Air Quality Factors in the Ocean SAMP

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Air Quality

Here we review relevant air pollution regulations, observed air quality data and non-attainment findings, together with related meteorological considerations. The focus is on US EPA regulations that apply on shore.

- EPA's six criteria pollutants
- Attainment compared to National Ambient Air Quality Standards
- Focus on surface level ozone, the pollutant most often in violation.

Criteria Air Pollutants

The National Ambient Air Quality Standards apply to substances that are listed as "criteria" pollutants. The criteria pollutants are these:

- Gases SO_2 (sulfur dioxide), NO_2 (nitrogen dioxide), CO (carbon monoxide) and O_3 (ozone).
- Fine and coarse particulate matter, $PM_{2.5}$ and PM_{10}, and lead (Pb).

The EPA sets limits on the concentration of these pollutants to protect public health and welfare. In Rhode Island and Massachusetts the monitoring data indicate that the standards are met for all of the substances except ozone.

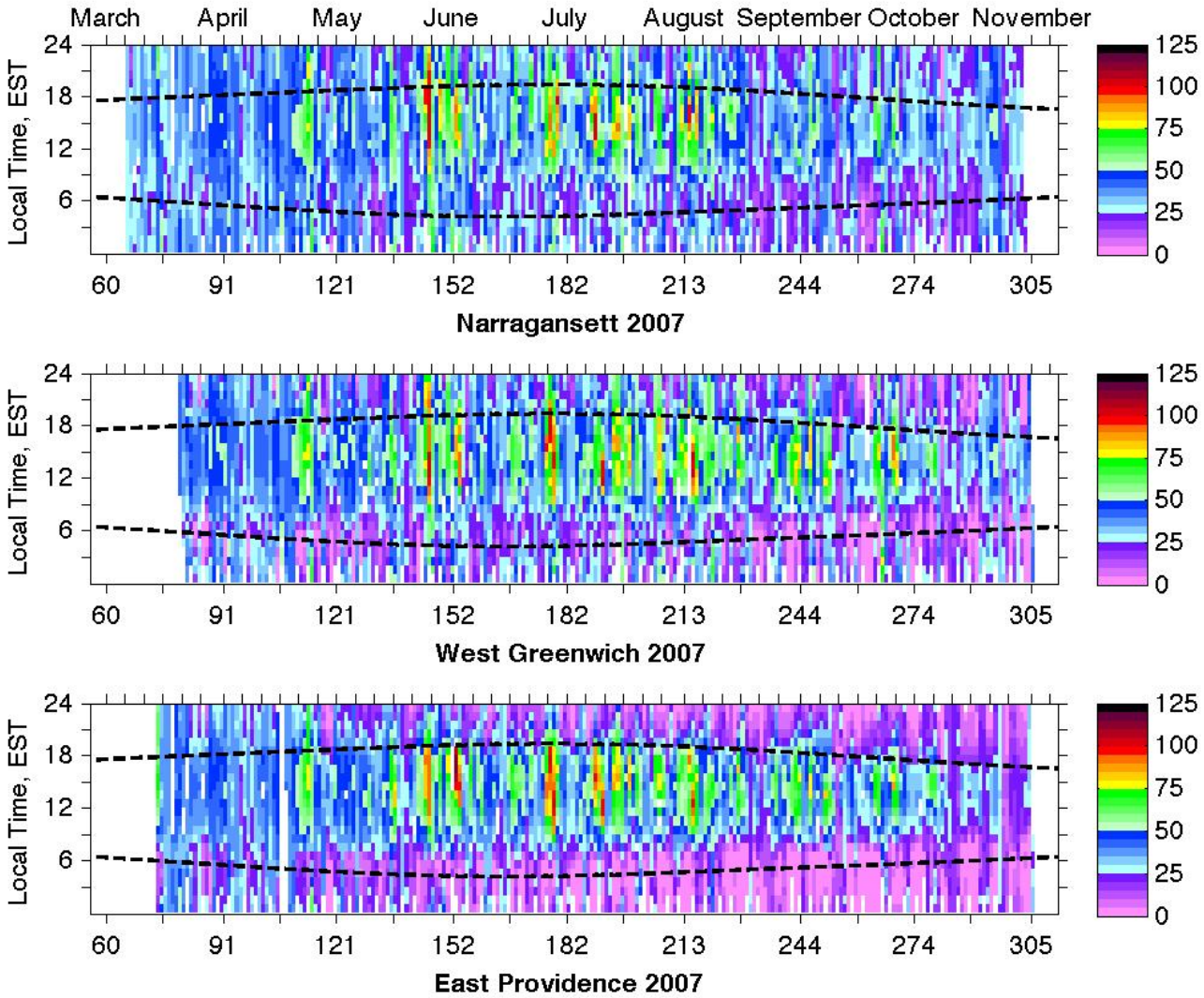
The NAAQS 8-hour standard for surface O_3 is met if the 3-year average of the fourth highest daily maximum 8-hour average mixing ratio at each monitoring site does not exceed 0.075 ppm.

Note that the maximum values are not regulated. At each monitoring site the three highest 8-hour average values are noted but do not constitute a violation. Also, peak 1-hour values and longer-term average values are not regulated.

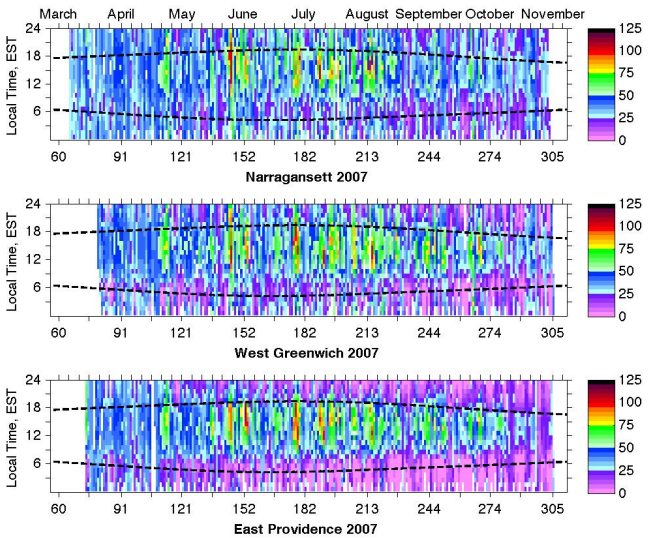
Surface ozone mixing ratios have been declining in recent years in response to regulatory measures. Nevertheless, Rhode Island remains a moderate non-attainment area. Here are some findings about surface ozone in Rhode Island.

- The standard is not met at any of the three monitoring sites.
- The ozone mixing ratio varies in time in a way that differs among the monitoring sites.
- This variation is informative in the context of on-shore/off-shore variations.

Also, the EPA has proposed strengthening the standard for ozone to make it consistent with the recommendations of its panel of advisors. This change will make meeting the standard more challenging.



Hourly-average surface O_3 mixing ratio, ppb (color scale at right) at the three monitoring sites in Rhode Island, for 2007.

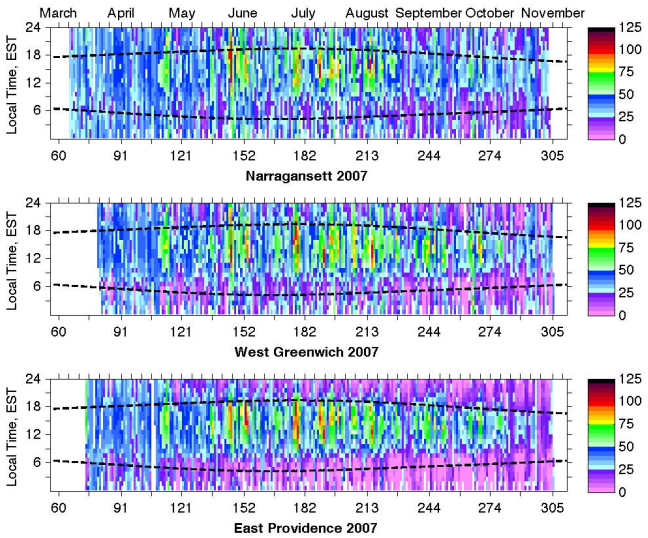


Ozone mixing ratios at the three monitoring sites in Rhode Island, 2007

The mixing ratio is indicated by the filled color at each hour of the day (vertical axis) and day of the year.

The green/yellow transition is at the 0.075 ppm regulatory value.

The black, dashed lines indicate the time of sunrise and sunset. The time of day is in EST, the time used by the EPA.

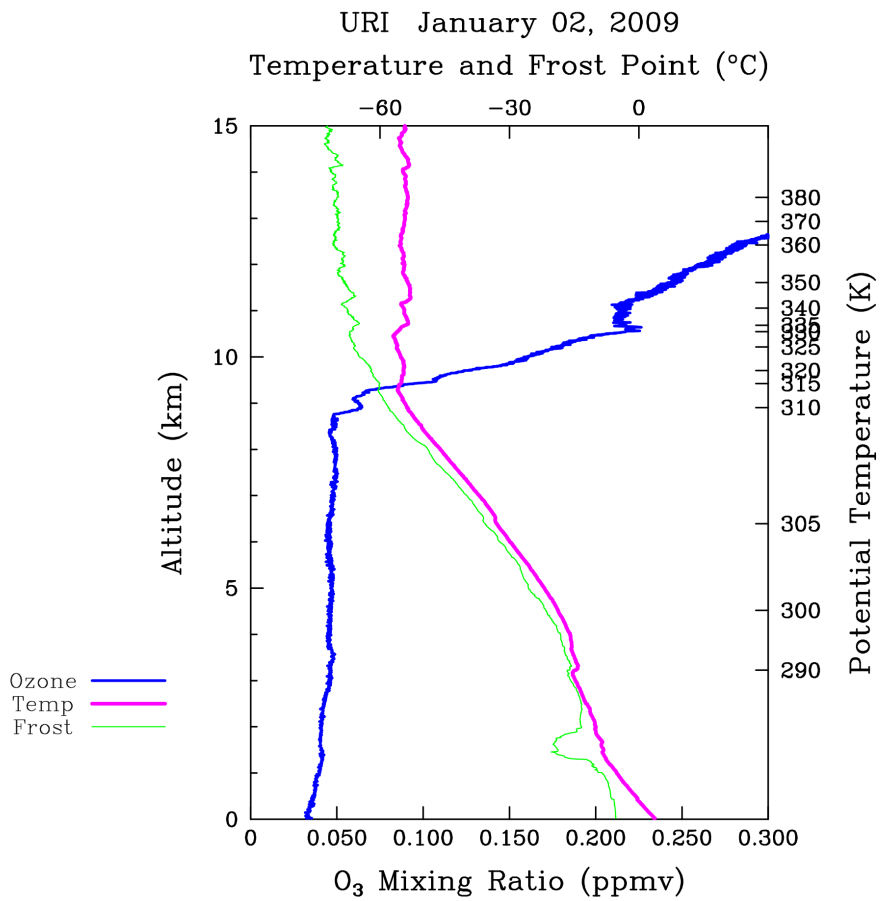


Ozone mixing ratios at the three monitoring sites in Rhode Island, 2007

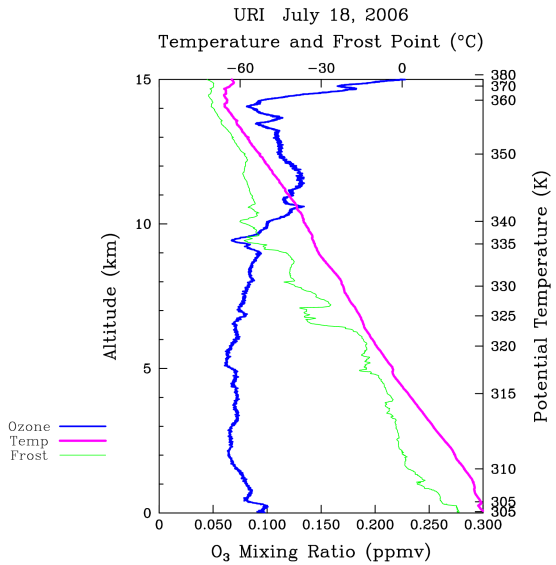
Peak values generally impact all of the sites, although the timing and duration can vary.

The occurrence of very low values of ozone overnight is evident, least at Narragansett and most at the East Providence site.

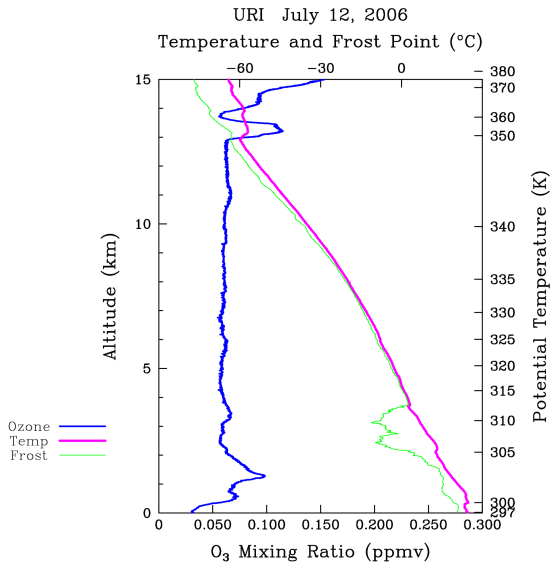
This variation reflects the role of titration by ambient pollutants in the absence of sunlight, and of the impact of a capping temperature inversion on the depth and stability of the surface mixed layer.



Vertical profile from Narragansett of ozone, temperature and dew/frost point temperature.



Conditions leading to high ozone at the surface usually include a near-surface temperature inversion. Peak ozone values are usually confined to a thin layer near the surface.



These same conditions can allow titration of ozone when insufficient light is present, even when the air is warm. Here, clouds blocked the sun.

The following are factors that we have not considered in our work.

- Emission of pollutants by fixed (land-based) energy production facilities will likely be reduced when there is a substantial capacity of renewable energy sources, because of decreased utilization of fossil fuel sources.
- Accurate estimation of the likely reduction of emissions is difficult for several reasons: energy generating facilities are widely distributed, and a number of factors contribute to decisions about their utilization.

Preparation for and installation of offshore turbine facilities will constitute large-scale industrial operations, requiring air-pollutant emissions permits.

- There are no off-shore air quality monitoring sites in southern New England.
- It is assumed that near-shore conditions are similar to those at the coastal monitoring sites (*e.g.* Narragansett).
- Surface ozone variations are known to be controlled by regional transport patterns, with major sources of ozone and ozone precursors carried here by the prevailing south-westerly surface level winds.
- Ozone precursors (NO_x and VOCs) emitted in offshore operations will contribute to the regional ozone nonattainment.

Emissions estimates for vessels and other equipment to be used in site preparation and construction are required as part of the permitting process.

- These estimates depend upon the types of equipment to be used, how the work is distributed in time and other factors that can only be determined together with project plans.
- Permitting involves State interests, as the emissions will be counted in the context of the State Implementation Plan. This is an agreement directed at bringing the state into compliance with the NAAQS.

Meteorology

Meteorological factors, not limited to the available wind energy resource, have relevance to the Ocean SAMP effort. I list these factors here, but will not present results on them at this time.

- Occurrence of disturbances - winter storms and gales, tropical storms and hurricanes.
- Precipitation - occurrence frequency and variability.
- Occurrence of fog; occurrence of icing conditions.

These phenomena have an impact on the design of facilities, and on their installation and maintenance. Despite their familiarity to those working in the marine environment in Southern New England, data on these factors need to be included in the SAMP report.

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