# Wildfire Emissions Transport Pathways in the Global Atmosphere

**Nikos Daskalakis**[1], Maria Kanakidou[1,2,3], Laura Gallardo[4], Mihalis Vrekoussis[1,5,6]

TM meeting, Wageningen 30-31/5/2022

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# As you may remember....

## Impact of biomass burning in the remote South Pacific Ocean

**Nikos Daskalakis**[1], Laura Gallardo[2], Maria Kanakidou[1,3,4], Rasmus Nüß[1], Camilo Menares[2], Roberto Rondanelli[2], Mihalis Vrekoussis[1,5,6]

iTM meeting, 18/10/2021

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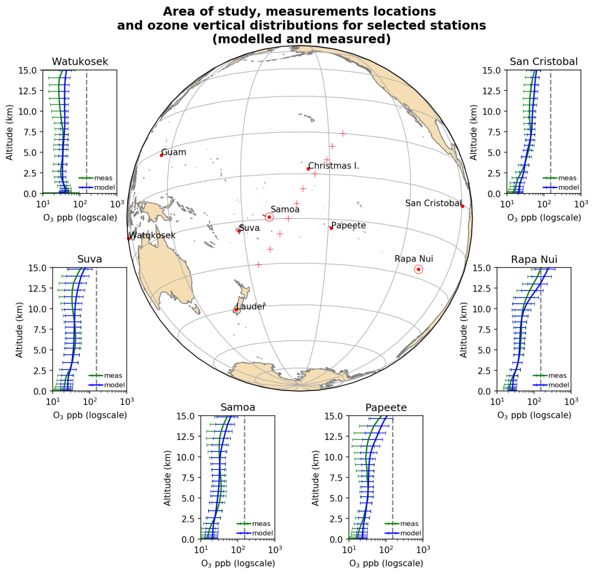

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Research article

## Impact of biomass burning and stratospheric intrusions in the remote South Pacific Ocean troposphere

**Nikos Daskalakis[1], Laura Gallardo[2], Maria Kanakidou[1,3,4], Johann Rasmus Nüß[1], Camilo Menares[2], Roberto Rondanelli[2], Anne M. Thompson[5], and Mihalis Vrekoussis[1,6,7]**

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# Getting good traction.

## WHY AIR POLLUTION PLAGUES REMOTE PACIFIC ISLAND

L TO R: LWM/NASA/LANDSAT/ALAMY; BARRY MANSELL/NATURE PICTURE LIBRARY

The fresh air of Rapa Nui, an island in the most pristine region of the global ocean, is not as clean as it could be, research suggests. That's because it is tainted by pollution from wildfires, some occurring half the world away.

For the past two decades, researchers have measured carbon monoxide (CO) concentrations at ground level on Rapa Nui, a Chilean territory that is also known as Easter Island and is located in a remote stretch of the southeastern Pacific Ocean. Nikos Daskalakis at the University of Bremen in Germany and his colleagues drew on these data to validate the accuracy of their global model of atmospheric chemistry.

The researchers used the model to determine that about 24% of the CO at Rapa Nui comes from fires, mostly natural wildfires. The biggest shares of CO were transported more than 3,500 kilometres westwards from South America, and roughly 20,000 kilometres eastwards from southern Africa.

It is important to study the long-distance spread of CO because the gas reacts to form ozone, which is both toxic — at ground level — and a greenhouse gas.

*Atmos. Chem. Phys.* **22**, 4075–4099 (2022)

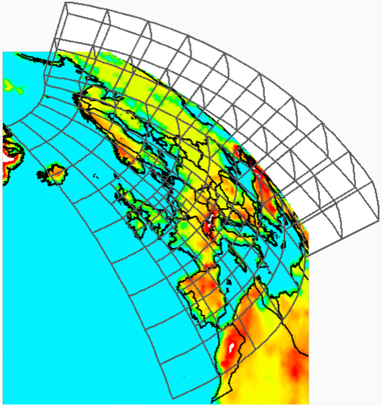


**Much of Rapa Nui's air pollution comes from Africa or South America.**

# TM4-ECPL model

Global TM4-ECPL CTM:

- $3^\circ$ x $2^\circ$ horizontal resolution
- 34 hybrid vertical layers up to 65km
- Driven by ECMWF ERA-Interim meteorology (Dee et al., 2010)
- Analytical chemical scheme.
- Thoroughly validated (Daskalakis et al., 2015,2016,2022, Tsigaridis, Daskalakis, Kanakidou et al., 2014)
- Detailed description in Daskalakis et al., ACP, 2016, 2022



# Experiment Setup

- TM4-ECPL simulation of 1980- 2015 with ERA interim meteorology
- Period of study: 1994-2015 (14 years of model stabilization)
- 2°(lat)x3°(lon)x 34 layers (up to 65km)
- Upper boundary of $O_3$ from MLS & GOME-2
- Biomass Burning emissions from ACCMIP
  - With Biomass Burning emissions
  - Without Biomass Burning emissions
  - With tagged CO tracers from 13 biomass burning regions

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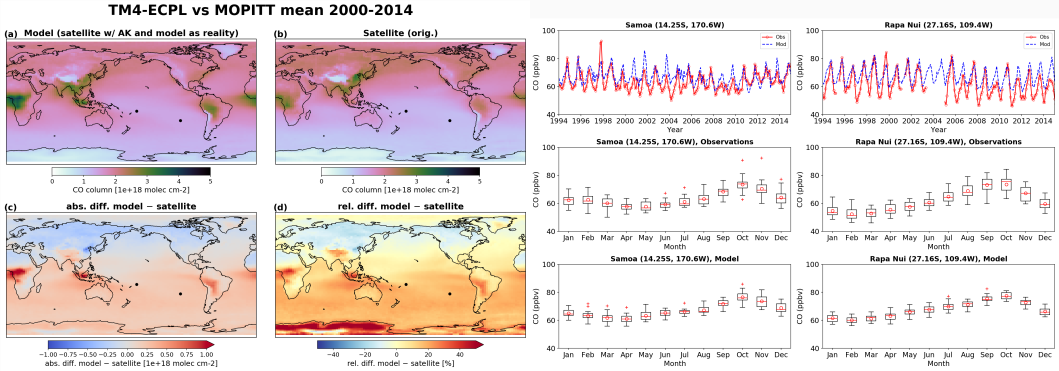
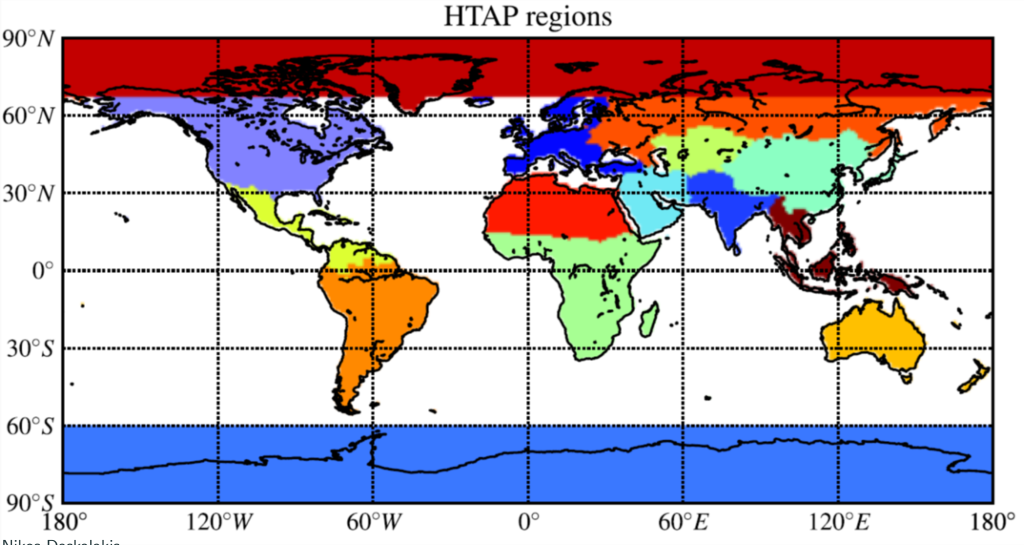
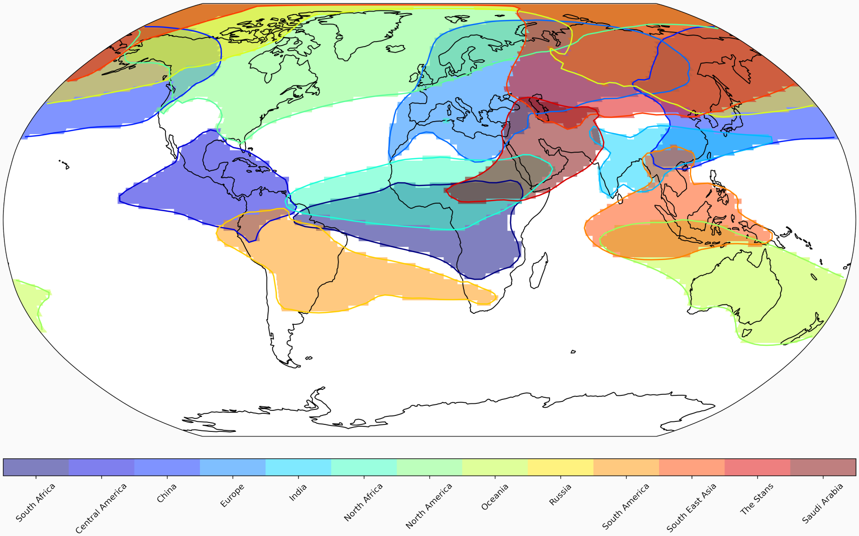
# Thorough CO validation



# HTAP regions



# Results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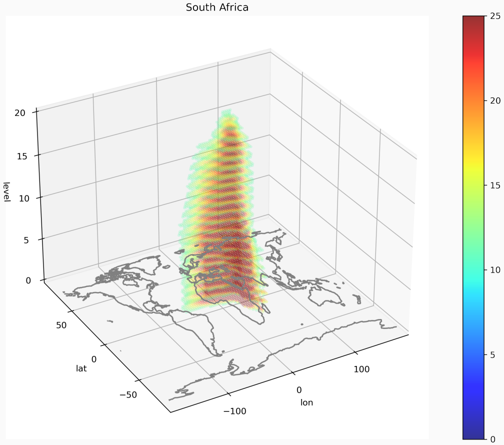
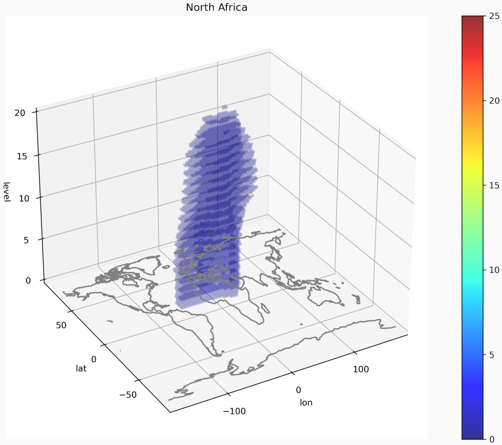
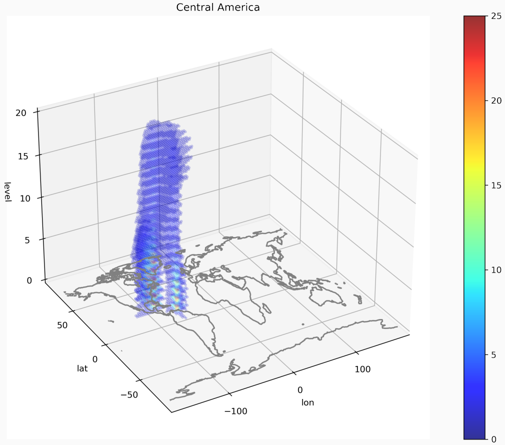
Central America
China
Europe
India
North Africa
North America
Oceania
Russia
South America
South East Asia
The Stans
Saudi Arabia

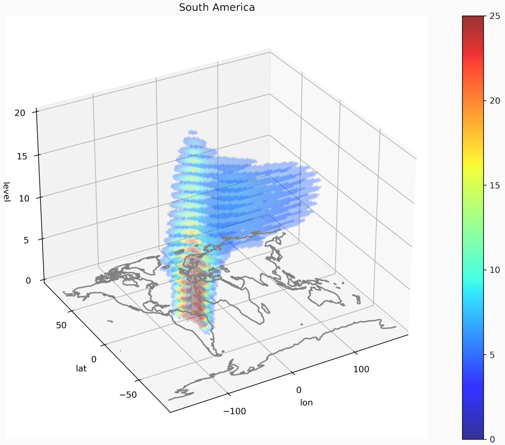
# Results – South and North Africa



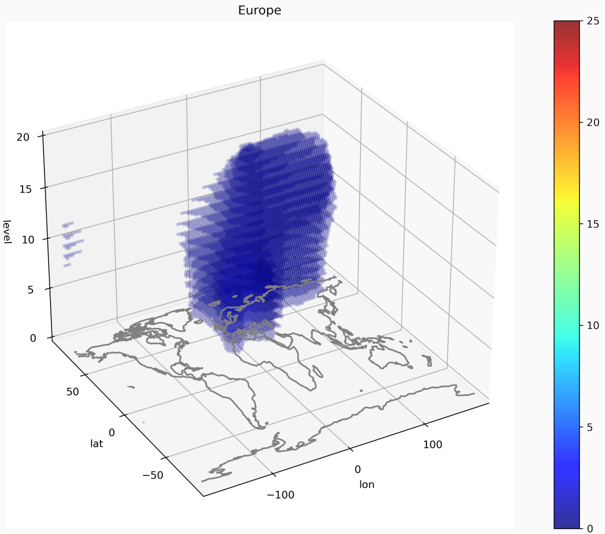



# Results – Central and South America

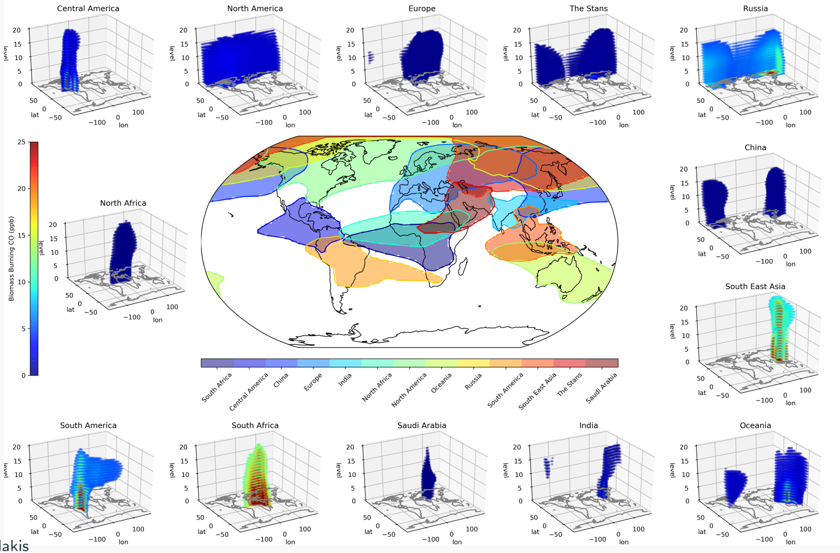


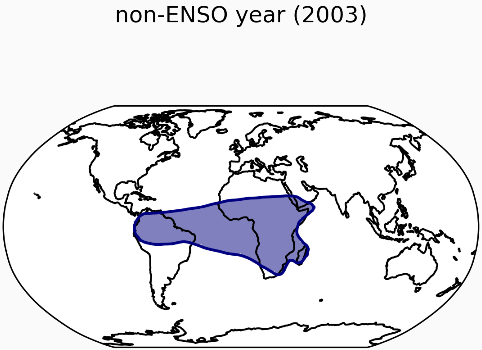
# Results – Europe

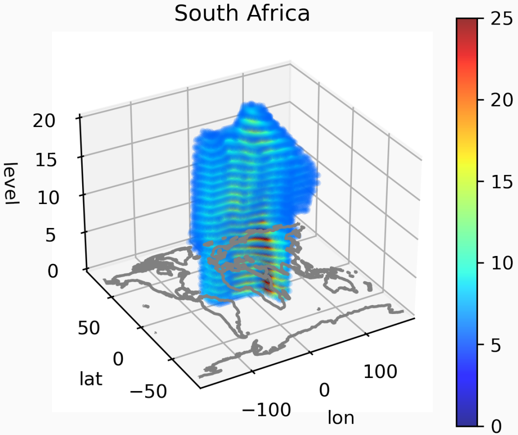


# Results – overview

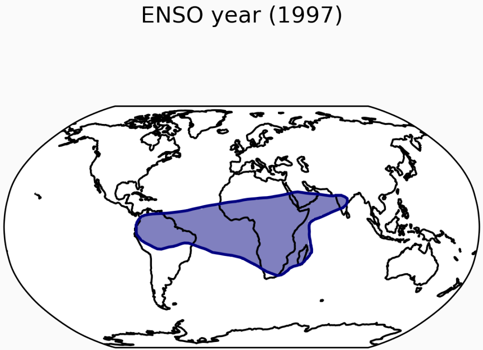


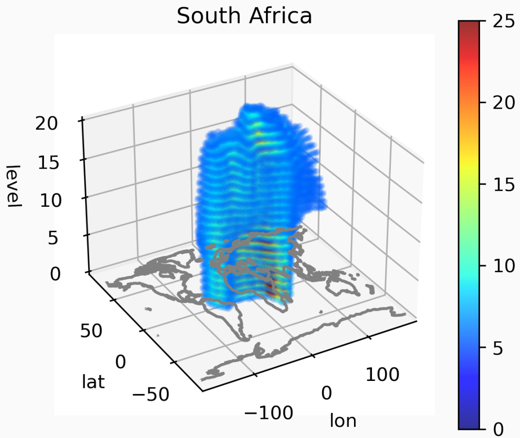
# Results – non-ENSO year (2003), South Africa



# Results – ENSO year (1997), South Africa



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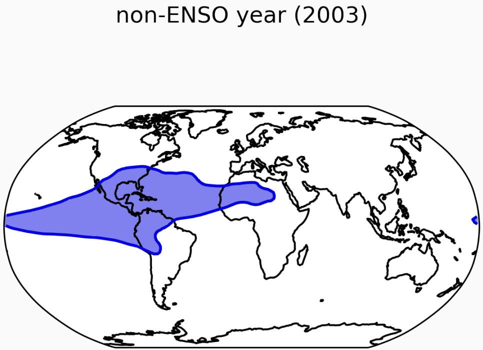


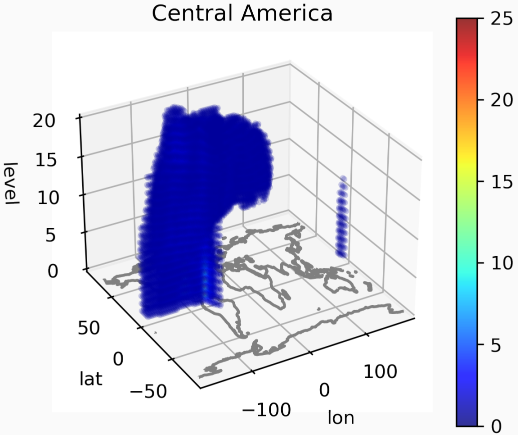

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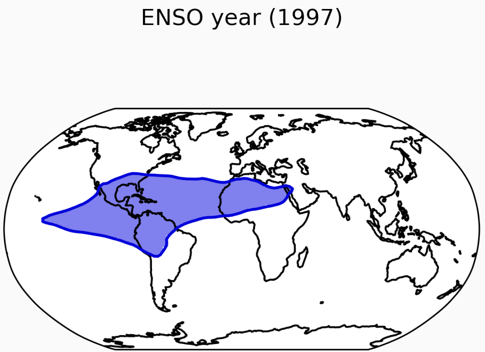
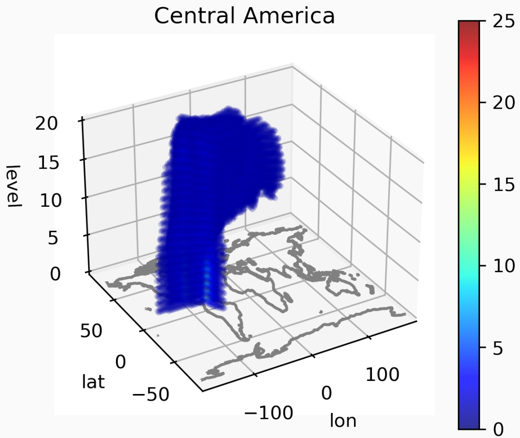
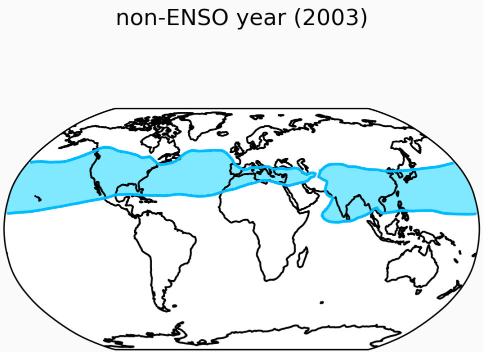
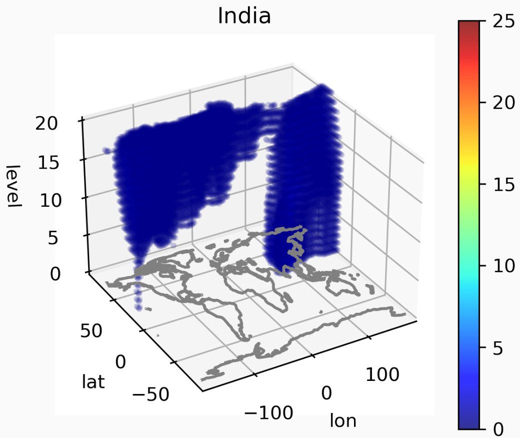


# Results – non-ENSO year (2003), India



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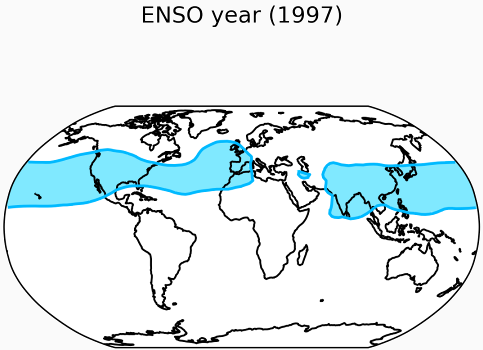
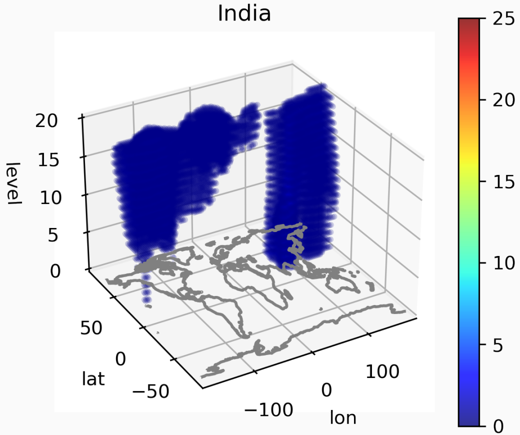
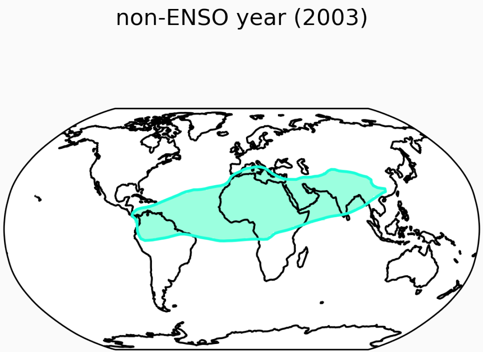
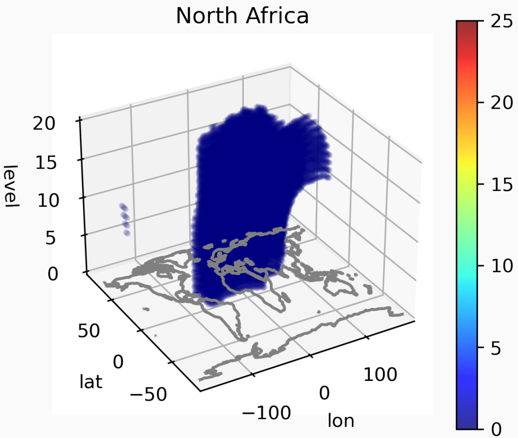


# Results – non-ENSO year (2003), North Africa



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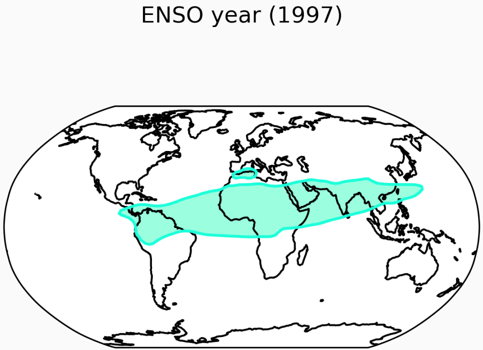
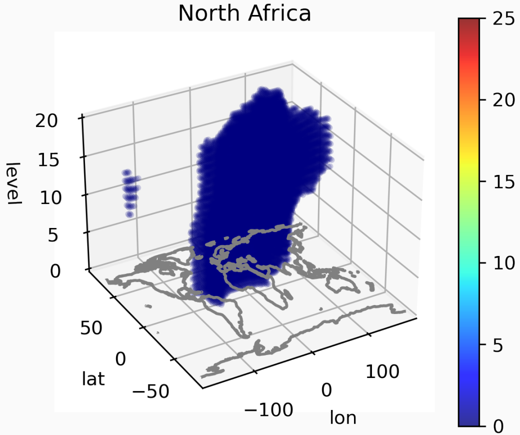
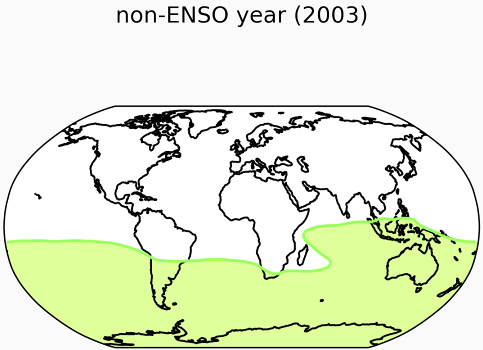
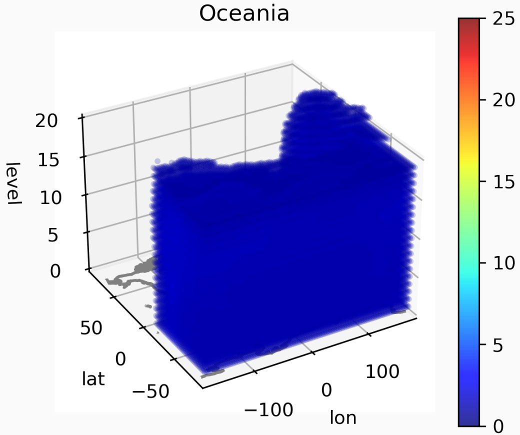


# Results – non-ENSO year (2003), Oceania



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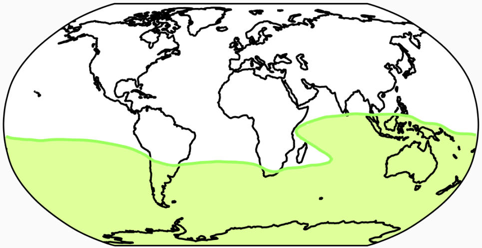

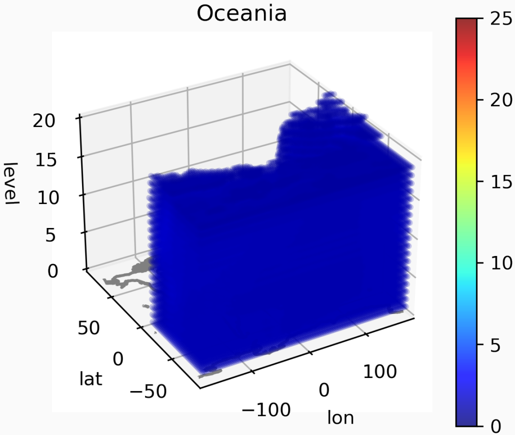

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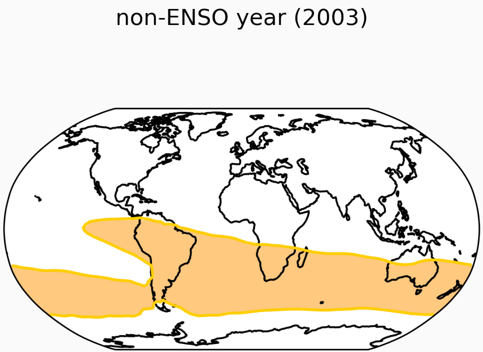


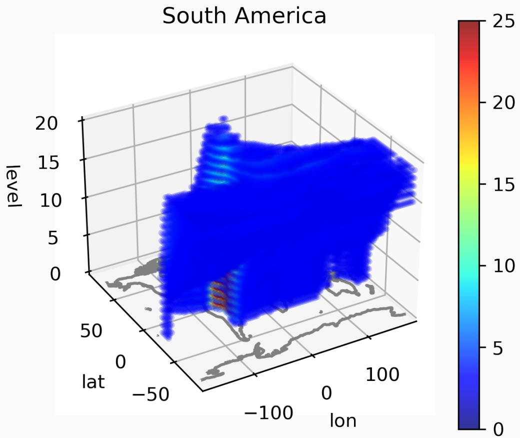

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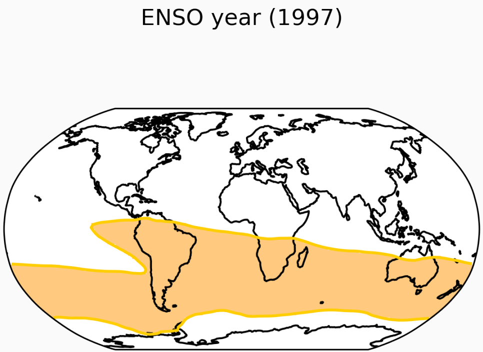
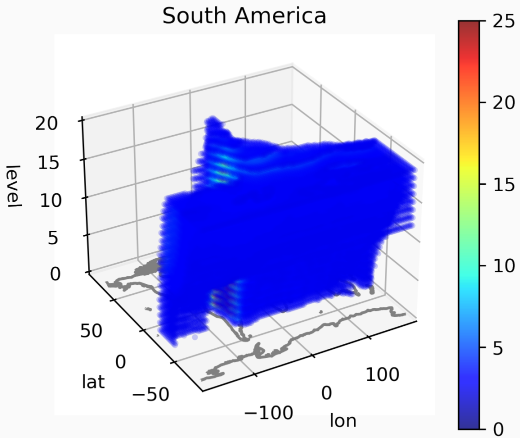
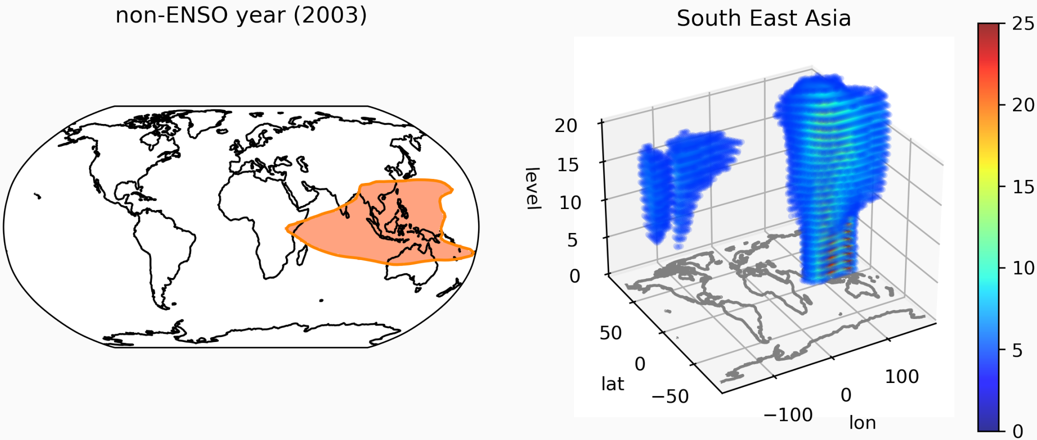


# Results – non-ENSO year (2003), South East Asia



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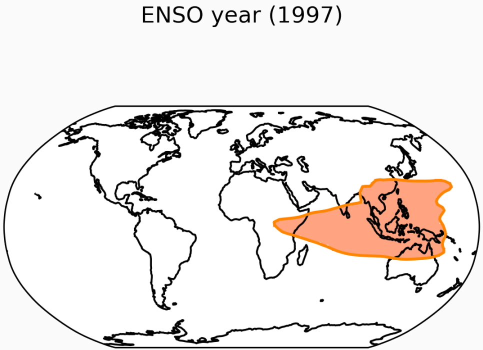
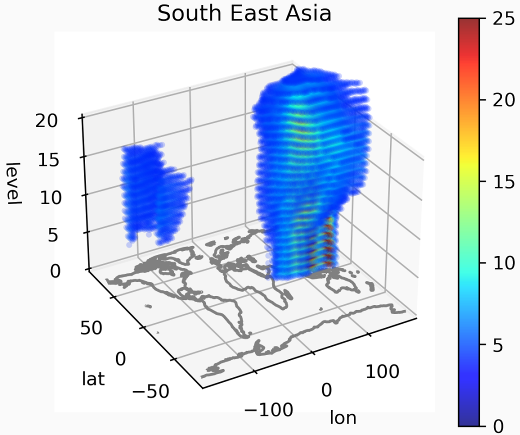
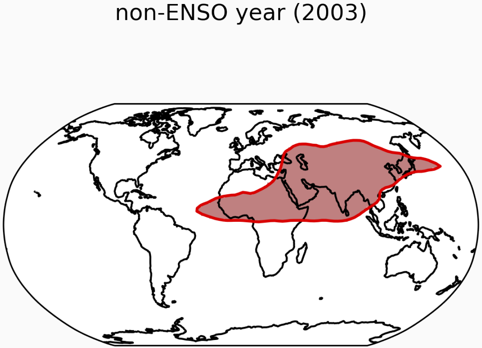
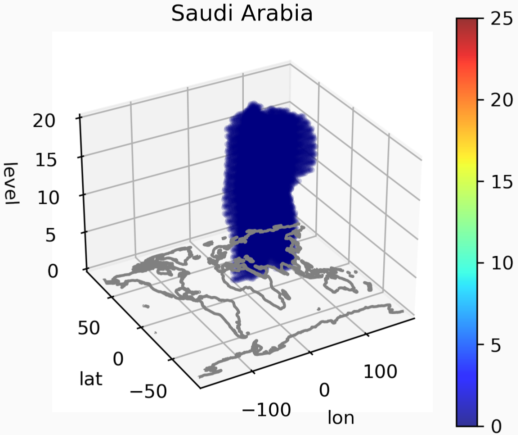


# Results – non-ENSO year (2003), Saudi Arabia



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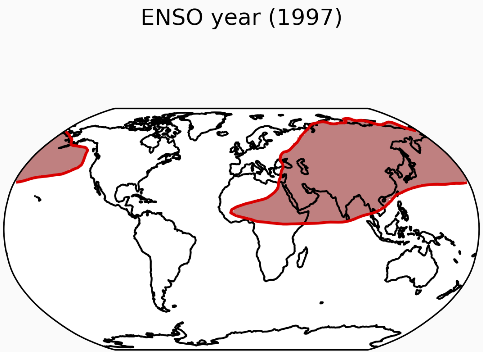


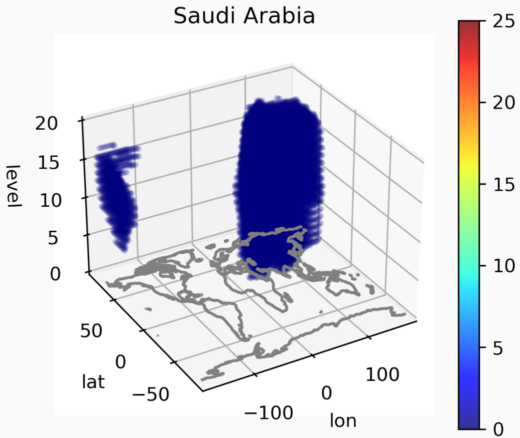

# Summary

- Biomass Burning pollution travels very far from the originating point
- Altitudinal information is rather important in understanding the pollution patterns
- El Niño/ impacts can be less predictable than what I originally thought..
- There are unanswered questions such as:
  - Which parts of the Oceans is each fire impacting?
  - What is the absolute importance of each region?
  - Statistics/numbers on all of the above!

# Thank you for your attention!

- Based on publications:
  - Daskalakis, N. et al.: **Impact of biomass burning and stratospheric intrusions in the remote South Pacific Ocean troposphere**, *Atmospheric Chemistry and Physics, 22, 4075-4099,* 10.5194/ACP-22-4075-2022, **2022**.
  - Daskalakis, N. et al.: **Wildfire emissions transport pathways in the Global Atmosphere**, *to be submitted,* **2022**


- Nikos Daskalakis is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany´s Excellence Strategy (University Allowance, EXC 2077, University of Bremen).
- The computations/simulations were performed on the HPC cluster Aether at the University of Bremen, financed by DFG within the scope of the Excellence