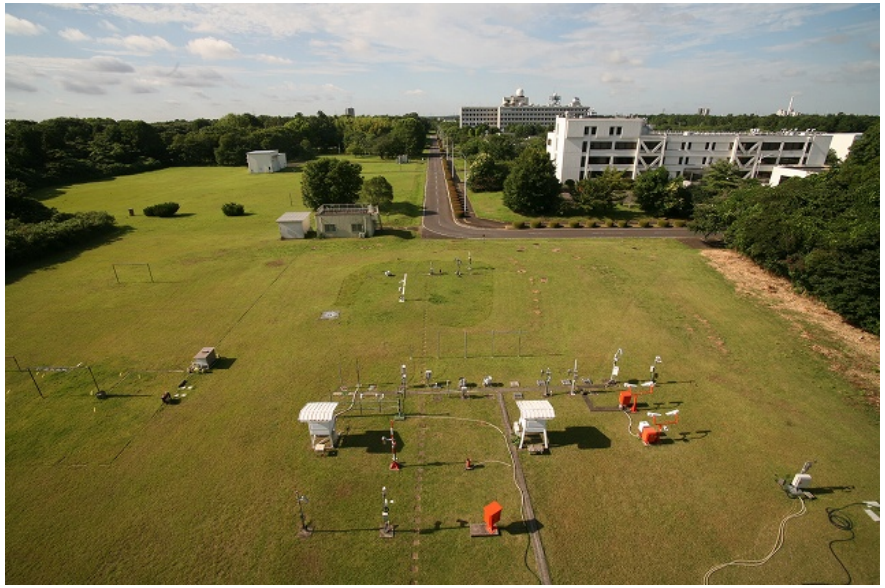
Field experiments to determine the effect of boundary fences on temperature observation



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Outline of presentation

- Background
  - Fence around AWS may affect its measurements.
- Field Experiment
  - Test fields surrounded by net
- Laboratory Experiment
  - Wind tunnel experiment
- Summary

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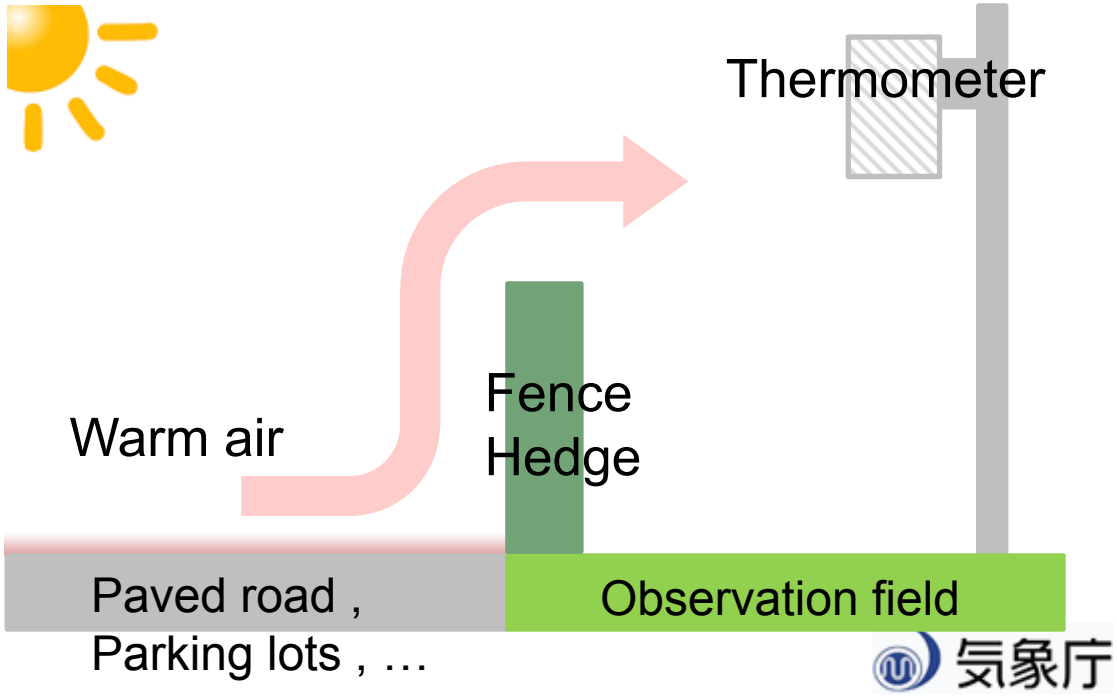
Background

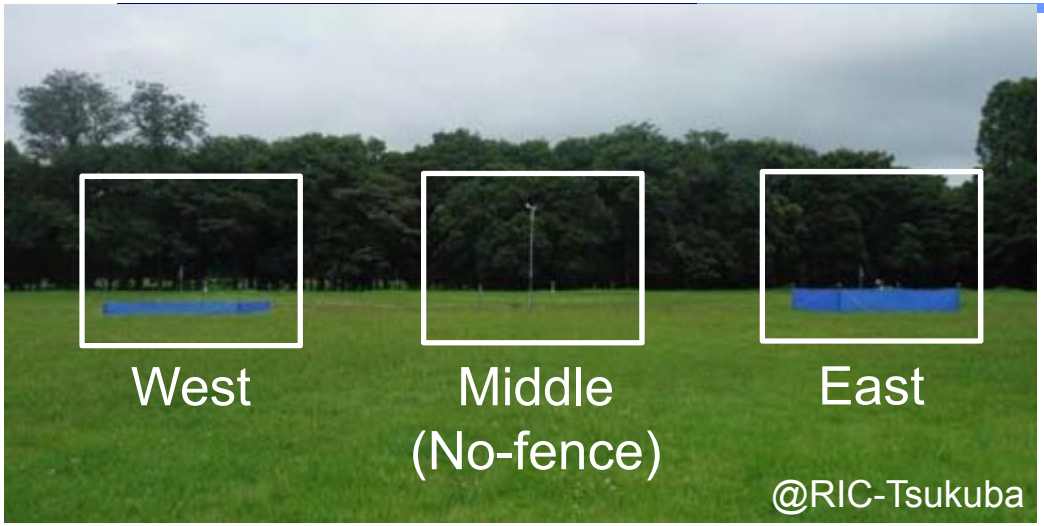
- JMA sets fences and hedges around some AWSs to minimize the thermal effect of artificial ground heat sources.

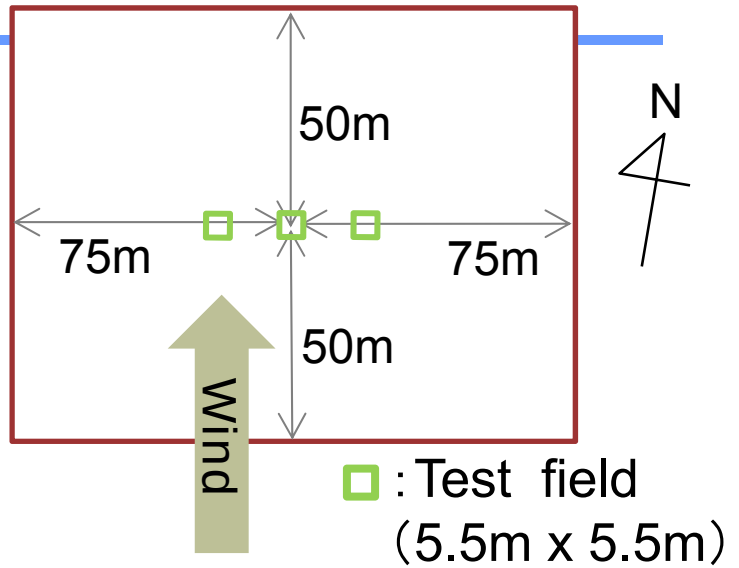
- There is a concern that the fences might affect temperature measurements by lifting warm air to the thermometer height.

A boundary hedge around the observation field of an AWS in Japan



Field Experiment



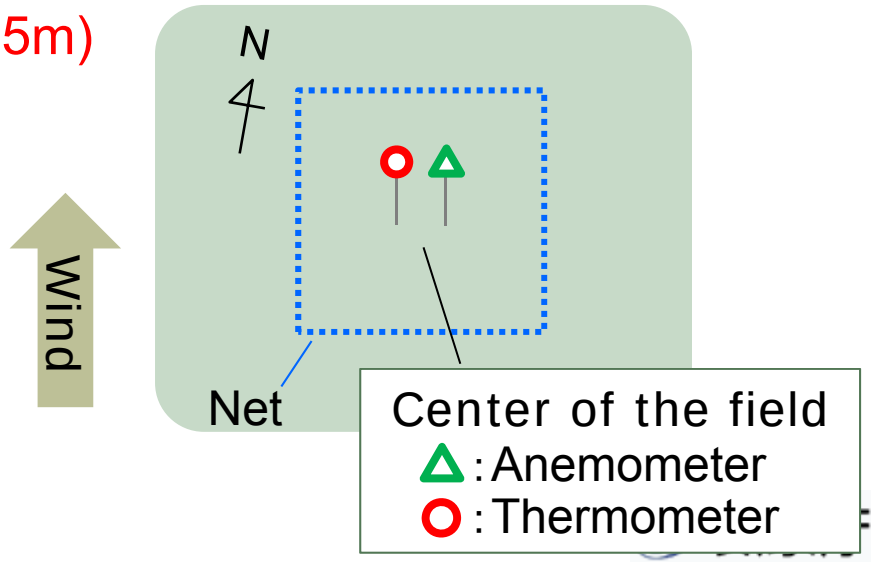


Target wind direction : 150˚ - 190˚

Thermometer (Height:1.5m)

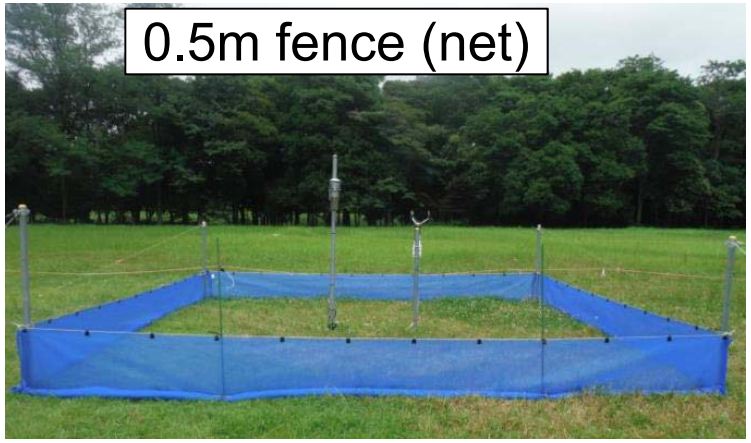
Anemometer (Height:1.5m)

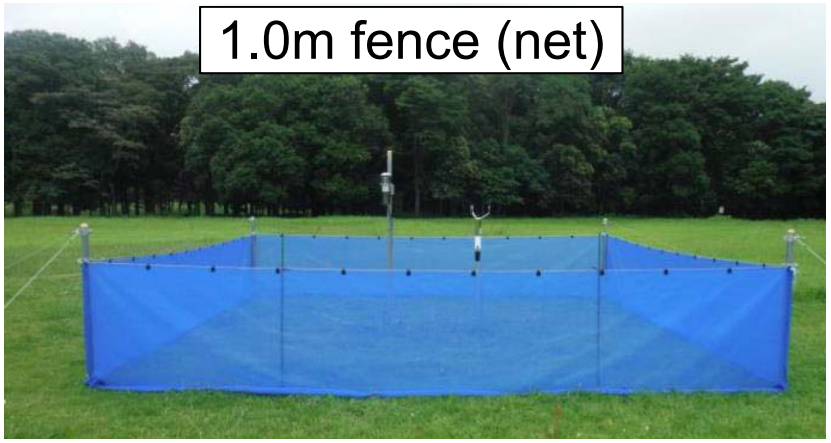
1-mm²-mesh net



Field Experiment

- Difference was also examined between the fences with heights of 0.5 and 1.0m.
  (July - September 2014, December 2014 - March 2015)

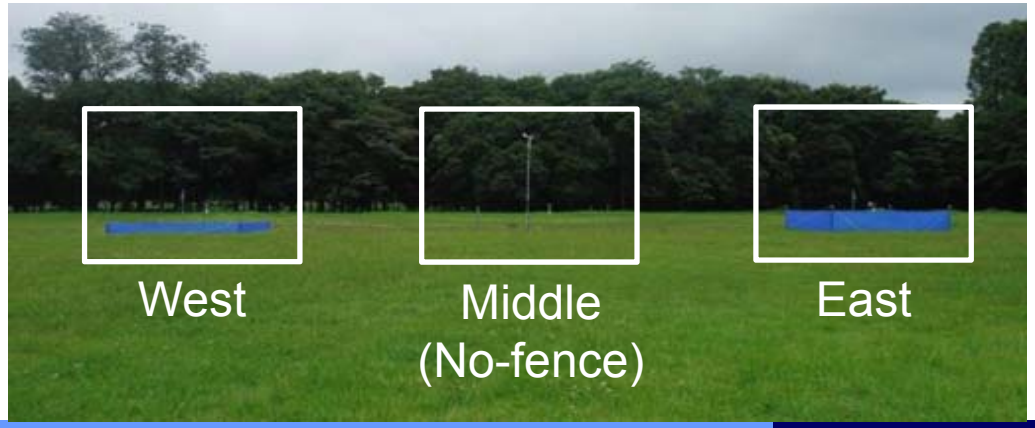




Field Experiment

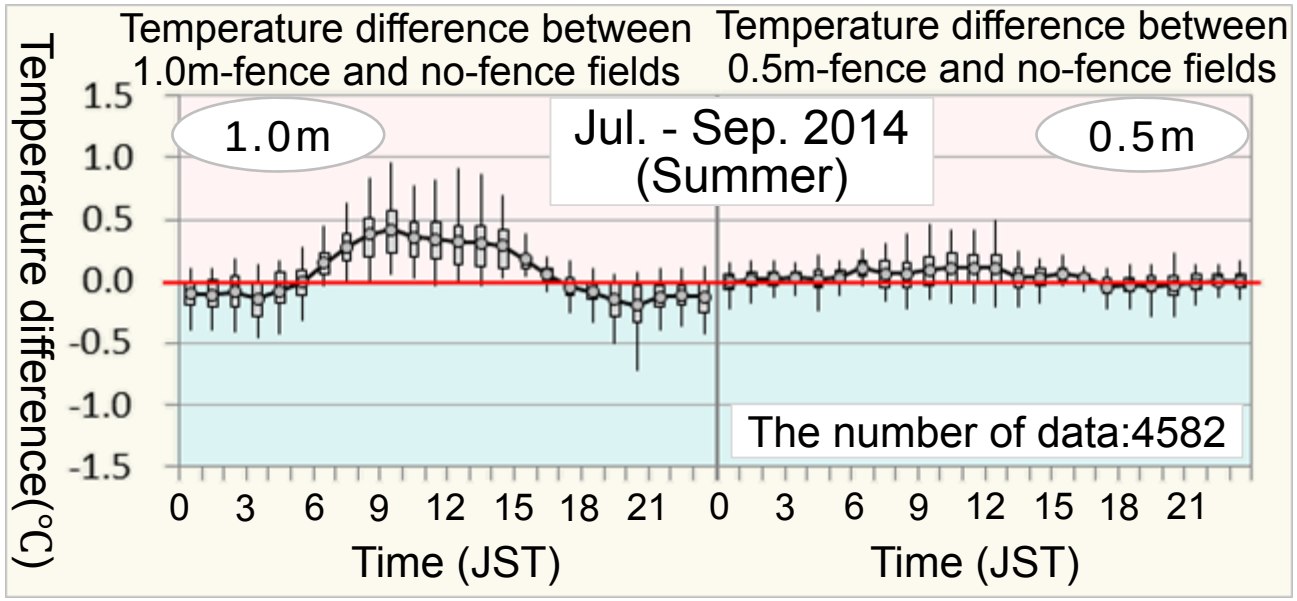
- Conditions for measurement
  - Wind direction (10-minute averages) : 150˚ - 190˚
  - Cloud coverage : Less than 80% over the preceding six hours

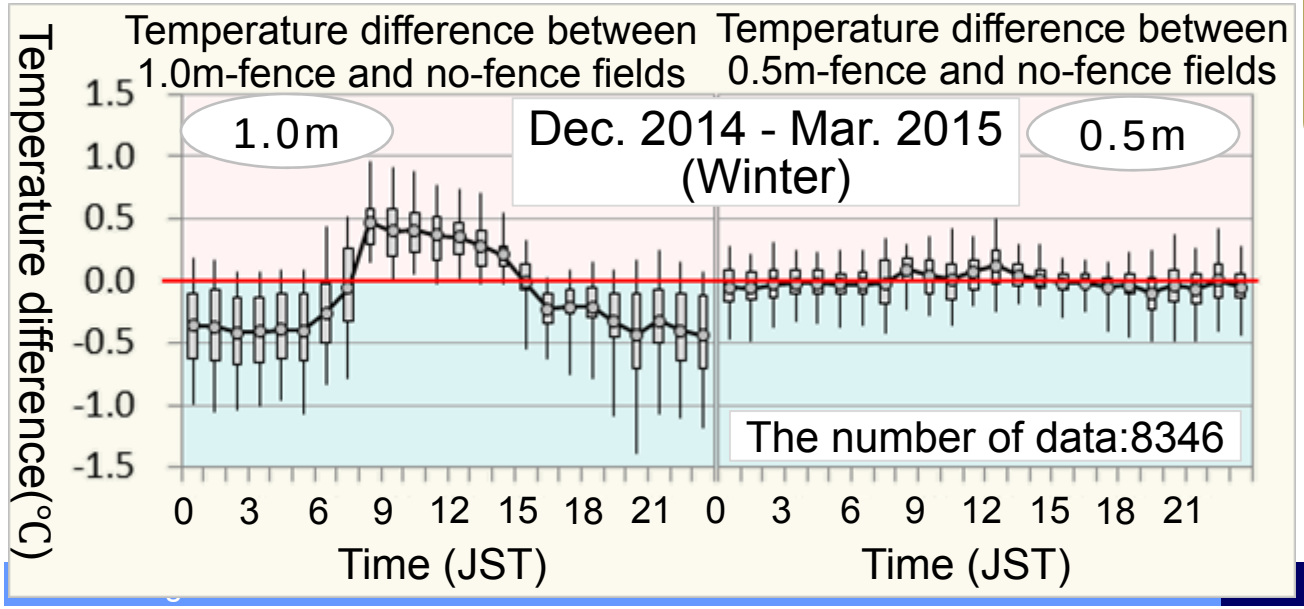
- Archived data
  - 1-minute average of the instantaneous values of temperature measurement.
  - Measurements at the three test fields; west & east (with a fence) and middle (without a fence).
  - Focused was the difference between “with a fence” and “without a fence” on an hourly basis.



Field Experiment

- Comparison between no-fence, 0.5- and 1.0-meter fences.





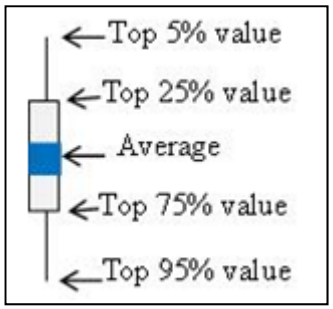
1.0-m fence field :

- Daytime: Higher (+0.3 - +0.4˚C)
- Nighttime : Lower

(Summer: -0.1˚C)
(Winter: -0.3 - -0.4˚C)

0.5-m fence field :

- Daytime: Slightly higher in summer



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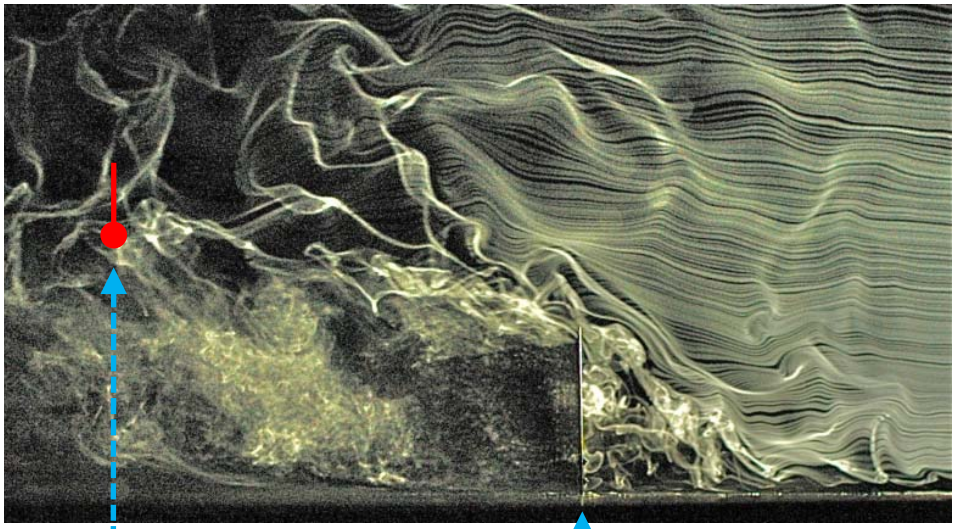
Laboratory Experiment (Wind tunnel)

Visualization of wind flow pattern (Smoke-wire technique)

※1/10-scale model of the test field



Wind
(1m/s)

Thermometer
(Correspond to 1.5m height)

Fence
(Correspond to 1.0m height)

- Surface wind was lifted to the thermometer height.
- Wind-related turbulence caused by fences may impact temperature observation.

Summary

- Field experiment
  - Measurement of temperatures is affected by the fence.
  - Impact of the 1.0m fence was most significant.
    - Daytime temperature were 0.3 - 0.4˚C higher than no-fence.

- Laboratory experiment
  - Surface wind was lifted by the fence to the thermometer height.

- Surface wind was lifted by the fence to the thermometer height and affected the temperature measurement.

- Future studies are necessary to examine other causes that could affect the AWS observation.

I hope our experience will be of some help to the development of AWS observation.

Thank you for your attention !

Field Experiment

- The field experiment was also conducted to assess the impact of difference in how to enclose the fences.
- One field was enclosed with a four-face fence with a height of 1.0m. Another field was enclosed with a three-face fence with a height of 1.0m with the open face at the windward or leeward side.
  (July-August and September-October in 2015)

1.0m fence
Open on the leeward side

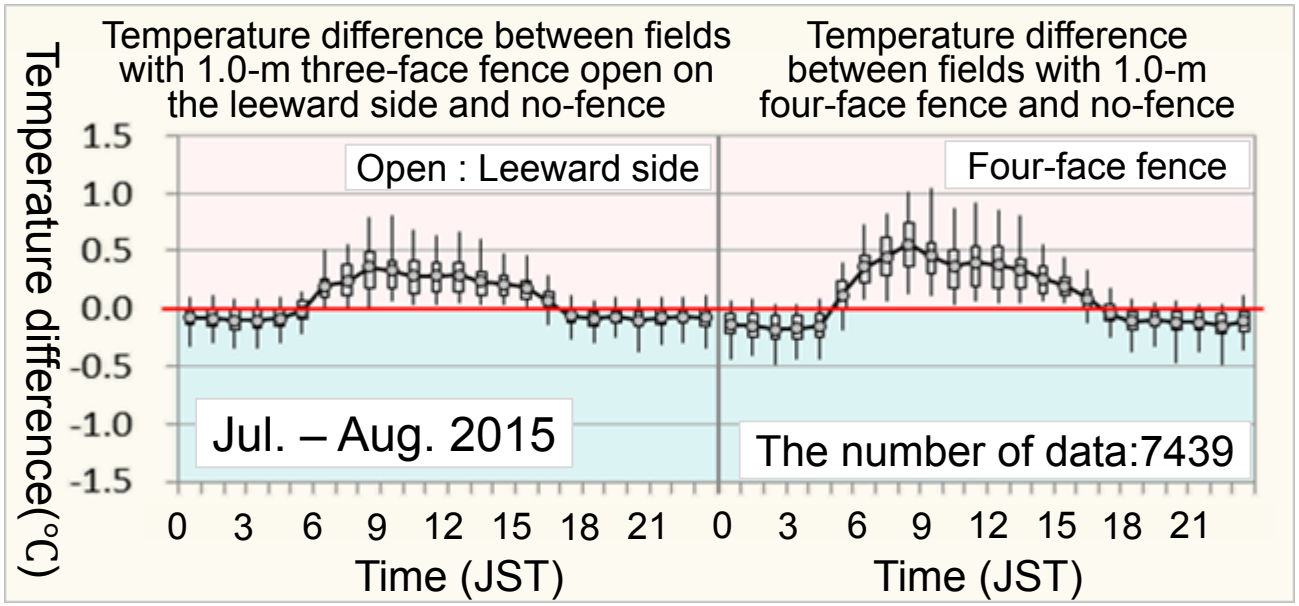
July-August

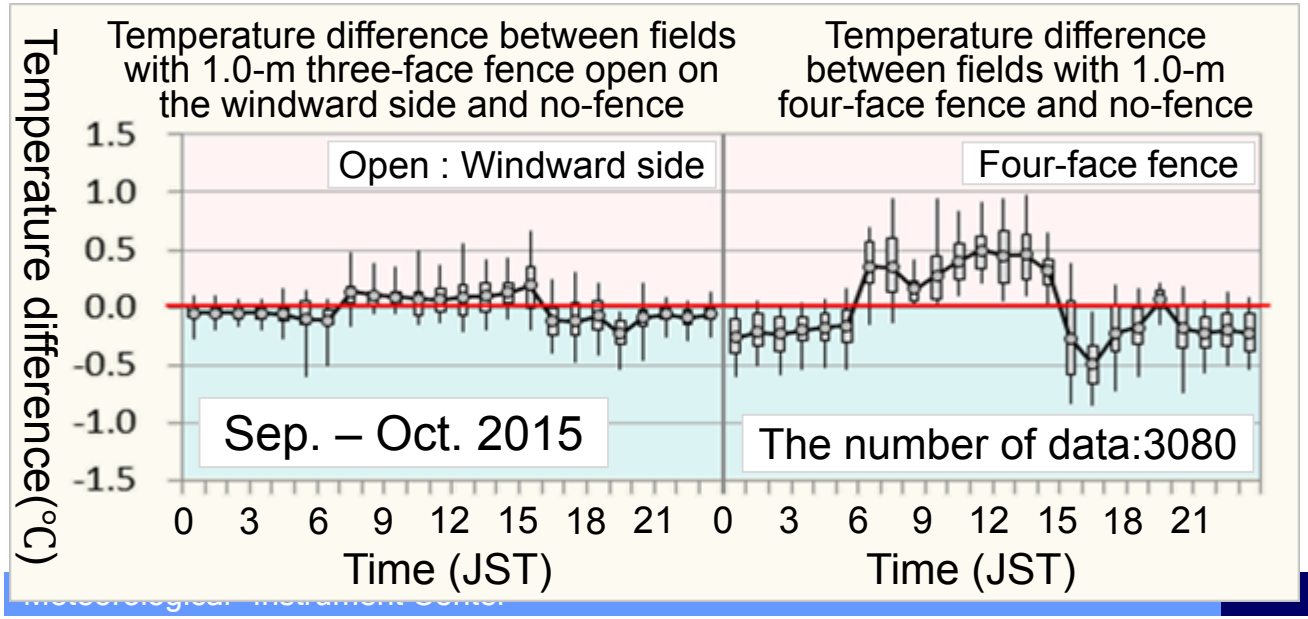
1.0m fence
Open on the windward side

September-October

Field Experiment

Comparison: 1.0-m three-face fence



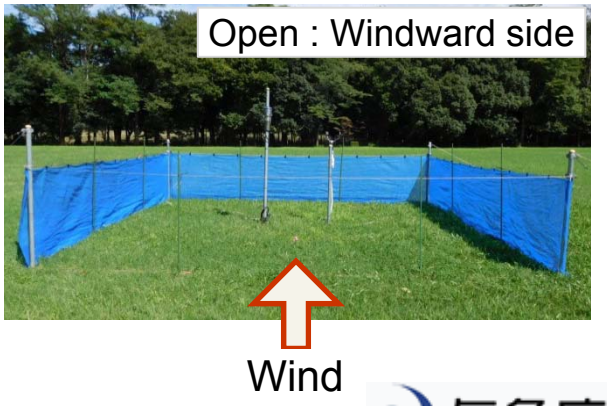


Daytime temperature

Open: Leeward side

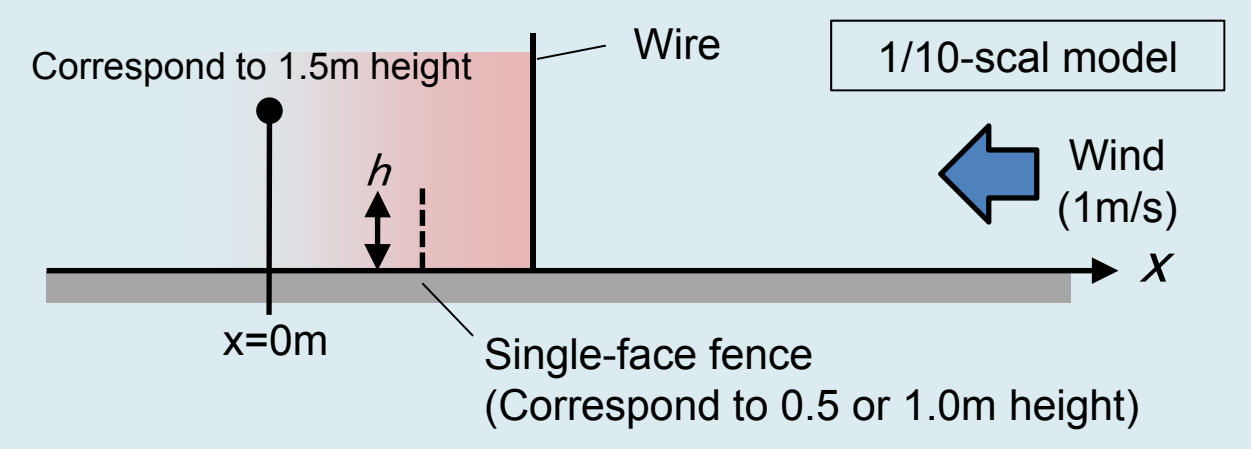
V

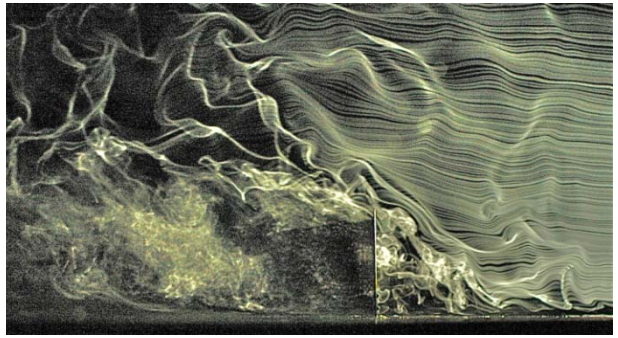
Open: Windward side



Laboratory Experiment (Wind tunnel)

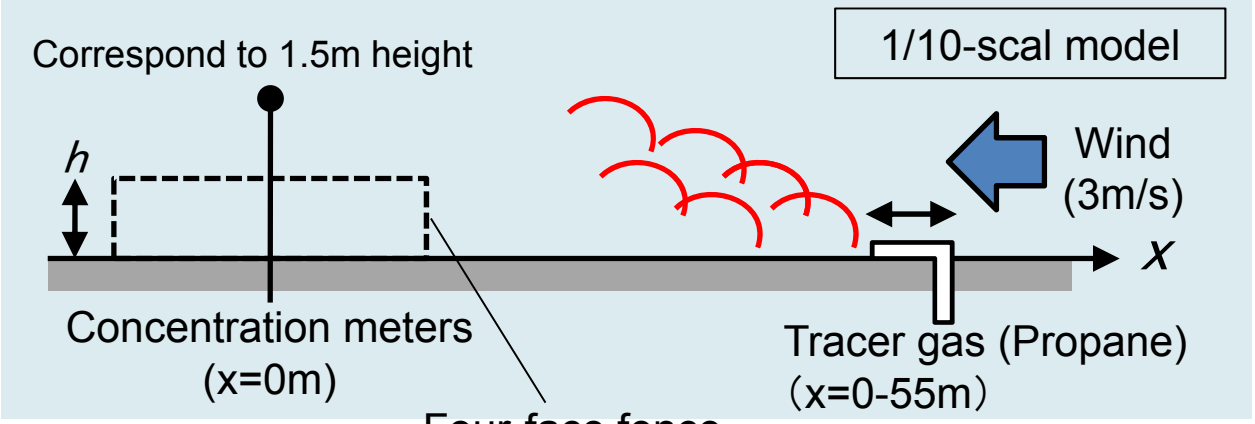
- Visualization of wind flow pattern (Smoke-wire technique)

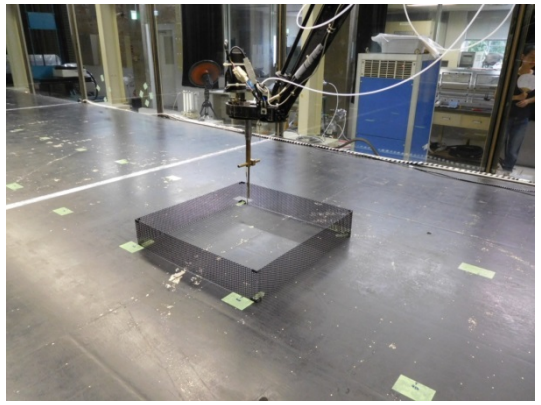




Wind flow pattern

- Monitoring the horizontal distribution of the tracer gas concentration

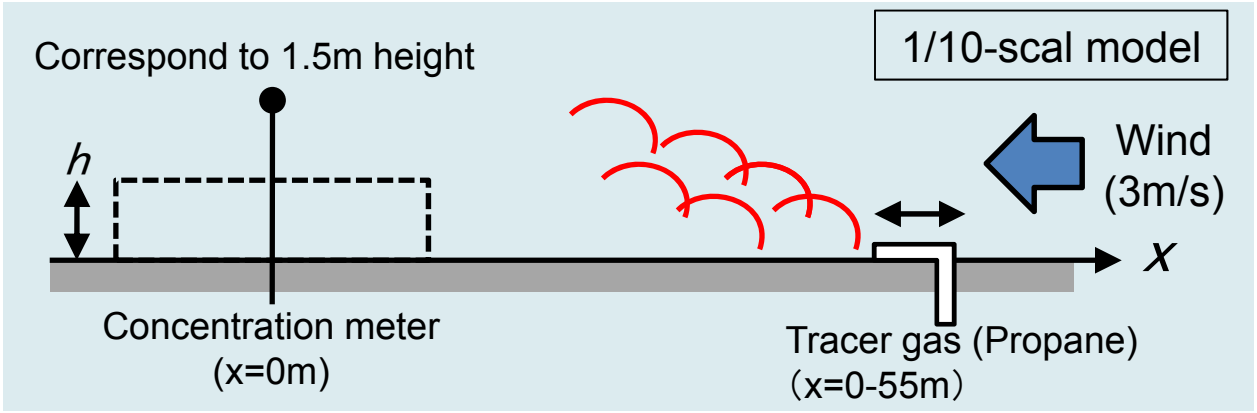


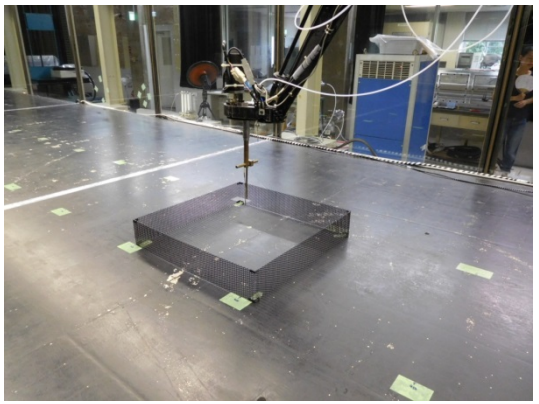


1/10-scale model of the test field

Laboratory Experiment (Wind tunnel)

- Monitoring the horizontal distribution of the tracer gas concentration





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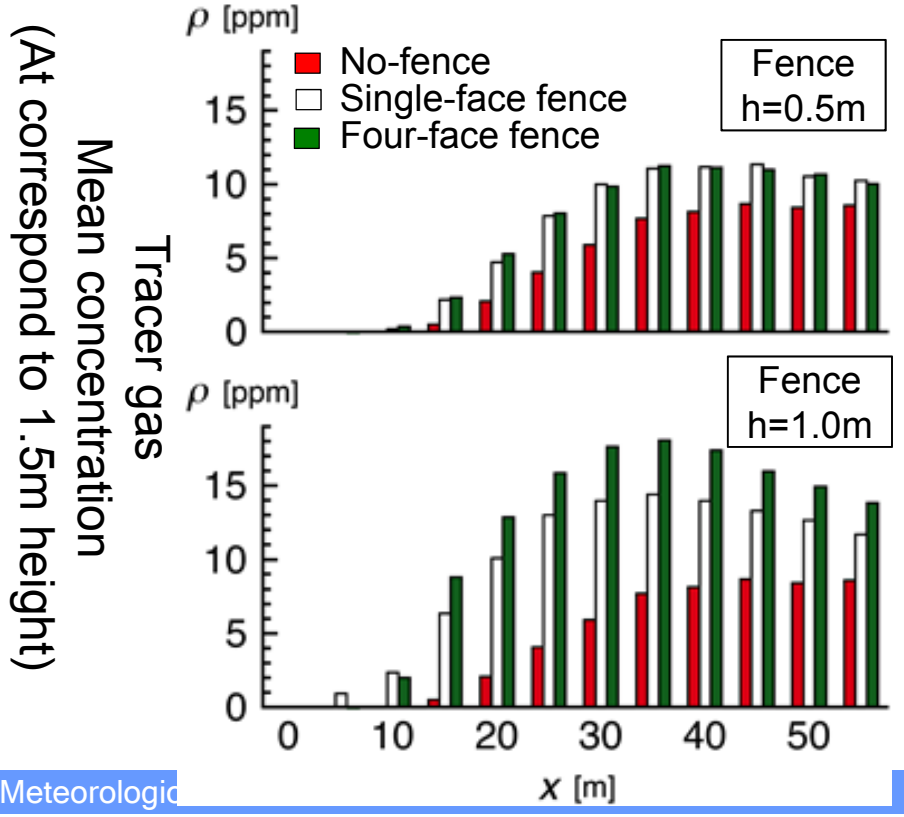

Tracer gas concentration(at 1.5m) :
Fence installed > No fence
(Remarkable : h=1.0m)

- X ≤ 10m : Detected only in case of a fence installed

⇒ Surface wind was Lifted to the thermometer height.