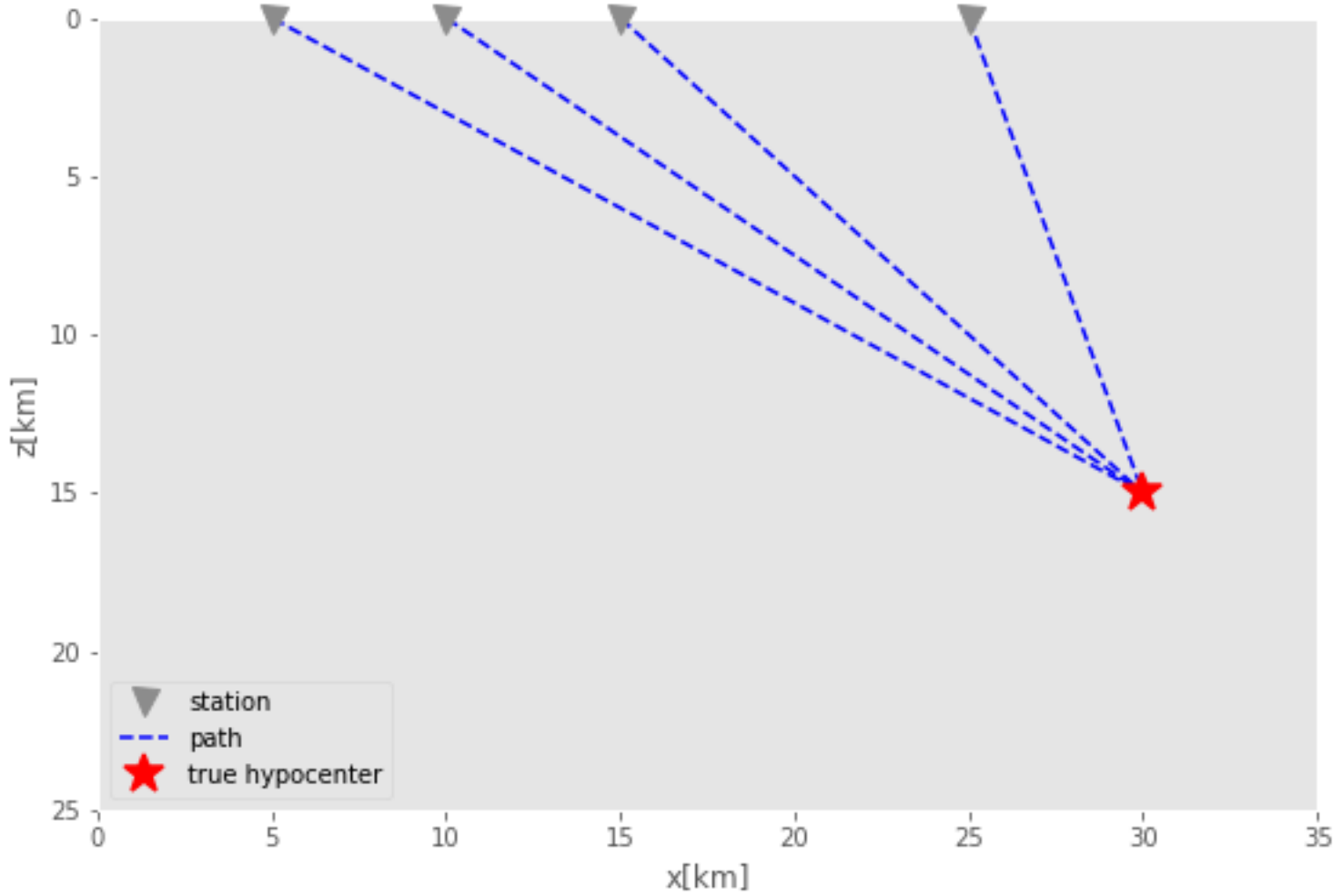
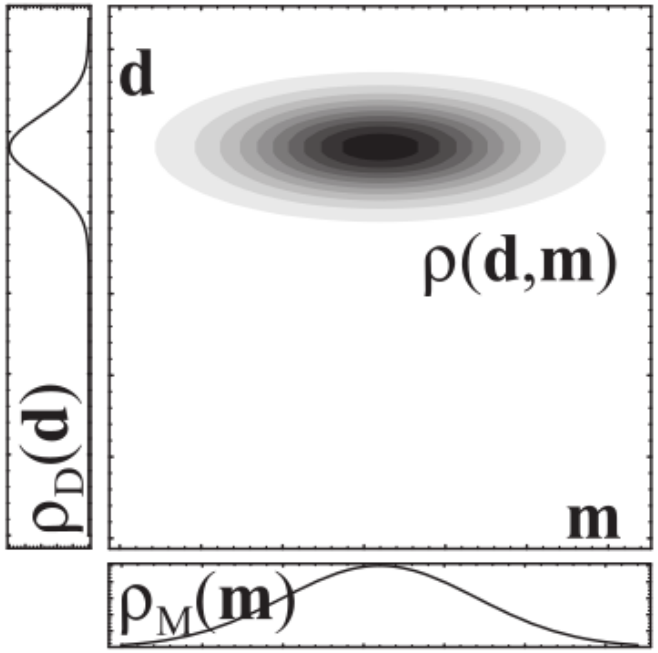
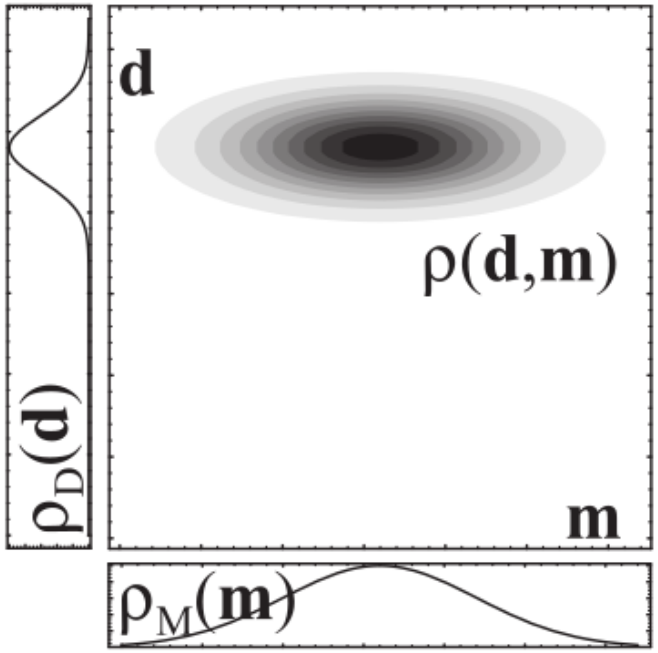
Jupyter Notebooks

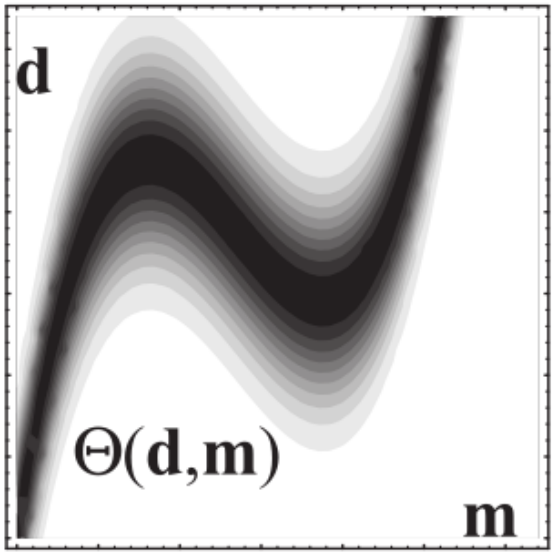
Probabilistic estimation of a hypocenter

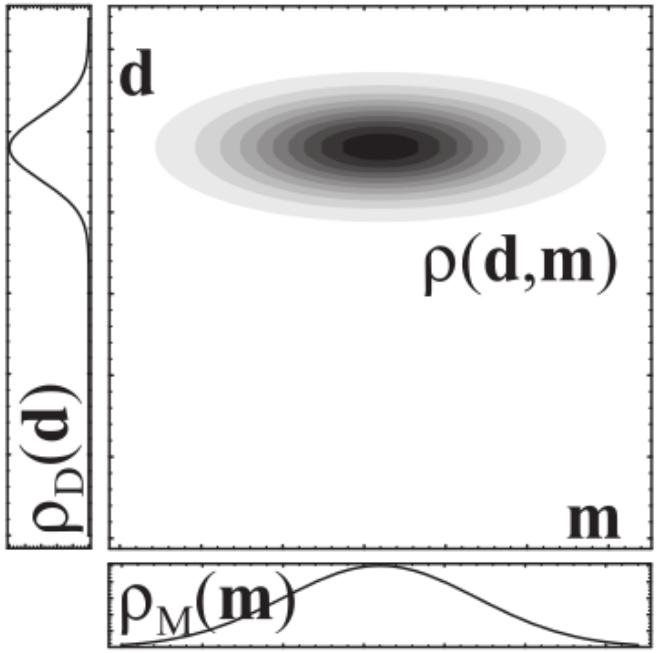


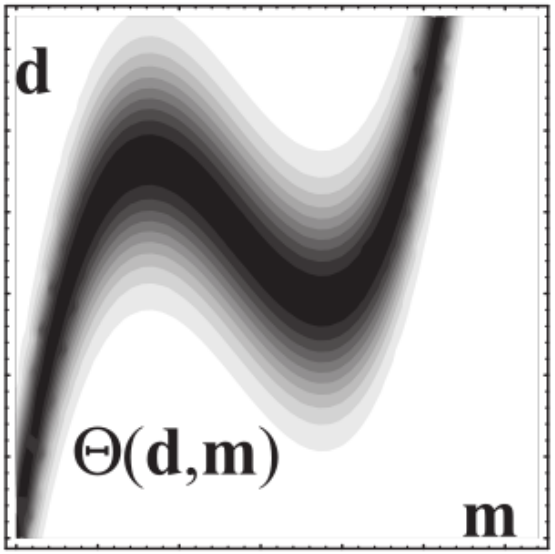


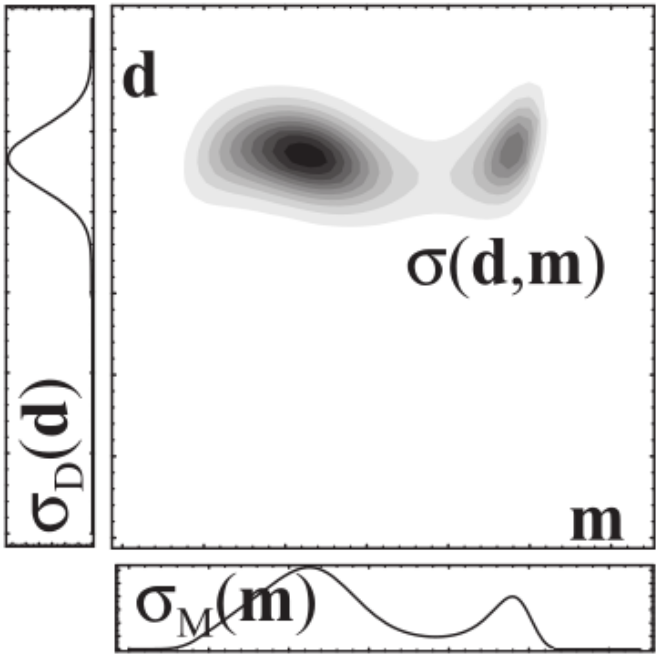
A priori information: obtained independently of the results of measurements


d
ρ(d,m)
m
ρD(d)
ρM(m)


d
Θ(d,m)
m





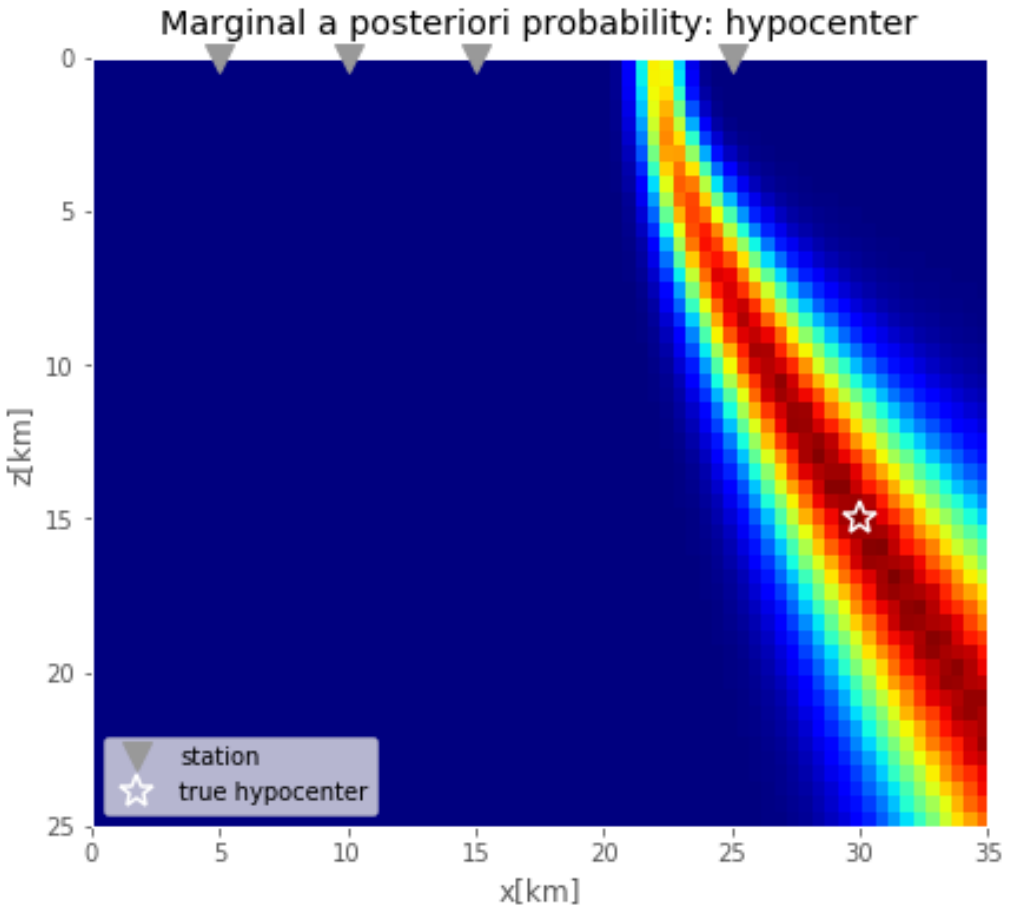


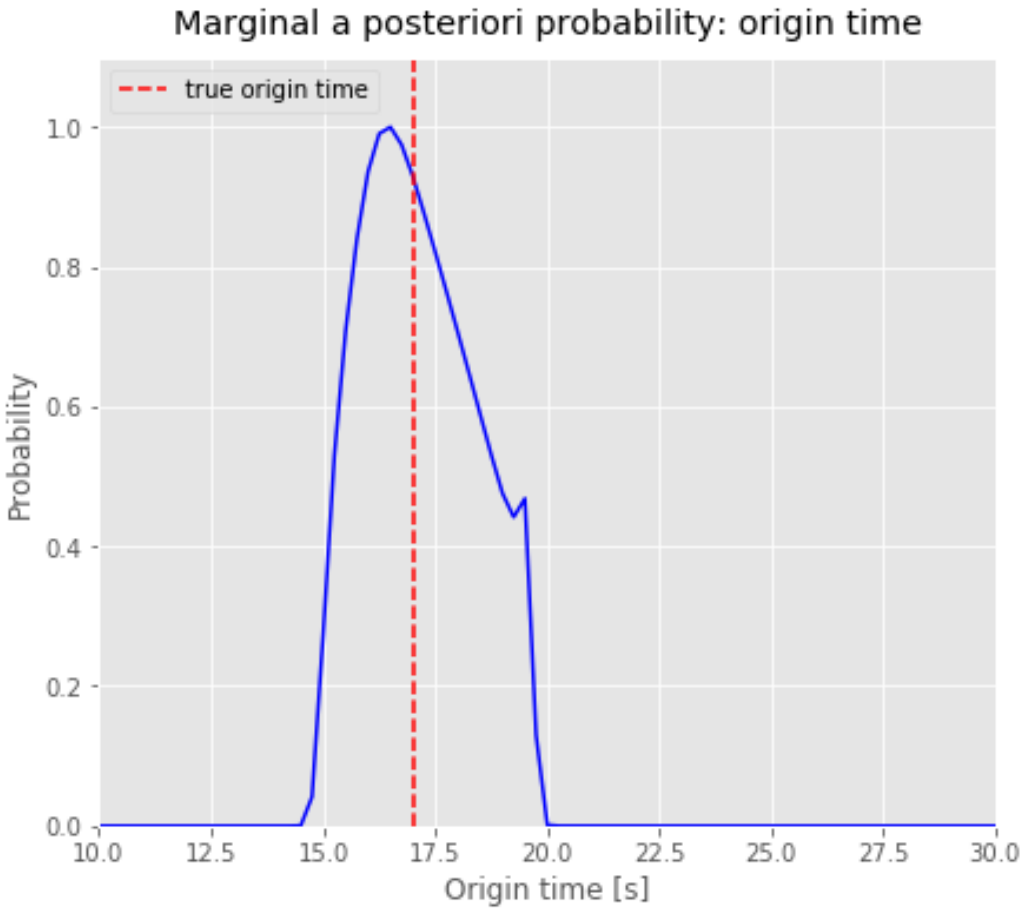
A posteriori probability density:

$$\sigma(\mathbf{d},\mathbf{m}) = k\,\frac{\rho(\mathbf{d},\mathbf{m})\;\Theta(\mathbf{d},\mathbf{m})}{\mu(\mathbf{d},\mathbf{m})}$$

Solution of the Inverse Problem

→ Calculation of a posteriori pdf for **293301 samples**

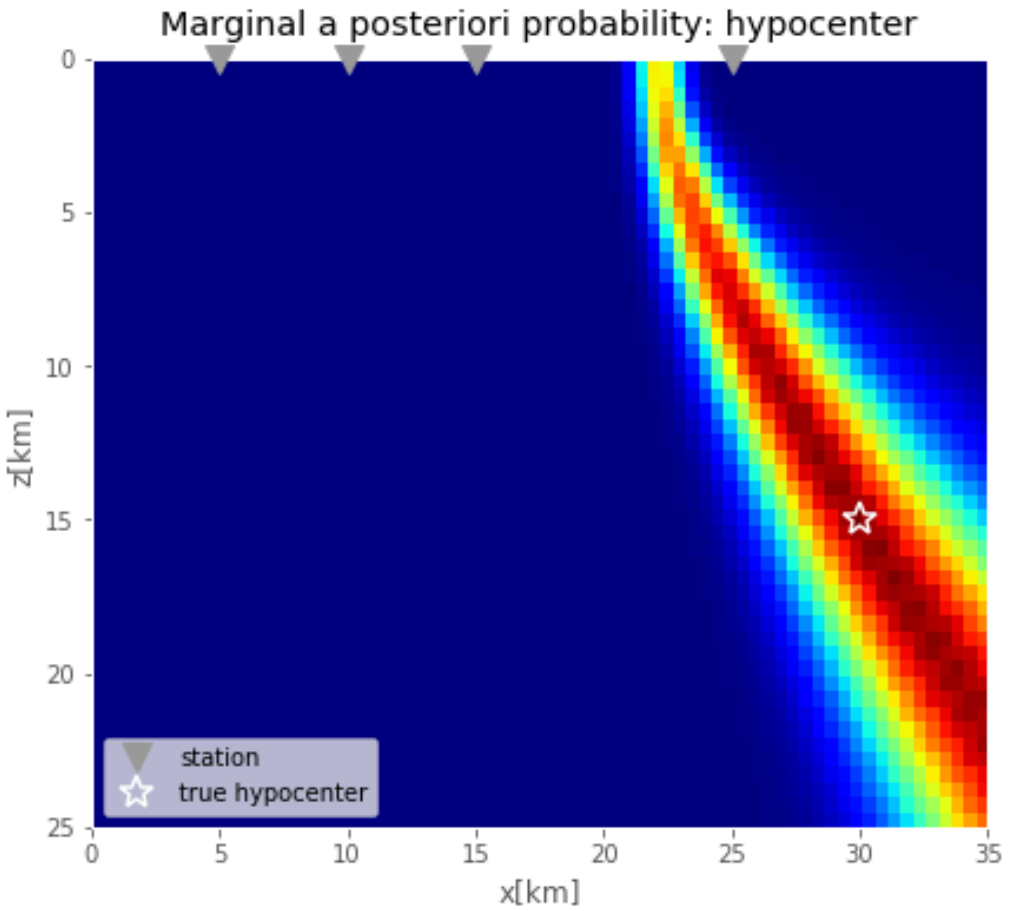


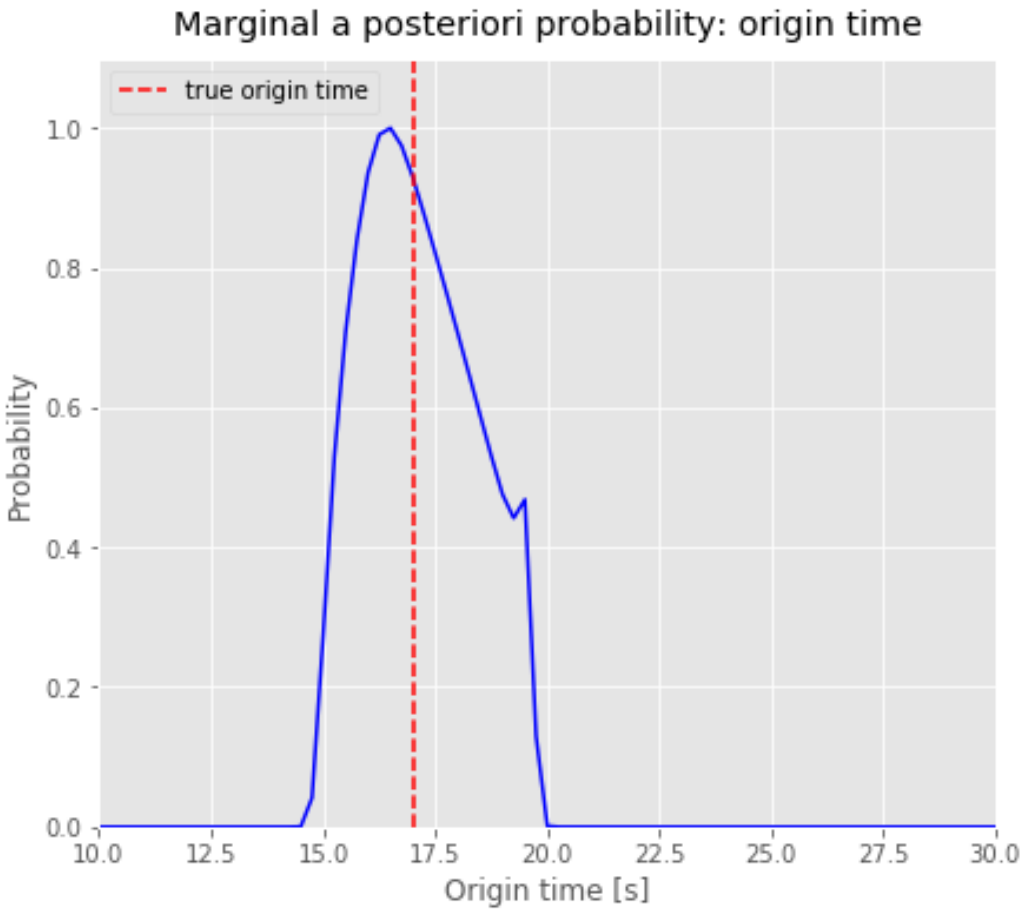


Exercises

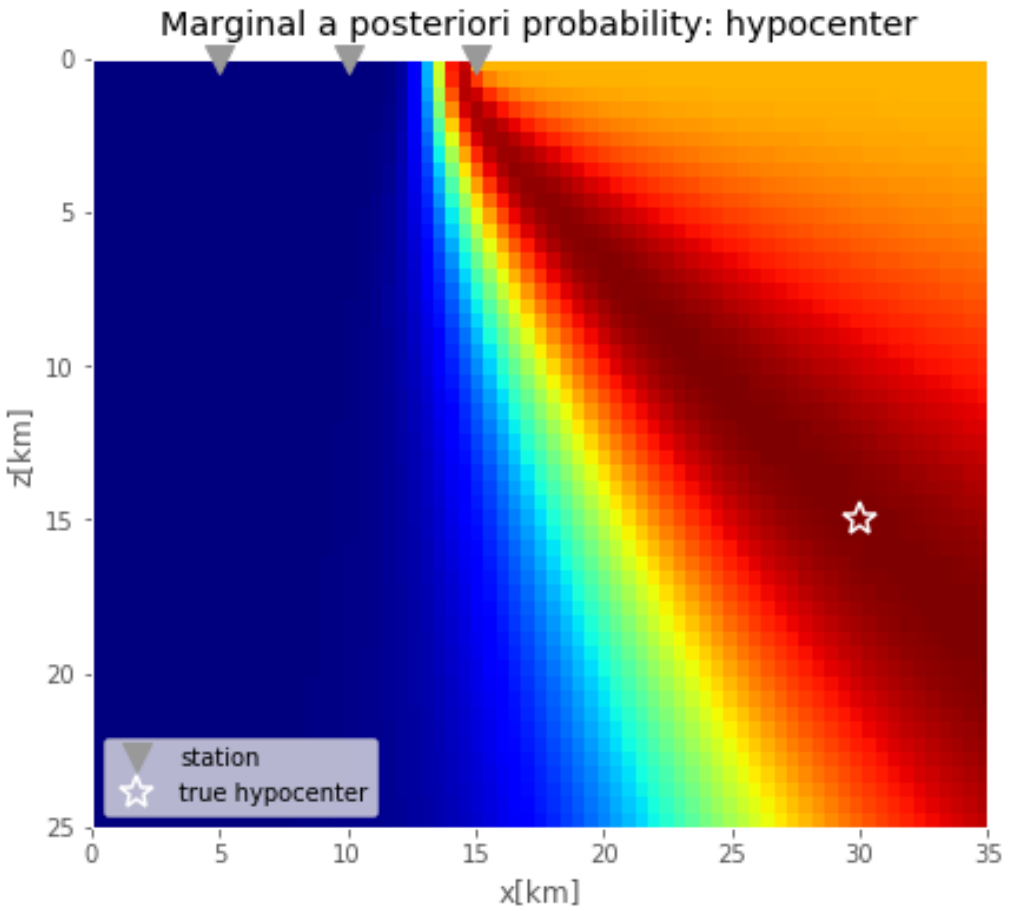
```
# Setup for data and model
#-------------------------

# Define station coordinates     # (original values)
sx = np.array([ 5,10,15,25])     # x(km) = [ 5,10,15,25]
sy = np.array([ 0, 0, 0, 0])     # y(km) = [ 0, 0, 0, 0]
sz = np.array([ 0, 0, 0, 0])     # z(km) = [ 0, 0, 0, 0]

# Define uncertainties of the oberservations for each station
sobs = np.array([.5,.2,.3,.2])  # [.5,.2,.3,.2]

# Define source properties
xs = 30                          # source location x = 30
ys =  0                          # source location y = 0
zs = 15                          # source location z = 15
t0 = 17                          # origin time = 17
v  =  5                          # homogeneous velocity (km/s) = 5

# For model exploration: upper bound | lower bound | increments
xl =  0;  xu = 35;  xinc = .5    # for x: 0, 35, 0.5
yl =  0;  yu =  0;  yinc = .5    # for y: 0, 0, 0.5
zl =  0;  zu = 25;  zinc = .5    # for z: 0, 25, 0.5
Tl = 10;  Tu = 30;  Tinc = .25   # for time: 10, 30, 0.25
```

Exercises


Marginal a posteriori probability: hypocenter
z[km]
x[km]
station
true hypocenter


Marginal a posteriori probability: origin time
true origin time
Probability
Origin time [s]

Exercises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z[km]
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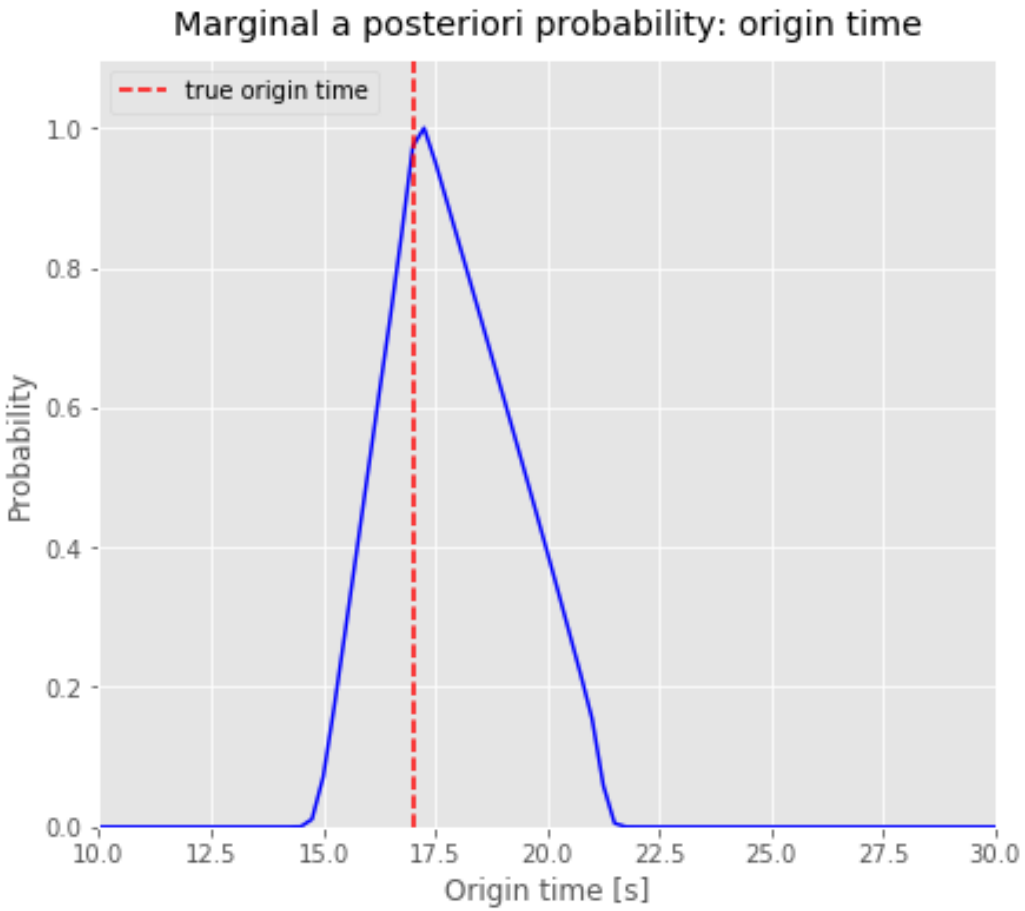
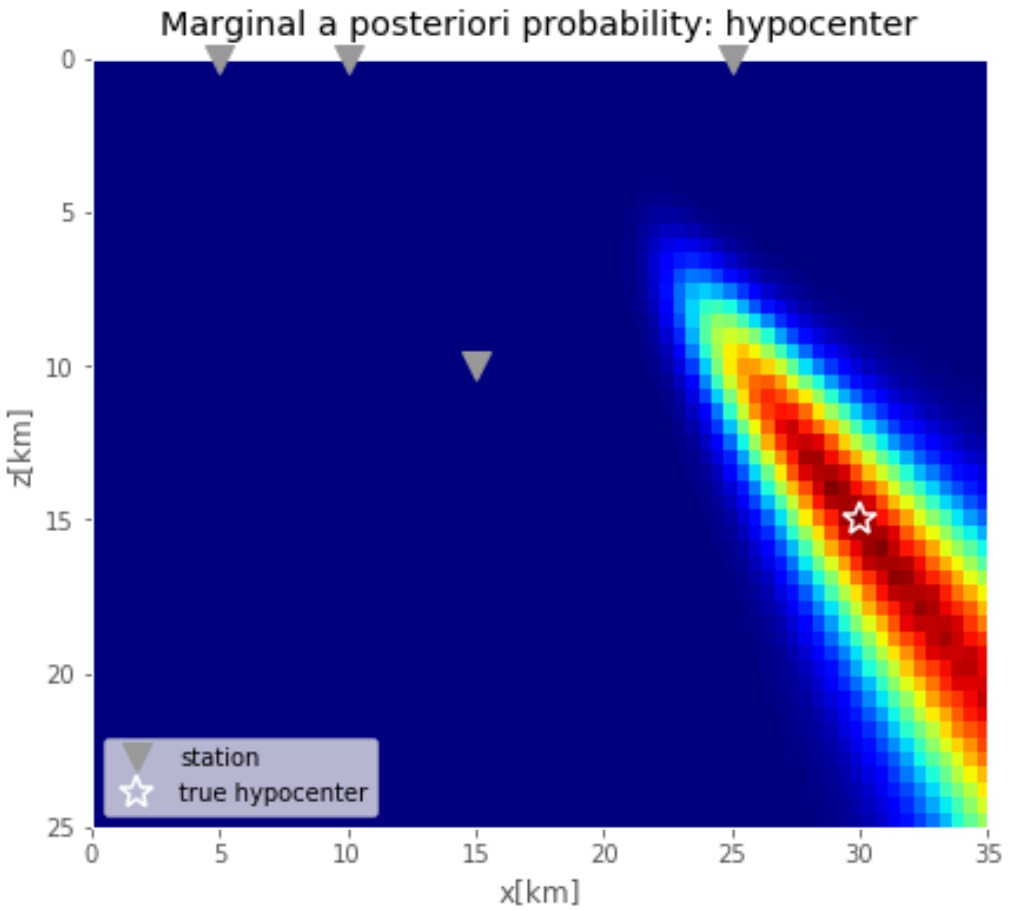
true hypocenter


Marginal a posteriori probability: origin time
true origin time
Probability
Origin time [s]

Exercises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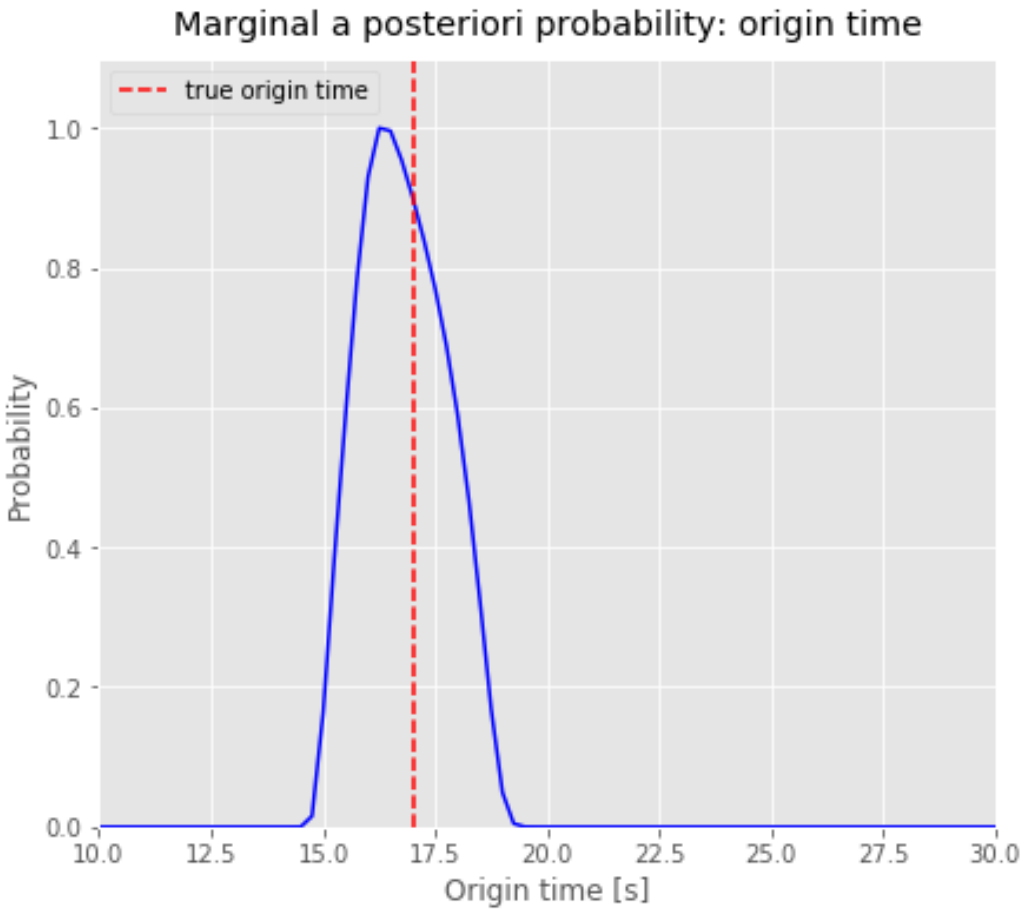
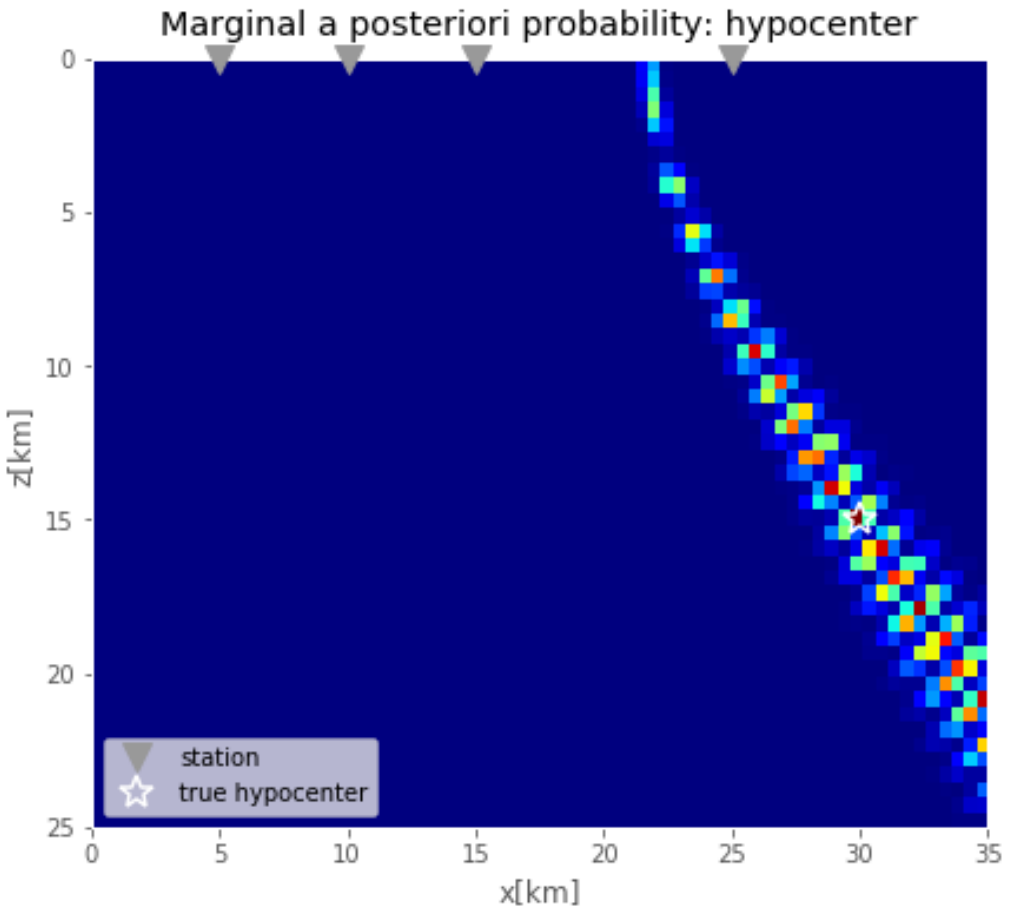

Marginal a posteriori probability: origin time
true origin time
Probability
Origin time [s]

Exercises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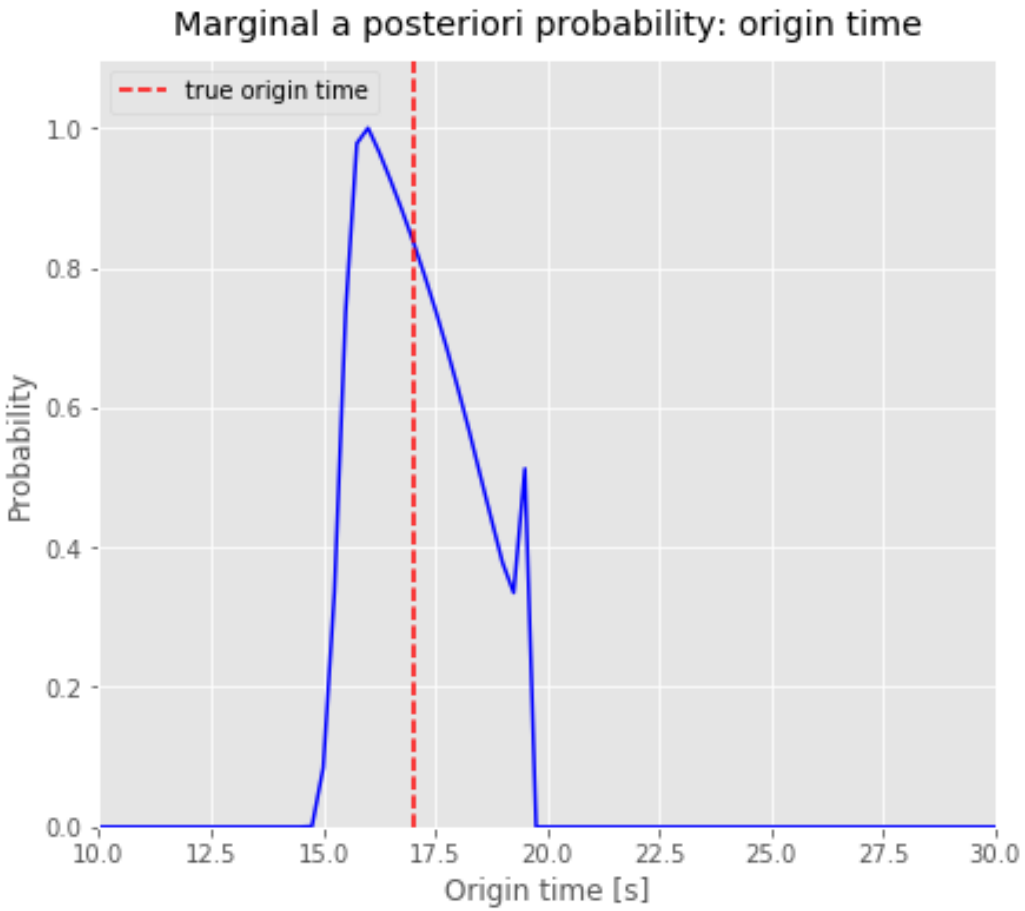
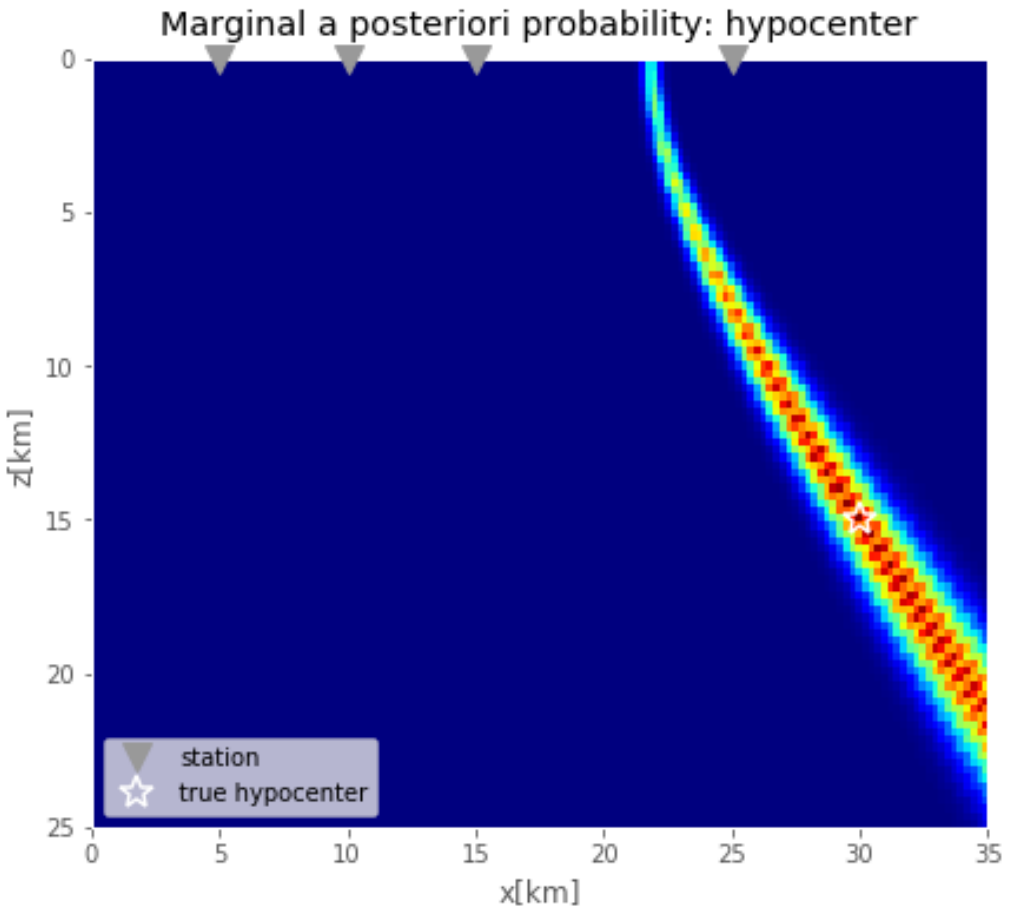
z[km]
x[km]
station
true hypocenter


Marginal a posteriori probability: origin time
true origin time
Probability
Origin time [s]

Exercises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z[km]
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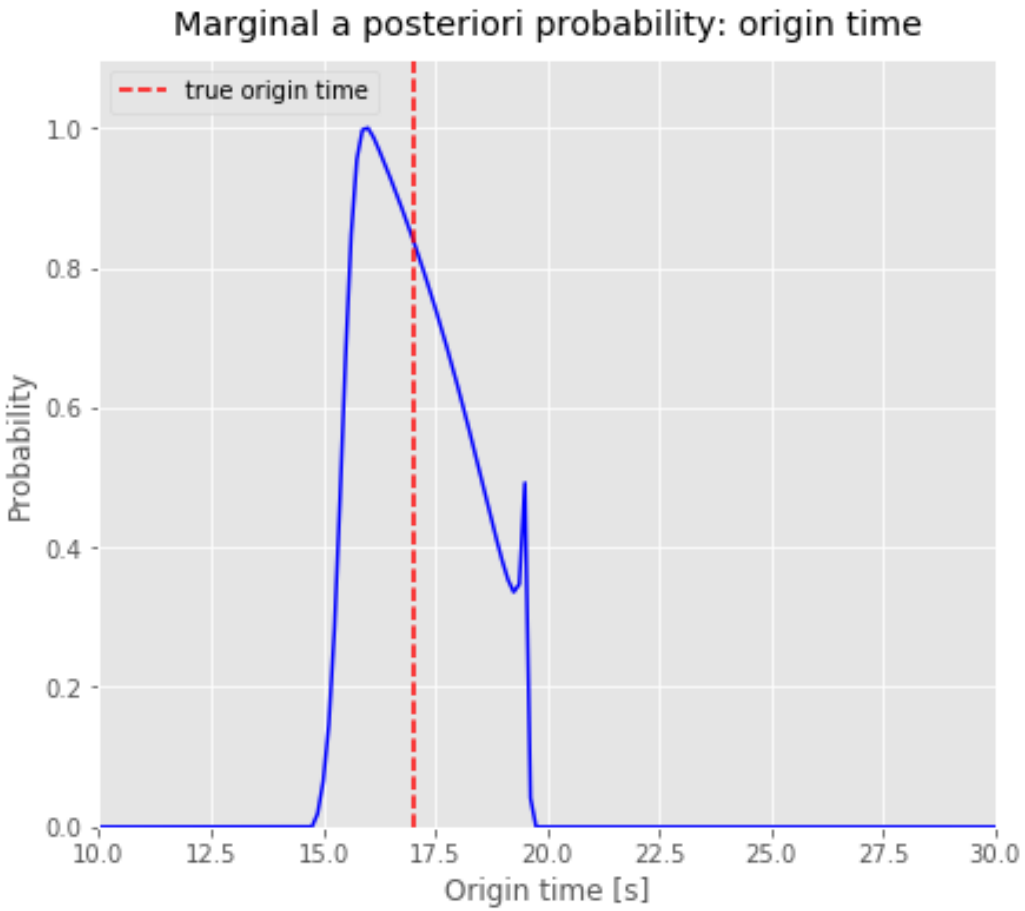
Marginal a posteriori probability: origin time
true origin time
Probability
Origin time [s]

To-Do List

1. Uncertainties in the velocity model and further plots?
2. Write introduction and theory part
3. Formulate exercises and solutions

→ Final tests

Resources

- Tarantola, A. (2005)
  Inverse problem theory and methods for model parameter estimation

- Tarantola, A. and Mosegaard, K.(2005)
  Probabilistic Approach to Inverse Problems

- Menke, W. (2012)
  Geophysical data analysis: discrete inverse theory: MATLAB edition