# **HEAVY: User guide**

## About HEAVY

HEAVY is a gravity forward model postprocessor for MODFLOW models. Heavy calculates the change in gravity from simulated groundwater storage change.

Heavy uses MODFLOW output (namely, the .hds head output file) but does not run MODFLOW directly. MODFLOW model runs are carried out separately.

Gravity station locations can be specified in a file, or a grid of stations across the model domain can be simulated.

Heavy is only applicable for transient models.

## Command-line arguments

Heavy has the following command line arguments:

|  |  |
| --- | --- |
| -v | Show version information |
| -q | Perform QA test calculations (Bouguer slab and point mass) |
| -g | Calculate gravity at a grid of stations across the model domain. Provides an alternative to specifying individual station locations. Requires one of the following parameters:  <Integer>  e.g., “-g 20”.  Creates an evenly-spaced grid of n x n stations in the row and column directions, starting and ending at the first and last cell centers.  <Integer>+0.0x0.0x0.0x0.0    e.g., “-g 20+0.4x0.2x0.6x0.6”.  Creates an n x n grid of stations within the subregion specified in left, bottom, right, top coordinates. E.g, the example creates a gravity-station grid within a region occupying the middle 20 percent of the model along rows and columns. |
| -l | Calculate gravity only for the specified layer.  e.g., “-l 1”  Calculates gravity only for layer 1. |
| -1 | Calculate gravity change relative to time step 1 (default is time step 0). This option is useful when the initial time step is stead state. |

In addition, the Heavy name file can be specified following any arguments. If the name file isn’t specified, the user is prompted after starting Heavy.

## Input files

### Name file:

The Heavy name file contains the names of the input and output files used in MODFLOW and Heavy simulation. The Heavy name file is constructed separately from the MODFLOW name file because Heavy is only able to read the packages listed below. The naming convention is <model basename>\_hvy.nam, but any filename can be used. The Heavy name file is constructed as follows.

**Data set 1:**

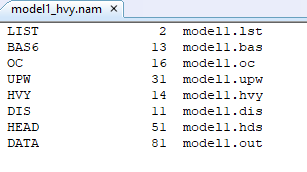
**Ftype Nunit Fname**

**Ftype:** Ftype—is the file type, which must be one of the following character values. Ftype may be entered in all uppercase, all lowercase, or any combination.

* **LIST:** for the forward run listing file. This is a required entry and will create the output LISTING file which includes information about the model run (Required)
* **DIS:** for the discretization file (Required)
* **HEAD:** for the binary head output file from a MODFLOW simulation (Required)
* **BAS6:** for the groundwater flow process Basic Package (Required)
* **LPF:** for the Groundwater Flow Process Layer Property Flow Package. Either LPF or UPW must be provided.
* **UPW:** for the Upstream Weighting Package. Either LPF or UPW must be provided
* **HVY:** for the microgravity package (HEAVY) (Required)
* **MULT:** for the multiplier array package
* **PVAL:** for the paramenter value file
* **ZONE:** for the zone array
* **DATA:** for formatted (text) files, such as those used to save microgravity output

**Nunit:** Nunit—is the Fortran unit to be used when reading from or writing to the file. Any legal unit number on the computer being used can be specified except units 96-99. Unit 99 is used for the name file and for reading multi-valued variables using the OPEN/CLOSE option of the utility modules.

**Fname:** Fname—is the name of the file, which is a character value. Pathnames may be specified as part of Fname. *However, space characters are not allowed in Fname.*

Example Name file:  
  


### HVY file:

Input instructions

The HVY file contains gravity station information for forward modeling microgravity from changes in groundwater storage. If the -g command line option is used to generate a grid of gravity stations, or the -q option for testing, the HVY file is ignored.

**DATA SET 1:**

**NFHVY IFUN**

**NFHVY:** Number of gravity stations/observation locations

**IFUN:** Data file unit number for Forsberg (1984) gravity output file.

**DATA SET 2:**

Repeat data set 2 **NFHVY** number of times if **NFHVY** and **NHVYUN** are both greater than 0

**KLAY ZLOC XLOC YLOC PRLBL**

**~~KLAY:~~** ~~Layer number to calculate gravity from storage change~~

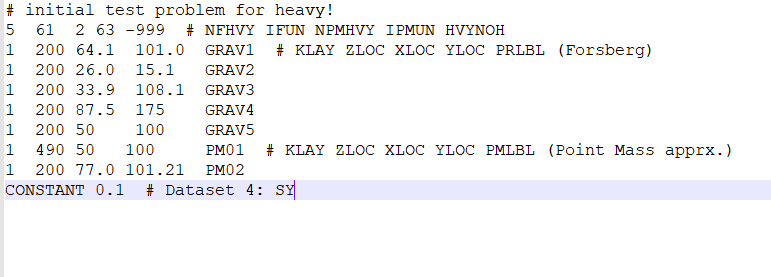
**ZLOC:** Sensor Z location (elevation) in model units

**XLOC:** Sensor X location relative to the lower left corner of the model grid (model units)

**YLOC:** Sensor Y location relative to the lower left corner of the model grid (model units)

**PRLBL:** Observation name label

Example HVY input file



## Output files

Output files are named according to the Heavy .nam file. The listing file (typically \*.lst) has run information, including MODFLOW parameters and observation locations. The other file (typically \*.out) is fixed-width format with fields for observation label (PRLBL), stress period, time step, total time, and gravity change from the starting time step, in microGal.