F09a

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OPERATIONS PLAN
EMISSIONS CALIBRATION STUDY
VERSION 5
FEBRUARY 12, 1992

1.0 Introduction

The Emissions Calibration Study (ECS) is comprised of a set of measurements to be conducted as a follow-on substudy of the Lake Michigan Ozone Study under the direction of the Lake Michigan Air Directors Consortium (LADCO). The measurements will be conducted during the summer of 1992 in the Milwaukee, WI region. The main purpose of the measurements is to collect data with which to estimate the emissions of VOC and NOx from a major urban/industrial center. The measurements will be employed to determine the mass balance of the emissions such that the mass balance can be compared against the inventory of emissions from the Milwaukee region. Thus the ECS is intended to provide data which will allow estimation of the representativeness of the conventional emissions inventory for the urban center of Milwaukee, WI. Ultimately this estimation will be integrated into the air quality modeling effort being conducted to design ozone air pollution abatement methodology within the lake Michigan Ozone Study domain. The measurement effort will employ standard ground level air quality sampling, airborne air quality sampling and meteorological measurements.

2.0 Objectives

The measurements described here will be made in an attempt to identify biases in the inventory of VOC and NOx emissions from Milwaukee, WI.

3.0 Approach

The field measurements of this effort will be made during a period which will be approximately a weeks duration during the summer of 1992. All personnel to be involved will be assembled in the Milwaukee region and will devote their entire effort to the measurement program. Measurement will be made in the vertical dimension both upwind and downwind of Milwaukee, WI in order to determine the three dimensional distribution of air quality elements in the air mass approaching the city and the distribution of those same elements in the air mass as it leaves the city, thus providing a mass balance of elements added to the volume of air over the city by emissions from within the city. The actual measurements and analyses of the data collected by the effort will be accomplished by contractors engaged by LADCO.

4.0 Meteorological Conditions

Each set of ECS measurements will be scheduled during regional wind conditions that are as steady in direction and speed as possible and from directions that will offer the most complete measurements and the least operational complication to the actual conduct of the measurements. Additionally, it is desirable that the measurements will be made when sky conditions are cloudy in order to limit transformation of precursor elements to ozone as much as possible, however steady winds from the land toward Lake Michigan are the most important conditions. Wind directions from the west are the most desirable although practically speaking it will be necessary to conduct the ECS measurements when the winds persist within the range between south clockwise to north.

5.0 Measurements

The measurement portion of this experiment will consist of several sets of measurements. Each set will be comprised of ground level air quality samples, aircraft air quality measurements and meteorological measurements. Each set will require approximately one and a half to two hours duration as that is the time required for the aircraft to complete one circuit of the flight pattern. On days when it is possible, as many as three sets of measurements will be made and during the week's duration of the experiment, as many as twelve sets of measurements are anticipated.

5.1 Air Quality

Continuous ground level sampling of SO2, NOx and ozone by conventional air quality monitors and time integrated samples of VOC's by canister collectors and carbonyl cartridges will be conducted employing the routine air quality monitoring network of the State of Wisconsin, Southeast District. This network will be supplemented by additional sampling stations operated at additional sites within the region in order to augment the density of the routine sampling network. The operating schedule of these samplers will be coordinated in order that their operating periods will match the times of the ECS experiments.

Aircraft sampling will be conducted by four aircraft, each of which will fly at a different given altitude in a square box pattern around the city. The aircraft will fly in a loose stacked pattern so as to yield a vertical profile of air quality measurements on legs of the flight pattern on all sides of the city. Each aircraft will collect continuous samples of SO2, NOx and ozone employing aircraft mounted air quality monitors and each will collect a time/distance integrated VOC canister sample and a carbonyl bag sample along each leg of the flight pattern.

5.2 Meteorological

All the meteorological stations located within the general region of the ECS and operated by the Wisconsin Southeast District will be operated for the ECS measurement periods. Additional meteorological stations owned by private endeavor will be operated as well provided cooperation of the owners can be accomplished. One rawinsonde station will be employed for this project. The station will be located in the western suburban portion of Milwaukee and it will make one "slow rise" sounding measuring pressure, temperature, winds and moisture during each set of measurements.

6.0 Operations

6.1 Experiment Controller

The conduct of ECS measurements will be coordinated by an experiment controller. He will schedule operations based on a forecast of favorable weather conditions and on readiness of all participants. In scheduling an operation, he will also coordinate aircraft operations with the FAA and will accomplish coordination between project flight operations schedules so as to be consistent with operation of the ground level sampling. Daily operations will be scheduled after a detailed briefing by the experiment controller for the participating staff.

6.2 Weather Forecasts

Forecasts of weather conditions within the greater Milwaukee region that will affect the operation of the ECS will be obtained through contract with commercial weather forecasting service. Those forecasts will be available continuously during the duration of the operations period in order that the experiment controller will have current forecast information with which to base decisions about scheduling and operation of the project.

6.3 Flight Patterns

Two flight patterns are designed with way points at fixed locations in order to simplify approval of the Federal Aviation Agency (FAA). These two flight patterns being "box" shaped some 40 statute miles (35 nautical miles) on each side, will be oriented, one on grid south-north, and the second, 45 degrees off that orientation on grid southwest-northeast. The pattern located on the grid south-north orientation will be employed for winds from the south, west and northerly directions. The pattern oriented on the grid southwest-northeast orientation will be employed for conditions with the winds from the southwesterly and northwesterly directions. Selection of the flight pattern to be employed will be made by the experiment controller at least two hours prior to flight time in order that air crews will have sufficient time to adapt the overall flight plan to the specific flight for that operation, to file flight plans and to accomplish the needed instrument calibrations and other flight preparations etc.

The two flight patterns are as described by the following way points.

Flight Box for South, West and North Winds (see Figure 1)

Way Point	Name	Latitude	Longitude
1	Burlington	42°43'00"N	88°21'00"W
2	Hartford	43°18'00"N	88°21'00"W
3	Northlake	43°18'00"N	87°38'00"W
4	Southlake	42°43'00"N	87°38'00"W

Flight Box for Southwest and Northwest Winds (see Figure 2)

Way Point	Name	Latitude	Longitude
5	Kenosha	42°37'00"N	88°00'00"W
6	Sullivan	43°02'00"N	88°34'00"W
7	Newburg	43°27'00"N	88°00'00"W
8	Midlake	43°02'00"N	87°26'00"W

With winds from different directions the sequence of legs as shown below will be flown. The distances of each flight as well as the flight times are also shown. The times of each flight include one additional minute for each 270 degree turn at the corners of the flight box.

Winds from	Fly from/to	Total Distance	Time @140mph
South	Base->Comparison leg->Way points 4 (Southlake)-> 1 (Burlington)->2 (Hartford)->3 (Northlake)-> 4 (Southlake)->Base.	240 st. mi.	1hr 47 min
Southwest	Base, Comparison leg->Way points 5 (Kenosha)->		

	6 (Sullivan)->7 (Newburg)->8 (Midlake)-> 5 (Kenosha)->Base.	215 st. mi.	1 hr 36 min
West	Base, Comparison leg->Way points 1 (Burlington)-> 2 (Hartford)->3 (Northlake)->4 (Southlake)-> 1(Burlington)->Base.	232 st. mi.	1 hr 44 min
Northwest	Base->Comparison leg->Way points 6 (Sullivan)-> 7 (Newburg)->8 (Midlake)->5 (Kenosha)-> 6 (Sullivan)->Base.	270 st. mi.	2 hrs 00 min
North	Base->Comparison leg->Way points 2 (Hartford)-> 3 (Northlake)->4 (Southlake)->1 (Burlington)-> 2 (Hartford)->Base.	294 st. mi.	2 hrs 11 min

6.4 Flight Operations

All four aircraft will be based at the Waukegan Airport. When an operation is scheduled, the four will prepare for departure as a group and to conduct the flight as a group. That is, the four aircraft will depart for their assigned flights one after the other with two minutes time separation. Upon take off, all aircraft will fly a comparison leg on their way to the assigned flight box. This comparison leg will consist of a flight leg located to have a significant cross wind component so as to avoid flying in the next aircraft's wake/exhaust and be of sufficient length to yield at least ten minutes flight duration for instrument output comparison from each aircraft. All aircraft will operate their instrumentation while flying this comparison leg, one behind the other at two minutes separation at the same altitude. As each aircraft approaches the starting way point of the flight box, each will break off from the comparison leg and ascend or descend to the assigned altitude. Each aircraft will then fly the assigned flight box at the assigned altitude at the assigned speed. In this way, a loose stack of flights will be accomplished and the measurements will provide a vertical profile of each measured parameter. At each way point turn to the next leg of the flight box, a 270 degree turn will be executed in order to allow time for instrument operators to change sample media and to accomplish identification marking of the data taken. When one circuit of the flight box has been completed, each aircraft will in turn break off and return to base at Waukegan Airport. The data collected during this flight period will constitute one data set. Upon return to base at Waukegan, each aircrew will complete the documentation of the data set just collected and prepare for the next flight with as many as three to be flown in a single day.

The comparison flight leg will be flown at 2000 ft AGL. The flight altitude assignments on the four main legs of the flight box will be 800 ft, 1800 ft, 2800 ft, and 3800 ft AGL. These altitudes may be revised as experience about the vertical distribution of the measured parameters is gained.

Note that we may want to have the flight altitudes 800, 2000, 3000 and a series of spirals from 4000 to just above surface both on the upwind and downwind sides of the box. Alternately, we may want to have 800, 2000, 3000 and the airborne Alpha-1 particle lidar at some altitude to give vertical distribution of atmospheric particulate concentrations. The latter may be a reasonable indicator of the vertical distribution of the other air quality variables that could be used along with the measurements made at the other altitudes to more completely determine the vertical distributions of each parameter.

6.5 Flight Schedules

Three flights per day will be scheduled when meteorological conditions are favorable. The first will be just before the morning air traffic rush hour at Milwaukee Mitchell Airport, the second will be during the mid-day period and the third will be during the early evening. Initially, the scheduled flights will be at 0630 to 0830, 1100 to 1300 and 1700 to 1900 CDT. On days when measurements are scheduled as many as three sets of data will be collected, but if conditions deteriorate during the course of the measurement day, the operation will be suspended when conditions are no longer acceptable. As many as four days operation are anticipated during the course of the operational week.

7.0 Listing of Sample media requirements
- Cartridges
- Canisters
- Bags

8.0 Cost Estimate
- Experiment Planner/Controller
  - (About 2 months time over 4 months period, then manage the field activities)
- Air quality sampler operation
  - WDNR
  - Supplemental
- Rawinsonde
- Forecast service
- Planning/Preparation/Meetings
- Aircraft
  - WDNR
  - NOAA
  - Contract for 2 or 1 + Alpha-1
    - * NAWC estimates 2 acft, 1-wk in the field, prepared, equipped, supported, coordinated, monitoring data except cans processed to be level-1, presented in a data report.....$100,000
    - * NAWC estimates 1 acft, same details.....$80,000
- Field Costs
  - Rentals (office space, maintenance shop/staging bldg, special equipment)
  - Shipping of sample media and exposed samples
  - Daily living costs
  - On-site transportation
  - Travel
- Field sample assay
- Data Processing (Air quality and meteorological data)
- Analysis and Reporting

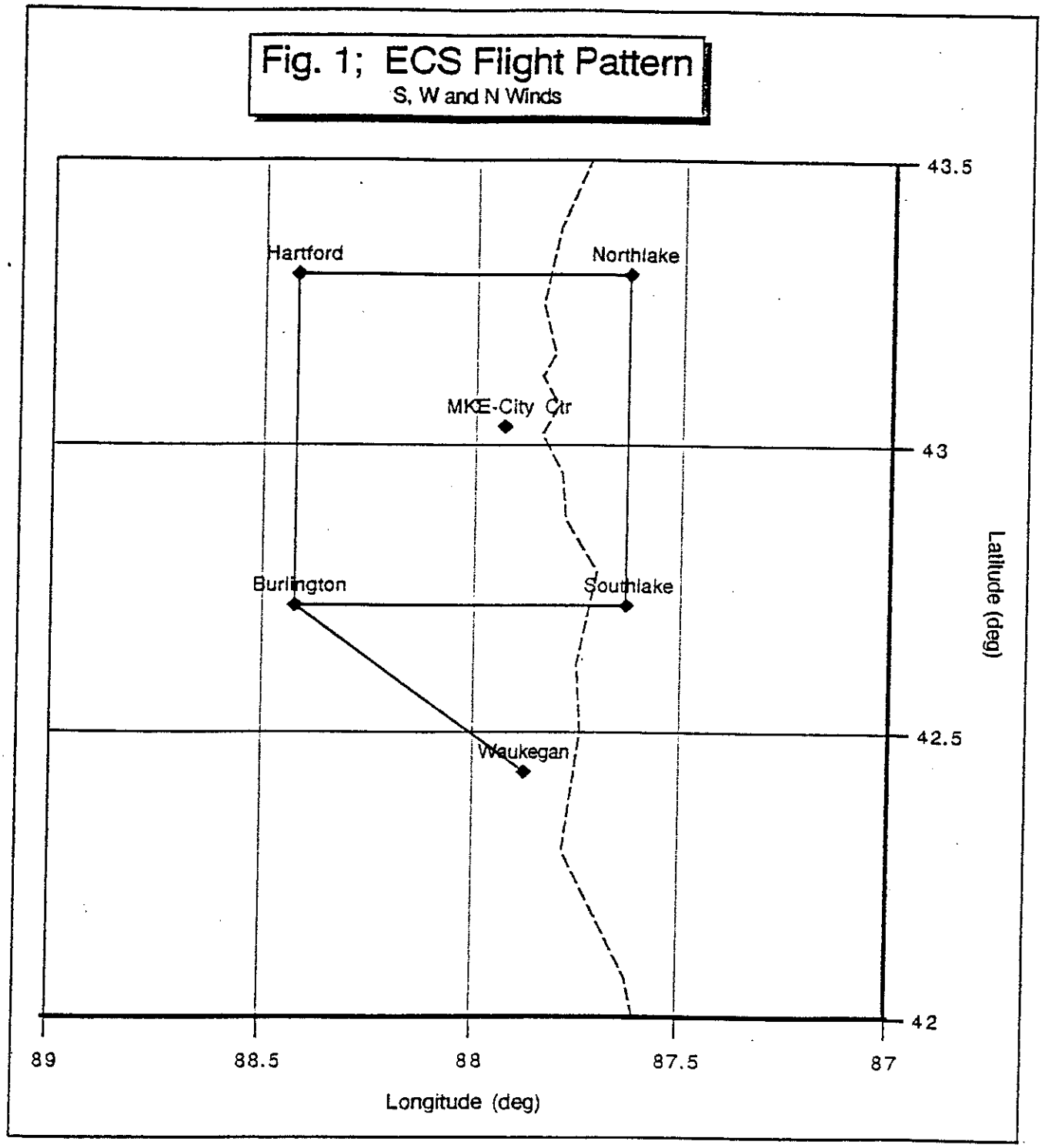
Fig. 1; ECS Flight Pattern
S, W and N Winds
Hartford
Northlake
MKE-City Ctr
Burlington
Southlake
Waukegan
43.5
43
42.5
42
89
88.5
88
87.5
87
Latitude (deg)
Longitude (deg)

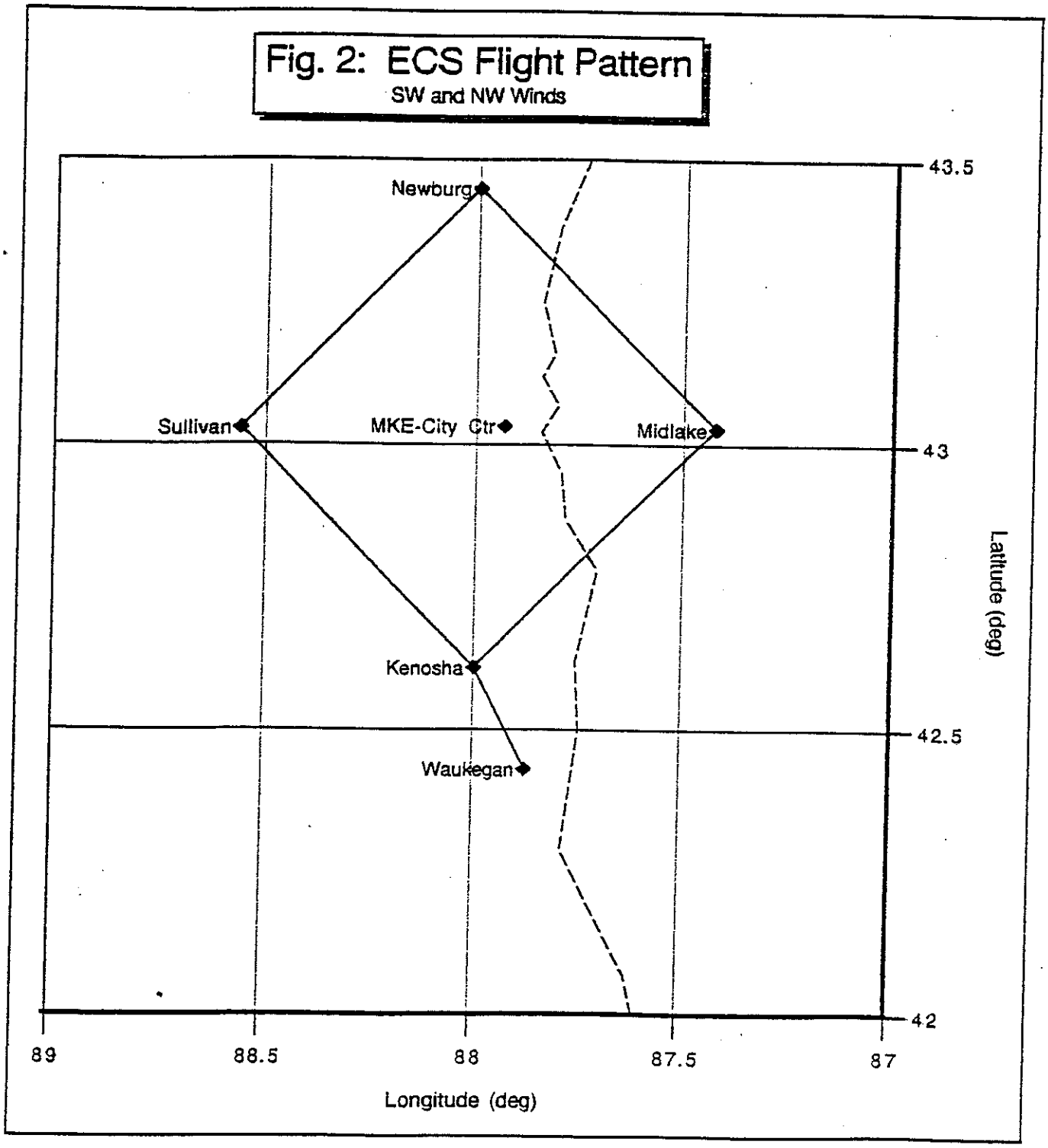
Fig. 2: ECS Flight Pattern
SW and NW Winds
Newburg
Sullivan
MKE-City Ctr
Midlake
Kenosha
Waukegan
43.5
43
42.5
42
89
88.5
88
87.5
87
Latitude (deg)
Longitude (deg)