Exploring the Ameriflux Data

Trends and Relationships

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Upscaling Group Meeting

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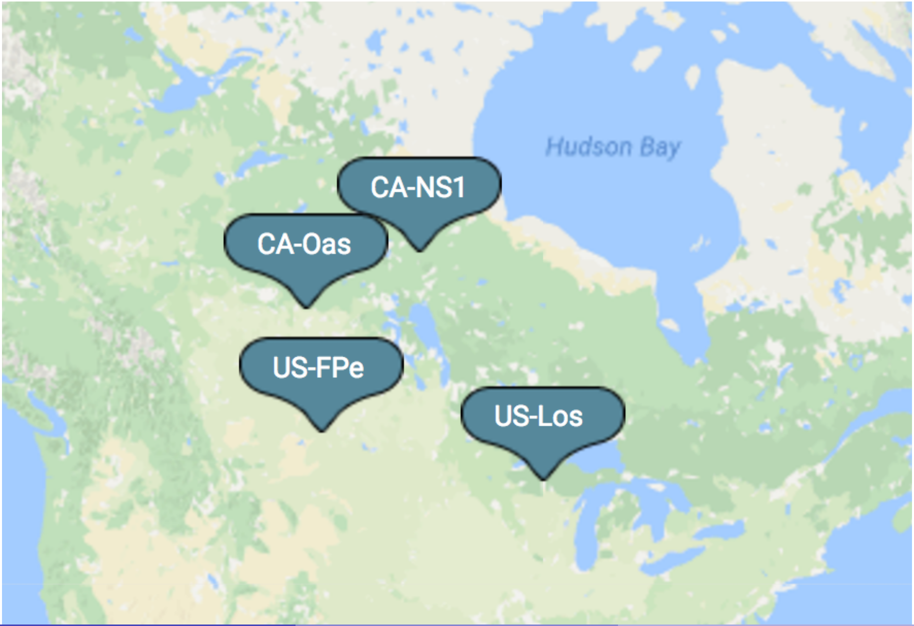
Sites

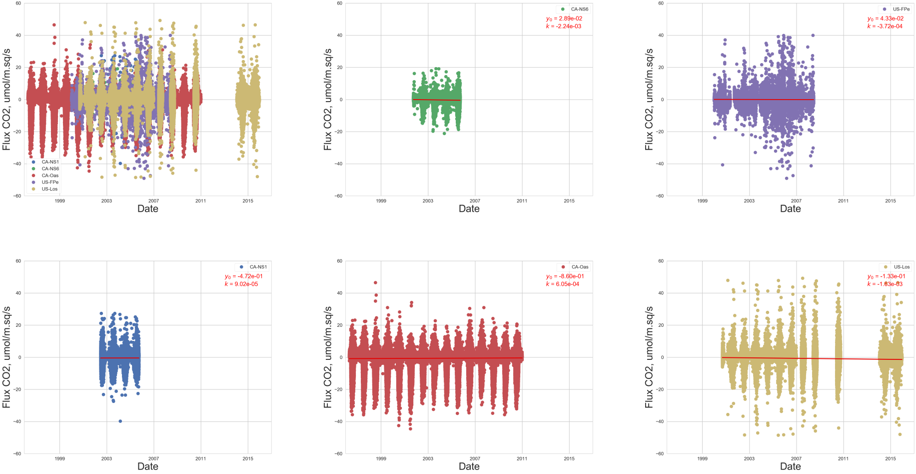
Name	Climate	Type	Mean T, C	Mean P, mm
CA-NS1	Dfc	ENF	-2.89	500.29
CA-NS6	Dfc	OSH	-3.08	495.37
CA-Oas	Dfc	DBF	0.34	428.53
US-FPe	Bsk	GRA	5.48	334.8
US-Los	Dfb	WET	4.08	828

Climate: Dfc - Subarctic: severe winter, no dry season, cool summer; Bsk - Cold semi-arid climate, steppe, warm winter; Dfb - Warm Summer Continental: significant precipitation in all seasons.
Vegetation: ENF - Evergreen Needleleaf Forests; OSH - Open Shrublands; DBF - Deciduous Broadleaf Forests; GRA - grassland; WET - Permanent Wetlands.

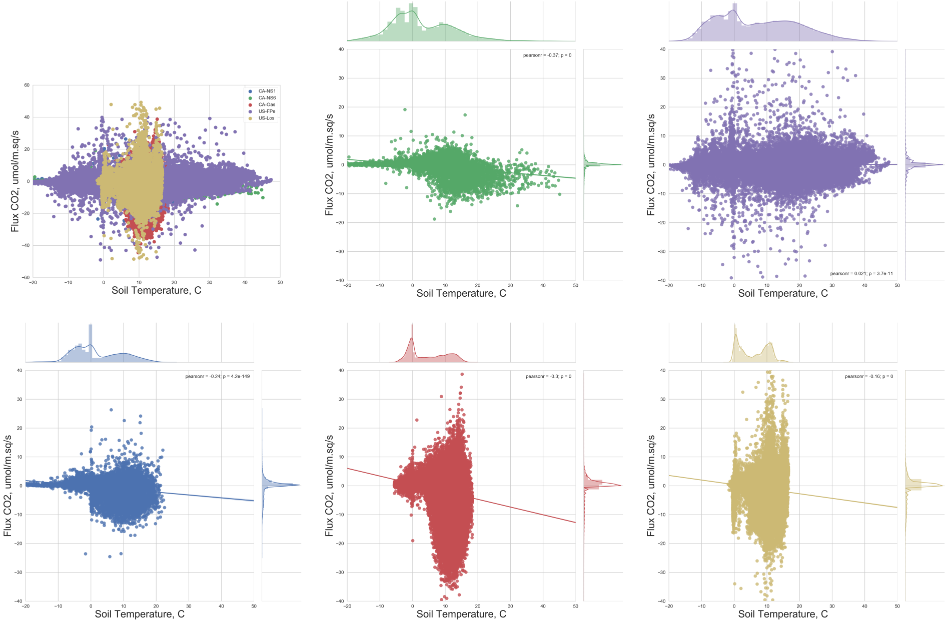
Sites



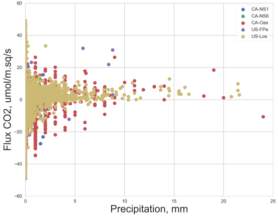
Flux in Time

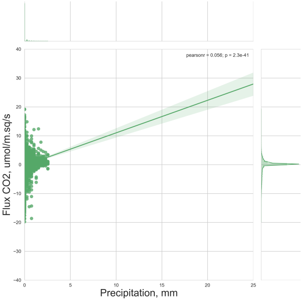

Flux CO2, umol/m.sq/s
Date
CA-NS1
CA-NS6
CA-Oas
US-FPe
US-Los
y_0 = 2.89e-02
k = -2.24e-03
y_0 = 4.33e-02
k = -3.72e-04
y_0 = -4.72e-01
k = 9.02e-05
y_0 = -8.60e-01
k = 6.05e-04
y_0 = -1.33e-01
k = -1.63e-03
60
40
20
0
-20
-40
-60
1999
2003
2007
2011
2015

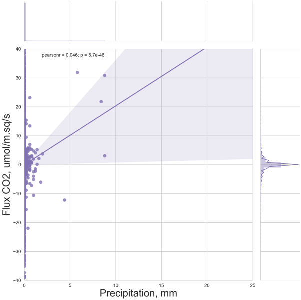
Flux vs Soil Temperature

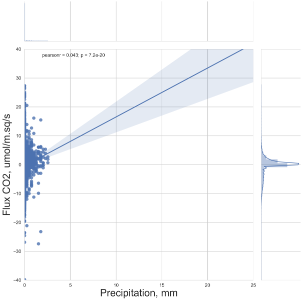


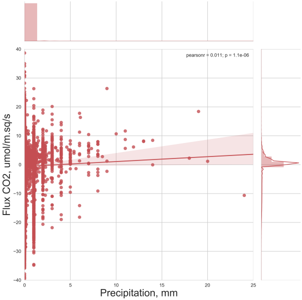
Flux vs Precipitation

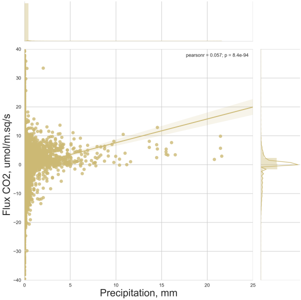




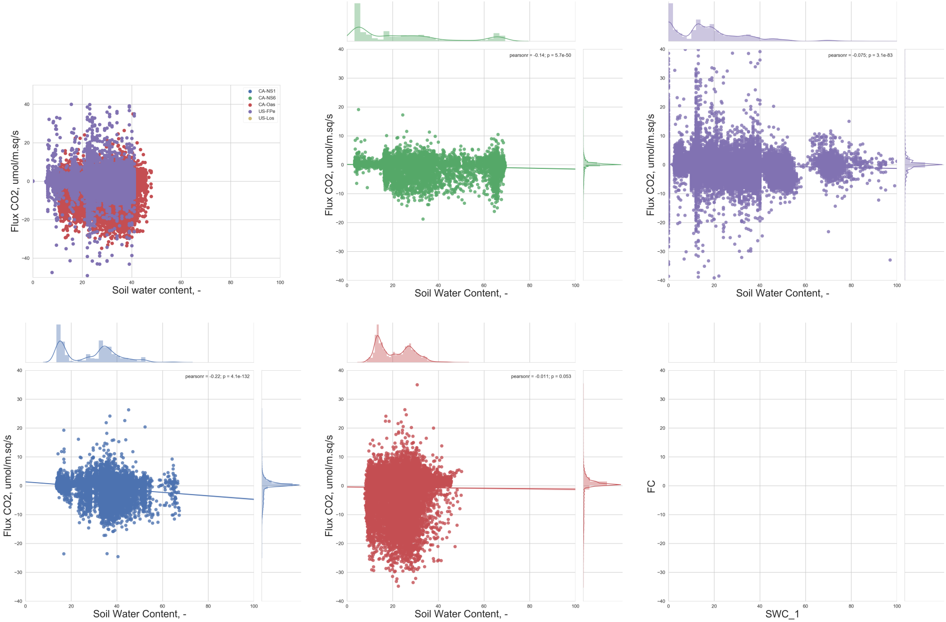




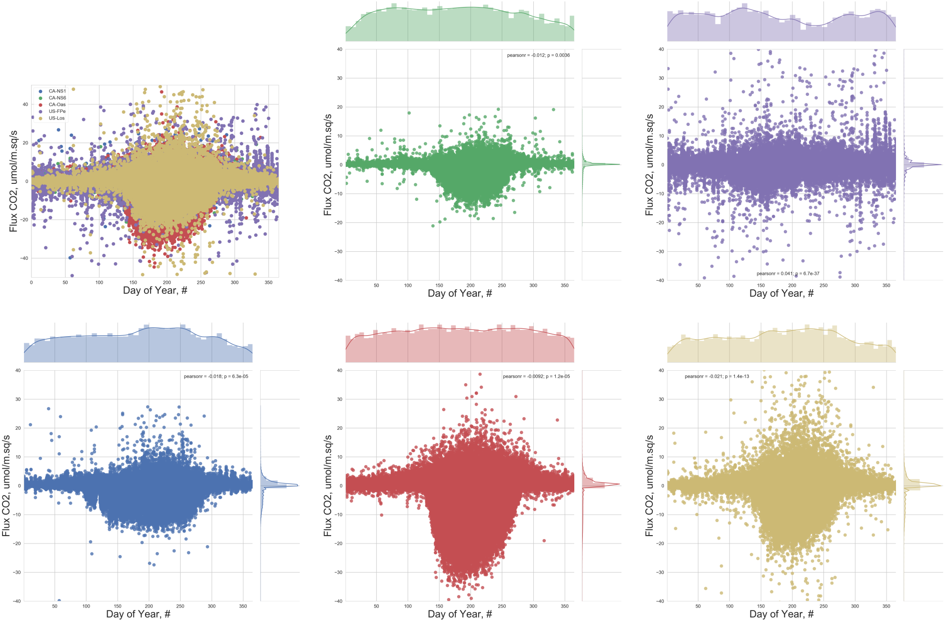




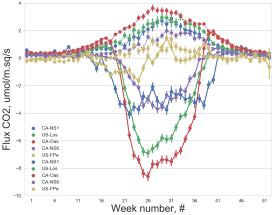
Flux vs Soil Water Content

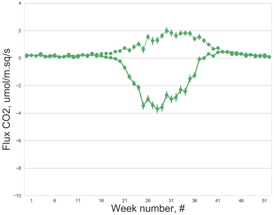


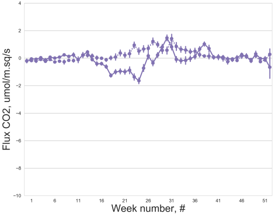
Flux on Yearly scale

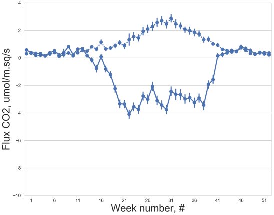


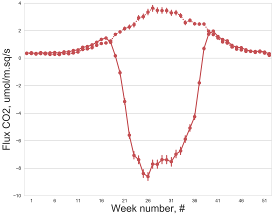
Weekly average: Day/Night

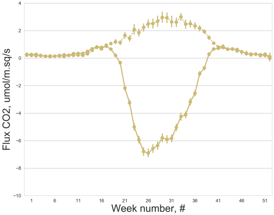




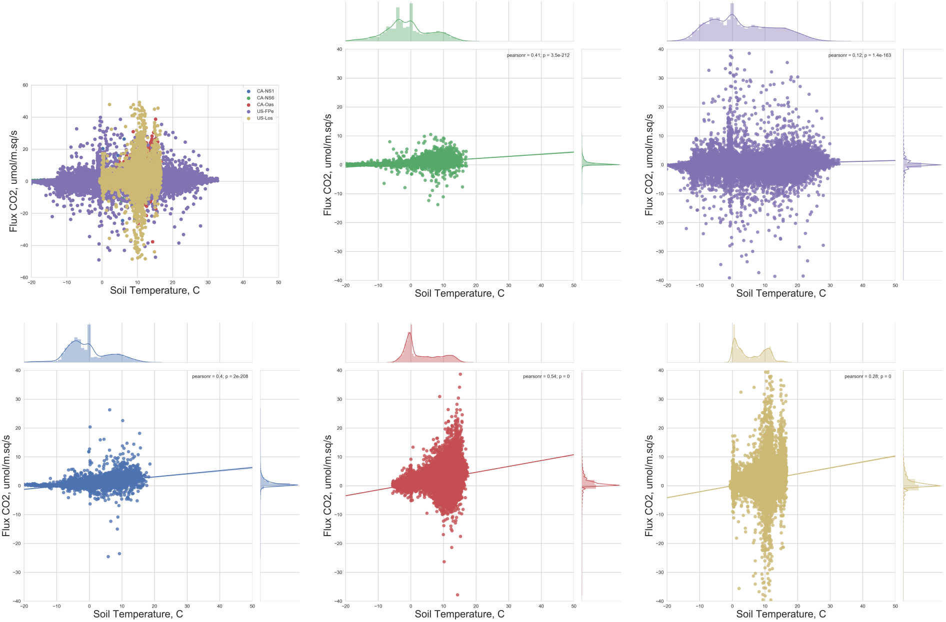




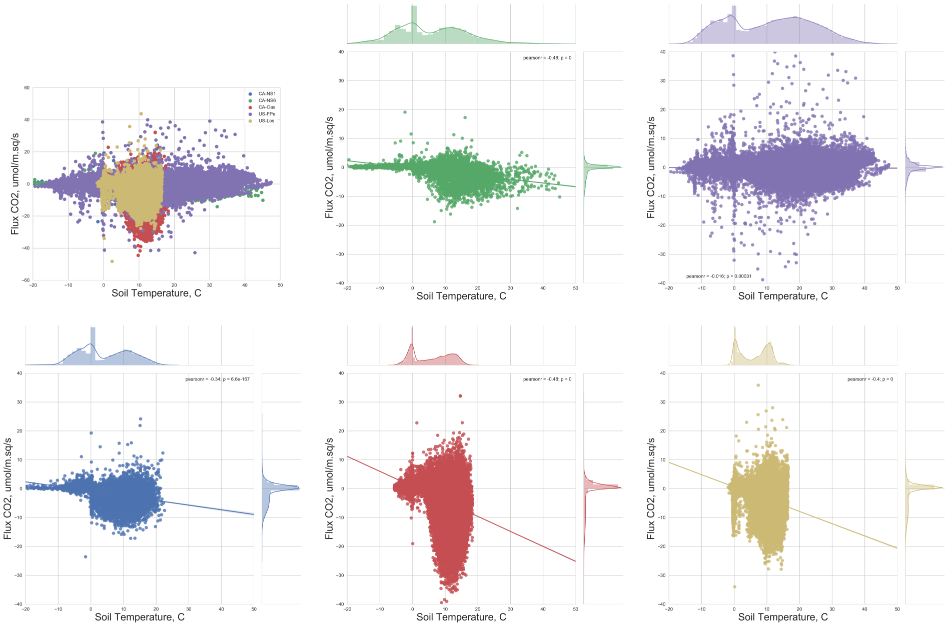




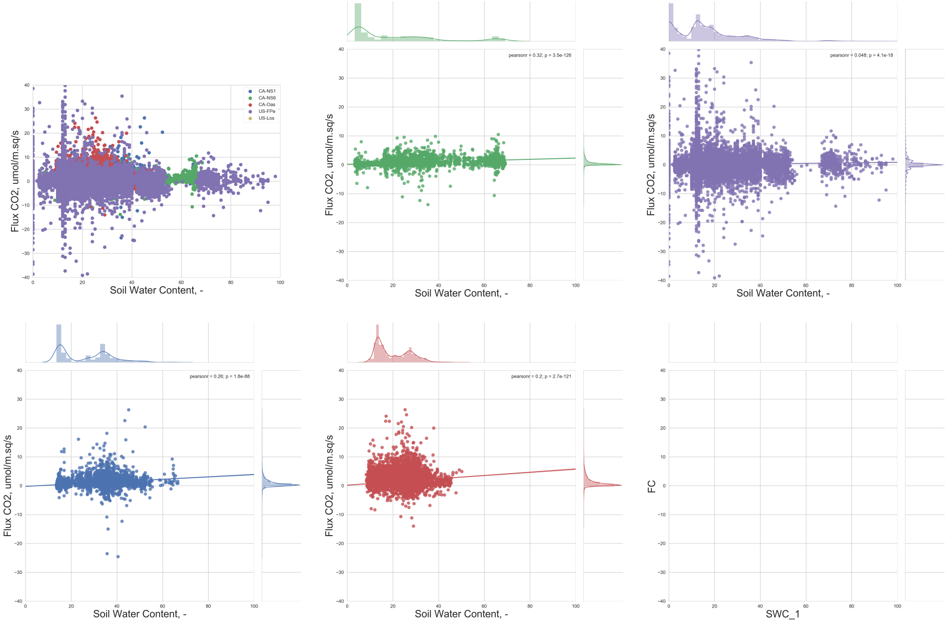
Flux vs Temperature at Night



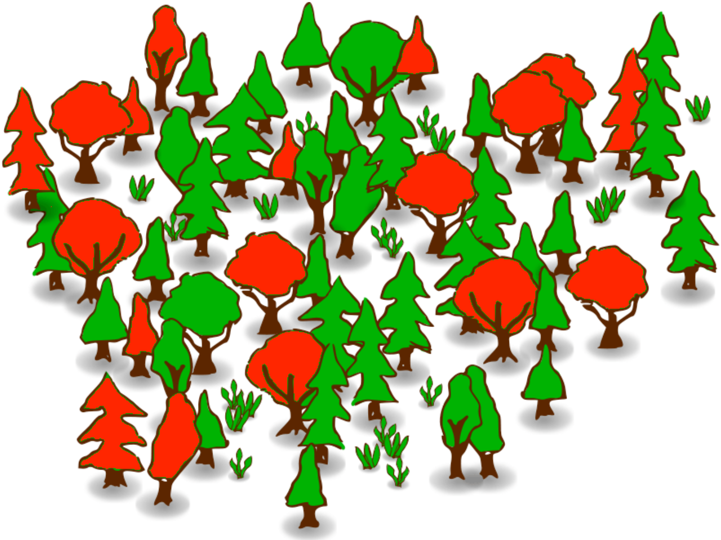
Flux vs Temperature during Daylight



Flux vs Soil Water Content at Night

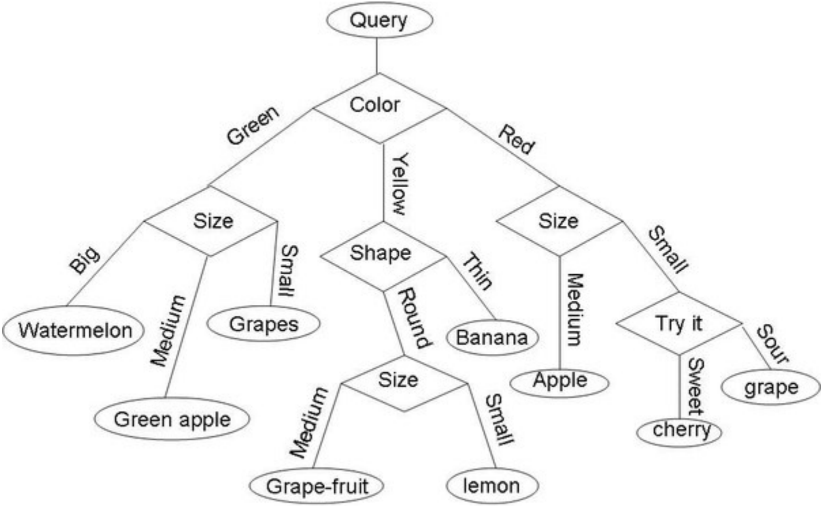


Machine Learning: Random Forests[1]



[1] **Breiman, L.** *Machine Learning (2001) 45:5.* doi:10.1023/A:1010933404324.

Machine Learning: Random Forests



Random Forests Algorithm: Predicted vs Measured (Night)

Features: SWC, T, P, Lat, Long, Date

Random Forests Algorithm: Predicted vs Measured (Night)

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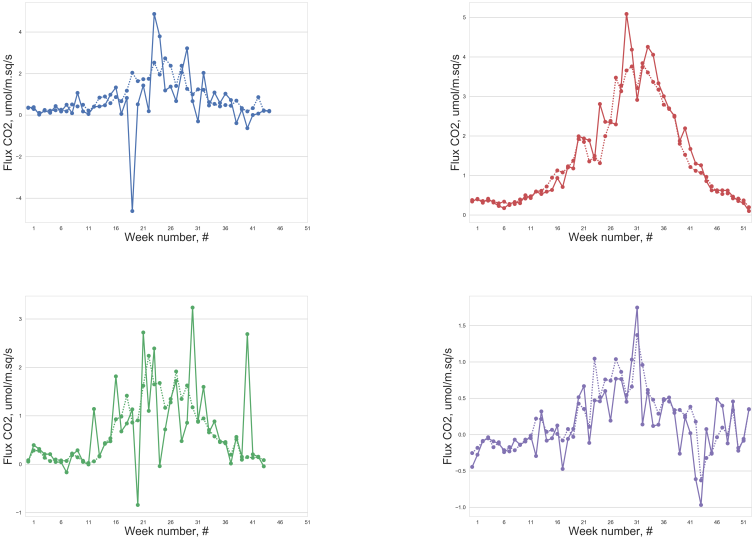
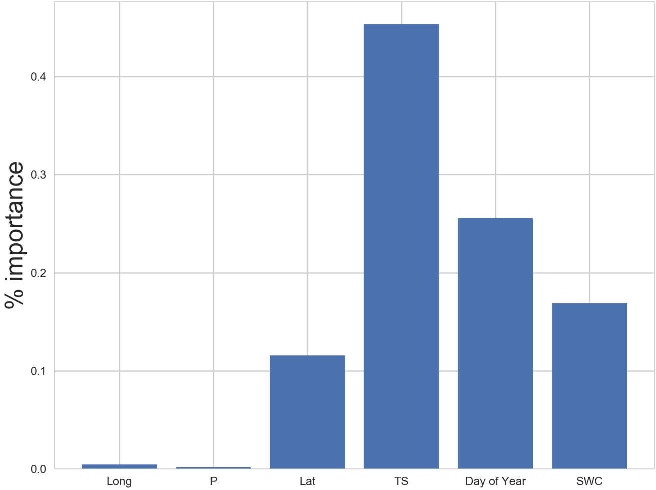


Random Forests Algorithm

Relative Importance of Features



Train on all data (25 Sites). Six Modeled Sites

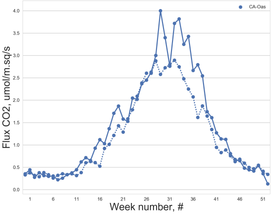
Modeled Sites:

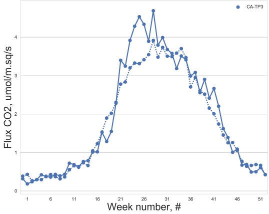
Station	Climate	Type	Mean T, C	Mean P, mm	Elev., m
CA-OAS	Dfc	DBF	0.34	428	530
CA-Qfo	Dfc	ENF	-0.36	962	382
CA-TP3	Dfb	ENF	8	1036	184
US-Fpe	Bsk	GRA	5.48	335	634
CA-TPD	Bsk	GRA	8	1036	260
CA-GRO	Dfb	MF	1.3	831	340

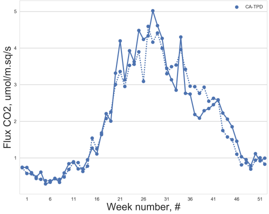
Climate: Dfc - Subarctic: severe winter, no dry season, cool summer; Bsk - Cold semi-arid climate, steppe, warm winter; Dfb - Warm Summer Continental: significant precipitation in all seasons.
Vegetation: ENF - Evergreen Needleleaf Forests; DBF - Deciduous Broadleaf Forests; GRA - grassland; MF - mixed forest;

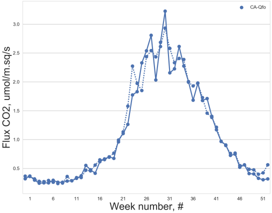
Random Forests Algorithm: Predicted vs Measured (Night)

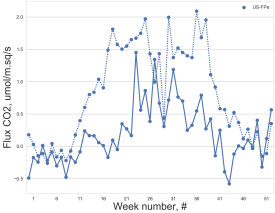
Features: SWC, T; Train on all data

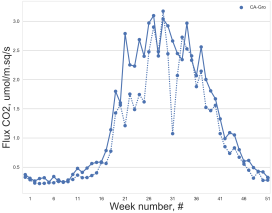






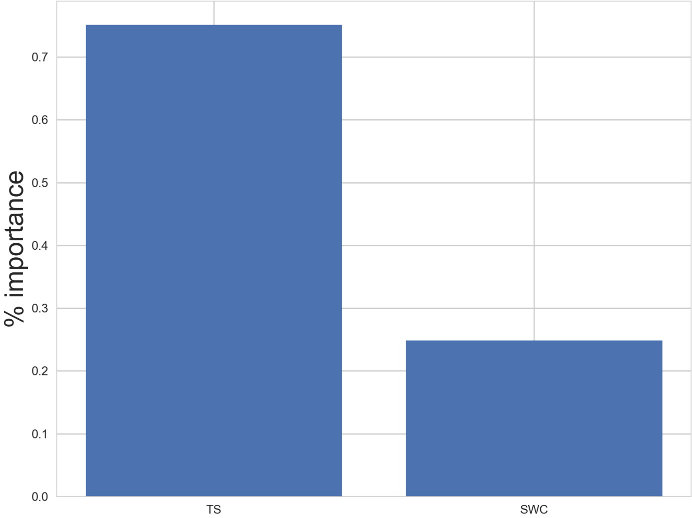






Random Forests Algorithm: Train on all data (25 Sites)

Relative Importance of Features



Reverse Engineering of Random Forests Algorithm

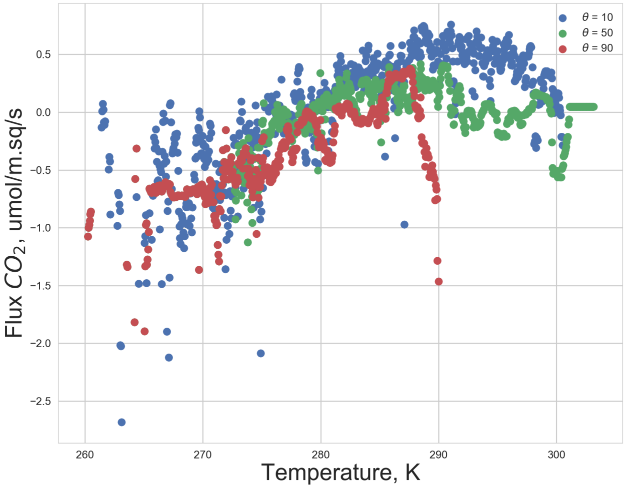
T = [-10; +30] with ΔT = 0.001

θ = [0; 1] with $\Delta\theta$ = 0.001

10^6 combinations

Reverse Engineering of Random Forests Algorithm

T dependence (Night)



Reverse Engineering of Random Forests Algorithm

T dependence (Night)

Modified Arrhenius equation for optimum T:

$$\frac{F}{F_{max}} = \frac{exp\left[\frac{-E_a}{RT_0}\left(1-\frac{T_0}{T}\right)\right]}{1+exp\left[\frac{ST-H_d}{RT}\right]} \qquad (1)$$

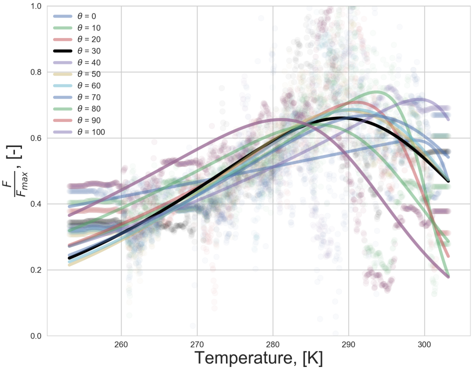
Fitting params:

$$T_0 = 293.4 \text{ K} \qquad (2)$$

$$E_a = -22.1 \text{ kJ/mol} \qquad (3)$$

$$S = 304.1 \text{ J/mol/K} \qquad (4)$$

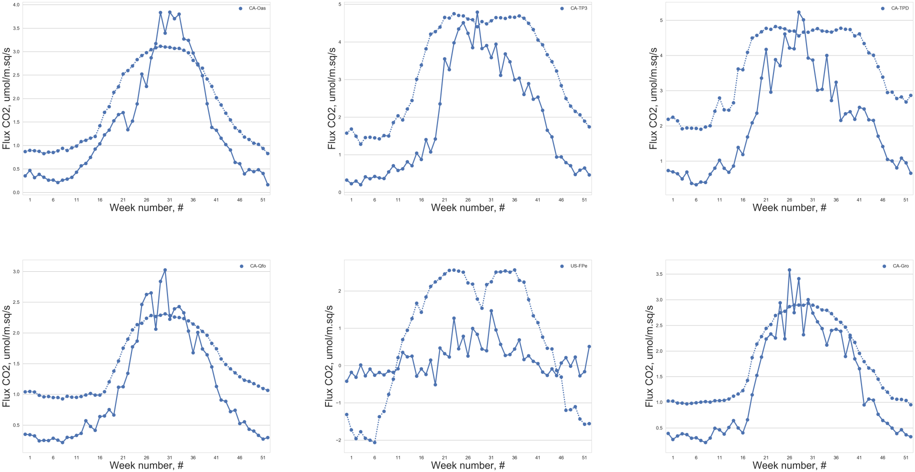
$$H_d = 90.6 \text{ kJ/mol} \qquad (5)$$



Reverse Engineering: Predicted (eq. 6) vs Measured

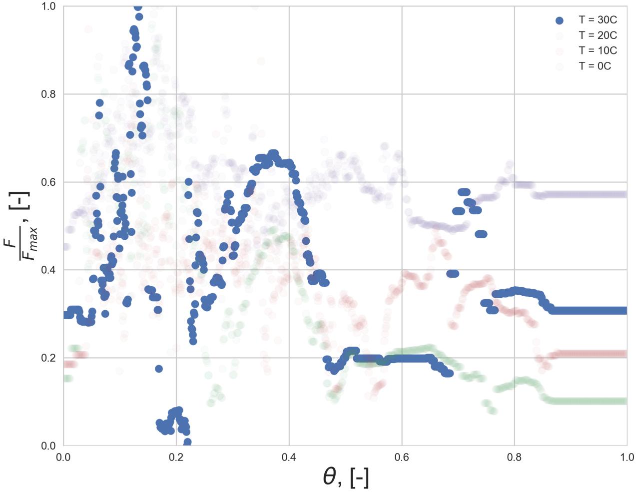
Measured - solid line; eq. 6 - dashed line

$$F = F_{max} \cdot f(T) \tag{6}$$



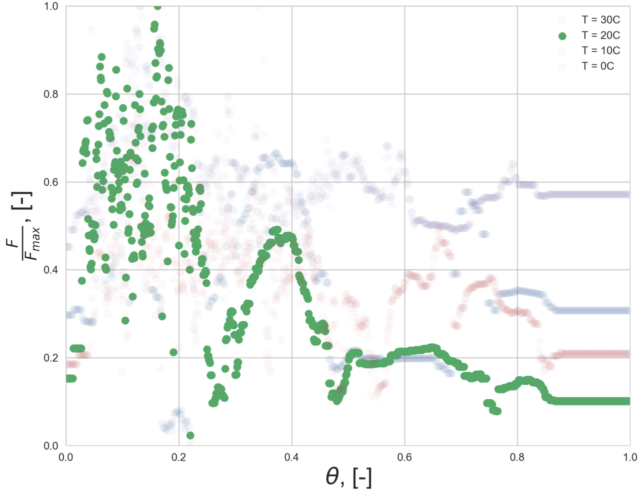
Reverse Engineering of Random Forests Algorithm

θ dependence (Night)



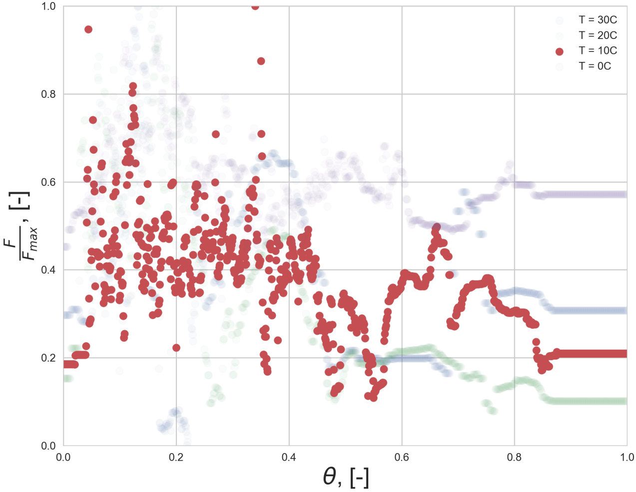
Reverse Engineering of Random Forests Algorithm

θ dependence (Night)



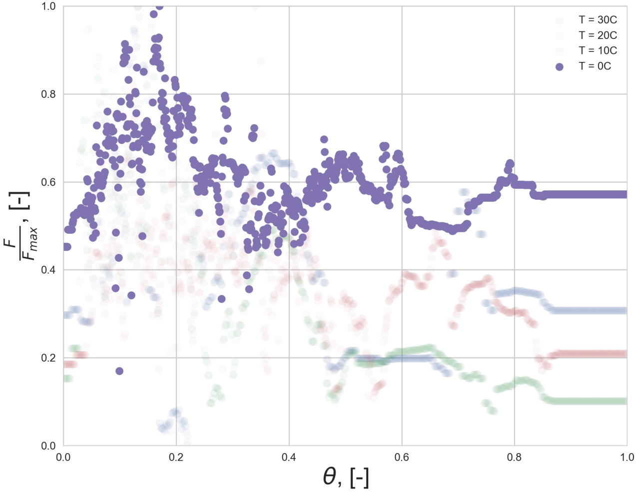
Reverse Engineering of Random Forests Algorithm

θ dependence (Night)



Reverse Engineering of Random Forests Algorithm

θ dependence (Night)



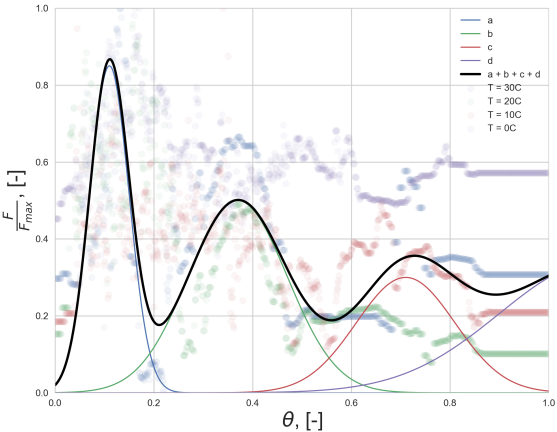
Reverse Engineering of Random Forests Algorithm

θ dependence (Night)

$$\frac{F}{F_{max}} = \sum_{i}^{4} A_i \frac{1}{\sqrt{2\pi\sigma_i^2}} e^{-\frac{(x-\mu_i)^2}{2\sigma_i^2}} \tag{7}$$

Fitting params:

Parameter	a	b	c	d
A	0.85	0.5	0.5	0.3
μ	0.11	0.37	0.71	1.1
σ	0.04	0.1	0.1	0.2



Reverse Engineering: Predicted (eq. 8) vs Measured

Measured - solid line; eq. 8 - dashed line

$$F = 0.75F_{max} \cdot f(T) + 0.25F_{max} \cdot f(\theta) \tag{8}$$