繪圖軟體應用 第16周(12/25)

M_Map

```
help m_map
```

```
m_map - mapping toolbox (Author: rich@eos.ubc.ca)
Version 1.4i  Nov 2017

You have collected your data, loaded it into Matlab, analyzed
everything to death, and now you want to make a simple map showing
how it relates to the world.

But you can't.

Instead you have to figure out how to save all your data, and
then read it into a mapping program, and then spend all that extra
time figuring out why the mapping program doesn't give you what
you expected it would...

No more!

                          Announcing M_Map v1.4!

M_Map is a set of mapping tools written for Matlab v5. These include:

   1. Routines to project data in 18 different spherical
      projections (and determine inverse mappings)
   2. A grid generation routine to make nice axes with
      limits either in long/lat terms or in planar
      X/Y terms.
   3. A coastline database (with 1/4 degree resolution)
   4. A global elevation database (1 degree resolution)
   5. Hooks into freely available high-resolution coastlines and
      bathymetry/topography.

M_Map v1.4 is available via the web at

      http://www.eos.ubc.ca/~rich/


Toolbox contents

   Contents.m    - This file
   m_demo.m      - demonstrates a few different maps.

 User-callable functions

   m_proj.m      - initializes projections
   m_coord.m     - converts between geomagnetic and geographic coords.

   m_grid.m      - draws grids
   m_scale       - forces map to a given scale.
   m_ruler       - draw a scale ruler

   m_ungrid.m    - erases map elements (if you want to change parameters)

   m_coast.m     - draws a coastline
   m_elev.m      - draws elevation data from 1 degree database
```

```
  m_tbase.m     - draws elevation data from 5-minute TerrainBase database
  m_gshhs.m     - draws coastline from GSHHS with specified resolution
  m_gshhs_c.m   - draws coastline from GSHHS crude database
  m_gshhs_l.m   - draws coastline from GSHHS low-resolution database
  m_gshhs_i.m   - draws coastline from GSHHS intermediate-resolution database
  m_gshhs_h.m   - draws coastline from GSHHS high-resolution database
  m_gshhs_f.m   - draws coastline from GSHHS full database
  m_plotbndry.m - draws a political boundary from the DCW
  m_usercoast.m - draws a coastline using a user-specified subset database.

  m_plot.m      - draws line data in map coords
  m_line.m      - draws line data in map coords
  m_text.m      - adds text data in map coords
  m_legend.m    - draws a legend box
  m_quiver.m    - draws arrows for vector data
  m_contour.m   - draws contour lines for gridded data
  m_contourf.m  - draws filled contours
  m_patch.m     - draws patch data
  m_pcolor.m    - draws pcolor data
  m_streamline.m- draws streamlines
  m_scatter.m   - draws scatter plot
  m_annotation.m- annotation lines/boxes/text

  m_track.m     - draws annotated tracklines
  m_hatch.m     - hatched or speckled patches.
  m_range_ring.m- draws range rings (spherical coords)
  m_ellipse.m   - draws tidal ellipses (most requested ocean feature!)

  m_ll2xy.m     - converts from long/lat to map coordinates
  m_xy2ll.m     - converts from map coordinates to long/lat

  m_geo2mag.m     - converts from long/lat to geomagnetic coordinates
  m_mag2geo.m     - converts from geomagnetic coordinates to long/lat

  m_lldist      - spherical distance/geodesics between points (long/lat coordinates)
  m_xydist      - spherical distance between points (map projection coordinates)

  m_fdist       - ellipsoidal geodesic forward calculation
  m_idist       - ellipsoidal geodesic inverse calculation
  m_geodesic    - points along ellipsoidal geodesics

  m_tba2b.m     - used in installing high-resolution elevation database.

  m_vec.m       - fancy arrows
  m_windbarb.m  - barbed wind arrows

  m_contfbar.m  - draws colorbars for contourf plots
  m_colmap.m    - useful perceptually uniform colourmaps.
  m_shaperead.m - reads ESRI shapefiles
  mygrid_sand2.m- reads Sandwell and Smith bathymetry file

  wysiwyg.m     - Sets figure window to match size/aspect of printed output

Internal functions (not meant to be user-callable)

  private/mp_azim.m   - azimuthal projections
  private/mp_cyl.m    - cylindrical projections (equatorial)
  private/mp_conic.m  - conic projections
  private/mp_tmerc.m  - transverse cylindrical projections
  private/mp_utm.m    - elliptical universal transverse cylindrical projections
  private/mp_omerc.m  - oblique cylindrical projection

  private/mu_util.m   - various utility routines
  private/mu_coast.m  - routines to handle coastlines.
```

```
   private/mc_coords.m - coordinate systems based on different poles.
   private/mc_ellips.m - parameters of different ellipsoidal earth models

   private/m_coasts.mat- low-res coastline data

 HTML documentation

   map.html           - Home page, examples
   private/mapug.html - User's guide
   private/*gif       - examples.


Questions or problems; email me - rich@eos.ubc.ca.

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```
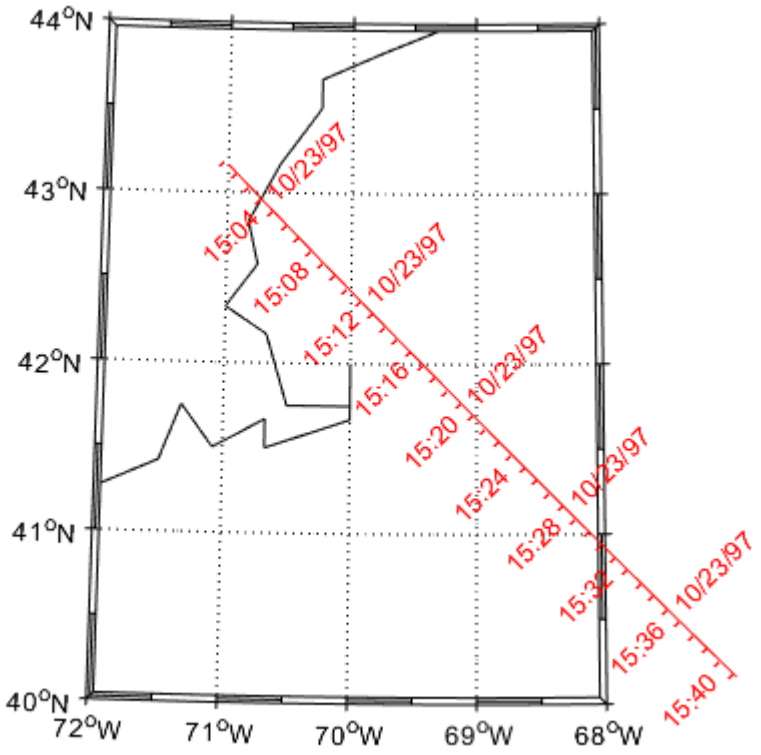

- **Drawing tracklines** 畫出航跡線

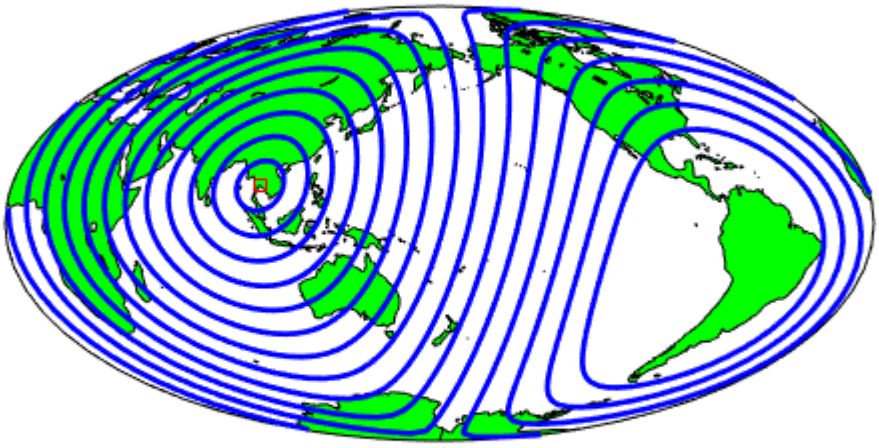
```
clear;clc
m_proj('UTM','long',[-72 -68],'lat',[40 44]);
m_coast('color','k');
m_grid('box','fancy','tickdir','out');

% fake up a trackline
lons=[-71:.1:-67];
lats=60*cos((lons+115)*pi/180);
dates=datenum(1997,10,23,15,1:41,zeros(1,41));

m_track(lons,lats,dates,'ticks',0,'times',4,'dates',8,...
    'clip','off','color','r','orient','upright');
```




```
% m_ungrid track
```

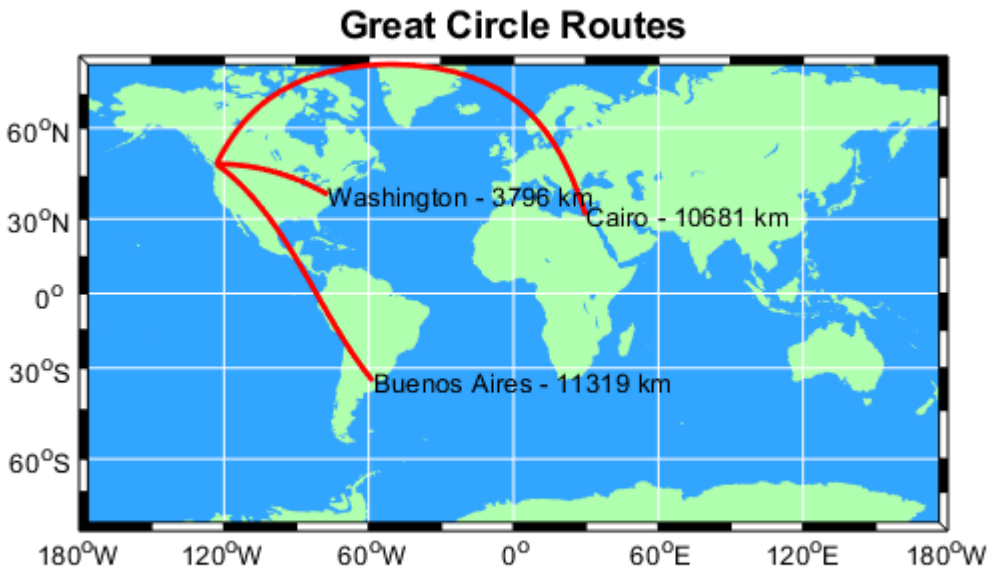
- **Drawing range rings and geodesics**

```
clf
m_proj('hammer','clong',170);
m_grid('xtick',[],'ytick',[],'linestyle','-');
m_coast('patch','g');
m_line(100.5,13.5,'marker','square','color','r');
m_range_ring(100.5,13.5,[1000:1000:15000],'color','b','linewi',2);
%從經緯(100.5,13.5)每1000公里畫一條線。畫到15000公里為止
xlabel('1000km range rings from Bangkok');
```

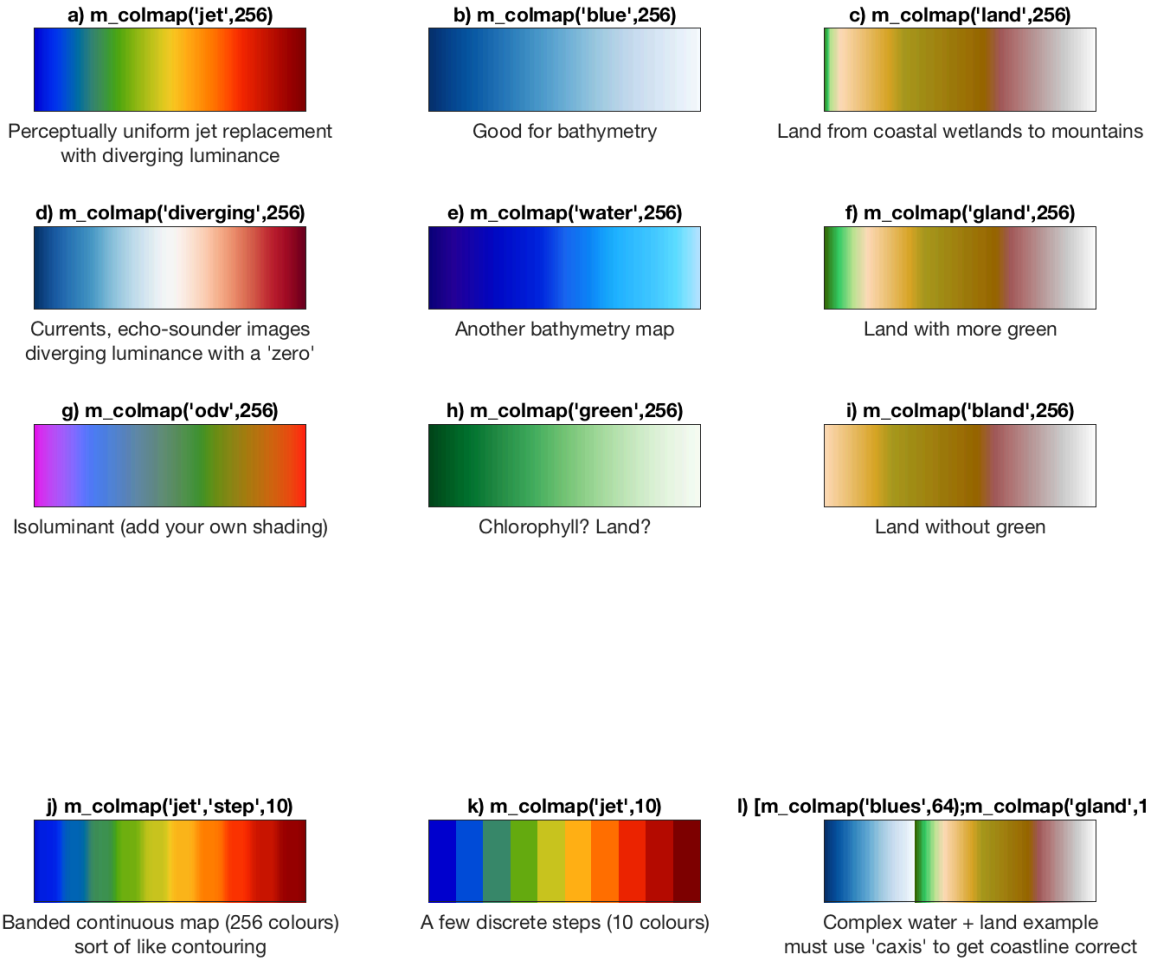


1000km range rings from Bangkok

```
clf
m_proj('miller','lat',[-77 77]);
m_coast('patch',[.7 1 .7],'edgecolor','none');
m_grid('box','fancy','linestyle','-','gridcolor','w','backcolor',[.2 .65 1]);

cities={'Cairo','Washington','Buenos Aires'};
lons=[ 30+2/60  -77-2/60   -58-22/60];
lats=[ 31+21/60  38+53/60  -34-45/60];
for k=1:3
%     [range,ln,lt]=m_lldist([121 lons(k)],[23.5  lats(k)],40);
  [range,ln,lt]=m_lldist([-123-6/60 lons(k)],[49+13/60  lats(k)],40);
  m_line(ln,lt,'color','r','linewi',2);
  m_text(ln(end),lt(end),sprintf('%s - %d km',cities{k},round(range)));
end;
title('Great Circle Routes','fontsize',14,'fontweight','bold');

set(gcf,'color','w');   % Need to do this otherwise 'print' turns the lakes black
```



- **Colour and Colourmaps**



- **Colourbars with Contourmaps**

7. Removing features from a map

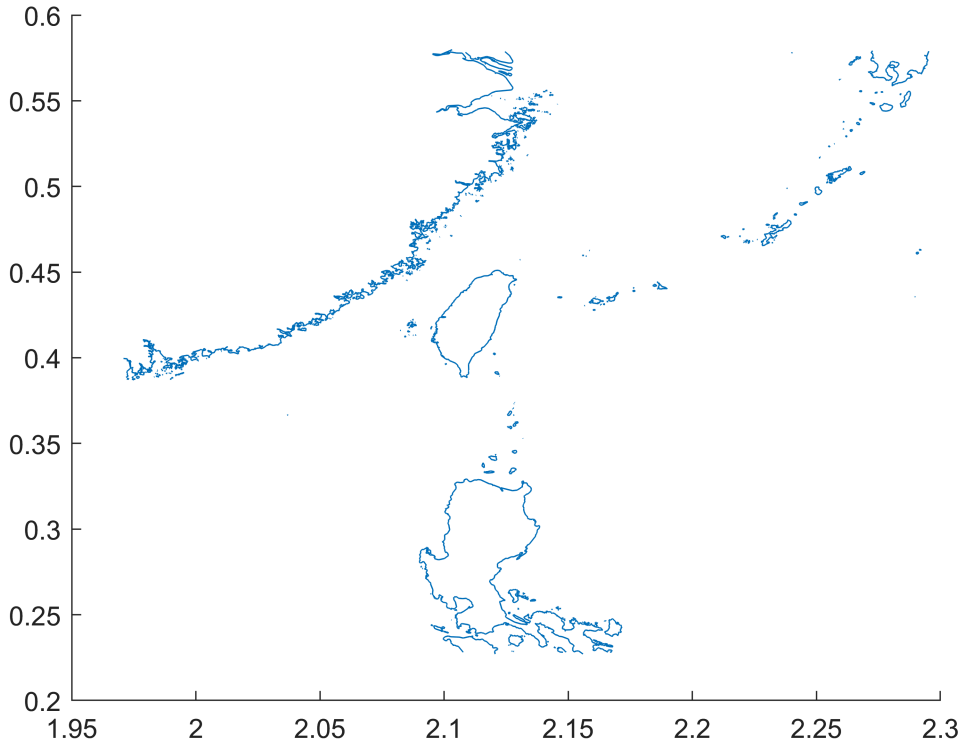
```
%nothing
%skip
```

8. Adding your own coastlines

Reading and Handling coastline data

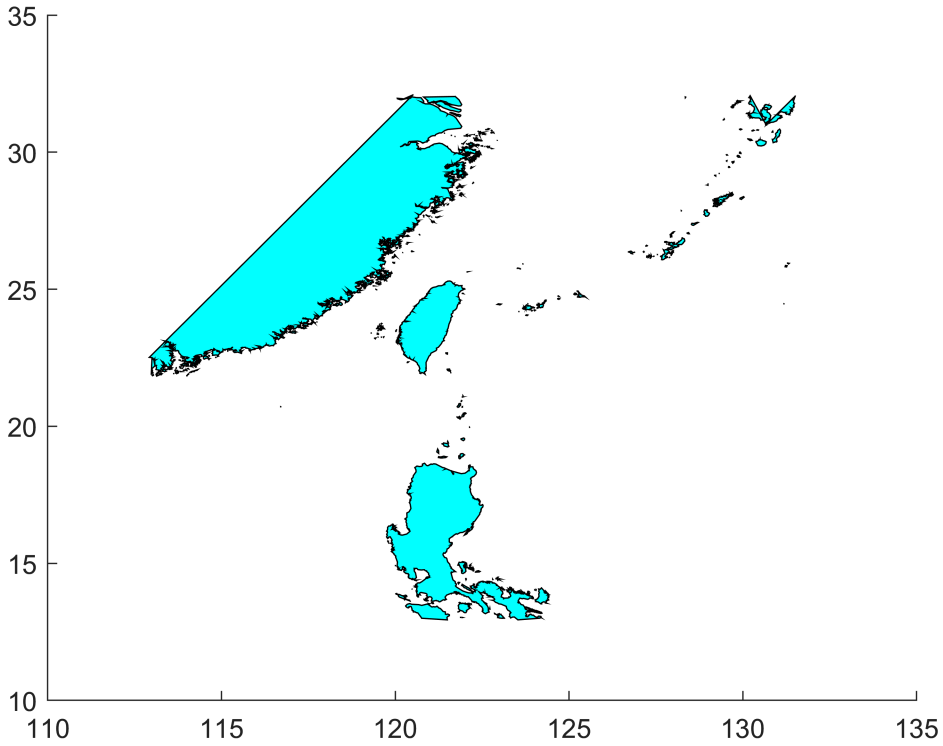
If you have data is stored in 2 columns (longitudes then latitudes, with line segments separated by a row of NaNs) in a file named "coast.dat", you can plot it (as lines) using the following:

```
clf
load taiwan_coast.dat
m_line(taiwan_coast(:,1),taiwan_coast(:,2));
```



Filled coastlines will require more work. First, if the coastline is in a number of discrete segments, you have to join them all together to make complete "islands" and "lakes". If you are lucky, (i.e. no lakes or anything else), you *may* achieve success with

```
clear;clc;clf
load taiwan_coast.dat
[X,Y]=m_ll2xy(taiwan_coast(:,1),taiwan_coast(:,2),'clip','patch');
k=[find(isnan(X(:,1)))];
for i=1:length(k)-1
     x=taiwan_coast([k(i)+1:(k(i+1)-1) k(i)+1],1);
     y=taiwan_coast([k(i)+1:(k(i+1)-1) k(i)+1],2);
     patch(x,y,'c');
end;
```



and then try replacing `patch` with `m_patch`.

- **GSHHS(G) high-resolution coastline database**

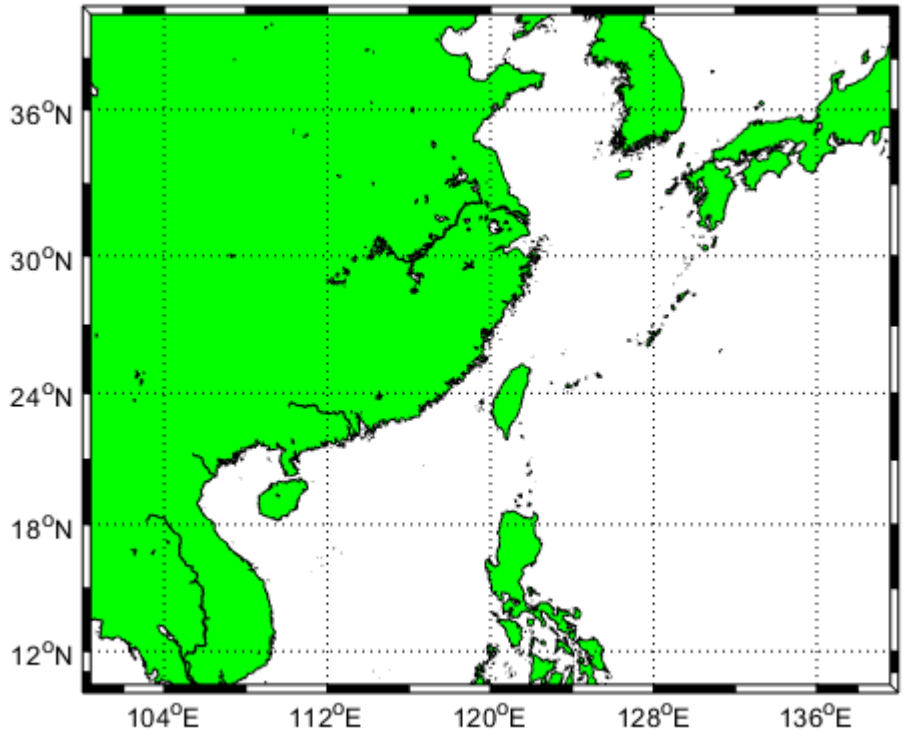
```
%               'c'  crude
%               'l'  low
%               'i'  intermediate
%               'h'  high
%               'f'  full
```

```
clf
help m_gshhs_i
```

```
  m_gshhs_i Add a coastline to a given map using the 'intermediate' resolution of
            the Global Self-consistant Hierarchical High-resolution
            Shorelines.

          m_gshhs_i( (standard line option,...,...) ) draws the coastline
          as a simple line.
          m_gshhs_i('patch' ( ,standard patch options,...,...) ) draws the
          coastline as a number of patches.

          m_gshhs_i('save',FILENAME) saves the extracted coastline data
          for the current projection in a file FILENAME. This allows
```

```
    speedier replotting using M_USERCOAST(FILENAME).

    See also m_proj, m_grid, m_coast, m_gshhs_l, m_gshhs_h, m_gshhs_c
    m_usercoast
```

```
m_proj('Mercator','lon',[100 140],'lat',[10 40])
m_gshhs_i('patch','g');
m_grid('box','fancy')
```

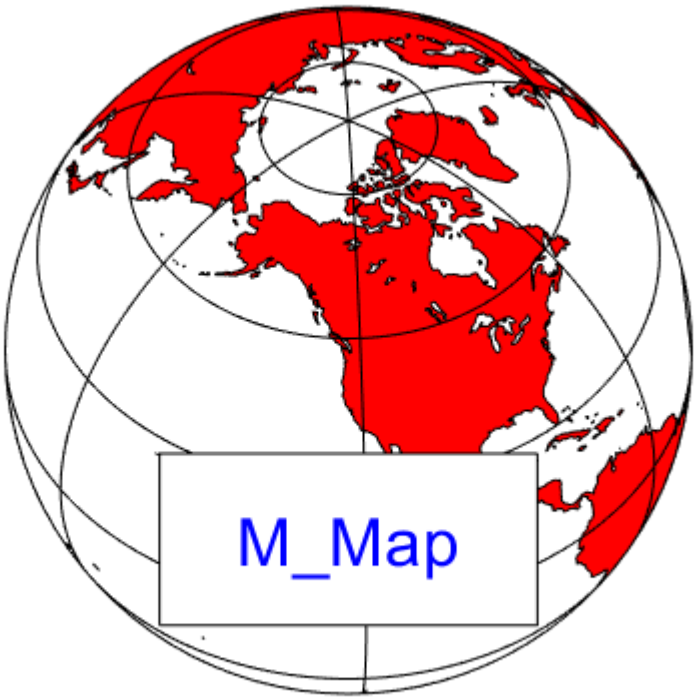


Example Code

https://www.eoas.ubc.ca/~rich/map.html#examples

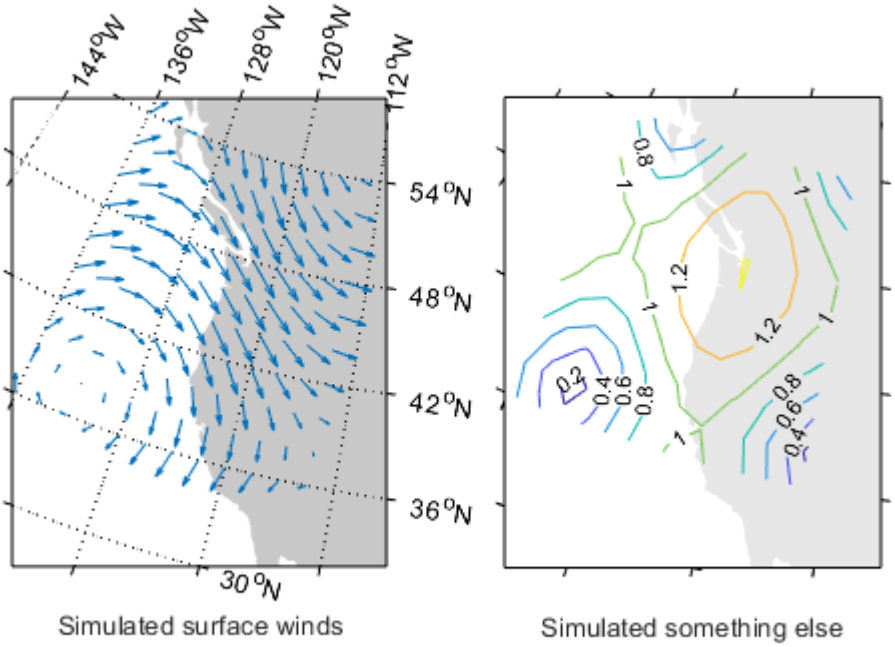
1. M_Map Logo

```
clf
m_proj('ortho','lat',48','long',-123');
m_coast('patch','r');
m_grid('linest','-','xticklabels',[],'yticklabels',[]);

patch(.55*[-1 1 1 -1],.25*[-1 -1 1 1]-.55,'w');
text(0,-.55,'M\_Map','fontsize',25,'color','b',...
    'verticalalignment','middle','horizontalalignment','center');
```



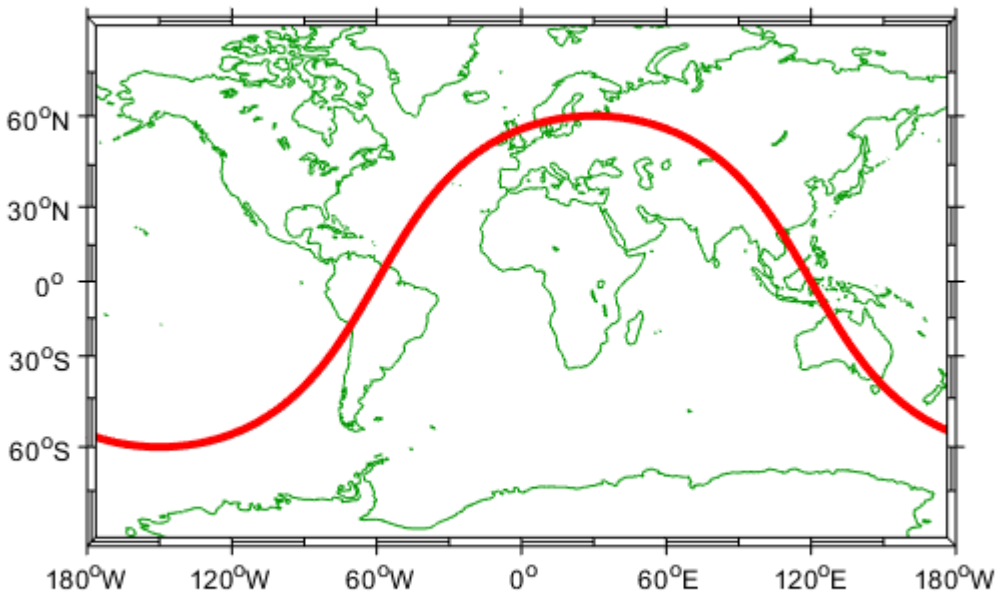
5. Oblique Mercator Projection with quiver and contour data

```
clf
%% Nice looking data
[lon,lat]=meshgrid([-136:2:-114],[36:2:54]);
u=sin(lat/6);
v=sin(lon/6);

m_proj('oblique','lat',[56 30],'lon',[-132 -120],'aspect',.8);
subplot(121);
m_coast('patch',[.8 .8 .8],'edgecolor','none');
m_grid('tickdir','out','yaxislocation','right',...
            'xaxislocation','top','xlabeldir','end','ticklen',.02);
hold on;
m_quiver(lon,lat,u,v);
xlabel('Simulated surface winds');
subplot(122);
m_coast('patch',[.9 .9 .9],'edgecolor','none');
m_grid('tickdir','out','yticklabels',[],...
              'xticklabels',[],'linestyle','none','ticklen',.02);
hold on;
[cs,h]=m_contour(lon,lat,sqrt(u.*u+v.*v));
clabel(cs,h,'fontsize',8);
xlabel('Simulated something else');
```



6. Miller Projection with Great Circle

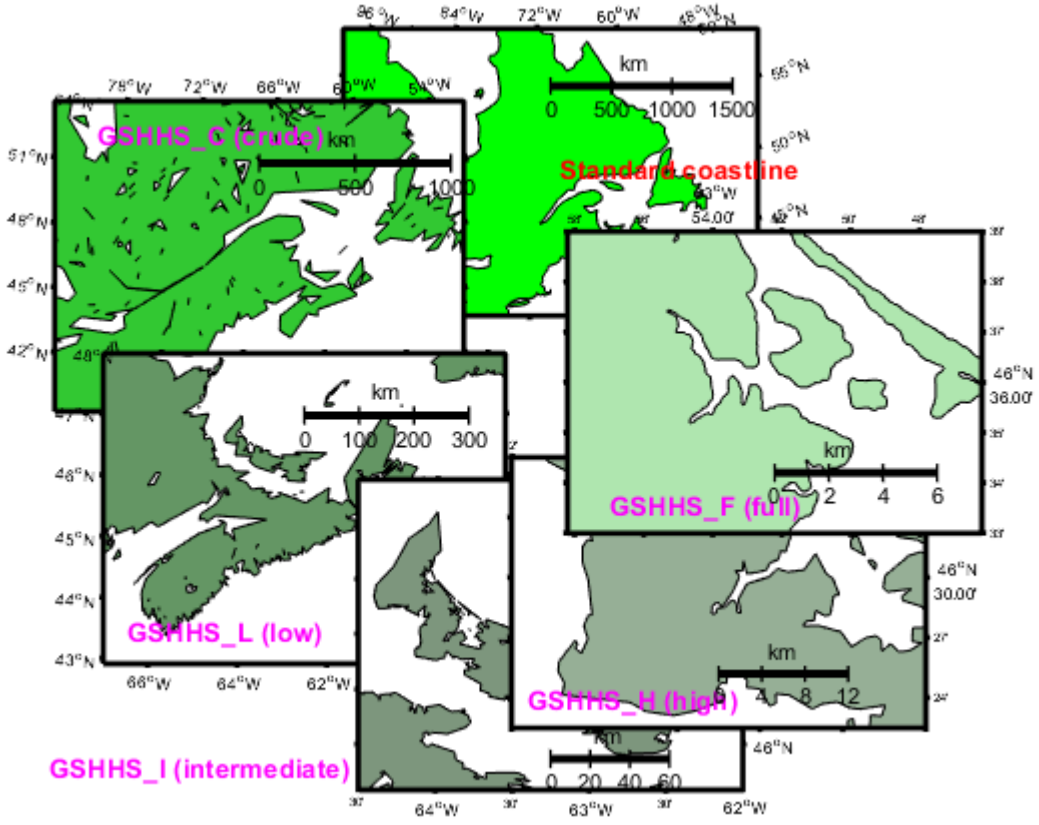
```
clear;clc;clf
% Plot a circular orbit
lon=[-180:180];
lat=atan(tan(60*pi/180)*cos((lon-30)*pi/180))*180/pi;
m_proj('miller','lat',82);
m_coast('color',[0 .6 0]);
m_line(lon,lat,'linewi',3,'color','r');
m_grid('linestyle','none','box','fancy','tickdir','out');
```



9. Zoom in on Prince Edward Island to show different coastline resolutions

```
% Example showing the default coastline and all of the different resolutions
% of GSHHS coastlines as we zoom in on a section of Prince Edward Island.

clear;clf
axes('position',[.35 .6 .37 .37]); %畫圖中圖
m_proj('albers equal-area','lat',[40 60],'long',[-90 -50],'rect','on');
m_coast('patch',[0 1 0]);
m_grid('linestyle','none','linewidth',2,'tickdir','out',...
       'xaxisloc','top','yaxisloc','right','fontsize',6);
m_text(-69,51,'Standard coastline','color','r','fontweight','bold');
m_ruler([.5 .9],.8,3,'fontsize',8)

axes('position',[.09 .5 .37 .37]); %畫圖中圖
m_proj('albers equal-area','lat',[40 54],'long',[-80 -55],'rect','on');
m_gshhs_c('patch',[.2 .8 .2]);
m_grid('linestyle','none','linewidth',2,'tickdir','out',...
       'xaxisloc','top','fontsize',6);
m_text(-80,52.5,'GSHHS\_C (crude)','color','m','fontweight','bold');
m_ruler([.5 .9],.8,2,'fontsize',8);

axes('position',[.13 .2 .37 .37]); %畫圖中圖
m_proj('albers equal-area','lat',[43 48],'long',[-67 -58],'rect','on');
m_gshhs_l('patch',[.4 .6 .4]);
m_grid('linestyle','none','linewidth',2,'tickdir','out','fontsize',6);
m_text(-66.5,43.5,'GSHHS\_L (low)','color','m','fontweight','bold');
m_ruler([.5 .9],.8,3,'fontsize',8);
```

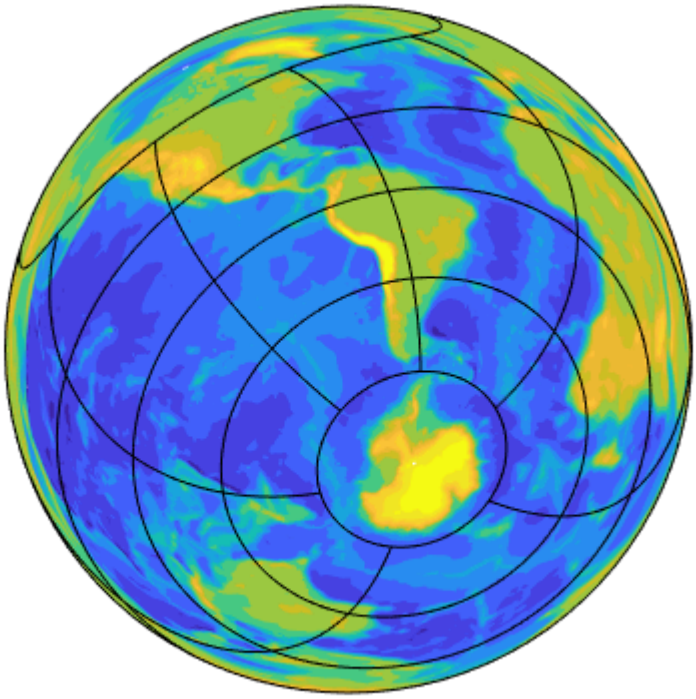
```
axes('position',[.35 .05 .37 .37]); %畫圖中圖
m_proj('albers equal-area','lat',[45.8 47.2],'long',[-64.5 -62],'rect','on');
m_gshhs_i('patch',[.5 .6 .5]);
m_grid('linestyle','none','linewidth',2,'tickdir','out',...
       'yaxisloc','right','fontsize',6);
m_text(-64.4,45.9,'GSHHS\_I (intermediate)   ','color','m',...
      'fontweight','bold','horizontalalignment','right');
m_ruler([.5 .8],.1,3,'fontsize',8);

axes('position',[.5 .1 .37 .37]); %畫圖中圖
m_proj('albers equal-area','lat',[46.375 46.6],'long',[-64.2 -63.7],'rect','on');
m_gshhs_h('patch',[.6 .7 .6]);
m_grid('linestyle','none','linewidth',2,'tickdir','out',...
       'xaxisloc','top','yaxisloc','right','fontsize',6);
m_text(-64.18,46.4,'GSHHS\_H (high)','color','m','fontweight','bold');
m_ruler([.5 .8],.2,3,'fontsize',8);

axes('position',[.55 .35 .37 .37]); %畫圖中圖
m_proj('albers equal-area','lat',[46.55 46.65],'long',[-63.97 -63.77],'rect','on');
m_gshhs_f('patch',[.7 .9 .7]);
m_grid('linestyle','none','linewidth',2,'tickdir','out',...
       'xaxisloc','top','yaxisloc','right','fontsize',6);
m_text(-63.95,46.56,'GSHHS\_F (full)','color','m','fontweight','bold');
m_ruler([.5 .8],.2,3,'fontsize',8);
```



%toolbox裡沒有m_map，會出現警告訊息

14. One Ocean Projection

```
%  This projection shows all the oceans connected to each other - the outside ring
%  is the Asian coastline (Thanks to M B-O for this idea)
% otherwise its just an example of different map types.
clear;clc;clf

m_proj('azimuthal equal-area','radius',156,'lat',-46,'long',-95,'rot',30);
m_elev('contourf',[-7000:1000:0 500:500:3000],'edgecolor','none');
% colormap(ax2,[m_colmap('blues',70);m_colmap('gland',30)]);
% caxis(ax2,[-7000 3000]);
m_grid('xticklabel',[],'yticklabel',[],'linestyle','-','ytick',[-60:30:60]);
```



Examples of satellite data manipulation

1. Global SST (or any variable on a global Lat/Long grid)

https://podaac.jpl.nasa.gov/SeaSurfaceTemperature

```
clear;clc;clf
% % NOAA/NASA Pathfinder AVHRR SST product
% % http://podaac.jpl.nasa.gov/sst/
%
% [P,map]=imread('../m_mapWK/199911h54ma-gdm.hdf');
%
% % Documentation for the 54km dataset gives
% % this formula for temperature
```

```
% P=0.15*double(P)-3; % deg C
%
% %...and defines this Lat/Long grid for the data
% Plat=90-.25-[0:359]*.5;Plon=-180+.25+[0:719]*.5;
%
% % Since the grid is rectangular in lat/long (i.e. not
% % really a projection at all, although it is included in
% % m_map under the name 'equidistant cyldindrical'), we
% % don't want to use the 'image' technique. Instead...
% % Create a grid, offsetting by half a grid point to account
% % for the flat pcolor
% [Plg,Plt]=meshgrid(Plon-0.25,Plat+0.25);
%
% m_proj('hammer-aitoff','clongitude',-150);
%
% % Rather than rearranging the data so its limits match the
% % plot I just draw it twice (you can see the join at 180W
% % because of the quirks of flat pcolor) (Note that
% % all the global projections have 360 deg ambiguities)
% m_pcolor(Plg,Plt,P);shading flat;colormap(map);
% hold on;
% m_pcolor(Plg-360,Plt,P);shading flat;colormap(map);
%
% m_coast('patch',[.6 1 .6]);
% m_grid('xaxis','middle');
%
% % add a standard colorbar.
% h=colorbar('h');
% set(get(h,'xlabel'),'string','AVHRR SST Nov 1999');
%
```

5. Meteorological data (netCDF format)

```
% clear;clf
% iday=156;   % the day to show
%
% % use ncdisp(filename) to discover file contents...
%
% lat=ncread('uwnd.10m.gauss.2017.nc','lat');
% lon=ncread('uwnd.10m.gauss.2017.nc','lon');
% [LN,LT]=meshgrid(lon,lat);
%
% mtime=ncread('uwnd.10m.gauss.2017.nc','time')/24+datenum(1800,1,1,0,0,0);
% u=ncread('uwnd.10m.gauss.2017.nc','uwnd',[1,1,iday],[192,94,1]);
% v=ncread('vwnd.10m.gauss.2017.nc','vwnd',[1,1,iday],[192,94,1]);
% prate=ncread('prate.sfc.gauss.2017.nc','prate',[1,1,iday],[192,94,1]);
%
% m_proj('miller','lon',[100 260],'lat',[0 65]);
% m_coast('patch',[.8 .8 .8]);
% hold on
% [CS,CH]=m_contourf(LN,LT,prate'*1e3,[0.05:.05:.7],'edgecolor','none');
% m_windbarb(LN,LT,u' ,v',2,'units','m/s','linewi',1,'color','r');
% hold off;
```

```
% m_grid('box','fancy','tickdir','out');
%
% ax=m_contfbar([.3 .7],.05,CS,CH);
% set(ax,'fontsize',12)
% xlabel(ax,'Mean Daily Precipitation Rate/(kg/m^2/s)');
%
% title(['North Pacific Surface Winds : ' datestr(mtime(iday))],'fontsize',16);
%
% colormap(flipud(m_colmap('Blues')))
```

6. ARGO drifter tracks (netCDF format)

7. SAR image of internal waves (HDF-5 format)