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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Outline

- Motivation/Aim
- Introduction
- Experiment setup
- Results
- Summary

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Burning impact in the S. Pacific

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Motivation/Aim

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- Quantify BB contribution to O_3 levels over S. Pacific.
- Quantify BB importance over stratospheric influx
- Understand patterns based on atmospheric dynamics
- Attribute and quantify CO enhancement from BB
- Region identification for CO contributions

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Introduction

Why are we interested in O_3?

- Known facts for O_3
  - Important for climate (grenhouse gas)
  - Impacts on human health and ecosystems
  - Impacts visibility (smog)
- Difficulties:
  - Secondary pollutant - hard to control through emission mitigation
- O_3 is impacted by:
  - Climate/meteorological patterns
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  - Pyrogenic emissions

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Main questions

- What are the background O_3 tendencies over the past two decades
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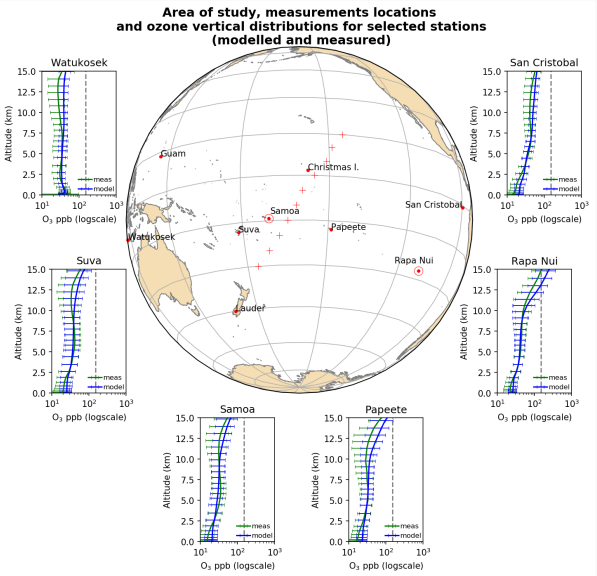
Burning impact in the S. Pacific

Experiment setup

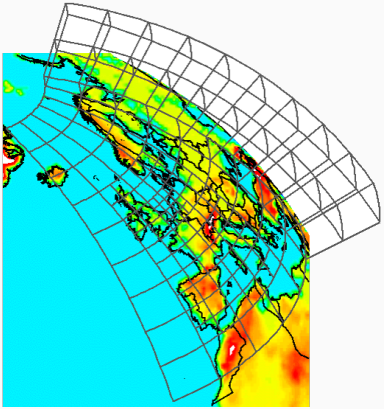
Station locations and area of interest



TM4-ECPL model

Global TM4-ECPL CTM:

- 3° x 2° 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, Tsigaridis, Daskalakis, Kanakidou et al., 2014)
- Detailed description in Daskalakis et al., ACP, 2016



Experiment Setup

- TM4-ECPL simulation of 1980- 2014 with ERA interim meteorology
- Period of study: 1994-2014 (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 US biomass burning regions

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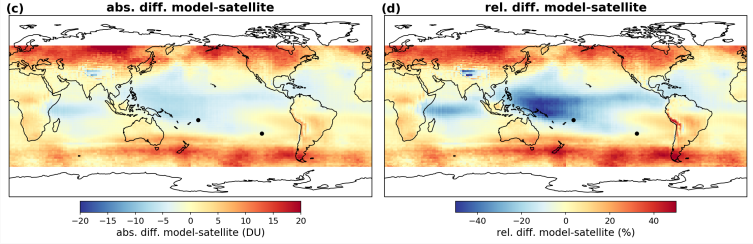
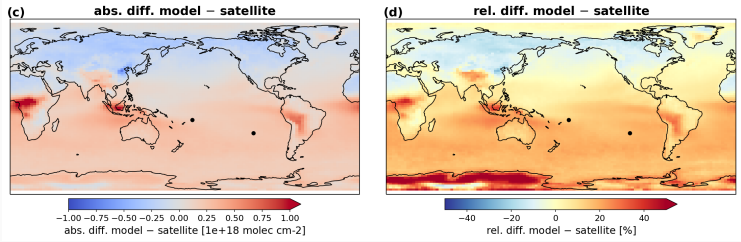
Results - Model validation

Model vs satellites

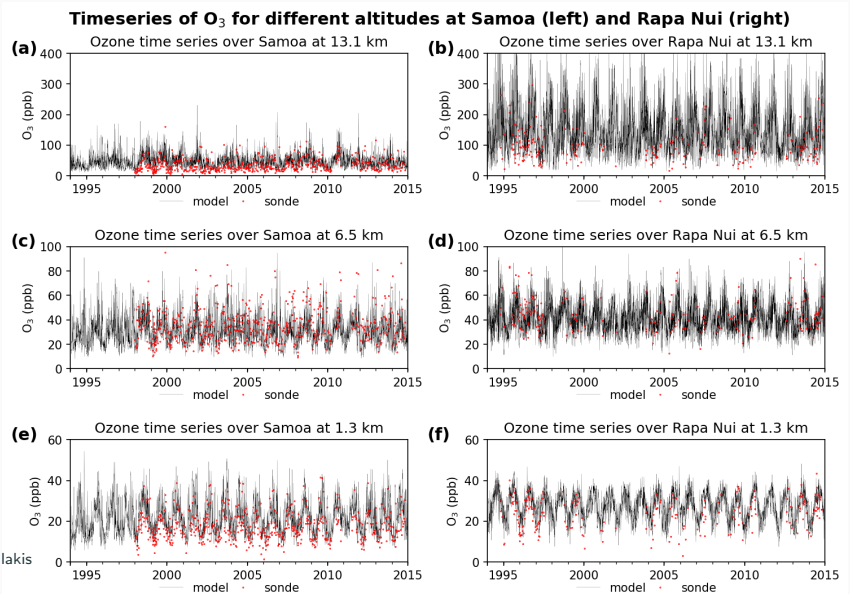
TM4-ECPL vs OMI/MLS mean 10/20040–12/2014



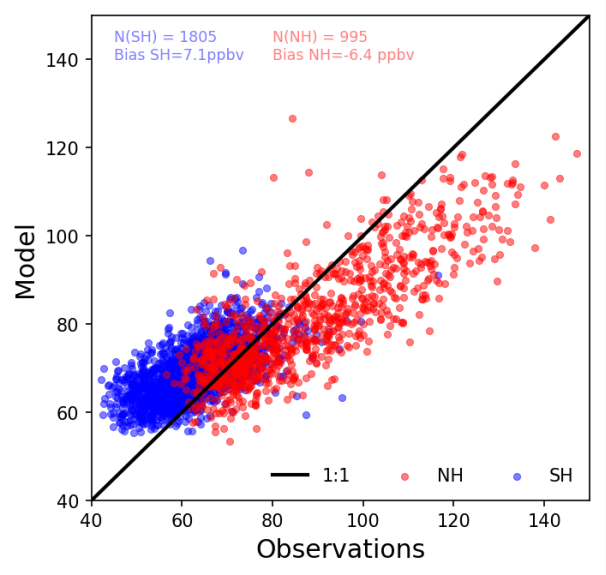
TM4-ECPL vs MOPITT mean 2000–2014



Model vs measurements (O_3)



Model vs measurements (CO)



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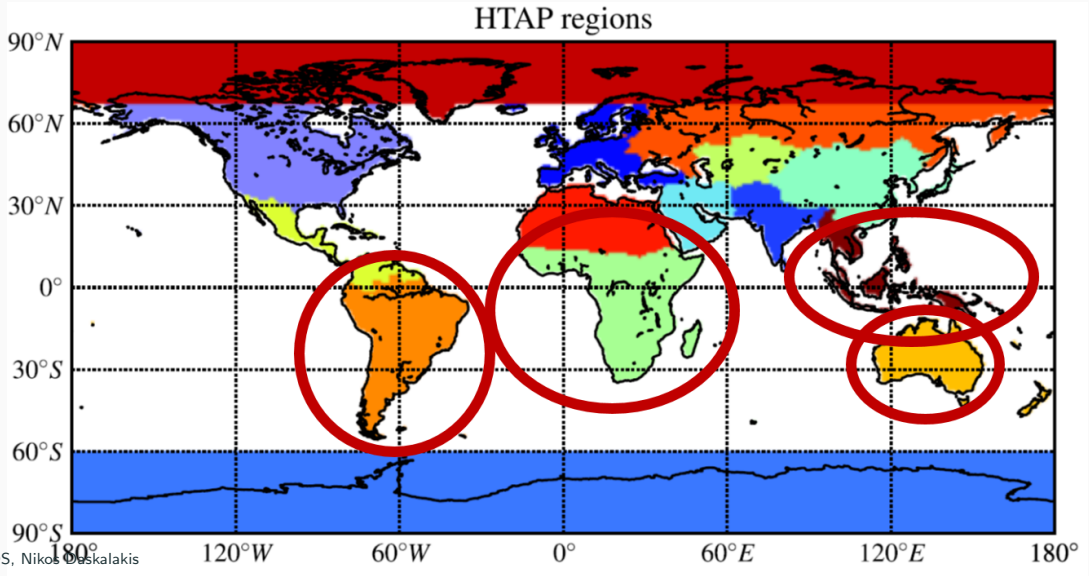
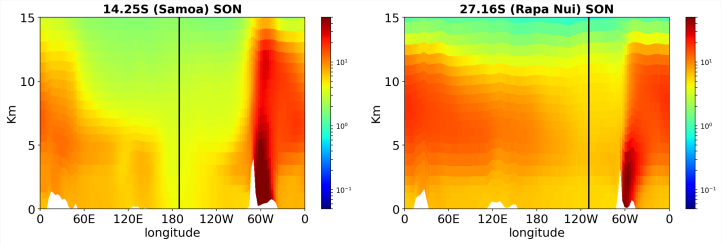
Results

Marked tracers

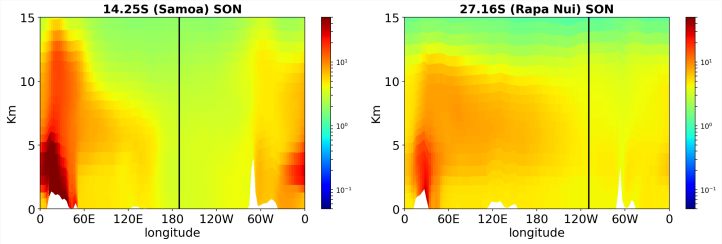


Impact of S. America and S. Africa

South America

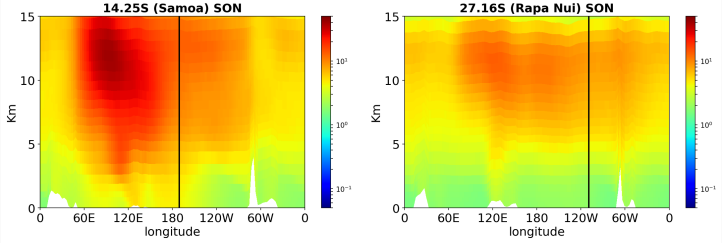


Southern Africa

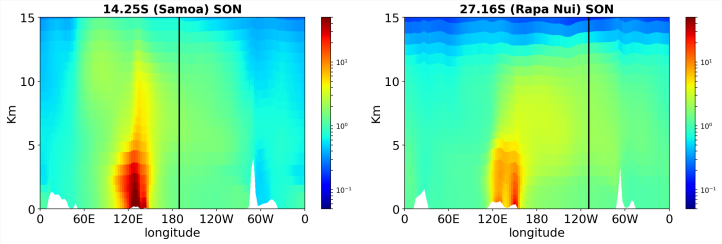


Impact of S.E. Asia and Oceania

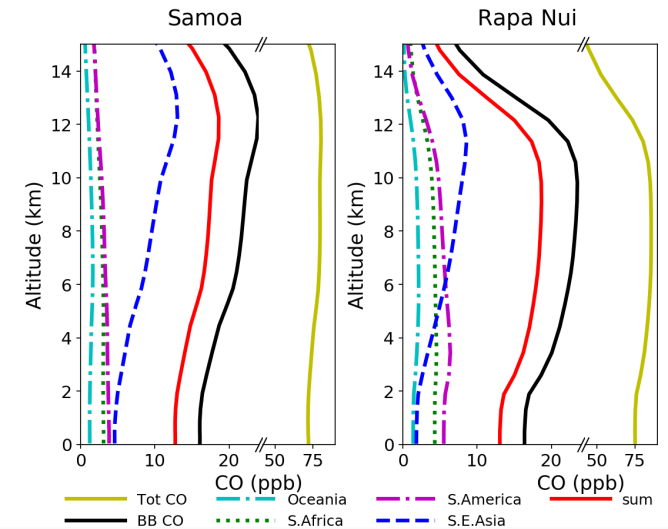
South East Asia



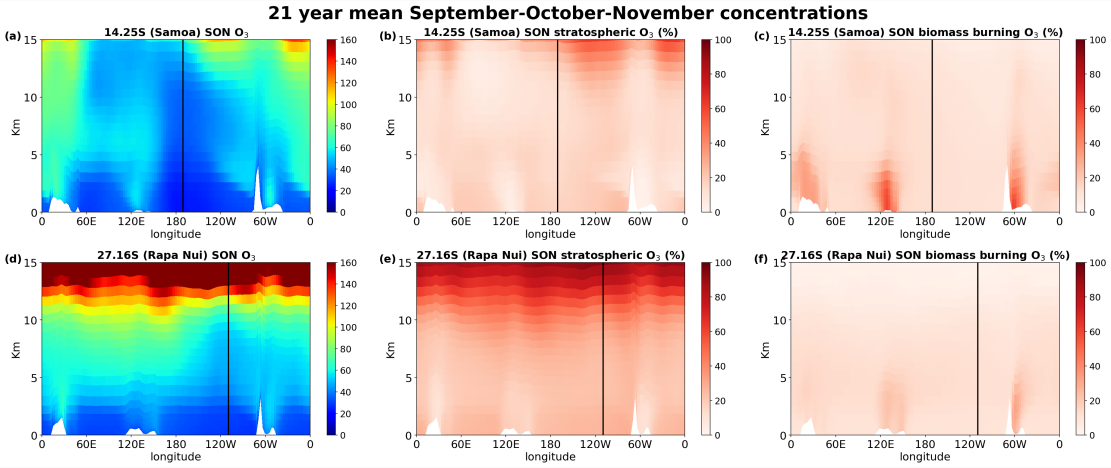
Oceania



BB contribution to CO concentration



O_3 origins breakdown



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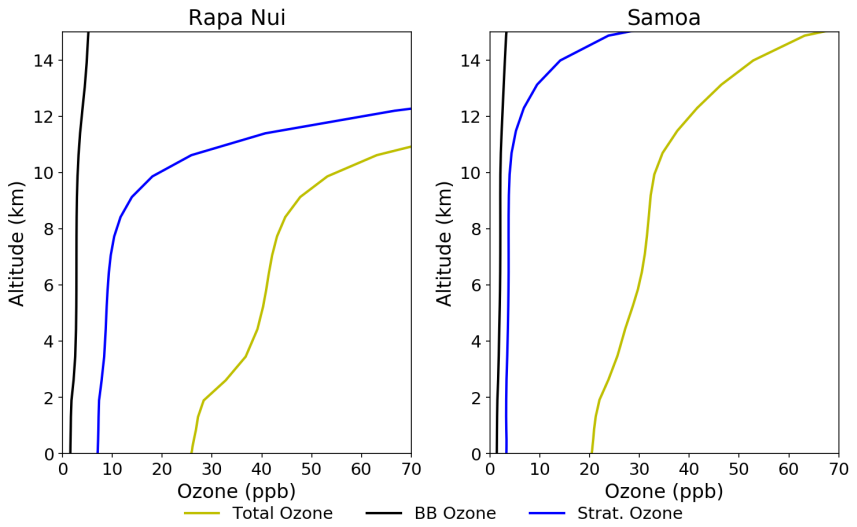

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- CO from Africa reaches the South Pacific following the westerlies
- CO from Indonesia
  - is lifted up in by convection to the warm pool
  - split into an eastward and a westward flow
- CO from Oceania is lifted less than that from Indonesia
  - the bulk of the emissions are subject to the lower tropospheric winds
- CO from South America in the lower troposphere is separated into two branches.
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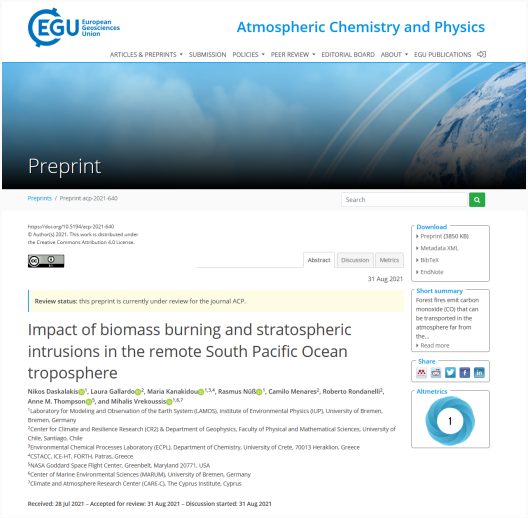

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Abstract | Discussion | Metrics

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Review status: this preprint is currently under review for the journal ACP.

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[2]Center for Climate and Resilience Research (CR2) & Department of Geophysics, Faculty of Physical and Mathematical Sciences, University of Chile, Santiago, Chile
[3]Environmental Chemical Processes Laboratory (ECPL), Department of Chemistry, University of Crete, 70013 Heraklion, Greece
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[6]Center of Marine Environmental Sciences (MARUM), University of Bremen, Germany
[7]Climate and Atmosphere Research Center (CARE-C), The Cyprus Institute, Cyprus

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Thank you for your attention!

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- Based on publications in preparation:
  Impact of biomass burning in the remote South Pacific Ocean, *Daskalakis, N. et al., under review*, **ACP, 2021**