

# setup\_pest\_interface

May 8, 2019

## 1 Setup the PEST(++) interface around the enhanced Freyberg model

In this notebook, we will construct a complex model independent (non-intrusive) interface around an existing MODFLOW-NWT model using the python/flopy/pyemu stack.

```
In [1]: import os
import shutil
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import flopy
import pyemu
import prep_deps
import redis
import matplotlib as mpl
plt.rcParams['font.size']=12
```

flopy is installed in /Users/jeremyw/Dev/gw1876/activities\_2day\_mfm/notebooks/flopy

First we define a base directory `b_d` from which we will read in a model already created `freyberg.nam`. This will form the basis of the remainder of the exercise

```
In [2]: b_d = os.path.join(".", "base_model_files")
nam_file = "freyberg.nam"
```

### 1.0.1 load the existing Freyberg model. This version should run but is not yet connected with PEST++

```
In [3]: # note that to load a model in a different folder, you supply the namefile without path
# to it in the model_ws variable
m = flopy.modflow.Modflow.load(nam_file, model_ws=b_d, check=False, forgive=False)
```

### 1.0.2 we can do a couple flopy things to move where the new model will be written

```
In [4]: # assign the executable name for the model
m.exe_name = "mfnt"
```

```

# now let's run this in a new folder called temp so we don't overwrite the original da
m.change_model_ws("temp",reset_external=True)

# this writes all the MODFLOW files in the new location
m.write_input()

# the following helps get the dependencies (both python and executables) in the right p
prep_deps.prep_template(t_d="temp")

```

```

changing model workspace...
temp

```

### 1.0.3 now we can run the model once using a pyemu helper

This helper is particularly useful if you run on more than one platform (e.g. Mac and Windows)

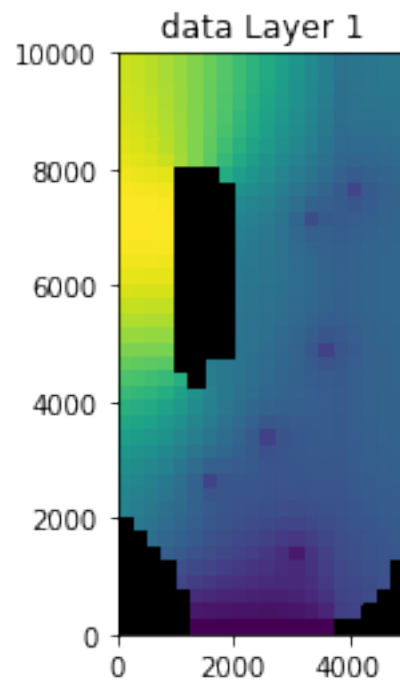
```
In [5]: pyemu.os_utils.run("{0} {1}".format("mfnewt",m.name+".nam"),cwd=m.model_ws)
```

### 1.0.4 read in the heads and plot them up along with the budget components

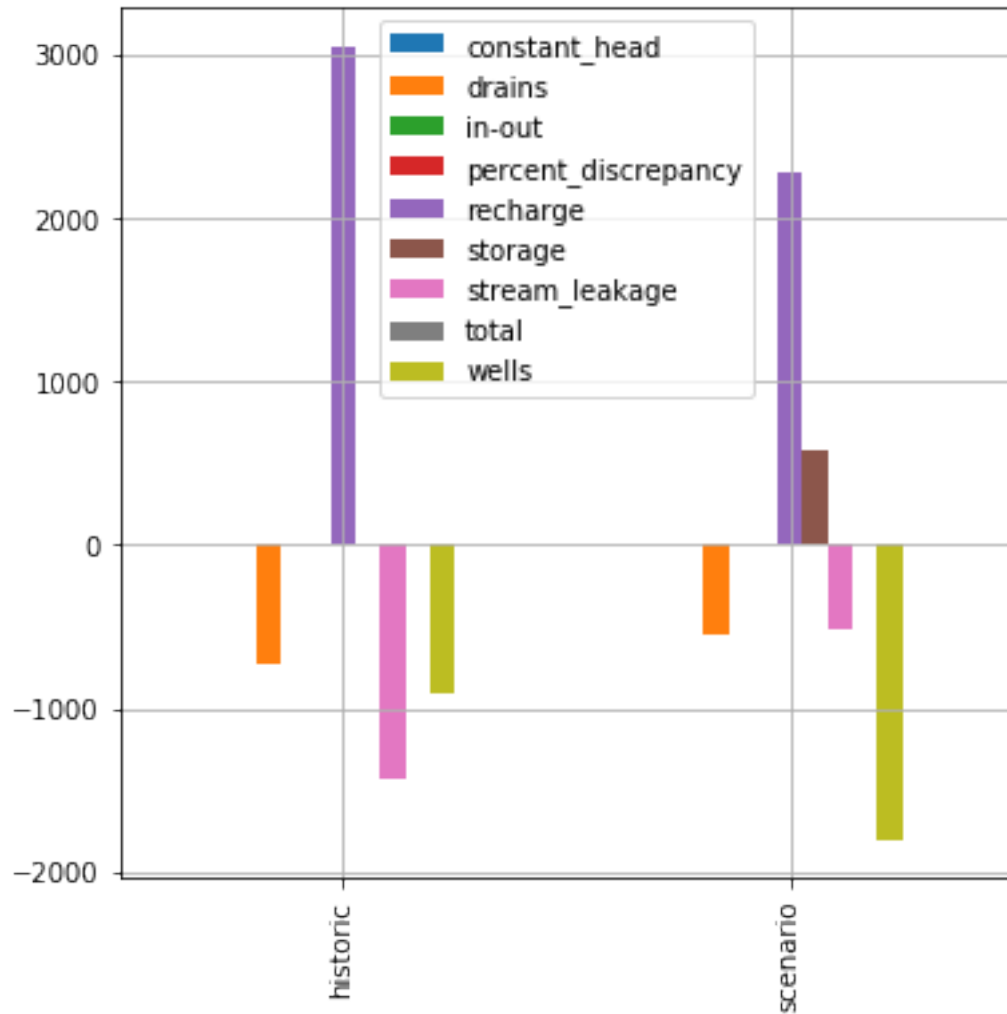
Note that there is a historic period and a scenario with future conditions that differ. For the future scenario, recharge is lower and pumping/abstraction is increased to make up for the presumed deficit in water for agriculture.

```
In [6]: plt.figure()
        hds = flopy.utils.HeadFile(os.path.join(m.model_ws,m.name+".hds"),model=m)
        hds.plot(mfay=0)
        lst = flopy.utils.MfListBudget(os.path.join(m.model_ws,m.name+".list"))
        df = lst.get_dataframes(diff=True)[0]
        plt.figure()
        ax = df.plot(kind="bar",figsize=(6,6), grid=True)
        ax.set_xticklabels(["historic","scenario"])
        plt.show()

```



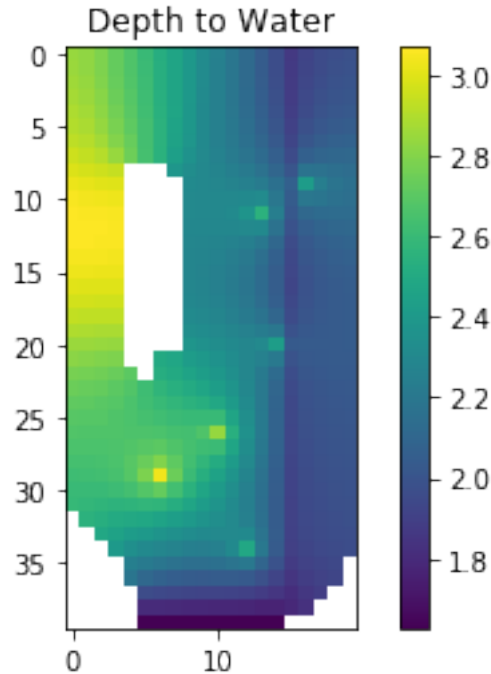
<Figure size 432x288 with 0 Axes>



We can see the effect of the “scenario” in the second stress period with less recharge and more abstraction.

### 1.0.5 Plot depth to water

```
In [7]: dtw = m.dis.top.array - hds.get_data()[0,:,:]
dtw = np.ma.masked_where(m.bas6.ibound[0].array==0,dtw)
c = plt.imshow(dtw)
plt.title('Depth to Water')
plt.colorbar(c)
plt.show()
```

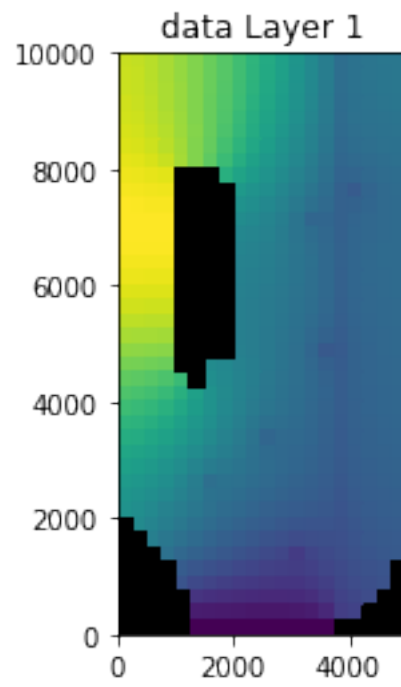


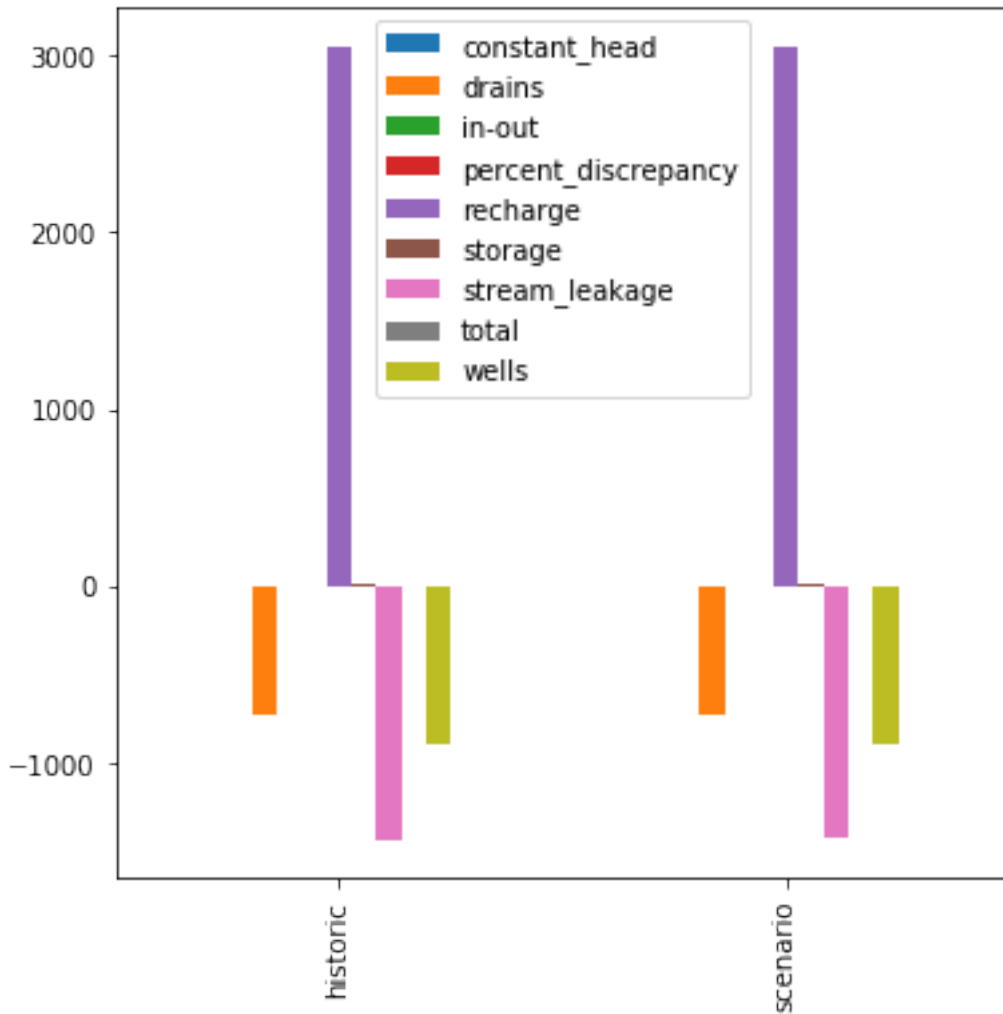
Clearly we can see the river and well locations expressed in the depth to water pattern.

**1.0.6 What we are going to do is implement the scenario with parameters so we can more easily account for the stochastic nature of the forcing conditions during the scenario stress period and also make implementation of future scenarios work in this stochastic framework:**

```
In [8]: # reset scenario period recharge
m.rch.rech[1] = m.rch.rech[0]
# reset scenario period abstraction
m.wel.stress_period_data[1] = m.wel.stress_period_data[0]
m.write_input()
pyemu.os_utils.run("{0} {1}".format("mfntw", m.name+".nam"), cwd=m.model_ws)
hds = flopy.utils.HeadFile(os.path.join(m.model_ws, m.name+".hds"), model=m)
axes = hds.plot(mflay=0)

lst = flopy.utils.MfListBudget(os.path.join(m.model_ws, m.name+".list"))
df = lst.get_dataframes(diff=True)[0]
ax = df.plot(kind="bar", figsize=(6,6))
ax.set_xticklabels(["historic", "scenario"])
plt.show()
```





Now we see that the scenario and historic periods have the same water balance

## 1.1 Setup data structures related to what we want to parameterize and what we want to observe

### 1.1.1 first the parameterization of model inputs

```
In [9]: props = []
        # here we specify which packages we wish to parameterize,
        # starting with those that do not change over time
        paks = ["upw.hk", "upw.vka", "upw.ss", "upw.sy", "bas6.strt", "extra.prsity"]
        for k in range(m.nlay):
            props.extend([[p,k] for p in paks])
        # next we specify that we want to make parameters for recharge
        # for both stress periods (zero-based! Python style)
        props.append(["rch.rech", 0])
        props.append(["rch.rech", 1])
```

### 1.1.2 we want to handle list-type parameters in two ways

for `spatial_list_props` this will apply a multiplier distributed spatially that applied in all stress periods throughout the model

for `temporal_list_props` this will apply a multiplier for each stress period applied to all the spatial locations

```
In [10]: spatial_list_props = [{"wel.flux",2}, {"drn.cond",0}]
        temporal_list_props = [{"wel.flux",0}, {"wel.flux",1}]
```

### 1.1.3 next we want to set up extracting observations. First, we will setup a post-processor that will read the heads for all active cells in both stress periods - why not?

```
In [11]: hds_kperk = [[0,k] for k in range(m.nlay)]
        hds_kperk.extend([[1,k] for k in range(m.nlay)])
```

### 1.1.4 then we setup monitoring of the SFR ASCII outputs.

we will accumulate the first 20 reaches and last 20 reaches together to form forecasts of sw-gw exchange in the headwaters (hw) and tailwaters (tw). Then we will also add each reach individually for monitoring as well

```
In [12]: sfr_obs_dict = {"hw":np.arange(1,int(m.nrow/2))}
        sfr_obs_dict["tw"] = np.arange(int(m.nrow/2),m.nrow)
        for i in range(m.nrow):
            sfr_obs_dict[i] = i+1
```

### 1.1.5 here we go...

This `pyemu` class has grown into a monster... it does (among other things): - sets up combinations of multiplier parameters for array inputs, including uniform, zones, pilot points, grids, and KL expansion types - sets up combinations of multiplier parameters for list inputs - handles several of the shitty modflow exceptions to the array and list style inputs - sets up large numbers of observations based on arrays or time series - writes `.tpl`, `.ins`, `.pst`, etc - writes a python forward run script (WAT?!) - writes a prior parameter covaraince matrix using geostatistical correlations - draws from the prior parameter covariance matrix to generate a prior parameter ensemble

This will be slow because the pure python kriging... but, hey, its free!

For our purposes, we will setup combinations of constant (by layer), pilot points and grid-scale parameters for each of the array-based properties we defined earlier. This lets us explore options for parameterization and also start to understand how information flows in the history matching problem

```
In [13]: pst_helper = pyemu.helpers.PstFromFlopyModel(nam_file,new_model_ws="template",org_model=
                                                    const_props=props,spatial_list_props=spat.
                                                    temporal_list_props=temporal_list_props,
                                                    grid_props=props,pp_props=props,sfr_pars=
                                                    sfr_obs=sfr_obs_dict,build_prior=False,m
                                                    pp_space=4)
        prep_deps.prep_template(t_d=pst_helper.new_model_ws)
```



2019-05-08 21:43:15.055433 starting: loading floppy model

Creating new model with name: freyberg

Parsing the namefile --> temp/freyberg.nam

External unit dictionary:

OrderedDict([(2, filename:temp/freyberg.list, filetype:LIST), (11, filename:temp/freyberg.dis,

ModflowBas6 free format:True

loading dis package file...

Loading dis package with:

3 layers, 40 rows, 20 columns, and 2 stress periods

loading laycbd...

loading delr...

loading delc...

loading top...

loading botm...

for 3 layers and 0 confining beds

loading stress period data...

for 2 stress periods

adding Package: DIS

DIS package load...success

LIST package load...skipped

loading bas6 package file...

adding Package: BAS6

BAS6 package load...success

loading upw package file...

loading ipakcb, HDRY, NPUPW, IPHDRY...

loading LAYTYP...

loading LAYAVG...

loading CHANI...

loading LAYVKA...

loading LAYWET...

loading hk layer 1...

loading vka layer 1...

loading ss layer 1...

loading sy layer 1...

loading hk layer 2...

loading vka layer 2...

loading ss layer 2...

loading sy layer 2...

loading hk layer 3...

loading vka layer 3...

```

    loading ss layer    3...
    loading sy layer    3...
Adding freyberg.cbc (unit=50) to the output list.
adding Package:  UPW
    UPW  package load...success
loading rch package file...
    loading rech stress period    1...
    loading rech stress period    2...
adding Package:  RCH
    RCH  package load...success
loading nwt package file...
adding Package:  NWT
    NWT  package load...success
loading oc package file...
Adding freyberg.hds (unit=51) to the output list.
adding Package:  OC
    OC   package load...success
loading lmt package file...
adding Package:  LMT6
    LMT6 package load...success
loading wel package file...
    loading <class 'flopymodflow.mfwel.ModflowWel'> for kper    1
    loading <class 'flopymodflow.mfwel.ModflowWel'> for kper    2
adding Package:  WEL
    WEL  package load...success
loading sfr2 package file...
Adding freyberg.sfr.out (unit=60) to the output list.
adding Package:  SFR
    SFR  package load...success
loading drn package file...
    loading <class 'flopymodflow.mfdrn.ModflowDrn'> for kper    1
    loading <class 'flopymodflow.mfdrn.ModflowDrn'> for kper    2
adding Package:  DRN
    DRN  package load...success
    DATA(BINARY) file load...skipped
        freyberg.cbc
    DATA(BINARY) file load...skipped
        freyberg.hds
    DATA file load...skipped
        freyberg.sfr.out
Warning: external file unit 0 does not exist in ext_unit_dict.

```

The following 10 packages were successfully loaded.

```

    freyberg.dis
    freyberg.bas
    freyberg.upw
    freyberg.rch
    freyberg.nwt

```

```

    freyberg.oc
    freyberg.lmt6
    freyberg.wel
    freyberg.sfr
    freyberg.drn
The following 1 packages were not loaded.
    freyberg.list
2019-05-08 21:43:15.086591 finished: loading floppy model took: 0:00:00.031158
2019-05-08 21:43:15.086659 starting: updating model attributes
2019-05-08 21:43:15.086781 finished: updating model attributes took: 0:00:00.000122
2019-05-08 21:43:15.086914 WARNING: removing existing 'new_model_ws

creating model workspace...
    template

changing model workspace...
    template
2019-05-08 21:43:16.110153 starting: writing new modflow input files

Writing packages:
    Package:  DIS
Util2d:delr: resetting 'how' to external
Util2d:delc: resetting 'how' to external
Util2d:model_top: resetting 'how' to external
Util2d:botm_layer_0: resetting 'how' to external
Util2d:botm_layer_1: resetting 'how' to external
Util2d:botm_layer_2: resetting 'how' to external
    Package:  BAS6
Util2d:ibound_layer_0: resetting 'how' to external
Util2d:ibound_layer_1: resetting 'how' to external
Util2d:ibound_layer_2: resetting 'how' to external
Util2d:strt_layer_0: resetting 'how' to external
Util2d:strt_layer_1: resetting 'how' to external
Util2d:strt_layer_2: resetting 'how' to external
    Package:  UPW
Util2d:hk: resetting 'how' to external
Util2d:vka: resetting 'how' to external
Util2d:ss: resetting 'how' to external
Util2d:sy: resetting 'how' to external
Util2d:hk: resetting 'how' to external
Util2d:vka: resetting 'how' to external
Util2d:ss: resetting 'how' to external
Util2d:sy: resetting 'how' to external
Util2d:hk: resetting 'how' to external
Util2d:vka: resetting 'how' to external
Util2d:ss: resetting 'how' to external
Util2d:sy: resetting 'how' to external
    Package:  RCH

```

Util2d:rech\_1: resetting 'how' to external

Util2d:rech\_2: resetting 'how' to external

Package: NWT

Package: OC

Package: LMT6

Package: WEL

Package: SFR

Package: DRN

2019-05-08 21:43:16.224564 finished: writing new modflow input files took: 0:00:00.114411

2019-05-08 21:43:16.225091 forward\_run line:pyemu.os\_utils.run('mf nwt freyberg.nam 1>freyberg.

2019-05-08 21:43:16.225378 starting: setting up 'template/arr\_org' dir

2019-05-08 21:43:16.225762 finished: setting up 'template/arr\_org' dir took: 0:00:00.000384

2019-05-08 21:43:16.225961 starting: setting up 'template/arr\_mlt' dir

2019-05-08 21:43:16.226401 finished: setting up 'template/arr\_mlt' dir took: 0:00:00.000440

2019-05-08 21:43:16.226610 starting: setting up 'template/list\_org' dir

2019-05-08 21:43:16.226971 finished: setting up 'template/list\_org' dir took: 0:00:00.000361

2019-05-08 21:43:16.227128 starting: setting up 'template/list\_mlt' dir

2019-05-08 21:43:16.227524 finished: setting up 'template/list\_mlt' dir took: 0:00:00.000396

2019-05-08 21:43:16.227737 starting: processing temporal\_list\_props

2019-05-08 21:43:16.246369 finished: processing temporal\_list\_props took: 0:00:00.018632

2019-05-08 21:43:16.246738 starting: processing spatial\_list\_props

2019-05-08 21:43:16.312233 finished: processing spatial\_list\_props took: 0:00:00.065495

2019-05-08 21:43:16.370576 forward\_run line:pyemu.helpers.apply\_list\_pars()

2019-05-08 21:43:16.400629 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.438049 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.474548 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.518750 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.551087 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.581994 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.621942 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.652813 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.682384 'extra' pak detected:extra.prsity

2019-05-08 21:43:16.763056 starting: writing grid tpl:hk3.dat\_gr.tpl

2019-05-08 21:43:16.771928 finished: writing grid tpl:hk3.dat\_gr.tpl took: 0:00:00.008872

2019-05-08 21:43:16.774293 starting: writing grid tpl:vka3.dat\_gr.tpl

2019-05-08 21:43:16.782464 finished: writing grid tpl:vka3.dat\_gr.tpl took: 0:00:00.008171

2019-05-08 21:43:16.784875 starting: writing grid tpl:ss3.dat\_gr.tpl

2019-05-08 21:43:16.793781 finished: writing grid tpl:ss3.dat\_gr.tpl took: 0:00:00.008906

2019-05-08 21:43:16.796507 starting: writing grid tpl:sy3.dat\_gr.tpl

2019-05-08 21:43:16.805294 finished: writing grid tpl:sy3.dat\_gr.tpl took: 0:00:00.008787

2019-05-08 21:43:16.807890 starting: writing grid tpl:strt3.dat\_gr.tpl

2019-05-08 21:43:16.816629 finished: writing grid tpl:strt3.dat\_gr.tpl took: 0:00:00.008739

2019-05-08 21:43:16.819218 starting: writing grid tpl:prsity3.dat\_gr.tpl

2019-05-08 21:43:16.829829 finished: writing grid tpl:prsity3.dat\_gr.tpl took: 0:00:00.010611

2019-05-08 21:43:16.832488 starting: writing grid tpl:hk4.dat\_gr.tpl

2019-05-08 21:43:16.841037 finished: writing grid tpl:hk4.dat\_gr.tpl took: 0:00:00.008549

2019-05-08 21:43:16.843875 starting: writing grid tpl:vka4.dat\_gr.tpl  
 2019-05-08 21:43:16.852032 finished: writing grid tpl:vka4.dat\_gr.tpl took: 0:00:00.008157  
 2019-05-08 21:43:16.854379 starting: writing grid tpl:ss4.dat\_gr.tpl  
 2019-05-08 21:43:16.862563 finished: writing grid tpl:ss4.dat\_gr.tpl took: 0:00:00.008184  
 2019-05-08 21:43:16.864928 starting: writing grid tpl:sy4.dat\_gr.tpl  
 2019-05-08 21:43:16.873981 finished: writing grid tpl:sy4.dat\_gr.tpl took: 0:00:00.009053  
 2019-05-08 21:43:16.876513 starting: writing grid tpl:strt4.dat\_gr.tpl  
 2019-05-08 21:43:16.884497 finished: writing grid tpl:strt4.dat\_gr.tpl took: 0:00:00.007984  
 2019-05-08 21:43:16.886789 starting: writing grid tpl:prsity4.dat\_gr.tpl  
 2019-05-08 21:43:16.897375 finished: writing grid tpl:prsity4.dat\_gr.tpl took: 0:00:00.010586  
 2019-05-08 21:43:16.899770 starting: writing grid tpl:hk5.dat\_gr.tpl  
 2019-05-08 21:43:16.907993 finished: writing grid tpl:hk5.dat\_gr.tpl took: 0:00:00.008223  
 2019-05-08 21:43:16.910264 starting: writing grid tpl:vka5.dat\_gr.tpl  
 2019-05-08 21:43:16.918865 finished: writing grid tpl:vka5.dat\_gr.tpl took: 0:00:00.008601  
 2019-05-08 21:43:16.921184 starting: writing grid tpl:ss5.dat\_gr.tpl  
 2019-05-08 21:43:16.929521 finished: writing grid tpl:ss5.dat\_gr.tpl took: 0:00:00.008337  
 2019-05-08 21:43:16.931843 starting: writing grid tpl:sy5.dat\_gr.tpl  
 2019-05-08 21:43:16.940254 finished: writing grid tpl:sy5.dat\_gr.tpl took: 0:00:00.008411  
 2019-05-08 21:43:16.942652 starting: writing grid tpl:strt5.dat\_gr.tpl  
 2019-05-08 21:43:16.950771 finished: writing grid tpl:strt5.dat\_gr.tpl took: 0:00:00.008119  
 2019-05-08 21:43:16.953385 starting: writing grid tpl:prsity5.dat\_gr.tpl  
 2019-05-08 21:43:16.964767 finished: writing grid tpl:prsity5.dat\_gr.tpl took: 0:00:00.011382  
 2019-05-08 21:43:16.967611 starting: writing grid tpl:rech2.dat\_gr.tpl  
 2019-05-08 21:43:16.976214 finished: writing grid tpl:rech2.dat\_gr.tpl took: 0:00:00.008603  
 2019-05-08 21:43:16.978585 starting: writing grid tpl:rech3.dat\_gr.tpl  
 2019-05-08 21:43:16.986842 finished: writing grid tpl:rech3.dat\_gr.tpl took: 0:00:00.008257  
 2019-05-08 21:43:16.989097 starting: writing const tpl:hk6.dat\_cn.tpl  
 2019-05-08 21:43:16.994666 finished: writing const tpl:hk6.dat\_cn.tpl took: 0:00:00.005569  
 2019-05-08 21:43:16.997214 starting: writing const tpl:vka6.dat\_cn.tpl  
 2019-05-08 21:43:17.002745 finished: writing const tpl:vka6.dat\_cn.tpl took: 0:00:00.005531  
 2019-05-08 21:43:17.005035 starting: writing const tpl:ss6.dat\_cn.tpl  
 2019-05-08 21:43:17.010565 finished: writing const tpl:ss6.dat\_cn.tpl took: 0:00:00.005530  
 2019-05-08 21:43:17.012839 starting: writing const tpl:sy6.dat\_cn.tpl  
 2019-05-08 21:43:17.018255 finished: writing const tpl:sy6.dat\_cn.tpl took: 0:00:00.005416  
 2019-05-08 21:43:17.020557 starting: writing const tpl:strt6.dat\_cn.tpl  
 2019-05-08 21:43:17.026191 finished: writing const tpl:strt6.dat\_cn.tpl took: 0:00:00.005634  
 2019-05-08 21:43:17.028541 starting: writing const tpl:prsity6.dat\_cn.tpl  
 2019-05-08 21:43:17.033678 finished: writing const tpl:prsity6.dat\_cn.tpl took: 0:00:00.005137  
 2019-05-08 21:43:17.036036 starting: writing const tpl:hk7.dat\_cn.tpl  
 2019-05-08 21:43:17.041359 finished: writing const tpl:hk7.dat\_cn.tpl took: 0:00:00.005323  
 2019-05-08 21:43:17.044340 starting: writing const tpl:vka7.dat\_cn.tpl  
 2019-05-08 21:43:17.049966 finished: writing const tpl:vka7.dat\_cn.tpl took: 0:00:00.005626  
 2019-05-08 21:43:17.052283 starting: writing const tpl:ss7.dat\_cn.tpl  
 2019-05-08 21:43:17.057575 finished: writing const tpl:ss7.dat\_cn.tpl took: 0:00:00.005292  
 2019-05-08 21:43:17.059974 starting: writing const tpl:sy7.dat\_cn.tpl  
 2019-05-08 21:43:17.065417 finished: writing const tpl:sy7.dat\_cn.tpl took: 0:00:00.005443  
 2019-05-08 21:43:17.067641 starting: writing const tpl:strt7.dat\_cn.tpl  
 2019-05-08 21:43:17.073455 finished: writing const tpl:strt7.dat\_cn.tpl took: 0:00:00.005814

```

2019-05-08 21:43:17.076585 starting: writing const tpl:prsity7.dat_cn.tpl
2019-05-08 21:43:17.081945 finished: writing const tpl:prsity7.dat_cn.tpl took: 0:00:00.005360
2019-05-08 21:43:17.084249 starting: writing const tpl:hk8.dat_cn.tpl
2019-05-08 21:43:17.089891 finished: writing const tpl:hk8.dat_cn.tpl took: 0:00:00.005642
2019-05-08 21:43:17.092292 starting: writing const tpl:vka8.dat_cn.tpl
2019-05-08 21:43:17.097469 finished: writing const tpl:vka8.dat_cn.tpl took: 0:00:00.005177
2019-05-08 21:43:17.099712 starting: writing const tpl:ss8.dat_cn.tpl
2019-05-08 21:43:17.105186 finished: writing const tpl:ss8.dat_cn.tpl took: 0:00:00.005474
2019-05-08 21:43:17.107734 starting: writing const tpl:sy8.dat_cn.tpl
2019-05-08 21:43:17.112966 finished: writing const tpl:sy8.dat_cn.tpl took: 0:00:00.005232
2019-05-08 21:43:17.115215 starting: writing const tpl:strt8.dat_cn.tpl
2019-05-08 21:43:17.120749 finished: writing const tpl:strt8.dat_cn.tpl took: 0:00:00.005534
2019-05-08 21:43:17.123193 starting: writing const tpl:prsity8.dat_cn.tpl
2019-05-08 21:43:17.128560 finished: writing const tpl:prsity8.dat_cn.tpl took: 0:00:00.005367
2019-05-08 21:43:17.130792 starting: writing const tpl:rech4.dat_cn.tpl
2019-05-08 21:43:17.136470 finished: writing const tpl:rech4.dat_cn.tpl took: 0:00:00.005678
2019-05-08 21:43:17.139199 starting: writing const tpl:rech5.dat_cn.tpl
2019-05-08 21:43:17.144662 finished: writing const tpl:rech5.dat_cn.tpl took: 0:00:00.005463
2019-05-08 21:43:17.165807 starting: setting up pilot point process
2019-05-08 21:43:17.166157 WARNING: pp_geostrcut is None, using ExpVario with contribution=1 and
2019-05-08 21:43:17.168706 pp_dict: {0: ['hk0', 'vka0', 'ss0', 'sy0', 'strt0', 'prsity0', 'rech0', 'rech1', 'prsity1']}
2019-05-08 21:43:17.169419 starting: calling setup_pilot_point_grid()
2019-05-08 21:43:17.720831 640 pilot point parameters created
2019-05-08 21:43:17.721513 pilot point 'pargp':hk0,vka0,ss0,sy0,strt0,prsity0,rech0,rech1,prsity1
2019-05-08 21:43:17.721569 finished: calling setup_pilot_point_grid() took: 0:00:00.552150
2019-05-08 21:43:17.723756 starting: calculating factors for p=hk0, k=0
2019-05-08 21:43:17.724497 saving krige variance file:template/pp_k0_general_zn.fac
2019-05-08 21:43:17.724891 saving krige factors file:template/pp_k0_general_zn.fac
starting interp point loop for 800 points
took 2.452591 seconds
2019-05-08 21:43:20.235048 finished: calculating factors for p=hk0, k=0 took: 0:00:02.511292
2019-05-08 21:43:20.235934 starting: calculating factors for p=vka0, k=0
2019-05-08 21:43:20.236706 finished: calculating factors for p=vka0, k=0 took: 0:00:00.000772
2019-05-08 21:43:20.237568 starting: calculating factors for p=ss0, k=0
2019-05-08 21:43:20.238528 finished: calculating factors for p=ss0, k=0 took: 0:00:00.000960
2019-05-08 21:43:20.239601 starting: calculating factors for p=sy0, k=0
2019-05-08 21:43:20.240481 finished: calculating factors for p=sy0, k=0 took: 0:00:00.000880
2019-05-08 21:43:20.241063 starting: calculating factors for p=strt0, k=0
2019-05-08 21:43:20.241953 finished: calculating factors for p=strt0, k=0 took: 0:00:00.000890
2019-05-08 21:43:20.242992 starting: calculating factors for p=prsity0, k=0
2019-05-08 21:43:20.243814 finished: calculating factors for p=prsity0, k=0 took: 0:00:00.000880
2019-05-08 21:43:20.244391 starting: calculating factors for p=rech0, k=0
2019-05-08 21:43:20.245543 finished: calculating factors for p=rech0, k=0 took: 0:00:00.001152
2019-05-08 21:43:20.246294 starting: calculating factors for p=rech1, k=0
2019-05-08 21:43:20.247313 finished: calculating factors for p=rech1, k=0 took: 0:00:00.001019
2019-05-08 21:43:20.247923 starting: calculating factors for p=prsity1, k=1
2019-05-08 21:43:20.248623 saving krige variance file:template/pp_k1_general_zn.fac
2019-05-08 21:43:20.249241 saving krige factors file:template/pp_k1_general_zn.fac

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starting interp point loop for 800 points
took 2.419359 seconds
2019-05-08 21:43:22.722396 finished: calculating factors for p=prsity1, k=1 took: 0:00:02.4744
2019-05-08 21:43:22.723715 starting: calculating factors for p=sy1, k=1
2019-05-08 21:43:22.724680 finished: calculating factors for p=sy1, k=1 took: 0:00:00.000965
2019-05-08 21:43:22.726109 starting: calculating factors for p=vka1, k=1
2019-05-08 21:43:22.727023 finished: calculating factors for p=vka1, k=1 took: 0:00:00.000914
2019-05-08 21:43:22.727638 starting: calculating factors for p=ss1, k=1
2019-05-08 21:43:22.728692 finished: calculating factors for p=ss1, k=1 took: 0:00:00.001054
2019-05-08 21:43:22.729484 starting: calculating factors for p=strt1, k=1
2019-05-08 21:43:22.730194 finished: calculating factors for p=strt1, k=1 took: 0:00:00.000710
2019-05-08 21:43:22.730766 starting: calculating factors for p=hk1, k=1
2019-05-08 21:43:22.731471 finished: calculating factors for p=hk1, k=1 took: 0:00:00.000705
2019-05-08 21:43:22.732386 starting: calculating factors for p=strt2, k=2
2019-05-08 21:43:22.733468 saving krige variance file:template/pp_k2_general_zn.fac
2019-05-08 21:43:22.733539 saving krige factors file:template/pp_k2_general_zn.fac
starting interp point loop for 800 points
took 2.445201 seconds
2019-05-08 21:43:25.224646 finished: calculating factors for p=strt2, k=2 took: 0:00:02.492260
2019-05-08 21:43:25.225791 starting: calculating factors for p=prsity2, k=2
2019-05-08 21:43:25.226741 finished: calculating factors for p=prsity2, k=2 took: 0:00:00.0009
2019-05-08 21:43:25.227826 starting: calculating factors for p=ss2, k=2
2019-05-08 21:43:25.229158 finished: calculating factors for p=ss2, k=2 took: 0:00:00.001332
2019-05-08 21:43:25.230015 starting: calculating factors for p=vka2, k=2
2019-05-08 21:43:25.230772 finished: calculating factors for p=vka2, k=2 took: 0:00:00.000757
2019-05-08 21:43:25.231393 starting: calculating factors for p=sy2, k=2
2019-05-08 21:43:25.232333 finished: calculating factors for p=sy2, k=2 took: 0:00:00.000940
2019-05-08 21:43:25.232952 starting: calculating factors for p=hk2, k=2
2019-05-08 21:43:25.233672 finished: calculating factors for p=hk2, k=2 took: 0:00:00.000720
2019-05-08 21:43:25.233818 starting: processing pp_prefix:vka2
2019-05-08 21:43:25.246592 starting: processing pp_prefix:ss1
2019-05-08 21:43:25.254963 starting: processing pp_prefix:vka1
2019-05-08 21:43:25.263022 starting: processing pp_prefix:ss0
2019-05-08 21:43:25.270927 starting: processing pp_prefix:prsity1
2019-05-08 21:43:25.279431 starting: processing pp_prefix:hk2
2019-05-08 21:43:25.288548 starting: processing pp_prefix:sy2
2019-05-08 21:43:25.297278 starting: processing pp_prefix:rech0
2019-05-08 21:43:25.305474 starting: processing pp_prefix:prsity2
2019-05-08 21:43:25.313198 starting: processing pp_prefix:hk1
2019-05-08 21:43:25.321047 starting: processing pp_prefix:ss2
2019-05-08 21:43:25.328849 starting: processing pp_prefix:vka0
2019-05-08 21:43:25.336656 starting: processing pp_prefix:sy1
2019-05-08 21:43:25.344556 starting: processing pp_prefix:prsity0
2019-05-08 21:43:25.352467 starting: processing pp_prefix:strt0
2019-05-08 21:43:25.360166 starting: processing pp_prefix:rech1
2019-05-08 21:43:25.368174 starting: processing pp_prefix:strt1
2019-05-08 21:43:25.375972 starting: processing pp_prefix:strt2
2019-05-08 21:43:25.384424 starting: processing pp_prefix:hk0

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2019-05-08 21:43:25.395082 starting: processing pp_prefix:sy0
2019-05-08 21:43:25.504201 finished: setting up pilot point process took: 0:00:08.338394
2019-05-08 21:43:25.504931 starting: setting up grid process
2019-05-08 21:43:25.505022 WARNING: grid_geostruc is None, using ExpVario with contribution=1
2019-05-08 21:43:25.505146 finished: setting up grid process took: 0:00:00.000215
2019-05-08 21:43:25.508889 starting: save test mlt array arr_mlt/hk0.dat_pp
2019-05-08 21:43:25.511497 finished: save test mlt array arr_mlt/hk0.dat_pp took: 0:00:00.002600
2019-05-08 21:43:25.512610 starting: save test mlt array arr_mlt/vka0.dat_pp
2019-05-08 21:43:25.514655 finished: save test mlt array arr_mlt/vka0.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.515487 starting: save test mlt array arr_mlt/ss0.dat_pp
2019-05-08 21:43:25.520809 finished: save test mlt array arr_mlt/ss0.dat_pp took: 0:00:00.005300
2019-05-08 21:43:25.521811 starting: save test mlt array arr_mlt/sy0.dat_pp
2019-05-08 21:43:25.524225 finished: save test mlt array arr_mlt/sy0.dat_pp took: 0:00:00.002400
2019-05-08 21:43:25.525280 starting: save test mlt array arr_mlt/strt0.dat_pp
2019-05-08 21:43:25.528150 finished: save test mlt array arr_mlt/strt0.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.529184 starting: save test mlt array arr_mlt/prsity0.dat_pp
2019-05-08 21:43:25.531761 finished: save test mlt array arr_mlt/prsity0.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.532665 starting: save test mlt array arr_mlt/hk1.dat_pp
2019-05-08 21:43:25.534868 finished: save test mlt array arr_mlt/hk1.dat_pp took: 0:00:00.002200
2019-05-08 21:43:25.535748 starting: save test mlt array arr_mlt/vka1.dat_pp
2019-05-08 21:43:25.537962 finished: save test mlt array arr_mlt/vka1.dat_pp took: 0:00:00.002200
2019-05-08 21:43:25.538839 starting: save test mlt array arr_mlt/ss1.dat_pp
2019-05-08 21:43:25.540925 finished: save test mlt array arr_mlt/ss1.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.541815 starting: save test mlt array arr_mlt/sy1.dat_pp
2019-05-08 21:43:25.543995 finished: save test mlt array arr_mlt/sy1.dat_pp took: 0:00:00.002100
2019-05-08 21:43:25.544729 starting: save test mlt array arr_mlt/strt1.dat_pp
2019-05-08 21:43:25.546915 finished: save test mlt array arr_mlt/strt1.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.547803 starting: save test mlt array arr_mlt/prsity1.dat_pp
2019-05-08 21:43:25.549823 finished: save test mlt array arr_mlt/prsity1.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.550704 starting: save test mlt array arr_mlt/hk2.dat_pp
2019-05-08 21:43:25.552766 finished: save test mlt array arr_mlt/hk2.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.553653 starting: save test mlt array arr_mlt/vka2.dat_pp
2019-05-08 21:43:25.555742 finished: save test mlt array arr_mlt/vka2.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.556649 starting: save test mlt array arr_mlt/ss2.dat_pp
2019-05-08 21:43:25.558872 finished: save test mlt array arr_mlt/ss2.dat_pp took: 0:00:00.002200
2019-05-08 21:43:25.559876 starting: save test mlt array arr_mlt/sy2.dat_pp
2019-05-08 21:43:25.562040 finished: save test mlt array arr_mlt/sy2.dat_pp took: 0:00:00.002100
2019-05-08 21:43:25.562735 starting: save test mlt array arr_mlt/strt2.dat_pp
2019-05-08 21:43:25.564975 finished: save test mlt array arr_mlt/strt2.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.565869 starting: save test mlt array arr_mlt/prsity2.dat_pp
2019-05-08 21:43:25.568064 finished: save test mlt array arr_mlt/prsity2.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.568976 starting: save test mlt array arr_mlt/rech0.dat_pp
2019-05-08 21:43:25.571057 finished: save test mlt array arr_mlt/rech0.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.571869 starting: save test mlt array arr_mlt/rech1.dat_pp
2019-05-08 21:43:25.574000 finished: save test mlt array arr_mlt/rech1.dat_pp took: 0:00:00.002000
2019-05-08 21:43:25.574882 starting: save test mlt array arr_mlt/hk3.dat_gr
2019-05-08 21:43:25.576926 finished: save test mlt array arr_mlt/hk3.dat_gr took: 0:00:00.002000
2019-05-08 21:43:25.577890 starting: save test mlt array arr_mlt/vka3.dat_gr

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2019-05-08 21:43:25.580007 finished: save test mlt array arr\_mlt/vka3.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.580835 starting: save test mlt array arr\_mlt/ss3.dat\_gr  
 2019-05-08 21:43:25.583085 finished: save test mlt array arr\_mlt/ss3.dat\_gr took: 0:00:00.0022  
 2019-05-08 21:43:25.583986 starting: save test mlt array arr\_mlt/sy3.dat\_gr  
 2019-05-08 21:43:25.586117 finished: save test mlt array arr\_mlt/sy3.dat\_gr took: 0:00:00.0021  
 2019-05-08 21:43:25.586946 starting: save test mlt array arr\_mlt/strt3.dat\_gr  
 2019-05-08 21:43:25.589080 finished: save test mlt array arr\_mlt/strt3.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.589806 starting: save test mlt array arr\_mlt/prsity3.dat\_gr  
 2019-05-08 21:43:25.592082 finished: save test mlt array arr\_mlt/prsity3.dat\_gr took: 0:00:00.  
 2019-05-08 21:43:25.593033 starting: save test mlt array arr\_mlt/hk4.dat\_gr  
 2019-05-08 21:43:25.595241 finished: save test mlt array arr\_mlt/hk4.dat\_gr took: 0:00:00.0022  
 2019-05-08 21:43:25.596164 starting: save test mlt array arr\_mlt/vka4.dat\_gr  
 2019-05-08 21:43:25.598270 finished: save test mlt array arr\_mlt/vka4.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.599178 starting: save test mlt array arr\_mlt/ss4.dat\_gr  
 2019-05-08 21:43:25.601315 finished: save test mlt array arr\_mlt/ss4.dat\_gr took: 0:00:00.0021  
 2019-05-08 21:43:25.602045 starting: save test mlt array arr\_mlt/sy4.dat\_gr  
 2019-05-08 21:43:25.604268 finished: save test mlt array arr\_mlt/sy4.dat\_gr took: 0:00:00.0022  
 2019-05-08 21:43:25.605031 starting: save test mlt array arr\_mlt/strt4.dat\_gr  
 2019-05-08 21:43:25.607255 finished: save test mlt array arr\_mlt/strt4.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.608176 starting: save test mlt array arr\_mlt/prsity4.dat\_gr  
 2019-05-08 21:43:25.610215 finished: save test mlt array arr\_mlt/prsity4.dat\_gr took: 0:00:00.  
 2019-05-08 21:43:25.611116 starting: save test mlt array arr\_mlt/hk5.dat\_gr  
 2019-05-08 21:43:25.613229 finished: save test mlt array arr\_mlt/hk5.dat\_gr took: 0:00:00.0021  
 2019-05-08 21:43:25.614118 starting: save test mlt array arr\_mlt/vka5.dat\_gr  
 2019-05-08 21:43:25.616200 finished: save test mlt array arr\_mlt/vka5.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.617023 starting: save test mlt array arr\_mlt/ss5.dat\_gr  
 2019-05-08 21:43:25.619209 finished: save test mlt array arr\_mlt/ss5.dat\_gr took: 0:00:00.0021  
 2019-05-08 21:43:25.620199 starting: save test mlt array arr\_mlt/sy5.dat\_gr  
 2019-05-08 21:43:25.622406 finished: save test mlt array arr\_mlt/sy5.dat\_gr took: 0:00:00.0022  
 2019-05-08 21:43:25.623345 starting: save test mlt array arr\_mlt/strt5.dat\_gr  
 2019-05-08 21:43:25.625447 finished: save test mlt array arr\_mlt/strt5.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.626147 starting: save test mlt array arr\_mlt/prsity5.dat\_gr  
 2019-05-08 21:43:25.628318 finished: save test mlt array arr\_mlt/prsity5.dat\_gr took: 0:00:00.  
 2019-05-08 21:43:25.629044 starting: save test mlt array arr\_mlt/rech2.dat\_gr  
 2019-05-08 21:43:25.631414 finished: save test mlt array arr\_mlt/rech2.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.632324 starting: save test mlt array arr\_mlt/rech3.dat\_gr  
 2019-05-08 21:43:25.634932 finished: save test mlt array arr\_mlt/rech3.dat\_gr took: 0:00:00.002  
 2019-05-08 21:43:25.636031 starting: save test mlt array arr\_mlt/hk6.dat\_cn  
 2019-05-08 21:43:25.638172 finished: save test mlt array arr\_mlt/hk6.dat\_cn took: 0:00:00.0021  
 2019-05-08 21:43:25.639068 starting: save test mlt array arr\_mlt/vka6.dat\_cn  
 2019-05-08 21:43:25.641311 finished: save test mlt array arr\_mlt/vka6.dat\_cn took: 0:00:00.002  
 2019-05-08 21:43:25.642220 starting: save test mlt array arr\_mlt/ss6.dat\_cn  
 2019-05-08 21:43:25.644293 finished: save test mlt array arr\_mlt/ss6.dat\_cn took: 0:00:00.0020  
 2019-05-08 21:43:25.645071 starting: save test mlt array arr\_mlt/sy6.dat\_cn  
 2019-05-08 21:43:25.647338 finished: save test mlt array arr\_mlt/sy6.dat\_cn took: 0:00:00.0022  
 2019-05-08 21:43:25.648233 starting: save test mlt array arr\_mlt/strt6.dat\_cn  
 2019-05-08 21:43:25.650738 finished: save test mlt array arr\_mlt/strt6.dat\_cn took: 0:00:00.002  
 2019-05-08 21:43:25.651790 starting: save test mlt array arr\_mlt/prsity6.dat\_cn

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2019-05-08 21:43:25.653930 finished: save test mlt array arr_mlt/prsity6.dat_cn took: 0:00:00.
2019-05-08 21:43:25.654984 starting: save test mlt array arr_mlt/hk7.dat_cn
2019-05-08 21:43:25.657467 finished: save test mlt array arr_mlt/hk7.dat_cn took: 0:00:00.0024
2019-05-08 21:43:25.658468 starting: save test mlt array arr_mlt/vka7.dat_cn
2019-05-08 21:43:25.661328 finished: save test mlt array arr_mlt/vka7.dat_cn took: 0:00:00.002
2019-05-08 21:43:25.662126 starting: save test mlt array arr_mlt/ss7.dat_cn
2019-05-08 21:43:25.664784 finished: save test mlt array arr_mlt/ss7.dat_cn took: 0:00:00.0026
2019-05-08 21:43:25.665721 starting: save test mlt array arr_mlt/sy7.dat_cn
2019-05-08 21:43:25.668200 finished: save test mlt array arr_mlt/sy7.dat_cn took: 0:00:00.0024
2019-05-08 21:43:25.669251 starting: save test mlt array arr_mlt/strt7.dat_cn
2019-05-08 21:43:25.671984 finished: save test mlt array arr_mlt/strt7.dat_cn took: 0:00:00.00
2019-05-08 21:43:25.673246 starting: save test mlt array arr_mlt/prsity7.dat_cn
2019-05-08 21:43:25.675805 finished: save test mlt array arr_mlt/prsity7.dat_cn took: 0:00:00.
2019-05-08 21:43:25.676749 starting: save test mlt array arr_mlt/hk8.dat_cn
2019-05-08 21:43:25.679033 finished: save test mlt array arr_mlt/hk8.dat_cn took: 0:00:00.0022
2019-05-08 21:43:25.680063 starting: save test mlt array arr_mlt/vka8.dat_cn
2019-05-08 21:43:25.683224 finished: save test mlt array arr_mlt/vka8.dat_cn took: 0:00:00.003
2019-05-08 21:43:25.684152 starting: save test mlt array arr_mlt/ss8.dat_cn
2019-05-08 21:43:25.690502 finished: save test mlt array arr_mlt/ss8.dat_cn took: 0:00:00.0063
2019-05-08 21:43:25.692030 starting: save test mlt array arr_mlt/sy8.dat_cn
2019-05-08 21:43:25.696533 finished: save test mlt array arr_mlt/sy8.dat_cn took: 0:00:00.0045
2019-05-08 21:43:25.698148 starting: save test mlt array arr_mlt/strt8.dat_cn
2019-05-08 21:43:25.701790 finished: save test mlt array arr_mlt/strt8.dat_cn took: 0:00:00.00
2019-05-08 21:43:25.703224 starting: save test mlt array arr_mlt/prsity8.dat_cn
2019-05-08 21:43:25.706975 finished: save test mlt array arr_mlt/prsity8.dat_cn took: 0:00:00.
2019-05-08 21:43:25.708820 starting: save test mlt array arr_mlt/rech4.dat_cn
2019-05-08 21:43:25.714117 finished: save test mlt array arr_mlt/rech4.dat_cn took: 0:00:00.00
2019-05-08 21:43:25.715846 starting: save test mlt array arr_mlt/rech5.dat_cn
2019-05-08 21:43:25.718912 finished: save test mlt array arr_mlt/rech5.dat_cn took: 0:00:00.00
2019-05-08 21:43:26.568140 forward_run line:pyemu.helpers.apply_array_pars()

all zeros for runoff...skipping...
all zeros for hcond1...skipping...
all zeros for ppts...skipping...
2019-05-08 21:43:26.723172 starting: processing obs type mflist water budget obs
2019-05-08 21:43:26.816796 forward_run line:pyemu.gw_utils.apply_mflist_budget_obs('freyberg.l
2019-05-08 21:43:26.817252 finished: processing obs type mflist water budget obs took: 0:00:00
2019-05-08 21:43:26.817576 starting: processing obs type hyd file
2019-05-08 21:43:26.817798 finished: processing obs type hyd file took: 0:00:00.000222
2019-05-08 21:43:26.818871 starting: processing obs type external obs-sim smp files
2019-05-08 21:43:26.819211 finished: processing obs type external obs-sim smp files took: 0:00
2019-05-08 21:43:26.819394 starting: processing obs type hob
2019-05-08 21:43:26.819706 finished: processing obs type hob took: 0:00:00.000312
2019-05-08 21:43:26.819842 starting: processing obs type hds
[[0, 0], [0, 1], [0, 2], [1, 0], [1, 1], [1, 2]]
2019-05-08 21:43:27.323904 finished: processing obs type hds took: 0:00:00.504062
2019-05-08 21:43:27.324268 starting: processing obs type sfr
writing 'sfr_obs.config' to template/sfr_obs.config

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2019-05-08 21:43:27.725182 finished: processing obs type sfr took: 0:00:00.400914
2019-05-08 21:43:27.725742 changing dir in to template
2019-05-08 21:43:27.726615 starting: instantiating control file from i/o files
2019-05-08 21:43:27.726715 tpl files: drn.csv.tpl,wel.csv.tpl,hk3.dat_gr.tpl,vka3.dat_gr.tpl,s
2019-05-08 21:43:27.726766 ins files: freyberg.hds.dat.ins,vol.dat.ins,freyberg.sfr.out.proces
2019-05-08 21:43:28.074337 finished: instantiating control file from i/o files took: 0:00:00.3
2019-05-08 21:43:28.306960 starting: writing forward_run.py
2019-05-08 21:43:28.307968 finished: writing forward_run.py took: 0:00:00.001008
2019-05-08 21:43:28.308215 writing pst template/freyberg.pst
noptmax:0, npar_adj:14819, nnz_obs:4434
2019-05-08 21:43:30.041653 starting: running pestchek on freyberg.pst
2019-05-08 21:43:30.115304 pestcheck:PESTCHEK Version 13.0. Watermark Numerical Computing.
2019-05-08 21:43:30.115654 pestcheck:
2019-05-08 21:43:30.115817 pestcheck:Errors ----->
2019-05-08 21:43:30.115978 pestcheck:Line 2403 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.116035 pestcheck:12 characters long.
2019-05-08 21:43:30.116079 pestcheck:Line 2404 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.116110 pestcheck:12 characters long.
2019-05-08 21:43:30.116149 pestcheck:Line 2404 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.116185 pestcheck:once.
2019-05-08 21:43:30.116215 pestcheck:Line 2405 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.116248 pestcheck:12 characters long.
2019-05-08 21:43:30.116760 pestcheck:Line 2405 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.116821 pestcheck:once.
2019-05-08 21:43:30.116861 pestcheck:Line 2406 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.117337 pestcheck:12 characters long.
2019-05-08 21:43:30.117465 pestcheck:Line 2406 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.117527 pestcheck:once.
2019-05-08 21:43:30.117887 pestcheck:Line 2407 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.118099 pestcheck:12 characters long.
2019-05-08 21:43:30.118214 pestcheck:Line 2407 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.118334 pestcheck:once.
2019-05-08 21:43:30.118443 pestcheck:Line 2408 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.118562 pestcheck:12 characters long.
2019-05-08 21:43:30.118671 pestcheck:Line 2408 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.118723 pestcheck:once.
2019-05-08 21:43:30.118764 pestcheck:Line 2409 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.118868 pestcheck:12 characters long.
2019-05-08 21:43:30.118985 pestcheck:Line 2409 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.119036 pestcheck:once.
2019-05-08 21:43:30.119143 pestcheck:Line 2410 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.119250 pestcheck:12 characters long.
2019-05-08 21:43:30.119367 pestcheck:Line 2410 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.119474 pestcheck:once.
2019-05-08 21:43:30.119591 pestcheck:Line 2411 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.119699 pestcheck:12 characters long.
2019-05-08 21:43:30.119816 pestcheck:Line 2411 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.119923 pestcheck:once.

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2019-05-08 21:43:30.120045 pestcheck:Line 2412 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.120153 pestcheck:12 characters long.  
2019-05-08 21:43:30.120269 pestcheck:Line 2412 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.120376 pestcheck:once.  
2019-05-08 21:43:30.120492 pestcheck:Line 2413 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.120599 pestcheck:12 characters long.  
2019-05-08 21:43:30.120715 pestcheck:Line 2414 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.120821 pestcheck:12 characters long.  
2019-05-08 21:43:30.120869 pestcheck:Line 2414 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.120975 pestcheck:once.  
2019-05-08 21:43:30.121167 pestcheck:Line 2415 of file freyberg.pst: parameter name "prsity3000  
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2019-05-08 21:43:30.121391 pestcheck:Line 2415 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.121499 pestcheck:once.  
2019-05-08 21:43:30.121615 pestcheck:Line 2416 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.121723 pestcheck:12 characters long.  
2019-05-08 21:43:30.121779 pestcheck:Line 2416 of file freyberg.pst: parameter name "prsity3000  
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2019-05-08 21:43:30.121980 pestcheck:Line 2417 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.122105 pestcheck:12 characters long.  
2019-05-08 21:43:30.122212 pestcheck:Line 2417 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.122328 pestcheck:once.  
2019-05-08 21:43:30.122435 pestcheck:Line 2418 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.122483 pestcheck:12 characters long.  
2019-05-08 21:43:30.122593 pestcheck:Line 2418 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.122700 pestcheck:once.  
2019-05-08 21:43:30.122815 pestcheck:Line 2419 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.122922 pestcheck:12 characters long.  
2019-05-08 21:43:30.123038 pestcheck:Line 2419 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.123228 pestcheck:once.  
2019-05-08 21:43:30.123336 pestcheck:Line 2420 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.123453 pestcheck:12 characters long.  
2019-05-08 21:43:30.123560 pestcheck:Line 2420 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.123675 pestcheck:once.  
2019-05-08 21:43:30.123783 pestcheck:Line 2421 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.123913 pestcheck:12 characters long.  
2019-05-08 21:43:30.124015 pestcheck:Line 2421 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.124136 pestcheck:once.  
2019-05-08 21:43:30.124238 pestcheck:Line 2422 of file freyberg.pst: parameter name "prsity3000  
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2019-05-08 21:43:30.124324 pestcheck:Line 2422 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.124421 pestcheck:once.  
2019-05-08 21:43:30.124522 pestcheck:Line 2423 of file freyberg.pst: parameter name "prsity3000  
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2019-05-08 21:43:30.124666 pestcheck:Line 2424 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.124767 pestcheck:12 characters long.  
2019-05-08 21:43:30.124877 pestcheck:Line 2424 of file freyberg.pst: parameter name "prsity3000  
2019-05-08 21:43:30.124978 pestcheck:once.

2019-05-08 21:43:30.125048 pestcheck:Line 2425 of file freyberg.pst: parameter name "prsity300.  
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2019-05-08 21:43:30.125238 pestcheck:Line 2425 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.125282 pestcheck:once.  
2019-05-08 21:43:30.125386 pestcheck:Line 2426 of file freyberg.pst: parameter name "prsity300.  
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2019-05-08 21:43:30.125809 pestcheck:Line 2427 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.125909 pestcheck:12 characters long.  
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2019-05-08 21:43:30.126142 pestcheck:once.  
2019-05-08 21:43:30.126209 pestcheck:Line 2428 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.126318 pestcheck:12 characters long.  
2019-05-08 21:43:30.126430 pestcheck:Line 2428 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.126476 pestcheck:once.  
2019-05-08 21:43:30.126513 pestcheck:Line 2429 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.126617 pestcheck:12 characters long.  
2019-05-08 21:43:30.126721 pestcheck:Line 2429 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.126770 pestcheck:once.  
2019-05-08 21:43:30.126810 pestcheck:Line 2430 of file freyberg.pst: parameter name "prsity300.  
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2019-05-08 21:43:30.127016 pestcheck:Line 2430 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.127072 pestcheck:once.  
2019-05-08 21:43:30.127172 pestcheck:Line 2431 of file freyberg.pst: parameter name "prsity300.  
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2019-05-08 21:43:30.127324 pestcheck:Line 2431 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.127428 pestcheck:once.  
2019-05-08 21:43:30.127531 pestcheck:Line 2432 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.127577 pestcheck:12 characters long.  
2019-05-08 21:43:30.127680 pestcheck:Line 2432 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.127784 pestcheck:once.  
2019-05-08 21:43:30.127895 pestcheck:Line 2433 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.127999 pestcheck:12 characters long.  
2019-05-08 21:43:30.128086 pestcheck:Line 2434 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.128156 pestcheck:12 characters long.  
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2019-05-08 21:43:30.128306 pestcheck:once.  
2019-05-08 21:43:30.128346 pestcheck:Line 2435 of file freyberg.pst: parameter name "prsity300.  
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2019-05-08 21:43:30.128549 pestcheck:Line 2435 of file freyberg.pst: parameter name "prsity300.  
2019-05-08 21:43:30.128615 pestcheck:once.  
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2019-05-08 21:43:30.129080 pestcheck:Line 2437 of file freyberg.pst: parameter name "prsity300.  
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2019-05-08 21:43:30.129284 pestcheck:Line 2437 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.129332 pestcheck:once.  
2019-05-08 21:43:30.129435 pestcheck:Line 2438 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.129652 pestcheck:Line 2438 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.129756 pestcheck:once.  
2019-05-08 21:43:30.129802 pestcheck:Line 2439 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.130006 pestcheck:Line 2439 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.130122 pestcheck:once.  
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2019-05-08 21:43:30.130310 pestcheck:Line 2440 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.130409 pestcheck:once.  
2019-05-08 21:43:30.130512 pestcheck:Line 2441 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.130727 pestcheck:Line 2441 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.130775 pestcheck:once.  
2019-05-08 21:43:30.130877 pestcheck:Line 2442 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.131246 pestcheck:Line 2443 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.131455 pestcheck:Line 2444 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.131543 pestcheck:Line 2444 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.132193 pestcheck:Line 2446 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.132398 pestcheck:Line 2446 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.132511 pestcheck:once.  
2019-05-08 21:43:30.132613 pestcheck:Line 2447 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.132701 pestcheck:Line 2447 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.133126 pestcheck:Line 2448 of file freyberg.pst: parameter name "prsity300  
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2019-05-08 21:43:30.133430 pestcheck:Line 2449 of file freyberg.pst: parameter name "prsity300  
2019-05-08 21:43:30.133467 pestcheck:once.

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2019-05-08 21:43:30.133725 pestcheck:Line 2450 of file freyberg.pst: parameter name "prsity3002  
2019-05-08 21:43:30.133762 pestcheck:once.  
2019-05-08 21:43:30.133862 pestcheck:Line 2451 of file freyberg.pst: parameter name "prsity3002  
2019-05-08 21:43:30.133965 pestcheck:12 characters long.  
2019-05-08 21:43:30.134018 pestcheck:Line 2451 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.134166 pestcheck:Line 2452 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.134305 pestcheck:Line 2452 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.134674 pestcheck:Line 2454 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.134831 pestcheck:Line 2454 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.135409 pestcheck:Line 2456 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.135702 pestcheck:Line 2457 of file freyberg.pst: parameter name "prsity3002  
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2019-05-08 21:43:30.137671 pestcheck:Line 2463 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.138118 pestcheck:Line 2465 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.138330 pestcheck:Line 2465 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.138517 pestcheck:Line 2466 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.138670 pestcheck:Line 2466 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.138825 pestcheck:Line 2467 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.138862 pestcheck:12 characters long.  
2019-05-08 21:43:30.138965 pestcheck:Line 2467 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.139264 pestcheck:Line 2468 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.139482 pestcheck:Line 2468 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.139595 pestcheck:once.  
2019-05-08 21:43:30.139697 pestcheck:Line 2469 of file freyberg.pst: parameter name "prsity3003  
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2019-05-08 21:43:30.139846 pestcheck:Line 2469 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.139949 pestcheck:once.  
2019-05-08 21:43:30.140071 pestcheck:Line 2470 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.140175 pestcheck:12 characters long.  
2019-05-08 21:43:30.140287 pestcheck:Line 2470 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.140396 pestcheck:once.  
2019-05-08 21:43:30.140508 pestcheck:Line 2471 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.140611 pestcheck:12 characters long.  
2019-05-08 21:43:30.140656 pestcheck:Line 2471 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.140761 pestcheck:once.  
2019-05-08 21:43:30.140866 pestcheck:Line 2472 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.140911 pestcheck:12 characters long.  
2019-05-08 21:43:30.141092 pestcheck:Line 2472 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.141141 pestcheck:once.  
2019-05-08 21:43:30.141214 pestcheck:Line 2473 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.141286 pestcheck:12 characters long.  
2019-05-08 21:43:30.141388 pestcheck:Line 2474 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.141500 pestcheck:12 characters long.  
2019-05-08 21:43:30.141603 pestcheck:Line 2474 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.141715 pestcheck:once.  
2019-05-08 21:43:30.141819 pestcheck:Line 2475 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.141931 pestcheck:12 characters long.



2019-05-08 21:43:30.142115 pestcheck:Line 2475 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.142218 pestcheck:once.  
2019-05-08 21:43:30.142263 pestcheck:Line 2476 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.142365 pestcheck:12 characters long.  
2019-05-08 21:43:30.142467 pestcheck:Line 2476 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.142579 pestcheck:once.  
2019-05-08 21:43:30.142632 pestcheck:Line 2477 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.142729 pestcheck:12 characters long.  
2019-05-08 21:43:30.142775 pestcheck:Line 2477 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.142812 pestcheck:once.  
2019-05-08 21:43:30.142911 pestcheck:Line 2478 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.143030 pestcheck:12 characters long.  
2019-05-08 21:43:30.143132 pestcheck:Line 2478 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.143237 pestcheck:once.  
2019-05-08 21:43:30.143349 pestcheck:Line 2479 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.143451 pestcheck:12 characters long.  
2019-05-08 21:43:30.143561 pestcheck:Line 2479 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.143662 pestcheck:once.  
2019-05-08 21:43:30.143772 pestcheck:Line 2480 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.143874 pestcheck:12 characters long.  
2019-05-08 21:43:30.143992 pestcheck:Line 2480 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.144094 pestcheck:once.  
2019-05-08 21:43:30.144204 pestcheck:Line 2481 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.144305 pestcheck:12 characters long.  
2019-05-08 21:43:30.144415 pestcheck:Line 2481 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.144517 pestcheck:once.  
2019-05-08 21:43:30.144624 pestcheck:Line 2482 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.144727 pestcheck:12 characters long.  
2019-05-08 21:43:30.144771 pestcheck:Line 2482 of file freyberg.pst: parameter name "prsity3003  
2019-05-08 21:43:30.144875 pestcheck:once.  
2019-05-08 21:43:30.145057 pestcheck:Line 2483 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.145158 pestcheck:12 characters long.  
2019-05-08 21:43:30.145270 pestcheck:Line 2484 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.145373 pestcheck:12 characters long.  
2019-05-08 21:43:30.145483 pestcheck:Line 2484 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.145584 pestcheck:once.  
2019-05-08 21:43:30.145631 pestcheck:Line 2485 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.145733 pestcheck:12 characters long.  
2019-05-08 21:43:30.145834 pestcheck:Line 2485 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.145882 pestcheck:once.  
2019-05-08 21:43:30.146056 pestcheck:Line 2486 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.146166 pestcheck:12 characters long.  
2019-05-08 21:43:30.146268 pestcheck:Line 2486 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.146315 pestcheck:once.  
2019-05-08 21:43:30.146416 pestcheck:Line 2487 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.146518 pestcheck:12 characters long.  
2019-05-08 21:43:30.146628 pestcheck:Line 2487 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.146730 pestcheck:once.

2019-05-08 21:43:30.146840 pestcheck:Line 2488 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.146942 pestcheck:12 characters long.  
2019-05-08 21:43:30.147060 pestcheck:Line 2488 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.147162 pestcheck:once.  
2019-05-08 21:43:30.147209 pestcheck:Line 2489 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.147310 pestcheck:12 characters long.  
2019-05-08 21:43:30.147411 pestcheck:Line 2489 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.147521 pestcheck:once.  
2019-05-08 21:43:30.147622 pestcheck:Line 2490 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.147733 pestcheck:12 characters long.  
2019-05-08 21:43:30.147834 pestcheck:Line 2490 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.147944 pestcheck:once.  
2019-05-08 21:43:30.148128 pestcheck:Line 2491 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.148230 pestcheck:12 characters long.  
2019-05-08 21:43:30.148340 pestcheck:Line 2491 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.148442 pestcheck:once.  
2019-05-08 21:43:30.148554 pestcheck:Line 2492 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.148655 pestcheck:12 characters long.  
2019-05-08 21:43:30.148700 pestcheck:Line 2492 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.148737 pestcheck:once.  
2019-05-08 21:43:30.148835 pestcheck:Line 2493 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.148964 pestcheck:12 characters long.  
2019-05-08 21:43:30.149138 pestcheck:Line 2494 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.149185 pestcheck:12 characters long.  
2019-05-08 21:43:30.149286 pestcheck:Line 2494 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.149388 pestcheck:once.  
2019-05-08 21:43:30.149498 pestcheck:Line 2495 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.149599 pestcheck:12 characters long.  
2019-05-08 21:43:30.149707 pestcheck:Line 2495 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.149810 pestcheck:once.  
2019-05-08 21:43:30.149857 pestcheck:Line 2496 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.149897 pestcheck:12 characters long.  
2019-05-08 21:43:30.149994 pestcheck:Line 2496 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.150104 pestcheck:once.  
2019-05-08 21:43:30.150151 pestcheck:Line 2497 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.150188 pestcheck:12 characters long.  
2019-05-08 21:43:30.150286 pestcheck:Line 2497 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.150386 pestcheck:once.  
2019-05-08 21:43:30.150496 pestcheck:Line 2498 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.150597 pestcheck:12 characters long.  
2019-05-08 21:43:30.150707 pestcheck:Line 2498 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.150809 pestcheck:once.  
2019-05-08 21:43:30.150918 pestcheck:Line 2499 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.151019 pestcheck:12 characters long.  
2019-05-08 21:43:30.151136 pestcheck:Line 2499 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.151239 pestcheck:once.  
2019-05-08 21:43:30.151349 pestcheck:Line 2500 of file freyberg.pst: parameter name "prsity3004  
2019-05-08 21:43:30.151451 pestcheck:12 characters long.

```

2019-05-08 21:43:30.151560 pestcheck:Line 2500 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.151661 pestcheck:once.
2019-05-08 21:43:30.151772 pestcheck:Line 2501 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.151873 pestcheck:12 characters long.
2019-05-08 21:43:30.151983 pestcheck:Line 2501 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.152163 pestcheck:once.
2019-05-08 21:43:30.152265 pestcheck:Line 2502 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.152346 pestcheck:12 characters long.
2019-05-08 21:43:30.152415 pestcheck:Line 2502 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.152515 pestcheck:once.
2019-05-08 21:43:30.152625 pestcheck:Line 2503 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.152727 pestcheck:12 characters long.
2019-05-08 21:43:30.152772 pestcheck:Line 2504 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.152876 pestcheck:12 characters long.
2019-05-08 21:43:30.152978 pestcheck:Line 2504 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.153096 pestcheck:once.
2019-05-08 21:43:30.153501 pestcheck:Line 2505 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.153565 pestcheck:12 characters long.
2019-05-08 21:43:30.154146 pestcheck:Line 2505 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.154345 pestcheck:once.
2019-05-08 21:43:30.154456 pestcheck:Line 2506 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.154508 pestcheck:12 characters long.
2019-05-08 21:43:30.154613 pestcheck:Line 2506 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.154718 pestcheck:once.
2019-05-08 21:43:30.154766 pestcheck:Line 2507 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.154870 pestcheck:12 characters long.
2019-05-08 21:43:30.154974 pestcheck:Line 2507 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.155023 pestcheck:once.
2019-05-08 21:43:30.155127 pestcheck:Line 2508 of file freyberg.pst: parameter name "prsity300
2019-05-08 21:43:30.155249 pestcheck:12 characters long.
2019-05-08 21:43:30.155622 finished: running pestchek on freyberg.pst took: 0:00:00.113969
2019-05-08 21:43:30.155704 starting: saving intermediate _setup_<> dfs into template
2019-05-08 21:43:30.282452 finished: saving intermediate _setup_<> dfs into template took: 0:0
2019-05-08 21:43:30.283028 all done

```

The `pst_helper` instance contains the `pyemu.Pst` instance:

```

In [14]: # so, pull out the `pyemu.Pst` instance which
         #contains all the input that ultimately goes in the PEST control %%file
         pst = pst_helper.pst
         pst.npar,pst.nobs

```

```

Out[14]: (14819, 4434)

```

Oh snap!

### 1.1.6 Add modpath input files, instruction files and calls

First copy over all the MODPATH-related files from the base directory identified in the `b_d` variable. We will track a single particle for forecast purposes

```
In [15]: mp_files = [f for f in os.listdir(b_d) if "mp" in f or "location" in f]
          [shutil.copy2(os.path.join(b_d,f),os.path.join(pst_helper.new_model_ws,f)) for f in mp_files]

Out[15]: ['template/mp_ibound_1.ref',
          'template/mp_ibound_2.ref',
          'template/mp_ibound_3.ref',
          'template/freyberg.locations',
          'template/freyberg.mpsim',
          'template/freyberg.mpbas',
          'template/freyberg.mpnam']
```

The following `frun_post_lines` property adds statements at the end of the `forward_run.py` script. In this case, it runs MODPATH using `mp6`. We will also identify any additional temporary files that the forward run script should attempt to remove at the start of a run.

```
In [16]: pst_helper.frun_post_lines.append("os.system('mp6 freyberg.mpsim >mp6.stdout')")
          pst_helper.tmp_files.append("freyberg.mpenpt")
          pst_helper.write_forward_run()
```

Create and add instruction files and related observations for MODPATH

```
In [17]: out_file = "freyberg.mpenpt"
          ins_file = out_file + ".ins"
          with open(os.path.join(pst_helper.new_model_ws,ins_file),'w') as f:
              f.write("pif ~\n")
              f.write("l7 w w !part_status! w w !part_time!\n")
          df = pst_helper.pst.add_observations(os.path.join(pst_helper.new_model_ws,ins_file),
                                              os.path.join(pst_helper.new_model_ws,out_file),
                                              pst_path=".")
```

error using inschek for instruction file ./freyberg.mpenpt.ins:File b'template/./freyberg.mpenpt.ins' observations in this instruction file will have generic values.

Finally we need to copy the original `prsim` arrays to the `arr_org` dir for use in the multiplier parameterization scheme

```
In [18]: for k in range(m.nlay):
          np.savetxt(os.path.join(pst_helper.new_model_ws,"arr_org","prsim_layer_{0}.ref".format(k)),
```

### 1.1.7 Final bits and bobs

We need to set some realistic parameter bounds and account for expected (but stochastic) scenario conditions:

`pyemu` uses pandas data frame format for the parameter and observation data sections. This exposes plenty of querying and bulk editing options.

```

In [19]: par = pst.parameter_data
# properties
tag_dict = {"hk": [0.1, 10.0], "vka": [0.1, 10], "strt": [0.95, 1.05], "prsity": [0.5, 1.5]}
for t, [l, u] in tag_dict.items():
    t_pars = par.loc[par.parnme.apply(lambda x: t in x), "parnme"]
    par.loc[t_pars, "parubnd"] = u
    par.loc[t_pars, "parlbnd"] = l

# recharge - just change the constant recharge mult
# for the historic and scenario stress periods
scen_rch = ["cn_rech5"]
hist_rch = ["cn_rech4"]
par.loc[par.pargp.apply(lambda x: x in scen_rch), "parubnd"] = 0.8
par.loc[par.pargp.apply(lambda x: x in scen_rch), "parlbnd"] = 0.1
par.loc[par.pargp.apply(lambda x: x in scen_rch), "parval1"] = 0.4
par.loc[par.pargp.apply(lambda x: x in hist_rch), "parubnd"] = 1.2
par.loc[par.pargp.apply(lambda x: x in hist_rch), "parlbnd"] = 0.8
par.loc[par.pargp.apply(lambda x: x in hist_rch), "parval1"] = 1.0

# well abstraction - same idea here: change the historic and scenario pars
par.loc["welflux_001", "parval1"] = 1.5
par.loc["welflux_001", "parlbnd"] = 1.0
par.loc["welflux_001", "parubnd"] = 2.0
par.loc["welflux_000", "parval1"] = 1.0
par.loc["welflux_000", "parlbnd"] = 0.5
par.loc["welflux_000", "parubnd"] = 1.5

```

given the combinations of multipliers, we need to set a hard upper bound on porosity and sy since those have physical upper limits

```

In [20]: arr_csv = os.path.join(pst_helper.new_model_ws, "arr_pars.csv")
df = pd.read_csv(arr_csv, index_col=0)
pr_sy = df.model_file.apply(lambda x: "prsity" in x or "sy" in x)
df.loc[:, "upper_bound"] = np.NaN
df.loc[pr_sy, "upper_bound"] = 0.4
df.to_csv(arr_csv)

```

```

In [21]: # table can also be written to a .tex file
pst.write_par_summary_table(filename="none").sort_index()

```

```

Out[21]:

```

	type	transform	count	initial value	\
cn_hk6	cn_hk6	log	1	0	
cn_hk7	cn_hk7	log	1	0	
cn_hk8	cn_hk8	log	1	0	
cn_prsity6	cn_prsity6	log	1	0	
cn_prsity7	cn_prsity7	log	1	0	
cn_prsity8	cn_prsity8	log	1	0	
cn_rech4	cn_rech4	log	1	0	
cn_rech5	cn_rech5	log	1	-0.39794	

cn_ss6	cn_ss6	log	1	0
cn_ss7	cn_ss7	log	1	0
cn_ss8	cn_ss8	log	1	0
cn_strt6	cn_strt6	log	1	0
cn_strt7	cn_strt7	log	1	0
cn_strt8	cn_strt8	log	1	0
cn_sy6	cn_sy6	log	1	0
cn_sy7	cn_sy7	log	1	0
cn_sy8	cn_sy8	log	1	0
cn_vka6	cn_vka6	log	1	0
cn_vka7	cn_vka7	log	1	0
cn_vka8	cn_vka8	log	1	0
drncond_k00	drncond_k00	log	10	0
flow	flow	log	1	0
gr_hk3	gr_hk3	log	705	0
gr_hk4	gr_hk4	log	705	0
gr_hk5	gr_hk5	log	705	0
gr_prsity3	gr_prsity3	log	705	0
gr_prsity4	gr_prsity4	log	705	0
gr_prsity5	gr_prsity5	log	705	0
gr_rech2	gr_rech2	log	705	0
gr_rech3	gr_rech3	log	705	0
...	...	...	...	...
gr_strt5	gr_strt5	log	705	0
gr_sy3	gr_sy3	log	705	0
gr_sy4	gr_sy4	log	705	0
gr_sy5	gr_sy5	log	705	0
gr_vka3	gr_vka3	log	705	0
gr_vka4	gr_vka4	log	705	0
gr_vka5	gr_vka5	log	705	0
pp_hk0	pp_hk0	log	32	0
pp_hk1	pp_hk1	log	32	0
pp_hk2	pp_hk2	log	32	0
pp_prsity0	pp_prsity0	log	32	0
pp_prsity1	pp_prsity1	log	32	0
pp_prsity2	pp_prsity2	log	32	0
pp_rech0	pp_rech0	log	32	0
pp_rech1	pp_rech1	log	32	0
pp_ss0	pp_ss0	log	32	0
pp_ss1	pp_ss1	log	32	0
pp_ss2	pp_ss2	log	32	0
pp_strt0	pp_strt0	log	32	0
pp_strt1	pp_strt1	log	32	0
pp_strt2	pp_strt2	log	32	0
pp_sy0	pp_sy0	log	32	0
pp_sy1	pp_sy1	log	32	0
pp_sy2	pp_sy2	log	32	0
pp_vka0	pp_vka0	log	32	0

pp_vka1	pp_vka1	log	32	0
pp_vka2	pp_vka2	log	32	0
strk	strk	log	40	0
welflux	welflux	log	2	0 to 0.176091
welflux_k02	welflux_k02	log	6	0

	upper bound	lower bound	standard deviation
cn_hk6	1	-1	0.5
cn_hk7	1	-1	0.5
cn_hk8	1	-1	0.5
cn_prsity6	0.176091	-0.30103	0.11928
cn_prsity7	0.176091	-0.30103	0.11928
cn_prsity8	0.176091	-0.30103	0.11928
cn_rech4	0.0791812	-0.09691	0.0440228
cn_rech5	-0.09691	-1	0.225772
cn_ss6	1	-1	0.5
cn_ss7	1	-1	0.5
cn_ss8	1	-1	0.5
cn_strt6	0.0211893	-0.0222764	0.0108664
cn_strt7	0.0211893	-0.0222764	0.0108664
cn_strt8	0.0211893	-0.0222764	0.0108664
cn_sy6	0.243038	-0.60206	0.211275
cn_sy7	0.243038	-0.60206	0.211275
cn_sy8	0.243038	-0.60206	0.211275
cn_vka6	1	-1	0.5
cn_vka7	1	-1	0.5
cn_vka8	1	-1	0.5
drncond_k00	1	-1	0.5
flow	0.09691	-0.124939	0.0554622
gr_hk3	1	-1	0.5
gr_hk4	1	-1	0.5
gr_hk5	1	-1	0.5
gr_prsity3	0.176091	-0.30103	0.11928
gr_prsity4	0.176091	-0.30103	0.11928
gr_prsity5	0.176091	-0.30103	0.11928
gr_rech2	0.0413927	-0.0457575	0.0217875
gr_rech3	0.0413927	-0.0457575	0.0217875
...	...	...	...
gr_strt5	0.0211893	-0.0222764	0.0108664
gr_sy3	0.243038	-0.60206	0.211275
gr_sy4	0.243038	-0.60206	0.211275
gr_sy5	0.243038	-0.60206	0.211275
gr_vka3	1	-1	0.5
gr_vka4	1	-1	0.5
gr_vka5	1	-1	0.5
pp_hk0	1	-1	0.5
pp_hk1	1	-1	0.5
pp_hk2	1	-1	0.5

pp_prsity0	0.176091	-0.30103	0.11928
pp_prsity1	0.176091	-0.30103	0.11928
pp_prsity2	0.176091	-0.30103	0.11928
pp_rech0	0.0413927	-0.0457575	0.0217875
pp_rech1	0.0413927	-0.0457575	0.0217875
pp_ss0	1	-1	0.5
pp_ss1	1	-1	0.5
pp_ss2	1	-1	0.5
pp_strt0	0.0211893	-0.0222764	0.0108664
pp_strt1	0.0211893	-0.0222764	0.0108664
pp_strt2	0.0211893	-0.0222764	0.0108664
pp_sy0	0.243038	-0.60206	0.211275
pp_sy1	0.243038	-0.60206	0.211275
pp_sy2	0.243038	-0.60206	0.211275
pp_vka0	1	-1	0.5
pp_vka1	1	-1	0.5
pp_vka2	1	-1	0.5
strk	2	-2	1
welflux	0.176091 to 0.30103	-0.30103 to 0	0.0752575 to 0.11928
welflux_k02	1	-1	0.5

[65 rows x 7 columns]

In [22]: `pst.write_obs_summary_table(filename="none")`

Out [22]:

	group	value	non-zero weight \
flaqx	flaqx	-977.239 to 32.171	84
flout	flout	10069 to 226396	84
flx_constan	flx_constan	0	2
flx_drains	flx_drains	-723.325 to -723.028	2
flx_in-out	flx_in-out	0.012695 to 0.046143	2
flx_percent	flx_percent	0	2
flx_recharg	flx_recharg	3045.6	2
flx_storage	flx_storage	5.7734 to 8.01049	2
flx_stream_	flx_stream_	-1430.27 to -1428.3	2
flx_total	flx_total	0.0126953 to 0.0461426	2
flx_wells	flx_wells	-900	2
hds	hds	32.5065 to 39.6612	4230
obgnme	obgnme	1E+10	2
vol_constan	vol_constan	0	2
vol_drains	vol_drains	-2.90404E+06 to -2.64014E+06	2
vol_in-out	vol_in-out	45 to 63	2
vol_percent	vol_percent	0	2
vol_recharg	vol_recharg	1.11164E+07 to 1.22281E+07	2
vol_storage	vol_storage	29238.3 to 31345.6	2
vol_stream_	vol_stream_	-5.74182E+06 to -5.22049E+06	2
vol_total	vol_total	45 to 63	2
vol_wells	vol_wells	-3.6135E+06 to -3.285E+06	2



	zero weight	weight	standard deviation	percent error
flaqx	0	1	1	0.102329 to 833.333
flout	0	1	1	0.000441704 to 0.00993147
flx_constan	0	1	1	NA
flx_drains	0	1	1	0.13825 to 0.138307
flx_in-out	0	1	1	2167.18 to 7877.12
flx_percent	0	1	1	NA
flx_recharg	0	1	1	0.0328343
flx_storage	0	1	1	12.4836 to 17.3208
flx_stream_	0	1	1	0.0699167 to 0.0700133
flx_total	0	1	1	2167.2 to 7876.92
flx_wells	0	1	1	0.111111
hds	0	1	1	2.52136 to 3.07631
obgnme	0	1	1	1E-08
vol_constan	0	1	1	NA
vol_drains	0	1	1	3.44348E-05 to 3.78768E-05
vol_in-out	0	1	1	1.5873 to 2.22222
vol_percent	0	1	1	NA
vol_recharg	0	1	1	8.1779E-06 to 8.99569E-06
vol_storage	0	1	1	0.00319024 to 0.00342017
vol_stream_	0	1	1	1.74161E-05 to 1.91553E-05
vol_total	0	1	1	1.5873 to 2.22222
vol_wells	0	1	1	2.7674E-05 to 3.04414E-05

Lets run the process once (noptmax=0) to make sure its all plumbed up

```
In [23]: pst.control_data.noptmax = 0
pst.write(os.path.join(pst_helper.new_model_ws,"freyberg.pst"))
pyemu.os_utils.run("pestpp-ies freyberg.pst",cwd=pst_helper.new_model_ws)
```

```
noptmax:0, npar_adj:14819, nnz_obs:4436
```

Now we need to generate the prior parameter covariance matrix and stochastic realizations. We will use the geostatistical covariance information in the pst\_helper instance for this:

```
In [24]: if pst_helper.pst.npar < 15000:
cov = pst_helper.build_prior(fmt="coo",filename=os.path.join(pst_helper.new_model_ws,"cov.coo"))
cov = np.ma.masked_where(cov.x==0,cov.x)
fig = plt.figure(figsize=(10,10))
ax = plt.subplot(111)
ax.imshow(cov)
plt.show()
```

```
2019-05-08 21:43:39.578982 starting: building prior covariance matrix
```

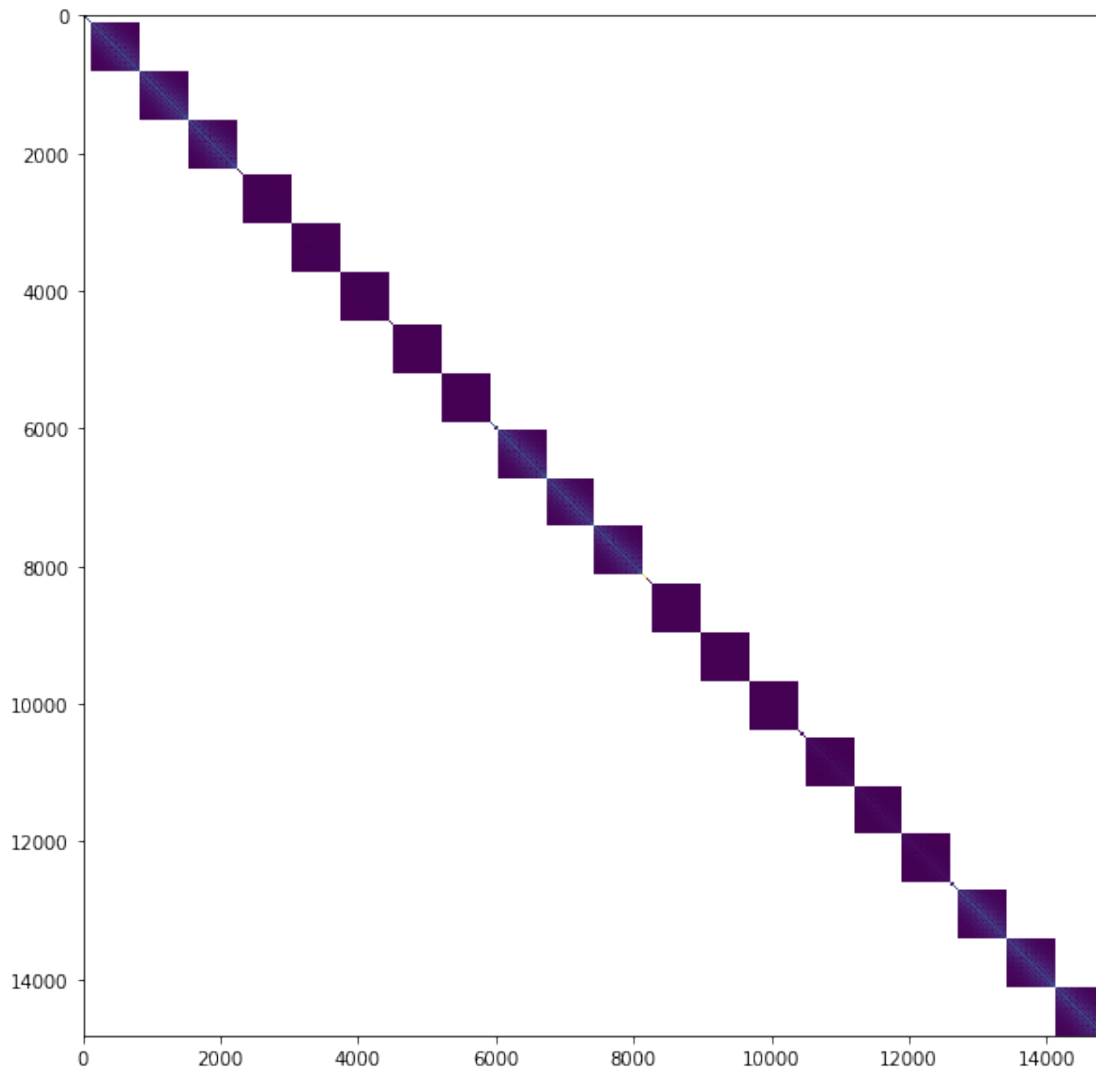
```
2019-05-08 21:43:39.690876 WARNING: geospatial prior not implemented for SFR pars
```

```
/Users/jeremyw/miniconda3/lib/python3.5/site-packages/pandas/core/indexing.py:362: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

```
See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html
  self.obj[key] = _infer_fill_value(value)
/Users/jeremyw/miniconda3/lib/python3.5/site-packages/pandas/core/indexing.py:543: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead
```

```
See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html
  self.obj[item] = s
```

```
2019-05-08 21:43:46.225474 saving prior covariance matrix to file template/prior_cov.jcb
2019-05-08 21:43:50.579926 finished: building prior covariance matrix took: 0:00:11.000944
```



### 1.1.8 now we can make a draw of 200 from the prior parameter covariance matrix to form a prior parameter ensemble

```
In [25]: pe = pst_helper.draw(200)
```

```
2019-05-08 21:44:05.471736 starting: drawing realizations
```

```
building diagonal cov
```

```
processing name:grid_geostruct,nugget:0.0,structures:
```

```
name:var1,contribution:1.0,a:2500.0,anisotropy:1.0,bearing:0.0
```

```
working on pargroups ['gr_hk3']
```

```
build cov matrix
```

```
done
```

```
getting diag var cov 705
```

```
scaling full cov by diag var cov
```

```
making full cov draws with home-grown goodness
```

```
working on pargroups ['gr_vka3']
```

```
build cov matrix
```

```
done
```

```
getting diag var cov 705
```

```
scaling full cov by diag var cov
```

```
making full cov draws with home-grown goodness
```

```
working on pargroups ['gr_ss3']
```

```
build cov matrix
```

```
done
```

```
getting diag var cov 705
```

```
scaling full cov by diag var cov
```

```
making full cov draws with home-grown goodness
```

```
working on pargroups ['gr_sy3']
```

```
build cov matrix
```

```
done
```

```
getting diag var cov 705
```

```
scaling full cov by diag var cov
```

```
making full cov draws with home-grown goodness
```

```
working on pargroups ['gr_strt3']
```

```
build cov matrix
```

```
done
```

```
getting diag var cov 705
```

```
scaling full cov by diag var cov
```

```
making full cov draws with home-grown goodness
```

```
working on pargroups ['gr_prsity3']
```

```
build cov matrix
```

```
done
```

```
getting diag var cov 705
```

```
scaling full cov by diag var cov
```

```

making full cov draws with home-grown goodness
working on pargroups ['gr_hk4']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_vka4']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_ss4']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_sy4']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_strt4']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_prsity4']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_hk5']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_vka5']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov

```

```

making full cov draws with home-grown goodness
working on pargroups ['gr_ss5']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_sy5']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_strt5']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_prsity5']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_rech2']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['gr_rech3']
build cov matrix
done
getting diag var cov 705
scaling full cov by diag var cov
making full cov draws with home-grown goodness
processing name:pp_geostruct,nugget:0.0,structures:
name:var1,contribution:1.0,a:1000.0,anisotropy:1.0,bearing:0.0

working on pargroups ['pp_hk0']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_vka0']
build cov matrix

```

```

done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_ss0']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_sy0']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_strt0']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_prsity0']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_rech0']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_rech1']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_prsity1']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_sy1']
build cov matrix

```

```

done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_vka1']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_ss1']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_strt1']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_hk1']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_strt2']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_prsity2']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_ss2']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_vka2']
build cov matrix

```

```

done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_sy2']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['pp_hk2']
build cov matrix
done
getting diag var cov 32
scaling full cov by diag var cov
making full cov draws with home-grown goodness
processing name:spatial_list_geostuct,nugget:0.0,structures:
name:var1,contribution:1.0,a:2500.0,anisotropy:1.0,bearing:0.0

working on pargroups ['drncond_k00']

```

```

/Users/jeremyw/miniconda3/lib/python3.5/site-packages/pandas/core/indexing.py:362: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

```

```

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html
    self.obj[key] = _infer_fill_value(value)
/Users/jeremyw/miniconda3/lib/python3.5/site-packages/pandas/core/indexing.py:543: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

```

```

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html
    self.obj[item] = s

```

```

build cov matrix
done
getting diag var cov 10
scaling full cov by diag var cov
making full cov draws with home-grown goodness
working on pargroups ['welflux_k02']
build cov matrix
done
getting diag var cov 6
scaling full cov by diag var cov
making full cov draws with home-grown goodness
processing name:temporal_list_geostuct,nugget:0.0,structures:

```



```
name:var1,contribution:1.0,a:180.0,anisotropy:1.0,bearing:0.0

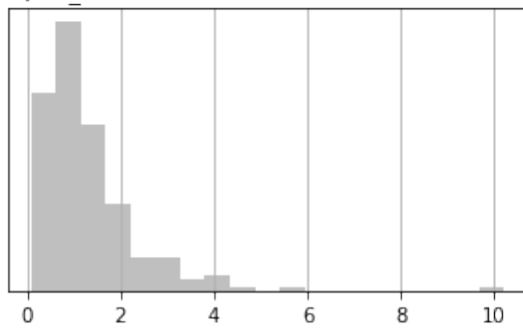
working on pargroups ['welflux']
build cov matrix
done
getting diag var cov 2
scaling full cov by diag var cov
making full cov draws with home-grown goodness
adding remaining parameters to diagonal
2019-05-08 21:44:13.488251 finished: drawing realizations took: 0:00:08.016515
```

You can see that parameters are treated in parameter group (pargp) blocks for this ensemble generation. Let's plot one parameter:

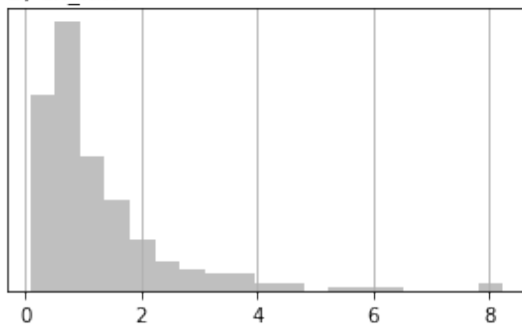
```
In [26]: par = pst_helper.pst.parameter_data
         pyemu.plot_utils.ensemble_helper(pe,plot_cols=par.groupby("pargp").groups,bins=20)
         plt.show()
```

<Figure size 576x756 with 0 Axes>

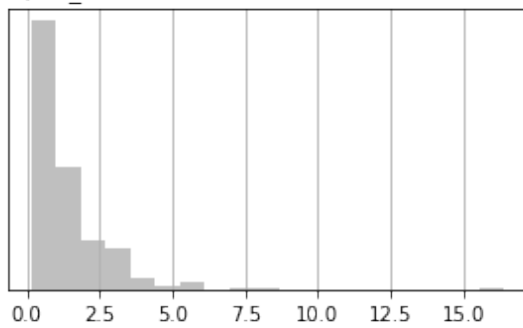
A) cn\_hk6



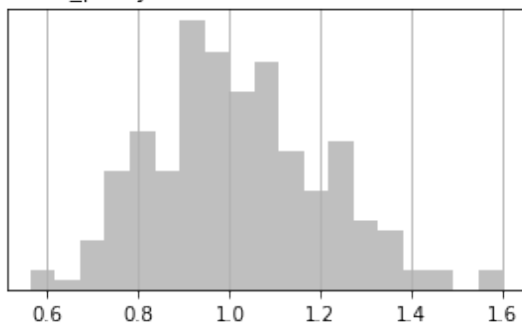
B) cn\_hk7



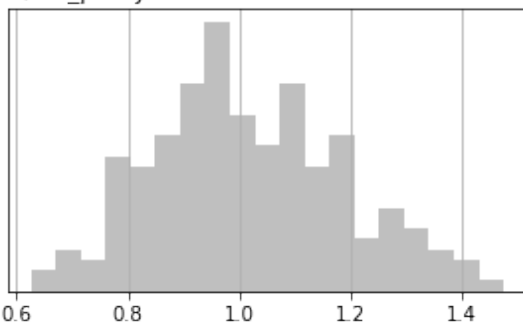
C) cn\_hk8



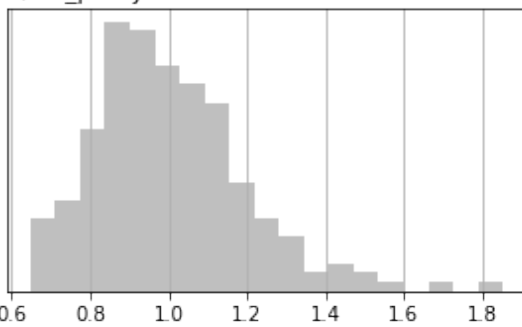
D) cn\_prsity6



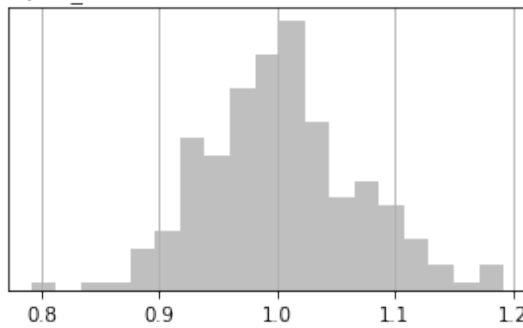
E) cn\_prsity7



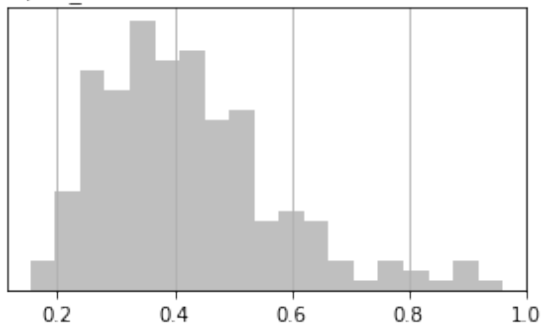
F) cn\_prsity8



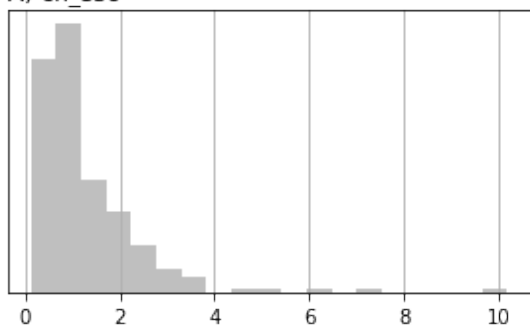
G) cn\_rech4



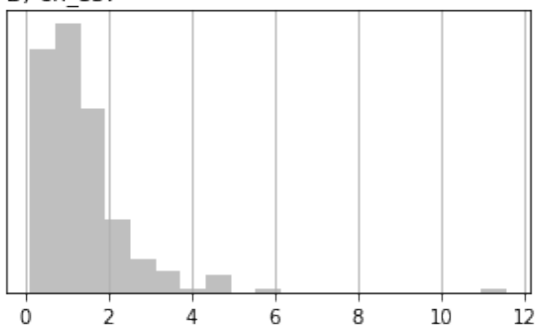
H) cn\_rech5



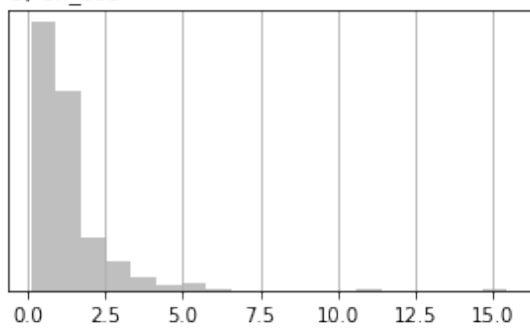
A) cn\_ss6



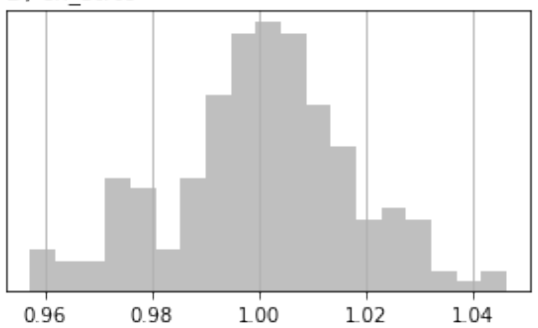
B) cn\_ss7



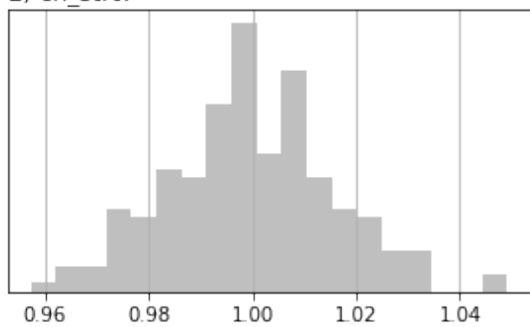
C) cn\_ss8



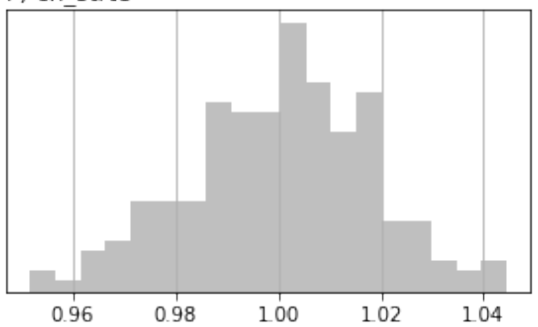
D) cn\_strt6



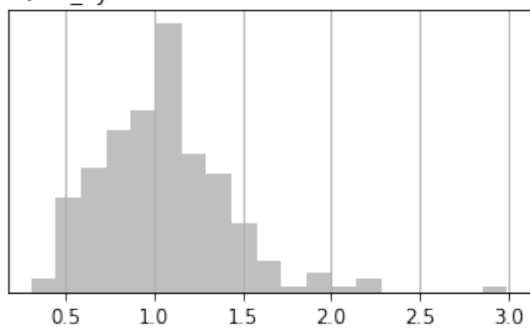
E) cn\_strt7



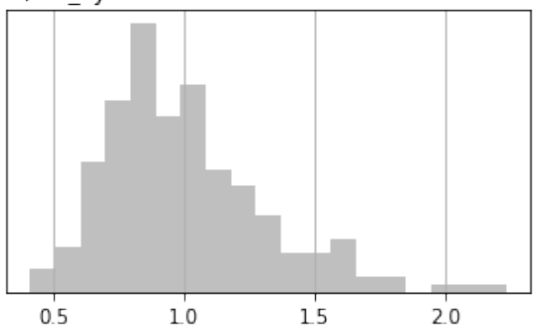
F) cn\_strt8



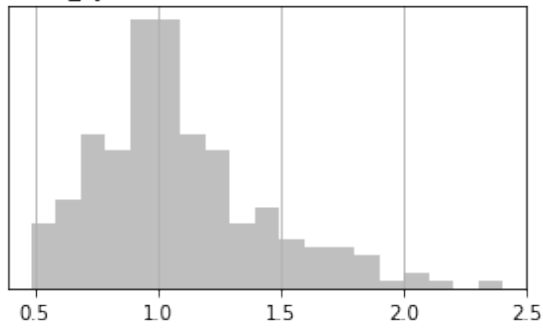
G) cn\_sy6



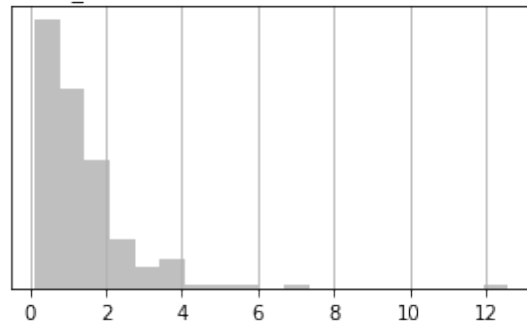
H) cn\_sy7



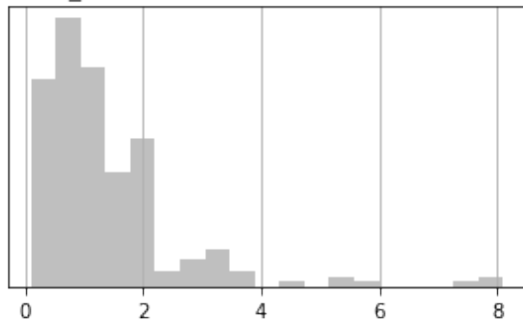
A) cn\_sy8



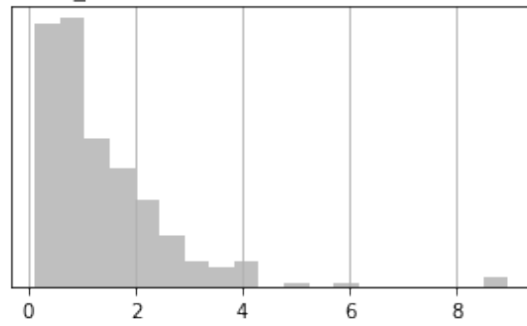
B) cn\_vka6



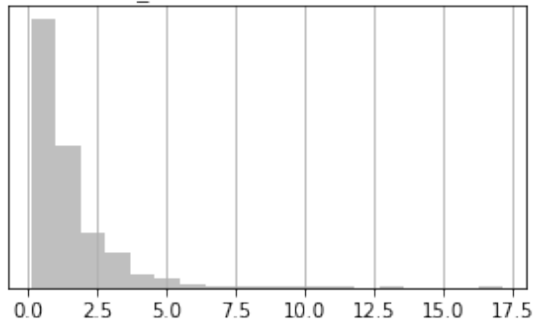
C) cn\_vka7



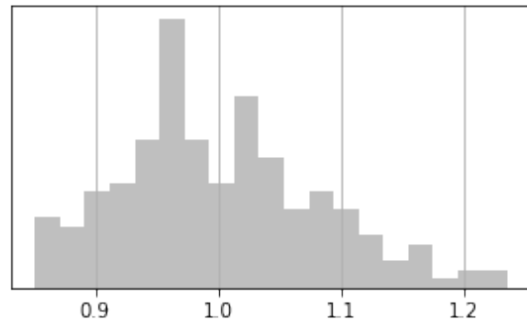
D) cn\_vka8



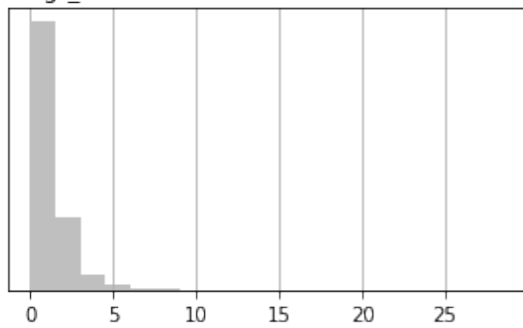
E) drncond\_k00



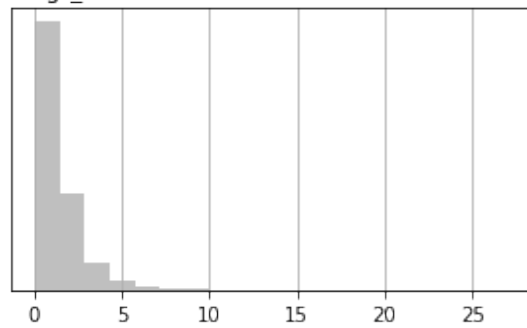
F) flow



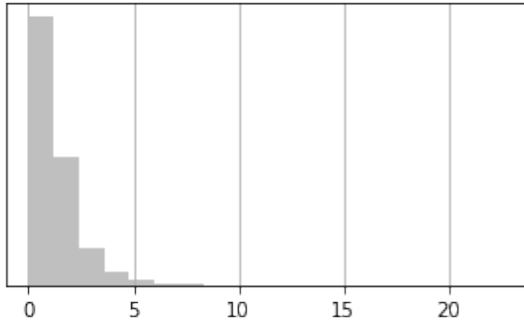
G) gr\_hk3



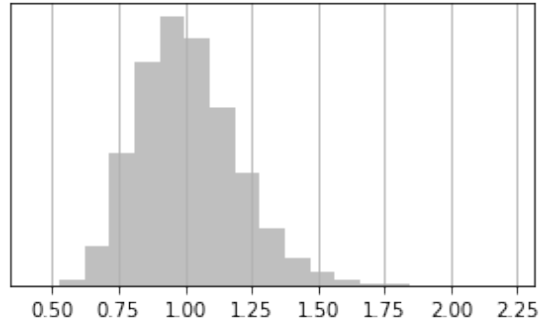
H) gr\_hk4



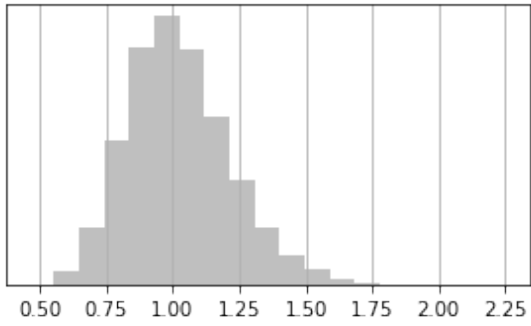
A) gr\_hk5



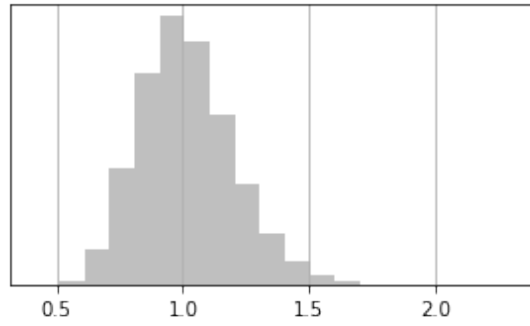
B) gr\_prsity3



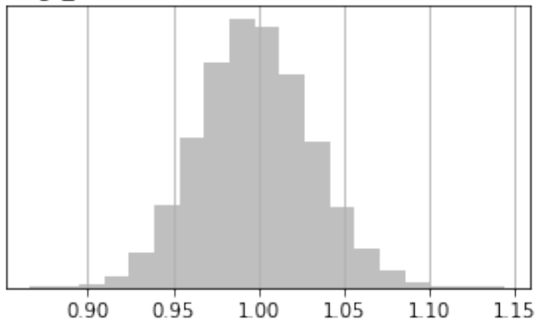
C) gr\_prsity4



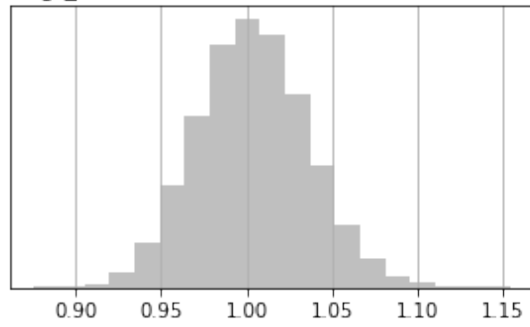
D) gr\_prsity5



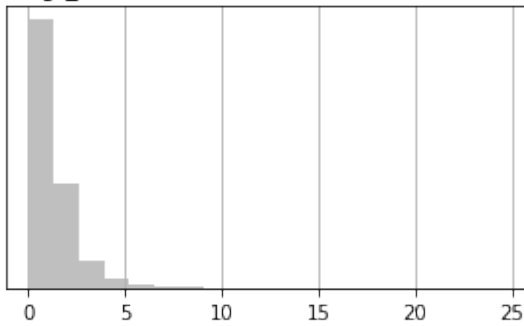
E) gr\_rech2



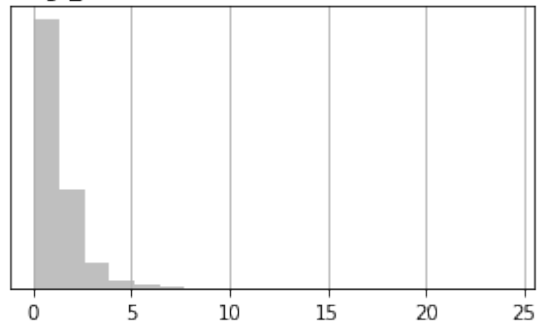
F) gr\_rech3



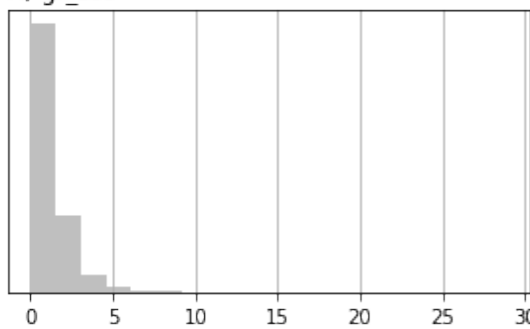
G) gr\_ss3



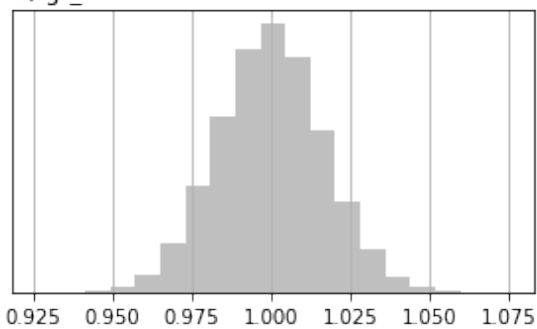
H) gr\_ss4



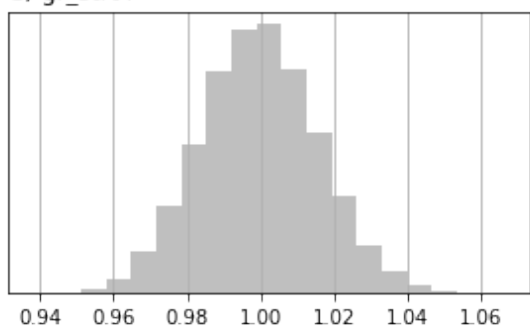
A) gr\_ss5



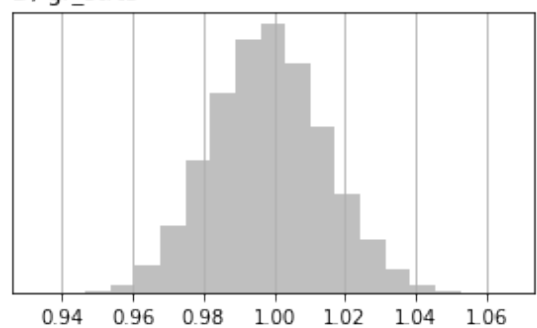
B) gr\_strt3



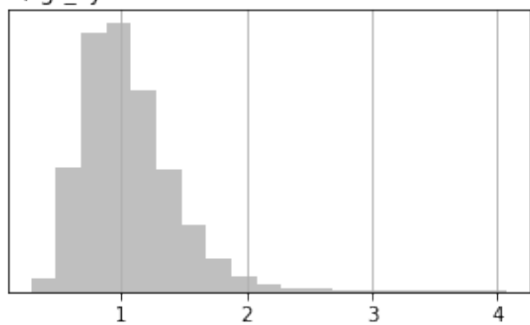
C) gr\_strt4



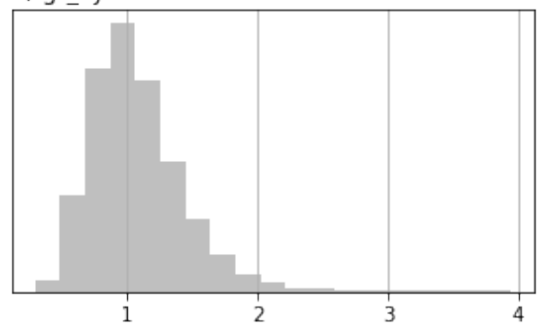
D) gr\_strt5



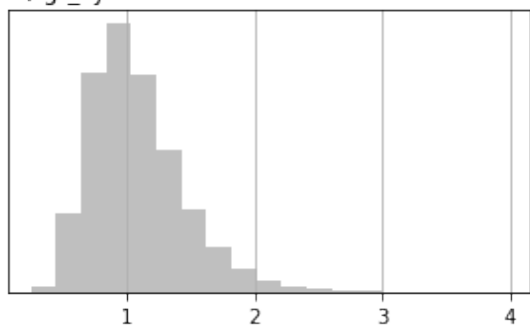
E) gr\_sy3



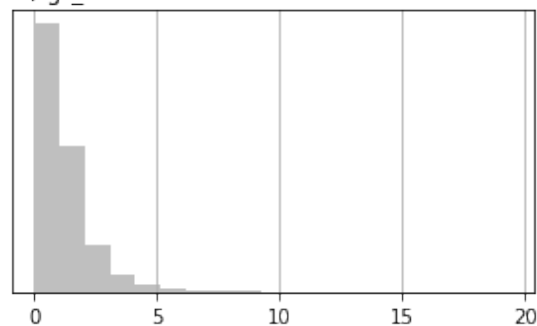
F) gr\_sy4



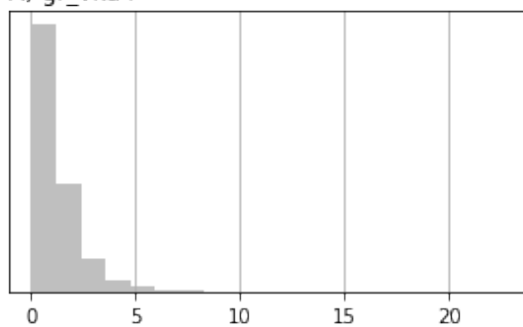
G) gr\_sy5



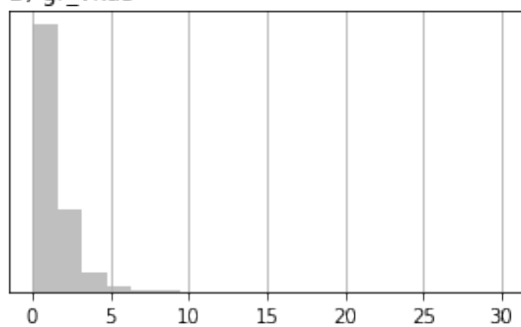
H) gr\_vka3



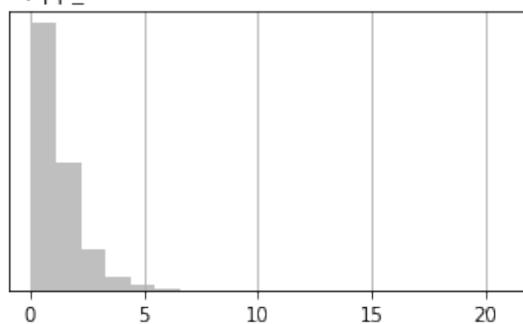
A) gr\_vka4



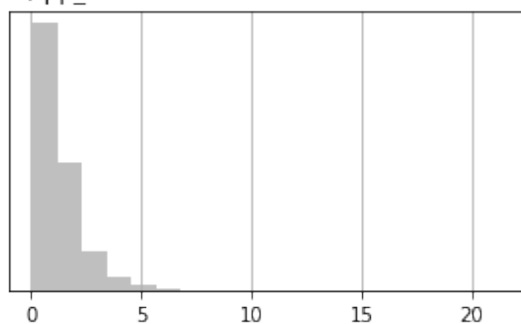
B) gr\_vka5



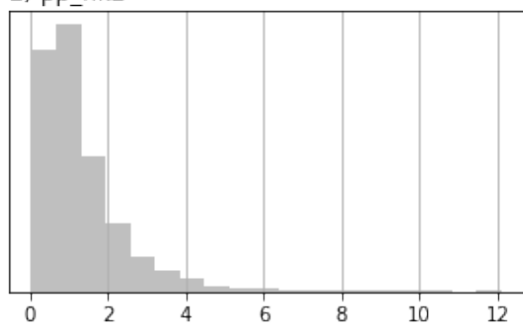
C) pp\_hk0



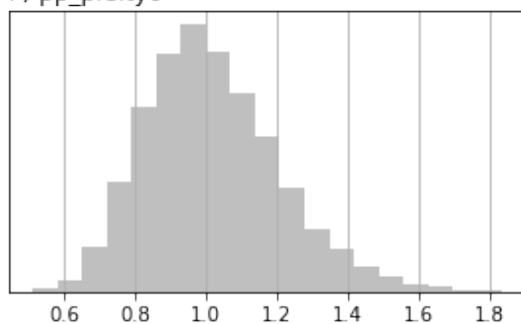
D) pp\_hk1



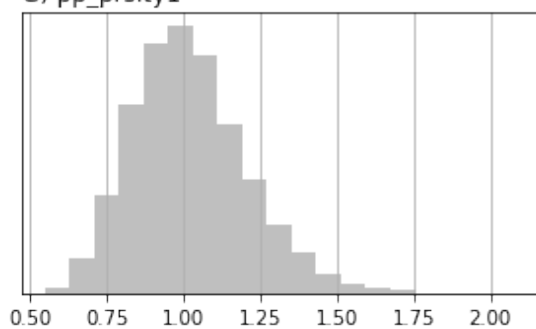
E) pp\_hk2



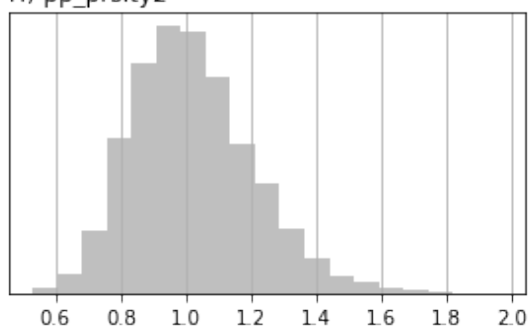
F) pp\_prsity0



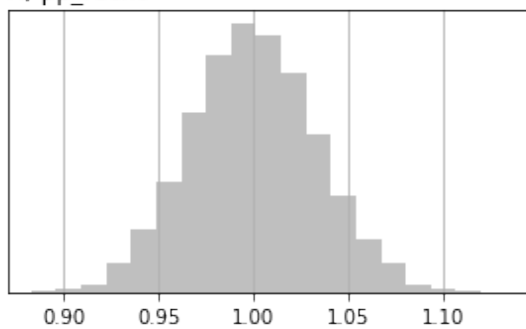
G) pp\_prsity1



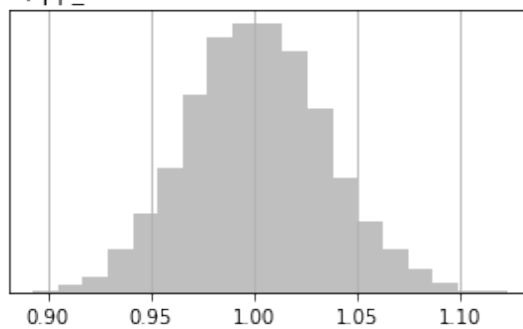
H) pp\_prsity2



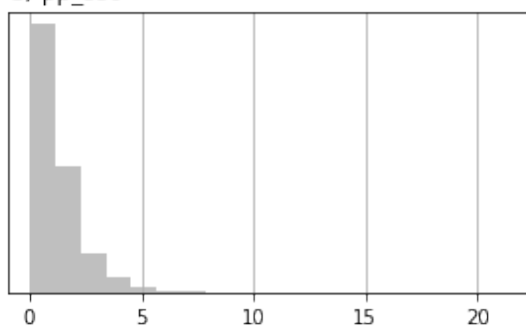
A) pp\_rech0



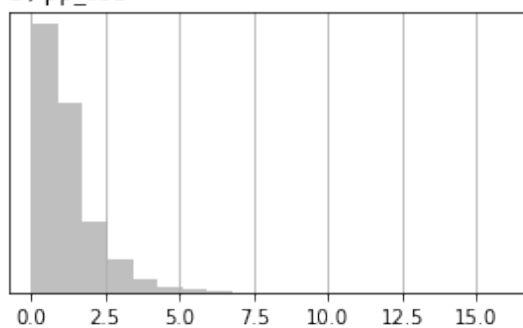
B) pp\_rech1



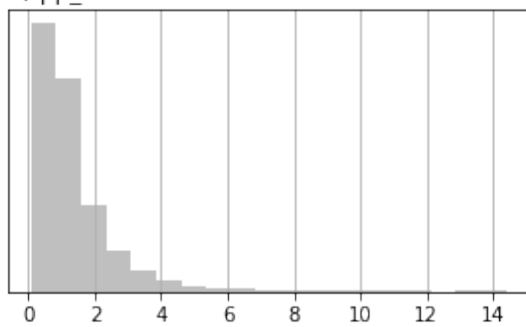
C) pp\_ss0



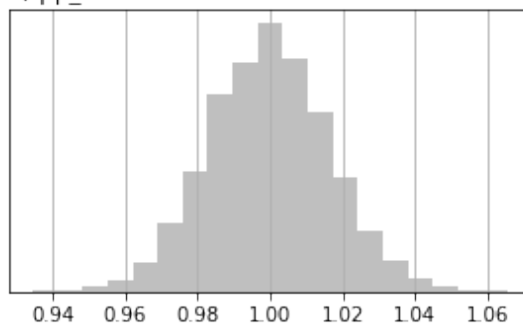
D) pp\_ss1



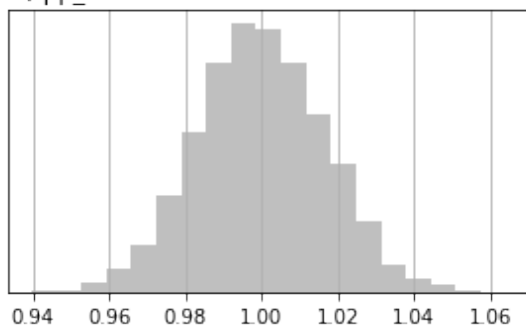
E) pp\_ss2



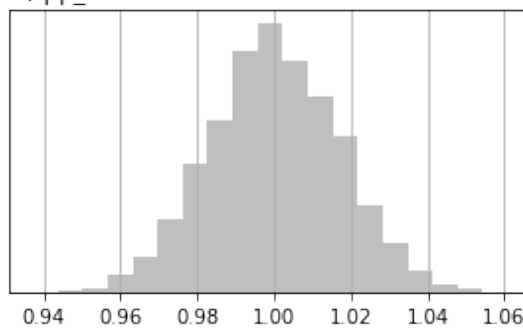
F) pp\_strt0



G) pp\_strt1

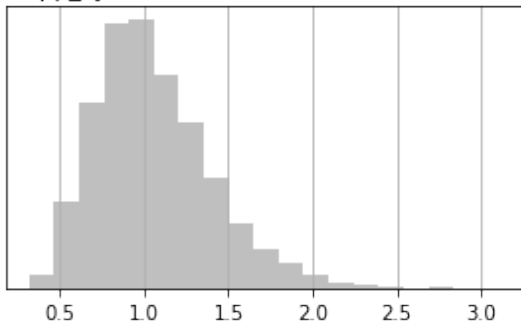


H) pp\_strt2

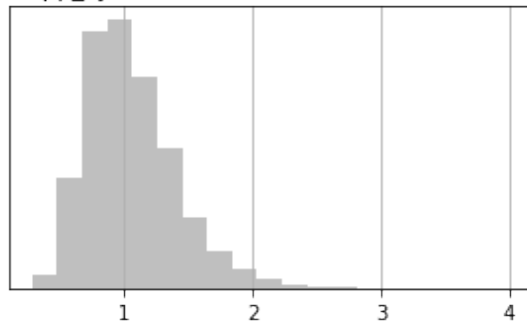




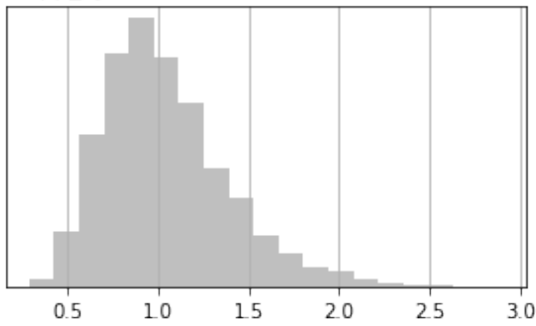
A) pp\_sy0



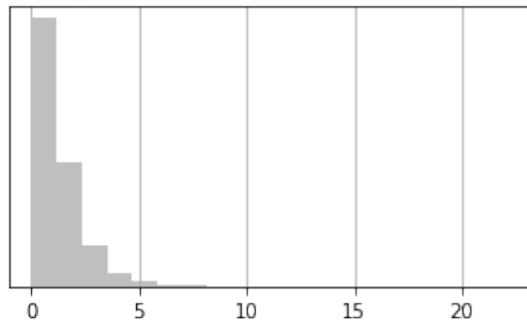
B) pp\_sy1



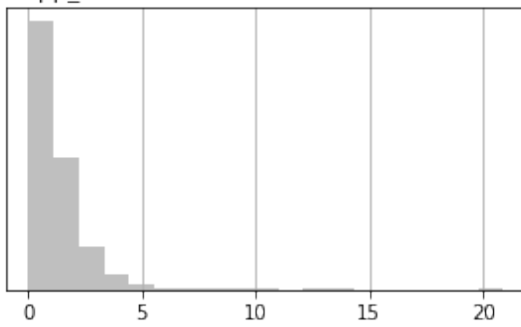
C) pp\_sy2



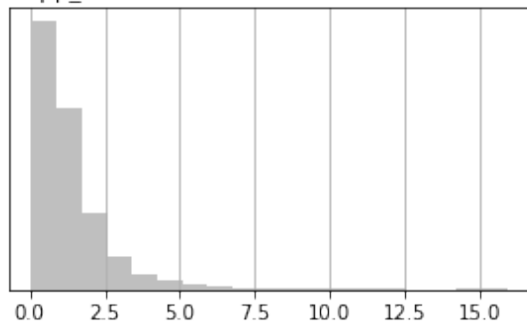
D) pp\_vka0



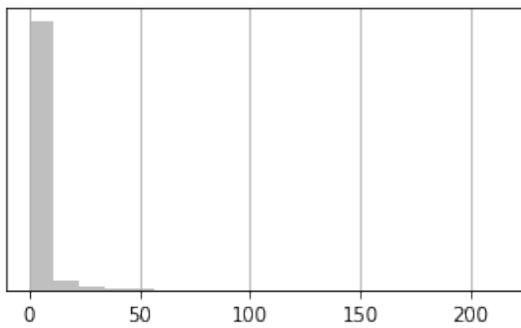
E) pp\_vka1



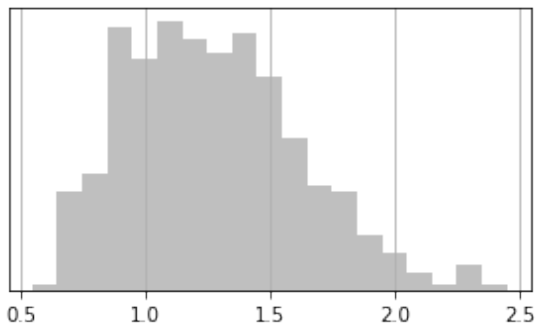
F) pp\_vka2

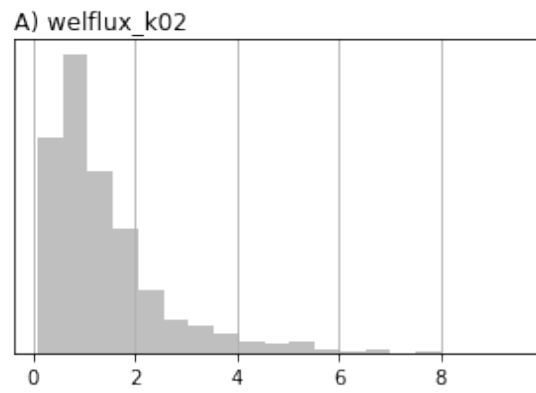


G) strk



H) welflux





Now we need to enforce parameter bounds and save this ensemble for later

```
In [27]: pe.enforce()  
         pe.to_binary(os.path.join(pst_helper.new_model_ws, "prior.jcb"))
```

### 1.1.9 set weights for “observations” and identify forecasts

The next major task is to set the weights on the observations. So far, in the `pst_helper` process, we simply identified what outputs from the model we want to observe. We now use a pre-cooked csv file to set nonzero weights only for GW level observation locations used in the original Freyberg model. We will also use the SFR flow out of the last reach (`fo` in the last row in 19791230)

```
In [28]: obs_locs = pd.read_csv(os.path.join("../", "base_model_files", "obs_loc.csv"))
        if pst_helper.m.nrow != 40:
            obs_locs.loc[:, "row"] = (obs_locs.row * redis_fac) + int(redis_fac / 2.0)
            obs_locs.loc[:, "col"] = (obs_locs.col * redis_fac) + int(redis_fac / 2.0)
            #build obs names that correspond to the obsnme values in the control file
            obs_locs.loc[:, "obsnme"] = obs_locs.apply(lambda x: "hds_00_{0:03d}_{1:03d}_000".format(x["row"], x["col"]), axis=1)
        obs_locs
```

```
Out[28]:
```

	row	col	obsnme
0	3	16	hds_00_002_015_000
1	3	10	hds_00_002_009_000
2	4	9	hds_00_003_008_000
3	10	2	hds_00_009_001_000
4	14	11	hds_00_013_010_000
5	16	17	hds_00_015_016_000
6	22	11	hds_00_021_010_000
7	23	16	hds_00_022_015_000
8	25	5	hds_00_024_004_000
9	27	7	hds_00_026_006_000
10	30	16	hds_00_029_015_000
11	34	8	hds_00_033_007_000
12	35	11	hds_00_034_010_000

Set all weights to zero first, then turn on the weights at only a few locations. These nonzero obs will be given meaningful weights in the prior monte carlo exercise

```
In [29]: obs = pst.observation_data
        obs.loc[:, "weight"] = 0.0
        obs.loc[obs_locs.obsnme, "weight"] = 1.0
        obs.loc[obs_locs.obsnme, "obgnme"] = "calhead"
        fo_obs = "fo_{0}_19791230".format(pst_helper.m.nrow-1)
        obs.loc[fo_obs, "weight"] = 1.0
        obs.loc[fo_obs, "obgnme"] = "calflux"
        pst.nnz_obs_names
```

```
Out[29]: ['fo_39_19791230',
          'hds_00_002_009_000',
          'hds_00_002_015_000',
          'hds_00_003_008_000',
          'hds_00_009_001_000',
          'hds_00_013_010_000',
          'hds_00_015_016_000',
```

```

'hds_00_021_010_000',
'hds_00_022_015_000',
'hds_00_024_004_000',
'hds_00_026_006_000',
'hds_00_029_015_000',
'hds_00_033_007_000',
'hds_00_034_010_000']

```

Now we will define which model outputs are going to be treated as “forecasts” and save the control file

```

In [30]: swgw_forecasts = obs.loc[obs.obsnme.apply(lambda x: "fa" in x and ("hw" in x or "tw" in x))]
print(swgw_forecasts)
hds_fore_name = "hds_00_{0:03d}_{1:03d}".format(int(pst_helper.m.nrow/3),int(pst_helper.m.nrow/3))
hds_forecasts = obs.loc[obs.obsnme.apply(lambda x: hds_fore_name in x), "obsnme"].tolist()
forecasts = swgw_forecasts
forecasts.extend(hds_forecasts)
forecasts.append("part_time")
forecasts.append("part_status")
pst_helper.pst.pestpp_options["forecasts"] = forecasts
pst.write(os.path.join(pst_helper.new_model_ws, "freyberg.pst"))

['fa_hw_19791230', 'fa_hw_19801229', 'fa_tw_19791230', 'fa_tw_19801229']
noptmax:0, npar_adj:14819, nnz_obs:14

```

Run one last time. phi should be near zero since we haven’t change the parval1 values for historic stress period and only the 13 gw level obs have nonzero weights

```

In [31]: pyemu.os_utils.run("pestpp-ies.exe freyberg.pst", cwd=pst_helper.new_model_ws)
pst = pyemu.Pst(os.path.join(pst_helper.new_model_ws, "freyberg.pst"))
pst.phi

```

```

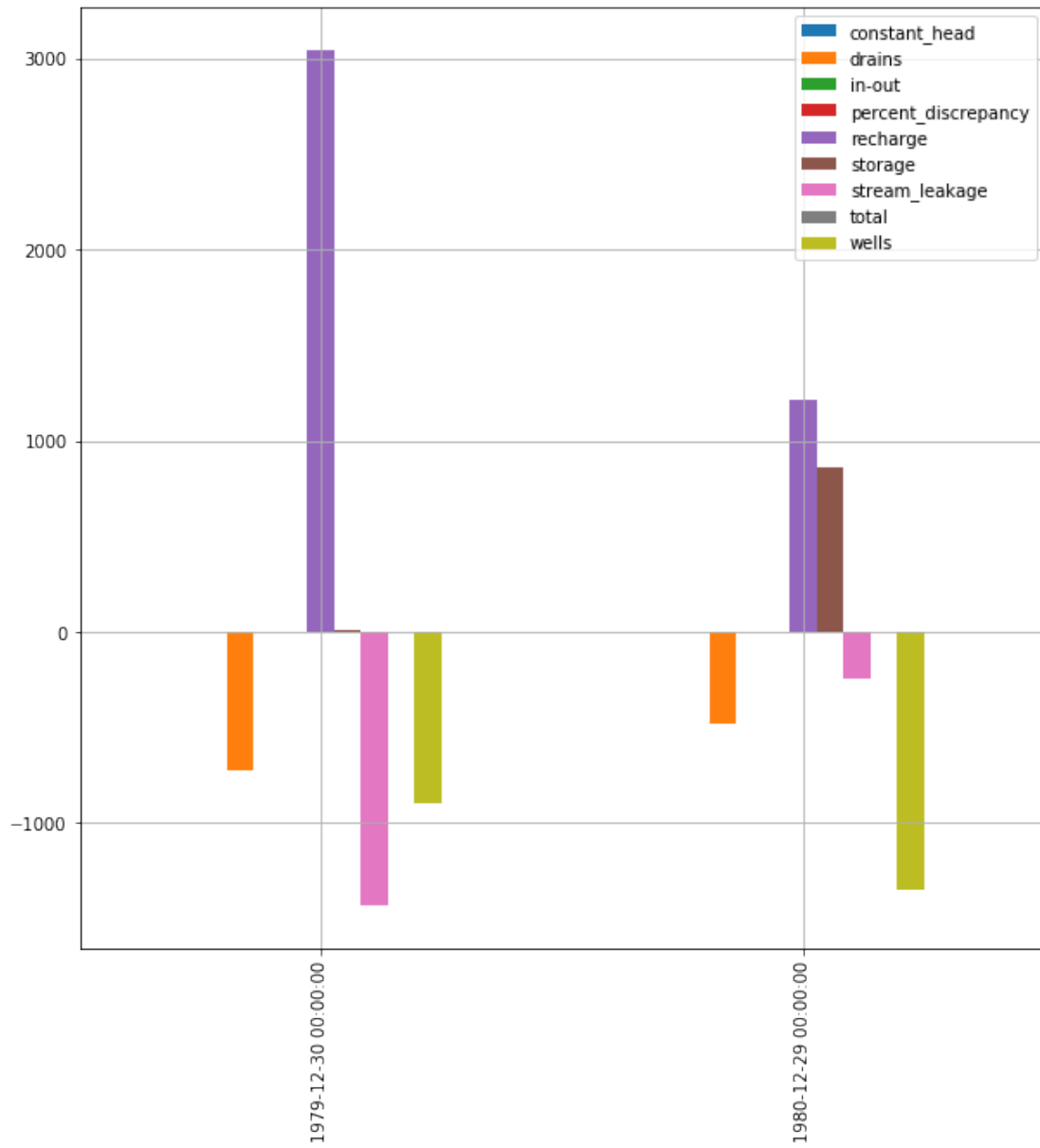
Out[31]: 9.456182577320024e-19

```

```

In [32]: lst = flopy.utils.MfListBudget(os.path.join("template", "freyberg.list"))
df = lst.get_dataframes(diff=True)[0]
df.plot(kind="bar", figsize=(10,10), grid=True)
plt.show()

```



We see the effect of our parameterized scenario - a large drop in recharge and more abstraction.