ICSolar Model

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Consider the model of air and water interaction consisting of an initial inlet region (denoted by 0) and a pair of regions, an open region with pipe followed by a module, denoted by (1,2) satisfying

$$W_1: \quad \dot{m}_w C_{p,w}(T_{w,1} - T_{w,0}) - h_{wa}(T_{a,1} - T_{w,1}) = 0 \tag{1}$$
$$A_1: \quad \dot{m}_a C_{p,a}(T_{a,1} - T_{a,0}) - h_{wa}(T_{w,1} - T_{a,1}) - h_e(T_e - T_{a,1}) - h_i(T_i - T_{a,1}) = 0 \tag{2}$$
$$W_2: \quad \dot{m}_w C_{p,w}(T_{w,2} - T_{w,1}) - Q_w = 0 \tag{3}$$
$$A_2: \quad \dot{m}_a C_{p,a}(T_{a,2} - T_{a,1}) - Q_a = 0 \tag{4}$$

Where i and e are interior and exterior contributions. Each pair of these forms a 'module'. In this work, we use

$$C_{p,w} = 4.218 kJ/(kgK) \tag{5}$$
$$\dot{m}_w = 0.0008483 kg/s \tag{6}$$
$$C_{p,a} = 1.005 kJ/(kgK) \tag{7}$$
$$\dot{m}_a = 0.384 kg/s \tag{8}$$
$$h_{wa} = 4.823 \times 10^{-5} kW/(Km) \tag{9}$$
$$h_i = 1.572 \times 10^{-4} kW/(Km) \tag{10}$$
$$h_e = 4.837 \times 10^{-4} kW/(Km) \tag{11}$$
$$\tag{12}$$

With Initial and Boundary Conditions of $T_{a,0} = 20C, T_i = 25.0C, T_e = 22.5C$. At this point, we set $Q_a = 0$ as the surrounding air acts like a reservoir and its effect is currently minimal. Our inputs are $T_{w,0}$ and Q_w from experimental data. We take experimental data from the file `nov25_2.csv` located in the github repository.

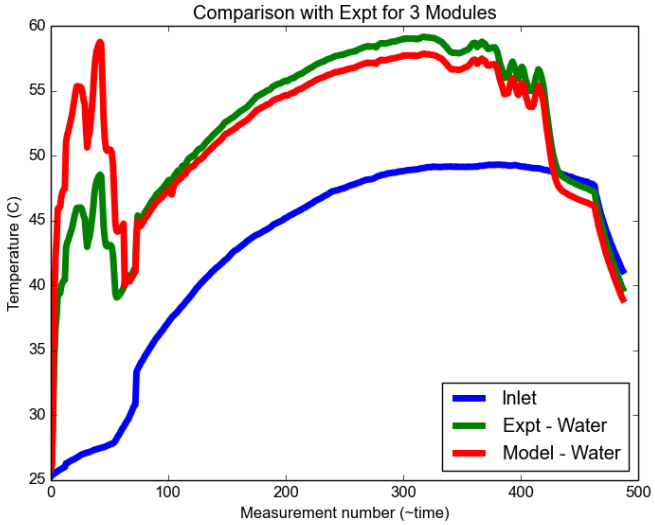

Figure 1: Comparison between experiment and model for 3 modules, water temperature in last module compared.

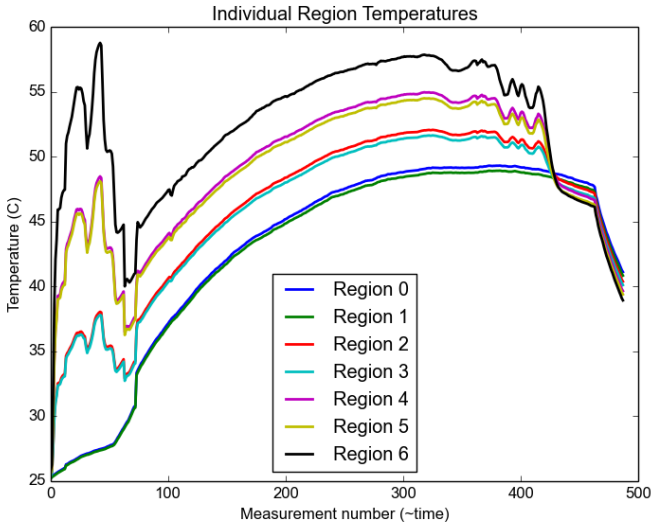

Figure 2: Model results for 3 module case, using experimental inputs. Regions 2,4,6 correspond to modules.

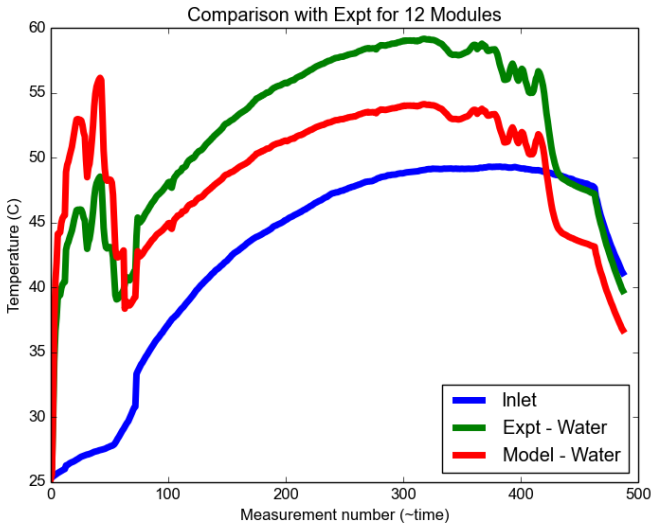

Figure 3: Comparison between experiment (3 modules) and model (12 modules), water temperature in last module compared.

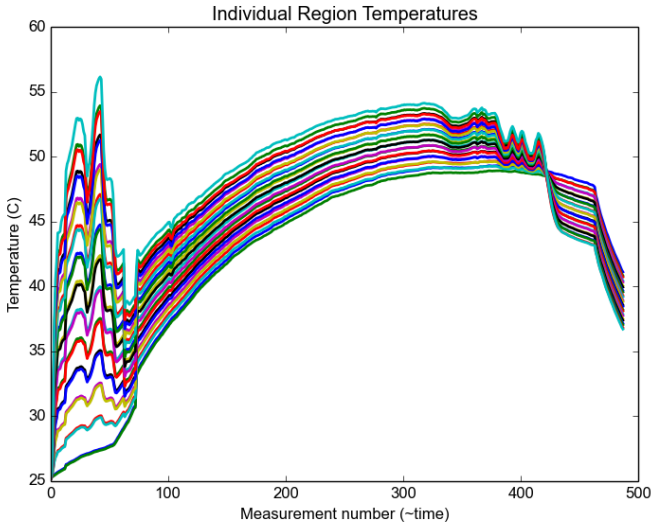

Figure 4: Model results for 3 module case, using experimental inputs. Legend not shown, but self explanatory.

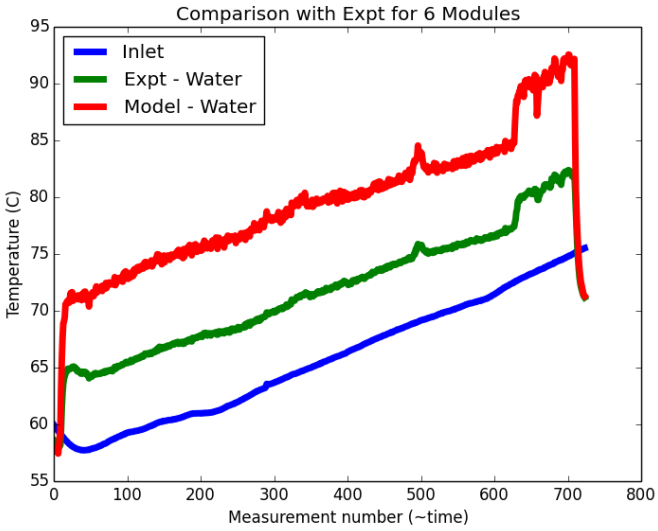

Figure 5: Model results for 6 module case, using experimental inputs. Experimental inputs were summed from individual modules, instead of summed over whole system (which includes losses).