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Aerosol Composition and Volatility in TTL - In situ Balloon Borne Measurements and sampling over Biak Indonesia -

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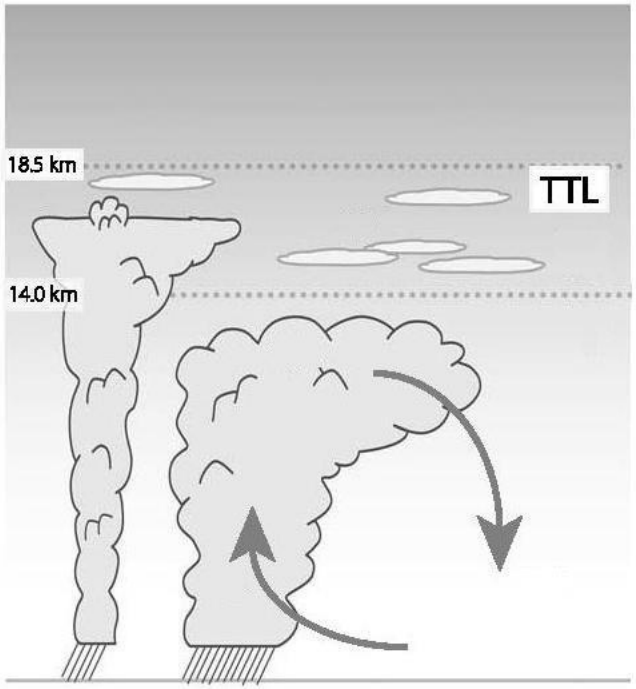
Outline

- Introduction and purpose
- Observation : Instruments and method
- Results

  Volatility of TTL aerosol over Biak, Indonesia observed in January of 2011, 2012 and 2013 and estimation of TTL aerosol constituents
- Sample return at Biak in 2015(, and analyses)
- Summary

Why do we observe aerosols?



・SOWER（Soundings of Ozone and Water in the Equatorial Region）have been trying to understand how do TTL processes control water vapor budget in stratosphere.

・One of key processes : cirrus and deep convective cloud.
・Any cloud needs aerosols as nuclei to form ice crystals and cloud droplets.

One symbolized question
Why such high super saturation (Rhi : 150%) appeared in TTL.

Aerosol cloud help to understand cirrus behavior in TTL.
Which kind of aerosol exist in TTL
How many particles exist in TTL.
How they are activate as nuclei in TTL.

Targets and observations

Aerosol composition, state and concentration in TTL by balloon borne observation

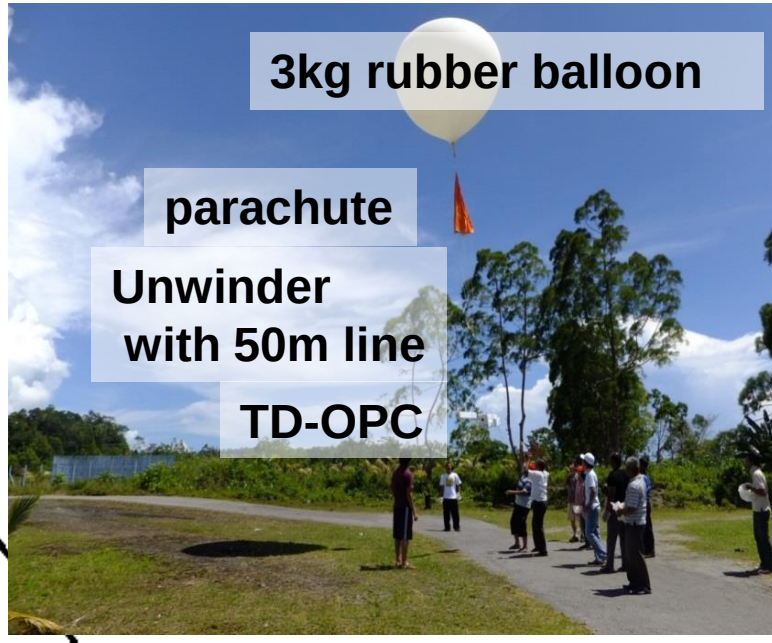
1. Volatility measurement using Thermo-Denueding Optical Particle Counter sonde (TD-OPC sonde)

2. Direct sampling using balloon borne impactor and elemental analyses using SEM-EDX

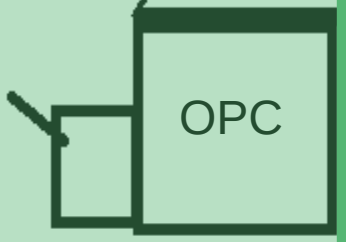
TD-OPC sonde : Thermo-Denuding Dual OPC

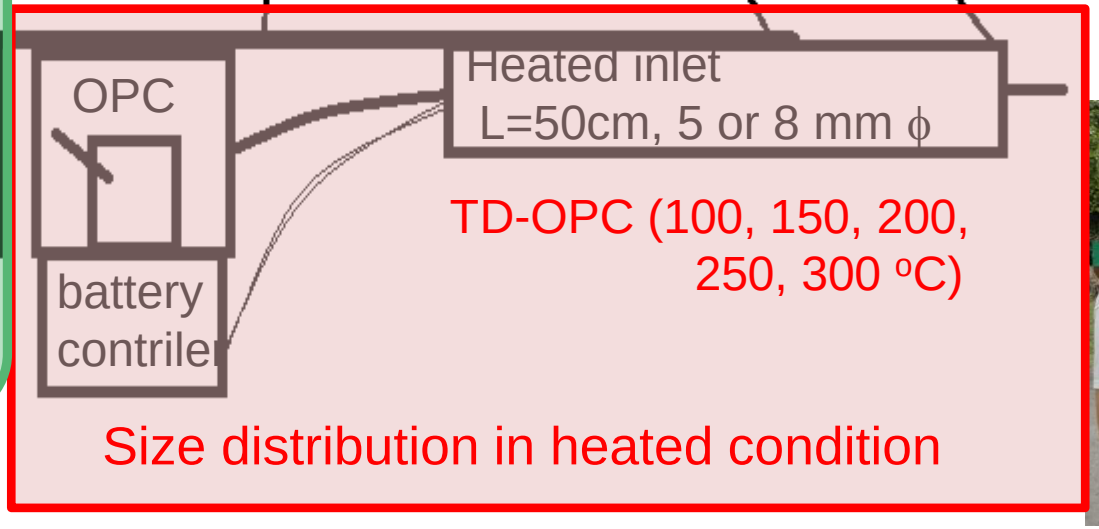
OPC ： Optical Particle Counter
Flow rate ：3 liter/min
Size discrimination：D > 0.3, 0.4, 0.5,0.8, 1.2,
2.0, 3.4, 5.0, 7.0, 11.4μm
Integrated period：4 sec
Height resolution: 20m

GPS sonde（RS06G Meisei Co. Ltd）
Temp., humidity, height (GPS), wind（GPS）



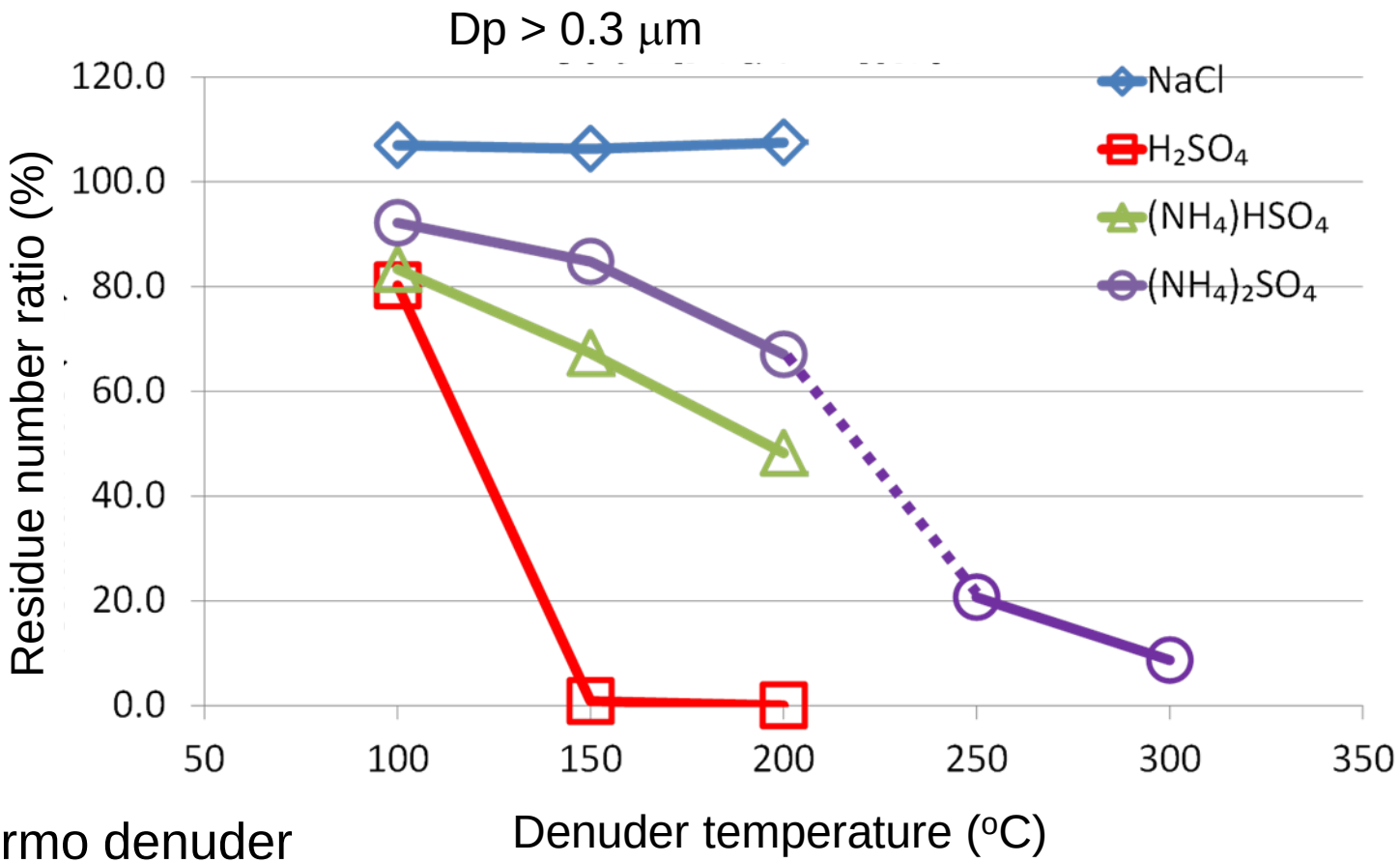
Size distribution
in ambient condition





TD-OPC, 5 kg

volatility v.s. denuder temp. for test particles in 1 atm



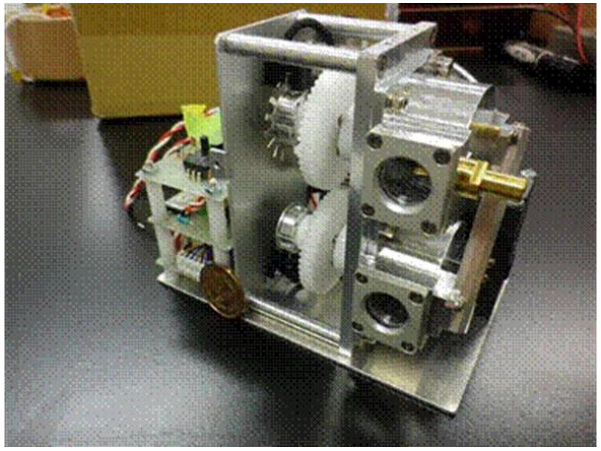
Thermo denuder
L = 50 cm,
ϕ= 5 or 8 mm,
sample flow rate
= 3 L/min
Residence time
≒ 0.1 or 0.25 sec

Sulfuric acid solution	: volatile completely
Ammonium sulfate	: steep slope
Ammonium bi-sulfate	: moderate slop
Sodium chloride	: flat

Aerosol sampling and individual particle analyses in 2015

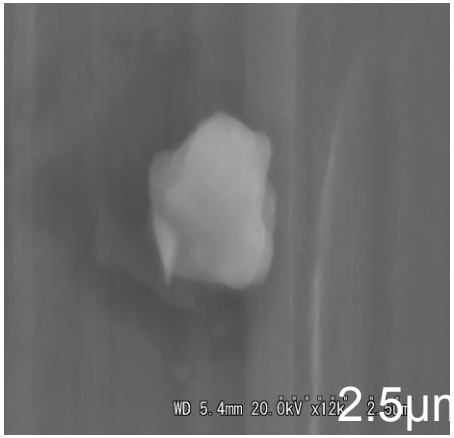
Aerosol sampling sonde (ASS): Two stage impactor with water proof arrangement

Dimension : 80 × 105 × 130 mm
Weight : 3000g (Including case)
Sampling rate : 1.6L/min at 1atm
Nozzle dia. : 1.3mm, 0.5mm
Cut off dia. : 1.4μm, 0.25μm
Sample numbers : 16 samples
Sampling duration : 3 minutes (variable)

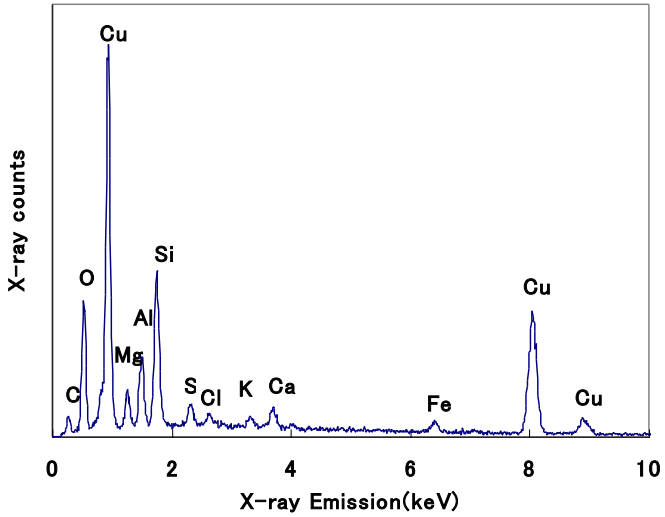


Analyses: individual particle analyses in the laboratory

Morphology by SEM



Elemental composition by EDX



Cray mineral collected at 1100 m over Japan on April 13th, 2008

observation

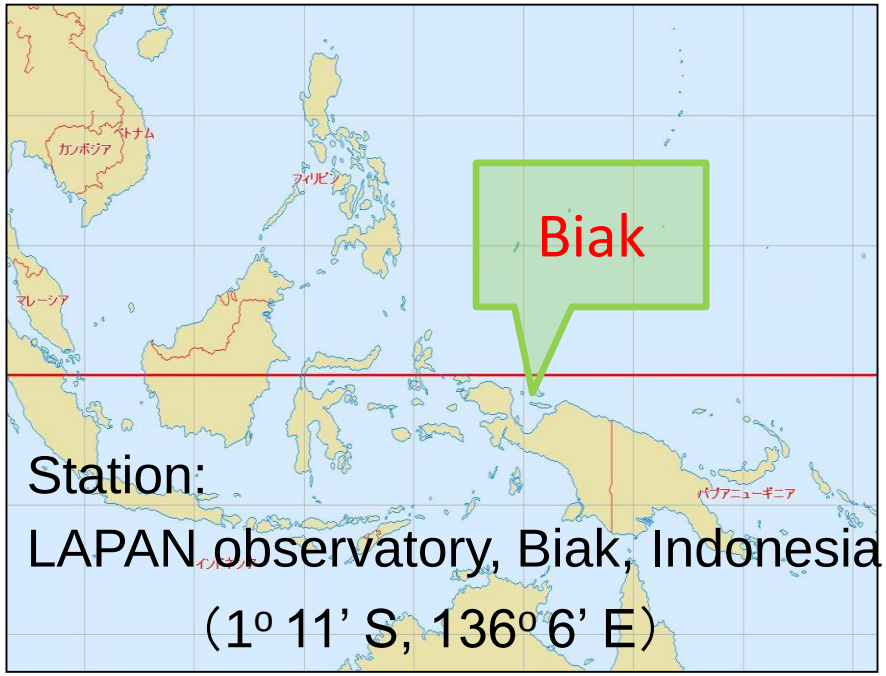
2011/1/4～1/13
- 1/ 7 OPC
- 1/10 TD-OPC (200)

2012/1/5～1/17
- 1/10 TD-OPC (200)
- 1/11 TD-OPC (150)
- 1/12 TD-OPC (100)

2013/1/4～1/14
- 1/ 9 TD-OPC (200)
- 1/10 TD-OPC (300)
- 1/11 TD-OPC (250)

2015/2/16～3/2
- 2/25 ASS
- 2/27 TD-OPC (200)
- 3/1 ASS

SOWER - Biak

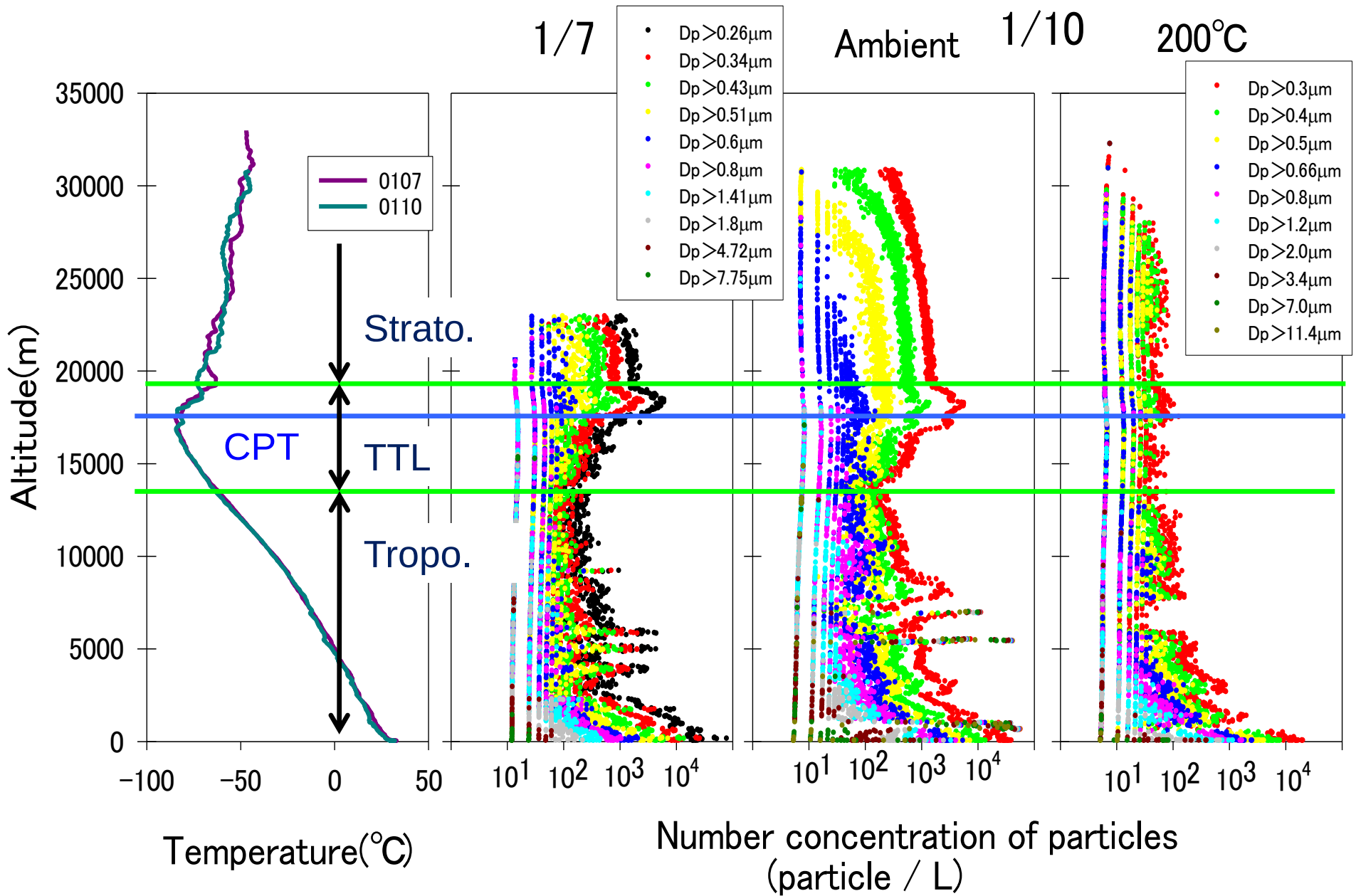


Fukuoka Univ. OPC(size distribution and volatility)

Nagoya Univ. Lidar（Nd:YAG 1064nm, 532nm, DPR）
HIVIS sonde

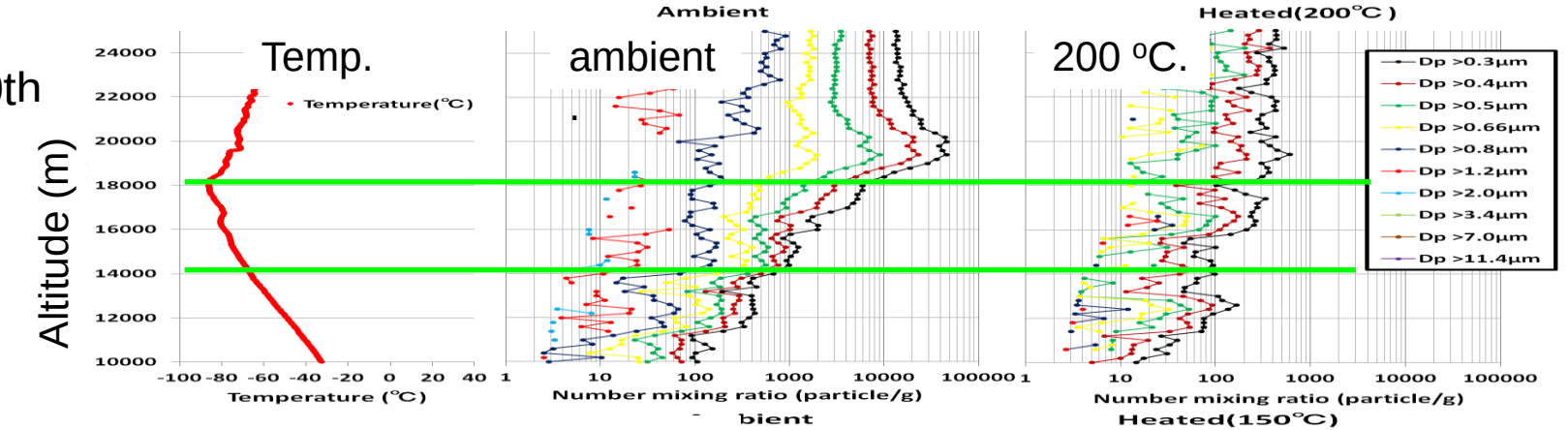
Hokkaido Univ. CFH (H2O), ECC ozone sonde, Flash, Fine dew, etc

Aerosol concentration profiles over Biak, January 2011

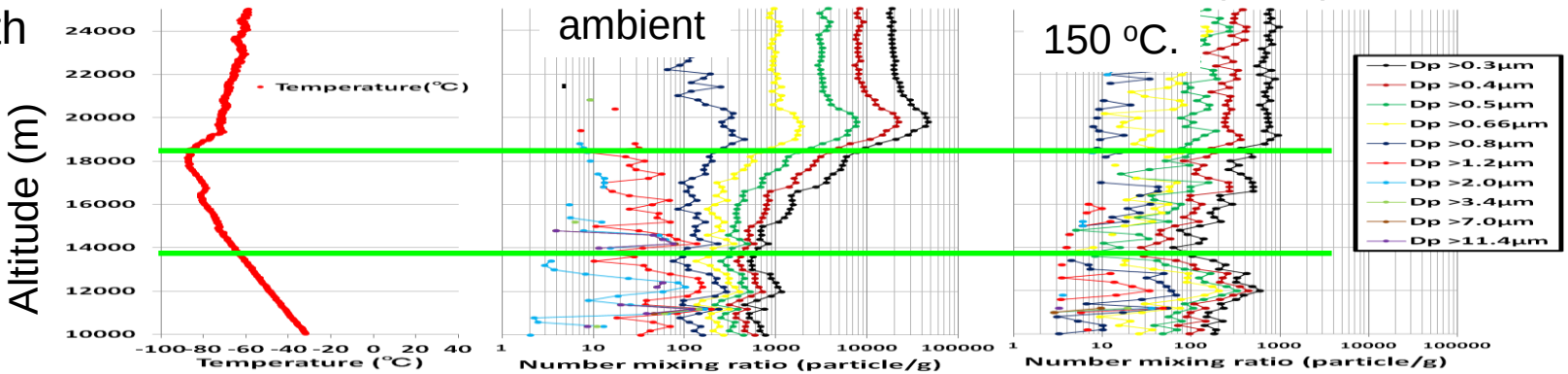


Aerosol concentration profiles over Biak, January 2012

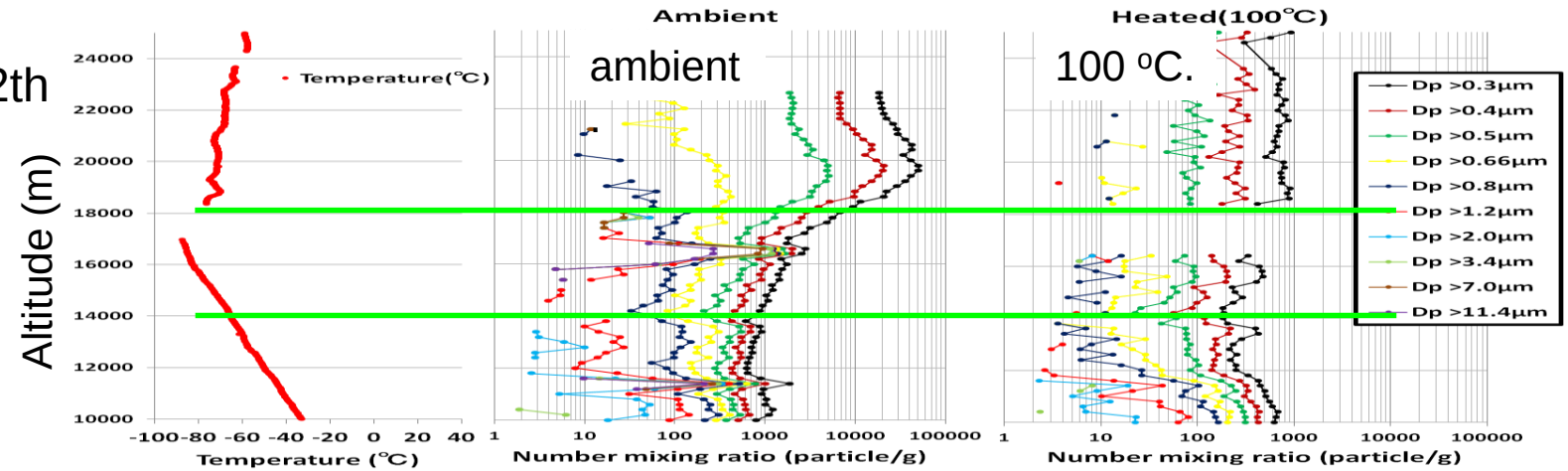
Jan. 10th



Jan. 11th

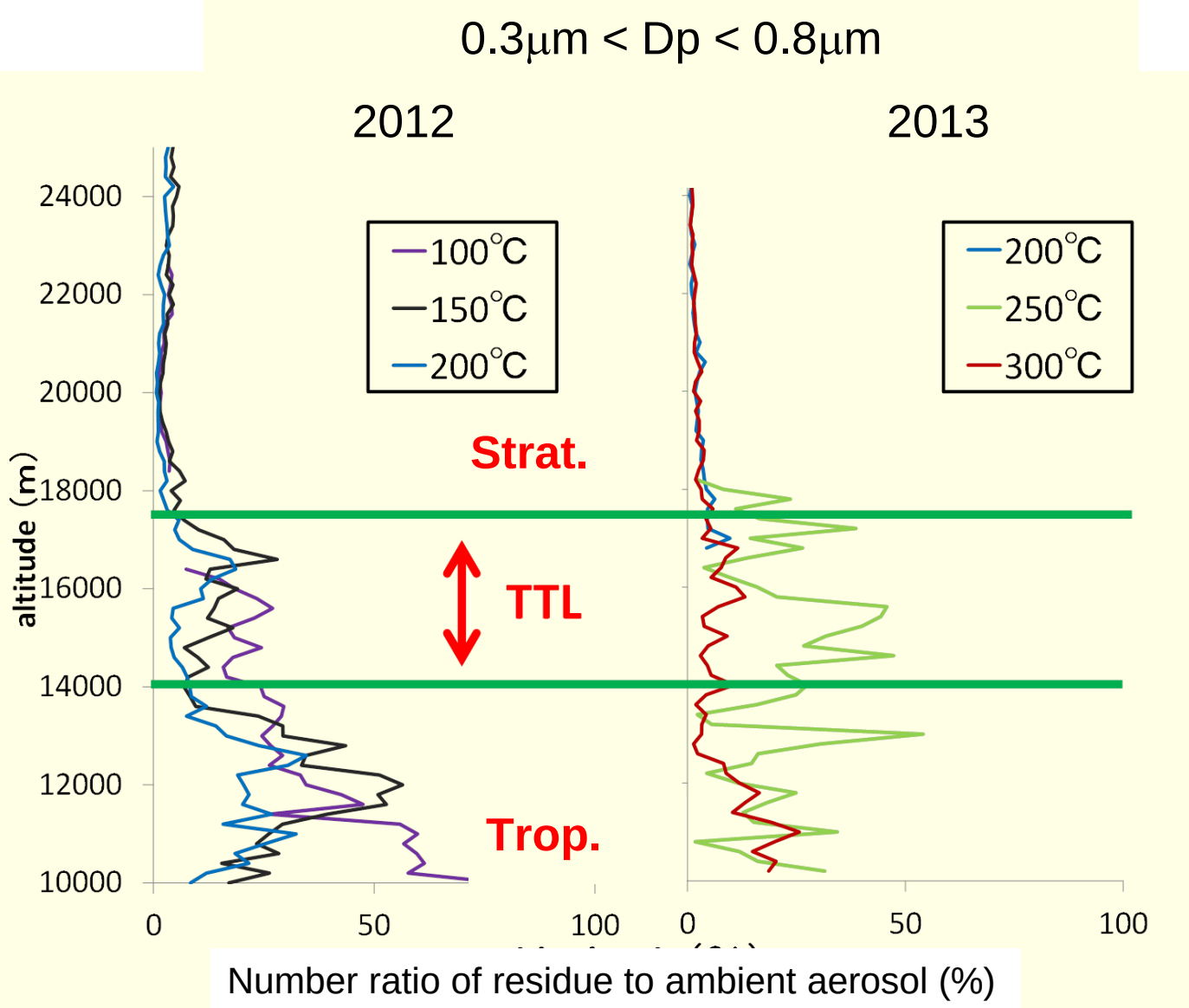


Jan. 12th

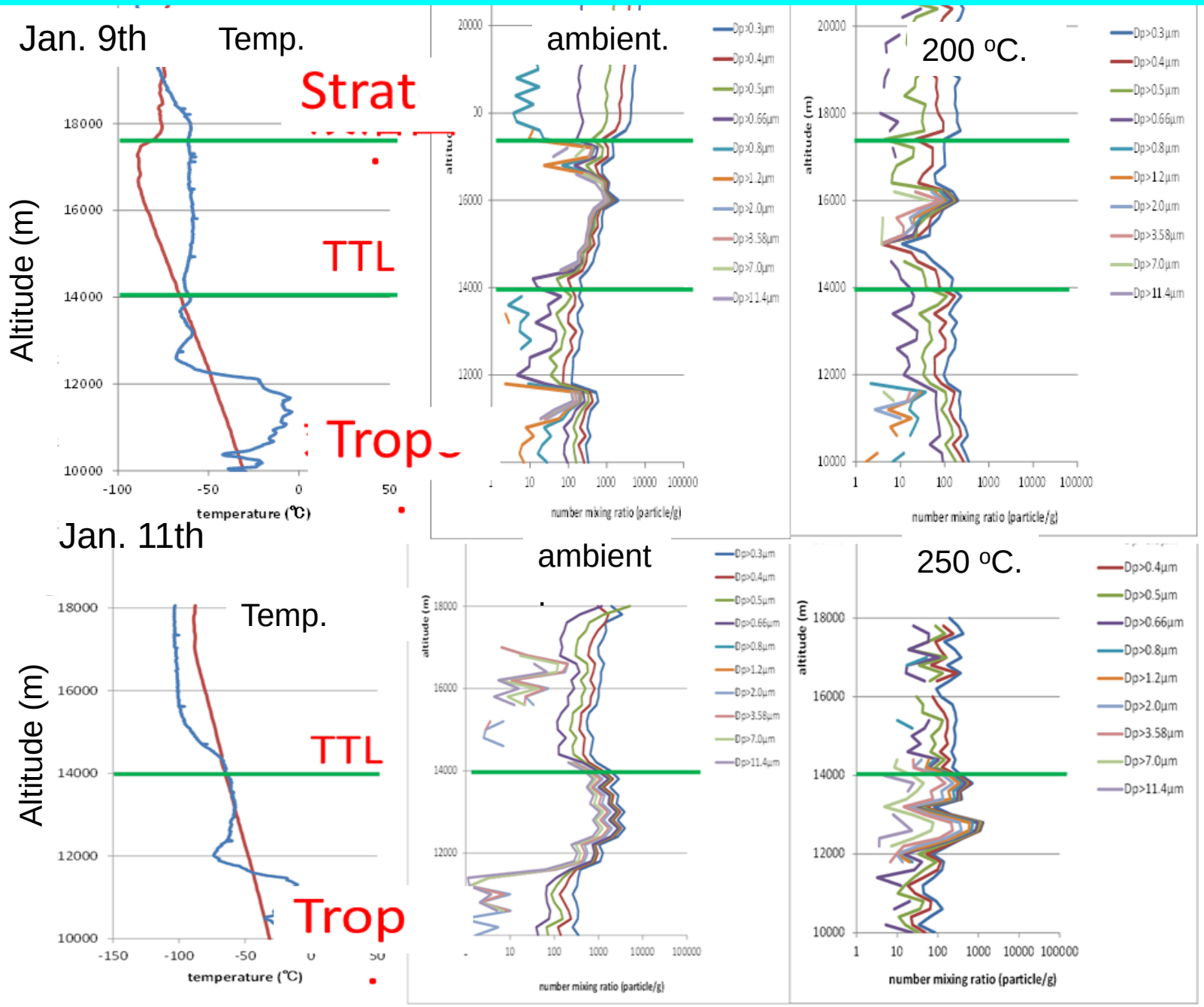


Ratio of residue to ambient aerosol in Jan., 2012 and 2013

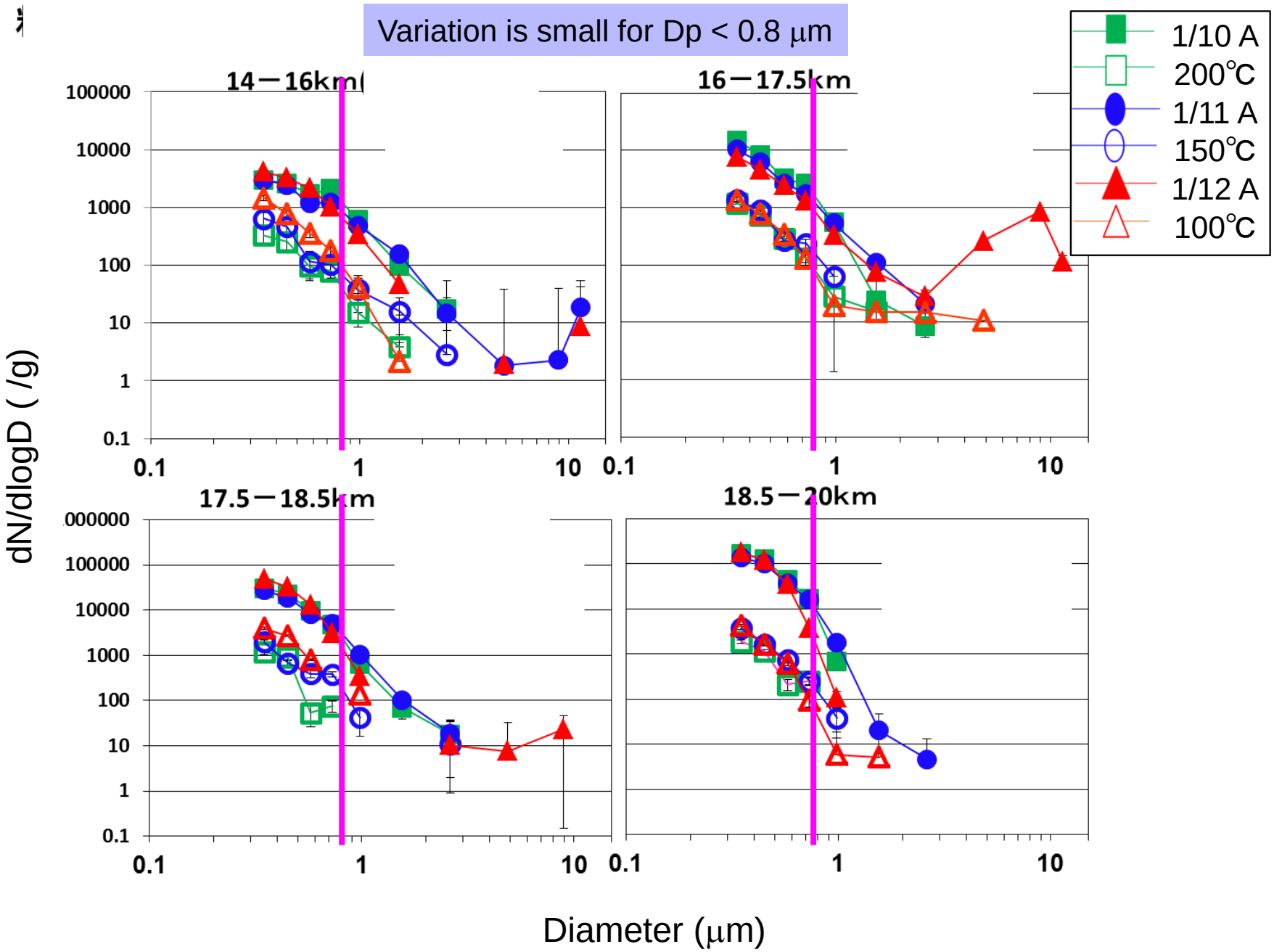
High and variable non-volatile constituent fraction in TTL



Cloud brings low volatile constituent to TTL, January 2013

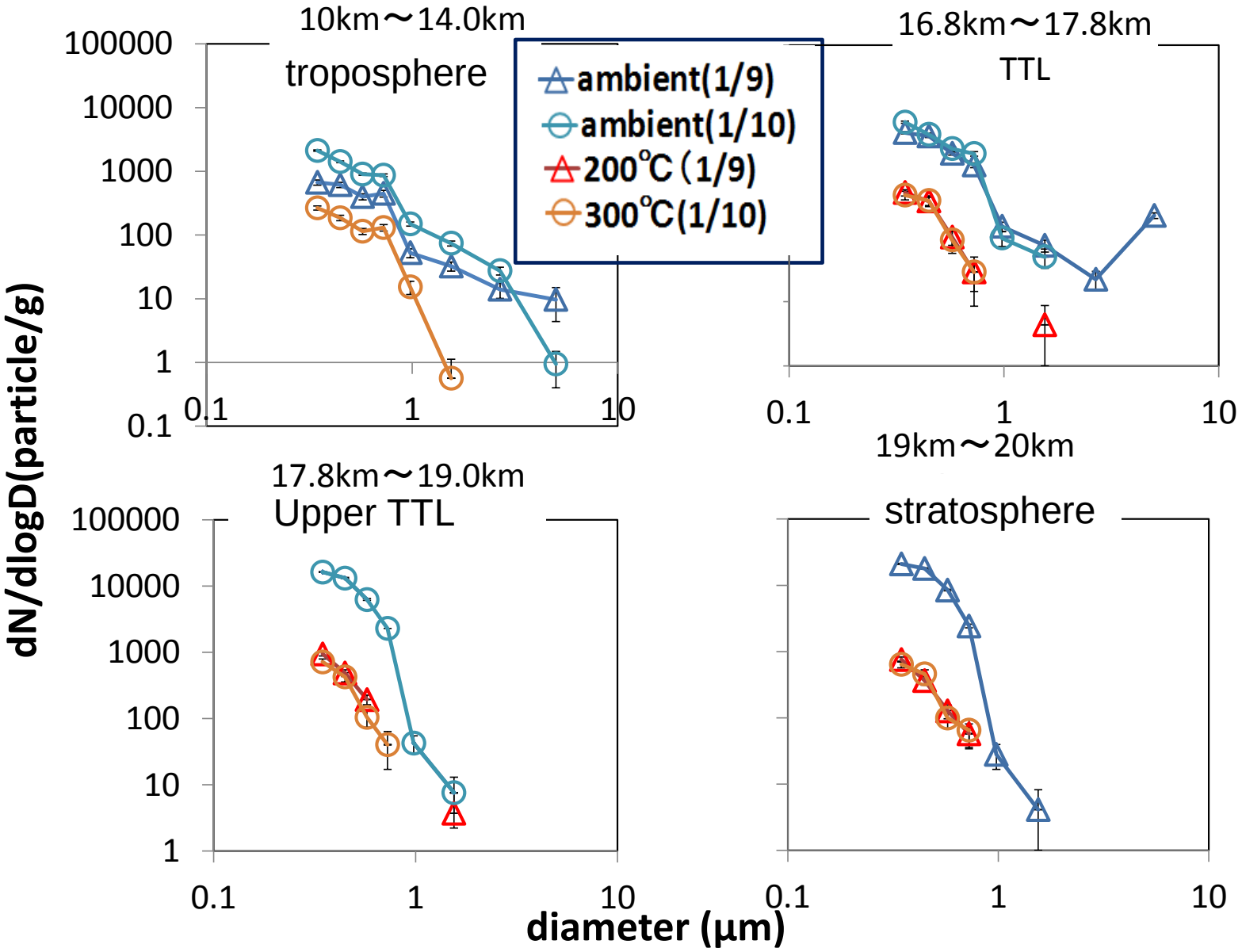


Size distributions in ambient and heated conditions, Jan., 2012

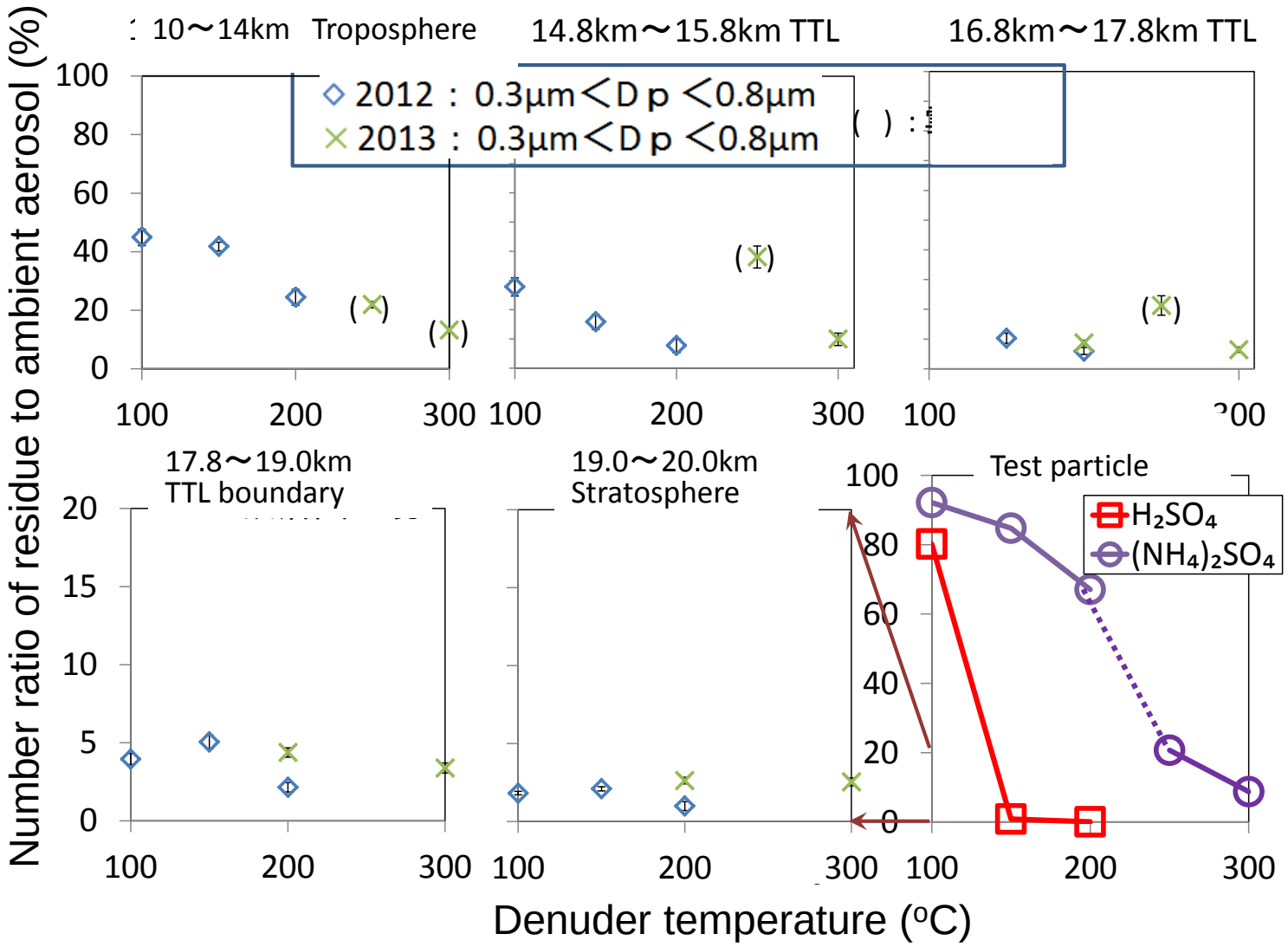


Size distribution in ambient and heated conditions in Jan., 2013

High uniformity of size distribution of low volatile constituent in TTL and stratosphere,



volatility v.s. denuder temp. : Composition estimation



Sulfate solution or sulfuric acid internaly / externaly mixed with low volatility constituents for 0.3 < Dp < 0.8 μm.

low-volatile constituent : Sea salt? Organic carbon? Soot? Mineral?

Aerosol sampling and individual particle analyses in 2015

Aerosol sampling sonde (ASS): Two stage impactor with water proof arrangement

Dimension : 80 × 105 × 130 mm
Weight : 650g
Sampling rate : 1.6L/min
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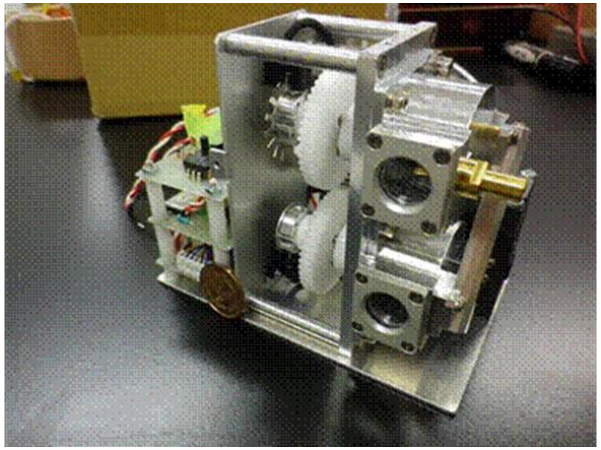

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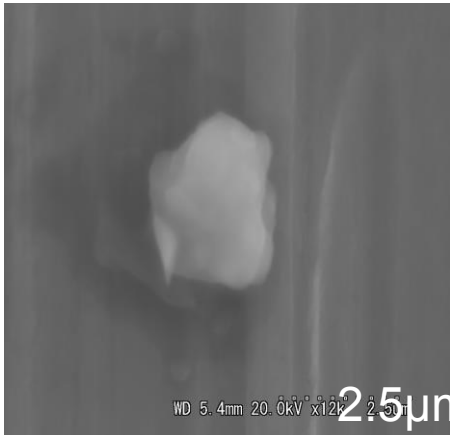
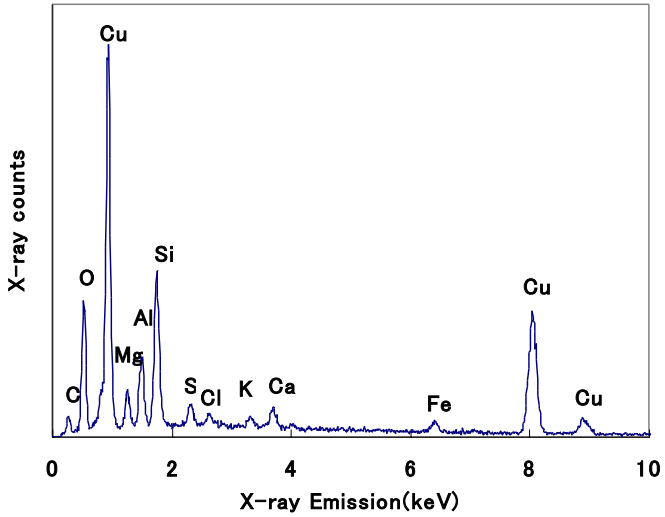


Elemental composition by EDX



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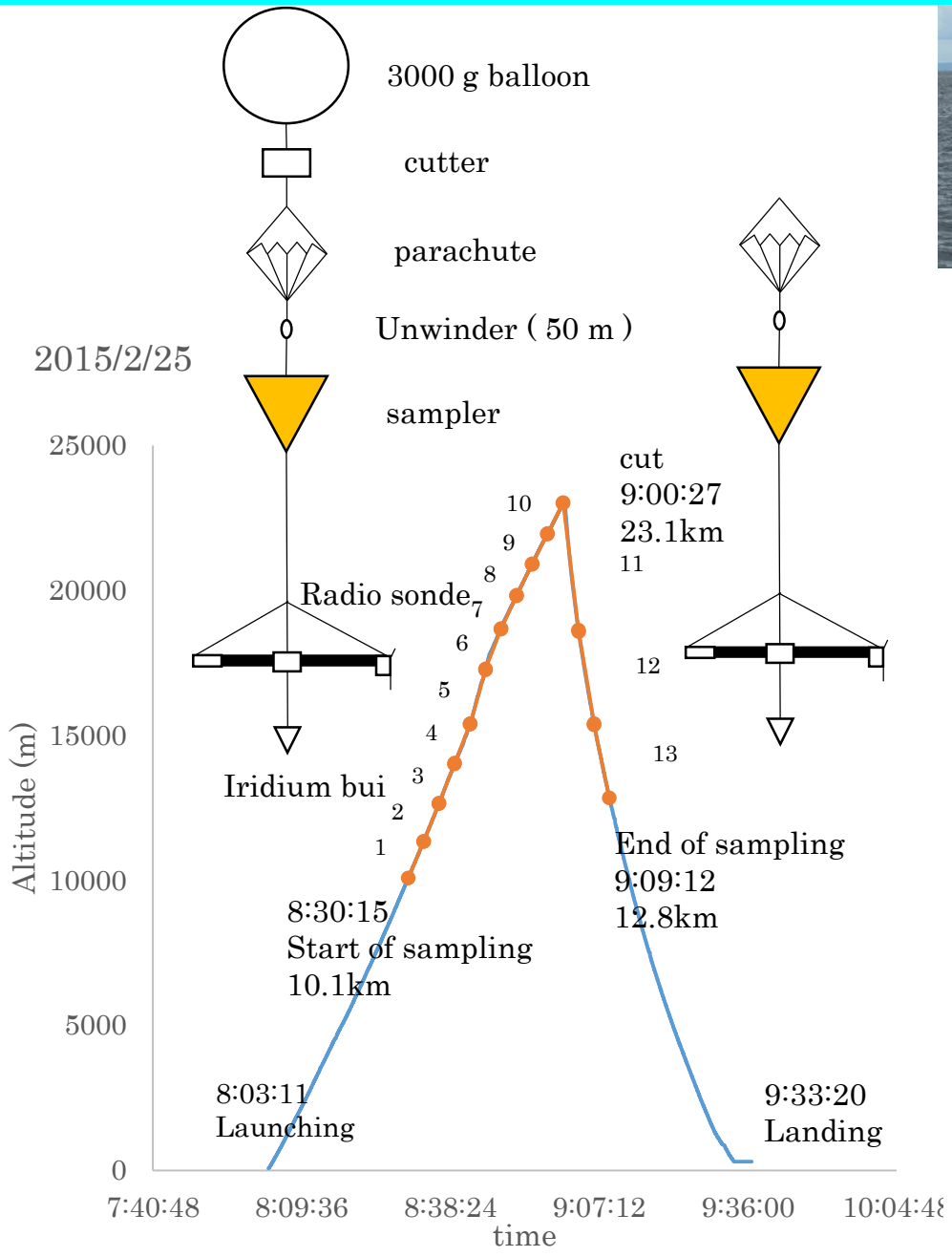

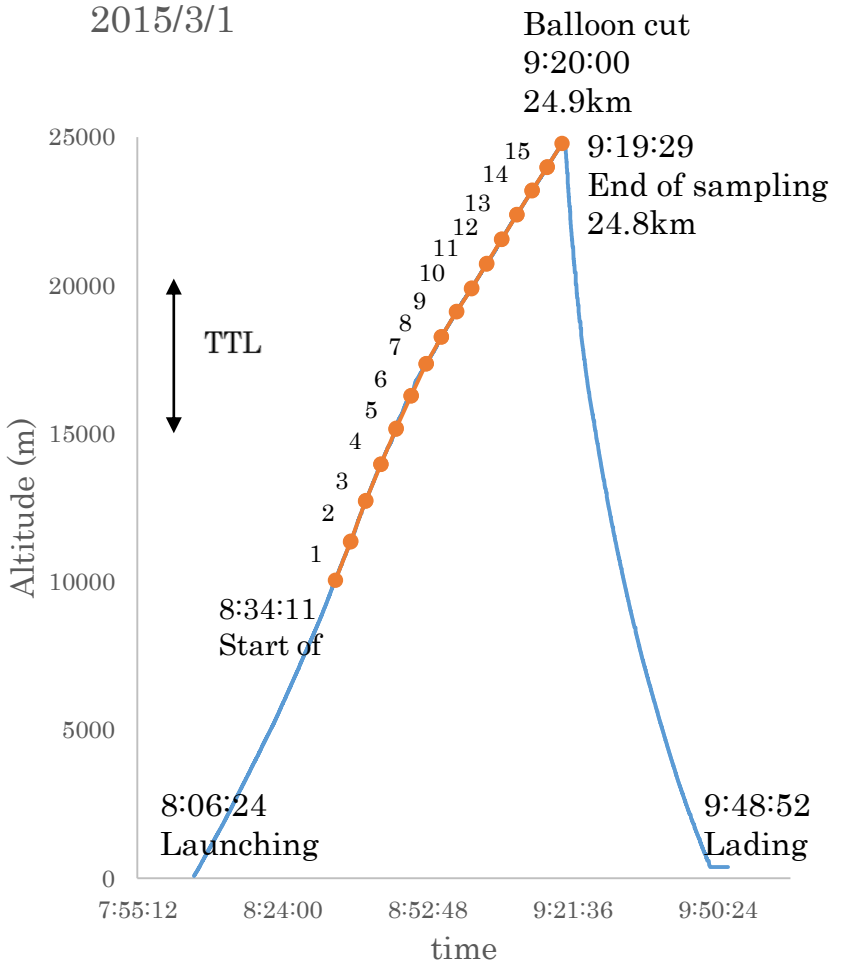

Summary
- Volatility and composition of TTL aerosol-

1. Volatility of TTL aerosol was observed by balloon borne thermo-denuding OPC at Biak in January of 2011, 2012 and 2013 and show as following,

- Major constituent of TTL aerosol is sulfate and low volatile constituent are commonly included as minor, whose origin is both in troposphere (sea salts?) and stratosphere (organic carbon? Meteorite?).

  a) Mixing ratios of residue aerosol in TTL is lower than those in stratosphere
  b) Number ratios of residue to ambient aerosol is variable and around 10 %, which is higher than those in stratosphere and just below TTL level.
  c) Ratio of low volatile constituent is higher in larger size (primary mode?) than those in smaller size.

- Concentrations of ambient aerosol and residue at 100 to 300 ℃, for Dp>0.3μm, range 100-1000 #/liter and 10-100 #/liter, respectively. Number concentrations of residue are comparable with those of cirrus in TTL.

2. Aerosol samples were recovered from TTL, upper free troposphere, and lower stratosphere using small rubber balloon in February and March, 2015.
(Analyses of those sample will be performed as soon as possible)


Thank you for your attentions