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MODFLOW-USG的网格划分工具 GRIDGEN程序（前处理）

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GRIDGEN简介

GRIDGEN是创建分层quadtree网格的数值模型，如MODFLOW-USG模型。GRIDGEN读取3D基础网格，可以是变化的行和列宽度，空间上变化的单元顶部和底部高程。从基础网格，GRIDGEN将连续地，与用户提供的细化特征（点、线、多边形shapefile）相交单元，分解为4个任意单元，直到达到期望的细化程度。然后，GRIDGEN将光滑或平衡网格，使得没有2个相邻的单元，包括上覆或垫底的单元，以用户自定义的误差区分。一旦这些网格化处理完成，GRIDGEN将保存树状结构文件，快速重构分层的四叉树网格。



一旦树状结构文件创建完成，可使用**GRIDGEN**：

(1) 输出**shapefile**格式的分层四叉树网格；

(2) 输出网格连接关系和单元信息（**ASCII**格式文件），用于**MODFLOW-USG**或其他数值模型；

(3) 点、线、多边形的**shapefile**相交网格，以**ASCII**文本文件和**shapefile**保存相交文件。

为Biscayne含水层创建分层四叉树网格来展示**GRIDGEN**的使用。

GRIDGEN是**C++**语言编程的，可在**Windows**和**Linux**系统上运行。



GRIDGEN是命令行形式的可执行程序，读取和保存shapefile文件。没有GUI，没有后处理功能。GRIDGEN创建MODFLOW-USG需要的离散信息，包括单元连接信息和其他单元连接属性，但不能为MODFLOW-USG创建非结构离散输入文件（使用flopyp或modflow-setup python脚本创建输入文件）。

GRIDGEN使用shapelib的C语言库读写shapefiles文件和相关属性文件（带.shx和.dbf文件后缀）。

空间信息

shapefile文件必须是有效的，与模型网格相同的地理单位（一般为米），GRIDGEN可以读写几种常见的空间特征，包括：点、线、多边形。



定义文件和信息块

除了shapefiles，GRIDGEN读写定义文件，都是简单的ASCII文本文件。定义文件一般使用.dfn文件后缀，与其他类型文件区分。定义文件用来提供指令和其他需要的信息。可以手动创建。定义文件不能存储数组或其他长列表信息，需要使用数组时，定义文件可指向一个包含数组的文件。

定义文件包含一个或多个信息块。

```
BEGIN block_type block_name
    record_name_1 = record_value_1
    record_name_2 = record_value_2
    ...
    record_name_n = record_value_n
END block_type
```



Record value一般是文本字符串、整数、浮点数或布尔数（true或false），使用如下语法：

```
record_name = <text>  
record_name = <integer>  
record_name = <real>  
record_name = <boolean>
```

下面的命令行执行称为qtgbuilder的块，定义文件为qtg.dfn:

```
gridgen.exe qtgbuilder qtg.dfn
```




GRIDGEN定义块

GRIDGEN_ver1.0支持的块类型如表1。不是每个例子都需要所有的块。后文详细介绍这些块。

表1 GRIDGEN ver.1.0支持的块类型

Block type	Block function	Block description
MODFLOW_GRID	Define object	Contains the information required to characterize a three-dimensional MODFLOW grid.
QUADTREE	Define object	Contains the information required to characterize a three-dimensional layered quadtree grid.
QUADTREE_BUILDER	Define action	An action block that will create a QUADTREE grid
REFINEMENT_FEATURES	Define object	Features from a shapefile that are used by QUADTREE_BUILDER
ACTIVE_DOMAIN	Define object	A polygon feature from a shapefile that will be used by the QUADTREE_BUILDER block to specify the active domain of the grid.
GRID_TO_SHAPEFILE	Define action	An action block that will create a shapefile for the specified grid
GRID_TO_USGDATA	Define action	An action block that will write information about the cell connectivity and geometry of the specified grid.
GRID_TO_VTKFILE	Define action	An action block that will create a Visualization Toolkit (VTK) file for the specified grid.
GRID_INTERSECTION	Define action	An action block that will write information about the spatial intersection of features from a shapefile and the specified grid.



MODFLOW_GRID

NLAY, NROW, NCOL 列间距DELX, 行间距DELY

水平面上，行自上而下增加，列从左到右增加。

层自上而下增加，顶层是Layer 1，Layer1的每个单元给出顶部高程，每层的各单元给出底部高程。因此，分层厚度可变，为了表征地下水文地质单元。注意：在MODFLOW_GRID块中，仅为顶层提供顶部高程，对下面的分层，单元顶部高程等于更下面单元的底部高程。

完整的MODFLOW_GRID块描述见表2。

MODFLOW_GRID块被其他后面的处理使用，是构建分层四叉树网格的基础网格。



MODFLOW_GRID

```
#comment - this is a MODFLOW_GRID with the name "basegrid"  
BEGIN MODFLOW_GRID basegrid  
  ROTATION_ANGLE = 15.  
  X_OFFSET = 5000.  
  Y_OFFSET = 5200.  
  LENGTH_UNIT = undefined  
  NLAY = 3  
  NROW = 30  
  NCOL = 40  
  DELR = CONSTANT 100.0  
  DELC = CONSTANT 100.0  
  TOP = CONSTANT 75.0  
  BOTTOM LAYER 1 = CONSTANT -100.0  
  BOTTOM LAYER 2 = CONSTANT -110.0  
  BOTTOM LAYER 3 = CONSTANT -275.0  
END MODFLOW_GRID
```

注意：DELR和DELC是1D数组和2D数组（TOP和BOTTOM），都赋给了常数值，可以是非常数的数组。



MODFLOW_GRID

表2 MODFLOW_GRID块的记录列表

[NCOL, number of columns; NROW, number of rows; NLAY, number of layers]

Record name	Numerical type	Default	Record description
ROTATION_ANGLE	<real>	Required	Clockwise rotation angle of upper left corner, in degrees
X_OFFSET	<real>	Required	x spatial coordinate of grid lower left corner
Y_OFFSET	<real>	Required	y spatial coordinate of grid lower left corner
LENGTH_UNIT	<text>	Required	Undefined, foot, or meter
NLAY	<integer>	Required	Number of layers
NROW	<integer>	Required	Number of rows
NCOL	<integer>	Required	Number of columns
DELR	<real[NCOL]>	Required	1D array of column widths along a row
DELC	<real[NROW]>	Required	1D array of row widths along a column
TOP	<real[NROW, NCOL]>	Required	2D array of top elevations for model layer 1
BOTTOM LAYER 1	<real[NROW, NCOL]>	Required	2D array of bottom elevations for model layer 1
BOTTOM LAYER 2	<real[NROW, NCOL]>	Required	2D array of bottom elevations for model layer 2
(Repeat for all layers)	<real[NROW, NCOL]>	Required	Bottom elevations for other model layers (not shown)
BOTTOM LAYER NLAY	<real[NROW, NCOL]>	Required	2D array of bottom elevations for bottom model layer



QUADTREE

四叉树网格的单元编号如图1，GRIDGEN可以排除括在计算区域以外的单元，这些单元都编号为-1

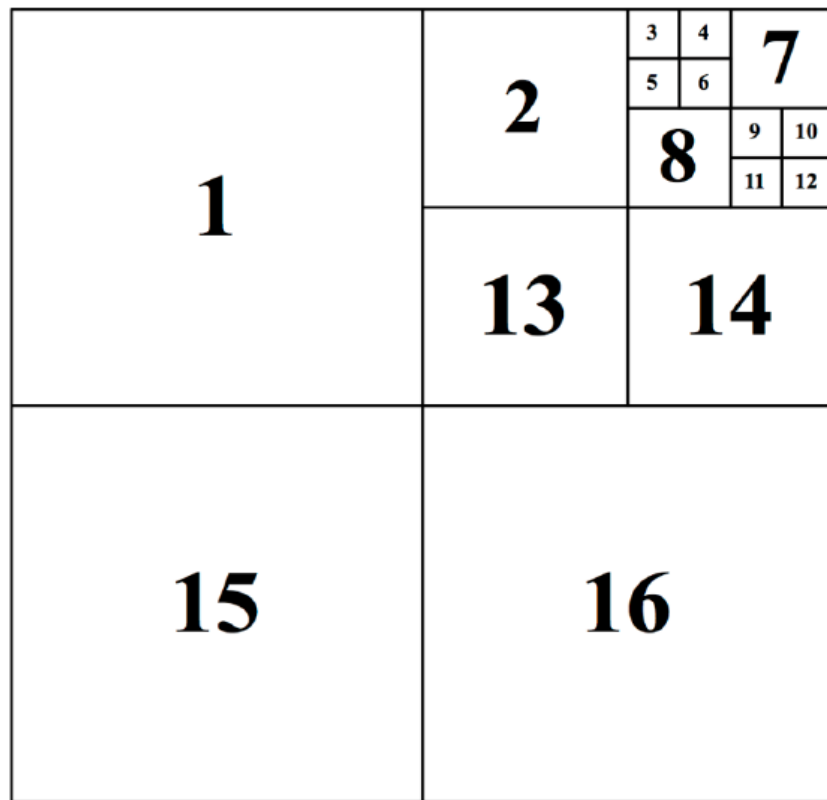


图1 四叉树网格



QUADTREE

分层的四叉树网格结构的信息存储为一个树状结构文件，使用关键词 **STRUCTURE_FILE** 识别。**QUADTREE_BUILDER** 块可用来创建树状结构文件。如图1的四叉树网格，树状文件包含以下17行：

```
16
1, (1,1,1)
2, (1,1,2) 1
3, (1,1,2) 211
4, (1,1,2) 212
5, (1,1,2) 213
6, (1,1,2) 214
7, (1,1,2) 22
8, (1,1,2) 23
9, (1,1,2) 241
10, (1,1,2) 242
11, (1,1,2) 243
12, (1,1,2) 244
13, (1,1,2) 3
14, (1,1,2) 4
15, (1,2,1)
16, (1,2,2)
```

第1行：单元个数

第2~16行：cell identifier, (层, 行, 列) 象限数（没有表示是basegrid）



分层四叉树网格使用QUADTREE块类型，需要MODFLOW_GRID块。下面的定义文件描述简单的图1中的四叉树网格。

```
#comment - this is the basegrid for the quadtree grid
BEGIN MODFLOW_GRID basegrid
  ROTATION_ANGLE = 0.
  X_OFFSET = 0
  Y_OFFSET = 0
  LENGTH_UNIT = undefined
  NLAY = 1
  NROW = 2
  NCOL = 2
  DELR = CONSTANT 1.0
  DELC = CONSTANT 1.0

  TOP = CONSTANT 1.0
  BOTTOM LAYER 1 = CONSTANT 0.0
END MODFLOW_GRID

#comment - this is the block describing the quadtree grid
BEGIN QUADTREE quadtreegrid
  MODFLOW_GRID = basegrid
  STRUCTURE_FILE = OPEN/CLOSE quadtreegrid.tsf
  TOP LAYER 1 = OPEN/CLOSE quadtreegrid.top1.dat
  BOTTOM LAYER 1 = OPEN/CLOSE quadtreegrid.bot1.dat
END QUADTREE
```



QUADTREE块也访问STRUCTURE_FILE和各分层的顶部和底部高程。各分层都需要顶部和底部高程，因为四叉树网格的各层的单元数不一样。

表3 QUADTREE块组成的记录列表

Table 3. List of the records that compose the QUADTREE block.

Record name	Record type	Default	Record description
MODFLOW_GRID	<modflow_grid>	Required	MODFLOW_GRID block name
STRUCTURE_FILE	<text>	Required	Name of tree structure file
TOP LAYER 1	<real[number of cells in layer 1]>	Required	1D array of top elevations for model layer 1
TOP LAYER 2	<real[number of cells in layer 2]>	Required	1D array of top elevations for model layer 2
...		Required	Top elevations for other model layers (not shown)
TOP LAYER NLAY	<real[number of cells in layer NLAY]>	Required	1D array of top elevations for bottom model layer
BOTTOM LAYER 1	<real[number of cells in layer 1]>	Required	1D array of bottom elevations for model layer 1
BOTTOM LAYER 2	<real[number of cells in layer 2]>	Required	1D array of bottom elevations for model layer 2
...	<real[number of cells in layer]>	Required	Bottom elevations for other model layers (not shown)
BOTTOM LAYER NLAY	<real[number of cells in layer NLAY]>	Required	1D array of bottom elevations for bottom model layer



QUADTREE_BUILDER

使用空间特征(shapefile)控制何处细化，何处单元激活，创建四叉树网格。通过创建和执行QUADTREE_BUILDER块生成四叉树网格。

使用QUADTREE_BUILDER块，大多数情况下是第一步。

下面是QUADTREE_BUILDER块用于创建分层四叉树网格的例子：

```
BEGIN QUADTREE_BUILDER quadtreebuilder
  MODFLOW_GRID = basegrid
  ACTIVE_DOMAIN LAYER 1 = active_domain_layer_1
  ACTIVE_DOMAIN LAYER 2 = active_domain_layer_2
  ACTIVE_DOMAIN LAYER 3 = active_domain_layer_3
  REFINEMENT_FEATURES LAYER 1 = ad_layer_1 river wells_layer_1
  REFINEMENT_FEATURES LAYER 3 = wells_layer_3
  SMOOTHING = full
  SMOOTHING_LEVEL_HORIZONTAL = 1
  SMOOTHING_LEVEL_VERTICAL = 1
  TOP LAYER 1= REPLICATE basegrid
  TOP LAYER 2= REPLICATE basegrid
  TOP LAYER 3= REPLICATE basegrid
  BOTTOM LAYER 1 = REPLICATE basegrid
  BOTTOM LAYER 2 = REPLICATE basegrid
  BOTTOM LAYER 3 = REPLICATE basegrid
  GRID_DEFINITION_FILE = quadtreegrid.dfn
END QUADTREE_BUILDER
```



QUADTREE_BUILDER

注意：MODFLOW_GRID块称为basegrid

为一个分层指定ACTIVE_DOMAIN，如果不指定，整层都是活动区域。

可选择使用REFINEMENT_FEATURES块，用于细化网格单元。不必每一层都

指定REFINEMENT_FEATURES，例如上例中，layer1由3套特征细化

（ad_layer_1, river, wells_layer_1），而layer3仅由1个特征细化

（wells_layer_3）。

用户可光滑细化相邻单元。上例的光滑操作应用于full网格，

SMOOTHING_LEVEL_HORIZONTAL = 1 and

SMOOTHING_LEVEL_VERTICAL = 1

还有，。。。



QUADTREE_BUILDER

Table 4. List of records that compose the QUADTREE_BUILDER block.

Record name	Record type	Default	Record description
MODFLOW_GRID	<modflow_grid>	Required	MODFLOW_GRID block name
GRID_DEFINITION_FILE	<text>	Required	Name of the GRID_DEFINITION_FILE to create.
(As needed for any layer) REFINEMENT_FEATURES LAYER layer	List of <refinement_features>	Optional	List of REFINEMENT_FEATURES blocks to refine a layer.
(As needed for any layer) ACTIVE_DOMAIN LAYER layer	<active_domain>	Optional	ACTIVE_DOMAIN block to specify which cells in a layer are active.
SMOOTHING	<text>	None	Smoothing options are "none" or "full"
HORIZONTAL_SMOOTHING_LEVEL	<positive integer>	1	Maximum level difference between two horizontally adjacent cells (normally 1).
VERTICAL_SMOOTHING_LEVEL	<positive integer>	1	Maximum level difference between two vertically adjacent cells (normally 1).
(For each layer) TOP LAYER layer	REPLICATE <modflow_grid> INTERPOLATE <modflow_grid> ASCII GRID asciigridfile	Required	Apply one of three methods for assigning cell top elevations.
(For each layer) BOTTOM LAYER layer	REPLICATE <modflow_grid> INTERPOLATE <modflow_grid> ASCII GRID asciigridfile	Required	Apply one of three methods for assigning cell bottom elevations.
AUTOALIGNMENT	<boolean>	False	If true, then align top and bottom elevations. If a larger cell overlies multiple smaller cells, then assign the larger cell bottom elevation to the tops of all underlying smaller cells. Likewise, if a larger cell underlies multiple smaller cells, then assign the top elevation of the larger cell to the bottom elevations of the smaller cells.



REFINEMENT_FEATURES

```
BEGIN REFINEMENT_FEATURES ad_layer_1  
  SHAPEFILE = shapefiles/active_domain_layer_1  
  FEATURE_TYPE = polygon  
  REFINEMENT_LEVEL = 1  
END REFINEMENT_FEATURES
```

```
BEGIN REFINEMENT_FEATURES river  
  SHAPEFILE = shapefiles/river  
  FEATURE_TYPE = line  
  REFINEMENT_LEVEL = 2  
END REFINEMENT_FEATURES
```

```
BEGIN REFINEMENT_FEATURES wells_layer_1  
  SHAPEFILE = shapefiles/wells_layer_1  
  FEATURE_TYPE = point  
  REFINEMENT_LEVEL = 2  
END REFINEMENT_FEATURES
```

```
BEGIN REFINEMENT_FEATURES wells_layer_3  
  SHAPEFILE = shapefiles/wells_layer_3  
  FEATURE_TYPE = point  
  REFINEMENT_LEVEL = 3  
END REFINEMENT_FEATURES
```

分层四叉树网格中的单元包含点，接触线，或者在多边形内，将根据定义的REFERENCE_LEVEL值细化。表5介绍了REFERENCE_FEATURES块的描述。

Table 5. List of records that compose the REFINEMENT_FEATURES block.

Record name	Record type	Default	Record description
SHAPEFILE	<text>	Required	Name of shapefile
FEATURE_TYPE	<text>	Required	"point," "line," or "polygon"
REFINEMENT_LEVEL	<integer>	Required	Level of refinement to use
REFINE_LEVEL_BY_ATTRIBUTE	<text>	Optional	Attribute name in shapefile that contains the refinement level. The attribute must contain integer refinement values for each feature. If specified, this will override the REFINEMENT_LEVEL value.



ACTIVE_DOMAIN

在QUADTREE_BUILDER块中，还可指定ACTIVE_DOMAIN确定哪些单元是active的，激活的单元分配一个正的整型单元号。可为每层分配激活域。如果指定了激活域，仅与ACTIVE_DOMAIN特征相交的单元是激活的。

```
BEGIN ACTIVE_DOMAIN active_domain_layer_1
  SHAPEFILE = shapefiles/active_domain_layer_1
  FEATURE_TYPE = polygon
  INCLUDE_BOUNDARY = True
END ACTIVE_DOMAIN
```

```
BEGIN ACTIVE_DOMAIN active_domain_layer_3
  SHAPEFILE = shapefiles/active_domain_layer_3
  FEATURE_TYPE = polygon
  INCLUDE_BOUNDARY = True
END ACTIVE_DOMAIN
```

表6介绍了ACTIVE_DOMAIN块的组成记录列表信息。

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Table 6. List of records that compose the ACTIVE_DOMAIN block.

Record name	Record type	Default	Record description
SHAPEFILE	<text>	Required	Name of shapefile
FEATURE_TYPE	<text>	Required	“point,” “line,” or “polygon”
INCLUDE_BOUNDARY	<boolean>	True	True or False. Determines whether cells partially intersected by a polygon boundary are included in the active domain.



GRID_TO_SHAPEFILE

为MODFLOW_GRID和QUADTREE块描述的网格用于创建shapefile。
多层模型，创建图示的重叠多边形。当加载shapefile可视化，有必要选择层的子集，显示有用的作图。

下面是为basegrid保存为多边形的shapefile，保存到output_shapefiles/mfgrid

下面的例子是保存为分层四叉树网格为一套点，每个点位于网格单元中心：

```
LOAD quadtreegrid.dfn

BEGIN GRID_TO_SHAPEFILE quadtree2shapefile
  GRID = quadtreegrid
  SHAPEFILE = output_shapefiles/quadtreegrid
  FEATURE_TYPE = point
END GRID_TO_SHAPEFILE
```

```
LOAD basegrid.dfn
```

```
BEGIN GRID_TO_SHAPEFILE mfg-to-shapefile
  GRID = basegrid
  SHAPEFILE = output_shapefiles/mfg
  FEATURE_TYPE = polygon
END GRID_TO_SHAPEFILE
```




GRID_TO_SHAPEFILE

创建的shapefile的各个特征（点、线、多边形）包含若干属性，都写为shapefile。对于MODFLOW_GRID，属性为：

1. nodenumber: number of the cell;
2. layer: layer number of the cell;
3. row: row number of the cell;
4. col: column number of the cell;
5. child_location: this attribute is empty. It is included here to maintain consistency with shapefiles of QUADTREE grids;
6. top: top elevation of the cell;
7. bottom: bottom elevation of the cell;
8. delr: width of the cell in the x direction; and
9. delc: width of the cell in the y direction.

QUADTREE网络的属性与MODFLOW_GRID类似，仅分层四叉树网络的叶子保存为shapefile。主要的区别是：创建的shapefile包含一个child_location属性，是象限序列数的列表。为QUADTREE网络创建的shapefile属性有：

1. nodenumber: number of the cell;
2. layer: layer number of the cell;
3. row: row number of the base grid cell;
4. col: column number of the base grid cell;
5. child_location: a string consisting of numbers from 1 to 4 defining the quadrants to locate the leaf node within the base grid cell;
6. top: top elevation of the cell;
7. bottom: bottom elevation of the cell;
8. delr: width of the cell in x-direction; and
9. delc: width of the cell in y-direction.



GRID_TO_USGDATA

GRID_TO_USGDATA块创建MODFLOW-USG需要的很多离散输入数组。保存ASCII文本文件，包含关于单元和单元连接关系的几何属性信息。例子如下：

```
BEGIN GRID_TO_USGDATA qtree2usgdata
  GRID = quadtreegrid
  USG_DATA_PREFIX = output/usginput
  VERTICAL_PASS_THROUGH = true
END GRID_TO_USGDATA
```

Table 8. List of records that compose the GRID_TO_USGDATA block.

Record name	Record value	Default	Record description
GRID	<text>	Required	Name of QUADTREE block
USG_DATA_PREFIX	<text>	Required	Filename prefix for files to create
VERTICAL_PASS_THROUGH	<boolean>	False	Option for connecting layers where intermediate layers are inactive.



GRID_TO_USGDATA

读取程序见MODFLOW-USG手册，其中有详细介绍写出到这些文件的数组的描述。

Table 9. Files created by the GRID_TO_USGDATA block.
[NCELLS, number of active cells for the grid; CSR, compress sparse row; NCON, total number of connections between cells]

File	Array type (number of entries)	Array description
prefix.ia.dat	<int[NCELLS+1]>	CSR row pointer array
prefix.ja.dat	<int[NCON]>	CSR column index pointer array
prefix.iac.dat	<int[NCELLS]>	Number of entries for each row
prefix.area.dat	<real[NCELLS]>	Cell surface area in plan view
prefix.c1.dat	<real[NCON]>	Distance from cell center to shared face of connected cell
prefix.c2.dat	<real[NCON]>	Distance from center of connected cell to shared face
prefix.fahl.dat	<real[NCON]>	Cross sectional area of the connection. For horizontal connections, this is calculated based on the average thickness of the connected cells.
prefix.fldr.dat	<int[NCON]>	Direction indicator for each connection. 0 is diagonal, 1, 2, and 3 are for the positive x, y, and z directions. -1, -2, and -3 are for the negative x, y, and z directions.
prefix.gnc.dat		List of ghost-node correction information. Note that the ghost-node correction information is only calculated for horizontal connections. Ghost-node correction information is not calculated for vertical cell connections. QUADTREE grids should be smoothed to a level difference of one in the horizontal direction for the information in this file to be useful.
prefix.nodesperlay.dat	<int[NLAY]>	Number of cells for each layer
prefix.nod		The first line in this file is the number of active cells and the number of connections. This file then contains one line for each active cell. Data for each line include: (1) cell number, (2) layer number, (3) centroid x, (4) centroid y, (5) centroid z, (6) delta x spacing, (7) delta y spacing, and (8) delta z spacing.



GRID_TO_VTKFILE

GRID_TO_VTKFILE用于创建VTK文件。

```
BEGIN GRID_TO_VTKFILE grid02qtg-to-vtkfile
  GRID = grid02qtg
  VTKFILE = output_vtkfiles/grid02qtg
  SHARE_VERTEX = false
END GRID_TO_VTKFILE
```

Table 10. List of records that compose the GRID_TO_VTKFILE block.

Record name	Record value	Default	Record description
GRID	<text>	Required	Name of MODFLOW_GRID or QUADTREE block
VTKFILE	<text>	Required	Filename prefix for VTK file to create
SHARE_VERTEX	<boolean>	False	If true, then the elevation for each cell vertex will be interpolated and vertices will be shared among neighboring cells. This results in a smooth surface and a smaller VTK file. If not, each cell in the VTK file will be given 8 vertices resulting in a stair-stepped cell representation.



GRID_INTERSECTION

确定水文特征与模型网格的相交特性。所有的相交子程序都是2D的，确定相交属性时不用高程信息。为每个相交需要提供分层编号。3种特征可以与模型网格相交：点、线和多边形。计算结果保存为shapefile和一个ASCII文本文件。表11展示了GRID_INTERSECTION块的记录列表，还展示了3种不同相交（点-网格、线-网格和多边形-网格）的细节。

Table 11. List of records that compose the GRID_INTERSECTION block.

Record name	Record value	Default	Record description
GRID	<text>	Required	Name of grid block
LAYER	<integer>	Required	Layer of the grid to intersect with the features
SHAPEFILE	<text>	Required	Name of grid shapefile containing the features to intersect with the grid
FEATURE_TYPE	<text>	Required	Type features to intersect with the grid: "point," "line," or "polygon"
OUTPUT_FILE	<text>	Required	Name of the ASCII output file to create
OUTPUT_SHAPEFILE	<text>	Optional	Name of the shapefile to create
ATTRIBUTES	<text>	"All"	List of attribute names from the input shapefile to include in the output shapefile created by the intersection. Note that attribute names are case sensitive and that the terms "all" or "none" can also be entered here.



Point-GRID intersection

```
BEGIN GRID_INTERSECTION well1_intersect
  GRID = quadtreegrid
  LAYER = 1
  SHAPEFILE = shapefiles/wells_layer_1
  FEATURE_TYPE = point
  OUTPUT_FILE = output_intersection/well1_intersect.ifo
  OUTPUT_SHAPEFILE = output_intersection/well1_intersect
END GRID_INTERSECTION
```

Line-Grid intersection

```
BEGIN GRID_INTERSECTION river_intersect
  GRID = quadtreegrid
  LAYER = 1
  SHAPEFILE = shapefiles/river
  FEATURE_TYPE = line
  OUTPUT_FILE = output_intersection/river_intersect.ifo
  OUTPUT_SHAPEFILE = output_intersection/river_intersect.shp
END GRID_INTERSECTION
```

Polygon-Grid Intersection

```
BEGIN GRID_INTERSECTION recharge_intersect
  GRID = quadtreegrid
  LAYER = 1
  SHAPEFILE = shapefiles/recharge
  FEATURE_TYPE = polygon
  OUTPUT_FILE = output_intersection/recharge_intersect.ifo
  ATTRIBUTES = rech_zone
  OUTPUT_SHAPEFILE = output_intersection/recharge_intersect.shp
END GRID_INTERSECTION
```




例子 (Biscayne含水层, Florida)

需要4个步骤，每个步骤执行一个GRIDGEN行为块。

第1步：使用QUADTREE_BUILDER块创建一个分层四叉树网格。

第2步：使用GRID_TO_USGDATA写出关于网格的信息到一套文件中。

第3步：为分层四叉树网格创建点和多边形的shapefiles

第4步：分层四叉树网格与点、线和多边形shapefile相交



生成分层四叉树网格

使用QUADTREE_BUILDER块创建分层四叉树网格。

基础的MODFLOW_GRID由1层、100行和58列组成。

基础网格的各单元是800m边长。

QUADTREE_BUILDER块使用的空间特征包括：一个活动计算域，**线表征淡水渠道**，线表示海岸线的潮汐边界，**井周围的多边形**（图2A）。还可以使用点表示井的细化特种工，但使用多线性提供方对井周围细化范围大小的控制。

这些特征使用**REFINEMENT_LEVEL=4**创建分层四叉树网格的单元，最小宽度50m（基础网格单元大小为800m，细化4次等于50m）。创建的分层四叉树网格见图2B。



生成分层四叉树网格

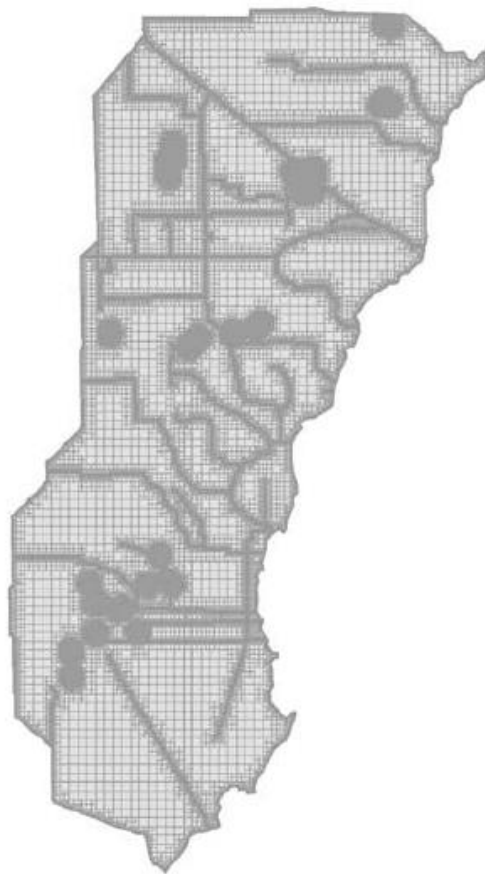
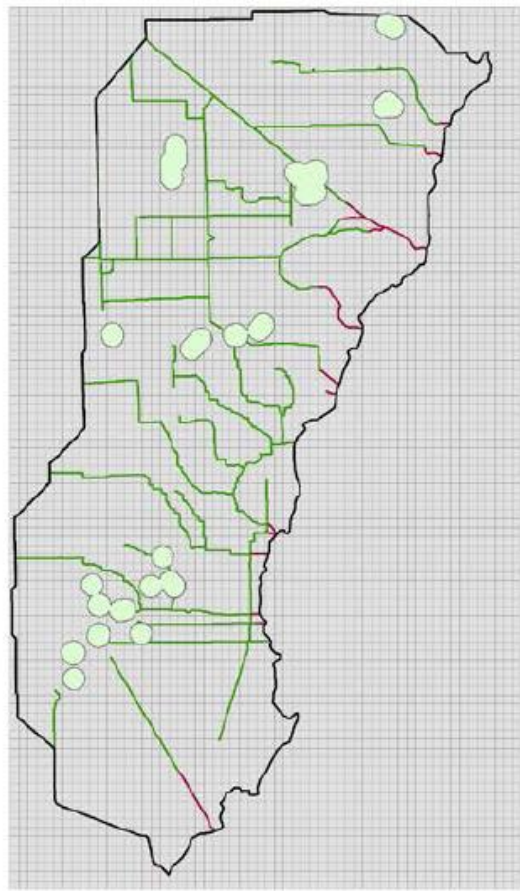


图2A 为生成的
基础网格

图2B 为生成的
四叉树网格，活
动域之外的单元
编号为-1，也包
含在树状结构文
件中，在水流模
拟时排除在外



输出网格信息

使用GRID_TO_USGDATA输出单元连接关系和网格的其他信息到ASCII文件。定义文件（action02_writeusgdata.dfn）包含如下几行：

```
LOAD grid02qtg.dfn
BEGIN GRID_TO_USGDATA grid02qtg-to-usgdata
  GRID = grid02qtg
  USG_DATA_PREFIX = output_usgdata/grid02qtg
END GRID_TO_USGDATA
```

执行命令：

gridgen.exe grid02qtg-to-usgdata action02_writeusgdata.dfn

将在output_usgdata文件夹下生成12个文件。这些文件包含的信息见表9的介绍。



创建网格的shapefiles

使用GRID_TO_SHAPEFILE块为分层四叉树网格创建点和多边形shapefile，定义文件（action03_shapefile.dfn）包含如下几行：

```
LOAD grid02qtg.dfn

BEGIN GRID_TO_SHAPEFILE grid02qtg-to-pointshapefile
  GRID = grid02qtg
  SHAPEFILE = output_shapefiles/grid02qtg_pts
  FEATURE_TYPE = point
END grid_to_shapefile

BEGIN GRID_TO_SHAPEFILE grid02qtg-to-polyshapefile
  GRID = grid02qtg
  SHAPEFILE = output_shapefiles/grid02qtg
  FEATURE_TYPE = polygon
END grid_to_shapefile
```

输出shapefile到文件夹output_shapefiles，使用如下命令：

gridgen.exe grid02qtg-to-pointshapefile action03_shapefile.dfn

和

gridgen.exe grid02qtg-to-polyshapefile action03_shapefile.dfn



切割网格

使用shapefiles中包含的空间特征风格分层四叉树网格。风格网格的定义文件有几个不同的shapefiles (action04_intersect.dfn), 包含如下几行:

```
LOAD grid02qtg.dfn

BEGIN GRID_INTERSECTION canal_grid02qtg_layer1_intersect
  GRID = grid02qtg
  LAYER = 1
  SHAPEFILE = shapefiles/MD_Canals_50m_v2
  FEATURE_TYPE = line
  OUTPUT_FILE = output_intersection/canal_grid02qtg_layer1_intersect.ifo
  ATTRIBUTES = HYDR_COND BOT_ELEV TOP_WIDTH DB_NAME
  OUTPUT_SHAPEFILE = output_intersection/canal_grid02qtg_layer1_intersect.shp
END GRID_INTERSECTION

BEGIN GRID_INTERSECTION well_grid02qtg_layer1_intersect
  GRID = grid02qtg
  LAYER = 1
  SHAPEFILE = shapefiles/county_wells_NAD_27_filtered
  FEATURE_TYPE = point
  OUTPUT_FILE = output_intersection/well_grid02qtg_layer1_intersect.ifo
  ATTRIBUTES = WellName
  OUTPUT_SHAPEFILE = output_intersection/well_grid02qtg_layer1_intersect.shp
END GRID_INTERSECTION

BEGIN GRID_INTERSECTION poly_grid02qtg_layer1_intersect
  GRID = grid02qtg
  LAYER = 1
  SHAPEFILE = shapefiles/twopolygons
  FEATURE_TYPE = polygon
  OUTPUT_FILE = output_intersection/poly_grid02qtg_layer1_intersect.ifo
  ATTRIBUTES = FID
  OUTPUT_SHAPEFILE = output_intersection/poly_grid02qtg_layer1_intersect.shp
END GRID_INTERSECTION

BEGIN GRID_INTERSECTION chd_grid02qtg_layer1_intersect
  GRID = grid02qtg
  LAYER = 1
  SHAPEFILE = shapefiles/chd_line
  FEATURE_TYPE = line
  OUTPUT_FILE = output_intersection/chd_grid02qtg_layer1_intersect.ifo
  #attributes = FID
  OUTPUT_SHAPEFILE = output_intersection/chd_grid02qtg_layer1_intersect.shp
END GRID_INTERSECTION

BEGIN GRID_INTERSECTION lu2008_grid02qtg_layer1_intersect
  GRID = grid02qtg
  LAYER = 1
  SHAPEFILE = shapefiles/SFWMMD_2008_09_LCLU_2004FILLED_MISSING
  FEATURE_TYPE = polygon
  OUTPUT_FILE = output_intersection/lu2008_grid02qtg_layer1_intersect.ifo
  ATTRIBUTES = FID
  OUTPUT_SHAPEFILE = output_intersection/lu2008_grid02qtg_layer1_intersect.shp
END GRID_INTERSECTION
```




切割网格

GRID_INTERSECTION块的各个块需要独立执行GRIDGEN。执行第1个块（称为canal_grid02qtg_lay1_intersect），执行如下命令：
canal_grid02qtg_lay1_intersect action04_intersect.dfn
剩下的切割块使用对应的名称单独执行类似的命令。



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