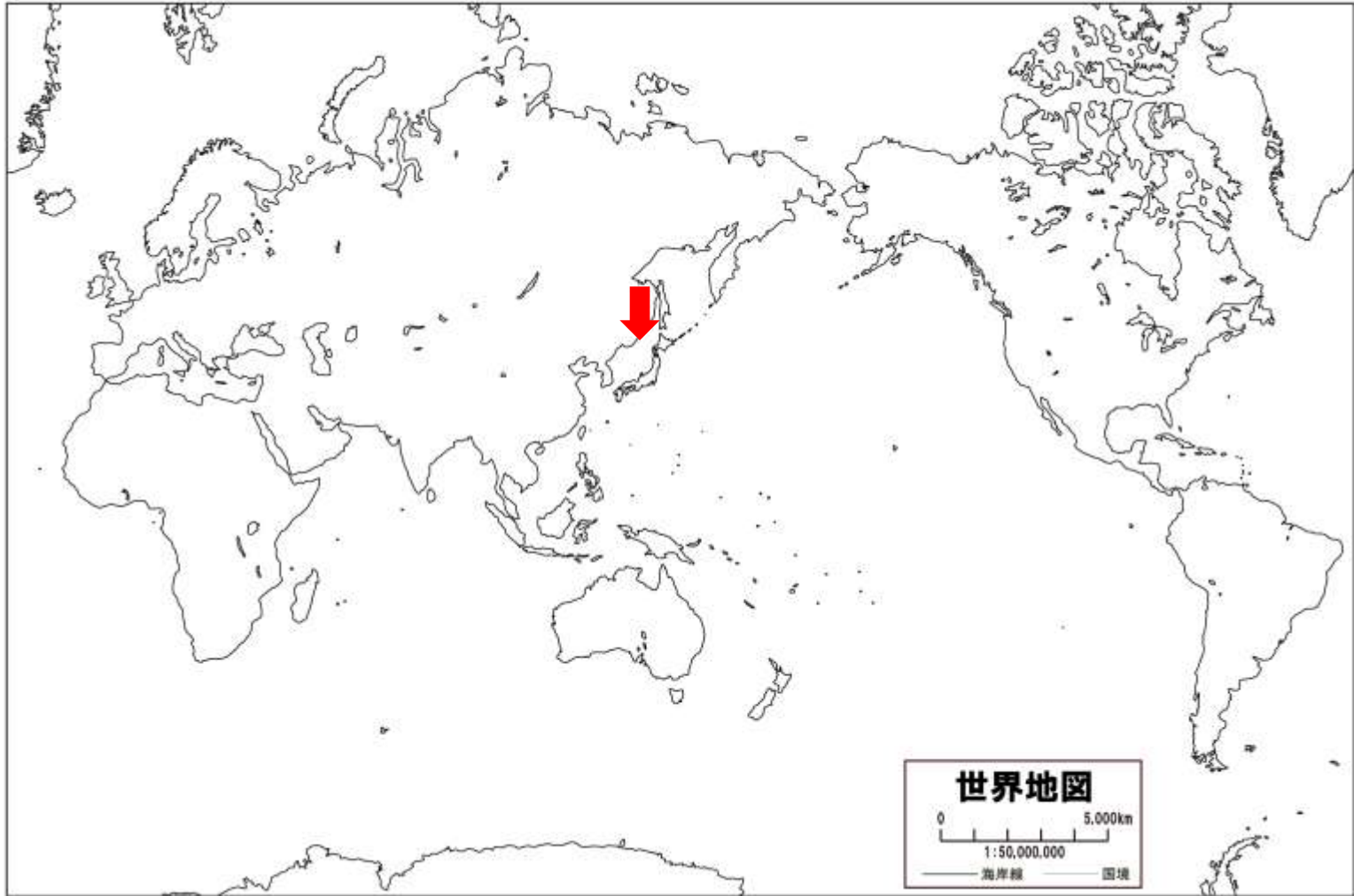


The Long Term Measurement of the Sky Quality in Nagano, Japan

Toru Suyama,
Nagano City Museum

Where is Nagano?

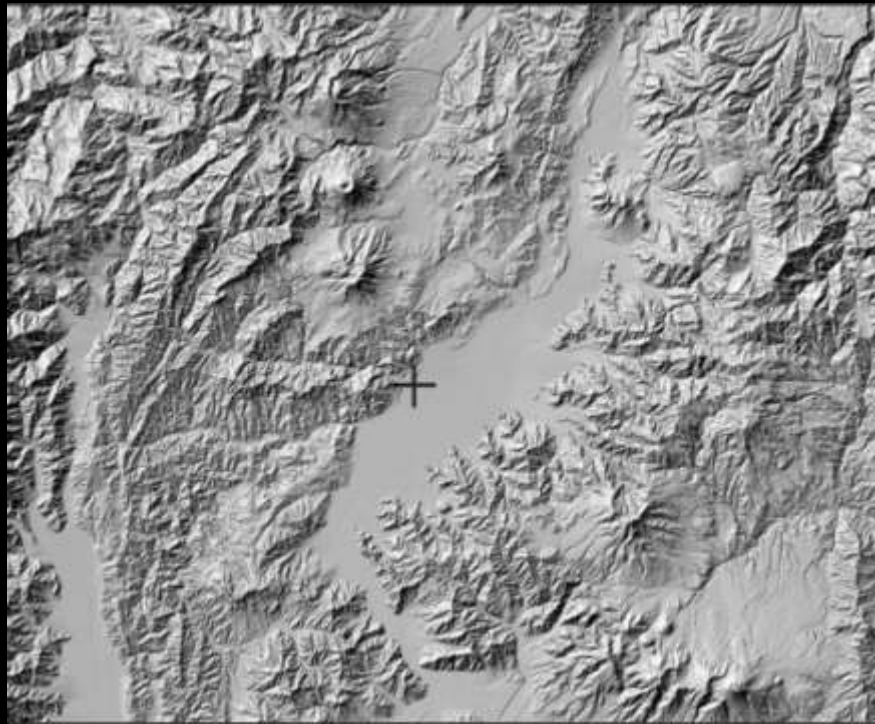


Where is Nagano?



Nagano City

- Population is 374,449.
- The city area is located in a basin and is surrounded by mountains.



Nagano City Museum

- We have a planetarium and an astronomical observatory.



Light pollution

- Developments of the town cause the light pollution in many cases.
- The light pollution results in losing the dark night sky.

We can not see faint stars!



NAGANO 1998 Winter Olympic Games

- Nagano olympic held on 1998.
- We assumed **the sky quality becomes bad in Nagano city,** because many developments to prepare olympic.

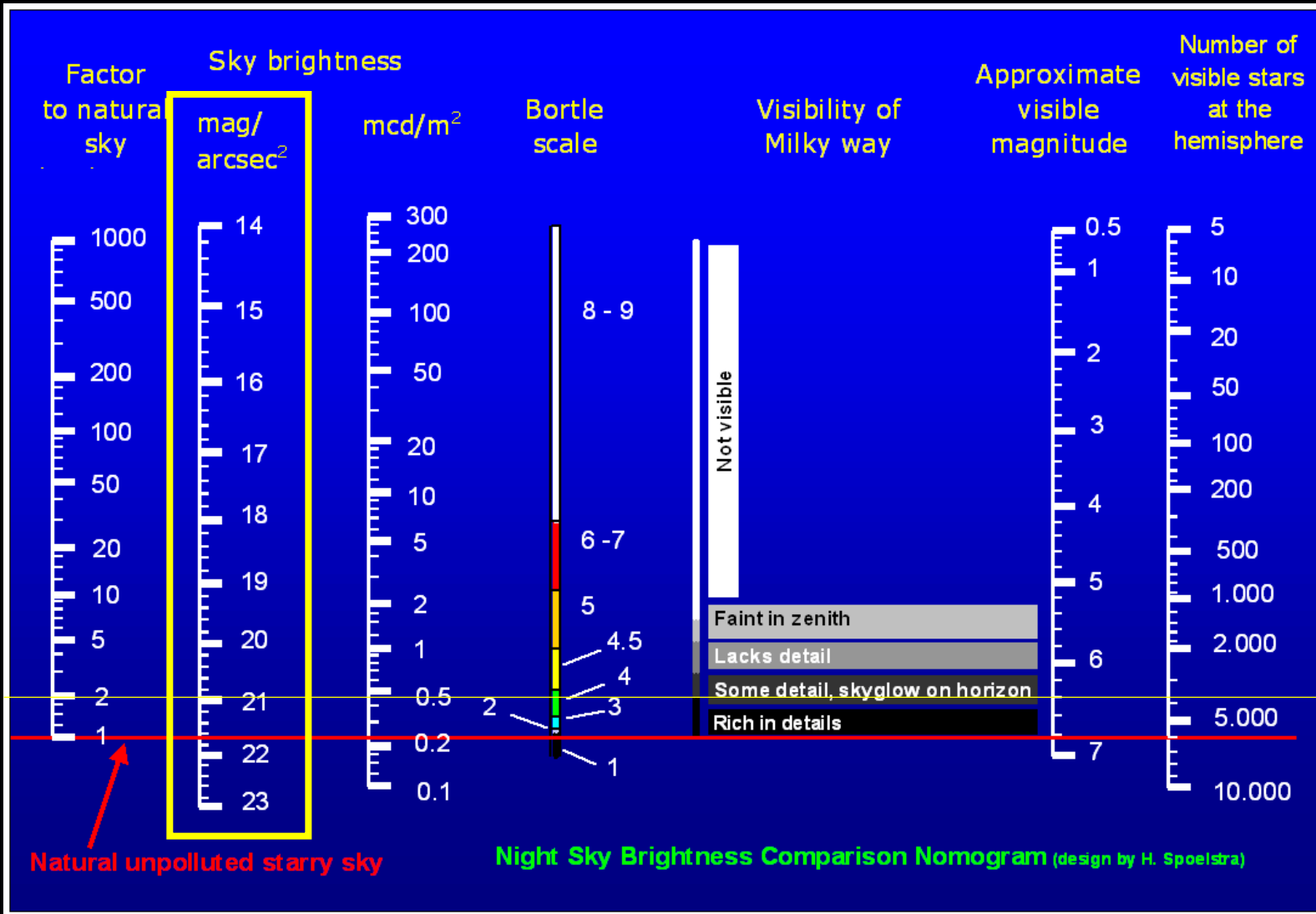


Aim

- Monitoring of **the sky quality** of Nagano city.
- Evaluation of **the light pollution** caused by the development of Nagano city with the hosting of the Olympics.



Index of the Sky Quality



Natural unpolluted starry sky

Night Sky Brightness Comparison Nomogram (design by H. Spoelstra)

You can see the milky way.

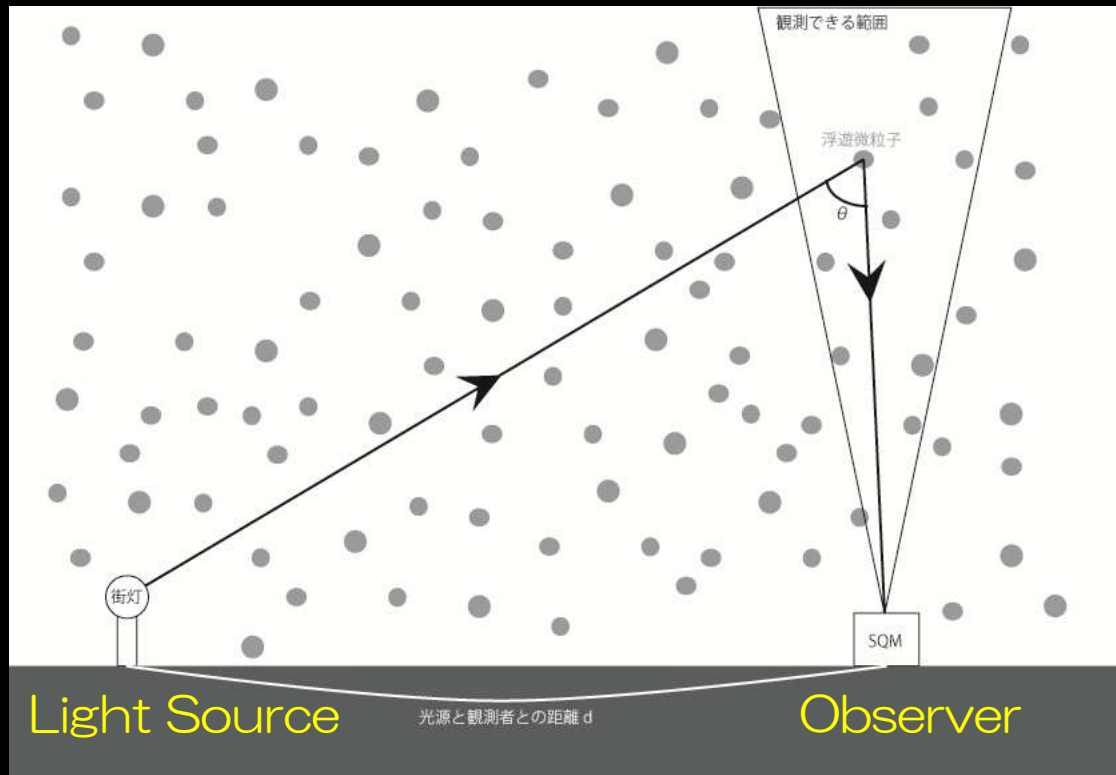
Astronomy Amateur Club “Kira-Kira”

- Astronomy amateur club “Kira-Kira” was established in 1992 at Nagano city.
- Kira-Kira started measuring the sky quality in 1993.
- Kira-Kira means twinkle.



How to Measure

- We measure the light emitted from artificial light sources scattered in the air. We do not measure the direct light.



How to Measure

- 1993 - 2009

- Film photograph + densitometer

- We take a photo the star at night.
 - We can measure the luminosity of the night sky.

- Number of observations: 102~244 locations

- Seasons: Every winter.

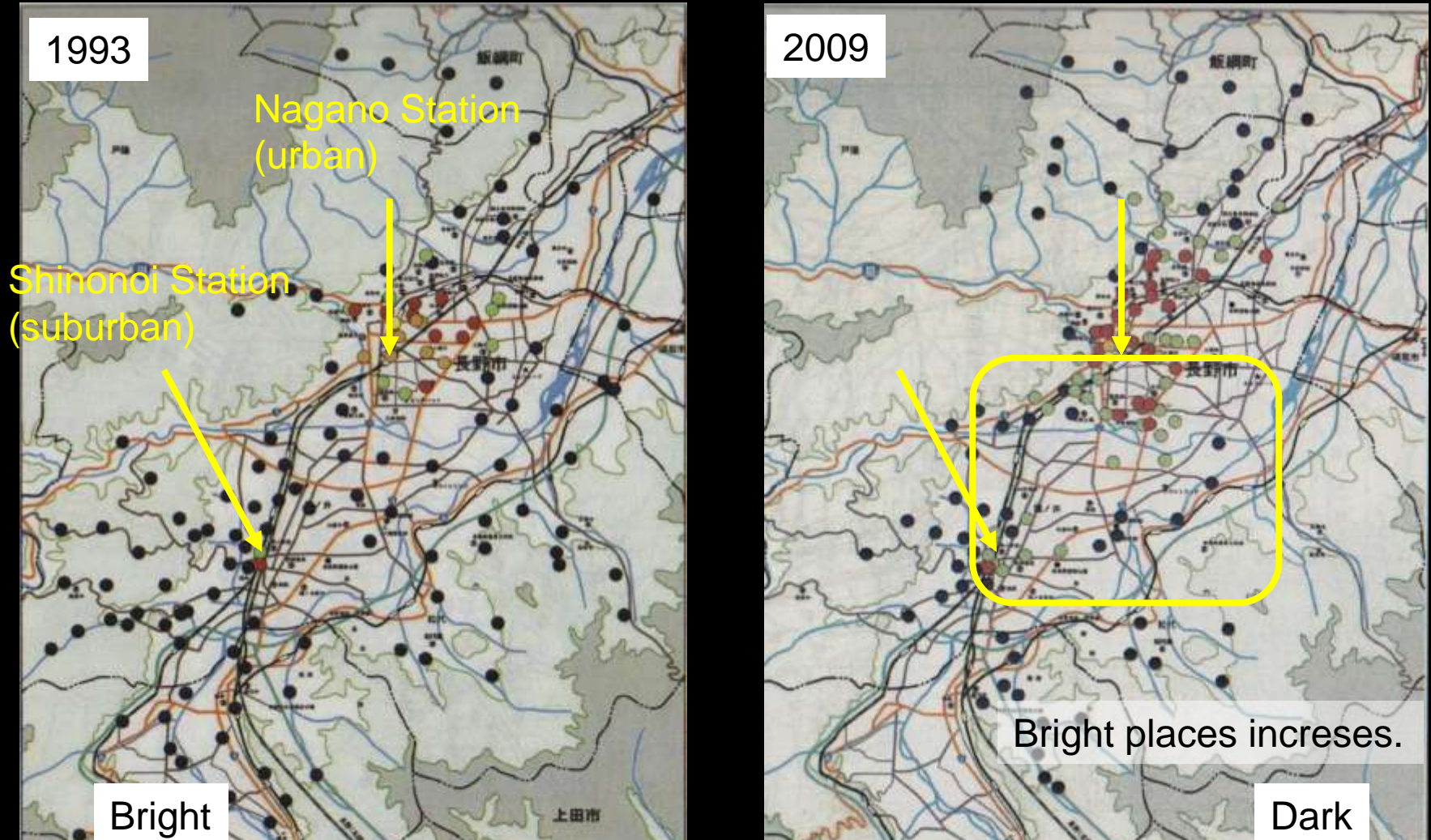
- 2010 -

- Sky Quality Meter (Unihedron)

- Only push a button. We can measure the sky quality. Very useful.



Results: Effects of Olympics



12

14

16

18

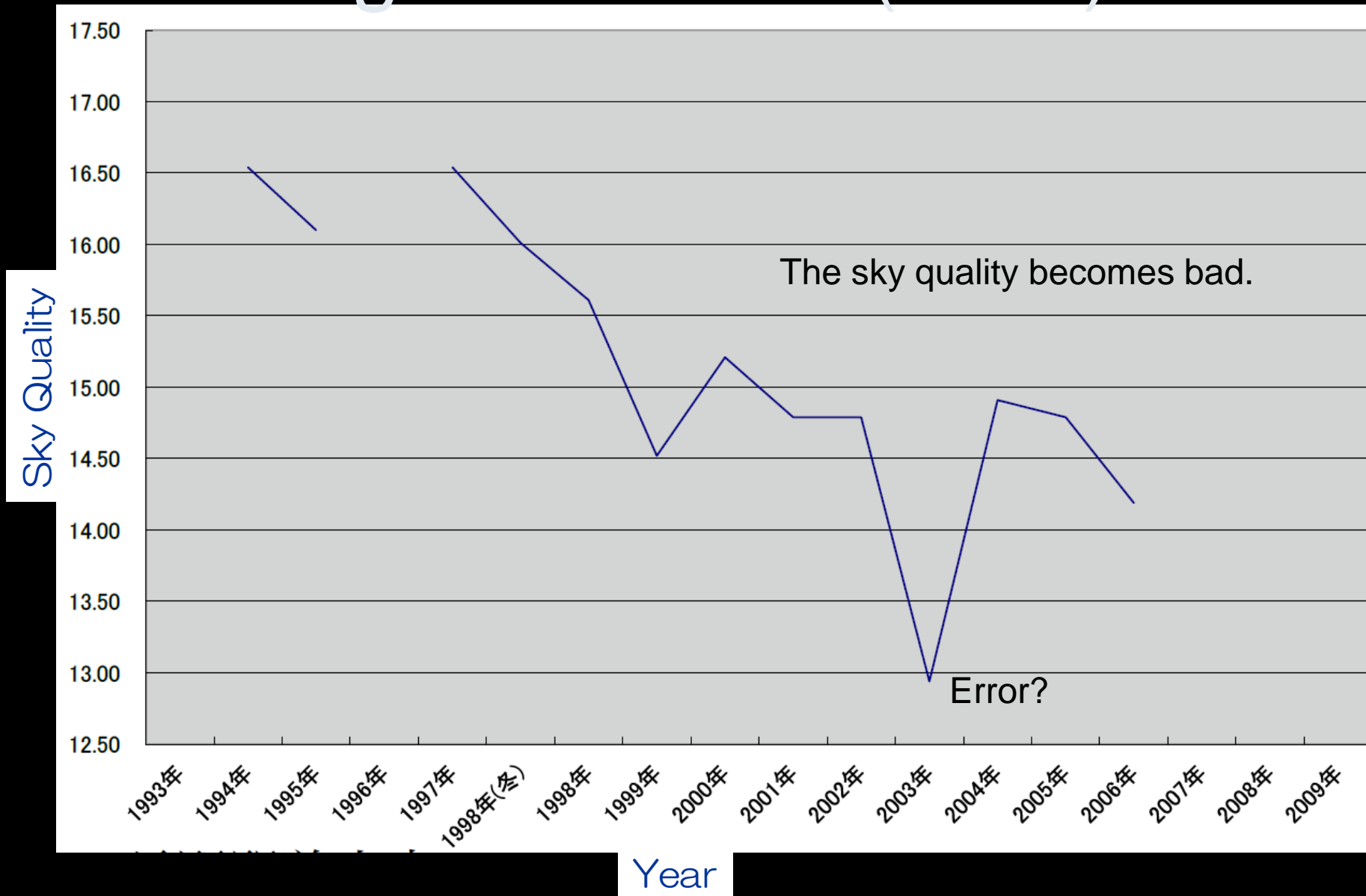
20

22

Results:

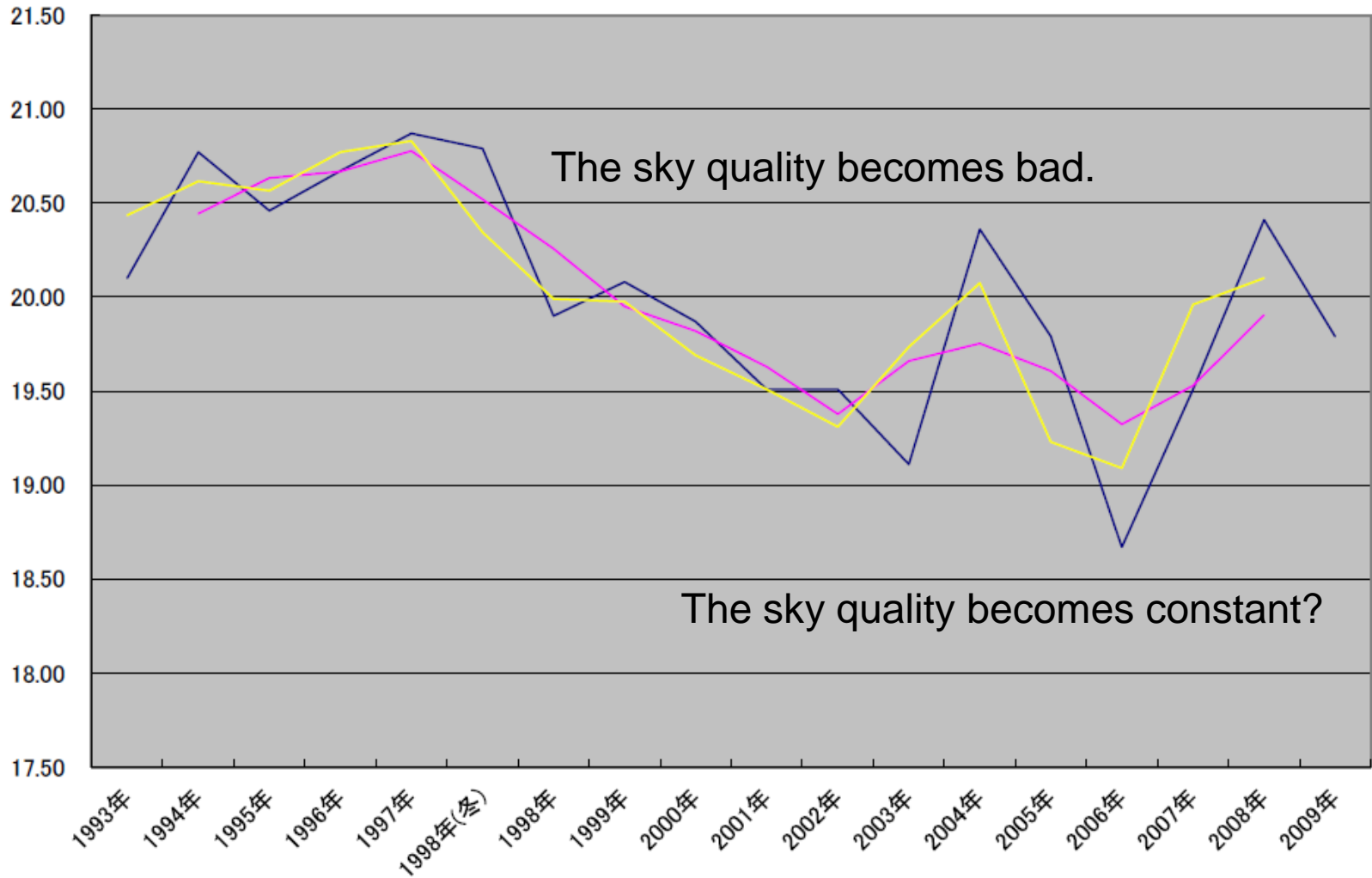
Time variation at some points
(until 2008)

Nagano Station (town)



Chausu-yama (Suburban)

Sky Quality



Year

Mure (Mountainous area)

Sky Quality

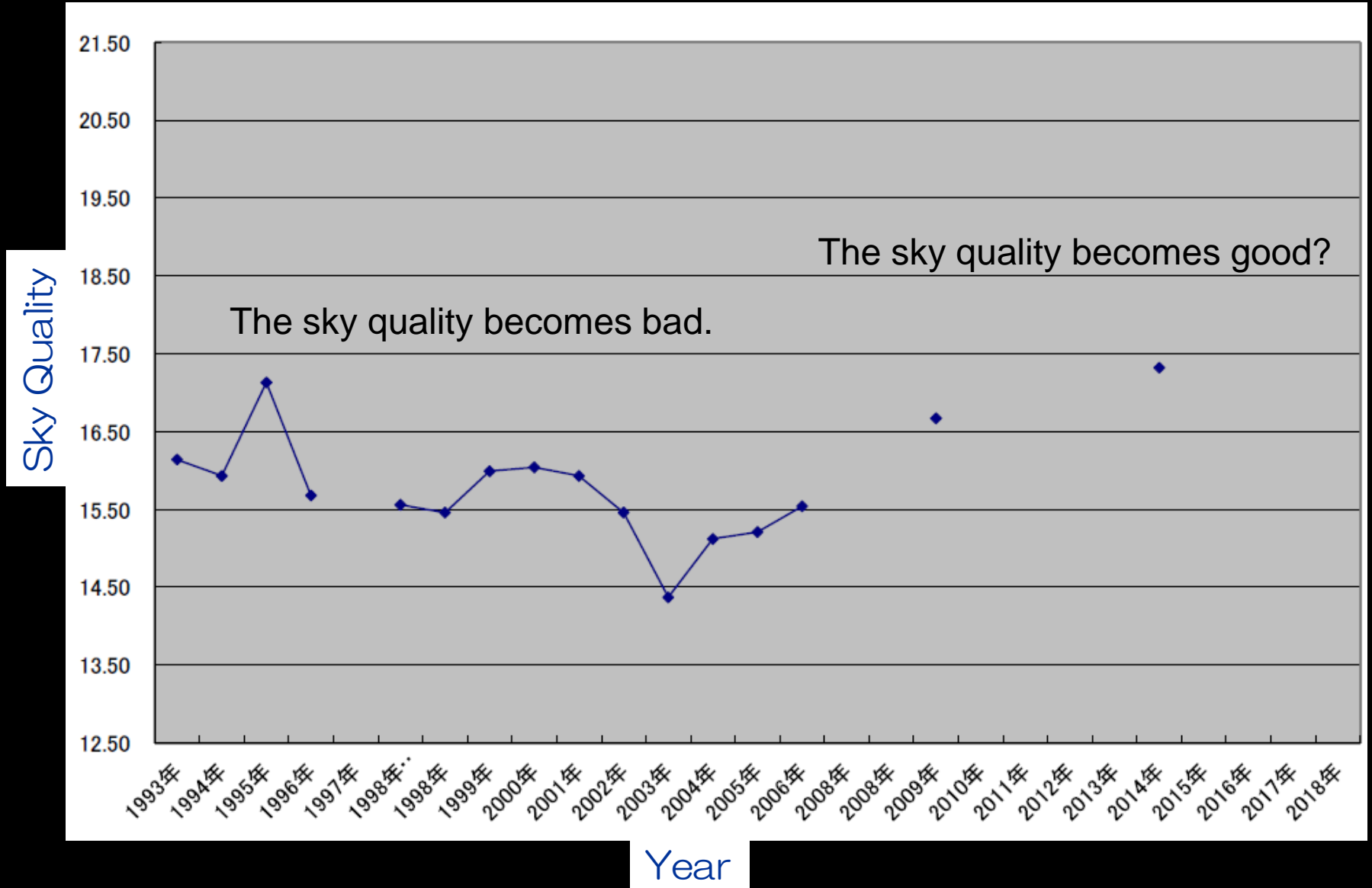


Year

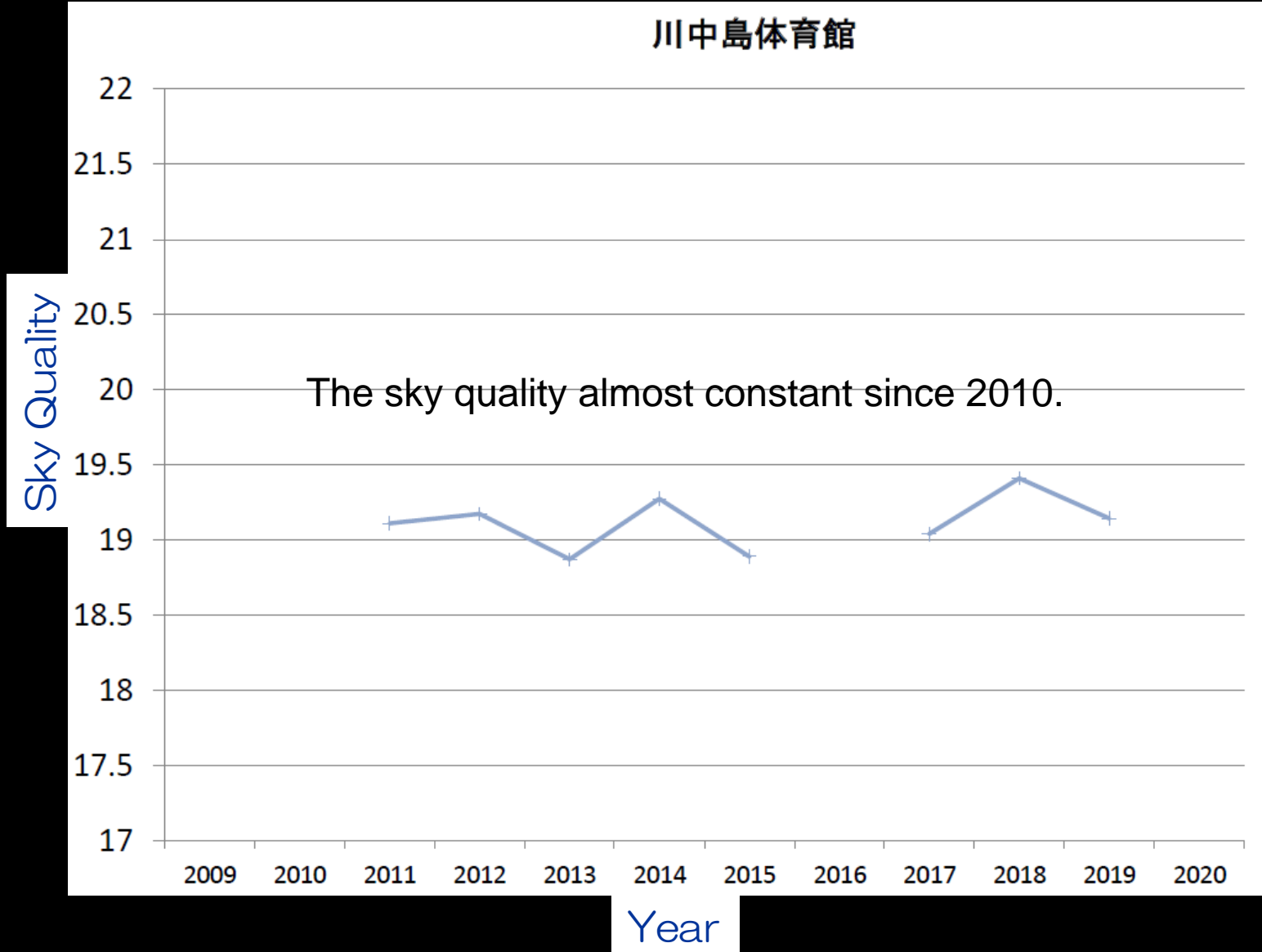
Results:

Time variation at some points
(until 2019)

Gondou (town)

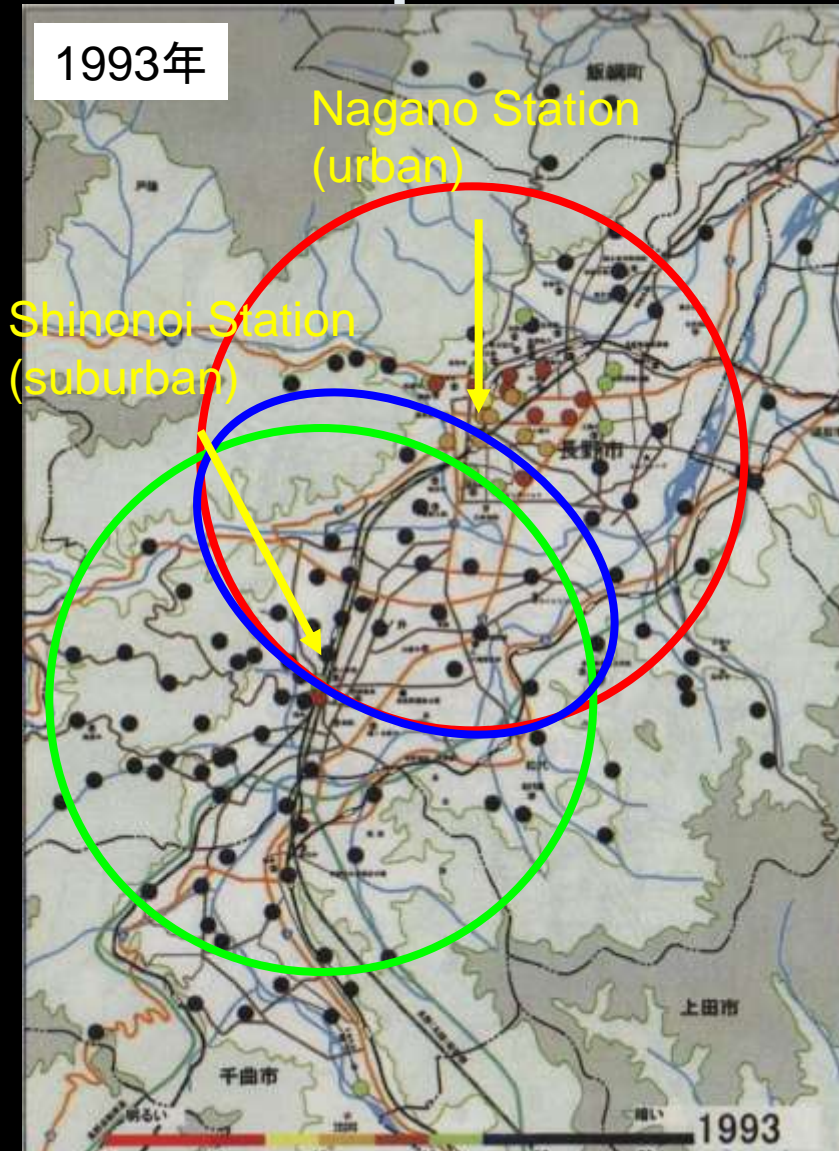


Kawanakajima (suburban)



Results:

Dependence on Distance



We divided the observation points into 4 groups.

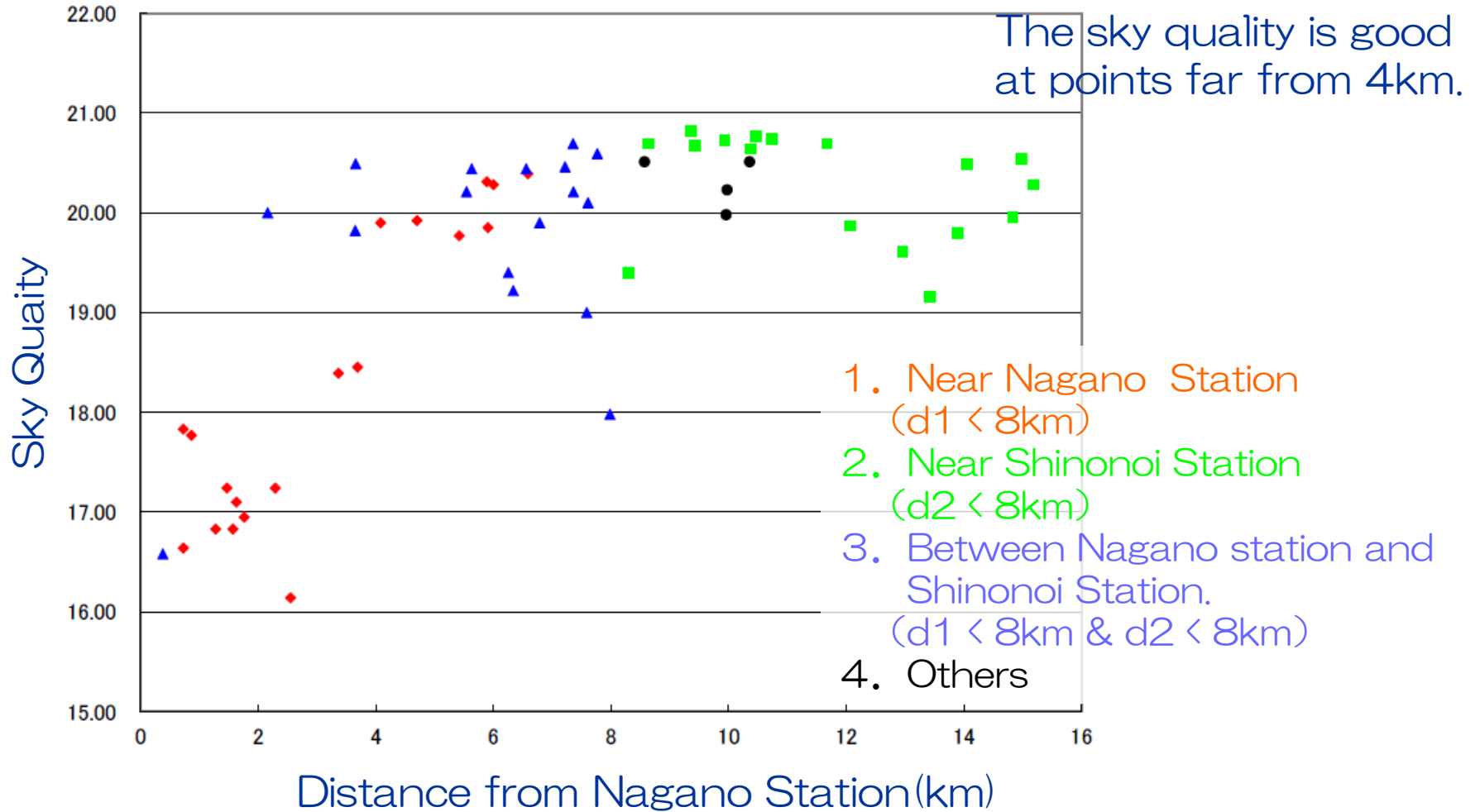
1. Near Nagano Station ($d1 < 8\text{km}$)
2. Near Shinonoi Station ($d2 < 8\text{km}$)
3. Between Nagano station and Shinonoi Station. ($d1 < 8\text{km} \ \& \ d2 < 8\text{km}$)
4. Others

Reason:

I think that the primary light source is Nagano station. And the secondary light source is Shinonoi station.

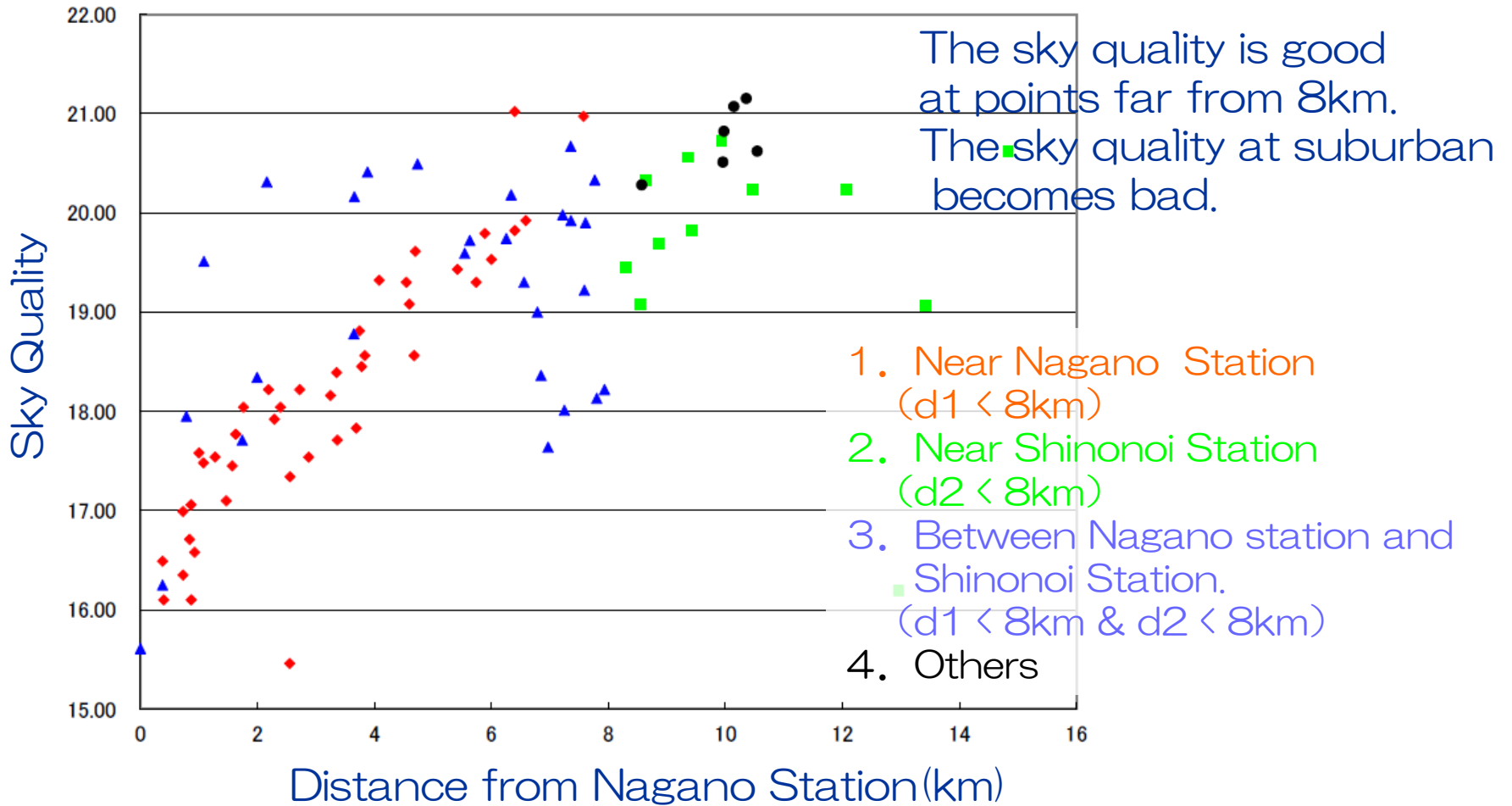
1993

長野市の夜空の明るさ1993



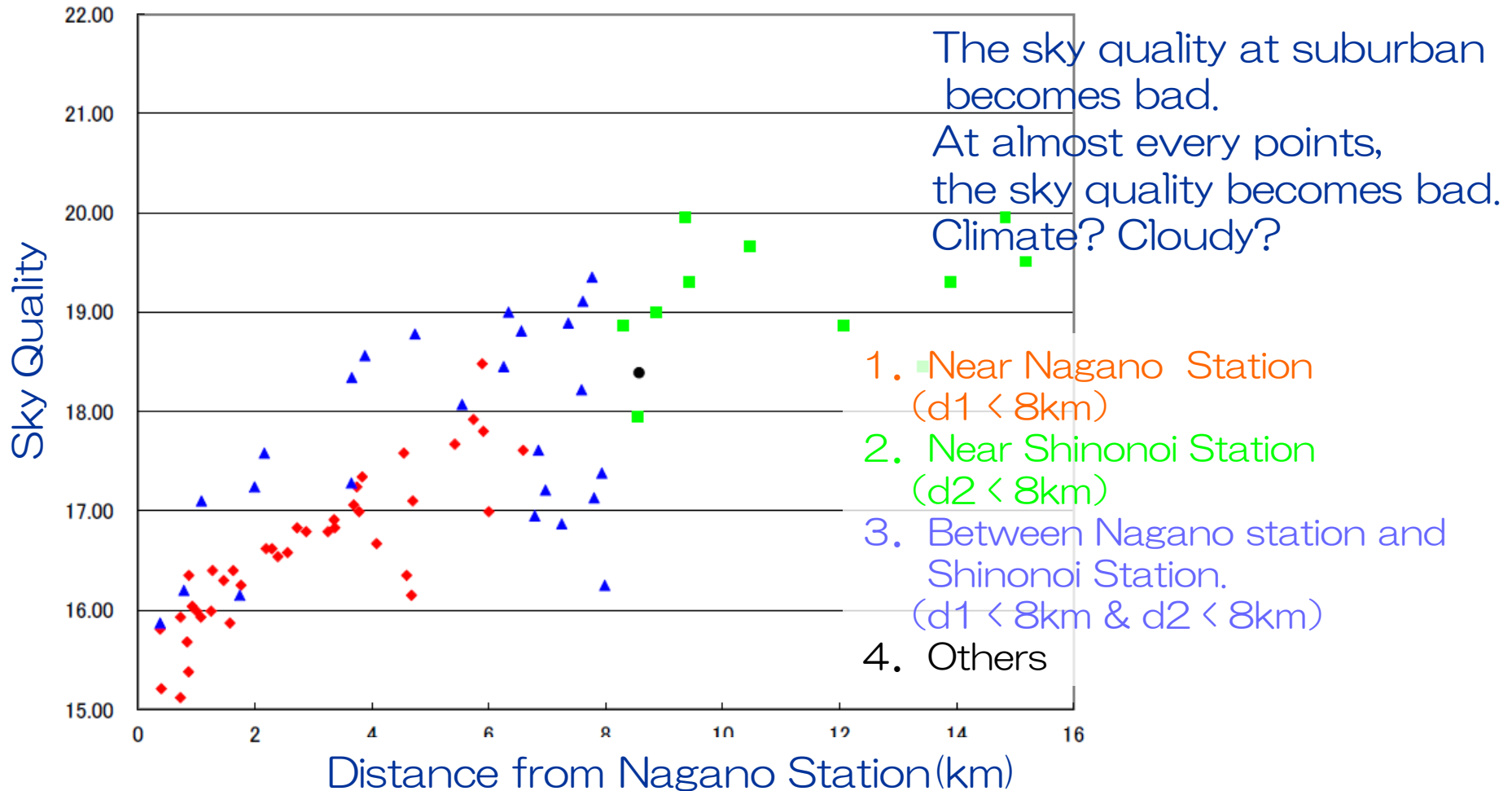
1998

長野市の夜空の明るさ1998



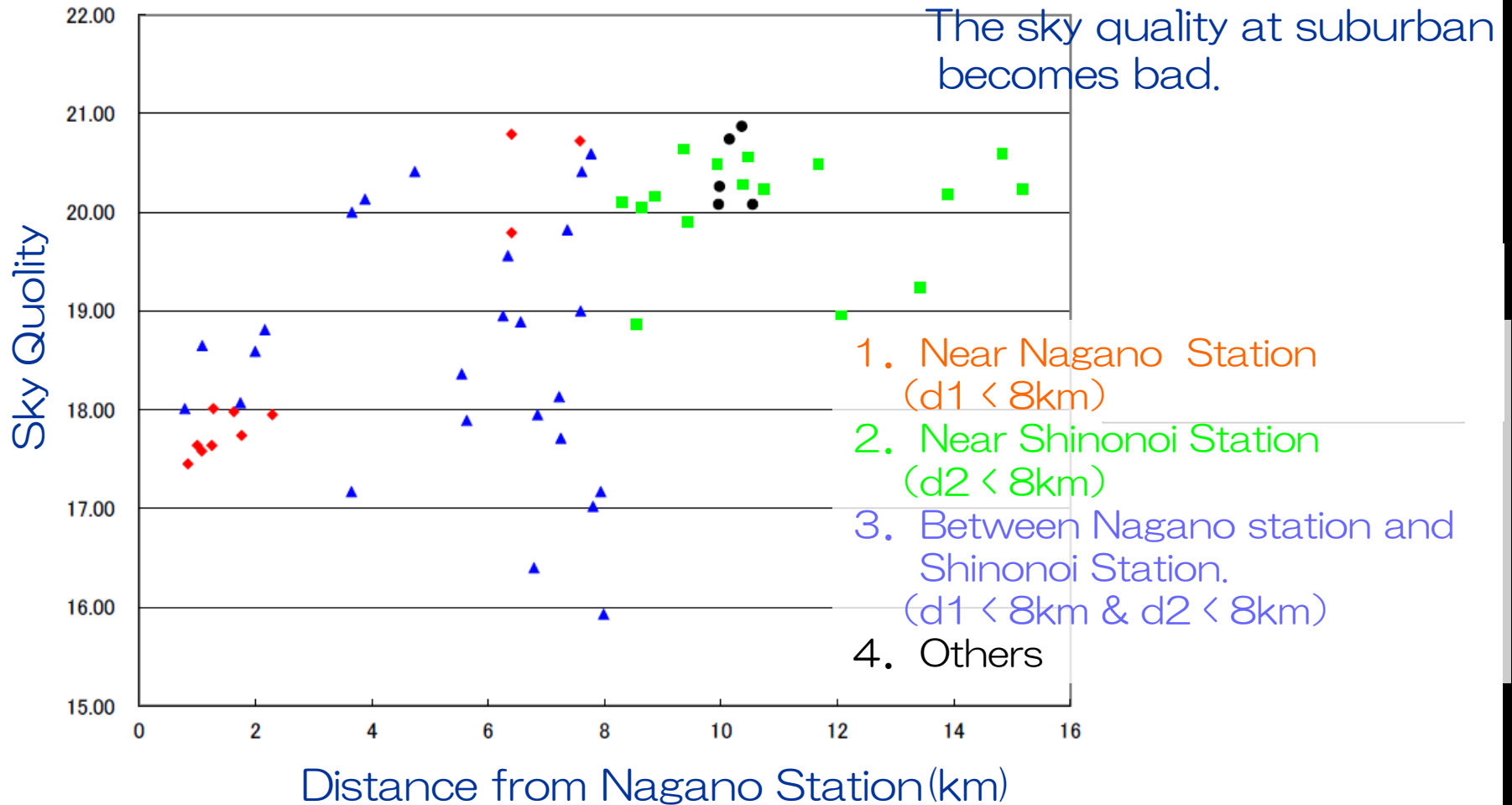
2003

長野市の夜空の明るさ2003



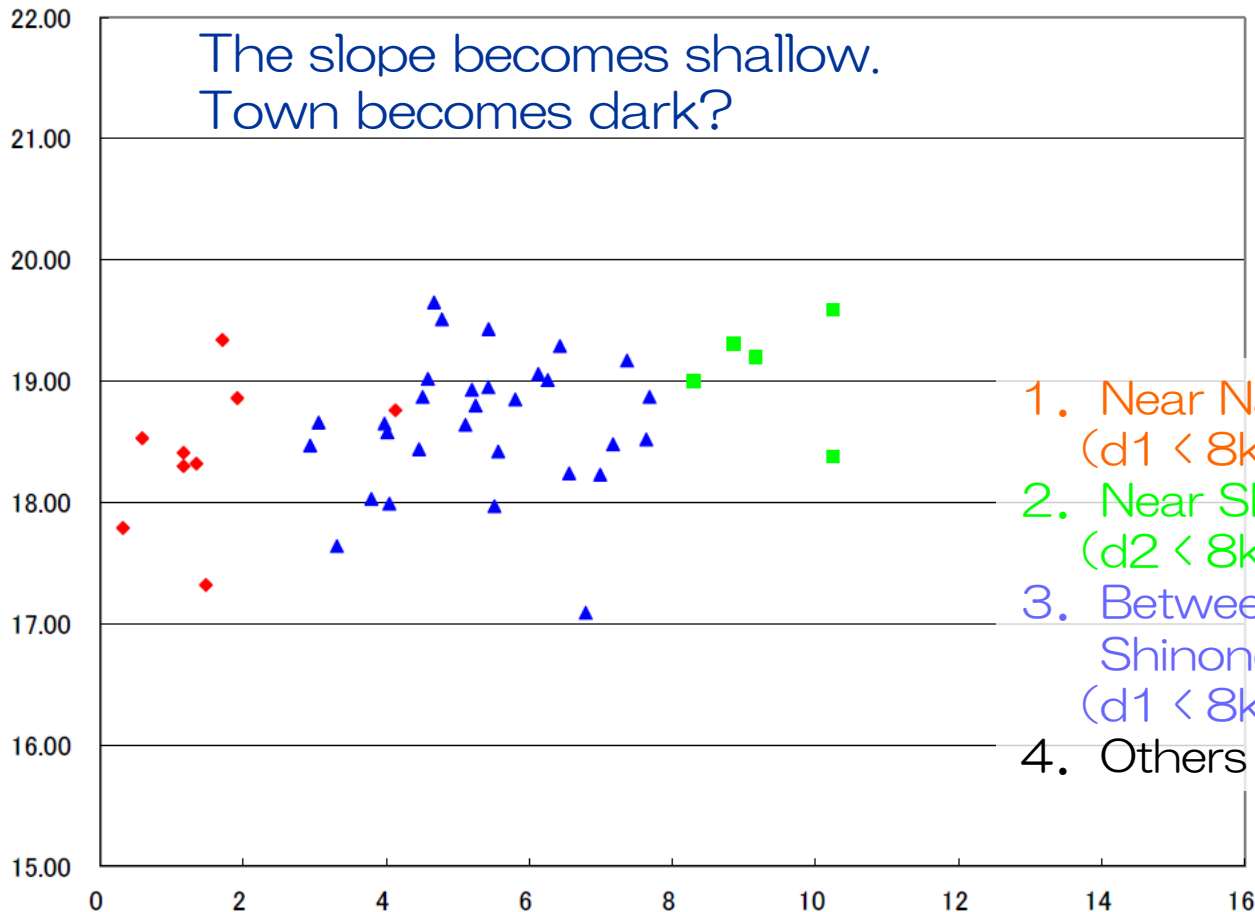
2008

長野市の夜空の明るさ2008



2013

Sky Quality



1. Near Nagano Station (d1 < 8km)
2. Near Shinonoi Station (d2 < 8km)
3. Between Nagano station and Shinonoi Station. (d1 < 8km & d2 < 8km)
4. Others

Distance from Nagano Station (km)

Summary & Disucssion

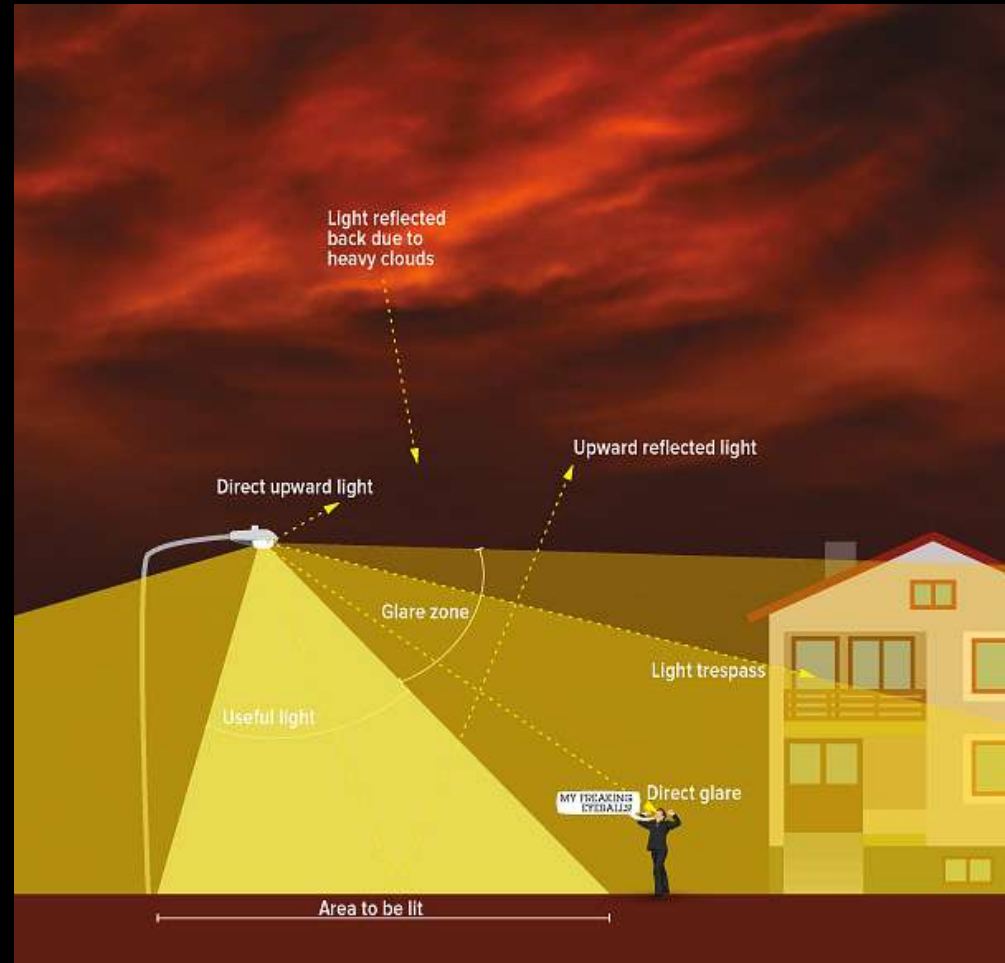
- We are monitoring of **the sky quality** of Nagano city since **1993**.
 - Problem is decreasing of observers.
 - It is important to continue to mesure.
- The sky quality becomes bad (especially **suburban**).
 - People made many buildings at suburban due to Olympics.
- The sky quality is good about **8 km from Nagano Station** (town).

Summary & Discussion

- Can we restore the sky quality to good?
 - Very difficult. But, we want to keep the present state of the sky quality.
 - The spread of the knowledge about the light pollution is important!

Summary & Disucssion

- Recently, people use **good light**.
 - Deterioration of the sky quality may stop.



Good light (Image by Anezka Gocova, in “The Night Issue”, Alternatives Journal 39:5 (2013)).

長野県は宇宙県

Nagano prefecture is “Uchu-ken”!
“Uchu” means universe, and “ken” means prefecture.

Nobeyama Radio Observatory.

イメージキャラクター

ほしくま



© Tamayo Kawamura

最も「宇宙に近い」県

標高が
高い

High
Altitude.

美しい
星空

Beutifull
Sky.

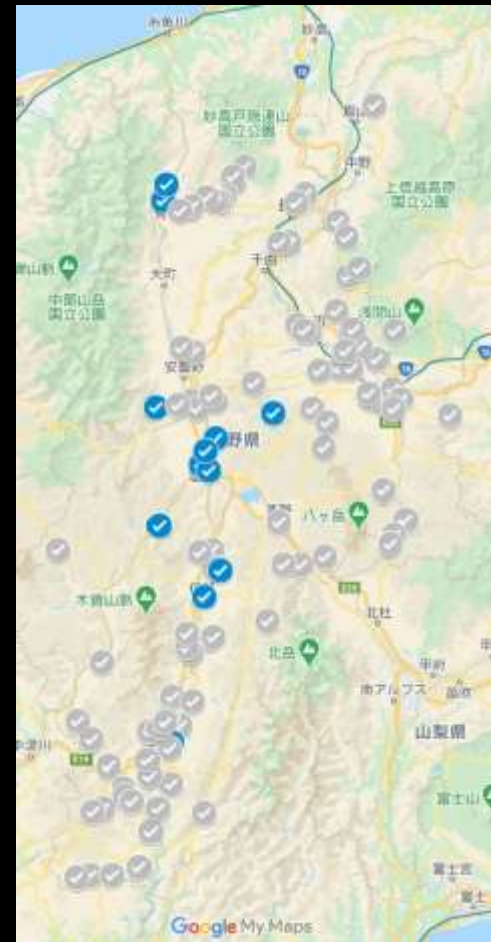
多くの
天文関連
施設

Many Observatory
and Planetarium.



Future work

- We start to measure the sky quality in “**Uchu-ken(Nagano)**” .
- We check the sky quality as follows:
 - Where can we look at **Milky way**?
 - The distribution of the sky quality.
 - Monitoring of the sky quality.
 - We want to keep the present state.



A night sky filled with stars, with a dark silhouette of a building at the bottom. The text is overlaid on the sky.

Thank you for your attention!

Please speak slowly in English,
because I can not speak and listen to English well.