Central Gulf Coast GAM Modeler's Training

February 7th

Travis Building

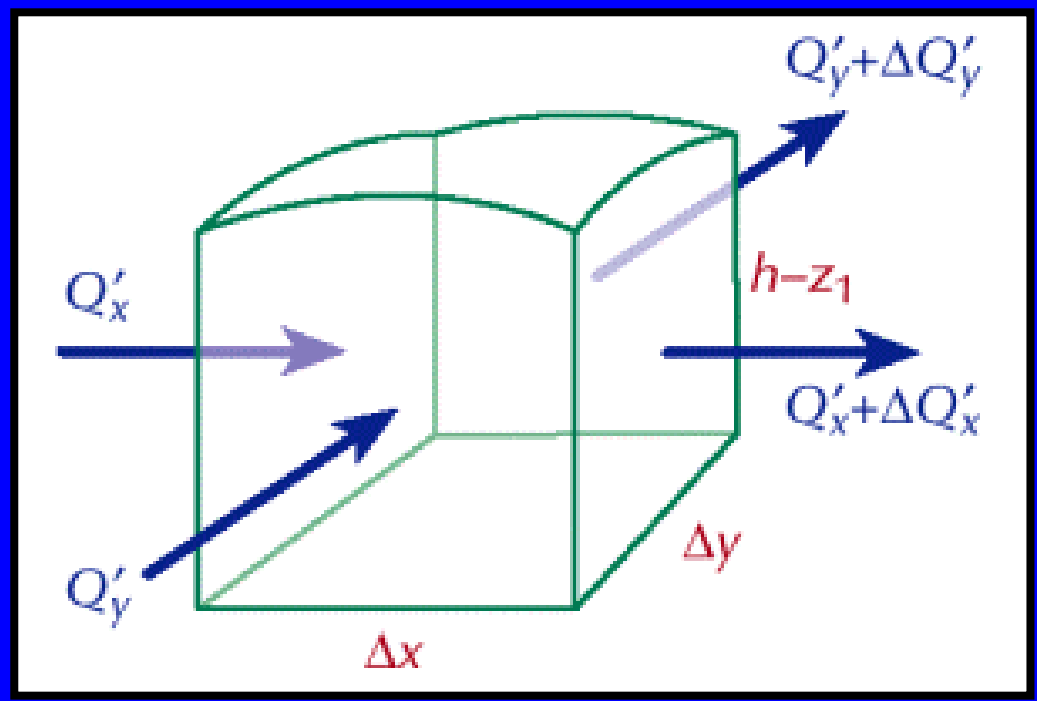
1701 N. Congress Ave

Austin, Texas

Models Start with Governing Equations

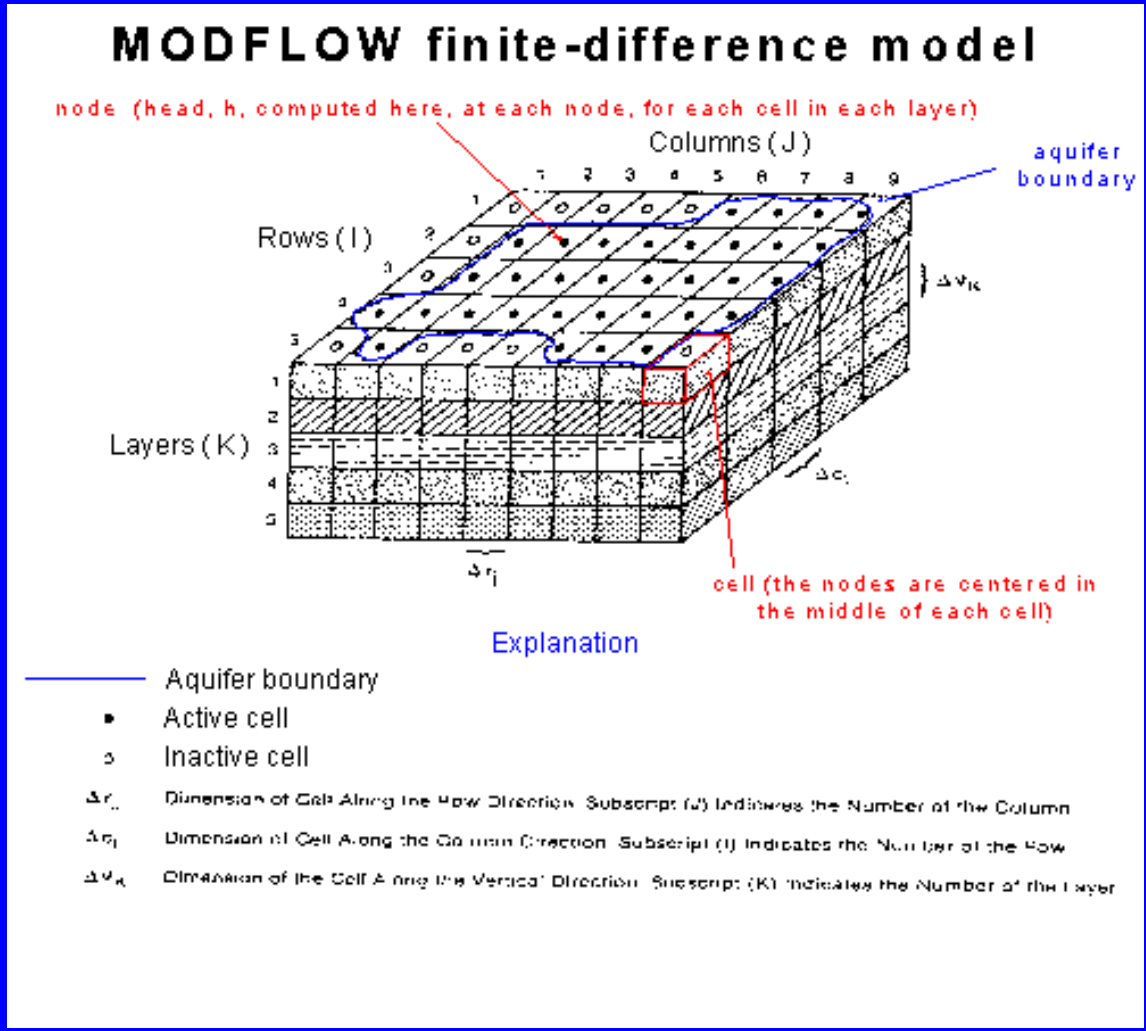
steady state flow	$\frac{\partial h}{\partial t} = 0$	$\frac{\partial}{\partial x} h \frac{\partial h}{\partial x} + \frac{\partial}{\partial y} h \frac{\partial h}{\partial y} + \frac{e}{K} = 0$
confined flow	$h = b$	$\frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = \frac{s}{bK} \frac{\partial h}{\partial t} = \frac{S}{T} \frac{\partial h}{\partial t}$

- Governing equations to mathematically express the physical system
- Equations to represent the flow of water



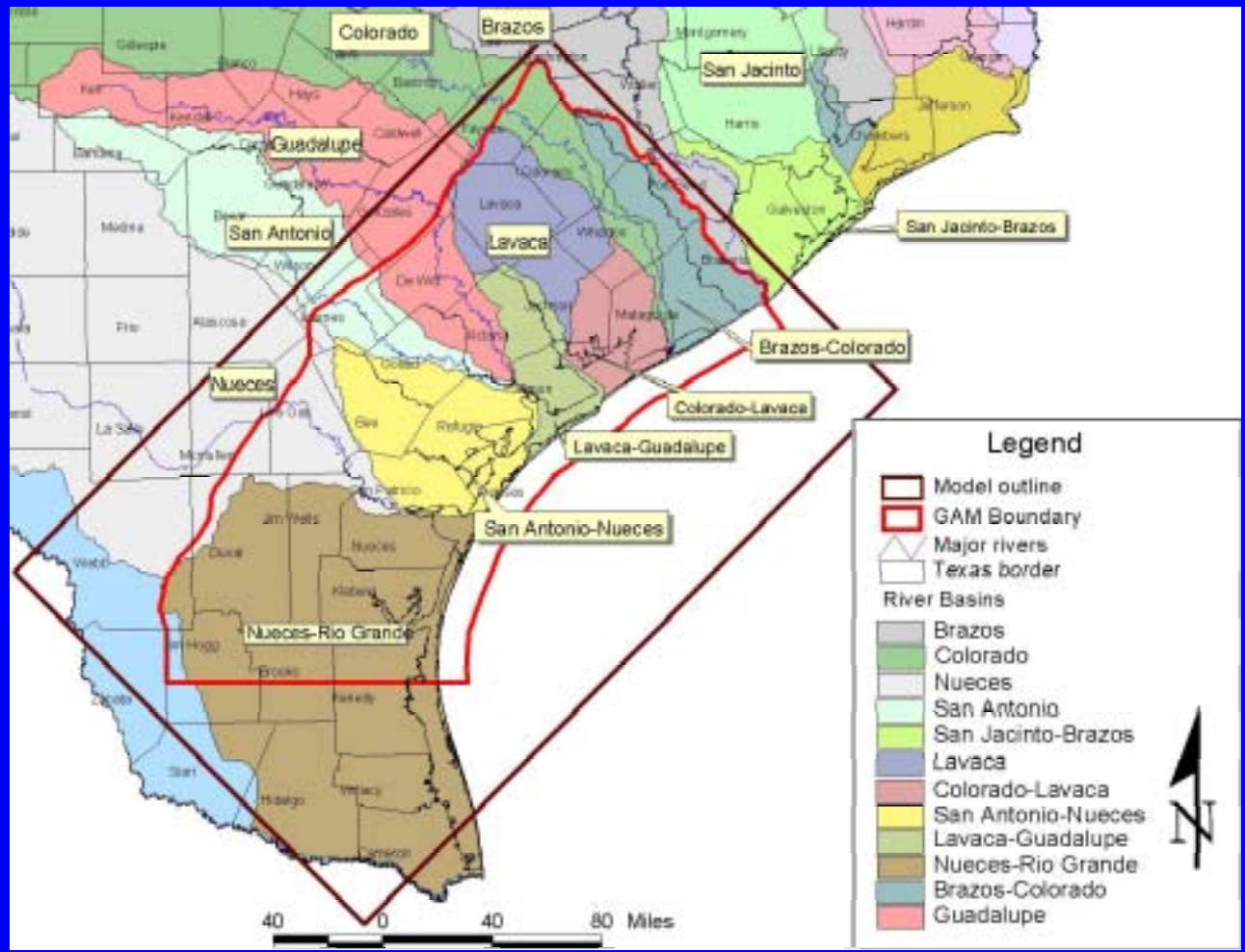
Moving From Equations to Models

- Analytical solutions not practical for most situations
- Create a finite difference approximation
- Use numerical methods to solve the large number of simpler equations

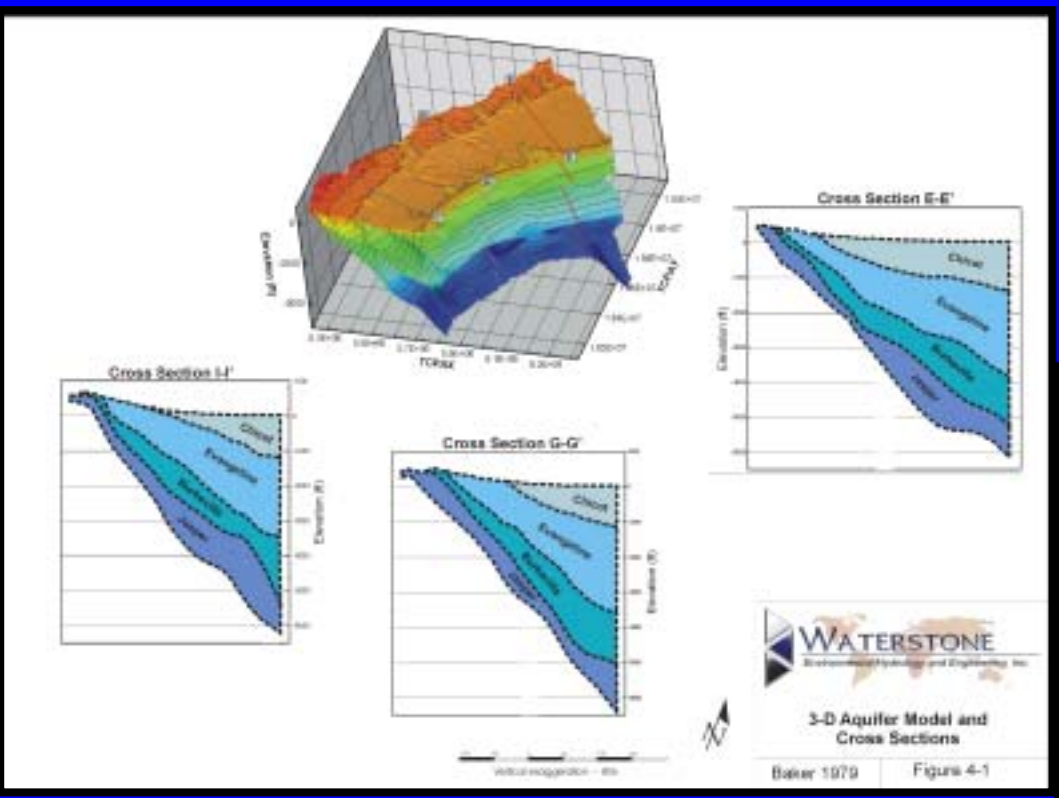


Parameterization: Specifying the Physical System in Your Model

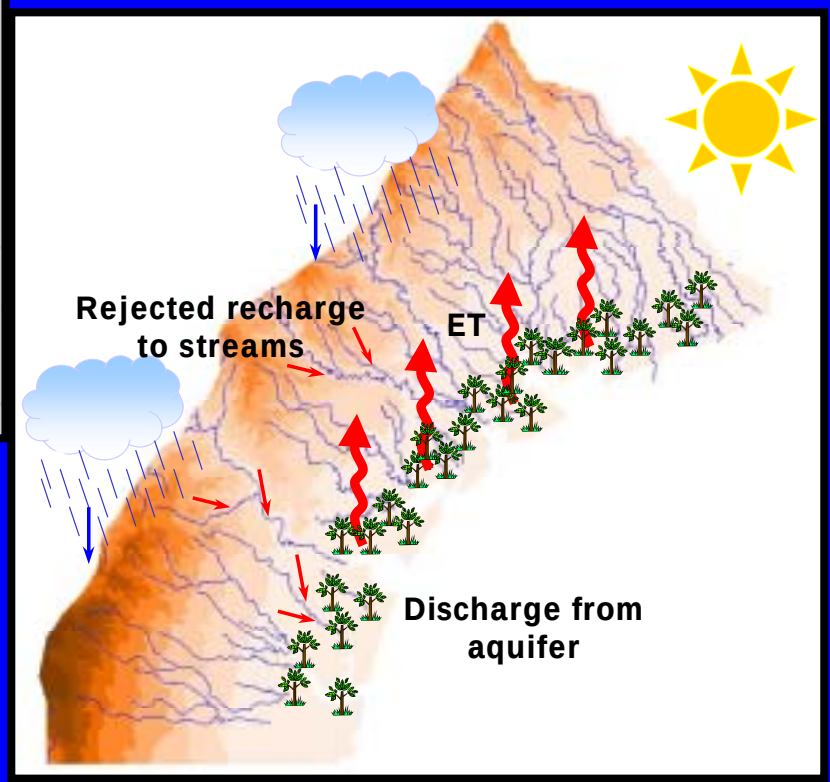
- Gather information regarding
  - Geometery
  - Boundary conditions
- Incoporate into the model
  - Input file formatting
  - Time varying data



CGC GAM Model



- Geometry from published data
- Hydraulic properties from pump tests and other data



- Boundary conditions from a wide range of data bases

CGC Gam Models Produced for the TWDB

- Model Development
  - Steady – State
    - Pre-1940 conditions
    - Data from 1901 – 1940
  - Calibration
    - Data from 1980 – 1989
    - Checked against 1988 data
  - Verification
    - Data from 1990 – 1999
    - Checked against 1998 data
  - Transient (1920-2000)
    - Combined all three

Years	Stress Periods	Description
1920-1939	1	Steady-state
1940-1980	1	
1981-1986	6 annual	Calibration/ Normal
1987-1989	36 monthly	Calibration /Drought
1990-1994	5 annual	Verification/ Normal
1995-1997	36 monthly	Verification/ Drought
1998-1999	2 annual	Verification/ Normal

Steady State MODFLOW Files

- Steady state simulation representing conditions prior to 1940

- .BAS
- .BCF
- .GHB
- .PCG
- .OC
- .STR
- .RIV
- .RCH
- .DRN

Programs and Files Needed

- ✓ PMWIN installed
  - Version 5 with 1st update → Ver 5.2.1
- ✓ 10 MODFLOW input files
  - including 2 .STR files
- ✓ MODLFOW name file
- ✓ MODFLOW executable, mf96l90.exe
  - and tnt.exe, lff90.err
- ✓ Overlays/Maps: DXF files
- ✓ Boreholes and Observations:
  - .bor and .obs files
- ✓ PMWINSOP.doc

Converting and Setting Up The Steady-State Model

- Import the MODFLOW files
  - CONVERT
- Environment settings
  - Orienting the Grid
- Add Maps
  - DXF/Map overlays
- Generate PMWIN MODFLOW files
- Copy .STR file
  - copy TEXAS.STR (or TX40.STR) to str1.dat

Running the Steady State

- Verify the output intervals.
  - Critical for transient runs, but does not affect the steady state
- Select to run
- Deselect .STR file
  - Do NOT regenerate .STR file
- Specify the executable
  - mf96l90.exe has additional screen output
- Proceed

Reviewing Results

- Results extractor: How to get the data you want
  - Looking at water levels in PMWIN
- Presentation: Making it look the way you want
  - Contouring and saving the head contour file (.ctf)
  - Label size formats do not save
- Export
  - Formats
  - .BMP for comparying to modified-K run

Modifying K

- Select a region in layer 1
  - Select with a zone
  - Save the zone
  - Explore cell-by-cell versus zone
- Specifying a multiplier
  - Decrease K by a factor of 100
- Saving the modified K field
- Go to layer two and repeat

Running the Modified Model

- Regenerate MODFLOW files
  - Do NOT regenerat .STR
- Run the model
- Load results
- Zoom
- Recontour
  - Pull in saved contours from previous run
- Export for comparison to base case


WATERSTONE
Environmental Hydrology and Engineering, Inc.


PARSONS

.BAS File

- 4 layer system
- 169 Columns
- 277 Rows
- Steady state
- Initial heads based on topography

Return to Model Files

.BCF File

- All layers are convertible: confined to unconfined.
- Transmissivity recalculated based on updated saturated thickness.
- Standard lateral GAM dimensions: 1 mi^2.
- Geometry based on published data.
- K based on analysis of pump test results.

Return to Model Files

.GHB File

- General head boundaries outline the coast.
  - Represent flow at the top of the salinity interface
  - Values adjusted during calibration

Return to Model Files

.OC File

- Recommend setting to a minimum number of needed outputs.
  - File sizes in excess of 5GB is not uncommon for the predictive runs

Return to Model Files

.PCG File

- For the steady state model the convergence criteria can is set to 1.0 for both the HCLOSE and RCLOSE.

Return to Model Files

.WEL File

- Information on net pumping from each model grid cell within the CGC GAM
  - REMEMBER: values do not represent individual wells unless there is only one well pumping in the entire 1 mi^2.

Return to Model Files

.STR File

- More than 278 stream segments are represented in 5000 model grid cells.
  - PMWIN cannot handle more than 25 stream segments.
  - Tricked PMWIN at the start but
    - NEVER GENERATE .STR PACKAGE FROM PMWIN.
  - Stream budget data will not be either.

Return to Model Files

.RIV File

- River file provides representation of the lakes in the CGC region
- Predevelopment (steady state) had a limited number of lakes with minimal influence on the model.

Return to Model Files

.RCH File

- Recharge assigned according to the array supplied.
  - Array designates the daylighting layer as the recharge recipient.
- Spatial distribution of recharge.

Return to Model Files

.DRN File

- Representation of seepage from the aquifer:
  - Includes water leaving the aquifer through seeps, springs and wetlands
  - Based on Land Use/Land Cover with the designation of wetlands
- Elevation is based on the minimum DEM in the grid cell
- Conductance is based on area and the local vertical hydraulic conductivity

Return to Model Files