setup_pest_interface

May 12, 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 pati
        # 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 = "mfnwt"
```

```
# 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 dependecies (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("mfnwt",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 deficite 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(mflay=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()
```
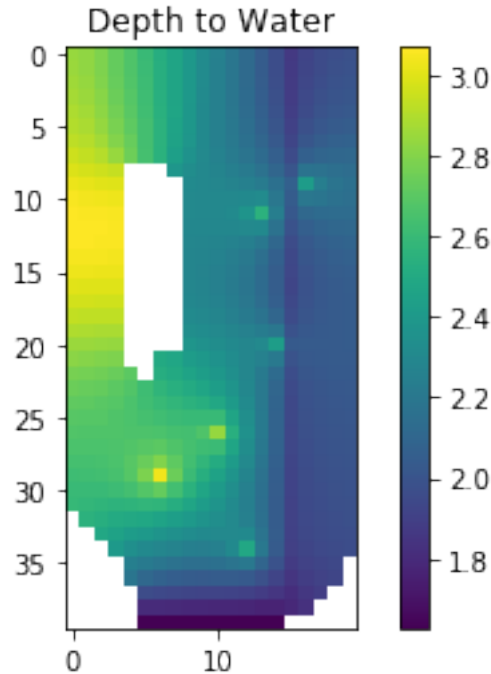
data Layer 1

<Figure size 432x288 with 0 Axes>
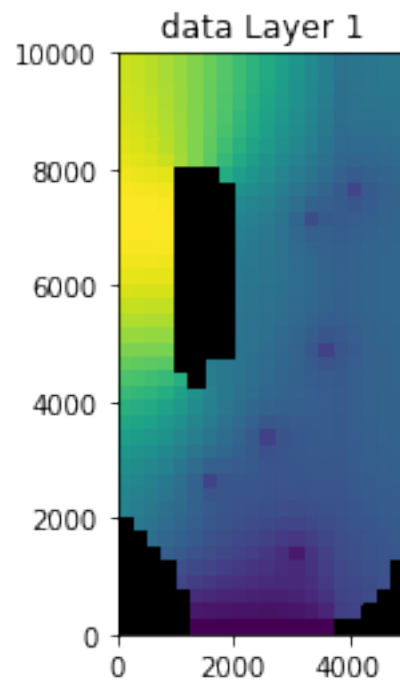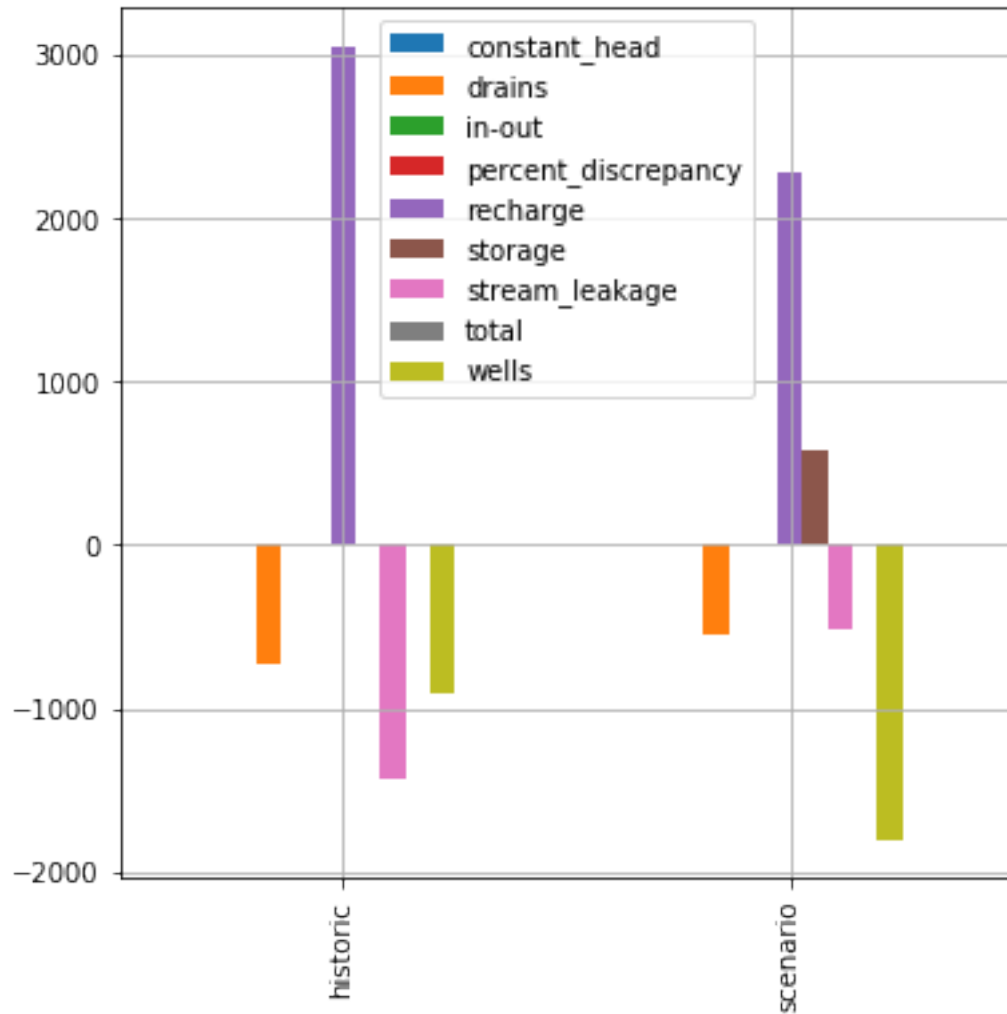
We can see the effect of the "scenario" in the second stress period with less recharge and more abstraction.

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()
```

Depth to Water

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 easy account for the stochastic nature of the forcing conditions during the scenario stress period and also make implemention 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("mfnwt",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()
```

data Layer 1
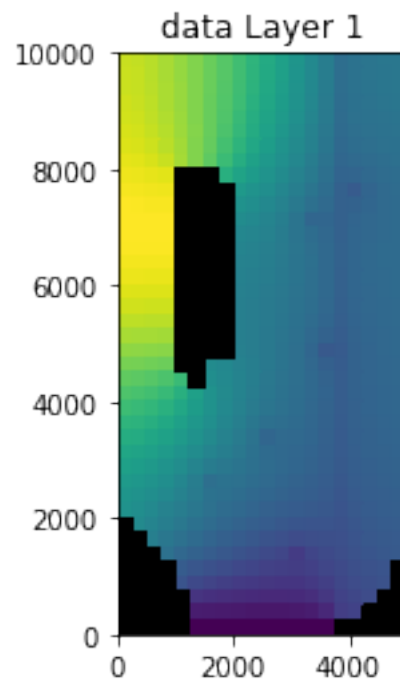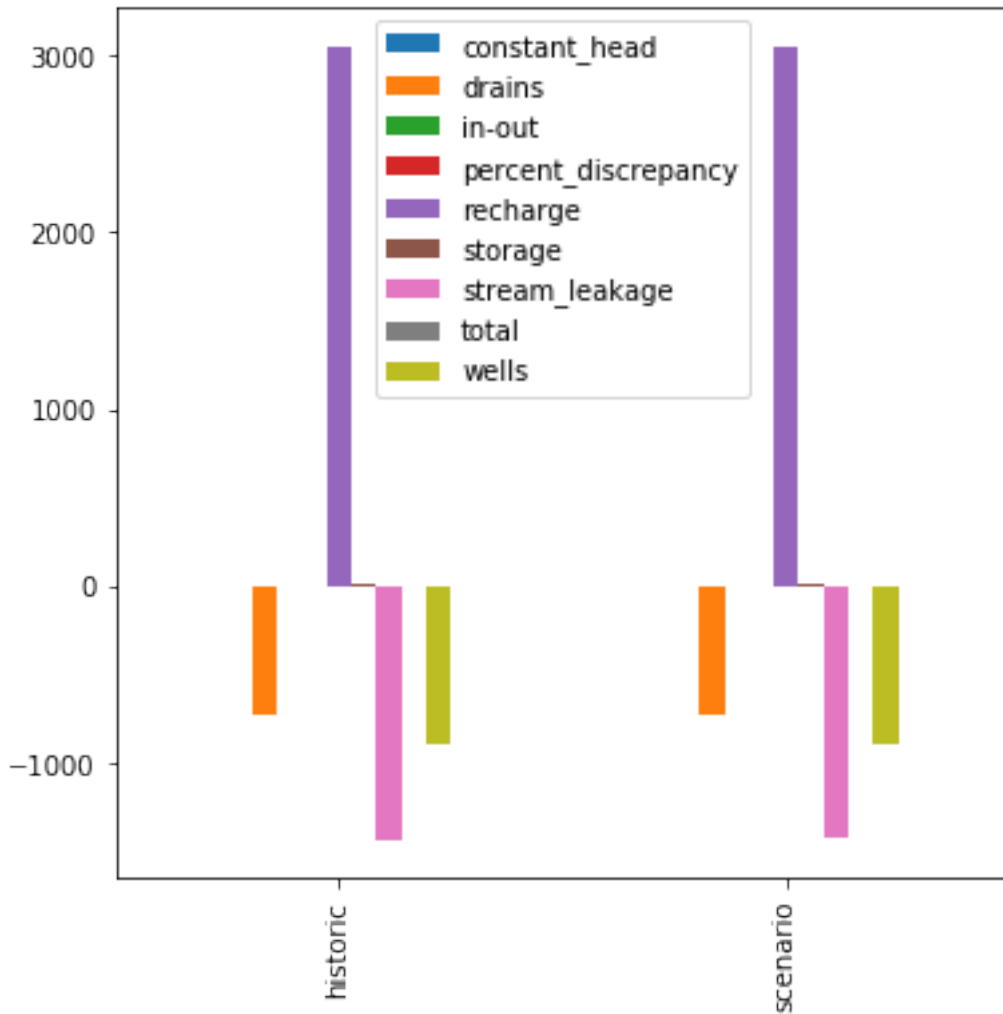
Now we see that the scenario and historic periods have the same water balance

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-processort 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_mode
                                  const_props=props,spatial_list_props=spati
                                   temporal_list_props=temporal_list_props,
                                  grid_props=props,pp_props=props,sfr_pars="
                                   sfr_obs=sfr_obs_dict,build_prior=False,mo
                                  pp_space=4)
         prep_deps.prep_template(t_d=pst_helper.new_model_ws)
```

```
2019-05-12 14:13:35.710348 starting: loading flopy 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 'flopy.modflow.mfwel.ModflowWel'> for kper     1
   loading <class 'flopy.modflow.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 'flopy.modflow.mfdrn.ModflowDrn'> for kper     1
   loading <class 'flopy.modflow.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
2019-05-12 14:13:35.742354 finished: loading flopy model took: 0:00:00.032006
2019-05-12 14:13:35.742548 starting: updating model attributes
2019-05-12 14:13:35.742628 finished: updating model attributes took: 0:00:00.000080
2019-05-12 14:13:35.742734 WARNING: removing existing 'new_model_ws

creating model workspace...
    template

changing model workspace...
    template
2019-05-12 14:13:36.967451 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


2019-05-12 14:13:37.093373 finished: writing new modflow input files took: 0:00:00.125922
2019-05-12 14:13:37.093889 forward_run line:pyemu.os_utils.run('mfnwt freyberg.nam 1>freyberg.
2019-05-12 14:13:37.094199 starting: setting up 'template/arr_org' dir
2019-05-12 14:13:37.094356 finished: setting up 'template/arr_org' dir took: 0:00:00.000157
2019-05-12 14:13:37.094409 starting: setting up 'template/arr_mlt' dir
2019-05-12 14:13:37.094519 finished: setting up 'template/arr_mlt' dir took: 0:00:00.000110
2019-05-12 14:13:37.094565 starting: setting up 'template/list_org' dir
2019-05-12 14:13:37.094667 finished: setting up 'template/list_org' dir took: 0:00:00.000102
2019-05-12 14:13:37.094712 starting: setting up 'template/list_mlt' dir
2019-05-12 14:13:37.094801 finished: setting up 'template/list_mlt' dir took: 0:00:00.000089
2019-05-12 14:13:37.094849 starting: processing temporal_list_props
2019-05-12 14:13:37.113378 finished: processing temporal_list_props took: 0:00:00.018529
2019-05-12 14:13:37.114003 starting: processing spatial_list_props
2019-05-12 14:13:37.186907 finished: processing spatial_list_props took: 0:00:00.072904
2019-05-12 14:13:37.243184 forward_run line:pyemu.helpers.apply_list_pars()


2019-05-12 14:13:37.280252 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.327630 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.375570 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.422899 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.453777 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.484491 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.523234 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.552955 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.585666 'extra' pak detected:extra.prsity
2019-05-12 14:13:37.661632 starting: writing grid tpl:hk3.dat_gr.tpl
2019-05-12 14:13:37.670200 finished: writing grid tpl:hk3.dat_gr.tpl took: 0:00:00.008568
2019-05-12 14:13:37.672998 starting: writing grid tpl:vka3.dat_gr.tpl
2019-05-12 14:13:37.681890 finished: writing grid tpl:vka3.dat_gr.tpl took: 0:00:00.008892
2019-05-12 14:13:37.684606 starting: writing grid tpl:ss3.dat_gr.tpl
2019-05-12 14:13:37.692964 finished: writing grid tpl:ss3.dat_gr.tpl took: 0:00:00.008358
2019-05-12 14:13:37.695377 starting: writing grid tpl:sy3.dat_gr.tpl
2019-05-12 14:13:37.703708 finished: writing grid tpl:sy3.dat_gr.tpl took: 0:00:00.008331
2019-05-12 14:13:37.706068 starting: writing grid tpl:strt3.dat_gr.tpl
2019-05-12 14:13:37.714661 finished: writing grid tpl:strt3.dat_gr.tpl took: 0:00:00.008593
2019-05-12 14:13:37.717257 starting: writing grid tpl:prsity3.dat_gr.tpl
2019-05-12 14:13:37.727728 finished: writing grid tpl:prsity3.dat_gr.tpl took: 0:00:00.010471
2019-05-12 14:13:37.730599 starting: writing grid tpl:hk4.dat_gr.tpl
2019-05-12 14:13:37.739305 finished: writing grid tpl:hk4.dat_gr.tpl took: 0:00:00.008706
```

```
2019-05-12 14:13:37.741954 starting: writing grid tpl:vka4.dat_gr.tpl
2019-05-12 14:13:37.751929 finished: writing grid tpl:vka4.dat_gr.tpl took: 0:00:00.009975
2019-05-12 14:13:37.754795 starting: writing grid tpl:ss4.dat_gr.tpl
2019-05-12 14:13:37.764174 finished: writing grid tpl:ss4.dat_gr.tpl took: 0:00:00.009379
2019-05-12 14:13:37.766648 starting: writing grid tpl:sy4.dat_gr.tpl
2019-05-12 14:13:37.775259 finished: writing grid tpl:sy4.dat_gr.tpl took: 0:00:00.008611
2019-05-12 14:13:37.778118 starting: writing grid tpl:strt4.dat_gr.tpl
2019-05-12 14:13:37.786940 finished: writing grid tpl:strt4.dat_gr.tpl took: 0:00:00.008822
2019-05-12 14:13:37.789789 starting: writing grid tpl:prsity4.dat_gr.tpl
2019-05-12 14:13:37.800665 finished: writing grid tpl:prsity4.dat_gr.tpl took: 0:00:00.010876
2019-05-12 14:13:37.803187 starting: writing grid tpl:hk5.dat_gr.tpl
2019-05-12 14:13:37.811396 finished: writing grid tpl:hk5.dat_gr.tpl took: 0:00:00.008209
2019-05-12 14:13:37.813873 starting: writing grid tpl:vka5.dat_gr.tpl
2019-05-12 14:13:37.823136 finished: writing grid tpl:vka5.dat_gr.tpl took: 0:00:00.009263
2019-05-12 14:13:37.825976 starting: writing grid tpl:ss5.dat_gr.tpl
2019-05-12 14:13:37.834615 finished: writing grid tpl:ss5.dat_gr.tpl took: 0:00:00.008639
2019-05-12 14:13:37.837373 starting: writing grid tpl:sy5.dat_gr.tpl
2019-05-12 14:13:37.845827 finished: writing grid tpl:sy5.dat_gr.tpl took: 0:00:00.008454
2019-05-12 14:13:37.848400 starting: writing grid tpl:strt5.dat_gr.tpl
2019-05-12 14:13:37.856474 finished: writing grid tpl:strt5.dat_gr.tpl took: 0:00:00.008074
2019-05-12 14:13:37.858698 starting: writing grid tpl:prsity5.dat_gr.tpl
2019-05-12 14:13:37.870114 finished: writing grid tpl:prsity5.dat_gr.tpl took: 0:00:00.011416
2019-05-12 14:13:37.873118 starting: writing grid tpl:rech2.dat_gr.tpl
2019-05-12 14:13:37.881713 finished: writing grid tpl:rech2.dat_gr.tpl took: 0:00:00.008595
2019-05-12 14:13:37.884216 starting: writing grid tpl:rech3.dat_gr.tpl
2019-05-12 14:13:37.892528 finished: writing grid tpl:rech3.dat_gr.tpl took: 0:00:00.008312
2019-05-12 14:13:37.894806 starting: writing const tpl:hk6.dat_cn.tpl
2019-05-12 14:13:37.900260 finished: writing const tpl:hk6.dat_cn.tpl took: 0:00:00.005454
2019-05-12 14:13:37.902554 starting: writing const tpl:vka6.dat_cn.tpl
2019-05-12 14:13:37.907900 finished: writing const tpl:vka6.dat_cn.tpl took: 0:00:00.005346
2019-05-12 14:13:37.910115 starting: writing const tpl:ss6.dat_cn.tpl
2019-05-12 14:13:37.915635 finished: writing const tpl:ss6.dat_cn.tpl took: 0:00:00.005520
2019-05-12 14:13:37.918309 starting: writing const tpl:sy6.dat_cn.tpl
2019-05-12 14:13:37.924272 finished: writing const tpl:sy6.dat_cn.tpl took: 0:00:00.005963
2019-05-12 14:13:37.926580 starting: writing const tpl:strt6.dat_cn.tpl
2019-05-12 14:13:37.932149 finished: writing const tpl:strt6.dat_cn.tpl took: 0:00:00.005569
2019-05-12 14:13:37.934656 starting: writing const tpl:prsity6.dat_cn.tpl
2019-05-12 14:13:37.940110 finished: writing const tpl:prsity6.dat_cn.tpl took: 0:00:00.005454
2019-05-12 14:13:37.942675 starting: writing const tpl:hk7.dat_cn.tpl
2019-05-12 14:13:37.947972 finished: writing const tpl:hk7.dat_cn.tpl took: 0:00:00.005297
2019-05-12 14:13:37.950217 starting: writing const tpl:vka7.dat_cn.tpl
2019-05-12 14:13:37.955771 finished: writing const tpl:vka7.dat_cn.tpl took: 0:00:00.005554
2019-05-12 14:13:37.958007 starting: writing const tpl:ss7.dat_cn.tpl
2019-05-12 14:13:37.964062 finished: writing const tpl:ss7.dat_cn.tpl took: 0:00:00.006055
2019-05-12 14:13:37.966635 starting: writing const tpl:sy7.dat_cn.tpl
2019-05-12 14:13:37.972408 finished: writing const tpl:sy7.dat_cn.tpl took: 0:00:00.005773
2019-05-12 14:13:37.974990 starting: writing const tpl:strt7.dat_cn.tpl
2019-05-12 14:13:37.981482 finished: writing const tpl:strt7.dat_cn.tpl took: 0:00:00.006492
```

```
2019-05-12 14:13:37.984127 starting: writing const tpl:prsity7.dat_cn.tpl
2019-05-12 14:13:37.990536 finished: writing const tpl:prsity7.dat_cn.tpl took: 0:00:00.006409
2019-05-12 14:13:37.993109 starting: writing const tpl:hk8.dat_cn.tpl
2019-05-12 14:13:38.000161 finished: writing const tpl:hk8.dat_cn.tpl took: 0:00:00.007052
2019-05-12 14:13:38.003055 starting: writing const tpl:vka8.dat_cn.tpl
2019-05-12 14:13:38.008667 finished: writing const tpl:vka8.dat_cn.tpl took: 0:00:00.005612
2019-05-12 14:13:38.011056 starting: writing const tpl:ss8.dat_cn.tpl
2019-05-12 14:13:38.016842 finished: writing const tpl:ss8.dat_cn.tpl took: 0:00:00.005786
2019-05-12 14:13:38.019490 starting: writing const tpl:sy8.dat_cn.tpl
2019-05-12 14:13:38.025263 finished: writing const tpl:sy8.dat_cn.tpl took: 0:00:00.005773
2019-05-12 14:13:38.027747 starting: writing const tpl:strt8.dat_cn.tpl
2019-05-12 14:13:38.033805 finished: writing const tpl:strt8.dat_cn.tpl took: 0:00:00.006058
2019-05-12 14:13:38.036466 starting: writing const tpl:prsity8.dat_cn.tpl
2019-05-12 14:13:38.042567 finished: writing const tpl:prsity8.dat_cn.tpl took: 0:00:00.006101
2019-05-12 14:13:38.045246 starting: writing const tpl:rech4.dat_cn.tpl
2019-05-12 14:13:38.050852 finished: writing const tpl:rech4.dat_cn.tpl took: 0:00:00.005606
2019-05-12 14:13:38.053258 starting: writing const tpl:rech5.dat_cn.tpl
2019-05-12 14:13:38.059089 finished: writing const tpl:rech5.dat_cn.tpl took: 0:00:00.005831
2019-05-12 14:13:38.082843 starting: setting up pilot point process
2019-05-12 14:13:38.083390 WARNING: pp_geostruct is None, using ExpVario with contribution=1 a
2019-05-12 14:13:38.086335 pp_dict: {0: ['hk0', 'vka0', 'ss0', 'sy0', 'strt0', 'prsity0', 'rec
2019-05-12 14:13:38.086721 starting: calling setup_pilot_point_grid()
2019-05-12 14:13:38.695794 640 pilot point parameters created
2019-05-12 14:13:38.696720 pilot point 'pargp':hk0,vka0,ss0,sy0,strt0,prsity0,rech0,rech1,vka1
2019-05-12 14:13:38.697070 finished: calling setup_pilot_point_grid() took: 0:00:00.610349
2019-05-12 14:13:38.699713 starting: calculating factors for p=hk0, k=0
2019-05-12 14:13:38.700819 saving krige variance file:template/pp_k0_general_zn.fac
2019-05-12 14:13:38.701115 saving krige factors file:template/pp_k0_general_zn.fac
starting interp point loop for 800 points
took 2.887433 seconds
2019-05-12 14:13:41.646987 finished: calculating factors for p=hk0, k=0 took: 0:00:02.947274
2019-05-12 14:13:41.647866 starting: calculating factors for p=vka0, k=0
2019-05-12 14:13:41.648605 finished: calculating factors for p=vka0, k=0 took: 0:00:00.000739
2019-05-12 14:13:41.649389 starting: calculating factors for p=ss0, k=0
2019-05-12 14:13:41.650780 finished: calculating factors for p=ss0, k=0 took: 0:00:00.001391
2019-05-12 14:13:41.651368 starting: calculating factors for p=sy0, k=0
2019-05-12 14:13:41.652345 finished: calculating factors for p=sy0, k=0 took: 0:00:00.000977
2019-05-12 14:13:41.653068 starting: calculating factors for p=strt0, k=0
2019-05-12 14:13:41.653826 finished: calculating factors for p=strt0, k=0 took: 0:00:00.000758
2019-05-12 14:13:41.654427 starting: calculating factors for p=prsity0, k=0
2019-05-12 14:13:41.655312 finished: calculating factors for p=prsity0, k=0 took: 0:00:00.00088
2019-05-12 14:13:41.656446 starting: calculating factors for p=rech0, k=0
2019-05-12 14:13:41.658046 finished: calculating factors for p=rech0, k=0 took: 0:00:00.001600
2019-05-12 14:13:41.659079 starting: calculating factors for p=rech1, k=0
2019-05-12 14:13:41.660390 finished: calculating factors for p=rech1, k=0 took: 0:00:00.001311
2019-05-12 14:13:41.661612 starting: calculating factors for p=vka1, k=1
2019-05-12 14:13:41.663450 saving krige variance file:template/pp_k1_general_zn.fac
2019-05-12 14:13:41.663687 saving krige factors file:template/pp_k1_general_zn.fac
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starting interp point loop for 800 points
took 2.574365 seconds
2019-05-12 14:13:44.299133 finished: calculating factors for p=vka1, k=1 took: 0:00:02.637521
2019-05-12 14:13:44.300329 starting: calculating factors for p=ss1, k=1
2019-05-12 14:13:44.301427 finished: calculating factors for p=ss1, k=1 took: 0:00:00.001098
2019-05-12 14:13:44.302283 starting: calculating factors for p=sy1, k=1
2019-05-12 14:13:44.303689 finished: calculating factors for p=sy1, k=1 took: 0:00:00.001406
2019-05-12 14:13:44.304560 starting: calculating factors for p=prsity1, k=1
2019-05-12 14:13:44.305481 finished: calculating factors for p=prsity1, k=1 took: 0:00:00.0009
2019-05-12 14:13:44.306425 starting: calculating factors for p=strt1, k=1
2019-05-12 14:13:44.307222 finished: calculating factors for p=strt1, k=1 took: 0:00:00.000797
2019-05-12 14:13:44.308090 starting: calculating factors for p=hk1, k=1
2019-05-12 14:13:44.308965 finished: calculating factors for p=hk1, k=1 took: 0:00:00.000875
2019-05-12 14:13:44.309578 starting: calculating factors for p=vka2, k=2
2019-05-12 14:13:44.310921 saving krige variance file:template/pp_k2_general_zn.fac
2019-05-12 14:13:44.311116 saving krige factors file:template/pp_k2_general_zn.fac
starting interp point loop for 800 points
took 2.458389 seconds
2019-05-12 14:13:46.823138 finished: calculating factors for p=vka2, k=2 took: 0:00:02.513560
2019-05-12 14:13:46.824394 starting: calculating factors for p=hk2, k=2
2019-05-12 14:13:46.825655 finished: calculating factors for p=hk2, k=2 took: 0:00:00.001261
2019-05-12 14:13:46.826352 starting: calculating factors for p=strt2, k=2
2019-05-12 14:13:46.827112 finished: calculating factors for p=strt2, k=2 took: 0:00:00.000760
2019-05-12 14:13:46.827917 starting: calculating factors for p=ss2, k=2
2019-05-12 14:13:46.829505 finished: calculating factors for p=ss2, k=2 took: 0:00:00.001588
2019-05-12 14:13:46.830261 starting: calculating factors for p=prsity2, k=2
2019-05-12 14:13:46.831214 finished: calculating factors for p=prsity2, k=2 took: 0:00:00.0009
2019-05-12 14:13:46.832187 starting: calculating factors for p=sy2, k=2
2019-05-12 14:13:46.833112 finished: calculating factors for p=sy2, k=2 took: 0:00:00.000925
2019-05-12 14:13:46.833261 starting: processing pp_prefix:vka1
2019-05-12 14:13:46.847404 starting: processing pp_prefix:ss0
2019-05-12 14:13:46.856769 starting: processing pp_prefix:prsity2
2019-05-12 14:13:46.864896 starting: processing pp_prefix:prsity1
2019-05-12 14:13:46.873014 starting: processing pp_prefix:rech1
2019-05-12 14:13:46.881893 starting: processing pp_prefix:hk2
2019-05-12 14:13:46.890715 starting: processing pp_prefix:ss2
2019-05-12 14:13:46.900161 starting: processing pp_prefix:prsity0
2019-05-12 14:13:46.909083 starting: processing pp_prefix:hk0
2019-05-12 14:13:46.917205 starting: processing pp_prefix:hk1
2019-05-12 14:13:46.924952 starting: processing pp_prefix:sy0
2019-05-12 14:13:46.933565 starting: processing pp_prefix:sy2
2019-05-12 14:13:46.943295 starting: processing pp_prefix:sy1
2019-05-12 14:13:46.952981 starting: processing pp_prefix:strt2
2019-05-12 14:13:46.961976 starting: processing pp_prefix:strt0
2019-05-12 14:13:46.971716 starting: processing pp_prefix:strt1
2019-05-12 14:13:46.980761 starting: processing pp_prefix:rech0
2019-05-12 14:13:46.990383 starting: processing pp_prefix:ss1
2019-05-12 14:13:46.999417 starting: processing pp_prefix:vka0
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2019-05-12 14:13:47.008408 starting: processing pp_prefix:vka2
2019-05-12 14:13:47.122898 finished: setting up pilot point process took: 0:00:09.040055
2019-05-12 14:13:47.123433 starting: setting up grid process
2019-05-12 14:13:47.123516 WARNING: grid_geostruct is None, using ExpVario with contribution=1
2019-05-12 14:13:47.123638 finished: setting up grid process took: 0:00:00.000205
2019-05-12 14:13:47.126689 starting: save test mlt array arr_mlt/hk0.dat_pp
2019-05-12 14:13:47.129617 finished: save test mlt array arr_mlt/hk0.dat_pp took: 0:00:00.0029
2019-05-12 14:13:47.130536 starting: save test mlt array arr_mlt/vka0.dat_pp
2019-05-12 14:13:47.132897 finished: save test mlt array arr_mlt/vka0.dat_pp took: 0:00:00.002
2019-05-12 14:13:47.133731 starting: save test mlt array arr_mlt/ss0.dat_pp
2019-05-12 14:13:47.141652 finished: save test mlt array arr_mlt/ss0.dat_pp took: 0:00:00.0079
2019-05-12 14:13:47.142730 starting: save test mlt array arr_mlt/sy0.dat_pp
2019-05-12 14:13:47.146064 finished: save test mlt array arr_mlt/sy0.dat_pp took: 0:00:00.0033
2019-05-12 14:13:47.147295 starting: save test mlt array arr_mlt/strt0.dat_pp
2019-05-12 14:13:47.150455 finished: save test mlt array arr_mlt/strt0.dat_pp took: 0:00:00.003
2019-05-12 14:13:47.151483 starting: save test mlt array arr_mlt/prsity0.dat_pp
2019-05-12 14:13:47.155020 finished: save test mlt array arr_mlt/prsity0.dat_pp took: 0:00:00.0
2019-05-12 14:13:47.155877 starting: save test mlt array arr_mlt/hk1.dat_pp
2019-05-12 14:13:47.158984 finished: save test mlt array arr_mlt/hk1.dat_pp took: 0:00:00.00310
2019-05-12 14:13:47.159788 starting: save test mlt array arr_mlt/vka1.dat_pp
2019-05-12 14:13:47.162731 finished: save test mlt array arr_mlt/vka1.dat_pp took: 0:00:00.0029
2019-05-12 14:13:47.163842 starting: save test mlt array arr_mlt/ss1.dat_pp
2019-05-12 14:13:47.166711 finished: save test mlt array arr_mlt/ss1.dat_pp took: 0:00:00.00286
2019-05-12 14:13:47.167496 starting: save test mlt array arr_mlt/sy1.dat_pp
2019-05-12 14:13:47.170301 finished: save test mlt array arr_mlt/sy1.dat_pp took: 0:00:00.00280
2019-05-12 14:13:47.171312 starting: save test mlt array arr_mlt/strt1.dat_pp
2019-05-12 14:13:47.174124 finished: save test mlt array arr_mlt/strt1.dat_pp took: 0:00:00.002
2019-05-12 14:13:47.175021 starting: save test mlt array arr_mlt/prsity1.dat_pp
2019-05-12 14:13:47.177922 finished: save test mlt array arr_mlt/prsity1.dat_pp took: 0:00:00.0
2019-05-12 14:13:47.178863 starting: save test mlt array arr_mlt/hk2.dat_pp
2019-05-12 14:13:47.181561 finished: save test mlt array arr_mlt/hk2.dat_pp took: 0:00:00.00269
2019-05-12 14:13:47.182488 starting: save test mlt array arr_mlt/vka2.dat_pp
2019-05-12 14:13:47.184778 finished: save test mlt array arr_mlt/vka2.dat_pp took: 0:00:00.0022
2019-05-12 14:13:47.185701 starting: save test mlt array arr_mlt/ss2.dat_pp
2019-05-12 14:13:47.188607 finished: save test mlt array arr_mlt/ss2.dat_pp took: 0:00:00.00290
2019-05-12 14:13:47.189567 starting: save test mlt array arr_mlt/sy2.dat_pp
2019-05-12 14:13:47.192751 finished: save test mlt array arr_mlt/sy2.dat_pp took: 0:00:00.00318
2019-05-12 14:13:47.193682 starting: save test mlt array arr_mlt/strt2.dat_pp
2019-05-12 14:13:47.195839 finished: save test mlt array arr_mlt/strt2.dat_pp took: 0:00:00.002
2019-05-12 14:13:47.196532 starting: save test mlt array arr_mlt/prsity2.dat_pp
2019-05-12 14:13:47.199535 finished: save test mlt array arr_mlt/prsity2.dat_pp took: 0:00:00.0
2019-05-12 14:13:47.200286 starting: save test mlt array arr_mlt/rech0.dat_pp
2019-05-12 14:13:47.203218 finished: save test mlt array arr_mlt/rech0.dat_pp took: 0:00:00.002
2019-05-12 14:13:47.204131 starting: save test mlt array arr_mlt/rech1.dat_pp
2019-05-12 14:13:47.206744 finished: save test mlt array arr_mlt/rech1.dat_pp took: 0:00:00.002
2019-05-12 14:13:47.207618 starting: save test mlt array arr_mlt/hk3.dat_gr
2019-05-12 14:13:47.210013 finished: save test mlt array arr_mlt/hk3.dat_gr took: 0:00:00.00239
2019-05-12 14:13:47.211035 starting: save test mlt array arr_mlt/vka3.dat_gr
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2019-05-12 14:13:47.213742 finished: save test mlt array arr_mlt/vka3.dat_gr took: 0:00:00.0027
2019-05-12 14:13:47.214451 starting: save test mlt array arr_mlt/ss3.dat_gr
2019-05-12 14:13:47.217178 finished: save test mlt array arr_mlt/ss3.dat_gr took: 0:00:00.00272
2019-05-12 14:13:47.218058 starting: save test mlt array arr_mlt/sy3.dat_gr
2019-05-12 14:13:47.221141 finished: save test mlt array arr_mlt/sy3.dat_gr took: 0:00:00.00308
2019-05-12 14:13:47.222260 starting: save test mlt array arr_mlt/strt3.dat_gr
2019-05-12 14:13:47.224861 finished: save test mlt array arr_mlt/strt3.dat_gr took: 0:00:00.002
2019-05-12 14:13:47.225818 starting: save test mlt array arr_mlt/prsity3.dat_gr
2019-05-12 14:13:47.231334 finished: save test mlt array arr_mlt/prsity3.dat_gr took: 0:00:00.0
2019-05-12 14:13:47.233857 starting: save test mlt array arr_mlt/hk4.dat_gr
2019-05-12 14:13:47.239020 finished: save test mlt array arr_mlt/hk4.dat_gr took: 0:00:00.00516
2019-05-12 14:13:47.241329 starting: save test mlt array arr_mlt/vka4.dat_gr
2019-05-12 14:13:47.244709 finished: save test mlt array arr_mlt/vka4.dat_gr took: 0:00:00.0033
2019-05-12 14:13:47.245866 starting: save test mlt array arr_mlt/ss4.dat_gr
2019-05-12 14:13:47.248854 finished: save test mlt array arr_mlt/ss4.dat_gr took: 0:00:00.00298
2019-05-12 14:13:47.249742 starting: save test mlt array arr_mlt/sy4.dat_gr
2019-05-12 14:13:47.252711 finished: save test mlt array arr_mlt/sy4.dat_gr took: 0:00:00.00296
2019-05-12 14:13:47.253849 starting: save test mlt array arr_mlt/strt4.dat_gr
2019-05-12 14:13:47.256386 finished: save test mlt array arr_mlt/strt4.dat_gr took: 0:00:00.002
2019-05-12 14:13:47.257364 starting: save test mlt array arr_mlt/prsity4.dat_gr
2019-05-12 14:13:47.260359 finished: save test mlt array arr_mlt/prsity4.dat_gr took: 0:00:00.0
2019-05-12 14:13:47.261260 starting: save test mlt array arr_mlt/hk5.dat_gr
2019-05-12 14:13:47.263919 finished: save test mlt array arr_mlt/hk5.dat_gr took: 0:00:00.0026
2019-05-12 14:13:47.264838 starting: save test mlt array arr_mlt/vka5.dat_gr
2019-05-12 14:13:47.267494 finished: save test mlt array arr_mlt/vka5.dat_gr took: 0:00:00.002
2019-05-12 14:13:47.268519 starting: save test mlt array arr_mlt/ss5.dat_gr
2019-05-12 14:13:47.271425 finished: save test mlt array arr_mlt/ss5.dat_gr took: 0:00:00.0029
2019-05-12 14:13:47.272405 starting: save test mlt array arr_mlt/sy5.dat_gr
2019-05-12 14:13:47.275191 finished: save test mlt array arr_mlt/sy5.dat_gr took: 0:00:00.0027
2019-05-12 14:13:47.276511 starting: save test mlt array arr_mlt/strt5.dat_gr
2019-05-12 14:13:47.280804 finished: save test mlt array arr_mlt/strt5.dat_gr took: 0:00:00.004
2019-05-12 14:13:47.282482 starting: save test mlt array arr_mlt/prsity5.dat_gr
2019-05-12 14:13:47.286384 finished: save test mlt array arr_mlt/prsity5.dat_gr took: 0:00:00.0
2019-05-12 14:13:47.288451 starting: save test mlt array arr_mlt/rech2.dat_gr
2019-05-12 14:13:47.292860 finished: save test mlt array arr_mlt/rech2.dat_gr took: 0:00:00.004
2019-05-12 14:13:47.293971 starting: save test mlt array arr_mlt/rech3.dat_gr
2019-05-12 14:13:47.296714 finished: save test mlt array arr_mlt/rech3.dat_gr took: 0:00:00.002
2019-05-12 14:13:47.297480 starting: save test mlt array arr_mlt/hk6.dat_cn
2019-05-12 14:13:47.300459 finished: save test mlt array arr_mlt/hk6.dat_cn took: 0:00:00.0029
2019-05-12 14:13:47.301381 starting: save test mlt array arr_mlt/vka6.dat_cn
2019-05-12 14:13:47.304217 finished: save test mlt array arr_mlt/vka6.dat_cn took: 0:00:00.0028
2019-05-12 14:13:47.304935 starting: save test mlt array arr_mlt/ss6.dat_cn
2019-05-12 14:13:47.307575 finished: save test mlt array arr_mlt/ss6.dat_cn took: 0:00:00.00264
2019-05-12 14:13:47.308434 starting: save test mlt array arr_mlt/sy6.dat_cn
2019-05-12 14:13:47.311204 finished: save test mlt array arr_mlt/sy6.dat_cn took: 0:00:00.0027
2019-05-12 14:13:47.312103 starting: save test mlt array arr_mlt/strt6.dat_cn
2019-05-12 14:13:47.314680 finished: save test mlt array arr_mlt/strt6.dat_cn took: 0:00:00.002
2019-05-12 14:13:47.315563 starting: save test mlt array arr_mlt/prsity6.dat_cn
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2019-05-12 14:13:47.318225 finished: save test mlt array arr_mlt/prsity6.dat_cn took: 0:00:00.(
2019-05-12 14:13:47.319158 starting: save test mlt array arr_mlt/hk7.dat_cn
2019-05-12 14:13:47.321837 finished: save test mlt array arr_mlt/hk7.dat_cn took: 0:00:00.0026;
2019-05-12 14:13:47.322771 starting: save test mlt array arr_mlt/vka7.dat_cn
2019-05-12 14:13:47.325957 finished: save test mlt array arr_mlt/vka7.dat_cn took: 0:00:00.003:
2019-05-12 14:13:47.327989 starting: save test mlt array arr_mlt/ss7.dat_cn
2019-05-12 14:13:47.332767 finished: save test mlt array arr_mlt/ss7.dat_cn took: 0:00:00.0047;
2019-05-12 14:13:47.334209 starting: save test mlt array arr_mlt/sy7.dat_cn
2019-05-12 14:13:47.338231 finished: save test mlt array arr_mlt/sy7.dat_cn took: 0:00:00.0040;
2019-05-12 14:13:47.339650 starting: save test mlt array arr_mlt/strt7.dat_cn
2019-05-12 14:13:47.343639 finished: save test mlt array arr_mlt/strt7.dat_cn took: 0:00:00.003
2019-05-12 14:13:47.344496 starting: save test mlt array arr_mlt/prsity7.dat_cn
2019-05-12 14:13:47.347371 finished: save test mlt array arr_mlt/prsity7.dat_cn took: 0:00:00.(
2019-05-12 14:13:47.348082 starting: save test mlt array arr_mlt/hk8.dat_cn
2019-05-12 14:13:47.351011 finished: save test mlt array arr_mlt/hk8.dat_cn took: 0:00:00.0029;
2019-05-12 14:13:47.351950 starting: save test mlt array arr_mlt/vka8.dat_cn
2019-05-12 14:13:47.354621 finished: save test mlt array arr_mlt/vka8.dat_cn took: 0:00:00.0026
2019-05-12 14:13:47.355464 starting: save test mlt array arr_mlt/ss8.dat_cn
2019-05-12 14:13:47.358193 finished: save test mlt array arr_mlt/ss8.dat_cn took: 0:00:00.0027;
2019-05-12 14:13:47.359016 starting: save test mlt array arr_mlt/sy8.dat_cn
2019-05-12 14:13:47.361668 finished: save test mlt array arr_mlt/sy8.dat_cn took: 0:00:00.0026!
2019-05-12 14:13:47.362624 starting: save test mlt array arr_mlt/strt8.dat_cn
2019-05-12 14:13:47.365249 finished: save test mlt array arr_mlt/strt8.dat_cn took: 0:00:00.002
2019-05-12 14:13:47.366143 starting: save test mlt array arr_mlt/prsity8.dat_cn
2019-05-12 14:13:47.368852 finished: save test mlt array arr_mlt/prsity8.dat_cn took: 0:00:00.(
2019-05-12 14:13:47.369566 starting: save test mlt array arr_mlt/rech4.dat_cn
2019-05-12 14:13:47.372540 finished: save test mlt array arr_mlt/rech4.dat_cn took: 0:00:00.002
2019-05-12 14:13:47.373478 starting: save test mlt array arr_mlt/rech5.dat_cn
2019-05-12 14:13:47.376535 finished: save test mlt array arr_mlt/rech5.dat_cn took: 0:00:00.003
2019-05-12 14:13:48.033511 forward_run line:pyemu.helpers.apply_array_pars()

all zeros for runoff...skipping...
all zeros for hcond1...skipping...
all zeros for pptsw...skipping...
2019-05-12 14:13:48.179826 starting: processing obs type mflist water budget obs
2019-05-12 14:13:48.289816 forward_run line:pyemu.gw_utils.apply_mflist_budget_obs('freyberg.l:
2019-05-12 14:13:48.290187 finished: processing obs type mflist water budget obs took: 0:00:00
2019-05-12 14:13:48.290302 starting: processing obs type hyd file
2019-05-12 14:13:48.290525 finished: processing obs type hyd file took: 0:00:00.000223
2019-05-12 14:13:48.290603 starting: processing obs type external obs-sim smp files
2019-05-12 14:13:48.290695 finished: processing obs type external obs-sim smp files took: 0:00
2019-05-12 14:13:48.290748 starting: processing obs type hob
2019-05-12 14:13:48.290824 finished: processing obs type hob took: 0:00:00.000076
2019-05-12 14:13:48.290878 starting: processing obs type hds
[[0, 0], [0, 1], [0, 2], [1, 0], [1, 1], [1, 2]]
2019-05-12 14:13:48.704959 finished: processing obs type hds took: 0:00:00.414081
2019-05-12 14:13:48.705601 starting: processing obs type sfr
writing 'sfr_obs.config' to template/sfr_obs.config
```

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2019-05-12 14:13:49.044655 finished: processing obs type sfr took: 0:00:00.339054
2019-05-12 14:13:49.045078 changing dir in to template
2019-05-12 14:13:49.045991 starting: instantiating control file from i/o files
2019-05-12 14:13:49.046087 tpl files: drn.csv.tpl,wel.csv.tpl,hk3.dat_gr.tpl,vka3.dat_gr.tpl,ss
2019-05-12 14:13:49.046137 ins files: freyberg.hds.dat.ins,vol.dat.ins,freyberg.sfr.out.process
2019-05-12 14:13:49.395907 finished: instantiating control file from i/o files took: 0:00:00.34
2019-05-12 14:13:49.622563 starting: writing forward_run.py
2019-05-12 14:13:49.623535 finished: writing forward_run.py took: 0:00:00.000972
2019-05-12 14:13:49.623943 writing pst template/freyberg.pst
noptmax:0, npar_adj:14819, nnz_obs:4434
2019-05-12 14:13:51.391613 starting: running pestchek on freyberg.pst
2019-05-12 14:13:51.496715 pestcheck:PESTCHEK Version 13.0. Watermark Numerical Computing.
2019-05-12 14:13:51.497268 pestcheck:
2019-05-12 14:13:51.497658 pestcheck:Errors ----->
2019-05-12 14:13:51.497991 pestcheck:Line 2403 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.498102 pestcheck:12 characters long.
2019-05-12 14:13:51.498161 pestcheck:Line 2404 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.498211 pestcheck:12 characters long.
2019-05-12 14:13:51.498261 pestcheck:Line 2404 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.498313 pestcheck:once.
2019-05-12 14:13:51.498856 pestcheck:Line 2405 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.498960 pestcheck:12 characters long.
2019-05-12 14:13:51.499044 pestcheck:Line 2405 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.499135 pestcheck:once.
2019-05-12 14:13:51.499307 pestcheck:Line 2406 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.499360 pestcheck:12 characters long.
2019-05-12 14:13:51.499410 pestcheck:Line 2406 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.499459 pestcheck:once.
2019-05-12 14:13:51.499538 pestcheck:Line 2407 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.499589 pestcheck:12 characters long.
2019-05-12 14:13:51.499716 pestcheck:Line 2407 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.499769 pestcheck:once.
2019-05-12 14:13:51.499819 pestcheck:Line 2408 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.499874 pestcheck:12 characters long.
2019-05-12 14:13:51.500024 pestcheck:Line 2408 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.500112 pestcheck:once.
2019-05-12 14:13:51.500163 pestcheck:Line 2409 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.500212 pestcheck:12 characters long.
2019-05-12 14:13:51.500407 pestcheck:Line 2409 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.500459 pestcheck:once.
2019-05-12 14:13:51.500507 pestcheck:Line 2410 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.500556 pestcheck:12 characters long.
2019-05-12 14:13:51.500604 pestcheck:Line 2410 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.500652 pestcheck:once.
2019-05-12 14:13:51.500730 pestcheck:Line 2411 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.500893 pestcheck:12 characters long.
2019-05-12 14:13:51.500965 pestcheck:Line 2411 of file freyberg.pst: parameter name "prsity300(
2019-05-12 14:13:51.501023 pestcheck:once.
```

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2019-05-12 14:13:51.501292 pestcheck:Line 2412 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.501348 pestcheck:12 characters long.
2019-05-12 14:13:51.501476 pestcheck:Line 2412 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.501538 pestcheck:once.
2019-05-12 14:13:51.501685 pestcheck:Line 2413 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.501726 pestcheck:12 characters long.
2019-05-12 14:13:51.501769 pestcheck:Line 2414 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.501807 pestcheck:12 characters long.
2019-05-12 14:13:51.501865 pestcheck:Line 2414 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.501906 pestcheck:once.
2019-05-12 14:13:51.501988 pestcheck:Line 2415 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.502147 pestcheck:12 characters long.
2019-05-12 14:13:51.502268 pestcheck:Line 2415 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.502325 pestcheck:once.
2019-05-12 14:13:51.502456 pestcheck:Line 2416 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.502518 pestcheck:12 characters long.
2019-05-12 14:13:51.502636 pestcheck:Line 2416 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.502693 pestcheck:once.
2019-05-12 14:13:51.502821 pestcheck:Line 2417 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.502948 pestcheck:12 characters long.
2019-05-12 14:13:51.503005 pestcheck:Line 2417 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.503225 pestcheck:once.
2019-05-12 14:13:51.503281 pestcheck:Line 2418 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.503408 pestcheck:12 characters long.
2019-05-12 14:13:51.503535 pestcheck:Line 2418 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.503674 pestcheck:once.
2019-05-12 14:13:51.503801 pestcheck:Line 2419 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.503939 pestcheck:12 characters long.
2019-05-12 14:13:51.504065 pestcheck:Line 2419 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.504209 pestcheck:once.
2019-05-12 14:13:51.504334 pestcheck:Line 2420 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.504390 pestcheck:12 characters long.
2019-05-12 14:13:51.504515 pestcheck:Line 2420 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.504640 pestcheck:once.
2019-05-12 14:13:51.504696 pestcheck:Line 2421 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.504820 pestcheck:12 characters long.
2019-05-12 14:13:51.504946 pestcheck:Line 2421 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.505002 pestcheck:once.
2019-05-12 14:13:51.505127 pestcheck:Line 2422 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.505356 pestcheck:12 characters long.
2019-05-12 14:13:51.505482 pestcheck:Line 2422 of file freyberg.pst: parameter name "prsity3000
2019-05-12 14:13:51.505537 pestcheck:once.
2019-05-12 14:13:51.505662 pestcheck:Line 2423 of file freyberg.pst: parameter name "prsity3001
2019-05-12 14:13:51.505791 pestcheck:12 characters long.
2019-05-12 14:13:51.505930 pestcheck:Line 2424 of file freyberg.pst: parameter name "prsity3001
2019-05-12 14:13:51.506056 pestcheck:12 characters long.
2019-05-12 14:13:51.506194 pestcheck:Line 2424 of file freyberg.pst: parameter name "prsity3001
2019-05-12 14:13:51.506341 pestcheck:once.
```

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2019-05-12 14:13:51.506479 pestcheck:Line 2425 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.506590 pestcheck:12 characters long.
2019-05-12 14:13:51.506711 pestcheck:Line 2425 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.506823 pestcheck:once.
2019-05-12 14:13:51.506943 pestcheck:Line 2426 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.507054 pestcheck:12 characters long.
2019-05-12 14:13:51.507175 pestcheck:Line 2426 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.507373 pestcheck:once.
2019-05-12 14:13:51.507484 pestcheck:Line 2427 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.507604 pestcheck:12 characters long.
2019-05-12 14:13:51.507715 pestcheck:Line 2427 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.507839 pestcheck:once.
2019-05-12 14:13:51.507950 pestcheck:Line 2428 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.508071 pestcheck:12 characters long.
2019-05-12 14:13:51.508181 pestcheck:Line 2428 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.508306 pestcheck:once.
2019-05-12 14:13:51.508416 pestcheck:Line 2429 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.508536 pestcheck:12 characters long.
2019-05-12 14:13:51.508644 pestcheck:Line 2429 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.508766 pestcheck:once.
2019-05-12 14:13:51.508876 pestcheck:Line 2430 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.508999 pestcheck:12 characters long.
2019-05-12 14:13:51.509110 pestcheck:Line 2430 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.509159 pestcheck:once.
2019-05-12 14:13:51.509347 pestcheck:Line 2431 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.509468 pestcheck:12 characters long.
2019-05-12 14:13:51.509578 pestcheck:Line 2431 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.509699 pestcheck:once.
2019-05-12 14:13:51.509809 pestcheck:Line 2432 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.509930 pestcheck:12 characters long.
2019-05-12 14:13:51.510040 pestcheck:Line 2432 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.510161 pestcheck:once.
2019-05-12 14:13:51.510290 pestcheck:Line 2433 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.510400 pestcheck:12 characters long.
2019-05-12 14:13:51.510510 pestcheck:Line 2434 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.510630 pestcheck:12 characters long.
2019-05-12 14:13:51.510741 pestcheck:Line 2434 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.510790 pestcheck:once.
2019-05-12 14:13:51.510900 pestcheck:Line 2435 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.511011 pestcheck:12 characters long.
2019-05-12 14:13:51.511130 pestcheck:Line 2435 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.511260 pestcheck:once.
2019-05-12 14:13:51.511305 pestcheck:Line 2436 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.511411 pestcheck:12 characters long.
2019-05-12 14:13:51.511521 pestcheck:Line 2436 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.511642 pestcheck:once.
2019-05-12 14:13:51.511756 pestcheck:Line 2437 of file freyberg.pst: parameter name "prsity300
2019-05-12 14:13:51.511876 pestcheck:12 characters long.
```

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2019-05-12 14:13:51.511988 pestcheck:Line 2437 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.512108 pestcheck:once.
2019-05-12 14:13:51.512237 pestcheck:Line 2438 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.512347 pestcheck:12 characters long.
2019-05-12 14:13:51.512457 pestcheck:Line 2438 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.512506 pestcheck:once.
2019-05-12 14:13:51.512616 pestcheck:Line 2439 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.512725 pestcheck:12 characters long.
2019-05-12 14:13:51.512845 pestcheck:Line 2439 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.512955 pestcheck:once.
2019-05-12 14:13:51.513044 pestcheck:Line 2440 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.513120 pestcheck:12 characters long.
2019-05-12 14:13:51.513323 pestcheck:Line 2440 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.513431 pestcheck:once.
2019-05-12 14:13:51.513549 pestcheck:Line 2441 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.513656 pestcheck:12 characters long.
2019-05-12 14:13:51.513773 pestcheck:Line 2441 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.513881 pestcheck:once.
2019-05-12 14:13:51.513998 pestcheck:Line 2442 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.514104 pestcheck:12 characters long.
2019-05-12 14:13:51.514224 pestcheck:Line 2442 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.514332 pestcheck:once.
2019-05-12 14:13:51.514450 pestcheck:Line 2443 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.514557 pestcheck:12 characters long.
2019-05-12 14:13:51.514606 pestcheck:Line 2444 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.514712 pestcheck:12 characters long.
2019-05-12 14:13:51.514819 pestcheck:Line 2444 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.514936 pestcheck:once.
2019-05-12 14:13:51.515042 pestcheck:Line 2445 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.515172 pestcheck:12 characters long.
2019-05-12 14:13:51.515358 pestcheck:Line 2445 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.515462 pestcheck:once.
2019-05-12 14:13:51.515576 pestcheck:Line 2446 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.515679 pestcheck:12 characters long.
2019-05-12 14:13:51.515793 pestcheck:Line 2446 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.515898 pestcheck:once.
2019-05-12 14:13:51.516011 pestcheck:Line 2447 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.516115 pestcheck:12 characters long.
2019-05-12 14:13:51.516229 pestcheck:Line 2447 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.516414 pestcheck:once.
2019-05-12 14:13:51.516545 pestcheck:Line 2448 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.516649 pestcheck:12 characters long.
2019-05-12 14:13:51.516753 pestcheck:Line 2448 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.516870 pestcheck:once.
2019-05-12 14:13:51.516975 pestcheck:Line 2449 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.517088 pestcheck:12 characters long.
2019-05-12 14:13:51.517192 pestcheck:Line 2449 of file freyberg.pst: parameter name "prsity300:
2019-05-12 14:13:51.517313 pestcheck:once.
```

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2019-05-12 14:13:51.517417 pestcheck:Line 2450 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.517531 pestcheck:12 characters long.
2019-05-12 14:13:51.517635 pestcheck:Line 2450 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.517749 pestcheck:once.
2019-05-12 14:13:51.517853 pestcheck:Line 2451 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.517899 pestcheck:12 characters long.
2019-05-12 14:13:51.517938 pestcheck:Line 2451 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.518038 pestcheck:once.
2019-05-12 14:13:51.518142 pestcheck:Line 2452 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.518257 pestcheck:12 characters long.
2019-05-12 14:13:51.518443 pestcheck:Line 2452 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.518547 pestcheck:once.
2019-05-12 14:13:51.518597 pestcheck:Line 2453 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.518702 pestcheck:12 characters long.
2019-05-12 14:13:51.518806 pestcheck:Line 2454 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.518920 pestcheck:12 characters long.
2019-05-12 14:13:51.519024 pestcheck:Line 2454 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.519139 pestcheck:once.
2019-05-12 14:13:51.519243 pestcheck:Line 2455 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.519361 pestcheck:12 characters long.
2019-05-12 14:13:51.519466 pestcheck:Line 2455 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.519513 pestcheck:once.
2019-05-12 14:13:51.519615 pestcheck:Line 2456 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.519721 pestcheck:12 characters long.
2019-05-12 14:13:51.519767 pestcheck:Line 2456 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.519806 pestcheck:once.
2019-05-12 14:13:51.519907 pestcheck:Line 2457 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.520011 pestcheck:12 characters long.
2019-05-12 14:13:51.520058 pestcheck:Line 2457 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.520162 pestcheck:once.
2019-05-12 14:13:51.520266 pestcheck:Line 2458 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.520385 pestcheck:12 characters long.
2019-05-12 14:13:51.520489 pestcheck:Line 2458 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.520536 pestcheck:once.
2019-05-12 14:13:51.520641 pestcheck:Line 2459 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.520745 pestcheck:12 characters long.
2019-05-12 14:13:51.520792 pestcheck:Line 2459 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.520896 pestcheck:once.
2019-05-12 14:13:51.521002 pestcheck:Line 2460 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.521048 pestcheck:12 characters long.
2019-05-12 14:13:51.521152 pestcheck:Line 2460 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.521256 pestcheck:once.
2019-05-12 14:13:51.521375 pestcheck:Line 2461 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.521479 pestcheck:12 characters long.
2019-05-12 14:13:51.521594 pestcheck:Line 2461 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.521698 pestcheck:once.
2019-05-12 14:13:51.521745 pestcheck:Line 2462 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.521848 pestcheck:12 characters long.
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2019-05-12 14:13:51.521952 pestcheck:Line 2462 of file freyberg.pst: parameter name "prsity3002
2019-05-12 14:13:51.521998 pestcheck:once.
2019-05-12 14:13:51.522103 pestcheck:Line 2463 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.522207 pestcheck:12 characters long.
2019-05-12 14:13:51.522253 pestcheck:Line 2464 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.522433 pestcheck:12 characters long.
2019-05-12 14:13:51.522480 pestcheck:Line 2464 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.522584 pestcheck:once.
2019-05-12 14:13:51.522689 pestcheck:Line 2465 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.522736 pestcheck:12 characters long.
2019-05-12 14:13:51.522775 pestcheck:Line 2465 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.522875 pestcheck:once.
2019-05-12 14:13:51.522979 pestcheck:Line 2466 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.523029 pestcheck:12 characters long.
2019-05-12 14:13:51.523134 pestcheck:Line 2466 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.523238 pestcheck:once.
2019-05-12 14:13:51.523357 pestcheck:Line 2467 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.523465 pestcheck:12 characters long.
2019-05-12 14:13:51.523512 pestcheck:Line 2467 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.523617 pestcheck:once.
2019-05-12 14:13:51.523721 pestcheck:Line 2468 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.523768 pestcheck:12 characters long.
2019-05-12 14:13:51.523807 pestcheck:Line 2468 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.523907 pestcheck:once.
2019-05-12 14:13:51.524010 pestcheck:Line 2469 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.524057 pestcheck:12 characters long.
2019-05-12 14:13:51.524096 pestcheck:Line 2469 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.524196 pestcheck:once.
2019-05-12 14:13:51.524301 pestcheck:Line 2470 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.524420 pestcheck:12 characters long.
2019-05-12 14:13:51.524524 pestcheck:Line 2470 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.524571 pestcheck:once.
2019-05-12 14:13:51.524675 pestcheck:Line 2471 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.524780 pestcheck:12 characters long.
2019-05-12 14:13:51.524827 pestcheck:Line 2471 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.524899 pestcheck:once.
2019-05-12 14:13:51.524971 pestcheck:Line 2472 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.525075 pestcheck:12 characters long.
2019-05-12 14:13:51.525122 pestcheck:Line 2472 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.525161 pestcheck:once.
2019-05-12 14:13:51.525265 pestcheck:Line 2473 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.525450 pestcheck:12 characters long.
2019-05-12 14:13:51.525555 pestcheck:Line 2474 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.525670 pestcheck:12 characters long.
2019-05-12 14:13:51.525774 pestcheck:Line 2474 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.525887 pestcheck:once.
2019-05-12 14:13:51.525992 pestcheck:Line 2475 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.526106 pestcheck:12 characters long.
```

```
2019-05-12 14:13:51.526211 pestcheck:Line 2475 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.526325 pestcheck:once.
2019-05-12 14:13:51.526513 pestcheck:Line 2476 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.526618 pestcheck:12 characters long.
2019-05-12 14:13:51.526732 pestcheck:Line 2476 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.526836 pestcheck:once.
2019-05-12 14:13:51.526951 pestcheck:Line 2477 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.527055 pestcheck:12 characters long.
2019-05-12 14:13:51.527170 pestcheck:Line 2477 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.527274 pestcheck:once.
2019-05-12 14:13:51.527387 pestcheck:Line 2478 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.527572 pestcheck:12 characters long.
2019-05-12 14:13:51.527677 pestcheck:Line 2478 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.527791 pestcheck:once.
2019-05-12 14:13:51.527896 pestcheck:Line 2479 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.528010 pestcheck:12 characters long.
2019-05-12 14:13:51.528114 pestcheck:Line 2479 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.528228 pestcheck:once.
2019-05-12 14:13:51.528332 pestcheck:Line 2480 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.528446 pestcheck:12 characters long.
2019-05-12 14:13:51.528634 pestcheck:Line 2480 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.528738 pestcheck:once.
2019-05-12 14:13:51.528852 pestcheck:Line 2481 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.528956 pestcheck:12 characters long.
2019-05-12 14:13:51.529006 pestcheck:Line 2481 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.529114 pestcheck:once.
2019-05-12 14:13:51.529217 pestcheck:Line 2482 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.529265 pestcheck:12 characters long.
2019-05-12 14:13:51.529369 pestcheck:Line 2482 of file freyberg.pst: parameter name "prsity3003
2019-05-12 14:13:51.529474 pestcheck:once.
2019-05-12 14:13:51.529593 pestcheck:Line 2483 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.529698 pestcheck:12 characters long.
2019-05-12 14:13:51.529746 pestcheck:Line 2484 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.529851 pestcheck:12 characters long.
2019-05-12 14:13:51.529956 pestcheck:Line 2484 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.530071 pestcheck:once.
2019-05-12 14:13:51.530177 pestcheck:Line 2485 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.530223 pestcheck:12 characters long.
2019-05-12 14:13:51.530327 pestcheck:Line 2485 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.530432 pestcheck:once.
2019-05-12 14:13:51.530478 pestcheck:Line 2486 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.530629 pestcheck:12 characters long.
2019-05-12 14:13:51.530693 pestcheck:Line 2486 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.530800 pestcheck:once.
2019-05-12 14:13:51.530850 pestcheck:Line 2487 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.530890 pestcheck:12 characters long.
2019-05-12 14:13:51.530998 pestcheck:Line 2487 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.531107 pestcheck:once.
```

```
2019-05-12 14:13:51.531155 pestcheck:Line 2488 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.531194 pestcheck:12 characters long.
2019-05-12 14:13:51.531297 pestcheck:Line 2488 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.531408 pestcheck:once.
2019-05-12 14:13:51.531539 pestcheck:Line 2489 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.531661 pestcheck:12 characters long.
2019-05-12 14:13:51.531781 pestcheck:Line 2489 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.531888 pestcheck:once.
2019-05-12 14:13:51.532008 pestcheck:Line 2490 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.532116 pestcheck:12 characters long.
2019-05-12 14:13:51.532164 pestcheck:Line 2490 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.532270 pestcheck:once.
2019-05-12 14:13:51.532376 pestcheck:Line 2491 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.532424 pestcheck:12 characters long.
2019-05-12 14:13:51.532530 pestcheck:Line 2491 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.532652 pestcheck:once.
2019-05-12 14:13:51.532757 pestcheck:Line 2492 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.532863 pestcheck:12 characters long.
2019-05-12 14:13:51.532911 pestcheck:Line 2492 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.533021 pestcheck:once.
2019-05-12 14:13:51.533133 pestcheck:Line 2493 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.533266 pestcheck:12 characters long.
2019-05-12 14:13:51.533373 pestcheck:Line 2494 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.533424 pestcheck:12 characters long.
2019-05-12 14:13:51.533463 pestcheck:Line 2494 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.533610 pestcheck:once.
2019-05-12 14:13:51.533729 pestcheck:Line 2495 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.533768 pestcheck:12 characters long.
2019-05-12 14:13:51.533865 pestcheck:Line 2495 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.533969 pestcheck:once.
2019-05-12 14:13:51.534018 pestcheck:Line 2496 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.534125 pestcheck:12 characters long.
2019-05-12 14:13:51.534227 pestcheck:Line 2496 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.534274 pestcheck:once.
2019-05-12 14:13:51.534380 pestcheck:Line 2497 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.534484 pestcheck:12 characters long.
2019-05-12 14:13:51.534530 pestcheck:Line 2497 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.534568 pestcheck:once.
2019-05-12 14:13:51.534668 pestcheck:Line 2498 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.534792 pestcheck:12 characters long.
2019-05-12 14:13:51.534831 pestcheck:Line 2498 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.534930 pestcheck:once.
2019-05-12 14:13:51.535033 pestcheck:Line 2499 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.535079 pestcheck:12 characters long.
2019-05-12 14:13:51.535117 pestcheck:Line 2499 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.535216 pestcheck:once.
2019-05-12 14:13:51.535319 pestcheck:Line 2500 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.535367 pestcheck:12 characters long.
```

```
2019-05-12 14:13:51.535406 pestcheck:Line 2500 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.535505 pestcheck:once.
2019-05-12 14:13:51.535607 pestcheck:Line 2501 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.535653 pestcheck:12 characters long.
2019-05-12 14:13:51.535828 pestcheck:Line 2501 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.535887 pestcheck:once.
2019-05-12 14:13:51.535987 pestcheck:Line 2502 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.536088 pestcheck:12 characters long.
2019-05-12 14:13:51.536133 pestcheck:Line 2502 of file freyberg.pst: parameter name "prsity3004
2019-05-12 14:13:51.536170 pestcheck:once.
2019-05-12 14:13:51.536267 pestcheck:Line 2503 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.536367 pestcheck:12 characters long.
2019-05-12 14:13:51.536414 pestcheck:Line 2504 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.536515 pestcheck:12 characters long.
2019-05-12 14:13:51.536614 pestcheck:Line 2504 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.536727 pestcheck:once.
2019-05-12 14:13:51.536827 pestcheck:Line 2505 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.536871 pestcheck:12 characters long.
2019-05-12 14:13:51.536909 pestcheck:Line 2505 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.537005 pestcheck:once.
2019-05-12 14:13:51.537106 pestcheck:Line 2506 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.537153 pestcheck:12 characters long.
2019-05-12 14:13:51.537191 pestcheck:Line 2506 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.537256 pestcheck:once.
2019-05-12 14:13:51.537327 pestcheck:Line 2507 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.537427 pestcheck:12 characters long.
2019-05-12 14:13:51.537472 pestcheck:Line 2507 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.537574 pestcheck:once.
2019-05-12 14:13:51.537675 pestcheck:Line 2508 of file freyberg.pst: parameter name "prsity3005
2019-05-12 14:13:51.537728 pestcheck:12 characters long.
2019-05-12 14:13:51.538016 finished: running pestchek on freyberg.pst took: 0:00:00.146403
2019-05-12 14:13:51.538148 starting: saving intermediate _setup_<> dfs into template
2019-05-12 14:13:51.668183 finished: saving intermediate _setup_<> dfs into template took: 0:00
2019-05-12 14:13:51.668417 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 filed 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

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 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.mpenp
observations in this instruction file will havegeneric values.

Finally we need to copy the original prsity 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","prsity_layer_{0}.ref".
```

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
```

32

	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_
             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()
```

```
2019-05-12 14:14:00.746864 starting: building prior covariance matrix
2019-05-12 14:14:00.855329 WARNING: geospatial prior not implemented for SFR pars
```

```
/Users/jeremyw/miniconda3/lib/python3.5/site-packages/pandas/core/indexing.py:362: SettingWith(
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: SettingWith(
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


2019-05-12 14:14:06.902241 saving prior covariance matrix to file template/prior_cov.jcb
2019-05-12 14:14:11.104237 finished: building prior covariance matrix took: 0:00:10.357373
```
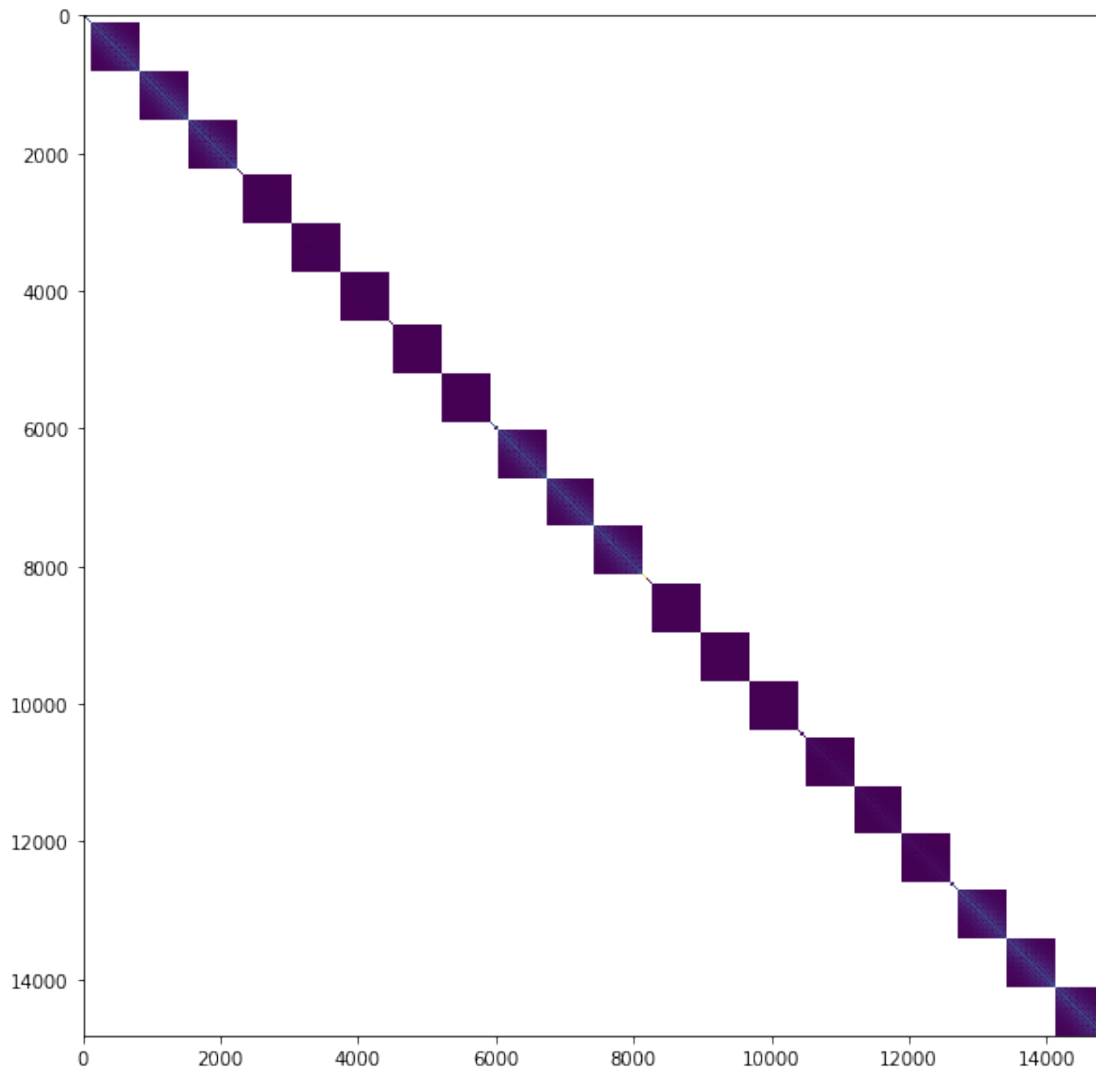
1.1.8 now we can make a draw from the prior parameter covariance matrix to form a prior parameter ensemble

```
In [25]: pe = pst_helper.draw(500)
```

```
2019-05-12 14:14:24.567473 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_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_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_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_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_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_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
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_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_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_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
processing  name:spatial_list_geostruct,nugget:0.0,structures:
name:var1,contribution:1.0,a:2500.0,anisotropy:1.0,bearing:0.0


working on pargroups ['drncond_k00']
build cov matrix
done
getting diag var cov 10
scaling full cov by diag var cov
making full cov draws with home-grown goodness



/Users/jeremyw/miniconda3/lib/python3.5/site-packages/pandas/core/indexing.py:362: SettingWith
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: SettingWith
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


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_geostruct,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
2019-05-12 14:14:34.064683 finished: drawing realizations took: 0:00:09.497210
```

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
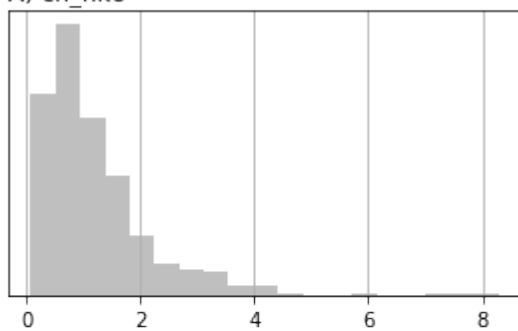
B) cn_hk7
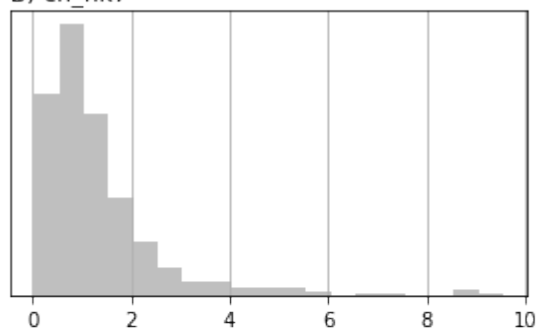
C) cn_hk8
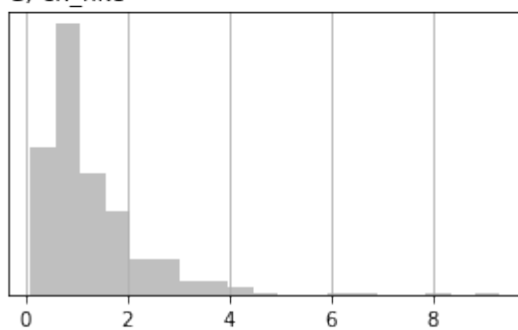
D) cn_prsity6
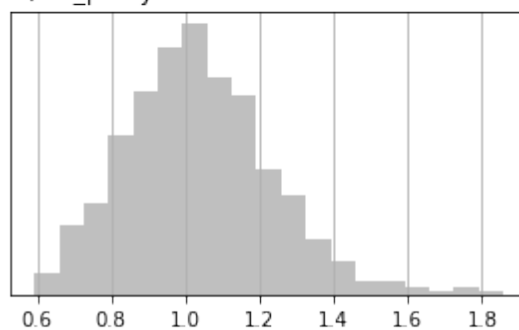
E) cn_prsity7
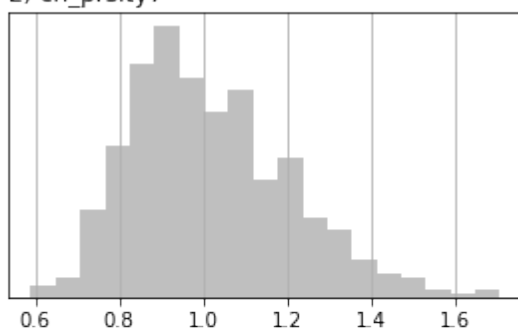
F) cn_prsity8
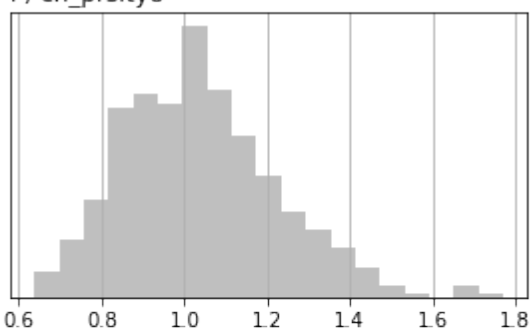
G) cn_rech4
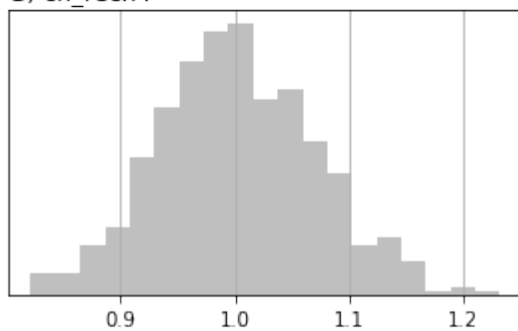
H) cn_rech5
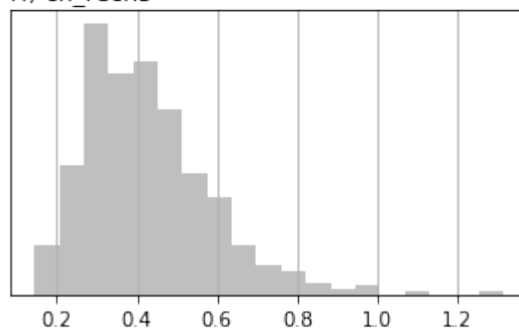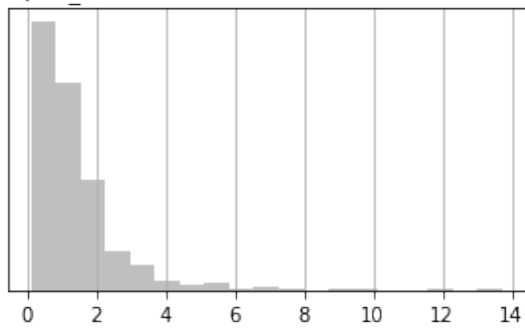
A) cn_ss6   B) cn_ss7
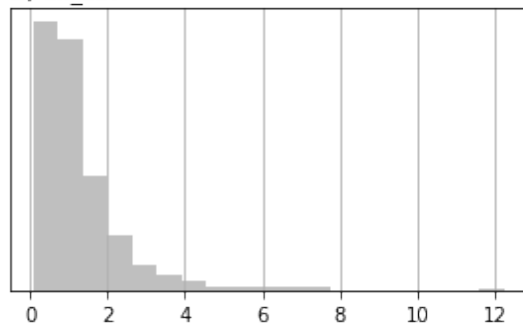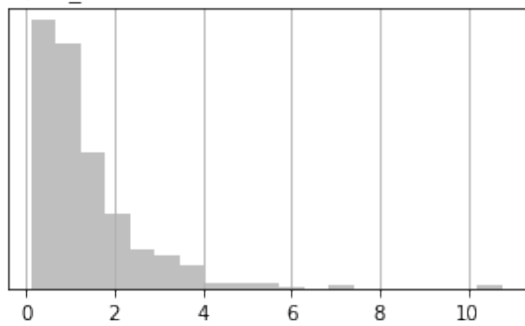
C) cn_ss8   D) cn_strt6
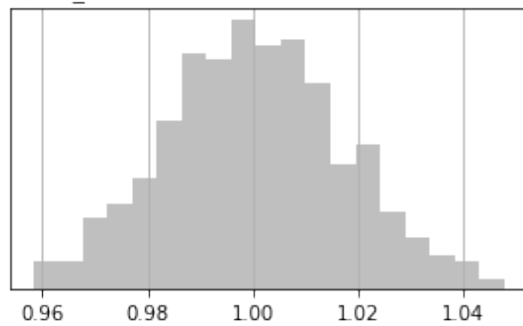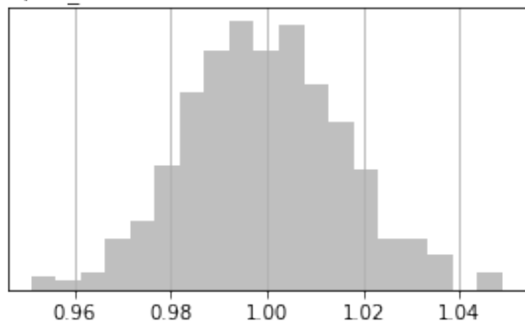
E) cn_strt7   F) cn_strt8
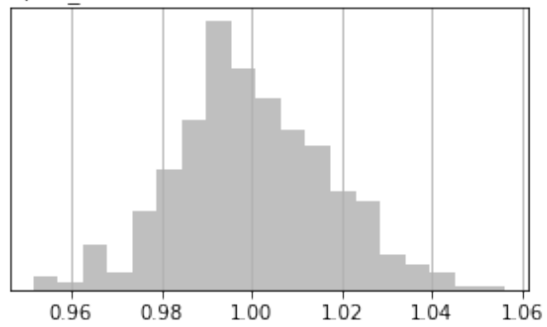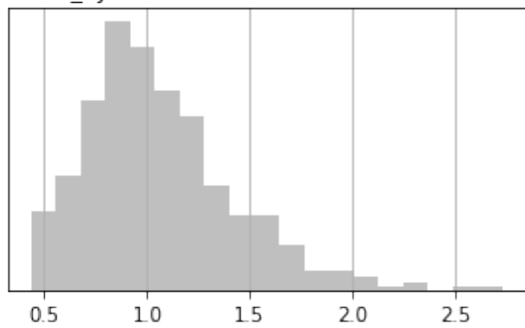
G) cn_sy6   H) cn_sy7
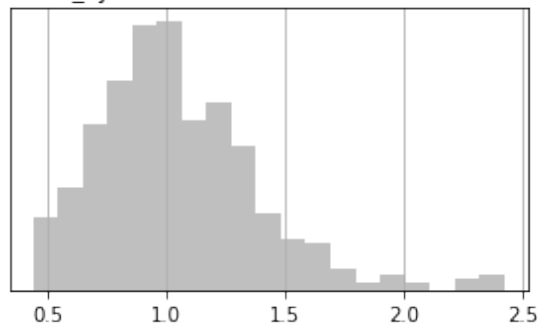
A) cn_sy8
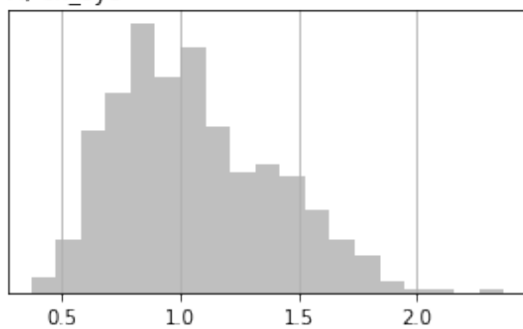
B) cn_vka6
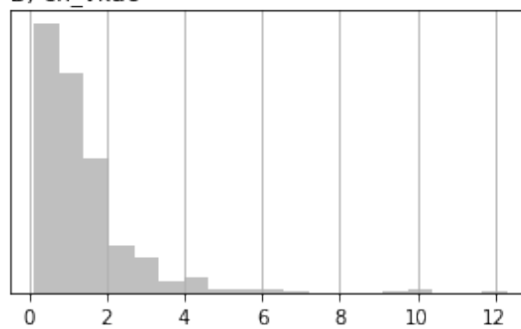
C) cn_vka7
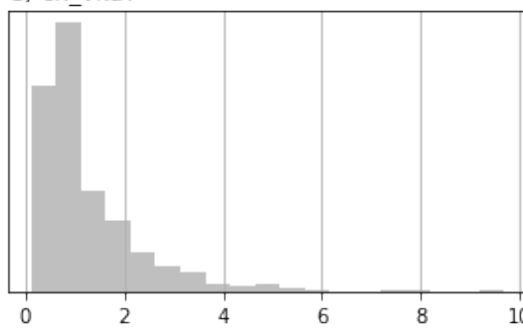
D) cn_vka8
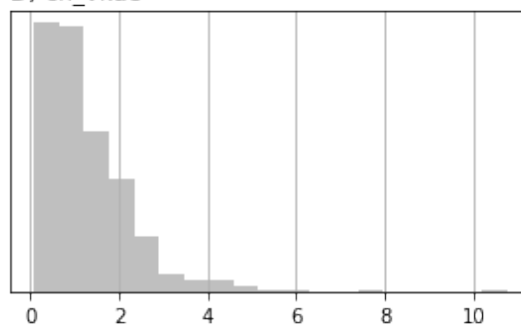
E) drncond_k00
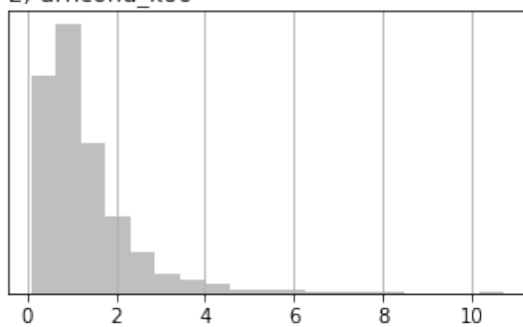
F) flow
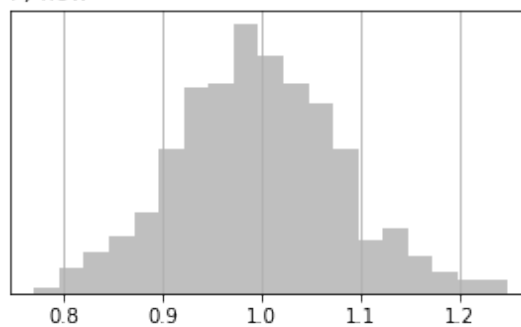
G) gr_hk3
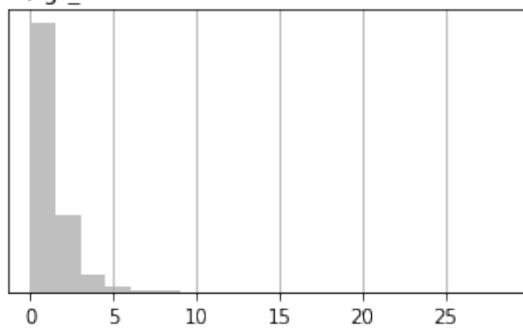
H) gr_hk4
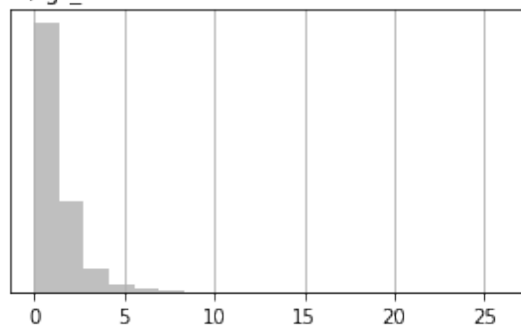
A) gr_hk5
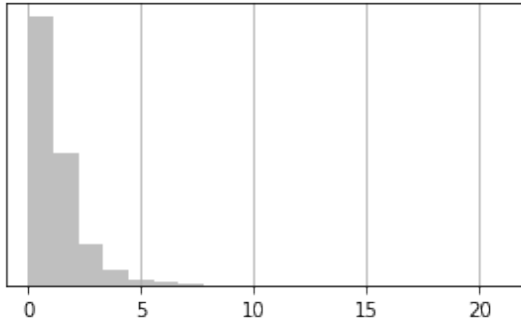
B) gr_prsity3
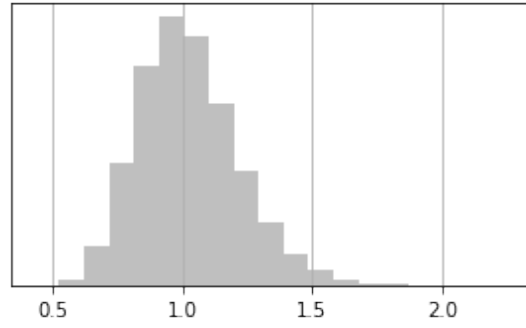
C) gr_prsity4
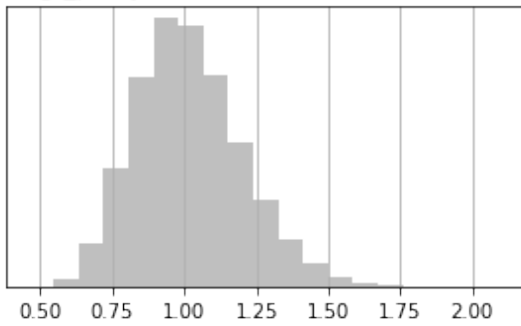
D) gr_prsity5
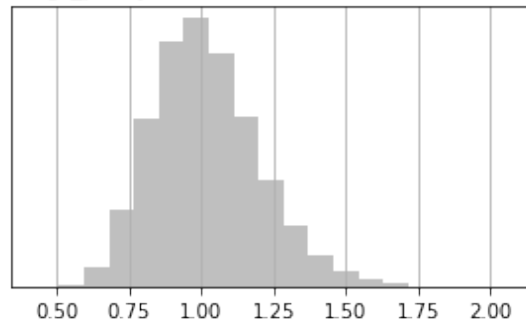
E) gr_rech2
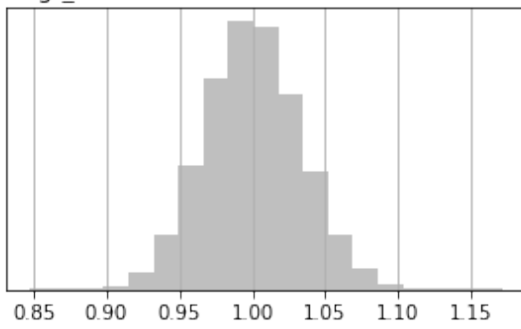
F) gr_rech3
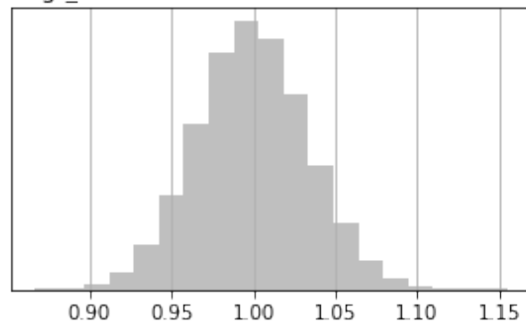
G) gr_ss3
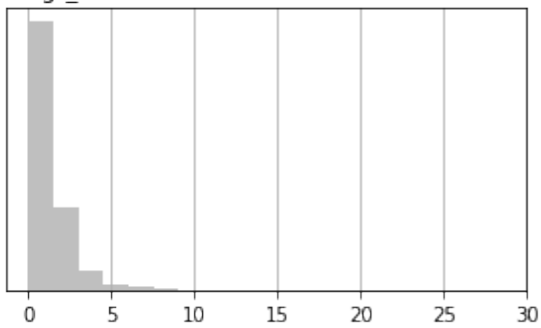
H) gr_ss4
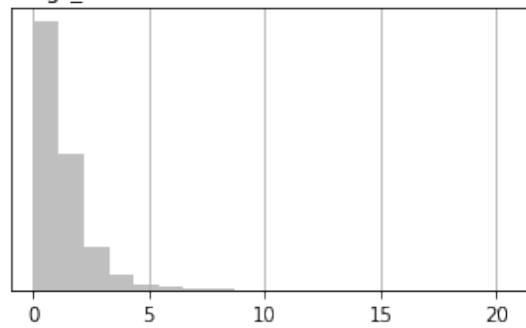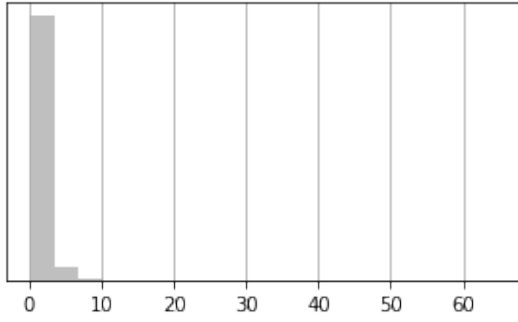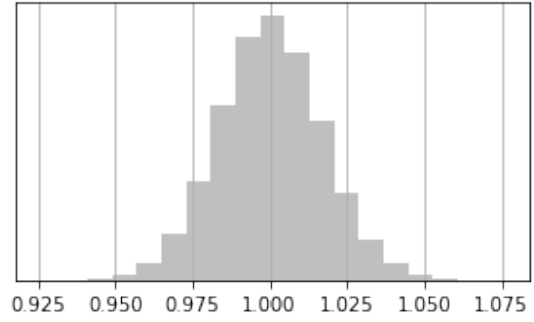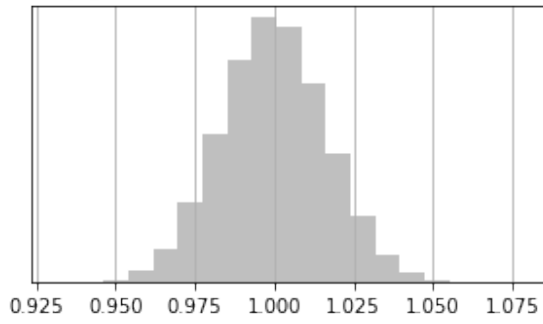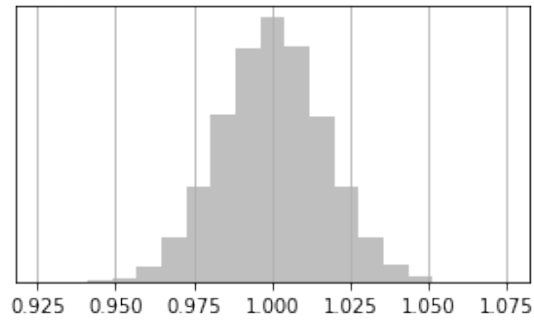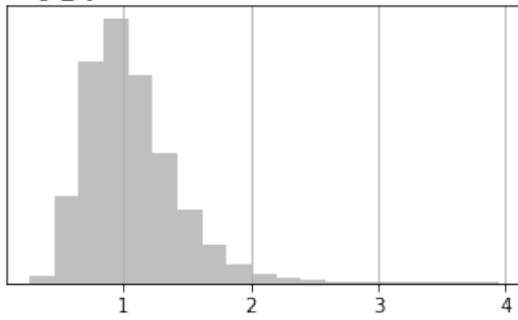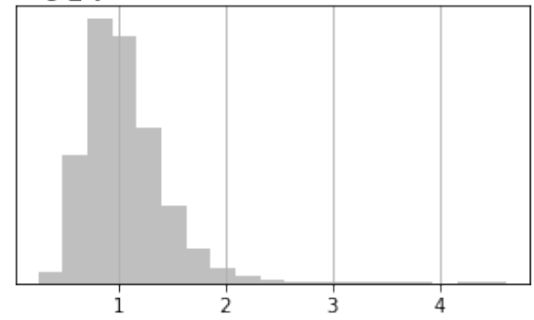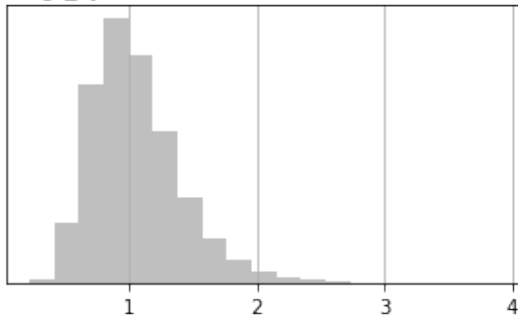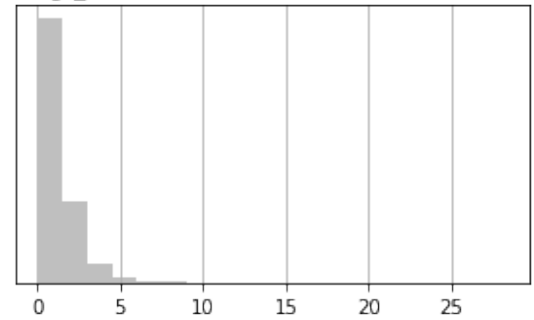
A) gr_vka4
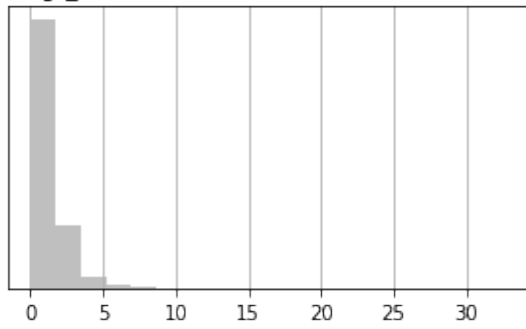
B) gr_vka5
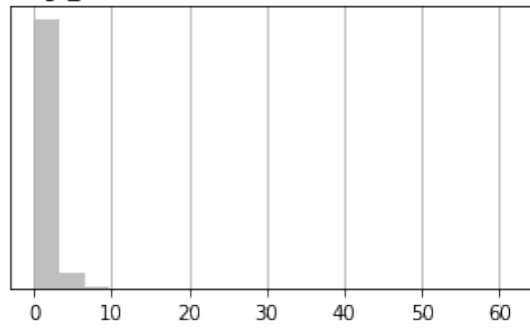
C) pp_hk0
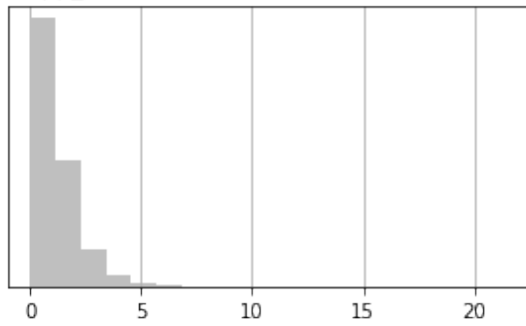
D) pp_hk1
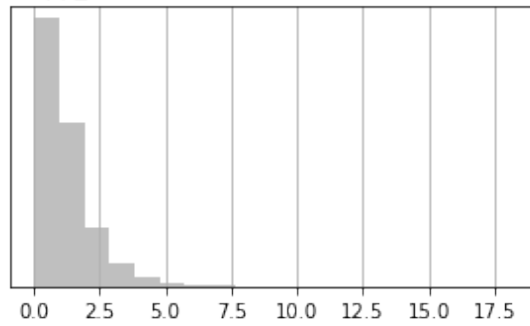
E) pp_hk2
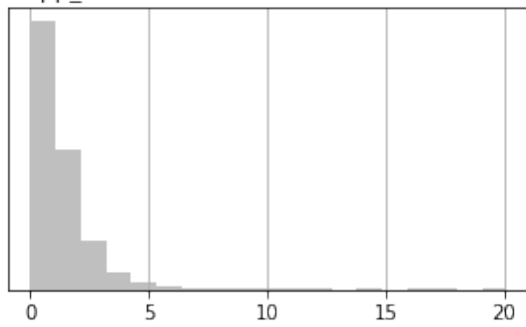
F) pp_prsity0
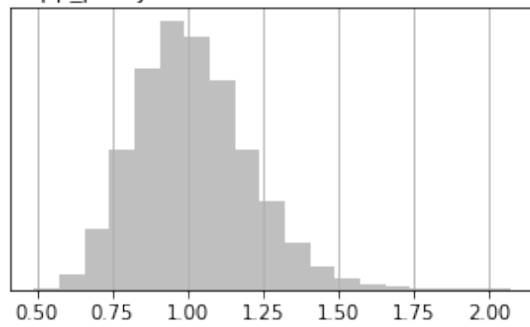
G) pp_prsity1

H) pp_prsity2
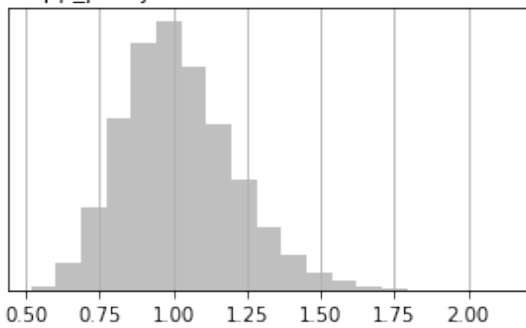
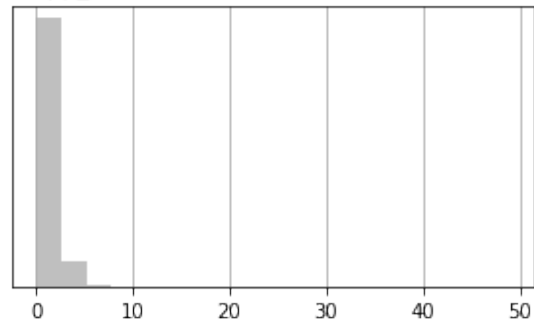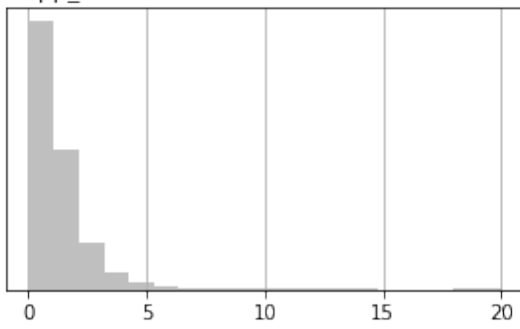A) pp_rech0   B) pp_rech1   C) pp_ss0   D) pp_ss1   E) pp_ss2   F) pp_strt0   G) pp_strt1   H) pp_strt2
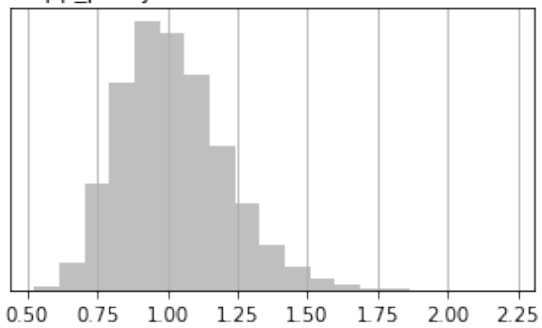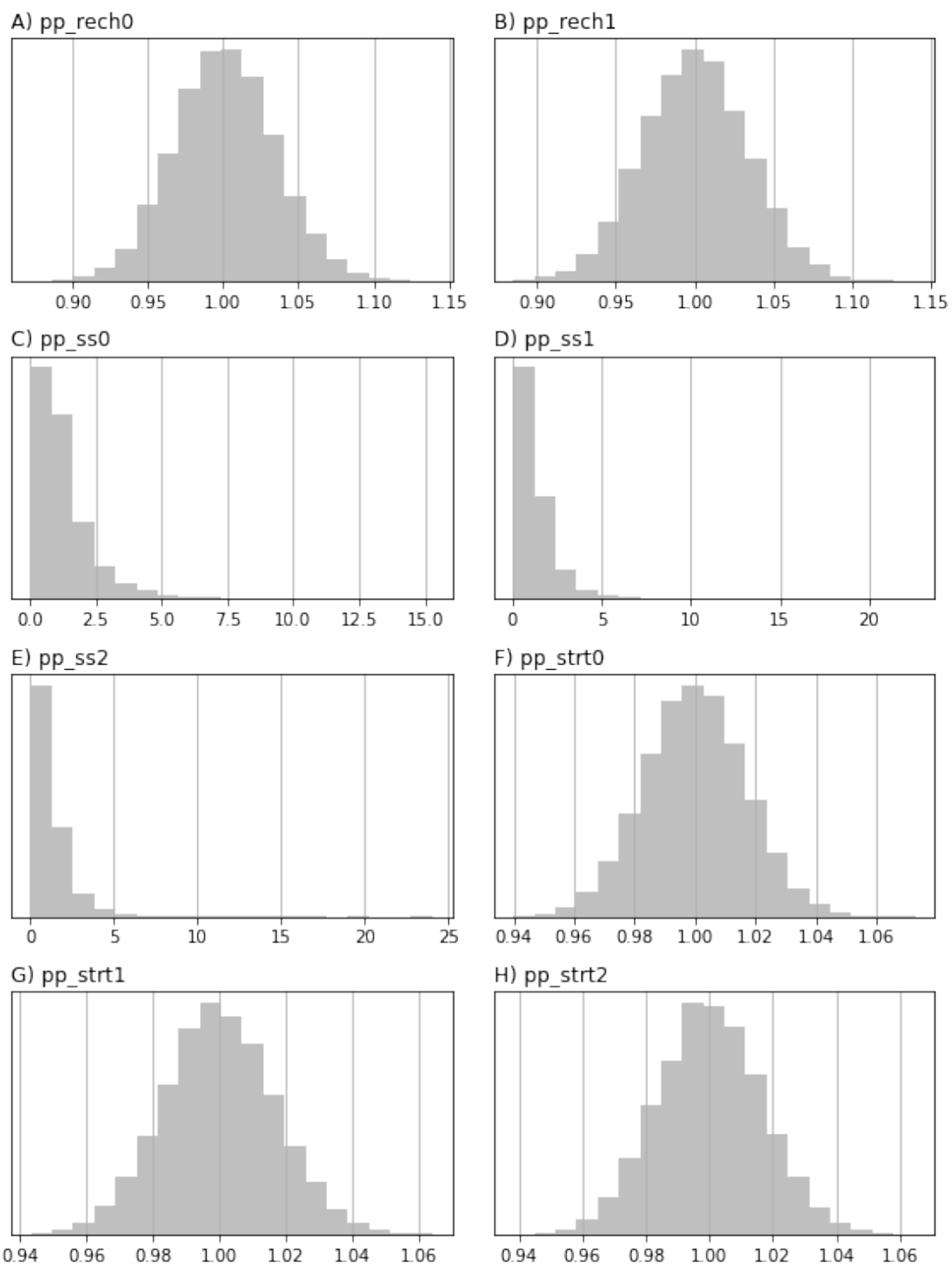
A) pp_sy0
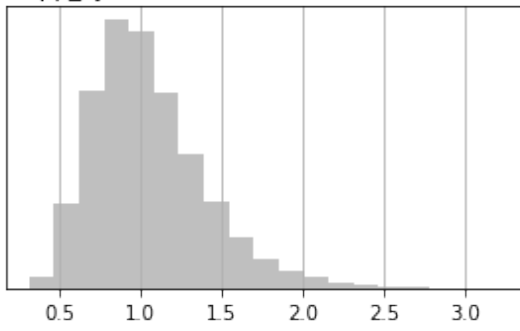
B) pp_sy1
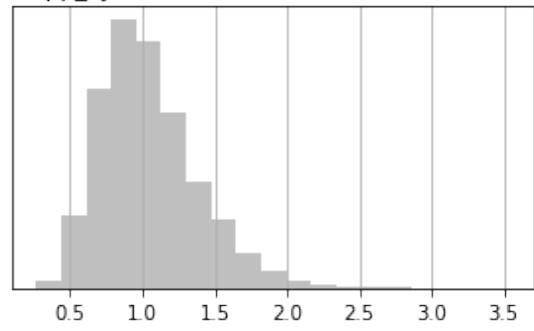
C) pp_sy2
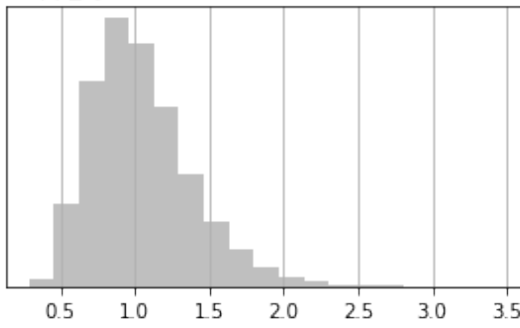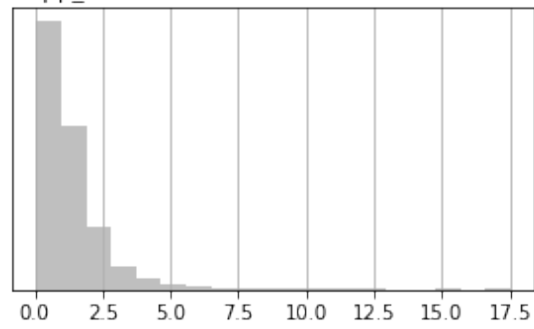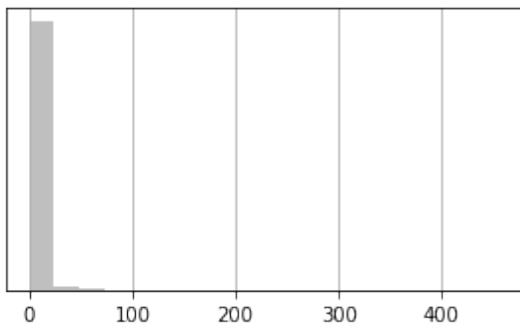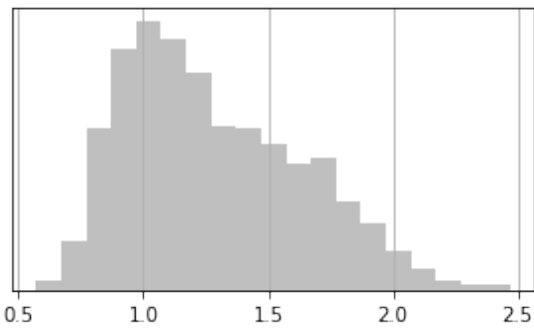
D) pp_vka0
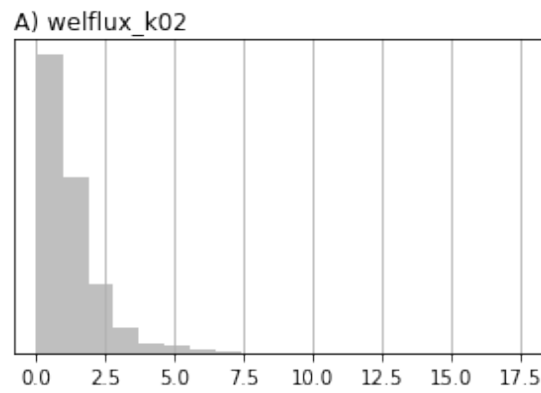
E) pp_vka1

F) pp_vka2

G) strk

H) welflux

A) welflux_k02

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".forma
         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 excercise

```
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" :
         print(swgw_forecasts)
         hds_fore_name = "hds_00_{0:03d}_{1:03d}".format(int(pst_helper.m.nrow/3),int(pst_helpe
         hds_forecasts = obs.loc[obs.obsnme.apply(lambda x: hds_fore_name in x),"obsnme"].tolis
         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
```
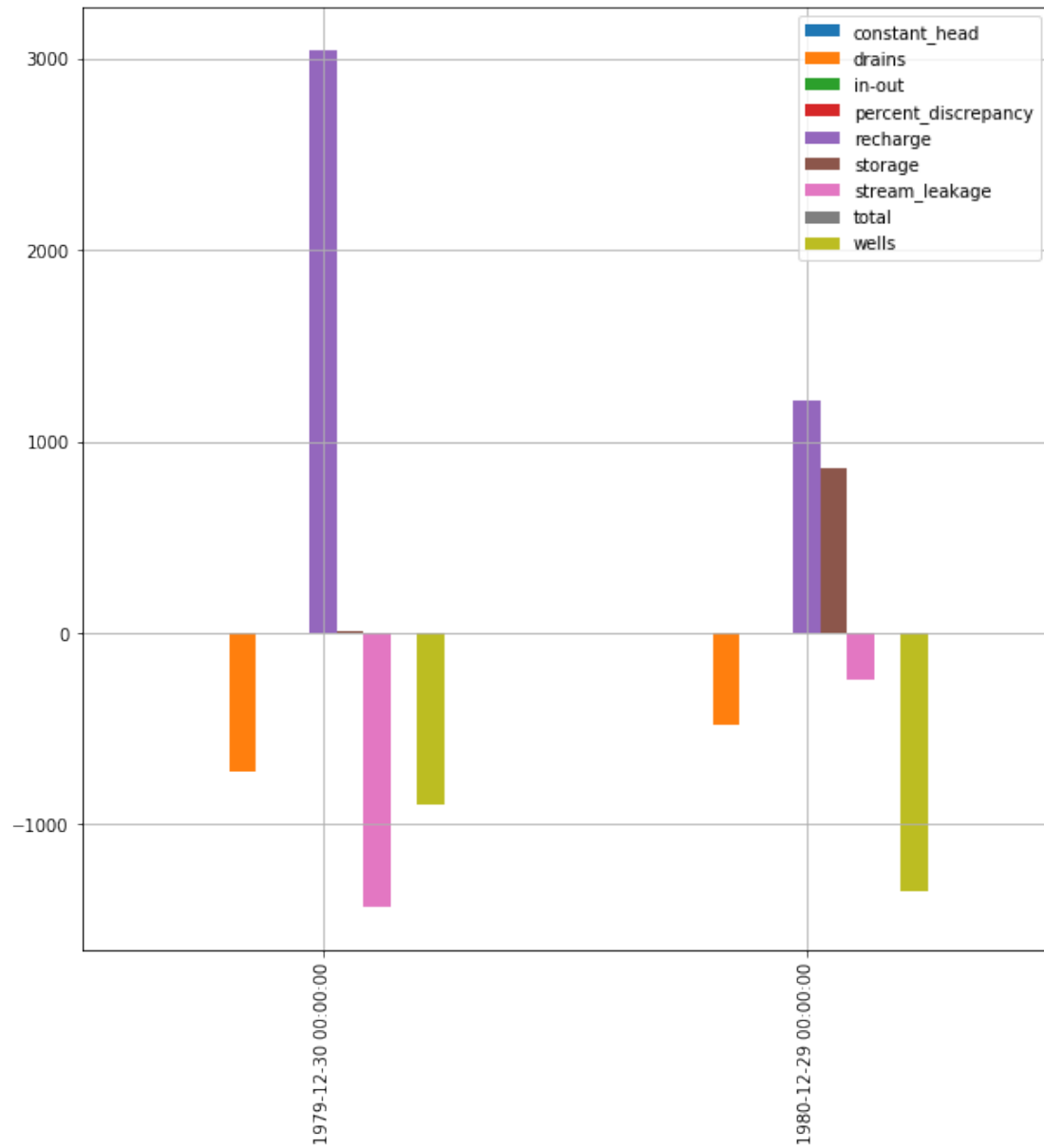
Out[31]: 9.456182577320024e-19

```
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.