2017 International Radiance Workshop

Integrating Radiance with OpenStudio's Parametric Analysis Tool

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Obligatory Eclipse Photo! [LAT 39.98, LON -105.24, MAG 0.94, FBL 76]

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- The Radiance community at large; you are all an inspiration to me

[In addition, several features of the Radiance Measure were developed for work under the Wells Fargo Innovation Incubator (IN^2) project.]

Agenda

- Existing work
  - OpenStudio Analysis Framework (OSAF)
  - The OpenStudio Measure Framework
- Case Study, Part I - The Problem
- OpenStudio Radiance Measure - The Solution(?)
- Case Study, Part II - Application
- Conclusions/Next Steps

Existing Work

OpenStudio & Measures

- Integrated application suite, SDK, and API for parametric building energy modeling
- Model/API for building energy modeling
- Application, SketchUp plugin, Parametric Analysis Tool (PAT)
- Ruby-based API for model generation, manipulation, and reporting
- [http://openstudio.net, https://unmethours.com/questions/]

OpenStudio Analysis Framework

- Containerized (Docker) OpenStudio instance (and many helper programs) for *large scale analysis* using OpenStudio and measures
- Spreadsheet-based problem generation, supporting advanced analysis problem generation and sampling (Morris method, LHS, et al.)
- [https://github.com/NREL/OpenStudio-server, https://github.com/NREL/OpenStudio-analysis-spreadsheet]
- Parametric Analycic Tool (PAT v2.0) Released

Case Study, Part I

[Da' Problem]

Technology Evaluation

- Investigate energy savings and glare control potential via "climate sweep"
- Large scale analysis of the product prototype on multiple, exemplar, commercial building types and climate zones
- Use Radiance to calculate Dynamic Daylight Metrics and account for spatial, climate-based daylight distributions (DA/cDA/UDI)
- Compare energy savings and daylight metrics of study building models with and without product installed

Meanwhile, in OpenStudio...

Meanwhile...

Tedious Model Creation

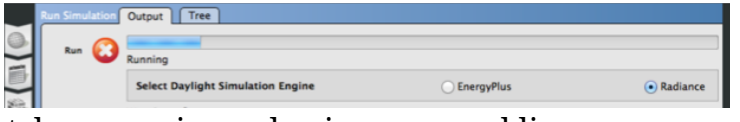
- No automated way to add daylighting objects to models
- No ability to model shading controls (i.e., no dynamic windows)

Limited output

- No daylight metrics

Limited batch processing

- Radiance Implementation "glued on" to OS GUI:



- Batch processing only via command line
- No Access to Measures, PAT, Spreadsheet, OS-Server [this is lame]

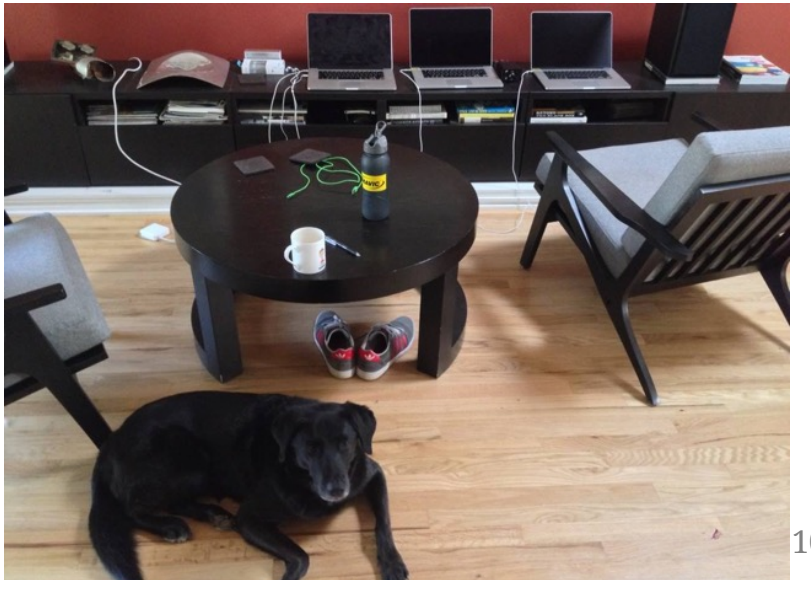
Previously...

IDEAKit Climate Sweep

Suboptimal Cluster Computing Resource

- Three (3) Macbook Pros
- Coffee(^n)
- Comfy Chair
- Dog (moral support)

Job creation, queuing, results collation and processing all performed by one (1) human (not shown).



Previously...

IDEAKit Climate Sweep

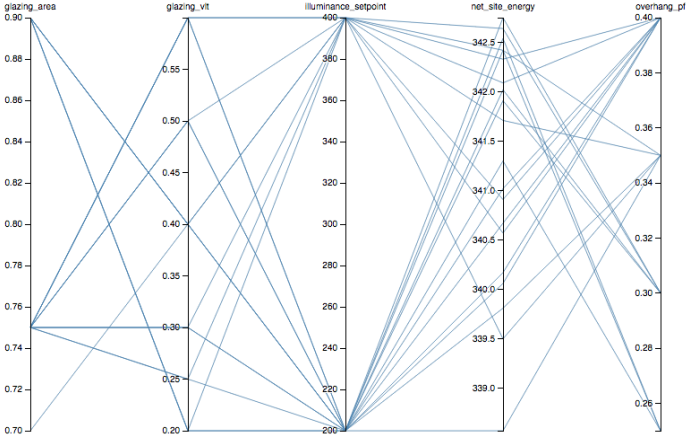
Manual model generation + Manual process distribution and management = Lean dataset

- 2 building types
- 2 climate zones
- 4 Daylighting ECMs, but very coarse sampling

IDEAKit

Daylighting Options

Small Office | 4C Mixed - Marine | pre1980



#TODO

- Support Shading Controls
  - Switchable Glazing
  - Daylight Redirection Devices
  - Traditional (e.g. blinds, shadecloth)
- "Measureize" the existing Radiance workflow
  - Radiance can leverage entire OpenStudio ecosystem
- New measures to add daylighting elements to model automatically

Measurification of the Radiance Workflow

Oh man, it was super hard! Look:

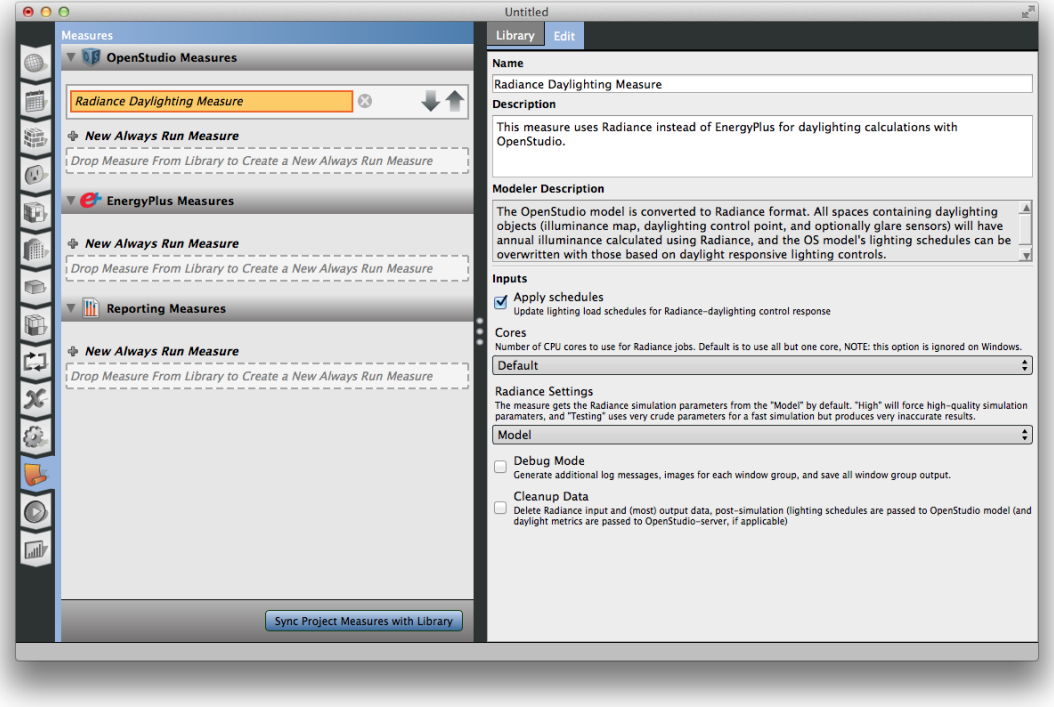
```
class RadianceMeasure < OpenStudio::Ruleset::ModelUserScript
```

- The OpenStudio API offers a macro* class for easy script generation within the OpenStudio application ecosystem

*Some folks call 'em macros, or scripts. We call 'em measures (mmm-hmmm).

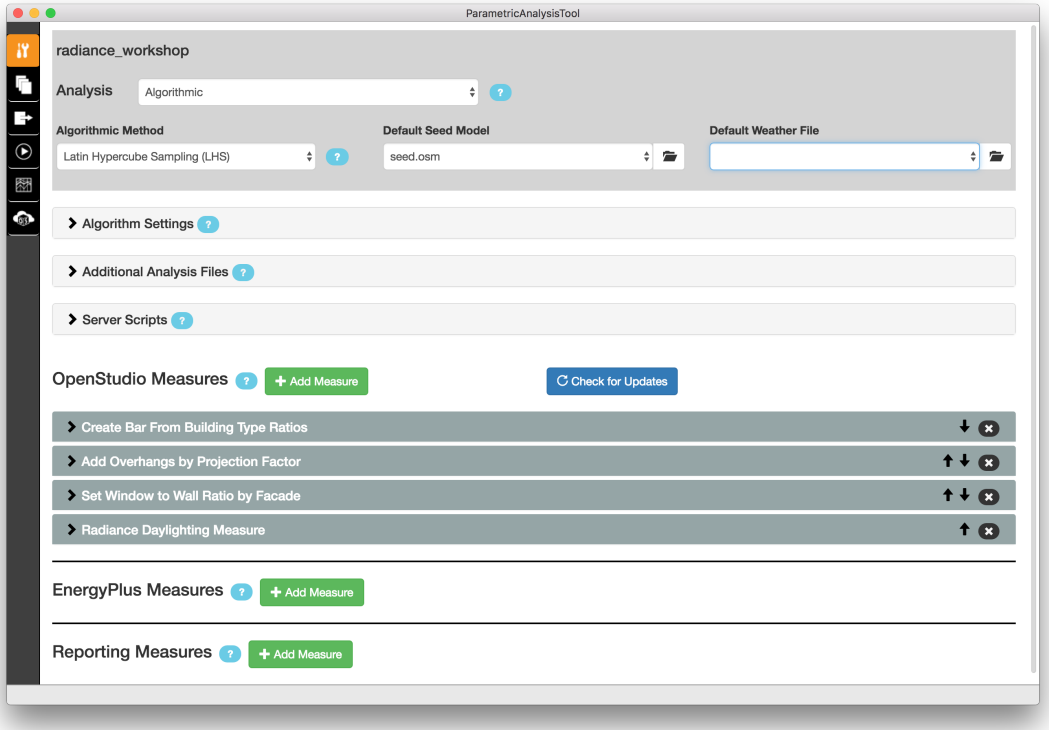
Radiance Measure

Radiance simulation workflow can by applied via OpenStudio Application:



Radiance Measure

...or via the Parametric Analysis Tool:



New Radiance Functionality

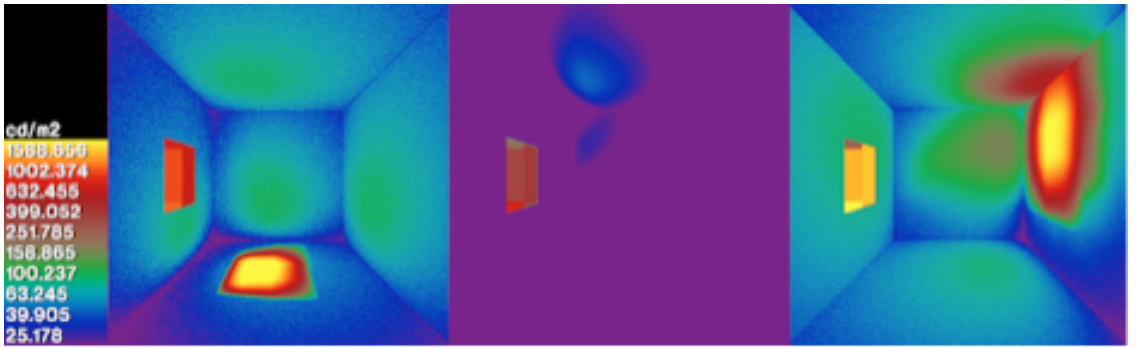
Support for dynamic windows in OpenStudio

Complex fenestration with bidirectional scatter distribution functions (BSDFs)

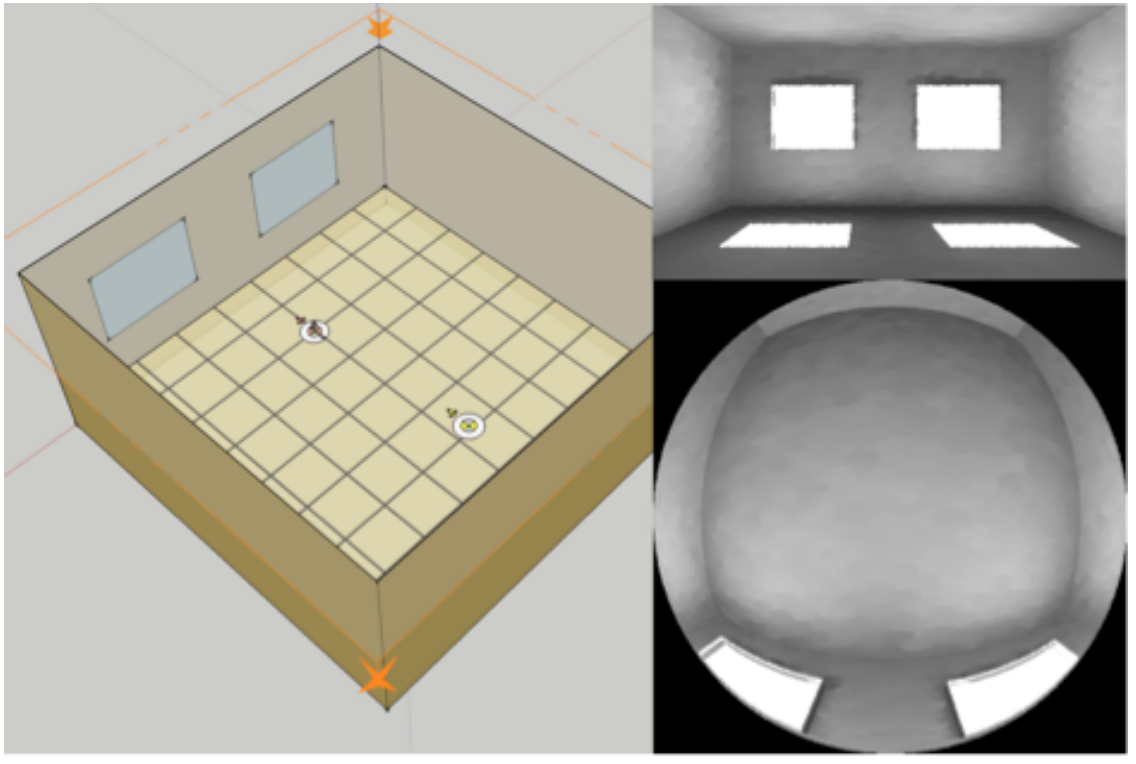
- Blinds
- Shadecloth
- Daylight Redirecting Devices

Dynamic glazings via multi-pass Radiance runs

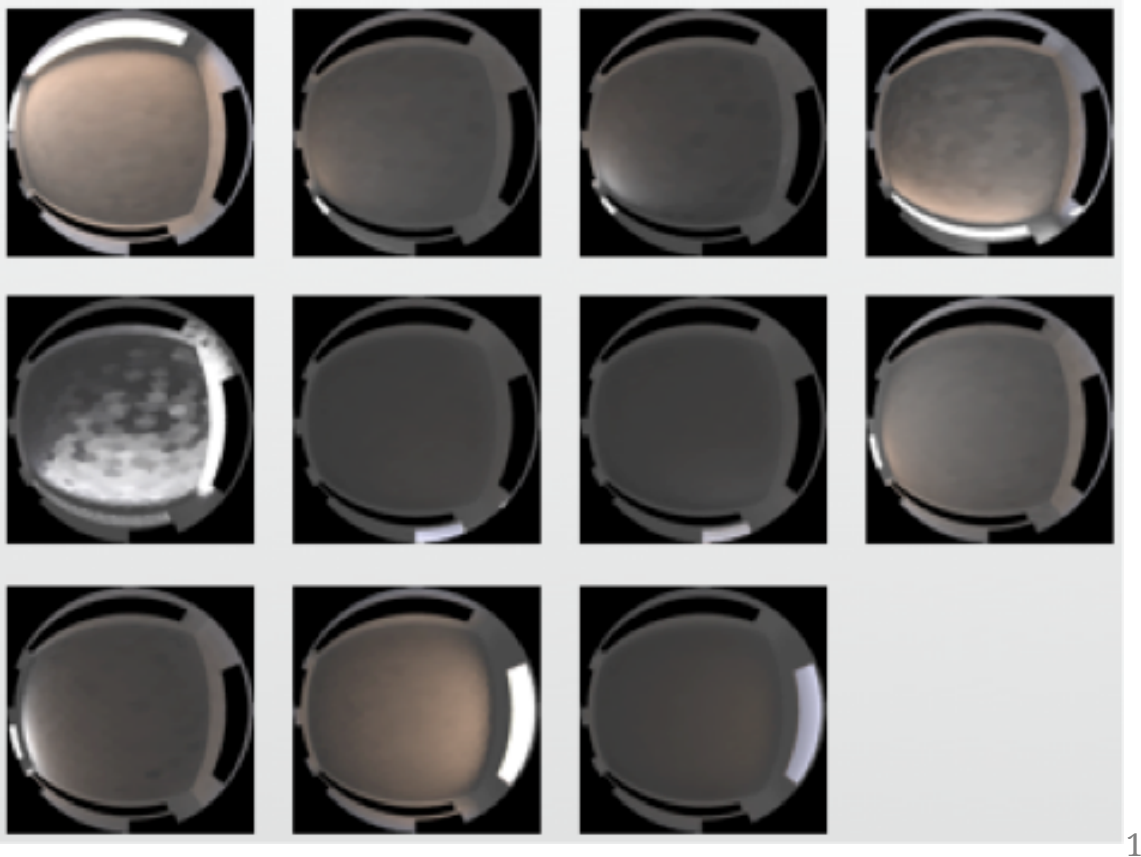
- Traditional Radiance materials glass and trans materials



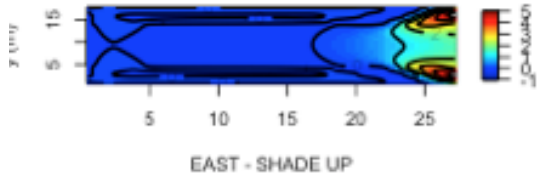
Generate sensor views of models, with Radiance



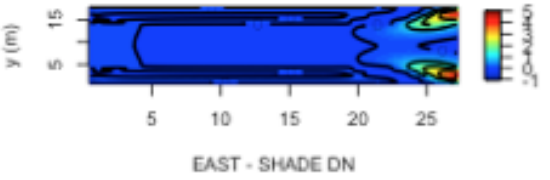
Generate "debug images" of each window group



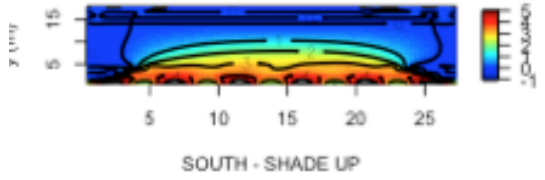
Calculate daylight illuminance per window group



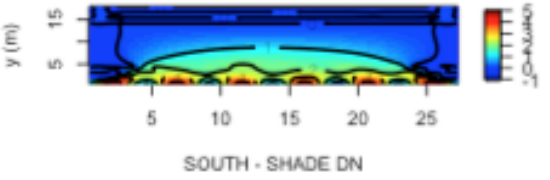
EAST - SHADE UP



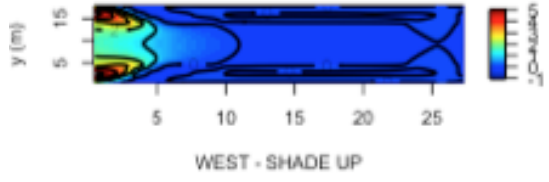
EAST - SHADE DN



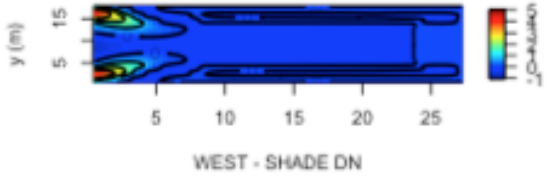
SOUTH - SHADE UP



SOUTH - SHADE DN



WEST - SHADE UP



WEST - SHADE DN

Case Study Part II

IN2 Climate Sweep

Proving ground for Radiance Measure

- Broke OpenStudio Server
  - Data merges overran available memory
- added silly hacks to git'er done, e.g.:

```
# check for number of rmtxop processes
def merge_count()
  return `pgrep rmtxop`.split.size
end
...
while merge_count() > 2
  puts "waiting in rmtxop queue..."
  sleep(5)
end
rad_command = "dctimestep output/dc/#{wg}.vmx \
annual-sky.mtx | rmtxop -fa -c 47.4 120 11.6 - \
> output/ts/#{wg}.ill"
exec_statement(rad_command, runner)
```

- Still broke server
  - Output overran available storage
- Ultimately had to reduce the parameter space
  - 1 building type (Small Office)
  - 16 climate zones
  - base case/lighting controls/shading controls (SmarterShade)

Conclusions, Benefits, WhatHaveYou

Benefits

Wells Fargo IN2 Project

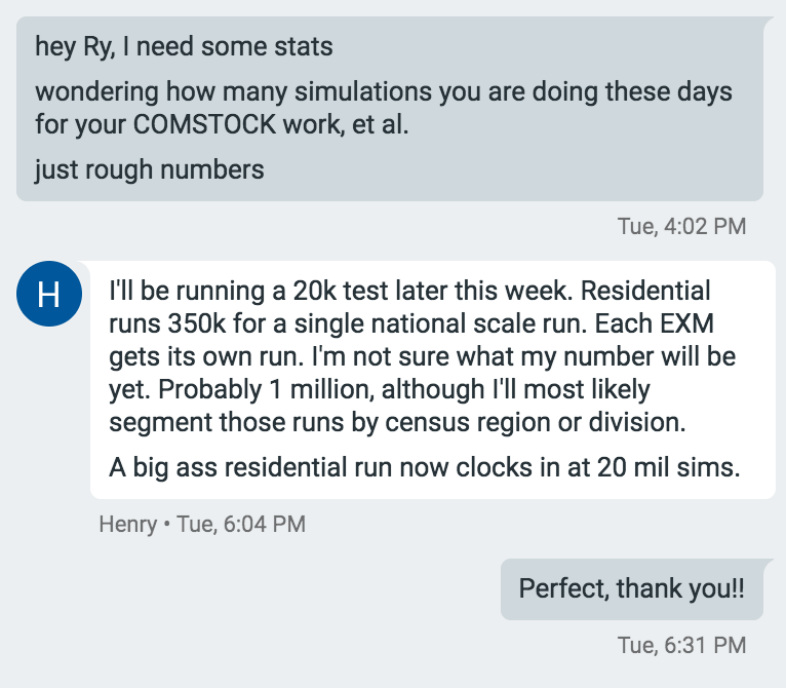
- Determined ideal use cases for product
- Verified pre-existing concerns WRT ultimate energy efficiency potential ¯\(ツ)/¯

NREL

- Vastly improved the Radiance integration within OpenStudio
- Added functionality
  - Works with other measures (e.g. in a parametric matrix)
  - PAT
  - OpenStudio Spreadsheet

Conclusions

"Just because you can, doesn't mean you should."



Conclusions

Running Radiance on an entire building, at a resolution to support complex fenestration devices AND dynamic daylight metrics, is intractible:

- Not enough time
- Not enough memory (RAM)
- Not enough storage

And "the cloud" is of little help; it just masks the mountain.

Next Steps

Give users ability to:

- Tag spaces (or groups of spaces) for Radiance analysis
- Apply shade & lighting schedules from exemplar spaces to similar spaces

Add new measures for:

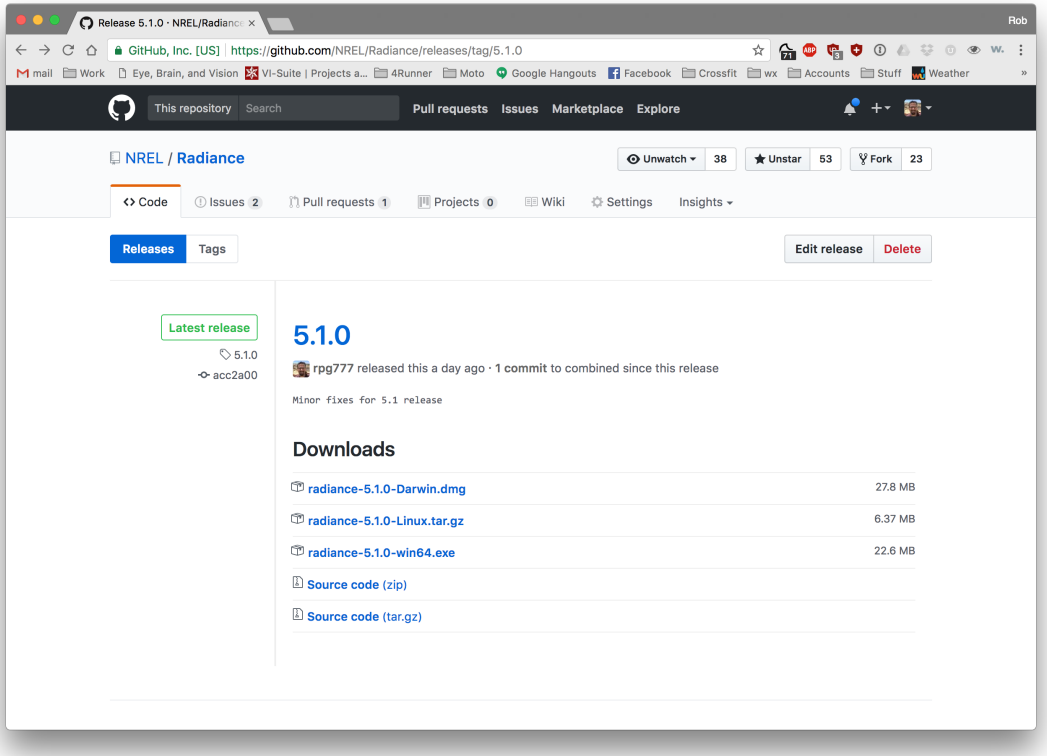
- Simple reporting of static data
- Interractive data browsing and manipulation (e.g. sensor setpoint optimization)

What Else?

- Many presentations this week have illustrated these issues remain
- Any Takers?
  - Partnerships?
    - Bueller?
    - Bueller?!

The good news...

New Radiance Packages [Windows too!]



Questions?

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[thank you.[!]]