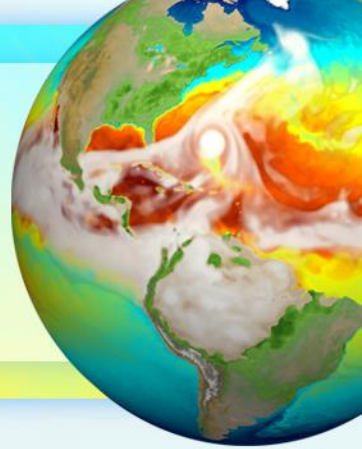

A Photolysis Scheme that Understands Clouds: Fast-J

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Qi Tang (LLNL)

E3SM Energy Exascale Earth System Model

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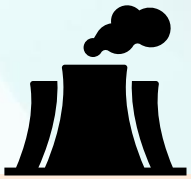
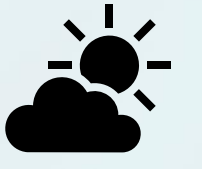
U.S. DEPARTMENT OF ENERGY

Photolysis affects radiative heating and biosphere



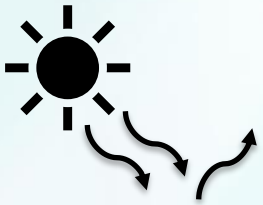
Emissions of chemicals (Anthropogenic)

Emissions of chemicals (Biogeochemistry)



CH4, H2O, N2O, NO2

Atmospheric Processes
- **Photolysis**
- Chemistry
- Deposition/scavenging
- Transport/mixing



Radiative Heating

Concentrations
- Greenhouse Gases
- Secondary Aerosols

Chemicals affect **Biogeochemistry**
- Fertilization
- Leaf damage

Fast-J has many advantages over existing Lookup Table

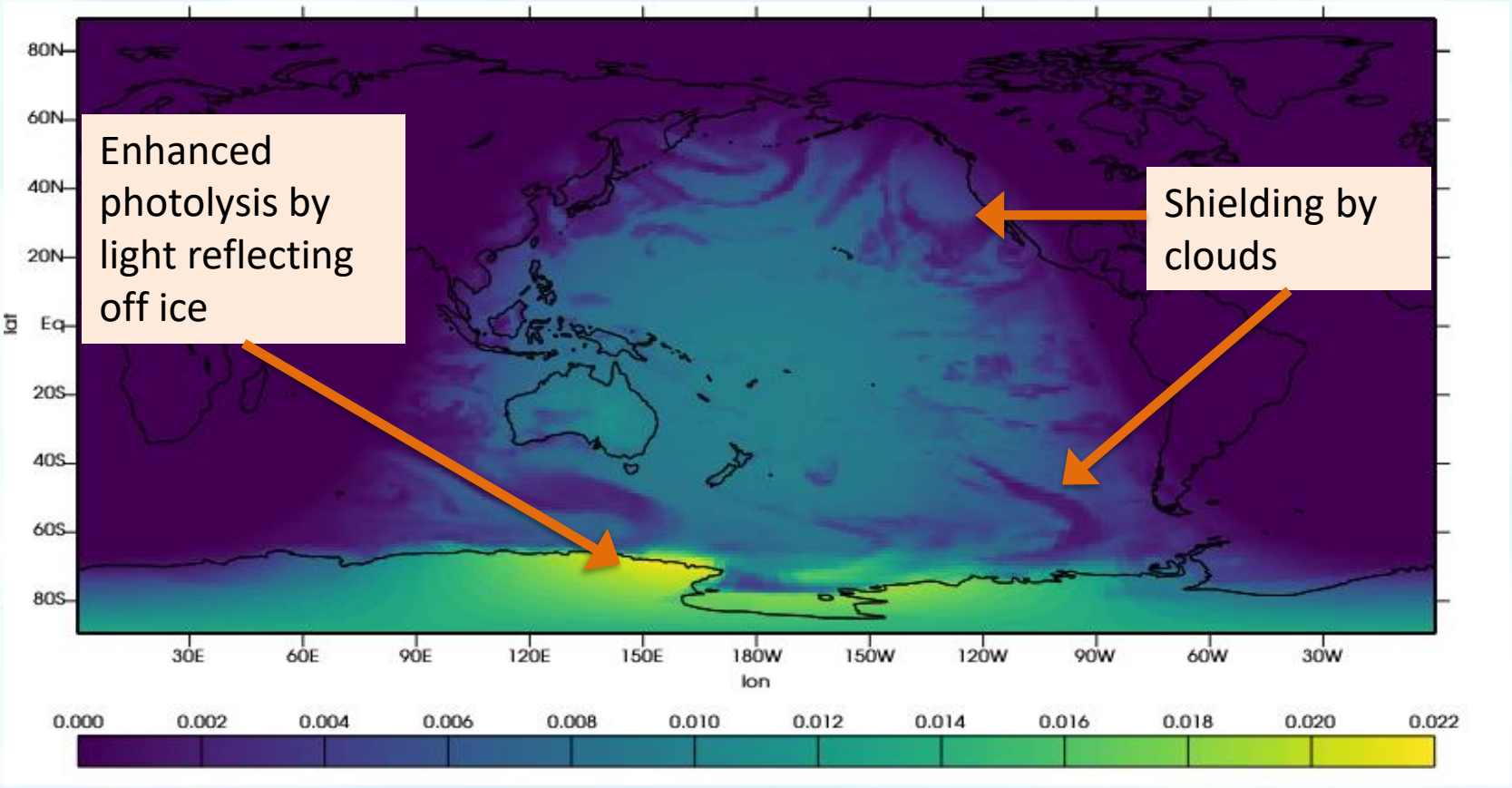
Lookup table inherited from CESM is 20 years old.

Fast-J has many advantages:

- Overlapping clouds.
- Aerosol absorption and scattering.
- Spherical geometry of atmosphere.
- Multi-angle scattering:
  - Enhanced photolysis above clouds and in top of clouds.
  - Realistic diffusive photosynthetically active radiation (PAR).
- Updated (and updatable) laboratory data tables.
- Supported for global community by UC Irvine.

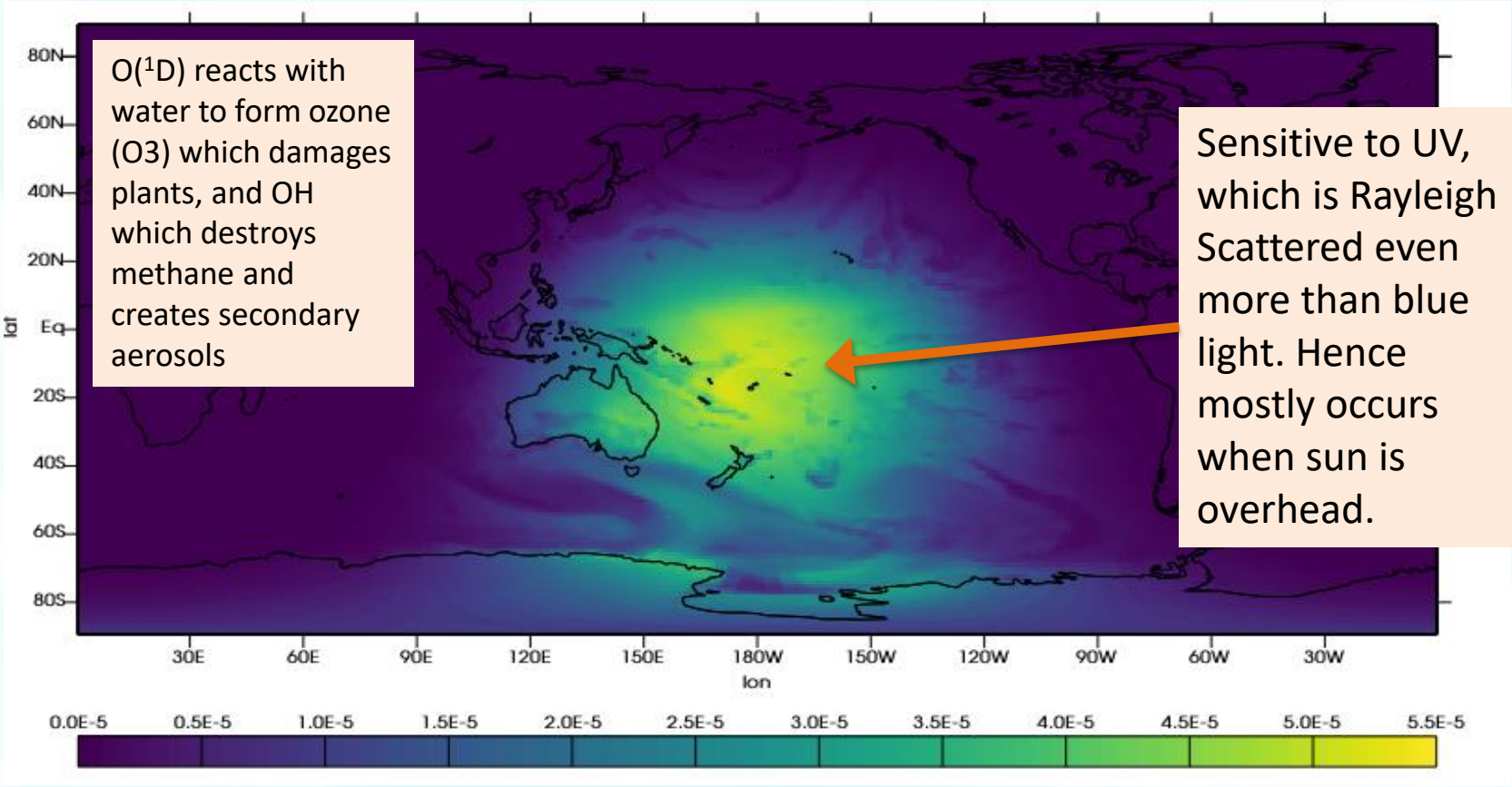
Fast-J has been installed in E3SM and coupled with other components

Photolysis Rate-Constant for NO2 -> NO + O (January 2, midnight GMT)

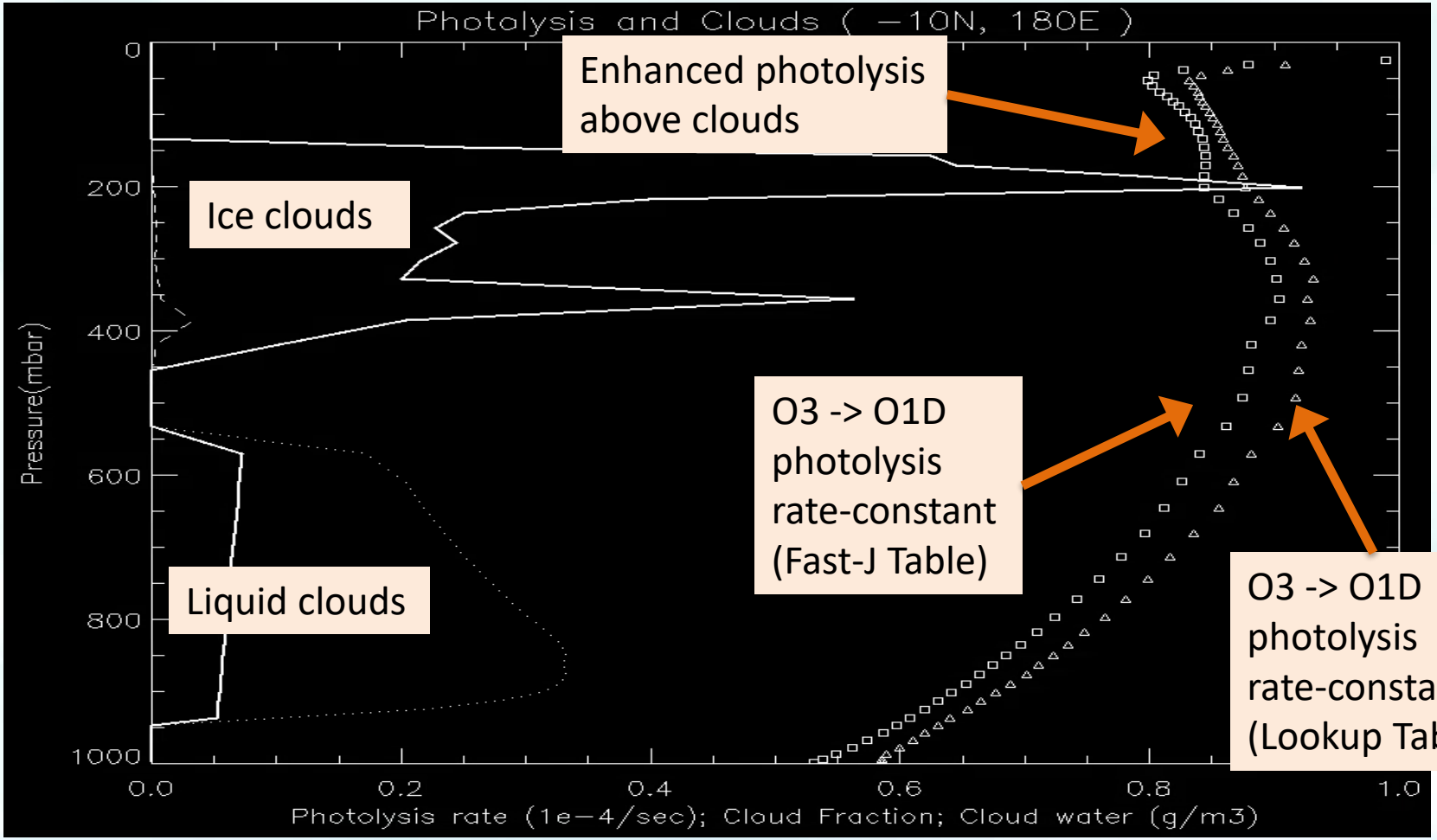


Different chemicals are sensitive to different wavelengths

Photolysis Rate-Constant for O3 -> O(^{1}D) + O2 (January 2, midnight GMT)



Fast-J should improve short-lifetime bias for methane (slower photolysis)



Next Steps

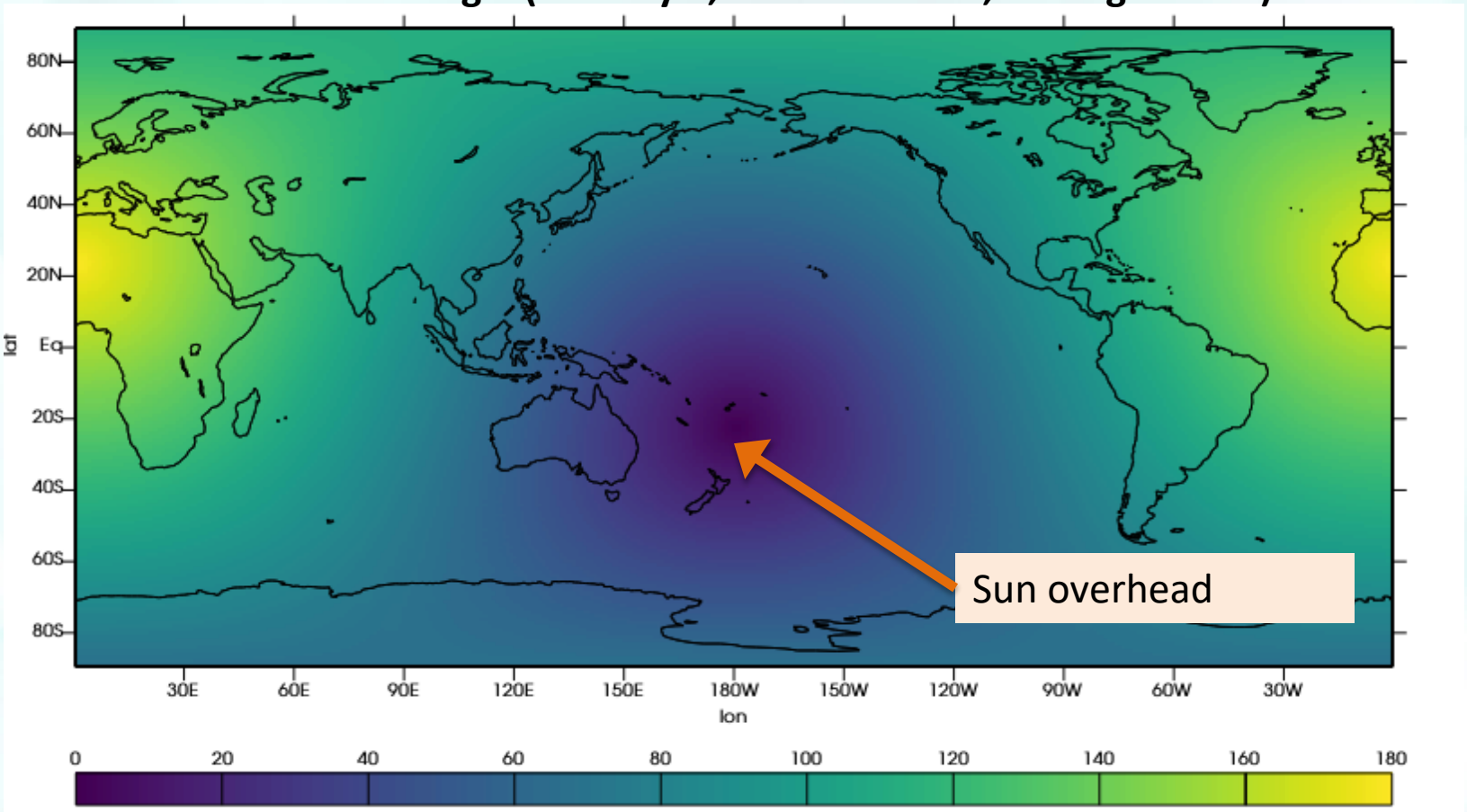
- Implement OpenMP.
- Merge Fast-J with:
  - New chemistry (chemUCI).
  - New aerosol scheme.

Summary

- Fast-J is a huge improvement for photolysis in E3SM:
  - Improves methane lifetime in E3SM (Superfast chemistry).
  - Overlapping clouds.
  - Aerosol absorption and scattering.
  - Spherical geometry of atmosphere.
  - Multi-angle scattering:
    - Enhanced photolysis above clouds and in top of clouds.
  - Updated laboratory data:
    - Updatable.
  - Supported by UC Irvine (M.Prather, J. Hsu).

Supplemental Slide: Solar Zenith Angle

Solar Zenith Angle (January 2, Instantaneous, midnight GMT)



Supplemental Slide: Shallower sun angle, thinner clouds