

FUNDING FOR THIS PROGRAM IS
PROVIDED BY...

[HORN HONKS]

Narrator: AIR POLLUTION --
WE CAN'T ALWAYS SEE IT, BUT ITS
EFFECTS CAN BE DEADLY.

TO FIND WAYS TO REDUCE ITS
IMPACT
WE NEED TO KNOW EXACTLY
WHAT POLLUTANTS ARE EMITTED
AND HOW THEY CHANGE AS THEY
TRAVEL THROUGH THE
ATMOSPHERE.
AT THIS POINT, WE PRIMARILY
HAVE SULFATE PARTICLES.
USING CUTTING-EDGE
INSTRUMENTS
AERODYNE RESEARCH
CAN DETECT TINY
CONCENTRATIONS OF
POLLUTANTS IN REAL TIME
TRACKING THEM BACK TO THEIR
SOURCES
AND SHOWING HOW THEY EVOLVE
HOUR BY HOUR
UNDER THE EFFECTS OF
SUNLIGHT AND WEATHER.

IN MEXICO CITY
LUIA MOLINA IS LEADING A
GROUP OF OVER 450 SCIENTISTS
IN THE MOST COMPREHENSIVE
STUDY EVER CONDUCTED
OF ONE CITY'S AIR EMISSIONS.
SAMPLING ITS PLUME OF
POLLUTANTS FROM CRADLE TO
GRAVE
THE TEAM HOPES TO LEARN HOW
THE CITY'S POLLUTION
AFFECTS THE SURROUNDING
REGIONS AND EVEN THE GLOBAL
CLIMATE.
TODAY, THE RAPID INCREASE OF
POPULATION AND
INDUSTRIALIZATION
IS CAUSING INCREASING
CONCERNS ABOUT AIR
POLLUTION.

BOTH RESEARCHERS HOPE TO
DISCOVER
WHAT'S CAUSING THE MOST
DAMAGE
AND FIND WAYS TO REDUCE THE
HUMAN AND GLOBAL IMPACT.

[HORN HONKS]
Kolb: ONE OF THE REAL FACTS
THAT WE ALL HAVE TO DEAL WITH
IS THAT PEOPLE MAKE POLLUTION

AND AS THE POPULATION OF THE
EARTH GROWS
UNLESS WE'RE VERY CLEVER AND
WORK VERY HARD
THE LEVELS OF POLLUTION WE
ALL HAVE TO LIVE WITH
WILL GROW ALONG WITH IT.
WE HAVE TO UNDERSTAND
WHICH POLLUTANTS ARE THE
ONES THAT WE MUST CONTROL
AND WE HAVE TO COME UP WITH
EITHER CHANGES IN OUR
TECHNOLOGY
OR CHANGES IN OUR LIFESTYLES
WHICH REDUCE THE HEAVY
POLLUTION BURDENS
THAT WE EMIT INTO THE
ATMOSPHERE.

Narrator: CHARLES KOLB IS
PRESIDENT OF AERODYNE
RESEARCH

A COMPANY THAT SPECIALIZES IN
STUDYING AIR POLLUTION
AND DESIGNING INSTRUMENTS TO
HELP MEASURE IT.

A NEW AEROSOL MASS SPEC
BODY.

Kolb: OUR AIR-POLLUTION
RESEARCH

FOCUSES ON WHAT'S EMITTED BY
VARIOUS POLLUTION SOURCES --
CARS, TRUCKS, PLANES,

FACTORIES, AND MANY OTHER
SOURCES --
AND TO UNDERSTAND HOW THEY
CHANGE THE ATMOSPHERE
AND HOW THAT CHANGED
ATMOSPHERE
TURNS AROUND AND IMPACTS
PEOPLE AND THE CLIMATE
AND THE ECOSYSTEMS THAT WE
WANT TO PRESERVE.

Narrator: AIR POLLUTANTS EXIST
AS HARMFUL GASES
OR AS AEROSOLS.
AEROSOLS ARE MICROSCOPIC
SOLID OR LIQUID PARTICLES
SUSPENDED IN THE AIR
AND THESE POLLUTANTS CAN
HAVE DEADLY EFFECTS.

Kolb: MOST OF US CAN ONLY
SURVIVE A MINUTE OR SO
WITHOUT A FRESH BREATH OF AIR
AND IF THE AIR CONTAINS
SUBSTANCES
WHICH ARE GOING TO REALLY
HURT YOUR HEALTH
YOU'D HATE TO THINK THAT
YOU'RE SHORTENING YOUR LIFE
WITH EVERY BREATH OF AIR YOU
TAKE.

Narrator: THE WORST

AIR-POLLUTION DISASTER ON
RECORD
OCCURRED IN LONDON IN
DECEMBER OF 1952.

AT THIS TIME, LONDONERS STILL
CONSUMED LOTS OF COAL
WHICH LED TO LARGE AMOUNTS
OF POLLUTANTS IN THE AIR
INCLUDING BLACK CARBON, OR
SOOT PARTICLES
AND SULFUR DIOXIDE.

AND THIS TOXIC MIX TURNED
FATAL.

Kolb: THE PARTICLE LOADING GOT
SO HEAVY DURING ONE EPISODE
THAT THE SO-CALLED KILLER
FOGS
ACTUALLY KILLED MANY
THOUSANDS OF PEOPLE
OVER ABOUT A WEEK AND A HALF.

Narrator: THANKS TO
REGULATIONS TO REDUCE THESE
POLLUTANTS
EVENTS LIKE THIS ARE RARE
TODAY.
HOWEVER, PUBLIC HEALTH
OFFICIALS ESTIMATE
THAT 70,000 AMERICANS DIE
PREMATURELY EACH YEAR

DUE TO AIR POLLUTION.

IN ORDER TO MONITOR THESE
POLLUTANTS
KOLB AND HIS TEAM AT
AERODYNE RESEARCH
DEVELOPED A SERIES
OF REVOLUTIONARY
LABORATORY-GRADE
INSTRUMENTS
THAT COULD BE DEPLOYED FROM
A MOBILE VAN.

Kolb: WE'VE DEVELOPED SOME
VERY CAPABLE
AND VERY FAST RESEARCH
INSTRUMENTS
THAT CAN BE DEPLOYED IN THE
ATMOSPHERE
AND MEASURE RIGHT AWAY
WHAT'S THERE.

Narrator: TRADITIONALLY
SAMPLES HAD TO BE BROUGHT
BACK TO THE LAB TO BE
ANALYZED
BUT WITH THE MOBILE VAN,
MEASUREMENTS ARE
INSTANTANEOUS.
THE BENEFIT OF USING REAL-TIME
INSTRUMENTATION
IS THAT IT MAXIMIZES THE
SCIENTIFIC IMPACT

THAT WE'RE ABLE TO HAVE WHEN
WE'RE OUT IN THE FIELD.

IT LOOKS LIKE WE'RE PICKING UP
A GOOD SULFATE PLUME.

Kolb: THE MOBILE LAB IS
EQUIPPED WITH INSTRUMENTS
THAT CAN MEASURE EVERY
SECOND OR SO.

IF YOU'RE CHARACTERIZING AN
EMISSIONS SOURCE
AND ITS EMISSIONS ARE
CHANGING SECOND BY SECOND
AS A VEHICLE MIGHT AS IT STOPS
AND STARTS
OR ACCELERATES OR GOES UP A
HILL

THEN IF YOU DON'T MEASURE
SECOND BY SECOND
YOU WON'T GET THE RIGHT
ANSWER.

NITRATES? YEAH, I SEE SOME
NITRATES.

Narrator: ONE KEY INSTRUMENT
IS AERODYNE'S AEROSOL MASS
SPECTROMETER

WHICH MEASURES THE TINY
SUSPENDED PARTICLES
IN THE ATMOSPHERE.

WHAT'S REALLY SPECIAL ABOUT
IT

IS THAT USUALLY WHEN YOU'RE
LOOKING AT PARTICLES

YOU JUST KNOW SORT OF HOW
MANY PARTICLES ARE IN YOUR
SAMPLE.
BUT WHAT THE AMS IS CAPABLE
OF DOING
IS TELLING YOU WHAT THE
CHEMICAL SPECIES
OF EACH OF THOSE PARTICLES IS.
YOU CAN SAY, "OH, YOU KNOW,
THERE'S 1,000 PARTICLES
IN THIS CUBIC CENTIMETER OF
AIR,"
ROUGHLY THIS BIG, BUT YOU CAN
ALSO SAY
"OH, A CERTAIN FRACTION OF
THEM ARE SULFATE
"A CERTAIN FRACTION OF THEM
ARE SOME SORT OF ORGANIC
A CERTAIN FRACTION OF THEM
ARE NITRATE,"
ET CETERA, ET CETERA.
AND SO THAT GIVES YOU A MUCH
STRONGER CAPABILITY
BECAUSE IT TURNS OUT THAT THE
WAY THESE PARTICLES
INTERACT WITH THE
ENVIRONMENT, FOR INSTANCE
HOW THEY MIGHT OR MIGHT NOT
AFFECT GLOBAL WARMING
DEPENDS UPON THEIR
COMPOSITION.
AND HOW THEY MIGHT AFFECT OR

MIGHT NOT AFFECT HUMAN
HEALTH
DEPENDS ON THEIR COMPOSITION
AS WELL AS THEIR SIZE.

Herndon: IF YOU'RE CONCERNED
ABOUT THE HEALTH IMPACTS
YOU'RE MOST CONCERNED
ABOUT THE SIZE OF PARTICLES
THAT ARE SUFFICIENTLY SMALL
SO THAT THEY GO INTO YOUR
LUNGS
DEEP INTO YOUR LUNGS, ALONG
WITH THE GAS FLOW.
AND IN THAT CASE
YOU COULD ACTUALLY BE
INTRODUCING SOME THINGS
INTO YOUR BODY, INTO YOUR
BLOODSTREAM, QUICKLY
THAT HAVE NO BUSINESS BEING
THERE.

Narrator: PARTICLES LESS THAN 10
MICROMETERS IN DIAMETER
JUST A FRACTION OF THE WIDTH
OF A HUMAN HAIR
CAN LODGE DEEP INTO THE
LUNGS.

THOSE SMALLER THAN 2.5
MICROMETERS
CLASSIFIED AS "FINE PARTICLES,"

HAVE BEEN LINKED TO THE MOST SERIOUS HEALTH PROBLEMS.

Kolb: IT CAN LEAD TO A NUMBER OF MEDICAL COMPLICATIONS INCLUDING NOT JUST LUNG DISEASE --

EMPHYSEMA, ASTHMA, POSSIBLY LUNG CANCER --

BUT CAN ALSO PUT A VERY HIGH STRAIN ON YOUR HEART AND CAN LEAD TO HEART ATTACKS.

Narrator: AERODYNE MEASURES BOTH THE HAZARDOUS PARTICLES AND THE POLLUTANT GASES BEING EMITTED FROM VARIOUS SOURCES.

YOU'D THINK YOU'D SEE SOME SULFATE, BUT I DON'T KNOW.

Kolb: WE WANT TO USE OUR MOBILE LABORATORY TO UNDERSTAND POLLUTANTS THAT ARE DIRECTLY EMITTED INTO THE ATMOSPHERE.

WE CALL THOSE "PRIMARY POLLUTANTS."

WITH A MOBILE LABORATORY YOU CAN ACTUALLY MAP OUT THE DISTRIBUTION OF THE AIR POLLUTANTS

SO THAT YOU HAVE A MUCH
BETTER PICTURE
OF HOW THE POLLUTANTS ARE
DISPERSED
AROUND, SAY, A CITY, OR
AROUND A FACTORY COMPLEX.
IN ADDITION, YOU CAN LOCATE
SOURCES OF POLLUTANTS
BECAUSE YOU CAN SEE A
CONCENTRATION IN A PLUME
AND YOU CAN THEN USE THE
MOBILE LABORATORY
TO ACTUALLY FOLLOW THE
PLUME BACK TO THE SOURCE.

Narrator: VEHICLE EMISSIONS ARE
ONE OF THE SOURCES
OF PRIMARY POLLUTANTS
TRACKED BY AERODYNE.
WHILE THE EMISSIONS FROM AN
INDIVIDUAL CAR
ARE RELATIVELY LOW COMPARED
WITH FACTORIES
IN MANY CITIES, THE MILLIONS OF
VEHICLES ON THE ROAD
ADD UP TO BE THE MOST SERIOUS
THREAT TO CLEAN AIR.

VEHICLE EXHAUST POLLUTANTS
INCLUDE AEROSOLS
AND THESE GASES...

USING THEIR TRACE-GAS
DETECTOR
THE AERODYNE TEAM CAN
MONITOR THESE POLLUTANT
GASES
EVEN AT VERY LOW LEVELS.
BUT THESE POLLUTANTS, BY
THEMSELVES
ARE NOT THE ONLY CONCERN.
SOME PRIMARY POLLUTANTS,
SUCH AS NO_x
BECOME EVEN MORE
DANGEROUS
WHEN THEY BEGIN A COMPLEX
CHEMICAL REACTION
AFTER BEING EXPOSED TO
SUNLIGHT.

SECOND BIG JOB WITH THE
MOBILE LAB
IS TO GO OUT AND ACTUALLY
THEN SEE WHAT HAPPENS
TO THOSE PRIMARY POLLUTANTS
AS THEY COOK IN THE
ATMOSPHERE.
THIS CHEMISTRY CAN CREATE
WHAT WE CALL "SECONDARY
POLLUTANTS."
IT CAN CHEMICALLY CHANGE THE
POLLUTANTS
THAT WERE EMITTED INTO THE
ATMOSPHERE

INTO DIFFERENT AND SOMETIMES
MORE DANGEROUS CHEMICALS.

Narrator: ONE SECONDARY
POLLUTANT THAT CONCERNS
SCIENTISTS IS OZONE.
OZONE IS A GAS MADE UP OF 3
OXYGEN MOLECULES
AND IT CAN HAVE BOTH GOOD
AND BAD EFFECTS
DEPENDING ON WHERE IT'S
LOCATED.

THE STRATOSPHERIC OZONE
LAYER
PROTECTS THE EARTH FROM
HARMFUL ULTRAVIOLET RAYS
BUT GROUND-LEVEL OZONE, IN
THE TROPOSPHERE
IS HIGHLY REACTIVE
AND CAN CAUSE IRRITATION OF
THE RESPIRATORY SYSTEM
PERMANENTLY SCARRING LUNG
TISSUE.

Kolb: OZONE IS A VERY POWERFUL
OXIDANT.

IT CAN KIND OF BLEACH THE
CELLS IN YOUR BODY
AND CAN CREATE A LOT OF
SERIOUS PROBLEMS
BOTH TO PEOPLE, TO OTHER
ANIMALS, AND TO PLANTS.

Narrator: THE MAIN PRECURSORS
IN CREATING OZONE
ARE NITROGEN OXIDES
EMITTED FROM VEHICLES AND
OTHER COMBUSTION SOURCES
AND HYDROCARBONS, THE
RESULT OF COMBUSTION
OTHER INDUSTRIAL PROCESSES,
AND VEGETATION.
WHEN THESE POLLUTANTS
INTERACT IN THE PRESENCE OF
SUNLIGHT
THEY PRODUCE GROUND-LEVEL
OZONE.
SUNLIGHT CAUSES NITROGEN
DIOXIDE, NO₂
TO SEPARATE INTO NITRIC OXIDE,
"NO," AND AN OXYGEN ATOM.
THE OXYGEN ATOM
ADDS TO NATURALLY OCCURRING
MOLECULAR OXYGEN, OR O₂
TO CREATE OZONE.
BUT THIS IS JUST THE FIRST STEP
IN A CHAIN REACTION OF OZONE
PRODUCTION.
THE REMAINING NITRIC OXIDE
REACTS WITH UNSTABLE
MOLECULES
THAT ARE PRODUCTS OF
HYDROCARBONS
OXIDIZING IN THE ATMOSPHERE
RECREATING NITROGEN DIOXIDE

CAUSING A VICIOUS CYCLE OF
OZONE PRODUCTION.

Kolb: SO OZONE GETS FORMED AS
A SECONDARY POLLUTANT.
IT'S NOT EMITTED DIRECTLY
AND IT'S IMPORTANT TO
UNDERSTAND
NOT ONLY HOW MUCH OZONE IS
IN THE ATMOSPHERE
BUT HOW MUCH OF ITS
PRECURSOR CHEMICALS ARE
THERE
SO WE CAN PREDICT WHAT THE
OZONE WILL LOOK LIKE
AS THE WIND BLOWS THAT
CHEMICAL MIXTURE ACROSS THE
COUNTRYSIDE.

Narrator: AERODYNE'S VAN HAS
BEEN DEPLOYED ALL OVER
NORTH AMERICA
TO HELP ENGINEERS AND
PLANNERS IDENTIFY THE BEST
STRATEGIES
TO REDUCE POLLUTANTS FROM
INDUSTRIES
AND TRANSPORTATION SYSTEMS.

Kolb: WE'VE WORKED WITH THE
METROPOLITAN TRANSIT
AUTHORITY
IN NEW YORK CITY
THAT RUNS ABOUT A THIRD OF

THE CITY'S BUSES
TO DETERMINE WHICH TYPES OF
BUSES
EMIT WHAT KINDS OF
POLLUTANTS.
SO ONE CAN TAKE THE MOBILE
LAB AND FOLLOW THE BUSES
AS THEY GO ABOUT THEIR
ROUTES IN THE CITY.
AND AS THEY STOP AND START,
TAKE ON PASSENGERS
ACCELERATE, SLOW DOWN
ONE CAN SEE HOW BOTH THE
PARTICLE POLLUTANTS
AND THE GASEOUS POLLUTANTS
THEY EMIT CHANGE.
THEN YOU CAN TAKE THE SAME
TYPE OF BUS
AND PUT SOME
EMISSION-CONTROL
TECHNOLOGY ON IT --
MAYBE A TRAP THAT TRAPS AND
BURNS THE PARTICLES --
AND YOU CAN SEE WHAT EFFECT
THAT HAS ON THE PARTICLE
EMISSIONS
AND ALSO WHAT EFFECT IT HAS
ON THE GASEOUS EMISSIONS.

Narrator: WHEN KOLB'S TEAM
TESTED THESE BUSES
THEY FOUND SOME UNEXPECTED

RESULTS.

Kolb: THE DIESEL BUSES WITH
PARTICLE TRAPS

DID, INDEED, EMIT ONLY ABOUT A
QUARTER OF THE PARTICLES
THAT NORMAL DIESEL BUSES
EMITTED

BUT THEY DID EMIT A LARGE
AMOUNT OF NITROGEN DIOXIDE
WHICH IS, AGAIN, A GAS THAT IS A
TOXIC AIR POLLUTANT.

SO YOU HAVE TO BE CAREFUL
WHEN YOU'RE TRYING TO SOLVE
ONE POLLUTION PROBLEM
THAT YOU DON'T CREATE A
SECOND POLLUTION PROBLEM
WHICH MAY BE AS SERIOUS AS
THE FIRST ONE.

Narrator: IN EUROPE AND THE
UNITED STATES
POLICIES HAVE BEEN PUT IN
PLACE TO REDUCE AIR
POLLUTION.

THE CLEAN AIR ACT OF 1970,
WHICH SET LIMITS
ON CONCENTRATIONS OF
CERTAIN POLLUTANTS
ALONG WITH SUBSEQUENT
PROGRAMS
HAS SIGNIFICANTLY IMPROVED
AIR QUALITY.

Kolb: SINCE 1970, WE'VE HAD
FAIRLY STRICT LAWS
WHICH HAVE HELPED STOP THE
INCREASE
IN BAD AIR-POLLUTION EPISODES
AND, IN FACT, IN MOST CITIES
HAVE DECREASED THEM.
BUT IN CITIES WITH RAPID
GROWTH AND WITH CHALLENGING
CLIMATES --
CLIMATES THAT CAN LEAD TO A
LOT OF CHEMISTRY IN THE AIR
AND A LOT OF SECONDARY
POLLUTION FORMATION
THERE ARE CERTAINLY STILL BIG
CHALLENGES LEFT.

Narrator: DEVELOPING INNOVATIVE
WAYS
TO MEASURE PRIMARY AND
SECONDARY POLLUTANTS
IS A NECESSARY FIRST STEP
IN CREATING EFFECTIVE
STRATEGIES FOR PROTECTING
HUMAN HEALTH.

BUT MEASURING THE LOCAL AIR
POLLUTION
FROM CARS AND FACTORIES IS
JUST ONE PIECE OF THE PUZZLE.

ATMOSPHERIC CIRCULATION

CARRIES POLLUTANT STREAMS
FAR BEYOND THE METROPOLITAN
AREAS WHERE THEY ARE
CREATED
CAUSING REGIONAL AND EVEN
GLOBAL EFFECTS.
AND SO THE POLLUTIONS THAT
ARE CREATED
IN THE LARGE MEGACITIES IN
CHINA
CAN DELIVER VERY HIGH LEVELS
OF POLLUTANTS
ALL ACROSS THE UNITED STATES
JUST AS THE POLLUTION THAT'S
CREATED IN THE MIDWEST
AND THE EASTERN PART OF THE
UNITED STATES
REACHES ALL THE WAY TO
EUROPE.
IT ONLY TAKES ABOUT TWO
WEEKS
FOR AIR TO GO ALL THE WAY
AROUND THE WORLD.

Narrator: AND SOME POLLUTANTS
SUCH AS AEROSOLS
AND GREENHOUSE GASES LIKE
CARBON DIOXIDE AND OZONE
EVEN AFFECT THE GLOBAL
CLIMATE.
SO WE DON'T HAVE THE LUXURY
OF THINKING

THAT IT'S OTHER PEOPLE'S
AIR-POLLUTION PROBLEMS
OTHER PEOPLE'S CLIMATE
PROBLEMS.
IF THEY'RE HAVING PROBLEMS
WE'RE GOING TO HAVE
PROBLEMS, TOO.

Narrator: AND ONE OF THE
BIGGEST EMERGING THREATS
TO THE GLOBAL ENVIRONMENT
IS INCREASED AIR POLLUTION
FROM MEGACITIES.

A MEGACITY IS DEFINED AS
HAVING 10 MILLION OR MORE
INHABITANTS.

CURRENTLY, THERE ARE OVER 20
MEGACITIES WORLDWIDE
AND THAT NUMBER CONTINUES
TO GROW AT AN ALARMING RATE.
HUNDREDS OF MILLIONS OF
PEOPLE CURRENTLY LIVE IN
THESE CITIES
AND IT IS PROJECTED THAT BY
THE MIDDLE OF THE CENTURY
THIS NUMBER WILL BE MULTIPLIED
MANY TIMES OVER
WITH 60% OF THE WORLD'S
POPULATION
LIVING IN URBAN AREAS.

THIS RAPID GROWTH

MEANS AN EVER-RISING TOLL TO
HUMAN HEALTH
UNLESS WE GAIN A BETTER
UNDERSTANDING
OF THE LIFE CYCLE OF AIR
POLLUTANTS.

AND THAT'S EXACTLY WHAT'S
BEING DONE IN MEXICO CITY
FOR THE MILAGRO PROJECT
THE LARGEST COORDINATED
STUDY EVER CONDUCTED
OF MEGACITY AIR POLLUTION.

1, 2, 3.

LUISA MOLINA IS THE PROJECT
COORDINATOR

AND ONE OF THE LEAD
SCIENTISTS ON THIS EFFORT.

Molina: "MILAGRO" STANDS FOR
"MEGACITY INITIATIVE LOCAL AND
GLOBAL RESEARCH
OBSERVATIONS."

AND WE WERE VERY, VERY
PLEASED

THAT WE WERE ABLE TO FIND AN
ACRONYM, MILAGRO

THAT NOT ONLY FIT THE THEMES
OF OUR MEASUREMENT

CAMPAIGN

BUT IT ALSO MEANS "MIRACLE" IN
SPANISH.

Narrator: IN MARCH 2006
MOLINA GATHERED AN
INTERNATIONAL TEAM OF MORE
THAN 450 SCIENTISTS
TO INVESTIGATE THE EFFECTS OF
LOCAL POLLUTION IN MEXICO CITY
ON THE SURROUNDING REGIONS
AND THE GLOBAL ATMOSPHERE.

THE SCIENTISTS REPRESENT
OVER 50 ACADEMIC AND
RESEARCH INSTITUTIONS
FROM MEXICO, EUROPE, AND THE
UNITED STATES
INCLUDING NASA, THE
DEPARTMENT OF ENERGY
AND THE NATIONAL SCIENCE
FOUNDATION.

MEXICO CITY IS AN IDEAL
LOCATION FOR MILAGRO'S
MEGACITY RESEARCH.

SURROUNDED ON THREE SIDES
BY MOUNTAINS
POLLUTANTS BECOME TRAPPED
WITHIN THE CITY.

Molina: THERE ARE MANY
REASONS FOR SELECTING
MEXICO CITY.
FIRST OF ALL, MEXICO CITY IS
ONE OF THE LARGEST

MEGACITIES.
IT HAS ABOUT 20 MILLION PEOPLE.
IT IS IN A TROPICAL LATITUDE
SO IT'S REPRESENTATIVE OF
MANY OF THE FUTURE
MEGACITIES
WHICH WILL BE IN ASIA, IN AFRICA.
MEXICO CITY IS AT A HIGH
ALTITUDE
AND THE SOLAR RADIATION IS
VERY STRONG
AND THE PHOTOCHEMISTRY, IT IS
VERY REACTIVE.
AND OF COURSE, WHAT WE HOPE
IS THAT WHAT WE LEARN FROM
MEXICO CITY
IT WILL PROVIDE INSIGHT FOR US
SO THAT WE CAN USE THAT
INSIGHT AND UNDERSTANDING
AND APPLY IT TO OTHER FUTURE
MEGACITIES.

Narrator: WHILE MANY PREVIOUS
STUDIES
REVEALED A GREAT DEAL ABOUT
POLLUTION WITHIN MEXICO CITY
WHAT HAPPENED TO THE
POLLUTION AFTER IT LEFT THE
CITY
AND WHAT ITS EFFECTS WERE ON
THE REGION AND THE GLOBE
HAD NEVER BEEN

SYSTEMATICALLY STUDIED UNTIL
MILAGRO.

SO YOU HAVE ALL THIS
POLLUTION COMING OUT
FROM BURNING OF FOSSIL FUELS,
FROM CARS, FROM INDUSTRY.
AND SO THE POLLUTANTS THAT
EMITTED LOCALLY
THE LOCAL EFFECTS WOULD BE
ON THE HEALTH OF THE
POPULATION
AND ON THE AIR QUALITY.
BUT THEN THEY COULD ALSO --
THE REGIONAL IMPACT
WHICH WOULD AFFECT THE
ECOSYSTEM.
AND THEN, ALSO, THERE'S THE
GLOBAL IMPACT
THAT WOULD AFFECT THE
CLIMATE.
SO THIS IS VERY SERIOUS.

Narrator: 24 HOURS A DAY FOR 30
DAYS

THE MILAGRO TEAM COLLECTED
DATA

USING AIRPLANES, RADARS,
WEATHER BALLOONS

AND DOZENS OF SCIENTIFIC
INSTRUMENTS.

I BROUGHT HERE TO MEXICO CITY
AN INSTRUMENT WHICH I CALL

THE DIFFERENTIAL
SUPERSATURATION SEPARATOR.
OUR INSTRUMENT IS CALLED
A LONG-PATH DIFFERENTIAL
OPTICAL ABSORPTION
SPECTROMETER.
PHOTOELECTRIC AEROSOL
SENSOR.
A PROTON TRANSFER MASS
SPECTROMETER.
THIS IS WHAT WE CALL A CAPS
PROBE, WHICH STANDS FOR
"CLOUD AEROSOL AND
PRECIPITATION SPECTRA" PROBE.
WHAT IT MEASURES IS AEROSOL
PARTICLES
WHICH ARE THE VERY FINE
PARTICLES IN THE AIR.
AS WE FLY, IT'S IN FRONT OF THE
PLANE
BECAUSE THERE WOULD BE
ENGINE EXHAUST IF IT WAS
FURTHER BACK
SO IT SEES THE AIR FIRST.
AEROSOL AIR COMES THROUGH
THIS PROBE
AND WHAT IS DETECTED IS THE
SIZE OF THE PARTICLES.

BY SIMULTANEOUSLY AND
COLLABORATIVELY GATHERING
THEIR DATA

THE SCIENTISTS WILL HAVE
BETTER INFORMATION
TO CREATE NEW MODELS
FOR PREDICTING THE TRANSPORT
OF POLLUTION
OVER WIDE GEOGRAPHIC AREAS.
Molina: THE OBJECTIVE OF THIS
STUDY, OF MILAGRO
IS TO FOLLOW THE PLUMES
AND FIND OUT WHERE AND
HOW AND WHEN
THE PLUMES ARE TRANSPORTED
TO OTHER REGIONS.
AND SO IT IS VERY IMPORTANT
FOR US
NOT ONLY JUST TO LOOK AT ONE
SITE
BUT TO LOOK AT VARIOUS SITES.

Narrator: TO STUDY THE
MOVEMENT OF PLUMES
THE RESEARCHERS HAVE THREE
MAIN FIXED GROUND SITES --
"T0," LOCATED IN THE CENTER OF
THE CITY
AND T1 AND T2, TWO POINTS
NORTH OF THE CITY
WHERE THE PREVAILING WINDS
ARE EXPECTED TO CARRY THE
PLUMES.

AT THESE SITES, RESEARCH

TEAMS MEASURE TRACE GASES
AEROSOL CONCENTRATIONS, AND
SOLAR-RADIATION LEVELS
AS WELL AS METEOROLOGICAL
DATA.

Molina: WE HAVE TO MEASURE THE
PRESSURE
WE MEASURE THE TEMPERATURE
WE MEASURE THE RELATIVE
HUMIDITY
AND THE WIND SPEED -- THE WIND
DIRECTION.
THESE ALL AFFECT THE
TRANSPORT OF THE POLLUTANTS.

Narrator: THE AERODYNE TEAM
TRAVELED TO MEXICO CITY
AS PART OF THE MILAGRO
CAMPAIGN.
TO HELP MONITOR THE PLUME
THEY SET UP THEIR MOBILE LAB
IN A UNIQUE, ELEVATED LOCATION
BETWEEN T0 AND T1, CALLED
PICO DE TRES PADRES.
WE'RE ABOUT A THOUSAND
METERS ABOVE EACH OF THESE
TWO SITES.
SO WE HAVE AN OPPORTUNITY AT
THIS LOCATION
TO ACTUALLY LOOK AT THE
LOFTED PLUME THAT'S COMING
TO US.

Narrator: IN THE MORNING
THIS LOCATION HAS RELATIVELY
CLEAN AIR
SINCE IT IS ABOVE THE
BOUNDARY LAYER
A LAYER NEAR THE GROUND
THAT DOES NOT MIX WELL WITH
THE ATMOSPHERE ABOVE.
THIS LAYER TRAPS THE
POLLUTION BELOW
IN THE BASIN OF MEXICO CITY.
BUT AS THE SUN HEATS THE
EARTH, THE BOUNDARY LAYER
RISES.

Herndon: BUT WHAT WE'RE
OBSERVING RIGHT NOW --
WE'RE ABOVE THE MIXING
HEIGHT.
ALL OF THE POLLUTION AND
EMISSIONS THAT ARE TAKING
PLACE
ARE NOT ABLE TO MIX UP AND
COME UP TO THIS LOCATION.
WHAT HAPPENS IS THAT THE SUN
COMES UP
AND BEGINS TO HEAT THE
SURFACE OF THE EARTH.
AND JUST LIKE PUTTING A PAN OF
BOILING WATER ONTO THE STOVE
IT BEGINS TO MIX AND BOIL,
MOVING THE AIR UPWARD,

UPWARD.
AND SO IT MIXES UP AND UP AND
UP.
AND WE'RE LOCATED UP HERE AT
THIS LOCATION
AND SUDDENLY WE BEGIN TO SEE
MUCH OF THE CITY POLLUTION
AND EMISSIONS COMING TO US
BUT IT'S A BIT LATER THAN WHEN
THE SUN COMES UP.
WE'RE SEEING INCREASES IN
CARBON MONOXIDE
CARBON DIOXIDE, AND NO_x.

Narrator: AS THE SUN PEAKS AND
CONTINUES THROUGH THE
AFTERNOON
THE POLLUTANTS CHEMICALLY
CHANGE AS THEY REACT IN THE
ATMOSPHERE.

Herndon: WHAT WE OBSERVED AT
T0

WE SAW A MIXTURE OF PRIMARY
AND SECONDARY POLLUTANT
SPECIES.

UP HERE, THE CHARACTER OF
JUST ABOUT EVERYTHING WE
HAVE SEEN
INDICATES THAT IT'S VERY
SECONDARY, VERY PROCESSED.
SO, FROM THAT POINT OF VIEW
WE HAVE AN OPPORTUNITY TO

LOOK AT THE FIRST STEPS
AS THE PLUME IS MOVING
DOWNWIND AS TO WHAT IS
HAPPENING
WHAT CHANGES ARE TAKING
PLACE
IN THE COMPOSITION OF THOSE
EMISSIONS.

Narrator: IN ADDITION TO GROUND
SITES
RESEARCHERS ALSO MEASURED
POLLUTANTS
FROM AIRPLANES AND
SATELLITES
TO CORROBORATE THEIR DATA
AND TO HELP TRACK THE PLUME.

Molina: IT IS VERY IMPORTANT FOR
US TO DO AN INTEGRATED
MEASUREMENT.

IN ORDER FOR YOU TO LOOK AT
THE OUTFLOW

NOT ONLY DO YOU NEED A
GROUND BASE

BUT YOU ALSO NEED TO HAVE A
LARGER COVERAGE

SO THE AIRPLANE IS VERY
ESSENTIAL.

AND THEN THE SATELLITE
OBSERVATION

PROVIDE EVEN LARGER INTO
SPACE.

WE WANTED TO USE DIFFERENT
TECHNIQUES
THAT COMPLEMENT EACH OTHER
SO IT'S VERY IMPORTANT FOR US
TO HAVE COMPLIMENTARY
MEASUREMENTS.
IT'S IMPORTANT FOR US TO HAVE
INTERCOMPARISON.
IN FACT, SOME OF THE
MEASUREMENTS DURING THE
CAMPAIGN
WERE DESIGNED EXACTLY FOR
THAT PURPOSE.

Narrator: LONG-TERM, MILAGRO
WILL LEAD TO BETTER MODELS
OF HOW EMISSIONS ARE
TRANSPORTED AND
TRANSFORMED
HELPING COUNTRIES MANAGE
AND IMPROVE AIR QUALITY.

PRELIMINARY DATA SHOW THAT
THE AEROSOL PLUME FROM
MEXICO CITY
TRAVELS OUTSIDE THE CITY AND
RISES HIGH INTO THE
TROPOSPHERE.
HERE, THE PREVAILING
HIGH-ALTITUDE WINDS
CAN POTENTIALLY TRANSPORT
THE POLLUTANTS LONG

DISTANCES
EVEN ACROSS CONTINENTS.

BUT IT WILL BE MANY YEARS
BEFORE MOLINA AND HER TEAM
HAVE DEFINITIVE RESULTS.

Molina: MILAGRO -- RIGHT NOW WE
ONLY FINISH THE FIRST PHASE
ONE

THE MEASUREMENT, THE
OBSERVATION STAGE.

AND THEN THE NEXT PHASE IS
NOW WE ARE IN THE PROCESS
OF DOING THE DATA ANALYSIS
SO WE HAVE ALL OF THIS TONS
AND TONS OF DATA.

THEN ALL THIS INFORMATION ARE
NOW FIT INTO MODELS.

THEN WE ARE GOING TO PRESENT
THE RESULTS
TO THE MEXICAN GOVERNMENT.

Narrator: WHILE THE MEXICAN
GOVERNMENT
HAS RECENTLY MADE STRIDES IN
REDUCING EMISSIONS
WITH STRICTER REGULATION
POLICIES AND CLEANER FUEL
MEXICO CITY IS JUST ONE OF A
GROWING NUMBER OF
MEGACITIES.

Molina: WE HOPE THAT BY

STUDYING MEXICO CITY
USE THIS AS A CASE STUDY
THEN WE CAN FIND OUT HOW
WOULD THE FUTURE MEGACITIES
THAT ARE COMING UP
HOW WOULD THEY INFLUENCE
THE ATMOSPHERIC
COMPOSITIONS
ON A LARGE REGIONAL-GLOBAL
SCALE.

Kolb: IF WE DON'T CONTROL THE
CHANGES WE MAKE TO THE
ATMOSPHERE
THE ATMOSPHERE MAY BEGIN TO
CONTROL
HOW MANY OF US ARE LEFT ON
THE PLANET.
SO IT'S VITAL THAT WE
UNDERSTAND
WHAT HAPPENS TO THE
POLLUTANTS WE EMIT
AND WE UNDERSTAND HOW TO
BETTER CONTROL THEM
SO THE PLANET CAN CONTINUE
TO BE A HABITABLE PLACE
FOR BOTH PEOPLE AND THE REST
OF THE CREATURES WE SHARE IT
WITH.