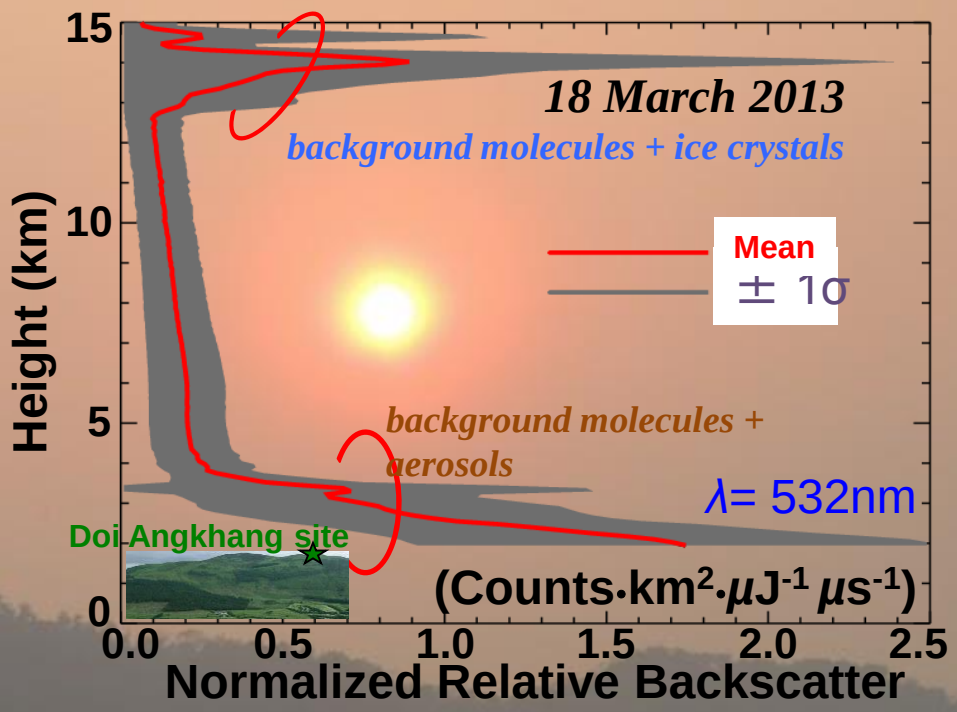
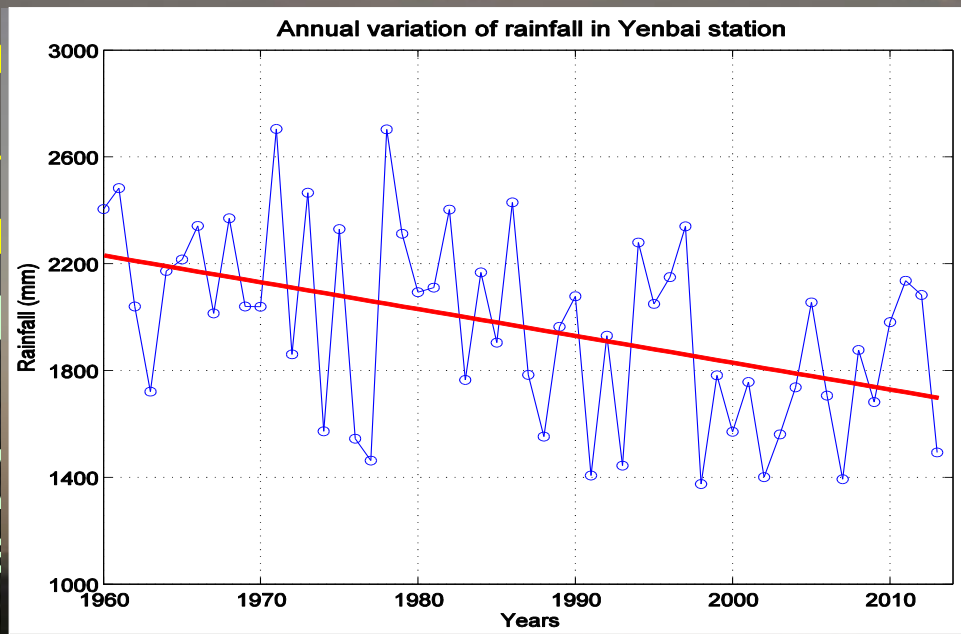
BASELInE Experiment 2013-2015

Biomass-burning
Aerosols &
Stratocumulus
Environment:
Lifecycles &
Interactions

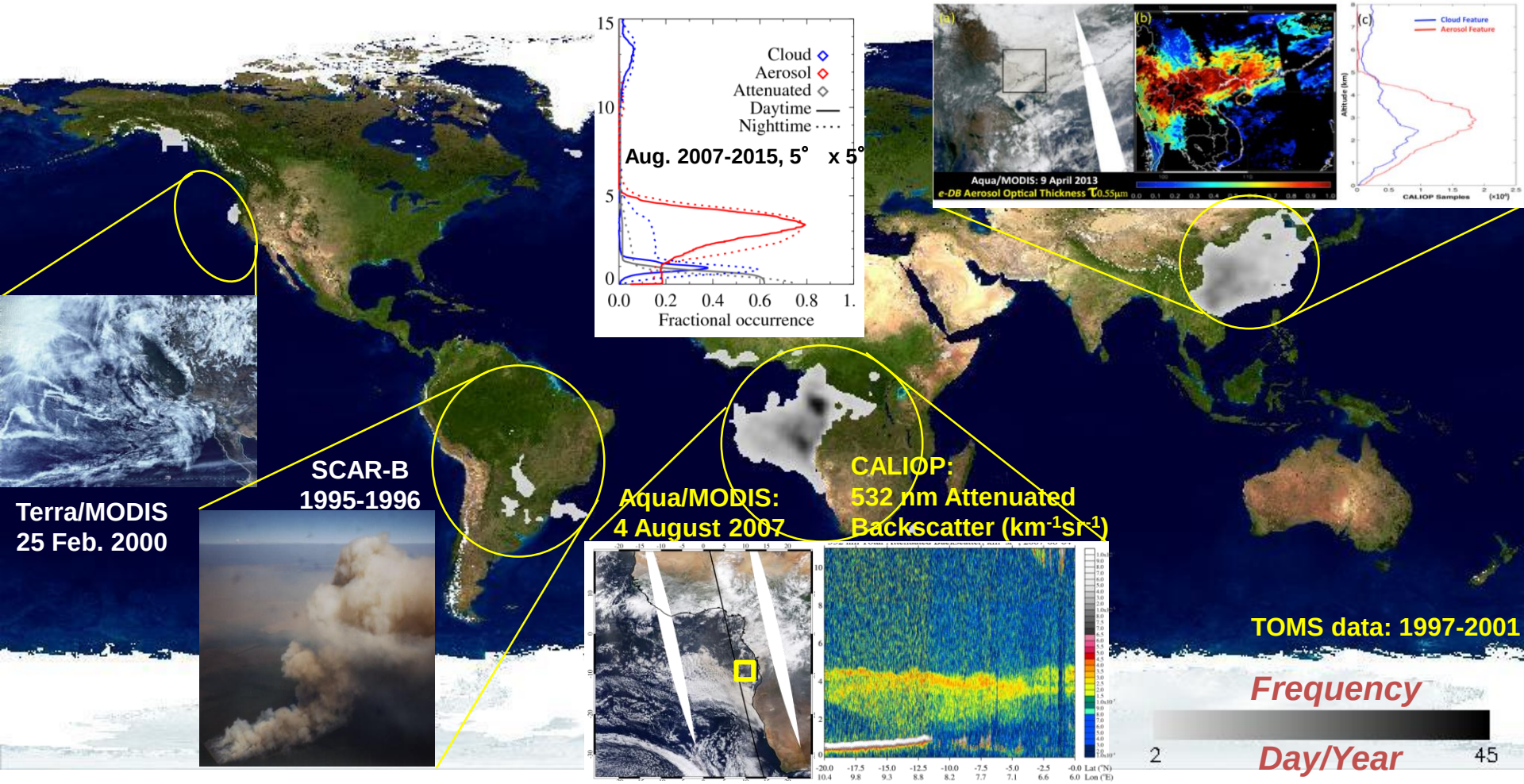
Satellite-surfa… and aerosol-clou… An overvie…

NASA: S.-C. Tsay, N. C. H…
Taiwan: led by N.-H. George…
Thailand: led by S. Janjai (SU…
Vietnam: led by Anh X. Nguye…



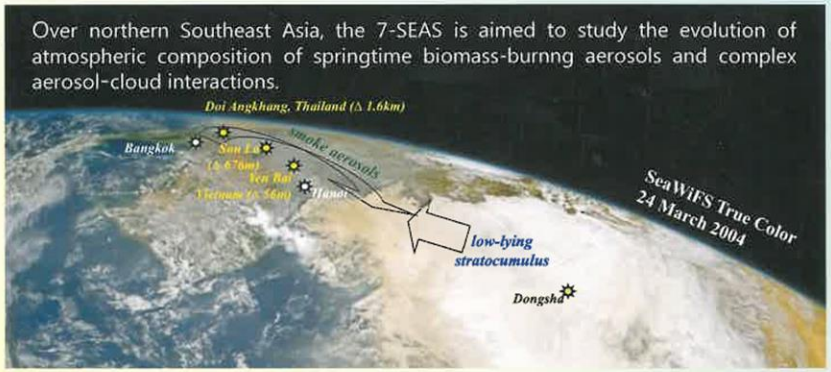


Global frequency distribution of Smoke *in the presence of* Clouds*



- **West coast of California: Ship tracks, a small-scale aerosol-cloud interaction**
- **South America: Convective “fumulus” clouds, diurnal cycle plays important role**
- **Southern Africa: Distinct, decoupled aerosol-cloud layers over west coast**
- **Southeast Asia: Upwind smoke and downwind coupled-aerosol-cloud system**

**Tsay, Hsu, Lau, et al., 2013, Atmos. Environ., 78, 20-34.*



Location of sites for BASE-ASIA, 7-SEAS/Dongsha Experiment and collaborative networks

78 Atmospheric Environment Vol. 78 (2013) 1-302

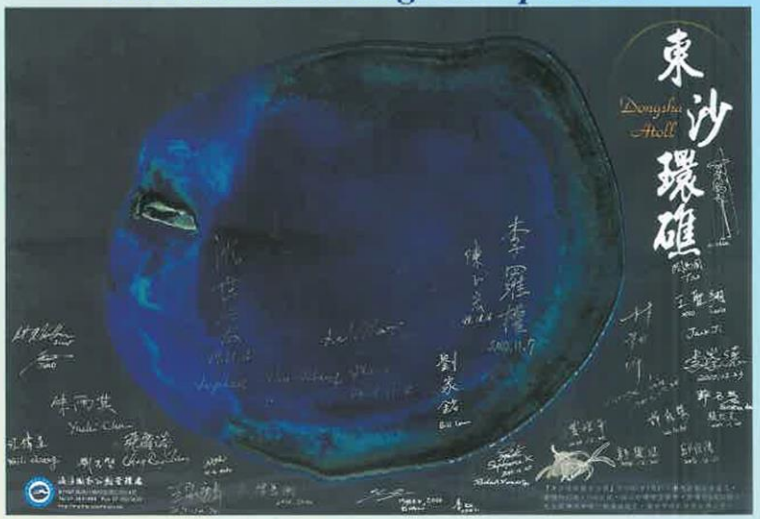
Special Issue: Observation, modeling and impact studies of biomass burning and pollution in the SE Asian Environment

Volume 78 October 2013 ISSN 1352-2310

ATMOSPHERIC ENVIRONMENT

Special Issue:Observation, modeling and impact studies of biomass burning and pollution in the SE Asian Environment

7-SEAS / 2010 Dongsha Experiment

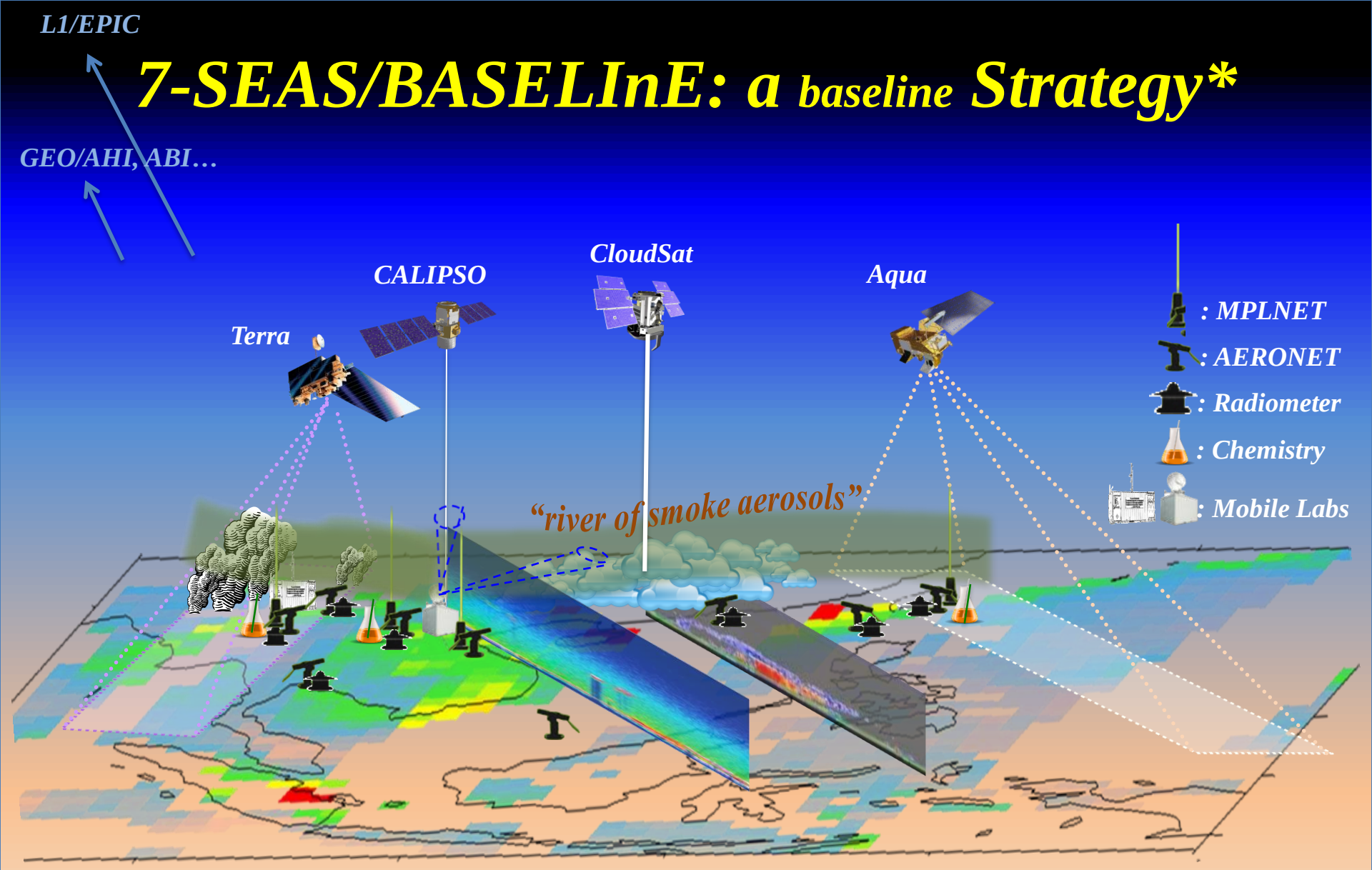


Delegates of 7-SEAS participating countries visited the Dongsha supersite on 18 June 2010.

7-SEAS (2013) special issue, Atmospheric Environment (28/37>75%)

7-SEAS (2017) special issue, Aerosol & Air Quality Res. (27/46>58%)

7-SEAS/BASELInE: a baseline Strategy*

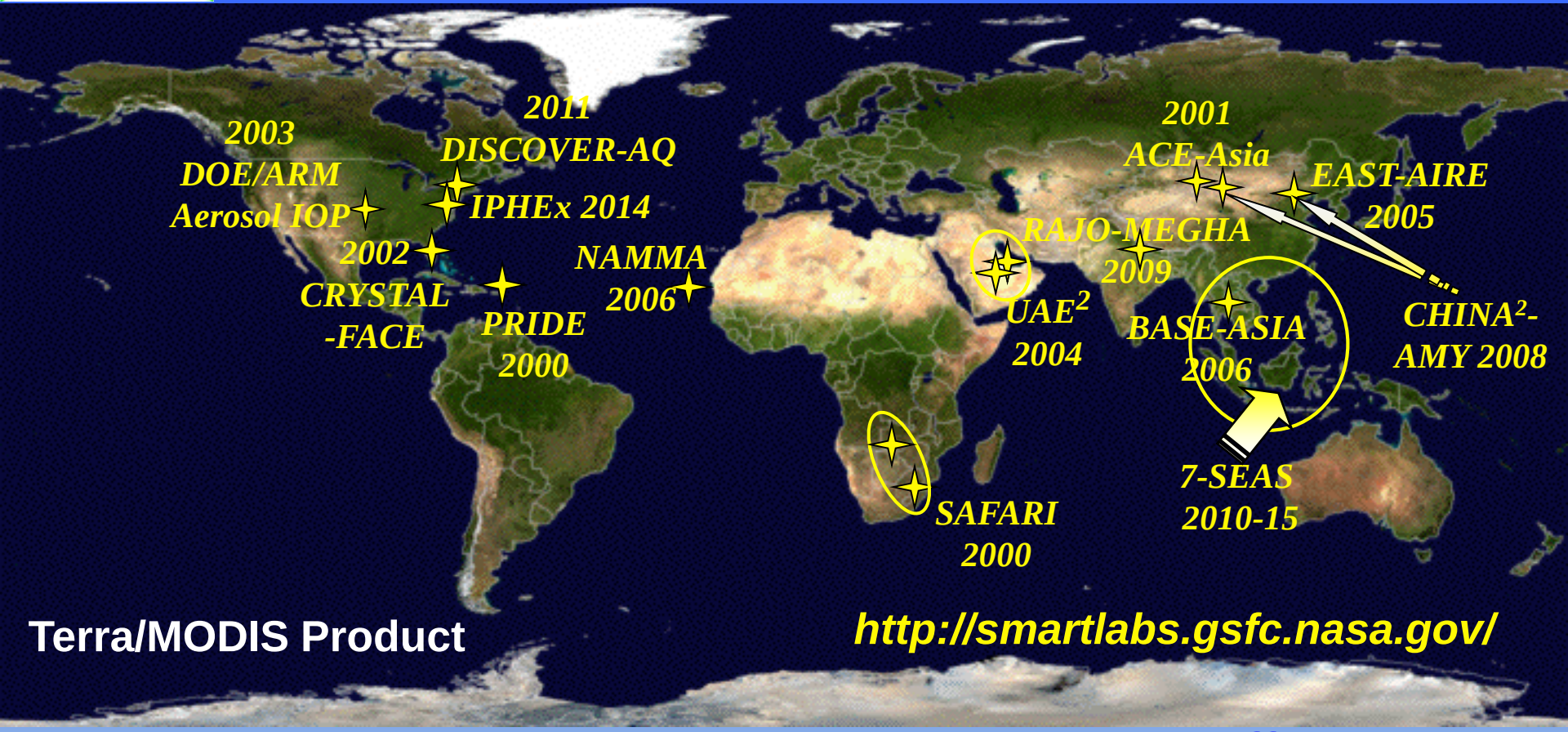


*Tsay, Maring, Lin, et al., 2017, Aerosol & Air Quality Research, in review.

Si-Chee Tsay, Deputy
EOS/Terra Project Scientist

September 21, 2016
NASA/GSFC

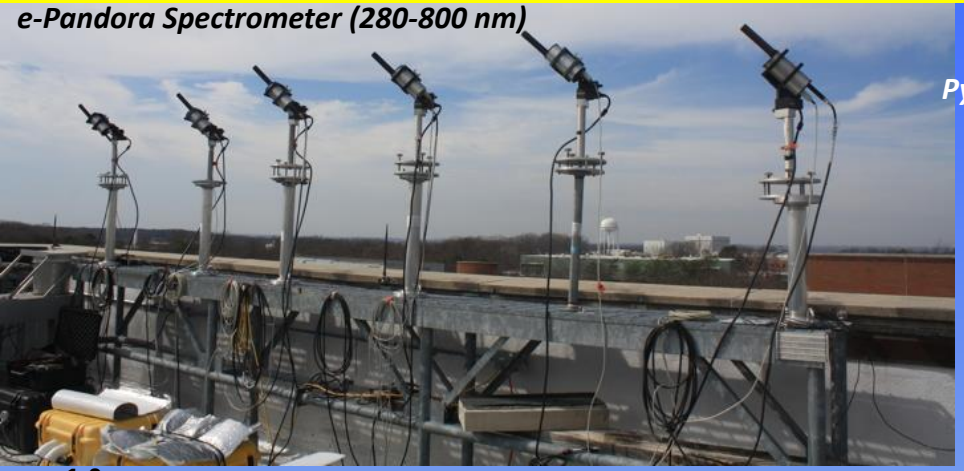
SMARTLabs: Surface-based Mobile Atmospheric Research & Testbed Laboratories

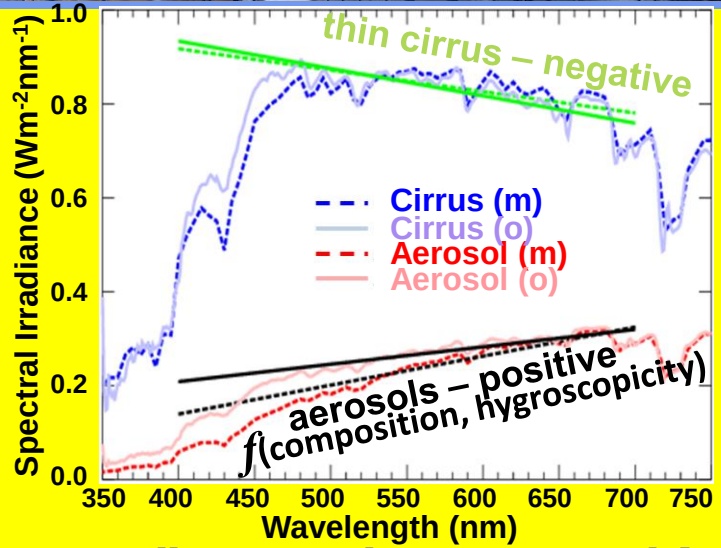


- *Small Operations (2-3 operators/scientists), yet Cost-Effective: over 10 countries on 3 continents for aerosol-cloud-radiation studies*
- *Achievements: >80 SMARTLabs publications since 2000 & many in process for the spring 2010-2015 7-SEAS deployments*
- *Future Missions: Cal/Val for S-NPP, GPM, …, and EV deployments*

SMART: Surface-sensing Measurements for Atmospheric Radiative Transfer (in mini-Network mode)

- *Better understanding of excess solar absorption*
- *Spectral Derivatives: partitioning subvisual cirrus & aerosols*
- *Lagrange-/DRAGON-like network deployment with AERONET*





Products:

- O_3, NO_2
- Cirrus (τ)
- Aerosols (τ)
- TDE-corrected solar irradiance
- Terrestrial irradiance

Applying Ideal Gas Law:

- Ji and Tsay, 2010: A novel non-intrusive method to resolve the thermal-dome-effect of pyranometers: *Instrumentation and observational basis*, JGR., 115, D00K21.
- Ji, Tsay, *et al.*, 2011: ----- *Radiometric calibration and implication*, JGR., 116, D24105.
- Tsay, *et al.*, 2016: ----- *From the lab to field measurements*, to be submitted.

- *Hansell, Tsay, et al., 2014, Spectral derivative analysis of solar spectroradiometric measurements: Theoretical basis, JGR, 119, 8908-8924.*

COMMIT: *Chemical, Optical & Microphysical Measurements of In-situ Troposphere*

Aerosol (& Precursor) ⇒ **CCN**

Hygroscopicity/Growth Factor*,^

- ✓ **Optical: Neph (Wet/Dry)**
- ✓ **Microphysical: SMPS (Wet/Dry)**
- ✓ **Activation (κ): *f*(Size, Comp, SS)**

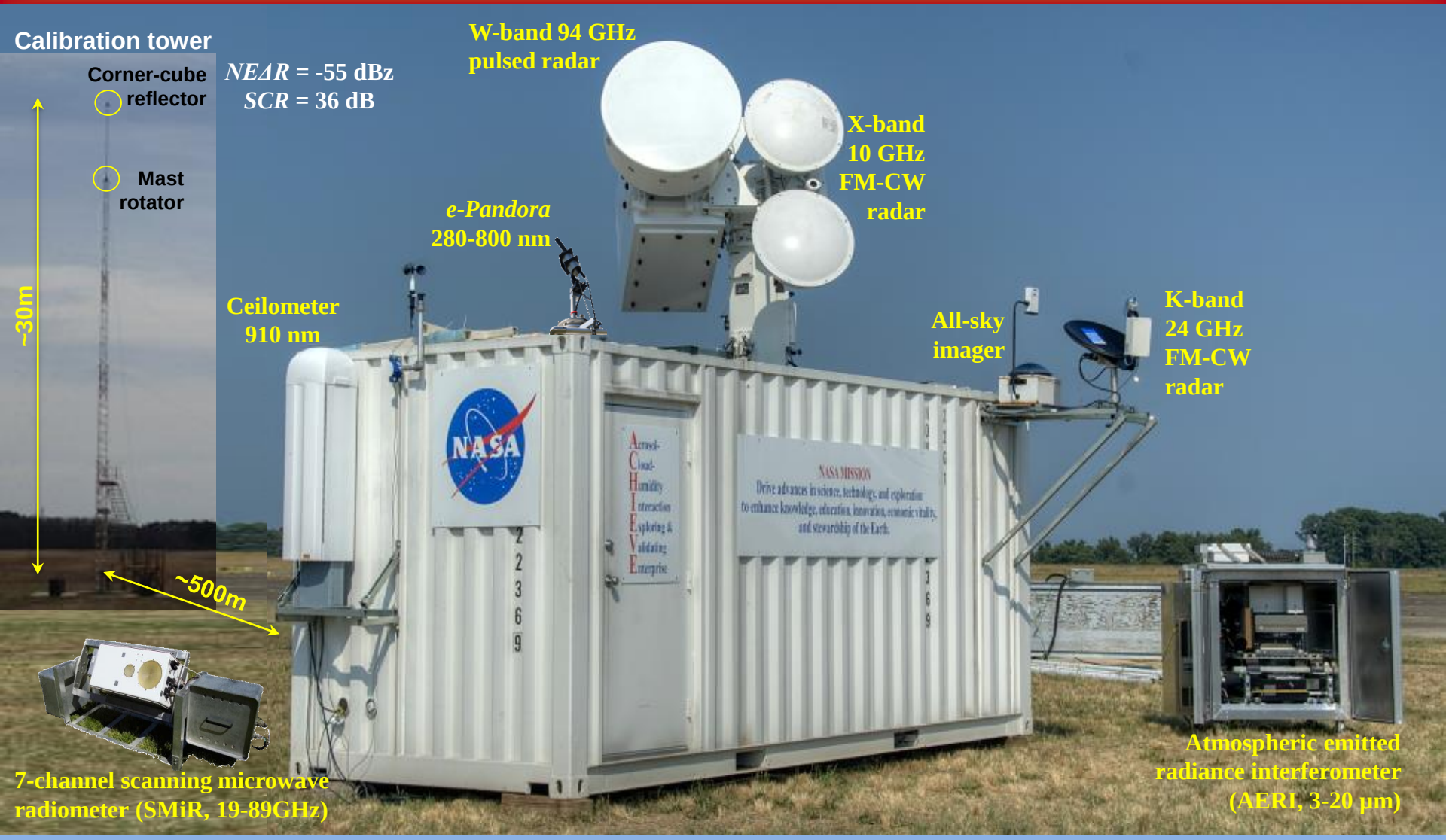
Host >25 instruments

- **Trace gas (CO, CO_2, SO_2, NO_x/NO_y, and O_3) concentrations;**
- **PM_1, $PM_{2.5}$, PM_{10} mass concentration;**
- **3λ-light (RGB) extinction; 3λ- & 7λ-light absorption;**
- **3λ-light scattering, in series operation for dry/wet conditions;**
- **Ambient size distribution (TSI/FMPS and TSI/APS);**
- **Wet/dry size distribution, in parallel operation (TSI/SMPS);**
- **Aerosol activation (DMT/CCN counter).**

Hsiao, Tsay, et al., 2016, Aero. Air Qual. Res., doi:10.4209/aaqr.2015.07.0447.

^***Pantina, Tsay, et al., 2016, Aero. Air Qual. Res.,*** doi:10.4209/aaqr.2015.011.0630.

ACHIEVE: Aerosol-Cloud-Humidity Interaction Exploring & Validating Enterprise



Products:

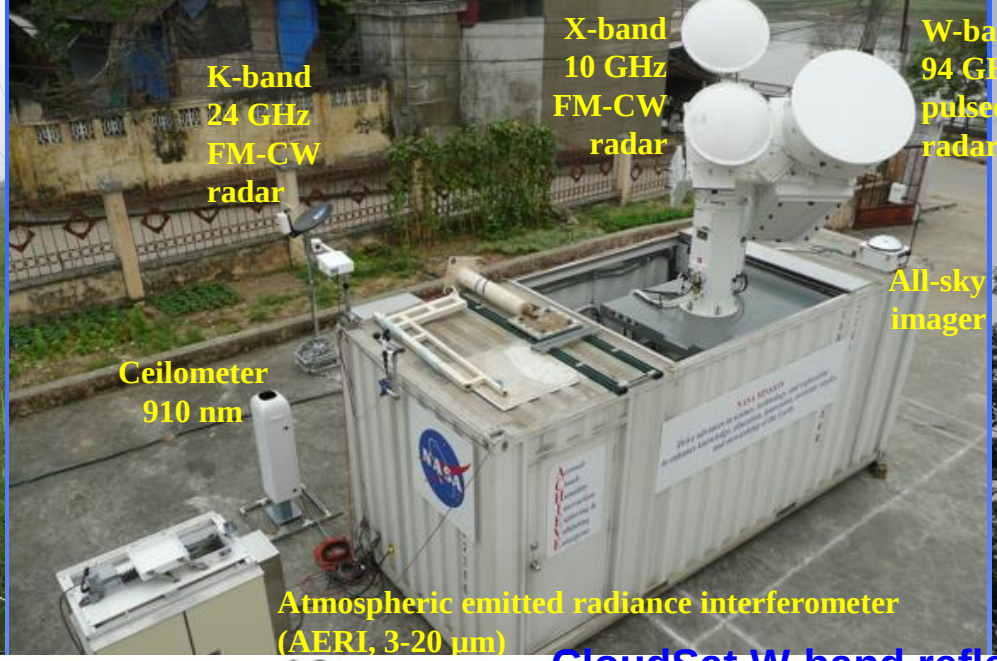
- *Cloud Optics/Radiation*: zenith downwelling radiance (UV–μwave), linear depolarization, reflectivity profile
- *Cloud Microphysics*: thermodynamic phase, water content, cloud-base/top/height, cloud fraction, Doppler fall-velocity, ice/liquid particle size (non-precipitation)

7-SEAS/BASELInE Data Products

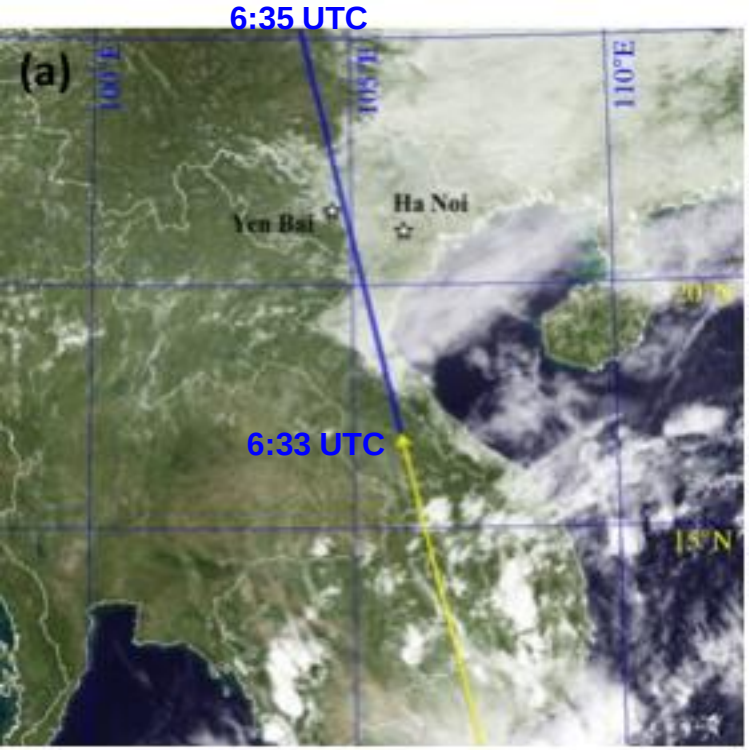
SMARTLabs/AERONET/MPLNET	Regional Instrumentation*
Trace Gas – Column: O_3, NO_2, SO_2, HCHO, CO, H_2O; – ***Surface***: CO, CO_2, O_3, SO_2, NO, NOx/NOy; – ***Profile***: NO_2, (O_3 in progress)	***Organic Carbon*** (OC): OC_1 (120°C), OC_2 (280°C), OC_3 (480°C), OC_4 (580°C), OP (pyrolyzed organic carbon, e.g., anhydrosugars, dicarboxylic acids)
Aerosol Optical Thickness: multi-spectral from UV to shortwave-IR, dust at longwave-IR, and extinction profile	***Elemental Carbon*** (EC): EC_1 (580°C – OP), EC_2 (740°C), EC_3 (840°C)
Aerosol Microphysics/Chemistry: size, mass, type, CCN, hygroscopicity, scattering/absorption/extinction	***Water soluble ions***: Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, Cl^-, NO_3^-, SO_4^{2-}, nss-SO_4^{2-}, NO^{2-}, F^-
Cloud Optical Thickness: multi-spectral from visible to longwave-IR	***Toxic***: Mercury, PCDD/Fs (dioxin)
Cloud Microphysics: size, liquid-/ice-water content, cloud-base/top/height, thermodynamic phase, Doppler fall-velocity, depolarization and reflectivity profiles	***Metal***: Ti, Mn, Co, Ni, Cu, Zn, Mo, Ag, Cd, Sn, Sb, Tl, Pb, V, Cr, As, Y, Se, Zr, Nb, Ge, Rb, Cs, Ga, La, Ce, Pr, Nd, Sm, Eu, Gd
Radiation Flux: surface solar and terrestrial irradiance	***UV radiation:*** spectral UV (erythemal) irradiance
Meteorology: P, T, RH, wind, mixed-layer height, precipitation, visibility	***Supplementary data***: sounding profile, sky image, particle spectroscopy/morphology, rainfall amount

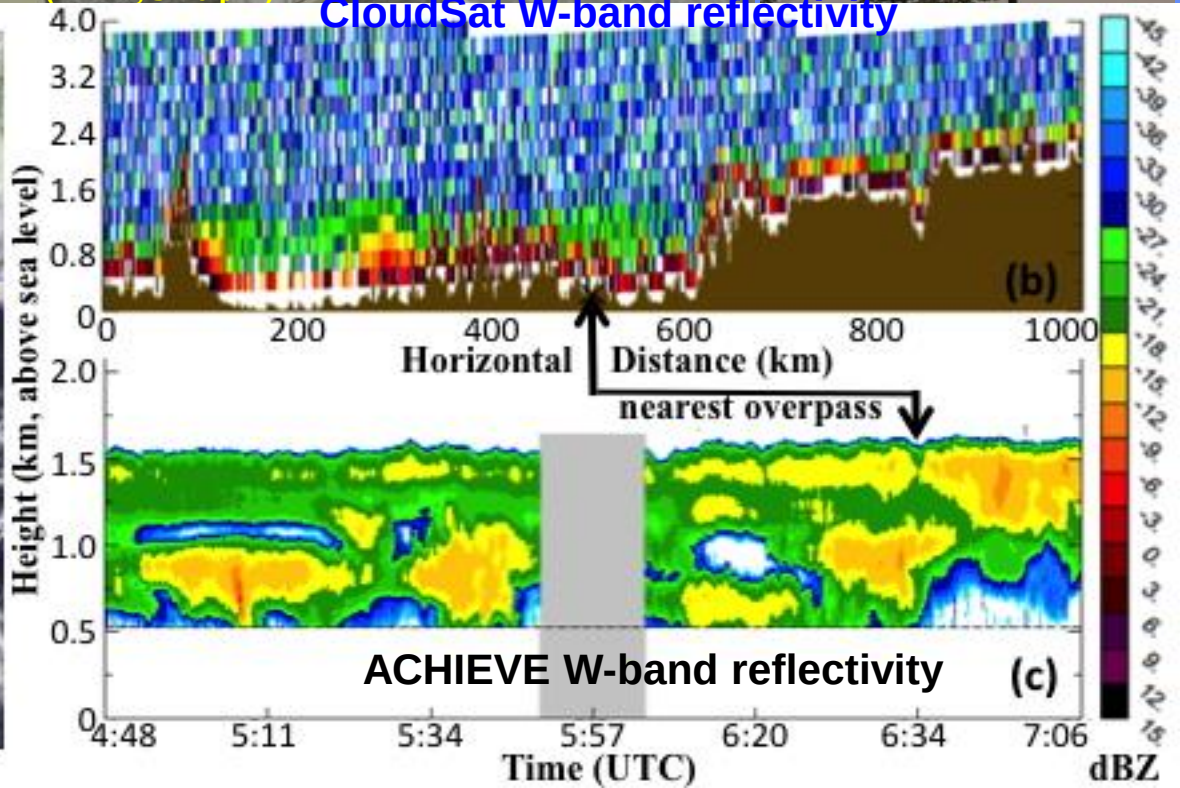
…(aeronet) …(mplnet)…
http://smartlabs.gsfc.nasa.gov

***nhlin@cc.ncu.edu.tw**

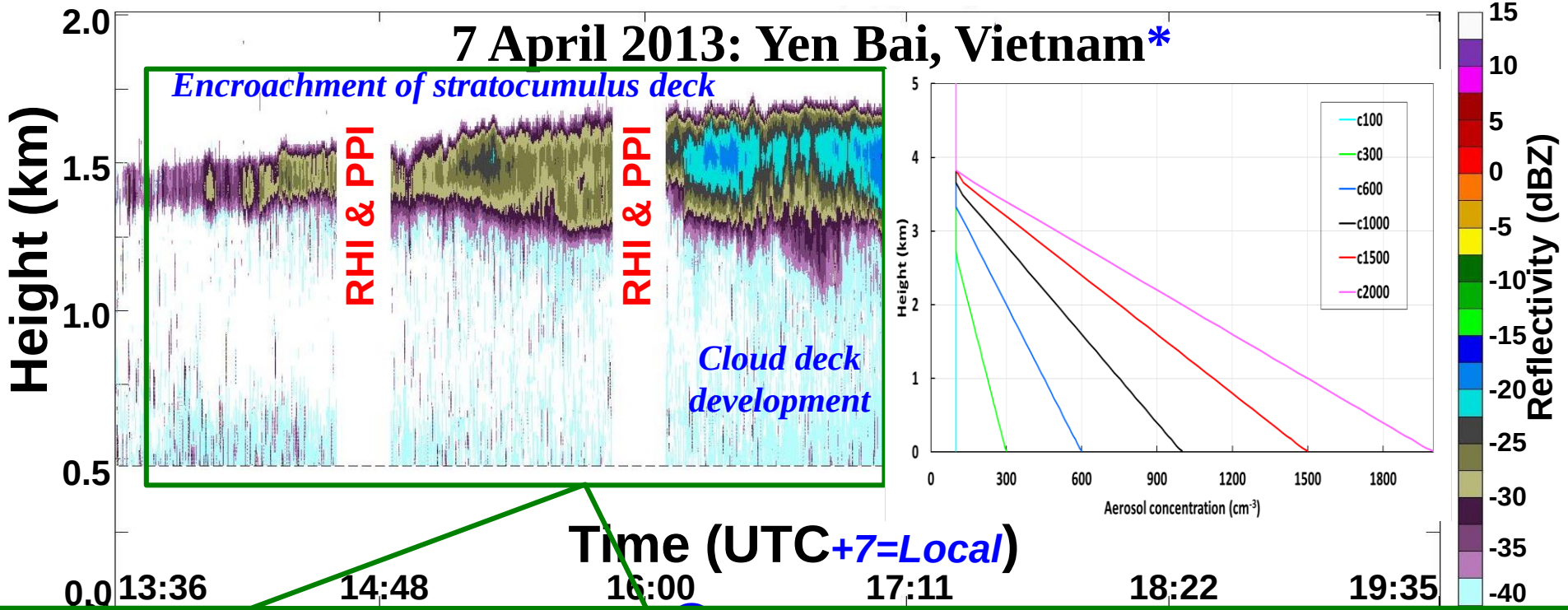

K-band
24 GHz
FM-CW
radar
X-band
10 GHz
FM-CW
radar
W-band
94 GHz
pulsed
radar
All-sky
imager
Ceilometer
910 nm
Atmospheric emitted radiance interferometer
(AERI, 3-20 μm)


Calibration tower

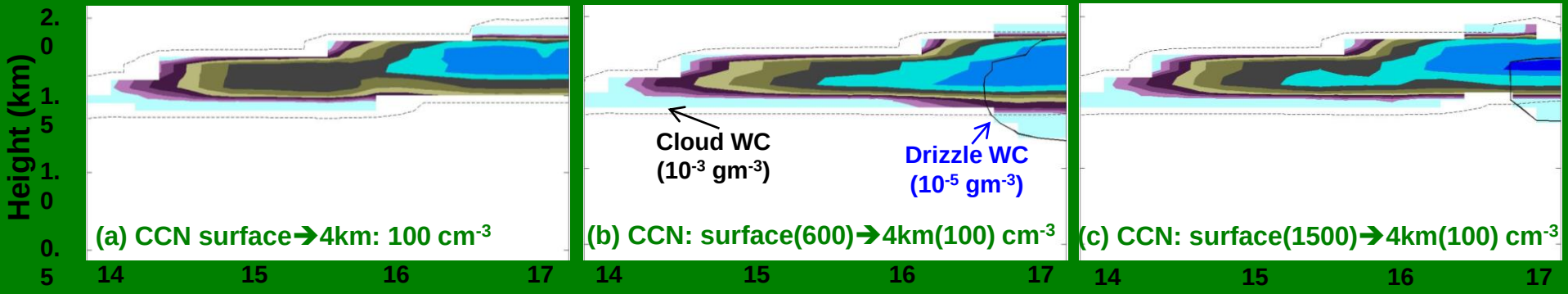

6:35 UTC
(a)
100°E
105°E
110°E
Yen Bai
Ha Noi
20°N
15°N
6:33 UTC


CloudSat W-band reflectivity
(b)
Height (km, above sea level)
4.0
3.2
2.4
1.6
0.8
0
0
200
400
600
800
1000
Horizontal Distance (km)
nearest overpass
2.0
1.5
1.0
0.5
0
4:48
5:11
5:34
5:57
6:20
6:34
7:06
Time (UTC)
ACHIEVE W-band reflectivity
(c)
dBZ

7 April 2013: Yen Bai, Vietnam*



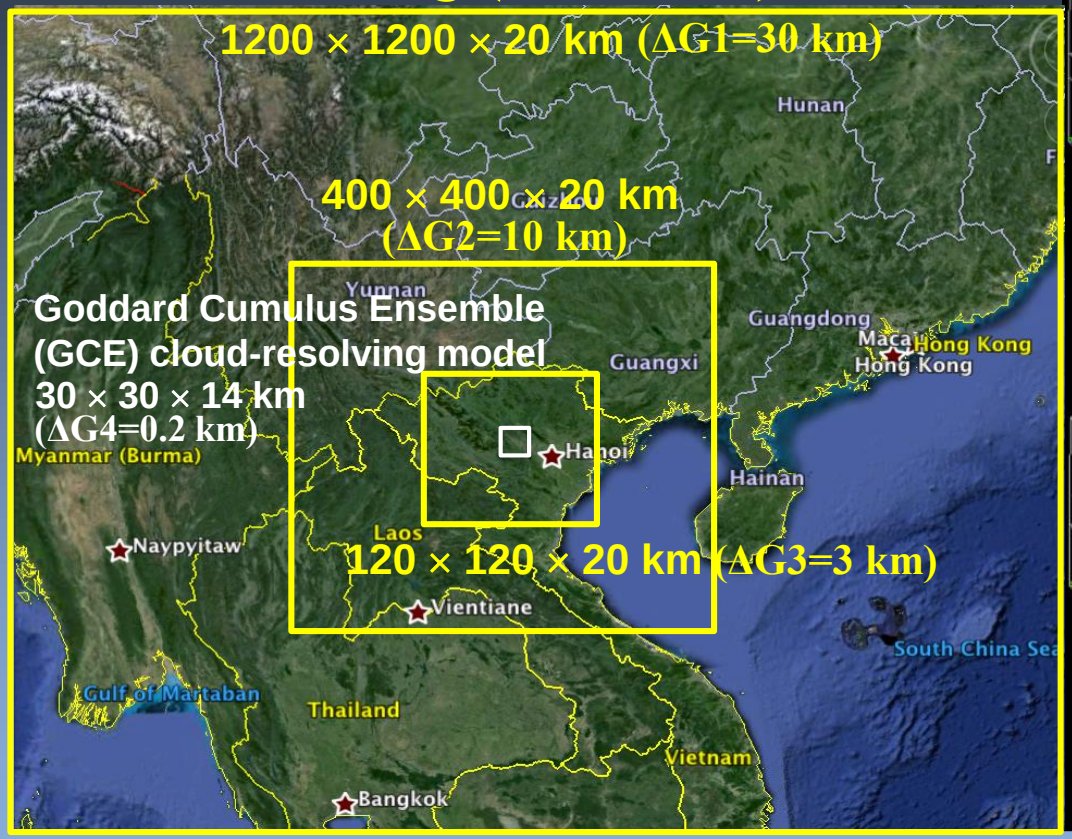
GCE with fully prognostic 3M-PSD: simulated W-band radar reflectivity by varying CCNs

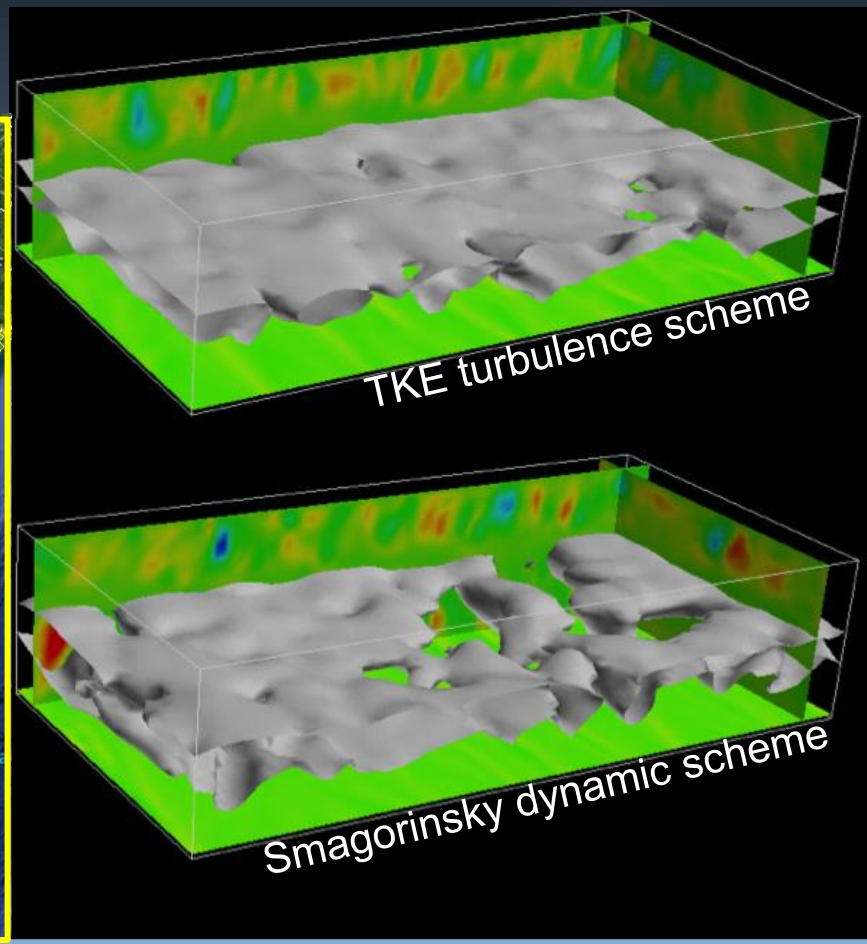


- As CCN increases, cloud droplet sizes decrease, number concentrations increase, cloud water content and integrated LWP increase; drizzle suppressed.
- Simulated reflectivity decreases with increasing CCN owing to more numerous smaller droplets and suppressed drizzle development.

Interaction & Lifecycle Simulations

NASA Unified Weather Research & Forecasting (NU-WRF) model

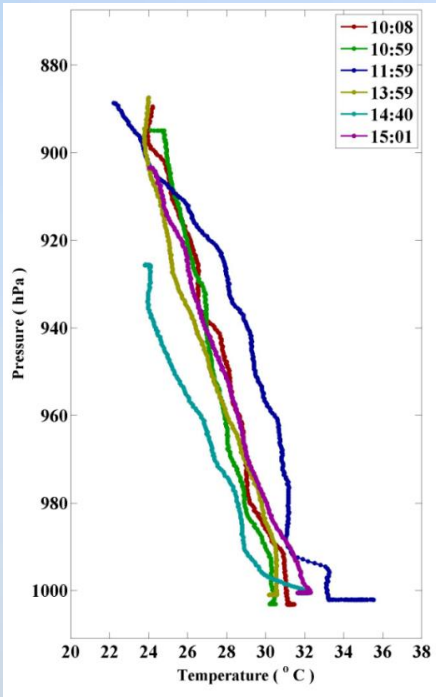


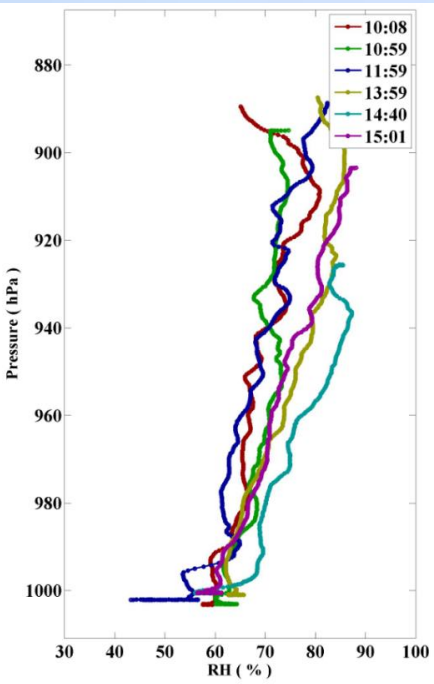


- **RAMS bulk aerosol module: aerosol hygroscopicity as function of species-dependent soluble fraction parameter (ε), analogous to the κ-parameter**
- **3M-bulk microphysics scheme: hydrometeor size distribution as function of mass mixing ratio (q), total number concentration (N_t), and distribution spectral width parameter (ν)**

Drone Measurements: Atmospheric (& Aerosol) Profiling

T & RH profiles

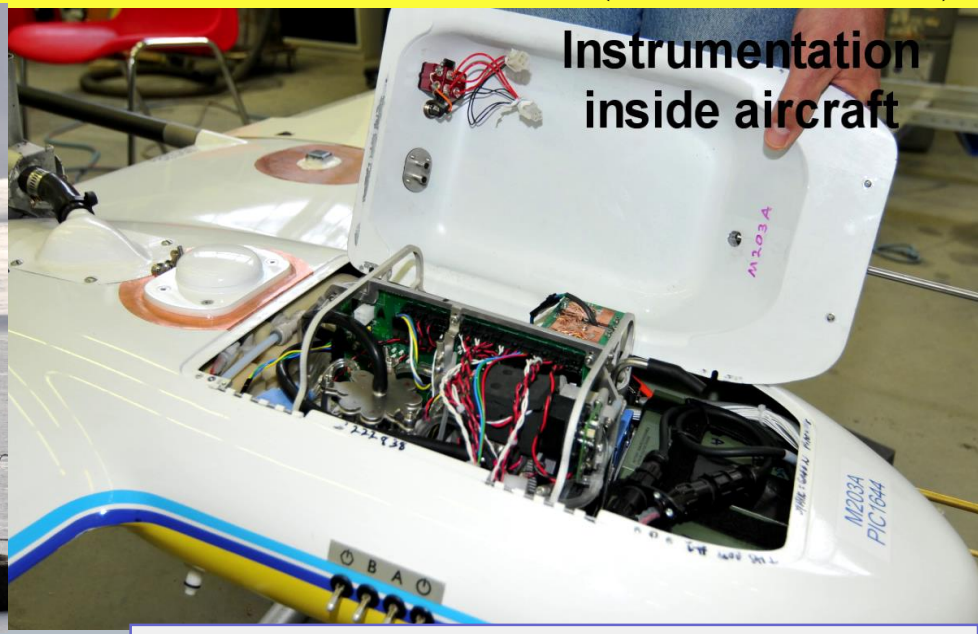




	Specifications
Max. Payload	4 kg
Max. altitude	1200 m
Measured parameters	Pressure, Temperature, RH, Radiation flux, PM conc.

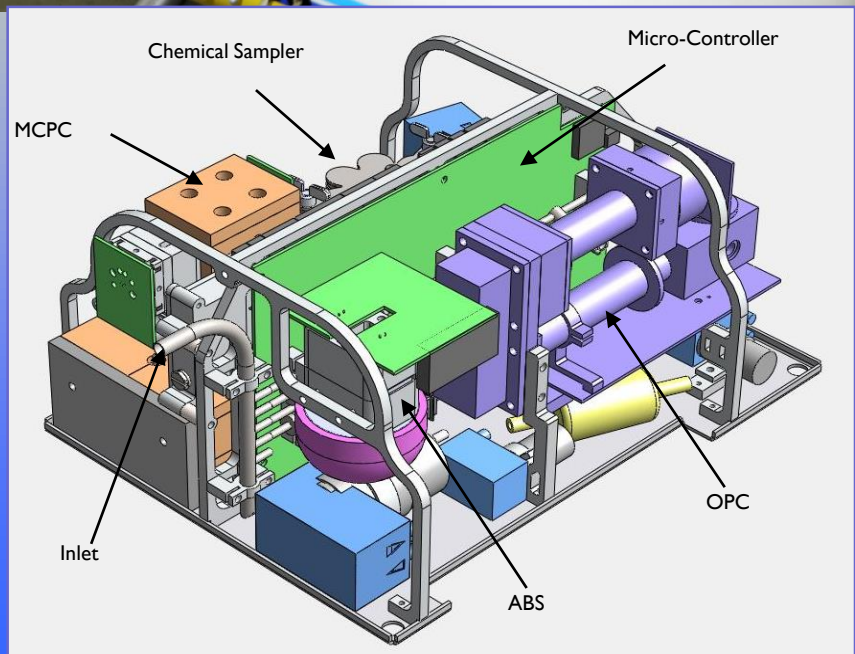
Aerosol Counting Composition Extinction and Sizing System

ACCESS (BRECHTEL 9400)



ACCESS includes:

- Mixing-based Condensation Particle Counter
- 3-wavelength absorption photometer
- 8-channel automated filter sampler
- Optical Particle Counter
- Total power at 12 VDC: 60 watts
- System size: 10(L) x 8(W) x 6(H) inches
- System weight: 9.5 lbs (without battery)



Brief Summary

- *A synergy of satellite, aircraft, and ground-based network (snapshots at spectral, spatial, temporal, and angular dimensions) measurements, together with physics-based modeling (process continuity) will greatly advance our understanding of interactions between extensive layers of aerosol and cloud, radiation, precipitation.*

- *Interdisciplinary and international collaborations are essential for quantifying fresh water redistribution, one of the greatest problems in the 21st century (e.g., NASA strategic plan, 2012).*

To Be Continued …