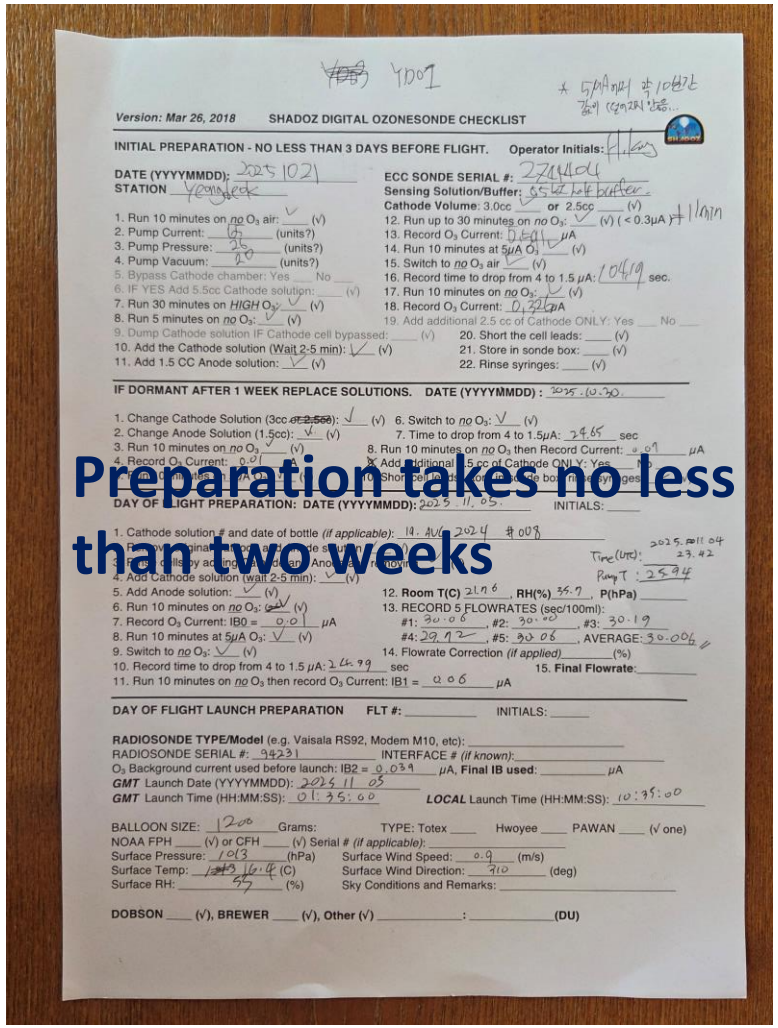
Toward Simpler Ozone Soundings:
Preliminary Data from a Solid Polymer Electrolyte Sensor

Seon Woong Kim
Korea Research Institute of Standards and Science(KRISS)

- **Why use solid polymer electrolyte sensors?**
- **Laboratory evaluation**
- **Field test**

Why use solid polymer electrolyte sensor?

- ECC ozonesonde preparation is labor-intensive and inconvenient.



Preparation takes no less than two weeks

Electrochemical concentration cell(ECC) ozonesonde, En-Sci

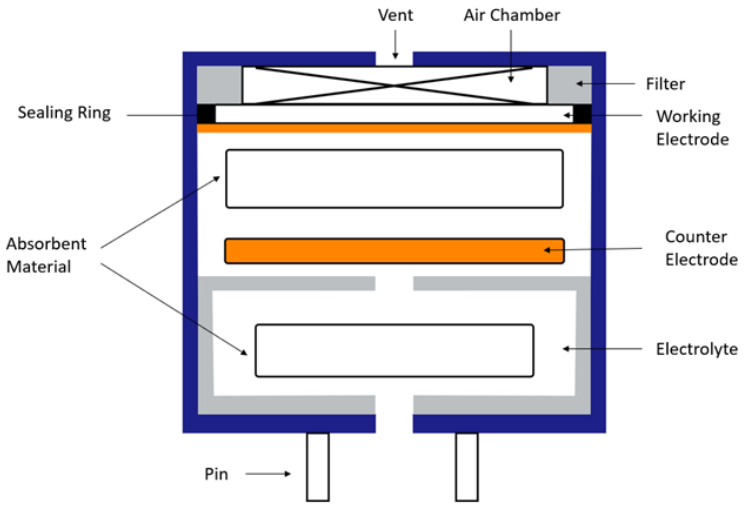
✓ Straight-forward operating principle

✓ High measurement accuracy

‼ Preparation is labor intensive and time-consuming

Why use solid polymer electrolyte sensor?

- Solid polymer electrolyte (SPE) ozone sensors offer user-friendly operation.



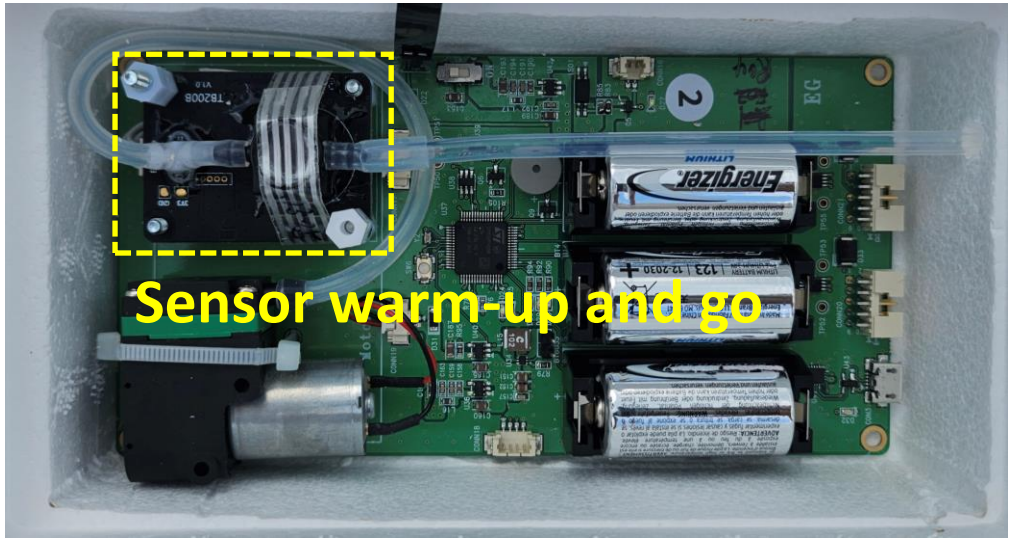
(figures from EC Sense web page)

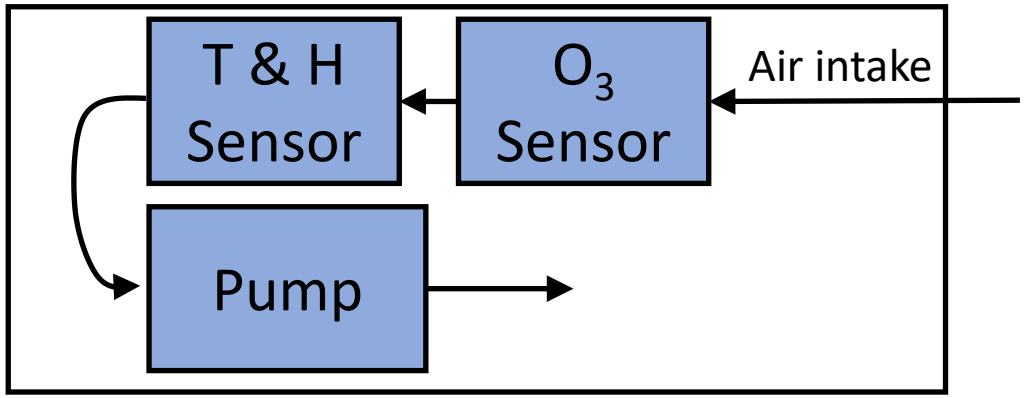
Solid polymer electrolyte(SPE) ozone sensor, EC Sense

✓ No liquid—no electrolyte leakage or drying out issues

✓ Minimal preparation on the user end

‼ Accuracy depends on calibration





Schematic diagram of ozone sensor for upper-air monitoring

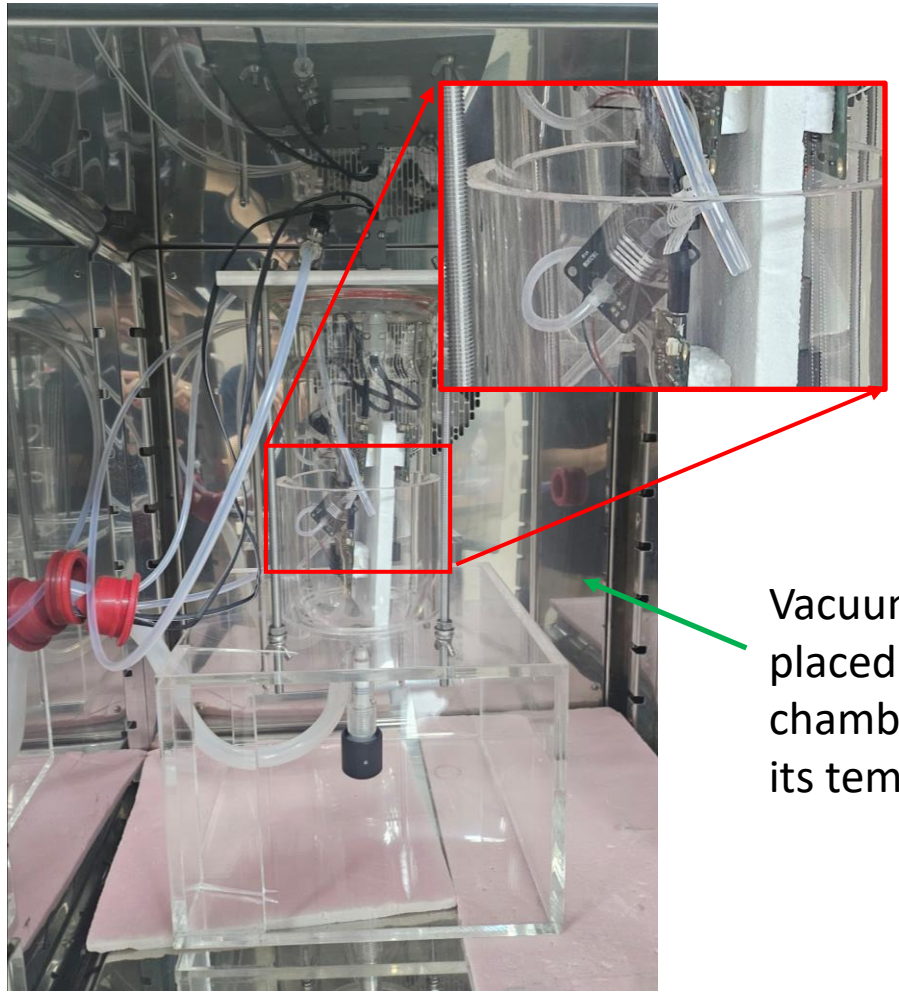
Lab evaluation: sensors are not built for low pressures

- Recalibration of ozone sensors are required across varying pressure and temperature conditions.

Performance	
Sensitivity	-70 nA/ppm ± 25 nA/ppm
Zero Current	± 2 nA
Range	0 - 5 ppm
Maximum Overload	10 ppm
Resolution (16Bit ADC)	< 0.01 ppm
Response Time	T_{50} < 40 s, T_{90} < 120 s
Repeatability	2 %
Linearity	Linear

Environment	
Operating Temperature Range	-20 ℃ to +55 ℃
Operating Humidity Range	15-95% RH non-condensing
Operating Pressure Range	800 to 1200 hPa
Storage Temperature	0 °C to 20 °C (Optimum temp. 4 °C to 6 °C)

EC Sense ES1-O3-5 datasheet

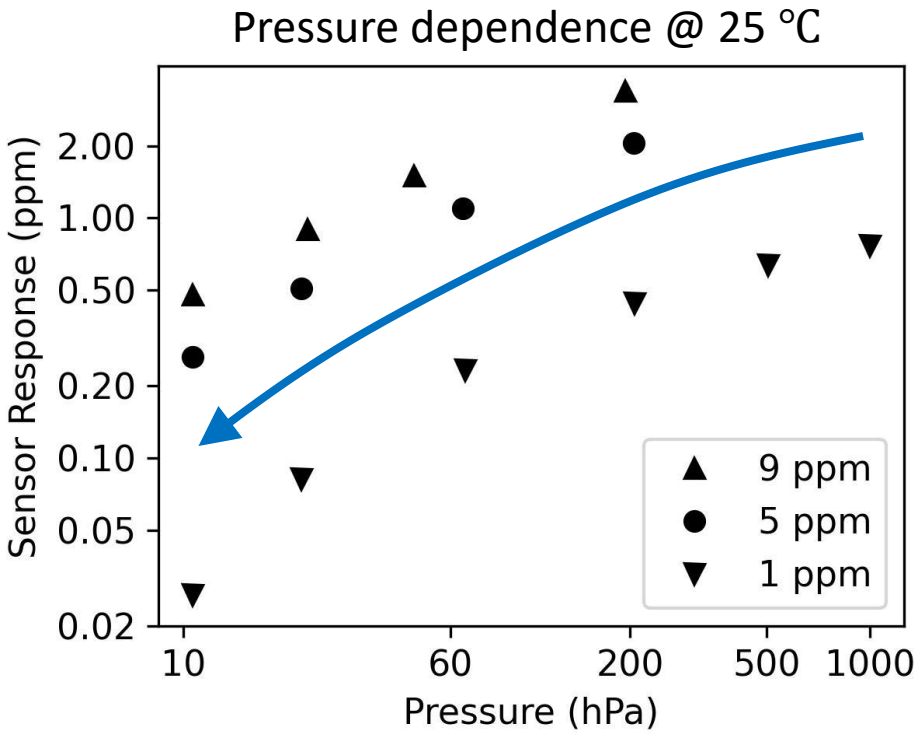


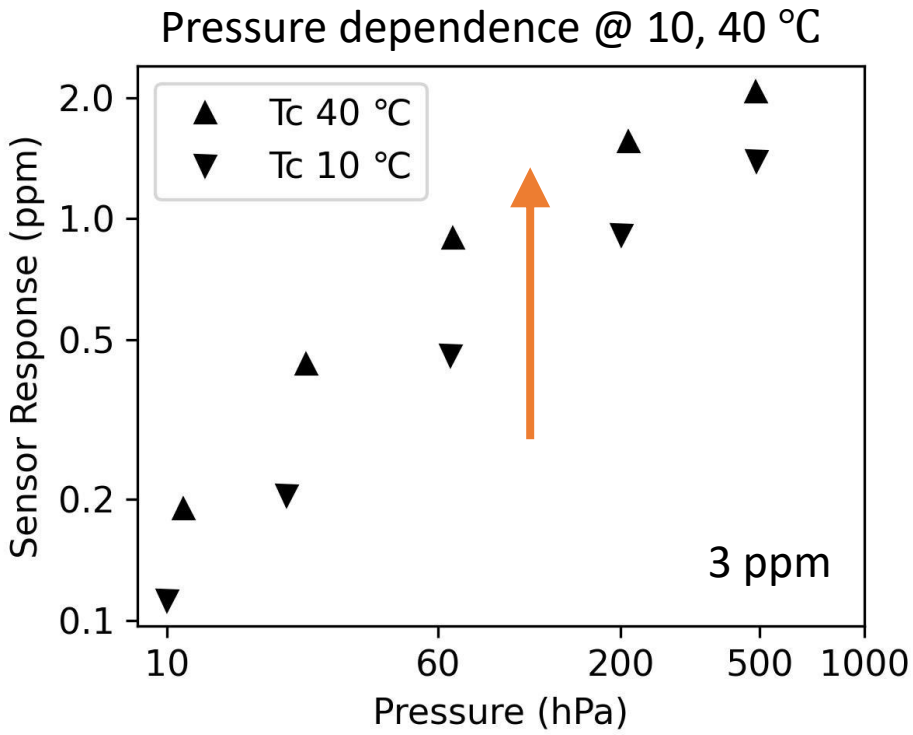
Sensor in glass vacuum chamber

Vacuum chamber is placed in a climatic chamber to control its temperature

Lab evaluation: model for varying P & T

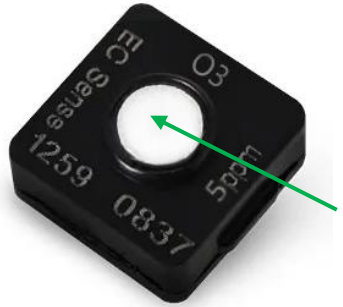
- Recalibration pressure range: 10–1020 hPa, temperature range: 5–45 °C



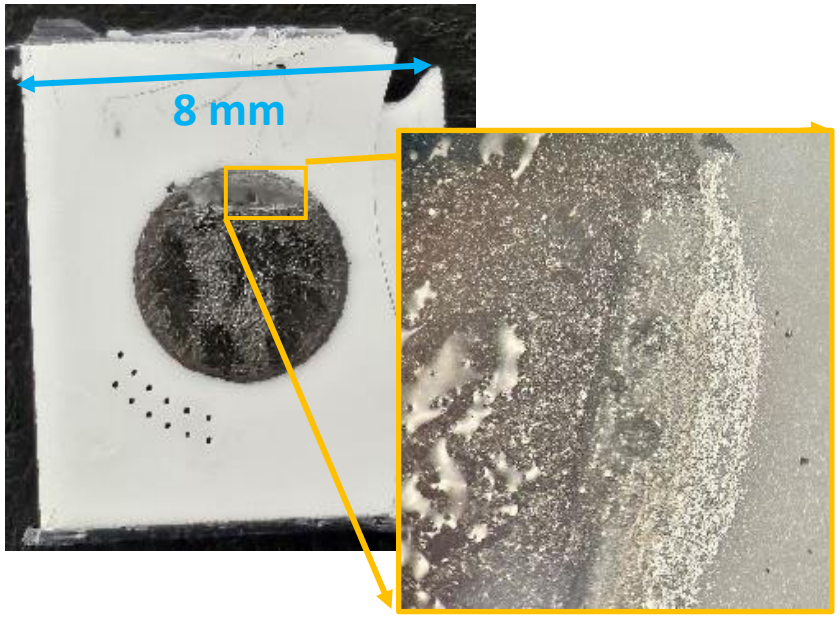


- Sensor response increases with pressure, but sensitivity (slope) is greater at lower pressures.
- Sensor output increases with temperature.

Lab evaluation: model for varying P & T



Gas diffusion membrane



Ozone sensor working electrode

- Diffusion mechanism shifts with pressure

  Molecular diffusion ⇔ Knudsen diffusion
  (high pressure) (low pressure)

- Basic form:

$$P_{O3} = S(aP + b)$$

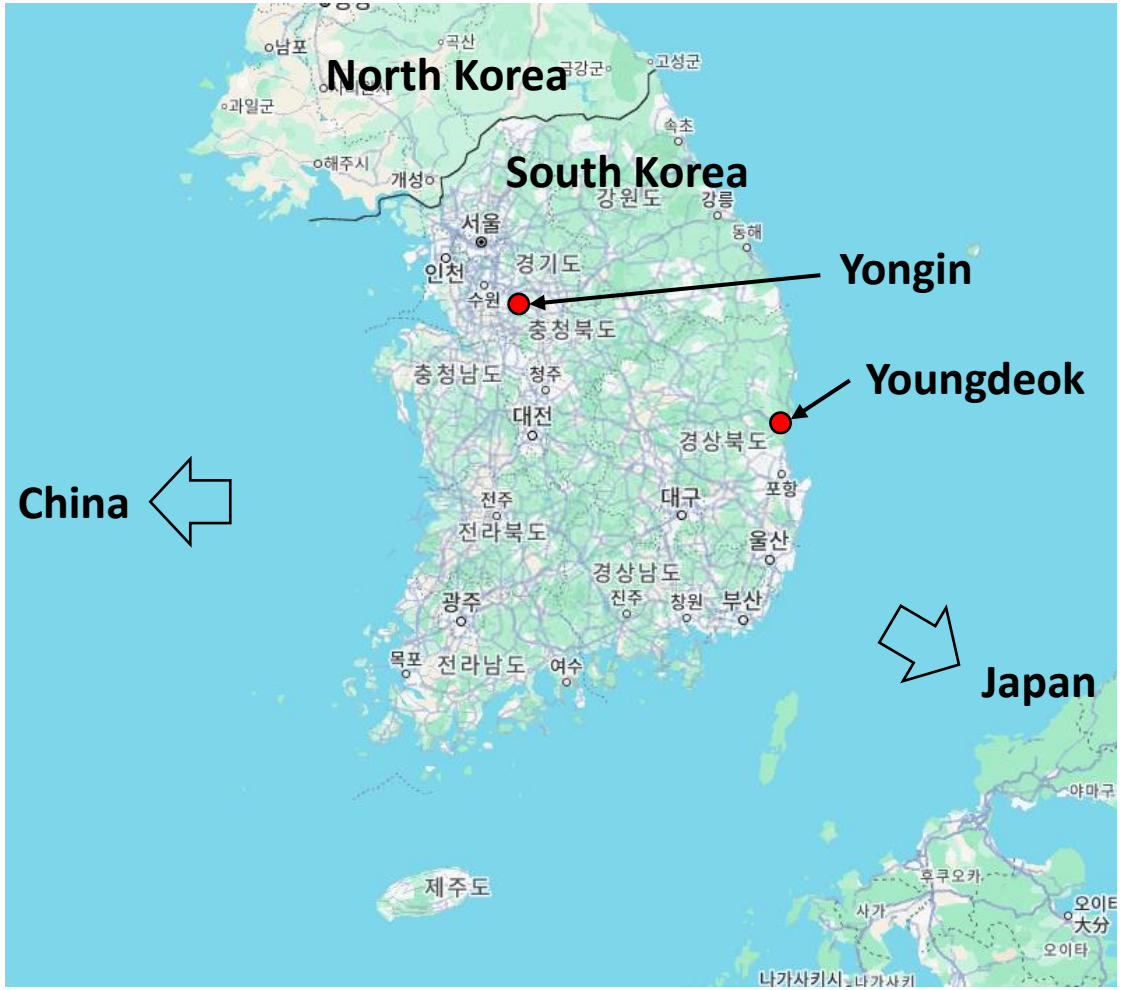
P_{O3}: *Ozone partial pressure* [mPa]
S: *Sensor reading* [ppb]
P: *pressure* [hPa]

- With empirical factors accounting for temperature dependence,

$$P_{O3} = \frac{S}{b}\left\{\frac{a\left(\frac{P}{1013}\right)}{\left(\frac{T}{T^*} - 1\right)^{\gamma}} + \frac{1}{\left(\frac{T}{T^*} - 1\right)}\right\}$$

- Four coefficients for each sensor: a, b, T^*, γ

Field test: test locations in South Korea

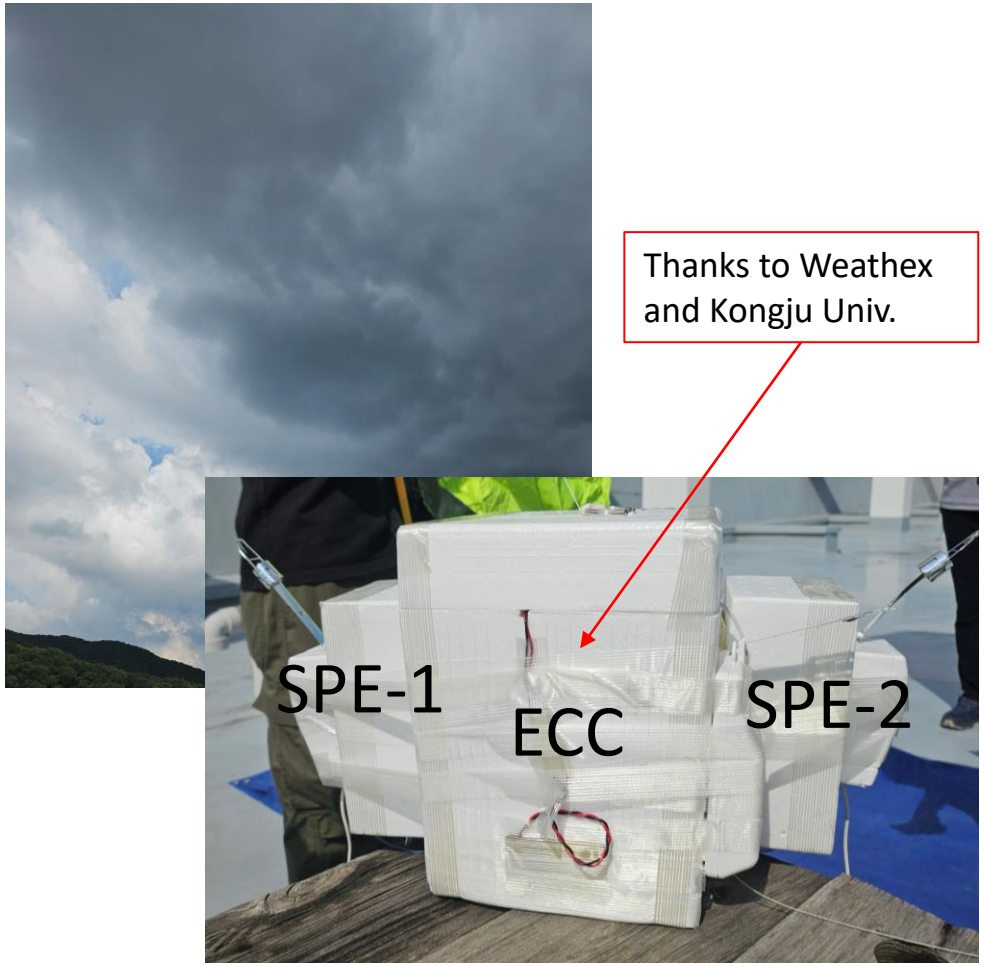


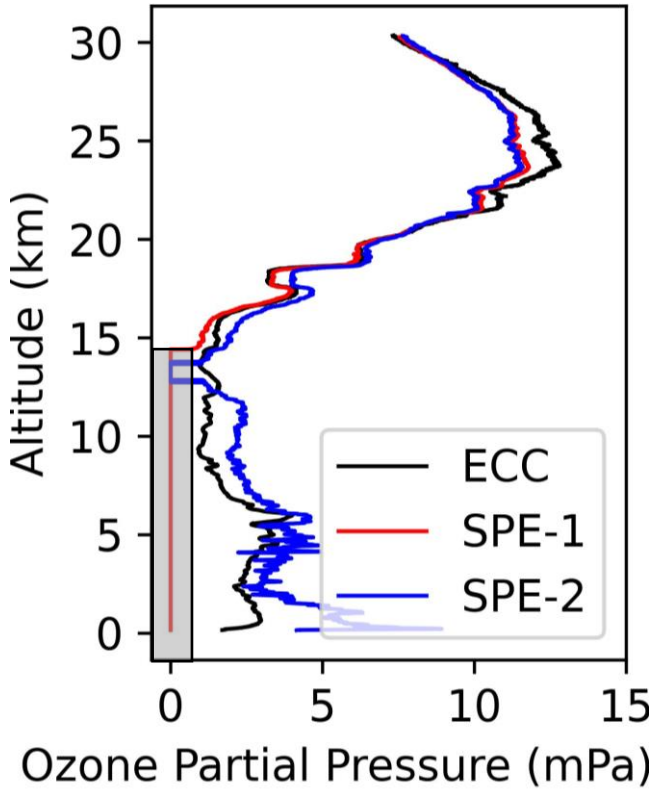
1. Yongin (August, 2025)

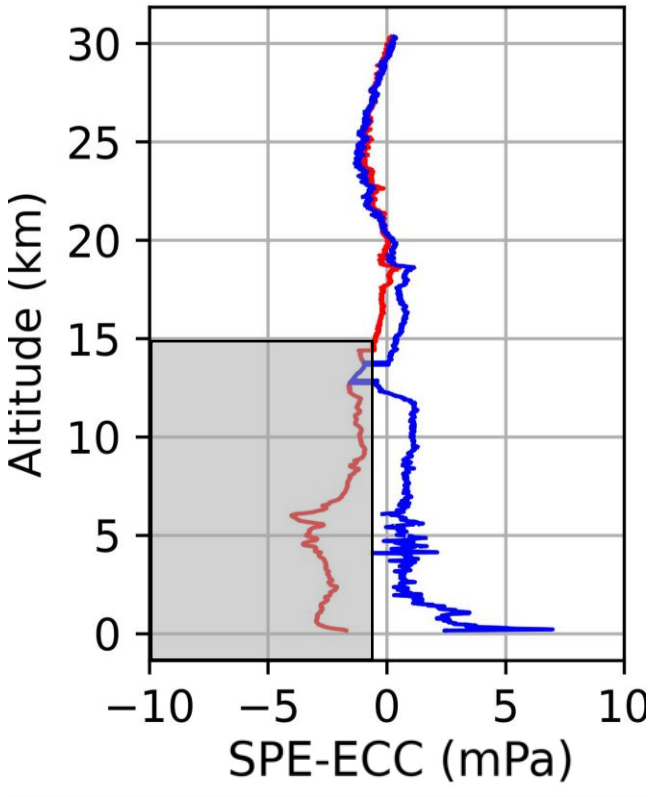
2. Youngdeok (November, 2025)

Field test: promising but revision required

- Yongin (August, 2025)



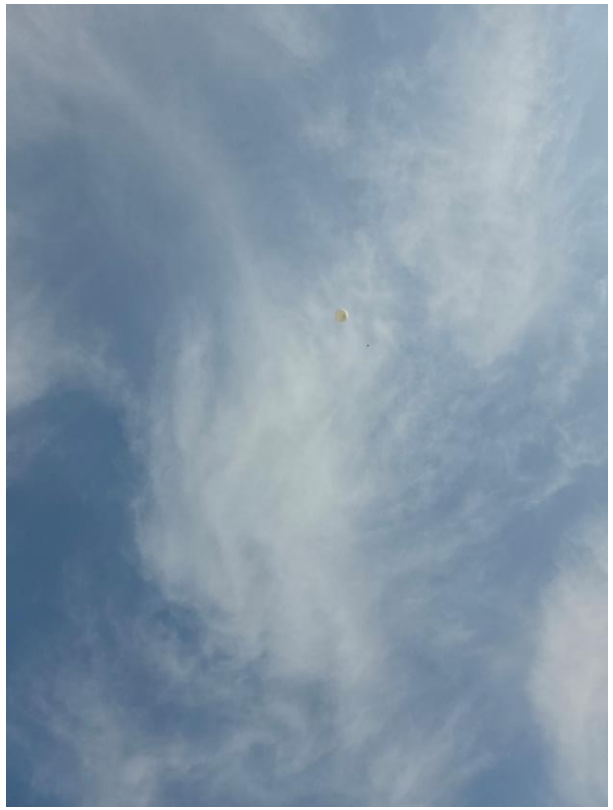




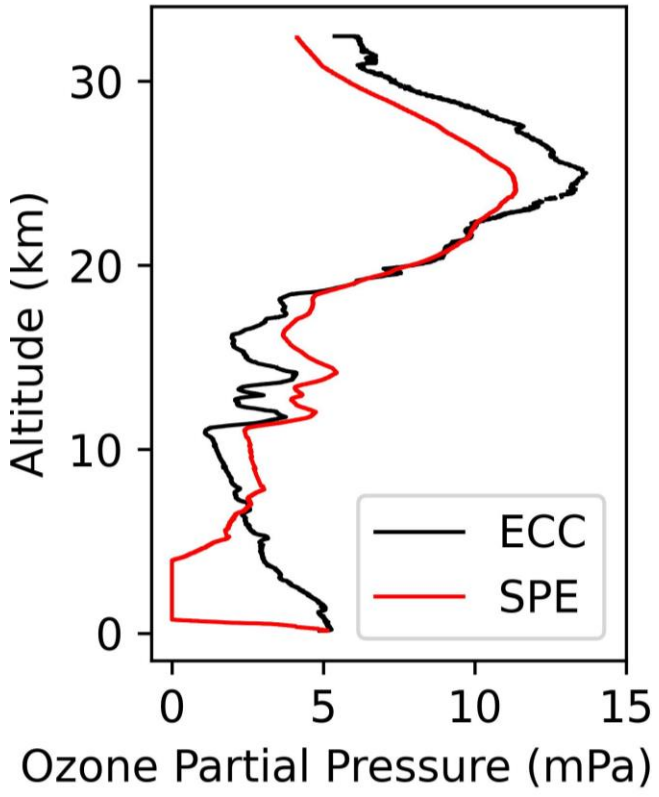
- Sensor response reflects local ozone changes comparably to ECC, with offset (15 km–)
- Lower detection limit issue (0–15 km)

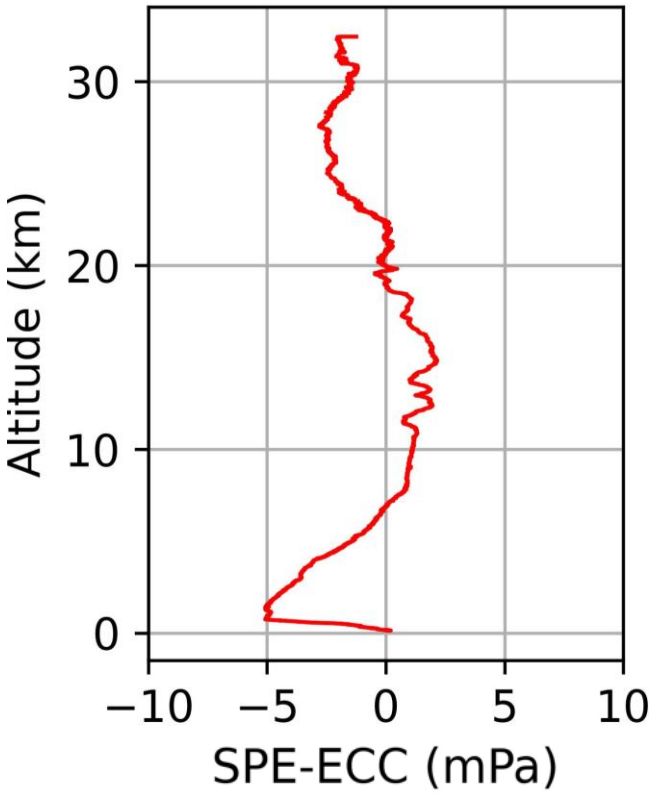
Field test: promising but revision required

- Youngdeok (November, 2025)



Larger sensor
(ES4-O3-5, EC Sense)





- Slow sensor response likely due to larger inner volume

Conclusion: call for collaboration

- Early-stage but has potential as a **supplemental ozone monitoring tool**
- Development demands time and effort: **collaboration is essential**
- For more info, please contact:

sw.kim@kriss.re.kr
Seonwoong Kim
Korea Research Institute of Standards and Science, South Korea