Lab12: Joint assimilation of navigation data coming from different sources

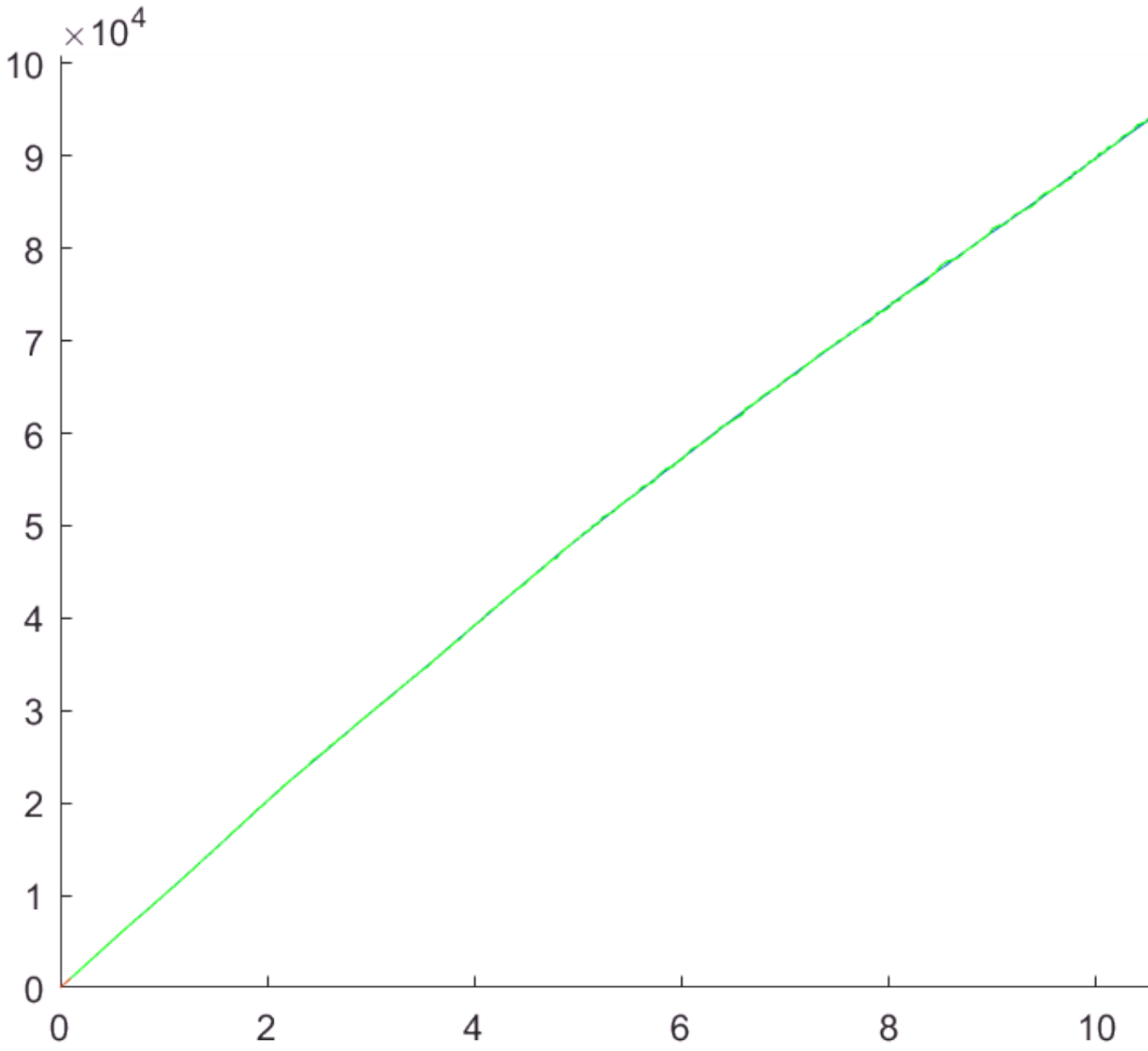
Team1: Dmitry Shadrin, Eugenii Israelit @Skoltech

```
clc; clear; close all;
addpath('functions/');

n = 500;

x1 = 1000;
vx1 = 100;
y1 = 1000;
vy1 =100;
t = 2;

sigmaA = 0.3;
AccX = normrnd(0, sigmaA, 1, n );
AccY = normrnd(0, sigmaA, 1, n );
X = calcTrajectory11( AccX, x1, vx1, t);
Y = calcTrajectory11( AccY, y1, vy1, t);

D = sqrt( X.^2 + Y.^2 );
B = atan( X ./ Y );
```

```
sigmaB = 0.004;
sigmaD = 50;
sigmaBodd = 0.001;

ErrSumextrD=0;
ErrSumfiltrD=0;
ErrSumextrB=0;
ErrSumfiltrB=0;
M=500;

for j=1:M
DNoise = normrnd(0,sigmaD,1,n);
BNoise = normrnd(0,sigmaB,1,n);
BNoiseOdd = normrnd(0,sigmaBodd,1,n);
Z=zeros(2,n);
for i=1:n
if mod(i,2)==0
Z(:,i) = [0; B(i)+BNoise(i)];
else
Z(:,i) = [D(i)+DNoise(i); B(i)+BNoiseOdd(i)];
end
end
xm1 = Z(1,1)*sin(Z(2,1));
xm2 = Z(1,3)*sin(Z(2,3));
ym1 = Z(1,1)*cos(Z(2,1));
ym2 = Z(1,3)*cos(Z(2,3));
z0 = [ xm2; (xm2-xm1)/2*t; ym2; (ym2-ym1)/2*t ];
ZX = Z(1,:).*sin(Z(2,:));
ZY = Z(1,:).*cos(Z(2,:));
P = [ 10^10 0 0 0; 0 10^10 0 0; 0 0 10^10 0; 0 0 0 10^10 ];
F = [ 1 t 0 0; 0 1 0 0; 0 0 1 t; 0 0 0 1 ];
G = [ (t^2)/2 0; t 0; 0 (t^2)/2; 0 t ];
Q = G * G' * sigmaA^2;
```

```
R1 = [ sigmaD^2 0; 0 sigmaB^2 ];
R2 = sigmaBodd^2 ;
[Xk,Dmextr,Dmfiltr,Bmextr,Bmfiltr] = calcKalmanExtended12(Z, z0, F, P, Q, R1, R2);
Dk=sqrt(Xk(1,:).^2+Xk(3,:).^2);
Bk=atan(Xk(1,:)./Xk(3,:));
ErrCurextrD = ( Dmextr - D).^2;
ErrCurfiltrD = (Dmfiltr - D).^2;
ErrCurextrB = ( Bmextr - B).^2;
ErrCurfiltrB = (Bmfiltr - B).^2;
ErrSumextrD = ErrSumextrD + ErrCurextrD;
ErrSumfiltrD = ErrSumfiltrD + ErrCurfiltrD;
ErrSumextrB = ErrSumextrB + ErrCurextrB;
ErrSumfiltrB = ErrSumfiltrB + ErrCurfiltrB;

end
% Xk_ = calcKalmanExtended12_(Z, z0, F, P, Q, R_)
```

```
figure; hold on;
plot(X(1:end),Y(1:end)); hold on;
plot(Xk(1,4:end),Xk(3,4:end));
plot(ZX(1:2:end), ZY(1:2:n), 'green');
axis([0 inf 0 inf]);
```

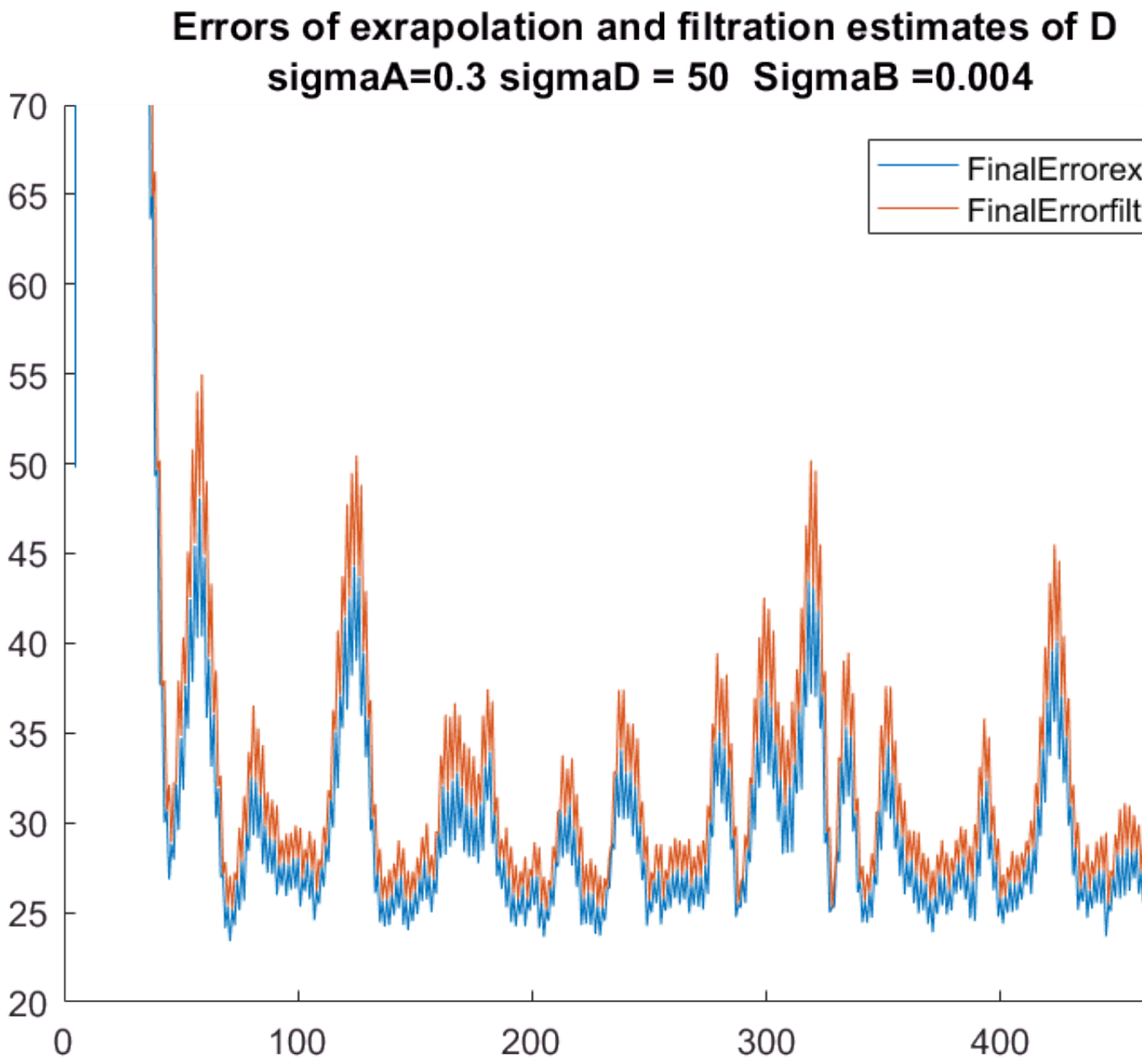



```
FinalErrorextrD = ( ErrSumextrD./M ).^0.5;
FinalErrorfiltrD = ( ErrSumfiltrD./M ).^0.5;
FinalErrorextrB = ( ErrSumextrB./M ).^0.5;
FinalErrorfiltrB = ( ErrSumfiltrB./M ).^0.5;
```

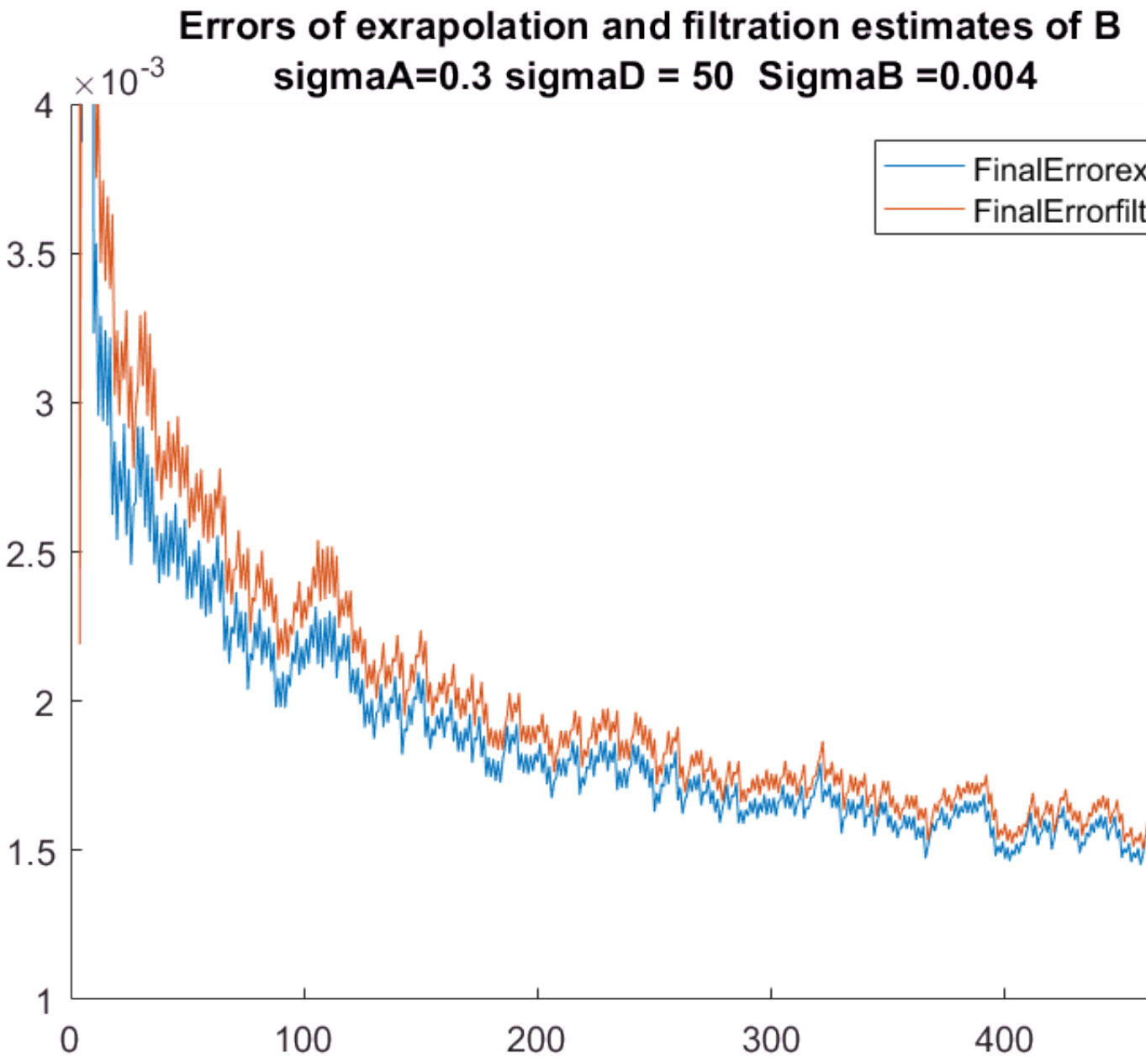
8. Comparing estimation results with measurement errors of D and B.

```
figure; hold on;
plot(FinalErrorfiltrD);
plot(FinalErrorextrD);
title( sprintf ('Errors of exrapolation and filtration estimates of D \n sigmaA=0.3 sigmaD = 50
legend('FinalErrorextrD', 'FinalErrorfiltrD');
```

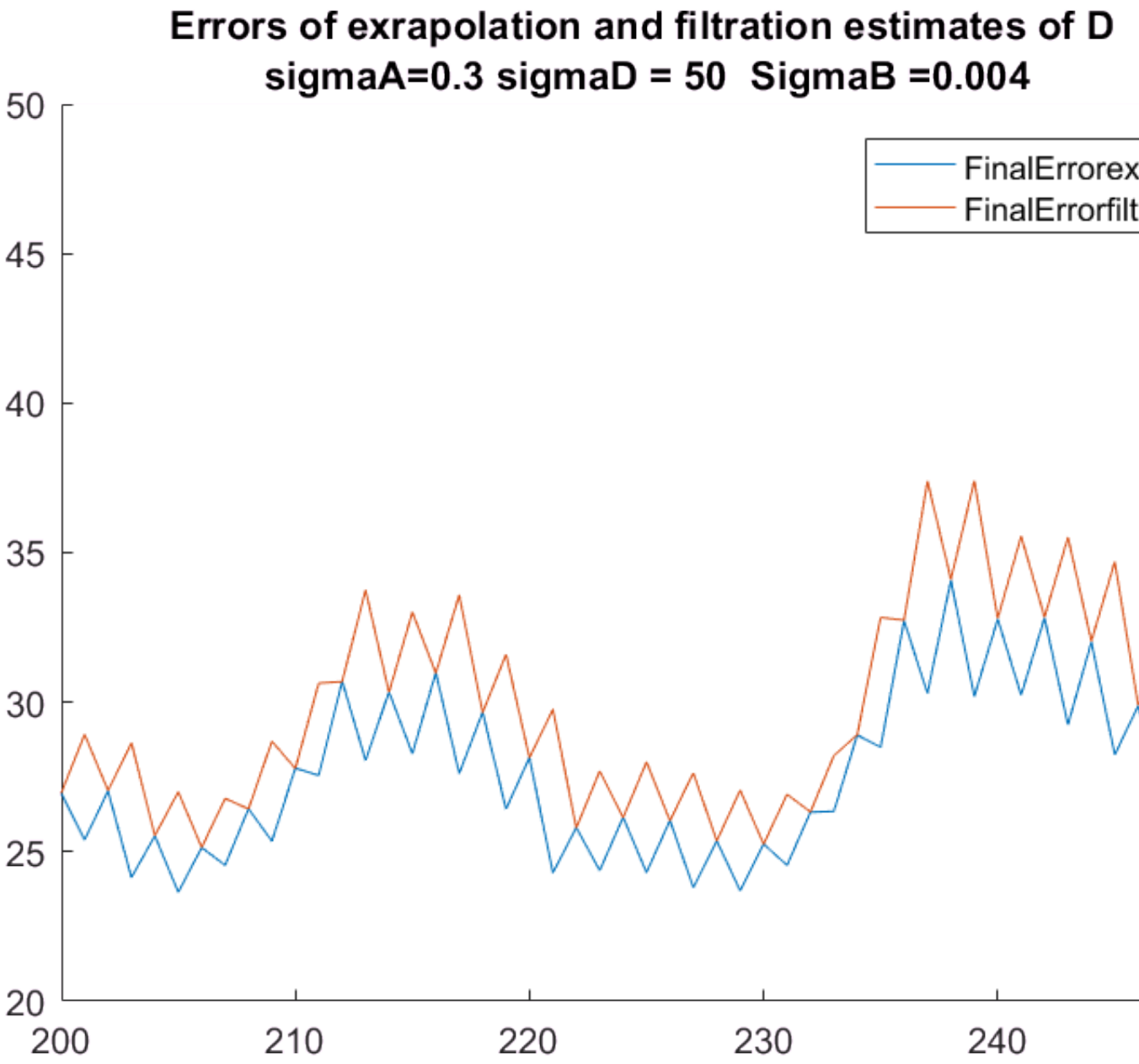
```
ylim([20 70]);
```



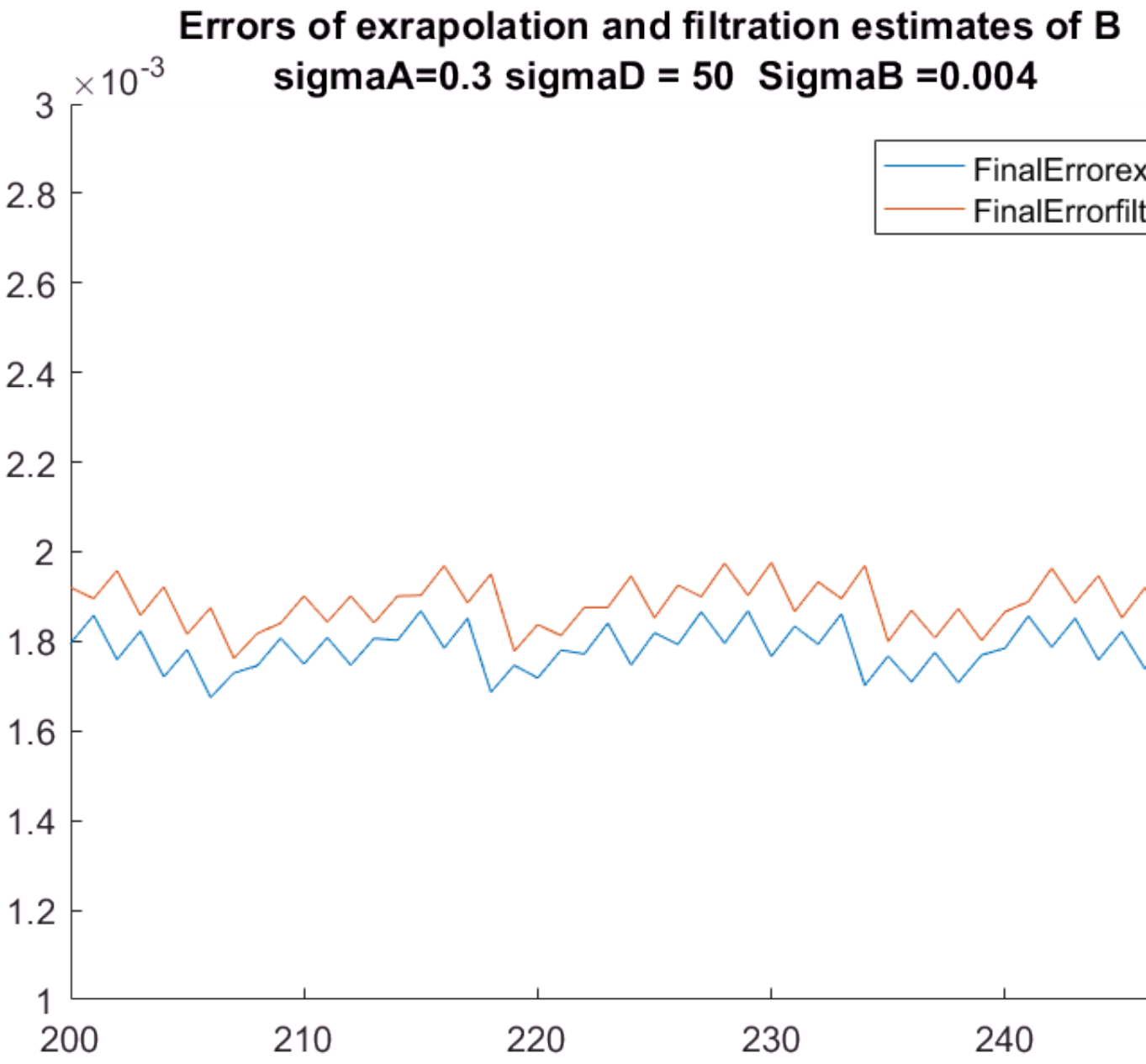

```
figure; hold on;
plot(FinalErrorfiltrB);
plot(FinalErrorextrB);
title( sprintf ('Errors of exrapolation and filtration estimates of B \n sigmaA=0.3 sigmaD = 50
legend('FinalErrorextrB', 'FinalErrorfiltrB');
ylim([0.001 0.004]);
```




```
figure; hold on;
plot(FinalErrorfiltrD);
plot(FinalErrorextrD);
title( sprintf ('Errors of exrapolation and filtration estimates of D \n sigmaA=0.3 sigmaD = 50
legend('FinalErrorextrD', 'FinalErrorfiltrD');
axis([200 250 20 50]);
```




```
figure; hold on;
plot(FinalErrorfiltrB);
plot(FinalErrorextrB);
title( sprintf ('Errors of exrapolation and filtration estimates of B \n sigmaA=0.3 sigmaD = 50
legend('FinalErrorextrB', 'FinalErrorfiltrB');
axis([200 250 0.001 0.003]);
```



Conclusion:

Accuracy of estimation of angle B varies from odd to even because on every even step we have a much better precision of angle sensor, but on the next step error encreases back

Accuracy of estimation of distance D varies from odd to even because on every even step we have lack of sensor data