

**Lake Michigan Area (Midwest)  
Air Quality Weather Forecasting Issues**

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# Lake Michigan Air Quality Forecasting

## Presentation Outline

- Describe L. Mich's unique summertime meteorology greatly enhancing ozone levels in the region.
- PM<sub>2.5</sub> weather forecasting issues in the region.
- How the L. Michigan states and Ontario coordinate on forecast discussions for both ozone and PM<sub>2.5</sub> levels in the region.
- Each state is responsible for issuing its own AQ Watch for its area(s) that are predicted to have unhealthfully high ozone or PM<sub>2.5</sub> for the next day.

# Lake Michigan Air Quality Forecasting

## Presentation Outline (Cont.)

- Wis DNR's posting an AQ Advisory when current ozone or PM<sub>2.5</sub> are already at unhealthy levels.
- How the Wis DNR coordinates with the National Weather Service (NWS) to help disseminate the AQ Watch or Advisory.
- Satellite products used in Wis air quality forecasting.

# Lake Michigan and Bordering States



# Lake Michigan Air Quality Forecasting

## Participating State / Provincial Air Pollution Control Agencies

- Michigan Dept of Environmental Quality (MDEQ)
- Indiana Dept of Environmental Mgmt (IDEM)
- Illinois Environmental Protection Agency (IEPA)
- Wisconsin Dept of Natural Resources (WDNR)
- Ontario Ministry of the Environment

# **L. Michigan Ozone Weather Forecasting**

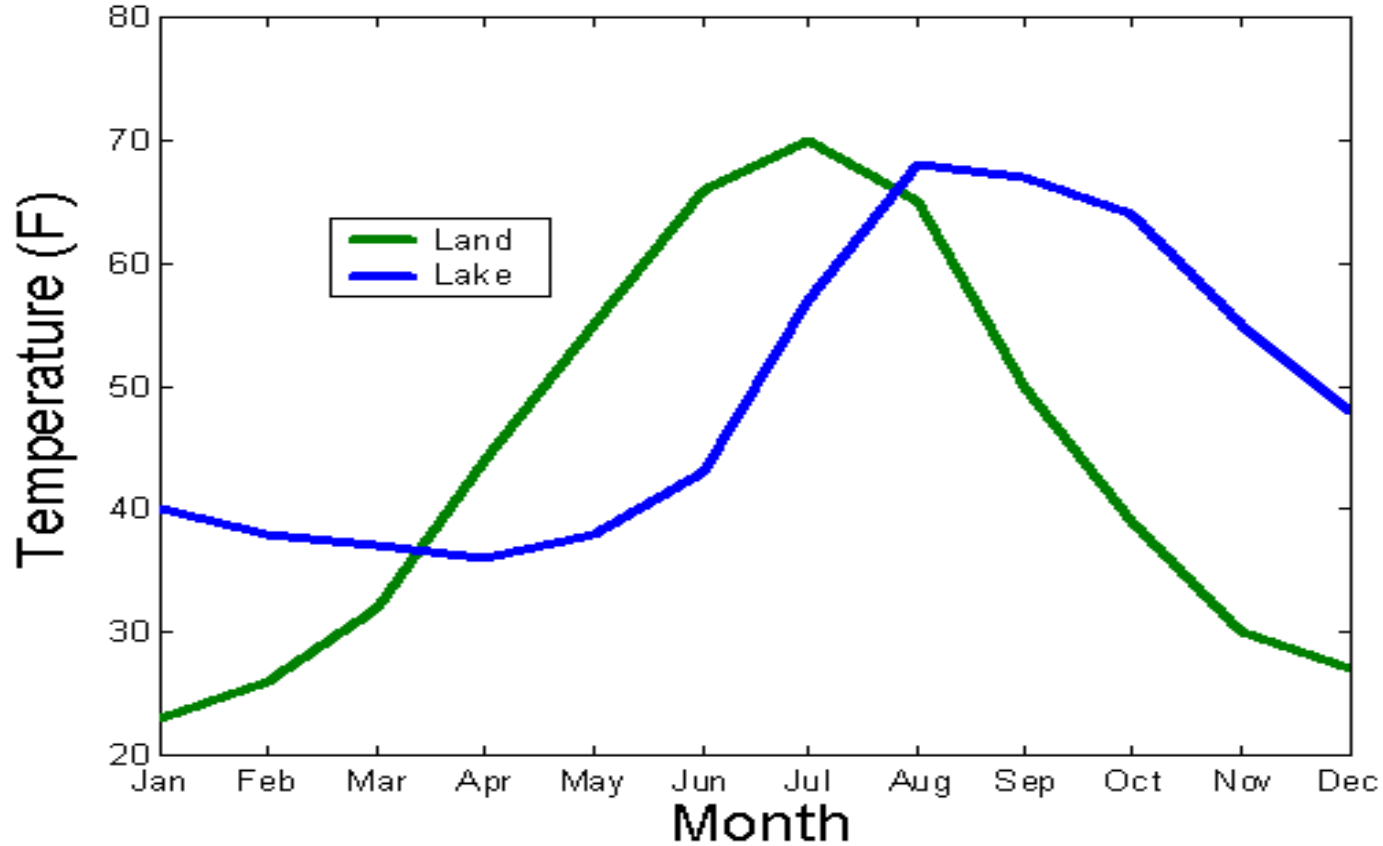
## **Geographical Influences**

During the warm months - ozone levels in the Lake Michigan basin (Figure 4) are greatly enhanced by the basin's atmospheric stability and flow characteristics -- after being sizably modified by the Lake's thermodynamic features.

The Lake's massive volume of water (1.3 quadrillion gallons over 22,400 square miles area) is a gigantic heat sink during May-August - significantly cooling the much warmer air advecting from land.

During spring to mid-summer: Surface water temps are colder than air temps over land by as much as 20F

**Southern Lake Michigan Region**  
**Monthly Ave Land Air Temperature**  
**vs**  
**Monthly Ave Surface Lake Temperature**



# **L. Michigan Meteorology in the Spring and Summer:**

## **The “Lake Breeze”**

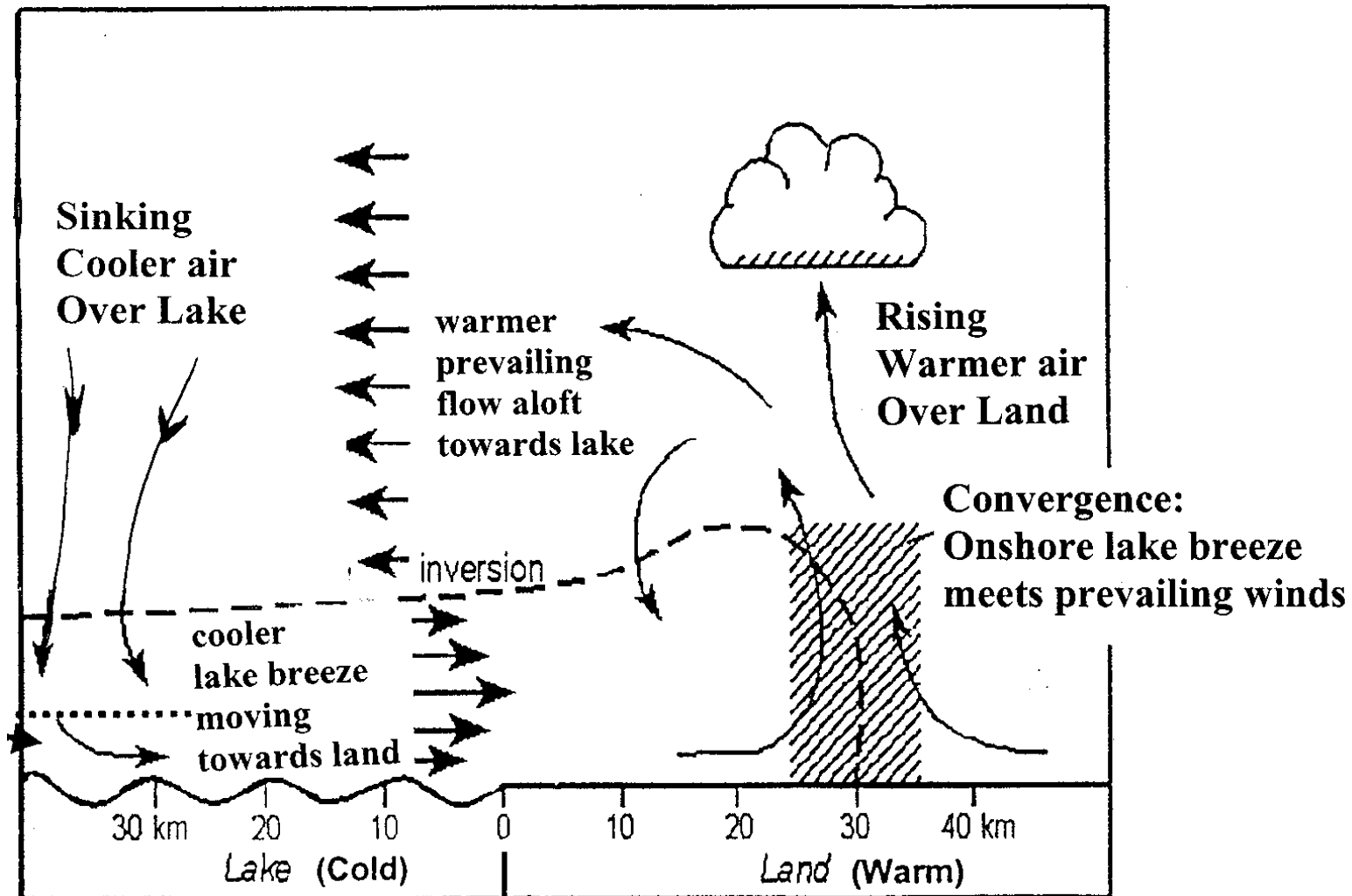
The temperature difference between a very large, cold lake & warm land sometimes generates a “*lake breeze*” circulation cell in shoreline areas.

Weather conditions favorable for a lake breeze are warm, sunny days during late spring to summer when prevailing wind speeds are relatively low.

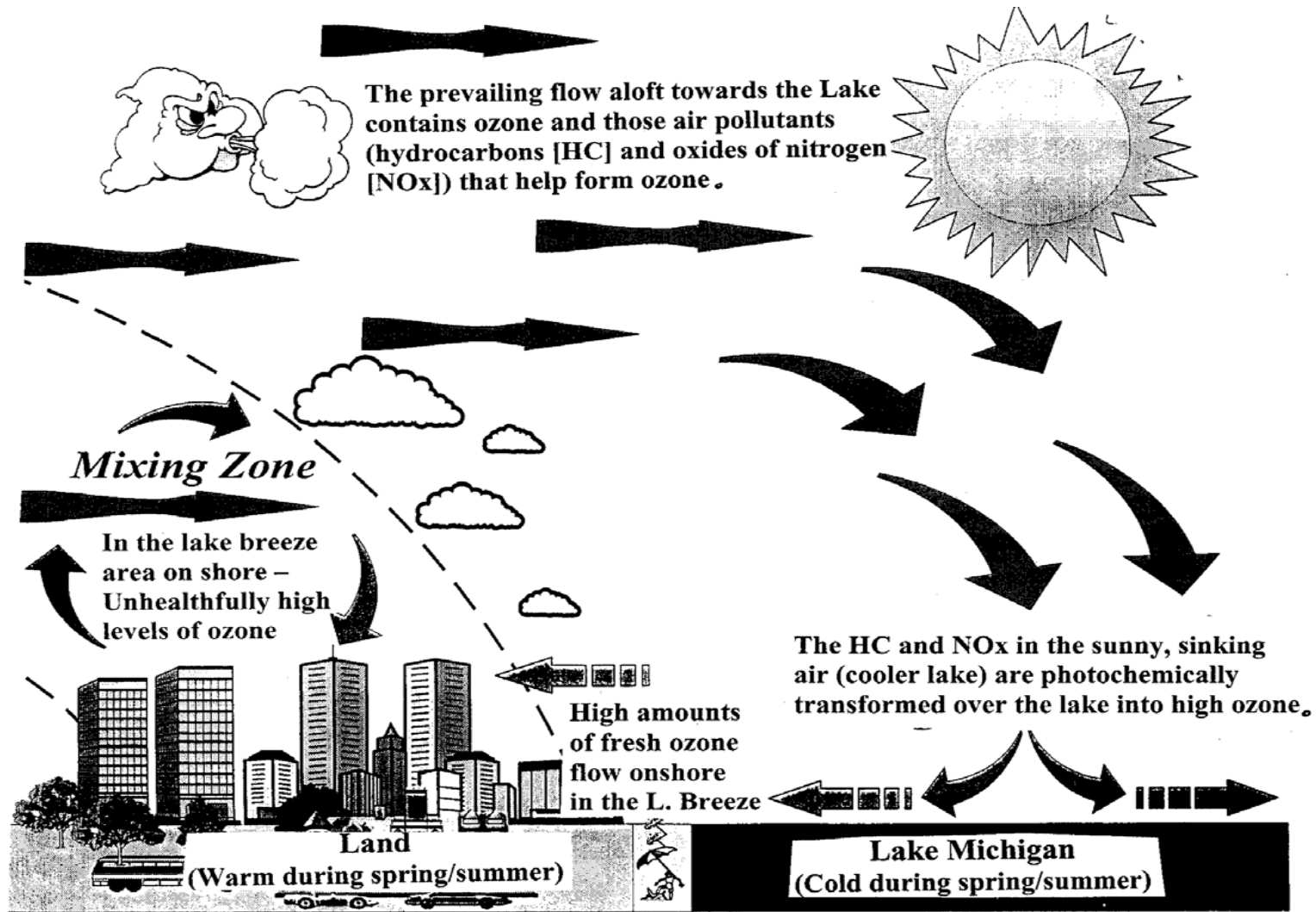
The lake breeze is conducive to the formation and transport of high levels of ambient ground-level ozone in coastal areas.



# Typical Lake Breeze Characteristics



# Lake Breeze can greatly increase ozone levels



# Lake Michigan: Ozone Nonattainment Counties

## Map

### Counties near Lake Michigan

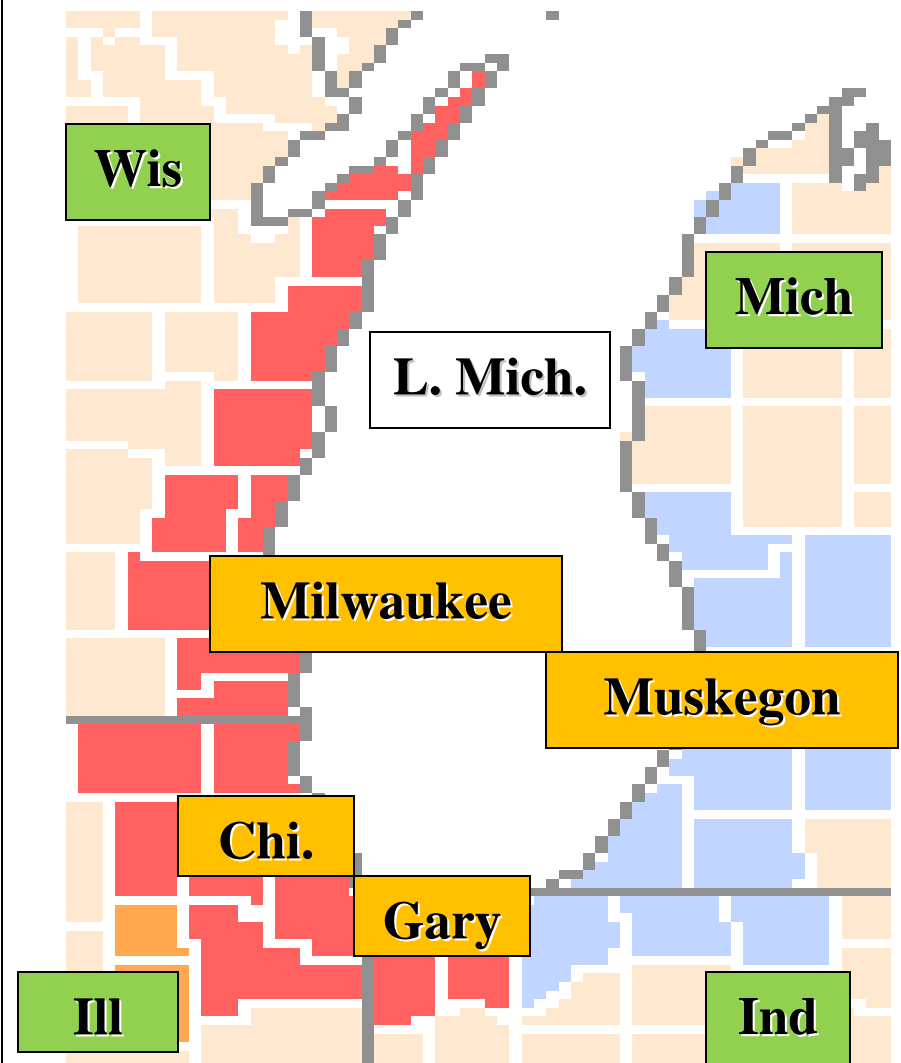
#### 1) Counties highlighted in **Red:**

As of May 08 -- designated as nonattainment of the 1997 8-hr O<sub>3</sub> nat'l ambient air quality std (NAAQS).

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#### 2) Counties highlighted in **Blue:**

Re-designated from nonattainment to attainment for the 1997 8-hr O<sub>3</sub> NAAQS.



# Lake Michigan Ozone Weather Forecasting

## Lake Michigan States Coordination

Coastal counties in the four L. Mich. states (slide 11) are especially susceptible to high ozone levels – brought on by ozone precursor emissions that are transformed and transported by the Lake's ozone-favorable meteorological processes (slides 8-10).

1995: The 4 state air pollution control agencies begin coordinating their summertime ozone forecasting programs - conducting weekly conference calls (more often if necessary) to discuss how the forecasted weather could impact ozone levels in the region.

# Lake Michigan AQ Weather Forecasting

## Lake Michigan States' Coordination

1999: Lake Michigan AQ forecasting program expands to year-around to include PM<sub>2.5</sub> and adjusts from 1-hr to 8-hr ozone averaging in order to reflect the PM<sub>2.5</sub> and 8-hr ozone standards promulgated in 1997.

2003: Meteorologists from the Ontario Ministry of the Environment begin participating in the Lake Michigan forecasting conference calls.

# **L. Michigan PM<sub>2.5</sub> Weather Forecasting**

## PM<sub>2.5</sub> Forecasting Considerations

Unlike ozone - high PM<sub>2.5</sub> levels are not restricted to the warm weather months and shoreline counties in the Lake Michigan airshed.

High PM<sub>2.5</sub> is often prevalent in stagnant air masses with high pressure, slow wind speeds, high relative humidity, and southerly winds.

During winter – intense inversions over snow can greatly restrict mixing – further enhancing PM<sub>2.5</sub> formation.

# **L. Michigan PM<sub>2.5</sub> Weather Forecasting**

## PM<sub>2.5</sub> Forecasting Considerations

Stagnant, humid weather conditions enhance secondary aerosol formation from gaseous precursors – similar to the photochemistry that generates ozone.

Local pollution sources in industrialized regions can be important contributors on high PM<sub>2.5</sub> days.

Some of the PM<sub>2.5</sub> mass is emitted directly from primary sources (i.e., does not undergo chemical transformation).

# Lake Michigan AQ Weather Forecasting

## Lake Michigan States' Coordination

Conference call discussions, review of ozone, PM<sub>2.5</sub>, current weather & forecasts - to evaluate each state's potential for having unhealthy air quality next day.

A major objective is to notify the public when forecasted next-day weather is conducive to ozone and / or PM<sub>2.5</sub> reaching unhealthfully high levels (i.e., the Air Quality Index [AQI] exceeding 100).

In these instances: Each State / Province predicting unhealthy air - calls an AQ "**Watch**" for next day.



# Lake Michigan AQ Weather Forecasting

## Lake Michigan States' Coordination

Each State / Province is responsible for issuing an air quality Watch for its area(s) that are predicted to have unhealthfully high ozone or PM<sub>2.5</sub> for the next day.

The Watch encourages 1) Citizens to take voluntary action to reduce activities that increase air pollution, and 2) People in pollution-sensitive groups to minimize exposure to air pollution.

# Wis DNR AQ Weather Forecasting Program

## Additional Wis DNR Protocol

When certain areas in Wisconsin have current ozone or PM<sub>2.5</sub> levels are already at unhealthfully-high levels for sensitive groups (“USG”, AQI > 100) - the WDNR issues an immediate notification (air quality “**Advisory**”) for targeted area(s) in Wis for which USG air quality levels already exist.

Each Advisory includes suggested actions for the public to take immediately in order to minimize exposure to air pollution.

# Wis DNR AQ Weather Forecasting Program

## Wis DNR Coordination With NWS

2002: The WDNR begins coordinating with the National Weather Service (NWS) State Forecast Office for Wis (“MKX”) – whereby MKX agrees to post WDNR “Watch” & “Advisory” public notices on its web site.

- MKX color codes those counties on its forecast region map that are affected by the AQ notice.
- MKX posts WDNR’s AQ notice text as a link from the “Read Watches, Warnings, Advisories” box.

# Wis DNR AQ Weather Forecasting Program

## Wis DNR Coordination With NWS

- MKX disseminates the AQ notice to those NWS offices that have forecast regions in Wis which include counties affected by the AQ notification. These other NWS offices do the same AQ posting steps as MKX.
- Note: The postings by the NWS offices supplement Wis DNR's own public notification system for Watches and Advisories.

# Lake Michigan AQ Weather Forecasting

## GOES Satellite Image Features Relevant to Ozone & PM<sub>2.5</sub> Dynamics

- Tracking current position, extent and approx. depth of the cloud deck(s) in the Lake Michigan airshed. Clouds reduce insolation levels which decrease photochemistry rates -- inhibiting ozone (and sometimes PM<sub>2.5</sub>) production.
- Time-lapse loops: Tracking direction and speed of the flow in which the clouds are embedded. Indicates the short-term advection and evolution of cloud systems in the airshed.

# Lake Michigan AQ Weather Forecasting

## GOES Satellite Image Features

### Relevant to Ozone & PM<sub>2.5</sub> Dynamics

“Rippled” shadowing on cloud top images might suggest significant convection – possibly including precipitation, which can further suppress ozone and PM<sub>2.5</sub> levels.

If any cloud top shadowing - check out appropriate NWS radar loop(s) for more detail.

# Lake Michigan AQ Weather Forecasting

## Satellite / other Remote Sensing Resources Relevant to Tracking Smoke Plumes

- High resolution (1 km) GOES images sometimes identifies smoke plumes coming from large-scale burns (e.g., forest fires). These plumes can make noticeable contributions to PM<sub>2.5</sub> levels.
- If smoke plumes seem apparent in the Lake Michigan region – check other fire tracking web sites for any verification / additional detail (e.g., NOAA's Fire Smoke Products, “GASP” & fire detection sites, Nat’l Forest Service Fire mapping site).

# Lake Michigan AQ Weather Forecasting

Other Satellite / Remote Sensing Weather  
Data Resources Reviewed

UMBC Atmospheric Lidar Group

Check their "Smog Blog" web site for current postings that could be relevant to any ozone or PM<sub>2.5</sub> dynamics in the Upper Midwest / L. Michigan area.



# **Lake Michigan AQ Weather Forecasting**

End of Presentation

Thank you

Any Questions? Comments?