Effect of statistical analysis parameters

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Effect of statistical analysis parameters: Definitions

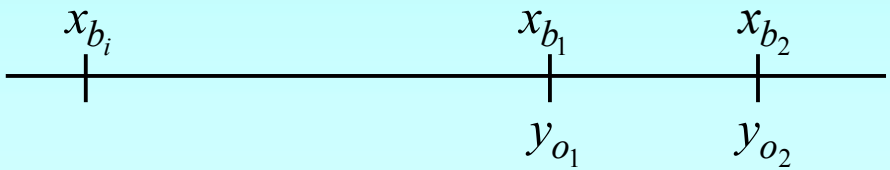
- Optimal interpolation:

$$\mathbf{x}_a = \mathbf{x}_b + \mathbf{BH}(\mathbf{HBH}^T + \mathbf{R})^{-1}(\mathbf{y}_o - \mathbf{Hx}_b)$$

$$\hat{\mathbf{A}}_{ij} = \sigma_b^2 \mu_{b_{ij}} \qquad \mu_{b_{ij}} = (1 + r_{b_{ij}} / L_b)\exp(-r_{b_{ij}} / L_b)$$

$$\mathbf{R}_{ij} = \sigma_y^2 \mu_{y_{ij}} \qquad \mu_{y_{ij}} = (1 + r_{y_{ij}} / L_y)\exp(-r_{y_{ij}} / L_y)$$

H is a simple interpolation operator



$$x_{a_i} = x_{b_i} + W[\grave{\imath}_{b_{i1}}((y_{o_1} - x_{b_1}) - C(y_{o_2} - x_{b_2})) + \grave{\imath}_{b_{i2}}((y_{o_2} - x_{b_2}) - C(y_{o_1} - x_{b_1}))]$$

$$C = \frac{(\sigma_b^2 \grave{\imath}_{b_{12}} + \sigma_y^2 \grave{\imath}_{y_{12}})}{(\sigma_b^2 + \sigma_y^2)} \qquad W = \frac{\sigma_b^2}{\sigma_b^2 + \sigma_y^2}(1 - C^2)^{-1}$$

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Effect of statistical analysis parameters: Example

- ANALYSIS_2OBS

Constructs 1-D analysis from 2 idealised obs with specified values and error characteristics

You may change the analysis parameters at the prompt, or press ENTER to retain previous values

- Current value o1 of ob#1 1.00000
- New o1 (between -2 and +2):
- Current position x1 of ob#1 4.00000
- New x1 (between 0 and 10):
- Current value o2 of ob#2 -1.00000
- New o2 (between -2 and +2):
- Current position x2 of ob#2 6.00000
- New x2 (between 0 and 10):

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Effect of statistical analysis parameters: Example

- Observation error s_y (used for both obs) 1.00000
- New s_y:

The observation error correlation depends on the distance between obs

- Current observation error correlation length L_y: 0.00000
- New L_y (put L_y = 0.0 for uncorrelated errors):
- Background error s_b (constant) 1.00000
- New s_b:
- Background error correlation length L_b 2.00000
- New L_b (put L_b = 0.0 for uncorrelated errors):

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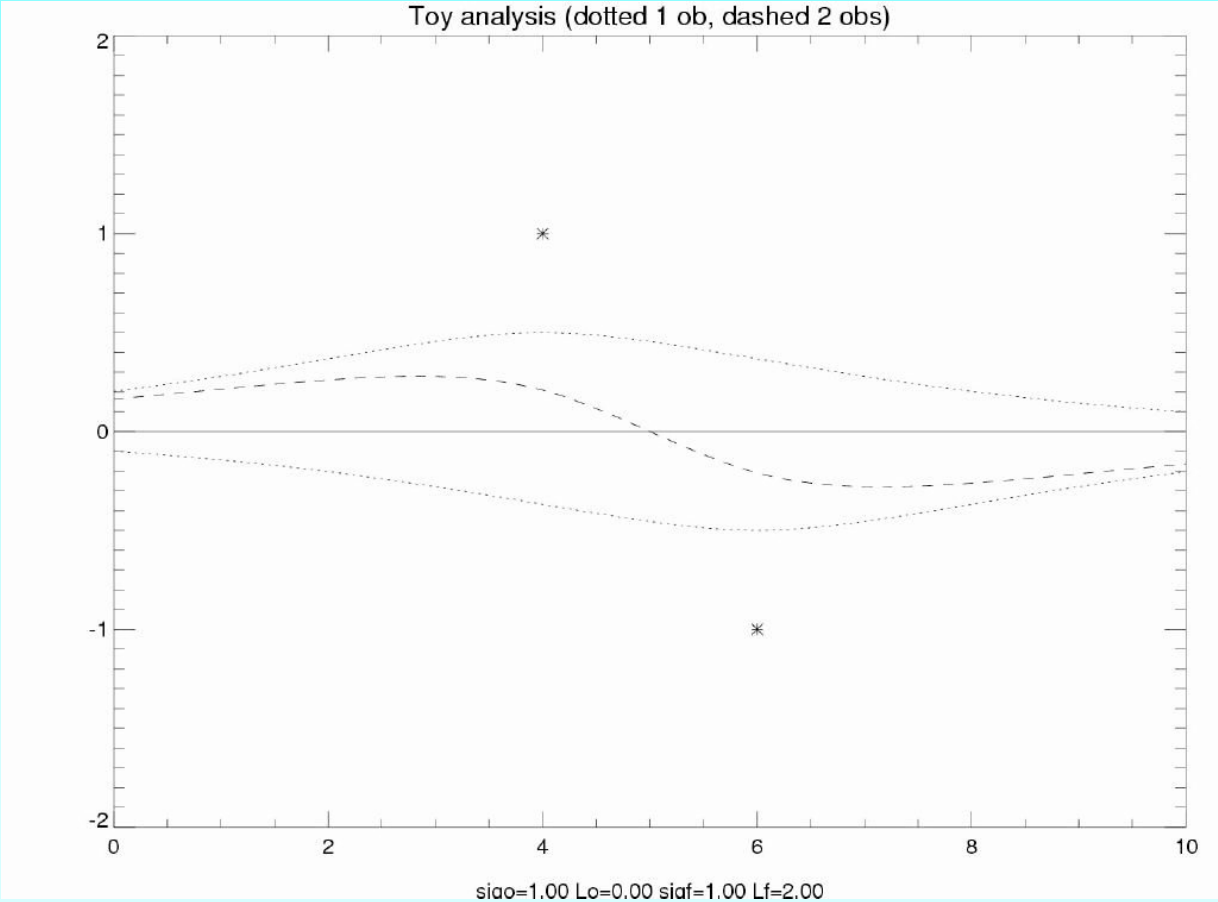
Effect of statistical analysis parameters: Example



Effect of statistical analysis parameters: Example

- ANALYSIS_MOBS

Constructs 1-D analysis from multiple idealised obs with specified values and error characteristics

- In this programme, we use two different ob types (A and B).
- The number of obs of each type should be in range 0 to 7.
- Press ENTER to retain previous values

- You may specify two separate observation types (A and B)
- Different observation types have different e characteristics

Effect of statistical analysis parameters: Example

- TYPE-A OBSERVATIONS
- Number of type A obs, noa: 3
- New noa (up to 7; 0 if none):
- Current type A ob locations 5.00000 4.00000 6.00000
- Current type A ob values 1.00000 1.00000 1.00000
- Do you want to change them (y or n)? n
- New type-A ob locations 5.00000 4.00000 6.00000
- New type-A ob values 1.00000 1.00000 1.00000
- Observation error for type A, s_{yA} : 2.00000
- Observation error correlation length L_{yA}: 0.00000

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Effect of statistical analysis parameters: Example

- TYPE-B OBSERVATIONS
- Number of type B obs, nob: 3
- New nob (up to 7; 0 if none):
- Current type-B ob locations 5.00000 6.00000 4.00000
- Current type-B ob values -1.00000 -1.00000 -1.00000
- Do you want to change them (y or n)? n
- New type-B ob locations 5.00000 6.00000 4.00000
- New type-B ob values -1.00000 -1.00000 -1.00000
- Observation error for type B, s_{yB} 1.00000
- Observation error correlation length L_{yB} 2.00000
- BACKGROUND ("FORECAST") ERROR STATISTICS
- Background error s_b (constant) 1.00000

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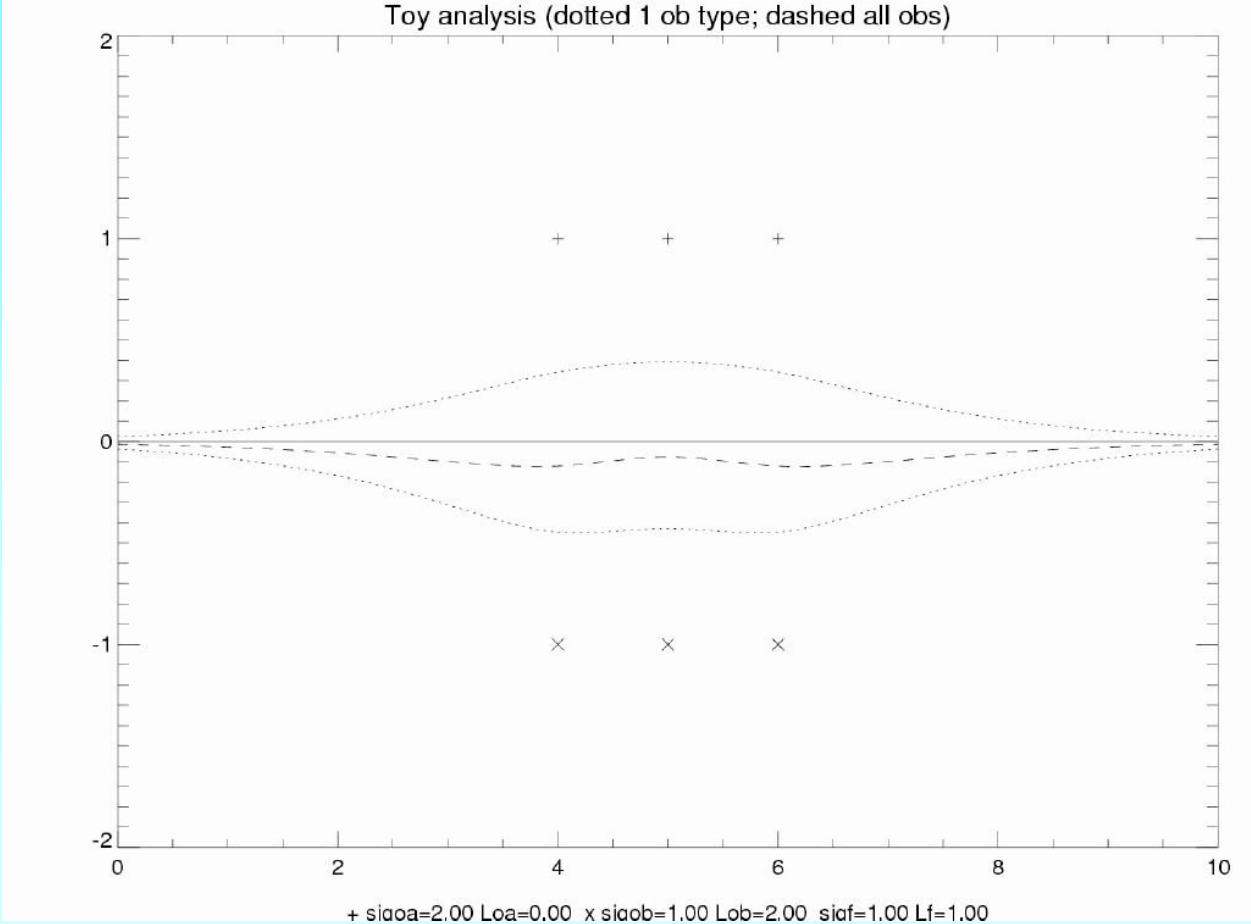
Effect of statistical analysis parameters: Example



Effect of statistical analysis parameters: Example

- ANALYSIS_SIM - Toy Analysis System
- Constructs 1-D analysis from simulated truth, forecast and observations with specified values and error characteristics
- You may change parameters, or just press ENTER to keep existing values
- The truth field is one of the following:
- 0 - zero everywhere
- 1 - pseudo step function
- 2 - sum of several sinusoidal curves
- 3 - statistically generated

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- Current truth type: 0

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Effect of statistical analysis parameters: Example

- BACKGROUND FIELD
- You may use a background field that is shifted relative to the "truth"
- OR a background equal to truth + random perturbation
- Current amount of background shift (positive on left): 0.00000
- New shift:
- Current background error, s_b: 2.00000
- New s_b:
- Background error correlation length L_y 2.00000
- New L_y (put L_y = 0.0 for uncorrelated errors):

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Effect of statistical analysis parameters: Example

- OBSERVATIONS
- Number of obs, no: 5
- New no (up to 11):
- Current ob locations 5.00000 6.00000 4.00000 7.00000 3.00000
- Do you want to change them (y or n)? n
- Current observation error, s_y: 1.00000
- New s_y:
- Observation error correlation length L_y: 0.00000
- New L_y (0.0 for uncorrelated errors):

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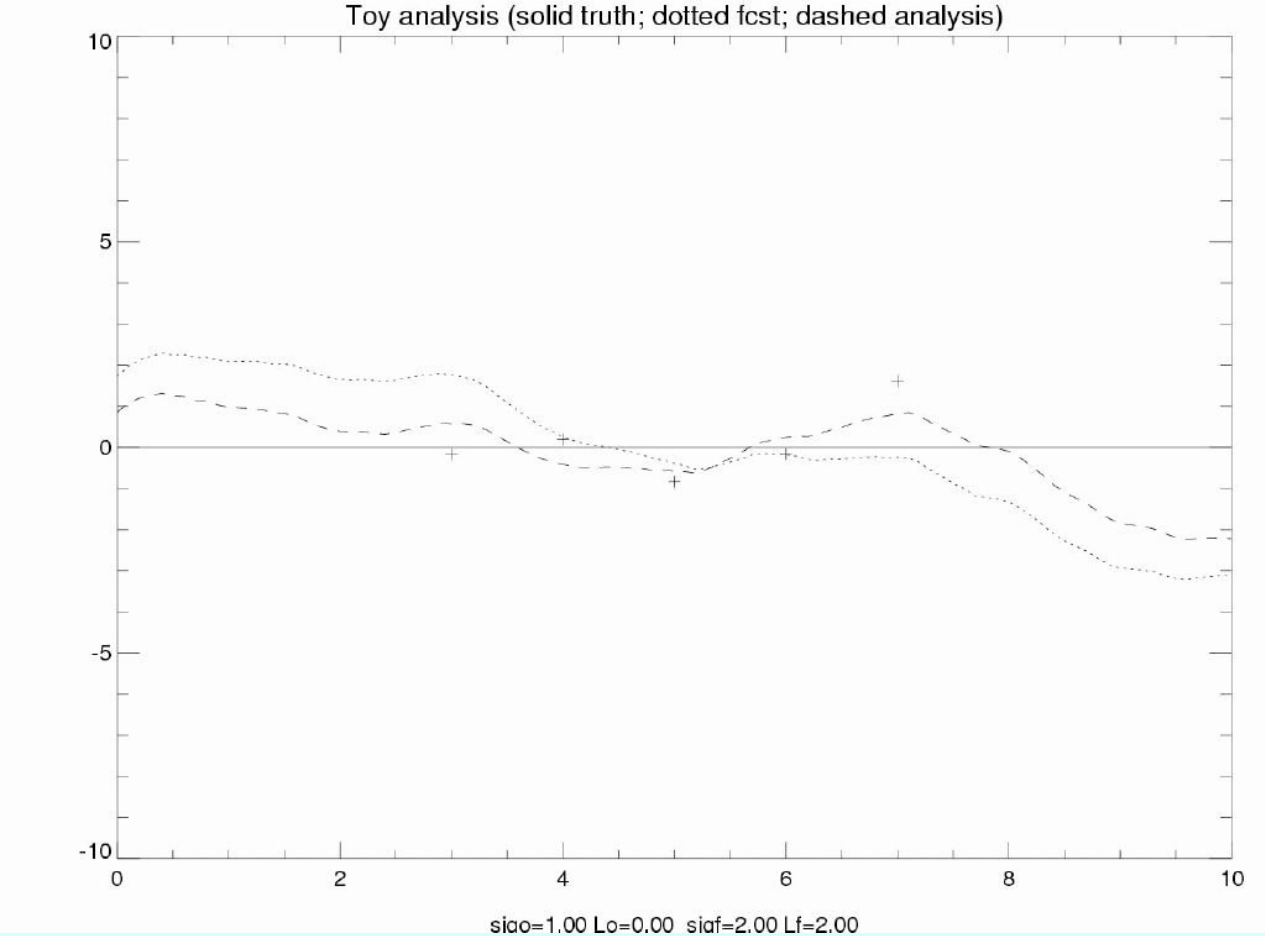
Effect of statistical analysis parameters: Example



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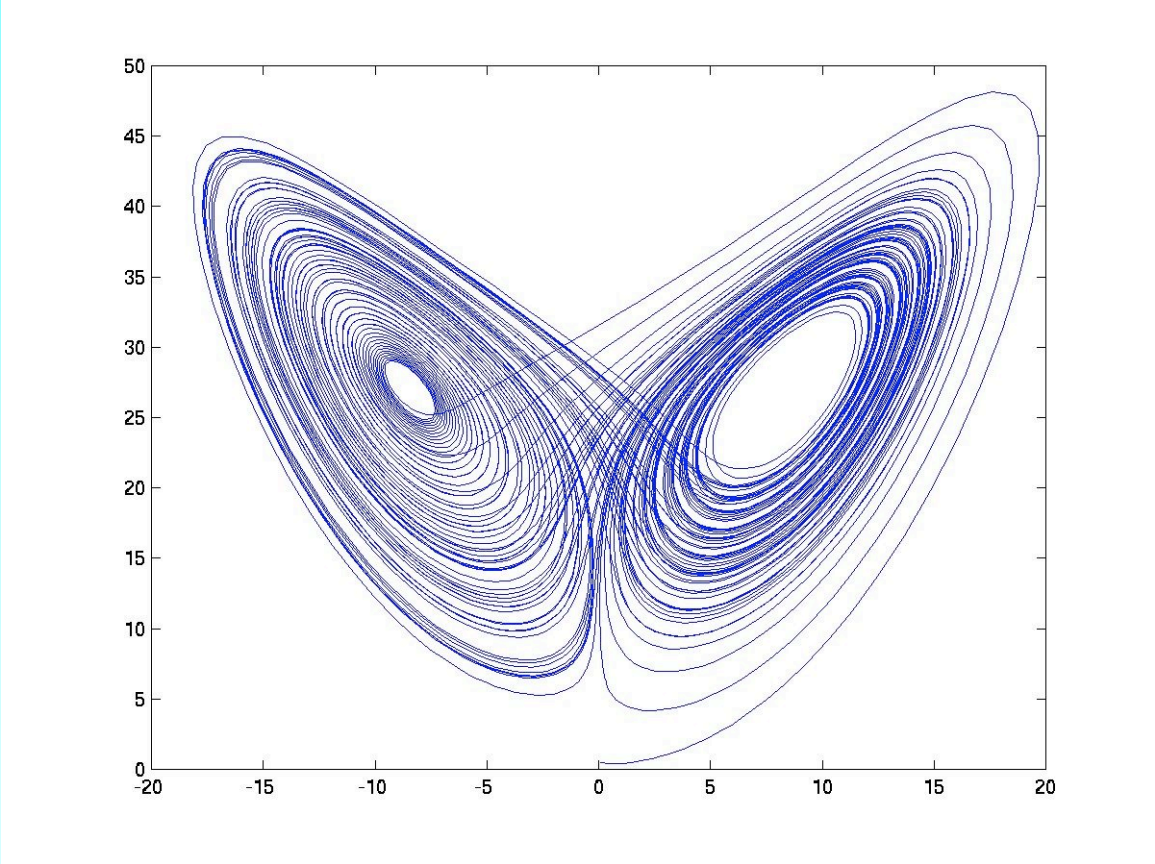
Lorenz equations: Sequential DA



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Lorenz equations: Sequential DA

- You will use the program *lorenz_menu* in the directory *lorenz/sequential.*
- You can experiment with four different sequential DA schemes
- Successive correction
- Analysis correction
- Optimal interpolation
- Kalman filter

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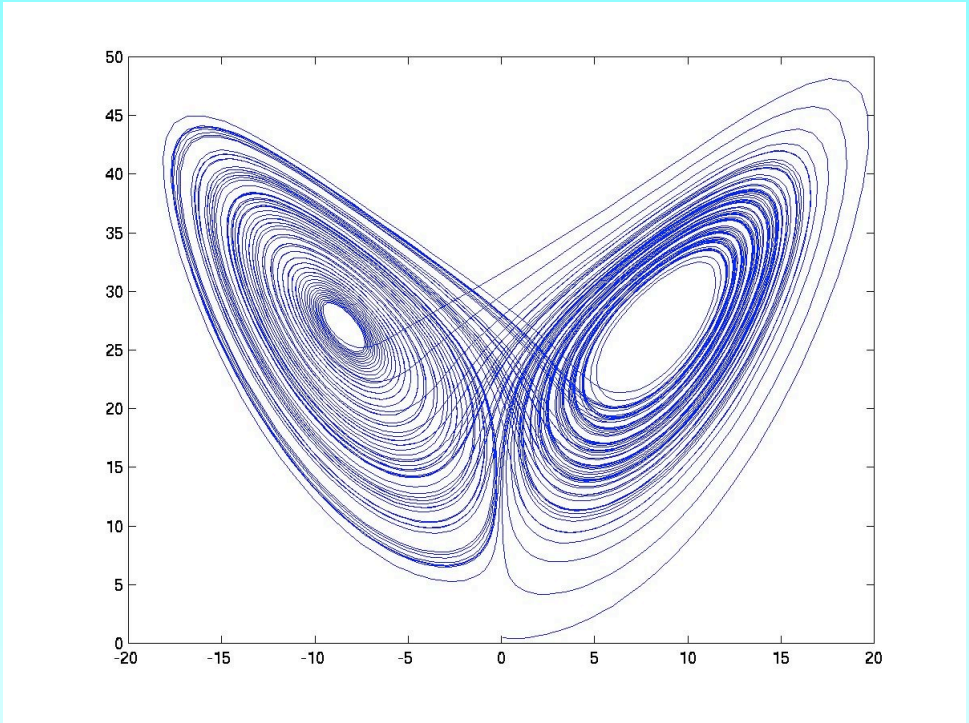
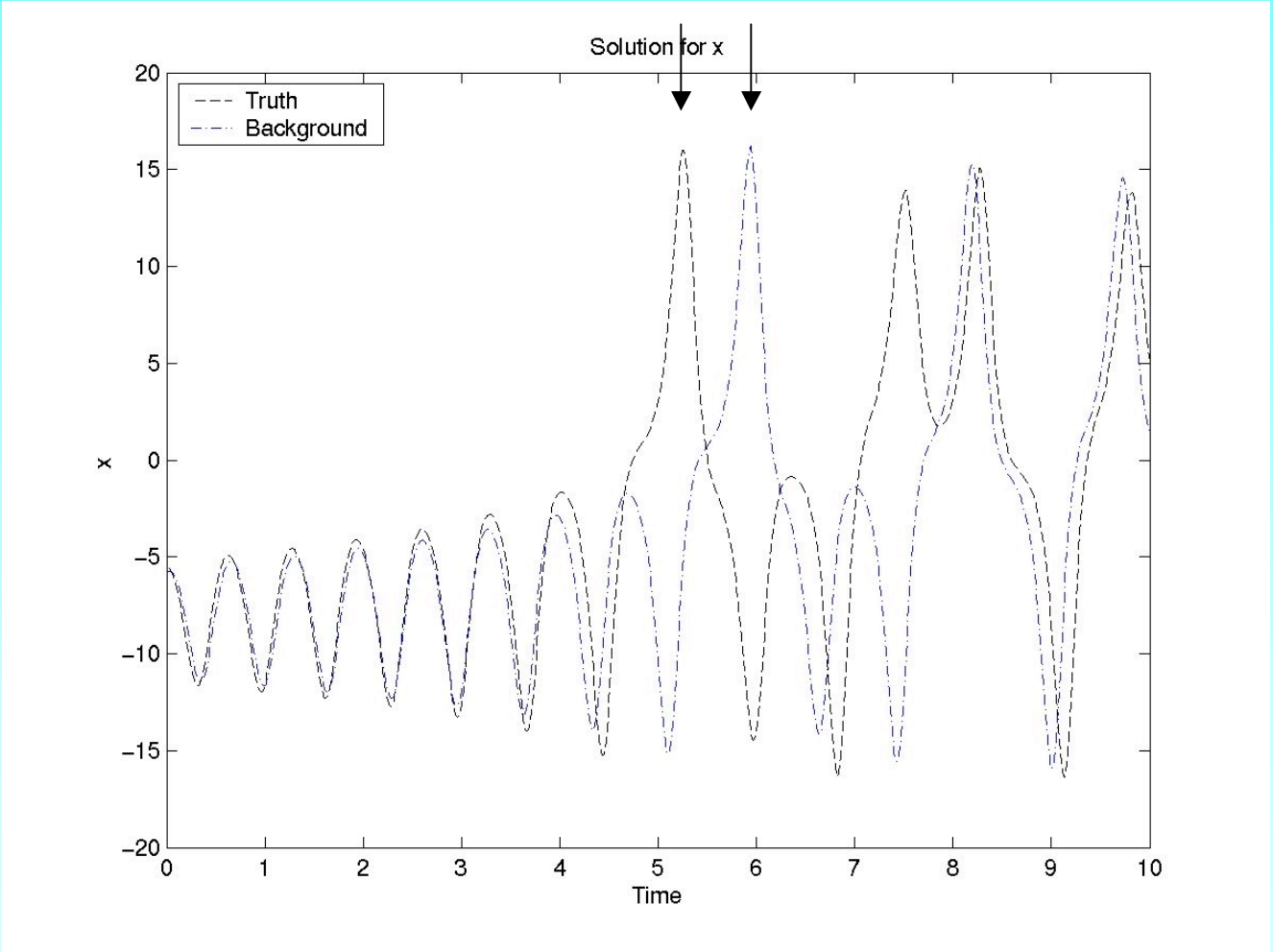
You can choose various parameters:

- Iterations
- Correct/ incorrect covariance matrices
- Frequency of observations
- Noise on observations

You are provided with a case in which the change in regime in the background occurs later than in the truth



Truth and background conditions



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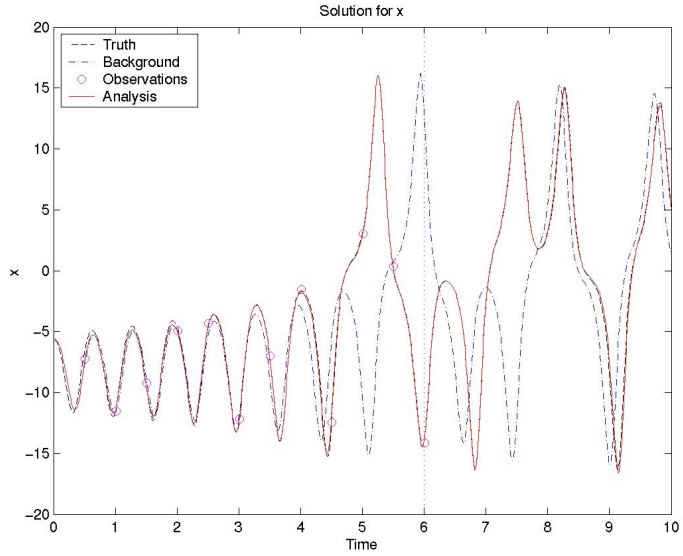

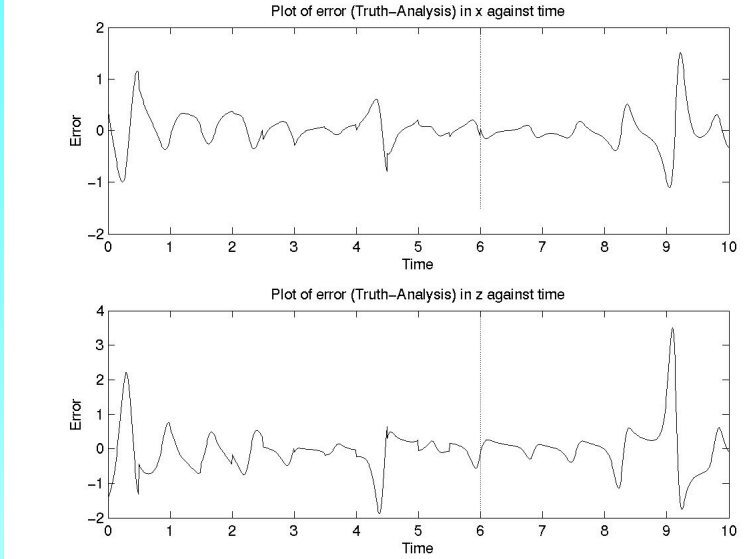

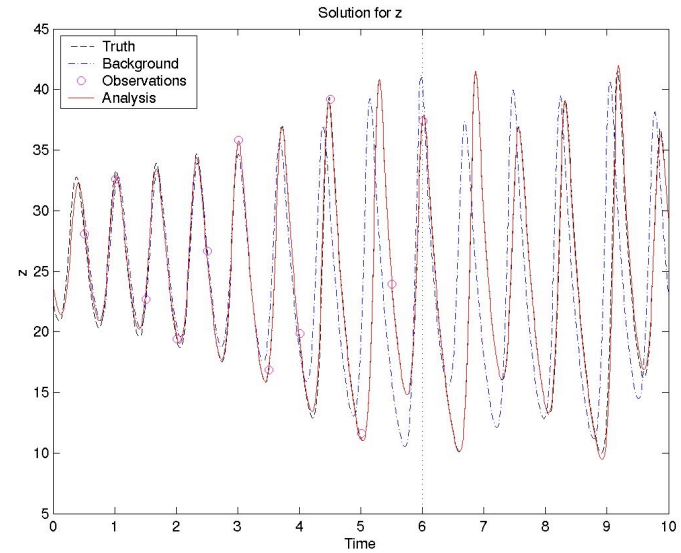

List of options chosen

Analysis scheme: Successive correction
Number of iterations: 1
Time steps between observations: 50
Observations have random noise with variance 0.1
Noise generated in program and saved to file

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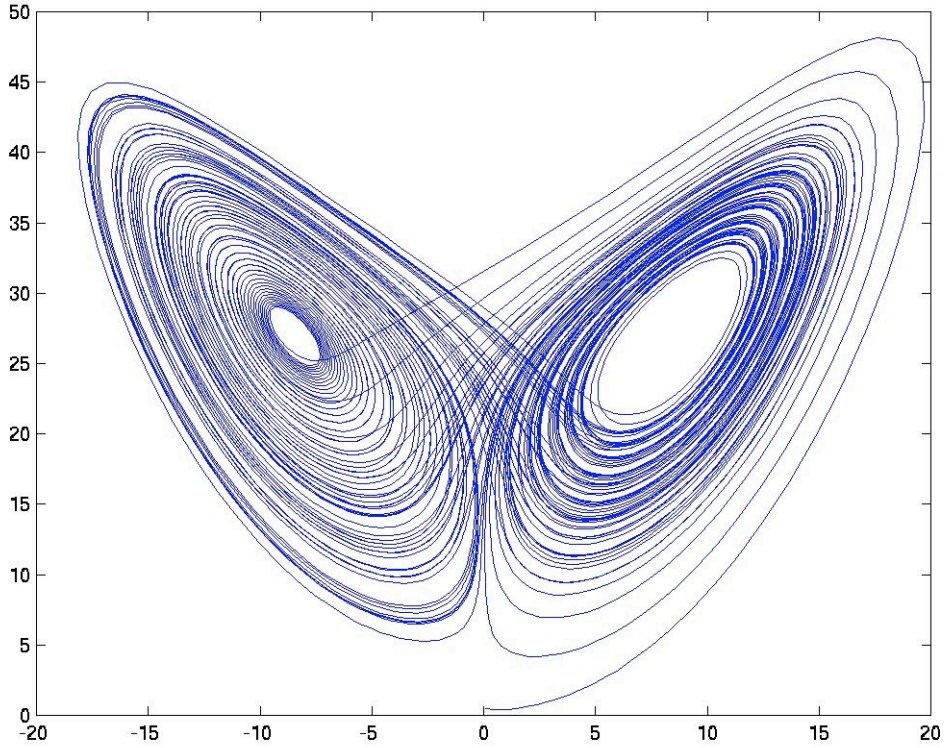
Lorenz equations: 4D-Var



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Lorenz equations: 4D-Var

- In the directory *lorenz/var* you have various programs related to 4D-Var.

- The first set of exercises allow you to understand how a 4D-Var system is tested, by running tests of
- Tangent linear model
- Adjoint model
- Gradient of cost funtion

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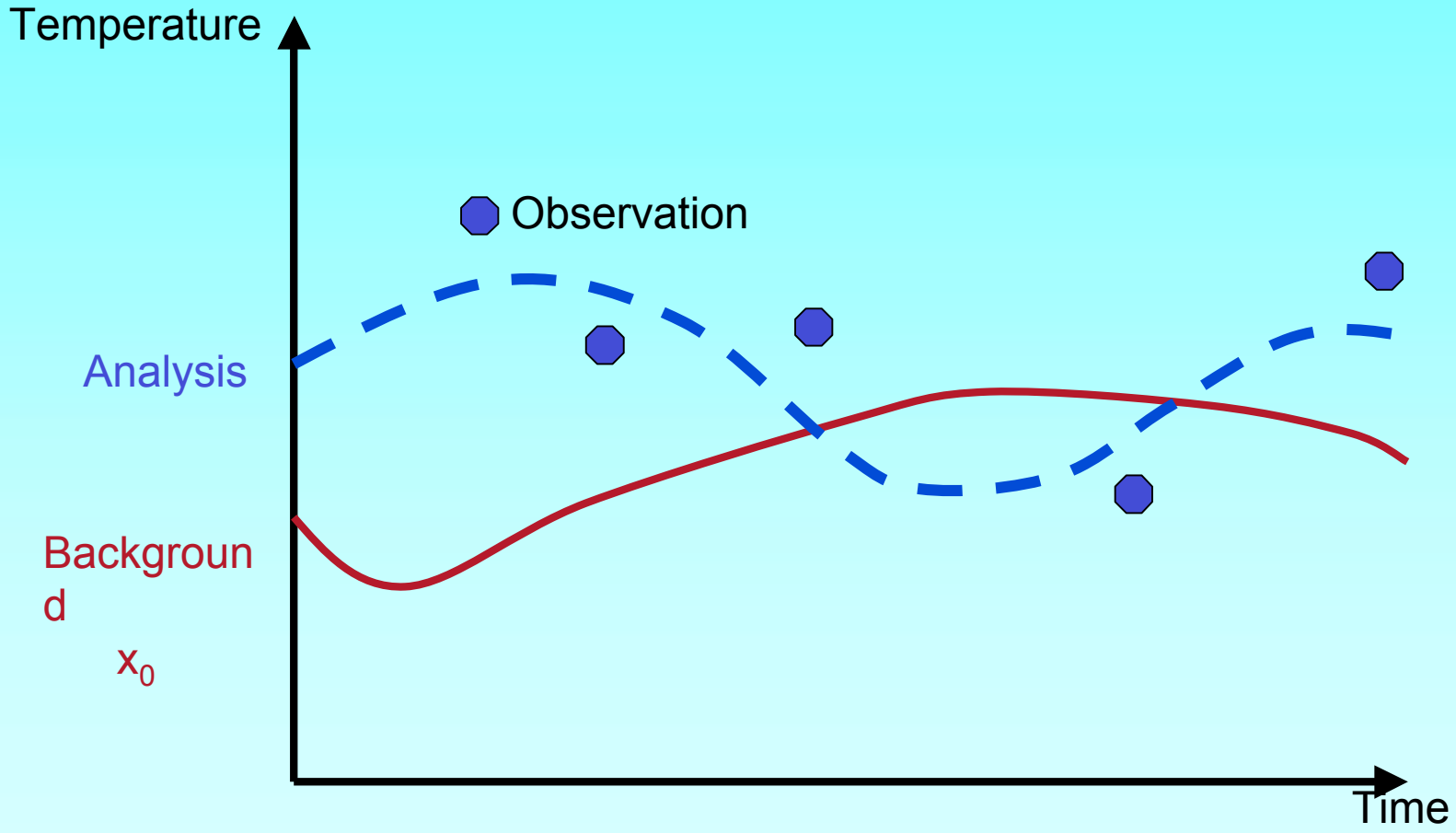
- You can then run two types of 4D-Var
- Full 4D-Var
- Incremental 4D-Var

- Start by using the parameters in the documentation and then try changing them to see the effect on the analysis.

Full 4D-Var



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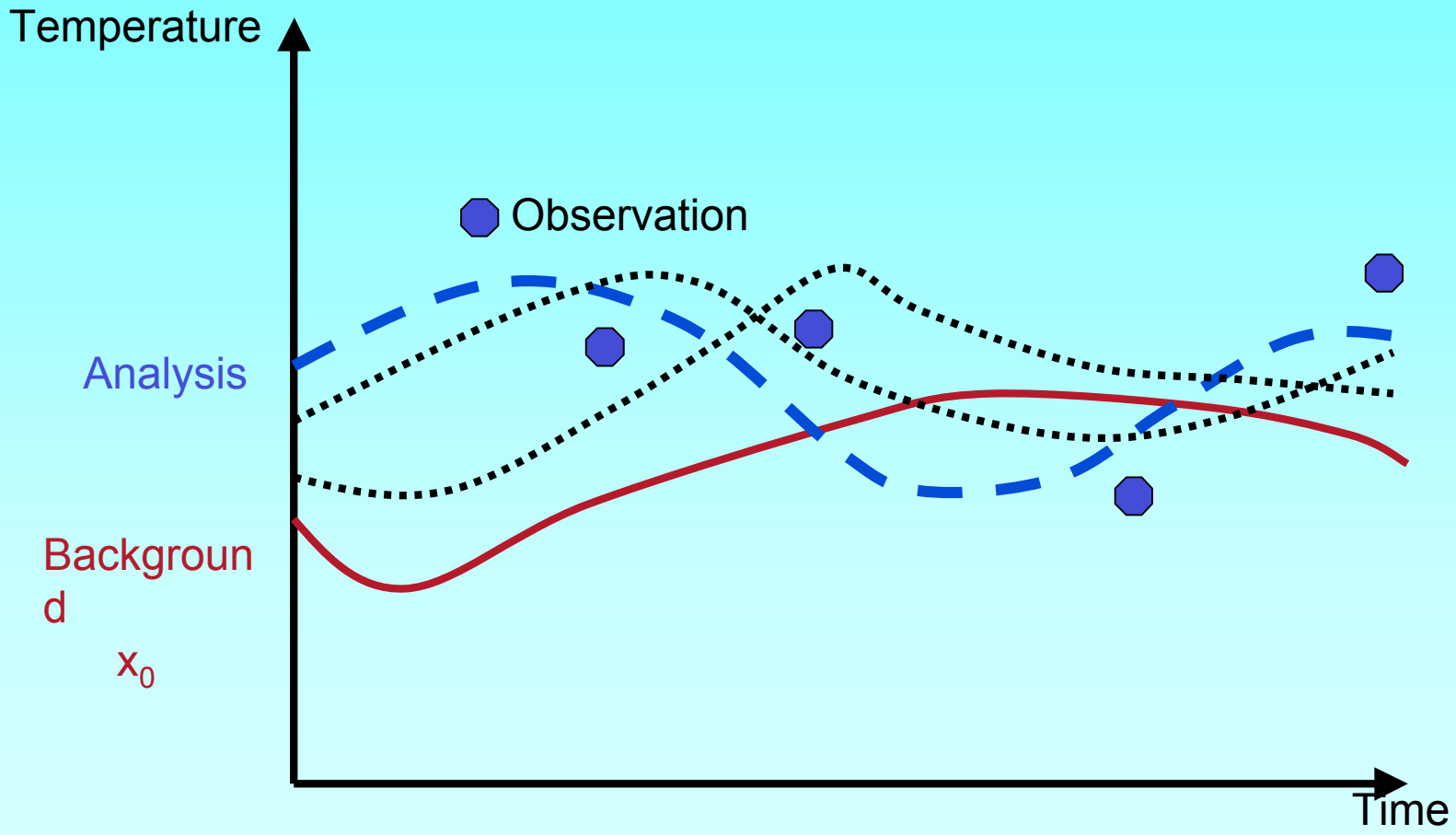
Incremental 4D-Var



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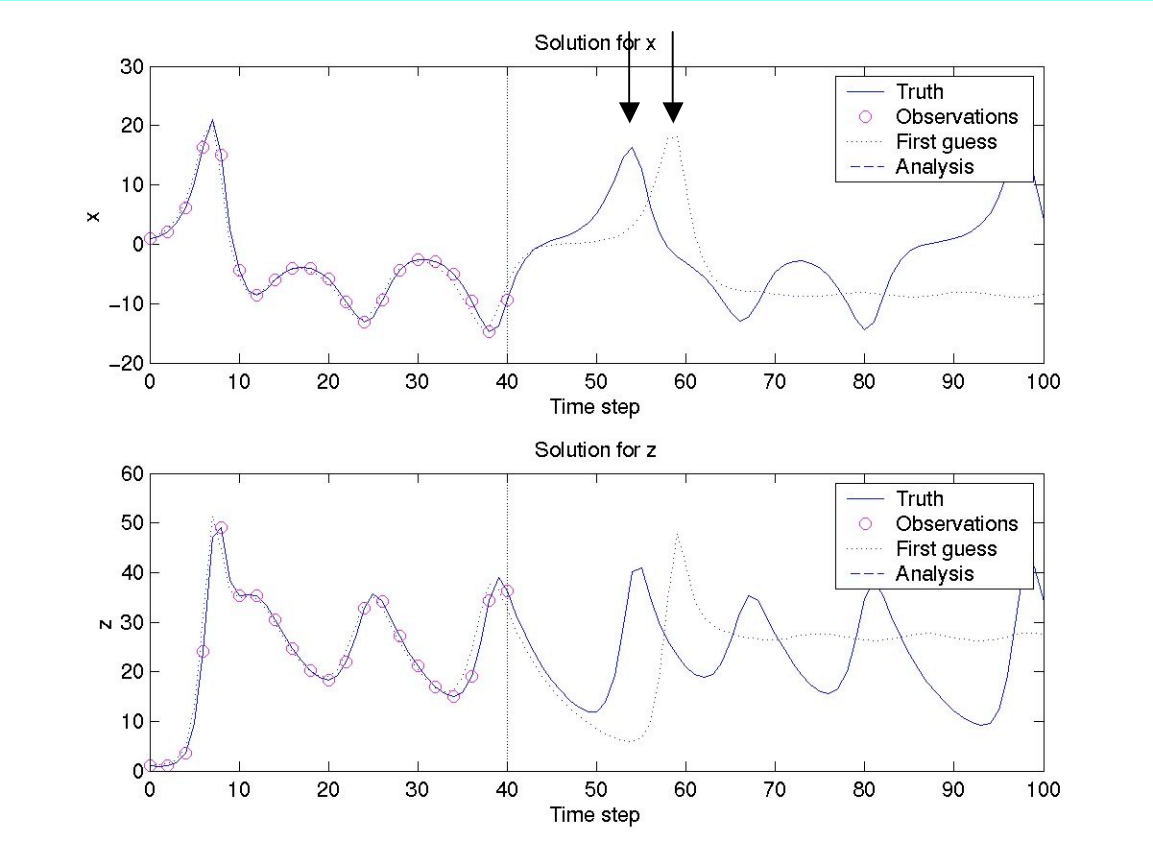
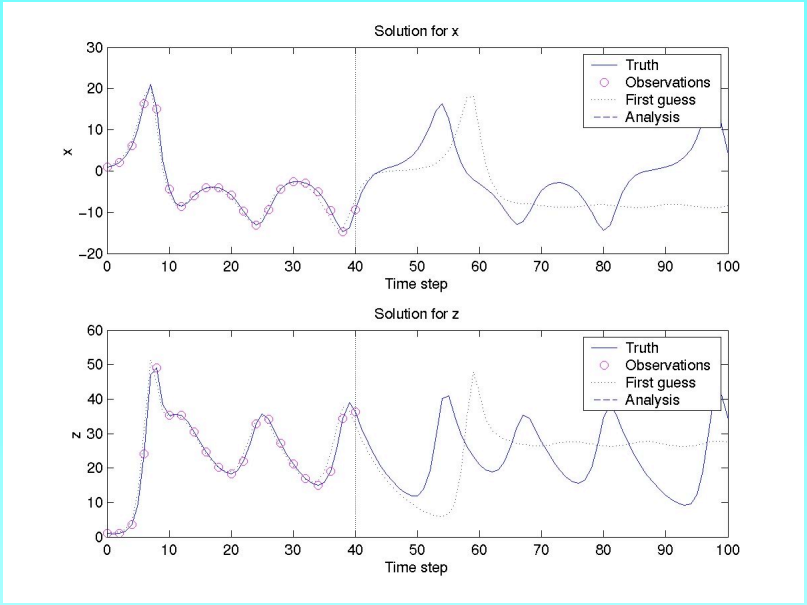
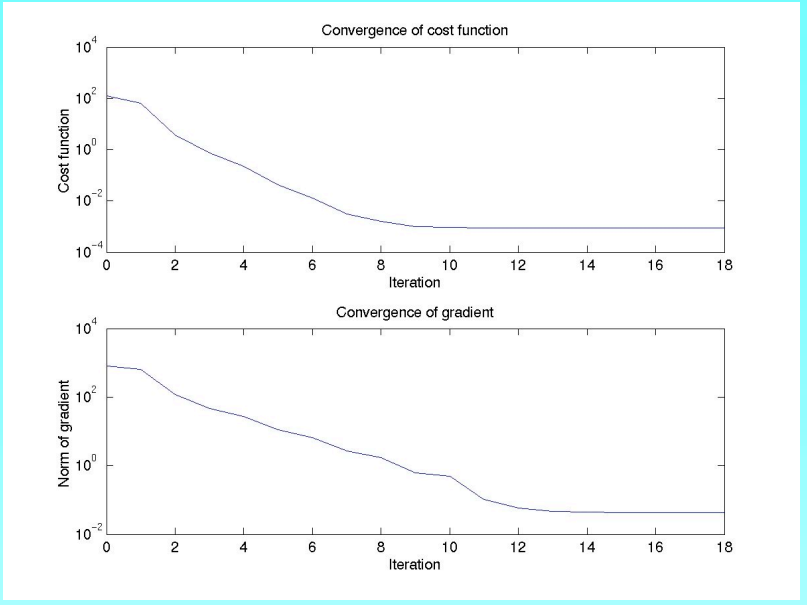
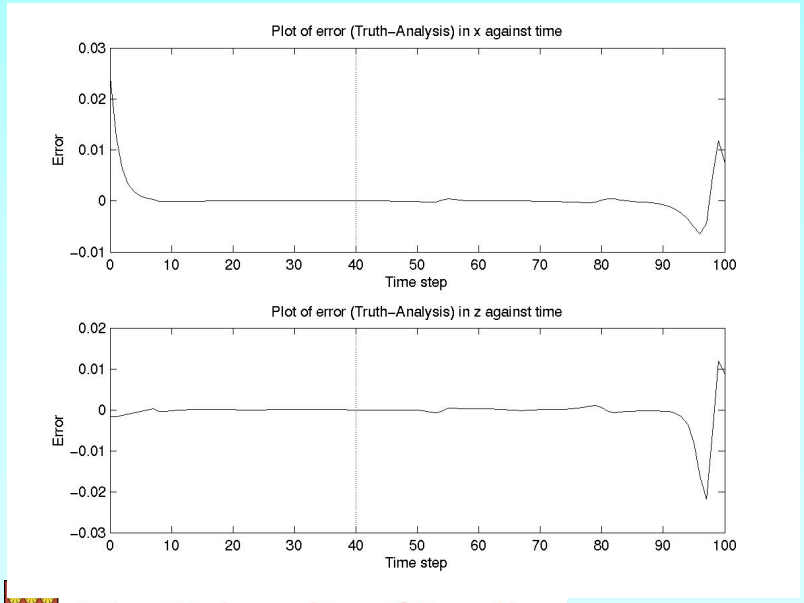
For this case a change of regime occurs towards the start of the forecast and is too late in the background









List of options chosen

True (x,y,z) at t=0: (1,1,1)
First guess (x,y,z) at t=0: (1.2,1.2,1.2)
Length of assimilation window: 2
Length of subsequent forecast: 3
Time step: .05
Frequency of observations = 2
Maximum iterations: 30
Tolerance: 1d−5
No noise on observations

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