A Quick Report on the CRYO-SOWER-LAPAN 2015 Biak Campaign

Yoichi Inai[1],
Fumio Hasebe[1], Shuji Aoki[2],
and the LAPAN-CRYO-SOWER science team
[1]Hokkaido University, Sapporo, Japan
[2]Tohoku University, Sendai, Japan

LAPAN:
the Indonesian
National Institute of
Aeronautics and Space

Group photo centered on F. Hasebe (PI)

SOWER/Pacific

Soundings of Ozone and Water in the Equatorial Region/Pacific Mission

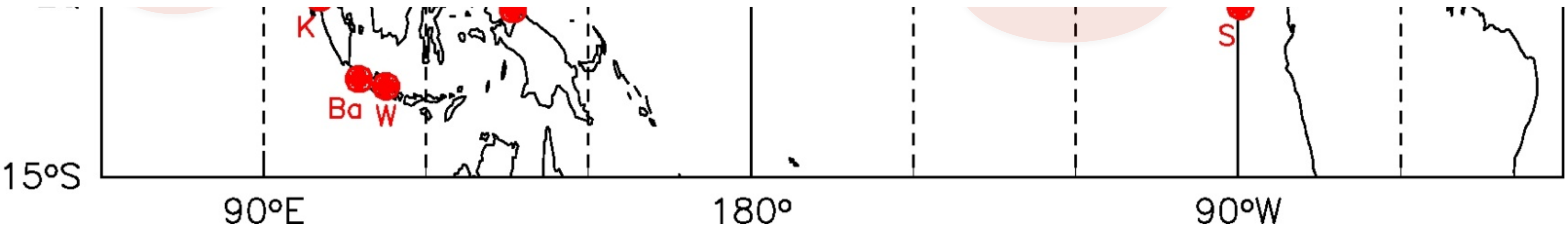
Balloon-borne campaigns for O_3/H_2O in Tropo/Strato over tropical Pacific (western Pacific in recent years)

- Proposed by Fumio Hasebe and Masato Shiotani
- Started in 1998 at Galapagos Is. with S. Oltmans and H. Voemel

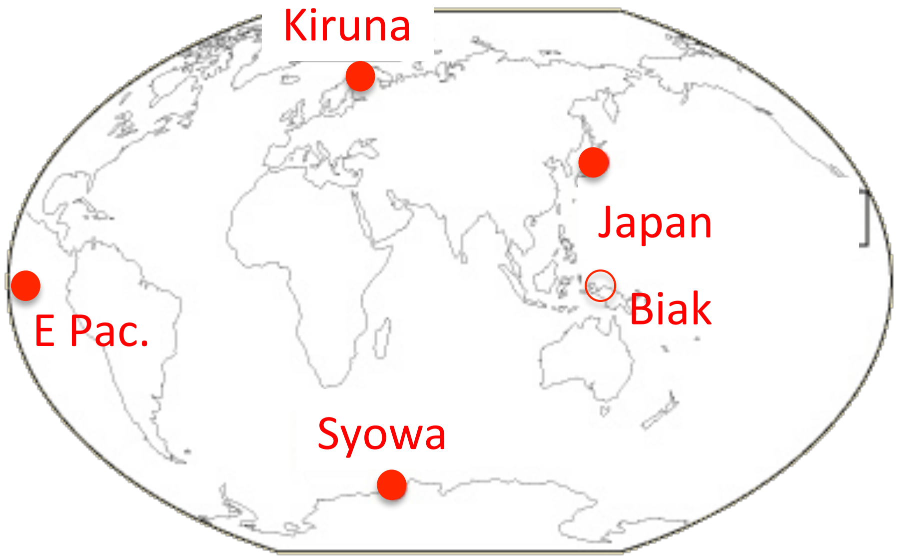
Our objectives are providing a long term meteorological record in the UT/LS over the Pacific and investigating the stratosphere-troposphere exchange (STE) processes via the TTL.

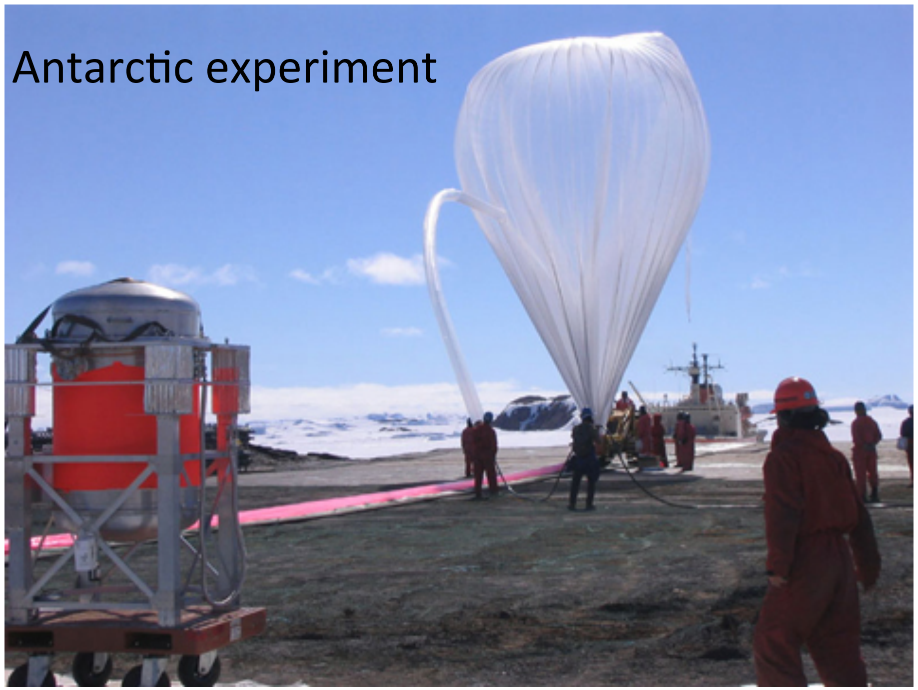
Especially, we focus on

- Dehydration/hydration processes in the TTL (e.g., Inai et al., 2013)
- Wave activity and cirrus formation (e.g., Fujiwara et al., 2012)
- Could microphysics in the UT/LS (e.g., Shibata et al., 2012)



Cryogenic Air Sampling





In addition to the SOWER group,
the CRYO group collaborated on this campaign.

Since 1980, the CRYO group has operated stratospheric whole air sampling called “cryogenic air sampling” in the Arctic, Japan, the Antarctic, and the eastern Pacific.

The CRYO group found that an enhancement of the BDC, it was projected by a lot of studies using global models, might not arise in collaboration with Germany research group (Engel et al., 2009) and also found the gravitational separation of atmospheric components in the stratosphere. (Ishidoya et al., 2008; 2013).

Recently, a compact cryogenic air sampler was developed (Morimoto et al., 2009), which made it possible to easily conduct a stratospheric whole air sampling even in remote part, such as Biak.

Summary of CRYO-SOWER-LAPAN 2015 campaign

	5:30/6:00	7:30/8:00	15:00	18:00
Feb. 16 – Mar. 3	10 RS	4 CAS, 2 ASS	4 CO2, 1 OPC, 1 CFH	4 CFH

CFH: Cryogenic Frostpoint Hygrometer (with ECC ozonesonde and Cloud Particle Sensor)
RS: Radiosonde
CAS: Cryogenic Air Sampler
ASS: Aerosol Sampler
CO2: CO2 sonde
OPC: Optical Particle Counter

CFH+ECC

CO2

Among them, I will talk about CAS, CFH, and CO2 sonde in this presentation.

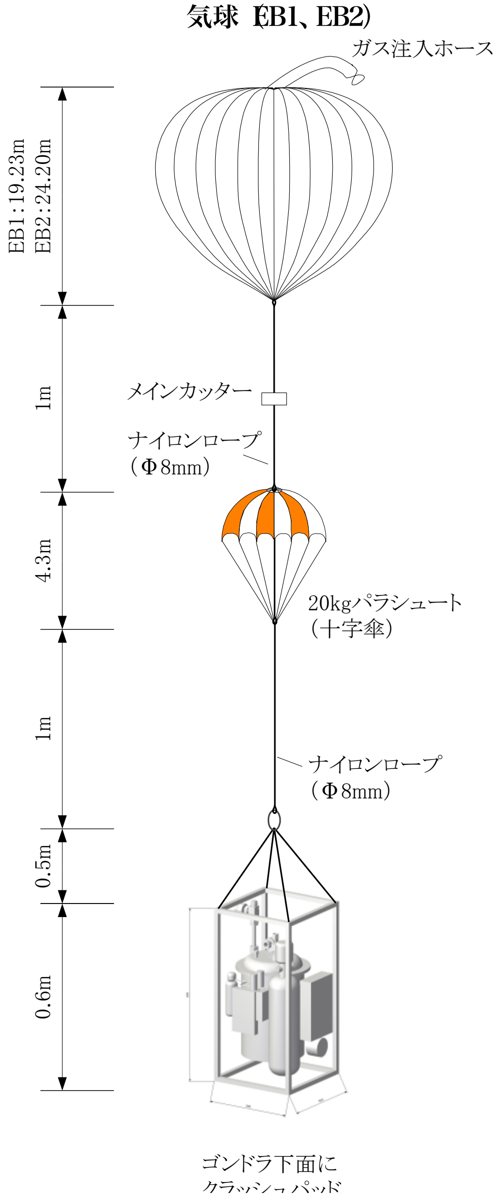
CAS

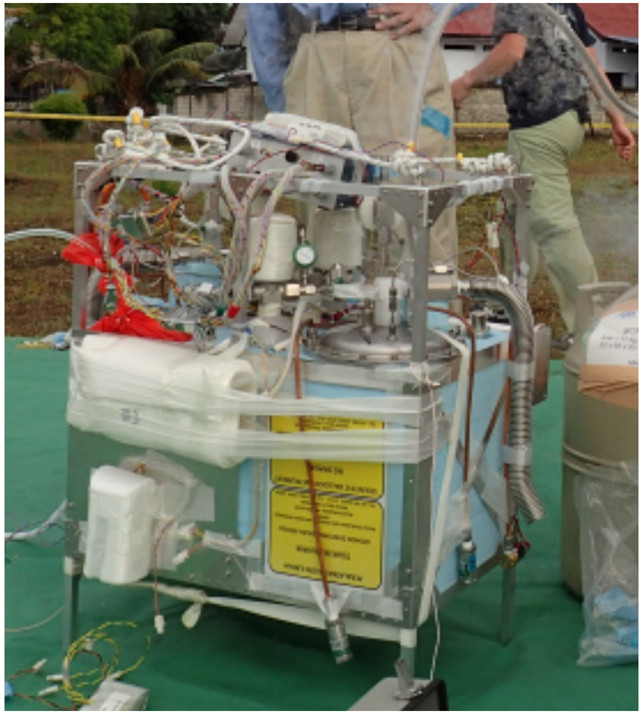
Compact Cryogenic Air Sampler (J-T sampler)

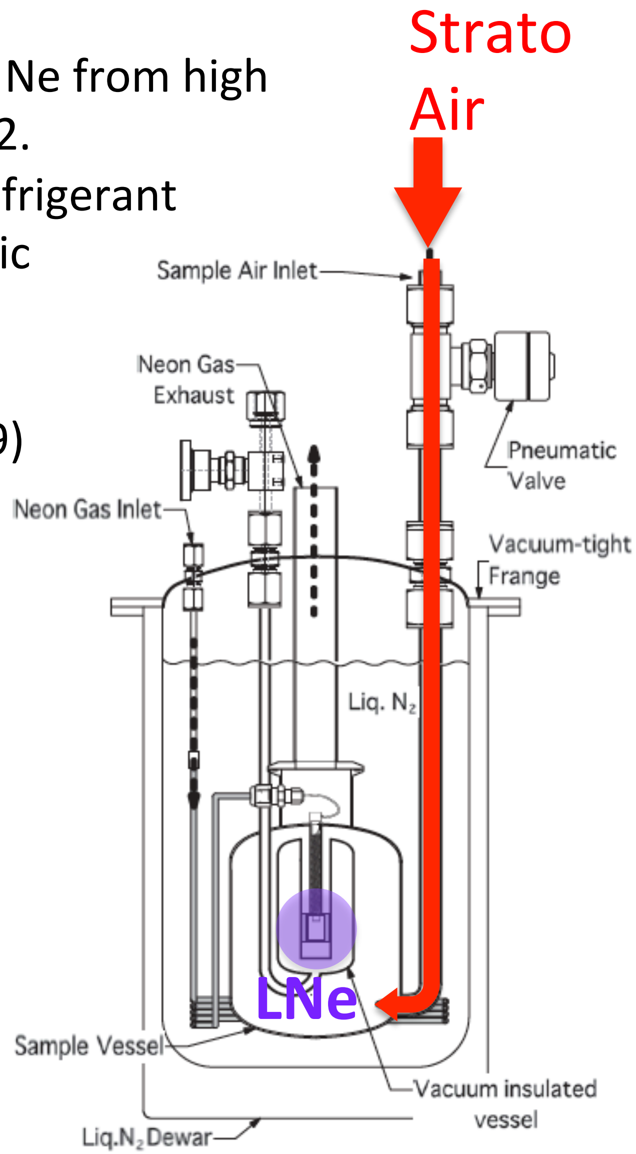
This sampler has the J-T minicooler which can get cold using the Joule-Thomson effect.
The J–T minicooler can produce liquid Ne from high pressure Ne gas precooled by liquid N2.
This sampler employs liquid Ne as a refrigerant to solidify or liquefy whole atmospheric components in the stratosphere except for He, H2, Ne.

(Morimoto et al., 2009)

Configuration

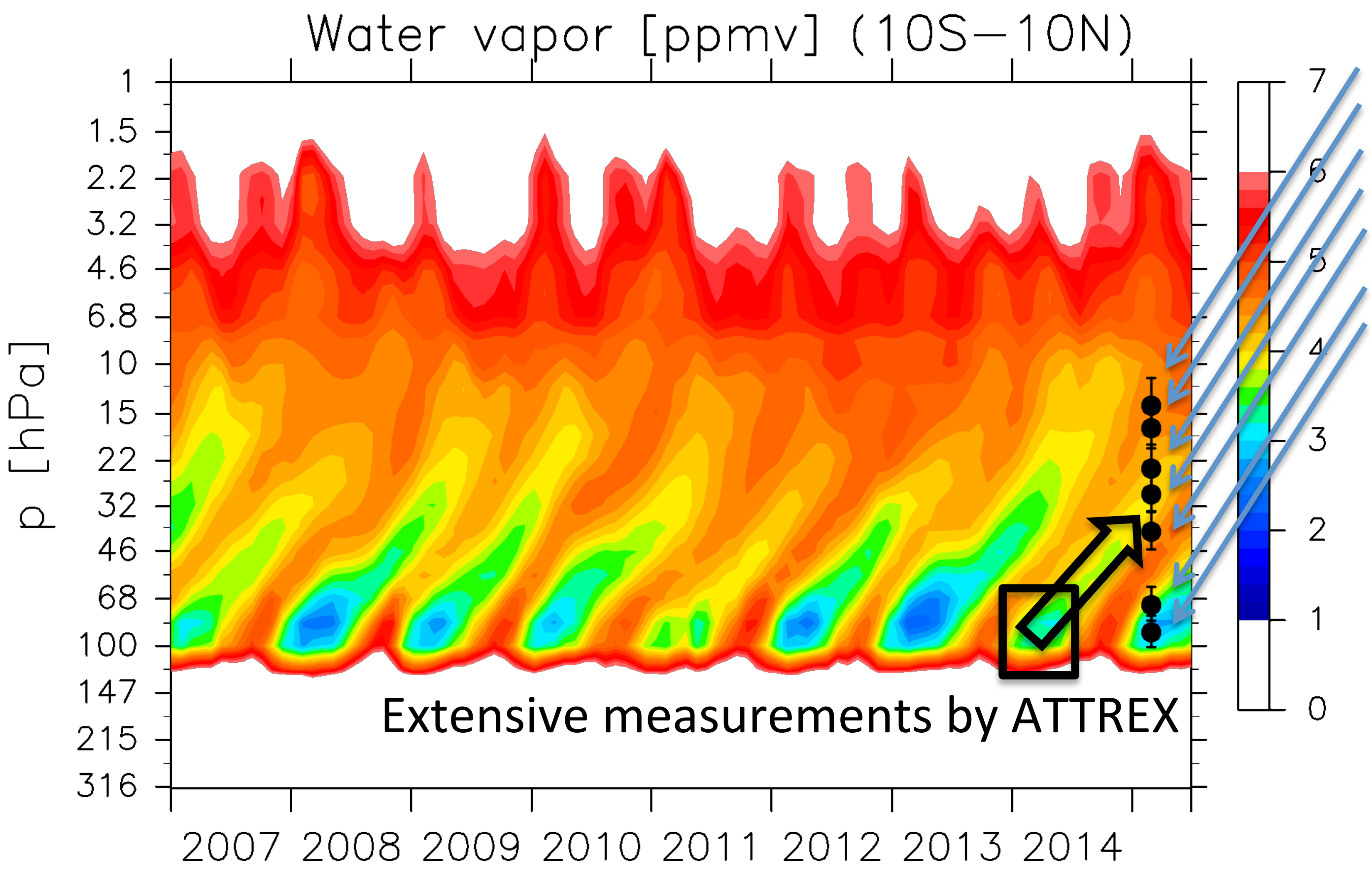






Cross section of the J-T sampler

Sampled air mass



Using this method
we successfully sampled
air masses
at 7 different altitudes.

ATTREX was conducted
in 2014 N. winter.
We might observe
upwelling air mass,
which located in the TTL
1 year before
and observed by
ATTREX/CONTRAST/CAST.

It will be interesting
if we compare our results
to the aircraft campaigns
because we can know
change of those
concentrations
during the one year.

We are analyzing abundance of chemical species including sampled air by gaschromatograph and mass spectrometer.

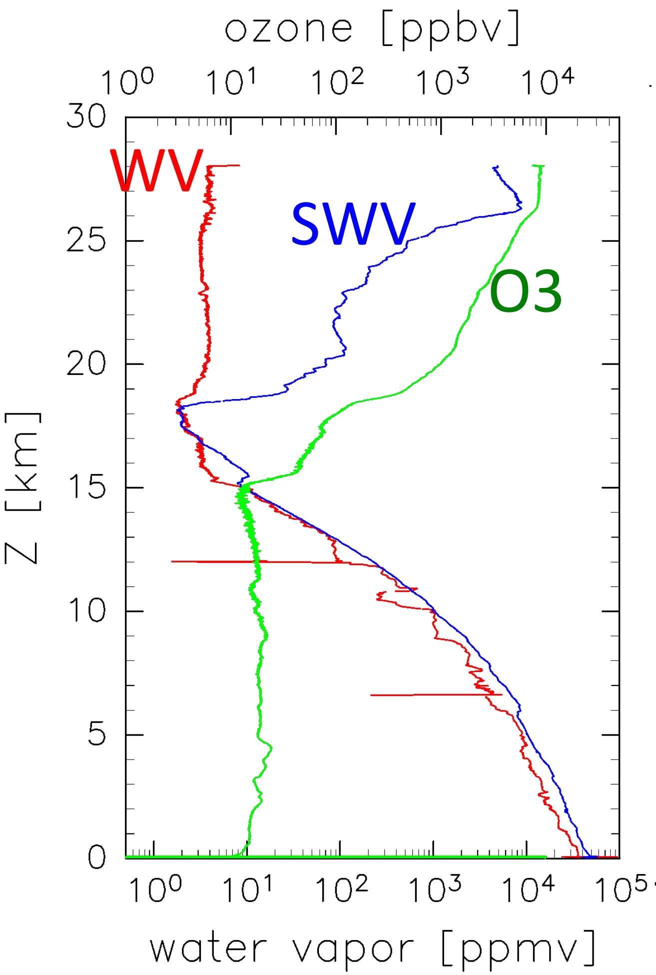
Analyzed component:

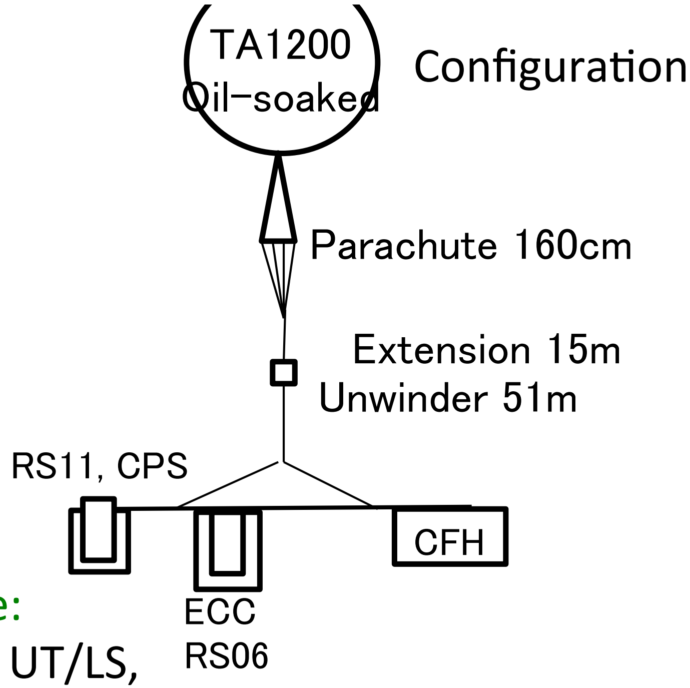
CO_2, CH_4, N_2O, SF_6, CO, H_2, O_2 etc.

$\delta^{13}C$ and $\delta^{18}O$ of CO_2, $\delta^{13}C$ and δD of CH_4 etc.

An example of CFH sounding

Launching Time :
18:11 2 March (LT)





Ozone:
In the UT/LS, ozone profile (also T) might be modulated by large-scale wave.

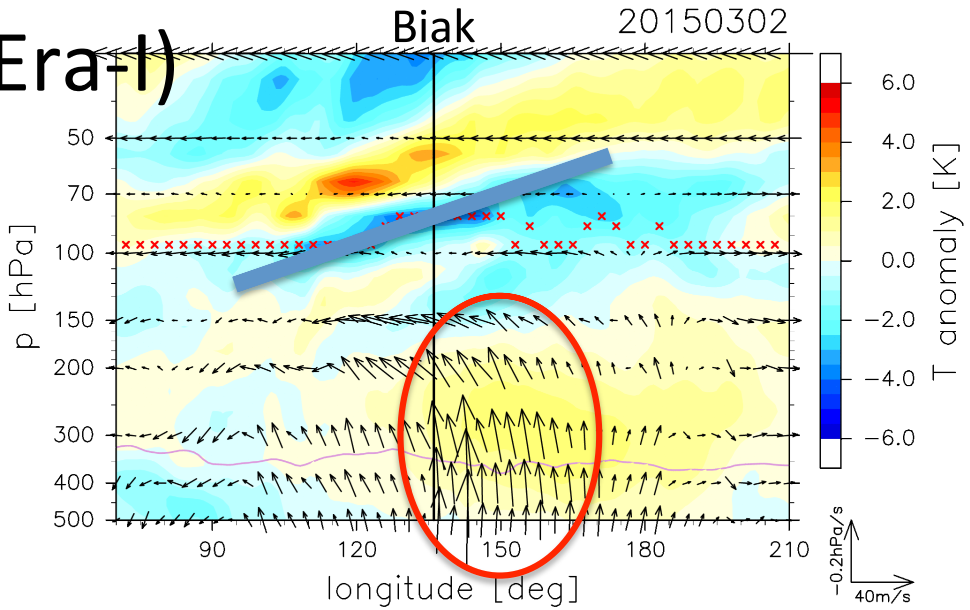
Temperature (SWV):
T at CPT is low enough to occur the dehydration at around 18 km.

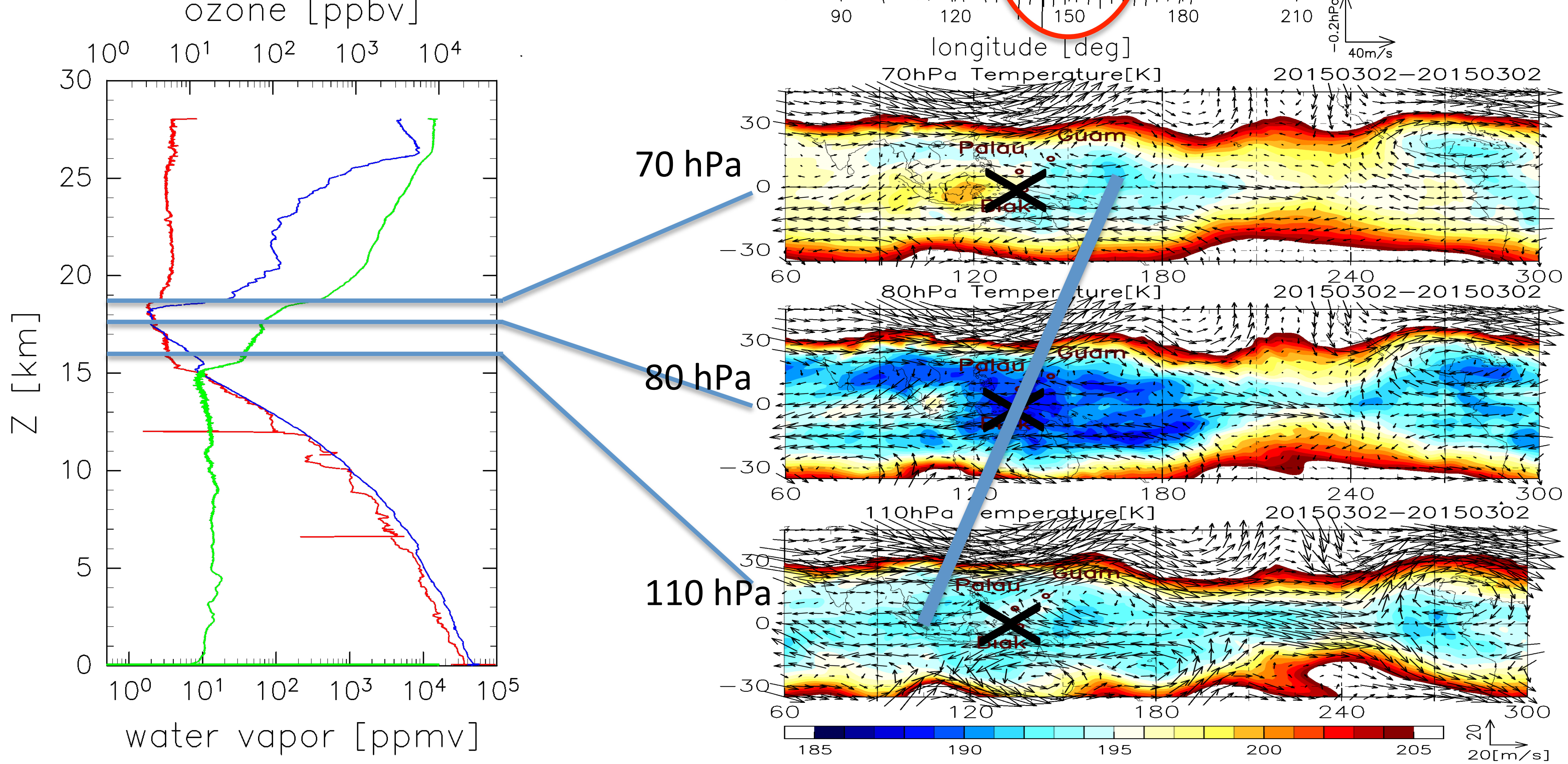
Water vapor:
WV MR decrease at CPT.

To see a picture of the large-scale wave, I took a quick look at the Met. field.

Meteorological fields (Era-I)

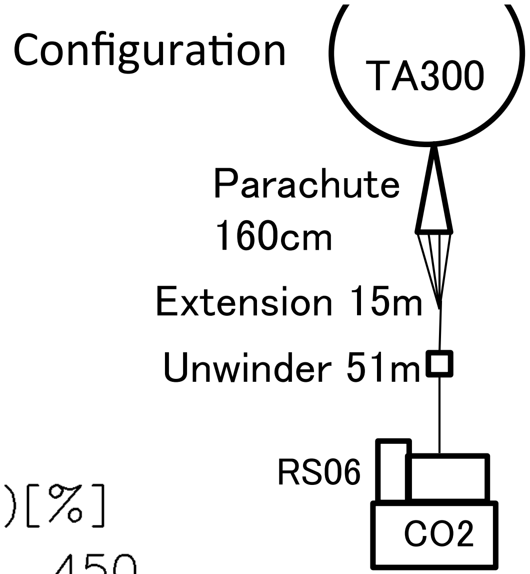
The cold point was at about 18 km. Large scale convective system located just east of Biak. As its dynamical response in the UT/LS, a tilted cold anomaly was formed, which modulated vertical structure of T and the coldness might dehydrate the TTL air over Biak.



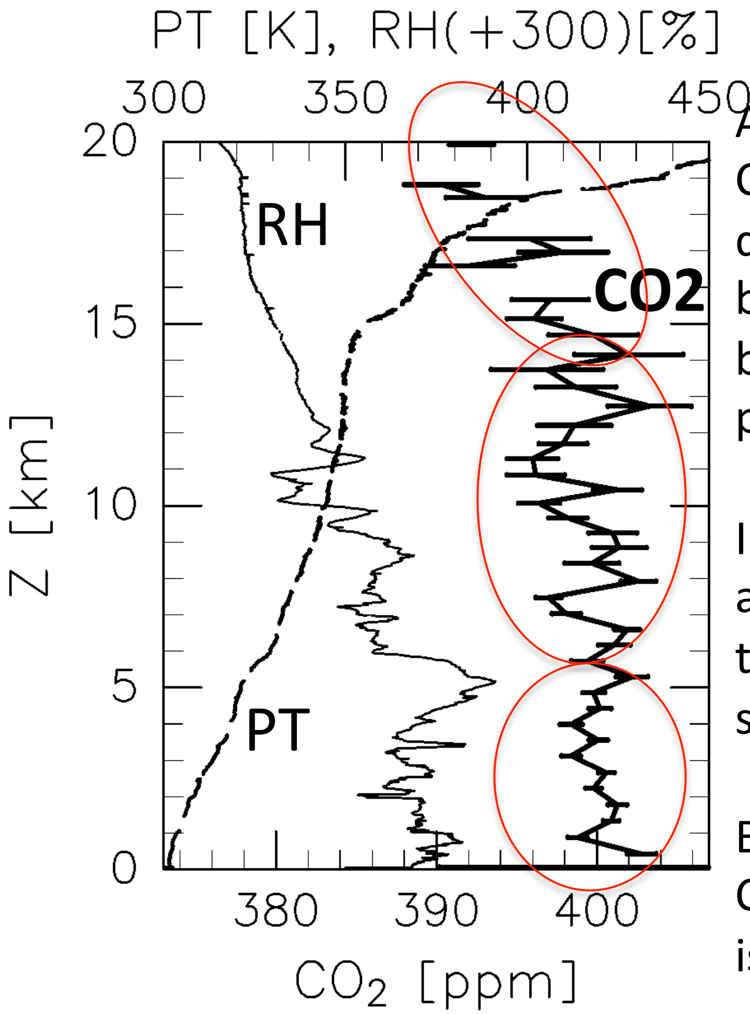


An example of CO2 sounding

Launching Time :
15:06 2 March (LT)



CO_2 sonde developed by Nagoya Univ. and Meisei Electric and contains 2 reference gases which have different CO_2 mix. ratio in own payload.
Those reference gases and ambient air lead to the NDIR CO_2 sensor switching by every 40 s.
Thus we can measure CO_2 profile with the precision of better than 1 ppm from ground to 10 km but worse above 10 km.



Above 15 km, CO_2 mix. ratio decrease with alt. but this alt. may be beyond the performance limit.

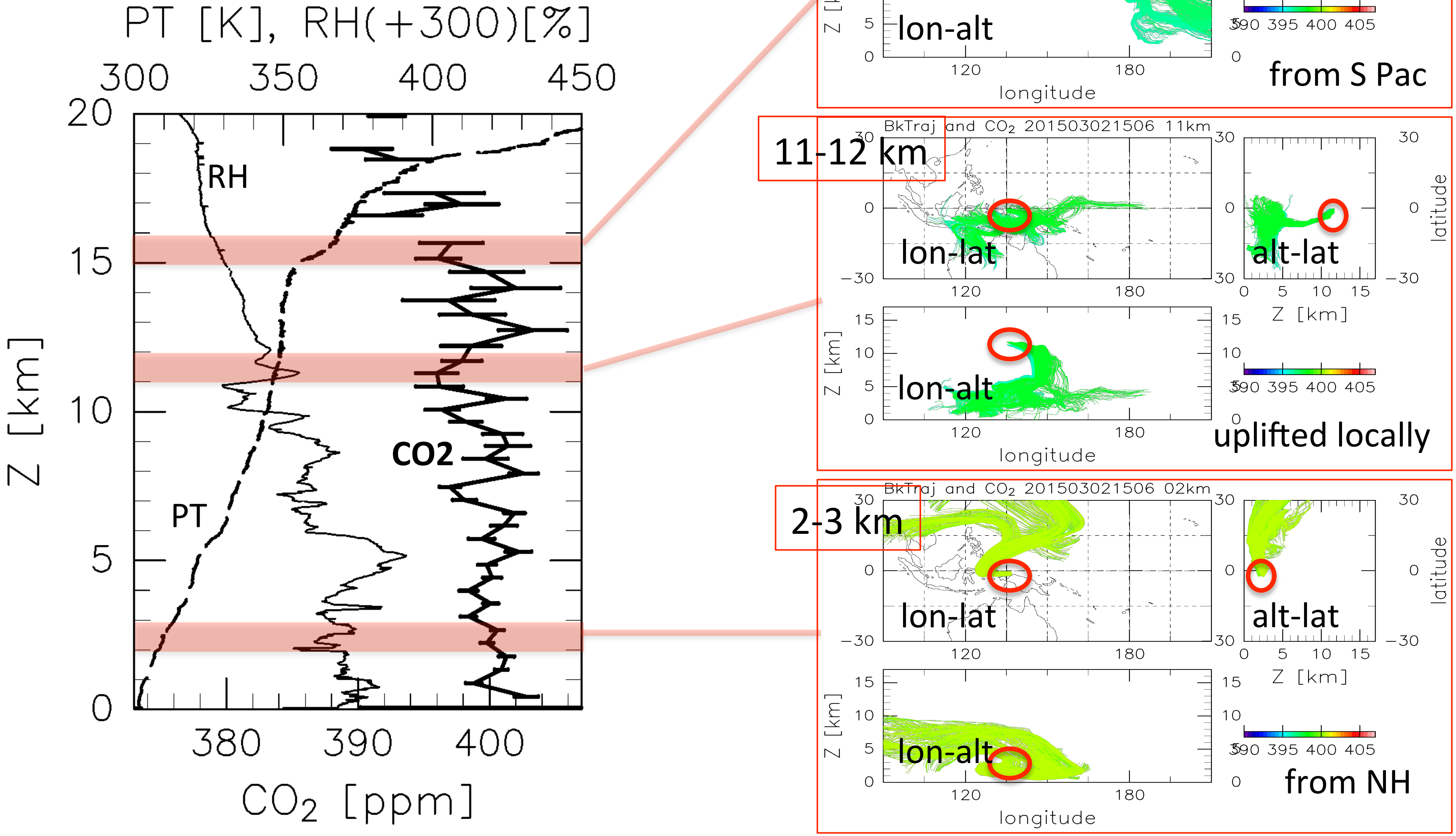
In contrast, above 5 km the profile has small scale variation.

Below 5 km CO_2 mix. ratio is almost constant.

Trajectory analysis

To estimate where did those air paeceles come from, back-trajectories are calculated from 3 alt. regions, 2-3 km, 11-12 km, and 15-16 km, for 2 weeks.

Further analysis will be done as a future work.



Summary

- The SOWER project conducted since 1998 (and ongoing) to investigate, for example, dehydration processes in the TTL.
- In addition to soundings for ozone and water vapor, cryogenic whole air samplings were conducted at 7 different altitudes from 17 km to 30 km by collaboration with the CRYO group in 2015 campaign.
- As a result, we successfully sampled upwelling stratospheric air mass which must be observed by the ATTREX one year in advance, and we are analyzing atmospheric composition of sampled air.
- CO2 sonde was launched 4 times, which might measure air parcels whose origins were different depending on altitude.