Instantaneous Field of View and Spatial Sampling of the Airborne Visible/Infrared Imaging
Spectrometer (AVIRIS)

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Abstract

The Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) measures the upwelling radiance
in 224 spectral bands. These data are acquired as images of approximately 11 by up to 100 km in
extent at nominally 20 by 20 meter spatial resolution. In this paper we describe the underlying
spatial sampling and spatial response characteristics of AVIRIS.

1.0 AVIRIS Spatial Resolution and Sampling Interval

The spatial field stop of the AVIRIS optical system is defined by one of four 200 μm circular
fibers for each of the spectrometers (Chrisp et al., 1987). The numerical aperture of the fibers
tapers off smoothly at the edges. In other words, it is not a sharp pillbox function, but a circularly
symmetric Gaussian-like function. By the time you add aberrations and scanner smear, a circularly
symmetric Gaussian is an excellent approximation. This is shown in Figure 1 for data measured in
the laboratory from a narrow beam (0.1 milliradians) of collimated light scanned across a portion
of the AVIRIS field of view (FOV). The slightly jagged nature of the data represents line-to-line
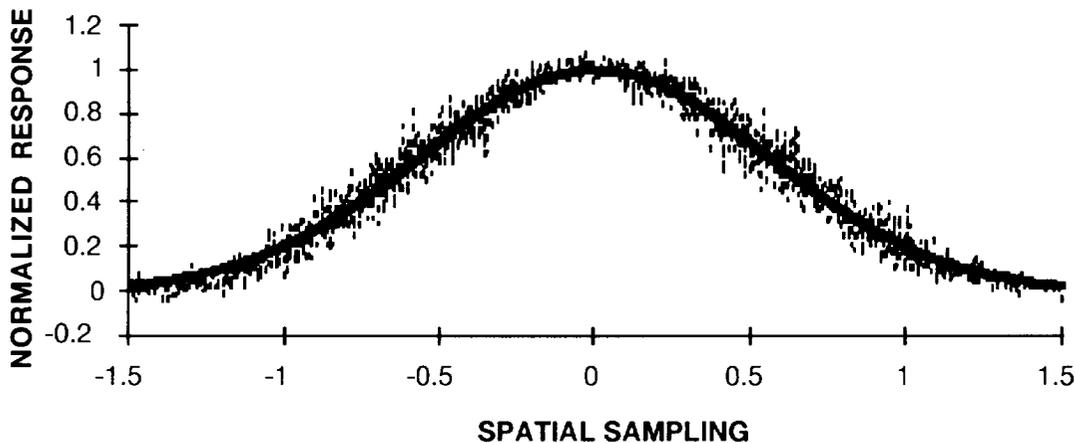scan jitter.

Figure 1.   AVIRIS spatial response function.

The AVIRIS spatial response function or instantaneous field of view (IFOV), including scan
smear, is a Gaussian function with a FWHM of 1.313 spatial samples and a line-to-line RMS jitter
of 0.077 spatial samples. Adjacent pixel samples within a given line are separated by 0.85
milliradians (Miller, 1987). Using this factor to convert to milliradians, the IFOV is 1.12

milliradians and the line-to-line jitter is 0.066 milliradians. Cross-track, these figures are independent of altitude. Ground spot sizes are, of course, the product of IFOV (in radians) and the aircraft platform altitude (AGL). AVIRIS operates from a NASA ER-2 at nominally 20 +−1 km altitude above sea level. A diagram of these relationships is shown in Figure 2, where s(n) refers to the nth cross-track sample.
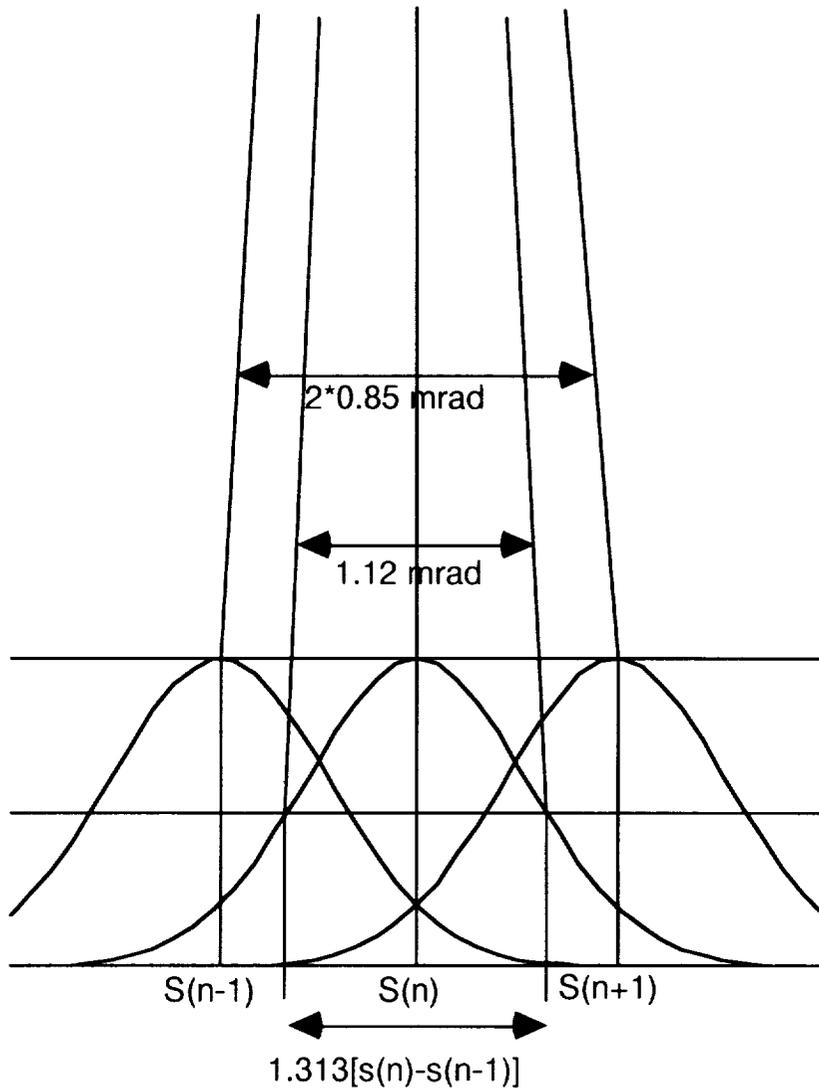

Figure 2.   Cross-track sampling

The detector read-out delay will cause a (n-1)/66 sample shift, where n is the read-out position of the spectral channel with respect to each of the four spectrometers. Table 1 can be used to determine the appropriate value for the index n for a given spectral channel. This read-out delay is compensated in the radiometrically calibrated data distributed to investigators (Green et al., 1991).

Table 1.   The index n for various spectral channels

Spectrometer	Channel	n
A	001	1
	032	32
B	033	1
	096	64
C	097	1
	160	64
D	161	1
	224	64

The down-track sampling distance is due entirely to the motion of the aircraft from line to line. This is determined by the product of the aircraft velocity and the line repeat period of $1/12$ of a second. For the ER-2, this distance is nominally 17 meters. Figure 3 shows the sampling where L(k) refers to the kth down-track line. In the down-track case, the GIFOV spot size can become less than the sampling interval for mountains above 4.8 km ASL when the aircraft is at 20 km ASL.
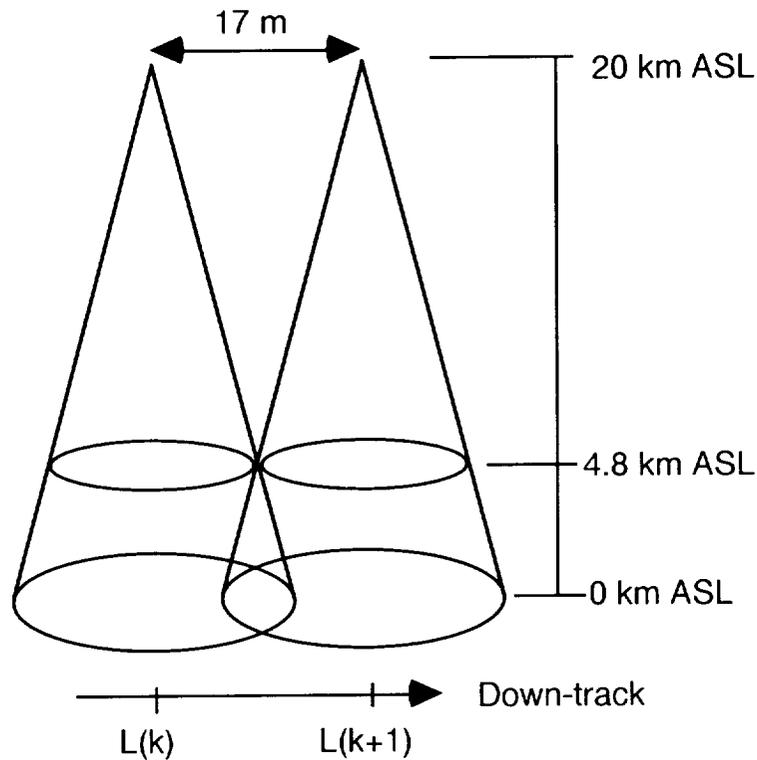

Figure 3.   Down-track sampling.

2.0 Summary

The spatial sampling and spatial response function of the AVIRIS system in the cross and down track directions have been described. These characteristics should be taken into account when quantitatively measuring expressed spectral abundance of discrete objects of less than 20 by 20 m size.

3.0 Acknowledgements

4.0 References

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