TPXO model and TMD toolbox tutorial

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Download TMD toolbox from

https://www.esr.org/research/polar-tide-models/tmd-software/

https://www.mathworks.com/matlabcentral/fileexchange/75599-tide-model-driver-tmd-version-2-5-toolbox-for-matlab

It is worth noting that TMD toolbox does not include TPXO model which are separately requested and downloaded from

https://www.tpxo.net/home

Once TMD toolbox is downloaded, unzip it and start from "TMD" folder. There are lots of useful functions. It is required to set up path for TPXO model in "TMD/DATA". Check the format in "TMD/DATA/Model_tpxo8_atlas30" that is a ASCII template which includes path and file names for grid, sea surface height, and velocity harmonic informations from TPXO. For example, I save TPXO model in "/media/jchoi/hdd1/tide/TPXO9_atlas_v5/". Create a new ASCII file of which name is set to "Model_tpxo9" in "TMD/DATA" and then the contents need to be below three lines:

/media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_*_tpxo9_atlas_30_v5

/media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_*_tpxo9_atlas_30_v5

/media/jchoi/hdd1/tide/TPXO9_atlas_v5/grid_tpxo9_atlas_30_v5

And then, make one more ASCII file for new submodel. Put path where you want to create submodel and the names. For example, I make "Model_tpxo9_YS" including below three lines:

/home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/h_tpxo9_atlas_YS

/home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS

/home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/grid_tpxo9_atlas_YS

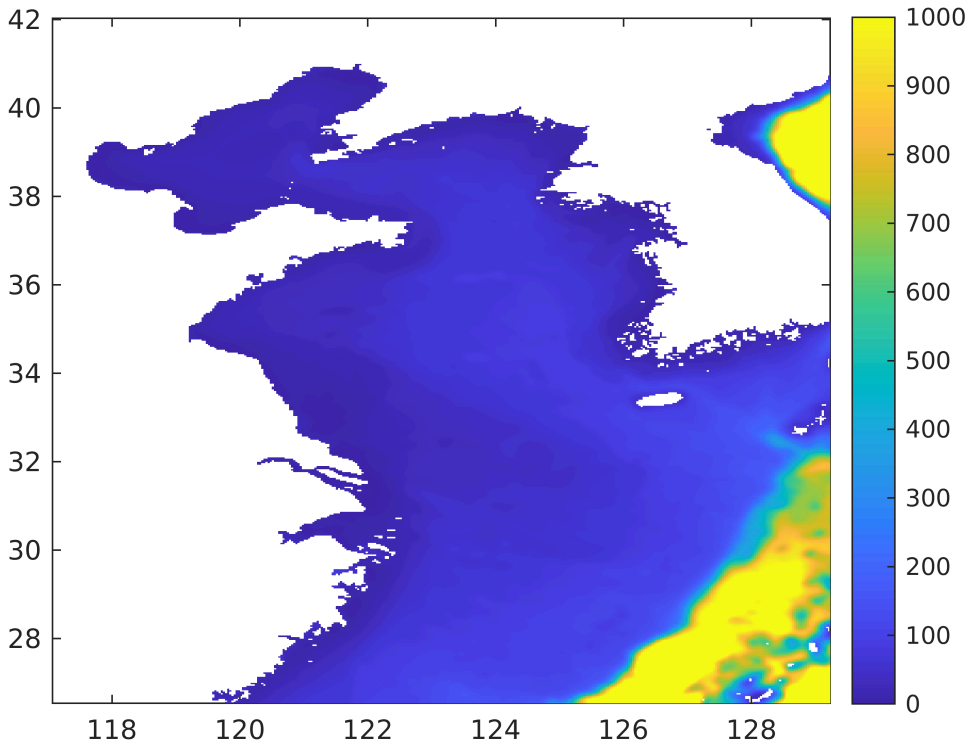
Mote to "TMD". It is usually better choice to create submodel. Download "tpxo_atlas2local.m" from https://www.tpxo.net/global/tpxo9-atlas.

```
cd TMD
ax=[117.0365  129.2650   26.5137   42.0395];

atlas_modfile='DATA/Model_tpxo9';
out_modfile='DATA/Model_tpxo9_YS';
lat_lims=ax(3:4);
lon_lims=ax(1:2);
tpxo_atlas2local(atlas_modfile,out_modfile,lat_lims,lon_lims);
```

```
Your area limits aligned to TPXO9-atlas grid are
lat:     26.517     42.050
lon:    117.050    129.250
Saving TPXO9-atlas grid outcut in /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/grid_tpxo9_atlas_YS...done

Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_2n2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_k1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_k2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_m2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_m4_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_mf_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_mm_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_mn4_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_ms4_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_n2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_o1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_p1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_q1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_s1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/h_s2_tpxo9_atlas_30_v5...done
Elevation constituents: 2n2 k1  k2  m2  m4  mf  mm  mn4 ms4 n2  o1  p1  q1  s1  s2
Saving TPXO9-atlas elevation outcut in /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/h_tpxo9_atlas_YS...don

Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_2n2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_k1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_k2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_m2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_m4_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_mf_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_mm_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_mn4_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_ms4_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_n2_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_o1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_p1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_q1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_s1_tpxo9_atlas_30_v5...done
Reading /media/jchoi/hdd1/tide/TPXO9_atlas_v5/u_s2_tpxo9_atlas_30_v5...done

Transport constituents: 2n2 k1  k2  m2  m4  mf  mm  mn4 ms4 n2  o1  p1  q1  s1  s2
Saving TPXO9-atlas transports outcut in /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS...do
```

Three files (listed in "Model_tpxo9_YS") are created, that is cropped submodel. Now, it is ready to use TPXO model. Below are several examples to use TMD toolbox.

```
% get grid and bathymetry
clc;clear;
[x,y,h]=tmd_get_bathy('DATA/Model_tpxo9_YS');
[xx,yy]=meshgrid(x,y);
h(h==0)=nan;
pcolor(xx,yy,h)
shading flat
colorbar
caxis([0 1000])
```




```
% get velocity field in specific time
t=datenum([2013 1 1 12 0 0])
```

```
t = 7.3524e+05
```

```
[u,~]=tmd_tide_pred('DATA/Model_tpxo9_YS',...
    t,yy,xx,'u',[]); u=u/100; %cm/s->m/s
```

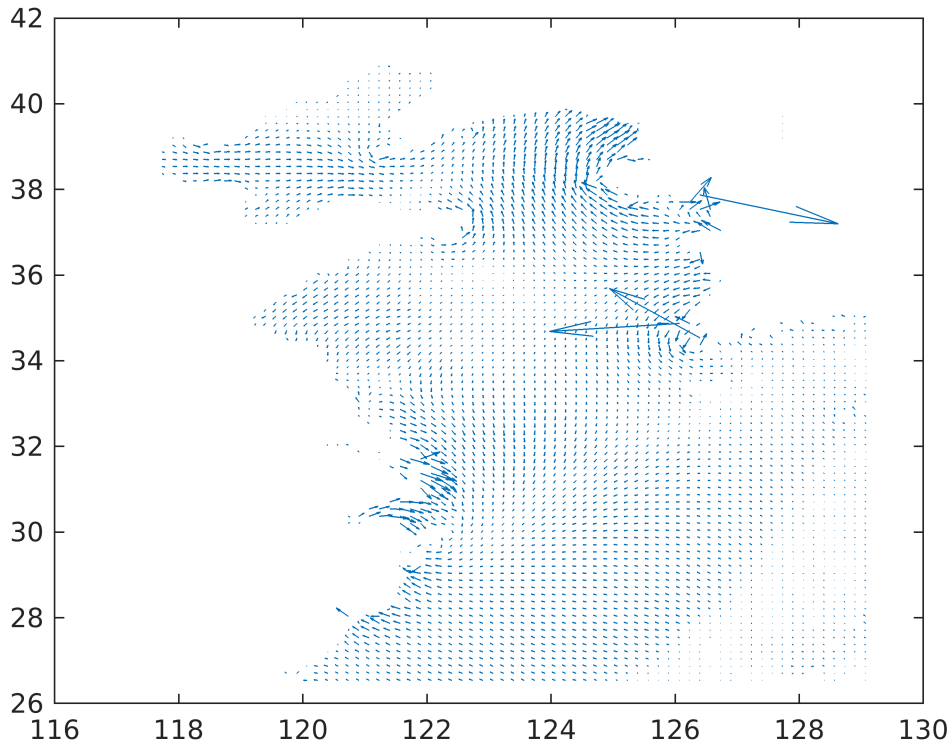
```
MODE: Map
Reading /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS and extracting HC...
Interpolating constituent 2n2 ...done
Interpolating constituent k1  ...done
Interpolating constituent k2  ...done
Interpolating constituent m2  ...done
Interpolating constituent m4  ...done
Interpolating constituent mf  ...done
Interpolating constituent mm  ...done
Interpolating constituent mn4 ...done
Interpolating constituent ms4 ...done
Interpolating constituent n2  ...done
Interpolating constituent o1  ...done
Interpolating constituent p1  ...done
Interpolating constituent q1  ...done
Interpolating constituent s1  ...done
Interpolating constituent s2  ...done
Done extracting HC
Predicting tide ...
Minor constituents inferred
done
```

```
[v,~]=tmd_tide_pred('DATA/Model_tpxo9_YS',...
```

```
    t,yy,xx,'v',[]); v=v/100; %cm/s->m/s
```

```
MODE: Map
Reading /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS and extracting HC...
Interpolating constituent 2n2 ...done
Interpolating constituent k1  ...done
Interpolating constituent k2  ...done
Interpolating constituent m2  ...done
Interpolating constituent m4  ...done
Interpolating constituent mf  ...done
Interpolating constituent mm  ...done
Interpolating constituent mn4 ...done
Interpolating constituent ms4 ...done
Interpolating constituent n2  ...done
Interpolating constituent o1  ...done
Interpolating constituent p1  ...done
Interpolating constituent q1  ...done
Interpolating constituent s1  ...done
Interpolating constituent s2  ...done
Done extracting HC
Predicting tide ...
Minor constituents inferred
done
```

```
quiver(xx(1:5:end,1:5:end),yy(1:5:end,1:5:end),...
    u(1:5:end,1:5:end),v(1:5:end,1:5:end),10)
```




```
% get time series in specific station
t=datenum([2013 1 1 12 0 0]):1/24:datenum([2013 1 5 12 0 0]);
x0=124;
```

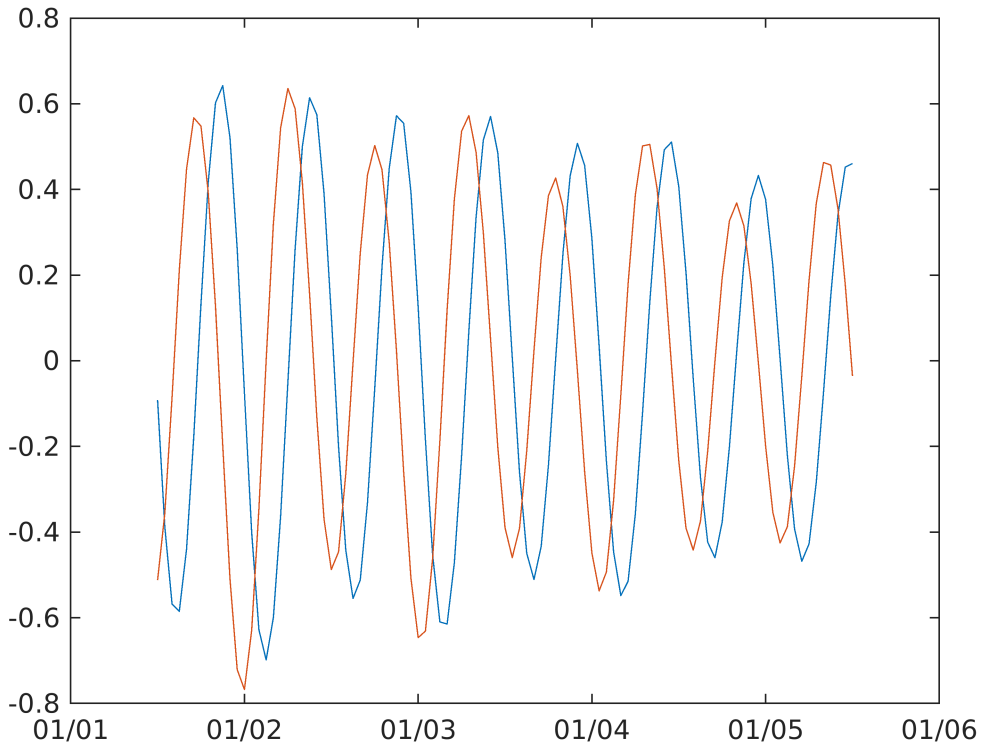
```
y0=32;
[u,~]=tmd_tide_pred('DATA/Model_tpxo9_YS',...
    t,y0,x0,'u',[]); u=u/100; %cm/s->m/s
```

```
MODE: Time series
Reading /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS and extracting HC...
Interpolating constituent 2n2 ...done
Interpolating constituent k1  ...done
Interpolating constituent k2  ...done
Interpolating constituent m2  ...done
Interpolating constituent m4  ...done
Interpolating constituent mf  ...done
Interpolating constituent mm  ...done
Interpolating constituent mn4 ...done
Interpolating constituent ms4 ...done
Interpolating constituent n2  ...done
Interpolating constituent o1  ...done
Interpolating constituent p1  ...done
Interpolating constituent q1  ...done
Interpolating constituent s1  ...done
Interpolating constituent s2  ...done
Done extracting HC
Predicting tide ...
Minor constituents inferred
done
```

```
[v,~]=tmd_tide_pred('DATA/Model_tpxo9_YS',...
    t,y0,x0,'v',[]); v=v/100; %cm/s->m/s
```

```
MODE: Time series
Reading /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS and extracting HC...
Interpolating constituent 2n2 ...done
Interpolating constituent k1  ...done
Interpolating constituent k2  ...done
Interpolating constituent m2  ...done
Interpolating constituent m4  ...done
Interpolating constituent mf  ...done
Interpolating constituent mm  ...done
Interpolating constituent mn4 ...done
Interpolating constituent ms4 ...done
Interpolating constituent n2  ...done
Interpolating constituent o1  ...done
Interpolating constituent p1  ...done
Interpolating constituent q1  ...done
Interpolating constituent s1  ...done
Interpolating constituent s2  ...done
Done extracting HC
Predicting tide ...
Minor constituents inferred
done
```

```
plot(t,u)
hold on
plot(t,v)
datetick
```



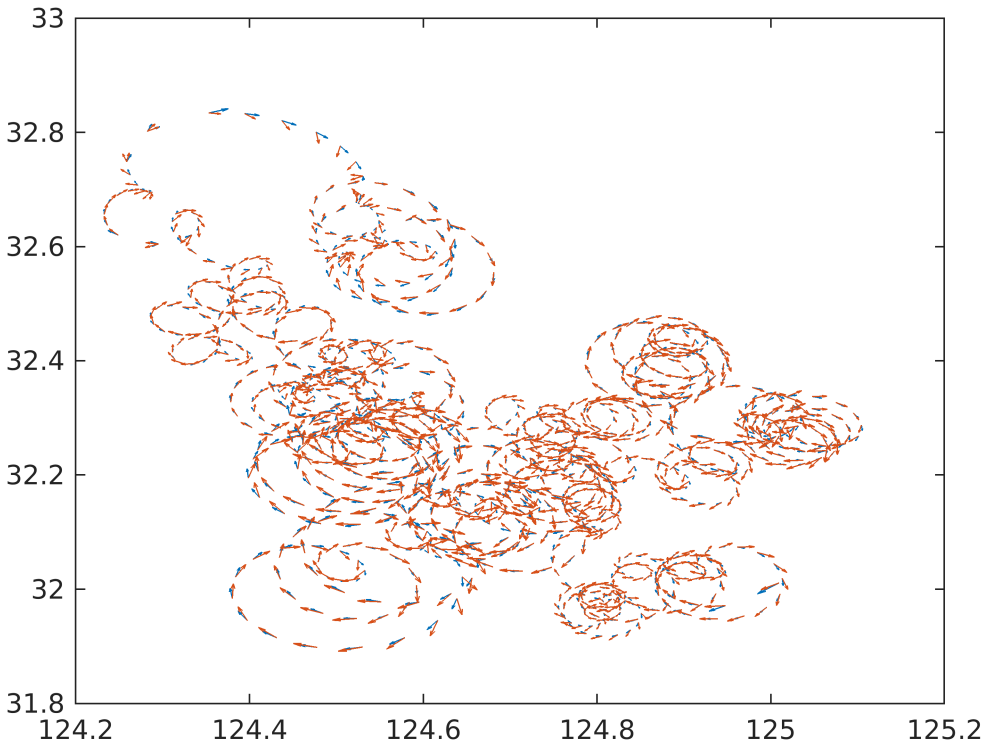

```
% get velocities along drifter trajectory
load('../demo_NIFS_drifter.mat')
T=T-9/24; % KST->"UTC(GMT)"
[u,~]=tmd_tide_pred('DATA/Model_tpxo9_YS',...
    T,Y,X,'u',[]); u=u/100; %cm/s->m/s
```

```
MODE: Drift Track
Reading /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS and extracting HC...
Interpolating constituent 2n2 ...done
Interpolating constituent k1  ...done
Interpolating constituent k2  ...done
Interpolating constituent m2  ...done
Interpolating constituent m4  ...done
Interpolating constituent mf  ...done
Interpolating constituent mm  ...done
Interpolating constituent mn4 ...done
Interpolating constituent ms4 ...done
Interpolating constituent n2  ...done
Interpolating constituent o1  ...done
Interpolating constituent p1  ...done
Interpolating constituent q1  ...done
Interpolating constituent s1  ...done
Interpolating constituent s2  ...done
Done extracting HC
Predicting tide ...
Minor constituents inferred
done
```

```
[v,~]=tmd_tide_pred('DATA/Model_tpxo9_YS',...
    T,Y,X,'v',[]); v=v/100; %cm/s->m/s
```

```
MODE: Drift Track
Reading /home/jchoi/Desktop/cokoaa/tpxo_tutorial/TMD/u_tpxo9_atlas_YS and extracting HC...
Interpolating constituent 2n2 ...done
Interpolating constituent k1  ...done
Interpolating constituent k2  ...done
Interpolating constituent m2  ...done
Interpolating constituent m4  ...done
Interpolating constituent mf  ...done
Interpolating constituent mm  ...done
Interpolating constituent mn4 ...done
Interpolating constituent ms4 ...done
Interpolating constituent n2  ...done
Interpolating constituent o1  ...done
Interpolating constituent p1  ...done
Interpolating constituent q1  ...done
Interpolating constituent s1  ...done
Interpolating constituent s2  ...done
Done extracting HC
Predicting tide ...
Minor constituents inferred
done
```

```
figure
quiver(X,Y,U,V)
hold on
quiver(X,Y,u',v')
```




```
figure
plot(u,U,'.')
hold on
plot(v,V,'.')
```

```
plot(xlim,xlim,'k','linewidth',2)
legend('u','v','1:1')
xlabel('Obs. (m/s)')
ylabel('TPXO model (m/s)')
```