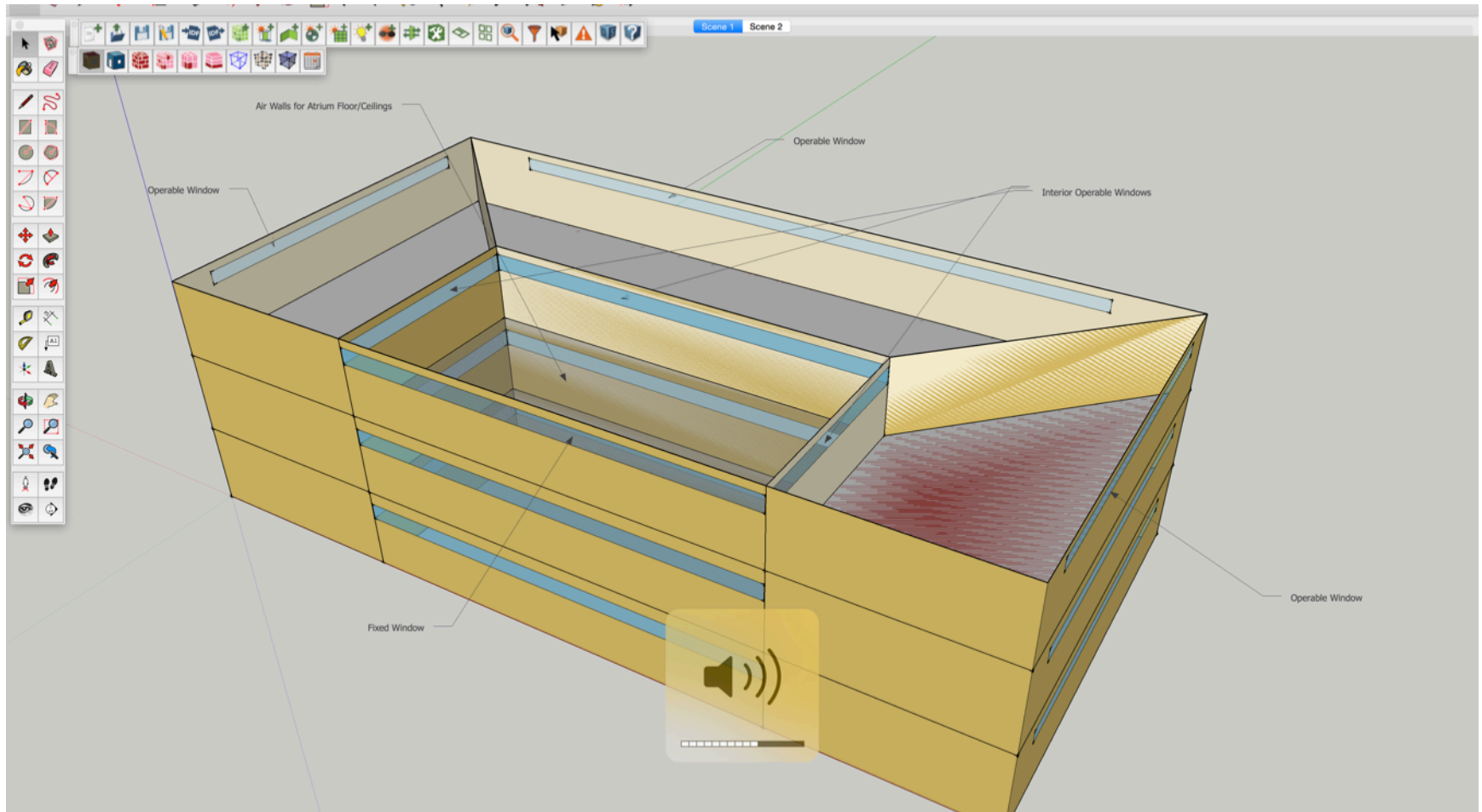


Guide for Fan Assist Night Ventilation Measure

Measure Intent

- This measure is meant to provide a simple approximation of the benefits of fan assisted night ventilation.
- It does not use CFD or AirflowNetwork.
- It relies on many assumptions about airflow from user inputs.
 - Flow rate relative to windows size.
 - Feasibility of air to move through building geometry at the specified rates.
- Initial testing used un-conditioned model.

View of Model in SketchUp Plugin



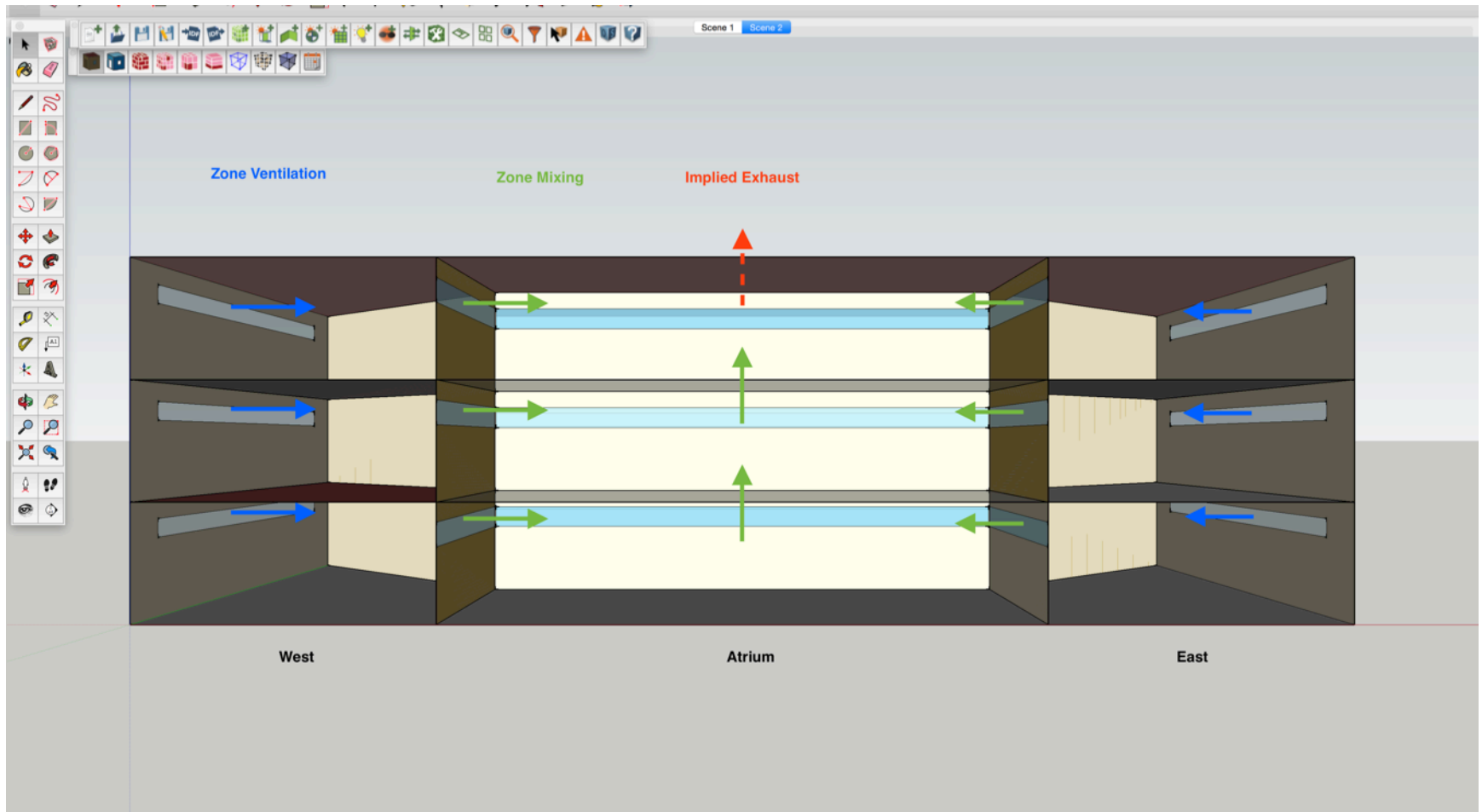
Seed Model Preparation

- Create operable exterior windows for all thermal zones that you want to participate in natural ventilation.
 - The size of the window affects the measure, but not the position.
- Create inter-zone windows or air walls for walls and ceilings to define the path of the natural ventilation from the zone it enters at to the zone it will be exhausted from.
 - The size and position of these windows or air walls is not important. They are serving as a bridge to communicate the desired zone connection for airflow.

Seed Model Preparation

- From each zone define exactly one possible horizontal path to a vertical shaft. Then define one path up to the intended exhaust zone.
 - The measure will always look up first, and then horizontally so it can handle many zones converging on a shared shaft.
- You don't need to any geometry to define the exhaust zone. One or more exhaust zones are determined by the path traced from the ventilation zones.
- Add in a fractional schedule for the night ventilation
 - Tested with value of 1 or 0 but I think it should work with fractional values as well.

Diagram of Intended Outcome of Measure



Use Surfaces Sub-Tab to set Air Wall Constructions.

Spaces Properties Loads Surfaces Subsurfaces Interior Partitions Shading

General Custom

Filters: Story Thermal Zone Space Type Surface Type Outside Boundary Condition Sun Exposure Wind Exposure

All All All All All All All

Space Name	All	Surface Name	Surface Type	Construction	Outside Boundary Condition	Outside Boundary Condition Object	Sun Exposure	Wind Exposure
atrium 1	<input type="checkbox"/>	atrium 1 - Floor:a	Floor	ExtSlabCarpet 4in Clir	Ground		NoSun	NoWind
	<input type="checkbox"/>	atrium 1 - Wall 180:a	Wall	ASHRAE 189.1-2009 E	Outdoors		SunExposed	WindExposed
	<input type="checkbox"/>	atrium 1 - Wall 270:a	Wall	Interior Wall	Surface	west 1 - Wall 090:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 1 - Wall 000:a	Wall	Interior Wall	Surface	north 1 - Wall 180:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 1 - Wall 090:a	Wall	Interior Wall	Surface	east 1 - Wall 270:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 1 - RoofCeiling:a	RoofCeiling	Air Wall	Surface	atrium 2 - Floor:a	NoSun	NoWind
atrium 2	<input type="checkbox"/>	atrium 2 - RoofCeiling:a	RoofCeiling	Air Wall	Surface	atrium 3 - Floor:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 2 - Floor:a	Floor	Air Wall	Surface	atrium 1 - RoofCeiling:	NoSun	NoWind
	<input type="checkbox"/>	atrium 2 - Wall 180:a	Wall	ASHRAE 189.1-2009 E	Outdoors		SunExposed	WindExposed
	<input type="checkbox"/>	atrium 2 - Wall 270:a	Wall	Interior Wall	Surface	west 2 - Wall 090:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 2 - Wall 000:a	Wall	Interior Wall	Surface	north 2 - Wall 180:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 2 - Wall 090:a	Wall	Interior Wall	Surface	east 2 - Wall 270:a	NoSun	NoWind
atrium 3	<input type="checkbox"/>	atrium 3 - Floor:a	Floor	Air Wall	Surface	atrium 2 - RoofCeiling:	NoSun	NoWind
	<input type="checkbox"/>	atrium 3 - Wall 180:a	Wall	ASHRAE 189.1-2009 E	Outdoors		SunExposed	WindExposed
	<input type="checkbox"/>	atrium 3 - Wall 270:a	Wall	Interior Wall	Surface	west 3 - Wall 090:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 3 - Wall 000:a	Wall	Interior Wall	Surface	north 3 - Wall 180:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 3 - Wall 090:a	Wall	Interior Wall	Surface	east 3 - Wall 270:a	NoSun	NoWind
	<input type="checkbox"/>	atrium 3 - RoofCeiling:a	RoofCeiling	ASHRAE 189.1-2009 E	Outdoors		SunExposed	WindExposed
east 1	<input type="checkbox"/>	east 1 - RoofCeiling:a	RoofCeiling	Interior Ceiling	Surface	east 2 - Floor:a	NoSun	NoWind
	<input type="checkbox"/>	east 1 - Floor:a	Floor	ExtSlabCarpet 4in Clir	Ground		NoSun	NoWind
	<input type="checkbox"/>	east 1 - Wall 270:a	Wall	Interior Wall	Surface	atrium 1 - Wall 090:a	NoSun	NoWind
	<input type="checkbox"/>	east 1 - Wall 315:a	Wall	Interior Wall	Surface	north 1 - Wall 135:a	NoSun	NoWind
	<input type="checkbox"/>	east 1 - Wall 090:a	Wall	ASHRAE 189.1-2009 E	Outdoors		SunExposed	WindExposed
	<input type="checkbox"/>	east 1 - Wall 180:a	Wall	ASHRAE 189.1-2009 E	Outdoors		SunExposed	WindExposed
	<input type="checkbox"/>	east 2 - Floor:a	Floor	Interior Floor	Surface	east 1 - RoofCeiling:a	NoSun	NoWind

My Model Library Edit

Luminaire Definitions

Electric Equipment Definitions

Gas Equipment Definitions

Heat Pump Water Heater

Water Use Equipment Definitions

Hot Water Equipment Definitions

Steam Equipment Definitions

Other Equipment Definitions

Internal Mass Definitions

Ruleset Schedules

Compact Schedules

Constant Schedules

Fixed Interval Schedules

Variable Interval Schedules

Constructions

Air Wall

ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1

ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 2-5

ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 7-8

ASHRAE 189.1-2009 ExtRoof Metal ClimateZone 6

ASHRAE 189.1-2009 ExtWall Mass ClimateZone 1

ASHRAE 189.1-2009 ExtWall Mass ClimateZone 2



Use Subsurfaces Sub-Tab to set Subsurface type to “Operable Window”


The screenshot displays the 'Subsurfaces' sub-tab in a software interface. The table lists subsurfaces for various spaces, including atriums and east/north wings. The 'Subsurface Type' column is set to 'OperableWindow' for most entries. The 'Construction' column shows 'ASHRAE 189.1-2009 E' and 'Interior Window'. The 'Outside Boundary Condition' column shows 'atrim 1 - Wall 270:a - S' and 'atrim 1 - Wall 090:a - S'.

Space Name	Subsurface Name	Parent Surface Name	Subsurface Type	Multiplier	Construction	Outside Boundary Condition
atrium 1	atrium 1 - Wall 180:a - Sub:a	atrium 1 - Wall 180:a	FixedWindow	1.000000	ASHRAE 189.1-2009 E	
	atrium 1 - Wall 270:a - Sub:a	atrium 1 - Wall 270:a	OperableWindow	1.000000	Interior Window	atrium 1 - Wall 270:a - S
	atrium 1 - Wall 000:a - Sub:a	atrium 1 - Wall 000:a	OperableWindow	1.000000	Interior Window	atrium 1 - Wall 000:a - S
	atrium 1 - Wall 090:a - Sub:a	atrium 1 - Wall 090:a	OperableWindow	1.000000	Interior Window	atrium 1 - Wall 090:a - S
atrium 2	atrium 2 - Wall 180:a - Sub:a	atrium 2 - Wall 180:a	FixedWindow	1.000000	ASHRAE 189.1-2009 E	
	atrium 2 - Wall 270:a - Sub:a	atrium 2 - Wall 270:a	OperableWindow	1.000000	Interior Window	atrium 2 - Wall 270:a - S
	atrium 2 - Wall 000:a - Sub:a	atrium 2 - Wall 000:a	OperableWindow	1.000000	Interior Window	atrium 2 - Wall 000:a - S
	atrium 2 - Wall 090:a - Sub:a	atrium 2 - Wall 090:a	OperableWindow	1.000000	Interior Window	atrium 2 - Wall 090:a - S
atrium 3	atrium 3 - Wall 180:a - Sub:a	atrium 3 - Wall 180:a	FixedWindow	1.000000	ASHRAE 189.1-2009 E	
	atrium 3 - Wall 270:a - Sub:a	atrium 3 - Wall 270:a	OperableWindow	1.000000	Interior Window	atrium 3 - Wall 270:a - S
	atrium 3 - Wall 000:a - Sub:a	atrium 3 - Wall 000:a	OperableWindow	1.000000	Interior Window	atrium 3 - Wall 000:a - S
	atrium 3 - Wall 090:a - Sub:a	atrium 3 - Wall 090:a	OperableWindow	1.000000	Interior Window	atrium 3 - Wall 090:a - S
east 1	east 1 - Wall 270:a - Sub:a	east 1 - Wall 270:a	OperableWindow	1.000000	Interior Window	east 1 - Wall 270:a - S
	Sub Surface 5	east 1 - Wall 090:a	OperableWindow	1.000000	ASHRAE 189.1-2009 E	
east 2	east 2 - Wall 270:a - Sub:a	east 2 - Wall 270:a	OperableWindow	1.000000	Interior Window	east 2 - Wall 270:a - S
	Sub Surface 4	east 2 - Wall 090:a	OperableWindow	1.000000	ASHRAE 189.1-2009 E	
east 3	east 3 - Wall 270:a - Sub:a	east 3 - Wall 270:a	OperableWindow	1.000000	Interior Window	east 3 - Wall 270:a - S
	Sub Surface 9	east 3 - Wall 090:a	OperableWindow	1.000000	ASHRAE 189.1-2009 E	
north 1	Sub Surface 2	north 1 - Wall 000:a	OperableWindow	1.000000	ASHRAE 189.1-2009 E	
	north 1 - Wall 180:a - Sub:a	north 1 - Wall 180:a	OperableWindow	1.000000	Interior Window	north 1 - Wall 180:a - S
north 2	Sub Surface 7	north 2 - Wall 000:a	OperableWindow	1.000000	ASHRAE 189.1-2009 E	
	north 2 - Wall 180:a - Sub:a	north 2 - Wall 180:a	OperableWindow	1.000000	Interior Window	north 2 - Wall 180:a - S

View of Measure Log messages

Run Simulations

Run Locally  

Select All Clear Selection 

Simulation	Time	Status	NAs	Warnings	Errors
Baseline	2015-Oct-28 16:53:38	Finished	0 NAs	11 Warnings	0 Errors
Fan Assist Night Ventilation 1,000 cfm Only	2015-Oct-28 16:53:38	Finished	0 NAs	43 Warnings	0 Errors
Fan Assist Night Ventilation 10,000 cfm Only	2015-Oct-28 16:53:39	Finished	0 NAs	43 Warnings	0 Errors
Fan Assist Night Ventilation 10,000 cfm	2015-Oct-28 16:53:39	Idle	0 Warnings	0 Errors	

Initial Condition: The building started with 0 zone ventilation design flow rate objects and 0 zone mixing objects.
 Final Condition: The building finished with 9 zone ventilation design flow rate objects and 18 zone mixing objects.

Info: Added natural ventilation to Thermal Zone: east 1 of 833.33 (cfm).
 Info: Thermal Zone: east 1 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: east 1 > Thermal Zone: atrium 1 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: east 2 of 833.33 (cfm).
 Info: Thermal Zone: east 2 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: east 2 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: east 3 of 833.33 (cfm).
 Info: Thermal Zone: east 3 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: east 3 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: north 1 of 1666.67 (cfm).
 Info: Thermal Zone: north 1 has 160.54 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: north 1 > Thermal Zone: atrium 1 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: north 2 of 1666.67 (cfm).
 Info: Thermal Zone: north 2 has 160.54 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: north 2 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: north 3 of 1666.67 (cfm).
 Info: Thermal Zone: north 3 has 160.54 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: north 3 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: west 1 of 833.33 (cfm).
 Info: Thermal Zone: west 1 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: west 1 > Thermal Zone: atrium 1 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: west 2 of 833.33 (cfm).
 Info: Thermal Zone: west 2 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: west 2 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3
 Info: Added natural ventilation to Thermal Zone: west 3 of 833.33 (cfm).
 Info: Thermal Zone: west 3 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).
 Info: Added Zone Mixing Path: Thermal Zone: west 3 > Thermal Zone: atrium 3
 Info: Zone Mixing flow rate into Thermal Zone: atrium 3 is 10000.0 (cfm). Fan Consumption included with zone ventilation zones.

ModelToldf	2015-Oct-28 16:53:40	Idle	0 Warnings	0 Errors
ExpandObjects	2015-Oct-28 16:53:42	Idle	0 Warnings	0 Errors
Report Request	2015-Oct-28 16:53:42	Idle	0 Warnings	0 Errors
EnergyPlusPreProcess	2015-Oct-28 16:53:43	Idle	0 Warnings	0 Errors
EnergyPlus	2015-Oct-28 16:53:43	Idle	43 Warnings	0 Errors

Added natural ventilation to Thermal Zone: east 1 of 833.33 (cfm).

Thermal Zone: east 1 has 80.27 (ft^2) of operable windows, estimated airflow speed at operable window is 0.17 (ft/sec).

Added Zone Mixing Path: Thermal Zone: east 1 > Thermal Zone: atrium 1 > Thermal Zone: atrium 2 > Thermal Zone: atrium 3

How the Measure Works

- The measure takes the target CFM and distributes it based on exterior operable window area per zone.
 - Each zone with an exterior operable window will have a ZoneVentilation object.
 - Instead of using “Natural” for the ventilation type “Exhaust” is used. This along with the user fan inputs and CFM creates fan power consumption
- Ventilation Controls (user defined)
 - Schedule is pre-defined by the use in the model
 - Minimum outdoor temperature is a user argument for the measure

How the Measure Works

- The measure looks first for a ceiling with an interior operable window or air wall, and if it can't find that it looks for a wall with an interior operable window or air wall. It goes until it finds a dead end, adding a one way zone mixing object for each zone boundary it crosses.
 - Do not provide a path into another zone that also has exterior operable windows.
 - There is no ZoneVentilation object in the implied exhaust zone. It just receives AirMixing.
- Zone Mixing Controls (user defined)
 - Uses same schedule defined for ZoneVentilation
 - Uses the same minimum outdoor temperature as ZoneVentilation
- Output Variables are added for ZoneVentilation, Fan power from ZoneVentilation, AirMixing, and outdoor dry bulb temperature.

Zone Ventilation heat map for First Floor Atrium

ResultsViewer File Preferences

Select File 23-EnergyPlus-0 Plot 3

Filter Criteria

Table View Tree View

Variable Name	Key Value	Reporting Frequency	Alias	Environment Period
Zone Mean Air Temperature	THERMAL ZONE: EAST 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mean Air Temperature	THERMAL ZONE: NORTH 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mean Air Temperature	THERMAL ZONE: NORTH 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mean Air Temperature	THERMAL ZONE: NORTH 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mean Air Temperature	THERMAL ZONE: WEST 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mean Air Temperature	THERMAL ZONE: WEST 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mean Air Temperature	THERMAL ZONE: WEST 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mixing Current Density Air Volume Flow Rate	THERMAL ZONE: ATRIUM 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mixing Current Density Air Volume Flow Rate	THERMAL ZONE: ATRIUM 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Mixing Current Density Air Volume Flow Rate	THERMAL ZONE: ATRIUM 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: ATRIUM 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: ATRIUM 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: ATRIUM 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: EAST 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: EAST 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: EAST 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: NORTH 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: NORTH 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: NORTH 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: WEST 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: WEST 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Outdoor Air Drybulb Temperature	THERMAL ZONE: WEST 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: EAST 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: EAST 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: EAST 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: NORTH 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: NORTH 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: NORTH 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: WEST 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: WEST 2	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Current Density Volume Flow Rate	THERMAL ZONE: WEST 3	Hourly	23-EnergyPlus-0	RUN PERIOD 1
Zone Ventilation Fan Electric Energy	THERMAL ZONE: EAST 1	Hourly	23-EnergyPlus-0	RUN PERIOD 1

(23-EnergyPlus-0) Zone Mixing Current Density Air Volume Flow Rate, THERMAL ZONE: ATRIUM 1

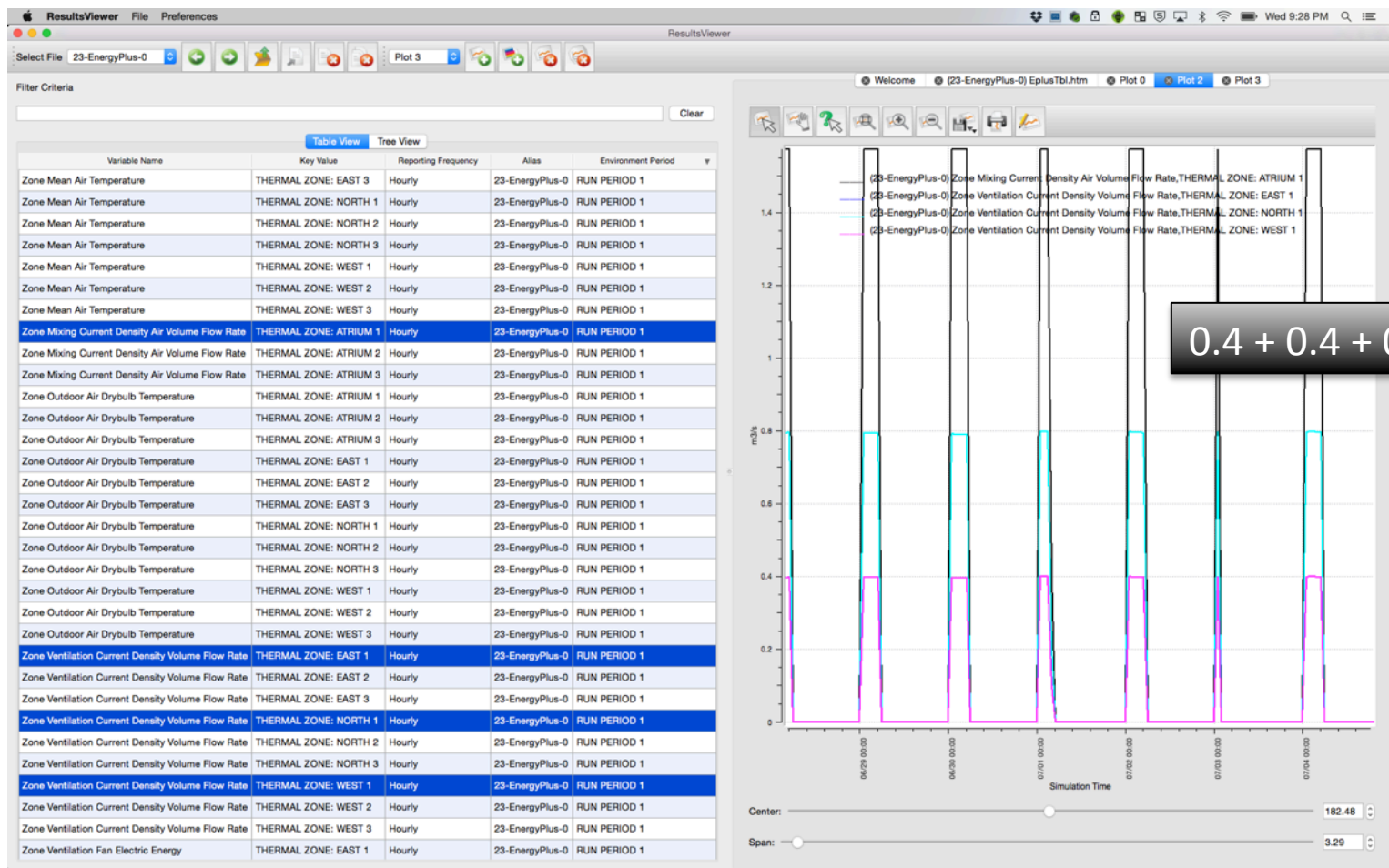
Hour of Day

Simulation Time

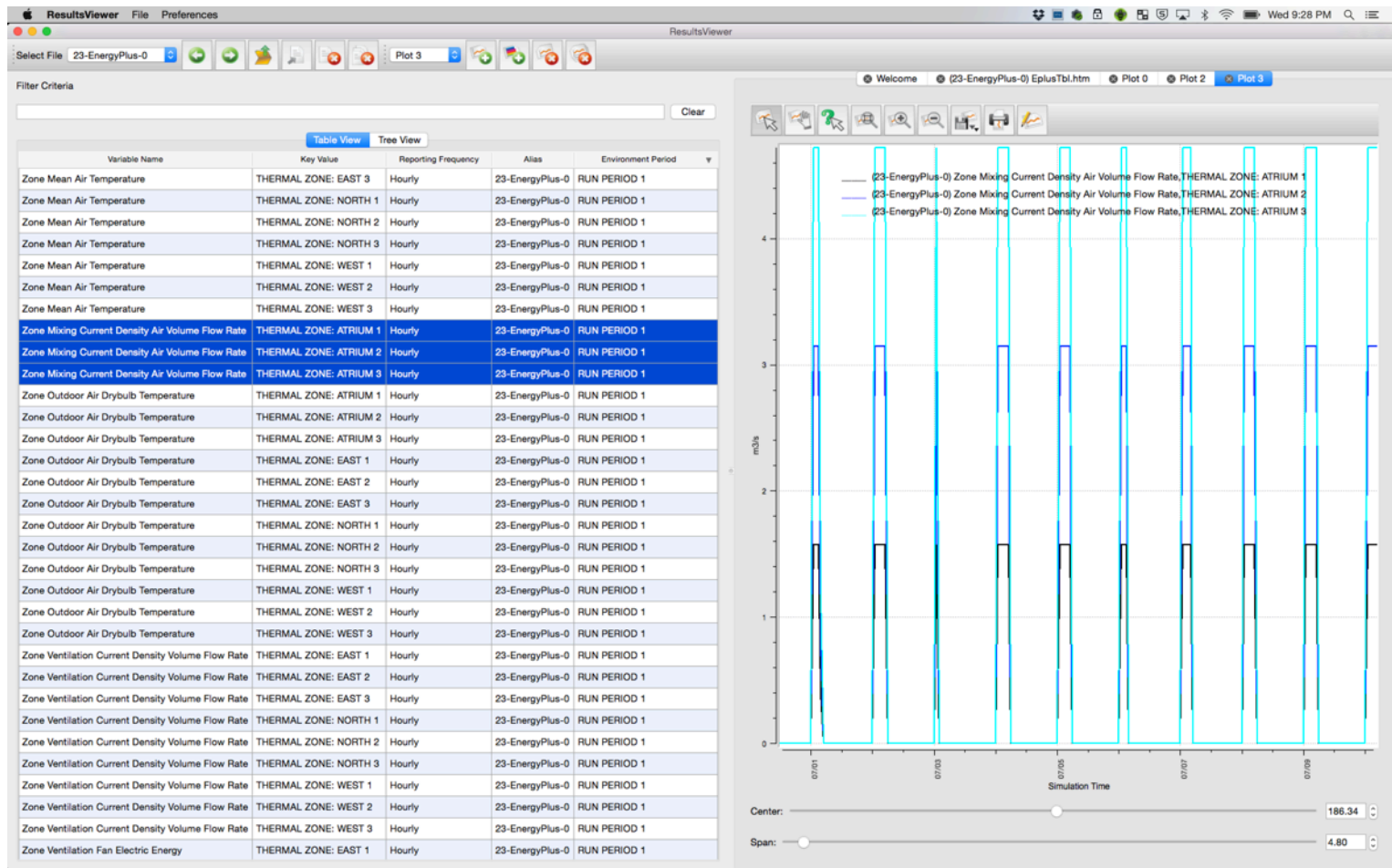
Center: 182.50

Span: 182.50

First floor atrium ZoneMixing and three feeder zones ZoneVentilation values.

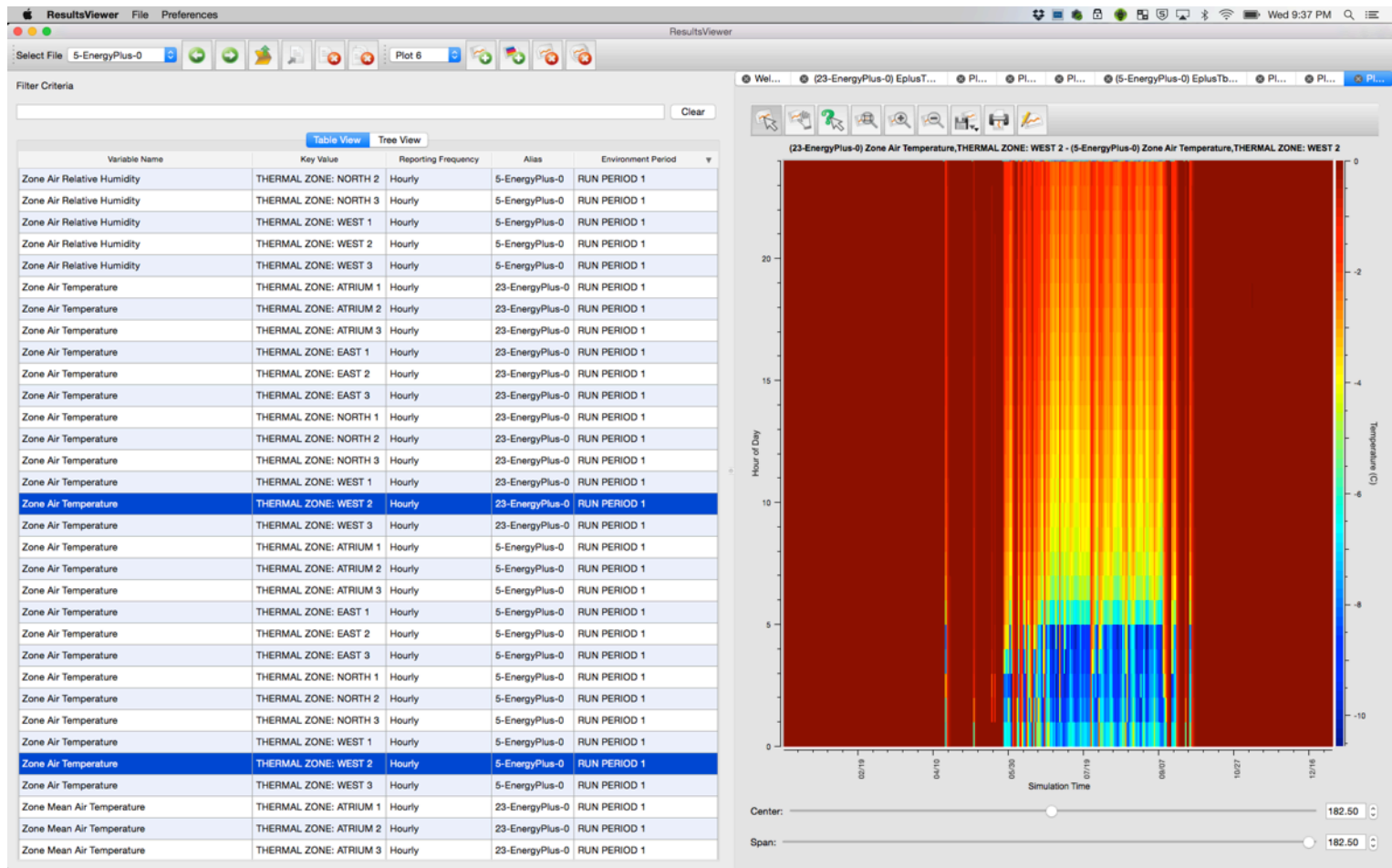


ZoneMixing ratesfor three atrium zones.

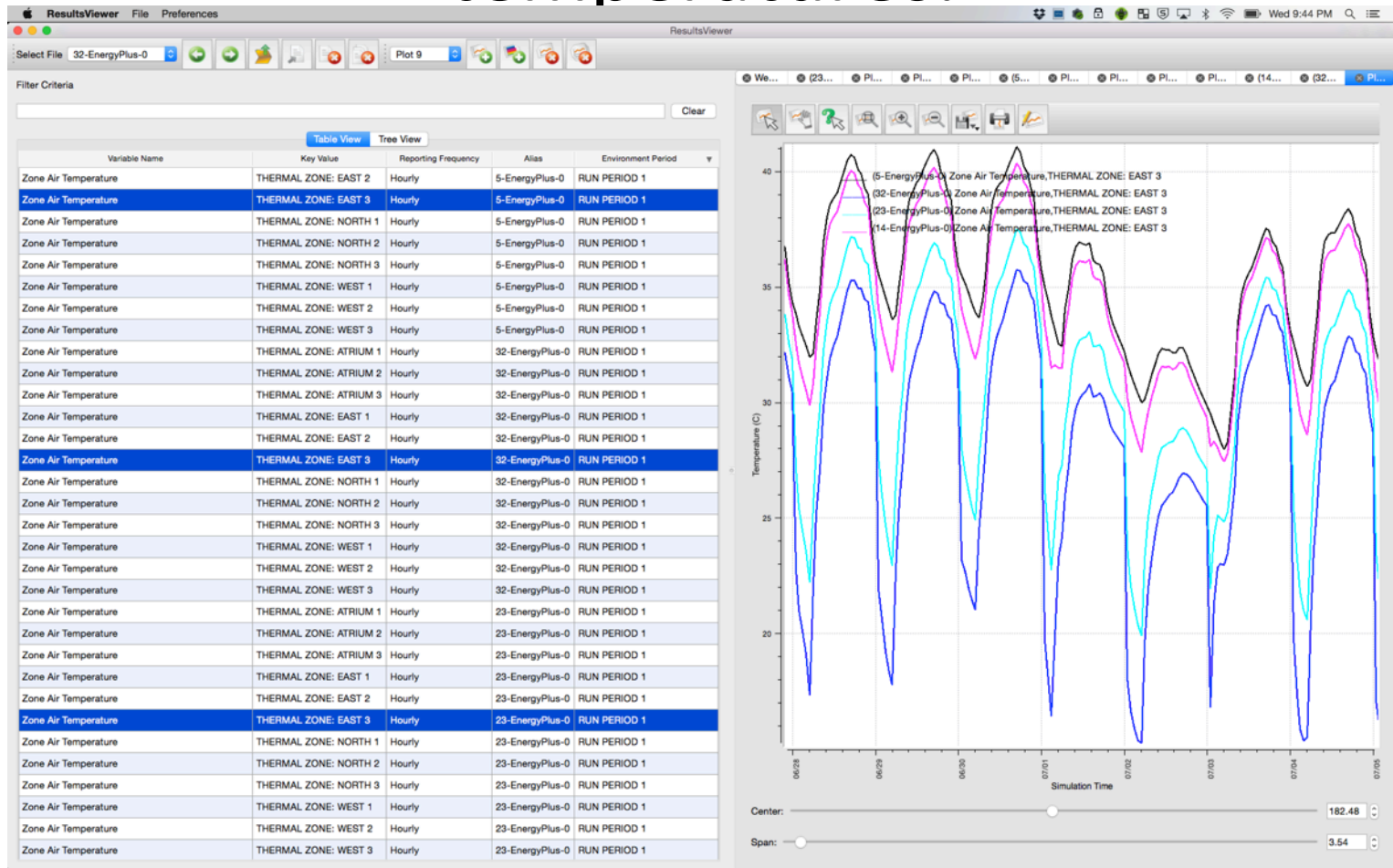


Second floor West zone temperatures

– Baseline vs. Night Ventilation



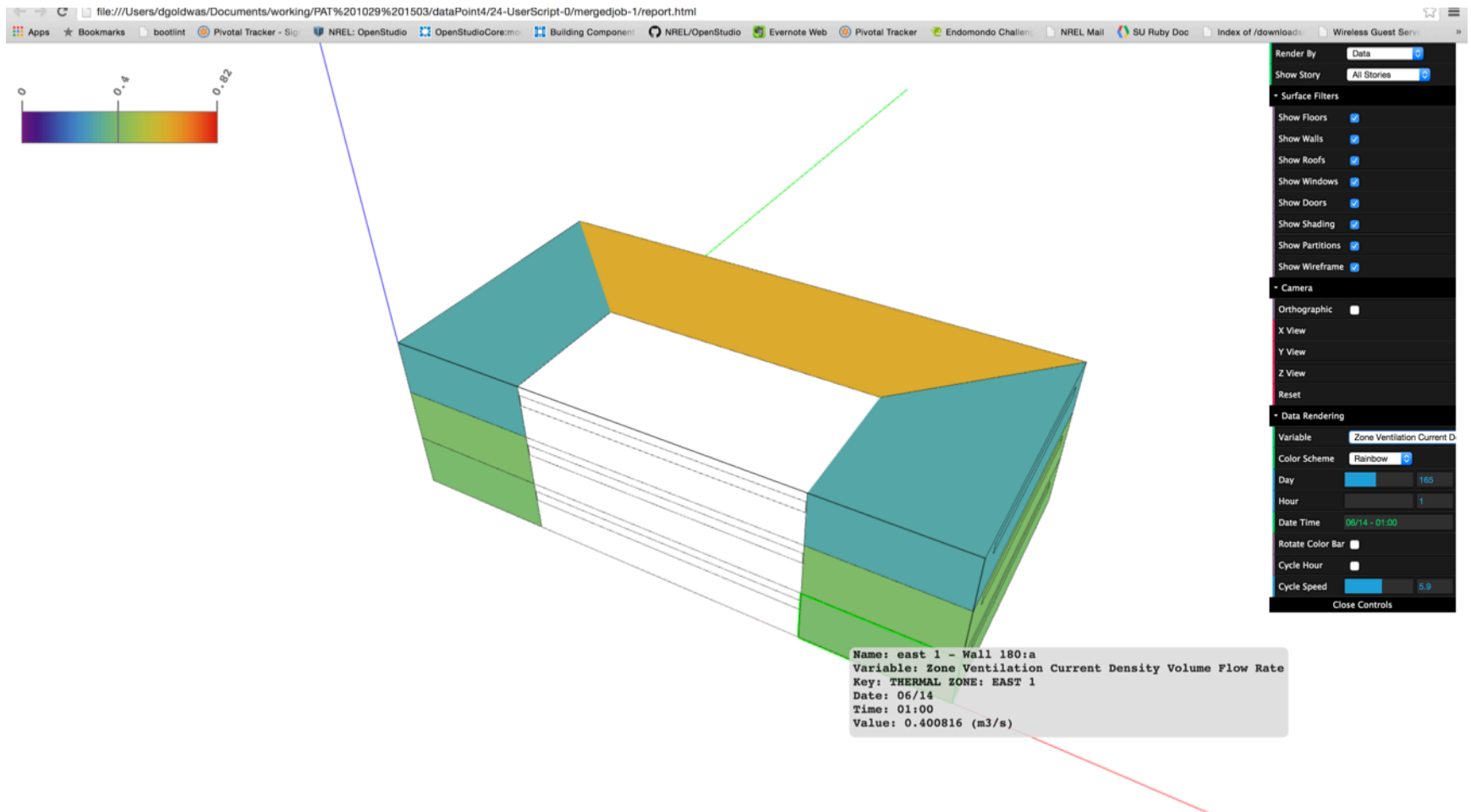
Parametric Study of 0, 1, 10, and 50 thousand cfm effect on zone temperatures.



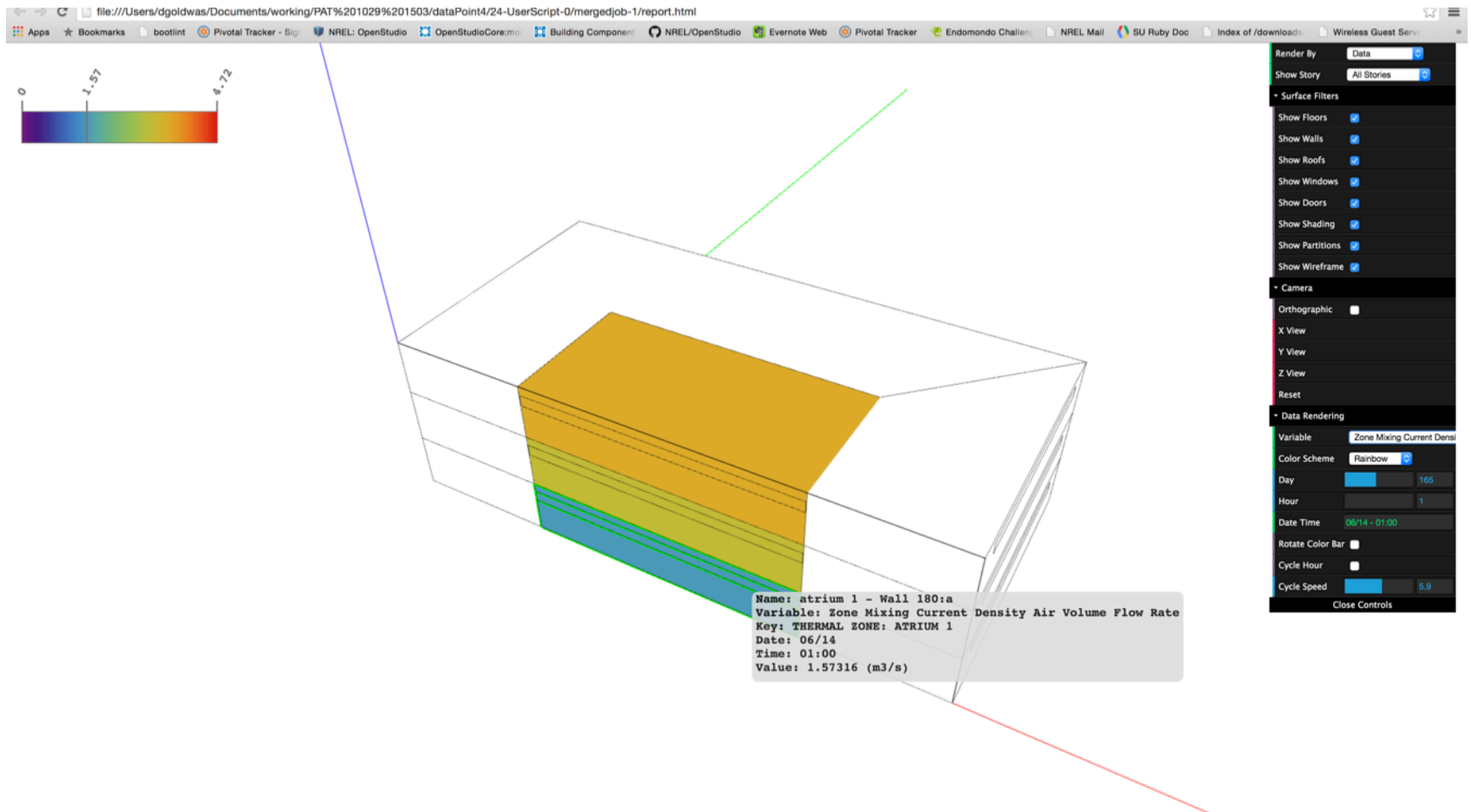
Limitations and Known Issues

- The measure doesn't do anything to confirm that the CFM defined for the operable windows on the building (size and position) is reasonable.
- It also doesn't take the size or position of interior windows, other than to create connections across zones.
- The measure reports out a log of activity that includes the inferred path. Review that to see that it matches what was expected.
- Review time-series data to confirm that controls are working as expected. Note that simple ventilation on the outdoor air table of the EnergyPlus tabular output will generally show zero values if the schedule for ventilation doesn't overlap with building occupation.

Render By Data Zone Ventilation



Render By Data Zone Mixing



Render by Data Zone Temperature

