MSS Modeling Assumptions Responses to Comments

June 30, 2023

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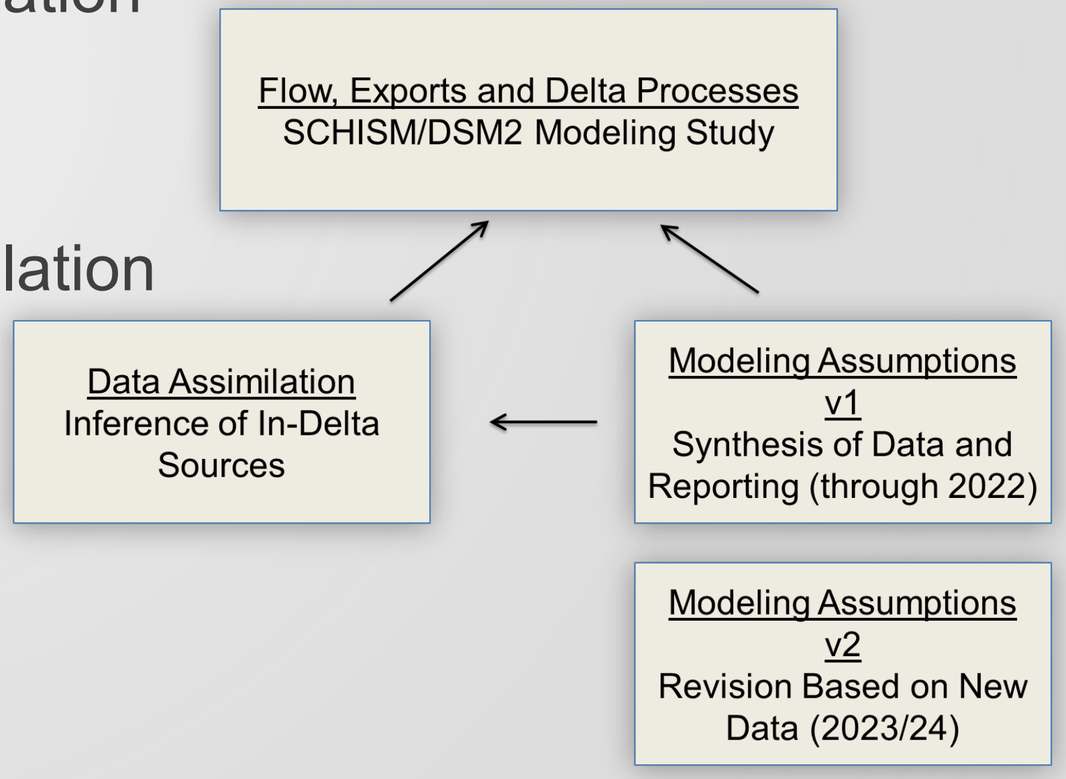
Topics

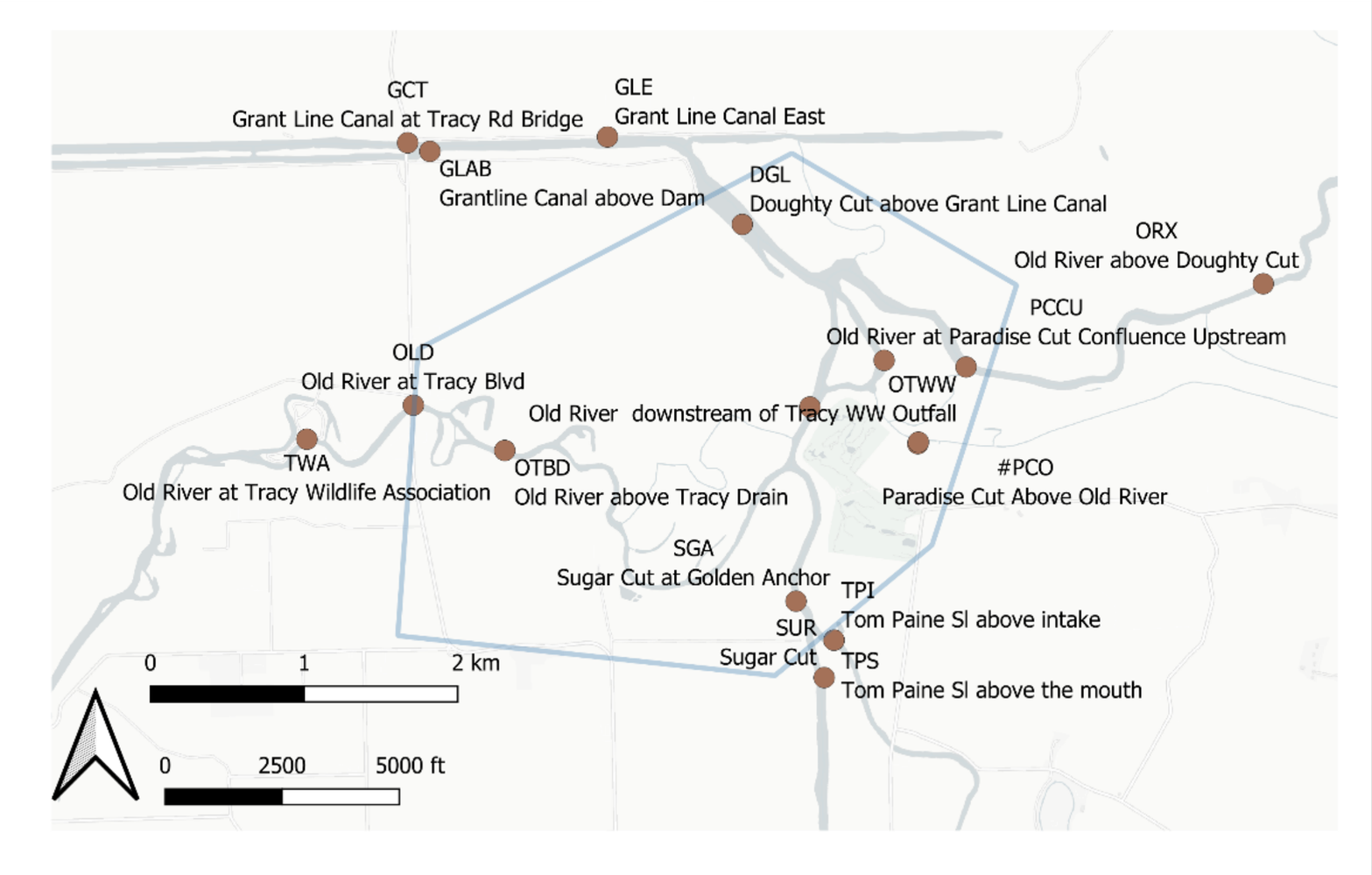
- *Assumptions* document scope
- Flow monitoring, averaging
- How DeltaCD/DCD fits in
- Specific stakeholder topics
  - Null Zone
  - Pescadero Circulation
  - Tidal Excursion and Doughty
  - Barrier Leakage
  - Source locations, Montoya transects
- Discussion and Next steps

Study Plan & *Assumptions* Document

- Modeling/analysis part of study plan
  - Main Study: interaction of flow, exports, in-Delta processes
  - Assumptions covers hard-to-quantify flows and circulation
    - Well-measured items (Vernalis flow, export volume) not discussed
    - Synthesizes incomplete, disparate information
    - Revision expected (Study Plan)
- Flow Assumptions based on observed data
- Needed for completion of main study and assimilation
  - Fine for items to be brackets
- Emphasis on improvement, sensitivity



Five Points Region



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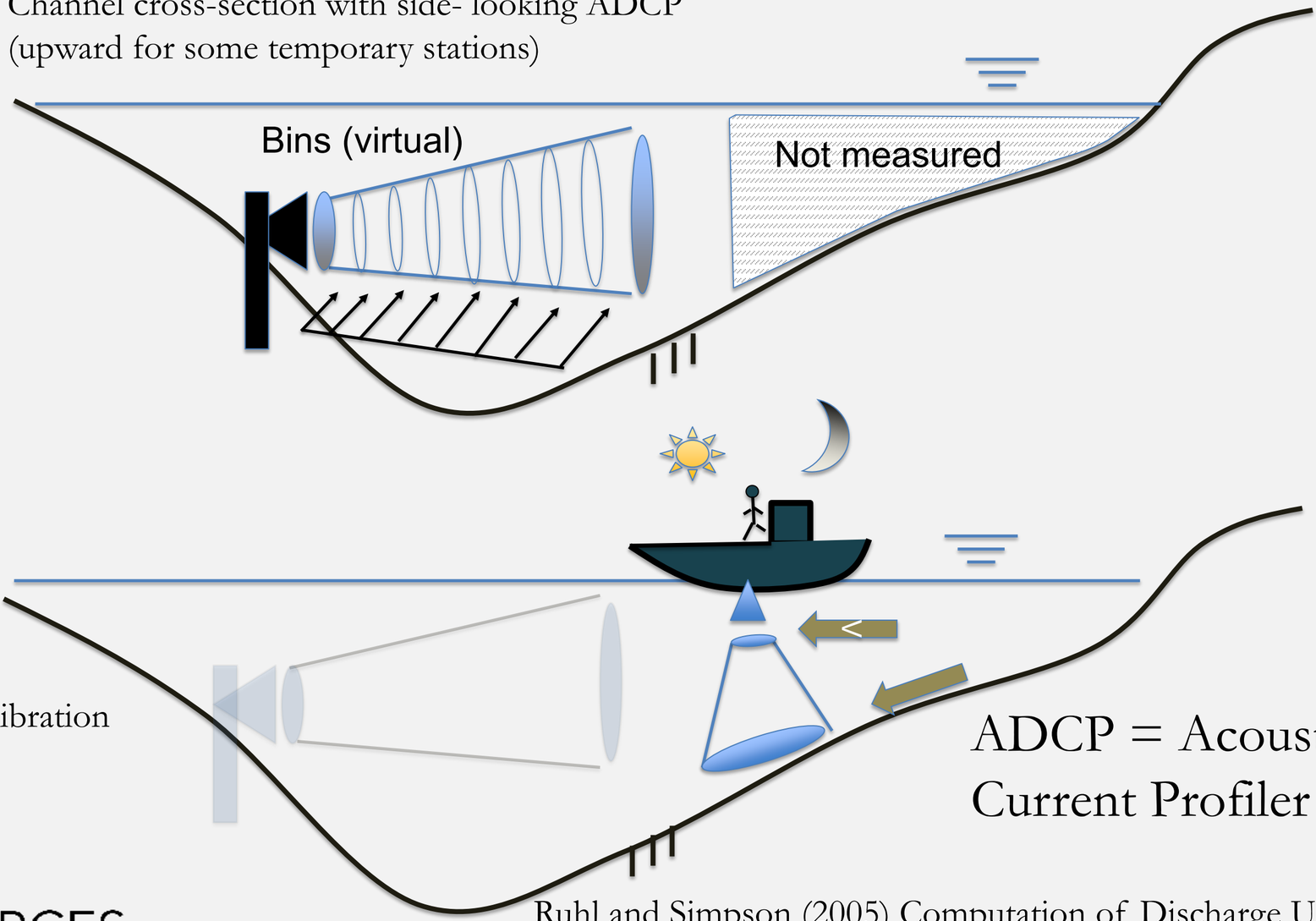
Note: This is our usage, not an official specific or customary definition.

FLOW MEASUREMENT AND ANALYSIS

Flow: Index Velocity Method

Channel cross-section with side- looking ADCP
(upward for some temporary stations)



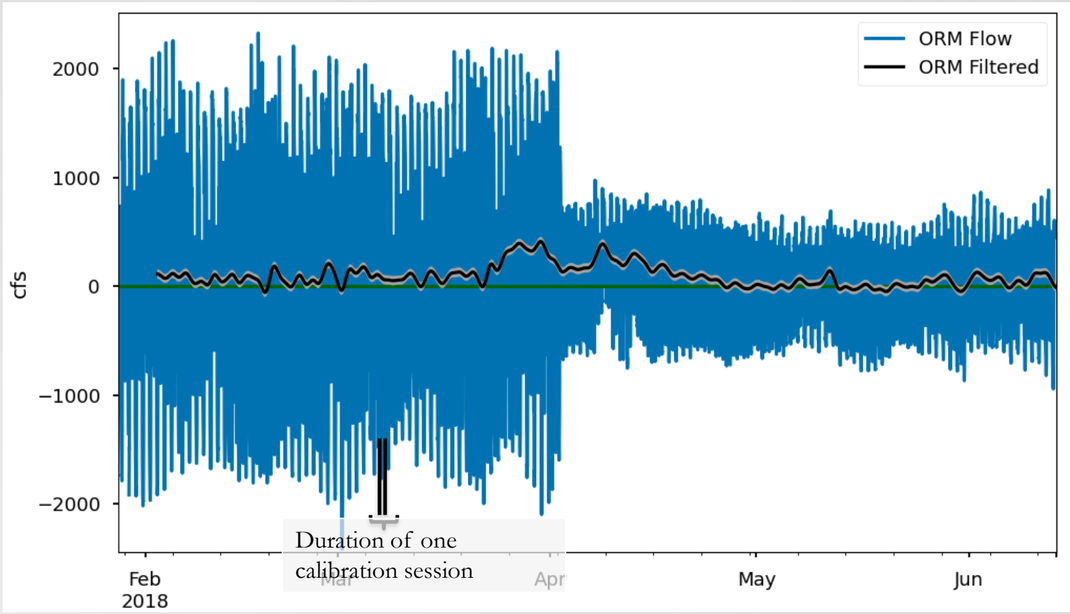
ADCP = Acoustic Doppler Current Profiler

Ruhl and Simpson (2005) Computation of Discharge Using the Index-Velocity Method in Tidally Affected Areas

The ADCP Station Rating Process

- Permanent instrument is side/up-looking
- Boat-mounted downward looking ADCP measures average velocity
- Rating: regress channel average velocity on index velocity:
  - Many possible forms
  - Simplest: $\bar{v} \sim a + bv_{index}$
  - PDC 2022: $\bar{v} \sim a + b * v_{index} + c * v_{index} * level$
  - Several gauges incompletely rated for barrier-in
- Bathymetric survey at site for stage-area relationship, Area(z)
- Final assembly of flow: (ave velocity) * (area)
- After swaps/damage starts from scratch (OMR in 2023)

Signal to Noise and Tidal Sampling



- Net flows small compared to tidal
- Calibration runs last ~25 hours, so few samples at tidal day time scale
- Squared energy in the low frequencies is small, so “bass” sacrificed to “treble”
- A flow station can have acceptable % error and still be biased on direction
- Flow rating issues are usually scaling/shift/distort, but:
  - Still produce the correct timing of subtidal wiggles
  - Do not flip sign (e.g. OLD barrier-in index velocities are most/all positive, flow is positive)

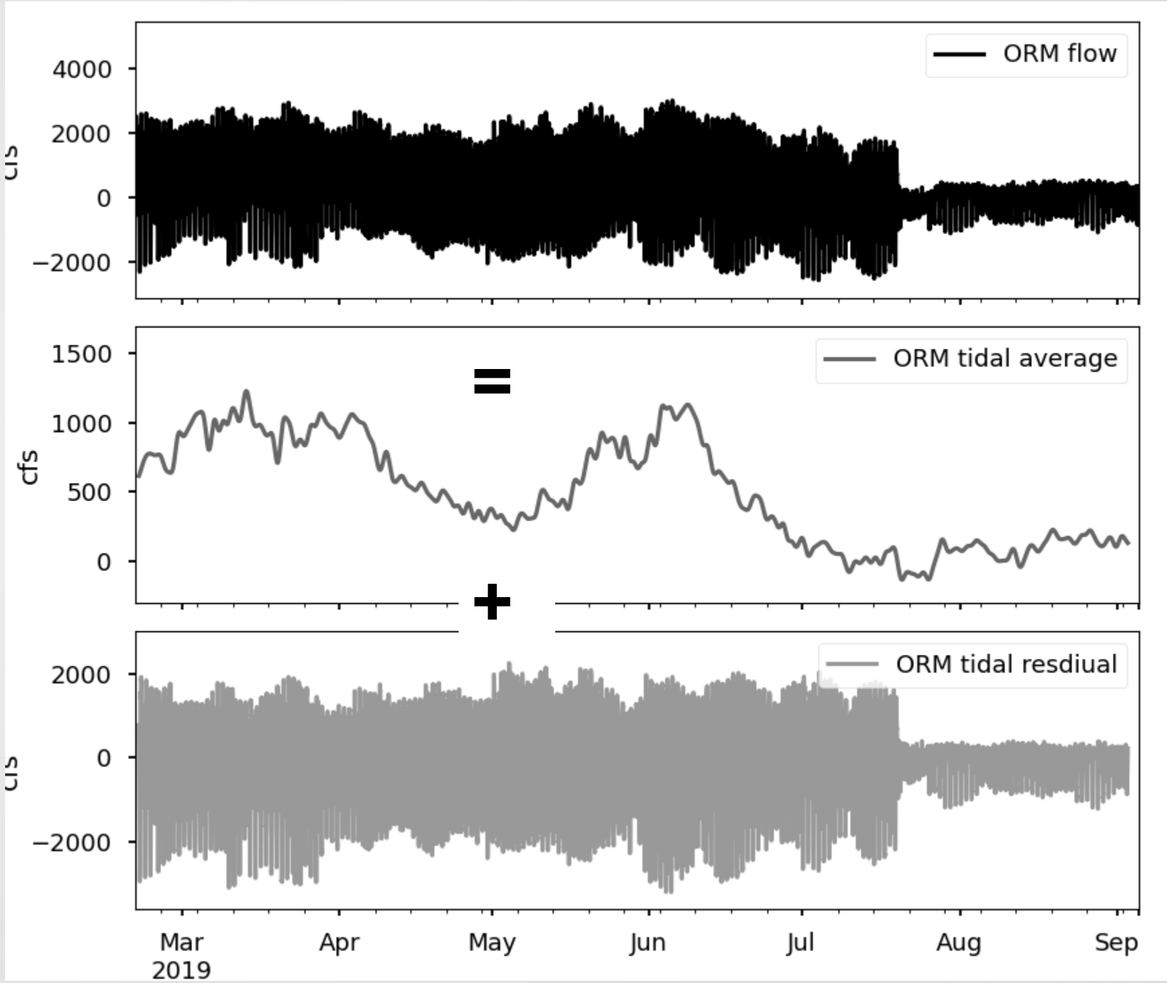
Flow Averaging

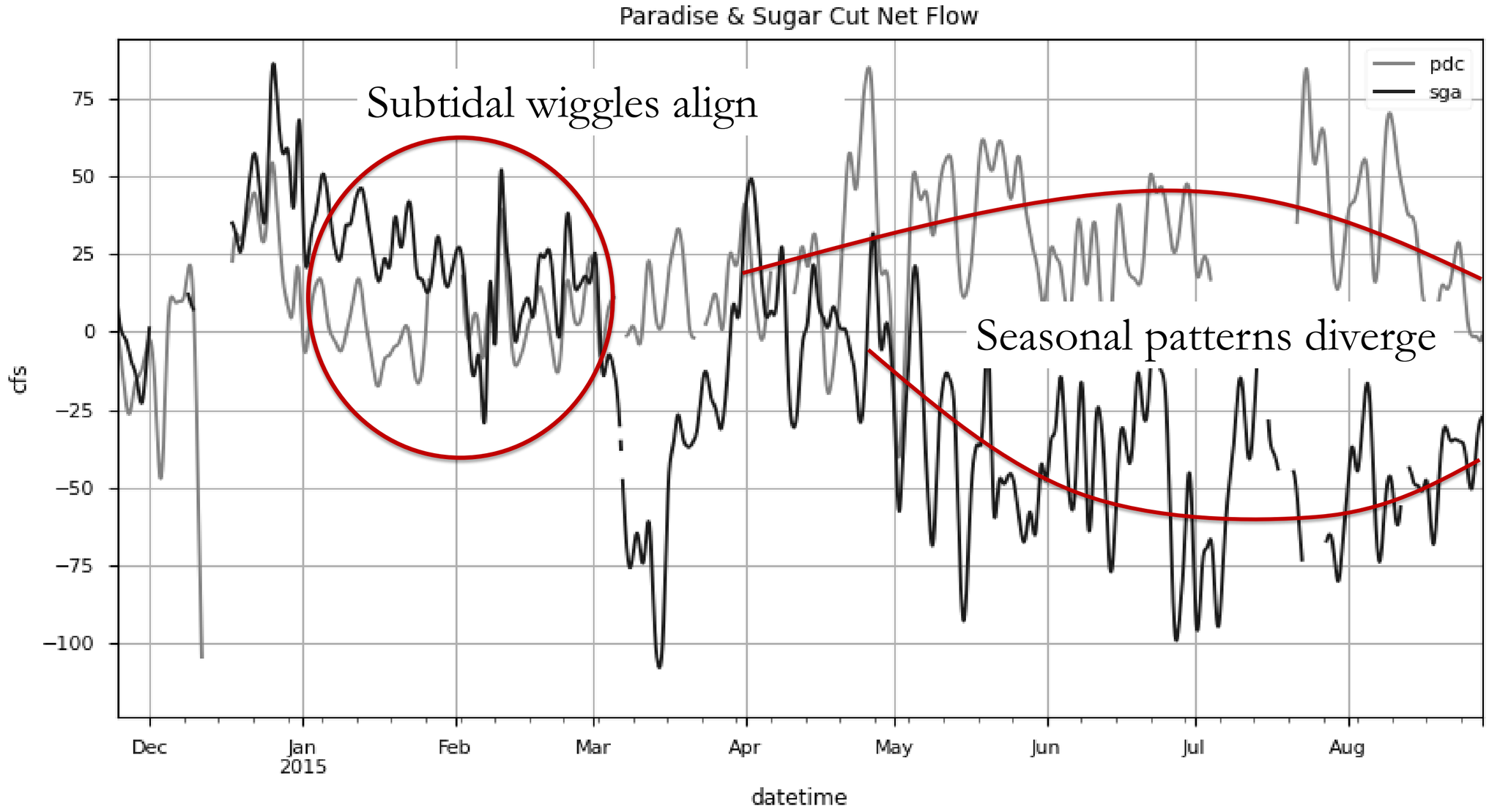
- Tidal quantities can be “filtered” into
  - Tidal average or mean
  - Residual fluctuation around that average
- Fluxes similarly into:
  - Mean flow transport
  - (Mean) dispersive transport
- Terms:
  - Subtide
  - Mean tide
  - Tidal average
  - ***Daily average (5% rule)***
  - Godin average
  - **Cosine-Lanczos**
  - **SCHA (Ateljevich and Wang, 2023)**

Conceptual

↓

Implementation





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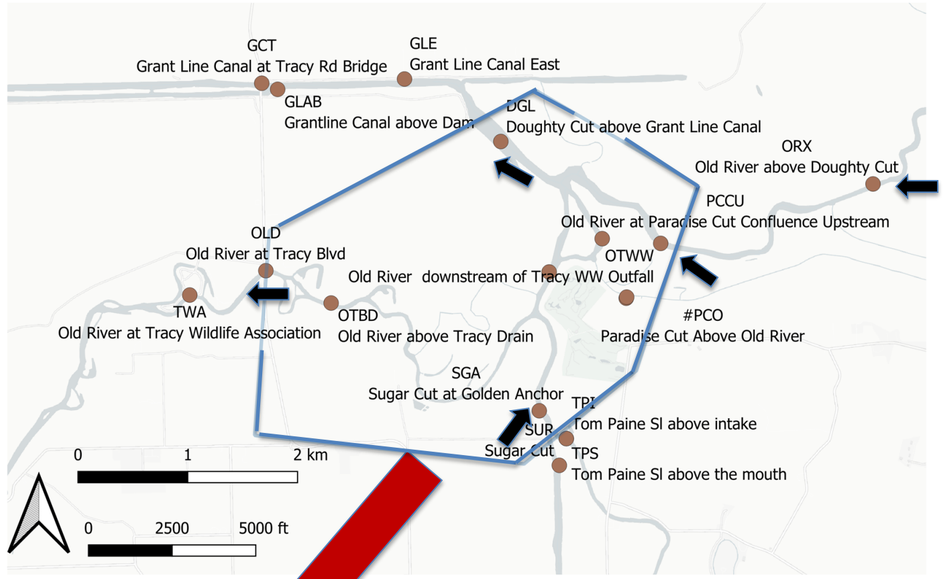
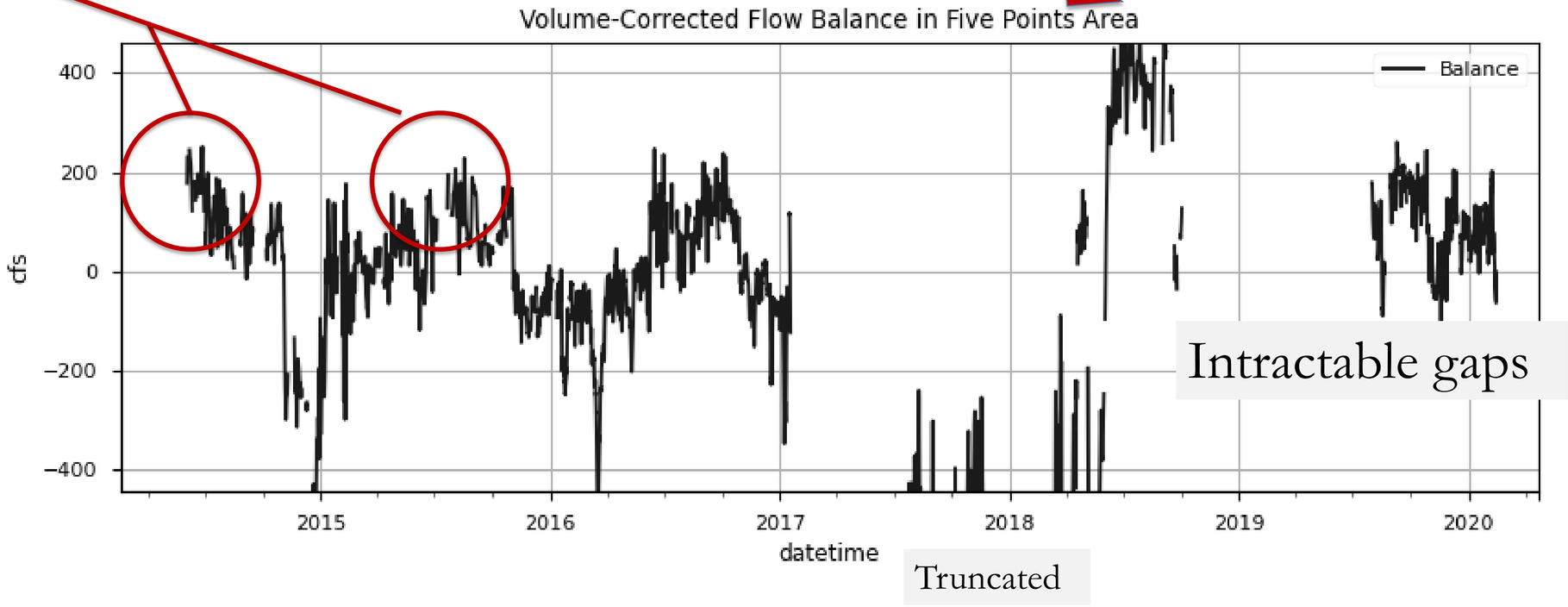
Signature of Pescadero but Upstream in W
Magnitude ??

Peaks 2015/2016: 150-175 cfs

In –
Out
(+)





Intractable gaps

Truncated

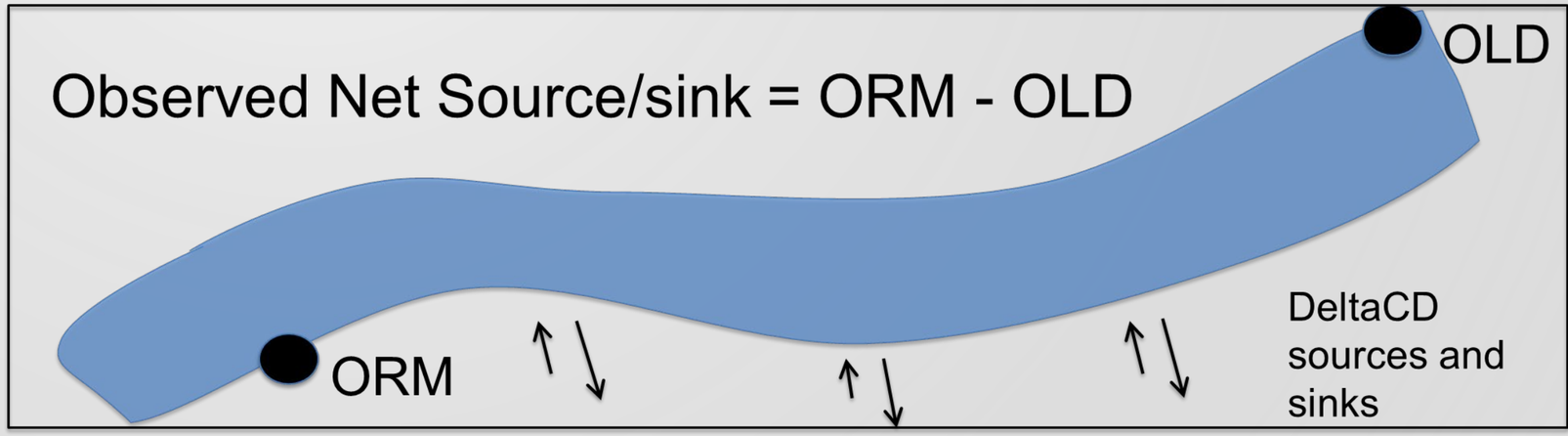
DCD/DELTA CD

DETAW/ DeltaCD/ DCD Terms

- DETAW: estimates water demand (UCD):
- DCD: maps demand from islands to channels
  - using distribution factors
- DeltaCD: Reimplements the code more cleanly
  - easier to adapt to local/improved information

DeltaCD and Observations

- Channel depletions model can be used:
  - Standalone: offline estimate of seepage/diversion/return (traditional)
  - Targeted: Approximately convey observed/reported depletion
- DSM2/SCHISM must organically produce
  - Flows on channels
  - “Null” phenomena



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Advantages and Disadvantages of DeltaCD

Pro

- Complete spec: sources/sinks
  - eWRIMS = sinks only
  - Flow diff = net only
- Few anomalies and gaps
- Way to check against land use
- Prediction and planning

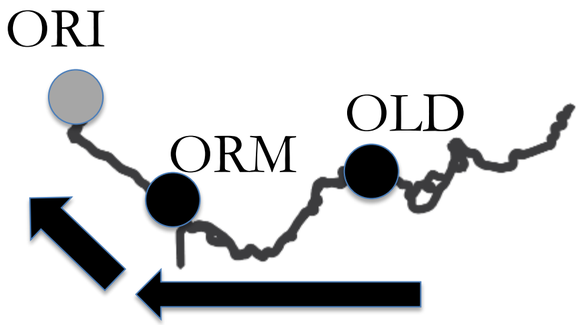
Con

- Approximate/seasonal match to observations

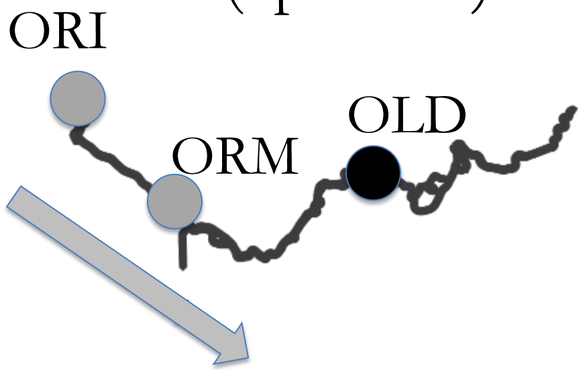
NULL ZONE

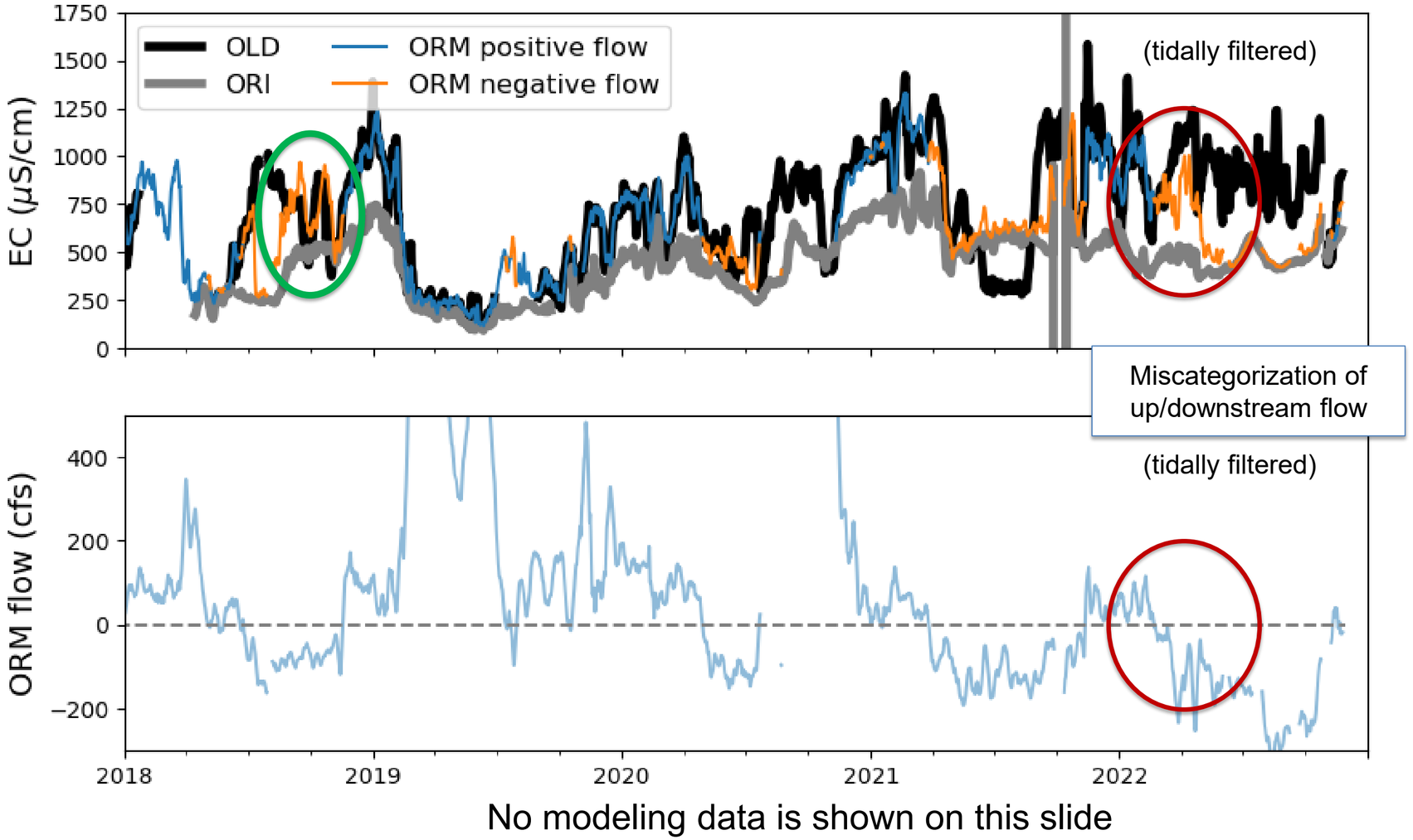
Observed EC Propagation

Net Positive Flow
(downstream)



Net Negative Flow
(upstream)





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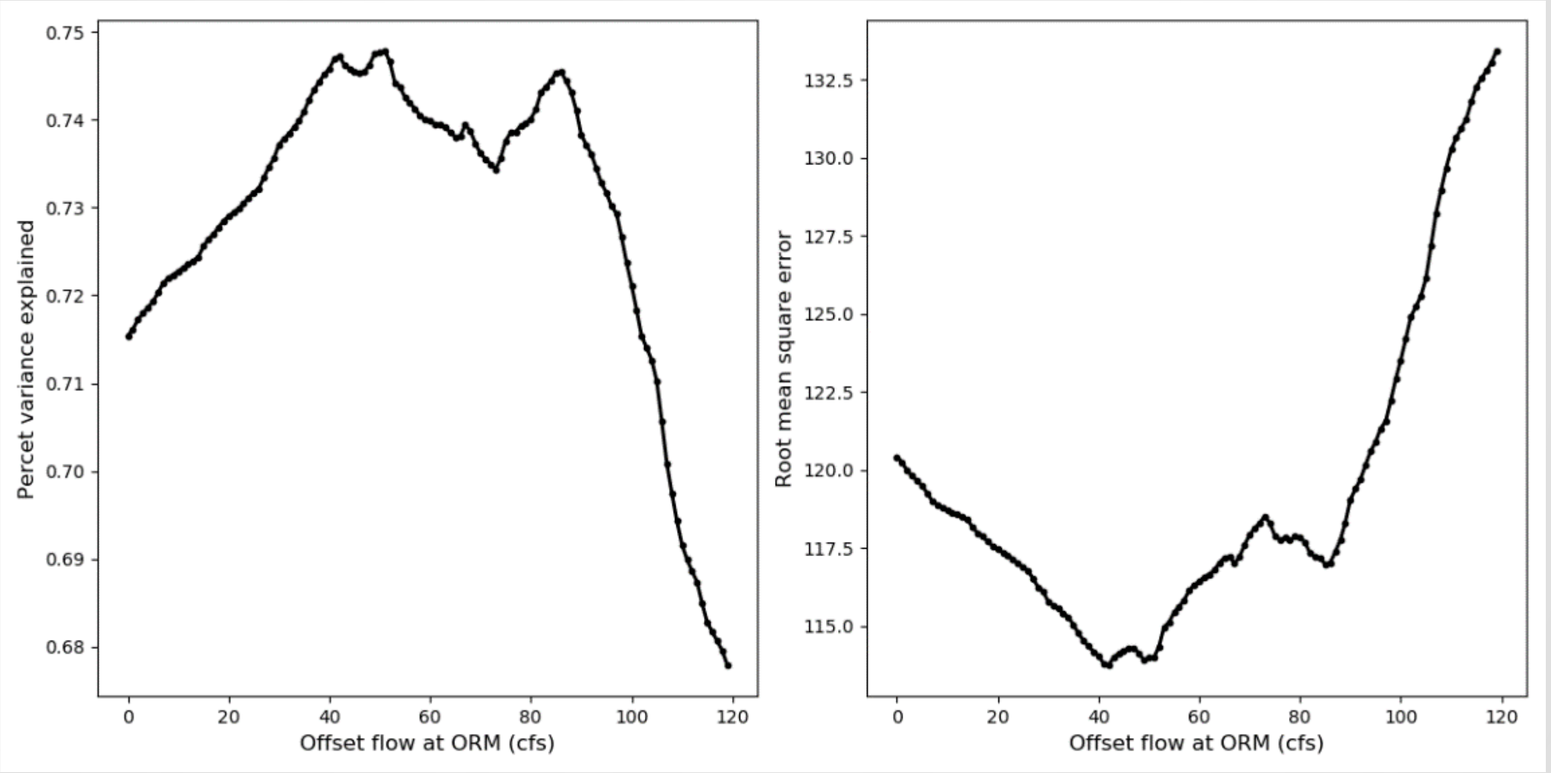
Flow Adjustment and EC Agreement



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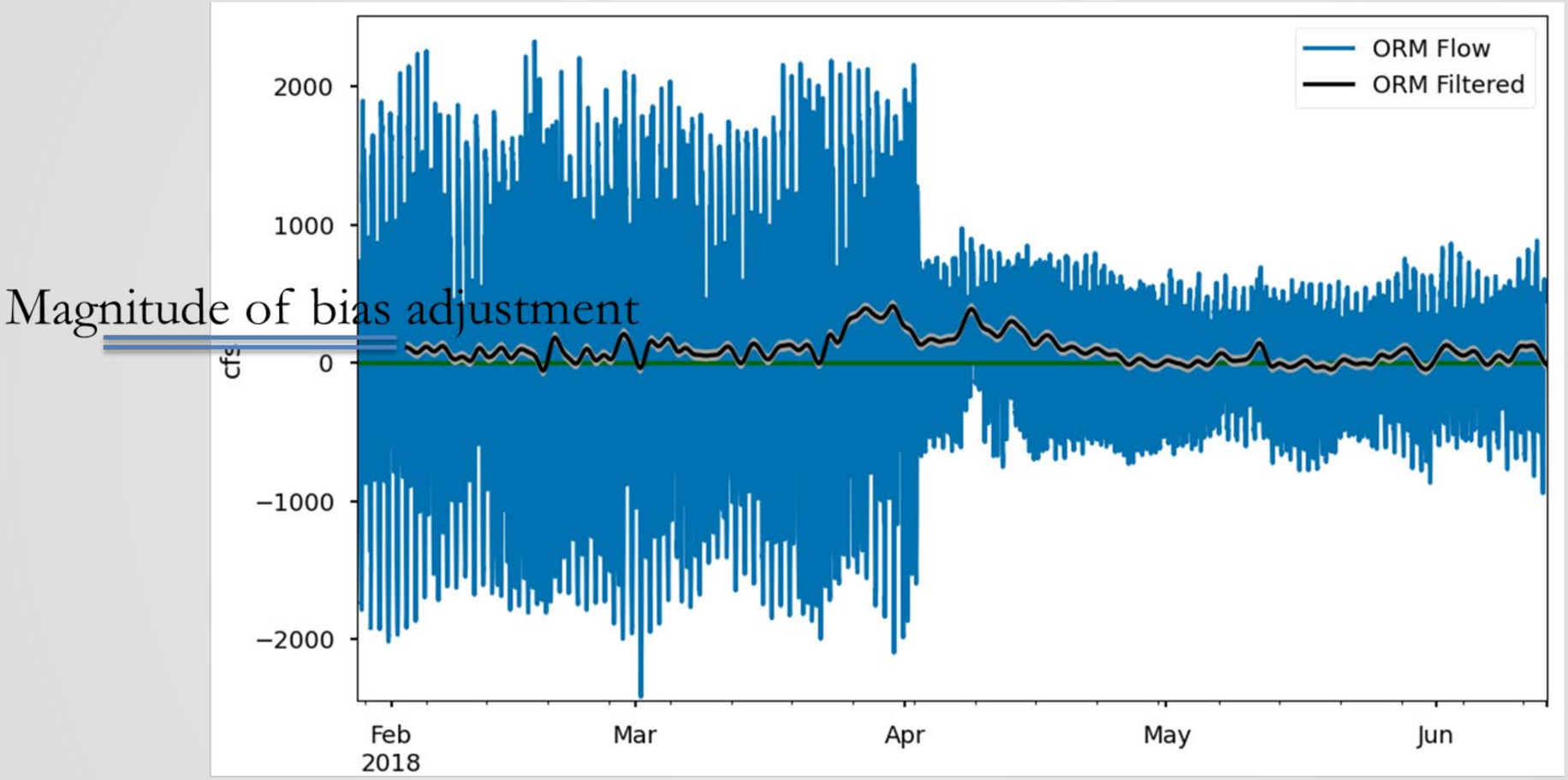
What Magnitude Change is Indicated*?



* How far to go with EC direction correction is arbitrary. This is based on variance of OMR EC explained by a single scalar correction.

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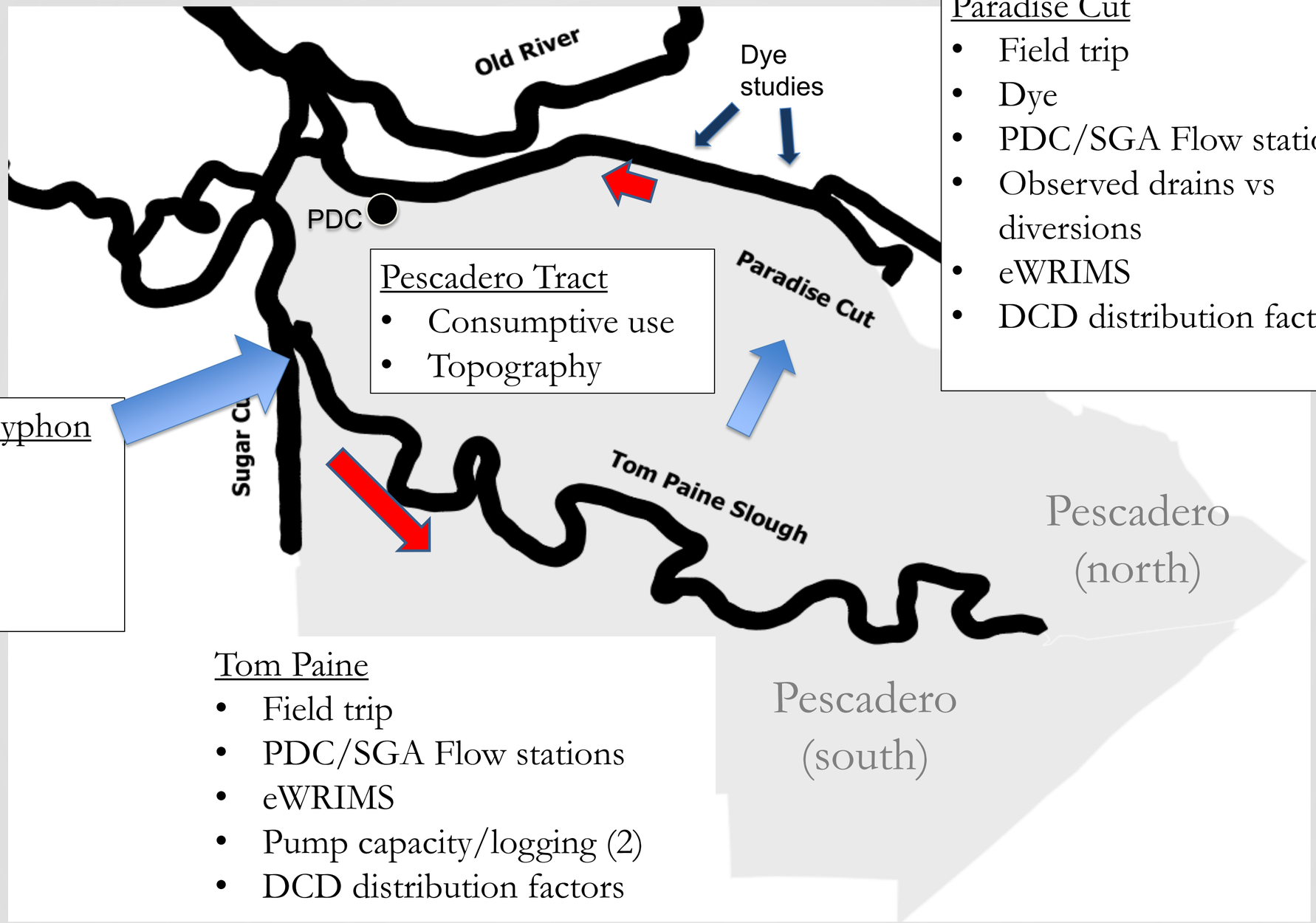
Null Zone: Conveying to Model

- ORM part of flow uses adjusted ORM
  - But the adjustment is a minor part of discussion
- DeltaCD based (may miss exceptional years)
- Mostly based on relocation of diversions:
  - Agrees with eWRIMS
  - Agrees with Siegfried (2014)
- Does use adjusted efficiency/groundwater

PESCADERO TRACT FLOW PATTERNS



Paradise Cut
- Field trip
- Dye
- PDC/SGA Flow stations
- Observed drains vs diversions
- eWRIMS
- DCD distribution factors

Pescadero Tract
- Consumptive use
- Topography

Barrier/culvert/syphon
- Tidal ops
- Closed
- Open
- Syphon

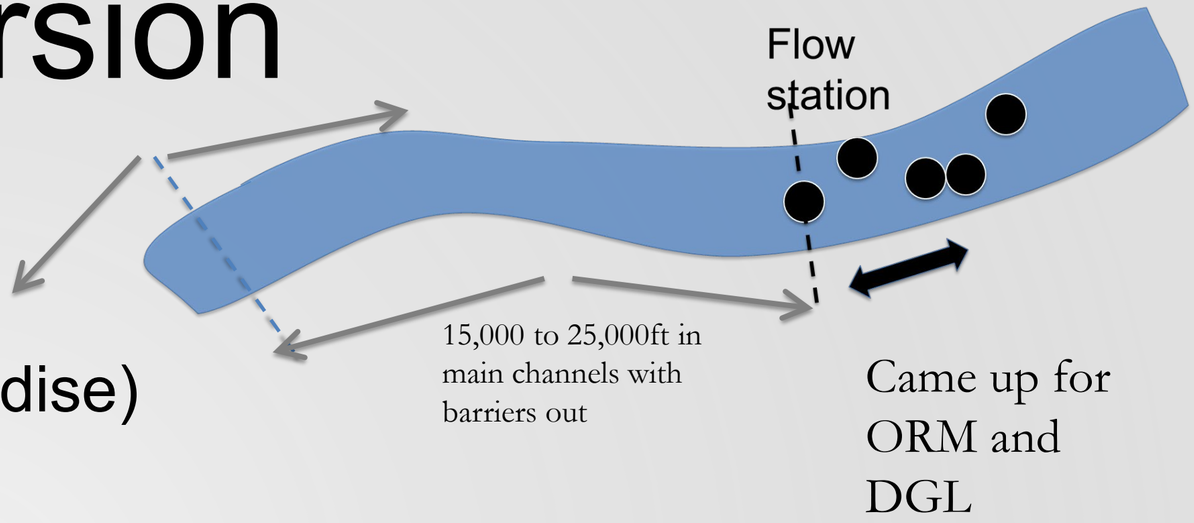
Tom Paine
- Field trip
- PDC/SGA Flow stations
- eWRIMS
- Pump capacity/logging (2)
- DCD distribution factors

Improvement

- Demonstrate implications of verbatim flow using DSM2/SCHISM
  - Overruns South Delta in both models
- Use DCD x2 and DCD x3 and show sensitivity
  - We prefer this to an “optimal” flow based on model fits
- Collaborative science
  - Monitor volume and EC at drains
  - In a designed experiment, with some assumptions, this can quantify other influences.
  - Basis for describing ionic composition

TIDAL EXCURSION AT ORM AND DOUGHTY CUT

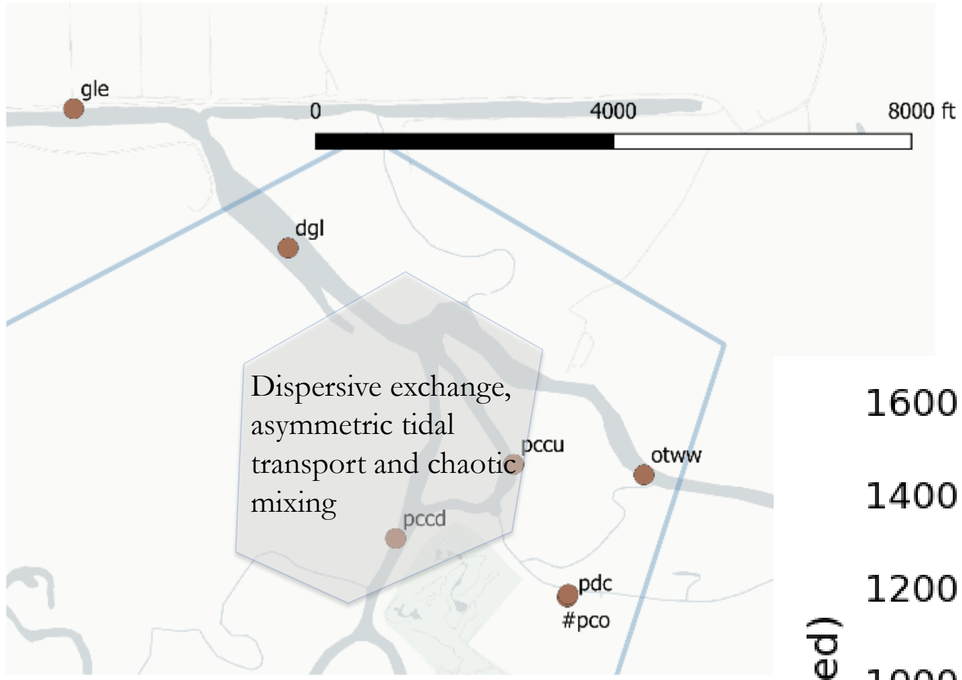
Tidal Excursion

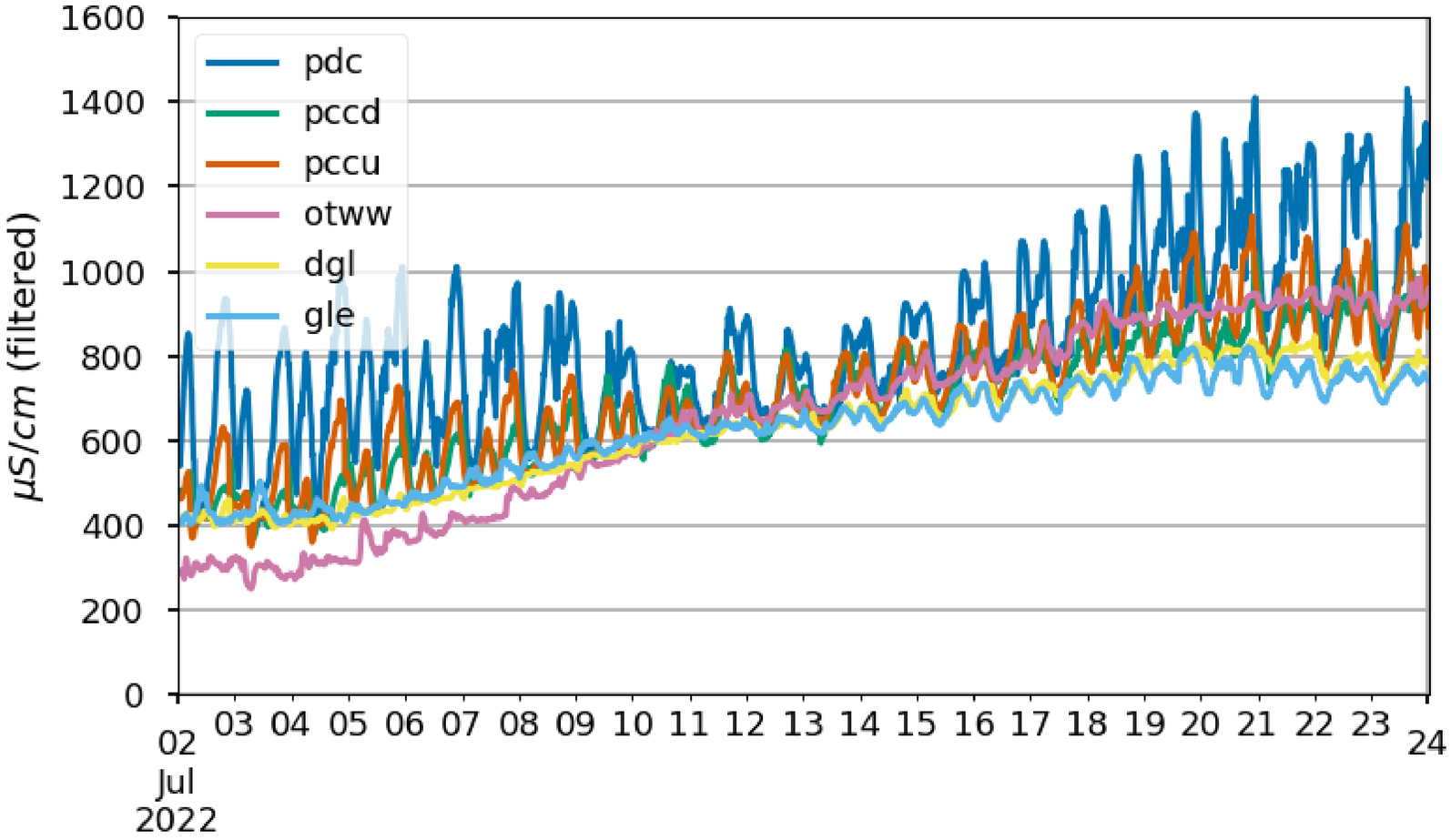


- Lagrangian measures:
  - Drifters
  - Dye centroid (~1000-2000 ft in Paradise)
  - Particle tracking models
- Eulerian approximation by integrating velocity at flow station:

$$x(t) = \int (u - \bar{u})dt, \qquad x = position\ u = velocity, \bar{u} = mean\ vel, t = time$$

- Qualitative:
  - Tidal range of EC flat? Not much gradient within excursion
  - Does tidal excursion of one station include another?
    - Overlap in EC during periods of strong gradient:
    - Amplitude versus Range perspective


gle
0
4000
8000 ft
dgl
Dispersive exchange, asymmetric tidal transport and chaotic mixing
pccu
otww
pccd
pdc
#pco


pdc
pccd
pccu
otww
dgl
gle
µS/cm (filtered)
1600
1400
1200
1000
800
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400
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02
Jul
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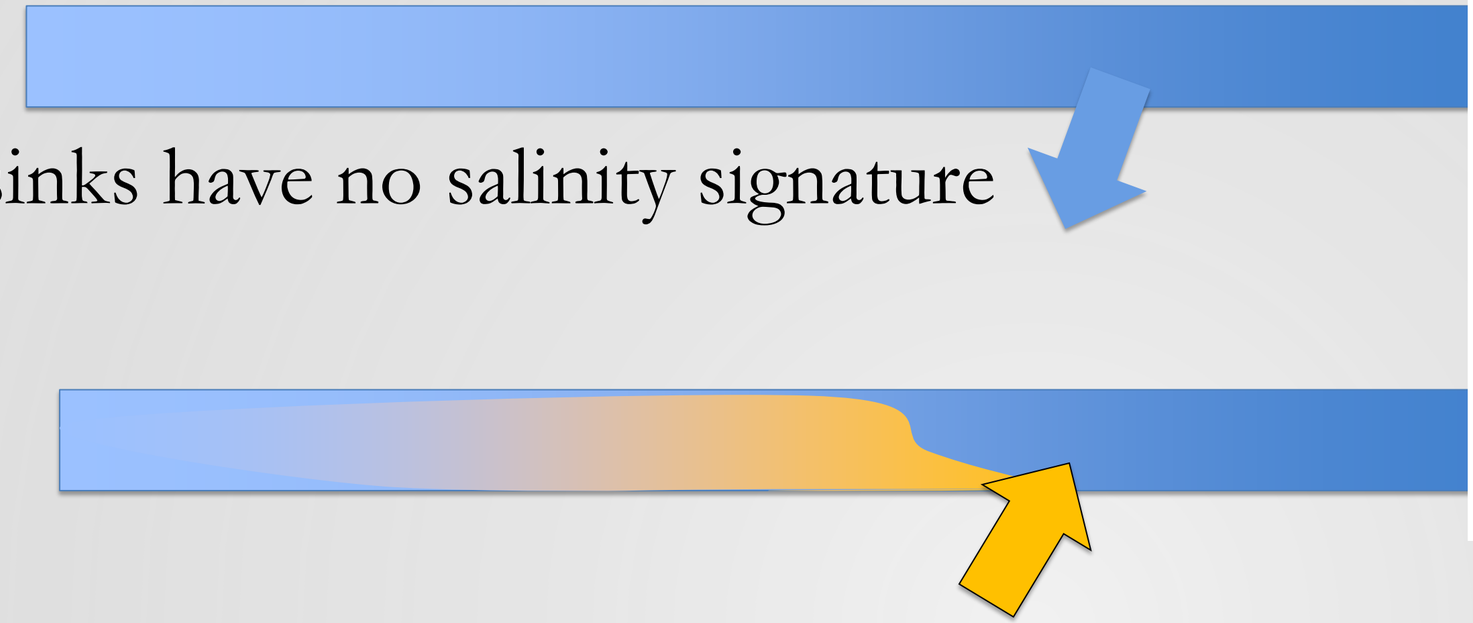
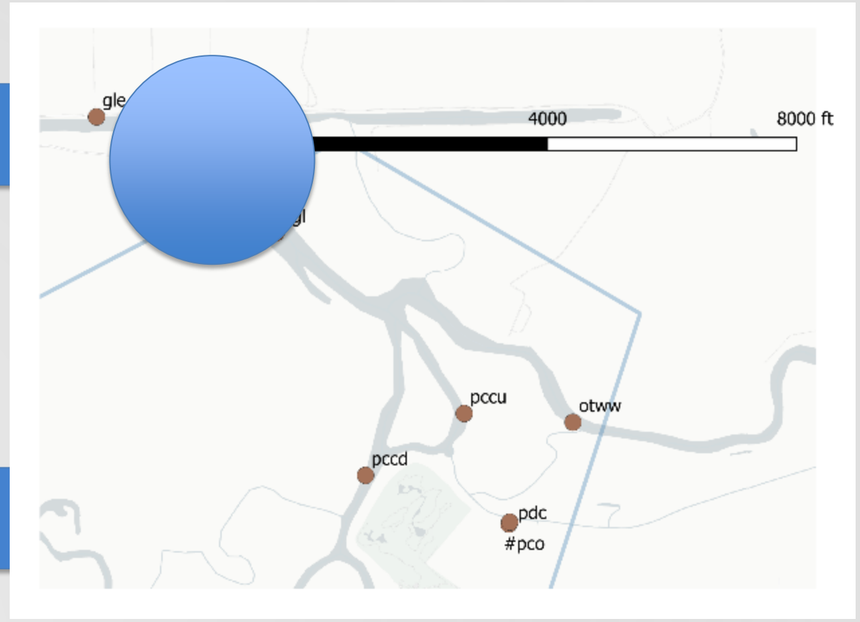
03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23
24
datetime



Flow sinks have no salinity signature



“Significant” sources have a salinity signature

Indirect but seemingly reliable:

Flow sources have different time varying salinity then ambient.

No salt source/change also suggests no water source

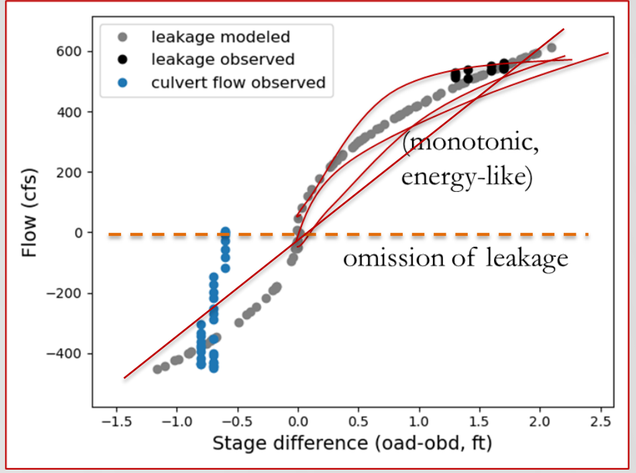
Doughty: Bottom Line

- Doughty and GLE highly redundant in the long term for EC, will note ***
- Description about no significant EC gradient within a tidal excursion of Doughty of questionable value and accuracy: will change.
- Assertion “no sign of an EC or flow source” between DGL will be made more specific
- Five Points area mixing is under study and will be important for data assimilation correctness. Strong gradients

BARRIER LEAKAGE

Leakage

- Orifice equation: $Q = CA(z)\sqrt{2g(z_{up} - z_{down})}$
  - Comes with SCHISM and DSM2
  - Uncertain aperture and energy loss bundled with C
  - Alternative is Darcy Equation, but linearity not apparent
  - West False River data may help confirm/change eqn.
- Data are sparse
  - Weir overtopping confounds leakage
  - No installation in 2023
  - Ideally, measure 0.5ft of difference
- Sensitivity to details not expected
  - Will be quantified in v2

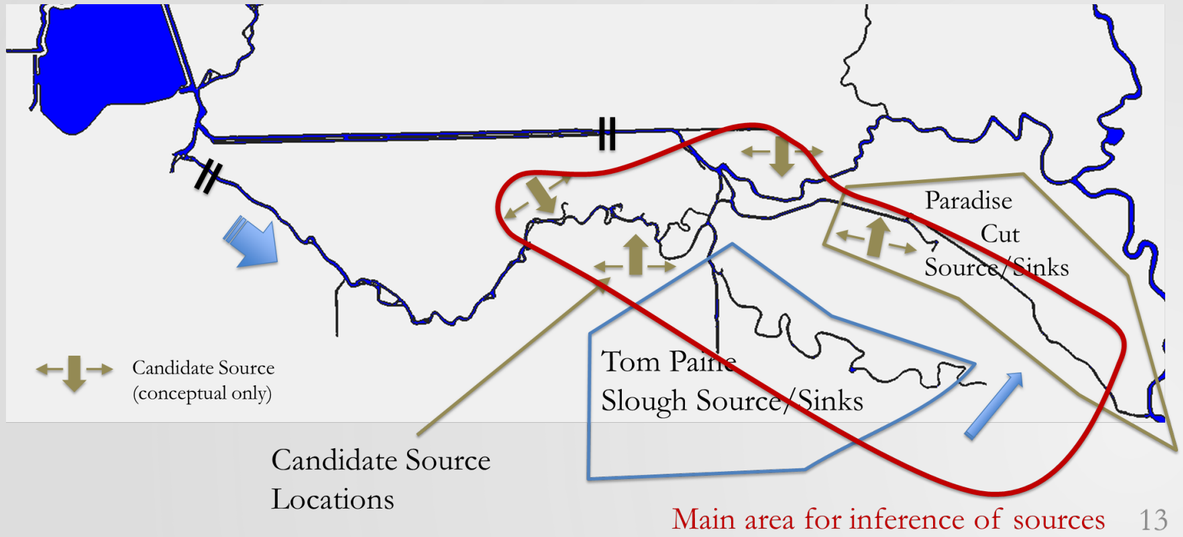


Given that the barrier leakage is arguably the most impactful change, the leakage curve needs to be justified. At a minimum, the paper should explain how leakage was modeled. Figure 16 shows flow of 0 cfs at 0-ft stage differential and the estimated leakage (black circles) for elevation differences of 1.3 ft to 1.7 ft. There are no other data points to support or validate the leakage curve …

Source Regions

- Candidate regions
  - Proof of concept: Montoya
  - Hypothesis test: reduced set
- Differences btw Montoya/current transects

Source Regions

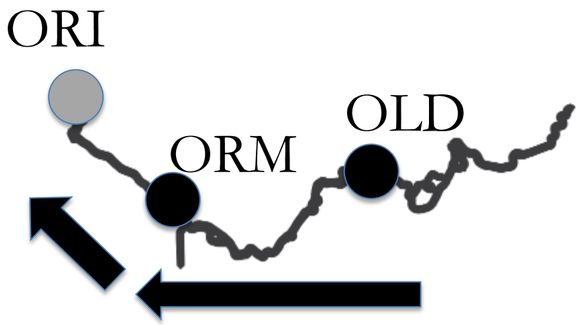


The fact that EC introduced outside this region does little to improve the modeled EC does not speak of the observed data. For instance, field measurements of EC published on CDEC, and a 2012 transect study (Montoya 2012) suggest that could EC potentially originate downstream of the area denoted in Figure 2.

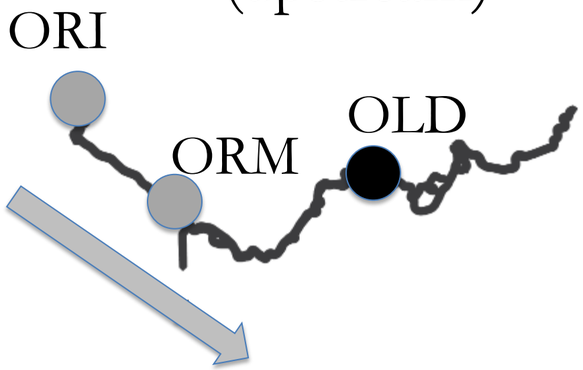
- Candidate regions
  - Proof of concept: Montoya
  - Hypothesis test: reduced set
- Montoya transects suggest significant downstream sources
- Continuous stations do not

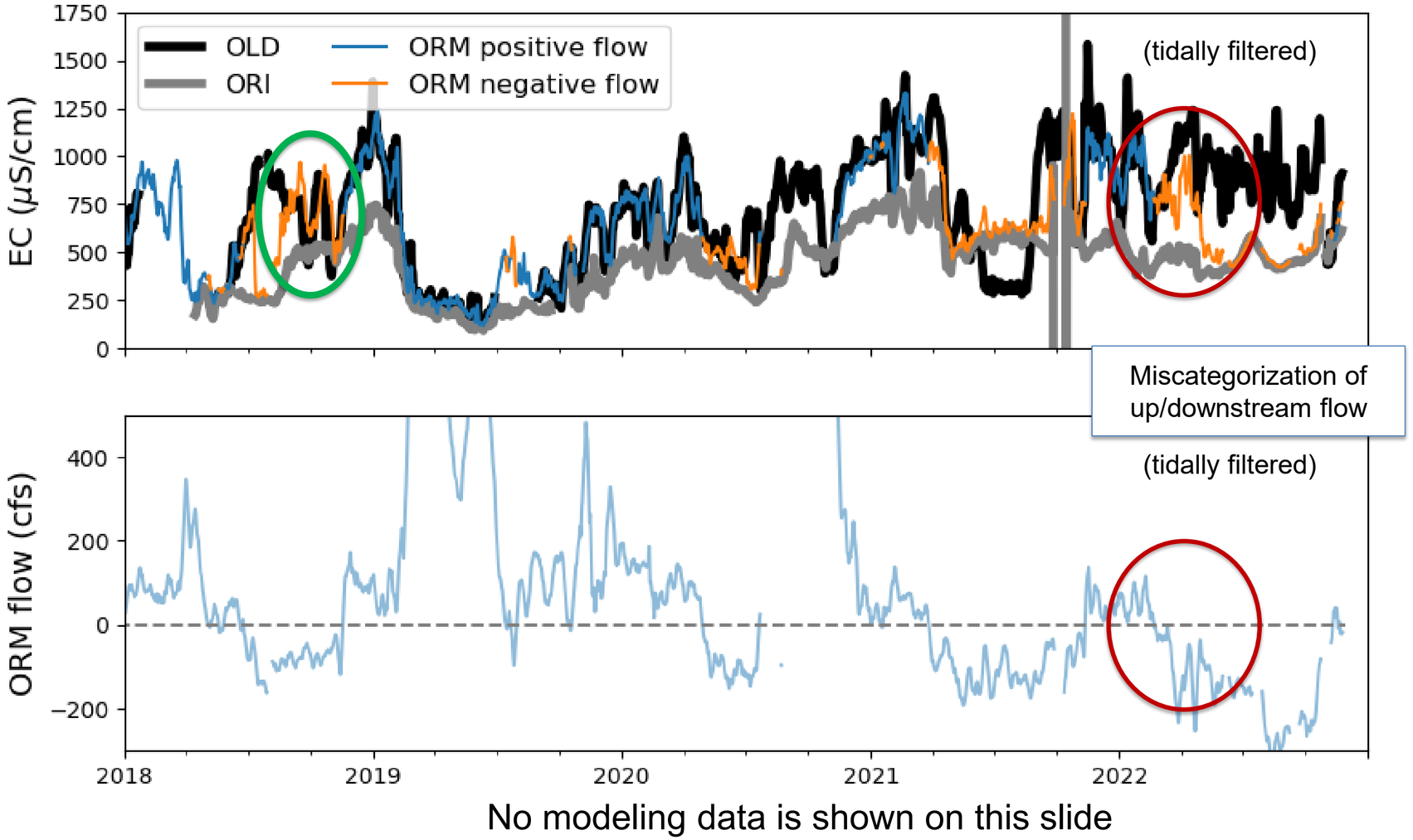
Observed EC Propagation is Obvious!!

Net Positive Flow
(downstream)



Net Negative Flow
(upstream)





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Key Montoya (2012) Results

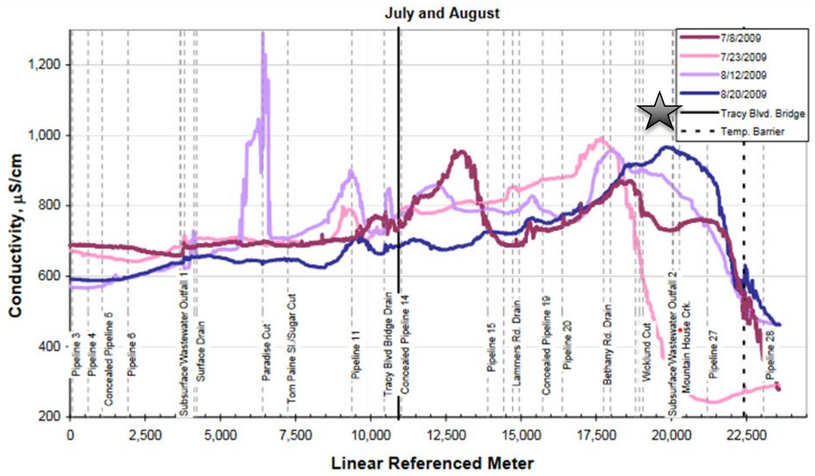

Figure 6. South Old River transects conducted during July and August

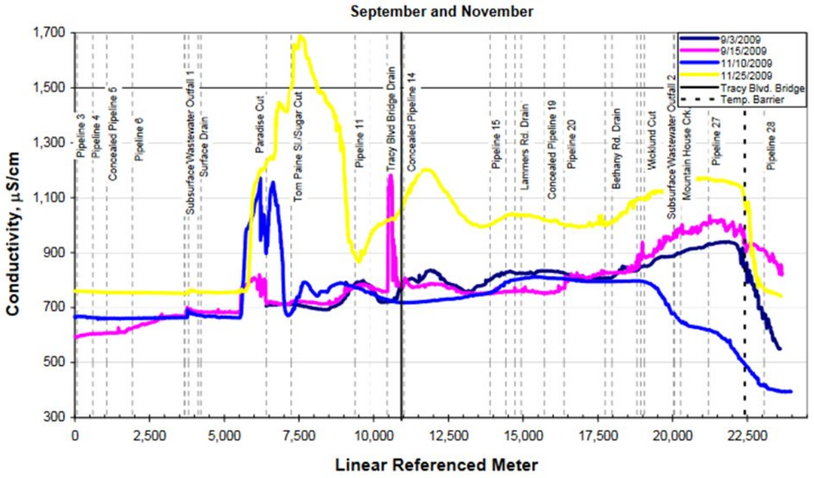

Figure 7. South Old River transects conducted during September and November

EAST

- Numerous interesting “bumps” indicating possible source locations
  - but many during anomalous conditions near OLD not repeated since 2010, e.g. OLD-TWI relationship June 2009 – March 2010

WEST

- Suggests increase in salinity from Tracy Blvd to near Mountain House

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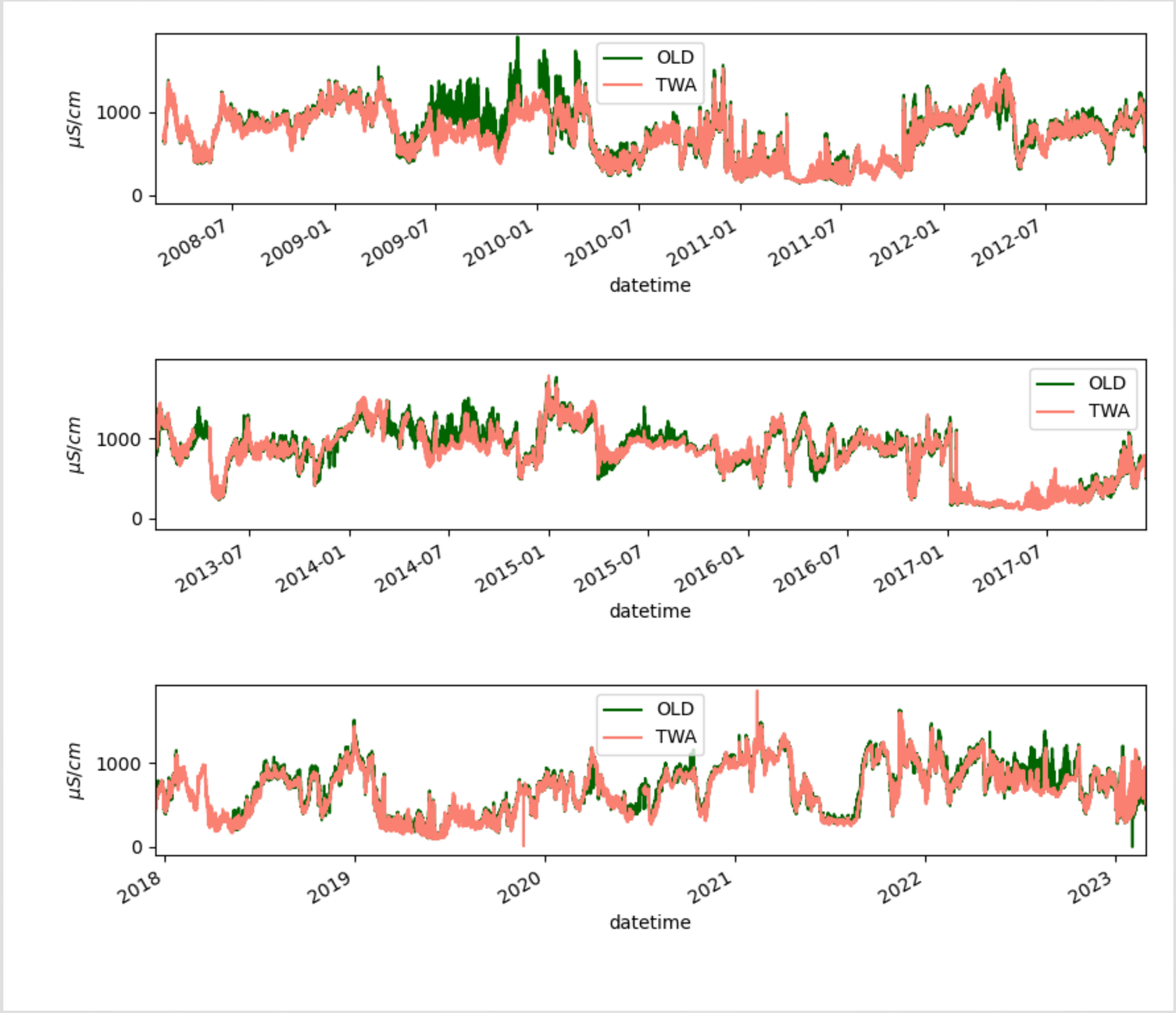
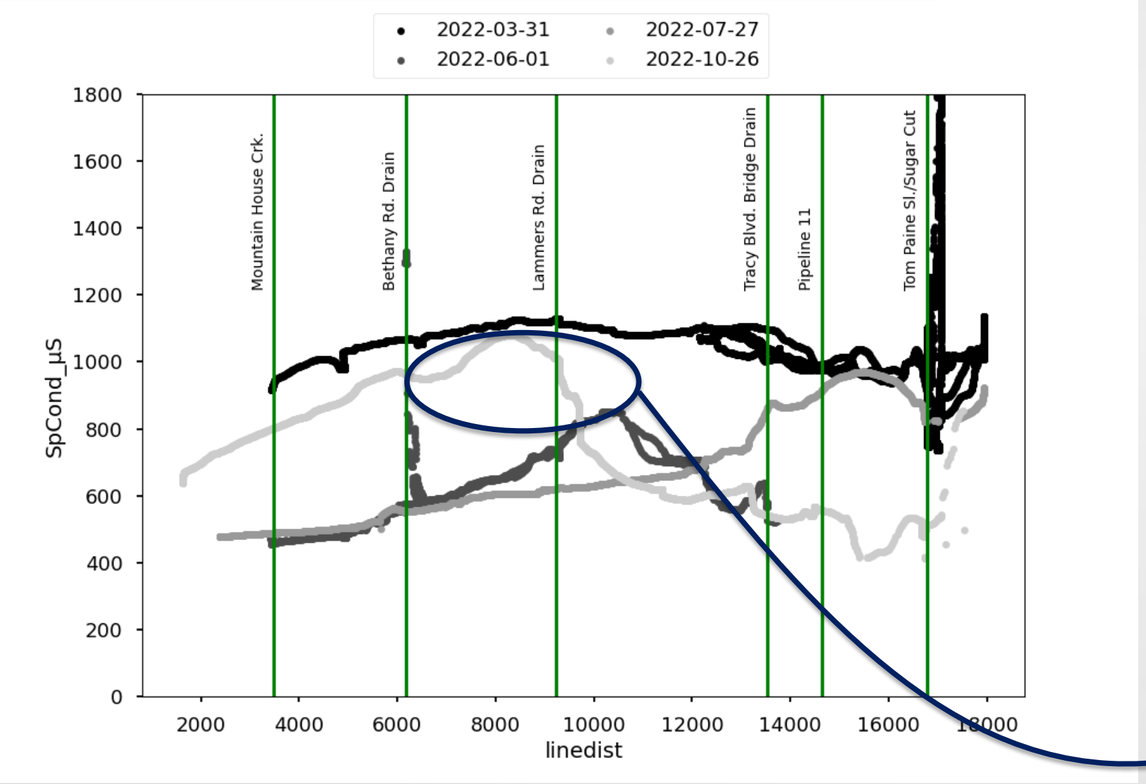
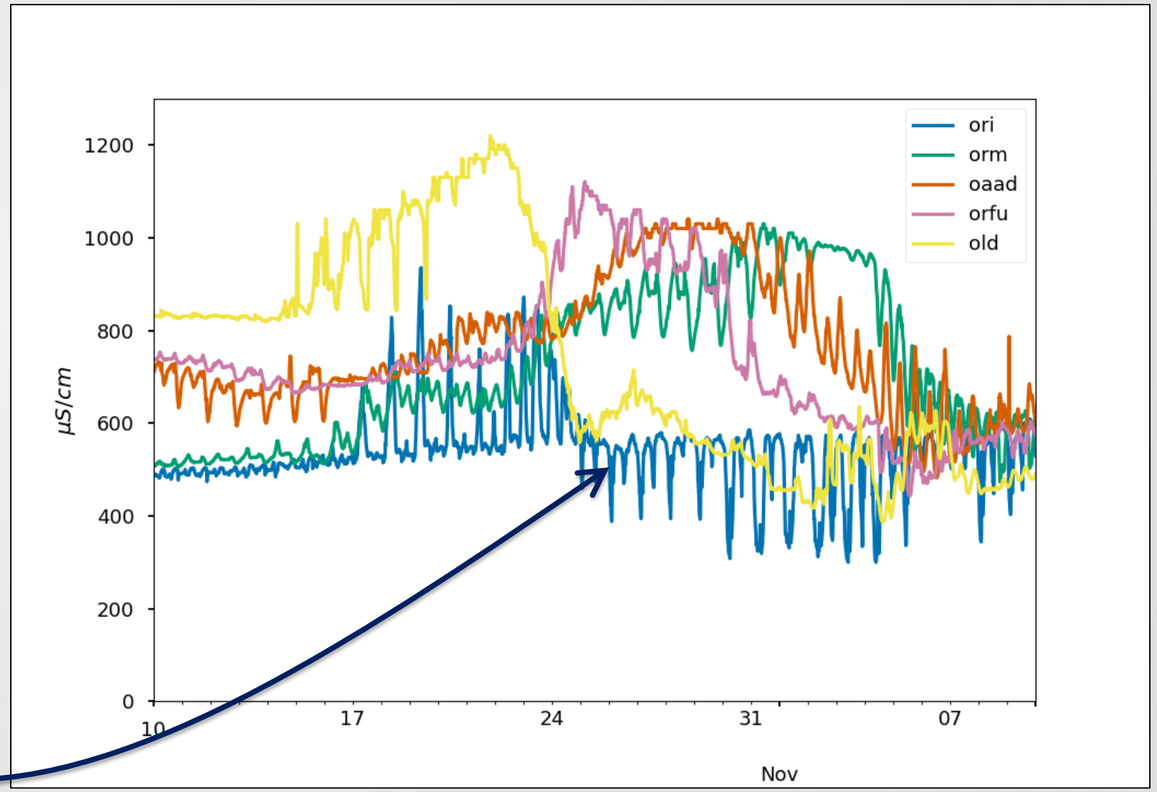

OLD
TWA
µS/cm
1000
0
2008-07
2009-01
2009-07
2010-01
2010-07
2011-01
2011-07
2012-01
2012-07
datetime
OLD
TWA
µS/cm
1000
0
2013-07
2014-01
2014-07
2015-01
2015-07
2016-01
2016-07
2017-01
2017-07
datetime
OLD
TWA
µS/cm
1000
0
2018
2019
2020
2021
2022
2023
datetime

MSS Results (Transects and Continuous)





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Next Steps

- Discuss
  - work with interested parties
  - towards constructive, well-posed proposals
- Monitoring and project feedback: find a place
- Develop *Assumptions* v2 expectations
  - Complete calibrations and demonstrate sensitivities
- Data assimilation
- Main study

Discussion

- Questions? Eli Ateljevich and Zhenlin Zhang