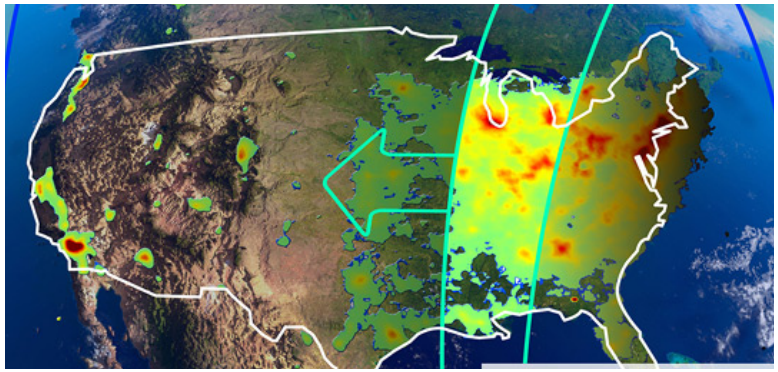
Updates to surface reflectance for trace gas retrievals

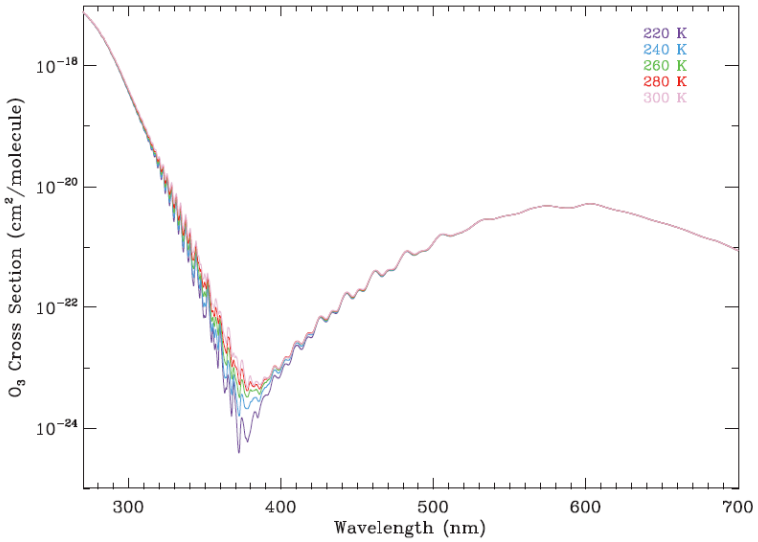


Peter Zoogman, Kelly Chance, Xiong Liu,
Qingsong Sun, Crystal Schaaf, Tobias Mahr, Thomas Wagner

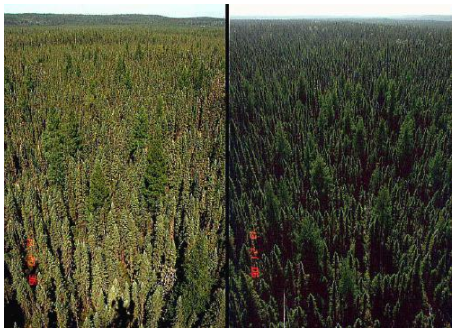
TEMPO Science Team Meeting
May 27, 2015

Ozone absorption in the Visible

- Ozone has weak spectral features in the Chappuis band
- Since the atmosphere is optically thin in the visible, can get information near the surface
- But retrieval is more sensitive to errors in **surface reflectance**

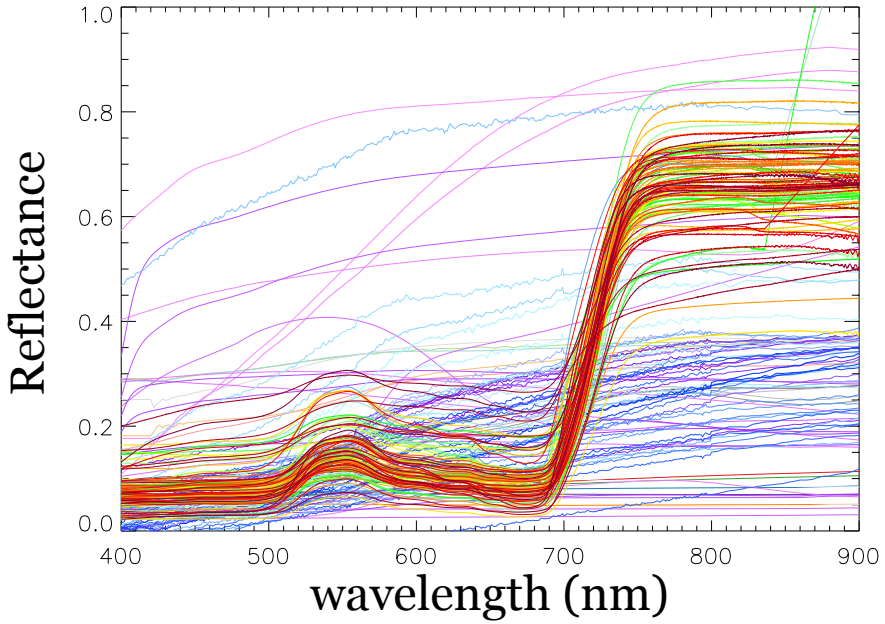


- Spectral variation
- Dependence on land cover
- Changes with viewing geometry



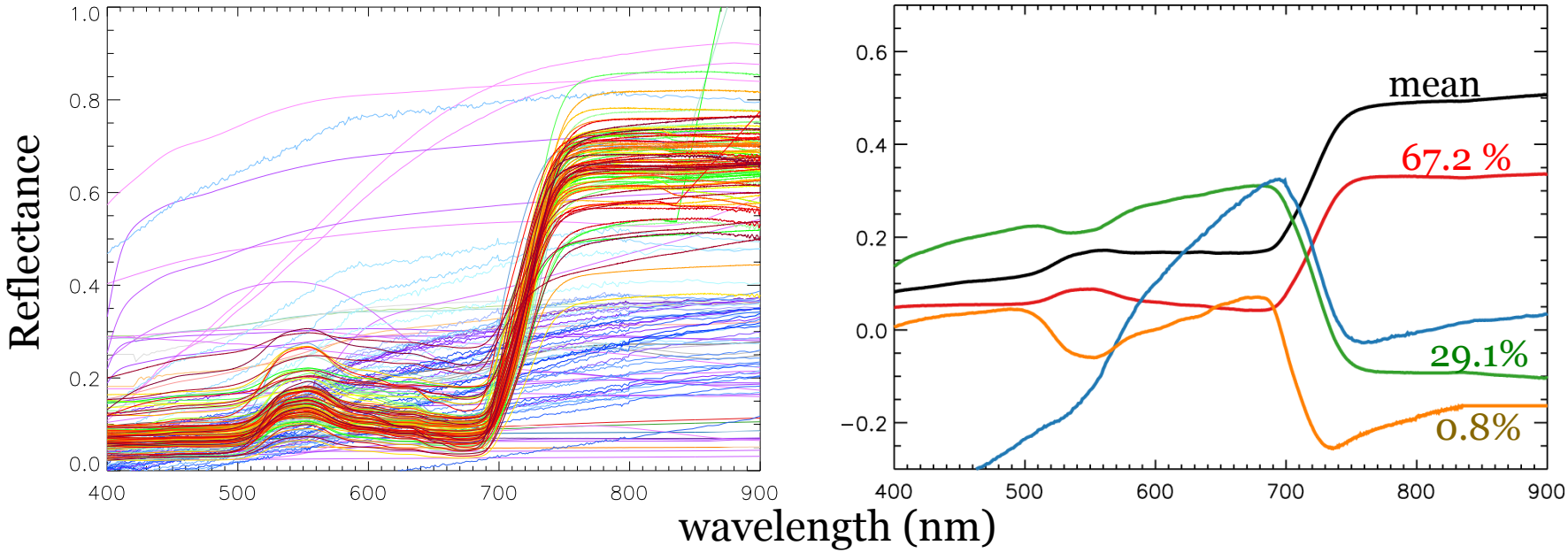
Pictures by Don Deering

Reflectance Spectra by Surface Type



- Obtained lab spectra of possible ground cover
  - Includes vegetation, soils, rocks, manmade materials
  - **Update**: added spectra from USGS database , have collaborators at SLU who are compiling a new albedo database

Reflectance Spectra by Surface Type

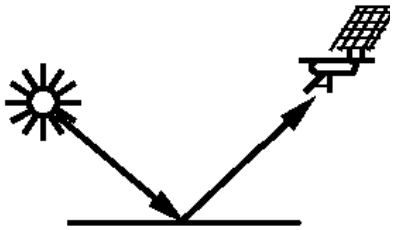


- Obtained lab spectra of possible ground cover
  - Includes vegetation, soils, rocks, manmade materials
  - **Update**: added spectra from USGS database , have collaborators at SLU who are compiling a new albedo database

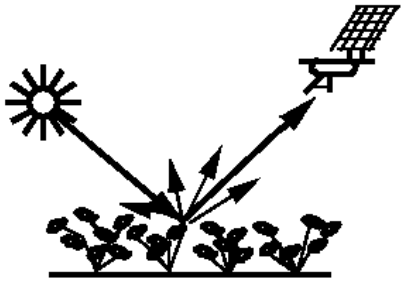
- **Update**: added 4th EOF for use in trace gas retrievals.

Viewing Geometry from MODIS

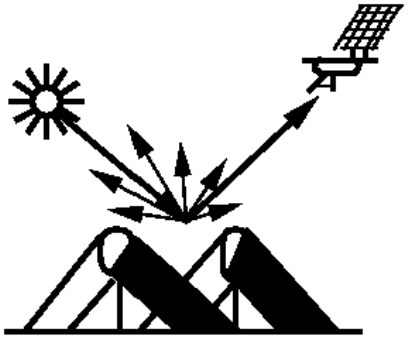
Bidirectional Reflectance Distribution Functions: Causes



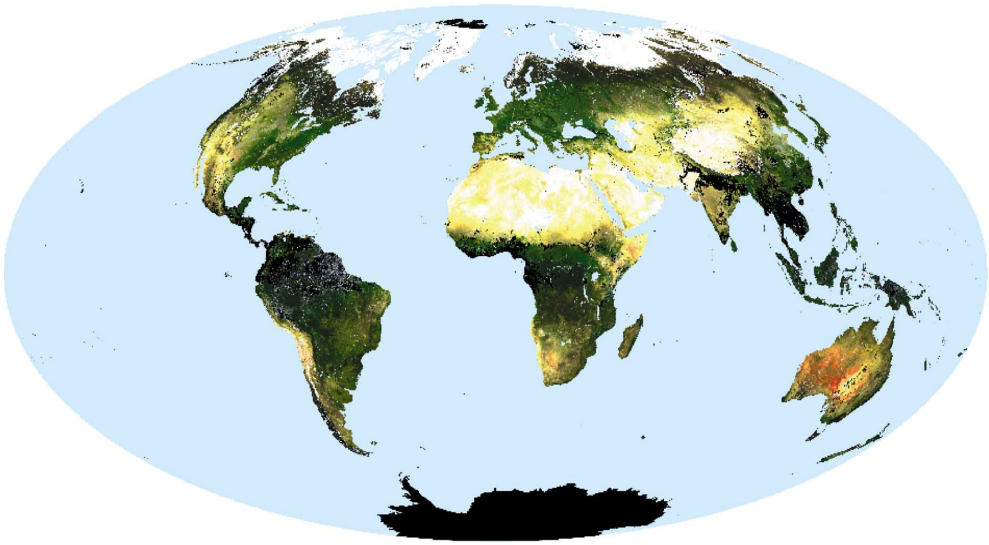
Mirror BRDF:
specular reflectance



Volume scattering BRDF:
leaf/vegetation reflectance

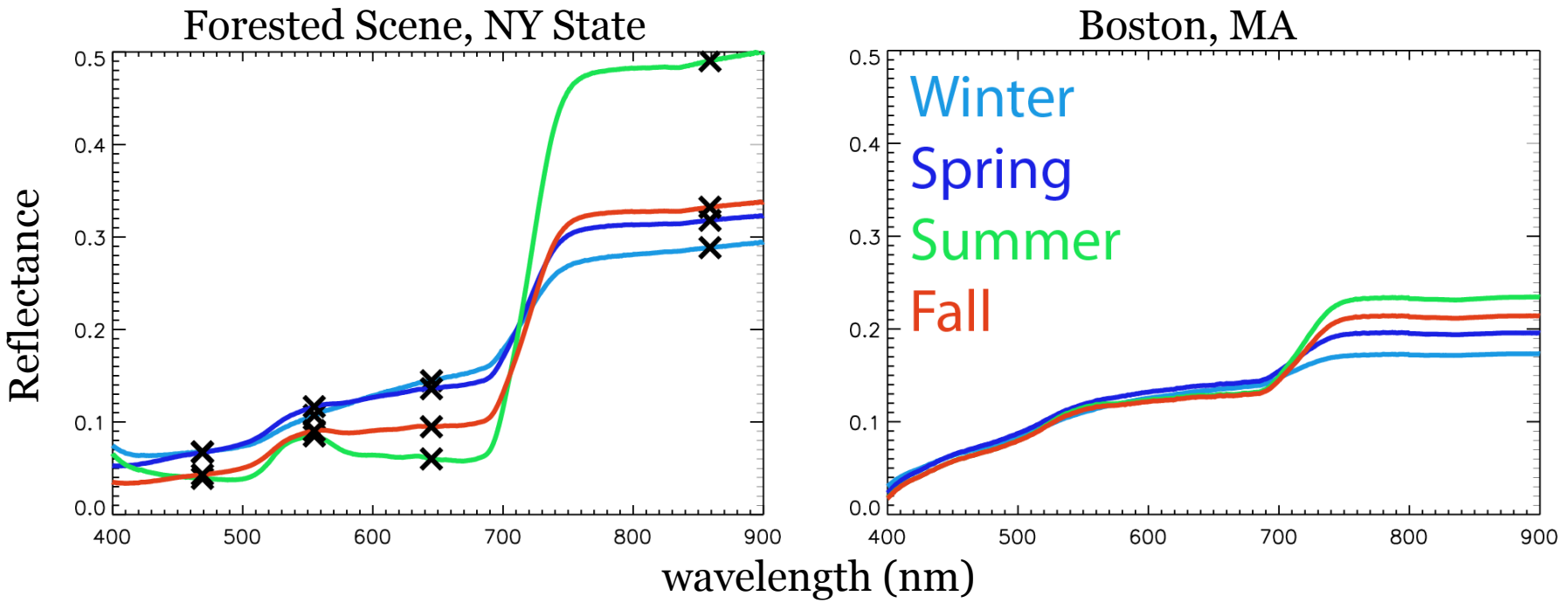


Gap-driven BRDF (Forest):
shadow-driven reflectance



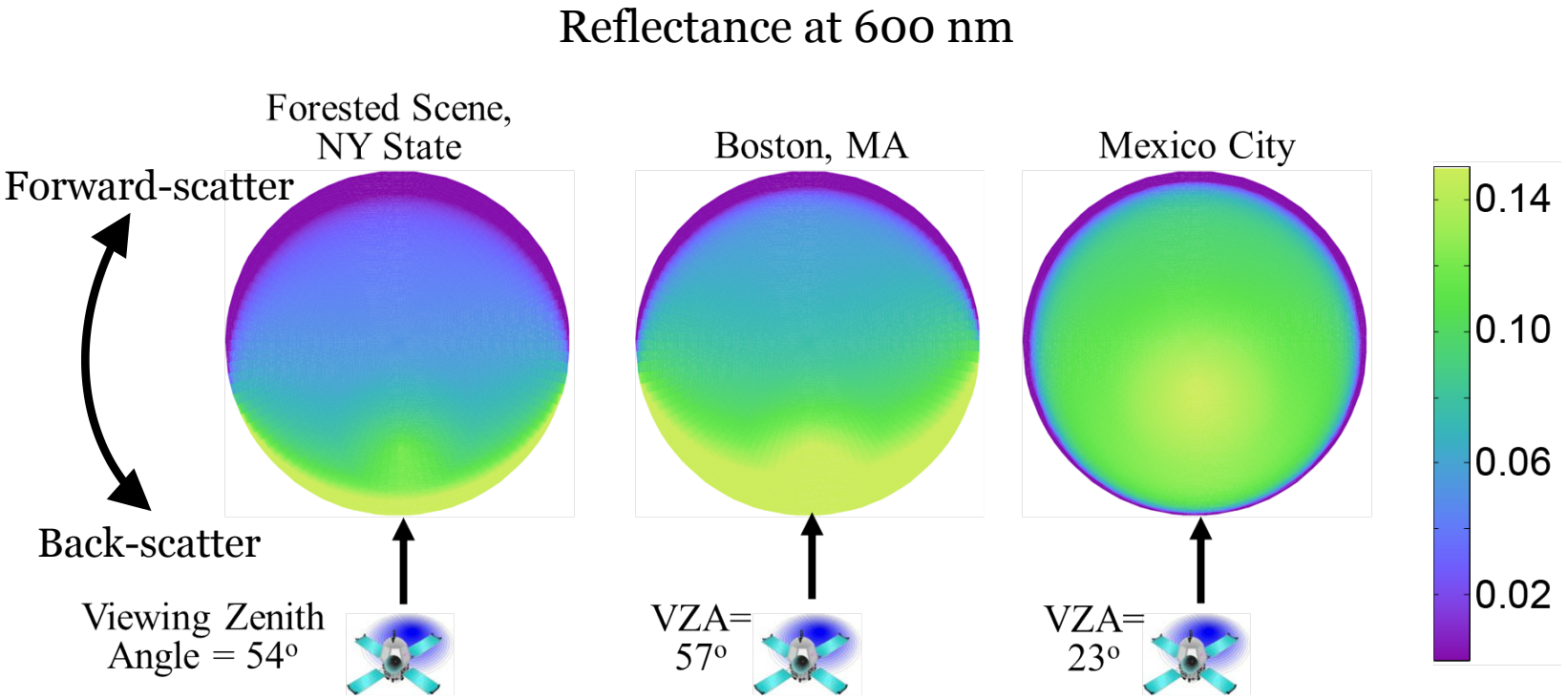
MODIS Composite Surface Reflectance (True Color) [Schaaf et al. 2002]

Seasonal Variation



We combine MODIS data at discrete bands with EOFs to create best estimate of surface reflectance spectra

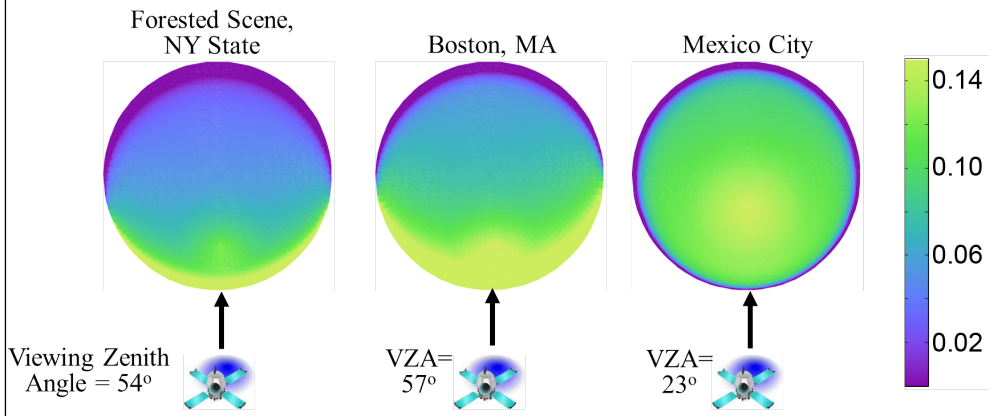
Reflectance as a function of solar position



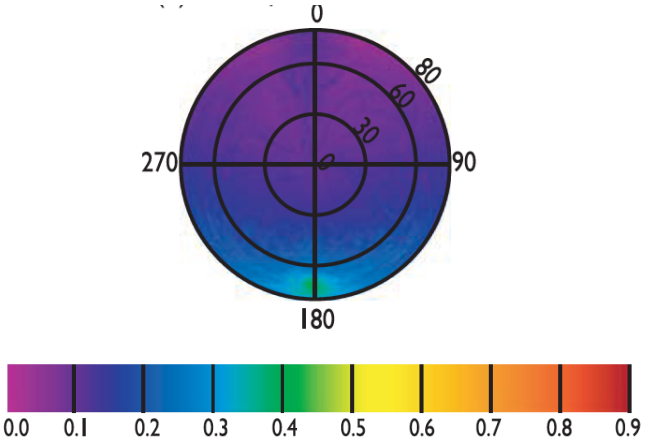
MODIS BRDF factors allow us to reconstruct the geometric variation of reflectance – even at wavelengths not measured by MODIS!

Reflectance as a function of solar position

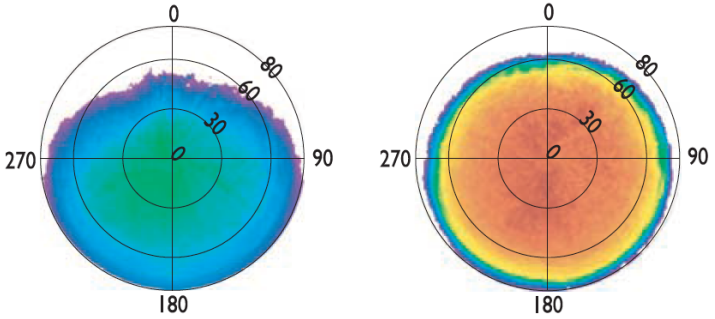
Reflectance at 600 nm



Reflectance at 680 nm from aircraft (vegetated scene)



Ratio of Reflectance 470 nm : 680 nm

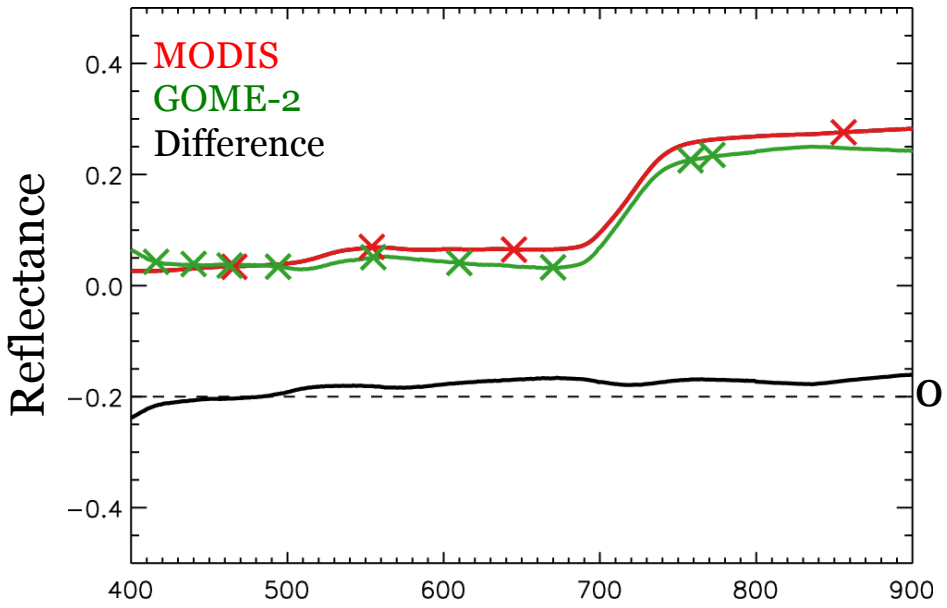


[Gatebe et al. 2003]

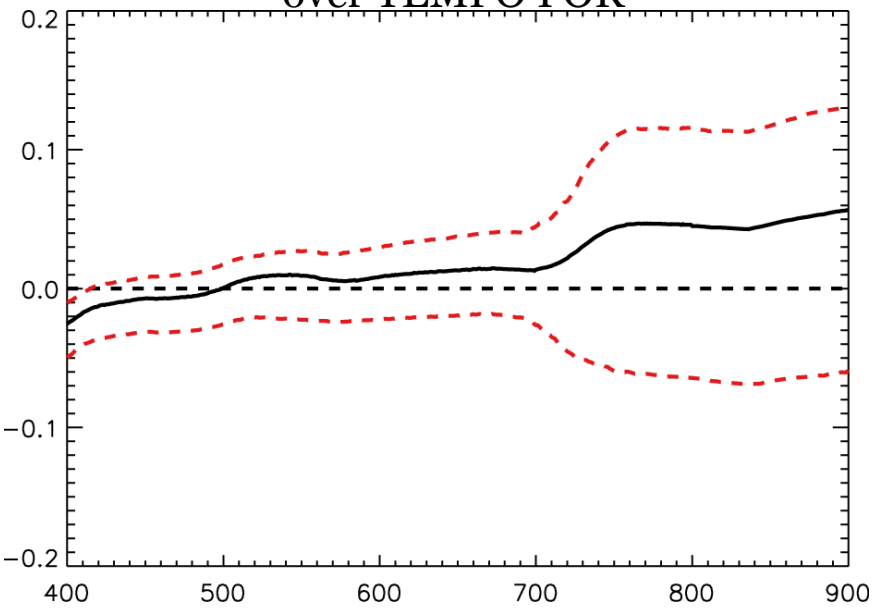
MODIS/GOME-2 Comparison

GOME-2 provides Lambertian Equivalent Reflectance (LER) over all scenes

MODIS Blue-sky albedo / GOME-2 LER comparison: Huntsville, AL



MODIS/GOME-2 mean difference over TEMPO FOR

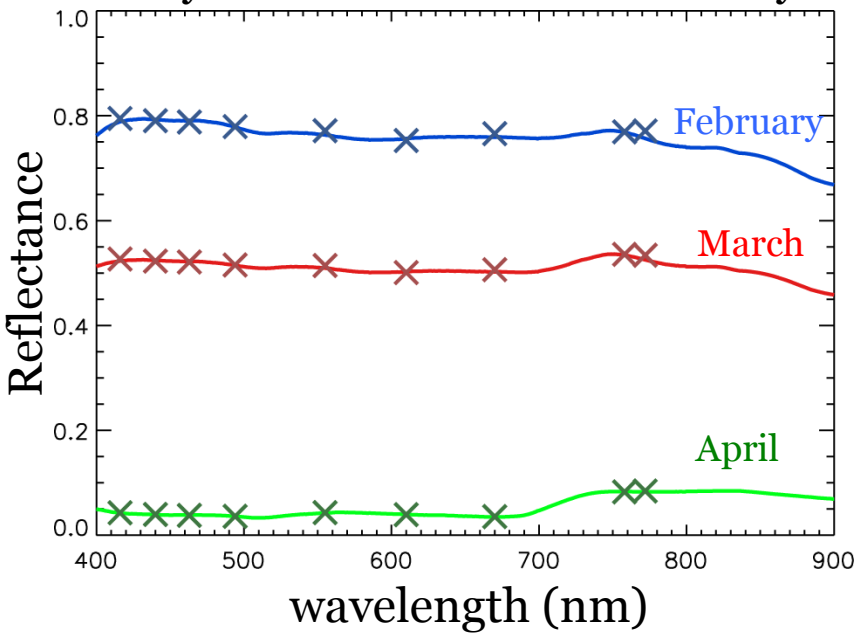


wavelength (nm)

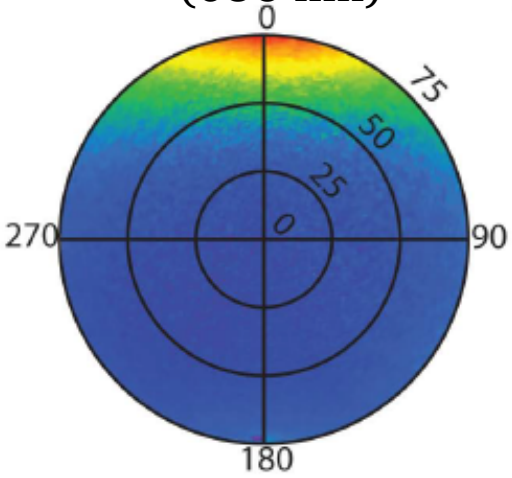
Using MODIS or GOME-2 may provide similar shapes for the surface reflectance spectrum for 450-700 nm

Snow/Ice Scenes

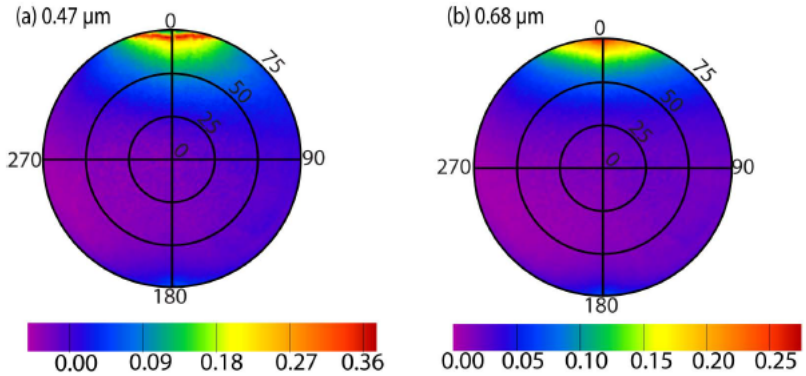
Monthly GOME-2 LER over a snowy scene



Measured Snow BRDF from CAR (680 nm)



Error from assuming Lambertian surface



[Lyapustin et al. 2010]

Conclusions

- Surface Reflectance in the visible has strong variability (spectral, spatial, seasonal) which we need to capture for ozone profiling
- 4 EOFs capture >99.5% of the spectral variation of surface reflectance from different land cover materials (400 – 900 nm)
- Fit EOFs to MODIS observed reflectance climatology (adjusted for viewing geometry) to generate high spectral resolution reflectance for use in TEMPO retrievals
- Can use GOME-2 for scenes not covered by MODIS (snow/ice, water)