Chemistry & Radiation Update

Prather, Hsu (UC Irvine)
Cameron-Smith (LLNL)

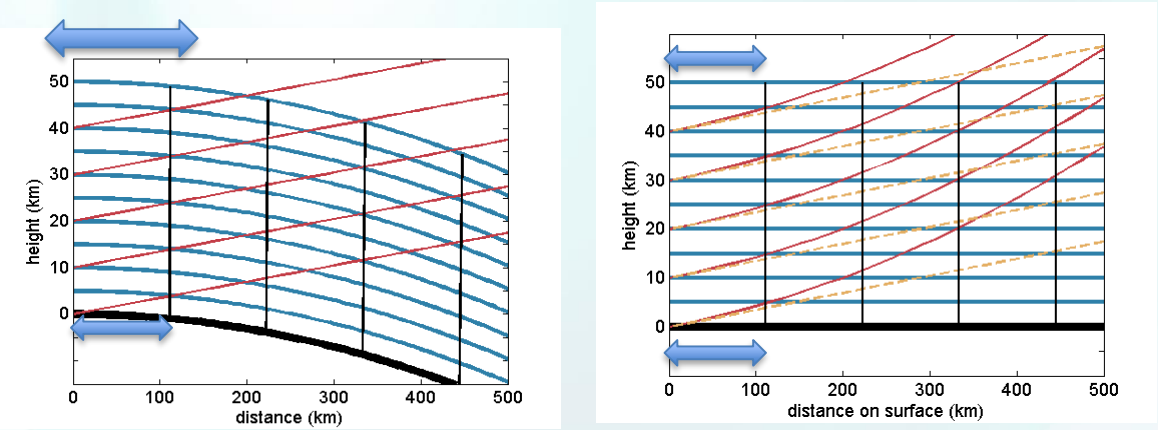
- Brief description of your project
  - Develop an interactive fully coupled atmospheric chemistry module for E3SM
    - More accurate atmospheric heating & non-linear aerosol-chemistry coupling,
    - Respond correctly to emission scenarios relevant to DOE.
  - Develop and test the Cloud-J/Solar-J radiation codes as a solar benchmark for E3SM
  - Implement Solar-J in E3SM for short climate runs to test impact of RT errors.
- Summary of Accomplishments (Oct. 1, 2018 - Mar. 15, 2019)
  - Full spherical atmosphere corrections: (i) spherical solar ray-tracing (from Fast-J); (ii) refraction (new); (iii) geometric expanding atmosphere (just completed).
  - Off-line analysis and UQ with RRTMG-SW is complete, papers being written.
  - Specified chemical mechanism in terms of reactants, tracers, and reactions.
  - Documented Historical Compsets in E3SMv1 watercycle paper (published)
  - Draft of design document for AP2.
- Summary of Issues (difficulties)
  - Diversion of effort to 'future compsets' is delaying implementation into E3SM by Philip.
    - Need a version of Cloud-J running in E3SM to get in-line Solar-J diagnostics.
    - Need a version of chemistry running to start testing model (will resurrect super-fast)

Part of this work was prepared by LLNL under Contract DE-AC52-07NA27344. LLNL-POST-769932

Highlights

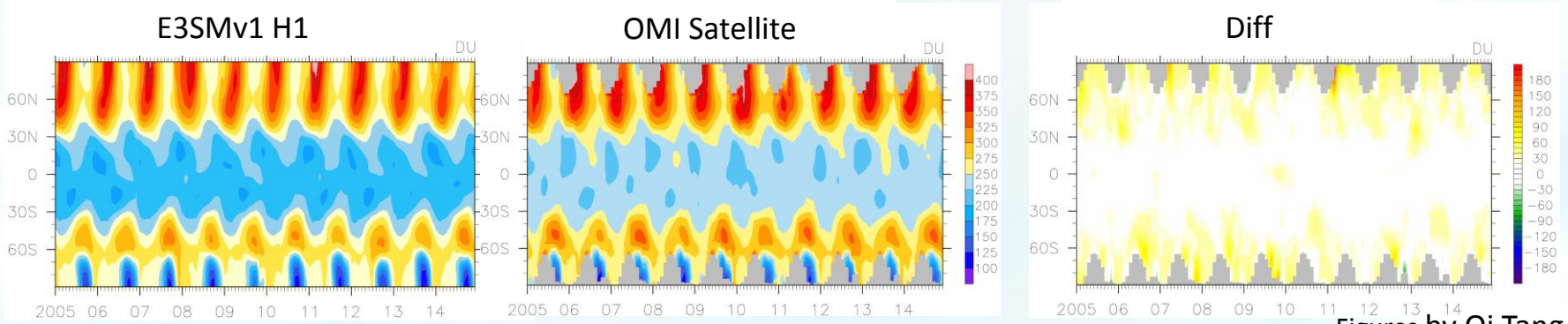
Prather, Hsu (UC Irvine)
Cameron-Smith (LLNL)

- Flat atmosphere underestimates heating by 10 Wm^{-2} for low sun (2 Wm^{-2} globally):



In a real, spherical atmosphere the grid expands with altitude, but in a flat one it is fixed (along with g_o).

- E3SMv1 stratospheric linearized ozone compares well to satellite observations:



Figures by Qi Tang

- Publications

1. M.J. Prather and J. Hsu, (2019) Spherical atmospheres capture more solar radiation and reduce aerosol radiative effects (in prep).
2. P. Cameron-Smith, et al. (2019) E3SMv1 stratosphere (in prep).
3. Golaz, et al. (2019) E3SMv1 watercycle (published).

Milestones (AP2 & AP9)

Prather, Hsu (UC Irvine)
Cameron-Smith (LLNL)

- Oct. – Dec. 2018:
  - Added refraction and geometrical expansion of atm Solar-J.
  - Provided UCI chemical reactions.
  - Documented Historical Compsets in E3SMv1 paper (published)
- Jan.- Mar. 2019:
  - UQ exploration for RRTMG-SW using Solar-J,
  - Design Document for AP2, including verification and validation,
  - Future compsets for watercycle and BGC.
- Apr. – Jun. 2019:
  - Write1st solar UQ paper (spherical atmospheres);
  - Write AP9 design doc.
  - Implement UCI chemistry into E3SM
- Jul. - Sept. 2019:
  - Submit 2nd solar UQ paper (RT approx.)
  - Connect Fast-J photolysis to chemistry.
- Oct. – Dec. 2019:
  - Preliminary interface of Cloud-J with E3SM designed and begin testing.