How ENSO affects Ozone, RHi and Transport dynamics at the UT/LS above Palau and the Tropical West Pacific (TWP)

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This presentation participates in OSPP — Outstanding Student & PhD candidate Presentation contest

Abstract

Background

- Tropical West Pacific is the "gateway into the Stratosphere"
- ENSO effects O3/RH in Free Troposphere
  Katrin Müller AS 3.32 PICO5.13
- TWP Cold-Trap influences uplift into Stratosphere
  Xiaoyu Sun AS 3.17 Talk

Sun et al.

Methods

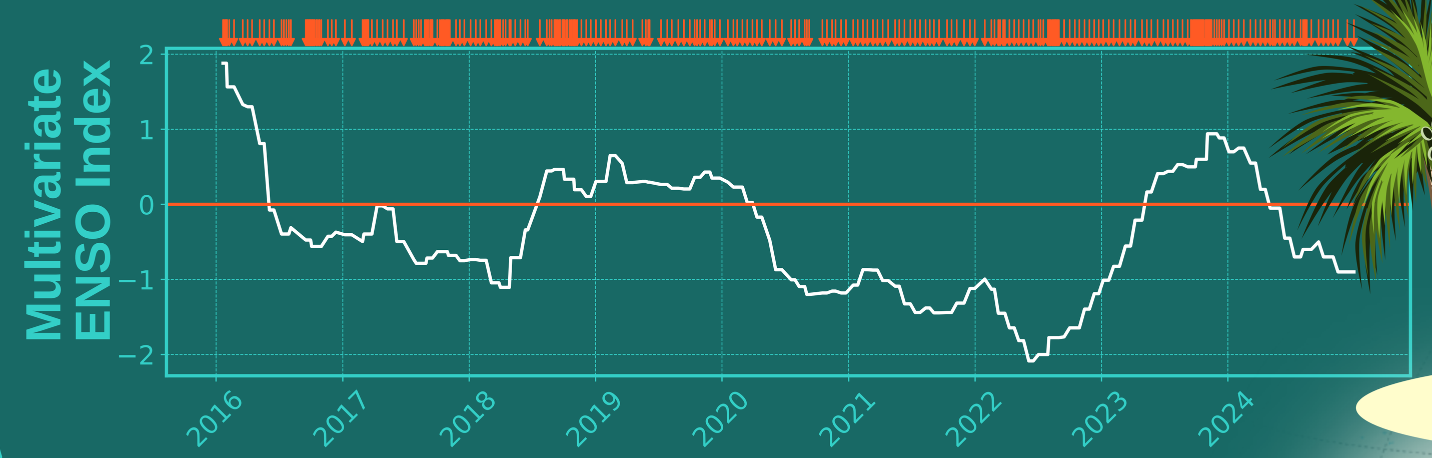
- Measurements with ECC Ozone Sondes at **P**alau **A**tmospheric **O**bservatory (2016-now) [1] → PAO
- Lagrangian Backtrajectories for PAO-measurements calculated with ATLAS

Alfred Wegener Ins**T**itute **LA**grangian Chemistry/**T**ransport **S**ystem Setup [2]

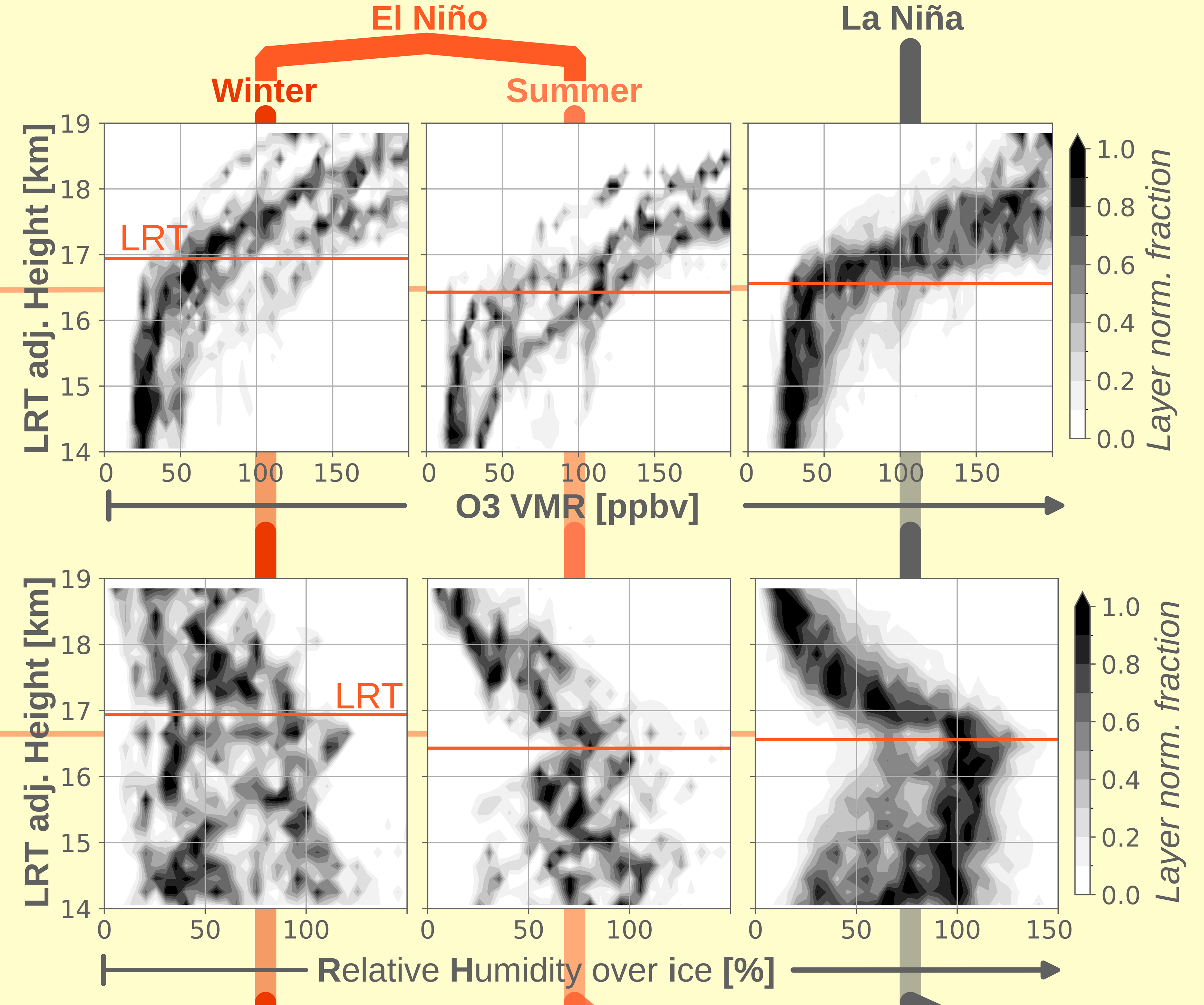
- Input ERA5 & Balloonsoundings
- Hybrid Pressure-Potential-Temp. Coordinate
- New scheme for modelling convection (trajectory-ensembles: 50 members)
- Backtrajectories calculated up to 25 days

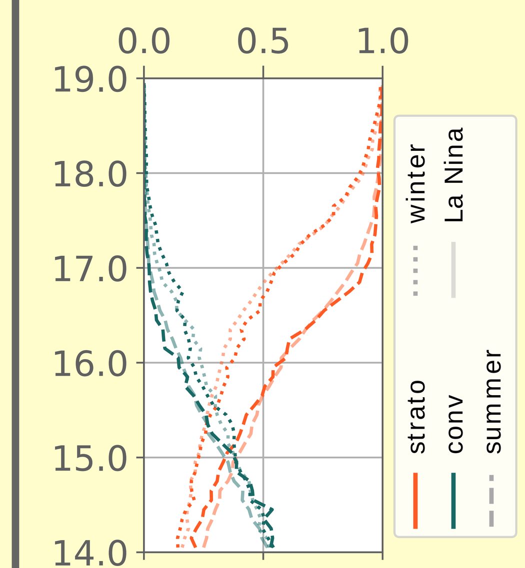
"In winter, El Niño's reduced convection leads to drier UT/LS,

while in summer the Western Pacific Anticyclone is dominant, transporting ozone-rich air to Palau."



UT/LS Ozone & Relative Humidity (*Balloonborne Measurements*)



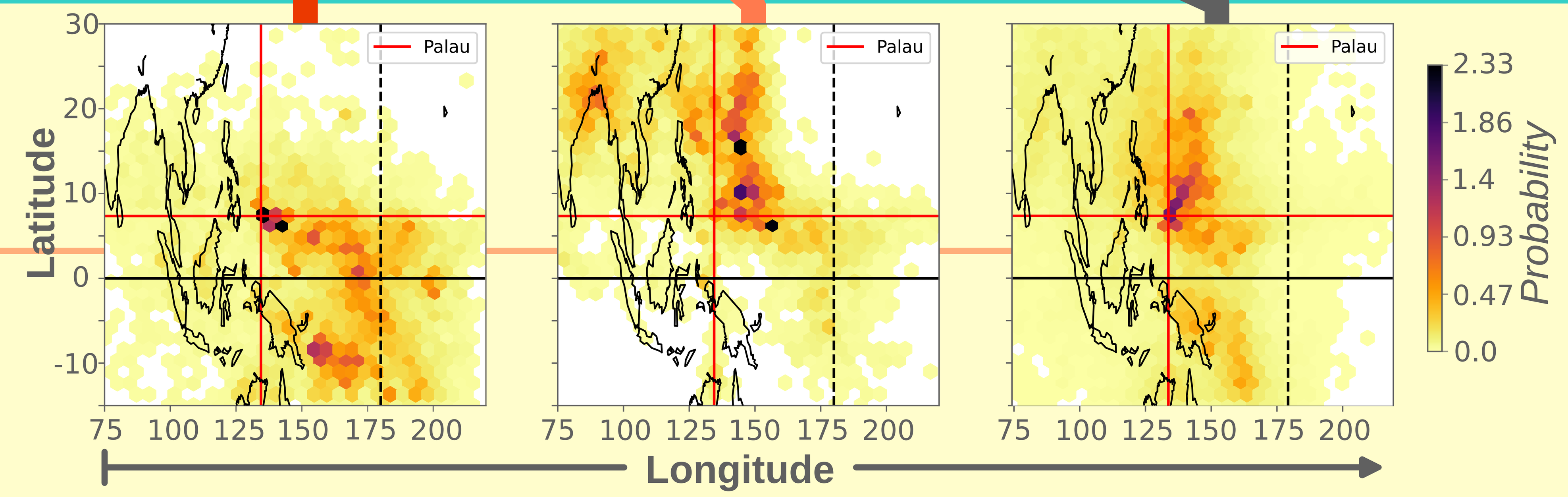


- Fraction of strato/conv ATLAS Trajectories over height

LRT adj. Plots

- **L**apse-**R**ate-**T**ropopause (WMO)
- Height Adjustment: $zg_{LRT\ adj.}(meas) = \overline{LRT} + [zg(meas) - LRT(meas)]$
- Hist. over Height-sections normalized

Convective Origin (*ATLAS*)



Conclusions

- O3 Increase during El Niño, stronger in summer ⟵ stratospheric air from **W**estern **P**acific **A**nticyclone)
- Anomalously low RHi occuring during winter El Niño ⟵ less convection close to Palau
- Winter El Nino: Convective Origin shifts eastwards, in summer WPA influence dominates

Sharing is encouraged

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[1] Müller, K., Tradowsky, J. S., von der Gathen, P., Ritter, C., Patris, S., Notholt, J., and Rex, M.: Measurement report: The Palau Atmospheric Observatory and its ozonesonde record – continuous monitoring of tropospheric composition and dynamics in the tropical western Pacific, Atmos. Chem. Phys., 24, 2169–2193, https://doi.org/10.5194/acp-24-2169-2024, 2024.

[2] Wohltmann, I., Lehmann, R., Gottwald, G. A., Peters, K., Protat, A., Louf, V., Williams, C., Feng, W., and Rex, M.: A Lagrangian convective transport scheme including a simulation of the time air parcels spend in updrafts (LaConTra v1.0), Geosci. Model Dev., 12, 4387–4407, https://doi.org/10.5194/gmd-12-4387-2019, 2019.

[3] Pan, L. L., Honomichl, S. B., Thornberry, T., Rollins, A., Bui, T. P., Pfister, L., & Jensen, E. E. (2019). Observational evidence of horizontal transport-driven dehydration in the TTL. Geophysical Research Letters, 46, 7848–7856. https://doi.org/10.1029/2019GL083647

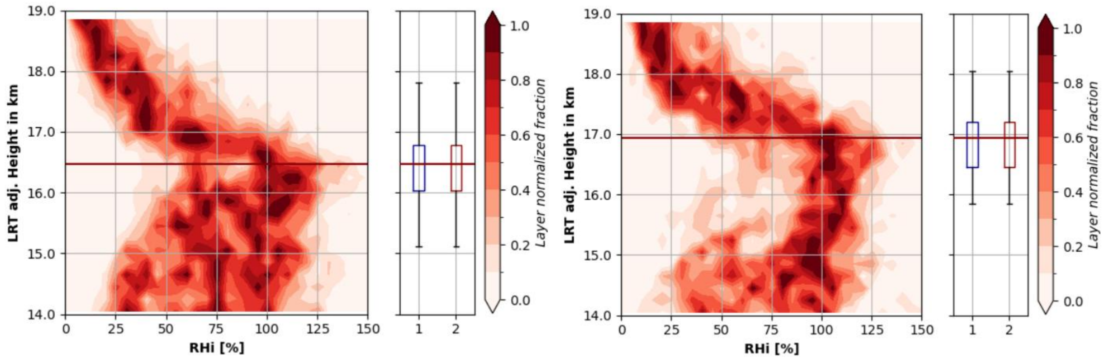
Palau 7° N 134 ° E

Supplementary Information

Info: Stratospheric Air is defined as airmasses, for which the trajectories had values above 2PVU for at least a day.

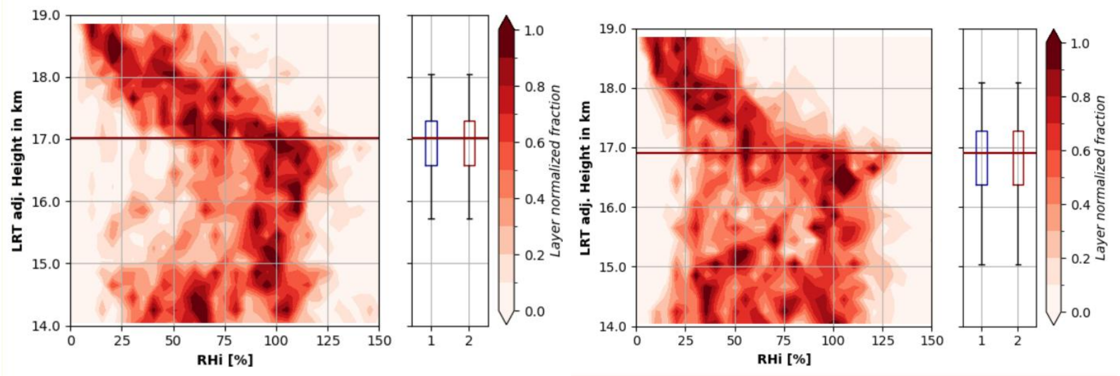
Layer Normalized plots for Relative Humidity

La Nina, summer & winter

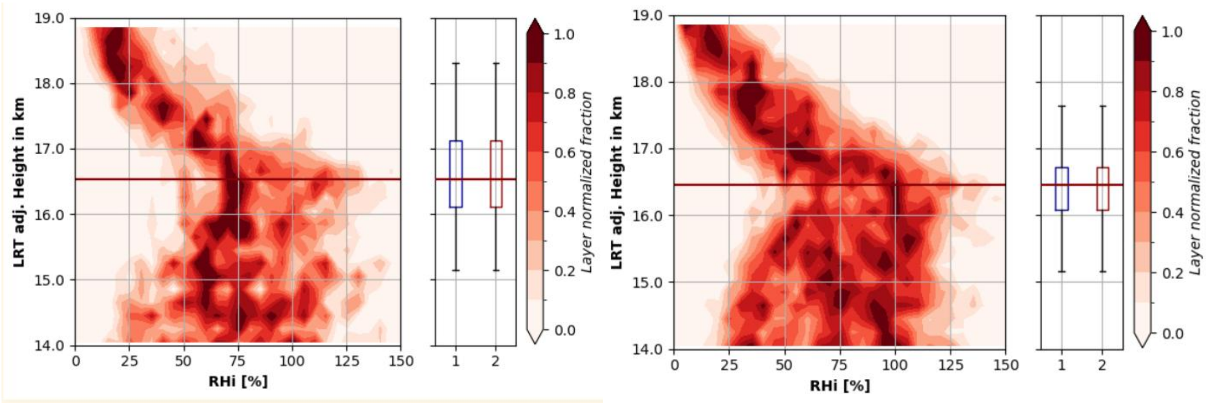


Seasons:

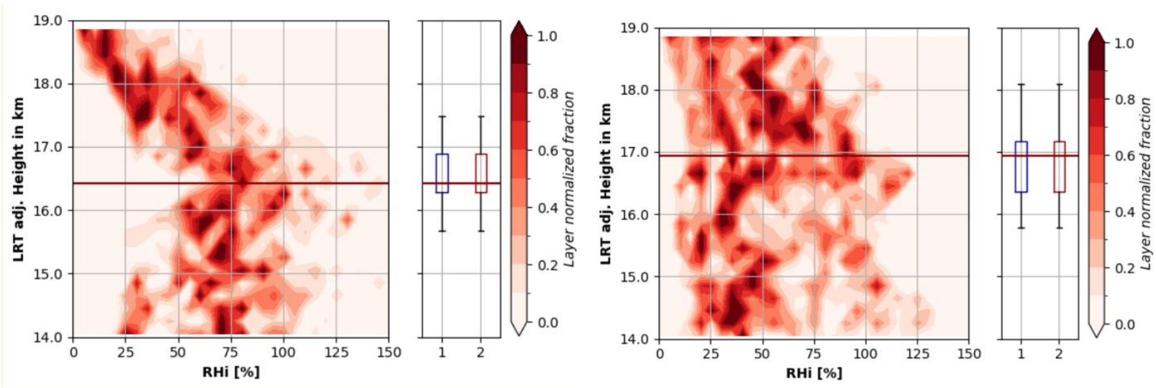
November, December, January & February, March, April



May, June, July & August, September, October

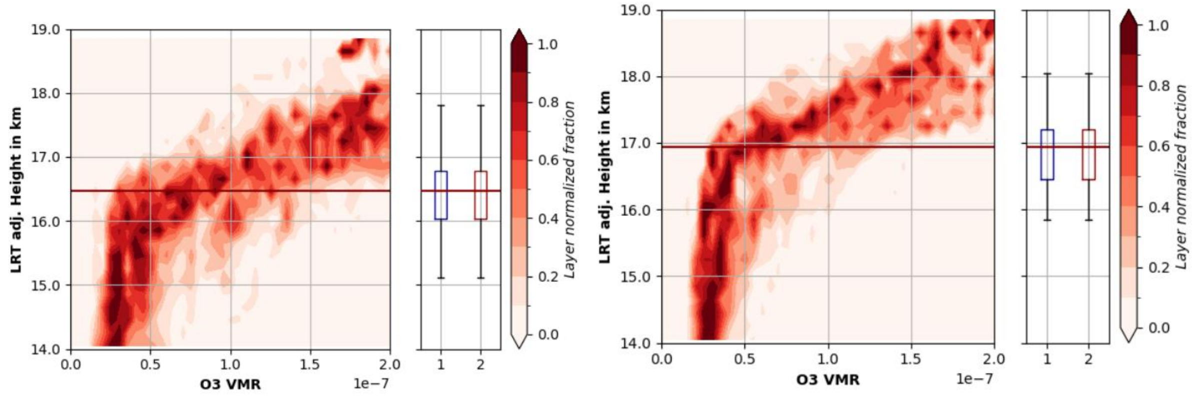


El Nino stratospheric air: summer & winter



Layer Normalized Plots for Ozone

La Nina, summer & winter



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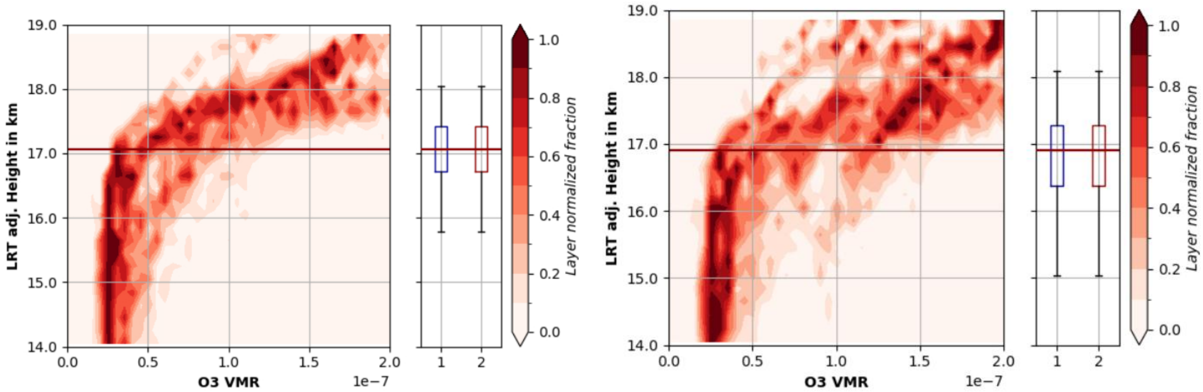

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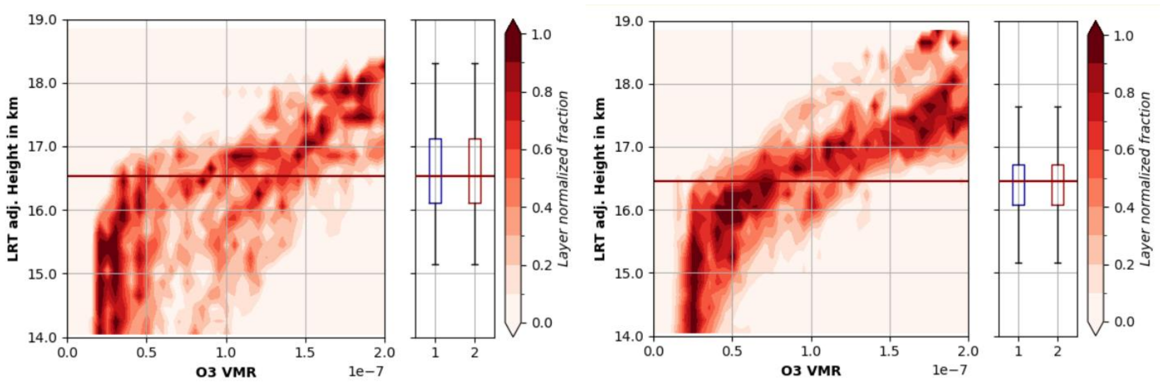

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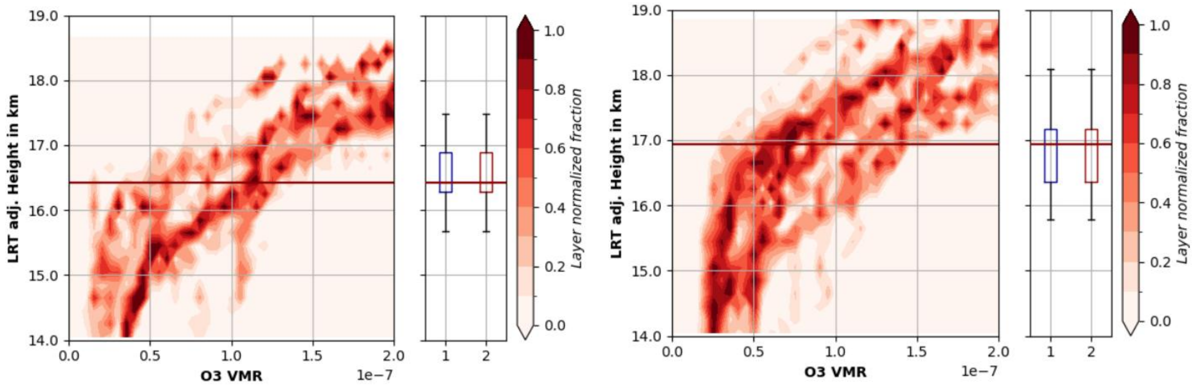
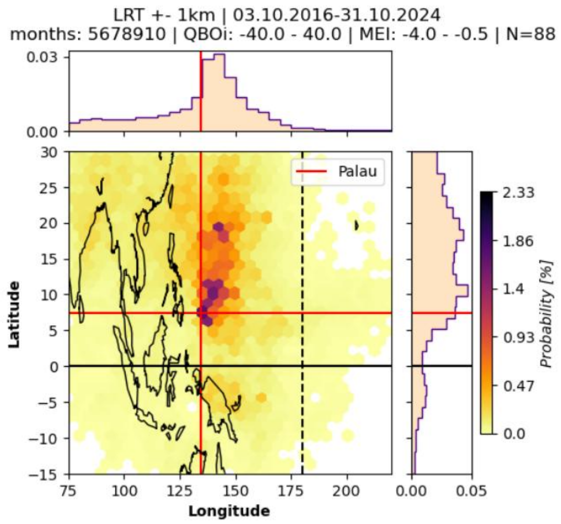
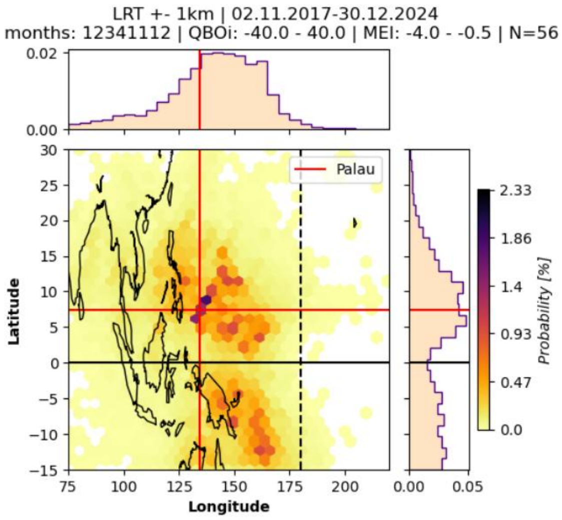


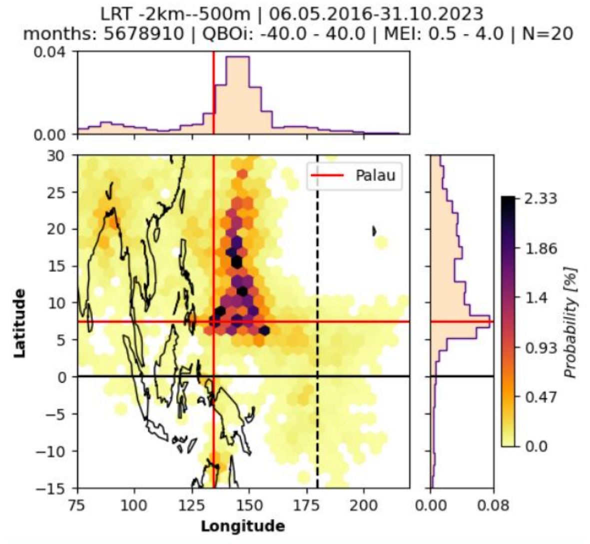
Convective Origin Plots

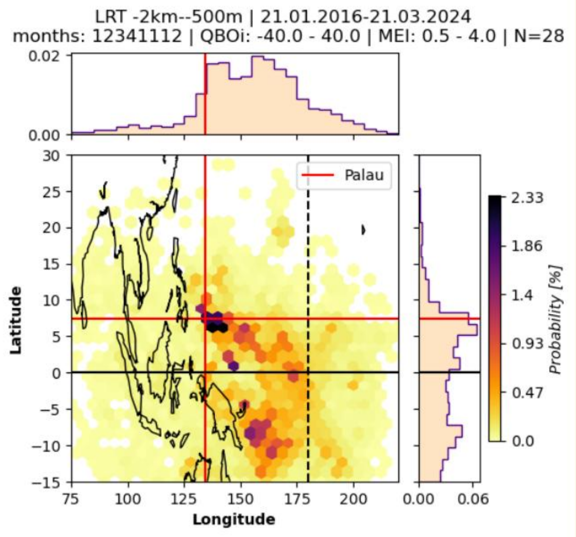
La Nina, summer & winter





El Nino summer & Winter LRT-2km – LRT-500m





El Nino summer & Winter LRT+500m – LRT+2km