Preliminary findings from the LAPAN-SOWER collaborative observations

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(RISH Kyoto Univ.)

and the SOWER LAPAN science team

SOWER member:
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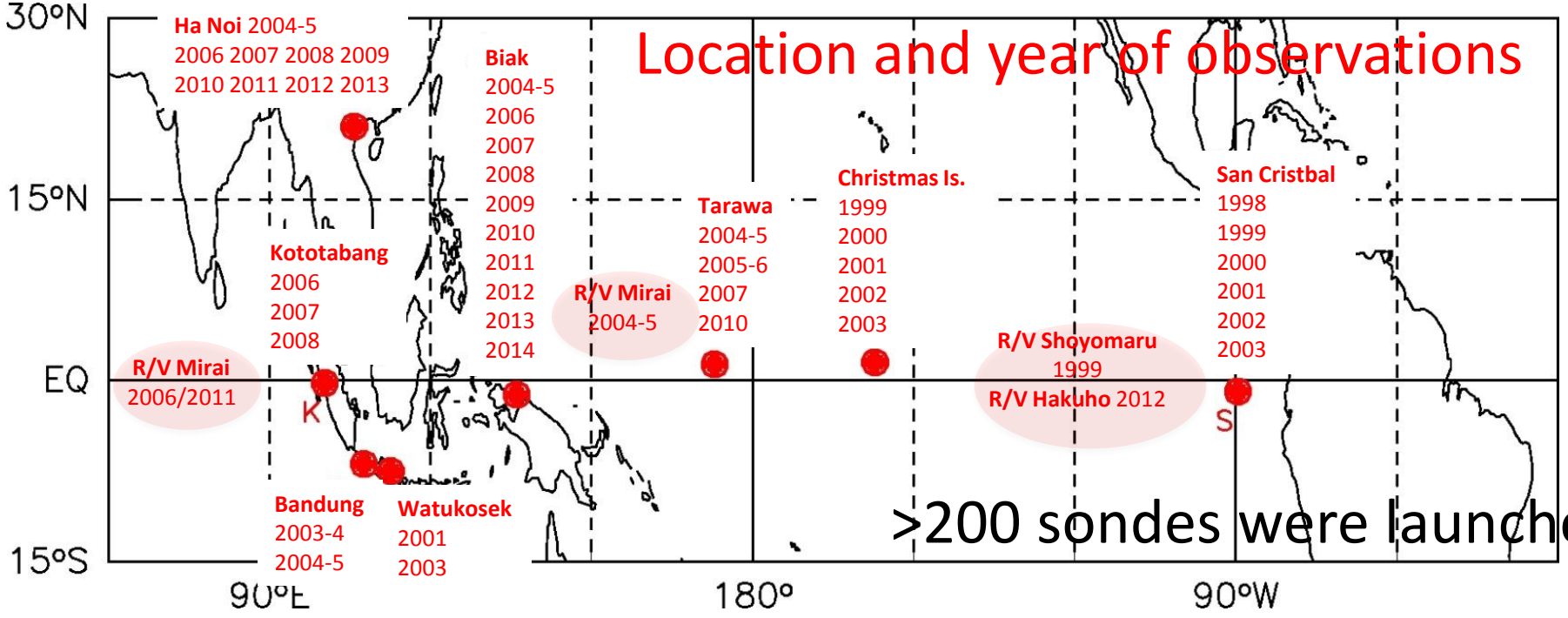
SOWER/Pacific

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-SE Asia in recent yrs)

- Proposed by Fumio Hasebe and Masato Shiotani
- Started in March 1998 at the Galapagos Is. by F. Hasebe & M. Shiotani, in collaboration with S. Oltmans & H. Voemel
- Many researchers and students participated



SOWER/Pacific

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

The motivations are providing a long term meteorological record in the UT/LS over WP and understanding of the stratosphere-troposphere exchange (STE) via the TTL.

Especially, we focus on

- Understanding of dehydration/ hydration processes in the TTL
- Understanding of wave actively and its role in the STE
- Understanding of microphysics in the UT/LS

For these purposes, we have operated the SOWER campaigns and conducted 2014 campaign.

Timeline of SOWER 2014 in Biak


Success


Something wrong

	2/17	2/18	2/19	2/20	2/21	2/22	2/23	2/24	2/25	2/26	2/27
Morning 15:00 (LT)	Start up	Start up	Test sonde				WV-O3				Finishing
18:00 (LT)			WV-O3 BB 19km	WV-O3 BB 14km	WV-O3	WV-O3	WV-ICE	WV-O3	WV-O3 CFH got wet	WV-O3	
Inai	→	→	→	→	→	→	→	→	→	→	→
Sugidachi								→			
Mimura								→			
Didik											→
Thohirin											→
Sawada					→	→	→	→	→	→	→
Takashima								→	→	→	→

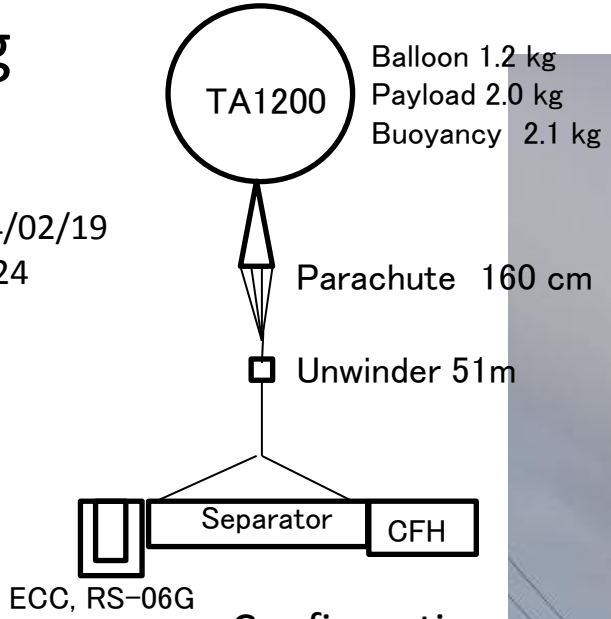
In 2014 campaign, we launched 10 sondes;
3 were something wrong, 7 were successful.

WV: CFH, newWV O3: ECC ICE: newCPS

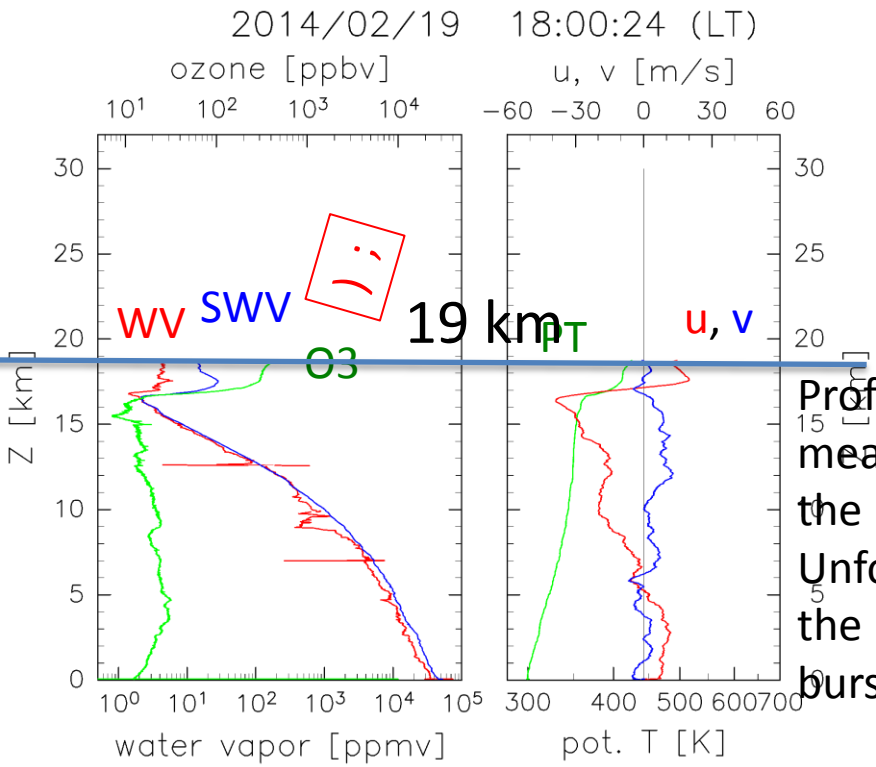
1st WV-O3 sounding (CFH-ECC)

Observation Date [yyyy/mm/dd] : 2014/02/19
Launching Time [hh:mm:dd] : 18:00:24

1st and 2nd CFH-ECC sonde could not measure the strato. due to balloon burst at low altitude.



Configuration



Profiles measured by the 1st sounding. Unfortunately, the balloon burst at 19 km.

Photo:
sky at 1st CFH-ECC sounding

Anti balloon-burst effort

After 1st and 2nd soundings,
we took action to prevent balloon from its burst
as follows.

1. Oil-soaking

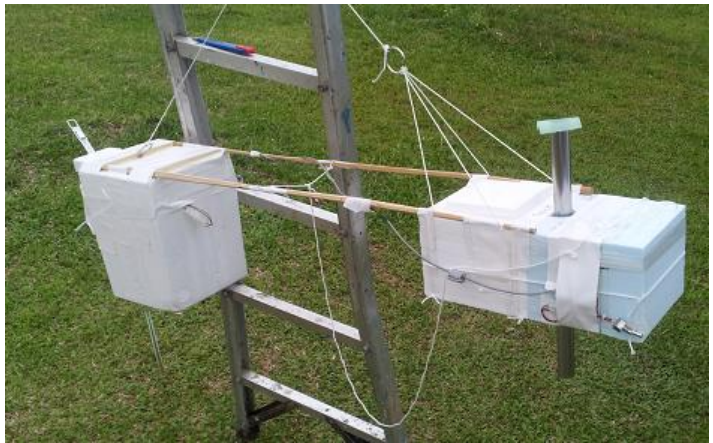
Heating oil makes
balloon rubber to be strong.
We soaked balloon in
heating oil and hanged out
40 min. before launch.

Hang out

2. Weight saving

Weight saving of sonde reduces strain of balloon rubber.
We could reduce 600 g of balloon strain by re-formation of our payload and saving He gas.

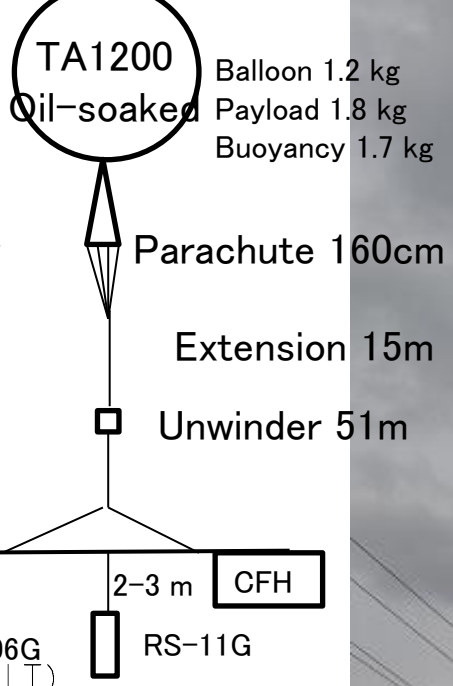
Balloon strain
— 600 g



3rd WV-O3 sounding (CFH-ECC)

Observation Date [yyyy/mm/dd] : 2014/02/21
Launching Time [hh:mm:dd] : 17:58:16

Our effort for anti balloon burst
enabled our sonde to go up
to the stratosphere
and it allowed us
to measure the strato.



Configuration

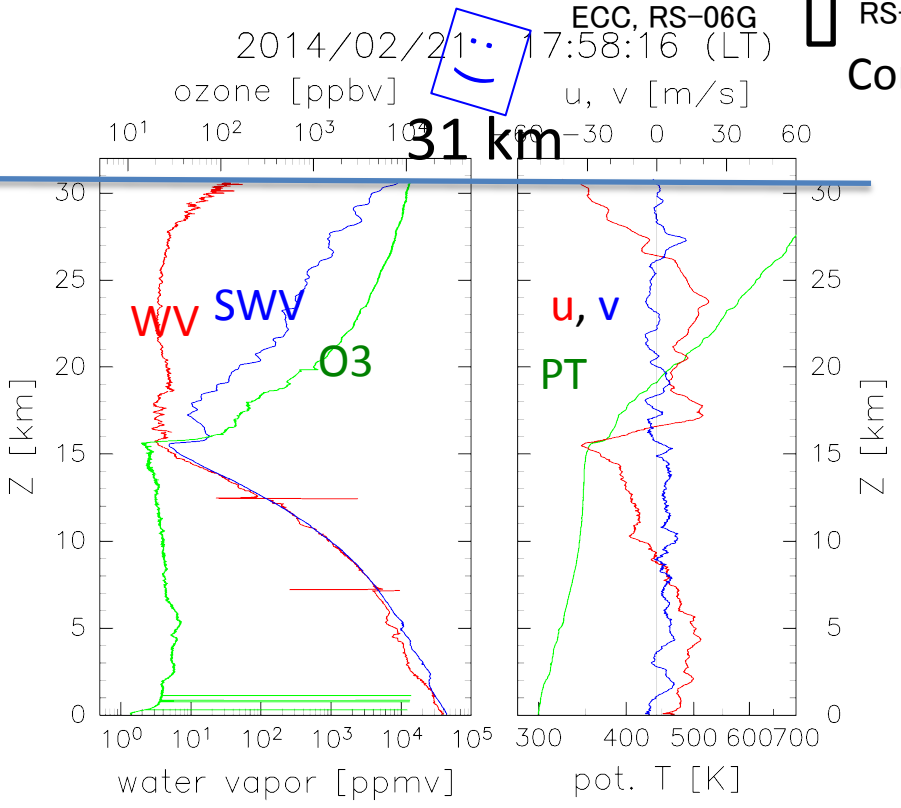


Photo:
sky at just after
the 3rd CFH-ECC launch

WV and O3 profile

Period: 21 – 26 Feb, 2014.

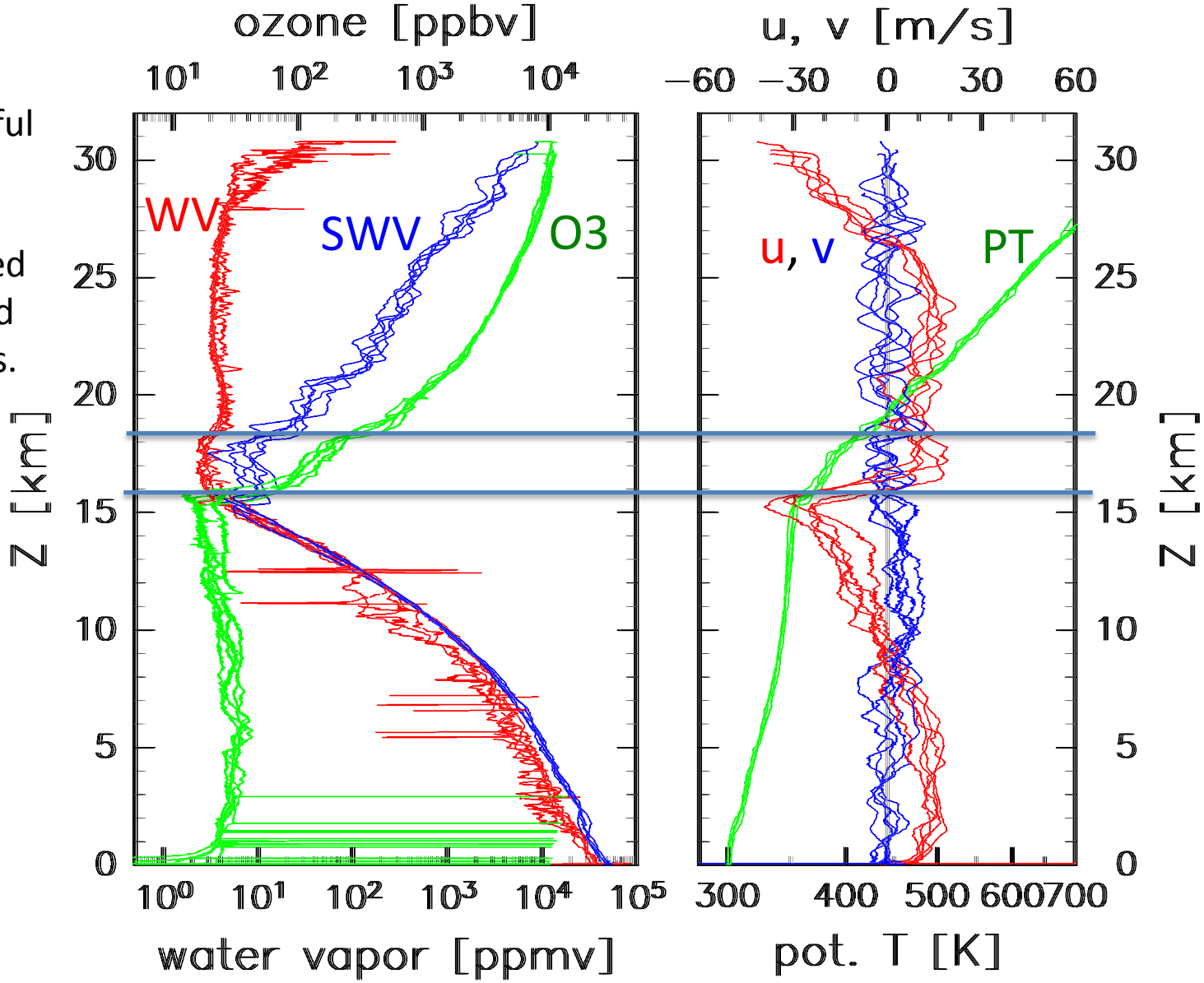
profiles of
WV, SWV, O3, u, v, PT
superposed 5 successful
CFH-ECC soundings.

The tropopause located
at 16 km where 03 and
u have steep gradients.

WV is 3 ppmv
at const. value
from 16 km–18 km.

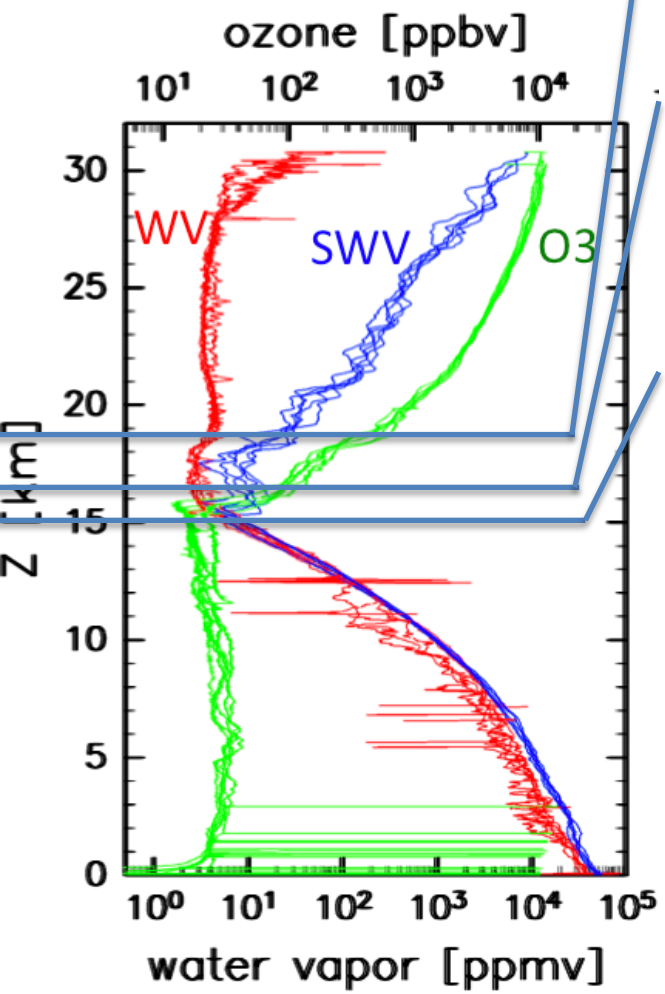
Vertical gradients of
WV, SWV, O3, PT
change at 18 km.

WV have a maximum
at around 20 km.



Meteorological field during obs. period

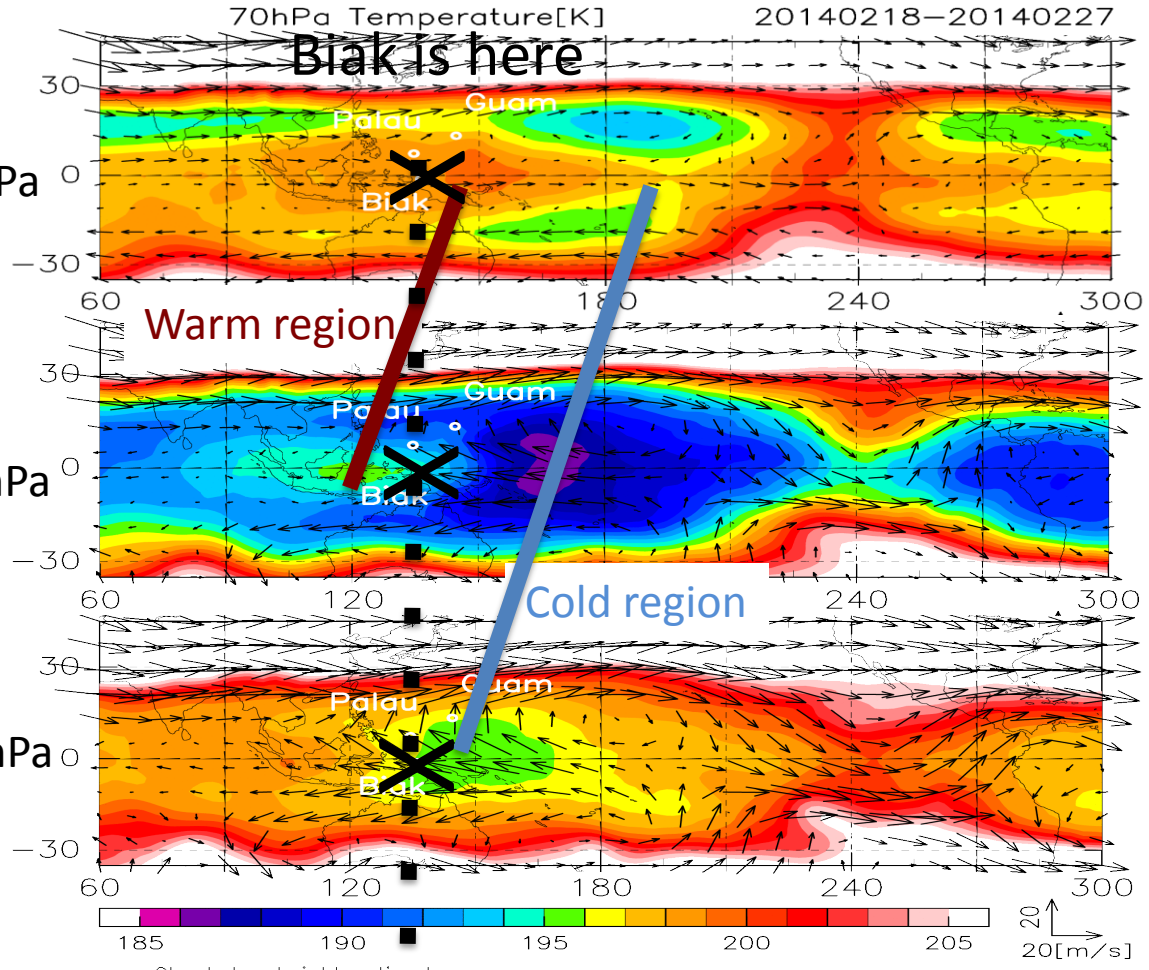
Horizontal distribution of T at



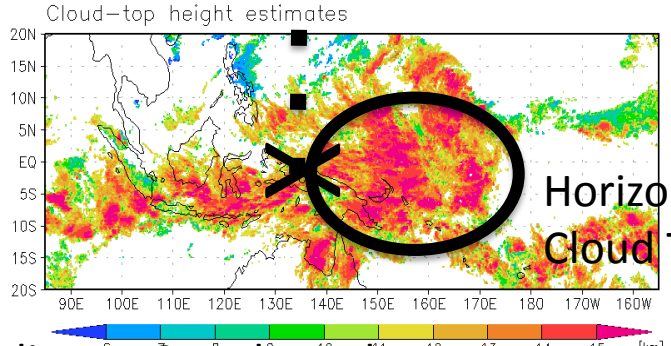
70 hPa

100 hPa

125 hPa



(ERA interim)

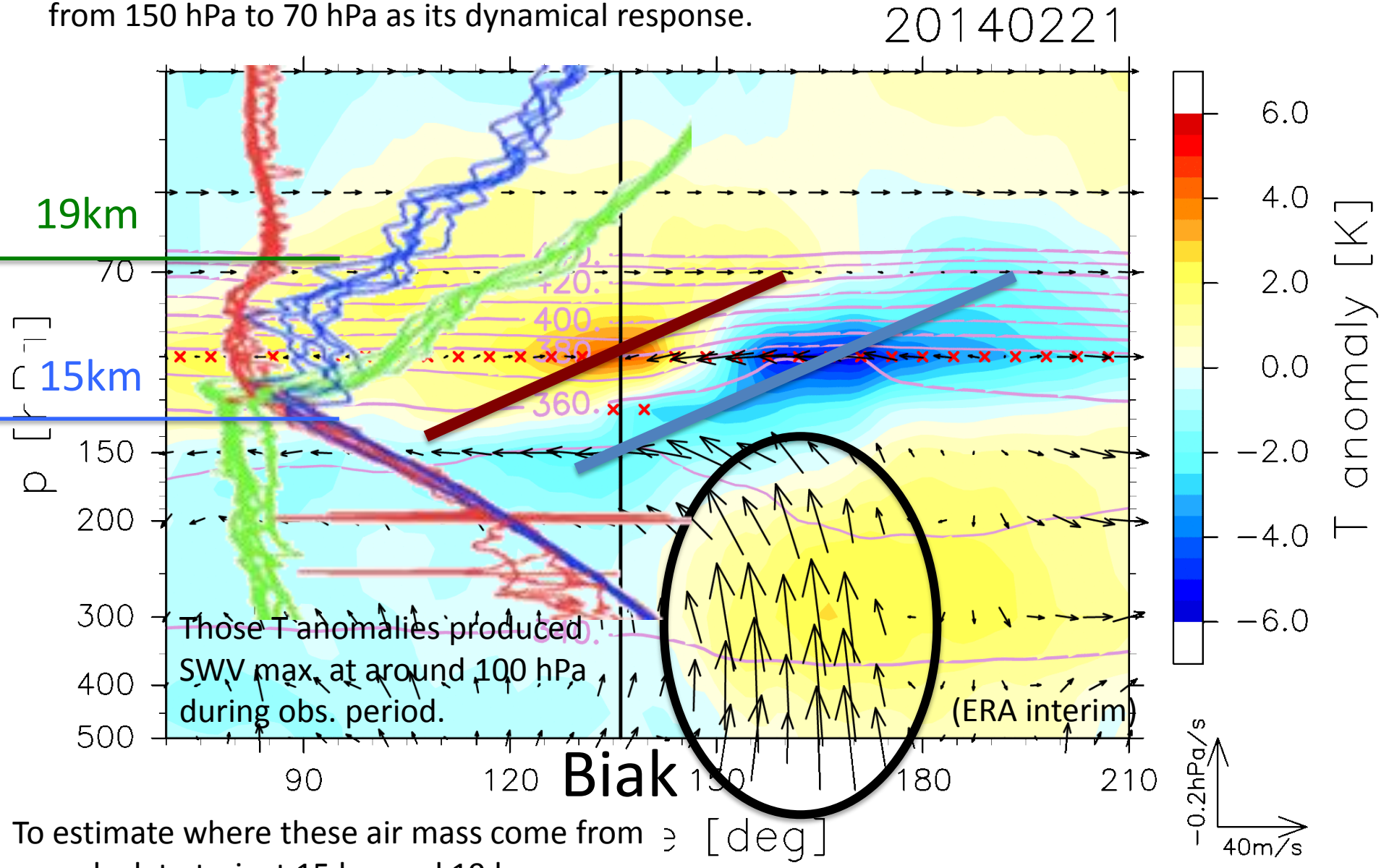


Horizontal distribution of Cloud Top Height [km]

According to CTH data, those T structure may be formed by large scale disturbance located at just east of Biak.

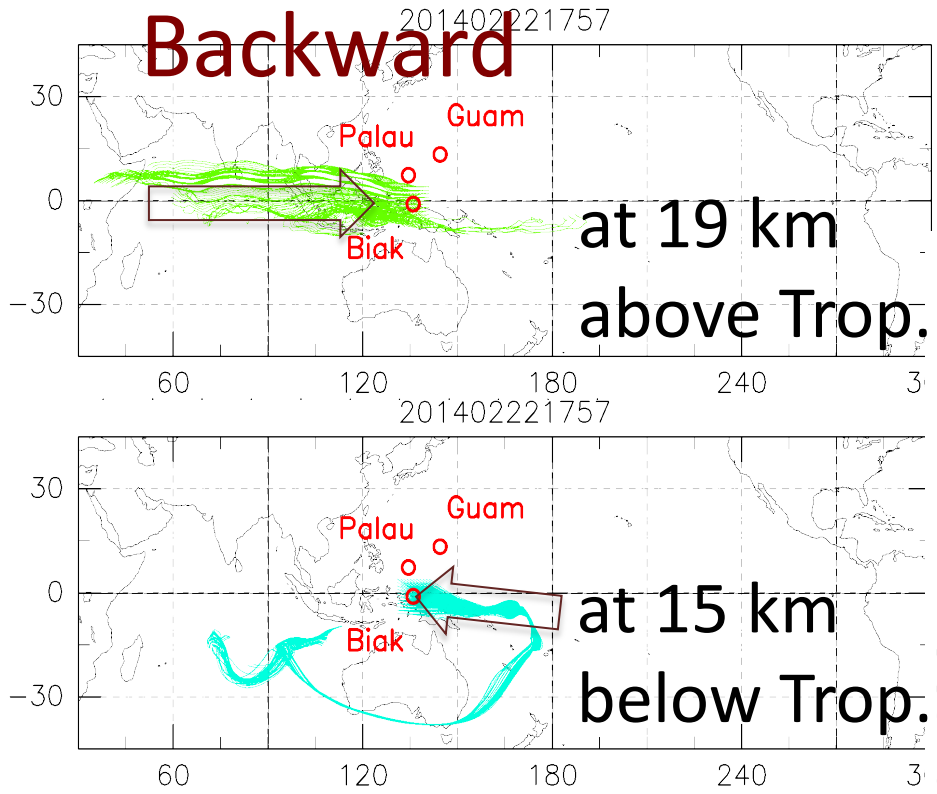
Large scale disturbance

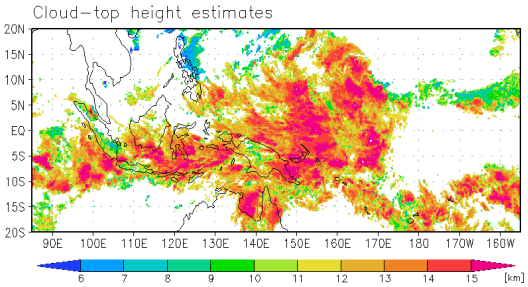
makes a cold/warm anomalies in the UT/LS that is tilted upward and eastward extending from 150 hPa to 70 hPa as its dynamical response.

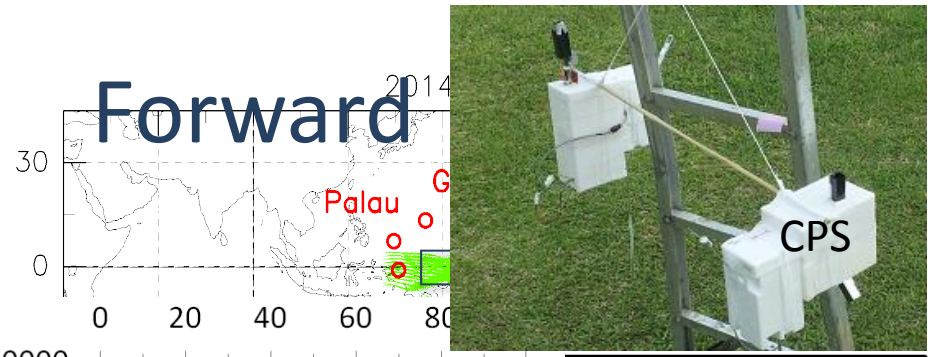


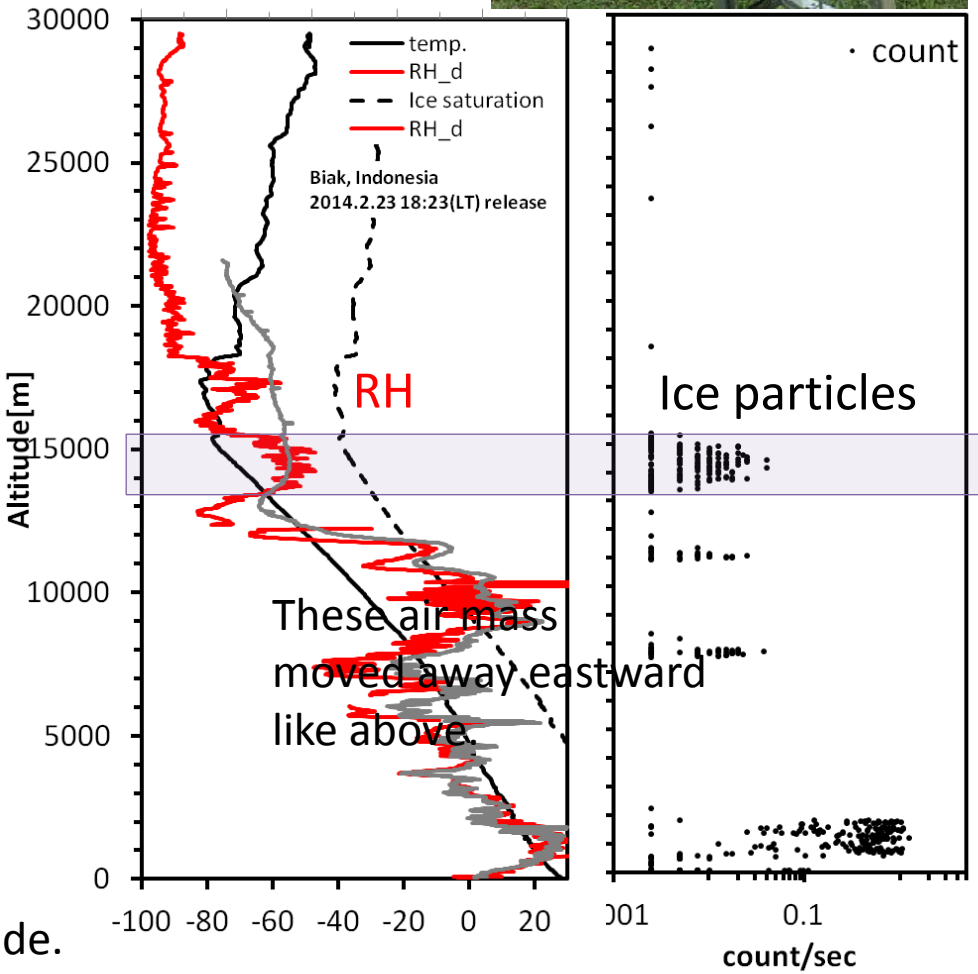
To estimate where these air mass come from we calculate traj. at 15 km and 19 km

Traj. (isentropic) for 4th sounding







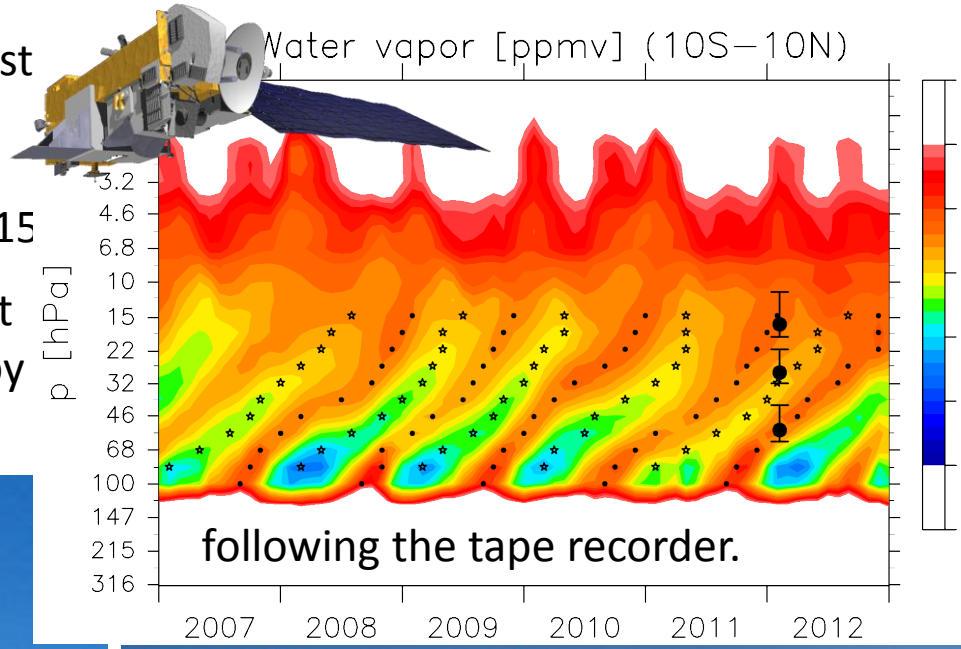


Air mass below Trop. came from conv. area.
This is consistent with the existence of
ice particles detected by CPS at the same altitude.

A new challenge: Sampling of air in the TTL/LS

We are planning cryogenic whole air sampling syst
(e.g., CH_4, N_2O, CO_2, SF_6; isotopes, isotopomer)
with a large plastic balloon
for the strato. measurement at Biak in Feb. 2015

We try to observe again upwelling air mass that located in the TTL 1 year before and observed by ATTREX/CONTRAST/CAST

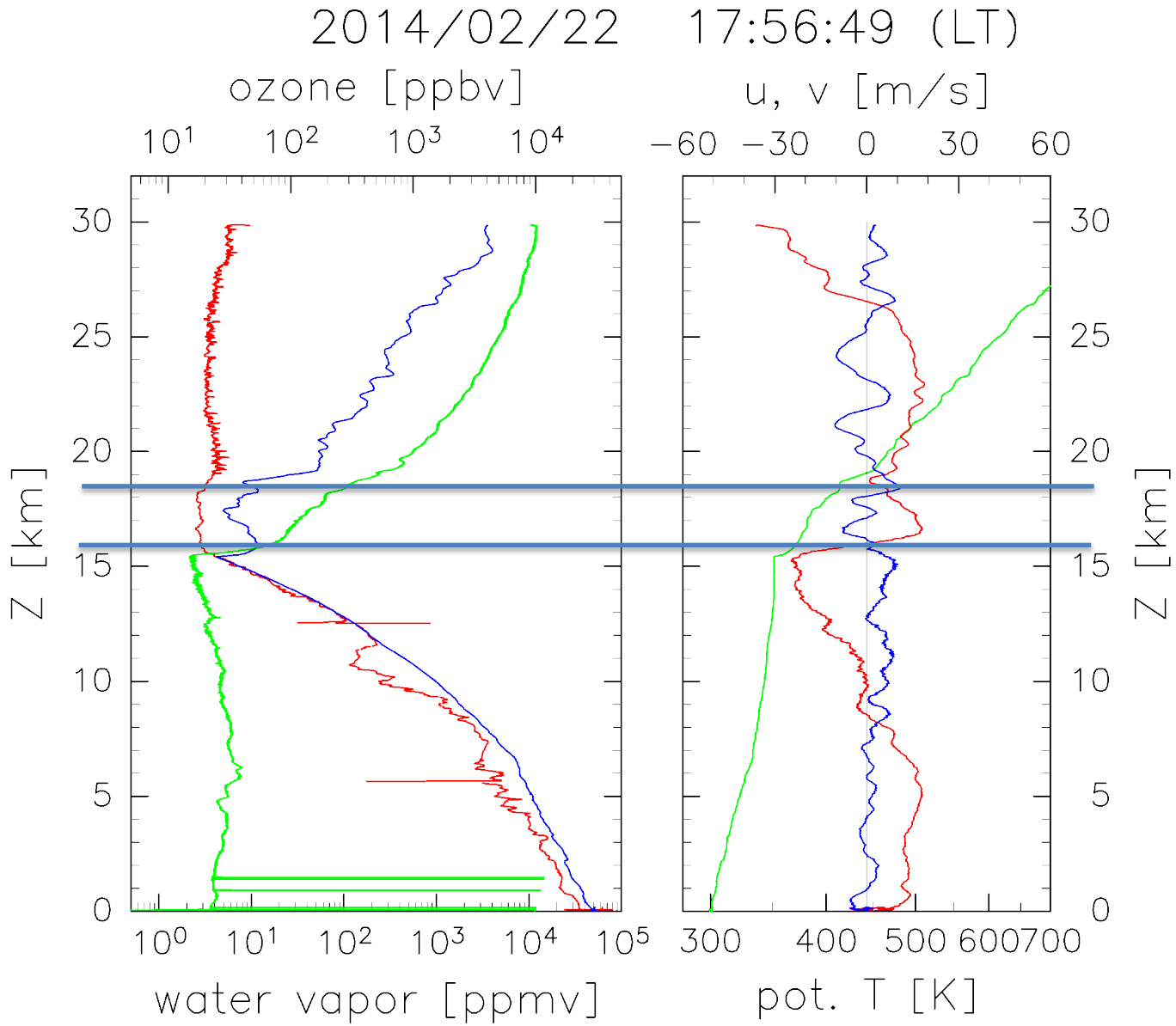


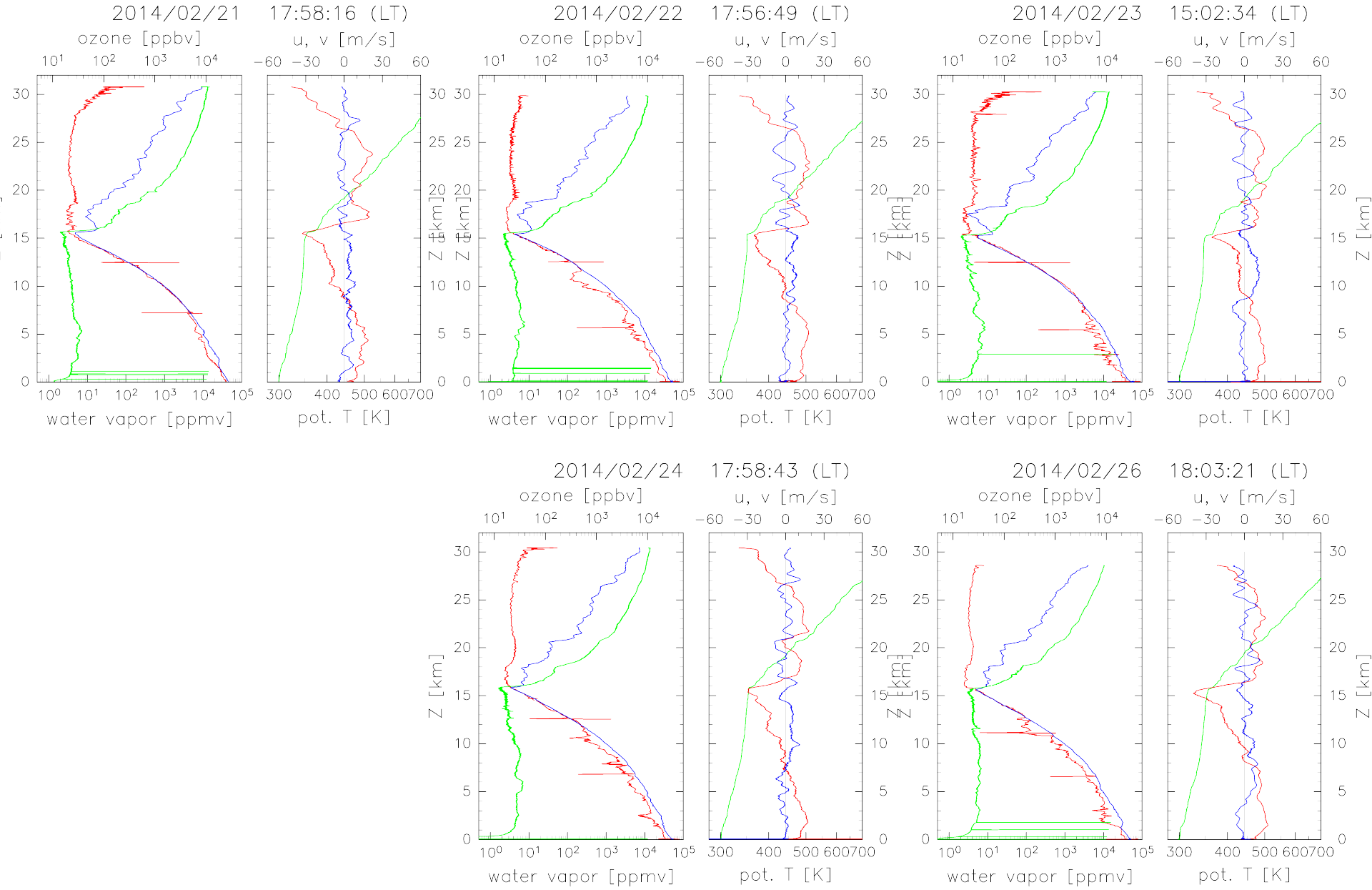
Summary

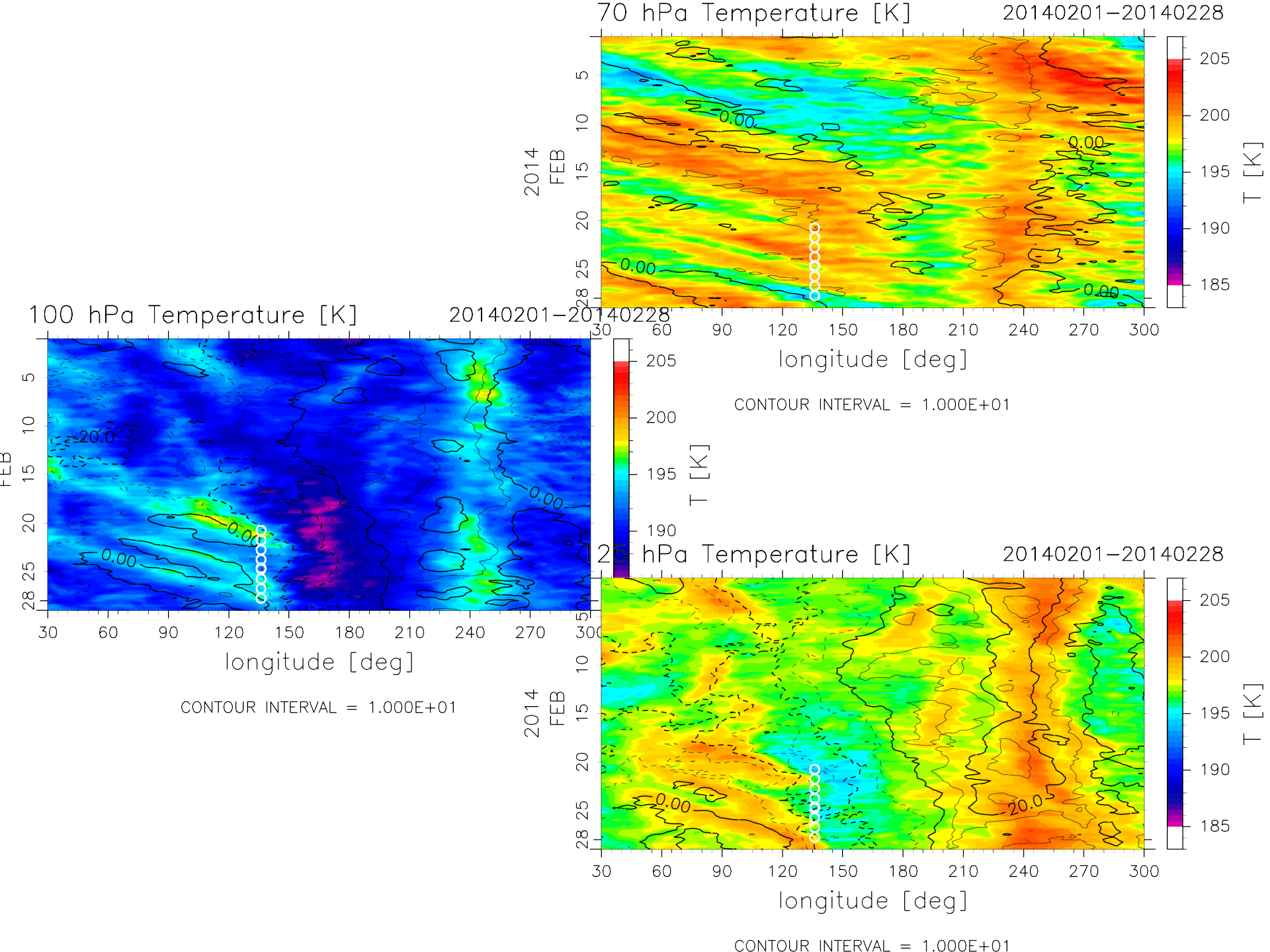
- In the SOWER 2014 campaign 5 CFH-ECC and 1 newWV-CPS were successful.
- Large scale disturbance was active at eastside of Biak in obs. period (19-26 Feb. 2014) and it affected to meteorological field over Biak.
- Now we are planning for SOWER 2015 campaign including strato. whole air sampling, we try to measure upwelling air mass which located TTL/LS 1 year before.
- Due to preparation for the 2015 campaign, Fumio could not come this meeting and then I made this presentation. Thank you.

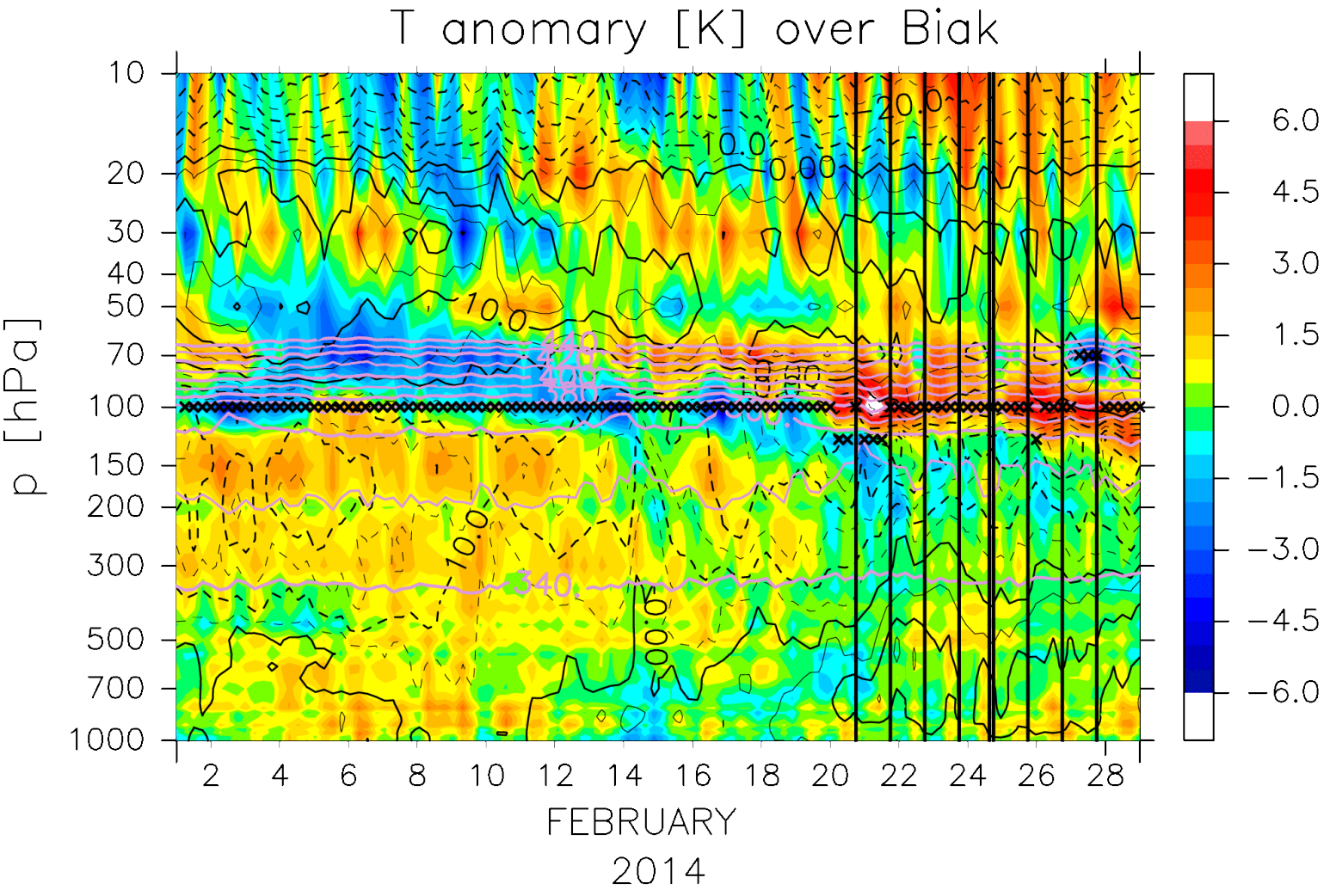


Biak, February 2014


2014/02/22 17:56:49 (LT)
ozone [ppbv]
u, v [m/s]
Z [km]
water vapor [ppmv]
pot. T [K]


2014/02/21 17:58:16 (LT)
ozone [ppbv]
u, v [m/s]
water vapor [ppmv]
pot. T [K]
Z [km]
2014/02/22 17:56:49 (LT)
ozone [ppbv]
u, v [m/s]
water vapor [ppmv]
pot. T [K]
Z [km]
2014/02/23 15:02:34 (LT)
ozone [ppbv]
u, v [m/s]
water vapor [ppmv]
pot. T [K]
Z [km]
2014/02/24 17:58:43 (LT)
ozone [ppbv]
u, v [m/s]
water vapor [ppmv]
pot. T [K]
Z [km]
2014/02/26 18:03:21 (LT)
ozone [ppbv]
u, v [m/s]
water vapor [ppmv]
pot. T [K]
Z [km]

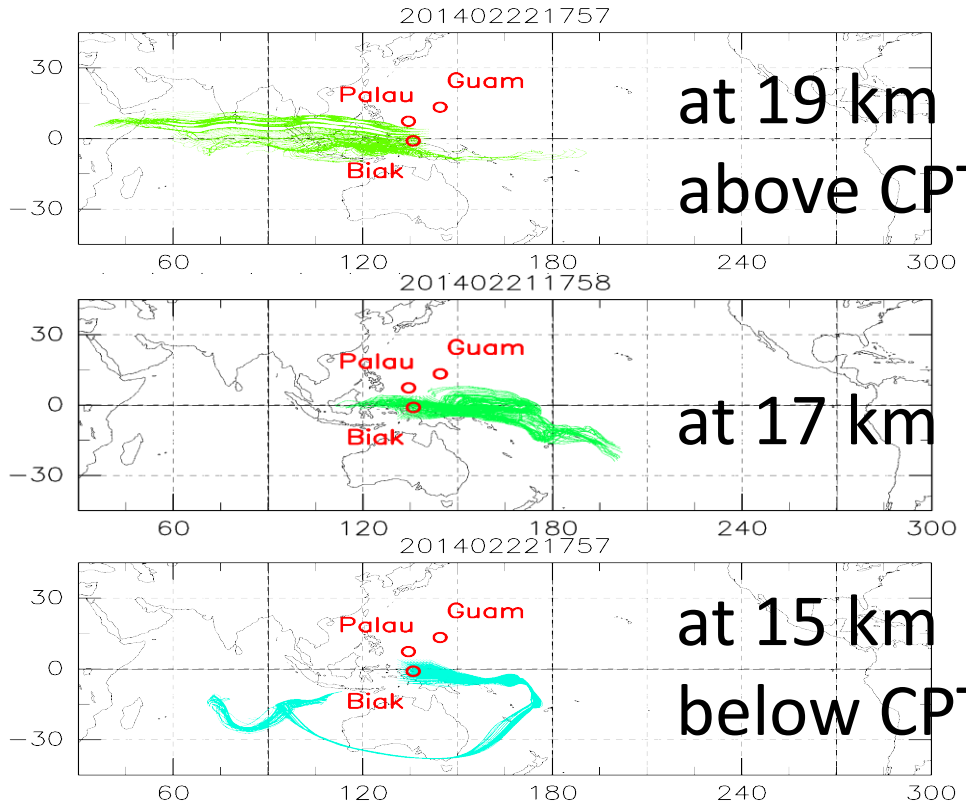

70 hPa Temperature [K]
20140201–20140228
2014 FEB
longitude [deg]
T [K]
CONTOUR INTERVAL = 1.000E+01
100 hPa Temperature [K]
20140201–20140228
FEB
longitude [deg]
T [K]
CONTOUR INTERVAL = 1.000E+01
hPa Temperature [K]
20140201–20140228
2014 FEB
longitude [deg]
T [K]
CONTOUR INTERVAL = 1.000E+01


T anomary [K] over Biak
p [hPa]
10
20
30
40
50
70
100
150
200
300
500
700
1000
2
4
6
8
10
12
14
16
18
20
22
24
26
28
FEBRUARY
2014
20.0
10.0
0.00
10.0
10.0
340
6.00
6.0
4.5
3.0
1.5
0.0
−1.5
−3.0
−4.5
−6.0

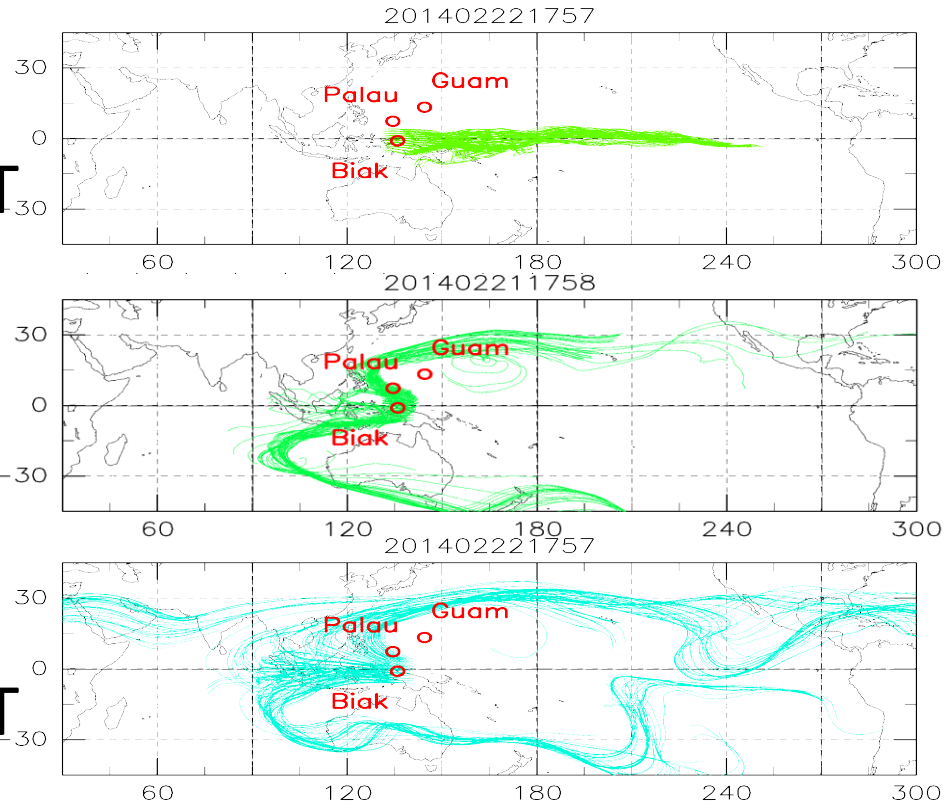
Trajectories

Back

Forward



at 19 km above CPT



at 17 km

at 15 km below CPT

A new challenge: Sampling of air and particles in the TTL/LS

Cryogenic air sampling system
(e.g., CH_4, N_2O, CO_2, SF_6; isotopes, isotopomer)
with a large plastic balloon
<Tohoku Univ., ISAS/JAXA>

Courtesy of Mitsuo Uematsu (R/V Hakuho 2012)

Aerosol sampling system with
a balloon-borne unmanned glider
<Fukuoka Univ., Kyushu Univ.>

Courtesy of Masahiko Hayashi

Renewing
SOWER web page
to open
our dataset

日本語 English

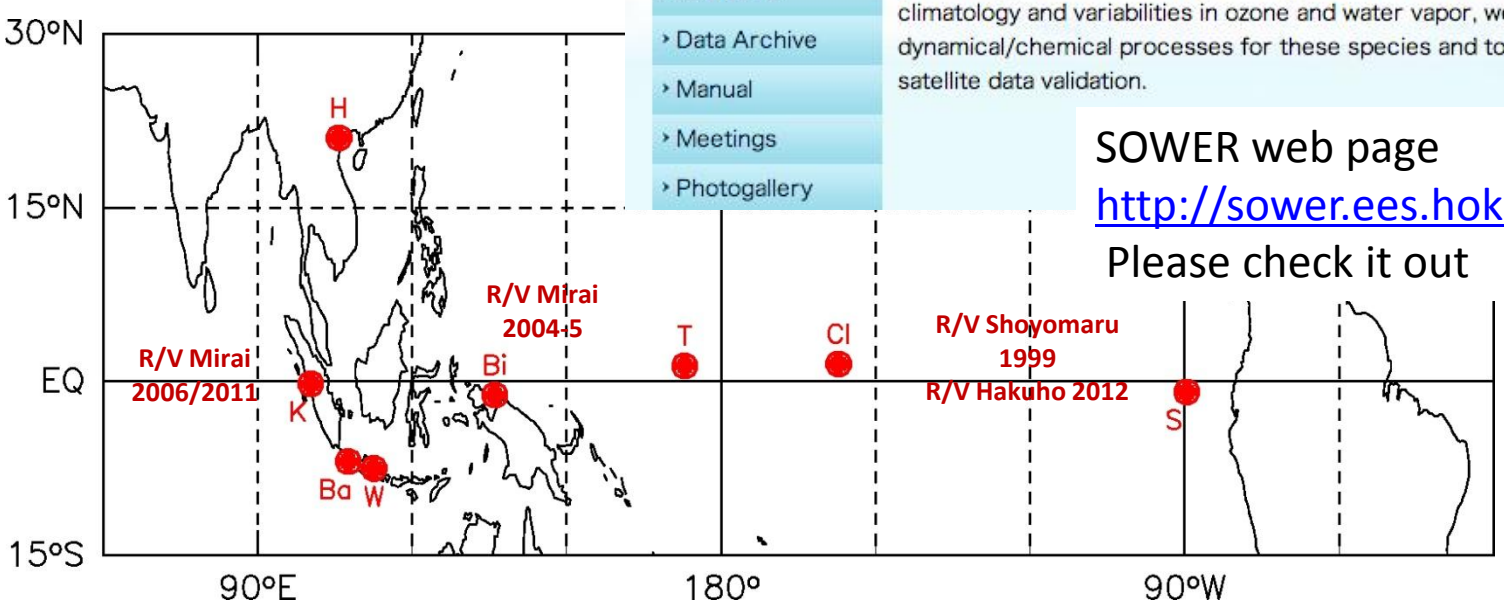
SOWER/Pacific

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

- Introduction
- Highlights
- Publications
- Members
- Data Archive
- Manual
- Meetings
- Photogallery

The Soundings of Ozone and Water in the Equatorial Region/Pacific Mission (SOWER/Pacific) has been running on a campaign basis since 1998 to improve our knowledge on the ozone and water vapor distributions in the tropical Pacific region by making coordinated radiosonde observations at three equatorial places, the Galapagos Islands (Ecuador), Christmas Island (Kiribati), and Indonesia. In addition to establishing the climatology and variabilities in ozone and water vapor, we also intend to explore controlling dynamical/chemical processes for these species and to collect correlative data for satellite data validation.

SOWER web page
http://sower.ees.hokudai.ac.jp/
Please check it out

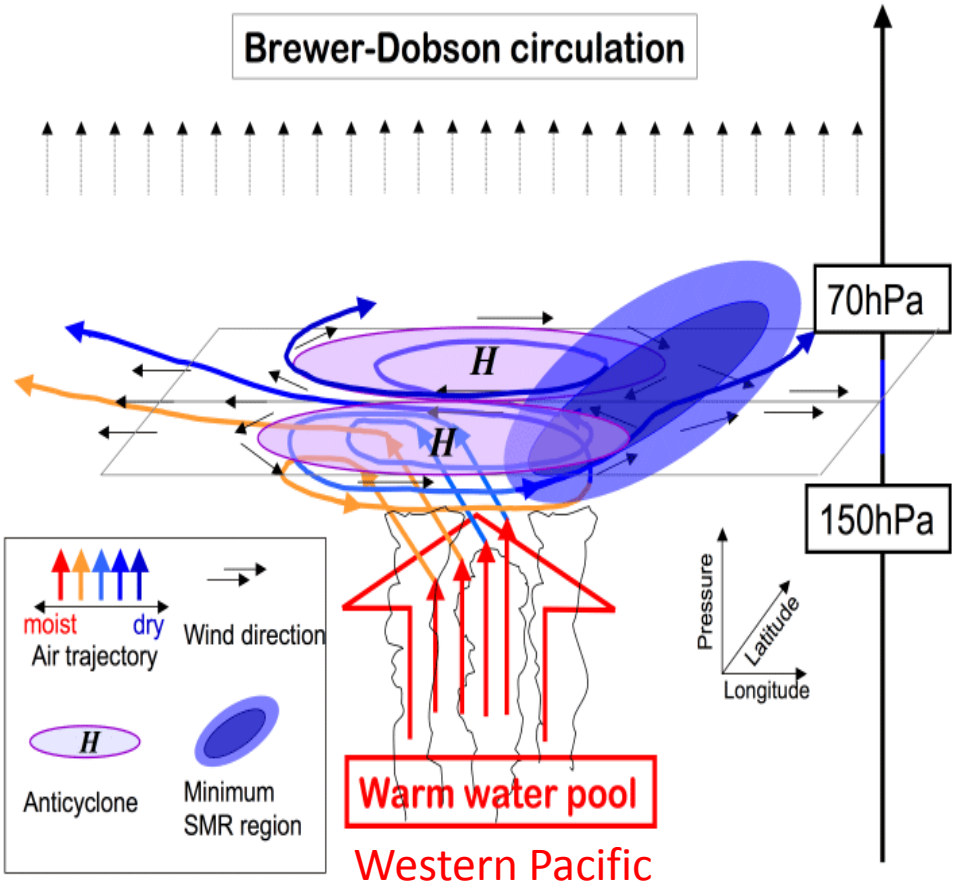


Dehydration process in the TTL

The key process:
"cold trap" dehydration process,
i.e., air mass in the TTL is dehydrated during horizontal advection through the cold trap region over the western/central tropical Pacific (Holton and Gettelman, 2001; Hatsushika and Yamazaki, 2003).

To quantify the dehydration associated with horizontal advection, Water Vapor "Match" in the TTL
- In situ measurements of Lagrangian H_2O changes -.

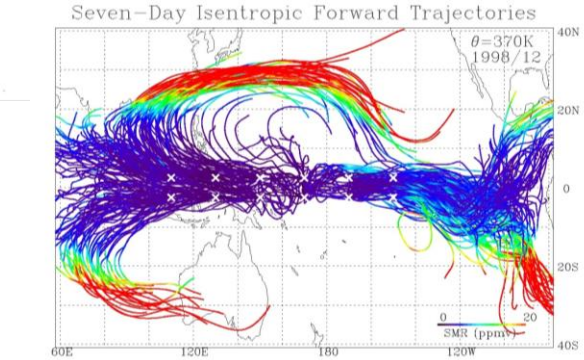
Inai et al., ACP, 2013



"Cold Trap" dehydration
(Holton and Gettelman, 2001)

GCM study
(Hatsushika and Yamazaki, 2003)

Data: Soundings of Ozone and Water in the Equatorial Region (SOWER) campaign



Multipoint coordinated sounding campaigns in the tropical western Pacific to measure the same air parcel twice or more (i.e., “match”) to quantify the Lagrangian water vapor changes in air parcels in the TTL.

SOWER 2004 – 2009: Inai et al. (ACP, 2013)
SOWER 2010: included in this talk

The number of soundings (all together with ECC ozonesonde).

Site	Dec.2004	Jan.2006	Jan.2007	Jan.2008	Jan.2009	Jan.2010
Bandung	4 (CFH)	-	-	-	-	-
Biak	3 (SW)	12(SW), 9(CFH)	6 (CFH)	7 (CFH)	4 (CFH)	6 (CFH)
Hanoi	8 (SW)	15 (SW)	6 (CFH)	5 (CFH)	4 (CFH)	5 (CFH)
Kototabang	-	10 (SW)	5 (CFH)	4 (CFH)	-	-
R/V *Mirai*	15 (SW)	-	-	-	-	-
Tarawa	10 (SW)	11(SW), 2(CFH)	5 (CFH)	-	-	5 (CFH)

CFH: Cryogenic Frostpoint Hygrometer (61) SW: Snow White peltier-cooler dew/frostpoint hygrometer (84)

Summary

- "Match" technique is applied to dehydration process associated with horizontal advection in the TTL
- Significant dehydration occurs in lower TTL (below 365 K PT)
  - ice nucleation should start < 146 +/- 19% RHi
  - dehydrated to 75 +/- 23% of the SMRmin
  - the dehydration efficiency is quite high at this alt. region
- However, the dehydration around CPT is not yet clear
  - dehydration around CPT may take much longer time than 5-day
  - dehydration may occur in different region from our campaign region
- SOWER 2014 Plans: Collaboration aircraft measurements

  The idea is follows,
  - Simultaneous measurement with aircrafts
  - Aircraft – sonde "match"