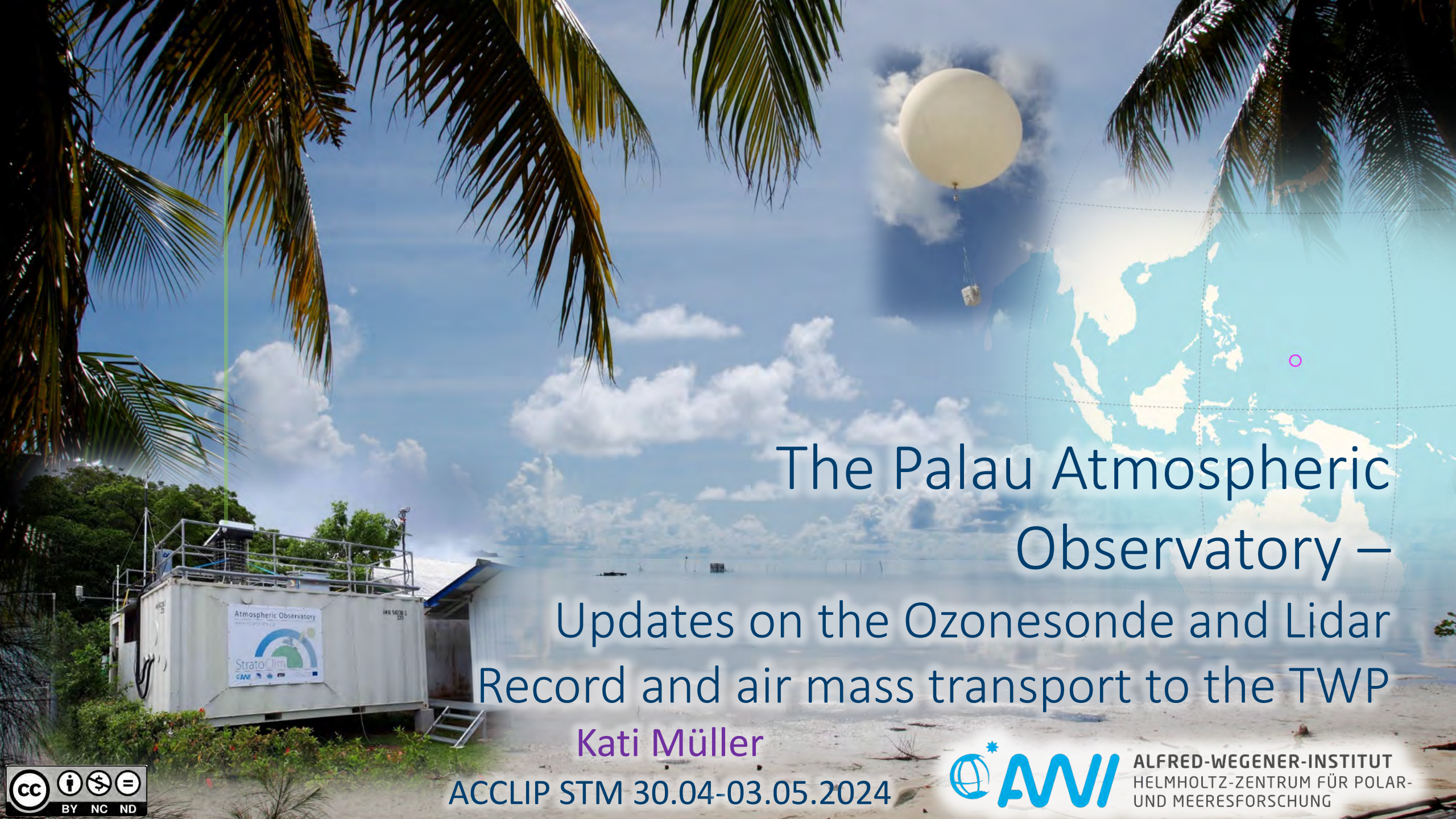


The Palau Atmospheric Observatory – Updates on the Ozonesonde and Lidar Record and air mass transport to the TWP

Kati Müller

ACCLIP STM 30.04-03.05.2024

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Quick History: Palau Atmospheric Observatory

PAST:

StratoClim (2015-2019)

→ Müller 2020 (thesis), Cairo et al. 2021, Müller et al. 2024a,b

POSIDON (campaign 2016)

Pandonia Network (since 2016/2022)

ACCLIP (campaign 2022)

TroStra (Uni Bremen, 2020-24)

→ Sun et al. 2023
Sun 2024 (thesis)
Sun et al. 2024

ONGOING:

2 Postdocs (Kati&Xiaoyu): -2025/27

New PhD &Master students (Tim & Lisa): -2025/26

SHADOZ (from 2024…), NDACC?

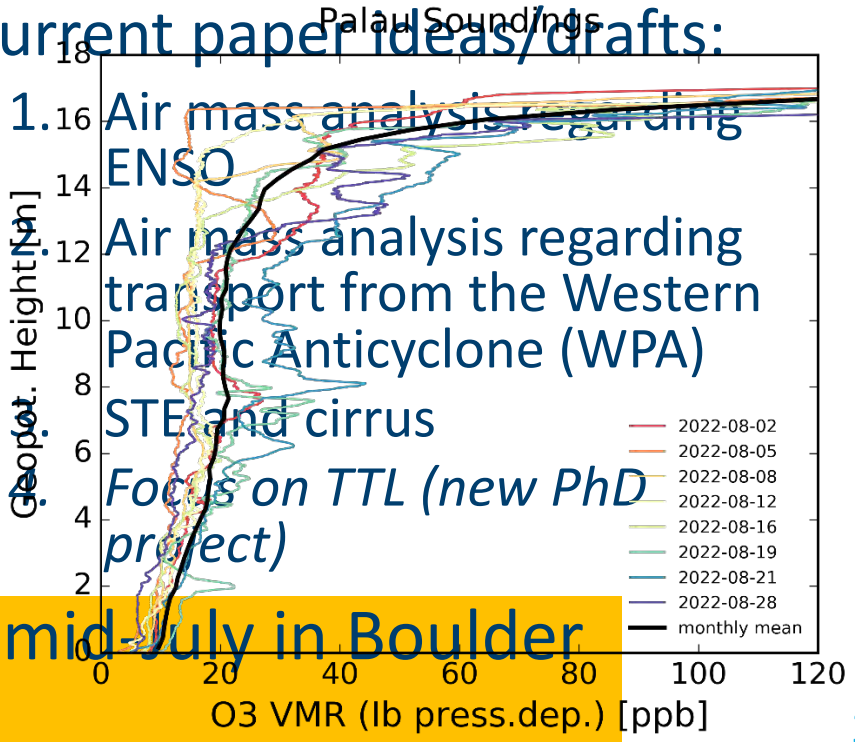
UPCOMING:

ATMOsense 2025-29

PARTNERS:

ACCLIP ground stations

- Ground station für balloon soundings and Lidar > joint publication?
- Datasets available for Ozonesondes, CFH-COBALD, Lidar
- Current paper ideas/drafts:
  1. Air mass analysis regarding ENSO
  2. Air mass analysis regarding transport from the Western Pacific Anticyclone (WPA)
  3. STE and cirrus
  4. *Focus on TTL (new PhD project)*

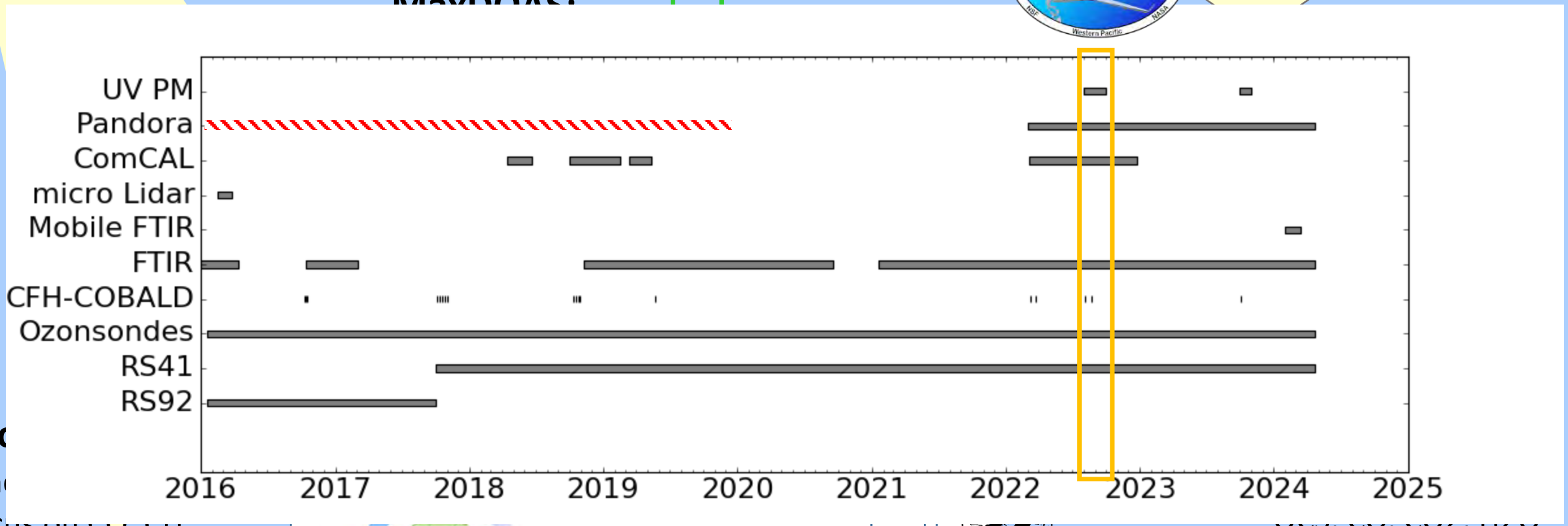


Upcoming: Quadrennial Ozone Symposium mid-July in Boulder – come and talk to me! ☺

Instrumentation

MaxDOAS:

Lidar:



Mo

Sin

focus on CO, CH_4...

UV Photometer:

Since 2022:

Ground Ozone

Temp. @ CRRF site

Müller et al. 2024a

Scientific „Output“

Characterization of Ozone and the Oxidizing Capacity

Atmos. Chem. Phys., 23, 7075–7090, 2023
https://doi.org/10.5194/acp-23-7075-2023
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Atmospheric Chemistry and Physics

Research article

Determination of the chemical equator from GEOS-Chem model simulation: a focus on the tropical western Pacific region

Atmos. Chem. Phys., 24, 2169–2193, 2024
https://doi.org/10.5194/acp-24-2169-2024
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Atmospheric Chemistry and Physics

Measurement report

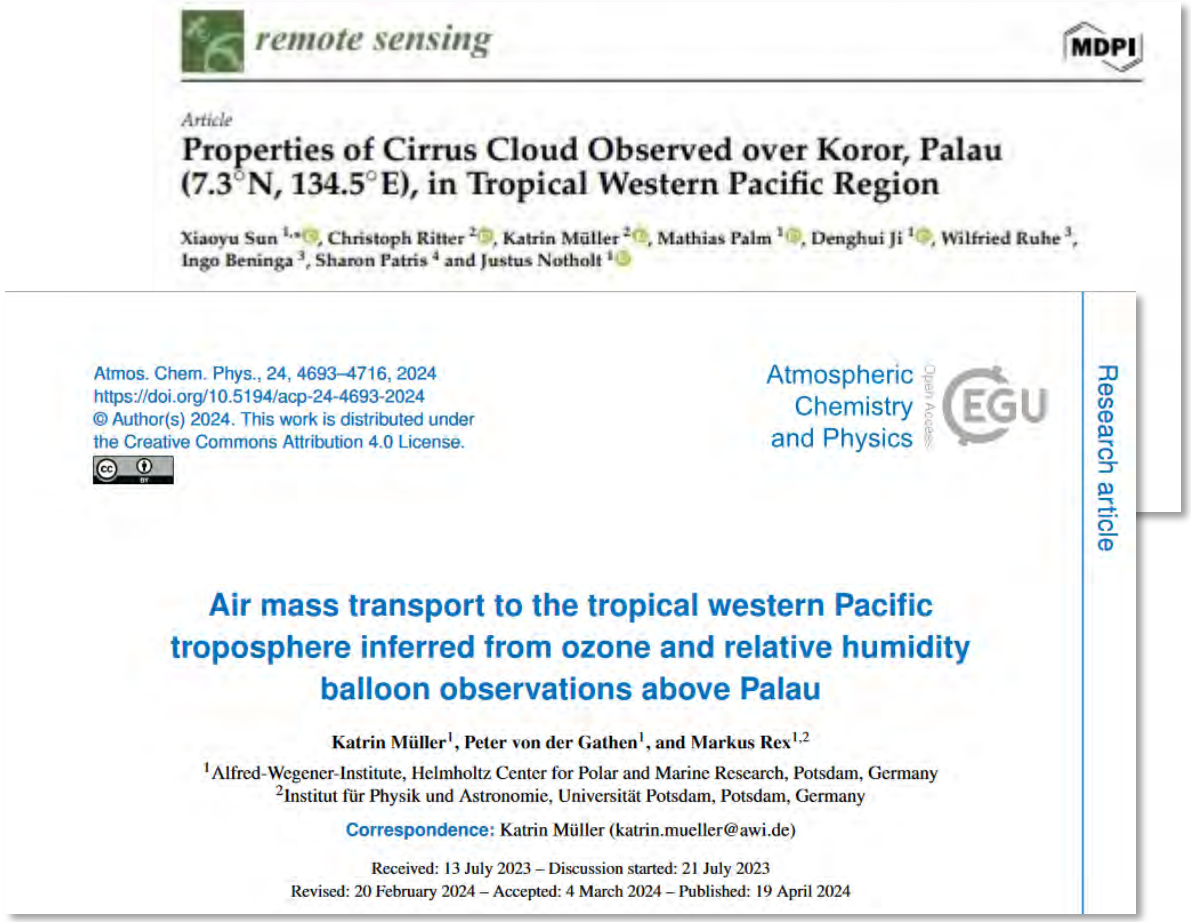
Measurement report: The Palau Atmospheric Observatory and its ozonesonde record – continuous monitoring of tropospheric composition and dynamics in the tropical western Pacific

Katrin Müller[1,Ω], Jordis S. Tradowsky[2,3], Peter von der Gathen[1], Christoph Ritter[1], Sharon Patris[4], Justus Notholt[5], and Markus Rex[1,6]

[1]Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Potsdam, Germany
[2]Norwegian Meteorological Institute, Oslo, Norway
[3]Bodeker Scientific, Alexandra, New Zealand
[4]Coral Reef Research Foundation, Koror, Palau
[5]Institut für Umweltphysik, University of Bremen, Bremen, Germany
[6]Institut für Physik und Astronomie, Universität Potsdam, Potsdam, Germany
[Ω]*Invited contribution by Katrin Müller, recipient of the EGU Atmospheric Sciences Outstanding Student Poster and PICO Award 2019.*

Correspondence: Katrin Müller (katrin.mueller@awi.de)

Received: 16 May 2023 – Discussion started: 12 June 2023
Revised: 25 October 2023 – Accepted: 1 November 2023 – Published: 21 February 2024



remote sensing

MDPI

Article

Properties of Cirrus Cloud Observed over Koror, Palau (7.3°N, 134.5°E), in Tropical Western Pacific Region

Xiaoyu Sun [1,*], Christoph Ritter [2], Katrin Müller [2], Mathias Palm [1], Denghui Ji [1], Wilfried Ruhe [3], Ingo Beninga [3], Sharon Patris [4] and Justus Notholt [1]

Atmos. Chem. Phys., 24, 4693–4716, 2024
https://doi.org/10.5194/acp-24-4693-2024
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Atmospheric Chemistry and Physics

Research article

Air mass transport to the tropical western Pacific troposphere inferred from ozone and relative humidity balloon observations above Palau

Katrin Müller[1], Peter von der Gathen[1], and Markus Rex[1,2]

[1]Alfred-Wegener-Institute, Helmholtz Center for Polar and Marine Research, Potsdam, Germany
[2]Institut für Physik und Astronomie, Universität Potsdam, Potsdam, Germany

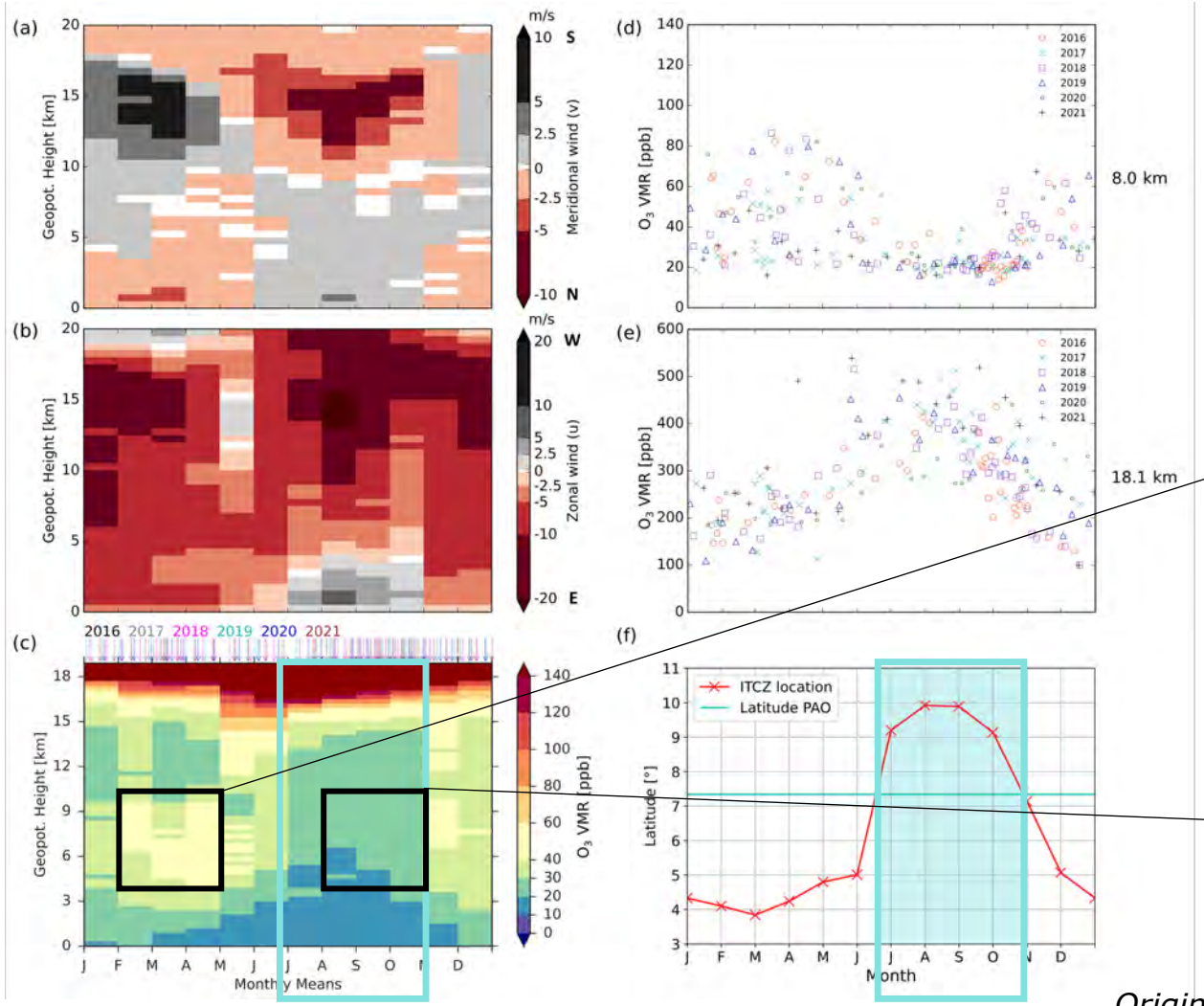
Correspondence: Katrin Müller (katrin.mueller@awi.de)

Received: 13 July 2023 – Discussion started: 21 July 2023
Revised: 20 February 2024 – Accepted: 4 March 2024 – Published: 19 April 2024

- Müller 2020,
- Sun et al. 2023
- Sun 2024

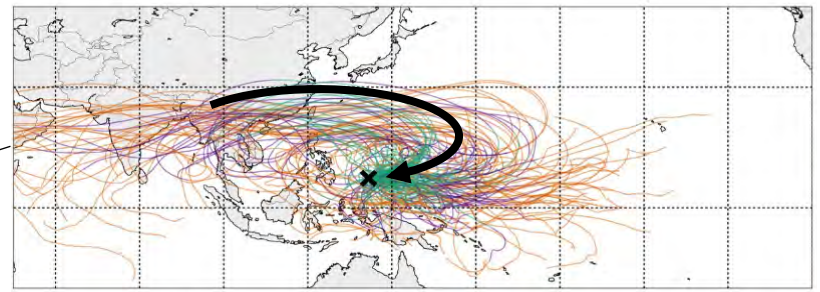
- Müller et al. 2024a,b
- Sun et al. 2024

Characterization of tropospheric Ozone

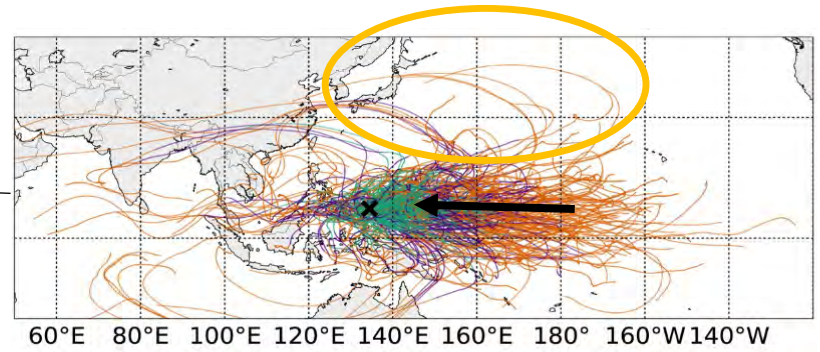


10-days back trajectories by ATLAS (Wohltmann et al. 2010)

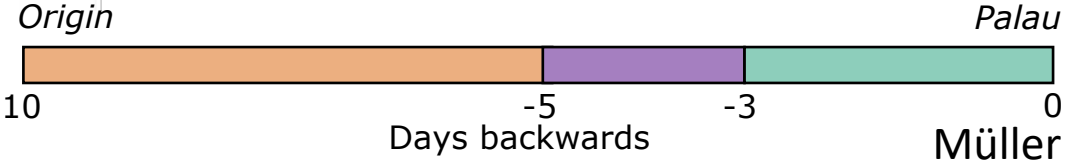
- driven by ERA5
- 2016-2019, initialized @ 5-10 km for O3 soundings



FMA



ASO

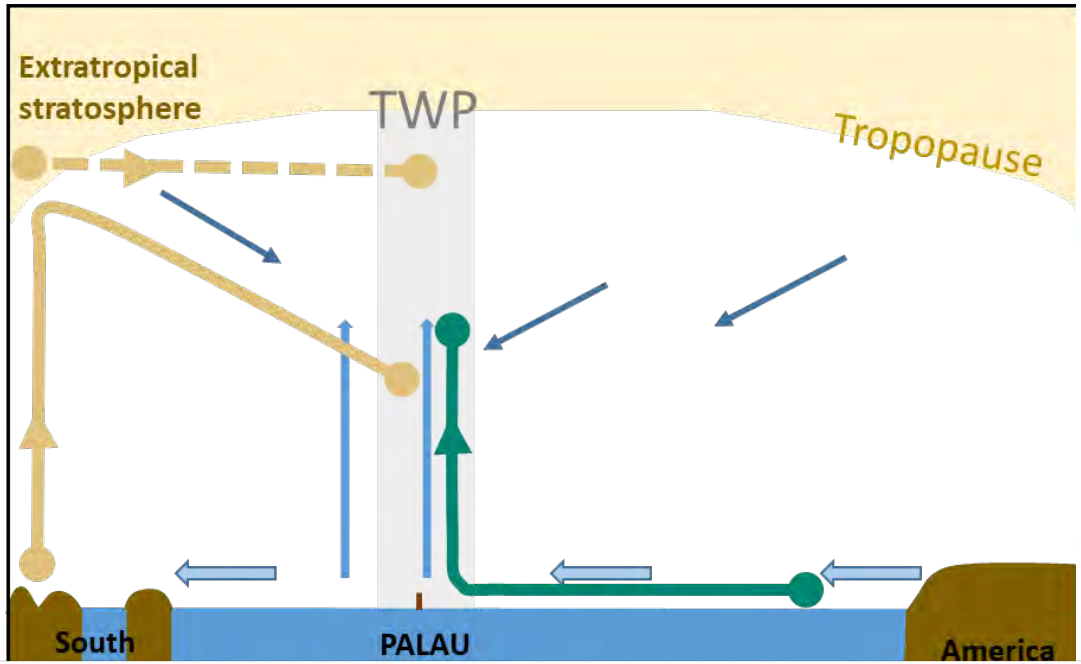


Müller et al. 2024a

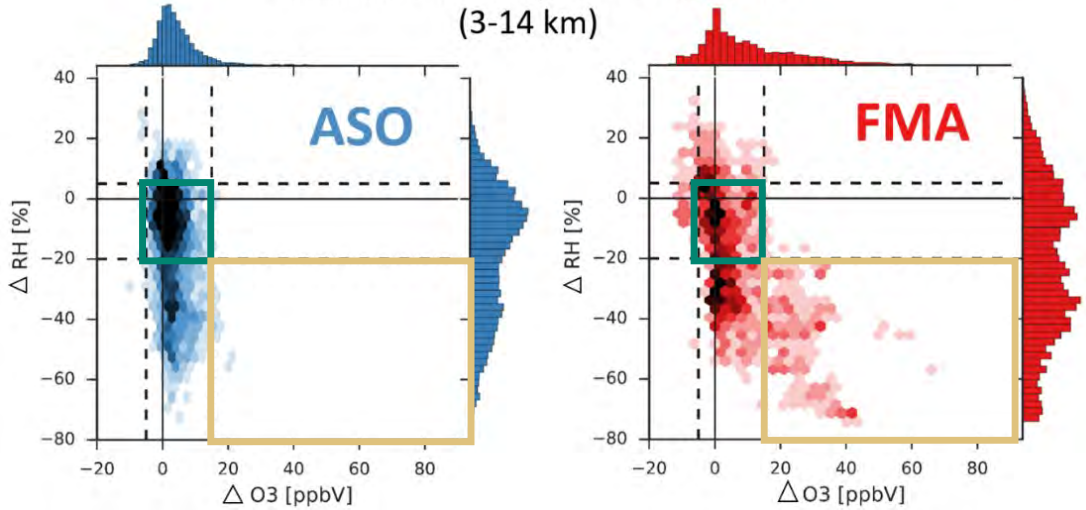
Müller et al. 2024b

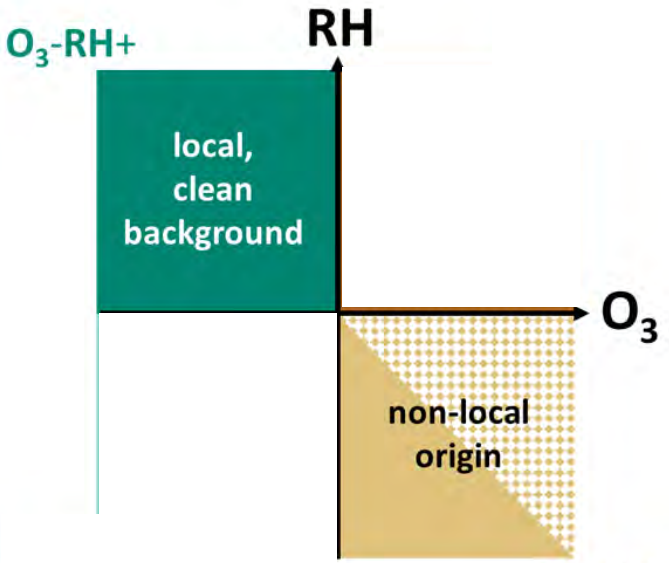
Origin of mid-tropospheric air masses

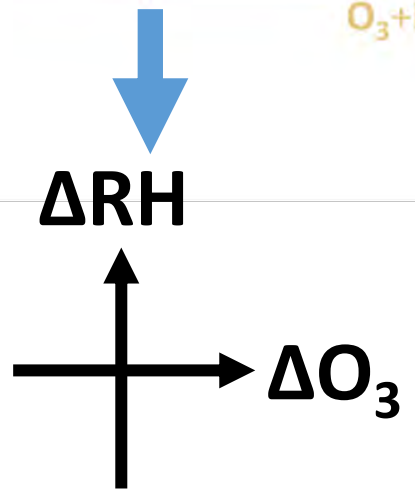
Müller et al. 2024b



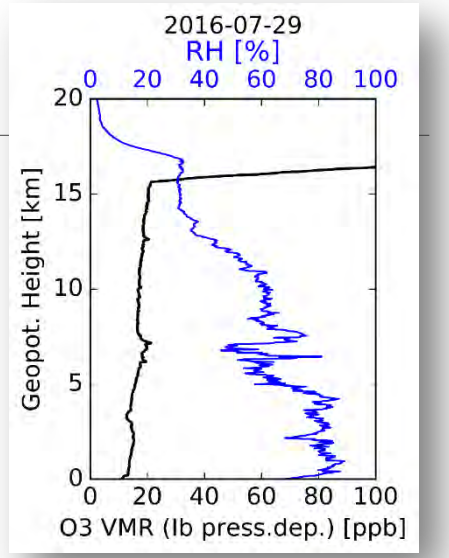
Anomalies from O_3/RH Background (3-14 km)



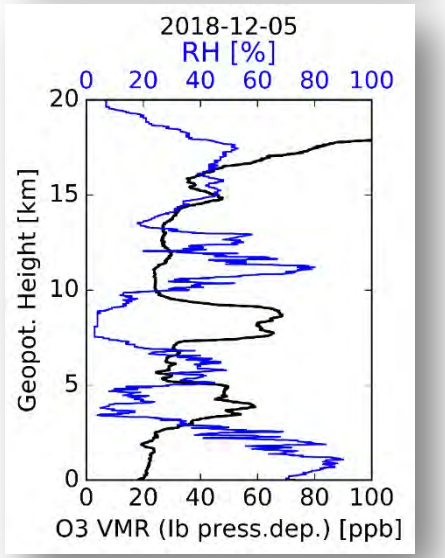




Background

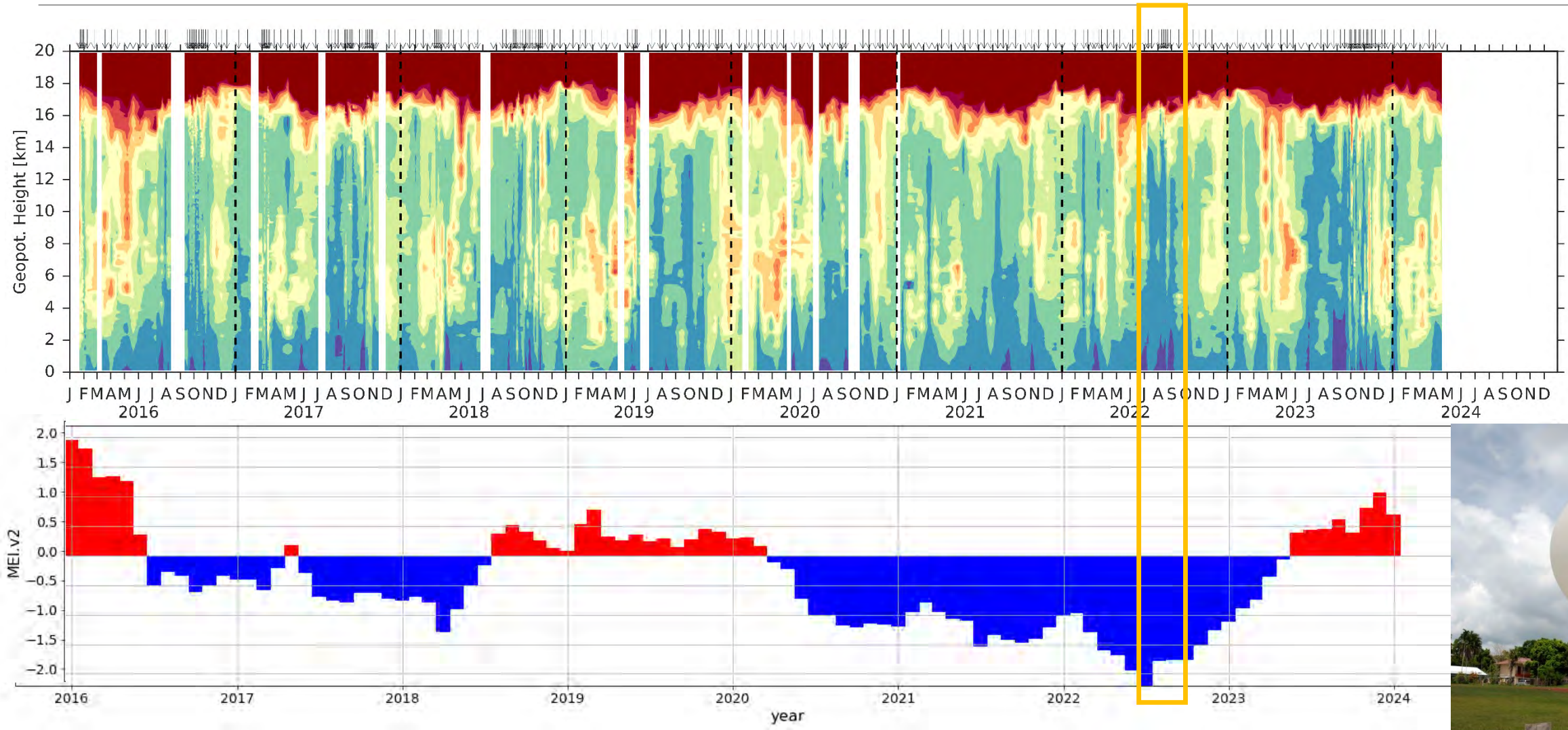


Anomalous Layers



Dry, ozon-rich air masses occur as layers in the mid-troposphere, controlled by transport

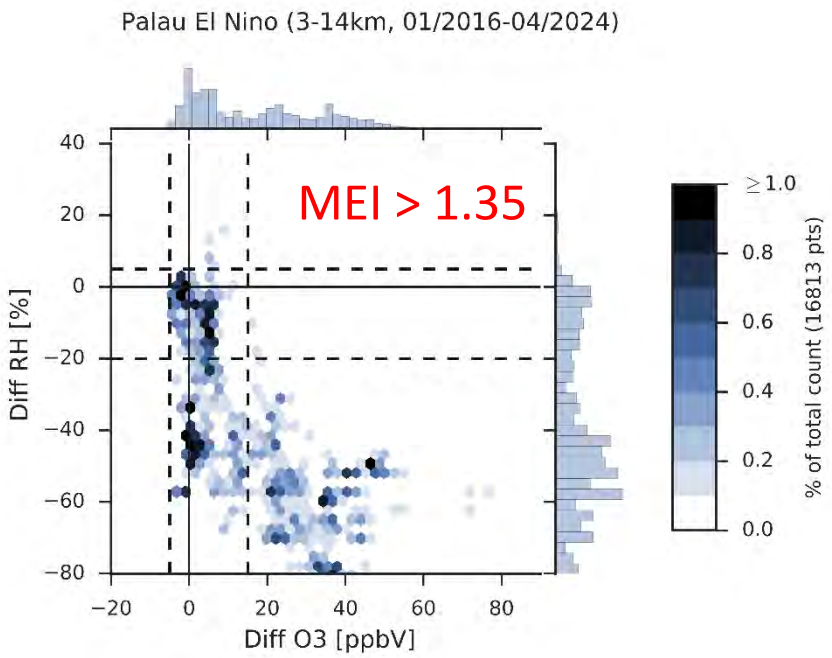
Characterization of tropospheric Ozone

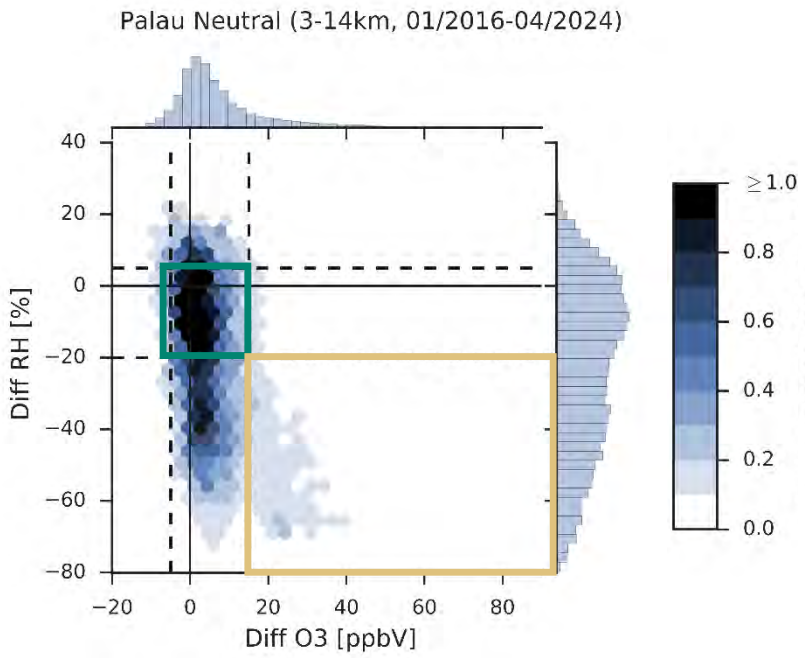


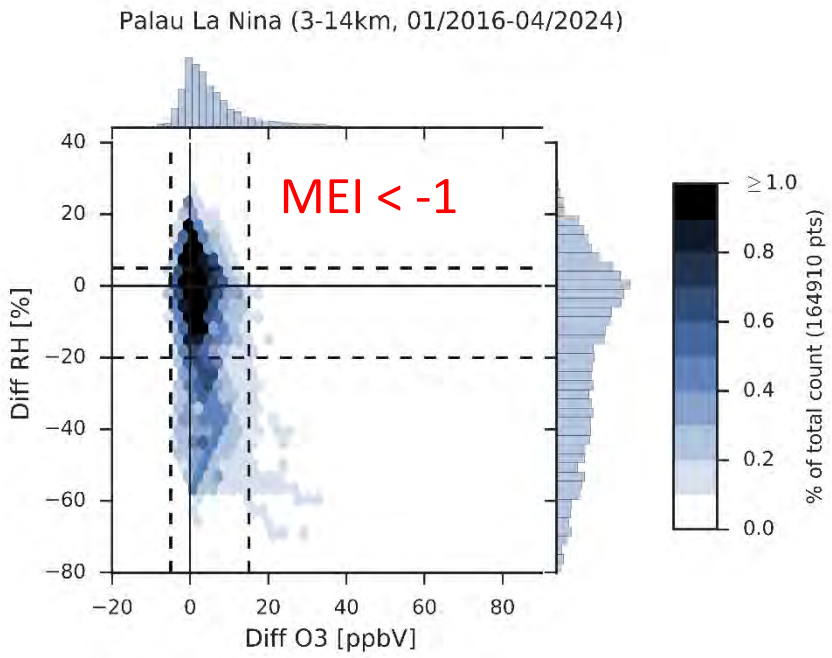
2016-04/2024: **279 ozone sondes**

> 8 years: extended ENSO cycle, …

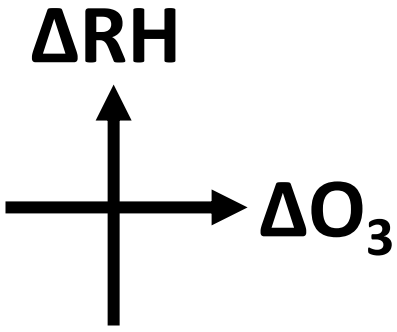
1. ENSO impact on midtroposphere → QOS

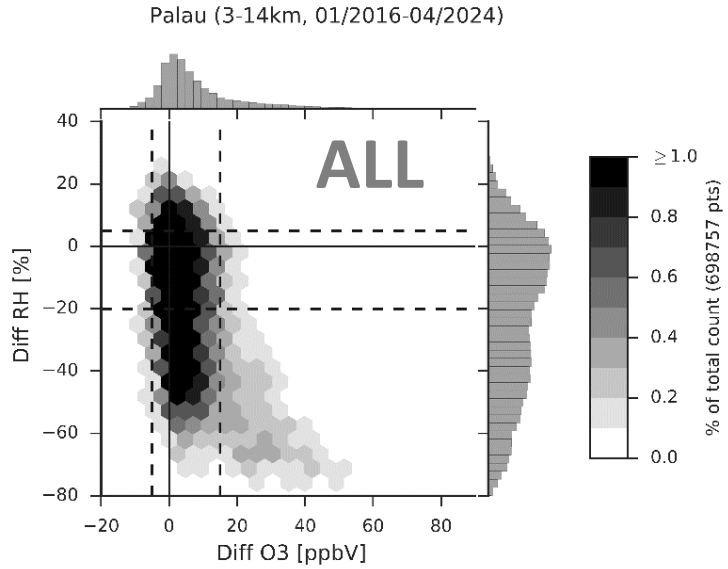






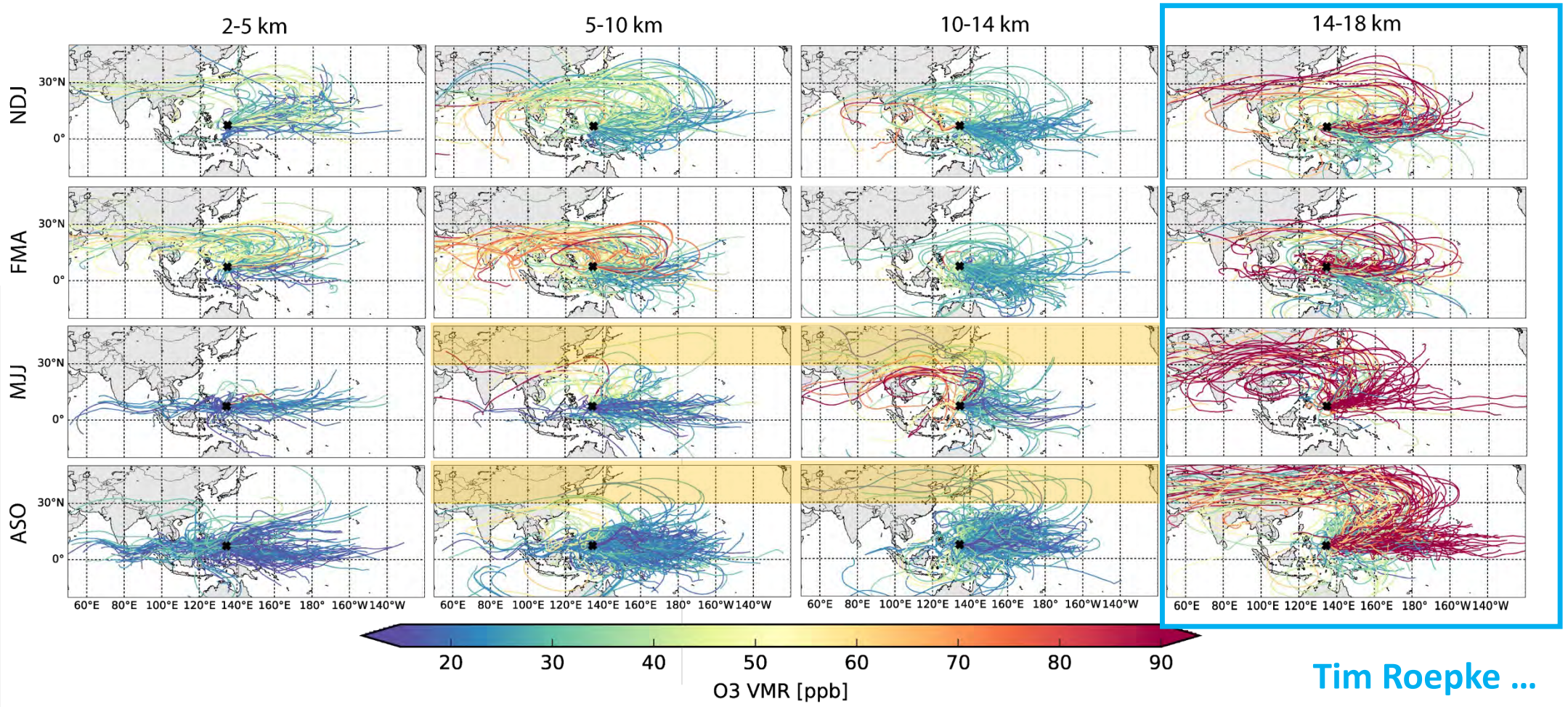
- Currently: update on Müller et al. 2024b analysis regarding updated timeseries and ENSO
- Pending: trajectories after 2021…





Air mass analysis → current projects

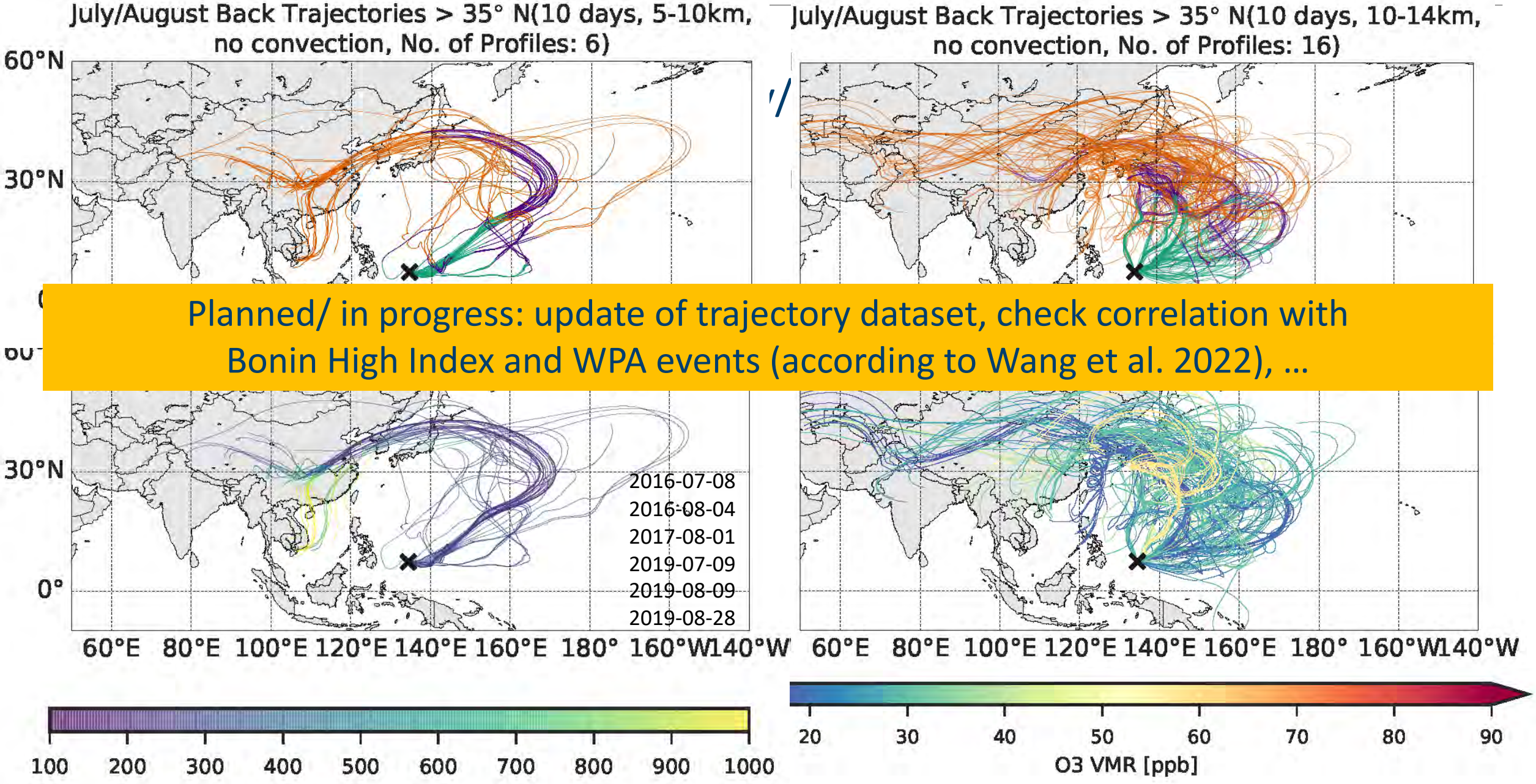
ATLAS trajectory dataset: 10-days backwards footprint



Tim Roepke …

- … regarding transport to the TTL, looking into O3, RHi, T, cirrus (→ QOS)
- … regarding transport from the Western Pacific Anticyclone (WPA) → very preliminary…

2. Transport from the WPA?

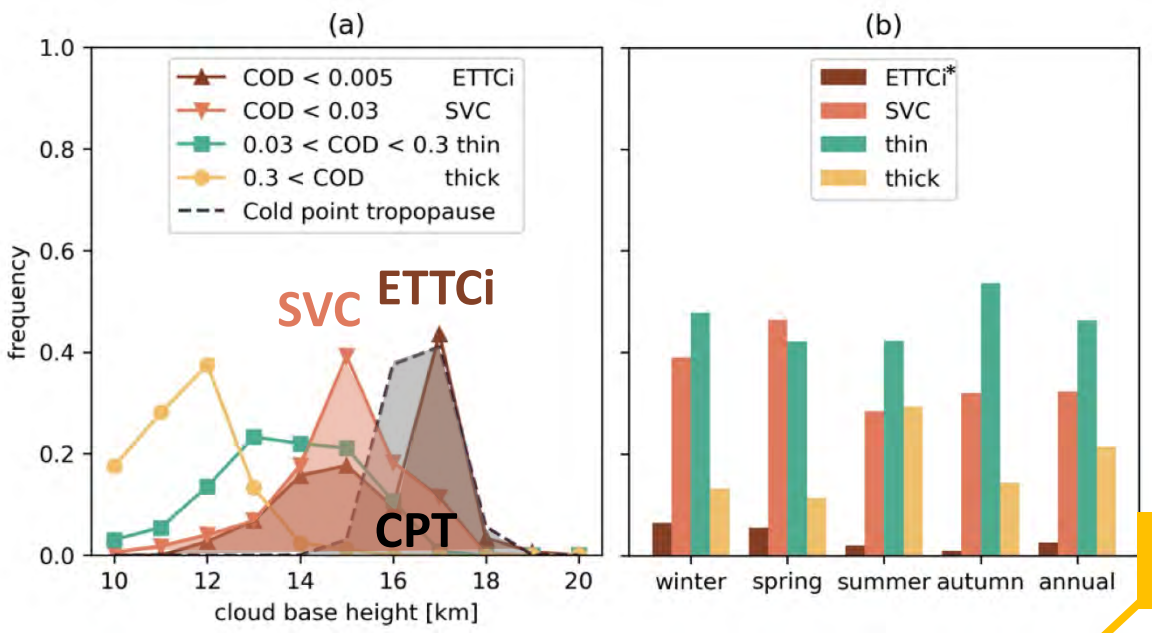


Planned/ in progress: update of trajectory dataset, check correlation with Bonin High Index and WPA events (according to Wang et al. 2022), …

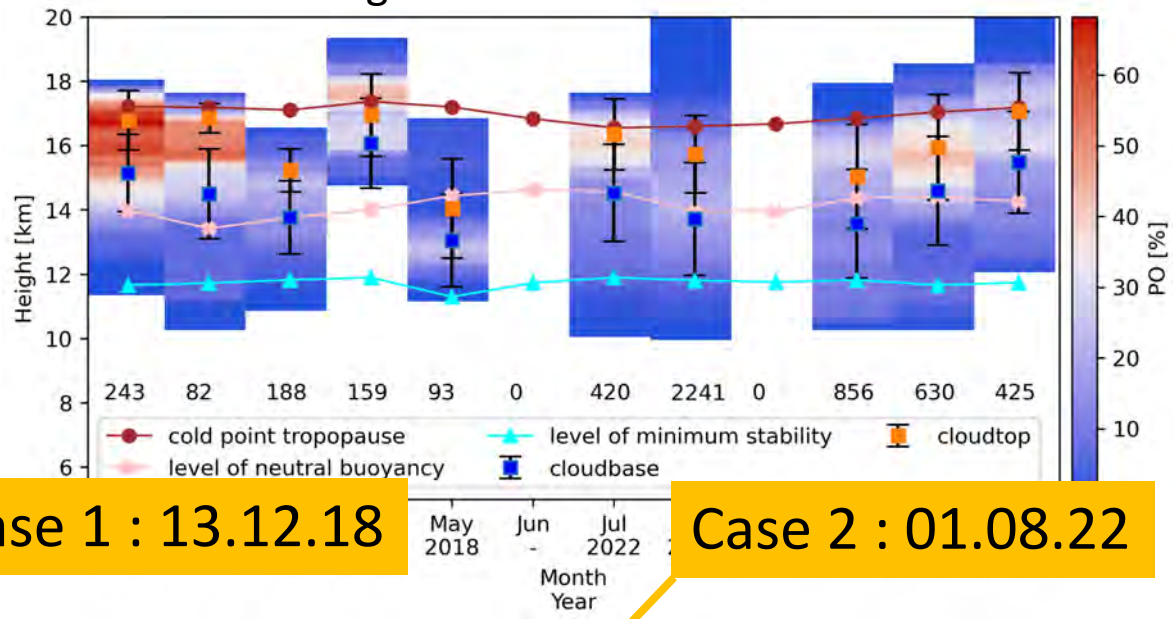
ComCAL

Photo: X.Sun

ComCAL lidar observations

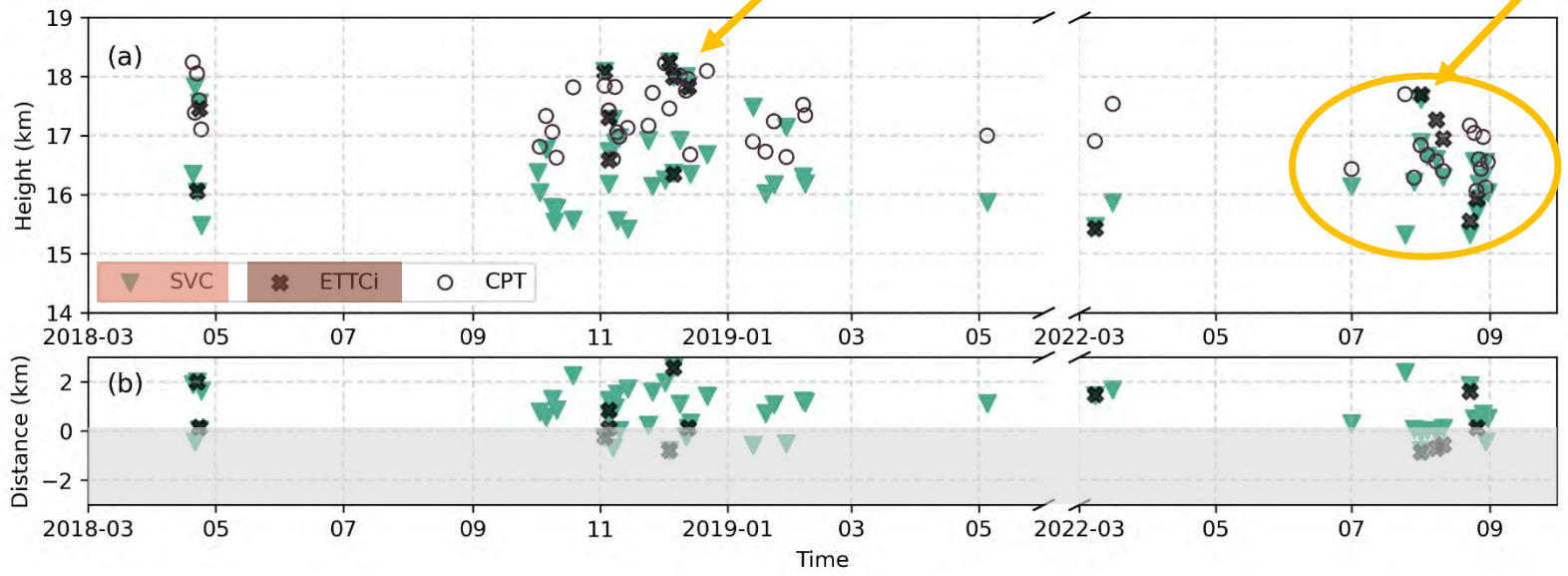


Percentage Occurence of cirrus clouds



Case 1 : 13.12.18

Case 2 : 01.08.22



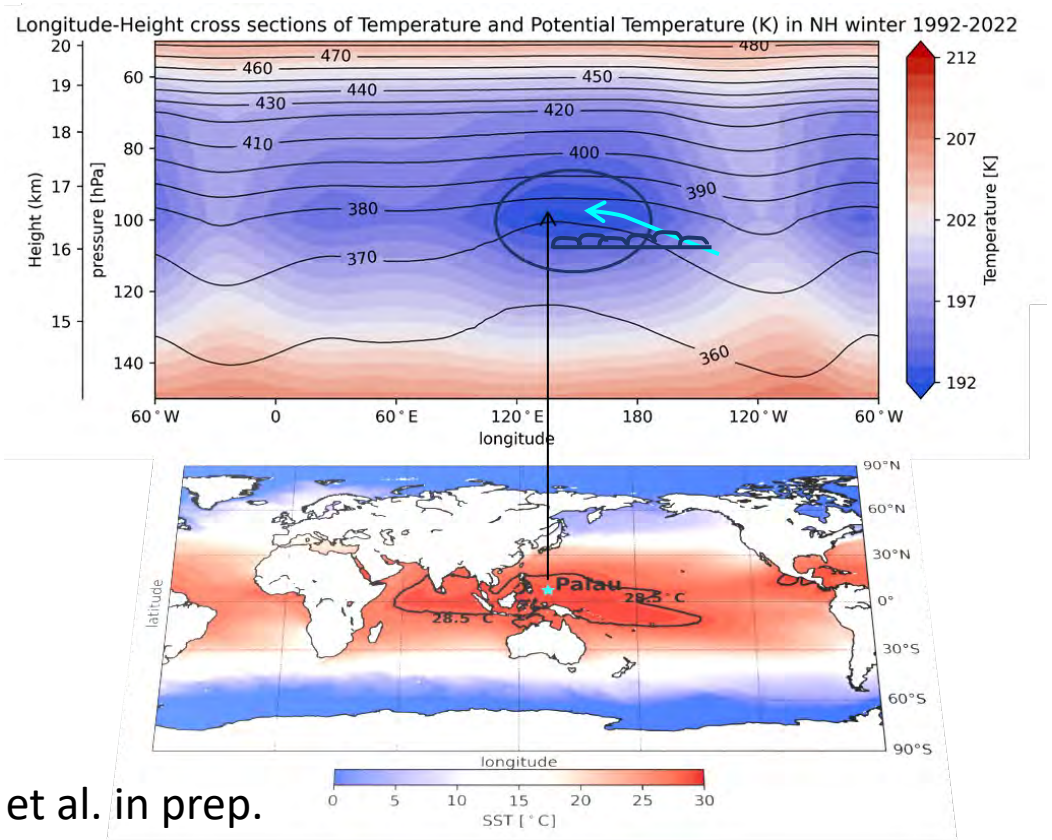
Above CPT

Sun et al. 2024

Cirrus above Palau

Compared with other tropical sites:

- Highest cloud base and top
- Coldest cloud temperature
- Dehydration process in this cold region



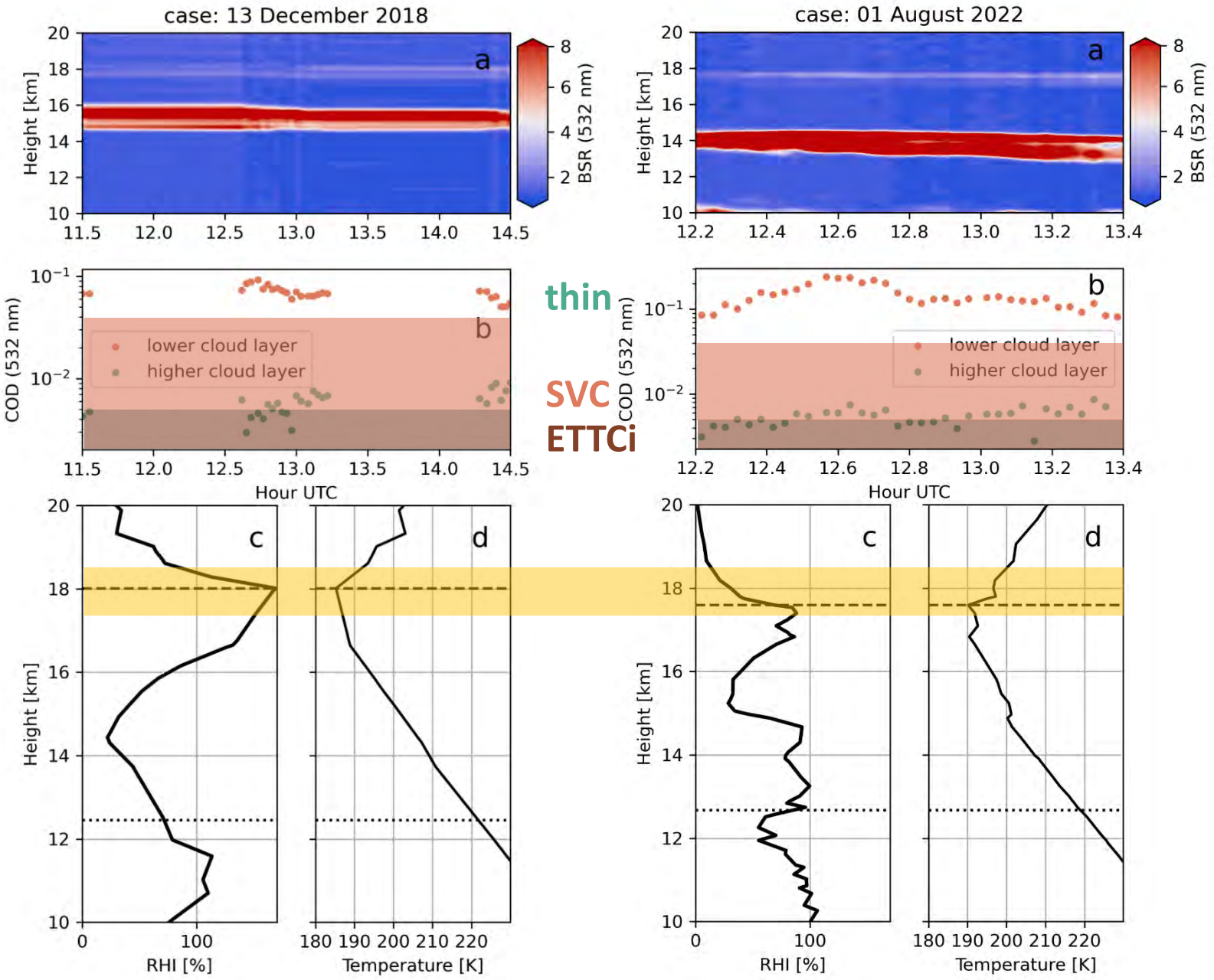
Site	C_{base} (km)	C_{top} (km)	GT (km)	Temperature (°C)
Koror (7.3°N, 134.5°E)	14.1 ± 1.7	15.8 ± 1.4	1.5 ± 0.9	−74 ± 10
Gwal Pahari (28.43°N, 77.15°E)	9.0 ± 1.5	10.6 ± 1.8	1.5 ± 0.7	−33 ± 6
Elandsfontein (26.25°S, 29.43°E)	9.2 ± 0.8	10.8 ± 0.9	1.6 ± 0.7	−34 ± 5
Chung-Li (24.58°N, 121.10°E)	12.3 ± 2.2	14.4 ± 1.7	1.5 ± 0.7	-
Gadanki (13.5°N, 79.2°E)	13.0 ± 2.2	15.3 ± 2.0	2.3 ± 1.3	−65 ± 12
Hulule (4.1°N, 73.3°E)	11.9 ± 1.6	13.7 ± 1.4	1.8 ± 1.0	−58 ± 11
Amazonia (2.9°S, 59.9°W)	12.9 ± 2.2	14.3 ± 1.9	1.4 ± 1.1	−60 ± 15
Nauru Island (0.5°S, 166.9°E)	-	16.5–17.0	-	-
Tropics ± 30° *	-	14.3 ± 1.7	0.6 ± 0.2	−66 ± 10

Sun et al. in prep.

Sun et al. 2024

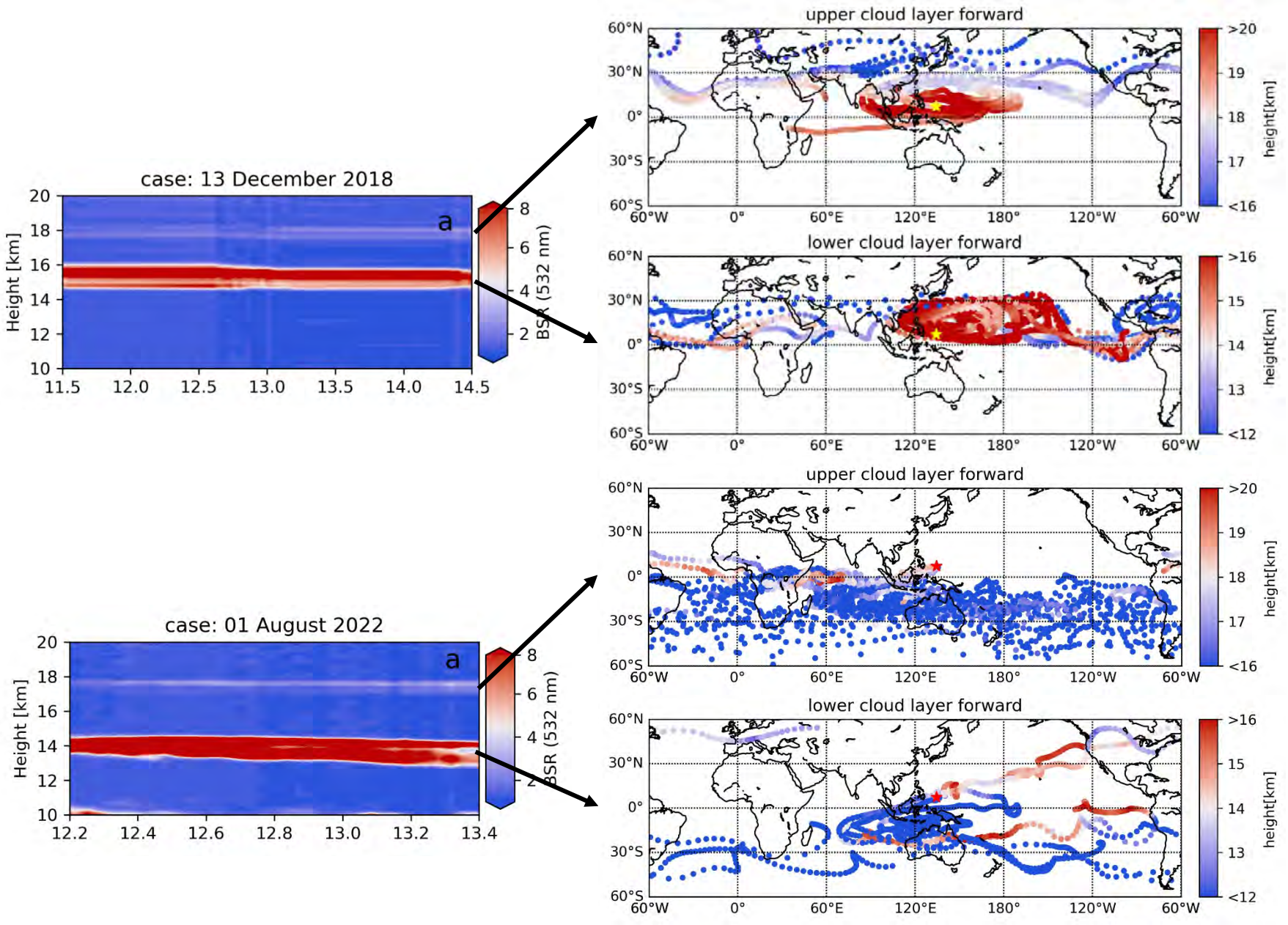
3. Case studies

- Winter and summer cases with two different cloud layers
- HYSPLIT 30-day forward trajectories, driven by NCEP reanalysis data



Sun et al. in prep.

3. Case studies



Ascent into the stratosphere (locally or NE of Palau)

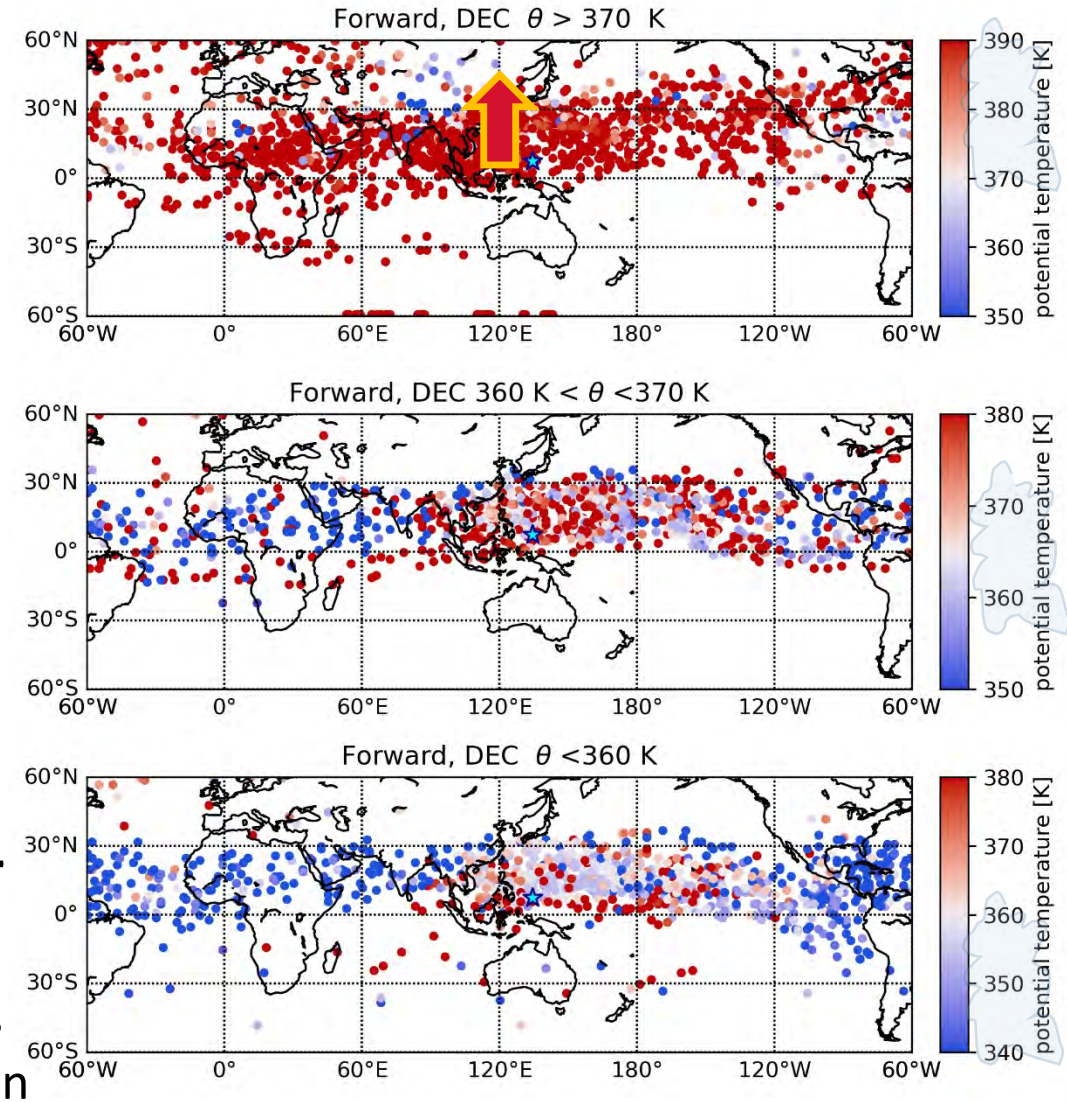
Descent and transport to the SH

Sun et al. in prep.

3. Cirrus „climatology“ of forward trajectories

December 2018

August 2022

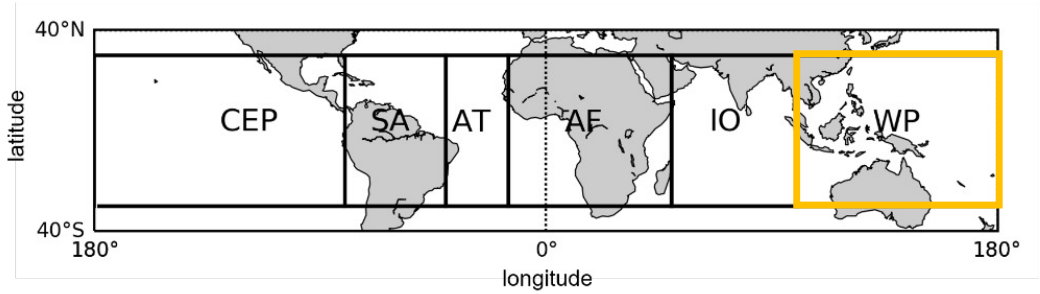


potT of cirrus location

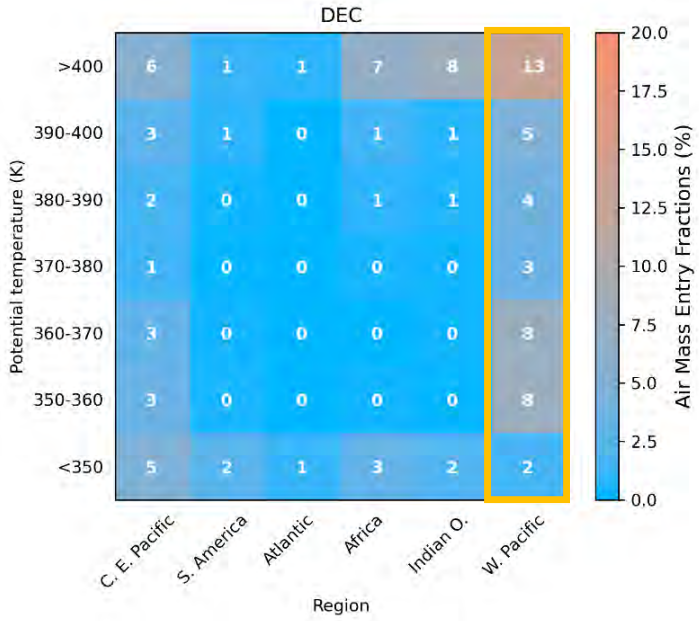
Sun et al. in prep.

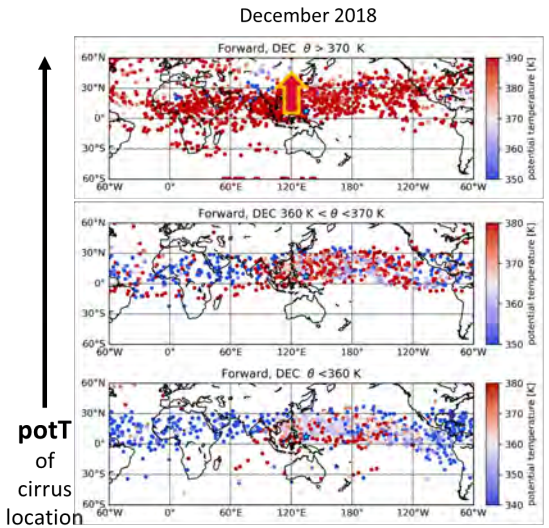
3. Cirrus „climatology“ of forward trajectories

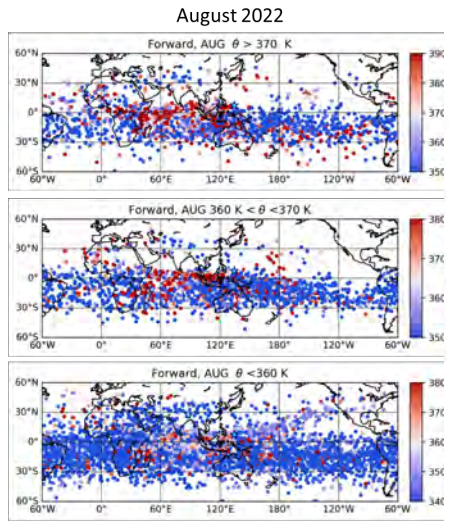
Air mass entry fraction:
N (Trajectory point in each box) / N (Total trajectory point)

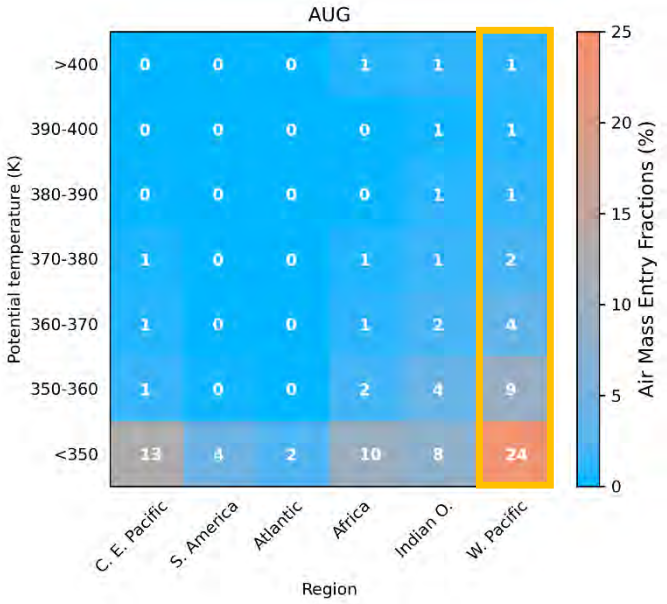


- In **December**: SVC and ETTCi occurrence shows transport pathway into the stratosphere within the WP cold trap
- In **August**: cirrus occurrence is no indicator STE



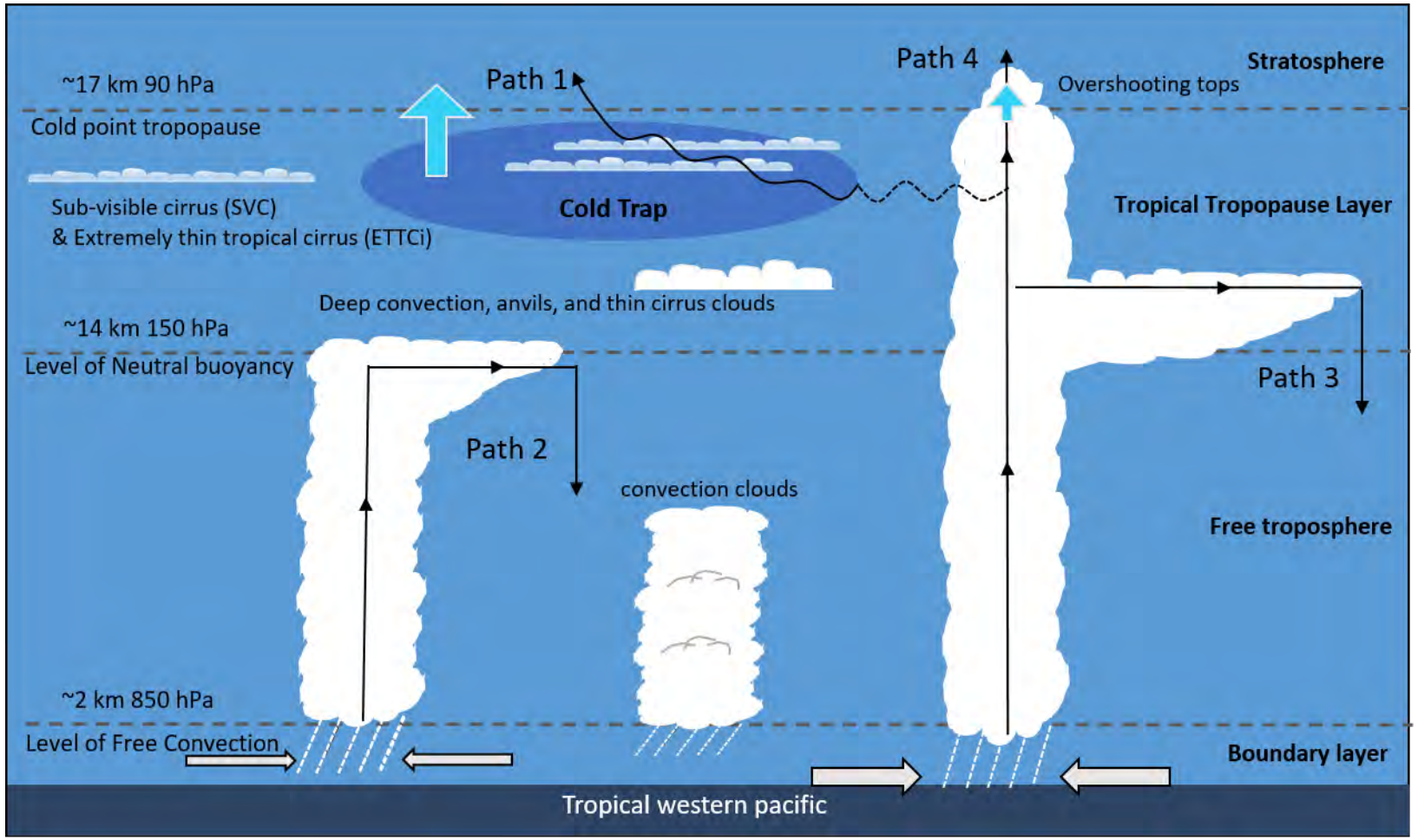






Sun et al. in prep.

3. Paper draft: Cirrus & transport into the stratosphere



Sun et al. in prep.

WRAP UP

- Meet me in person at the QOS in mid-July in Boulder! ☺
- Check out our recent paper publications about the Ozonesonde and Lidar record!
- Ongoing work:
  - Air mass analysis regarding ENSO, transport from the WPA → wait for the trajectory dataset update…
  - STE and cirrus

The Palau Atmospheric Observatory – Updates on the Ozonesonde and Lidar Record and air mass transport to the TWP

Kati Müller

ACCLIP STM 30.04-03.05.2024

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Images: KM and courtesy of Jürgen Gräser (AWI), Wilfried Ruhe (impres GmbH), Thomas Schubert and Jordis Tradowsky (Bodeker Scientific)