

## **Specification of UV, Visible, and Infrared Emission Spectra of Sprites and Blue Jets**

**Timothy F. Bell**

**STAR Laboratory, 350 Serra Mall  
Stanford University  
Stanford CA 94305-9515**

**18 Jan 2002**

**Final Report**

**APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.**

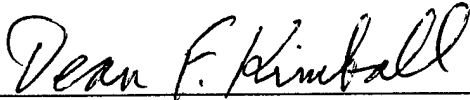


**AIR FORCE RESEARCH LABORATORY  
Space Vehicles Directorate  
29 Randolph Rd  
AIR FORCE MATERIEL COMMAND  
Hanscom AFB, MA 01731-3010**

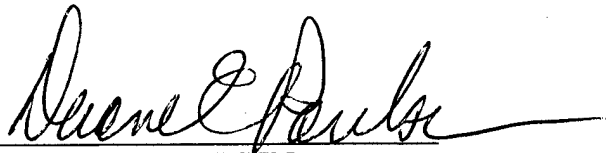
---

**20020510 202**

This technical report has been reviewed and is approved for publication.



DEAN F. KIMBALL  
Contract Manager



DUANE E. PAULSEN  
Deputy Chief, AFRL/VSSS

This report has been reviewed by the ESC Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS).

Qualified requestors may obtain additional copies from the Defense Technical Information Center (DTIC). All others should apply to the National Technical Information Service (NTIS).

If your address has changed, if you wish to be removed from the mailing list, or if the addressee is no longer employed by your organization, please notify PL/IM, 29 Randolph Road, Hanscom AFB MA 01731-3010. This will assist us in maintaining a current mailing list.

Do not return copies of this report unless contractual obligations or notices on a specific document require that it be returned.

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 18 January 2002	3. REPORT TYPE AND DATES COVERED FINAL (May 96-May 98)	
4. TITLE AND SUBTITLE Specification of UC, Visible, and Infrared Emission Spectra of Sprites and Blue Jets			5. FUNDING NUMBERS PE: 61102F PR: 2310 TA: GD WU: AQ  Contract: F19628-96-C-0075	
6. AUTHOR(S) Timothy F. Bell				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) STAR Laboratory Stanford University Stanford, CA 94305-9515			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory 29 Randolph Road Hanscom AFB MA 01731-3010  Contract Manager: Dean Kimball/VSSS			10. SPONSORING/MONITORING AGENCY REPORT NUMBER  AFRL-VS-TR-2002-1548	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION AVAILABILITY STATEMENT Approved for Public Release; Distribution Unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) During the period of performance Stanford University constructed a VLF/ELF receiver to measure the VLF/ELF electromagnetic and quasi-electrostatic fields produced by lightning during Sprite and Blue Jet events, and deployed this instrument in the field to make such measurements. The data acquired in the field was used to characterized the electromagnetic and quasi-electrostatic fields produced by lightning during Sprite and Blue Jet events.				
14. SUBJECT TERMS Sprite Blue Jet VLF/ELF  quasi-electrostatic			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT  UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE  UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT  UNCLASSIFIED	20. LIMITATION OF ABSTRACT  SAR	

## SUMMARY

During the period of performance Stanford University constructed a VLF/ELF receiver to measure the VLF/ELF electromagnetic and quasi-electrostatic fields produced by lightning during Sprite and Blue Jet events, and deployed this instrument in the field to make such measurements. The data acquired in the field was used to characterize the electromagnetic and quasi-electrostatic fields produced by lightning during Sprite and Blue jet events.

## FINAL TECHNICAL REPORT

### 1. Contract Purpose

The Contract goal is to measure and interpret ELF/VLF waveforms of causative lightning discharges in order to determine the electromagnetic pulse and quasi-static electric fields which constitute critical inputs to theoretical models of the UV, visible, and infrared emission spectra of Sprites and Blue jets.

### 2. Period of Performance

The period of performance under this contract extended from May 22, 1996, through May 21, 1998.

### 3. Work Provided

During the period of performance Stanford University constructed a VLF/ELF receiver to measure the electromagnetic and quasi-electrostatic fields produced by lightning during Sprite and Blue Jet events, and deployed this instrument in the field to make such measurements. The VLF/ELF receiver was constructed, tested and validated during the first year. Field data were acquired during the second year. Analysis and interpretation of the field data was also carried out in the second year.

### 6. Results

Results of the data analysis was reported in a paper delivered at the December American Geophysical Union in 1998 [Reising *et al.*, 1998] and in a paper published in the journal *Geophysical Research Letters* [Reising *et al.*, 1999]. The complete citations for these papers is given in the Reference section.

## 7. References

1) Reising, S. C., U. S. Inan, T. F. Bell, Y. Takahashi, and M. Sera, Further evidence of electrical current in Sprites using measurements of ELF radio atmospheric with simultaneous high time-resolution multi-anode array photometer observations. *EOS*, 79, F176, 1998.

2) Reising, S. C., U. S. Inan, and T. F. Bell, ELF spheric energy as a proxy indicator for sprite occurrence, *Geophysical Research Letters*, 26, 987, 1999.

## 7. List of personnel contributing to report

The list of Stanford University scientists and engineers who contributed to the work reported in this document is as follows:

Tim Bell

Steve Reising

Umran Inan