Routines to produce plots given in Choudhury and Tesche (2023) data paper

Figure 2

Read model and CALIOP data

```
clc,clear,close all
% model data
model_path = 'data\model\surface_global_models_year2011.hdf';
mlat = double(hdfread(model_path, '/lat'));
mlon = double(hdfread(model_path, '/lon'));
mCCN = read_ccn_model(model_path);
mCCN_med = nanmedian(mCCN,3);
mCCN_max = nanmax(mCCN,[],3);
mCCN_min = nanmin(mCCN,[],3);
```

```
% CALIOP data
caliop_path = 'data\CALIOPyearly\CCN_monthly_cloudfree_2011_8km.nc';
clat = double(ncread(caliop_path,'lat'));
clon = double(ncread(caliop_path,'lon'));
calt = double(ncread(caliop_path,'altitude'));
cCCN = double(ncread(caliop_path,'CCN'));
cN = double(ncread(caliop_path,'N'));
% annual average
cCCN1 = nansum(cCCN.*cN,4)./nansum(cN,4); % yearly average
% average CCN between altitudes of 0.5 and 1 km
cCCN1 = squeeze(nanmean(cCCN1(:,:,calt<1 & calt>0.5),3))';
```

Regrid model data to CALIOP grid

```
[mlong,mlatg]=meshgrid(mlon,mlat);
[clong,clatg]=meshgrid(clon,clat);
mCCN_medc = interp2(mlong,mlatg,mCCN_med,clong,clatg);
mCCN_maxc = interp2(mlong,mlatg,mCCN_max,clong,clatg);
mCCN_minc = interp2(mlong,mlatg,mCCN_min,clong,clatg);
```

Plot the global CCN maps from CALIOP and model

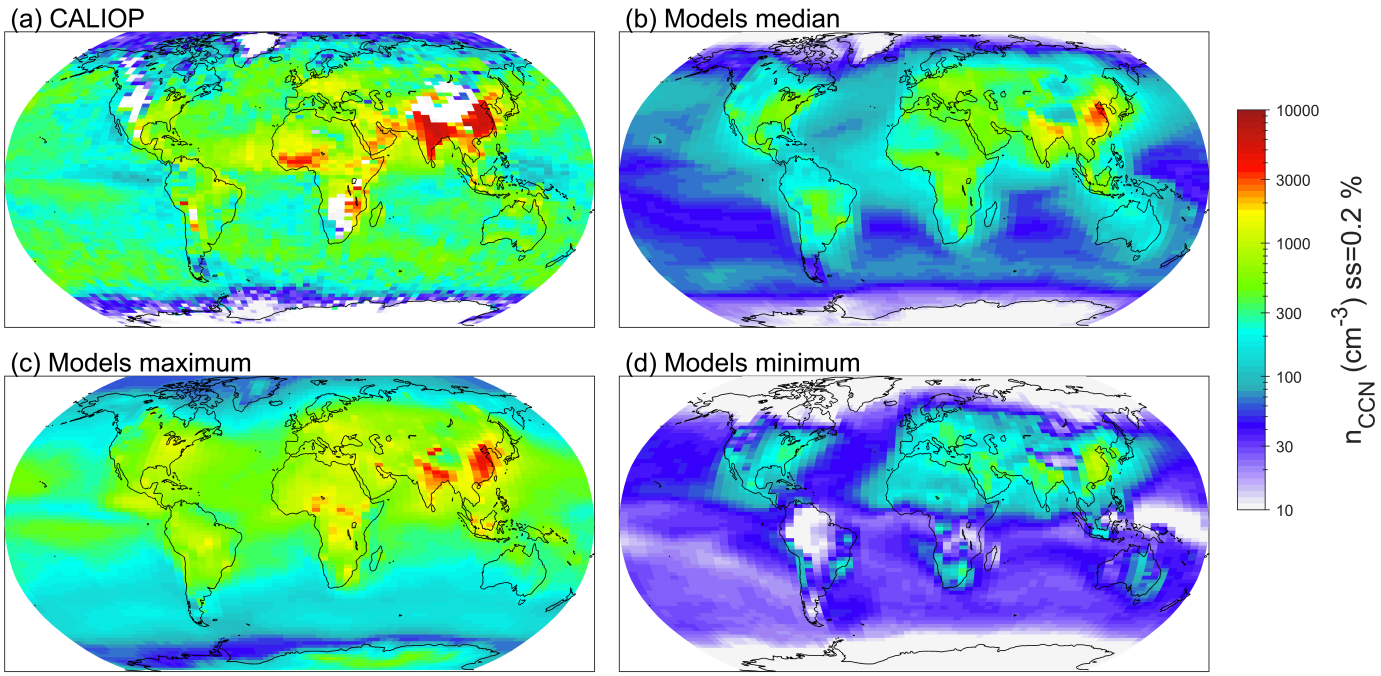
```
close all
cm = customcolormap([0,0.15,0.25,0.45,0.55,0.7,0.8,1], {'#a31d1b','#ff1300','#fffb02','#70ff00'
clims = [10,1e4];
load coastlines.mat
f1 = figure('units','centimeters','position',[1,1,28.5,14.5]);
ax1 = axes('units','centimeters','position',[0.5,7,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(clat,clon,cCCN1,'LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
```

```
colormap(cm);
colorbar('off');
% cb.TickDirection= 'both'; cb.Ticks = [100,300,1000,3000,10000];
caxis(clims)
text(0.01,1.05,'(a) CALIOP','FontSize',15,'units','normalized')

ax2 = axes('units','centimeters','position',[13,7,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(clat,clon,mCCN_medc,'LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off');
caxis(clims)
text(0.01,1.05,'(b) Models median','FontSize',15,'units','normalized')

ax3 = axes('units','centimeters','position',[0.5,0,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(clat,clon,mCCN_maxc,'LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off')
caxis(clims)
text(0.01,1.05,'(c) Models maximum','FontSize',15,'units','normalized')

ax4 = axes('units','centimeters','position',[13,0,12,7]);
axis tight
ax4a = axesm('MapProjection','robinson');
pcolorm(clat,clon,mCCN_minc,'LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
caxis(clims)
colorbar(ax4a,'off')
text(0.01,1.05,'(d) Models minimum','FontSize',15,'units','normalized')
%%%%%%%%%%%%%% colorbar %%%%%%%%%%%%%%%%%
cb = colorbar(ax4);
ylabel(cb,'n_{CCN} (cm^{-3}) ss=0.2 %','FontSize',16)
cb.TickDirection= 'both'; cb.Ticks = [10,30,100,300,1000,3000,10000];
cb.Position = cb.Position+[0.065,0.2,0,0.2];
```




```
% saveas(f1,'fig02.png')
```

Figure 3

```
clc,clear,close all
% load the climatology data
file_path = 'data\CCN_climatology_cloudfree_8km.nc';
lat = double(ncread(file_path,'lat'));
lon = double(ncread(file_path,'lon'));
altitude = double(ncread(file_path,'altitude'));
CCN = double(ncread(file_path,'CCN_cl'));
CCN_d = double(ncread(file_path,'CCN_cl_d'));
CCN_m = double(ncread(file_path,'CCN_cl_m'));
CCN_es = double(ncread(file_path,'CCN_cl_es'));
CCN_pc = double(ncread(file_path,'CCN_cl_pc'));
```

```
% altitude < 2
altid = altitude>0 & altitude<2;
% average for a altitude < 2 km
aCCN= nanmean(CCN(:,:,altid),3);
aCCN_d = nanmean(CCN_d(:,:,altid),3);
aCCN_m = nanmean(CCN_m(:,:,altid),3);
aCCN_es = nanmean(CCN_es(:,:,altid),3);
aCCN_pc = nanmean(CCN_pc(:,:,altid),3);
```

```
close all
load coastlines.mat

cm = customcolormap([0,0.15,0.25,0.45,0.55,0.7,0.8,1], {'#a31d1b','#ff1300','#fffb02','#70ff00'
```

```
clims = [10,1e4];

f1 = figure('units','centimeters','position',[1,1,25.5,21.5]);
ax0 = axes('units','centimeters','position',[6,14,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,aCCN','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off');
% cb.TickDirection= 'both'; cb.Ticks = [100,300,1000,3000,10000];
caxis(clims)
text(0.01,1.05,'(a) Total CCN','FontSize',15,'units','normalized')
%%%%%%%%%
ax1 = axes('units','centimeters','position',[0.5,7,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,aCCN_d','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off');
% cb.TickDirection= 'both'; cb.Ticks = [100,300,1000,3000,10000];
caxis(clims)
text(0.01,1.05,'(b) Dust CCN','FontSize',15,'units','normalized')

ax2 = axes('units','centimeters','position',[13,7,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,aCCN_pc','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off');
caxis(clims)
text(0.01,1.05,'(c) Polluted continental CCN','FontSize',15,'units','normalized')

ax3 = axes('units','centimeters','position',[0.5,0,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,aCCN_m','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off')
caxis(clims)
text(0.01,1.05,'(d) Marine CCN','FontSize',15,'units','normalized')

ax4 = axes('units','centimeters','position',[13,0,12,7]);
axis tight
ax4a = axesm('MapProjection','robinson');
pcolorm(lat,lon,aCCN_es','LineStyle','none')
plotm(coastlat,coastlon,'k');
```

```
set(gca,'ColorScale','log')
colormap(cm);
caxis(clims)
colorbar(ax4a,'off')
text(0.01,1.05,'(e) Elevated smoke CCN','FontSize',15,'units','normalized')
%%%%%%%%%%%%%%% colorbar %%%%%%%%%%%%%%%%
cb = colorbar(ax0);
ylabel(cb,'n_{CCN} (cm^{-3}) ss=0.2 %','FontSize',16)
cb.TickDirection= 'both'; cb.Ticks = [10,30,100,300,1000,3000,10000];
cb.Position = cb.Position+[0.065,0.0,0,0.0];
% saveas(f1,'fig03.png')
```

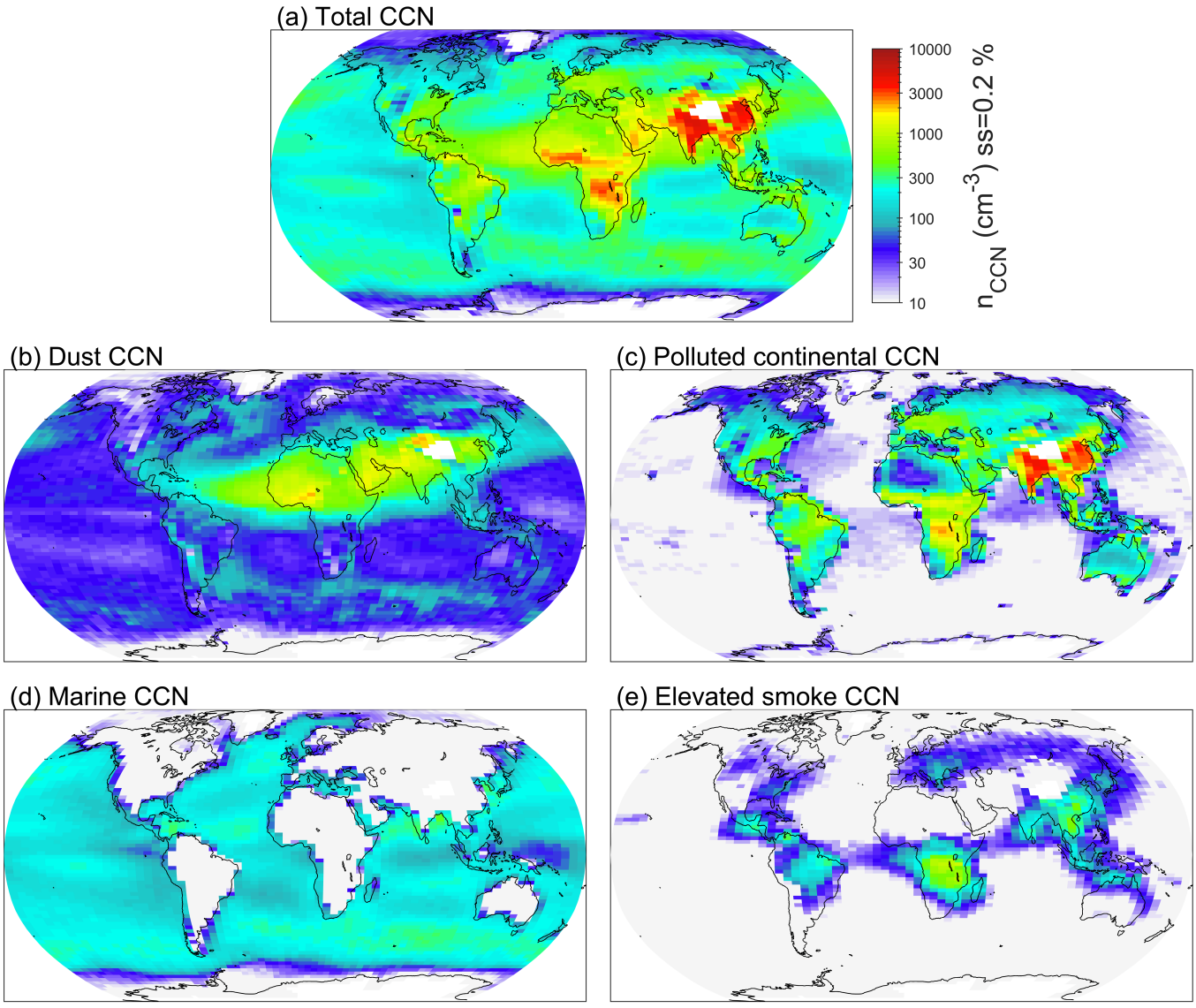


Figure 4

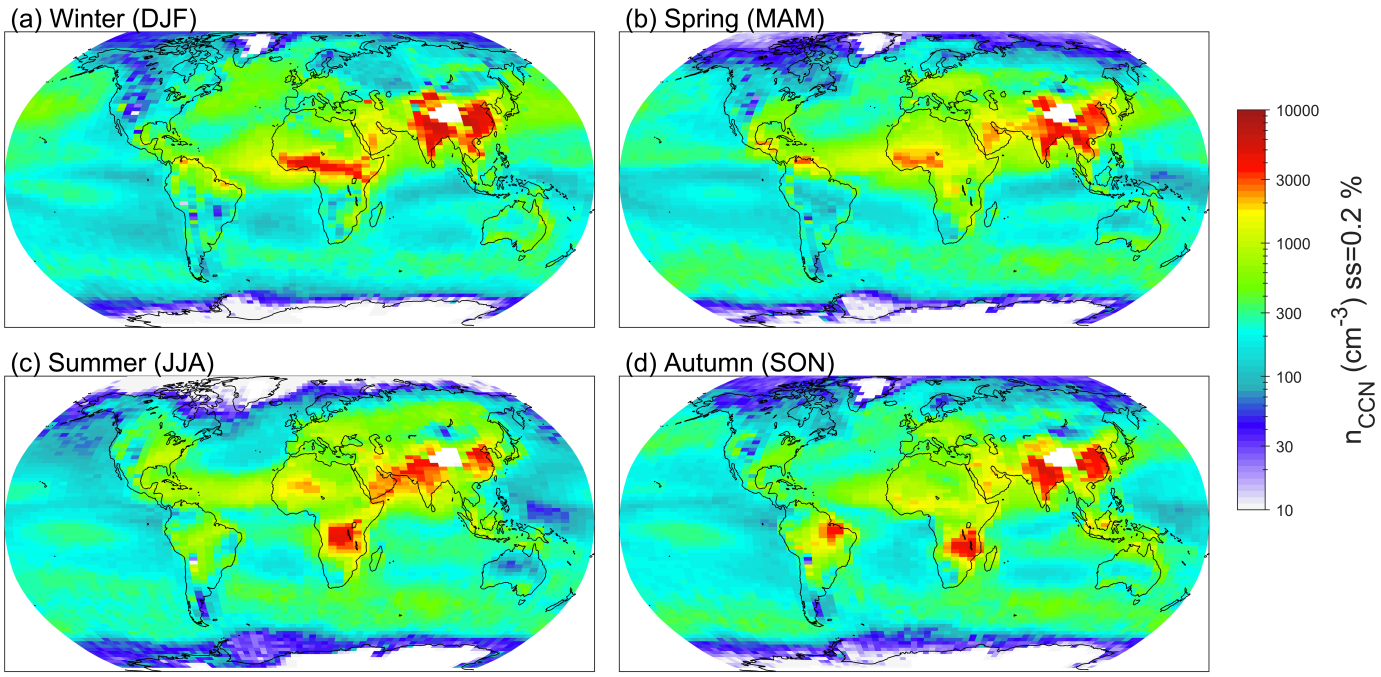
```
clc,clear,close all
% load the climatology data
file_path = 'data\CCN_climatology_cloudfree_8km.nc';
lat = double(ncread(file_path,'lat'));
```

```
lon = double(ncread(file_path,'lon'));
altitude = double(ncread(file_path,'altitude'));
nCCN_cl_sn = double(ncread(file_path,'CCN_cl_sn'));
```

```
nCCN_cl_sn_a = squeeze(nanmean(nCCN_cl_sn(:,:,altitude>0 & altitude<2,:),3));
% close all
cm = customcolormap([0,0.15,0.25,0.45,0.55,0.7,0.8,1], {'#a31d1b','#ff1300','#fffb02','#70ff00'
clims = [10,1e4];
load coastlines.mat
f2 = figure('units','centimeters','position',[1,1,28.5,14.5]);
ax1 = axes('units','centimeters','position',[0.5,7,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,squeeze(nCCN_cl_sn_a(:,:,1))','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off');
% cb.TickDirection= 'both'; cb.Ticks = [100,300,1000,3000,10000];
caxis(clims)
text(0.01,1.05,'(a) Winter (DJF)','FontSize',15,'units','normalized')

ax2 = axes('units','centimeters','position',[13,7,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,squeeze(nCCN_cl_sn_a(:,:,2))','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off');
caxis(clims)
text(0.01,1.05,'(b) Spring (MAM)','FontSize',15,'units','normalized')

ax3 = axes('units','centimeters','position',[0.5,0,12,7]);
axis tight
axesm('MapProjection','robinson');
pcolorm(lat,lon,squeeze(nCCN_cl_sn_a(:,:,3))','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
colorbar('off')
caxis(clims)
text(0.01,1.05,'(c) Summer (JJA)','FontSize',15,'units','normalized')

ax4 = axes('units','centimeters','position',[13,0,12,7]);
axis tight
ax4a = axesm('MapProjection','robinson');
pcolorm(lat,lon,squeeze(nCCN_cl_sn_a(:,:,4))','LineStyle','none')
plotm(coastlat,coastlon,'k');
set(gca,'ColorScale','log')
colormap(cm);
caxis(clims)
colorbar(ax4a,'off')
```

```
text(0.01,1.05,'(d) Autumn (SON)','FontSize',15,'units','normalized')
%%%%%%%%%%%%%%% colorbar %%%%%%%%%%%%%%%%
cb = colorbar(ax4);
ylabel(cb,'n_{CCN} (cm^{-3}) ss=0.2 %','FontSize',16)
cb.TickDirection= 'both'; cb.Ticks = [10,30,100,300,1000,3000,10000];
cb.Position = cb.Position+[0.065,0.2,0,0.2];
```