Update on the Spectral Shortwave Quality Measurement Experiment (SW QME) at the Southern Great Plains ACRF

J. Delamere, E. Mlawer, S. Clough, C. Flynn

C. Long, P. Kiedron, J. Michalsky,

P. Pilewskie, T. Shippert

The Longwave "QME"

- Scientific
  - Improved modeling of longwave radiation
    - Validation of spectroscopic line parameters
    - Refinement of water vapor continuum
  - MWR-scaling of input water vapor profile improved radiance calculations over nominal radiosondes
  - Publication in J. Atmos. Science (Turner et al. 2004)
  - Motivation for far-infrared studies, RHUBC

- Quality Control - Excellent means of detecting issues in
  - Data streams (MWR, PIR,…)
  - VAPS (Merged Sounding,…)

Spectral SW QME Paradigm

Model Input (P, T, PWV, Aerosols, Clouds & Surface Alb)

⇕

Line Parameters, Continuum Model, ET Spectrum ⟺ **Line-By-Line RT Model (CHARTS)**

⇕

Spectral Radiance/Irradiance Measurements

Objectives of SW QME

- Critical evaluation of all components of closure study:
  - Measurement Quality
  - Accuracy of calculation
    - Water vapor spectroscopy
    - Extraterrestrial spectrum
  - Model inputs
    - Spectral Surface Albedo
    - Aerosol Properties (e.g. spectral dependence of SSA, vertical distribution of aerosol)
    - Cloud Properties

Shortwave QME (Cloud-Free) Inputs

(1) Atmospheric State

Radiosonde

MWR

Atmospheric State (Gases, Aerosols); Surface Albedo

(2) Aerosol Optical Properties

AOS/ABE

IAP

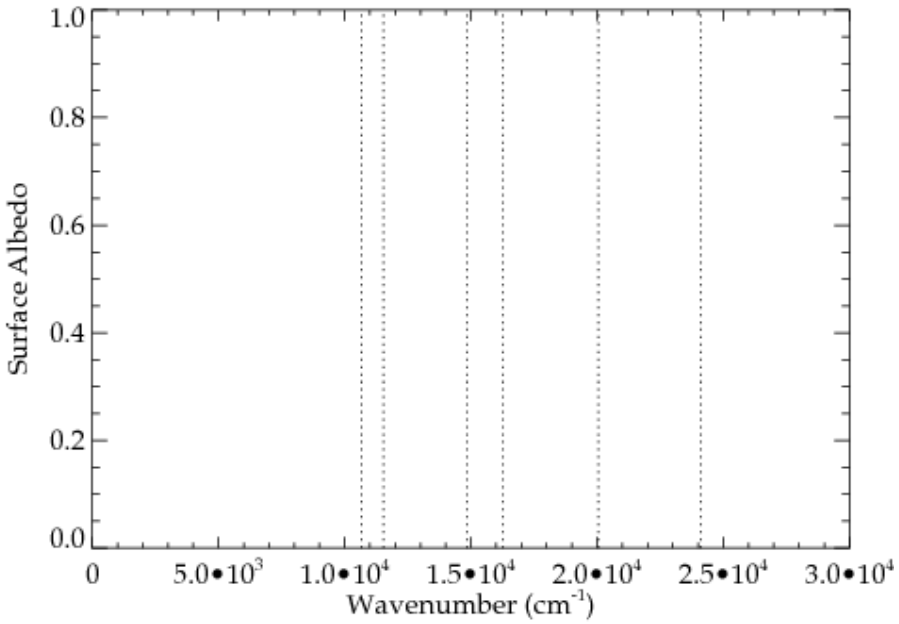
Thanks, Connor!

(3) Shortwave Sfc Albedo

Thanks, Chuck!

Spectral Surface Albedo

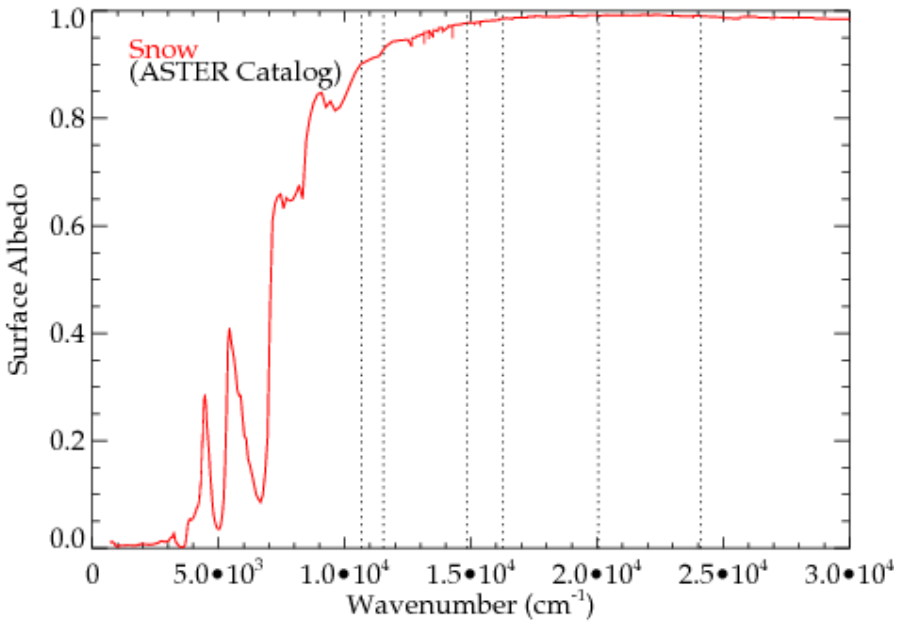
- MFRSR
- Tower MFRs
  - 10m, 25 m
- 6 Surface Albedo values for each tower



GOAL: Determine reasonable spectral surface albedo given limited spectral measurements

Spectral Surface Albedo

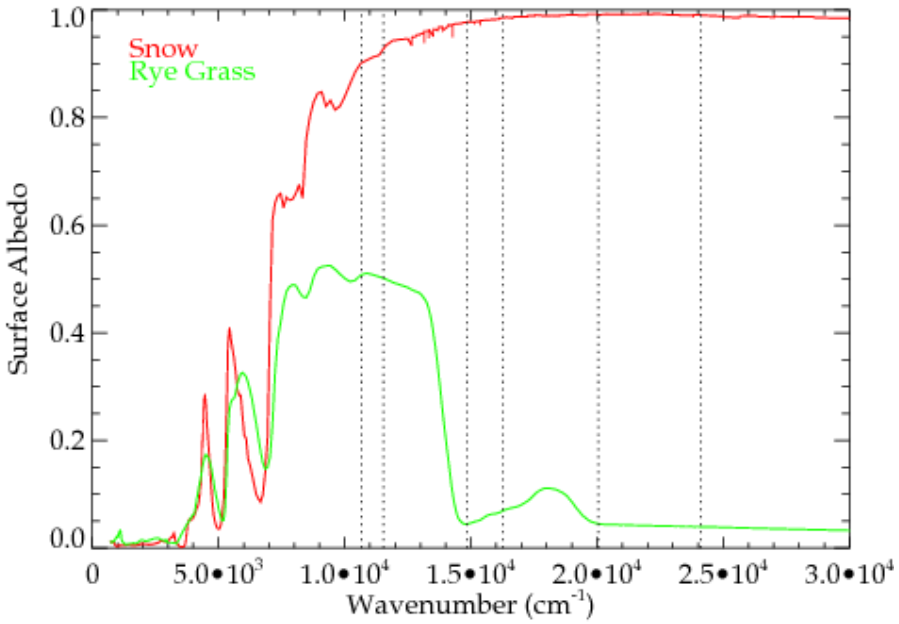
- MFRSR
- Tower MFRs
  - 10m, 25 m
- 6 Surface Albedo values for each tower



GOAL: Determine reasonable spectral surface albedo given limited spectral measurements

Spectral Surface Albedo

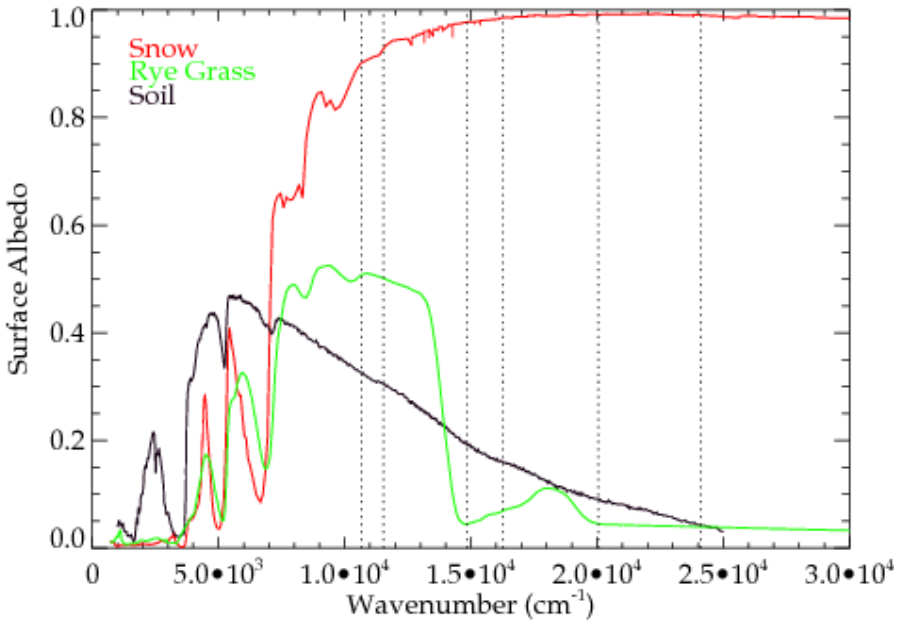
- MFRSR
- Tower MFRs
  - 10m, 25 m
- 6 Surface Albedo values for each tower



GOAL: Determine reasonable spectral surface albedo given limited spectral measurements

Spectral Surface Albedo

- MFRSR
- Tower MFRs
  - 10m, 25 m
- 6 Surface Albedo values for each tower

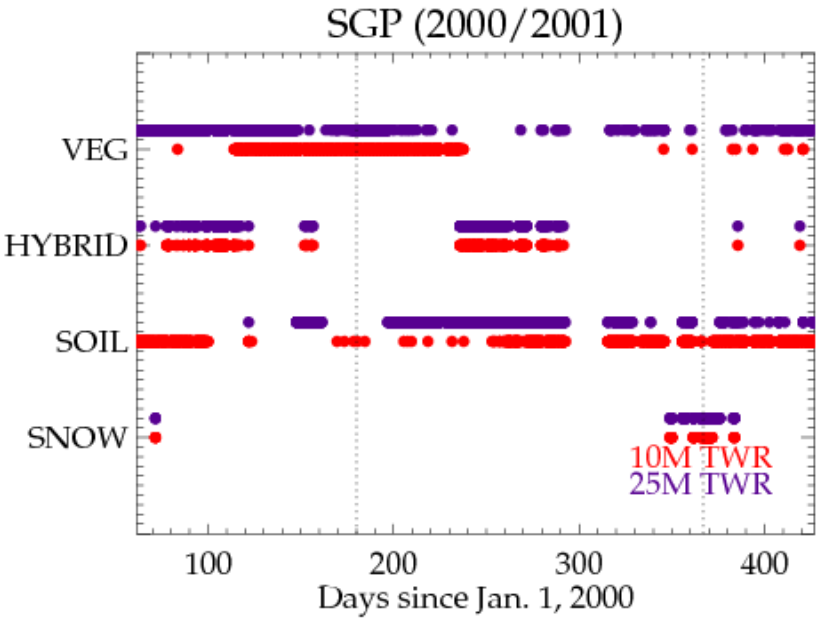


GOAL: Determine reasonable spectral surface albedo given limited spectral measurements

Spectral Surface Albedo Algorithm

1. Based on the 6 MFR channel albedos, every surface classified as either:

- Snow
- Soil
- Vegetation
- Soil/Vegetation Combination



Spectral Surface Albedo Algorithm

1. Based on the 6 MFR channel albedos, every surface classified as either:

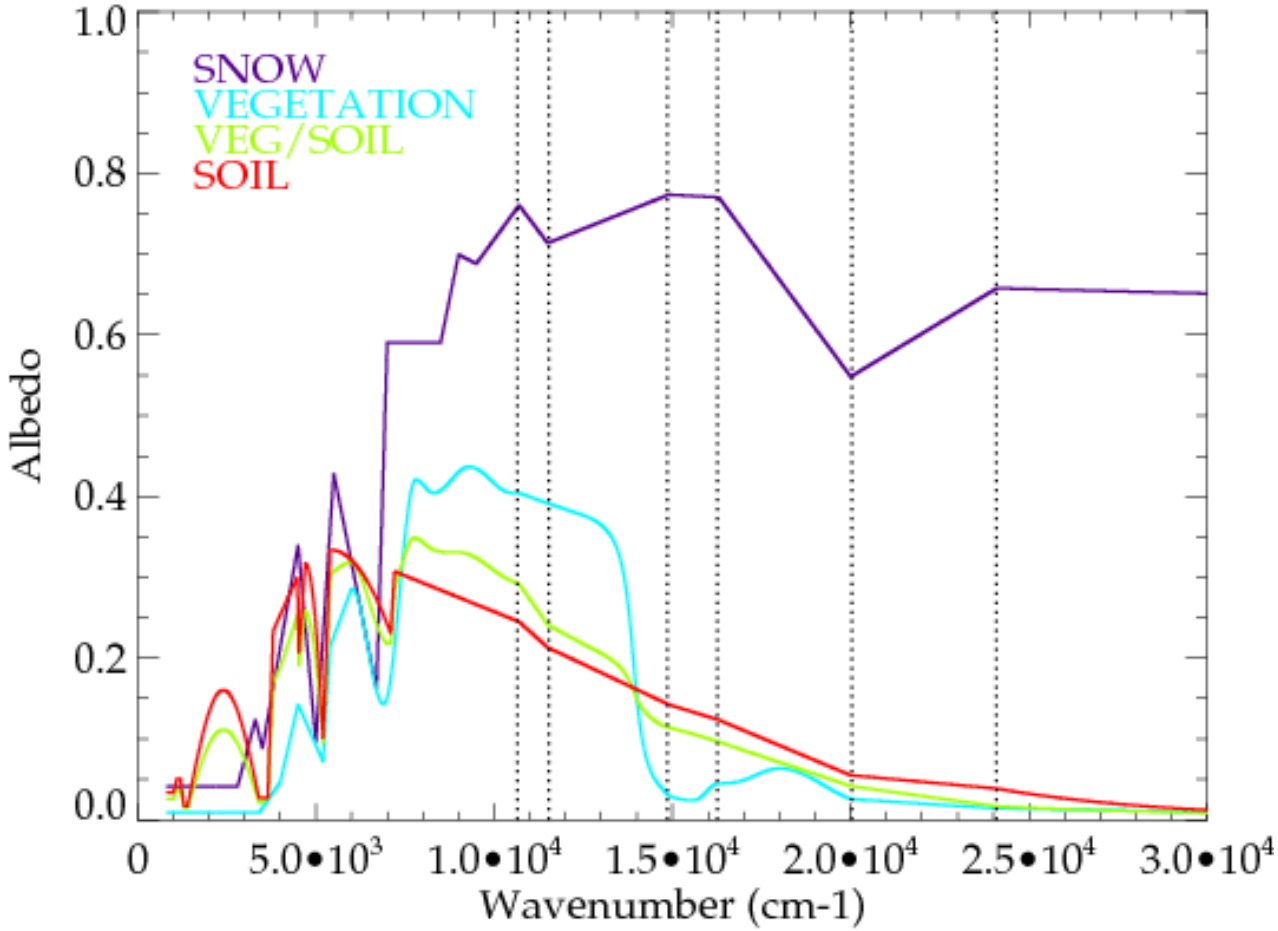
- Snow
- Soil
- Vegetation
- Soil/Vegetation Combination

2. Surface classification +☐ MFR channel albedos used to create full spectral albedo on 10 cm^{-1} grid

- Function constrained to measurements

3. Combine 10m and 25m tower albedos for RT calculation

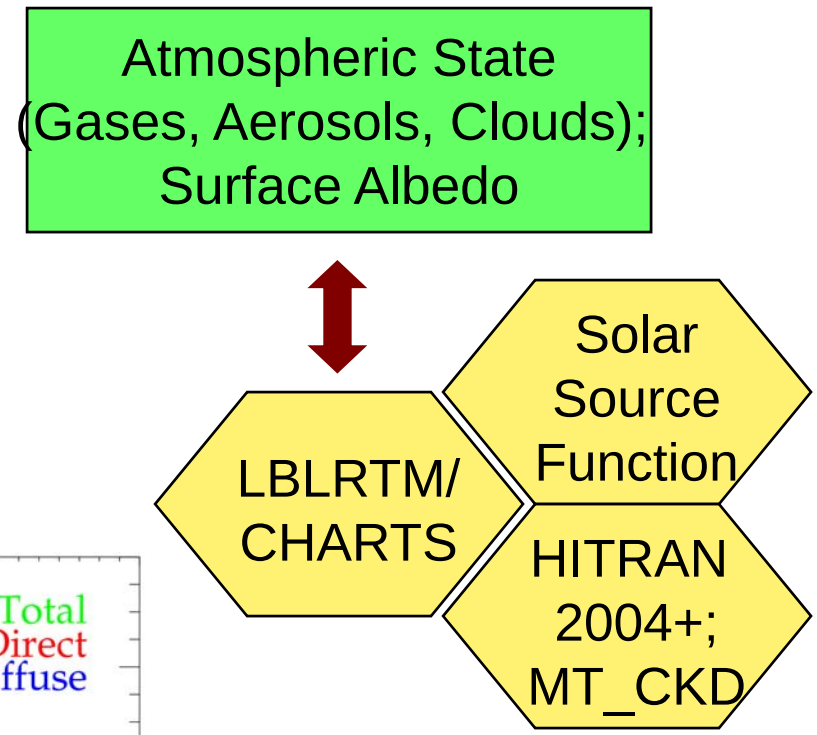
Spectral Surface Albedo Examples

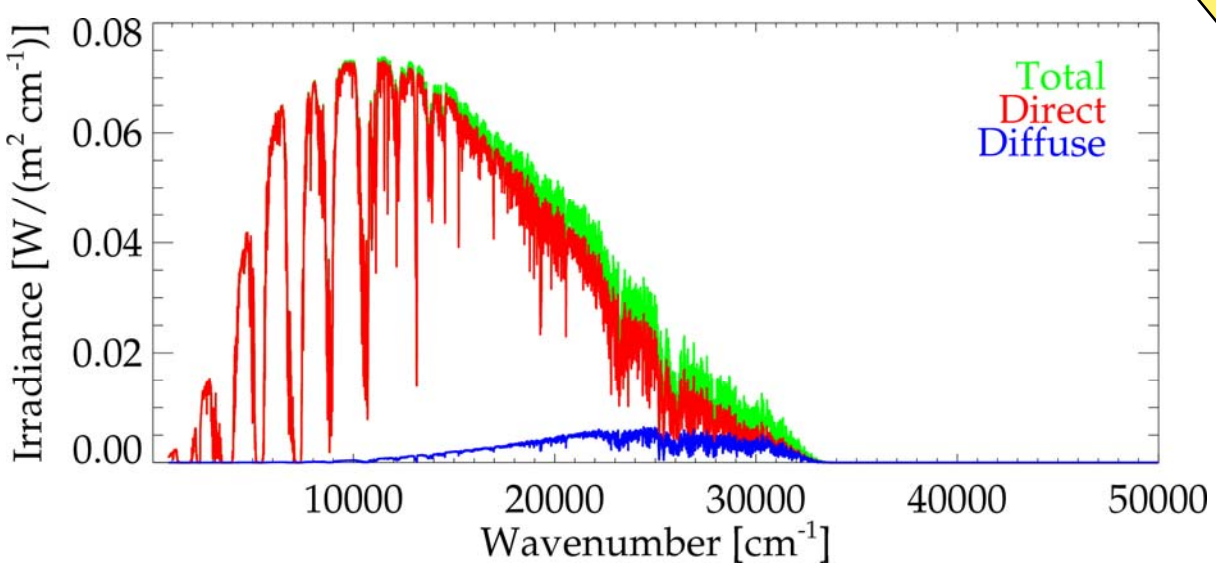


Shortwave QME Model Components

Multiple-Scattering Line-by-Line Radiative Transfer Model (LBLRTM/CHARTS)

- Validated extensively against high-resolution measurements
- Flexibility to include instrument functions



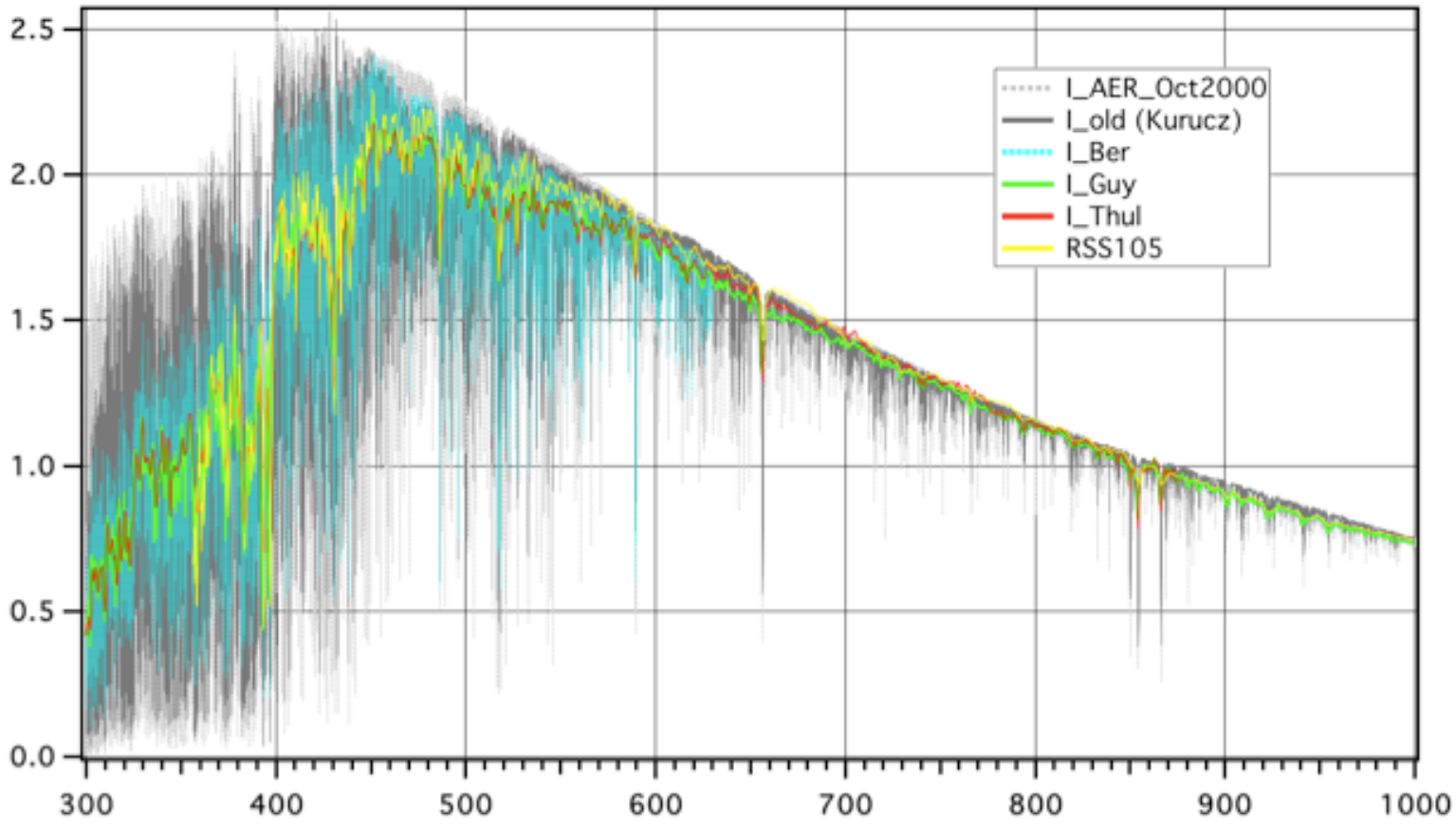


<u>MLS Profile</u>

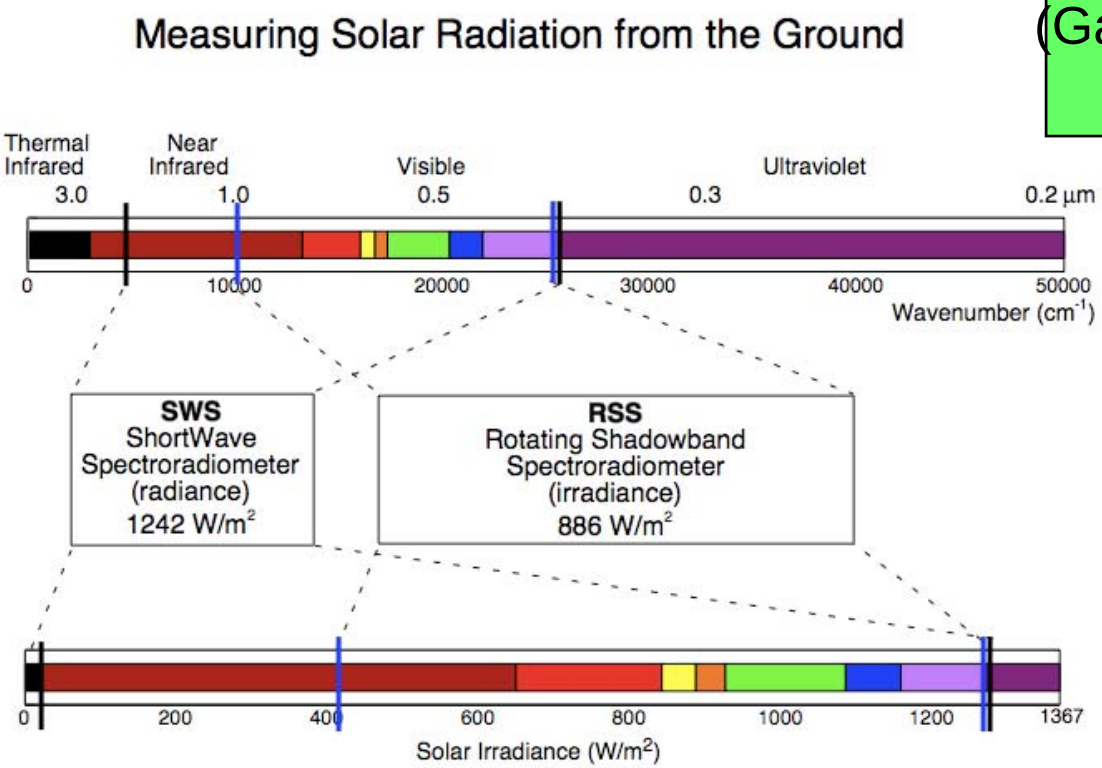
TOA: 1368.2

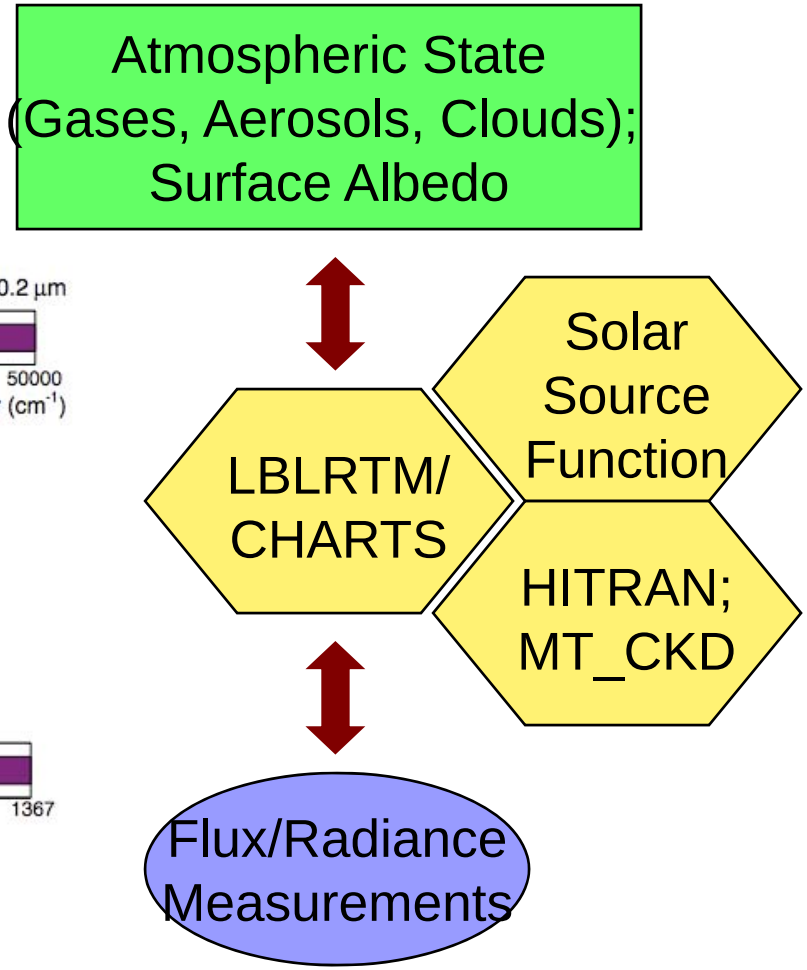
SFC: 1084.0

The Extraterrestrial Spectrum



☐Shortwave Spectral Measurements

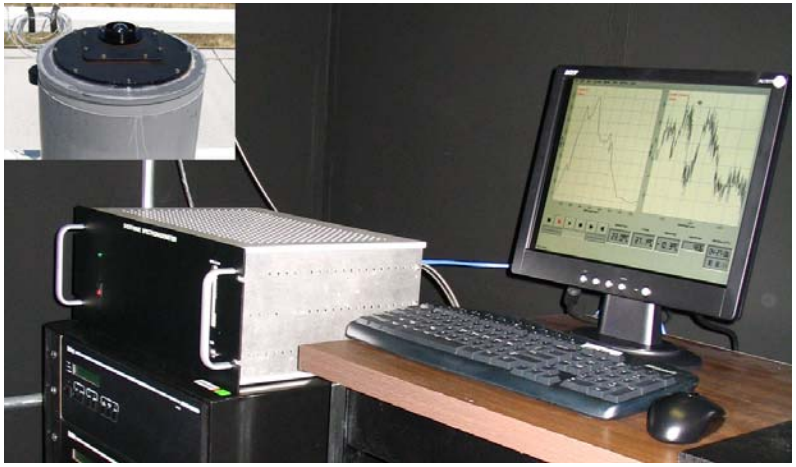




ShortWave Spectrometer at SGP

Overview

- Measures zenith solar spectral radiance
- Spectral Range 380-2200nm
- Spectral Resolution VIS:8nm NIR:12nm
- Sampling rate 1 Hz
- Field of view 1.4^{o}
- Calibrated weekly, with a 12in. integrating sphere

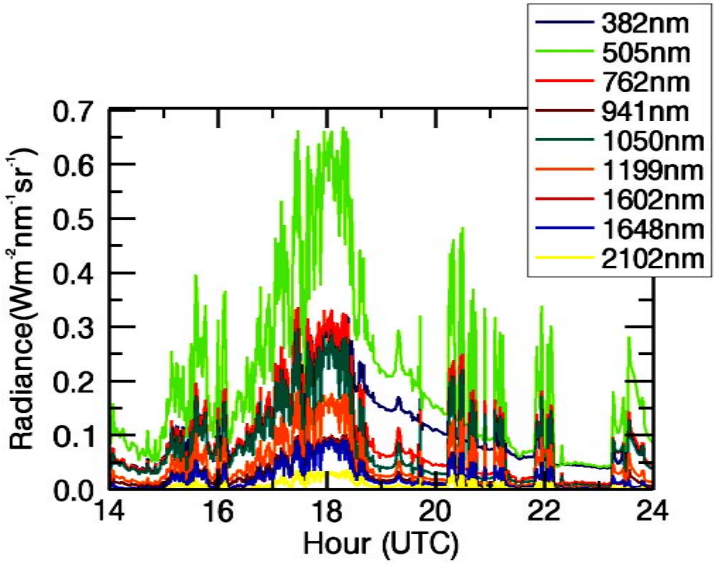


May 10, 2007 SWS Measurement

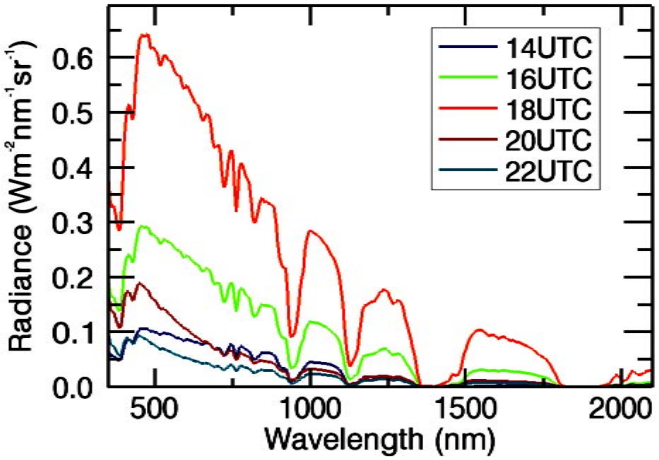
Mostly cloudy
(local AM)
16:00 UTC

Mostly cloud-free
(local PM)
20:00 UTC

Time series data

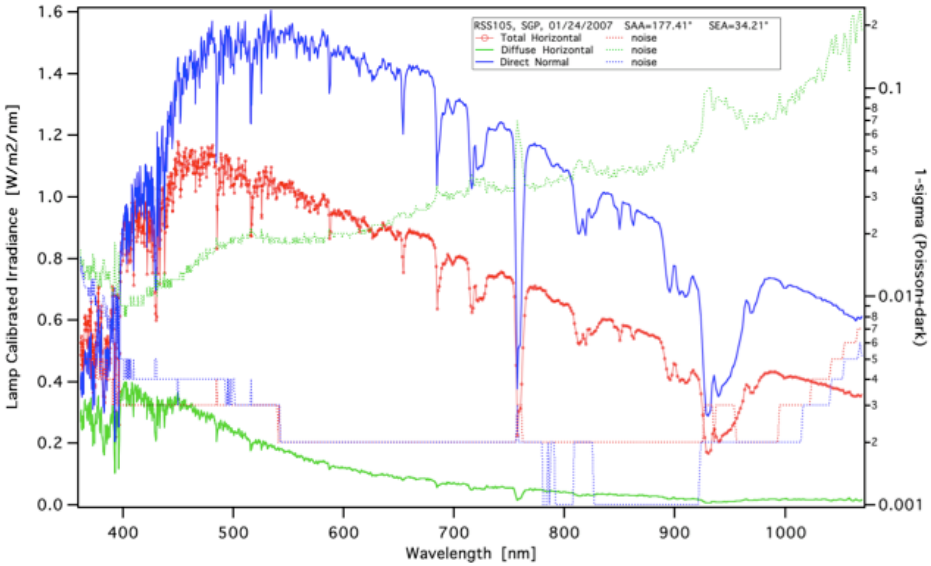


Spectral data



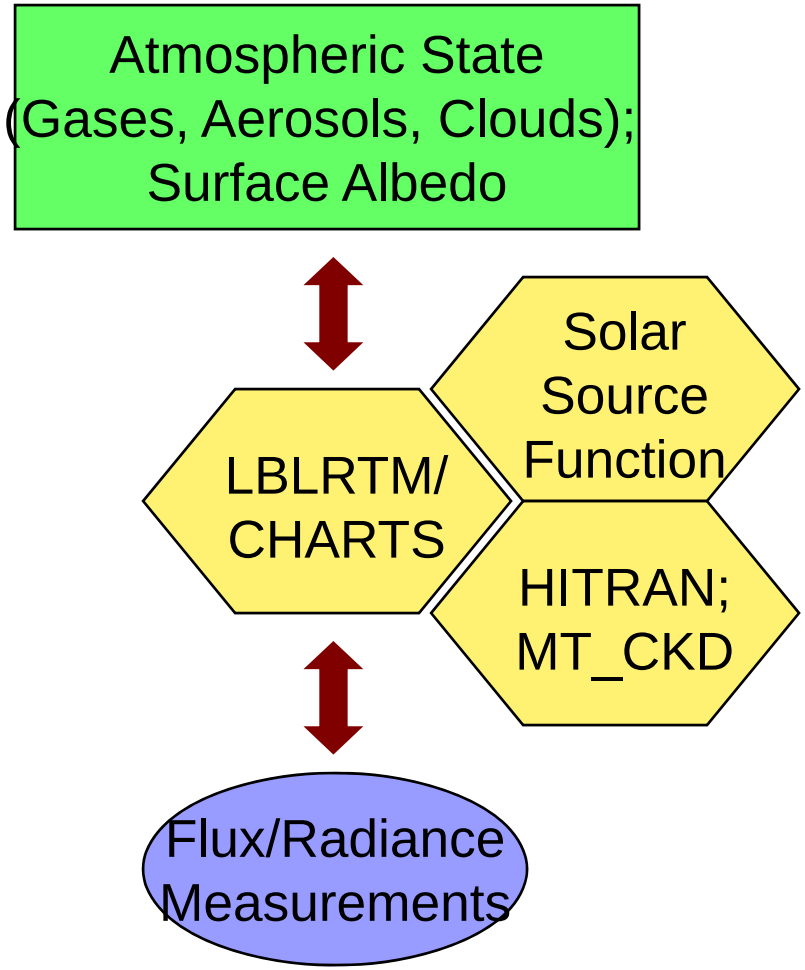
Rotating Shadowband Spectroradiometer

- 362-1076 nm (9400-27500 cm^{-1})
    - 1040 Nominal Pixels
- Sampling Rate (1/min)
- Total, Diffuse, Direct Normal Irradiance [W /(m^2 nm)]
    - Calibration ~2 weeks
- Normal irradiances used to perform Langley regression analyses ("V_o")
- Derive transmittance from irradiance and V_o

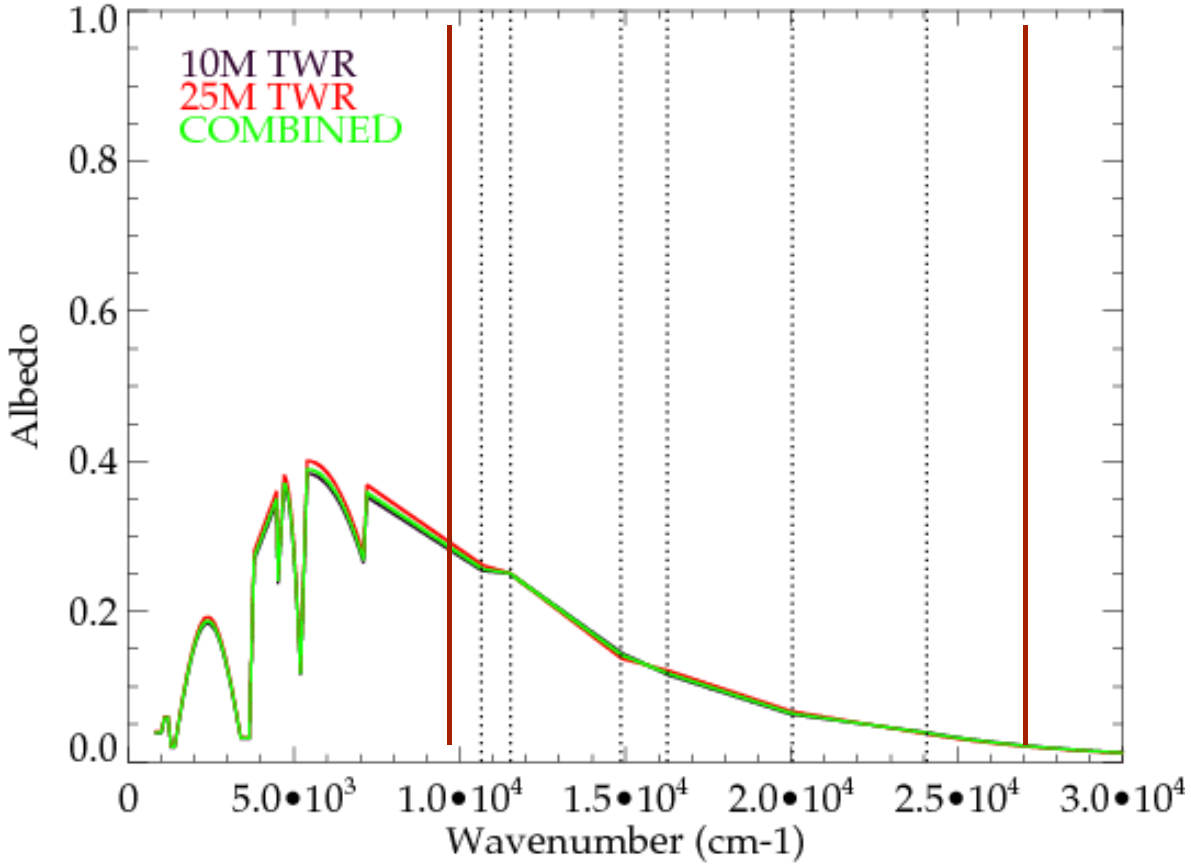


Shortwave RT Closure Example

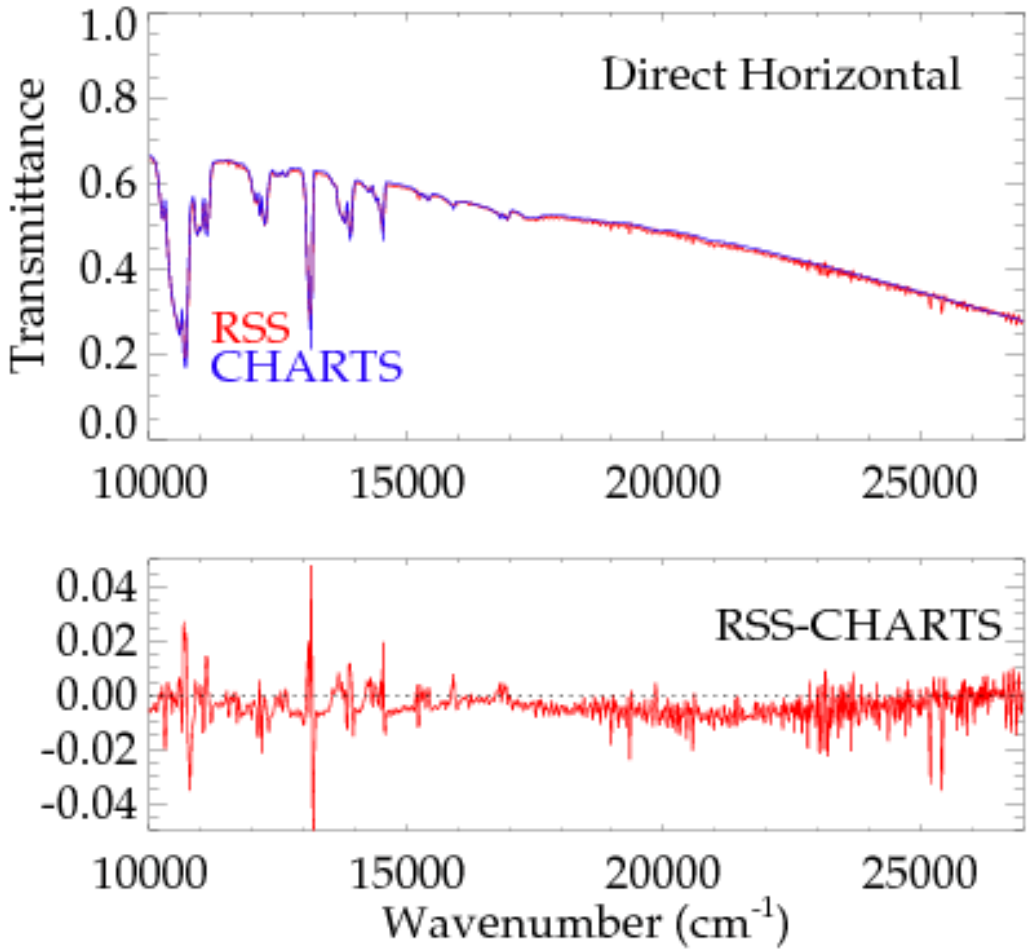
- Case from 2006 Diffuse IOP
  - October 13, 2006
- SZA = 45.0
- PWV = 1.57 cm, DU = 312
- AOD @ 500 nm = 0.115 (*NIMFR*)
- SSA = 0.96 (AOS)
- ASYM = 0.60 (AOS)



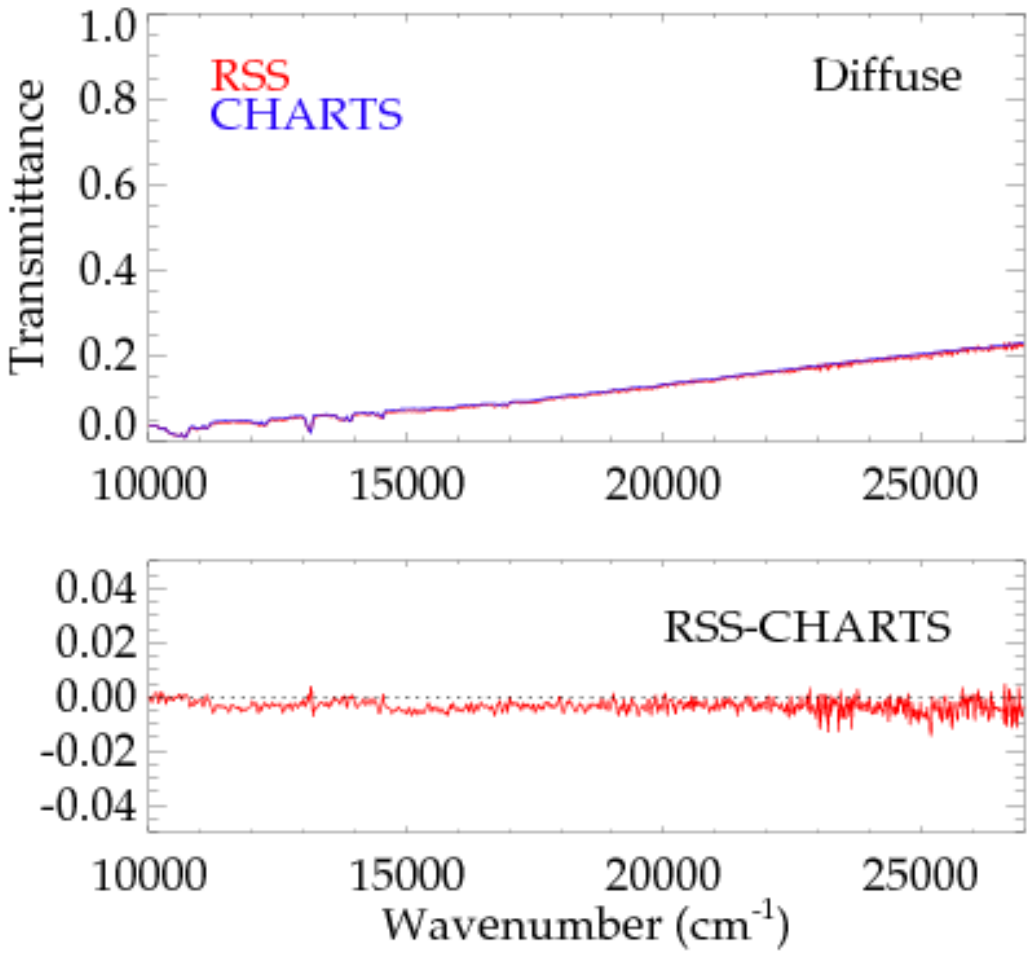
Surface Albedo - Soil



RSS/CHARTS Comparison



RSS/CHARTS Comparison



What Can We Accomplish?

- **Analyze measurements from 2 permanently deployed SW spectral radiometers at SGP site**
  - Simultaneous closure in spectral and broadband analysis

- **Analyze ARM RT-model input data streams**
  - Long-term analysis of aerosol properties (with recent upgrades to AOS, IAP) from different sources
  - How do we extrapolate AOD from measured wavelengths to UV and near-IR?
  - Spectral shortwave surface albedo VAP
  - Cloud properties (Microbase)

- **Analyze external RT-model input data streams**
  - Uncertainties in solar source function
  - Uncertainties or missing line parameters/continuum

- **Can we adapt SW QME to other ARM ACRFs?**