

# Atmospheric Correction using Tafkaa

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- The object is to convert radiance measured at the sensor (on an airborne platform or satellite) to reflectance
  - Remove solar and atmospheric effects
  - Compare to ground-based measurements, spectral libraries, etc.
- Steps include
  - Apparent (or planetary) reflectance, correct only for solar illumination, no atmospheric correction
    - Useful for diagnostics
  - Atmospheric correction
    - Methods depend on availability of spectral bands needed to determine aerosol type and/or optical depth; otherwise user selection
    - Availability of ancillary data
    - Without/with adjacency effect
    - Without/with glint correction

# General Methods of Atmospheric Correction



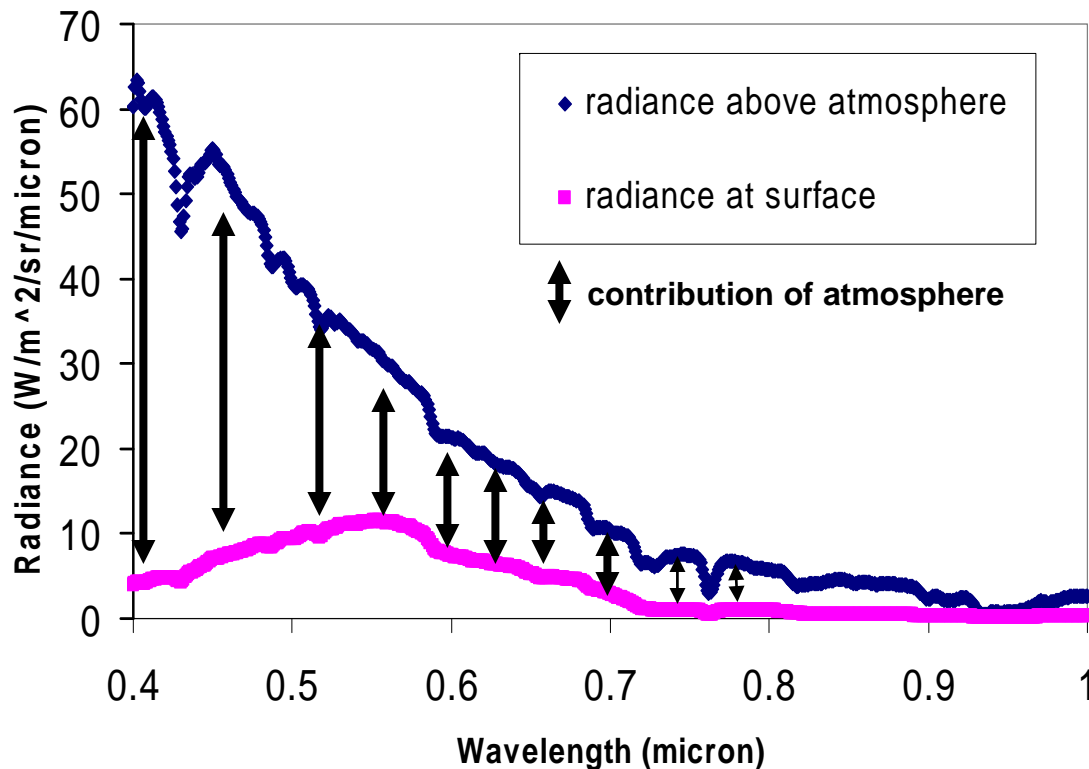
- Empirical “Data Driven”
  - Flat fielding: yes
  - Absolute calibration: no
  - Empirical
  - Field data: used to calibrate (vicarious calibration)
  - Field data: validation
  - Need large uniform areas?
  - Usually assumes same correction over scene
  - Examples: ELM “Empirical Line Method”; ZP Lee’s “Cloud and Shadow” method, QUAC, *etc.*
  - Usually cannot determine aerosol parameters
- Absolute/Model
  - Flat fielding: yes
  - Absolute Calibration: yes
  - RT Models
  - Field data: may help determine aerosol param.
  - Field data: validation
  - May allow different aerosol params. across scene
  - Examples: Tafkaa, FLAASH, ACORN, *etc.*
  - Allows determination of aerosol model, optical depth, wind speed

Field reflectance measurements need to have appropriate spatial scales (size) and location (geometric) accuracy in order to be able to compare to HSI measurements (pixels) for calibration and/or validation. (Other factors are temporal, BRDF, ...)

# Difficulty of Atmospheric Removal over dark surfaces (water)



Radiance calculated from measured coastal spectrum



- Atmosphere most of signal
- Atmospheric gasses well mixed, well understood
- Aerosols variable in space & time
- Accurate aerosol models and radiative transfer necessary

# Tafkaa

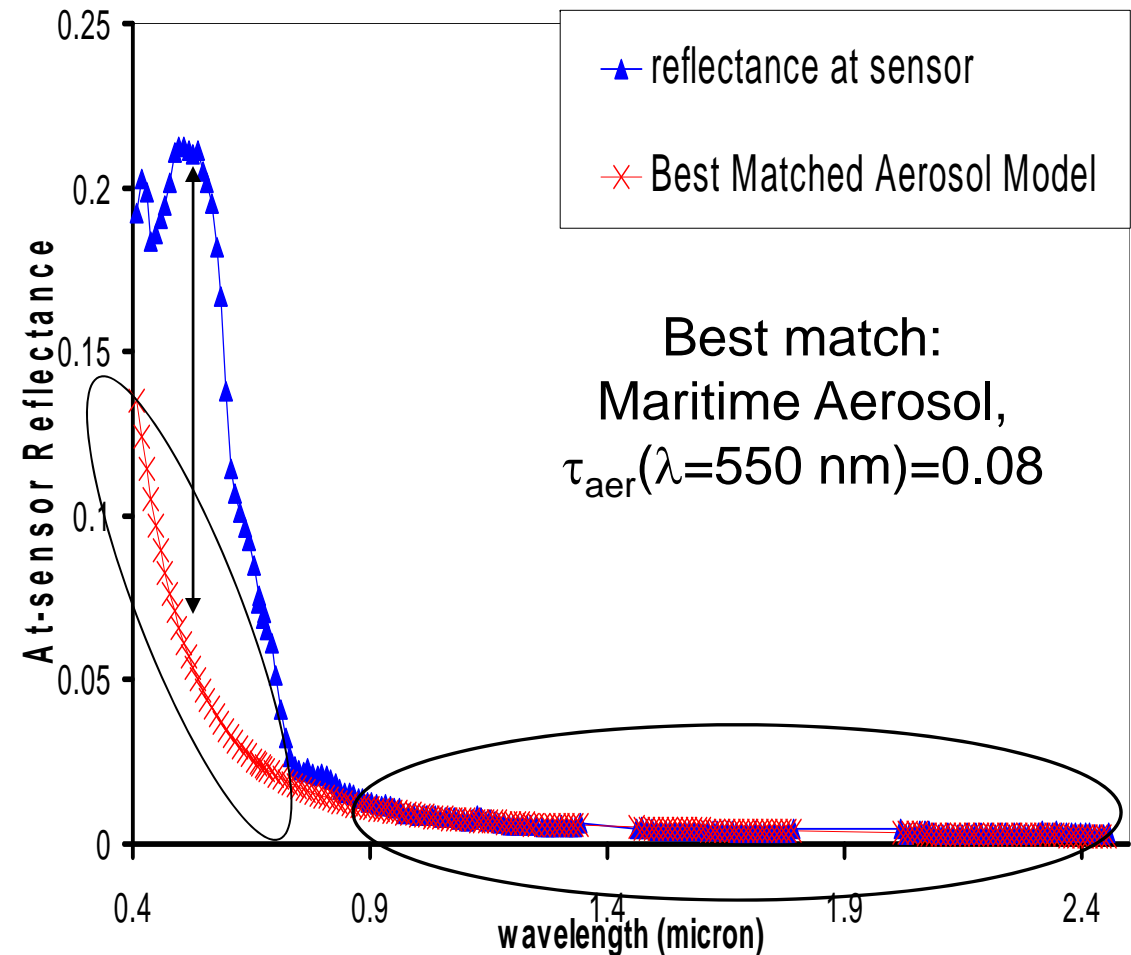
- Tafkaa-orig
  - Based on ATREM (Gao & Davis 1997 PROC SPIE)
  - Most changes include ability to parse image header file, improve speed, use larger set of aerosol models
- Tafkaa-tabular
  - Much of the code based on ATREM (Gao & Davis 1997, PROC SPIE)
  - Changes as listed above
  - Originally described in (Gao, Montes, Ahmad, & Davis, Applied Optics 2000), modifications in several SPIE proceedings
- Tafkaa-multispec
  - Gao, Montes, Li, Dierssen, & Davis, 2007, TGARS 45(6):1835-1843.
  - A multi-spectral version of Tafkaa-tabular



- Tafkaa-tabular
  - Scattering effects determined using pre-calculated aerosol parameter look-up table
  - “Dark pixel”: assumes that there is a set of wavelengths for which the radiance in an ocean/water pixel is entirely due to atmosphere and surface effects (no water leaving radiance at selected wavelengths)
  - Wavelengths that may be used are usually  $\lambda > 865$  nm; with caution (very particular conditions) may use 665 nm and/or 750 nm
  - User selects wavelengths, provides land mask, Tafkaa-tabular determines aerosol model and optical depths
  - Optionally, user may select model
- Tafkaa-orig
  - Scattering effects calculated utilizing 6S
  - User selects aerosol model and optical depth
  - May use models with AERONET derived optical parameters and size distribution
  - Applies model over entire scene

# “Tafkaa-tabular” methodology

- Find the best match to the NIR/SWIR portion of the HSI data
- Based on selected model, calculate aerosol properties in UV/VIS
- Water leaving reflectance proportional to difference





# Problems/Challenges

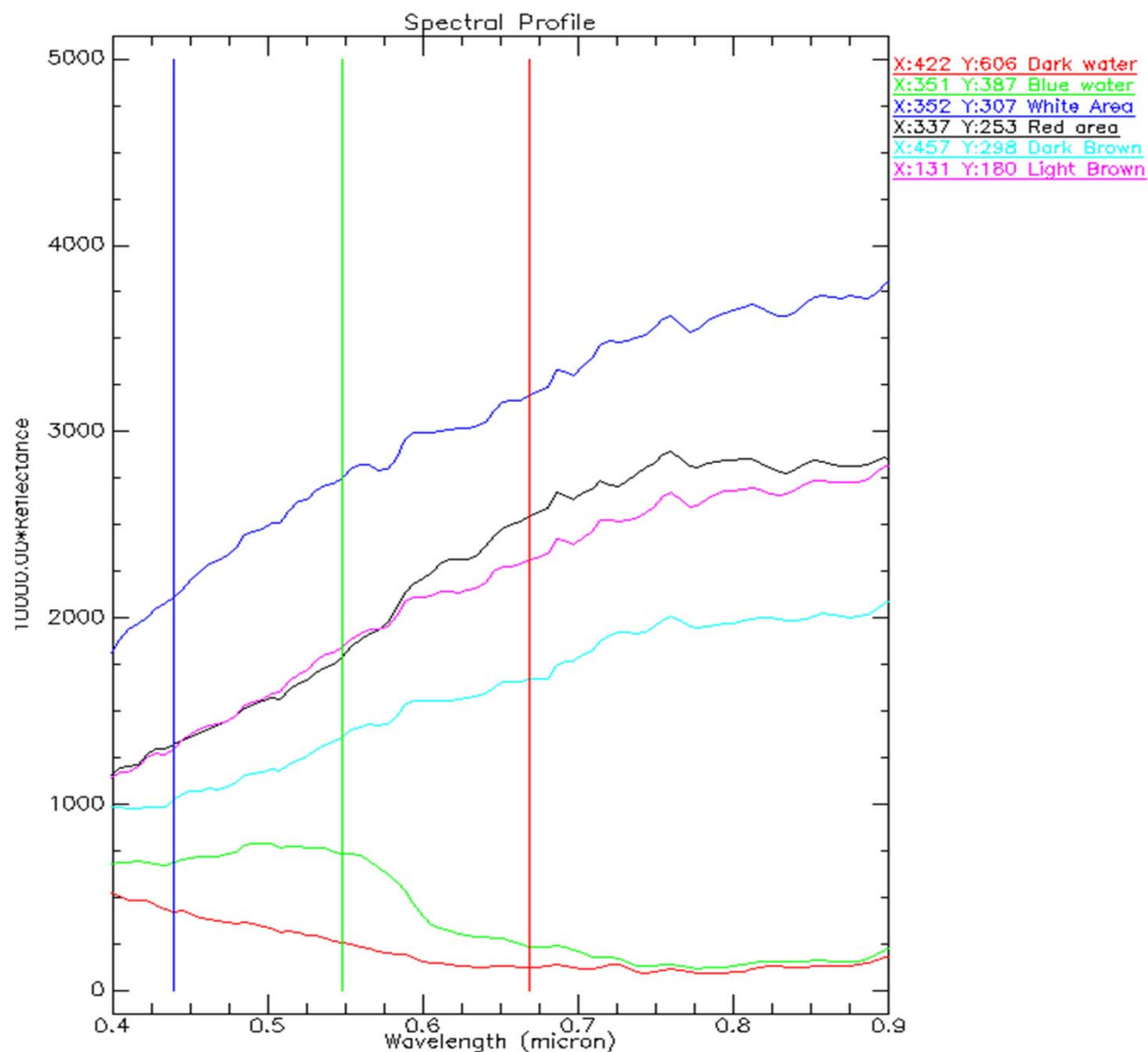
- Challenges to atmospheric correction
  - Contributions due to scattered light?
  - Second order contributions needs slight modification
  - Polarization sensitivity (different polarization environment in lab vs. light measured on orbit)
- Noisy signal at long wavelengths (sometimes)
- Standard “dark pixel” assumption to determine aerosol model and optical depth (i.e., like Tafkaa-tabular) does not work well
- Glint?
  - HICO data usually obtained (except for special requests) to stay away from solar glint pattern
  - Small field of view, no glint variability across scene

# HICO atmospheric correction: Tafkaa-orig



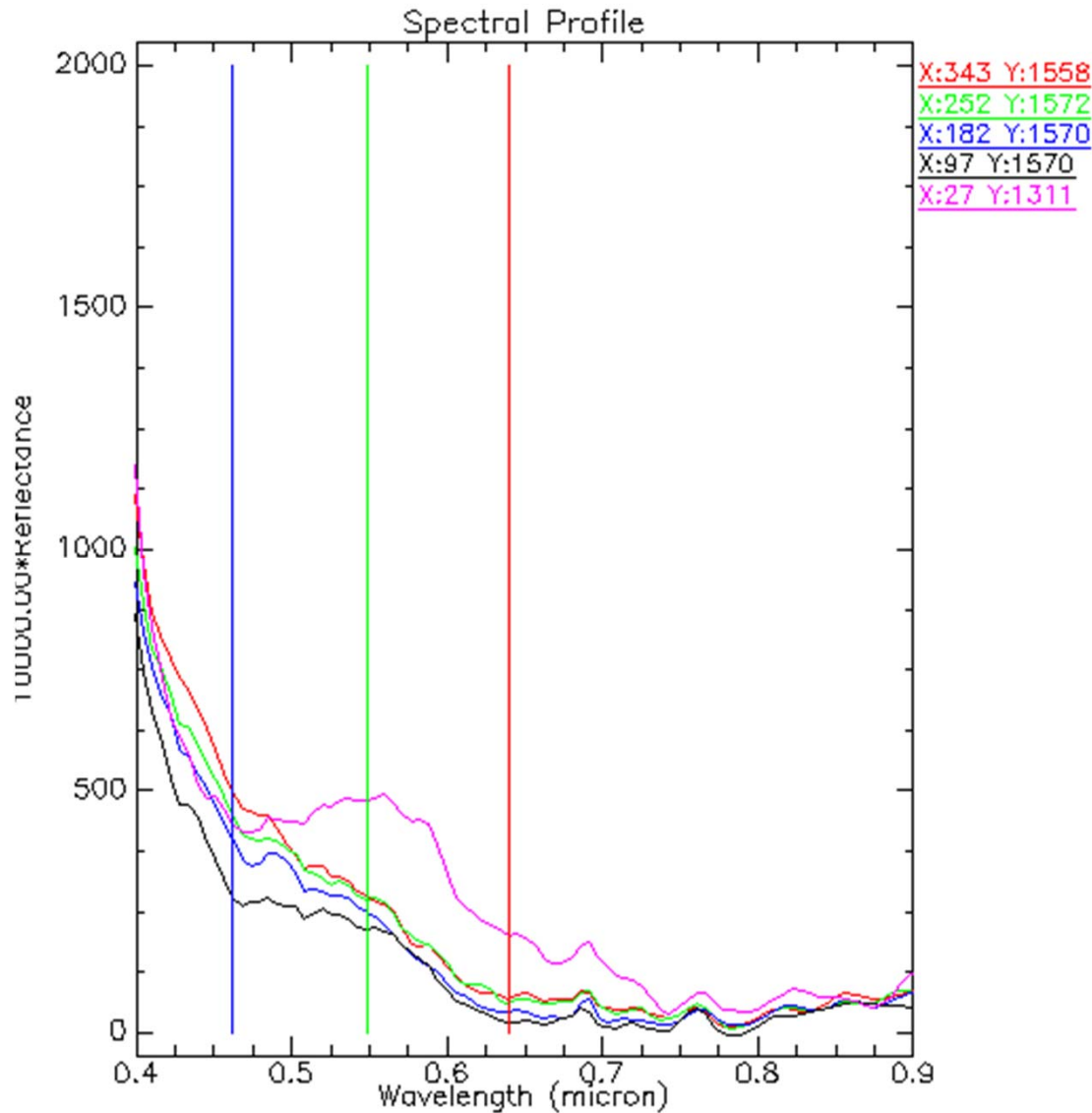
- Utilize Tafkaa-orig
- Need to specify the aerosol model and optical depth
  - Most good looking scenes can be processed with “no aerosol”, i.e., pure Rayleigh scattering or a very low optical depth (high visibility)
  - Special treatment needed for water vapor lines (Gao & Li): use the 720 nm water vapor feature when there is little signal in the 820 band. The 820 nm feature can suffer from noise yielding poor retrievals and non-sensical results
    - Reflectance switch can be set by user (we use 0.05 at 750 nm)
- Reads ancillary data from header file

# Examples: HICO Gulf of California Pure Rayleigh



# Example: Chesapeake Bay 2009 Oct 07

## Continental model, $\tau=0.15$



# Questions?

- HICO data has been corrected (as shown)
  - Difficult to use Tafkaa-tabular, mostly use methods from the family of Tafkaa-orig/ATREM
  - Spectra look reasonable, but more ground truth (of course) helps in comparison and determination of calibration/atmospheric correction
- As with many Ocean Color sensors in space (SeaWiFS, MODIS-Terra, MODIS-Aqua), reprocessing (with adjusted calibrations) is likely

# Examples: HICO Gulf of California Pure Rayleigh

