Measuring concentration of surface ozone by means of semiconductor gas sensors

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1. INTRODUCTION

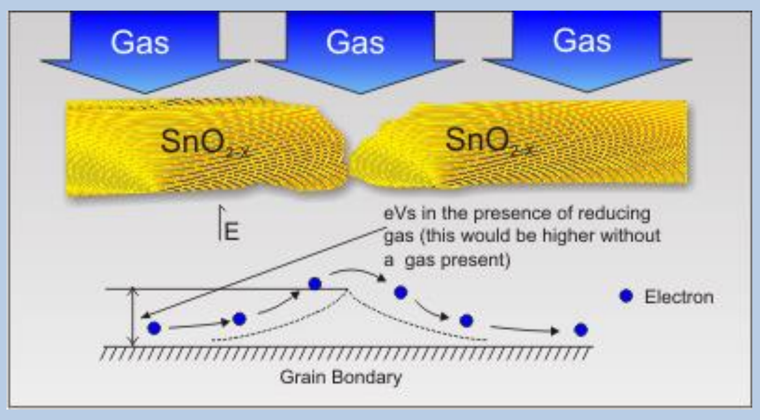
For a number of years, specialists at the National Ozone Monitoring Research and Education Center of the Belarusian State University (NOMREC BSU) have been deep involved in creating easy-to-operate compact indicators and meters of surface ozone concentration that would provide reliable monitoring of this gas component as well as significantly reduce a cost of performing such measurements.

Such a device based on a semiconductor gas sensor has been originated at the National Ozone Monitoring Research & Education Center.

2. INSTRUMENTATION

PION-SO surface ozone concentrations meter

- Device type: surface ozone concentration meter
- Detector: SnO2 semiconductor gas sensor
- Detecting concentration range : 10-1000ppb
- Power consumption: 5W
- Measuring interval: 5 min.
- Internal data storage: 4 GB SD flash card
- Interfaces : USB Host Mass Storage, LAN, Wi-Fi



The operation principle of HMOS (Heated Metal-Oxide Semiconductor) and GSS (Gas Sensitive Semiconductor) based ozone sensors is that of heating a small semiconductor substrate to high temperatures thus making it to be extremely sensitive to the ozone. This is seen as a change in the resistance of the material, which is measured by the circuitry, interpreted as the ozone, and either displayed or output for one's use.

One of the key benefits of this sensor technology is that it is very inexpensive allowing widespread adoption at many facilities.

Another advantage of semiconductor-based sensors is their solid ozone response below 0.1 ppm. This allows them to be used in many ambient ozone safety scenarios with a display resolution as fine-grained as 1 ppb. While not as stable or sensitive as UV-based ozone analyzers in this range, they are worth consideration for ambient safety scenarios where low ozone concentrations are expected.

Disadvantages include a slower response time to ozone (if compared to electrochemical sensor) and the extended warm-up time that the sensor requires.

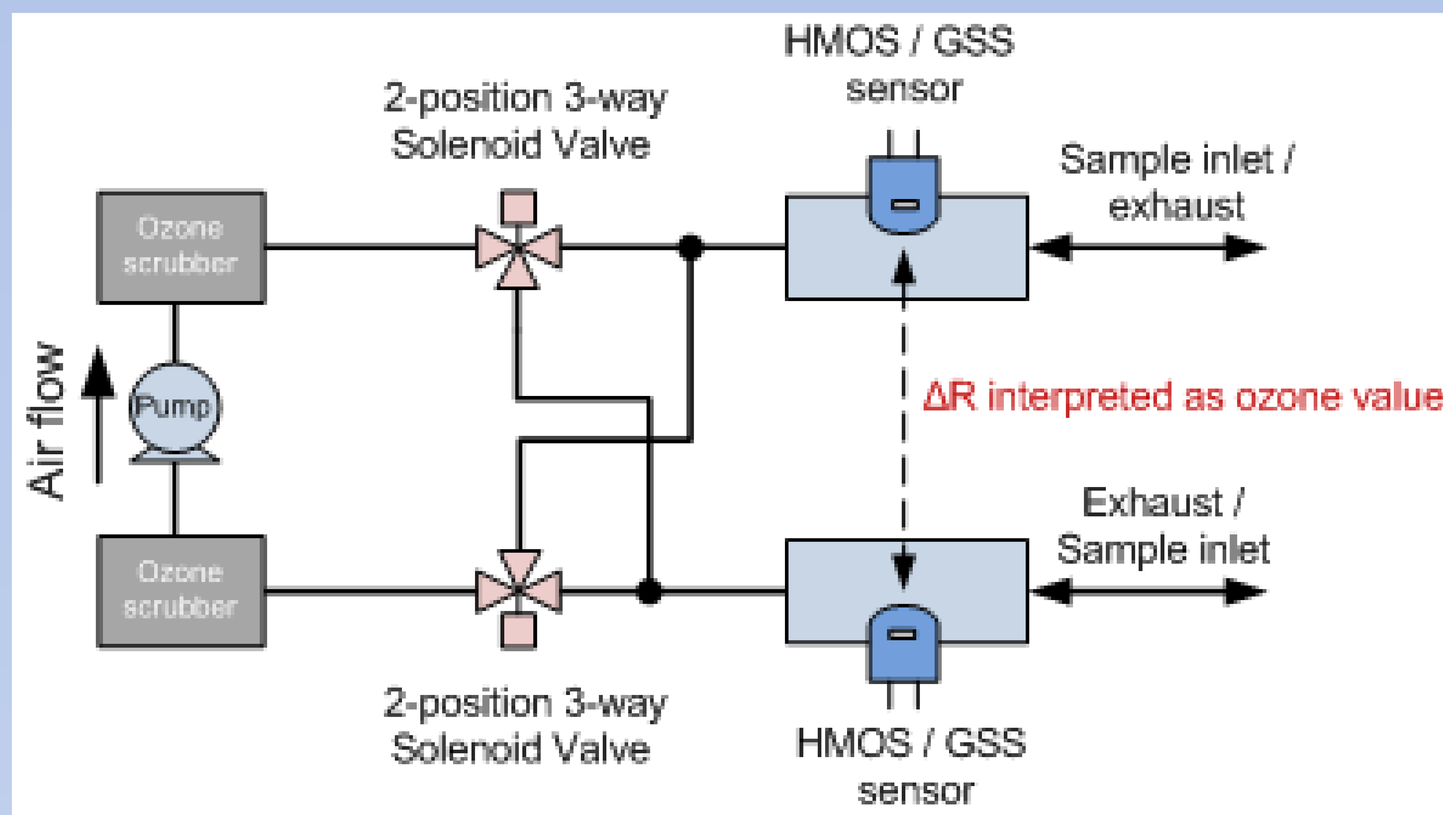


Fig. 1. Air flow scheme of the PION-SO device.
Differential scheme with sensors, which have similar characteristics, allows to minimize a zero drift error.

3. PURPOSE

1. Designing low-cost and easy-to-operate compact device for surface ozone measurement.
2. Field tests of the instrument during the seasonal Belarusian Antarctic Expedition (BAE) of 2015-2016 at the Station of "Gora Vechernyaya". Polar regions pose certain interest for tropospheric ozone research for several reasons. Anthropogenic sources and sinks are scarce because of low human population density and the general absence of industries. In this environment, tropospheric ozone is mostly determined by natural processes, synoptic transport and downward transfer from the stratosphere.

Calibration and test of the PION-SO device.
Tests of the instrument and parallel measurements of surface ozone concentrations with an optical gas analyzer TEI 49C have shown a good result thus allowing to make a conclusion about the prospects of creating measuring equipment based on semiconductor gas sensors.

4. RESULTS

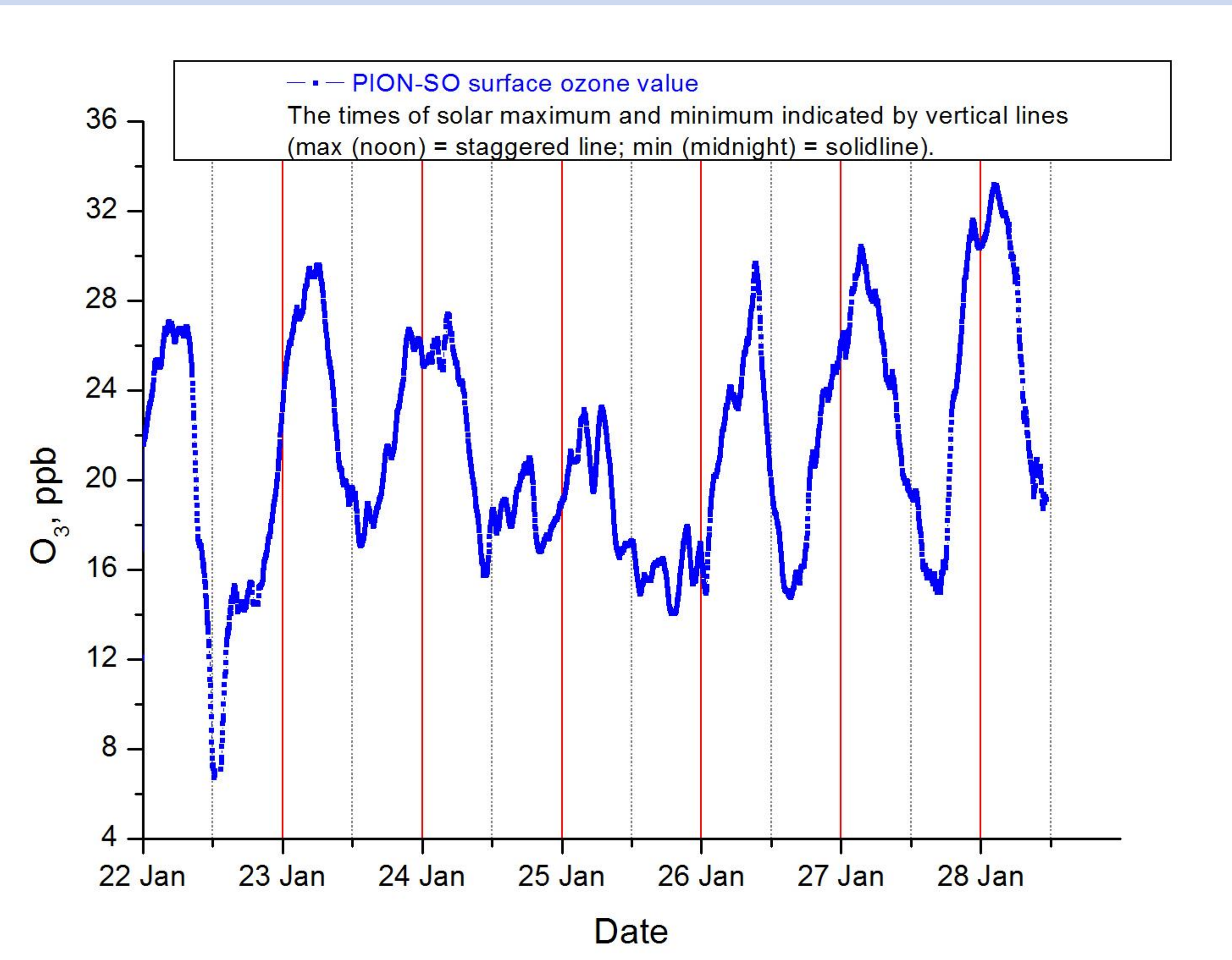
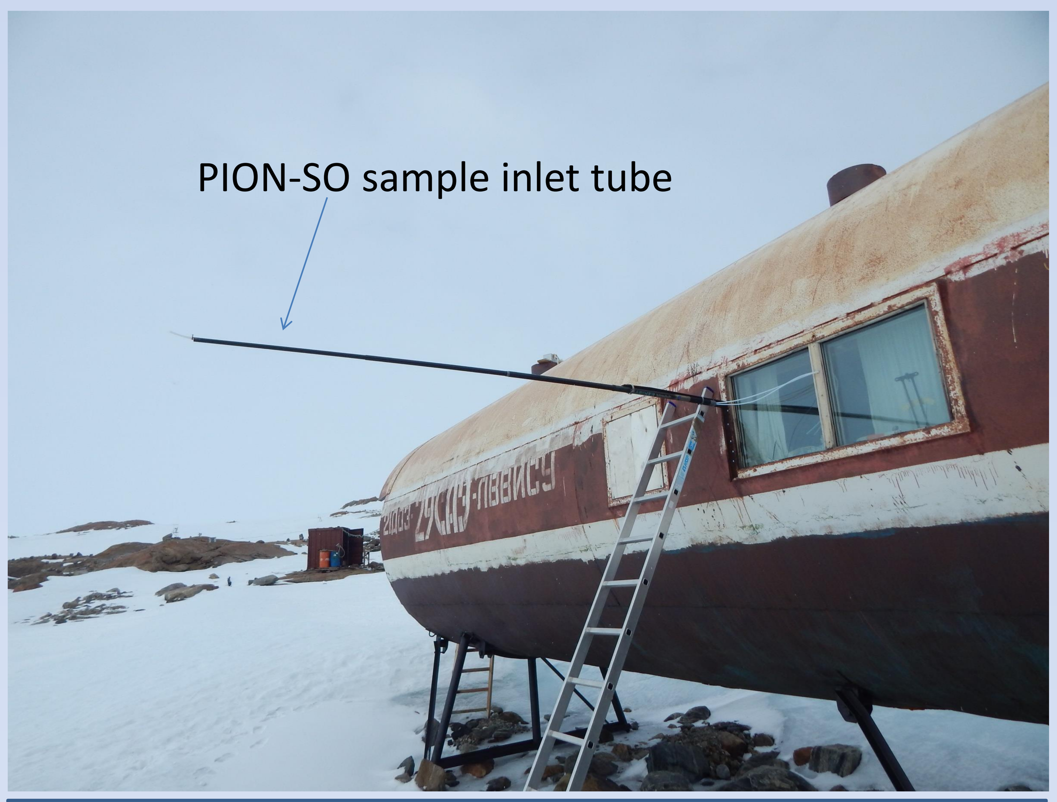


Fig.2.Diurnal cycles of surface ozone concentrations value at the Station of "Gora Vechernyaya".



The PION-SO device located at the Antarctic Station of "Gora Vechernyaya".

4. DISCUSSION

Daily changes of surface ozone concentration measured by a PION-SO device at the station of "Gora Vechernyaya" possibly depend on diurnal solar irradiance. With maximum solar irradiance the device has registered minimum surface ozone concentration and vice versa. We suggest that such a cycle may deal with snow-photochemical processes including radiation-modulated NOx chemistry and solar-modulated ozone deposition or is due to the fact that station is located near the coast, where local effects, such as diurnal cycles of flow regimes, e.g. diurnal on-shore/offshore sea-breeze flow, may occur.

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