

LLM Salinity Transportation Modeling

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Introduction

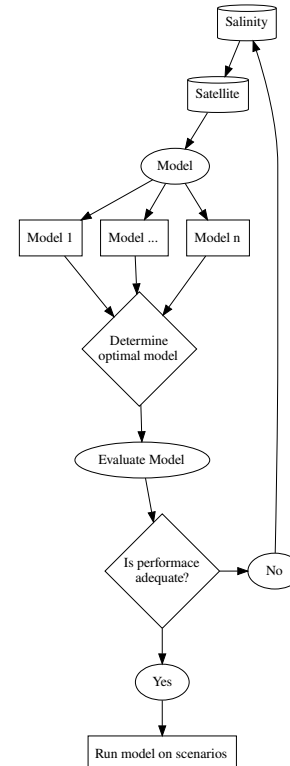
- **Martin Flores**
 - Bachelors in Computer Science
 - Machine Learning
 - Instrument Classification
 - Civil Engineering
 - Dwight David Eisenhower Transportation Fellowship Program (DDETFP)
 - Flood Navigation

Overview

- Modeling Process
- Background
- Overview of Progress
 - Data
 - Modeling
- Deep Learning (DL) Key Notes
- Planned Developments & Scenarios

Modeling Process

- Gather Data
- Create Multiple Models
 - Varying architecture
- Evaluate Models
- Test Models on Scenarios



Background

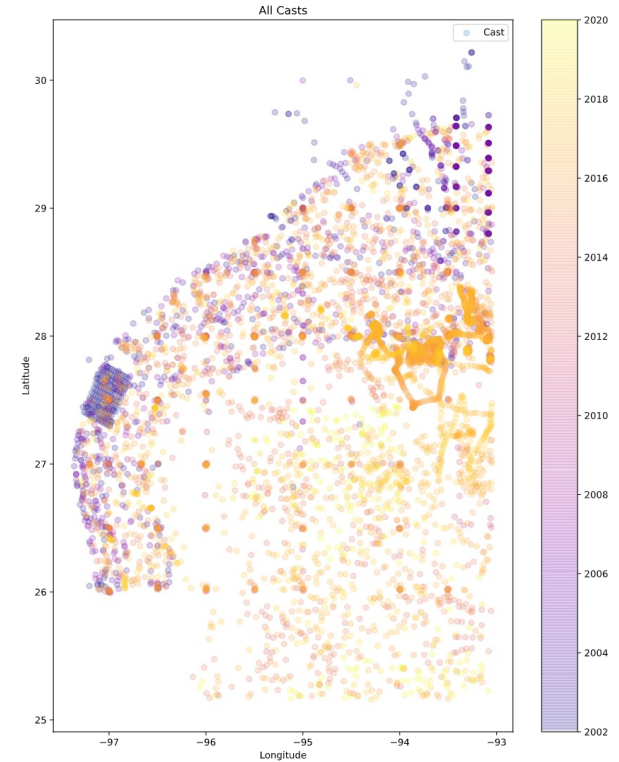
- Salinity Data in the Laguna Madre is Sparse
 - *In Situ*
 - Spatially Lacking
- Sea surface salinity (SSS) is key to climate forecasting and monitoring of marine ecosystems.

Data

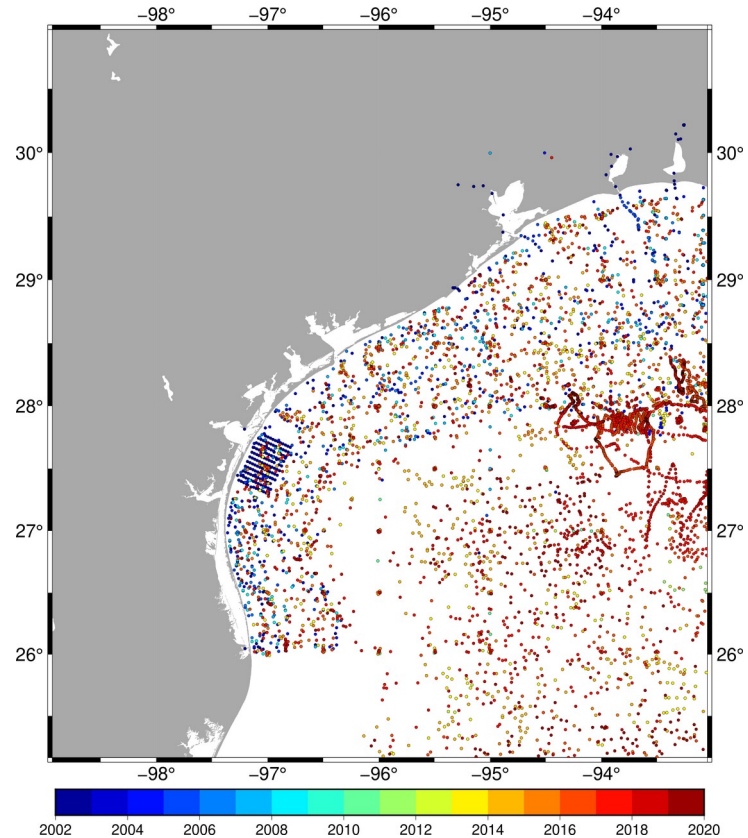
- **Salinity**
 - World Ocean Database (WOD)
 - Water Data for Texas
 - Practical Salinity Unit (PSU)
- **Satellite**
 - MODIS-Aqua
 - Ocean Color (OC)
 - Remote Sensing Reflectance (Rrs)
 - Sea Surface Temperature (SST)

Data: Salinity

- WOD
 - Salinity at Multiple Depths
 - Years of 2002-2020 Utilized
 - 5m chosen for study
 - Most data points
 - 3507 Sample points at depth
 - 5130 points \pm 0.5 m
 - Only two data points in Laguna Madre

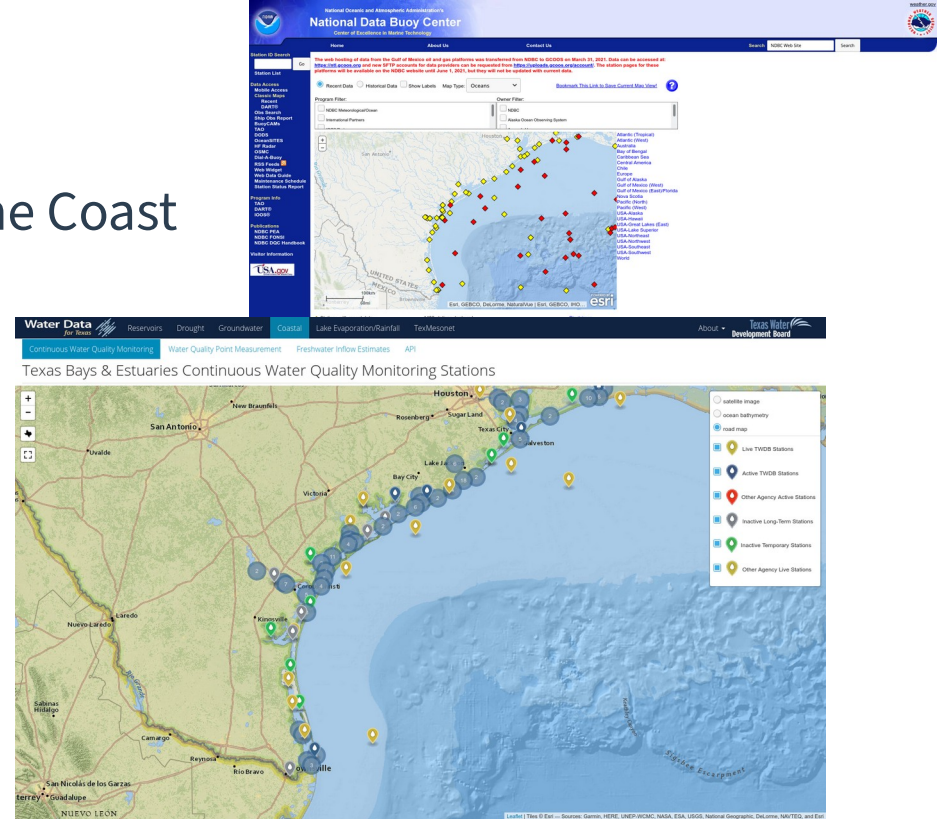


Data: Salinity



Data: Salinity

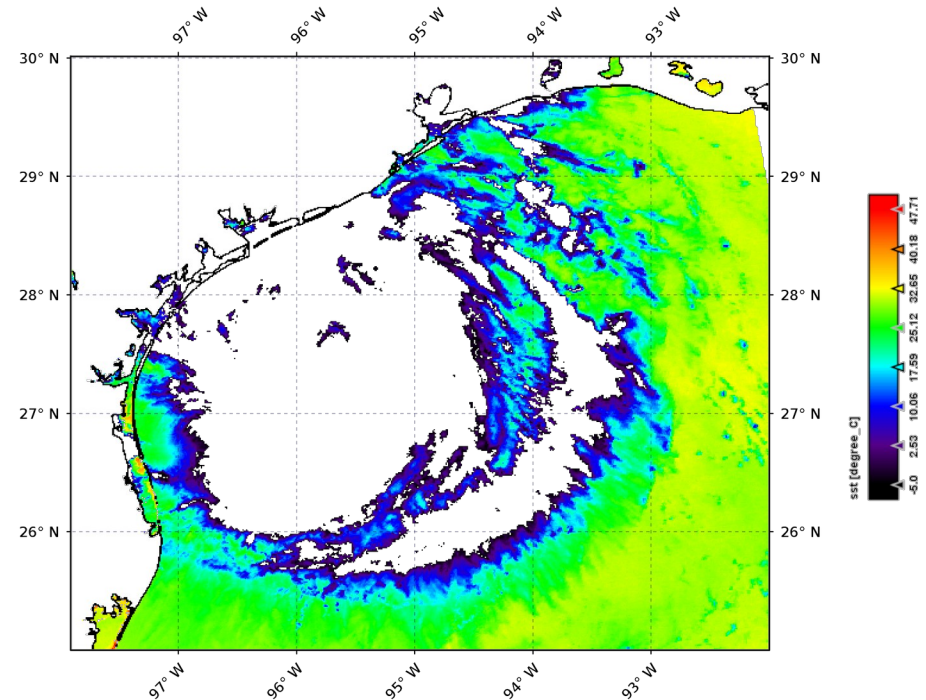
- **NOAA National Data Buoy Center**
 - Lower and Upper Laguna Madre/Off the Coast
 - No salinity data found
- **TWDB Water Data for Texas**
 - *In Situ* data for the Laguna Madre



Data: Satellite

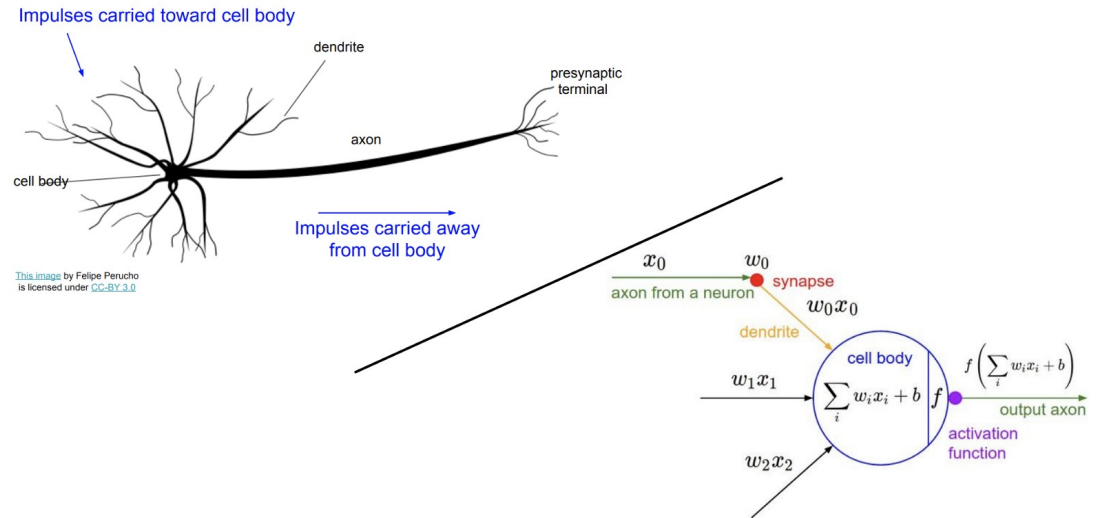
- MODIS-Aqua

- Swaths
 - Irregular Grid Data
- Subject to Cloud Interference
- Daily Coverage
 - Coverage Area
 - Quality
 - SST
 - Rrs



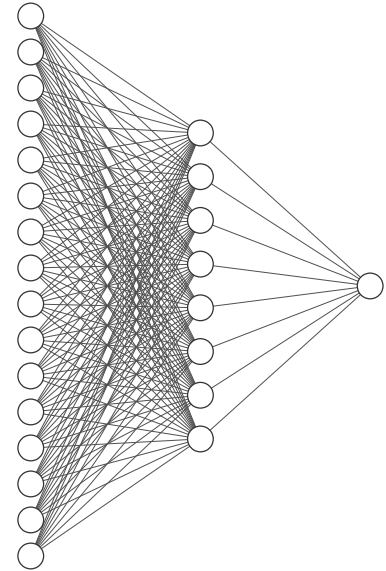
Deep Learning Key Notes

- Neuron
 - Core of Deep Learning (DL)
- “Learns”
 - Minimize Loss
 - Mean Square Error (MSE)
 - Update Weight and Biases
- Layers
 - Increase Dimensionality



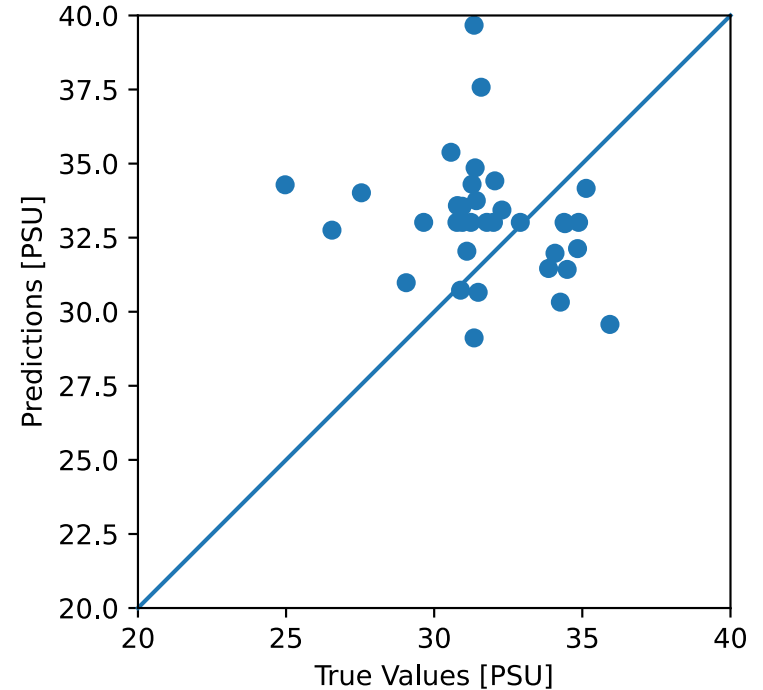
Modeling

- **Pilot Model Evaluation**
 - Now-casting model
 - 1-day forecast model
- **Planned Developments**
 - Model Architecture & Techniques
 - 2-5 day forecast
- **Scenarios of Interest**



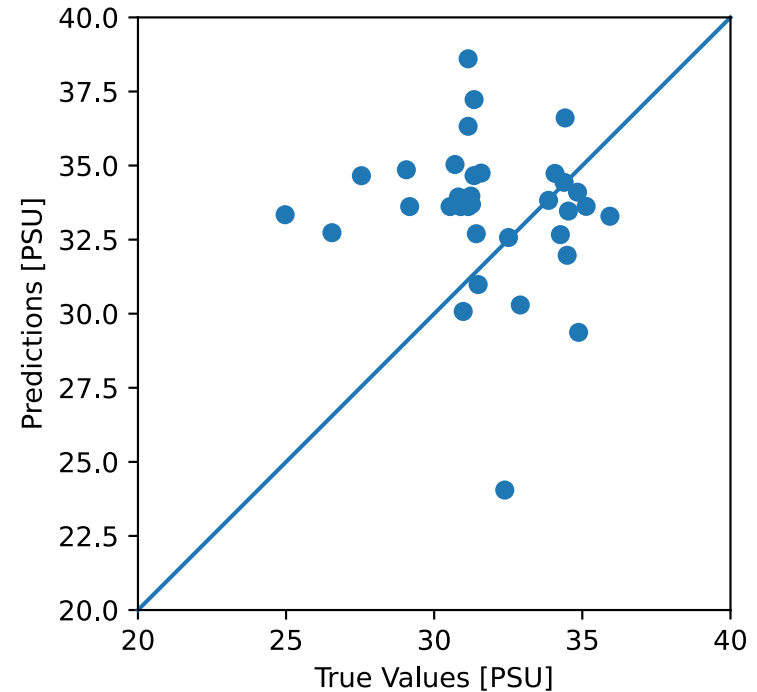
Modeling: Now-Casting

- **Simple DNN**
 - 2 Hidden Dense Layers
 - 64 & 32 Neurons Respectively
- **RMSE of ~4**
- **Results Scattered**
 - Bias towards overestimating

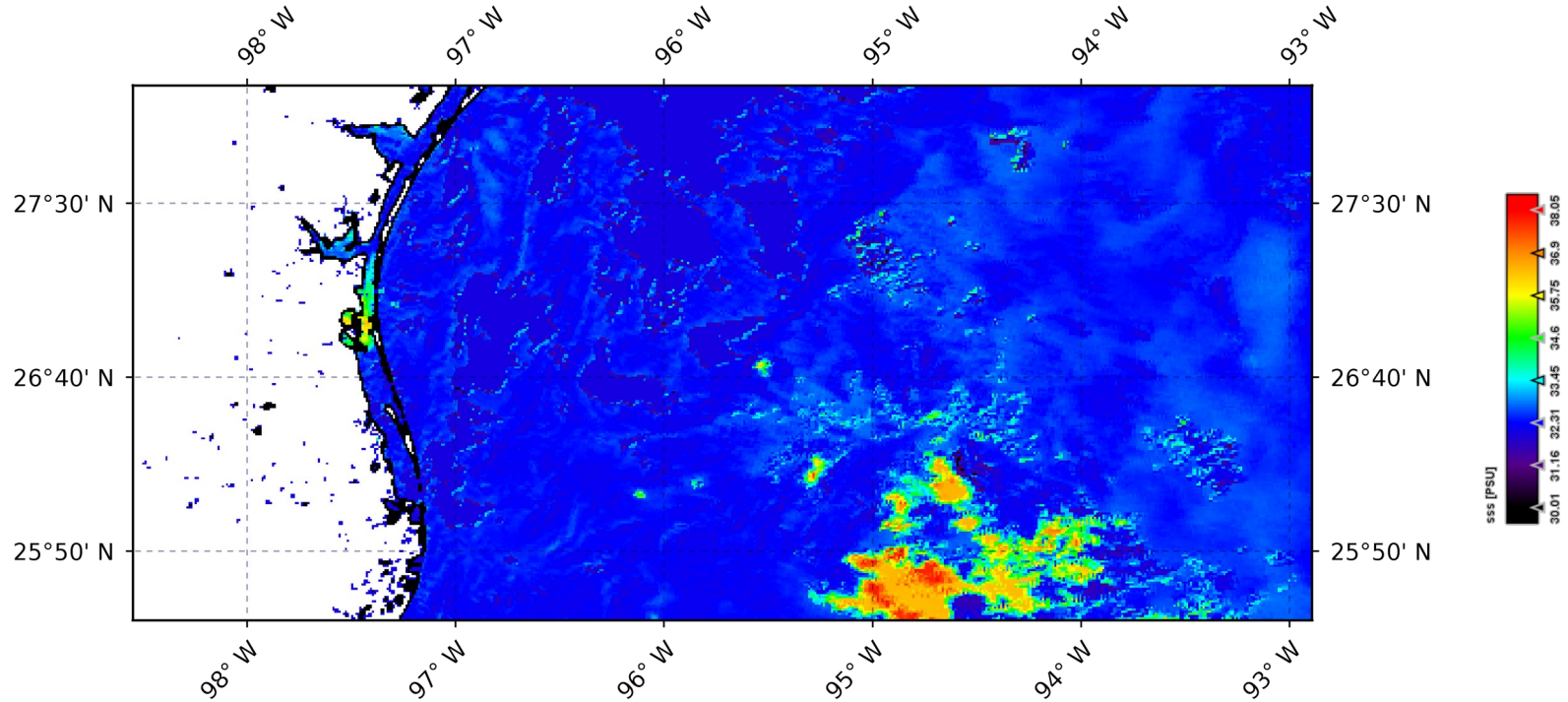


Modeling: 1-Day Forecast

- Same architecture as previous
- RMSE similar to Now-Casting
 - Slight increase in error
- **Scattered Results**
 - ~10 PSU outlier

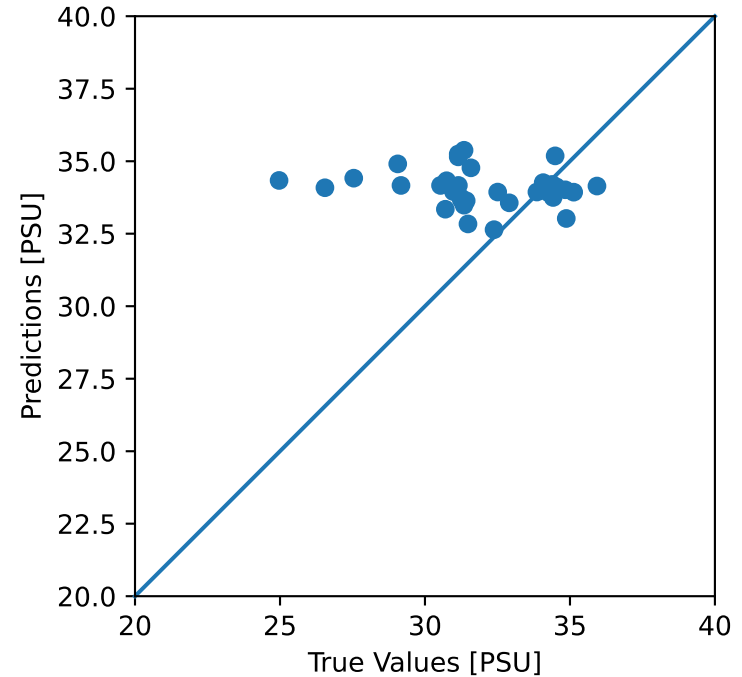


Modeling: 1-Day Forecast



Modeling: Planned Developments

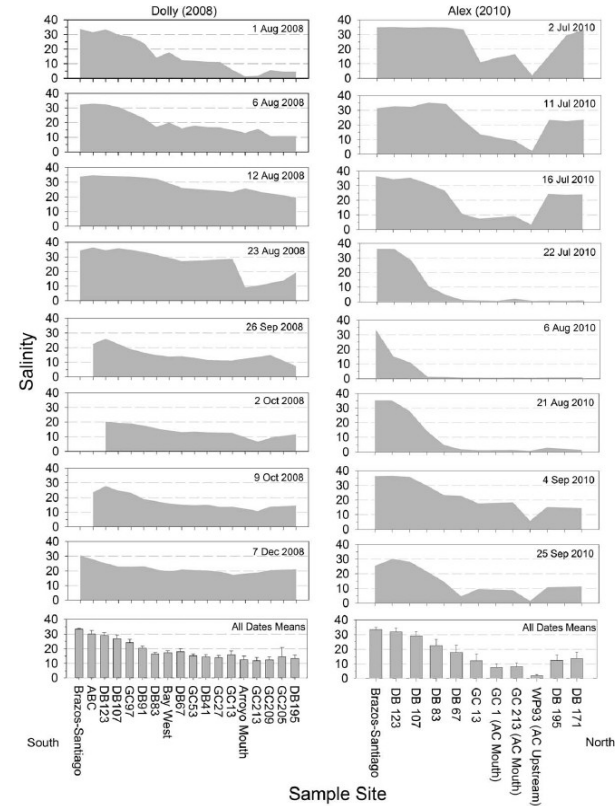
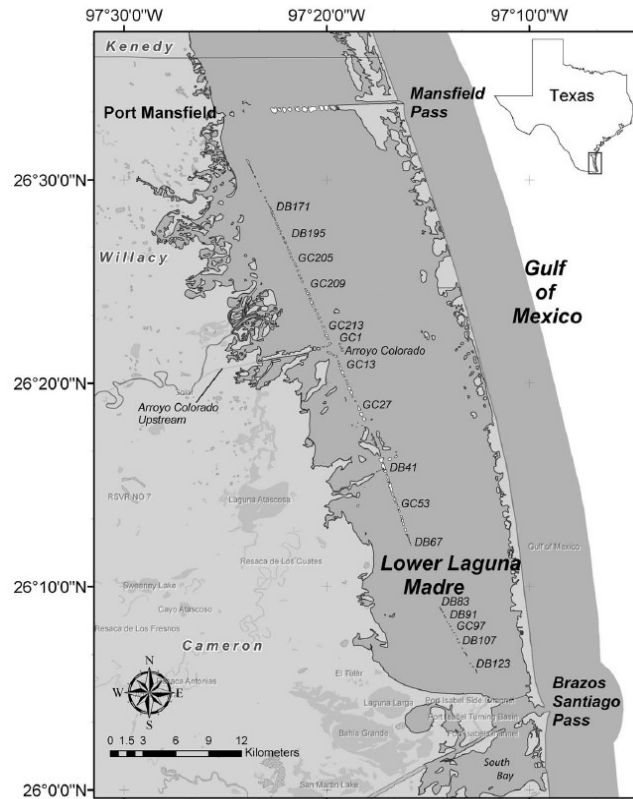
- **Prevent overfitting**
 - Dropout Layers
 - Batch Regularization
- **Different architectures**
 - CNN before Dense Layers
- **Discover cause of bias**
- **Implement 2-5 day forecasting**



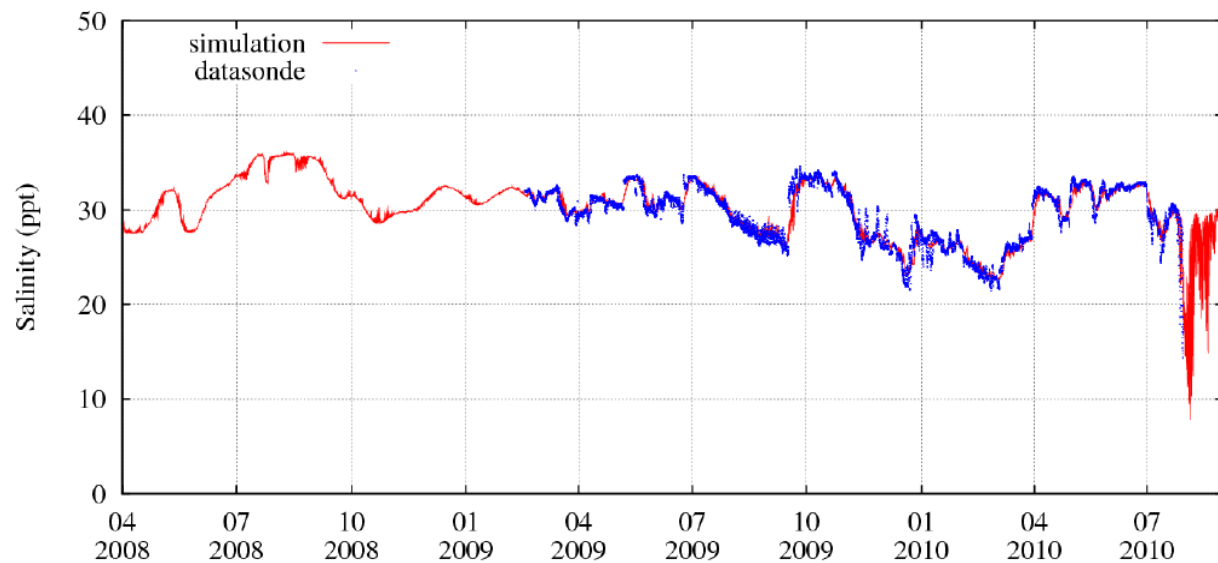
Modeling: Scenarios of Interest

- **Hurricane Events**
 - Dolly & Alex
 - Hanna
 - Depressed Salinity Throughout
 - Arroyo Colorado Heavily Affected
- **TxBLEND**
 - Comparison to Numerical Model
 - Point Based
 - Map Based

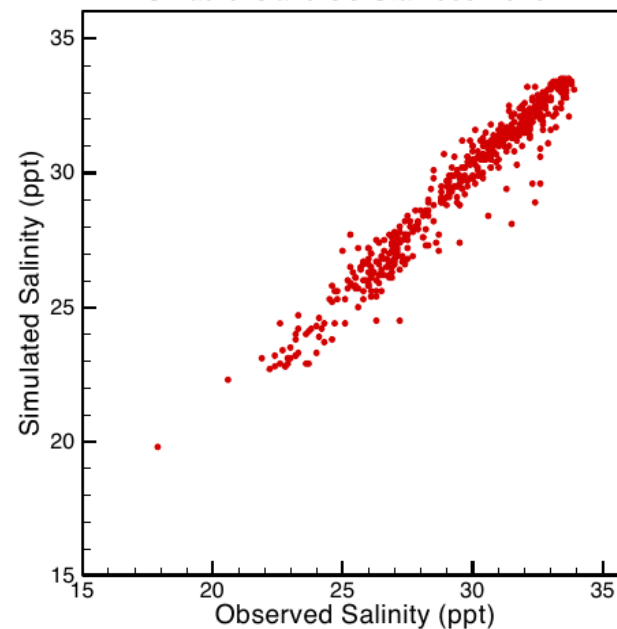
Dolly & Alex



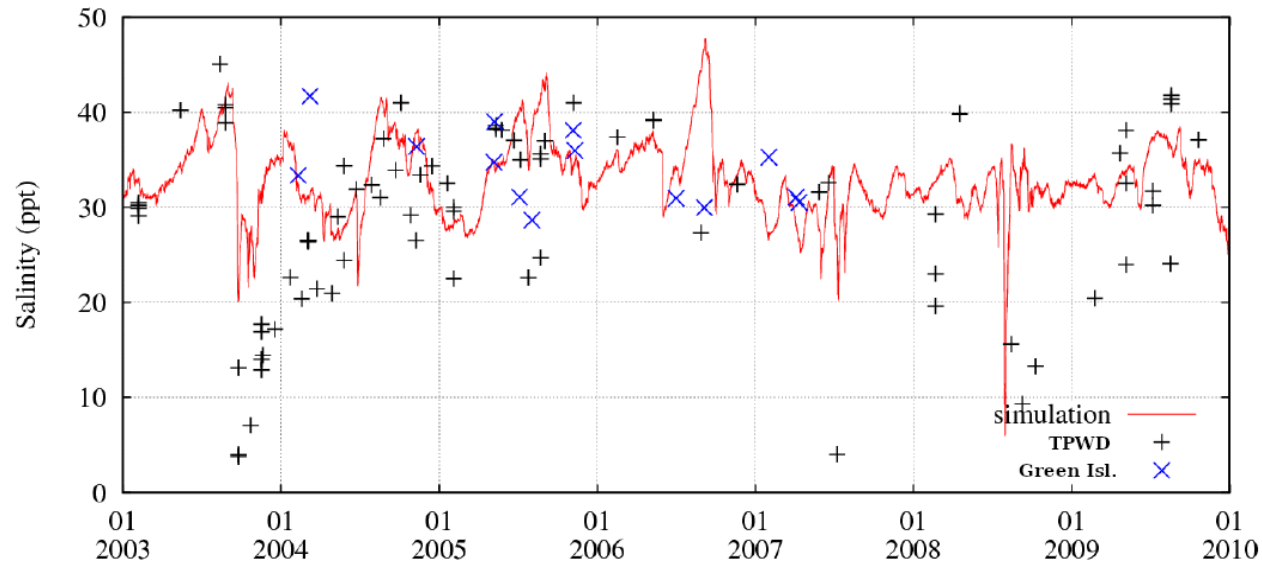
Simulated and observed salinity at South Padre Isl CG Sta



S Padre Island CG Sta 2009-2010



Simulated and Observed Salinity at GIWW-Arroyo-Colorado and Green Island



GIW-Arroyo and Green Island 2003-2009

