# Atmospheric Research Activities

"You can't manage what you can't measure."
- Peter Druker

**Ronald Macatangay**

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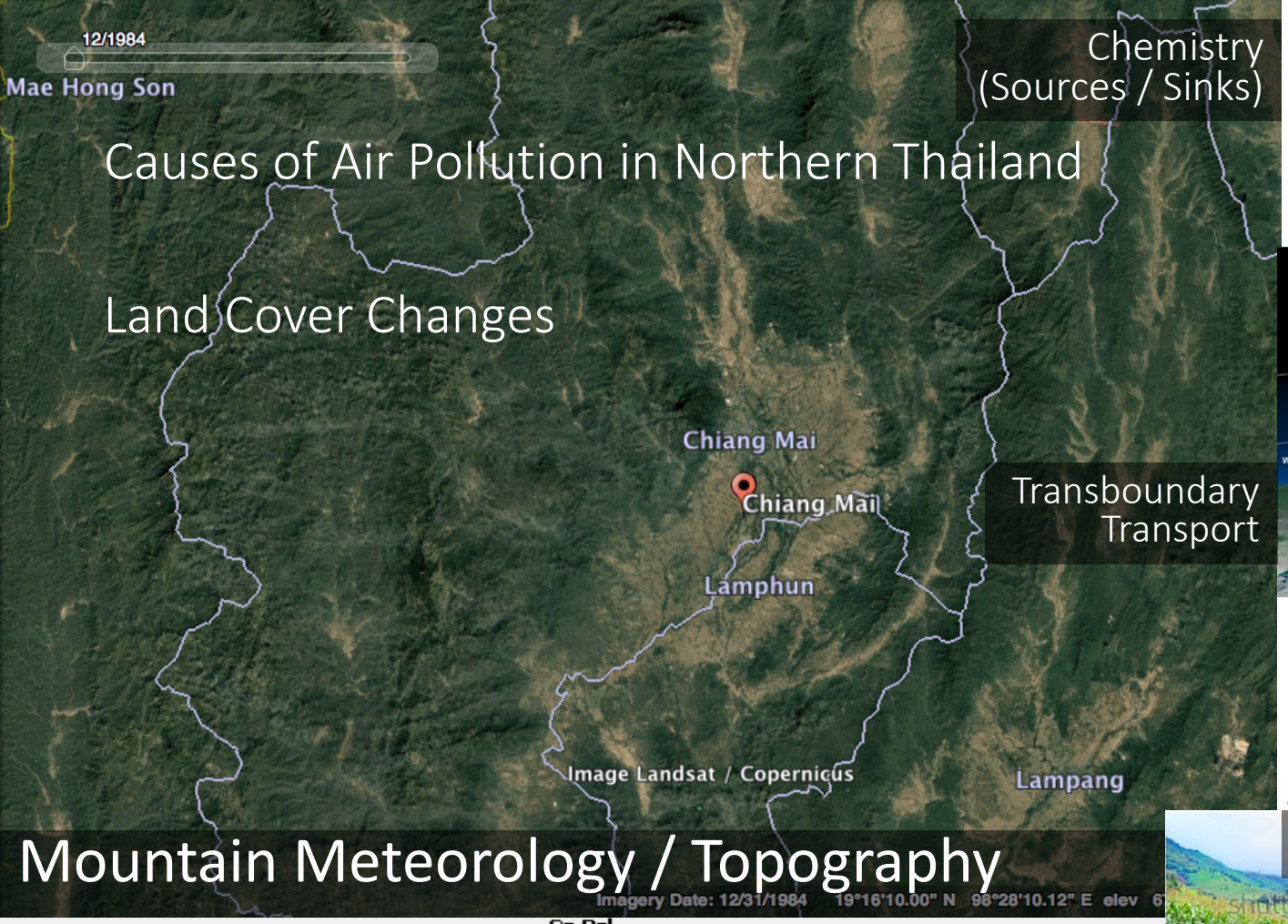
Raman Solanki, Thiranan Sonkaew, Voltaire Velazco, Gerry Bagtasa, Mylene Cayetano, John Burrows, Lola Andres Hernandez, Frank Probst, Hans Schlager, Marc Krebsbach, Ralf Koppmann, Robert Baumann, Sherin Hassan Bran, Kanoksri Sarinnapakorn, Kasemsan Manomaiphiboon, Vichawan Sakulsipich, Paul Griffiths, Vanisa Surapipith, Carlo Wang, Somporn Chantara, Titaporn Supasri and Serm Janjai

# Consistent and year-long mixing layer height measurements with LiDAR in the mountain valley of Chiang Mai

# HALO-EMeRGe Asian Aircraft Measurement Campaign

# WRF-Chem Aerosol Radiative Properties Sensitivity to Land Cover / Land Use Terrestrial Datasets

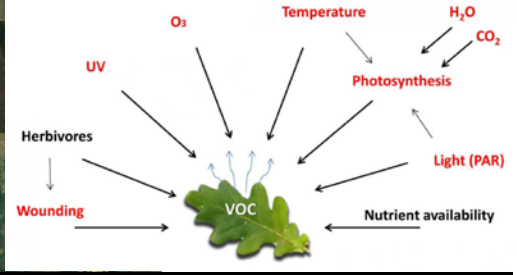
# Causes of Air Pollution in Northern Thailand



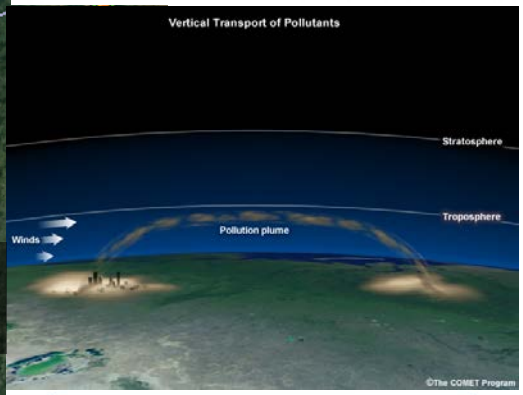

Land Cover Changes

Mountain Meteorology / Topography

Chemistry (Sources / Sinks)



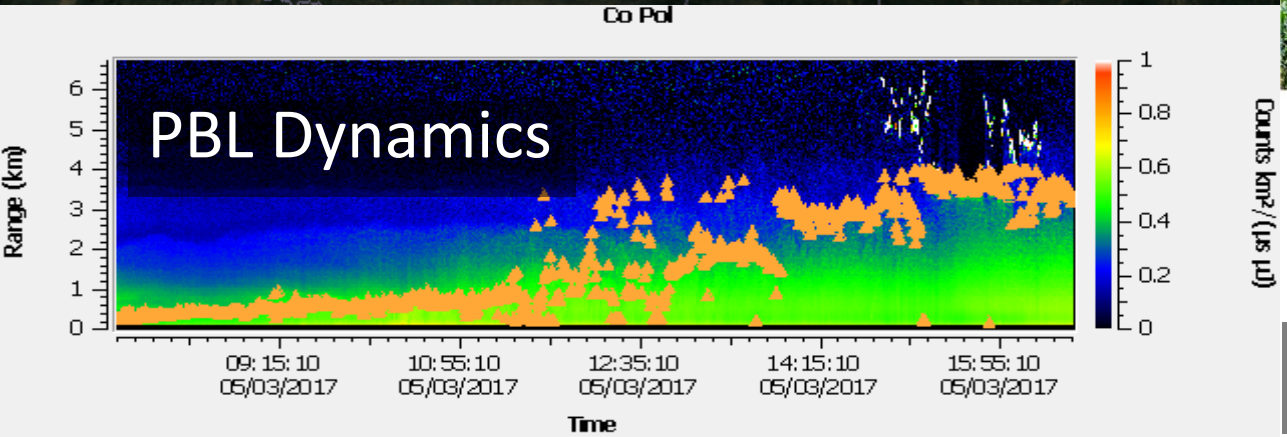

Transboundary Transport



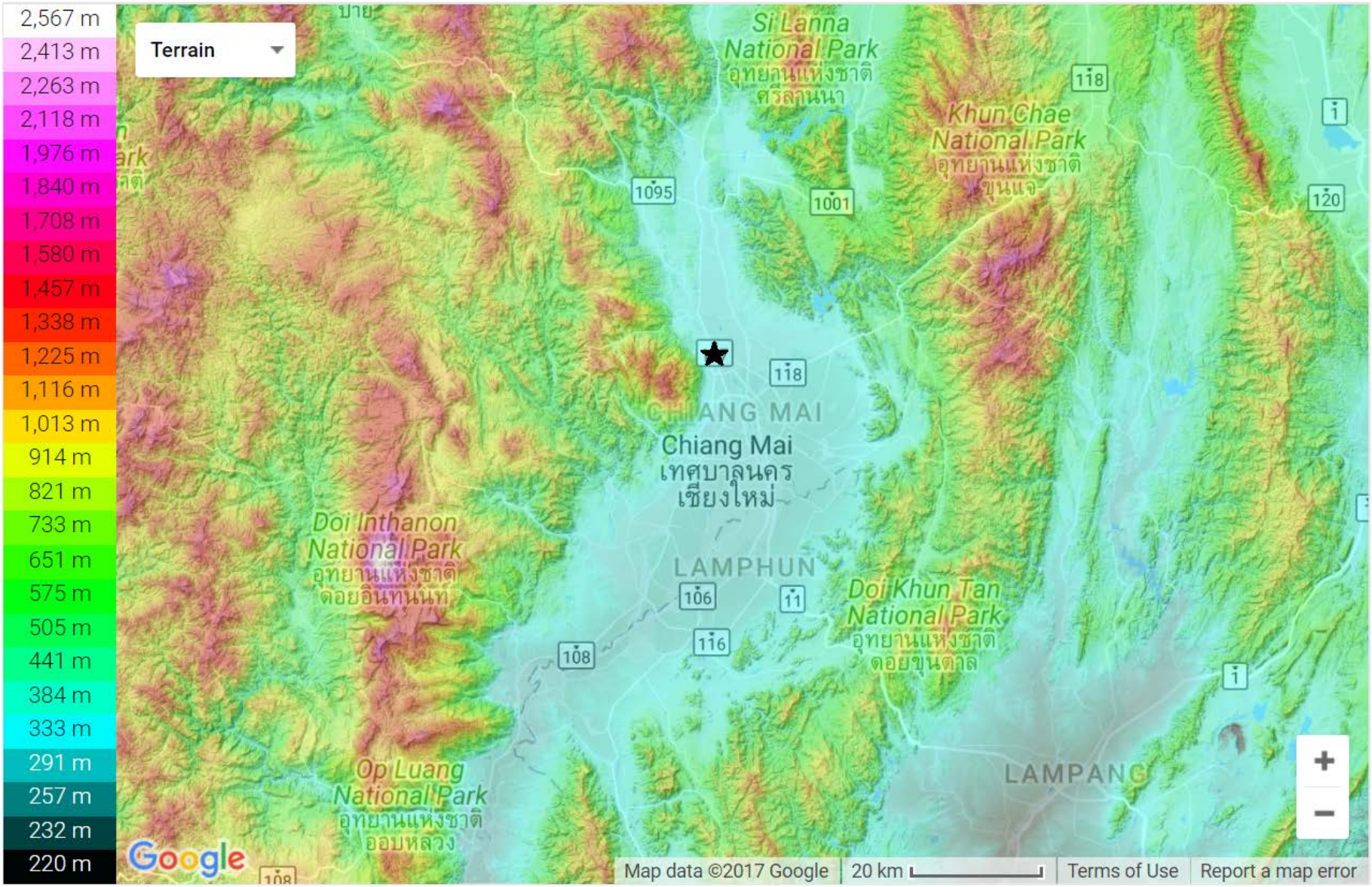
Land Use Changes

Proliferation of Commercial Contract Farming

Agricultural residue burning and forest fires



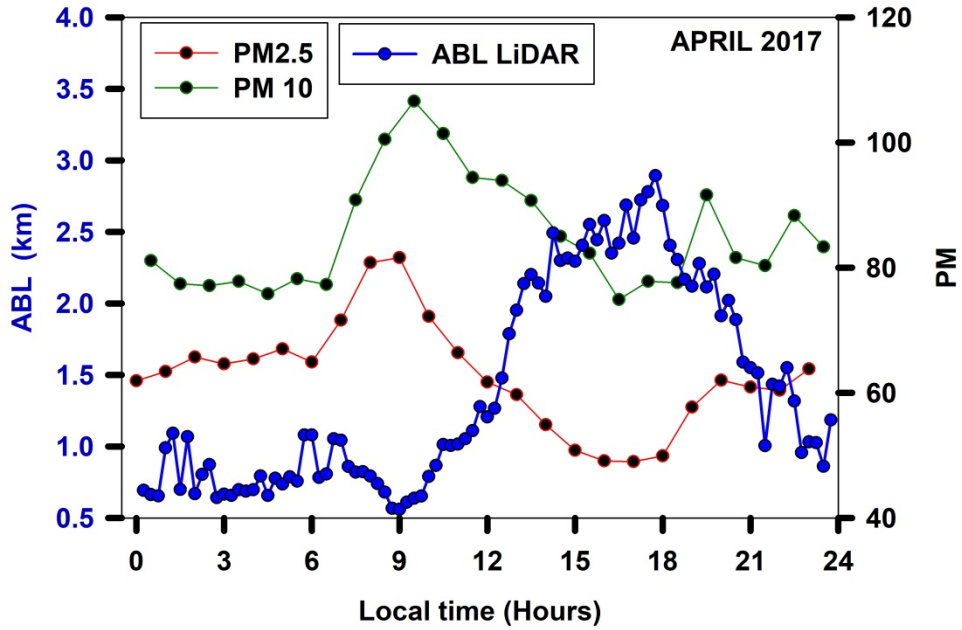
# Mini-Micropulse LiDAR ("Phoon" = "Dust") at NARIT, Chiang Mai, Thailand

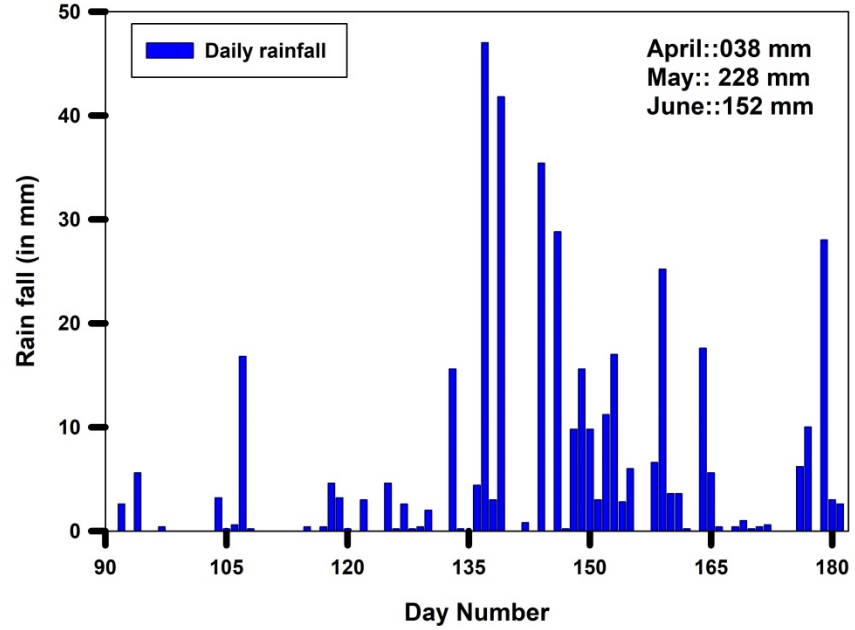


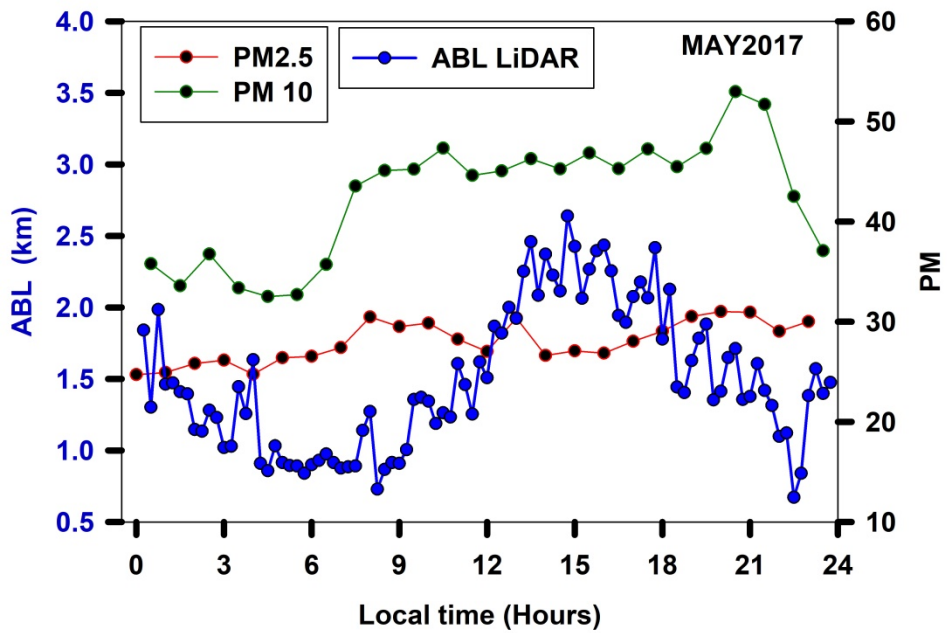
# Specification of mini MPL at NARIT

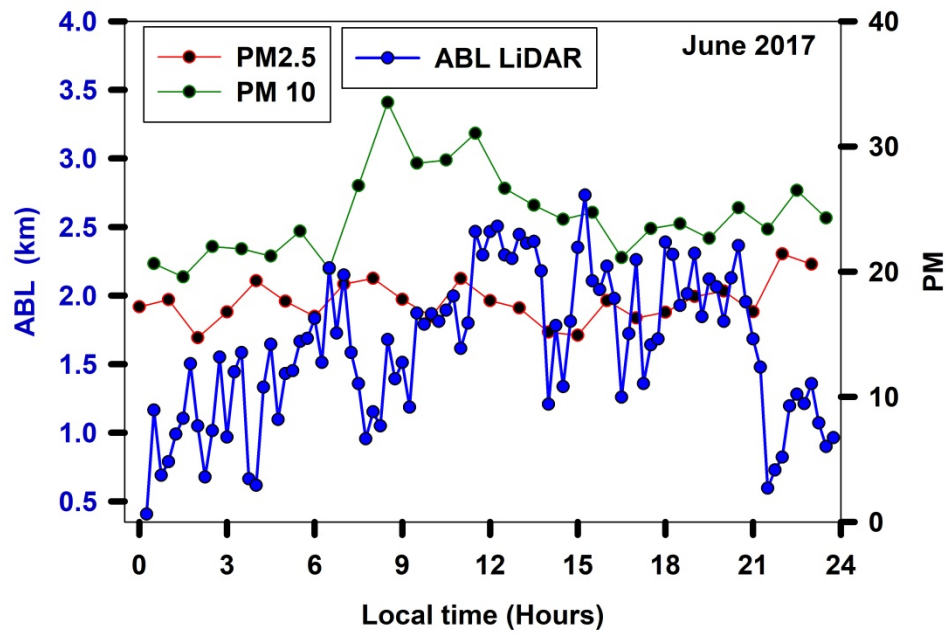
| Transmitter : Laser | Nd: YAG |
|---|---|
| Wavelength | 532 nm |
| Pulse energy | 3.5 μJ |
| PRF | 2500 Hz |
| Pulse width | 10 ns |

| Receiver : Telescope | Galilean |
|---|---|
| FOV | 220 μrad |
| Diameter | 80 mm |


APRIL 2017
PM2.5
PM 10
ABL LiDAR
ABL (km)
PM
Local time (Hours)

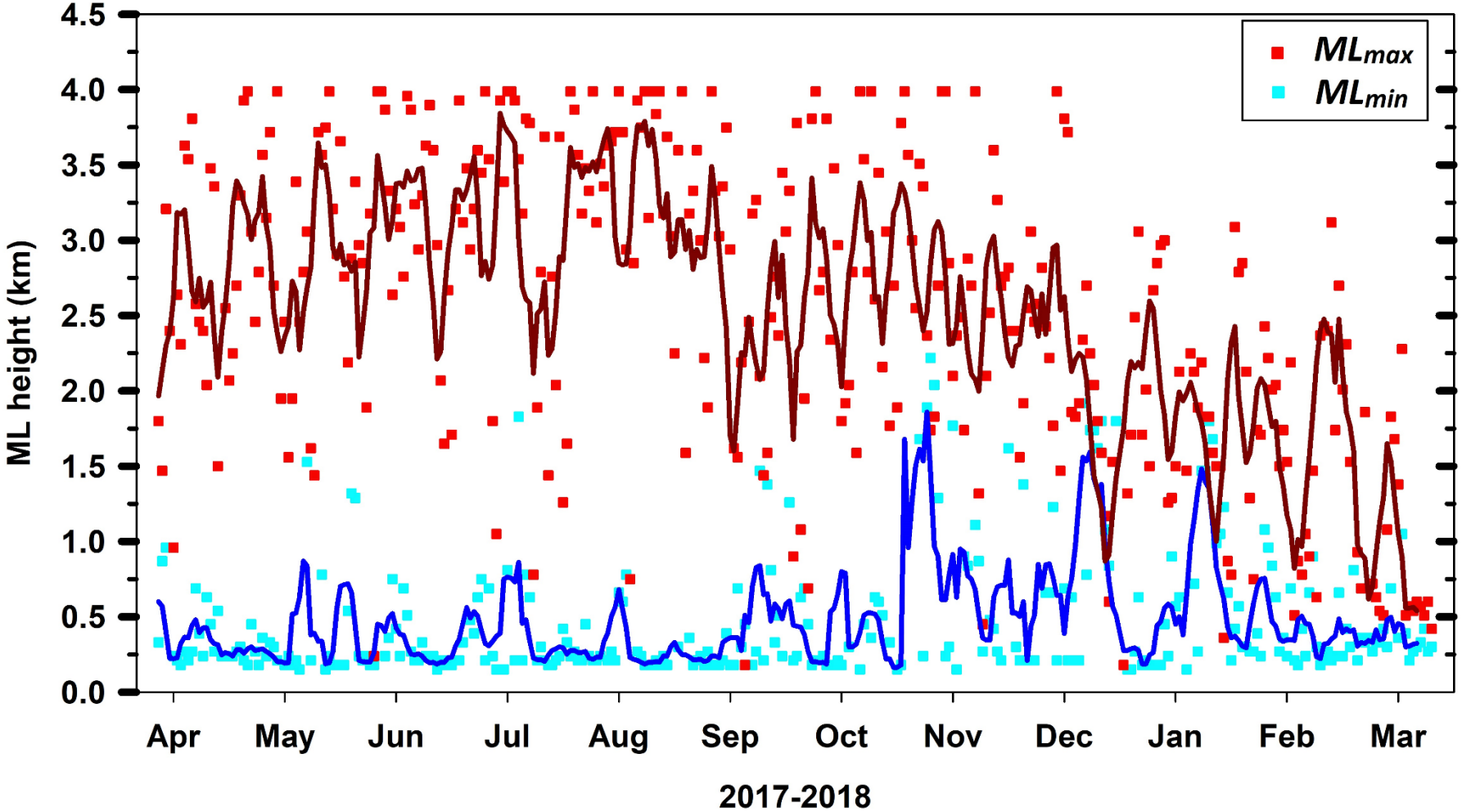

Daily rainfall
April::038 mm
May:: 228 mm
June::152 mm
Rain fall (in mm)
Day Number


MAY2017
PM2.5
PM 10
ABL LiDAR
ABL (km)
PM
Local time (Hours)

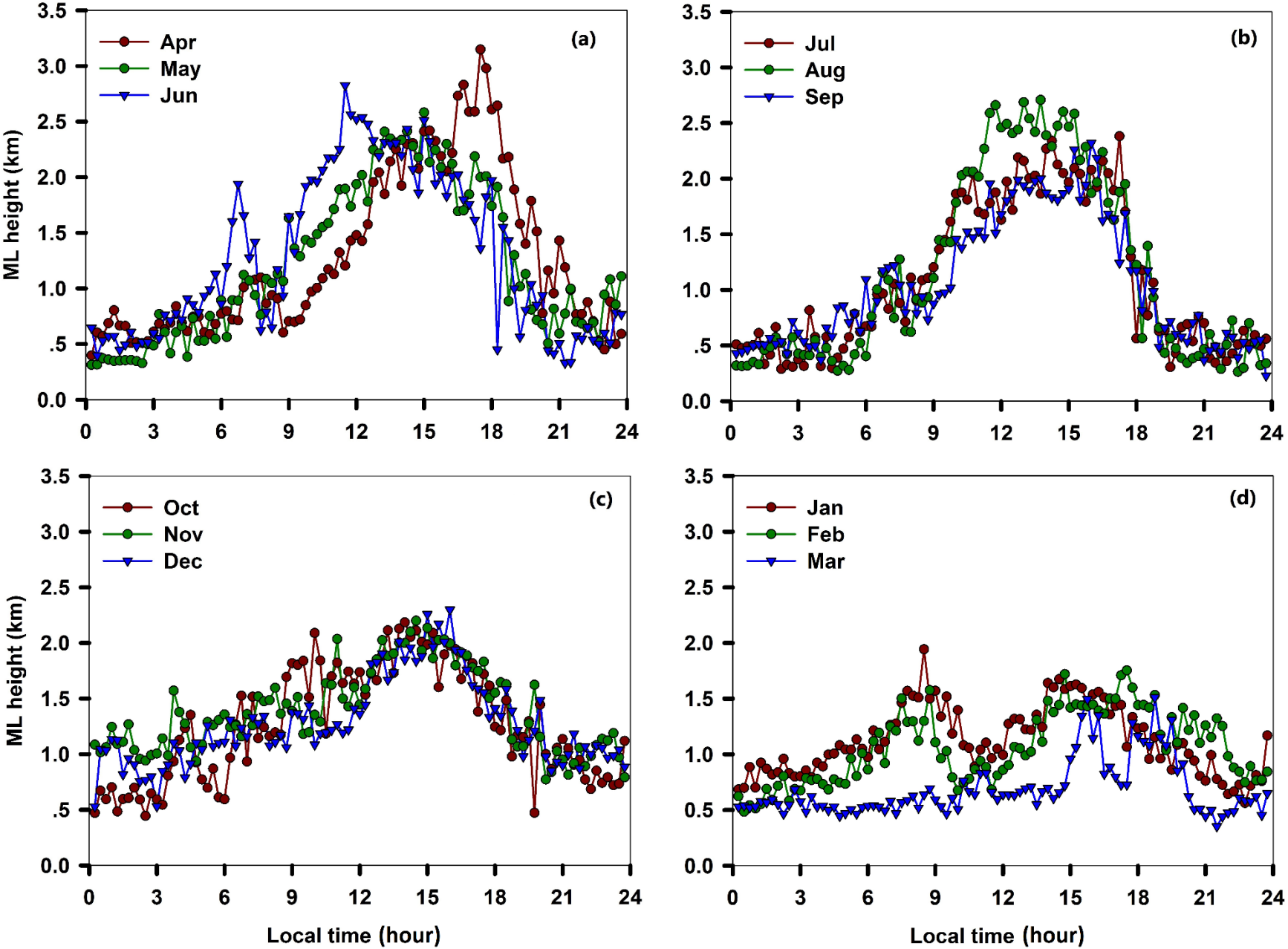

June 2017
PM2.5
PM 10
ABL LiDAR
ABL (km)
PM
Local time (Hours)

# Part 1: Consistent and year-long mixing layer height measurements with LiDAR in the mountain valley of Chiang Mai

Solanki et al., submitted to the International Journal of Digital Earth (LCLUC Special Issue)



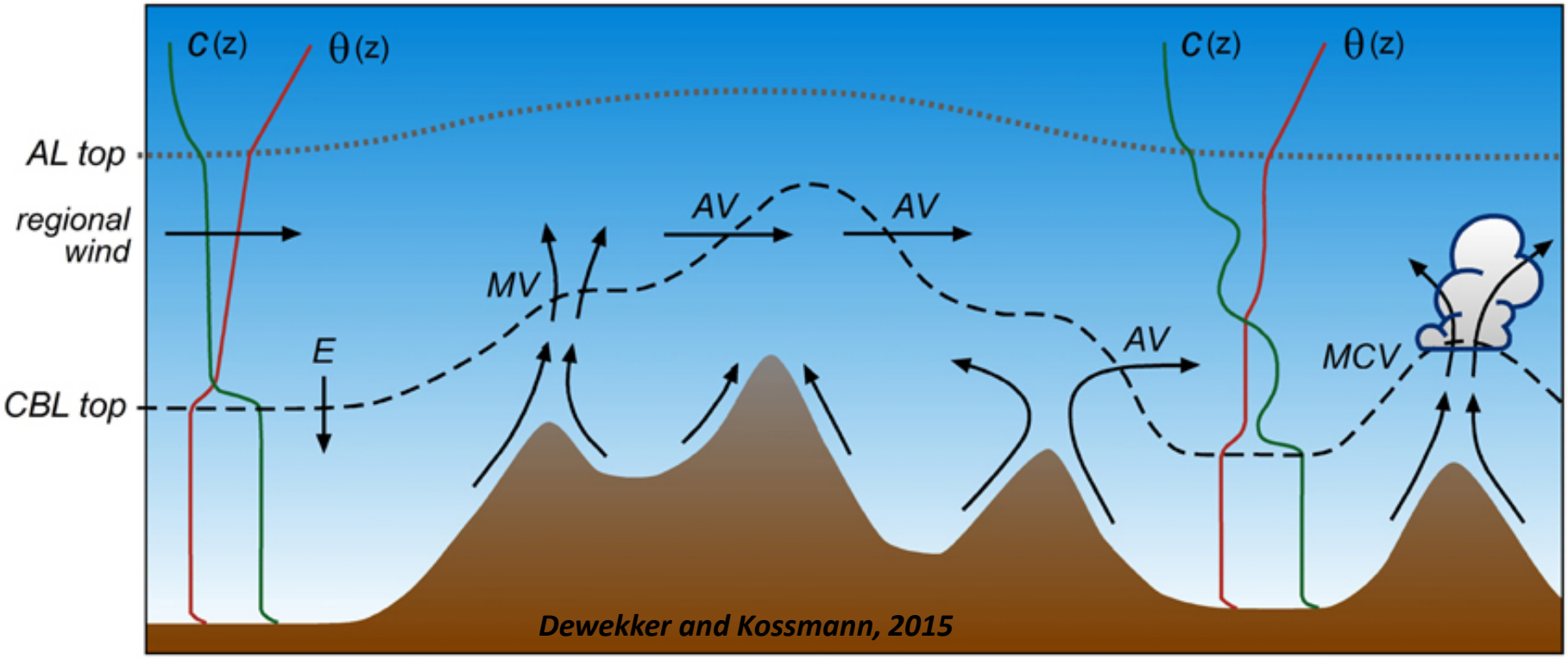

Yearlong (April 2017 to March 2018) variations in the 15-minute binned daytime (maximum) and nighttime (minimum) ML height measurement. The solid line represents a 5-day centered moving average for the daytime (dark red) and nighttime (dark blue).




Diurnal Variations in the 15-minute binned average of ML height measurements for (a) April, May and June; (b) July, August and September; (c) October, November and December; (d) January, February and March.

# Atmospheric pollutants and the mixing layer height

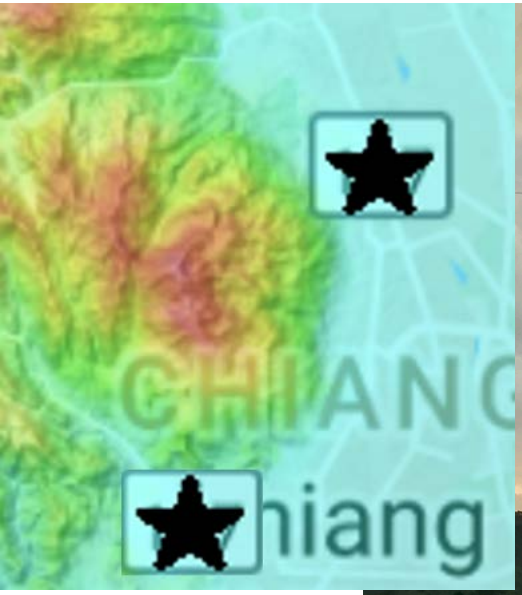
**The mixing height usually acts as a confinement to the pollutants and water vapor emitted from the Earth's surface, hence controlling their concentration with variations in the mixing layer top height.**




*Dewekker and Kossmann, 2015*

# Chiang Mai UAV-LiDAR Test Flights (May 18-20, 2018)

Mae Hia CMU Agriculture Campus in cooperation with Carlo Wang (NCU, Taiwan) and Somporn Chantara (ESRC CMU) / Full Campaign planned in March 2019



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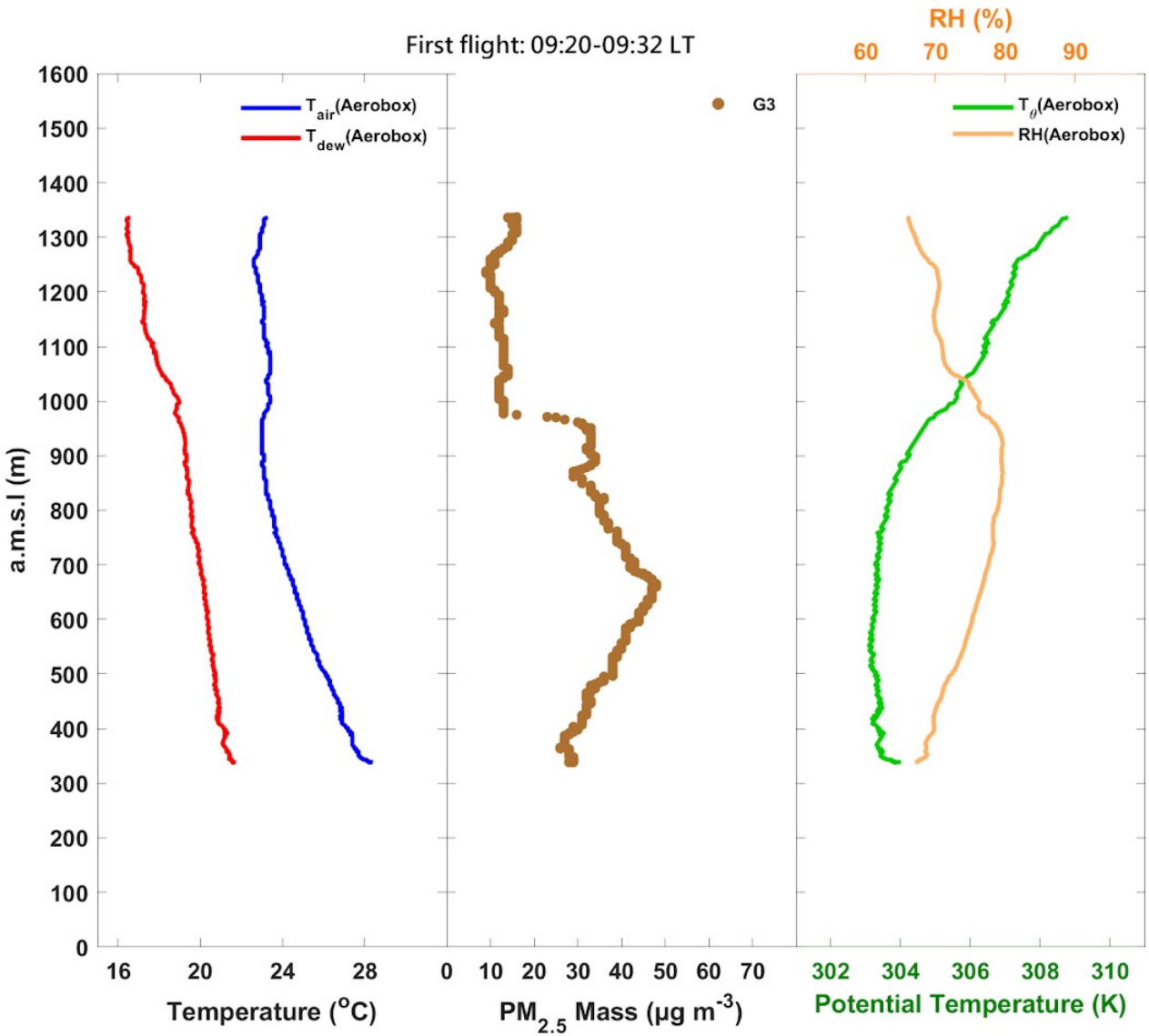
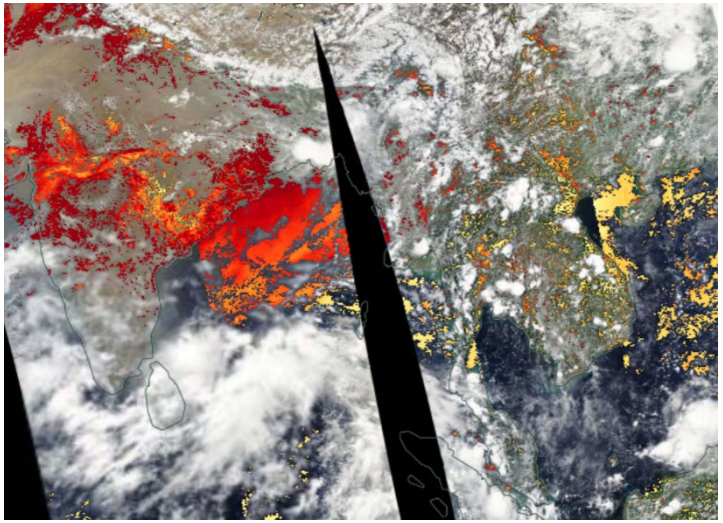
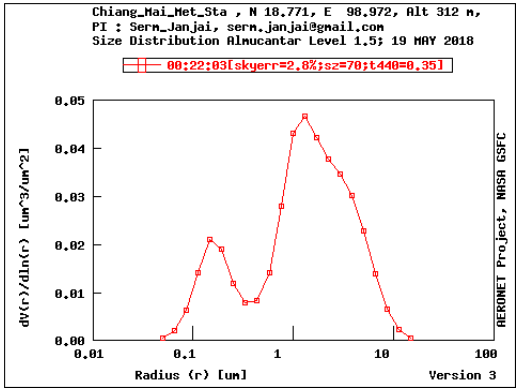


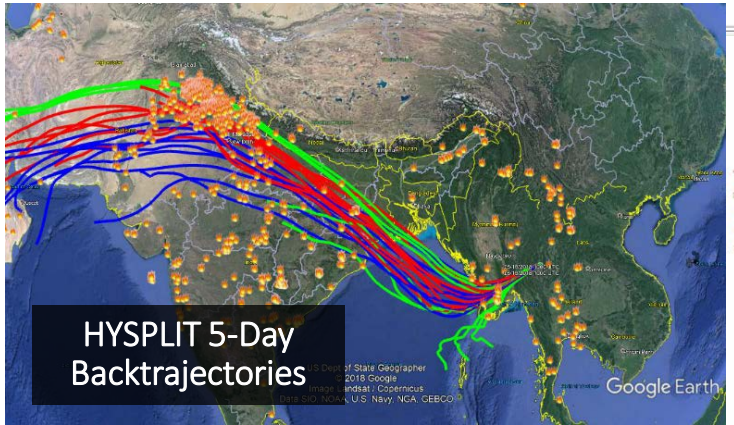

Estimated LiDAR Mixing Height: approx. 660 m.

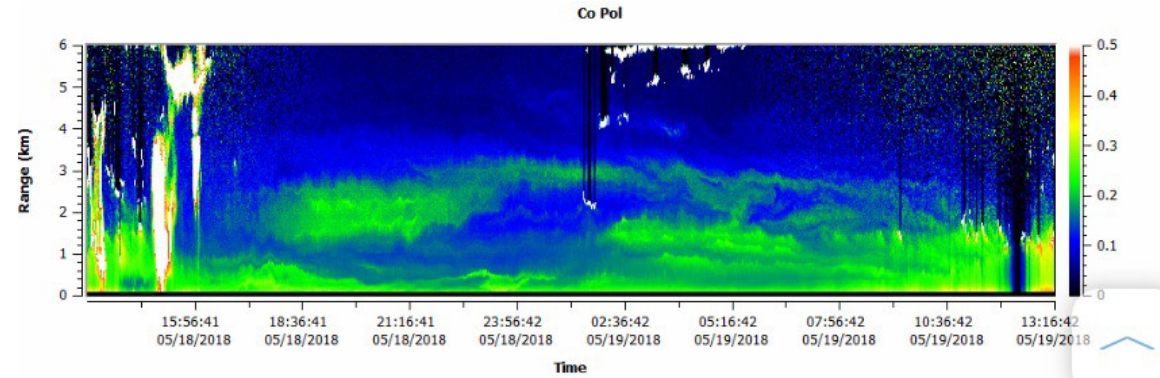
# Chiang Mai UAV-LiDAR Test Flights (May 18-20, 2018)

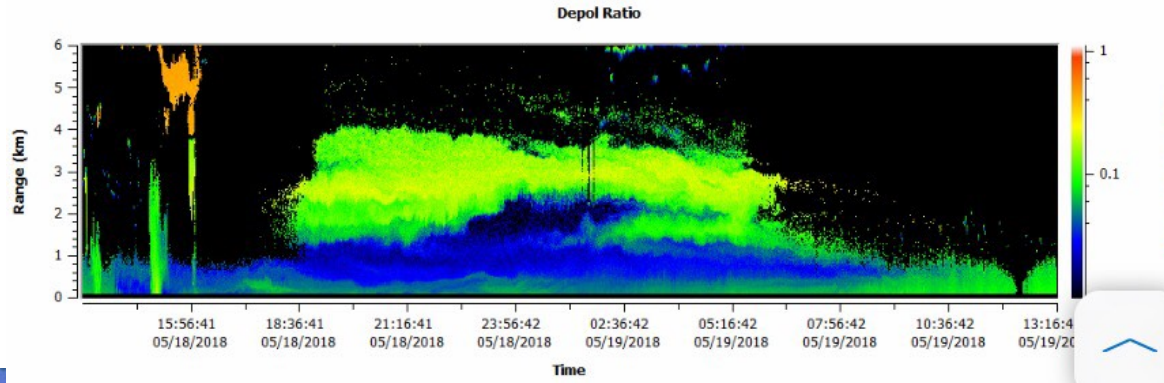


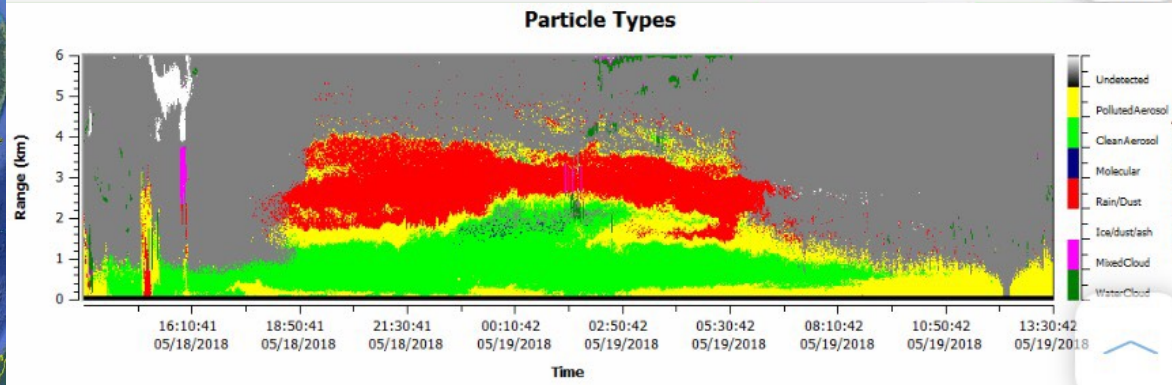
Smoke / Dust Transport?



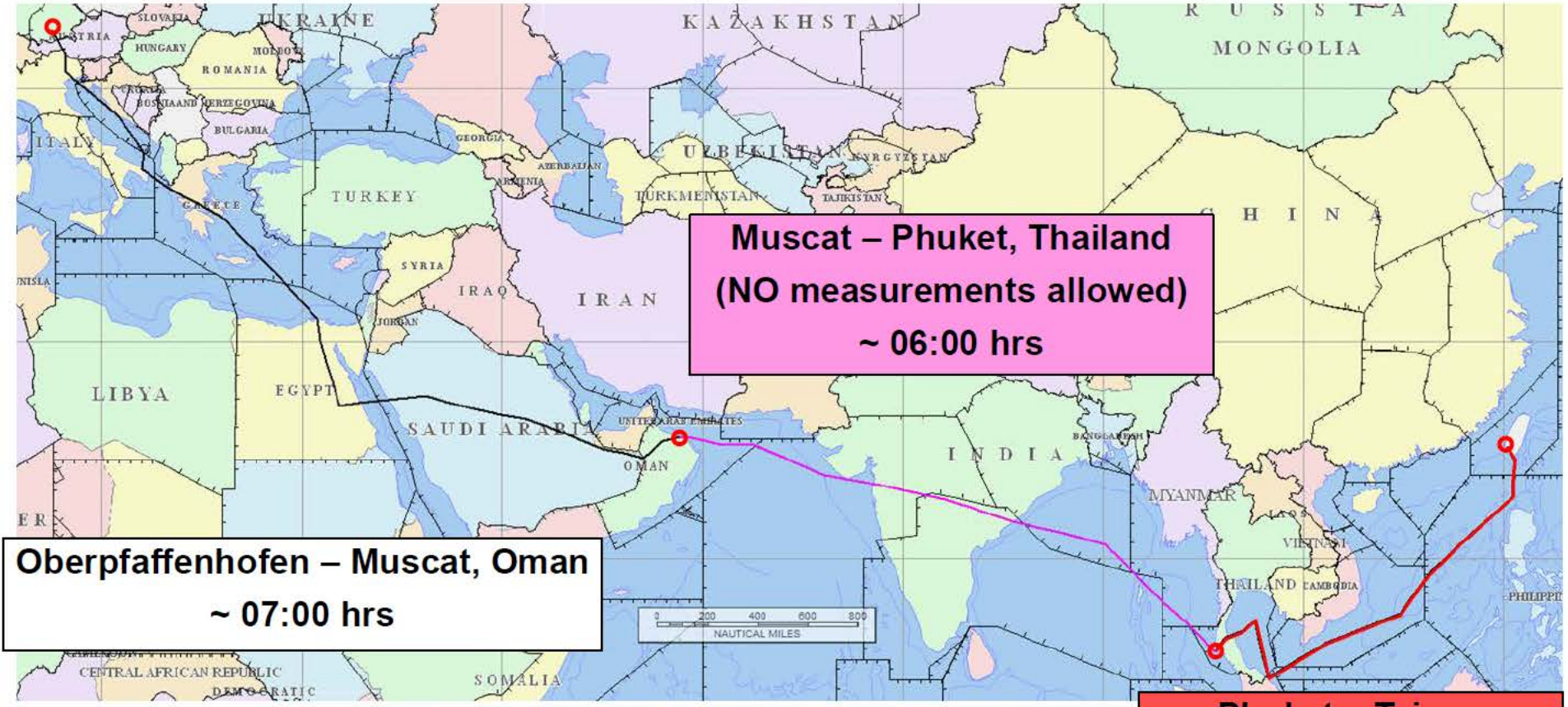
# Part 2: High Altitude and LOng Range (HALO) – Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales (EMeRGe) Asian Aircraft Measurement Campaign (March 10 – April 8, 2018)

in cooperation with UniBremen and the German Aerospace Center (DLR), Germany

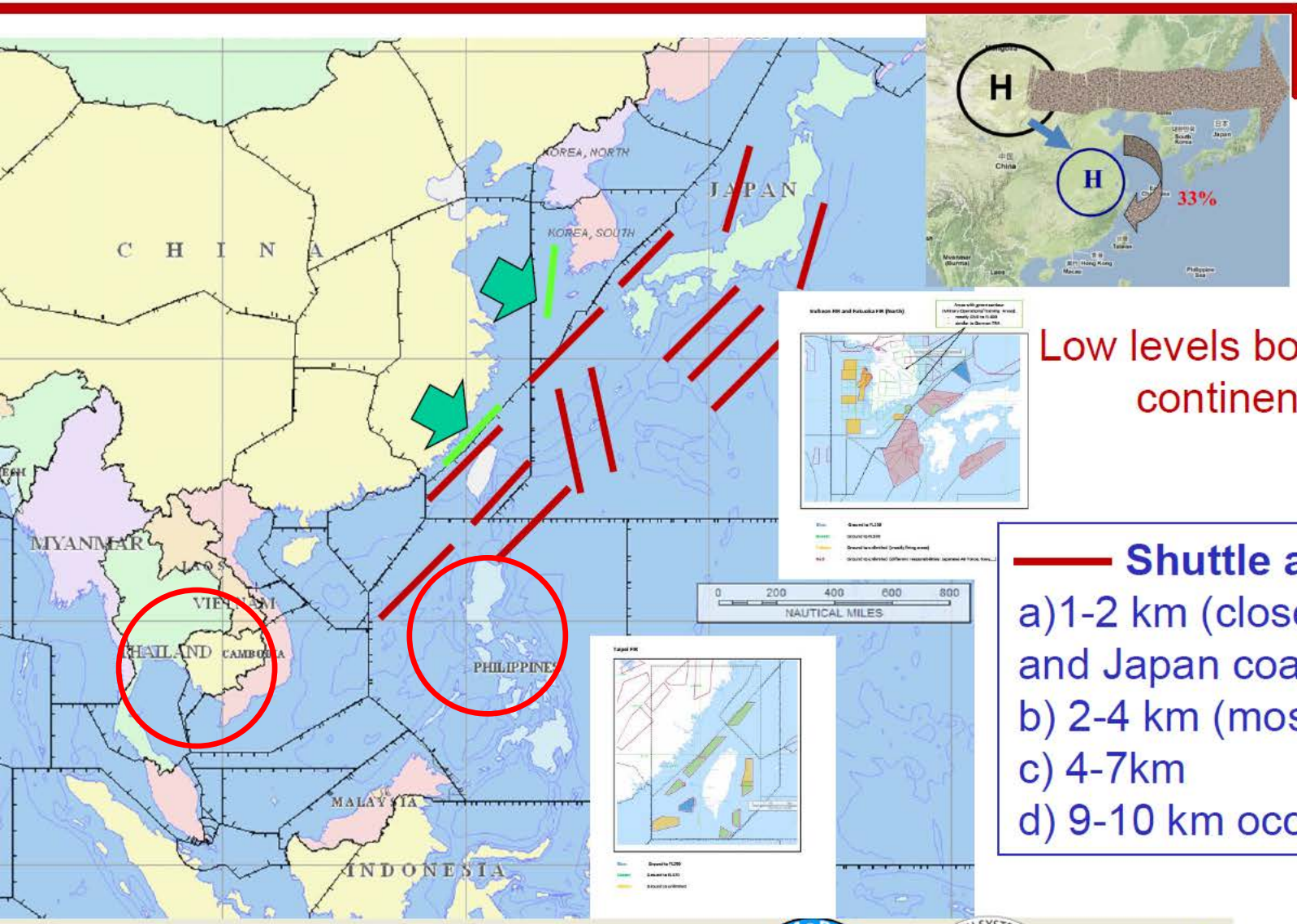
| Institution | PI | Gas/Parameter | Instrument / Model |
|---|---|---|---|
| Institute for Environmental Physics-University of Bremen (UB-IUP) | J.P. Burrows / M.D Andrés Hernández | $HO_2$+$RO_2$ | PeRCEAS |
| University of Wuppertal (BUW-IAU) | R. Koppmann / M. Krebsbach | VOC / carbon isotope ratios | MIRAH |
| Institute for Environmental Physics-University of Heidelberg (UH-IUP) | K. Pfeilsticker | $O_3$, $NO_2$, HONO, $CH_2O$, $C_2H_2O_2$, $O_4$, BrO, ClO, IO | mini-DOAS |
| | U. Platt / D. Pöhler | $NO_2$, $CH_2O$, $C_2H_2O_2$, $H_2O$, $O_4$, $SO_2$, IO, BrO, $O_3$ | 2D/3D HAIDI |
| Forschungszentrum Jülich (FZJ-IEK-8) | B. Bohn | UV radiation, J($O_3$), J($NO_2$) | HALO-SR |
| Particle Chemistry - Department MPIC/ University of Mainz (JGU-IPA) | S. Borrmann / J. Schneider | Aerosol particle composition<br>Fine aerosol | C-ToF-AMS<br>AMETYST |
| Multiphase Chemistry Department MPIC- Mainz (MPIC) | U. Poschl / M.O. Andreae | CCN, soot, aerosol microscopic properties | HALO-CCN |
| Institute of Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT-IMK) | A. Zahn | $O_3$, 5-10 VOCs | FAIRO / HKMS |
| Institute of Atmospheric Physics, Deutsches Zentrum für Luft und Raumfahrt (DLR-IPA) | H.Schlager / H. Ziereis | CO, $CO_2$, $CH_4$, PFC tracer | AMTEX / PERTRAS |
| | | $SO_2$, $HNO_3$,HONO, organic acids<br>NO, $NO_2$, NOy | CI-ITMS<br>AENEAS |
| University of Bremen /Atmospheric Chemistry, MPIC Mainz (UB, MPIC) | M.Vrekoussis / A. Pozzer | Modelling | TM5/Flexpart/EMAC |

# Transfer flights

## (routing in both ways similar)



# EMeRGe in Asia: flight tracks and target areas




Low levels both sea and continental air

**Shuttle altitudes:**

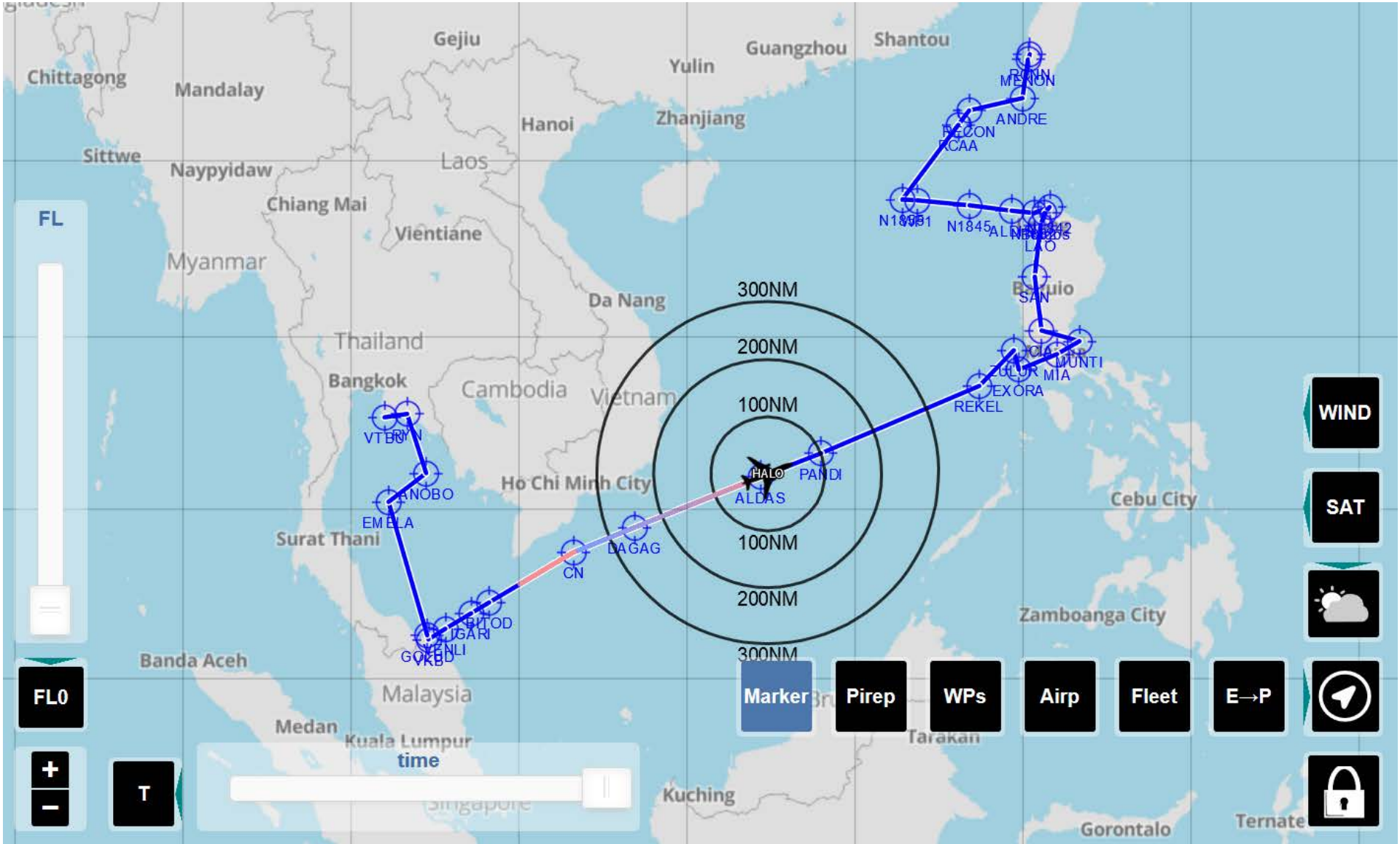
a) 1-2 km (close to Taiwan and Japan coastal areas)
b) 2-4 km (most frequent)
c) 4-7km
d) 9-10 km occasionally

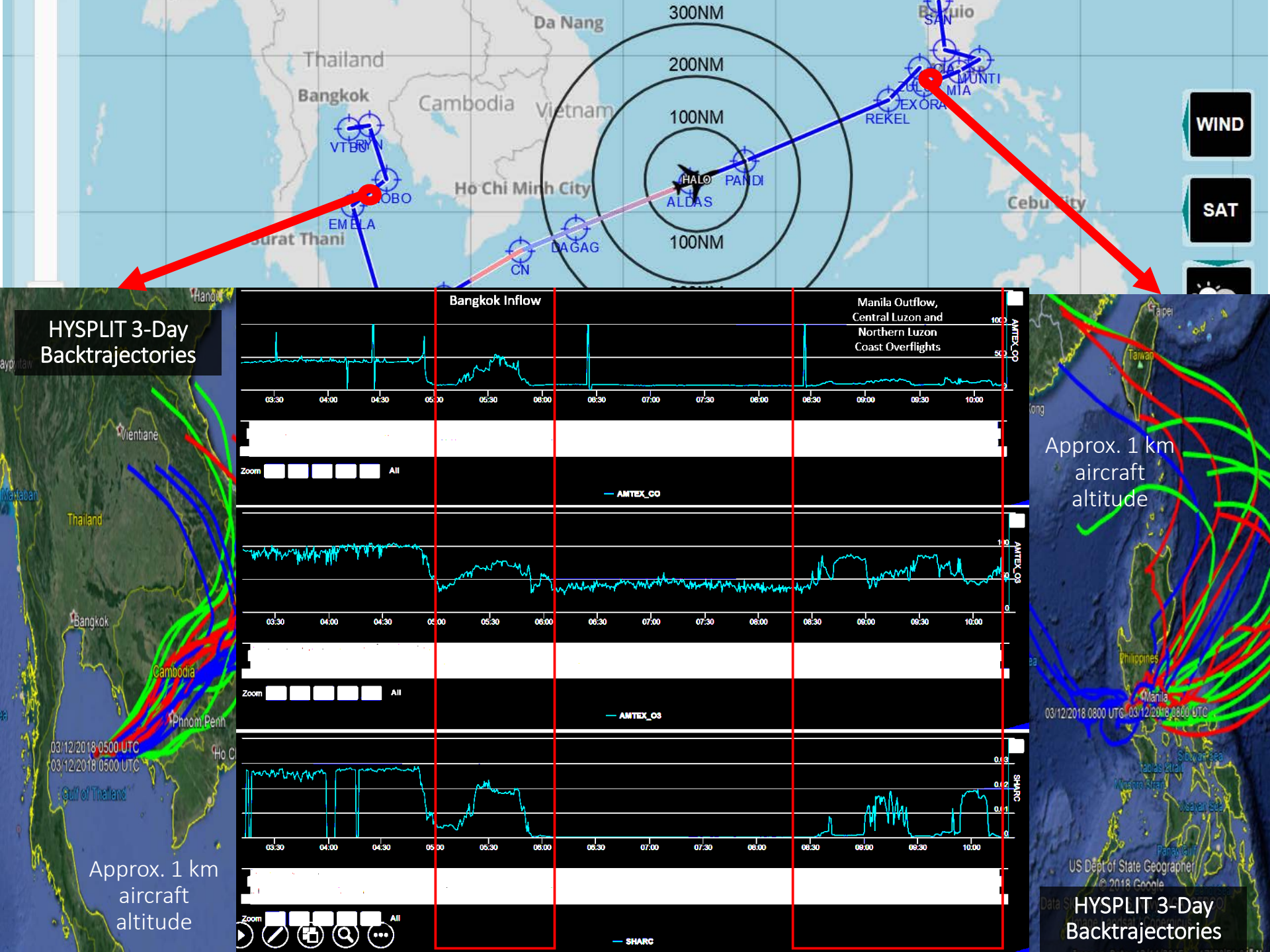
Universität Bremen
lola@iup.physik.uni-bremen.de

# HALO in Abu Dhabi (March 10, 2018)

# Transfer Flight # 1 (Munich – Abu Dhabi – Utapao – Thai Gulf - Manila – Taiwan) March 12, 2018

Science Objective: To study the Bangkok pollution inflow and the Manila pollution outflow
TCCON Validation





300NM
200NM
100NM
100NM
Da Nang
Thailand
Bangkok
Cambodia
Vietnam
Ho Chi Minh City
Surat Thani
Cebu City
VTBU
EMELA
DAGAG
CN
HALO
ALDAS
PANDI
REKEL
EXORA
MIA
MUNTI
SAN
WIND
SAT
HYSPLIT 3-Day Backtrajectories
Approx. 1 km aircraft altitude
Bangkok Inflow
Manila Outflow, Central Luzon and Northern Luzon Coast Overflights
AMTEX_CO
AMTEX_O3
SHARC
Zoom
All
03:30
04:00
04:30
05:00
05:30
06:00
06:30
07:00
07:30
08:00
08:30
09:00
09:30
10:00
Vientiane
Thailand
Bangkok
Cambodia
Phnom Penh
03/12/2018 0500 UTC
Gulf of Thailand
Taipei
Taiwan
Philippines
Manila
03/12/2018 0800 UTC
US Dept of State Geographer
© 2018 Google
Approx. 1 km aircraft altitude
HYSPLIT 3-Day Backtrajectories

HALO over the Northern Philippines (TCCON Validation; March 12, 2018)

HALO in Taiwan (March 12, 2018)

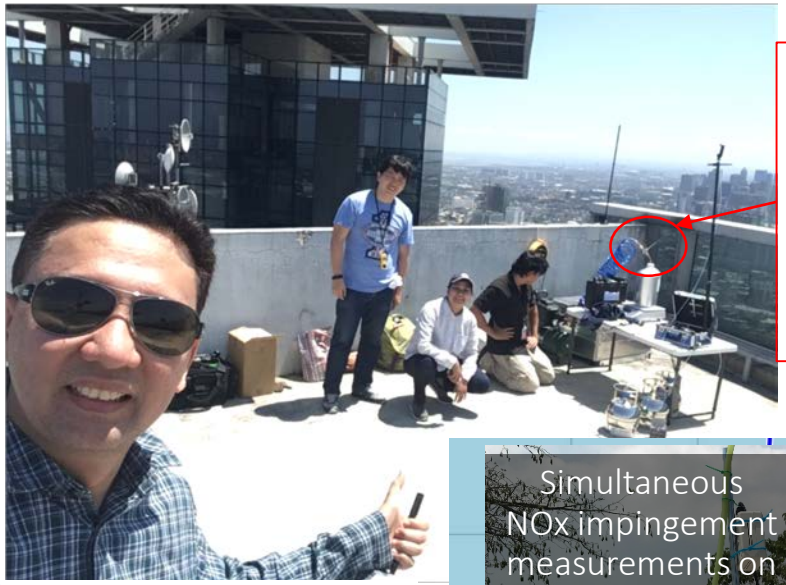
# Mission Flight # 6 (Taiwan - Manila – Taiwan) March 19-20, 2018

Science Objective: To validate HYSPLIT plume forecast by releasing PFC plume tracer and air sampling

Air Sampling and Plume Tracer Release the Day Before the Flight from 220 mASL in Manila (Highly Urbanized Area)

March 19, 2018

1 PM Local Time



Plume Tracer Jet

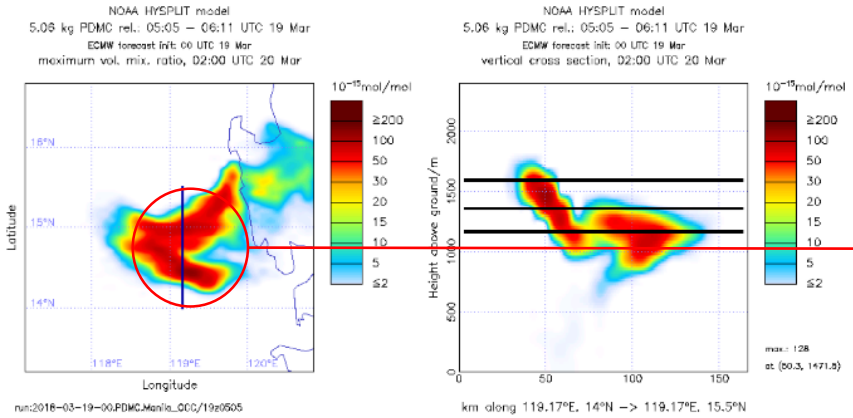
*Plume Tracer = PFC = Perfluorocarbon (harmless, non-reactive aerosol)

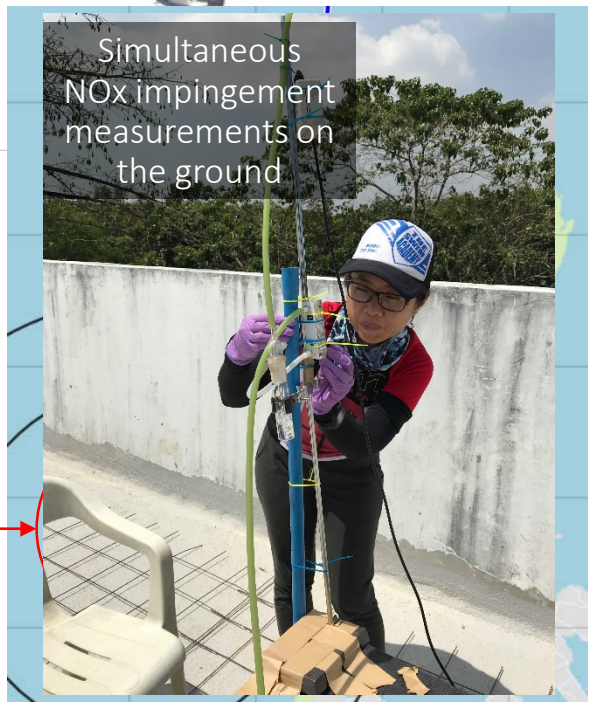
EMERGE Manila Tracer Experiment

PDMCH Release on rooftop of OCC skyscraper (5.06 kg, 19 March 2018, 06:05-05:05 UTC)

PDMCH sampling with HALO on 20 March 2018

Model Forecast to aid the Flight Plan for the Next Day (Model Simulations from DLR)



# Mission Flight # 10 (Taiwan - Manila – Taiwan) March 27-28, 2018

Science Objective: To validate HYSPLIT plume forecast by releasing PFC plume tracer and air sampling

Air Sampling and Plume Tracer Release the Day Before the Flight from 75.4 mASL in the University of the Philippines (Urbanized Area with Greenspaces)

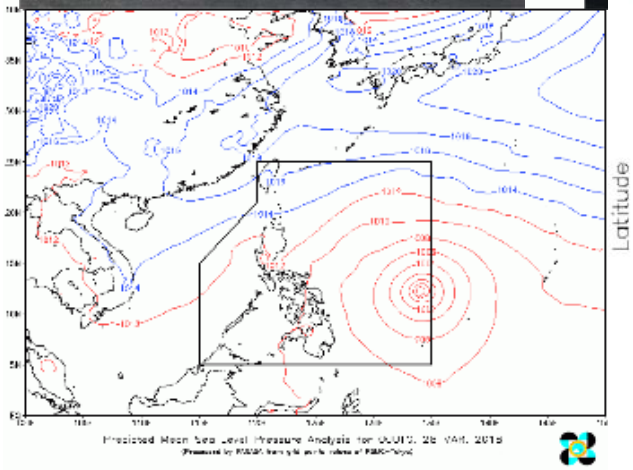
March 27, 2018

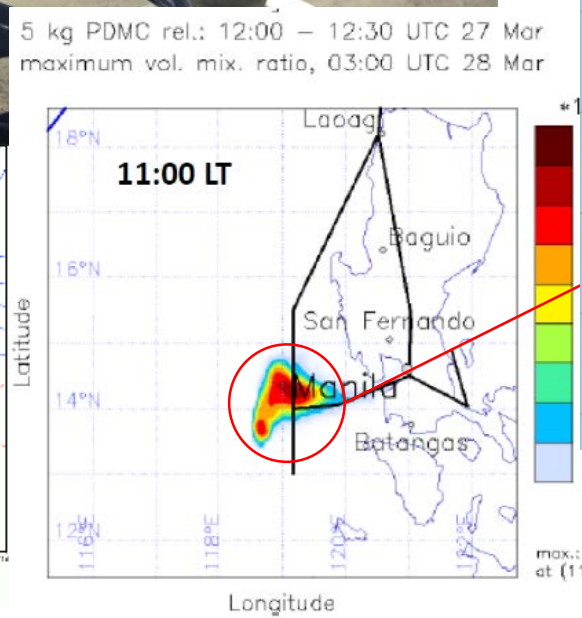
8 PM Local Time

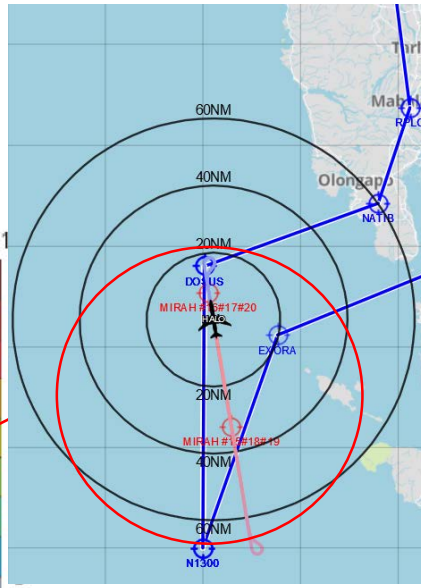
Plume Tracer Jet

*Plume Tracer = PFC = Perfluorocarbon (harmless, non-reactive aerosol)

Model Forecast to aid the Flight Plan for the Next Day (Model Simulations from DLR); Complication due to tropical cyclone Jelawat (Caloy)

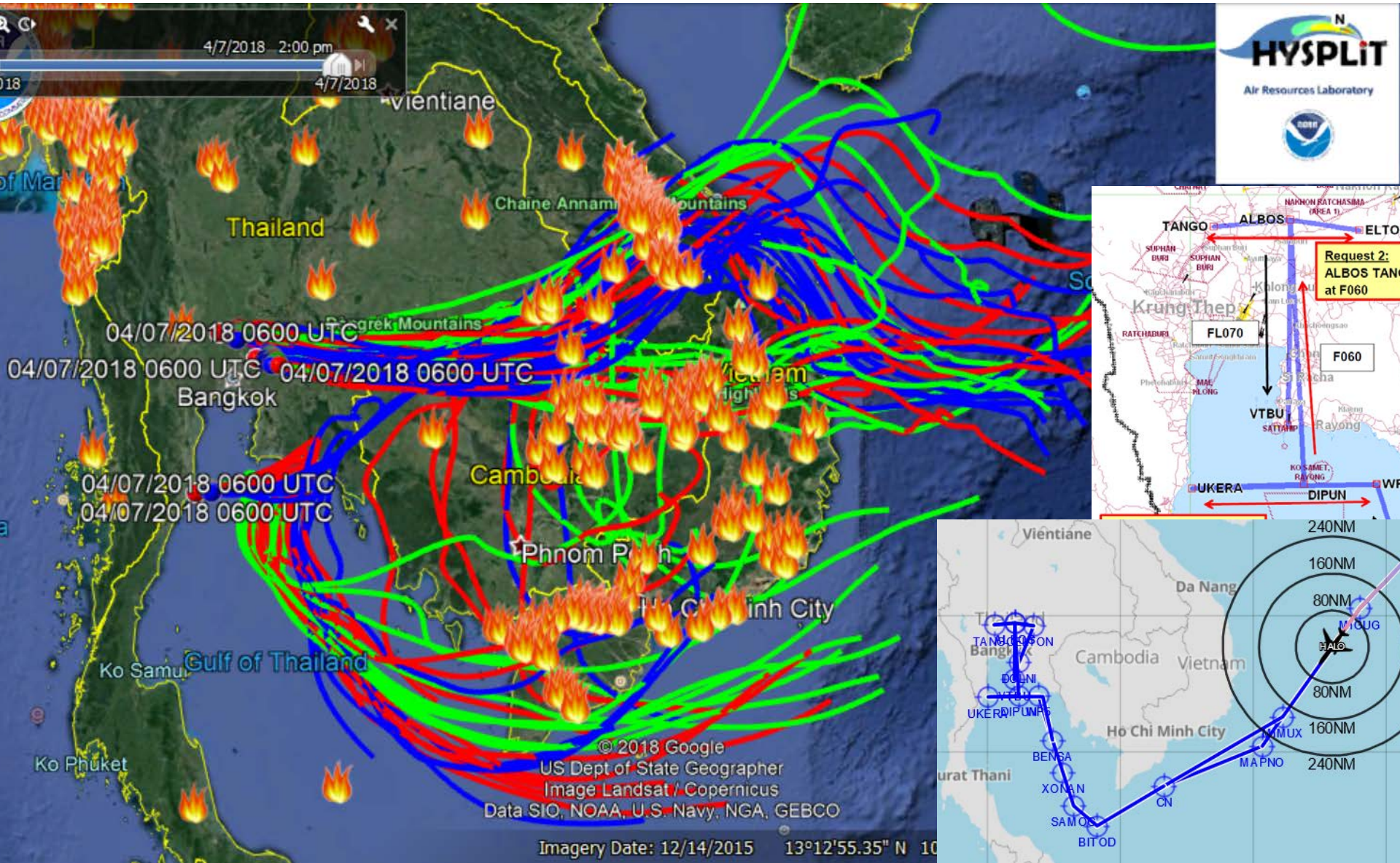




# Transfer Flight # 2 (Taiwan – Thai Gulf - Bangkok – Utapao – Abu Dhabi – Munich) April 6, 2018

Science Objective: To study the Bangkok pollution inflow and inland Bangkok emissions

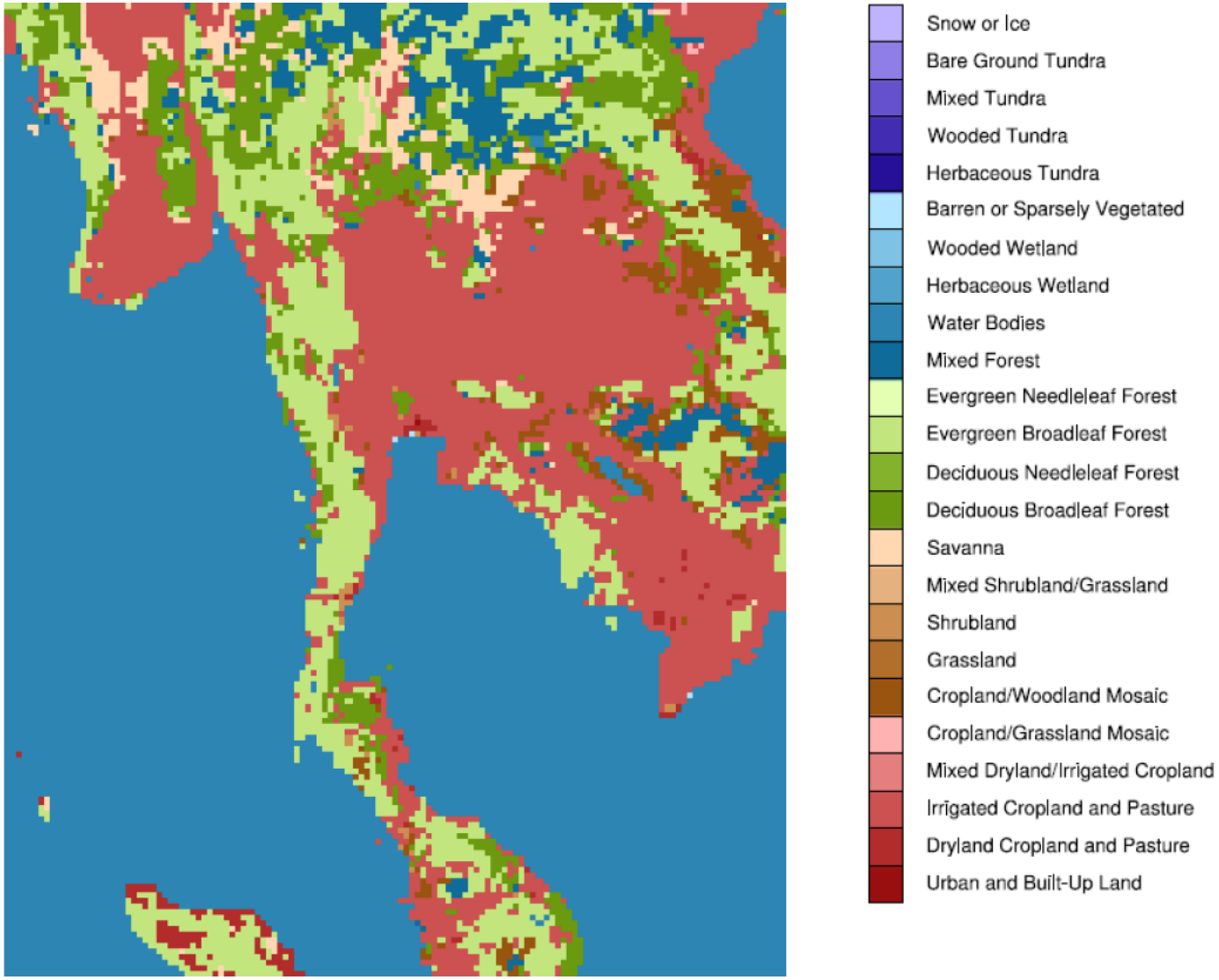


# HALO in Utapao, Thailand (April 7, 2018)

# Part 3: WRF-Chem Aerosol Radiative Properties Sensitivity to Land Cover / Land Use Terrestrial Datasets

Macatangay, Bran, et al., submitted to Environmental Research Letters (LCLUC Special Issue)

USGS (WRF Default v. 3.7 and below)



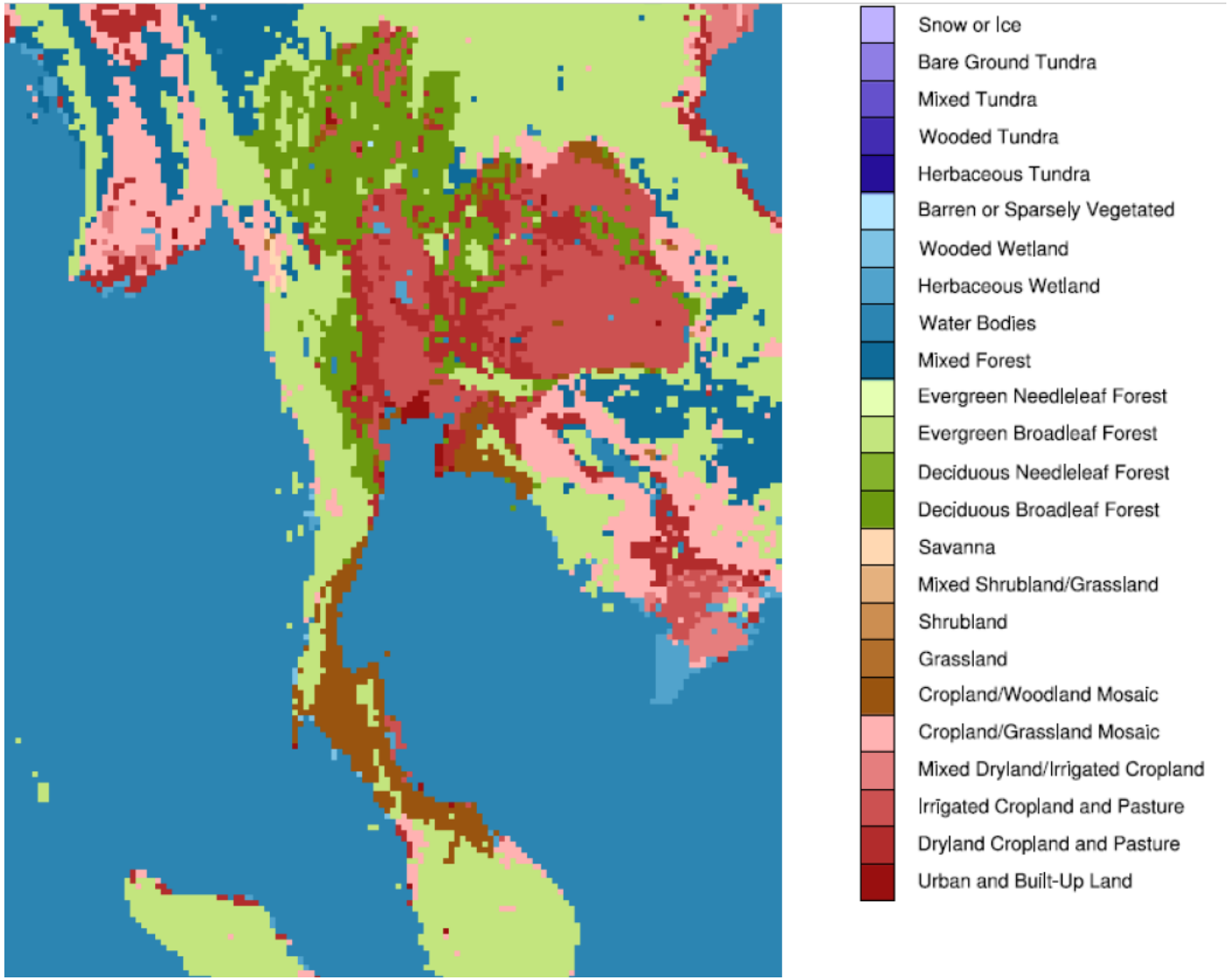
# WRF-Chem Aerosol Radiative Properties Sensitivity to Land Cover / Land Use Terrestrial Datasets

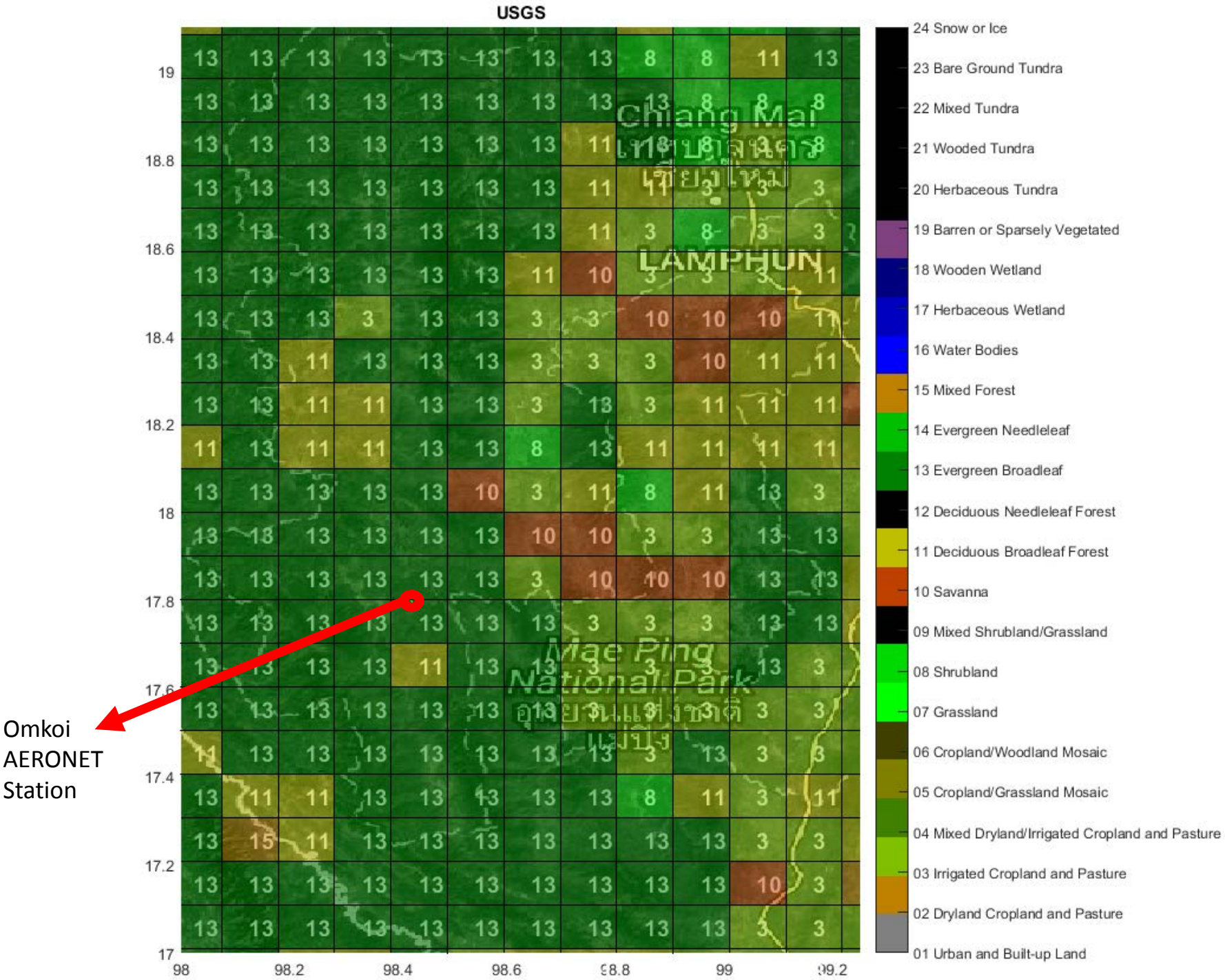
Macatangay, Bran, et al., submitted to Environmental Research Letters (LCLUC Special Issue)

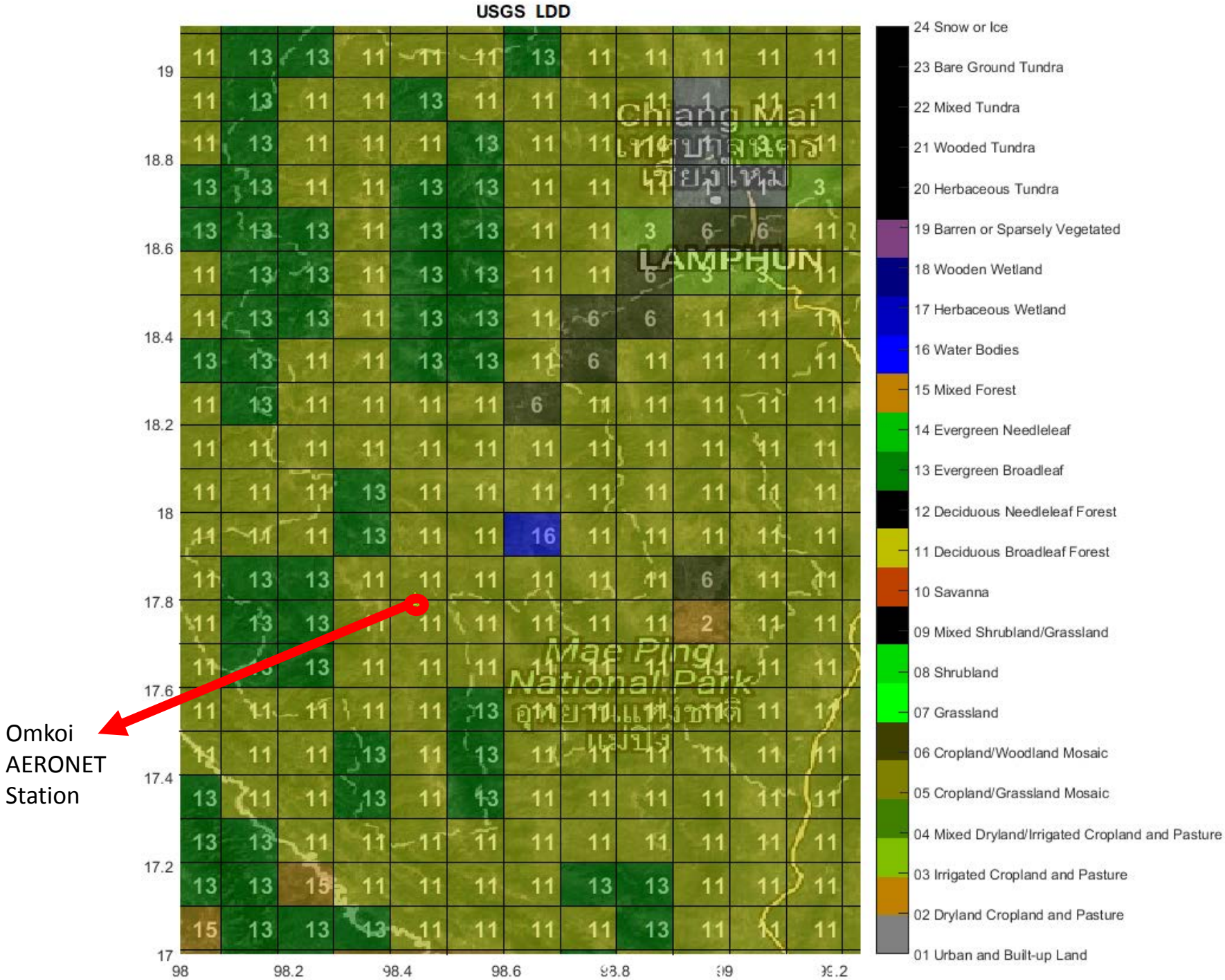
USGS Land Development Department (LDD) Update

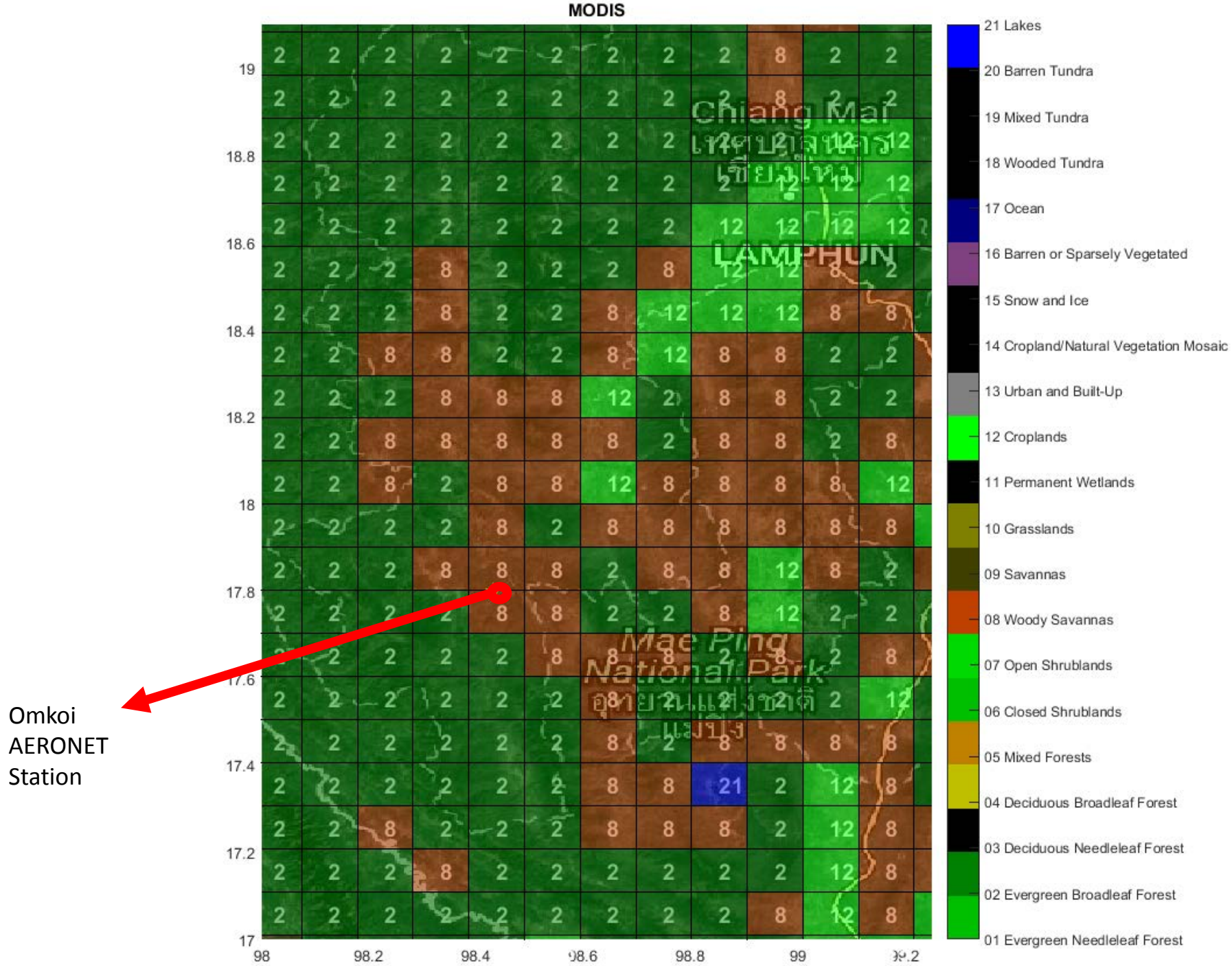
Sarinnapakorn (HAII) Manomaiphiboon (JSGEE, KMUTT)

(terrain height, land use, green fraction, leaf area index, surface albedo, soil texture (top and bottom), land mask, etc.)



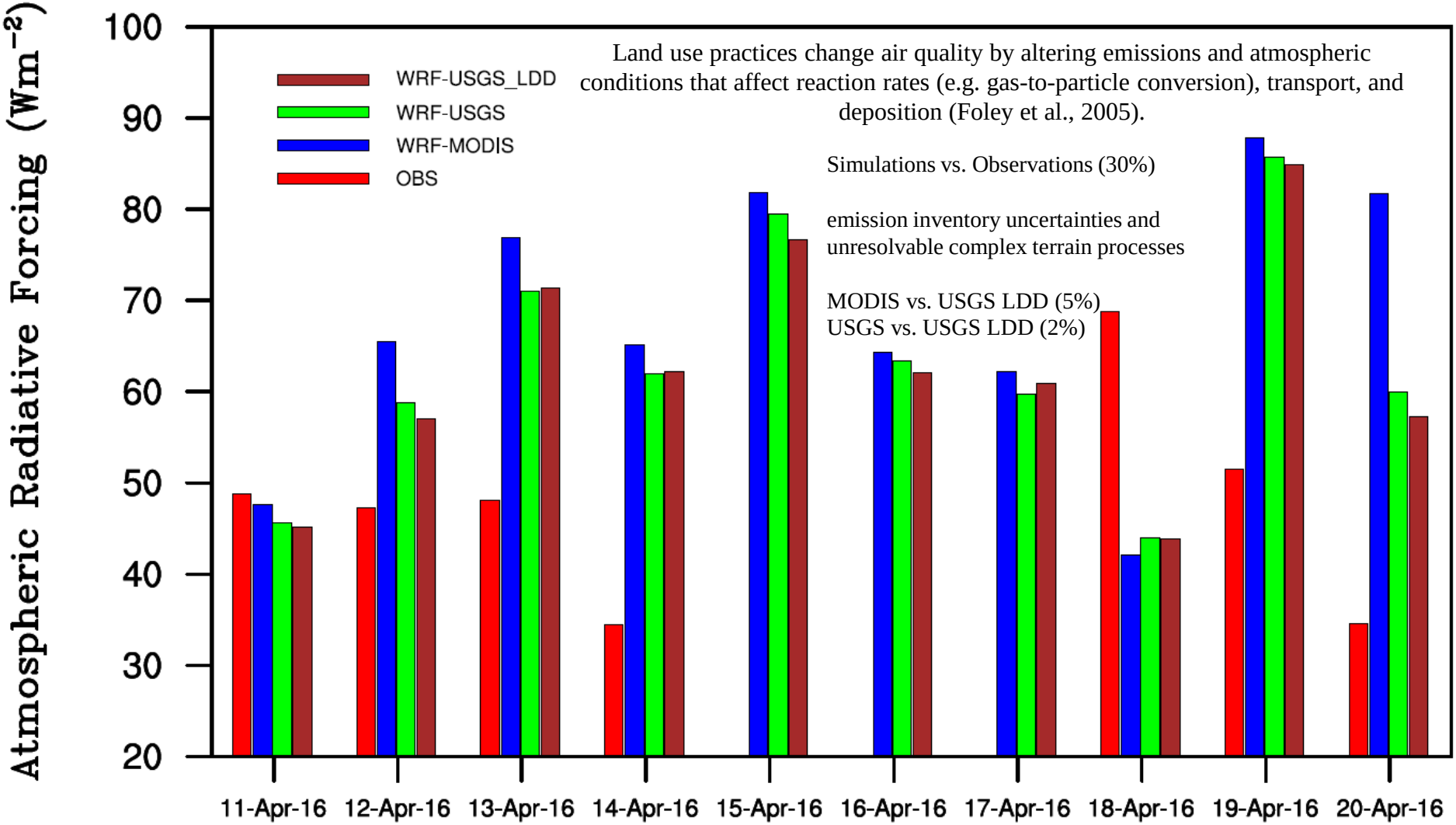

USGS
Chiang Mai
LAMPHUN
Mae Ping
National Park
Omkoi
AERONET
Station
24 Snow or Ice
23 Bare Ground Tundra
22 Mixed Tundra
21 Wooded Tundra
20 Herbaceous Tundra
19 Barren or Sparsely Vegetated
18 Wooden Wetland
17 Herbaceous Wetland
16 Water Bodies
15 Mixed Forest
14 Evergreen Needleleaf
13 Evergreen Broadleaf
12 Deciduous Needleleaf Forest
11 Deciduous Broadleaf Forest
10 Savanna
09 Mixed Shrubland/Grassland
08 Shrubland
07 Grassland
06 Cropland/Woodland Mosaic
05 Cropland/Grassland Mosaic
04 Mixed Dryland/Irrigated Cropland and Pasture
03 Irrigated Cropland and Pasture
02 Dryland Cropland and Pasture
01 Urban and Built-up Land


USGS LDD
Chiang Mai
LAMPHUN
Mae Ping
National Park
Omkoi
AERONET
Station
24 Snow or Ice
23 Bare Ground Tundra
22 Mixed Tundra
21 Wooded Tundra
20 Herbaceous Tundra
19 Barren or Sparsely Vegetated
18 Wooden Wetland
17 Herbaceous Wetland
16 Water Bodies
15 Mixed Forest
14 Evergreen Needleleaf
13 Evergreen Broadleaf
12 Deciduous Needleleaf Forest
11 Deciduous Broadleaf Forest
10 Savanna
09 Mixed Shrubland/Grassland
08 Shrubland
07 Grassland
06 Cropland/Woodland Mosaic
05 Cropland/Grassland Mosaic
04 Mixed Dryland/Irrigated Cropland and Pasture
03 Irrigated Cropland and Pasture
02 Dryland Cropland and Pasture
01 Urban and Built-up Land


MODIS
Chiang Mai
LAMPHUN
Mae Ping
National Park
Omkoi
AERONET
Station
21 Lakes
20 Barren Tundra
19 Mixed Tundra
18 Wooded Tundra
17 Ocean
16 Barren or Sparsely Vegetated
15 Snow and Ice
14 Cropland/Natural Vegetation Mosaic
13 Urban and Built-Up
12 Croplands
11 Permanent Wetlands
10 Grasslands
09 Savannas
08 Woody Savannas
07 Open Shrublands
06 Closed Shrublands
05 Mixed Forests
04 Deciduous Broadleaf Forest
03 Deciduous Needleleaf Forest
02 Evergreen Broadleaf Forest
01 Evergreen Needleleaf Forest
19
18.8
18.6
18.4
18.2
18
17.8
17.6
17.4
17.2
17
98
98.2
98.4
98.6
98.8
99
99.2

# WRF-Chem Aerosol Radiative Properties Sensitivity to Land Cover / Land Use Terrestrial Datasets

Macatangay, Bran, et al., submitted to Environmental Research Letters (LCLUC Special Issue)




SWARF, $\Delta F = (F_{a,\ \text{downward flux}} - F_{a,\ \text{upward flux}}) - (F_{wa,\ \text{downward flux}} - F_{wa,\ \text{upward flux}})$

Thank You
for
Your Attention!

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