ABSTRACT. Mercury is the only atmospheric pollutant that is present in the atmosphere in atomic form. The optical resonance line at 254 nm can be used for absorption measurements using different optical remote sensing techniques. Range-resolved Hg mapping can be performed using the differential absorption lidar (DIAL) technique. We have used the lidar technique both for mapping of industrial plumes and for background concentration measurements. Our studies also include Hg of geophysical origin.

1. Introduction

Atomic Hg is present in very low concentrations as a pollutant in the atmosphere. Great interest is being taken in environmental Hg, since this species is known to have very adverse effects. Atomic Hg is generated from chlorine-alkali plants, coal-fired power plants, refuse incineration plants, and refuse deposits. Recently, a discussion on the substantial Hg emissions from crematories has emerged. Hg of natural origin is also present in the atmosphere, related to geothermal, seismic and volcanic activities. Mercury has also been observed to be a tracer gas for ore deposits. Typical background concentrations of atomic Hg are a few ng m, requiring high measurement sensitivities.

Mercury is the only atmospheric pollutant that is present in atomic form and this leads to an increase in detection sensitivity over molecular species when using optical spectroscopic techniques. Since the optical absorption is not spread out over a large number of rotational-vibrational transitions a sensitivity gain of a factor of almost 1000 over typical molecular compounds is obtained. We have taken advantage of this high sensitivity to perform absorption monitoring of the very low atmospheric atomic Hg concentrations using the 254 nm resonance line (6s$^1$S$^0$ - 6p$^3$P$^1$). Our first attempts to detect atmospheric Hg using lidar (light detection and ranging) techniques date back to 1982. When high-power, narrow-bandwidth tunable lasers became available the sensitivity of the technique could be improved to allow practical applica-
Measurements of ambient background concentrations and industrial emissions could then be performed. The differential absorption lidar (DIAL) technique was used, tuning the laser on and off resonance every second pulse. We have also used the Hg lidar technique for measurements in Icelandic geothermal fields, investigating possible connections between geothermal water and Hg emissions. We have also investigated an alternative lidar technique, which could be of considerable interest for Hg monitoring; gas correlation lidar. In parallel, atmospheric atomic Hg monitoring using long-path absorption of light from classical light sources has been developed. In such measurements, referred to as DOAS (differential optical absorption spectroscopy), mean concentration values are derived using basically classical absorption techniques. The unusually narrow lines encountered for Hg calls for a high spectral resolution, especially in view of the interference from absorbing O₂.

In the present paper a review of our continuing work on atomic Hg monitoring using lidar techniques is given, with a description of the lidar system and examples of Hg DIAL measurements on plumes and ambient air.

Figure 1. Lay-out of the Hg lidar system (From Ref. 9).

2. Methods

A mobile laser radar system, as illustrated in Figure 1, was used in our atomic mercury measurements. The basic construction of the system has been presented and special arrangements pertaining to Hg have been further elaborated on. Here a brief description of the system will be given.