Measuring river flows from space: when will we no longer need streamgages?

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Chad McKenna, Jonathan Tanis, Brennan Davis (GeoSystems Analysis)

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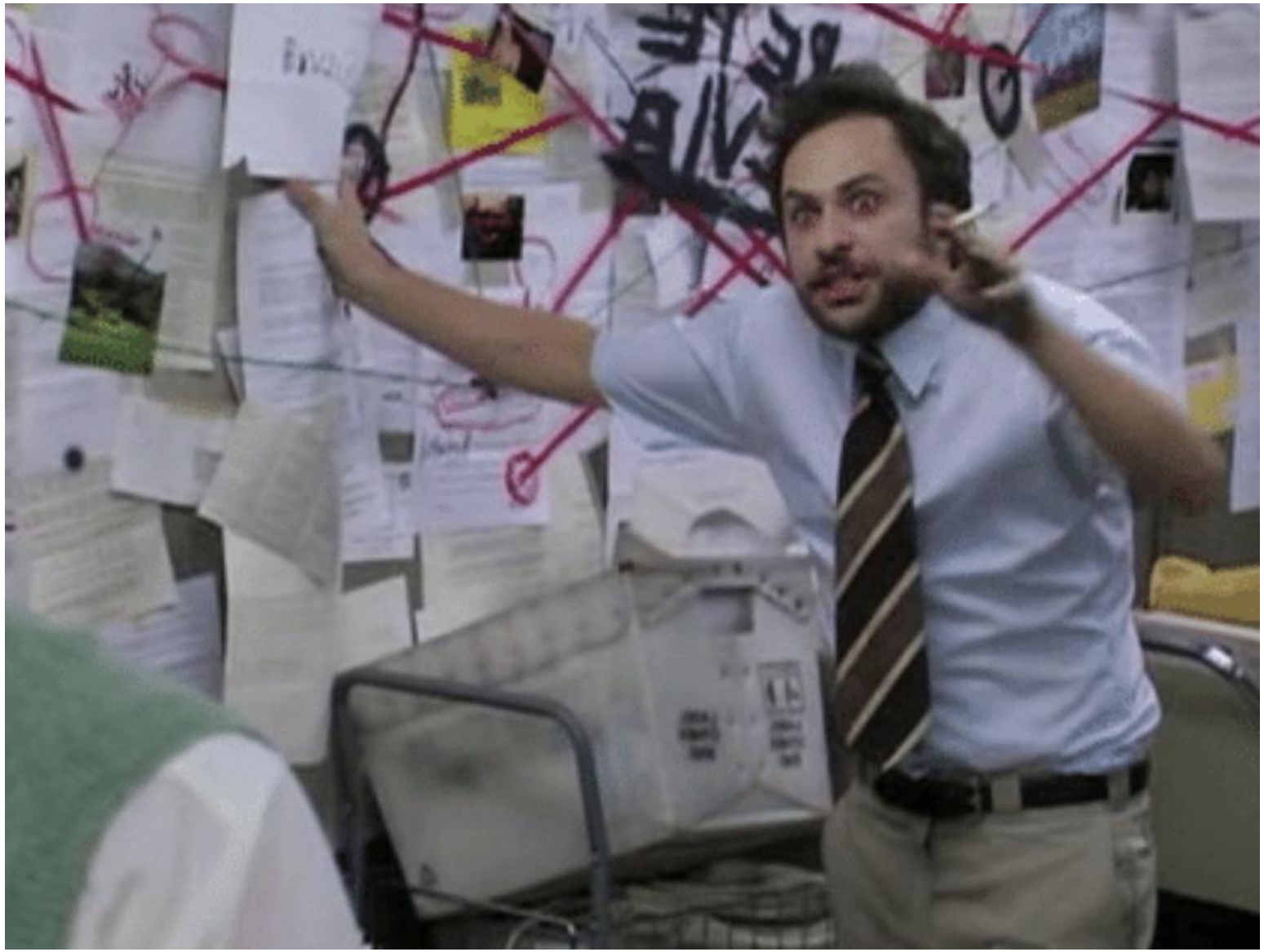
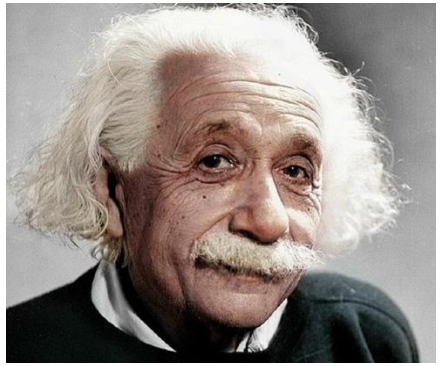
Hazen

Connecting the Dots!



Connecting the ~~Dots~~! Drops

Connectivity is super important!



- State & Federal Agencies
- River Authorities
- Municipalities
- Tribes
- Irrigation Districts
- Compact Commissioners
- Industry
- Universities
- Consultants
- Public and other Stakeholders…

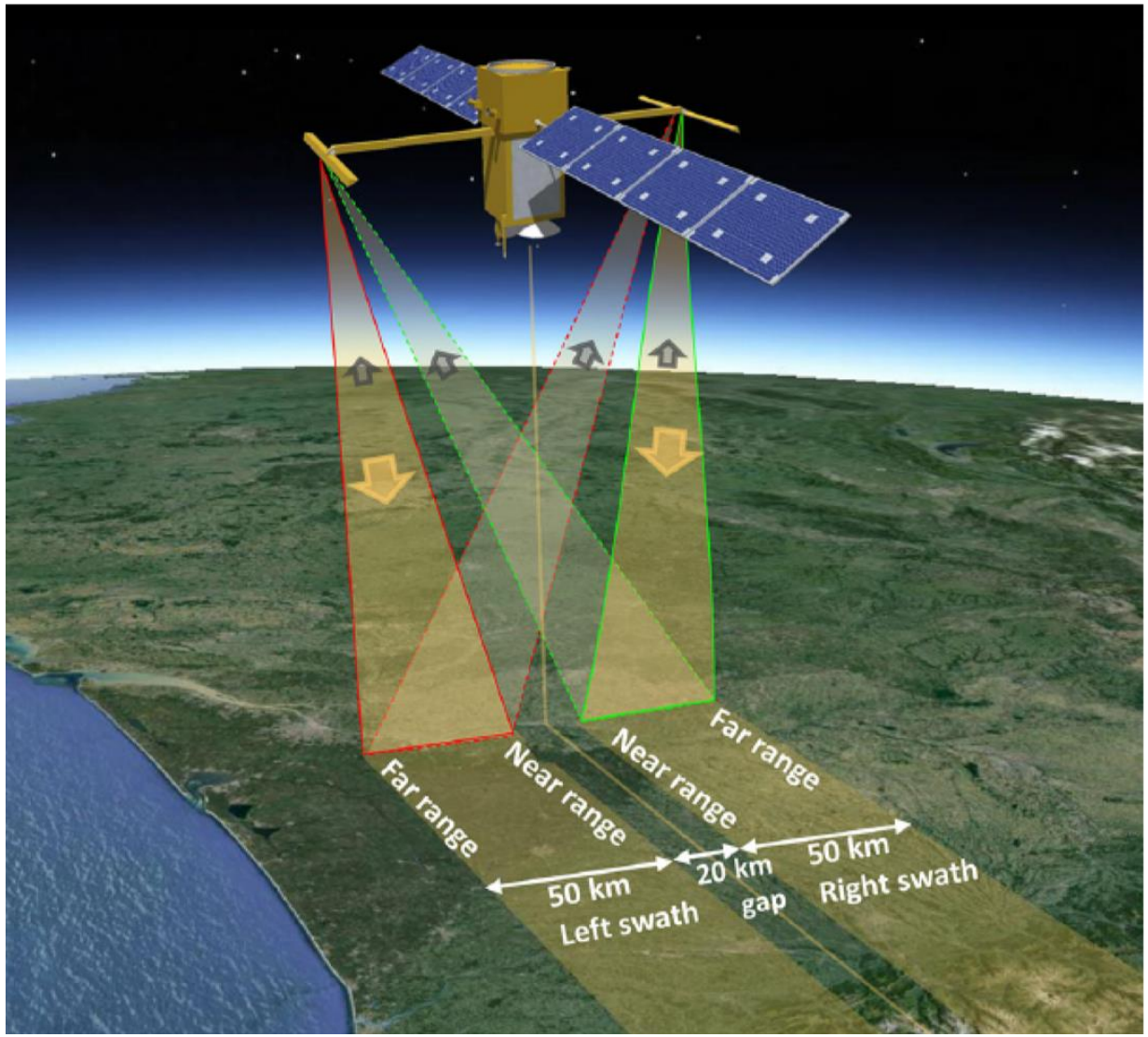
Project Purpose

Determine if SWOT estimates of water surface elevation in large rivers can be used to derive flows with a degree of accuracy sufficient to estimate Groundwater – Surface Water interaction in large rivers.

The Surface Water and Ocean Topography Mission

The SWOT satellite uses **radar interferometry** technology to provide "**spatially continuous**" observations of water surface extent, elevation, and slope:

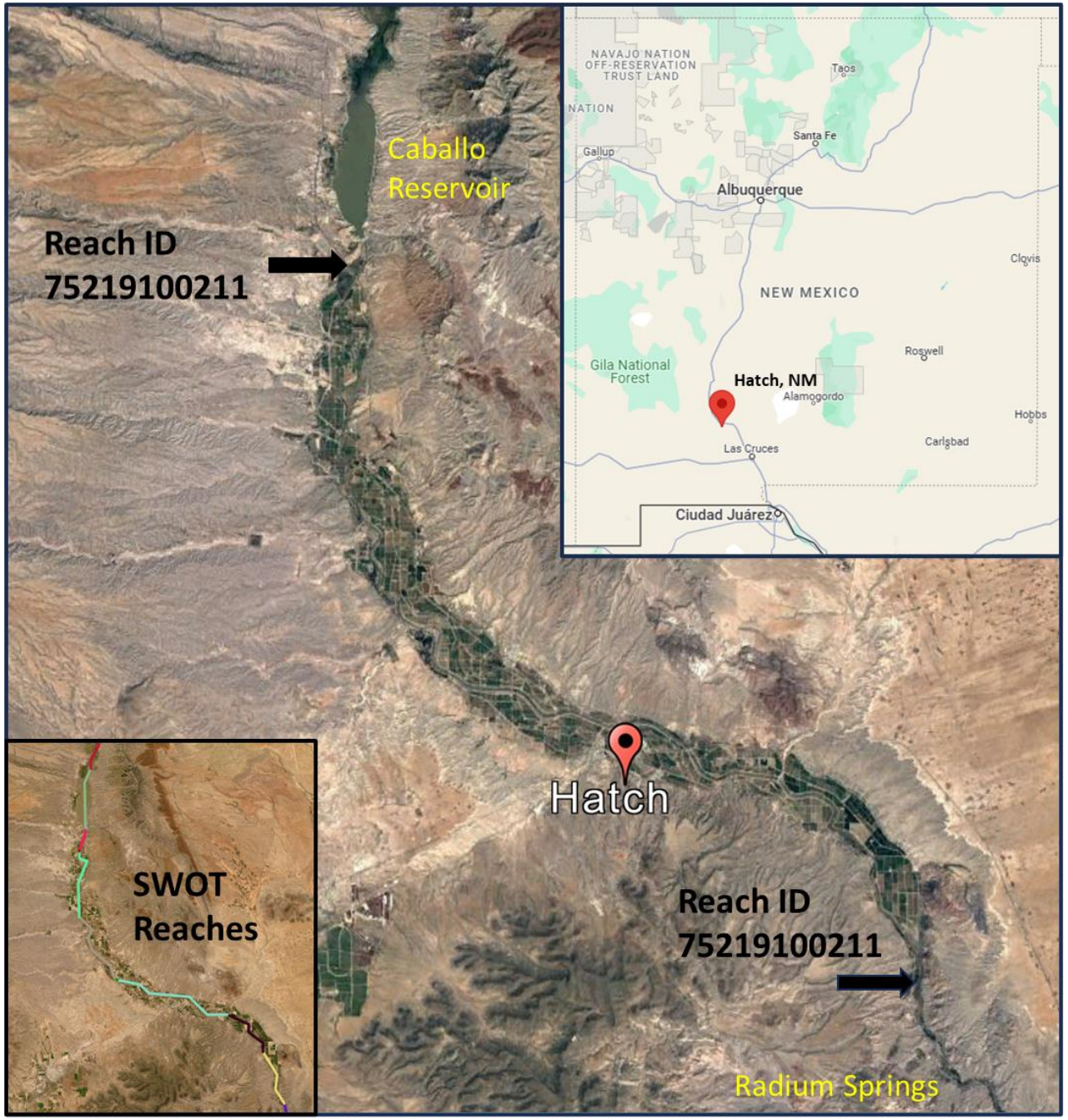
- Launched Dec. 16, 2022
- Observations every 10 days, on average
- Covers 78°N to 78°S
- Data latency goal of <3 days
- 3.5 years nominal mission lifetime
- Partnership between NASA, CNES (France), Canadian Space Agency, and UK Space Agency



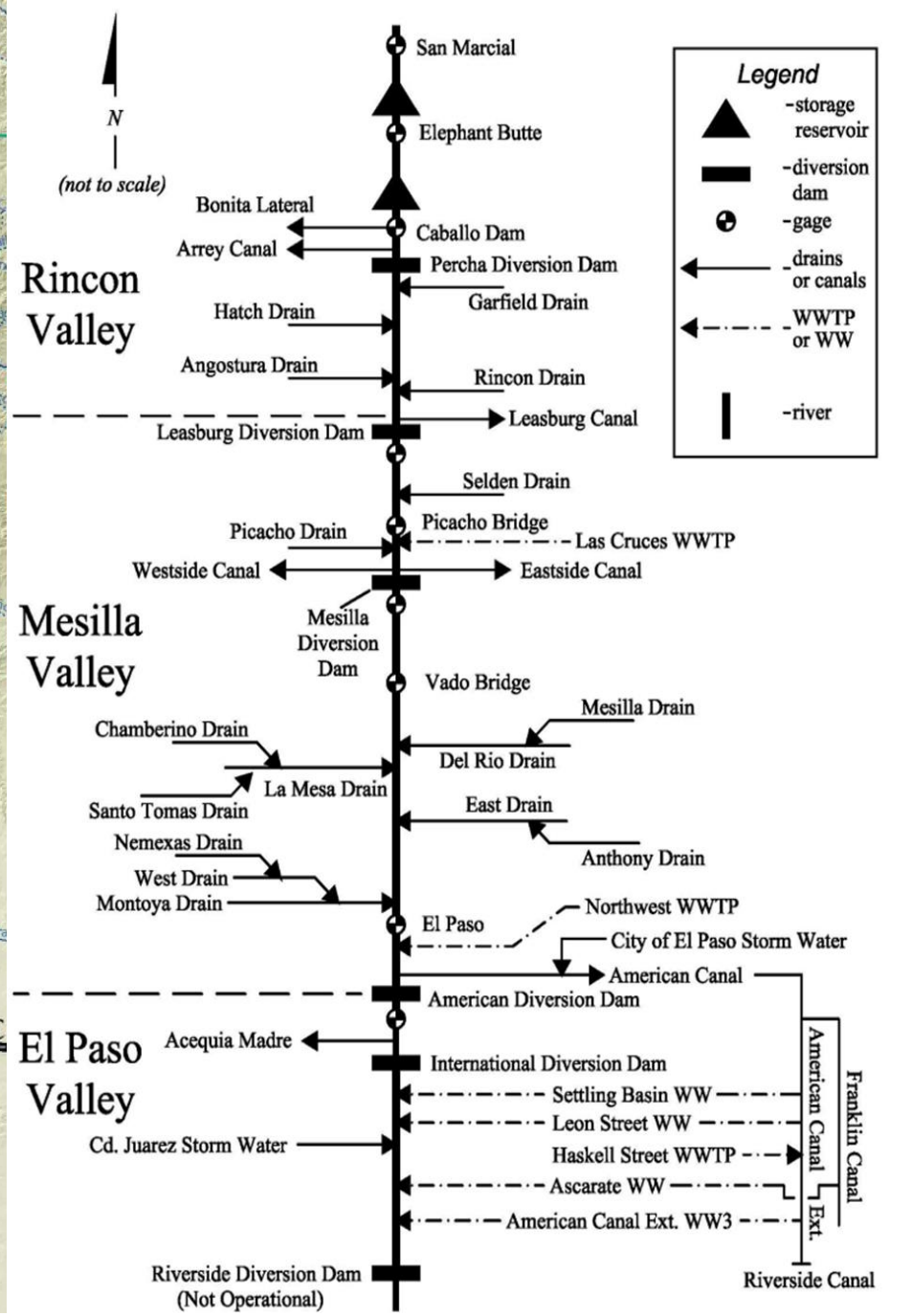
Biancamaria, Lettenmaier, and Pavelsky, *SoG*, 2016

Project Location

Determine if SWOT estimates of water surface elevation in large rivers can be used to derive flows with a degree of accuracy sufficient to estimate Groundwater – Surface Water interaction in large rivers.



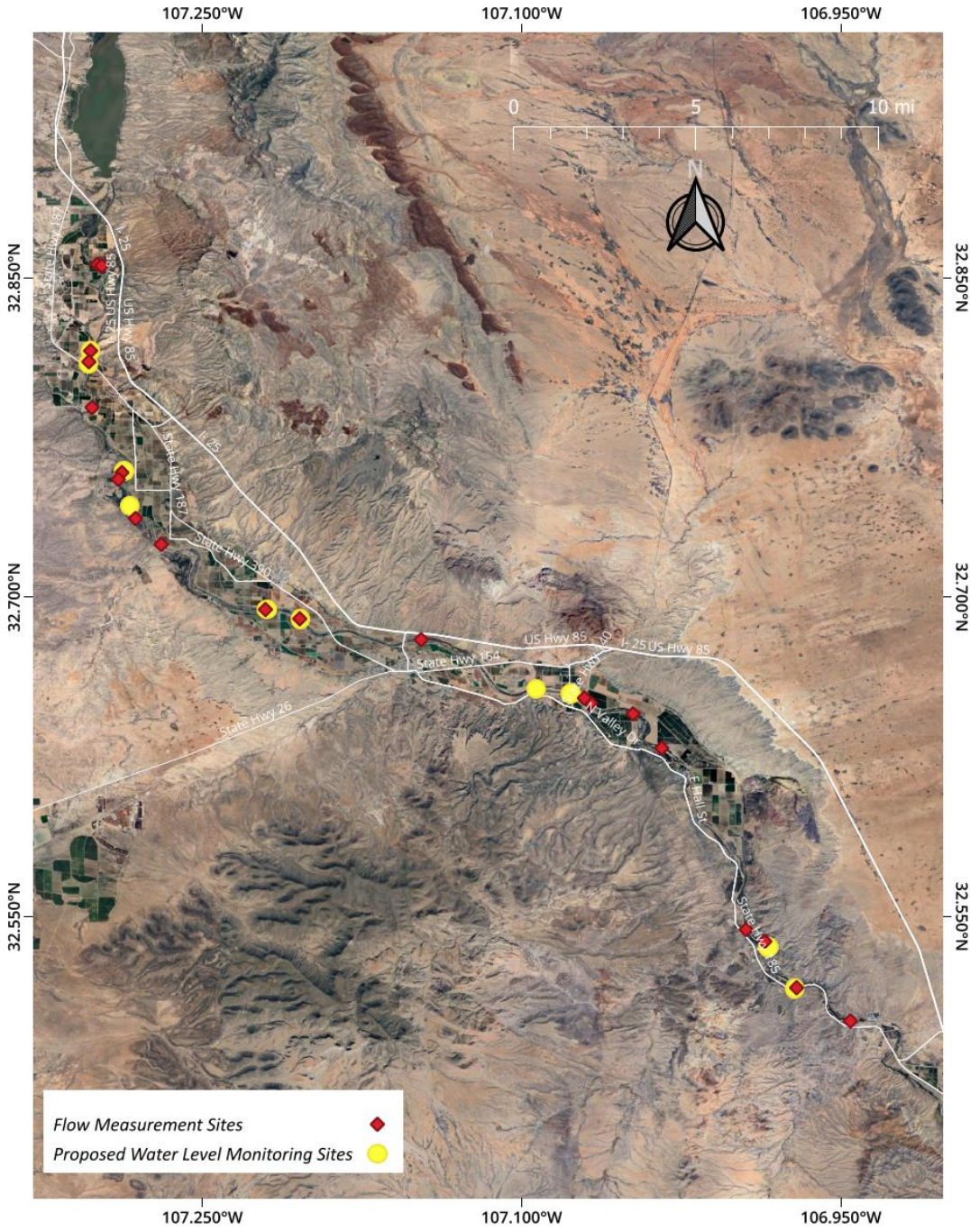
Flow is close to zero outside of the irrigation season



Instrumentation

Water surface elevation and flow measurements throughout the reach!

- Pressure transducer (water elevation)
- ADCP (flow)



Spot Water Surface Elevation Measurements

Pressure Transducers

Flow measurements

Flow measurements

Field data collection

Water surface elevation and flow measurements throughout the reach for SWOT.

For GW-SW interaction:

- *Reservoir releases (Caballo res.)*
- *SW diversions (irrigation)*
- *Groundwater pumping (irrigation)*
- *Return flows*

EBID monitoring

More data! 539 GB…

- AMERICAN
- HUDSPETH
- LEASBURG
- MESILLA
- PERCHA
- RESERV
- data_matrix.xls
- Metadata.doc

→

- CANAL
- DRAIN
- RIVER

→

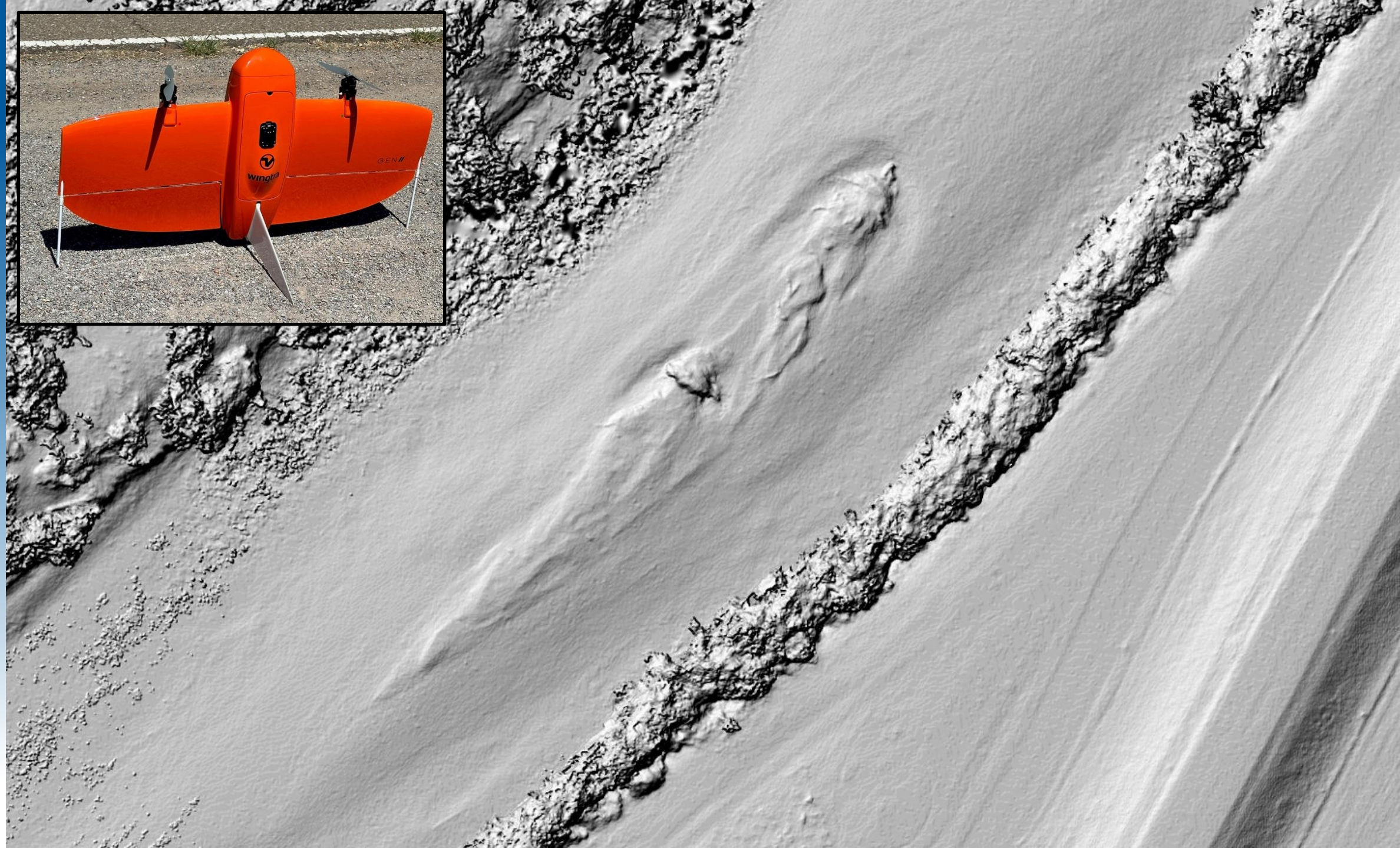
- RioGrandeAtAnthonyBridge.xls
- RioGrandeAtCanutilloBridge.xls
- RioGrandeAtElPaso.xls
- RioGrandeAtVadoBridge.xls
- RioGrandeAtVintonBridge.xls
- RioGrandeBelowMesillaDivDam.xls

→

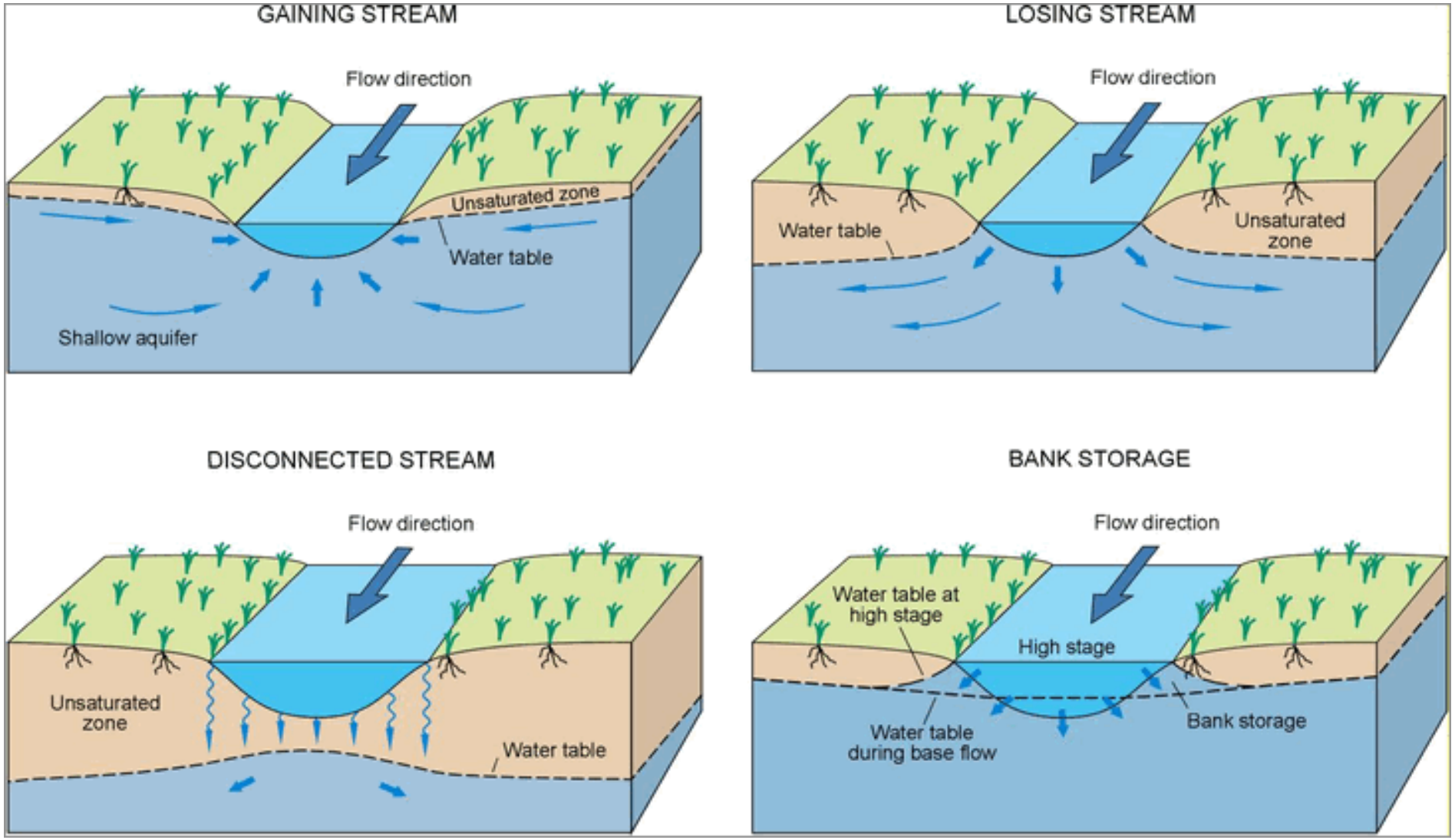
Day	Month	Year	Date	NMSU Data (cfs)
1	1	1985	1/1/1985	133
2	1	1985	1/2/1985	110
3	1	1985	1/3/1985	98
4	1	1985	1/4/1985	92
5	1	1985	1/5/1985	92
6	1	1985	1/6/1985	90
7	1	1985	1/7/1985	86
8	1	1985	1/8/1985	84
9	1	1985	1/9/1985	86
10	1	1985	1/10/1985	82
11	1	1985	1/11/1985	75
12	1	1985	1/12/1985	72
13	1	1985	1/13/1985	81
14	1	1985	1/14/1985	82
15	1	1985	1/15/1985	102
16	1	1985	1/16/1985	96
17	1	1985	1/17/1985	88
18	1	1985	1/18/1985	86
19	1	1985	1/19/1985	82
20	1	1985	1/20/1985	77
21	1	1985	1/21/1985	70
22	1	1985	1/22/1985	79
23	1	1985	1/23/1985	74
24	1	1985	1/24/1985	75
25	1	1985	1/25/1985	70
26	1	1985	1/26/1985	75
27	1	1985	1/27/1985	77
28	1	1985	1/28/1985	81
29	1	1985	1/29/1985	104
30	1	1985	1/30/1985	115
31	1	1985	1/31/1985	113
1	2	1985	2/1/1985	88
2	2	1985	2/2/1985	74

Dr. Phil King (EBID hydrologist)

• Digital Elevation Model (Drone)



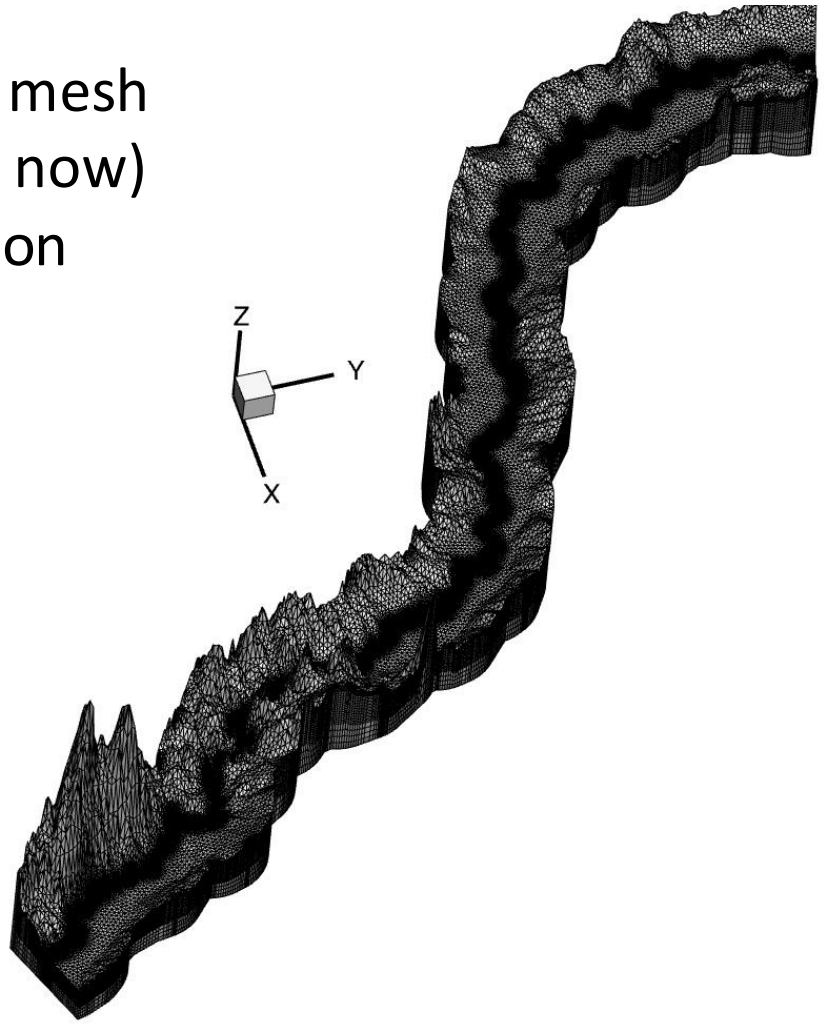
Quantifying GW-SW Interaction

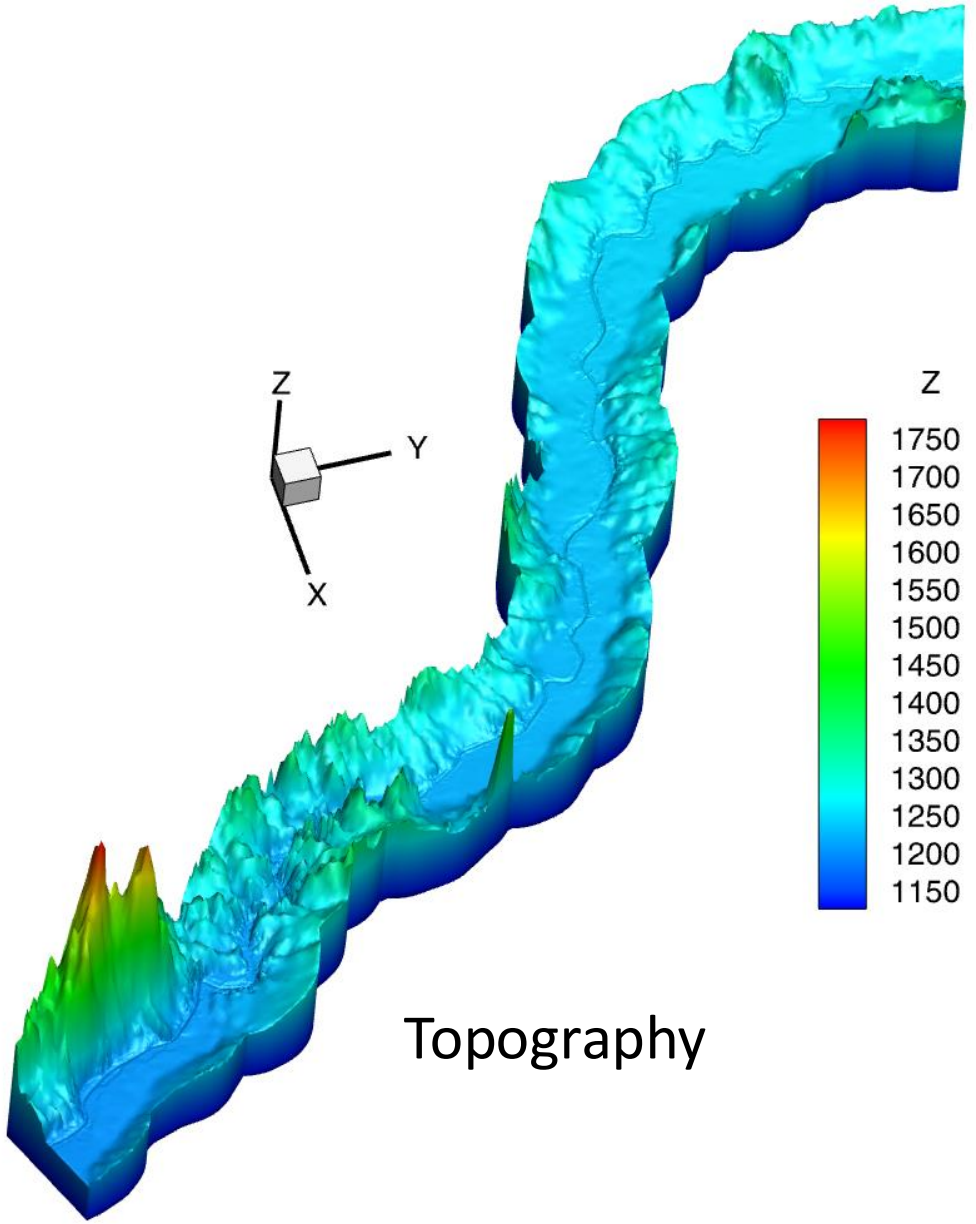


Theiss method

HydroGeoSphere Model

3D unstructured mesh
Static model (for now)
GW-SW interaction





Topography

Project Partners

Texas Water Development Board (Chair)
World Wildlife Fund
North American Development Bank
International Boundary Water Commission
Elephant Butte Irrigation District
Sustainable Waters

North American Development Bank

Can satellites replace in-situ flow measurements?

$35k+ install
$30k+ /yr O&M

- In some instances, we think so.
- It will be a long time before all streamgages are replaced
  - Latency and temporal resolution remain issues
  - Minimum channel width also an issue
  - Flood forecasting is a challenge!
- Local observations (channel geometry, roughness, etc) will improve the SWOT estimates

Hazen

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