

Applying Distributed Temperature Sensing (DTS) to New Mexico Climate Change Research

Jevon Harding

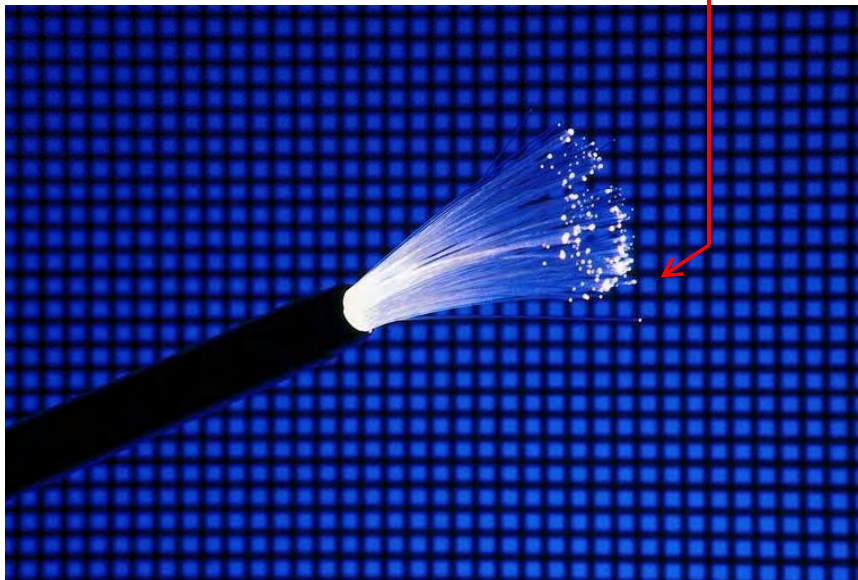
Hydrology Program

Earth & Environmental Science Dept.

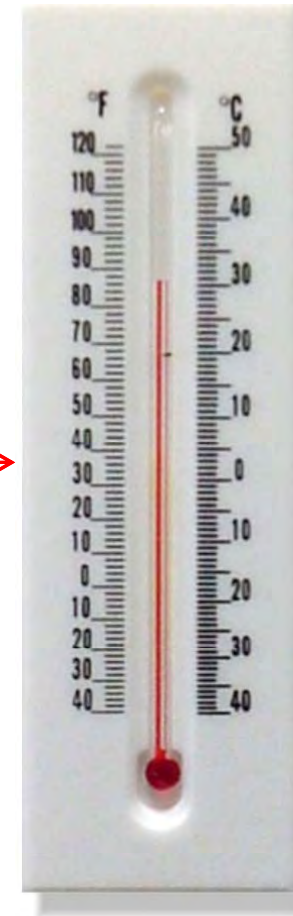
New Mexico Institute of Mining & Technology

Distributed Temperature Sensing

Using one of these



To give us this



Distributed Temperature Sensing



Capability

- **High spatial resolution**
- **High temporal resolution**
- **High temperature resolution**
- **Long distance coverage**
- **Doesn't require coordination/calibration/upkeep of many field sensors**

Capability

- High spatial resolution

1-2 meters

- High temporal resolution

- High temperature resolution

- Long distance coverage

- Doesn't require coordination/calibration/upkeep of many field sensors

Capability

- High spatial resolution

1-2 meters

- High temporal resolution

every 1 min

- High temperature resolution

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Capability

- High spatial resolution

1-2 meters

- High temporal resolution

every 1 min

- High temperature resolution

0.01 - 0.5°C (NMT: 0.3°C)

- Long distance coverage

- Doesn't require coordination/calibration/upkeep of many field sensors

Capability

- High spatial resolution

1-2 meters

- High temporal resolution

every 1 min

- High temperature resolution

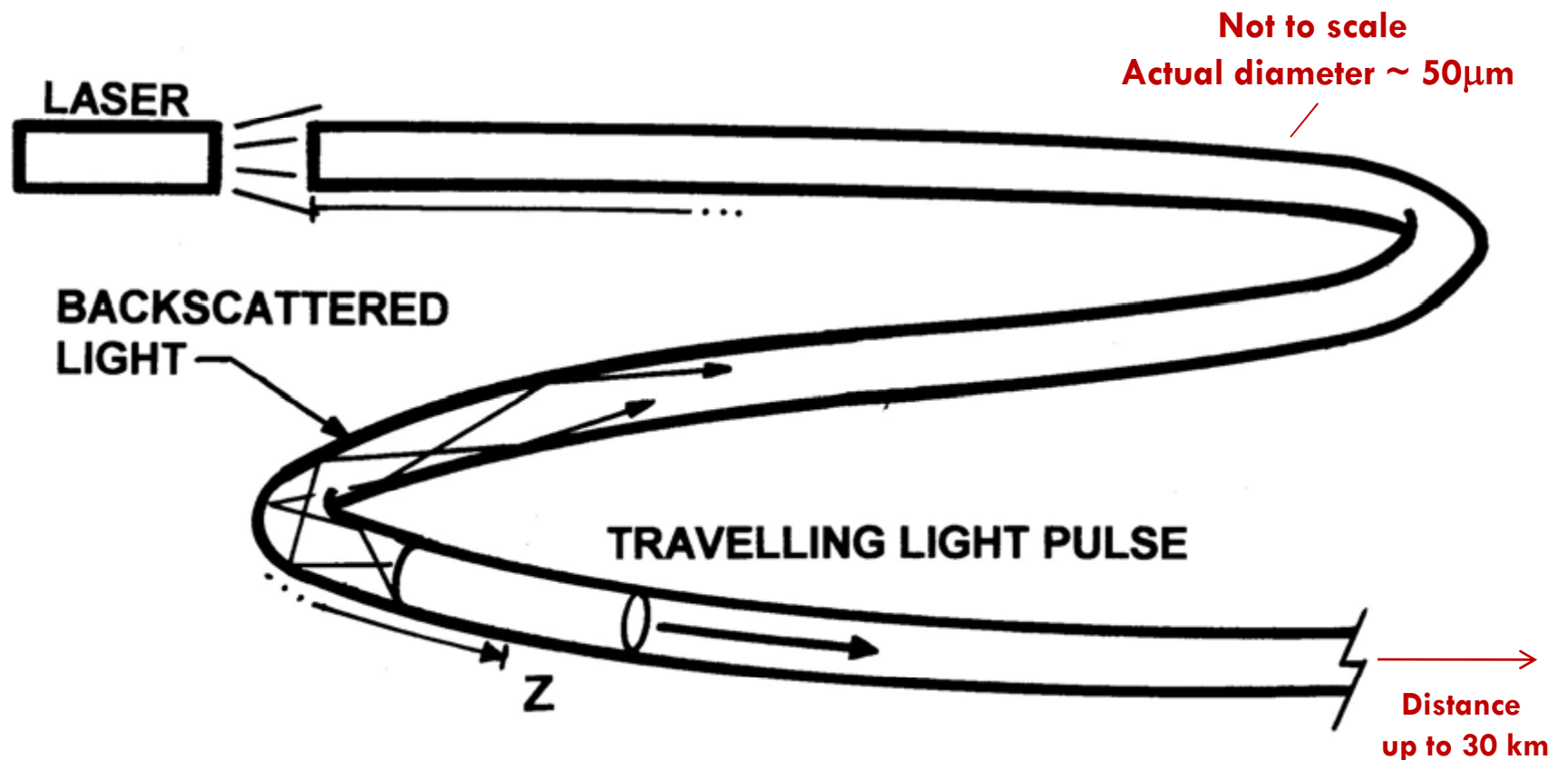
0.01 - 0.5°C (NMT: 0.3°C)

- Long distance coverage

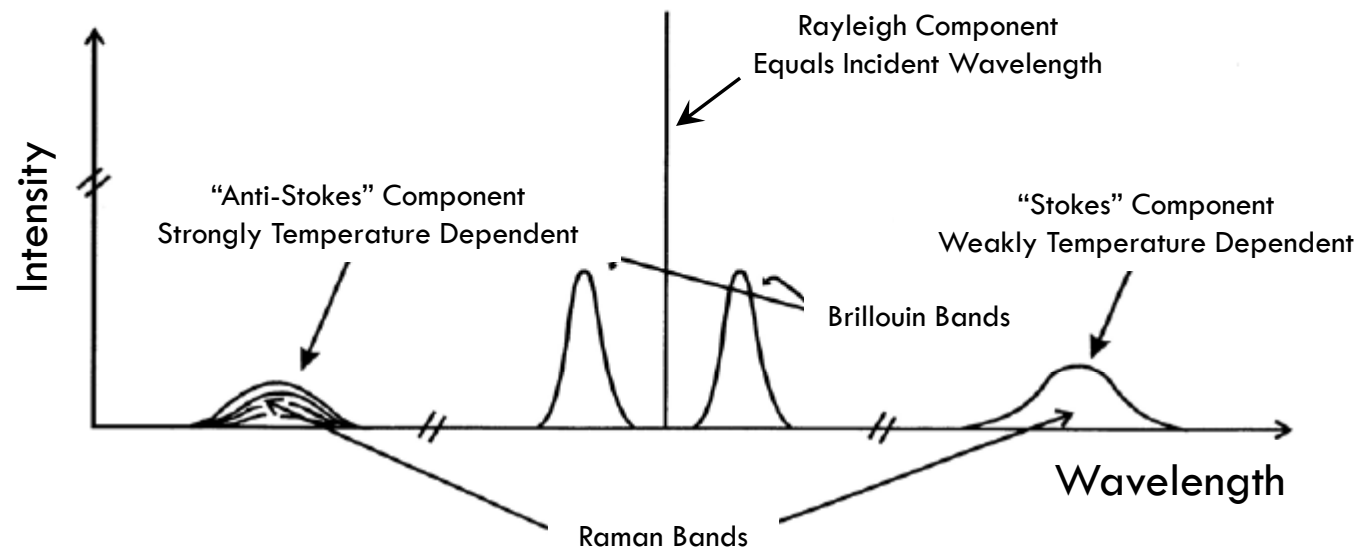
up to 30 km (NMT: 4 km)

- Doesn't require coordination/calibration/upkeep of many field sensors

Distributed Temperature Sensing

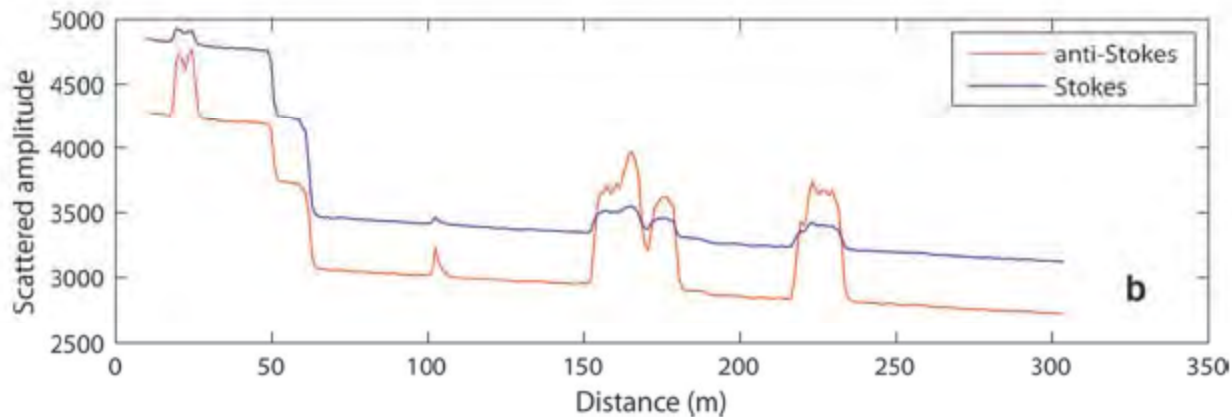


Distributed Temperature Sensing

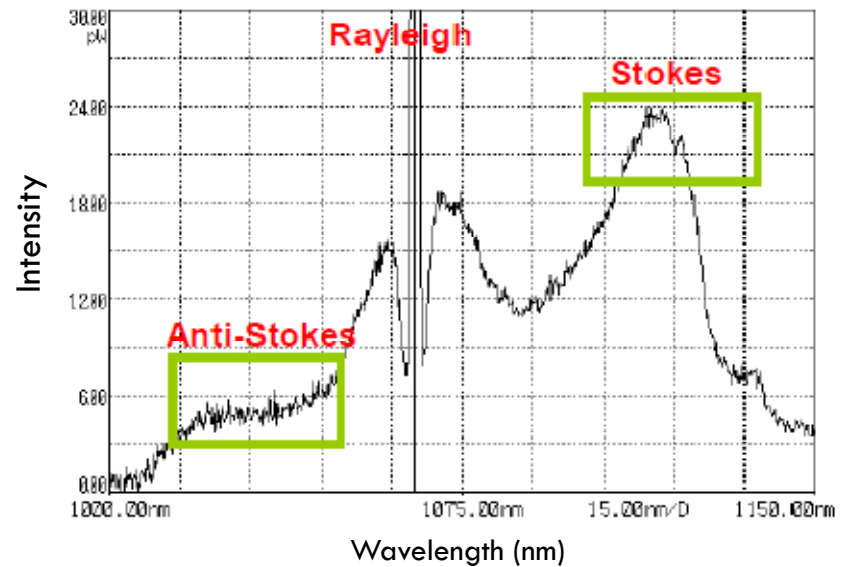


Smolen & van der Spek, 2003

Distributed Temperature Sensing



Tyler et al, 2008



Distributed Temperature Sensing

$$T(z) = T_{\text{ref}} \left(\frac{1 + \Delta\alpha z}{\ln\left(\frac{C^+}{C^-}\right)} + \frac{\ln\left(\frac{I^+}{I^-}\right)}{\ln\left(\frac{C^+}{C^-}\right)} \right)$$

z = distance along cable

$T(z)$ = Temperature at z (K)

T_{ref} = Reference temperature (K)

$\Delta\alpha$ = Differential attenuation between Stokes and anti-Stokes backscatter (m^{-1})

I^+ = Intensity of Stokes band

I^- = Intensity of anti-Stokes band

C^+, C^- = Constants relating to sensitivity of I^+/I^- to temp.

Instruments



Gemini, SensorTran



Sentinel, SensorNet



Halo, SensorNet

Cons

- **Expensive Instrument**
- **Costly specialty cables**
- **Power-hungry field setup**
- **Operators need to be trained**
- **Still not immune to usual field problems**

Field Concerns

- **Fiber optic cables**
TANGLE easily



Field Concerns

- Fiber optic cables **TANGLE** easily



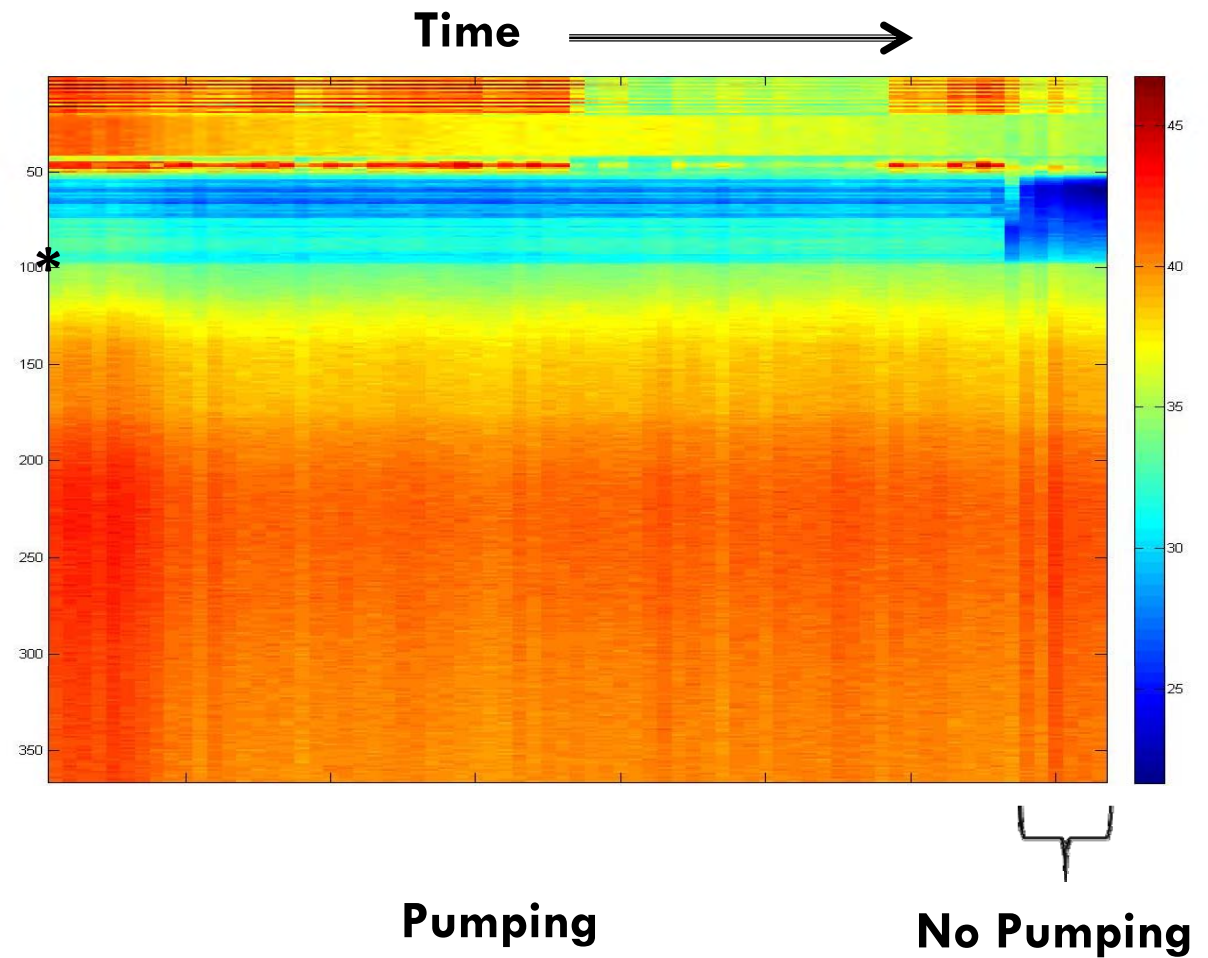
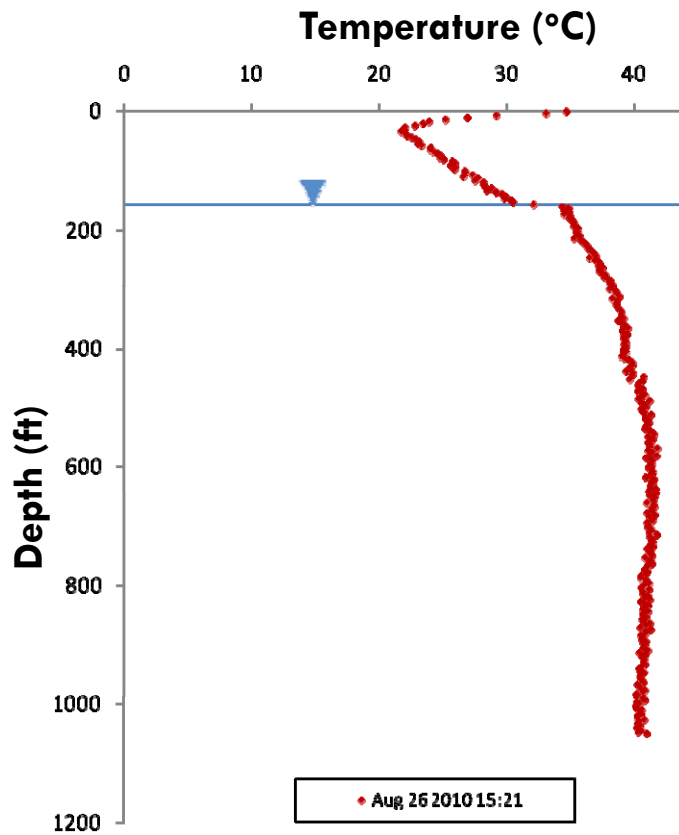
Geothermal



Geothermal



Geothermal

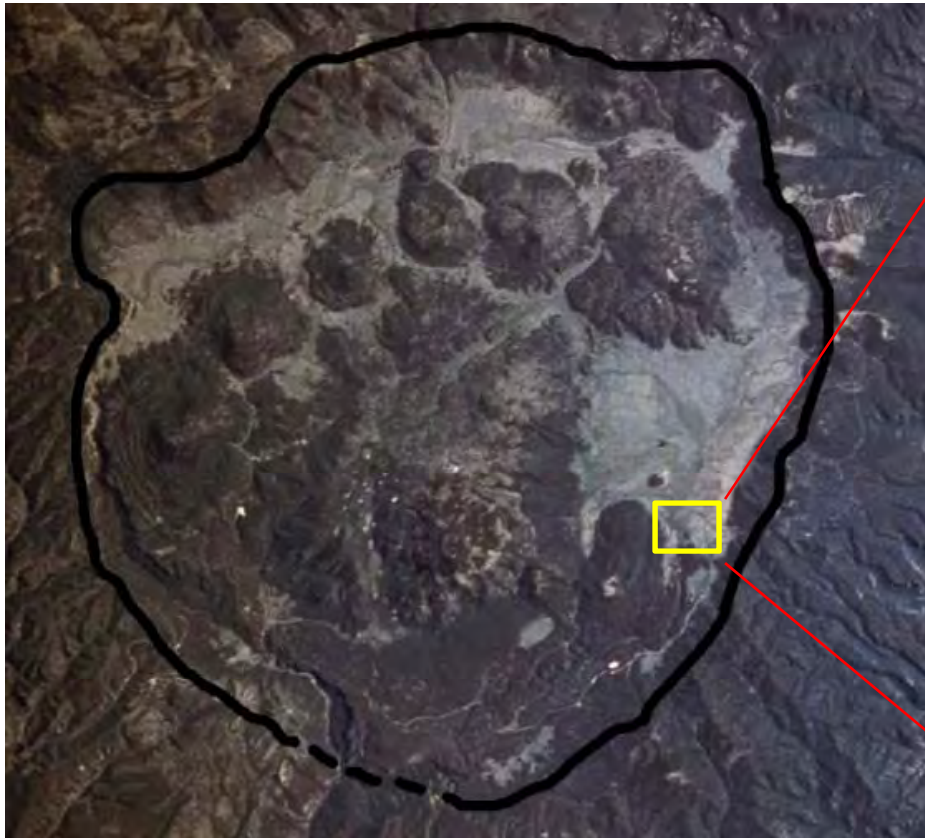


Valles Caldera



Aquatic ecology in meandering streams and associated hyporheic zones

Our Field Site

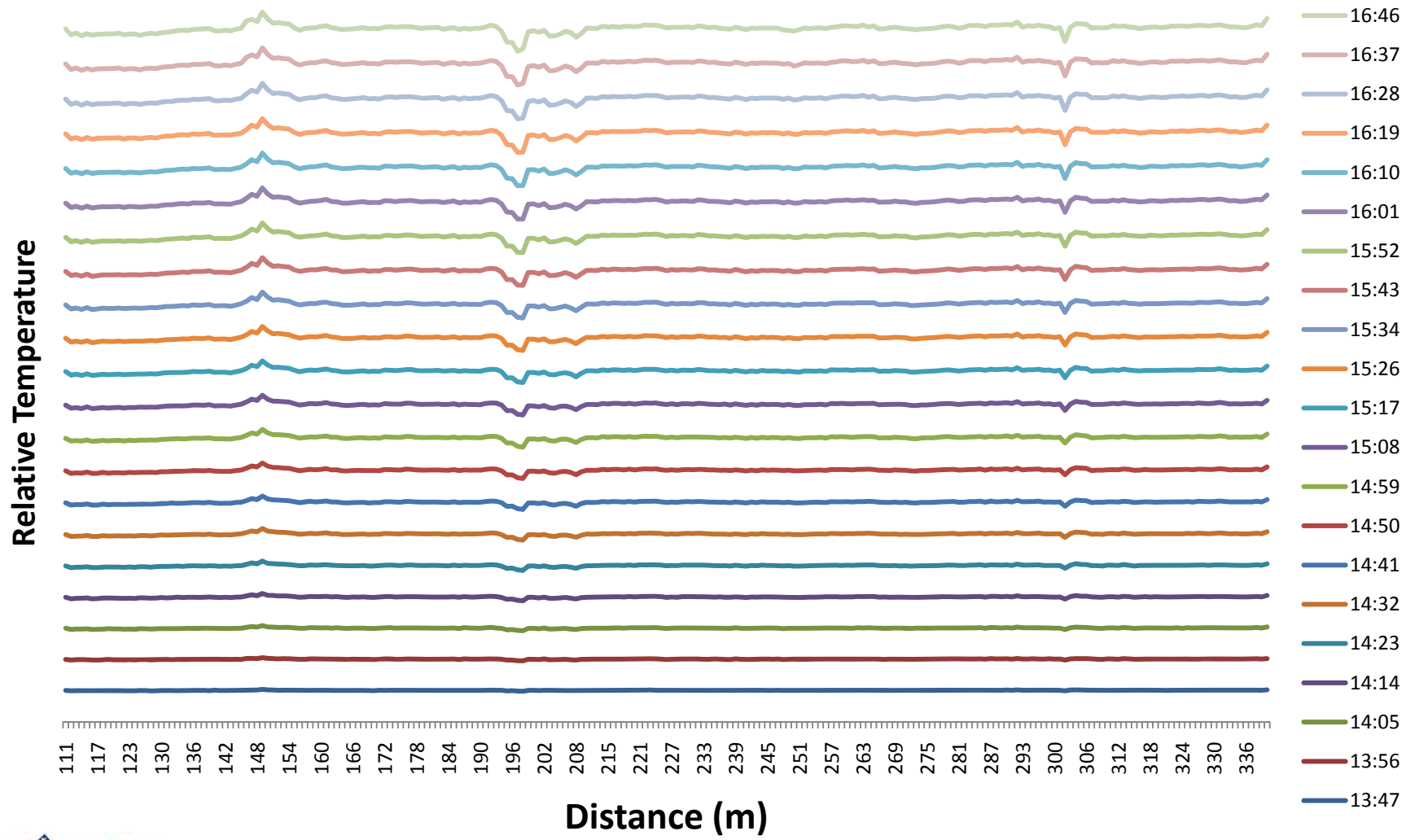


Our Field Site

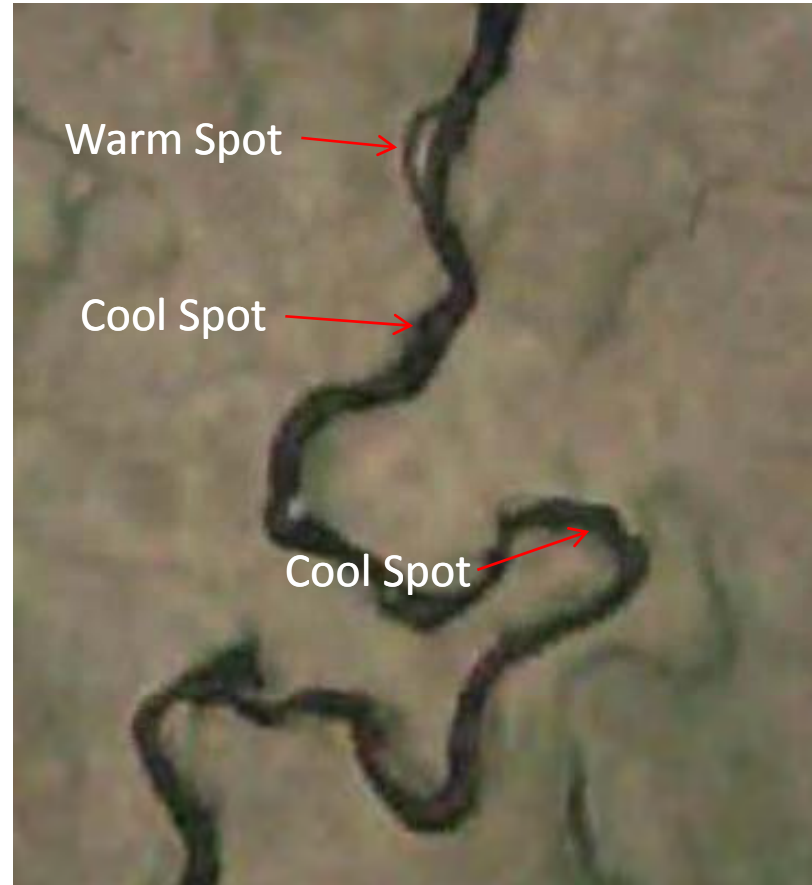


Photo: Google Earth

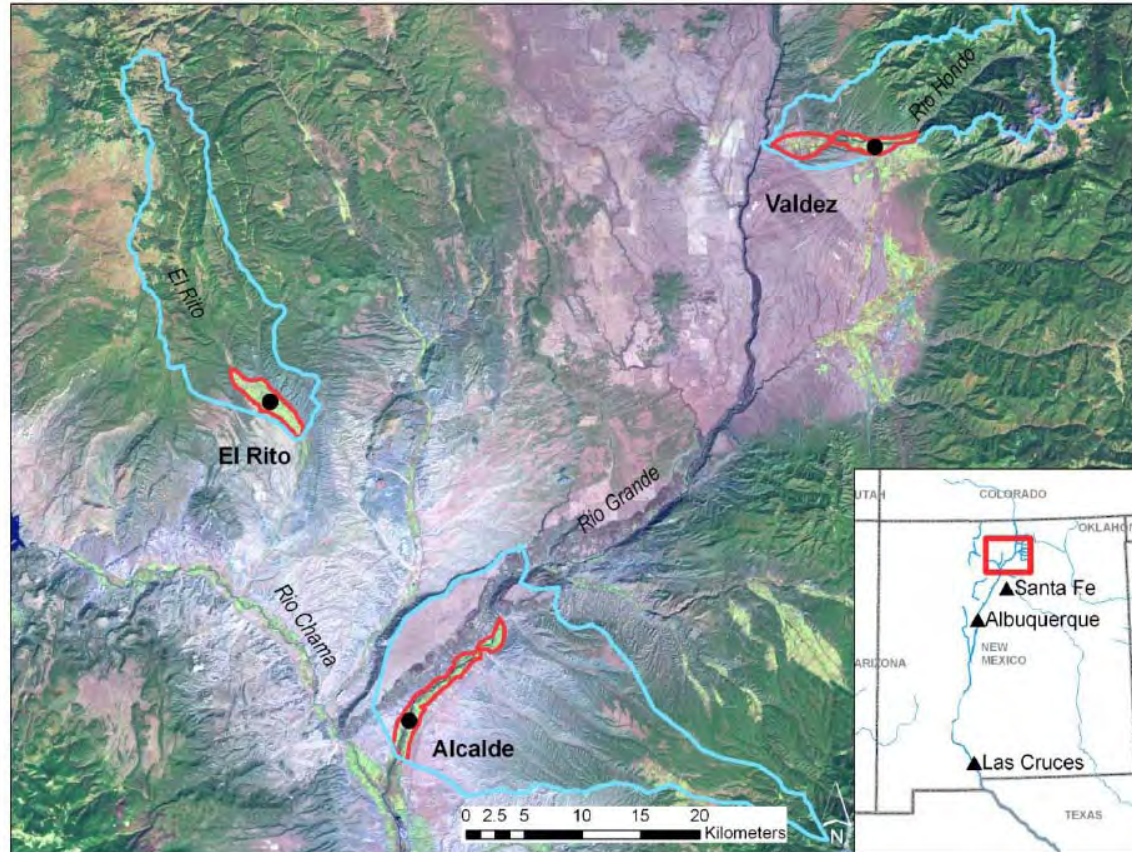
Temperature Data



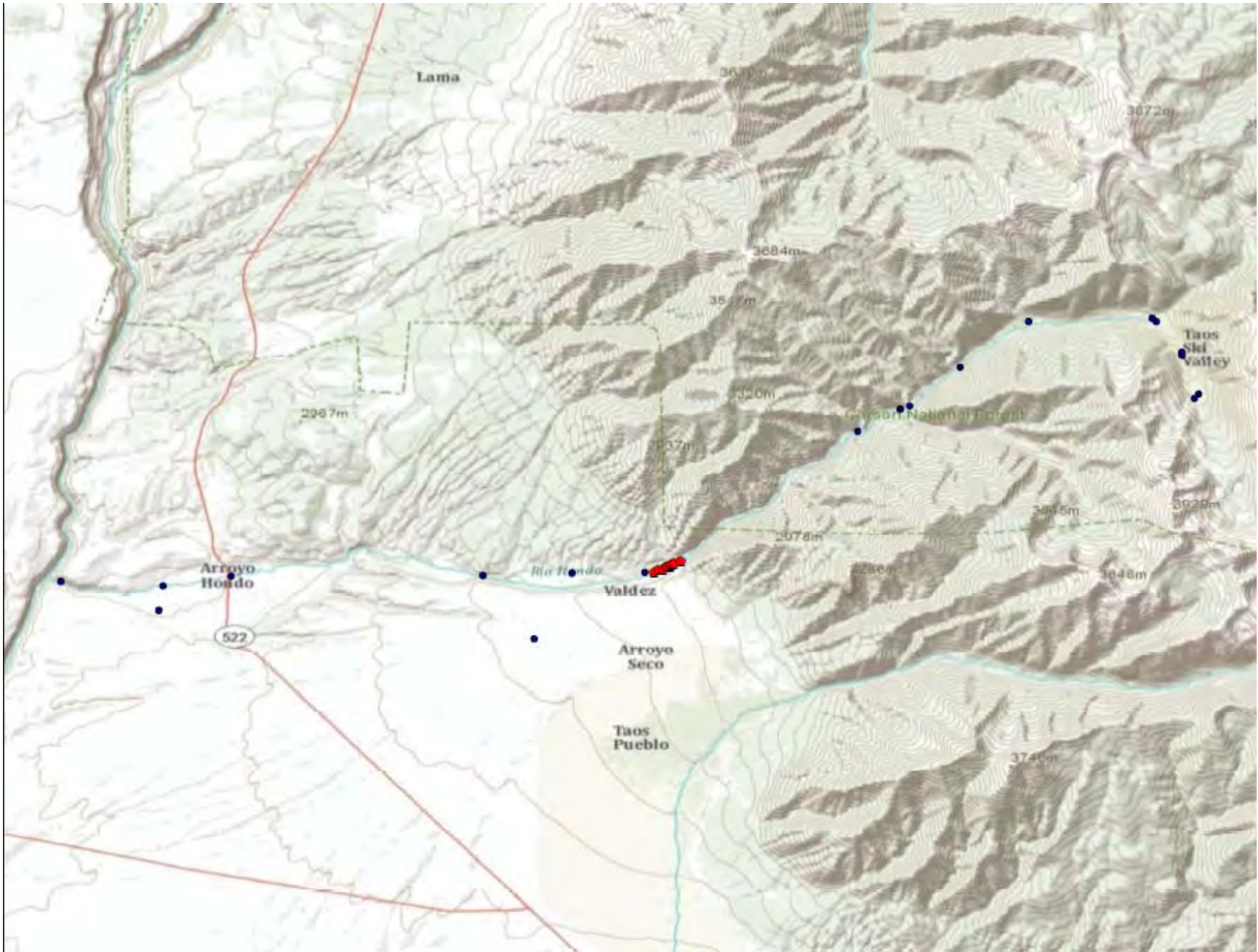
Temperature Data

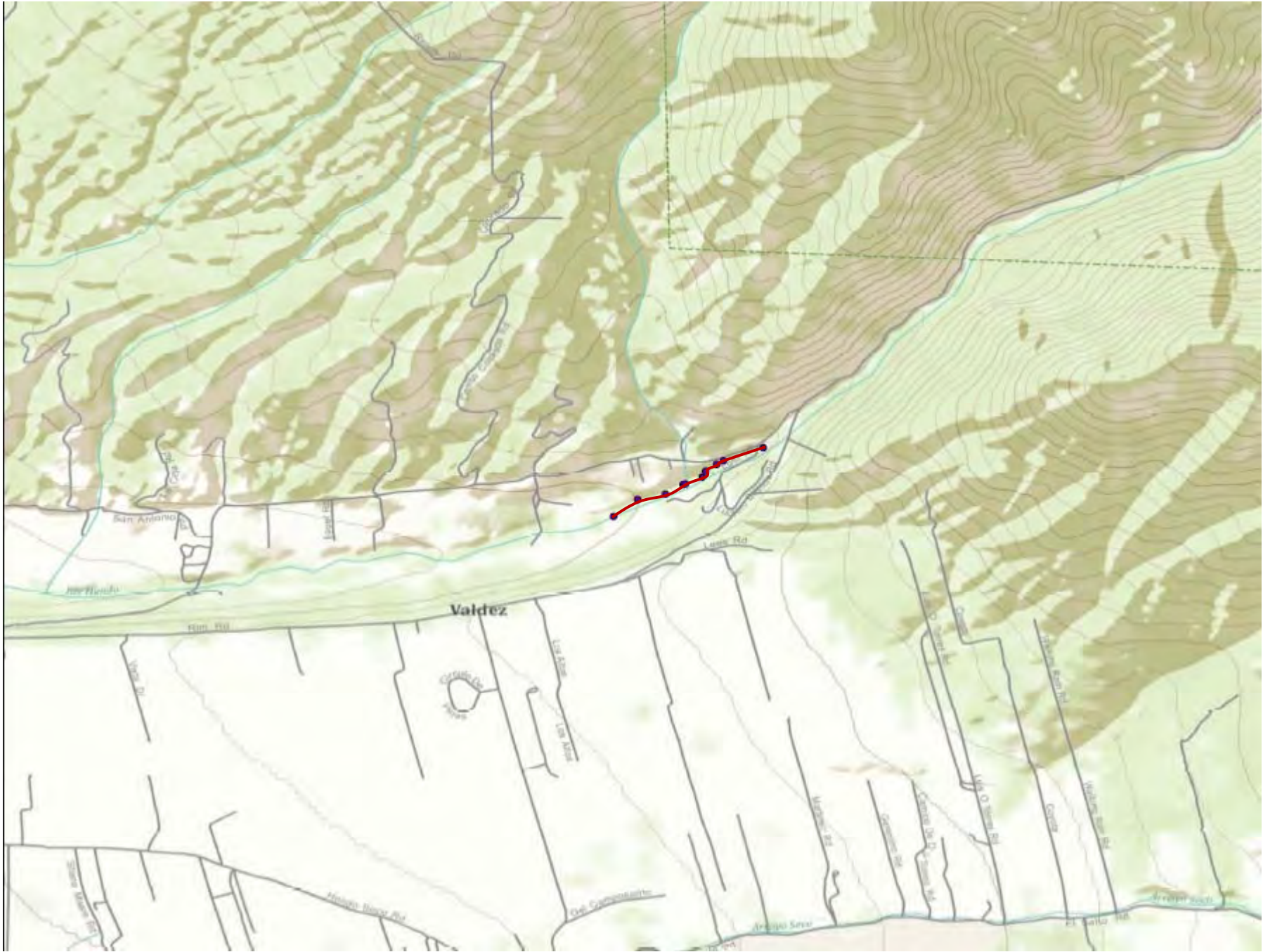


Rio Hondo



Acequias in Northwestern New Mexico



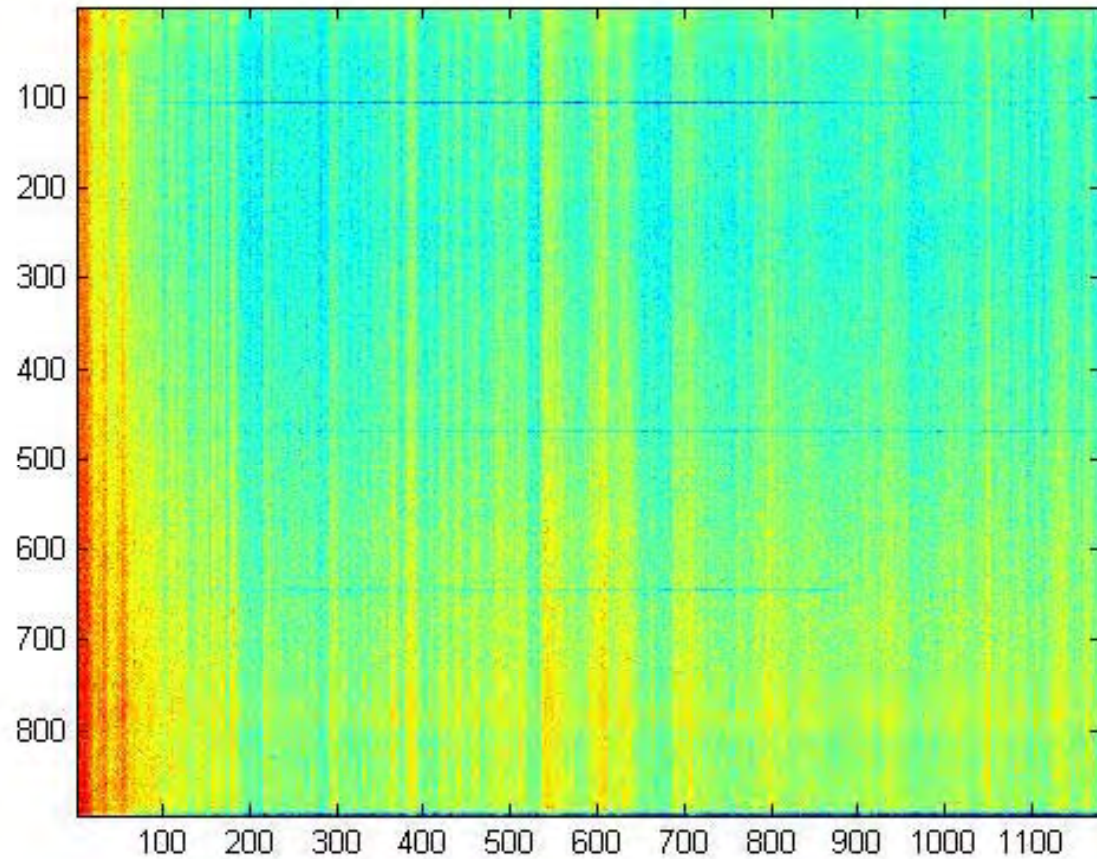


Rio Hondo

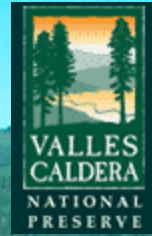
Downstream



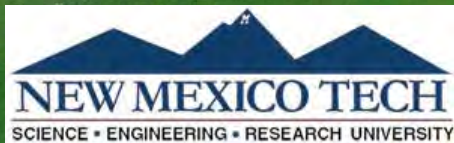
Upstream



Time

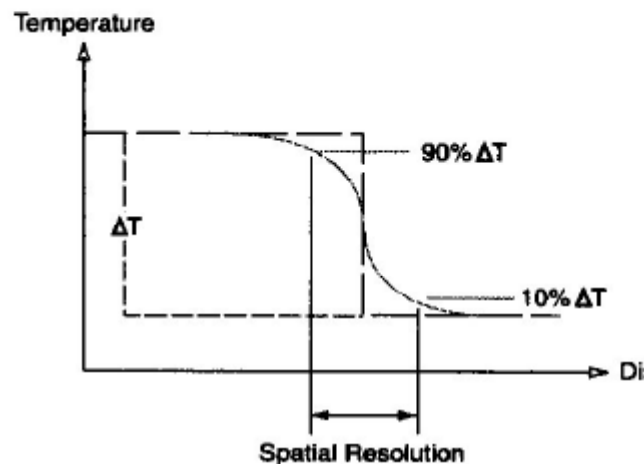


**DTS Innovative Working Group
and Training Workshop
Oct 1- 3 , 2010
Valles Caldera Science & Education Center
Jemez Springs, NM
Funded by NM EPSCoR**

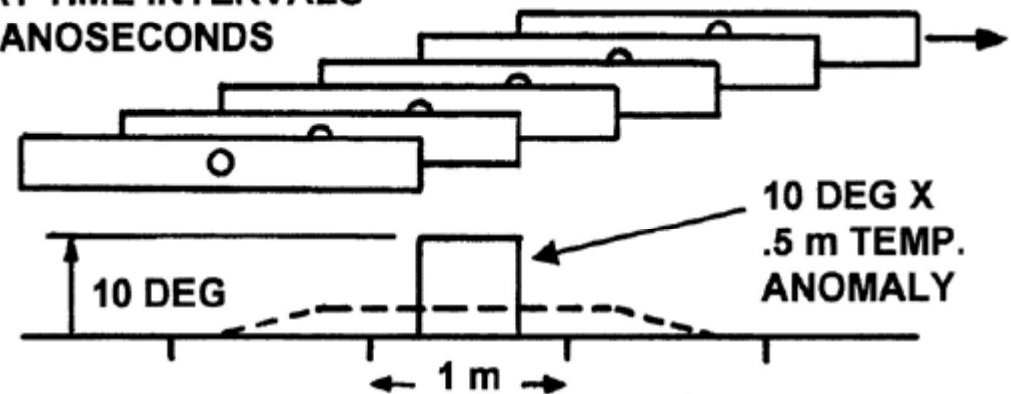


Adjusting Spatial Resolution

- **Can't adjust spatial resolution directly**
- **Longer spacing can create smoothing**



POSITION OF 2 m LIGHT PULSE AT TIME INTERVALS OF 2.5 NANOSECONDS

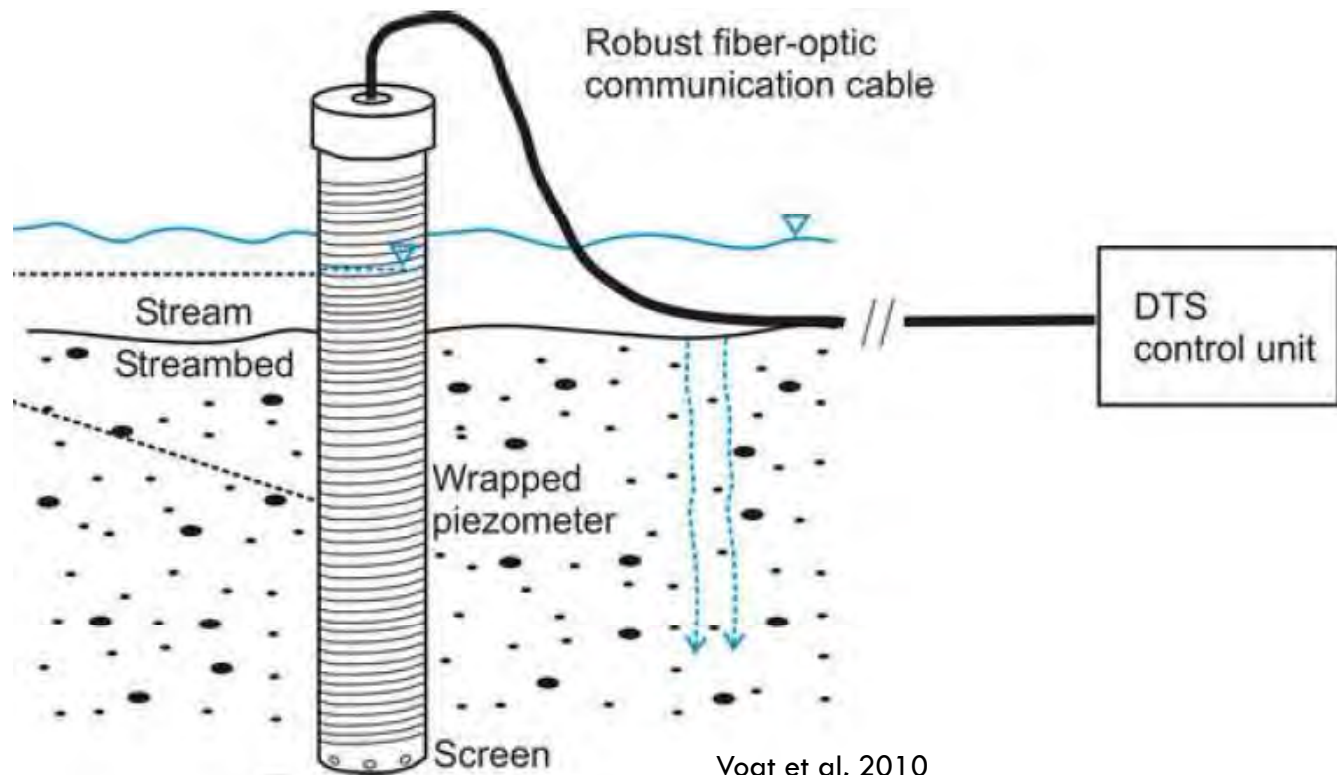


Smolen & van der Spek, 2003

Adjusting Spatial Resolution

- Can adjust spatial resolution physically

Ex. Can get sub- cm resolution by wrapping

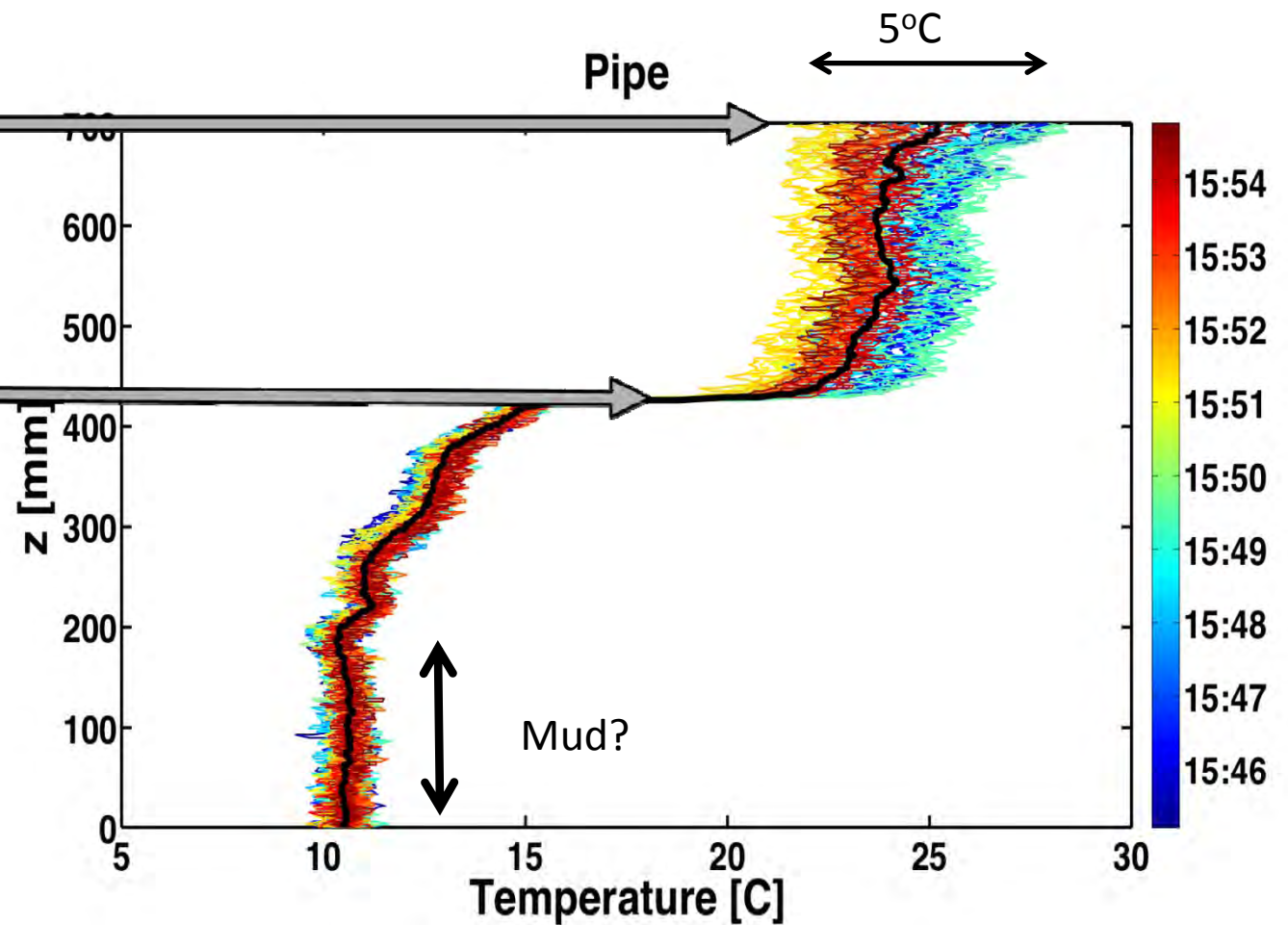


Vogt et al, 2010

Adjusting Spatial Resolution



Adjusting Spatial Resolution



Opportunities



<http://ctemps.org/>

Acknowledgements

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- **John Wilson, Mark Person, & Jesus Gomez (NMT)**
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- **SensorTran**

Questions?

