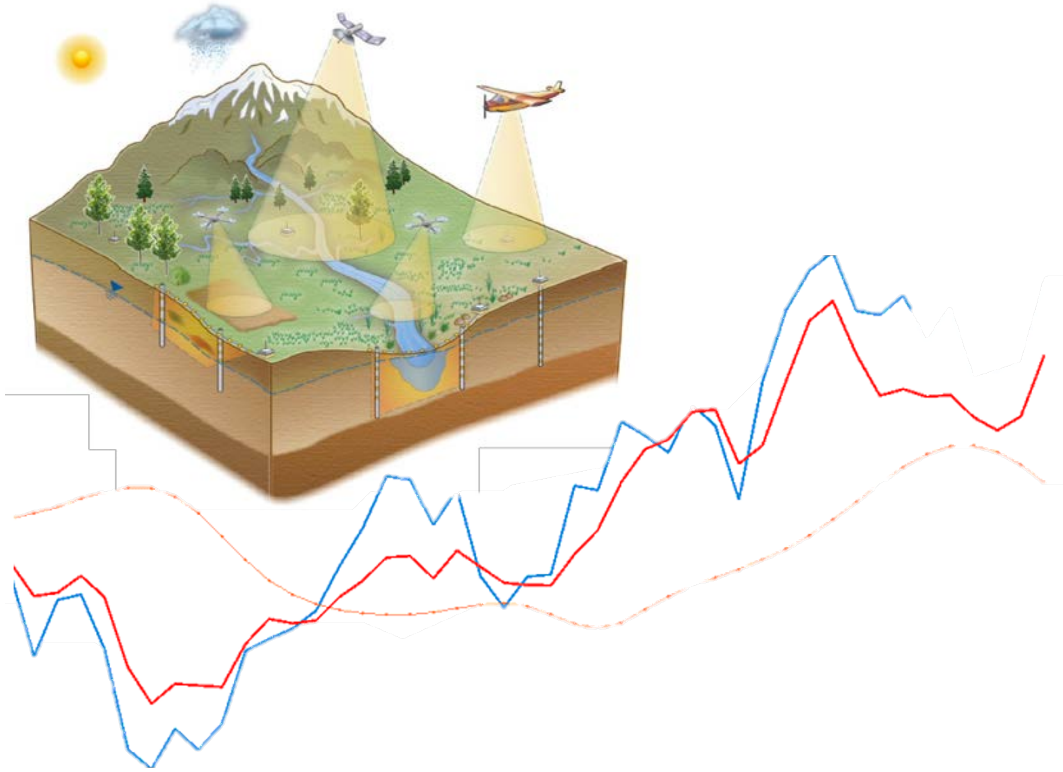
Project 3 – Task 8

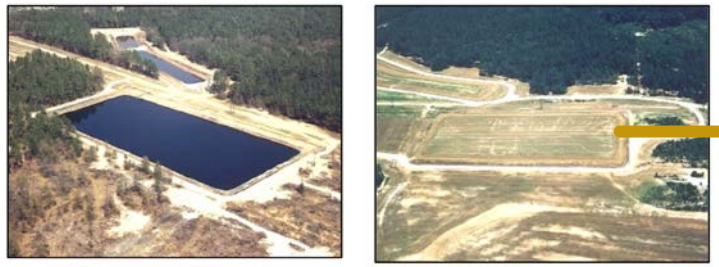
Artificial Intelligence System Interface for Sensor Data Ingestion and Descriptive Visual and Data Analytics (LBNL, SRNL)



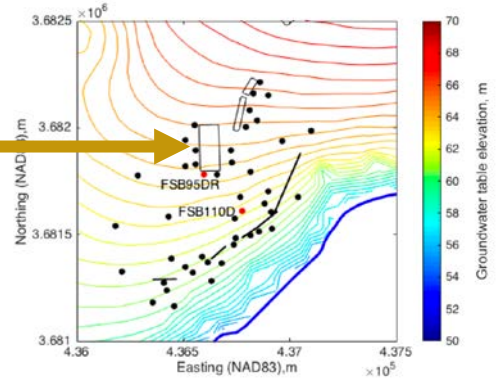
Task 8: AI for EM Problem Set (Soil and Groundwater) – AI System interface for sensor data ingestion and descriptive visual and data analytics (LBNL, SRNL)

Site Needs:

- Develop machine learning tools to automate the monitoring and forecasting of contaminant transport dynamics at the Savannah River Site (SRS) F-Area to support DOE-EM's goal for long term monitoring of contaminated groundwater sites.



Photographs of the SRS F-Area



Site map of the SRS F-Area

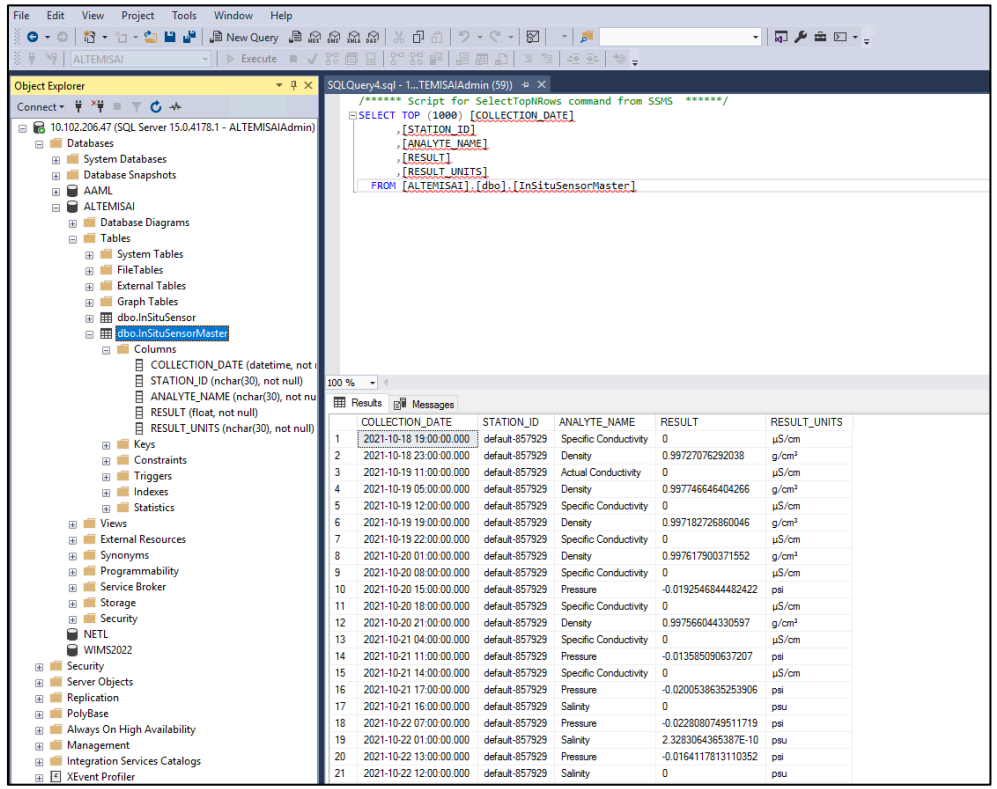
Objectives:

- Develop data exploration tools for understanding the spatial and temporal distribution of the F-Area dataset.
- Develop a spatial interpolation approach for estimating a plume.
- Examine proxy variables at the site.
- Development of the AI/ML based system to perform predictive analytics.

Subtask 8.4: Data interfacing module development for the AI/ML System

FIU Year 2 Research Highlights:

- **Data interfacing module development for the AI/ML System**
  - The sensor data from the ALTEMIS project will be available through an application programming interface (API) called HydroVu API
  - Sensor collected variables will be water temperature, pH, specific conductance, and the water table (depth or DEPTH_TO_WATER)
  - To ensure that a reliable system is established for holding the latest in-situ sensor data, a SQL Server Database was created.
  - Once this data is secured on the database, it can be accessed from other systems and machine learning algorithms.



	COLLECTION_DATE	STATION_ID	ANALYTE_NAME	RESULT	RESULT_UNITS
1	2021-10-18 19:00:00.000	default-857929	Specific Conductivity	0	µS/cm
2	2021-10-18 23:00:00.000	default-857929	Density	0.99727076292038	g/cm³
3	2021-10-19 11:00:00.000	default-857929	Actual Conductivity	0	µS/cm
4	2021-10-19 05:00:00.000	default-857929	Density	0.997746646404266	g/cm³
5	2021-10-19 12:00:00.000	default-857929	Specific Conductivity	0	µS/cm
6	2021-10-19 19:00:00.000	default-857929	Density	0.997182726860046	g/cm³
7	2021-10-19 22:00:00.000	default-857929	Specific Conductivity	0	µS/cm
8	2021-10-20 01:00:00.000	default-857929	Density	0.997617900371552	g/cm³
9	2021-10-20 08:00:00.000	default-857929	Specific Conductivity	0	µS/cm
10	2021-10-20 15:00:00.000	default-857929	Pressure	-0.0192546844482422	psi
11	2021-10-20 18:00:00.000	default-857929	Specific Conductivity	0	µS/cm
12	2021-10-20 21:00:00.000	default-857929	Density	0.997566044330597	g/cm³
13	2021-10-21 04:00:00.000	default-857929	Specific Conductivity	0	µS/cm
14	2021-10-21 11:00:00.000	default-857929	Pressure	-0.013585090637207	psi
15	2021-10-21 14:00:00.000	default-857929	Specific Conductivity	0	µS/cm
16	2021-10-21 17:00:00.000	default-857929	Pressure	-0.0200538635253906	psi
17	2021-10-21 16:00:00.000	default-857929	Salinity	0	psu
18	2021-10-22 07:00:00.000	default-857929	Pressure	-0.0228080749511719	psi
19	2021-10-22 01:00:00.000	default-857929	Salinity	2.3283064365387E-10	psu
20	2021-10-22 13:00:00.000	default-857929	Pressure	-0.0164117813110352	psi
21	2021-10-22 12:00:00.000	default-857929	Salinity	0	psu

In-Situ Sensor Database in SQL server

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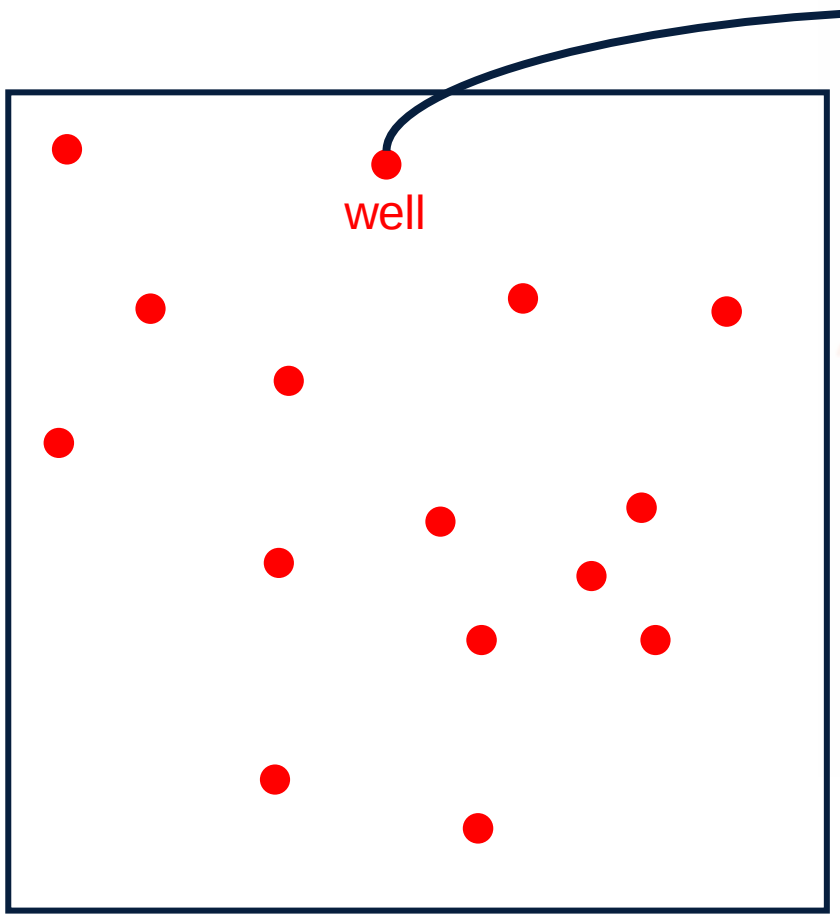
Subtask 8.5: Development of the AI/ML based system to perform predictive analytics using datasets containing time-series and imagery data from sensors

FIU Year 2 Research Highlights:

- Predict contaminant concentrations using sensor collected variables using Deep Learning (DL).



Sensor collected variables:

pH
specific conductance
water temperature
water table
…

Contaminants:

uranium-238
iodine-129
tritium
…

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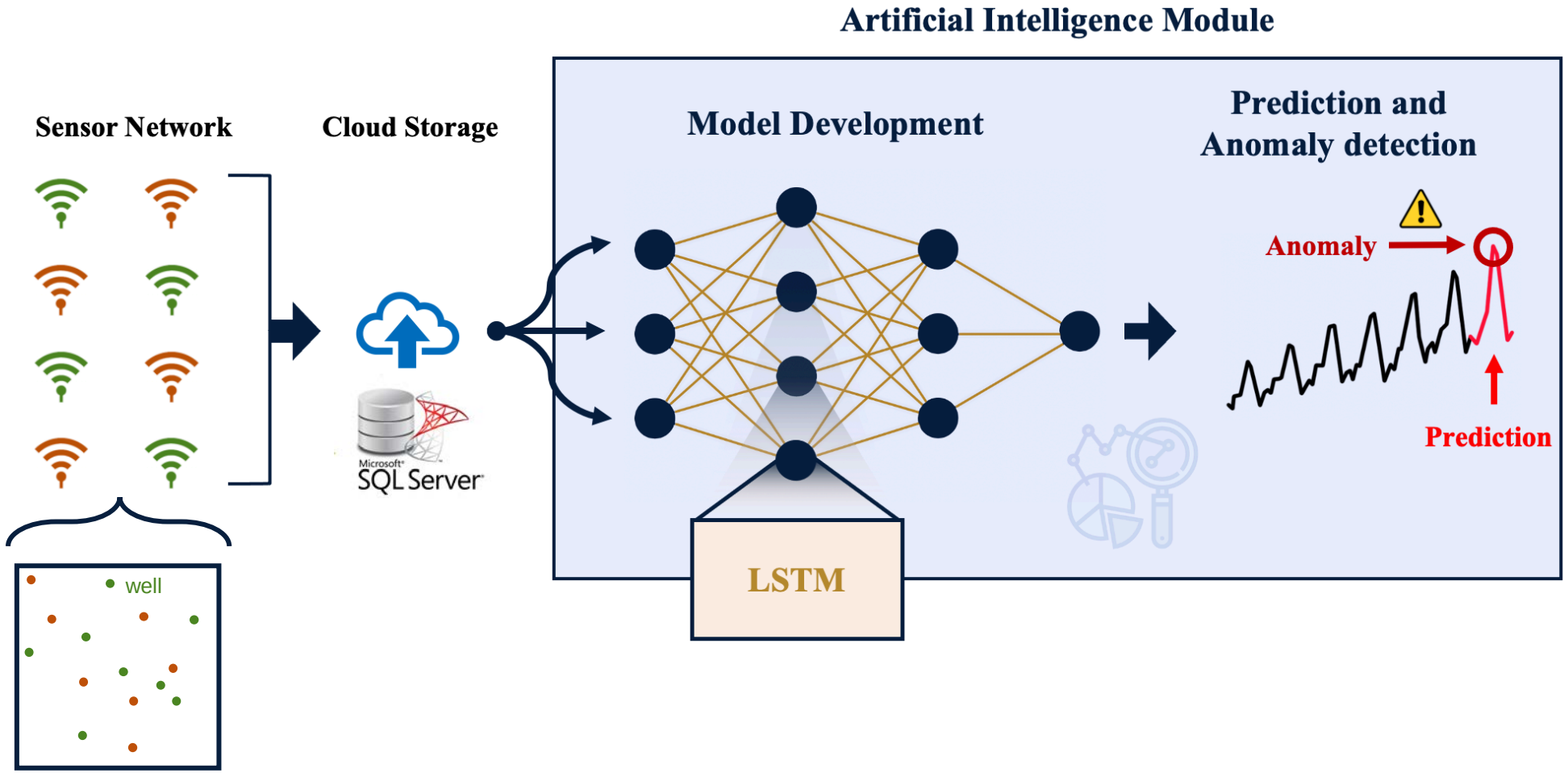
Subtask 8.5: Development of the AI/ML based system to perform predictive analytics using datasets containing time-series and imagery data from sensors

FIU Year 2 Research Highlights:

- Predict contaminant concentrations using sensor collected variables using Deep Learning (DL).



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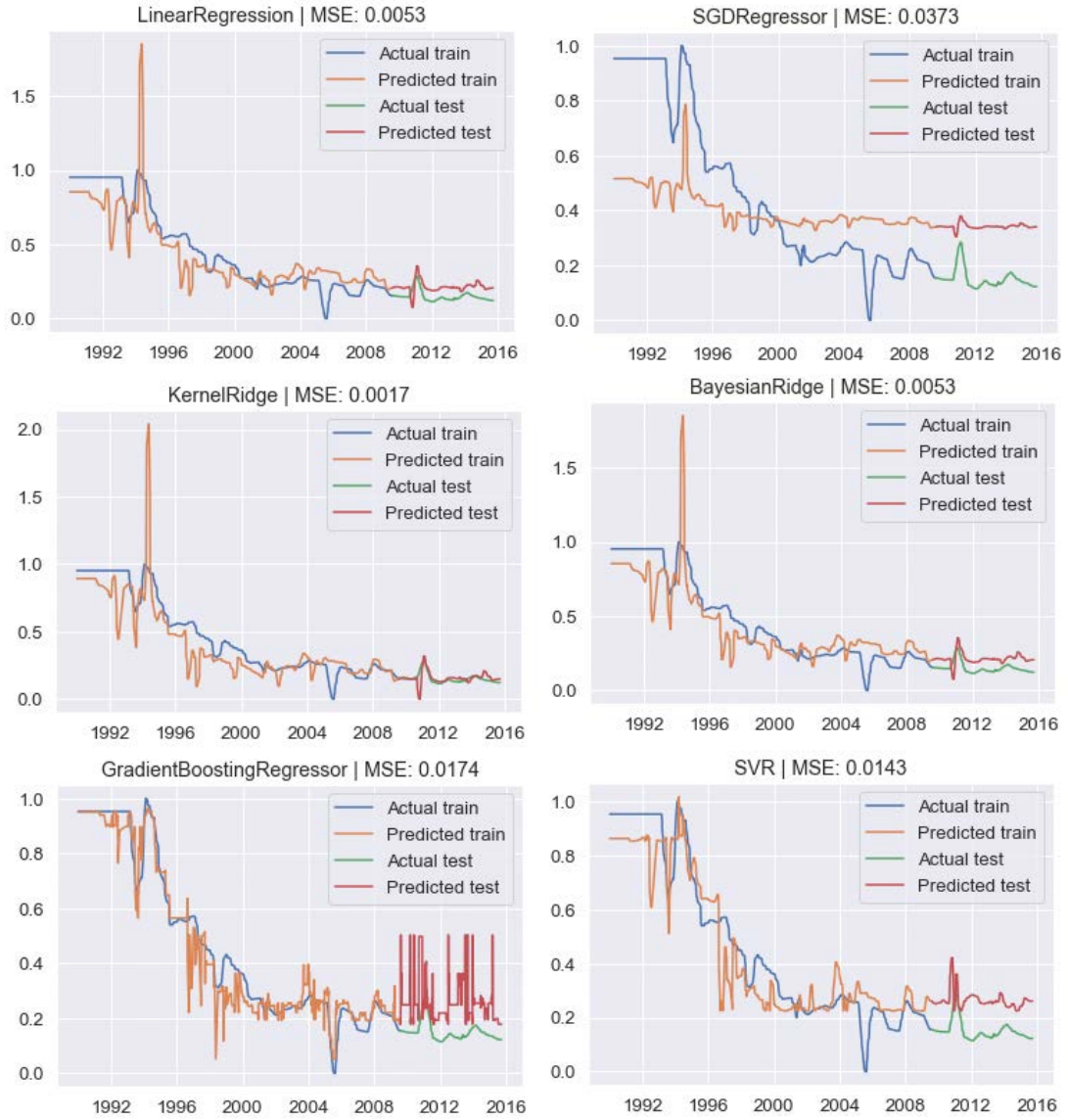
Subtask 8.5: Development of the AI/ML based system to perform predictive analytics using datasets containing time-series and imagery data from sensors

FIU Year 2 Research Highlights:

- **Machine Learning (ML) model's prediction of contaminant concentrations using sensor collected variables**
  - As is evident in the MSE results, kernel ridge regression performed the best giving an error of 0.0016 on the testing set.
  - The prediction matches best the actual concentration in the plot.
  - Although the results are according to the metric used for evaluation, most of the models did not generalize well on the training or the testing set which is assumed to be due to single feature used.



Training and testing predictions of each ML Model

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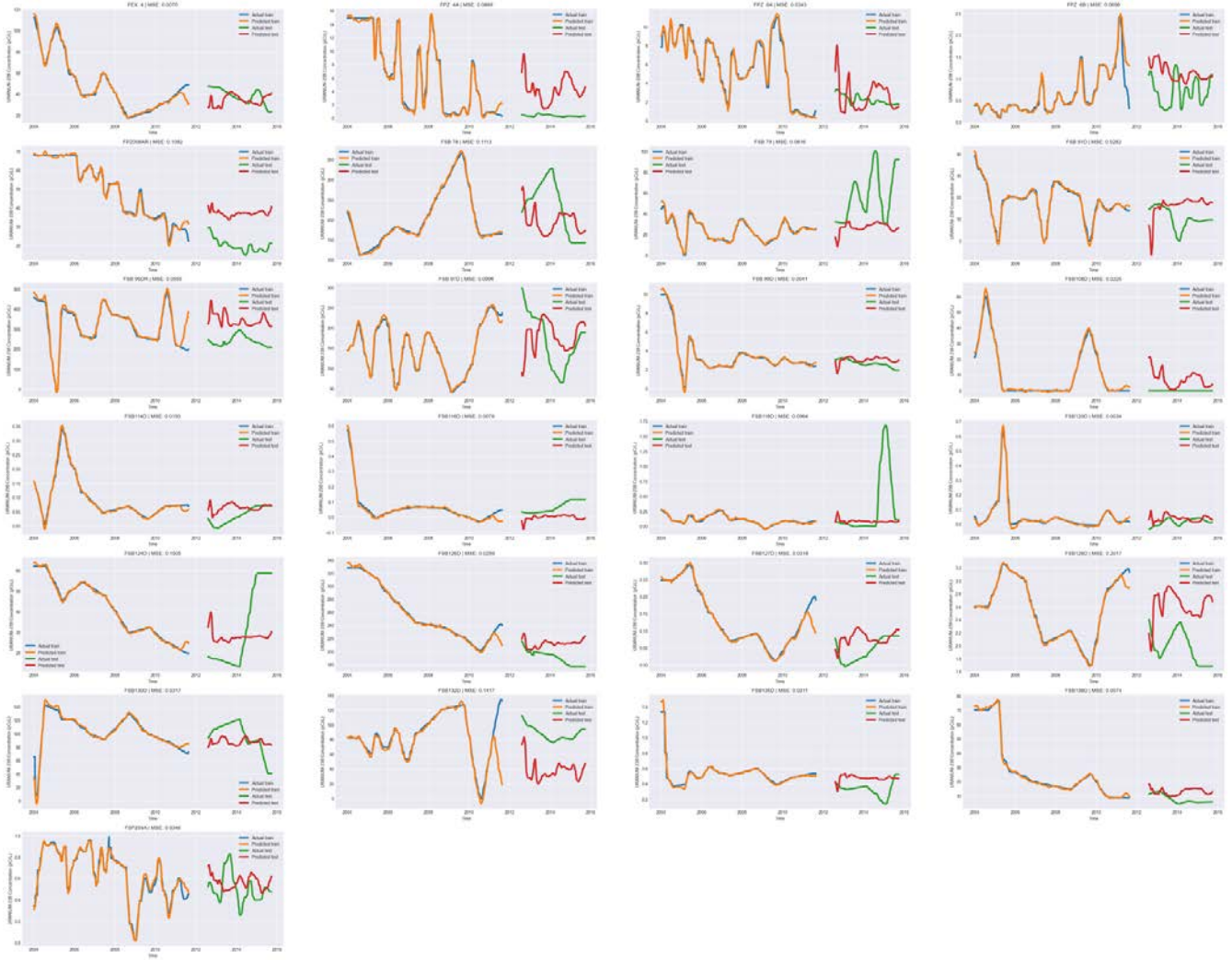
Subtask 8.5: Development of the AI/ML based system to perform predictive analytics using datasets containing time-series and imagery data from sensors

FIU Year 2 Research Highlights:

- **Deep Learning (DL) model's prediction**
  - Time series plot of the train and test predictions shown in Figure.
  - The two best predicted wells, FSB120D and FSB 99D (0.003397, 0.004078 respectively) have test prediction and true values close to one another.
  - Training predictions follow the true values which indicate that the network was learning on the input data, but overall performs poorly on the testing data.
  - The model needed to go deeper in order to generalize.



Training and testing predictions using DL method

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Task 8

FIU Year 3 Projected Scope

- **AI System interface:**
  - The AI system interface will be fine tuned according to the sensors' data streams following the completion of the sensor network deployment under the ALTEMIS project.
- **AI development for QA/QC and predictive analysis:**
  - Further developments of the Machine learning and Deep learning algorithms from the multi-sensors data stream from the sensor network under the ALTEMIS project.

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Thank You! Questions?