# Our Amazing and Cute Smart Umbrellas

WXBC Weather × IoT Study Group Team A
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## The Weather Business Consortium (WXBC)

Human Resource Development WG

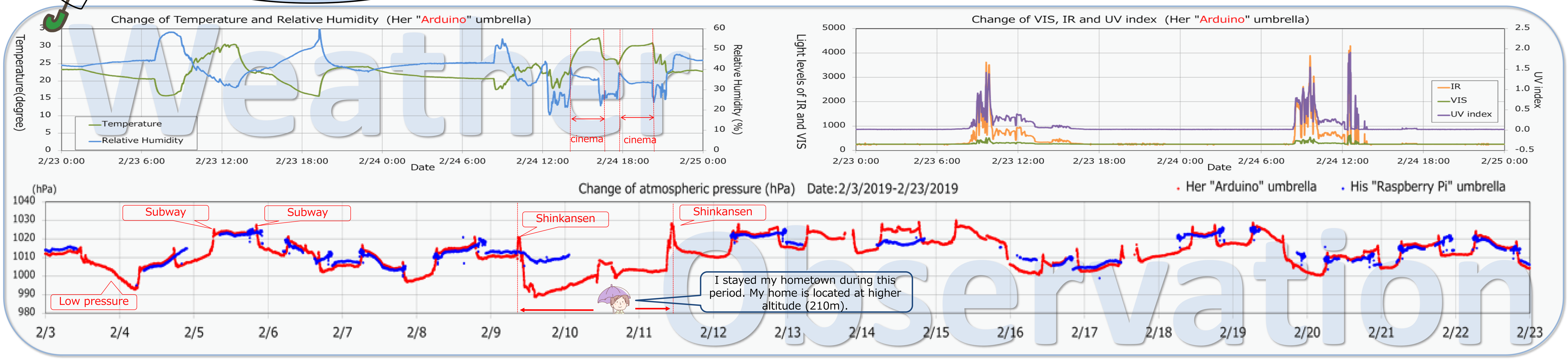
Sub-WG
**Weather × IoT Study Group**

- Established in March, 2017 by public, private and academic sectors including current and potential meteorological data users.
- Works to drive commerce involving intensive usage of meteorological data in technologies such as IoT and AI (machine learning) via extensive joint efforts in the public, private and academic sectors, thereby enhancing socio-economic productivity in Japan
- Supported by JMA for members' commercial activities both as the secretariat and via further provision of meteorological data based on commercial needs, as well as improving data usage environments and promoting deregulation.

## Smart Umbrellas

**Weather observation**

Temperature | Humidity | Pressure | UV/IR/VIS

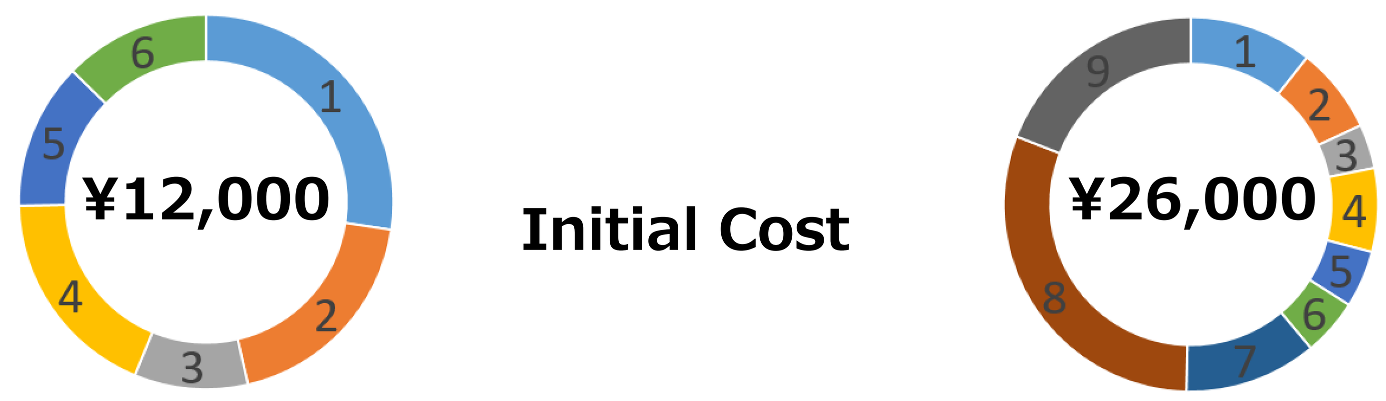



**Two models available**

My "Raspberry Pi" umbrella — Wi-Fi only

My "Arduino" umbrella — LTE

| No. | Item | URL |
|---|---|---|
| 1 | Raspberry Pi (Microcomputer) | https://jp.rs-online.com/web/p/processor-microcontroller-development-kits/8332699/ |
| 2 | GPS module GYSFDMAXB | http://akizukidenshi.com/catalog/g/gK-09991/ |
| 3 | Temperature, humidity and pressure sensor module kit with BME280 | http://akizukidenshi.com/catalog/g/gK-09421/ |
| 4 | Geomagnetic and acceleration sensor MLSM303DLHC | https://www.marutsu.co.jp/pc/i/137793/ |
| 5 | SI1145 UV/IR/VIS sensor | https://www.switch-science.com/catalog/1709/ |
| 6 | NeoPixel Ring 16 full color serial LED | https://www.switch-science.com/catalog/1537/ |
| 7 | Arduino Uno (Microcomputer) | https://www.amazon.co.jp/dp/B0044X2E5S/ref=cm_sw_em_r_mt_dp_U_4G7BCbP3VCNPA |
| 8 | sakura.io module(LTE) SCM-LTE-01 | https://sakura.io/product/module_lte.html |
| 9 | sakura.io shield for Arduino SCO-ARD-01 | https://sakura.io/product/arduino.html |



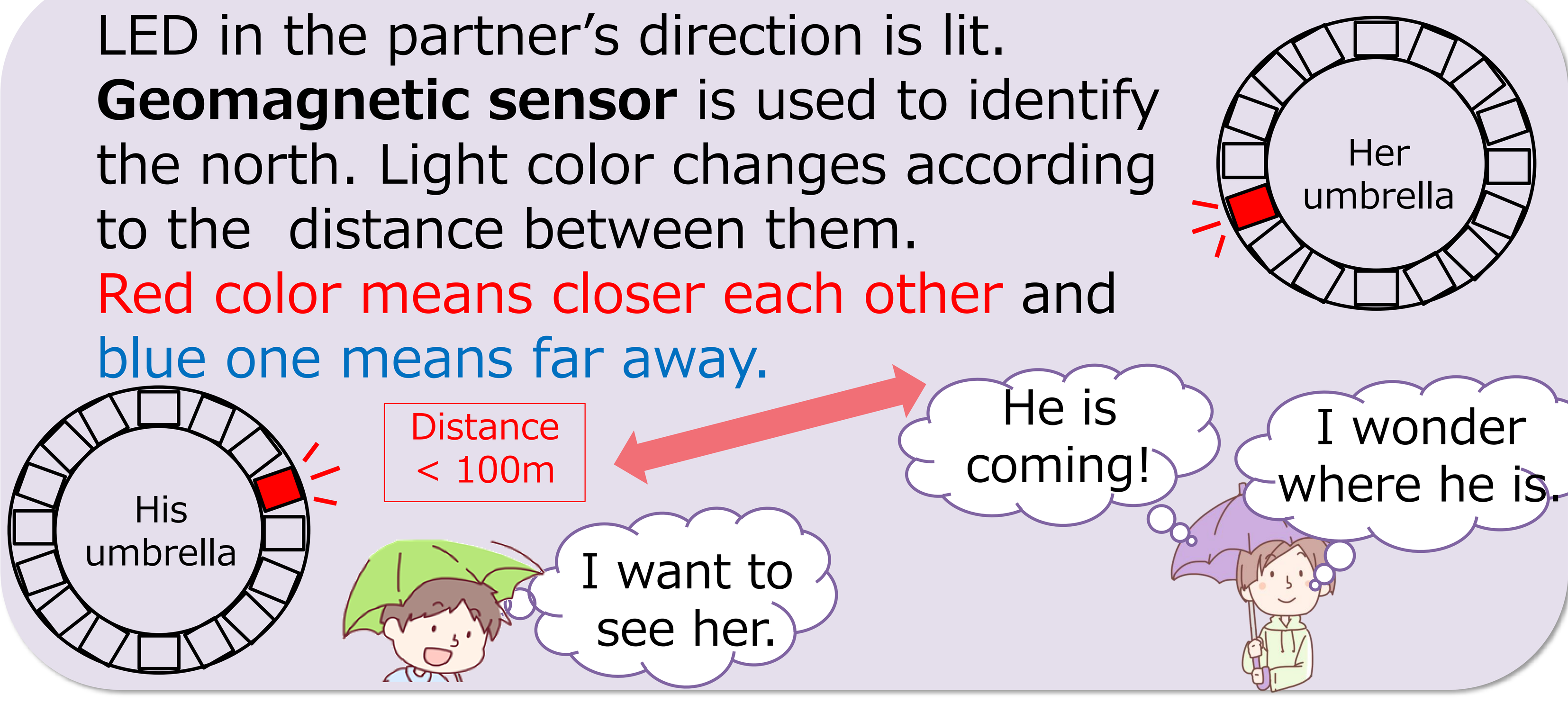

| My "Raspberry Pi" umbrella | | My "Arduino" umbrella |
|---|---|---|
| ¥12,000 | **Initial Cost** | ¥26,000 |
| Very low if free Wi-Fi used | **Running Cost** | Low (¥500/month) |

**Incentive promotion**

Check partner's location on the web site anytime.

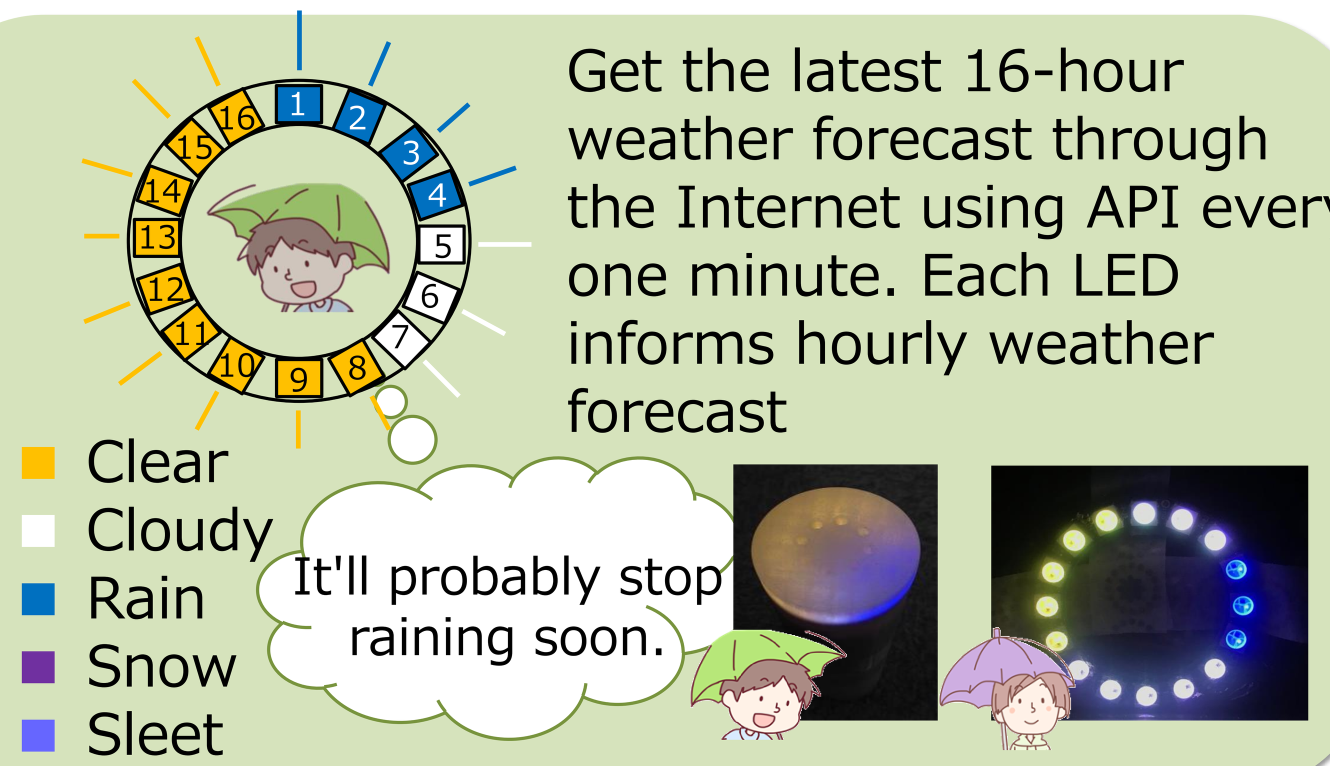

If he is moving

LED in the partner's direction is lit. **Geomagnetic sensor** is used to identify the north. Light color changes according to the distance between them. Red color means closer each other and blue one means far away.



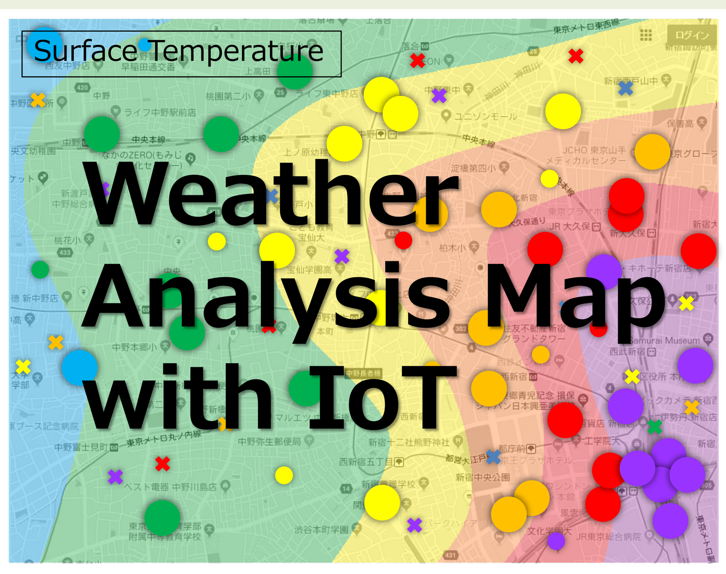

If he stays somewhere

Get the latest 16-hour weather forecast through the Internet using API every one minute. Each LED informs hourly weather forecast




## Discussion and Future work

- Low-cost instruments are available for weather observation using commercial devices.
- Its running cost is also reasonable.
- Additional service helps give a powerful incentive for establishing a smart umbrellas network.
- No traceability
- Information on observation environment is required.
- Integrated use of observation data and Numerical Weather Prediction technology help enhance JMA's Weather Analysis Map
- Make everyone happy like "She" and "He".



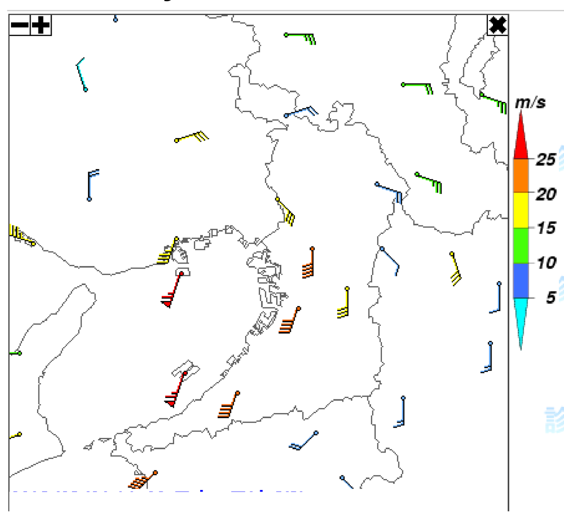
# A basic study of the horizontal scale of topography which determines surface wind directions in mountainous areas

Masanori Oigawa (Japan Meteorological Agency)

## Introduction

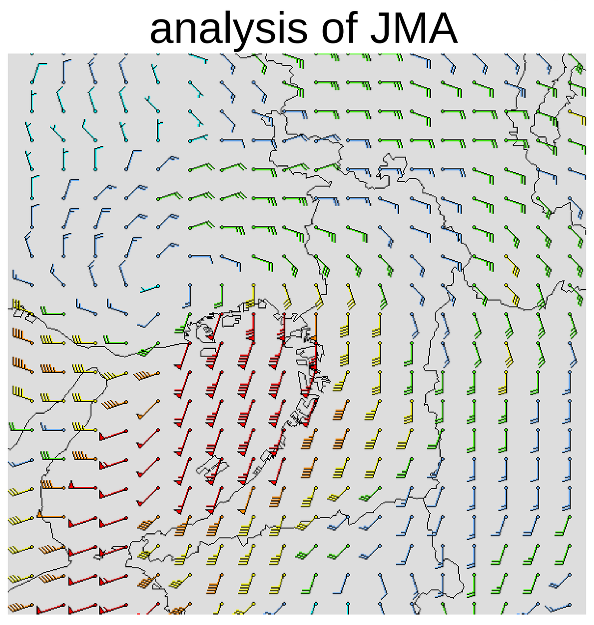
- At the Office of Meteorological Analysis and Application Development, we are developing meteorological nowcasts with high frequency and high resolution, including moisture, fog, and wind.
- JMA currently operates the hourly analysis of wind and temperature with 5 km horizontal grid interval by using the forecast data of the meso-scale model as a first guess values. However, it is difficult to estimate the surface wind distributions because surface winds are greatly influenced by ground roughness and topography, especially around mountainous areas with complex terrains.

Surface winds observed by AMeDAS

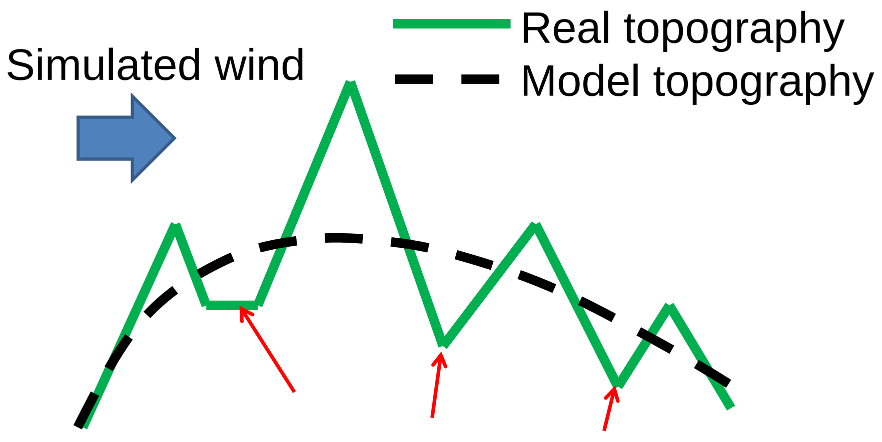


Data assimilation

Surface winds of the hourly analysis of JMA



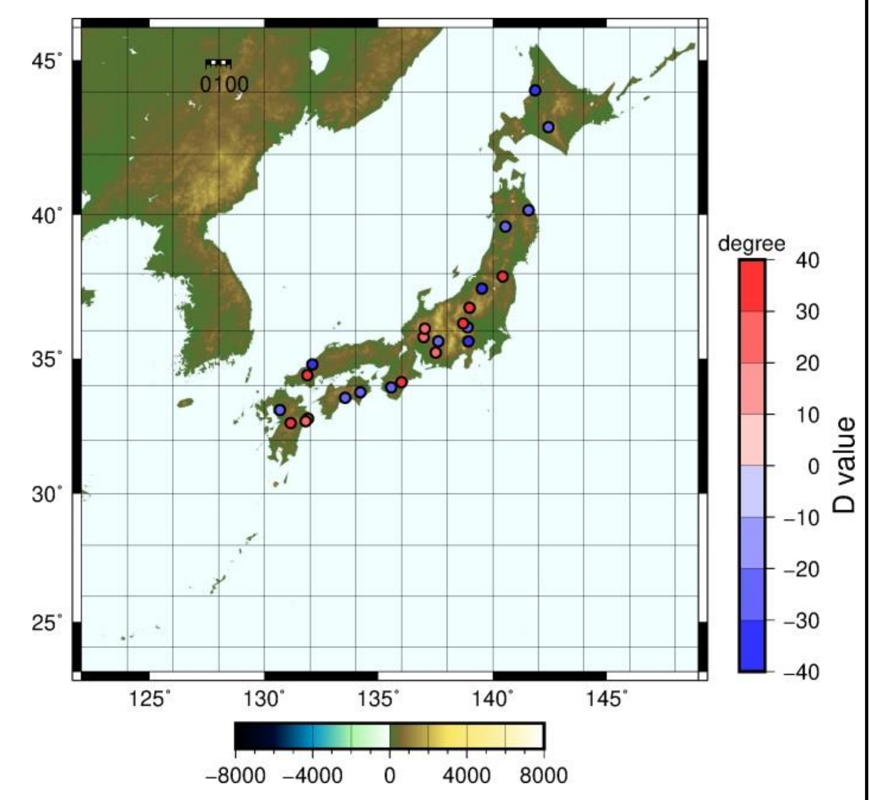
AMeDAS: Automated Meteorological Data Acquisition System




Simulated wind directions will be different from the observation result at valleys.

For example, in the hourly analysis of JMA, wind directions of first guess values tend to have large biases of wind directions around the mountainous areas as shown in the right figure. This fact proves that 5 km grid interval is not enough to reproduce surface wind directions around the mountains.

Twenty four AMeDAS stations which have the largest departure values of wind direction in the hourly analysis of JMA.




Note that departure value is a difference between observation value and first guess.

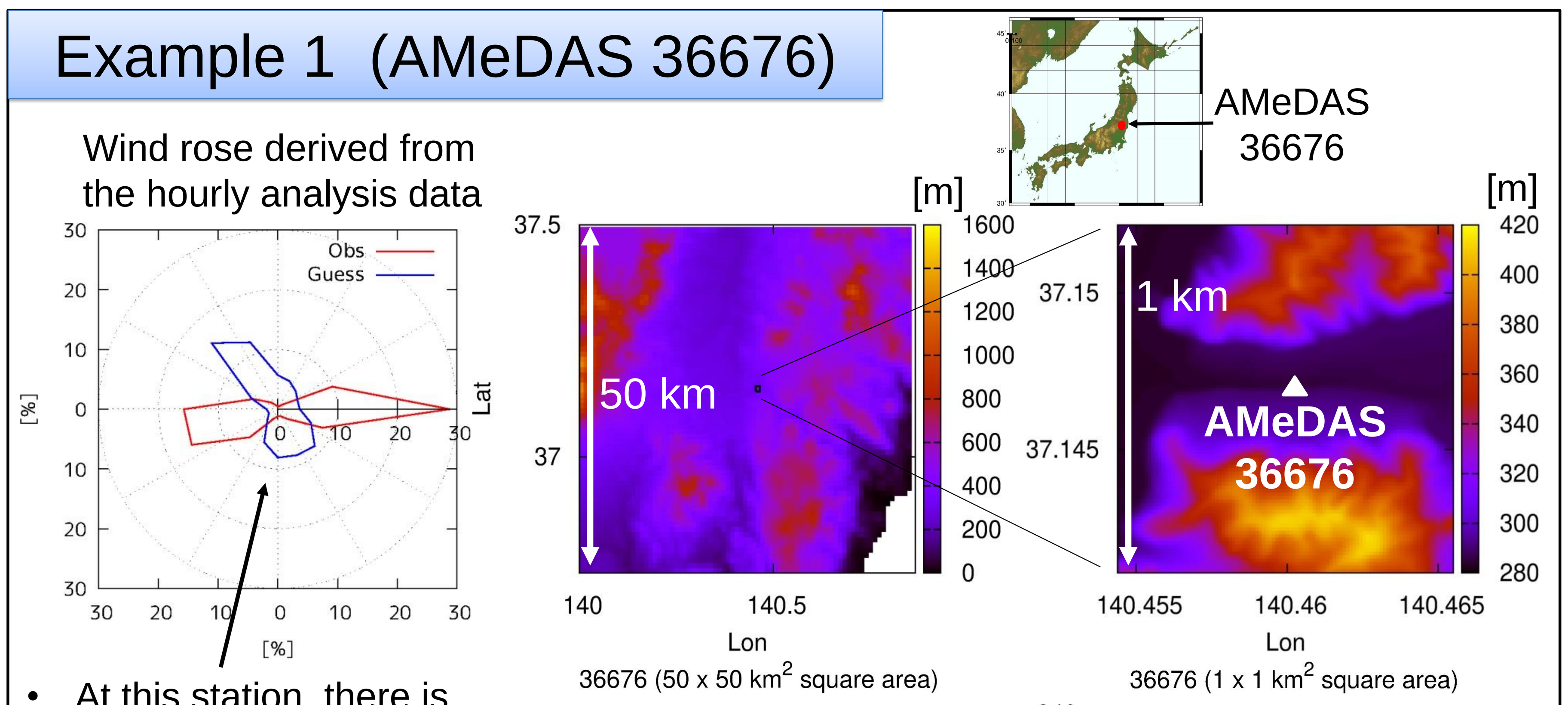
### Goal

**Determine the horizontal resolution of a numerical model in order to estimate the surface wind directions correctly.**

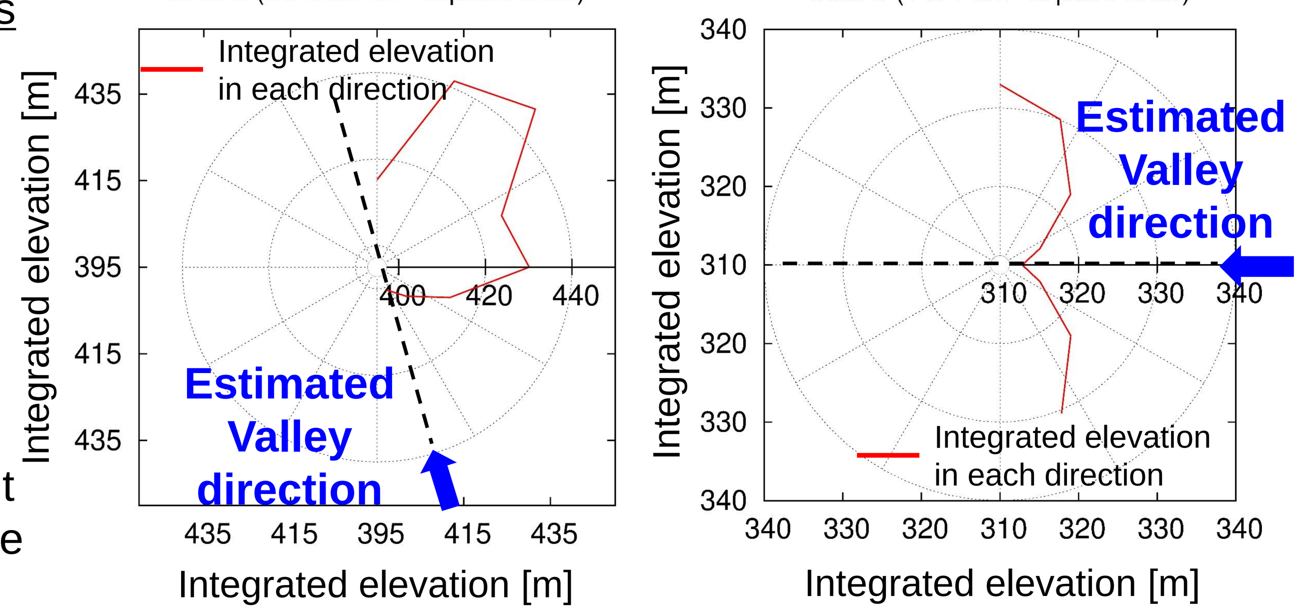
We carried out a basic research about the horizontal scale of topography which determines the surface wind directions around the mountainous areas.

## Example 1 (AMeDAS 36676)

Wind rose derived from the hourly analysis data

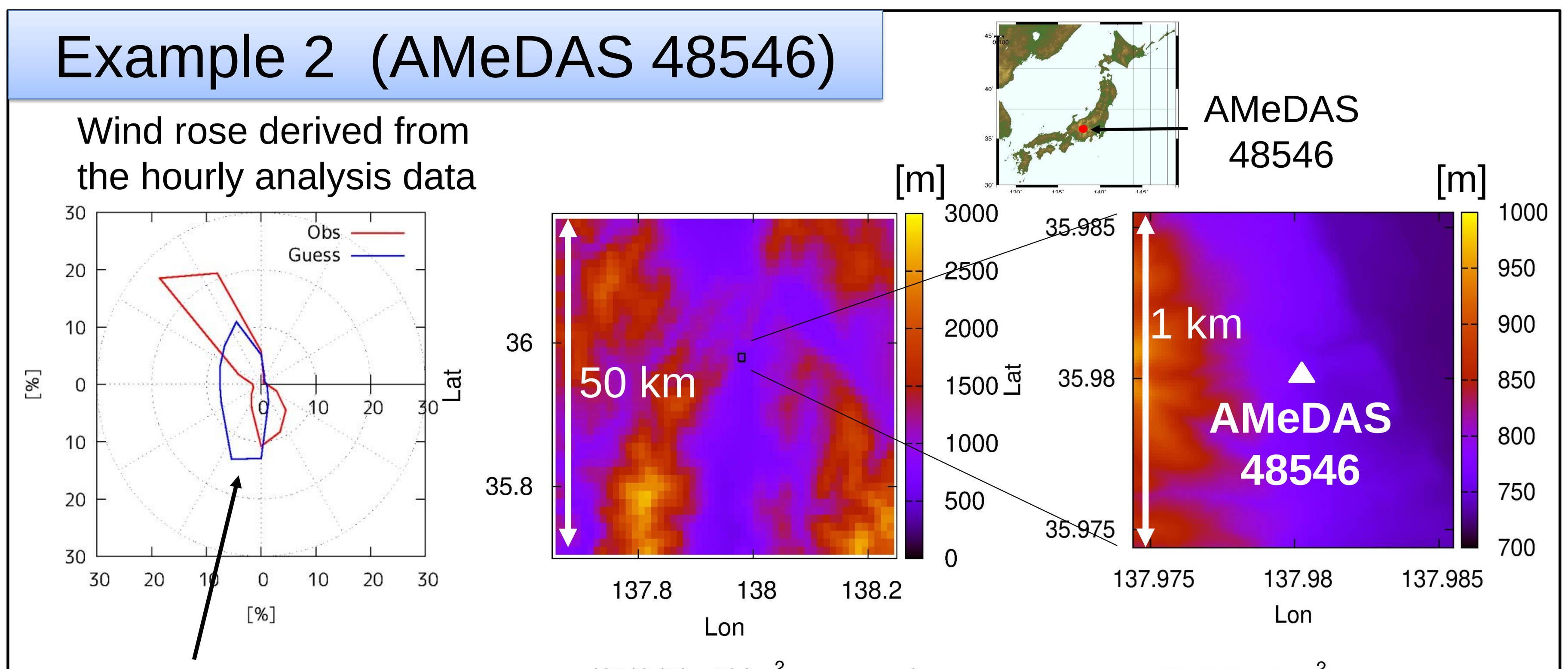



- At this station, there is a big difference in wind directions between observation and the first guess.
- This is probably because the valley directions in the square area of 1×1 km² is largely different from the square area of 50×50 km².

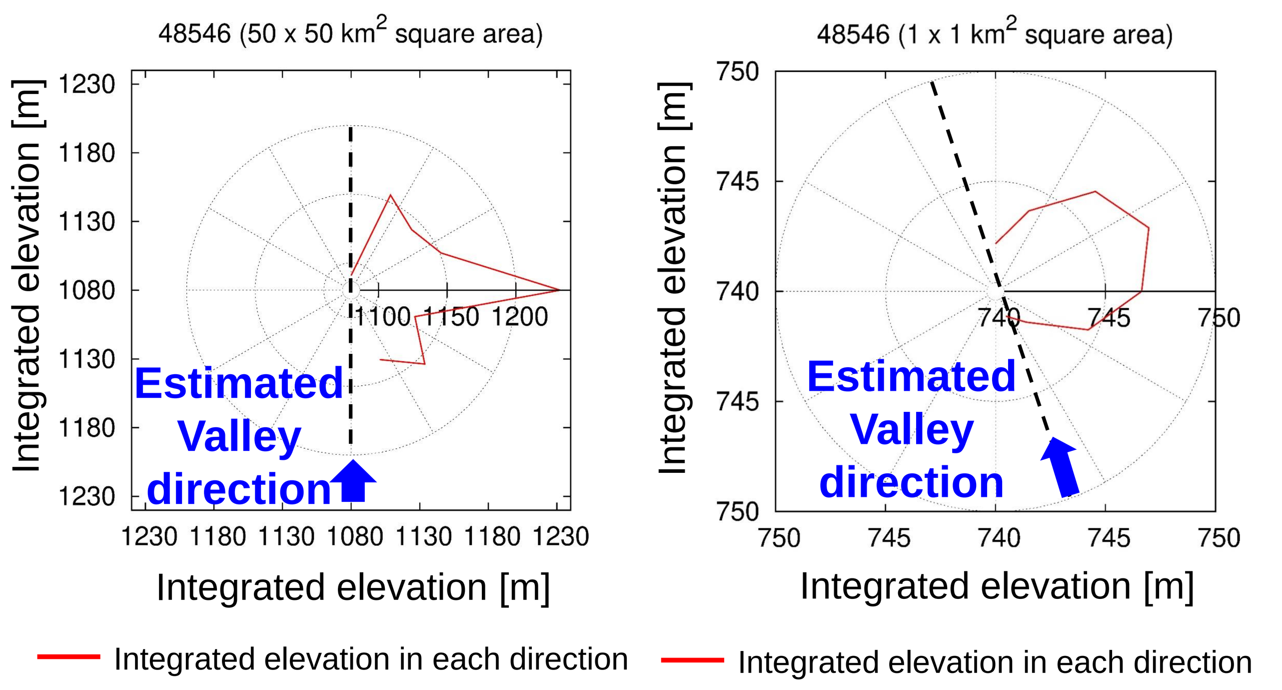



## Example 2 (AMeDAS 48546)

Wind rose derived from the hourly analysis data



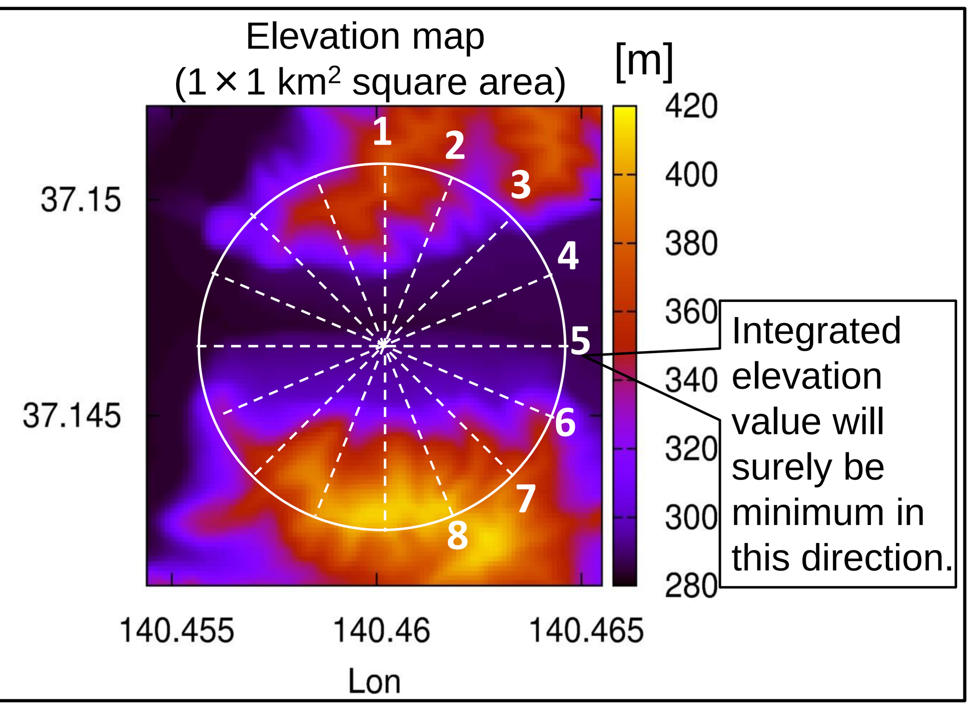

- At this station, there is a small difference in wind directions between observation and the first guess.
- This is probably because the valley directions in the square area of 1×1 km² is almost as same as that in the square area of 50×50 km².




## Method

- To analyze valley directions, we used the method of Suda (1990) which calculate integrated elevation values in each azimuth direction (right figure).
- The direction which has the minimum integrated elevation value is defined as the valley direction.
- We used 10 m mesh topography data provided by Geospatial Information Authority of Japan.

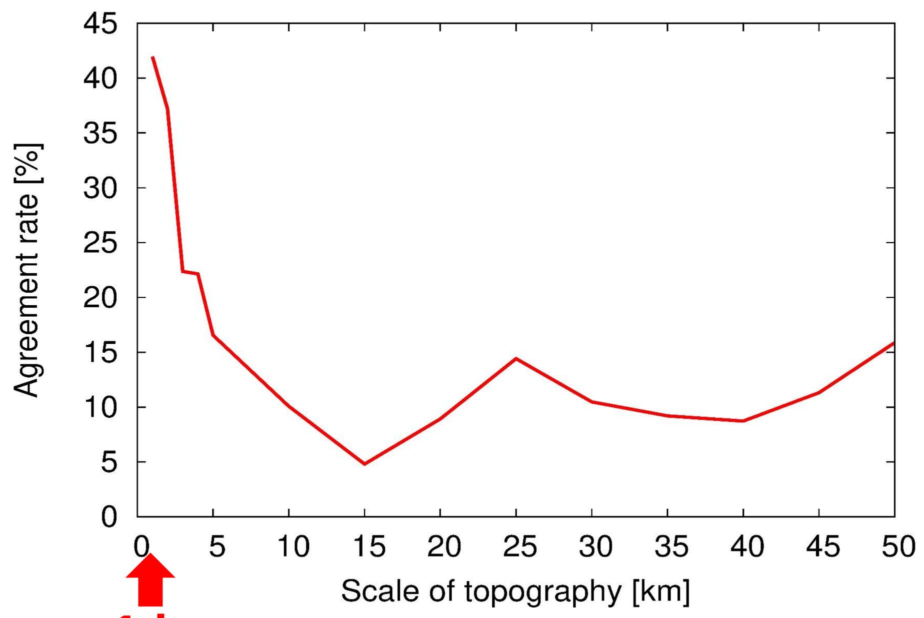
Elevation map (1×1 km² square area)




## Result

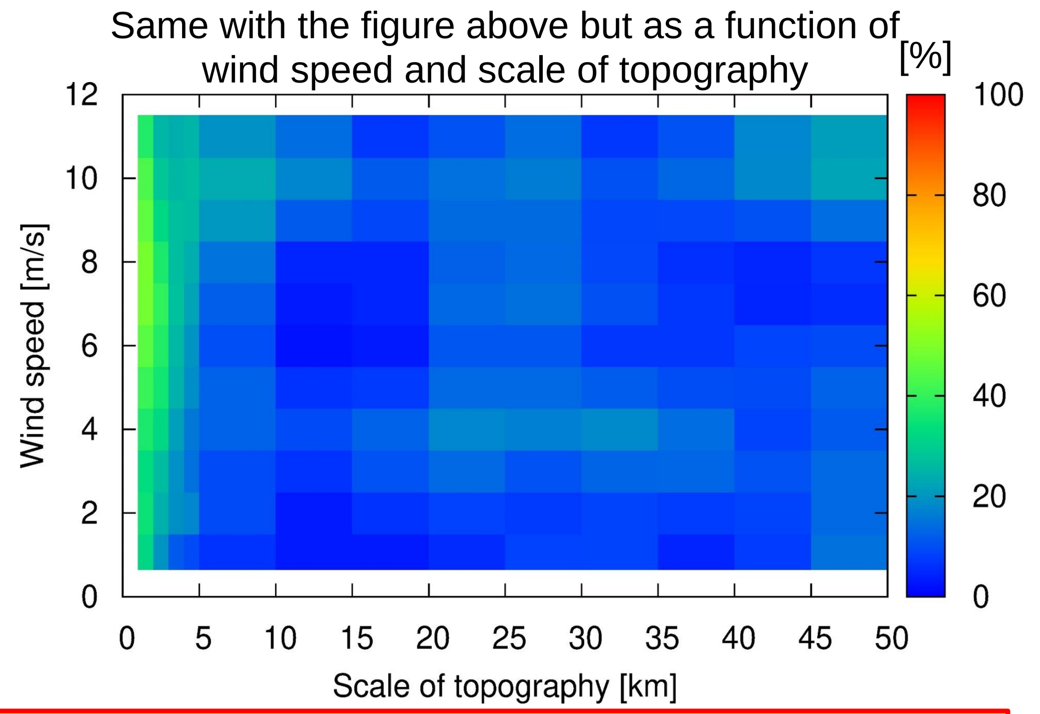
At the horizontal scale of 1 km, the agreement rate between the most frequent wind direction and the valley direction is the highest.

Agreement rate between the most frequent wind directions and the valley directions among the 24 AMeDAS stations shown in the introduction




In every wind speed, agreement rates are the highest at the scale of 1 km. This means that local topography strongly affects wind directions in those stations.

Same with the figure above but as a function of wind speed and scale of topography




### Conclusion

**The topography scale of less than 1 km determines surface wind directions at the AMeDAS stations where departure values of surface wind direction are large in the hourly analysis of JMA.**

### Future Plan

- These results suggest that if we try to analyze the surface wind directions by numerical models correctly, we must set the horizontal grid interval of the model less than 1 km.
- Another plausible way is to use statistical methods based on ground roughness and topographic information in addition to the numerical model data.

## Reference

Suda, Y., 1990: The terrain scale which determines wind directions around mountainous areas during night, *Tenki*, **37**, 57-64 (in Japanese).