NARIT

ARUN
Atmospheric Research Unit of NARIT

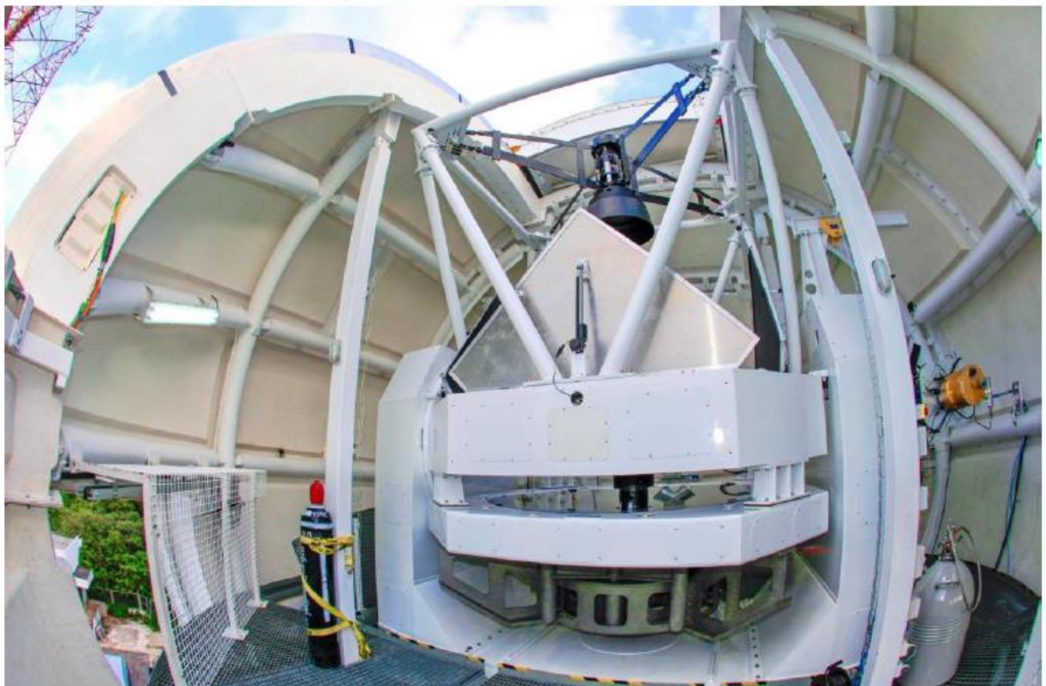
Atmospheric Characterization at TNO for Astronomy

"The atmosphere is an astronomer's worst enemy."

Ronald Macatangay (ronmcdo@gmail.com) and Somsawat Rattanasoon (Operations)

Atmospheric Research Unit, National Astronomical Research Institute of Thailand, Chiang Mai, Thailand

Jansawang Panomprai, Sauwaporn Pongpaisirikul, Porrawit Thaimai, Panpaka Suropan, Donduedee Sookjai, Thiranan Sonkaew, Ram Kesh Yadav, Raman Solanki, Pornisara Nuchvanichakul and Kyra Rumbaua



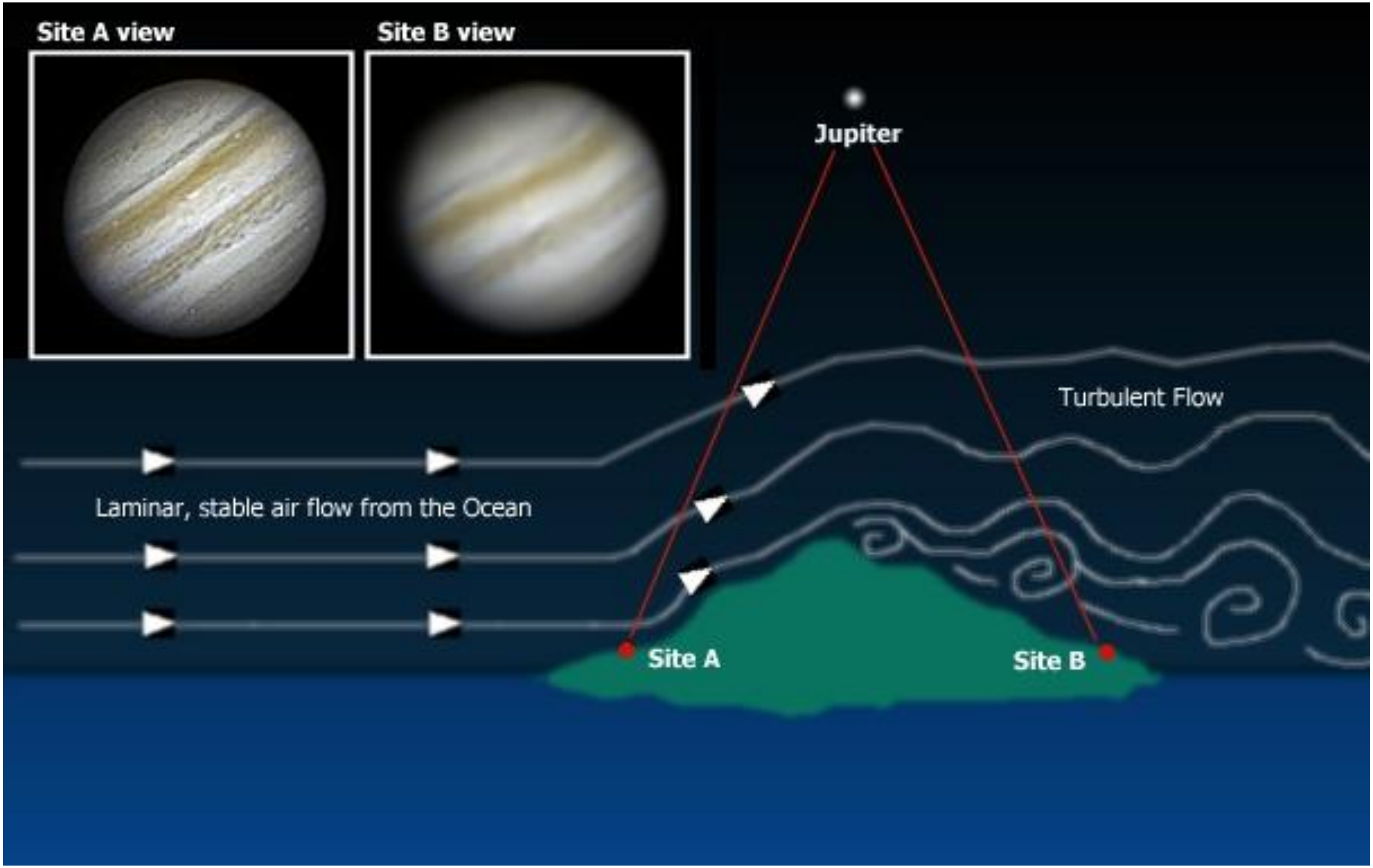
Thai National Observatory,
2.4-m Thai National Telescope, TNT

Outline

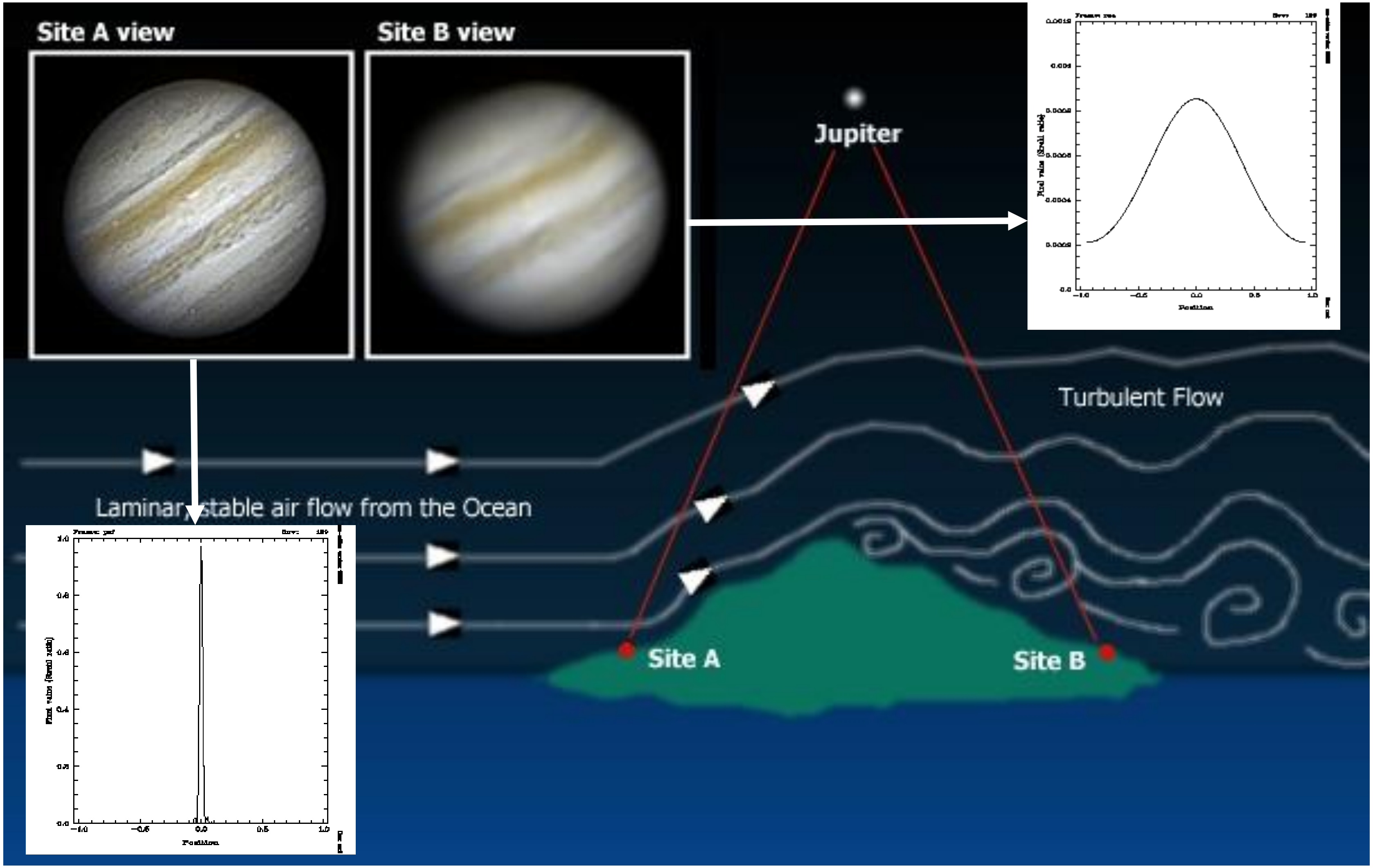
- Astronomical Seeing
- Atmospheric Extinction
- Aerosols
- Atmospheric Light Detection and Ranging (LiDAR)
- Potential Research Topics

Astronomical Seeing

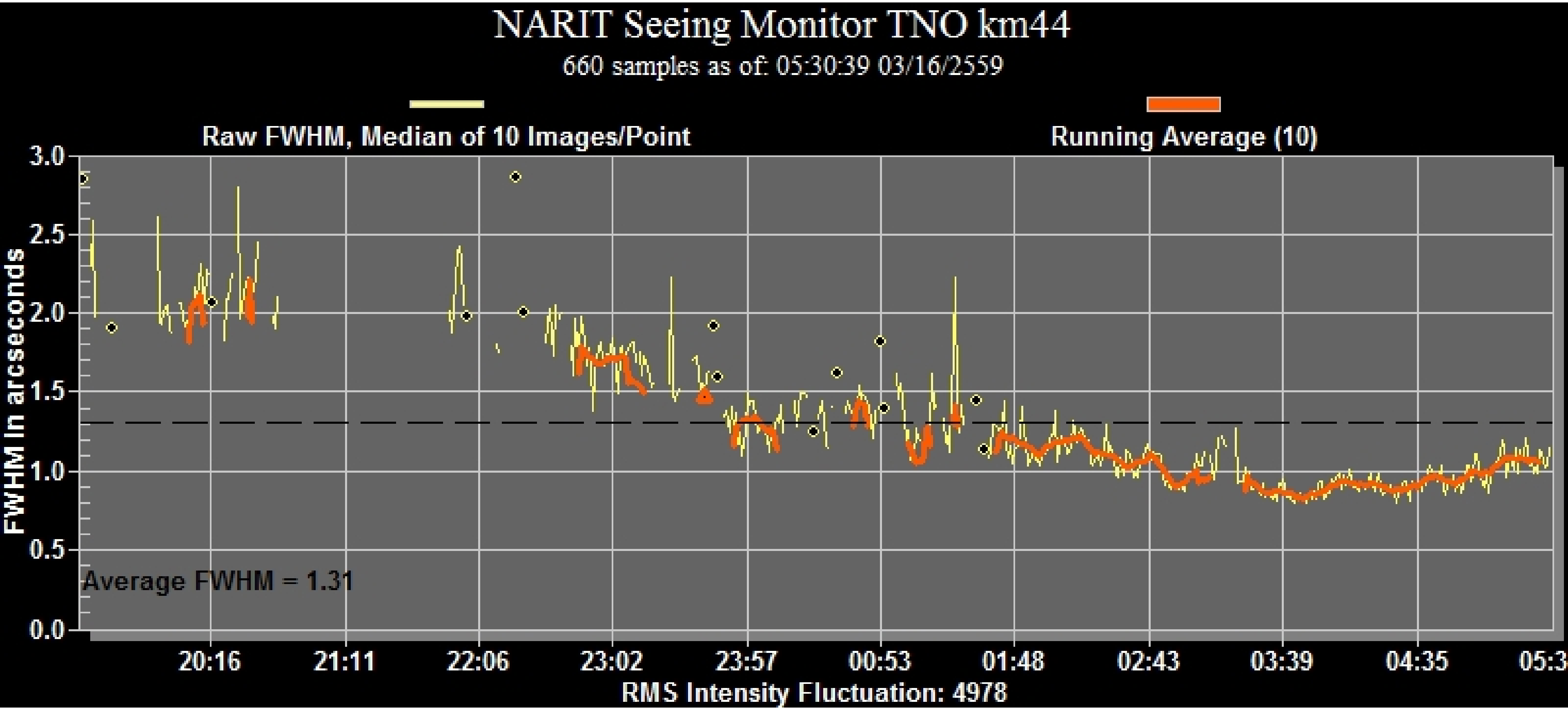
Air is responsible for poor *seeing* when it bends light chaotically, causing telescopic images to waver and smear. And it's responsible for poor transparency when it absorbs and scatters light, causing faint objects to appear even fainter than they really are.



Air is responsible for poor *seeing* when it bends light chaotically, causing telescopic images to waver and smear. And it's responsible for poor transparency when it absorbs and scatters light, causing faint objects to appear even fainter than they really are.



Air is responsible for poor *seeing* when it bends light chaotically, causing telescopic images to waver and smear. And it's responsible for poor transparency when it absorbs and scatters light, causing faint objects to appear even fainter than they really are.



Astronomical Seeing Forecast at TNO Using the Weather Research and Forecasting Model

Model Setup

(i) Initial / lateral boundary conditions from the NCEP Global Forecast System (GFS) 0.25 degree resolution

(ii) A coarse grid, having a resolution of delta x = delta y = 9 km.

(iii) 28 vertical levels, with a higher resolution in the surface layer delta h1 = 56.6 m and delta h28 = 1047 m

The main parameters used for the simulation are as follows:

(i) the microphysics scheme used is the Lin scheme (mp_physics = 2),

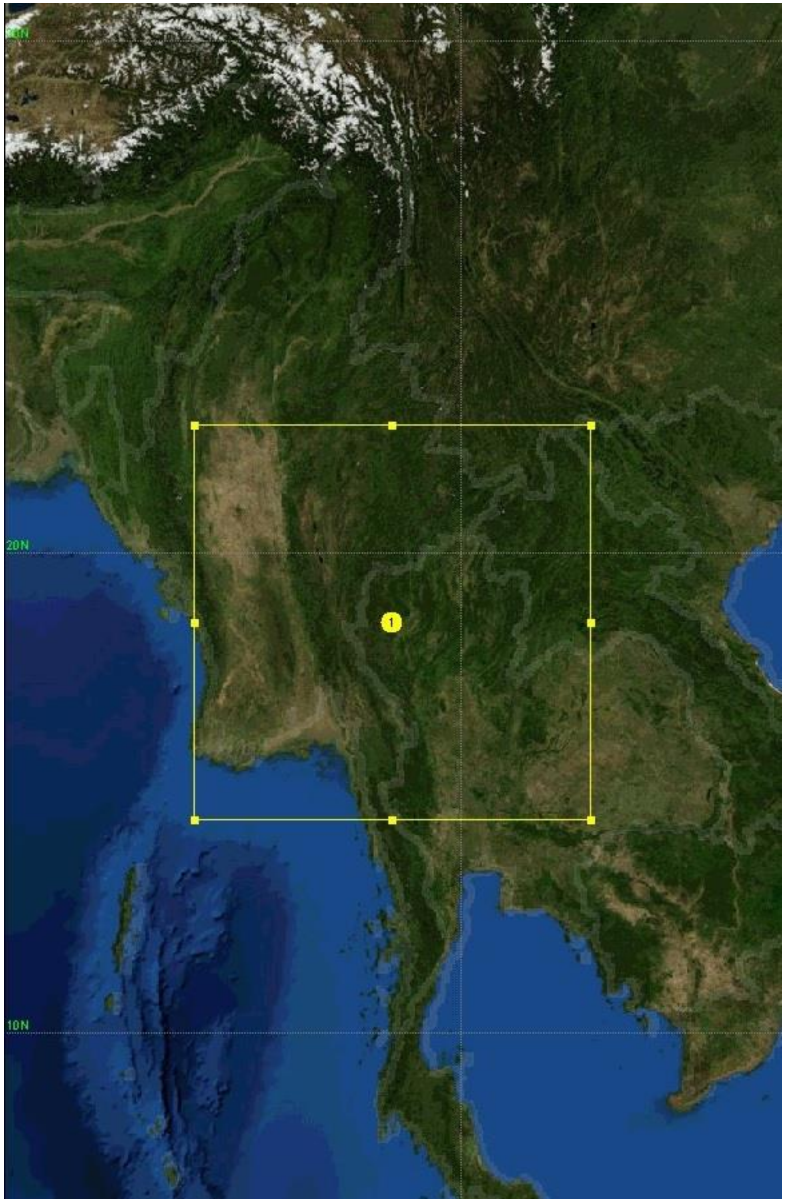
(ii) the Rapid Radiative Transfer Model (RRTM) scheme is used for the long wave radiation (ra_lw_phyics = 1),

(iii) the Dudhia scheme is used for the short wave radiation (ra_sw_physics = 1),

(iv) the Yonsei University scheme is used for the planetary boundary layer (PBL) (bl_pbl_physics = 1)

(v) the 'simple diffusion' option is used to compute the diffusion (diff_opt = 1)

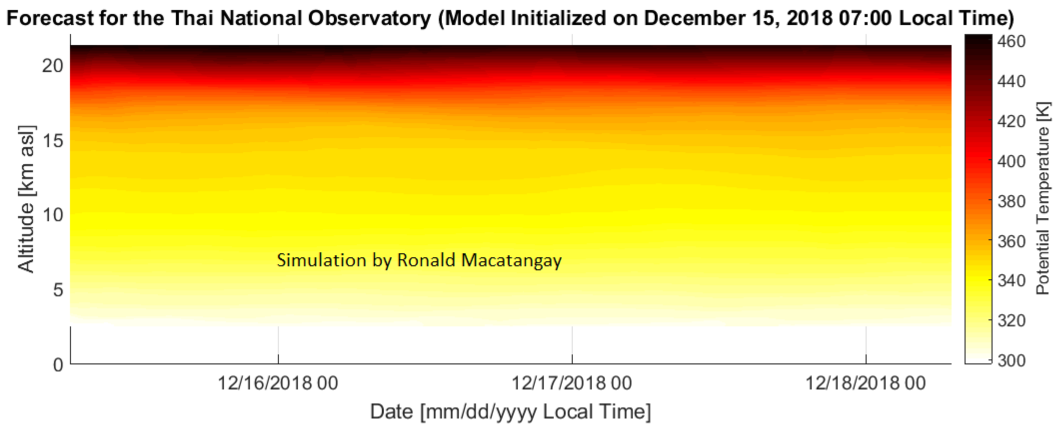
Model Domain

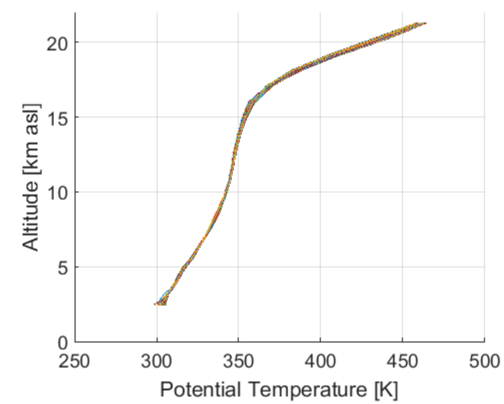


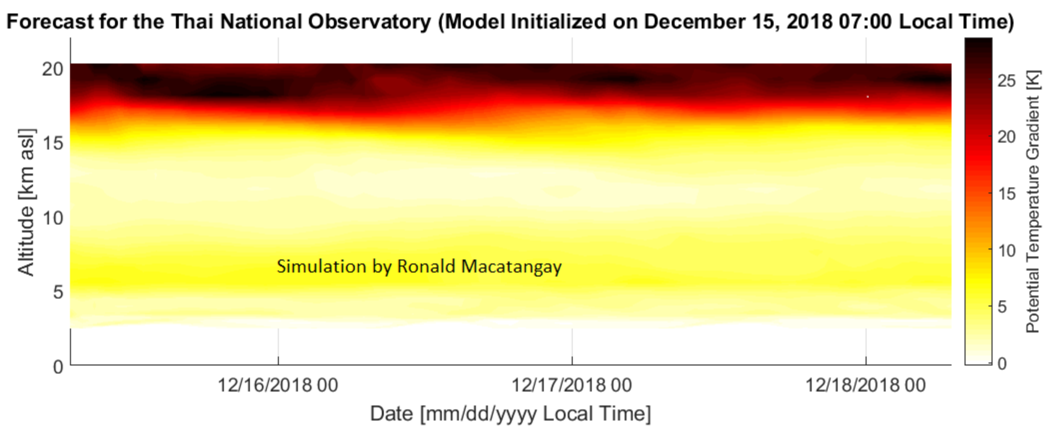
Astronomical Seeing Forecast at TNO Using the Weather Research and Forecasting Model

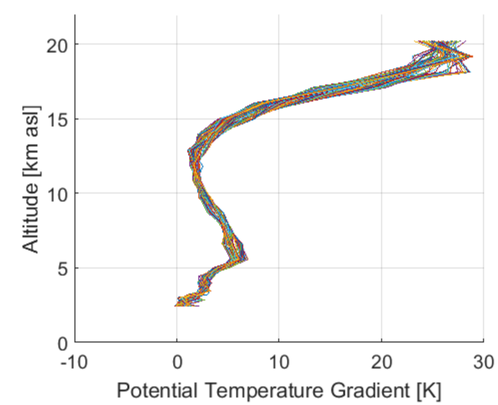
$$\chi(h) = \frac{\mathrm{d}\bar{\theta}}{\mathrm{d}z}$$ gradient of the mean potential temperature

Giordano et al. (MNRAS 2013)





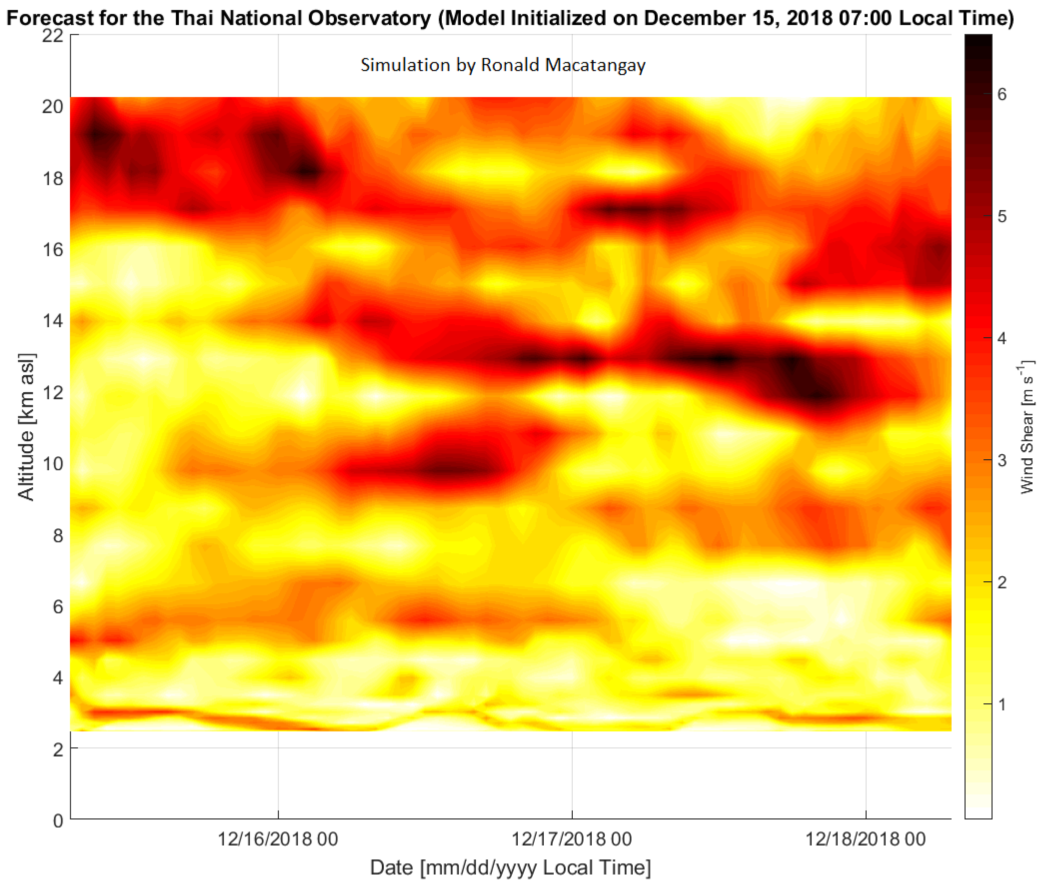


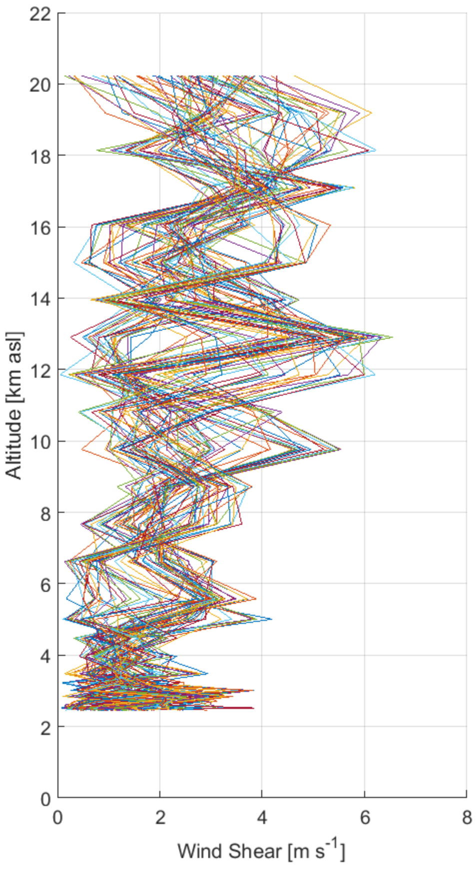


Astronomical Seeing Forecast at TNO Using the Weather Research and Forecasting Model

$$S(h) = [(\frac{dV_x}{dz})^2 + (\frac{dV_y}{dz})^2]^{1/2}$$ wind shear profile

Giordano et al. (MNRAS 2013)





Astronomical Seeing Forecast at TNO Using the Weather Research and Forecasting Model

temperature structure vertical profile

$$C_T^2(h) = \phi(h)\,\chi(h)\,S(h)^{1/2}$$

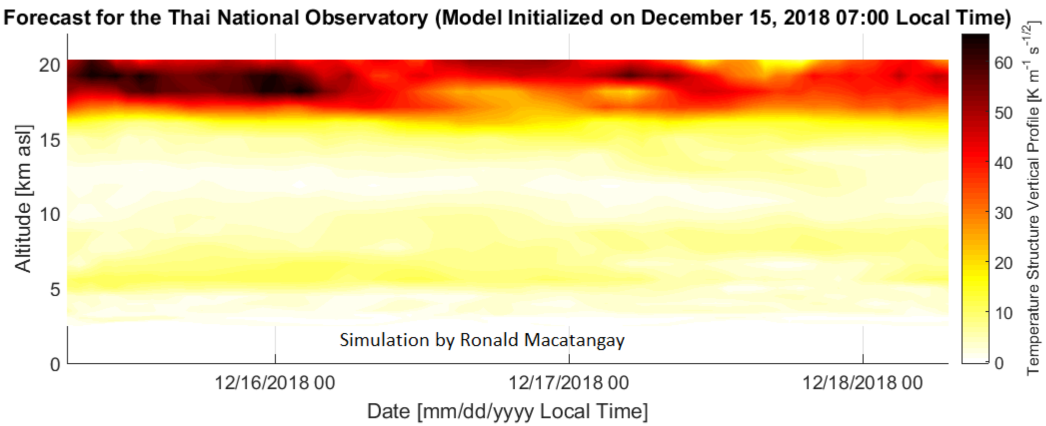
$\phi(h)$ parameter deduced from meteorological balloons

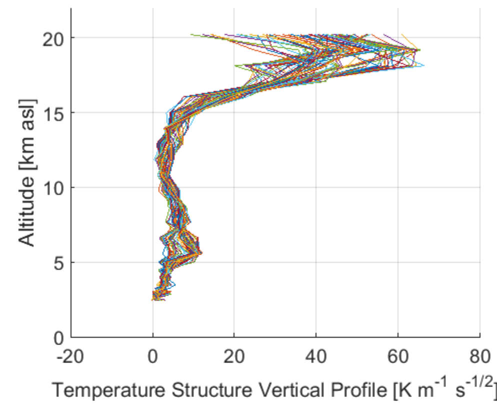
We don't have this. Bias correction needed.

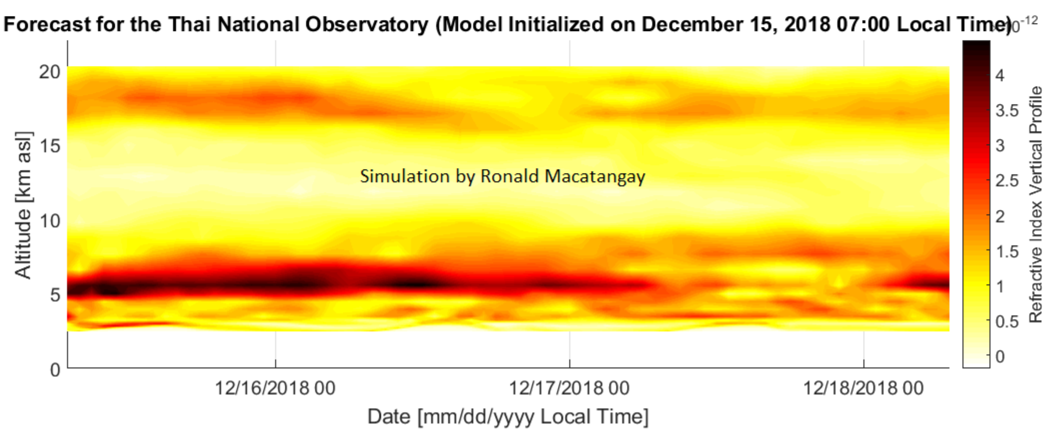
Giordano et al. (MNRAS 2013)

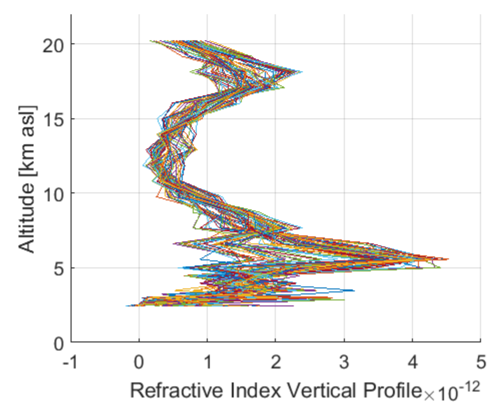
refractive index vertical profile

$$C_N^2(h) = \left(\frac{80 \times 10^{-6}\,P(h)}{T(h)^2}\right)^2 C_T(h)^2$$







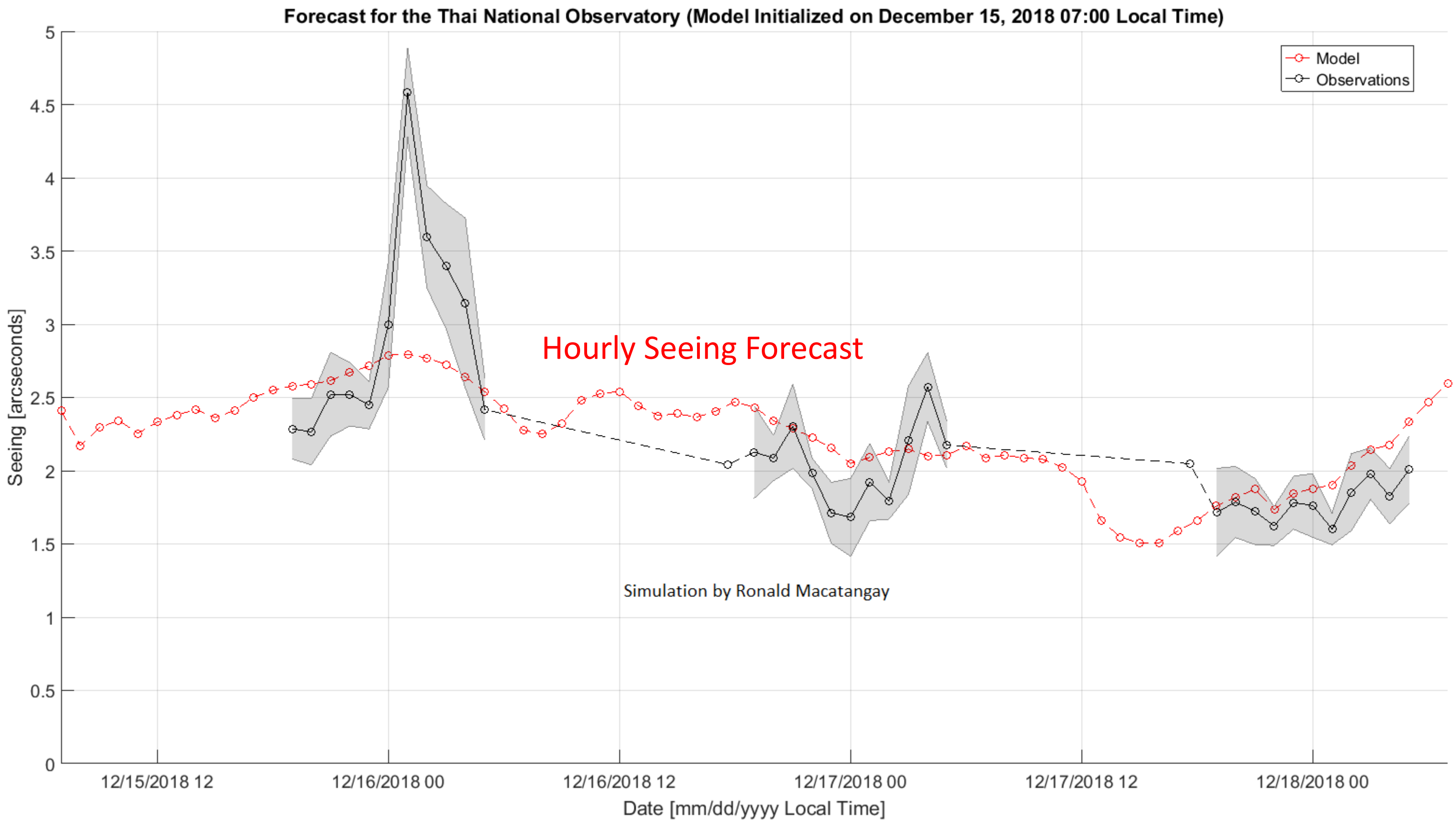


Astronomical Seeing Forecast at TNO Using the Weather Research and Forecasting Model

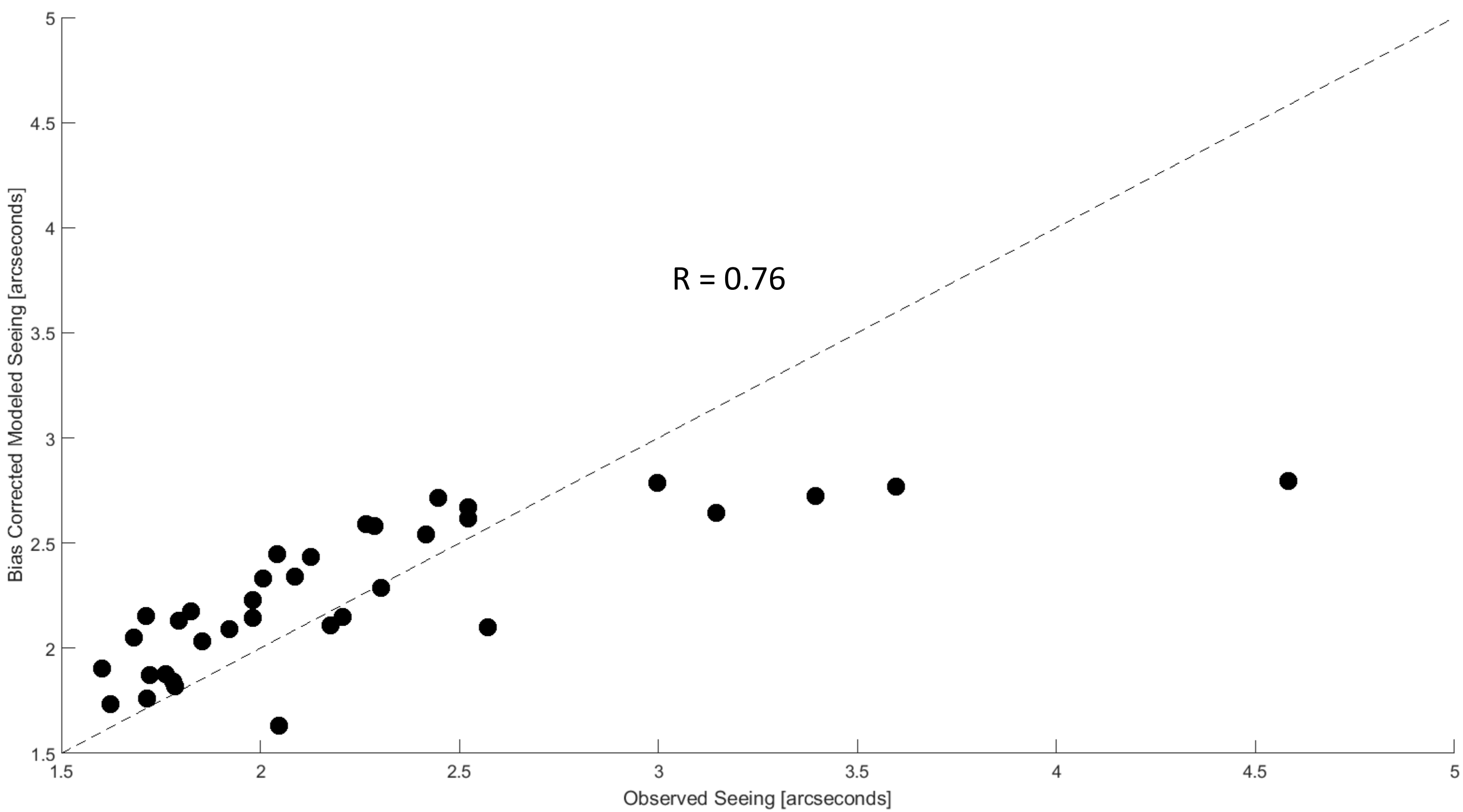
$$\underset{\text{seeing}}{\varepsilon_0} = 5.25\lambda^{-1/5}\left[\int_0^\infty C_N^2(z)\,\mathrm{d}z\right]^{3/5} + C \quad ; \quad \text{where } C = \text{bias correction offset value} = -5.43 \text{ arc seconds}$$

λ = 532 nm

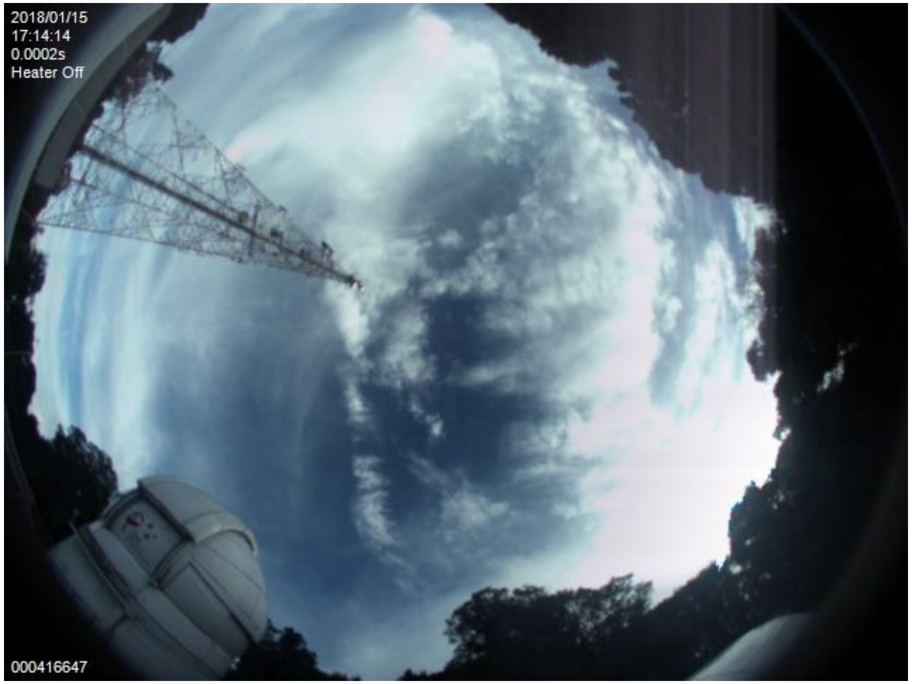
Giordano et al. (MNRAS 2013)



Astronomical Seeing Forecast at TNO Using the Weather Research and Forecasting Model



All-Sky Camera at TNO
Cloud Cover

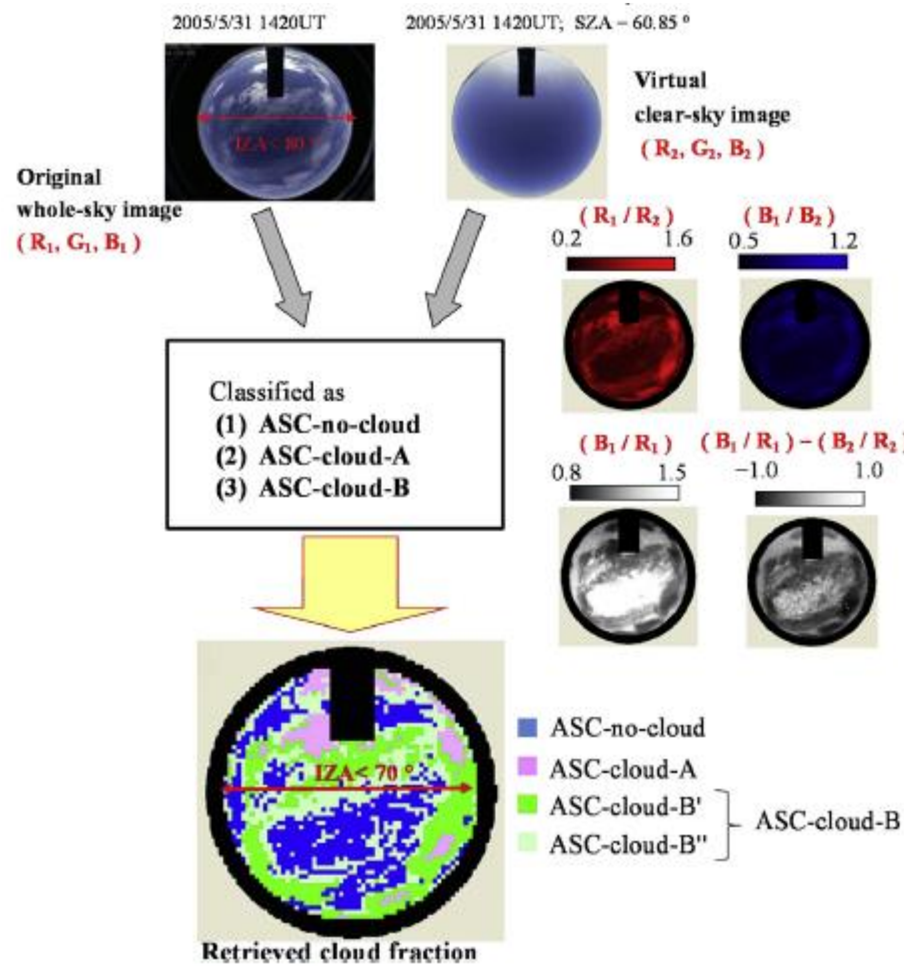


Development of a cloud detection method from whole-sky color images

Masanori Yabuki [a,*], Masataka Shiobara [b,c], Kimiko Nishinaka [d], Makoto Kuji [d]

[a] Research Institute for Sustainable Humanosphere, Kyoto University, Uji, Kyoto 611–0011, Japan
[b] National Institute of Polar Research, Tachikawa Tokyo 190–8518, Japan
[c] Department of Polar Science, The Graduate University for Advanced Studies, Tachikawa, Tokyo 190-8518, Japan
[d] Nara Women's University, Nara, Nara 630–8506, Japan

Received 15 January 2014; revised 5 June 2014; accepted 18 July 2014
Available online 7 August 2014



Atmospheric Extinction

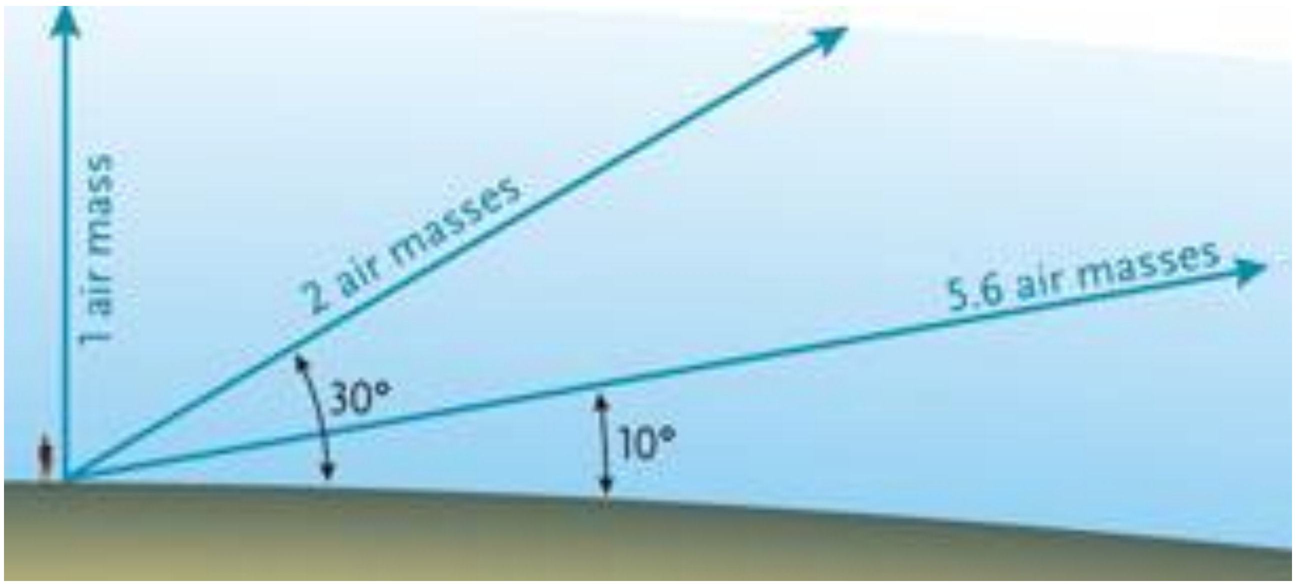
Astronomers who specialize in photometry need to compensate for *atmospheric extinction*: the reduction in a celestial object's apparent brightness when its light passes through the atmosphere.

This depends on three factors:

The *transparency* (clarity) of the air.

Your *elevation* above sea level.

The *altitude (celestial altitude)* above the horizon of your celestial target.



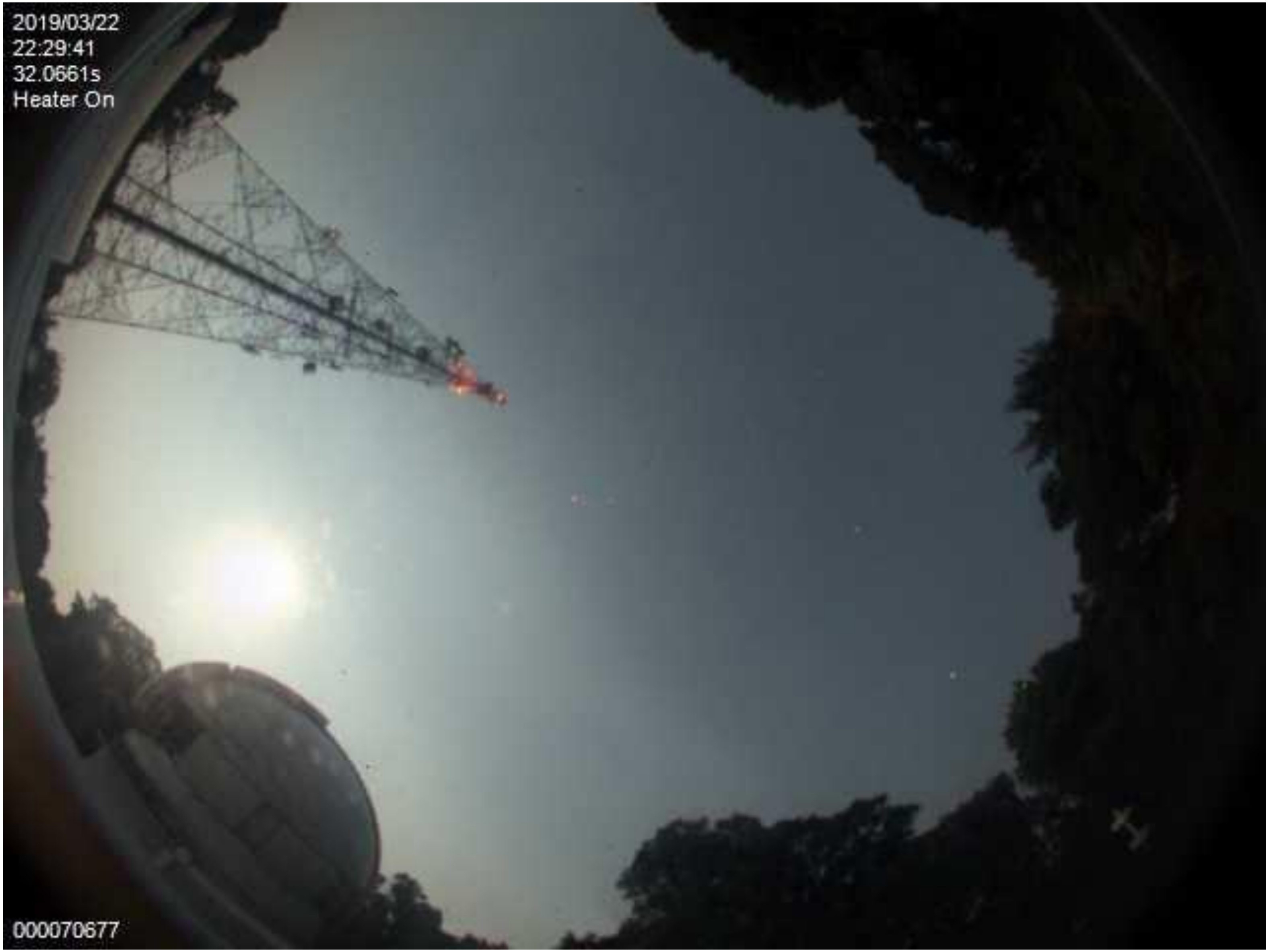
Extinction has two components:

absorption, where light is stopped cold in its tracks, and

scattering, where light is diffused away from its original source.

Thin fog scatters light, and smoke absorbs it.

Scattering is more harmful for astronomy, because it not only dims the object that you're observing, but also reduces contrast by brightening the background sky.



Scattering is more harmful for astronomy, because it not only dims the object that you're observing, but also reduces contrast by brightening the background sky.

สถาบันวิจัยดาราศาสตร์แห่งชาติ (องค์การมหาชน) เชิญร่วมงาน...

เสวนาดาราศาสตร์เอเชีย

เมืองฟ้ามืดเห็นดาว...กำลังจะเป็นเทรนด์ใหม่

Dark Sky Campaign

ถึงเวลา...เรียกหาความมืดของท้องฟ้าเพื่อโลกและดวงดาว

วันศุกร์ที่ 24 พฤศจิกายน 2560 | 16:00 – 19:30 น.

ณ ห้องสัมมนา อาคาร SMEs 2 ศูนย์ประชุมและแสดงสินค้านานาชาติ เฉลิมพระเกียรติ 7 รอบ พระชนมพรรษา จังหวัดเชียงใหม่

****เริ่มลงทะเบียน 15.00 น. เป็นต้นไป**

พบกับเรื่องราวน่าสนใจ อาทิ

- ทำไมมองไม่เห็นดวงดาวในเมืองใหญ่? หลายคนไม่เคยเห็นทางช้างเผือก?
- **"มลภาวะทางแสง"** ส่งผลกระทบต่อชีวิตมนุษย์และสัตว์อย่างไร?
- เป็นไปได้ไหม!? ไทยจะมีเขตอนุรักษ์ฟ้ามืดสากล (International Dark Sky Reserve)
- **"เมืองฟ้ามืด"** ส่งผลดีต่อการถ่ายภาพดาราศาสตร์อย่างไร?
- กิจกรรมรณรงค์ลดการใช้แสงสว่างในเขตชุมชนของต่างประเทศ

โดย...

Mr.Sze - Leung Cheung
ผู้ประสานงานบริการวิชาการนานาชาติ
สำนักงานบริการวิชาการทางดาราศาสตร์
สหพันธ์ดาราศาสตร์สากล ประเทศญี่ปุ่น (IAU OAO)

มติพล ตั้งมติธรรม
ผู้เชี่ยวชาญด้านดาราศาสตร์

เจษฎา กีรติภารัตน์
ผู้ประสานงานโครงการ Dark Sky Campaign ประเทศไทย

ชวนท่องเอกภพใน ท้องฟ้าจำลองเคลื่อนที่

Fulldome Digital ระบบ Full HD DX4

ชวนชมดาว...เคล้าดนตรี

19.30 – 21.00 น.

(บริเวณลานกิจกรรมด้านหน้า)

- ตั้งกล้องส่องดวงจันทร์ กระจุกดาวและกาแล็กซี
- แนะนำการดูดาวเบื้องต้นและการใช้แผนที่ดาว ท่ามกลางลมหนาวเคล้าเสียงดนตรีอันไพเราะขับกล่อมตลอดงาน

DARK SKY

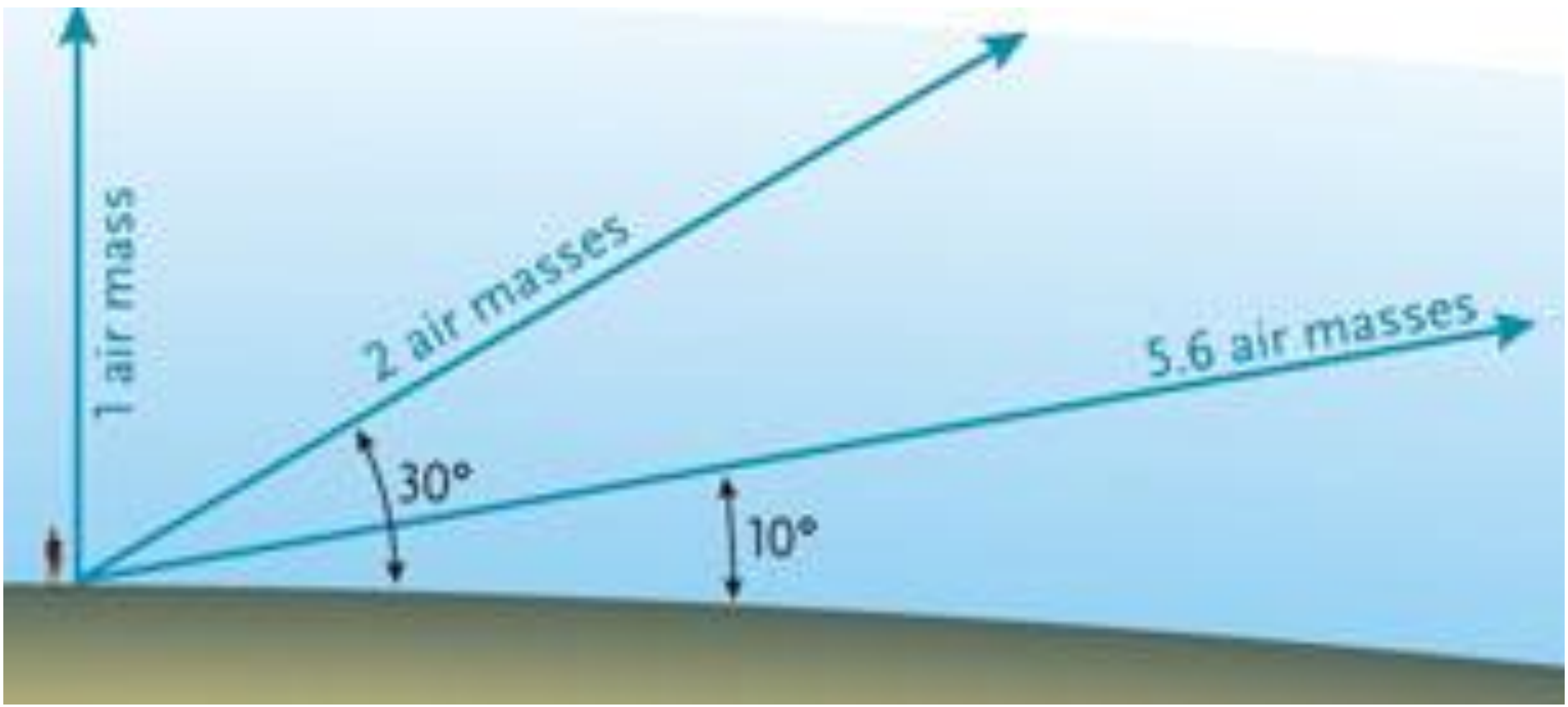
ฟรี! สำรองที่นั่งล่วงหน้าได้ที่

สอบถามเพิ่มเติม 053-121268-9 ต่อ 305, 081-764-8834 (คุณพิสิฏฐ)

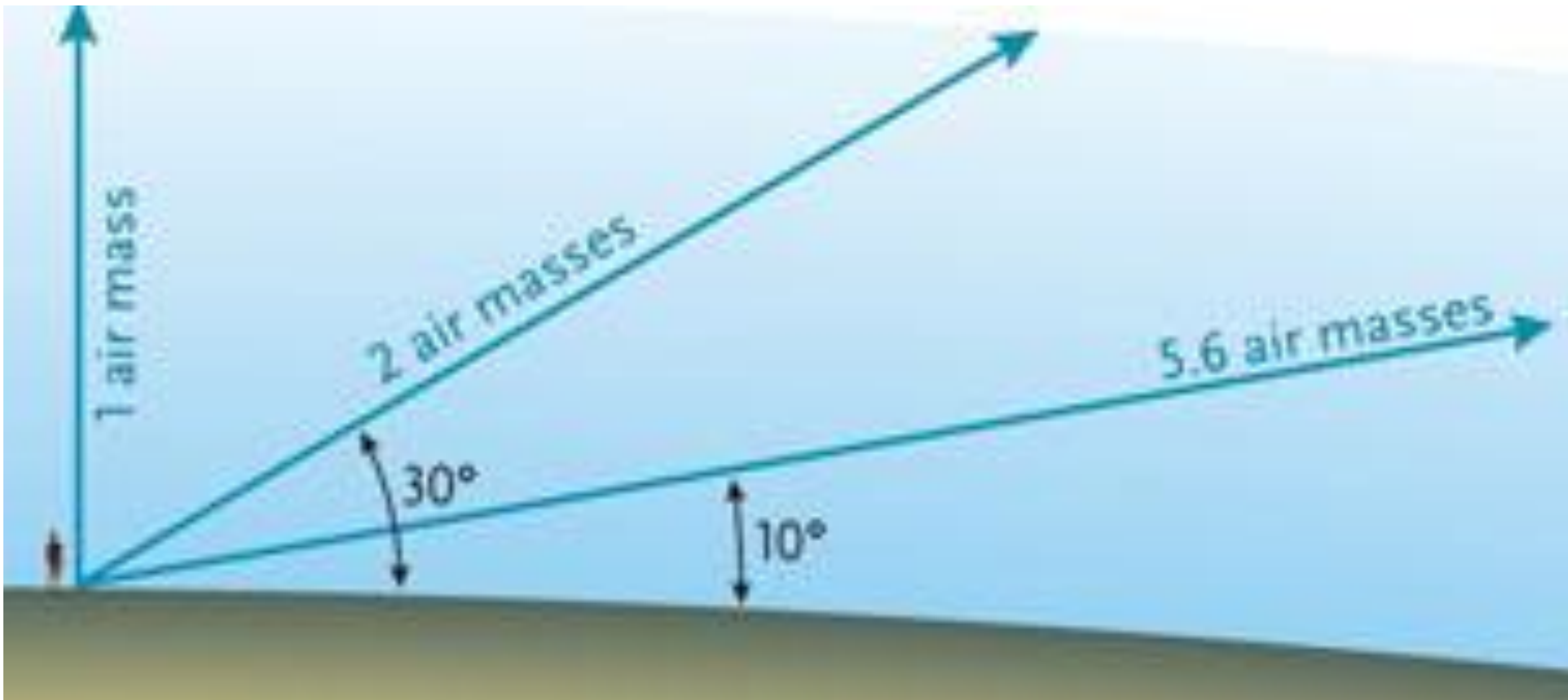
Credit : https://environmentallysound.wordpress.com/light-excreta-2/light-excreta
https://www.nasa.gov/content/iberian-peninsula-at-night

The closer your target is to the horizon, the more air you have to look through, and the more degraded your view gets.

The amount of air directly overhead is called one *airmass*. (The actual amount of air in one airmass varies depending on your elevation above sea level.)



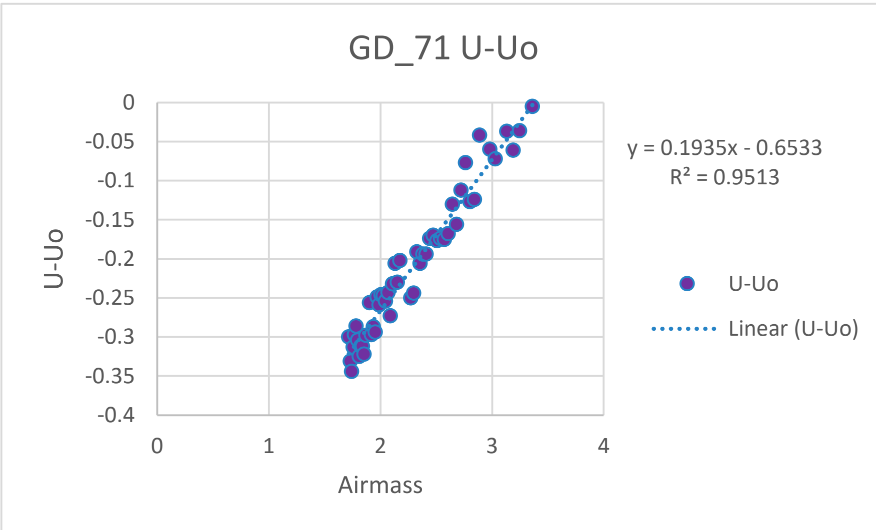
Extinction is usually measured in magnitudes per airmass. For instance, let's say that extinction is 0.16 magnitudes per airmass, the best it can ever get at sea level. Then a star overhead appears 0.16 magnitude fainter (86% as bright) as it really is, a star 30° above the horizon, with 2 airmasses to look through, appears 0.32 magnitude fainter, or 74% as bright, and an star 10° above the horizon appears 0.90 magnitude fainter, or just 44% as bright.



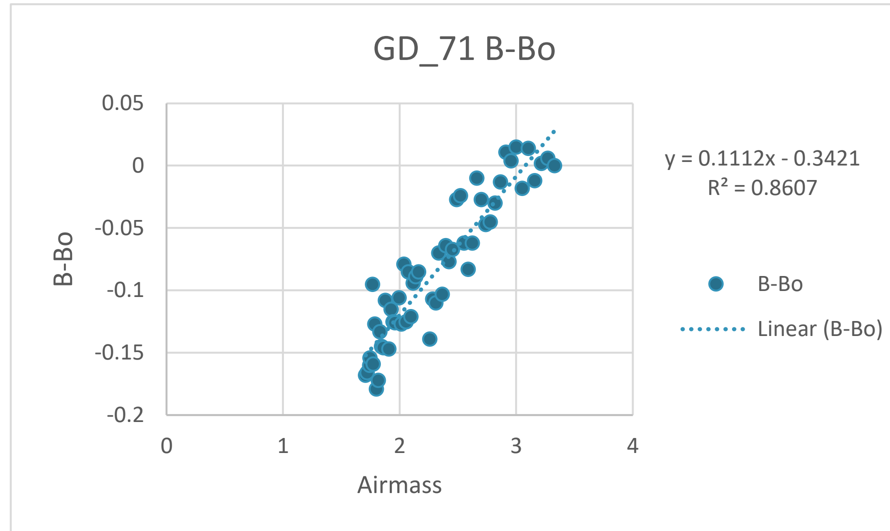
Measurement of Atmospheric Extinction at TNO Using the 2.4 m Telescope

Analysis by Jansawang Panomprai, Sauwaporn Pongpaisirikul, Porrawit Thaimai, Panpaka Suropan, Somsawat Rattanasoon, Donduedee Sookjai and Thiranan Sonkaew

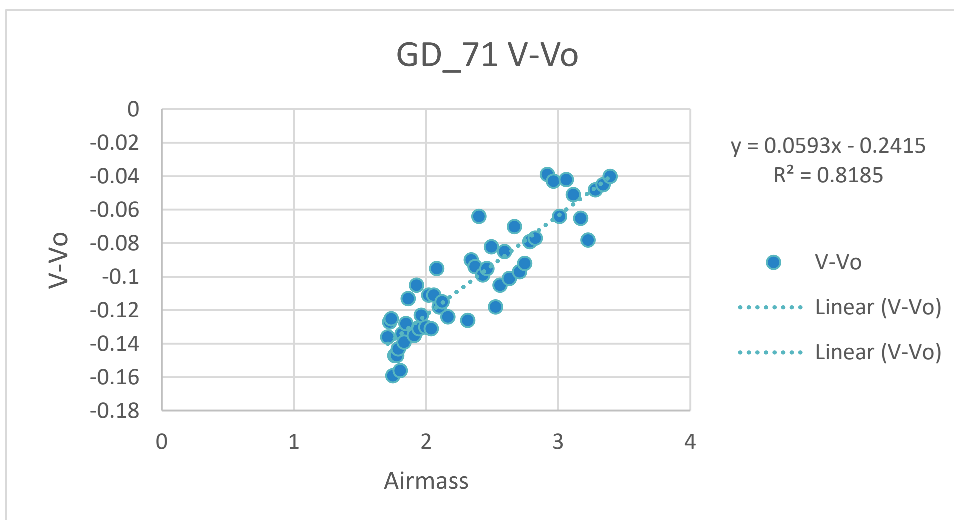
334 – 400 nm



389– 483 nm



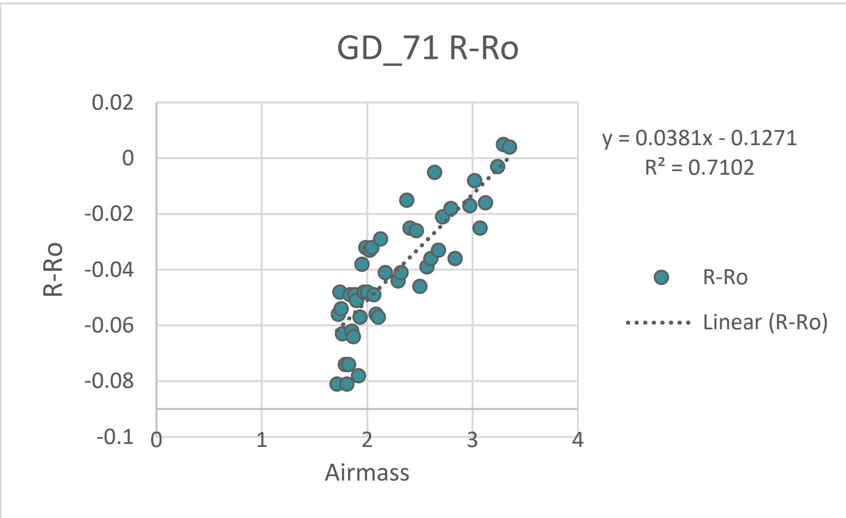
501– 589 nm



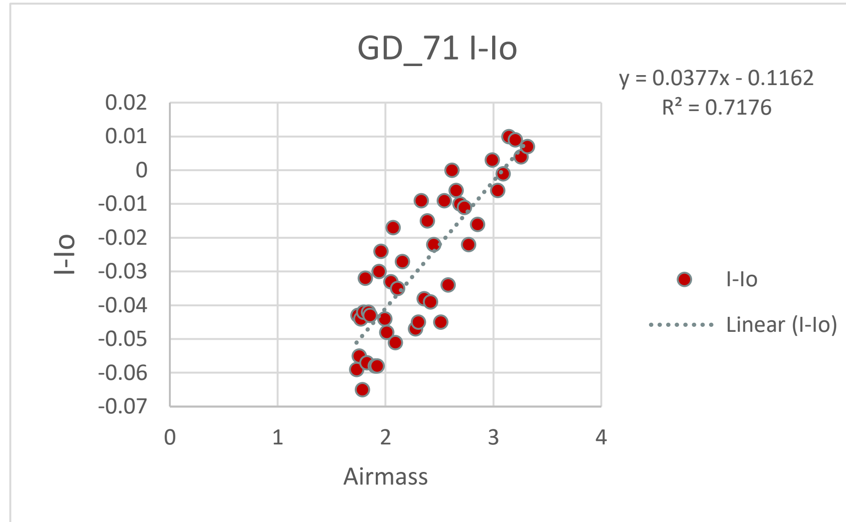
Measurement of Atmospheric Extinction at TNO Using the 2.4 m Telescope

Analysis by Jansawang Panomprai, Sauwaporn Pongpaisirikul, Porrawit Thaimai, Panpaka Suropan, Somsawat Rattanasoon, Donduedee Sookjai and Thiranan Sonkaew

569 – 707 nm



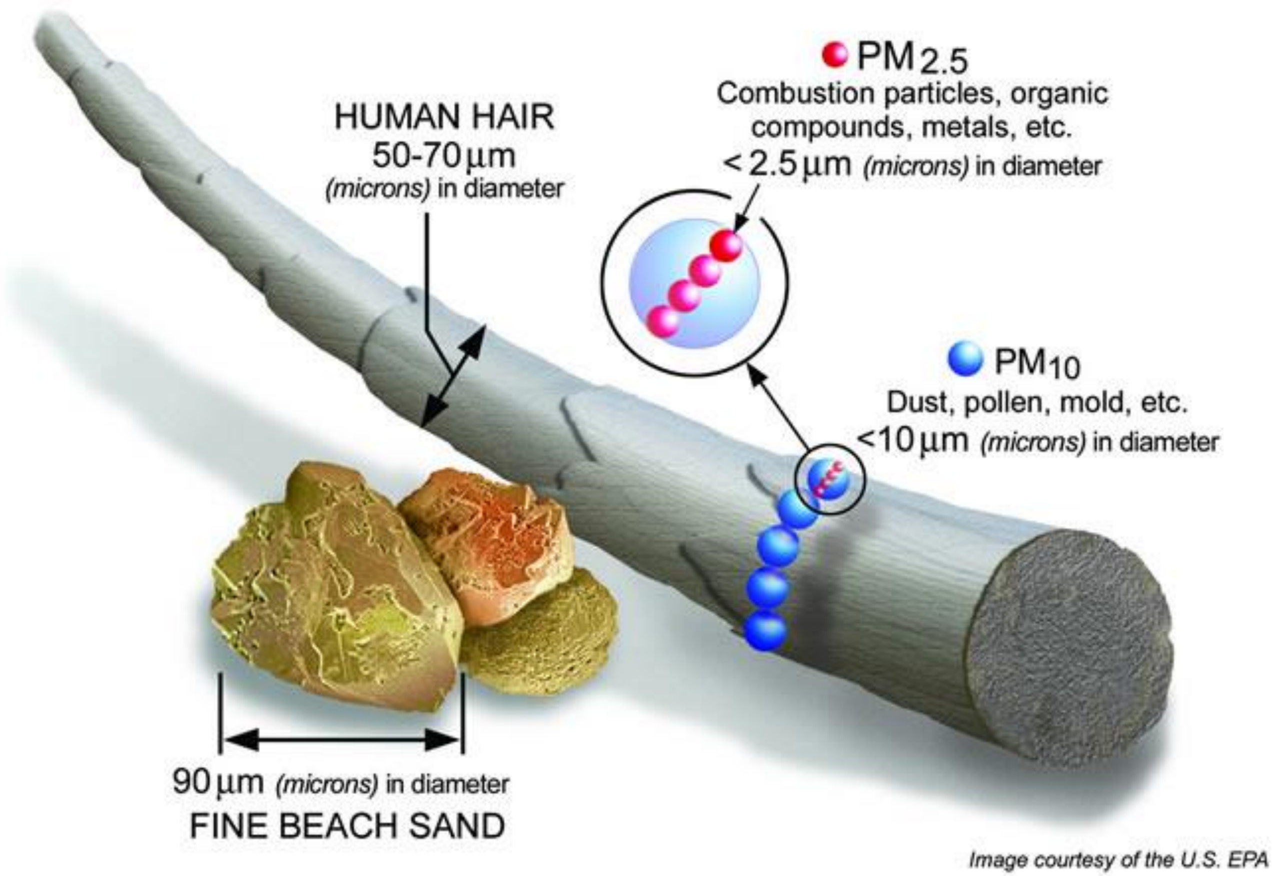
722.5 – 871.5 nm



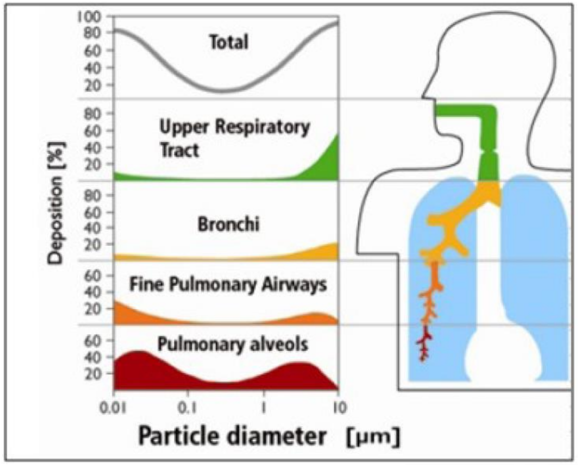
Optical filter	Atmospheric Extinction	R^2
U	0.1935	0.9513
B	0.1112	0.8607
V	0.0593	0.8185
R	0.0381	0.7102
I	0.0377	0.7176

Aerosols

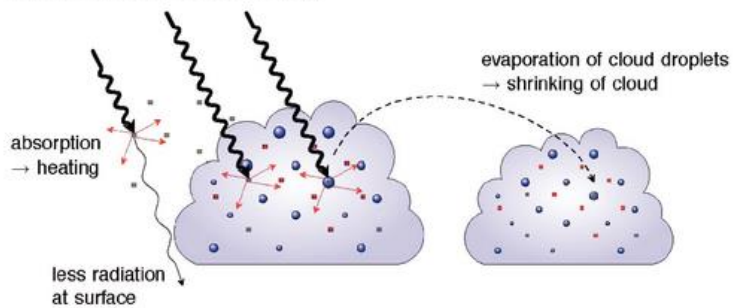
In practice, air is never perfectly clean. That's especially true in the summer, when natural pollutants such as dust and forest-fire smoke are at their worst, and humidity combines with emissions from power plants and motor vehicles to form smog. Generically, these pollutants are called *aerosols*: microscopic solid or liquid particles suspended in the atmosphere.

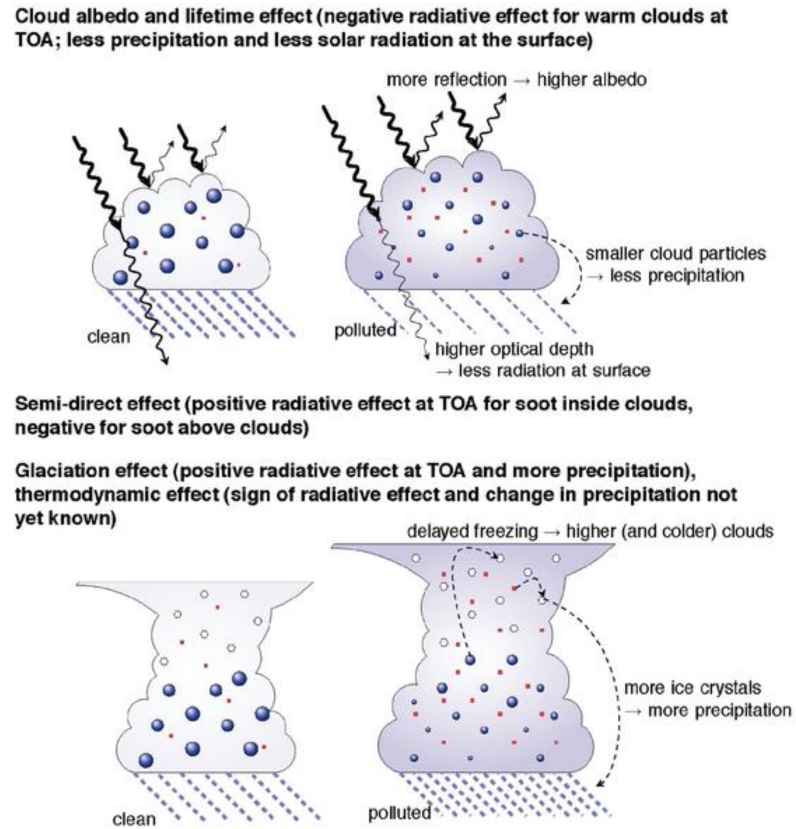


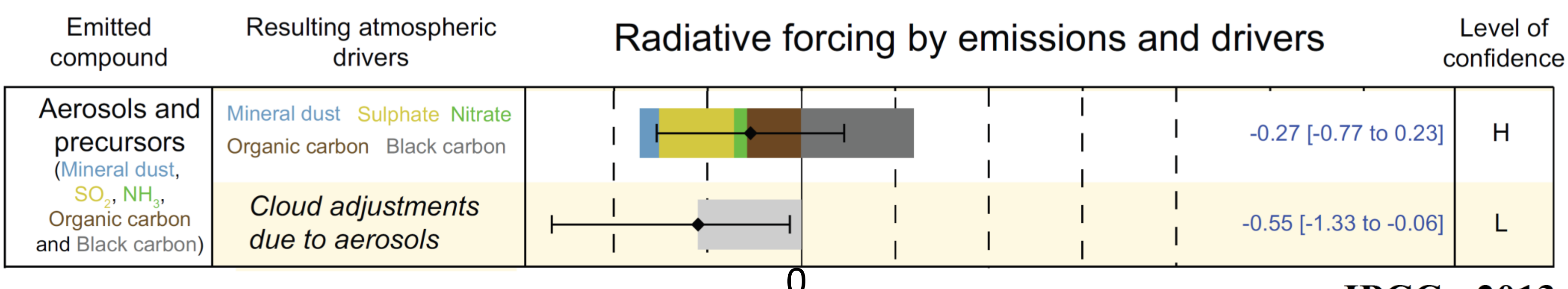
Health and Climate Effects



Semi-direct effect (positive radiative effect at TOA for soot inside clouds, negative for soot above clouds)

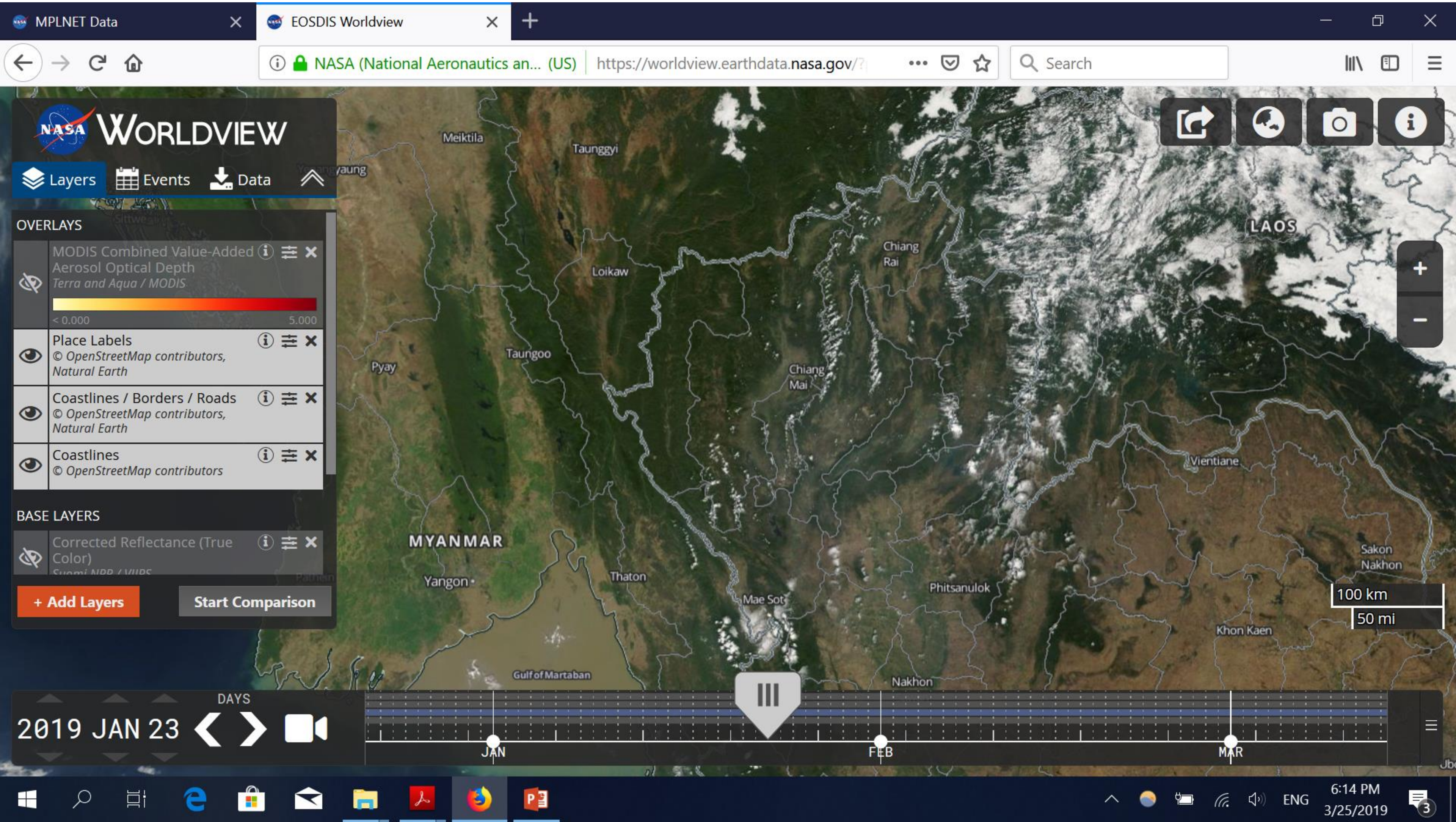




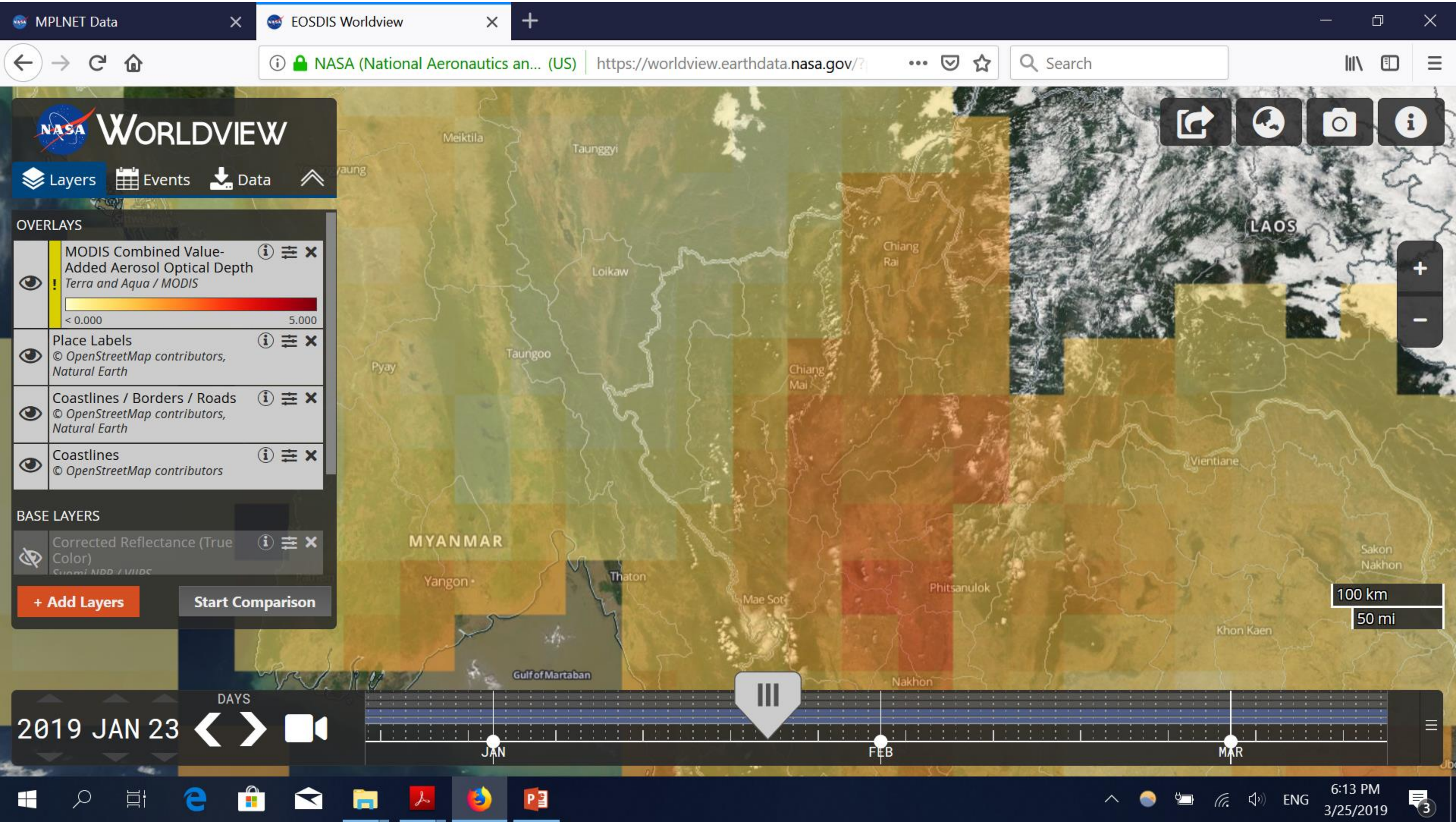


IPCC - 2013

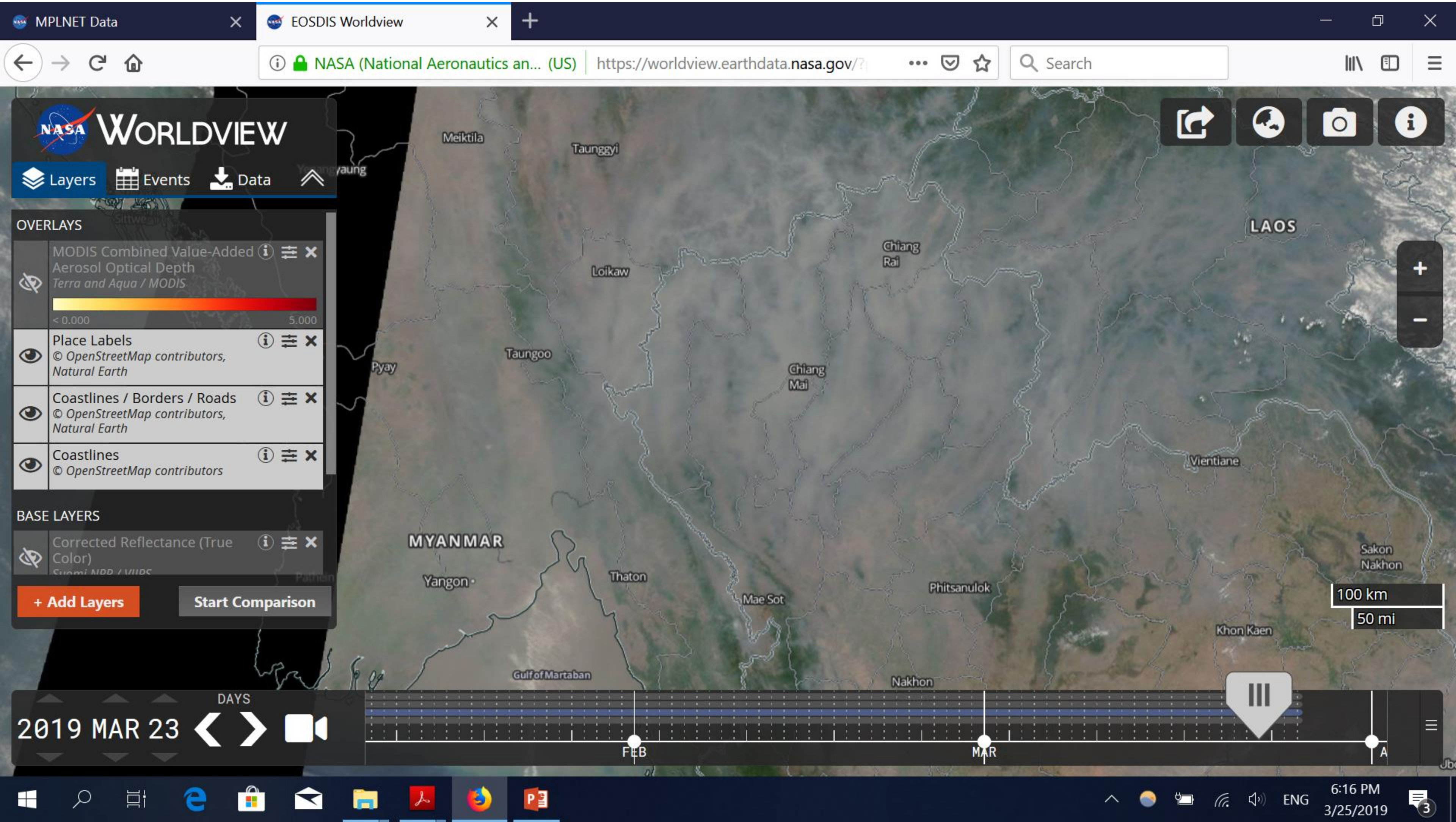
Reduction in visibility due to aerosols is called *aerosol optical depth* (AOD). Optical depth is the term used by atmospheric scientists for what astronomers call extinction. Both are usually measured on logarithmic scales, but optical depth uses "natural" logs with a base of *e* (roughly 2.718), while astronomical magnitudes are based on the fifth root of 100 (roughly 2.512). Multiply by 1.086 to convert optical depth to magnitudes.



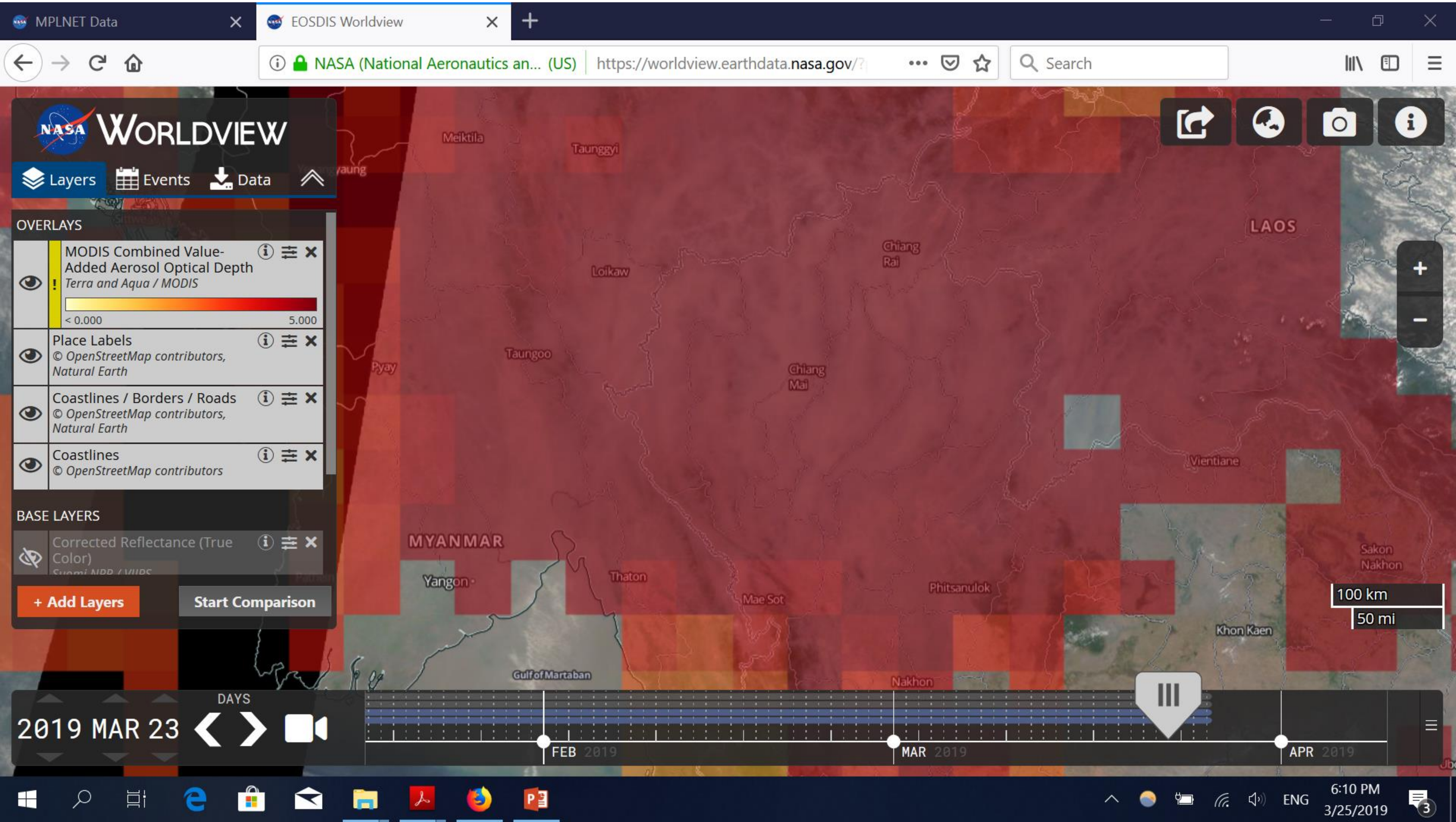
Reduction in visibility due to aerosols is called *aerosol optical depth* (AOD). Optical depth is the term used by atmospheric scientists for what astronomers call extinction. Both are usually measured on logarithmic scales, but optical depth uses "natural" logs with a base of *e* (roughly 2.718), while astronomical magnitudes are based on the fifth root of 100 (roughly 2.512). Multiply by 1.086 to convert optical depth to magnitudes.



Reduction in visibility due to aerosols is called *aerosol optical depth* (AOD). Optical depth is the term used by atmospheric scientists for what astronomers call extinction. Both are usually measured on logarithmic scales, but optical depth uses "natural" logs with a base of *e* (roughly 2.718), while astronomical magnitudes are based on the fifth root of 100 (roughly 2.512). Multiply by 1.086 to convert optical depth to magnitudes.



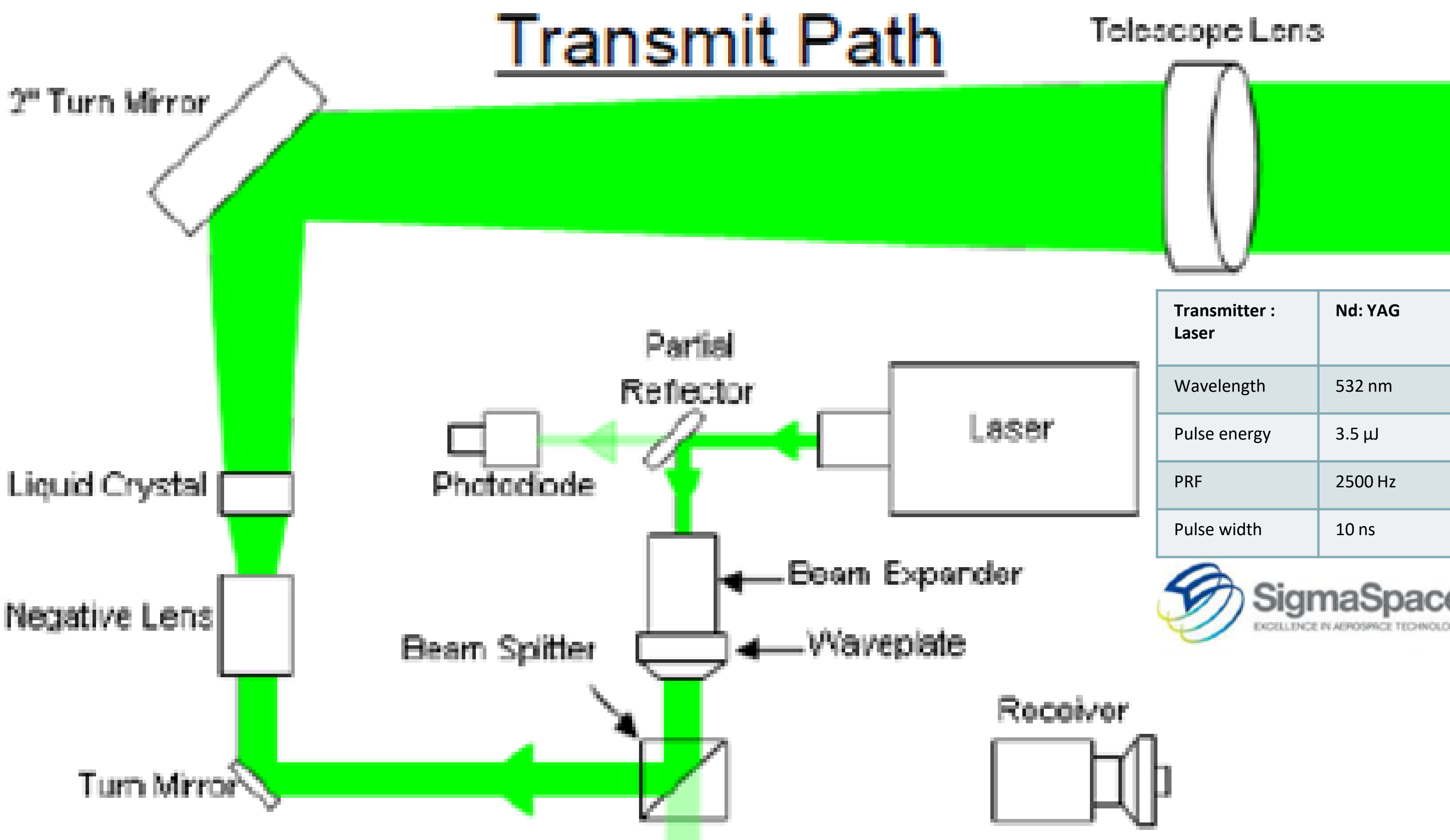
Reduction in visibility due to aerosols is called *aerosol optical depth* (AOD). Optical depth is the term used by atmospheric scientists for what astronomers call extinction. Both are usually measured on logarithmic scales, but optical depth uses "natural" logs with a base of *e* (roughly 2.718), while astronomical magnitudes are based on the fifth root of 100 (roughly 2.512). Multiply by 1.086 to convert optical depth to magnitudes.



Atmospheric Light Detection and Ranging (LiDAR)

Light Detection and Ranging (LiDAR)

Principle, Components and Types of Atmospheric LiDAR Systems



Transmitter : Laser	**Nd: YAG**
Wavelength	532 nm
Pulse energy	3.5 µJ
PRF	2500 Hz
Pulse width	10 ns

SigmaSpace
EXCELLENCE IN AEROSPACE TECHNOLOGY

Light Detection and Ranging (LiDAR)

Principle, Components and Types of Atmospheric LiDAR Systems

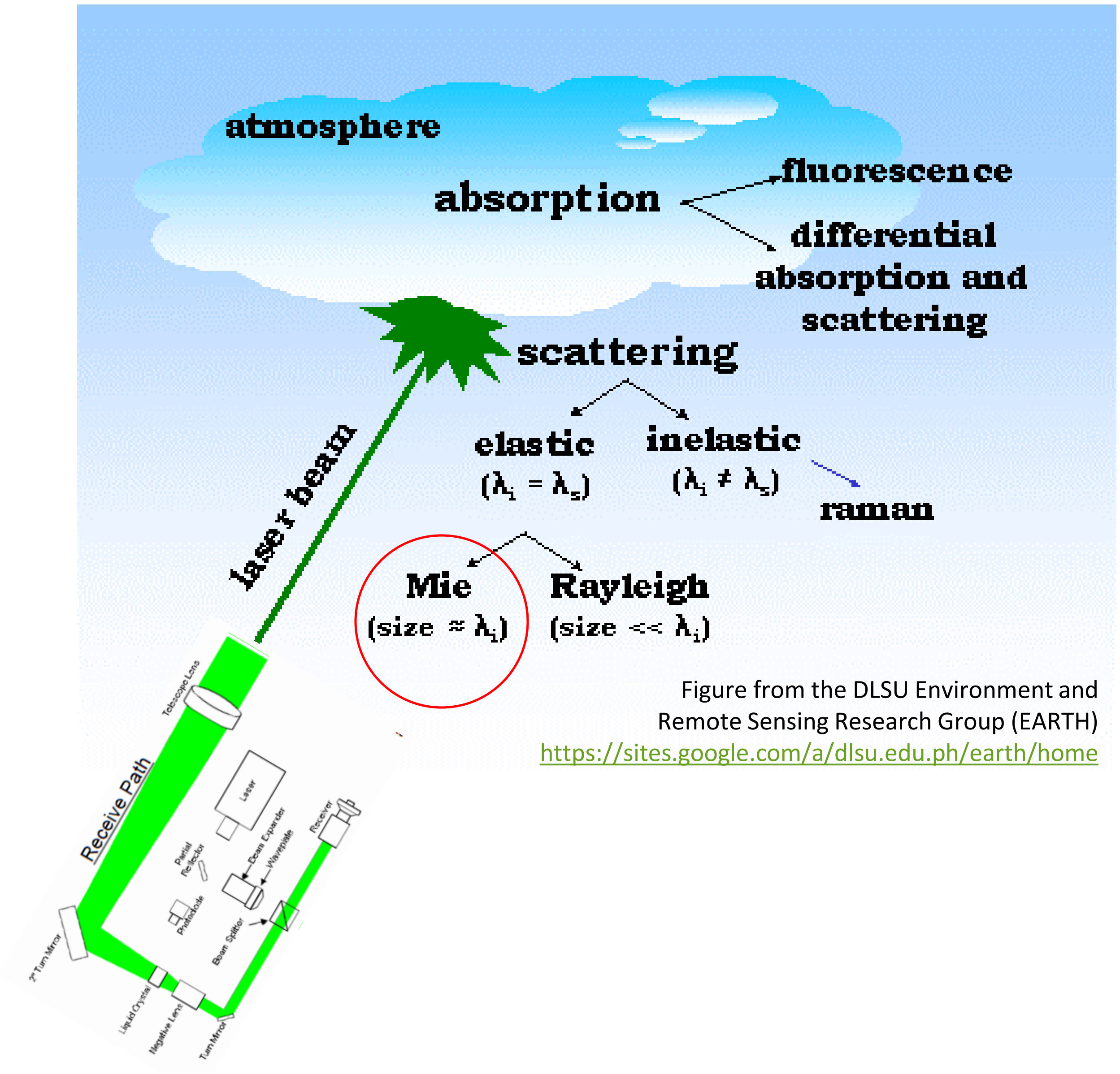
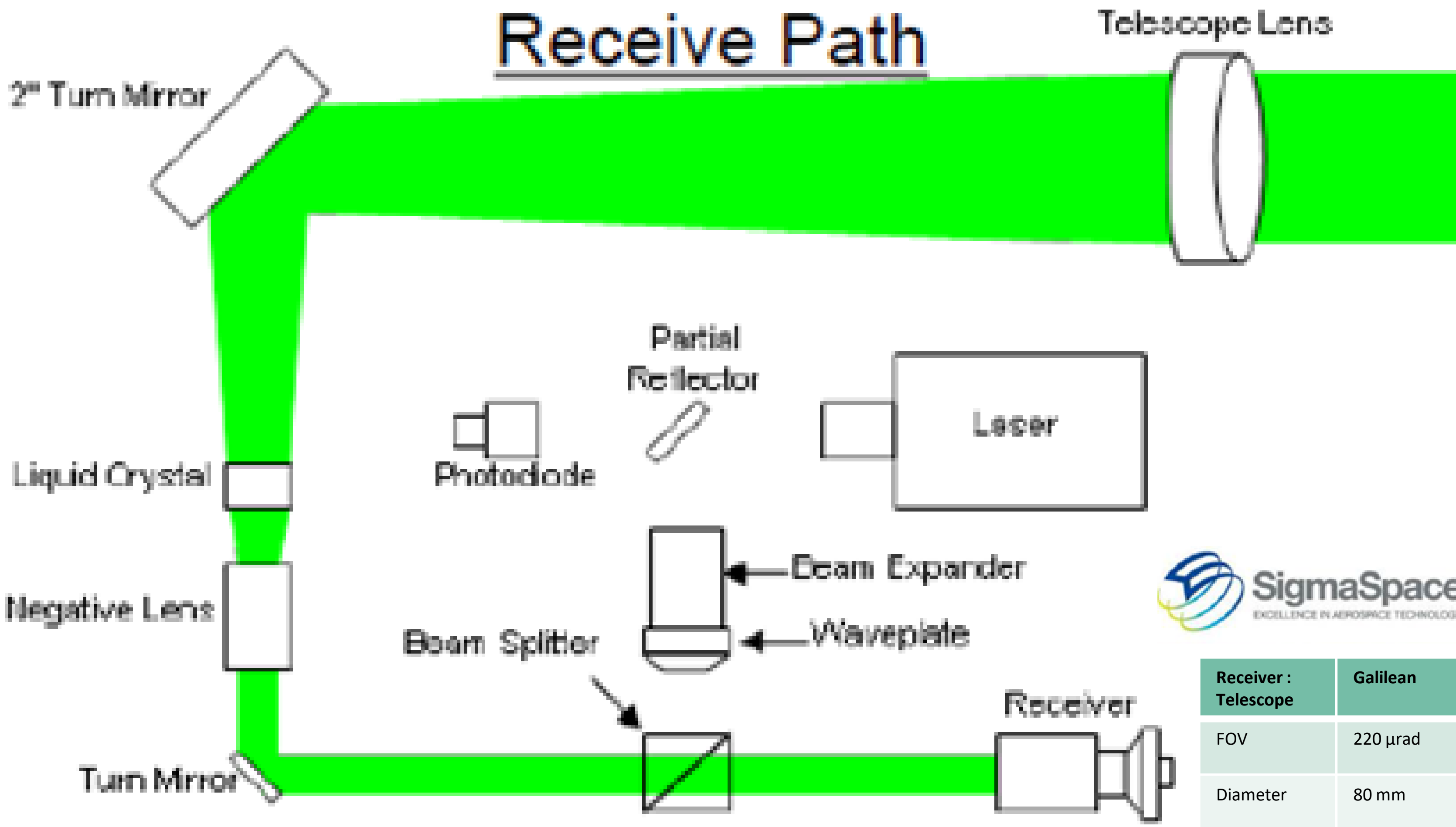


Figure from the DLSU Environment and Remote Sensing Research Group (EARTH)
https://sites.google.com/a/dlsu.edu.ph/earth/home

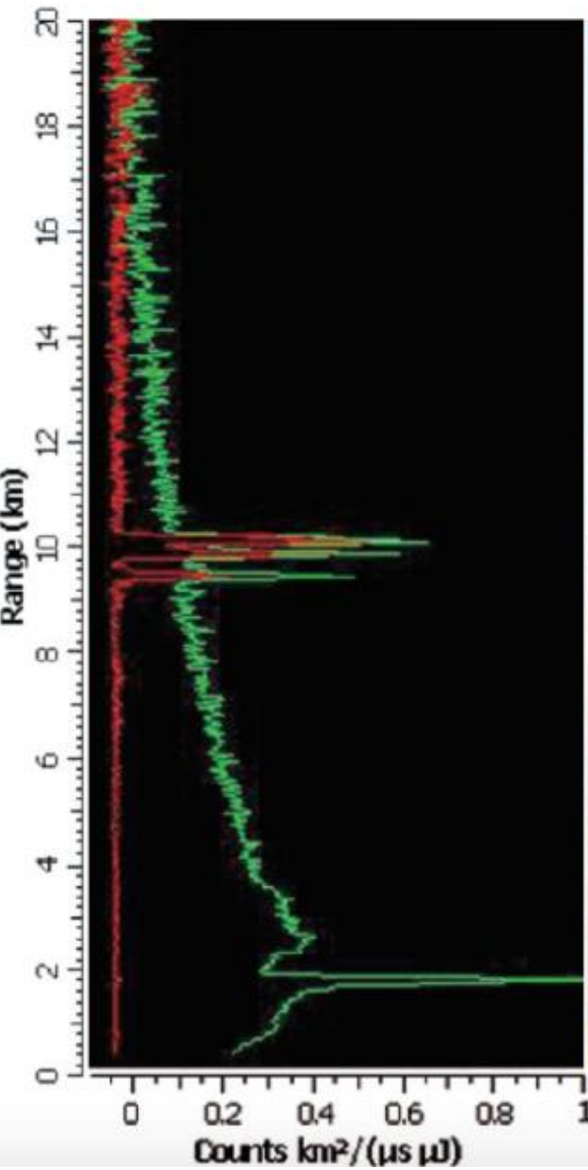
Light Detection and Ranging (LiDAR)

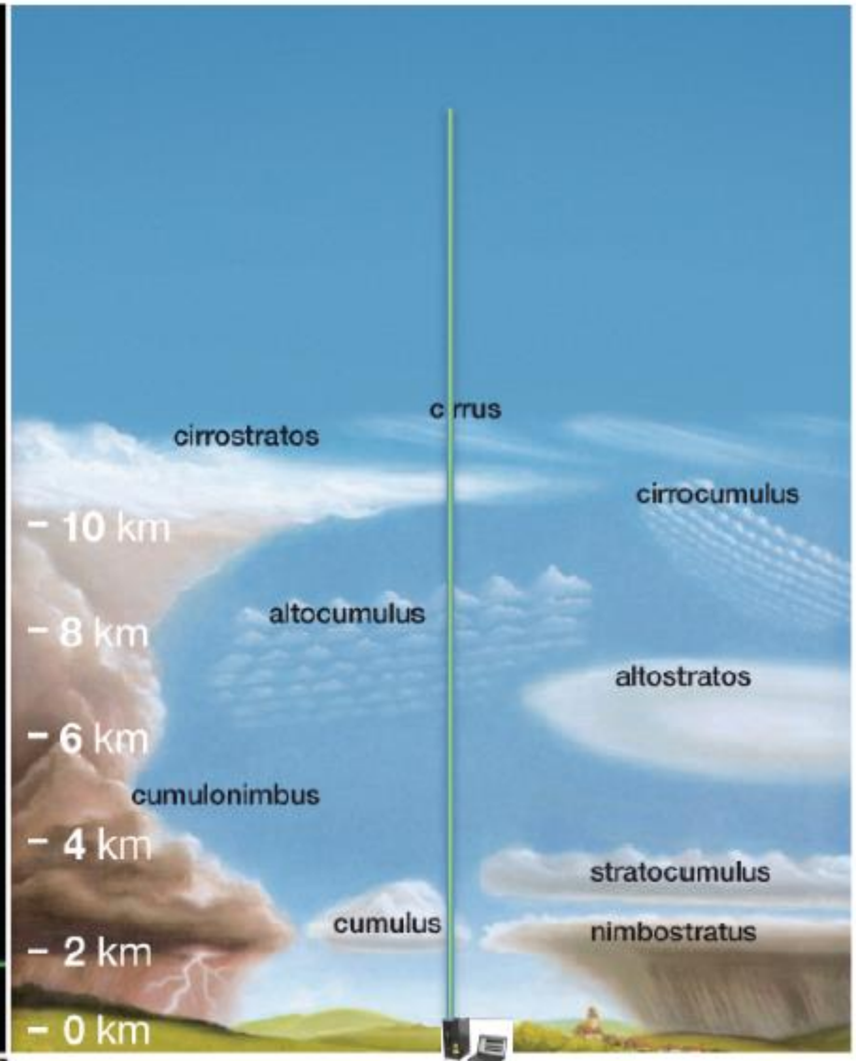
Principle, Components and Types of Atmospheric LiDAR Systems

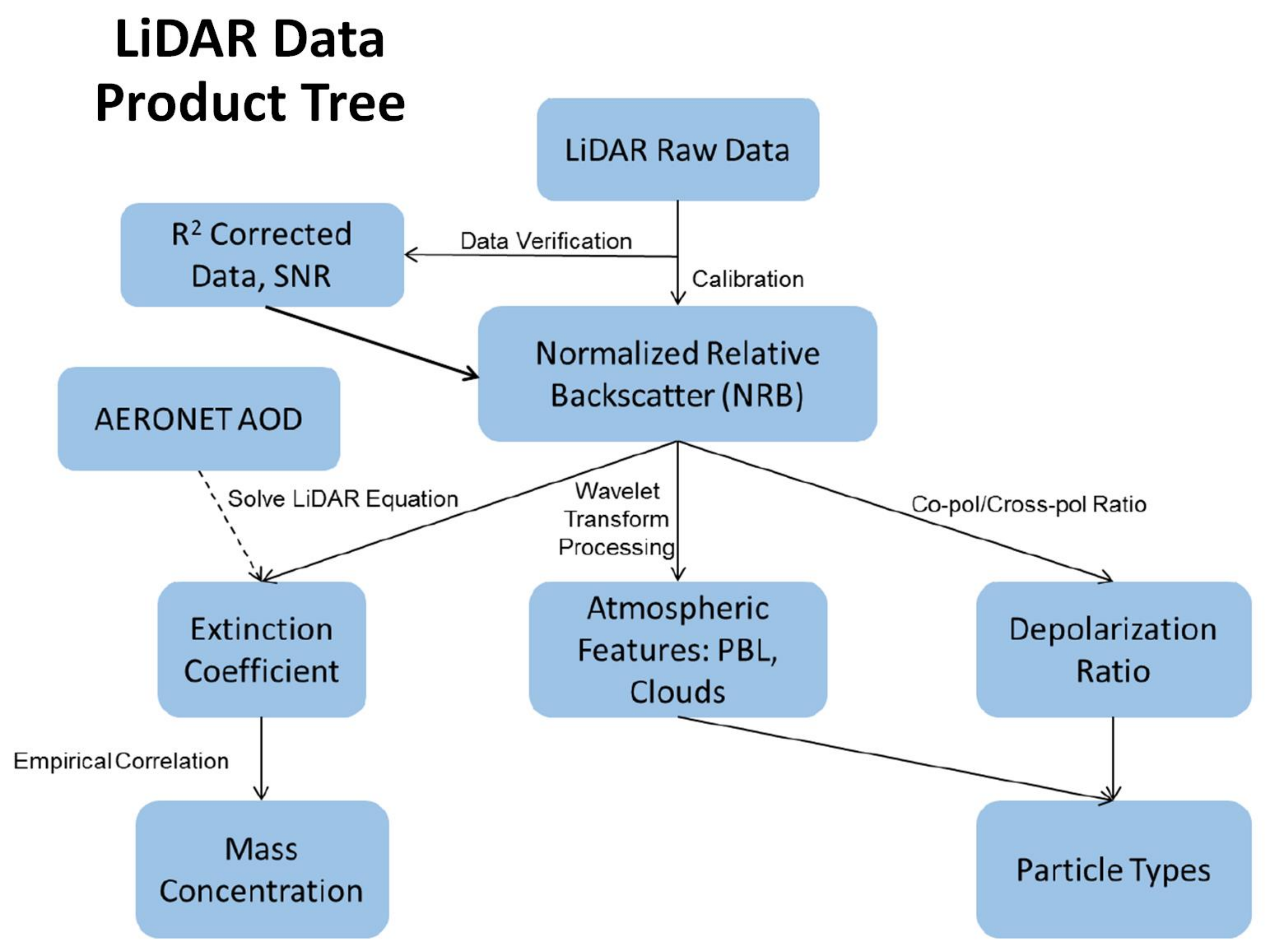


Receiver : Telescope	Galilean
FOV	220 µrad
Diameter	80 mm
Detector efficiency	25 %

mini-Micropulse LiDAR Signals (Backscatter Signal)

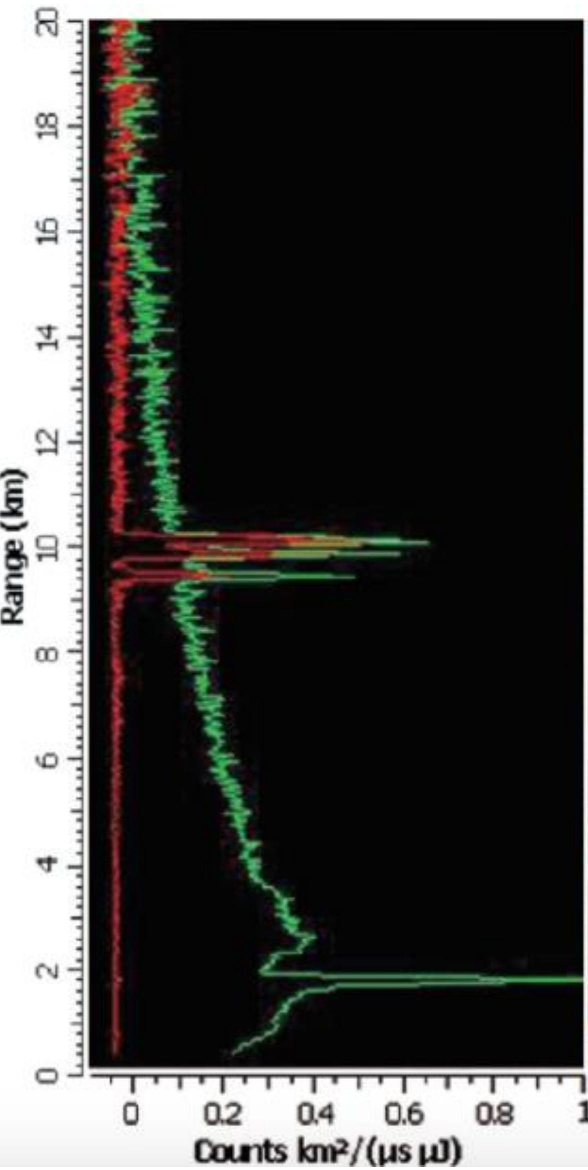


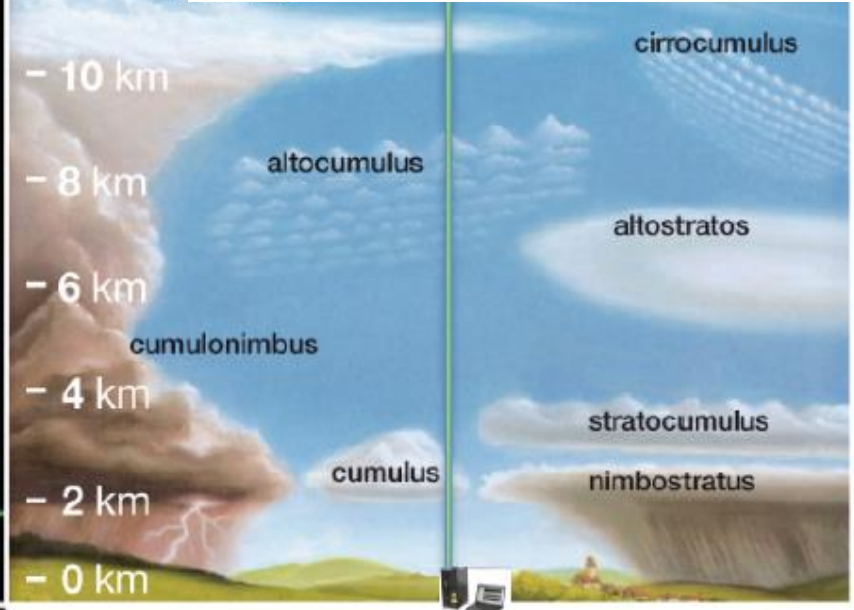


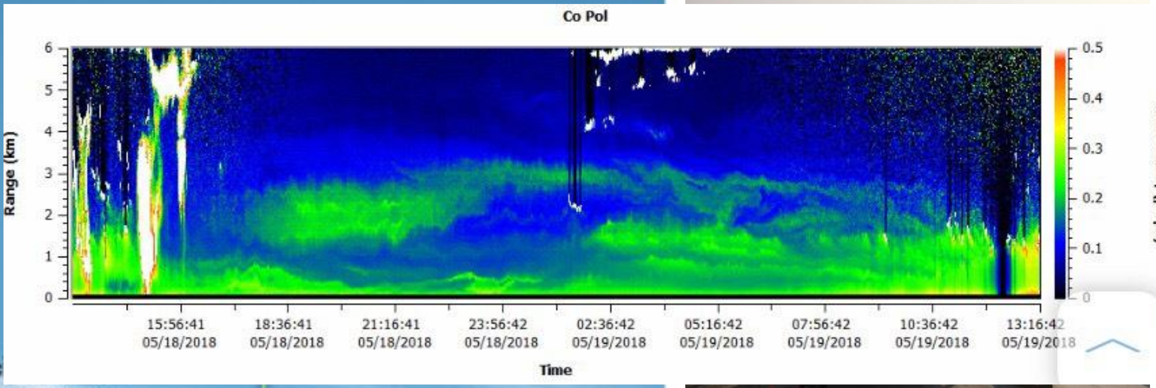


LiDAR Data Product Tree
LiDAR Raw Data
Data Verification
Calibration
R^2 Corrected Data, SNR
Normalized Relative Backscatter (NRB)
AERONET AOD
Solve LiDAR Equation
Wavelet Transform Processing
Co-pol/Cross-pol Ratio
Extinction Coefficient
Atmospheric Features: PBL, Clouds
Depolarization Ratio
Empirical Correlation
Mass Concentration
Particle Types

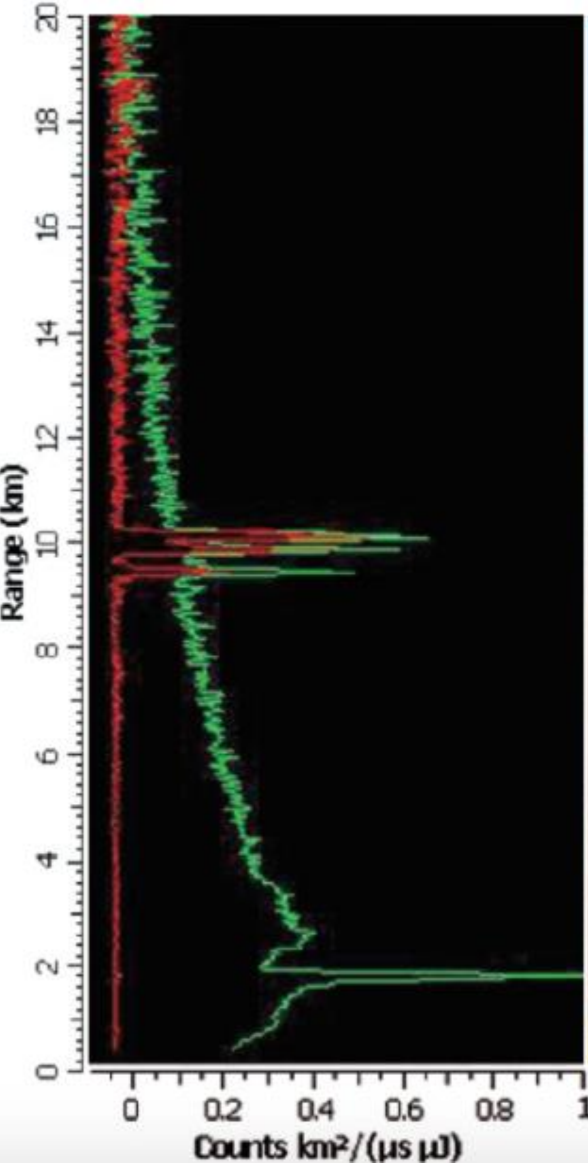
Normalized Relative Backscatter (NRB)

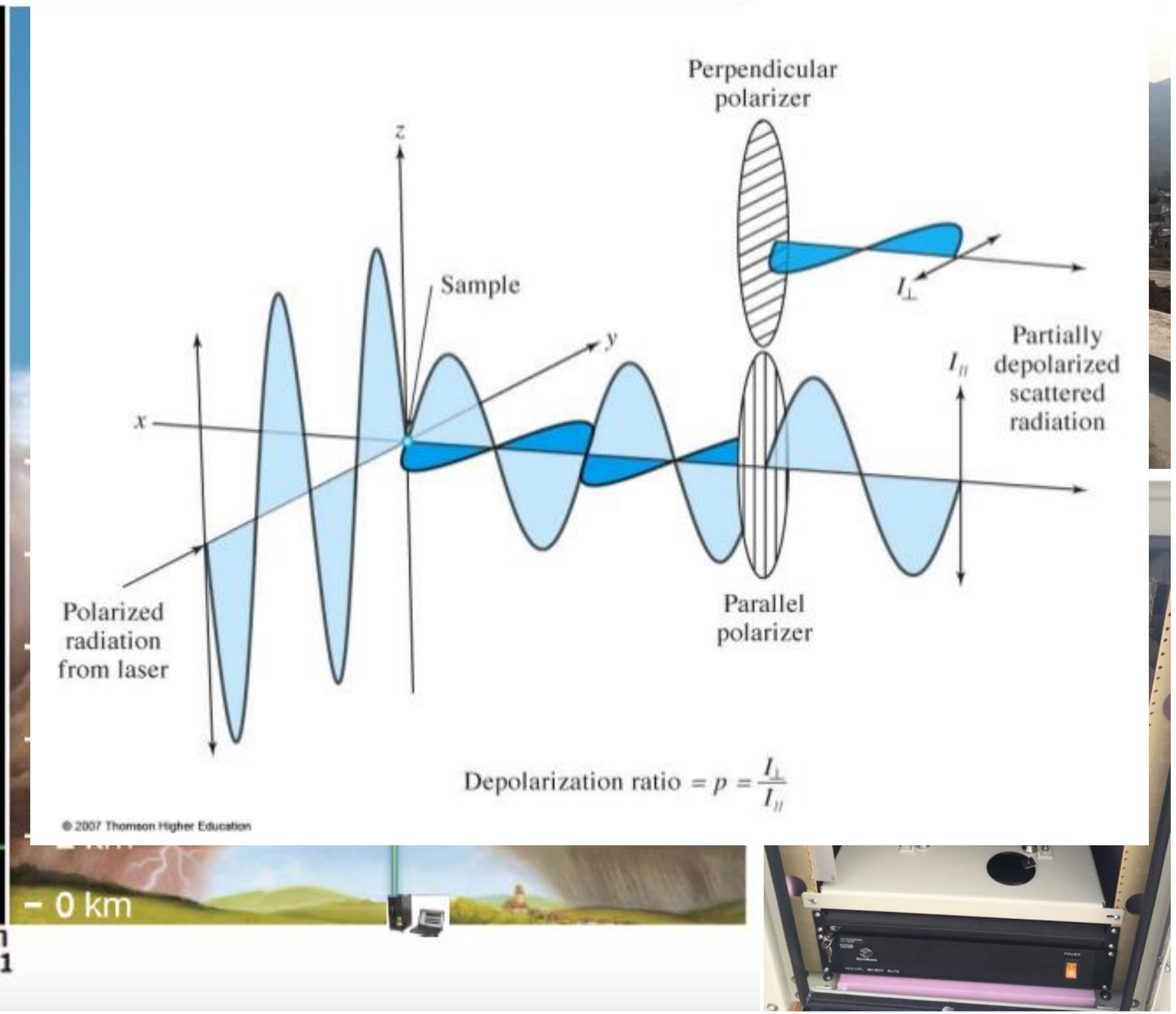




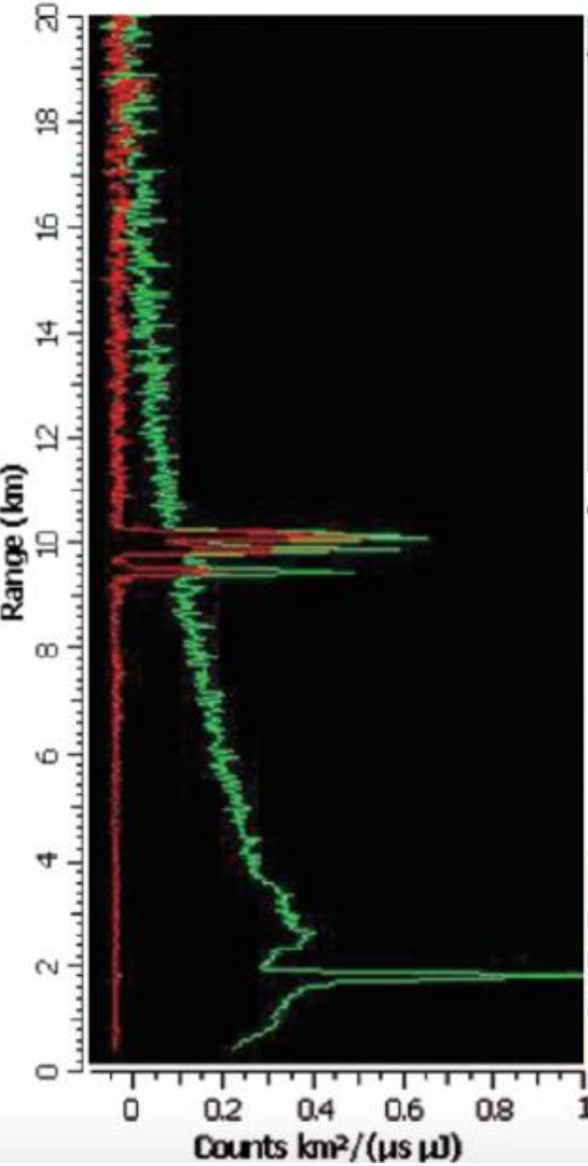


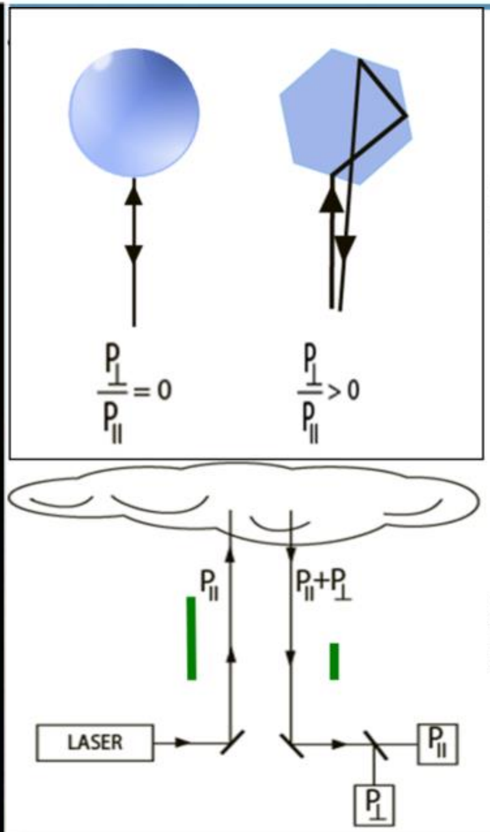
Polarization

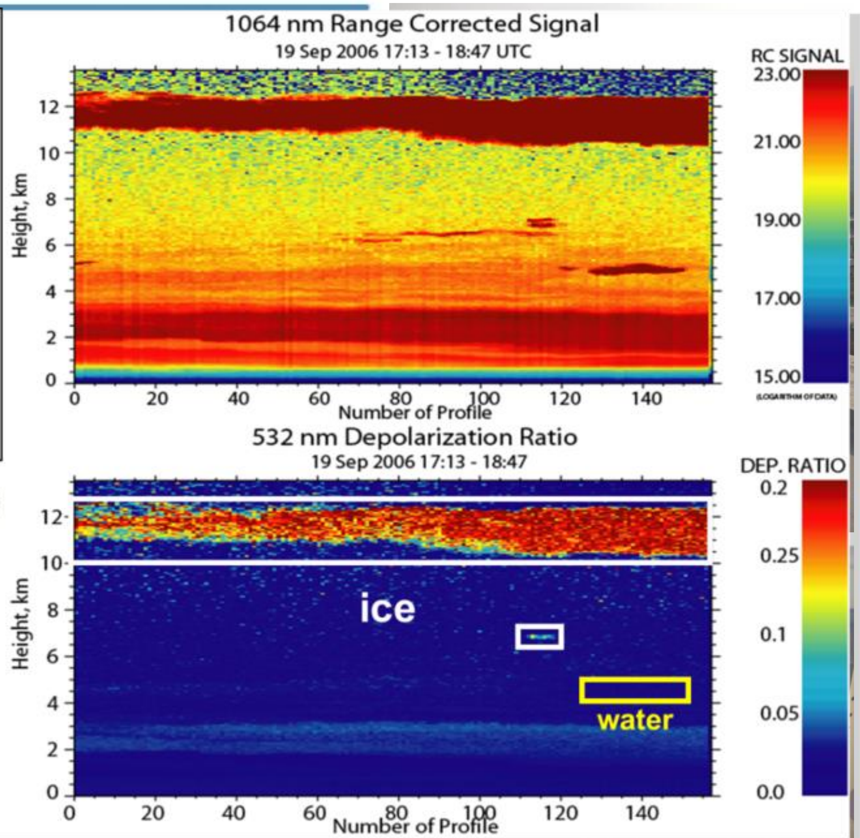


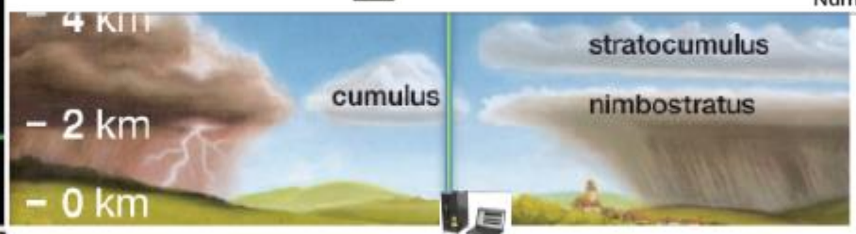


Depolarization

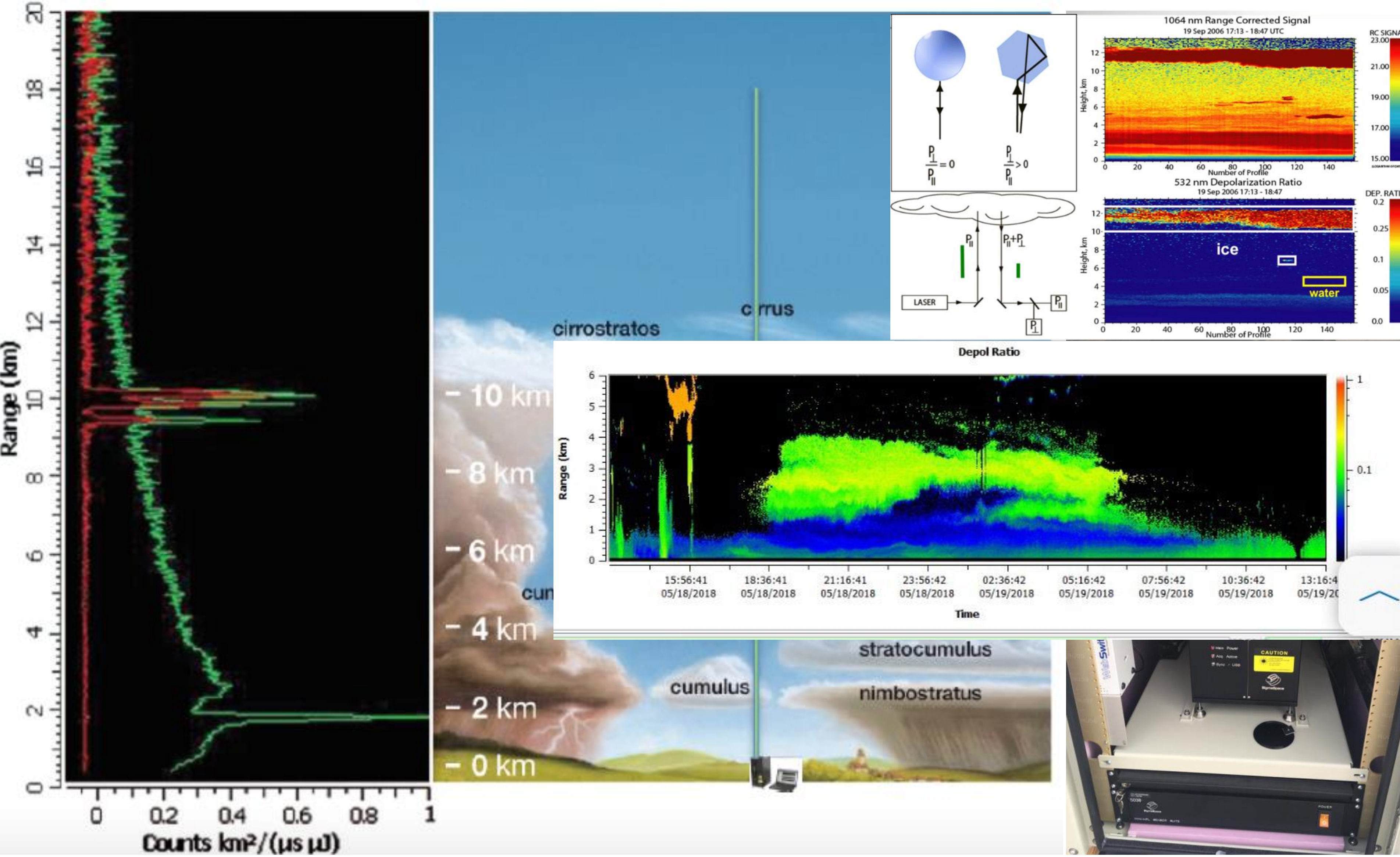




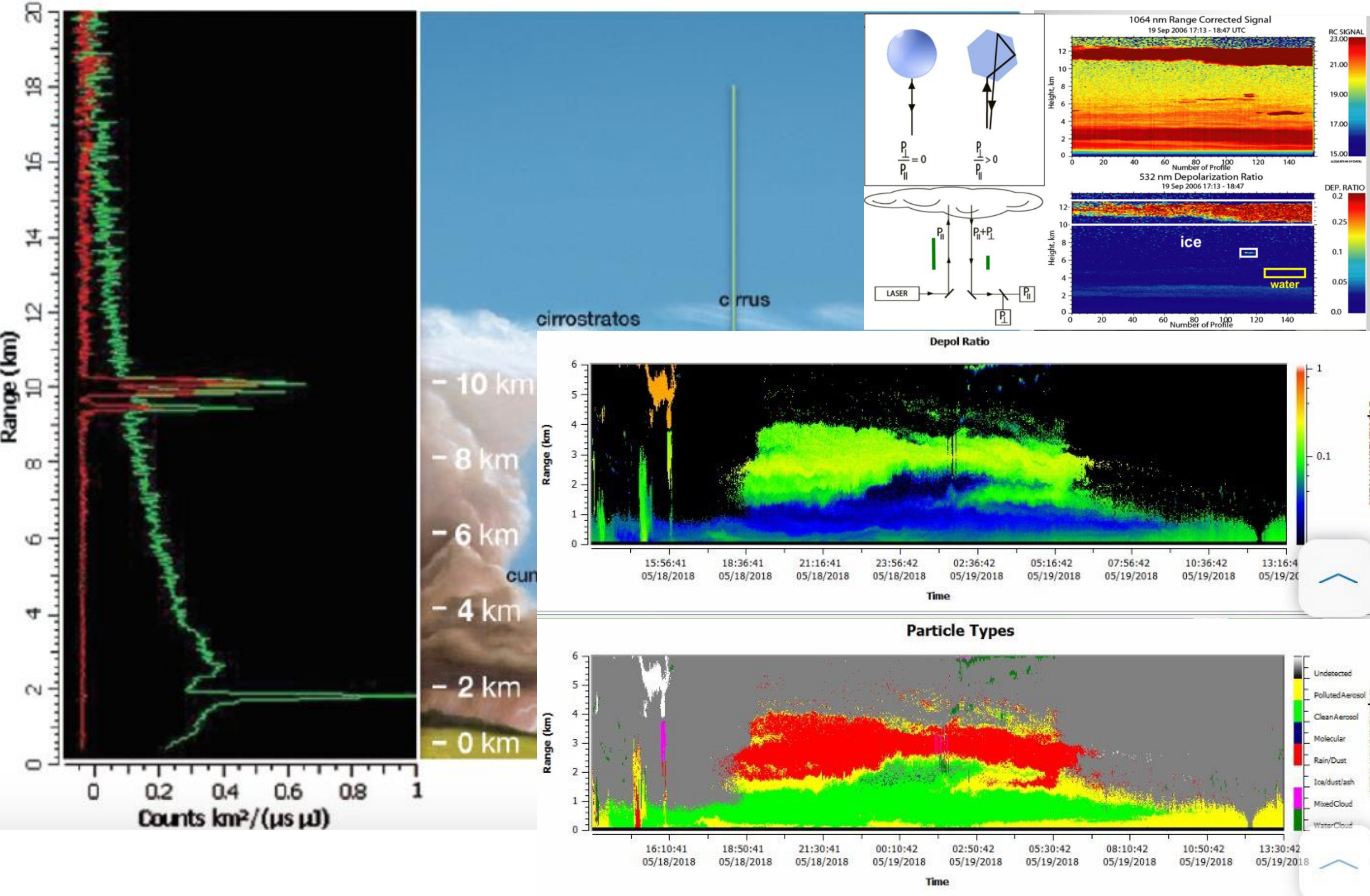




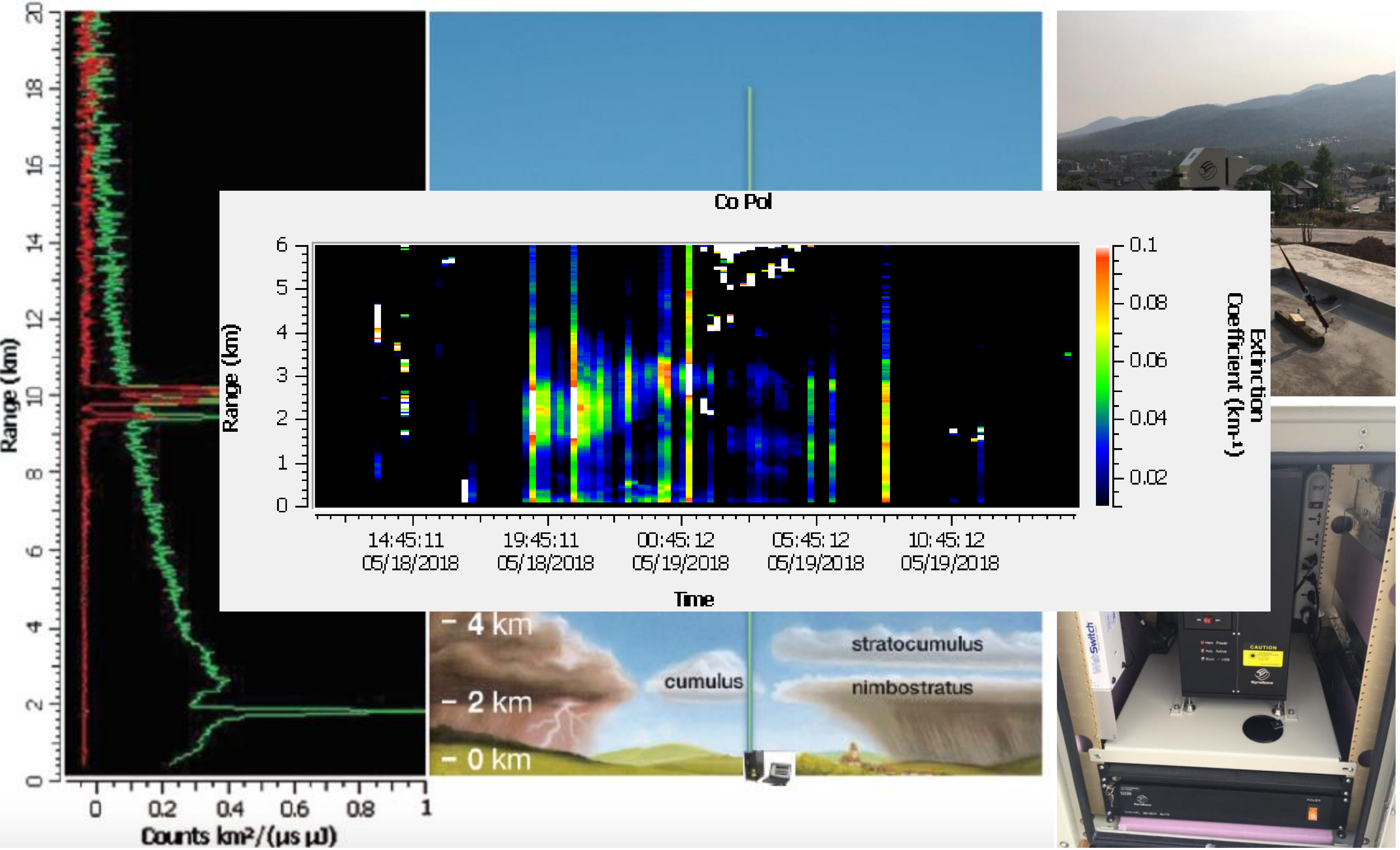
Depolarization Ratio



Depolarization Ratio to Particle Types (Aerosols and Cloud Phase)



Extinction Coefficient



Thank You
for
Your Attention!

Atmospheric Science

https://www.facebook.com/AtmosphericScience/

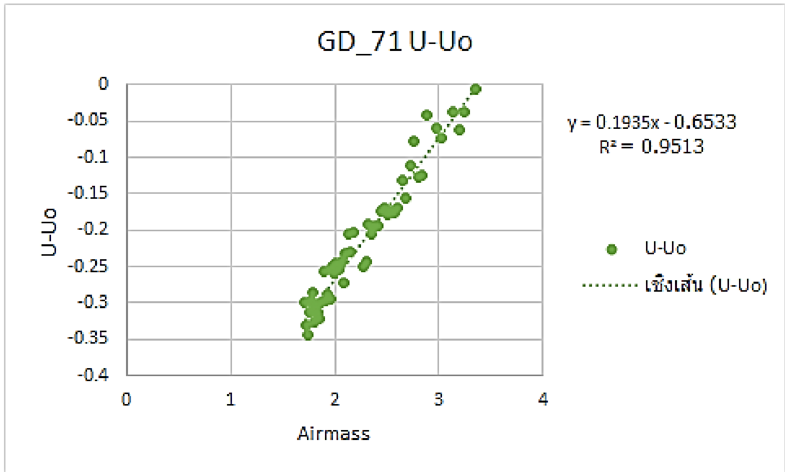
The Atmospheric Research Unit
of NARIT (ARUN) – ronmcdo@gmail.com

ARUN

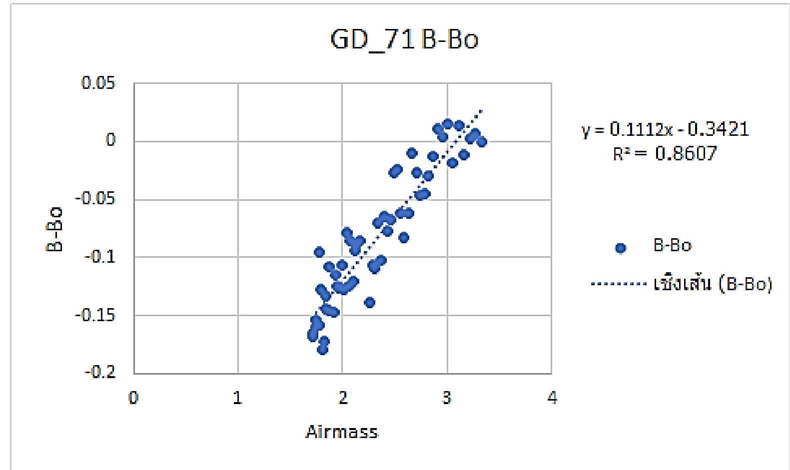
Measurement of Atmospheric Extinction at TNO Using the 2.4 m Telescope

Analysis by Jansawang Panomprai, Sauwaporn Pongpaisirikul, Porrawit Thaimai, Panpaka Suropan, Somsawat Rattanasoon, Donduedee Sookjai and Thiranan Sonkaew

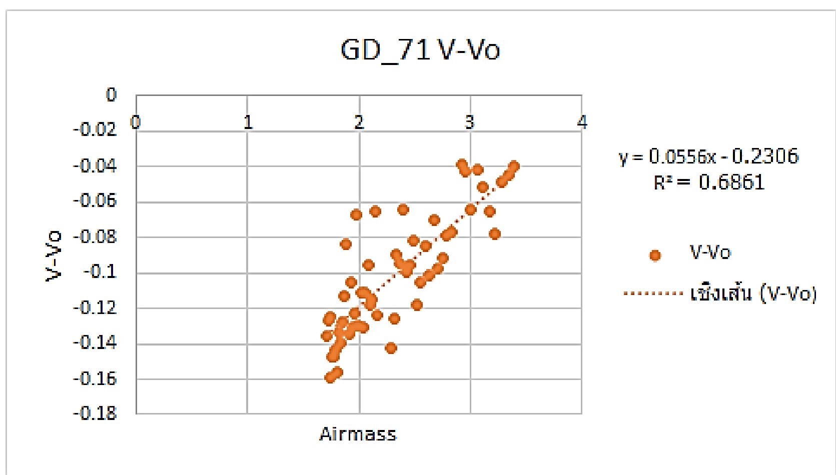
334 – 400 nm



389– 483 nm



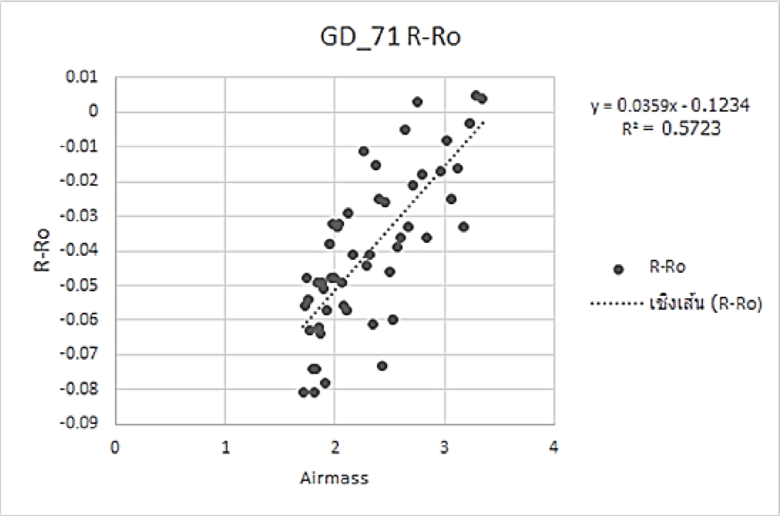
501– 589 nm



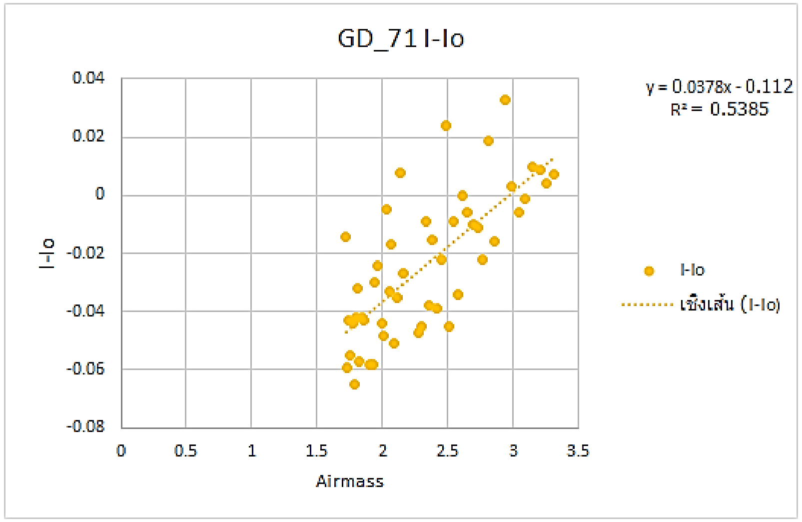
Measurement of Atmospheric Extinction at TNO Using the 2.4 m Telescope

Analysis by Jansawang Panomprai, Sauwaporn Pongpaisirikul, Porrawit Thaimai, Panpaka Suropan, Somsawat Rattanasoon, Donduedee Sookjai and Thiranan Sonkaew

569 – 707 nm



722.5 – 871.5 nm



Optical filter	Atmospheric Extinction
U	0.1935
B	0.1112
V	0.0556
R	0.0359
I	0.0387