

```
%script to read example data product
```

```
clear all; close all;
```

```
addpath E:\readSWOTBeta %replace this line with local path to : https://github.com/mikedu
```

```
addpath E:\SWOTAprimeCalcs %replace this line with local path to : https://github.com/mikedu
```

```
DataDir='C:\Users\wei.263\Desktop\L2_HR_Final\L2_HR_Sac_data_product_6 - Copy\';
```

```
%DataDir='E:\SWOTPO1051\Po_floodplain_study\RiverObs\Po_v2\L2_HR_Final\L2_HR_Sac_data_product
```

```
River='Sac';
```

```
% define passes and cycle variables
```

```
DefinePassCycle_Rui;
```

```
% read reaches & nodes
```

```
[SWOTReaches,TrueReaches,SWOTNodes,TrueNodes]=ReadShapeData(Cycles,Passes,Dates,DataDir,River)
```

```
% extract reaches & nodes
```

```
ExtractHWS;
```

```
% error stats
```

```
CalcErrStats_Rui;
```

```
% check partial observation
```

```
for i=1:nObs
```

```
    for j=1:nReach
```

```
        fracObs(j,i)=sum(~isnan(Hn(NodesInReach{j},i)))/sum(NodesInReach{j});
```

```
    end
```

```
end
```

```
for i=1:nPass
```

```
    for j=1:nReach
```

```
        fracObsPass(j,i)=median(fracObs(j,[i:3:nObs]),2);
```

```
    end
```

```
end
```

```
zone = utmzone(latn(1),lonn(1));
```

```
utmstruct=defaultm('utm');
```

```
utmstruct.zone=zone;
```

```
utmstruct=defaultm(utmstruct);
```

```
[X, Y] = mfwddtran(utmstruct,latn(:,1), lonn(:,1));
```

```
FD = GetFlowDist(nan(size(X)),Y,-9999);
```

```
for i=1:nObs
```

```
    [~,iSort{i}]=sort(ReachIDnt(:,i));
```

```
end
```

```
for i=1:nReach
```

```
    FDr(i,1)=FD(find(ReachIDnt(:,1)==i,1,'first'));
```

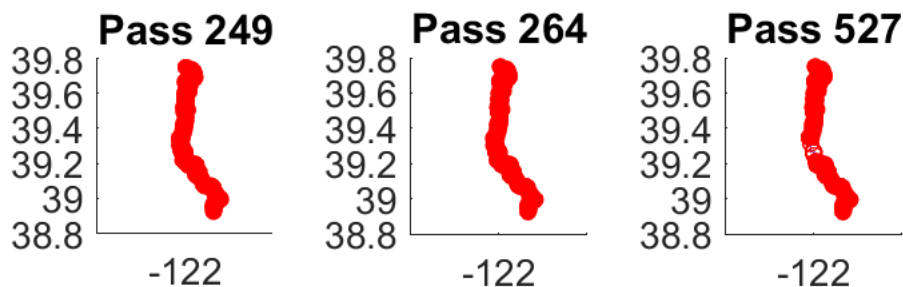
```
    FDr(i,2)=FD(find(ReachIDnt(:,1)==i,1,'last'));
```

```
    RL(i)=FDr(i,2)-FDr(i,1);
```

```
end
```

overview plots

```
figure(1)
subplot(131)
mapshow(TrueReaches(1).S, 'Color', 'Blue')
mapshow(SWOTNodes(1).S, 'Color', 'Red', 'Marker', 'o')
set(gca, 'FontSize', 14)
title('Pass 249')
subplot(132)
mapshow(TrueReaches(1).S, 'Color', 'Blue')
mapshow(SWOTNodes(7).S, 'Color', 'Red', 'Marker', 'o')
set(gca, 'FontSize', 14)
title('Pass 264')
subplot(133)
mapshow(TrueReaches(1).S, 'Color', 'Blue')
mapshow(SWOTNodes(3).S, 'Color', 'Red', 'Marker', 'o')
set(gca, 'FontSize', 14)
title('Pass 527')
```

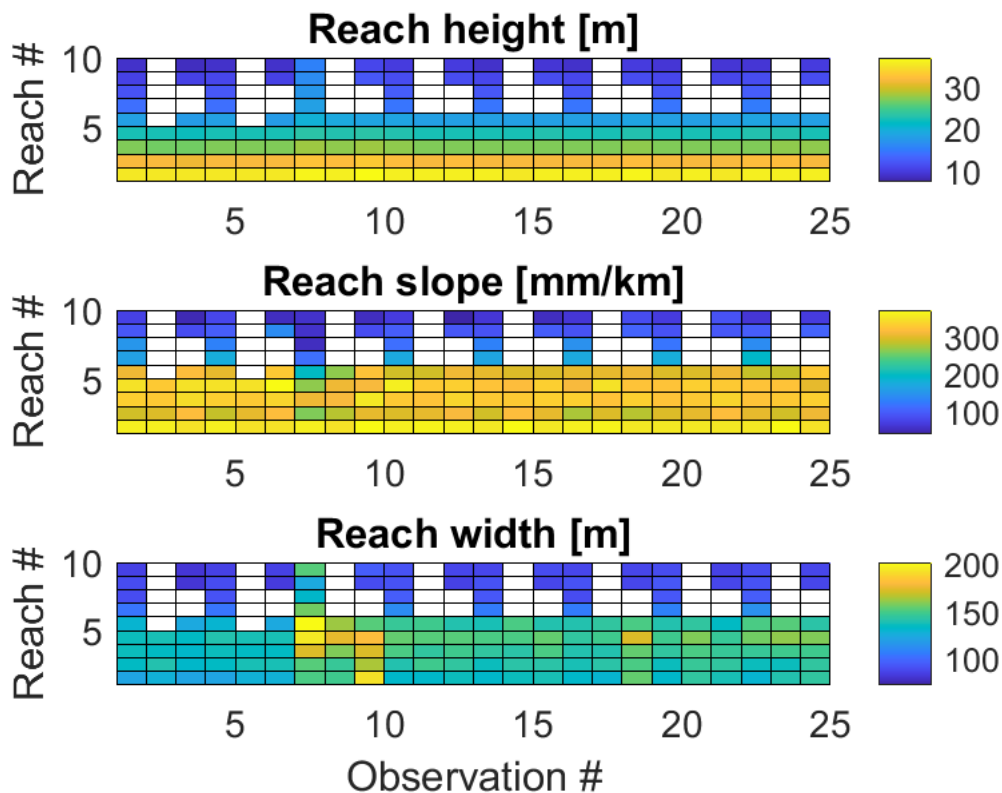


```
figure(2) %missing data and reach overveiw
subplot(311)
pcolor(Hr)
colorbar
set(gca, 'FontSize', 14)
title('Reach height [m]')
```

```

ylabel('Reach #')
subplot(312)
pcolor(Sr)
set(gca,'FontSize',14)
title('Reach slope [mm/km]')
ylabel('Reach #')
colorbar
subplot(313)
pcolor(Wr)
colorbar
set(gca,'FontSize',14)
title('Reach width [m]')
xlabel('Observation #')
ylabel('Reach #')

```



```

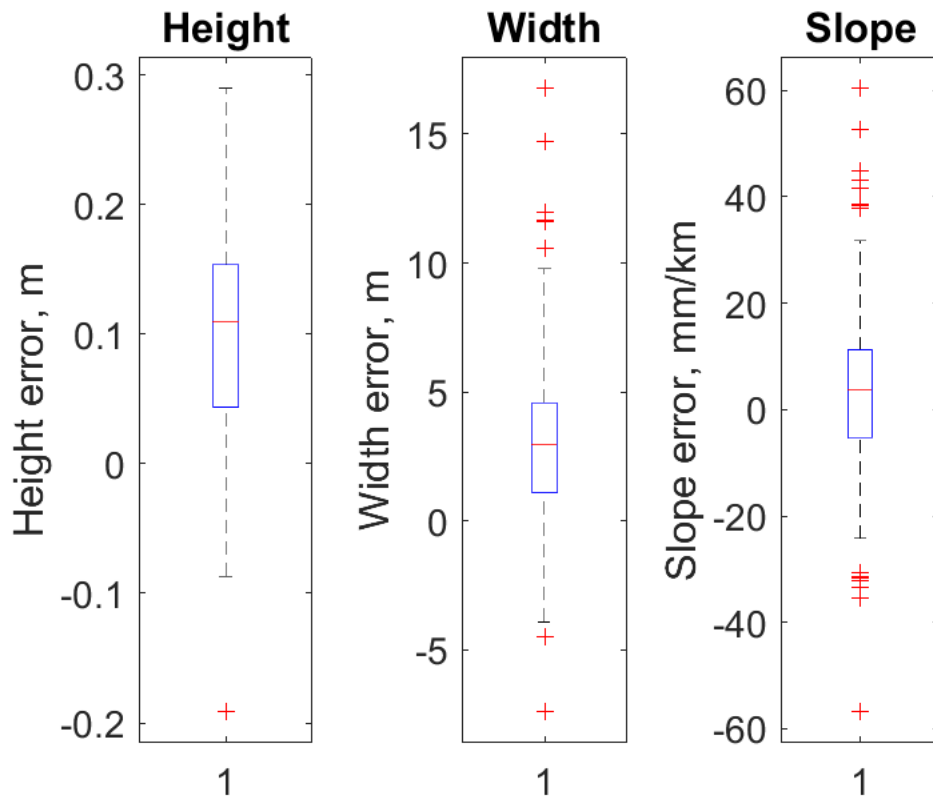
figure(3)
subplot(131)
boxplot(Err.RchHeight.All.Allv)
set(gca,'FontSize',14)
title('Height')
ylabel('Height error, m')
subplot(132)
boxplot(Err.RchWidth.All.Allv)
set(gca,'FontSize',14)
title('Width')
ylabel('Width error, m')
subplot(133)

```

```

boxplot(Err.RchSlope.All.Allv)
set(gca, 'FontSize', 14)
title('Slope')
ylabel('Slope error, mm/km')

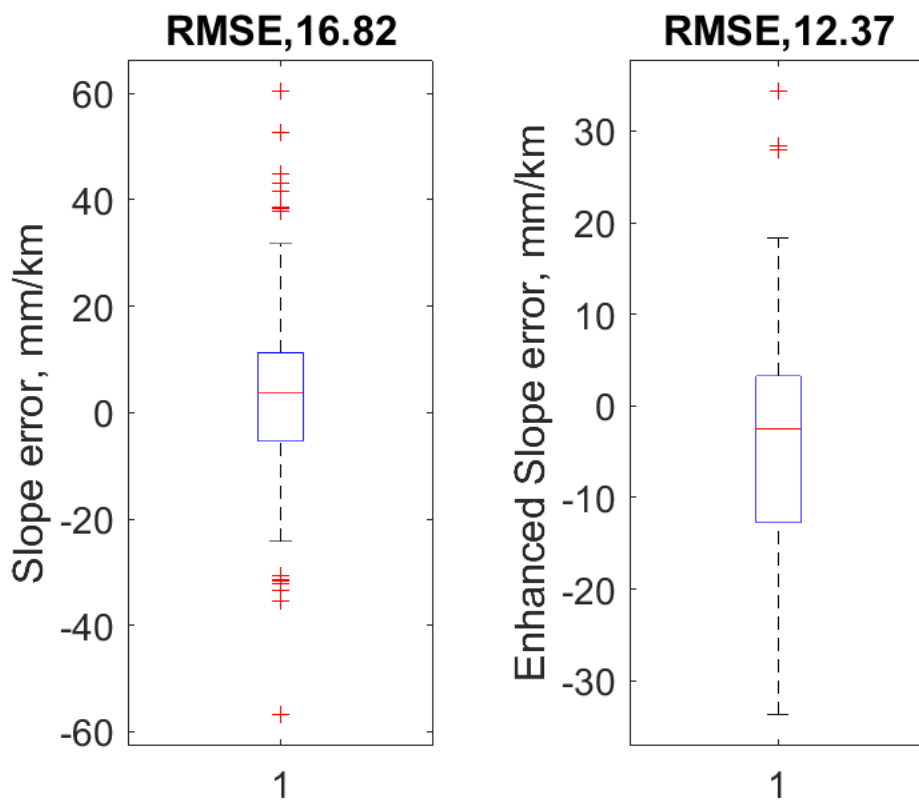
```



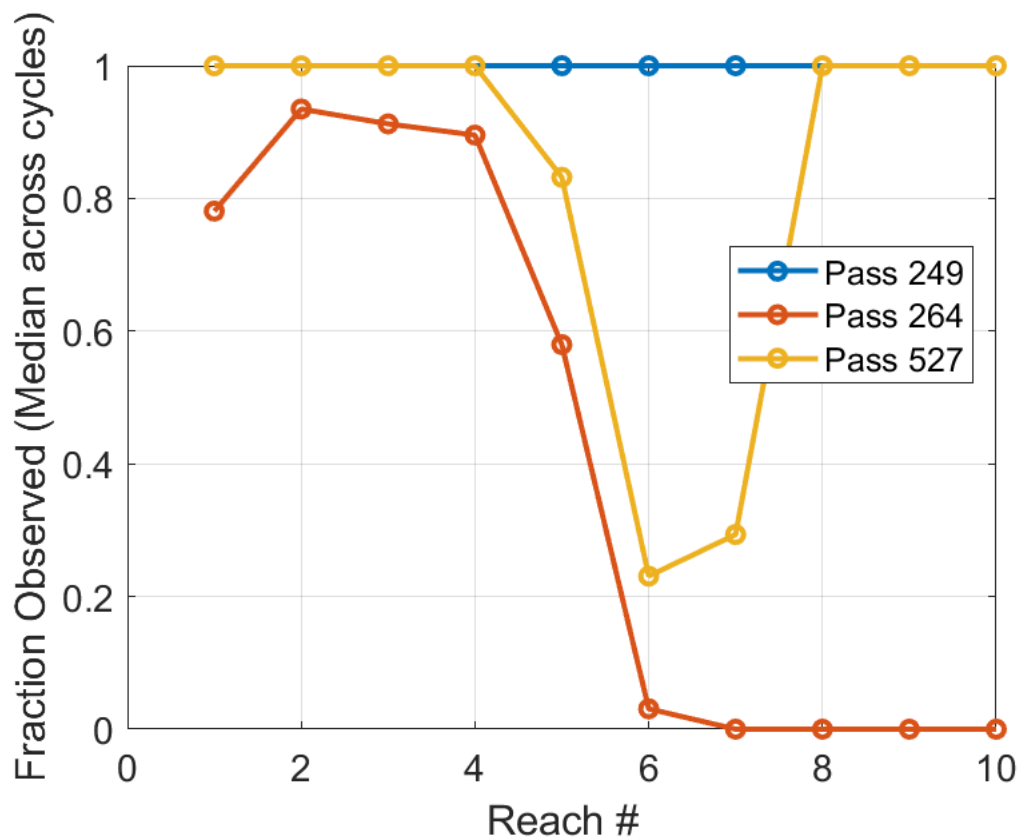
```

figure(30)
subplot(121)
boxplot(Err.RchSlope.All.Allv)
title(['RMSE,' num2str(round(Err.RchSlope.All.RMSE,2))])
set(gca, 'FontSize', 14)
ylabel('Slope error, mm/km')
subplot(122)
boxplot(Err.RchSlopeEn.All.Allv)
title(['RMSE,' num2str(round(Err.RchSlopeEn.All.RMSE,2))])
set(gca, 'FontSize', 14)
ylabel('Enhanced Slope error, mm/km')

```

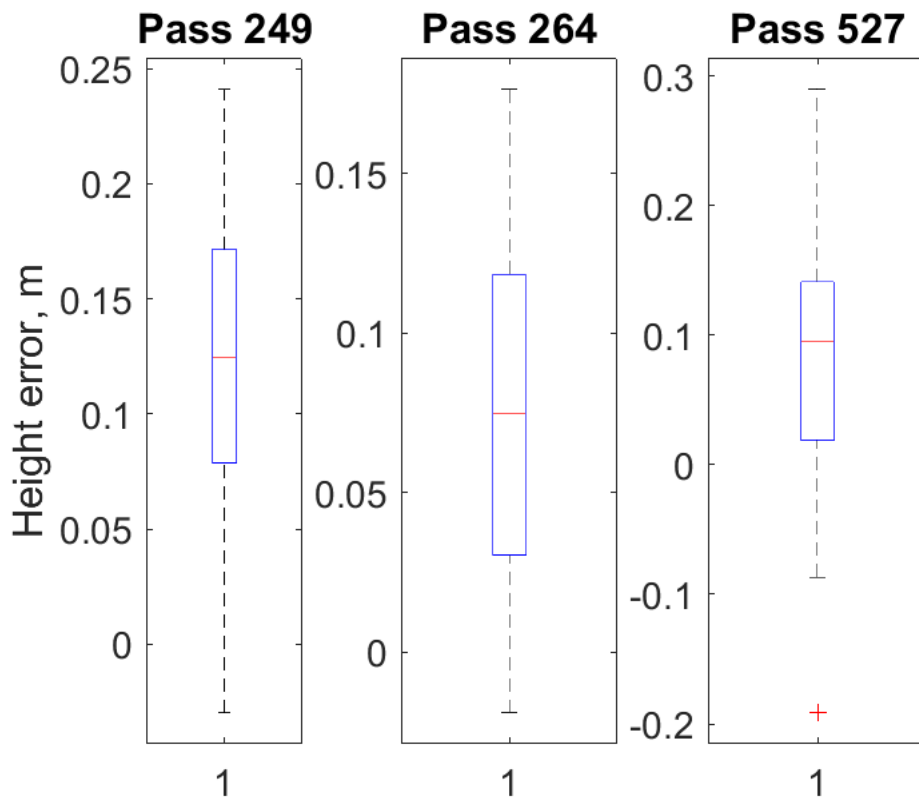


```
figure(4)
plot(1:nReach,fracObsPass,'o-','LineWidth',2)
set(gca,'FontSize',14)
xlabel('Reach #')
ylabel('Fraction Observed (Median across cycles)')
legend('Pass 249','Pass 264','Pass 527','Location','Best')
grid on
```

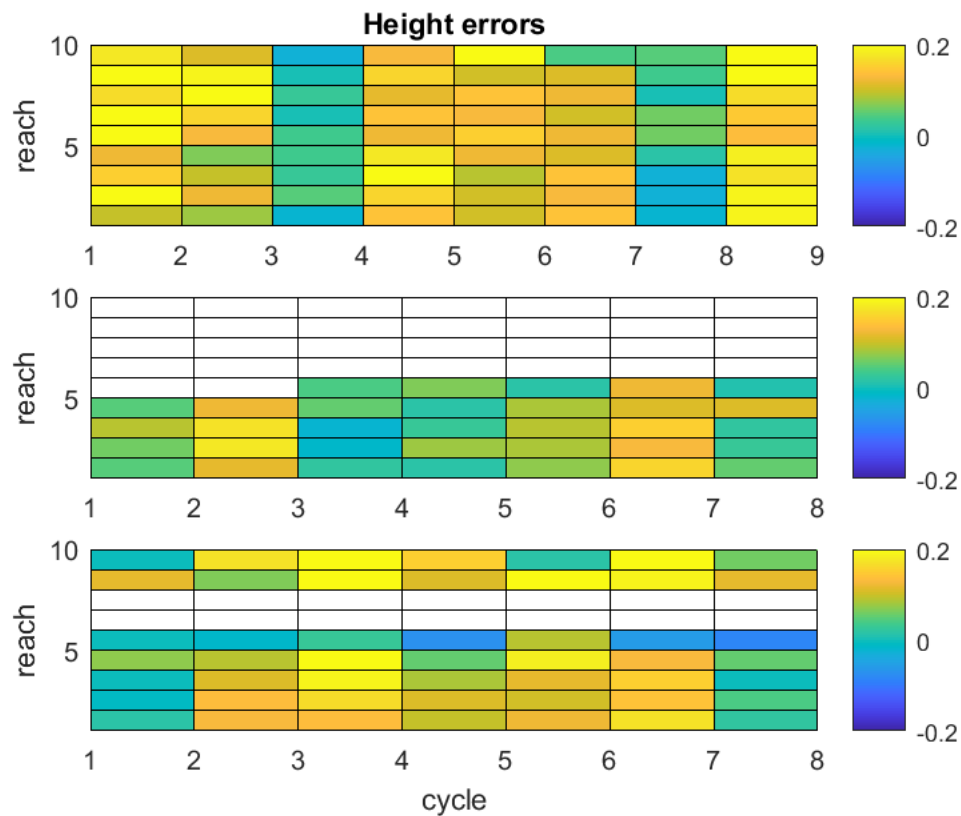


height plots

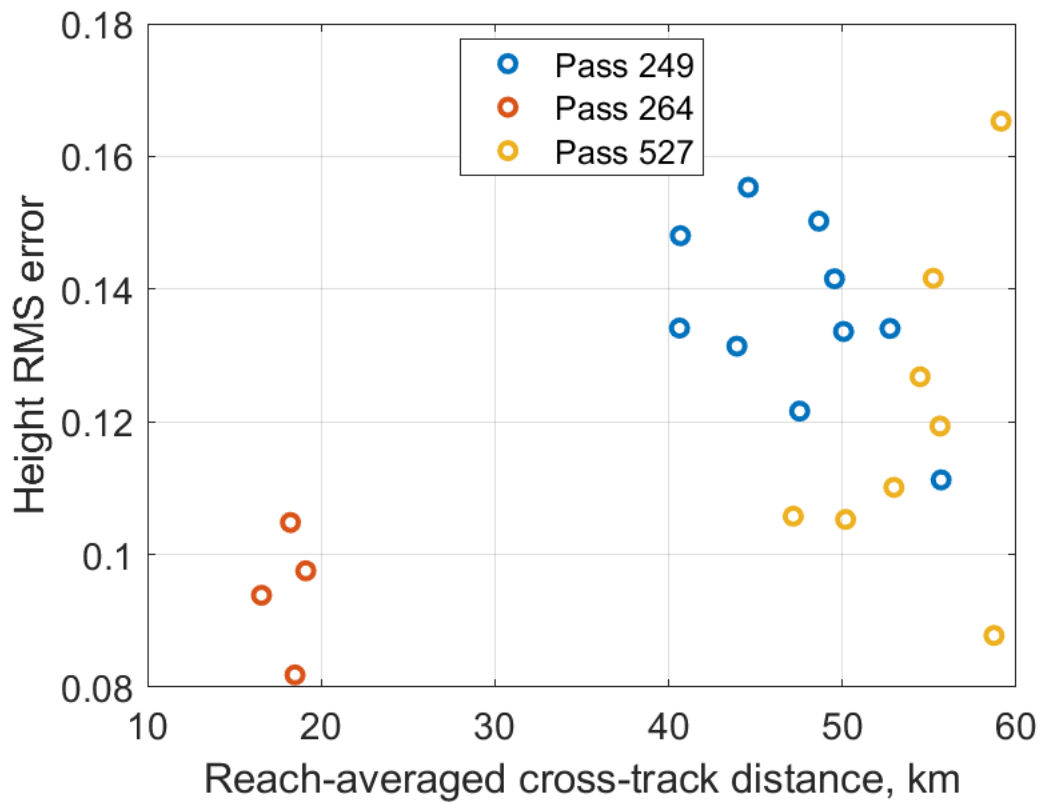
```
figure(5) %reach height error by pass
subplot(131)
boxplot(Err.RchHeight.Pass249.Allv)
set(gca,'FontSize',14)
ylabel('Height error, m')
title('Pass 249')
subplot(132)
boxplot(Err.RchHeight.Pass264.Allv)
set(gca,'FontSize',14)
title('Pass 264')
subplot(133)
boxplot(Err.RchHeight.Pass527.Allv)
set(gca,'FontSize',14)
title('Pass 527')
```



```
figure(6) %reach height errors by cycle and node
subplot(311)
pcolor(Err.RchHeight.Pass249.All)
colorbar
set(gca,'CLim',[-0.2 0.2])
ylabel('reach')
title('Height errors')
subplot(312)
pcolor(Err.RchHeight.Pass264.All)
set(gca,'CLim',[-0.2 0.2])
colorbar
ylabel('reach')
subplot(313)
pcolor(Err.RchHeight.Pass527.All)
set(gca,'CLim',[-0.2 0.2])
colorbar
xlabel('cycle')
ylabel('reach')
```

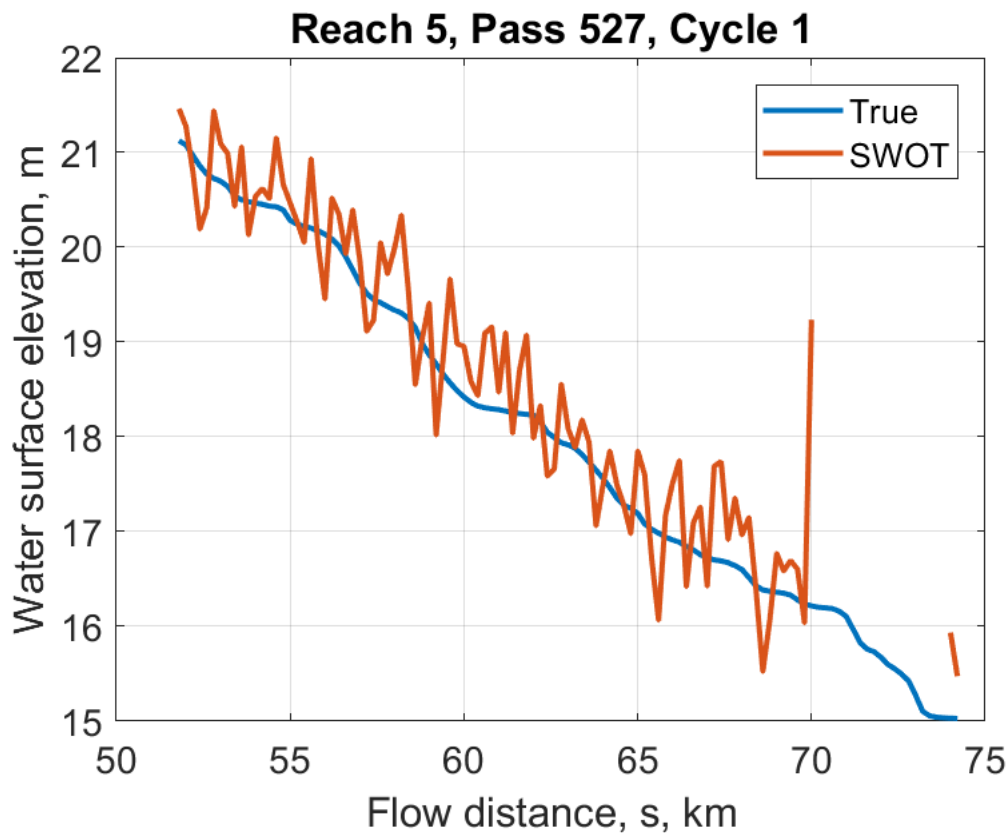


```
figure(7) %it's not cross-track distance!
plot(XTDr(:,1)./1000,rms(Err.RchHeight.Pass249.All,2),'o','LineWidth',2); hold on;
plot(XTDr(:,2)./1000,rms(Err.RchHeight.Pass264.All,2),'o','LineWidth',2);
plot(XTDr(:,3)./1000,rms(Err.RchHeight.Pass527.All,2),'o','LineWidth',2); hold off;
set(gca,'FontSize',14)
legend('Pass 249','Pass 264','Pass 527','Location','Best')
xlabel('Reach-averaged cross-track distance, km')
ylabel('Height RMS error')
grid on
```

partially-observed reach sample calculation

```
figure(8)
i5=find(NodesInReach{5});
plot(FD(i5),Hnt(i5,6),FD(i5),Hn(i5,6),'LineWidth',2)
% plot(NodeID(i5),Hnt(i5,3),NodeID(i5),Hn(i5,3),'LineWidth',2)
set(gca,'FontSize',14)
xlabel('Flow distance, s, km')
% xlabel('Node ID')
ylabel('Water surface elevation, m')
title('Reach 5, Pass 527, Cycle 1')
legend('True','SWOT')
grid on;
```



```
% i1=find(NodesInReach{1});
% x_t = FD(i5)-51.8;
% x_t2 = x_t - max(x_t)/2;
% cef_t = polyfit(x_t2,Hnt(i5,9)',1)
% x=FD(i5)-51.8;
% x2=x-max(x)/2;
% y=Hn(i5,9)';
% idx=~isnan (Hn(i5,9));
% cef_est = polyfit(x2(idx),y(idx),1)
```

```
Method='Current';
```

```
[TrueSlope,TrueHeight] = SampleCalcReachAvg(FD(i5).*1000,Hnt(i5,3)',Method);
```

```
[SWOTSlope,SWOTHeight] = SampleCalcReachAvg(FD(i5).*1000,Hn(i5,3)',Method);
```

```
disp(['RiverObs vs Sample calc: truth: ' num2str(TrueReaches(3).A(5).height) ...
      ' vs ' num2str(TrueHeight)])
```

```
RiverObs vs Sample calc: truth: 17.8107 vs 17.8356
```

```
disp(['RiverObs vs Sample calc: SWOT: ' num2str(SWOTReaches(3).A(5).height) ...
      ' vs ' num2str(SWOTHeight)])
```

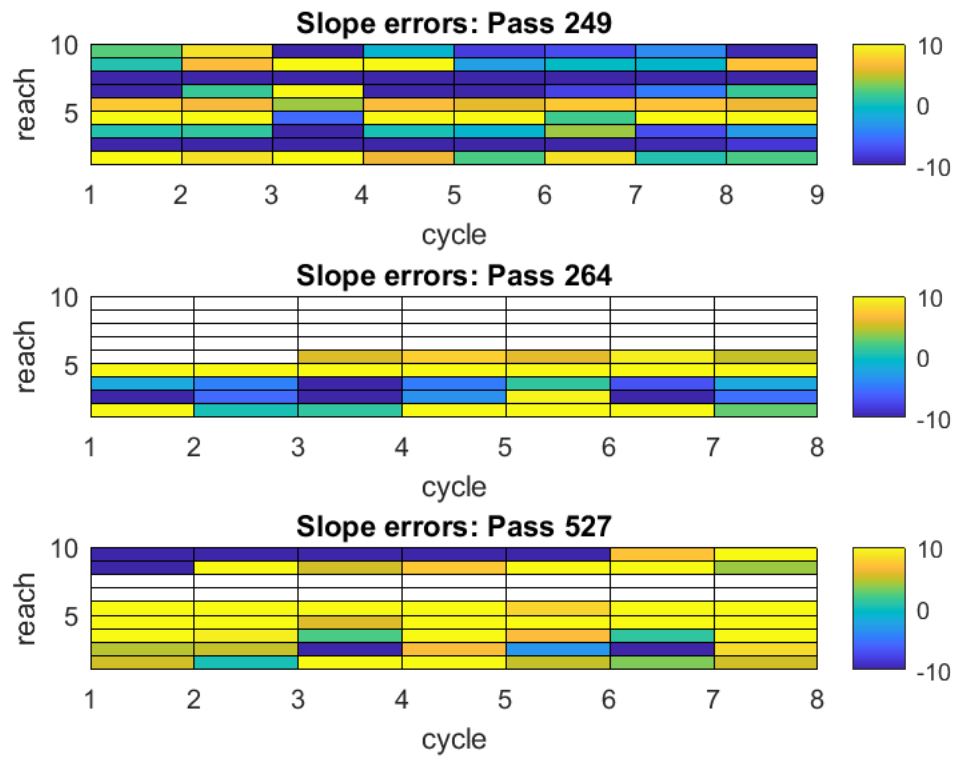
```
RiverObs vs Sample calc: SWOT: 17.8095 vs 18.5116
```

```
Method='Fixed';
```

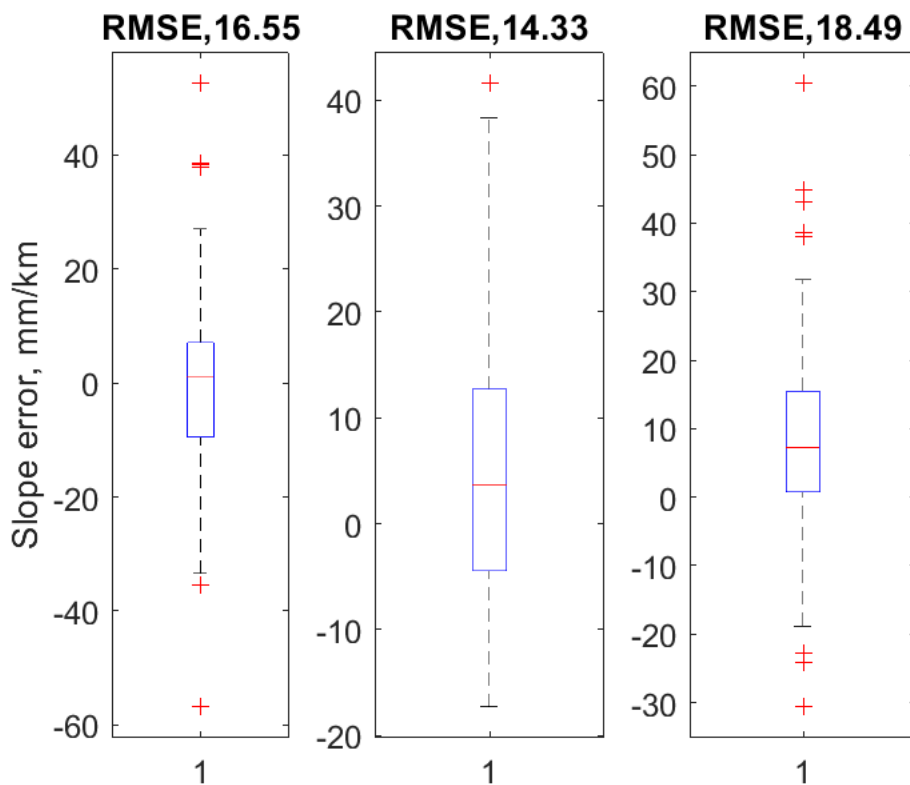
```
[SWOTSlopeFix,SWOTHeightFix] = SampleCalcReachAvg(FD(i5).*1000,Hn(i5,3)',Method);
disp(['RiverObs True vs SWOT fixed Sample calc: ' num2str(TrueReaches(3).A(5).height) ...
    ' vs ' num2str(SWOTHeightFix)])
```

RiverObs True vs SWOT fixed Sample calc: 17.8107 vs 17.955

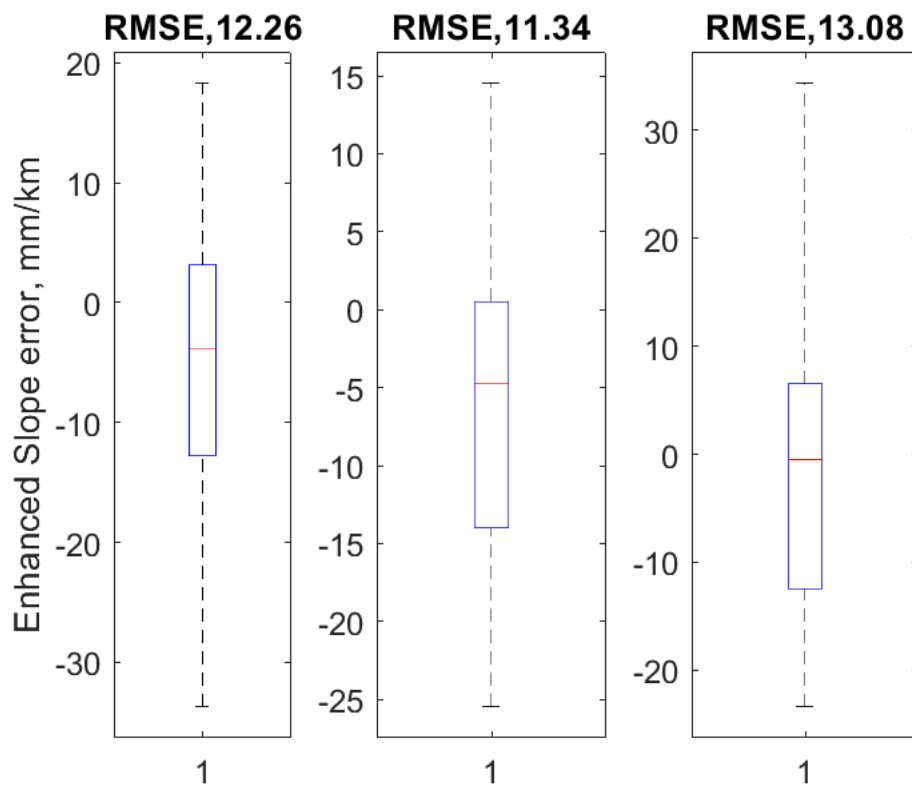
```
figure(9) %reach slope errors by cycle and node
subplot(311)
pcolor(Err.RchSlope.Pass249.All)
colorbar
set(gca,'CLim',[-10 10])
xlabel('cycle')
ylabel('reach')
title('Slope errors: Pass 249')
subplot(312)
pcolor(Err.RchSlope.Pass264.All)
set(gca,'CLim',[-10 10])
colorbar
xlabel('cycle')
ylabel('reach')
title('Slope errors: Pass 264')
subplot(313)
pcolor(Err.RchSlope.Pass527.All)
set(gca,'CLim',[-10 10])
colorbar
xlabel('cycle')
ylabel('reach')
title('Slope errors: Pass 527')
```



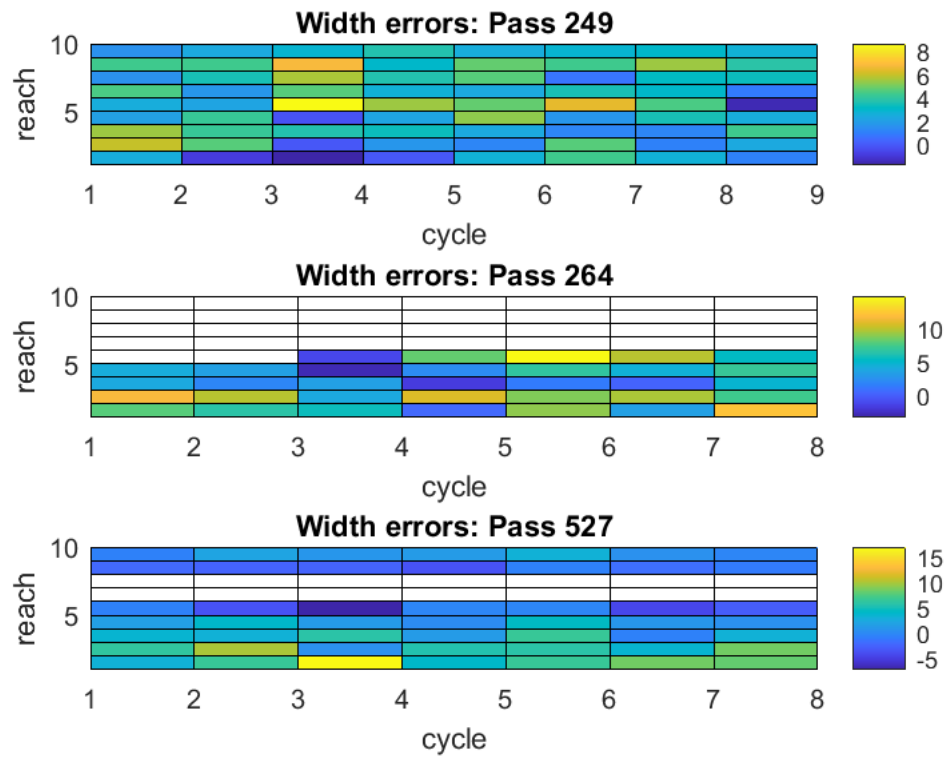
```
figure(10)
subplot(131)
boxplot(Err.RchSlope.Pass249.Allv)
set(gca,'FontSize',12)
title(['RMSE,' num2str(round(Err.RchSlope.Pass249.RMSE,2))])
ylabel('Slope error, mm/km')
subplot(132)
boxplot(Err.RchSlope.Pass264.Allv)
title(['RMSE,' num2str(round(Err.RchSlope.Pass264.RMSE,2))])
set(gca,'FontSize',12)
subplot(133)
boxplot(Err.RchSlope.Pass527.Allv)
title(['RMSE,' num2str(round(Err.RchSlope.Pass527.RMSE,2))])
set(gca,'FontSize',12)
```



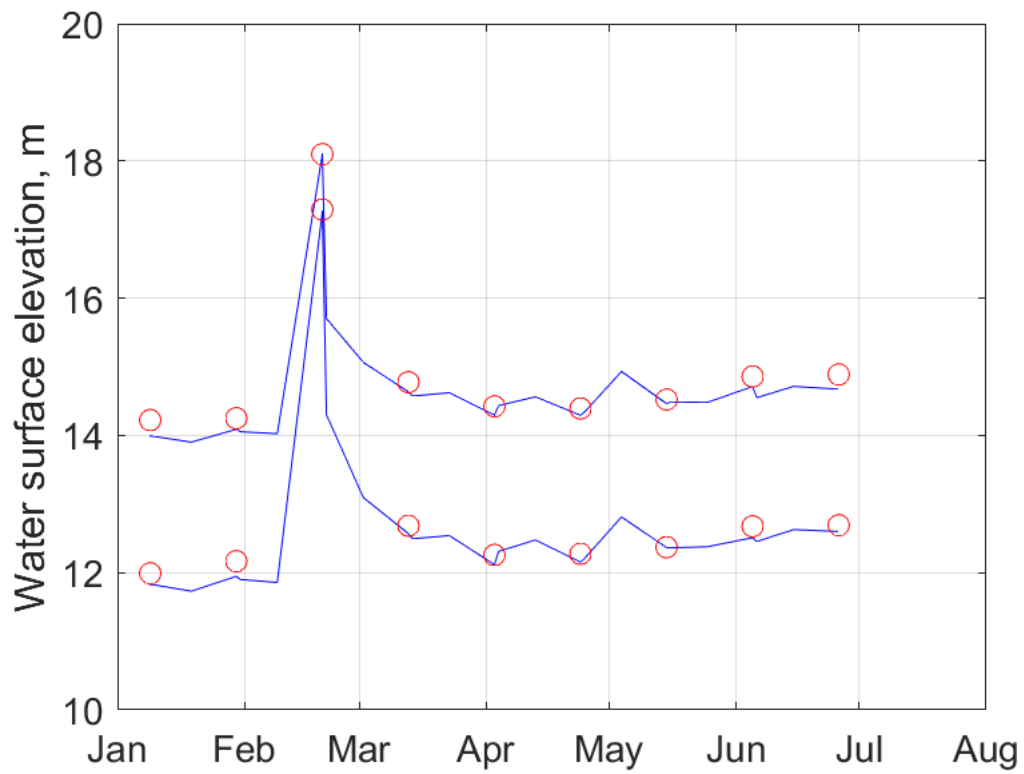
```
figure(11)
subplot(131)
boxplot(Err.RchSlopeEn.Pass249.Allv)
set(gca, 'FontSize', 12)
ylabel('Enhanced Slope error, mm/km')
title(['RMSE,' num2str(round(Err.RchSlopeEn.Pass249.RMSE,2))])
subplot(132)
boxplot(Err.RchSlopeEn.Pass264.Allv)
title(['RMSE,' num2str(round(Err.RchSlopeEn.Pass264.RMSE,2))])
set(gca, 'FontSize', 12)
subplot(133)
boxplot(Err.RchSlopeEn.Pass527.Allv)
title(['RMSE,' num2str(round(Err.RchSlopeEn.Pass527.RMSE,2))])
set(gca, 'FontSize', 12)
```



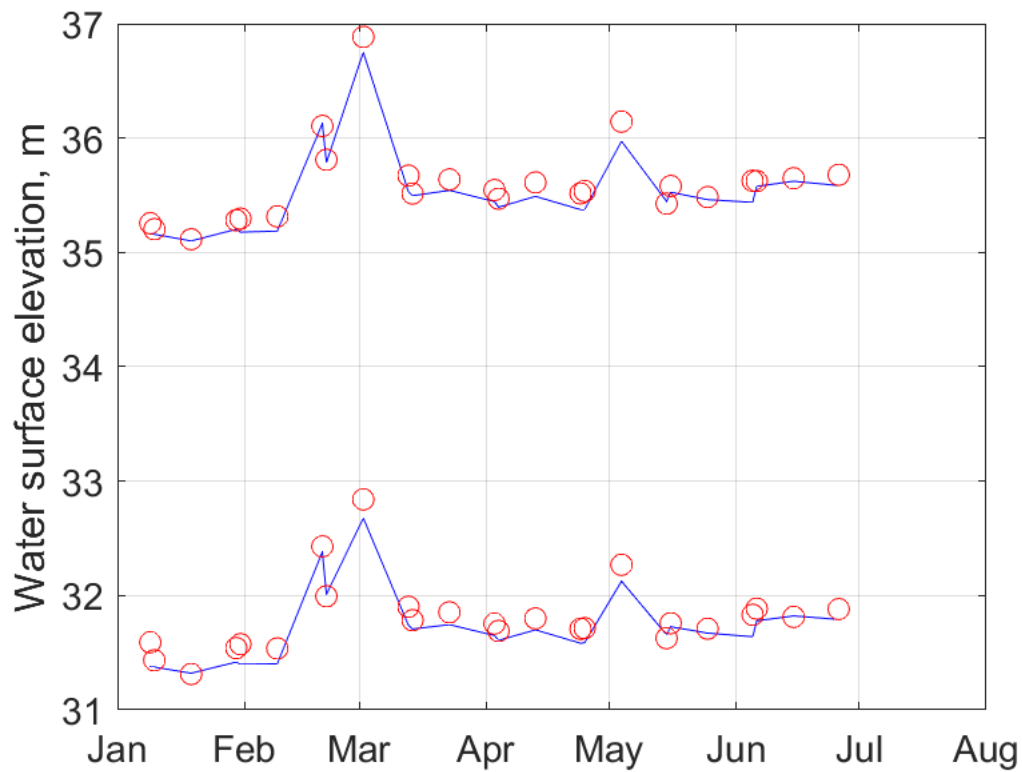
```
figure(12) %reach slope errors by cycle and node
subplot(311)
pcolor(Err.RchWidth.Pass249.All)
colorbar
% set(gca,'CLim',[-10 10])
xlabel('cycle')
ylabel('reach')
title('Width errors: Pass 249')
subplot(312)
pcolor(Err.RchWidth.Pass264.All)
% set(gca,'CLim',[-10 10])
colorbar
xlabel('cycle')
ylabel('reach')
title('Width errors: Pass 264')
subplot(313)
pcolor(Err.RchWidth.Pass527.All)
% set(gca,'CLim',[-10 10])
colorbar
xlabel('cycle')
ylabel('reach')
title('Width errors: Pass 527')
```



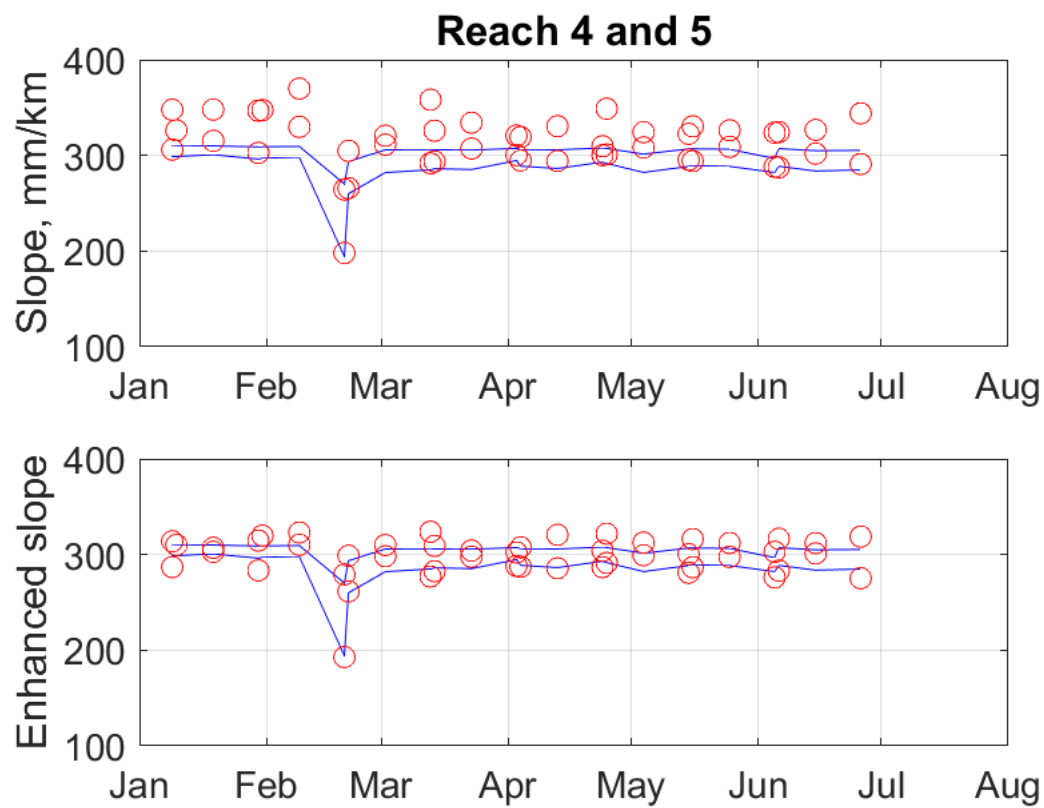
```
figure(13)
[f13_x,ind_x]=sort(cell2mat(Dates));
plot(dates(ind_x),Hrt([6 7],ind_x),'b-',dates(ind_x),Hr([6 7],ind_x),'ro','MarkerSize',8)
set(gca,'FontSize',14)
datetick
ylabel('Water surface elevation, m')
grid
```



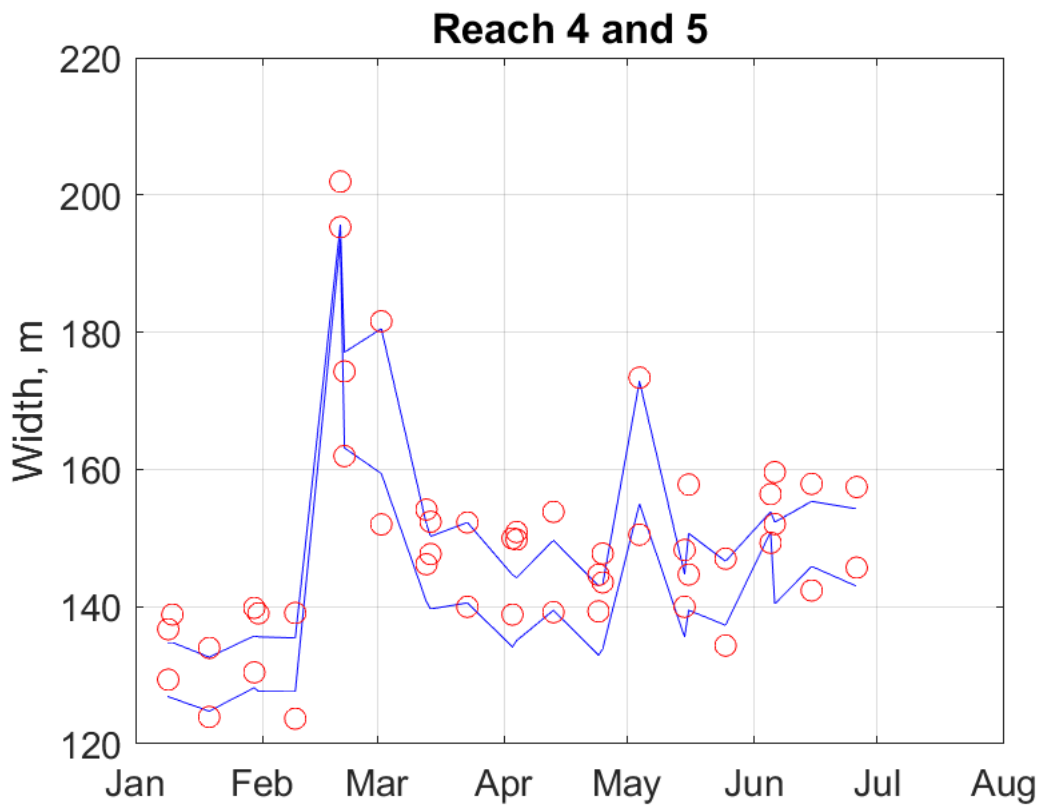
```
figure(13)
[f13_x,ind_x]=sort(cell2mat(Dates));
plot(dates(ind_x),Hrt([1 2],ind_x),'b-',dates(ind_x),Hr([1 2],ind_x),'ro','MarkerSize',8)
set(gca,'FontSize',14)
datetick
ylabel('Water surface elevation, m')
grid
```

```
figure(14)
subplot(211)
plot(dates(ind_x),Srt([4 5],ind_x),'b-',dates(ind_x),Sr([4 5],ind_x),'ro','MarkerSize',8)
set(gca,'FontSize',14)
datetick
ylabel('Slope, mm/km')
title('Reach 4 and 5')
grid
subplot(212)
plot(dates(ind_x),Srte([4 5],ind_x),'b-',dates(ind_x),Sre([4 5],ind_x),'ro','MarkerSize',8)
set(gca,'FontSize',14)
datetick
ylabel('Enhanced slope')
grid
```



```
figure(15)
plot(dates(ind_x),Wrt([4,5],ind_x),'b-',dates(ind_x),Wr([4,5],ind_x),'ro','MarkerSize',8)
set(gca,'FontSize',14)
datetick
ylabel('Width, m')
title('Reach 4 and 5')
grid
```

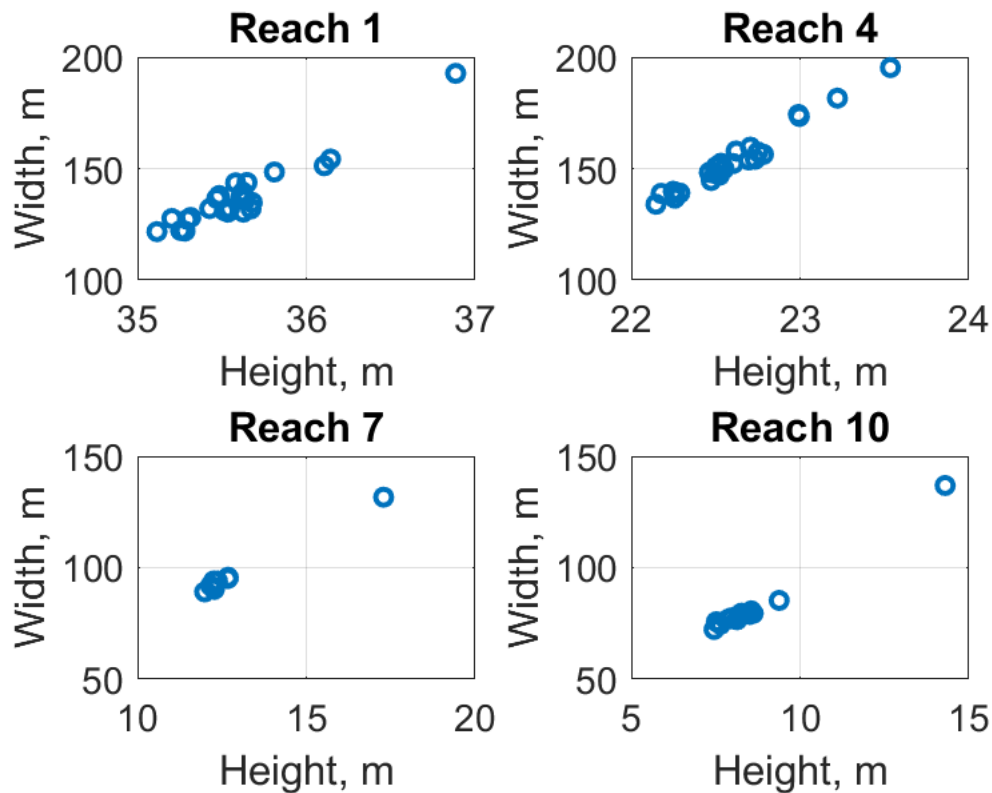


```
figure(16)
subplot(221)
r=1;
plot(Hr(r,:),Wr(r,:), 'o', 'LineWidth', 2)
set(gca, 'FontSize', 14)
xlabel('Height, m'); ylabel('Width, m')
title('Reach 1')
grid on;
subplot(222)
r=4;
plot(Hr(r,:),Wr(r,:), 'o', 'LineWidth', 2)
set(gca, 'FontSize', 14)
xlabel('Height, m'); ylabel('Width, m')
title('Reach 4')
grid on;
subplot(223)
r=7;
plot(Hr(r,:),Wr(r,:), 'o', 'LineWidth', 2)
set(gca, 'FontSize', 14)
xlabel('Height, m'); ylabel('Width, m')
title('Reach 7')
grid on;
subplot(224)
r=10;
plot(Hr(r,:),Wr(r,:), 'o', 'LineWidth', 2)
set(gca, 'FontSize', 14)
```

```

xlabel('Height, m'); ylabel('Width, m')
title('Reach 10')
grid on;

```

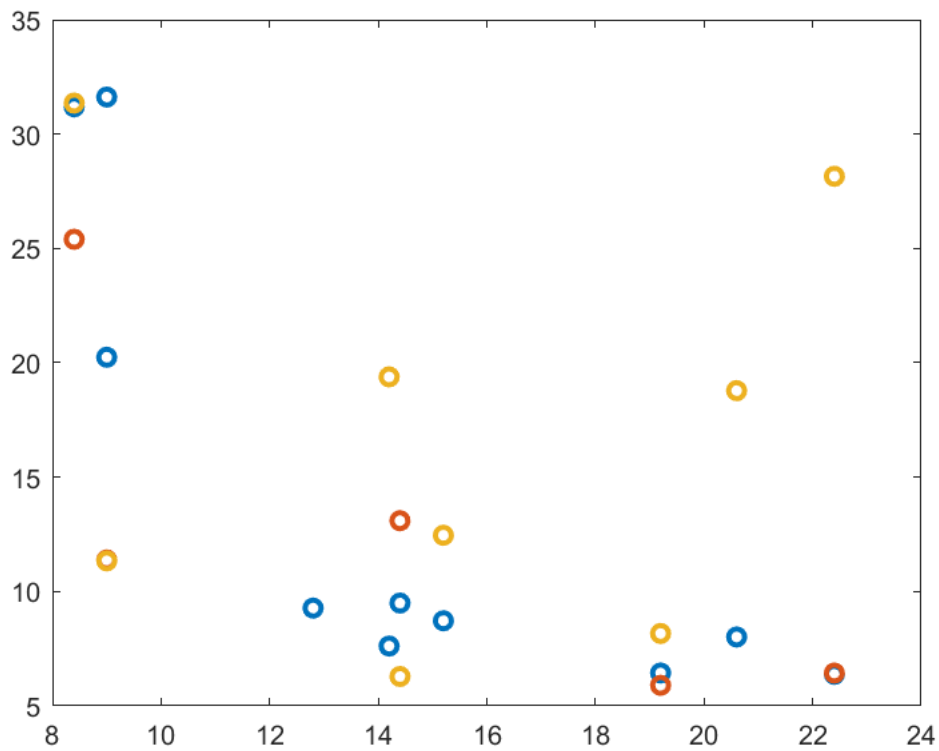


```

for i=1:nReach
    Pass249RMSESlope(i)=(nanmean(Err.RchSlope.Pass249.All(i,:)).^2+ ...
        nanstd(Err.RchSlope.Pass249.All(i,:)).^2).^5;
    Pass264RMSESlope(i)=(nanmean(Err.RchSlope.Pass264.All(i,:)).^2+ ...
        nanstd(Err.RchSlope.Pass264.All(i,:)).^2).^5;
    Pass527RMSESlope(i)=(nanmean(Err.RchSlope.Pass527.All(i,:)).^2+ ...
        nanstd(Err.RchSlope.Pass527.All(i,:)).^2).^5;
    Pass249RMSEHeight(i)=(nanmean(Err.RchHeight.Pass249.All(i,:)).^2+ ...
        nanstd(Err.RchHeight.Pass249.All(i,:)).^2).^5;
    Pass264RMSEHeight(i)=(nanmean(Err.RchHeight.Pass264.All(i,:)).^2+ ...
        nanstd(Err.RchHeight.Pass264.All(i,:)).^2).^5;
    Pass527RMSEHeight(i)=(nanmean(Err.RchHeight.Pass527.All(i,:)).^2+ ...
        nanstd(Err.RchHeight.Pass527.All(i,:)).^2).^5;
end

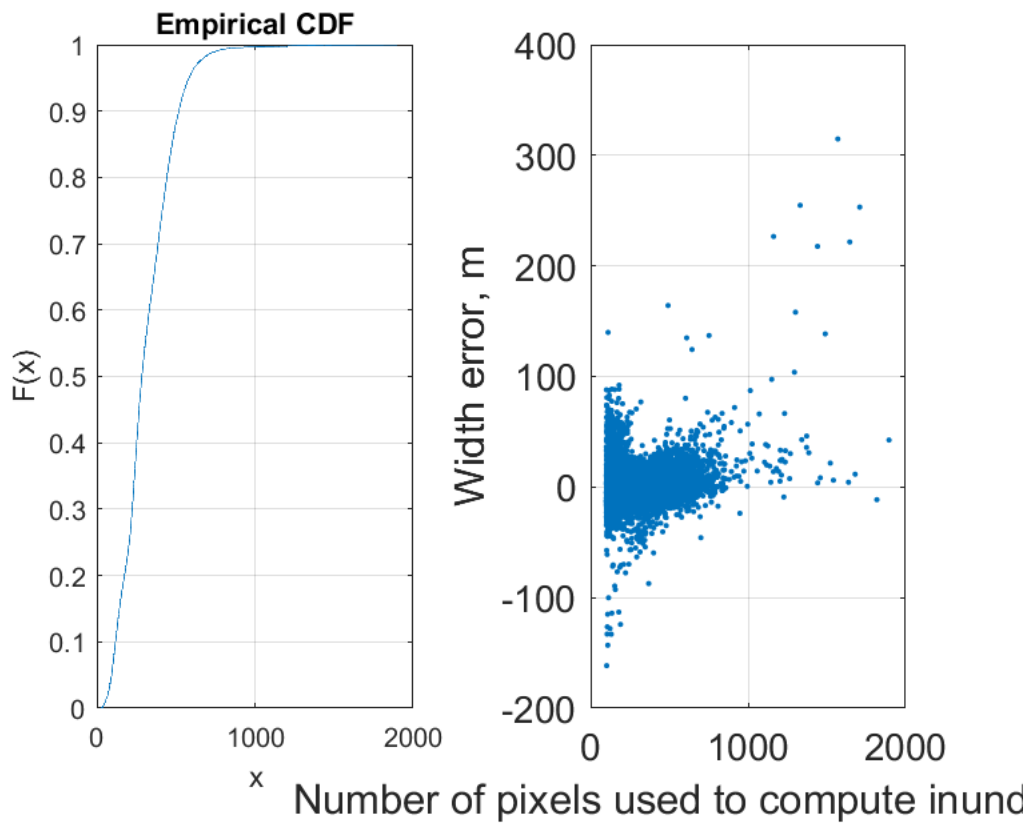
figure(18)
plot(RL,Pass249RMSESlope,'o',RL,Pass264RMSESlope,'o',RL,Pass527RMSESlope,'o','LineWidth',2)

```

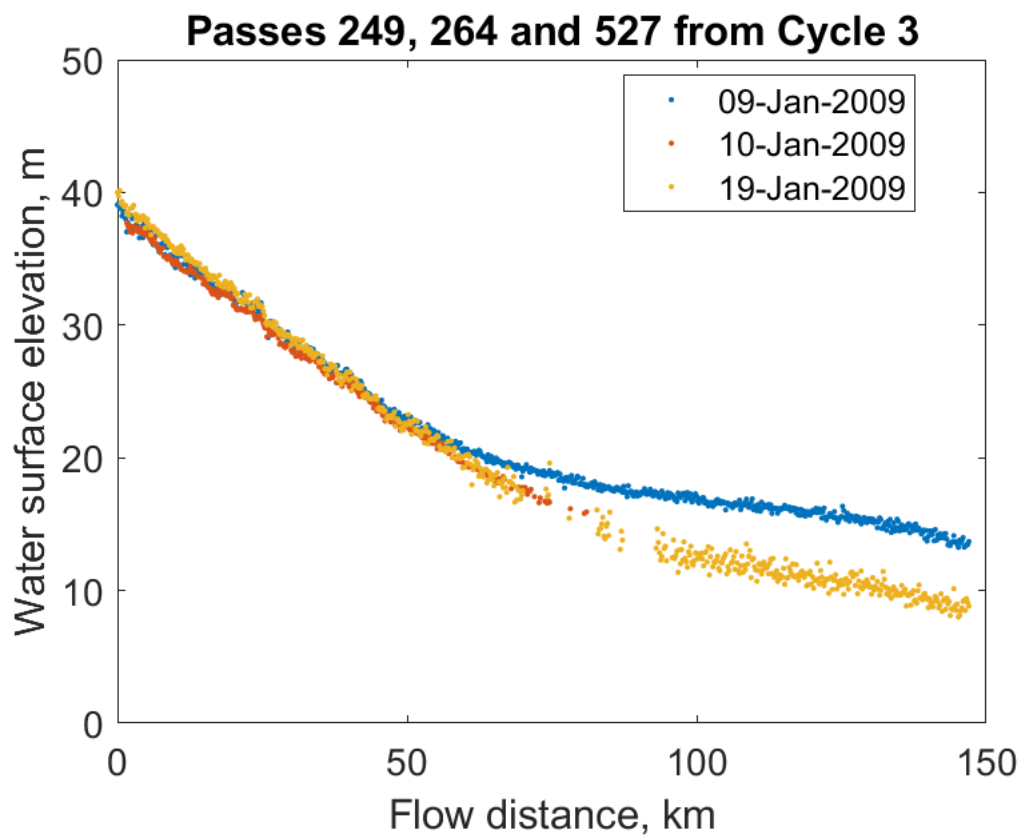


nodes

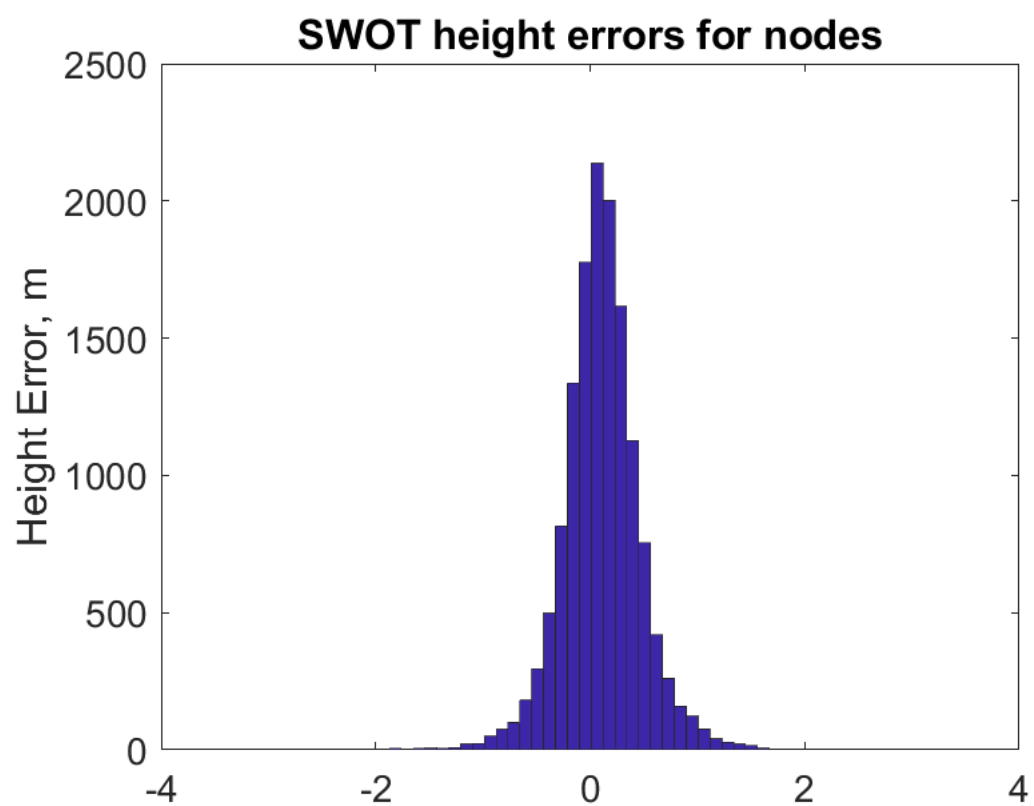
```
figure(17)
subplot(121)
cdfplot(nPix(:))
subplot(122)
plot(nPix(:),Wn(:)-Wnt(:),'.')
set(gca,'FontSize',14)
grid on
xlabel('Number of pixels used to compute inundated area')
ylabel('Width error, m')
```



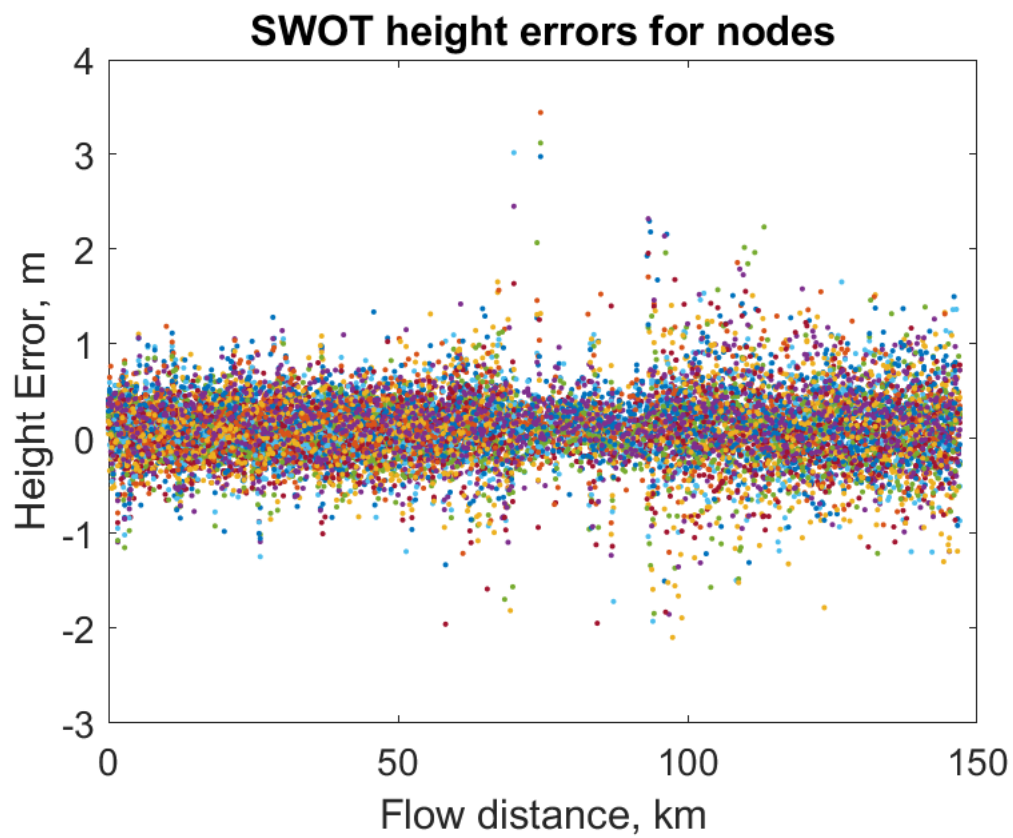
```
figure(18)
plot(FD,Hn(iSort{5},7),'.'); hold on;
plot(FD,Hn(iSort{6},8),'.');
plot(FD,Hn(iSort{7},9),'.'); hold off;
set(gca,'FontSize',14)
xlabel('Flow distance, km')
ylabel('Water surface elevation, m')
legend(datestr(dates(1:3)'),'Location','Best')
title('Passes 249, 264 and 527 from Cycle 3')
```



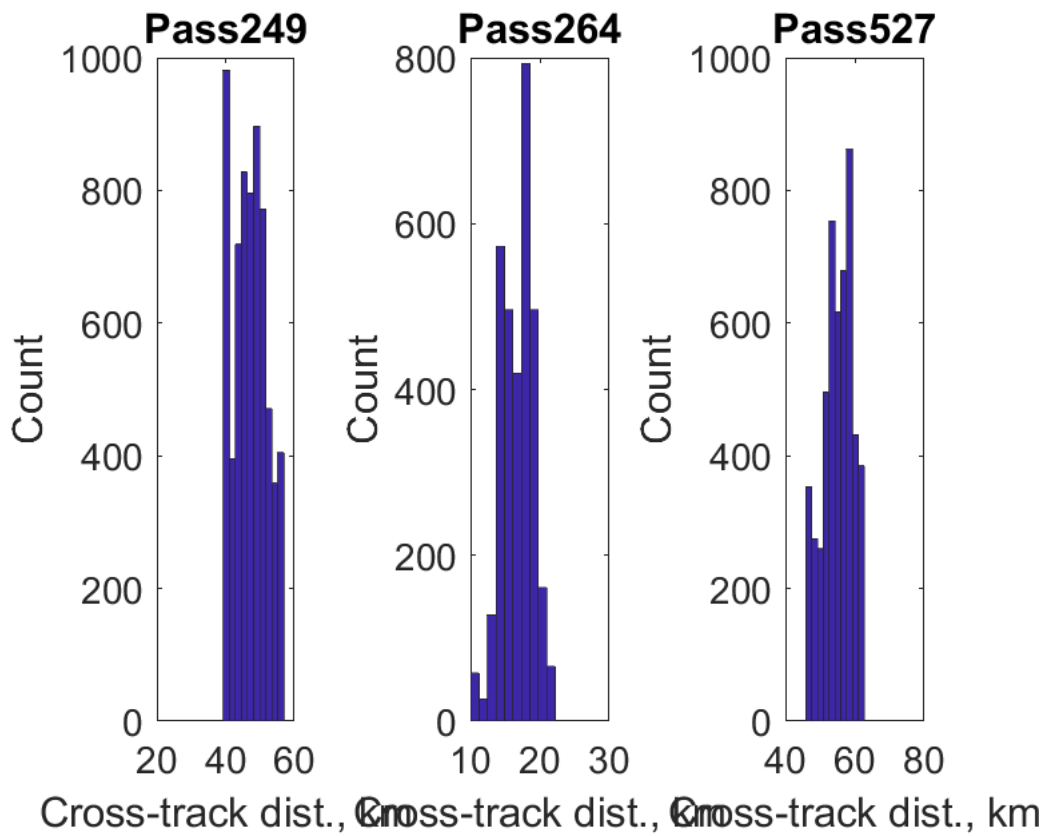
```
figure(19)
hist(Err.NodeHeight.Allv,50)
set(gca,'FontSize',14)
ylabel('Height Error, m')
title('SWOT height errors for nodes')
```



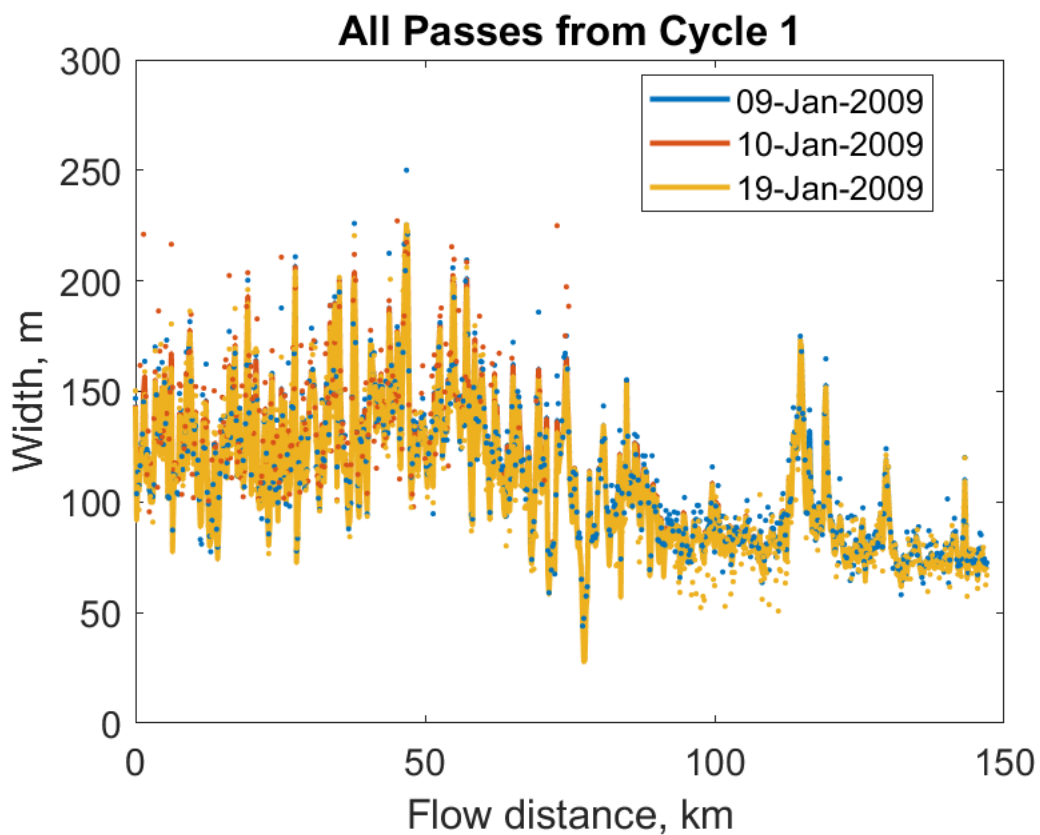
```
figure(20)
plot(FD,Err.NodeHeight.All, '.')
set(gca, 'FontSize', 14)
xlabel('Flow distance, km')
ylabel('Height Error, m')
title('SWOT height errors for nodes')
```

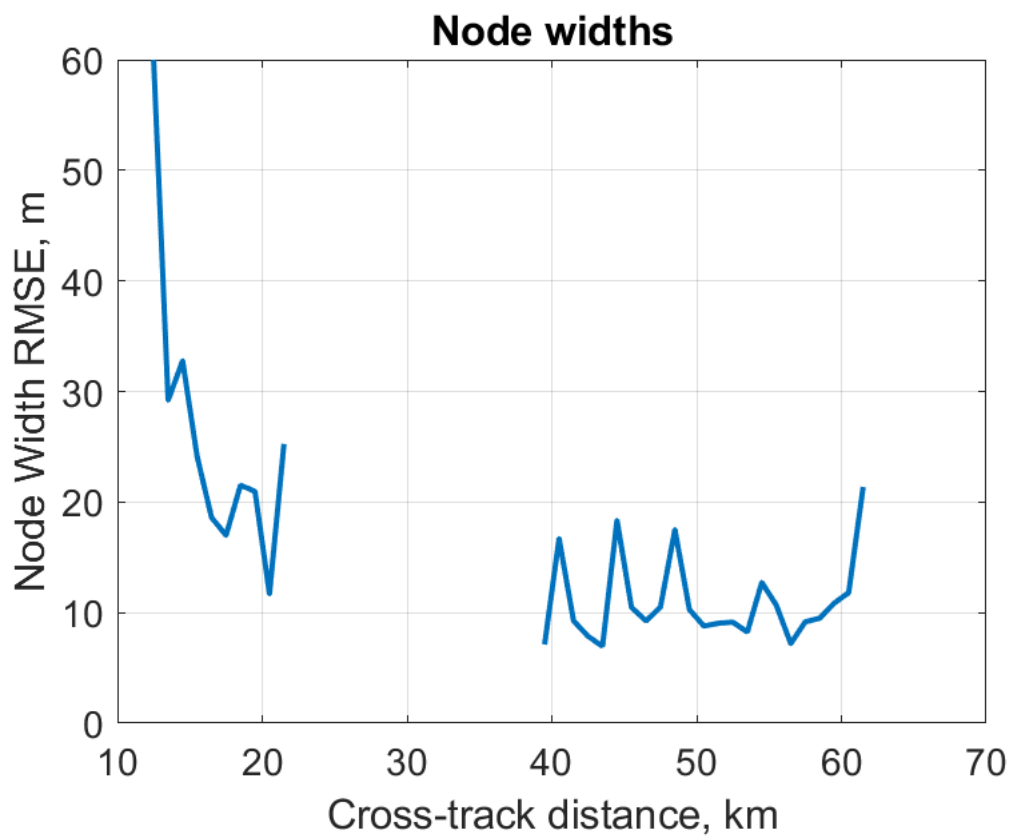
```
figure(21)
for i=1:nPass
    subplot(1, nPass, i)
    xt=XTDn(:,ind.(['Pass' num2str(Pass(i))]));
    hist(xt(:)./1000)
    set(gca,'FontSize',14)
    title(['Pass' num2str(Pass(i))])
    ylabel('Count')
    xlabel('Cross-track dist., km')
end
```



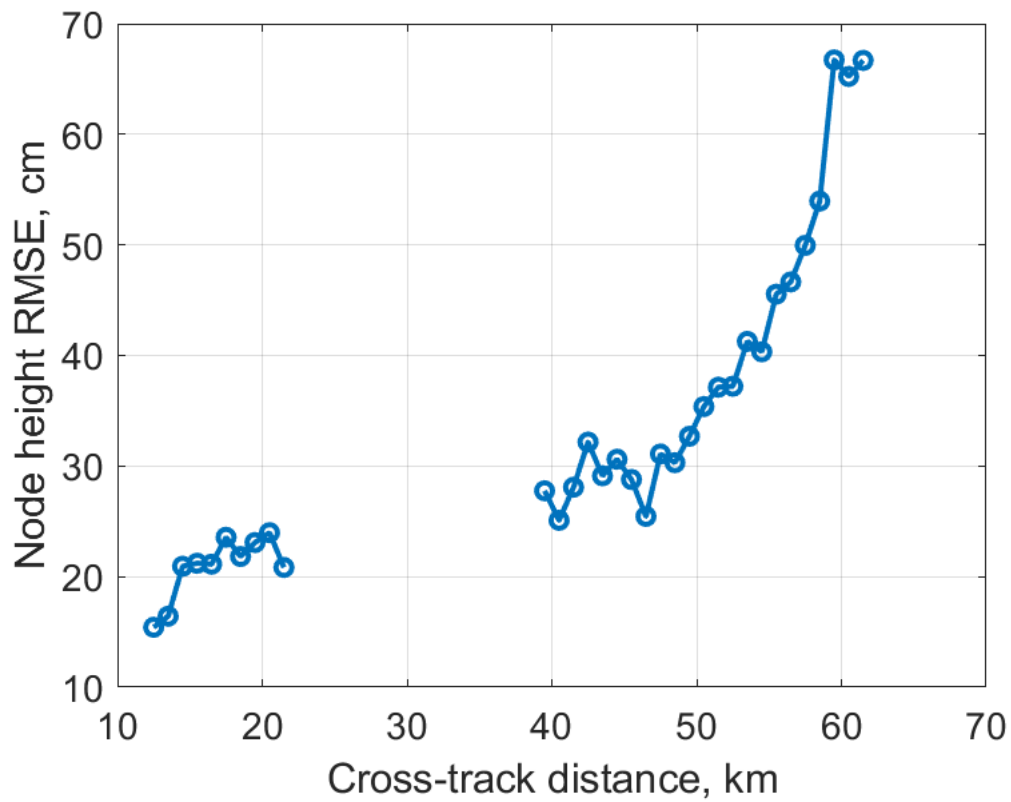
```
figure(22)
C=get(groot,'defaultAxesColorOrder');
plot(FD,Wnt(:,[1 2 3]),'LineWidth',2); hold on;
h=plot(FD,Wn(:,[1 2 3]),'.','LineWidth',2); hold off;
for i=1:3
    set(h(i),'Color',C(i,:))
end
set(gca,'FontSize',14)
xlabel('Flow distance, km')
ylabel('Width, m')
title('All Passes from Cycle 1')
legend(datestr(dates(1:3)'),'Location','Best')
```



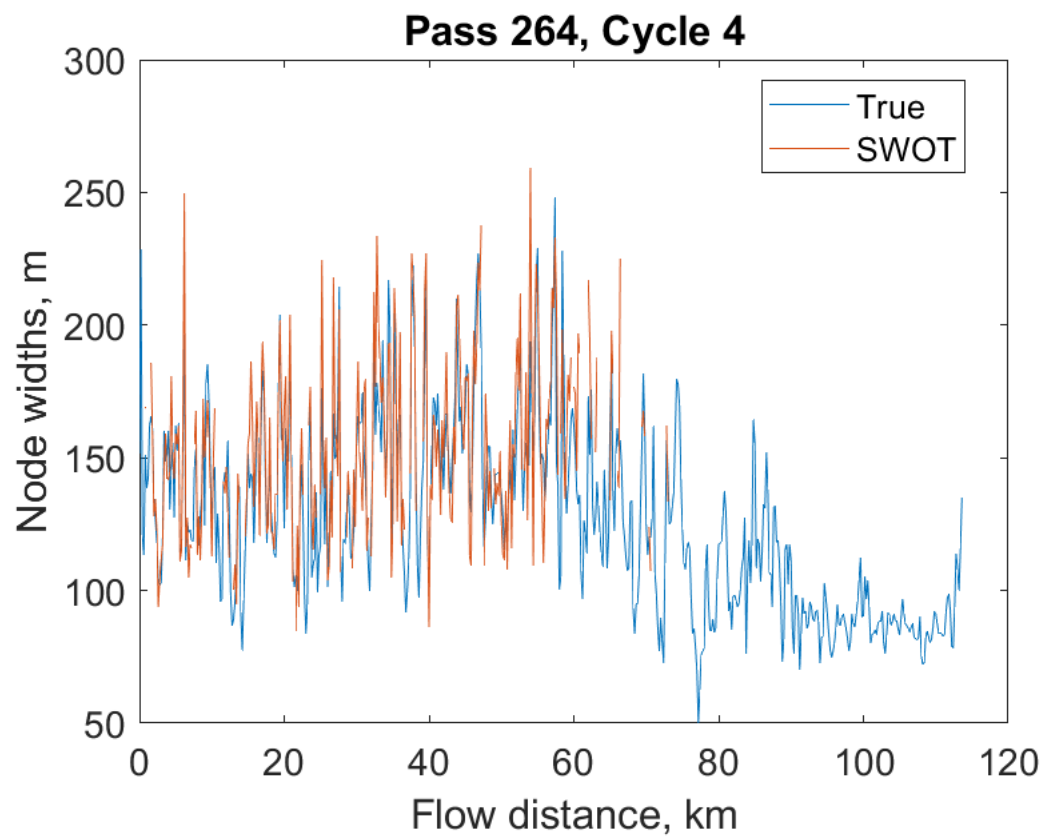
```
figure(23)
XTDnBinBound=[10:62].*1000;
for i=1:length(XTDnBinBound)-1
    j=XTDn(:)>=XTDnBinBound(i) & XTDn(:)<XTDnBinBound(i+1) & ~isnan(Err.NodeWidth.All(:));
    RmsNodeWidthXT(i)=rms(Err.NodeWidth.All(j));
end
plot(XTDnBinBound(1:end-1)./1000+.5,RmsNodeWidthXT,'LineWidth',2)
set(gca,'FontSize',14)
xlabel('Cross-track distance, km')
ylabel('Node Width RMSE, m')
title('Node widths')
grid on;
```



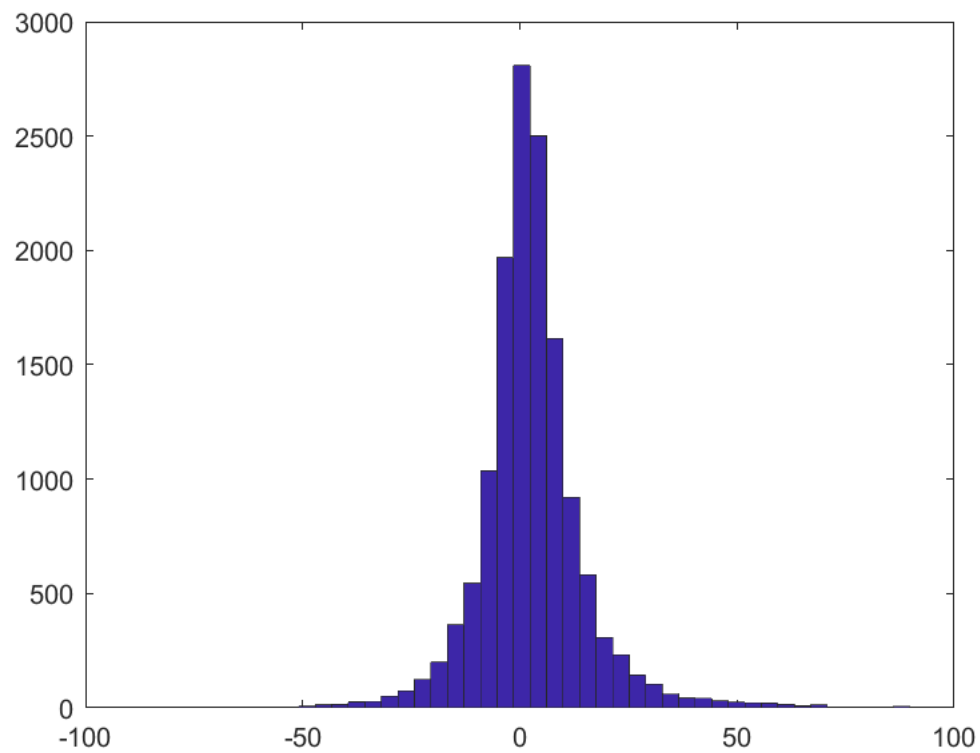
```
figure(24)
XTDnBinBound=[10:62].*1000;
for i=1:length(XTDnBinBound)-1
    j=XTDn(:)>=XTDnBinBound(i) & XTDn(:)<XTDnBinBound(i+1) & ~isnan(Err.NodeHeight.All(:));
    RmsNodeHeightXT(i)=rms(Err.NodeHeight.All(j));
end
plot(XTDnBinBound(1:end-1)./1000+.5,RmsNodeHeightXT.*100,'o-','LineWidth',2)
set(gca,'FontSize',14)
xlabel('Cross-track distance, km')
ylabel('Node height RMSE, cm')
grid on
```



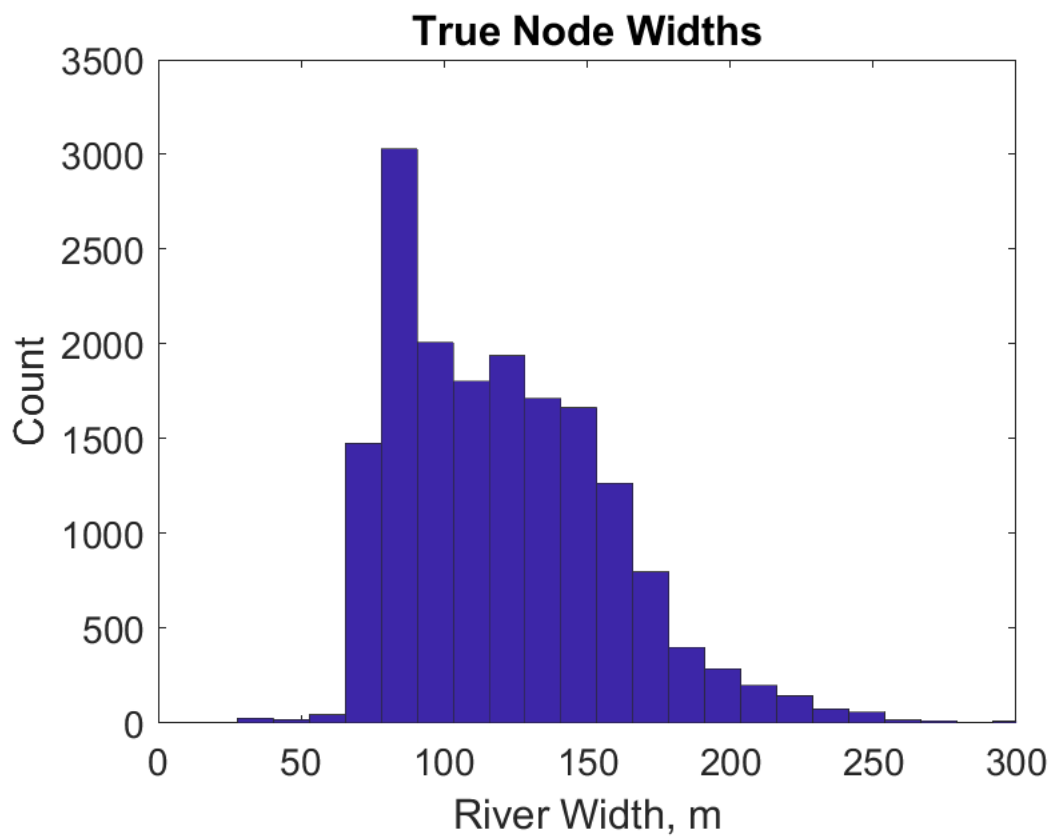
```
figure(25)
i=11;
% j=2:nNode-1;
j=1:nNode;
plot(FD(j),Wnt(j,i),FD(j),Wn(j,i))
set(gca,'FontSize',14)
legend('True','SWOT','Location','Best')
xlabel('Flow distance, km')
ylabel('Node widths, m')
title(['Pass ' num2str(Passes(i)) ', Cycle ' num2str(Cycles(i))])
```



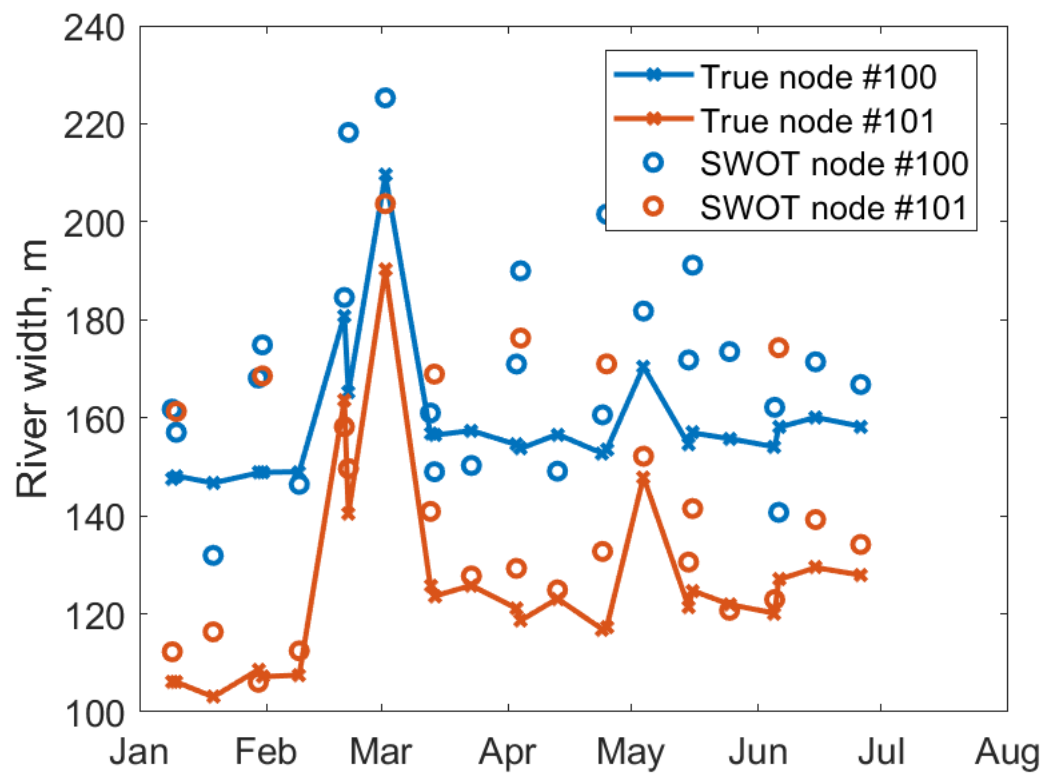
```
figure(26)
wcut=100;
hist(Err.NodeWidth.Allv(abs(Err.NodeWidth.Allv)<wcut),50)
```



```
figure(27)
hist(Wnt(:),50)
set(gca,'XLim',[0 300],'FontSize',14)
xlabel('River Width, m')
ylabel('Count')
title('True Node Widths')
```



```
figure(28)
nids=[100 101];
plot(dates,Wnt(nids,:), 'x-', 'LineWidth',2); hold on;
h=plot(dates,Wn(nids,:), 'o', 'LineWidth',2); hold off;
for i=1:2
    set(h(i), 'Color', C(i,:))
end
set(gca, 'FontSize',14)
datetick
ylabel('River width, m')
legend('True node #100', 'True node #101', 'SWOT node #100', 'SWOT node #101', 'Location', 'Best')
```

et al.: le geoid!

```
figure(29)
plot(FD,[TrueNodes(1).A.geoid_hght])
```

