Atmospheric Visibility Monitoring (AVM) Program

Muthu Jeganathan and Loretta Tong

JPL Jet Propulsion Laboratory
Outline

- Program objective
- Project overview and description
- Atmospheric transmission data
- Future upgrades & enhancements
- Summary
AVM: Objectives

- Obtain Atmospheric Transmission Statistics Data to Support Optical Communications
  - Atmospheric loss in optical comm. channel
  - Joint PDFs for multiple site reception
  - Statistical modeling
  - Extrapolate PDFs for other sites
AVM: Description

- An autonomous system that measures ground intensity of stars through different filters
  - 10-inch (4-cm) diameter f/10 telescope
  - Six spectral filters (5 operational)
  - Cooled slow-scan CCD camera
  - Weather station to guard system
  - 386 powered PC controls all subsystems and collects data
AVM: Description

- One star observed every 15 minutes
  - Standard stars between 0 & 4 magnitude
  - About 50 stars in list covering entire sky
- Each star observed through 6 filters
  - Narrow band: 532 nm, 830 nm & 1.06 μm
  - Broad band: Astronomical V, R & I
- 24 observations (images) per hour
AVM: Description

- Collected data is automatically sent via modem to a dedicated computer at JPL on a daily basis.

- Image/data processing reveals star intensity values on ground.

- Attenuation determined by normalizing ground intensity values to above-the-atmosphere intensity values.

- Subsequent data analysis provides statistical information of interest.
Table Mountain Facility (TMF)
- Altitude: 2.3 km (7500 ft)

Mt. Lemmon near Tucson Arizona
- Altitude: 2.8 km (9150 ft)

Mesa near JPL

Goldstone (as of August 1996)
- Altitude: 1 km (3400 ft)
System Calibration

Calibration achieved from observation of stars through different air-mass

\[ I = I_0 \exp(-\sec \theta \int \alpha(z) \, dz) \]

\[ I = I_0 \eta^{-\sec \theta} \]

\[ y = \ln I \]
\[ y_0 = \ln I_0 \]
\[ x = \sec \theta \text{ (air mass)} \]

\[ y = y_0 - \eta x \]
Calibration

Observation of star #5933 through 860 nm filter from TMF

![Graph showing the relationship between log of collected signal (au) and Air Mass. The data points are scattered, and a linear trend is visible.](image)
Visibility Statistics

Site: Mt. Lemmon; Filter 860 nm
Period: 3rd and 4th quarter of 1995
Visibility Statistics

Site: Mt. Lemmon; = t er 532 m
Period: 3rd and 4th quarter of 1995

Prob(Attenuation < a0)

Zenith attenuation = a0 (dB)

- - 2720 observations 7/1/95 - 9/30/95
- - 4780 observations 10/1/95 - 12/31/95
Visibility Statistics

Site: TMF; Filter 860 nm
Period: 3rd and 4th quarter of 1995

![Graph showing probability of attenuation vs. zenith attenuation.](image)
Visibility Statistics

Site: TMF; Filter 532 nm
Period: 3rd and 4th quarter of 1995

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0

~3117 observations 7/1/95 - 9/30/95

4414 observations 10/1/95 - 12/31/95

Zenith attenuation - a0 (dB)
Work in Progress

- Maintain AVM data **using** MS Access
- Use queries to extract necessary data
- Analyze extracted data using Interactive Data Language (IDL)
- Obtain **joint** statistics from the three sites (diversified-site availability)
Planned Activities

- Capability to collect data in the IR
  - especially at the important laser wavelengths of 1.06 µm and 1.55 µm

- Compare and correlate AVM data to other atmospheric databases

- Statistical modeling and prediction
Conclusions

- Fully autonomous AVM systems collect atmospheric visibility data from three sites.

- Database of visibility data is being created to easily extract atmospheric transmission statistics information.