

CTS Reader

CTS Spatial

plot the monthly CTS depth (cold ice thickness) evolution

```
% clearvars; close all;  
% % load('output\20190426small.mat');  
% load('output\20090503.mat');
```

define roi

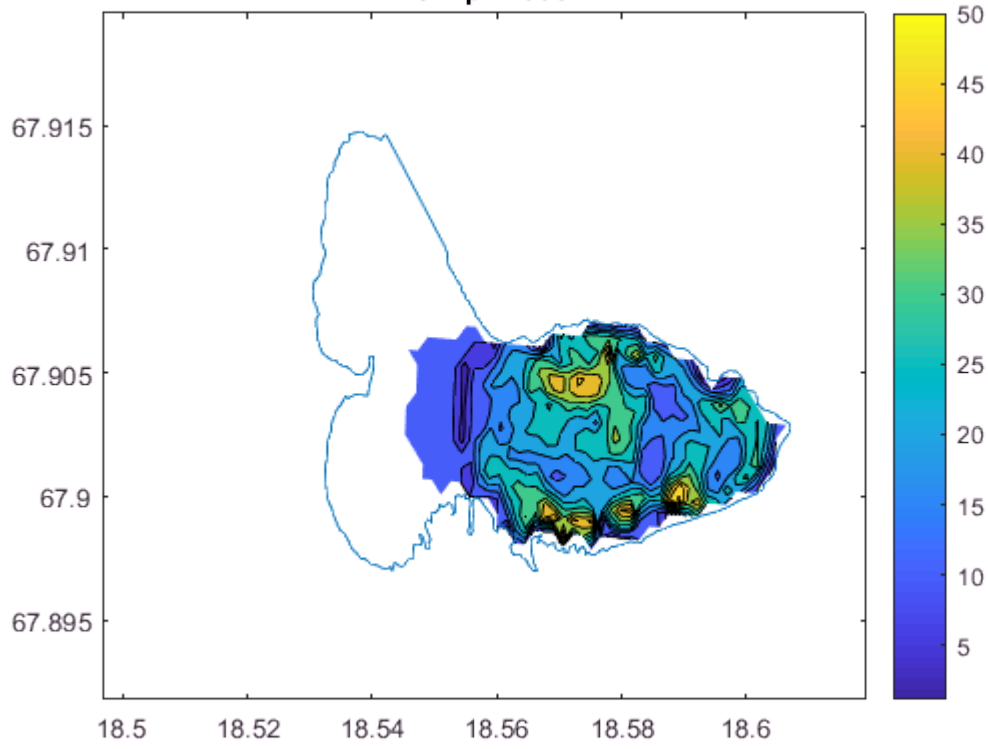
```
grid = 0.runinfo.grid;  
load('DEM\DEMStor.mat');  
grid.Outline = DEM.Outline;  
clearvars DEM storDEM;  
grid.ablmask = (grid.z > 1495); % ELA at 2009
```

CTS mapping

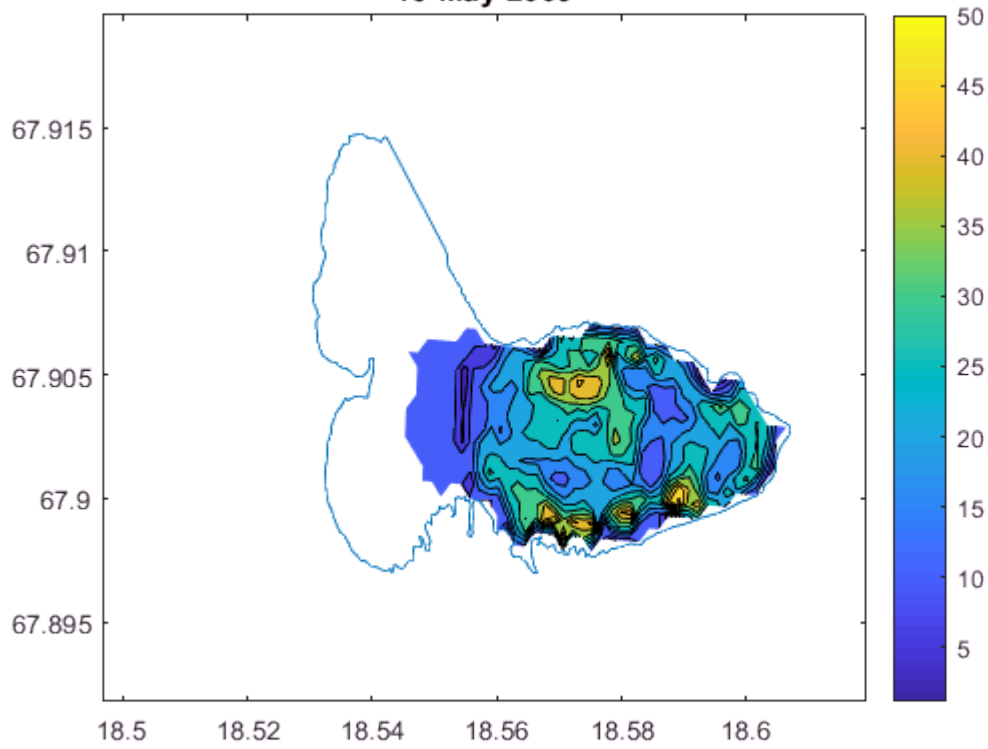
```
% time = datetime(0.t,'ConvertFrom','datenum');  
time = datetime(0.t(366:end),'ConvertFrom','datenum');  
  
[yr,mo,da] = ymd(time);  
G = findgroups(yr,mo);  
datemean = splitapply(@mean,0.t(366:end),G);  
datemean = datetime(datemean,'ConvertFrom','datenum');  
for i = 1:G(end)  
    index = find(G == i);  
    subT = 0.subT(:,index,:)-273.15;  
    subZ = 0.subZ(:,index,:);  
    subTmean = squeeze(mean(subT,2));  
    subZmean = squeeze(mean(subZ,2));  
    subTmean(subTmean > 0) = 0;  
    loc = subTmean(:,1) == 0; % reset surface layer T=0 to -1  
    subTmean(loc,1) = -1;  
  
    loc = subTmean == 0; % find 0 degree in all layers  
    subZmean(loc) = 0;  
    CTS = sum(subZmean);  
    % CTS(grid.ablmask) = nan;  
    % figure; scatter(grid.x_mask,grid.y_mask,10,CTS); colorbar;  
    map = nan(size(grid.maskfull));  
    map(grid.maskfull==1) = CTS;  
    map(grid.ablmask) = nan;  
    figure;  
    % surface(grid.lon,grid.lat,grid.z,map); colorbar;  
    contourf(grid.lon,grid.lat,map); colorbar;  
    hold on;  
    plot(grid.Outline(:,2), grid.Outline(:,1));  
    hold off;  
    title(datestr(datemean(i)));
```

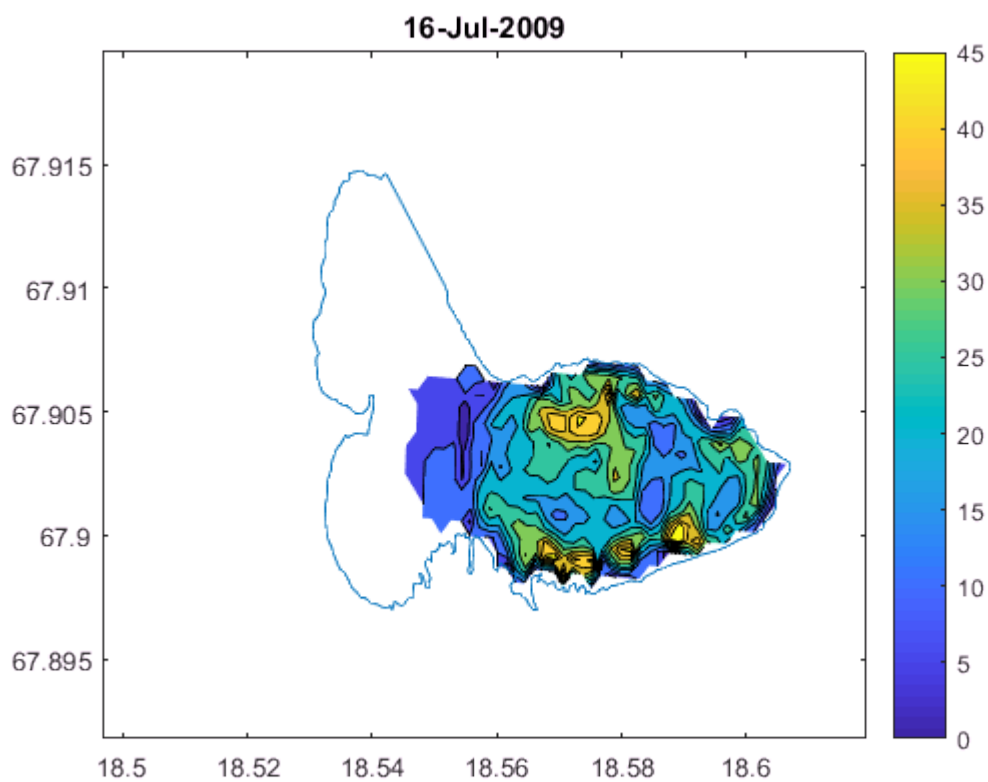
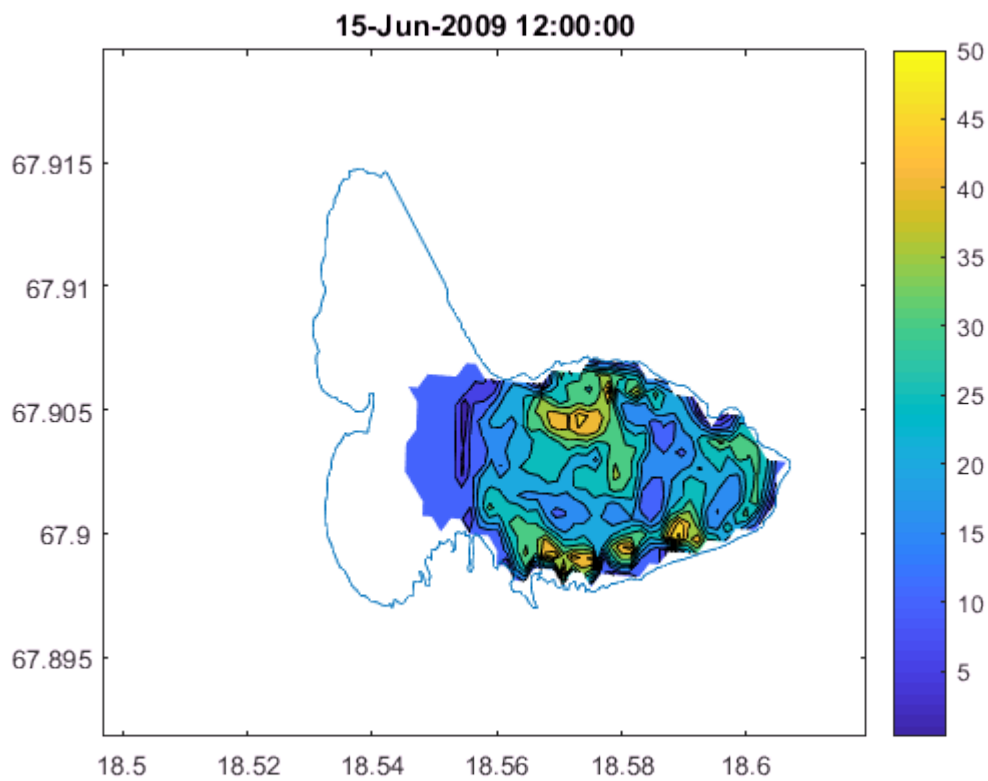
end

16-Apr-2009

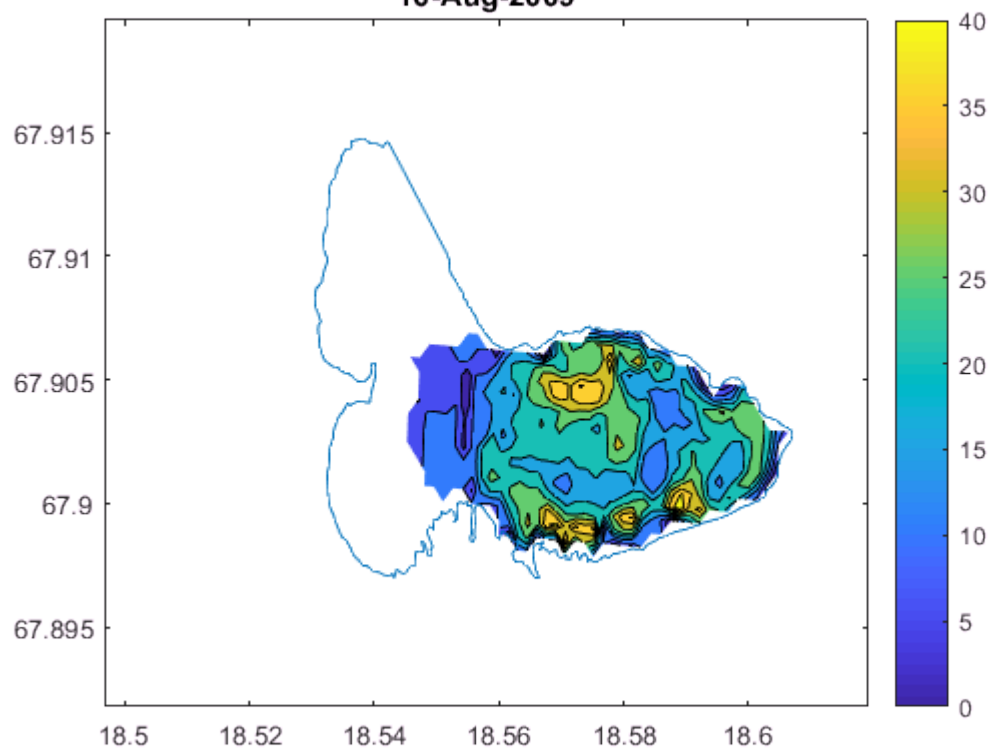


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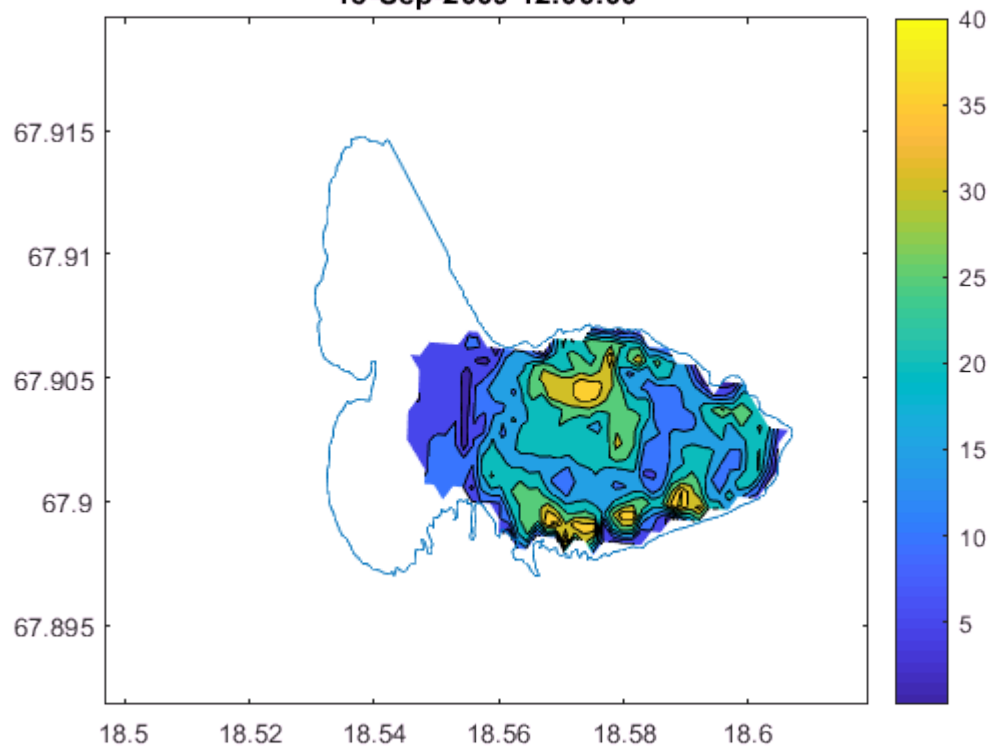




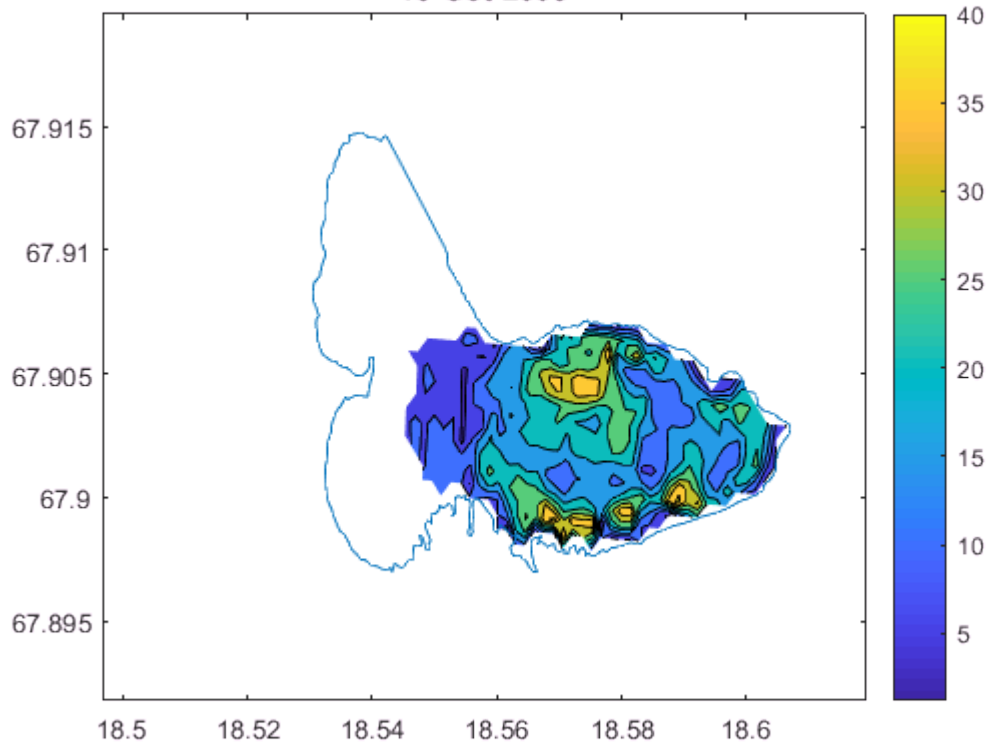
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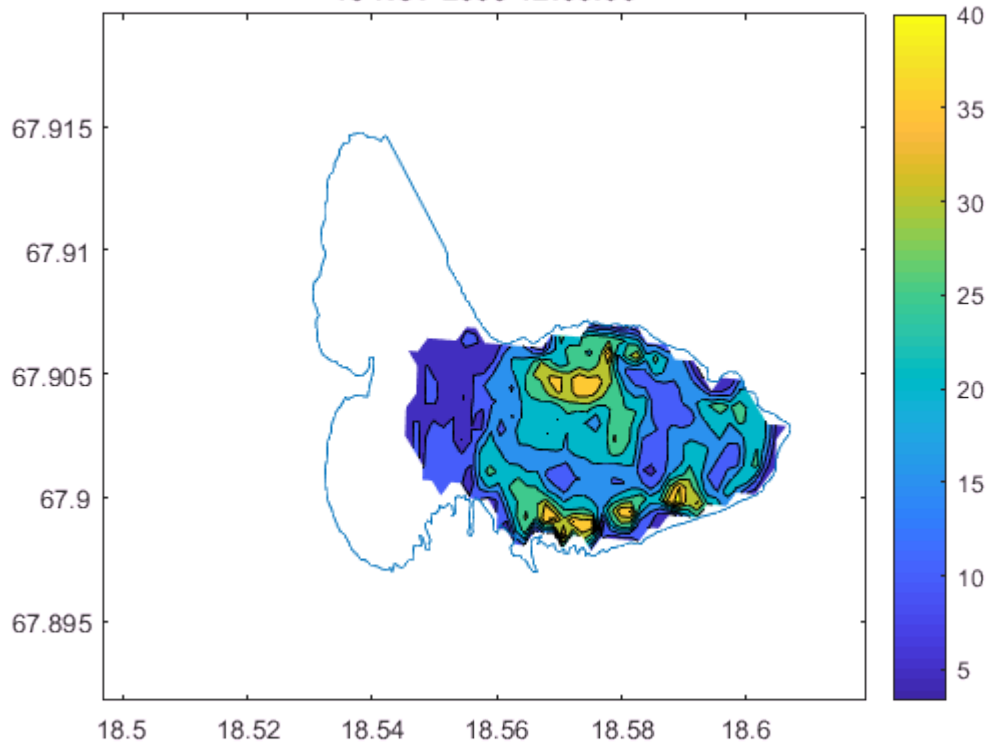
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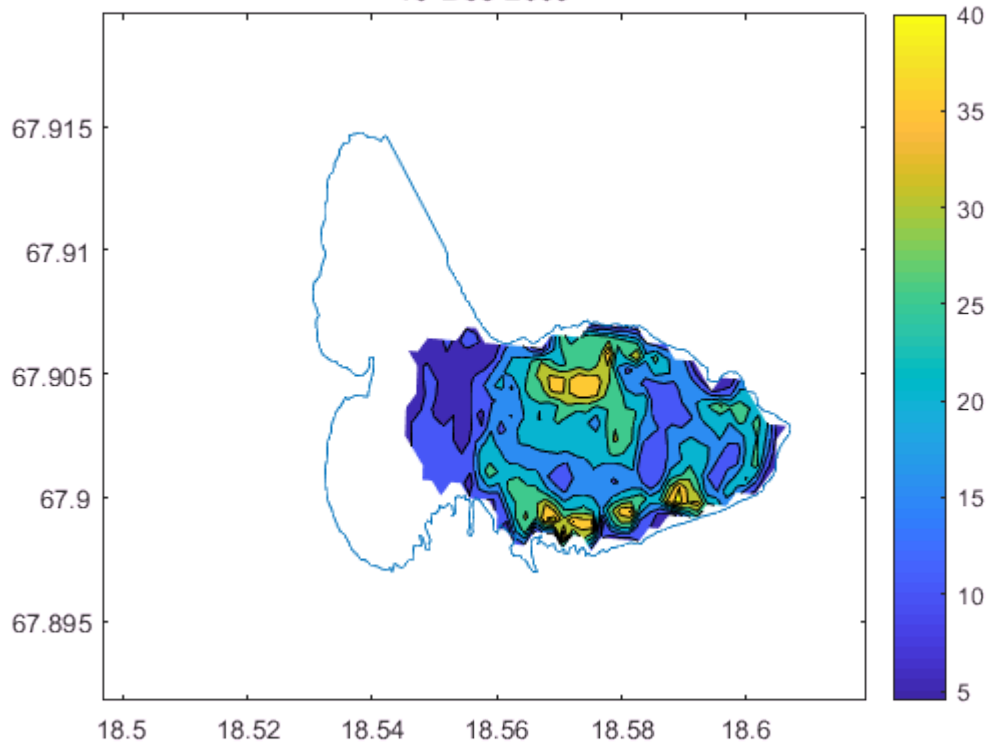
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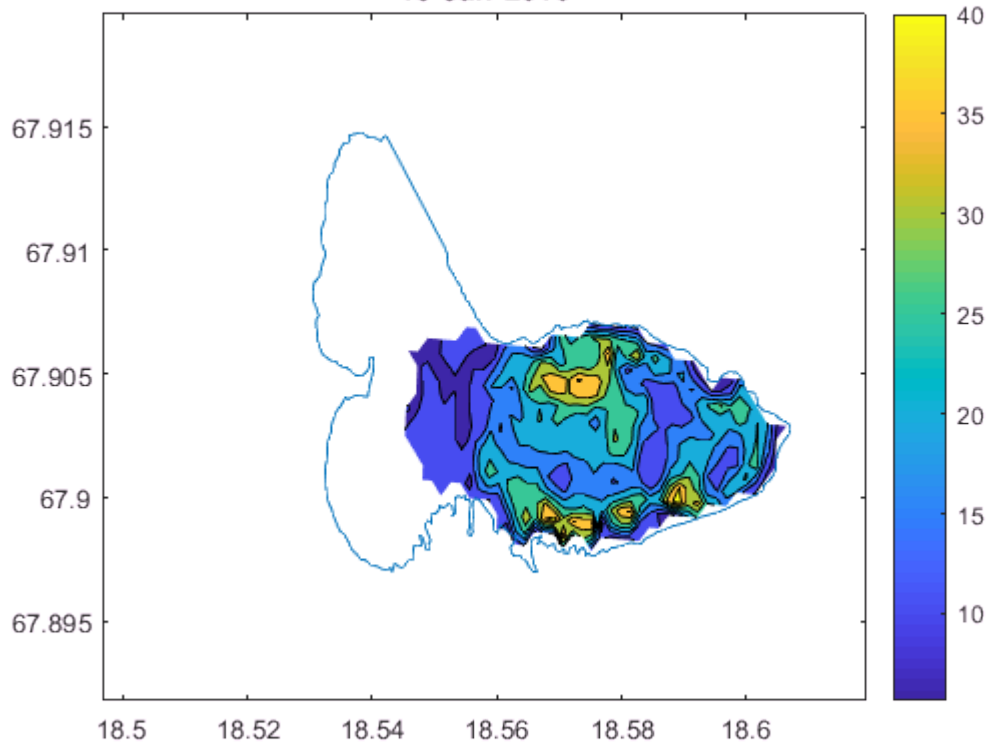
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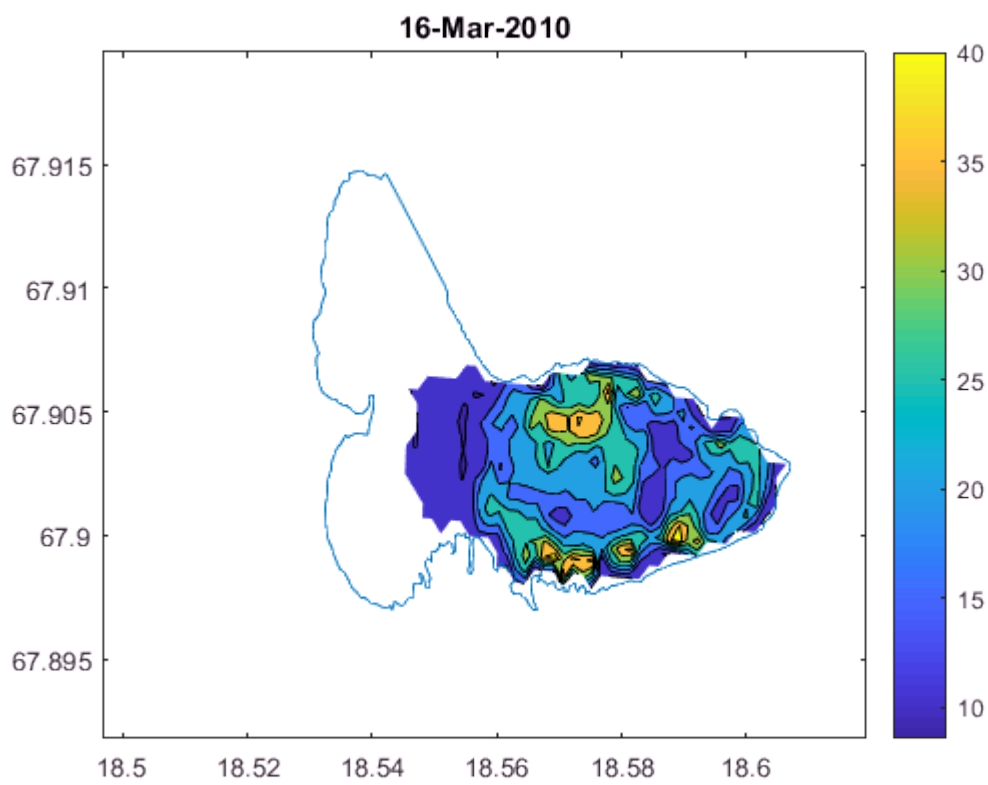
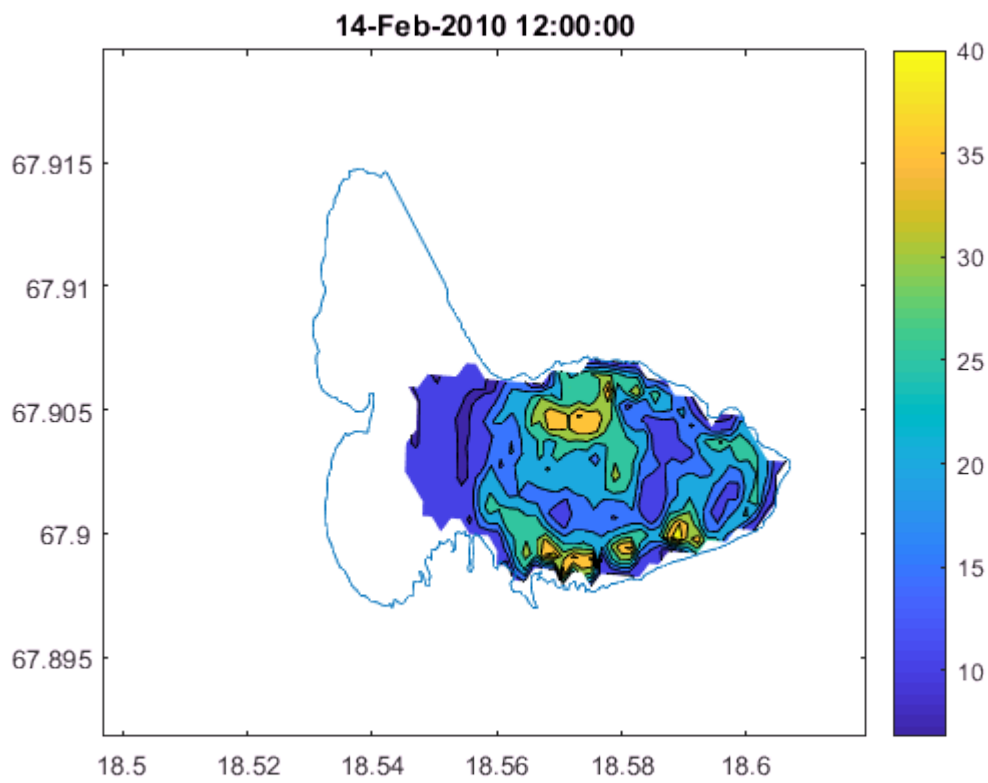


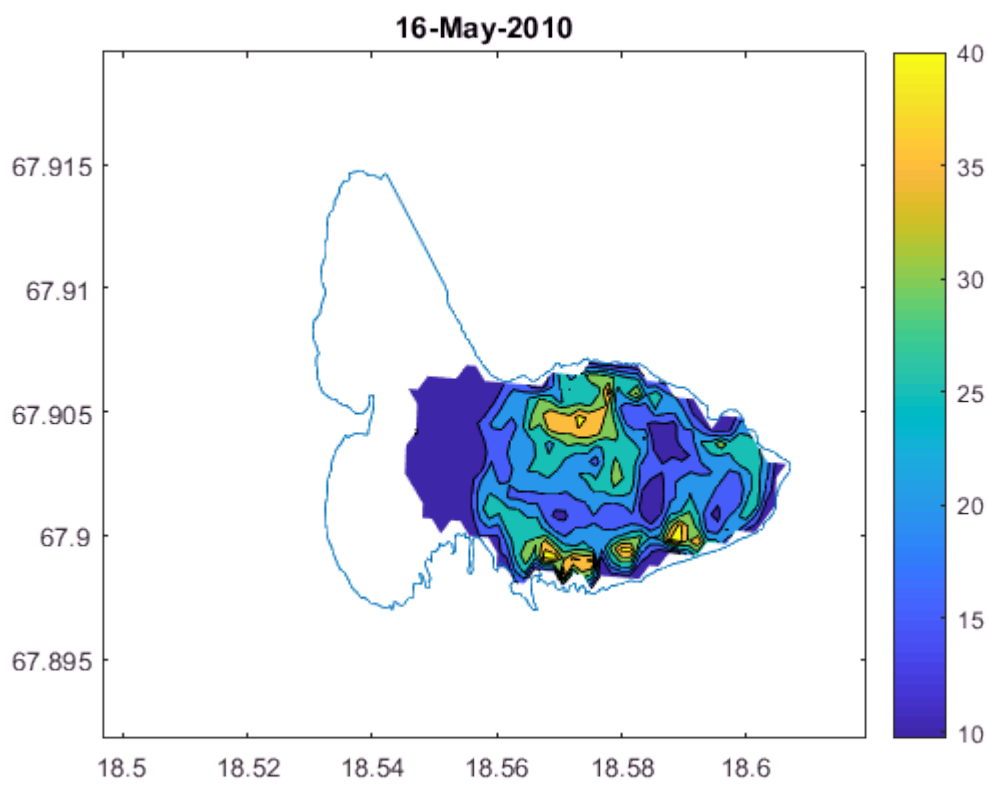
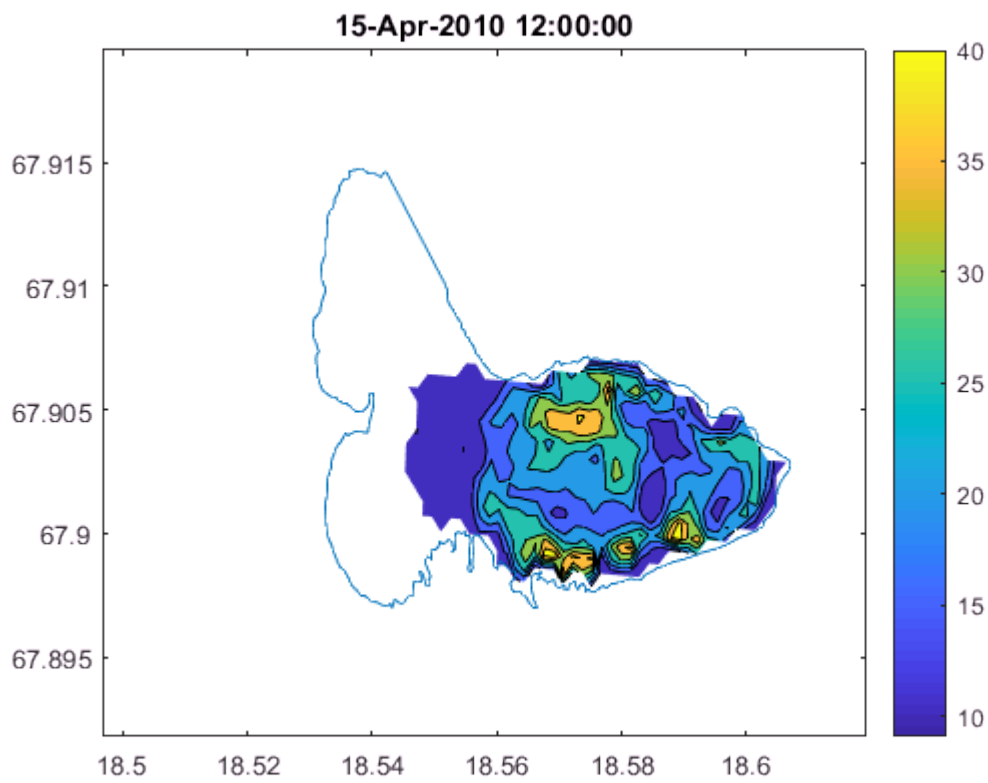
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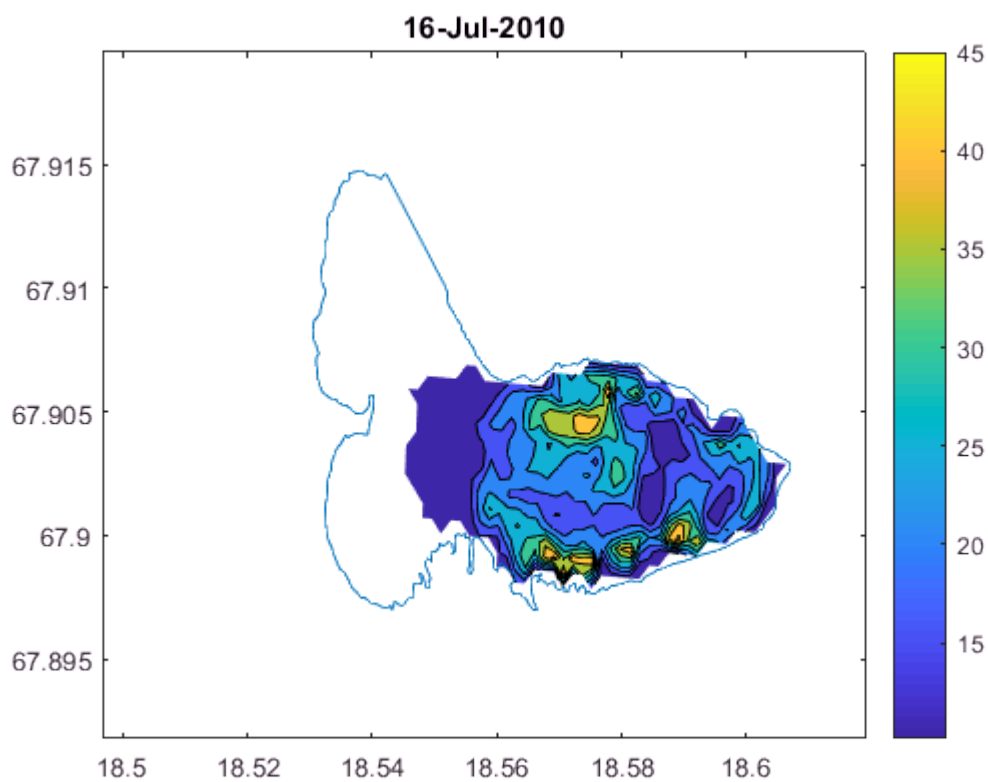
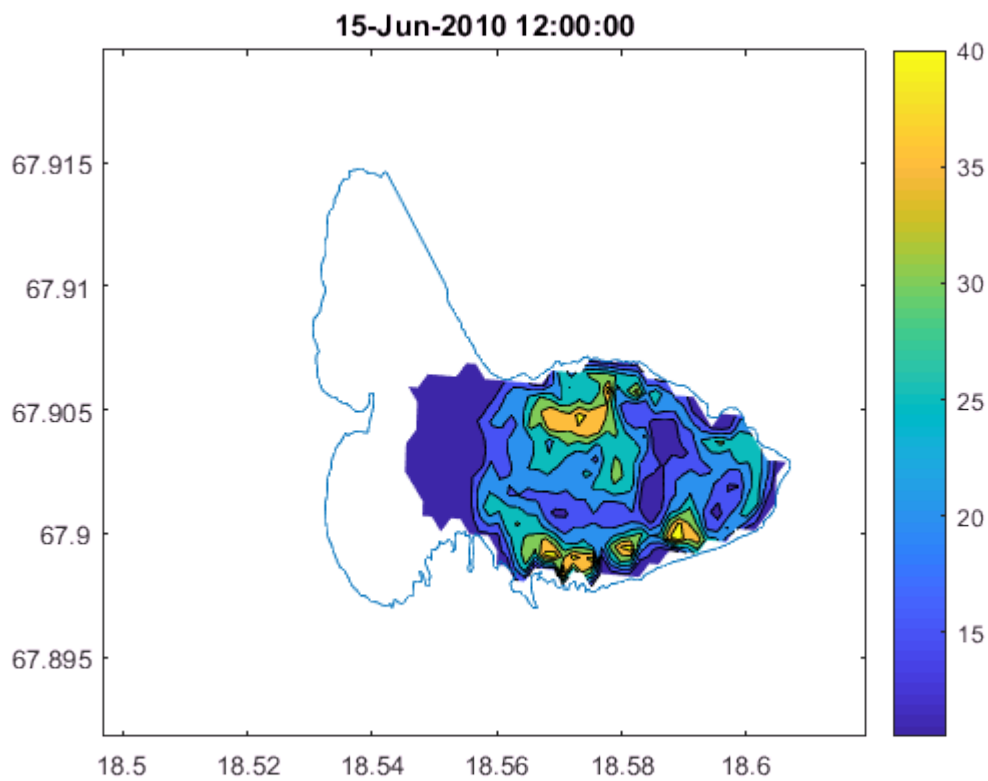


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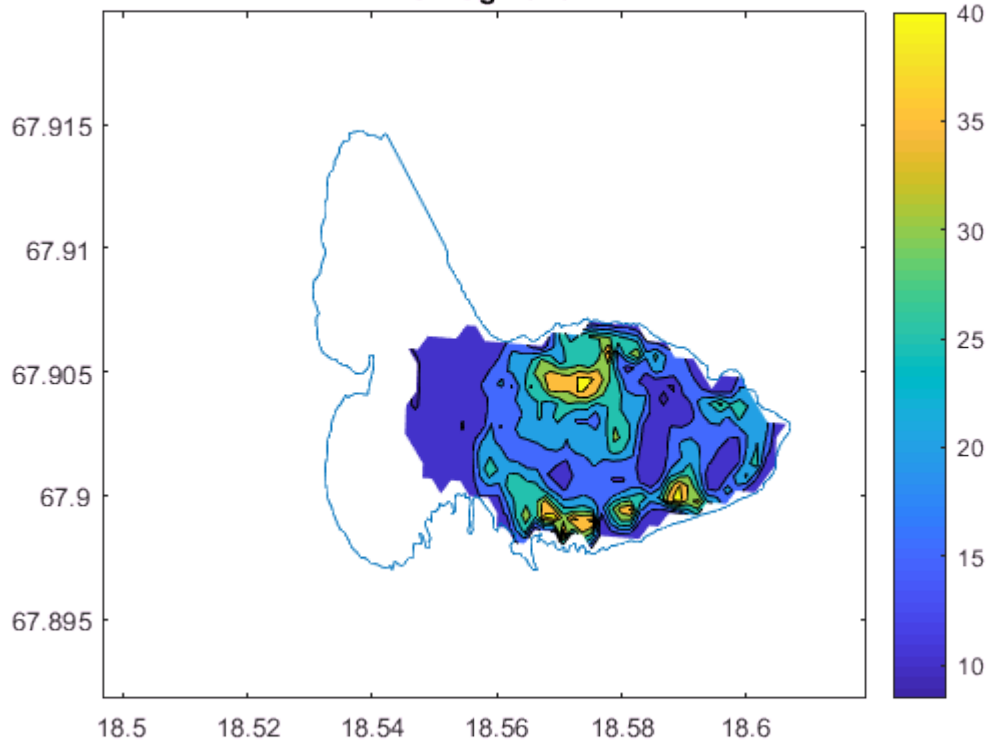




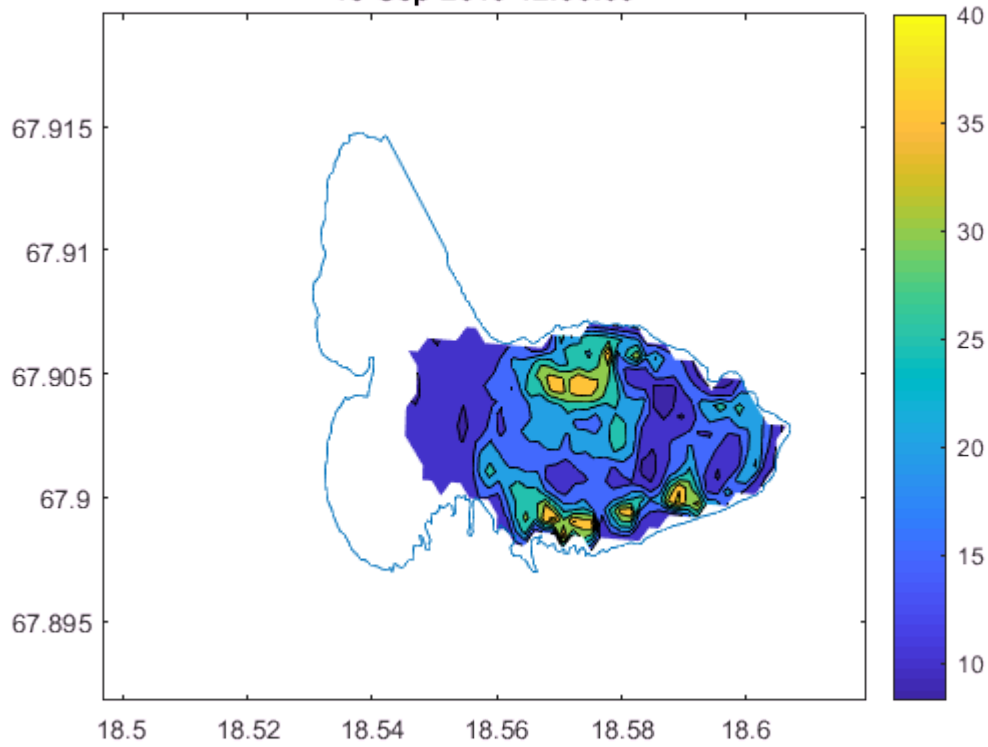




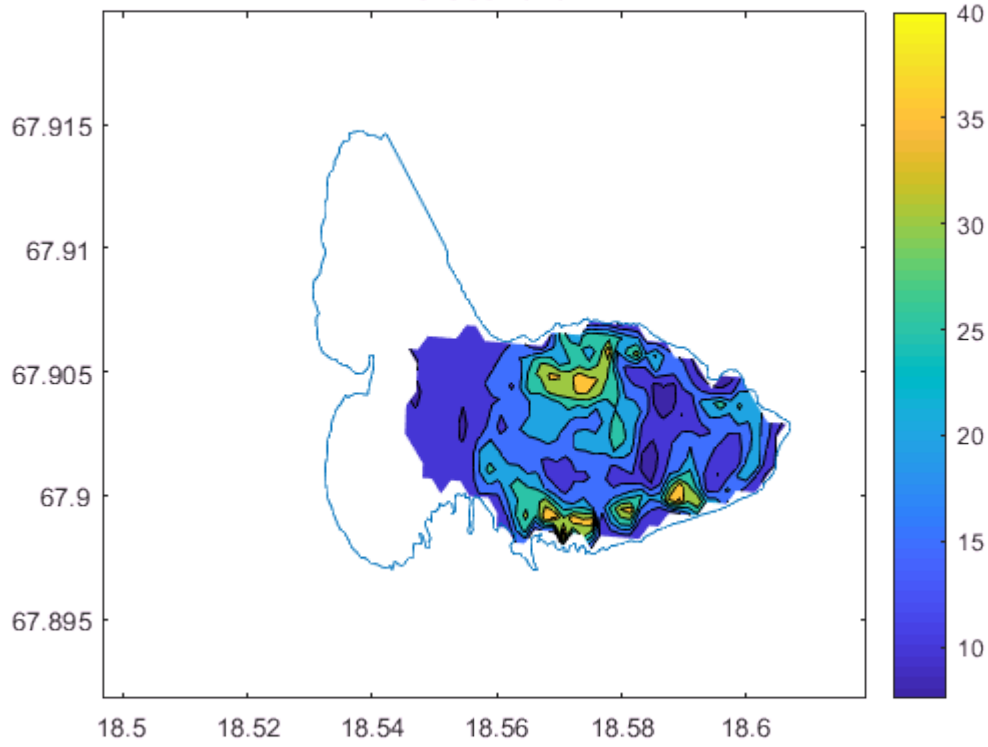
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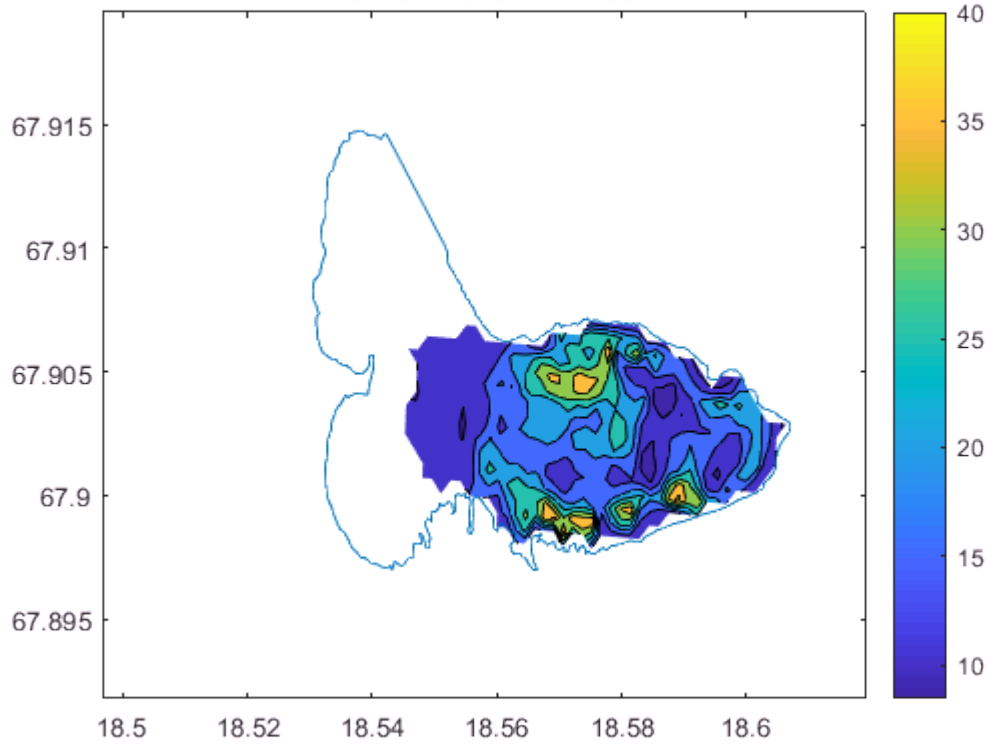
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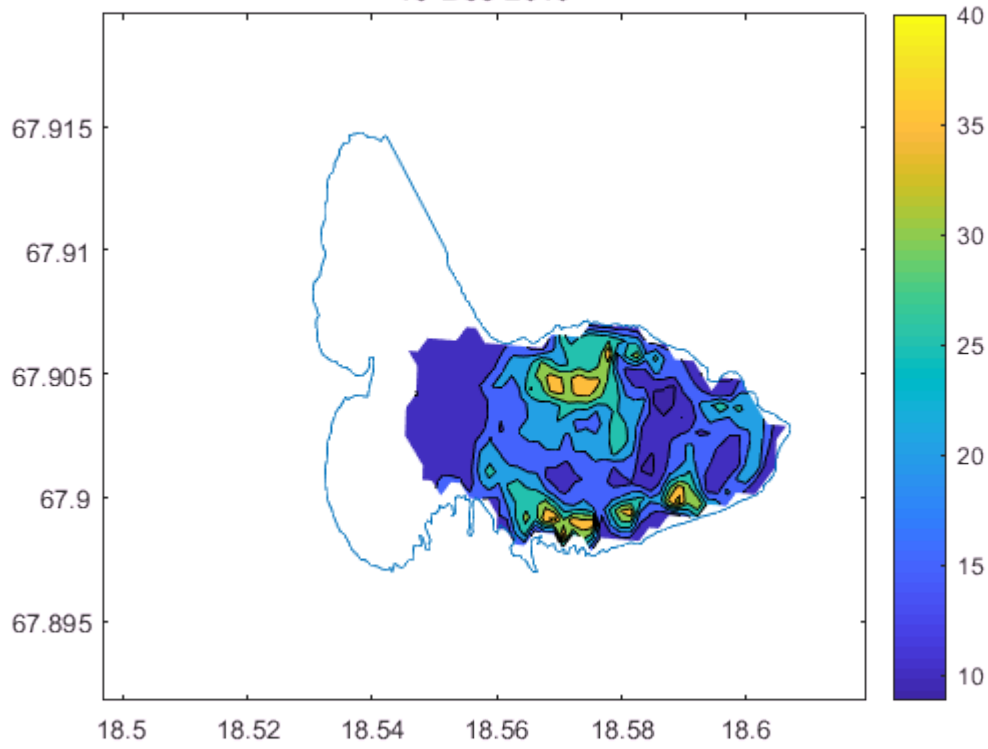
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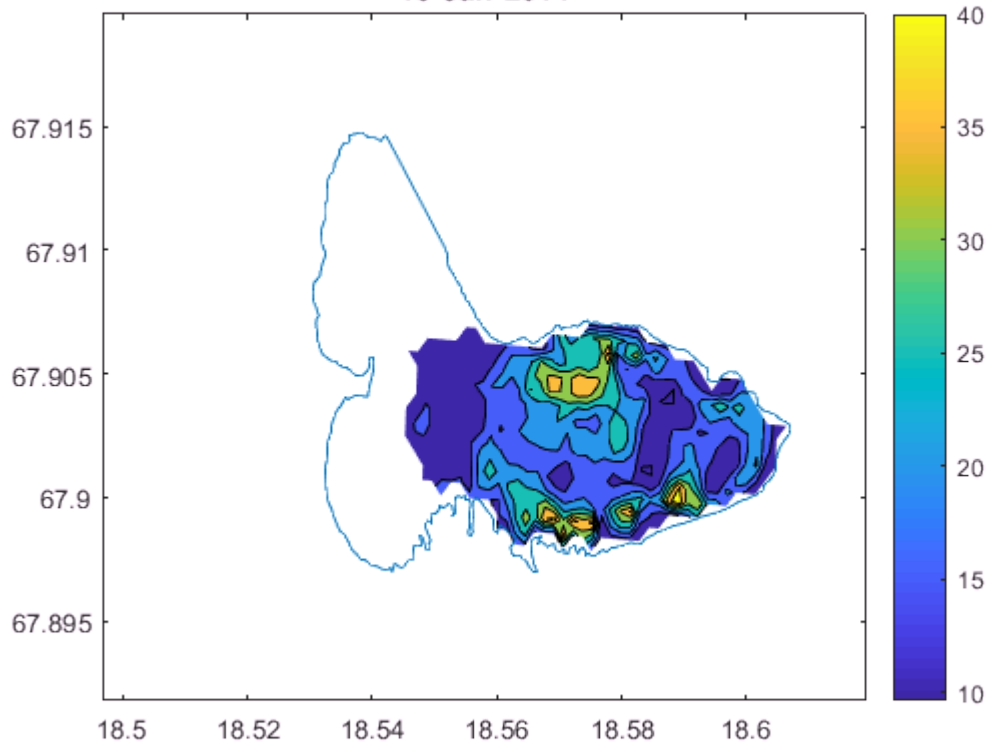
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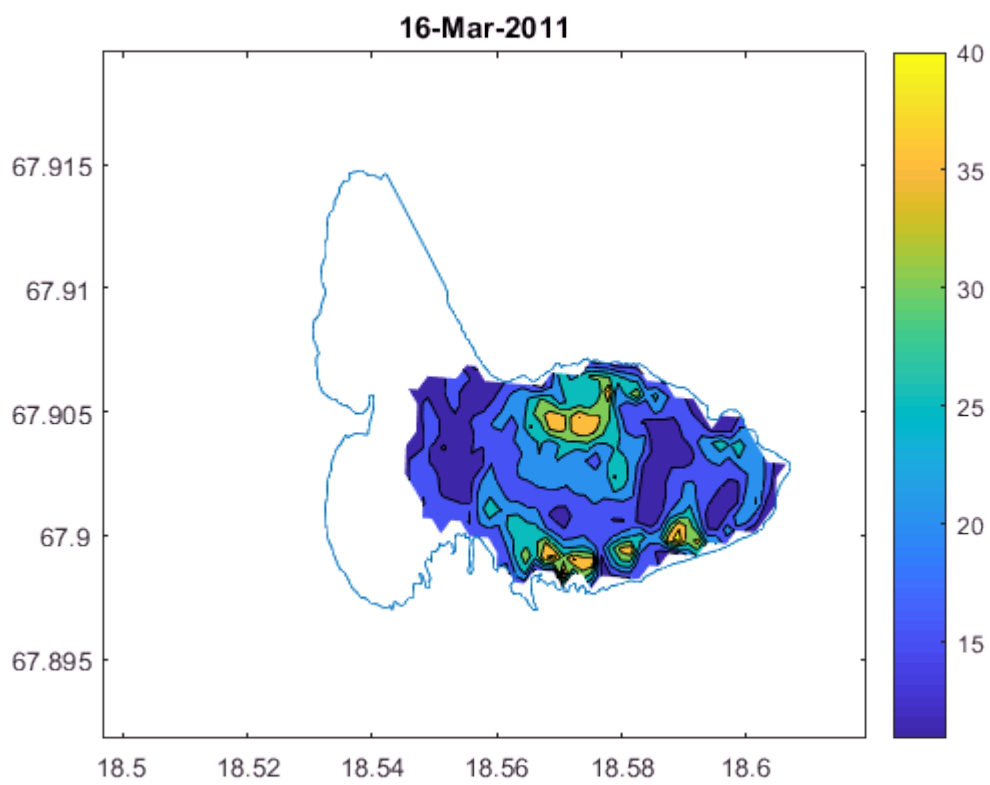
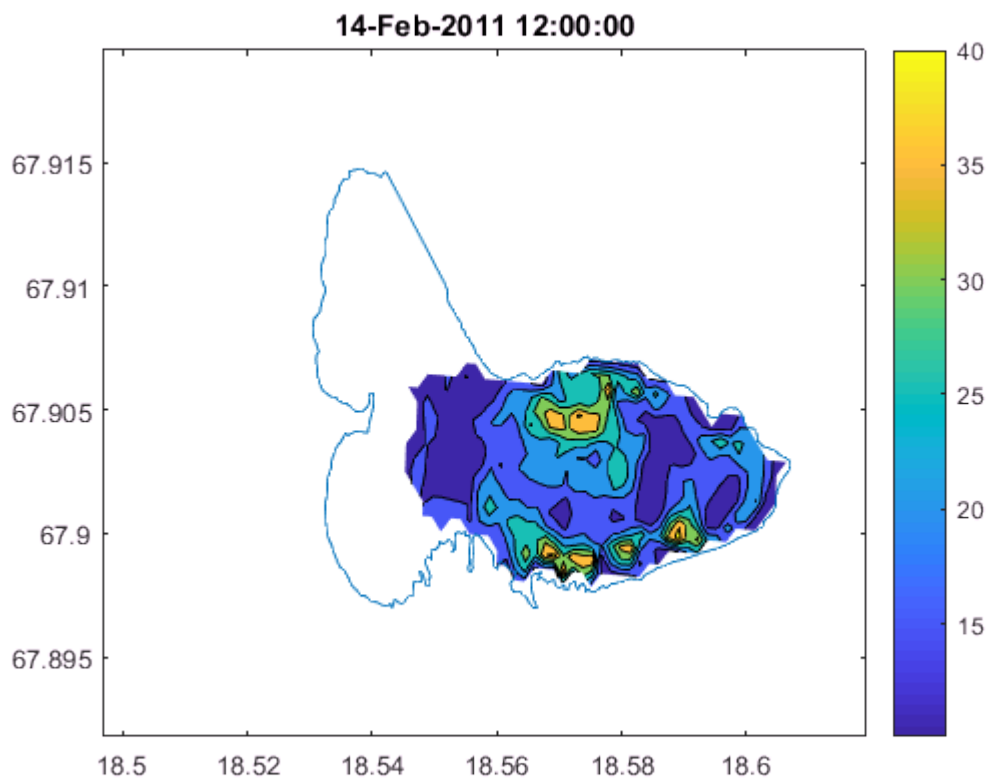


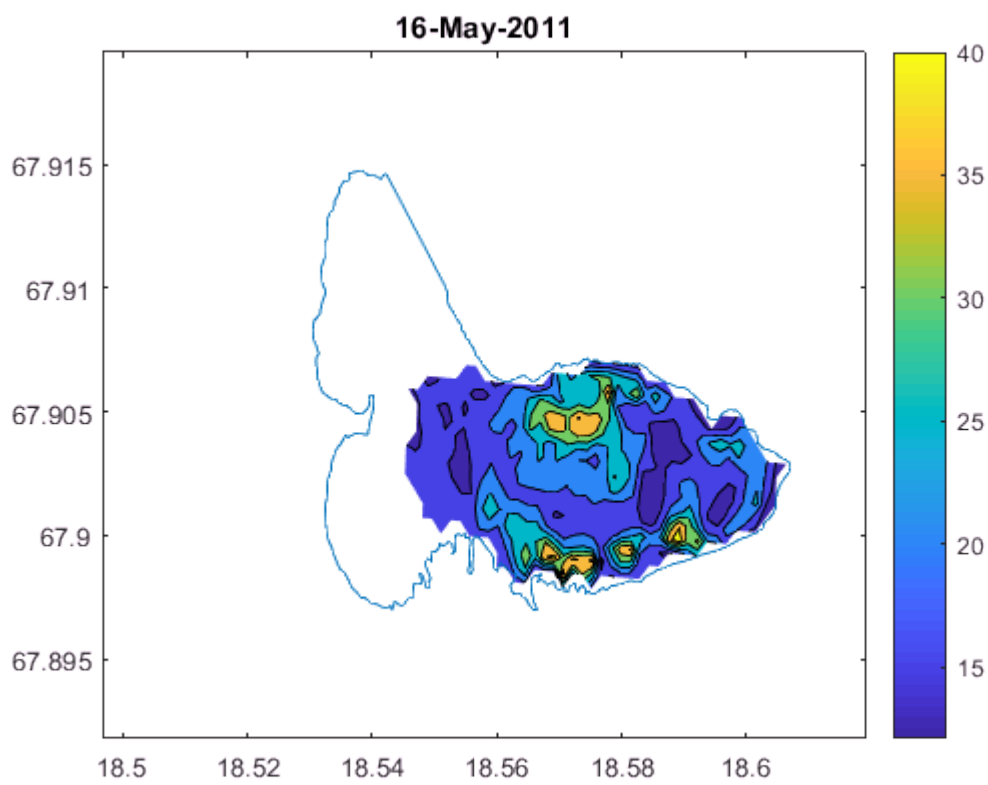
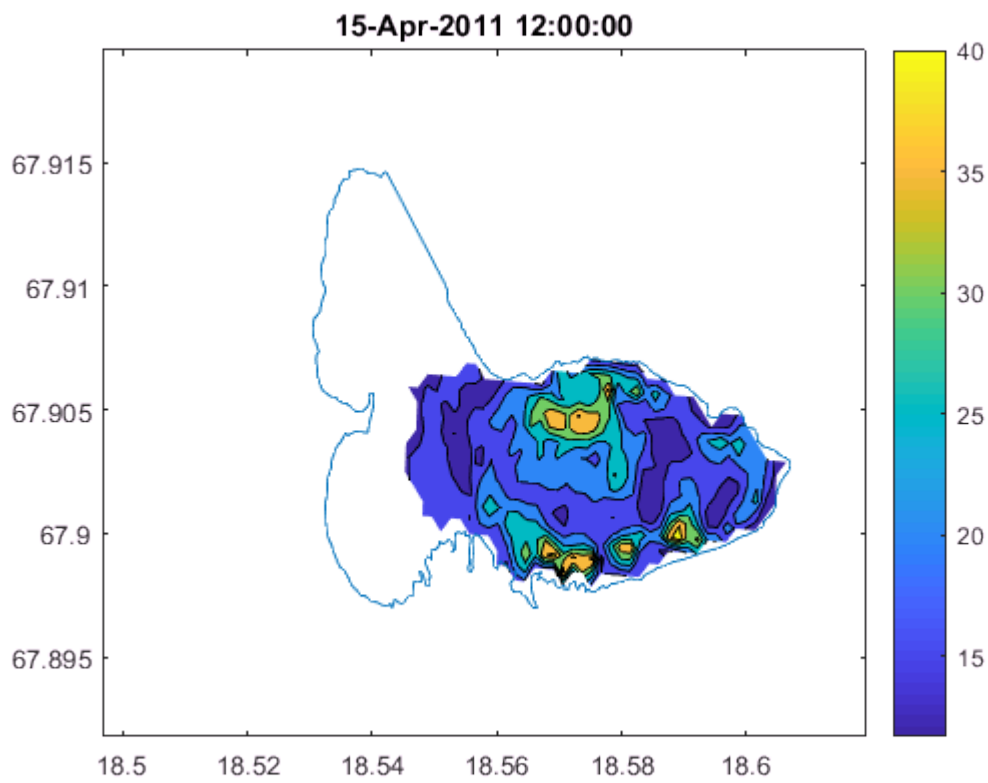
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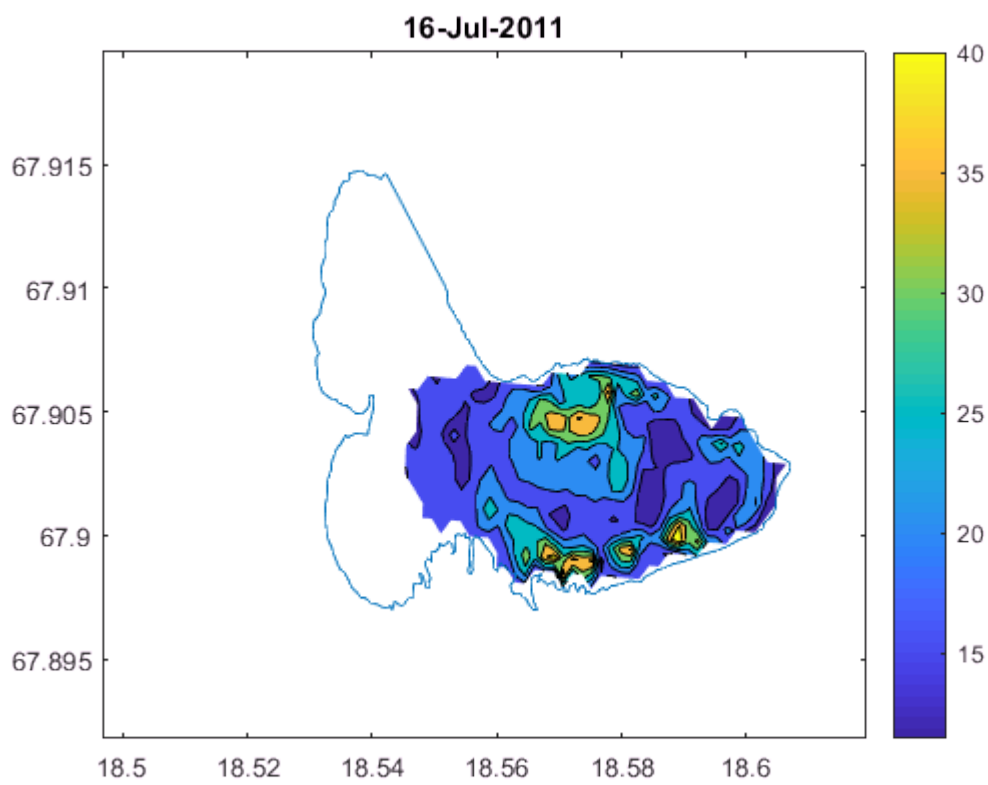
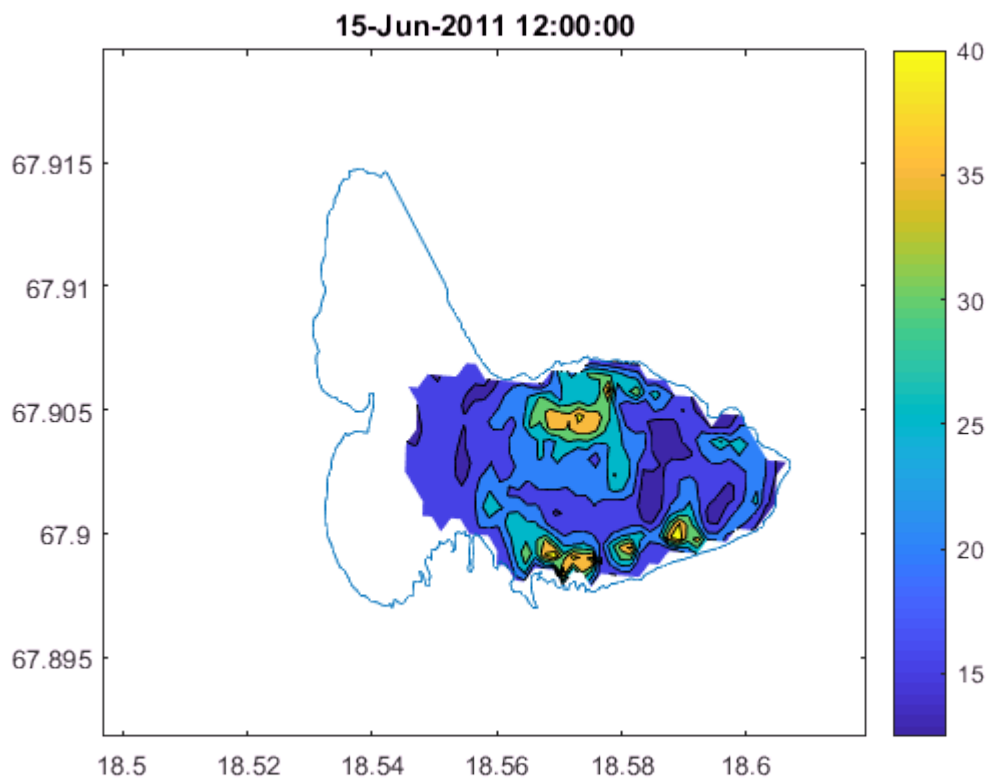


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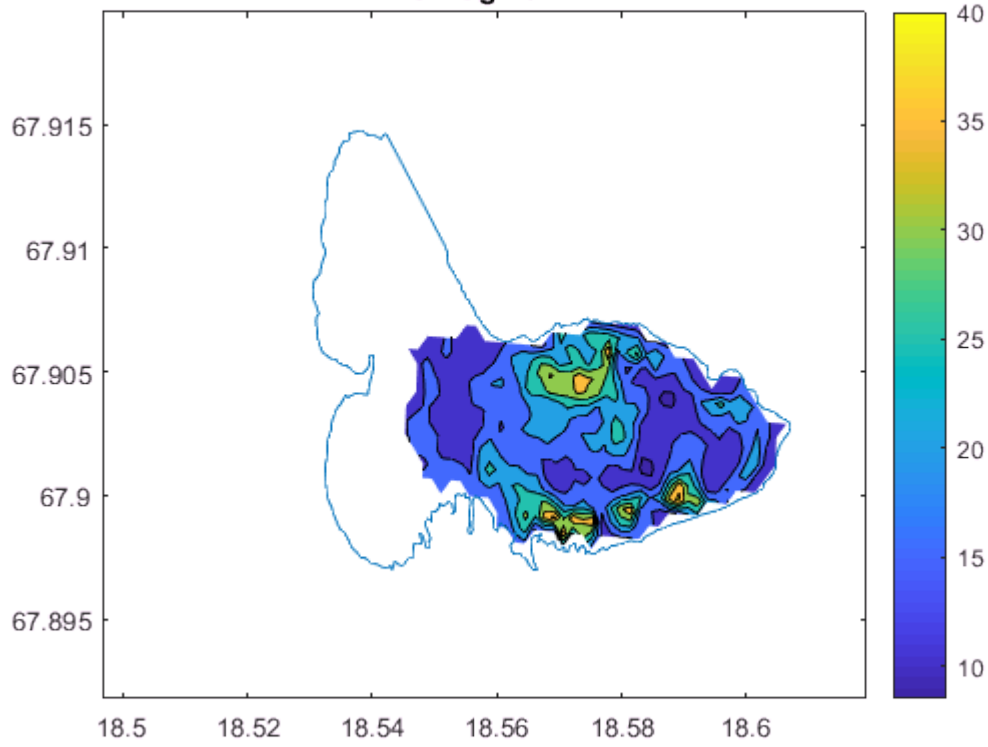




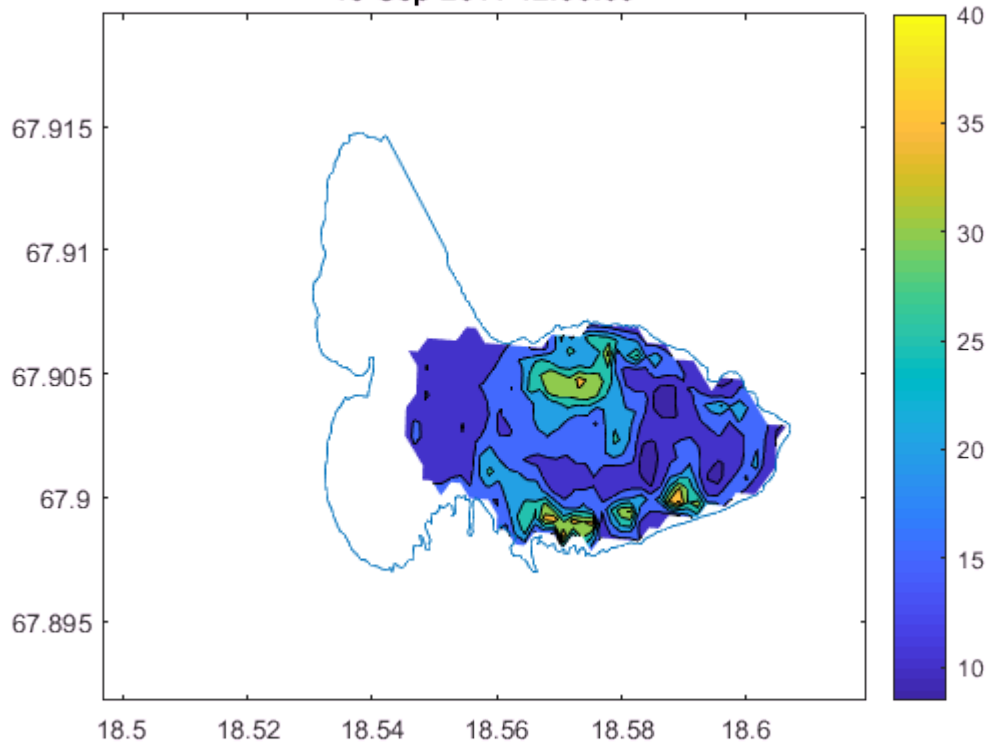




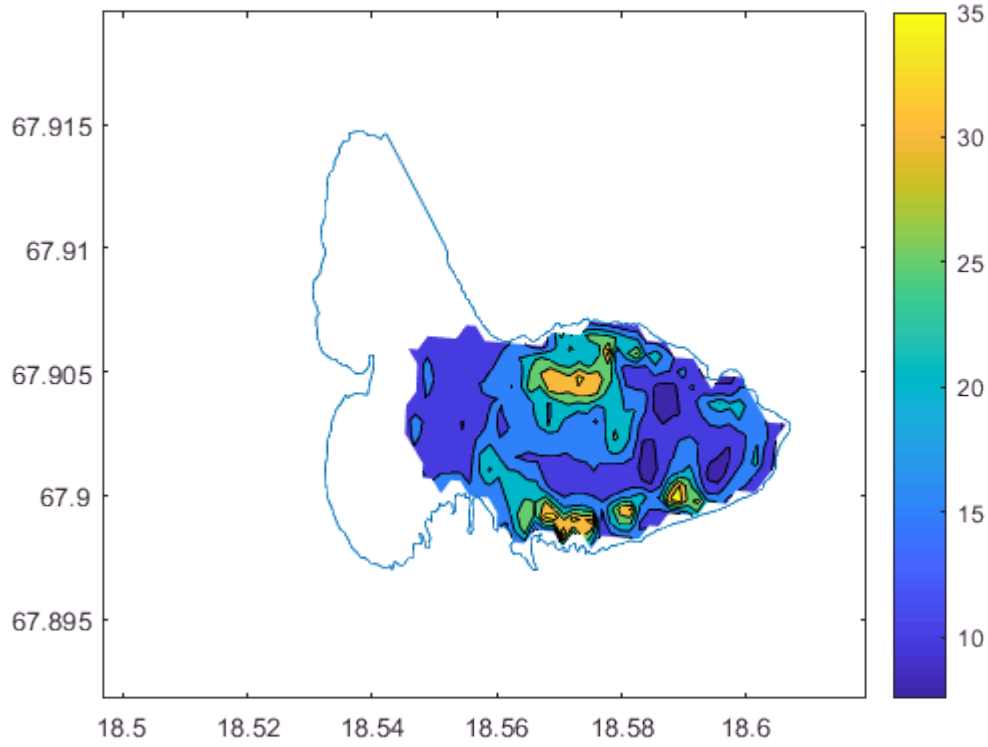
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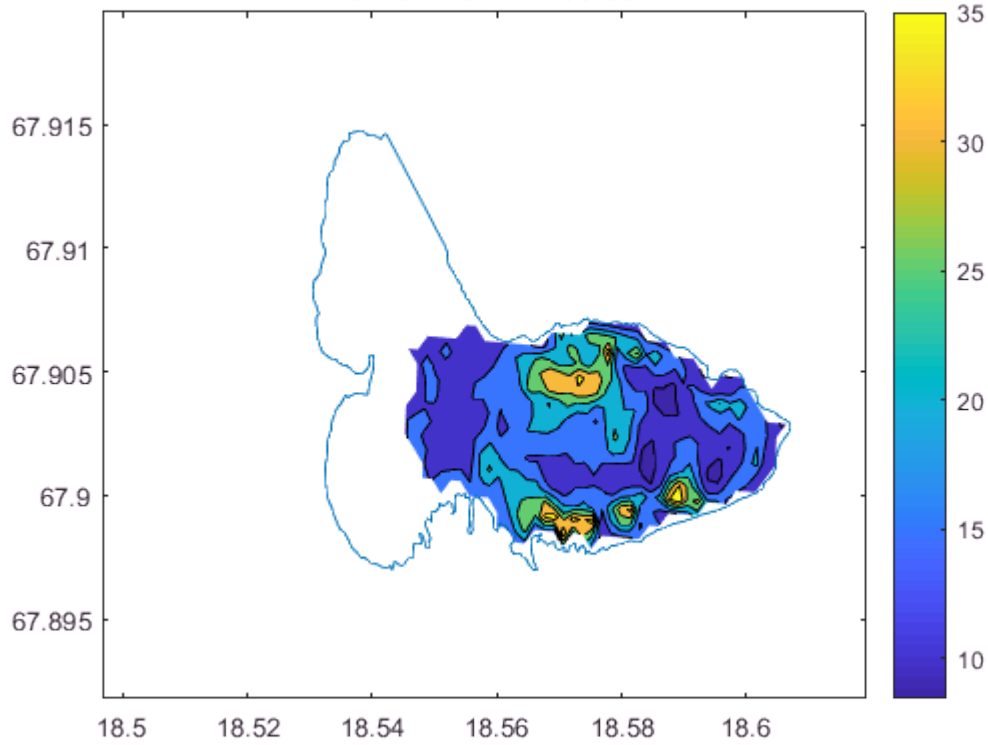
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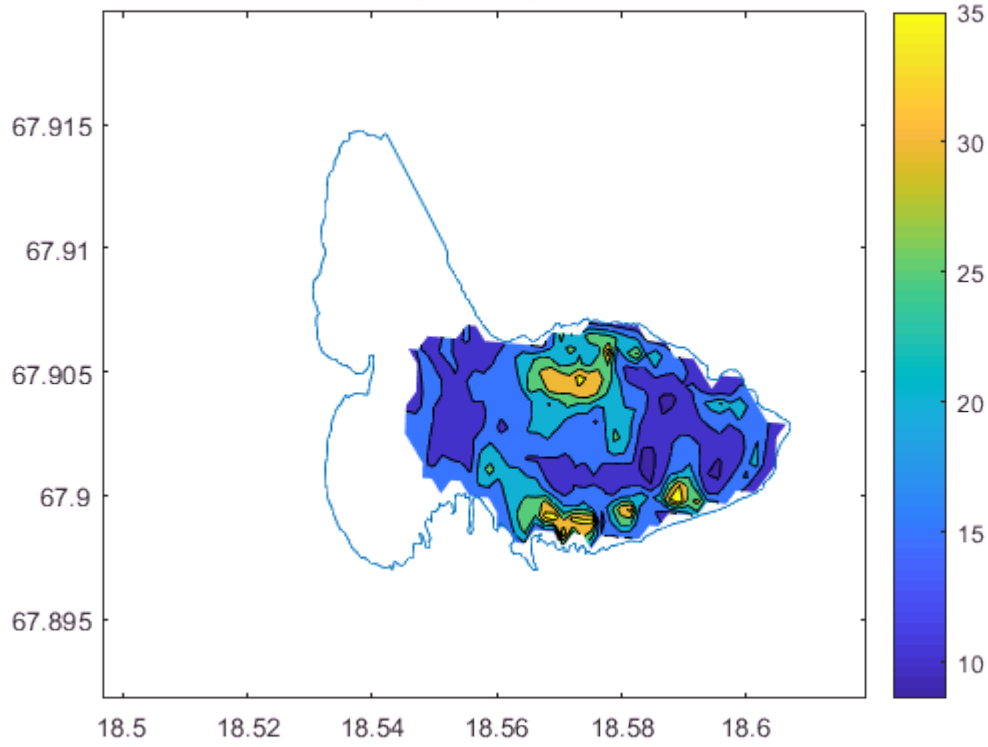
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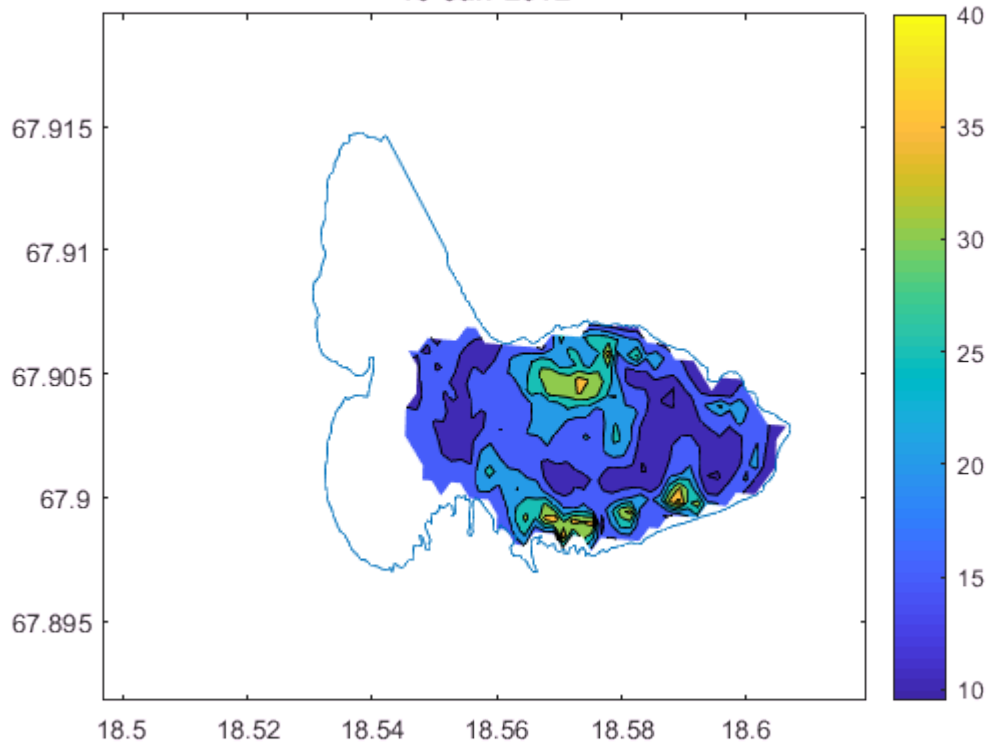
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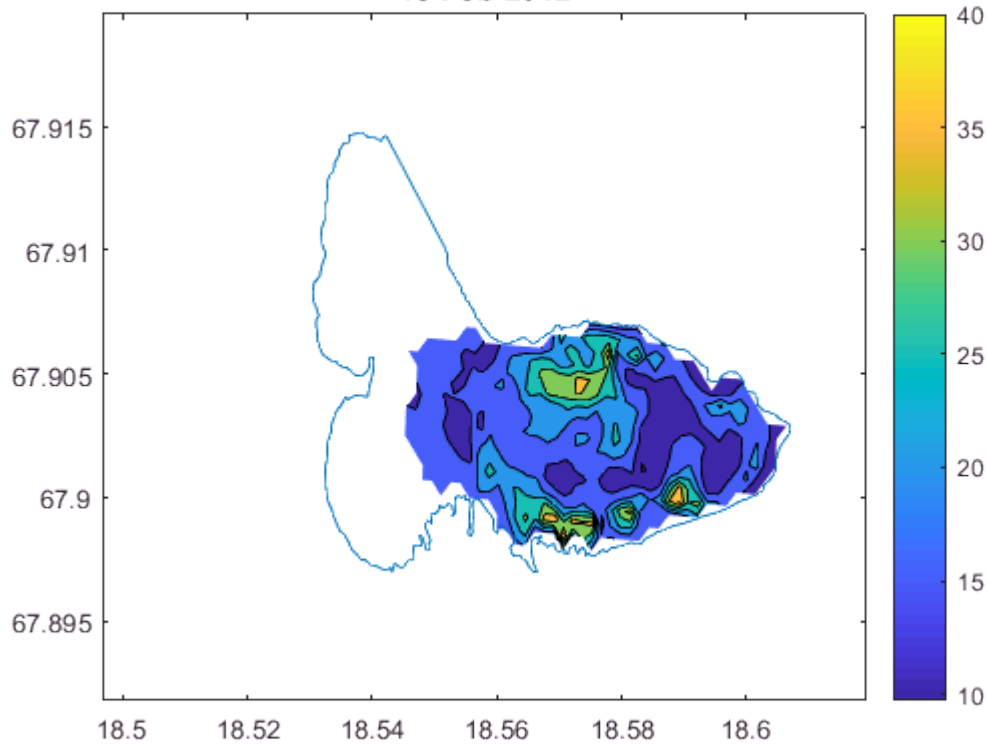
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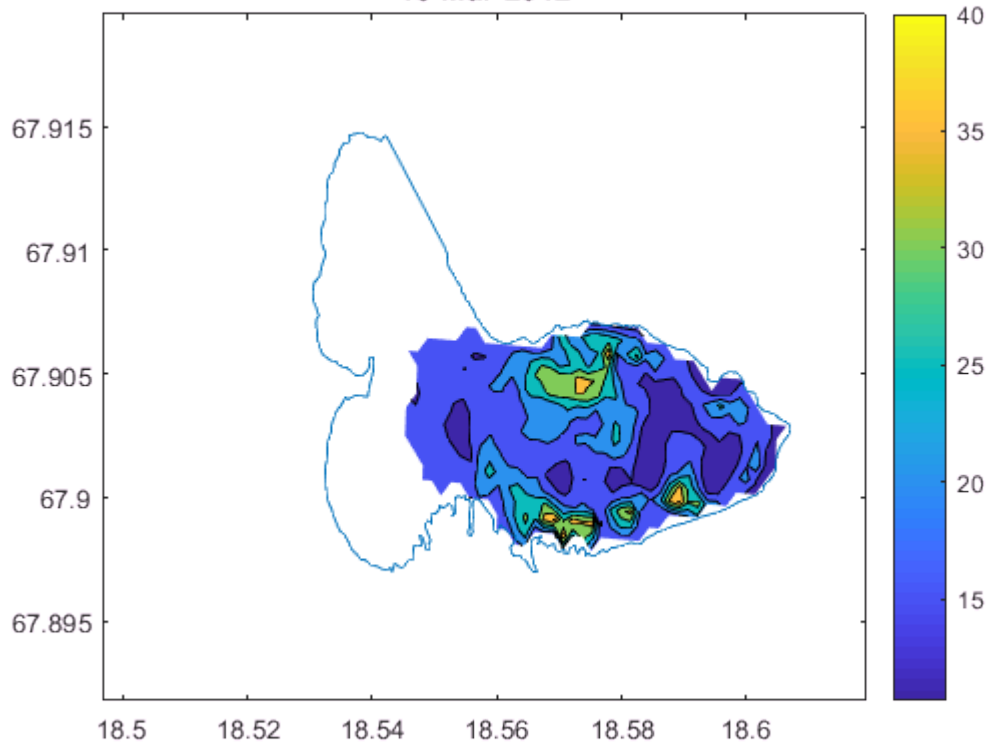
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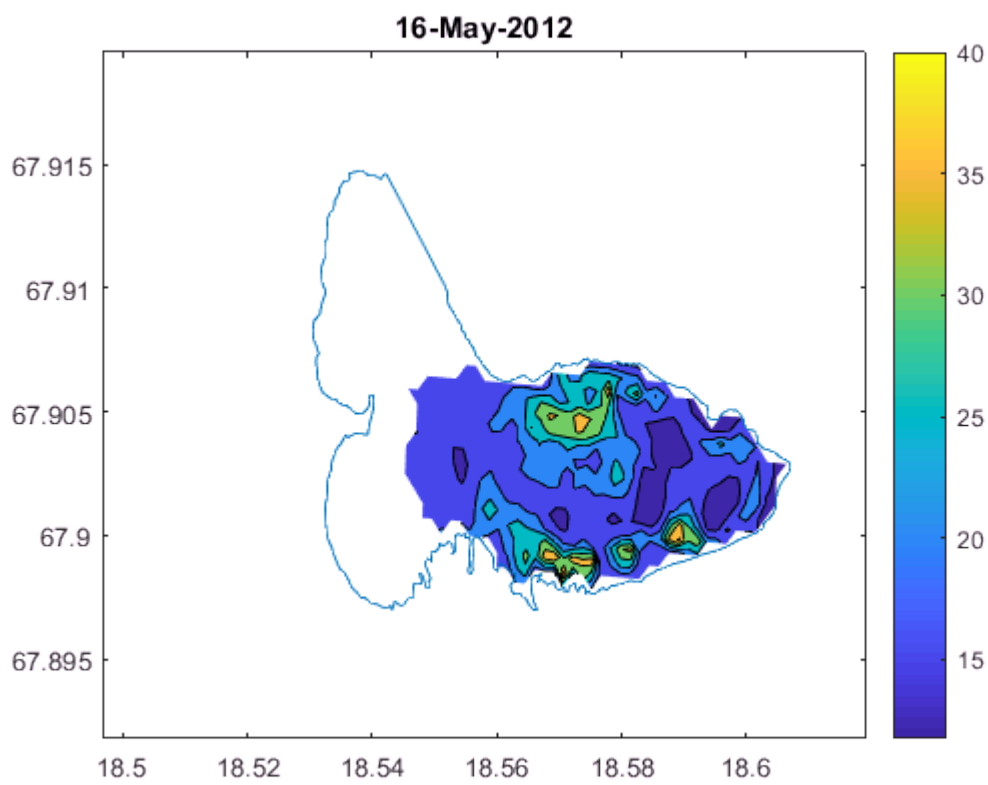
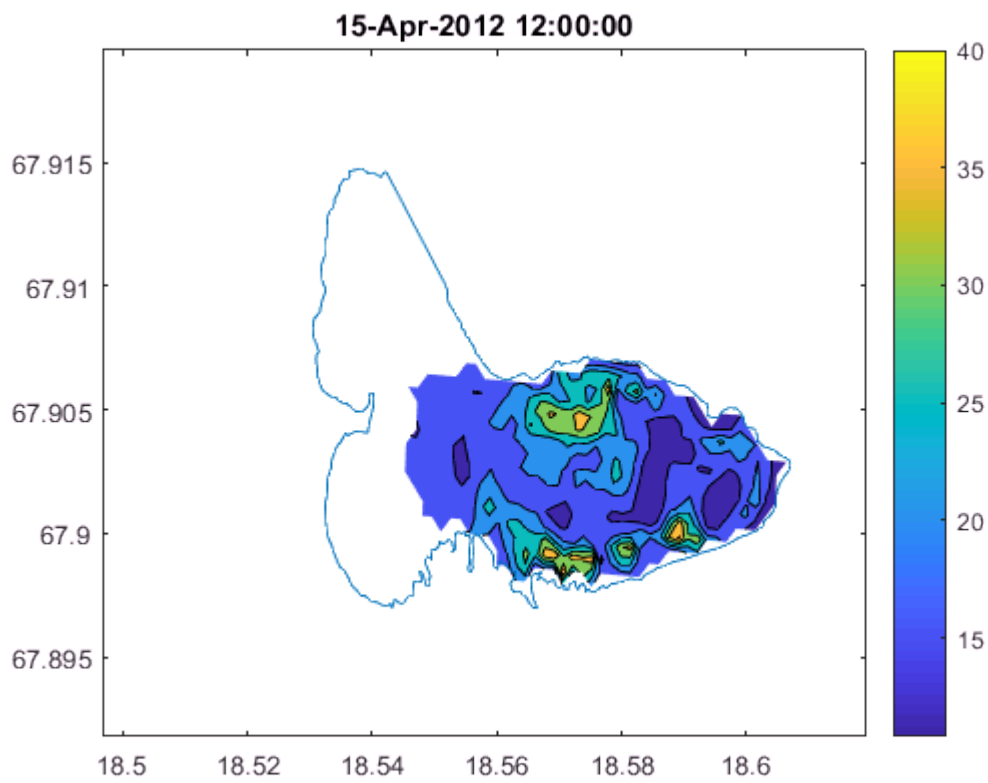


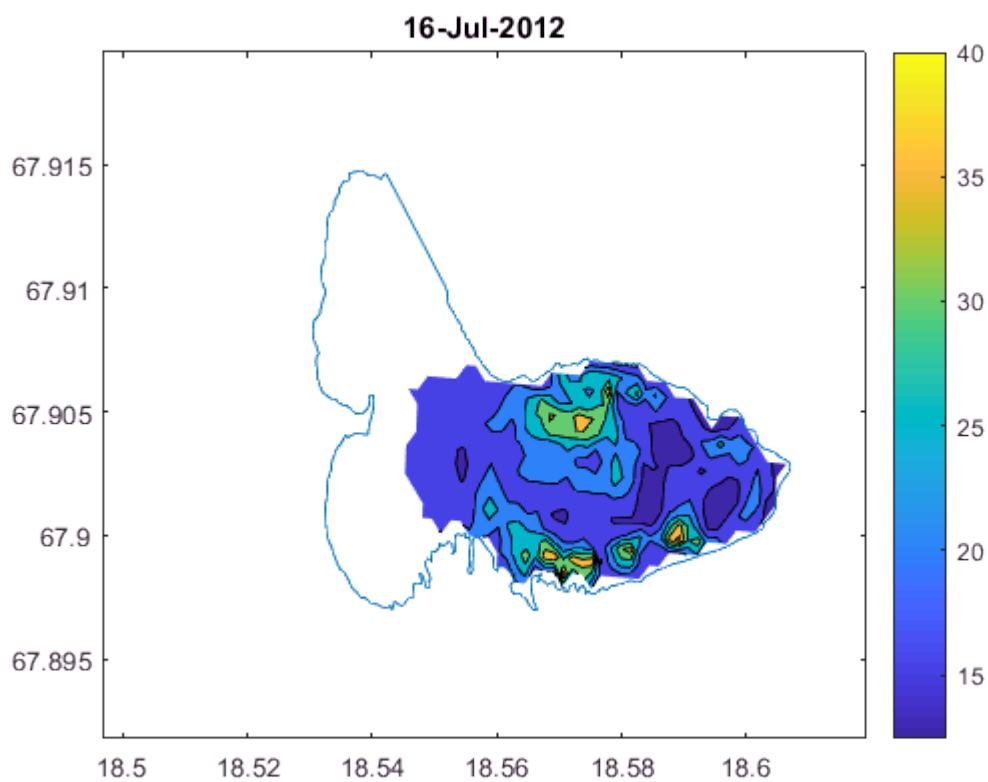
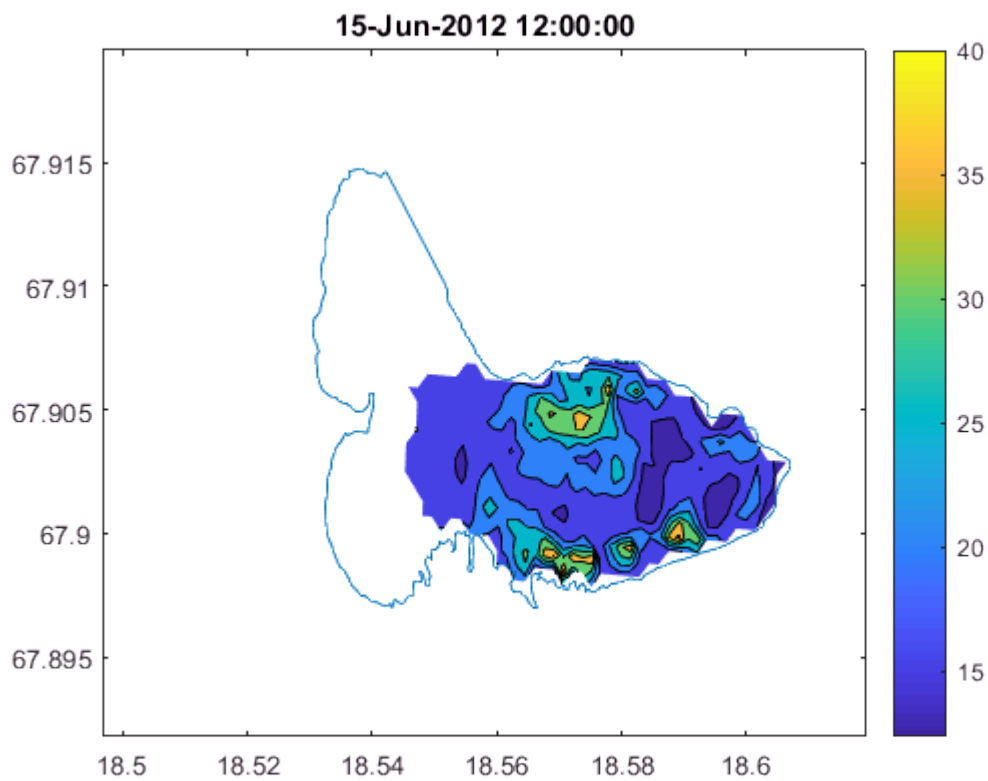
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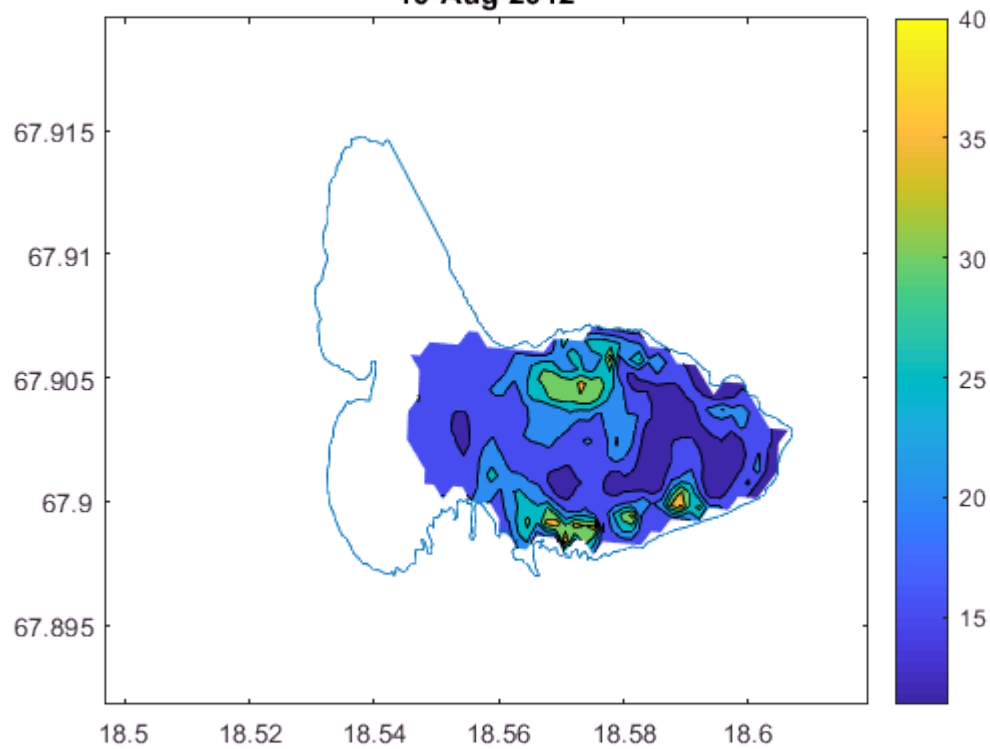
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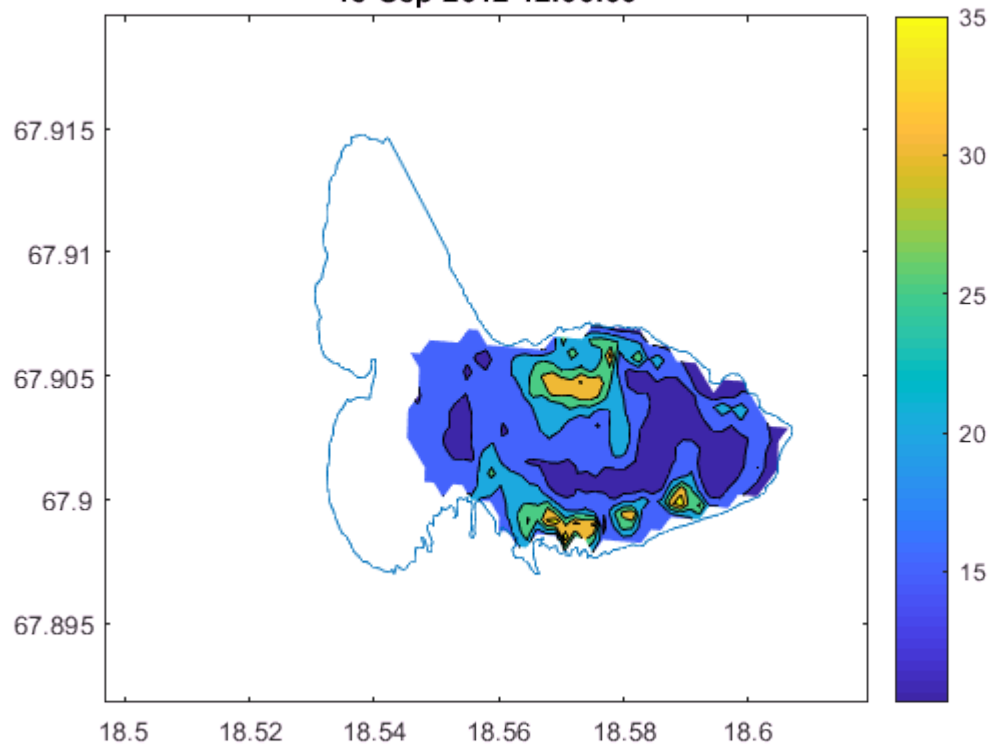




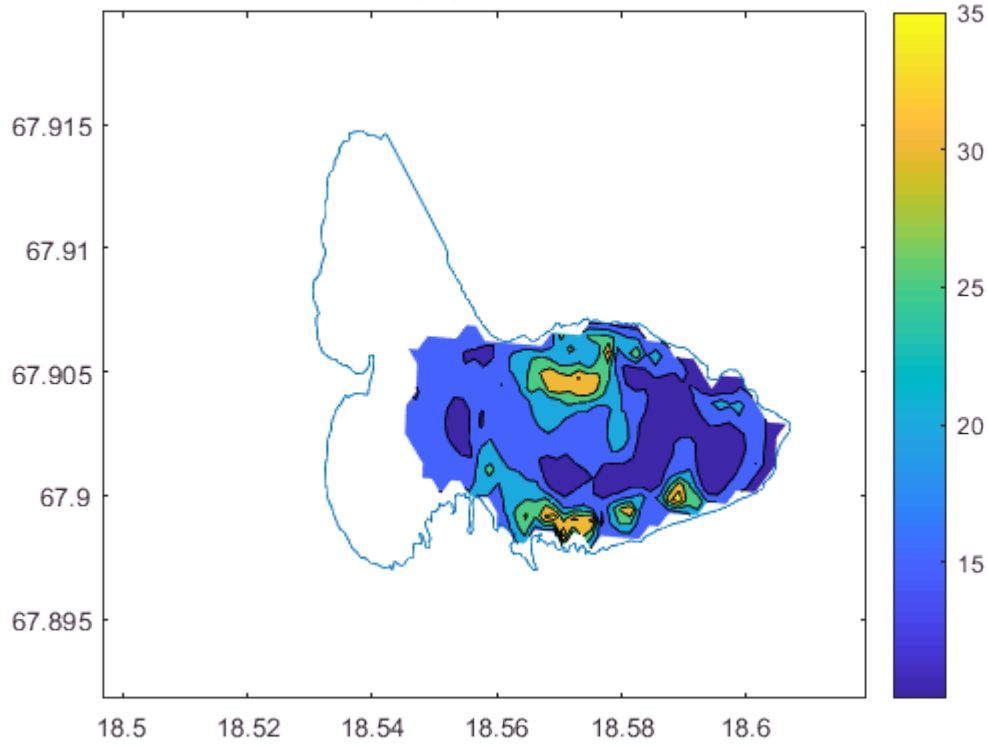
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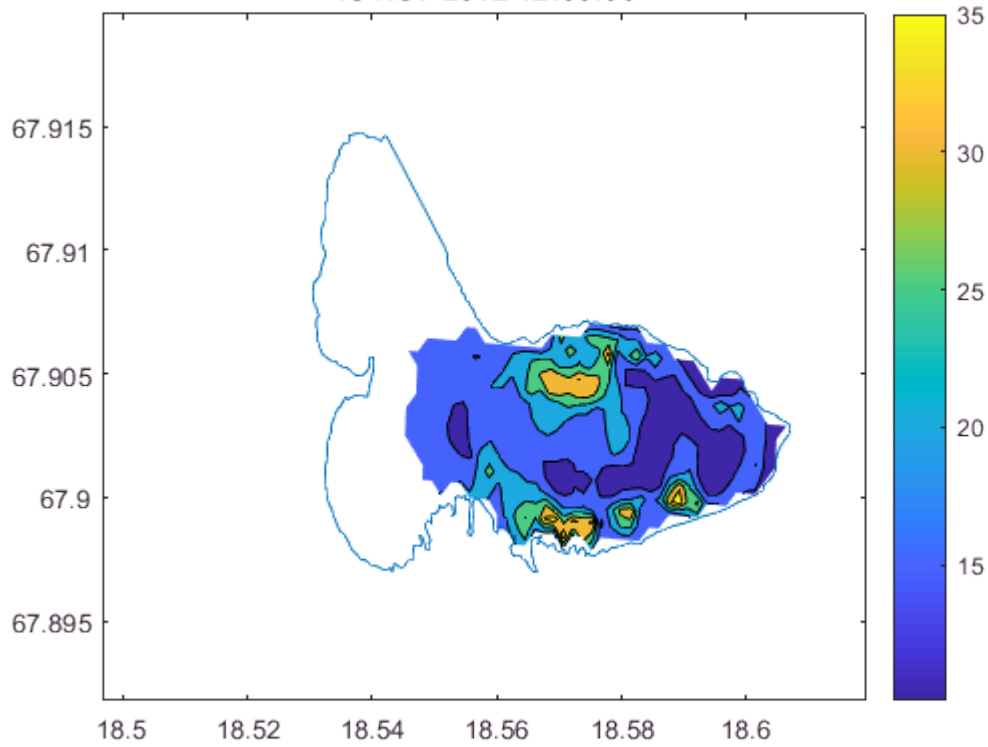
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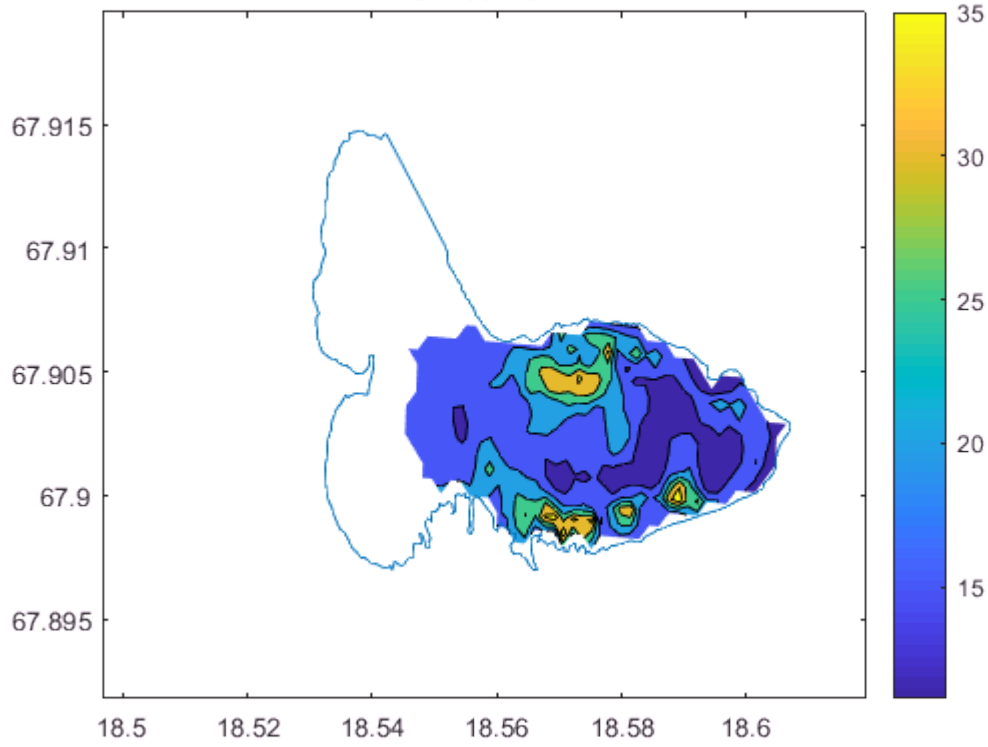
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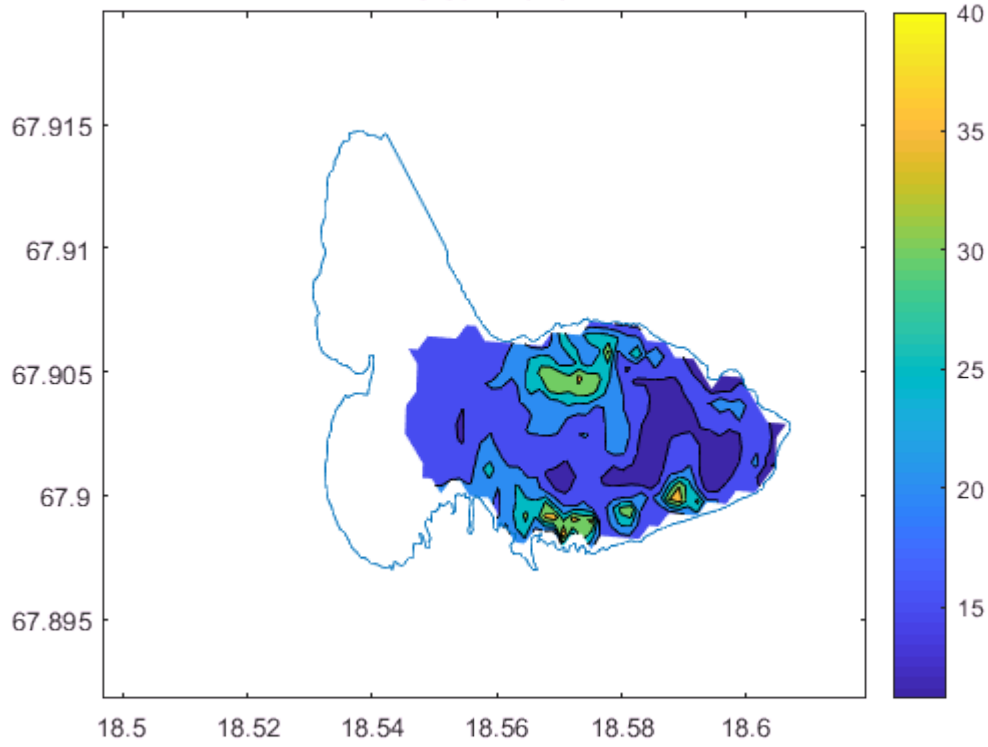
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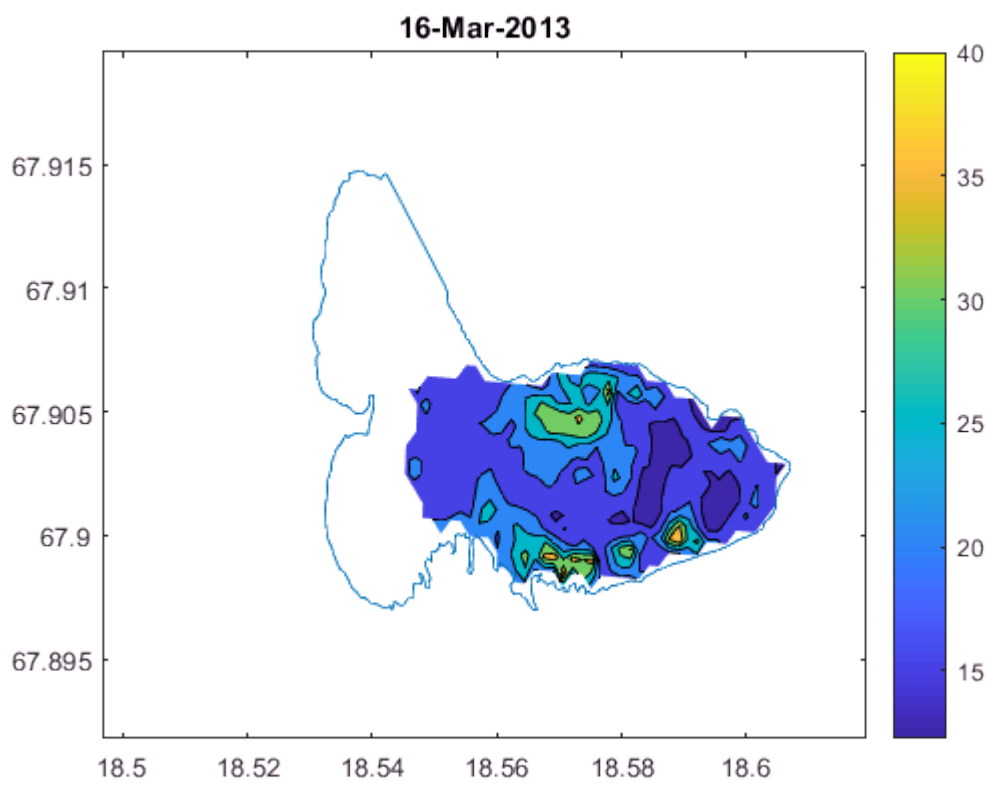
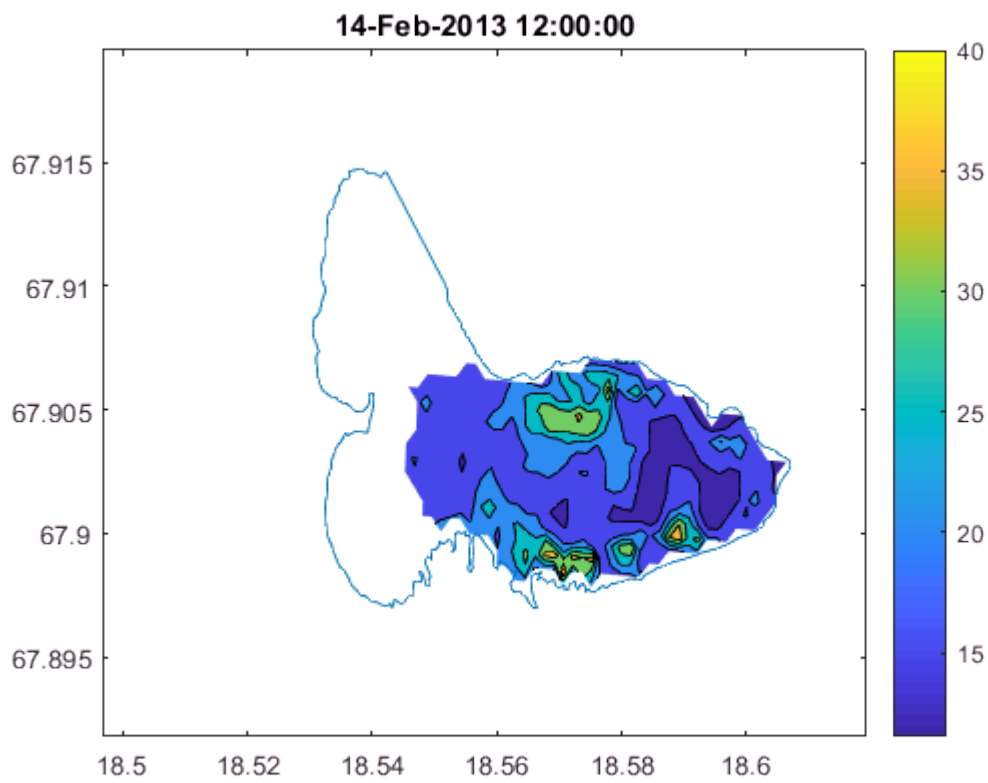


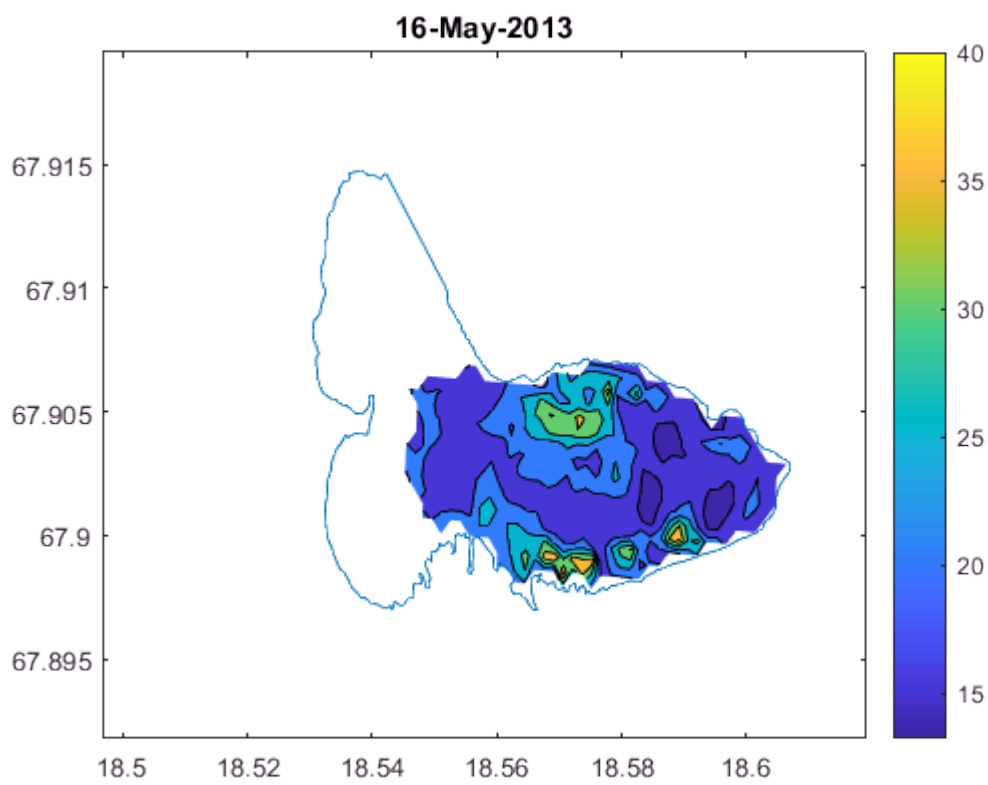
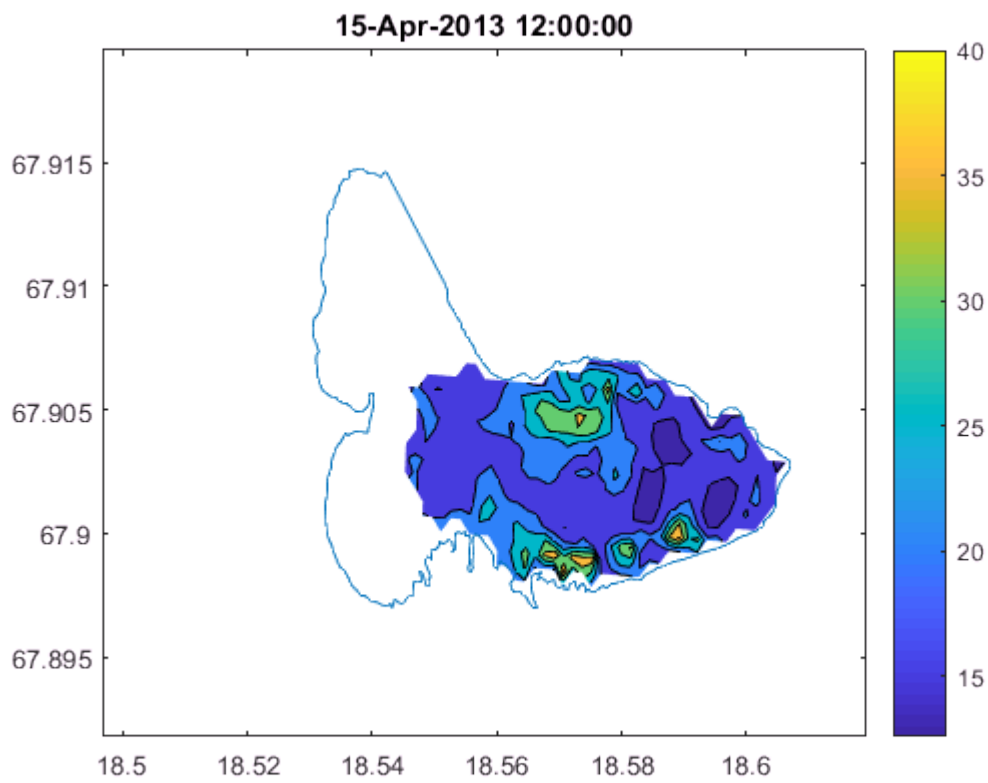
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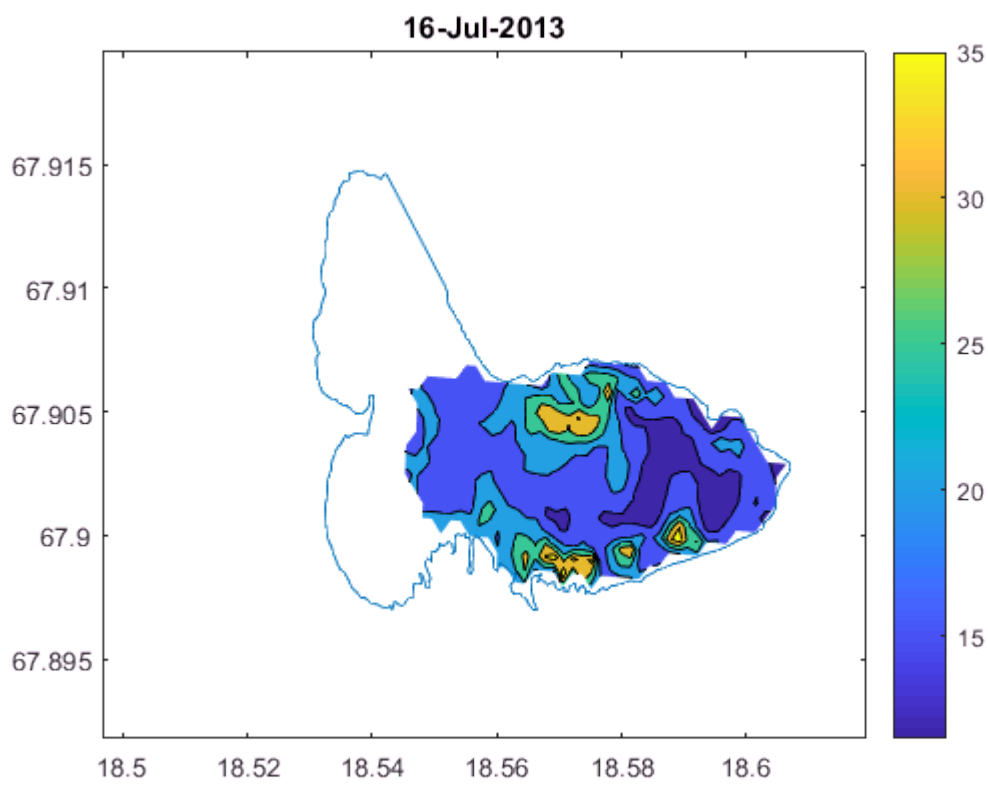
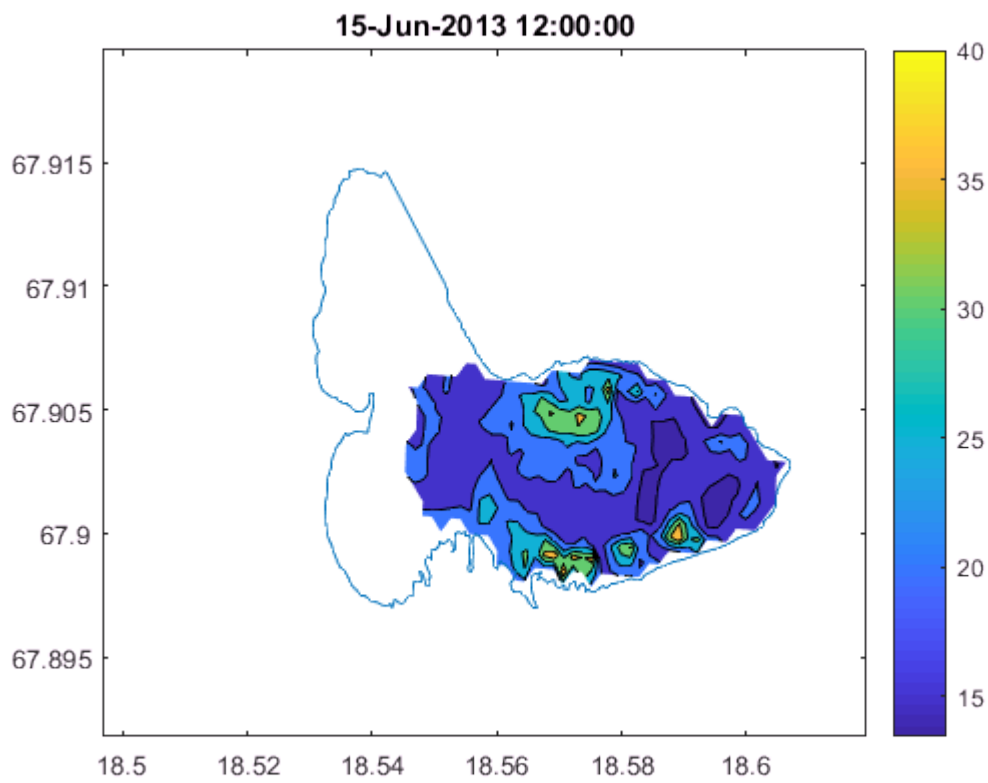


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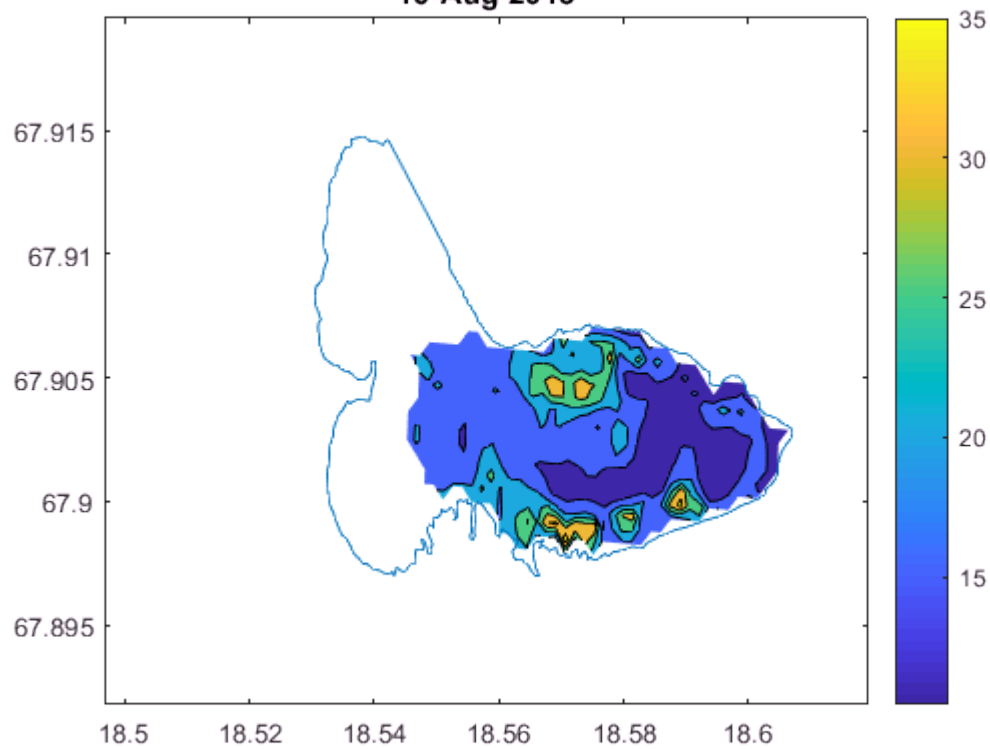




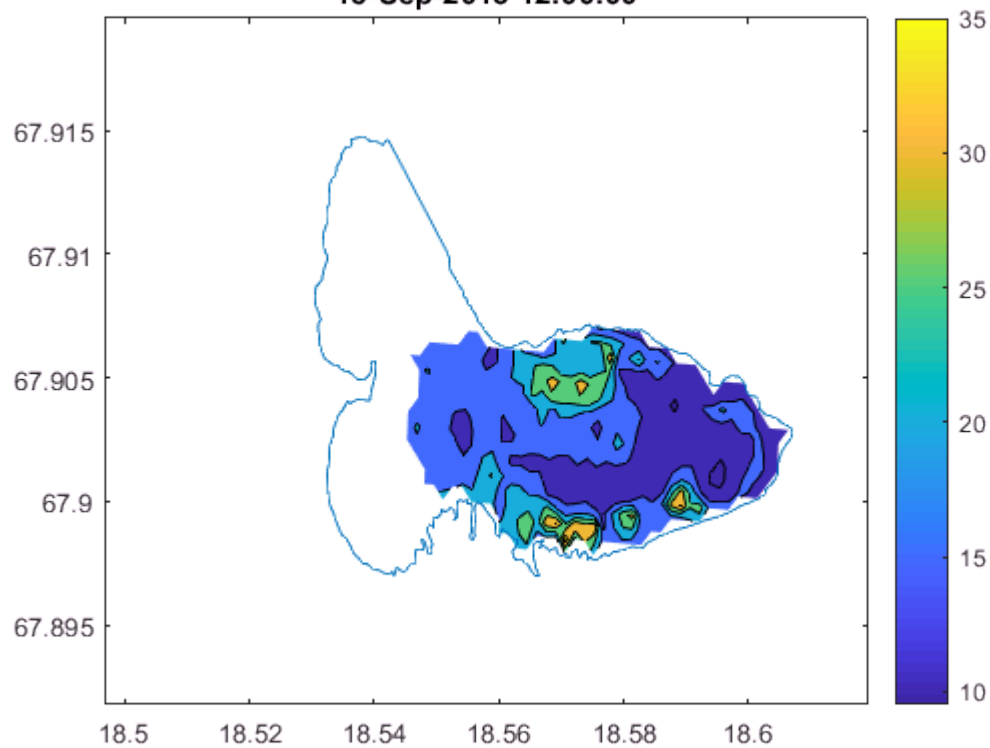




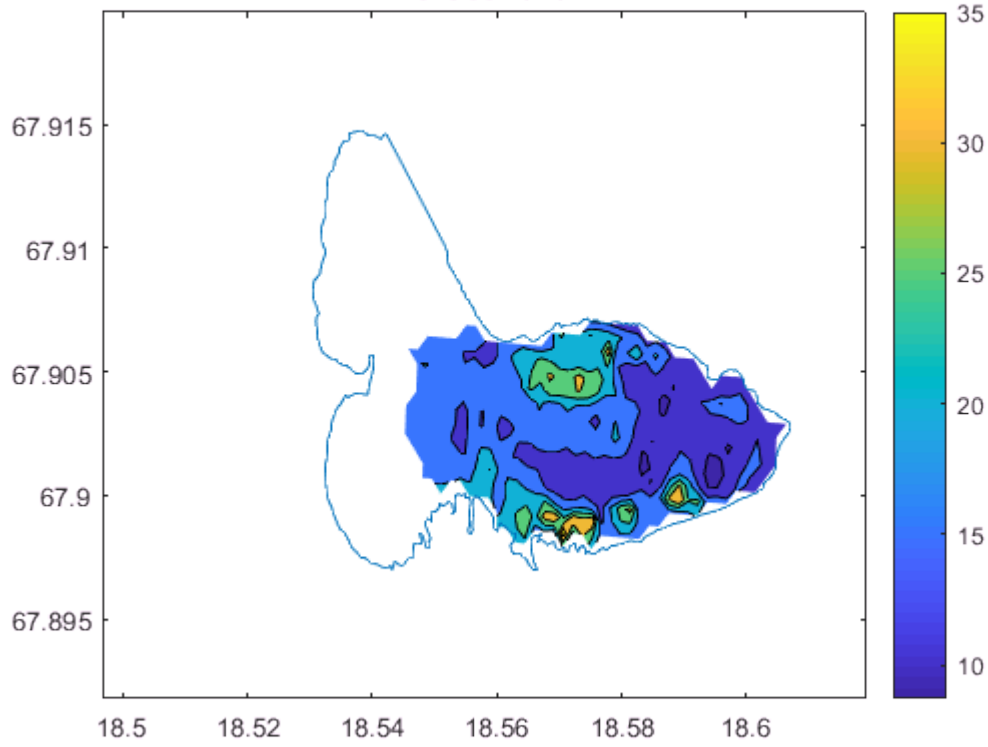
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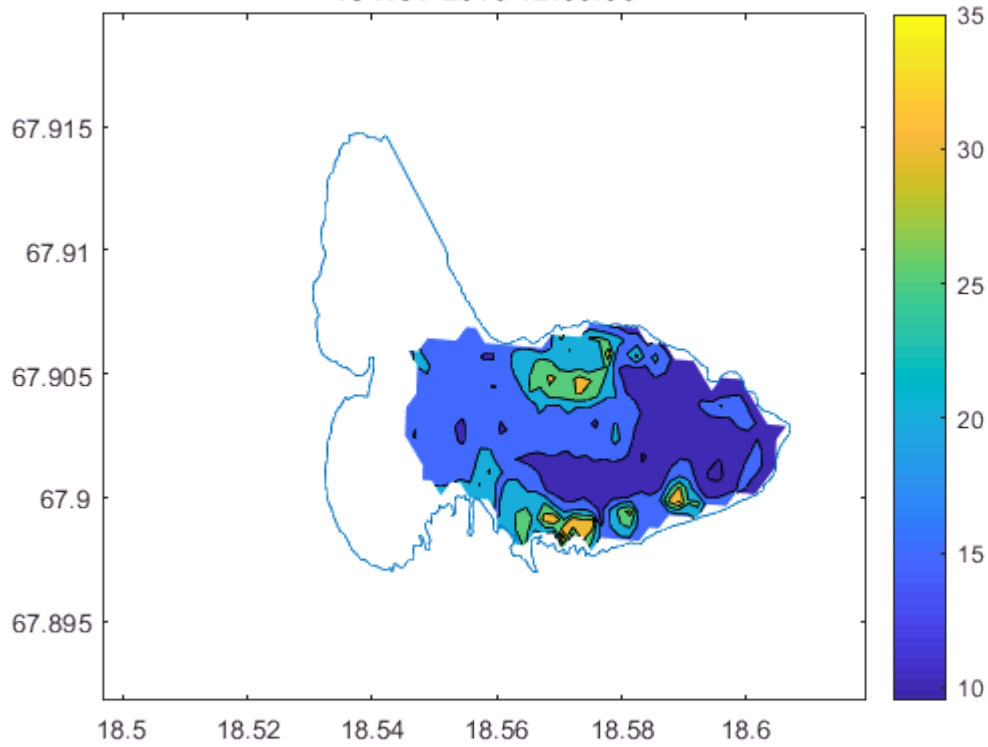
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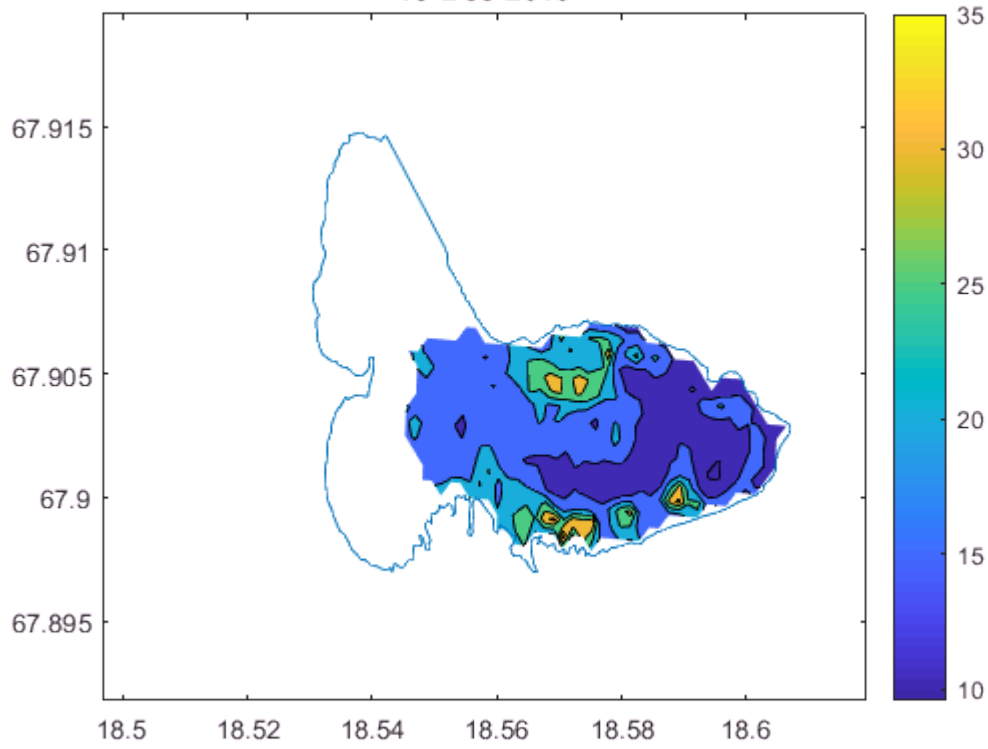
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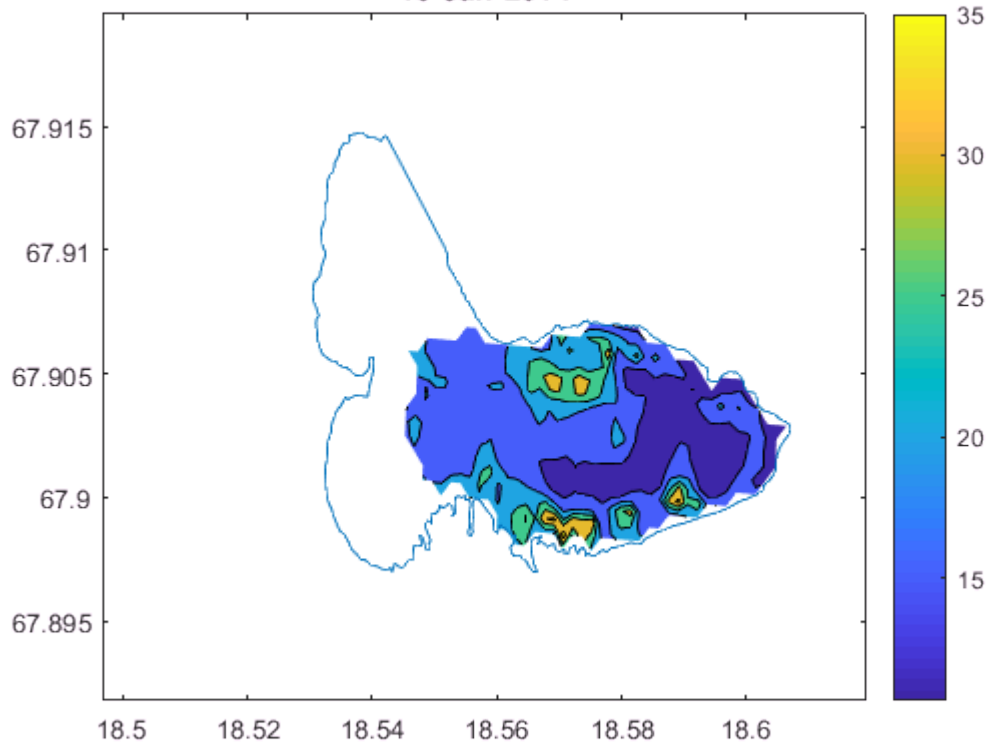
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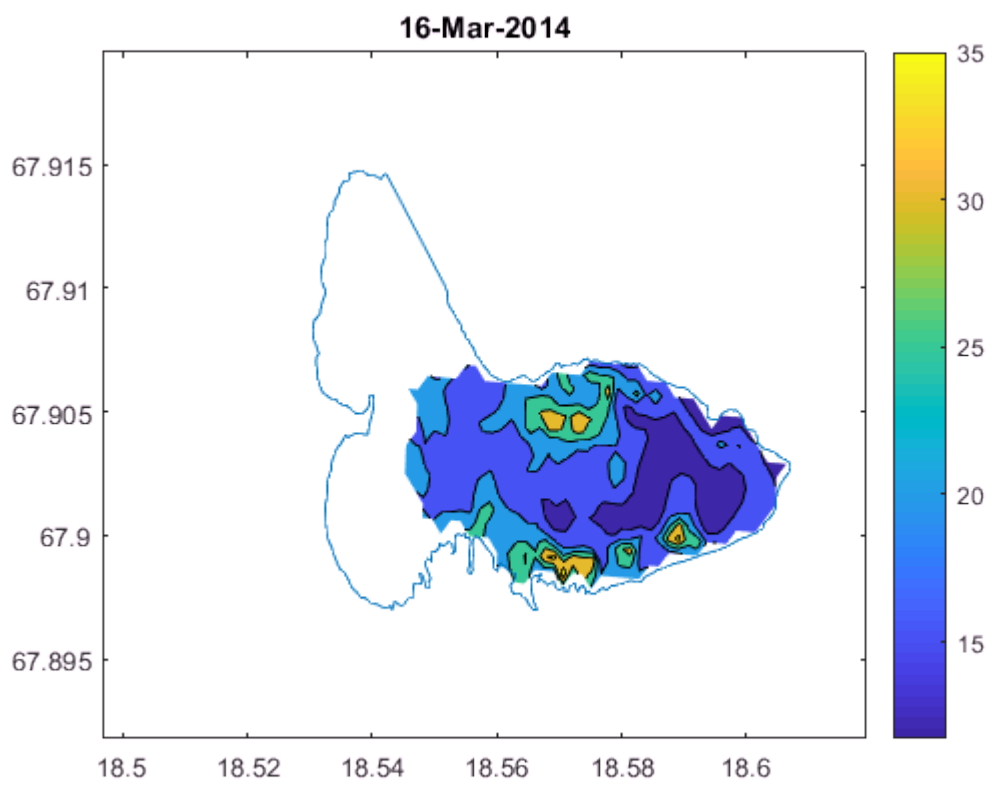
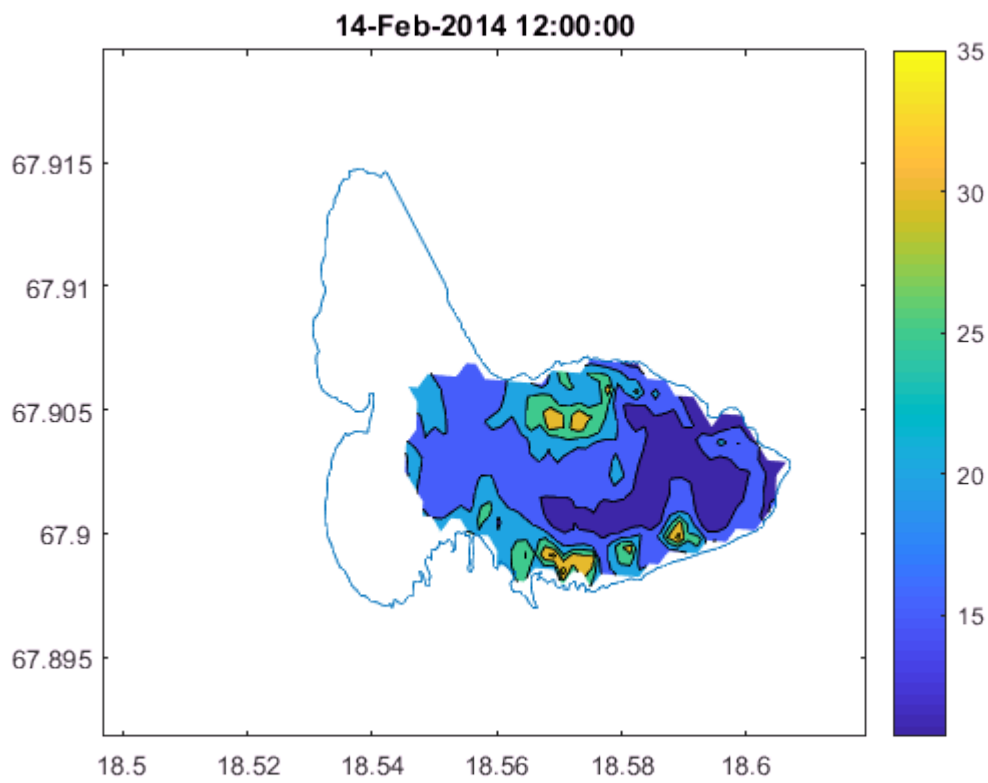


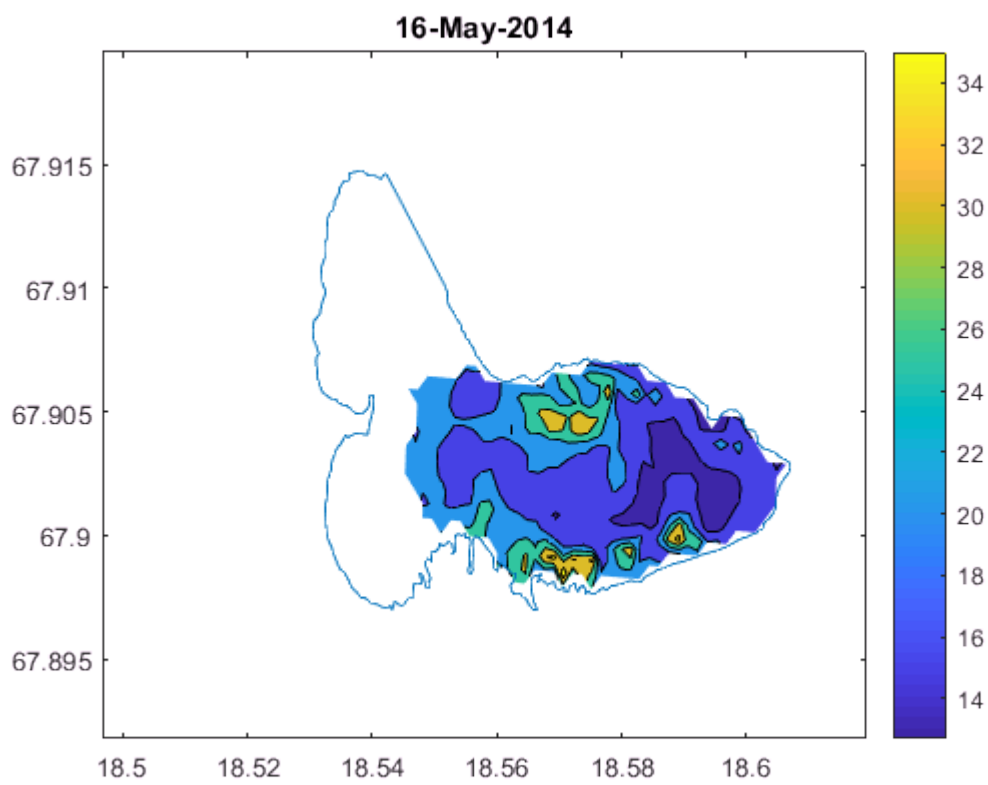
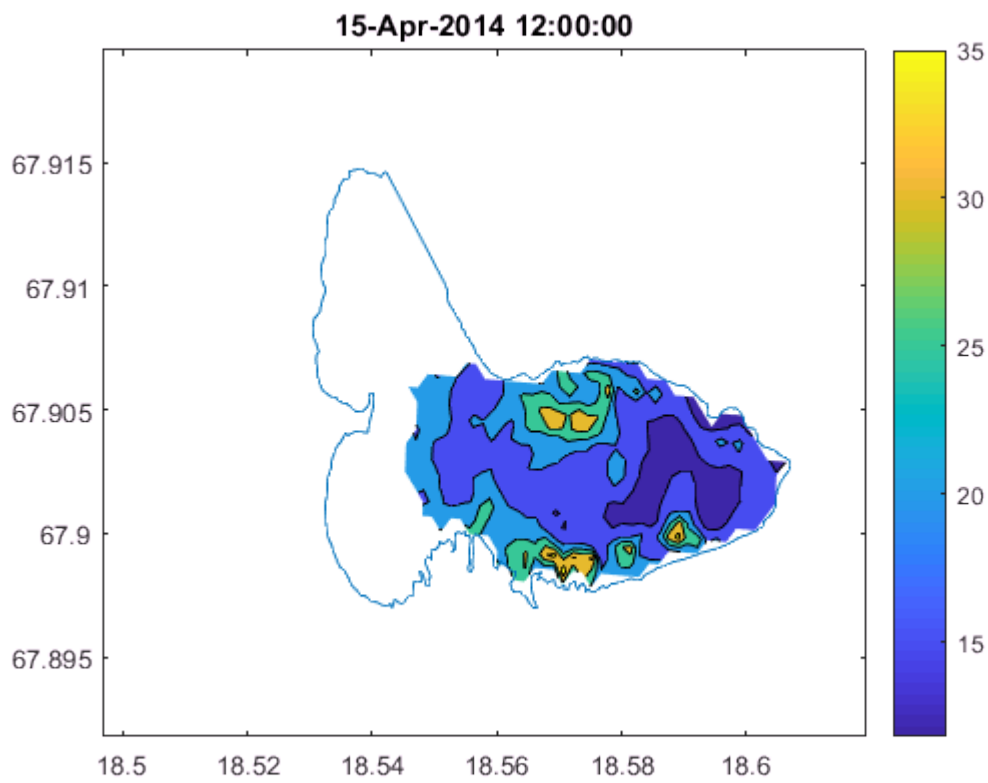
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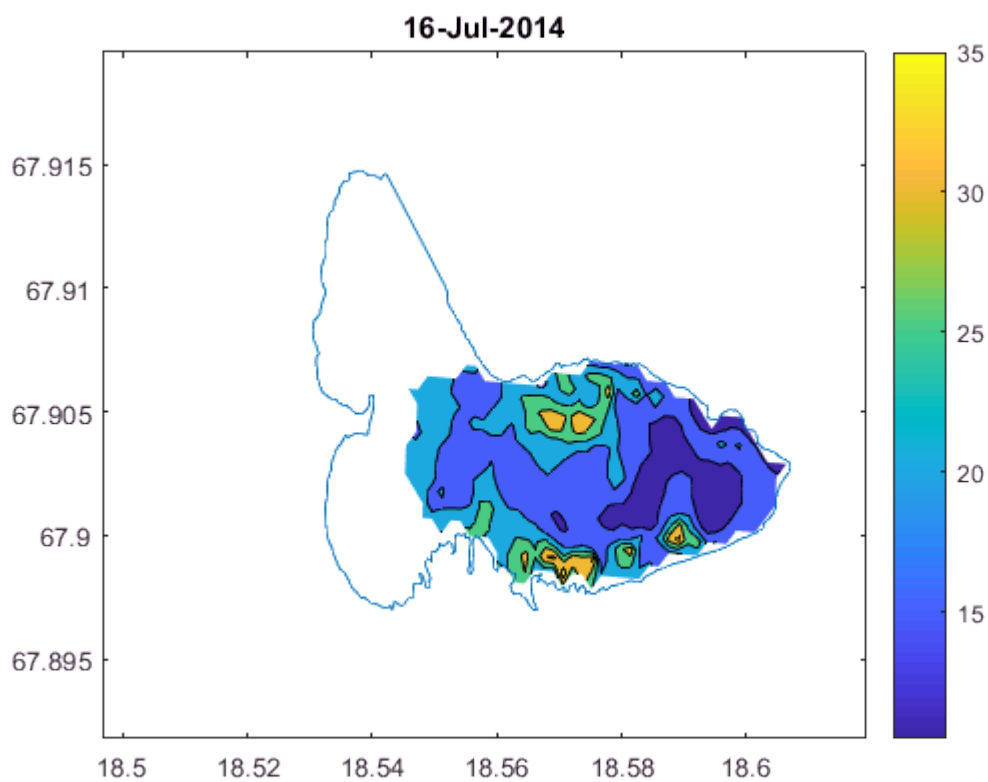
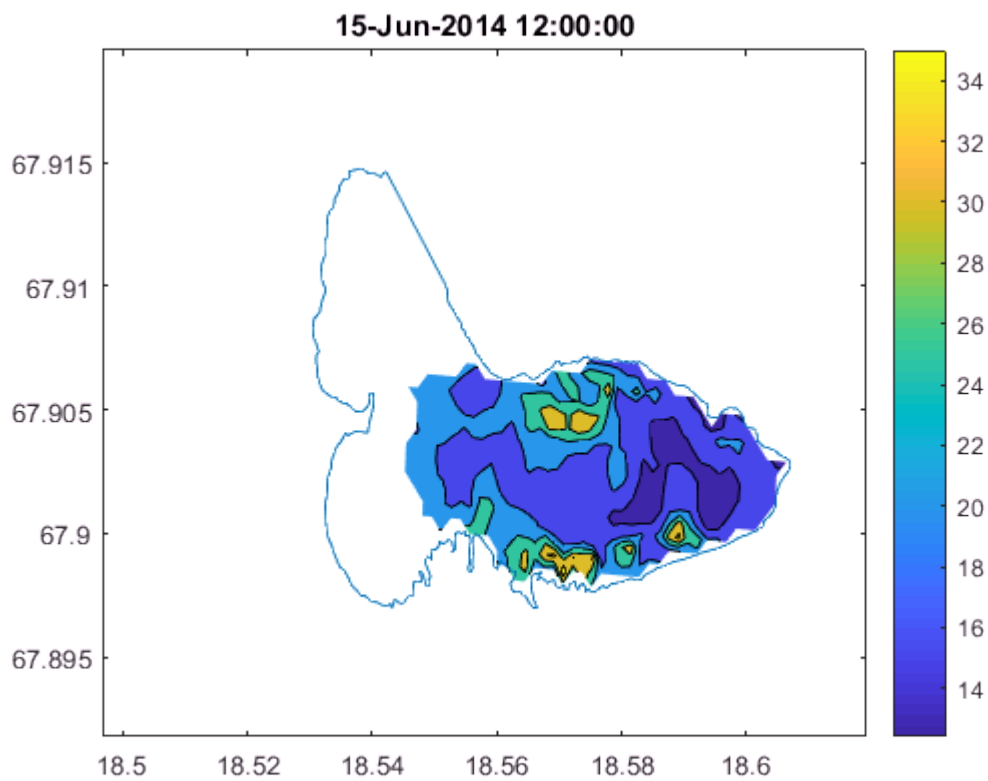


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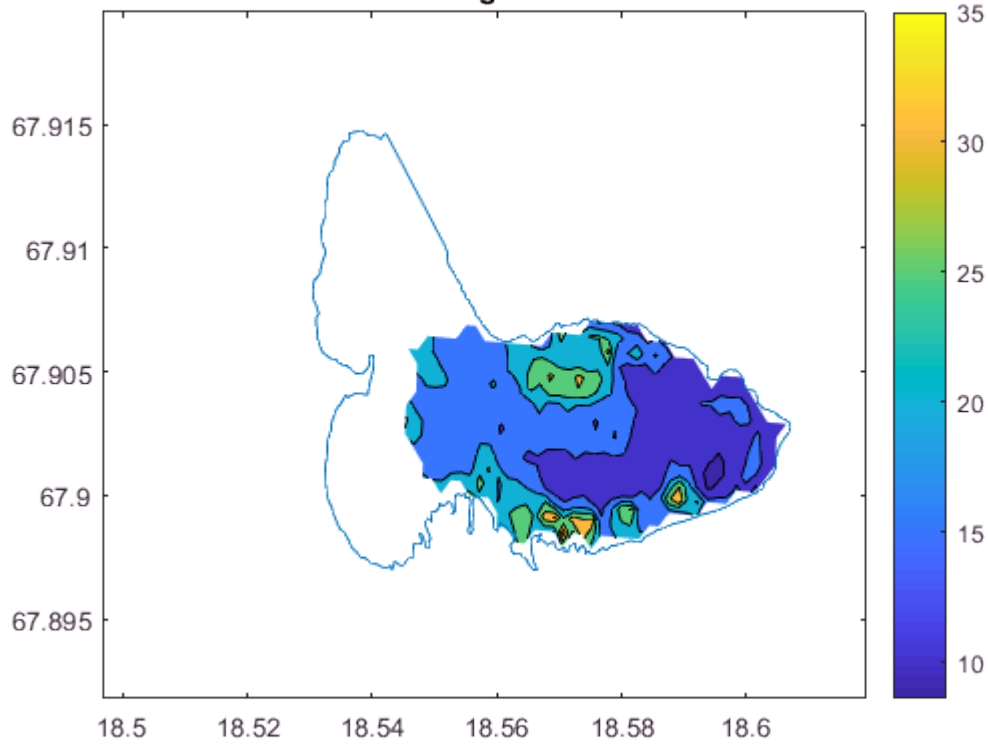




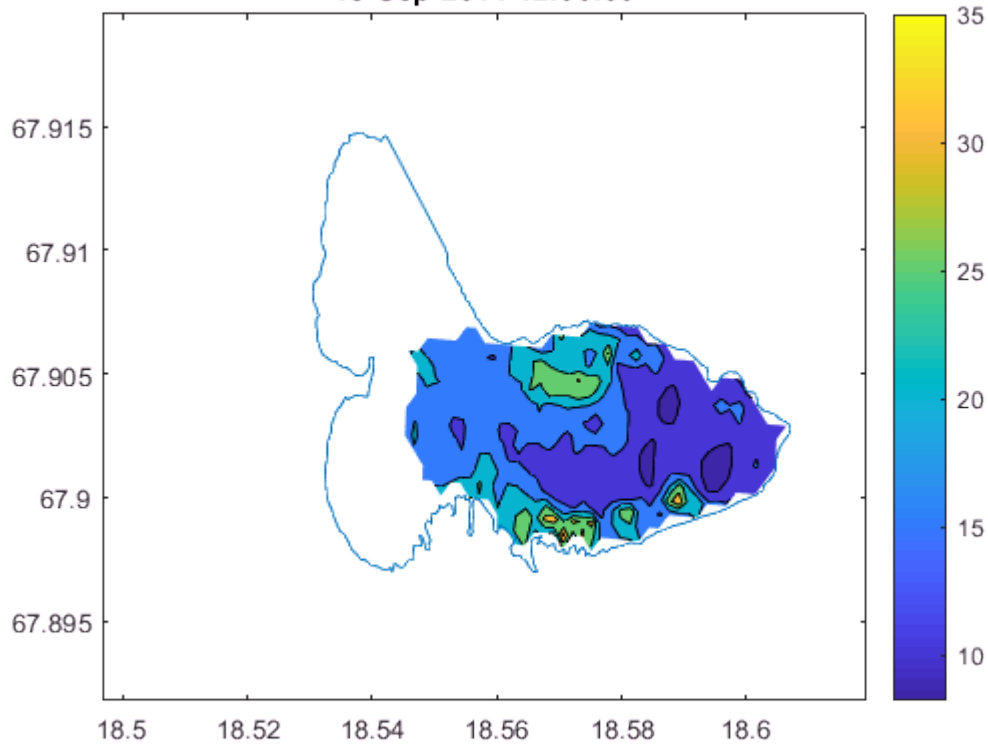




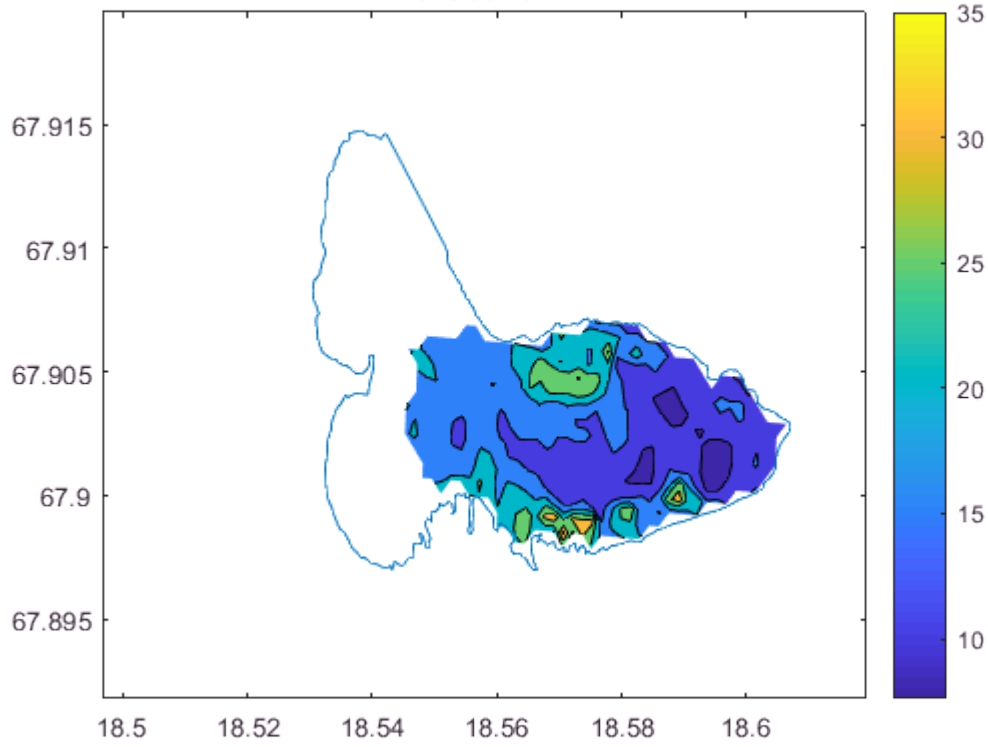
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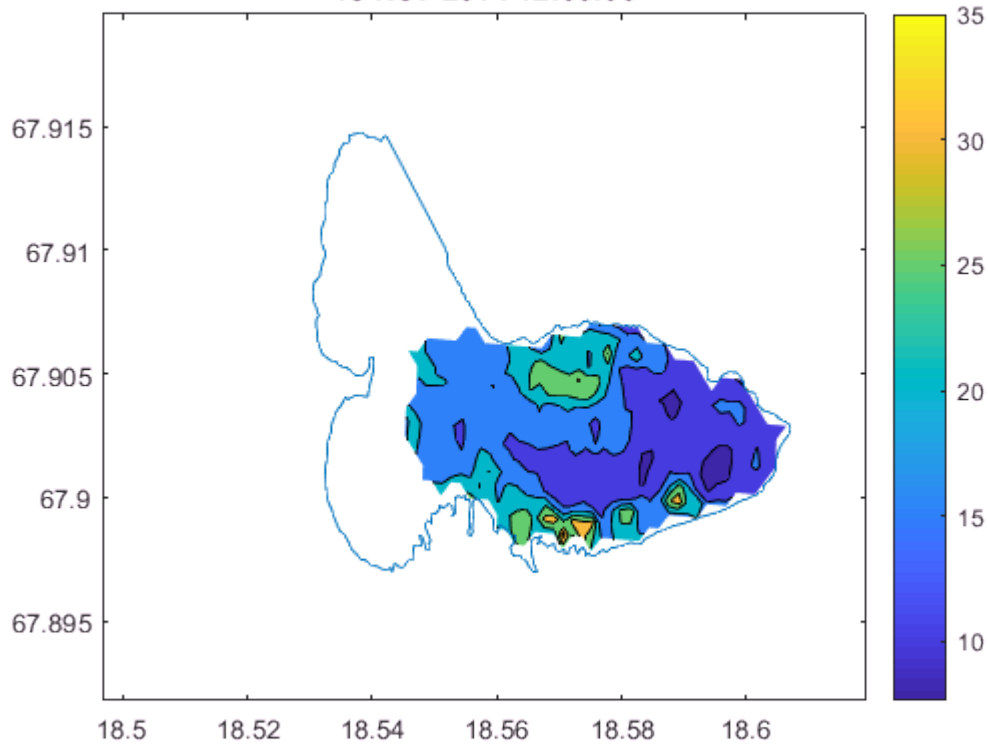
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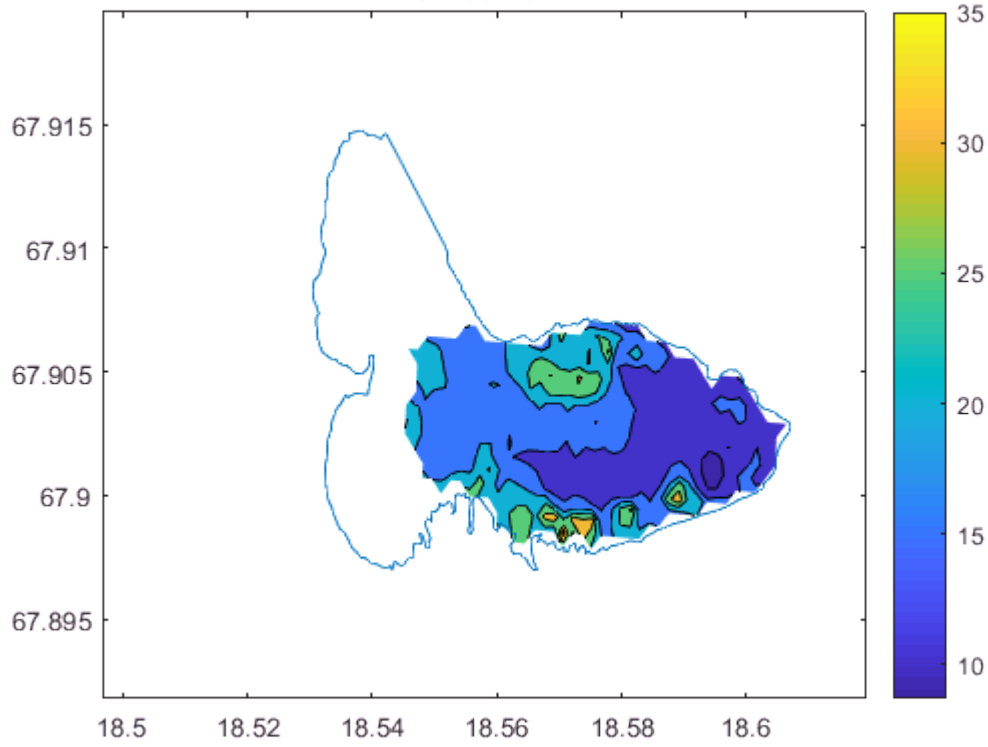
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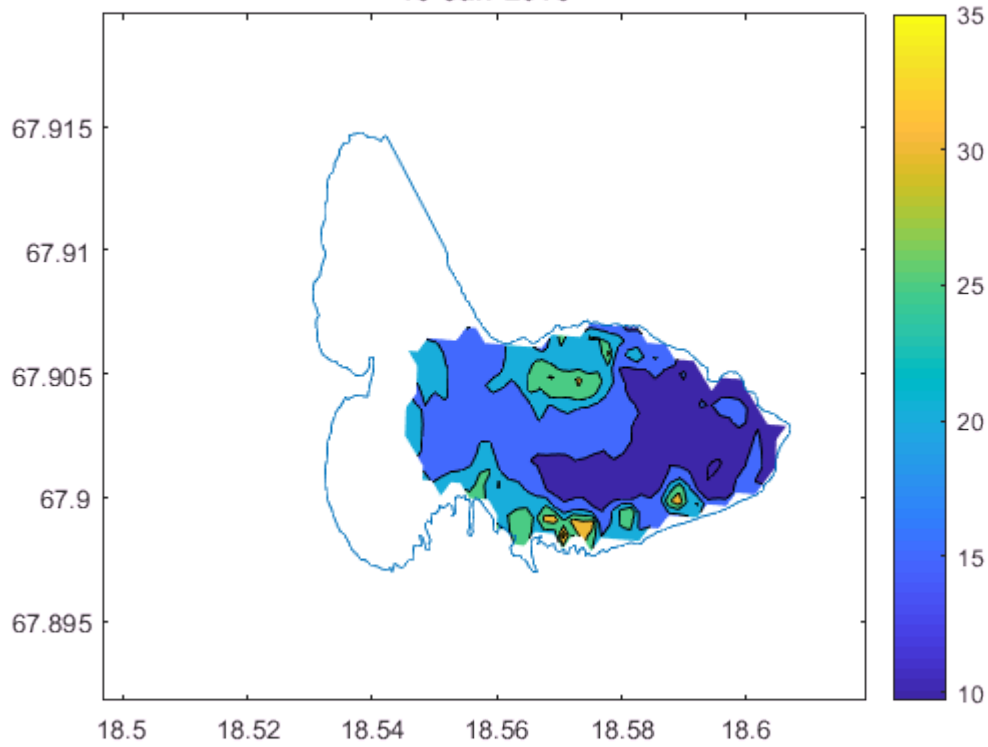
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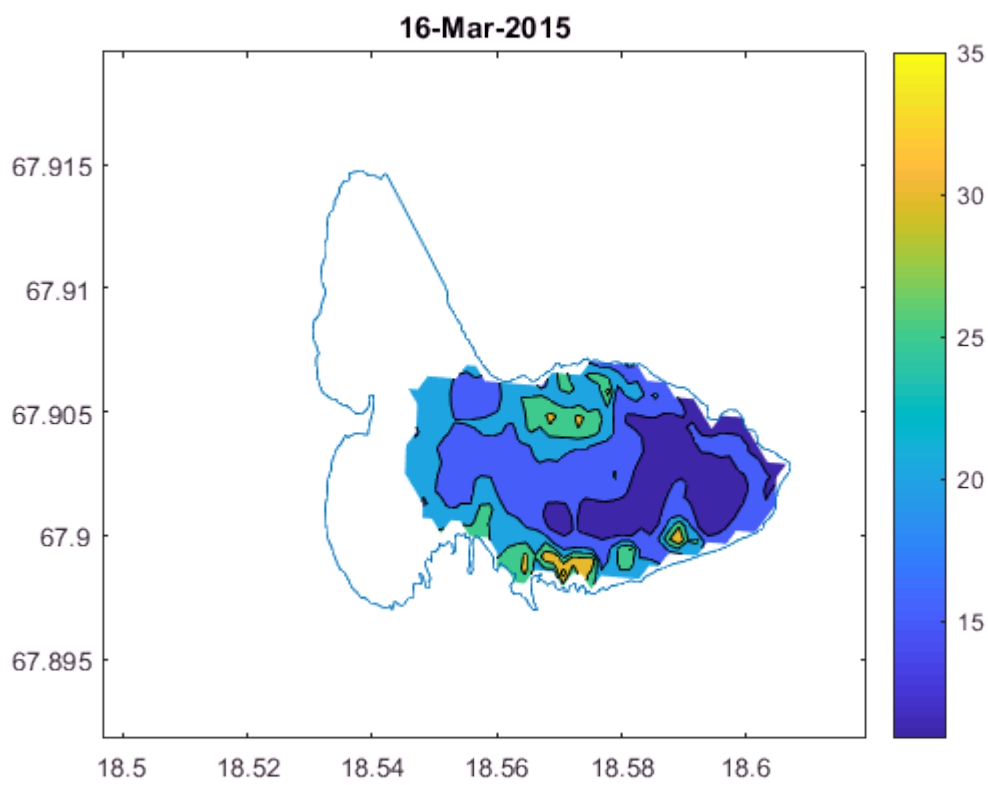
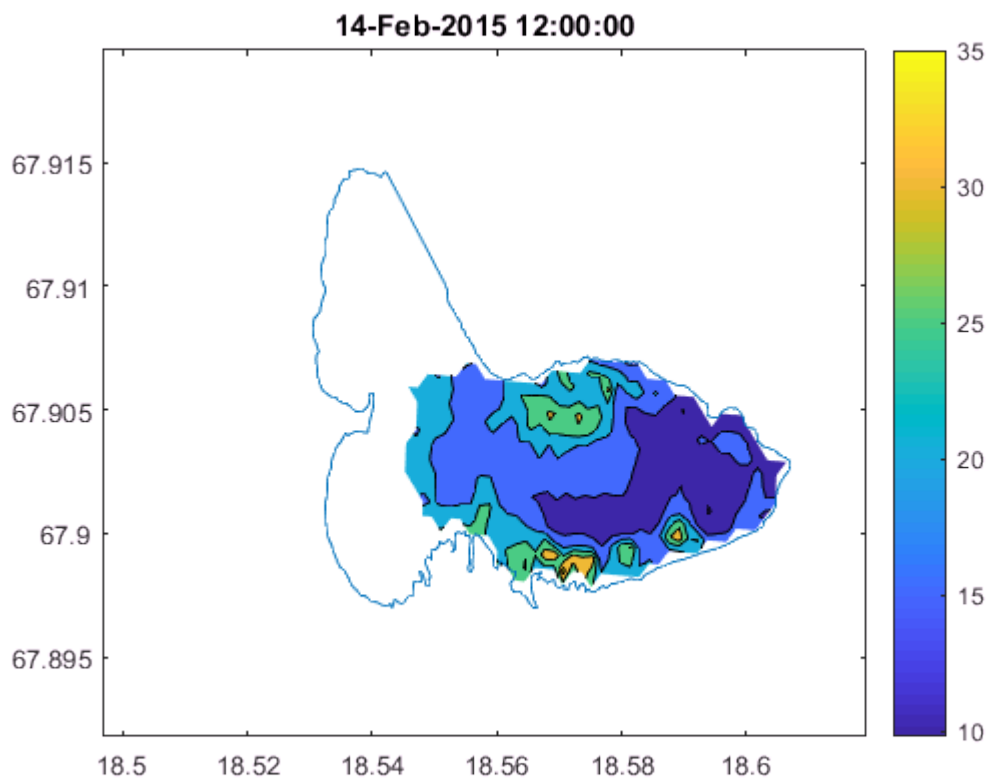


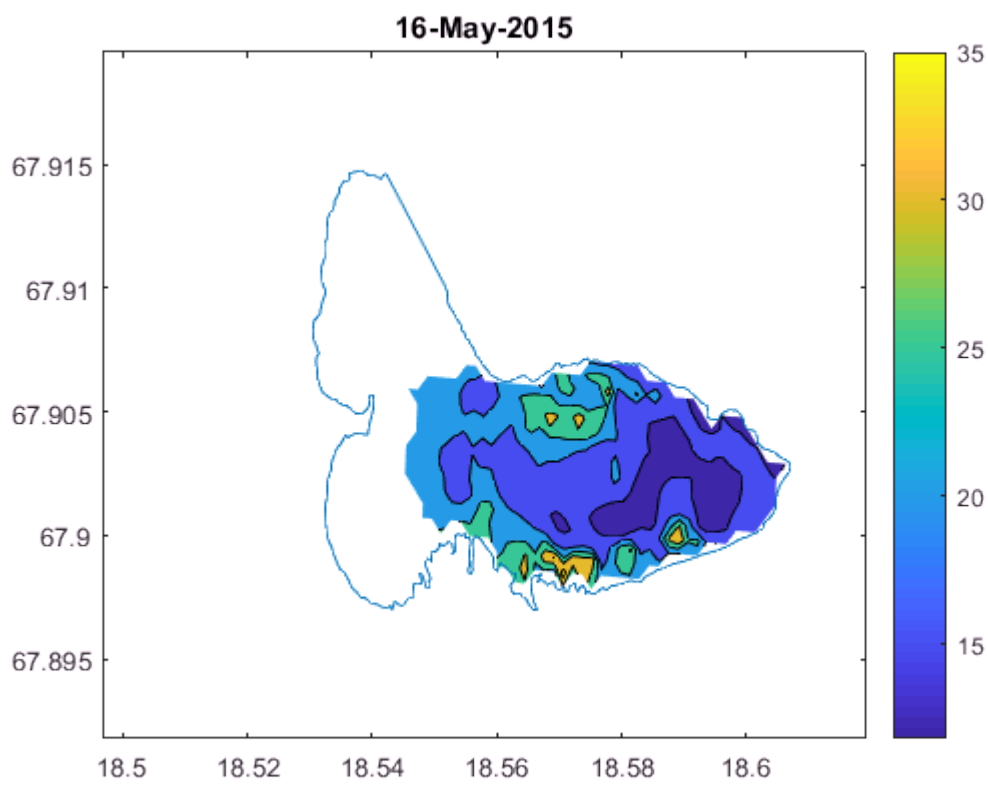
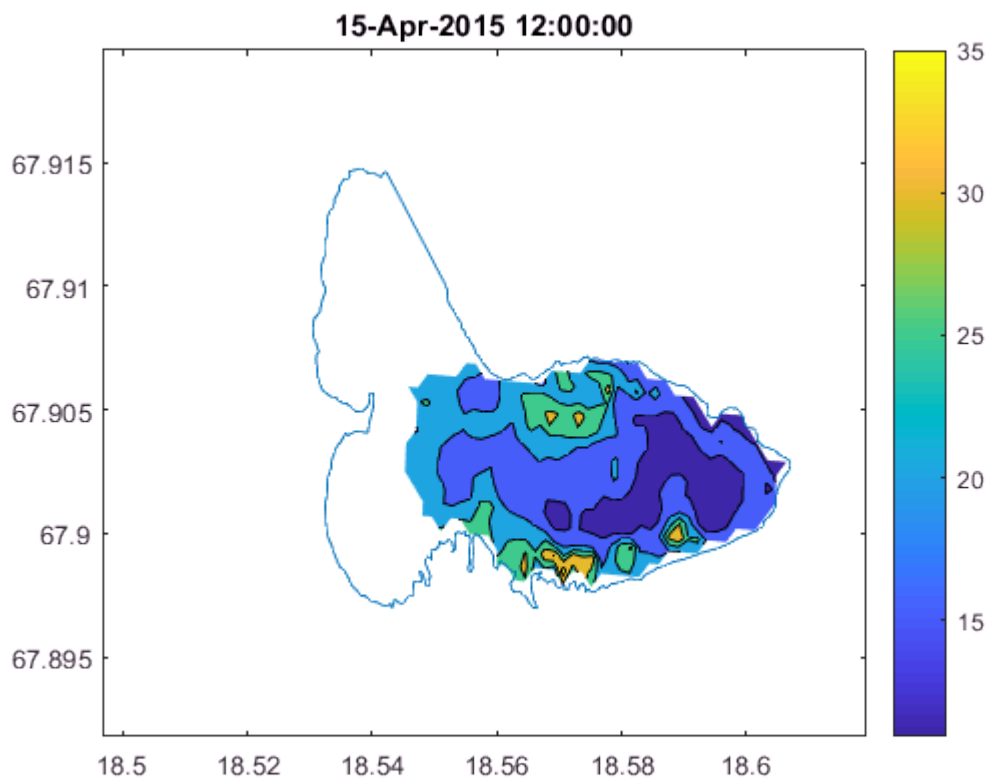
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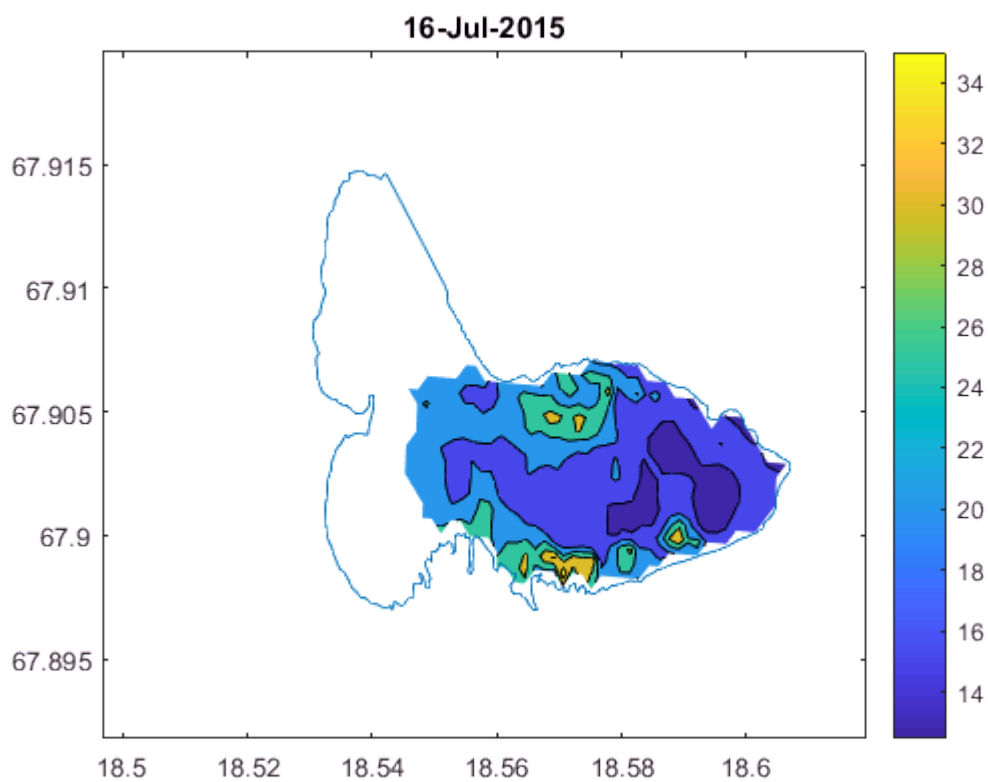
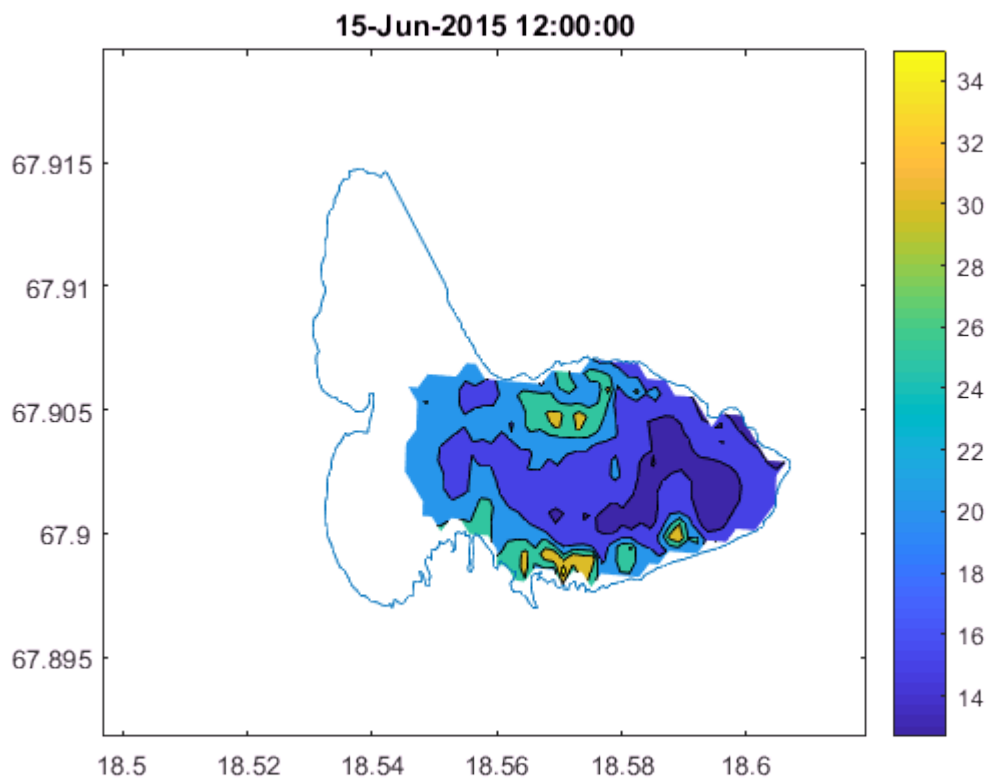


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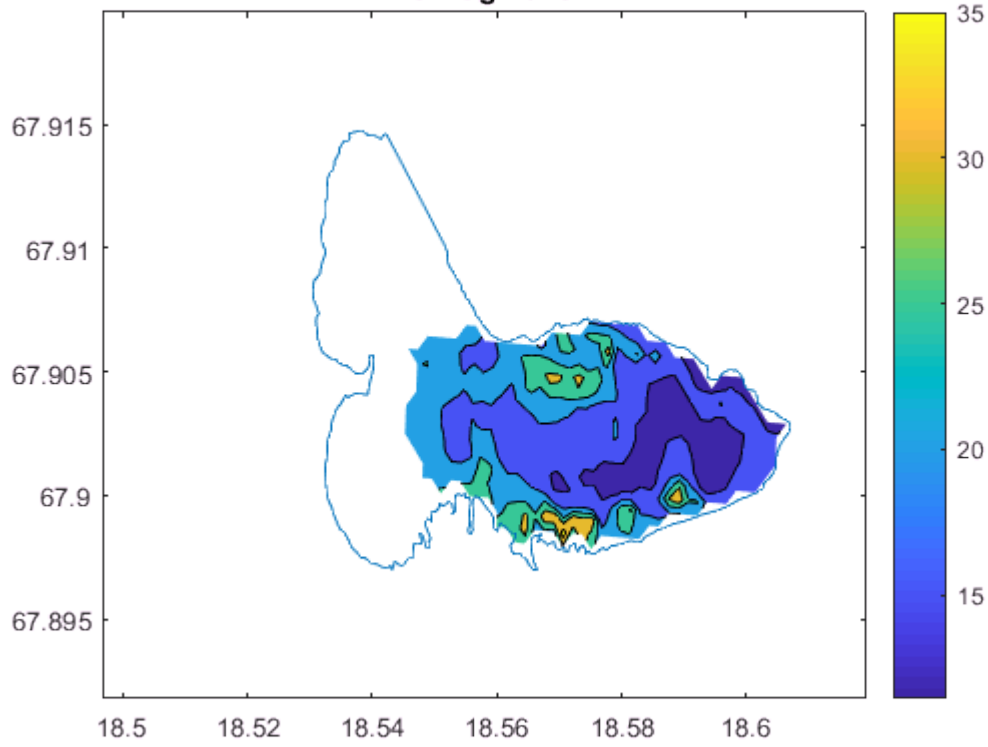




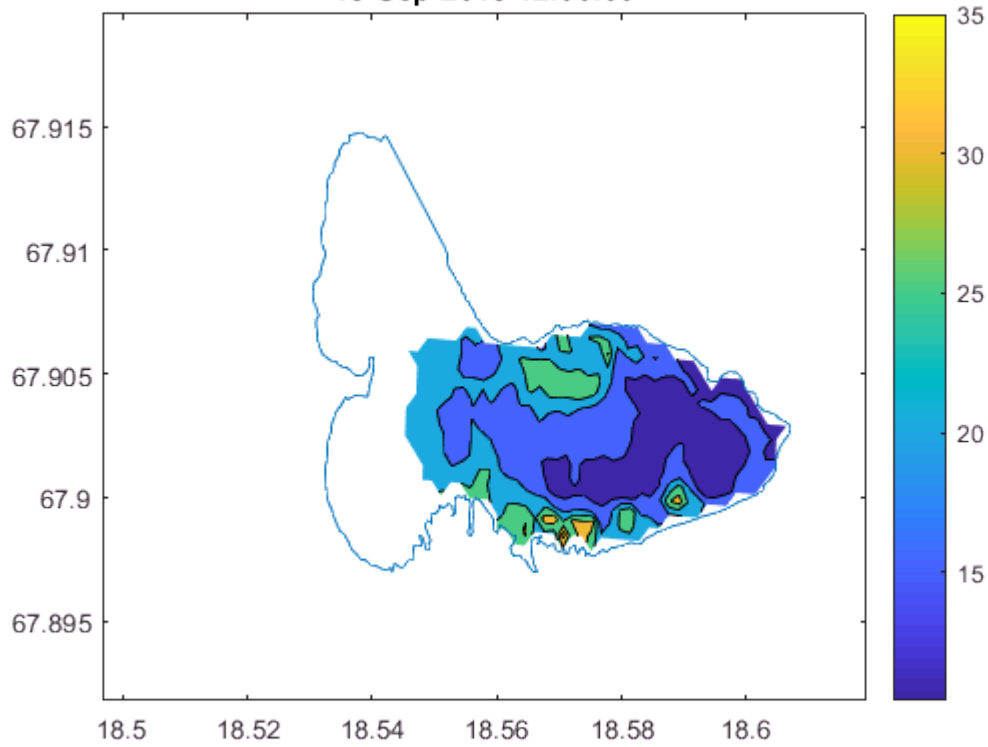




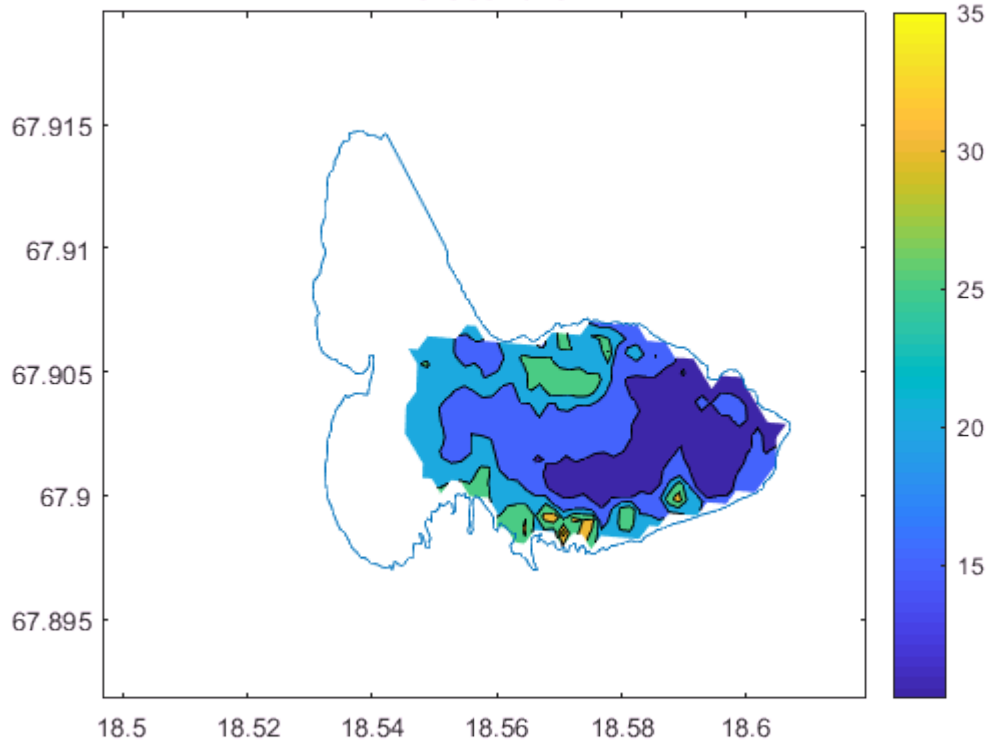
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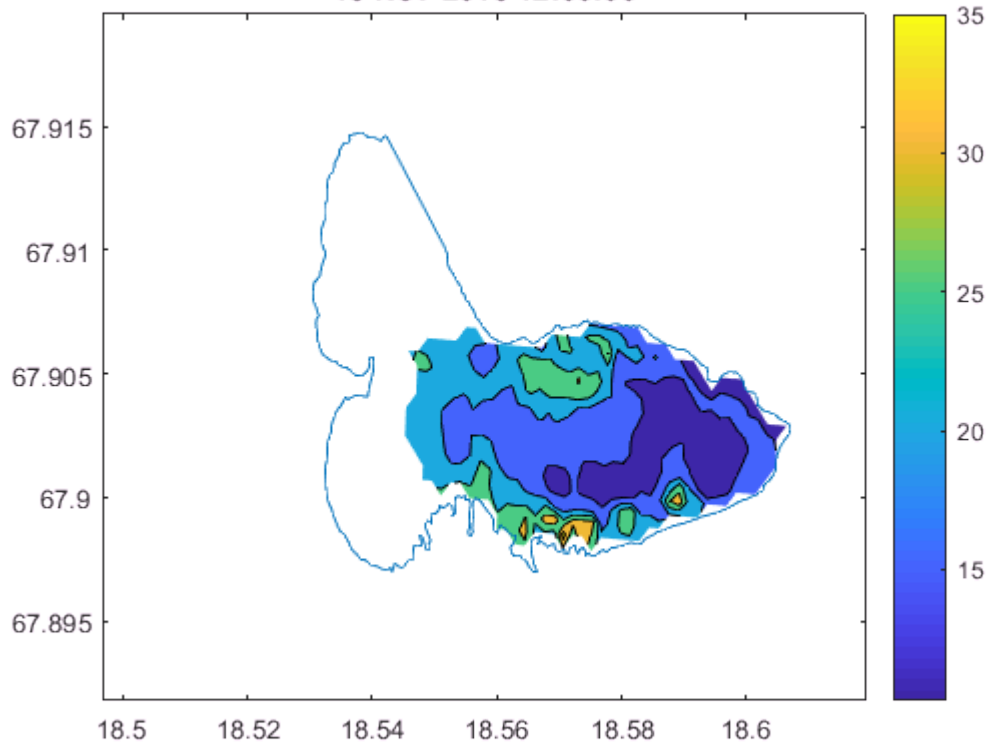
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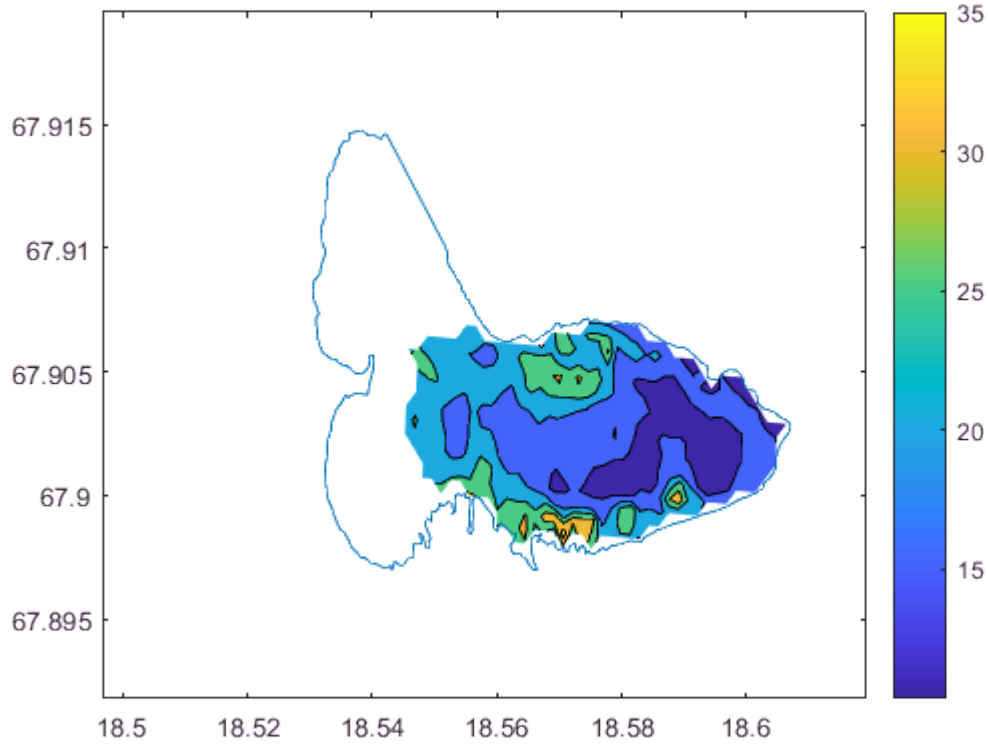
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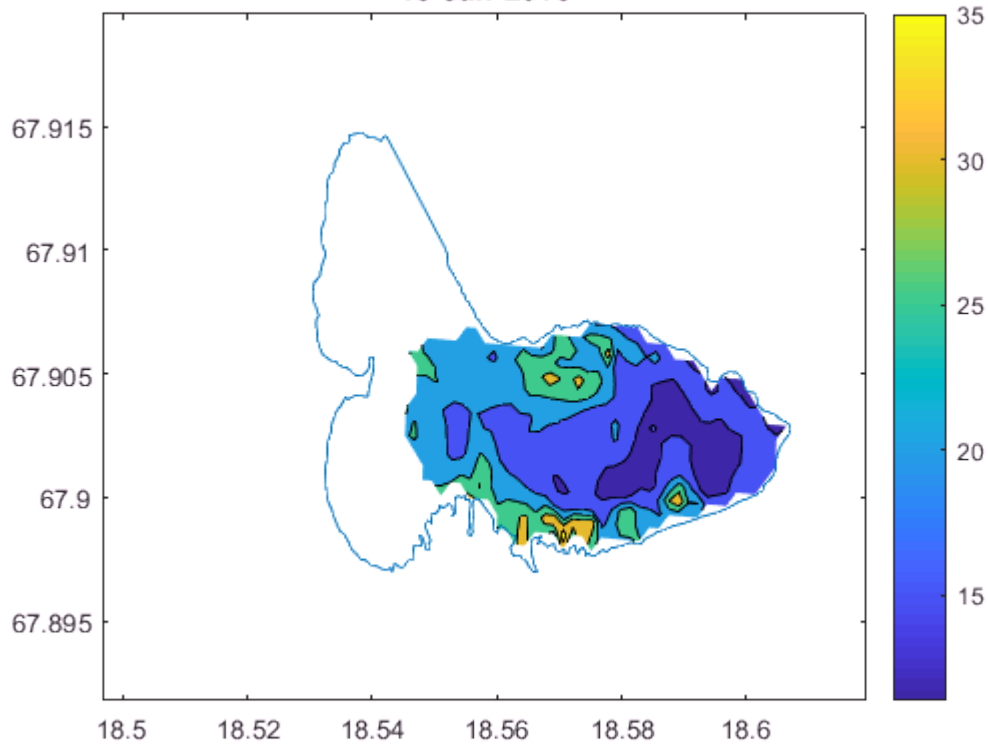
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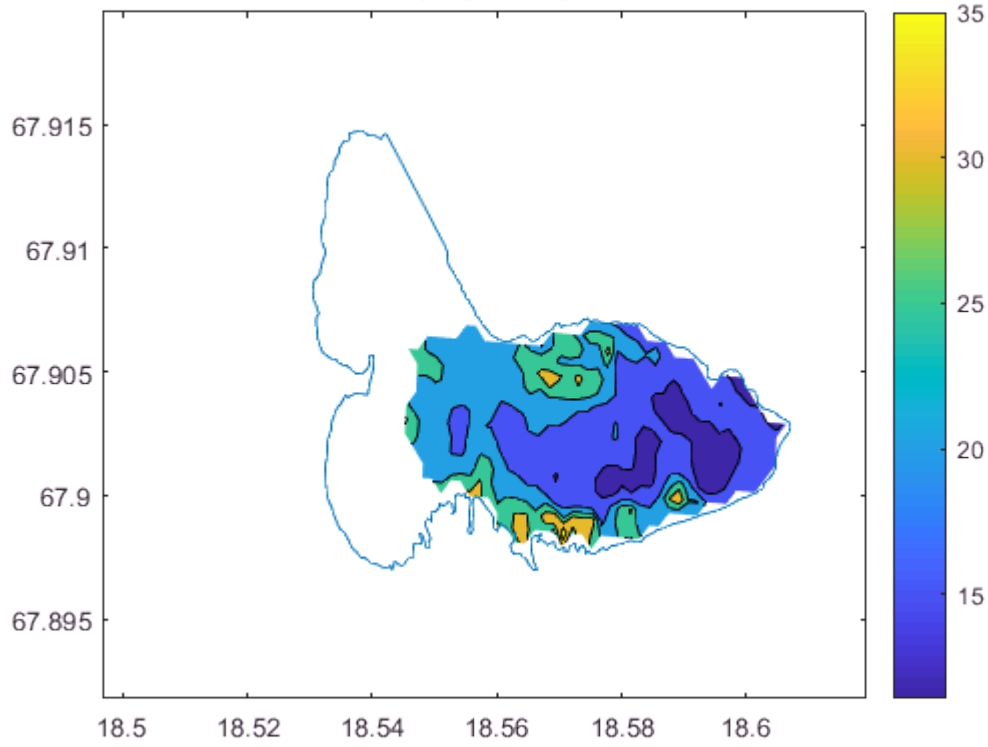
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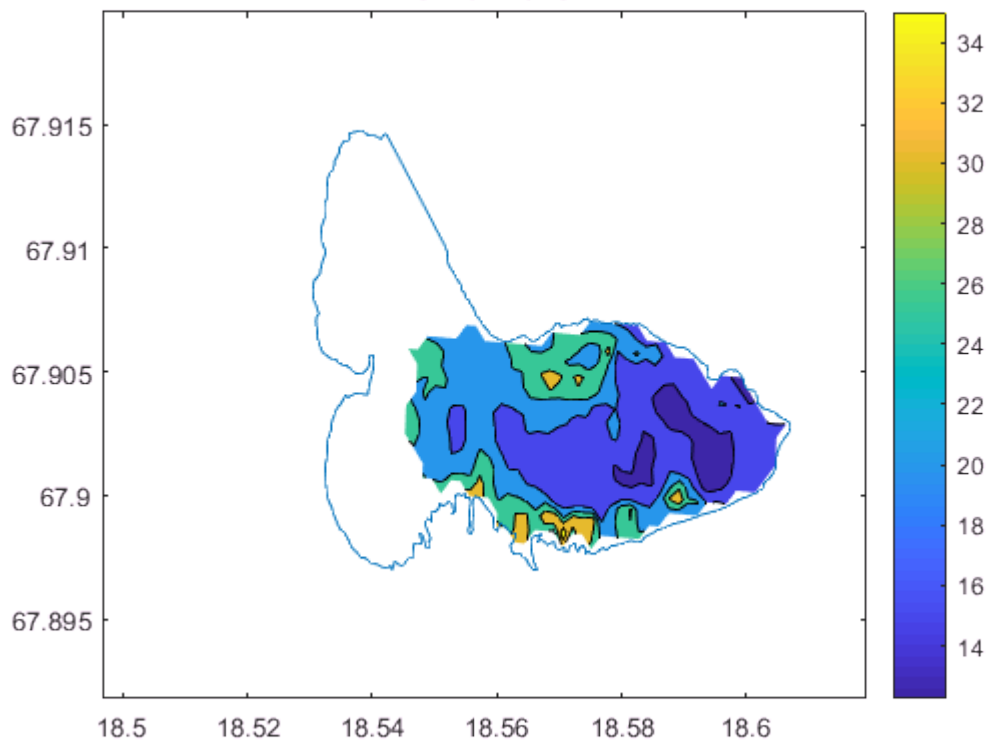
16-Jan-2016

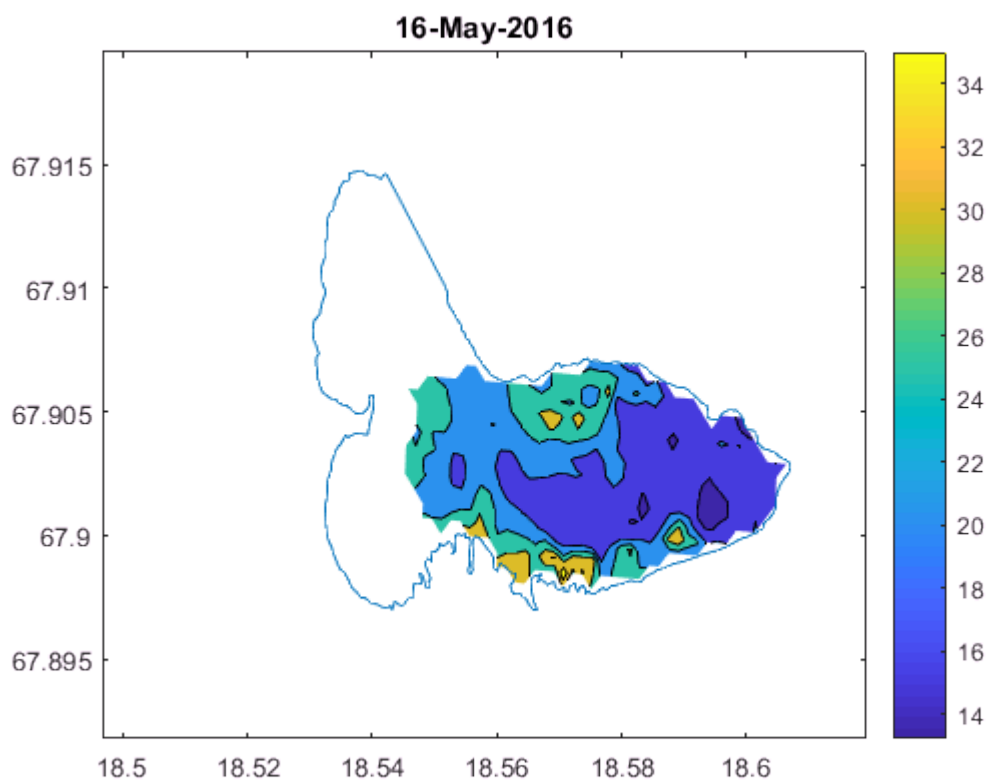
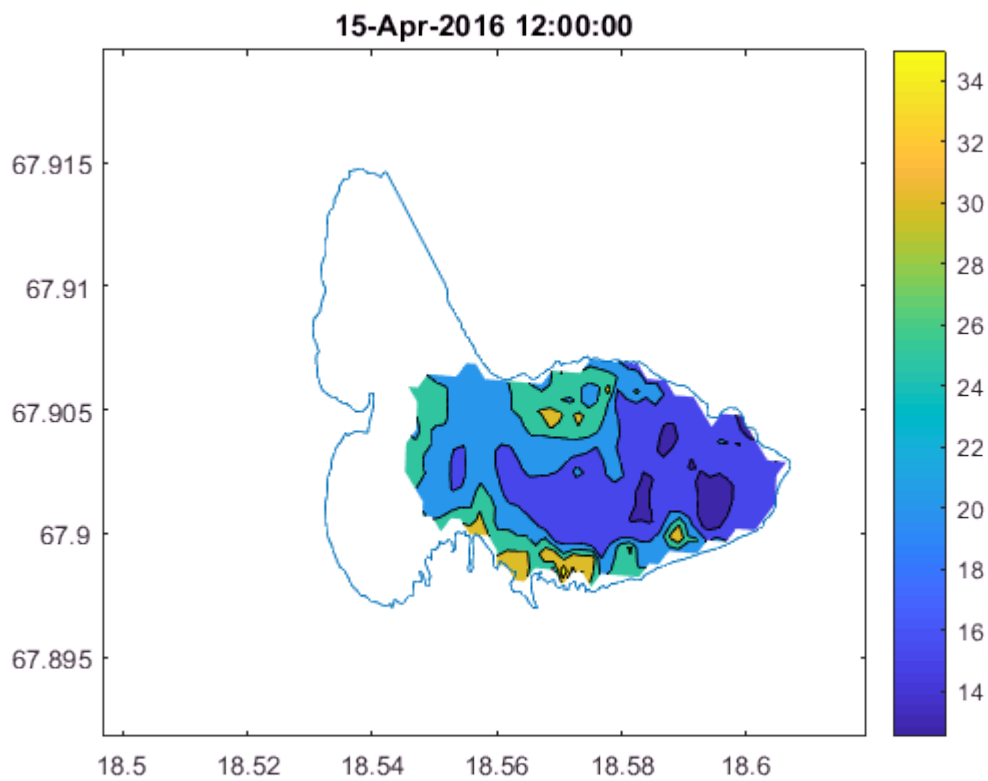


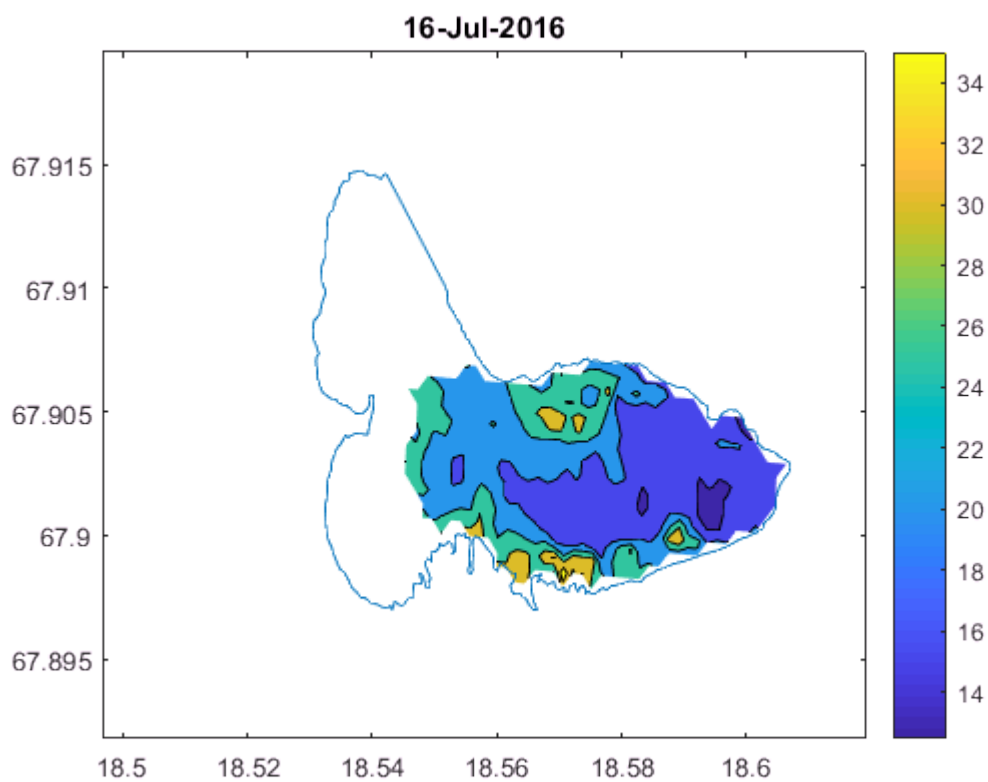
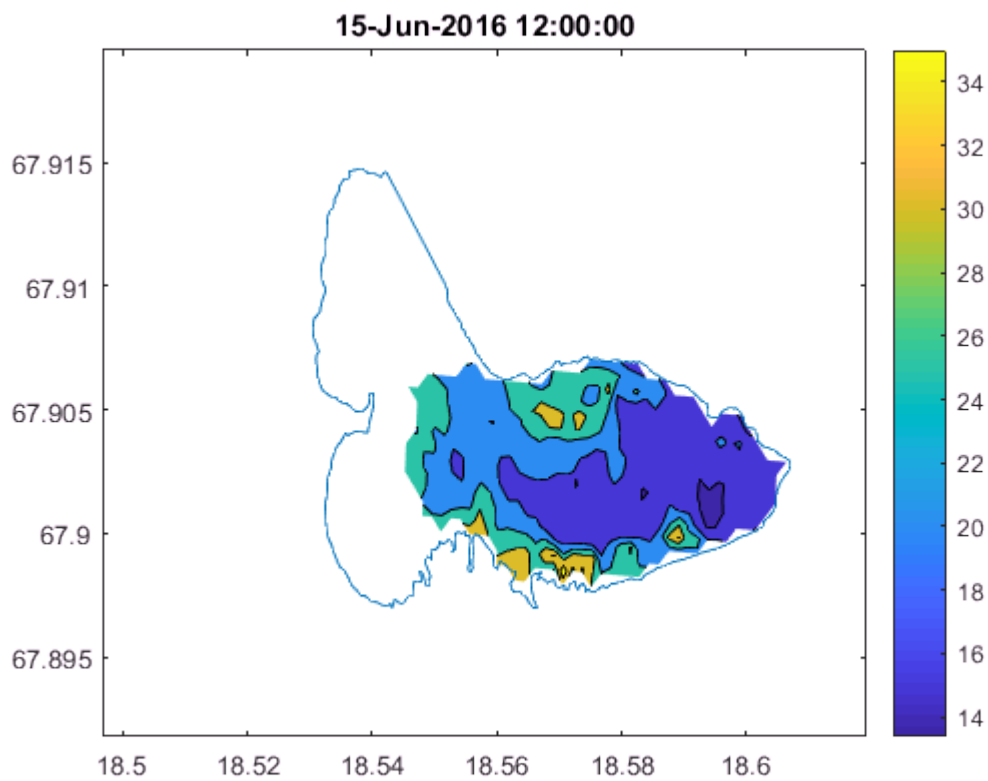
15-Feb-2016



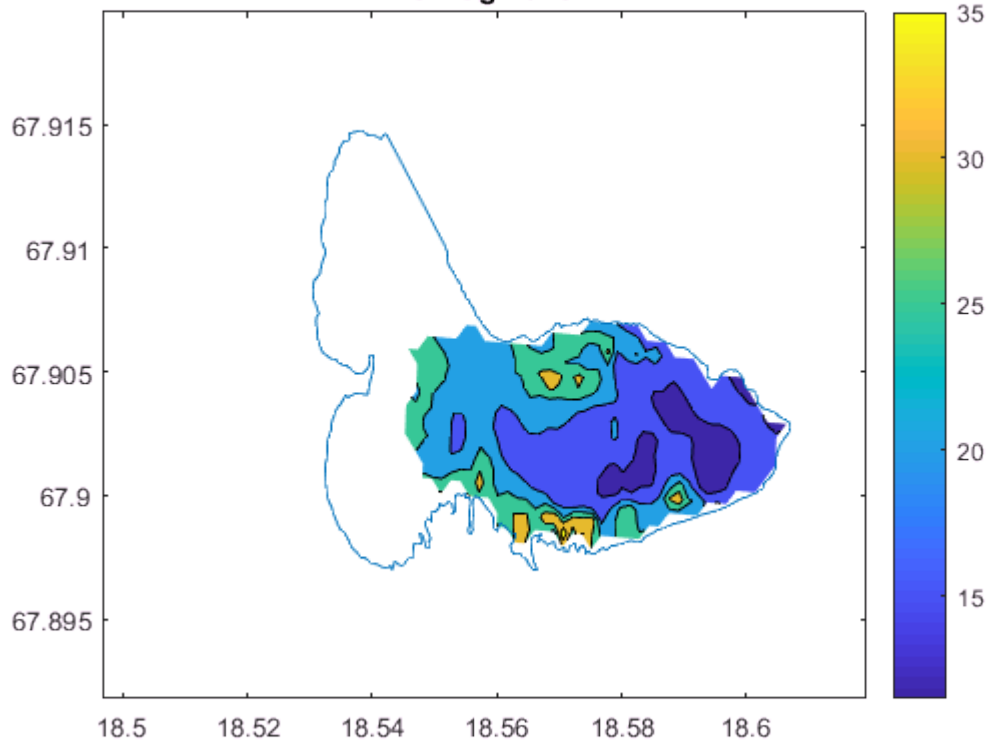
16-Mar-2016



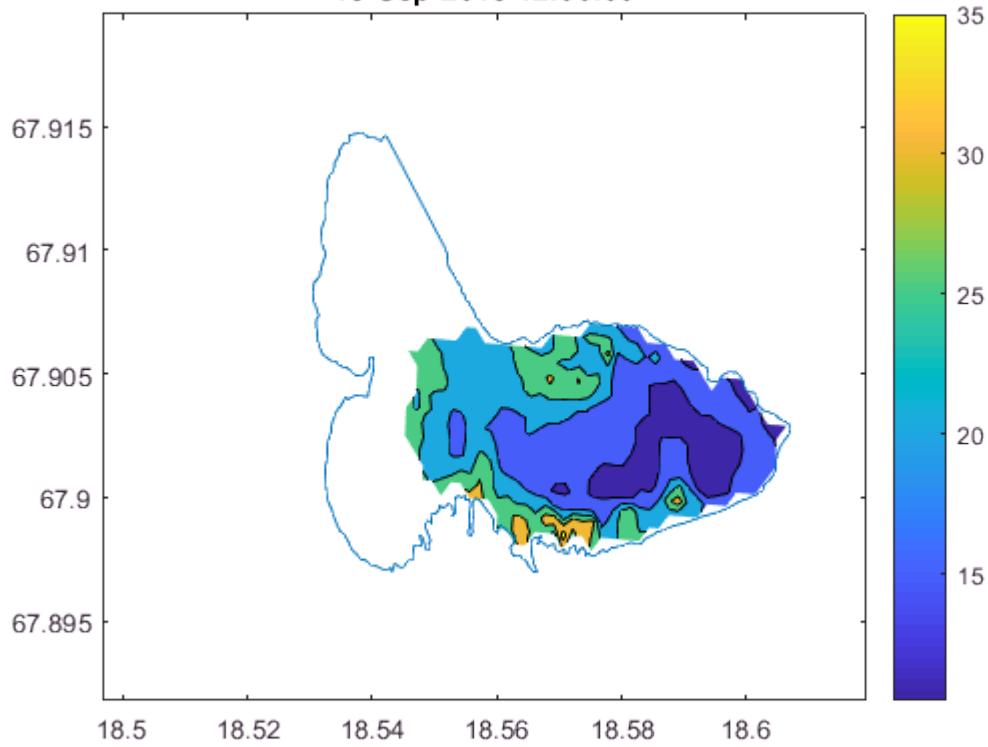




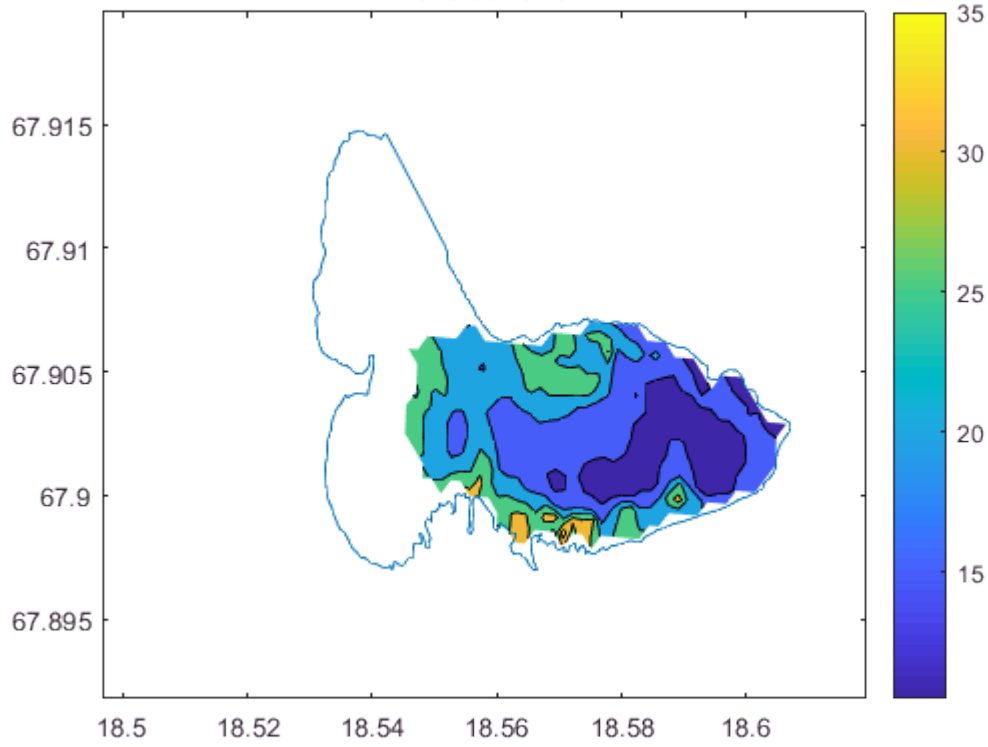
16-Aug-2016



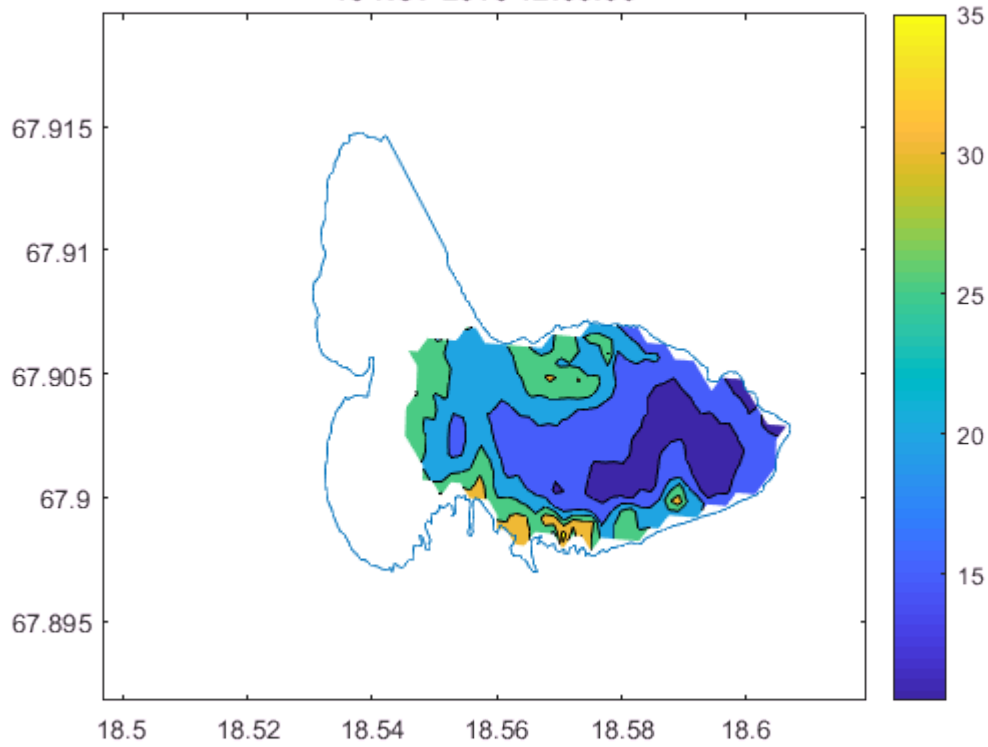
15-Sep-2016 12:00:00



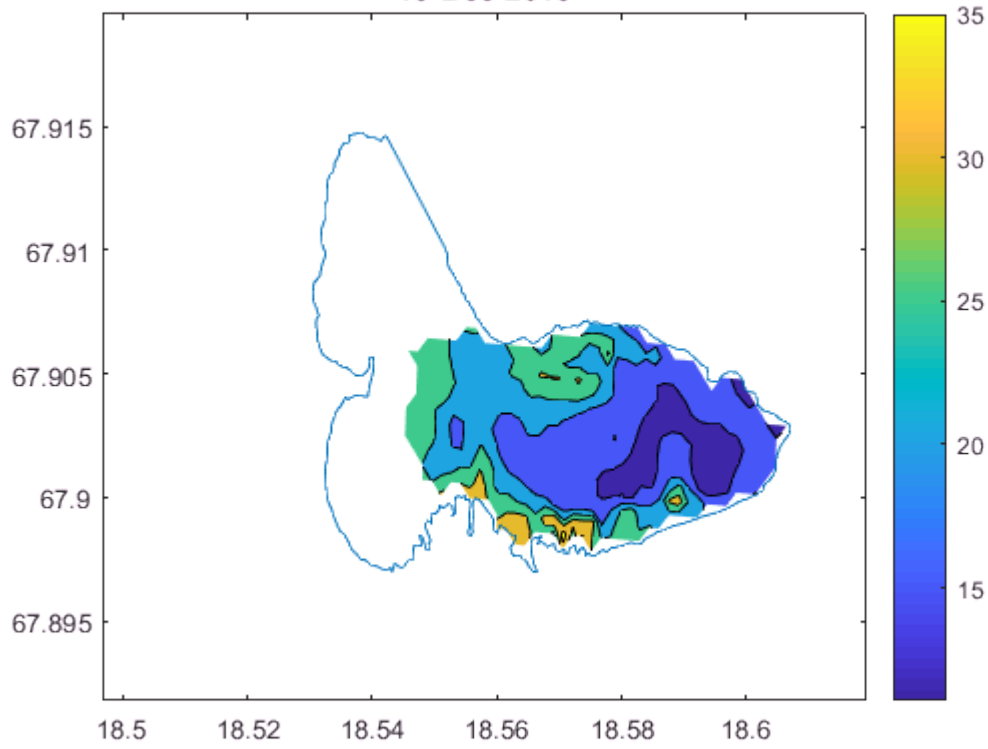
16-Oct-2016



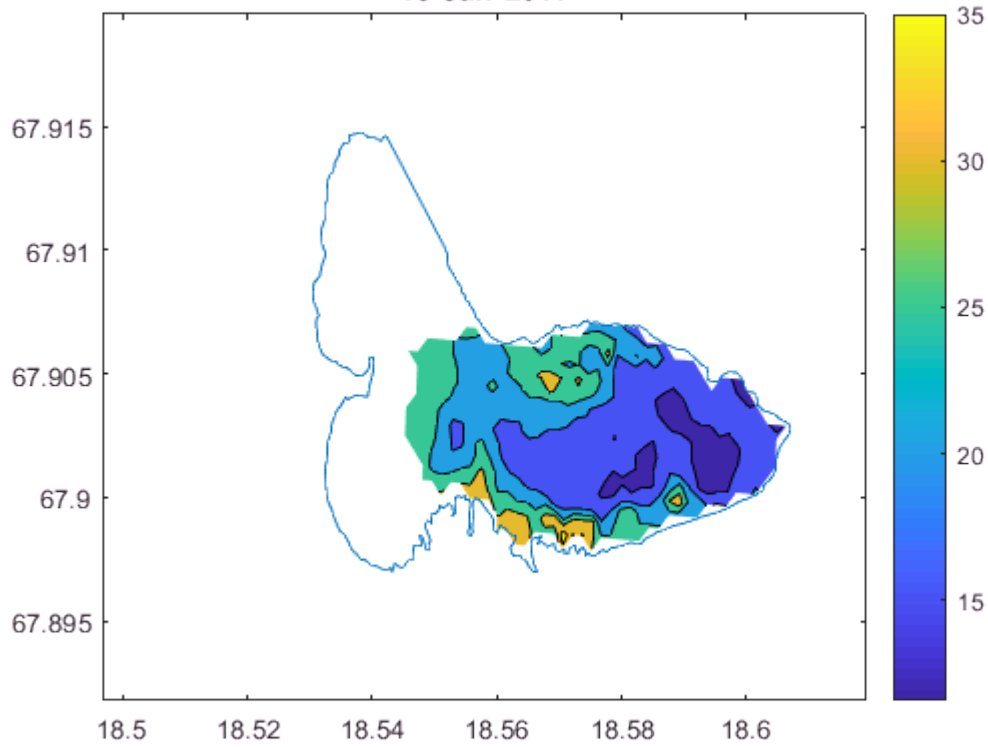
15-Nov-2016 12:00:00

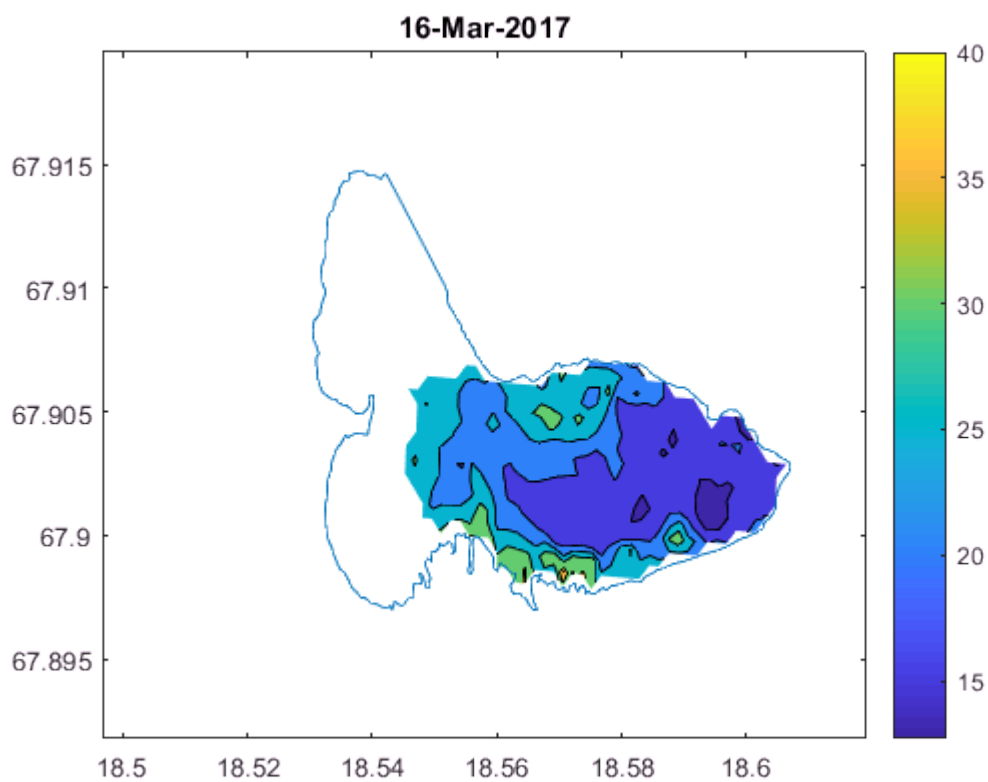
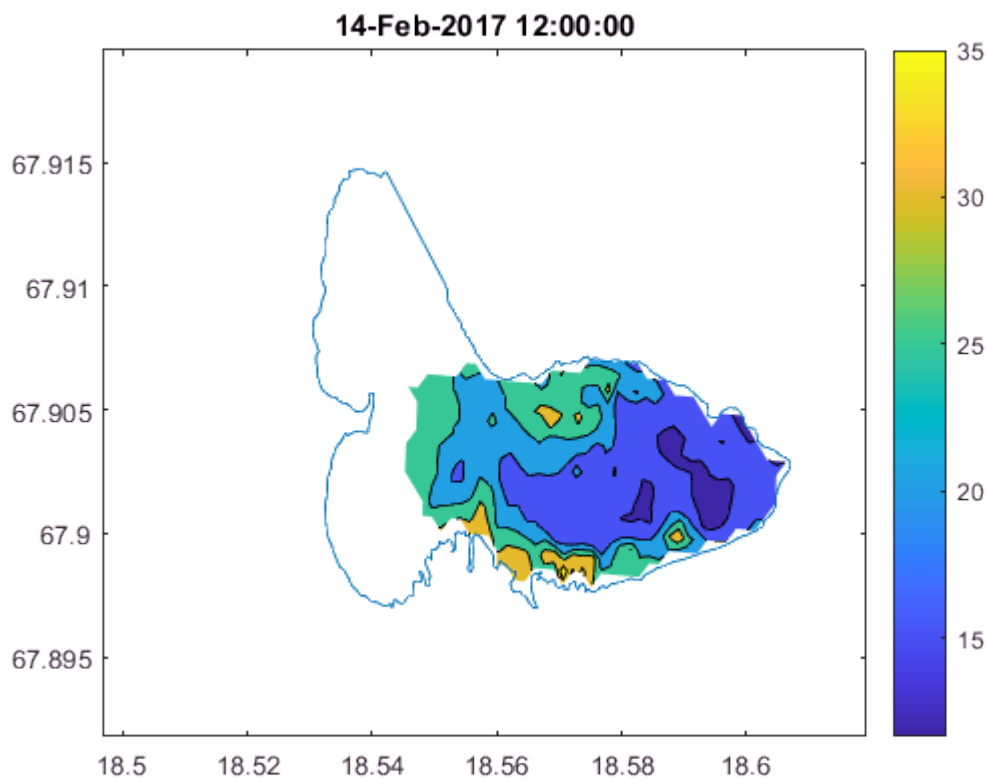


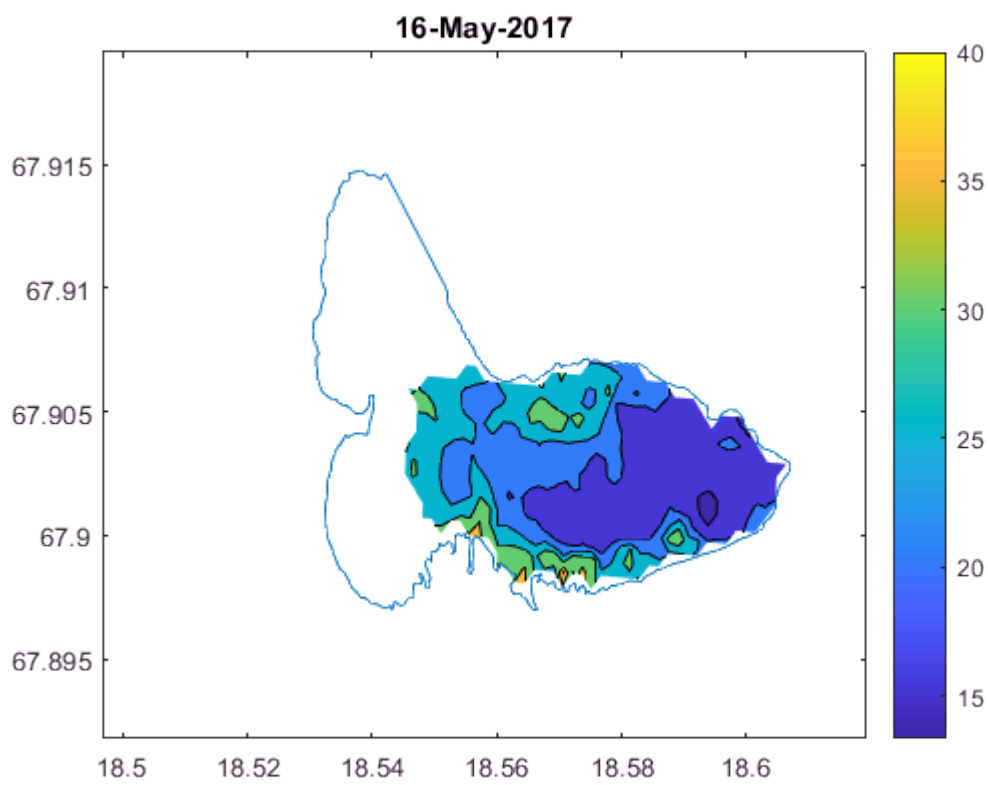
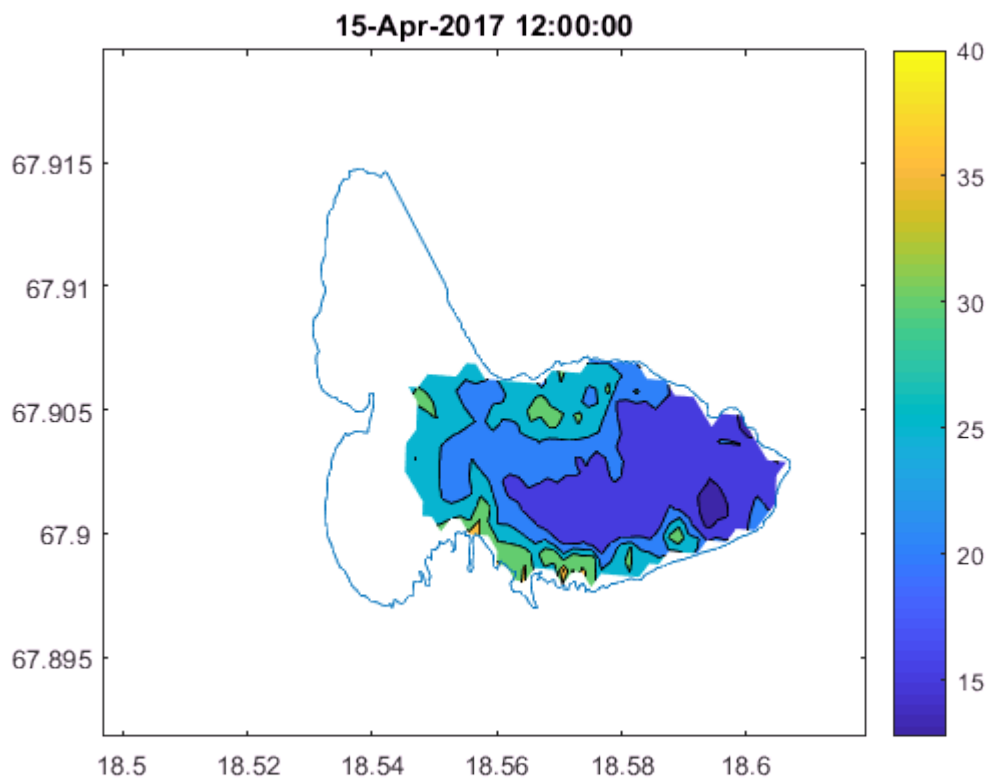
16-Dec-2016

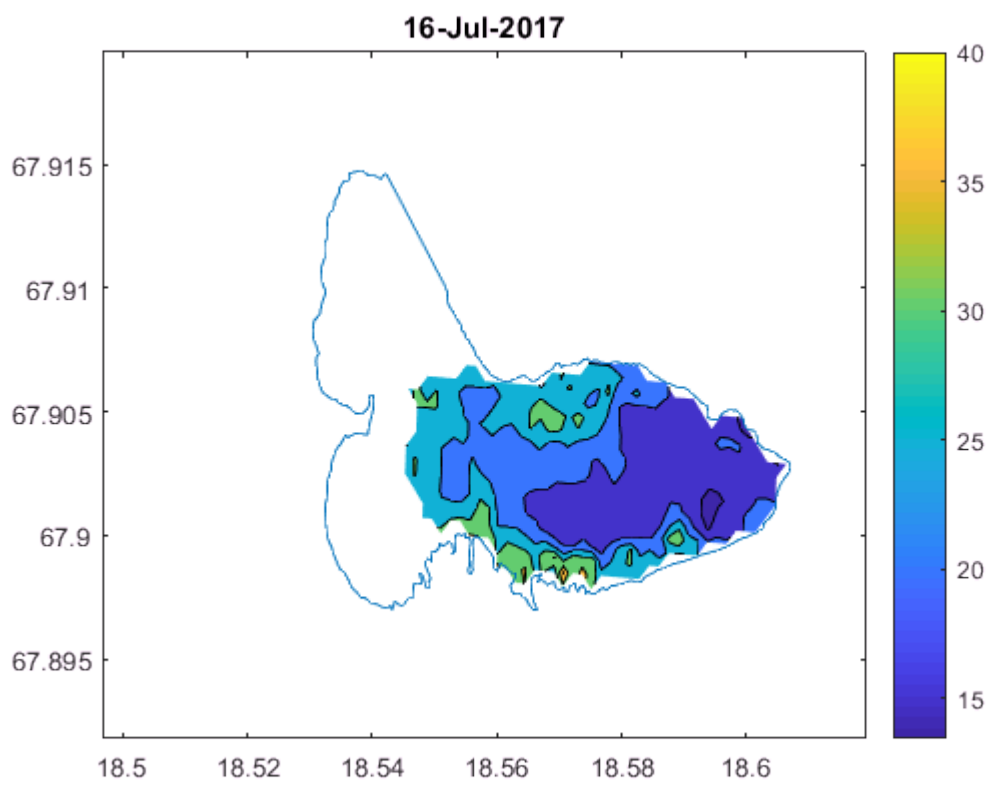
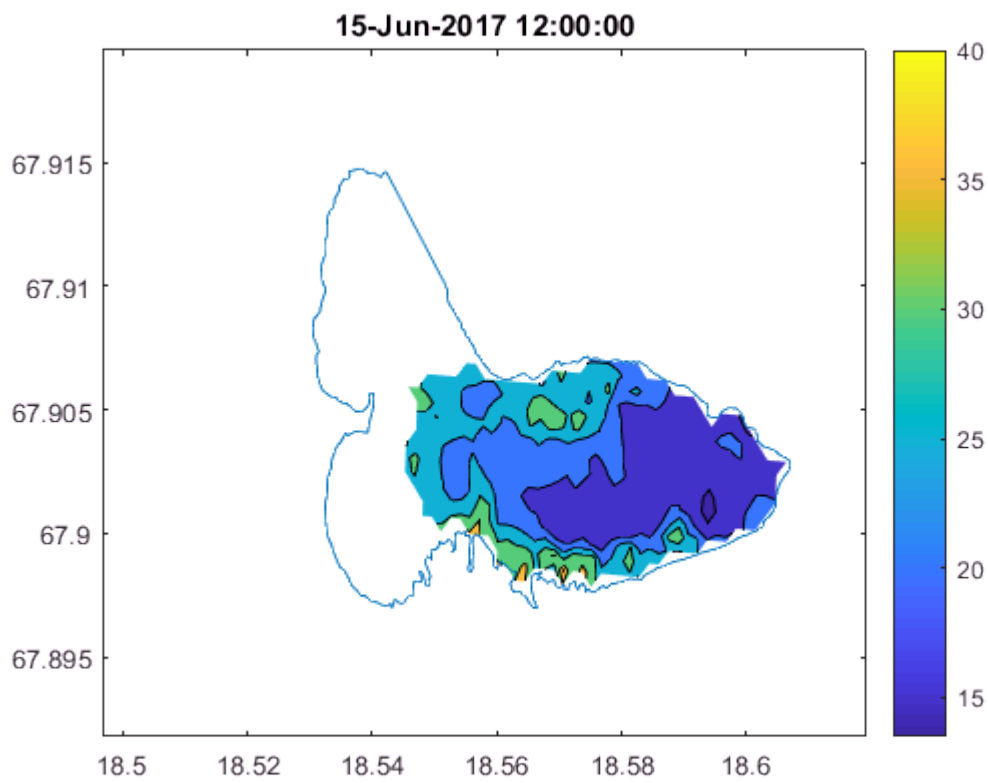


16-Jan-2017

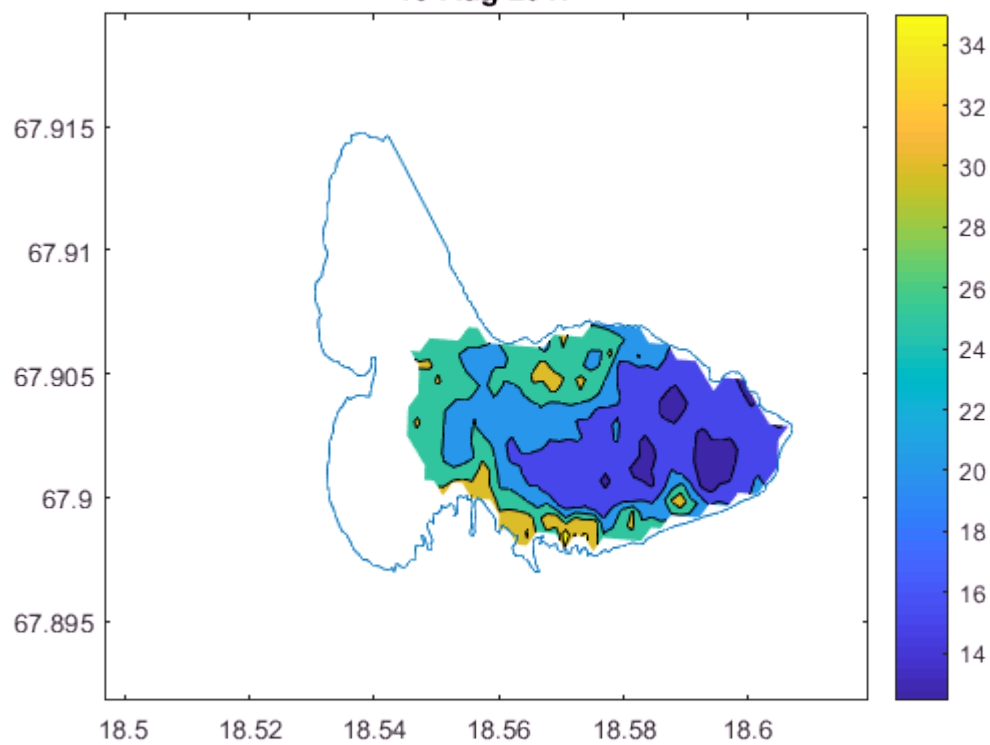




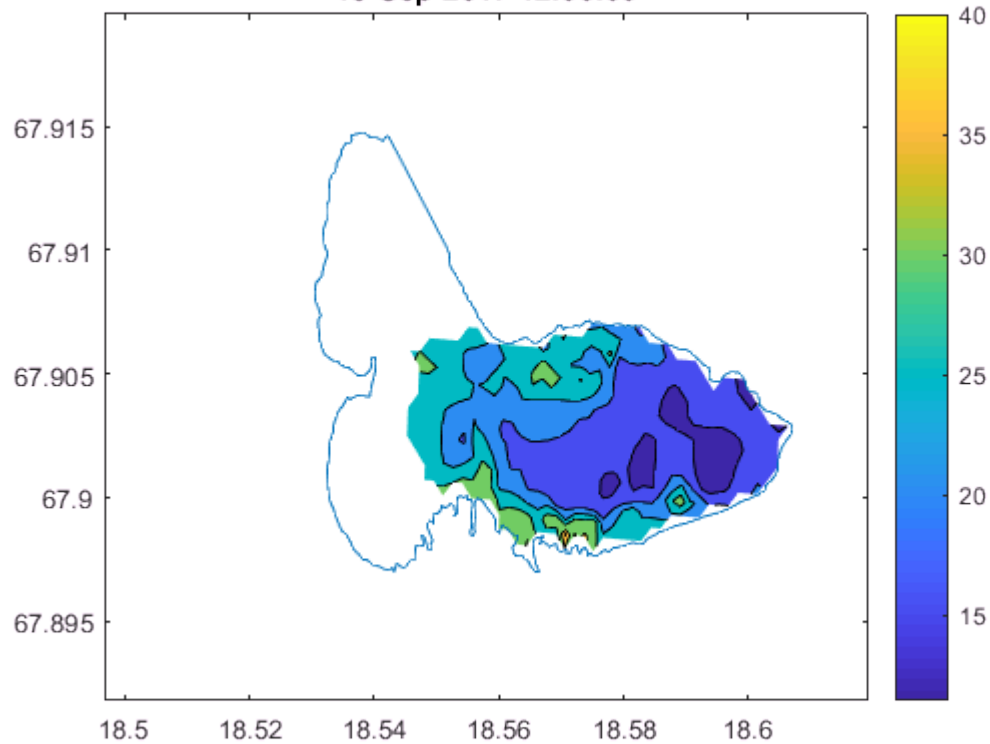




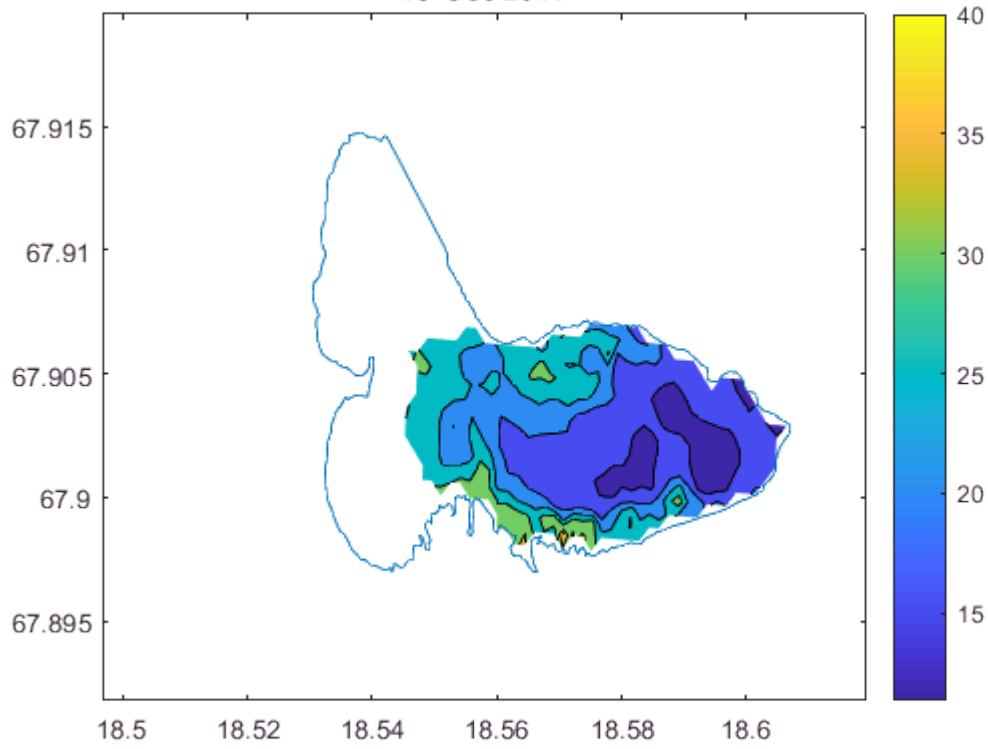
16-Aug-2017



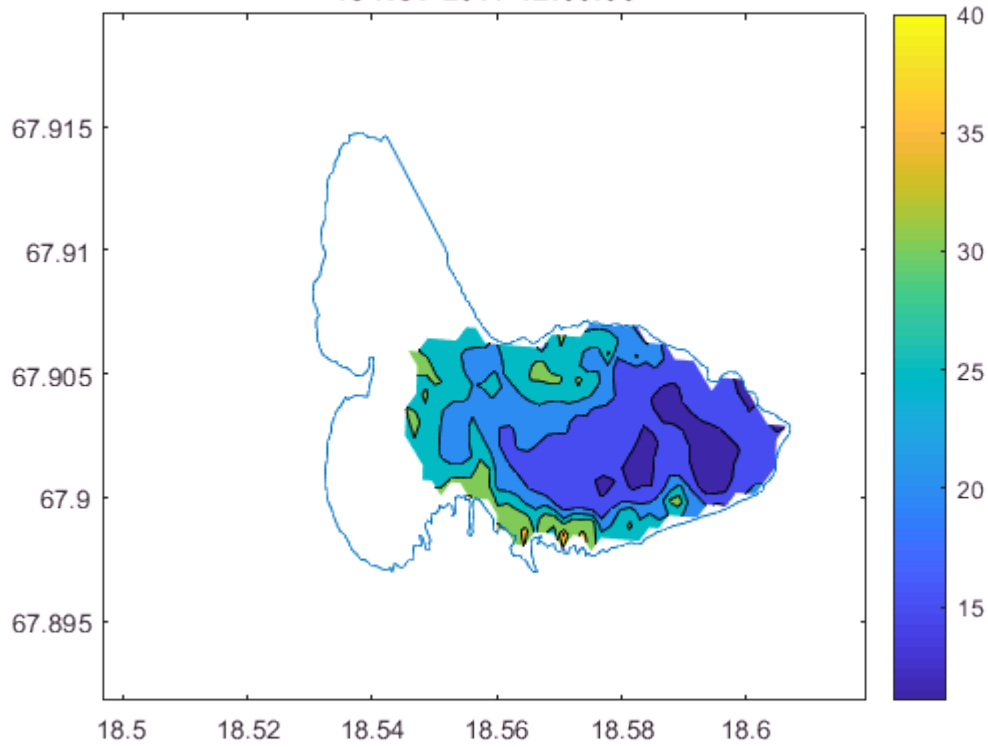
15-Sep-2017 12:00:00



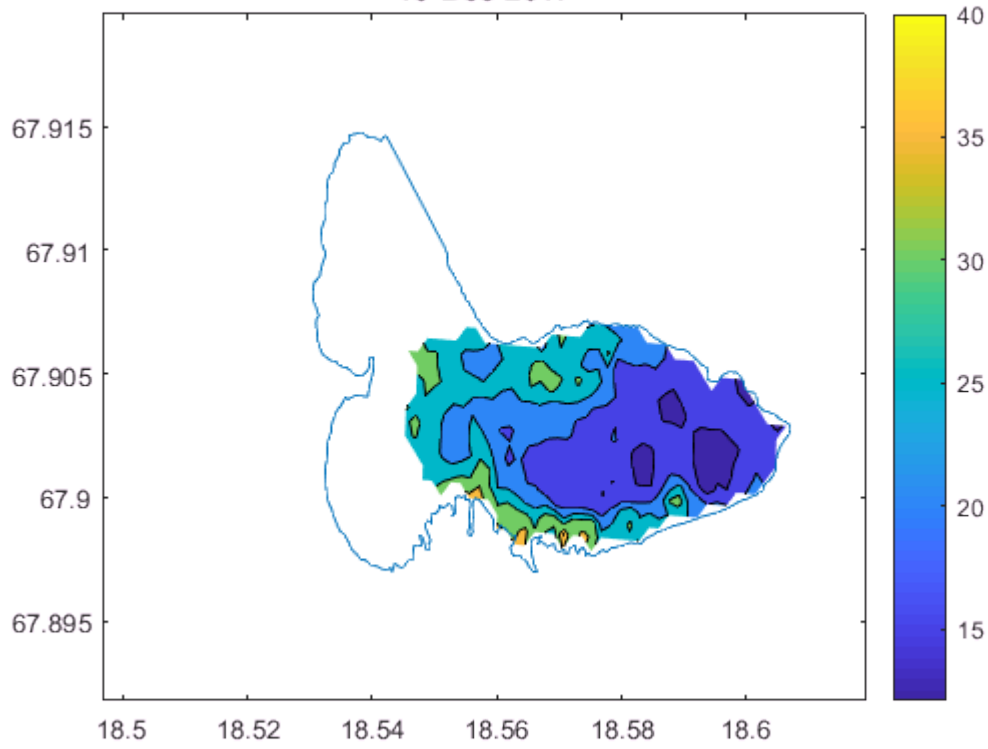
16-Oct-2017



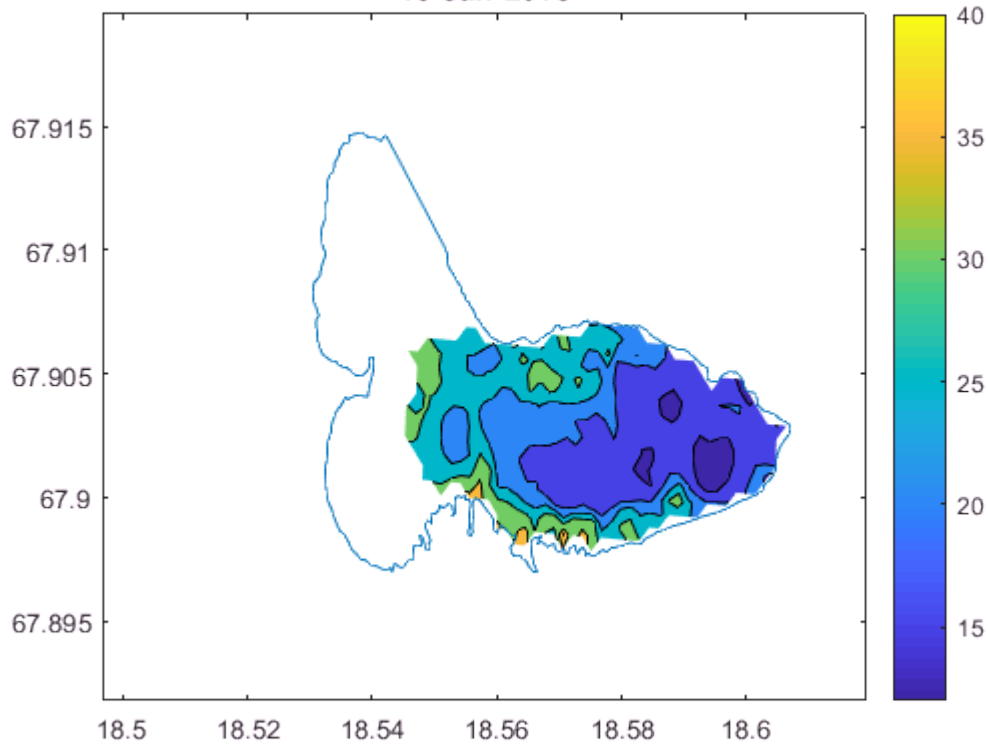
15-Nov-2017 12:00:00

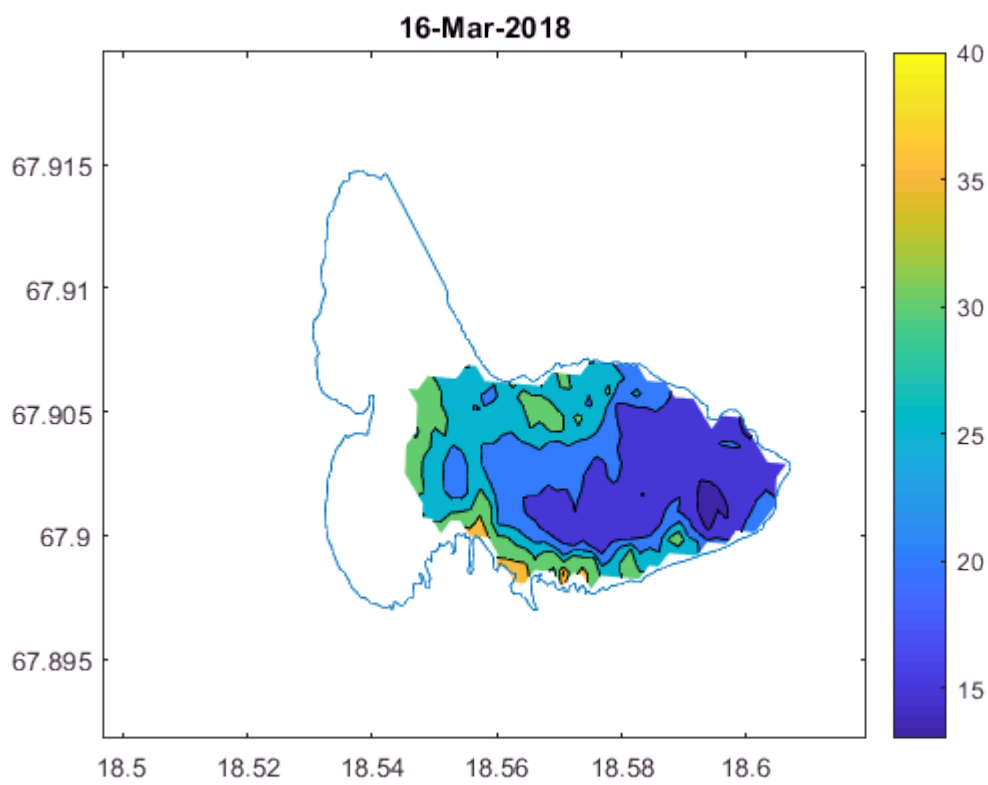
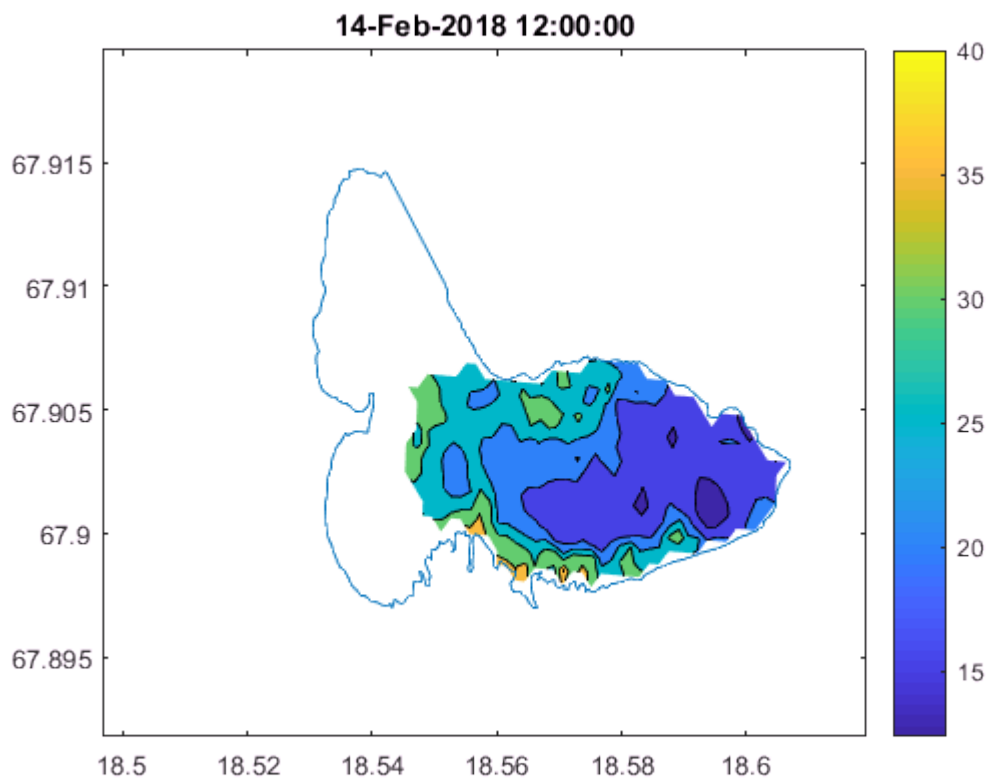


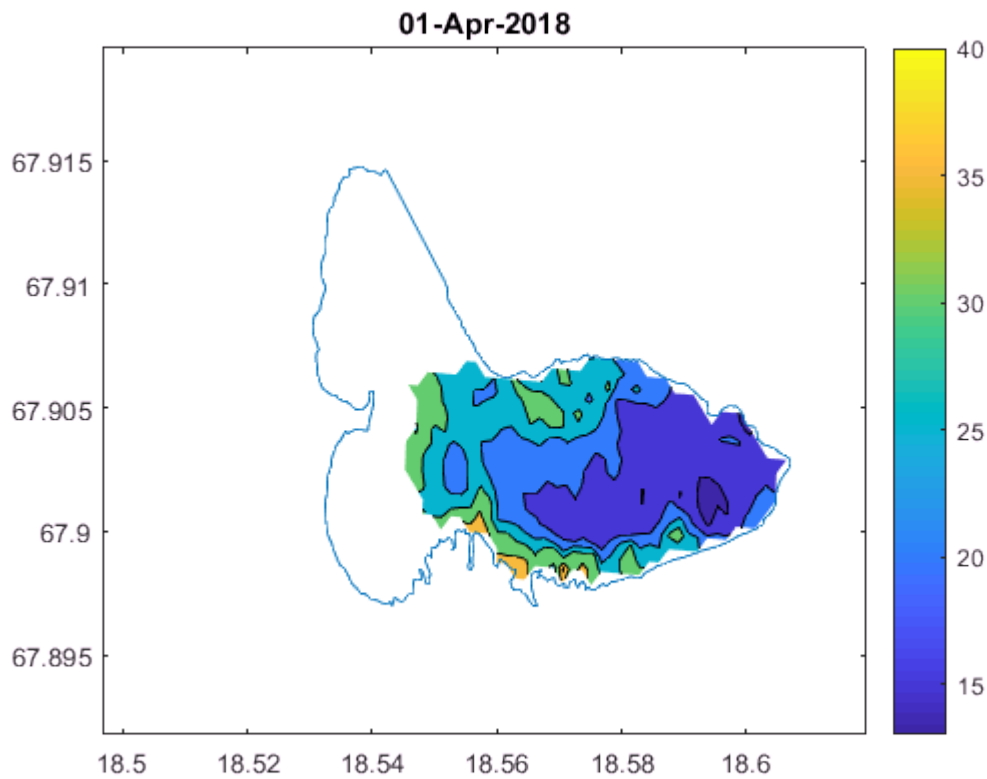
16-Dec-2017



16-Jan-2018







```
% clearvars -except 0
```

annual CTS and mass balance

mass balance is cumsum

```
[yr,mo,da] = ymd(time);
G = findgroups(yr);
datemean = splitapply(@mean,0.t(366:end),G);
datemean = datetime(datemean,'ConvertFrom','datenum');
mbalAnnual = ones(783,G(end));
CTSannual = ones(size(mbalAnnual));
for i = 1:G(end)
    index = find(G == i);
    subT = 0.subT(:,index,:);
    subZ = 0.subZ(:,index,:);
    mbal = squeeze(0.mbal(:,index,:));
    mbalAnnual(:,i) = mean(mbal,1); % yearly average mass balance
    subTmean = squeeze( mean(subT,2) );
    subZmean = squeeze( mean(subZ,2) );
    subTmean(subTmean > 0) = 0;
    loc = subTmean(:,1) == 0; % reset surface layer T=0 to -1
    subTmean(loc,1) = -1;

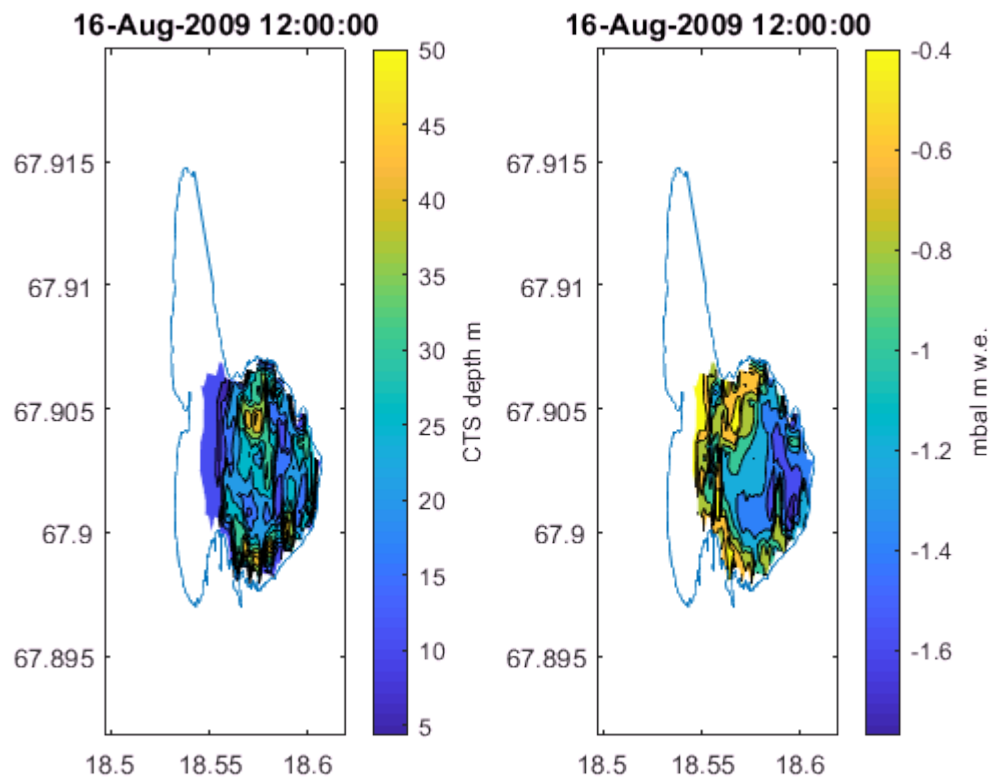
    loc = subTmean == 0; % find 0 degree in all layers
    subZmean(loc) = 0;
    CTSannual(:,i) = sum(subZmean);
%     CTS(grid.ablmask) = nan;
%     figure; scatter(grid.x_mask,grid.y_mask,10,CTS); colorbar;
map = nan(size(grid.maskfull));
map(grid.maskfull==1) = CTSannual(:,i);
```

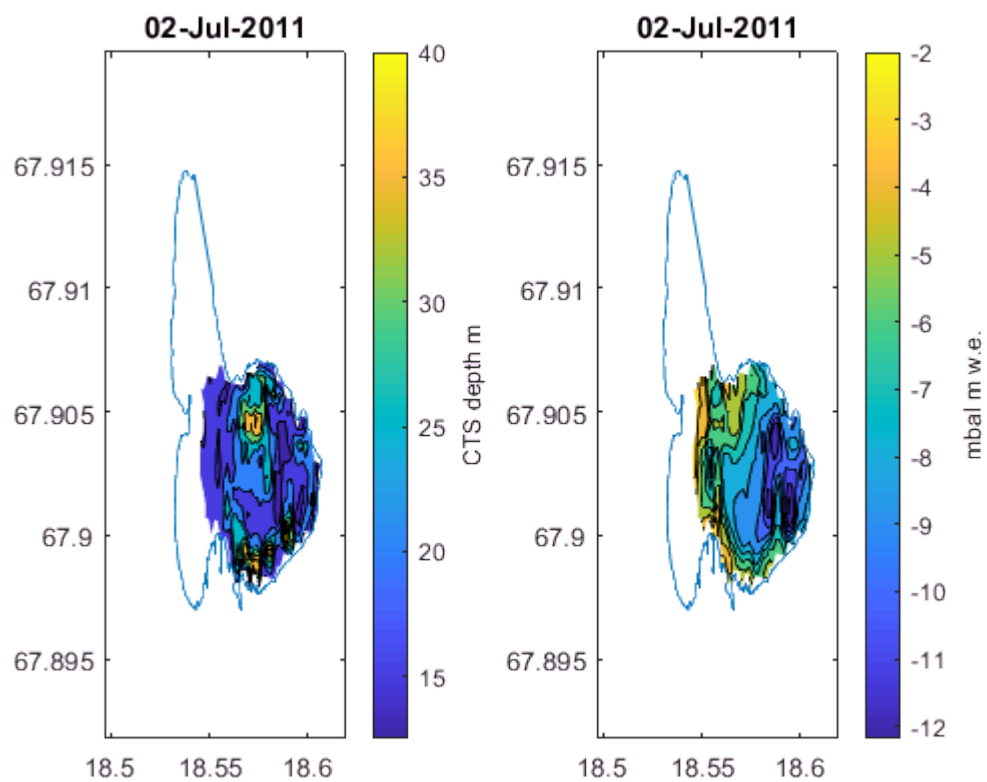
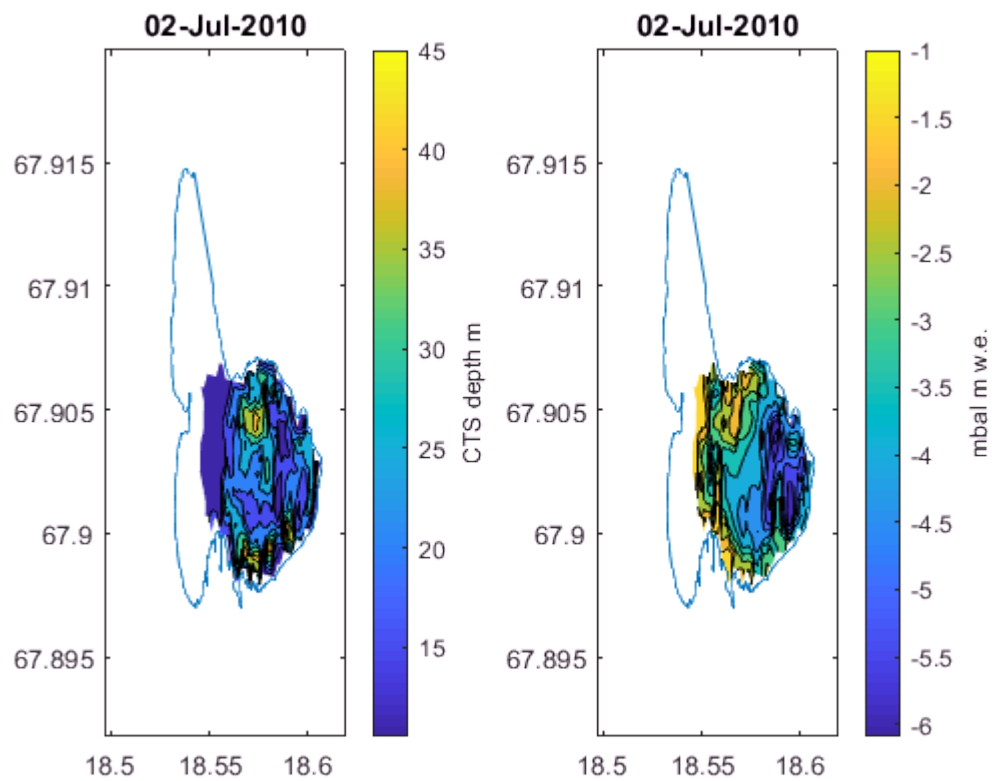


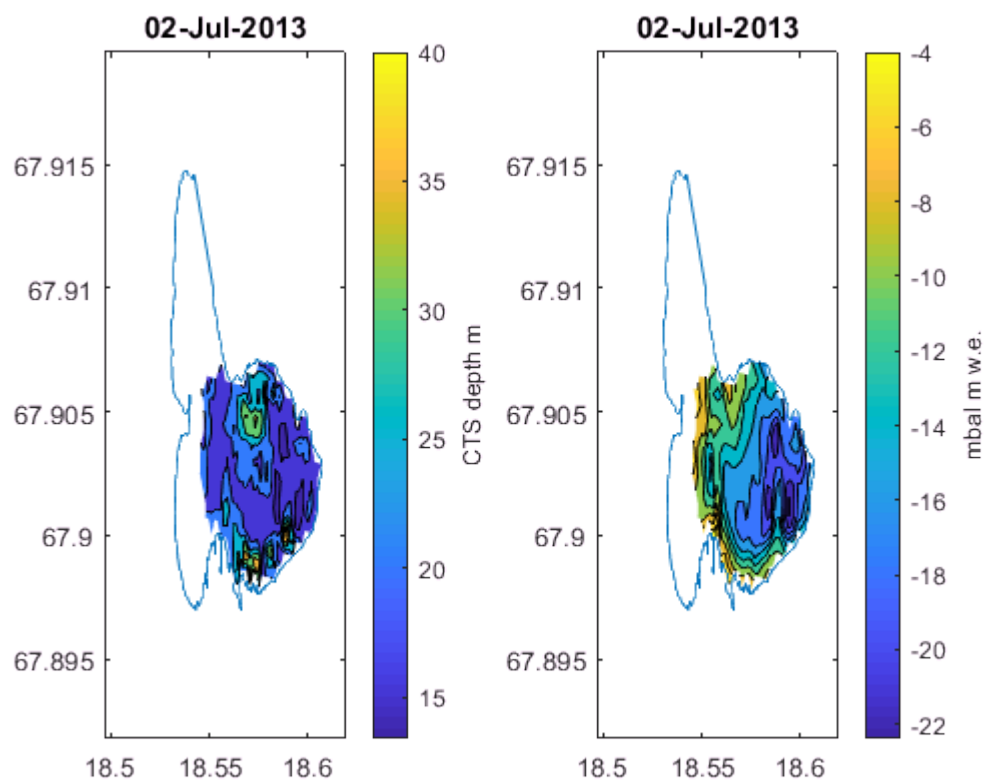
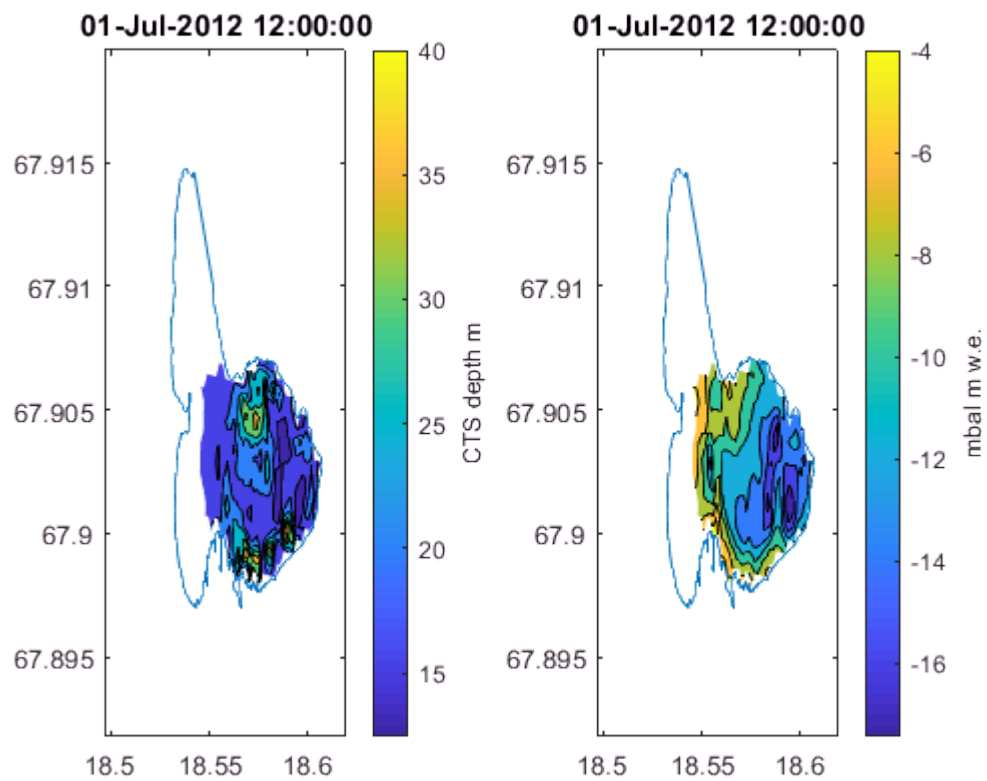
```

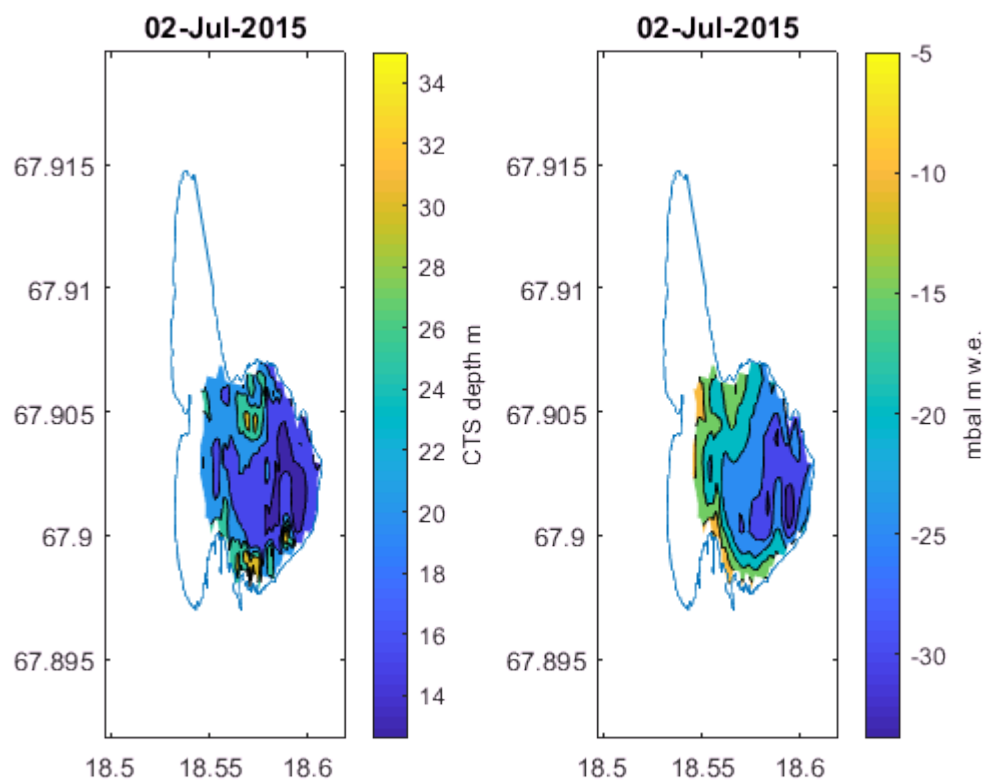
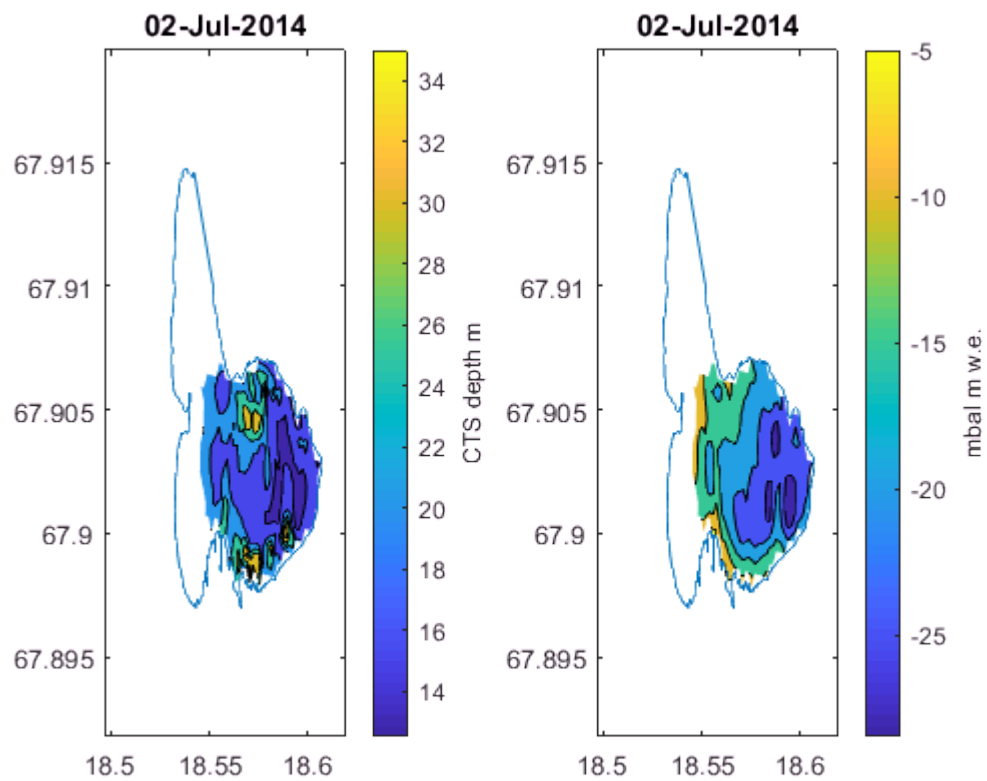
map(grid.ablmask) = nan;
figure;
% surface(grid.lon,grid.lat,grid.z,map); colorbar;
subplot(1,2,1);
contourf(grid.lon,grid.lat,map); colo = colorbar;
colo.Label.String = 'CTS depth m';
hold on;
plot(grid.Outline(:,2), grid.Outline(:,1));
hold off;
title(datestr(datemean(i)));
subplot(1,2,2);
map(grid.maskfull==1) = mbalAnnual(:,i);
map(grid.ablmask) = nan;
contourf(grid.lon,grid.lat,map); colo = colorbar;
colo.Label.String = 'mbal m w.e.';
hold on;
plot(grid.Outline(:,2), grid.Outline(:,1));
hold off;
title(datestr(datemean(i)));
end

```

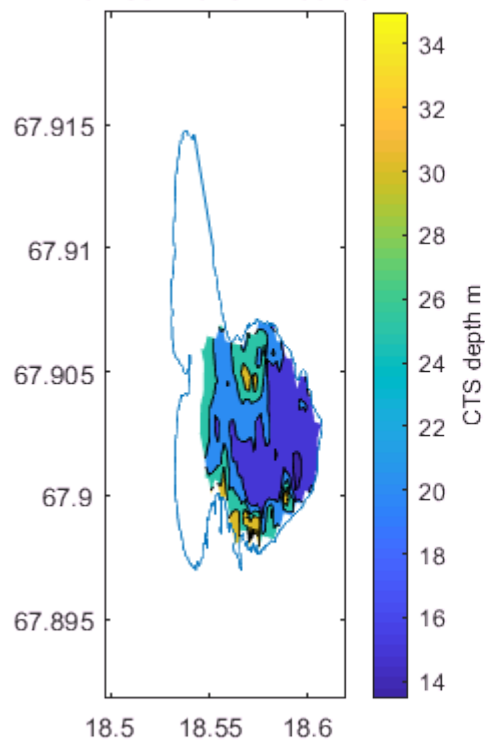




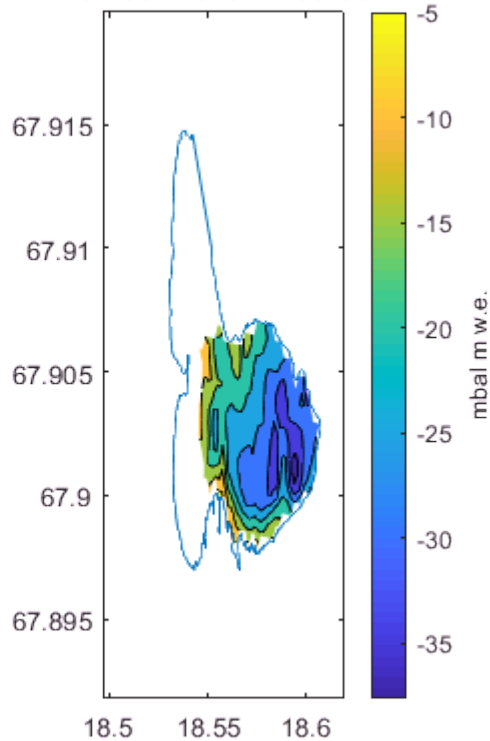




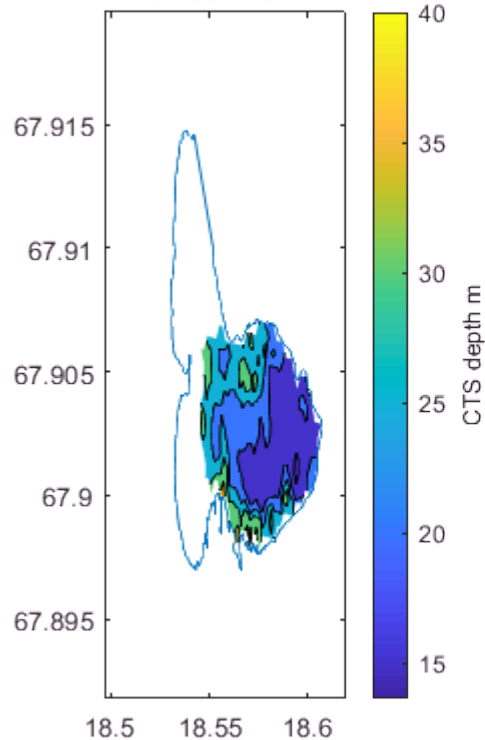
01-Jul-2016 12:00:00



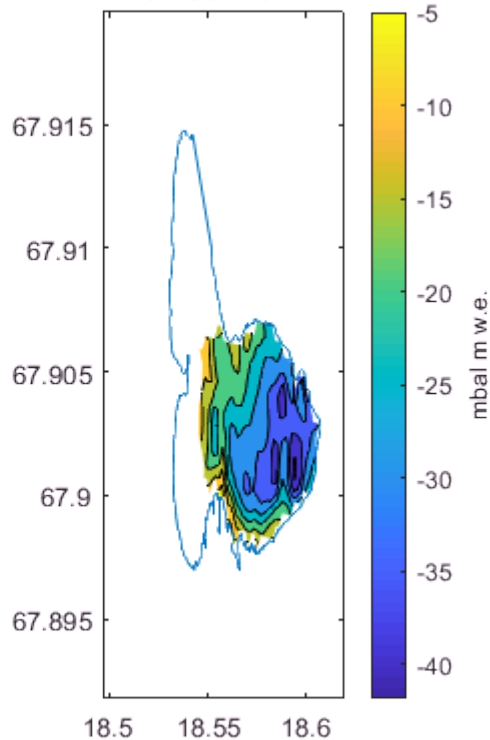
01-Jul-2016 12:00:00

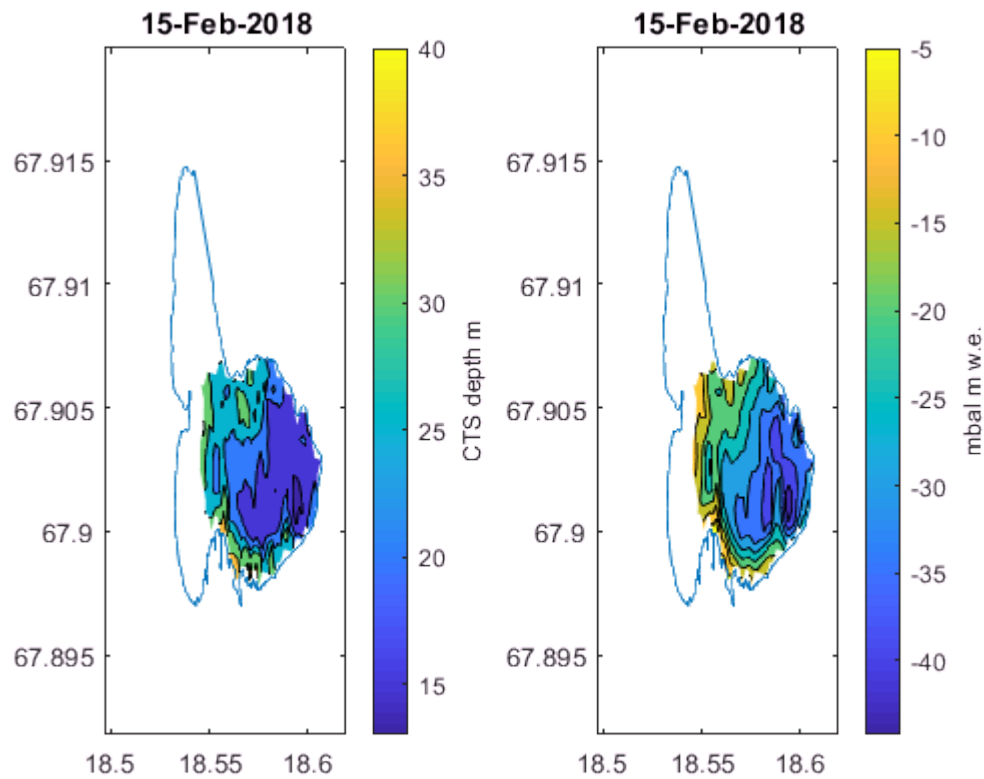


02-Jul-2017



02-Jul-2017



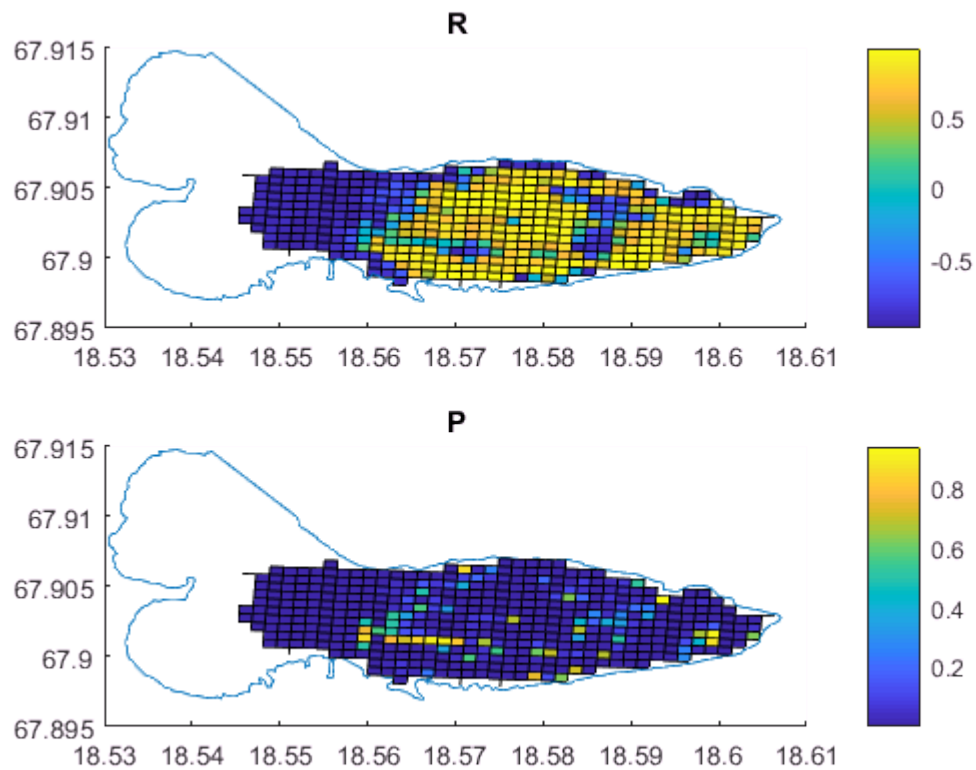


spatial correlation

cumsum mbal vs cts annual

```
R = ones(783,1);    P = ones(783,1);
for i = 1:783
    [r, p] = corrcoef(mbalAnnual(i,:), CTSannual(i,:));
    R(i) = r(2);    P(i) = p(2);
end

map = nan(size(grid.maskfull));
map(grid.maskfull==1) = R;
map(grid.ablmask) = nan;
figure;
subplot(2,1,1);
surface(grid.lon, grid.lat, map);
hold on; plot(grid.Outline(:,2), grid.Outline(:,1));
title('R');    colorbar;    hold off;
subplot(2,1,2);
map(grid.maskfull==1) = P;
map(grid.ablmask) = nan;
surface(grid.lon, grid.lat, map);
hold on; plot(grid.Outline(:,2), grid.Outline(:,1));
title('P');    colorbar;    hold off;
```

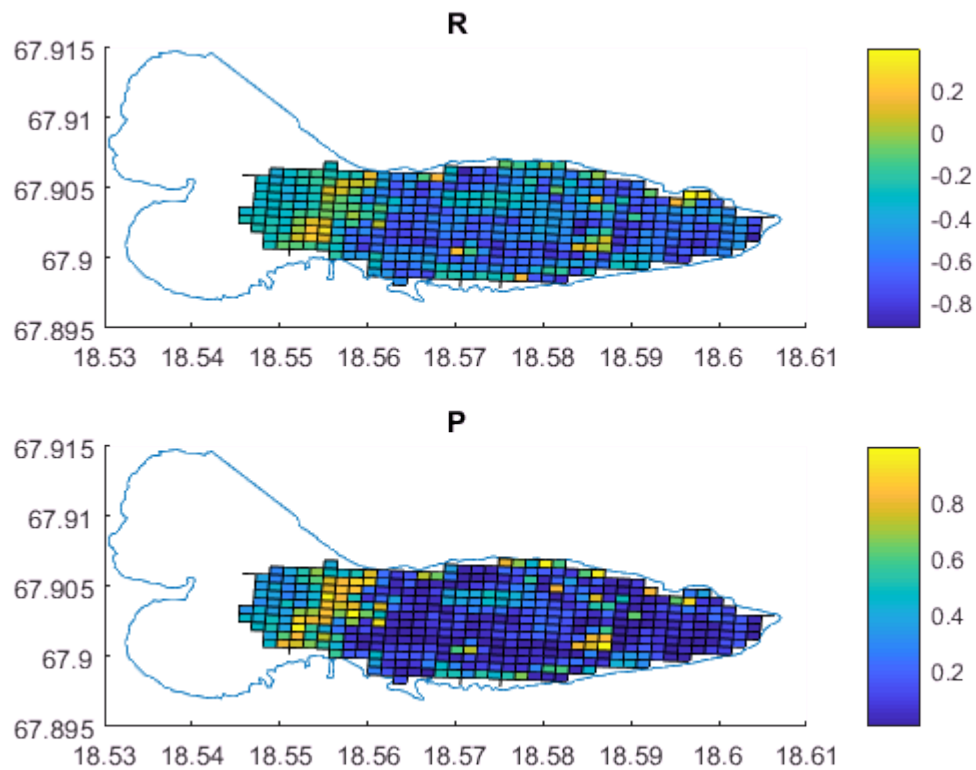


annual mbal vs cts

```
mbalAnnualR = mbalAnnual;
mbalAnnualR(:,2:end) = diff(mbalAnnual,1,2) * -1;

R = ones(783,1);    P = ones(783,1);
for i = 1:783
    [r, p] = corrcoef(mbalAnnualR(i,:), CTSannual(i,:));
    R(i) = r(2);    P(i) = p(2);
end

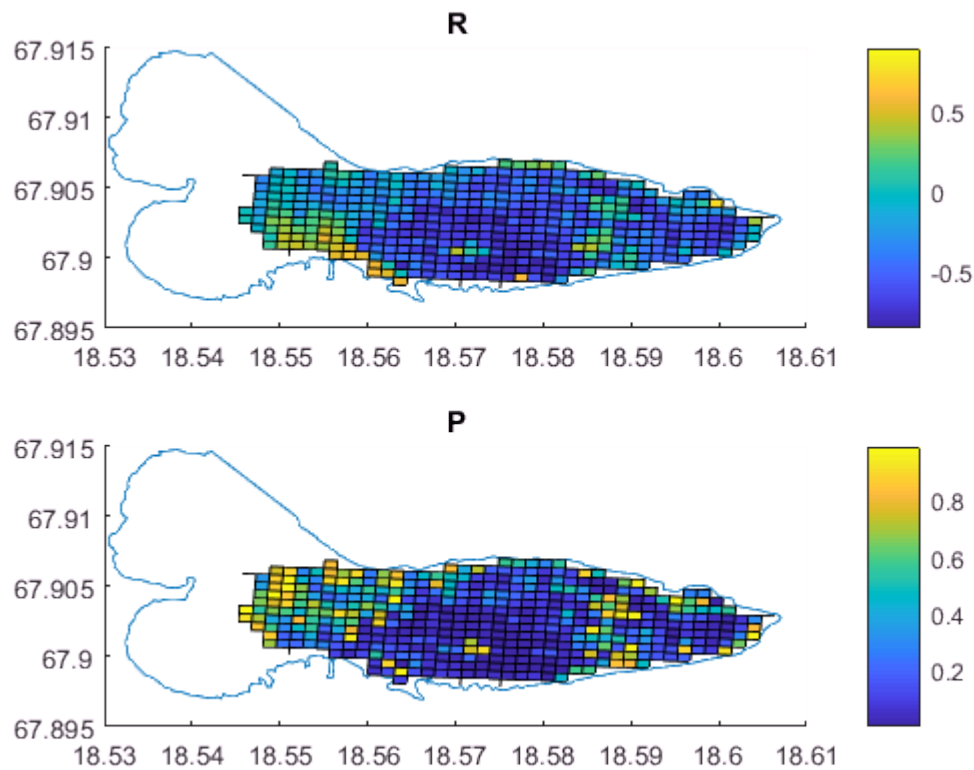
map = nan(size(grid.maskfull));
map(grid.maskfull==1) = R;
map(grid.ablmask) = nan;
figure;
subplot(2,1,1);
surface(grid.lon, grid.lat, map);
hold on; plot(grid.Outline(:,2), grid.Outline(:,1));
title('R');    colorbar;    hold off;
subplot(2,1,2);
map(grid.maskfull==1) = P;
map(grid.ablmask) = nan;
surface(grid.lon, grid.lat, map);
hold on; plot(grid.Outline(:,2), grid.Outline(:,1));
title('P');    colorbar;    hold off;
```



annual snowfall vs cts

```
snowpath = 'D:\data\Tarfala\glacier\sg_mb_output\snow\';
subsnow = dir(snowpath);
snowfall = ones(size(CTSAnnual));
for i = 3:length(subsnow)
    load([snowpath,subsnow(i).name]);
    snowGrid = griddata(snow.X,snow.Y,snow.snow,grid.lon,grid.lat,'v4');
    snowfall(:,i-2) = snowGrid(grid.maskfull == 1);
end
snowfall(:,1) = []; % remove snowfall in 2008
R = ones(783,1);    P = ones(783,1);
for i = 1:783
    [r, p] = corrcoef(snowfall(i,:), CTSAnnual(i,:));
    R(i) = r(2);    P(i) = p(2);
end

map = nan(size(grid.maskfull));
map(grid.maskfull==1) = R;
map(grid.ablmask) = nan;
figure;
subplot(2,1,1);
surface(grid.lon, grid.lat, map);
hold on; plot(grid.Outline(:,2), grid.Outline(:,1));
title('R');    colorbar;    hold off;
subplot(2,1,2);
map(grid.maskfull==1) = P;
map(grid.ablmask) = nan;
surface(grid.lon, grid.lat, map);
hold on; plot(grid.Outline(:,2), grid.Outline(:,1));
title('P');    colorbar;    hold off;
```

thermistor string

thermistor string is installed at N67.90049 E018.58180 H1320

UTM 34W 398495mE 7533754mN

```
tsX = 67.90049; tsY = 67.90049;
grid = 0.runinfo.grid;
[roiX, roiXindex] = min(abs(grid.lon_mask - tsX));
[roiY, roiYindex] = min(abs(grid.lat_mask - tsY));
% roiX = grid.x_mask(roiXindex);
% roiY = grid.y_mask(roiYindex);
% index = find(grid.x_mask == roiX & grid.y_mask == roiY);
% roiX = grid.lon_mask(roiXindex);
% roiY = grid.lat_mask(roiYindex);
subT = 0.subT(:, :, roiYindex);
subZ = 0.subZ(:, :, roiYindex);
subZ = cumsum(subZ);
time = datetime(0,t,'ConvertFrom','datenum');
[yr,mo,da] = ymd(time);
G = findgroups(yr);
datemean = splitapply(@mean,yr,G);
% datemean = datetime(datemean,'ConvertFrom','datenum');
figure; hold on
for i = 1:G(end)
    index = find(G == i);
    subTmean = mean(subT(:,index),2);
    subZmean = mean(subZ(:,index),2);
    % plot(subTmean,subZmean*-1,'DisplayName',datestr(datemean(i)));
    plot(subTmean,subZmean*-1,'DisplayName', num2str(datemean(i)));
end
```

legend