RRTMGP: a radiation code for the next decade

With funding from ONR ESPC AOLI and NASA MAPP we (CU, AER) have been developing RRTMGP, a radiation code for the next decade. This is the successor to the widely-used RRTMG code developed at AER, with emphasis on

flexibility for use in different contexts e.g. across scales

efficiency on modern and near-future computing platforms

Changes to science capabilities are modest but real

RRTMGP remains a plane-parallel correlated-*k* two-stream radiative transfer model

Upated spectroscopy; changes will be larger in the SW then in the LW

Optional treatment of scattering in the longwave (TK)

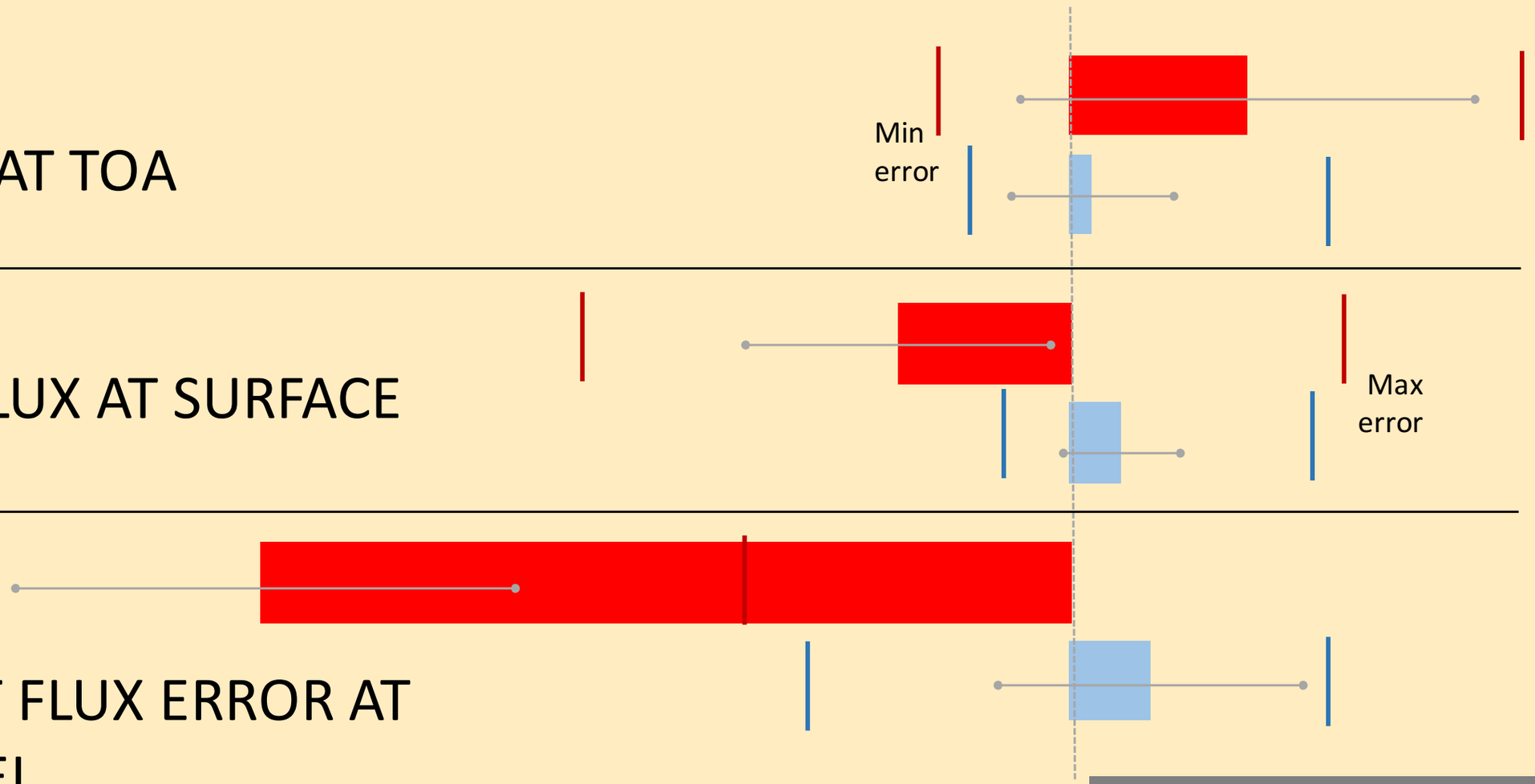
RRTMGP is a parameterization targeted for use in atmospheric models. Other infrastructure (e.g. use in offline calculations) is the user's responsibility, though the code is modular enough to enable many applications.

Spectroscopy has changed since RRTMG

UP FLUX AT TOA

DOWN FLUX AT SURFACE

MAX NET FLUX ERROR AT ANY LEVEL



Mean error (stdev)	
0.55 (0.70)	0.07 (0.25)
-0.53 (0.47)	0.16 (0.18)
-2.50 (0.77)	0.25 (0.47)

RRTMG – existing code

RRTMGP – new code

Calling structure is entirely new

Important arguments are Fortran 2003 classes

`optical_props` as inputs, `fluxes` as outputs

Enables e.g. reporting of surface PAR without code changes (flexibility)

Minimizes data transfer to/from radiation calculation (efficiency)

Aerosol and cloud optics are the user's responsibility.

Shell-core optics for aerosols? Sampling CLUBB? Go crazy.

Provide as code or arrays

High performance should be possible

Code is vectorized across columns

Large amounts of fine-grained parallelism is exposed (many algorithms simplified)

Minimal data transfer

Computation is isolated in kernels operating on assumed-size arrays

Amenable to GPU implementations etc.

Iteration with NCAR software engineers has sped up LW code by 35% so far

We (me, Matt Norman, Erich Foster) are participating in EuroHack 2017 to push GPU efforts

Status

The code works today but is being polished under the hood.

We are using placeholder spectroscopy… (sad face)

We are optimizing on a diverse set of atmospheres; assessing with a globally-representative set.

Coupling to other projects

Charlie Zender's work on surface albedo could flow into RRTMGP seamlessly but requires revisions to CIME.

Michael Prather's work on photolysis could be incorporated as another "instance" with some effort

I can leverage other work to sample CLUBB cloud macrophysics, but ACME still needs to develop/adapt cloud and aerosol optics

Brian Eaton has already coupled CAM6 to RRTMGP

Mike Iacono is the RRTMGP point person for coupling. He can leverage his experience building new-but-generic cloud optics