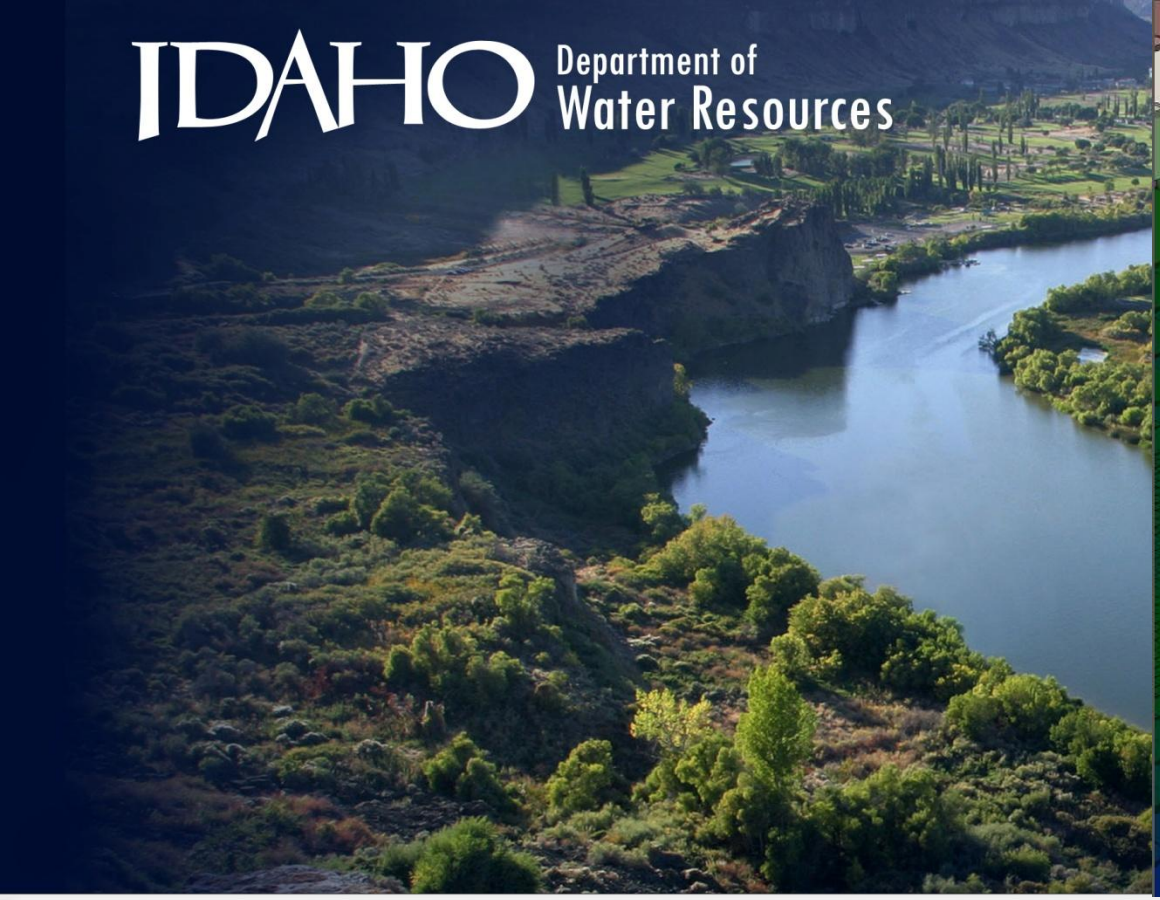
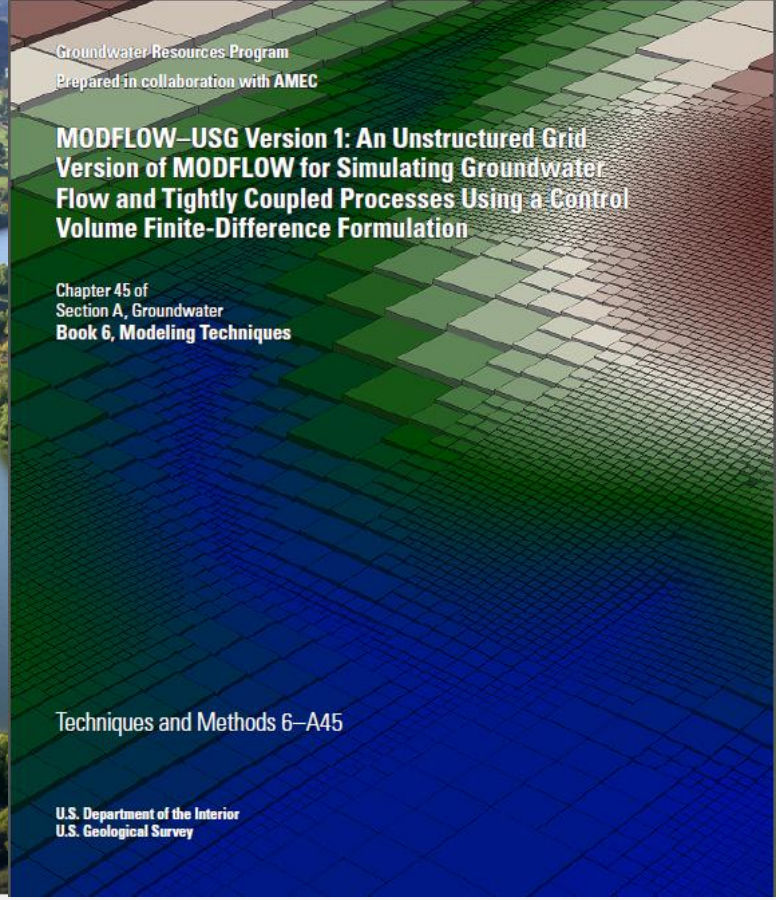




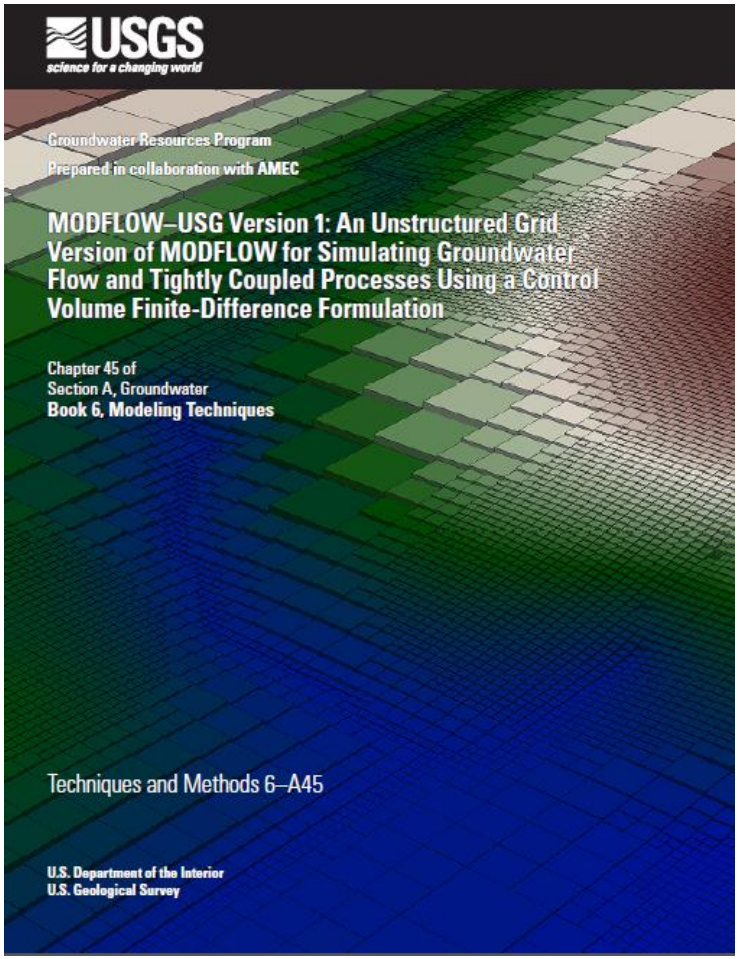
MODFLOW USG

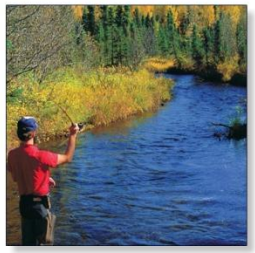
Allan Wylie IDWR

24 September 2013

MODFLOW USG

- Outline
  - Brief discussion of MFUSG
    - If you are a real modeling geek this will be unduly brief
  - Features of potential use in ESPAM



MODFLOW USG

- USGS MODFLOW groundwater model
  - Extensive USGS review
  - Free
- Works with our existing input files
  - Minor change to BCF file
  - Need minor change to WEL file
- Sparse Matrix Solver
  - Several methods to solve matrix
  - Rather than relax convergence criteria use different method to solve matrix
- Works with PEST

MF2K

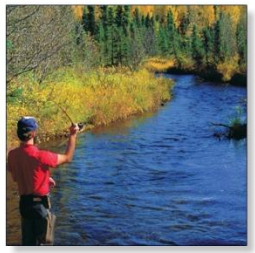
- Optimised measurement objective function = 6060.
- Optimised regularisation weight factor = 1.000
- Optimised regularisation objective function = 2305.

- Correlation coefficient = 0.9991

MFUSG

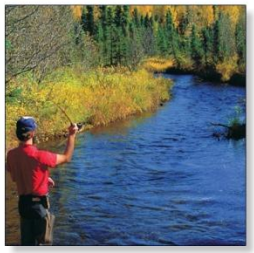
- Optimised measurement objective function = 6060.9
- Optimised regularisation weight factor = 1.000
- Optimised regularisation objective function = 2305.3

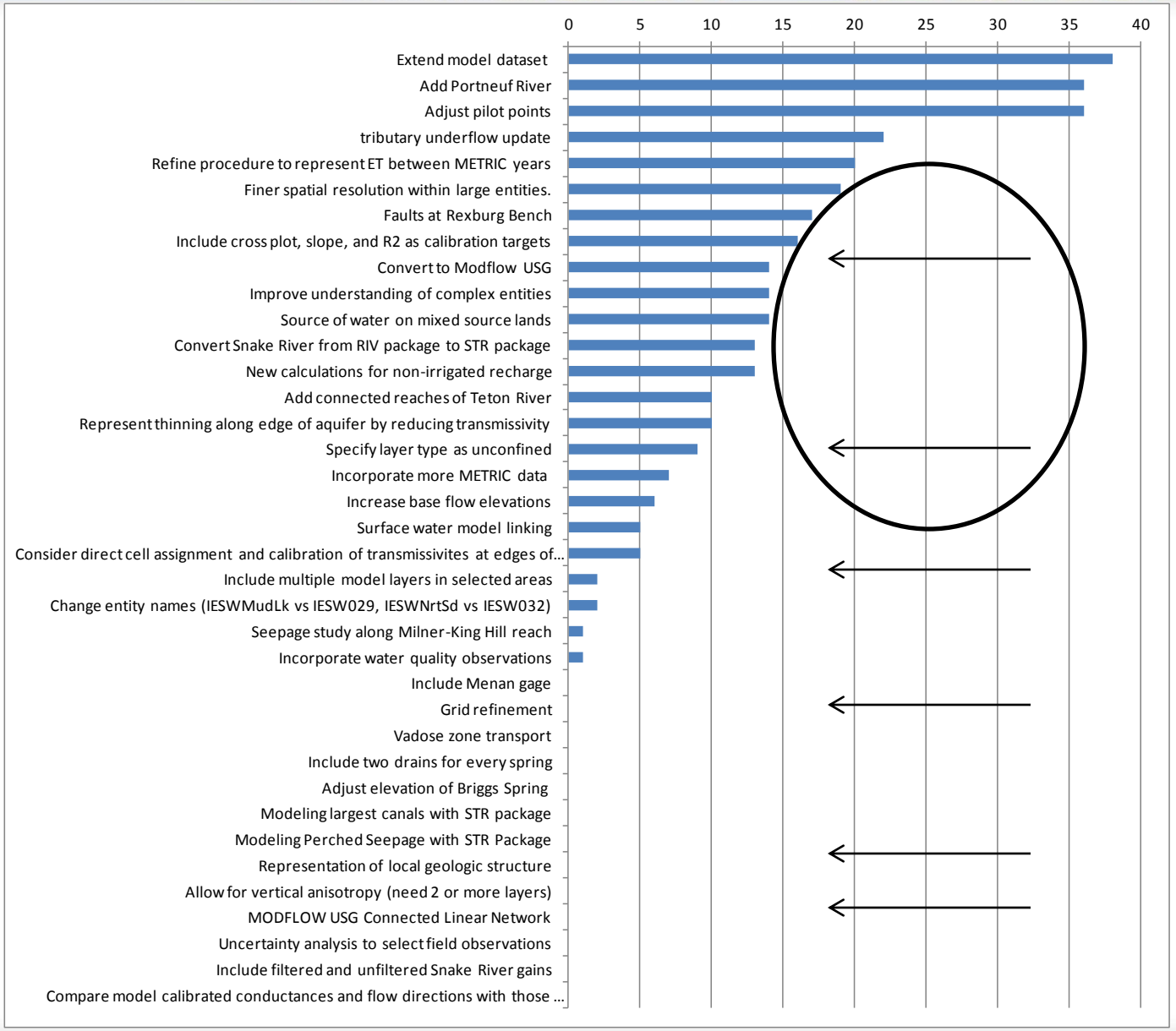
- Correlation coefficient = 0.99907

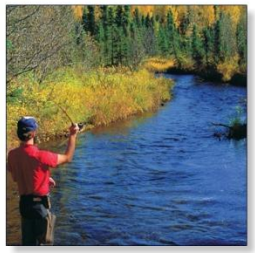



Calibration with MFUSG

- No problems when in fixed transmissivity mode
  - Runs in about ¼ the time
  - Gets similar answer
- More stable than MF2K in variable transmissivity mode
  - Does fail to converge from time to time

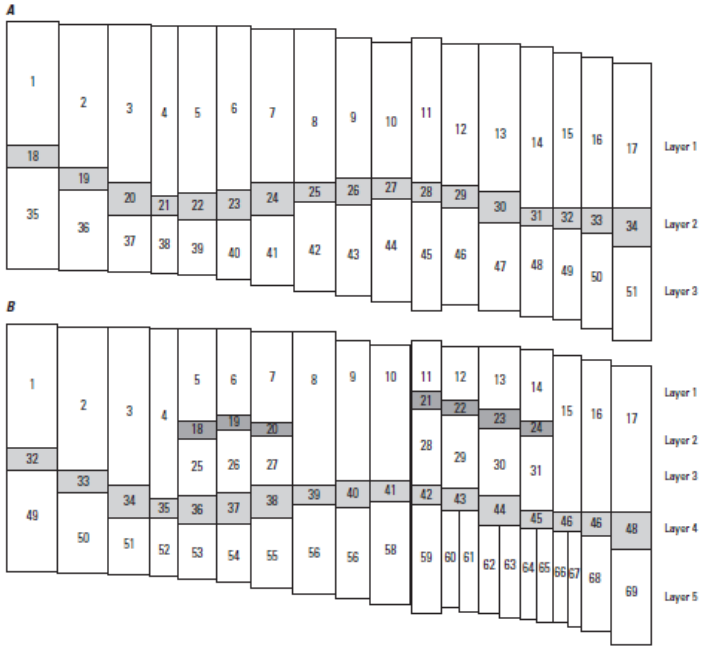



0
5
10
15
20
25
30
35
40
Extend model dataset
Add Portneuf River
Adjust pilot points
tributary underflow update
Refine procedure to represent ET between METRIC years
Finer spatial resolution within large entities.
Faults at Rexburg Bench
Include cross plot, slope, and R2 as calibration targets
Convert to Modflow USG
Improve understanding of complex entities
Source of water on mixed source lands
Convert Snake River from RIV package to STR package
New calculations for non-irrigated recharge
Add connected reaches of Teton River
Represent thinning along edge of aquifer by reducing transmissivity
Specify layer type as unconfined
Incorporate more METRIC data
Increase base flow elevations
Surface water model linking
Consider direct cell assignment and calibration of transmissivites at edges of...
Include multiple model layers in selected areas
Change entity names (IESWMudLk vs IESW029, IESWNrtSd vs IESW032)
Seepage study along Milner-King Hill reach
Incorporate water quality observations
Include Menan gage
Grid refinement
Vadose zone transport
Include two drains for every spring
Adjust elevation of Briggs Spring
Modeling largest canals with STR package
Modeling Perched Seepage with STR Package
Representation of local geologic structure
Allow for vertical anisotropy (need 2 or more layers)
MODFLOW USG Connected Linear Network
Uncertainty analysis to select field observations
Include filtered and unfiltered Snake River gains
Compare model calibrated conductances and flow directions with those ...

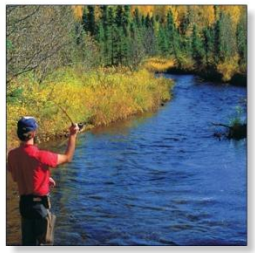


MFUSG layering schemes

Figure shamelessly taken from USGS document

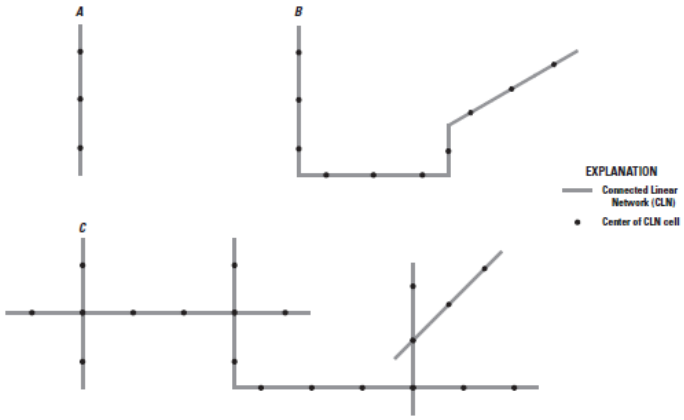


- Same grid configuration for all layers
- Different grid configuration for different layers
- Subdiscretization within a layer



Connected Linear Network (CLN)

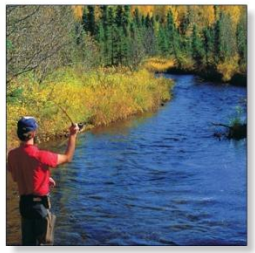
Figure shamelessly taken from USGS document

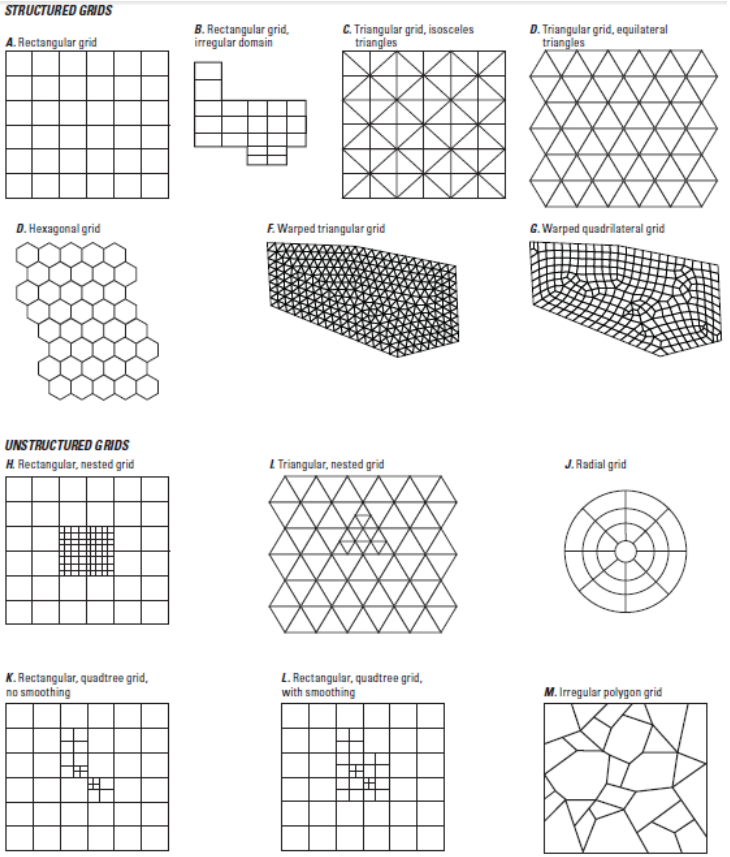


- Any hydrogeologic or hydrologic water conveying feature having a smaller cross-sectional area than the cell
  - i.e. canal or river
- Allows incorporation of one dimensional features to a structured or unstructured grid

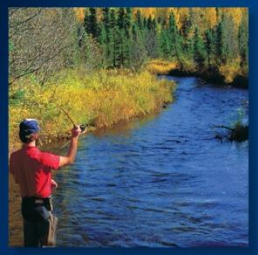
MFUSG grid options

Figure shamelessly taken from USGS document





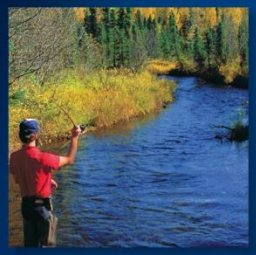
- Structured grid
  - Number of connections to a cell is constant
- Unstructured grid
  - Number of connections may be variable for each cell

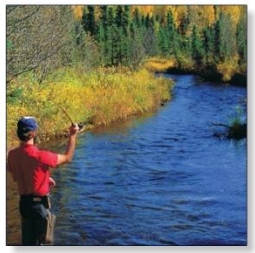
Recommendation

- Convert to MFUSG for ESPAM2.2
- Experiment with variable transmissivity
- Explore other options
  - CLN
  - USG
  - Layering

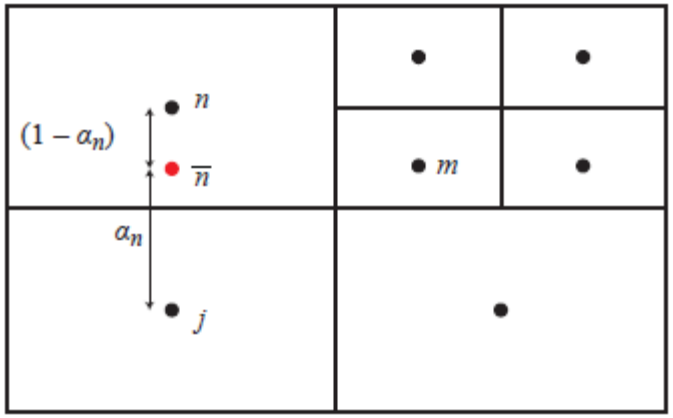
IDAHO Department of Water Resources



End

MFUSG Ghost Note Correction



- Control Volume Finite Difference (CVFD) formulation is good approximation when line connecting the center of two adjacent cells is perpendicular to and coincides with midpoint of each cell
- CVFD not good otherwise, as in the case of a nested grid where length of face is divided amongst various nested child grids
- Use of ghost node can overcome this flux error
  - Interpolate between n and j to get head at ň