Python Workshop
How we use python

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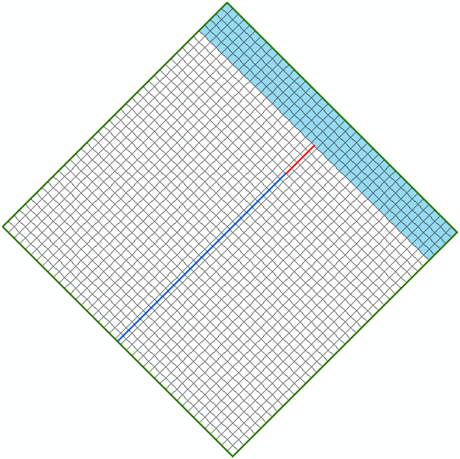
Create GHB file from raw data (1)

[xoff,yoff,rot]=[1000,1000,45]



Create GHB file from raw data (2)

CreateCoastalGHB.py

```python
import numpy as np
import MFArrayUtil as au
#--function for calculating equivalent freshwater head
def eqfwh( rho, h, z ):
    return ( rho / 1000. ) * h - ( ( rho - 1000. ) / 1000. ) * min( h, z )
#--main script
#--spatial dimensions
nlay, nrow, ncol  = 1, 41, 40
dx, dy = 500.0, 500.0 #m
#--temporal dimensions
nper = 3
#--boundary condition data
icbc, start_coast = 0, 36
kh    = 10.000 #m/d
cond  = kh * dx * dy
#--read MODFLOW data from external files
ibound  = au.loadArrayFromFile(nrow,ncol,'..\\ref\\ibound.ref')
top     = au.loadArrayFromFile(nrow,ncol,'..\\ref\\top.ref')
```

Create GHB file from raw data (3)

CreateCoastalGHB.py

```
#--ghb dataset
nghb = 0
for ir in range(0,nrow):
    for ic in range(0,ncol):
        if ibound[ir,ic] == 2:
            nghb += 1
f = open('Model.ghb','w')
#--dataset 0
f.write( '#Coastal Aquifer GHB Package\n' )
#--dataset 1
f.write( '{0:10d}{1:10d}  NOPRINT\n'.format( nghb, icbc ) )
#--write header for ghb file -- stress period 1
f.write( '{0:10d}         0          #STRESS PERIOD {1:05d}\n'.format( nghb, 1 ) )
for ir in range(0,nrow):
    for ic in range(0,ncol):
        if ibound[ir,ic] == 2:
            f.write( ' {0:9d} {1:9d} {2:9d} {3:9.5f} {4:9.3g}\n'.format(nlay,ir+1,ic+1, \
                     eqfwh( 1025., 0.0, top[ir,ic]),cond ) )
#--reuse data for the remaining stress period(s)
for iper in range(1,nper):
    f.write( '{0:10d}         0          #STRESS PERIOD {1:05d}\n'.format(-1,iper+1) )
f.close()
```

Output GHB file from raw data (4)

Model.ghb

```
#Coastal Aquifer GHB Package
       205         0  NOPRINT
       205         0          #STRESS PERIOD 00001
         1         1        36   0.00000   2.5e+06
         1         1        37   0.05000   2.5e+06
         1         1        38   0.10000   2.5e+06
         1         1        39   0.15000   2.5e+06
         1         1        40   0.20000   2.5e+06
         1         2        36   0.00000   2.5e+06
         1         2        37   0.05000   2.5e+06
         1         2        38   0.10000   2.5e+06
         1         2        39   0.15000   2.5e+06
         1         2        40   0.20000   2.5e+06

         1        41        36   0.00000   2.5e+06
         1        41        37   0.05000   2.5e+06
         1        41        38   0.10000   2.5e+06
         1        41        39   0.15000   2.5e+06
         1        41        40   0.20000   2.5e+06
        -1         0          #STRESS PERIOD 00002
        -1         0          #STRESS PERIOD 00003
```

Extract heads to create a new initial head array

extractSteadyHead.py

```
import numpy as np
import MFBinaryClass as mfb
#--problem size
nlay, nrow, ncol = 1, 41, 40
nper, nstp = 1, 100
#--name of MODFLOW head file
head_file = '..\\Results.SWI\\CoastalAquifer.hds'
#--read head data
#--create instance of head object from MFBinaryClass
headObj = mfb.MODFLOW_Head(nlay,nrow,ncol,head_file)
#--read array
totim,kstp,kper,h,success = headObj.get_record(nstp,nper)
#--save array or print error message
if success:
    np.savetxt('..\\ref\\steady_ihead.ref',h[0,:,:])
else:
    print 'Could not read Stress Period {0} Time Step {1}\n  from {2}'.format(nper,nstp,\
                                                                               head_file)
```

Binary head data

plotHeads.py

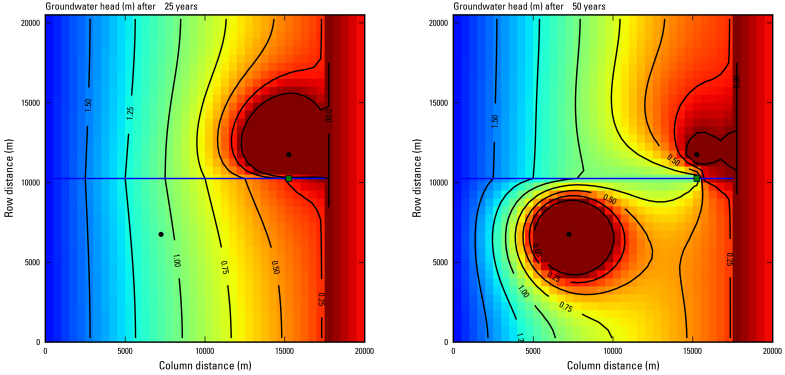
```
#--get available times
headObj = mfb.MODFLOW_Head(nlay,nrow,ncol,head_file)
t = headObj.get_gage(1)
ntimes = t.shape[0]
mf_times = np.zeros( (ntimes), np.float )
for i in range(0,ntimes):
    mf_times[i] = t[i,0]

#--create figures for each output time
for ipos,on_time in enumerate( mf_times ):
    #--build output file name
    output_name = '{0}{1}_{2:05d}.{3}'.format(base_dir,base_name,int(ipos),extension)
    fnames.append( output_name )
    #--read head data
    headObj = mfb.MODFLOW_Head(nlay,nrow,ncol,head_file)
    totim,kstp,kper,h,success = headObj.get_record(on_time)
    hd = np.copy( h[0,:,:] )
```

Figures (1)

plotHeads.py

```
    hp = ax.pcolor(Xedge,Yedge,hd,\
                   vmin=0,vmax=2,cmap='jet_r',alpha=1.0,edgecolors='None')
    ch = ax.contour(xcell,ycell,hd,\
                    levels=hdcontour,colors='k',linewidths=1)
    ax.clabel(ch,inline=1,fmt='%5.2f',fontsize=6)
    ax.plot([xedge[0],xedge[35]],[ycell[20],ycell[20]],linewidth=1,color='b',label='River')
    ax.plot(xcell[struct_loc[1]],ycell[struct_loc[0]],'gs',markersize=4,label='Structure')
    ax.plot(xcell[well_loc[0,1]],ycell[well_loc[0,0]],'ko',markersize=3,label='PW-1')
    ax.plot(xcell[well_loc[1,1]],ycell[well_loc[1,0]],'ko',markersize=3,label='PW-2')
```

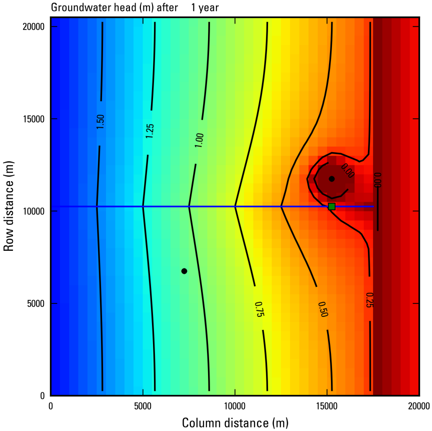
Figures (2)


Groundwater head (m) after 25 years
Row distance (m)
Column distance (m)
0
5000
10000
15000
20000
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Groundwater head (m) after 50 years
0.50
0.25
0.00
1.00
0.75
1.2

Using `ffmpeg.exe`

```
#--animate head data
coutf = '{0}{1}.swf'.format(base_dir,base_name)
cline = 'ffmpeg.exe -i {0}{1}_%05d.png {2} -y'.format( base_dir,base_name,coutf )
try:
    os.remove(coutf)
except:
    print 'could not remove...{0}'.format( coutf )
subprocess.call(cline, stdin=None, stdout=None, stderr=None, shell=False)
```

Using `ffmpeg.exe`



Making shapefiles (1)

`makeShapefileFromDIS.py`

```
import numpy as np
import shapefile
import MFArrayUtil as au

filename = '..\\data\\CoastalAquifer.dis'
offset,nlay,nrow,ncol,delr,delc = load_dis_file(filename)
#--flip the delc since we moved the orgin to lower left
delc = np.flipud( delc )
#--sum the lengths along the distance vectors
delr_cum = np.cumsum(delr)
delc_cum = np.cumsum(delc)
#--flip the delc since we moved the origin to lower left
delc_cum = np.flipud( delc_cum )
#--insert '0' in the first position
xedge = np.hstack((0,delr_cum))
yedge = np.hstack((delc_cum,0))
#--read MODFLOW data from external files
ibound  = au.loadArrayFromFile(nrow,ncol,'..\\ref\\ibound.ref')
top     = au.loadArrayFromFile(nrow,ncol,'..\\ref\\top.ref')
```

Making shapefiles (2)

makeShapefileFromDIS.py

```
#--create polygon shapefile of grid
wr = shapefile.Writer()
wr.field('row',fieldType='N',size=20)
wr.field('column',fieldType='N',size=20)
wr.field('delx',fieldType='N',size=20)
wr.field('dely',fieldType='N',size=20)
wr.field('cellnum',fieldType='N',size=20)
wr.field('ibound',fieldType='N',size=20)
wr.field('elev_m',fieldType='N',size=16,decimal=7)
#--create each polygon
cell_count = 0
for ir in range(0,nrow):
    for ic in range(0,ncol):
        #--calc the box points relative to the grid
        lowleft = [xedge[ic],yedge[ir]]
        lowright = [xedge[ic+1],yedge[ir]]
        upright = [xedge[ic+1],yedge[ir+1]]
        upleft = [xedge[ic],yedge[ir+1]]
        closeit = [xedge[ic],yedge[ir+1]-0.0001]
        this_box = [upleft,upright,lowright,lowleft,closeit]
```

Making shapefiles (3)

makeShapefileFromDIS.py

```
        #--if rotation is non-zero
        if offset[2] != 0.0:
            this_box = rotate(this_box,offset[2])
        #--add the offset in after the rotation
        this_box = add_offset(this_box,offset)
        ibt    = ibound[ir,ic]
        ttop   = top[ir,ic]
        wr.poly(parts=[this_box], shapeType=5)
        wr.record([ir+1,ic+1,delc[ir],delr[ic],cell_count+1,ibt,ttop])
        cell_count += 1
#--save polygon shapefile
wr.save(target='..\\data\\CoastalAquifer_grid')
```