FAF'05 Mission A1 Report Draft

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Objective & Principle:

The objective in FAF'05 Mission A1 is to test the Adaptive Rapid Environmental Assessment (AREA) mechanisms. In this mission, AUV will follow an adaptively up-and-down yoyo track to capture sound speed uncertainties as much as possible in water column in regard to minimizing acoustic uncertainties. The experiment site is around Pianosa, Italy. In this area, existence of thermocline usually leads to main sound speed uncertainties. So, in mission A1, AUV will focus on capturing the thermocline.

By comparing local vertical gradient of sound speed (LVGSS) with a threshold, AUV can estimate whether it is above, inside of or below the thermocline. It assumes that at the beginning of the mission AUV is always on the surface. Then, while AUV is diving with the maximum pitch angle, CTD will collect sound speed data every 1 second. The LVGSS will be computed every 20 or more sampling points through *Linear Least Squares Fitting* method. As AUV diving, if LVGSS becomes greater than the threshold and then gets lower, it means that AUV just crossed the thermocline and is below it. Then, AUV will turn around upwards. If thereafter LVGSS becomes greater than the threshold and then lower again, that means AUV gets back above the thermocline. See Figure 1 for the control flow chart. Moreover, in this mission we set an upper bound and a lower bound for AUV. No matter has AUV crossed the thermocline or not, once the lower bound or upper bound is reached, AUV will have to turn around back to up or down respectively. In most range of FAF'05 area, the lower bound is set even lower than seabed and we assumes that AUV will be forced to turn around at 5 m above seabed by collision avoidance device.

In AUV yoyo control, there are two parameters needed to be optimized: 'points' and 'threshold'. 'points' is the number of sampling points used to compute LVGSS; 'threshold' is the value used to be compared with LVGSS to determine the relative position between AUV and thermocline, as mentioned before. It is supposed that before the experiment a priori sound velocity profile (SVP) error field σ, horizontal and vertical correlation length Lr, Lz are known. Also it is supposed that the correlation coefficient function of SVP between two locations $\mathbf{x}_1$, $\mathbf{x}_2$ is:

$$\rho_{x_1,x_2} = e^{-\frac{(\frac{r_1-r_2}{Lr})^2+(\frac{z_1-z_2}{Lz})^2}{2}}$$

Where r_1, r_2 are horizontal coordinates of $\mathbf{x}_1$ and $\mathbf{x}_2$ respectively; z_1, z_2 are vertical coordinates of $\mathbf{x}_1$ and $\mathbf{x}_2$ respectively. Thus, covariance between $\mathbf{x}_1$, $\mathbf{x}_2$ is:

$$Cov(\mathbf{x}_1, \mathbf{x}_2) = \sigma(\mathbf{x}_1)\sigma(\mathbf{x}_2)\rho_{x_1,x_2}$$

In addition, the principal ocean estimate ψ_0 and n different realizations $\psi_1, \cdots, \psi_n$ for the FAF'05 area on the next day will be given. By randomly taking one scenario ψ_i from $(\psi_0, \psi_1, \cdots, \psi_n)$ and implementing yoyo control with parameter pairs (points, threshold) and white measurement noise in ψ_i, a sequence of in-situ measurements $\mathbf{d}$ can be obtained at locations $\mathbf{X}$. By doing z-direction-oriented interpolation and extrapolation with respect to $\mathbf{d}$ and $\mathbf{X}$ on the vector of model grid point locations $\mathbf{x}$, the SVP background $\bar{\psi}$ can be obtained. Thus, Objective Analysis (OA) can be implemented through the following formula:

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

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

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

where $\bar{d}$ is the background field at in-situ measurements locations $\mathbf{X}$, $\hat{\psi}^{OA}$ is the new principal ocean estimate from OA, P^{OA} is the OA estimate error covariance matrix, σ^{OA} is the diagonal items in P^{OA}. R is the error covariance matrix of $\mathbf{d}$. By the white noise assumption,

$$R = \begin{bmatrix} \sigma_n & & & \\ & \sigma_n & & \\ & & \ddots & \\ & & & \sigma_n \end{bmatrix}$$

where, σ_n is the CTD measurement error.

So, it can be seen that by doing in-situ measurements and data assimilation, a priori principal ocean estimate and error field $\{\psi_0, \sigma\}$ has been improved to be $\{\hat{\psi}^{OA}, \sigma^{OA}\}$, i.e. at the beginning, SVP in FAF'05 area was viewed as a Gaussian random vector $C \sim N(\psi_0, \sigma, Lr, Lz)$; after OA, the Gaussian random vector becomes as $C^{OA} \sim N(\hat{\psi}^{OA}, \sigma^{OA}, Lr, Lz)$. Usually, $\sigma^{OA} < \sigma$.

Since acoustic field is a function of SVP, transmission loss (TL) can be written as

$$TL = f(C)$$

and

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

Usually function f is highly non-linear. To compute standard deviation or variance of TL, Monte Carlo simulations are necessary. Simply speaking, in project AREA the objective is to minimize $std(TL^{OA})$ by optimally choosing in-situ measurements locations. However, we have a lot of possible scenarios: $\psi_0, \psi_1, \cdots, \psi_n$. By taking each of them but implementing the same yoyo control pattern, a certain $std(TL^{OA})$ will be obtained, i.e. for ψ_i and the kth yoyo control pattern, $std(TL^{OA}_{i,k})$ will be obtained. So, to judge how good it is for the kth yoyo control parameters pair, we select:

$$\underset{i=0,1,\cdots,n}{E} \{std(TL^{OA}_{i,k})\}$$

as the cost function.

The optimal $(points, threshold) = arg \underset{k=1,2,\cdots}{min} \{E_{i=0,1,\cdots,n}\{std(TL^{OA}_{i,k})\}\}$

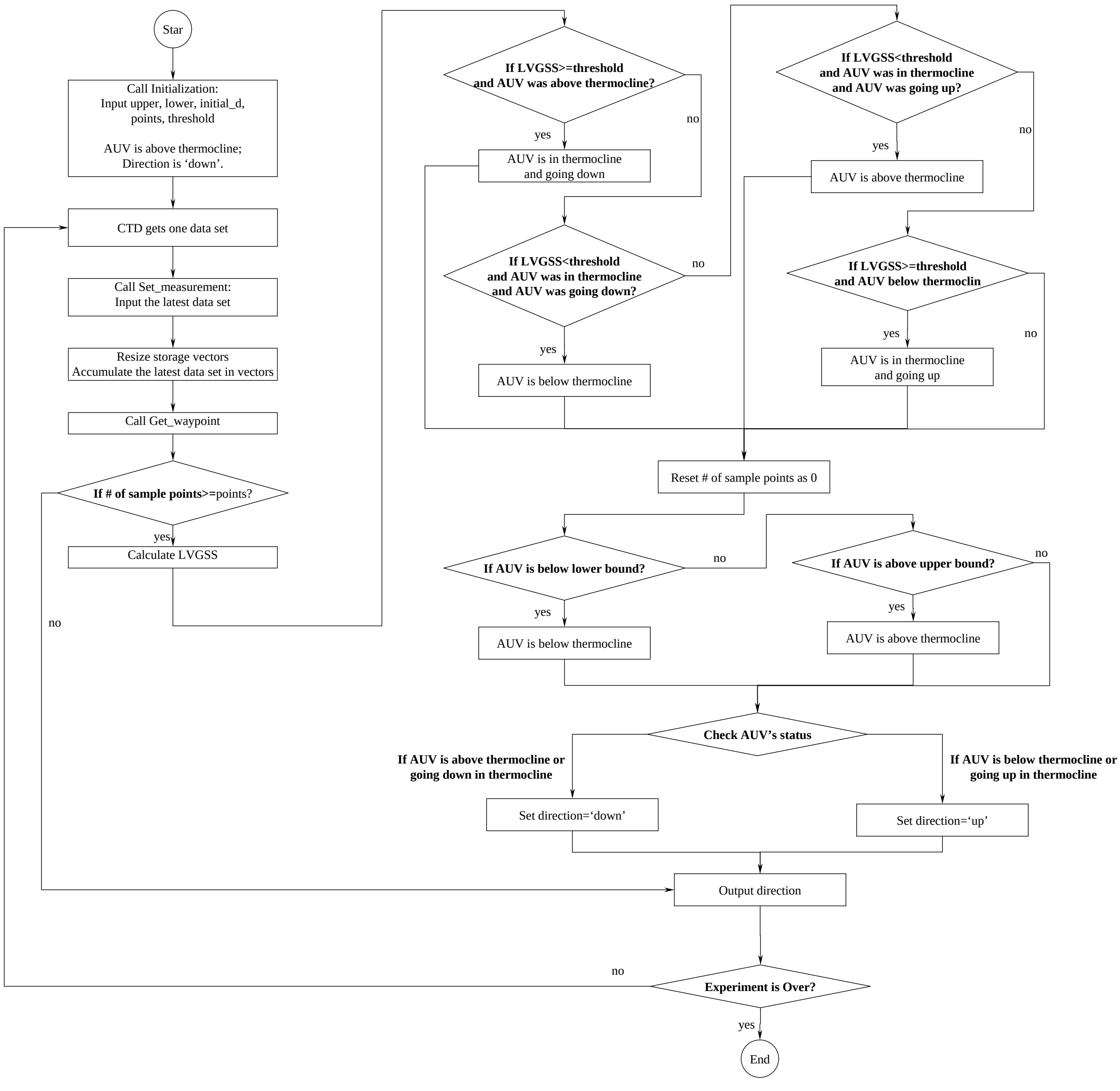

Figure 1: Yoyo control flow chart

Experiment Plan:

- First week (7/13∼7/16):
  For the first few days, measurements should cover the largest area possible (in the horizontal and in the vertical) so as to get good data coverage and good engineering tests. This could be carried out jointly with the bathymetric survey. Doing some CTD calibration between the Leonardo and the AUV would also be very useful (run some AUV yoyos at the same time and place that the ship CTD profiles). For the AUV yoyo pattern, on the first few days, our suggestion is to maximize the vertical extent (from the surface to the deepest possible). To reach this objective, parameters 'points' and 'threshold' in the yoyo control code should be equal to 30 and 1000 respectively (just call: `yoyo.Initialize(3, 80, 30, 1000)`). Those data will be objectively analyzed and given as input to AREA and HOPS/ESSE. Sufficiently wide area data coverage is limited (Alliance is north of Elba). Ocean forecasts may not be carried out in the first week.

- Second and third week (7/17∼7/28):

  1. On each day, we will have a forecast ensemble containing the principal estimate and n different realizations for the FAF'05 area on the next day. Moreover, we will also have the associated SVP error field and SVP correlation length in horizontal and vertical direction.
  2. We take one scenario from the forecast ensemble.
  3. Implement the ith yoyo pattern in that scenario with adding simulated CTD noise (white). Obtain a sequence of in-situ measurement results.
  4. Do objective analysis based on the in-situ measurement results, SVP error field, SVP correlation lengths, and CTD noise. Obtain a new SVP principal estimate and SVP error field, based on which we can generate another nowcast ensemble.
  5. Calculate TL for each scenario in the nowcast ensemble. Calculate TL uncertainty.
  6. Repeat from the 3rd step for m times (m=10).
  7. Repeat from the 2nd step with choosing another scenario. Calculate sample mean of TL uncertainty for the ith yoyo pattern.
  8. Repeat from the 2nd step with the i+1th yoyo pattern. In the end, find the jth yoyo pattern which has the minimum sample mean of TL uncertainty. See Figure 2, 3.

  After we find the optimal yoyo control pattern, the corresponding optimal parameters will be sent to Pianosa. On the next day, AUV will follow the yoyo control with the optimal parameters and do in-situ measurement. At evening of the next day, in-situ measurement data will be sent back to Cambridge. HOPS/ESSE will be run to generate a forecast ensemble containing principal estimate and n different realizations for the day after.

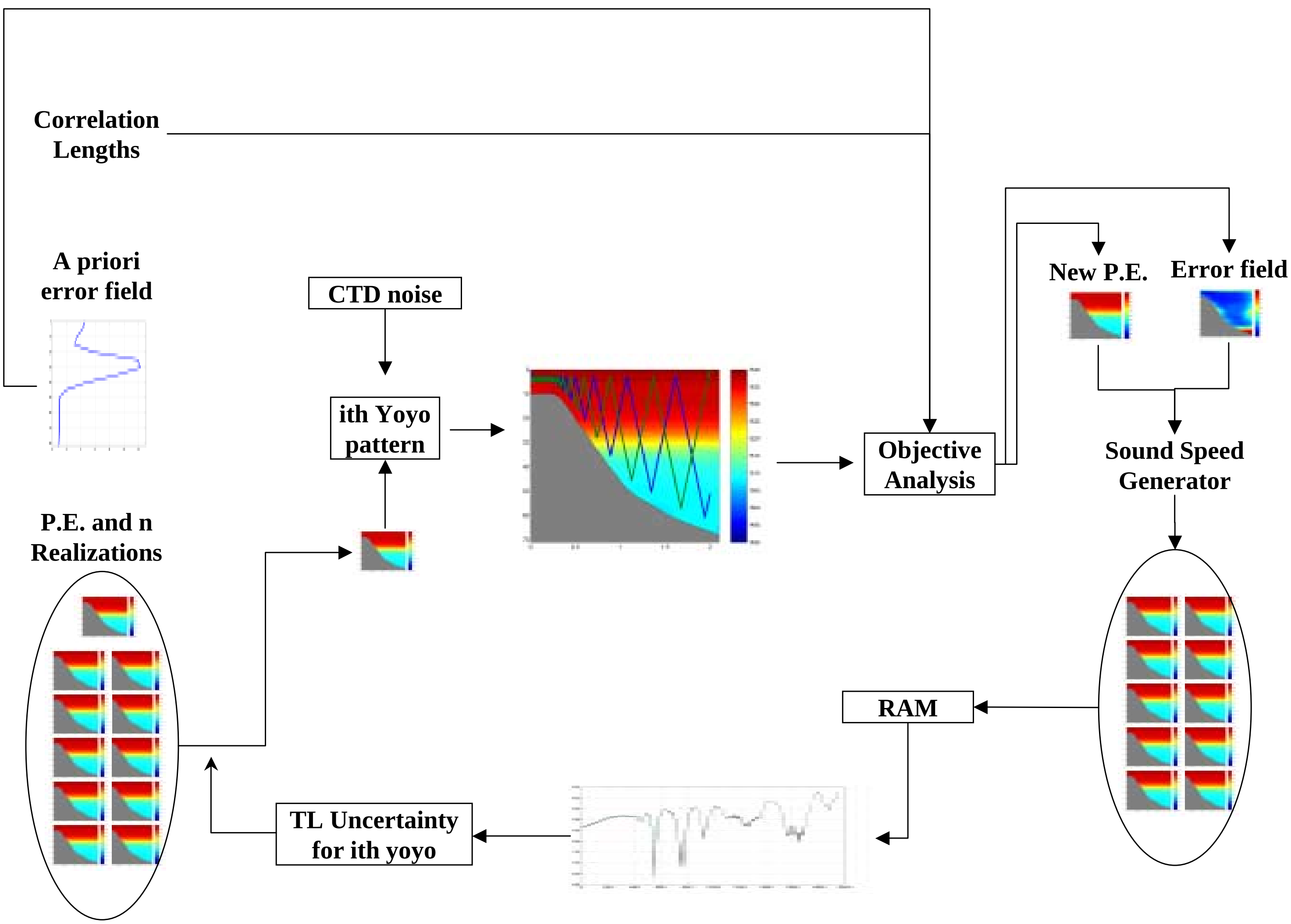

Figure 2: Step 2, 3, 4, 5.

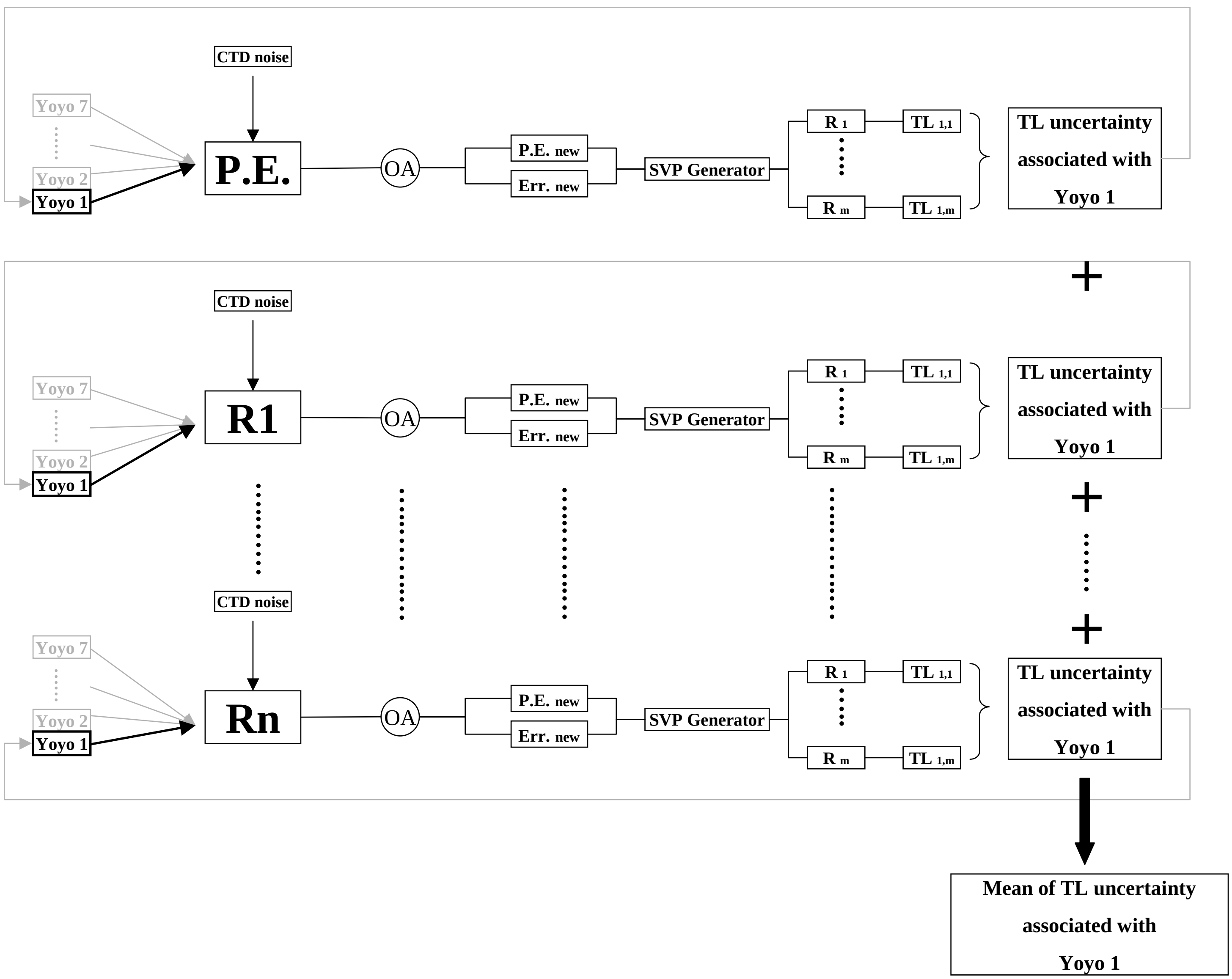

Figure 3: Wiring diagram

Experiment Log:
7/12∼13/05:

1. We determined waypoints of Leonardo's track for the first few days.

	Latitude	Longitude
1	$42^o35'18''N$	$10^o6'7''E$
2	$42^o35'18''N$	$10^o7'48''E$
3	$42^o35'34''N$	$10^o7'48''E$
4	$42^o35'34''N$	$10^o6'18''E$
5	$42^o35'50''N$	$10^o6'30''E$
6	$42^o35'50''N$	$10^o7'48''E$
7	$42^o36'6''N$	$10^o7'48''E$
8	$42^o36'6''N$	$10^o6'42''E$
9	the same as 1	the same as 1

2. We determined start and end points of the straight line for mission A1.

	Latitude	Longitude
start	$42^o35'18''N$	$10^o6'33''E$
end	$42^o36'13''N$	$10^o7'30''E$

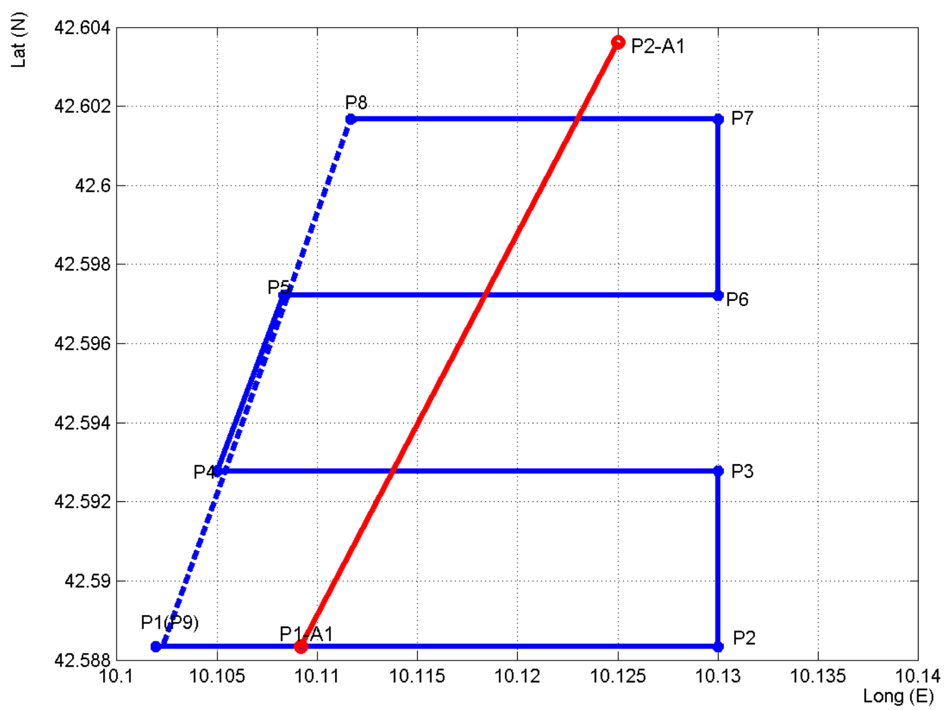

Figure 4: Blue lines: tracks for Leonardo; Red line: track for Mission A1.

7/14∼15/05:

1. The 1st CTD data set from Pianosa was received through email. There are 2 SVPs. One of them shows double thermoclines. According to Pierre's guess, SVP CTD_071305_0800Z may be located further from the island and SVP CTD_071305_1530Z may be closer to the island (we also guess the 1st one was taken at 8am and the 2nd was taken 3:30 pm). Anyway, totally 4 scenarios were synthesized and AUV yoyo control was implemented in each of them. Note that it assumes at the beginning AUV is on surface and the maximum range for AUV is around 2137m. When AUV reaches that range, it will do a U-turn and float up to surface. CTD error standard deviation is 0.5(m/s)

2. The 1st scenario is from CTD_071305_0800Z and suppose SVP is range independent. The bathymetry was guessed by Pierre. AUV yoyo control was implemented in this scenario and parameters are (points=30, threshold=0.2). From Figure 5 we can see that AUV goes up and down between 10m and 50m. Note that in this case, thermocline is between 20m and 40m.

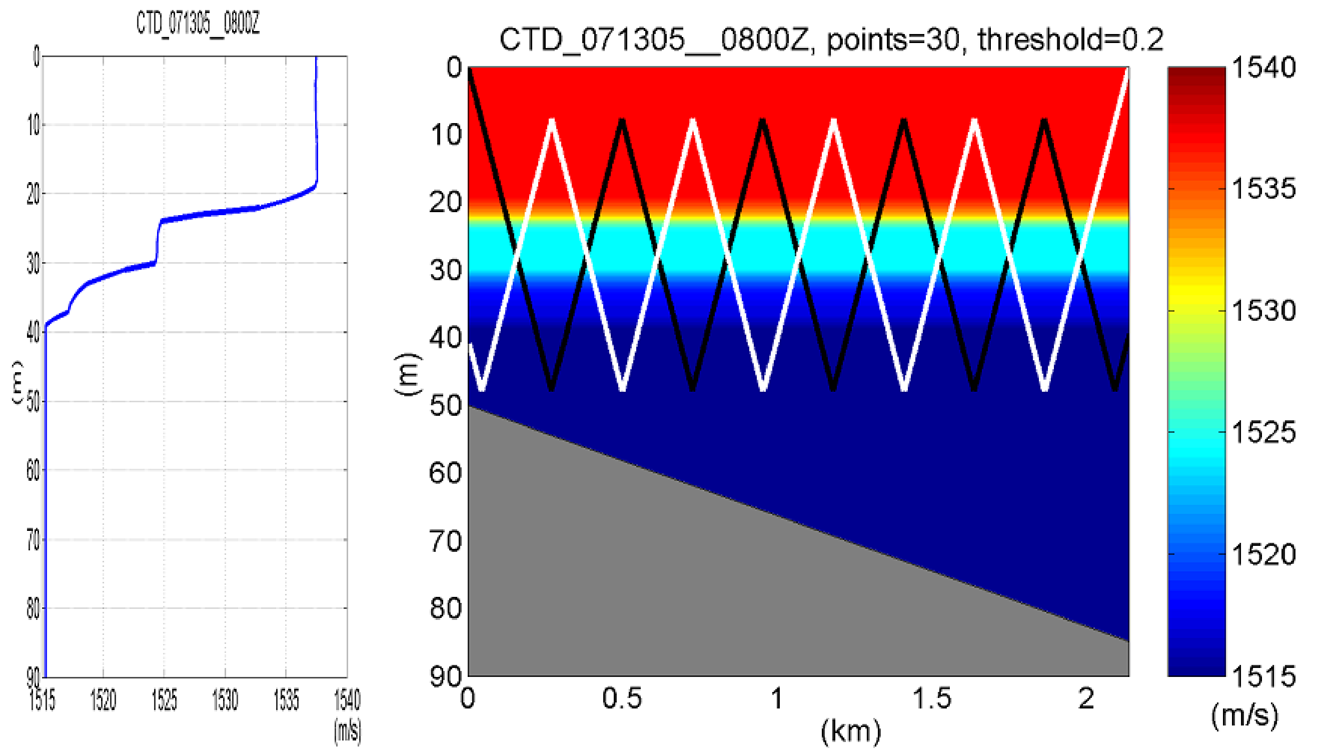

Figure 5: Yoyo control implementation in CTD_071305_0800Z. Black line is the forward path; White line is the backward path.

3. The 2nd one is from CTD_071305_1530Z and suppose SVP is range independent. The bathymetry was guessed by Pierre. AUV yoyo control was implemented in this scenario and parameters are (points=20, threshold=1). From Figure 6 we can see that AUV goes up and down between 20m and 40m. Note that in this case, thermoclines are between 20m and 40m. Compared with the 1st case, in case 2 AUV focuses more in the thermocline. This is because in case 1 there are 2 thermoclines and to make sure AUV will capture both of them, big number for 'points' is used. Consequently, AUV will make more in-situ measurements before make a turn.

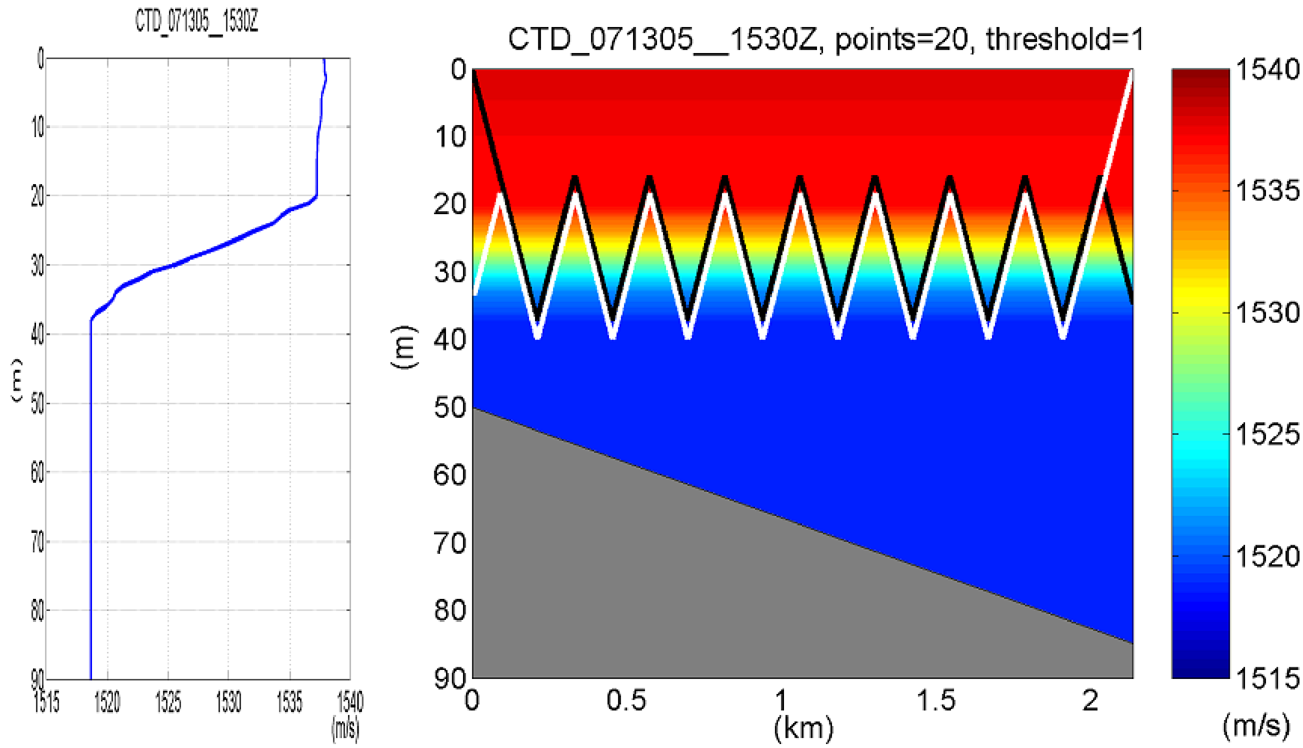

Figure 6: Yoyo control implementation in CTD_071305_1530Z. Black line is the forward path; White line is the backward path.

4. The 3rd one is the combo of CTD_071305_0800Z and CTD_071305_1530Z. From 0 to 1.25km we used CTD_071305_0800Z; beyond 1.25km, we used CTD_071305_1530Z. AUV yoyo control was implemented in this scenario and parameters are (points=30, threshold=0.2). From Figure 7 we can see that AUV goes up and down between 10m and 50m. In this case, all thermoclines are between 20m and 40m depth, so we can't see AUV's path changes much.

5. The 4th one is the combo of CTD_071305_0800Z and its truncation, where we truncated SVP in CTD_071305_0800Z at 30m depth and assume it's constant below 30m. From 0 to 1.25km we used truncated one; beyond 1.25km, we used CTD_071305_0800Z. AUV yoyo control was implemented in this scenario and parameters are (points=30, threshold=0.2). From Figure 8 we can see AUV's path firstly focus on the top thermocline and then when the 2nd one shows up, it yoyoed more widely and covered both thermoclines.

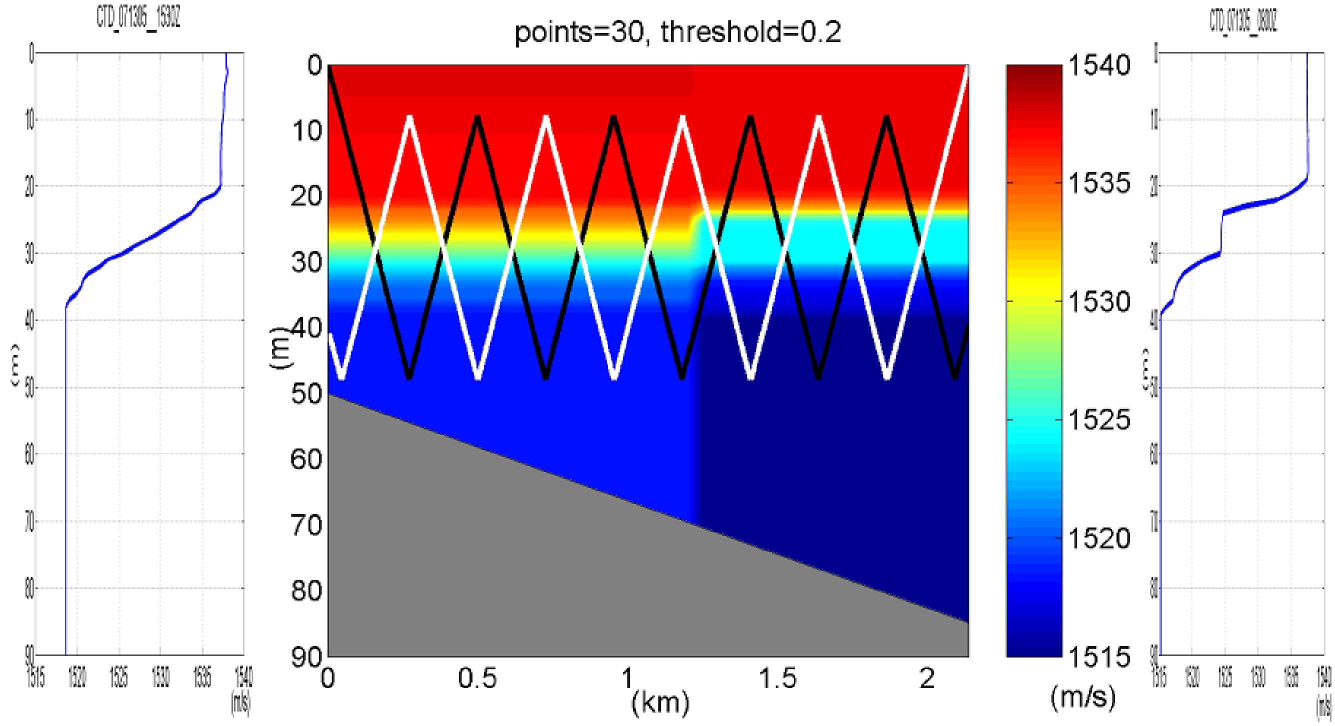

Figure 7: Yoyo control implementation in combo of CTD_071305_0800Z and CTD_071305_1530Z. Black line is the forward path; White line is the backward path.

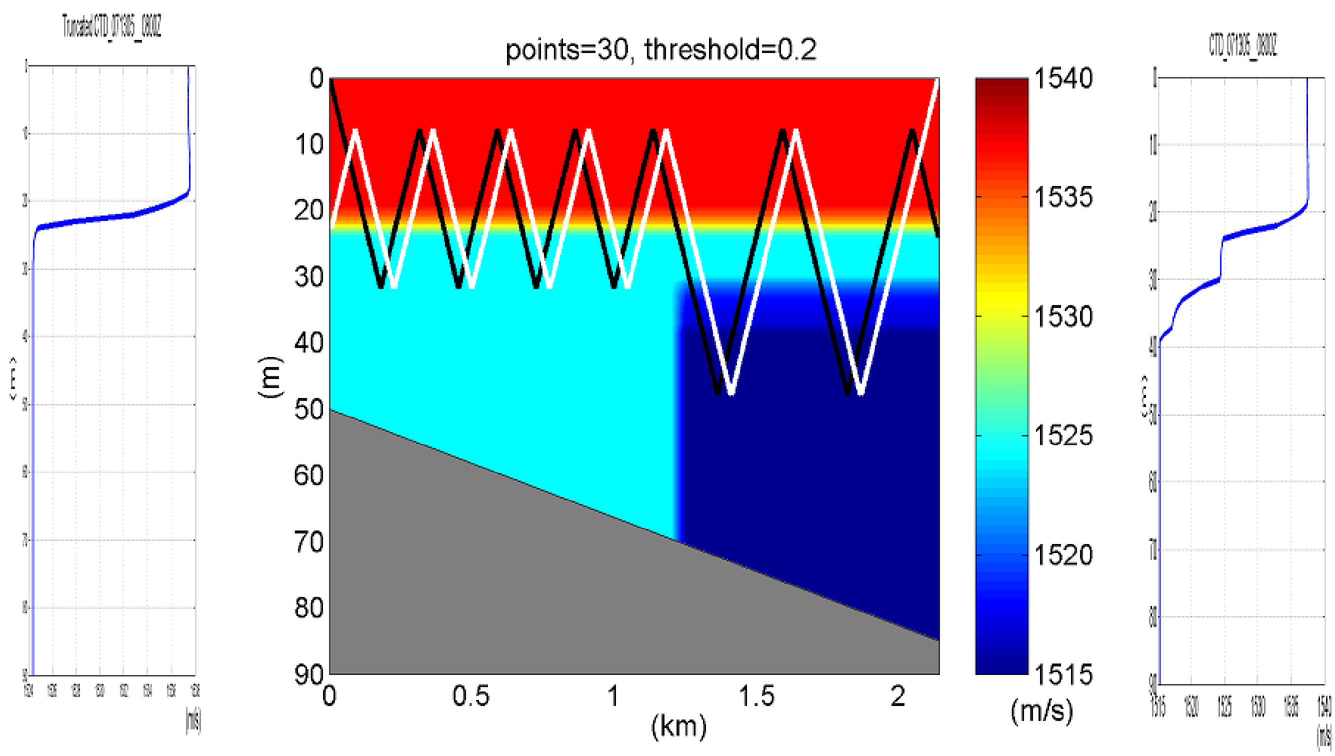

Figure 8: Yoyo control implementation in combo of CTD_071305_0800Z and its truncation. Black line is the forward path; White line is the backward path.

7/16∼18/05: Drill

12 SVP realizations in FAF05 area were generated. Yoyo control was implemented in the last two (file sound_faf05_jul14_run04_day6_6.5.mat). The first one is associated with morning scenario; the second one is associated with afternoon scenario. For each scenario, yoyo control was implemented 10 times with adding white CTD measurement noise. With using a priori error field (see Figure 9, 11), ObjectiveAnalysis was used to generate SVP estimate and error field. The estimates of the error reduction due to the assimilation of the predicted adaptive sampling path in the HOPS vertical sections are shown in "Err from OA" plots. Parameter values in the table below were used throughout the whole experiment.

sound frequency=100Hz
sound source r=1950m
sound source z=35m
receivers z=5m
horizontal correlation length=2000m
vertical correlation length=5m
AUV maximum range=2000m

SVP error and TL error were used as cost function respectively. Yoyo control parameters pairs:

	points	threshold
1	20	0.1
2	20	0.5
3	20	1
4	30	0.1
5	30	0.5
6	30	1
7	30	1000

were used one by one for optimization purpose.

From optimization results, (points=30, threshold=1000) was found the optimal parameters pair for both SVP error and TL error cost function. Since now the horizontal correlation length is 2000m, just one in-situ measurement will dramatically reduce SVP error in the horizontal direction. From Figure 9 we can see that in error field, almost only errors in the most right lower place are greater than 0.5. So, if a yoyo pattern can reach deepest place and scan most area, it would be very possibly the optimal one for SVP error cost function. Since (points=30, threshold=1000) means that AUV will just go most up and down between upper bound and lower bound, SVP error got minimized. Because of this reason, in the next few days SVP error cost function will not be used.

Optimal: points=30, threshold=1000 for morning 7/20/05
Optimal: points=30, threshold=1000 for afternoon 7/20/05

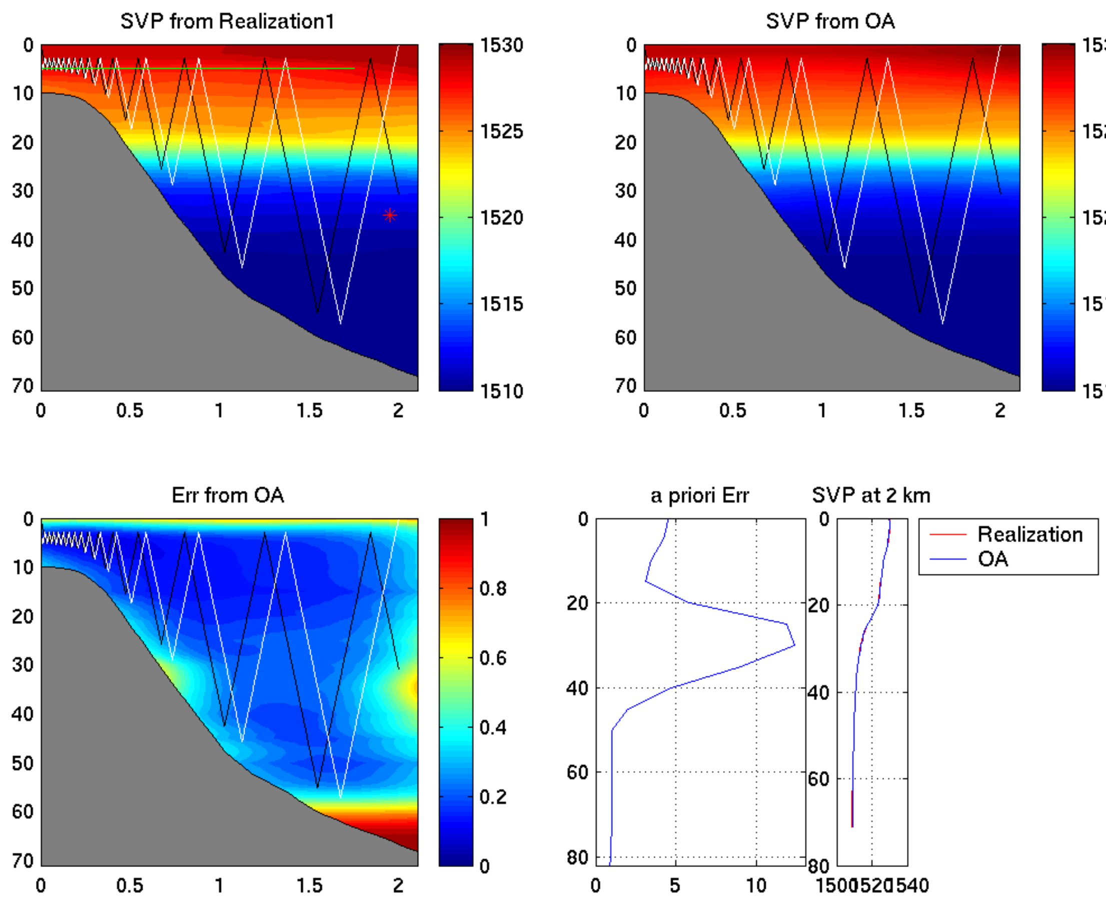

Figure 9: Yoyo control implementation. Morning 7/20/05. sound_faf05_jul14_run04_day6_6.5.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

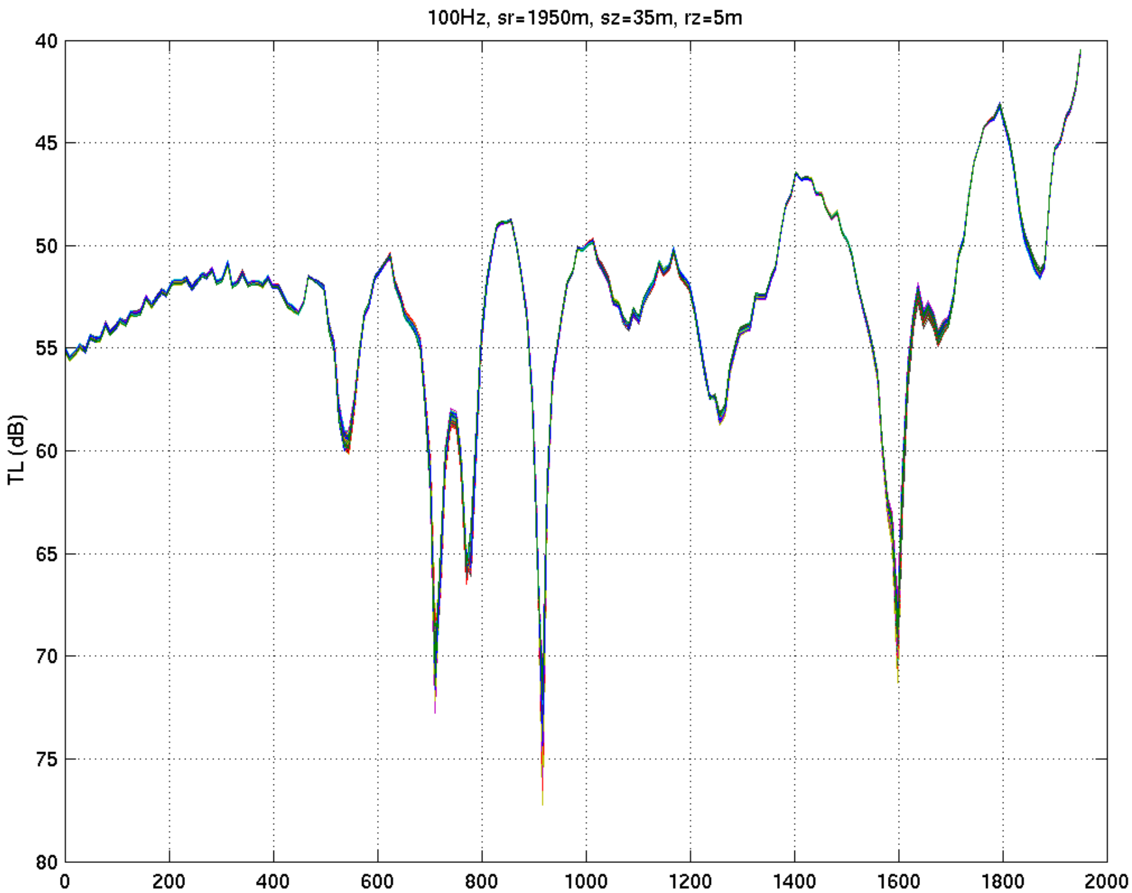

Figure 10: Morning 7/20/05. sound_faf05_jul14_run04_day6_6.5.mat.

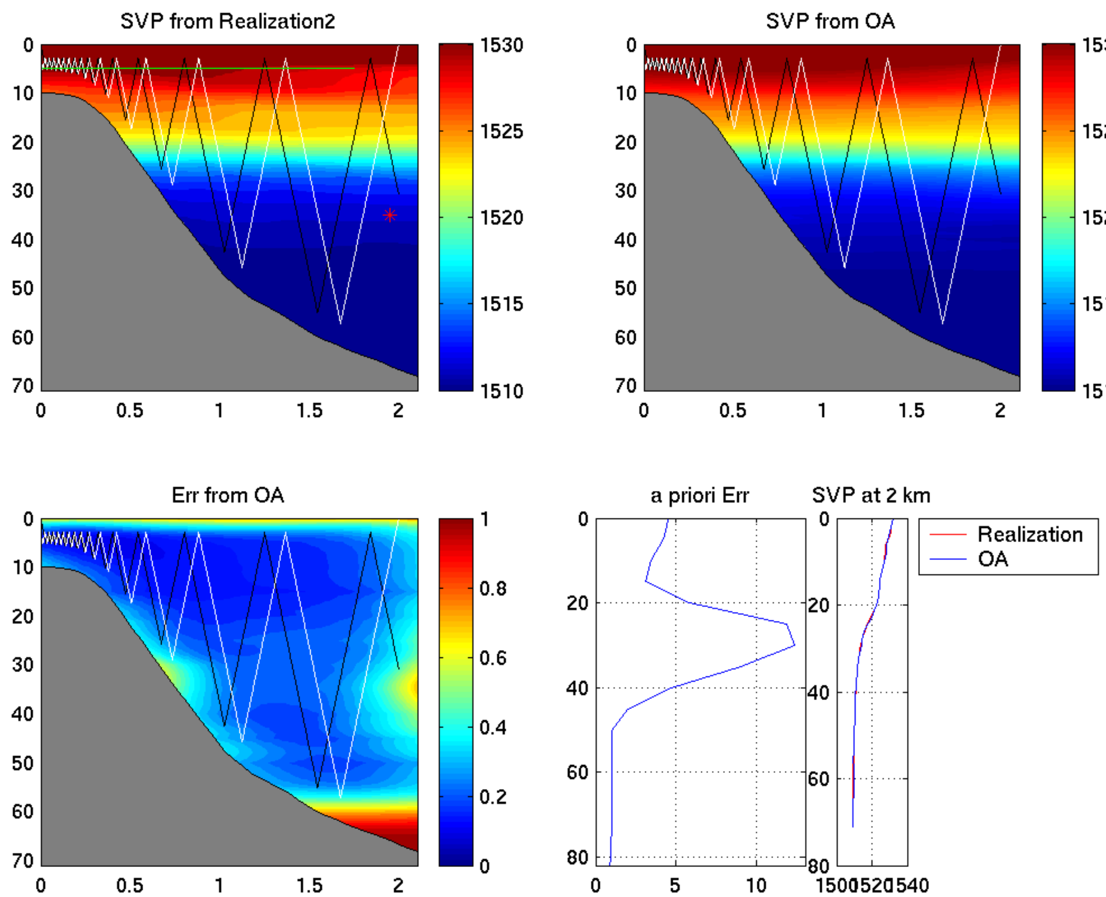

Figure 11: Yoyo control implementation. Afternoon 7/20/05. sound_faf05_jul14_run04_day6_6.5.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

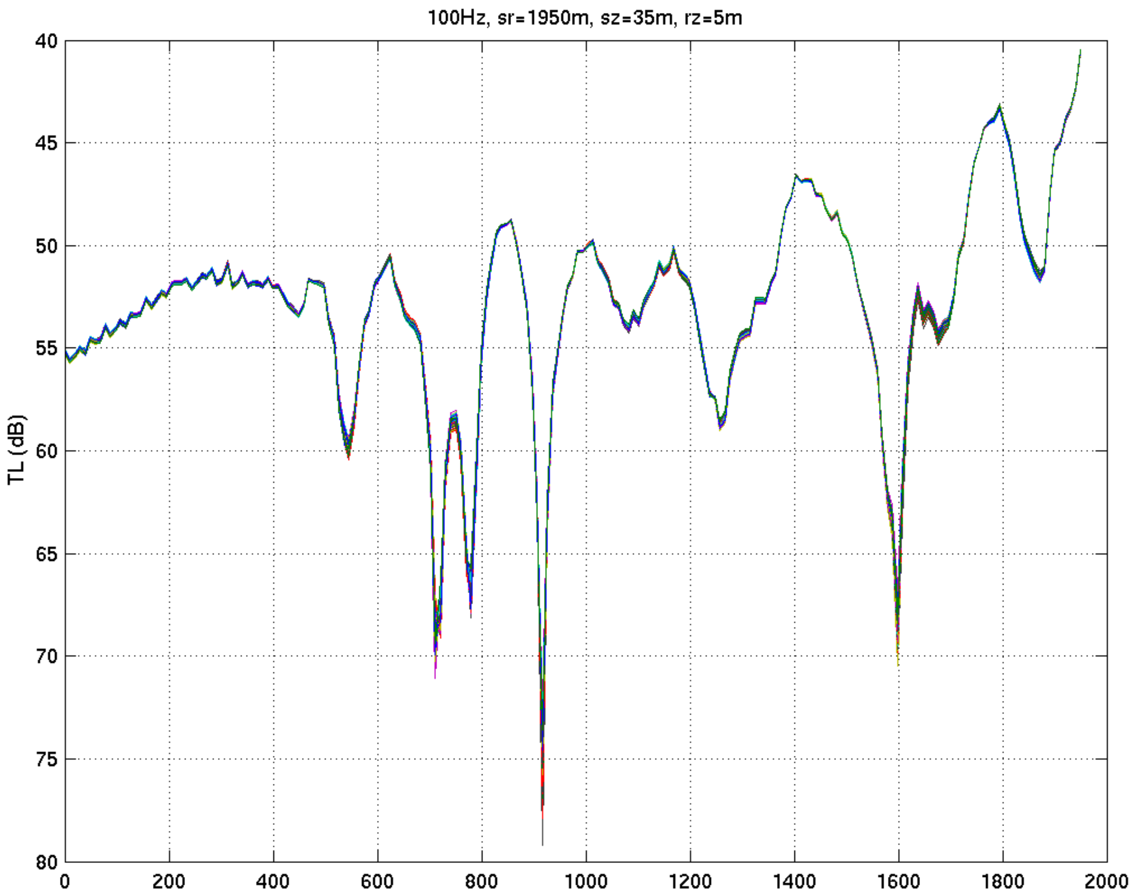

Figure 12: Afternoon 7/20/05. sound_faf05_jul14_run04_day6_6.5.mat.

Summary about how to run the optimization code:

1. Download the newest data files to /seismics2/season/Data/No_4_from_Pierre_FAF05/.
2. Open /seismics2/season/Data/No_4_from_Pierre_FAF05/transform.m. Check file names in line 4, 5 and 7. Make sure original_filename, filename_to_output and a priori std file correct. Run transform.m and check if 'filename_to_output'.mat is generated. Load 'filename_to_output'.mat to check data.
3. make a copy of folder /sonar0/season/TLtracker/AREA_DP_RL_AS_v11/ in directory /sonar0/season/TLtracker/ and give name AREA_DP_RL_AS_v11_month_date_sec?_rl? to it.
4. move /seismics2/season/Data/No_4_from_Pierre_FAF05/'filename_to_output'.mat to /sonar0/season/TLtracker/AREA_DP_RL_AS_v11_month_date_sec?_rl?/src.
5. Open current AREA.cpp to check: global_SyntheticOcean_HOPS_filename, global_frequency, global_source_r, global_source_z, global_virtual_receivers_r, global_virtual_receivers_z, global_Lr_ls, global_Lz_ls, global_Lr_ss, global_Lz_ss, global_sig_c, global_sig_n, global_AUV_rmax. Also it needs to make sure (global_source_r/dr/ndr) is an integer.
6. Open ControlAgent.h to check: yoyo control's Initialize.
7. Open Search.h to check: rmax, zmax, dr, dz.
8. Open Surveillance.h to check: if comment out range is correct and number_MC.
9. Open AUTORUN_FAF05.cpp to check: scenario_index_length, scenario_index, CTD_std, p_p_length, parameter_pair, MC_times_each_scenario.
10. make cleanAREA
11. make
12. make cleanAU
13. make AU
14. Run AUTORUN_FAF05 in a screen
15. After finishing running AUTORUN_FAF05, load Optimization_results.mat; check optimal_cost_parameters; find the parameters pair associated with the minimum average cost.
16. Open OutputResults.m and adjust caxis. Run OutputResults.m.
17. Check if 2 png files are generated there.

7/19/05:

8 realizations of SVP in FAF05 area were generated today. Yoyo control was implemented in the 2 scenarios in file sound_faf05_jul19_01_day0_0.5_sec1.mat. Parameters are the same as what were used yesterday. Unfortunately, today many people are using computer monopole, hydrophone and seismics. So, it took much longer to run the optimization code.

Optimal: points=30, threshold=1000 for morning 7/19/05

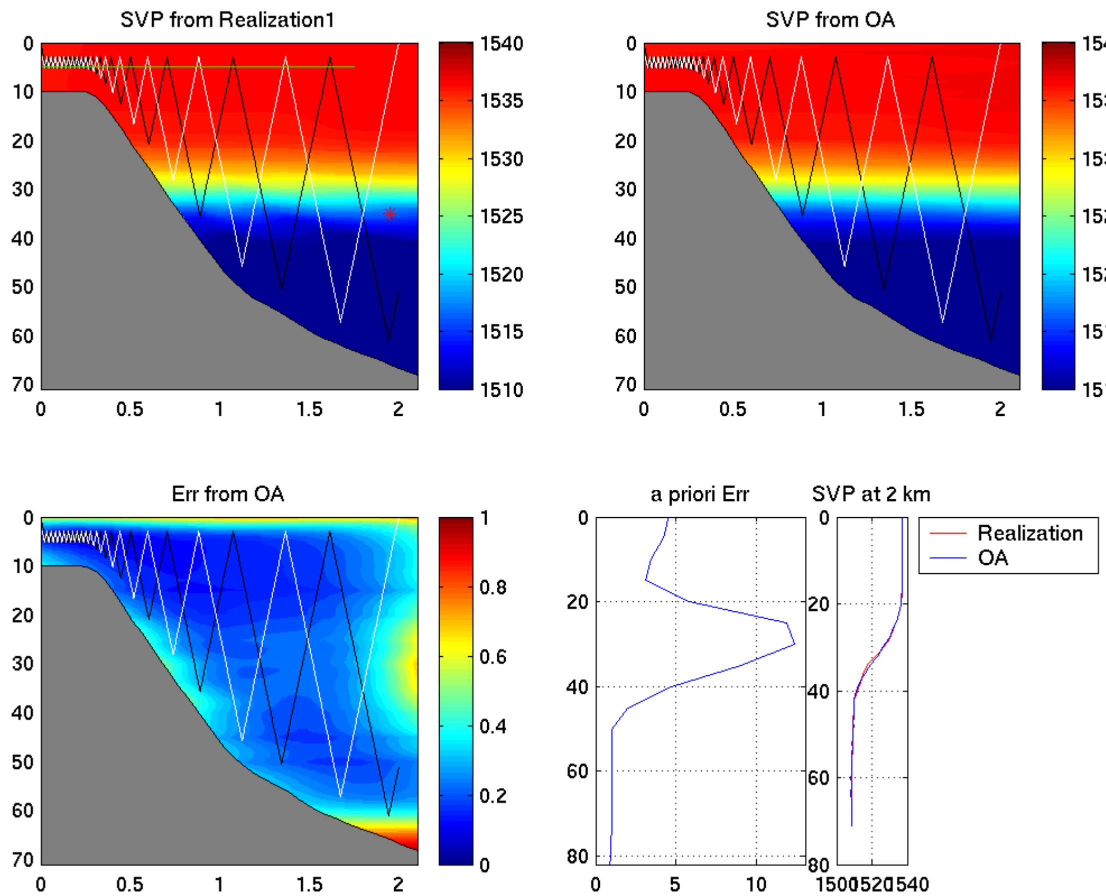

Figure 13: Yoyo control implementation. Morning 7/19/05. sound_faf05_jul19_01_day0_0.5_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

Optimal: points=30, threshold=1000 for afternoon 7/19/05

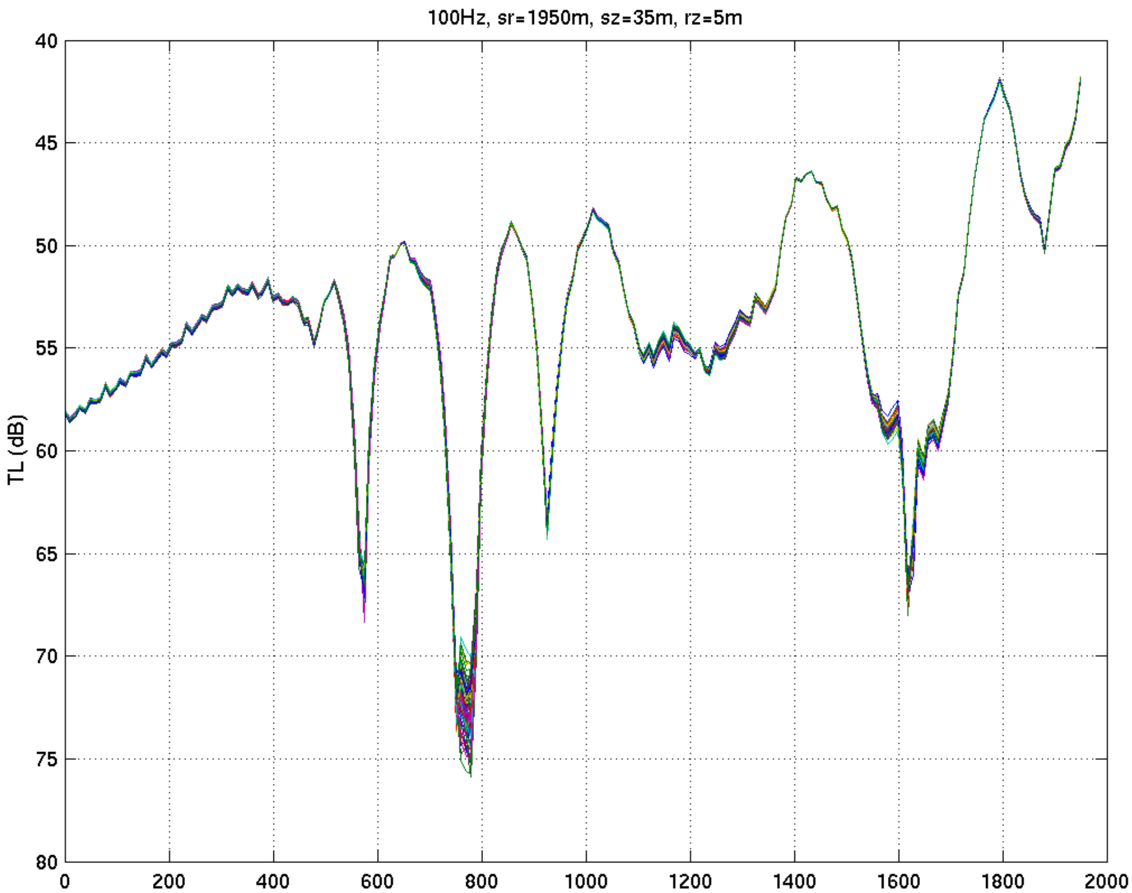

Figure 14: Morning 7/19/05. sound_faf05_jul19_01_day0_0.5_sec1.mat.

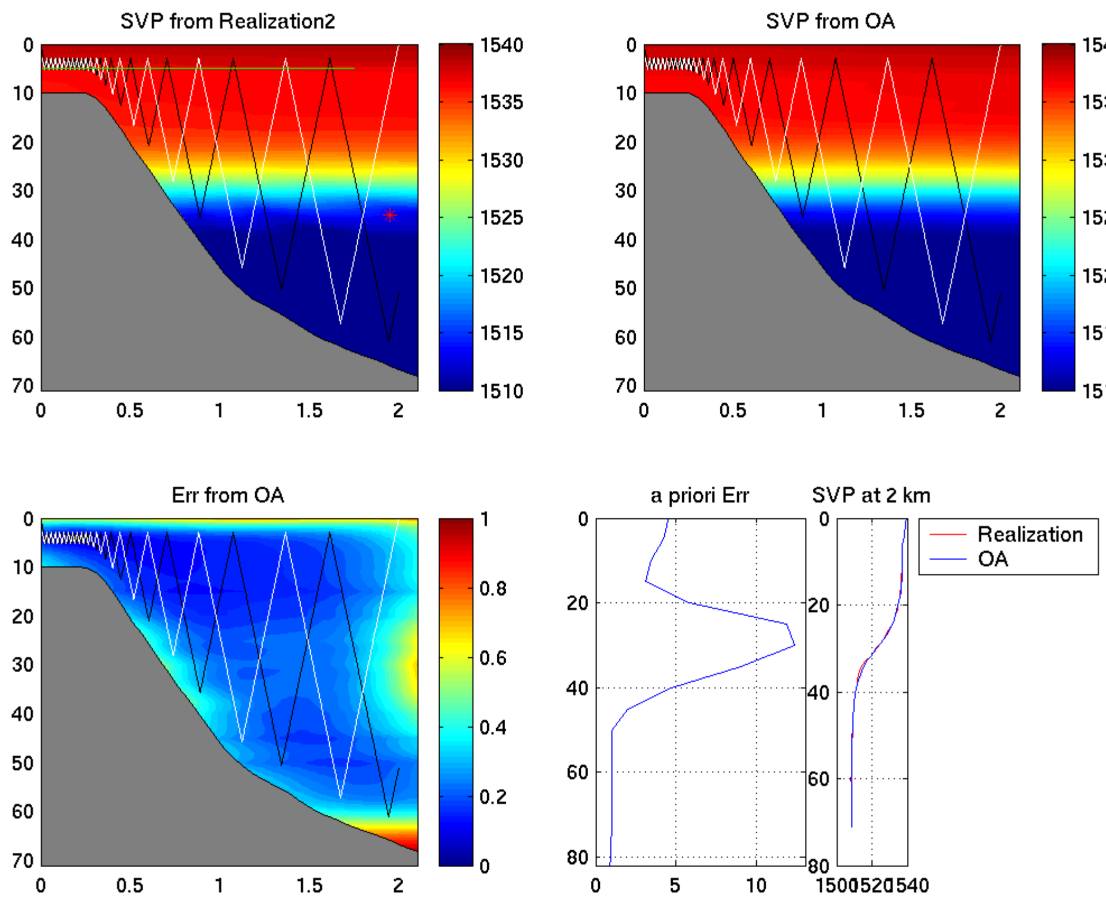

Figure 15: Yoyo control implementation. Afternoon 7/19/05. sound_faf05_jul19_01_day0_0.5_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

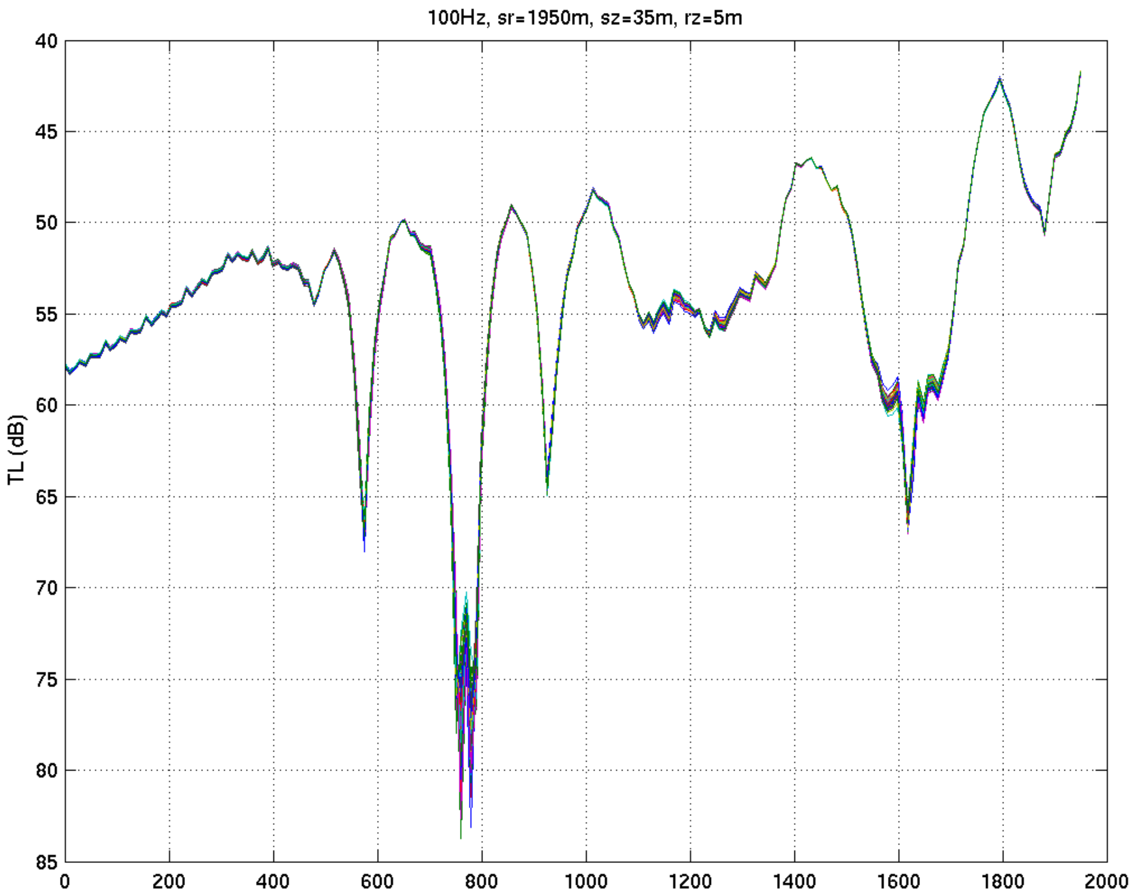

Figure 16: Afternoon 7/19/05. sound_faf05_jul19_01_day0_0.5_sec1.mat.

7/20/05:

Yoyo control was implemented in the 2 scenarios in file sound_faf05_jul20_02_day1_1.5_sec1.mat.

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

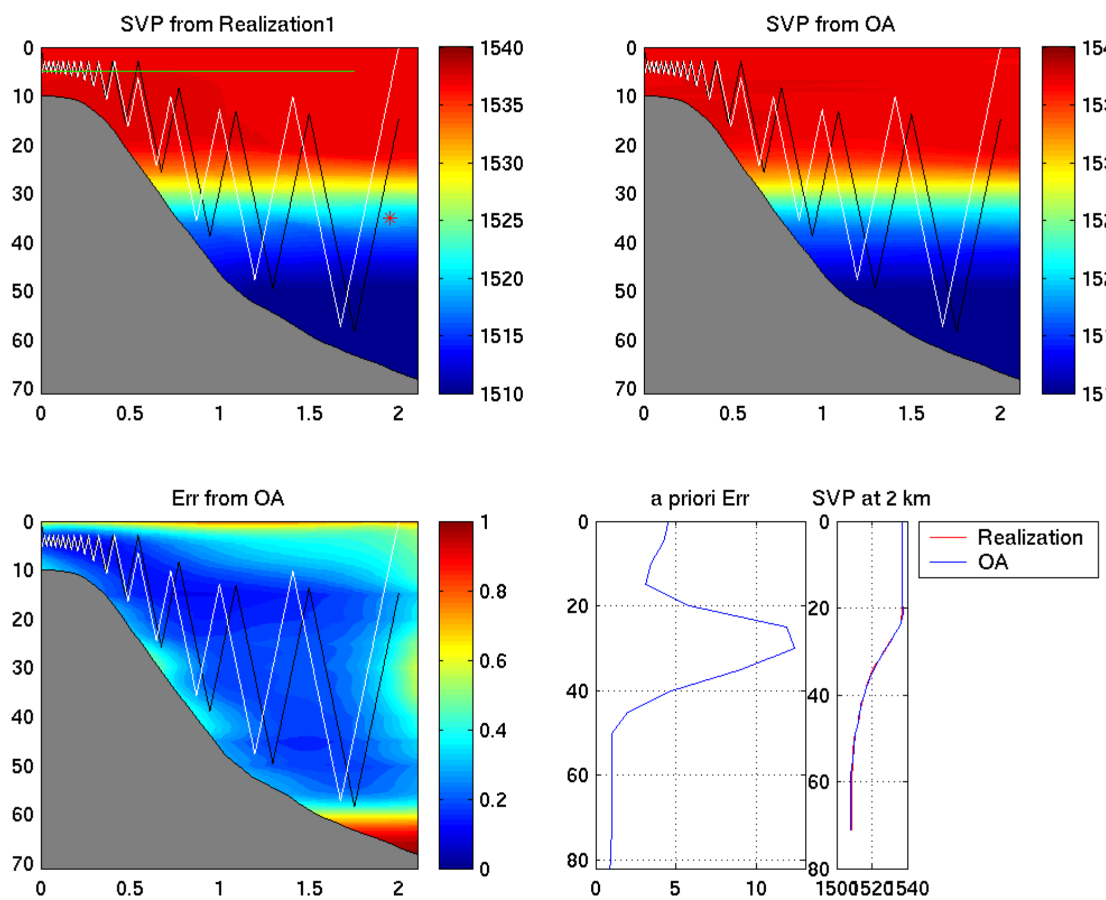

Figure 17: Yoyo control implementation. Morning 7/21/05. sound_faf05_jul20_02_day1_1.5_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

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

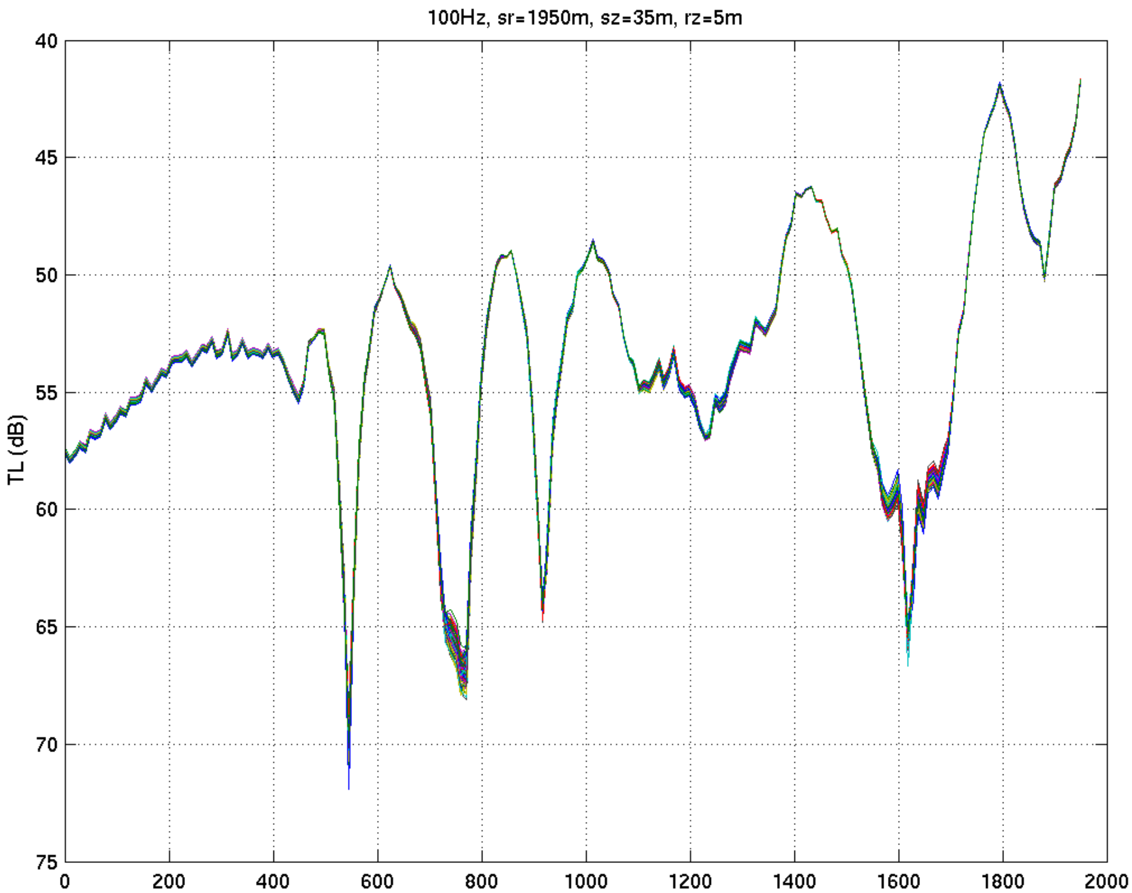

Figure 18: Morning 7/21/05. sound_faf05_jul20_02_day1_1.5_sec1.mat.

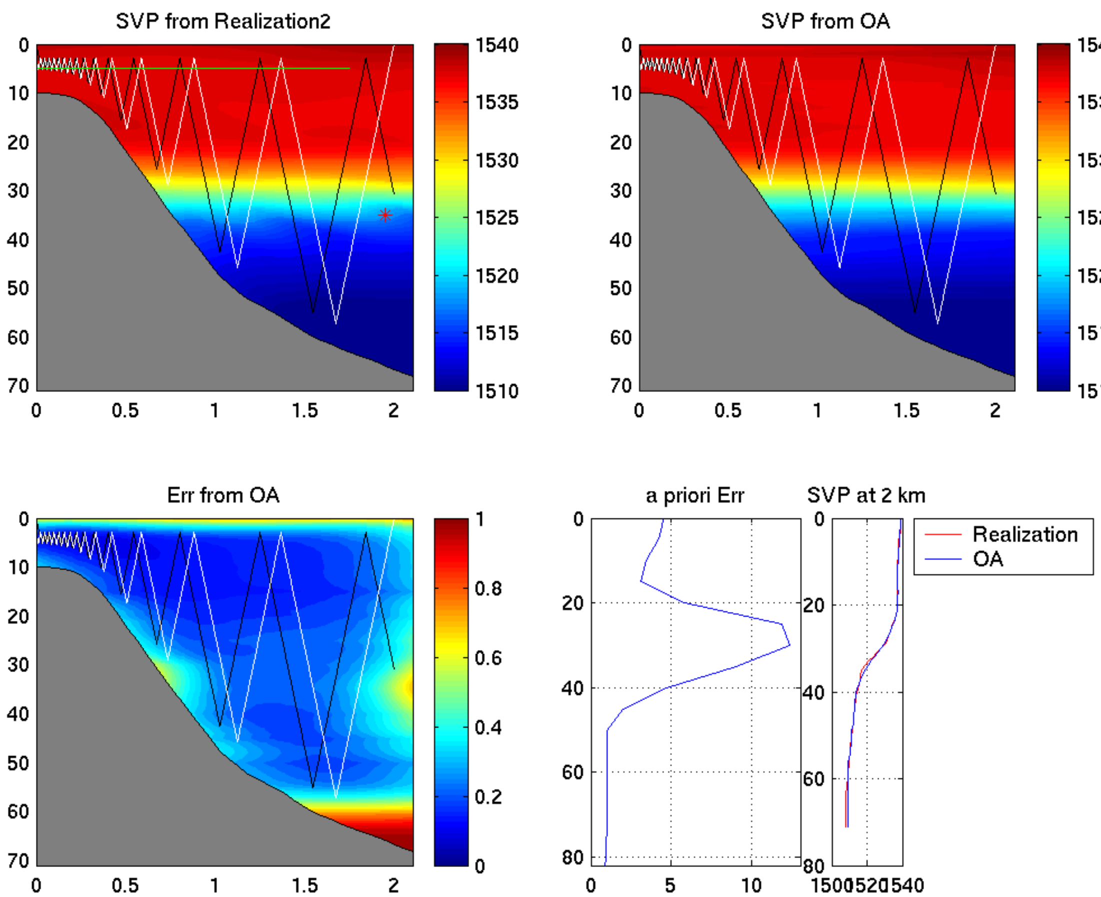

Figure 19: Yoyo control implementation. Afternoon 7/21/05. sound_faf05_jul20_02_day1_1.5_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

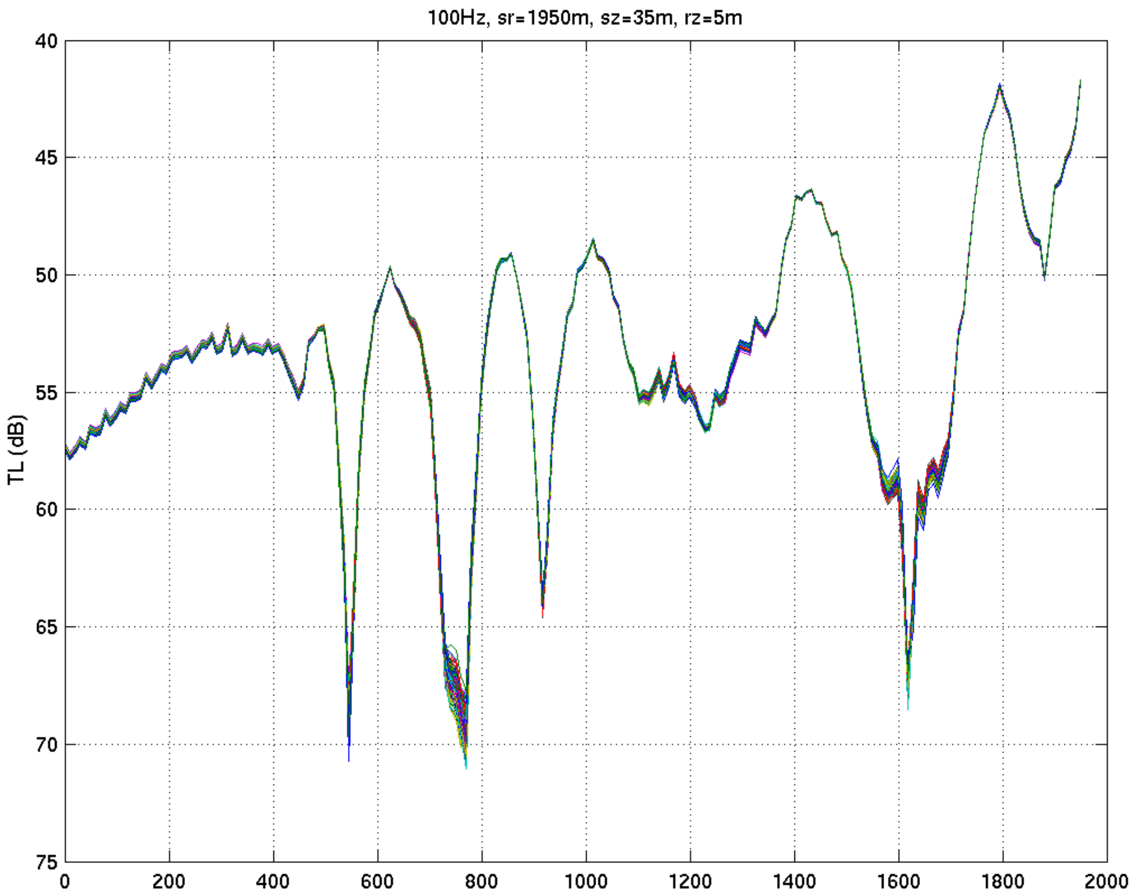

Figure 20: Afternoon 7/21/05. sound_faf05_jul20_02_day1_1.5_sec1.mat.

7/21/05:

Yoyo control was implemented in the 3 scenarios in file sound_faf05_jul21_02_day0_1_sec3.mat. Today the 3 scenarios are in section 3. The total length is about 4.6km. Parameter values in the table below were used today.

sound frequency=100Hz
sound source r=4550m
sound source z=35m
receivers z=5m
horizontal correlation length=2000m
vertical correlation length=5m
AUV maximum range=4551m

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

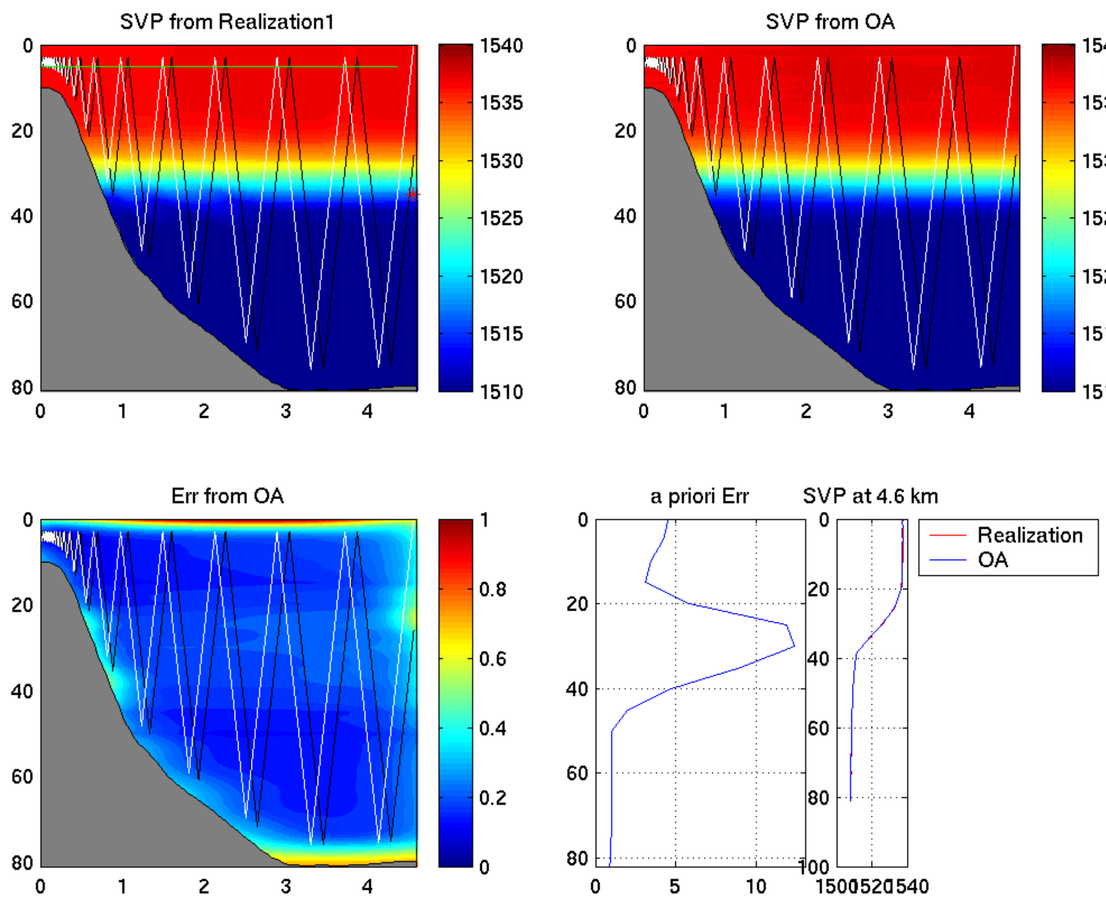

Figure 21: Yoyo control implementation. Morning 7/21/05. sound_faf05_jul21_02_day0_1_sec3.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

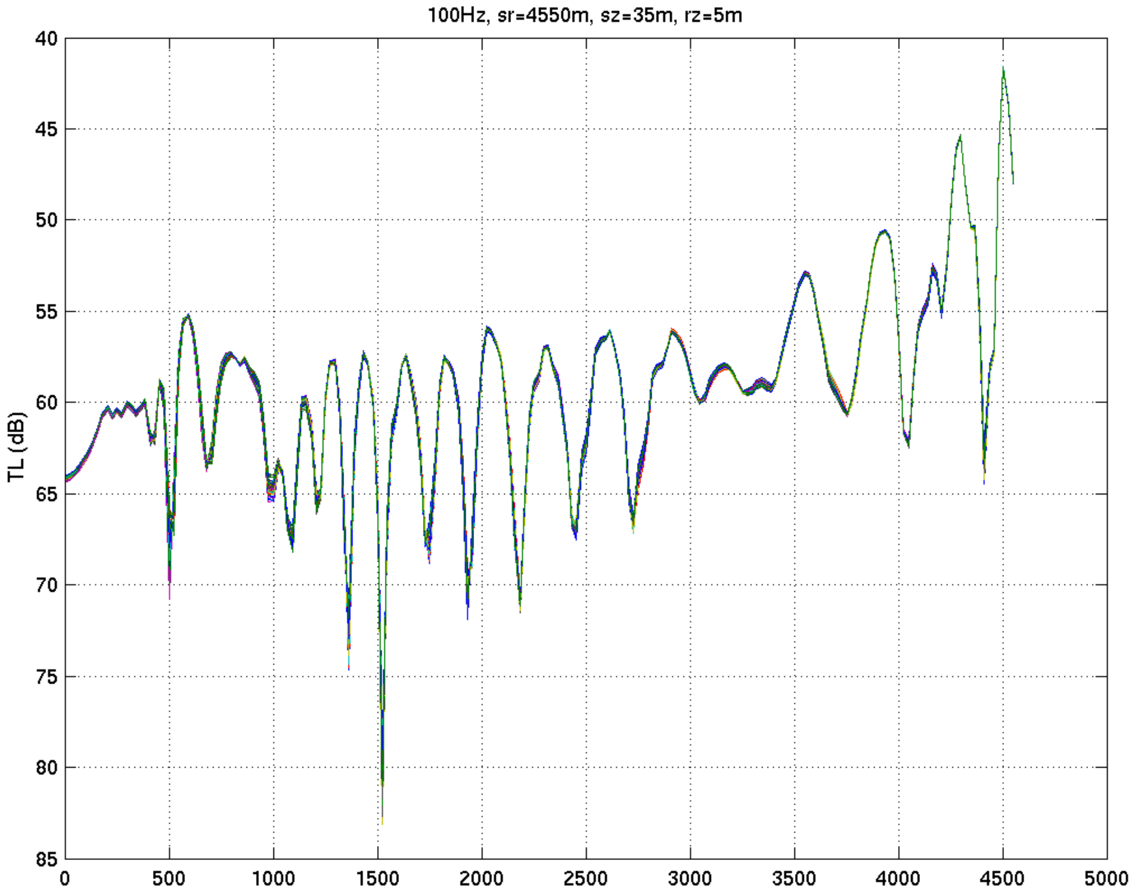

Figure 22: Morning 7/21/05. sound_faf05_jul21_02_day0_1_sec3.mat.

Optimal: points=30, threshold=1000 for afternoon 7/21/05
Optimal: points=30, threshold=1000 for morning 7/22/05

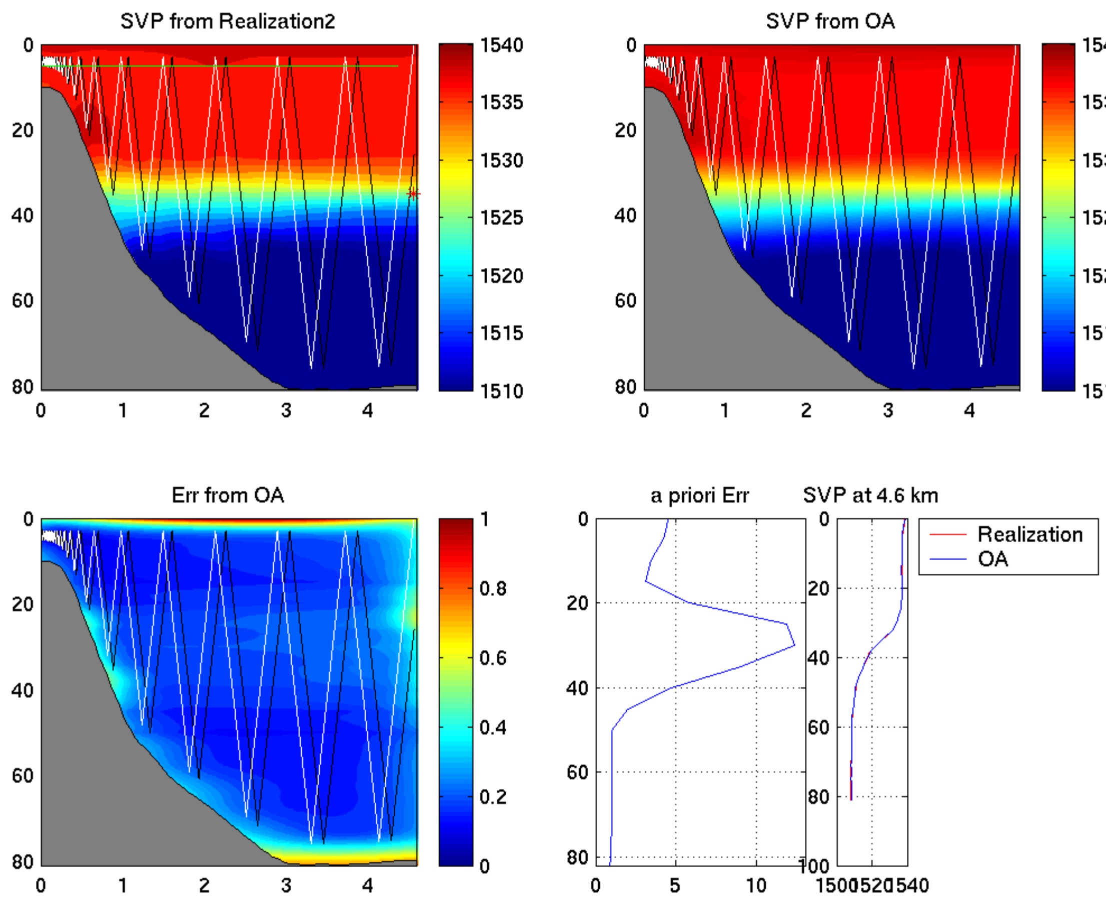

Figure 23: Yoyo control implementation. Afternoon 7/21/05. sound_faf05_jul21_02_day0_1_sec3.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

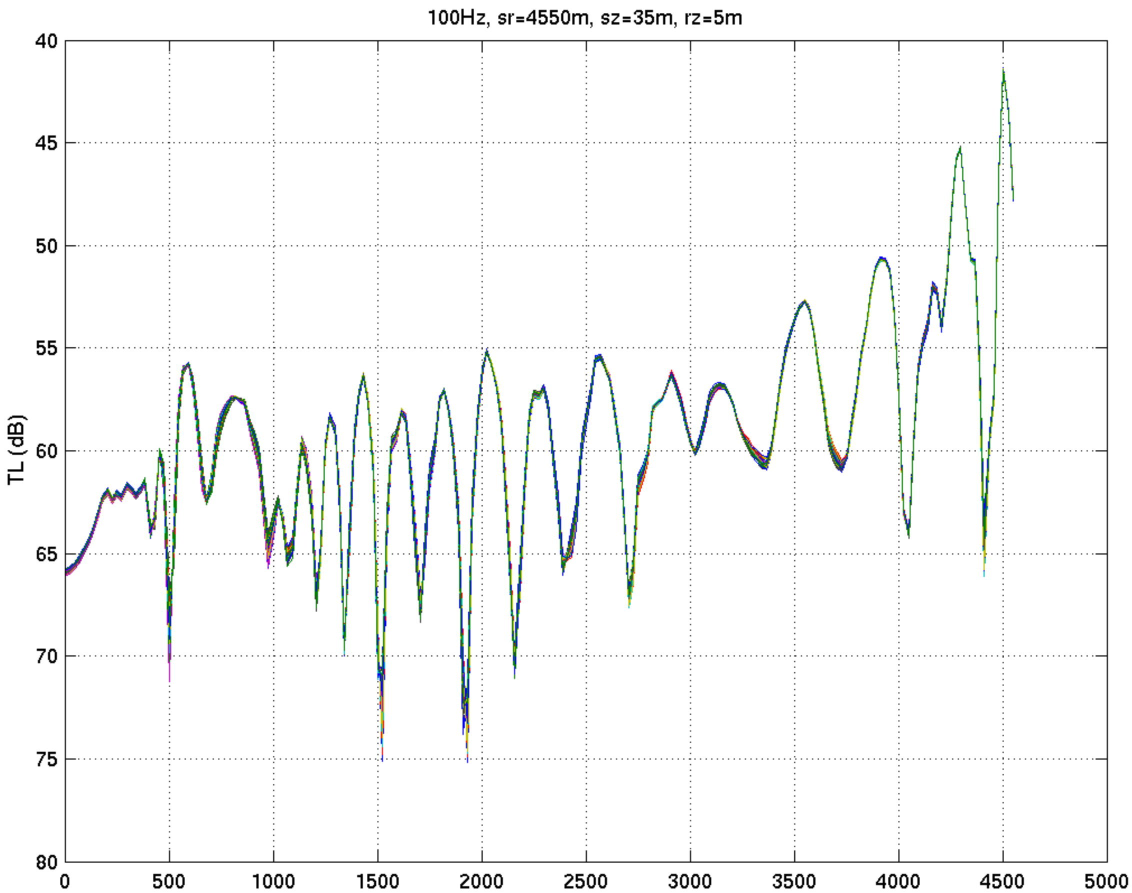

Figure 24: Afternoon 7/21/05. sound_faf05_jul21_02_day0_1_sec3.mat.

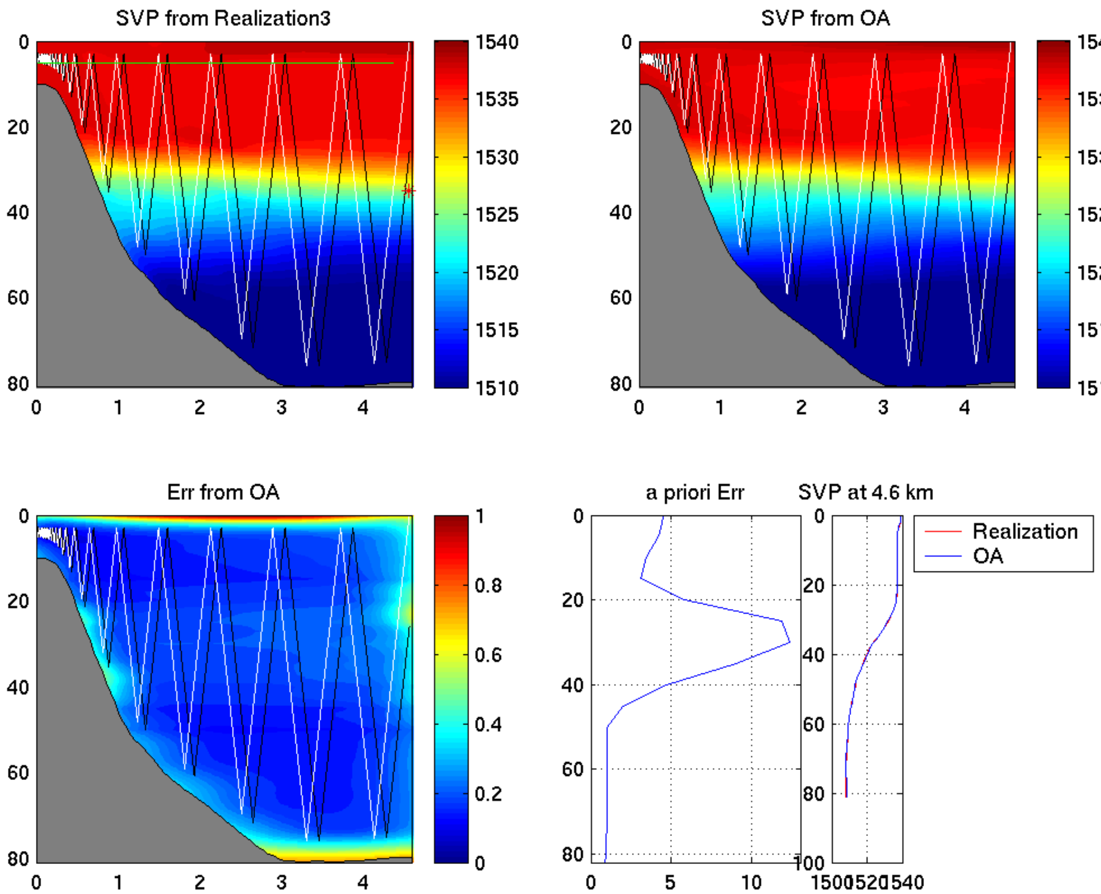

Figure 25: Yoyo control implementation. Morning 7/22/05. sound_faf05_jul21_02_day0_1_sec3.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

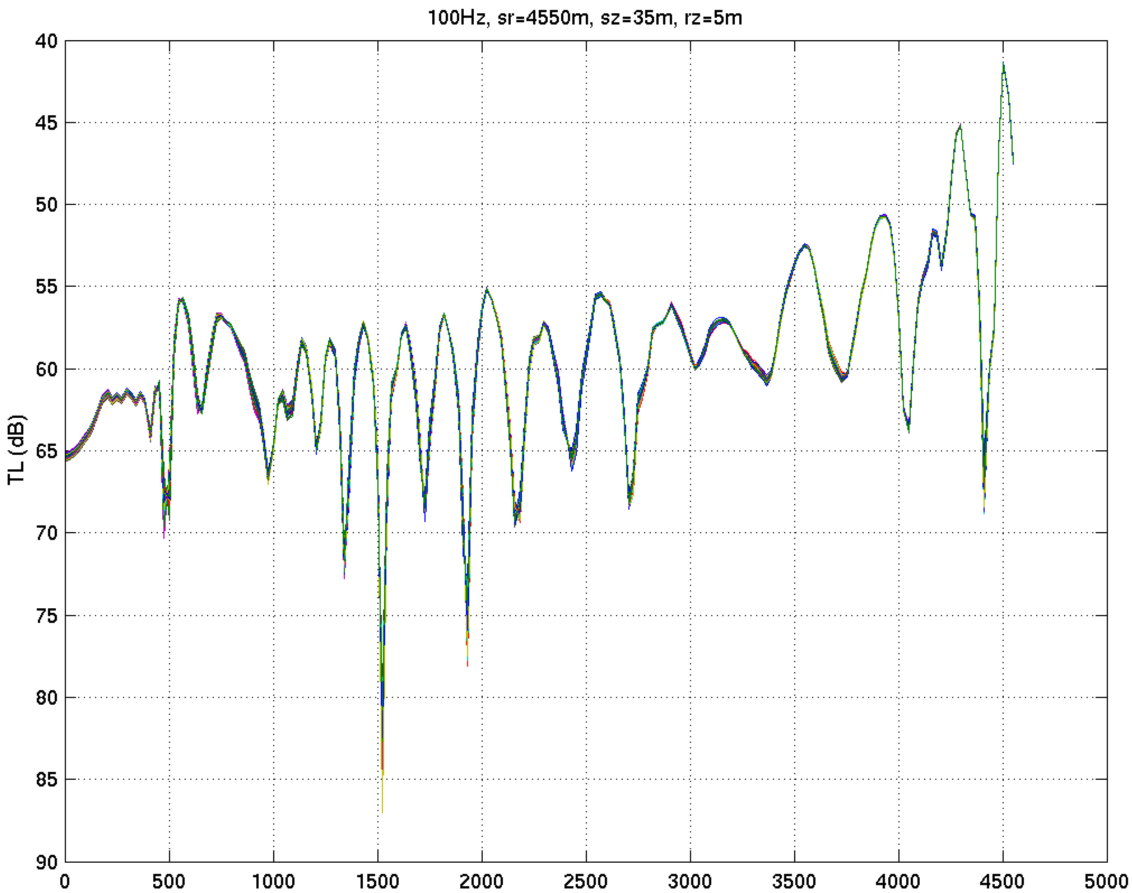

Figure 26: Morning 7/22/05. sound_faf05_jul21_02_day0_1_sec3.mat.

7/22/05:

Yoyo control was implemented in the 2 scenarios in file sound_faf05_jul22_04_day.5_1_sec1.mat.

Optimal: points=30, threshold=1000 for morning 7/22/05

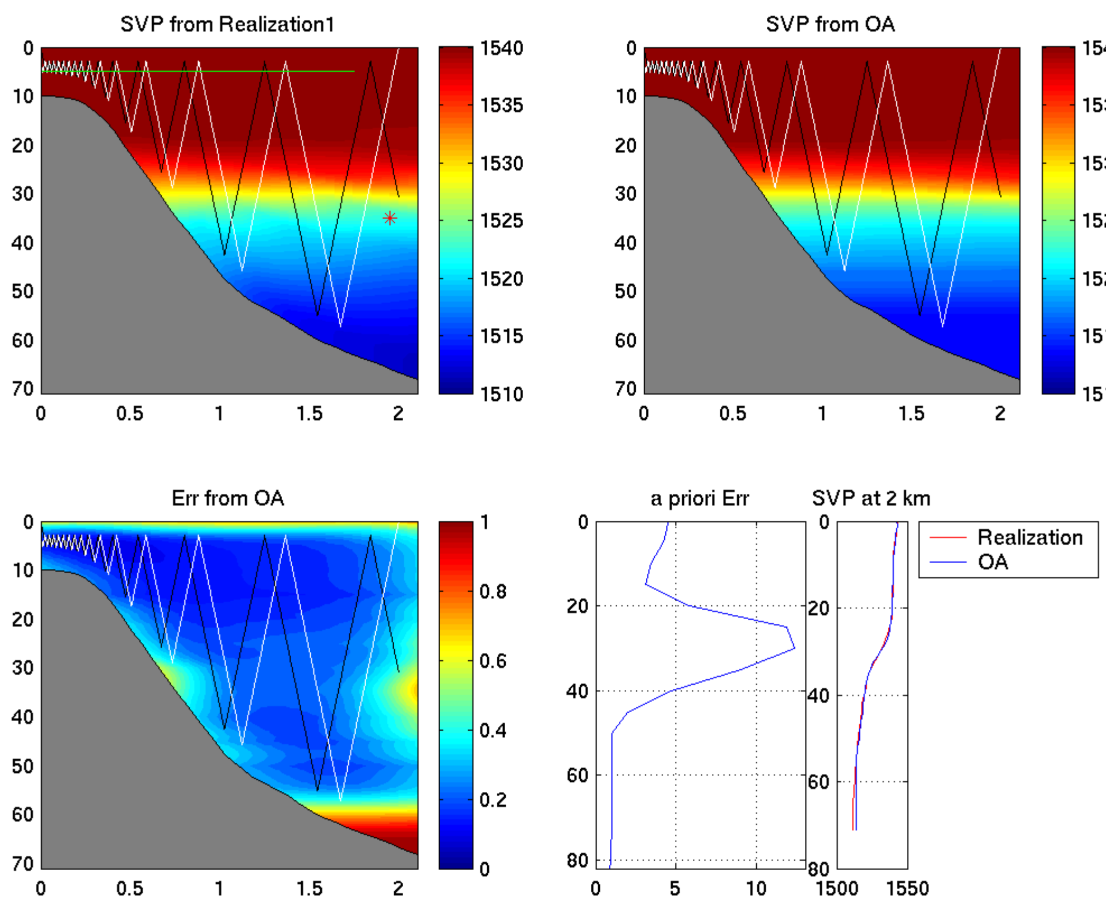

Figure 27: Yoyo control implementation. Morning 7/22/05. sound_faf05_jul22_04_day.5_1_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

Optimal: points=30, threshold=1000 for afternoon 7/22/05

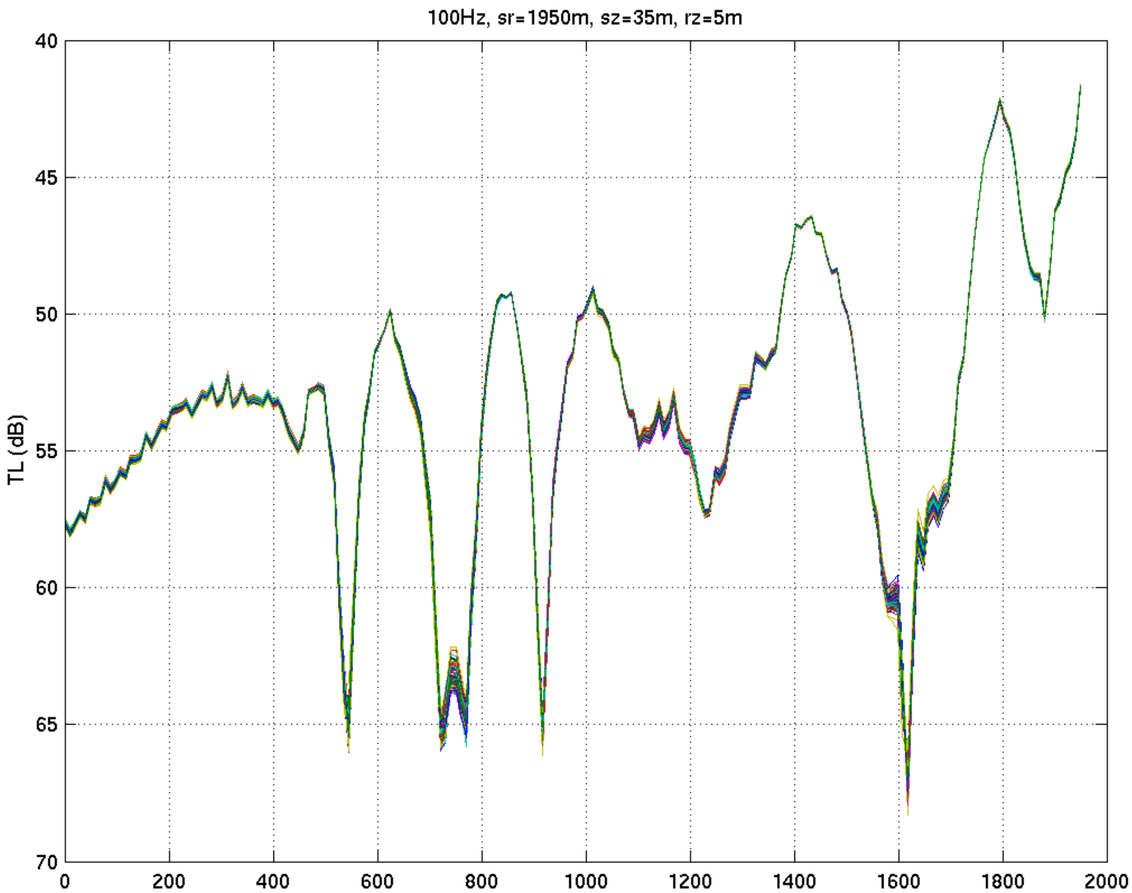

Figure 28: Morning 7/22/05. sound_faf05_jul22_04_day.5_1_sec1.mat.

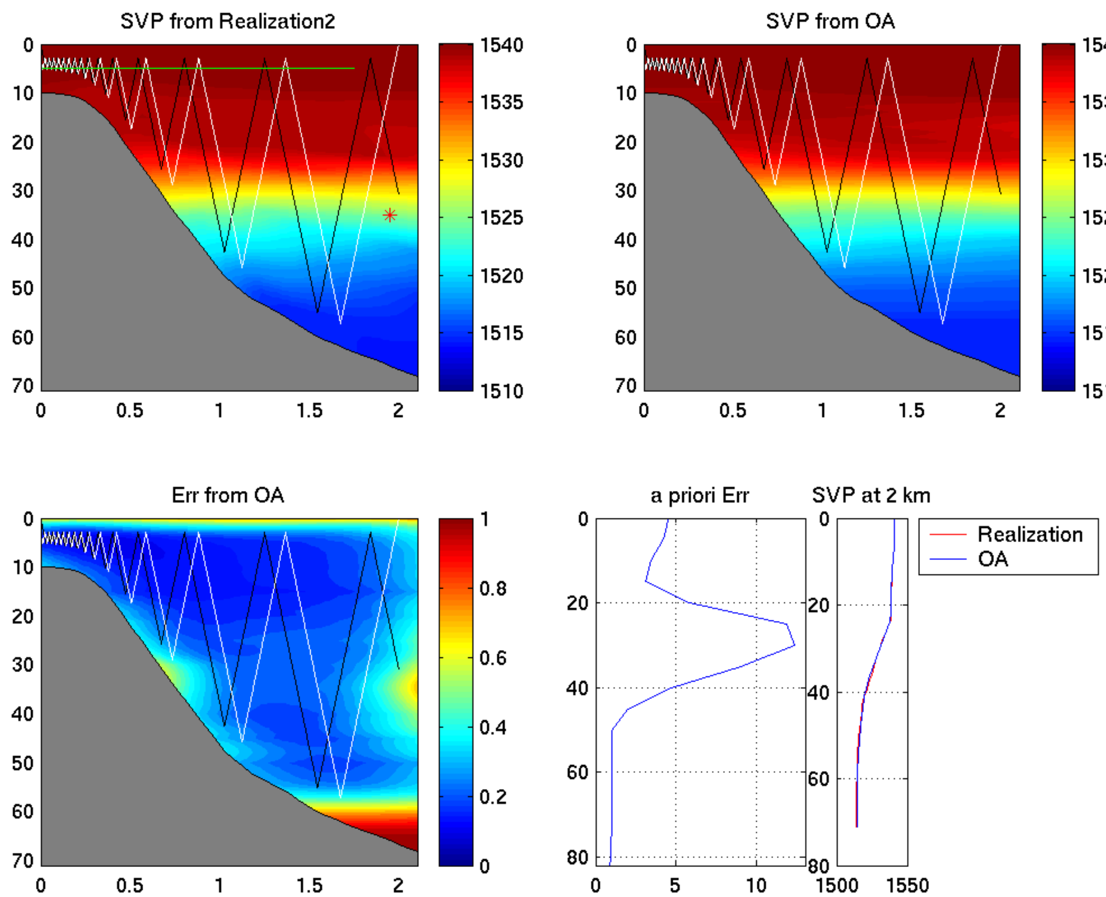

Figure 29: Yoyo control implementation. Afternoon 7/22/05. sound_faf05_jul22_04_day.5_1_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

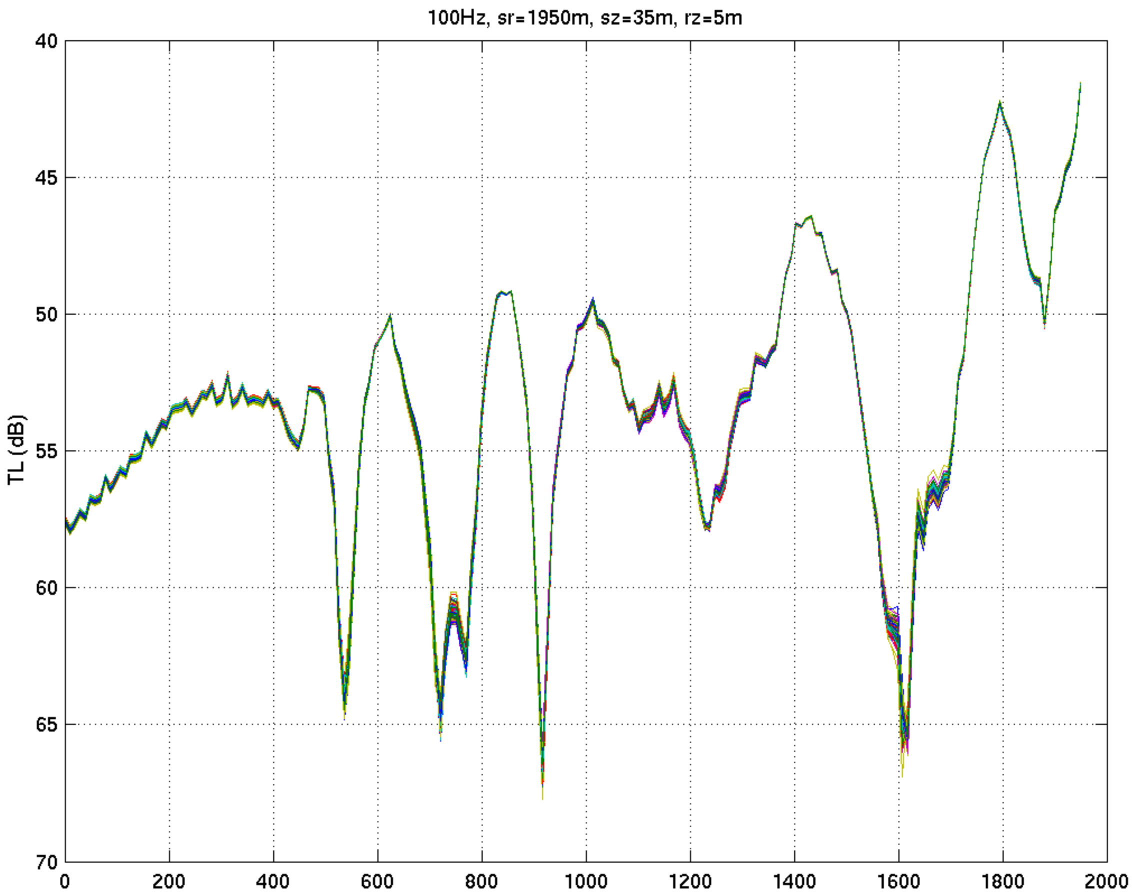

Figure 30: Afternoon 7/22/05. sound_faf05_jul22_04_day.5_1_sec1.mat.

7/23/05:

Yoyo control was implemented in the 3 scenarios in file sound_faf05_jul22_14_day1_2_sec1.mat.

Optimal: points=30, threshold=1000 for morning 7/23/05

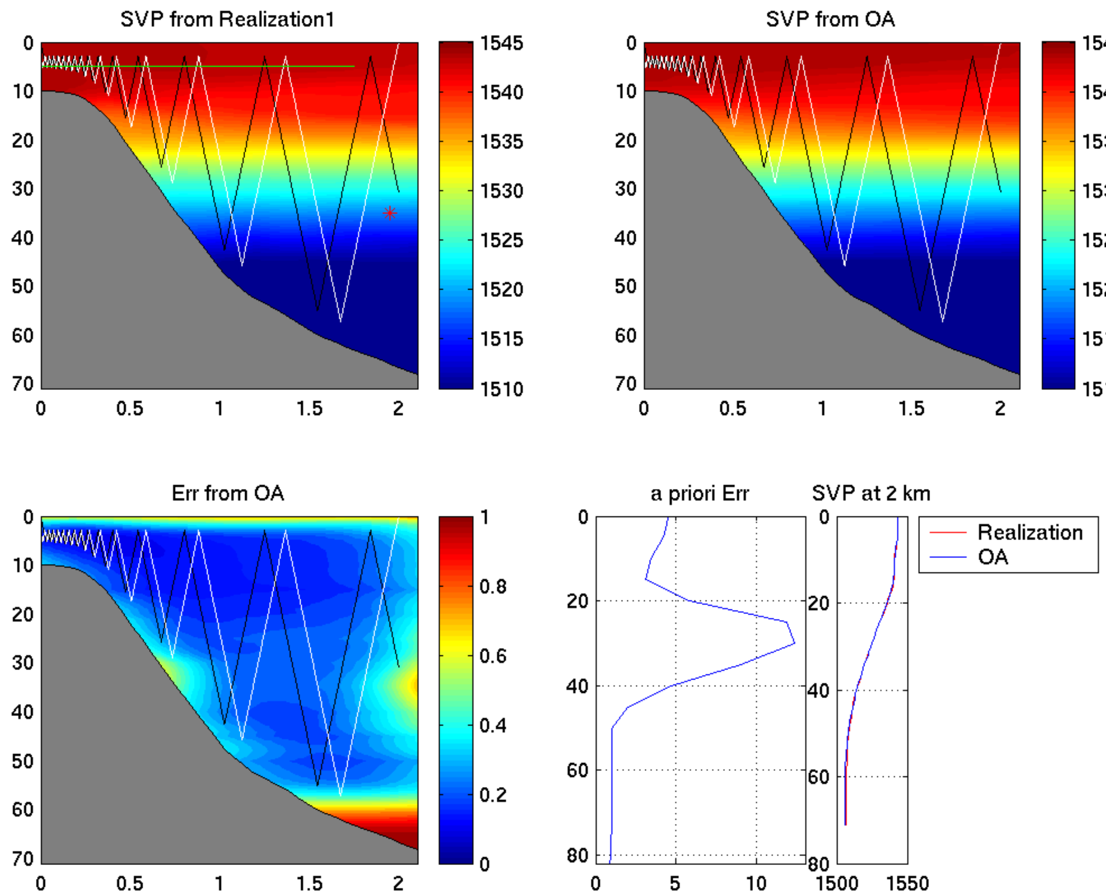

Figure 31: Yoyo control implementation. Morning 7/23/05. sound_faf05_jul22_14_day1_2_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

Optimal: points=30, threshold=0.1 for afternoon 7/23/05
Optimal: points=30, threshold=0.5 for morning 7/24/05

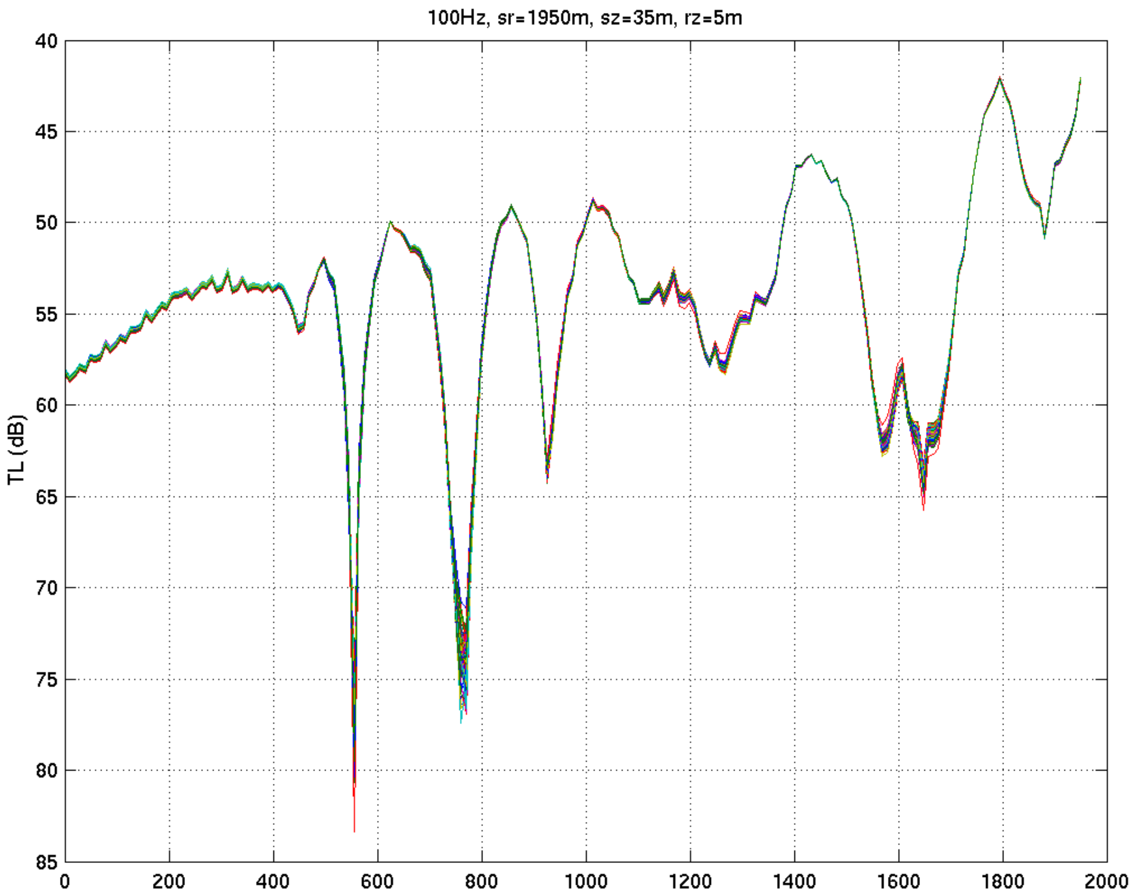

Figure 32: Morning 7/23/05. sound_faf05_jul22_14_day1_2_sec1.mat.

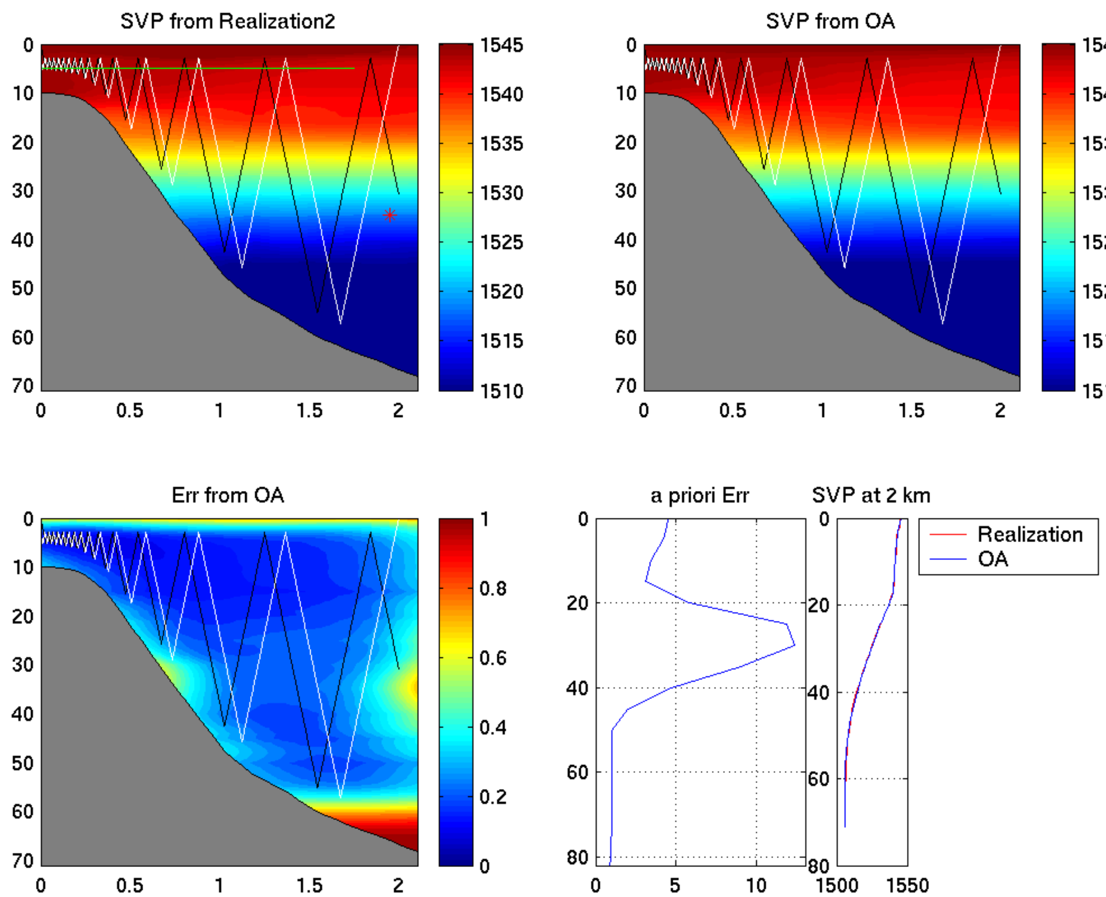

Figure 33: Yoyo control implementation. Afternoon 7/23/05. sound_faf05_jul22_14_day1_2_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

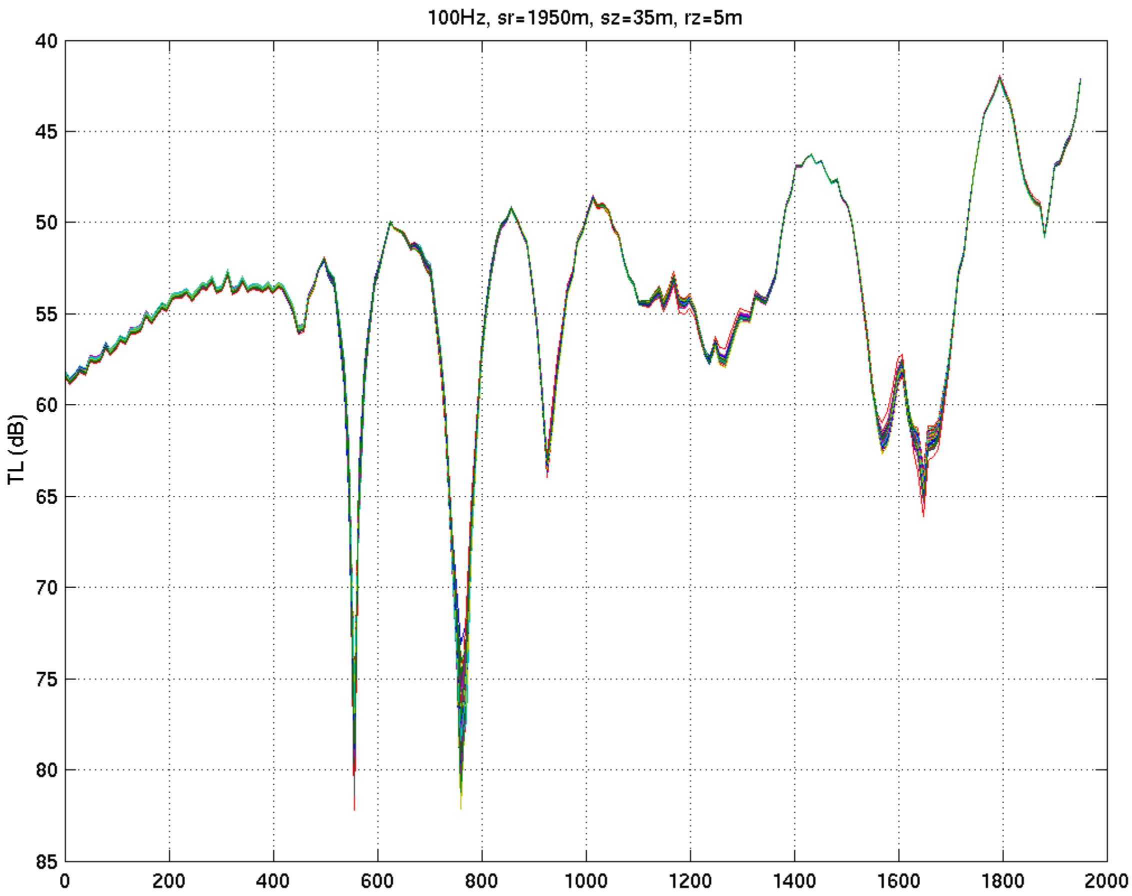

Figure 34: Afternoon 7/23/05. sound_faf05_jul22_14_day1_2_sec1.mat.

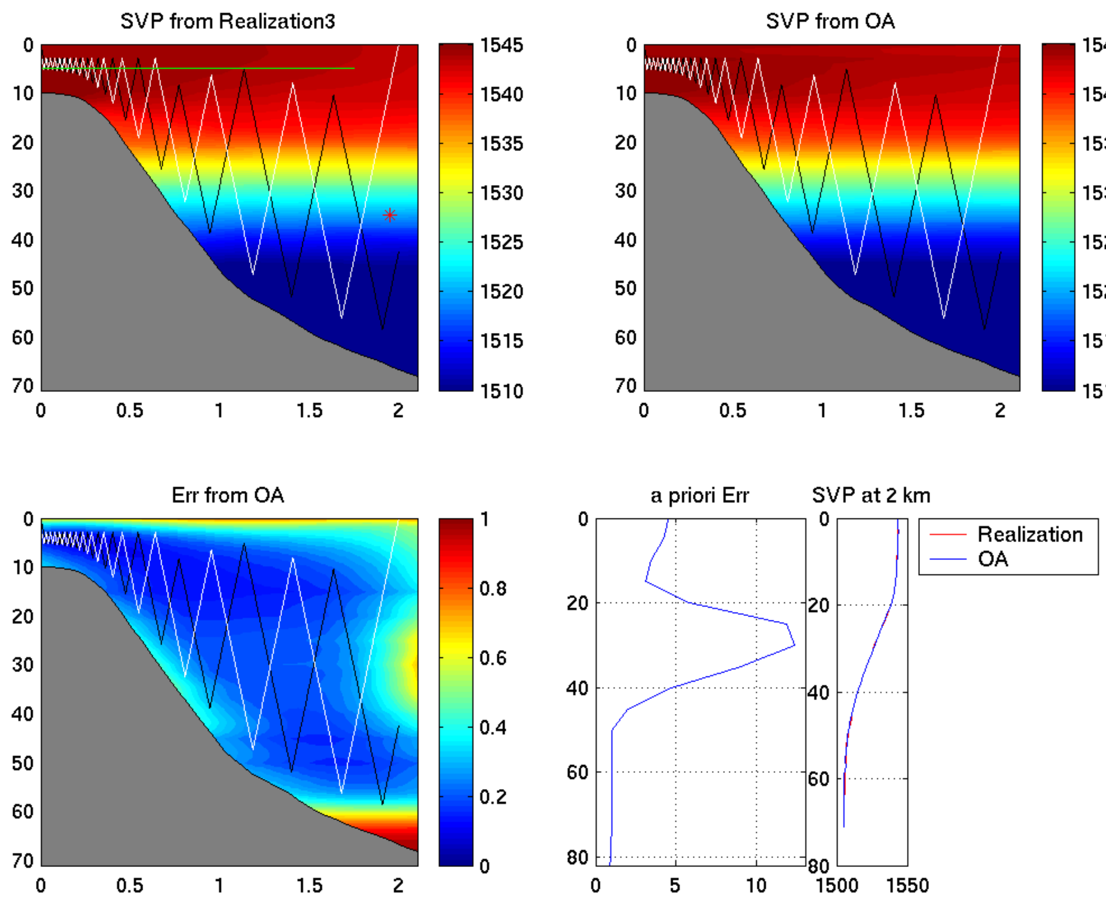

Figure 35: Yoyo control implementation. Morning 7/24/05. sound_faf05_jul22_14_day1_2_sec1.mat. Black line is the forward path; White line is the backward path; Red star is the sound source location; Green line is receivers' location. Note that to avoid bottom AUV turns around at 5 m above bottom.

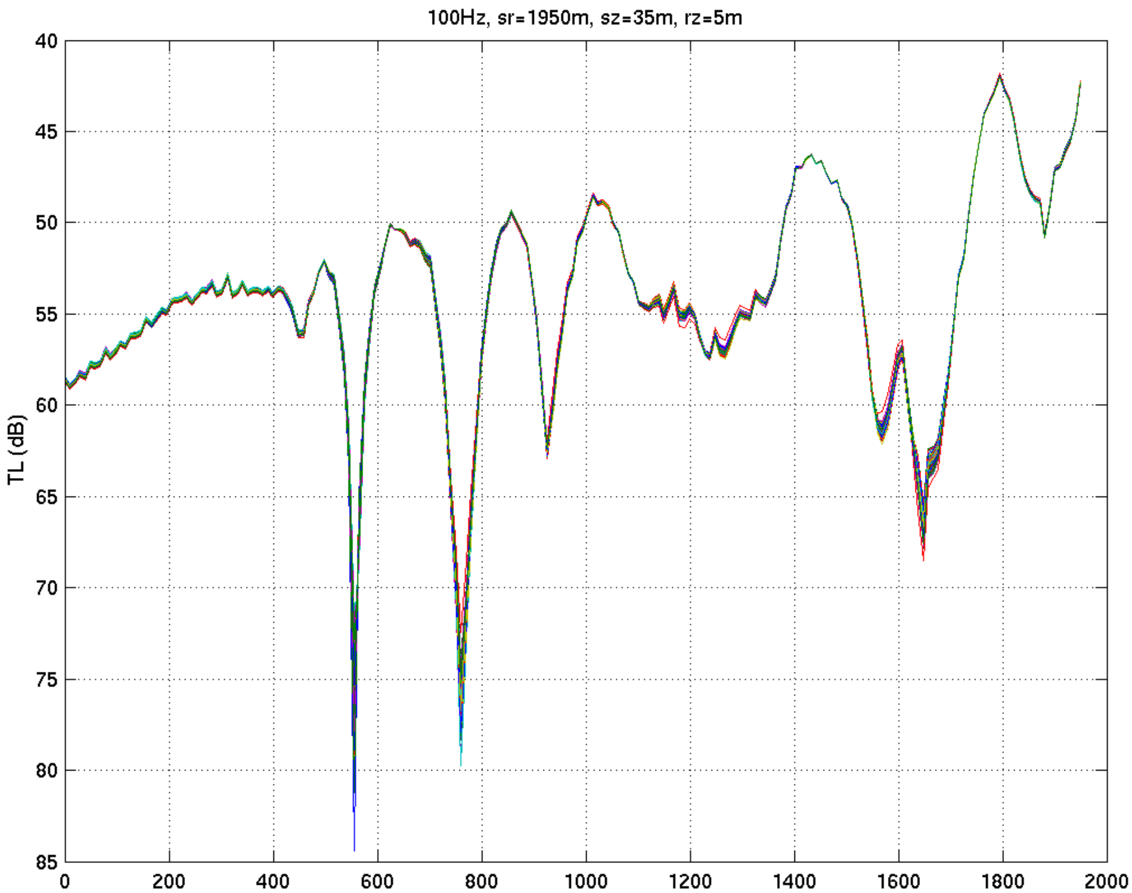

Figure 36: Morning 7/24/05. sound_faf05_jul22_14_day1_2_sec1.mat.

7/24/05:

Yoyo control was implemented in the 3 scenarios in file sound_faf05_jul24_02_day0_1_sec1.mat.

Optimal: points=30, threshold=0.1 for morning 7/24/05

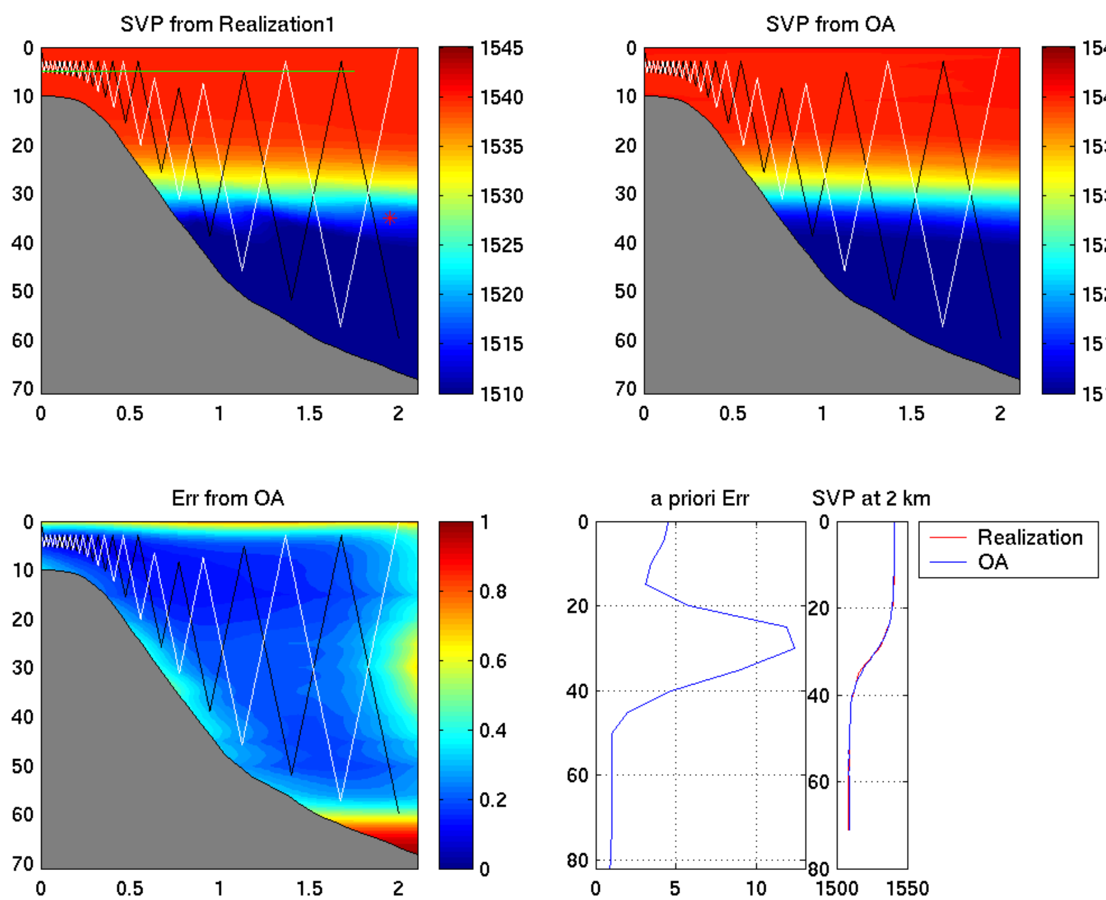

Figure 37: Yoyo control implementation. Morning 7/24/05. sound_faf05_jul24_02_day0_1_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

Optimal: points=30, threshold=1000 for afternoon 7/24/05
Optimal: points=30, threshold=0.1 for morning 7/25/05

I have also included 4 images that illustrate what we think are our best environmental nowcast and predictions. They are horizontal maps in the HOPS runs that Pat carried out and they show the temperature and current fields at 0 and 20m, for this afternoon and for tomorrow morning. See Figure 43, 44, 45, 46

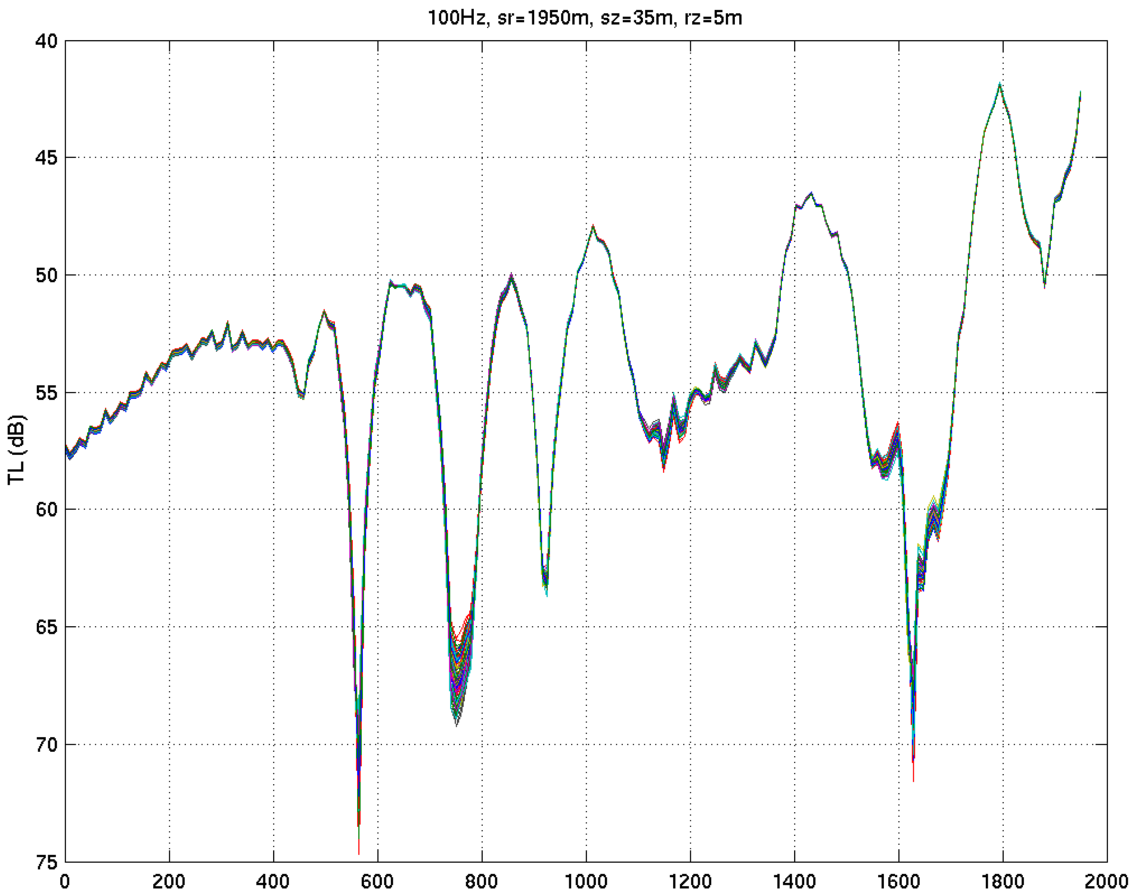

Figure 38: Morning 7/24/05. sound_faf05_jul24_02_day0_1_sec1.mat.

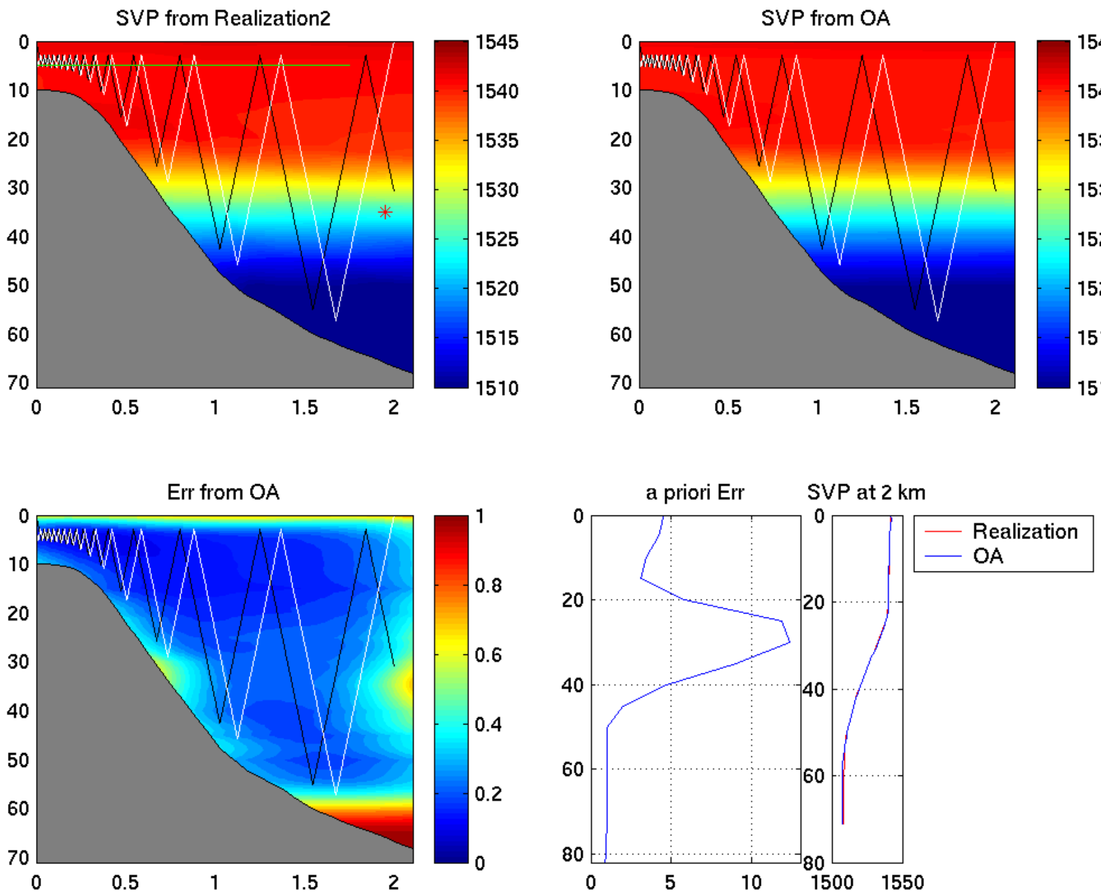

Figure 39: Yoyo control implementation. Afternoon 7/24/05. sound_faf05_jul24_02_day0_1_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

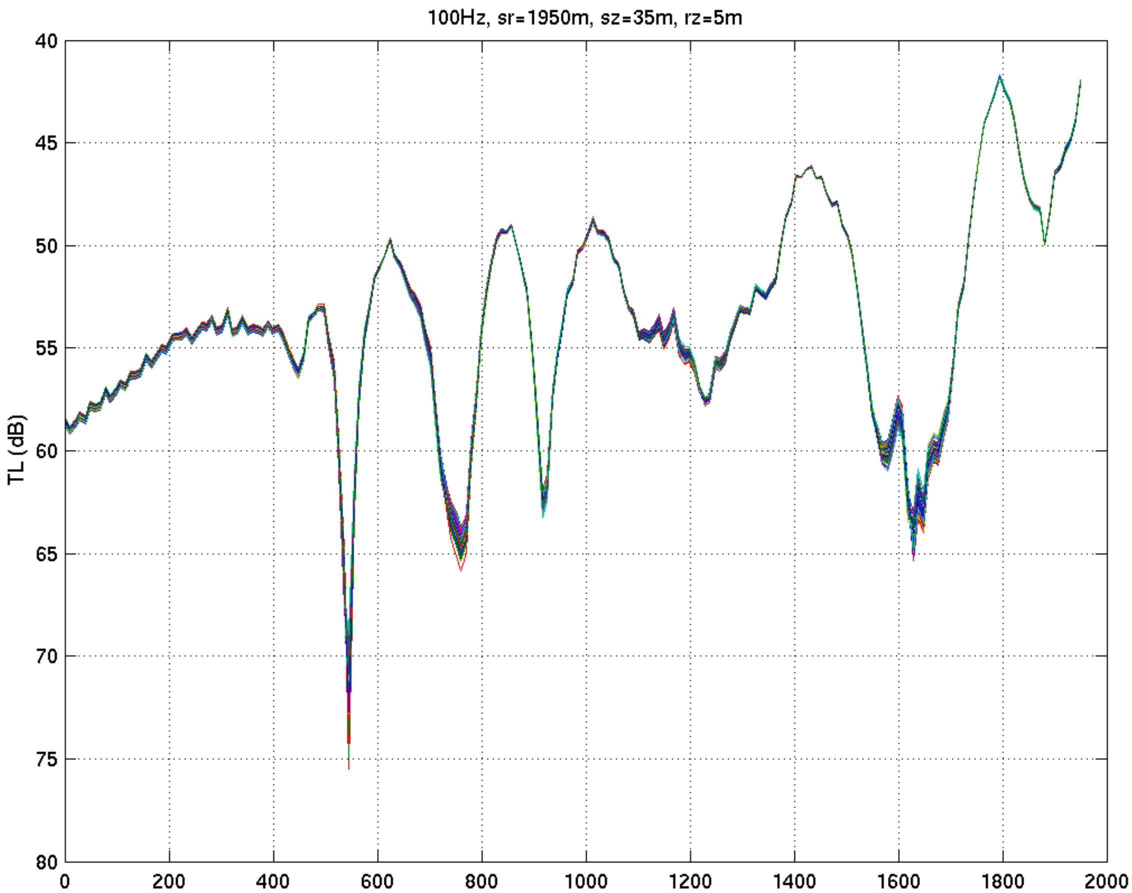

Figure 40: Afternoon 7/24/05. sound_faf05_jul24_02_day0_1_sec1.mat.

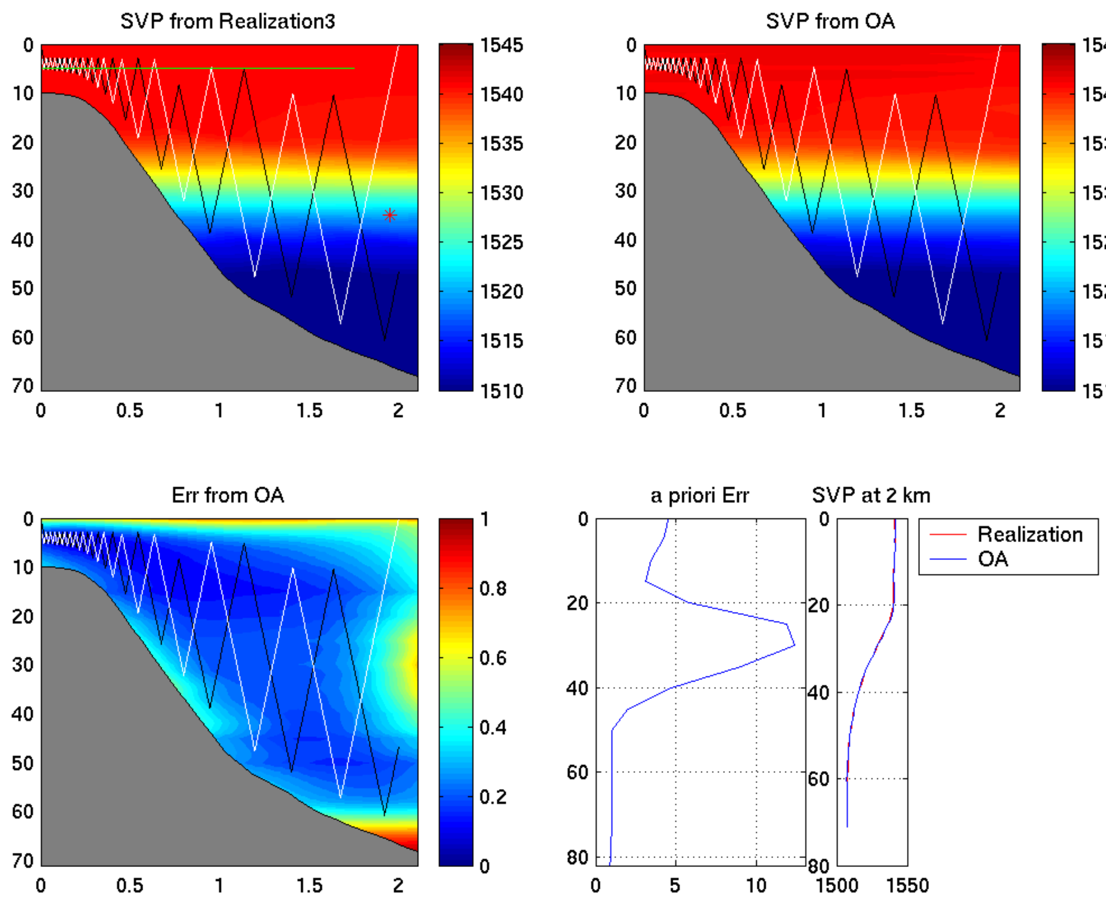

Figure 41: Yoyo control implementation. Morning 7/25/05. sound_faf05_jul24_02_day0_1_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

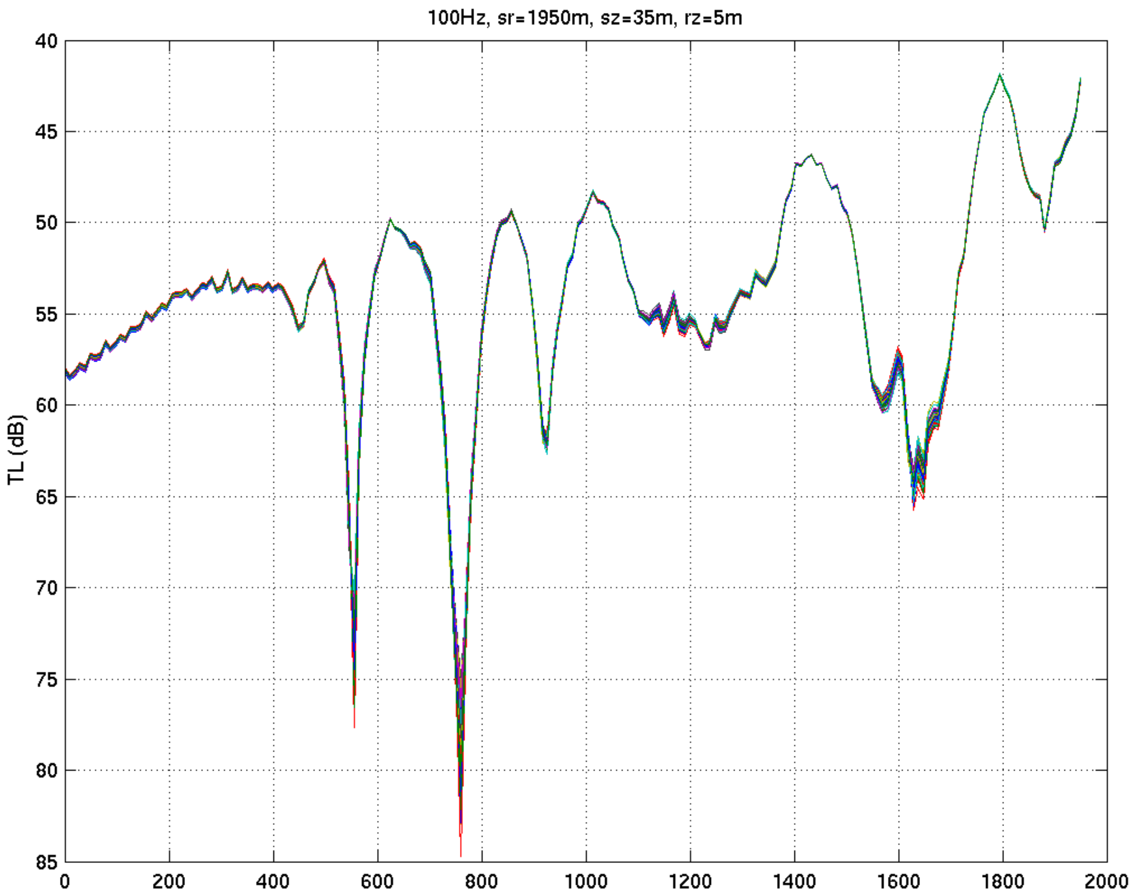

Figure 42: Morning 7/25/05. sound_faf05_jul24_02_day0_1_sec1.mat.

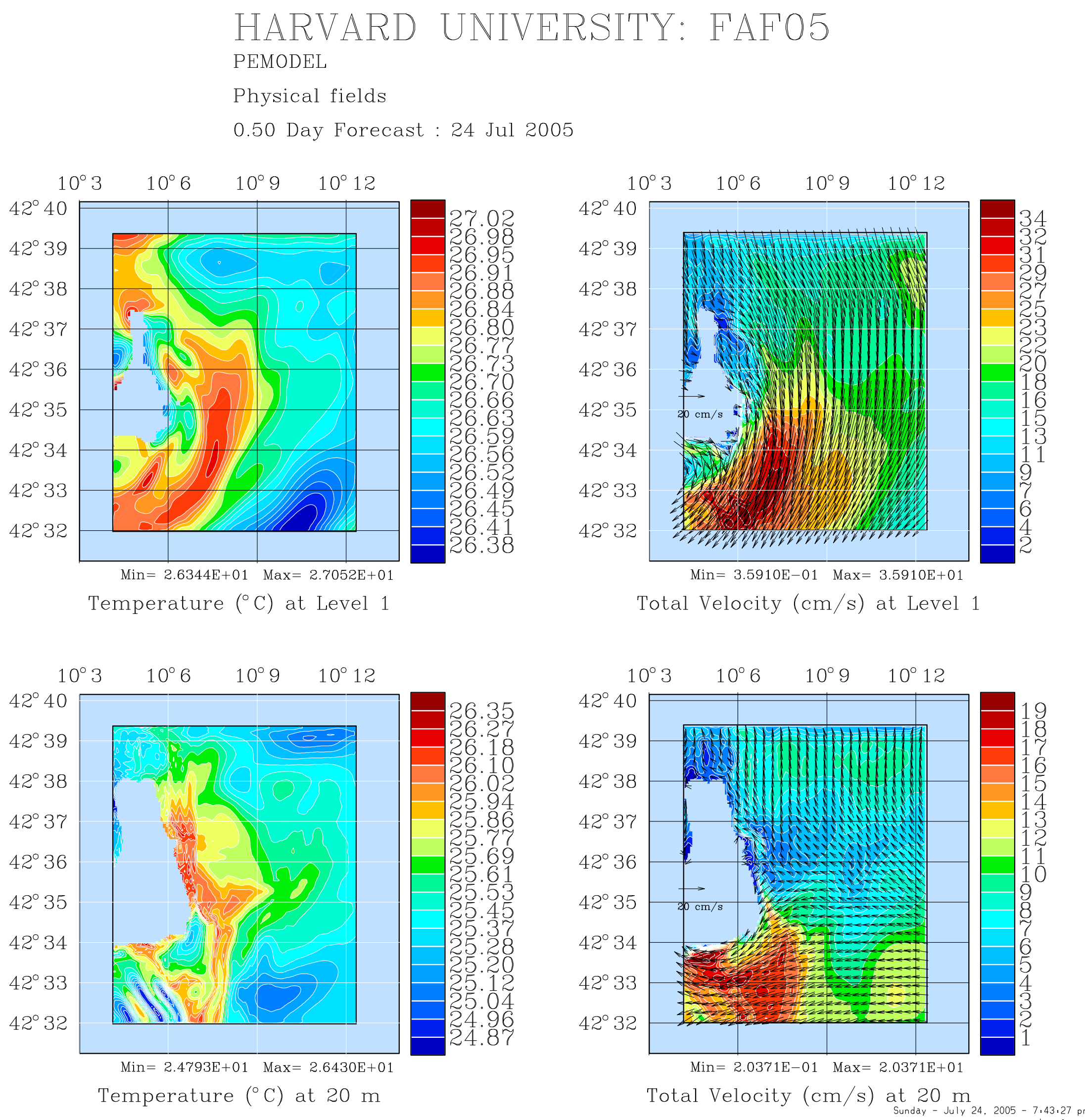

Figure 43: Temperature and current fields at 0 and 20m, for 7/24/05 afternoon. Pianosa area.

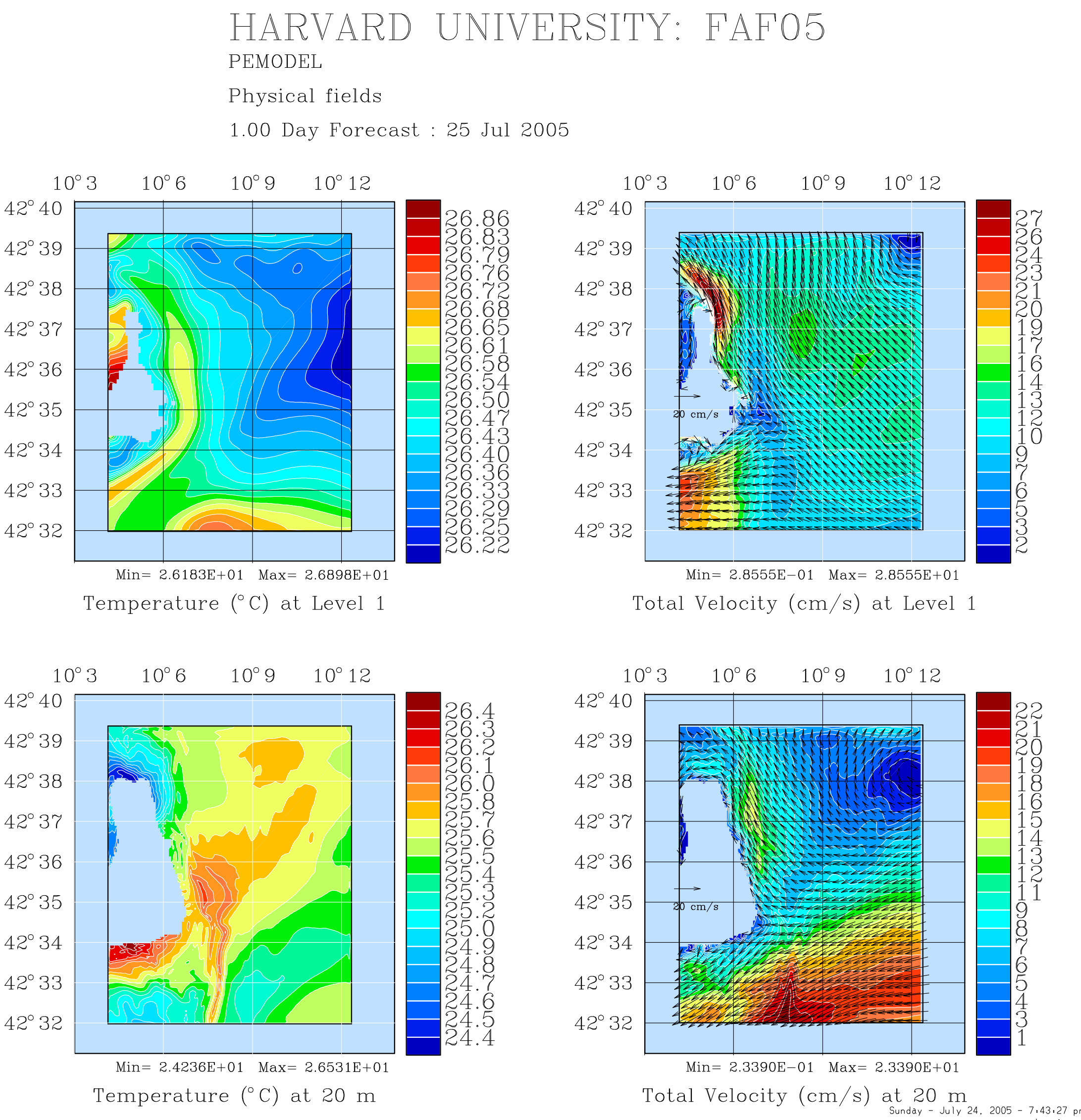

Figure 44: Temperature and current fields at 0 and 20m, for 7/25/05 morning. Pianosa area.

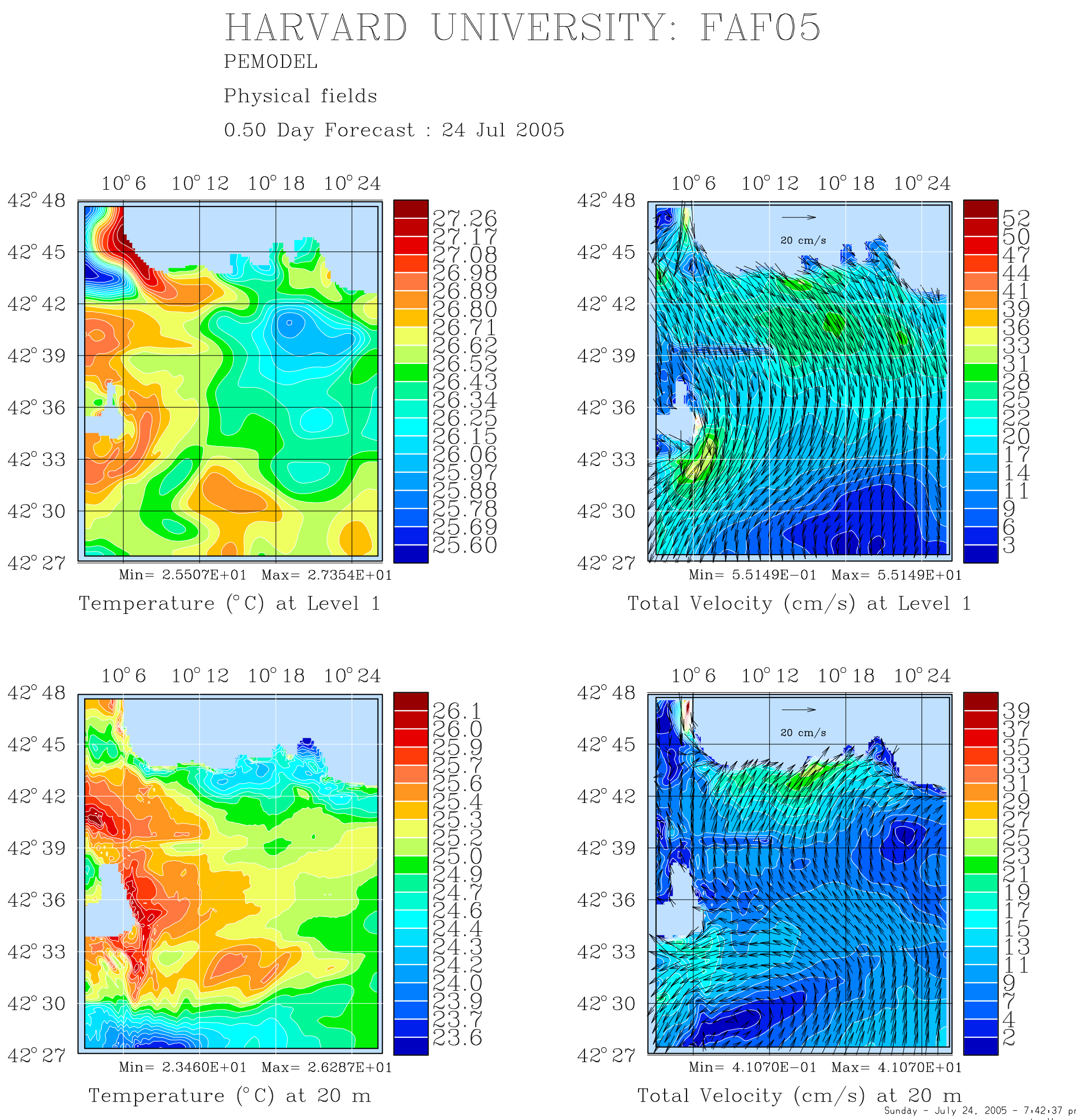

Figure 45: Temperature and current fields at 0 and 20m, for 7/24/05 afternoon. Elba area.

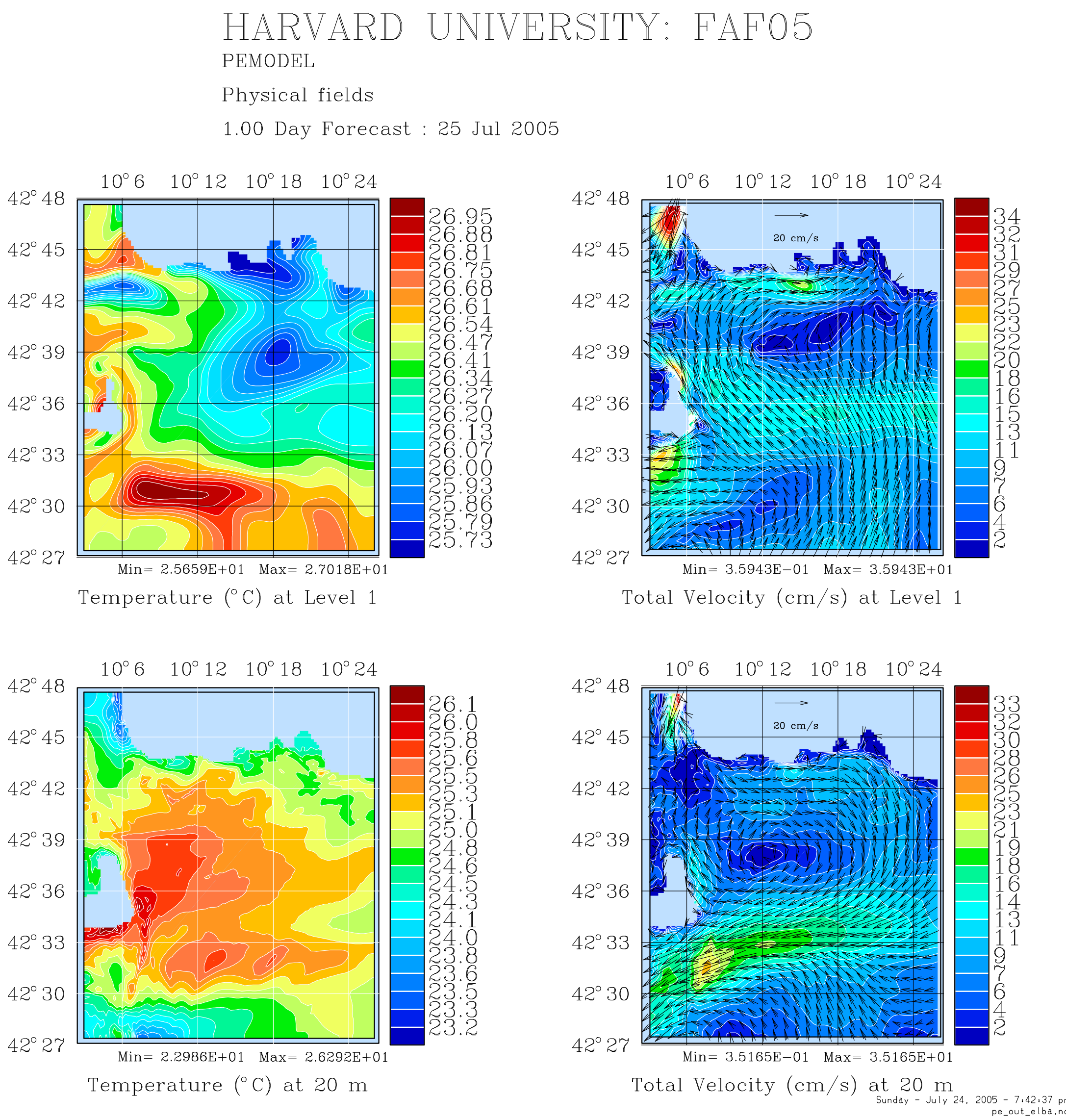

Figure 46: Temperature and current fields at 0 and 20m, for 7/25/05 morning. Elba area.

7/25/05:

Today we have 4 realizations from section 1: afternoon of Jul 25, morning and afternoon of Jul26, and morning of Jul27. Yoyo control was implemented in the 2 scenarios in file sound_faf05_jul26_06_day.5_2_sec1.ma

Optimal: points=30, threshold=0.1 for afternoon of Jul 25

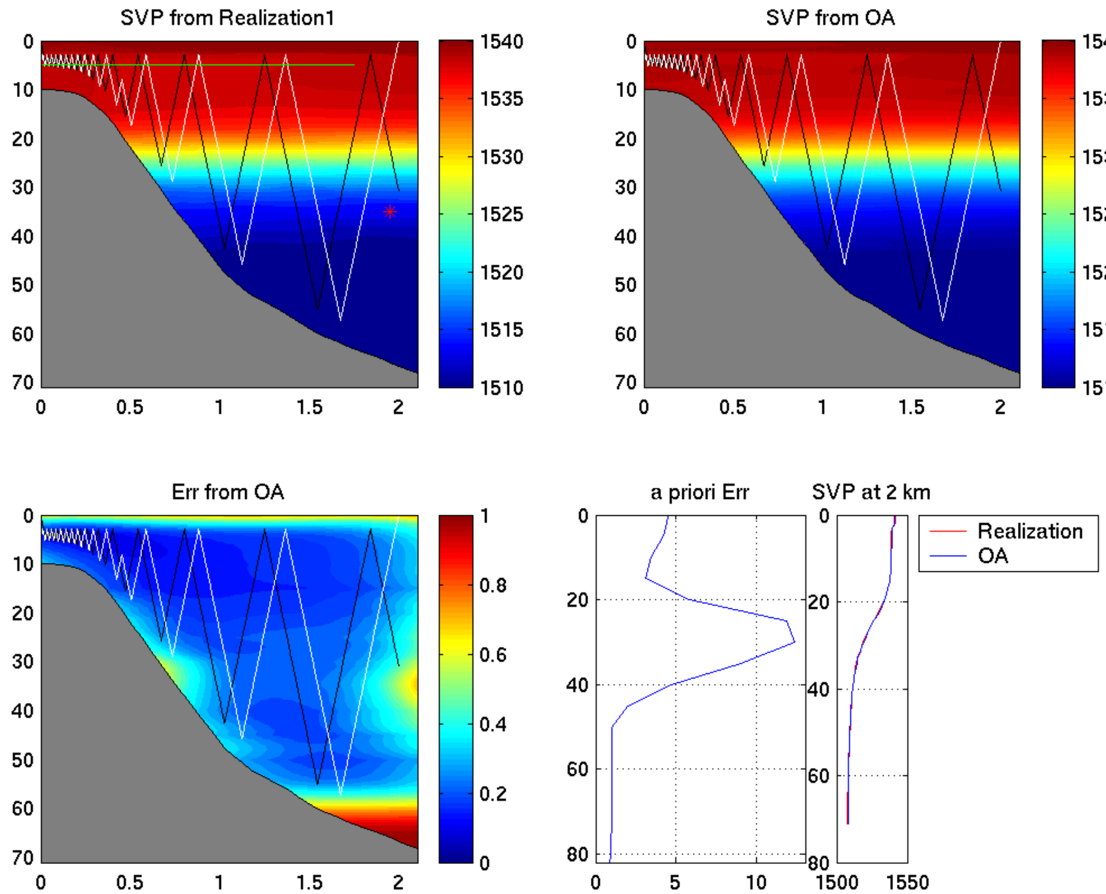

Figure 47: Yoyo control implementation. Afternoon 7/25/05. sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

Optimal: points=30, threshold=0.1 for morning of Jul 26
Optimal: points=30, threshold=1000 for afternoon of Jul 26
Optimal: points=30, threshold=1000 for morning of Jul 27

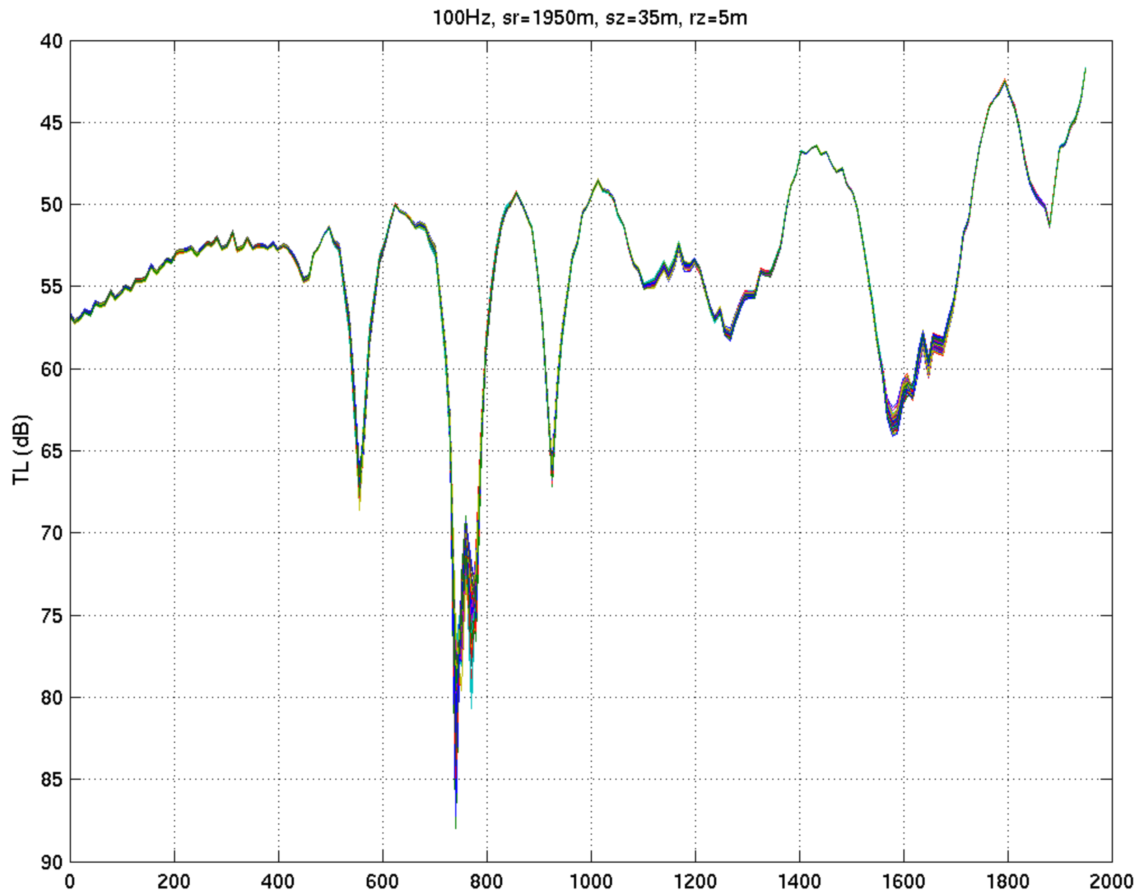

Figure 48: Afternoon 7/25/05. sound_faf05_jul26_06_day.5_2_sec1.mat.

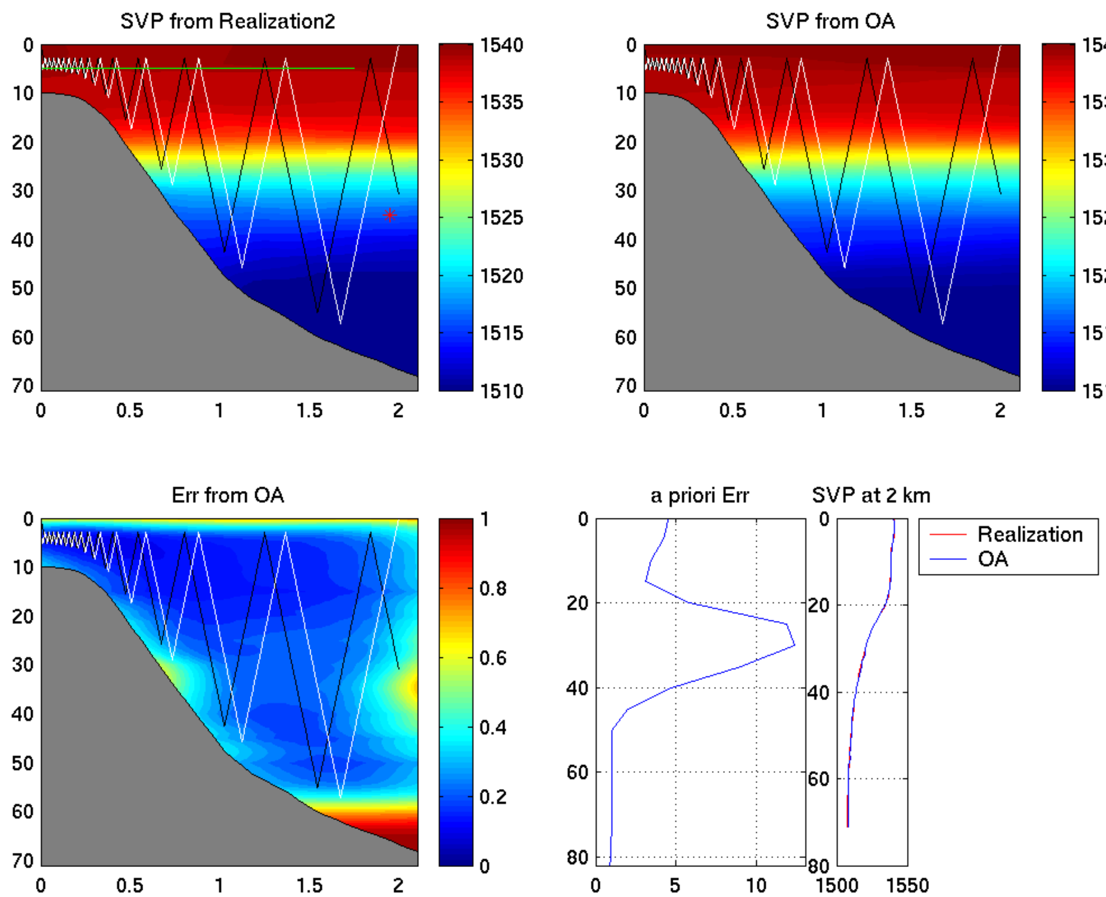

Figure 49: Yoyo control implementation. Morning 7/26/05. sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

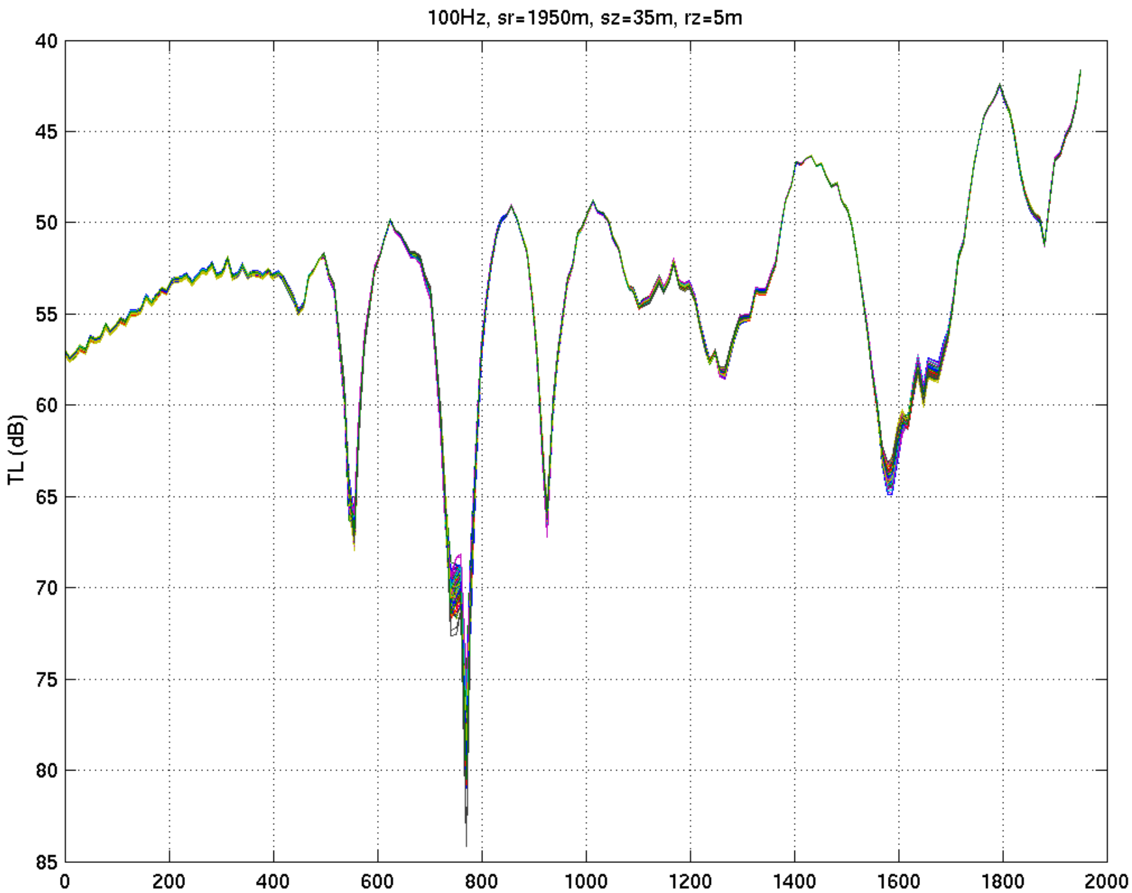

Figure 50: Morning 7/26/05. sound_faf05_jul26_06_day.5_2_sec1.mat.

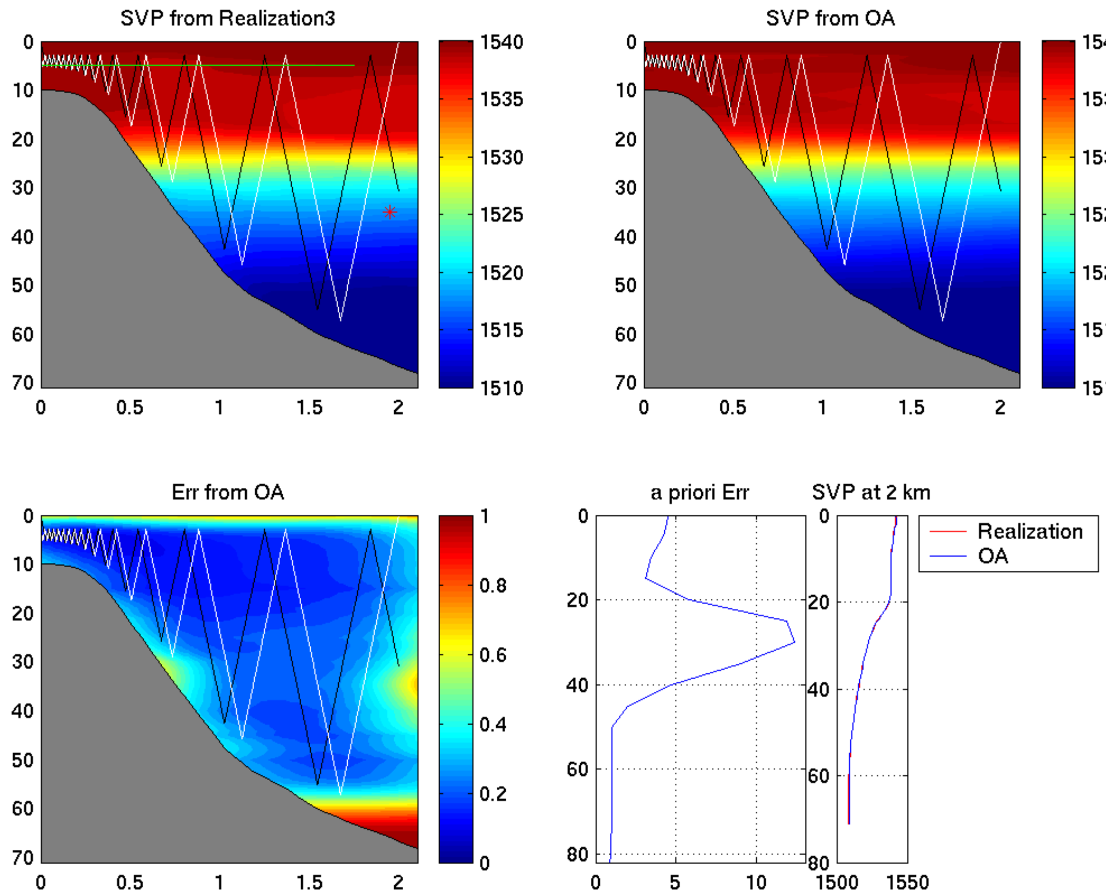

Figure 51: Yoyo control implementation. Afternoon 7/26/05. sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

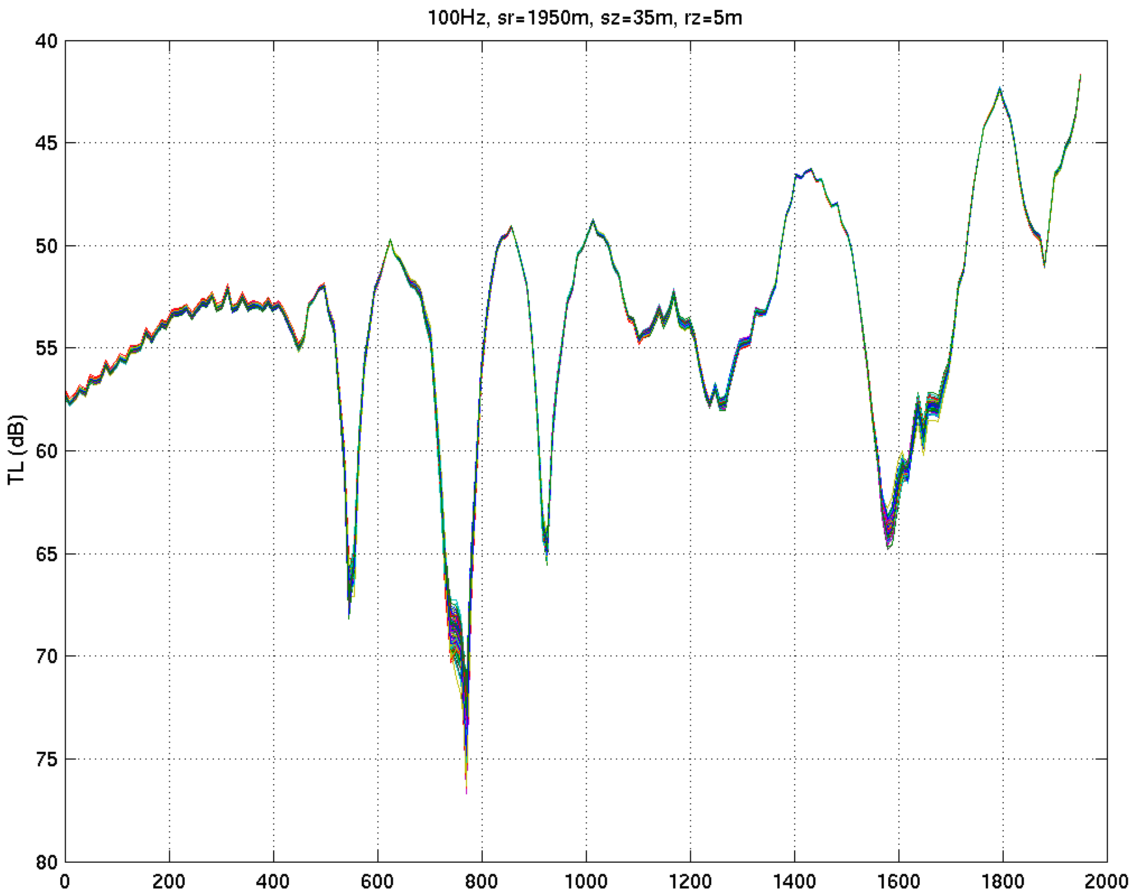

Figure 52: Afternoon 7/26/05. sound_faf05_jul26_06_day.5_2_sec1.mat.

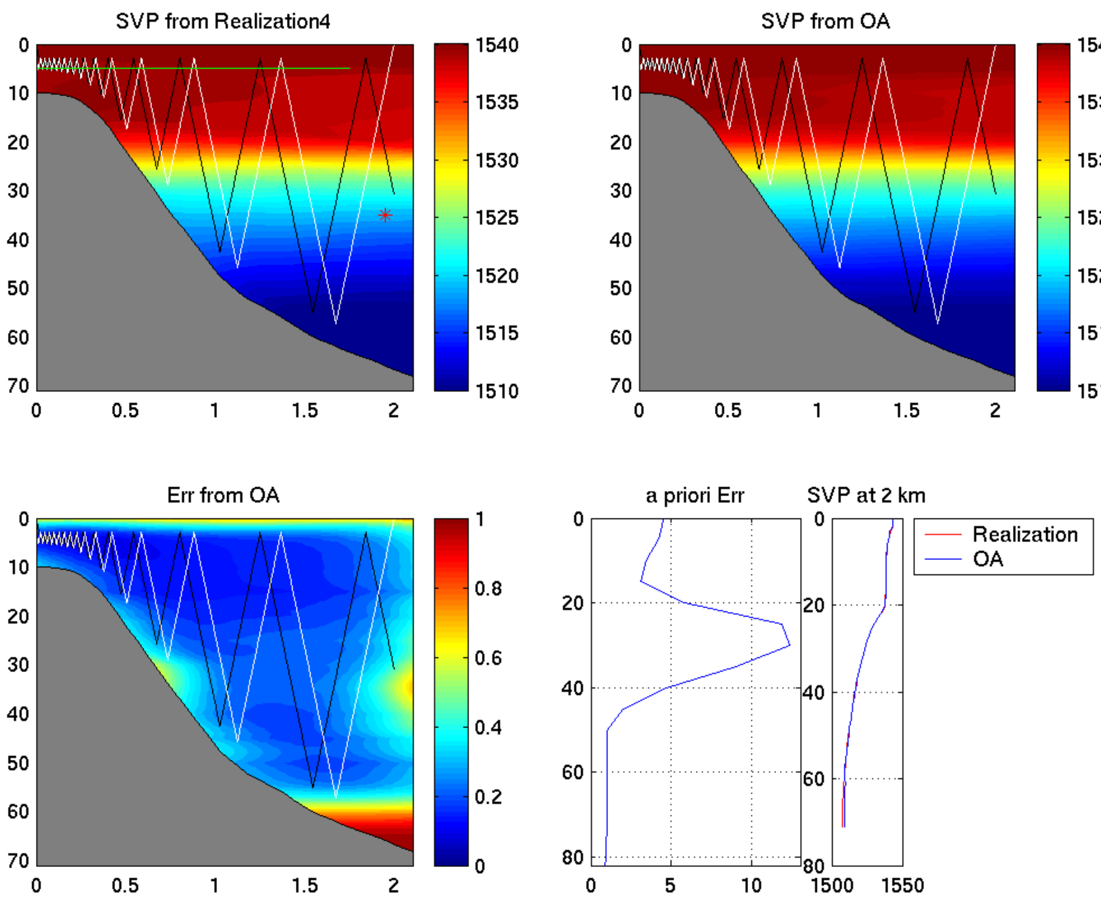

Figure 53: Yoyo control implementation. Morning 7/27/05. sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

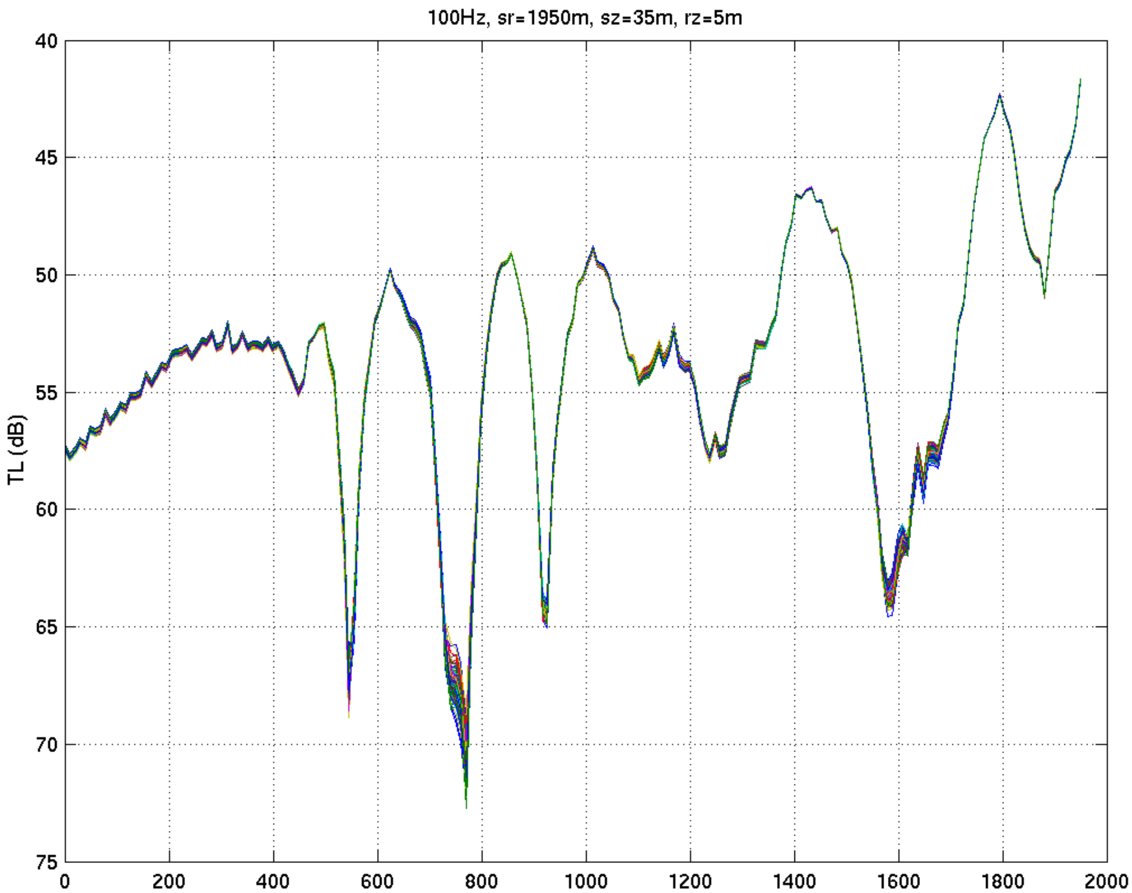

Figure 54: Morning 7/27/05. sound_faf05_jul26_06_day.5_2_sec1.mat.

7/26/05:

Today we have 4 realizations from section 1: afternoon of Jul 26, morning and afternoon of Jul27, and morning of Jul28.

Optimal: points=30, threshold=1000 for afternoon of Jul 26

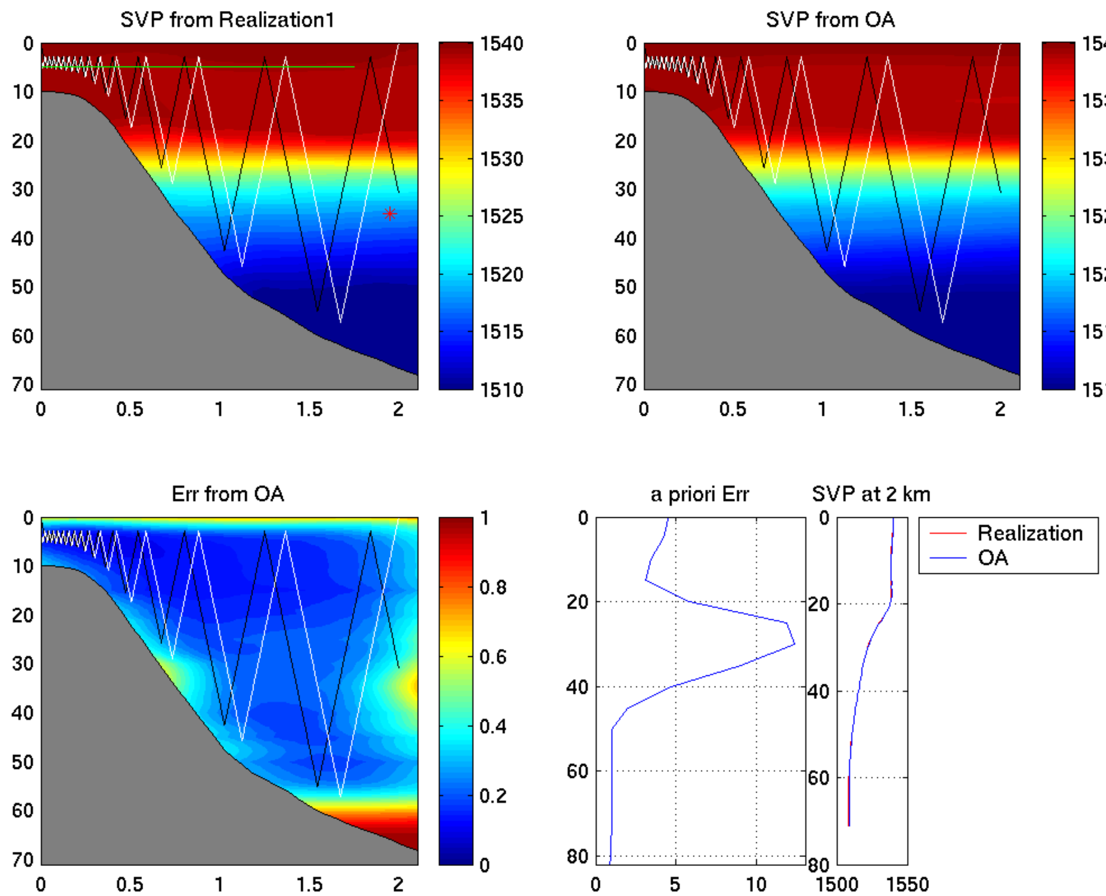

Figure 55: Yoyo control implementation. Afternoon 7/26/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

Optimal: points=30, threshold=1000 for morning of Jul 27
Optimal: points=30, threshold=1000 for afternoon of Jul 27
Optimal: points=30, threshold=1000 for morning of Jul 28

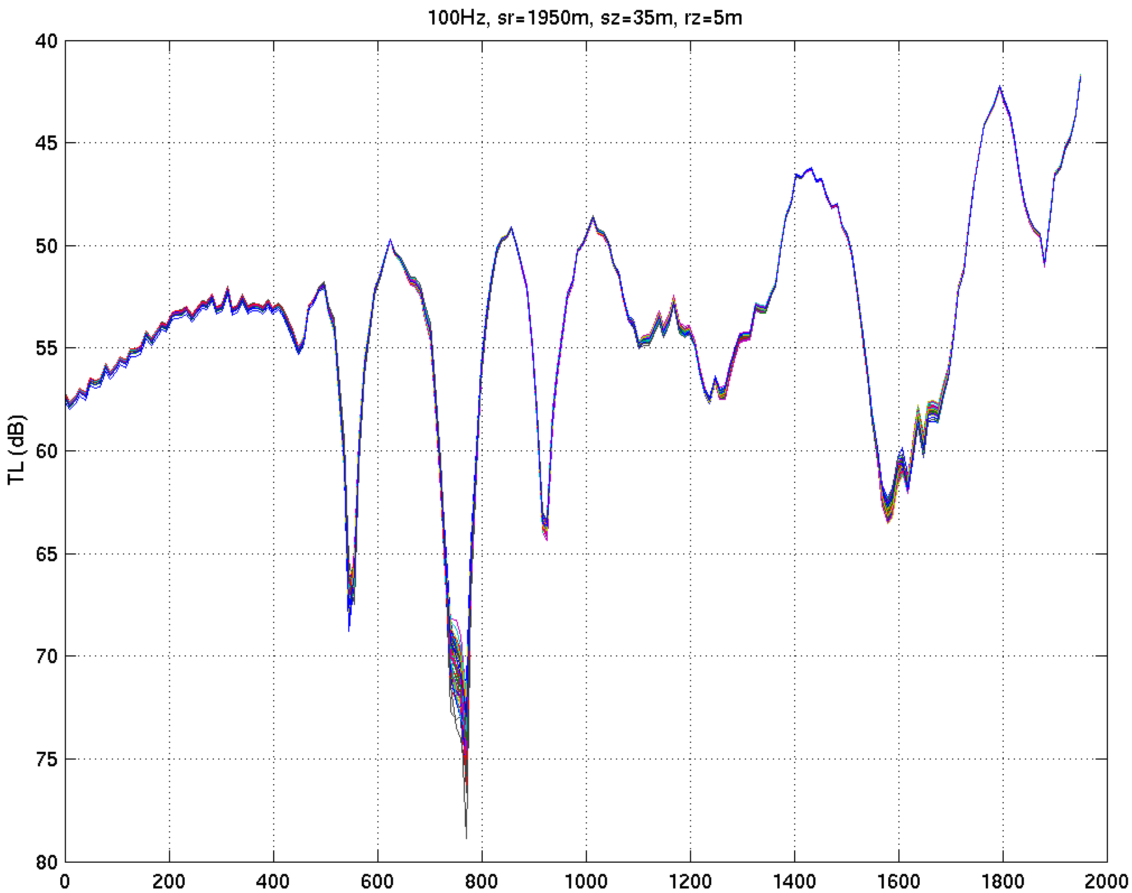

Figure 56: Afternoon 7/26/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat.

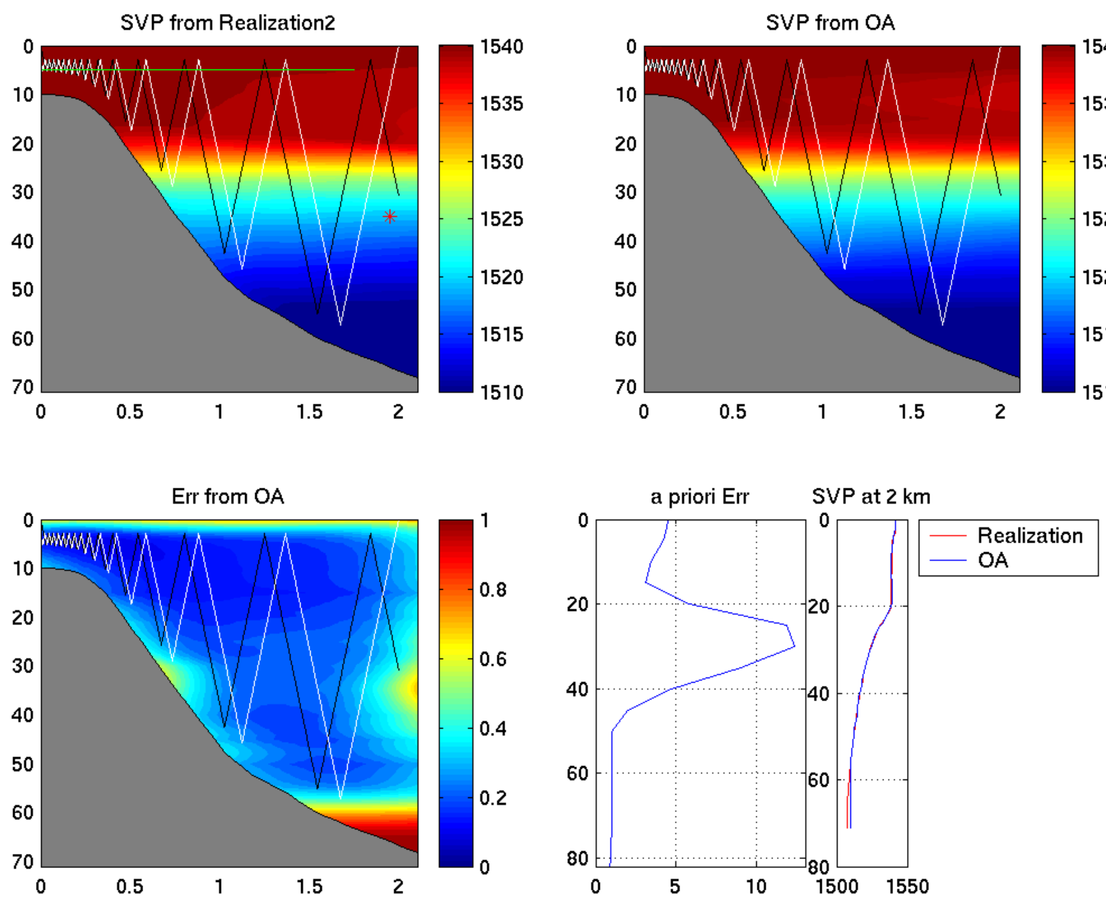

Figure 57: Yoyo control implementation. Morning 7/27/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

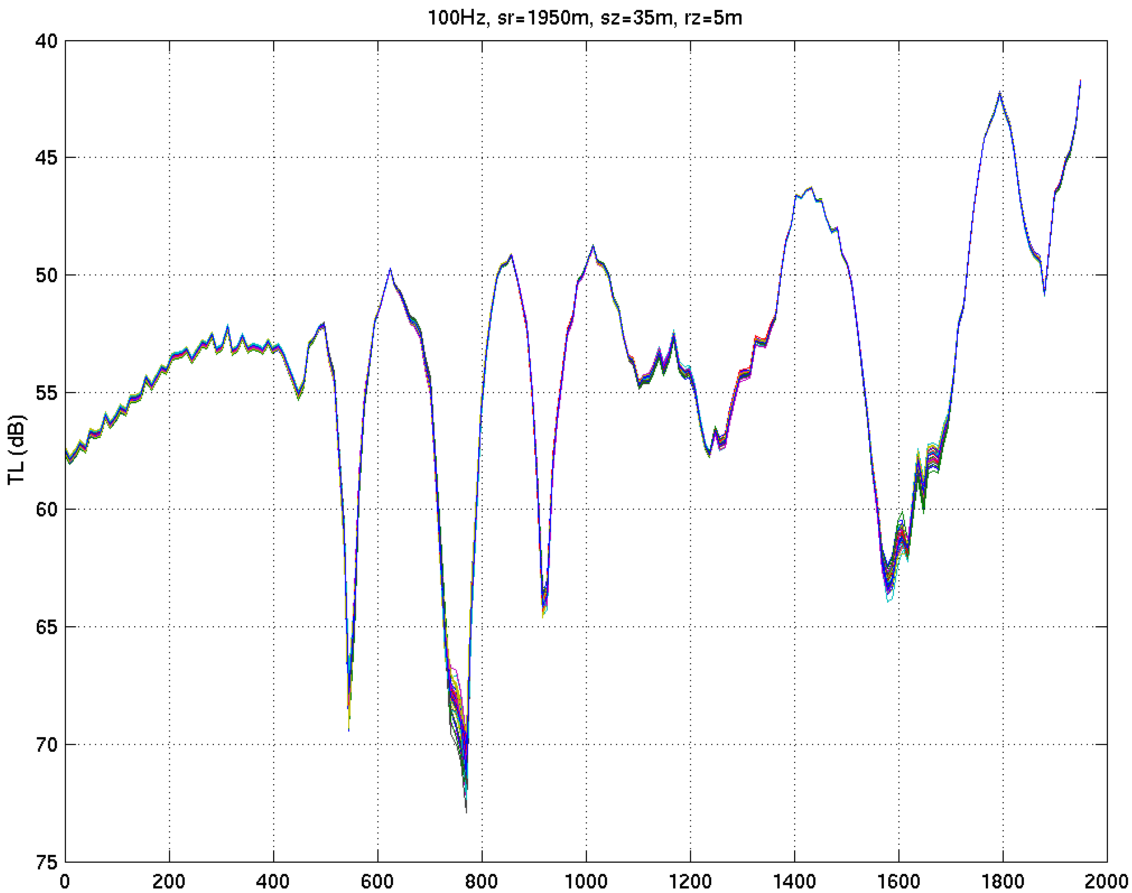

Figure 58: Morning 7/27/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat.

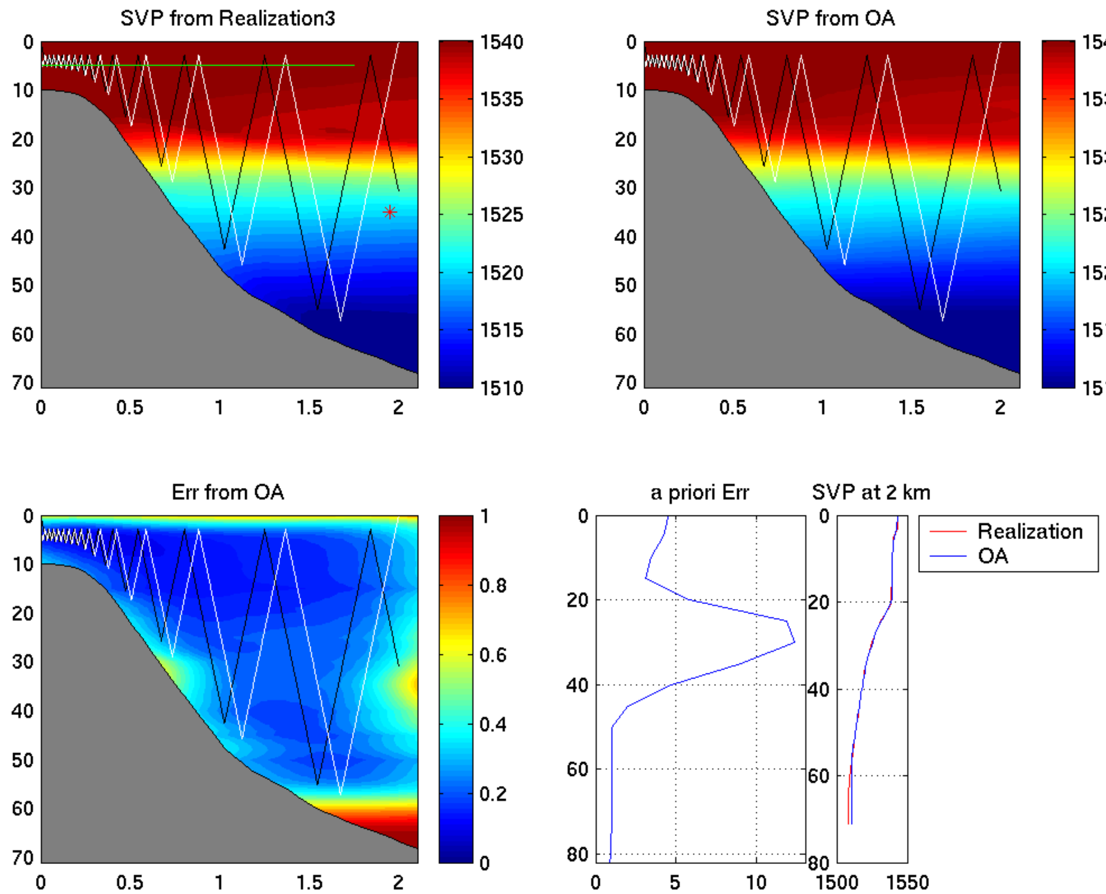

Figure 59: Yoyo control implementation. Afternoon 7/27/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

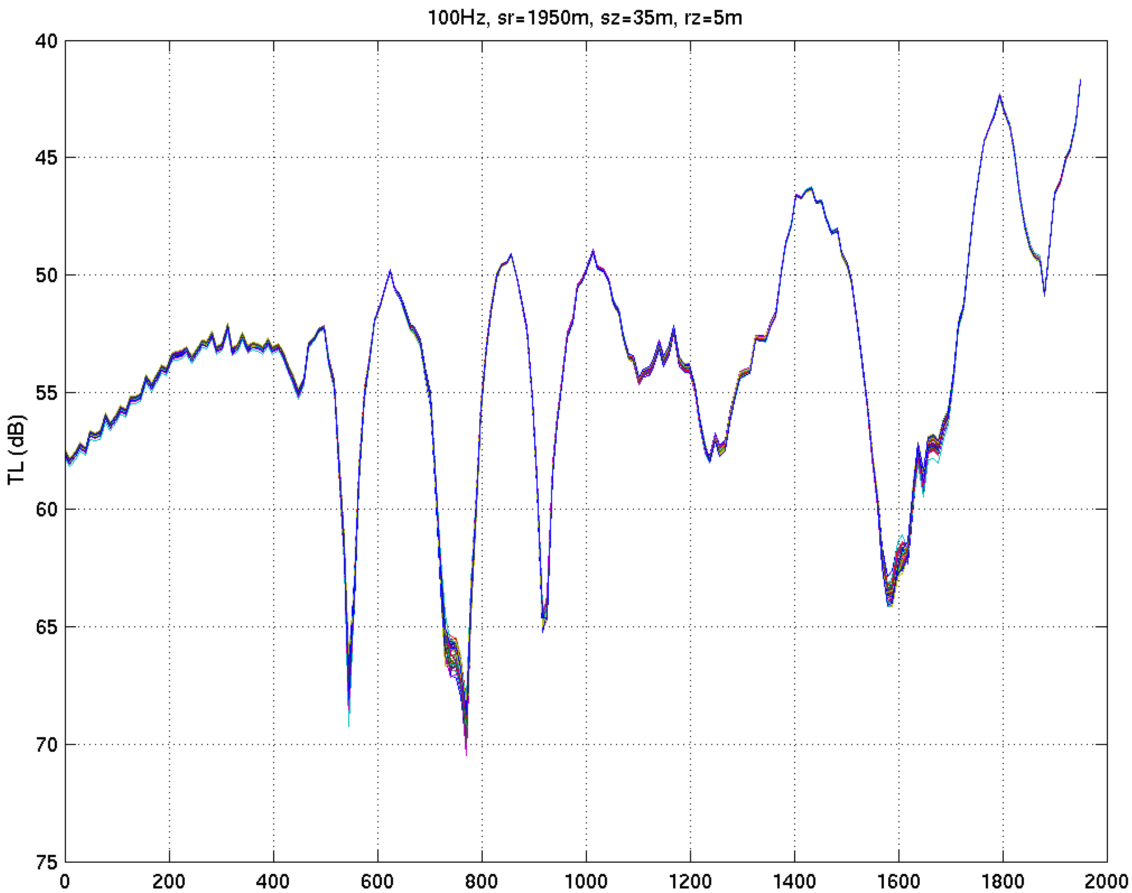

Figure 60: Afternoon 7/27/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat.

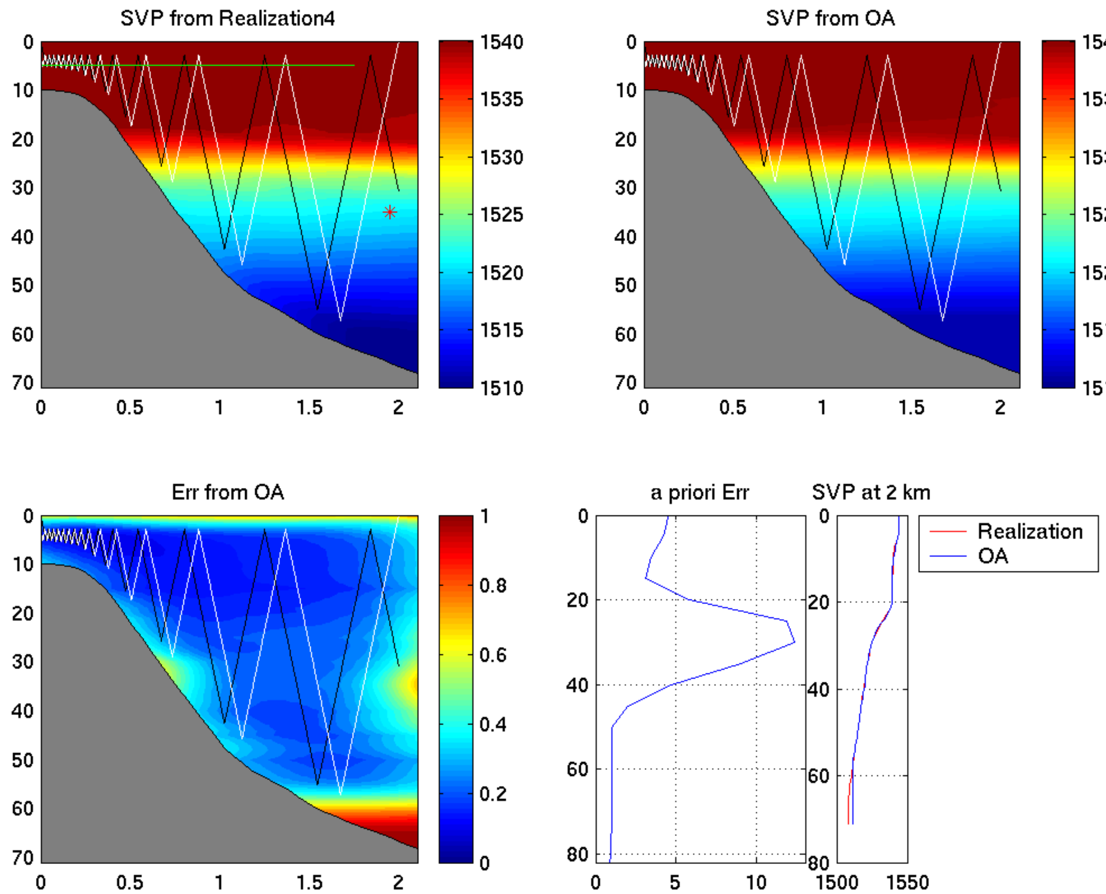

Figure 61: Yoyo control implementation. Morning 7/28/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat. Black line is the forward path; White line is the backward path. Note that to avoid bottom AUV turns around at 5 m above bottom.

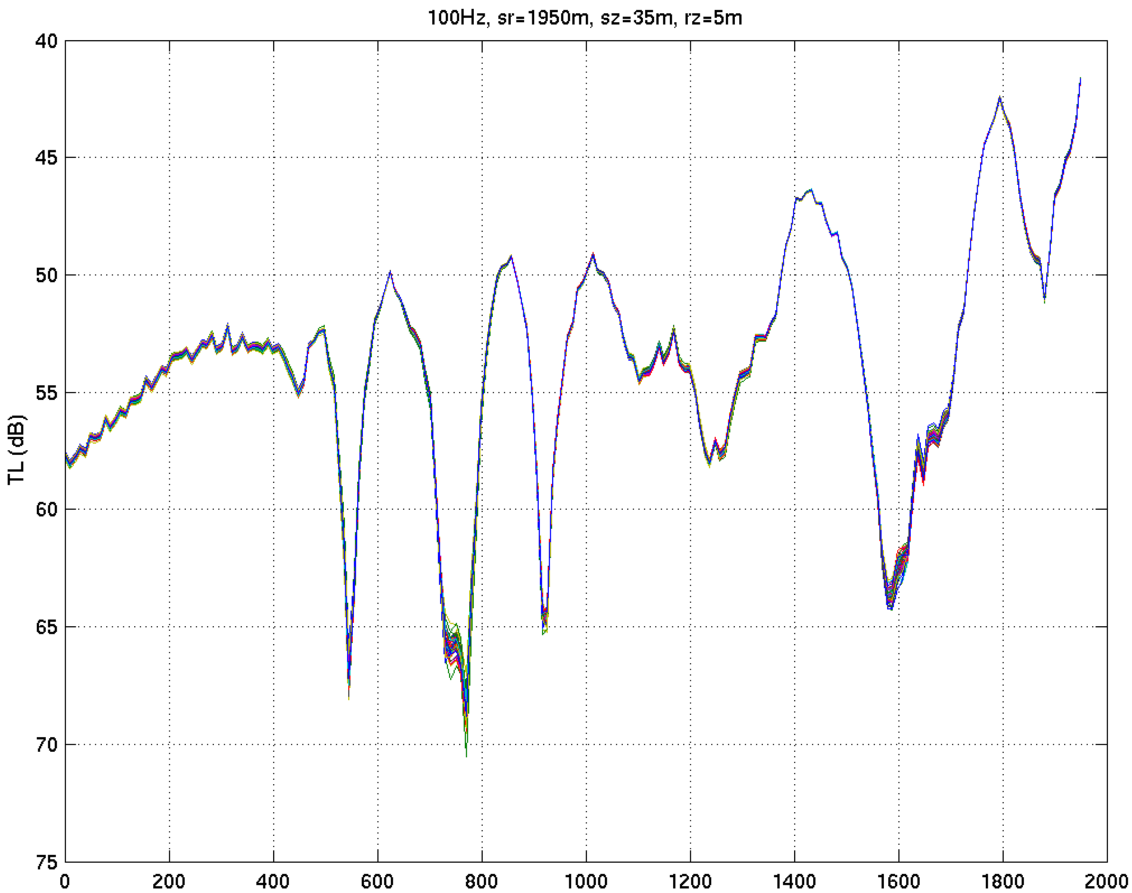

Figure 62: Morning 7/28/05. true_sound_faf05_jul26_06_day.5_2_sec1.mat.

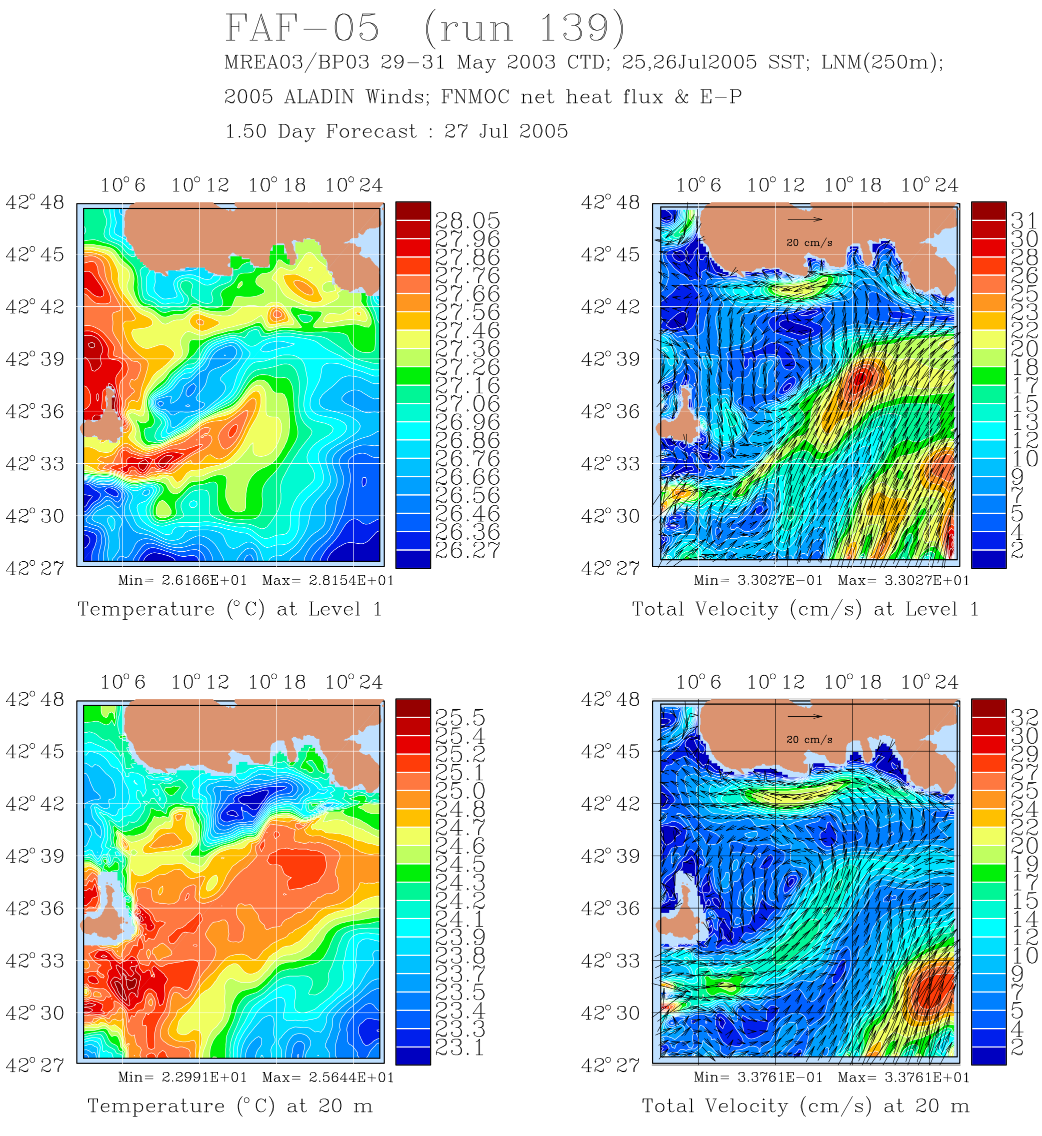

Figure 63: Temperature and current fields at 0 and 20m, for 7/27/05 afternoon. Elba area.

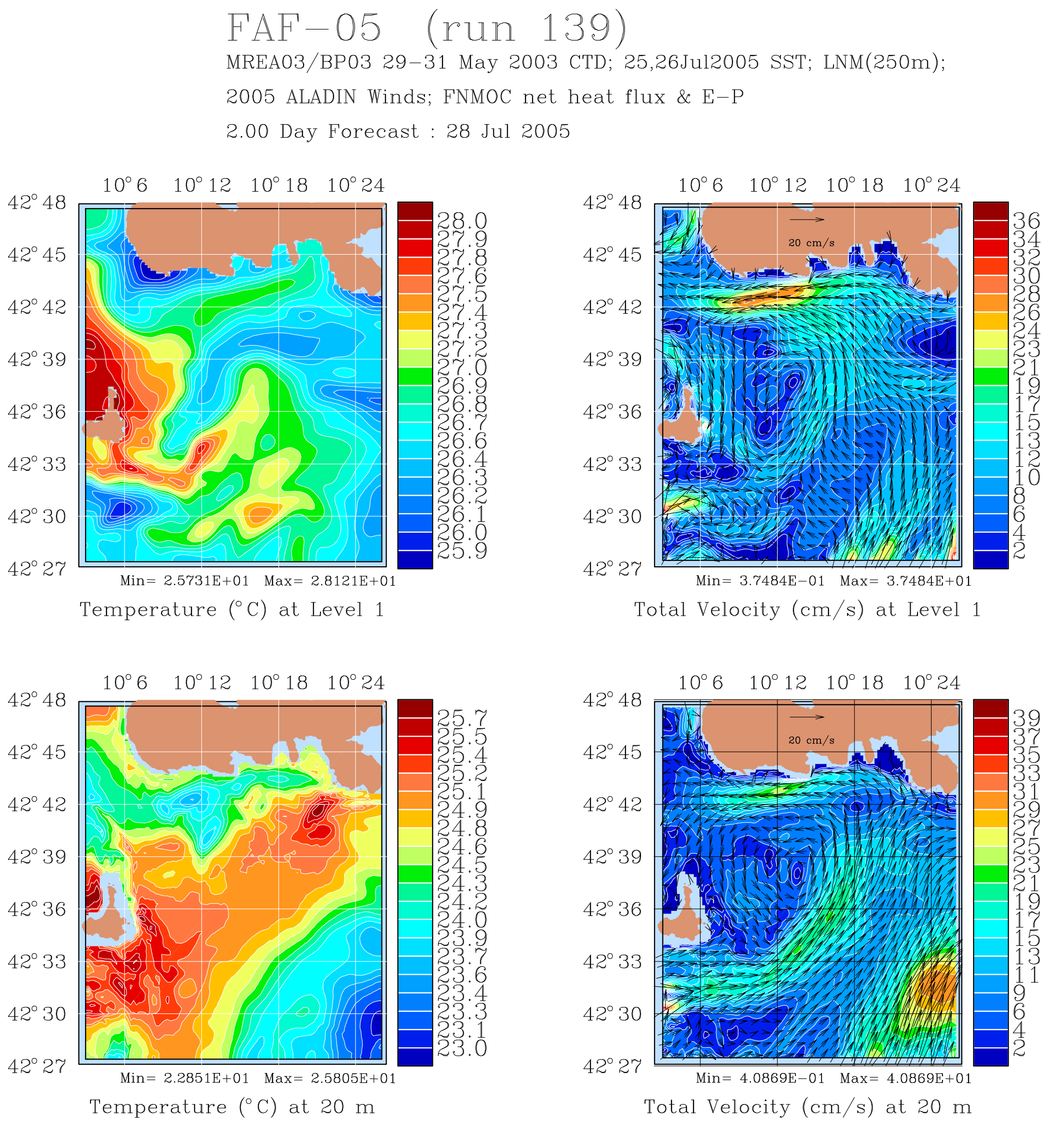

Figure 64: Temperature and current fields at 0 and 20m, for 7/28/05 morning. Elba area.