High Accuracy 3D Radiative Transfer in Cloudy Atmospheres

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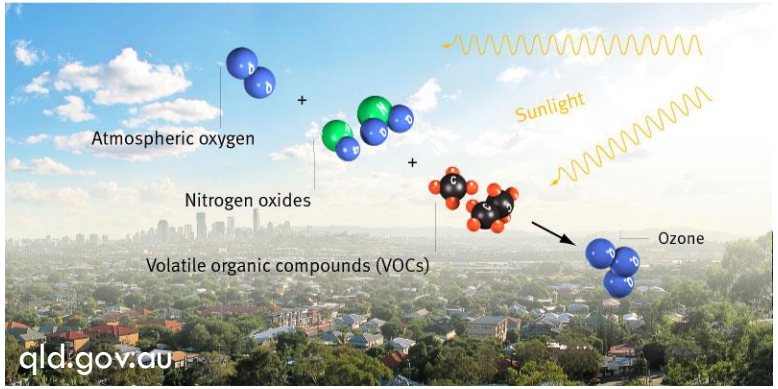
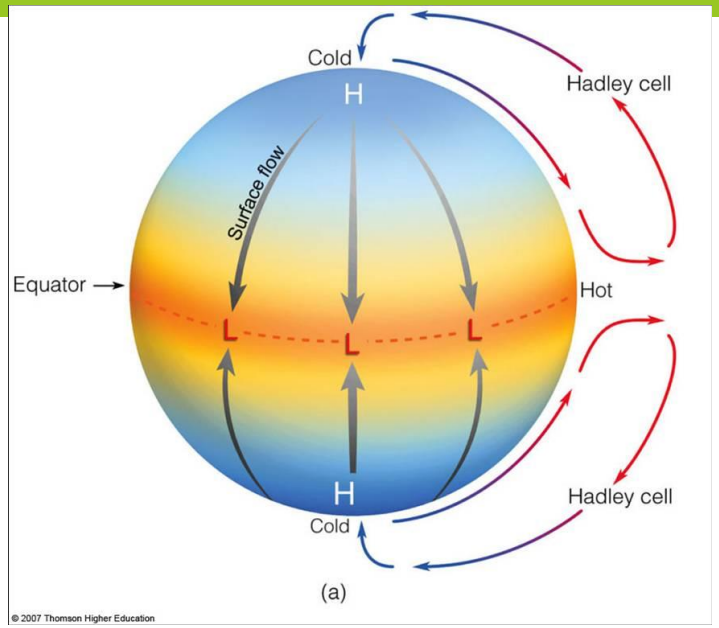
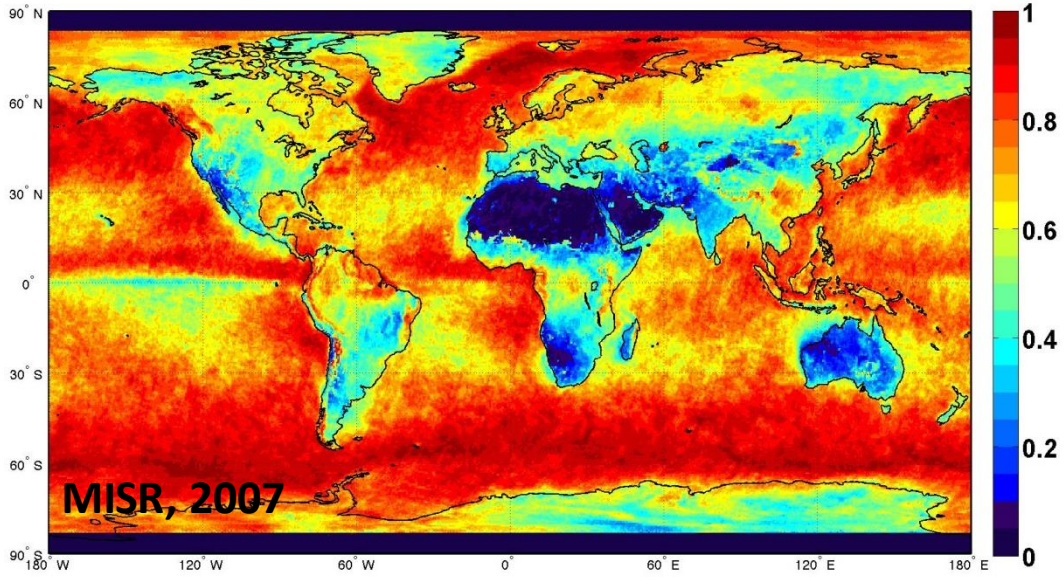
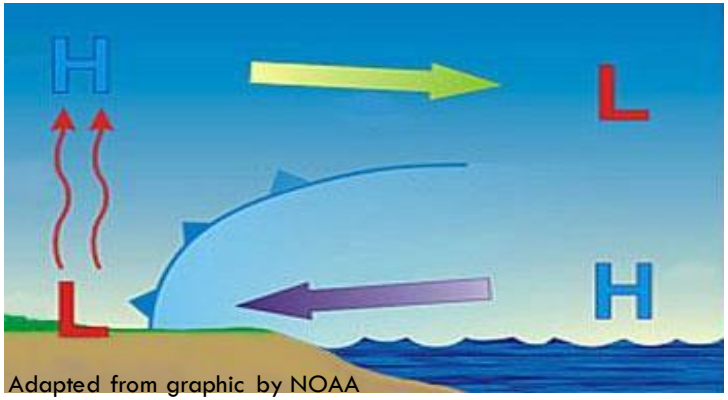
Importance of Radiation







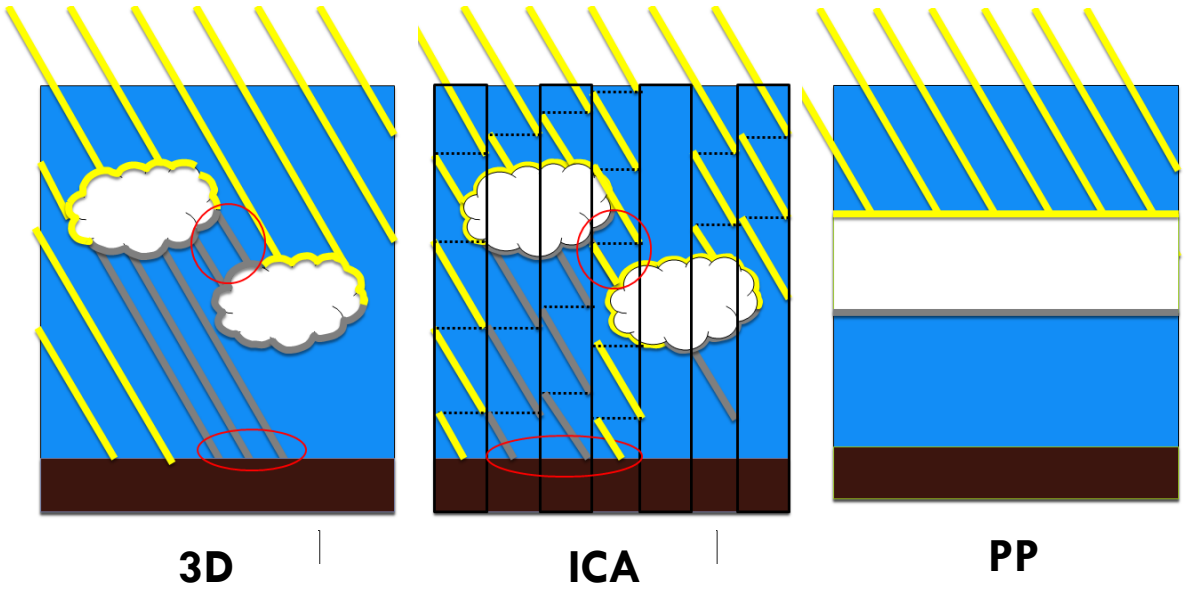


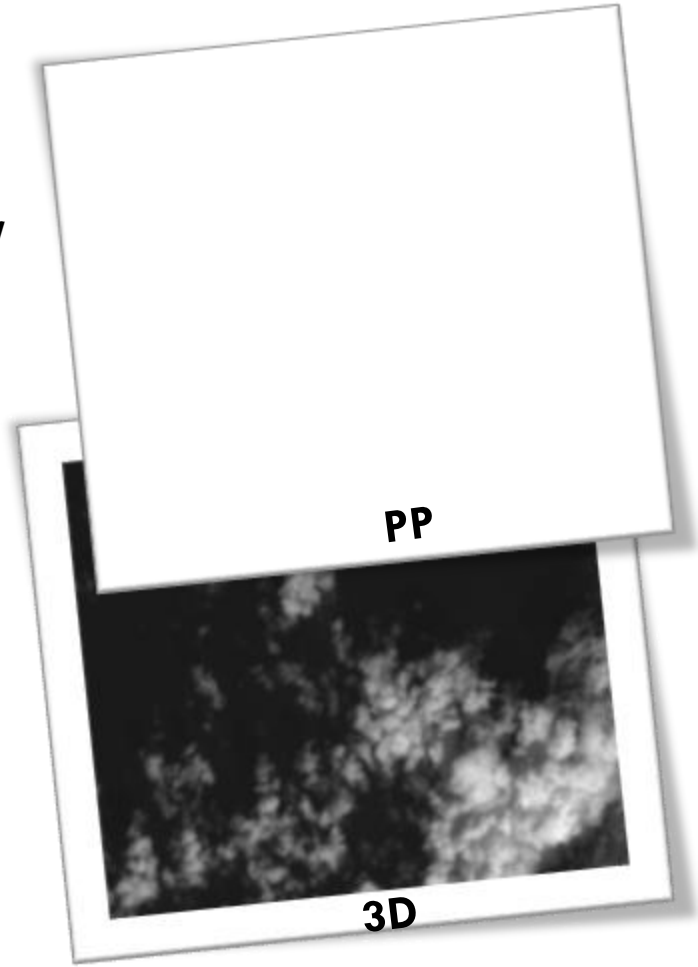
Why is radiation in a cloudy atmosphere important?

Current Representation of Radiation

$$\omega \cdot \nabla I(\mathbf{r},\omega) = -\sigma_e(\mathbf{r}) I(\mathbf{r},\omega) + \sigma_a(\mathbf{r}) B(T(\mathbf{r}))$$

$$+ \frac{\sigma_s(\mathbf{r})}{4\pi} \int_{4\pi} p(\mathbf{r},\omega',\omega) I(\mathbf{r},\omega') d\omega'$$





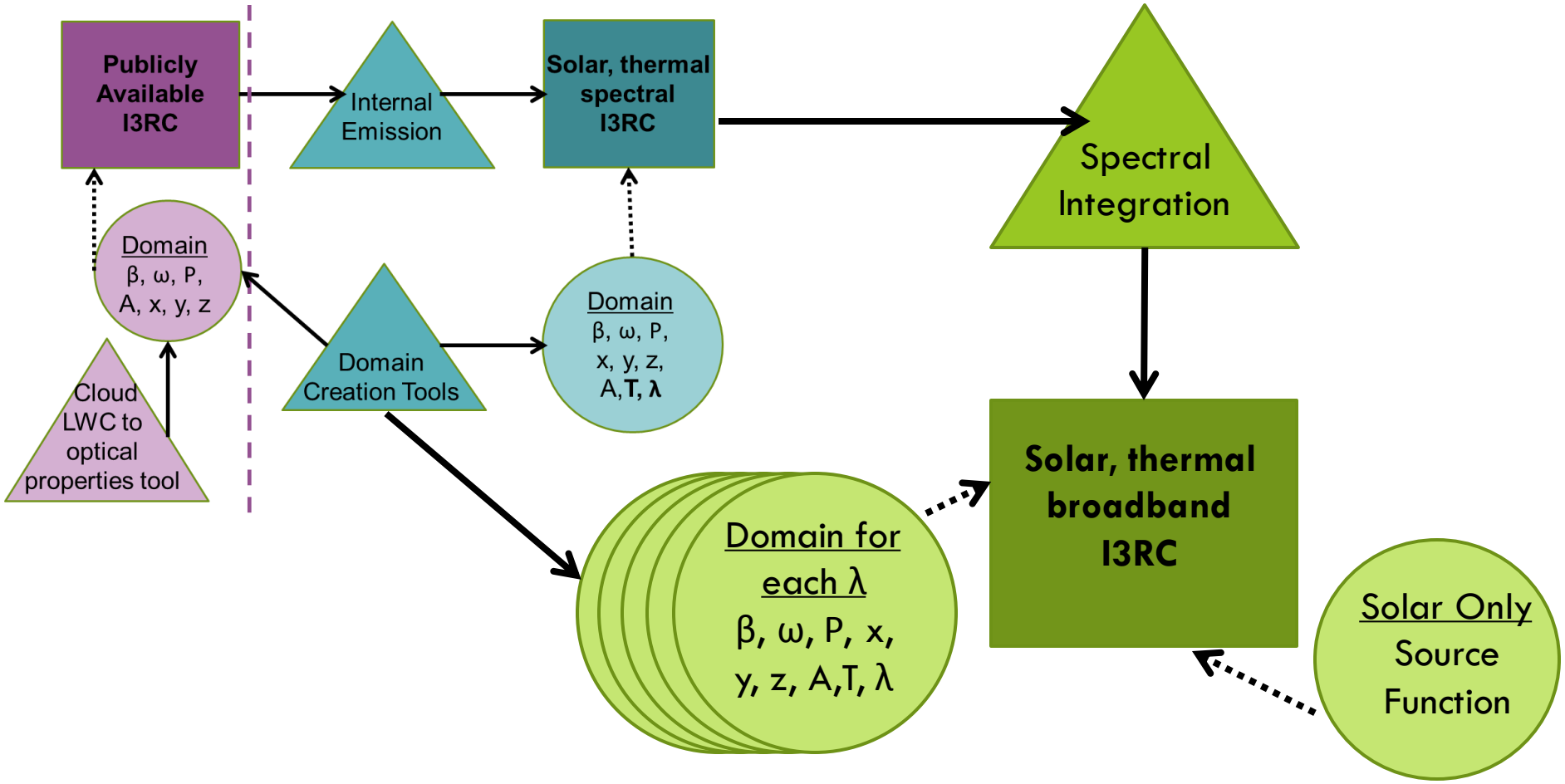
What's the problem?

Goals

- Produce Highly Accurate Benchmark Simulations
  - Quantify bias in our approximations
  - Improve simpler/faster parameterizations

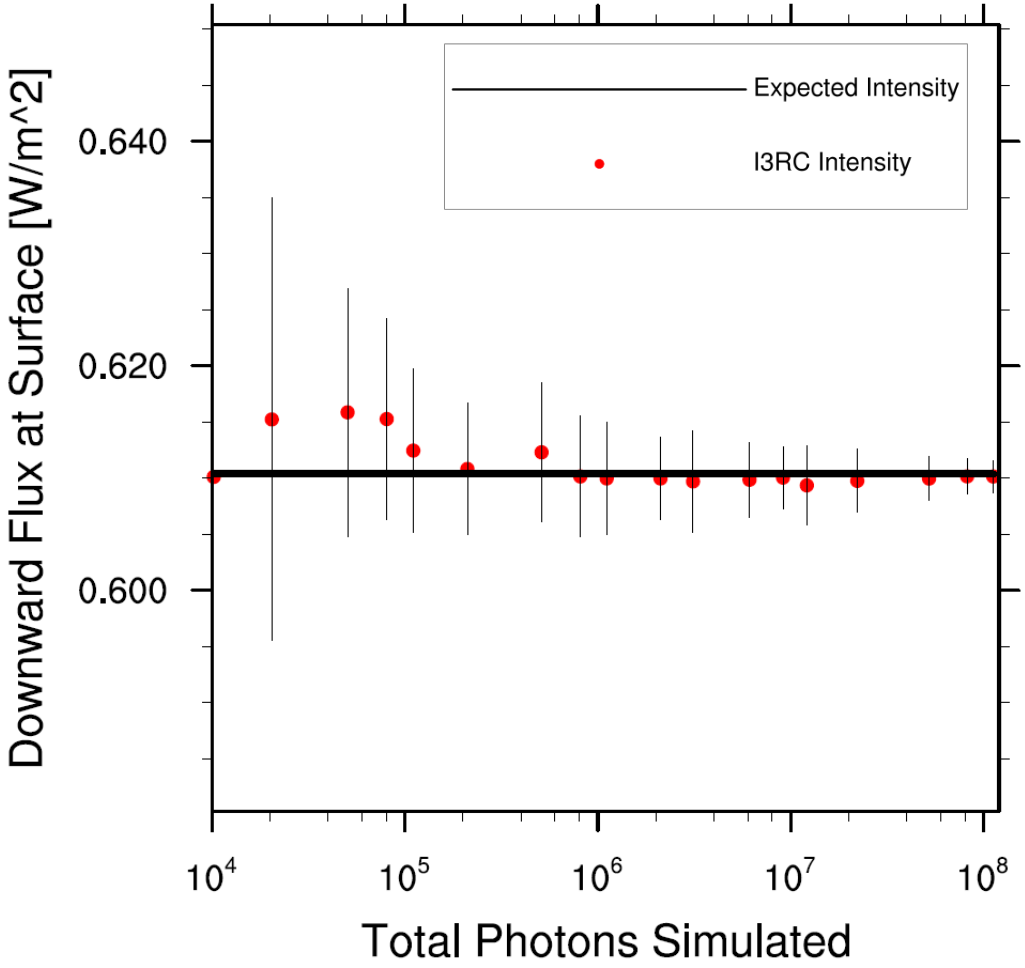
- 3D Broadband Monte Carlo Community Model
  - Faster science progress
  - Starting point: I3RC

Model Development: Spectral Integration



How do we do better? The I3RC

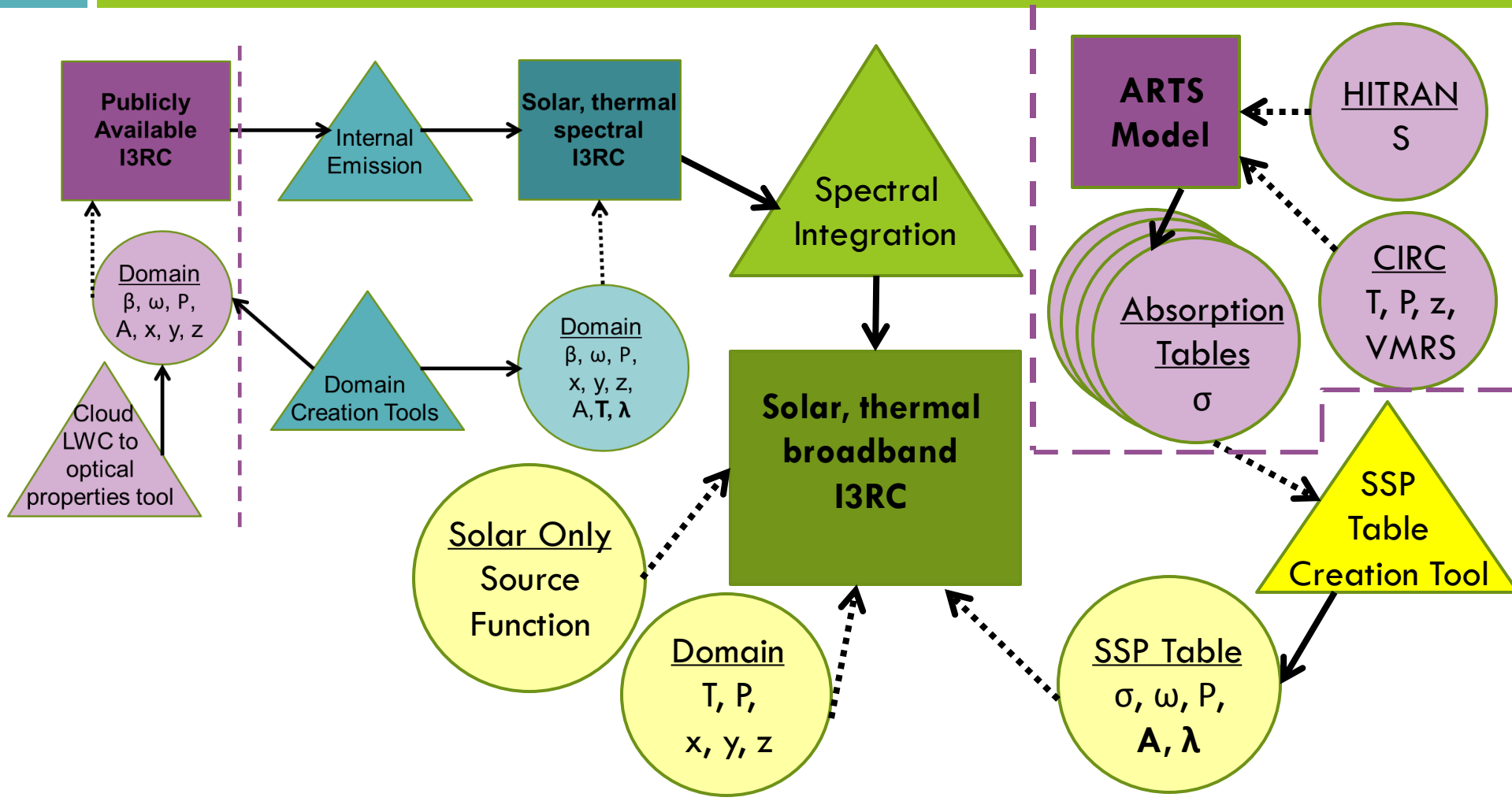
Comparing to Analytical Solution



$$F^{\downarrow sfc} = \frac{-b}{(a\Delta z)^2}\left[e^{-a\lambda_f \Delta z}(a\lambda_f \Delta z + 1) - e^{-a\lambda_i \Delta z}(a\lambda_i \Delta z + 1)\right]$$

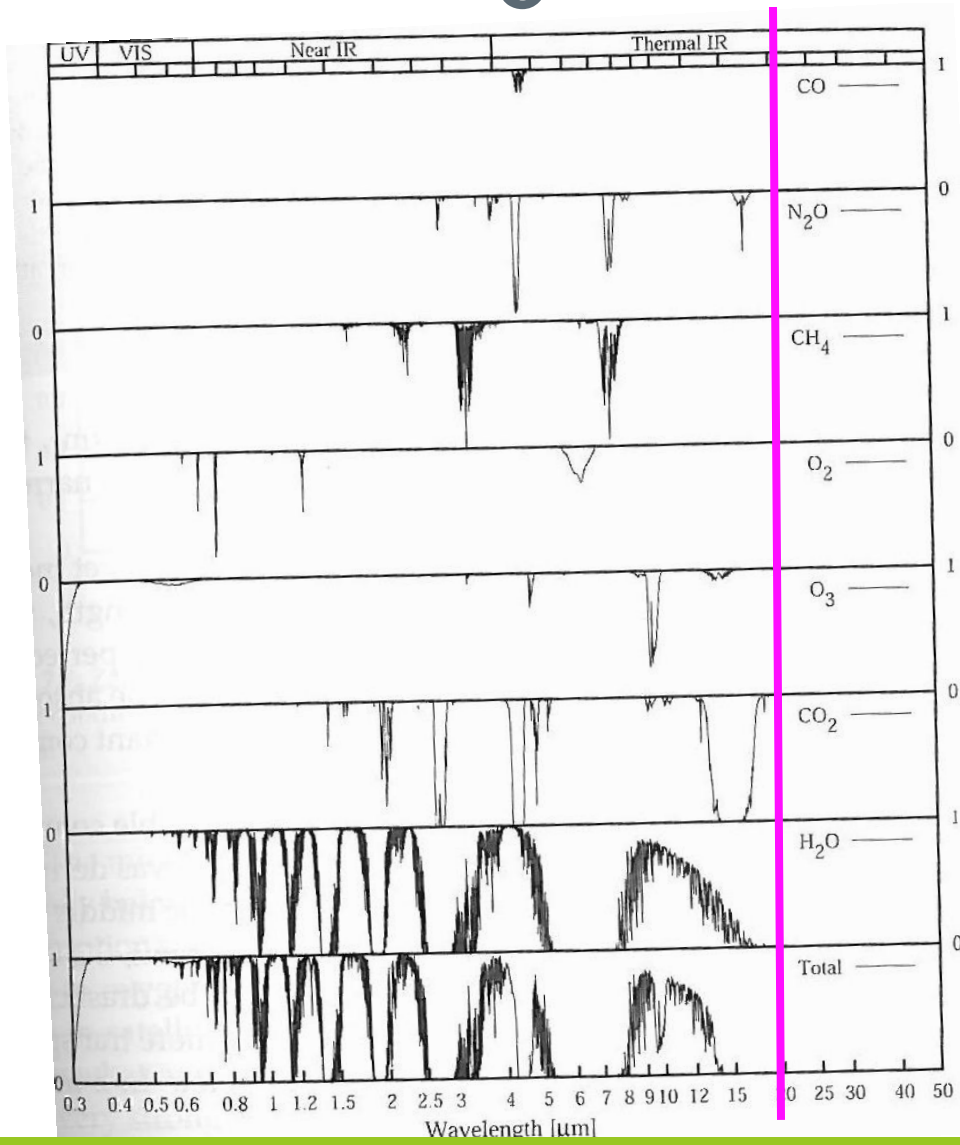
- TOA input flux linear function of wavelength
  - $F^{\downarrow TOA}(\lambda) = b\lambda$
- Absorption coefficient linear function of wavelength
  - $\beta_a(\lambda) = a\lambda$

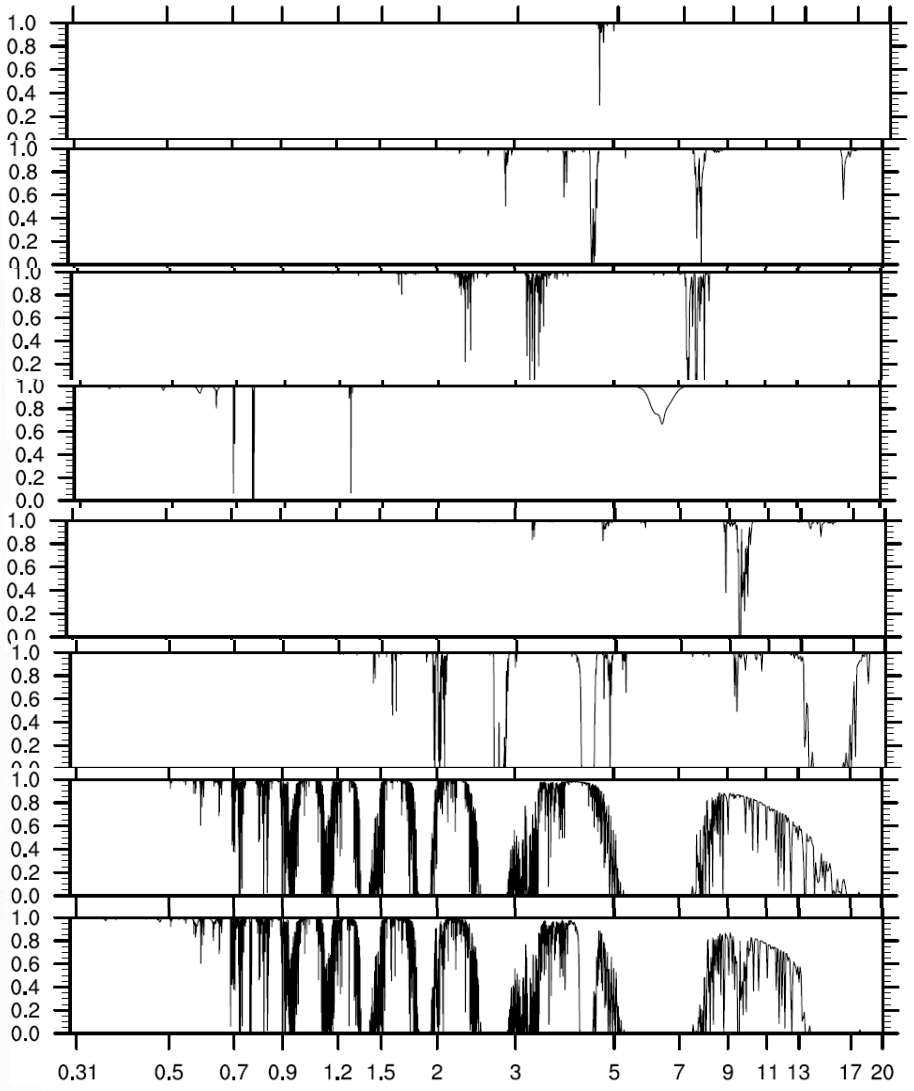
Model Development: the Real Atmosphere



How do we do better? The I3RC

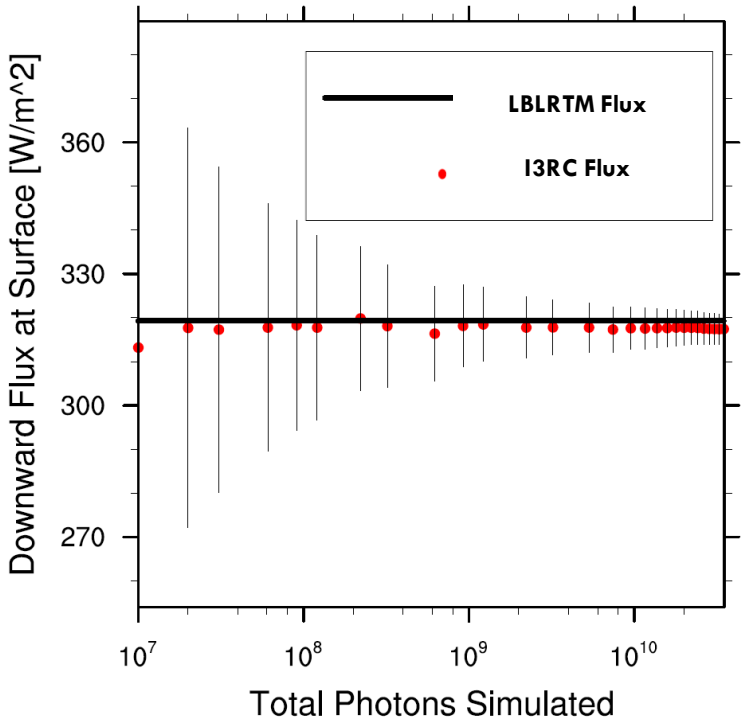
Checking Transmittance

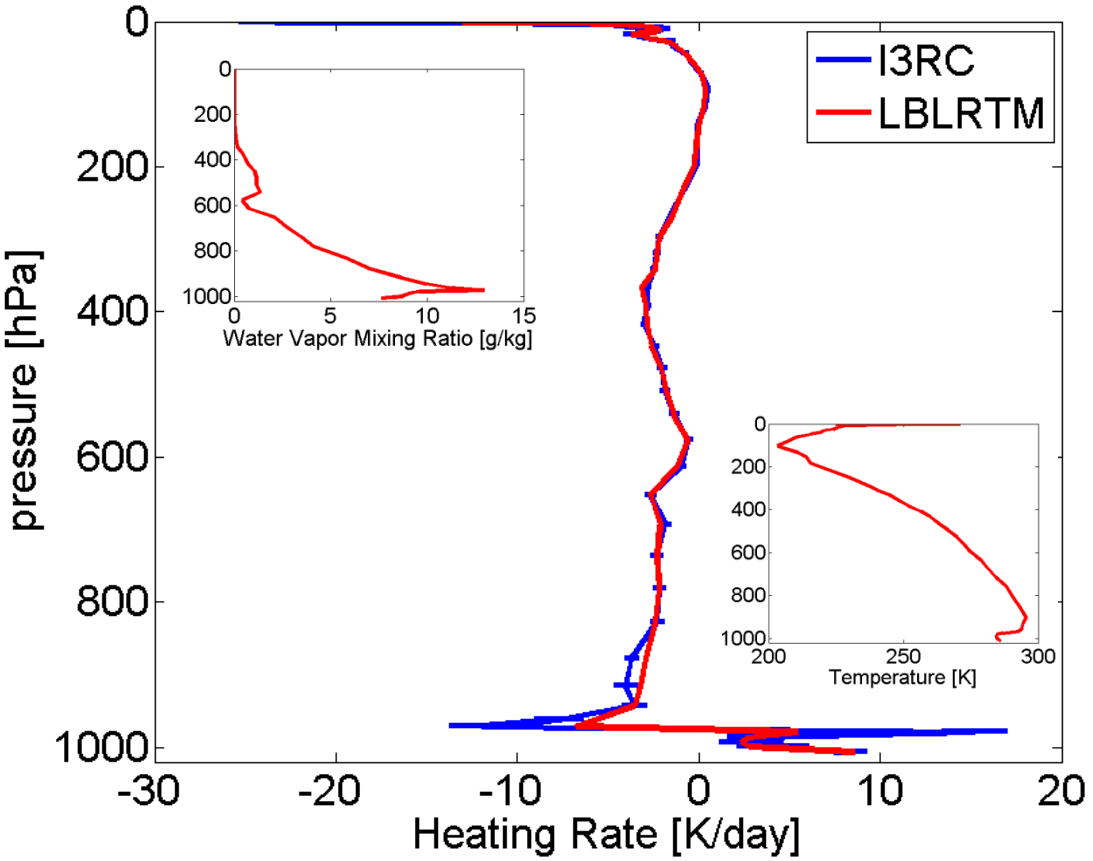




How do we do better? The I3RC

Real Atmosphere: Clear-sky Absorption



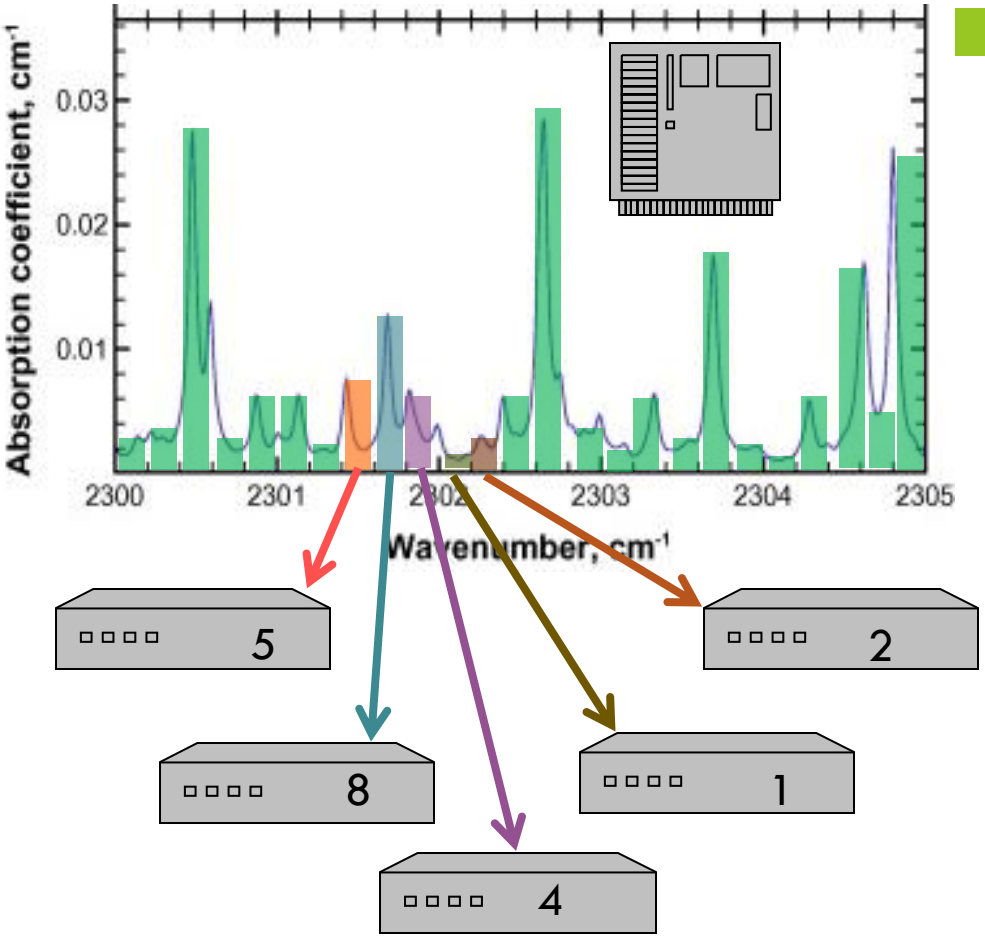


How do we do better? The I3RC

Reducing MPI-communication Time

FORMER

- Master assigns lesser of *#perBatch* or total remaining photons in bin to each worker
- Workers trace those photons. Then ask for more work to do
- Repeat until no photons remaining

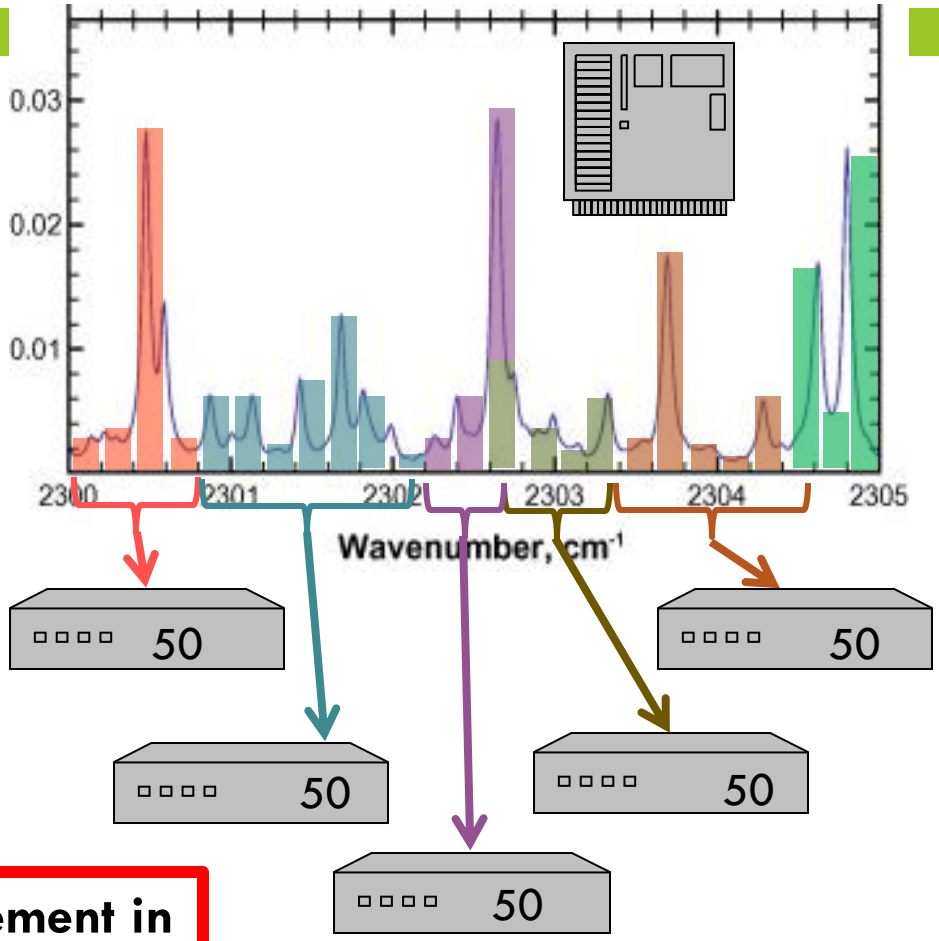


How does it perform?

Reducing MPI-communication Time

CURRENT

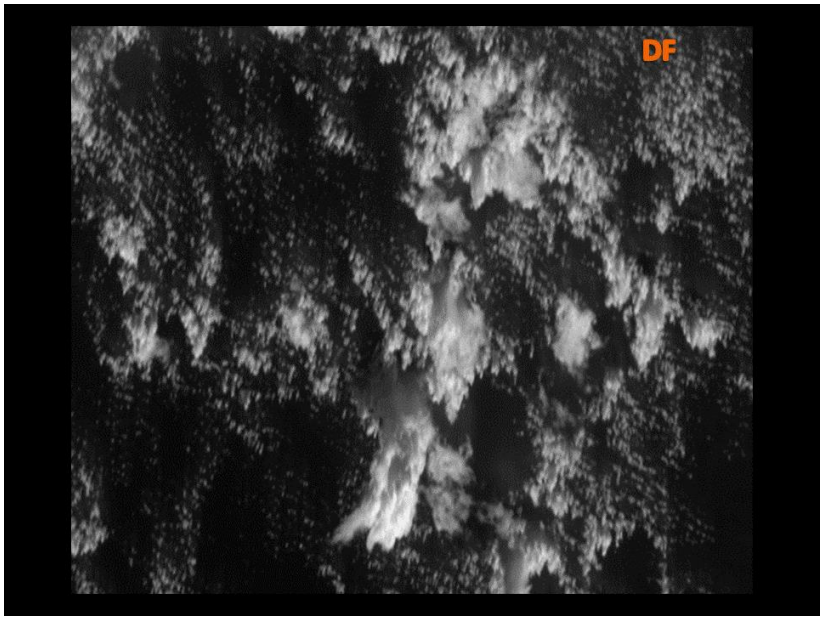
- Master assigns *#perBatch* photons even if spanning multiple bins
- Workers trace those photons. Then ask for more work to do
- Repeat until no photons remaining



92% improvement in total compute time

How does it perform?

Acknowledgements and Questions



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List of references can be found on my poster

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