

FloPy Release Notes

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Introduction

FloPy includes support for MODFLOW 6, MODFLOW-2005, MODFLOW-NWT, MODFLOW-USG, and MODFLOW-2000. Other supported MODFLOW-based models include MODPATH (version 6 and 7), MT3DMS, MT3D-USGS, and SEAWAT.

For general modeling issues, please consult a modeling forum, such as the MODFLOW Users Group. Other MODFLOW resources are listed in the MODFLOW Resources section.

Documentation

FloPy code documentation is available at <https://flopy.readthedocs.io>

Contributing

Bug reports, code contributions, or improvements to the documentation are welcome from the community. Prior to contributing, please read up on our guidelines for contributing and then check out one of our issues in the hotlist: [community-help](#).

How to Cite

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Installation

To install FloPy version 3.3.2 from the USGS FloPy website:

```
pip install https://water.usgs.gov/ogw/flopy/flopy-3.3.2.zip
```

To update to FloPy version 3.3.2 from the USGS FloPy website:

```
pip install https://water.usgs.gov/ogw/flopy/flopy-3.3.2.zip --upgrade
```

FloPy Supported Packages

MODFLOW-2000, MODFLOW-2005, and MODFLOW-NWT

Package	Creation and Write	Load Available	Template Creation
Basic (BAS6)	Supported	Supported	Not supported
Block Centered Flow (BCF)	Supported	Supported	Not supported
Time-Variant Specified-Head (CHD)	Supported	Supported	Not supported
Direct Solver (DE4)	Supported	Supported	Not supported
Discretization (DIS)	Supported	Supported	Not supported
Drain (DRN)	Supported	Supported	Not supported
Drain Return (DRT)	Supported	Supported	Not supported
Evapotranspiration (EVT)	Supported	Supported	Not supported
Evapotranspiration Segments (ETS)	Not supported	Not supported	Not supported
Flow and Head Boundary (FHB)	Supported	Supported	Not supported
General Head Boundary (GHB)	Supported	Supported	Not supported
Geometric Multi-Grid (GMG)	Supported	Supported	Not supported
Horizontal Flow Barrier (HFB)	Supported	Supported	Not supported
Hydrogeologic-Unit Flow (HUF)	Not supported	Not supported	Not supported
Interbed-Storage (IBS)	Not supported	Not supported	Not supported
Lake (LAK)	Supported	Supported	Not supported
Layer Property Flow (LPF)	Supported	Supported	Supported
Link-AMG (LMG)	Not supported	Not supported	Not supported
MODFLOW Link-MT3DMS (LMT)	Supported	Supported	Not supported
Multiplier (MULT)	Not supported	Supported	Not supported
Multi-Node Well 1 (MNW1)	Supported	Supported	Not supported
Multi-Node Well 2 (MNW2)	Supported	Supported	Not supported
Multi-Node Well Information (MNWI)	Supported	Supported	Not supported
Newton (NWT)	Supported	Supported	Not supported
Output Control (OC)	Supported	Supported	Not supported
Periodic Boundary Condition (PBC)	Supported	Not supported	Not supported
Preconditioned Conjugate Gradient (PCG)	Supported	Supported	Not supported
Preconditioned Conjugate Gradient Nonlinear (PCGN)	Supported	Supported	Not supported
Parameter Value (PVAL)	Not supported	Supported	Not supported
Recharge (RCH)	Supported	Supported	Not supported
River (RIV)	Supported	Supported	Not supported
Streamflow Routing (SFR2)	Supported	Supported	Not supported
Strongly Implicit Procedure (SIP)	Supported	Not supported	Not supported
Slice-successive Overrelaxation (SOR)	Supported	Not supported	Not supported
Stream (STR)	Supported	Supported	Not supported
Seawater Intrusion (SWI2)	Supported	Supported	Not supported
Surface-Water Routing (SWR)	Not supported	Not supported	Not supported
Subsidence (SUB)	Supported	Supported	Not supported
Subsidence and Aquifer-System Compaction (SWT)	Supported	Supported	Not supported
Upstream Weighted (UPW)	Supported	Supported	Not supported
Unsaturated Zone Flow (UZF)	Supported	Supported	Not supported
Well (WEL)	Supported	Supported	Not supported
Zone (ZONE)	Not supported	Supported	Not supported

MODFLOW-USG

Package	Creation and Write	Load Available	Template Creation
Unstructured Discretization (DISU)	Supported	Supported	Not supported
Sparse Matrix Solver (SMS)	Supported	Supported	Not supported

MODPATH 6

Package	Creation and Write	Load Available	Template Creation
MODPATH Basic (MPBAS)	Supported	Not supported	Not supported
MODPATH Simulation (MPSIM)	Supported	Not supported	Not supported

MODPATH 7

Package	Creation and Write	Load Available	Template Creation
MODPATH Basic (MPBAS)	Supported	Not supported	Not supported
MODPATH Simulation (MPSIM)	Supported	Not supported	Not supported
Starting Location Data - Input Style 1	Supported	Not supported	Not supported
Starting Location Data - Input Style 2	Supported	Not supported	Not supported
Starting Location Data - Input Style 3	Supported	Not supported	Not supported
Starting Location Data - Input Style 4	Not supported	Not supported	Not supported

MT3DMS, MT3D-USGS

Package	Creation and Write	Load Available	Template Creation
Advection (ADV)	Supported	Supported	Not supported
Basic Transport (BTN)	Supported	Supported	Not supported
Dispersion (DSP)	Supported	Supported	Not supported
Generalized Conjugate Gradient (GCG)	Supported	Supported	Not supported
Lake (LKT)	Supported	Supported	Not supported
PHT3D-PHREEQC Interface (PHC)	Supported	Not supported	Not supported
Streamflow (SFT)	Supported	Supported	Not supported
Reaction (RCT)	Supported	Supported	Not supported
Sink and Source Mixing (SSM)	Supported	Supported	Not supported
Transport Observation (TOB)	Supported	Not supported	Not supported
Unsaturated-zone (UZT)	Supported	Supported	Not supported

SEAWAT

Package	Creation and Write	Load Available	Template Creation
Variable Density Flow (VDF)	Supported	Supported	Not supported
Viscosity (VSC)	Supported	Supported	Not supported

MODFLOW-2000, MODFLOW-2005, and MODFLOW-NWT Observations

Package	Creation and Write	Load Available	Template Creation
Drain Observation (DROB)	Not supported	Not supported	Not supported
HYDMOD (HYD)	Supported	Supported	Not supported
Gage (GAGE)	Supported	Supported	Not supported
General Head Boundary Observation (GBOB)	Supported	Not supported	Not supported

Package	Creation and Write	Load Available	Template Creation
Head Observation (HOB)	Supported	Supported	Not supported
River Observation (RVOB)	Supported	Not supported	Not supported
Stream Observation (STOB)	Supported	Not supported	Not supported
Specified-Head Flow Observation (CHOB)	Supported	Not supported	Not supported

MODFLOW 6

Package	Creation and Write	Load Available
Temporal Discretization (TDIS6)	Supported	Supported
Structured Discretization (DIS6)	Supported	Supported
Discretization with Vertices (DISV6)	Supported	Supported
Unstructured Discretization (DISU6)	Supported	Supported
Initial Conditions (IC6)	Supported	Supported
Output Control (OC6)	Supported	Supported
Groundwater Flow Observations (OBS6)	Supported	Supported
Node Property Flow (NPF6)	Supported	Supported
Horizontal Flow Barrier (HFB6)	Supported	Supported
Storage (STO6)	Supported	Supported
Skeletal Storage, Compaction, and Subsidence (CSUB6)	Supported	Supported
Skeletal Storage, Compaction, and Subsidence Observations (OBS6)	Supported	Supported
Buoyancy (BUY6)	Supported	Supported
Constant-Head (CHD6)	Supported	Supported
Constant-Head Observations (OBS6)	Supported	Supported
Well (WEL6)	Supported	Supported
Well Observations (OBS6)	Supported	Supported
Drain (DRN6)	Supported	Supported
Drain Observations (OBS6)	Supported	Supported
River (RIV6)	Supported	Supported
River Observations (OBS6)	Supported	Supported
General-Head-Boundary (GHB6)	Supported	Supported
General-Head-Boundary Observations (OBS6)	Supported	Supported
Recharge (RCH6) - List-Based	Supported	Supported
Recharge (RCH6) - Array-Based	Supported	Supported
Recharge Observations (OBS6)	Supported	Supported
Evapotranspiration (EVT6) - List-Based	Supported	Supported
Evapotranspiration (EVT6) - Array-Based	Supported	Supported
Evapotranspiration Observations (OBS6)	Supported	Supported
Multi-Aquifer Well (MAW6)	Supported	Supported
Multi-Aquifer Well Observations (OBS6)	Supported	Supported
Streamflow Routing (SFR6)	Supported	Supported
Streamflow Routing Observations (OBS6)	Supported	Supported
Lake Package (LAK6)	Supported	Supported
Lake Table Input	Supported	Supported
Lake Observations (OBS6)	Supported	Supported
Unsaturated Zone Flow (UZSF6)	Supported	Supported
Unsaturated Zone Flow Observations (OBS6)	Supported	Supported
Water Mover (MVR6)	Supported	Supported
Ghost-Node Correction (GNC6)	Supported	Supported
Groundwater Flow Exchange (GWF-GWF)	Supported	Supported
Groundwater Transport Observations (OBS6)	Supported	Supported
Advection (ADV6)	Supported	Supported
Dispersion (DSP6)	Supported	Supported
Source and Sink Mixing (SSM6)	Supported	Supported

Package	Creation and Write	Load Available
Mobile Storage and Transfer (MST6)	Supported	Supported
Immobile Storage and Transfer (IST6)	Supported	Supported
Constant Concentration (CNC6)	Supported	Supported
Constant Concentration Observations (OBS6)	Supported	Supported
Mass Source Loading (SRC6)	Supported	Supported
Mass Source Loading Observations (OBS6)	Supported	Supported
Streamflow Transport (SFT6)	Supported	Supported
Streamflow Transport Observations (OBS6)	Supported	Supported
Lake Transport (LKT6)	Supported	Supported
Lake Transport Observations (OBS6)	Supported	Supported
Multi-Aquifer Well Transport (MWT6)	Supported	Supported
Multi-Aquifer Well Transport Observations (OBS6)	Supported	Supported
Unsaturated Zone Transport (UZT6)	Supported	Supported
Unsaturated Zone Transport Observations (OBS6)	Supported	Supported
Flow Model Interface (FMI6)	Supported	Supported
Mover Transport (MVT6)	Supported	Supported
Iterative Model Solution (IMS6)	Supported	Supported
Timeseries File (TS6)	Supported	Supported

FloPy Model Checks

List of available FloPy model checks

Package	Check	Implemented	Type
NAM	unit number conflicts	Supported	Error
NAM	compatible solver	Supported	Error
NAM	package minimum packages needed to run the model	Not supported	Error
all BC packages	overlapping boundary conditions	Not supported	Error
all BC packages	NaN values in stress_period_data	Supported	Error
all BC packages	valid indices for stress_period_data	Supported	Error
LPF/UPW	hk or vka ≤ 0	Supported	Error
LPF/UPW	hani < 0	Supported	Error
LPF/UPW	vkcb (quasi-3D kv values) ≤ 0	Supported	Error
LPF/UPW	unusually high or low values in hk and vka arrays	Supported	Warning
LPF/UPW	unusually high or low values in vkcb (quasi-3D kv values)	Supported	Warning
LPF/UPW	storage values ≤ 0 (transient only)	Supported	Error
LPF/UPW	unusual values of storage (transient only)	Supported	Error
RIV/SFR/STR	check for surface water BCs in confined layers	Not supported	Warning
BAS	isolated cells	Supported	Warning
BAS	NaN values	Supported	Error

Package	Check	Implemented	Type
DIS	cell thicknesses ≤ 0	Supported	Error
DIS	cell thicknesses $<$ thin_cell_threshold (default 1.0)	Supported	Warning
DIS	NaN values in top and bottom arrays	Supported	Error
DIS	discretization that violates the 1.5 rule	Not supported	Warning
DIS	large changes in elevation	Not supported	Warning
DISU	large changes in elevation	Not supported	Warning
DISU	cell thicknesses ≤ 0	Not supported	Error
DISU	cell thicknesses $<$ thin_cell_threshold (default 1.0)	Not supported	Warning
DISU	NaN values in top and bottom arrays	Not supported	Error
DISU	discretization that violates the 1.5 rule	Not supported	Warning
DISU	large changes in elevation	Not supported	Warning
MNW2	ITMP ≥ 0 for first stress period	Supported	Error
MNW2	ITMP $>$ MNWMAX	Supported	Error
MNWI	MNWI present without MNW2 package	Supported	Warning
RCH	unusually high or low R/T ratios	Supported	Warning
RCH	NRCHOP not specified as 3	Supported	Warning
SFR	continuity in segment and reach numbering	Supported	Error
SFR	segment number decreases in downstream direction	Supported	Warning
SFR	circular routing	Supported	Error
SFR	multiple non-zero conductances in a model cell	Supported	Warning
SFR	elevation increases in the downstream direction	Supported	Error
SFR	streambed elevations above model top	Supported	Warning
SFR	streambed elevations below cell bottom	Supported	Error
SFR	negative stream depth when icalc=0	Not supported	Error
SFR	slopes above or below specified threshold	Supported	Warning
SFR	unusual values for manning's roughness and unit constant	Not supported	Warning

Package	Check	Implemented	Type
SFR	gaps in segment and reach routing	Not supported	Warning
SFR	outlets in interior of model domain	Not supported	Warning
WEL	PHIRAMP is < 1 and should be close to recommended value of 0.001	Not supported	Warning
MPSIM	invalid stop times	Supported	

Visualizations

Package	Check	Implemented	Type
All	Shapefile with detected errors	Not supported	Information
All	Shapefile with detected warnings	Not supported	Information
SFR/STR	Segment Connectivity	Not supported	Information
SFR/STR	Identification of diversions	Not supported	Information
SFR/STR	Identification of outlet tributaries	Not supported	Information

Additional model checks and visualizations

Please submit additional proposed model checks as issues on the FloPy development branch on github.

FloPy Changes

Version 3.3.2

- New features:
 - feat(mf6): Update t503 autotest to use mf6examples zip file (#1007). Committed by jdughes-usgs on 2020-10-21.
 - feat(mf6): Add modflow 6 gwt dfn and classes (#1006). Committed by jdughes-usgs on 2020-10-21.
 - feat(geospatial_util): Geospatial consolidation utilities (#1002). Committed by Joshua Larsen on 2020-10-19.
 - feat(cvfdutil): Capability to create disv nested grids (#997). Committed by langevin-usgs on 2020-10-02.
 - feat(cellid not as tuple): List data input now accepts cellids as separate integers (#976). Committed by spaulins-usgs on 2020-08-27.
 - feat(set_all_data_external): New check_data option (#966). Committed by spaulins-usgs on 2020-08-17.
- Bug fixes:
 - fix(gridintersect): Use linestrings and structured grid (#996). Committed by Tom van Steijn on 2020-09-25.
 - fix(): fix(extraneous blocks and zero length data in a list) (#990). Committed by spaulins-usgs on 2020-09-03.
 - fix(internal): Flopy fixed to correctly reads in internal keyword when no multiplier supplied. also, header line added to package files. (#962). Committed by spaulins-usgs on 2020-08-13.
 - fix(mfsr2.py: Find_path): wrap find_path() so that the routing dictionary (graph) can still be copied, but won't be copied with every call of find_path() as it recursively finds the routing connections along a path in the sfr network. this was severely impacting performance for large sfr networks. (#955). Committed by aleaf on 2020-08-11.
 - fix(#958): Fix gridintersect._vtx_grid_to_shape_generator rtree for cells with more than 3 vertices (#959). Committed by mkennard-aquaveo on 2020-08-07.
 - fix(GridIntersect): Fix crash intersecting 3d points that are outside... (#957). Committed by mkennard-aquaveo on 2020-08-05.

- fix(mvr): Added documentation explaining the difference between the two flopy mvr classes (#950). Committed by spaulins-usgs on 2020-07-31.
- fix(check): Get_active() error for confining bed layers (#937). Committed by Michael Ou on 2020-07-29.
- fix(rcha and evta): Irch and ievt arrays now zero based. fix for issue #941. also changed createpackages.py to always produce python scripts with unix-style line endings. (#949). Committed by spaulins-usgs on 2020-07-29.
- fix(lgrutil): Corrected bug in child to parent vertical exchanges (#948). Committed by langevin-usgs on 2020-07-27.
- fix(time series slowness): Speeds up performance when a large number of time series are used by a single stress package (#943). Committed by spaulins-usgs on 2020-07-17.
- fix: Restore python 3.5 compatibility (modulenotfounderror -> importerror) (#933). Committed by Mike Taves on 2020-07-09.
- fix(read binary file): Fix for reading binary files with array data (#931). Committed by spaulins-usgs on 2020-06-30.
- fix(idomain): Data checks now treat all positive idomain values as active (#929). Committed by spaulins-usgs on 2020-06-29.
- fix(Modpath7Sim): Fix timepointinterval calculation for timepointoption 3 (#927). Committed by jd Hughes on 2020-06-26.

Version 3.3.1

- New features:
 - feat(ModflowAg): Add the modflowag package for nwt (pull request #922). Committed by Joshua Larsen on 2020-06-25.
 - feat(GridIntersect): #902 (#903). Committed by David Brakenhoff on 2020-06-10.
 - feat(mbase): Suppress duplicate package warning if verbose is false (#908). Committed by Hughes, J.D on 2020-06-09.
 - feat(ModflowSms): Add support for simple, moderate, complex (#906). Committed by langevin-usgs on 2020-06-09.
 - feat(str): Add irdflg and iptflg control to str (#905). Committed by Hughes, J.D on 2020-06-09.
 - feat(Mf6ListBudget): Add support for mf6 budgets with multiple packages with same name (#900). Committed by langevin-usgs on 2020-06-02.
 - feat(mfchd.py): Prevent write chk-file always (#869). Committed by Ralf Junghanns on 2020-05-08.
 - feat(set all data external): Set all data external for simulation (#846). Committed by spaulins-usgs on 2020-04-08.
 - feat(vtk): Improve export at vertices (#844). Committed by Etienne Bresciani on 2020-04-06.
 - feat(netcdf): Use modern features from pyproj>=2.2.0 (#840). Committed by Mike Taves on 2020-03-31.
 - feat(vtk): Export vectors to vtk. Committed by Etienne Bresciani on 2020-03-31.
 - feat(vtk): Export in .vti and .vtr when possible. Committed by Etienne Bresciani on 2020-03-28.
 - feat(vectors): Vector plots when stresses applied along boundaries (#817). Committed by langevin-usgs on 2020-03-05.
 - feat(plot_bc): Updated plot_bc for maw, uzf, sfr, and multiple bc packages (#808). Committed by Joshua Larsen on 2020-02-11.
 - feat(disl grids): Support for 1d vertex grids. fix for writing gridlines to shapefile (#799). Committed by spaulins-usgs on 2020-02-04.
 - feat(zb netcdf): Zonebudget netcdf export support added (#781). Committed by Joshua Larsen on 2020-01-17.
 - feat(mf6 checker): Input data check for mf6 (#779). Committed by spaulins-usgs on 2020-01-16.
- Bug fixes:
 - fix(#280, #835): Set_all_data_external now includes constants, cellids in list data are checked (#920). Committed by spaulins-usgs on 2020-06-23.
 - fix(mfsfr2.check): Negative segments for lakes no longer included in segment numbering order check (#915). Committed by aleaf on 2020-06-23.
 - fix(GridIntersect): Fixes #916 and #917 (#918). Committed by David Brakenhoff on 2020-06-22.
 - fix(ZoneBudget): Fix faulty logic in ZoneBudget (#911). Committed by Jason Bellino on 2020-06-22.

- fix(SwtListBudget): Totim was not being read correctly for seawat list file (#910). Committed by langevin-usgs on 2020-06-10.
- fix(Seawat.modelgrid): Pass lenuni from dis file into modelgrid instance (#901). Committed by Joshua Larsen on 2020-06-02.
- fix(mfsimulation): Repair change for case insensitive model names (#897). Committed by langevin-usgs on 2020-06-01.
- fix(_plot_util3d_helper, export_array): (#895). Committed by Joshua Larsen on 2020-06-01.
- fix(): fix building in clean env (#894). Committed by Ritchie Vink on 2020-05-28.
- fix(setup.py): Read package name, version, etc. from version.py (#893). Committed by Hughes, J.D on 2020-05-26.
- fix(MFSimulation): Remove case sensitivity from register_ims_package() (#890). Committed by Joshua Larsen on 2020-05-25.
- fix(modelgrid): Fix offset for xul and yul in read_usgs_model_reference_file and attribs_from_namefile_header (#889). Committed by Joshua Larsen on 2020-05-19.
- fix(#886): Mfarray aux variable now always returned as an numpy.ndarray. fixed problem with pylistutil not fully supporting numpy.ndarray type. (#887). Committed by spaulins-usgs on 2020-05-19.
- fix(CellBudgetFile): Update for auto precision with imeth = 5 or 6 (#876). Committed by Joshua Larsen on 2020-05-14.
- fix(#870): Update ims name file record after removing ims package (#880). Committed by Joshua Larsen on 2020-05-14.
- fix: #868, #874, #879 (#881). Committed by spaulins-usgs on 2020-05-14.
- fix(#867): Fixed minimum record entry count for lists to never include keywords in the count (#875). Committed by spaulins-usgs on 2020-05-11.
- fix(SfrFile): Update sfrfile for streambed elevation when present (#866). Committed by Joshua Larsen on 2020-05-04.
- fix(#831, #858): Data length check and case-insensitive lookup (#864). Committed by spaulins-usgs on 2020-05-01.
- fix(#856): Specifying period data with value none now only removes data from that period. also, fixed an unrelated problem by updating the multi-package list. (#857). Committed by spaulins-usgs on 2020-04-22.
- fix(plot_array): Update plot_array method to mask using np.ma.masked_values (#851). Committed by Joshua Larsen on 2020-04-15.
- fix(ModflowDis): Zero based get_node() and get_lrc()... (#847). Committed by Joshua Larsen on 2020-04-10.
- fix(binaryfile_utils, CellbudgetFile): Update for imeth == 6 (#823). Committed by Joshua Larsen on 2020-04-10.
- fix(utils.gridintersect): Bug in gridintersect for vertex grids (#845). Committed by David Brakenhoff on 2020-04-06.
- fix(mflmt.py): Clean up docstring for package_flows argument in lmt. Committed by emorway-usgs on 2020-03-31.
- fix(str): Add consistent fixed and free format approach (#838). Committed by Hughes, J.D on 2020-03-31.
- fix(vtk): Issues related to nan and type cast. Committed by Etienne Bresciani on 2020-03-31.
- fix(pyproj): Pyproj.proj's errcheck keyword option not reliable (#837). Committed by Mike Taves on 2020-03-29.
- fix: (#830): handling 'none' cellids in sfr package (#834). Committed by spaulins-usgs on 2020-03-25.
- fix(): Fix quasi3d plotting (#819). Committed by Ruben Caljé on 2020-03-02.
- fix(ModflowSfr2.export): Update modflowsfr2.export() to use grid instead of spatialreference (#820). Committed by Joshua Larsen on 2020-02-28.
- fix(flopy3_MT3DMS_examples.ipynb): Wrong indices were indexed (#815). Committed by Eric Morway on 2020-02-20.
- fix(build_exes.py): Fix bugs for windows (#810) (#813). Committed by Etienne Bresciani on 2020-02-18.
- fix(mflist): Default value not working (#812). Committed by langevin-usgs on 2020-02-13.
- fix(flopy3_MT3DMS_examples.ipynb): Match constant heads to original problem (#809). Committed by Eric Morway on 2020-02-11.
- fix(vtk): Change in export_cbc output file name (#795). Committed by rodrperez on 2020-01-30.
- fix(mf6): Update create packages to support additional models (#790). Committed by Hughes, J.D on 2020-01-24.
- fix(remove_package): Fixed remove_package to rebuild namefile recarray correctly after removing package

- issue #776 (#784). Committed by spaulins-usgs on 2020-01-17.
- fix(gridgen): X, y center was not correct for rotated grids (#783). Committed by langevin-usgs on 2020-01-16.
- fix(mtssm.py): Handle 1st stress period with incrch equal to -1 (#780). Committed by Eric Morway on 2020-01-16.
- fix(vtk): Change in export_model when packages_names is none (#770). Committed by rodrperez on 2019-12-30.
- fix(): fix(repeating blocks) (#771). Committed by spaulins-usgs on 2019-12-30.
- fix(replace package): When a second package of the same type is added to a model, the model now checks to see if the package type supports multiple packages. if it does not it automatically removes the first package before adding the second (#767). (#768). Committed by spaulins-usgs on 2019-12-18.
- fix(Mfist): Allow none as a list entry (#765). Committed by langevin-usgs on 2019-12-16.

Version 3.3.0

- Dropped support for python 2.7
- Switched from pangeo binder binder to mybinder.org binder
- Added support for MODFLOW 6 Skeletal Compaction and Subsidence (CSUB) package
- Bug fixes:
 - Fix issue in MNW2 when the input file had spaced between lines in Dataset 2. #736
 - Fix issue in MNW2 when the input file uses wellids with inconsistent cases in Dataset 2 and 4. Internally the MNW2 will convert all wellids to lower case strings. #736
 - Fix issue with VertexGrid plotting errors, squeeze proper dimension for head output, in `PlotMapView` and `PlotCrossSection`
 - Fix issue in `PlotUtilities._plot_array_helper` mask MODFLOW-6 no flow and dry cells before plotting
 - Removed assumption that transient SSM data appears in the first stress period #754 #756. Fix includes a new autotest (`t068_test_ssm.py`) that adds transient concentration data after the first stress period.
 - Fix issues with `add_record` method for `MfList` #758

Version 3.2.13

- `ModflowFlwob`: Variable `irefsp` is now a zero-based integer (#596)
- `ModflowFlwob`: Added a `load` method and increased precision of `toffset` when writing to file (#598)
- New feature `GridIntersect` (#610): The `GridIntersect` object allows the user to intersect shapes (Points, LineStrings and Polygons) with a MODFLOW grid. These intersections return a `numpy.recarray` containing the intersection information, i.e. cell IDs, lengths or areas, and a shapely representation of the intersection results. Grids can be structured or vertex grids. Two intersections methods are implemented: "`structured`" and "`strtree`": the former accelerates intersections with structured grids. The latter is more flexible and also works for vertex grids. The `GridIntersect` class is available through `flopy.utils.gridintersect`. The functionality requires the Shapely module. See the example notebook for an overview of this new feature.
- New feature `Raster` (#634): The `Raster` object allows the user to load raster files (Geotiff, arc ascii, .img) and sample points, sample polygons, create cross sections, crop, and resample raster data to a Grid. Cropping has been implemented using a modified version of the ray casting algorithm for speed purposes. Resampling a raster can be performed with structured, vertex, and unstructured Grids. Rasters will return a numpy array of resampled data in the same shape as the Grid. The `Raster` class is available by calling `flopy.utils.Raster`. The functionality requires rasterio, affine, and scipy. See the (example notebook) for an overview of this feature.
- Modify NAM and MFList output files to remove excessive whitespace (#622, #722)
- Deprecate `crs` class from `flopy.utils.reference` in favor of `CRS` class from `flopy.export.shapefile_utils` (#608)
- New feature in `PlotCrossSection` (#660). Added a `geographic_coords` parameter flag to `PlotCrossSection` which allows the user to plot cross sections with geographic coordinates on the x-axis. The default behavior is to plot distance along cross sectional line on the x-axis. See the (example notebook) for an overview of this feature.

- New feature with binaryfile readers, including `HeadFile` and `CellBudgetFile` (#669): `with` statement is supported to open files for reading in a context manager, which automatically close when done or if an exception is raised.
- Improved the flopy list reader for MODFLOW stress packages (for mf2005, mfnwt, etc.), which may use SFAC to scale certain columns depending on the package. The list reading now supports reading from external files, in addition to open/close. The (binary) option is also supported for both open/close and external. This new list reader is used for reading standard stress package lists and also lists used to create parameters. The new list reader should be consistent with MODFLOW behavior.
- SfrFile detects additional columns (#708)
- Add a `default_float_format` property to `mfsfr2`, which is string formatted by NumPy versions > 1.14.0, or `{:.8g}` for older NumPy versions (#710)
- Support for pyshp 1.2.1 dropped, pyshp 2.1.0 support maintained
- Improved VTK export capabilities. Added export for VTK at array level, package level, and model level. Added binary head file export and cell by cell file export. Added the ability to export point scalars in addition to cell scalars, and added smooth surface generation. VTK export now supports writing transient data as well as exporting to binary .vtu files.
- Support for copying model and package instances with `copy.deepcopy()`
- Added link to Binder on README and notebooks_examples markdown documents. Binder provides an environment that runs and interactively serves the FloPy Jupyter notebooks.
- Bug fixes:
 - When using the default `iuzfbnd=None` in the `__init__` routine of `mtuzt.py`, instantiation of `IUZBND` was generating a 3D array instead of a 2D array. Now generates a 2D array
 - `ModflowSfr2.__init__` was being slowed considerably by the `ModflowSfr2.all_segments` property method. Modified the `ModflowSfr2.graph` property method that describes routing connections between segments to handle cases where segments aren't listed in stress period 0.
 - Ensure disordered fields in `reach_data` (Dataset 2) can be supported in `ModflowSfr2` and written to MODFLOW SFR input files.
 - When loading a MF model with UZF active, item 8 (“[IUZROW] [IUZCOL] IFTUNIT [IUZOPT]”) wasn't processed correctly when a user comment appeared at the end of the line
 - MODFLOW-6 DISU JA arrays are now treated as zero-based cell IDs. JA, IHC, CL12 are outputted as jagged arrays.
 - Models with multiple MODFLOW-6 WEL packages now load and save correctly.
 - Exporting individual array and list data to a shapefile was producing an invalid attribute error. Attribute reference has been fixed.
 - Fix `UnboundLocalError` and typo with `flopy.export.shapefile_utils.CRS` class (#608)
 - Fix Python 2.7 issue with `flopy.export.utils.export_contourf` (#625)
 - When loading a MT3D-USGS model, keyword options (if used) were ignored (#649)
 - When loading a modflow model, spatial reference information was not being passed to the `SpatialReference` class (#659)
 - Fix `specifysurfk` option in UZF, `ModflowUZF1` read and write `surf` variable
 - Fix minor errors in flopy gridgen wrapper
 - Close opened files after loading, to reduce `ResourceWarning` messages (#673)
 - Fix bugs related to flake8's F821 “undefined name ‘name’”, which includes issues related to `Mt3dPhc`, `ModflowSfr2`, `ModflowDe4`, `ListBudget`, and `ModflowSms` (#686)
 - Fix bugs related to flake8's F811 “redefinition of unused ‘name’” (#688)
 - Fix bugs related to flake8's W605 “invalid escape sequence ‘\s’” (or similar) (#700)
 - Fix `EpsgReference` class behavior with JSON user files (#702)
 - Fix `ModflowSfr2` read write logic for all combinations of `isfrop` and `icalc`
 - `IRCH` array of the Recharge Package is now a zero-based variable, which means an `IRCH` value of 0 corresponds to the top model layer (#715)
 - MODFLOW lists were not always read correctly if they used the SFAC or binary options or were used to define parameters (#683)

- Changed VDF Package density limiter defaults to zero (#646)

Version 3.2.12

- Added a check method for OC package (#558)
- Change default map projection from EPSG:4326 to None (#535)
- Refactor warning message visibility and categories (#554, #575)
- Support for MODFLOW 6 external binary files added. Flopy can read/write binary files containing list and array data (#470, #553).
- Added silent option for MODFLOW 6 write_simulation (#552)
- Refactored MODFLOW-6 data classes. File writing operations moved from mfddata*.py to new classes created in mfileaccess.py. Data storage classes moved from mfddata.py to mfdastorage.py. MFArray, MFList, and MFScalar interface classes simplified with most of the data processing code moved to mfdastorage.py and mfileaccess.py.
- Added MODFLOW 6 quickstart example to front page.
- Added lgrutil test as autotest/t063_test_lgrutil.py and implemented a get_replicated_parent_array() method to the Lgr class so that the user can pass in a parent array and get back an array that is the size of the child model.
- Refactored much of the flopy code style to conform with Python conventions and those checked by Codacy. Added an automated Codacy check as part of the pull request and commit checks.
- Bug fixes:
 - Fixed bug in Mt3dms.load to show correct error message when loading non-existent NAM file (#545)
 - Removed errant SFT parameter contained in Mt3dUzt.__init__ routine (#572)
 - Fixed DISV shapefile export bug that applied layer 1 parameter values to all model layers during export (#508)
 - Updated ModflowSfr2.load to store channel_geometry and channel_flow_data (6d, 6e) by nseg instead of itmp position (#546)
 - Fixed bug in ModflowMnw2.make_node_data to be able to set multiple wells with different numbers of nodes (#556)
 - Fixed bug reading MODFLOW 6 comma separated files (#509)
 - Fixed bug constructing a grid class with MODFLOW-USG (#513)
 - Optimized performance of grid class by minimizing redundant operations through use of data result caching (#520)
 - Fixed bug passing multiple auxiliary variables for MODFLOW 6 array data (#533)
 - Fixed bug in Mt3dUzt.__init__; the variable ioutobs doesn't exist in the UZT package and was removed.
 - Fixed MODFLOW-LGR bug in which ascii files were not able to be created for some output. Added better testing of the MODFLOW-LGR capabilities to t035_test.py.
 - Fixed multiple issues in mfdis that resulted in incorrect row column determination when using the method get_rc_from_node_coordinates (#560). Added better testing of this to t007_test.py.
 - Fixed the export_array_contours function as contours would not export in some cases (#577). Added tests of export_array_contours and export_array to t007_test.py as these methods were not tested at all.

Version 3.2.11

- Added support for the drain return package.
- Added support for pyshp version 2.x, which contains a different call signature for the writer than earlier versions.
- Added a new flopy3_MT3DMS_examples notebook, which uses Flopy to reproduce the example problems described in the MT3DMS documentation report by Zheng and Wang (1999).
- Pylint is now used on Travis for the Python 3.5 distribution to check for coding errors.
- Added testing with Python 3.7 on Travis, dropped testing Python 3.4.

- Added a new `htop` argument to the `vtk` writer, which allows cell tops to be defined by the simulated head.
- Generalized exporting and plotting to also work with MODFLOW 6. Added a new grid class and deprecated `SpatialReference` class. Added new plotting interfaces, `PlotMapView` and `PlotCrossSection`. Began deprecation of `ModelMap` and `ModelCrossSection` classes.
- Spatial reference system cache moved to `epsgref.json` in the user's data directory.
- Attempts to read empty files from `flopy.utils` raise a `IOError` exception.
- Changed interface for creating and accessing MODFLOW 6 observation, time series, and time array series packages. These packages can now be created and accessed directly from the package that references them. These changes are not backward compatible, and will require existing scripts to be modified. See the `flopy3_mf6_obs_ts_tas.ipynb` notebook for instructions.
- Changed the MODFLOW 6 `fname` argument to be filename. This change is not backward compatible, and will require existing scripts to be modified if the `fname` argument was used in the package constructor.
- Added modflow-nwt options support for `ModflowWel`, `ModflowSfr2`, and `ModflowUzf1` via the `OptionBlock` class.
- Bug fixes:
 - Removed variable `MXUZCON` from `mtuvt.py` that was present during the development of MT3D-USGS, but was not included in the release version of MT3D-USGS.
 - Now account for UZT -> UZT2 changes with the release of MT3D-USGS 1.0.1. Use of UZT is no longer supported.
 - Fixed bug in `mfufz1.py` when reading and writing `surfk` when `specifysurfk = True`.
 - Fixed bug in `ModflowStr.load()`, utility would fail to load when comments were present.
 - Fixed bug in MNW2 in which nodes were not sorted correctly.
 - Ensure that external 1-D free arrays are written on one line.
 - Typos corrected for various functions, keyword arguments, property names, input file options, and documentation.
 - Fixed bug in `Mt3dUzt.__init__` that originated when copying code from `mtsft.py` to get started on `mtuvt.py` class. The variable `ioutobs` doesn't exist in the UZT package and should never have appeared in the package to begin with.

Version 3.2.10

- Added parameter `_load` variable to `mbase` that is set to `True` if parameter data are applied in the model (only used in models that support parameters). If this is set to `True` `free_format_input` is set to `True` (if currently `False`) when the `write_input()` method is called. This change preserves the precision of parameter data (which is free format data).
- MODFLOW 6 model and simulation packages can not be retrieved as a `MFSimulation` attribute
- Added support for multicomponent load in `mfsft.py`
- Added functionality to read esri-style epsg codes from `spatialreference.org`.
- Added functionality to MODFLOW 6 that will automatically replace the existing package with the one being added if it has the same name as the existing package.
- Added separate MODFLOW 6 model classes for each model type. Model classes contain name file options.
- Added standard `run_model()` method arguments to `mf6 run_simulation()` method.
- some performance improvements to checking
- `SpatialReference.export_array()` now writes 3-D numpy arrays to multiband GeoTiffs
- Add load support to for MNW1; `ModflowMnw1` now uses a `stress_period_data` `Mflist` to store MNW information, similar to other BC packages.
- Added a `Triangle` class that is a light wrapper for the `Triangle` program for generating triangular meshes. Added a notebook called `flopy3_triangle.ipynb` that demonstrates how to use it and build a MODFLOW 6 model with

a triangular mesh. The current version of this Triangle class should be considered beta functionality as it is likely to change.

- Added support for MODPATH 7 (beta).
- Added support for MODPATH 3 and 5 pathline and endpoint output files.
- Added support for MODPATH timeseries output files (`flopy.utils.TimeseriesFile()`).
- Added support for plotting MODPATH timeseries output data (`plot_timeseries()`) with ModelMap.
- Bug fixes:
 - Fixed issue in HOB when the same layer is specified in the MLAY data (dataset 4). If the layer exists the previous fraction value is added to the current value.
 - Fixed bug in segment renumbering
 - Changed default value for `ioutobs **kwargs` in `mtsft.py` from None to 0 to prevent failure.
 - Fixed bug when passing extra components info from load to constructor in `mtsft.py` and `mtrct.py`.
 - Fixed bug in `mt3ddsp` load - if `multidiffusion` is not found, should only read one 3d array.
 - Fixed bug in `zonbud` utility that wasn't accumulating flow from constant heads.
 - Fixed minor bug that precluded the passing of mass-balance record names (`TOTAL_IN`, `IN-OUT`, etc.).
 - Fixed bug when writing shapefile projection (`.prj`) files using relative paths.
 - Fixed bugs in `sfr.load()` - `weight` and `flwtol` should be cast as floats, not integers.
 - Fixed bug when `SpatialReference` supplied with geographic CRS.
 - Fixed bug in `mfsfr.py` when writing kinematic data (`irtflg > 0`).
 - Fixed issue from change in MODFLOW 6 `inspect.getargspec()` method (for getting method arguments).
 - Fixed MODFLOW 6 BINARY keyword for reading binary data from a file using `OPEN/CLOSE` (needs parentheses around it).
 - Fixed bug in `mtlkt.py` when initiating, loading, and/or writing lkt input file related to multi-species problems.

Version 3.2.9

- Modified MODFLOW 5 OC `stress_period_data=None` default behaviour. If MODFLOW 5 OC `stress_period_data` is not provided then binary head output is saved for the last time step of each stress period.
- added multiple component support to `mt3dusgs` SFT module
- Optimized loading and saving of MODFLOW 6 files
- MODFLOW 6 identifiers are now zero based
- Added `remove_package` method in `MFSimulation` and `MFModel` that removes MODFLOW 6 packages from the existing simulation/model
- Changed some of the input argument names for MODFLOW 6 classes. Note that this will break some existing user scripts. For example, the stress period information was passed to the boundary package classes using the `periodrearray` argument. The argument is now called `stress_period_data` in order to be consistent with other Flopy functionality.
- Flopy code for MODFLOW 6 generalized to support different model types
- Flopy code for some MODFLOW 6 arguments now have default values in order to be consistent with other Flopy functionality
- Added `ModflowSfr2.export_transient_variable` method to export shapefiles of segment data variables, with stress period data as attributes
- Added support for UZF package gages
- Bug fixes:
 - Fixed issue with default settings for MODFLOW 5 SUB package `dp` dataset.
 - Fixed issue if an external BC list file has only one entry
 - Some patching for recarray issues with latest `numpy` release (there are more of these lurking...)

- Fixed setting model relative path for MODFLOW 6 simulations
- Python 2.7 compatibility issues fixed for MODFLOW 6 simulations
- IMS file name conflicts now automatically resolved
- Fixed issue with passing in numpy ndarrays arrays as layered data
- Doc string formatting for MODFLOW 6 packages fixed to make doc strings easier to read
- UZF package: fixed issues with handling of finf, pet, extdp and extwc arrays.
- SFR package: fixed issue with reading stress period data where not all segments are listed for periods > 0.
- `SpatialReference.write_gridSpec` was not converting the model origin coordinates to model length units.
- shorted integer field lengths written to shapefiles to 18 characters; some readers may misinterpret longer field lengths as float dtypes.

Version 3.2.8

- Added `has_package(name)` method to see if a package exists. This feature goes nicely with `get_package(name)` method.
- Added `set_model_units()` method to change model units for all files created by a model. This method can be useful when creating MODFLOW-LGR models from scratch.
- Added SFR2 package functionality
 - `export_inlets` method to write shapefile showing locations where external flows are entering the stream network.
- Bug fixes:
 - Installation: Added dfn files required by MODFLOW 6 functionality to MANIFEST.in so that they are included in the distribution.
 - SFR2 package: Fixed issue reading transient data when `ISFOPT` is 4 or 5 for the first stress period.

Version 3.2.7

- Added beta support for MODFLOW 6 See [here](#) for more information.
- Added support for retrieving time series from binary cell-by-cell files. Cell-by-cell time series are accessed in the same way they are accessed for heads and concentrations but a text string is required.
- Added support for FORTRAN free format array data using `n*value` where `n` is the number of times value is repeated.
- Added support for comma separators in 1D data in LPF and UPF files
- Added support for comma separators on non array data lines in DIS, BCF, LPF, UPW, HFB, and RCH Packages.
- Added `.reset_budgetunit()` method to OC package to facilitate saving cell-by-cell binary output to a single file for all packages that can save cell-by-cell output.
- Added a `.get_residual()` method to the `CellBudgetFile` class.
- Added support for binary stress period files (`OPEN/CLOSE filename (BINARY)`) in `wel` stress packages on load and instantiation. Will extend to other list-based MODFLOW stress packages.
- Added a new `flopy.utils.HeadUFile` Class (located in `binaryfile.py`) for reading unstructured head files from MODFLOW-USG. The `.get_data()` method for this class returns a list of one-dimensional head arrays for each layer.
- Added `metadata.acdd` class to fetch model metadata from ScienceBase.gov and manage CF/ACDD-complaint metadata for NetCDF export
- Added sparse export option for boundary condition stress period data, where only cells for that B.C. are exported (for example, `package.stress_period_data.export('stuff.shp', sparse=True)`)
- Added additional SFR2 package functionality:
 - `.export_linkages()` and `.export_outlets()` methods to export routing linkages and outlets
 - sparse shapefile export, where only cells with SFR reaches are included
 - `.plot_path()` method to plot streambed elevation profile along sequence of segments
 - `.assign_layers()` method
 - additional error checks and bug fixes
- Added `SpatialReference` / GIS export functionality:
 - GeoTiff export option to `SpatialReference.export_array`
 - `SpatialReference.export_array_contours`: contours an array and then exports contours to shapefile
 - inverse option added to `SpatialReference.transform`

- automatic reading of spatial reference info from .nam or usgs.model.reference files
- Modified node numbers in SFR package and `ModflowDis.get_node()` from one- to zero-based.
- Modified HYDMOD package `klay` variable from one- to zero-based.
- Added `.get_layer()` method to DIS package.
- Added `.get_saturated_thickness()` and `.get_gradients()` methods
- Bug fixes:
 - OC package: Fixed bug when printing and saving data for select stress periods and timesteps. In previous versions, OC data was repeated until respecified.
 - SUB package: Fixed bug if data set 15 is passed to preserved unit numbers (i.e., use unit numbers passed on load).
 - SUB and SUB-WT packages: Fixed bugs `.load()` to pop original unit number.
 - BTN package: Fixed bug in obs.
 - LPF package: Fixed bug regarding when HANI is read and written.
 - UZF package: added support for MODFLOW NWT options block; fixed issue with loading files with `thti/thtr` options
 - SFR package: fixed bug with segment renumbering, issues with reading transient text file output,
 - Fixed issues with dynamic setting of `SpatialReference` parameters
 - NWT package: forgive missing value for `MXITERXMD`
 - MNW2 package: fix bug where `ztop` and `zbotm` were written incorrectly in `get_allnode_data()`. This was not affecting writing of these variables, only their values in this summary array.
 - PCGN package: fixed bug writing package.
 - Fixed issue in `Util2d` when non-integer `cnstnt` passed.

Version 3.2.6

- Added functionality to read binary `grd` file for unstructured grids.
- Additions to `SpatialReference` class:
 - `xll`, `yll` input option
 - transform method to convert model coordinates to real-world coordinates
 - `epsg` and `length_multiplier` arguments
- Export:
 - Added writing of `prj` files to shapefile export; `prj` information can be passed through spatial reference class, or given as an EPSG code or existing `prj` file path
 - Added NetCDF export to MNW2
- Added MODFLOW support for:
 - FHB Package - no support for flow or head auxiliary variables (datasets 2, 3, 6, and 8)
 - HOB Package
- New utilities:
 - `flopy.utils.get_transmissivities()` Computes transmissivity in each model layer at specified locations and open intervals. A saturated thickness is determined for each row, column or x, y location supplied, based on the well open interval (`sctop`, `scbot`), if supplied, otherwise the layer tops and bottoms and the water table are used.
- Added MODFLOW-LGR support - no support for model name files in different directories than the directory with the `lgr` control file.
- Additions to MODPATH:
 - shapefile export of MODPATH Pathline and Endpoint data
 - `Modpath.create_mpsim()` supports MNW2
 - creation of MODPATH StartingLocations files
 - Easy subsetting of endpoint and pathline results to destination cells of interest
- New `ZoneBudget` class provides ZONEBUDGET functionality:
 - reads a `CellBudgetFile` and accumulates flows by zone
 - pass `kstpker` or `totim` keyword arguments to retrieve a subset of available times in the `CellBudgetFile`
 - includes a method to write the budget recarrays to a `.csv` file
 - `ZoneBudget` objects support numerical operators to facilitate conversion of units
 - utilities are included which read/write ZONEBUDGET-style zone files to and from numpy arrays
 - pass a dictionary of `{zone: "alias"}` to rename fields to more descriptive names (e.g. `{1: 'New York', 2: 'Delmarva'}`)

- Added new precision='auto' option to flopy.utils.binaryfile for HeadFile and UcnFile readers. This will automatically try and determine the float precision for head files created by single and double precision versions of MODFLOW. 'auto' is now the default. Not implemented yet for cell by cell flow file.
- Modified MT3D-related packages to also support MT3D-USGS
 - BTN will support the use of keywords (e.g., 'MODFLOWStyleArrays', etc.) on the first line
 - DSP will support the use of keyword NOCROSS
 - Keyword FREE now added to MT3D name file when the flow-transport link (FTL) file is formatted. Previously defaulted to unformatted only.
- Added 3 new packages:
 - SFT: Streamflow Transport, companion transport package for use with the SFR2 package in MODFLOW
 - LKT: Lake Transport, companion transport package for use with the LAK3 package in MODFLOW
 - UZT: Unsaturated-zone Transport, companion transport package for use with the UZF1 package in MODFLOW
- Modified LMT
 - load() functionality will now support optional PACKAGE_FLOWS line (last line of LMT input)
 - write_file() will now insert PACKAGE_FLOWS line based on user input
- Bug fixes:
 - Fixed bug in parsenamefile when file path in namefile is surrounded with quotes.
 - Fixed bug in check routine when THICKSTRT is specified as an option in the LPF and UPW packages.
 - Fixed bug in BinaryHeader.set_values method that prevented setting of entries based on passed kwargs.
 - Fixed bugs in reading and writing SEAWAT Viscosity package.
 - The DENSE and VISC arrays are now Transient3d objects, so they may change by stress period.
 - MNW2: fixed bug with k, i, j node input option and issues with loading at model level
 - Fixed bug in ModflowDis.get_cell_volumes().

Version 3.2.5

- Added support for LAK and GAGE packages - full load and write functionality supported.
- Added support for MNW2 package. Load and write of .mnw2 package files supported. Support for .mnwi, or the results files (.qsu, .byn) not yet implemented.
- Improved support for changing the output format of arrays and variables written to MODFLOW input files.
- Restructured SEAWAT support so that packages can be added directly to the SEAWAT model, in addition to the approach of adding a modflow model and a mt3d model. Can now load a SEAWAT model.
- Added load support for MT3DMS Reactions package
- Added multi-species support for MT3DMS Reactions package
- Added static method to Mt3dms().load_mas that reads an MT3D mass file and returns a recarray
- Added static method to Mt3dms().load_obs that reads an MT3D mass file and returns a recarray
- Added method to flopy.modpath.Modpath to create modpath simulation file from modflow model instance boundary conditions. Also added examples of creating modpath files and post-processing modpath pathline and endpoint files to the flopy3_MapExample notebook.
- Bug fixes:
 - Fixed issue with VK parameters for LPF and UPW packages.
 - Fixed issue with MT3D ADV load in cases where empty fields were present in the first line of the file.
 - Fixed cross-section array plotting issues.
 - BTN observation locations must now be entered in zero-based indices (a 1 is now added to the index values written to btn file)
 - Uploaded supporting files for SFR example notebook; fixed issue with segment_data submitted as array (instead of dict) and as 0d array(s).
 - Fixed CHD Package so that it now supports options, and therefore, auxiliary variables can be specified.
 - Fixed loading BTN save times when numbers are touching.

Version 3.2.4

- Added basic model checking functionality (`.check()`).
- Added support for reading SWR Process observation, stage, budget, flow, reach-aquifer exchanges, and structure flows.
- `flopy.utils.HydmobObs` returns a numpy recarray. Previously numpy arrays were returned except when the `slurp()` method was used. The `slurp` method has been deprecated but the same functionality is available using the `get_data()` method. The recarray returned from the `get_data()` method includes the `totim` value and one or all of the observations (HYDLBL).
- Added support for MODFLOW-USG DISU package for unstructured grids.
- Added class (`Gridgen`) for creating layered quadtree grids using GRIDGEN (`flopy.utils.gridgen`). See the `flopy3_gridgen` notebook for an example of how to use the `Gridgen` class.
- Added user-specified control on use of `OPEN/CLOSE` array options (see `flopy3_external_file_handling` notebook).
- Added user-specified control for array output formats (see `flopy3_array_outputformat_options` IPython notebook).
- Added shapefile as optional output format to `.export()` method and deprecated `.to_shapefile()` method.
- Bug fixes:
 - Fixed issue with right justified format statement for array control record for MT3DMS.
 - Fixed bug writing PHIRAMP for MODFLOW-NWT well files.
 - Fixed bugs in NETCDF export methods.
 - Fixed bugs in LMT and BTN classes.

Version 3.2.3

- Added template creation support for several packages for used with PEST (and UCODE).
- Added support for the SEAWAT viscosity (VSC) package.
- Added support for the MODFLOW Stream (STR), Streamflow-Routing (SFR2), Subsidence (SUB), and Subsidence and Aquifer-System Compaction Package for Water-Table Aquifers (SWT) Packages.
- Mt3d model was redesigned based on recent changes to the Modflow model. Mt3d packages rewritten to support multi-species. Primary packages can be loaded (btn, adv, dsp, ssm, gcg). Array utilities modified to read some MT3D RARRAY formats.
- Fixed array loading functionality for case when the CNSTNT value is zero. If CNSTNT is zero and is used as an array multiplier, it is changed to 1 (as done in MODFLOW).
- Added support for the MODFLOW HYDMOD (HYD) Package and reading binary files created by the HYDMOD Package (`HydmobObs` Class) in the `flopy.utils` submodule.
- `flopy.utils.CellBudgetFile` returns a numpy recarray for list based budget data. Previously a dictionary with the `node` number and `q` were returned. The recarray will return the `node` number, `q`, and the `aux` variables for list based budget data.
- Added travis-ci automated testing.

Version 3.2.2

- FloPy now supports some simple plotting capabilities for two- and three-dimensional model input data array classes and transient two-dimensional stress period input data using the `.plot()` methods associated with the data array classes (`util_2d`, `util_3d`, and `transient_2d`). The model results reader classes (`HeadFile`, `UcnFile`, and `CellBudgetFile`) have also been extended to include a `.plot()` method that can be used to create simple plots of model output data. See the notebook `flopy3_PlotArrayExample`.
- Added `.to_shapefile()` method to two- and three-dimensional model input data array classes (`util_2d` and `util_3d`), transient two-dimensional stress period input data classes (`transient_2d`), and model output data

classes (`HeadFile`, `UcnFile`, and `CellBudgetFile`) that allows model data to be exported as polygon shapefiles with separate attribute columns for each model layer.

- Added support for ASCII model results files.
- Added support for reading MODPATH version 6 pathline and endpoint output files and plotting MODPATH results using mapping capabilities in `flopy.plot` submodule.
- Added `load()` method for MODFLOW GMG solver.
- Bug fixes:
 - Multiplier in array control record was not being applied to arrays
 - `vani` parameter was not supported

Version 3.2.1

- FloPy can now be used with **Python 3.x**
- Revised setters for package class variables stored using the `util_2d` or `util_3d` classes.
- Added option to load a subset of MODFLOW packages in a MODFLOW model name file using `load_only=` keyword.

Version 3.1

- FloPy now supports some simple mapping and cross-section capabilities through the `flopy.plot` submodule. See the notebook `flopy3_MapExample`.
- Full support for all Output Control (OC) options including DDREFERENCE, SAVE IBOUND, and layer lists. All Output Control Input is specified using words. Output Control Input using numeric codes is still available in the `ModflowOc88` class. The `ModflowOc88` class is currently deprecated and no longer actively maintained.
- Added support for standard MULT package FUNCTION and EXPRESSION functionality are supported. MODFLOW parameters are not supported in `write()` methods.

Version 3.0

FloPy is significantly different from earlier versions of FloPy (previously hosted on googlecode). The main changes are:

- FloPy is fully zero-based. This means that layers, rows and columns start counting at *zero*. The reason for this is consistency. Arrays are zero-based by default in Python, so it was confusing to have a mix.
- Input for packages that take *layer*, *row*, *column*, *data* input (like the `wel` or `ghb` package) has changed and is much more flexible now. See the notebook `flopy3boundaries`
- Input for the MT3DMS Source/Sink Mixing (SSM) Package has been modified to be consistent with the new MODFLOW boundary package input and is more flexible than previous versions of FloPy. See the notebook `flopy3ssm`
- Support for use of EXTERNAL and OPEN/CLOSE array specifiers has been improved.
- `load()` methods have been developed for all of the standard MODFLOW packages and a few less used packages (*e.g.* SWI2).
- MODFLOW parameter support has been added to the `load()` methods. MULT, PVAL, and ZONE packages are now supported and parameter data are converted to arrays in the `load()` methods. MODFLOW parameters are not supported in `write()` methods.