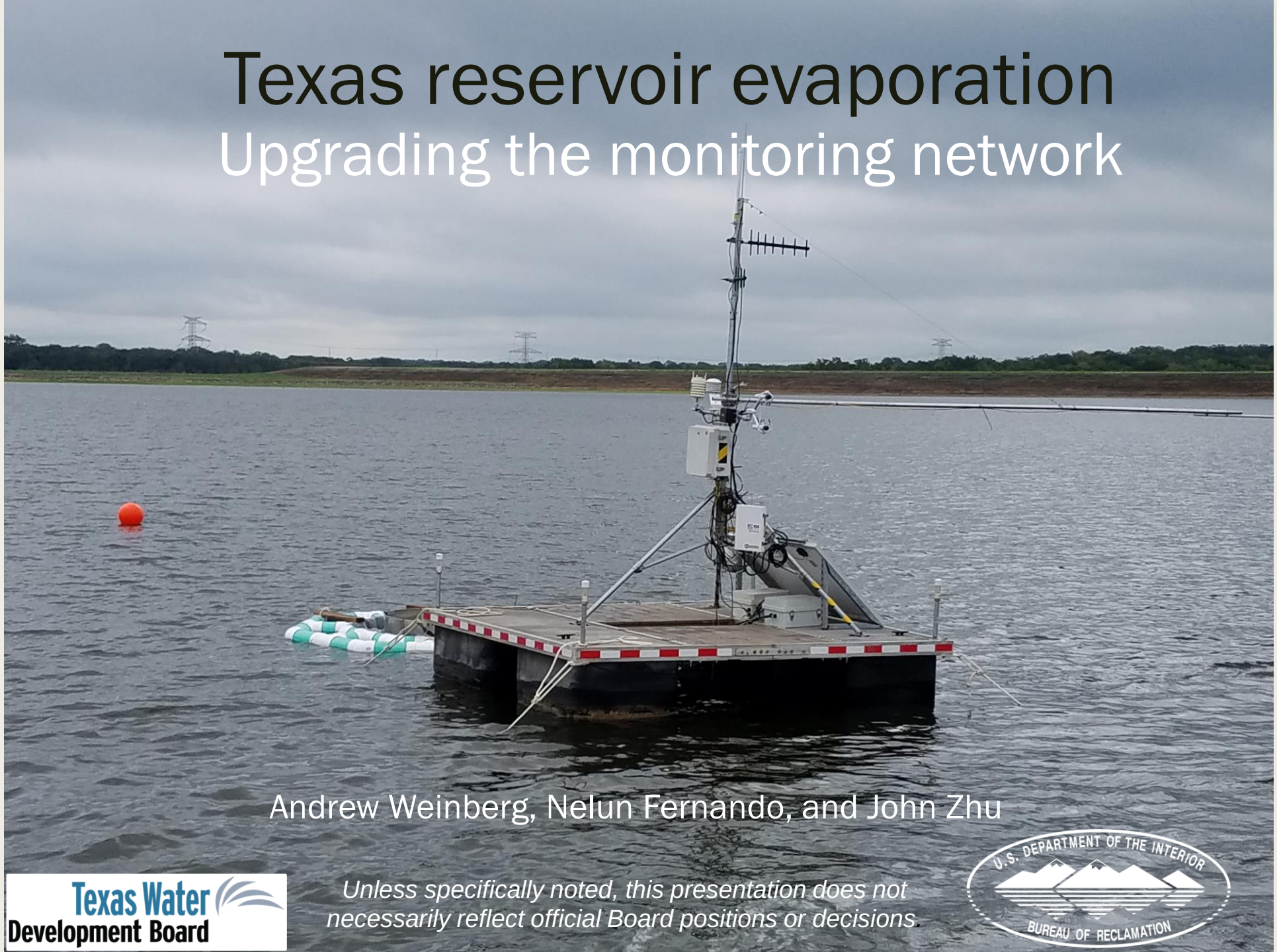
Texas reservoir evaporation

Upgrading the monitoring network



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Texas Water Development Board

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U.S. DEPARTMENT OF THE INTERIOR
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Texas reservoirs – over 1.2 million acres of water for recreation and water supply

- Good news:
  - *Texas reservoir capacity equals 4.4 years max water use*

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- Good news:
  - *Texas reservoir capacity equals 4.4 years max water use*
- Bad news:
  - *factoring in evaporation losses, reservoirs only hold 2.5 years supply*
  - *Inflows in drought years largely go to meet in-stream flow requirements*

Photo credit: Austin American Statesman

Evaporation and water availability

- WRAP model uses monthly evaporation to calculate firm yield and availability
- If evaporation data are biased high, less water is available for uninterruptible supplies
- If evaporation data are biased low, firm yield is too high and critical infrastructure is at risk

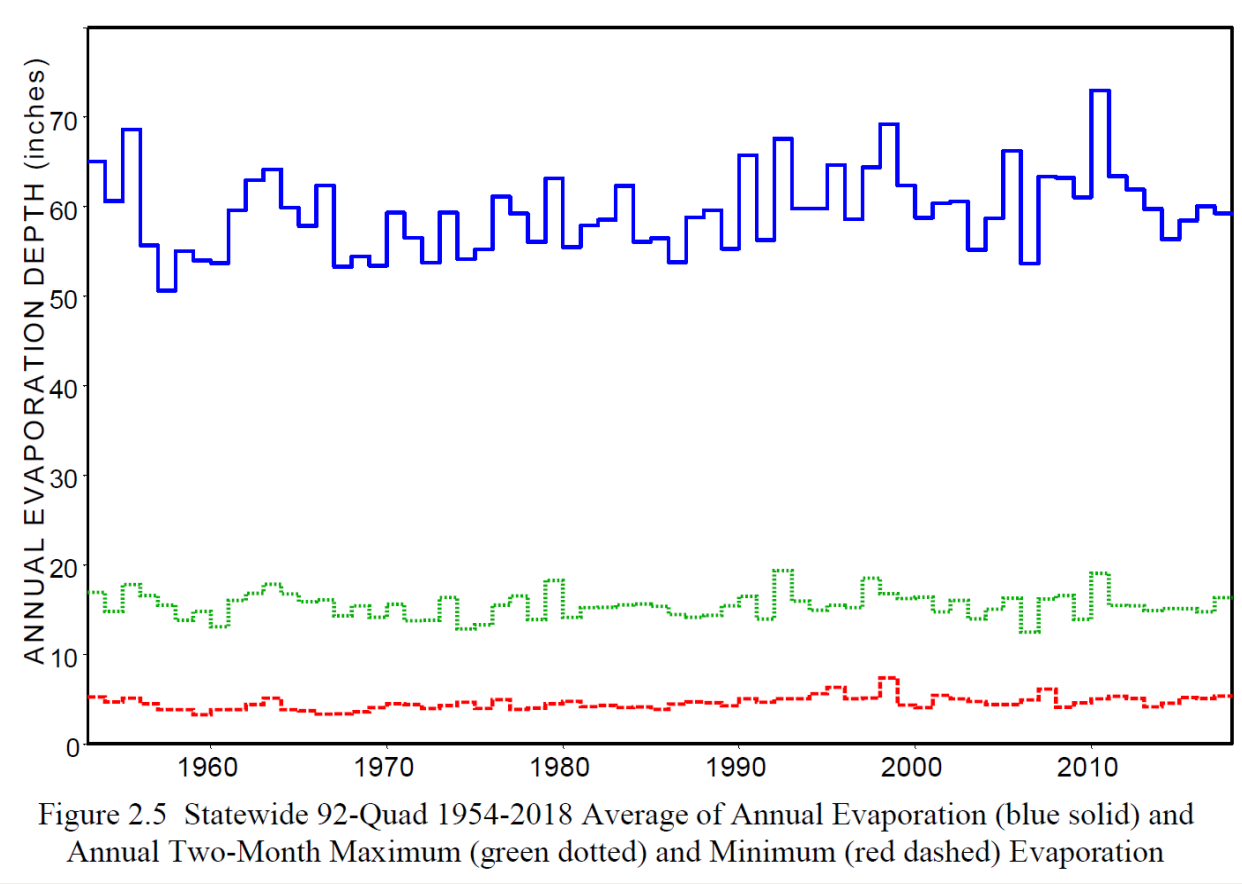
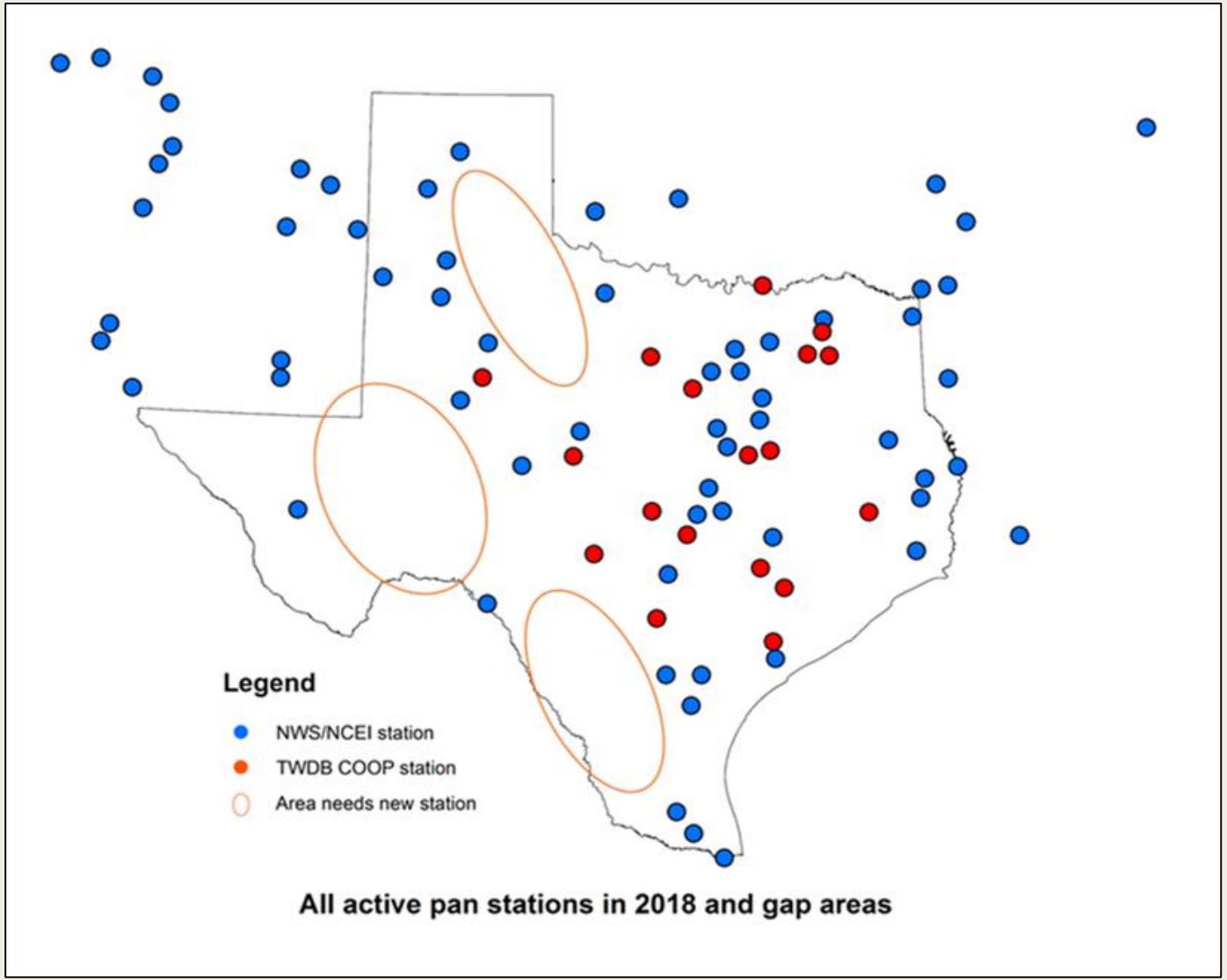


Figure 2.5 Statewide 92-Quad 1954-2018 Average of Annual Evaporation (blue solid) and Annual Two-Month Maximum (green dotted) and Minimum (red dashed) Evaporation

Current reservoir evaporation monitoring network

Class A pans

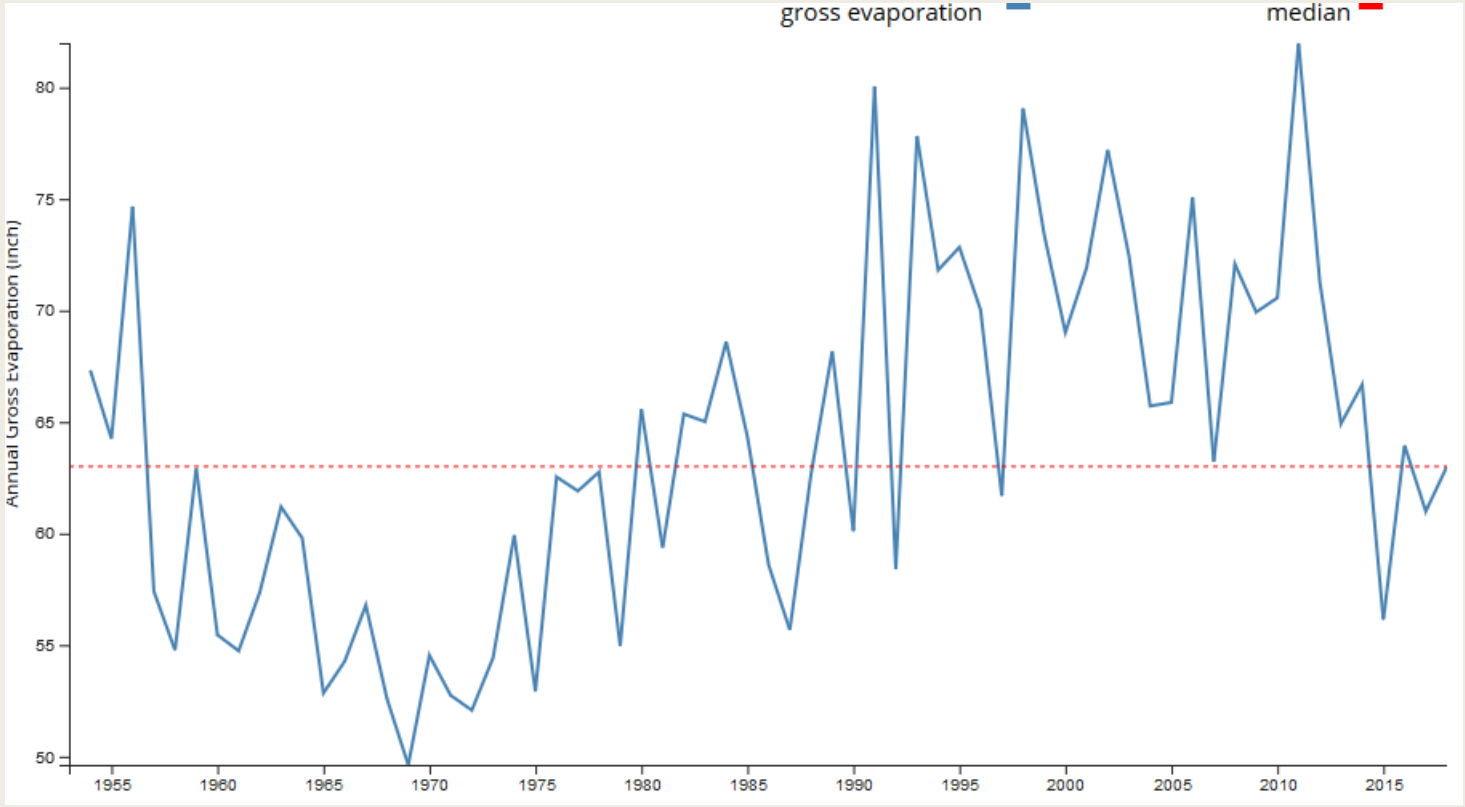
- 60 in Texas plus neighboring states
- 18 TWDB Coop sites
- 64 NWS sites
- Looking to add data from IBWC and Mexico



Issues with current monitoring program

- Limited spatial coverage
- Low temporal resolution
- Large uncertainty in monthly values
- Additional uncertainty from data aggregation

Quad 305 evaporation, 1954 - 2018



A multi-pronged approach to evaporation monitoring

Goals

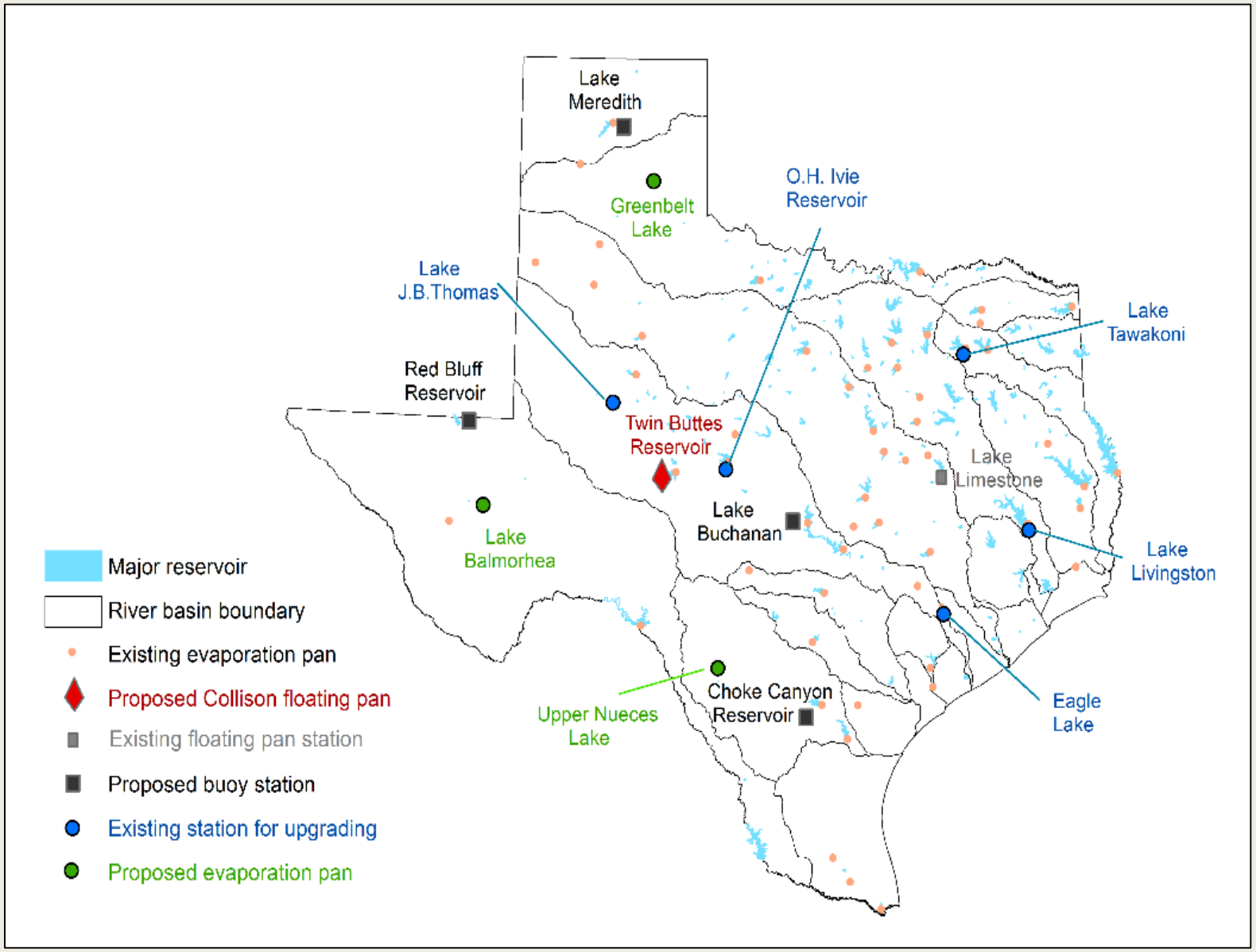
- Upgrade and improve current network of Class A pans
- Directly measure open water evaporation
- Calculate evaporation from meteorological data
- Help develop remote sensing tools to monitor reservoir evaporation

A multi-pronged approach to evaporation monitoring

Strategies

1. *Estimate open water evaporation using buoy stations*
2. *QC buoys with one floating pan evaporation station and one floating eddy covariance station*
3. *Upgrade Class A pan stations with automated data readings and pan refills, and supplemental meteorological measurements*
4. *Install new Class A pans in areas without evaporation observations, and*
5. *Compute evaporation from meteorological measurements at Class A pan and Texmesonet sites.*

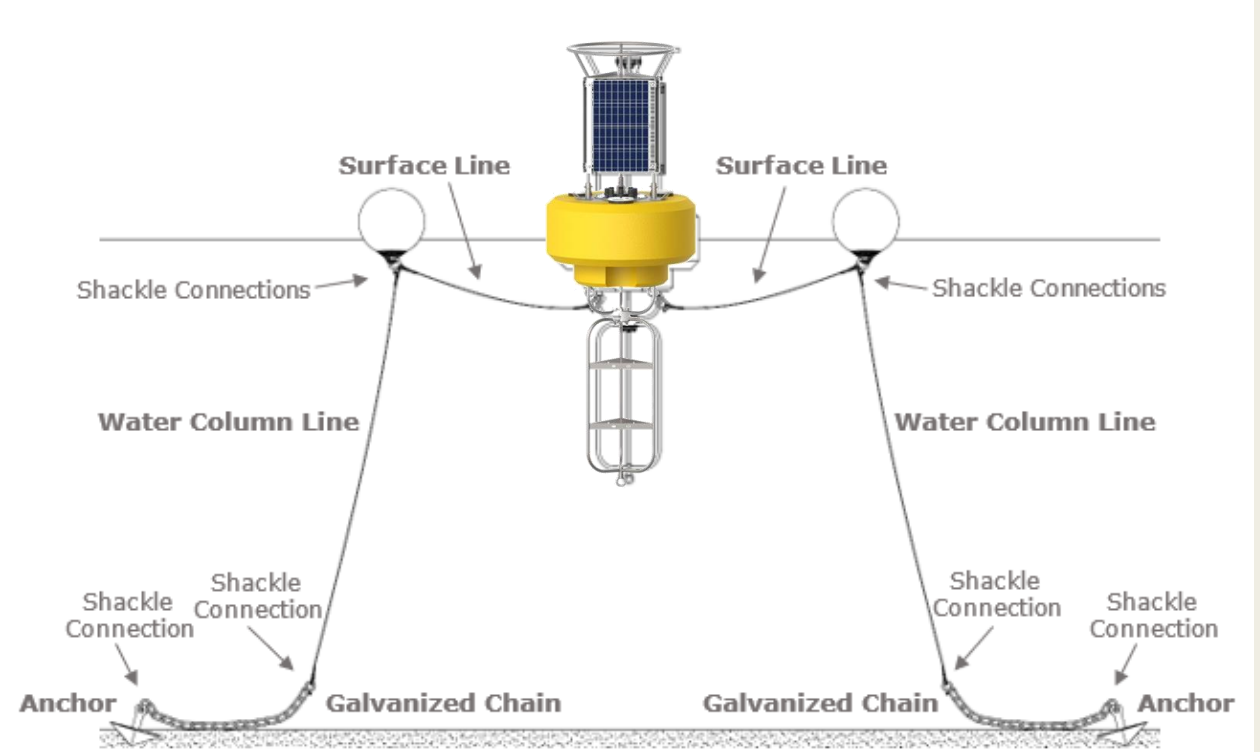
Project locations



Buoy measurement of open water evaporation

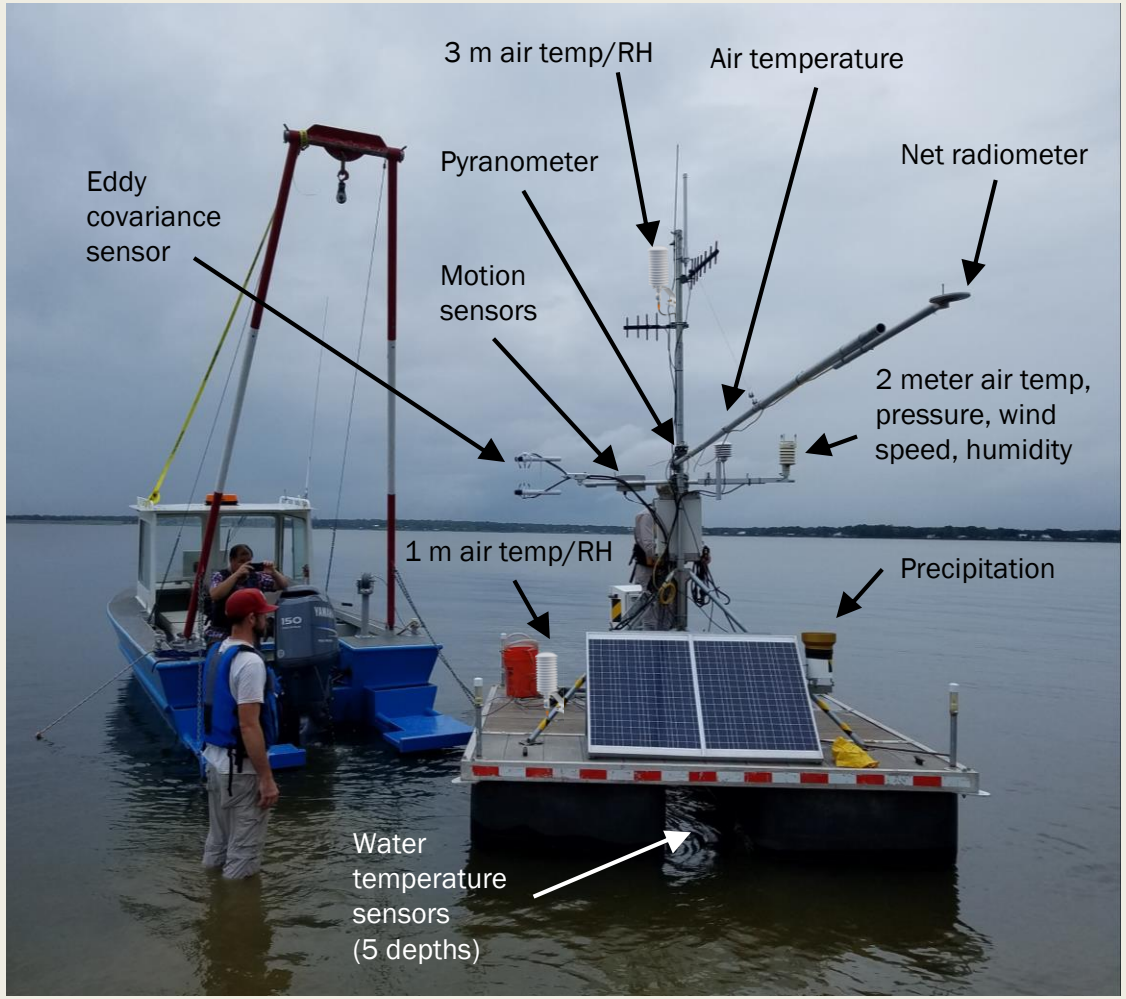
Data for combined equation potential evaporation

- Air temperature/humidity
- Wind speed/direction
- Net radiation
- Barometric pressure
- Water surface temperature
- Water column temperature



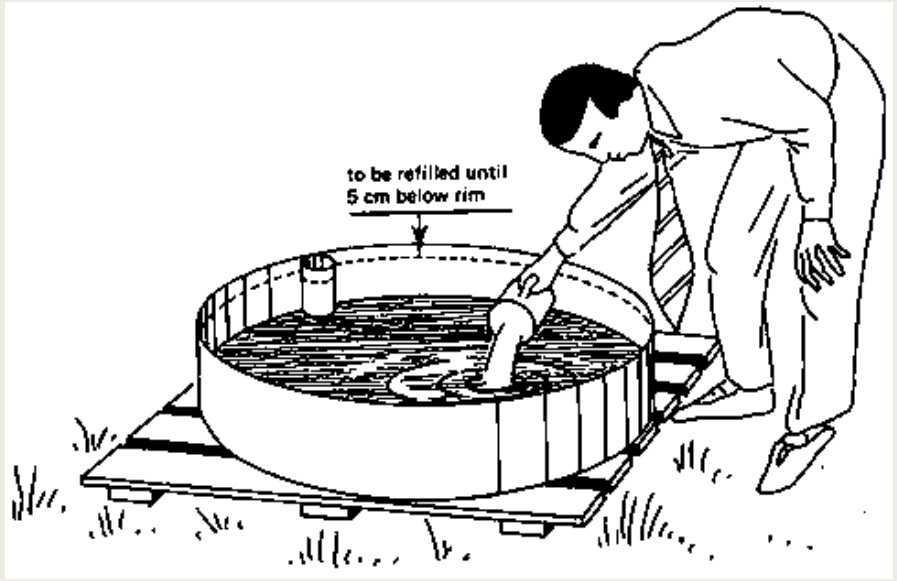
QC for open water evaporation

- Collision floating pan at Twin Buttes Reservoir
  - *Includes quarterly flux chamber measurements*
  - *Plus meteorological instrumentation*
- Eddy covariance system at rotating locations



Pan site upgrades

- Add meteorological instruments
- Automate pan level readings
- Automate pan filling
- Connect sites to internet for real-time data acquisition

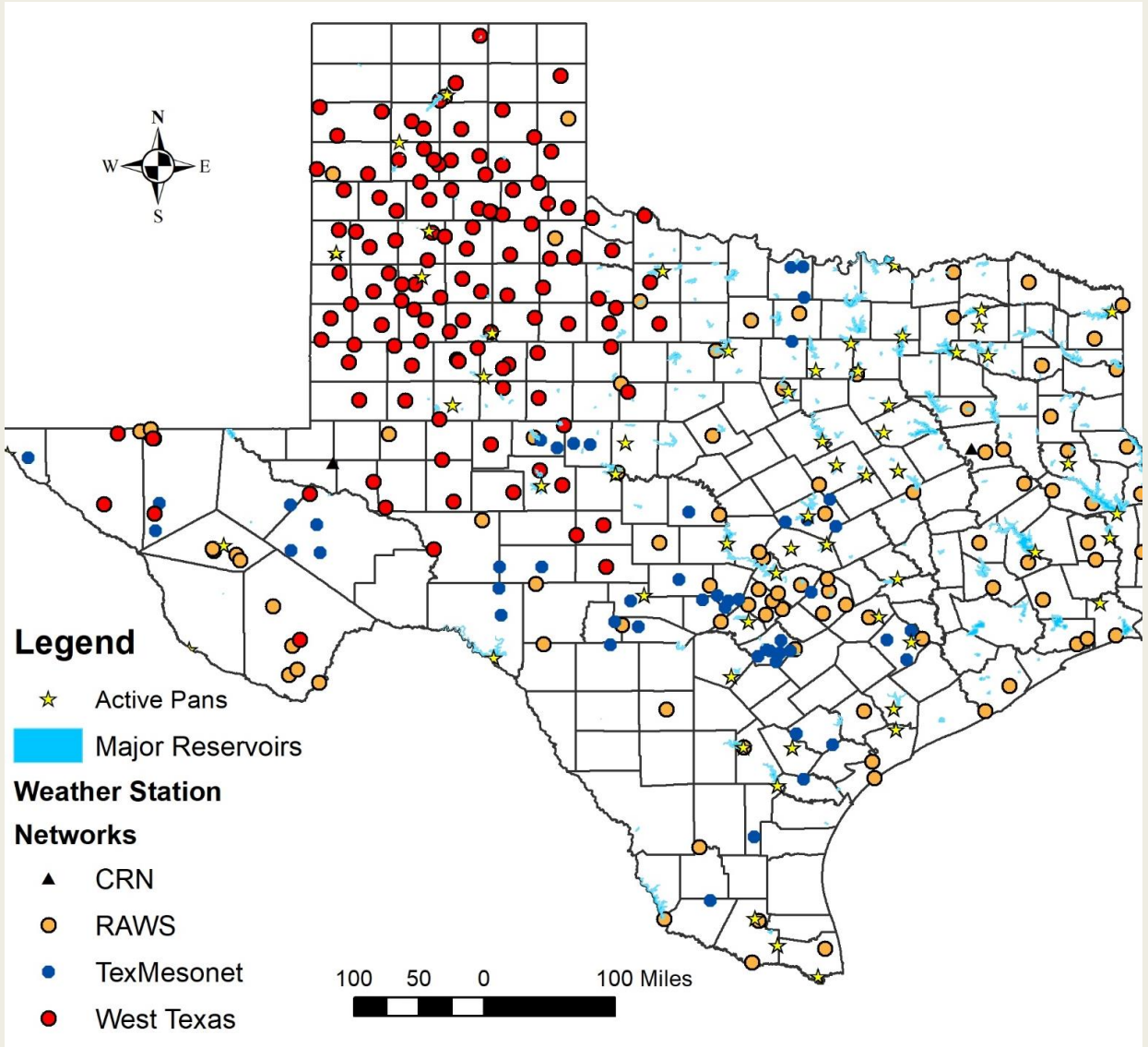


Add water when the water depth in the pan drops too much

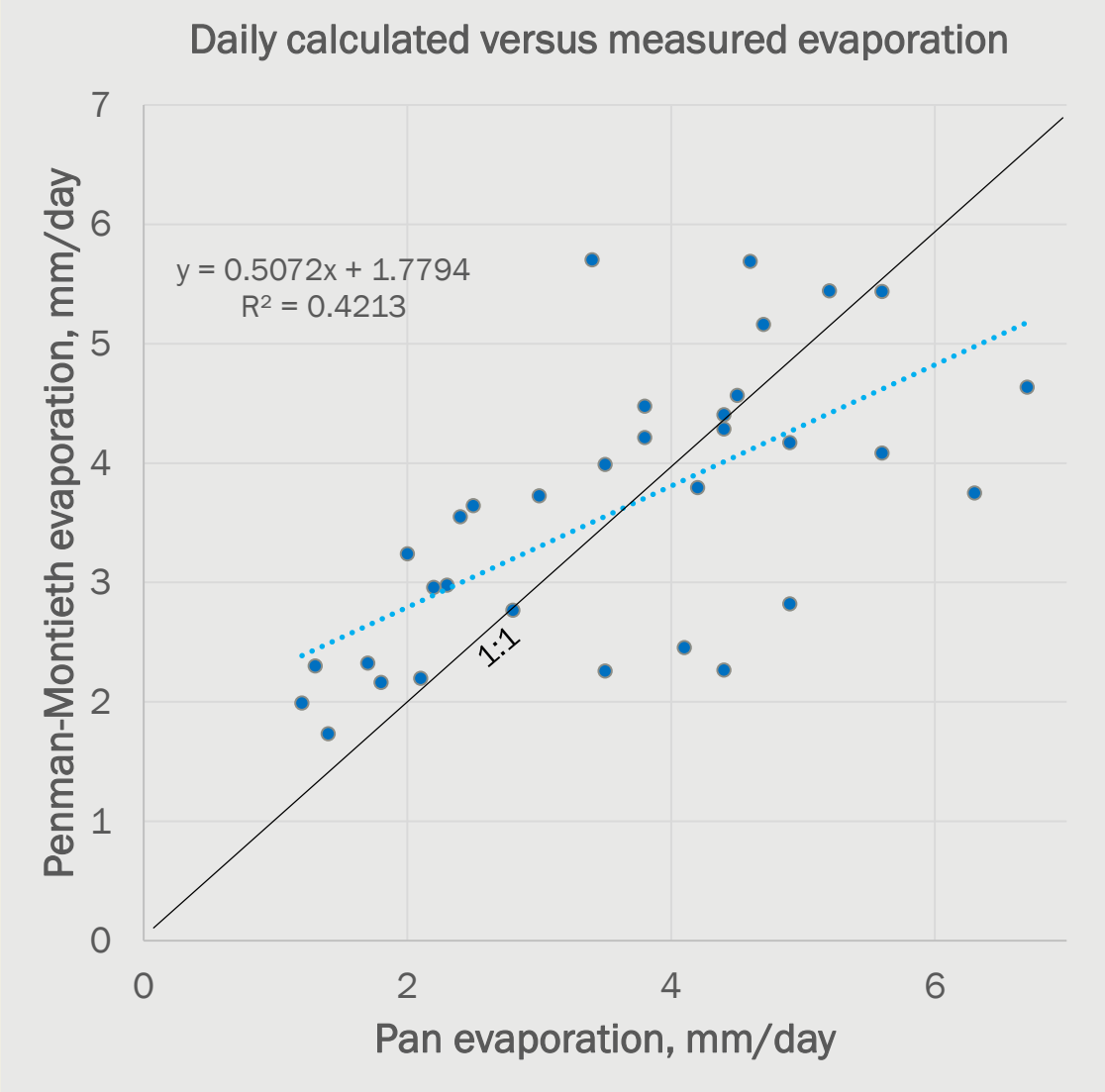
Take water out of the pan when the water depth rises too much

Calculated evaporation

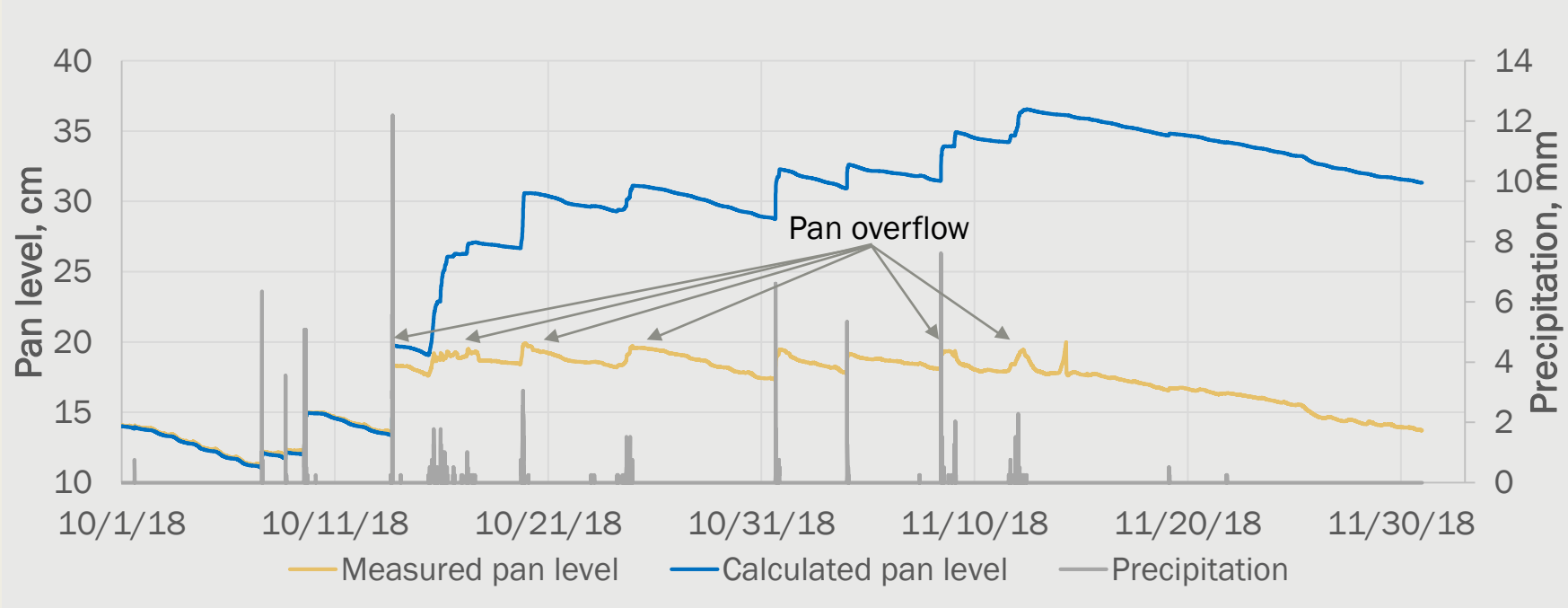
- Several meteorological networks in place
- Evaluate different methods for calculation
  - *CRLE*
  - *Penman-type*
- Assess applications
  - *Major reservoirs*
  - *Ponds and tanks*



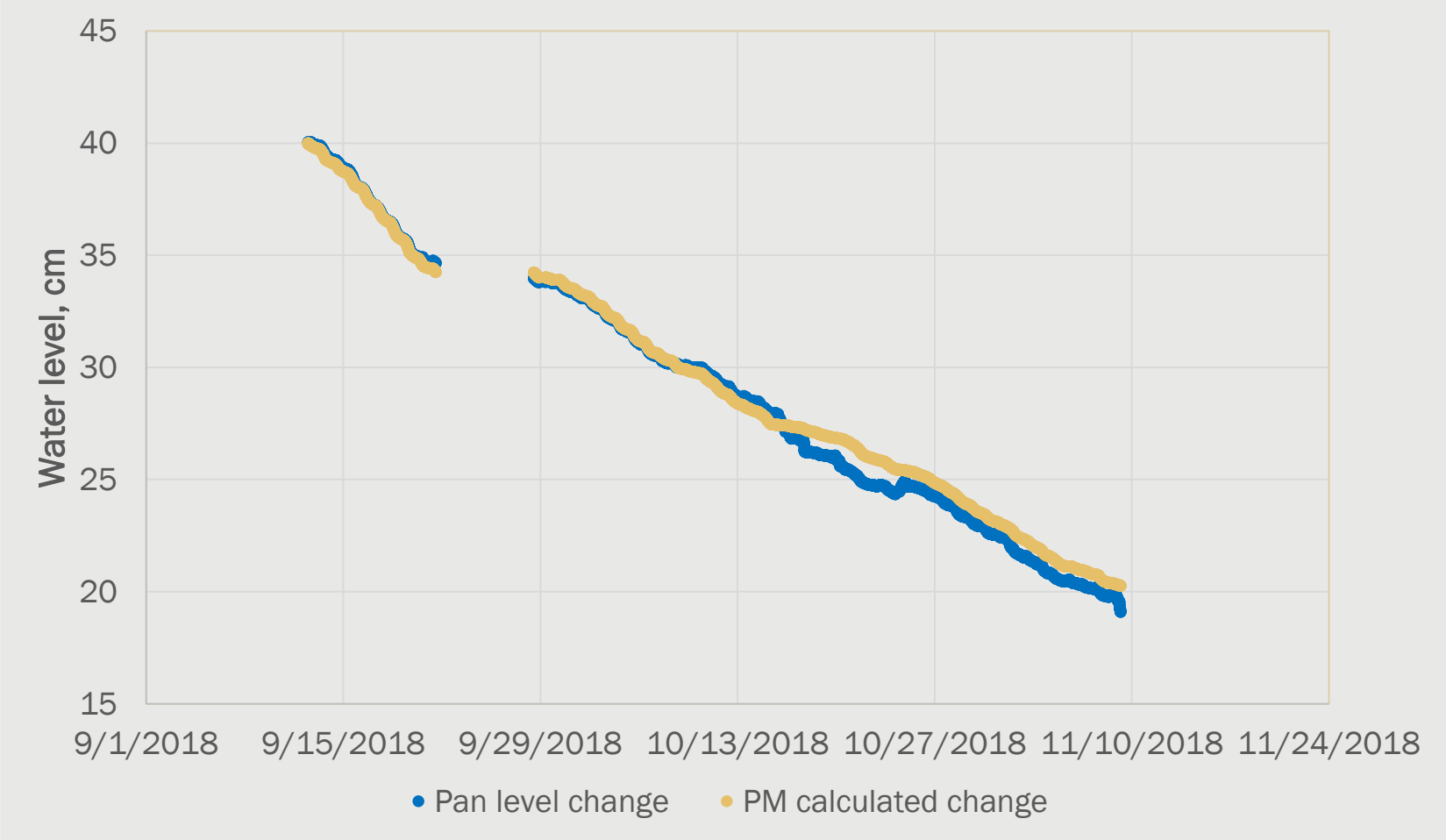
Correlation between Class A Pan and Penman-Montieth evaporation

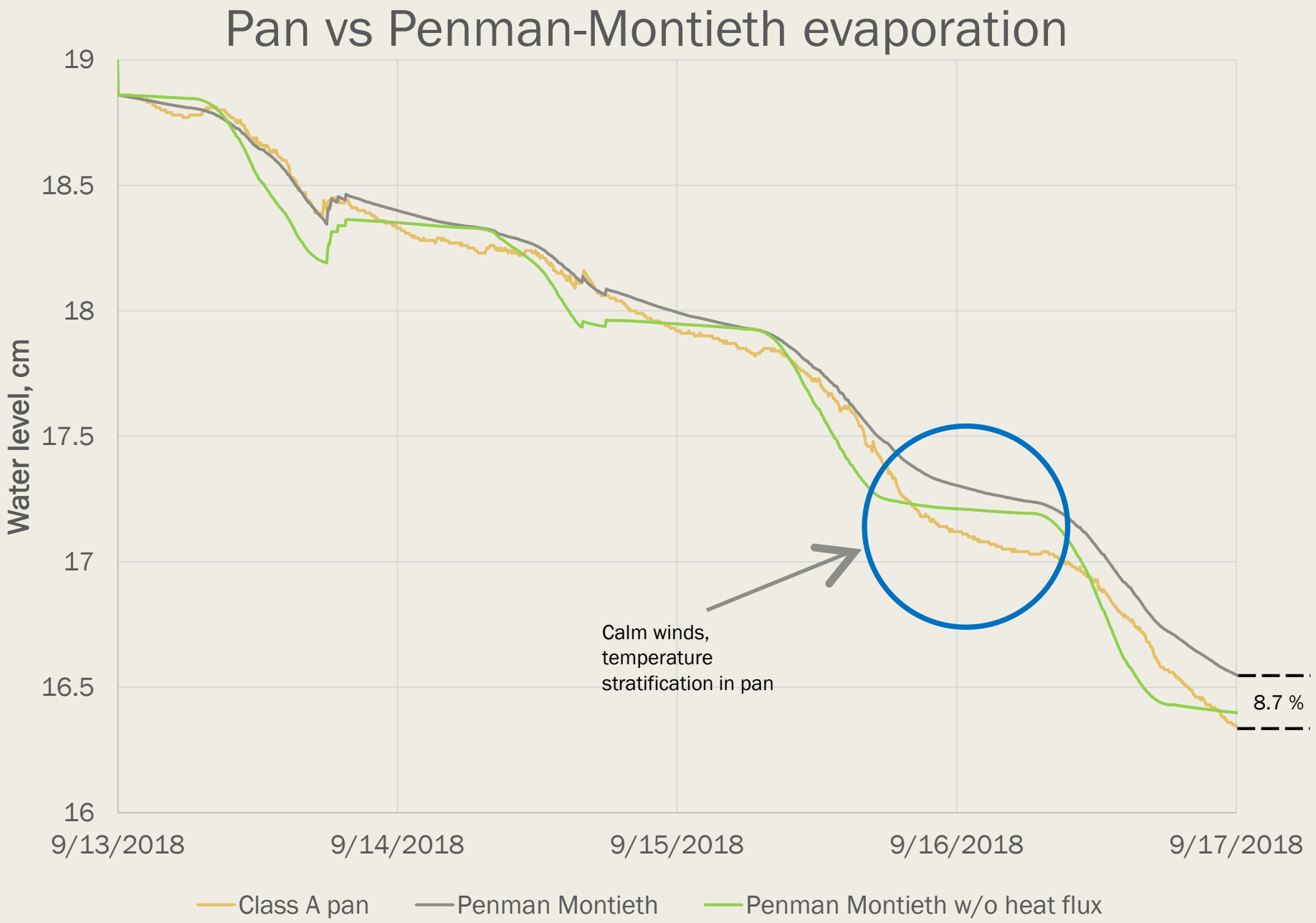


Measured and modeled pan levels



Measured and modeled evaporation losses for rain-free periods




Pan vs Penman-Montieth evaporation
Water level, cm
19
18.5
18
17.5
17
16.5
16
9/13/2018
9/14/2018
9/15/2018
9/16/2018
9/17/2018
Calm winds, temperature stratification in pan
8.7 %
Class A pan
Penman Montieth
Penman Montieth w/o heat flux

Field measurement challenges

- Lake system down March 2019 due to lightning strike
- Datalogger, modem, and several sensors destroyed
- Floating pan system problematic from the start
- On-going calibration issues
- Re-grouping for 2020

Questions?

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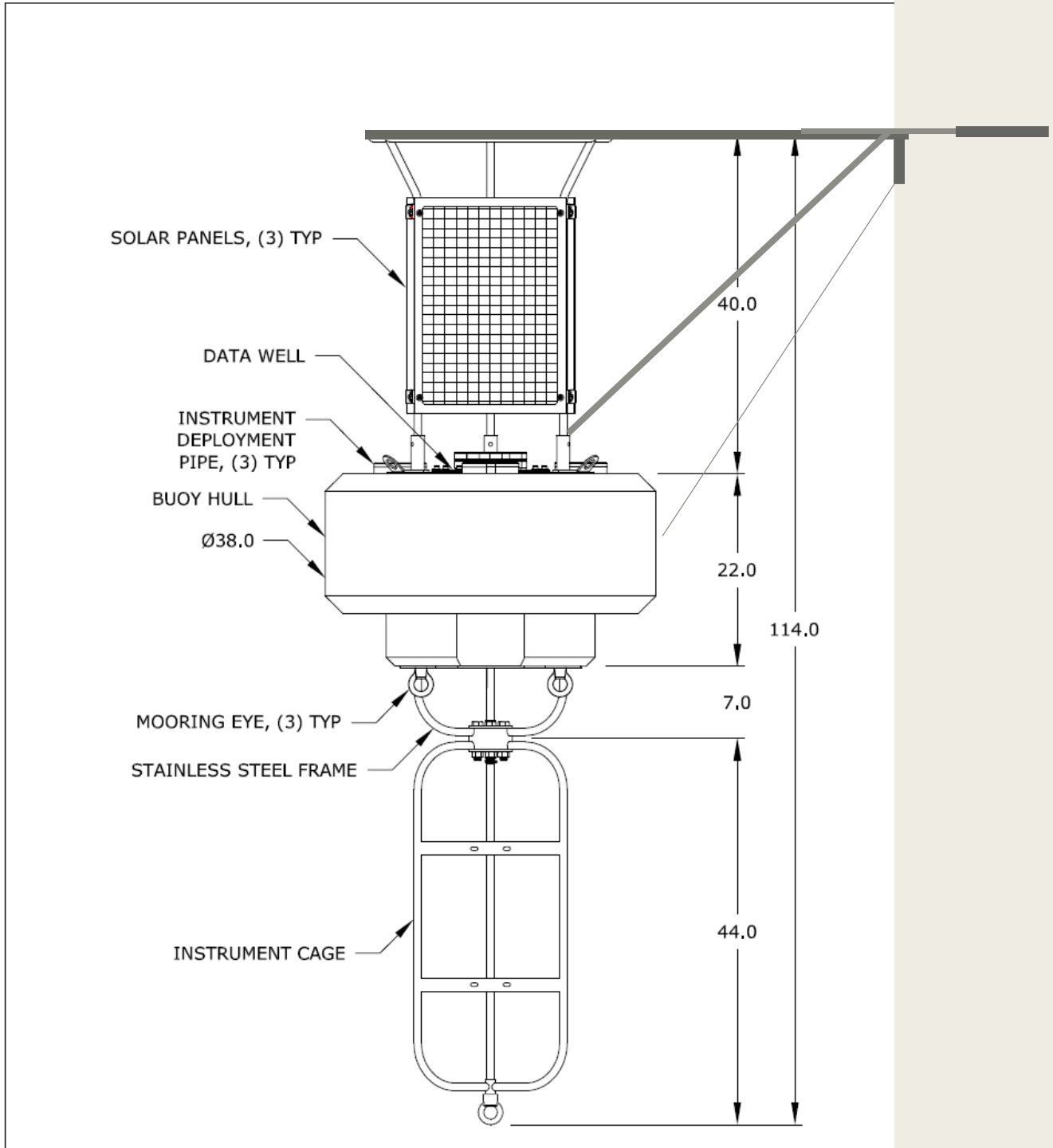
SOLAR PANELS, (3) TYP
DATA WELL
INSTRUMENT DEPLOYMENT PIPE, (3) TYP
BUOY HULL
Ø38.0
MOORING EYE, (3) TYP
STAINLESS STEEL FRAME
INSTRUMENT CAGE
40.0
22.0
7.0
44.0
114.0