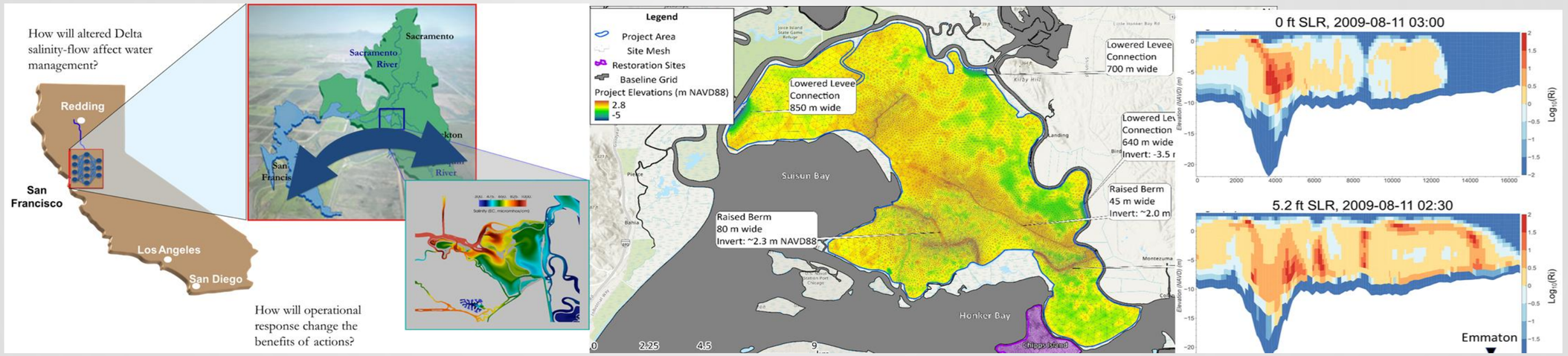
CALIFORNIA DEPARTMENT OF WATER RESOURCES

Generalizing Salinity-Outflow Surrogates in CalSim

CWEMF 2025 Annual Meeting, May 13, 2025

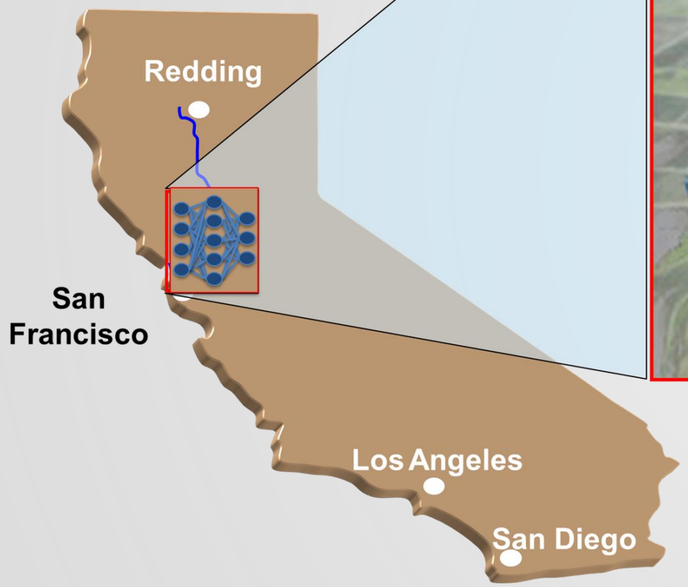


Collaborators:
Resource Management Associates (RMA)
Delta Science Program (DSP)
DWR CalSim team

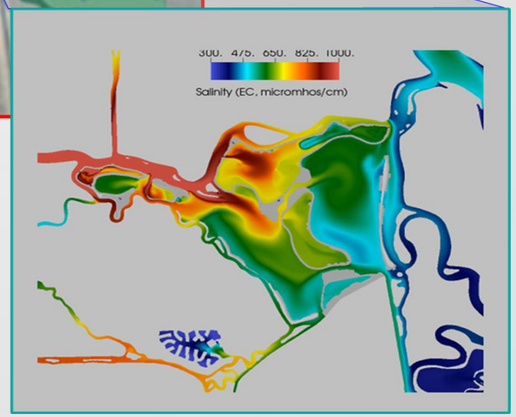
Eli Ateljevich, PE, PhD, DWR
Lily Tomkovic, PE, PhD, DWR
Can Ruso, UCB

Core Task: Reconcile Statewide/Delta Scales

How will altered Delta salinity-flow affect water management?



How will operational response change the benefits of actions?



Franks Tract Futures
SCHISM

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Limiters to Generalization

- Reference model DSM2 has limited applicability to:
  - Complex geometry
  - Sea level
  - Beyond-historical drought
- CalSim data used as inputs to reference simulations:
  - band limited to a month
  - compliance limited
  - limited perturbation, memorizeable
- ANNs have single station output
  - No latent representation of the Delta
- Multidimensional hydrodynamic expensive
- Need to get contrasts between “with landscape change and “without”

Some Fixes

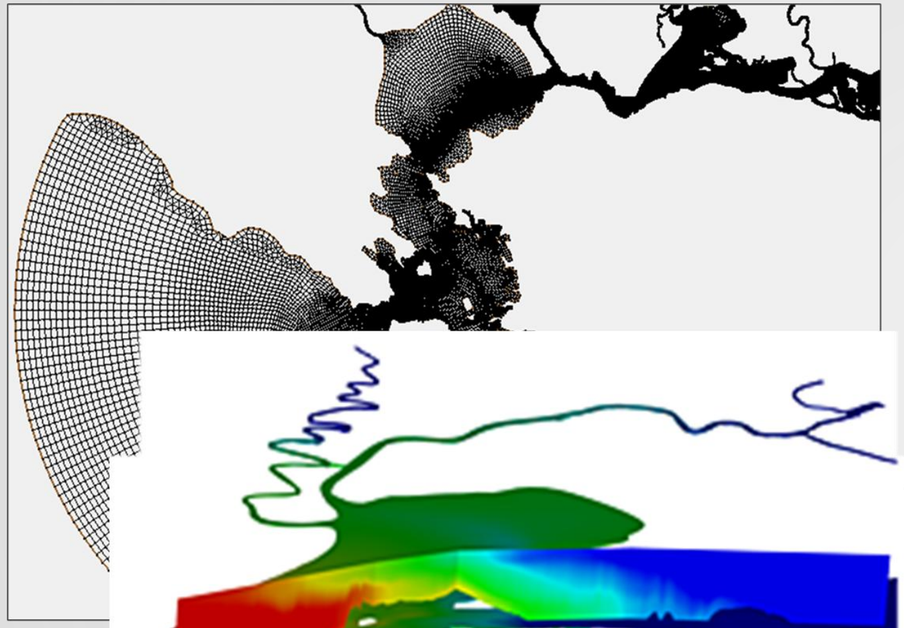
Multidimensional models

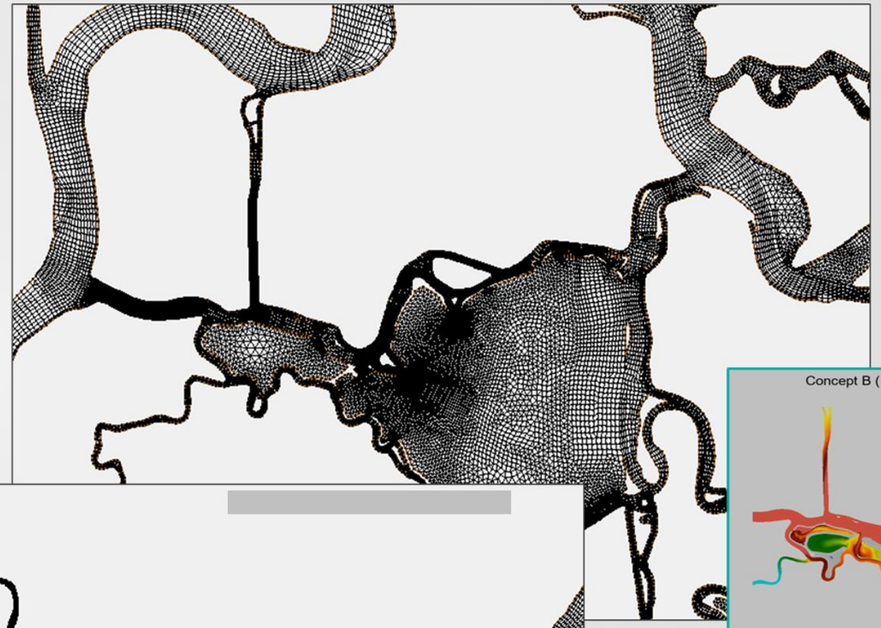
Design of Experiments (Lily Tomkovic)

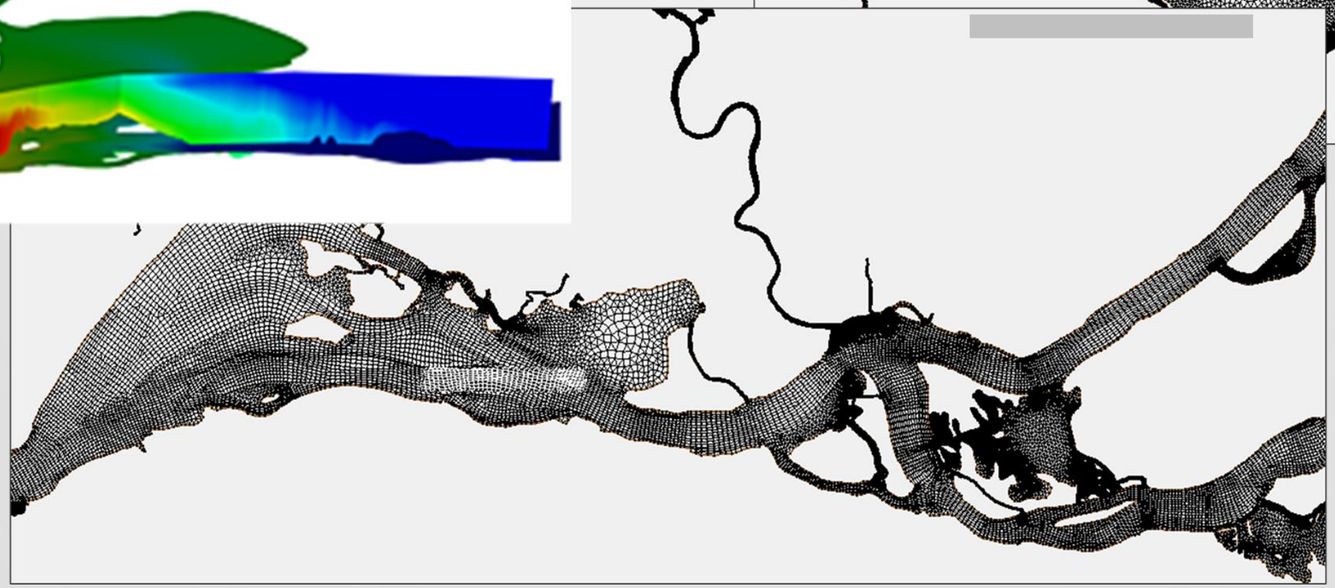
Multi-station models

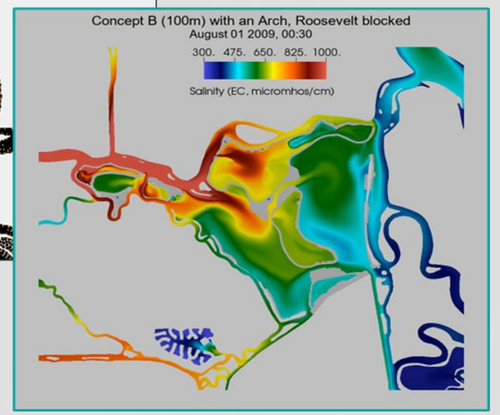
Transfer learning
Contrastive Loss functions

Multidimensional Models
(RMA in 2D / Bay-Delta SCHISM 3D)



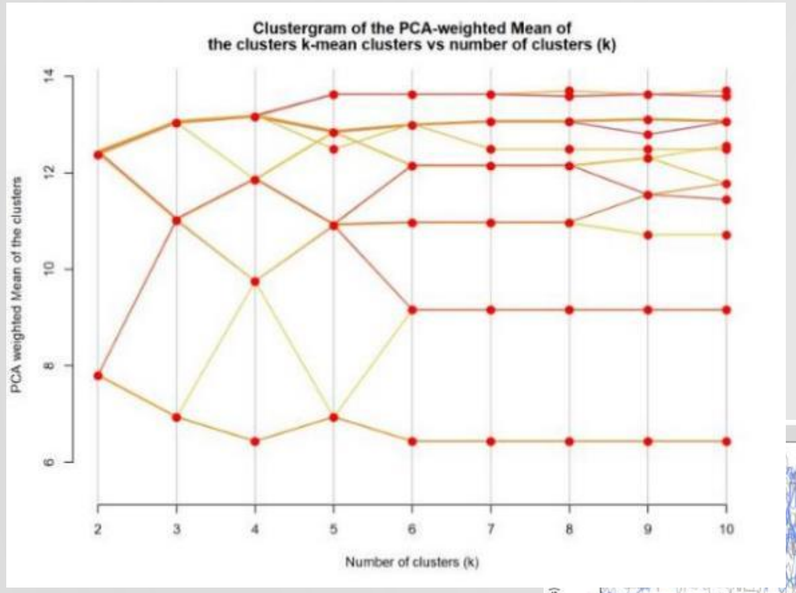


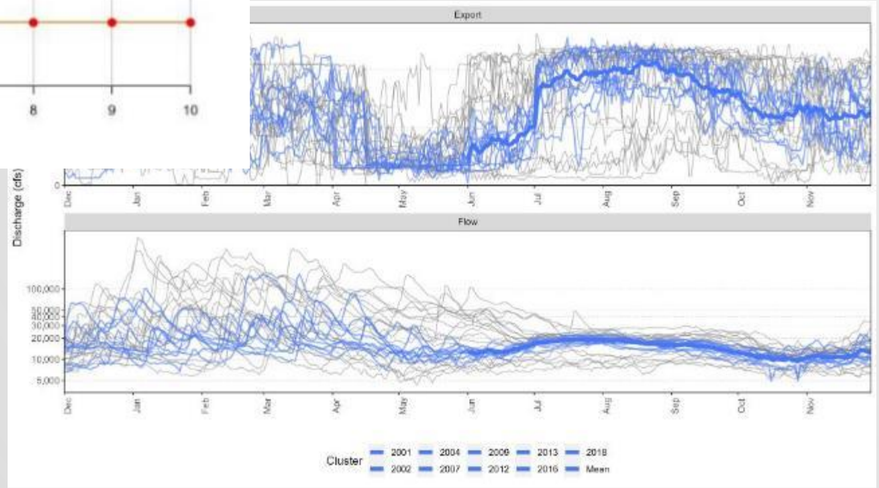




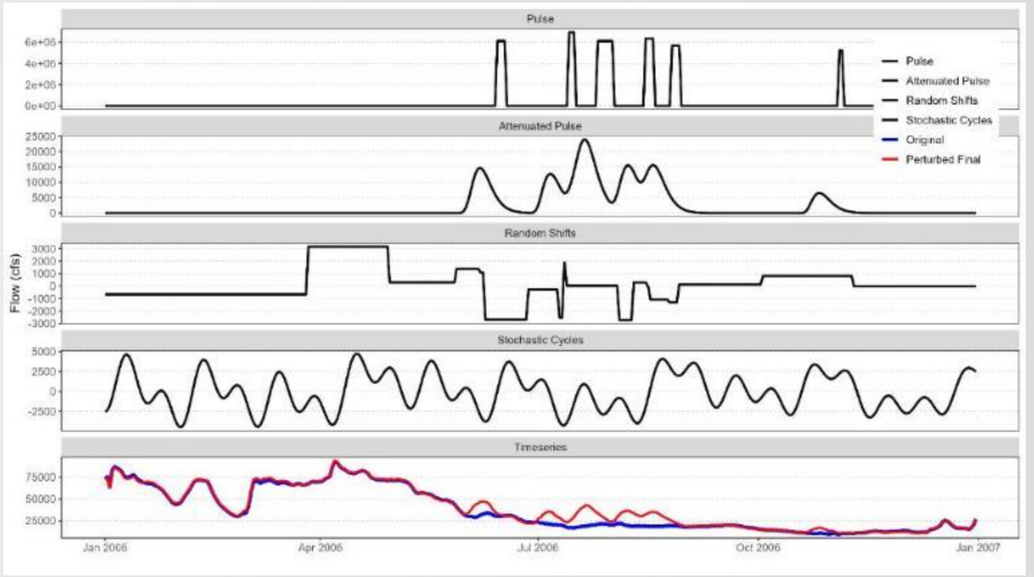
Design of Experiments

Canonical Year Through Cluster Analysis (<< 10)





Aseasonal shifts and Stochastic Perturbation



Training Datasets
For DSM2:~110 1-2 yr cases
For RMA/SCHISM 7 1-2 yr cases

Little exhaustion of the historical record
Lots of tricks to avoid memorization

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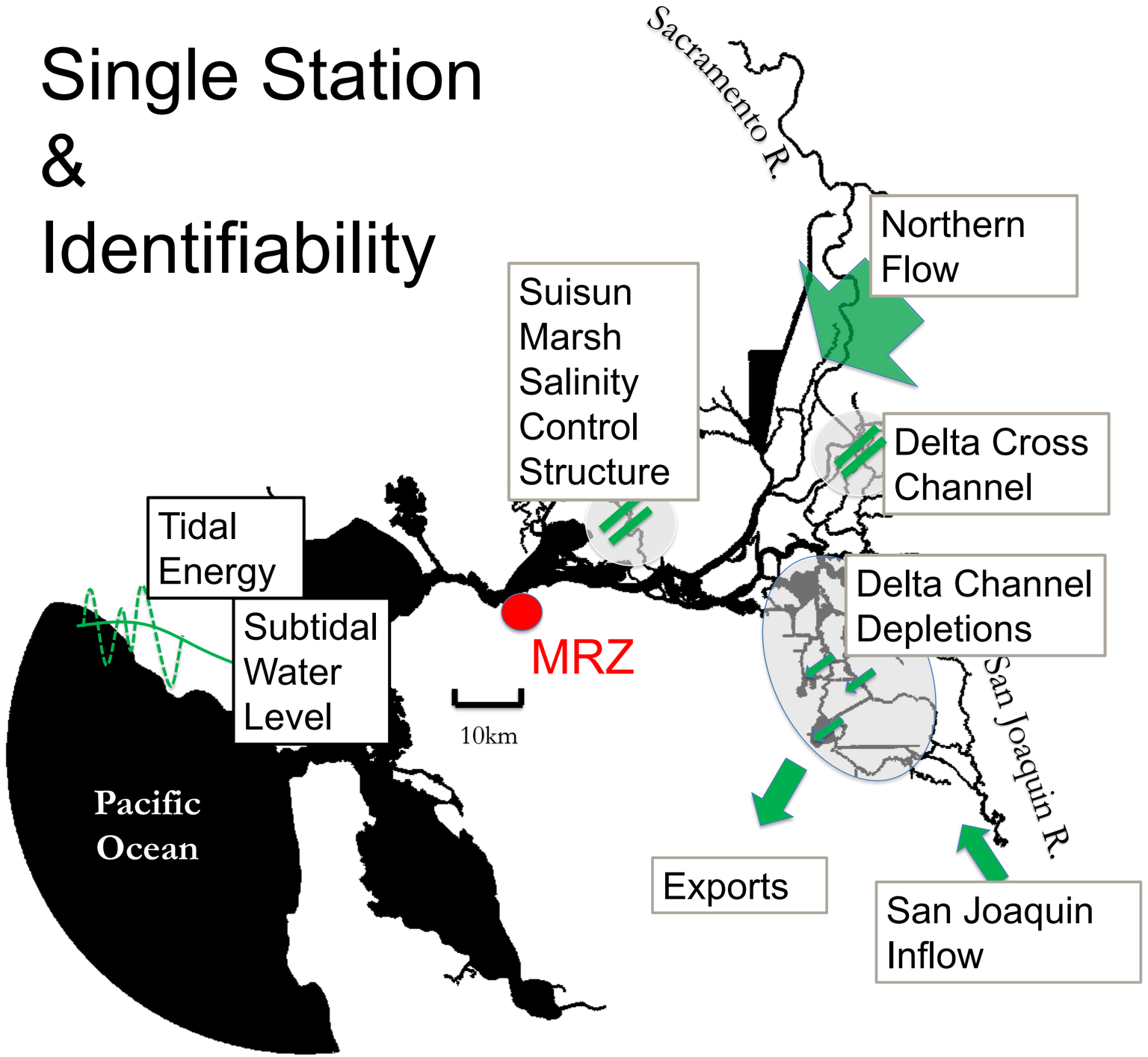
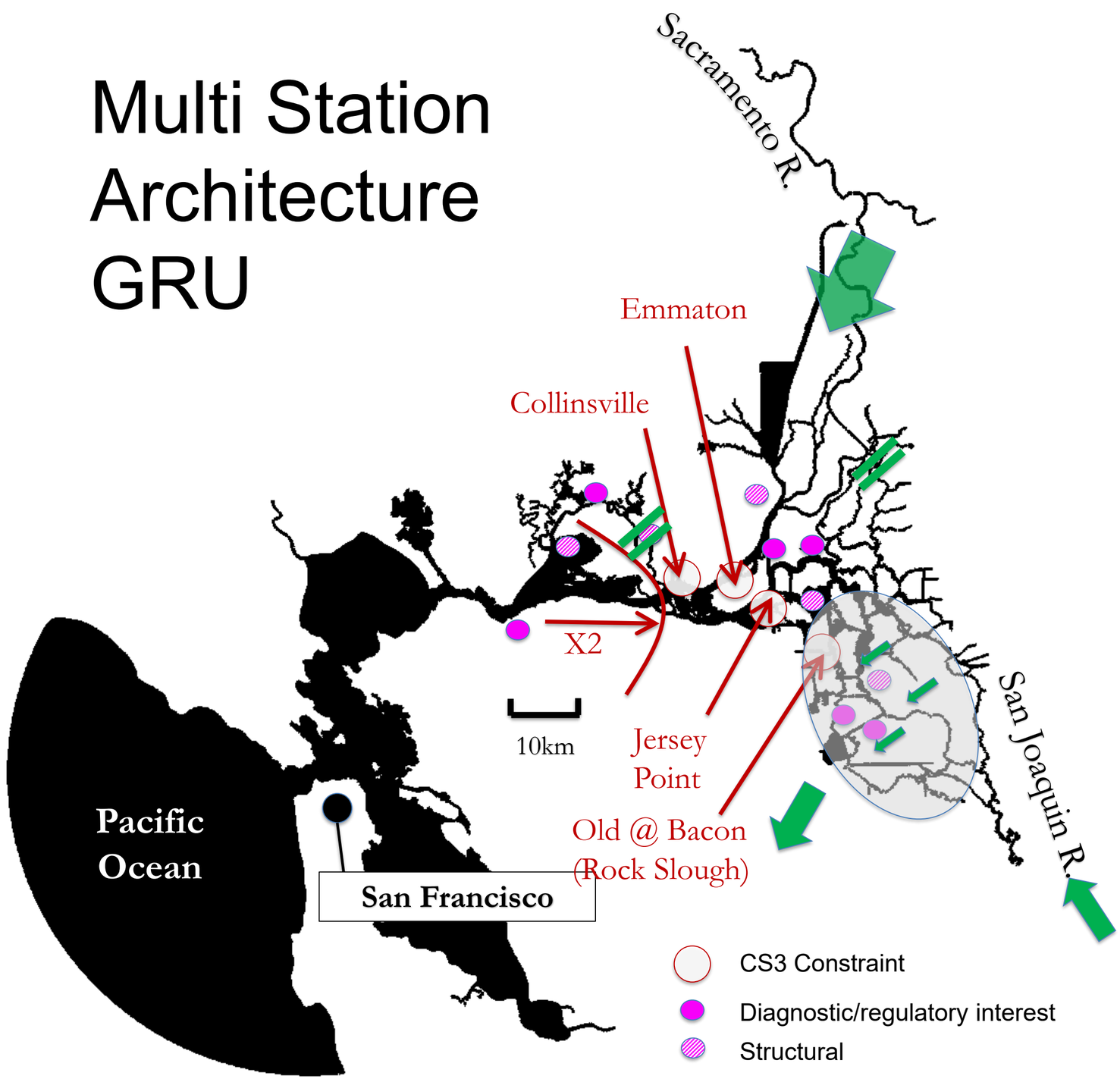
Single Station & Identifiability



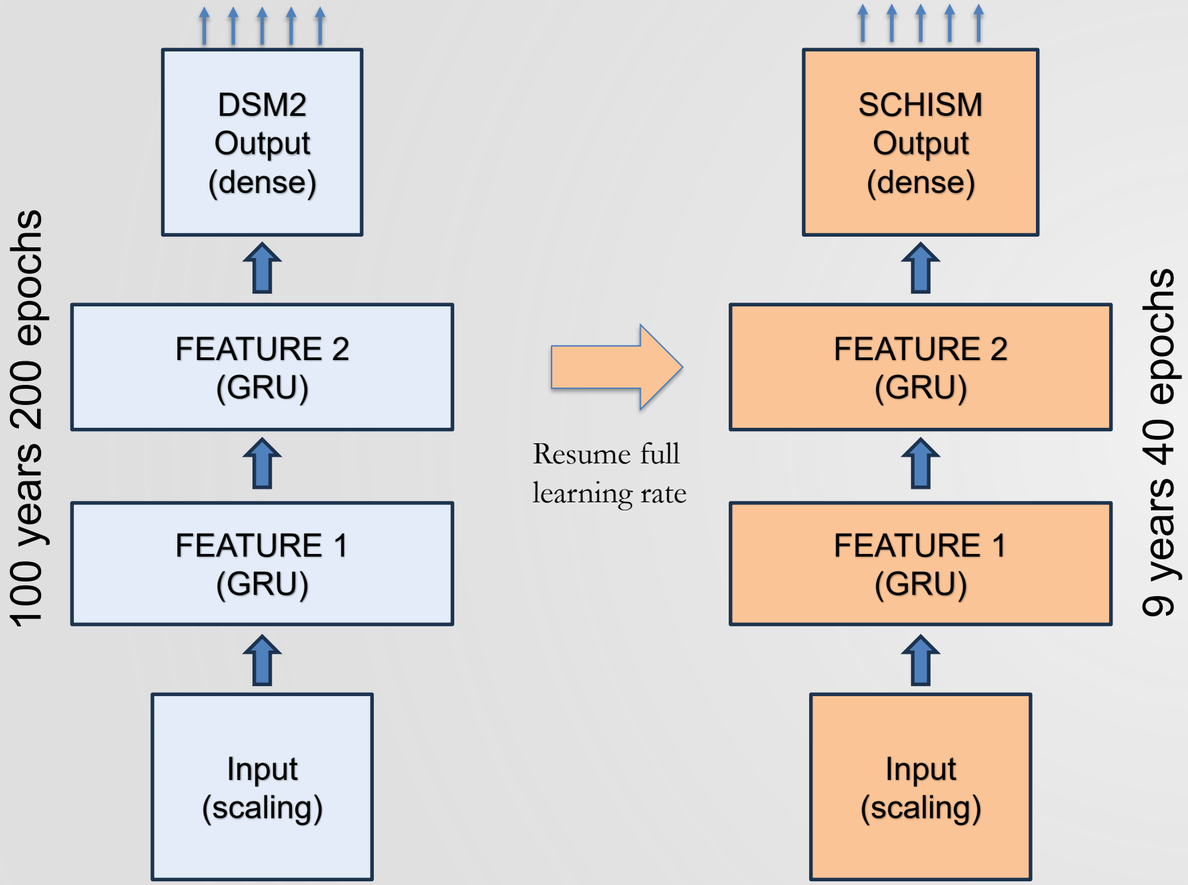
Multi Station Architecture GRU



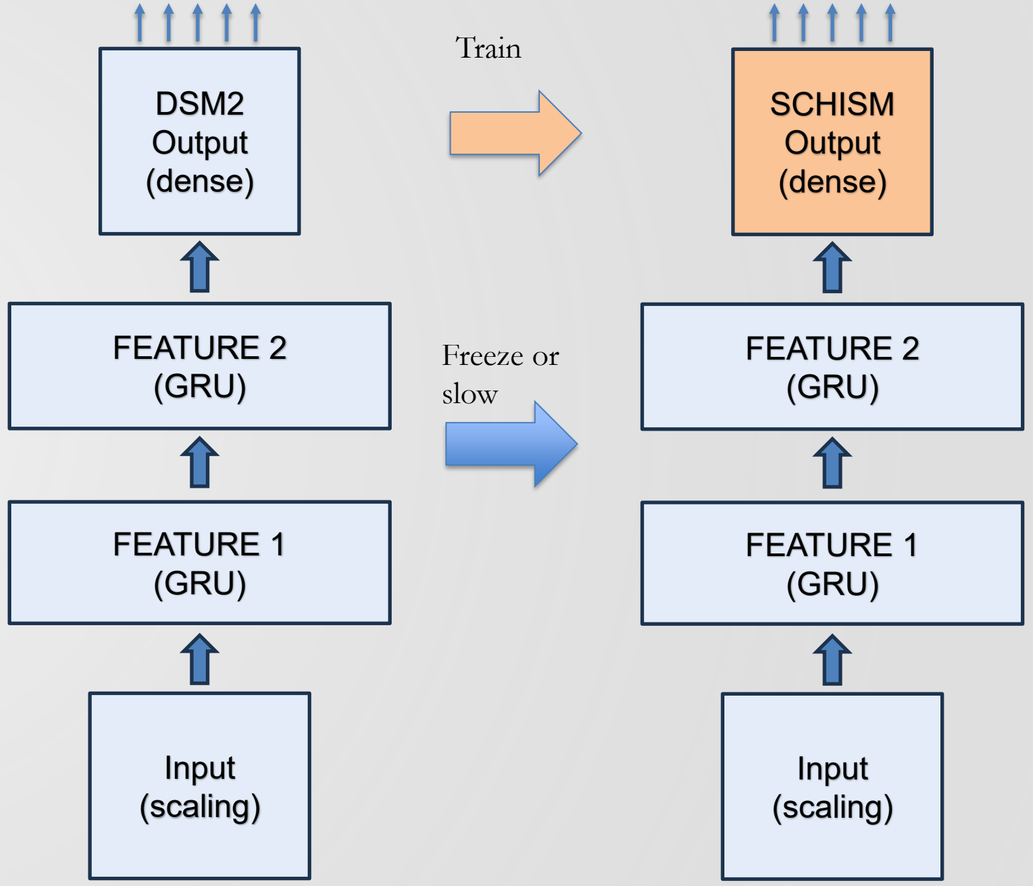
Transfer Learning and Multitask

- Transfer: Learn a new task based on previous
- Multitask: Learn several related tasks together

Pre-training (direct)



Pre-training plus Embedding (direct + freezing/ low learning)



Many perturbations depending on how much gets embedded

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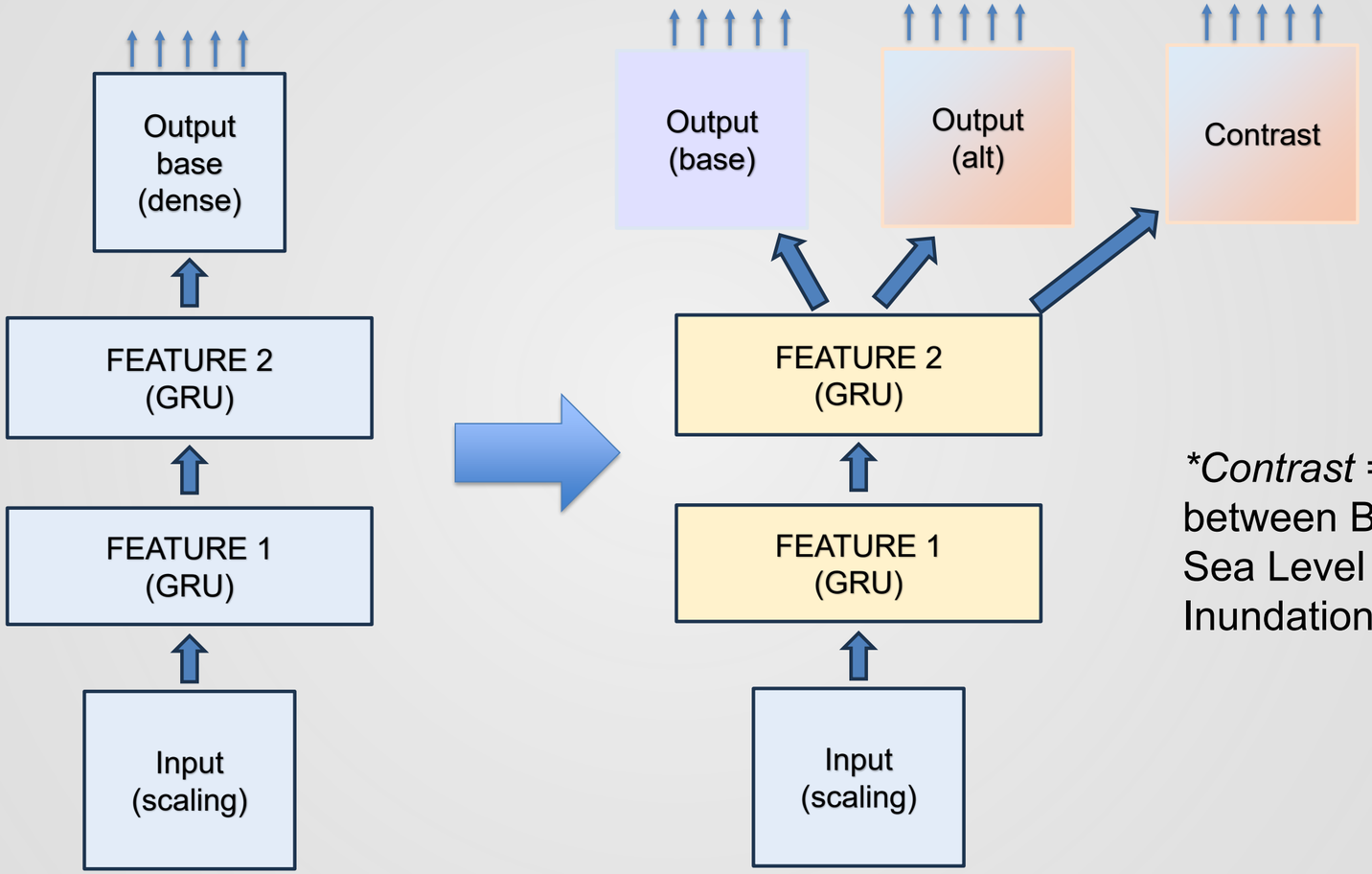
Shared Features, Contrastive* Loss

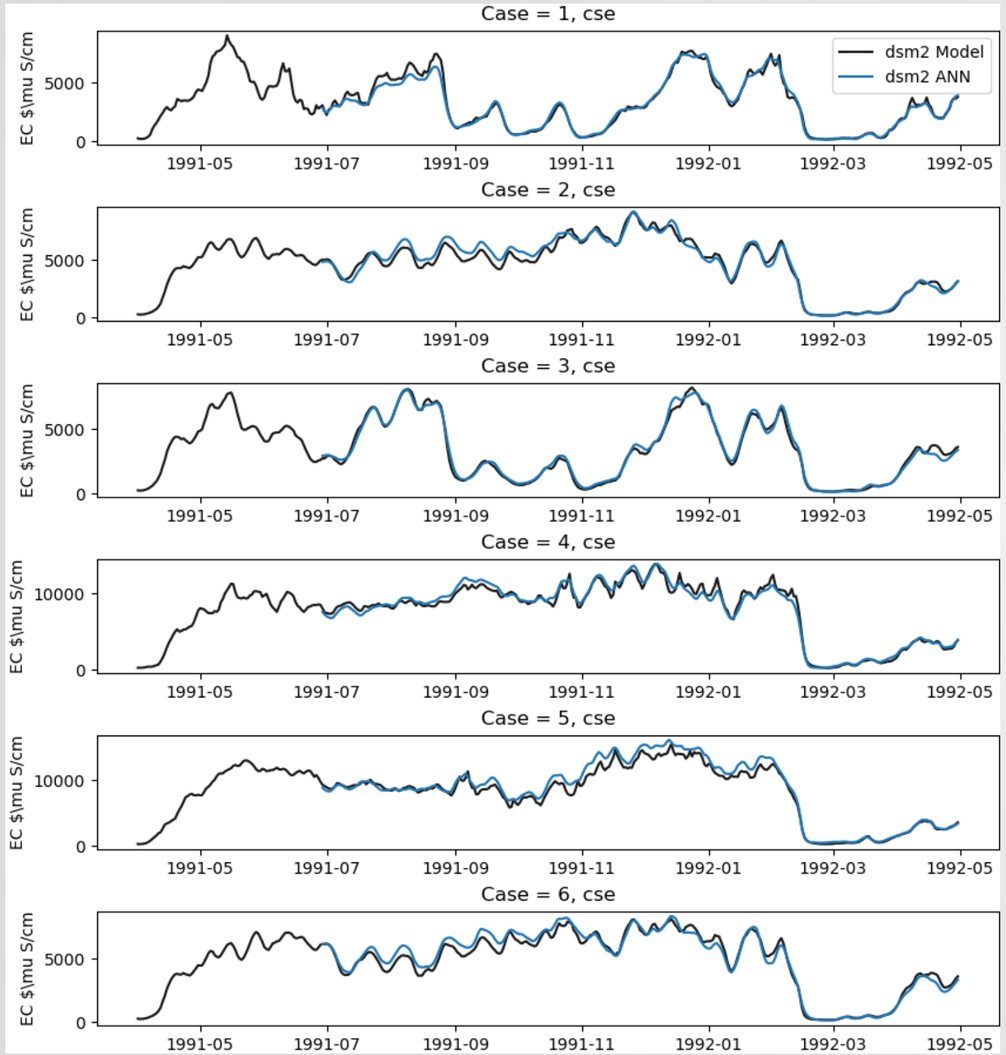


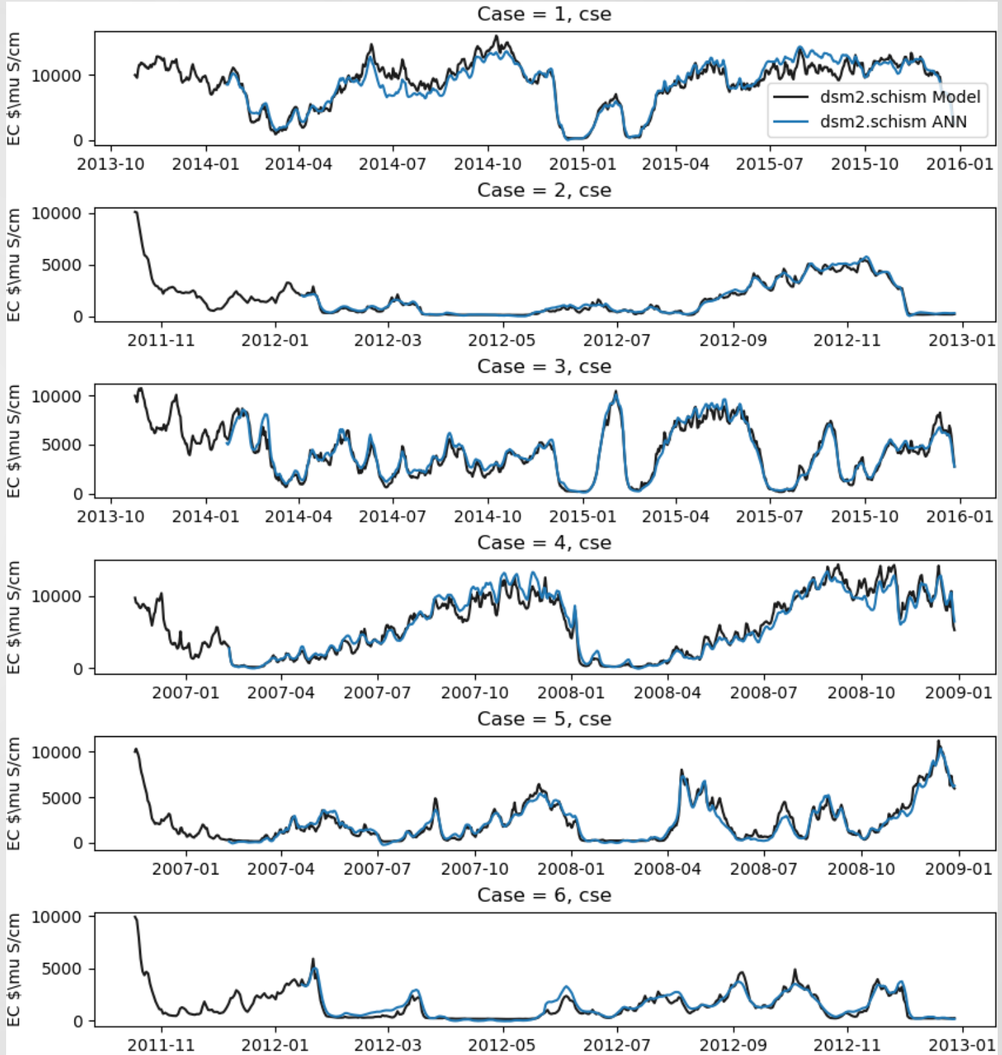
**Contrast* = Error in the contrast between Base and Alternative like Sea Level Rise or Suisun Inundation, say

DSM2 + DOE

Pretraining →

SCHISM+DOE





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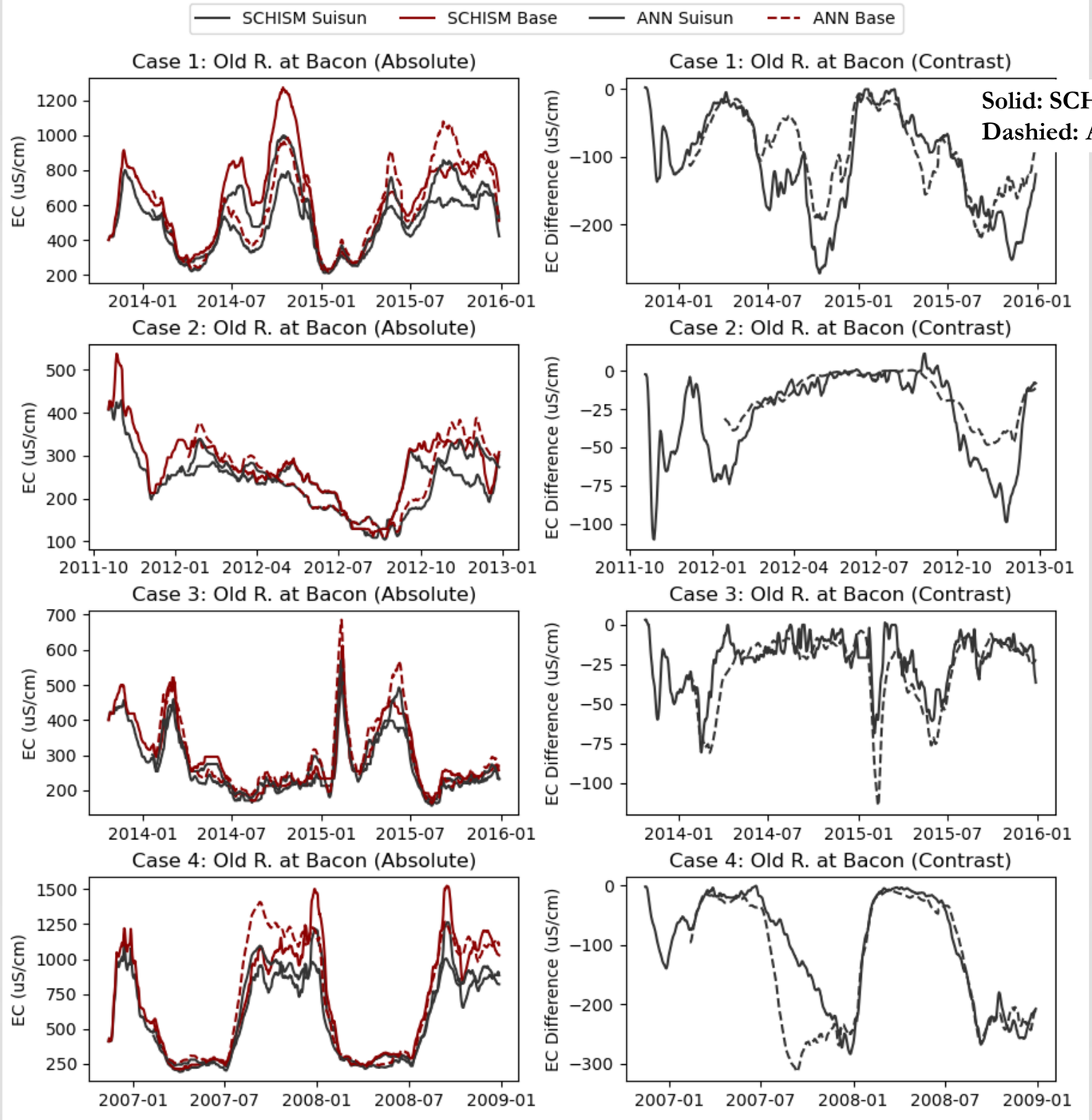
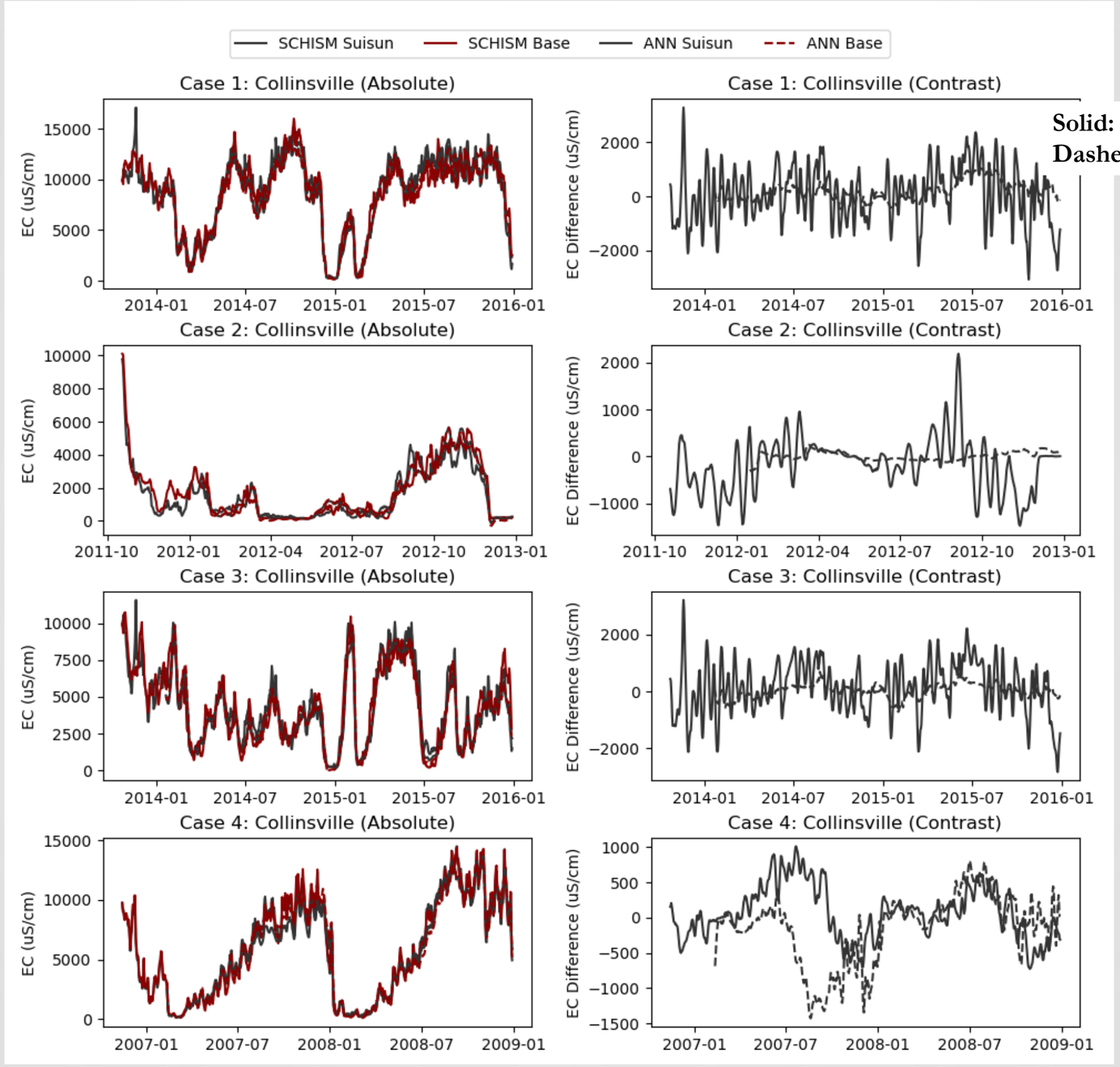
Performance on Cross-Validation (for withheld case)


SCHISM Suisun
SCHISM Base
ANN Suisun
ANN Base
Case 1: Old R. at Bacon (Absolute)
Case 1: Old R. at Bacon (Contrast)
Case 2: Old R. at Bacon (Absolute)
Case 2: Old R. at Bacon (Contrast)
Case 3: Old R. at Bacon (Absolute)
Case 3: Old R. at Bacon (Contrast)
Case 4: Old R. at Bacon (Absolute)
Case 4: Old R. at Bacon (Contrast)
EC (uS/cm)
EC Difference (uS/cm)
Solid: SCHISM
Dashied: ANN


SCHISM Suisun
SCHISM Base
ANN Suisun
ANN Base
Case 1: Collinsville (Absolute)
Case 1: Collinsville (Contrast)
Case 2: Collinsville (Absolute)
Case 2: Collinsville (Contrast)
Case 3: Collinsville (Absolute)
Case 3: Collinsville (Contrast)
Case 4: Collinsville (Absolute)
Case 4: Collinsville (Contrast)
EC (uS/cm)
EC Difference (uS/cm)
Solid: SCHISM
Dashed: ANN

Conclusions Thus Far

- Skill in the NSE=0.85-0.90 range
  - Varies by training but even more so by nature/extent of generalization
  - Physicality responses
  - Small contrasts represented, noise/phase an issue downstream
- Pre-training on DSM2 dataset accelerates learning.
  - We did about 100yrs of DOE cases
- Contrastive multitask approach equally beneficial
- Data interoperability details crucial for transfer learning

Products

- Design of Experiments for training surrogates
- Casanntra:
  - testbed and training libary for transfer learning

  https://github.com/CADWRDeltaModeling/casanntra/
- Calsurrogate:
  - Plugin library for surrogates in CalSim
  - Includes linearization, time marching, salinity-to-flow inversion

  https://github.com/CADWRDeltaModeling/calsurrogate

Questions?

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