Real Time Detection of Sodium in Size-Segregated Marine Aerosols

Eric S. Saltzman
Rosenstiel School of Marine and Atmospheric Science
4600 Rickenbacker Cswy.
Miami, FL 33149
phone (703) 306-1522 fax (703) 306-0377 email esaltzman@rsmas.miami.edu

Anthony J. Hynes
Rosenstiel School of Marine and Atmospheric Science
4600 Rickenbacker Cswy.
Miami, FL 33149
phone (305) 361-4173 fax (305) 361-4689 email ahynes@rsmas.miami.edu

Grant Number: N0001499-1-0031
http://www.rsmas.miami.edu

LONG-TERM GOALS

Our long range goals for this project is to improve our understanding of: 1) the chemistry and physical properties of seasalt aerosols, 2) the relationship between seasalt aerosol properties and the turbulence that generates them, 3) the effect of seasalt aerosols on the propagation of light through the marine atmosphere, and 4) to develop improved relationships between seasalt aerosol production and remotely observable parameters.

OBJECTIVES

This project is an effort to develop a new capability for making measurements of the sodium content of individual seasalt aerosols. The project involves proof-of-principle demonstration and laboratory testing of an LIF (laser-induced-fluoresence)-based Aerosol Sodium Detector (ASD). Ultimately, the instrument would be utilized in both field and laboratory studies.

APPROACH

Our approach is to introduce individual aerosols into a hydrogen/air flame and to utilize an excimer laser to excite the D-line emission of atomic sodium. Particles are size-segregated prior to analysis using a differential mobility analyzer. This phase of the project was directed towards characterizing the detection limits of the technique and to investigate the response to sodium as a function of varying aerosol size and chemical composition. The goal is to develop a detector which is sensitive to sub-micron particles, responds linearly to aerosol sodium content, and is unaffected by the presence of other chemicals in the particle, such as sulfates, nitrates, ammonia, organic carbon, etc..

In order to probe a single particle using an excimer laser, a trigger signal is needed. This signal is provided either by optical scattering before the particle enters the flame, or by detecting the thermal D-line emission from sodium in the particle after it enters the flame. The triggering requirement limits the size of particles detected to diameters greater than about 0.25 um. Eventually, the excimer laser will be replaced by a high frequency, solid state laser, which would not require triggering and, hence, will allow us to exploit the sensitivity of LIF in the detection of much smaller particles.

Report Documentation Page					*Form Approved* *OMB No. 0704-0188*
Public reporting burden for the 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 Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number					
1. REPORT DATE **30 SEP 1999**		2. REPORT TYPE			3. DATES COVERED **00-00-1999 to 00-00-1999**
4. TITLE AND SUBTITLE **Real Time Detection of Sodium in Size-Segregated Marine Aerosols**					5a. CONTRACT NUMBER
					5b. GRANT NUMBER
					5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)					5d. PROJECT NUMBER
					5e. TASK NUMBER
					5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **University of Miami,Rosenstiel School of Marine and Atmospheric Science,4600 Rickenbacker Causeway,Miami,FL,33149**					8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)					10. SPONSOR/MONITOR’S ACRONYM(S)
					11. SPONSOR/MONITOR’S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a REPORT **unclassified**	b ABSTRACT **unclassified**	c THIS PAGE **unclassified**	**Same as Report (SAR)**	**3**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

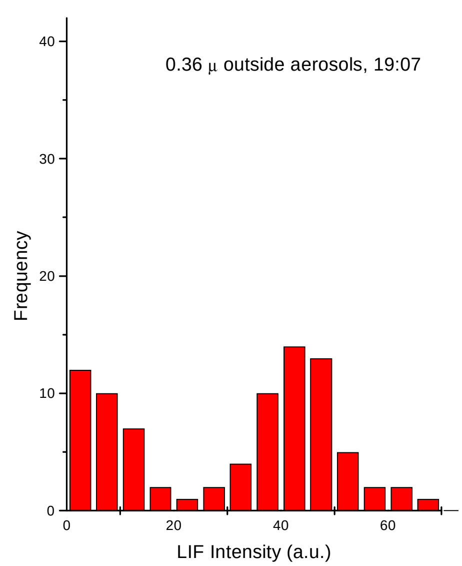
WORK COMPLETED

We have carried out a variety of experiments designed to optimize the transmission of particles to the flame and the detection of sodium in the flame. Most of these experiments were done on synthetic sodium chloride particles generated using a vibrating orifice aerosol generator, which can produce nearly monodisperse size distributions. The delivery of synthetic and ambient aerosols to the flame was accomplished using an automated valving system which draws air through a tube, then pushes the contents of the tube into the flame with particle-free air. This configuration is being used for detection limit and response studies. The system has been coupled to a differential mobility analyzer to used to detect sodium in sized aerosols in marine air sampled from the RSMAS laboratory roof.

RESULTS

We have devoted considerable effort to understanding the cause of variability in the signals obtained from monodisperse aerosols. This variability is believed to be caused by variations in the dilution and trajectory of individual particles as they transit through the flame. One interesting result is that the LIF signal is not linear for larger aerosols (>0.8 micron diameter). This response may indicate self absorption, suggesting that the aerosol is confined to a relatively small region of the flame. Extrapolation of our experimental results suggest that the LIF technique is capable of detecting a sodium chloride aerosol of 0.1 um diameter with a signal to noise of 10:1. Thus far our results indicate that LIF response is insensitive to aerosol constituents other than sodium, which is ideal for this purpose.

Below is an example of some recent LIF data from ambient air sampled from the roof of our laboratory at RSMAS. The aerosols were size-segregated using a differential mobility analyzer and detected using LIF, with triggering provided from the sodium emission signal. The plot is a frequency distribution of the LIF signal from approximately 100 aerosols of 0.38 um diameter. The smaller signal mode represents the LIF signal blank (largely electronic noise), which has not been subtracted from the data. The higher mode represents the distribution of sodium signals detected from aerosols. These observations demonstrate that seasalt aerosols contribute to the submicron fraction of the marine aerosol.



RELATED PROJECTS

This project is closely related to a DURIP award for the purchase of aerosol sizing and high frequency laser instrumetation. This instrumentation will allow us to overcome the triggering requirement of the excimer laser and allow detection of smaller aerosols. It will ultimately be used to construct a field instrument based on the research carried out in this project.