Chemistry & Radiation Update

• 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)
Highlights

- 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 \(g_0\)).

- E3SMv1 stratospheric linearized ozone compares well to satellite observations:

- Publications
Milestones (AP2 & AP9)

- **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:**
  - Write 1st 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.