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Project Summary

Conceptual Design for a Gulf Coast Oxidant Transport and Transformation Experiment: Workshop Proceedings and Recommendations

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The transport of ozone and oxidant-precursor emissions from the industrial areas of the Gulf Coast to other areas of the United States, particularly the Northeast and Midwest, may exacerbate documented smog problems in those areas. The extent of this transport is unknown. This document presents the output of a workshop held in Durham, NC, November 1982, to develop a conceptual design for a Gulf Coast transport and transformation experiment. It outlines a field study designed to quantify the amounts of material injected into the large-scale flow and the amount remaining in the Gulf Coast area. Results of the field study will help to describe such transport, and aid in the application of the Regional Oxidant Model to the Gulf Coast area to perform sensitivity studies on the regional transport of ozone and precursors.

This Project Summary was developed by EPA's Atmospheric Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction and Discussion

The basic objective of a Gulf Coast oxidant study would be to "investigate the unique meteorological and chemical processes in the Gulf Coast region that must be understood to effectively adapt the EPA Regional Oxidant Model to that geographical area." Some of the more important and relevant processes to be studied include

- Three-dimensional transport by land-breeze and sea-breeze circulations
- Transport and diffusion under near-stagnation conditions
- Ozone (and precursor) venting or mixing by precipitating and non-precipitating cumulus clouds
- Washout of nitrogeneous and oxygenated species and the impact on oxidant production
- Parameterization of the over-water atmospheric surface layer
- Large-scale inflow to and outflow from the region
- Investigation of anomalously low values of the ratios of NO_x/NMHC and PAN/O_3 and the concentration of PAN
- Nocturnal NO_x removal and transformation mechanisms.

Thirty atmospheric scientists from government, industry, academia, and the private research sector participated in a 3-day workshop to develop a conceptual design for the field study. Two working groups were formed, focusing on problems of meteorology and atmospheric chemistry, and measurement needs and methods.

Atmospheric Chemistry

The atmospheric chemistry working group addressed and prioritized the trace chemicals that must be measured during any planned Gulf Coast oxidant study. The exact platforms to be employed, frequency of measurements, and spatial density of monitoring stations were issues which could not be considered by the working group since a detailed design of the Gulf Coast study did not exist. The group, therefore, focused on broader considerations dealing with trace chemical measurements and emissions data requirements.

Trace chemical measurements (both gas and liquid phases) were identified and ranked according to the importance and feasibility of the measurements. Among the nonchemical parameters, liquid water content and ultraviolet radiation measurements were highly emphasized. It was generally believed that gas-phase processes provide the dominant source for ozone formation and hence constitute the most important measurements. The roles of aldehydes and H_2O_2 in liquid phases is not well understood but may be potentially important. Nitrate measurements in the aqueous phase were ranked high because of the sink potential of the aqueous phase for NO_2 and HNO_3. Despite the recognized importance of gas-phase chemistry, the working group felt that liquid-phase processes may play a more important role in the wet and humid environment of the Gulf Coast, as compared to relatively dry regions.

Tracers of opportunity were suggested, but only chlorofluorocarbons were considered high priority. ^{7}Be or ^{33}P stratospheric tracers were ranked low, in part because of the complexity of data interpretation. Injected specialty tracers are unique tools to study long-range transport, but are to be measured only when a planned tracer experiment is under way.

Recommendations and guidelines were developed for the emissions data required for input to the Regional Oxidant Model (ROM) or other photochemical models; these included

- A 2-km by 2-km gridded inventory of emissions
- Hourly temporal resolution, i.e., diurnal and seasonal emission patterns
- Vertical resolution of emissions sources
- Source types (stationary, mobile, area, point, natural, etc.)
- Natural volatile organic compounds (VOCs) on land
- Gulf Coast water emissions.

It was recommended that some sensitivity studies should be performed with existing models to estimate the importance of source emissions, particularly natural VOCs of land or water origin. One of the most pernicious problems is the very nature of the emissions inventory. In principle, emissions data (temporally and spatially resolved) should be available for individual species. This is not possible in practice. Current models can use groups of chemicals (alkanes, alkenes, and aromatics) and this is a desirable speciation of emission data. It was suggested, however, that carbon bond mechanisms may be employed in a future version of ROM.

Meteorology

The meteorology working group discussed a wide range of atmospheric circulations and phenomena which were judged to be potentially important in determining oxidant concentrations in the Gulf Coast and interior regions downwind; these features included

- Land-breeze and sea-breeze circulations
- Convective cumulus cloud venting
- Synoptic-scale transport and disturbances
- Surface deposition and destruction
- Synoptic-scale subsidence
- Characteristics of planetary layer over the Gulf of Mexico.

On the basis of these discussions, the working group made recommendations and developed conceptual designs for a mesoscale sea-breeze experiment, a medium-range transport study, and an enhanced monitoring network.

An Eulerian box-budget experiment would be carried out for the sea-breeze study in a rectangular area, 300 km north-to-south, and 200 to about 400 km east-to-west. This area would include the sea-breeze circulation and coastal emission sources of the Houston-Galveston-Lake-Charles area. The box would be 3 km deep (the average depth of the sea breeze).

The sea-breeze program should also include studies of venting by cumulonimbus and cumulus congestus clouds that form in the afternoon inland along the sea-breeze convergence zone. This zone roughly parallel to the coastline is fairly lengthy and these clouds occur with high frequency. Therefore, these clouds may be an effective mechanism for transport of ozone precursors out of the Gulf Coast emissions source region, thereby minimizing local ozone formation but impacting regions further downwind. It was recommended that an inert gas tracer would be a useful tool for quantifying the effects of cumulus-cloud venting.

An intermediate-range oxidant transport experiment would involve a total time of 30 to 48 h for atmospheric measurements. The experiment would cover a horizontal distance of 400 to 500 km from the Gulf Coast emissions source, which would take the experiment from the Houston-Galveston area northward into Oklahoma and Arkansas. It would focus on ozone and its precursors, and on released tracers. The intermediate transport experiment would take place under conditions of synoptic-scale southerly flow, preferably during the occurrence of a nocturnal low-level jet.

A wide variety of in situ and remote measurement systems were considered necessary for successful completion of the sea-breeze and intermediate-range transport experiment; these included airborne backscatter and differential-absorption laser radar (lidar) systems, airborne Doppler radar and ground-based Doppler sodar, in situ aerometric sampling aircraft, and meteorological profiling systems.

The work group recommended that an enhanced network of surface and upper-air observations be operated throughout the time period that the mesoscale sea-breeze and intermediate-range transport programs are conducted. The network area was outlined as extending from Fort Worth, Texas, eastward to the Alabama border (about 300 km), and then 600 km southward to a point approximately 200 km offshore. The existing National Weather Service (NWS) radiosonde stations within the network area (about six) would be enhanced by five or six additional stations, including two stations offshore, to double the spatial resolution of the NWS network. Vertical profiles of ozone would be obtained to 700 mba (10,000 ft MSL) by single-engine aircraft at each of 12 available radiosonde locations. The network would be operated for a 3-month period.

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The complete report, entitled "Conceptual Design for a Gulf Coast Oxidant Transport and Transformation Experiment: Workshop Proceedings and Recommendations," (Order No. PB 85-173 789/AS; Cost: $11.50, subject to change) will be available only from:

National Technical Information Service
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