Aerosol-PBL Interactions Observed During PLUME

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ARUN
Atmospheric Research Unit of NARIT

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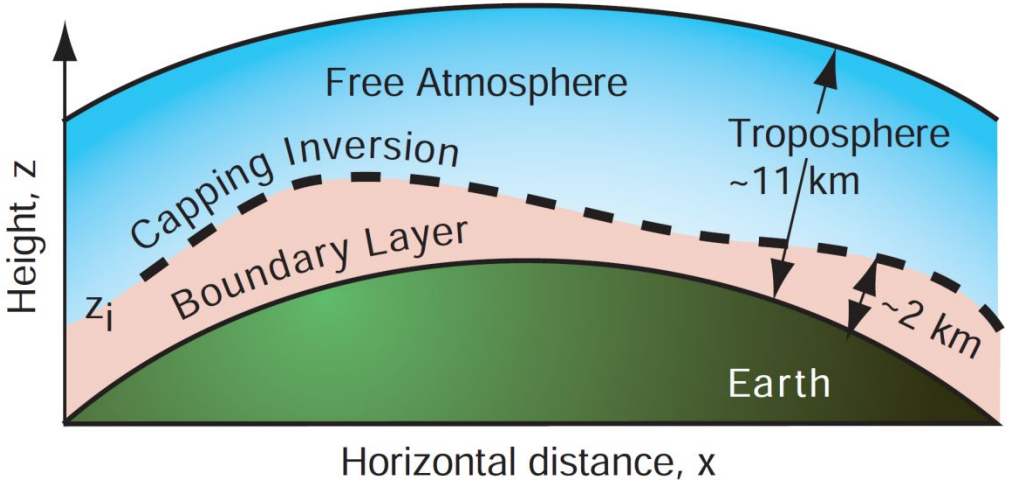
What is the PBL?

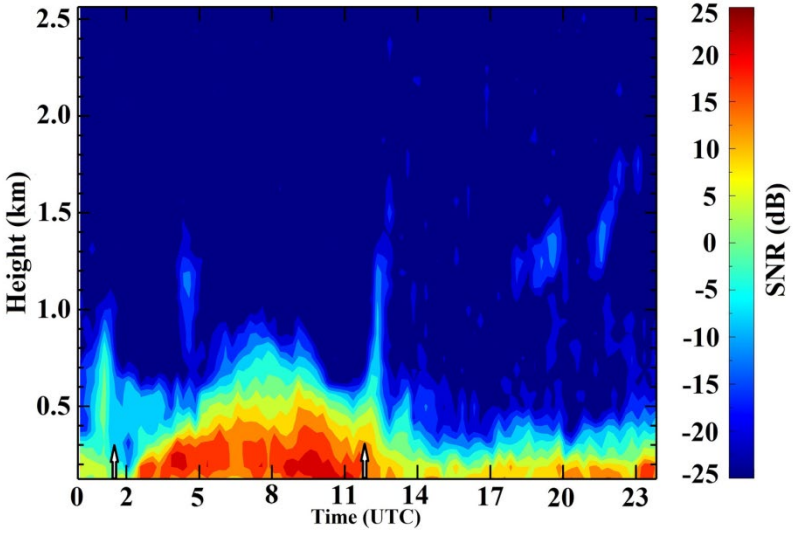
Planetary Boundary Layer (PBL)

Atmospheric boundary layer (ABL) / Mixing layer (ML)

A turbulent layer in constant state of exchange with the earth's surface, responding over the time scale of an hour or less.

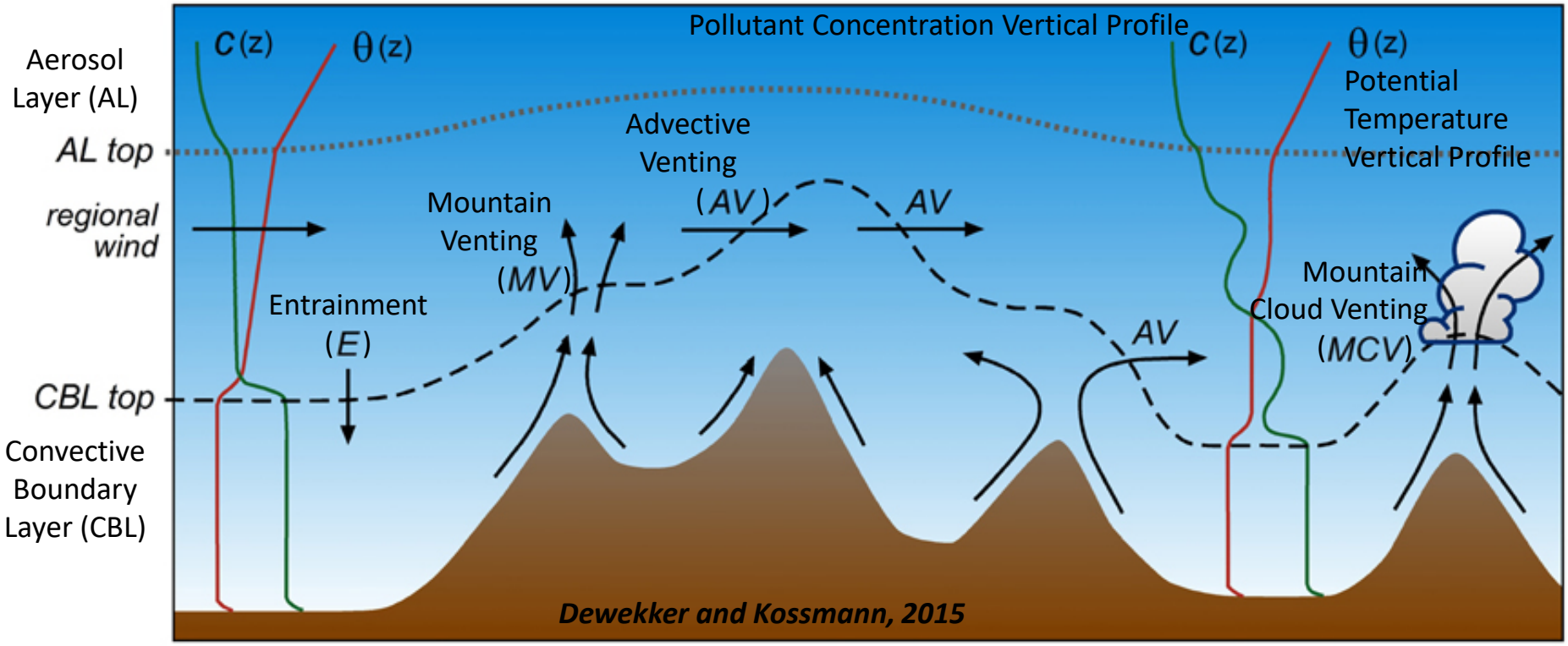
Diurnal cycles of exchanging heat, water vapor, and pollutants.





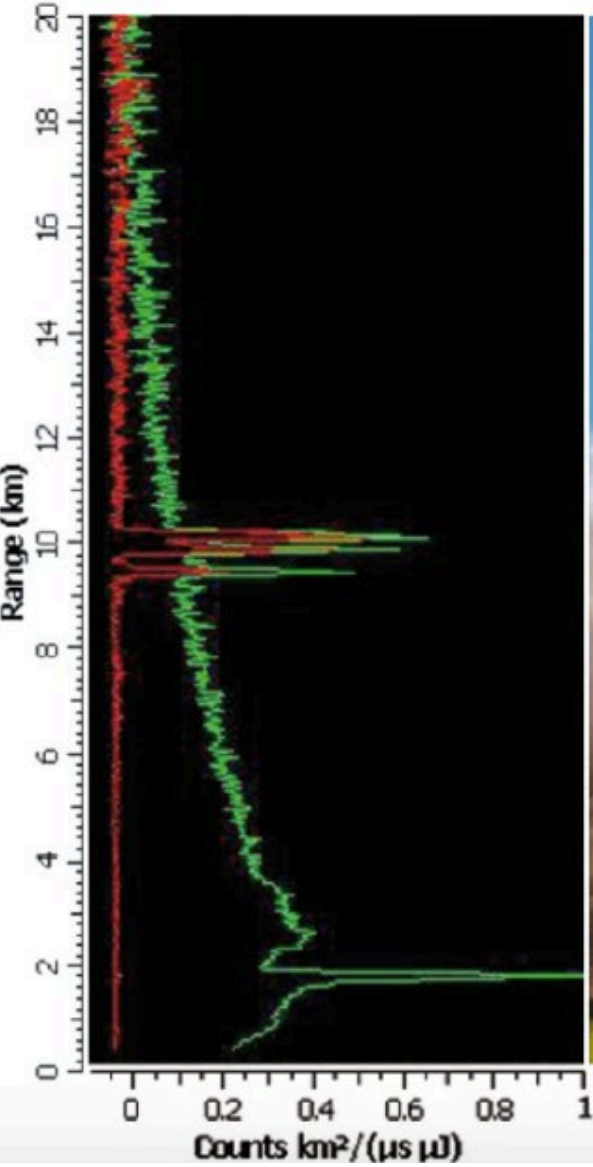
Atmospheric pollutants and the mixing layer height

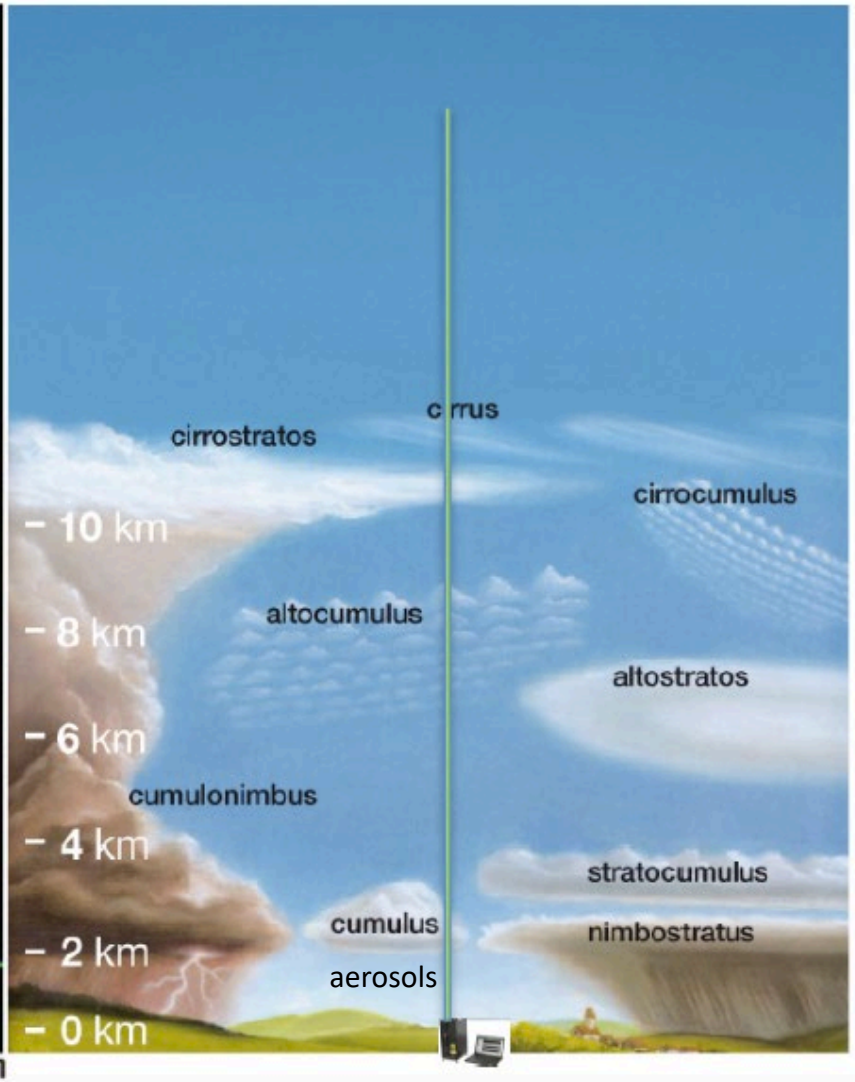
The mixing height usually acts as a confinement to the pollutants emitted from the Earth's surface, hence controlling their concentration with variations in the mixing layer top height.



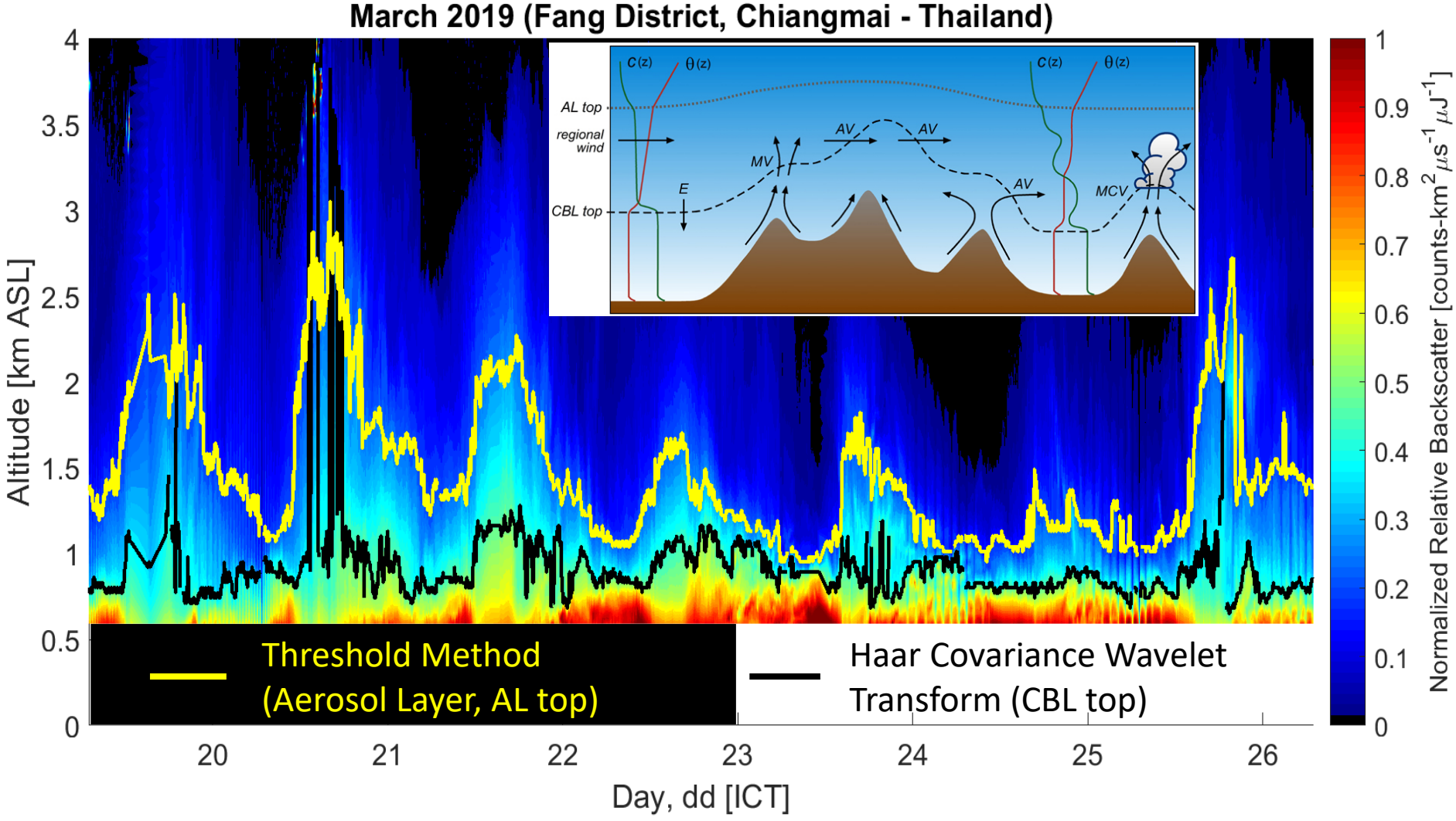
Atmospheric Light Detection and Ranging (LiDAR)

Micropulse LiDAR (MPL) Backscatter Signal

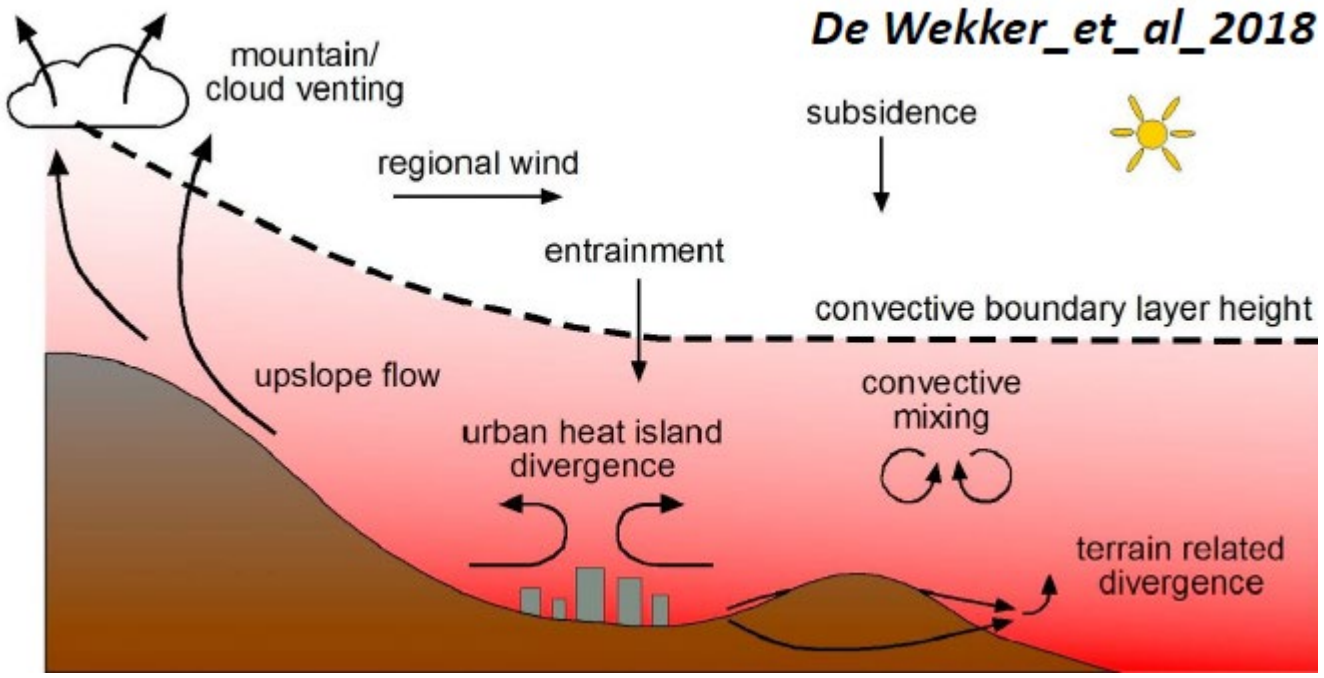




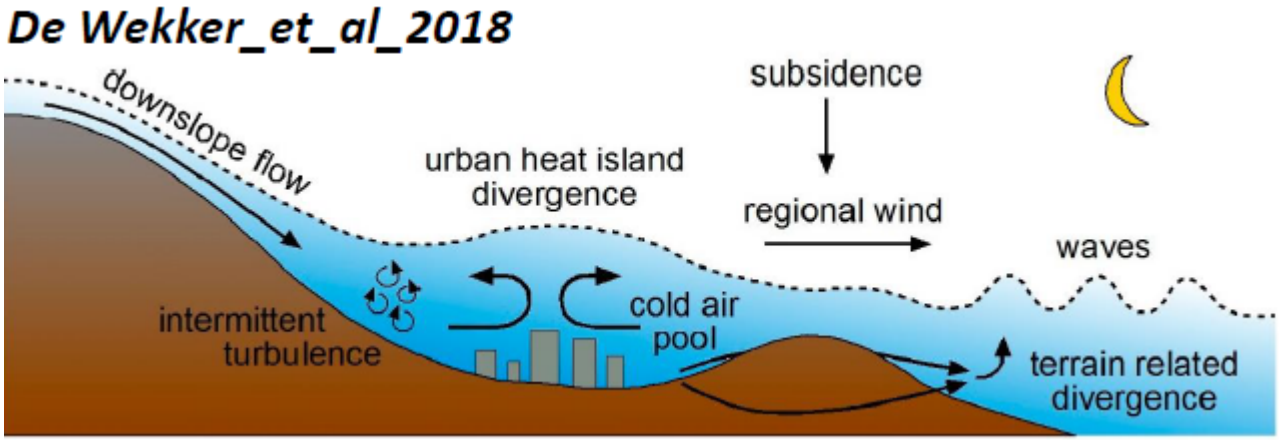
ML Top Height (Mixing Height) Estimation from Normalized Relative LiDAR Backscatter



Mixing Height Diurnal (Daily) Variations over Mountainous Terrain

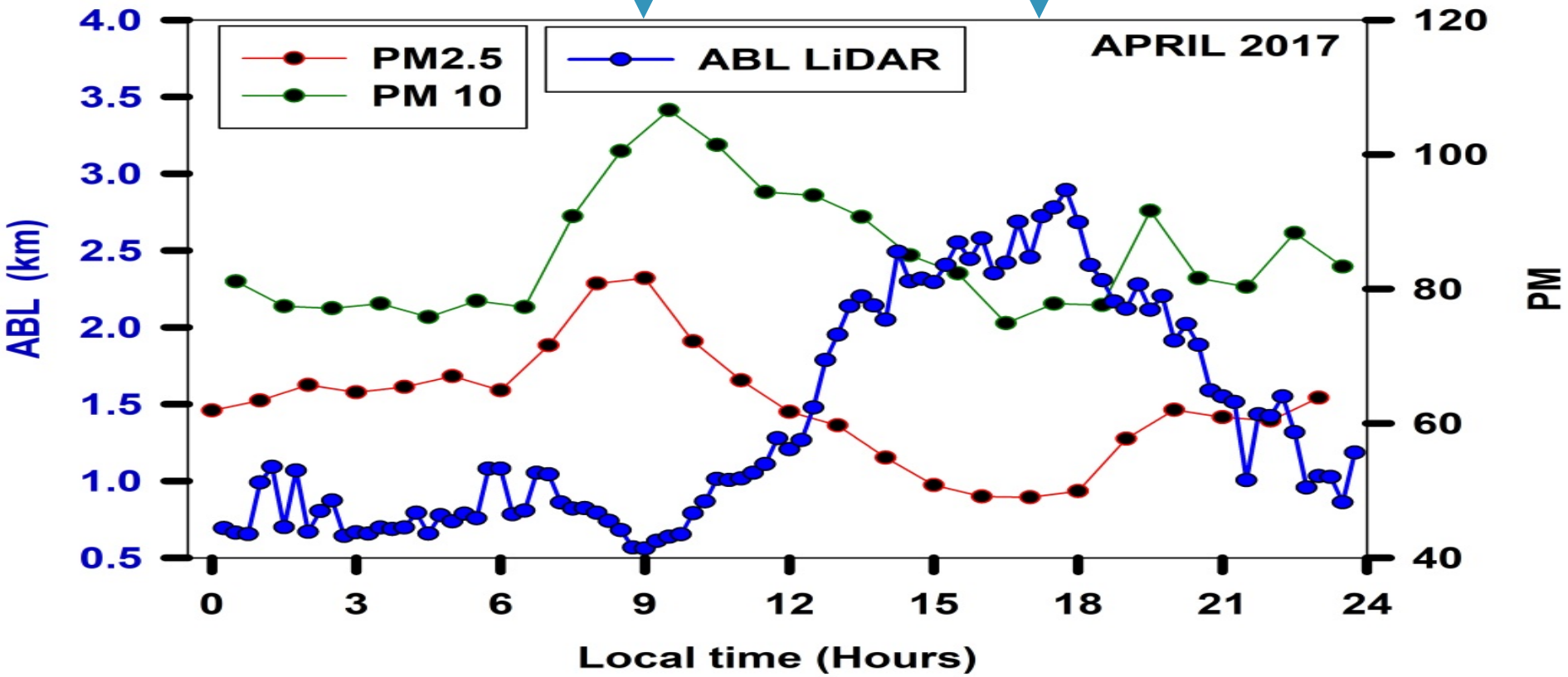


Daytime

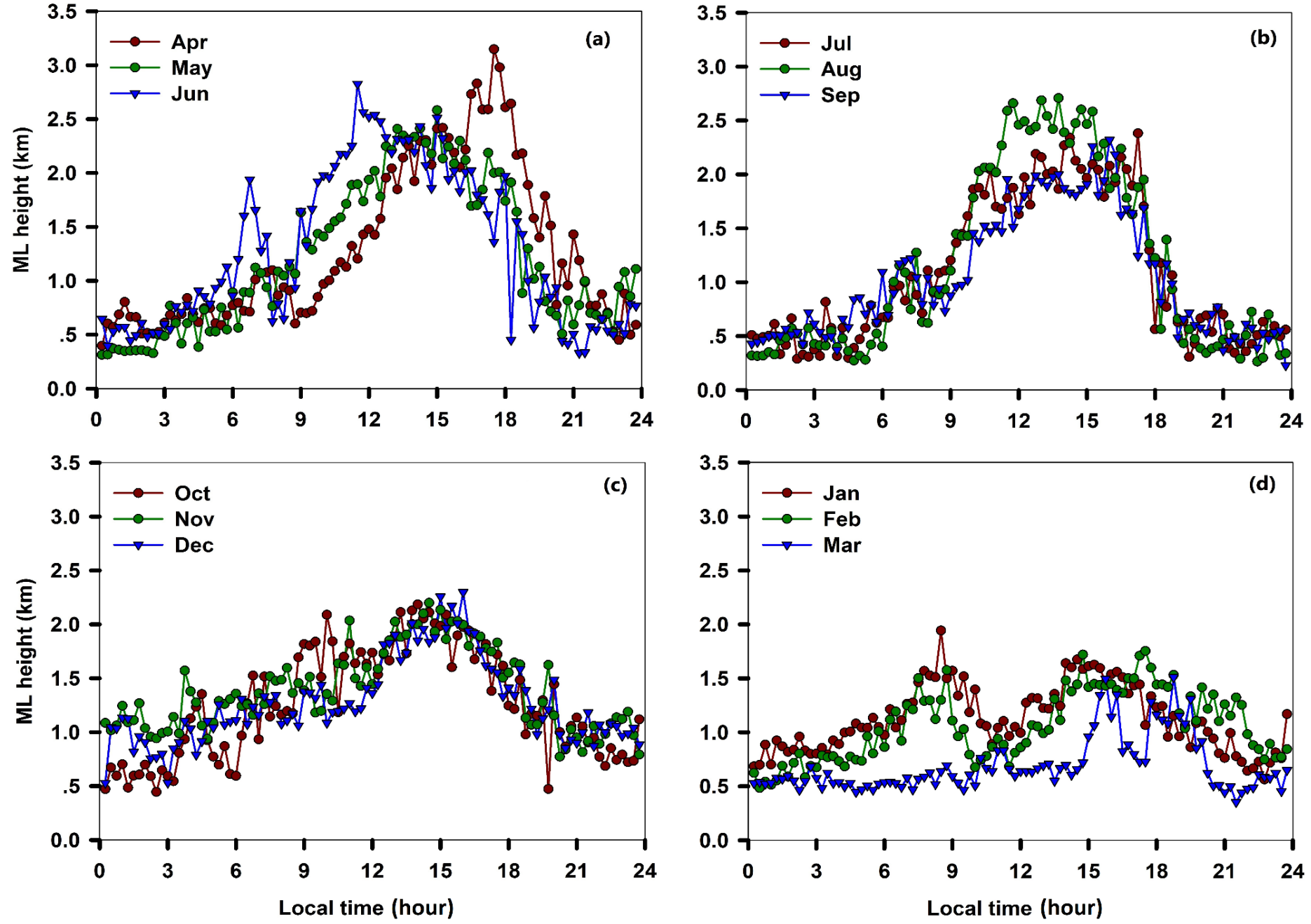


Nighttime

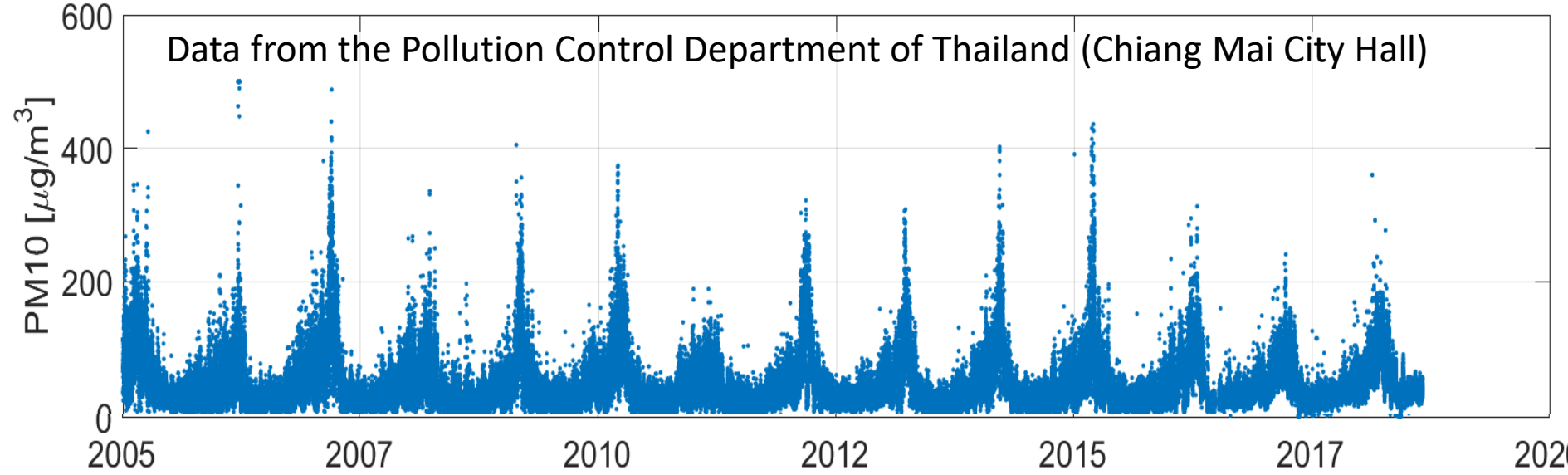
Monthly Mixing Height Diurnal (Daily) Variations over Chiangmai, Thailand

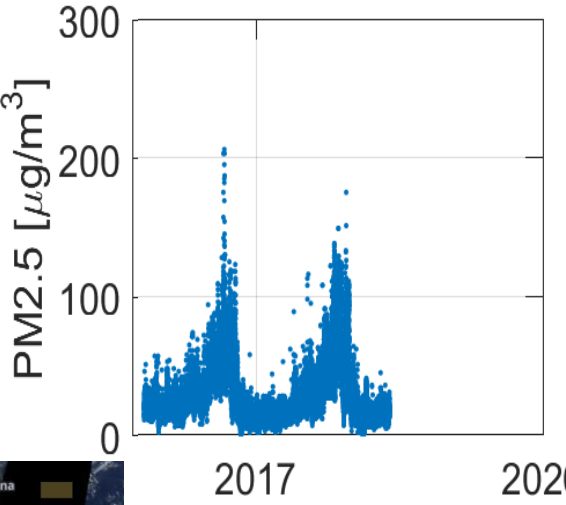


Monthly Mixing Height Diurnal (Daily) Variations over Chiangmai, Thailand (2017-2018)



What is happening in March over the Upper Indochina Highlands?





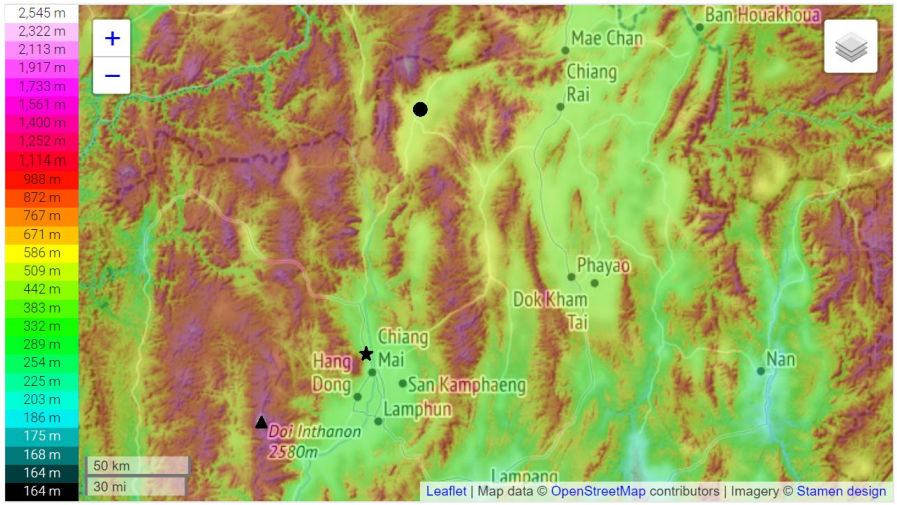
Do emissions from fires affect PBL development?

Visualization from NASA Worldview

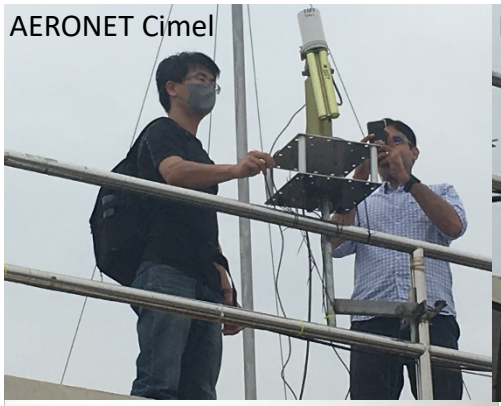
Full Campaign: PLUME = “Profiling with Lidar and Uav Multi-scale Experiment” (Mar 10-30, 2019)

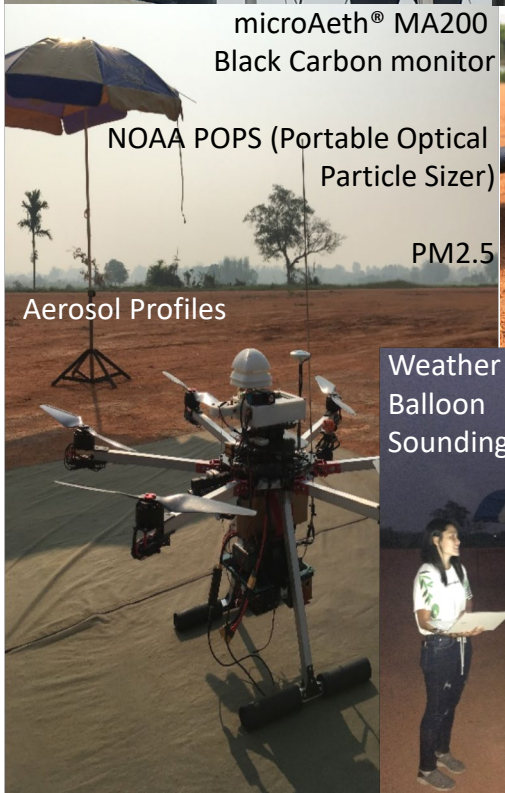
Fang, Chiangmai in cooperation with Carlo Wang, Ying-Jen Wu, Li-Jin Ke (NCU, Taiwan), Somporn Chantara, Nuttipon Yabueng, Duangduean Thepnuan, Wan Wiriya (ESRC CMU, Thailand) and See Chee Tsay (NASA GSFC, USA)

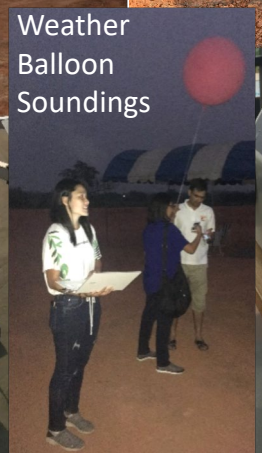
NARIT's mini-micropulse 24/7 LiDAR : "PHOON"

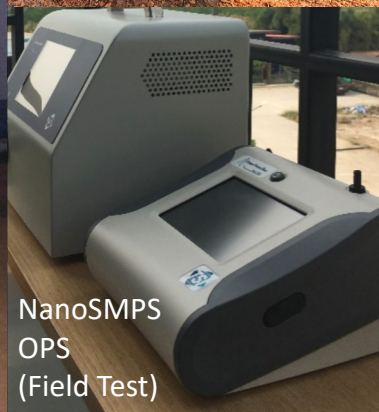


★	Astro park, Chiang Mai	|| 18.852°N, 98.958°E, 332 m AMSL || 10 Apr 2017 to 24 Oct 2018
▲	TNO, Doi Inthanon	|| 18.574°N, 98.482°E, 2457 m AMSL || 25 Oct 2018 to 25 Jan 2019
●	Fang District	|| 19.911°N, 99.202°E, 470 m AMSL || 31 Jan 2019 -- ongoing









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BROWN CARBON (BrC)

Organic molecules like tar balls or fats, given off by long-smoldering fires

BLACK CARBON (BC)

Carbon particles given off by hot fires, like coal plants, forest fires, and combustion from cars

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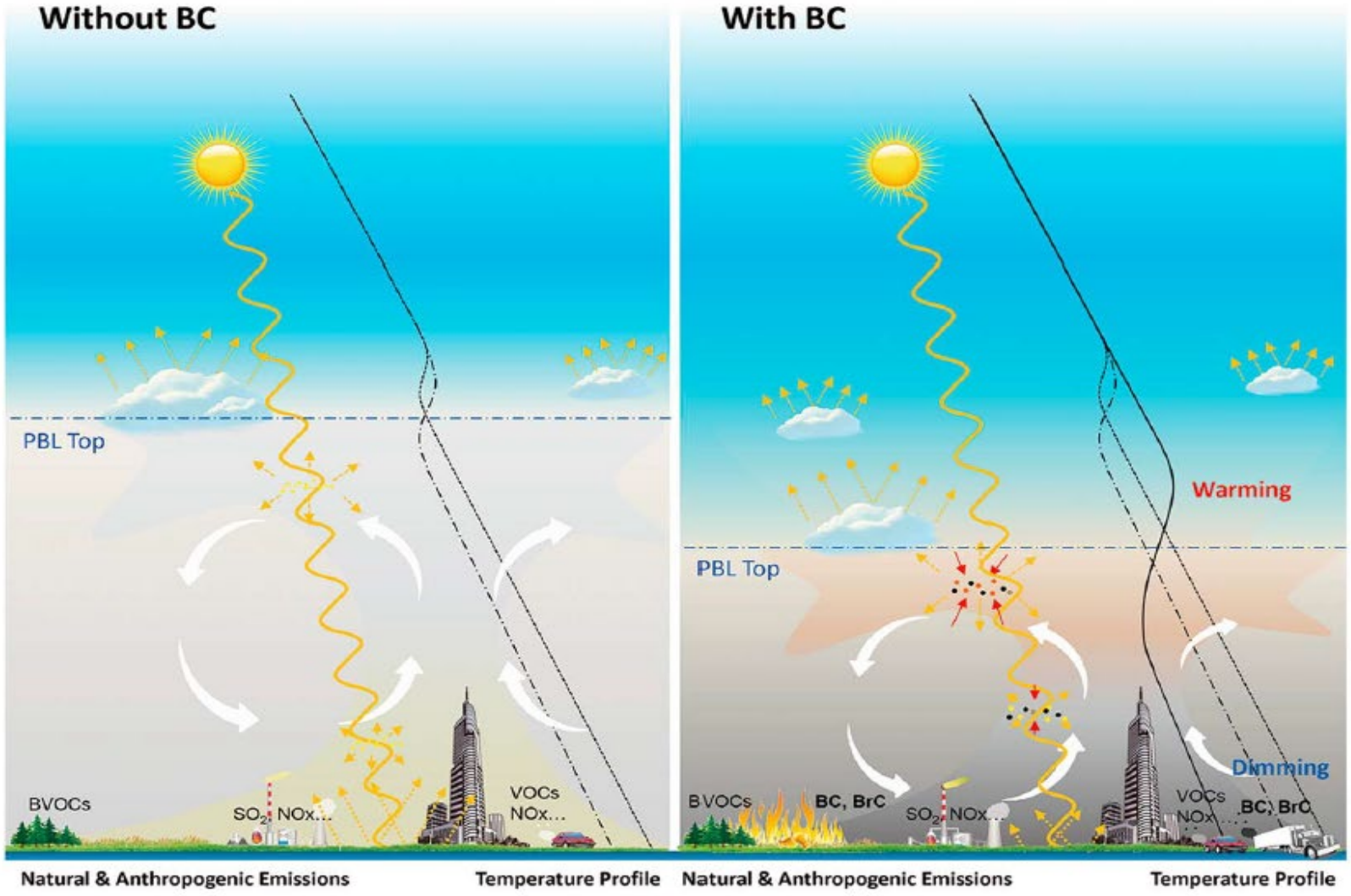
Aerosol-PBL Interactions

Ding et al., 2016



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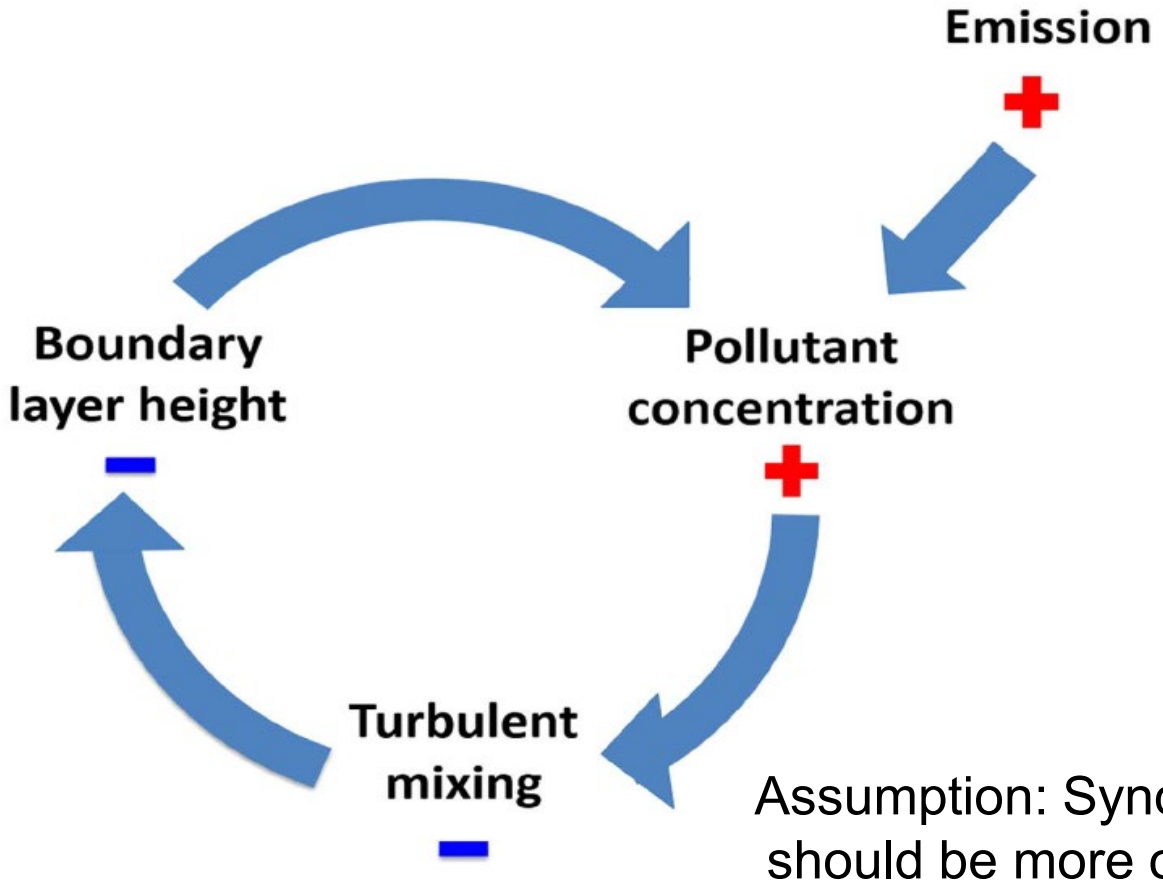
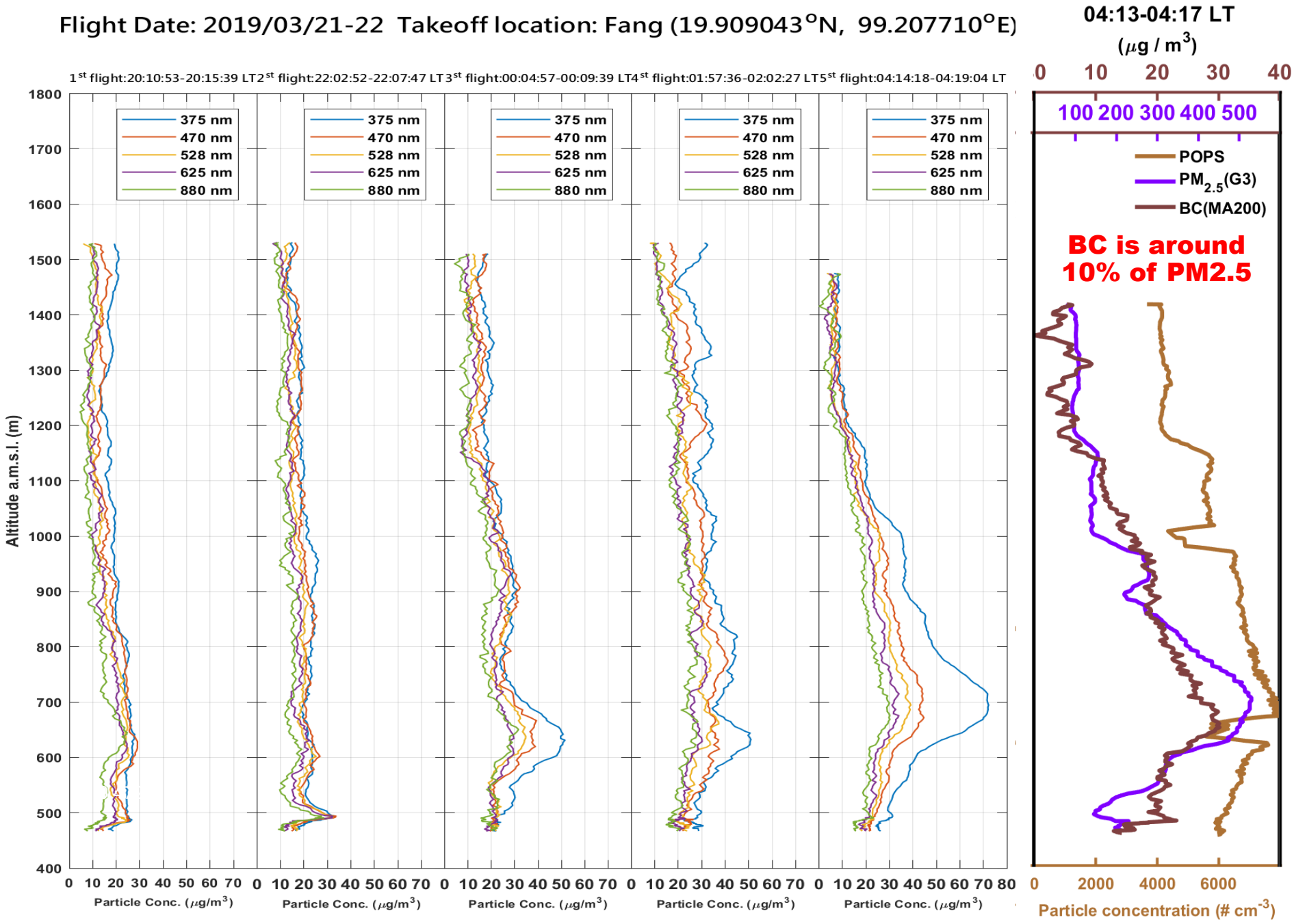
Aerosol-PBL Interactions



Assumption: Synoptic Conditions should be more or less constant

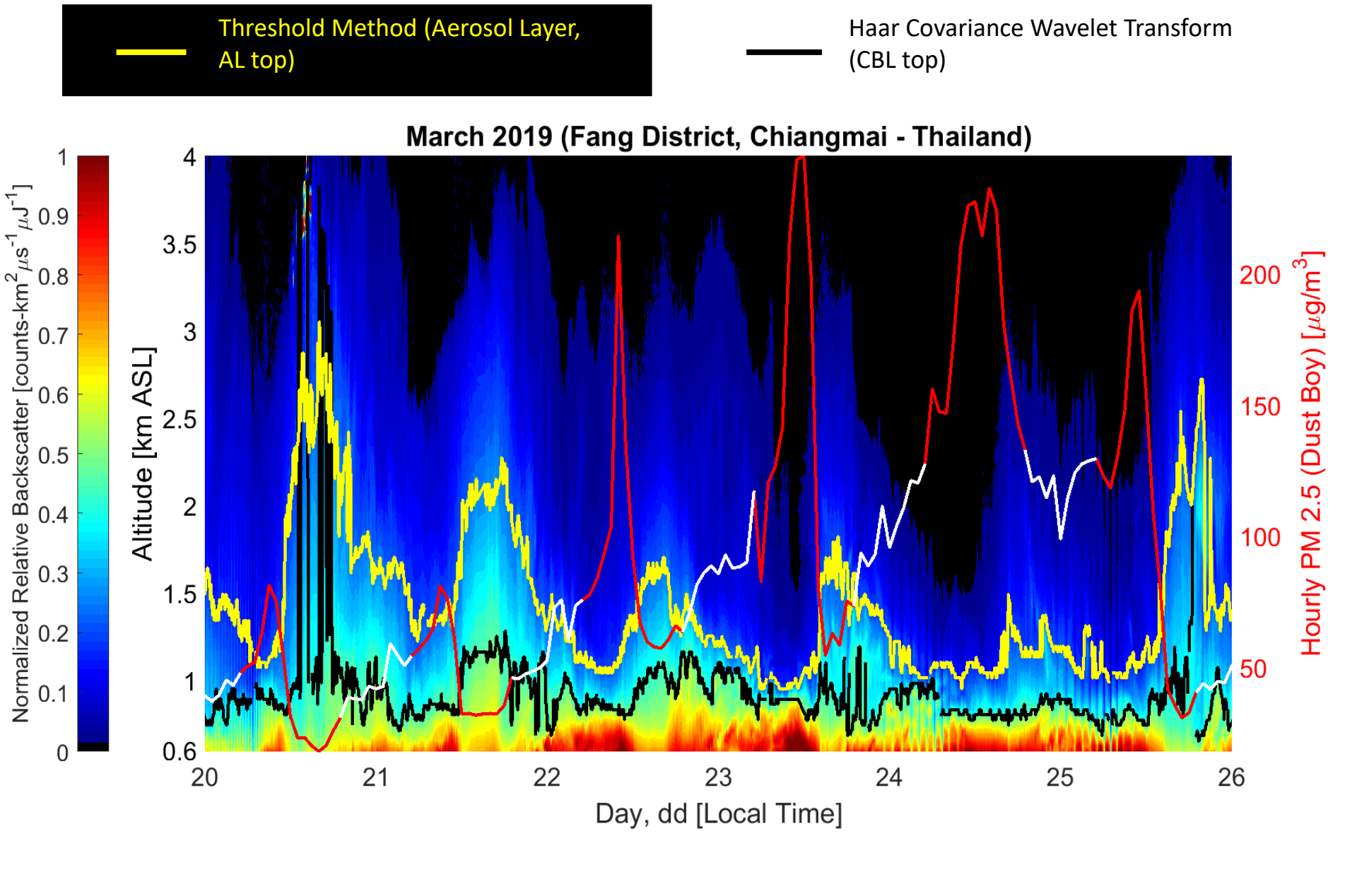
Petäjä et al., 2016

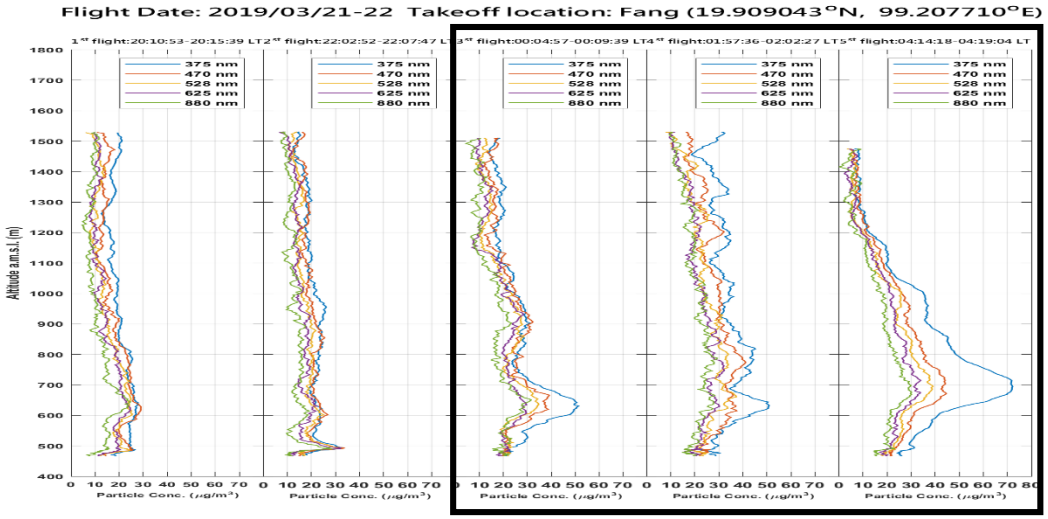
Black Carbon Particle Concentration from UAV (microAeth® MA200 Black Carbon monitor)



Normalized Relative Backscatter and Mixing Height from NARIT's Micropulse LiDAR

Surface PM2.5 Concentrations from Chiang Mai University's "Dust Boy"





March 22, 2019 (00 - 04 Local Time)

Threshold Method (Aerosol Layer, AL top)

Haar Covariance Wavelet Transform (CBL top)

March 2019 (Fang District, Chiangmai - Thailand)

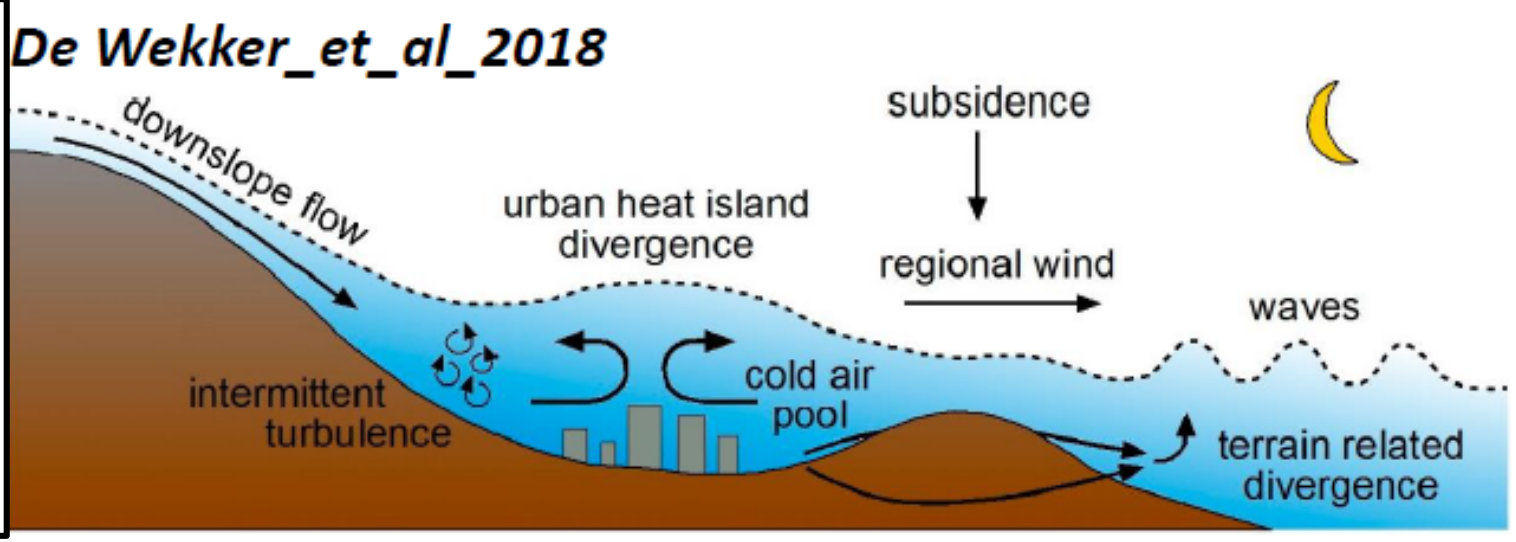
Normalized Relative Backscatter [counts-km^2 μs^{-1} μJ^{-1}]

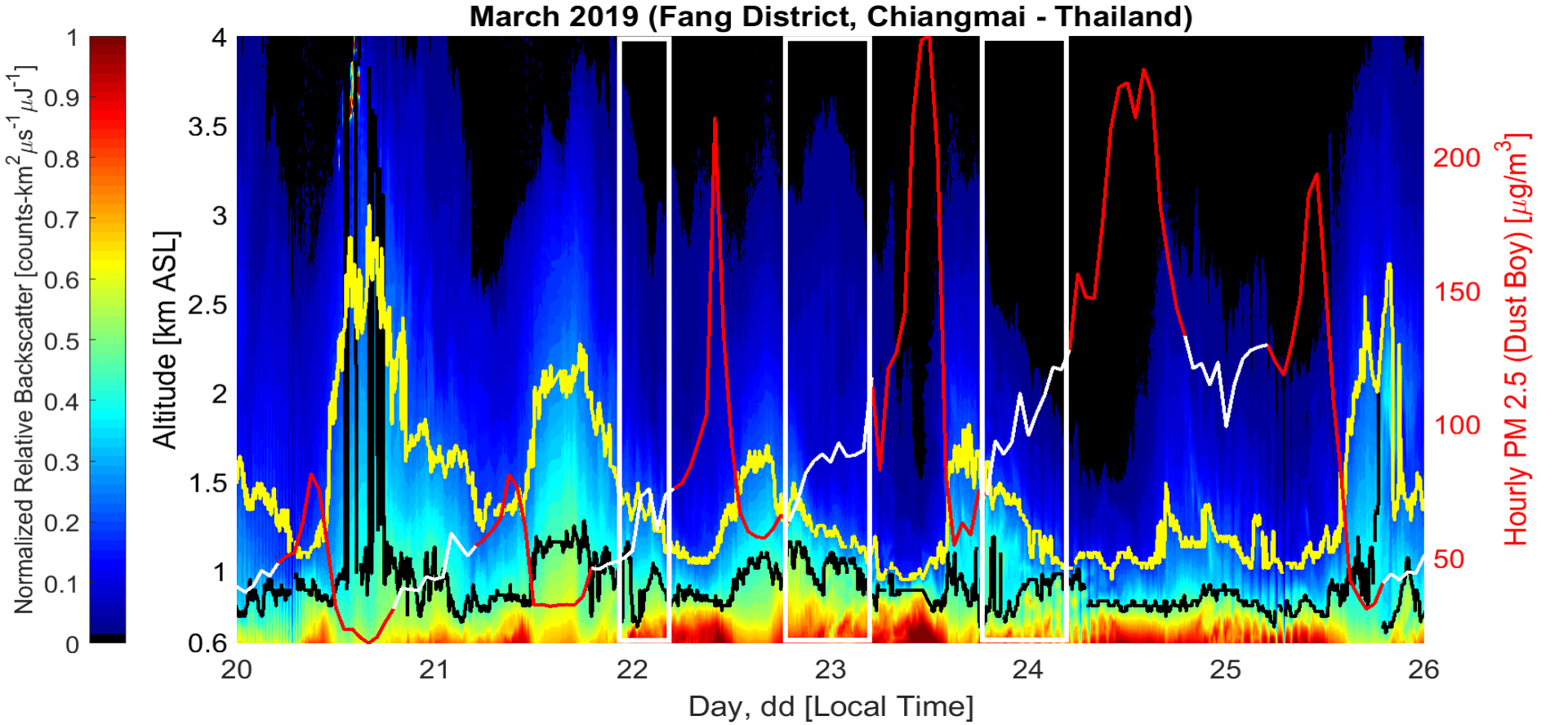
Altitude [km ASL]

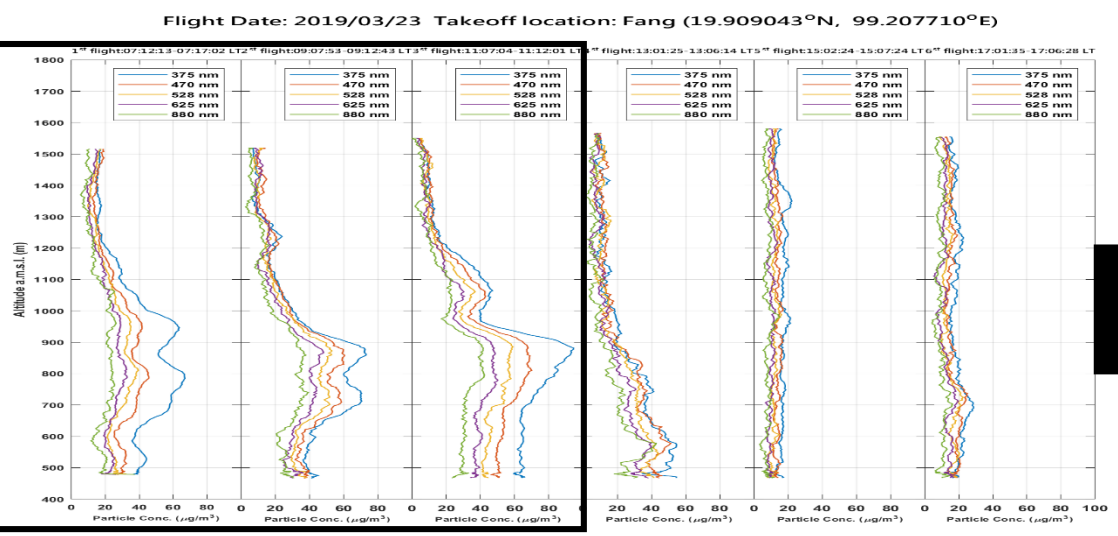
Hourly PM 2.5 (Dust Boy) [μg/m^3]

Day, dd [Local Time]

Significant BrC or BC emissions during the nighttime, suppress PBL development the following day.







March 23, 2019 (07 – 11 Local Time)

Threshold Method (Aerosol Layer, AL top)

Haar Covariance Wavelet Transform (CBL top)

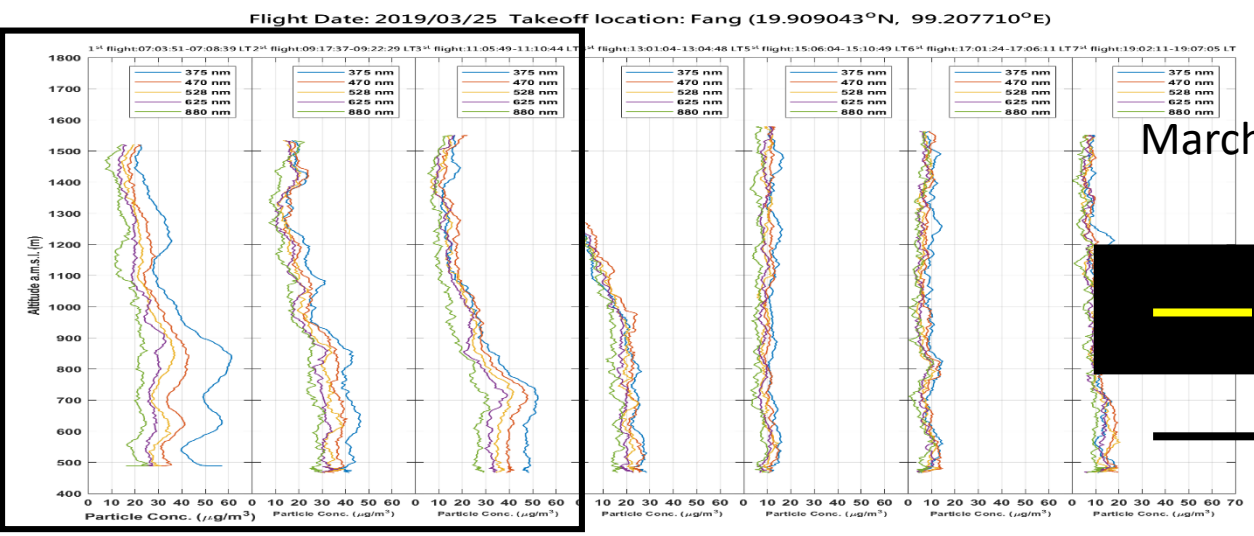
March 2019 (Fang District, Chiangmai - Thailand)

Normalized Relative Backscatter [counts-km^2 μs^{-1} μJ^{-1}]

Altitude [km ASL]

Hourly PM 2.5 (Dust Boy) [μg/m^3]

Day, dd [Local Time]



March 25, 2019 (07 – 11 Local Time)

Threshold Method (Aerosol Layer, AL top)

Haar Covariance Wavelet Transform (CBL top)

March 2019 (Fang District, Chiangmai - Thailand)

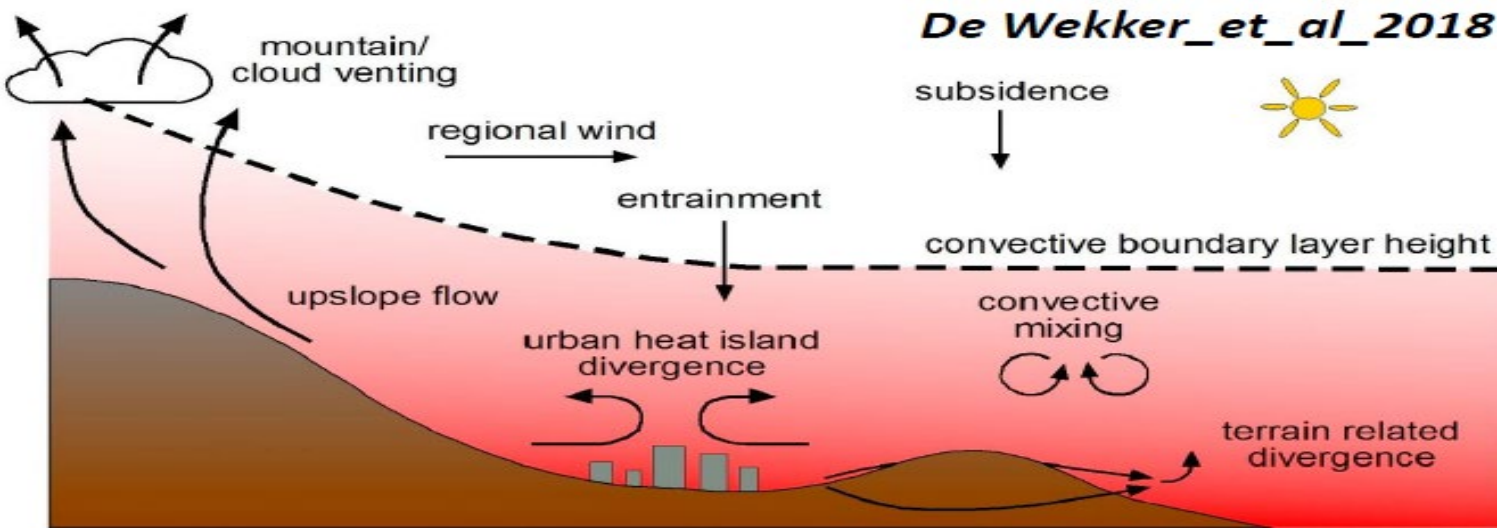
Normalized Relative Backscatter [counts-km^2 μs^{-1} μJ^{-1}]

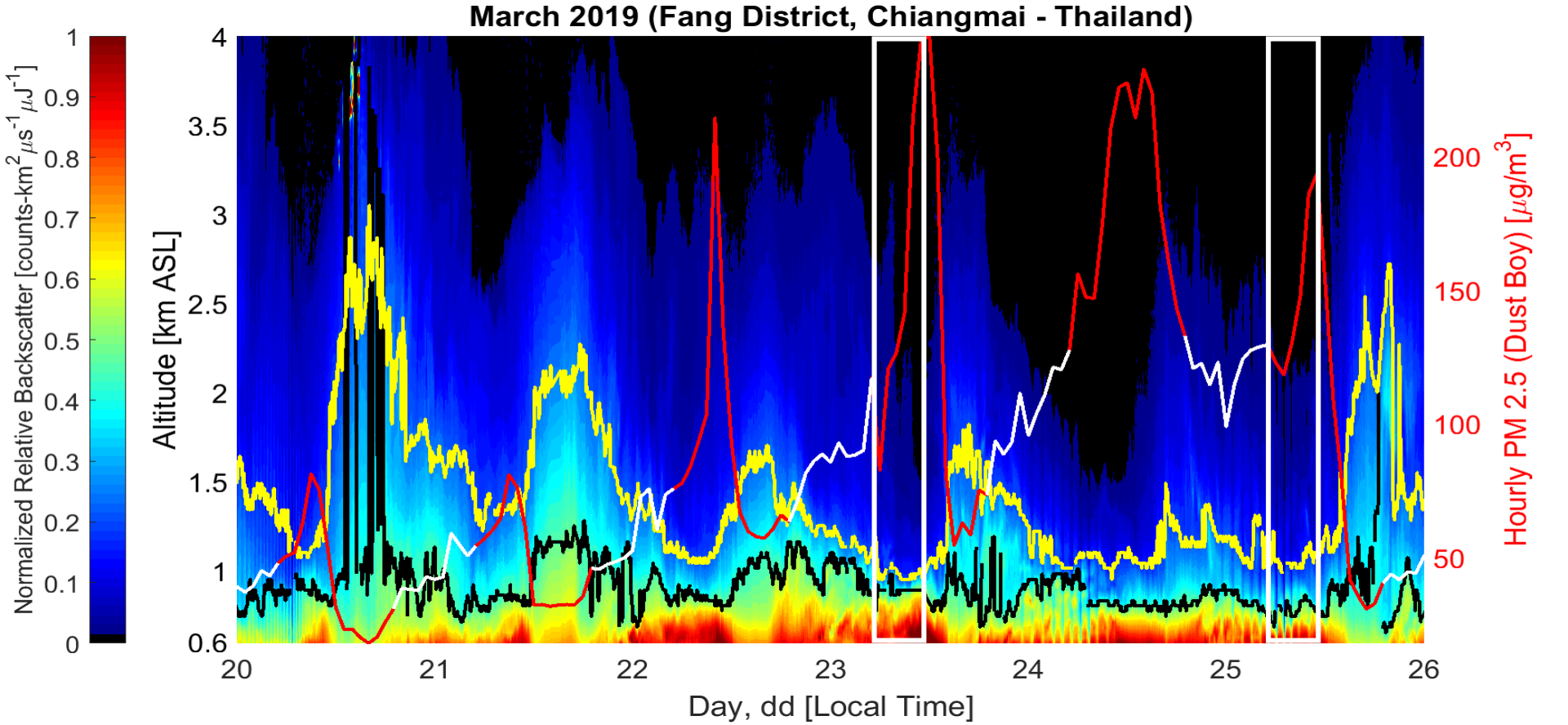
Altitude [km ASL]

Hourly PM 2.5 (Dust Boy) [μg/m^3]

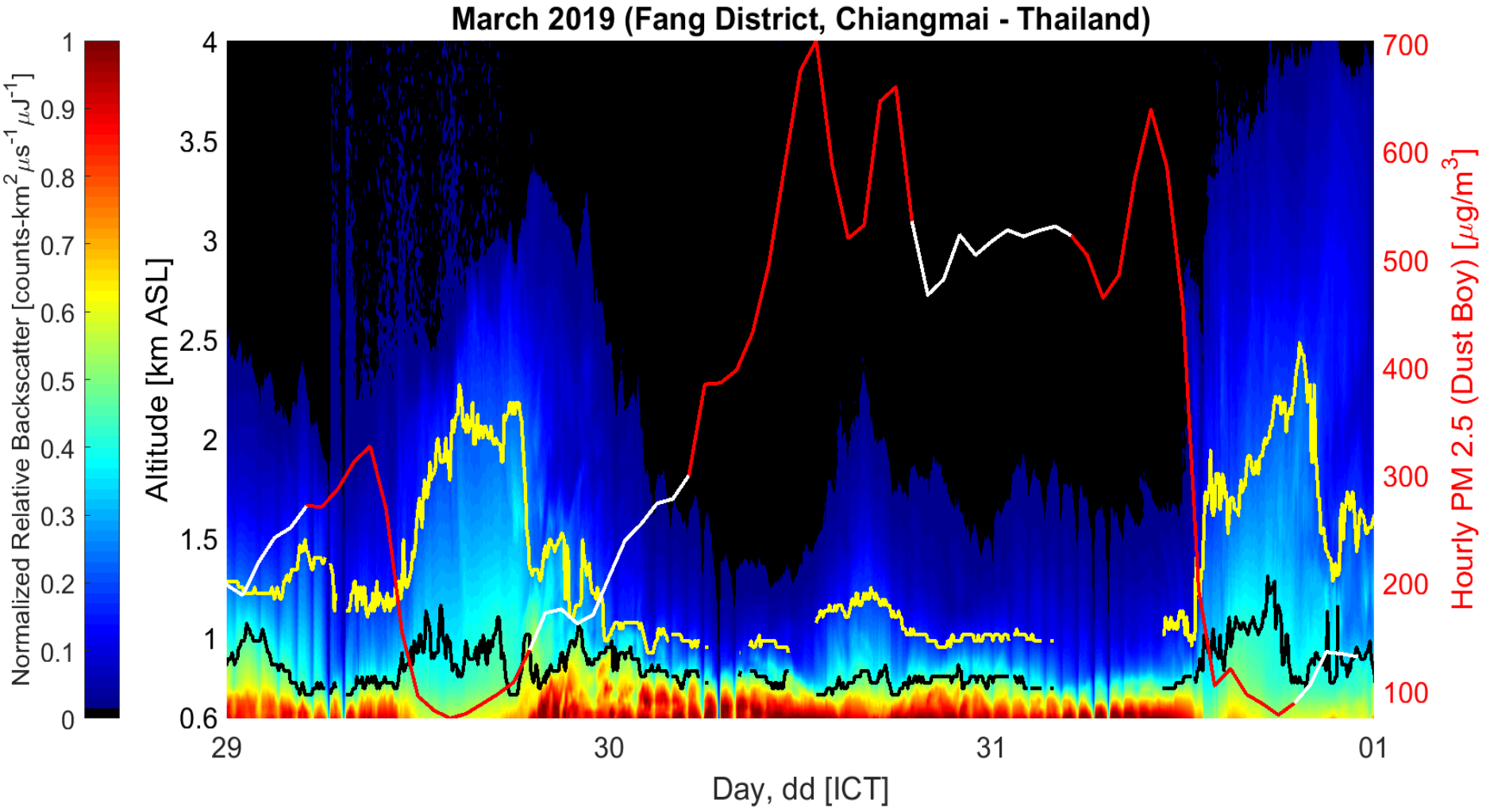
Day, dd [Local Time]

Significant BrC / BC emissions during the daytime, have a chance to disperse, lessening PBL development suppression.



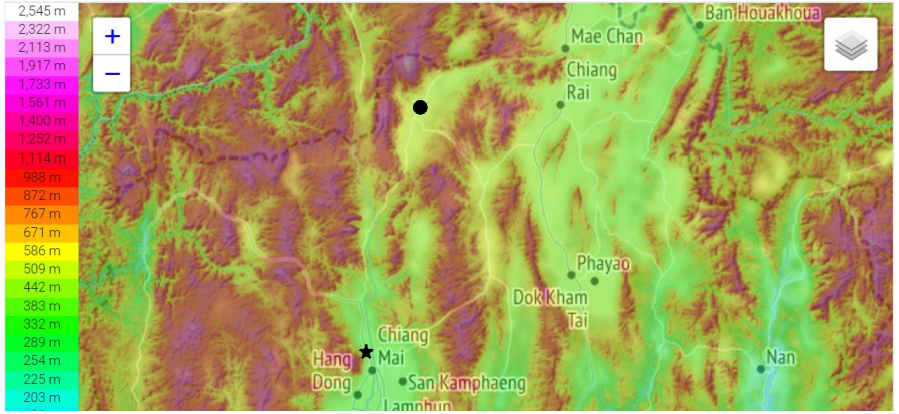


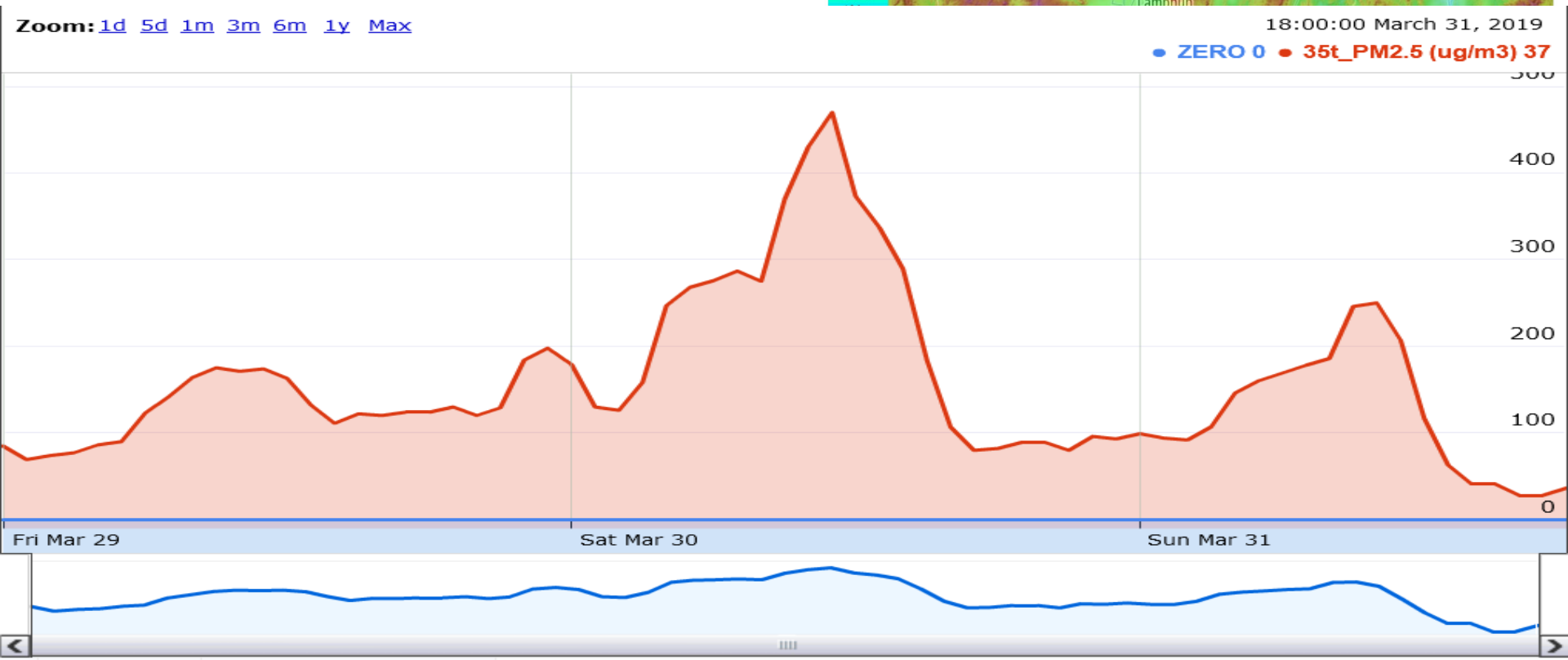
The Following Week:



Significant BrC or BC emissions during the nighttime, suppress PBL development the following day.

Data from the Pollution Control Department of Thailand (Chiang Mai City Hall)



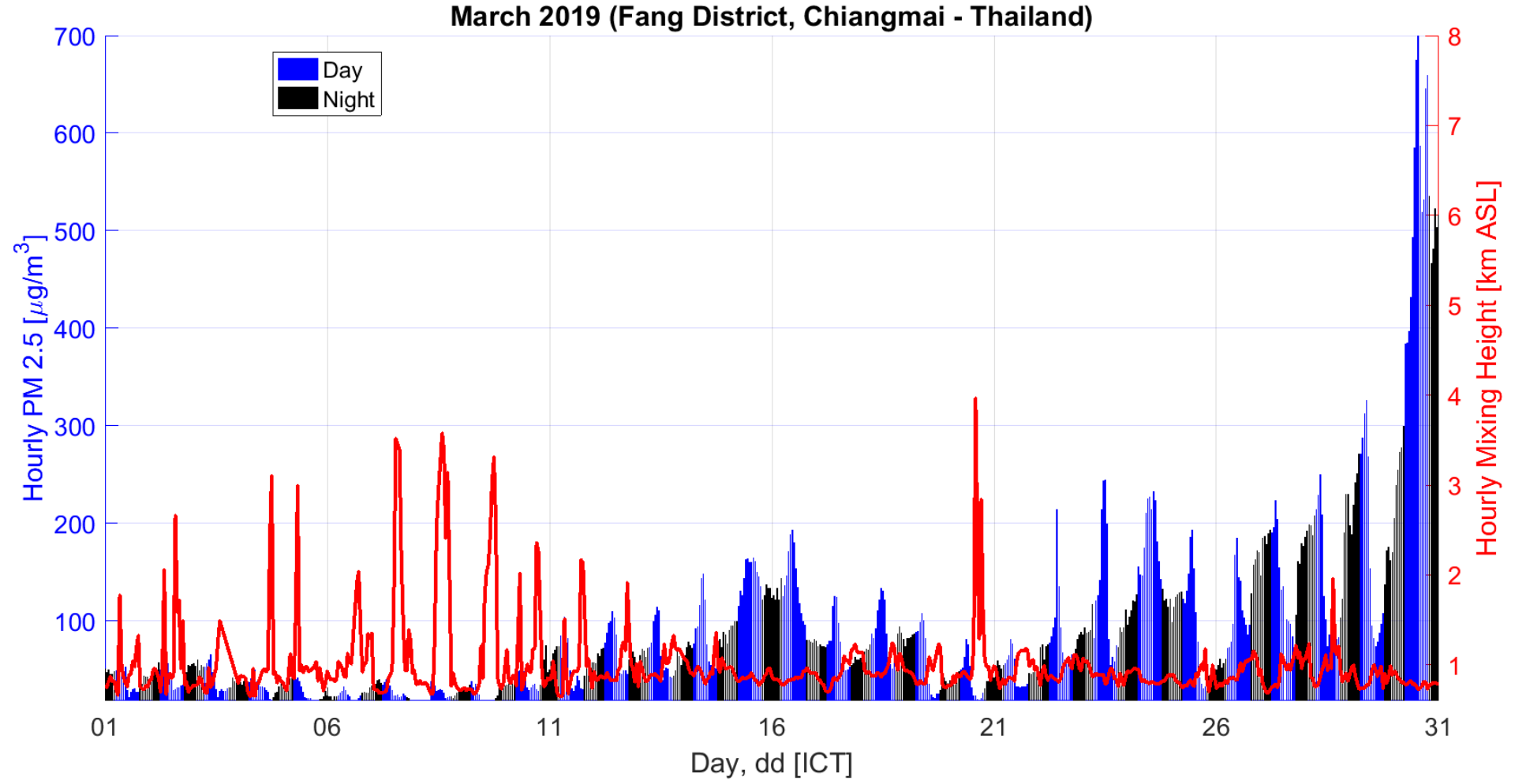


	Summary	35t_PM2.5 (ug/m3)
1	MAX	470
2	MIN	28
3	%	100
4	N	67
5	Average	157

For the whole month of March 2019:

Mixing Height Estimated from NARIT's Micropulse LiDAR

PM 2.5 Data from Chiang Mai University's Dust Boy



Summary and Next Steps

- **Black Carbon (BC) / Brown Carbon (BrC) emissions from fires especially on the slopes can affect PBL development the next day (producing HIGH and PERSISTENT air pollution) when IT'S A LOT and when its observed in a valley during NIGHTTIME**

- **Look at aerosol optical properties during episode days**

- **Perform a modeling experiment by removing BC in the model and see if PBL development is NOT suppressed**

ASIA-PACIFIC NETWORK FOR
GLOBAL CHANGE RESEARCH

CBA2018-01MY-Wanthongchai

Integrated Highland Wildfire, Smoke and Haze Management in the Upper Indochina Region

Thank You for Your Attention!

Light Detection and Ranging (LiDAR)

Principle, Components and Types of Atmospheric LiDAR Systems

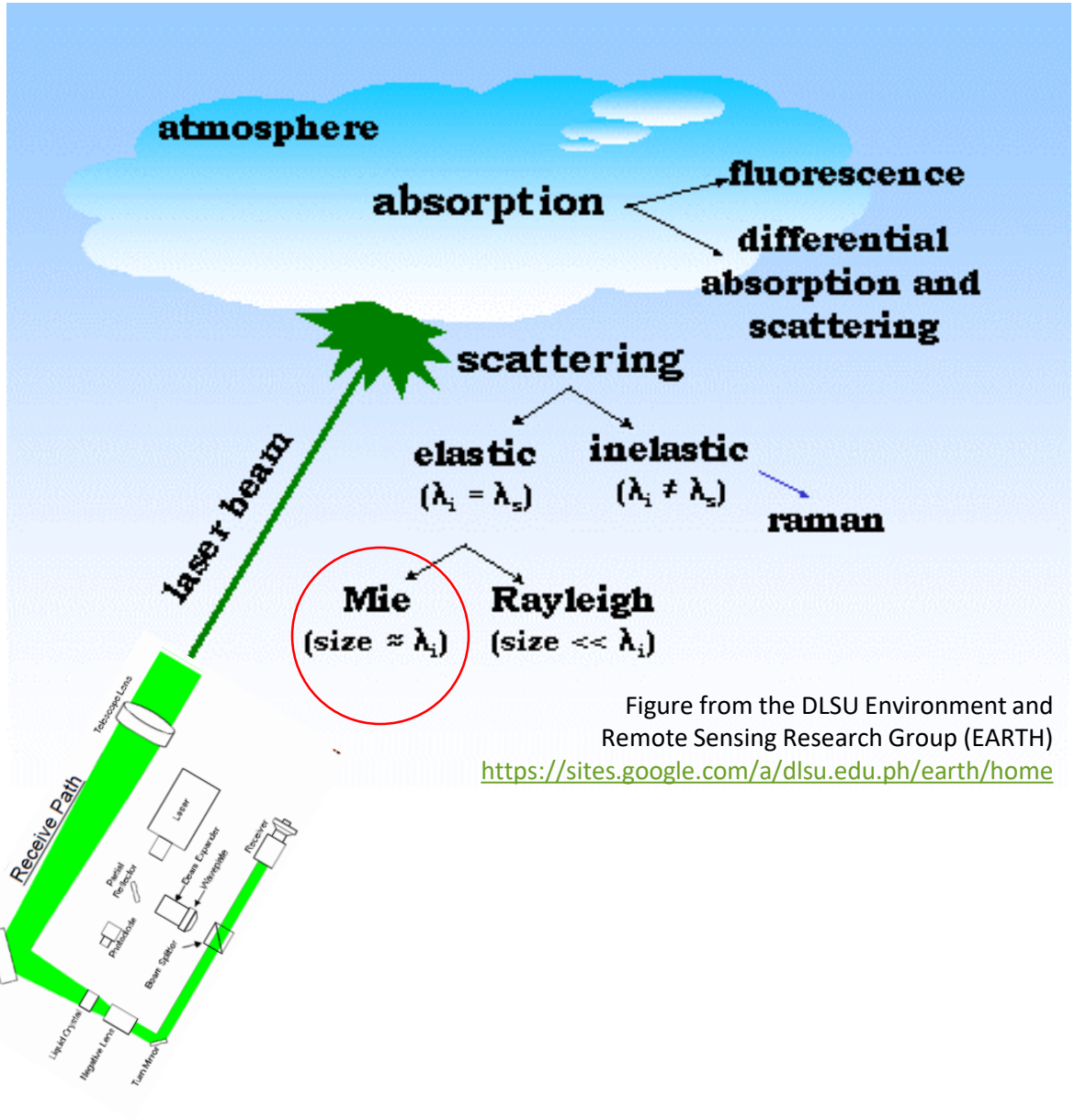
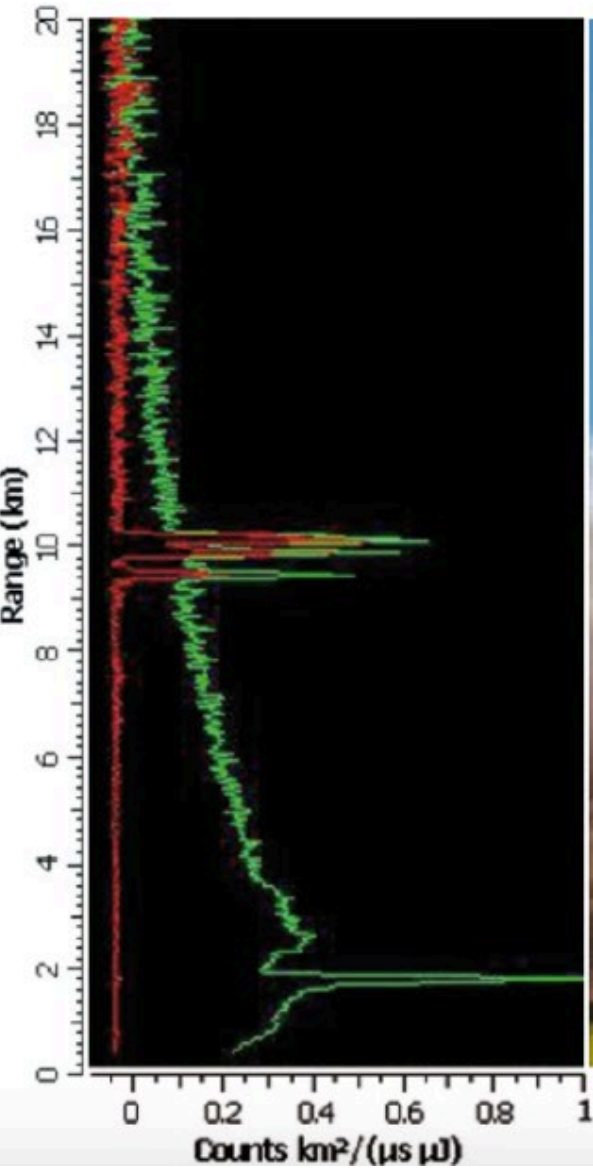
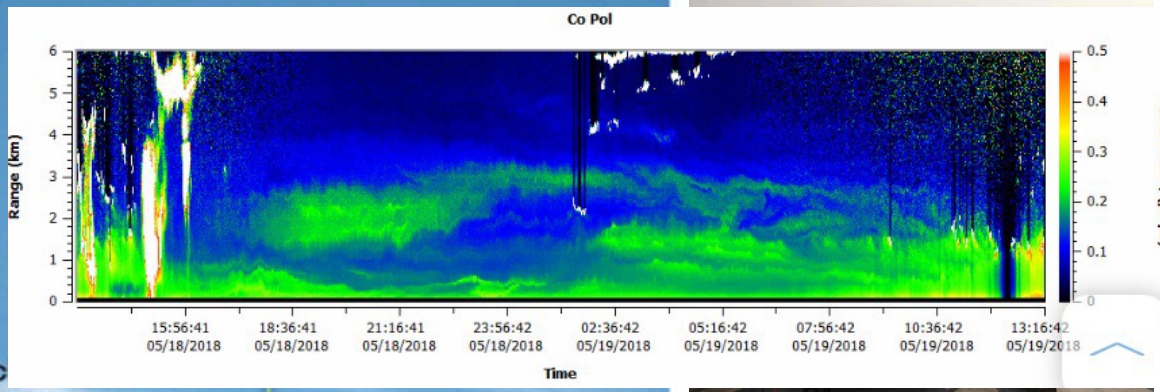
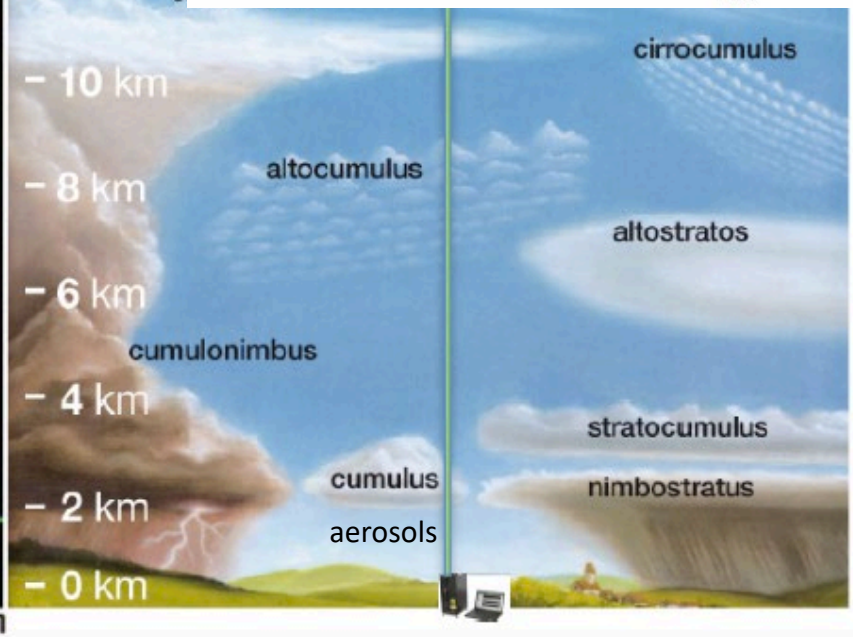


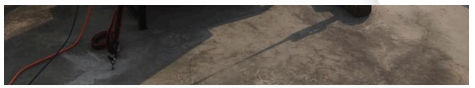
Figure from the DLSU Environment and Remote Sensing Research Group (EARTH)
https://sites.google.com/a/dlsu.edu.ph/earth/home

Normalized Relative Backscatter (NRB)



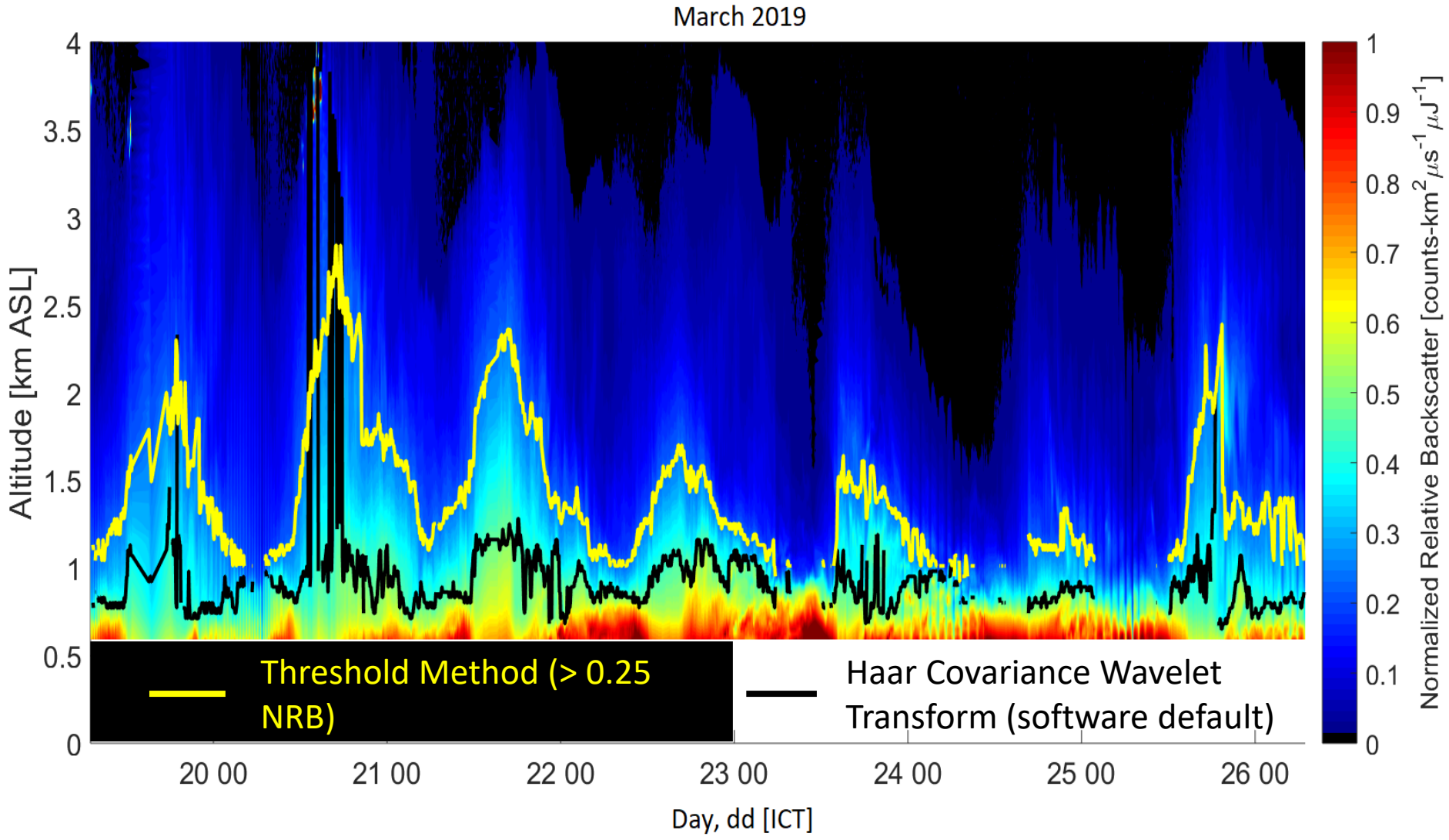






Solanki, Macatangay et al., in preparation

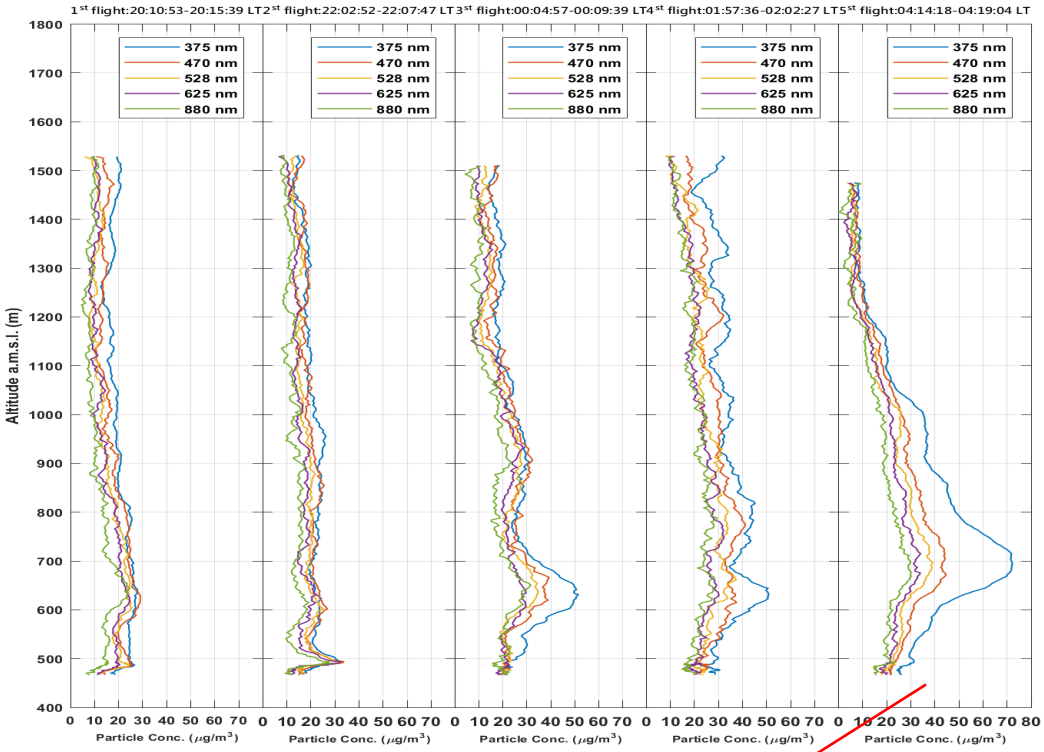
ML Top Height (Mixing Height) Estimation

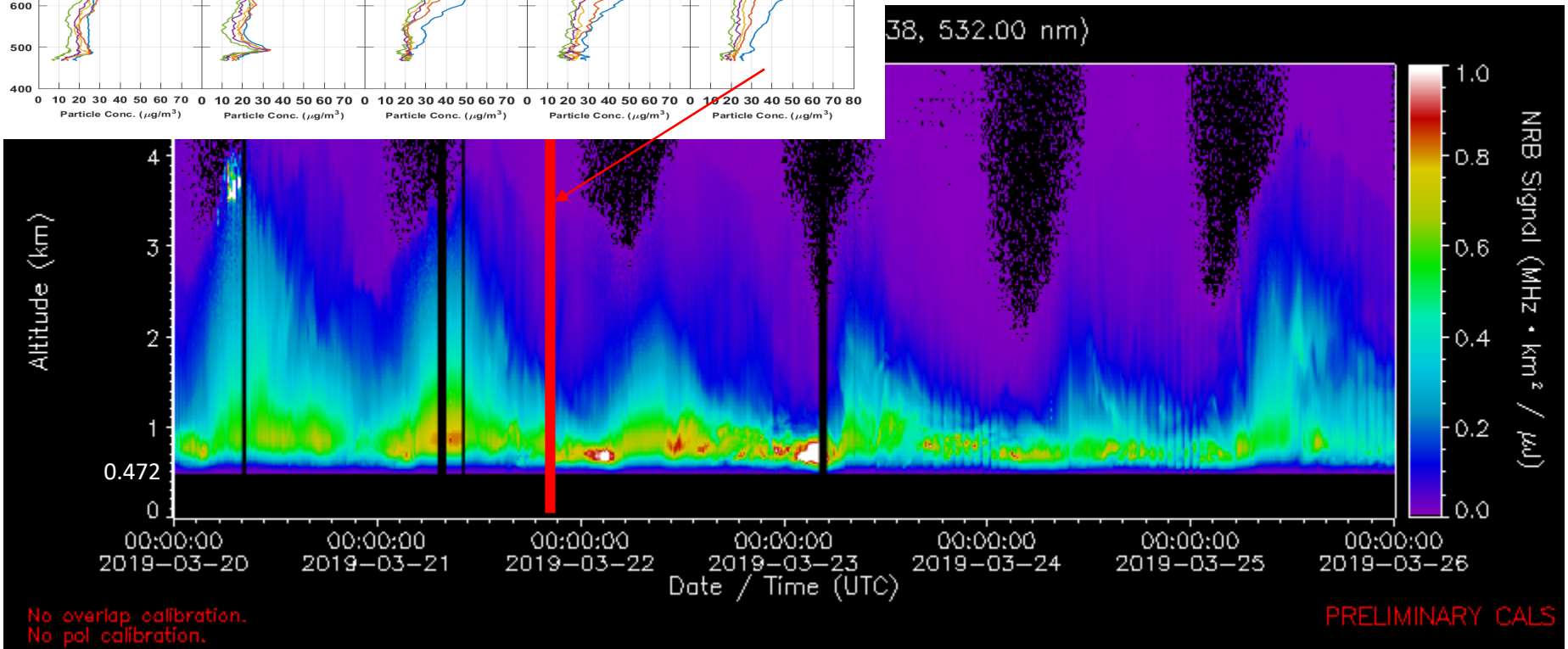


ofiling with Lidar and t" (Mar 10-30, 2019)

Jin Ke (NCU, Taiwan), Somporn Chantara, Nuttipon and) and See Chee Tsay (NASA GSFC, USA)

LT: March 22, 2019 (04:00)
UT: March 21, 2019 (21:00)

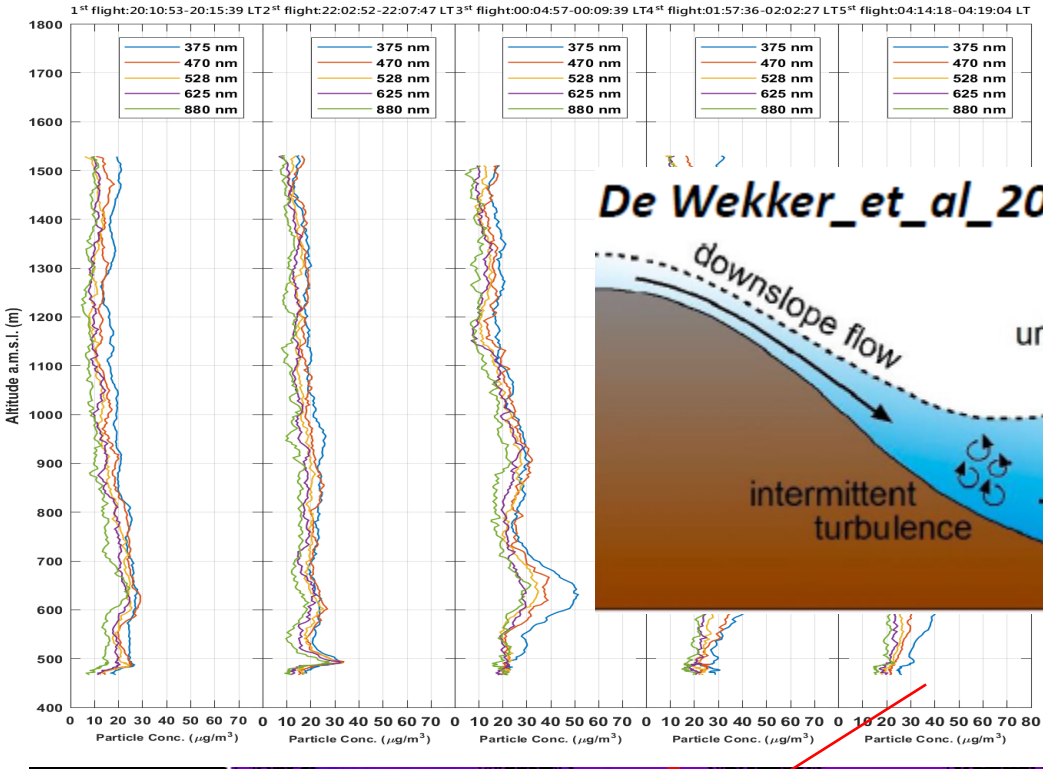


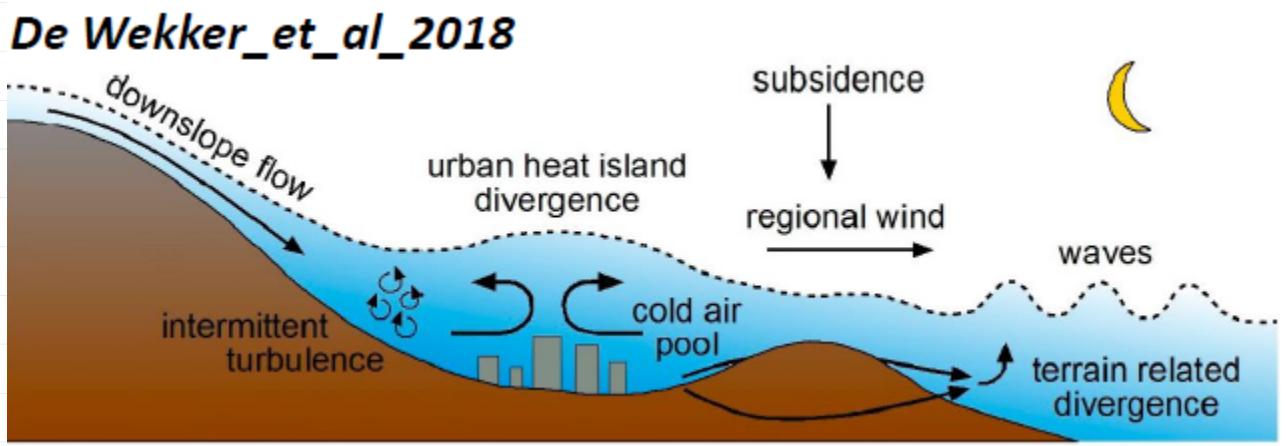


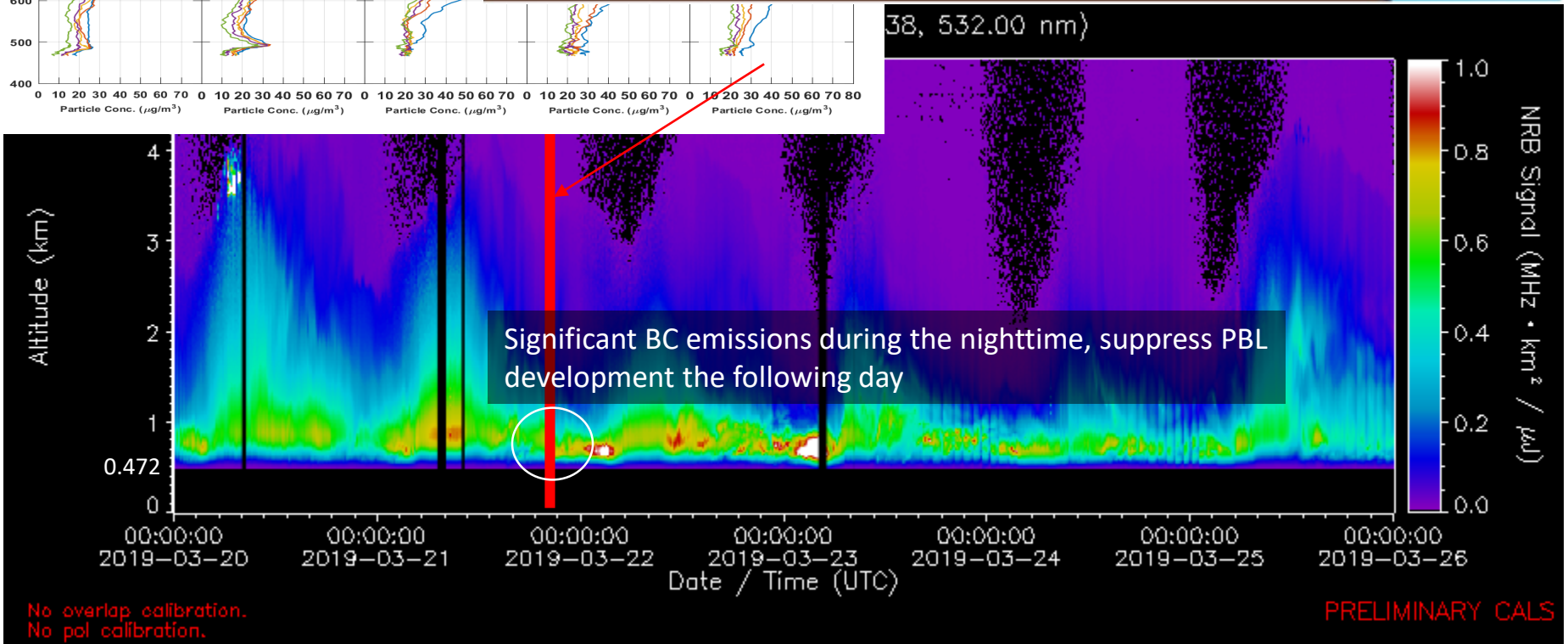
ofiling with Lidar and t" (Mar 10-30, 2019)

Jin Ke (NCU, Taiwan), Somporn Chantara, Nuttipon and) and See Chee Tsay (NASA GSFC, USA)

Flight Date: 2019/03/21-22 Takeoff location: Fang (19.909043°N, 99.207710°E)



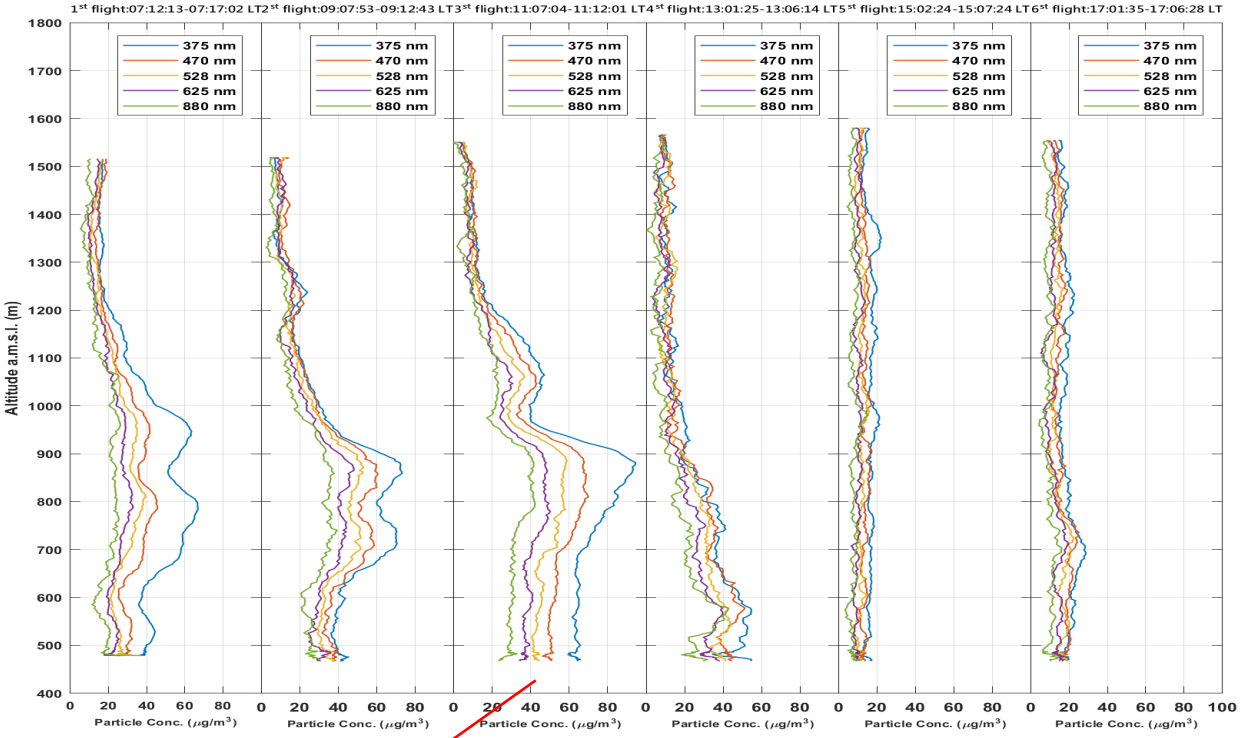


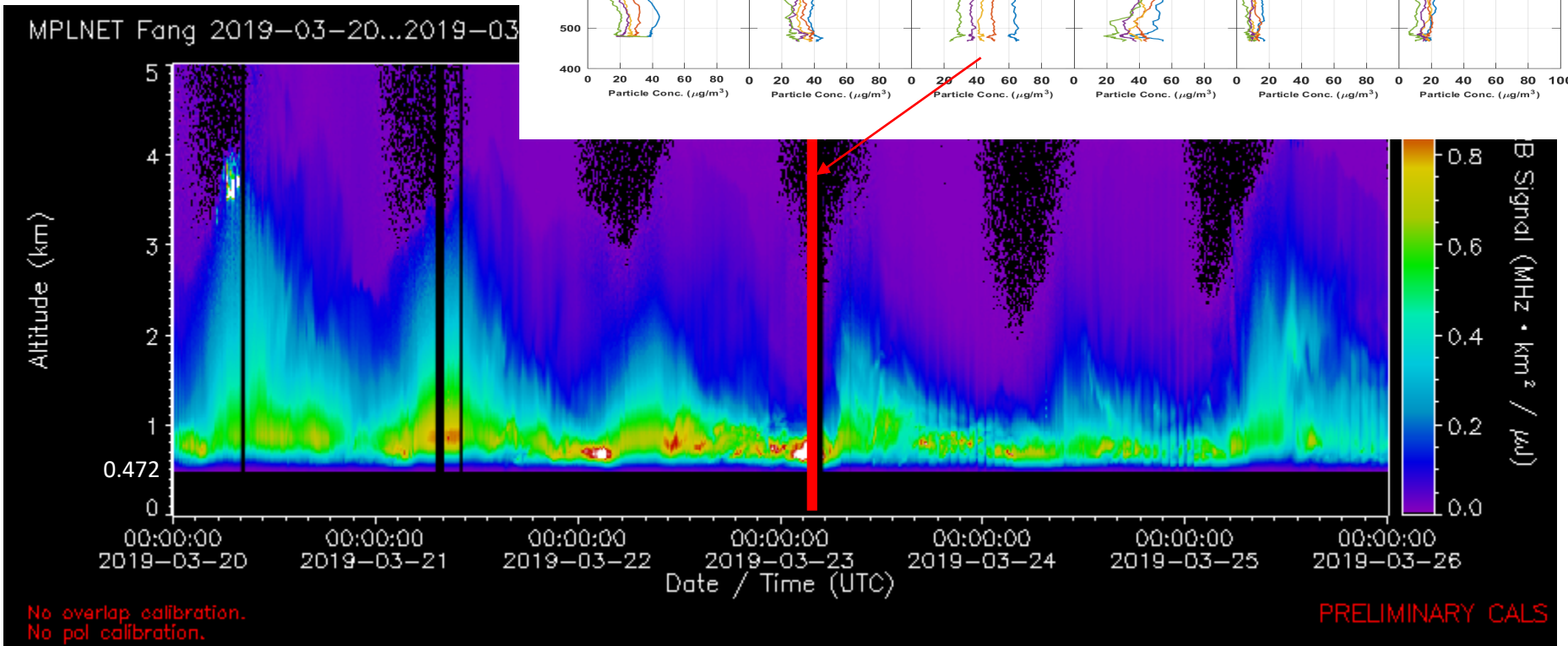


Full Campaign: I
Uav Multi-scal

Fang, Chiangmai in cooperation with Ca
Yabueng, Duangduean Thepnuan,

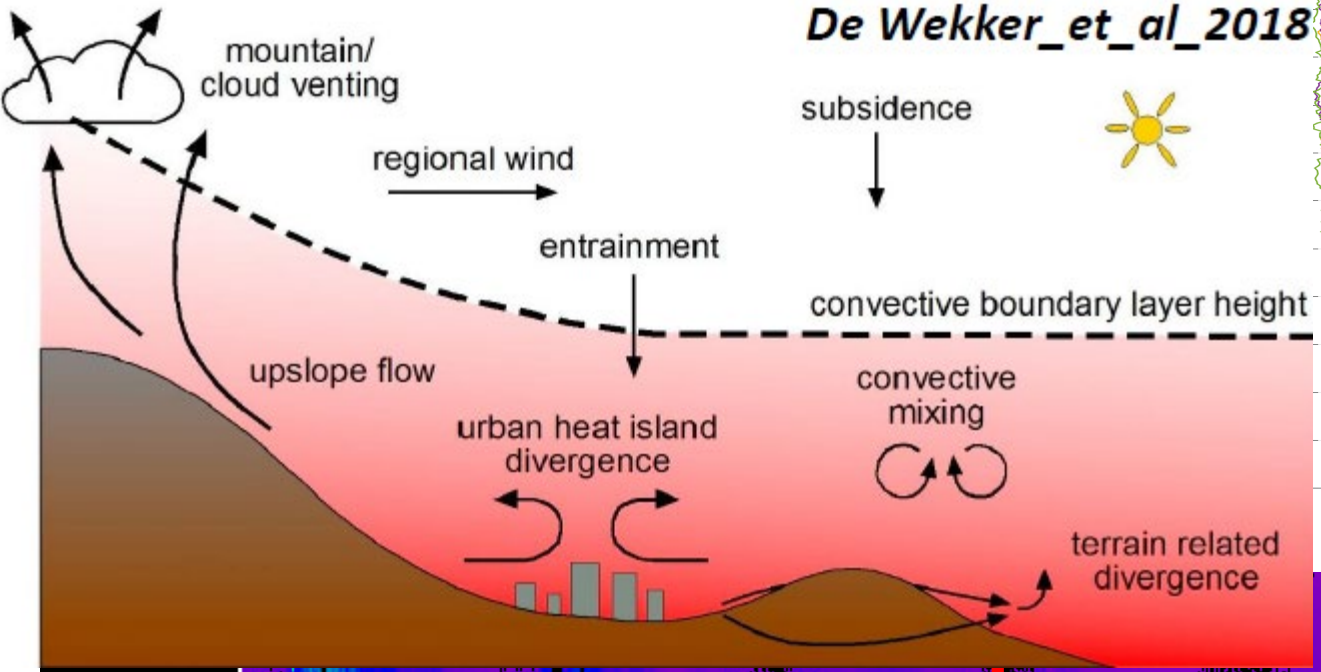
LT: March 23, 2019 (11:00)
UT: March 23, 2019 (04:00)

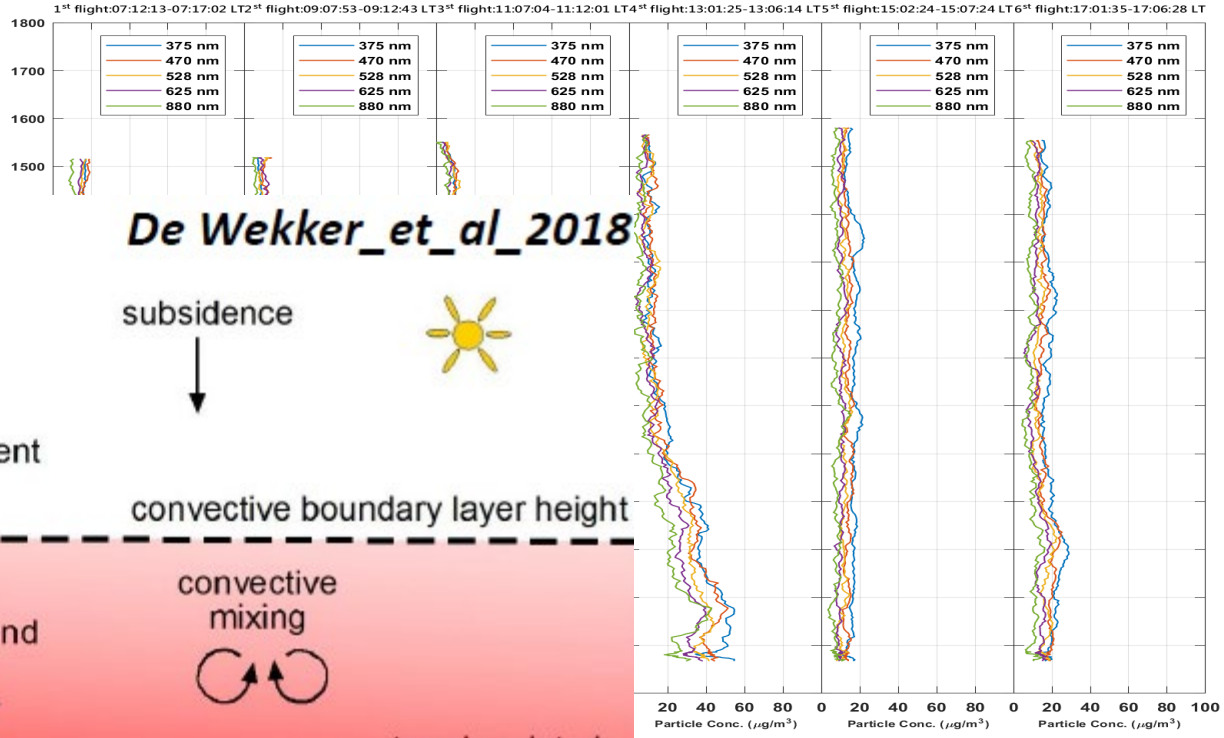


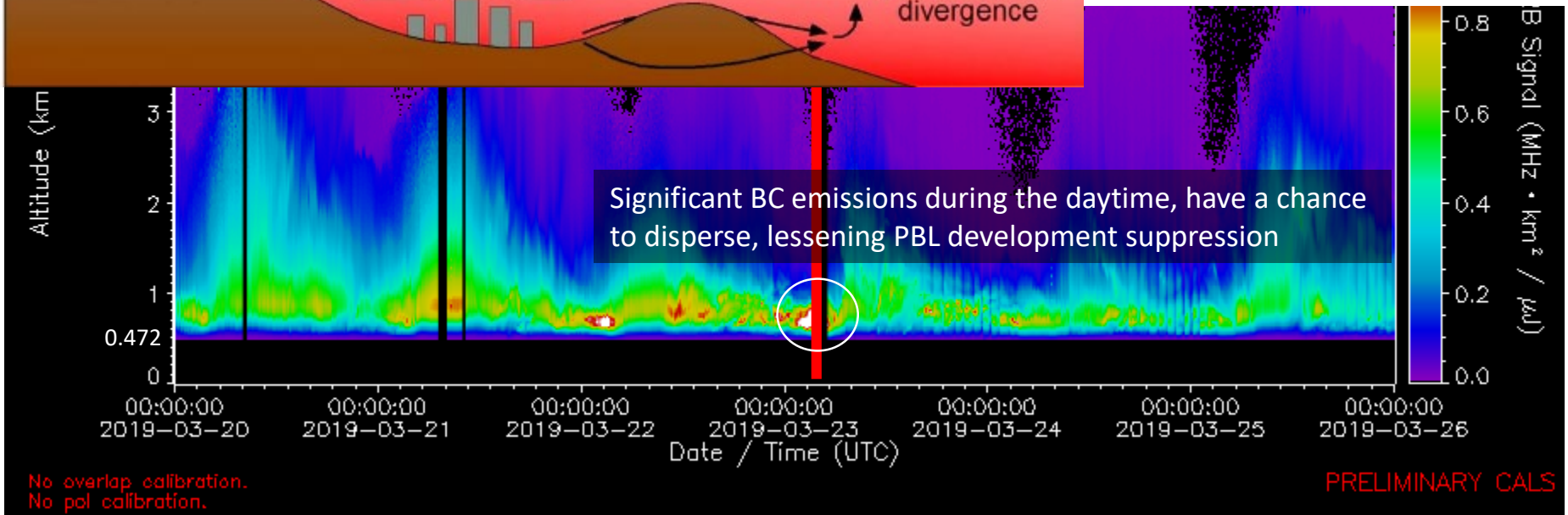


Full Campaign: I
Uav Multi-scal

Fang, Chiangmai in cooperation with Ca
Yabueng, Duangduean Thepnuan,





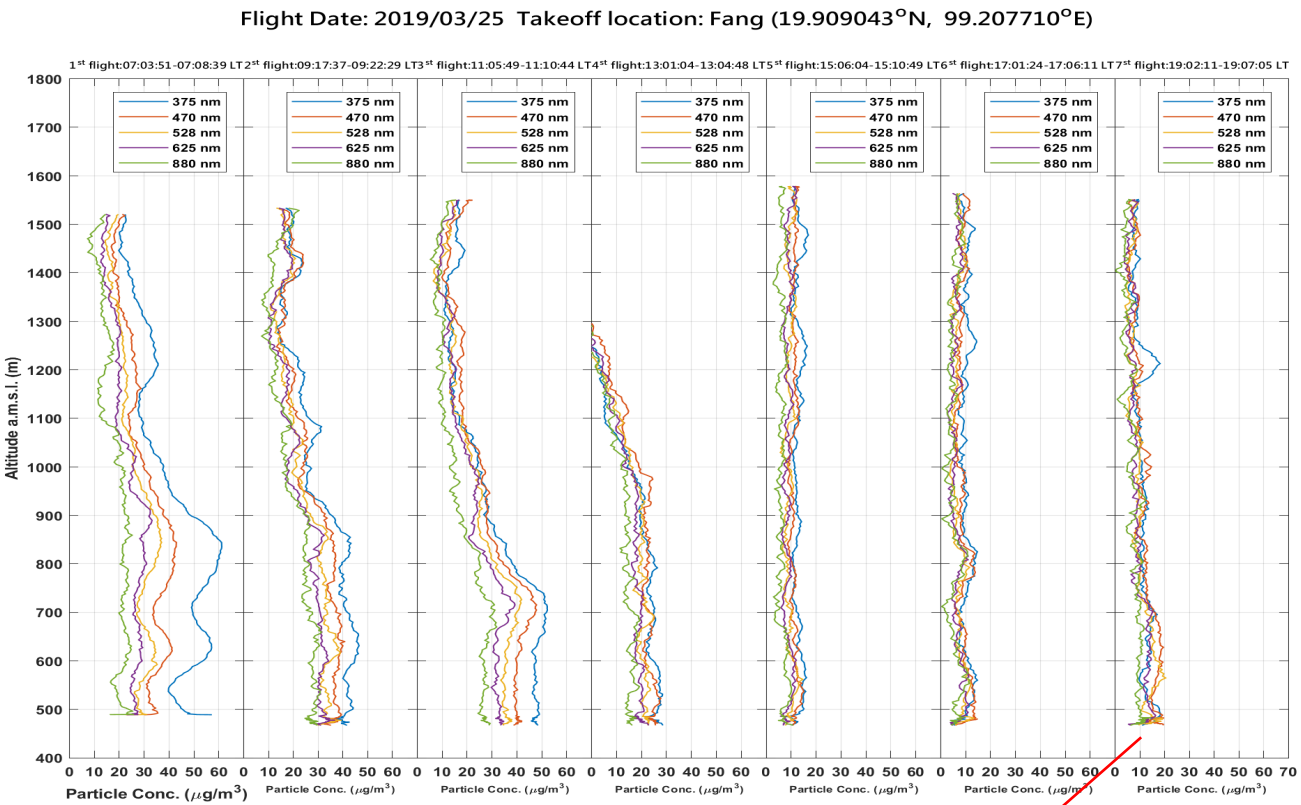


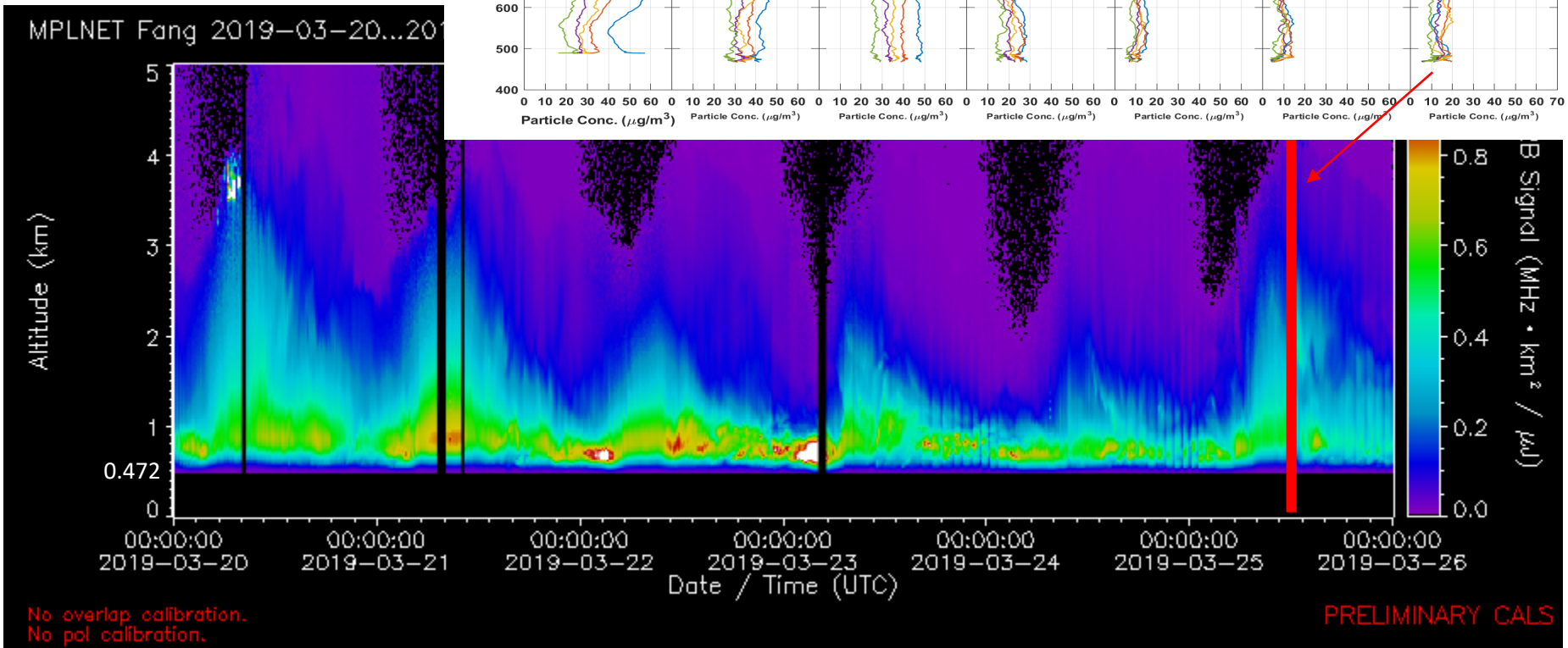
Significant BC emissions during the daytime, have a chance to disperse, lessening PBL development suppression

Full Campaig
Uav Multi-sc

Fang, Chiangmai in cooperation w
Yabueng, Duangduean Thepr

LT: March 25, 2019 (19:00)
UT: March 25, 2019 (12:00)

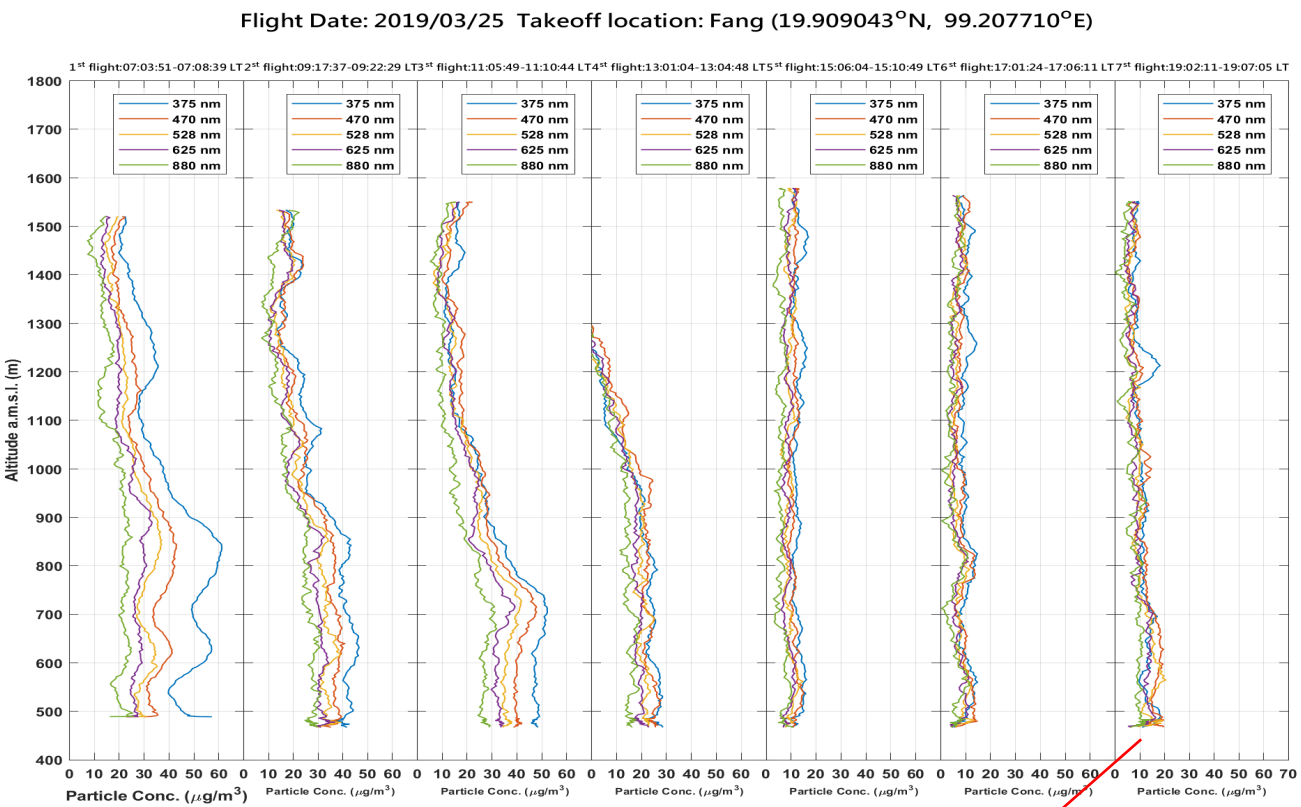


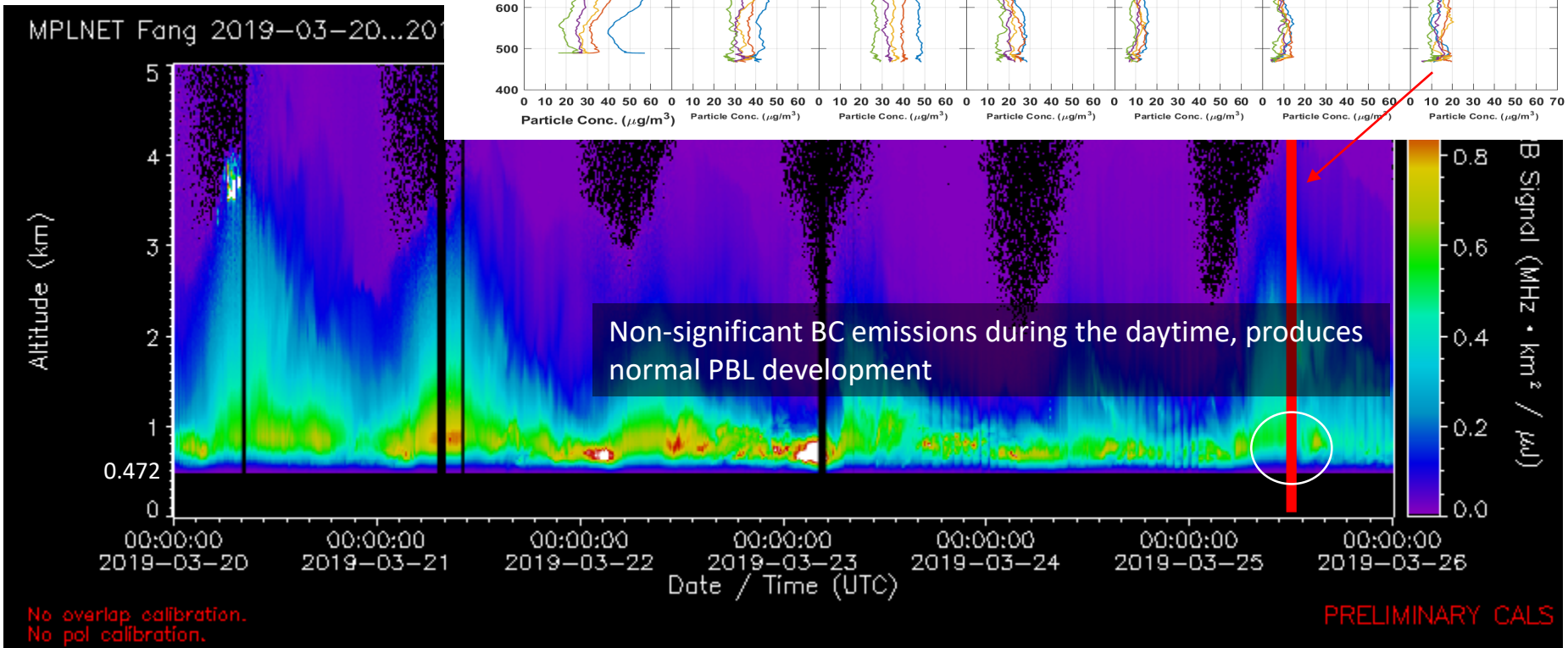


Full Campaig
Uav Multi-sc

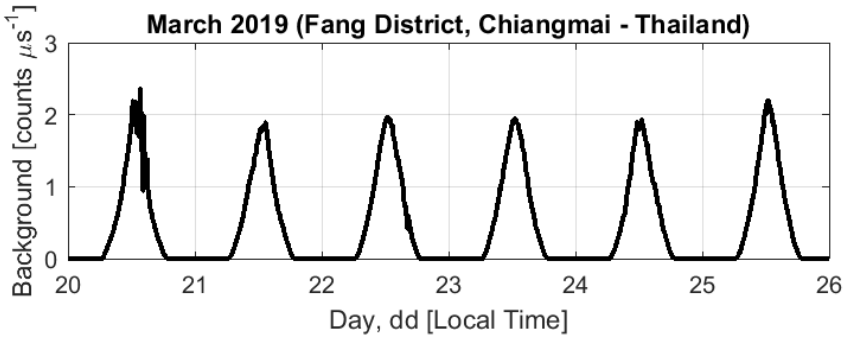
Fang, Chiangmai in cooperation w
Yabueng, Duangduean Thepr

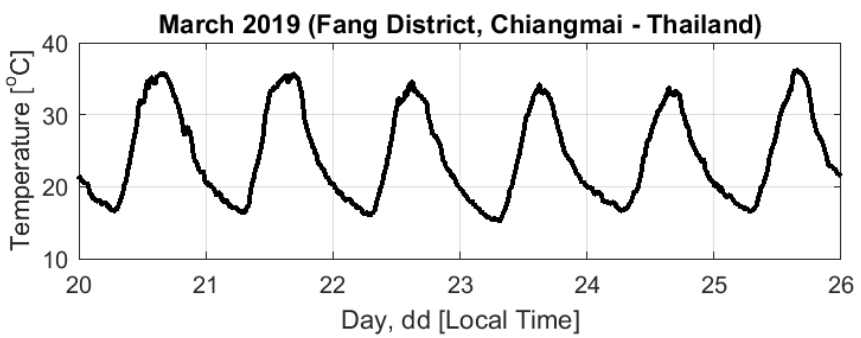
LT: March 25, 2019 (19:00)
UT: March 25, 2019 (12:00)

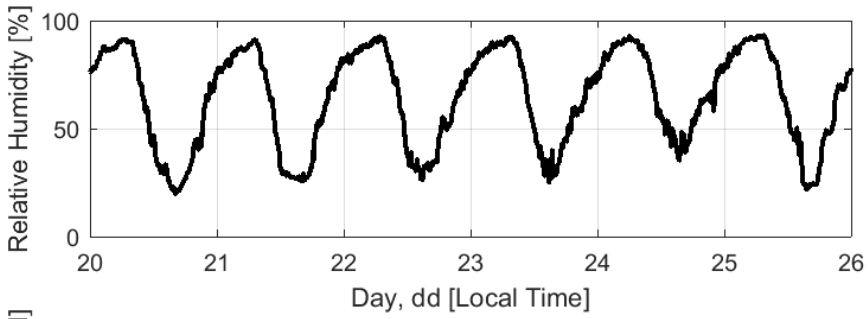


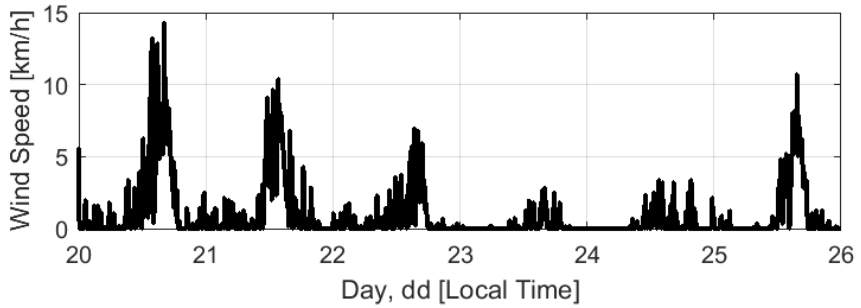


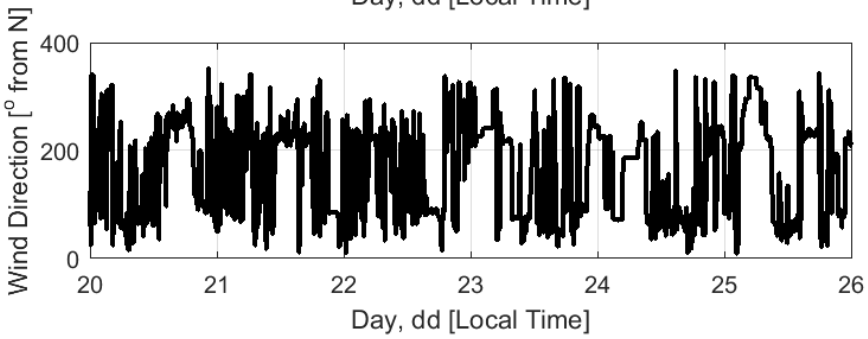
Synoptic Conditions from March 20 – 25, 2019

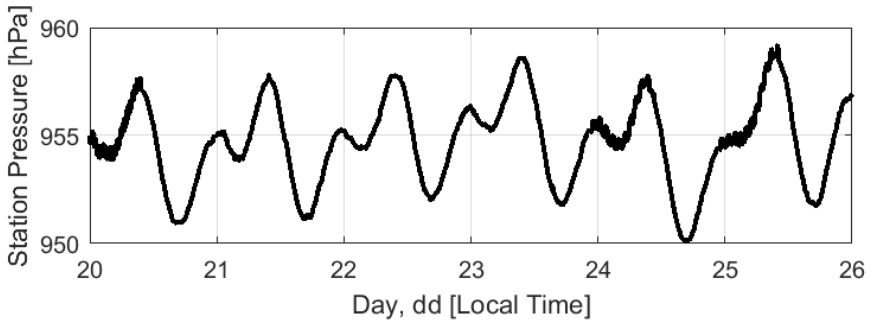


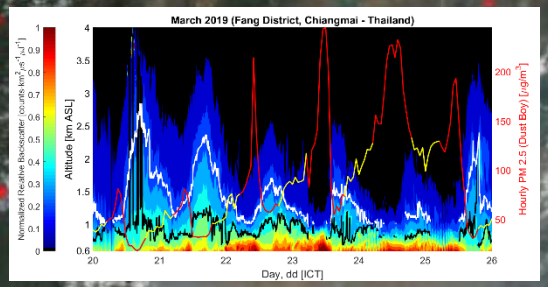












Lashio
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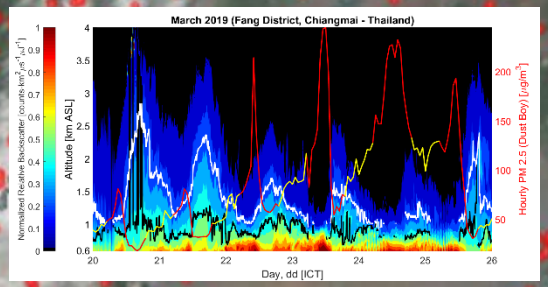
Dawei
Bangkok

March 20, 2019



Lashio
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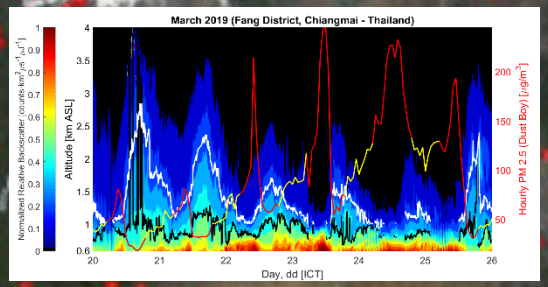
Phitsanulok
Khon Kaen
THAILAND
Dawei
Bangkok

March 21, 2019



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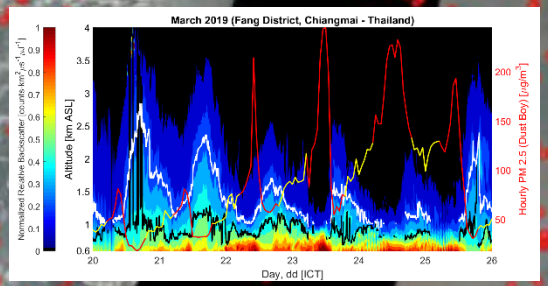
Ubon Ratchat
Dawei
Bangkok

March 22, 2019



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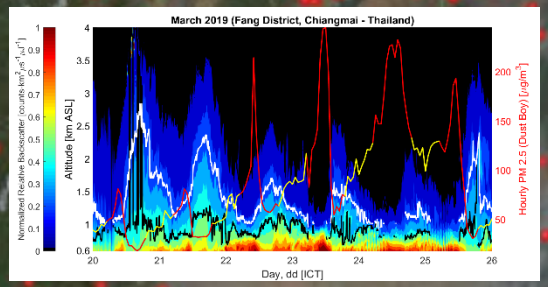
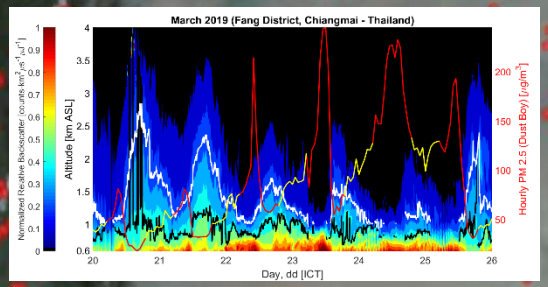
Khon Kaen
THAILAND
Dawei
Bangkok

March 23, 2019



March 24, 2019



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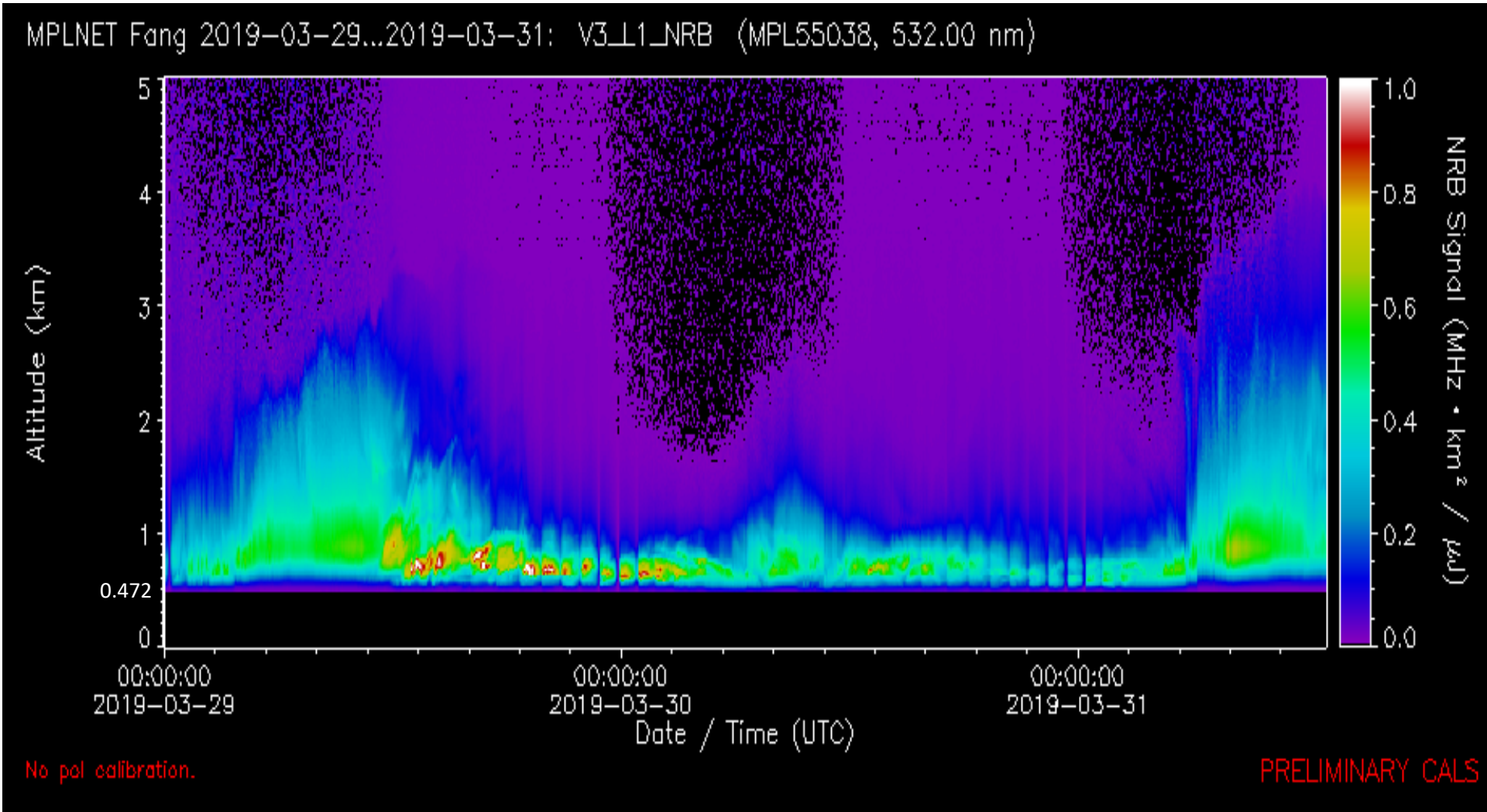
Khon Kaen
THAILAND
Dawei
Bangkok

March 25, 2019

Full Campaign: PLUME = “Profiling with Lidar and Uav Multi-scale Experiment” (Mar 10-30, 2019)

Fang, Chiangmai in cooperation with Carlo Wang, Ying-Jen Wu, Li-Jin Ke (NCU, Taiwan), Somporn Chantara, Nuttipon Yabueng, Duangduean Thepnuan, Wan Wiriya (ESRC CMU, Thailand) and See Chee Tsay (NASA GSFC, USA)

The Following Week: Aerosol-PBL Interactions



Full Campaign: PLUME = “Profiling with Lidar and Uav Multi-scale Experiment” (Mar 10-30, 2019)

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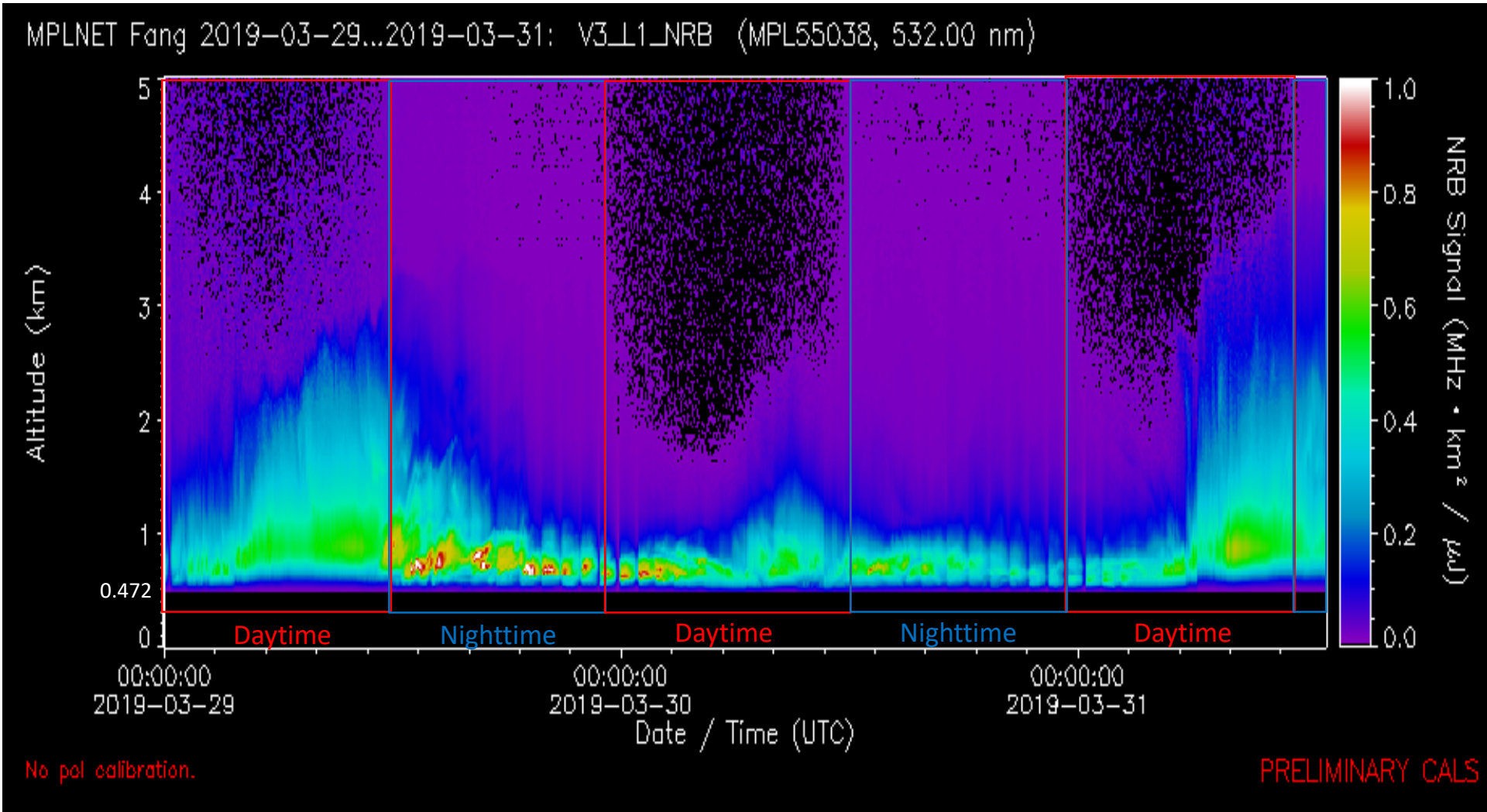
The Following Week: Aerosol-PBL Interactions



Full Campaign: PLUME = “Profiling with Lidar and Uav Multi-scale Experiment” (Mar 10-30, 2019)

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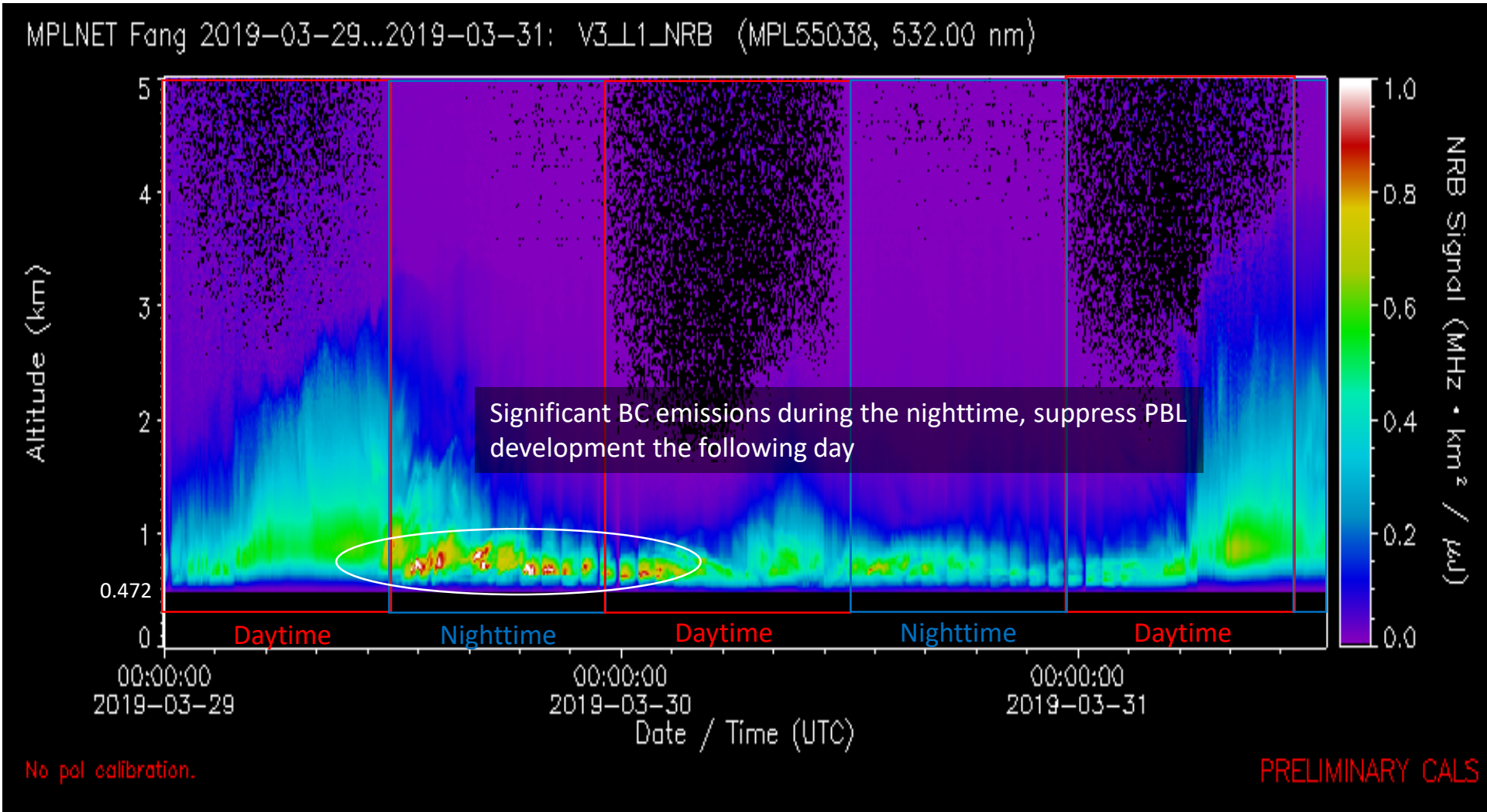
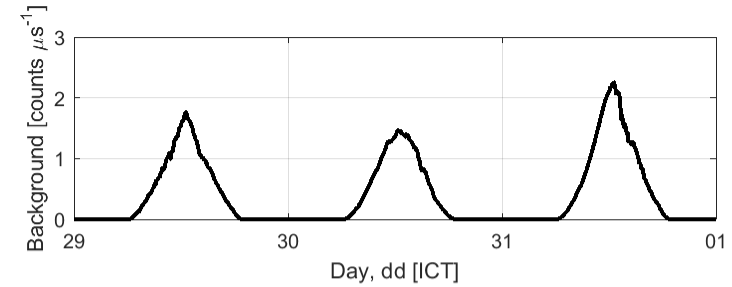
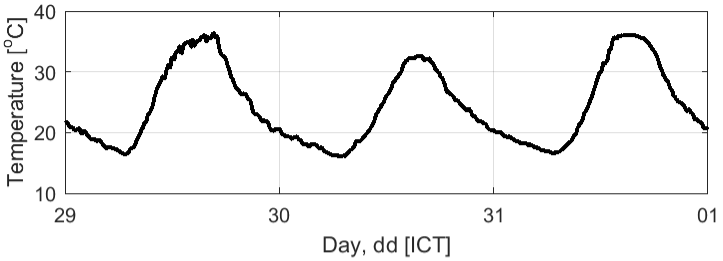
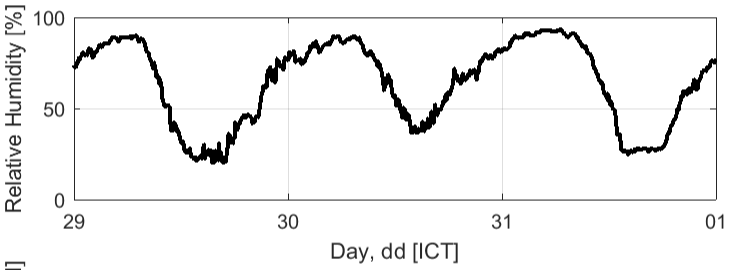
The Following Week: Aerosol-PBL Interactions

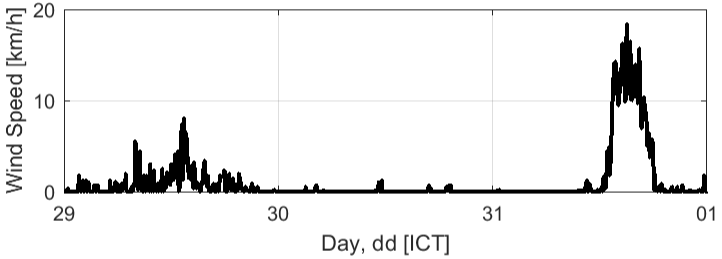


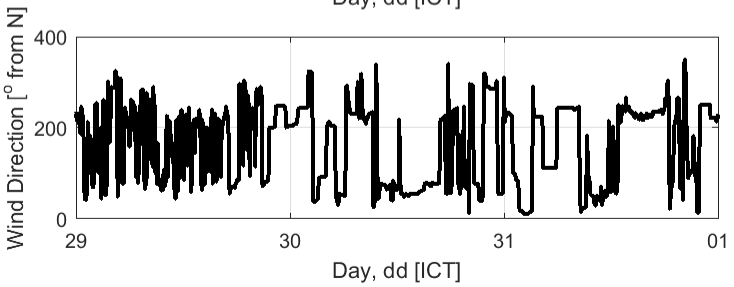
Synoptic Conditions from March 29 – 31, 2019

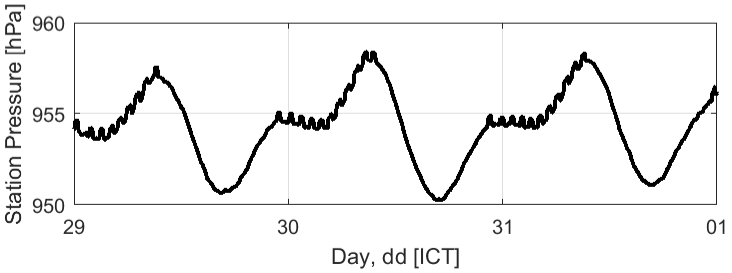


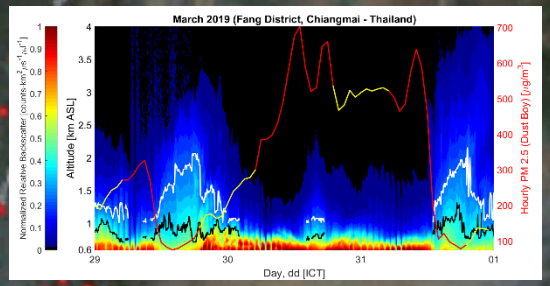












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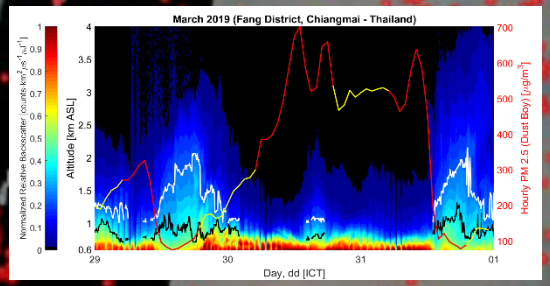
Khon Kaen
THAILAND
Dawei
Bangkok

March 29, 2019



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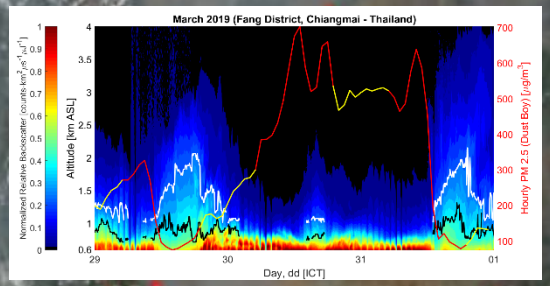
March 30, 2019



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March 31, 2019