11th European Symposium for the Protection of the Night Sky

Osnabrück, Germany

Night Sky Brightness Monitoring Network in Hong Kong

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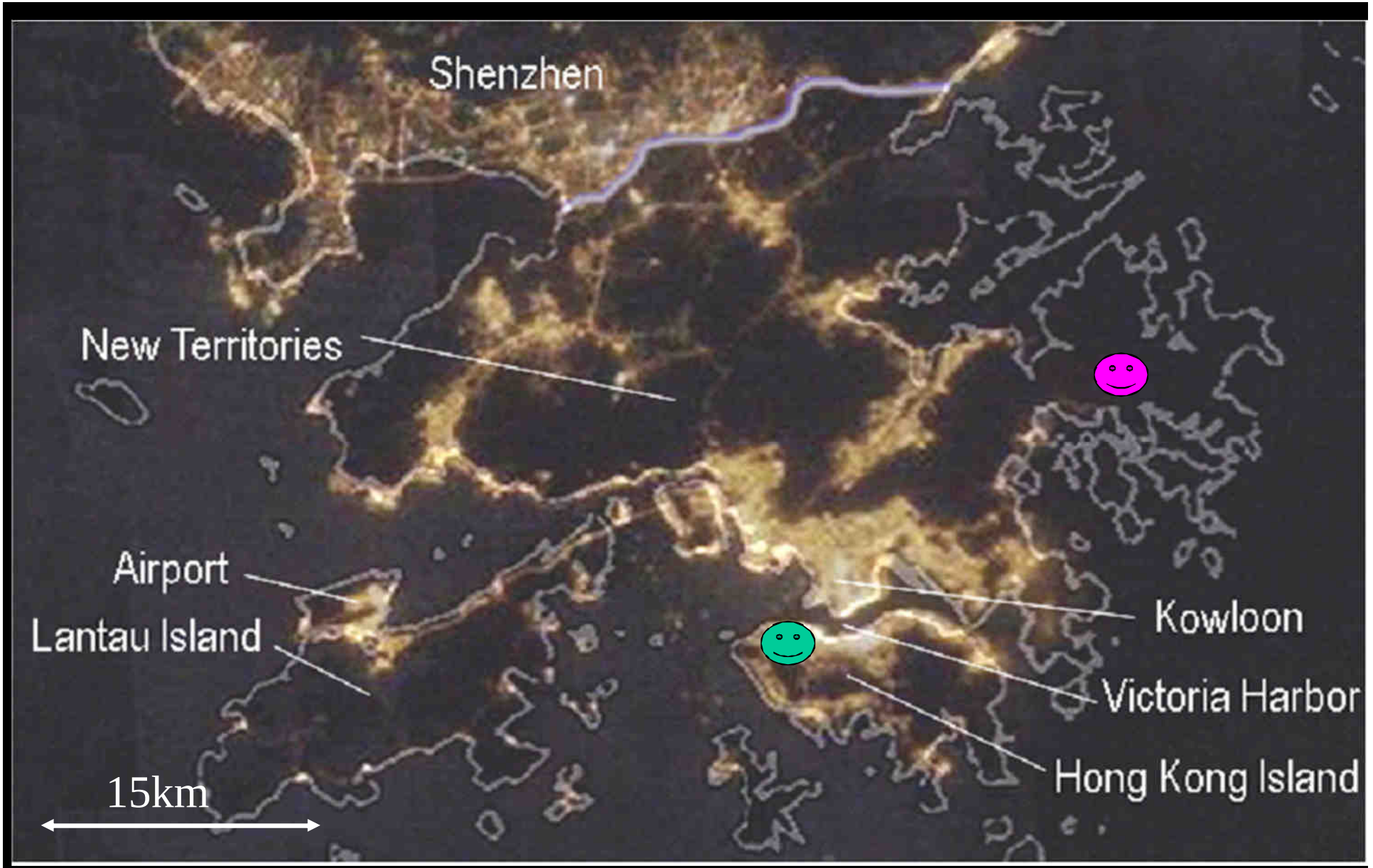
October 6, 2011



Nighttime picture of Hong Kong taken from ISS (2007-2008, credit: NASA)

Urban: The University of Hong Kong

Rural: iObservatory

Hong Kong Night Sky Brightness Monitoring Network (NSN)

- Funded by "Environment and Conservation Fund" of the Hong Kong SAR government
- Duration: June 2010 - May 2012
- NSN data:
  - Night Sky Brightness (NSB) by Sky Quality Meters – Lens Ethernet (SQM-LE) at 18 monitoring stations
  - Cloud amount by IR sensors (Boltwood, AAG) at selected stations
  - Meteorological data by on-site weather stations and observations by Hong Kong Observatory (HKO)

SQM-LE

cloud sensors

NSN stations

SQM-LE points to zenith
(under transparent window)

weatherproof casing:
reflective surface
3G modem, router
power adapters
fans, timer

mounting frame

mounting pole

cloud sensor

weather station

NSN monitoring station at iObs (rural site)

NSN stations

- Special thing about NSN stations:
  - Measure NSB simultaneously, continuously at multiple locations
  - 10 urban + 7 rural + 1 airport
    - Cooperation with HK Observatory, secondary schools, government agencies
  - Data collection
    - Each SQM-LE is connected to a 3G router and modem with a fix IP address
    - Server at The University of Hong Kong requests reading from all stations every 5 minutes
    - Store raw data in a database
  - Custom-made outdoor casing
    - Polycarbonate (after one-year of aging, effect of the case ~ 0.2 mag)
    - Electric fans for ventilation (interior reaches 45^{o}C in summer!)
  - Timer (with battery backup)
    - Daily reboot (4pm power up, 8am power off)
    - Hardware and network connection may be self recovered after reboot
    - Avoid overheat during daytime

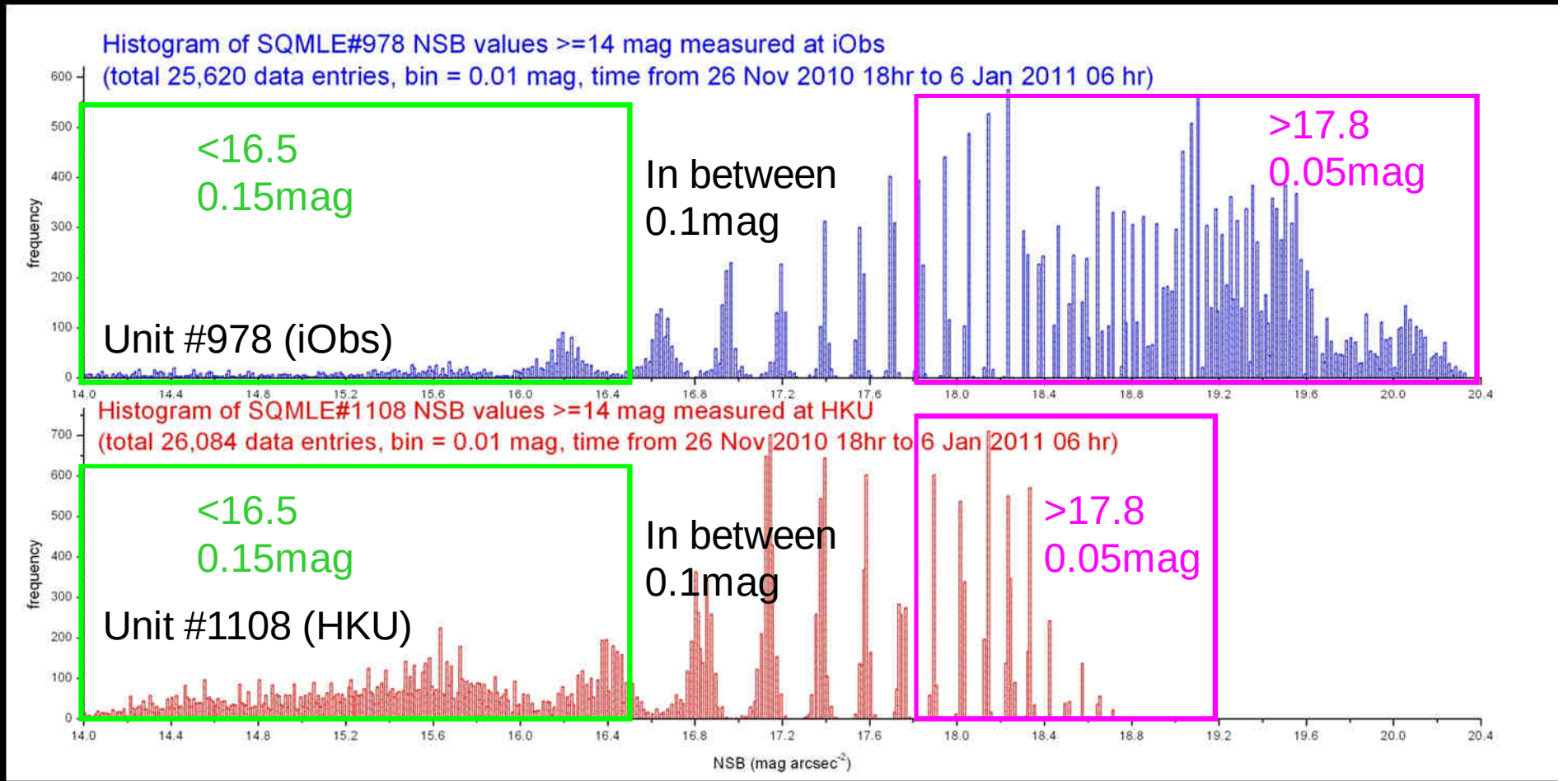
Real-time night sky condition map

http://nightsky.physics.hku.hk

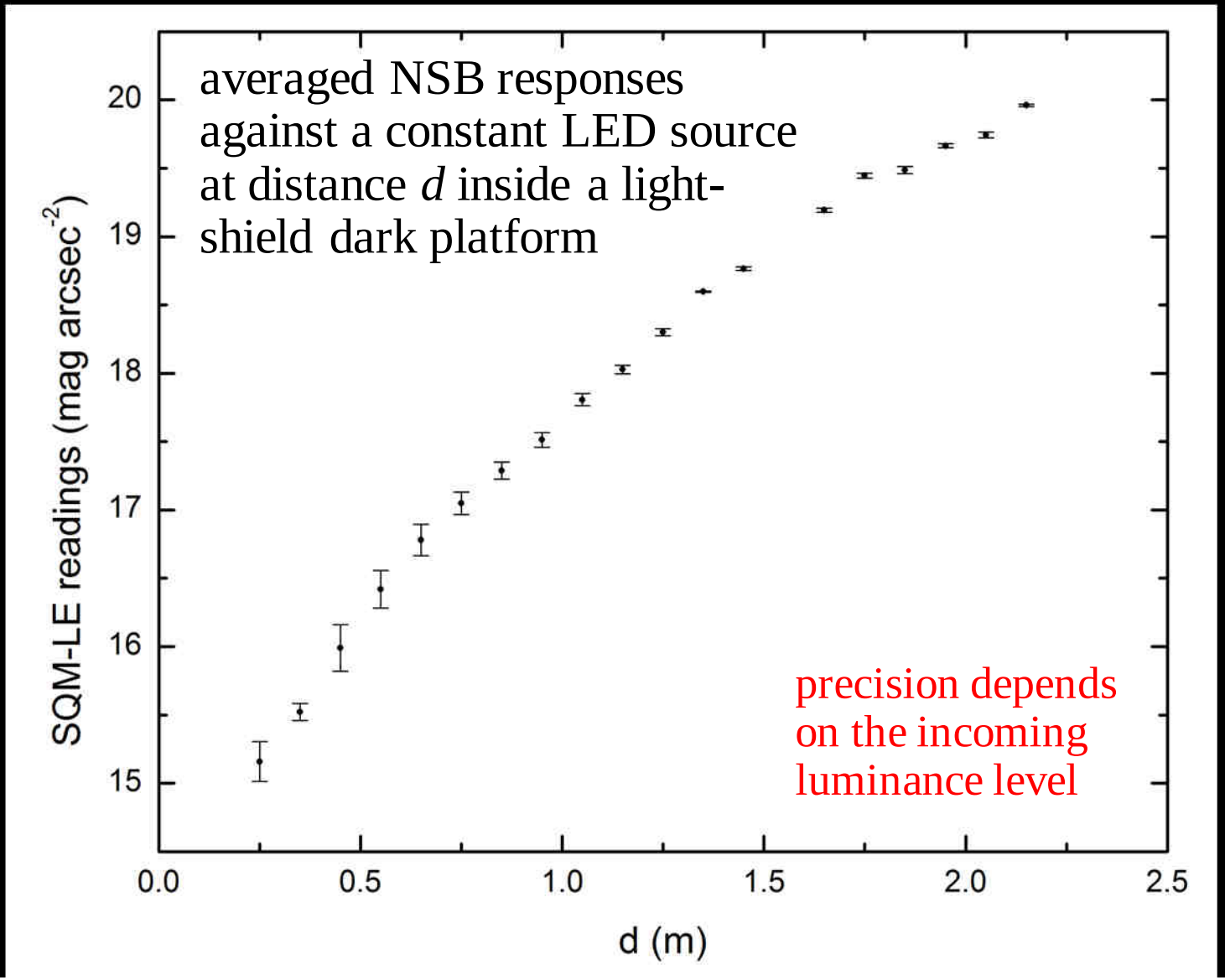
Uncertainties of SQM-LE measurements

- Manufacturer's claimed accuracy:
  - +/- 10% or +/- 0.1 mag arcsec^{-2} for all magnitude readings
- Additional factors in considering uncertainties of SQM-LE readings:
  - digitization error
    - ranged 0.05 to 0.15 mag arcsec^{-2}
  - Measured data spread depends on the incoming luminance level
    - ranged form 0.02 to 0.16 mag arcsec^{-2}
  - frequency-period modes switching point
    - uncertainty increased to 0.2 mag arcsec^{-2} below around ~14.6 mag arcsec^{-2}
- Generally, found larger uncertainty for brighter measurements
  - Could be problematic when making comparisons between urban and rural skies

Uncertainties of SQM-LE measurements - Digitization error



Uncertainties of SQM-LE measurements – measured data spread vs input luminance



Effects of human lightings on NSB

- Attempt to identify the effects of human lightings on night skies
- Compiled the "darkest" NSB profiles vs time by selecting the dimmest nights at any particular time
  - Large quantity of data used (over 9 months)
  - Brightening of night sky due to meteorological or astronomical factors such as moonlight, cloud, air pollution(?) not included
  - Compare and contrast the profiles from urban and rural sites

Effects of human lightings on NSB

(1) The urban site is roughly 2 mag arcsec^{-2} brighter than the rural site

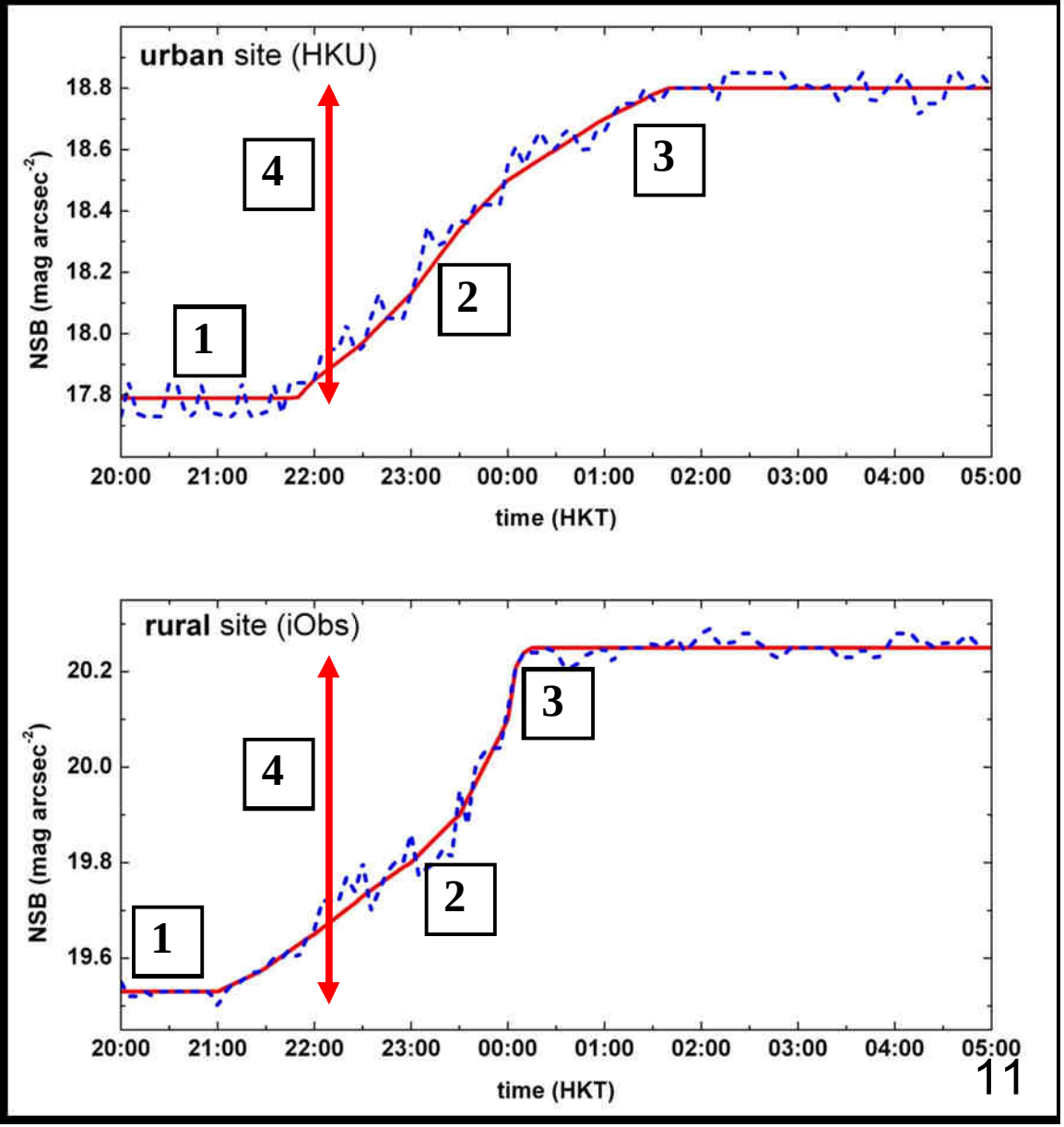
(2) NSB stayed constant for a prolonged period until the night sky got dimmer for a few hours (probably due to the reduction of human lightings), after which the night sky stayed roughly at the same level

(3) The night sky turned dark earlier for rural site and got to the final level earlier than the urban site (due to different lighting usage pattern?)

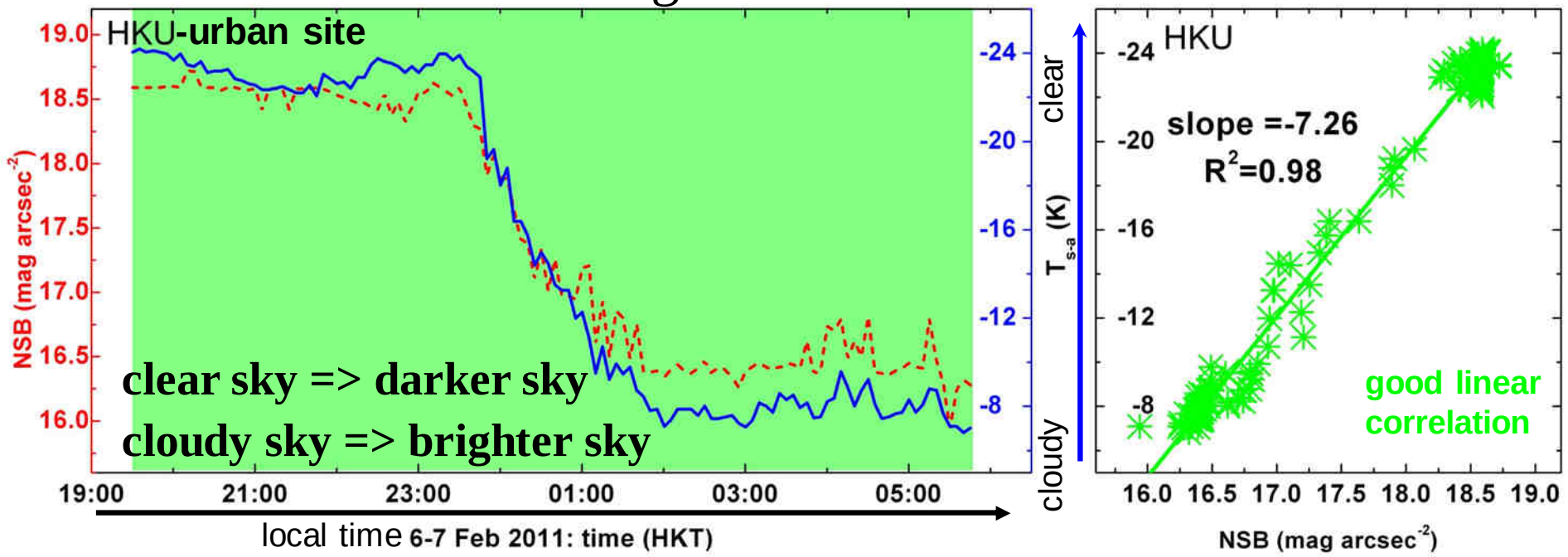
(4) Greater amount of "jump" (red arrows) in urban site than rural site, due to more human lightings used

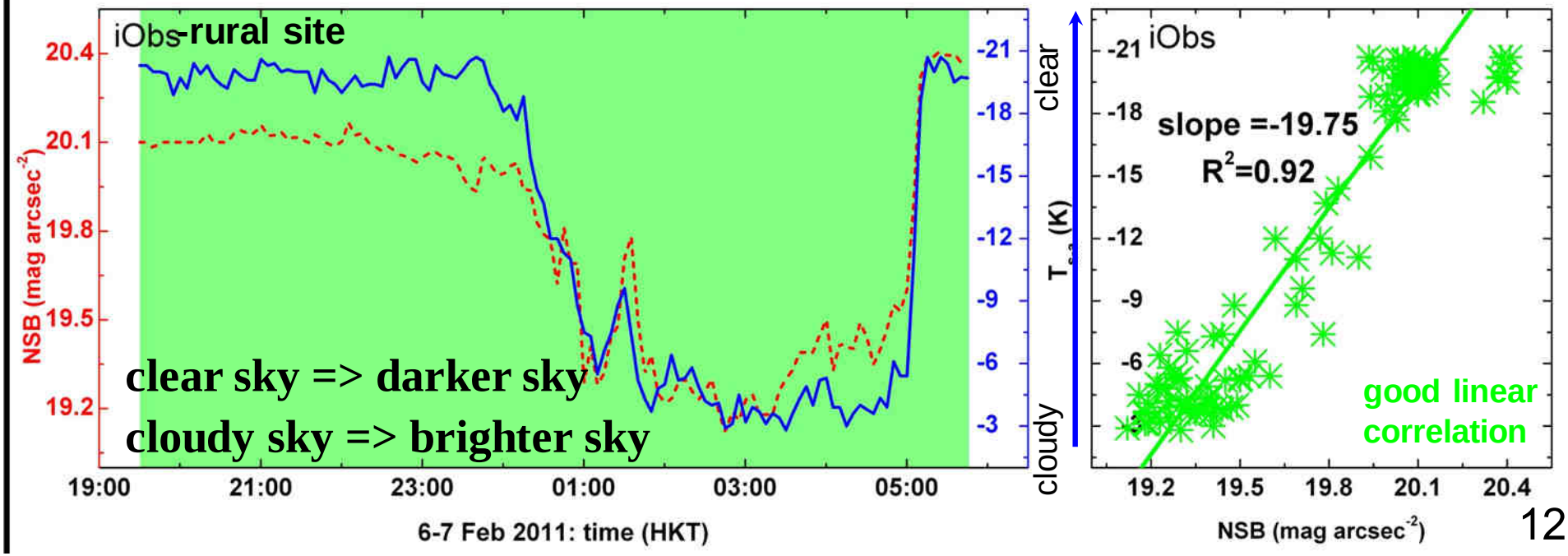
*remark:

NSB show by the blue dash curves here are the maximum values sampled over large data sets covering June 2010 to March 2011; The red curves show the their best fits.



Effects of change in cloud amount on NSB





Danke!

Webpage:

http://nightsky.physics.hku.hk

- NSN details
- Map of night sky condition on Google Maps
- Research publications

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