REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
30/04/2009	Quarterly Report	2/1/02-4/30/09

4. TITLE AND SUBTITLE
Passive Imaging System for Measuring Atmospheric Scattering and CFLOS: Quarterly Report April 2009

5a. CONTRACT NUMBER

5b. GRANT NUMBER
N00014-07-1-1060

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Shields, J.E.

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Marine Physical Laboratory
Scripps Institution of Oceanography
291 Rosecrans Street
San Diego, CA 92106

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
One Liberty Center
875 N. Randolph St
Arlington, VA 22203-1995
Lewis DeSandre, ONR 351

10. SPONSOR/MONITOR'S ACRONYM(S)
ONR

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Statement A: Approved for public release; distribution is unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This quarterly report describes the work done for the "Passive Imaging System for Measuring Atmospheric Scattering and CFLOS", under ONR Contract N00014-07-1-1060, between 1 February 2009 and 30 April 2009.

15. SUBJECT TERMS
Clouds, passive imaging, atmospheric scattering, cloud-free line of sight, CFLOS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Anne J. Footer
unclassified	unclassified	unclassified	None	4	19b. TELEPHONE NUMBER *(Include area code)* 858-534-1802

Reset

University of California, San Diego
JTO/ONR HEL_MRI Quarterly Report April 2009

Project Title: Passive Imaging System for Measuring Atmospheric Scattering and CFLOS
Grant Number: N00014-07-1-1060

POC: Janet Shields jshields@ucsd.edu (858) 534-1769

1. **Activities for Current Quarter, February 09 – April 09**

Task 1: (Experimental test site)

As mentioned in the last report, we had a problem with the MSI camera, which was essentially operating as a 12 bit, rather than 16 bit camera. The camera manufacturer had been unable to understand and correct the problem, however our technician was able to isolate the problem (3 bad chips), and repair it. Following the repair of the MSI, we installed new filters and cleaned the optics, adjusted the filters to avoid an interference pattern that had cropped up, tested a minor noise issue, and reinstalled the MSI at the site. We also performed the linearity and shutter calibrations, and the uniformity calibration. In the environmental housing, we repaired the pump, and added a relay to protect the camera should the pump die when no one is at the site, although the relay is still under evaluation.

We completed stabilization of the transmissometers in their new location in a new trailer provided by our site hosts, and did some stray light tests

We made significant progress in getting an IR system ready for the site, as discussed under Task 3.

Task 2: (Weather at test site)

The ground weather station installed by the NPS team in Feb continues to operate well.

The buoy has been undergoing refurbishment, following its retrieval in January. A new location for the buoy was chosen and approved, and a new mooring for this location has been designed and finalized. Additional work has included setting up a new data-logging computer to receive the data by telemetry from the buoy, calibrating sensors, and replacing corroded components. The mooring is under construction, and redeployment is planned for June.

Task 3: (Purchase IR system components)

The AlphaNIR camera we had ordered to use in the Short Wave IR System arrived in-house. We have built the lower environmental housing for it, and the upper housing is in the shop, where it is about half completed. We assembled the camera with its rotary table and a computer, and acquired software libraries, and wrote programs to enable us to control the camera and acquire test data. We are able to control the camera and the rotary table. The program for automated data acquisition is partly written, and will undergo test soon. We acquired test data to evaluate lens, exposure, and gain choices, and to evaluate the scene. The images look good.

Task 4: (Data analysis)

Using the Sep 08 field data test set that we analyzed earlier, we extracted information from the weather station including air and sea temperature, relative humidity, and wind speed.

We analyzed the impact of refraction, which appears to be quite minimal, and analyzed the impact of the relative humidity on the transmissometer measurements. Further analysis of the test set showed that when the MSI results were different than the transmissometer, it was because the conditions on the path over the water used by the MSI were different than the conditions on the path along the coast used by the transmissometer. This work was documented in a series of technical memoranda, which are available on request.

Task 5: (Visibility algorithm)

We updated the algorithm to minimize the impact of white caps and slicks (e.g. from the kelp beds). This had little impact. We evaluated horizon position in the imagery, and determined that it varies slightly due to the slight tilt (0.1°) of the rotary table. We plan to update the algorithm to enable us to correct for this. We further evaluated images as a function of wind speed, and found that there are cases where the sea is calm and the surface quite reflective. This means that although a fixed input value of inherent contrast worked surprisingly well, we will need to evaluate inherent contrast as a function of wind speed and sun angle, because there are occasional cases where a fixed inherent contrast will not work well.

Task 6: (Slant-Path Transmittance)

We ran MODTRAN model calculations to evaluate the slant path transmittance, and how it relates to the horizontal path transmittance under varying conditions. To a first approximation, the slant path values are easy to derive using standard lapse rates for extinction. To improve these results, we would need to look at horizon radiance profiles. We ran MODTRAN model calculations of radiances near the horizon, but the results were counter-intuitive. We are working with the MODTRAN experts to evaluate this. A lidar would be helpful to evaluate our slant path results, and this is not funded at the present time. We began evaluating if there are options for obtaining one on loan.

Task 7: (Evaluate Visible vs. SWIR Advantages)

To begin evaluating whether it is better to measure the IR extinction directly, or measure it in the visible where the sensors are better but we have to extrapolate to the SWIR (Short Wave IR), we ran MODTRAN calculations relating the visible and SWIR extinction. Although we recognize that a model is only our best representation for the more complex real world, we were pleased that the model results show that an extrapolation from the visible should do well, especially if the visible system has two wavelengths.

Task 8: (Robust System – mostly year 3)

We documented a number of system mockups for potential robust systems. These versions use prisms to enable acquiring the full horizon at high resolution, and some of the designs enable acquiring zenith angles above the horizon, or even the full sky, if necessary.

Task 9: (Research military needs)

We worked with a graduate student at UCSD who has a program with SSC to use the MSI theory to correct surveillance images of the harbor for weather. That work was done without cost to this project.

2. Events

There were no events this quarter, however there is a meeting planned for May, and in preparation for this we prepared a new talk and submitted it.

3. Technical Results/Accomplishments

Task 1: (Experimental test site)

We have completed and documented (in a technical memo) repair of the MSI so that it will be ready to acquire a new data base in association with the buoy and other systems. In the meantime, it is acquiring data routinely. We have also restabilized the transmissometers following their move. In previous quarters, we acquired a useful data set from all instruments to use in analysis.

Task 2: (Weather at test site)

We have acquired more useful data from the ground weather station. The buoy is being refurbished for redeployment.

Task 3: (Purchase IR system components)

The SWIR camera was received. The camera, rotary table, and computer hardware were set up and integrated into a test system, and control was achieved. Test images were acquired at the site and documented in a technical memo. The environmental housing and the automated control software are partially completed.

Task 4: (Data analysis)

We determined that the discrepancy between the transmissometers is not due to high relative humidity conditions. We determined that within the test set, the cases where the MSI results are not consistent with the transmissometer are due to differences in the paths (i.e. over the ocean vs. along the coast). We determined that changes in atmospheric refraction are not significantly affecting our results. This work and previous data analysis was documented in technical memos.

Task 5: (Visibility algorithm)

We updated the algorithm to handle white caps better, and determined that we need to update the algorithm to handle changes in horizon position due to the slight mis-level of the rotary table. We determined that we will need to evaluate inherent contrast further, even though a fixed value works well surprisingly often. This work was documented in technical memos.

Task 6: (Slant-Path Transmittance)

Several model runs were completed and evaluated. Initial results look good, and indicate that we should be able to calculate the slant path transmittance, with reasonable accuracy, from the horizontal extinctions determined by the MSI. We initiated contact with lidar manufacturers to explore possibilities for obtaining one on loan to use in testing our results.

Task 7: (Evaluate Visible vs. SWIR Advantages)

Several model runs were completed and documented. Initial results look good, and indicate that we should be able to predict SWIR extinction from the visible.

Task 8: (Robust System – mostly year 3)

We documented a number of system mockups for potential robust systems.

Task 9: (Research military needs)

No significant effort this quarter.

4. Issues

Our spending rates were slow in previous quarters, partly because the Year 1 funding was received 1 month after originally anticipated, and the Year 2 funding was received 3 months after originally anticipated, but we have been able to remedy this to a large extent this quarter. We have completed all tasks from Year 1. In general, we are on schedule for the technical tasks for Year 2. The milestone for Year 2 (deploy the IR system) was originally to be completed in March, however given the 3 month delay mentioned above, I believe it is reasonable to consider it due in June. We anticipate that it will be completed in May or June.

5. Activities for Upcoming Quarter: (May 09 – Jul 09)

Task 1: (Experimental test site)
We plan to continue data acquisition, and continue evaluation of the transmissometers. We hope to field the SWIR system this quarter. Ongoing monitoring of all systems will continue.

Task 2: (Weather at test site)
Ongoing monitoring of shore systems will continue. The buoy mooring will be built, and we hope to redeploy the buoy toward the end of this quarter.

Task 3: (Purchase IR system components)
As soon as the shop completes their fabrication work, we should be in a position to complete assembly of the SWIR system, and then deploy it. If time permits, we would like to acquire some calibration data with this system. We have named it the Shortwave IR Extinction Imager or SRI. We expect to complete the data acquisition software during this time also.

Task 4: (Data analysis)
We plan to begin a study of the inherent contrast under low wind speed conditions.

Task 5: (Visibility algorithm)
We plan to upgrade the algorithms to adjust for the tilt in the system, and plan to begin work on the software to determine extinction from the SWIR system.

Task 6: (Slant-Path Transmittance)
We plan to continue to explore the impact of extinction profile on radiance near the horizon, if the PLEXUS people can figure out the problem with the MODTRAN model, or if we can use SBDART.

Task 7: (Evaluate Visible vs. SWIR Advantages)
This task may be delayed until we have acquired test SWIR data.

Task 8: (Robust System – mostly year 3)
This task may be delayed until we have further defined the system requirements based on data to be acquired in year 2.

Task 9: (Research military needs)
This task has low priority for this quarter, in comparison with the other tasks.

6. Cost Report

The cost report was sent earlier today, 1 May.

7. Milestone Status

The milestone for Year 1 was completed in a timely manner, as reported in the July quarterly report. The Year 2 milestone is to complete the IR system deployment by the end of March, although if a correction is made for the fact that Year 2 funding was received in October 08 instead of July 08, it would be reasonable to similarly delay this milestone 3 months to June 09. We anticipate completing this milestone in May or June.

8. Summary

We have made excellent progress this quarter in development of the Short Wave IR Extinction Imager (SRI), assembling much of the system and acquiring test images that look good. We have made significant progress in the modeling effort, determining that the models indicate that we should be able to estimate SWIR extinction from the visible, and we should be able to estimate the slant path extinction from the horizontal extinction with reasonable accuracy. We have further analyzed the first data test set, determining that the few observed discrepancies between the MSI and the transmissometer were due to path differences. We have completed repair of the MSI, and much of the refurbishment of the buoy, in preparation for acquiring a full test set later in the year.