McDonald Geodetic Observatory

Students:

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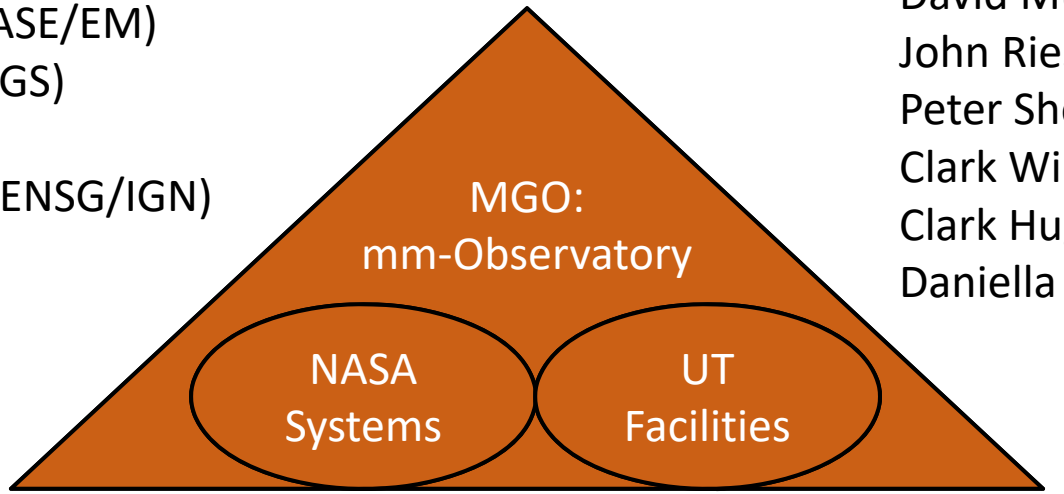

Staff:

Bettadpur (UTCSR)
David Munton (UT:ARL)
John Ries (UTCSR)
Peter Shelus (UTCSR)
Clark Wilson (UT-JSG)
Clark Hughes (UT:ARL)
Daniella Rempe (UT-JSG)

IGETS Potsdam Jun 18-20 2018

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Partners in MGO

- The University of Texas at Austin:
  - Site preparation and infrastructure – complete Fall 2018
  - Superconducting gravimeter and other experiments
- NASA Space Geodesy Project (NASA/SGP):
  - New space geodetic systems;
  - Funds staff to install/operate GNSS, VLBI & SLR.
- McDonald Observatory: Hosts for the new systems
  - A facility of UT-Astronomy/College of Natural Sciences
  - History of space geodesy starting with LLR
  - Long-envisioned as a fundamental site…
- Schedule
  - Infrastructure in place by late 2018
  - Superconducting Gravimeter installed when infrastructure complete
  - GNSS receivers (5 multi-constellation) 2018-2019
  - VLBI operational in 2019
  - SGSLR operational in 2020

MGO at McDonald Observatory

McDonald Observatory, Texas – Stable location representing the motion of the North American Plate.

Astronomy since 1939, Space Geodesy since 1970 (LLR + SLR 1970-85, MLRS 1986-, GPS 1992-) Nearby Ft. Davis geodetic VLBI since 1970's

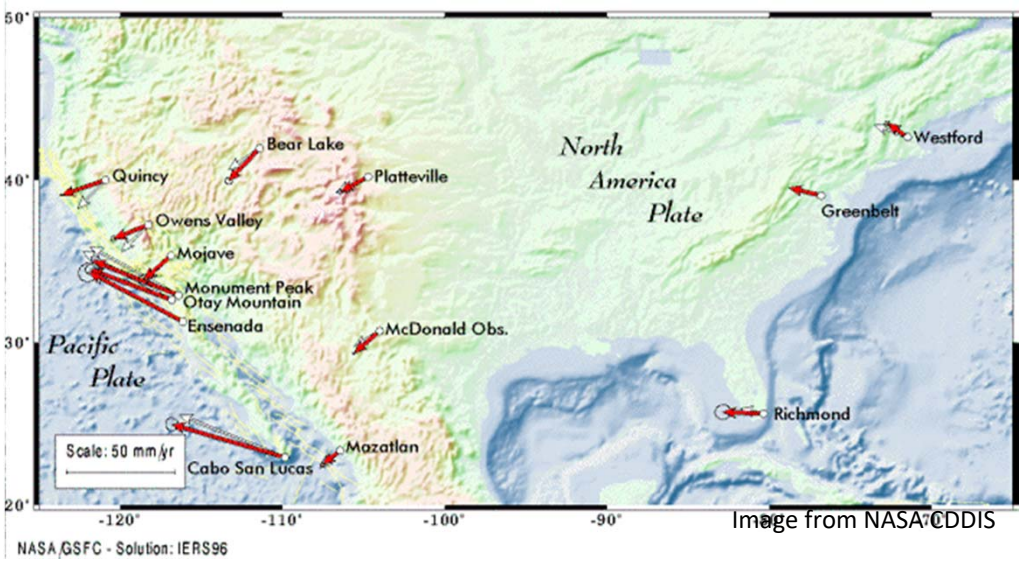
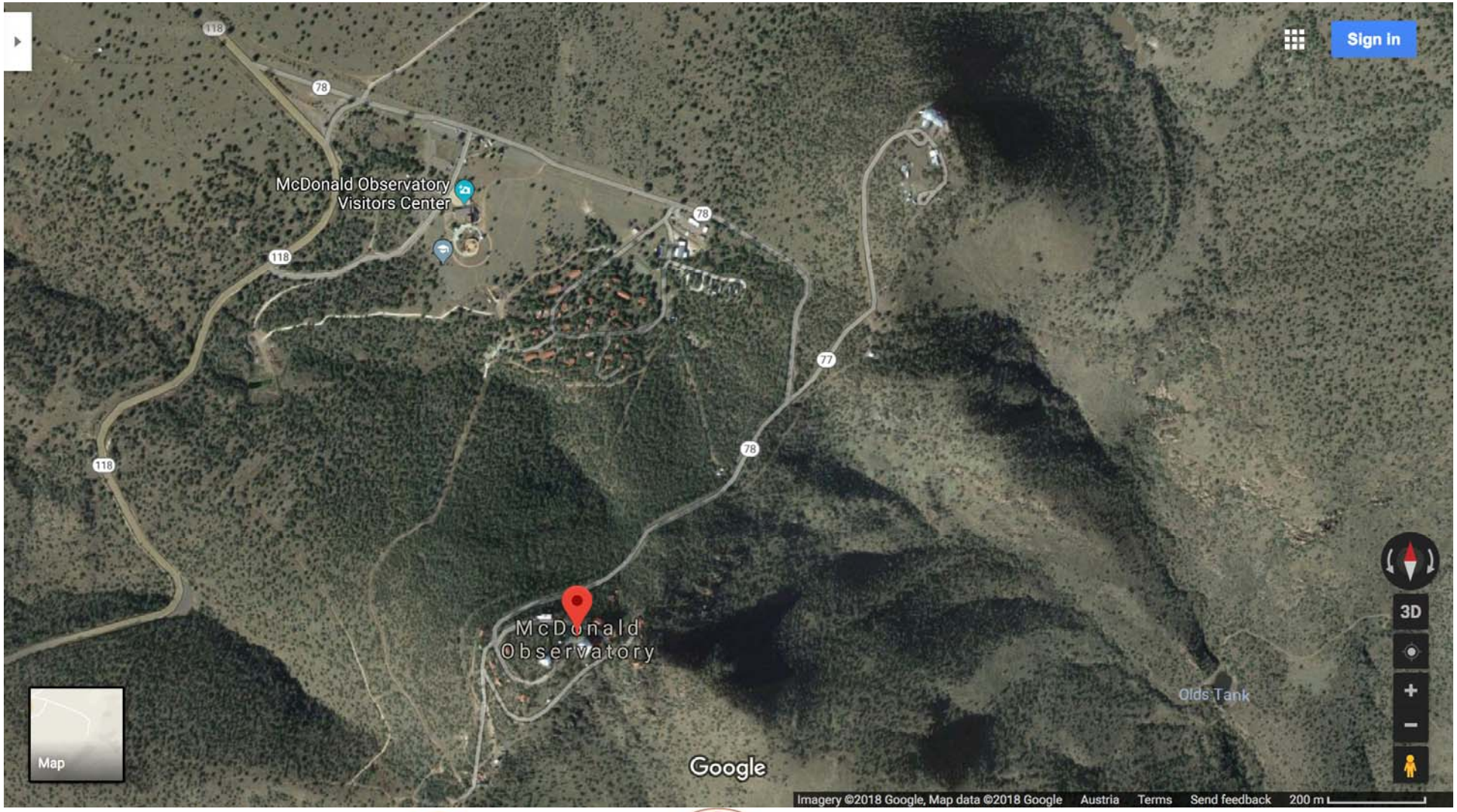


Image from NASA CDDIS

- MGO is a multi-technique geodetic observatory, designed to fulfill Next-Generation Reference Frame Requirements
  - NASA is installing new SLR, VLBI, and GNSS equipment starting Fall 2018.
- MGO planned to be first of several NASA core stations contributing to the Global Geodetic Observation System (GGOS).

McDonald Observatory: ~2000 meters elevation, in the Davis Mountains, arid, sparsely populated



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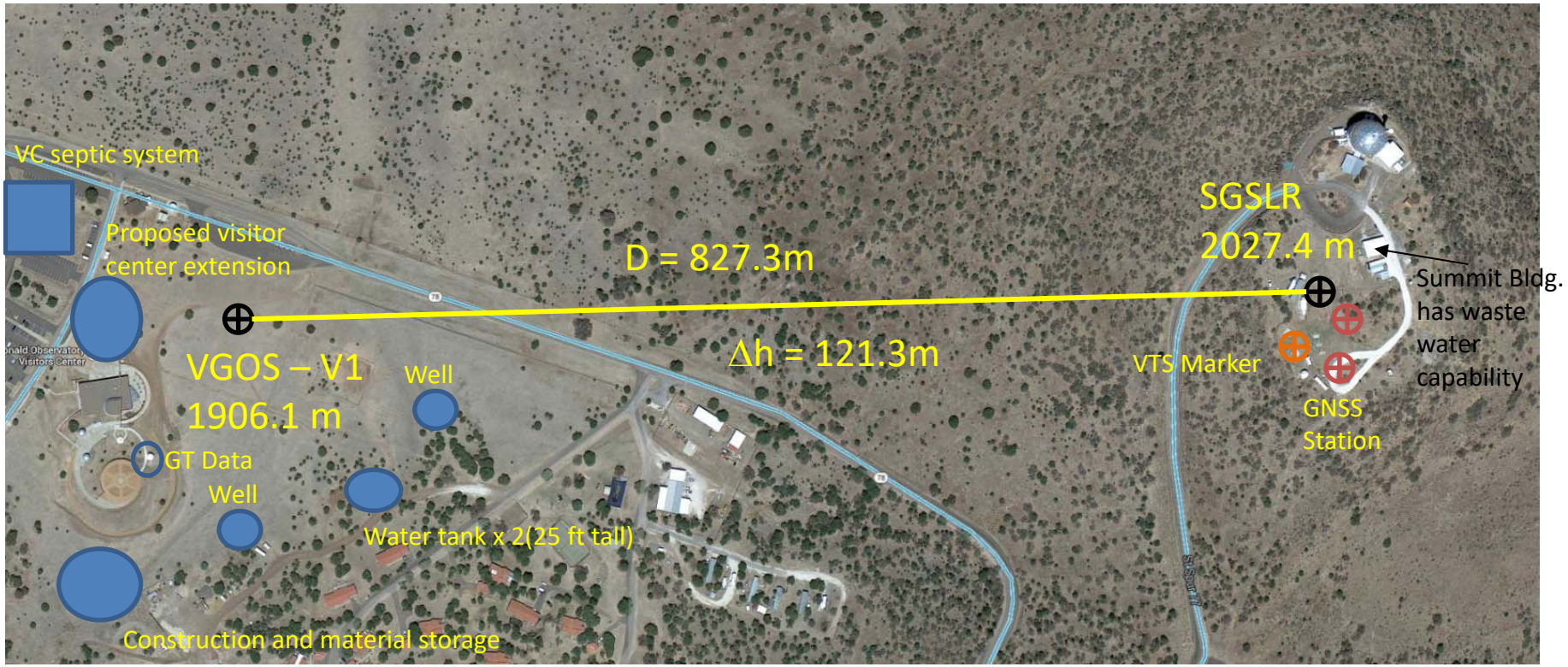
MGO Instrument layout

VLBI (VGOS) separated from SLR (SGSLR) and SG by 827 m horizontally and 121 m vertically – needs connection at mm level



UT Austin Supporting Experiments

- mm-Metrology- connecting MGO instruments at mm level
  - (Bettadpur, UTCSR)
- Superconducting Gravimeter
  - (Wilson, JSG)
- Local hydrologic variations
  - (Rempe, UT-JSG)
- Regional (≈ 40 km) hydrology
  - (Caldwell, UT-JSG)
- Celestial Sources through GNSS antenna
  - (Munton & York, UT:ARL)
- Deflection of the Vertical Camera
  - (Hughes, UT:ARL)

1a mm-Metrology at MGO

- Principal Investigator: Bettadpur (UTCSR)
- Purpose: mm-Level ties between sites separated by ≈1-km horizontal and 120-m vertical separation, using both laser metrology and GPS
- Funding: NASA/ROSES-SGR
- Status @ April 9, 2018
  - Sub-mm horizontal and 2/3 mm vertical precision achieved over the baseline.
  - Metrology carried out separately with two Leica TS-30 (one from NGA)+ GPS
  - exploring methods for removing tropospheric error.
  - Accuracy-limiting factors identified, and algorithmic improvements being researched.

Graduate student Jullian Rivera (CSR)

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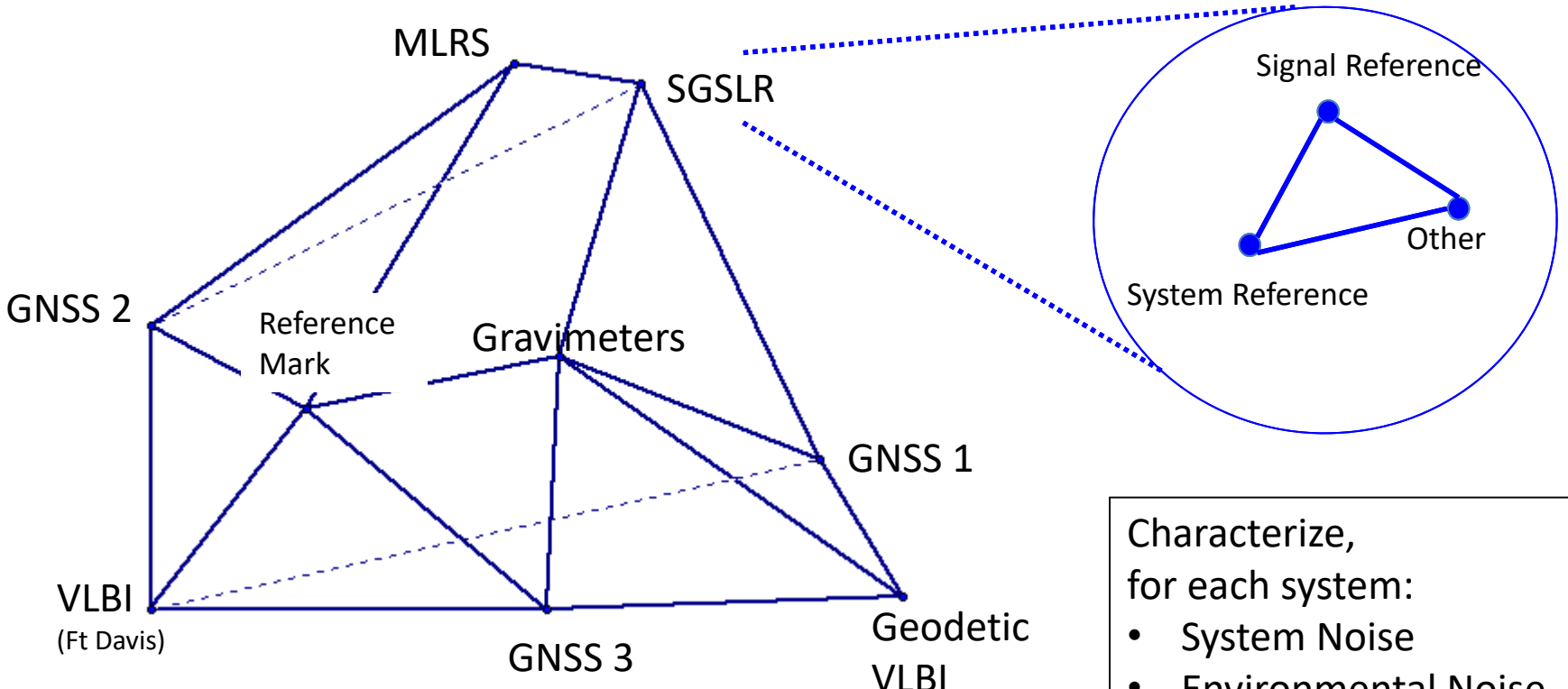
1.b Millimeter Level Site Ties



Characterize,
for each system:

- System Noise
- Environmental Noise
- Analysis Noise

Time-variable Polygon:

- Measurement
- Characterization
- Application

Define & monitor a dynamic polygon framework

2.a Superconducting Gravimeter

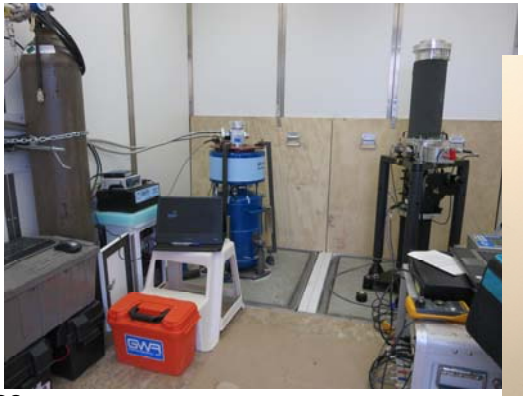
- Principal Investigator:

  Clark Wilson, UT Jackson School of Geosciences

- Status
  - Gravimeter hut installed on geodetic quality concrete pad.
  - Temporary Power
  - SG Installation upon completion of permanent internet and power Fall 2018

2.b Superconducting Gravimeter

- GWR SG047- (right) contained in a single cabinet. Operating in Austin Texas since 2013 rebuild at GWR.
- Interior photo (left) from a previous deployment of gravity building showing two piers: For SG and supporting absolute gravity measurements.
- NGA (David Wheeler) plans annual absolute measurements starting October 2018



3.a Water storage in soil and bedrock

Trees rooted directly into rock at MGO suggest water storage could extend beyond soils, into fractured bedrock.

OBJECTIVE:

Improve understanding of deep, bedrock water storage ("rock moisture") by using experimental and conventional tools to intensively monitor dynamic subsurface water storage.

Help predict loading and gravity variations due to water cycle.

METHODS:

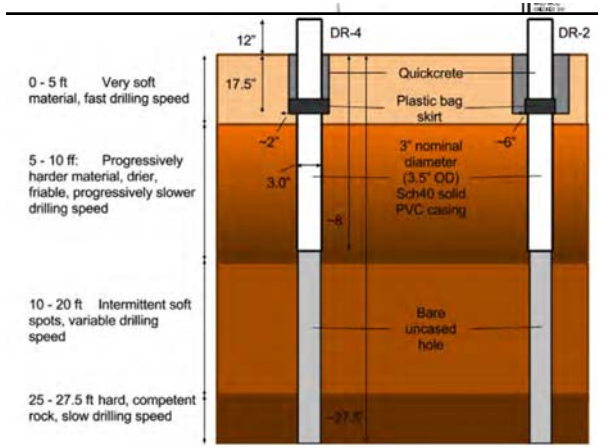
- Shallow (<30 cm) soil moisture monitoring via Time-Domain Reflectometry (TDR)
- Deep borehole logging (neutron, gamma, nuclear magnetic resonance)
- Surface electrical resistivity tomography and ground penetrating radar to quantify subsurface storage.

3.b – Water storage in soil and bedrock

- Status
  - Two holes drilled in vegetated area near gravity hut by UNAVCO
  - Surveyed during storm using borehole nuclear magnetic resonance (BNMR) to evaluate water storage
  - Preliminary survey data following a storm indicate high water storage capacity in upper 2 m, with little to no water stored in fractures.
- Future
  - Logging with BNMR, neutron and gamma log to capture successive changes in water storage
  - Hand drilling and auguring holes in vegetated areas away from infrastructure for borehole logging later this Spring.

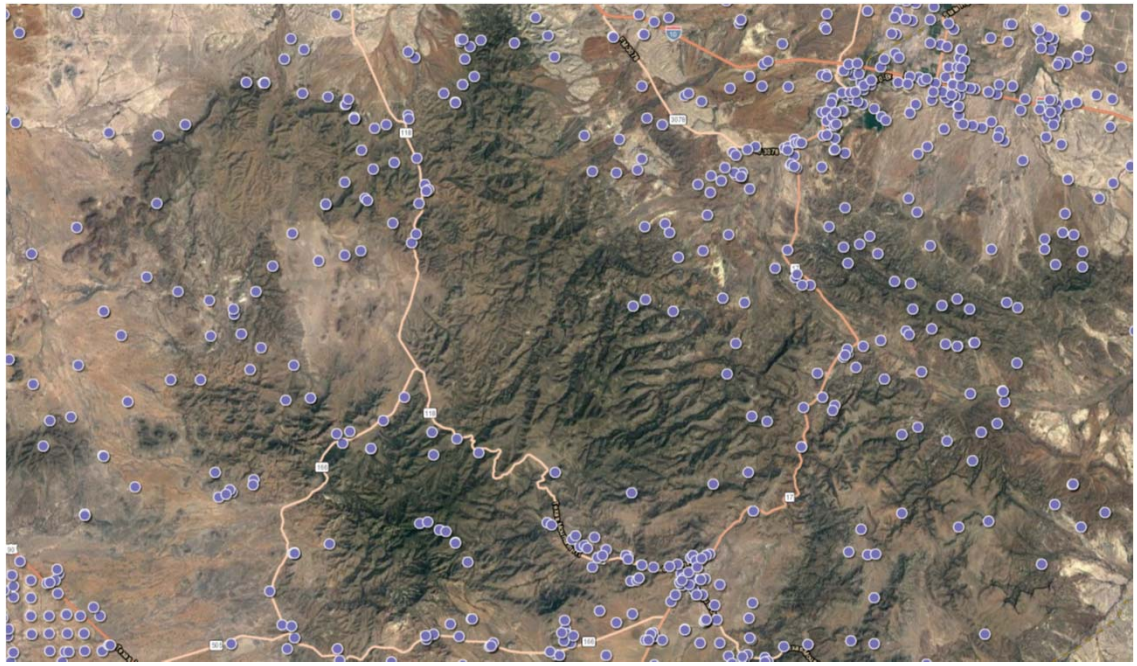
Graduate student Logan Schmidt

Two monitoring boreholes drilled by UNAVCO



4 – Regional Water Cycle Characterization

Candidate well locations in Davis Mountains



Todd Caldwell (UT-JSG) NSF-funded study on ephemeral recharge in trans-Pecos spring complex; part of larger project on regional groundwater flow system

Total water storage estimation

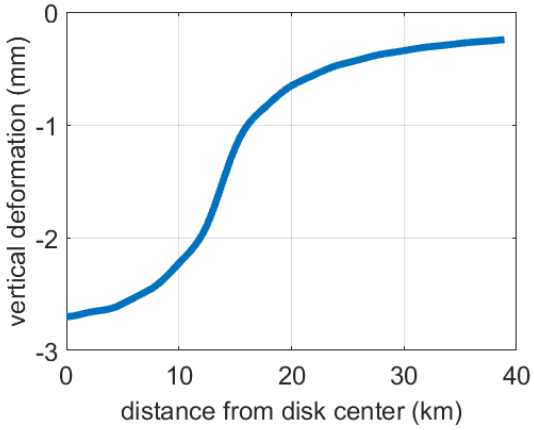
Ground Water: Well level time-series

Soil Moisture: Network of CS655 probes

Surface Water: Precipitation and Stream gauges

Average annual precip: 45 cm

Deformation due to a 1-m thick water disk of 14 km radius



5.a –VLBI with a GNSS Antenna

High Rate Tracking Receiver

- Developed at UT ARL
- Direct-to-Digital Receiver
  - 3 band configurations
    - 0.1-1 GHz, 1-2 GHz, 2-3 GHz
  - 1 GHz instantaneous direct sample bandwidth
  - Minimal analog front-end to minimize biases

Experiment (NASA/ROSES-STMD):

- 16 km baseline established
- ~5m dish and GNSS choke ring
- Data collected daily
- Testing processing algorithms

16 km baseline

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6: Deflection of Vertical Camera

- Principal Investigator:
  Clark Hughes, UT Applied Research Laboratory
- Purpose: Development of high-precision Deflection of Vertical cameras.
  - Could support improved realization of the horizontal at the MF and VC sites.
- Funding: NGA (ARL Texas Astro Project)

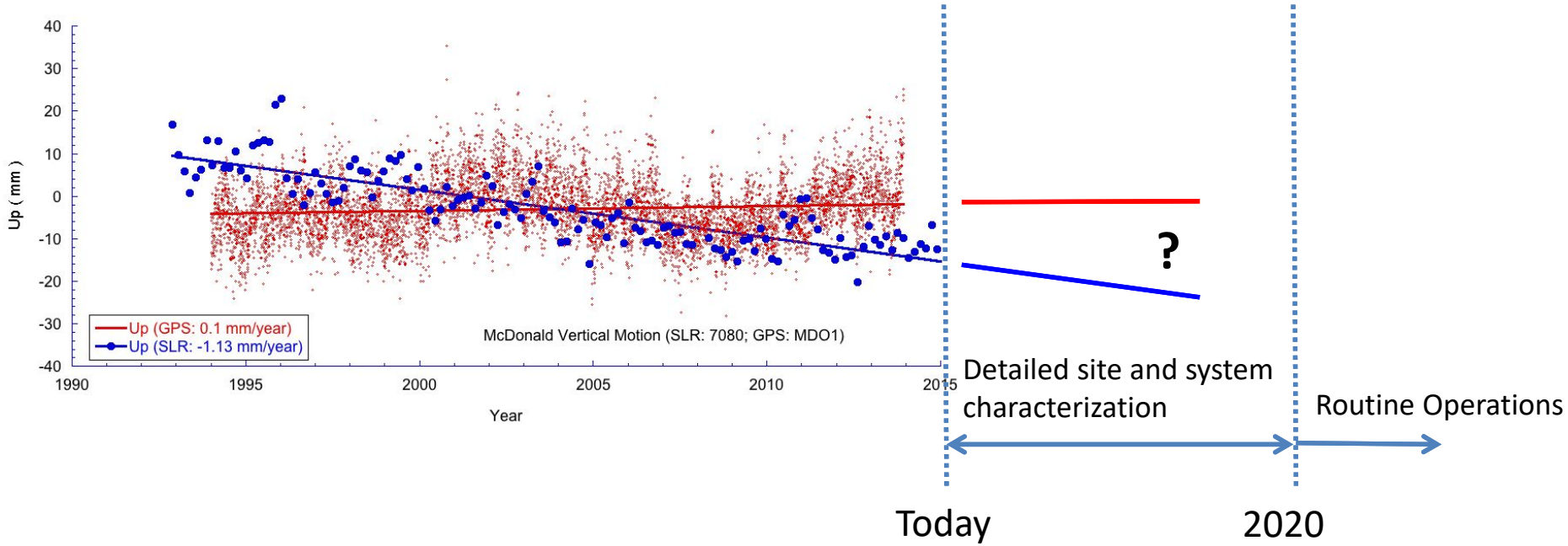
- Status @ April 9, 2018
  - DoV camera prototype developed and tested in previous programs at UT:ARL facilities.
  - A35M Astrolabe survey completed at Mt. Fowlkes in April 2017.
  - Requested re-survey of Mt. Fowlkes and Visitor Center sites with the DoV camera.

DESCRIPTION OF GEODETIC STATION

STATION NAME	WGS84 Position
NASA-GSFC RM3	Lat: 30°40'50.576"N Long: 104°00'55.781"W EH:2000.31m
LOCATION McDonald Observatory, Texas	DESCRIBED BY Shain
ESTABLISHED BY NASA, Greenbelt, Maryland	DATE April 2017

Station is located less than 100 m southwest of the Hobby-Eberly Telescope (HET) atop Mount Fowlkes in the Davis Mountains of West Texas. The HET is approximately 16 miles northwest of Fort Davis, TX along TX State Highway 118.

Key Outcomes



Near-term outcomes

- Demonstrate MGO is a mm-Observatory
- Resolve discrepancies in historical space geodetic data
- Establish framework for using MGO and similar observatories for TRF
- Provide a research resource for UT Austin and collaborators

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