# Analyze Unsented Kalman filter output data

In [24]:

```
#fusion data variables
fusion_cycleNumber = []
fusion_x0,fusion_x1,fusion_x2,fusion_x3 = [],[],[],[]
fusion_px,fusion_py = [],[]
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3 = [],[],[],[]
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy = [],[],[],[]
fusion_NIS_laser, fusion_NIS_radar = [],[]

#lidar data
lidar_cycleNumber = []
lidar_x0,lidar_x1,lidar_x2,lidar_x3 = [],[],[],[]
lidar_px,lidar_py = [],[]
lidar_gt0,lidar_gt1,lidar_gt2,lidar_gt3 = [],[],[],[]
lidar_RMSE_x,lidar_RMSE_y,lidar_RMSE_vx,lidar_RMSE_vy = [],[],[],[]
lidar_NIS_laser, lidar_NIS_radar = [],[]

#radar data
radar_cycleNumber = []
radar_x0,radar_x1,radar_x2,radar_x3 = [],[],[],[]
radar_px,radar_py = [],[]
radar_gt0,radar_gt1,radar_gt2,radar_gt3 = [],[],[],[]
radar_RMSE_x,radar_RMSE_y,radar_RMSE_vx,radar_RMSE_vy = [],[],[],[]
radar_NIS_laser, radar_NIS_radar = [],[]
```

In [25]:

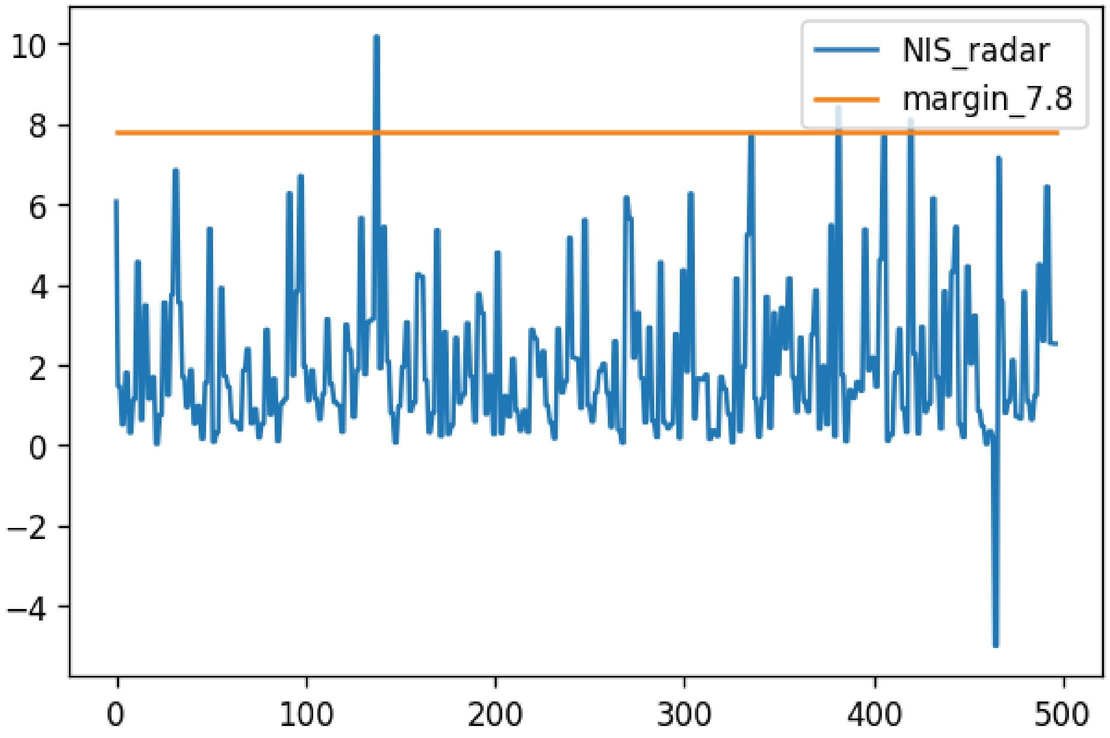
```
import re

# read EKF datalog, output the data to lists
def read_datalog(logname):
    biglist = []
    for line in open(logname):
        numberlist = []
        for myword in re.findall(r"[-]?\d+\.?\d*",line):
            numberlist.append(float(myword))
        biglist.append(numberlist)

    cycle_number = []
    x0 = []
    x1 = []
    x2 = []
    x3 = []
    px = []
    py = []
    gt0 = []
    gt1 = []
    gt2 = []
    gt3 = []
    RMSE_x = []
    RMSE_y = []
    RMSE_vx = []
    RMSE_vy = []
    NIS_laser = []
    NIS_radar = []

    j = 0
    for mylist in biglist:
        j = j + 1
        #print(j)
        if j > 2 :
            cycle_number.append(mylist[0])
            x0.append(mylist[1])
            x1.append(mylist[2])
            x2.append(mylist[3])
            x3.append(mylist[4])
            px.append(mylist[5])
            py.append(mylist[6])
            gt0.append(mylist[7])
            gt1.append(mylist[8])
            gt2.append(mylist[9])
            gt3.append(mylist[10])
            RMSE_x.append(mylist[11])
            RMSE_y.append(mylist[12])
            RMSE_vx.append(mylist[13])
            RMSE_vy.append(mylist[14])
            NIS_laser.append(mylist[15])
            NIS_radar.append(mylist[16])

    print("data length is: ",len(x0))

    return cycle_number,x0,x1,x2,x3,px,py,gt0,gt1,gt2,gt3,RMSE_x,RMSE_y,\
           RMSE_vx,RMSE_vy,NIS_laser,NIS_radar
```

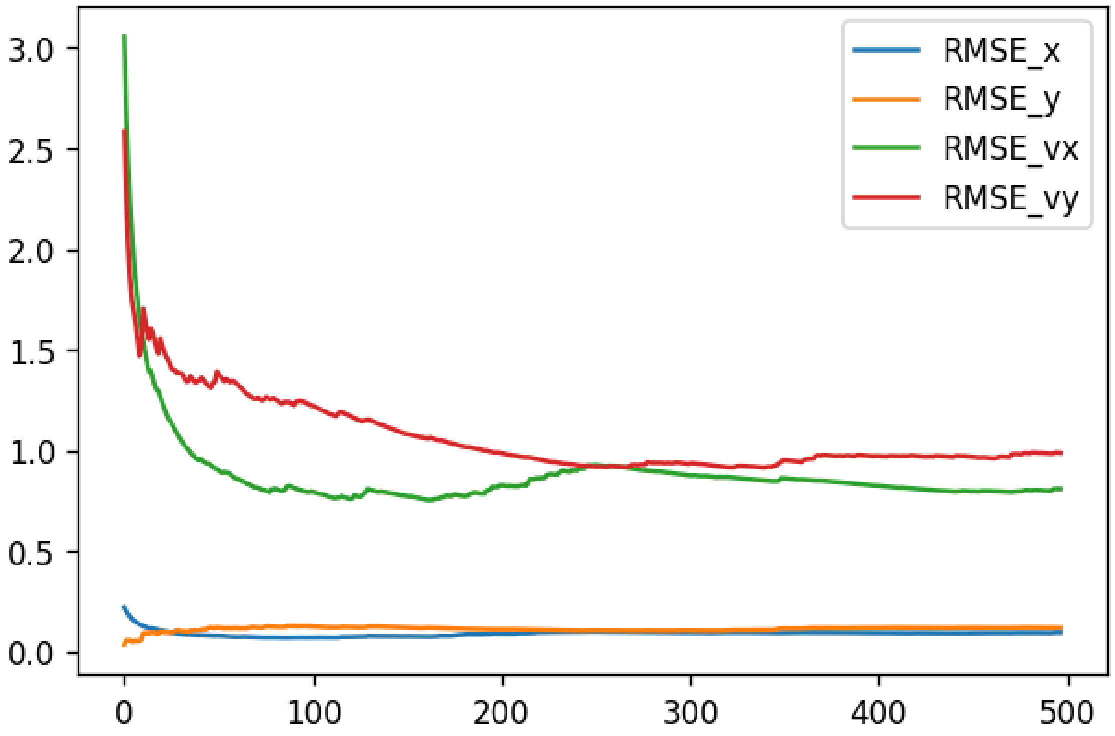
# Noise parameter: std_a = 30, std_yawdd = 30

In [10]:

```
# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy, \
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_30.txt")

x = []
y_margin = []
for i in range(0, len(fusion_x0)):
    x.append(i)
    y_margin.append(7.8)

import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
#pl.plot(x,fusion_NIS_laser,label='NIS_laser')# use pylab to plot x and y
pl.plot(x,fusion_NIS_radar,label='NIS_radar')# use pylab to plot x and y
pl.plot(x,y_margin,label='margin_7.8')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_RMSE_x,label='RMSE_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_vy')# use pylab to plot x and y

pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

```
data length is:  497
```





## Noise parameter: std_a = 10, std_yawdd = 10

In [12]:

```
# std_a_ = 10;
# std_yawdd_ = 10;

# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy, \
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_10.txt")

x = []
y_margin = []
for i in range(0, len(fusion_x0)):
    x.append(i)
    y_margin.append(7.8)

import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_NIS_radar,label='NIS_radar')# use pylab to plot x and y
pl.plot(x,y_margin,label='margin_7.8')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_RMSE_x,label='RMSE_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_vy')# use pylab to plot x and y

pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

```
data length is:  497
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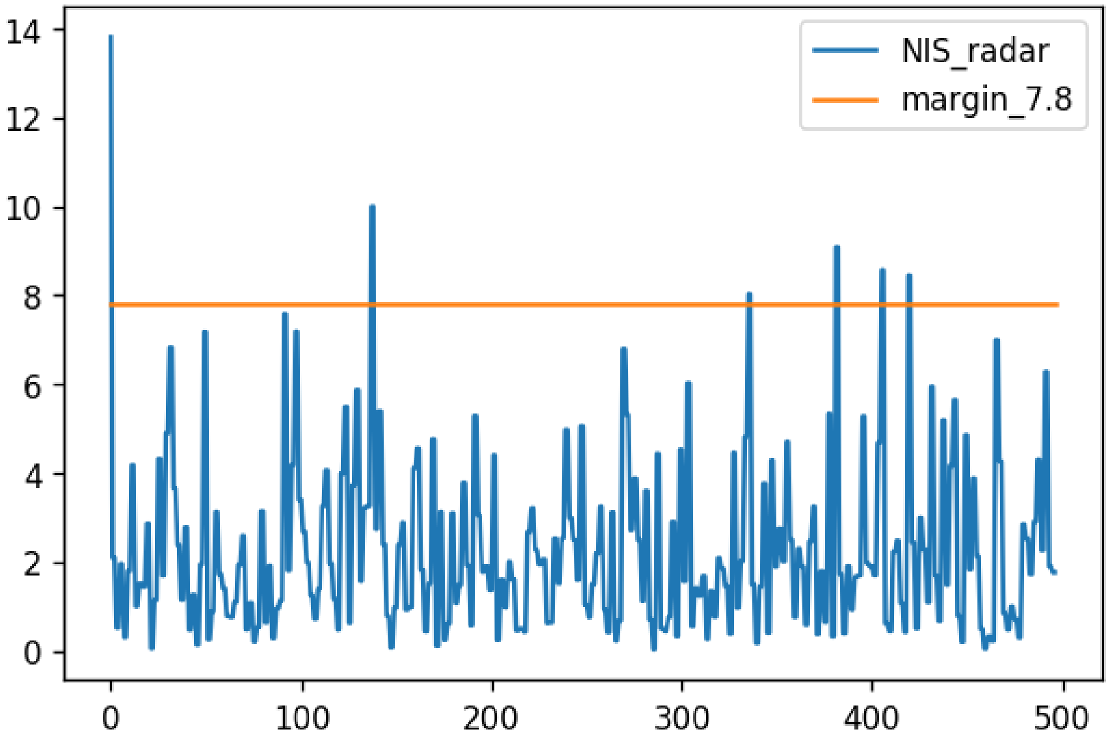

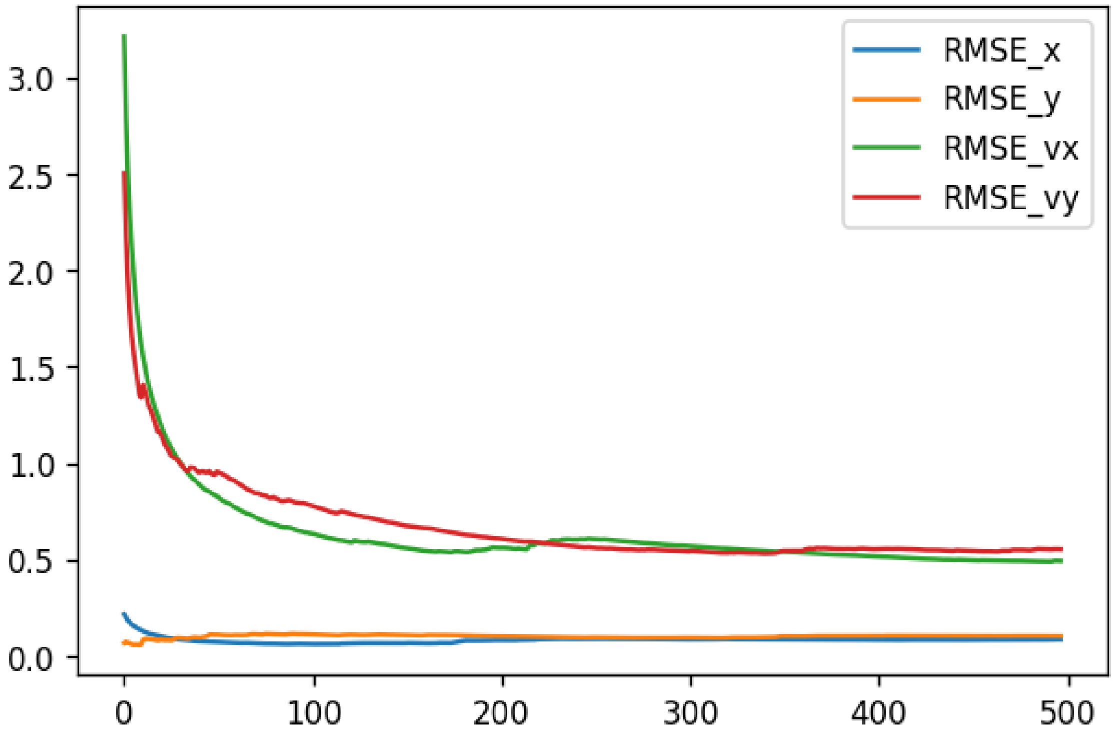

## Noise parameter: std_a = 3, std_yawdd = 3

In [13]:

```
# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy, \
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_3.txt")

x = []
y_margin = []
for i in range(0, len(fusion_x0)):
    x.append(i)
    y_margin.append(7.8)

import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_NIS_radar,label='NIS_radar')# use pylab to plot x and y
pl.plot(x,y_margin,label='margin_7.8')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_RMSE_x,label='RMSE_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_vy')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

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data length is:  497
```
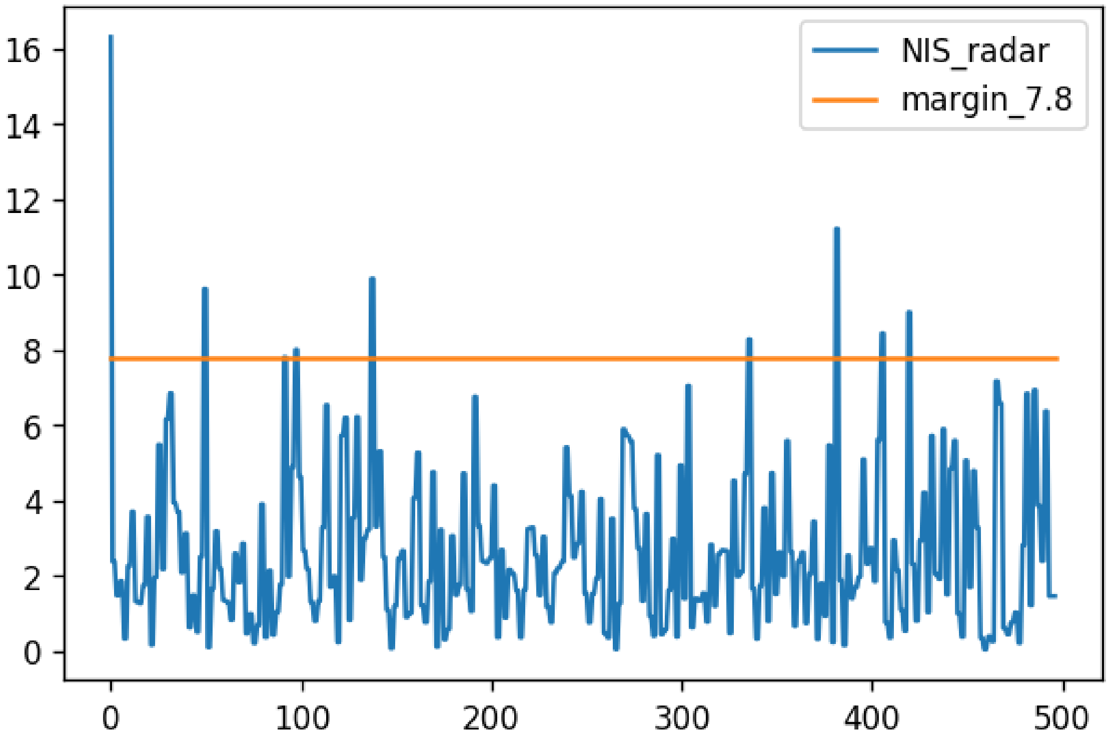
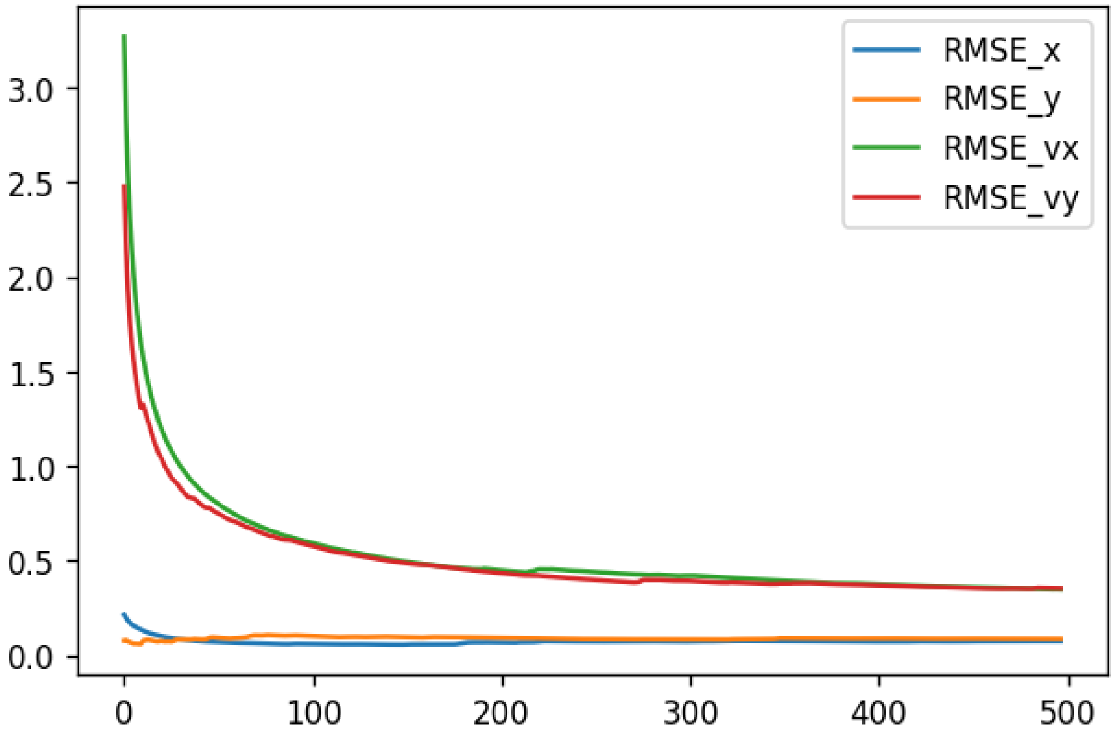



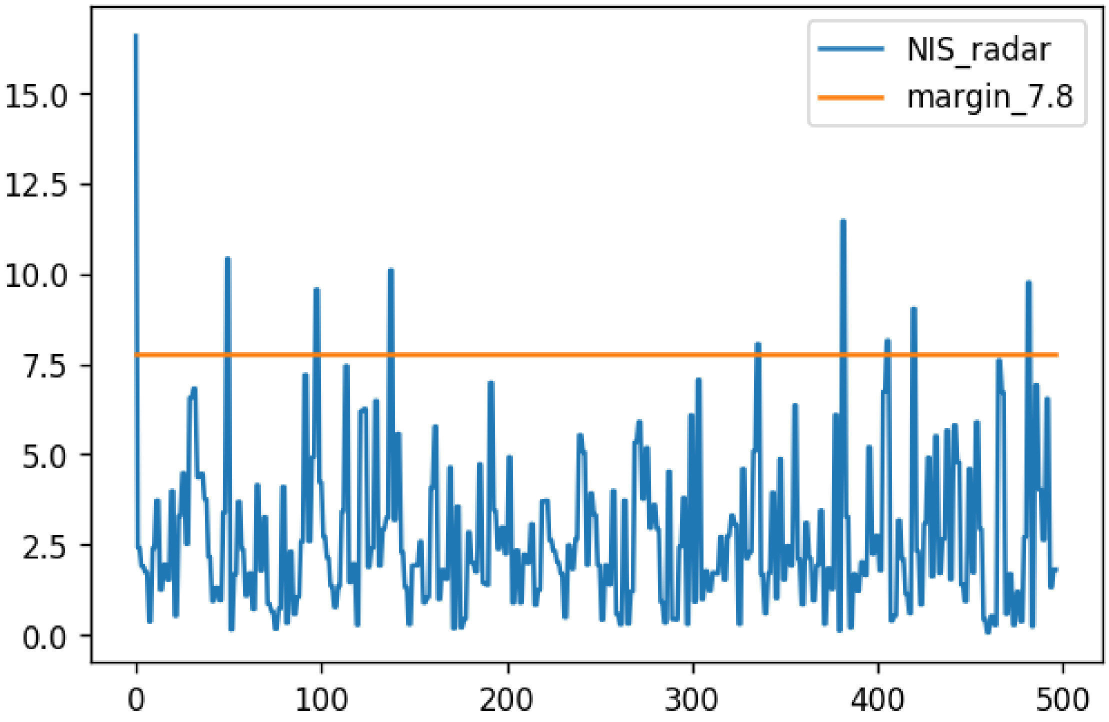


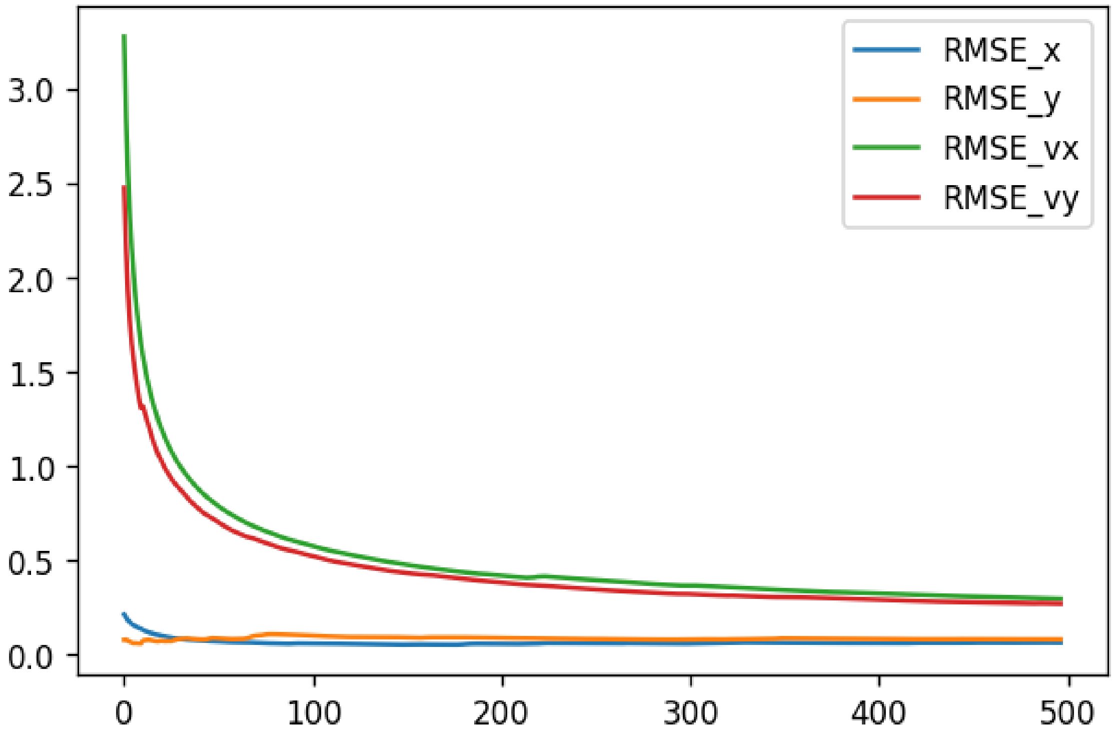
## Noise parameter: std_a = 1, std_yawdd = 1

In [26]:

```
# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy, \
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_1.txt")

x = []
y_margin = []
for i in range(0, len(fusion_x0)):
    x.append(i)
    y_margin.append(7.8)

import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_NIS_radar,label='NIS_radar')# use pylab to plot x and y
pl.plot(x,y_margin,label='margin_7.8')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_RMSE_x,label='RMSE_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_vy')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

```
data length is:  497
```





## Noise parameter: std_a = 0.3, std_yawdd = 0.3

In [19]:

```
# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy, \
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_0.3.txt")

x = []
y_margin = []
for i in range(0, len(fusion_x0)):
    x.append(i)
    y_margin.append(7.8)

import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_NIS_radar,label='NIS_radar')# use pylab to plot x and y
pl.plot(x,y_margin,label='margin_7.8')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_RMSE_x,label='RMSE_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_vy')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

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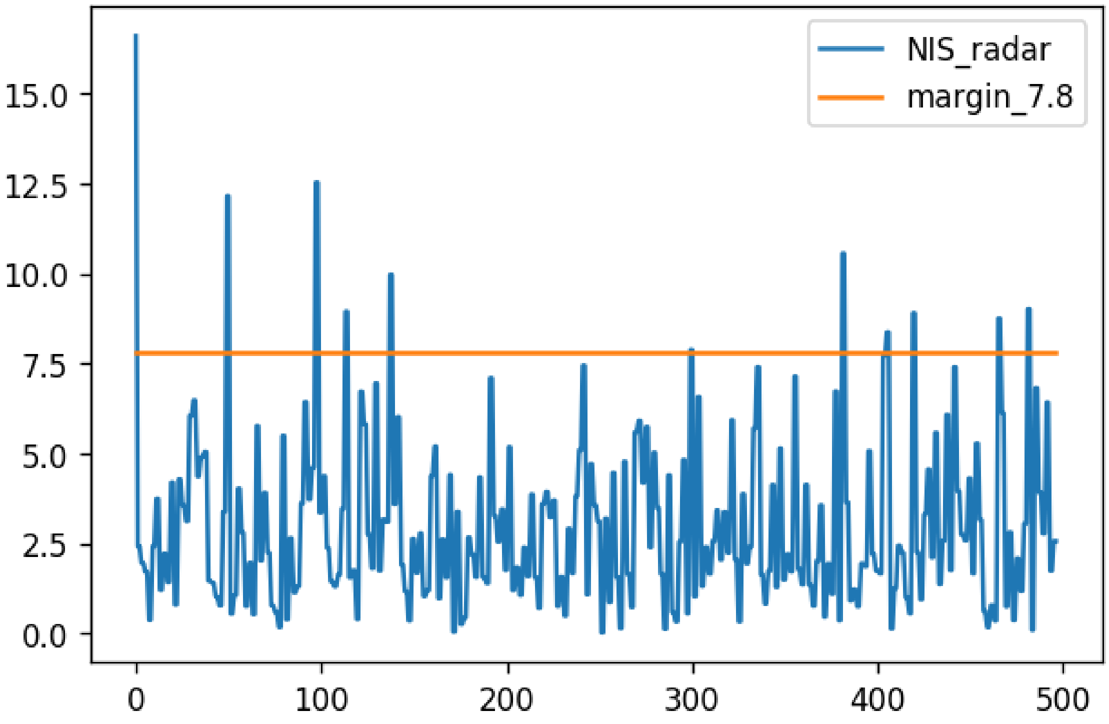
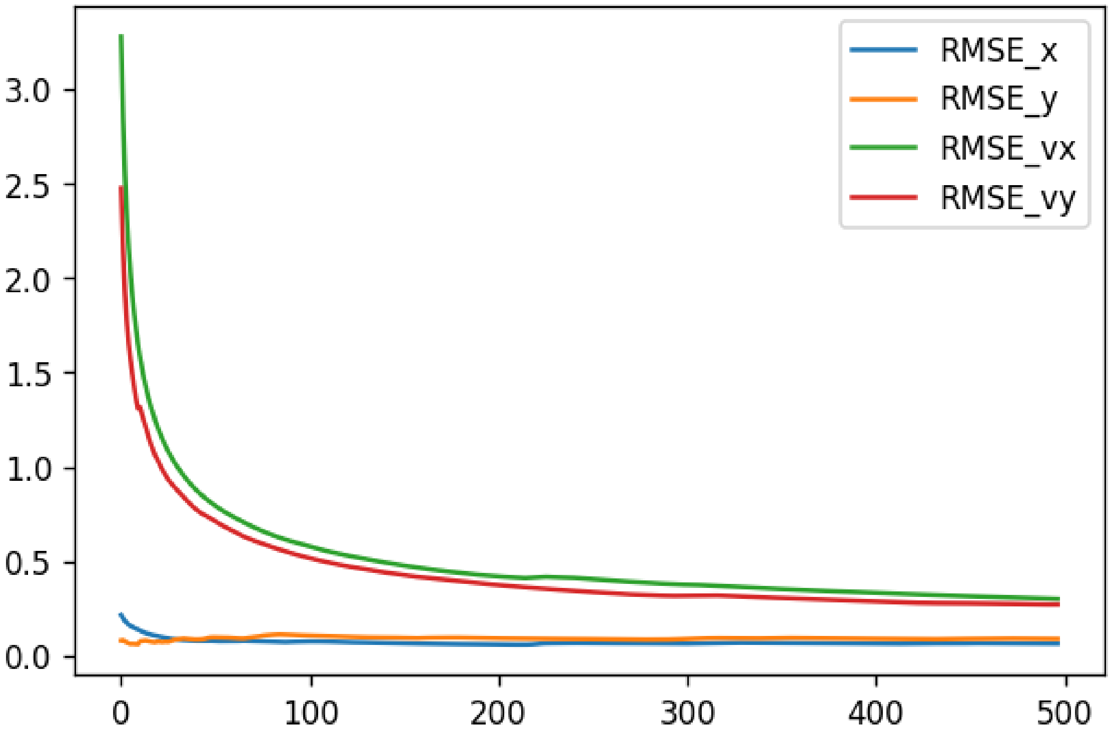
data length is:  497
```





## Noise parameter: std_a = 0.3, std_yawdd = 0.3

In [20]:

```
# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy, \
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_0.1.txt")

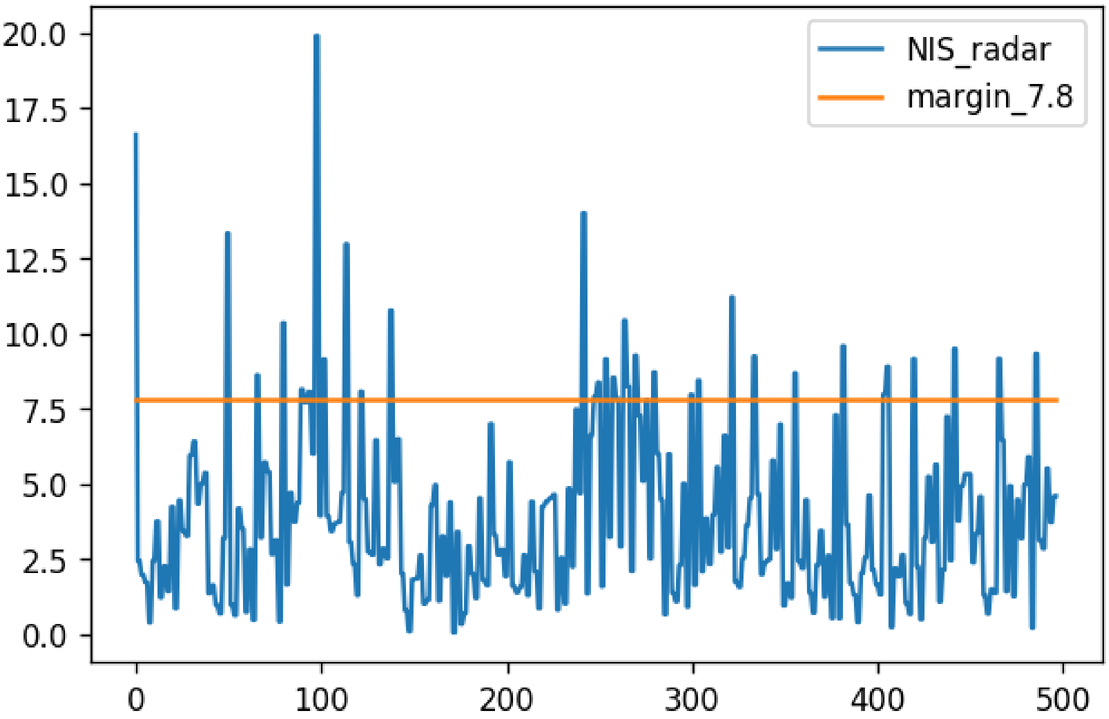
x = []
y_margin = []
for i in range(0, len(fusion_x0)):
    x.append(i)
    y_margin.append(7.8)

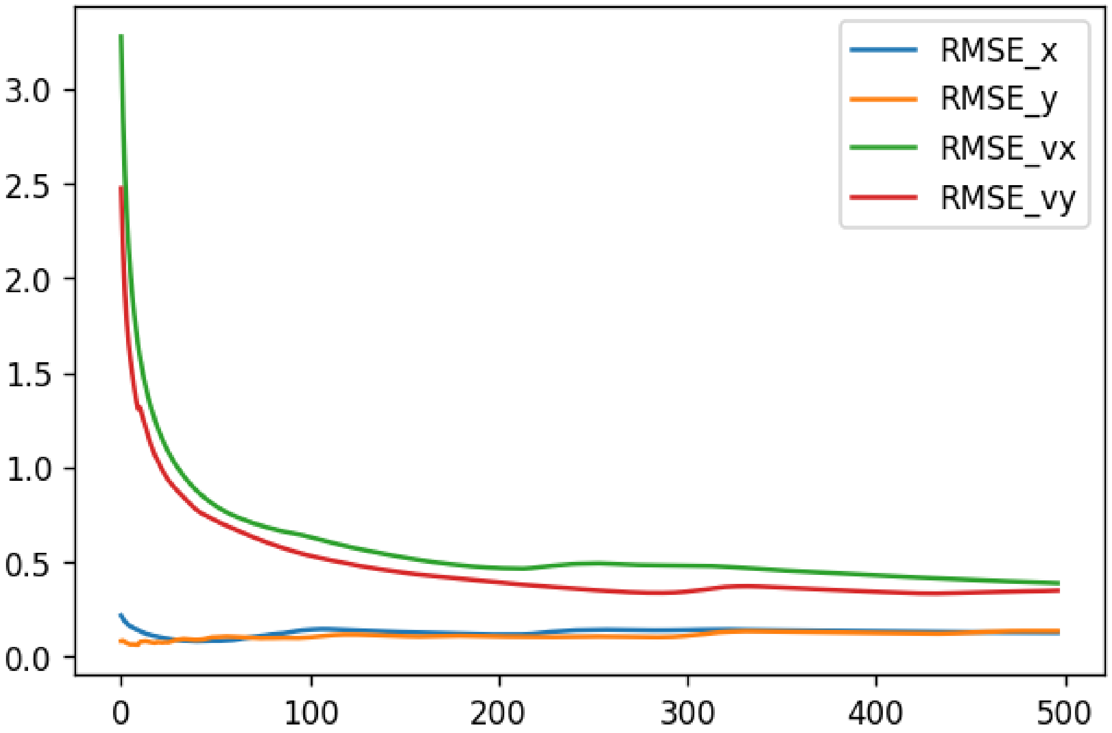
import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_NIS_radar,label='NIS_radar')# use pylab to plot x and y
pl.plot(x,y_margin,label='margin_7.8')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,fusion_RMSE_x,label='RMSE_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_vy')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

```
data length is:  497
```




RMSE_x
RMSE_y
RMSE_vx
RMSE_vy
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
100
200
300
400
500

In [31]:

```
# read fusion data to list
fusion_cycleNumber,fusion_x0,fusion_x1,fusion_x2,fusion_x3,fusion_px,fusion_py,\
fusion_gt0,fusion_gt1,fusion_gt2,fusion_gt3,\
fusion_RMSE_x,fusion_RMSE_y,fusion_RMSE_vx,fusion_RMSE_vy,\
fusion_NIS_laser, fusion_NIS_radar\
= read_datalog(logname = "ukf_log_1.txt")

# read lidar data to list
lidar_cycleNumber,lidar_x0,lidar_x1,lidar_x2,lidar_x3,lidar_px,lidar_py,\
lidar_gt0,lidar_gt1,lidar_gt2,lidar_gt3,\
lidar_RMSE_x,lidar_RMSE_y,lidar_RMSE_vx,lidar_RMSE_vy,\
lidar_NIS_laser, lidar_NIS_radar\
= read_datalog(logname = "ukf_log_1_lidar.txt")

# read radar data to list
radar_cycleNumber,radar_x0,radar_x1,radar_x2,radar_x3,radar_px,radar_py,\
radar_gt0,radar_gt1,radar_gt2,radar_gt3,\
radar_RMSE_x,radar_RMSE_y,radar_RMSE_vx,radar_RMSE_vy,\
radar_NIS_laser, radar_NIS_radar\
= read_datalog(logname = "ukf_log_1_radar.txt")

x = []
for i in range(0, len(fusion_x0)):
    x.append(i)


import numpy as np
import pylab as pl

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,radar_RMSE_x,label='RMSE_radar_x')# use pylab to plot x and y
pl.plot(x,radar_RMSE_y,label='RMSE_radar_y')# use pylab to plot x and y
pl.plot(x,lidar_RMSE_x,label='RMSE_lidar_x')# use pylab to plot x and y
pl.plot(x,lidar_RMSE_y,label='RMSE_lidar_y')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_x,label='RMSE_fusion_x')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_y,label='RMSE_fusion_y')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen

pl.figure(figsize=(6,4), dpi=120)
pl.plot(x,radar_RMSE_vx,label='RMSE_radar_vx')# use pylab to plot x and y
pl.plot(x,radar_RMSE_vy,label='RMSE_radar_vy')# use pylab to plot x and y
pl.plot(x,lidar_RMSE_vx,label='RMSE_lidar_vx')# use pylab to plot x and y
pl.plot(x,lidar_RMSE_vy,label='RMSE_lidar_vy')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vx,label='RMSE_fusion_vx')# use pylab to plot x and y
pl.plot(x,fusion_RMSE_vy,label='RMSE_fusion_vy')# use pylab to plot x and y
pl.legend(loc='upper right')
pl.show()# show the plot on the screen
```

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data length is:  497
data length is:  497
data length is:  497
```

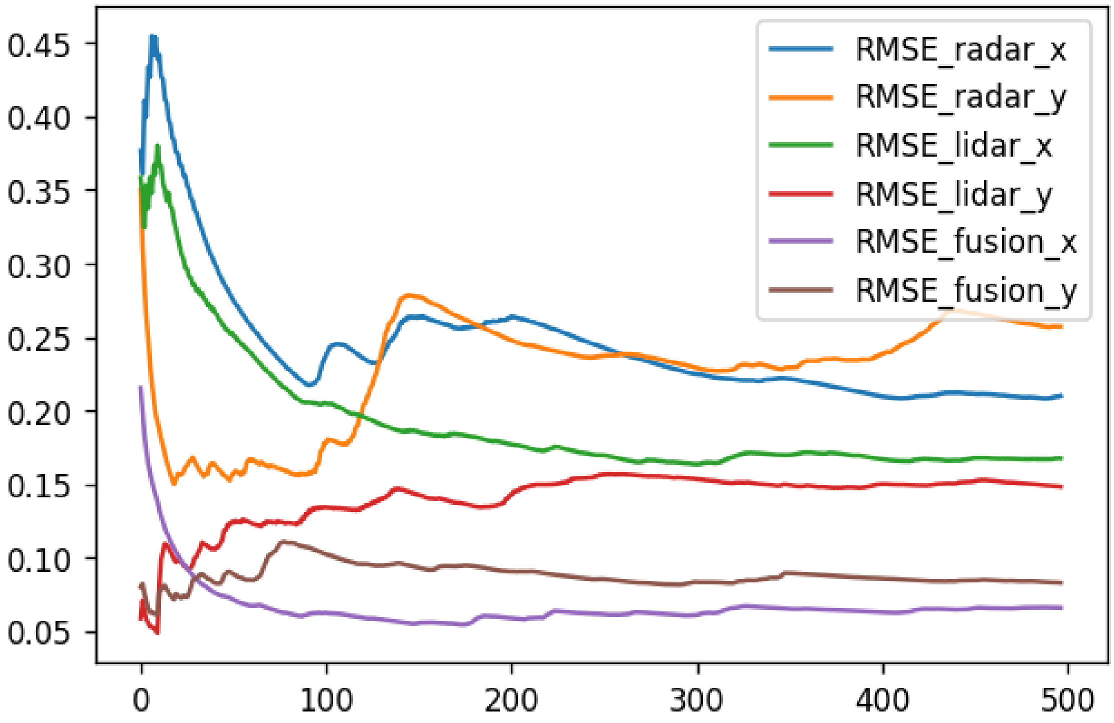

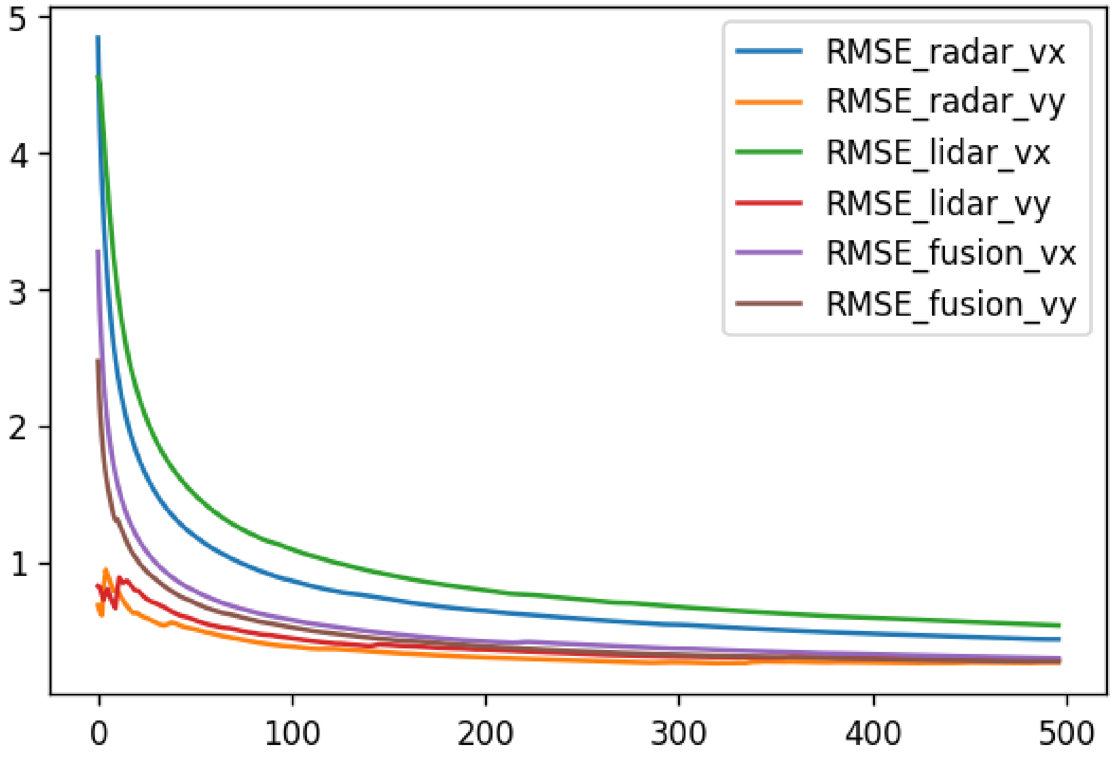

from the trace diagram, we also could see that , the fusion result is better than only-radar or only-lidar