

MODFLOW-IDC (MF-IDC)

**A New Integrated Hydrologic Modeling Tool
from California for the Rest of the World**

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Developers: Reza Namvar, Adrien Camille, Ahmed Ali

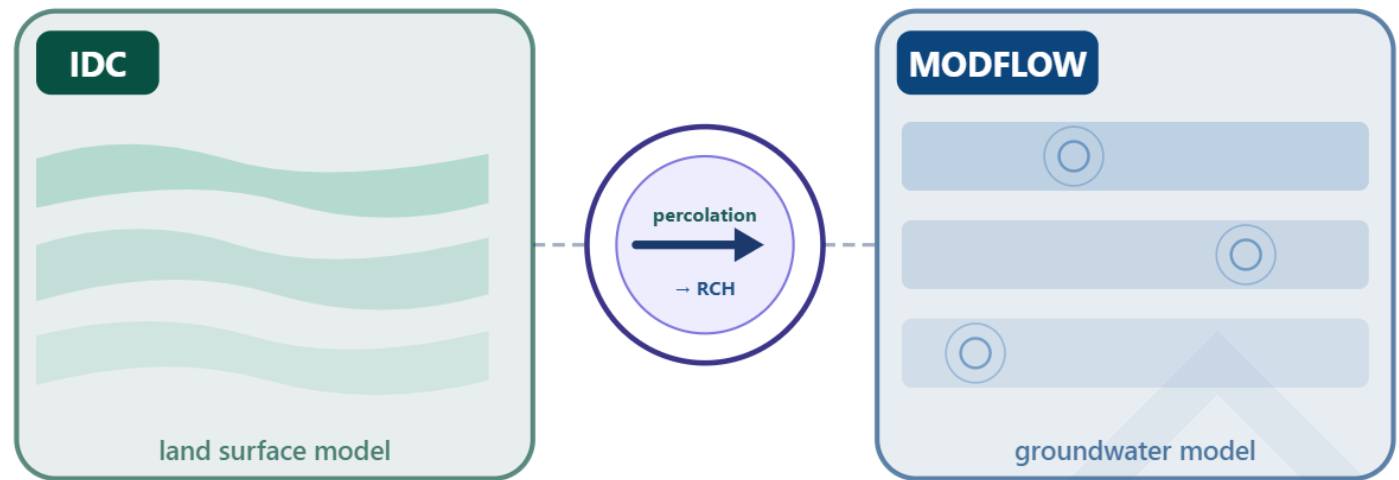


**Woodard
& Curran**

MF-IDC Modeling Tool – Phase 1 Overview

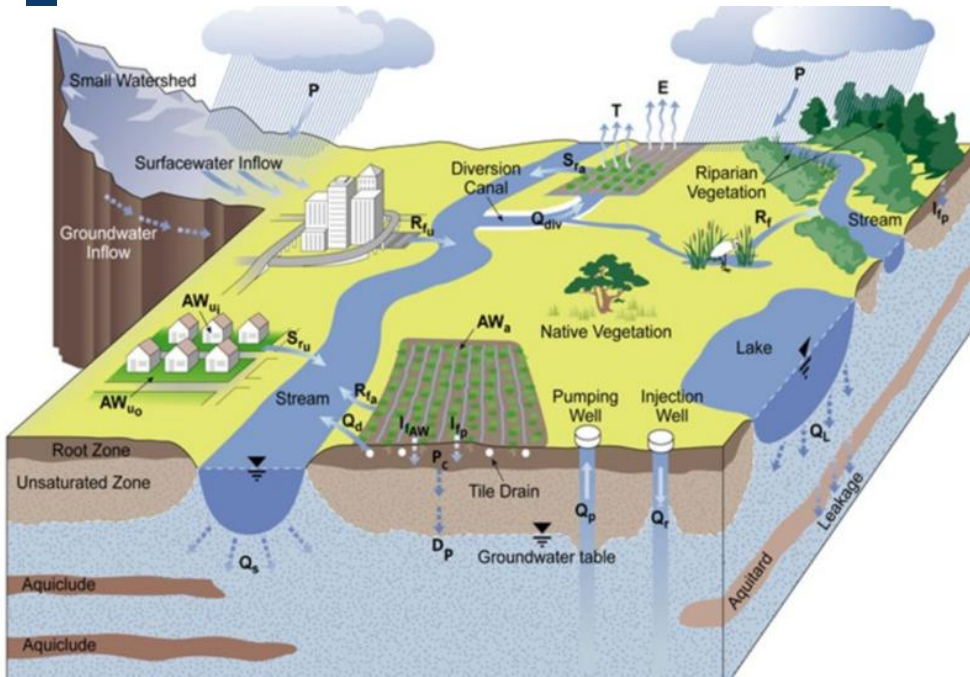
► Agenda

- Tool Background
- MF-IDC coupling requirements and workflow
- MF-IDC coupling approach and example
- Next steps

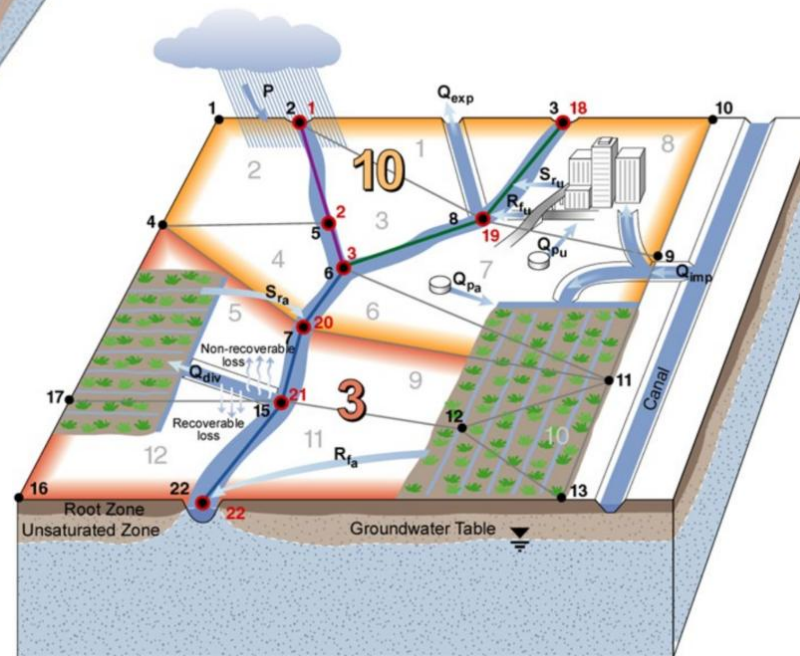


MODFLOW-IDC
COUPLING TOOL

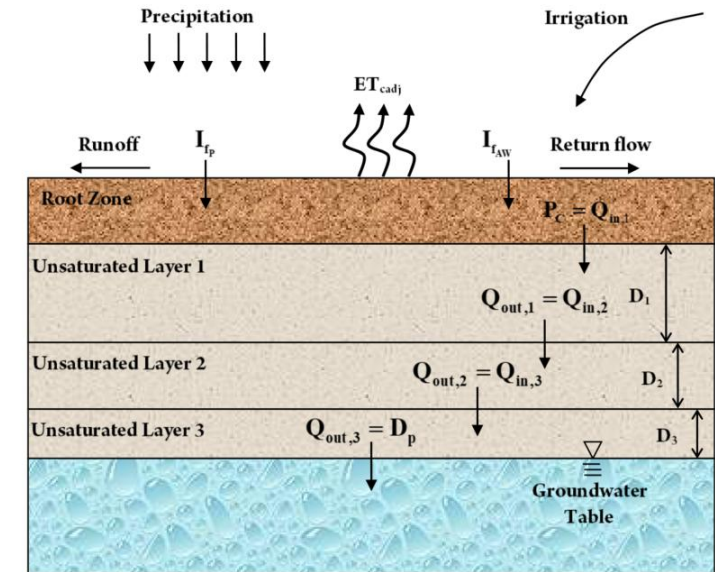
Integrated Water Flow Model (IWFM) Developed by DWR



IWFM uses Finite
Element Method



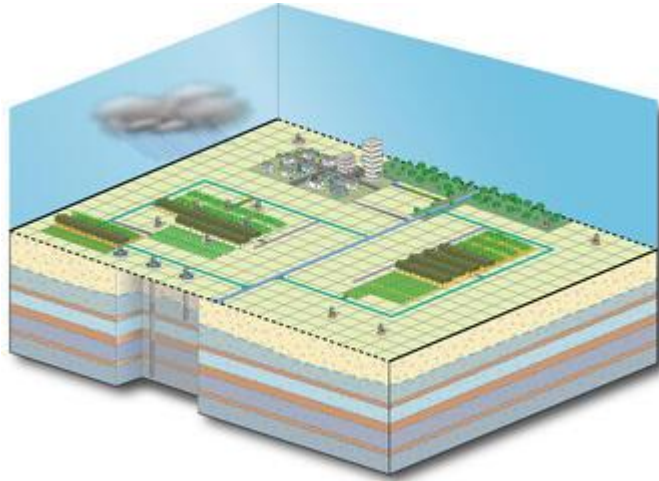
Water Use and Supply



Root Zone and
Unsaturated Zone

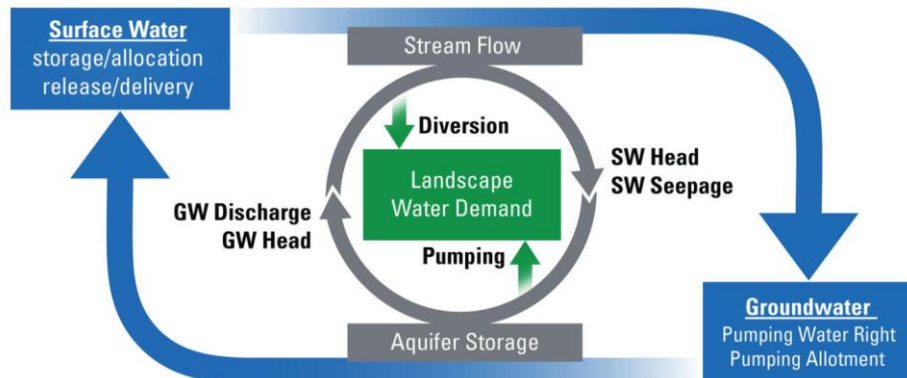
Hydrologic processes
modeled in IWFM

Linking MODFLOW to Land Surface Processes



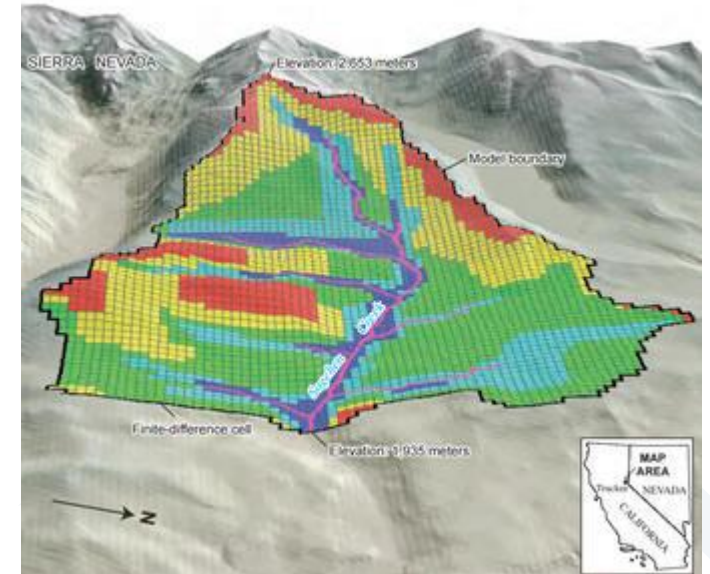
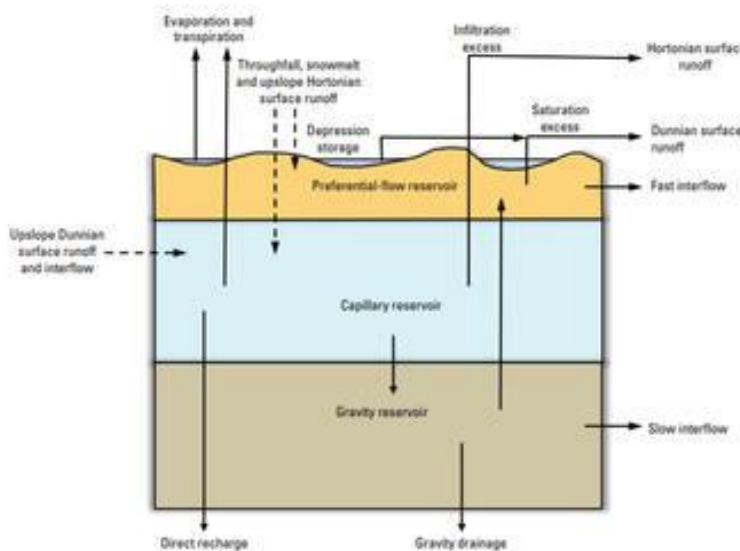
MODFLOW One-Water Hydrologic Flow Model (**MF-OWHM**)

Conjunctive Use Simulation



<https://pubs.usgs.gov/publication/tm6A60>

GSFLOW – Coupled GW and SW Flow Model
MODFLOW + Precipitation-Runoff Modeling System (PRMS)



<https://www.usgs.gov/software/gsfLOW-coupled-groundwater-and-surface-water-flow-model>

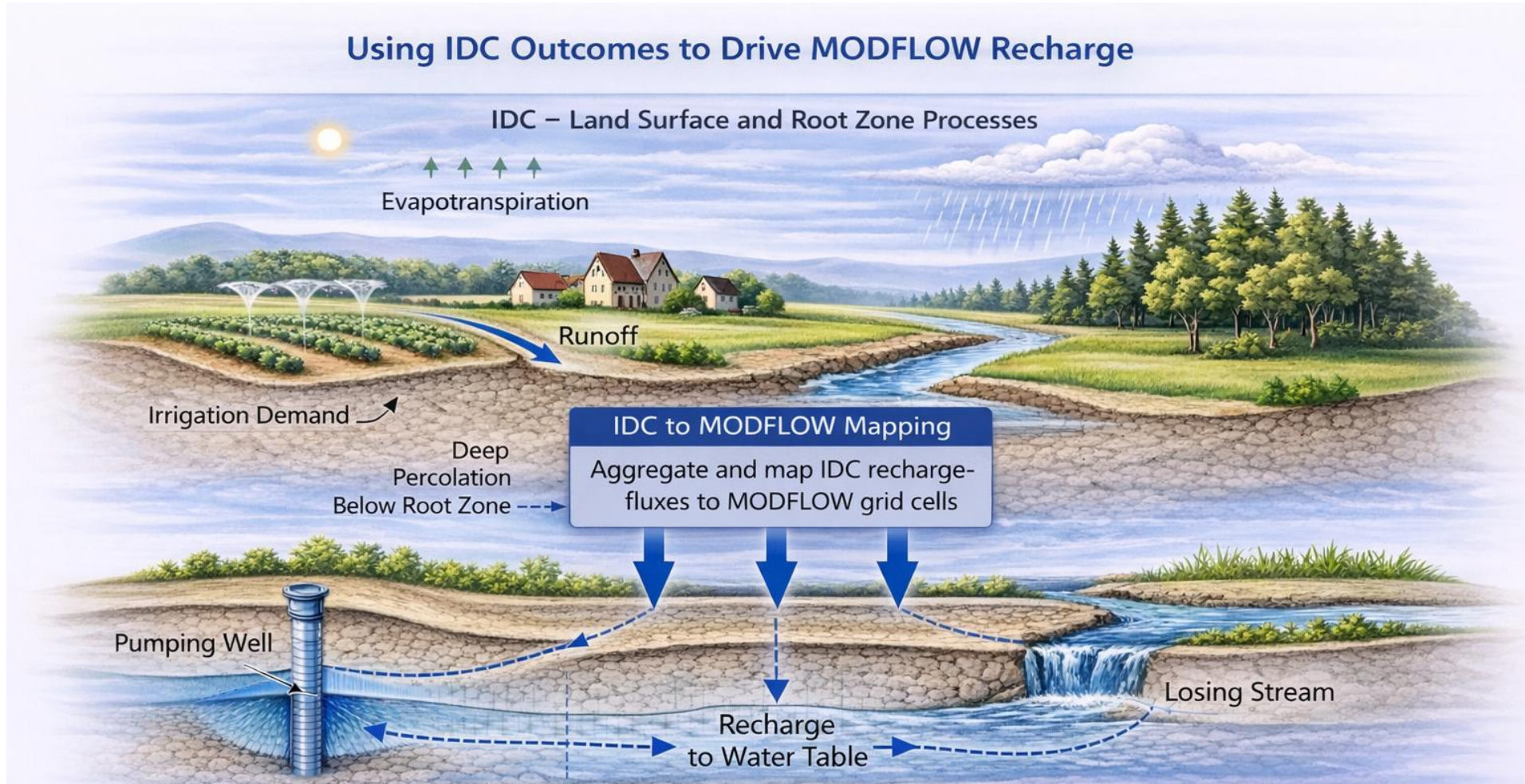
Why Link MODFLOW with IDC?

► What IDC provides

- Land-surface simulation
- Per-element water budgets
- Land use & operations

► What MODFLOW provides

- Industry-standard model for groundwater flow simulation.



MF-IDC Requirements

Python 3.10+

Package dependencies

SCIENTIFIC

- numpy
- pandas
- matplotlib

GEOSPATIAL

- geopandas
- shapely
- fiona
- rtree
- pyproj

HDF5 / MODELING

- h5py
- flopy

Executables

Required binaries

IDC

- IDC_x64.exe
- ZBudget_x64.exe

MODFLOW 6

- mf6.exe

IDC Files

Required files

GRID GEOMETRY

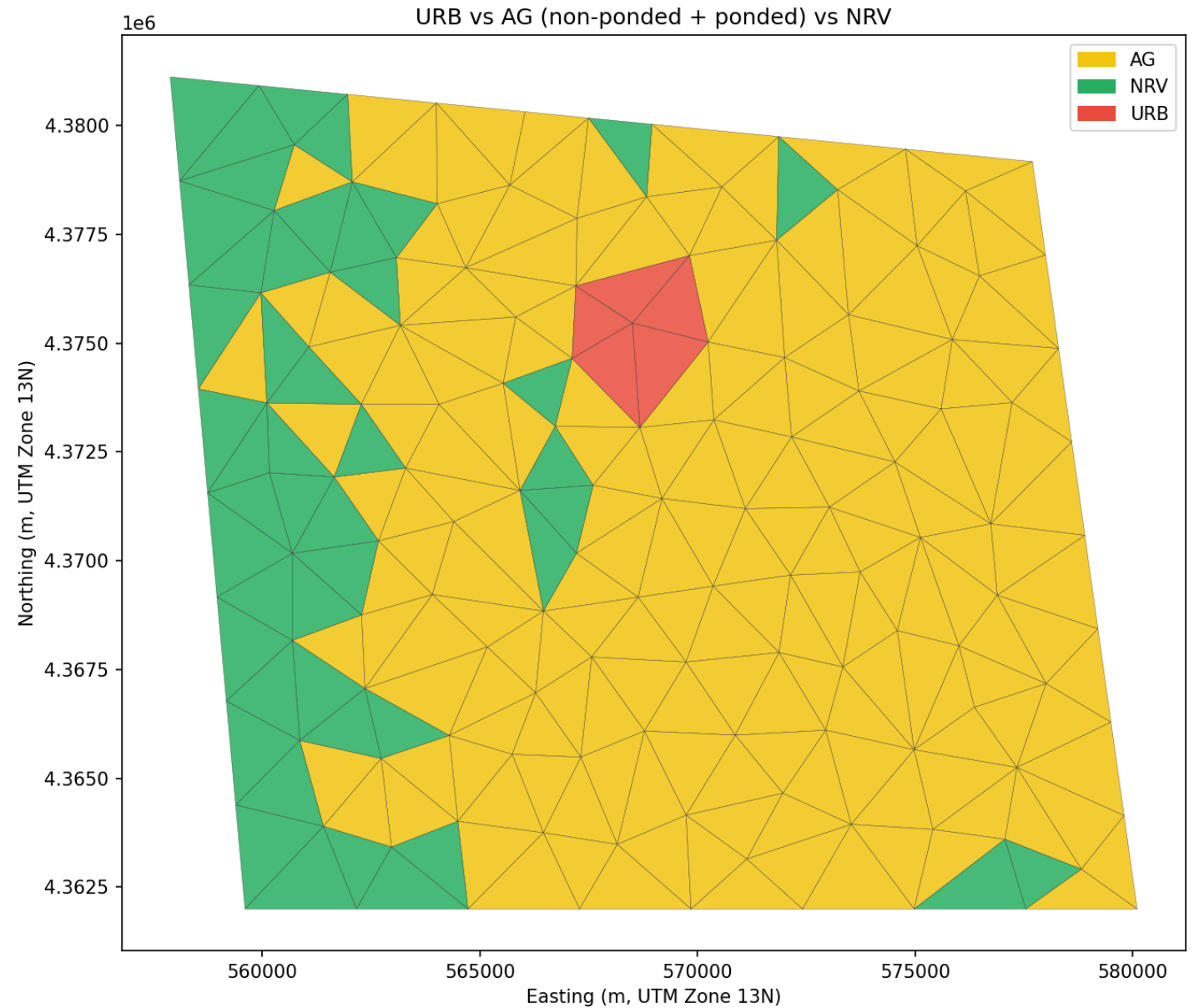
- Grid/Element.dat
- Grid/NodeXY.dat

PERCOLATION

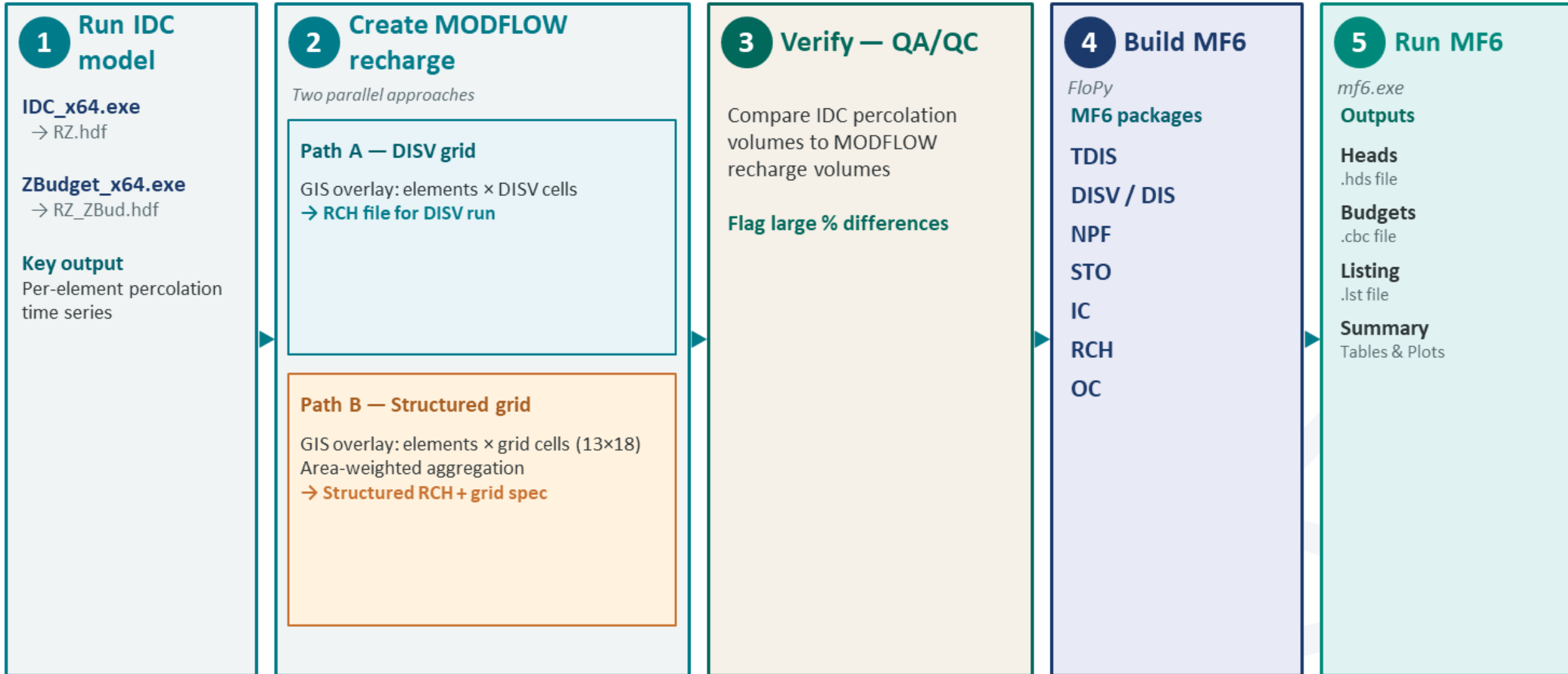
- ZBudget/RZ_ZBud.hdf

IDC Example

- 223 land-surface elements, 90k acres, 3 subregions.
- Simulates surface/root-zone fluxes; percolation goes to the coupling → **MODFLOW RCH**



MF-IDC Workflow



DISV Approach: 1:1MF-IDC Grid

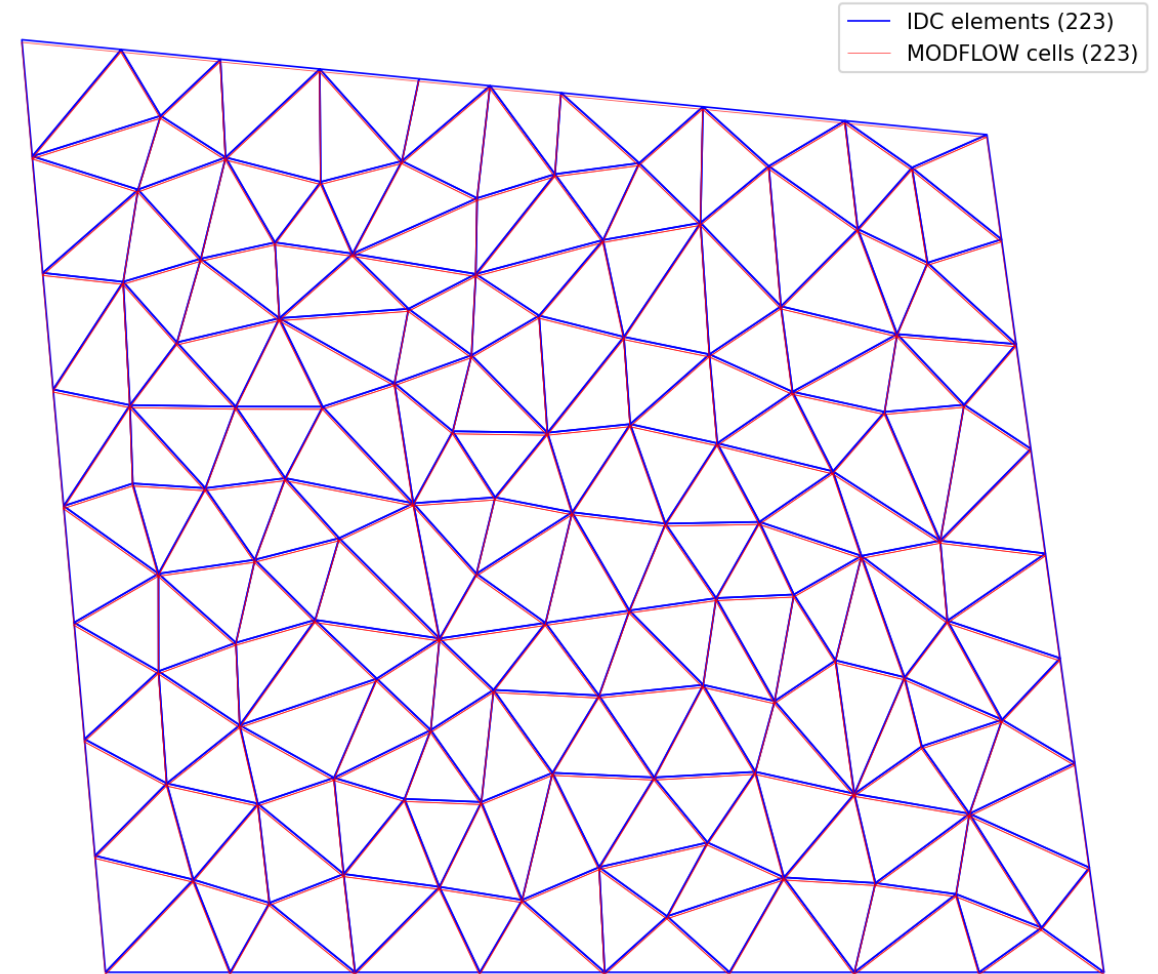
- **Grid design**

- MODFLOW 6 DISV grid
- One MODFLOW cell per IDC element (223 cells)

- **Distribution of IDC percolation**

- 1:1 element-to-cell mapping
- Per-element RCH rate written directly to the MODFLOW RCH package

IDC and MODFLOW grids – matching (1:1)



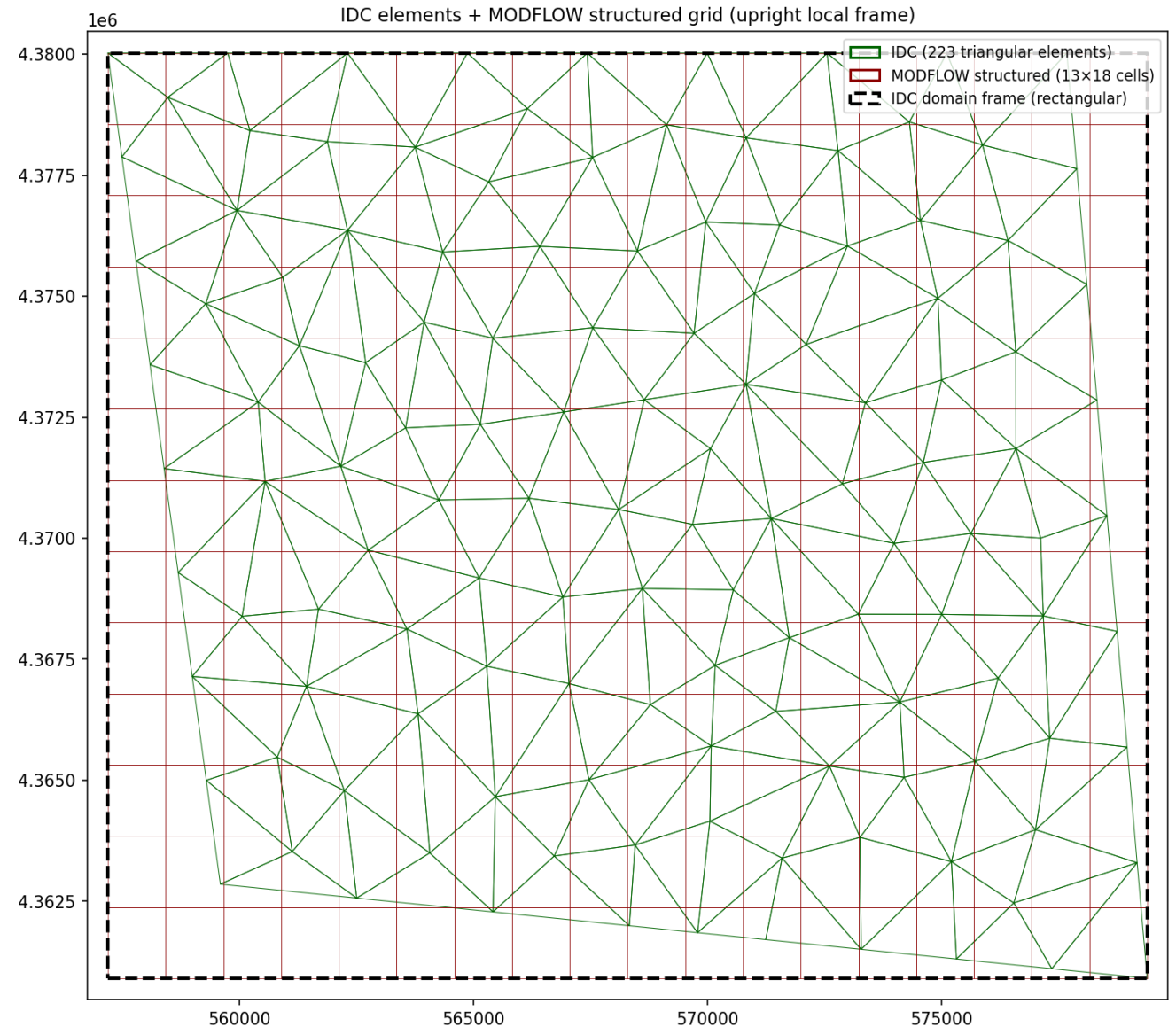
Structured Approach: Rectangular MODFLOW Grid

► Grid design

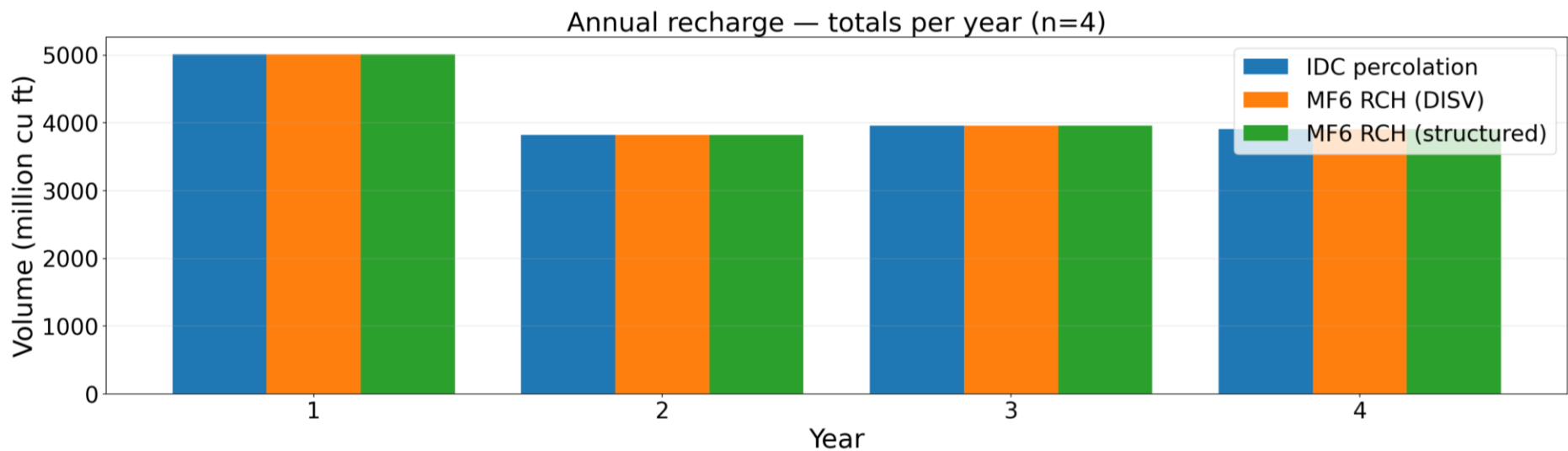
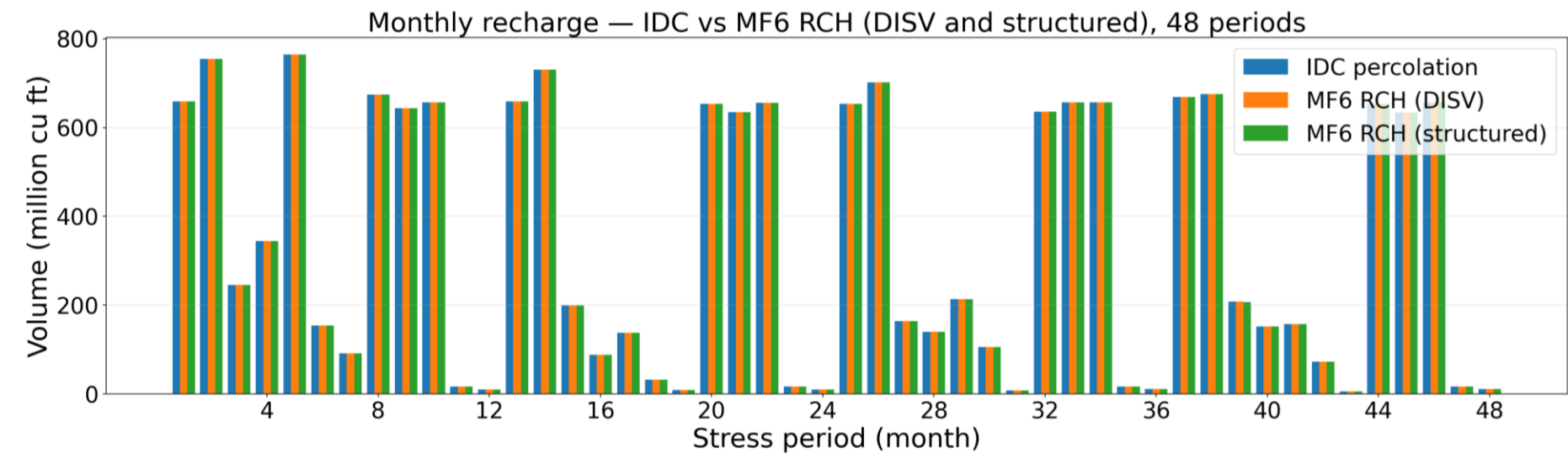
- Standard MODFLOW 6 DIS grid (e.g., 13×18 rows/columns, 3 layers).

► Distribution of IDC percolation

- Overlay IDC element polygons with structured cells
- For each structured cell, compute overlap fractions with IDC elements



Per-Period Volume: IDC Percolation vs MODFLOW 6 RCH (DISV and Structured)



Global recharge totals (IDC vs MODFLOW)

4-year simulation | 1,461 days | 89,872 acres

IDC percolation 383.7 TAF 383,723.6 AF Baseline · RZ_ZBud.hdf	DISV MF6 RCH 383.7 TAF 383,723.6 AF Discrepancy: 0.003 AF	Structured MF6 RCH 383.7 TAF 383,714.6 AF Discrepancy: 9.0 AF
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Mass balance check

● DISV vs IDC	0.003 AF
● Structured vs IDC	9.0 AF

Average recharge rate

Annual	1.06 ft/year	(DISV run)
Annual	1.07 ft/year	(Structured run)

Approach comparison

Path A — DISV	Path B — Structured
● 1:1 with IDC elements ● Element-by-element RCH ● Fine-scale spatial patterns ● Discrepancy: 0.003 AF	● 13×18 rectangular grid ● Area-weighted RCH ● Smoothed regional field ● Discrepancy: 9.0 AF (0.002%)

Looking ahead – Phase 2 (future work)

- ▶ **Goal** : A coupled tool where both MF and IDC are dynamically linked and exchange information at every time step
 - IDC + MODFLOW run in the same time loop
 - Two-way feedback:
 - Heads from MODFLOW update IDC
 - Percolation from IDC updates MODFLOW

Thank you

Questions/Comments?

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