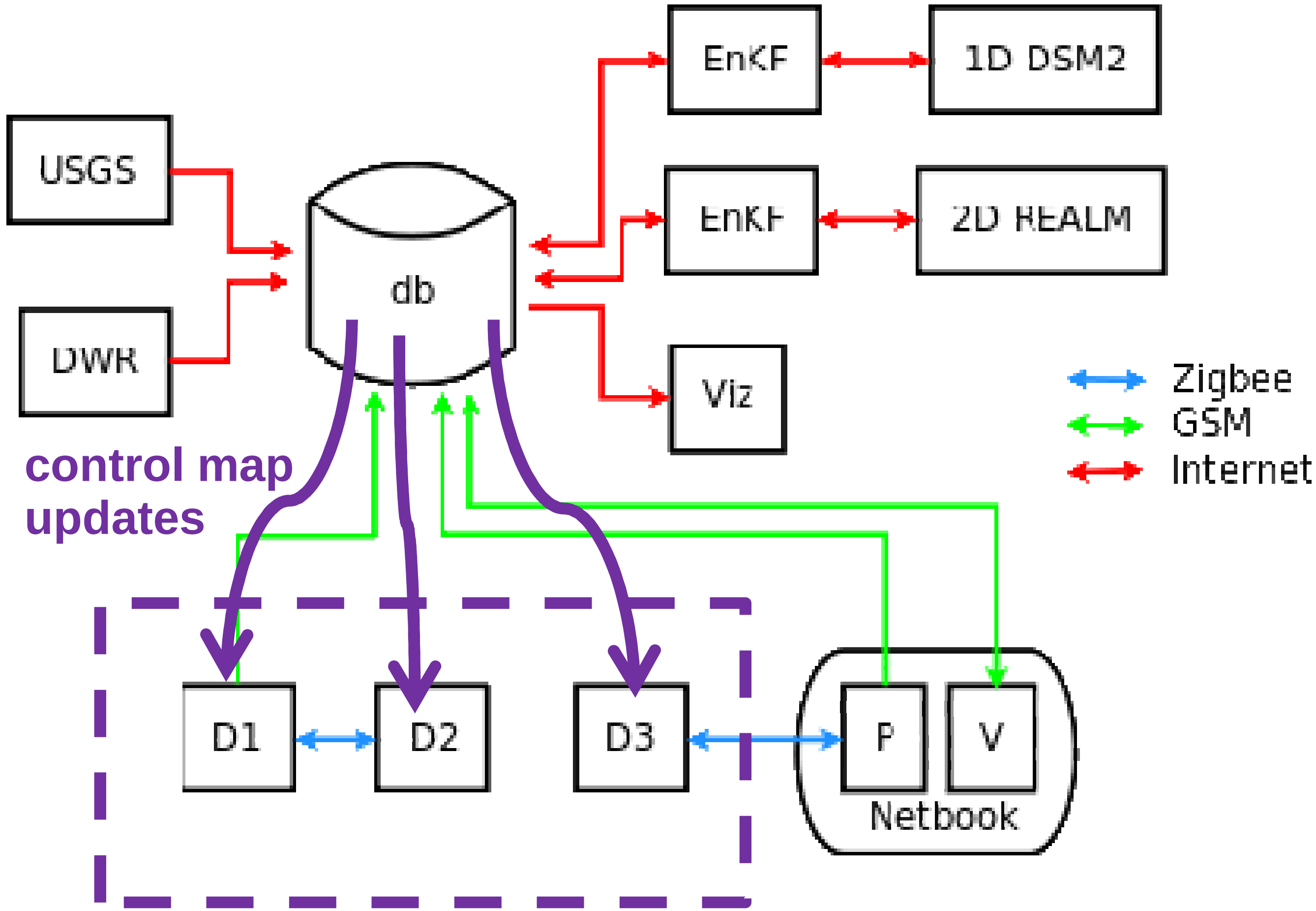
- Monitoring delta flow and salinity
- Network of motorized vehicles
- Provide accessibility to remote areas
- Integrated with mathematical delta model



# Motivation

- Without use of motors, “passive drifters” tend to get stuck on shore
- Maximize duration of uncontrolled movement
- Determine unsafe region where motor control is necessary

# Drifter System



# Problem Statement

- Use Ian Mitchell's level set toolbox to solve Hamilton Jacobi Bellman (HJB) Equation numerically

$$\frac{\partial \phi(x,t)}{\partial t} + \min[0, H^{\star}(x, \nabla \phi(x,t))] = 0$$

- Requires definition of Hamiltonian and terminal condition, $\phi(x,0) = \phi_0(x)$

| | |
|---|---|
| $\phi(x,t)$ | Implicit surface |
| $w(x,t)$ | Water current |
| $a(x,t)$ | Drifter (good guy) actions |
| $b(x,t)$ | Boat wake/wind (bad guy) actions |

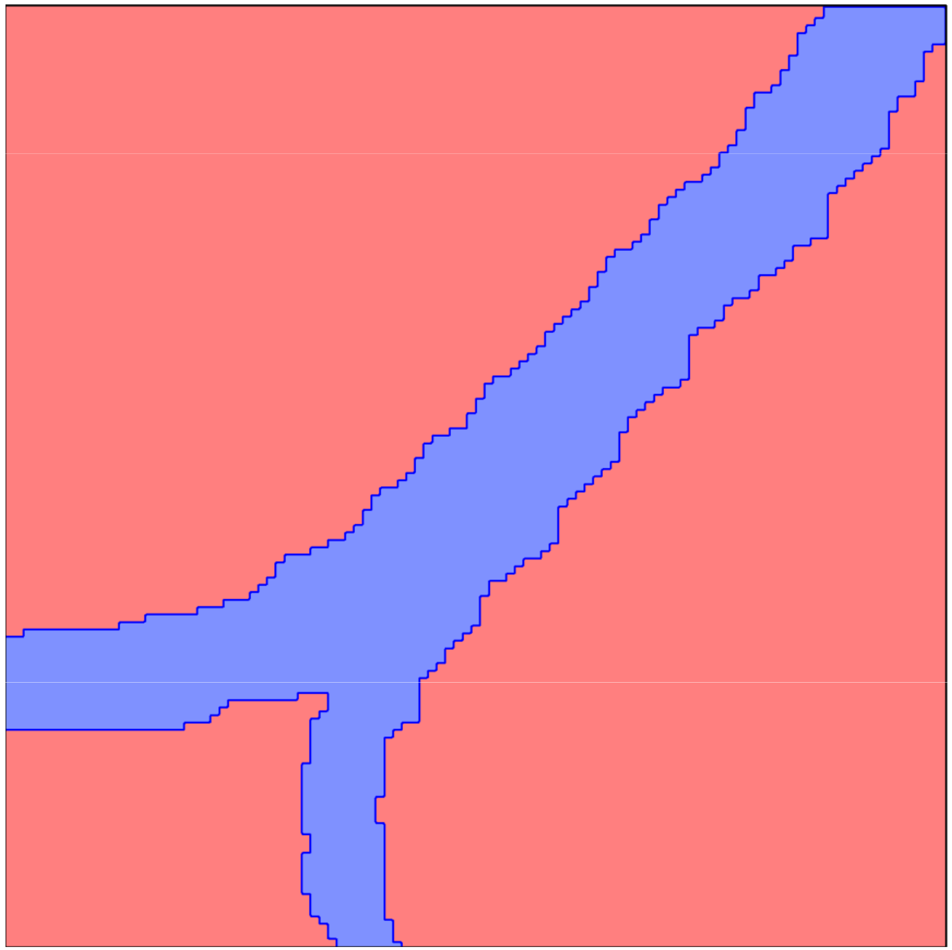
$$\begin{aligned} H^\star(x,p) &= \max_{\|a\|_2\le\bar{a}}\ \min_{\|b\|_b\le\bar{v}} H(x,p,a,b) \\ &= \max_{\|a\|_2\le\bar{a}}\ \min_{\|b\|_2\le\bar{b}} p^T\cdot f(x,a,b) \end{aligned}$$

$$p^T\cdot f(x,a,b) = (w_1+a_1+b_1)p_1 + (w_2+a_2+b_2)p_2$$

$$\Longrightarrow\ H^\star(x,p) = w_1p_1 + w_2p_2 + \bar{a}\sqrt{p_1^2+p_2^2} - \bar{b}\sqrt{p_1^2+p_2^2}$$

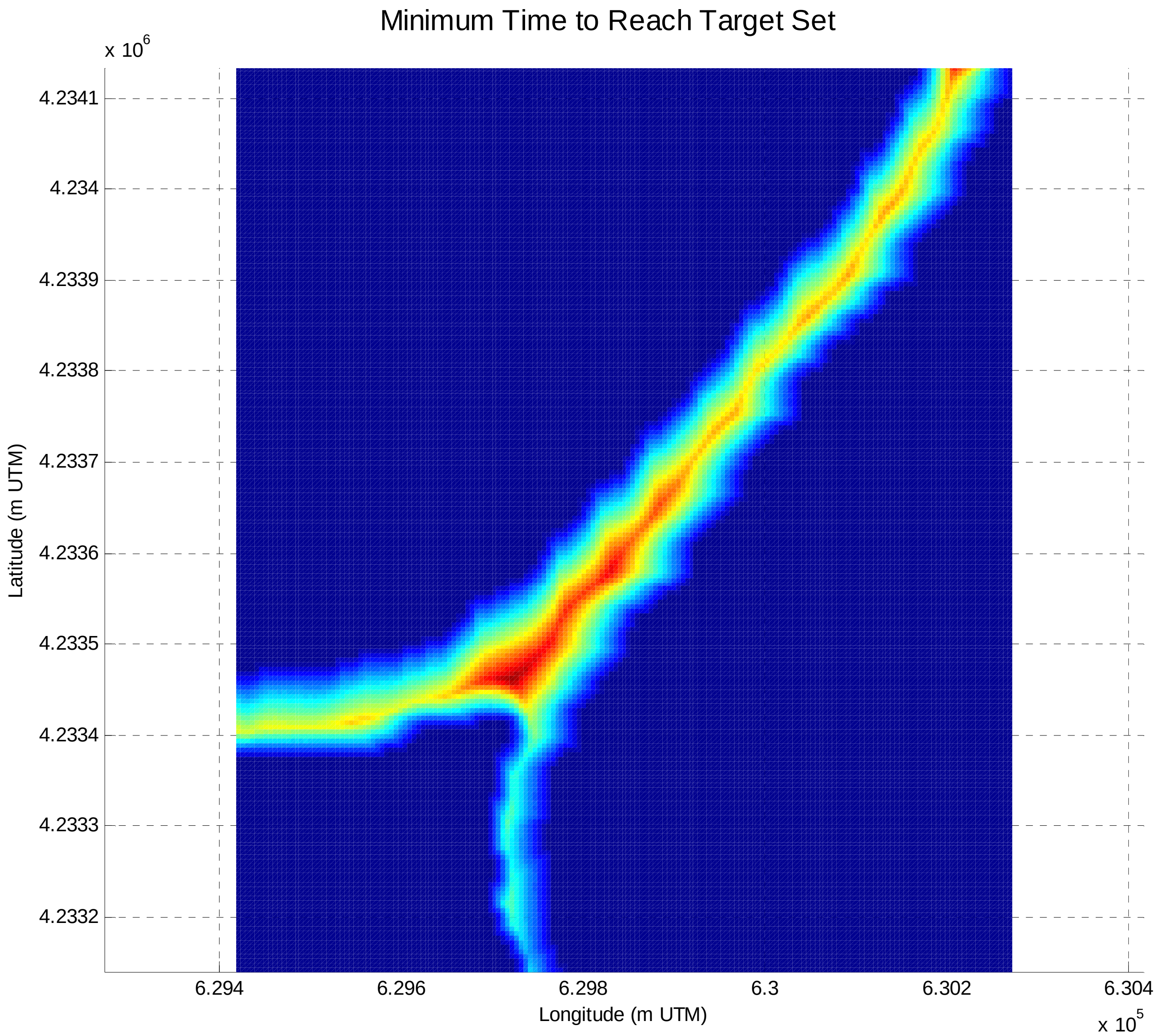
# Terminal Conditions:

$$\phi(x,0) = \phi_0(x)$$

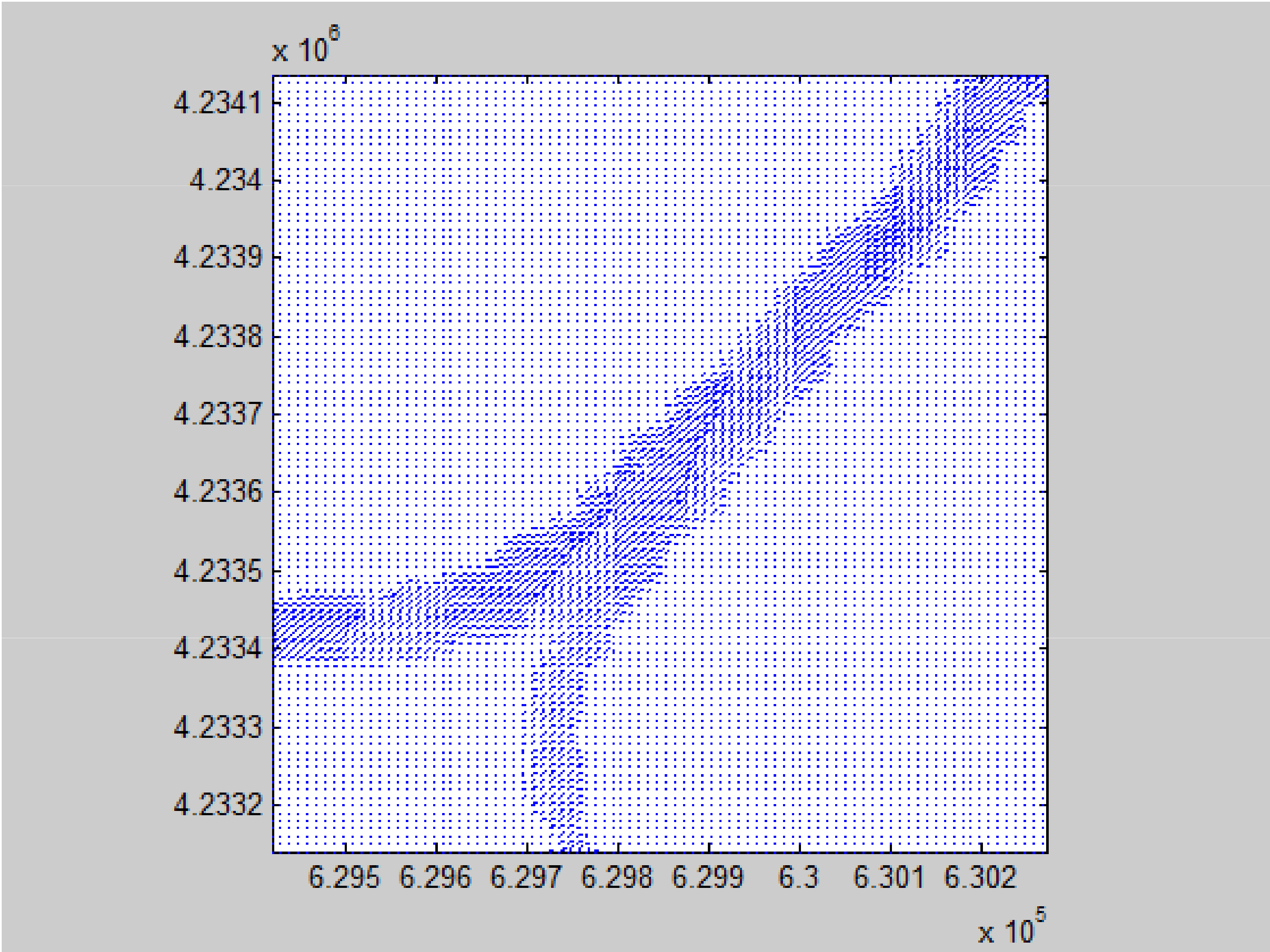


- Red areas (land) set to 1 (>0)
- Blue areas (water) set to -1 (<0)
- Ensures level crossing at shoreline

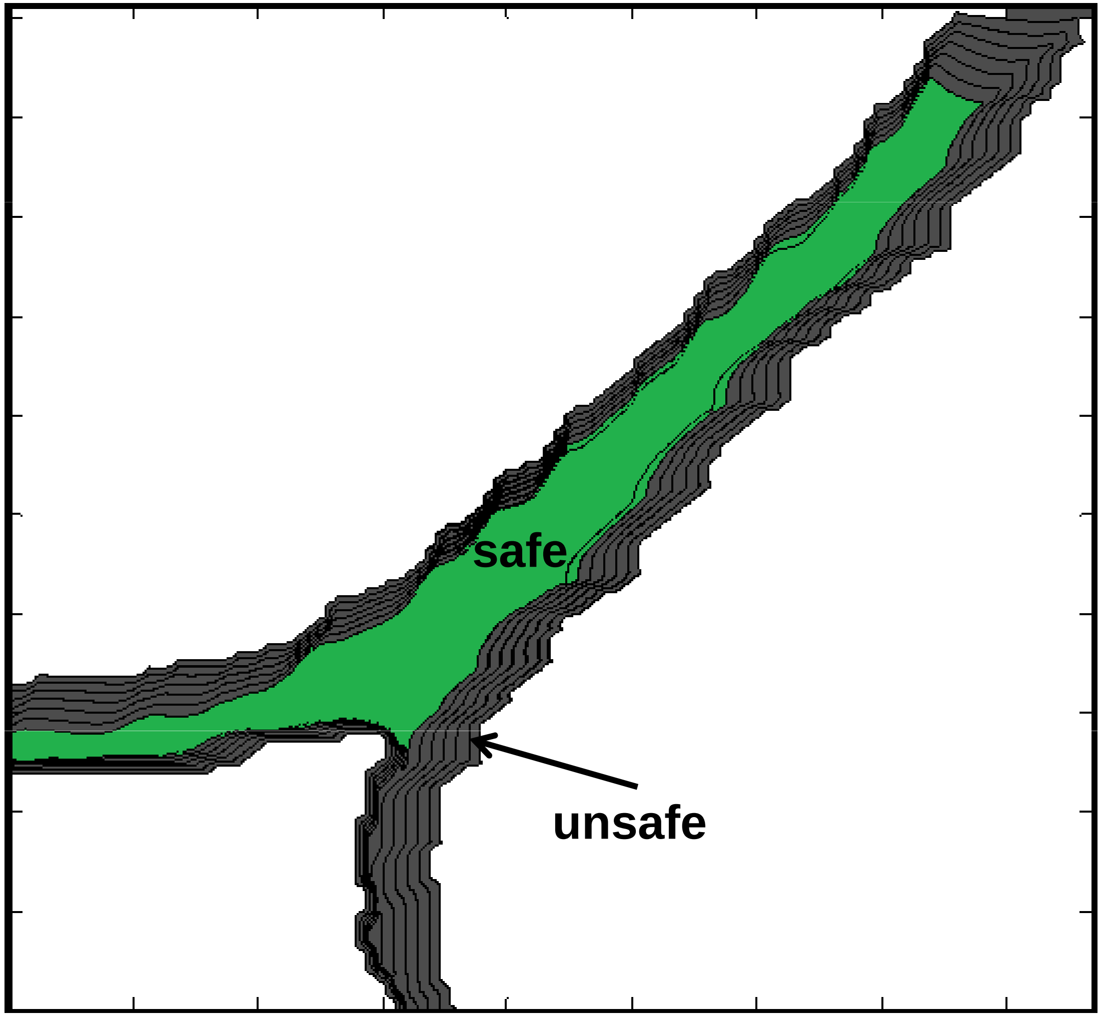
# Results : Time-to-reach function



# Results : Control Policy



# Results: Safety Region




- TTR function ran up to 100 time steps (arbitrary, for now)
- Control "turns off" once drifter is inside safety region
- Numerical inconsistency at top boundary likely due to target definition

# Further Issues

- Effect of discrete-time observation and control
- Observation noise as antagonist in differential game
- More complex drifter dynamics (inertia, drag, etc...)
- Dealing with modeling errors in flows and geometry