SOWER campaign 2014 and its science idea

Yoichi Inai and Masato Shiotani

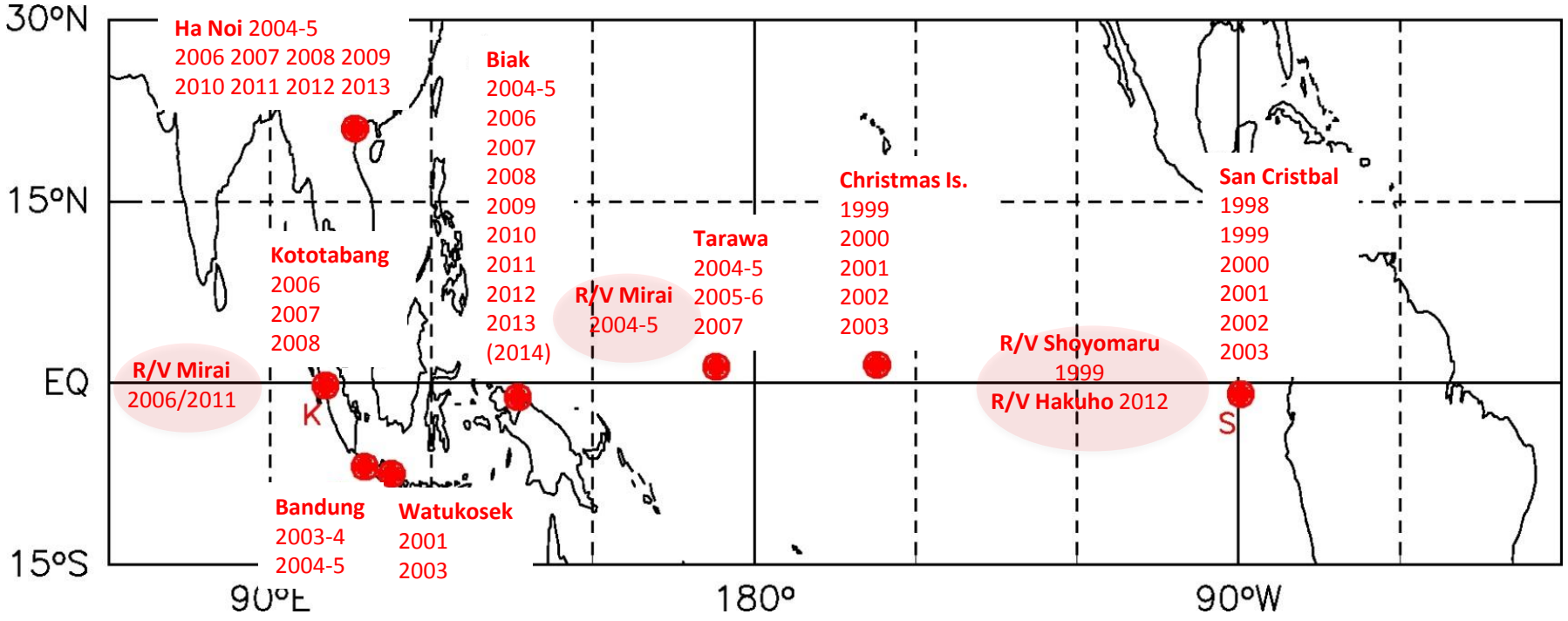
Kyoto University

SOWER since 1998 (ongoing!)

(Soundings of Ozone and Water in the Equatorial Region)

- 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

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



Accomplishments

easonal variation of ozone over Christmas Is.

2007

Vömel, H., J. E. Barnes, R. N. Forno, M. Fujiwara, F. Hasebe, S. Iwasaki, R. Kivi, N. Komala, E. Kyrö, T. Leblanc, B. Morel, S.-Y. O Saraspriya, H. Selkirk, M. Shiotani, J. Valverd
Validation of Aura Microwave Limb Sour Cryogenic Frost point Hygrometer meas
Journal of Geophysical Research, 112, D24
[JGR]

Takashima, H., and M. Shiotani (2007),
Ozone variation in the tropical tropopau data,
Journal of Geophysical Research, 112, D11
[JGR]

Nishi, N., J. Suzuki, A. Hamada, and M. Shiota
Rapid transitions in zonal wind around t relation to the amplified equatorial Kelv
Scientific Online Letters on the Atmospher
[SOLA]

Shibata, T., H. Vömel, S. Hamdi, S. Kaloka, F. (2007),
Tropical cirrus clouds near cold point tr conditions observed by lidar and balloo hygrometer,
Journal of Geophysical Research, 112, D03
[JGR]

Hasebe, F., M. Fujiwara, N. Nishi, M. Shiotani,

Mar 1999	San Cristóbal Island, the Galápagos	SO	
Sep–Oct 1999	San Cristóbal Island, the Galápagos	SO	
Nov–Dec 2000	San Cristóbal Island, the Galápagos	SO	
Nov–Dec 2001	Watukosek, Indonesia	SOWER	5
Aug 2002	San Cristóbal Island, the Galápagos	NOAA	2
Jan 2003	Watukosek, Indonesia	SOWER	3
Mar 2003	San Cristóbal Island, the Galápagos	NOAA	1

6] Aug 2002 [04] Dec 2000 [07]

2009

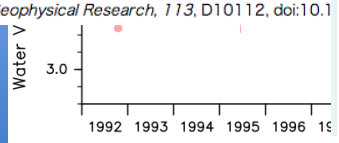
Inai, Y., F. Hasebe, K. Shimizu, and M. Fujiwara (2009),
Correction of radiosonde pressure and temperature simultaneous GPS height data,
Scientific Online Letters on the Atmosphere, 5, 109-112
028. [SOLA]

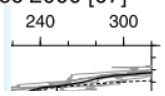
Fujiwara, M., S. Iwasaki, A. Shimizu, Y. Inai, M. Shiotani, F. H Sugimoto, H. Okamoto, N. Nishi, A. Hamada, T. Sakazaki, a
Cirrus observations in the tropical tropopause layer Pacific,
Journal of Geophysical Research, 114, D09304, doi:10.1
[JGR]

2008

Suzuki J., and M. Shiotani (2008),
Space-time variability of equatorial Kelvin waves an oscillations around the tropical tropopause,
Journal of Geophysical Research, 113, D16110, doi:10.1
[JGR]

Takashima, H., M. Shiotani, M. Fujiwara, N. Nishi, and F. Ha
Ozonesonde observations at Christmas Island (2N, central Pacific,
Journal of Geophysical Research, 113, D10112, doi:10.1





2010

Shimizu, K., and F. Hasebe (2010),
Fast-response high-resolution temperature sonde aimed at contamination-free profile observations,
Atmos. Meas. Tech., 3, 1673-1681, doi:10.5194/amt-

Fujiwara, M., H. Vömel, F. Hasebe, M. Shiotani, S.-Y. Ogi Shibata, K. Shimizu, E. Nishimoto, J. M. Valverde-Canos Oltmans (2010),
Seasonal to decadal variations of water vapor in t stratosphere observed with balloon-borne cryoge hygrometers,
Journal of Geophysical Research, 115, D18304, doi:1
[JGR]

Nishi, N., E. Nishimoto, H. Hayashi, M. Shiotani, H. Takas
Quasi-stationary temperature structure in the upp tropical Indian Ocean inferred from radio occultat
Journal of Geophysical Research, 115, D14112, doi:1
[JGR]

Hamada, A., and N. Nishi (2010),
Development of a cloud-top height estimation me satellite split-window measurements trained with
Journal of Applied Meteorology and Climatology, 49, 2
10.1175/2010JAMC2287.1. [JAMC]

Suzuki, J., M. Fujiwara, A. Hamada, Y. Inai, J. Yamaguchi T. Takano (2010),
Cloud-top height variability associated with equat

	Ozonesonde	Water Vapor
25 Feb–9 Mar 1999	4 (Science Pump 6A)	–
17–28 Sep 1999	–	
	6 (EN-SCI 2Z)	6
	7 (EN-SCI 1Z)	7
	–	4

2012

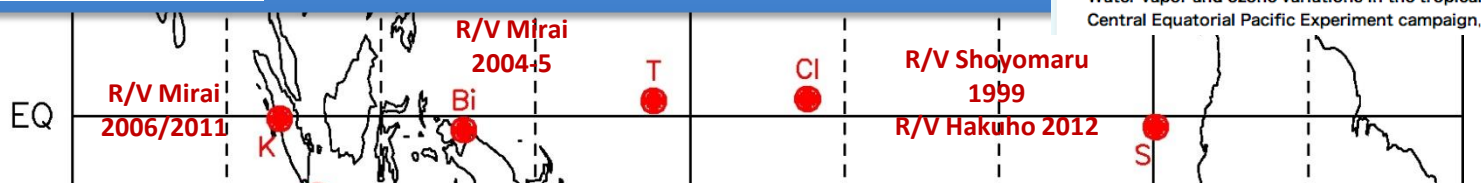
Inai, Y., T. Shibata, M. Fujiwara, F. Hasebe, and H. Vömel (2012),
High supersaturation inside cirrus in well-developed tropical tropopause layer over Indonesia,
Geophysical Research Letters, 39, L20811, doi:10.1029/2012GL053638. [GRL]

Fujiwara, M., J. Suzuki, A. Gettelman, M. I. Hegglin, H. Akiyoshi, and K. Shibata (201
Wave activity in the tropical tropopause layer in seven reanalysis and four chemistry climate model data sets,
Journal of Geophysical Research, 117, D12105, doi:10.1029/2011JD016808.
[JGR]

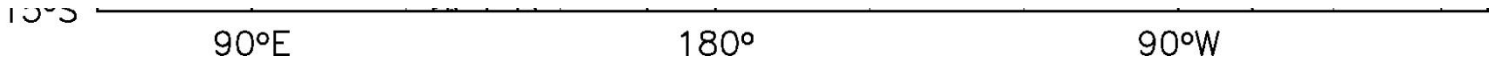
Iwasaki, S., T. Shibata, H. Okamoto, H. Ishimoto, and H. Kubota (2012),
Mixtures of stratospheric and overshooting air measured using A-Train sensors,
Journal of Geophysical Research, 117, D12207, doi:10.1029/2011JD017402.
[JGR]

Shibata, T., M. Hayashi, A. Naganuma, N. Hara, K. Hara, F. Hasebe, K. Shimizu, N. Komala, Y. Inai, H. Vömel, S. Hamdi, S. Iwasaki, M. Fujiwara, M. Shiotani, S.-Y. Ogino, and N. Nishi (2012),
Cirrus cloud appearance in a volcanic aerosol layer around the tropical col point tropopause over Biak, Indonesia, in January 2011,
Journal of Geophysical Research, 117, D11209, doi:10.1029/2011JD017029.
[JGR]

Koishi, K., and M. Shiotani (2012),
Water vapor and ozone variations in the tropical tropopause layer during t Central Equatorial Pacific Experiment campaign,



- Recent focus: Dehydration processes in the TTL, Match campaigns

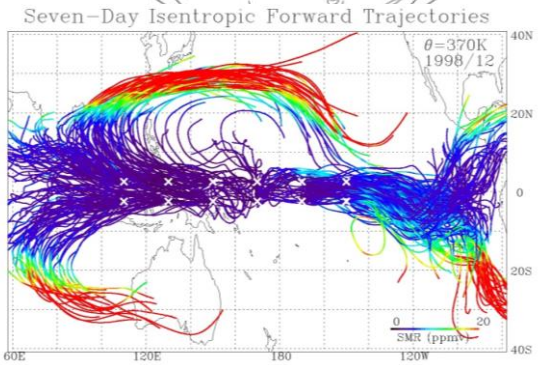


Water Vapor “Match” in the TTL

- In situ measurements of Lagrangian H_2O changes -

Inai et al., ACP, 2013

Multipoint Ozonesonde – Water-vapor-sonde Soundings in the Western Pacific



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 H_2O changes in air parcels in the TTL

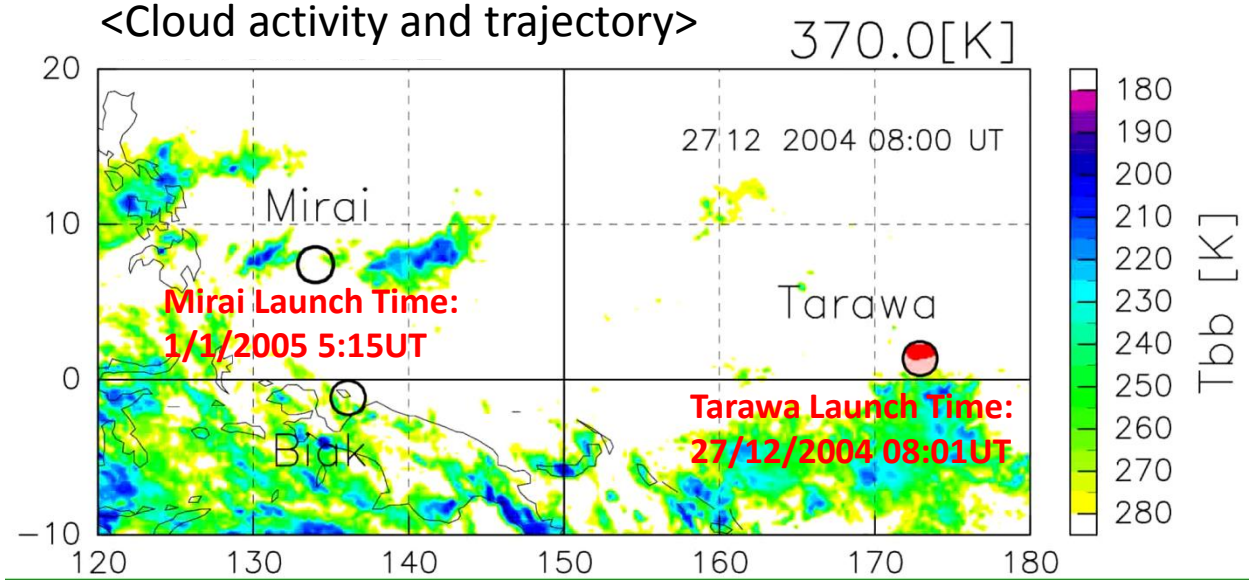
Site	Dec.2004	Jan.2006	Jan.2007	Jan.2008	Jan.2009
Bandung	4 (CFH)	-	-	-	-
Biak	3 (SW)	12 (SW), 9 (CFH)	6 (CFH)	7 (CFH)	4 (CFH)
Hanoi	8 (SW)	15 (SW)	6 (CFH)	5 (CFH)	4 (CFH)
Kototabang	-	10 (SW)	5 (CFH)	4 (CFH)	-
R/V *Mirai*	15 (SW)	-	-	-	-
Tarawa	10 (SW)	11 (SW) , 2 (CFH)	5 (CFH)		

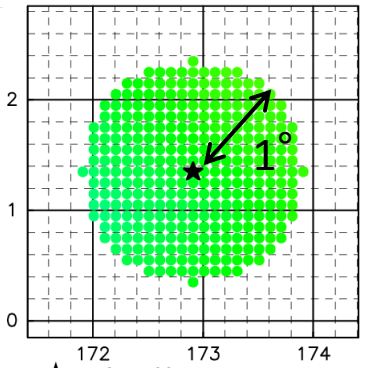
[Inai et al., ACP, 2013]

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

Trajectory Calculations

<Cloud activity and trajectory>





★: balloon site

Cluster of isentropic trajectories (both forward and backward)
to seek sonde-to-sonde "match" cases during the SOWER campaigns

Air parcel: Circular area of 1° radius, with 0.1°x0.1° air segments, centered at balloon sites
0.2/1.0 K at 350-360/360-400 K potential temperature levels

Meteorological data: opECMWF (1°x1°, L60 or L91, 6 hourly → interpolated 1 hourly)

~900 preliminary "match" (connected by both forward and backward trajectories)

After intensive screening procedures → 107 match cases were found.

[Inai et al., ACP, 2013]

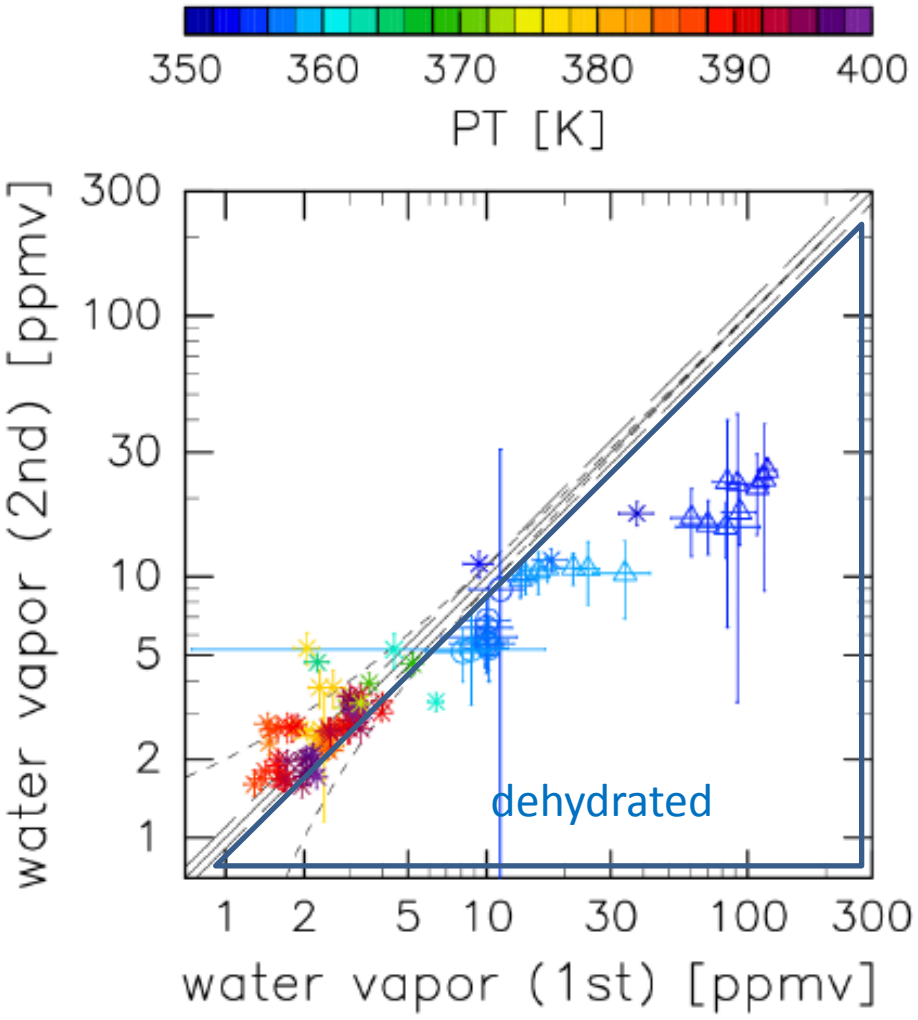


Figure: Scatter plot of water vapor mixing ratio for the match pairs (1st sounding versus 2nd sounding) after applying all the screening processes. (107 matches, 25 different sounding pairs)

[Inai et al., ACP, 2013]

Statistical Features of Dehydration

- Significant dehydration occurs below 365 K
- H_2O broadly unchanged above 365 K (for 5-day trajectories; dehydration around CPT may take much longer time)

- First direct evidence of TTL dehydration in horizontal advection
- Lack of dehydrated cases around CPT
  - → Reduce the uncertainty of H_2O measurements
  - → Simultaneous cloud-particle measurements
  - → More sites in the central Pacific

SOWER

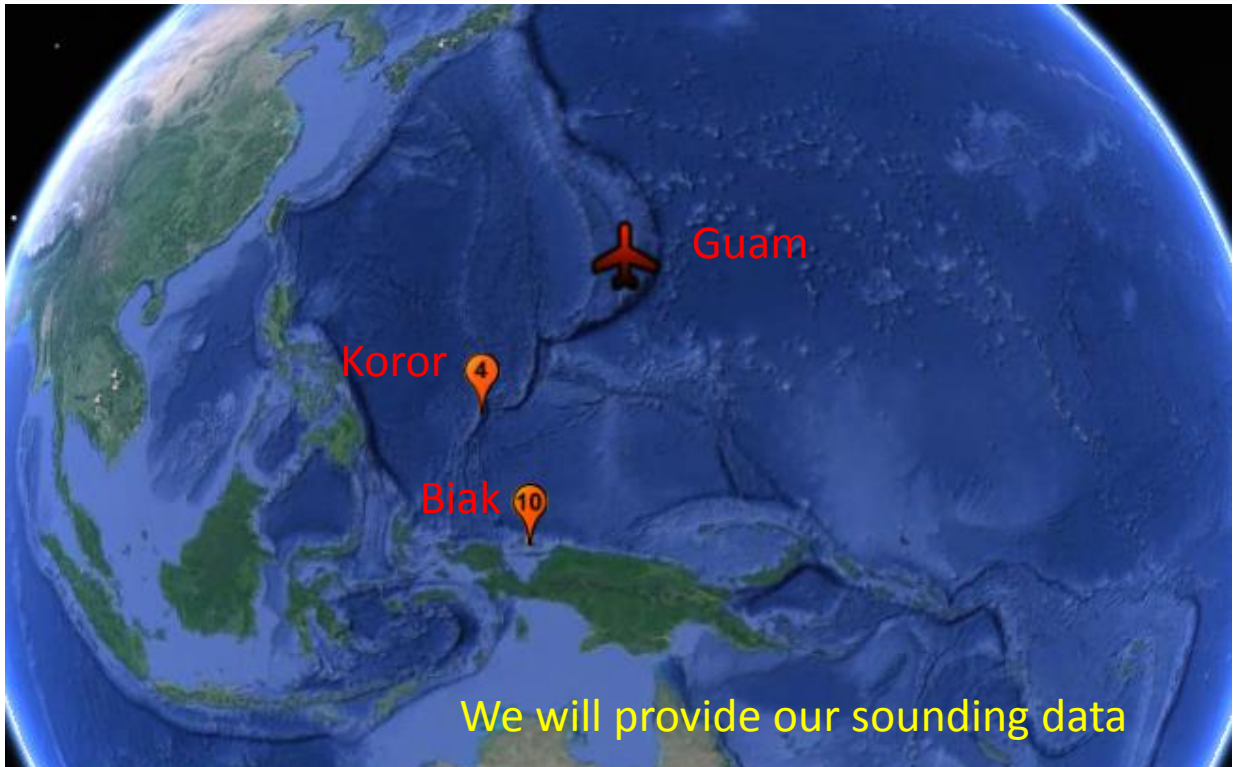
(Soundings of Ozone and Water in the Equatorial Region) since 1998
Ongoing project

2014
- Station: Biak
- 10 sets of CFH + ECC (Meisei)
  and some additional sondes
  period: Mid-Jan. – End of Feb.

JAMSTEC

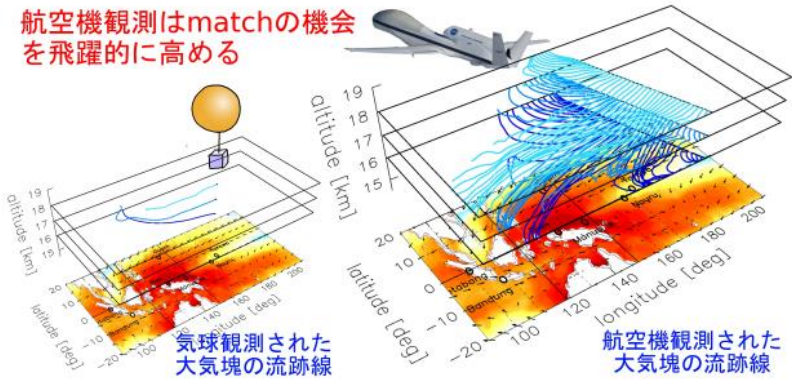
- Station: Koror
- 4 sets of CFH + ECC (Meisei)
- Mie Lidar will be active
  period: 2 weeks
  during 20 Jan. – 12 Feb.

Payload (H2O, O3)

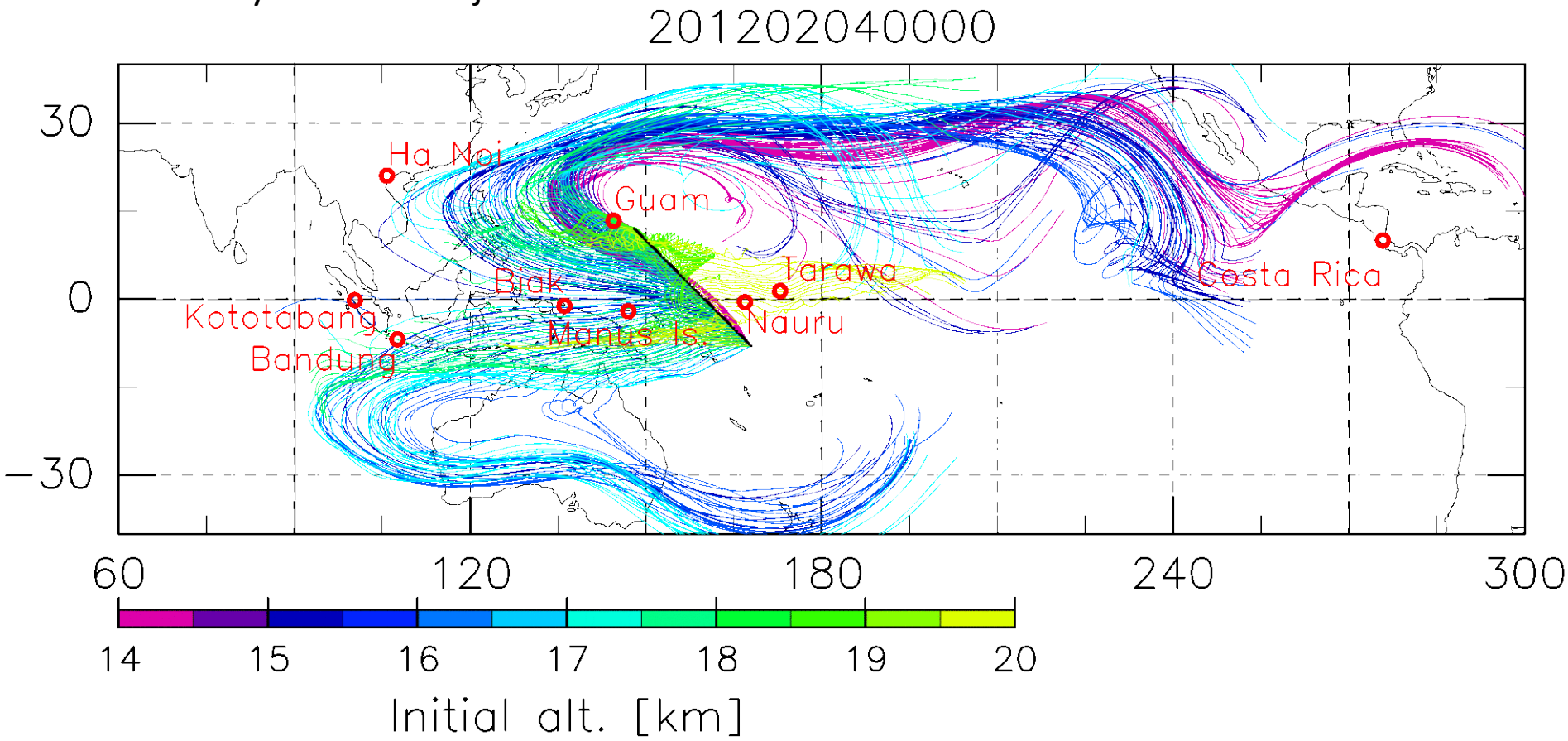


launched by balloon

SOWER 2014



7 days forward trajectories



Summary of the Talk

1. Introduction
2. Water Vapor “Match” in the TTL
   - In situ measurements of Lagrangian H_2O changes
3. 2014 Plans: Collaboration ATTREX
   - Collocated measurement
   - ATTREX - SOWER match

Renewing SOWER web page to open our dataset

SOWER web page
http://sower.ees.hokudai.ac.jp/

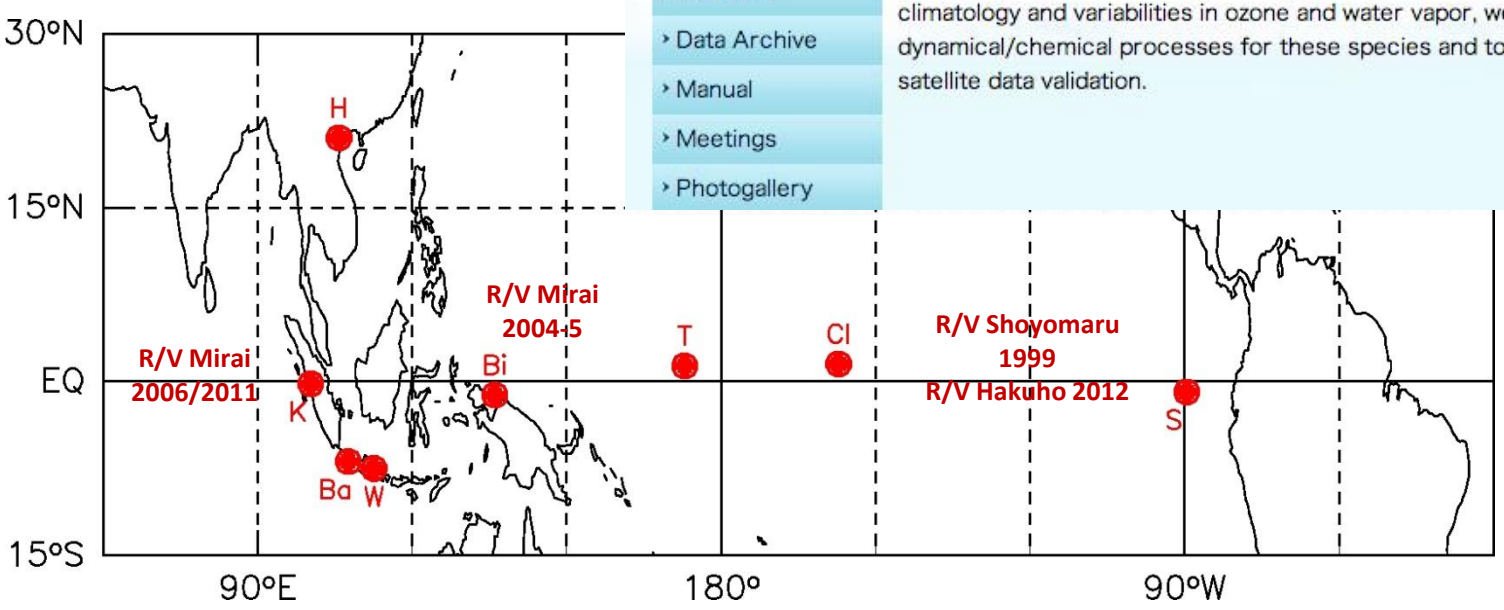
日本語 English

SOWER/Pacific

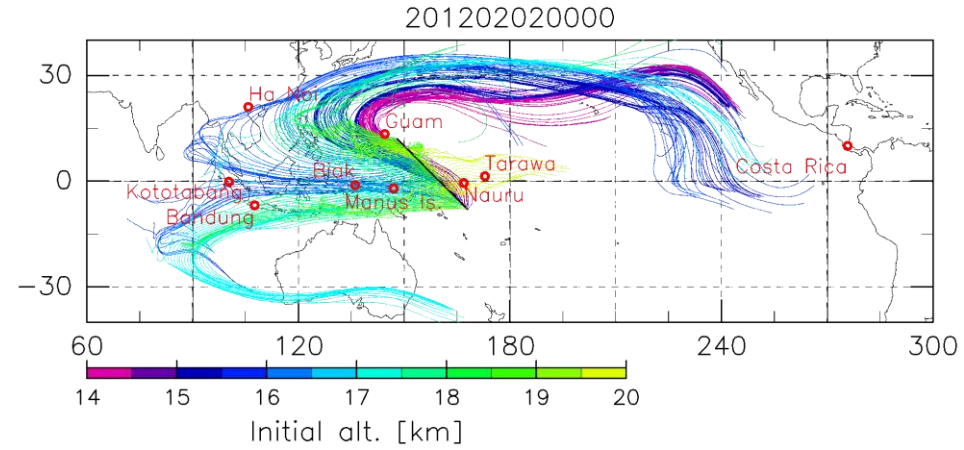
Soundings of Ozone and Water
in the Equatorial Region/Pacific Mission

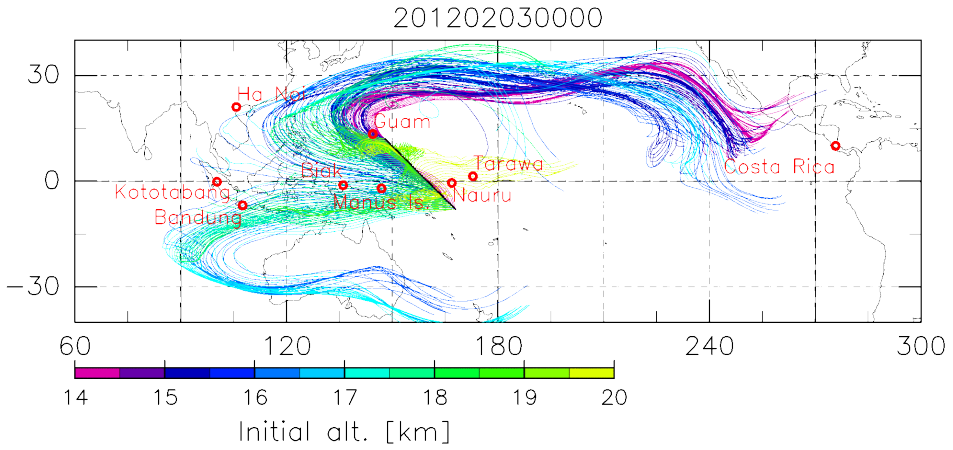
- Introduction
- Highlights
- Publications
- Members
- Data Archive
- Manual
- Meetings
- Photogallery

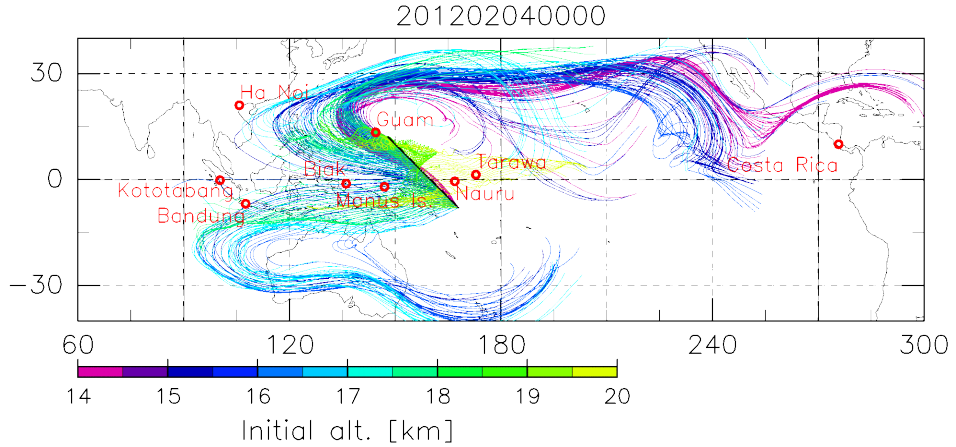
The Soundings of Ozone and Water in the Equatorial Region/Pacific Mission (SOWER/Pacific) has been running on a campaign basis since 1998 to improve our knowledge on the ozone and water vapor distributions in the tropical Pacific region by making coordinated radiosonde observations at three equatorial 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.

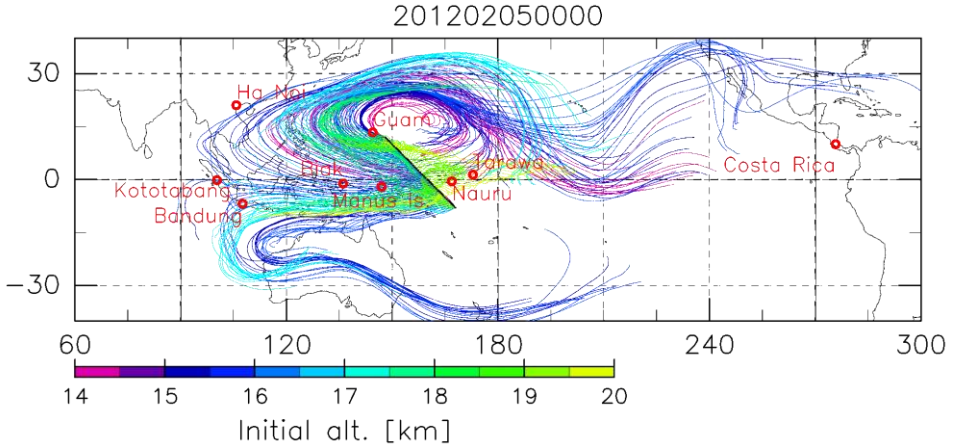


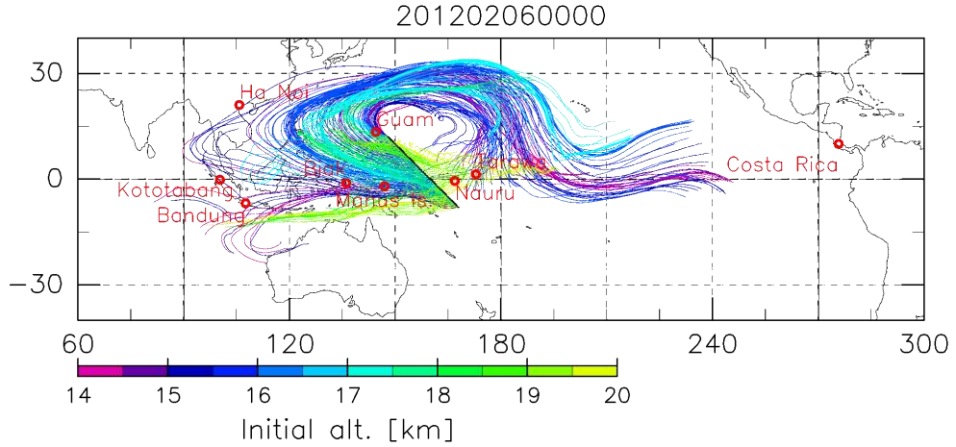
Different date, different features.

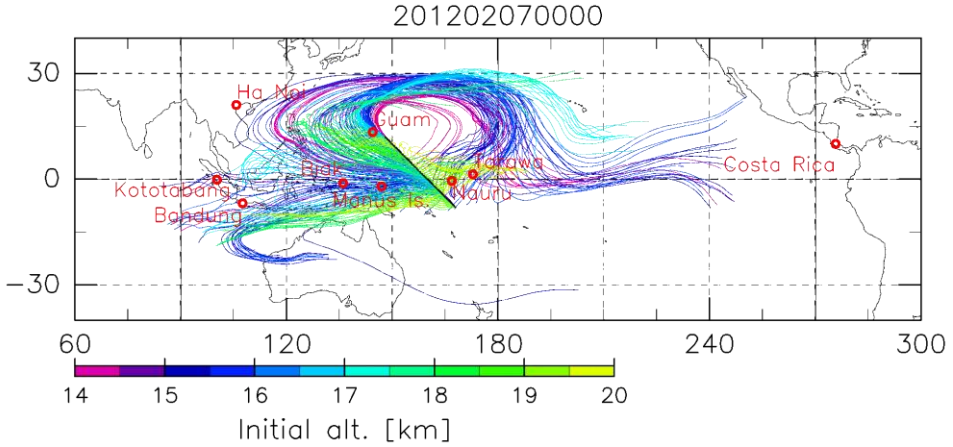


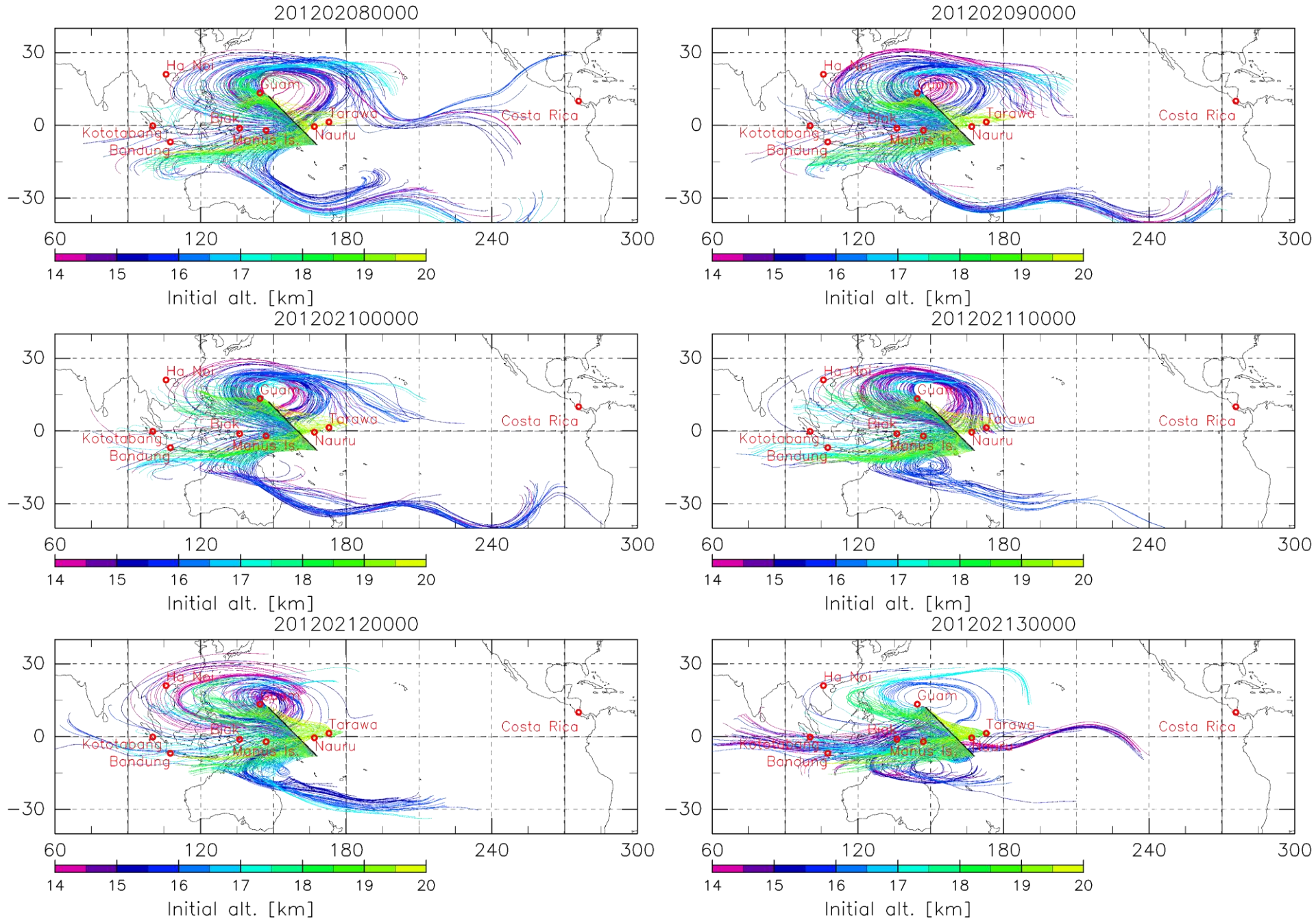


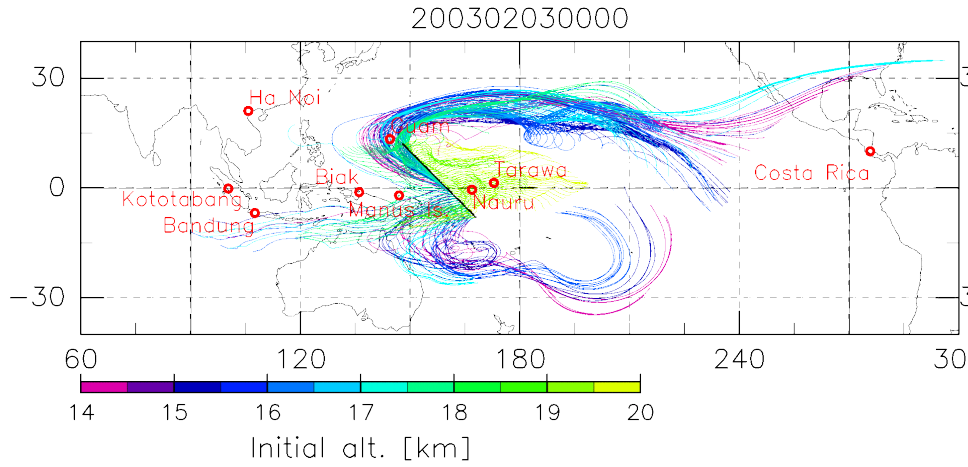


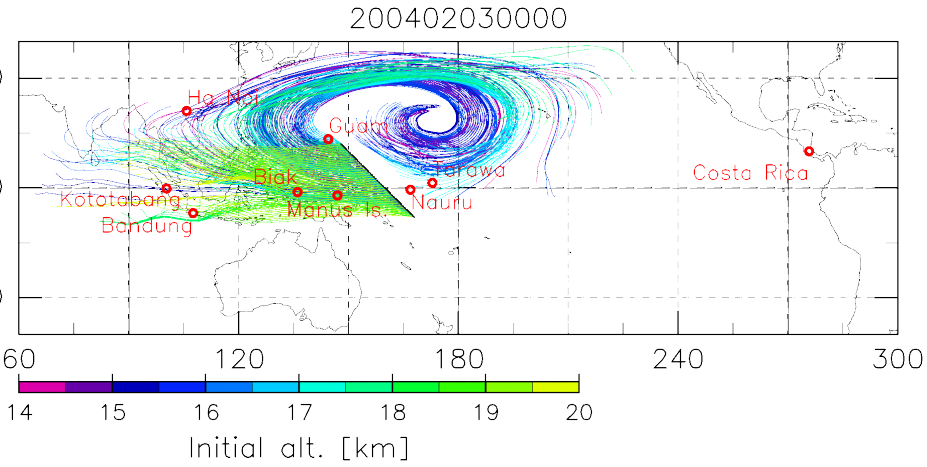


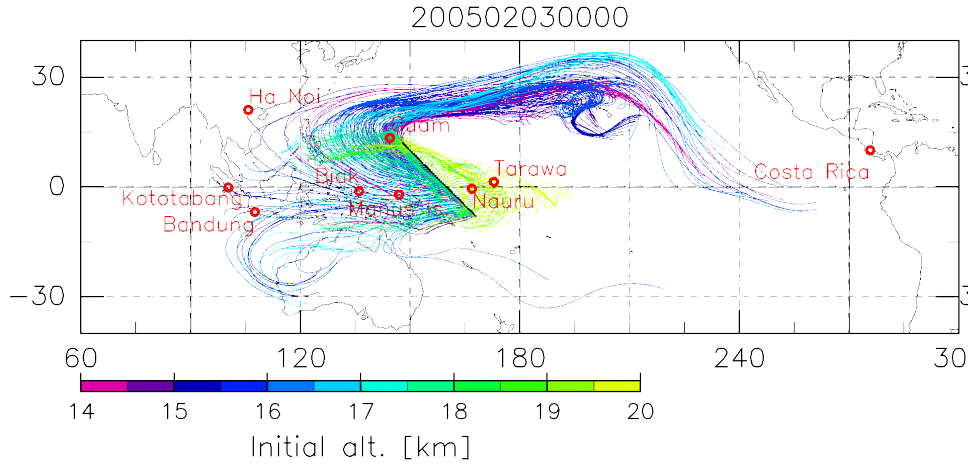


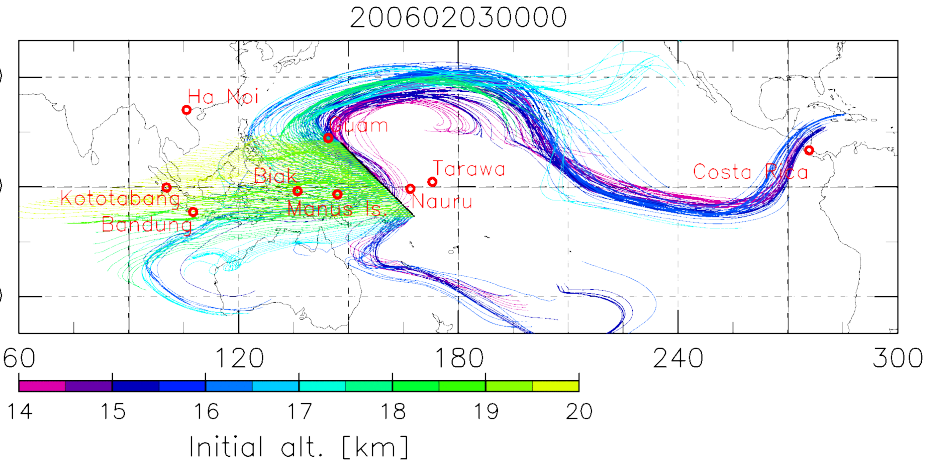
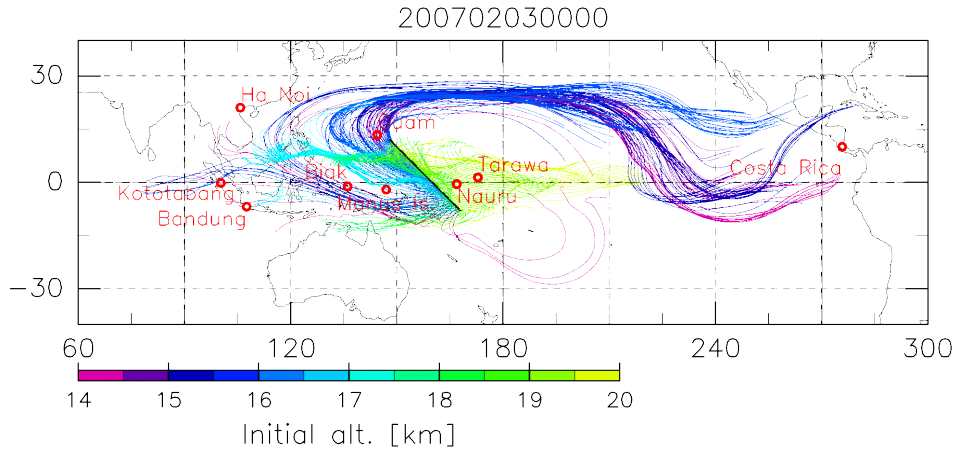
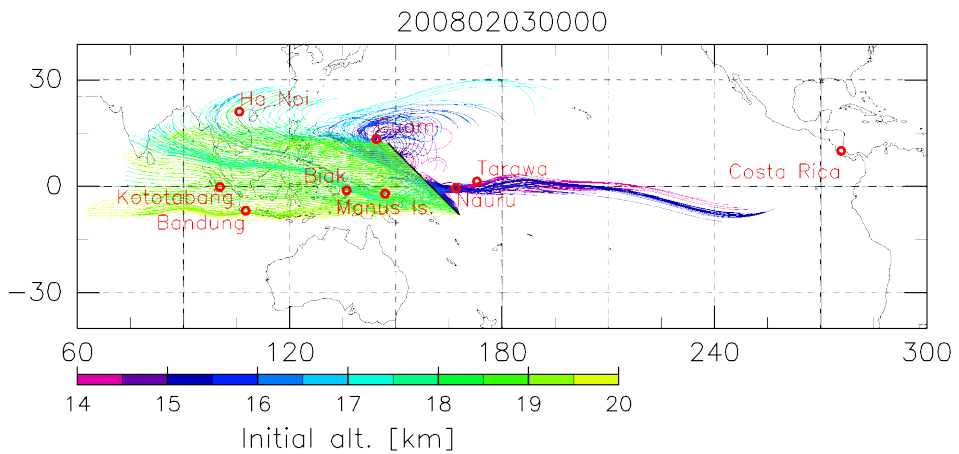
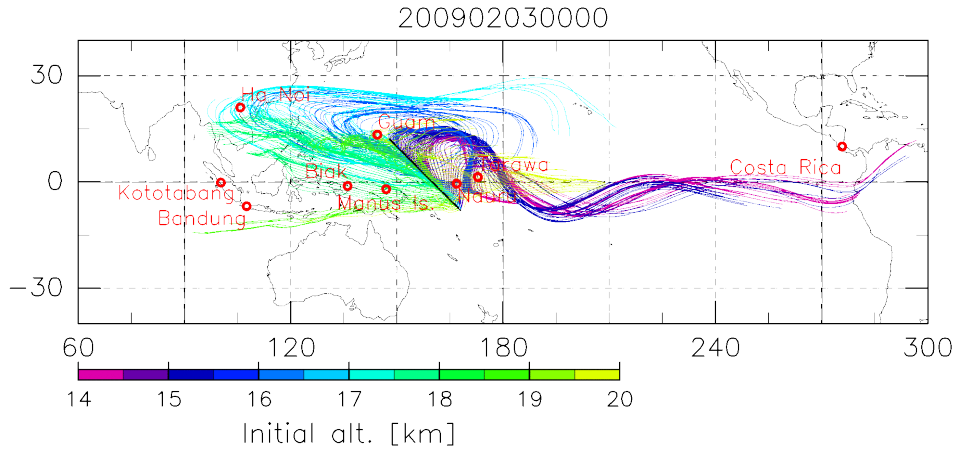
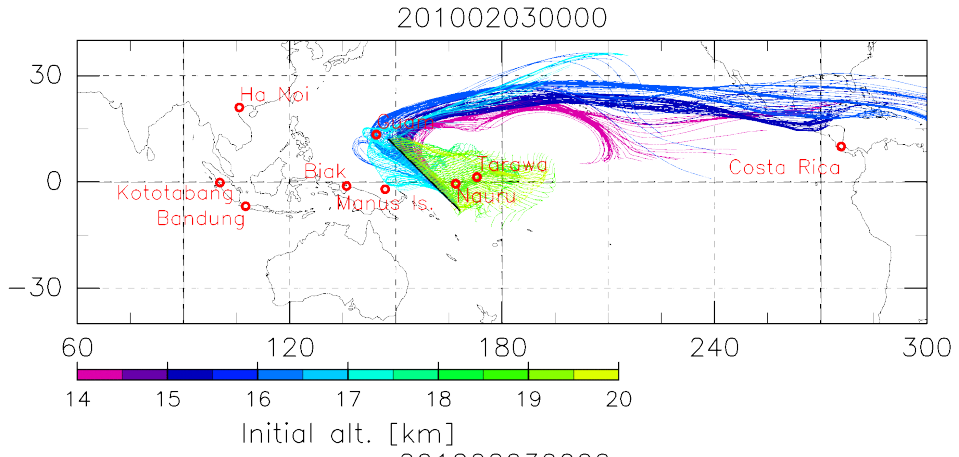
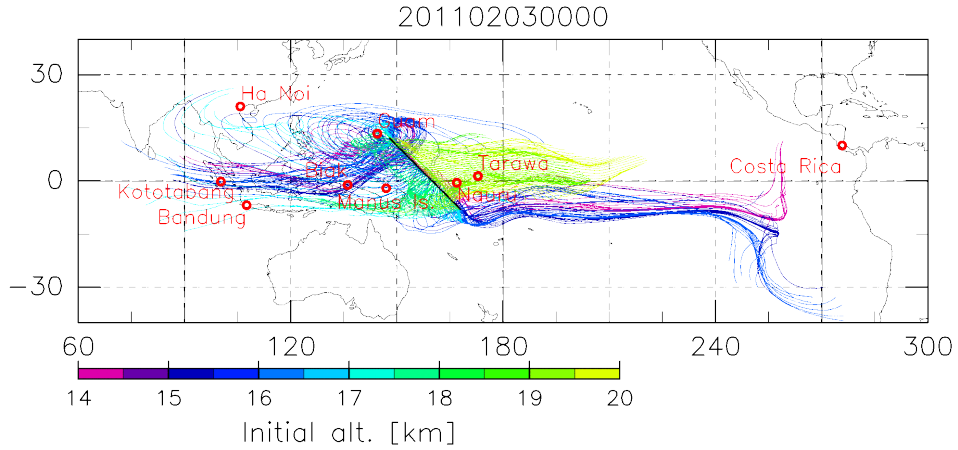
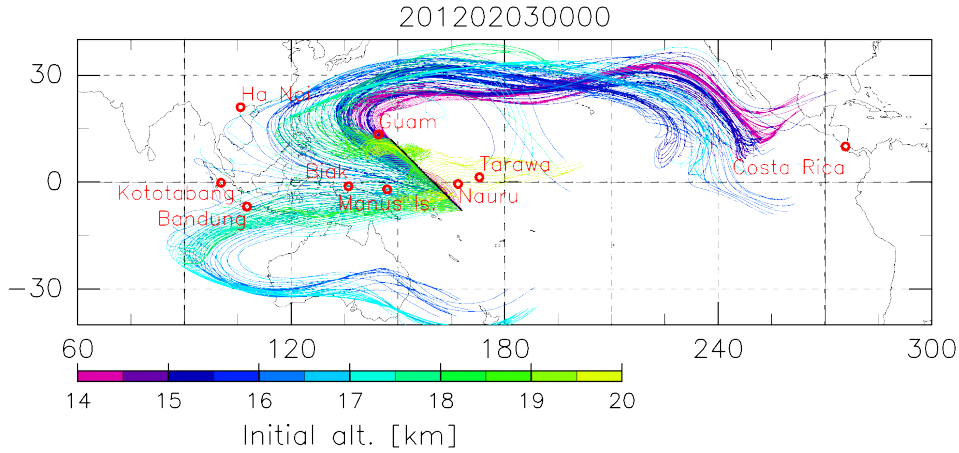



201202080000
201202090000
201202100000
201202110000
201202120000
201202130000
Ha Noi
Guam
Tarawa
Costa Rica
Kototabang
Bandung
Biak
Manus Is.
Nauru
30
0
−30
60
120
180
240
300
14
15
16
17
18
19
20
Initial alt. [km]


200302030000
Ha Noi
Guam
Biak
Tarawa
Costa Rica
Kototabang
Manus Is.
Nauru
Bandung
30
0
−30
60
120
180
240
300
14
15
16
17
18
19
20
Initial alt. [km]


200402030000
Ha Noi
Guam
Biak
Tarawa
Costa Rica
Kototabang
Manus Is.
Nauru
Bandung
30
0
30
60
120
180
240
300
14
15
16
17
18
19
20
Initial alt. [km]


200502030000
Ha Noi
Guam
Biak
Tarawa
Costa Rica
Kototabang
Manus Is.
Nauru
Bandung
30
0
−30
60
120
180
240
300
14
15
16
17
18
19
20
Initial alt. [km]


200602030000
Ha Noi
Guam
Biak
Tarawa
Costa Rica
Kototabang
Manus Is.
Nauru
Bandung
30
0
30
60
120
180
240
300
14
15
16
17
18
19
20
Initial alt. [km]

Different year, different features.