COASTAL VARIABILITY ANALYSIS, MEASUREMENT, AND PREDICTION (COVAMP)

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LONG TERM GOALS

The long-term goal is to provide representative three-dimensional, time-varying refractivity and optical property inputs for propagation models.

OBJECTIVES

The objectives are to provide a testbed to develop and evaluate urgently needed state-of-the-art measurement capabilities and accurate now- and forecasting techniques.

APPROACH

No one instrument or model is currently available with the capability to characterize propagation conditions on the necessary spatial and temporal scales thought to be typical of the coastal regions. Therefore, sensing information from a variety of sources/instruments are to be combined with high-resolution meteorological mesoscale models to provide a better description of the propagation environment than either sensing or models alone. COVAMP is divided into 2 tasks: (1) Electrooptical Propagation Assessment in Coastal Environments (EOPACE), and (2) Remote Sensing.

WORK COMPLETED

EOPACE

FY97 is the third year of EOPACE. An EOPACE home page (http://sunspot.spawar.navy.mil/543/eopace/eomain.html) on the Internet contains all the EOPACE information, updated as necessary. The EOPACE effort for FY97 was conducted as per the EOPACE Work Plan. Four Intensive Observation Periods (IOPs) were conducted:

1. The November 1996 San Diego EOPACE IOP was conducted 4-22 November 1996.
2. The March 1997 EOPACE Air Mass Parameterization study was conducted off the southern California Coast (8-20 March 1997).
3. The March surf impact IOP was conducted on Scripps Pier, Scripps Institution of Oceanography (31 March - 12 April 1997).
4. The August/September 1997 EOPACE transmission IOP (25 August - 5 September 1997) was conducted in San Diego.

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IOP participants included the Naval Postgraduate School, the RV Point Sur, PSU/ARL, NSWC, FEL/TNO (Holland), DREV (Canada), University of Sunderland (United Kingdom), and SPAWARSYSCEN San Diego (SSC SD). The emphasis for this series of IOPs was to make closure for the transmission measurements on both the 7 and 15 km transmission paths and to determine the surf impact on the transmission measurements.

The EOPACE data analysis is proceeding. An EOPACE work shop was conducted in San Diego, 30 - 31 July 1997. Over 24 participants in EOPACE attended the work shop. Twenty two presentations were given on: 1) surf effects, 2) transmission/polarization, and 3) air mass characterization. An EOPACE collaborative analysis/publication effort was outlined. The tentative publication plans were divided into 5 groups: 1) surf aerosols, 2) near ocean surface transmission, 3) air mass characterization, 4) EO systems performance, and 5) mesoscale modeling. Specific research/publication topics were identified for each category and principal participants assigned to coordinate the work in the given category.

At the 42nd Annual SPIE Meeting on Optical Science, Engineering, and Instrumentation, a special EOPACE session entitled "Propagation and Imaging Through the Atmosphere" was held. A total of seventeen EOPACE papers were presented. In addition, two papers were presented at the European Aerosol Conference, Hamburg, Germany, 15-19 September 1997, on surf aerosol production and air mass parameterization.

NPS conducted buoy-based near-surface and sea-surface measurements during the IOPs in November 1996 and August 1997; reduced and distributed data. During the March IOP, NPS conducted shipboard surface layer and rawinsonde measurements from R/V Point Sur. Optical depths were computed in real-time from NOAA AVHRR satellite passes and enhanced GOES-9 imagery was used during experiment to direct ship and aircraft

REMOTE SENSING

In the GPS Sounder task, discussions with UNAVCO on the possibility of using just the direct ray in the inversion process lead to a new start effort called GPS/SLANT and uses very accurate measurements of signal phase as an estimator. A set of GPS measurements was collected 10-13 February 1997 in support of the SSC SD/UNAVCO GPS/SLANT effort. A very strong surface-based duct formed during the morning of the 13th and the data clearly show the effects; the satellite signal arrived 5 minutes and 38 seconds earlier than expected. This data set emphasized the need for a simple qualitative assessment system to flag or alert the operator when a surface-based duct is present. This system has been named GPS ALERT. Two geodetic quality field GPS units were delivered to Lincoln Laboratory, Lexington, MA, for development of GPS ALERT control software. Preparations were started on supporting a multifrequency propagation experiment that will be conducted off of Wallops Island, VA, this coming March. Both GPS Tide Gauge and GPS ALERT will be involved in the two week effort. ALERT hardware and software will be mounted on the NSWCDD research boat 'Sealion' for testing in 'at-sea' conditions.

Under the Lidar Atmospheric Profiling task, data obtained during the EOPACE measurement periods at Scripps Pier and at Moss Landing in FY96 have been investigated to determine the characteristics of the aerosol plumes which are generated in the surf zone. The results from digital images have been converted to the projection in the plane parallel to the pier and physical characteristics have been described. The surf aerosol generation was found to be quite different at the two sites and the

measurements were used to design the April 1997 experiments at Scripps Pier. These measurements were carried out 26 March through 11 April 1997, and focused on characterizing and quantifying the properties of the surf generated aerosol. The measurements made with the thin laser sheet beam have been used to illuminate the aerosols above the surf.

In the Remote Boundary Layer Sensing task, analysis of the RASS (Radio Acoustic Sounding System) and radiosonde data collected at Pt. Loma in FY96 was completed and an article describing the results was accepted by the *Journal of Atmospheric and Oceanic Technology*. Correlation of some radiosonde and profiler-measured quantities was actually higher than the correlation between the radiosonde-measured wind speeds and the radar-measured wind speeds Another experiment was successfully carried out in late May at Vandenberg AFB with supporting aircraft measurements by the Air Resources Laboratory. The many data sets are presently being collected and organized. A joint experiment with the University of Hannover was organized for execution in the first 2 weeks November 1997 at Vandenberg AFB. The university is bringing over their multi-million dollar "helipod" (designed to be lifted by helicopter) near the Air Force's new 449 MHz wind profiler for detailed inter-comparison of radar-measured turbulence quantities and in-situ helipod measurements. The German helipod is a state-of-the-art package of turbulence sensors of temperature, wind and humidity. An FM-CW radar from White Sands will also be operated alongside the sounder to observe the detailed structure of the refractive index distribution within the profiler's pulse volume.

In the Polarization Effects in the Infrared task, NPS made an extensive series of polarized image measurements from Point Loma during the EOPACE IOP in November 1997. Comparative image sequences of land, sea, and sky background through an azimuth range of 150 degrees were taken in the 3-5 and 8-12 micrometer bands. Two large area (12 inch) temperature reference sources were deployed for scene calibration. Concurrent measurement series using the LWIR (Long Wave IR, 8-12 micron) split-field polarimeter and the internal filter method were recorded for validation of the split-field method. This is the final year of this task.

RESULTS

EOPACE

Analysis of the character of the aerosols from FY96 measurements (PSU - Philbrick, Bas and NPS - Davidson, Kiser) raised many questions which could not be answered with those results. During the March-April 1997 measurements, high resolution digital imagery was improved, capability to measure the temperature gradient in the first 20 meters above the surf zone was added, and a visible transmissometer path was added. These measurements have led to an ability to describe the surf aerosol as a tracer injected into the intense convective surface boundary layer. The surf is the source of the aerosols within the first few centimeters of the water, however the plumes result from dispersal of the aerosols into the convective surface boundary layer, which is driven by the gradient of the air temperature in the first several meters of the water.

REMOTE SENSING

In the GPS Sounder task, evaluating large order, large argument Hankel functions as a propagator to satellite altitudes proved to be numerically intractable. An improved “high” angle (>5°) rayoptics routine in RPO is valid to satellite heights and RPO will be used as the propagation model for the inversion work.

In the Remote Boundary Layer Sensing task, a significant breakthrough occurred. Until now it has been assumed that Doppler radar wind profilers could only provide profiles of refractive index gradient - but not profiles of refractive index. However, the new availability of GPS values of total precipitable water vapor (and total refractive index) allow the radar-sensed gradients to be integrated with the constraint that the totals equal those found from GPS and initialized with the measured value of surface refractive index. The method was tested by comparing seven hours of GPS and radar data collected at Pt Loma with three radiosonde-measured profiles of refractive index collected during the period. The results are excellent and an article has been written for submission to *Journal of Atmospheric and Oceanic Technology*.

IMPACT

The spatial and temporal data collected under this project are used to validate system performance models and provide variability statistics to EM/EO system designers. The EOPACE results are quantifying, for the first time, the effects of aerosols in the variable coastal regime and, in particular, the effects of surf-generated aerosol on IR transmission across a coastline.

TRANSITIONS

The GPS ALERT technique is being transitioned to demonstration and validation.

RELATED PROJECTS

This project is closely related to the synoptic and mesoscale numerical analysis and prediction projects pursued by NRL Monterey, the EM Propagation and EO Propagation projects, and the Remote Refractivity Sensing project under ONR 321SI. Tri-service coordination is conducted under the Technology Area Review and Assessment.

REFERENCES

Propagation Division home page: http://sunspot.spawar.navy.mil