Math GR 5320: Financial Risk Management and Regulation

Assignment 11

Department of Mathematics
Columbia University

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Head, Quantitative Risk Analytics
Bloomberg LP

Fall 2016

Compilation: November 17, 2016 at 23:00

Due a week from Thanksgiving (December 1st) by 1:00 pm.

For help. the preferred approach is to post questions on the Q&A tab in Piazza:

https://piazza.com/columbia/fall2016/mathg5320_001_2016_3/home

These will be quickly responded to and will be helpful to others in the class.

Otherwise, attend TA office hours, email a TA or the professor, or schedule a meeting.

1. **Backtesting, 5 year window**

   Back test the GBM based VaR estimates for long and short portfolios by counting the number of times the VaR on each date is exceeded by the subsequent 5 day change in each 1 year window. Use the VaRs based on 5 year period parameter estimates.

   What is the expected number of exceptions and how well do the number of exceptions match the expected number of exceptions?

2. **Backtesting, exponential equivalent**

   Repeat the previous problem using a lambda of 0.9989 (a 5 year window equivalent lambda).

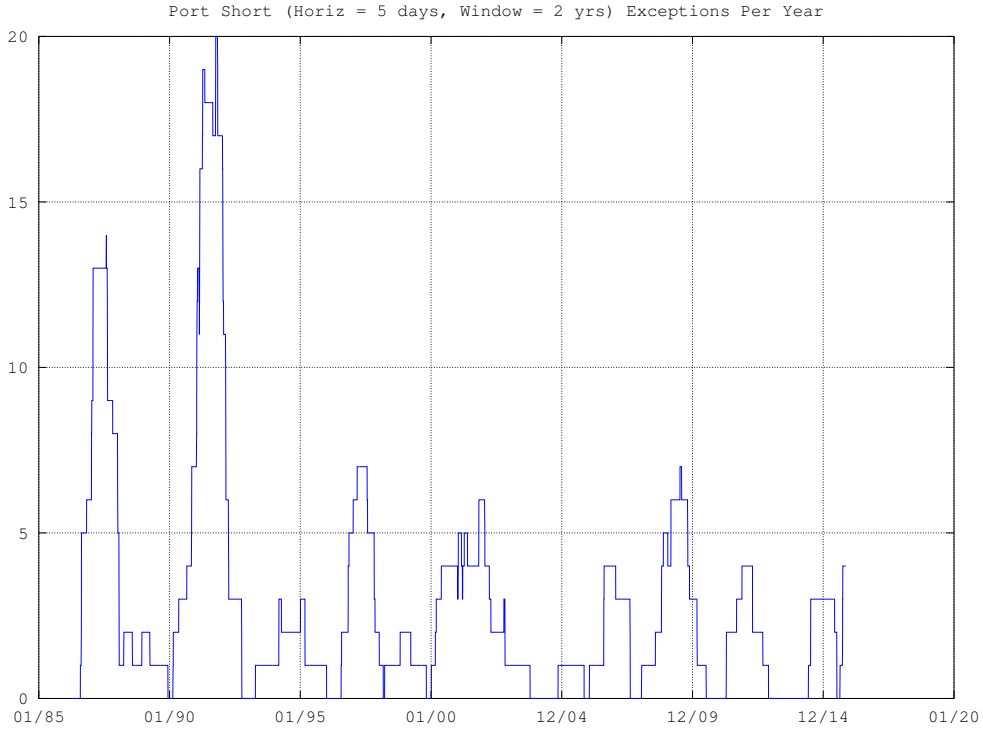
   How do the results using a exponential weighting compare to the prior results?

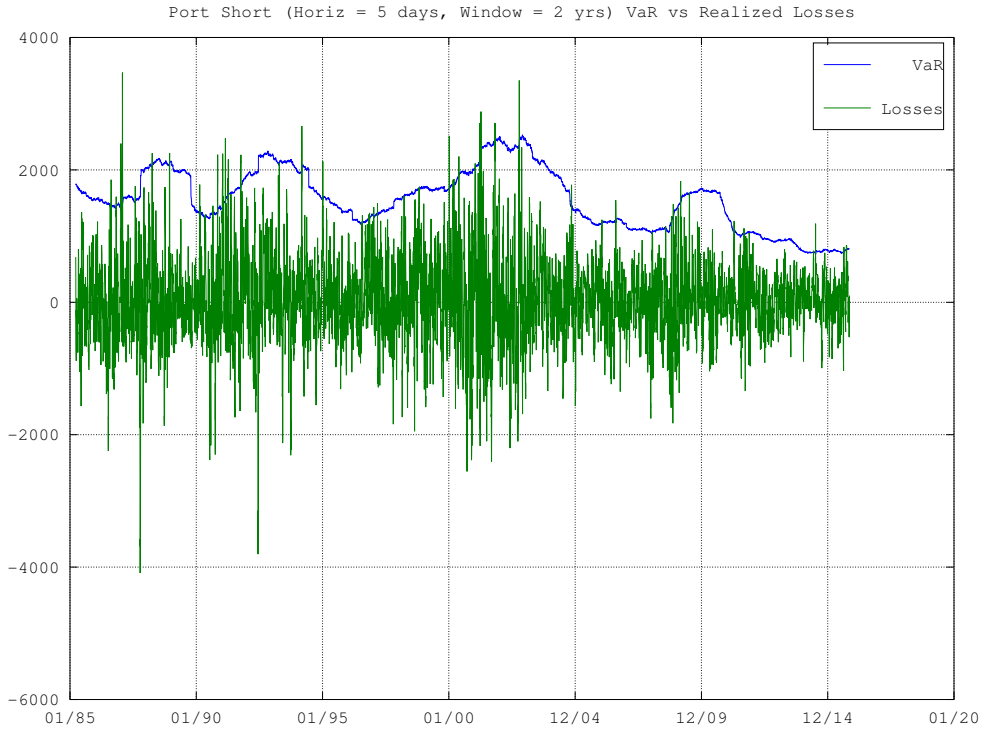
For reference, here are the remaining cases.

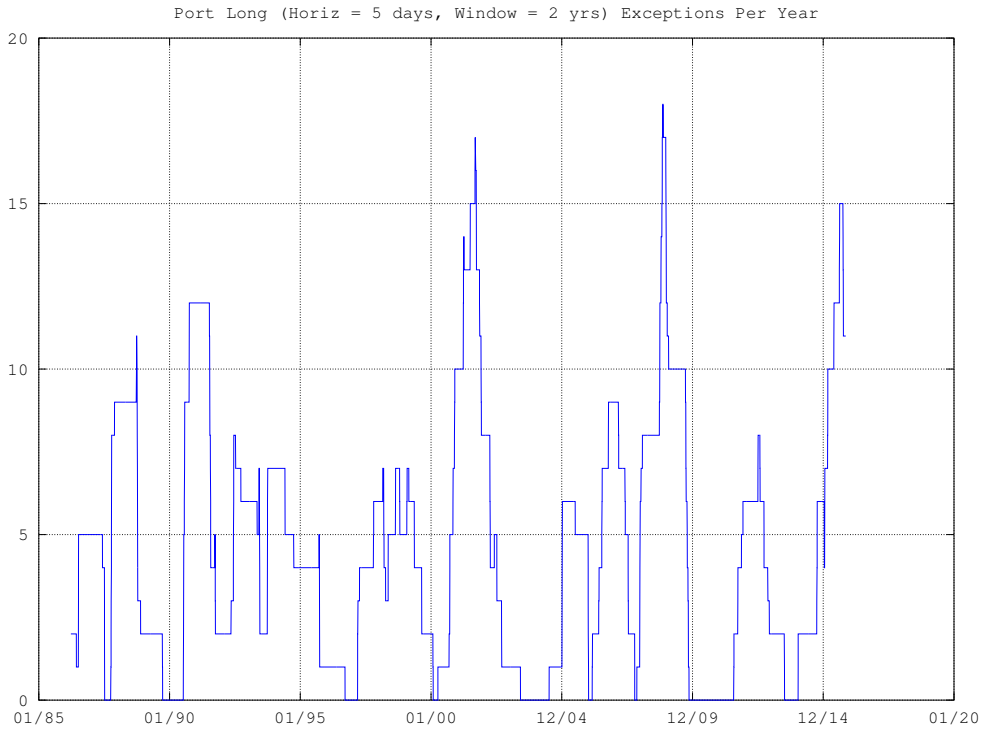
Observations:

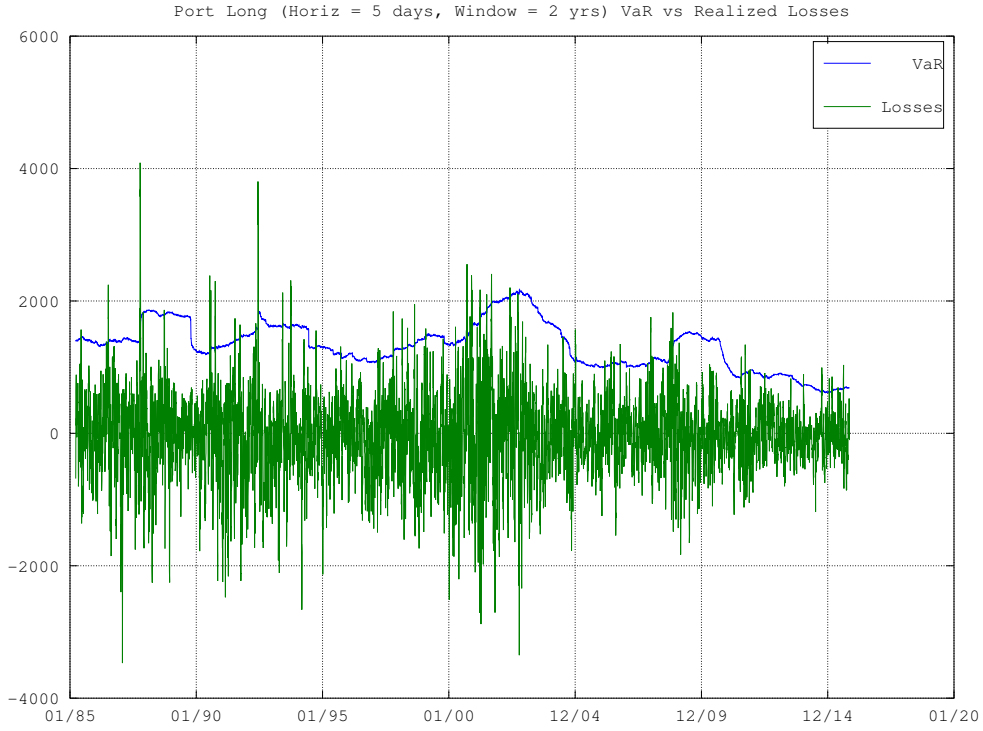
- The 5 year equivalent exponential weighting tends to give the best results.
- 1 day VaRs perform slightly better but not substantially better.
- The 2 year window and the 2 year equivalent exponential weighting both give much noiser VaRs. Presumably the parameter estimates are noisier.

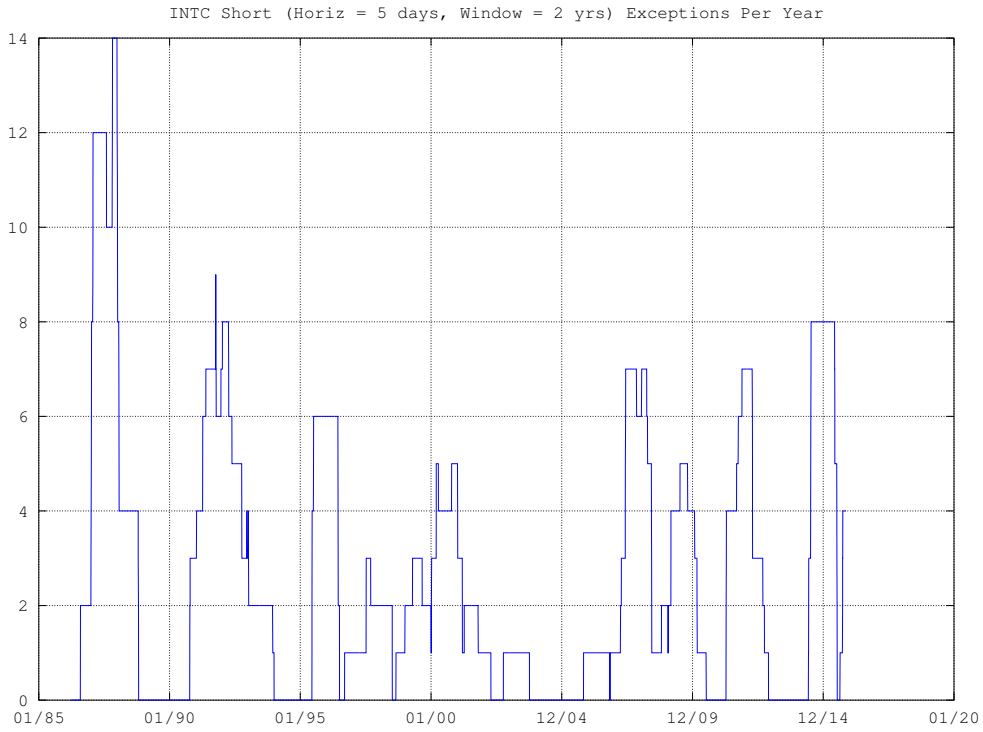
2 year windows, 5 day horizon:

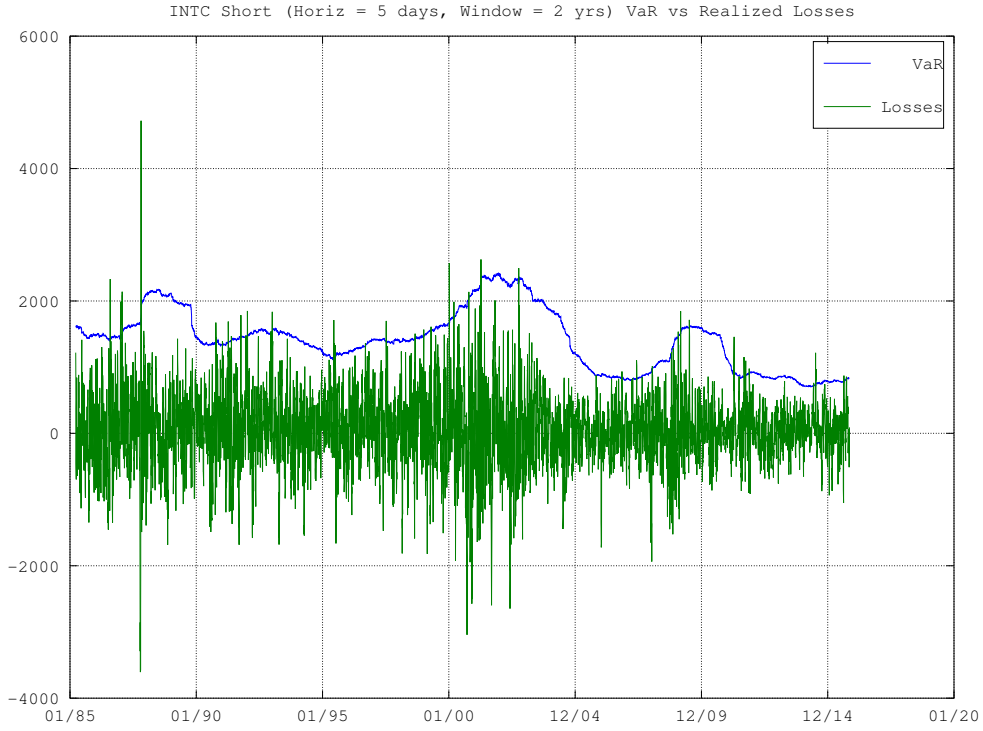


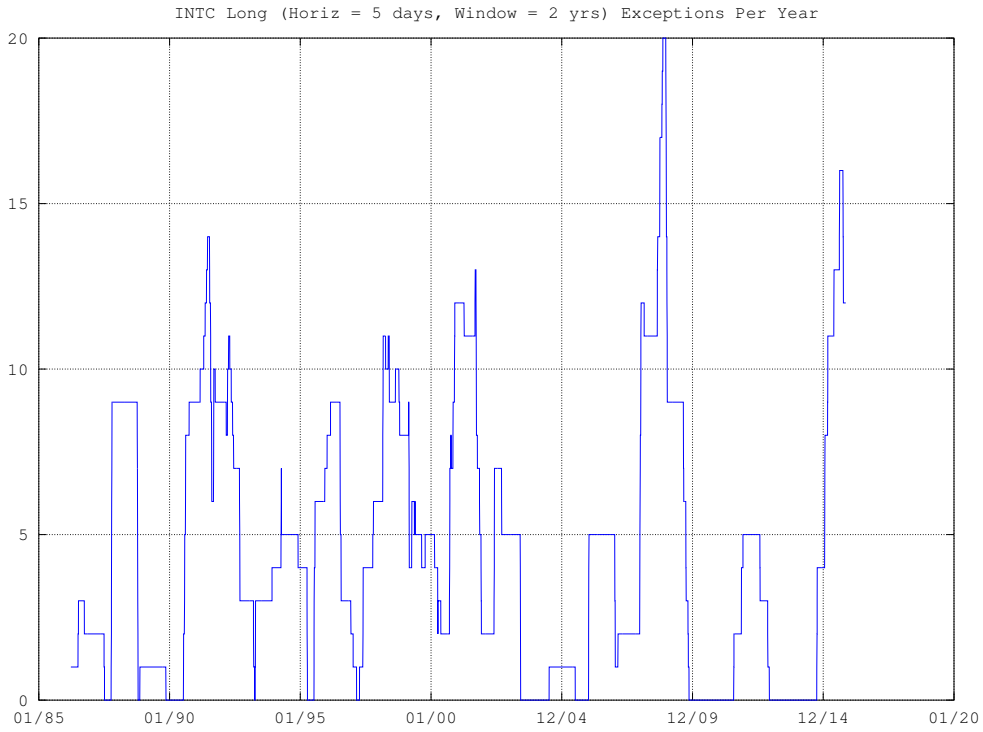


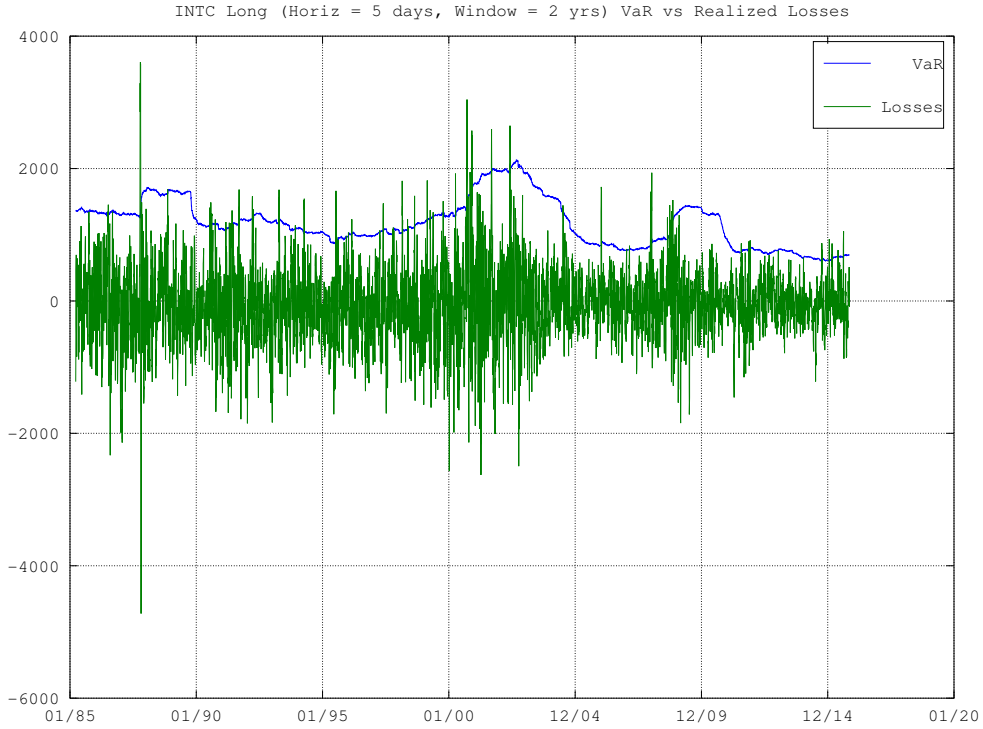

Port Long (Horiz = 5 days, Window = 2 yrs) Exceptions Per Year
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

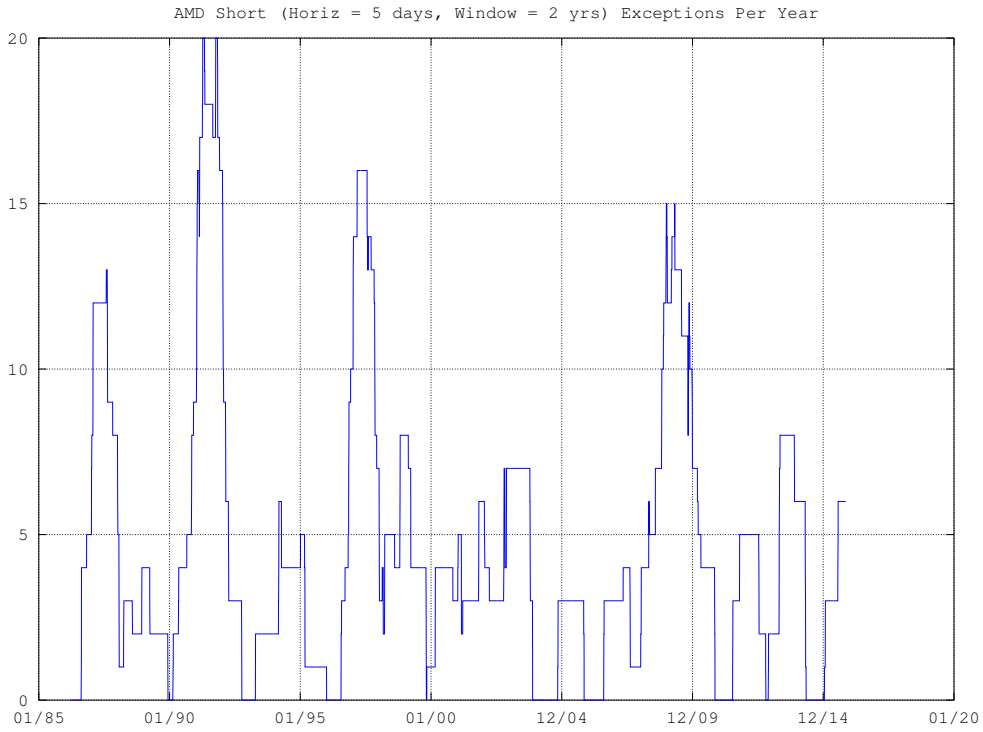

Port Long (Horiz = 5 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
6000
4000
2000
0
-2000
-4000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Short (Horiz = 5 days, Window = 2 yrs) Exceptions Per Year
14
12
10
8
6
4
2
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Short (Horiz = 5 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
6000
4000
2000
0
-2000
-4000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Long (Horiz = 5 days, Window = 2 yrs) Exceptions Per Year
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Long (Horiz = 5 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
4000
2000
0
-2000
-4000
-6000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20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15
10
5
0
01/85
01/90
01/95
01/00
12/04
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12/14
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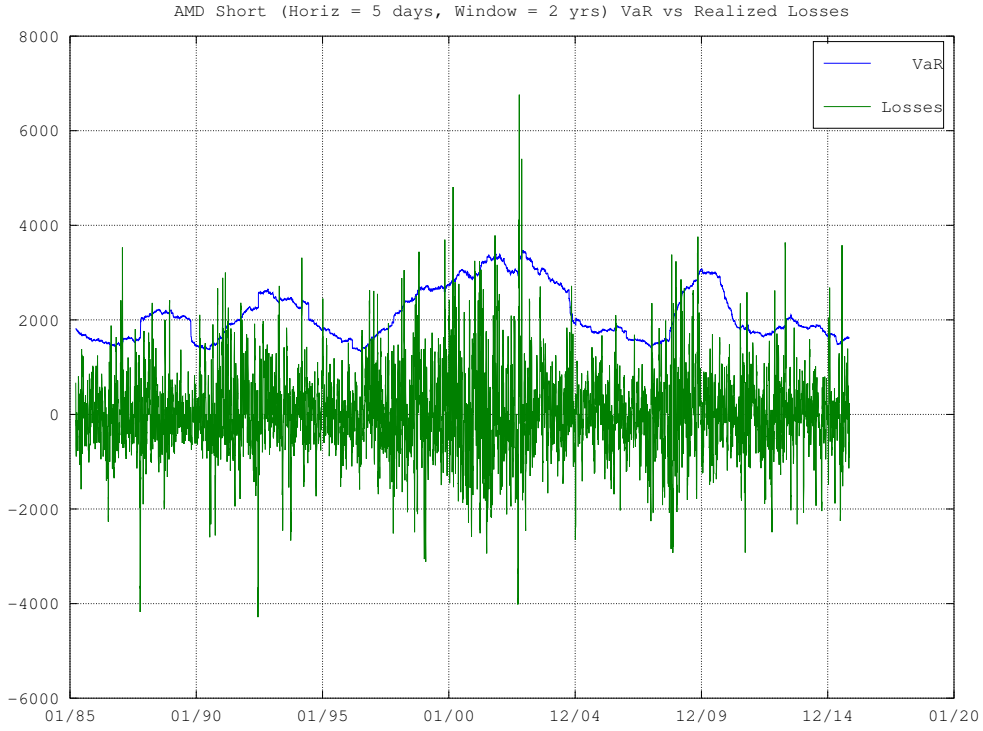
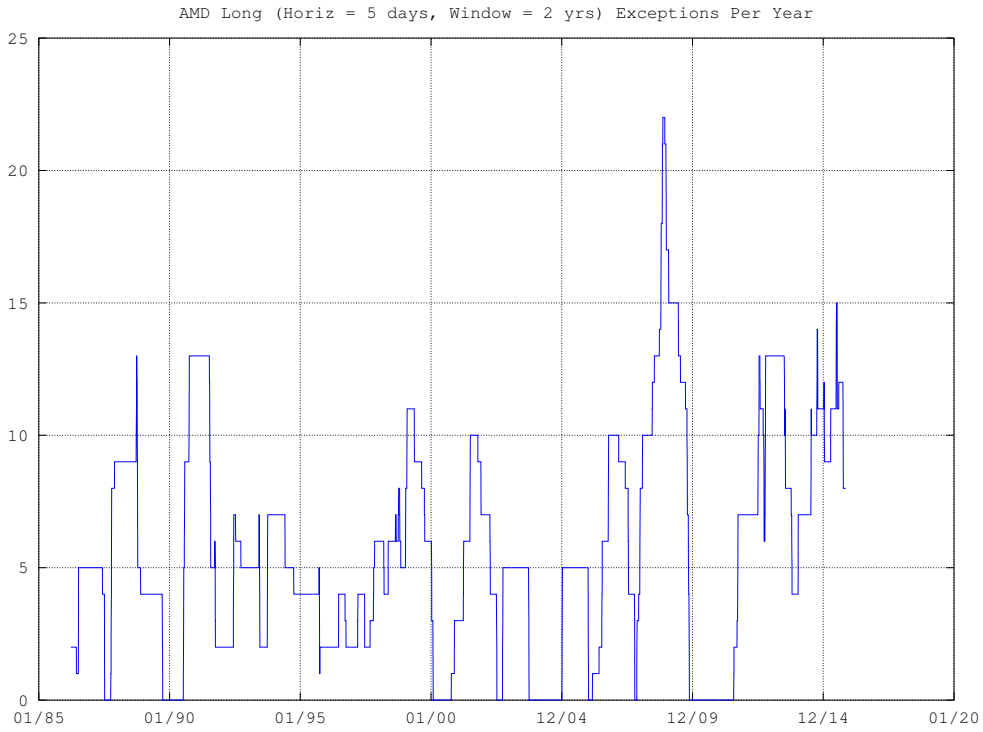

AMD Short (Horiz = 5 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
8000
6000
4000
2000
0
-2000
-4000
-6000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20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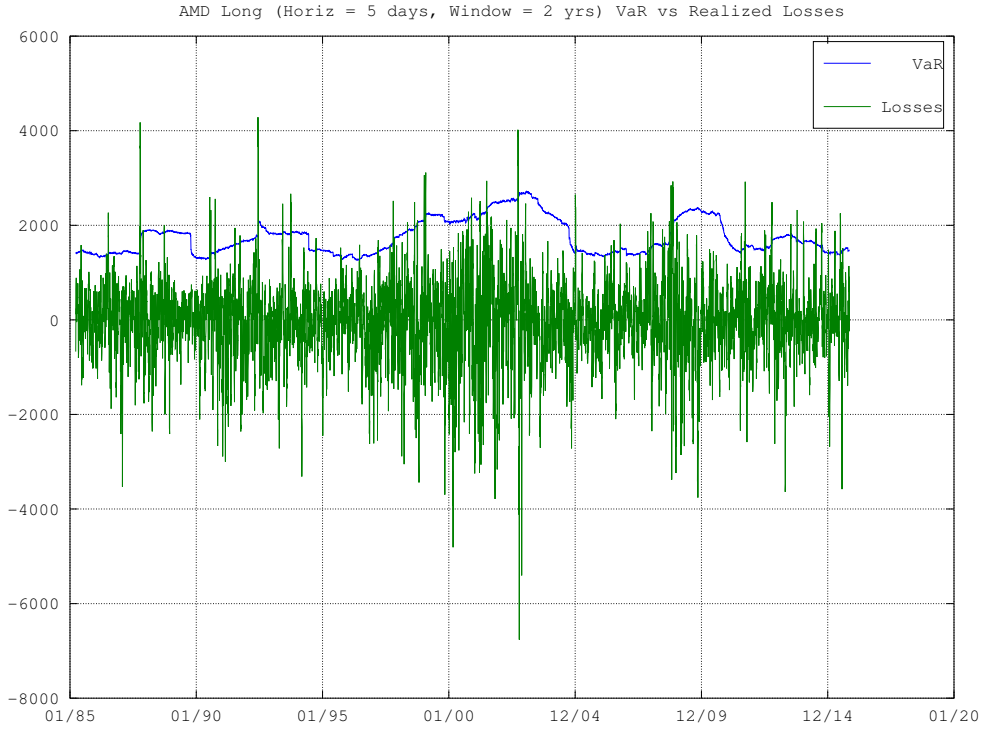
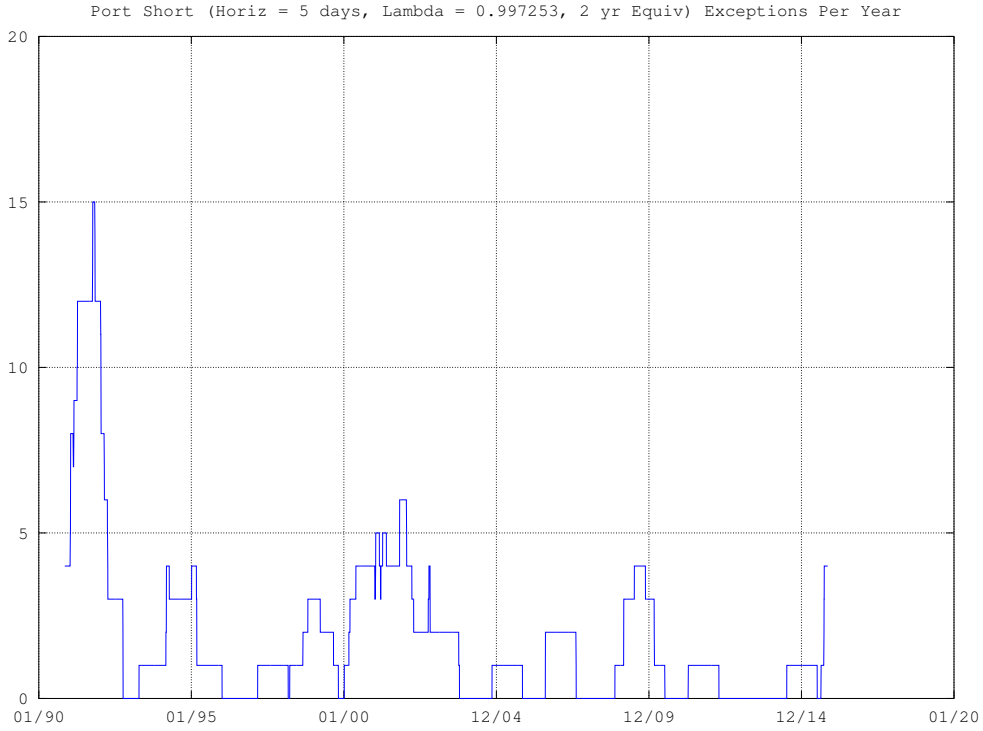
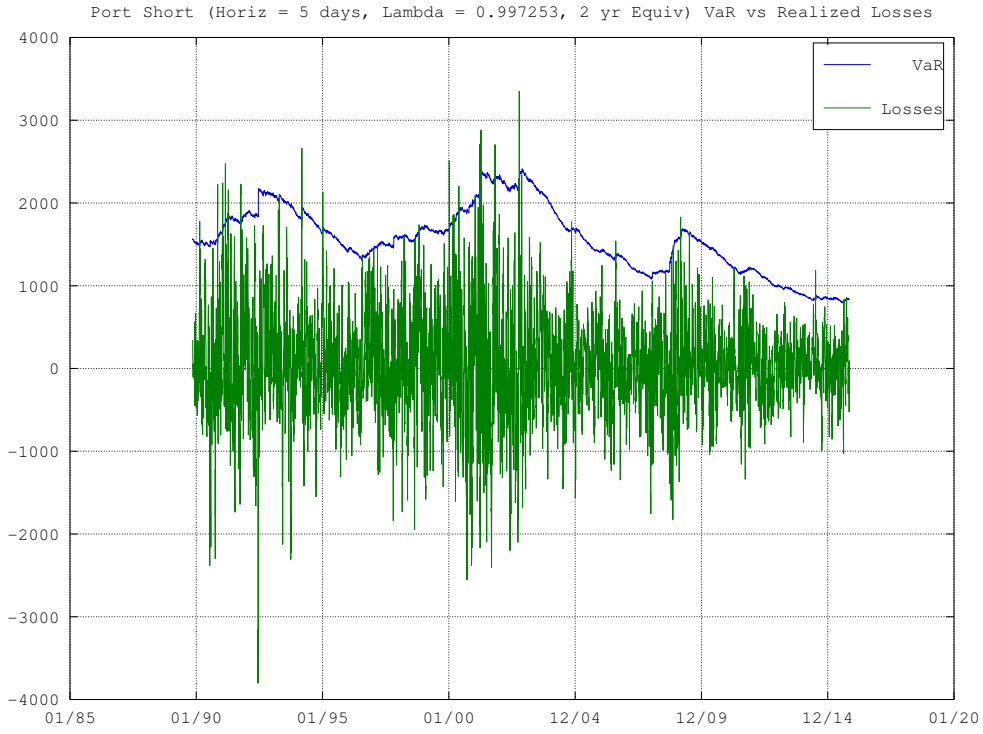
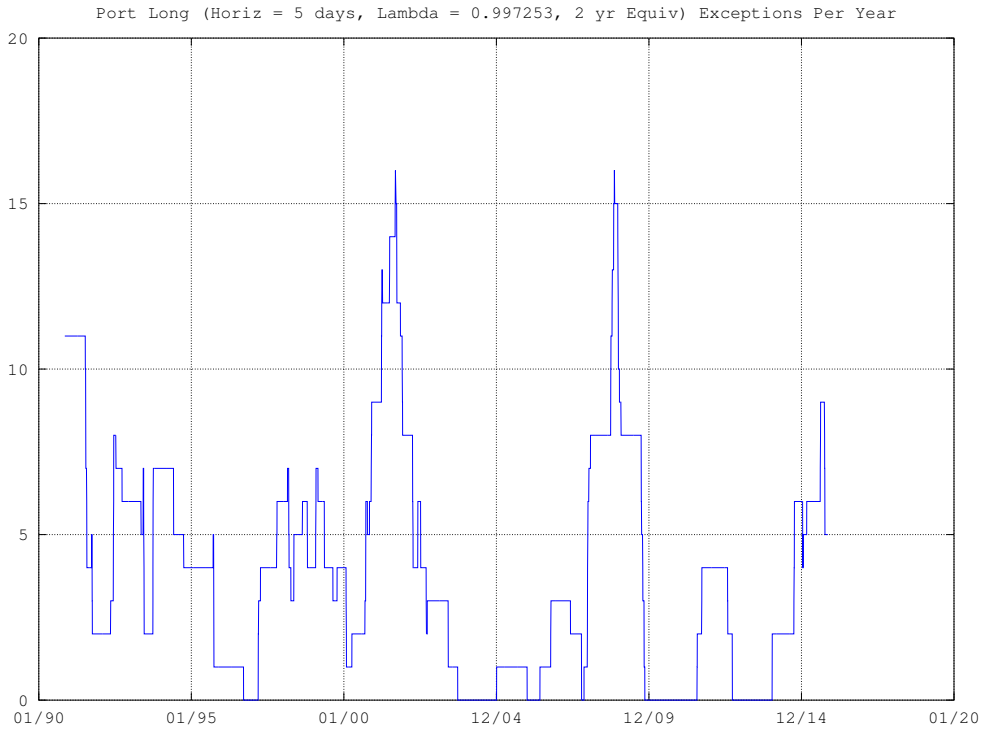
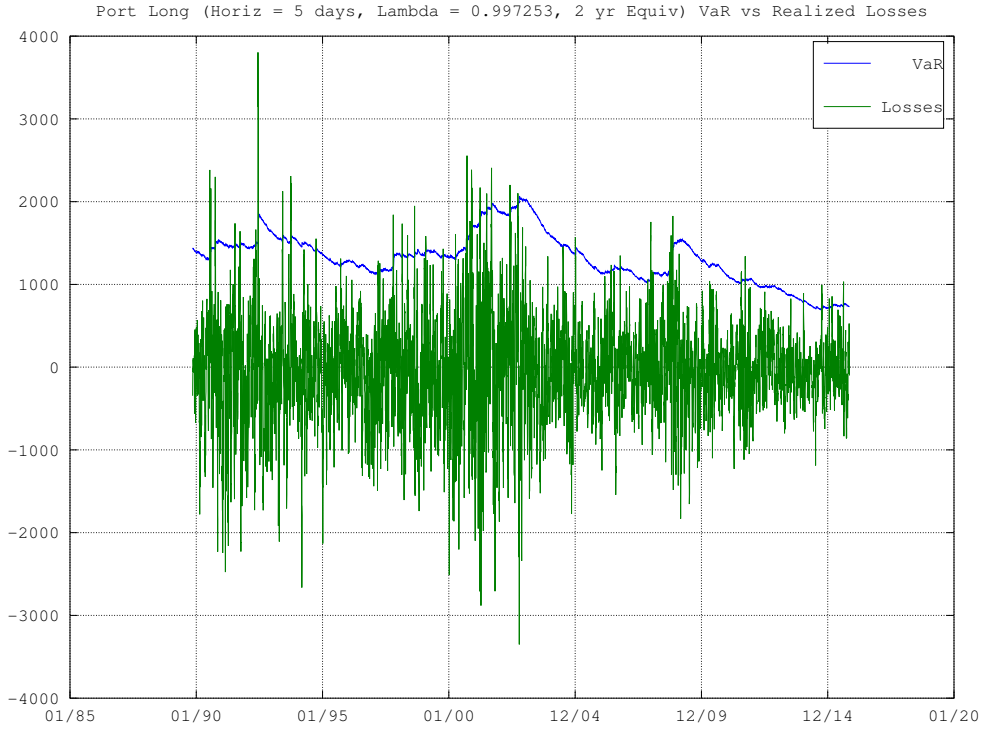

AMD Long (Horiz = 5 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
6000
4000
2000
0
-2000
-4000
-6000
-8000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

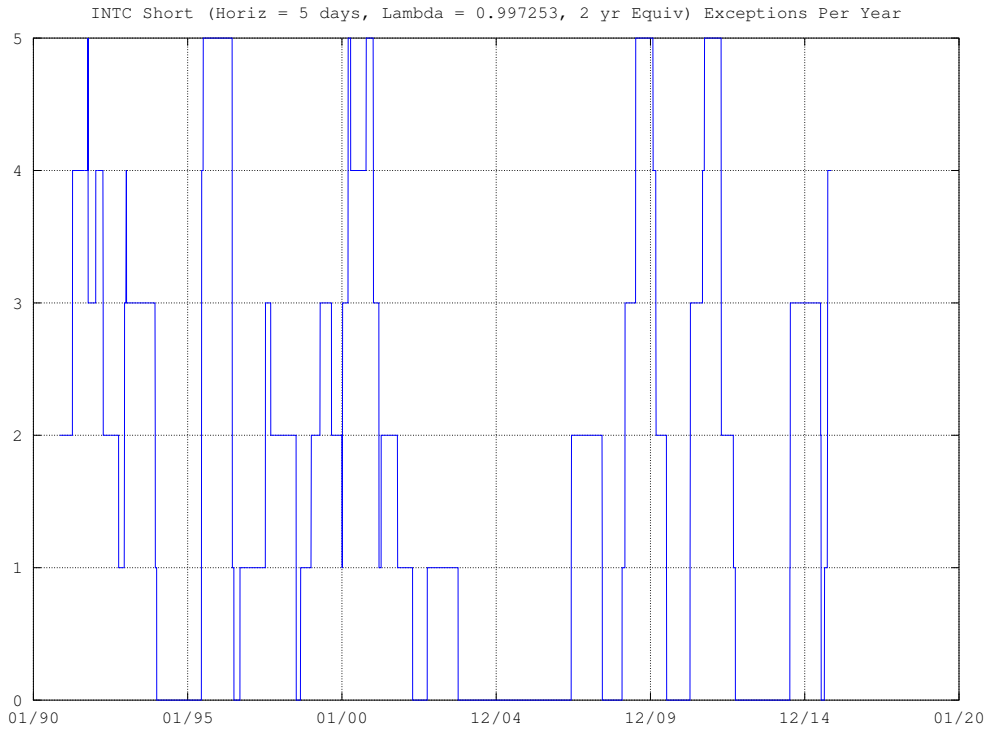
2 year equivalent exponential weighting, 5 day horizon:

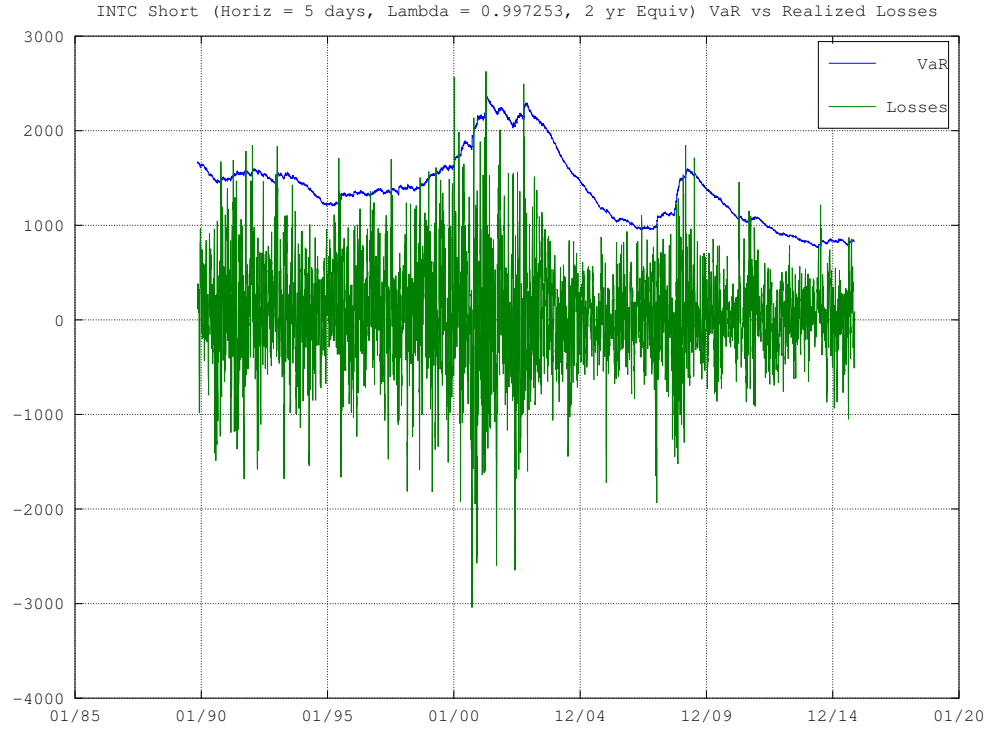





Port Long (Horiz = 5 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


Port Long (Horiz = 5 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
-4000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Short (Horiz = 5 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
5
4
3
2
1
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20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VaR
Losses
3000
2000
1000
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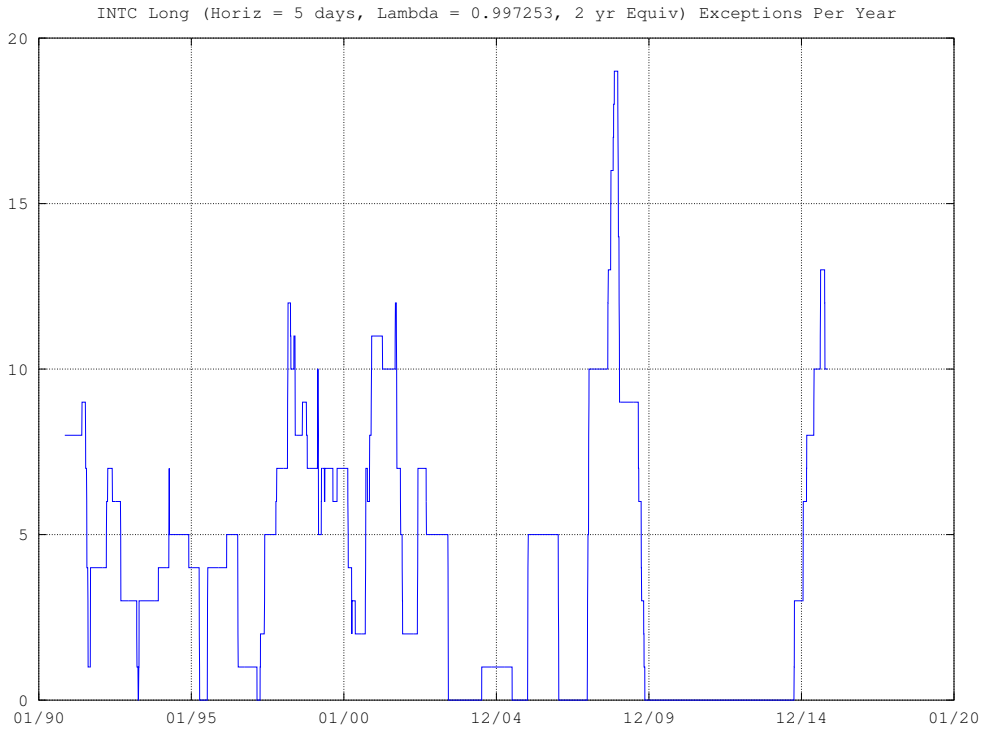
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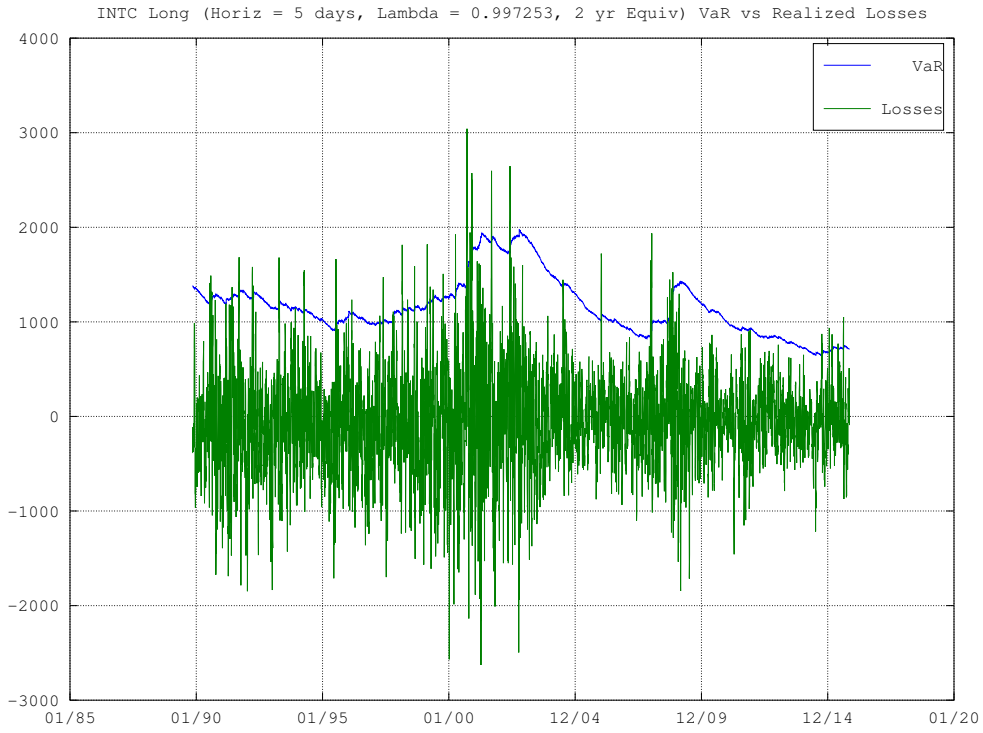
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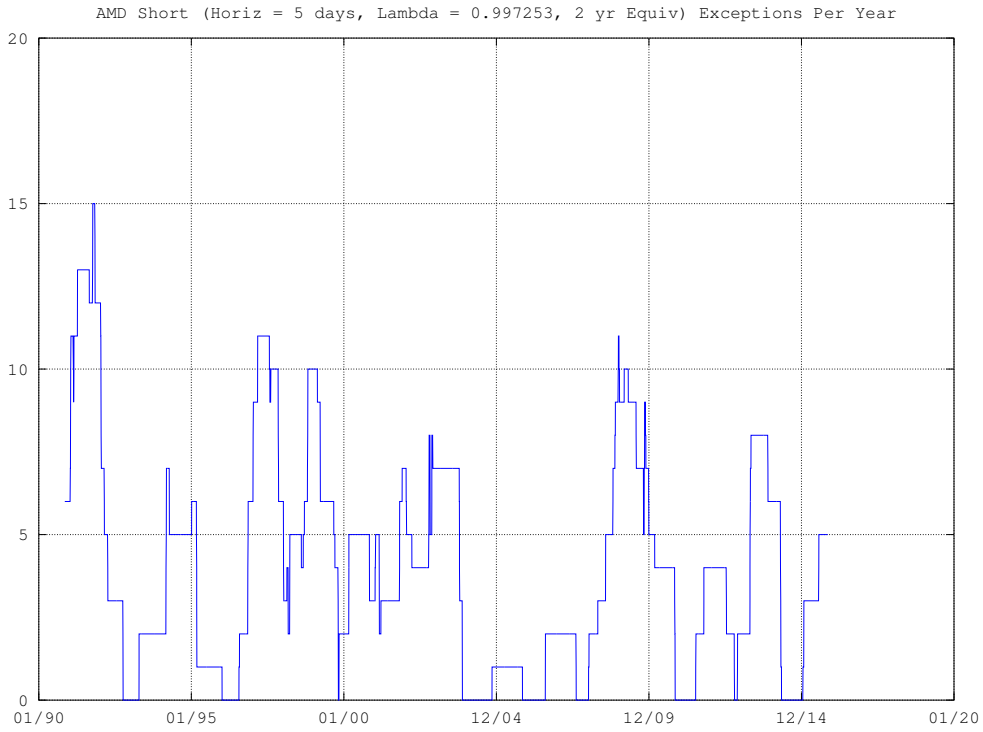
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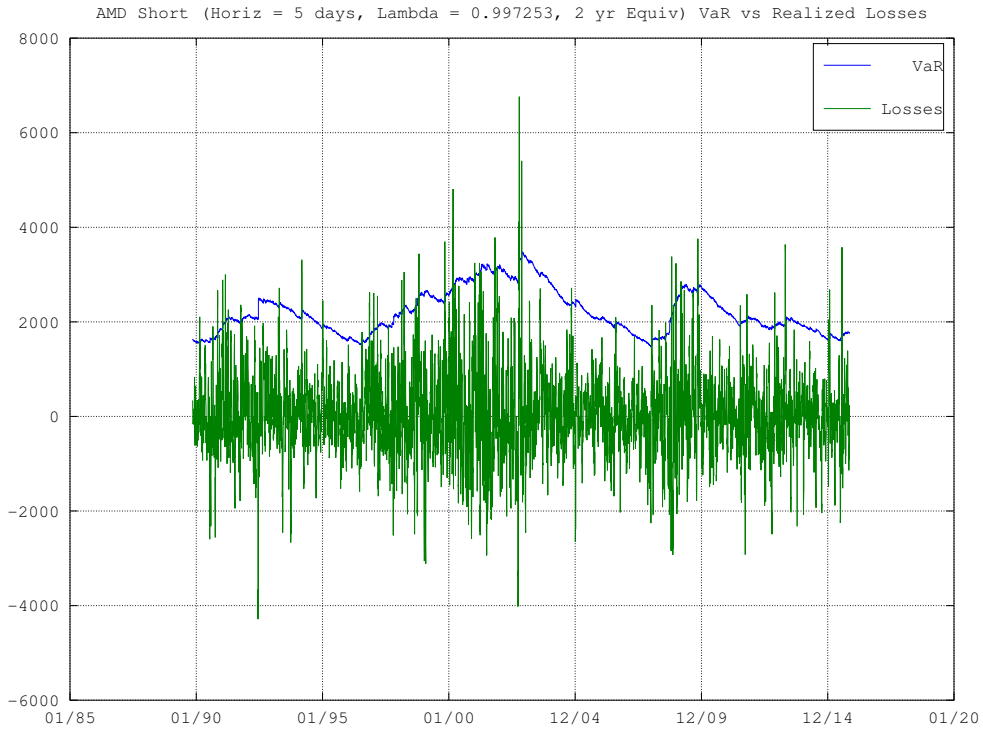
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8000
6000
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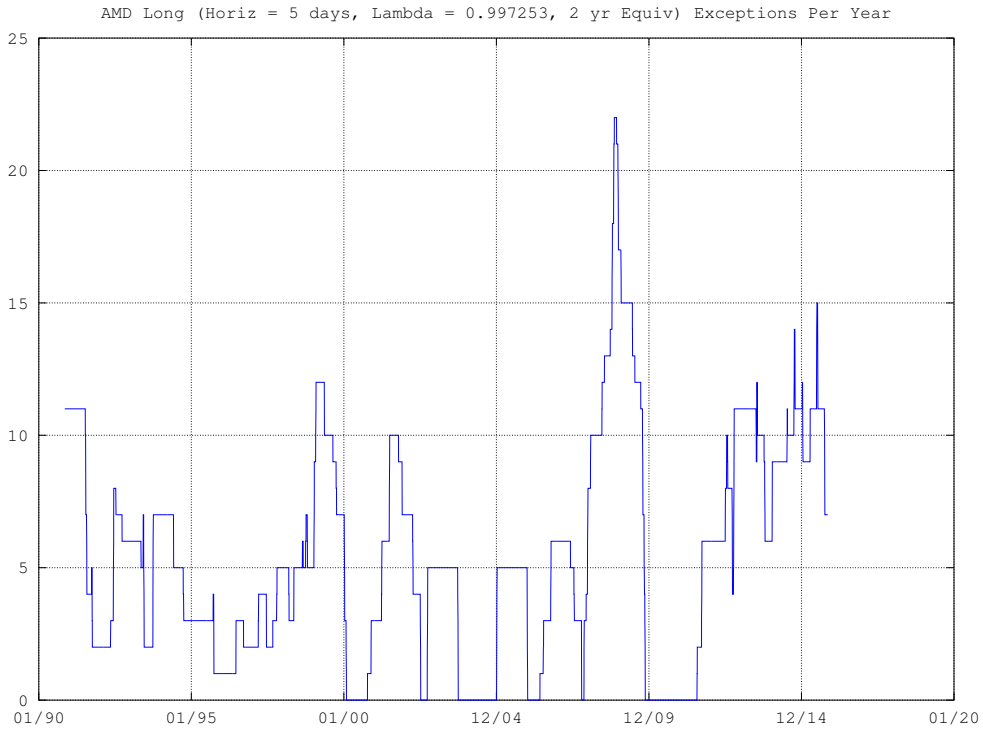
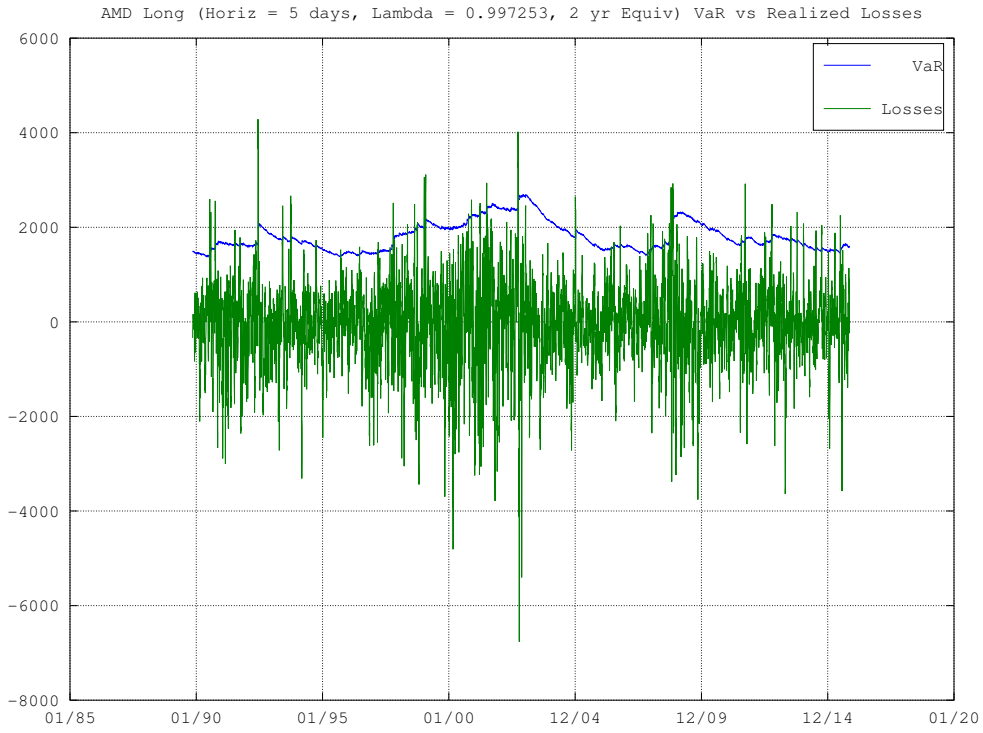
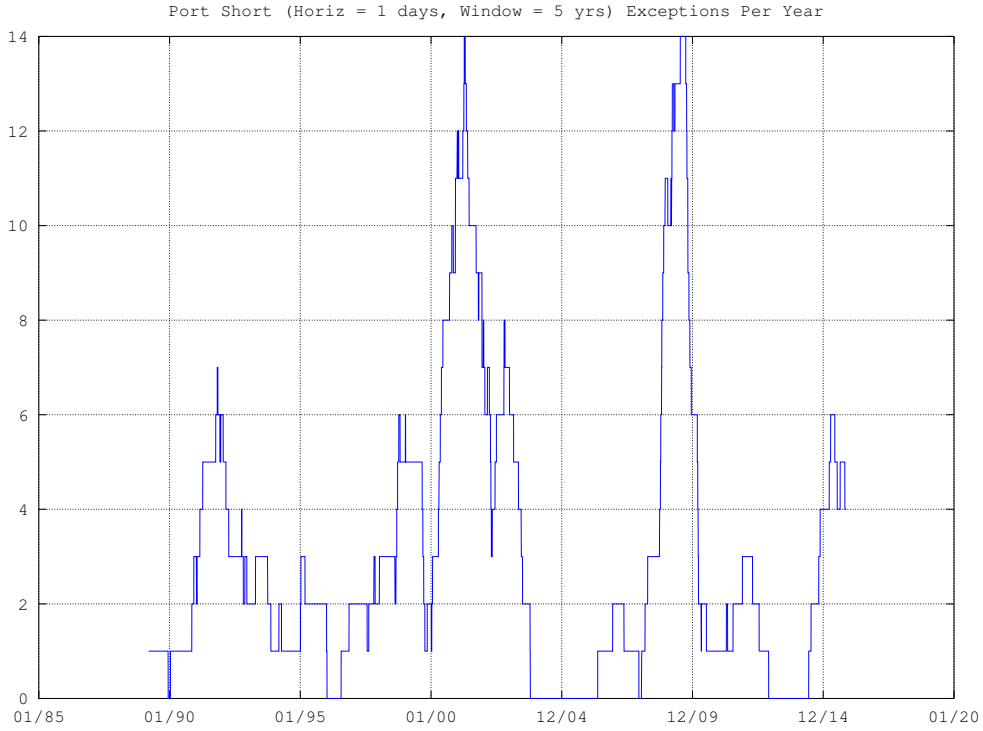
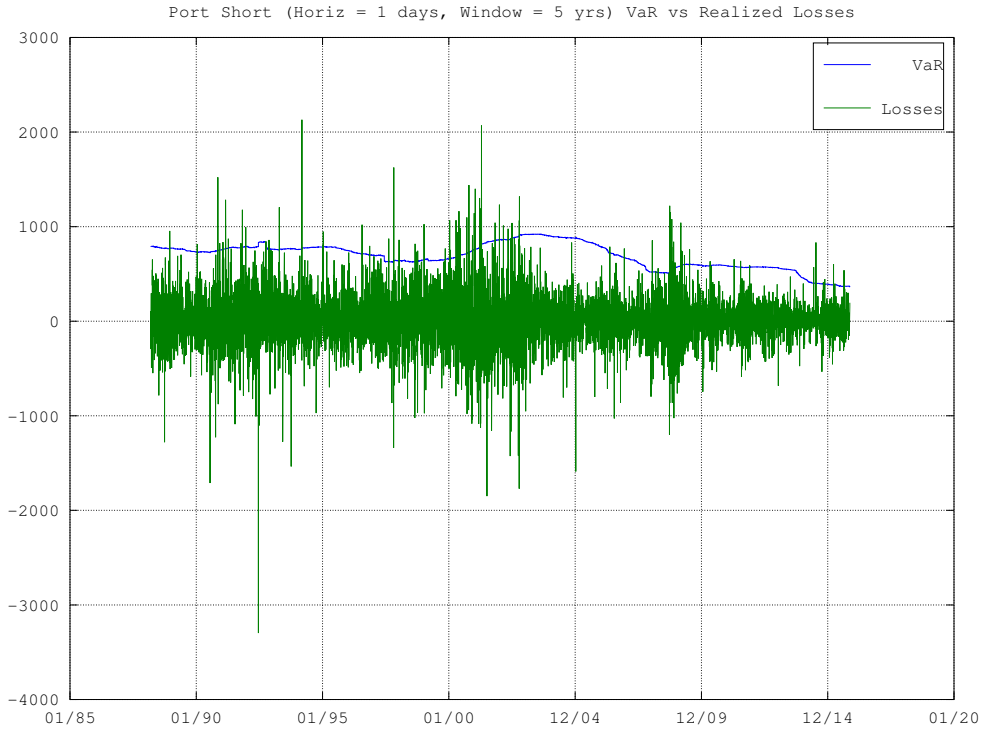
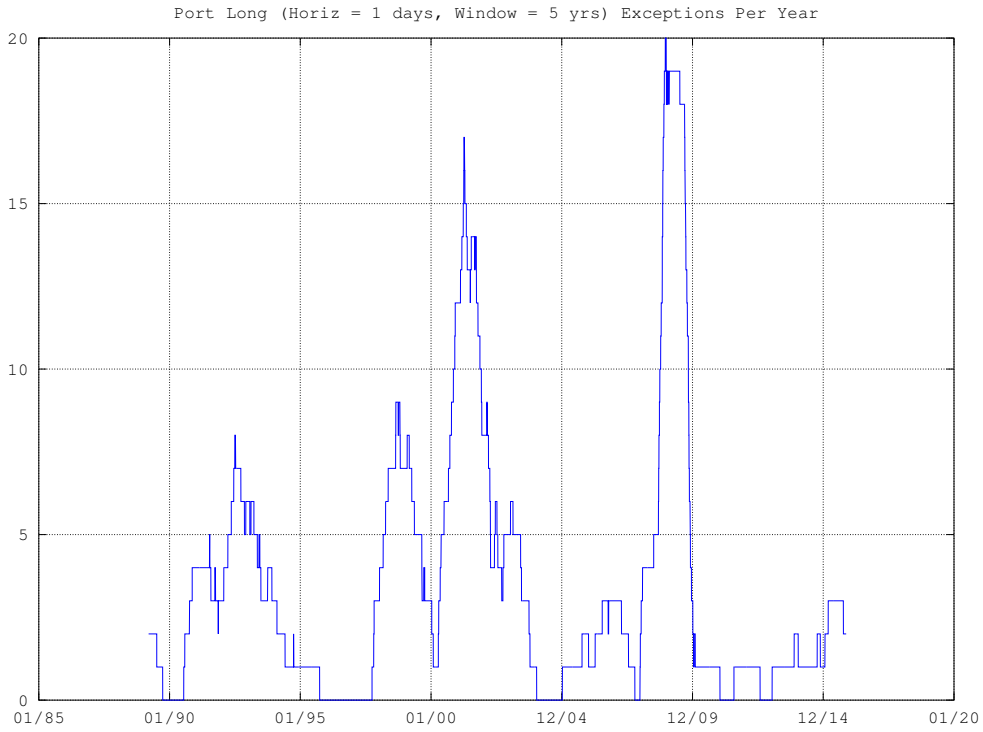

AMD Long (Horiz = 5 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
25
20
15
10
5
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


AMD Long (Horiz = 5 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
6000
4000
2000
0
-2000
-4000
-6000
-8000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

5 year window, 1 day horizon:






Port Long (Horiz = 1 days, Window = 5 yrs) Exceptions Per Year
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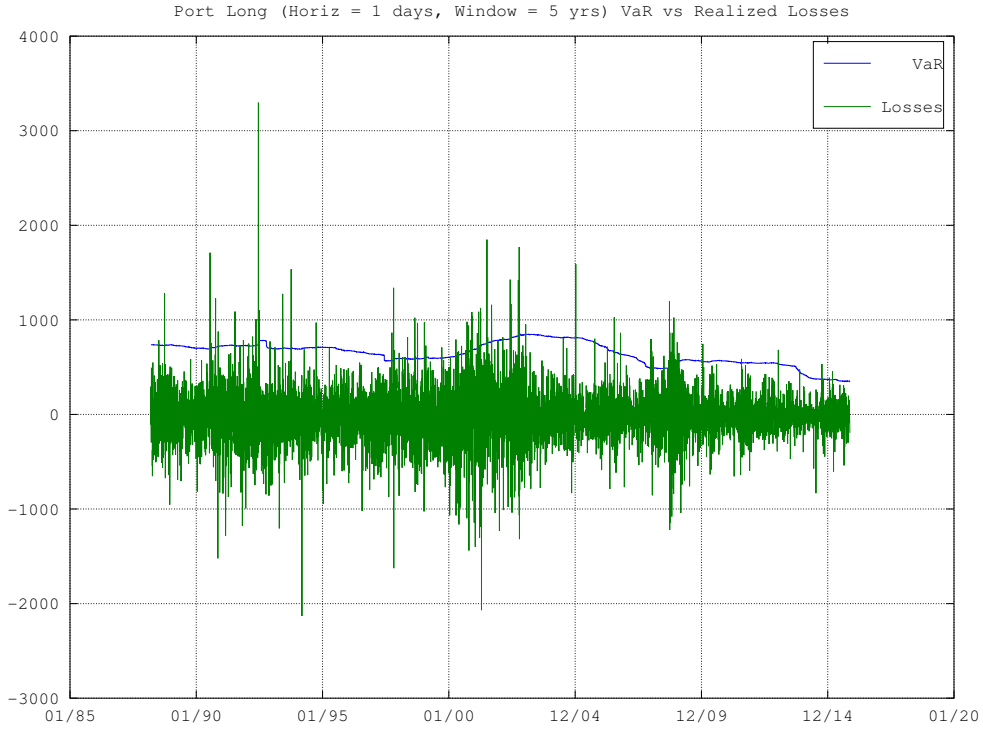
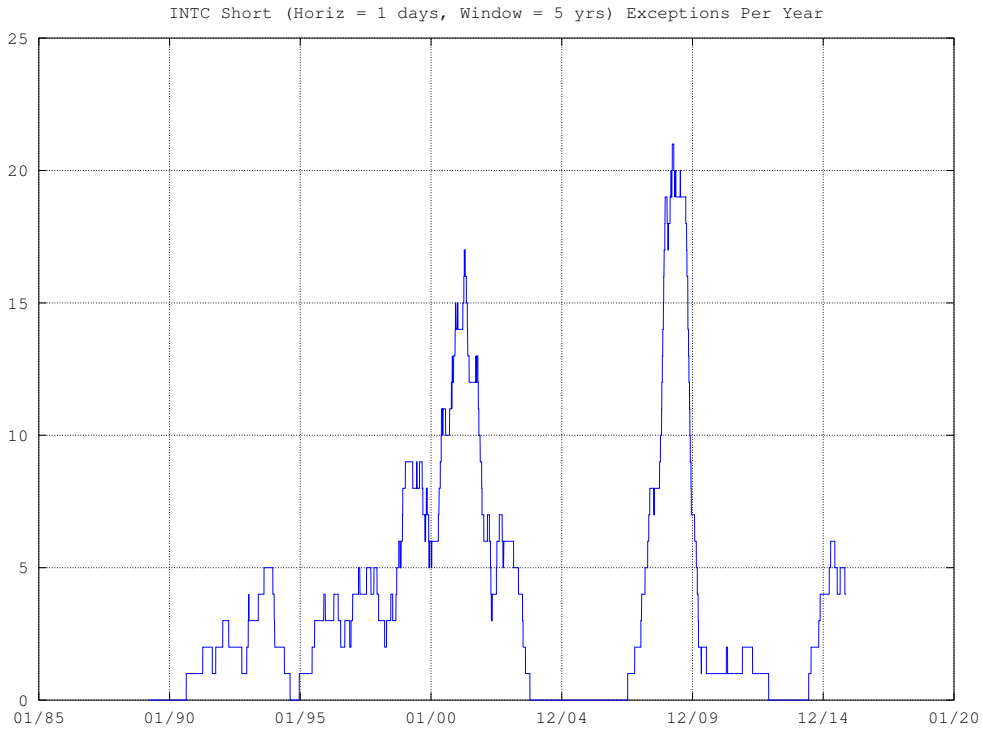
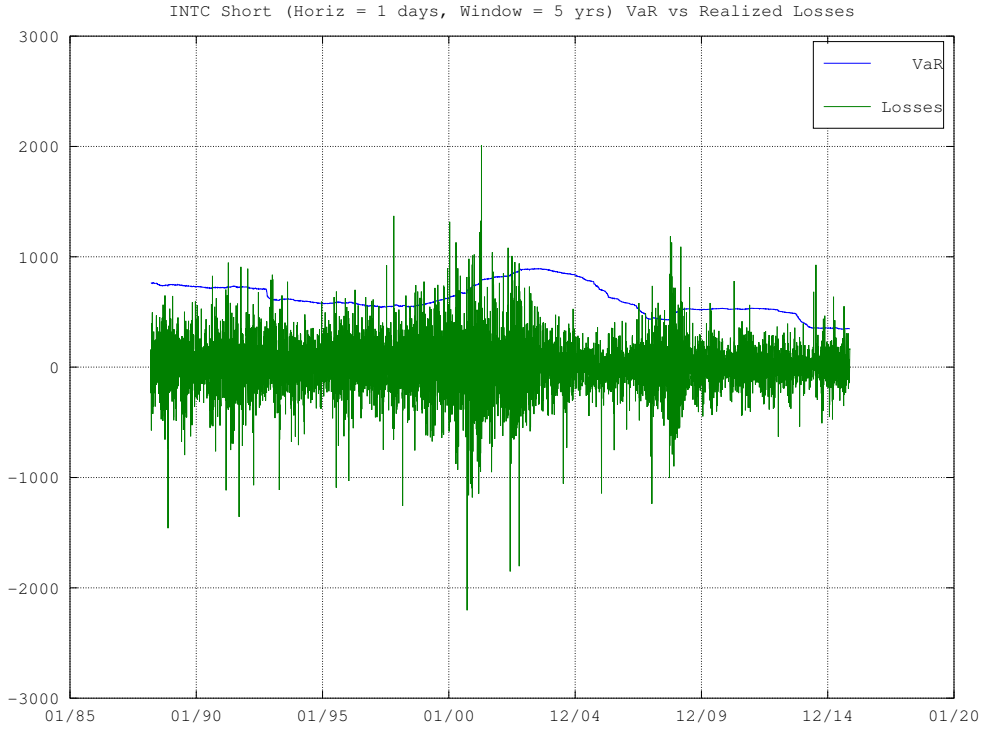
01/95
01/00
12/04
12/09
12/14
01/20


Port Long (Horiz = 1 days, Window = 5 yrs) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Short (Horiz = 1 days, Window = 5 yrs) Exceptions Per Year
25
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20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-2000
-3000
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01/95
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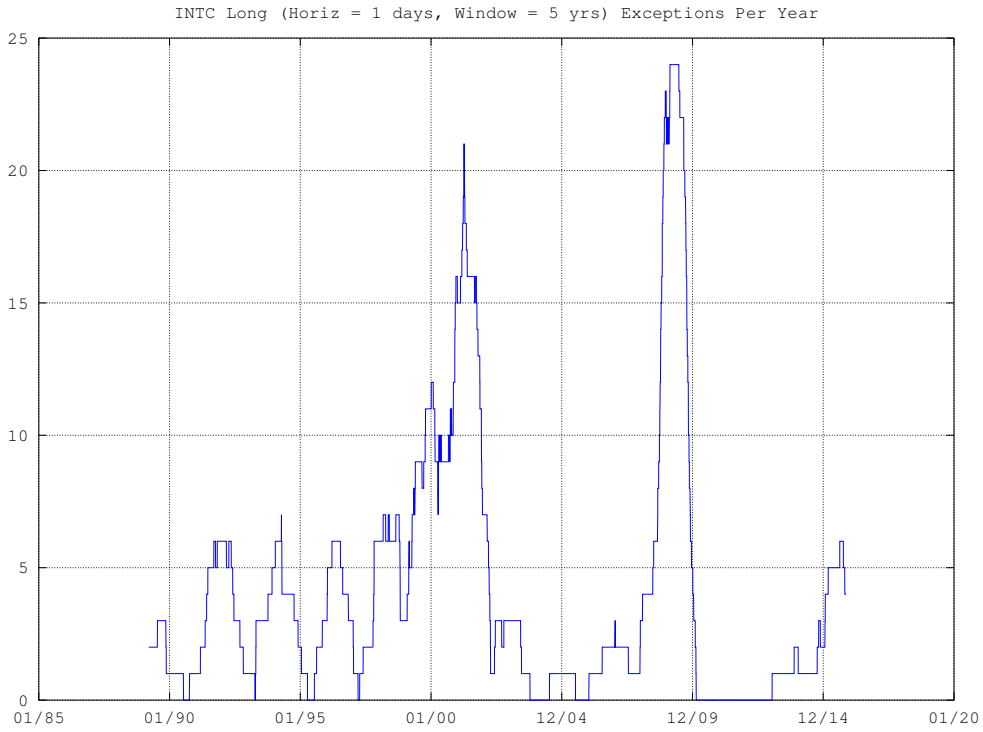
12/04
12/09
12/14
01/20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12/14
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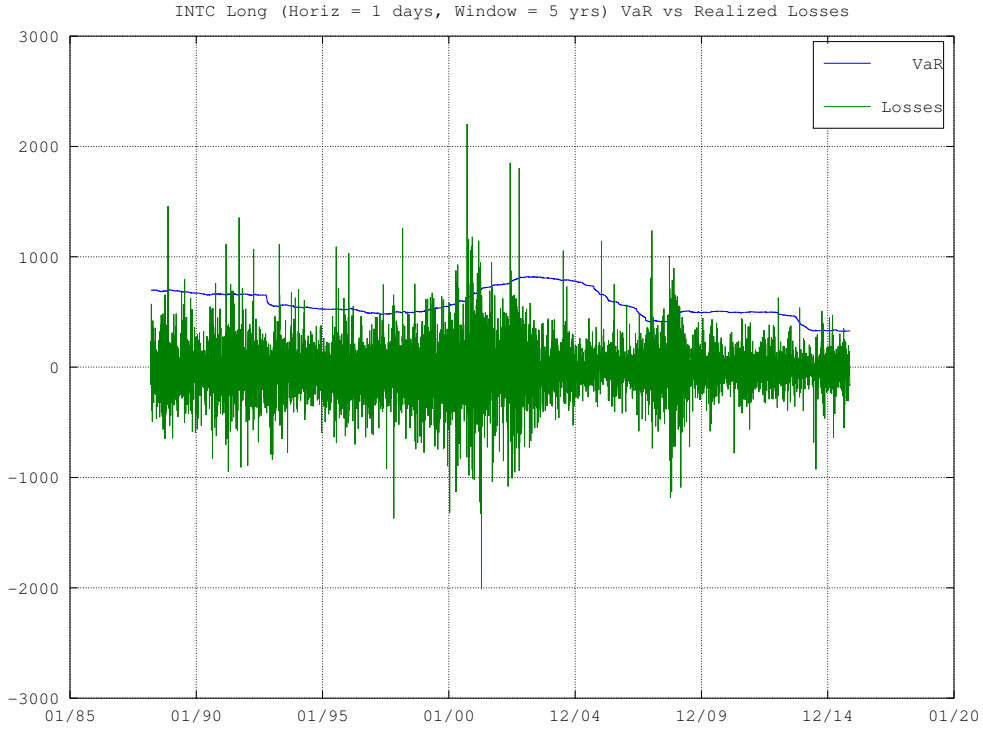
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2000
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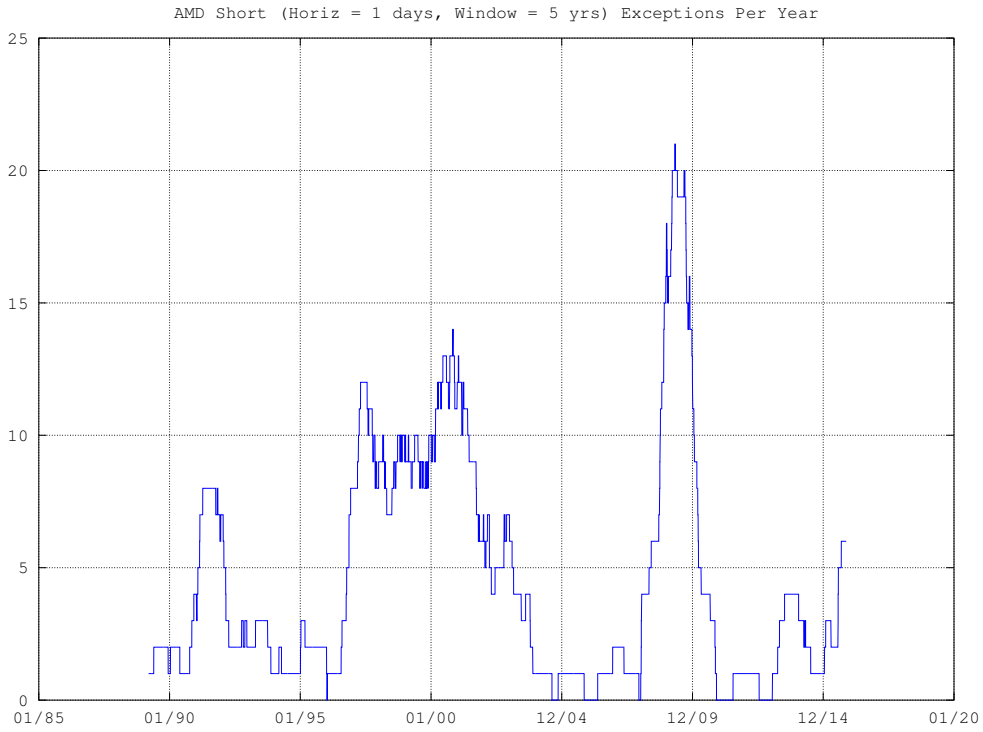
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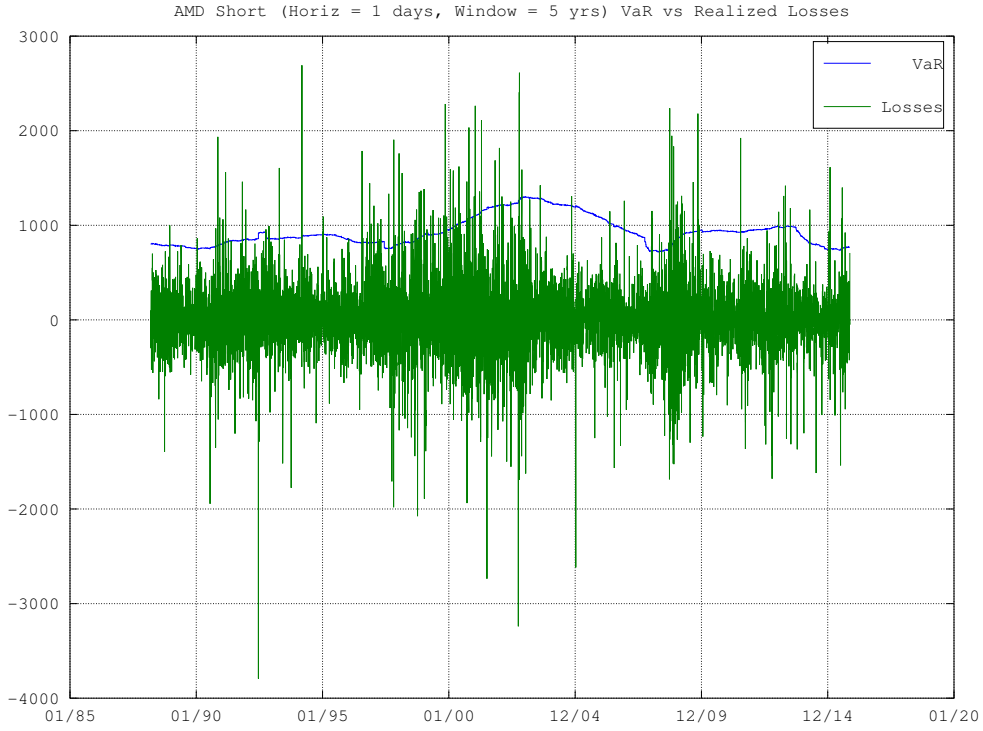
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Losses
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12/09
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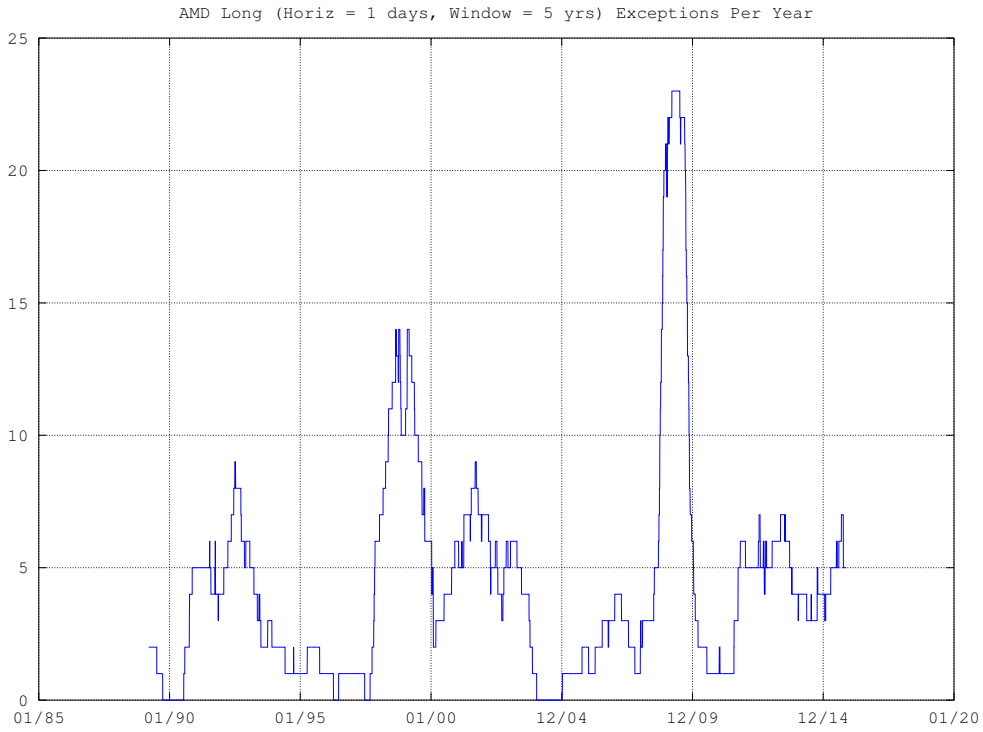
01/20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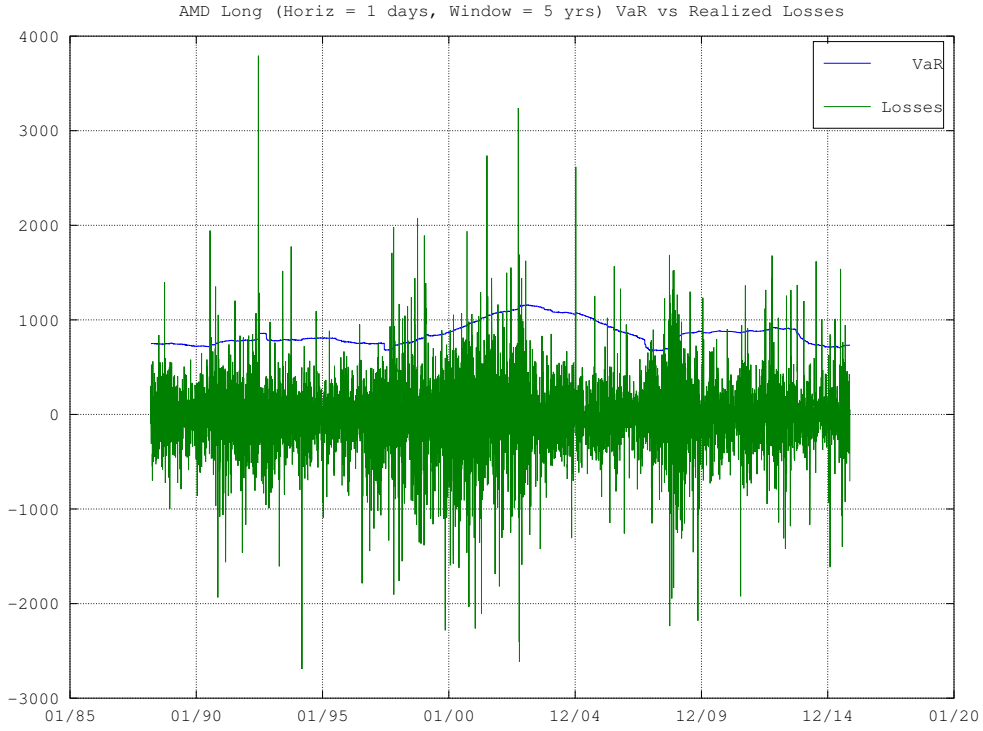
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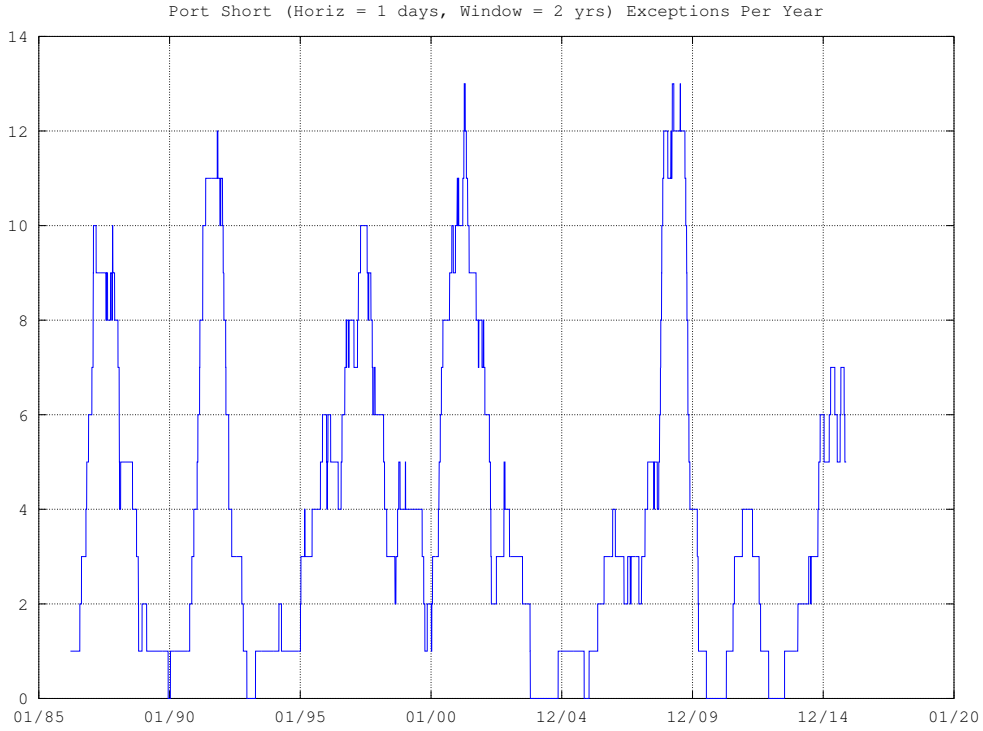
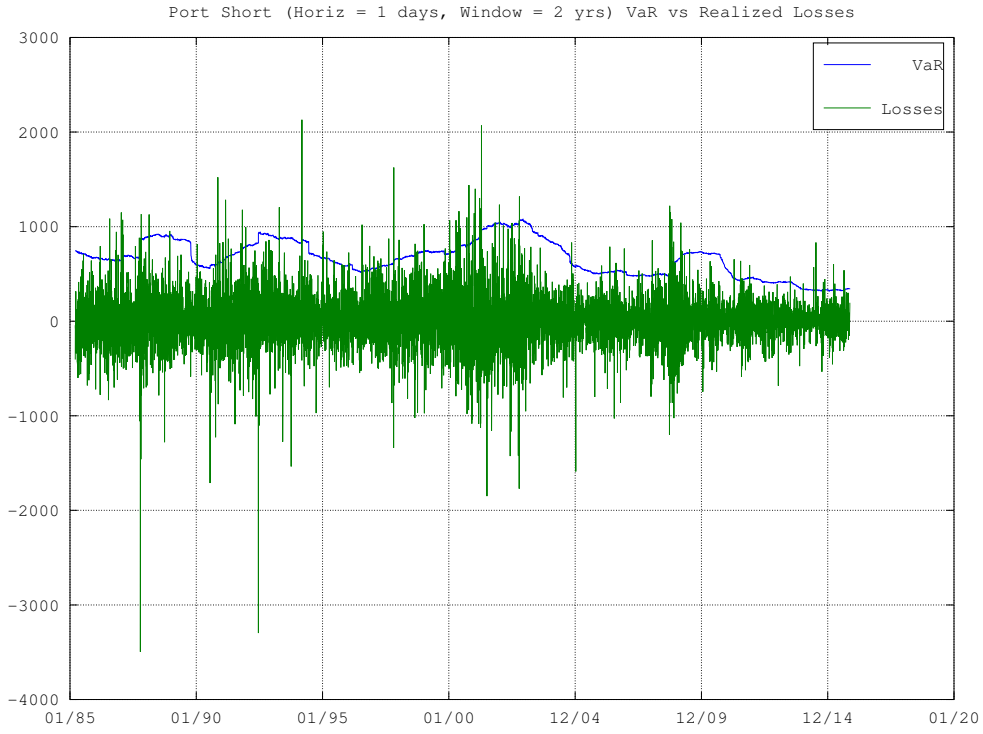
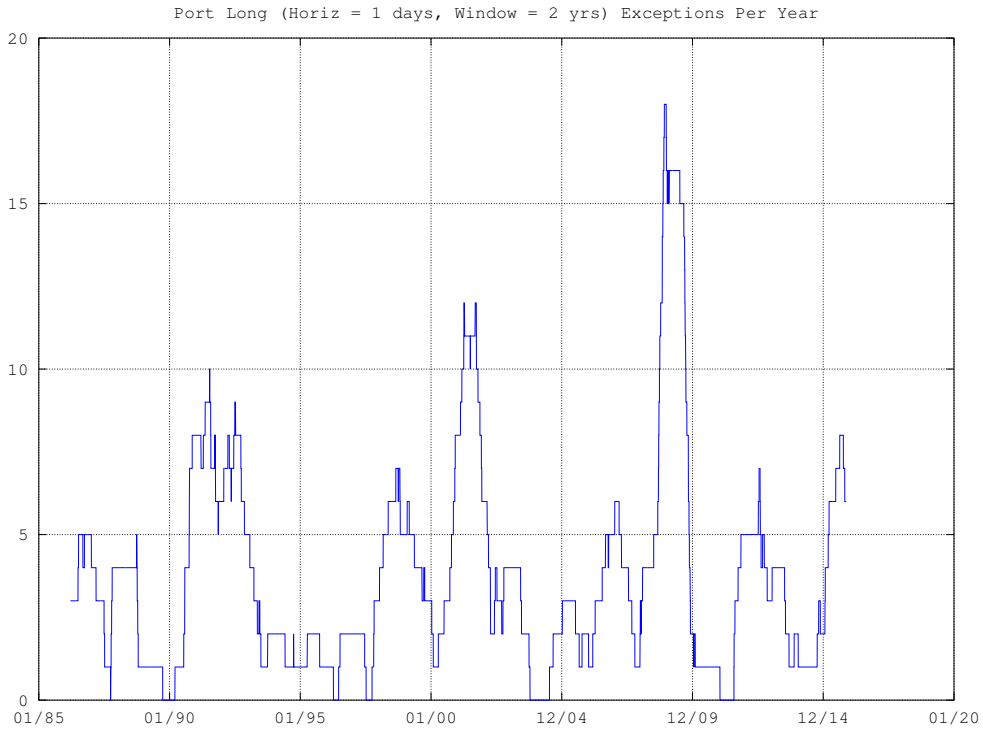
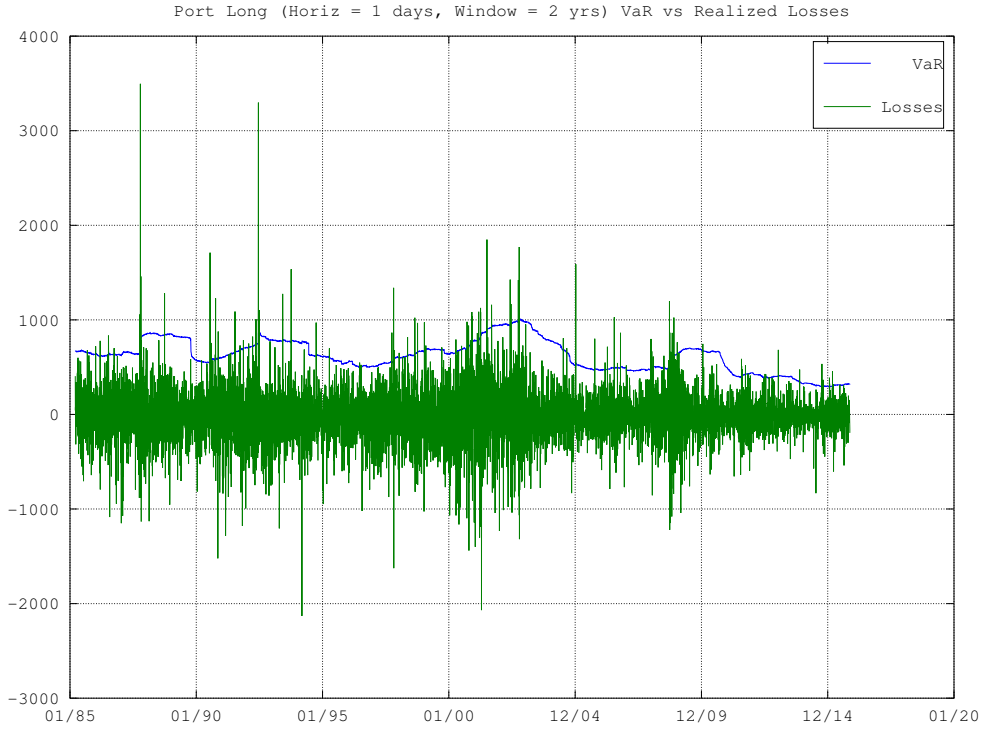
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

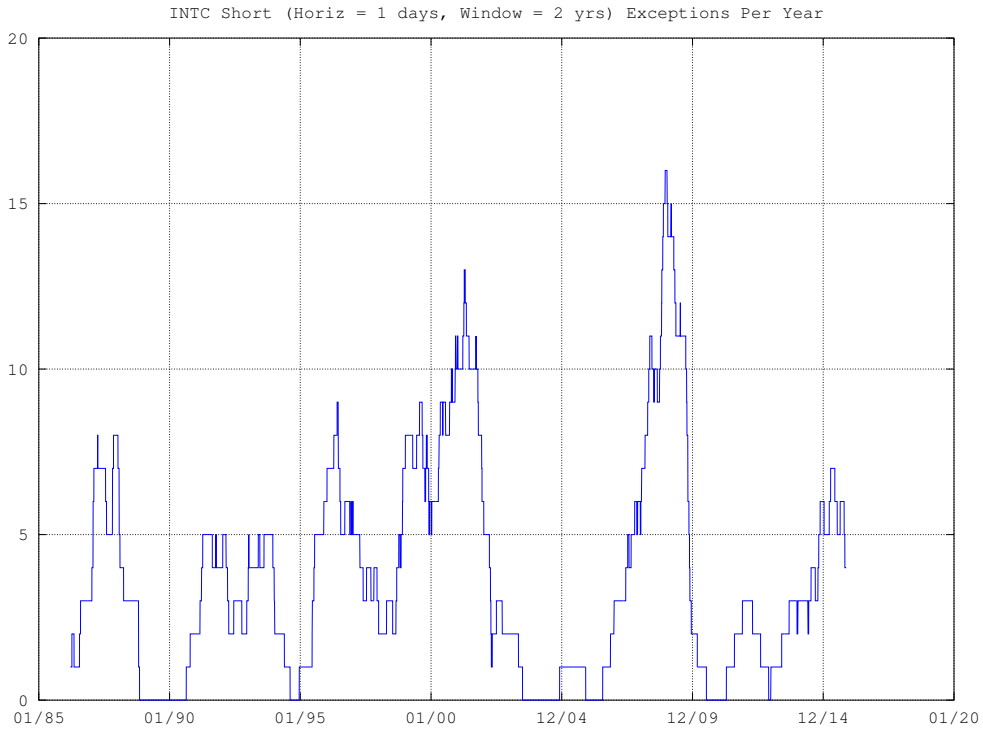
2 year window, 1 day horizon:

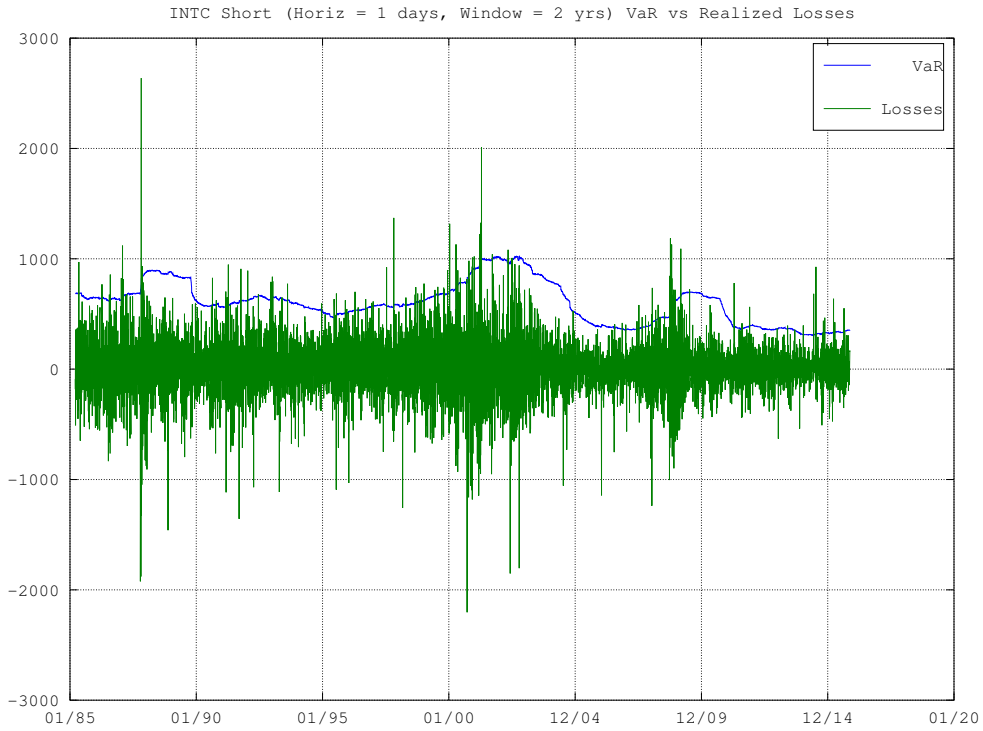


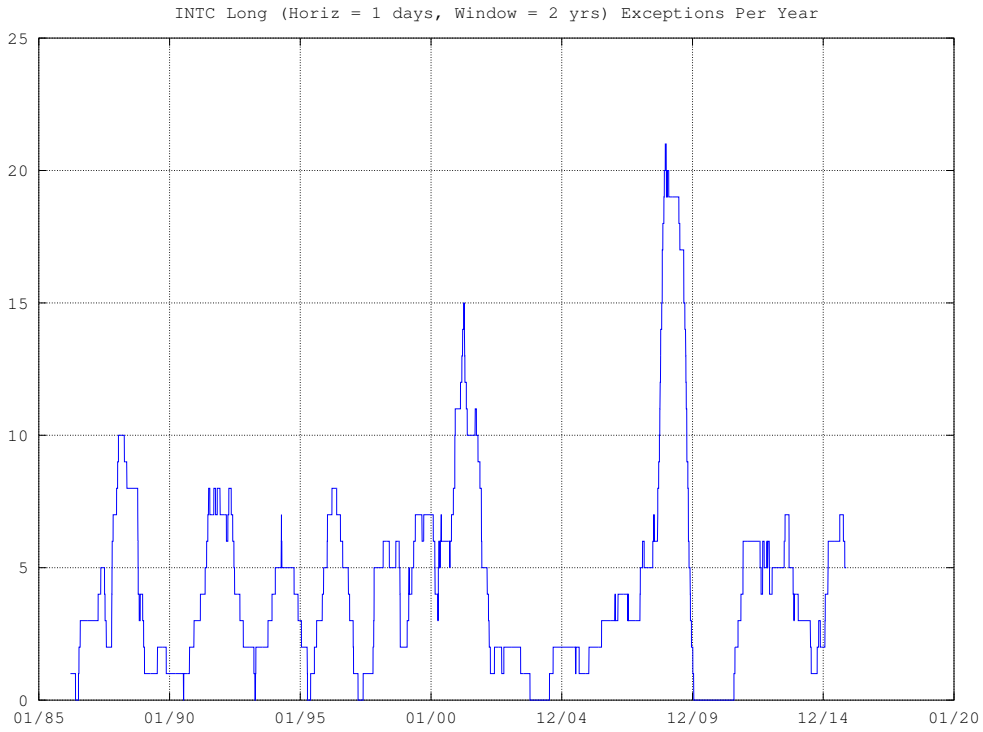


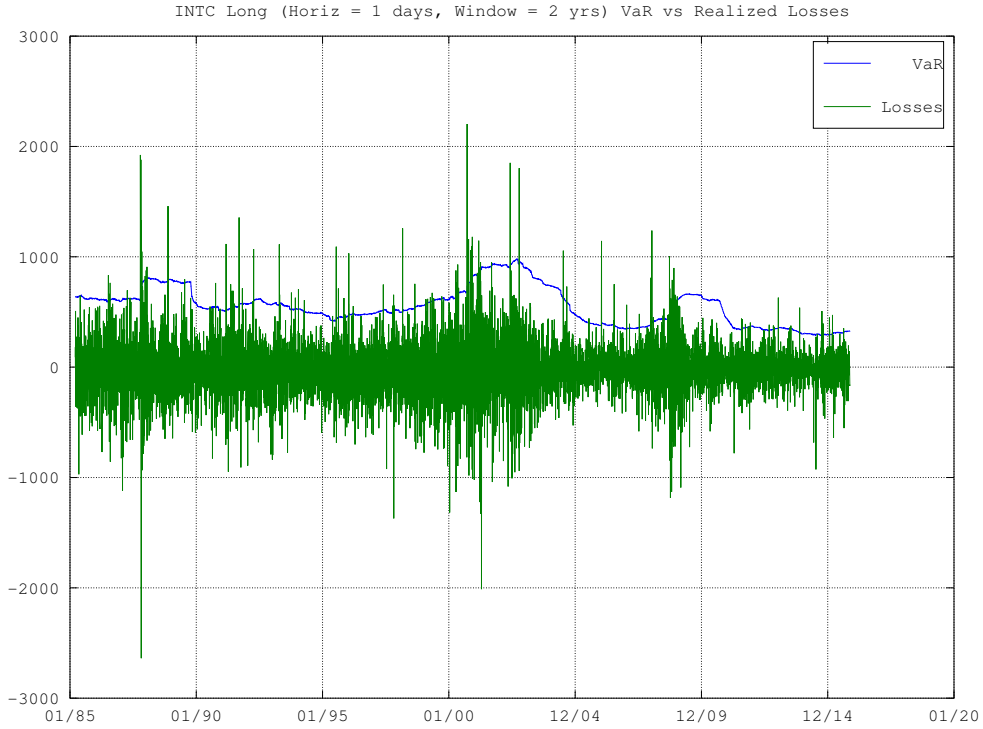

Port Long (Horiz = 1 days, Window = 2 yrs) Exceptions Per Year
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

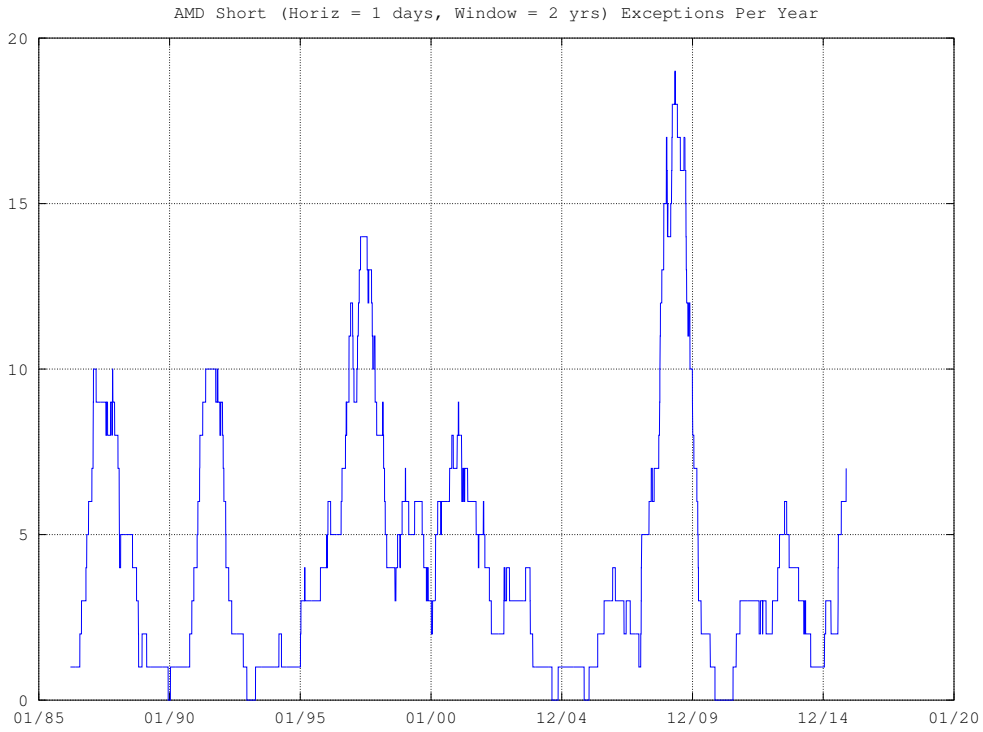

Port Long (Horiz = 1 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

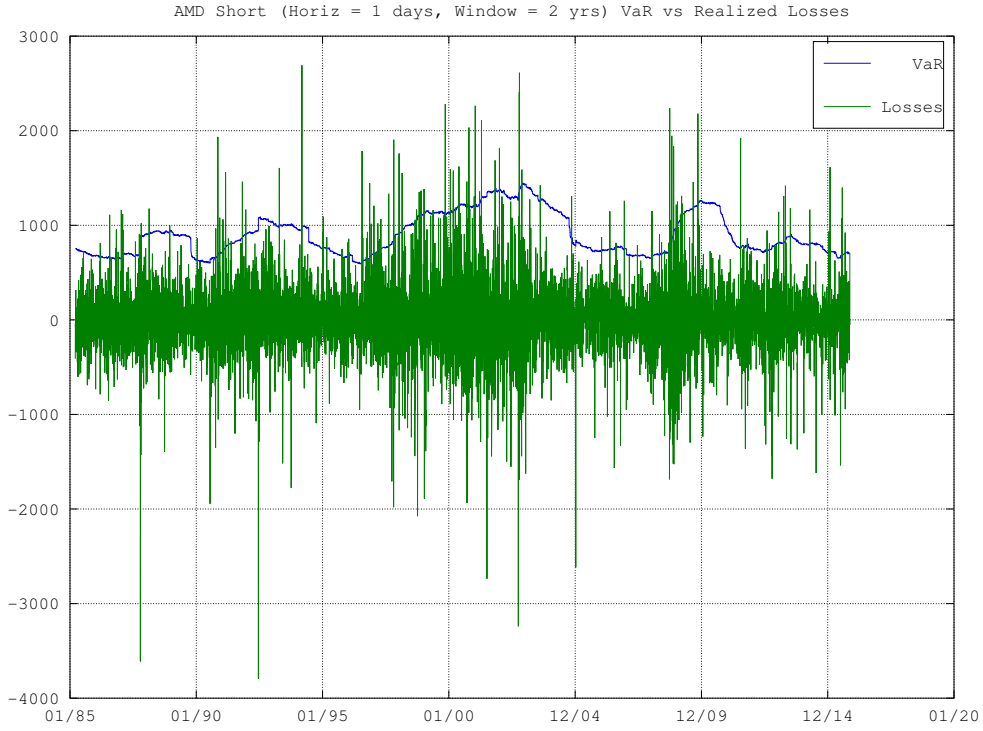

INTC Short (Horiz = 1 days, Window = 2 yrs) Exceptions Per Year
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

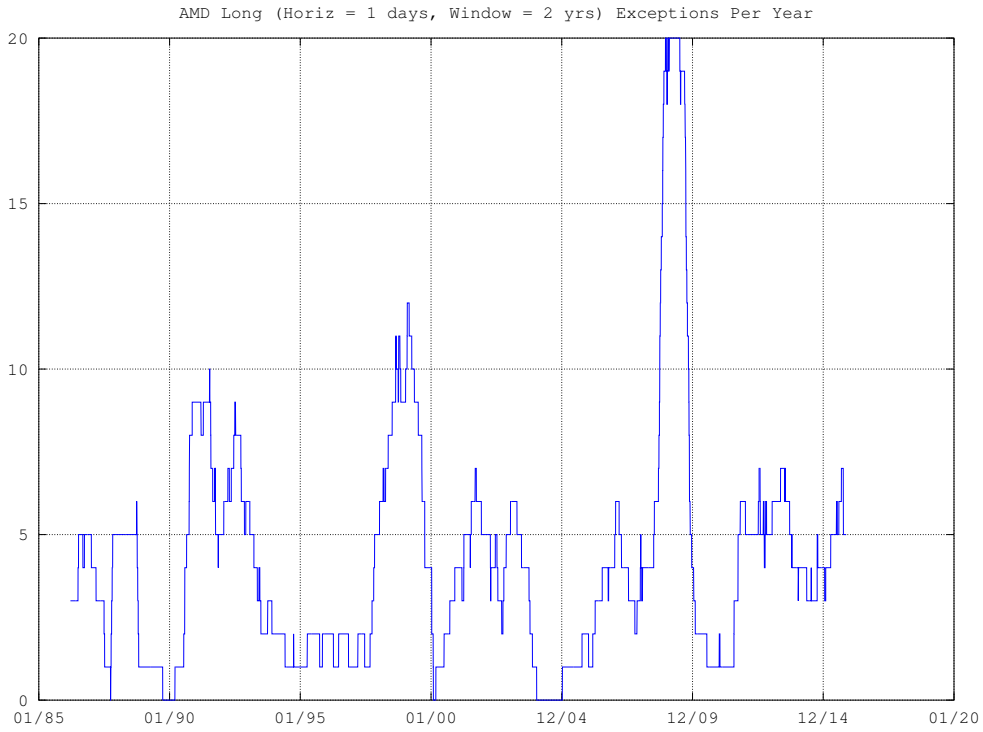

INTC Short (Horiz = 1 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

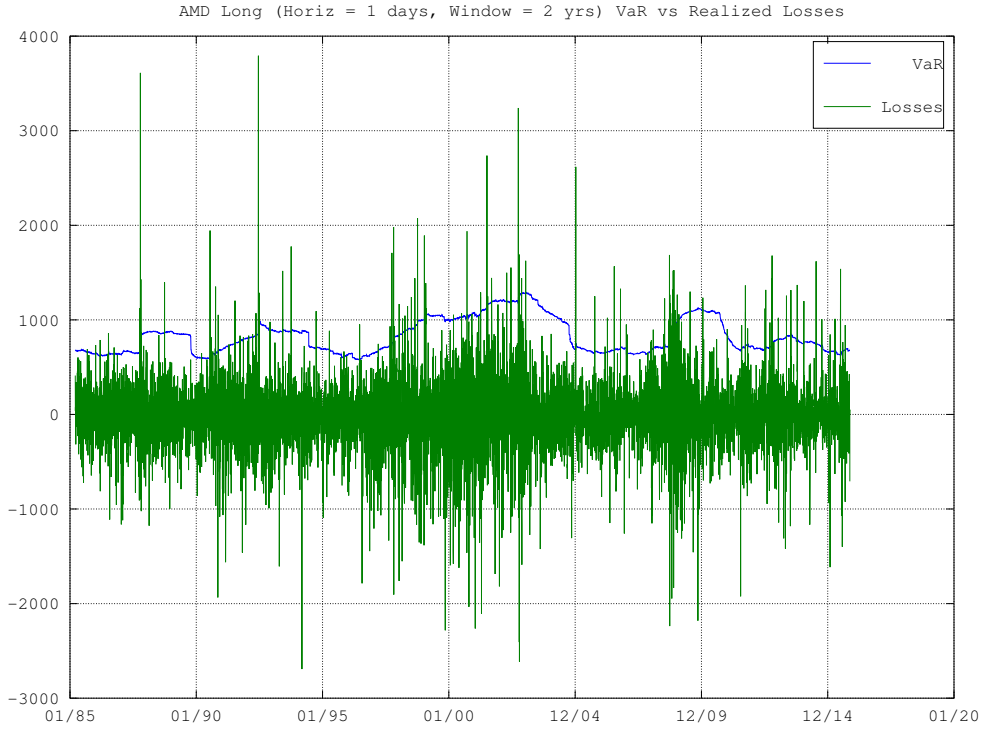

INTC Long (Horiz = 1 days, Window = 2 yrs) Exceptions Per Year
25
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Long (Horiz = 1 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

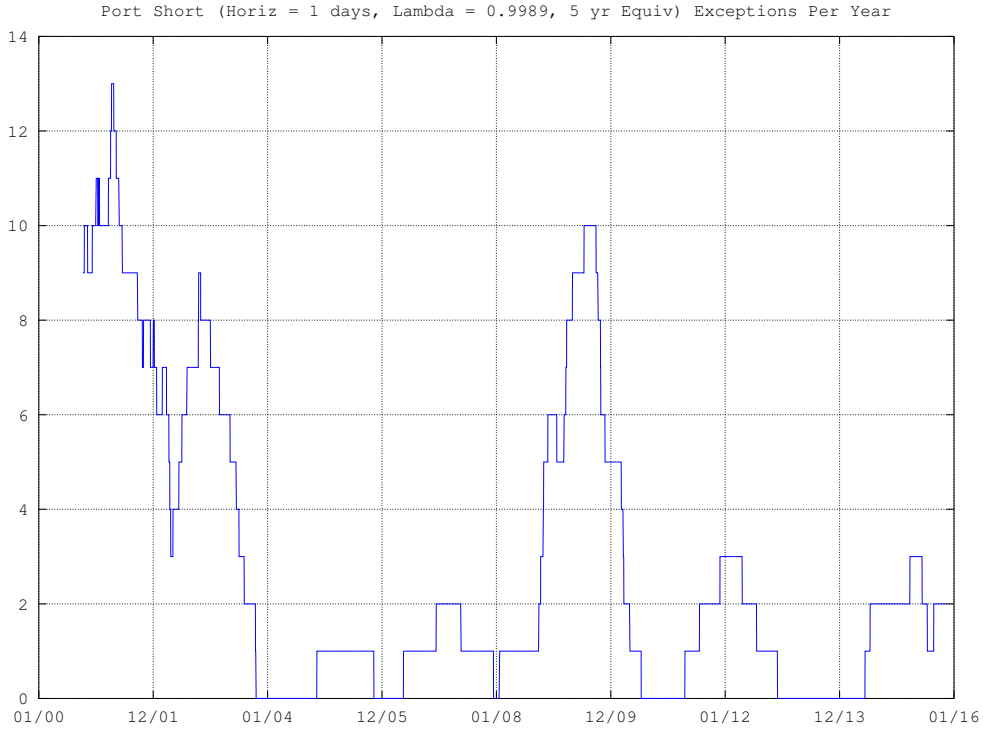

AMD Short (Horiz = 1 days, Window = 2 yrs) Exceptions Per Year
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

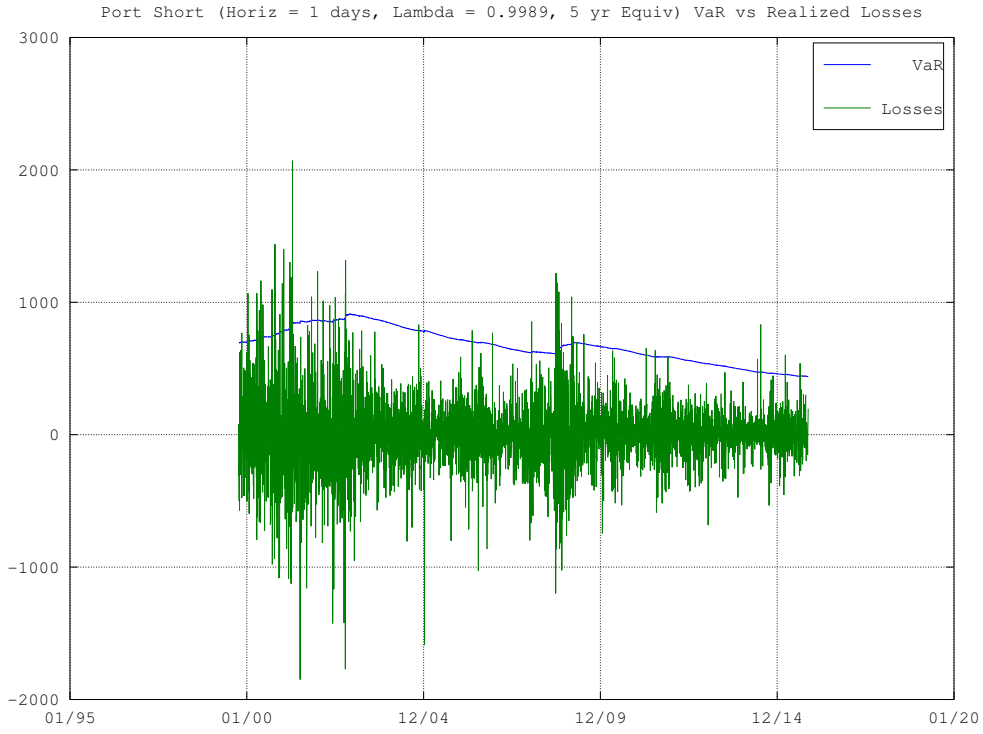

AMD Short (Horiz = 1 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
-4000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

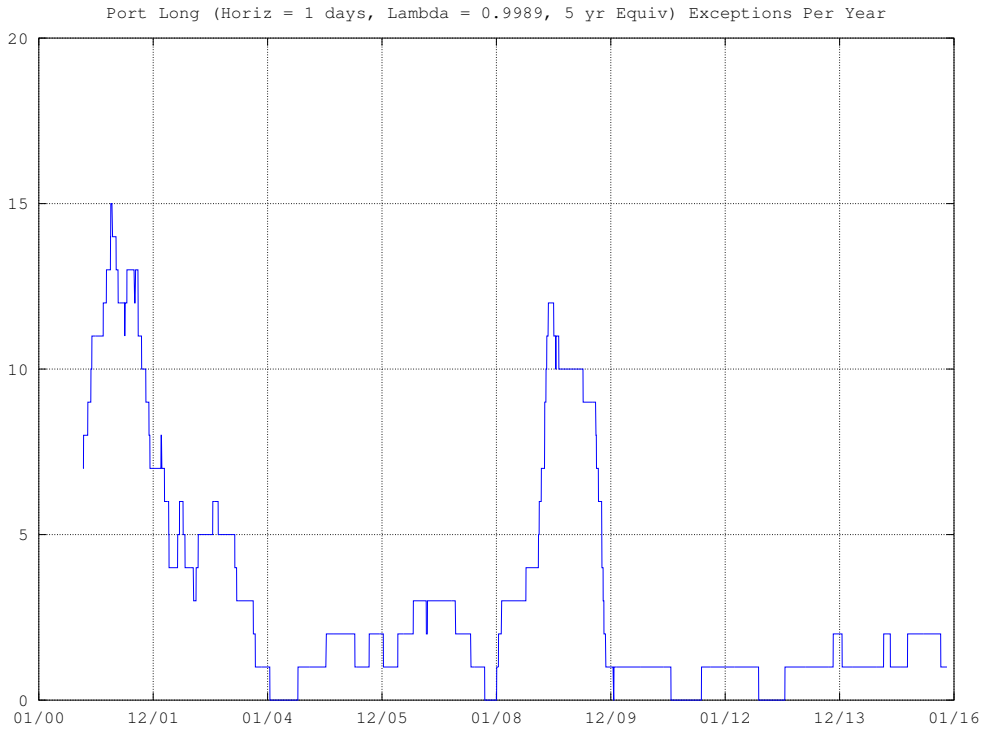

AMD Long (Horiz = 1 days, Window = 2 yrs) Exceptions Per Year
20
15
10
5
0
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

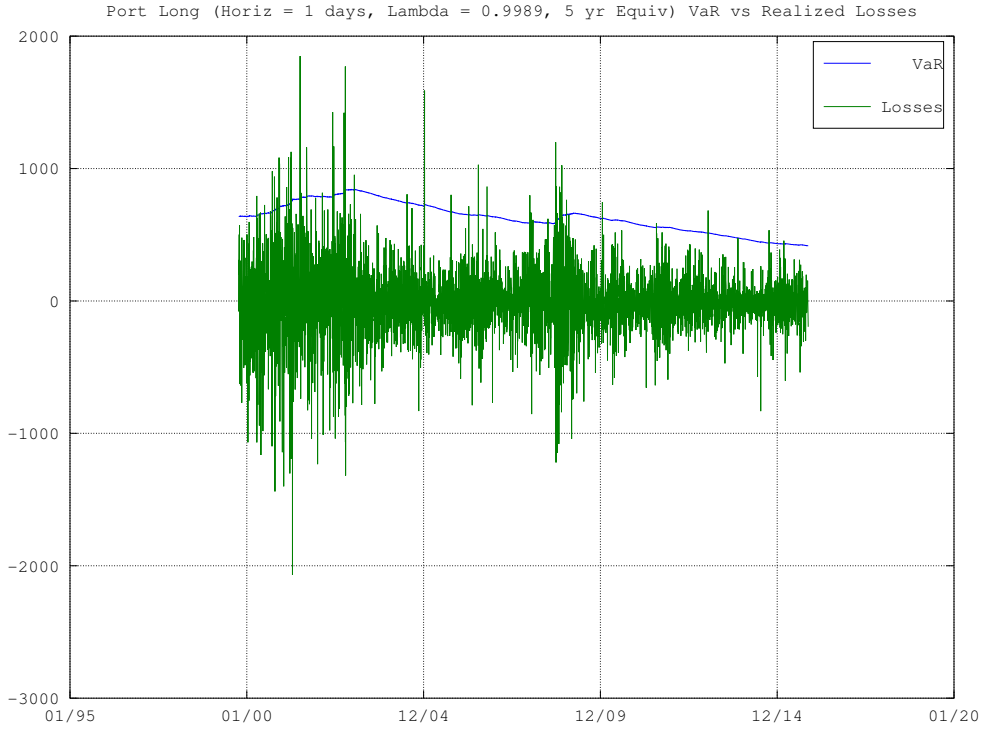

AMD Long (Horiz = 1 days, Window = 2 yrs) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20

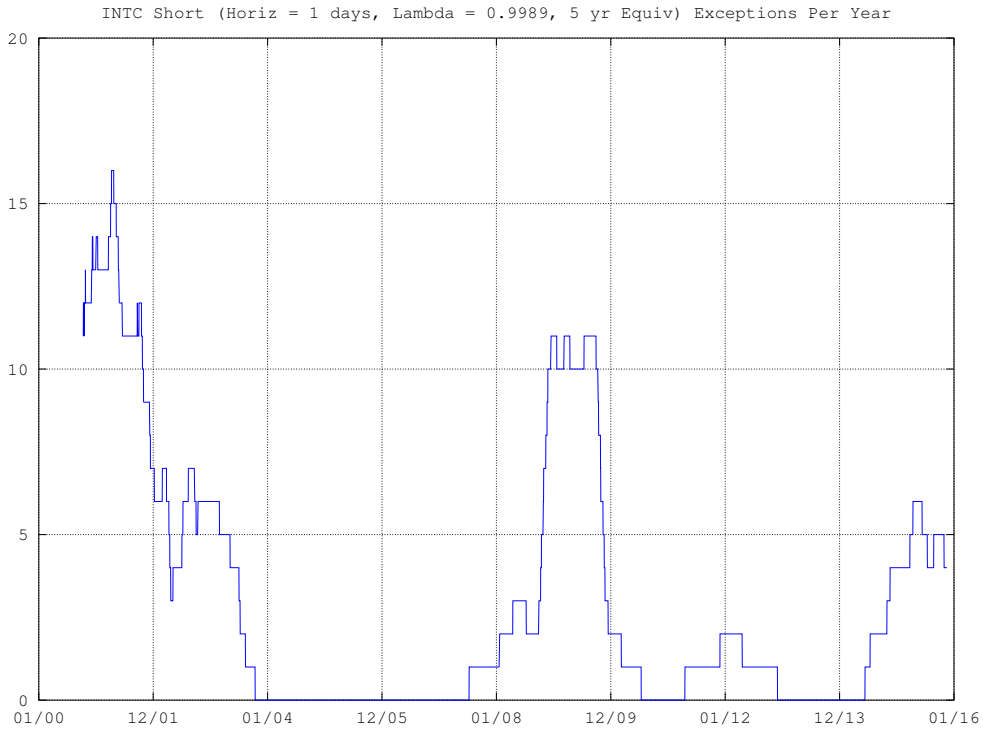
Exponential weighting, 5 year equivalent, 1 day horizon:

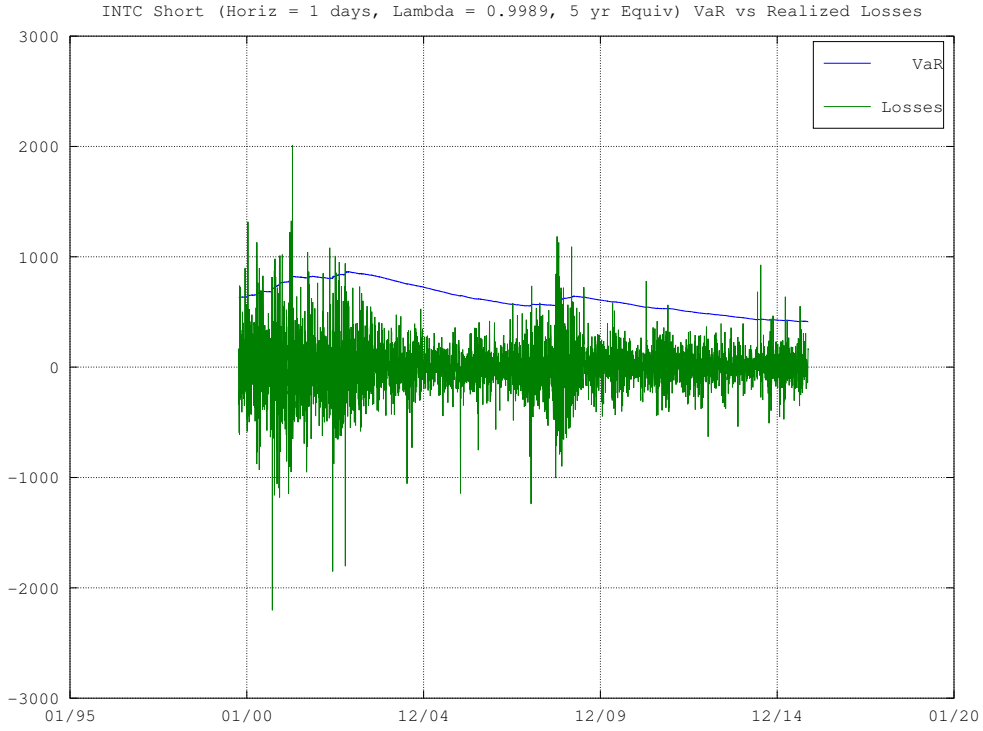


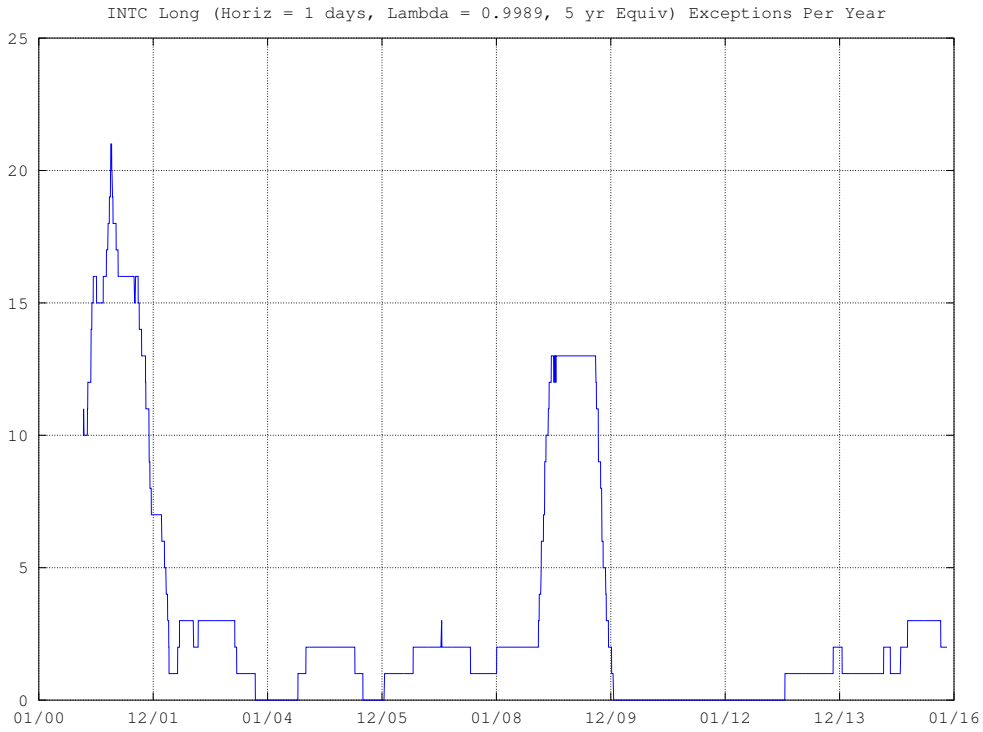


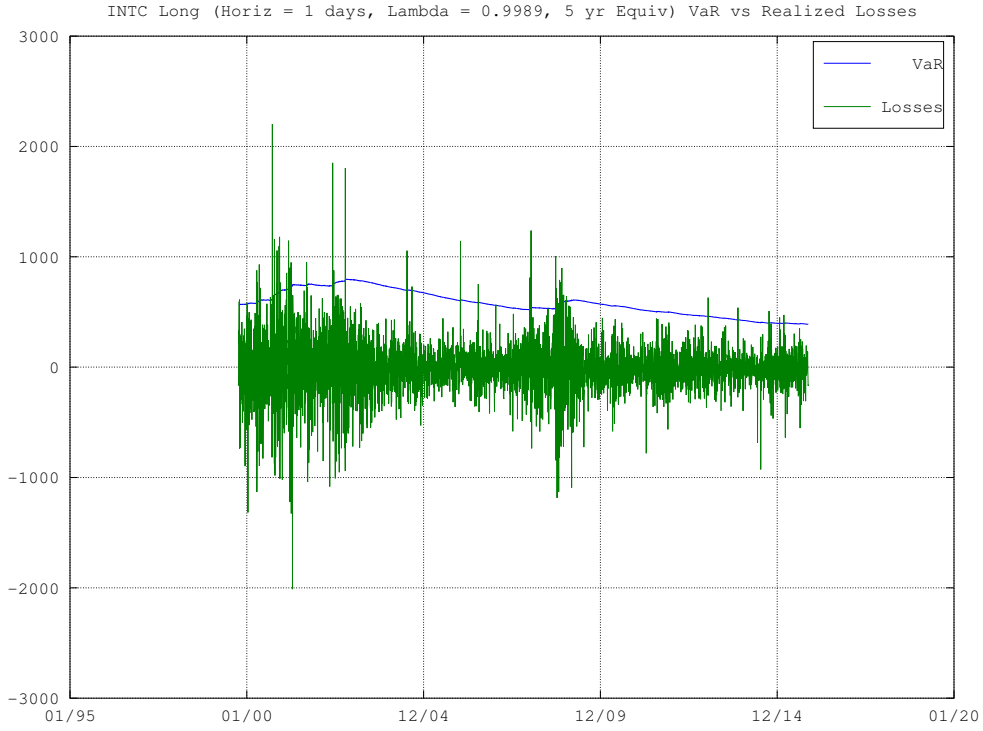

Port Long (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/00
12/01
01/04
12/05
01/08
12/09
01/12
12/13
01/16

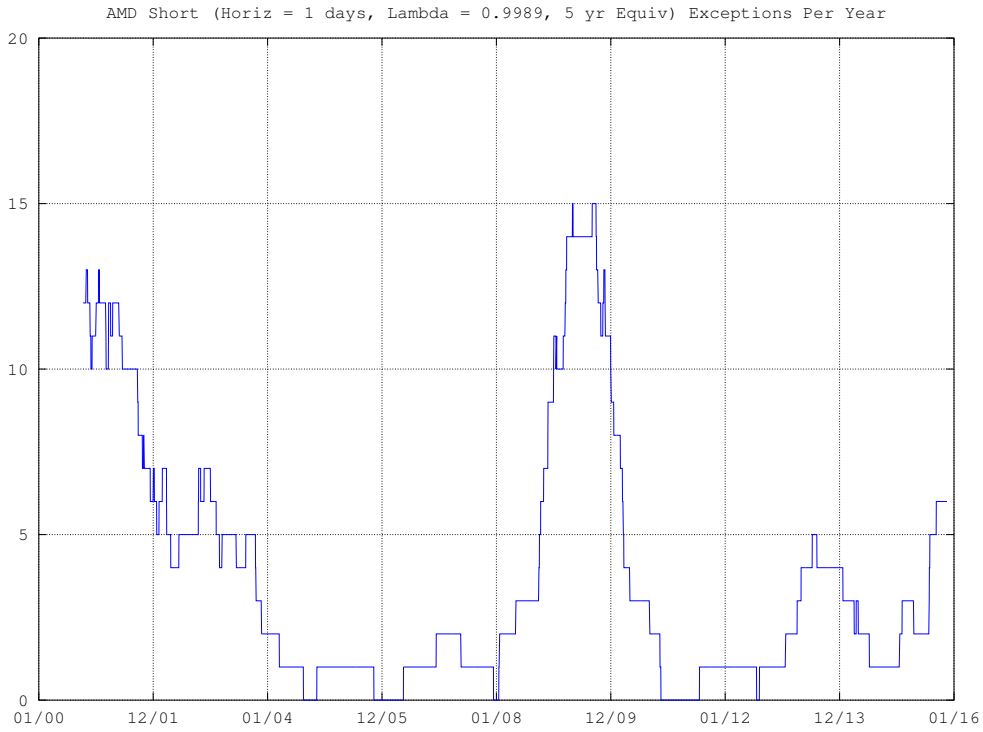

Port Long (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) VaR vs Realized Losses
VaR
Losses
2000
1000
0
-1000
-2000
-3000
01/95
01/00
12/04
12/09
12/14
01/20

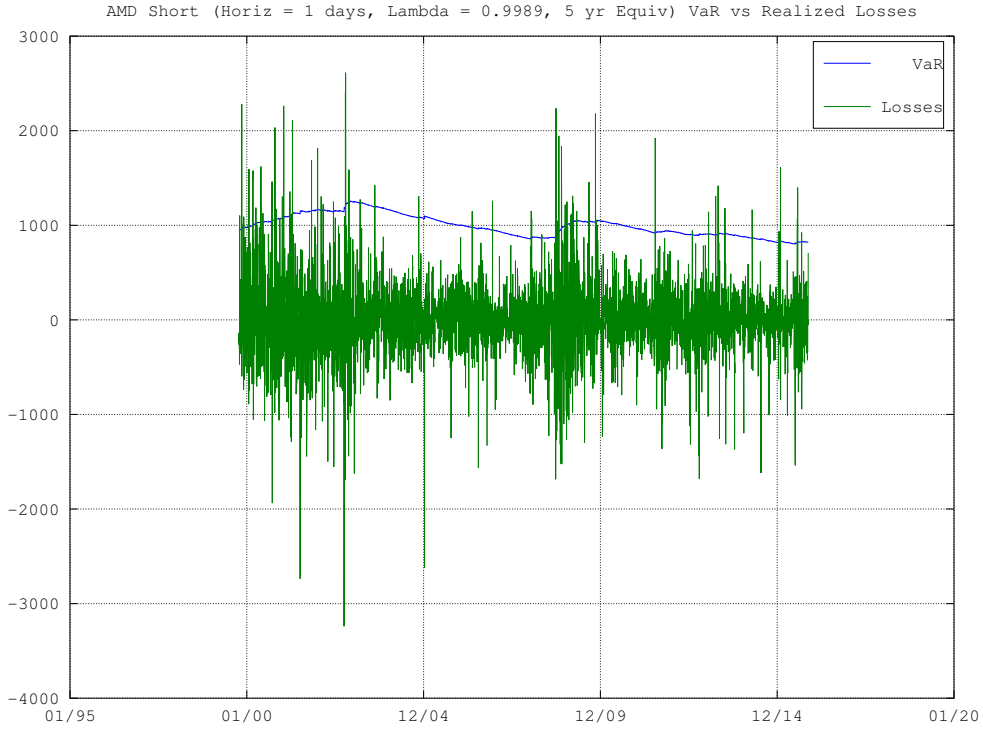

INTC Short (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/00
12/01
01/04
12/05
01/08
12/09
01/12
12/13
01/16

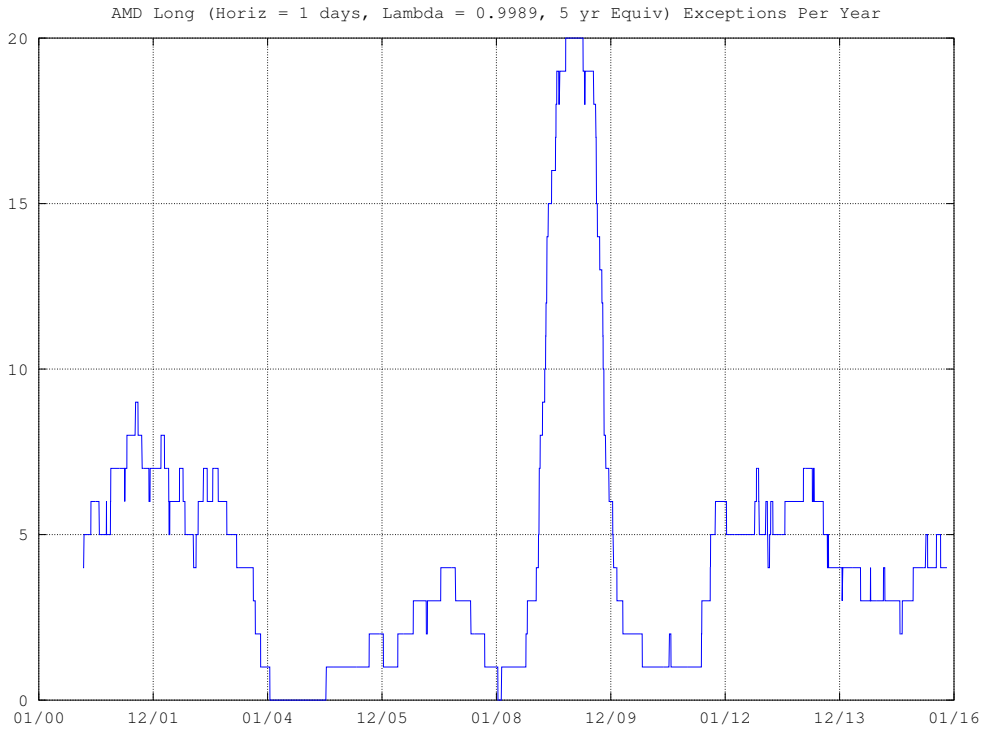

INTC Short (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
01/95
01/00
12/04
12/09
12/14
01/20

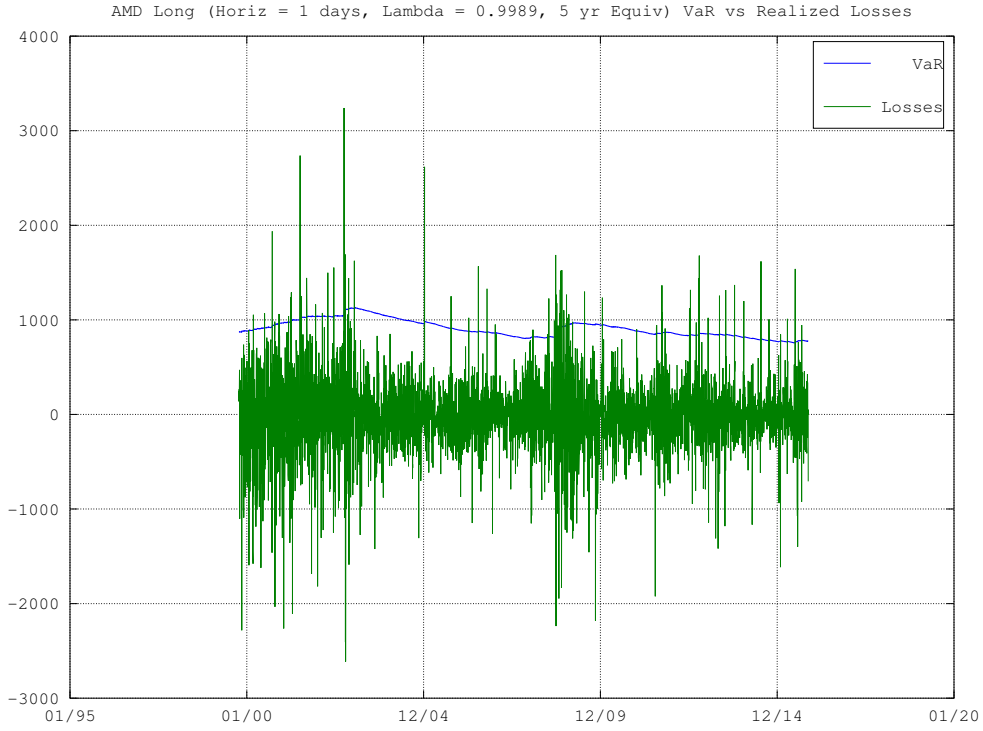

INTC Long (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) Exceptions Per Year
25
20
15
10
5
0
01/00
12/01
01/04
12/05
01/08
12/09
01/12
12/13
01/16


INTC Long (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
01/95
01/00
12/04
12/09
12/14
01/20

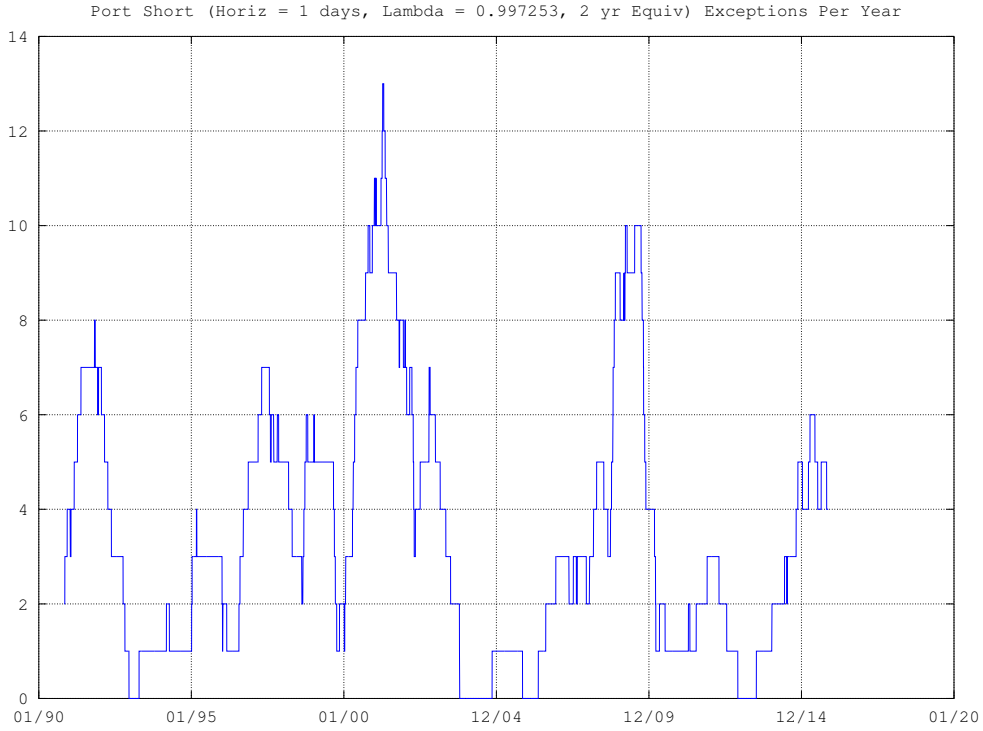

AMD Short (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/00
12/01
01/04
12/05
01/08
12/09
01/12
12/13
01/16

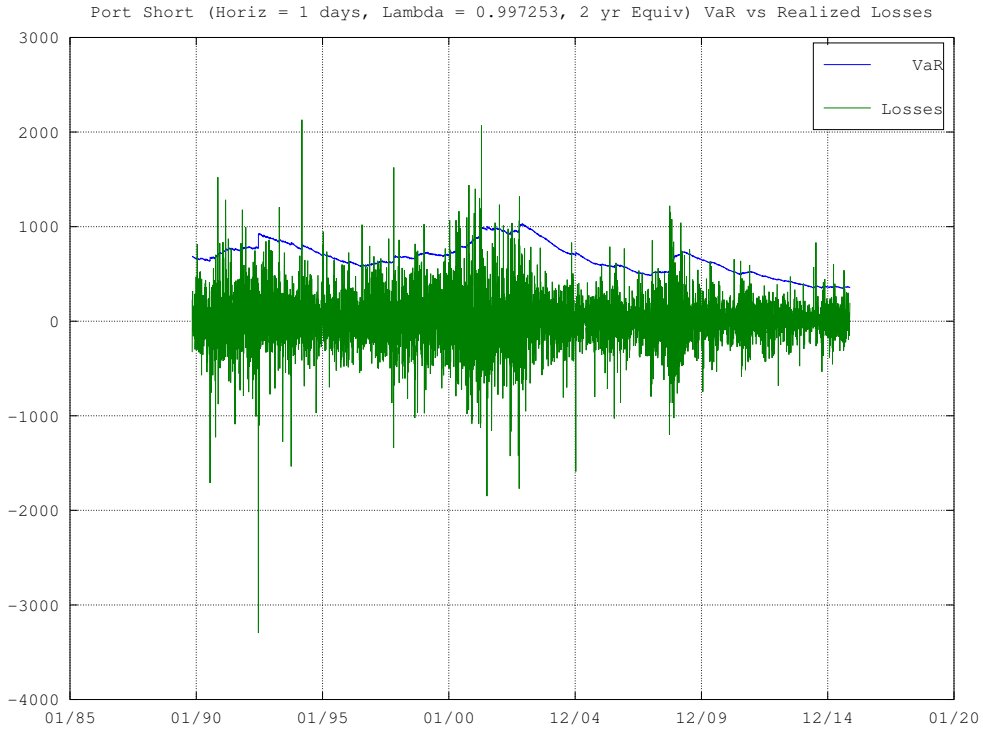

AMD Short (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
-4000
01/95
01/00
12/04
12/09
12/14
01/20

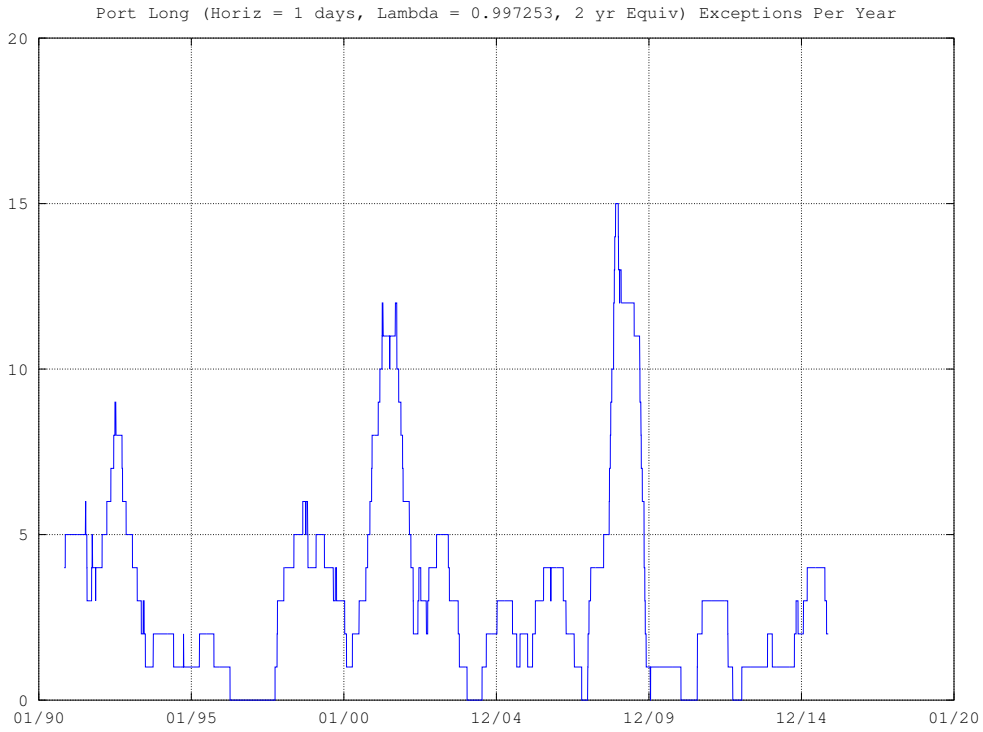

AMD Long (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/00
12/01
01/04
12/05
01/08
12/09
01/12
12/13
01/16

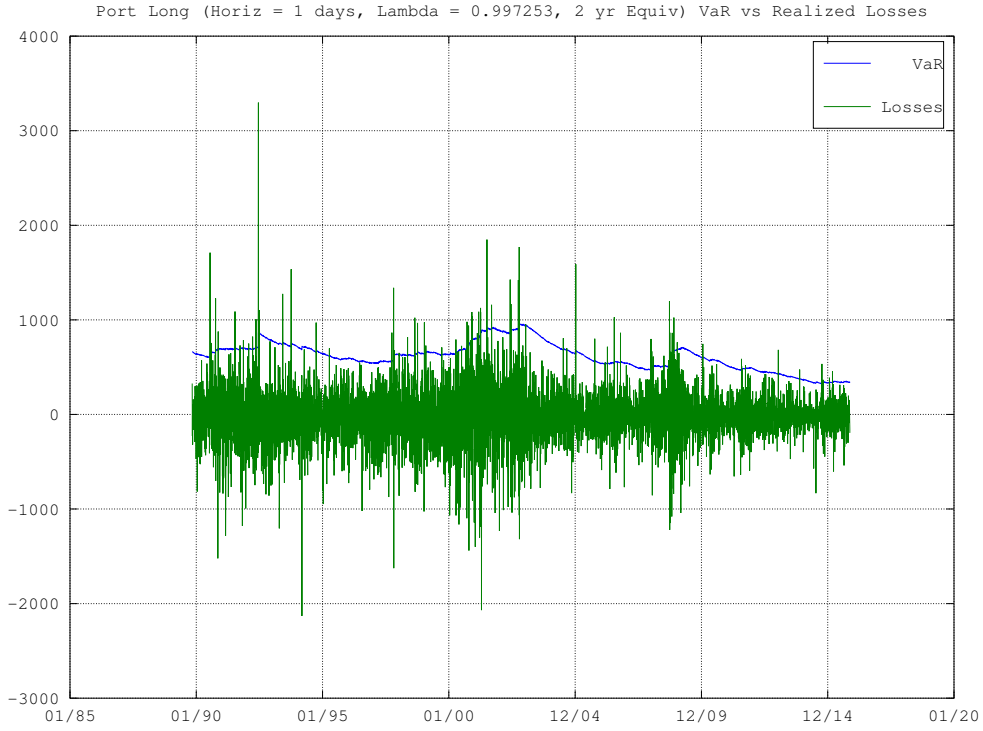

AMD Long (Horiz = 1 days, Lambda = 0.9989, 5 yr Equiv) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
01/95
01/00
12/04
12/09
12/14
01/20

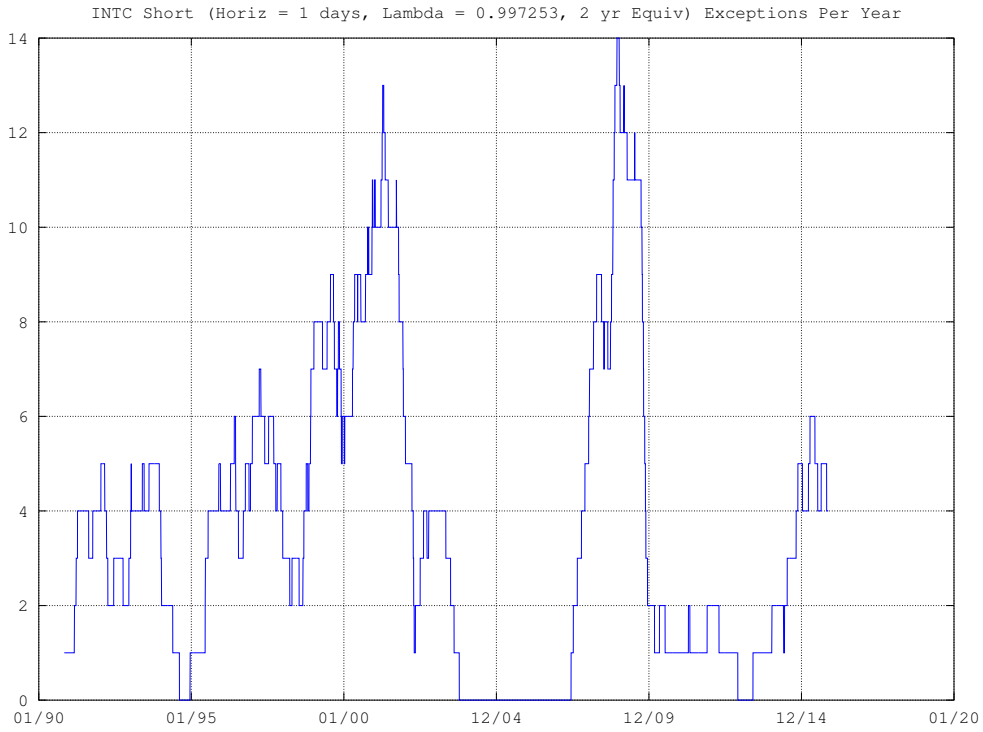
Exponential weighting, 2 year equivalent, 1 day horizon:

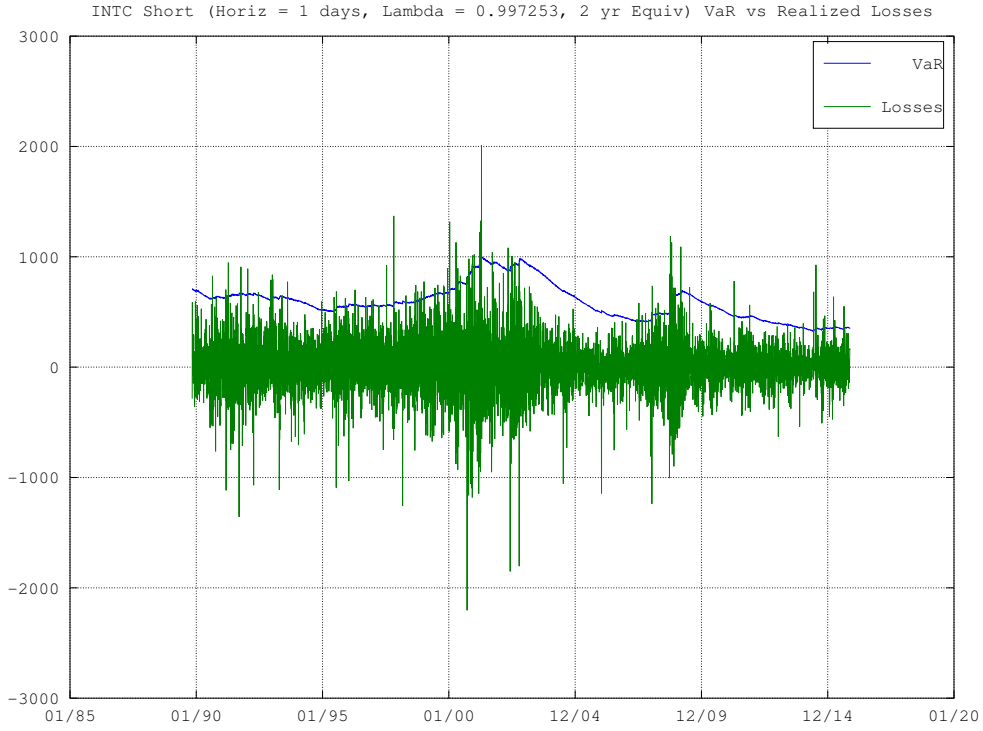


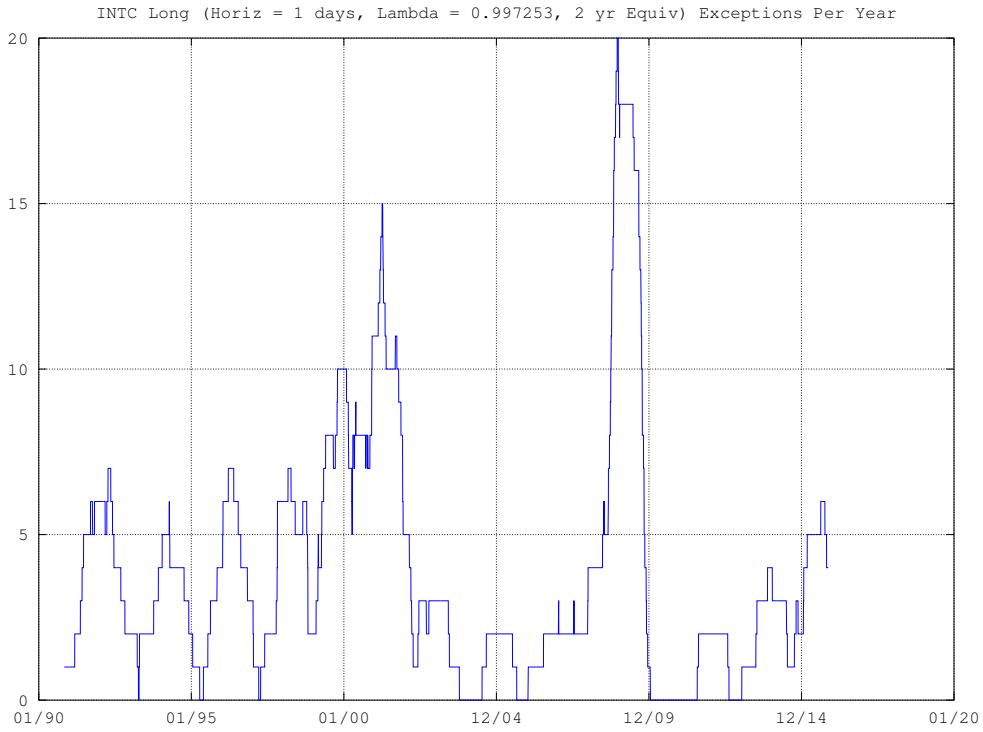


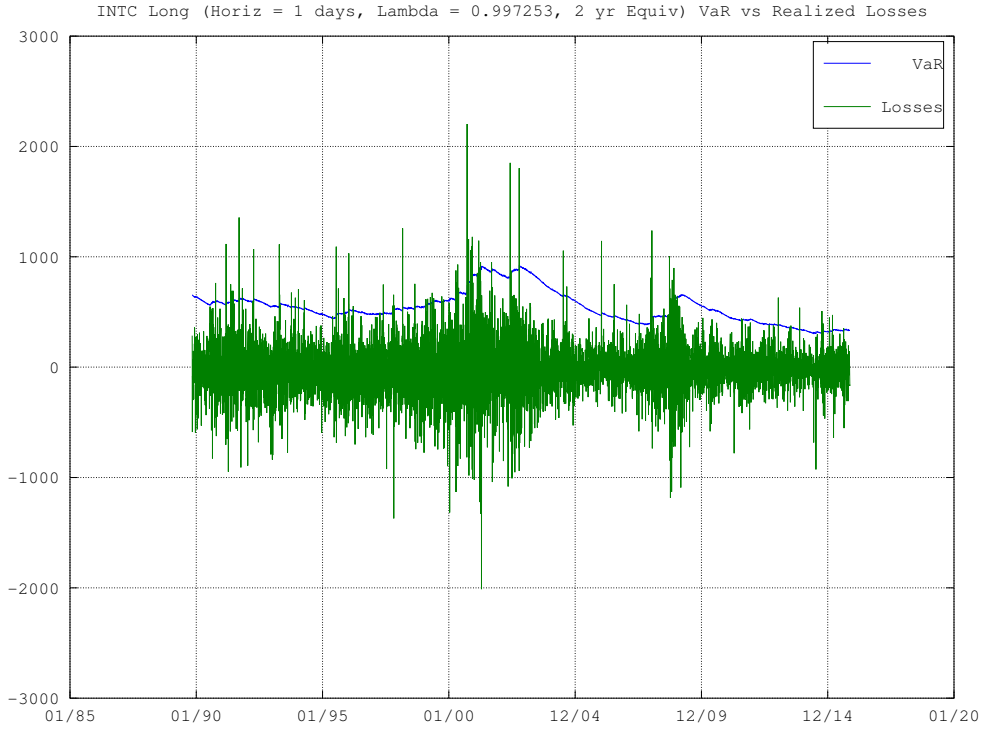

Port Long (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


Port Long (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Short (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
14
12
10
8
6
4
2
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Short (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Long (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


INTC Long (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
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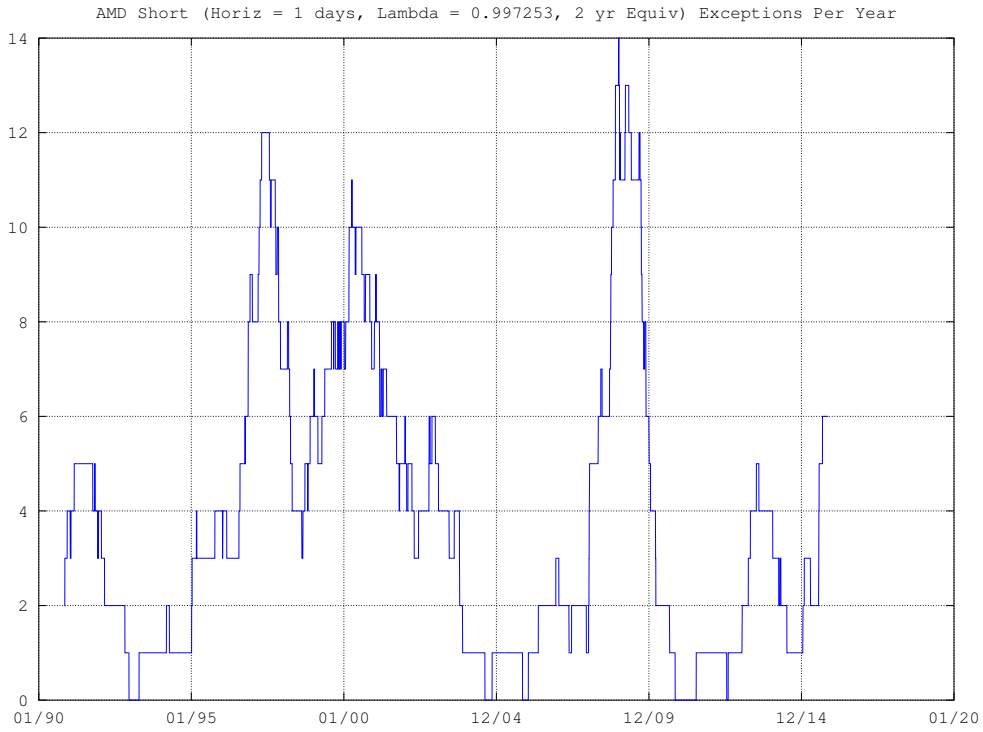
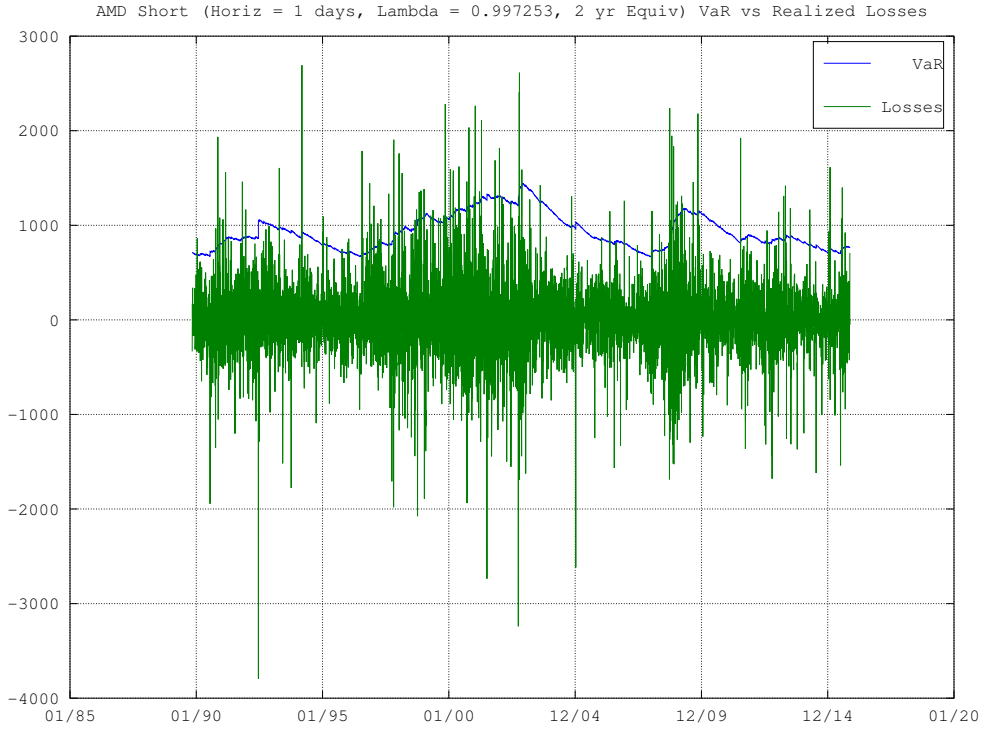
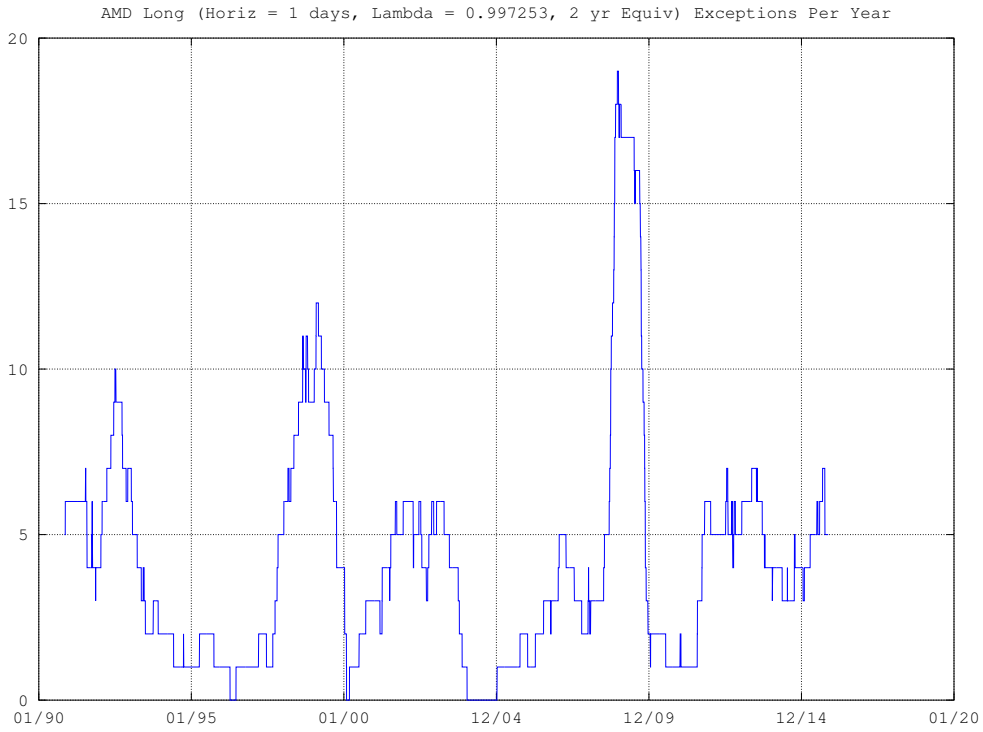
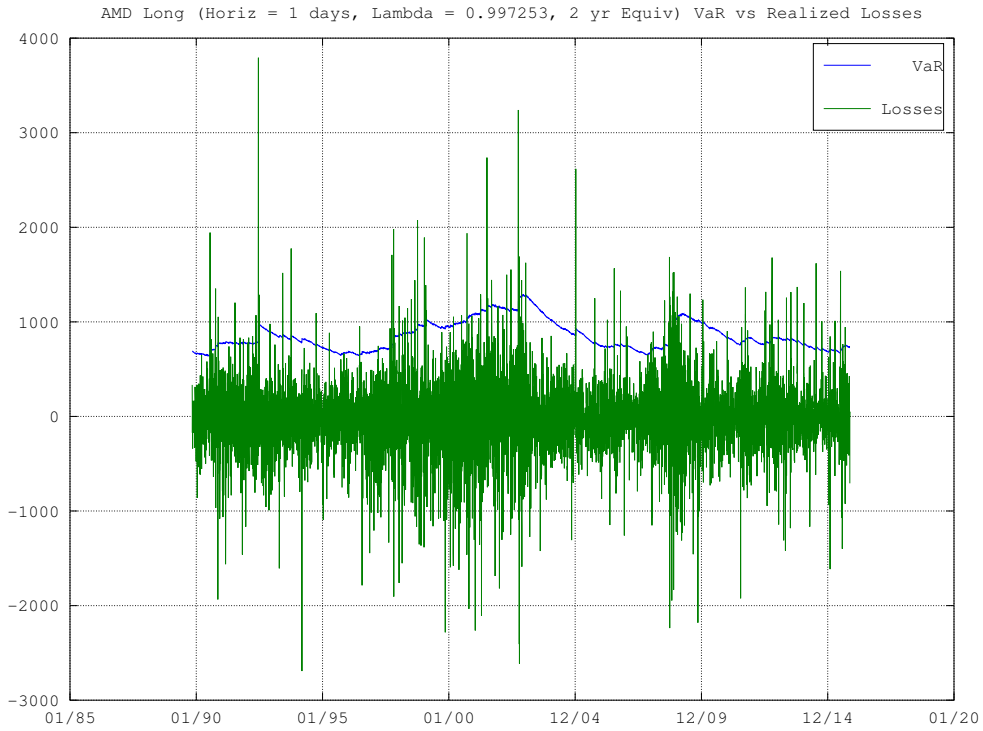
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


AMD Short (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
14
12
10
8
6
4
2
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


AMD Short (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
3000
2000
1000
0
-1000
-2000
-3000
-4000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20


AMD Long (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) Exceptions Per Year
20
15
10
5
0
01/90
01/95
01/00
12/04
12/09
12/14
01/20


AMD Long (Horiz = 1 days, Lambda = 0.997253, 2 yr Equiv) VaR vs Realized Losses
VaR
Losses
4000
3000
2000
1000
0
-1000
-2000
-3000
01/85
01/90
01/95
01/00
12/04
12/09
12/14
01/20