FAF'05 Mission A1

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Outline:

- **Major Accomplishment**
- **Objective**
- **Principle and method**
- **Implementation and results**
- **Main improvements**
- **Conclusion and future work**

Major Accomplishment

- Constructed an adaptive AUV path control.
- Coupled HOPS outputs, AREA simulator and optimization codes together.
- Implemented HOPS/ESSE ocean prediction and AUV path control parameters approximate optimization in real-time.

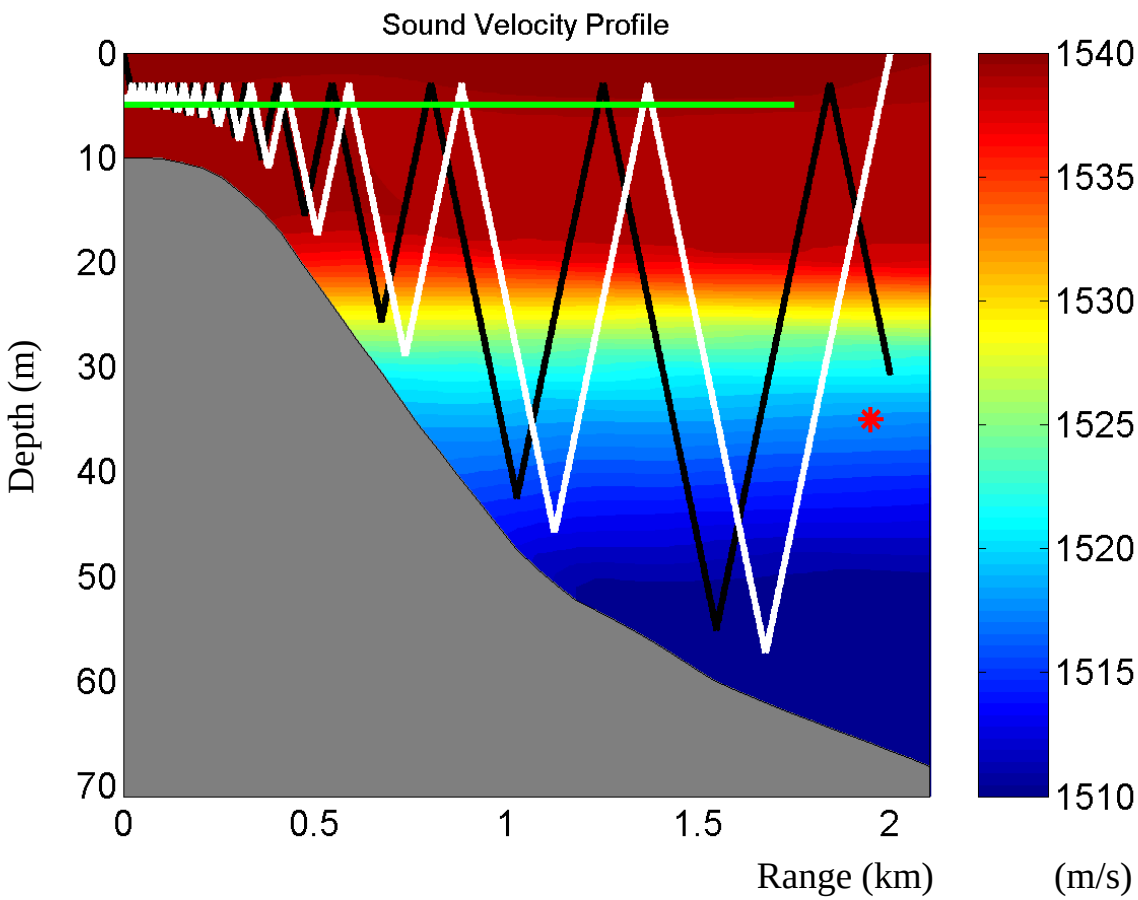
FAF'05 Mission A1

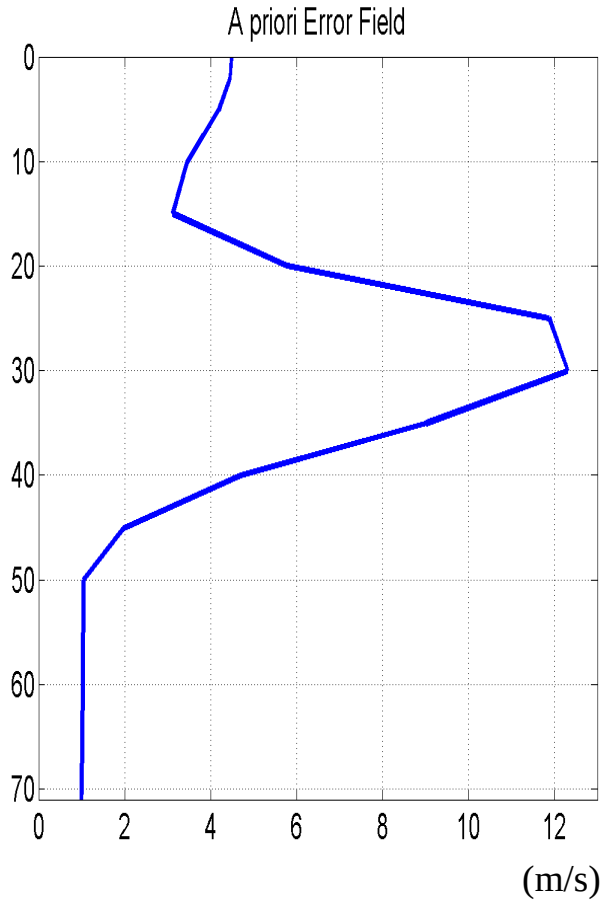
Objective: Test Adaptive Rapid Environmental Assessment mechanisms.

- Construct an adaptive AUV path control.
- Predict ocean in real-time.
- Optimize control parameters in real-time, s.t. minimize TL uncertainty.

Principle & Method

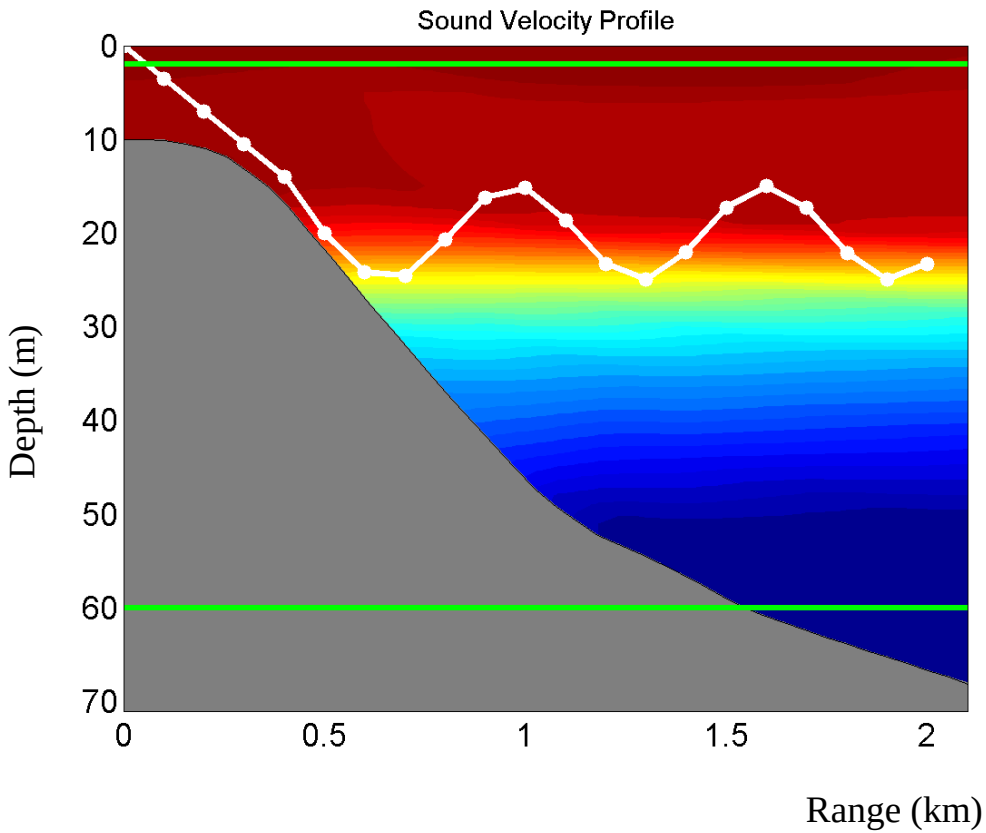
- Adaptive AUV path control --- yoyo control





Principle & Method

- Adaptive AUV path control --- yoyo control



- compare $\left|\frac{\partial c}{\partial z}\right|_n$ with a threshold d
- Relative position to thermocline.
- Relative position to upper bound , lower bound and bottom.

Principle & Method

- Data assimilation through objective analysis

$$\hat{\psi}^{OA} = \overline{\psi} + Cov(x, X)\left[Cov(X, X) + R\right]^{-1}\left[d - \overline{d}\right]$$

$$P^{OA} = Cov(x, x) - Cov(x, X)\left[Cov(X, X) + R\right]^{-1} Cov(X, x)$$

$\overline{\psi}$: background of SVP

x : random vector of sound velocities at grid points

X : random vector of sound velocities at measurement locations

R : convariance matrix of CTD noise

d : vector of measurement result

$\overline{d}$: background of sound velocities at measurement locations

$\hat{\psi}^{OA}$: SVP estimate from OA

P^{OA} : error convariance matrix

Principle & Method

- Cost function

$$\{\psi_0, \sigma_0\} \rightarrow \{\hat{\psi}^{OA}, \sigma^{OA}\}$$

$$C \sim N(\psi_0, \sigma_0, Lr, Lz) \rightarrow C^{OA} \sim N(\hat{\psi}^{OA}, \sigma^{OA}, Lr, Lz)$$

ψ_0 : principal estimate

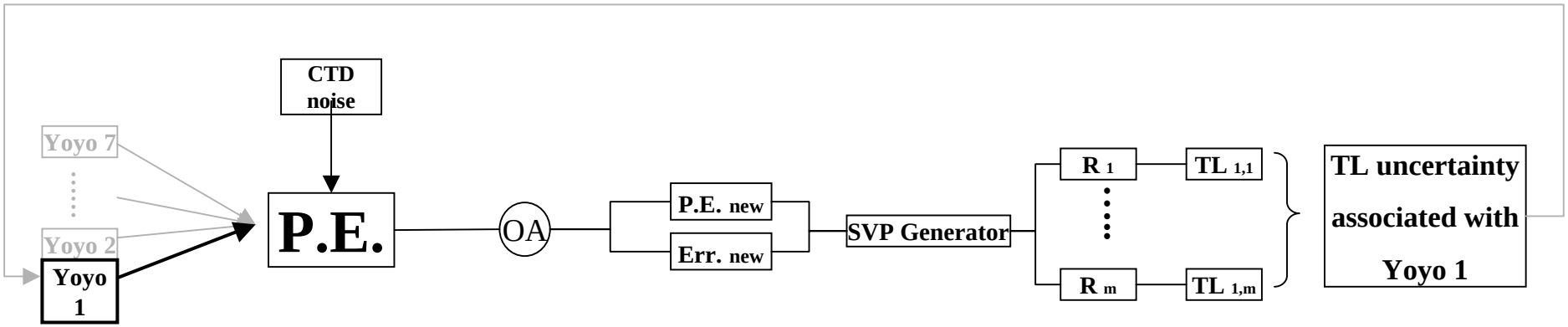
σ_0 : a priori error field

$$\left(\sigma^{OA}\right)^2 = diag\ (P^{OA})$$

$$TL^{OA} = f(C^{OA})$$

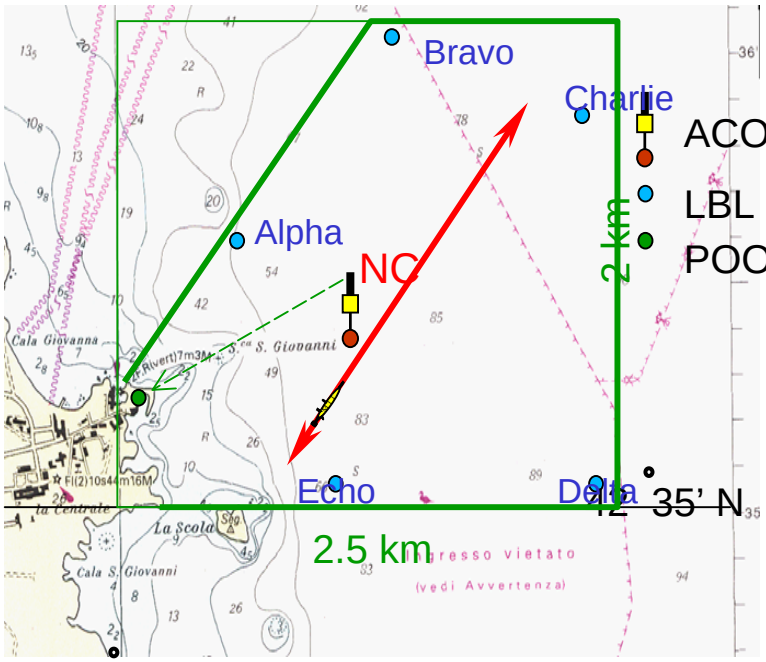
$$\text{cost} = \underset{\text{CDT}}{E}_{\text{noise}} \left\{\text{var}\left(TL^{OA}\right)\right\}$$

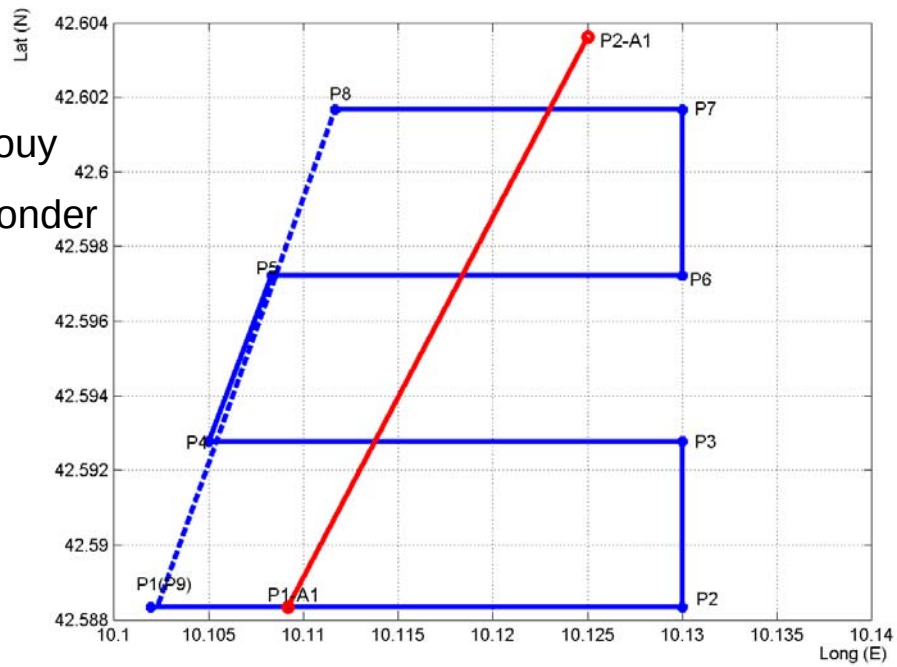
Principle & Method



Implementation

- Plan 7/13~7/16

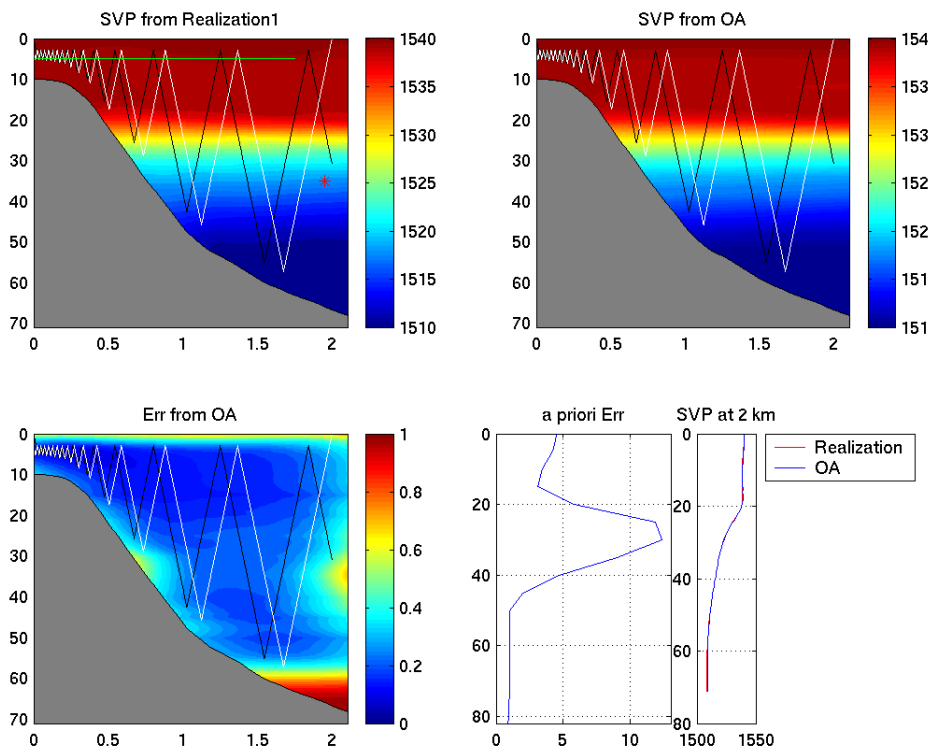


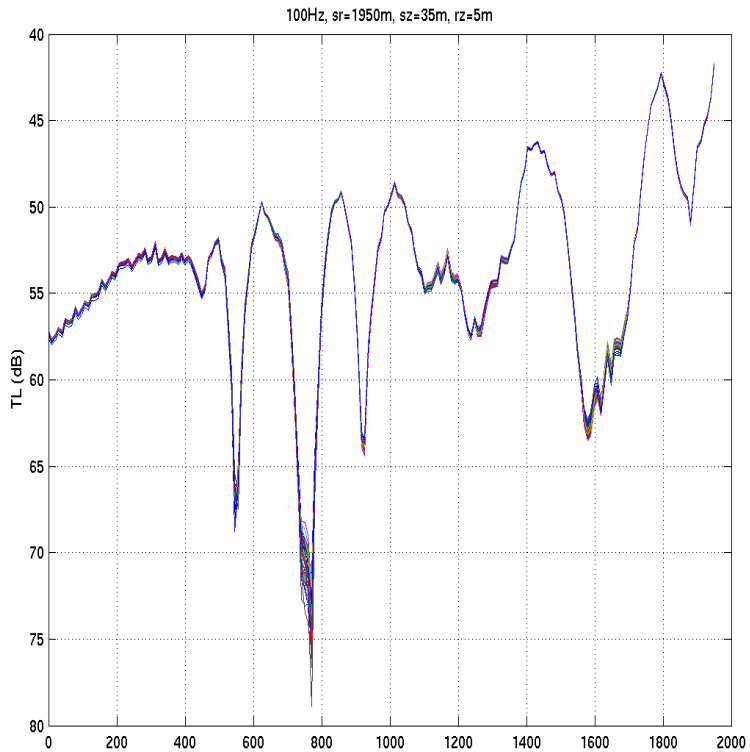


Implementation & Results

- Plan for 7/17~7/26

Optimal: n=30, d=1000 for afternoon of Jul 26

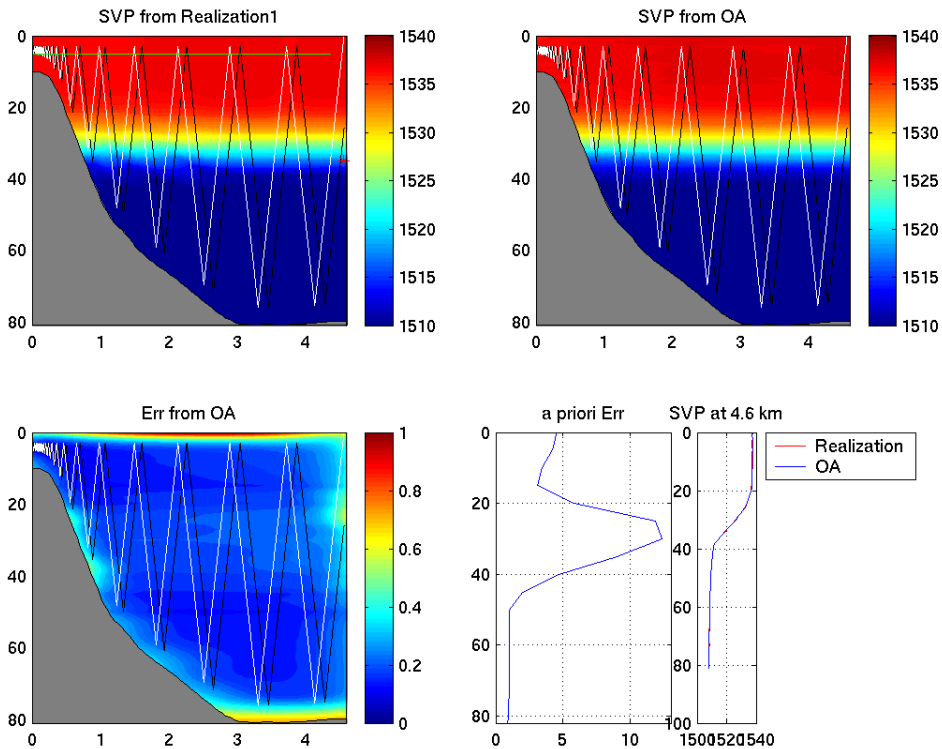


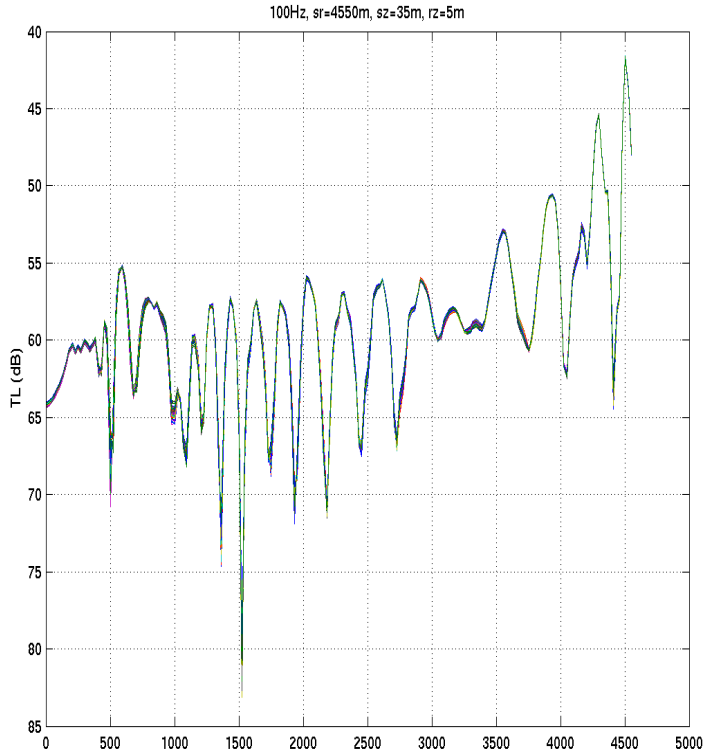


Max range=2.1km, frequency=100Hz

Implementation & Results

Optimal: points=30, threshold=1000 for morning 7/21/05

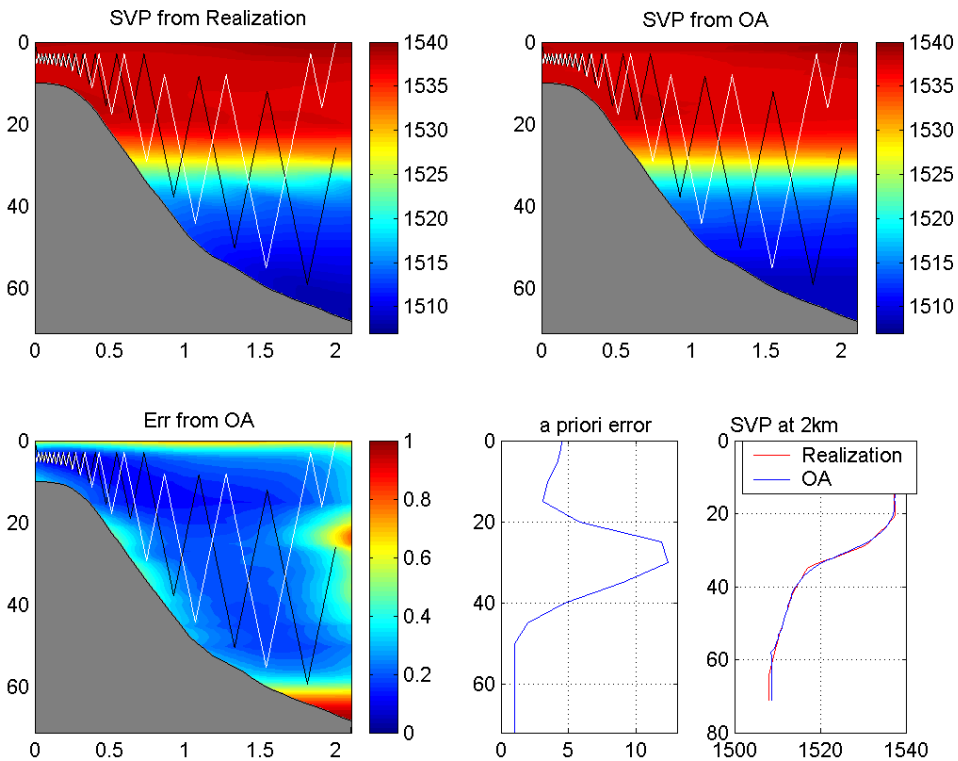


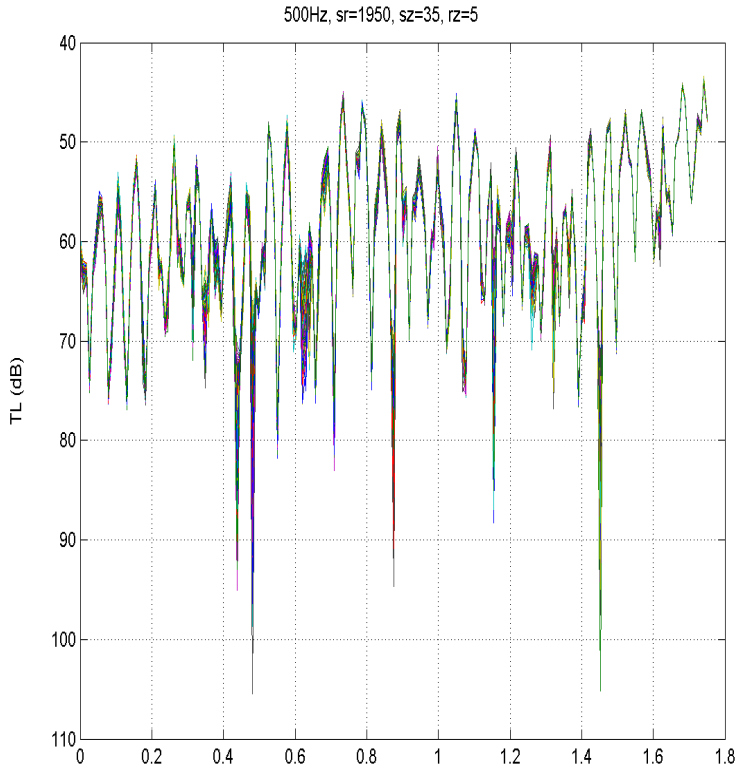


Max range=4.3km, frequency=100Hz

Implementation & Results

Optimal: points=30, threshold=0.1 for afternoon 7/21/05

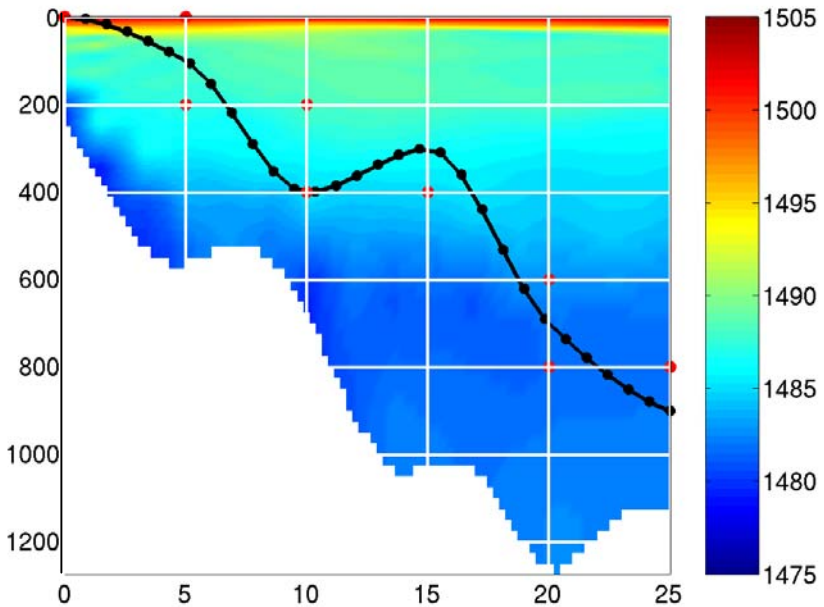


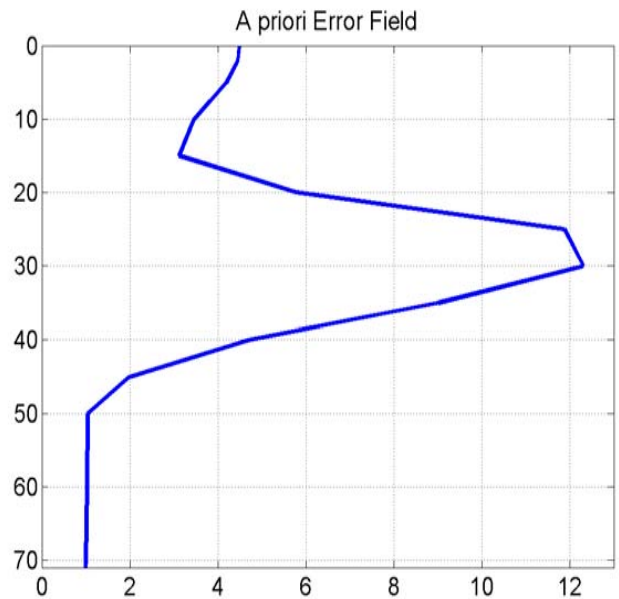


Max range=2.1km, frequency=500Hz

Main Improvements

- OA grid
- A priori error field
- SVP background for OA
- Gaussian random vector realizations base





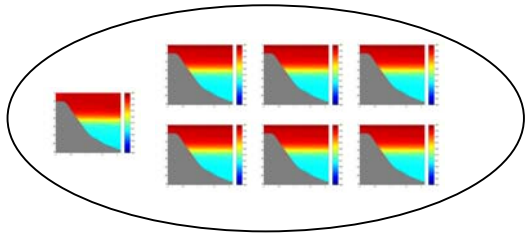
Conclusion

- Constructed an AUV yoyo control.
- Improved algorithms.
- Implemented ocean prediction and control parameters optimization in real-time.

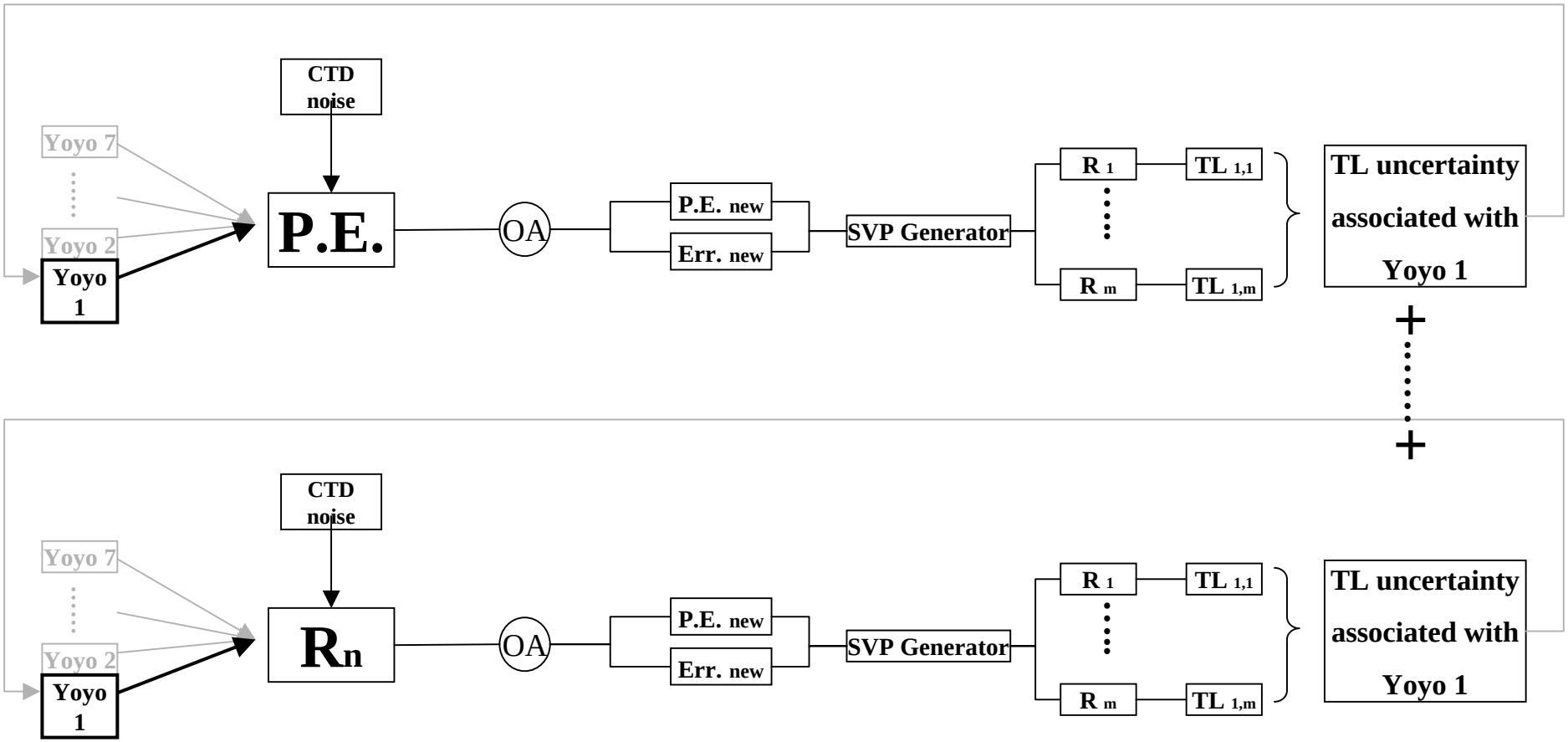
Future work

- Improve optimization for nonlinear, nonseparable cost function.
- Stochastic optimization

Principal Estimate



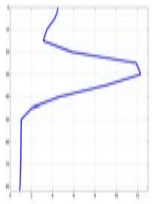
Forcast Ensemble



$$\text{cost} = \underset{\text{CDT noise},\ R_0 \cdots R_n}{E} \left\{ \text{var} \left(TL^{OA} \right) \right\}$$

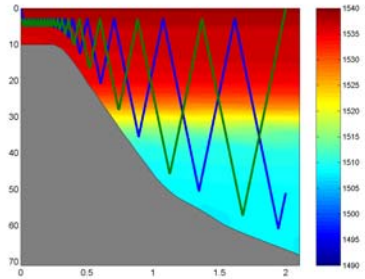
Correlation Lengths

A priori error field



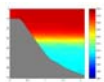
CTD noise

ith Yoyo pattern

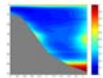


Objective Analysis

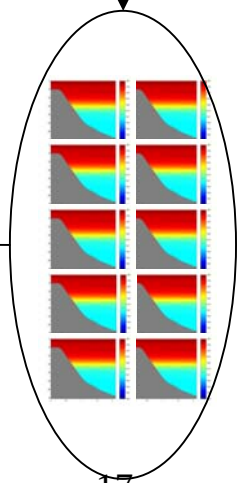
New P.E.



Error field



Sound Speed Generator



RAM

Principle Estimate

TL Uncertainty for ith yoyo