# WG 2: Meteorology, Transport, and Modeling

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An unprecedented amount of meteorological measurements were made both inside and outside the basin, in contrast to previous studies that focused only on basin-scale processes. Measurements were made at several surface sites and from from aircraft. Since the October conference, most of the data has been made available to MILAGRO investigators. These measurements are necessary to adequately describe the mixing, transport, and chemical processing of trace gases and particulates over the central plateau. Models perform reasonably well in predicting plume transport, but are not sufficient to capture all the details.


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# Current Analysis and Findings (1)

*Confirmatory Results*

**Large-scale flow regimes:** For the T0-T1-T2 sampling sites, transport towards the N-NE during southwesterly flow regimes occurred as frequently as expected. Overall meteorological conditions during 2006 typical of other years.

**PBL:** Daytime PBL growth similar to to other field campaigns (e.g. 1997, 2003). Explosive PBL growth often observed between 9 and 12 LT. However, processes responsible for this feature have not been fully explored.

**Basin Transport:** Models and data suggests that pollutants were usually rapidly transported out of the basin so that there was little multi-day accumulation.

**Thermally-driven circulations:** Strong southerly winds through the gap near Tenango del Aire were observed on many afternoons, similar to previous measurements. These flows have a profound effect on basin convergence and appear to responsible for most of the dust events over the eastern basin.

# Current Analysis and Findings (2)

*New results*

**Meteorological classifications:** Day-to-day meteorology in the basin classified into 5 categories for the field campaign and follows MCMA 2003 categories.

**Transport though terrain gaps:** Observations indicate pollutants often exiting and then re-entering the basin through SE gap and over the rim. More analyses necessary.

**Regional recirculation**: While pollutants readily transported out of the basin, there may be multi-day accumulation over the central plateau on some days. Models and aircraft data also suggest high concentrations of pollutants along the edge of the Sierra Madre Oriental. More modeling studies are needed to quantify the accumulation and how it affects chemical evolution further downwind.

**Synoptic recirculation:** Trajectories suggest one event of circulation around stationary high in Gulf of Mexico with large ages.

**Mountain venting:** Lidar measurements provide evidence of slope flows transporting particulates to higher altitudes. Additional studies needed to examine venting of pollutants into the free troposphere and their importance.

# Current Analysis and Findings (3)

*New results*

**Daytime PBL:** Days with/without convection showed no difference in morning growth (clear in morning); however, afternoon PBL may be modulated by deep convection. 5 sites with PBL information will provide measure of spatial variability of the PBL (inside and outside basin; lower and higher terrain) that was not obtained during previous studies. Comparisons of T1 and T2 suggest that CBL is terrain-following during the early morning, but flat during the afternoon).

**Nighttime PBL:** New measurements of the vertical extent of mixing in the city and beyond the city over T1 and T2. Mechanical mixing (converging flows, vertical wind shears, urban canopy effects) is the most likely reason. More analysis needed to understand how vertical mixing affects nighttime near-surface concentrations and chemistry.

**Marine BL:** First (?) detailed profiling along Gulf of Mexico to describe the vertical structure of Norte and marine BL.

**Chemical clocks:** Lagrangian time scales that employ air mass trajectories are now being used to help interpret chemical aging.

# Gaps and Outstanding Problems (1)

There does not appear to be a lack of meteorological data or analyses. Most problems are related to modeling of meteorology, chemistry, and particulates.

| *Problems* | *How are they being resolved?* |
|---|---|
| Ability to predict complex winds in the basin (e.g. speeds, convergence) that are similar to observed spatial variations. | Data assimilation techniques are being employed, but predictability during weak ambient forcing is an on-going problem in the meteorological community. |
| Ability of models to represent interactions between local and synoptic forcing. | Need to perform sensitivity tests that force model with different large-scale models (most have used GFS). |
| Representing the urban processes and their effect on vertical mixing, circulations, and heating/cooling. | New urban canopy parameterization in MM5 that includes building morphology (Jacilevich et al.). Need to use fluxes & energy balance data from flux tower. |
| Accurate land use information to define urban areas and sources of dust. | Compilation of GIS mapping (Jazcilevich et al). Need a compilation of dust events from aircraft data (photos and data) for source regions. |

# Gaps and Outstanding Problems (2)

| *Problems* | *How are they being resolved?* |
| --- | --- |
| Large uncertainties in fluxes of dust produced by various parameterizations. | More thorough evaluation of dust predictions and a comparison of the performance of dust emission modules. |
| Over-prediction of $NO_3$ and $NH_4$ by models. | Further analysis of models results and trace gas chemistry, including performance in predicting $NH_3$ treatment of dust effects. |
| Under-prediction of SOA by models. | Studies of SOA formation from laboratory and field measurements needed before implementation of new techniques in 3-D models. |
| Emission rate estimates usually not geared toward air quality modeling. | Several modelers (e.g. Zavala, Mena) devoted their time to prepare gridded emission inventories suitable for models Further work and updates are needed as well as assembling a “clearinghouse” of gridded emissions. |

# Gaps and Outstanding Problems (3)

| *Problems* | *How are they being resolved?* |
| --- | --- |
| Are VOC emission speciation suitable for Mexico City? | Need to more thoroughly evaluate current predictions of VOCs. |
| Background values of trace gases and particulates for regional models. | Linking to global models or using measurements to infer background values. |
| Adequately representing nighttime vertical mixing of pollutants. Simulated CBL too fast during morning. | Testing new PBL parameterizations in models. |
| Comparisons of model predictions and observations. | More model analyses that mimic observational analyses. |

# Cross-Cutting Issues

**WG 6, Emissions:** Inventories of anthropogenic, biomass burning, volcanic inventories, as well as more accurate and detailed land-use information for biogenic and dust emissions. Modeling studies need to define which emission inventories are used and some general statistics (total mass per time, etc.) Dust emissions - need information from aircraft on dust events (photos), need to compile information

**WG: 1, 2, 4, 5:** Use meteorological measurements and modeling to help interpret measurements of trace gas chemistry, aerosol chemistry and microphysics, particulates, and aerosol optical properties and radiative effects. Several collaborations are already going on, as indicated by presentations. For example trajectories to infer transport and source/receptor relationships, PBL information to determine air mass regimes and dilution effects on chemistry evolution, and Lagrangian time scales and chemical clocks. Collaborations are like to increase as investigations continue.

**Mexico City Air Quality:** Data and findings from MILAGRO will help improve local air quality models, thereby increasing our confidence in predictions of the impact of new car technologies and new fuels on air quality.

# Planned Publications (1)

25 total papers planned and many are cross-disciplinary.

*Meteorology focus:*

- Synoptic meteorological overview: Fast et al. (published in ACP)
- Basin meteorological overview: de Foy et al. (this summer)
- Meteorological model evaluations: de Foy, Skamarock
- Evolution of PBL heights at T1 & T2 from radiosonde, radar wind profilers and lidars: Shaw, Coulter
- Spatial variability of PBL evolution: Wohnschimmel, et al.
- Mechanically generated turbulence at night from lidar: Eichinger

*Transport focus:*

- Regional plume transport predictions using WRF: Skamarock
- Comparison of Eulerian transport, trajectory analyses: Skamarock
- Reconstruction of trajectories/atmospheric stability/wind shear along downwind transport using balloons, aircraft. and profilers: Voss

# Planned Publications (2)

*Transport focus (continued):*

- Trajectory analysis associated DC-8 measurements: Fuelberg
- Transport of pollutants through the gap and age of air parcels: Garcia
- Footprint of the Mexico City pollutant plume using AIRS: McMillen

*Chemistry focus:*

- Back trajectories to support C-130 measurements and how they relate to Lagrangian time scales and chemical clocks: McKenna
- Impact of city on surrounding crop/forest areas: Garcia
- Evolution of oxidants downwind of Mexico City: Tie
- Improving ozone modeling during MILAGRO by recovering emission scaling factors through data assimilation: Mena
- Evaluating the impact of Mexico City emission on ozone production regimes: Mena
- Estimation of ozone formation, sensitivity to anthropogenic sources of NOx and VOC for Mexico City; policy implications: Mena

# Planned Publications (3)

*Chemistry focus (continued):*

- Model study on the influence of aerosol and clouds on urban photochemistry: Tang
- Sensitivity of oxidants to emission inventories: Zhang
- Source apportionment of downwind chemistry: Emmons

*Particulate focus:*

- Evolution of particulates and their impact on aerosol radiative forcing and meteorology downwind of Mexico City: Fast
- Using Lidar data from the B-200 to understand pollutant transport and aerosol optical properties of pollutants: Fast and de Foy
- The relative role of anthropogenic and biomass burning on aerosol optical properties downwind of Mexico City: Hodzic and Fast
- 3-D modeling of secondary organic aerosols: Pandis