A long-term comprehensive study on environmental impacts on biomass productivity of periphytic algae flow-way deployed at contaminated US territory.

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Sandia National Laboratories

Deployment:

Corpus Christi, TX

Texas A&M AgriLife

✓ Marine-estuarine source water

✓ Power plant site with fresh water reservoir and marine water intake canal

✓ Pumping station for cooling water & AgriLife research station use

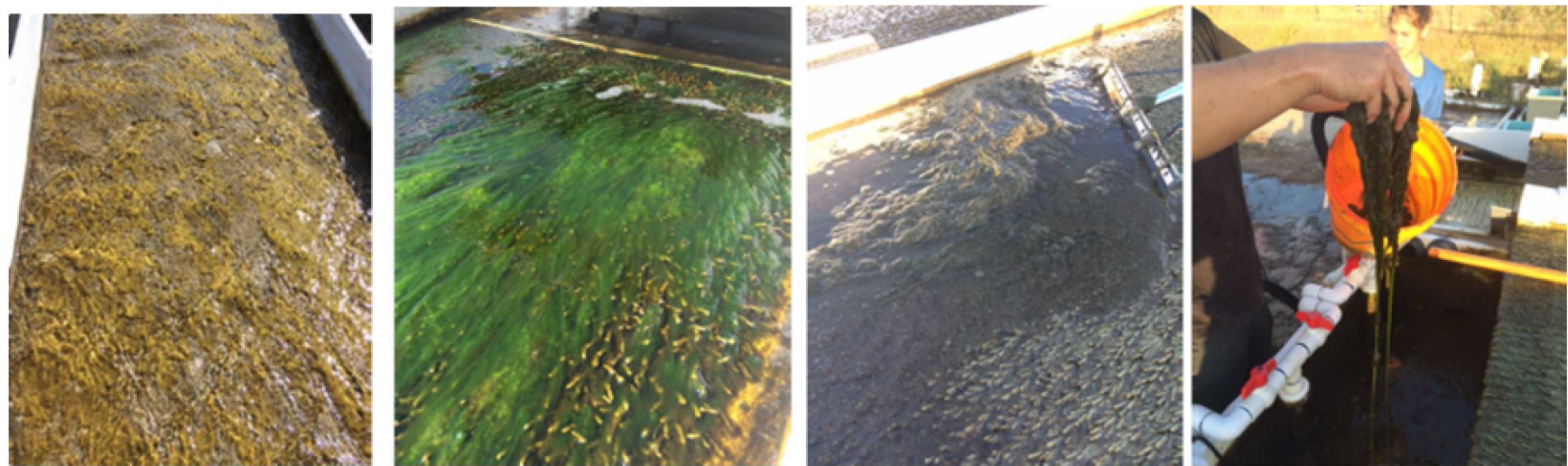✓ Side-by-side raceway & floway operation for comparative assessment

Corpus Christi, TX

Figure 1: Pictures of actual flow-way deployed at Corpus Christi, TX.

Pioneer algal turf (benthic diatoms) → Established algal turf (Cheatomorpha) → Weekly harvest (low cost) → Biomass!

- Stably operating since July, 2016
- Initially populated by modest productivity pioneer turf
- Rapid population shift to stable, high productivity filamentous green alga following pioneer phase
- >100 Kg biomass delivered to characterization, logistics, and processing teams
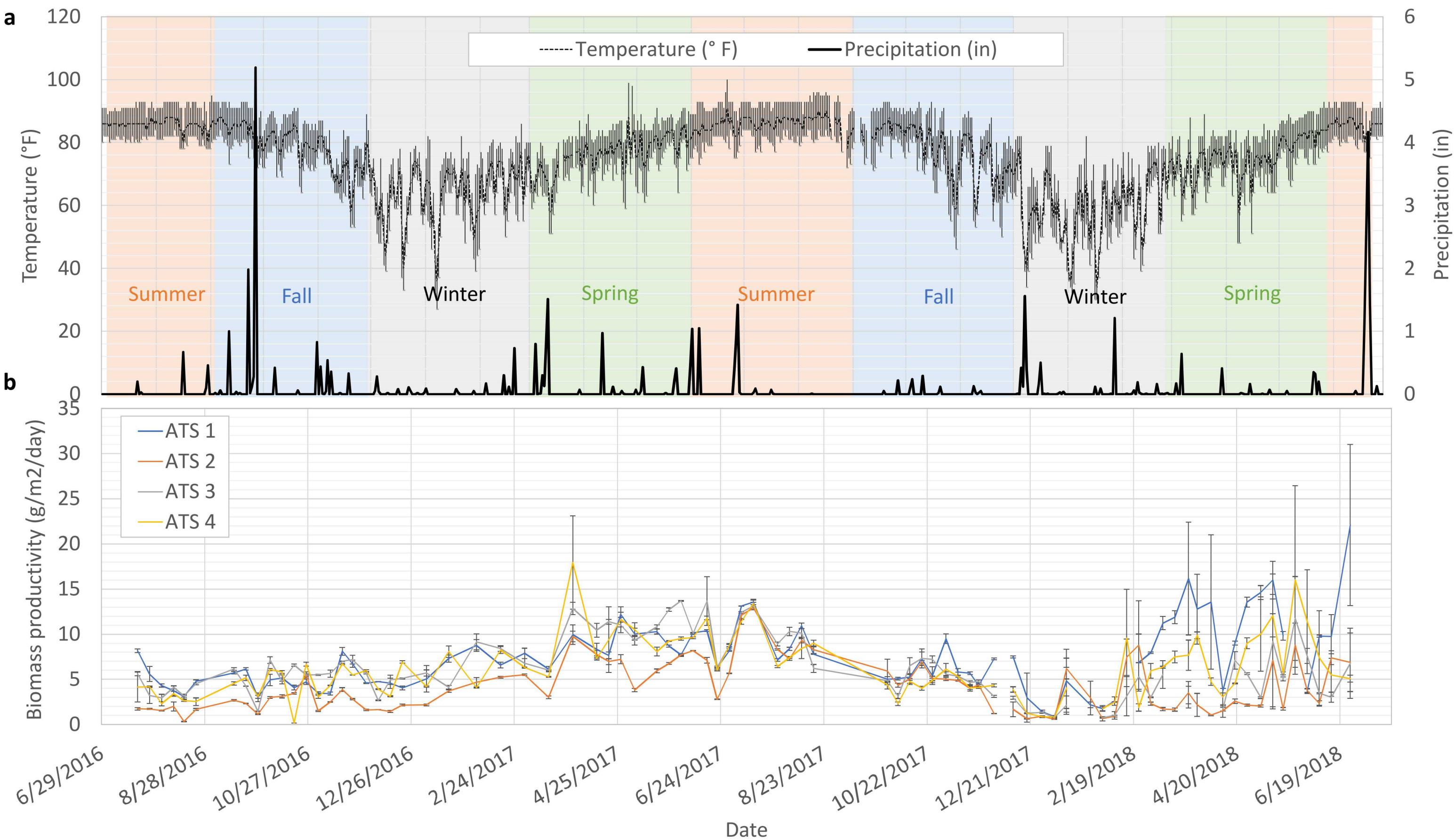
Figure 2a&b: Graph of weather condition including daily variance of temperature and precipitation throughout the entire period of cultivation (a) and biomass productivity from 4 different periphytic algae flow-way (b)
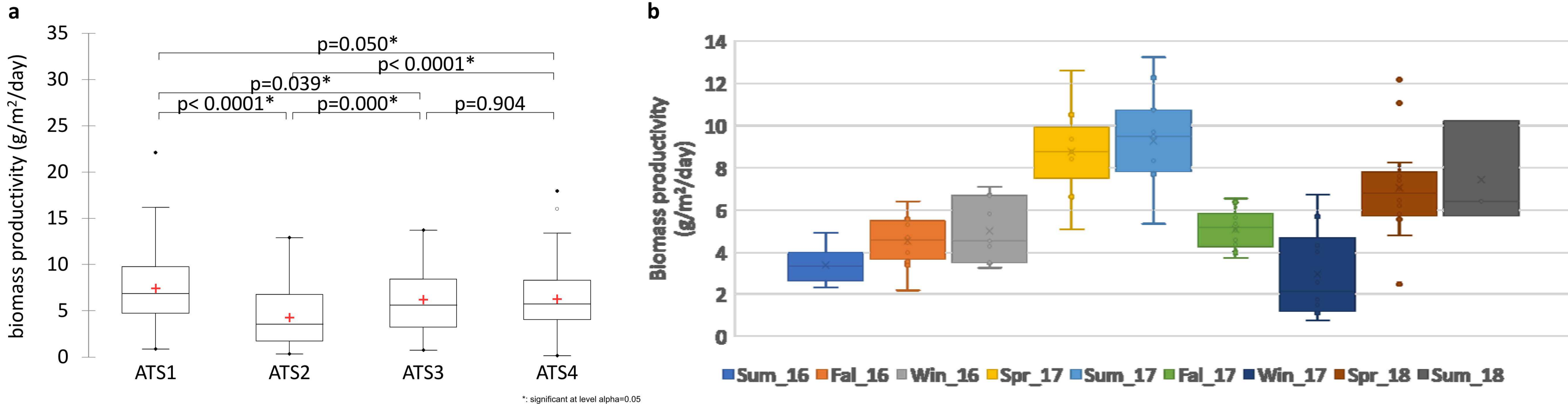
Figure 3a&b: Box plot of average total biomass productivity of all 4 flow-ways (a) and seasonal variation of biomass productivity (b)

		Summer_16	Fall_16	Winter_16	Spring_17	Summer_17	Fall_17	Winter_17	Spring_18	Summer_18	Entire period
ATS 1 (Highest)	Biomass productivity (g/m2/day)	5.0±1.8	5.0±1.5	5.9±1.7	9.0±1.8	9.4±2.4	6.1±1.5	3.4±2.4	11.1±4.1	13.9±7.1	7.4±3.8
	Ash content (%)	70.7±1.2	71.1±1.6	72.0±6.2	74.6±8.1	71.3±2.0	66.1±2.3	60.5±8.5	67.1±6.8	61.3±8.5	68.7±6.7
	Carb (%)	67.4±4.3	68.4±4.2	70.3±3.9	57.2±15.9	74.8±4.1	74.9±3.2	82.4±5.1	79.8±2.7	NA	71.9±9.9
	Lipid (%)	1.1±0.4	1.2±0.5	0.7±0.2	0.9±0.7	0.1±0.0	0.2±0.2	0.2±0.2	0.4±0.2	NA	0.7±0.6
	Protein (%)	31.5±4.3	30.4±3.9	29.2±4.0	41.9±15.3	25.2±4.1	24.9±3.2	17.5±5.2	19.9±2.5	NA	27.6±9.5
ATS 2 (Lowest)	Biomass productivity (g/m2/day)	1.5±0.6	2.8±1.2	3.0±1.5	6.3±2.0	8.2±2.8	4.7±1.5	3.1±3.2	3.0±2.2	5.5±2.8	4.2±2.9
	Ash content (%)	70.8±2.3	69.7±2.7	72.4±6.7	76.2±2.9	70.9±1.9	63.8±2.5	55.3±13.7	64.3±9.6	61.5±6.1	67.2±8.9
	Carb (%)	65.4±5.1	68.7±3.4	68.2±3.7	61.8±11.7	76.2±3.2	75.9±5.0	82.0±3.6	80.4±3.7	NA	72.5±8.5
	Lipid (%)	1.1±0.6	0.9±0.4	0.7±0.3	1.1±0.8	0.3±0.3	0.2±0.1	0.3±0.2	0.2±0.1	NA	0.7±0.5
	Protein (%)	33.5±4.6	30.4±3.2	31.2±3.5	37.5±11.1	23.7±3.2	24.0±5.0	17.9±3.5	19.4±3.6	NA	27.1±8.1

Observations (axes PC1 and PC2: 70.45 %)

	PC1	PC2
Eigenvalue	4.252	1.439
Variability (%)	53.144	17.983
Cumulative %	53.144	71.128

	PC1	PC2
Air Temp	20.961	0.507
SolarRad	18.526	0.011
Precip.	0.014	49.737
Water Temp.	19.772	3.111
Sal	16.941	0.024
pH	15.940	2.153
NH3 ppm	1.854	30.320
Humidity (%)	5.992	14.137

Legend: ● Fall ● Spring ● Summer ● Winter ● Centroid

Biplot (axes PC1 and PC2: 70.45 %)
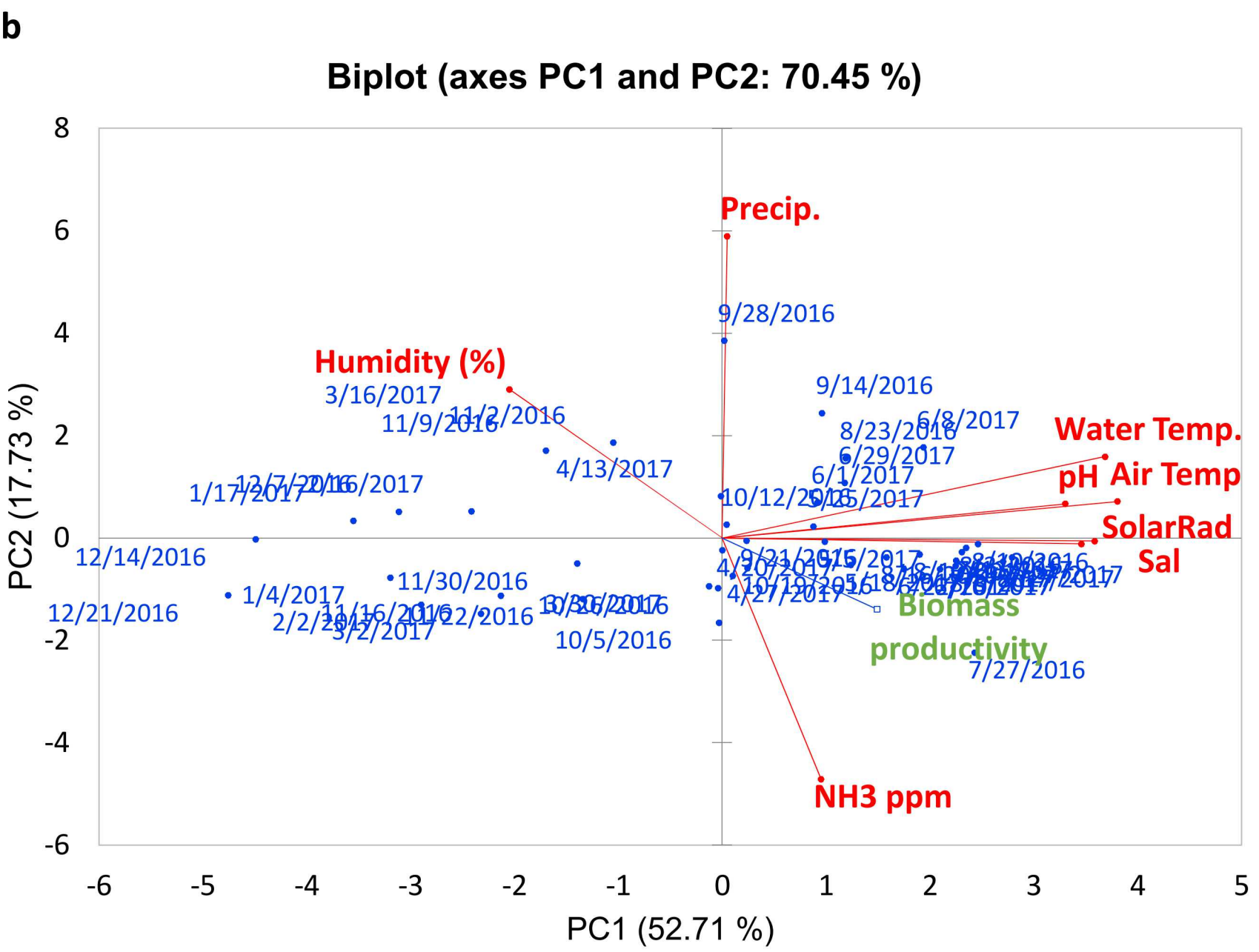
✓ Group of points that have high biomass productivity are located where shows positive correlation with **water temperature, air temperature, pH, solar radiation, and salinity**. This group consist mostly samples from summer season and some from spring and fall. Non of samples from winter is included in this group, instead they show the opposite correlation.

Figure 4a&b: Principle Component Analysis (PCA) on biomass productivities with environmental parameters.

Pred(Biomass productivity) / Biomass productivity

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Air Temp	-0.679	0.489	-1.389	0.173	-1.670	0.312
SolarRad	0.302	0.173	1.748	0.089	-0.049	0.653
Water Temp.	0.073	0.458	0.159	0.875	-0.857	1.002
Sal	1.105	0.175	6.316	< 0.0001	0.750	1.460
pH	-0.341	0.167	-2.044	0.048	-0.679	-0.003

➤ **Biomass productivity**

= 32.8-0.4***Air Temp**+3.3E-03***SolarRad**+4.0E-02***Water Temp.**+0.5***Sal**-4.4*pH

✓ Salinity has the highest explanatory value to explain biomass productivity.

✓ Obviously, salinity have had impact on biomass productivity. In addition to that, salinity shows relatively high correlation between other important environmental parameters like water temperature, solar radiation, and pH, which makes salinity to have a higher explanatory value than others.
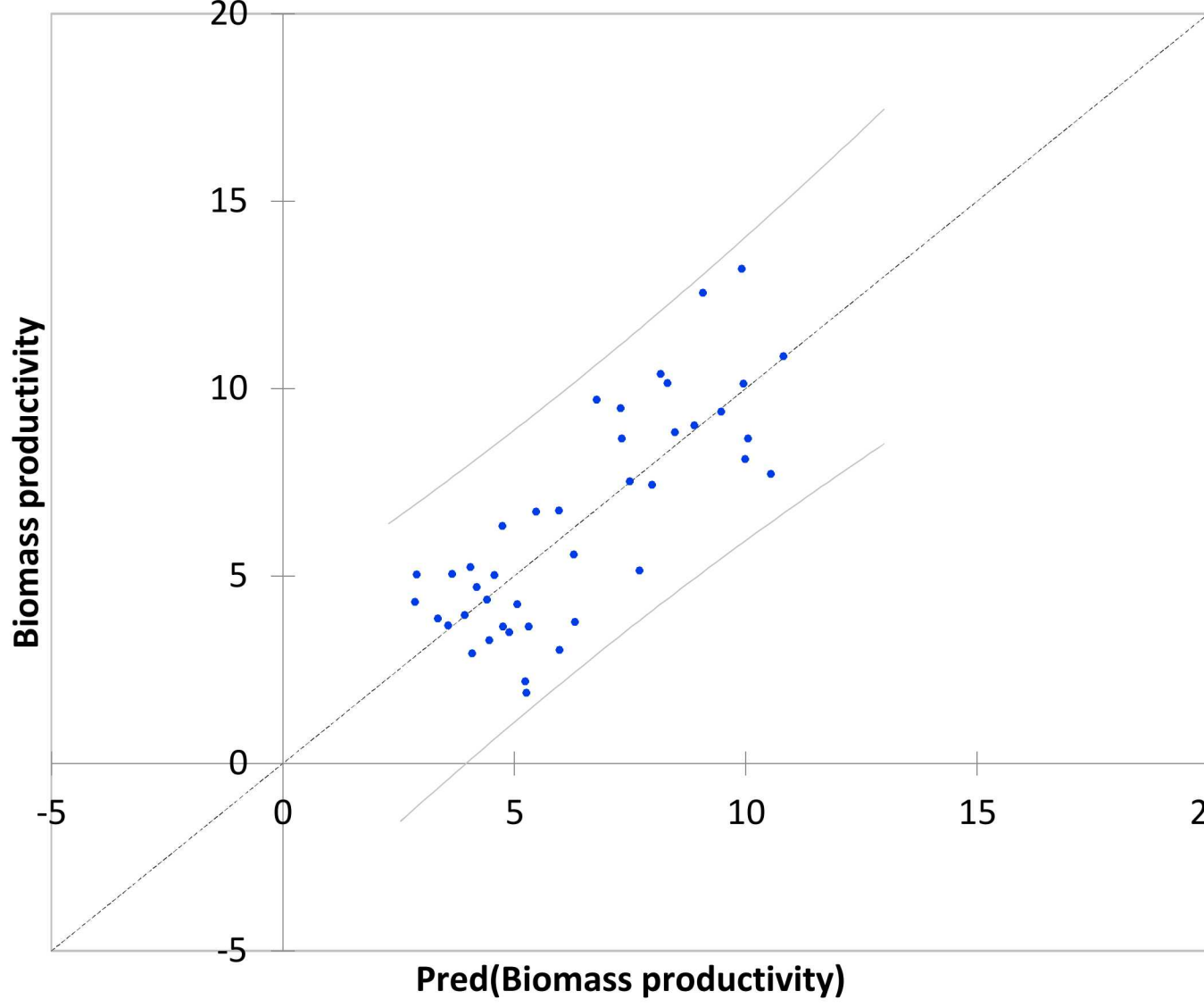
Figure 5: Scatter plot of experimental versus predicted biomass productivity

y = 0.799x + 16.434
R² = 0.4595

y = 0.0128x + 27.555
R² = 0.3929

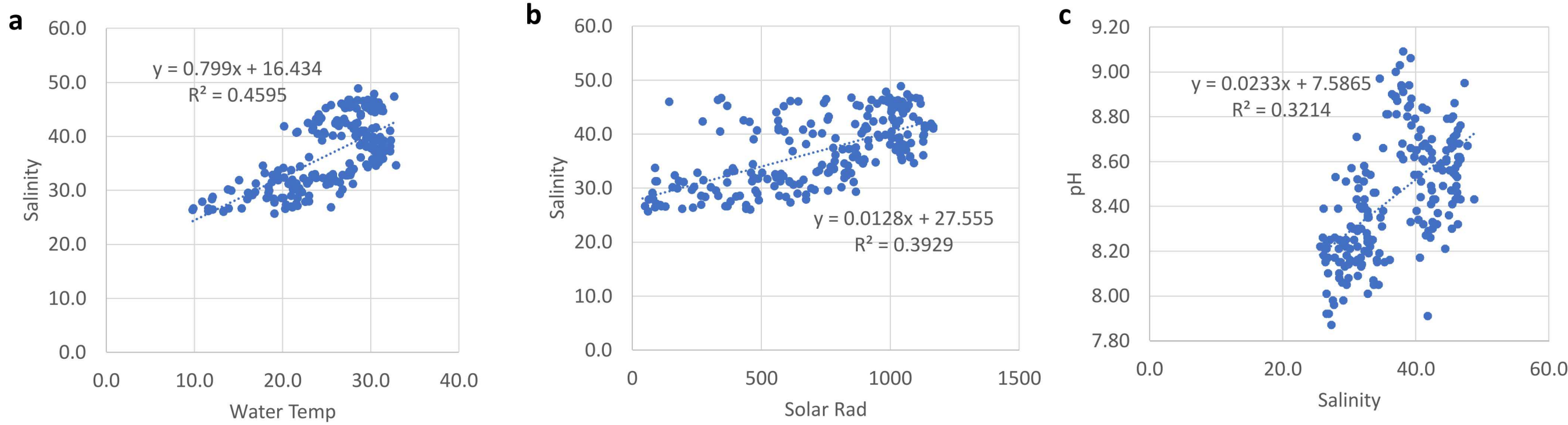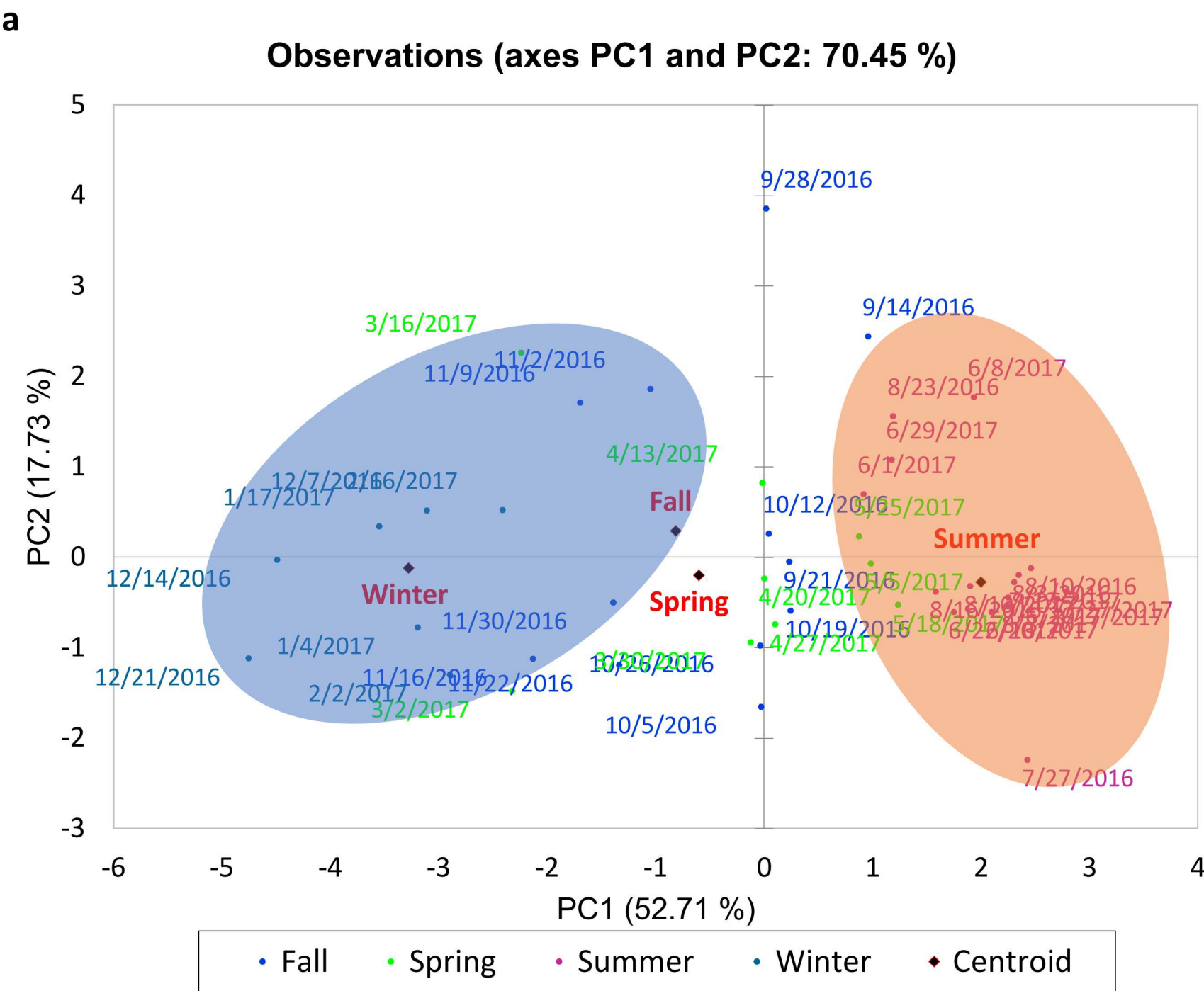y = 0.0233x + 7.5865
R² = 0.3214

Figure 6a&b&c: Scatter plots to see correlation between salinity and other environmental parameters including water temperature (a), solar radiation (b), and salinity (c)

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