My co-authors and I would like to express our gratitude to the reviewers for their constructive feedback and suggestions for strengthening our research. The changes we have made to the attached file in response to such feedback and suggestions have been highlighted in blue to facilitate their identification. I would also like to offer my apologies for the length of time it took us to prepare this response.

Reviewer #2

By mixing System Dynamics and GIS, this study overcomes the weakness of System

Dynamics, which is challenging to use spatial information. Since Black Ice Prediction in

this paper was performed on various scenarios using spatial and meteorological data, so it

is judged to be differentiated from traditional studies.

The paper is well written but needs to be improved further. Additional considerations

should be given to the following.

1.   The units must be unified. For example, g/m^3 and g/m^2 are virtually the same.

-    Thank you for pointing this out. As a result of additional research on References, contrary to my intention of expressing the amount of black ice as g/m^3 considering the three-dimensional space, other studies usually indicate snow, water, and other liquids on the road surface as g/m^2. Therefore, I have adopted g/m^2 between g/m^3 and g/m^2. I have changed the unit of Evaporation, Condensation, Road Moisture, and Black Ice in Table 2 to g/m^2 and the unit of the corresponding part of the Manuscript. The following References have been added to the Manuscript.

Lines 661
➢ Lysbakken, K. and Norem, H.: The Amount of Salt on Road Surfaces after Salt Application, Surface Transportation Weather and Snow Removal and Ice Control Technology, 85, 2008.
  ➔ This is a study on the road surface condition, and the amount of water is expressed in g/m^2.
Lines 665
➢ Nilssen, K.: Ice melting capacity of deicing chemicals in cold temperatures, 2017.
  ➔ This is a study on road surface conditions and ice melting, and the unit of g/m^2 was used for the thin ice layer.
Lines 680
➢ Schulson, E.: Sliding heavy stones to the Forbidden City on ice, Proceedings of the National Academy of Sciences, 110, 19978-19979, 2013.

➔ The thickness of the ice was converted into g/m^2 and explained.

2. The map in Figure 4 should also show the total length of the test road, and this is because it does not cover the entire Suncheon Wanju highway, so the scope should be seen more intuitively.

- We agree with the Referee's comment. The total length of the Suncheon-Wanju Highway is 117.8 km, but the section in Gurye-gun, Jeollanam-do, South Korea, is about 16 km long. As mentioned by Referee, I have inserted the length of the Suncheon-Wanju Highway in Gurye-gun, Jeollanam-do, into the map and caption composing Figure 4(before correction).
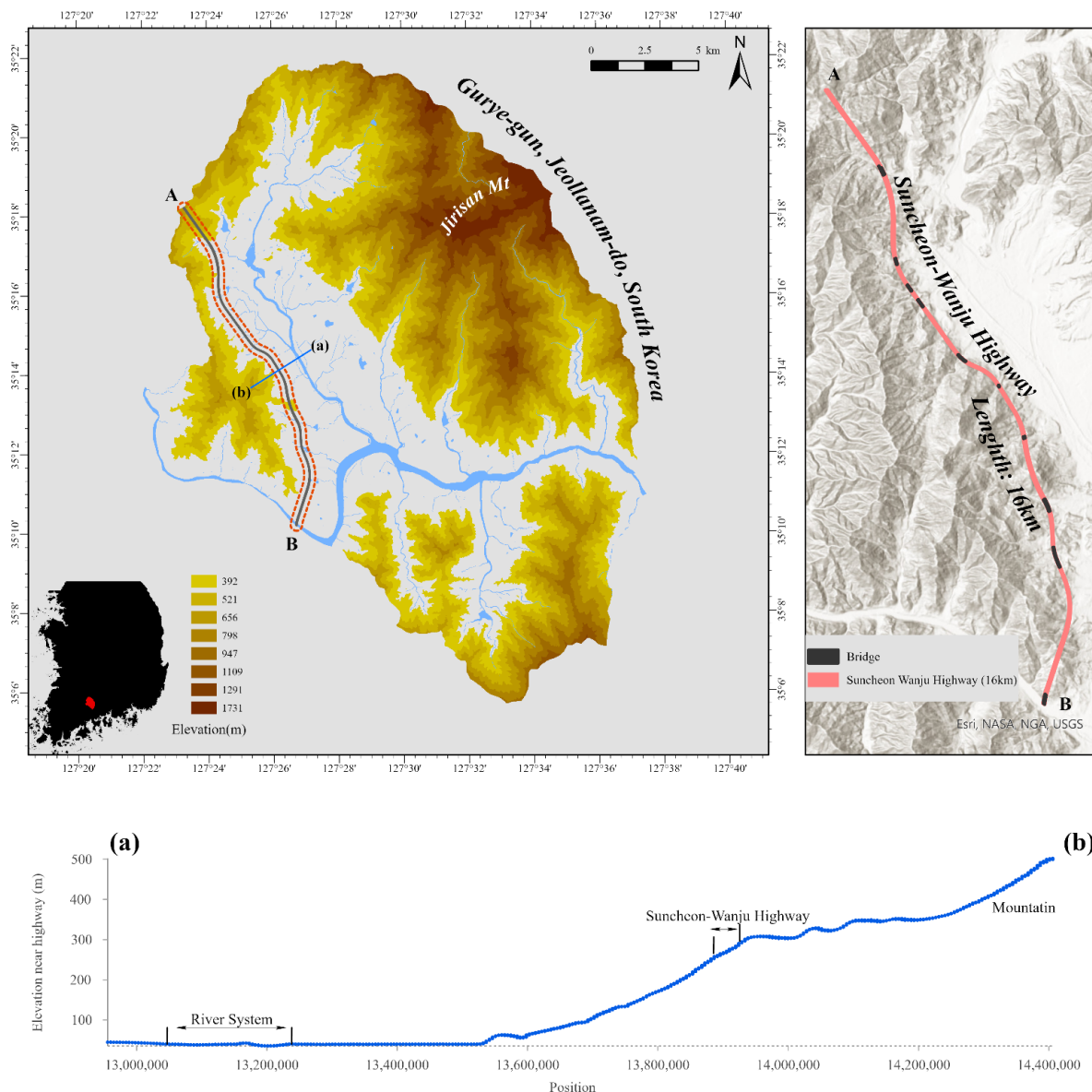
Figure (4→5): Suncheon-Wanju highway, Gurye-gun, Jeollanam-do, a research area for system dynamics model.

The Suncheon-Wanju Expressway in Gurye-gun(16km), Jeollanam-do runs from point A (35°18'S) to point B (35°10'S). If the section from (a) to (b) is selected and the cross-section is analysed, mountains and water systems are observed to the left and right.

3. The map in Figure 10 should include a background illustration so that the reader can monitor the installation environment of the sensing system. In connection with the modeling results, it would be great if the reader could understand the environment in which the sensor is installed more intuitively.

- Thank you for this comment. The environment where the sensor has been installed is the area where black ice was predicted in the System Dynamics model, and the site is mainly of bridges and shady areas. As mentioned by Referee, I have added the actual map to Figure 10 and modified the legend and symbol of the multi-sensor buried location so that readers of this paper can observe the environment in which the sensor is installed on a map.
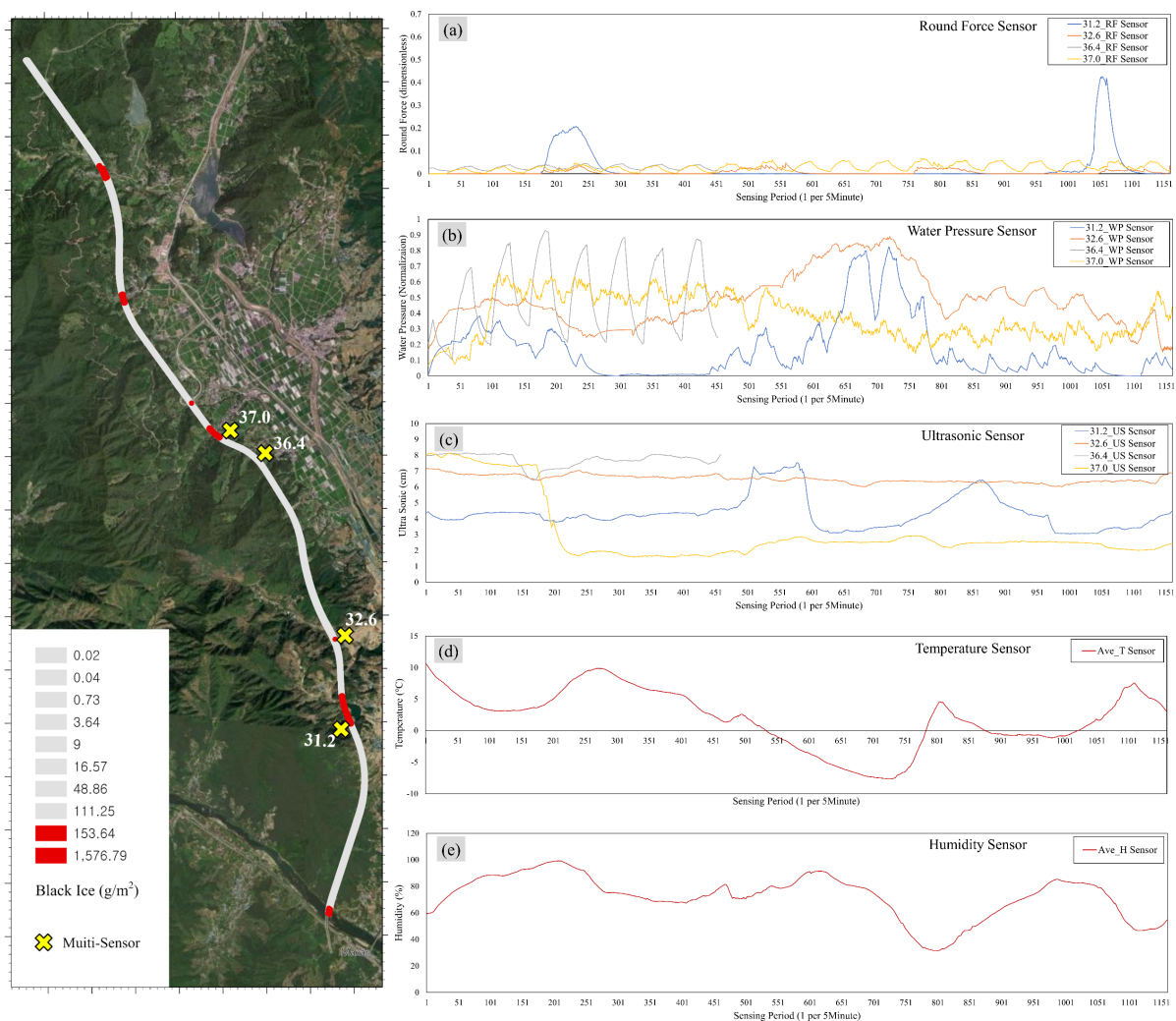
Figure 10: The location of occurrence of black ice (top 2 levels) and data collection results for each sensor. Points 31.2, 32.6, and 37.0 are the experimental group, and points 36.4 are the comparison group. (a) Data graph of the round force sensor. (b) Data graph of the water pressure sensor. (c) Data graph of ultrasonic sensor. (d) Average of temperature from temperature/humidity sensor. (e) Average of humidity from temperature/humidity sensor. (Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community.)