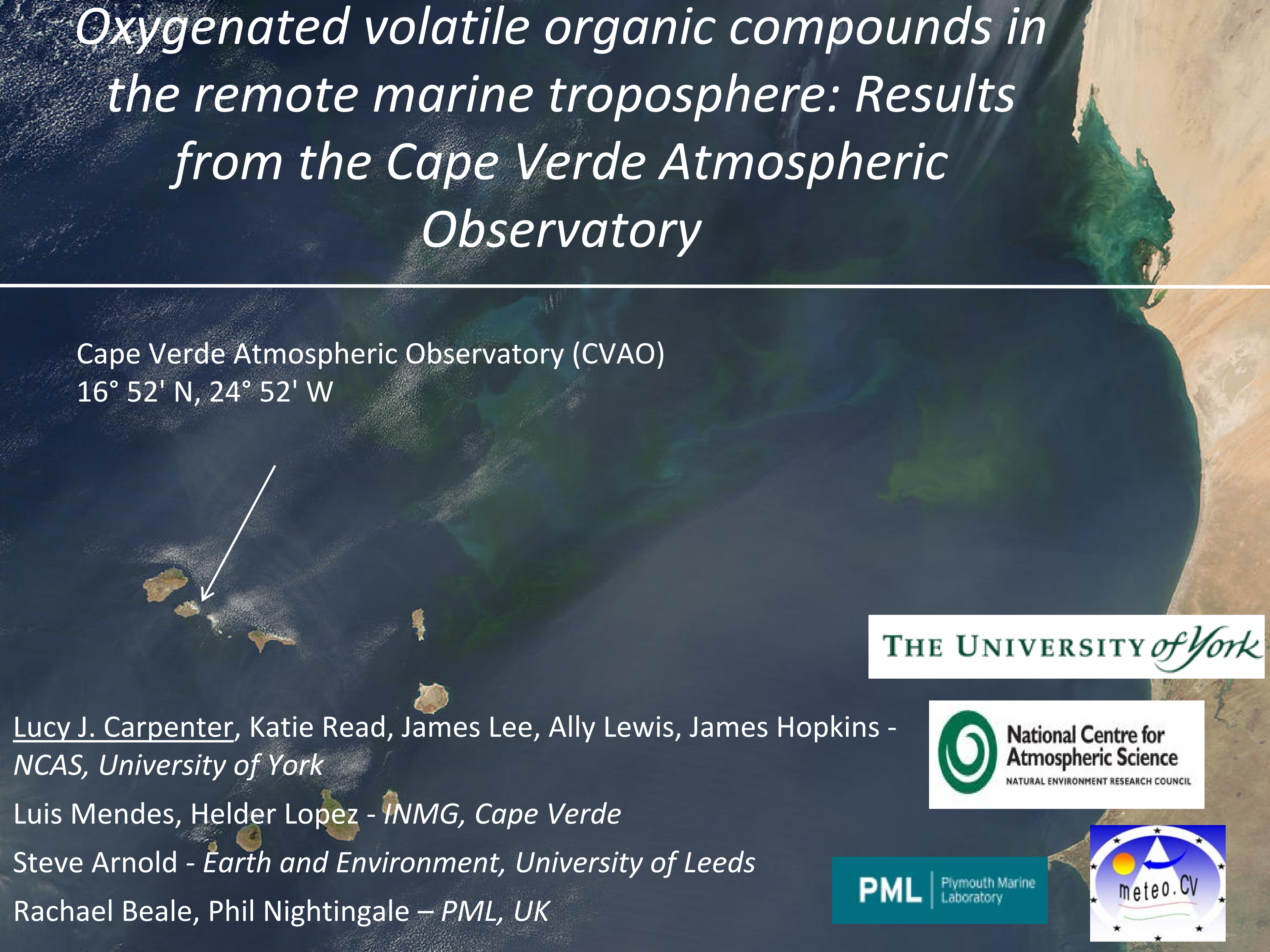
Oxygenated volatile organic compounds in the remote marine troposphere: Results from the Cape Verde Atmospheric Observatory



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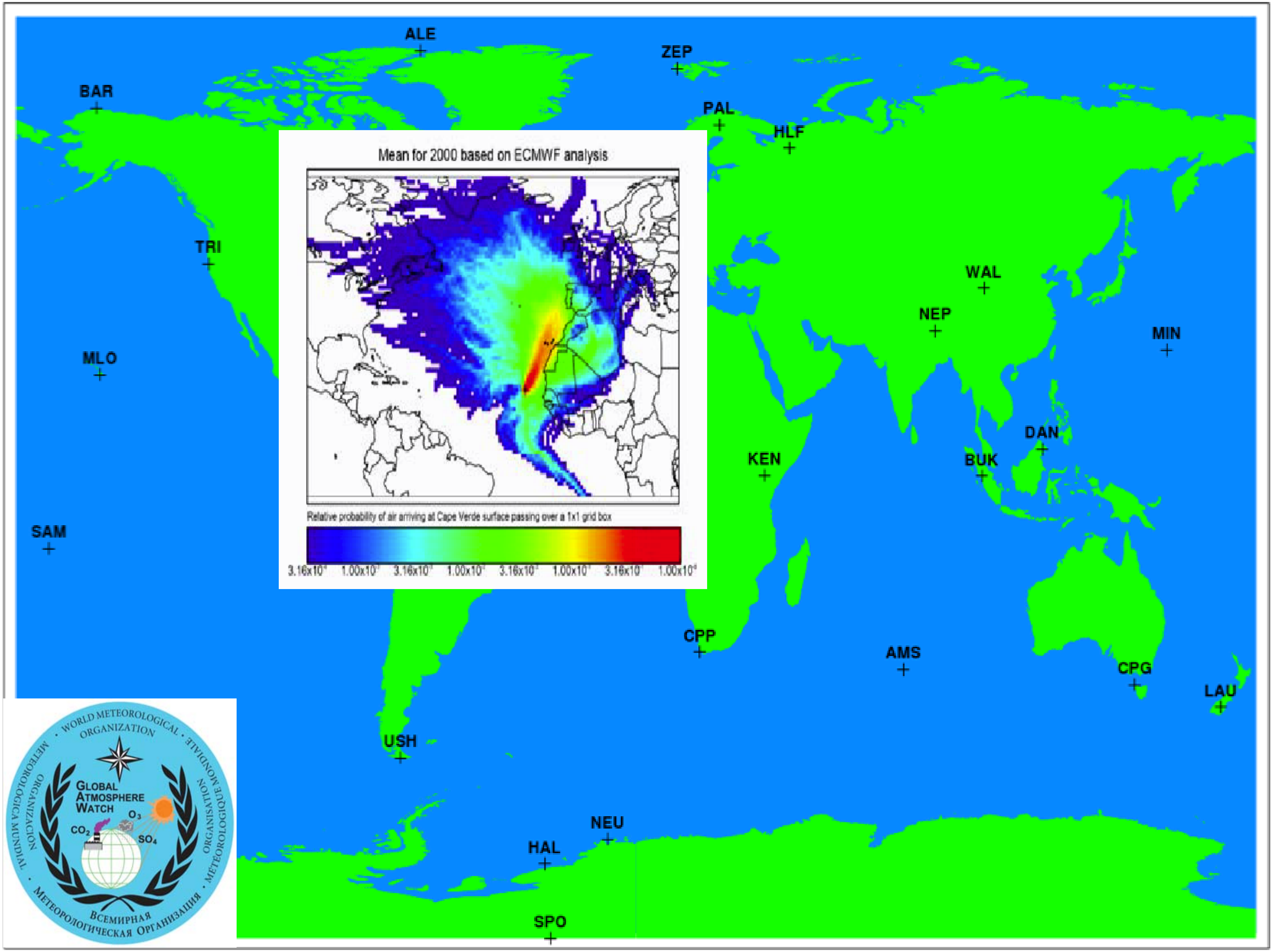
Rachael Beale, Phil Nightingale – *PML, UK*


ALE
ZEP
BAR
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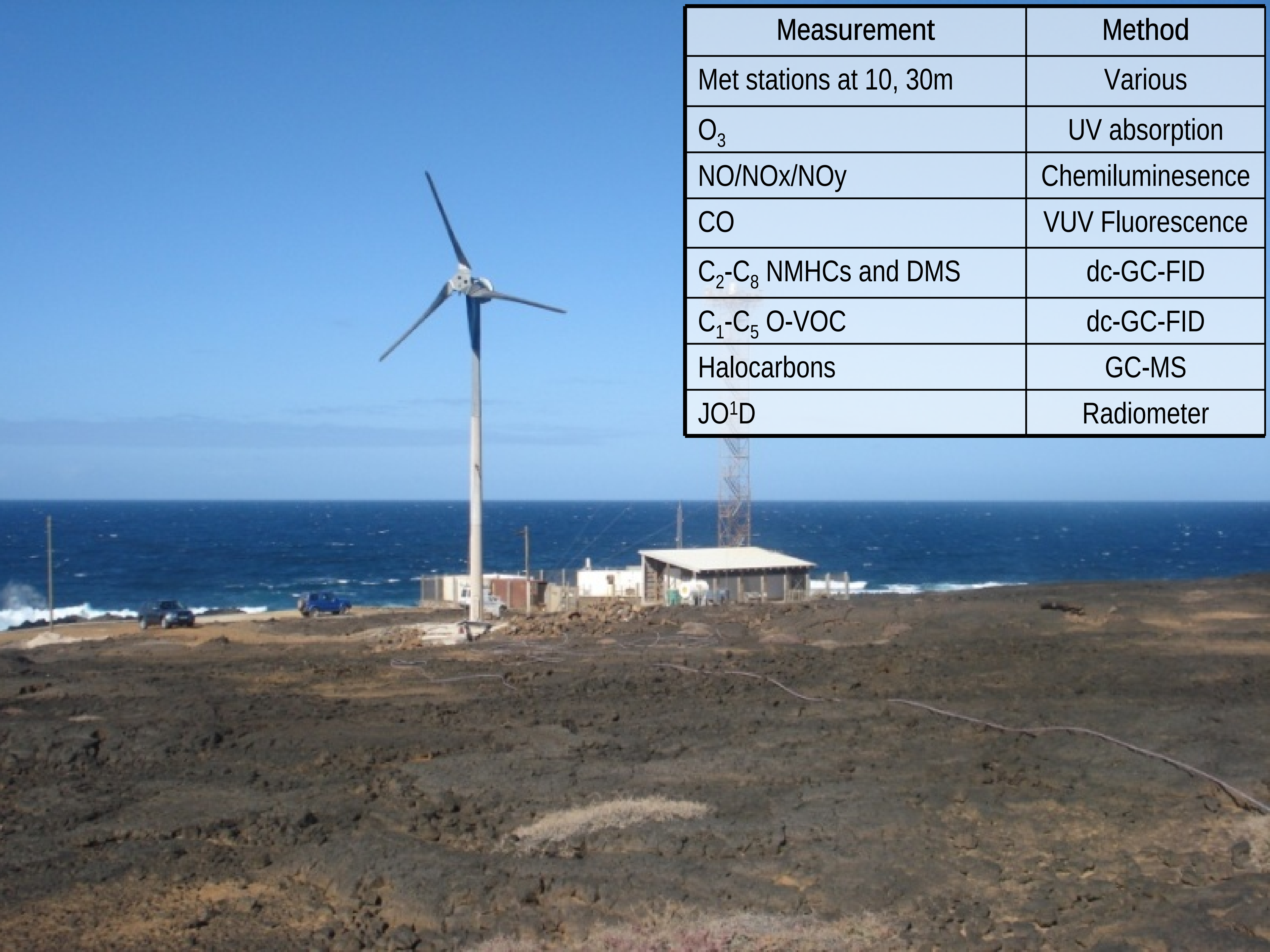
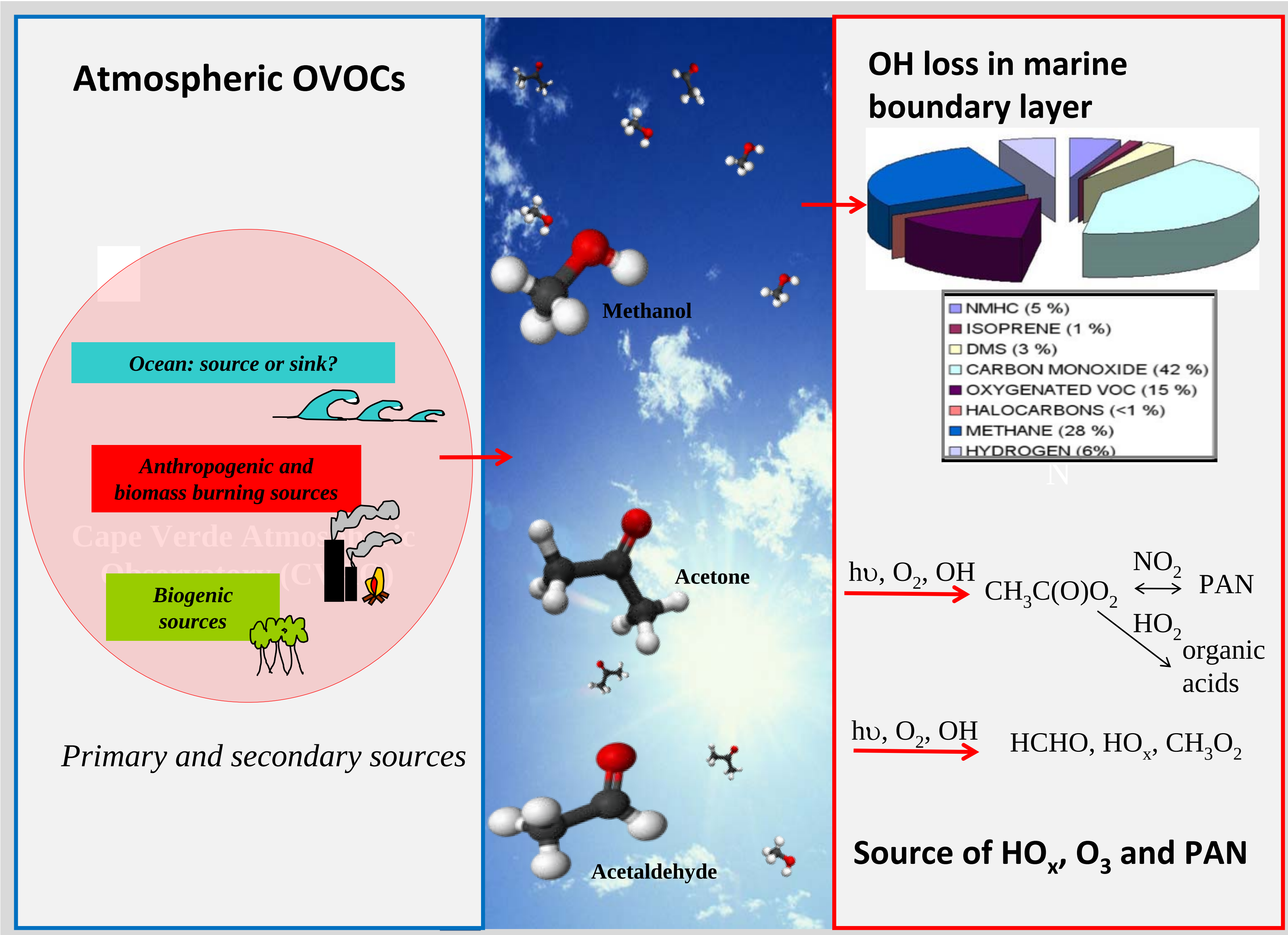
HLF
TRI
WAL
NEP
MIN
MLO
DAN
BUK
KEN
SAM
CPP
AMS
CPG
LAU
USH
NEU
HAL
SPO
Mean for 2000 based on ECMWF analysis
Relative probability of air arriving at Cape Verde surface passing over a 1x1 grid box
WORLD METEOROLOGICAL ORGANIZATION
GLOBAL ATMOSPHERE WATCH
ORGANISATION MÉTÉOROLOGIQUE MONDIALE
ORGANIZACION METEOROLOGICA MUNDIAL
ВСЕМИРНАЯ МЕТЕОРОЛОГИЧЕСКАЯ ОРГАНИЗАЦИЯ

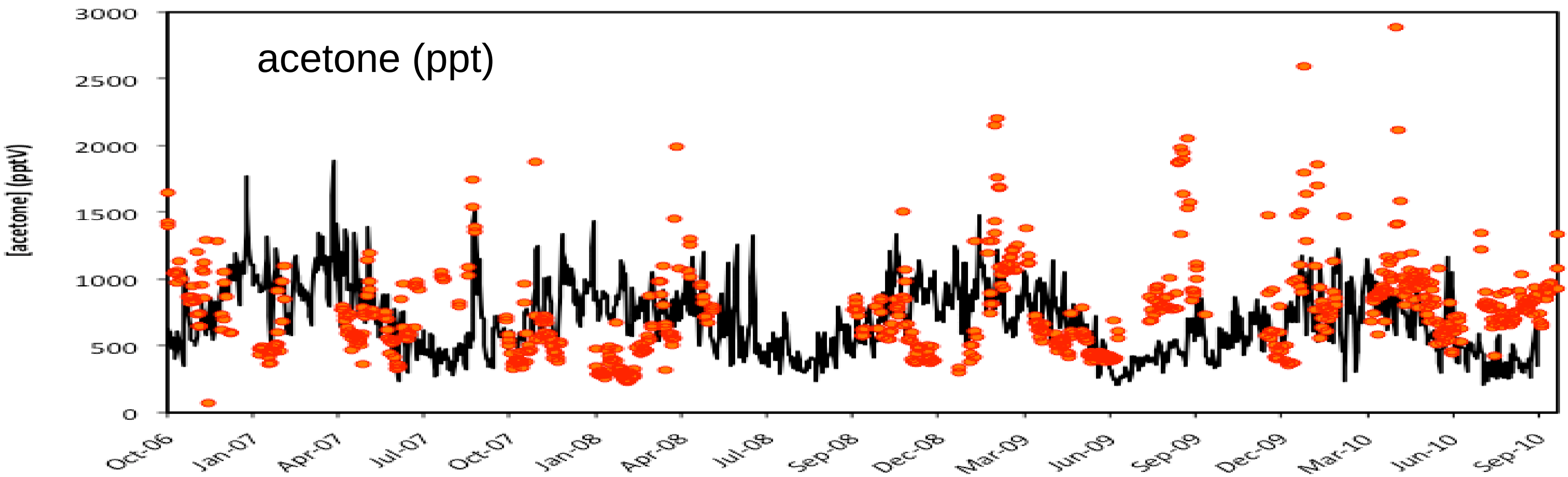


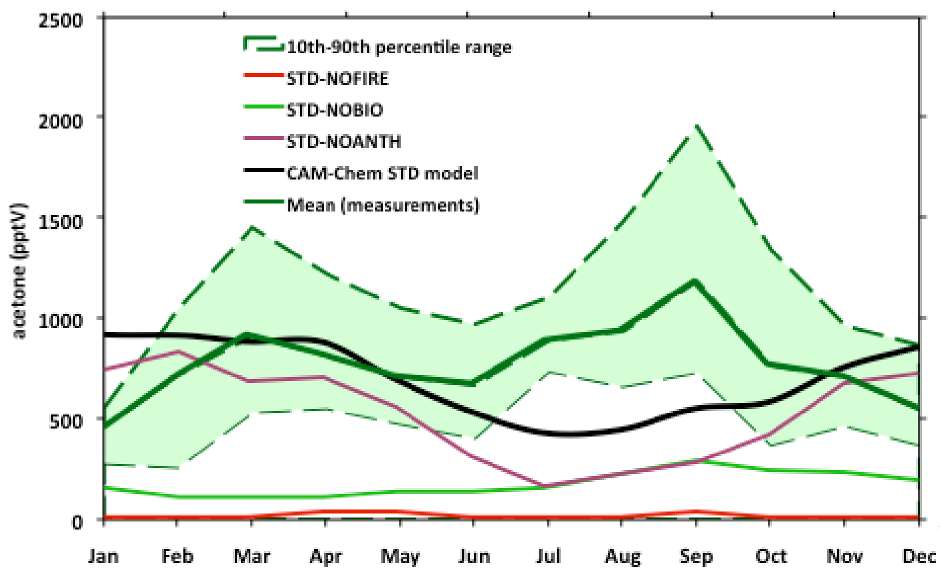
Measurement	Method
Met stations at 10, 30m	Various
O_3	UV absorption
NO/NOx/NOy	Chemiluminesence
CO	VUV Fluorescence
C_2-C_8 NMHCs and DMS	dc-GC-FID
C_1-C_5 O-VOC	dc-GC-FID
Halocarbons	GC-MS
JO^1D	Radiometer

Oxygenated volatile organic compounds (OVOCs)



CAM-Chem vs measurements

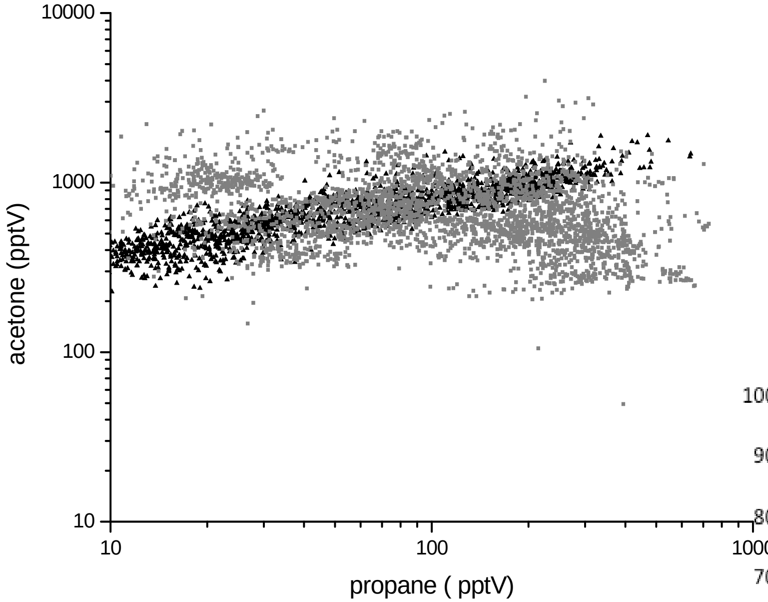


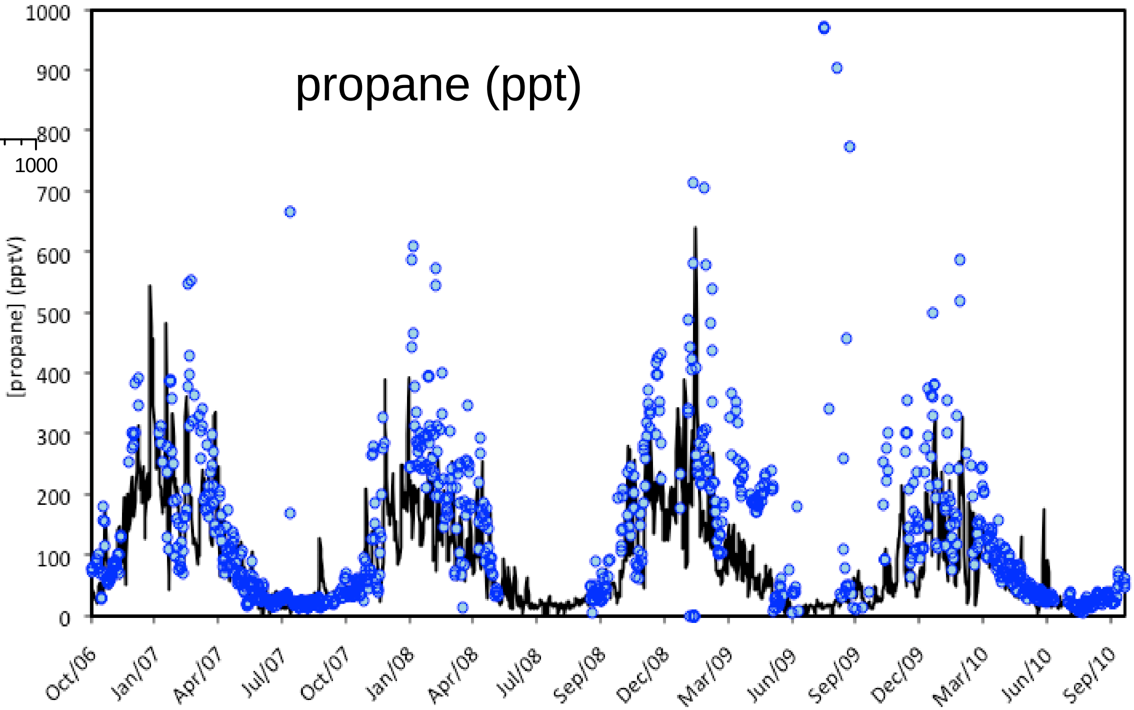


Monthly averages

Dominated by anthropogenic emissions (39 %-91 %)?

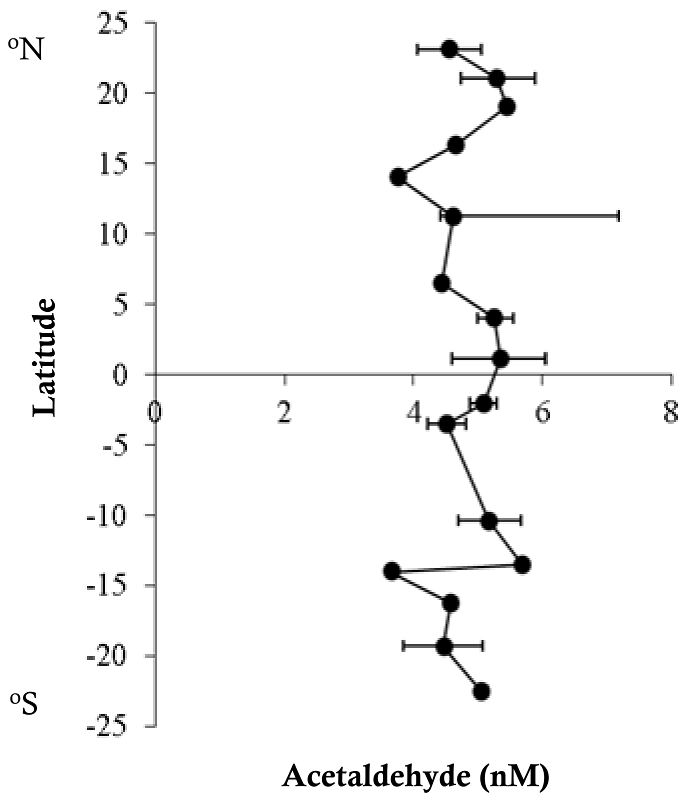
Are MBL acetone concentrations controlled by anthropogenic NMHC?



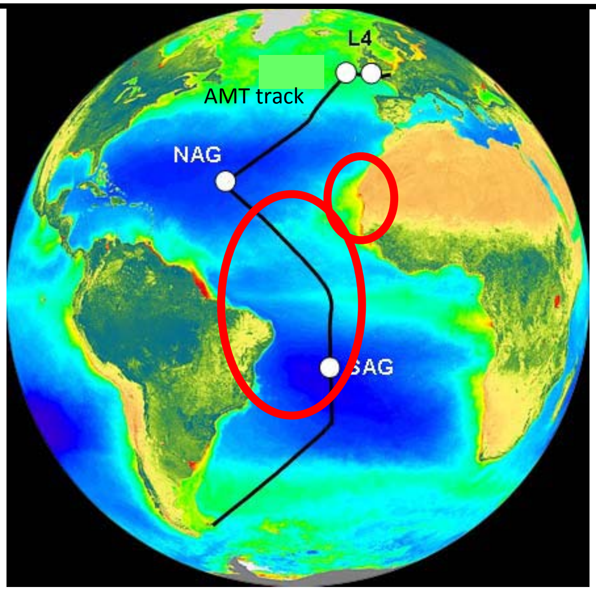


Role of the oceans?

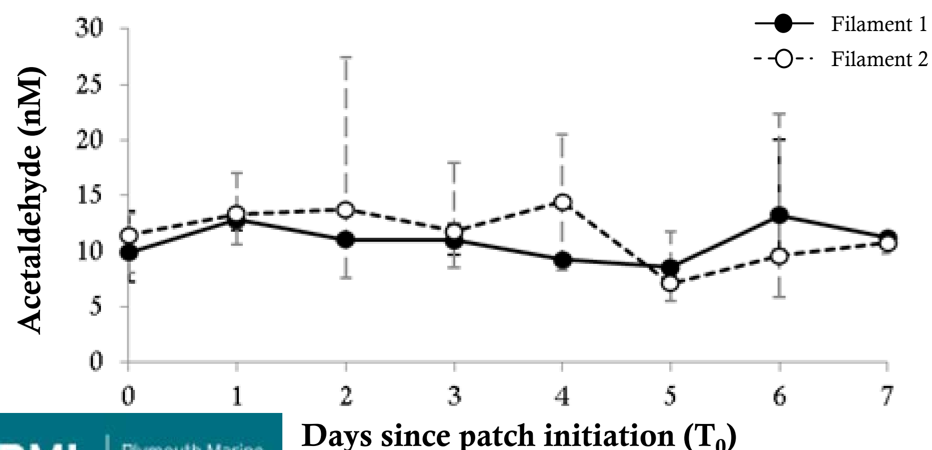
- Jacob et al. (2002)- ocean a significant source of acetone



- *Methanol, acetaldehyde and acetone quantified in seawater via MI-PTR/MS*



Acetaldehyde in Mauritanian Upwelling (ICON)

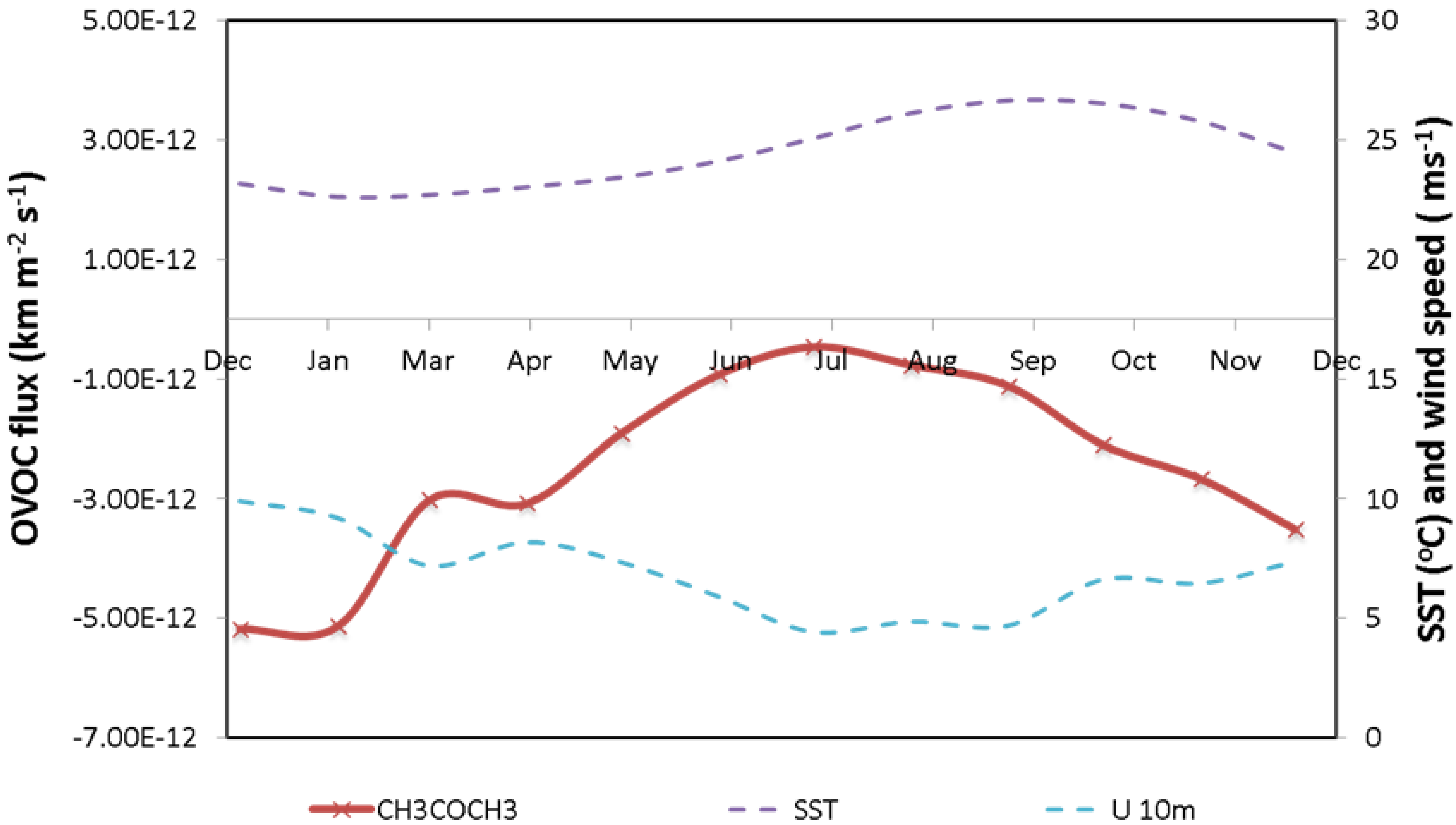


PML Plymouth Marine Laboratory

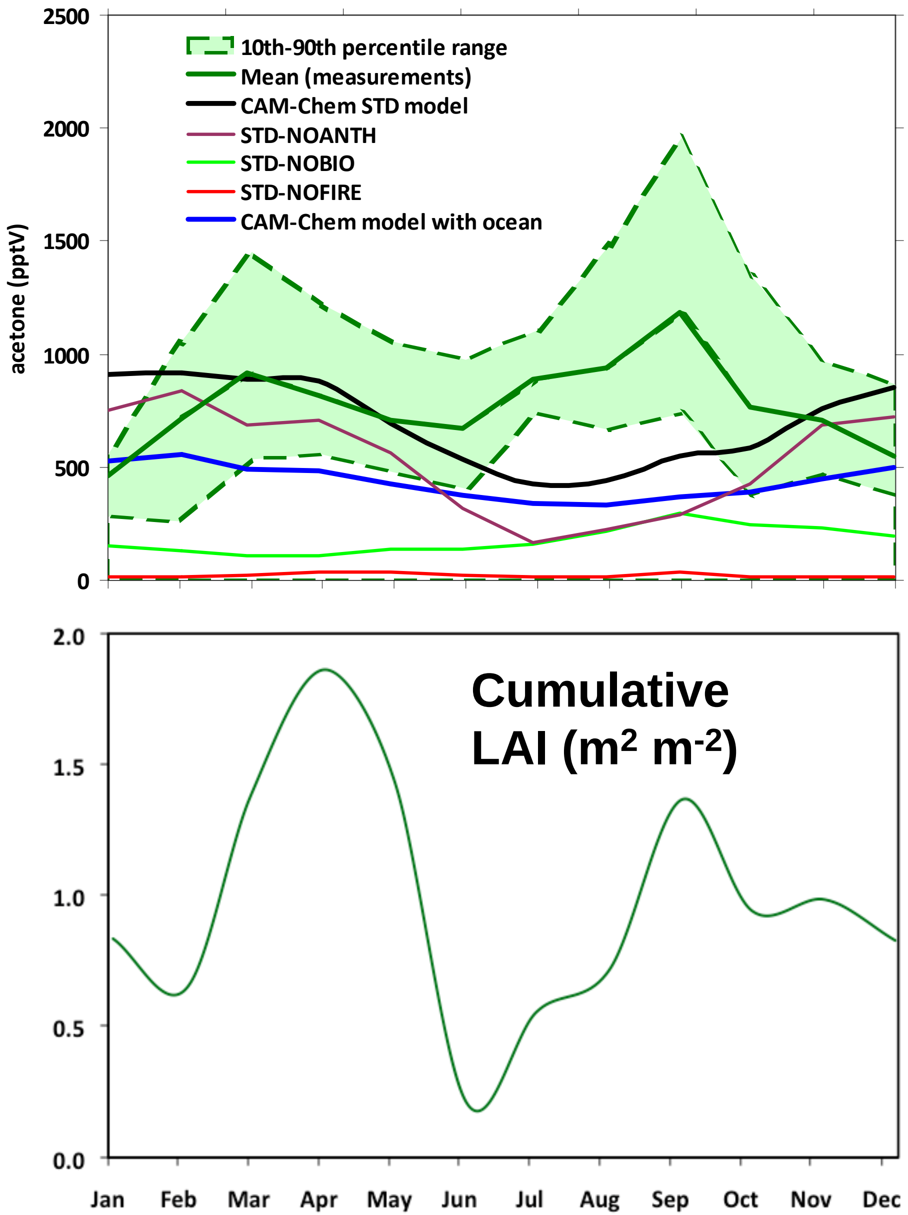
Beale, R. Quantification of oxygenated volatile organic compounds (OVOCs) in seawater, 2011, Ph.D thesis, University of East Anglia, UK. *Manuscripts in preparation.*

Modelled oceanic acetone fluxes

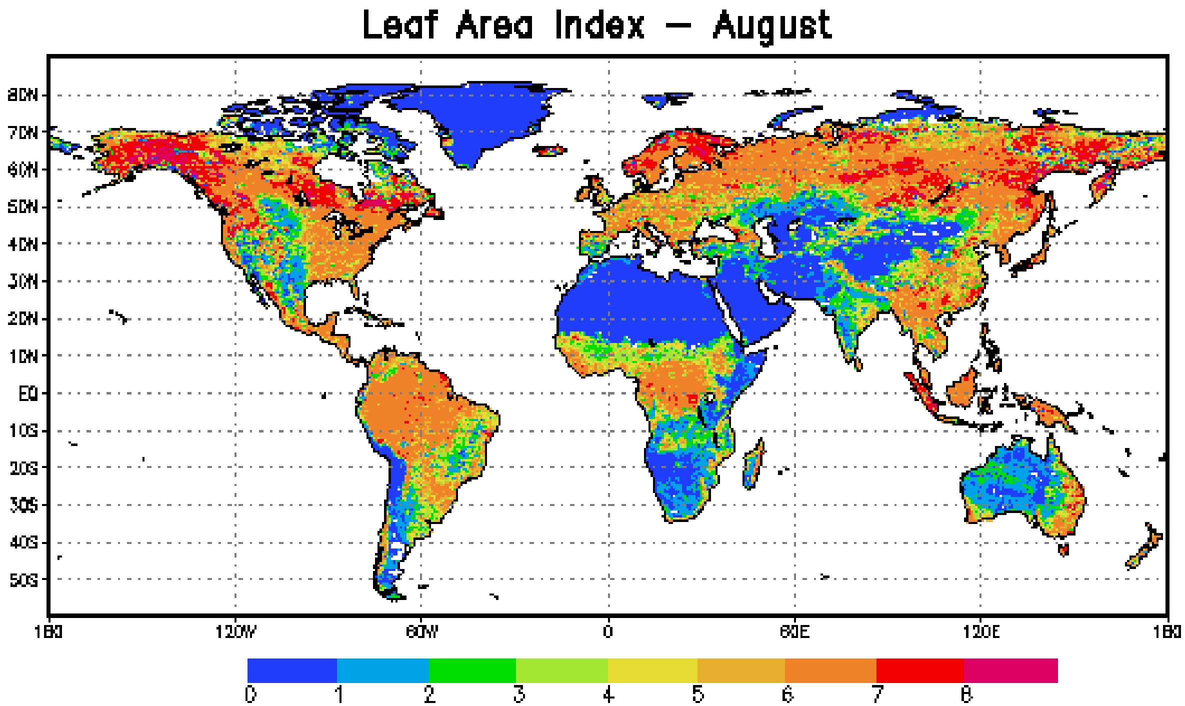
- Sea-air flux $F = k_t (C_w - C_a/H)$ $\quad 1/k_t = 1/k_w + 1/Hk_a$

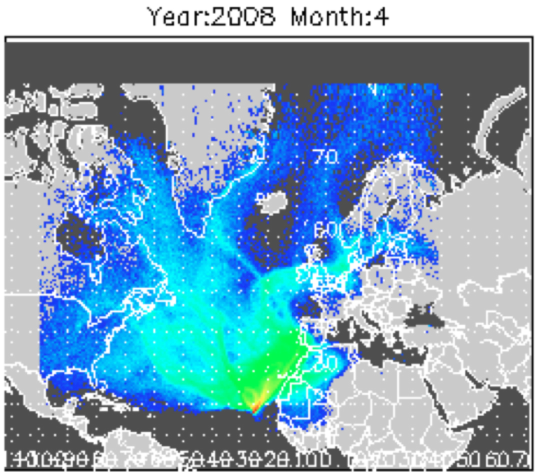


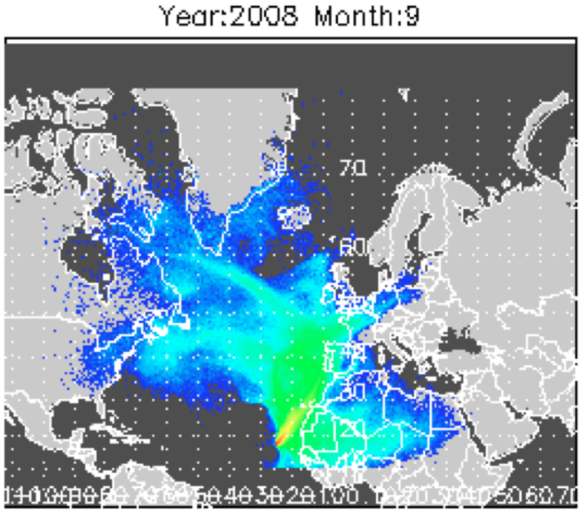
How does this change model results?



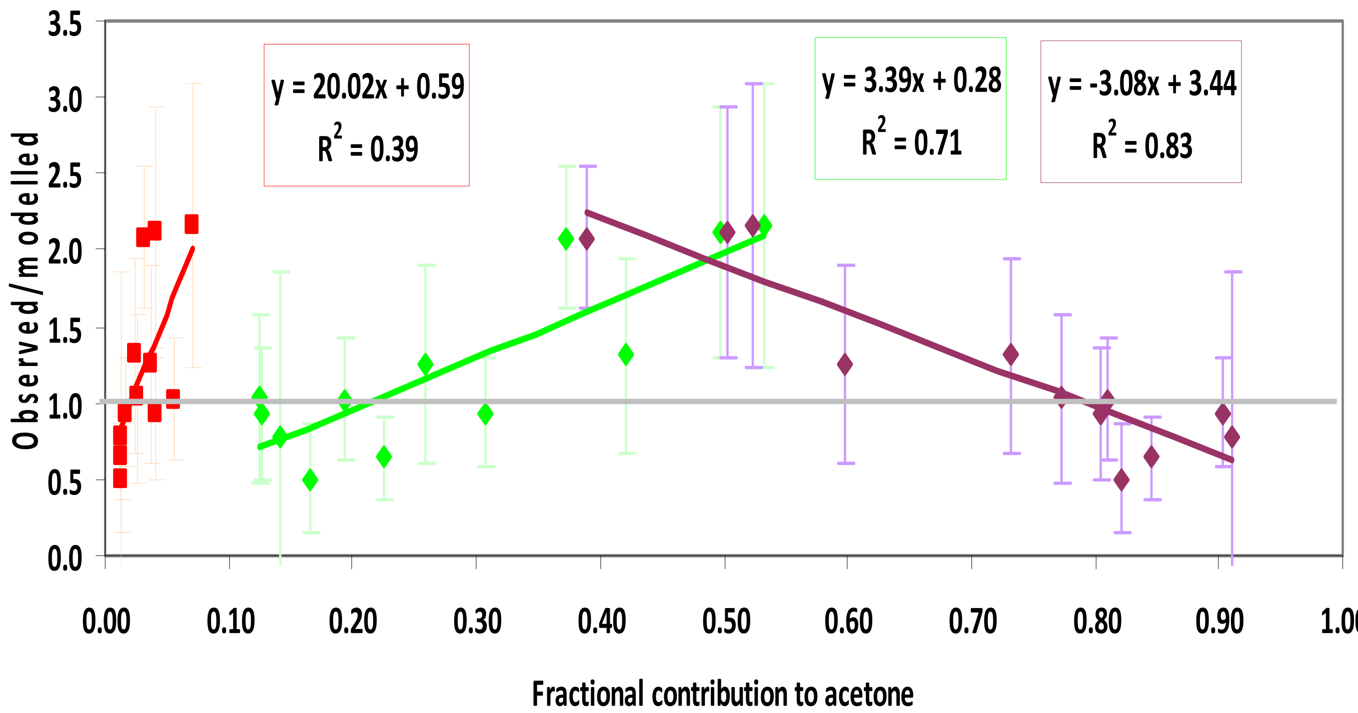
Biological (terrestrial) influences







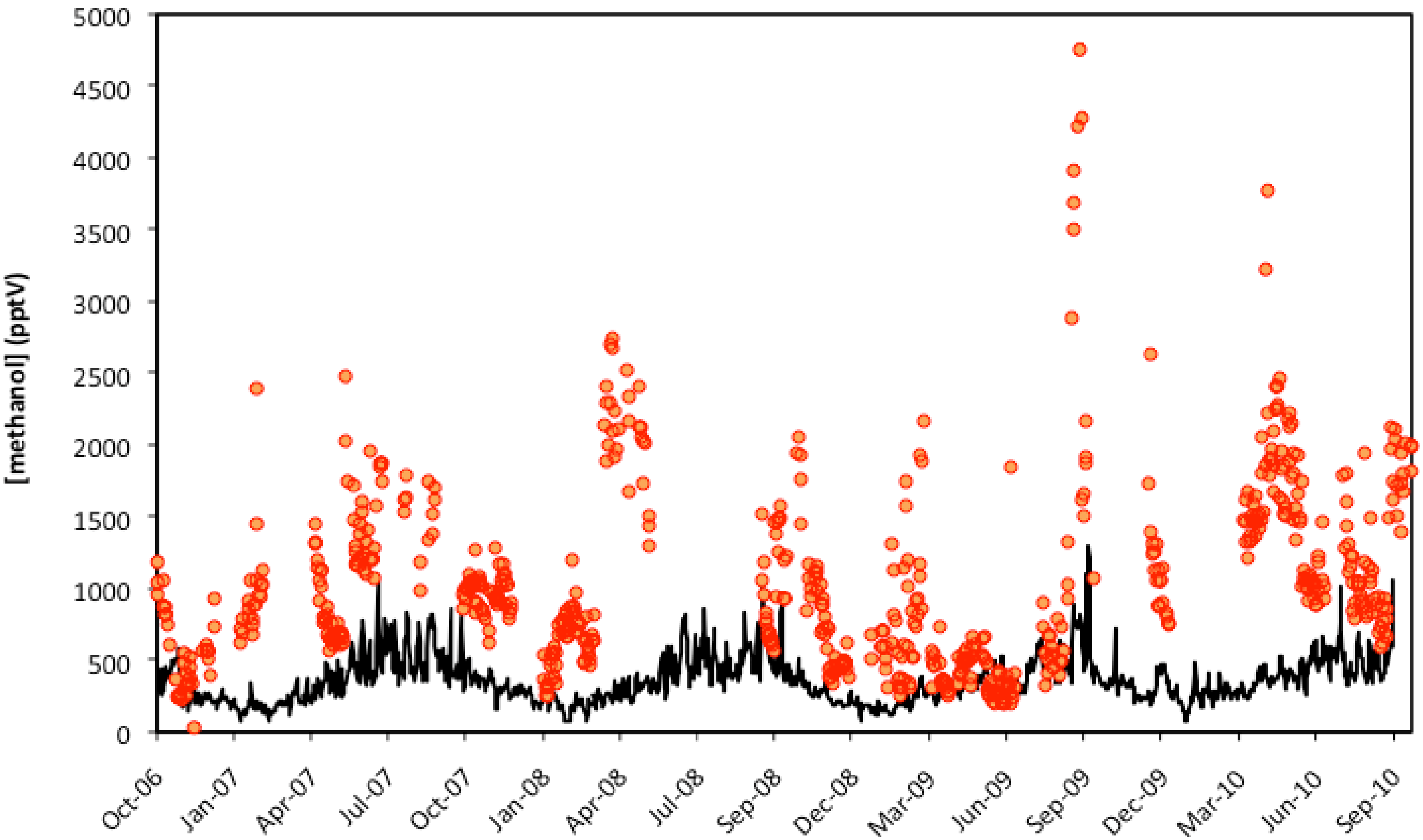
Could model bias be due to underestimated biogenic emissions?



Fractional contribution from biogenic (green), anthropogenic (purple) and biomass burning (red) sources as calculated from CAM-Chem.

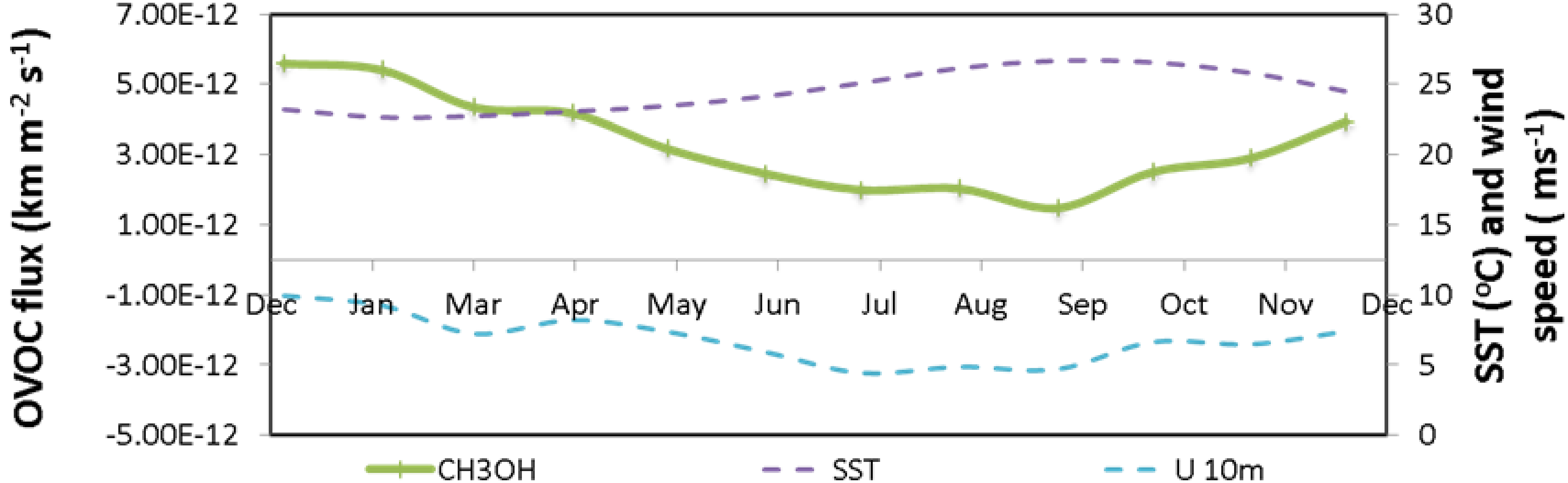
Grey lines indicate 1:1 observation:model agreement.

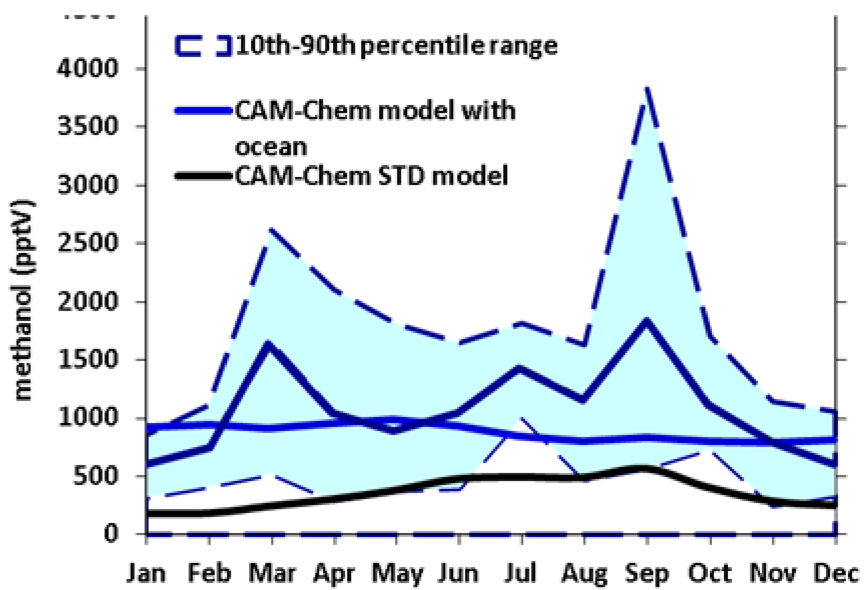
Methanol



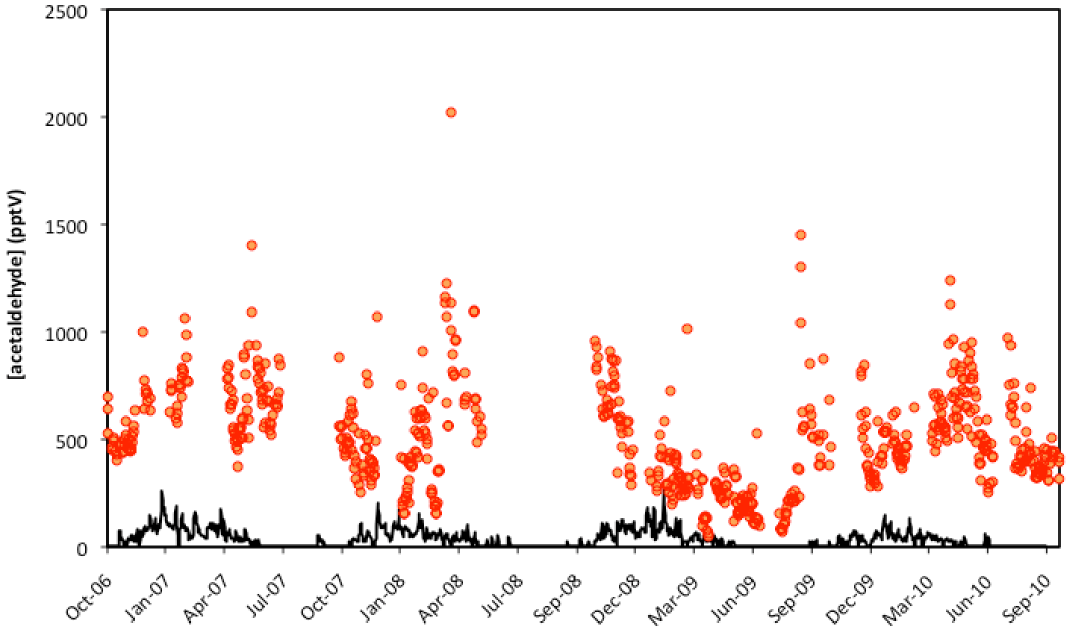
[methanol] (pptV)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Oct-06
Jan-07
Apr-07
Jul-07
Oct-07
Jan-08
Apr-08
Jul-08
Sep-08
Dec-08
Mar-09
Jun-09
Sep-09
Dec-09
Mar-10
Jun-10
Sep-10

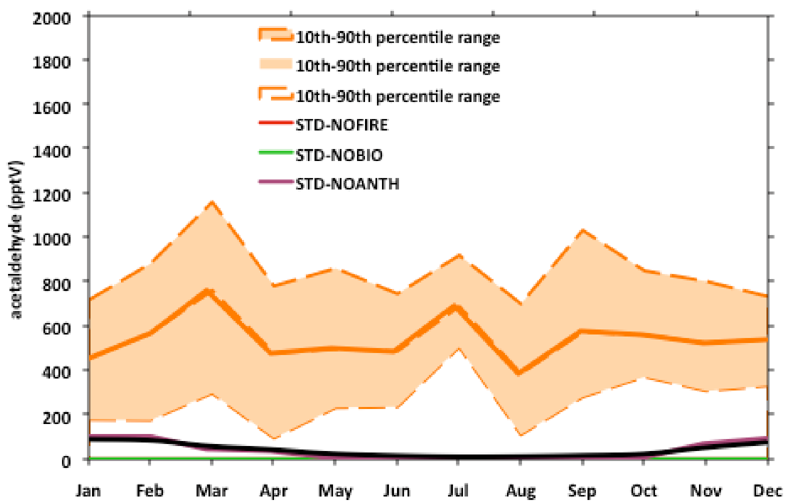
Modification of atmospheric methanol by oceans

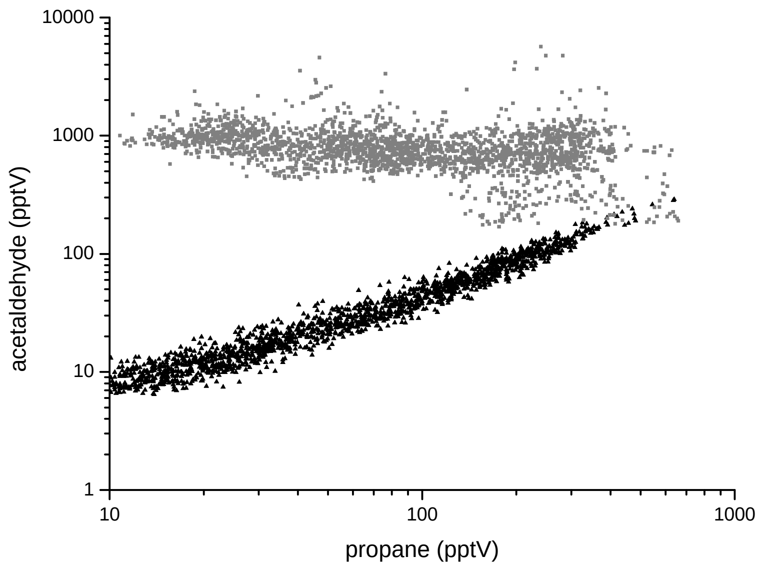




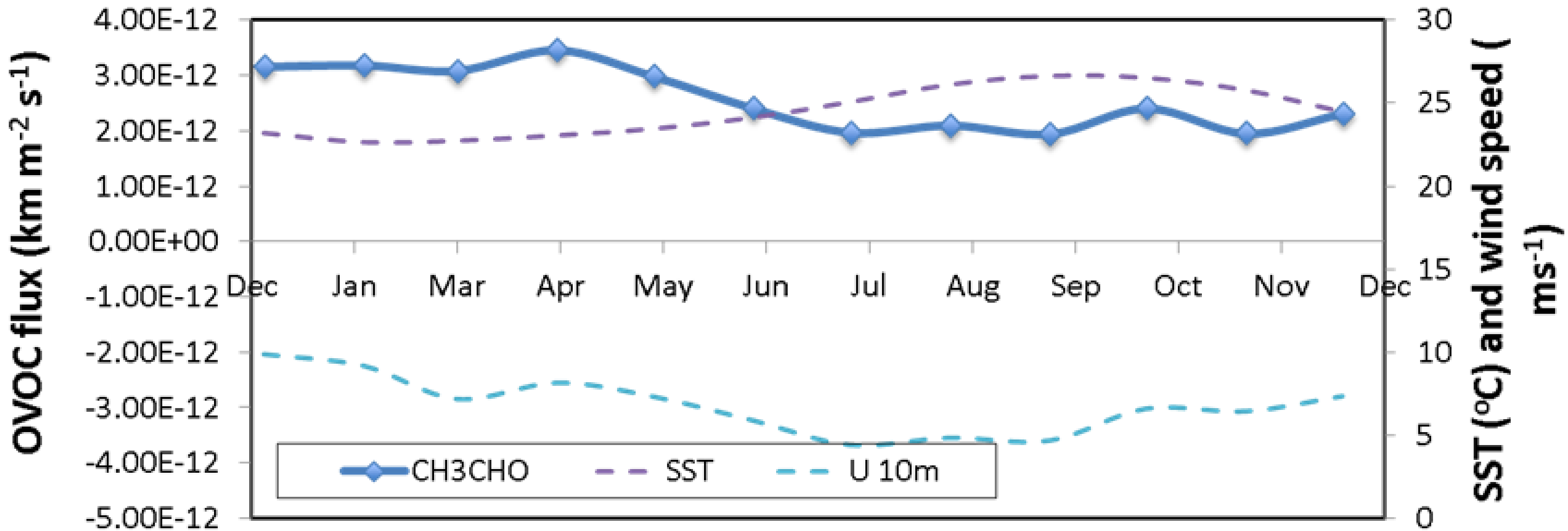
Acetaldehyde

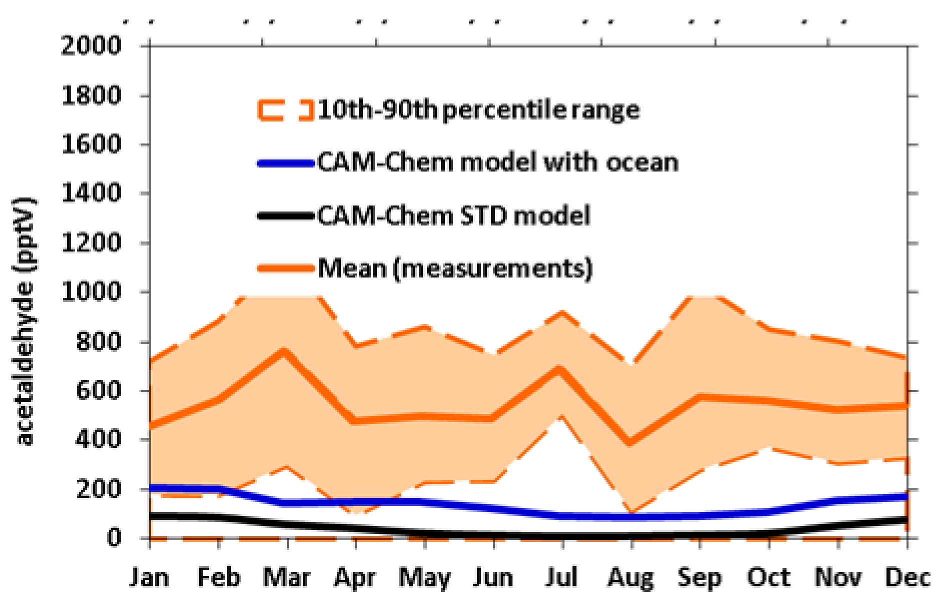






Acetaldehyde modification by oceans





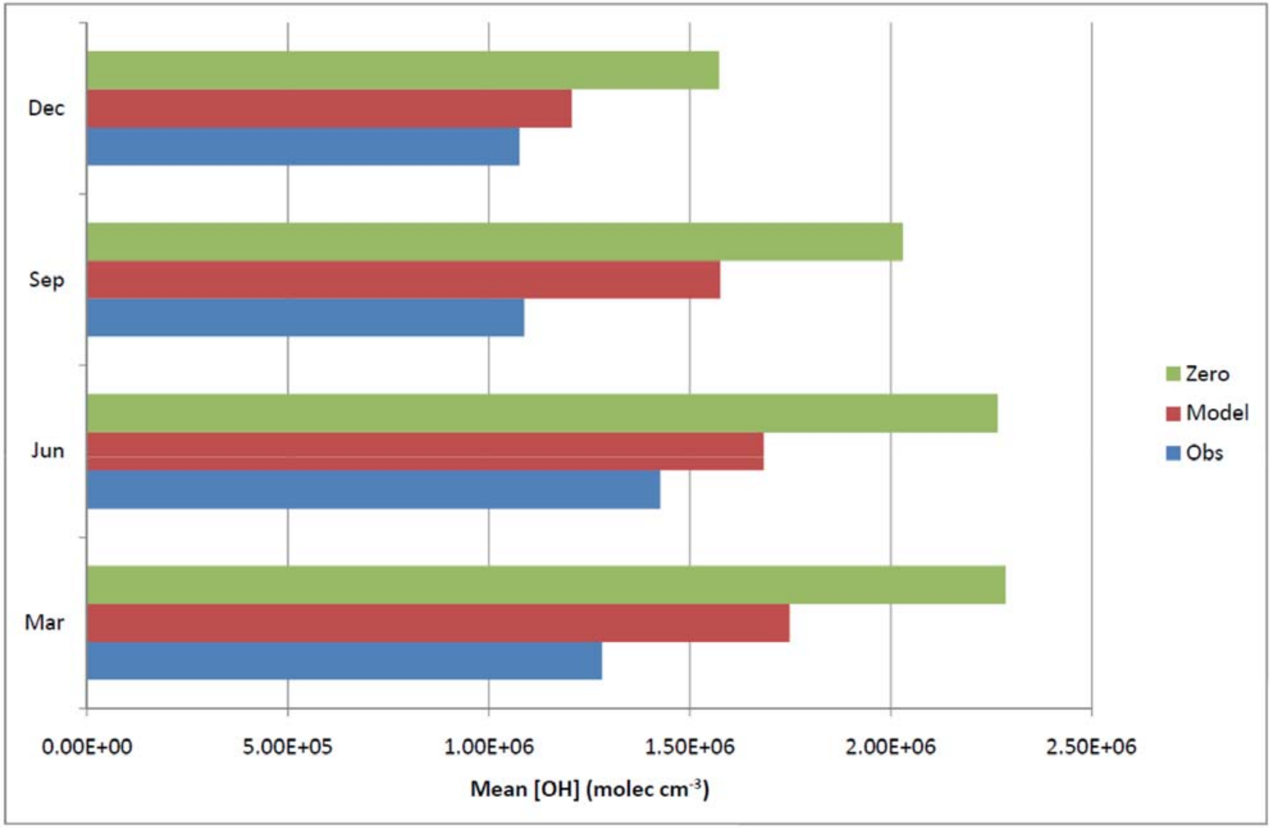
Impact of OVOCs on diurnal mean MBL [OH]

OVOC concentrations from:

(i)observations at Cape Verde

(ii)monthly-mean CAM-Chem model output including ocean fluxes

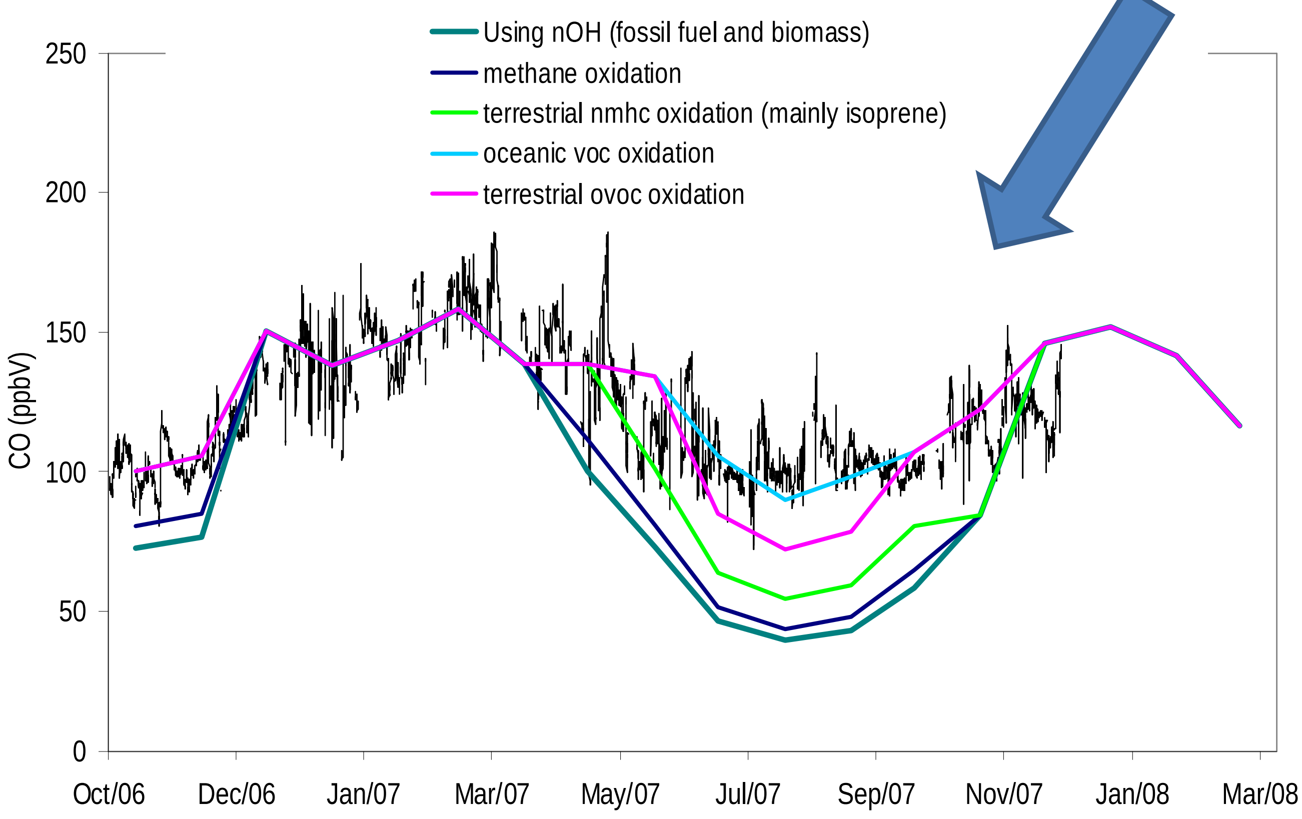
(iii)set to zero



CittyCat box model simulations

Indirect impact: OVOC as sources of CO

	Additional % contribution from summer CO emission sources not shared by ethane	Reference
Methane oxidation	5 % (May-October)	Granier et al., 2000
NMHC oxidation	12 % (May-October)	Granier et al., 2000
Terrestrial oVOC oxidation	20 % (June-November)	Miller et al., 2008
Oceanic NMVOC oxidation	20 % (July-September)	Guenther et al., 1995



Conclusions

- Oxygenated VOCs are a significant direct sink of OH in the MBL
- Their abundance in the remote marine environment is underestimated (particularly CH_3CHO)
- Marine and biological terrestrial sources of OVOCs could explain some of this model underestimation – more work required to establish emission strength and variability
- >C3 alkanes and alkenes – chemistry and emissions

Acknowledgements

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NATURAL ENVIRONMENT RESEARCH COUNCIL

solas
surface.ocean lower.atmosphere.study

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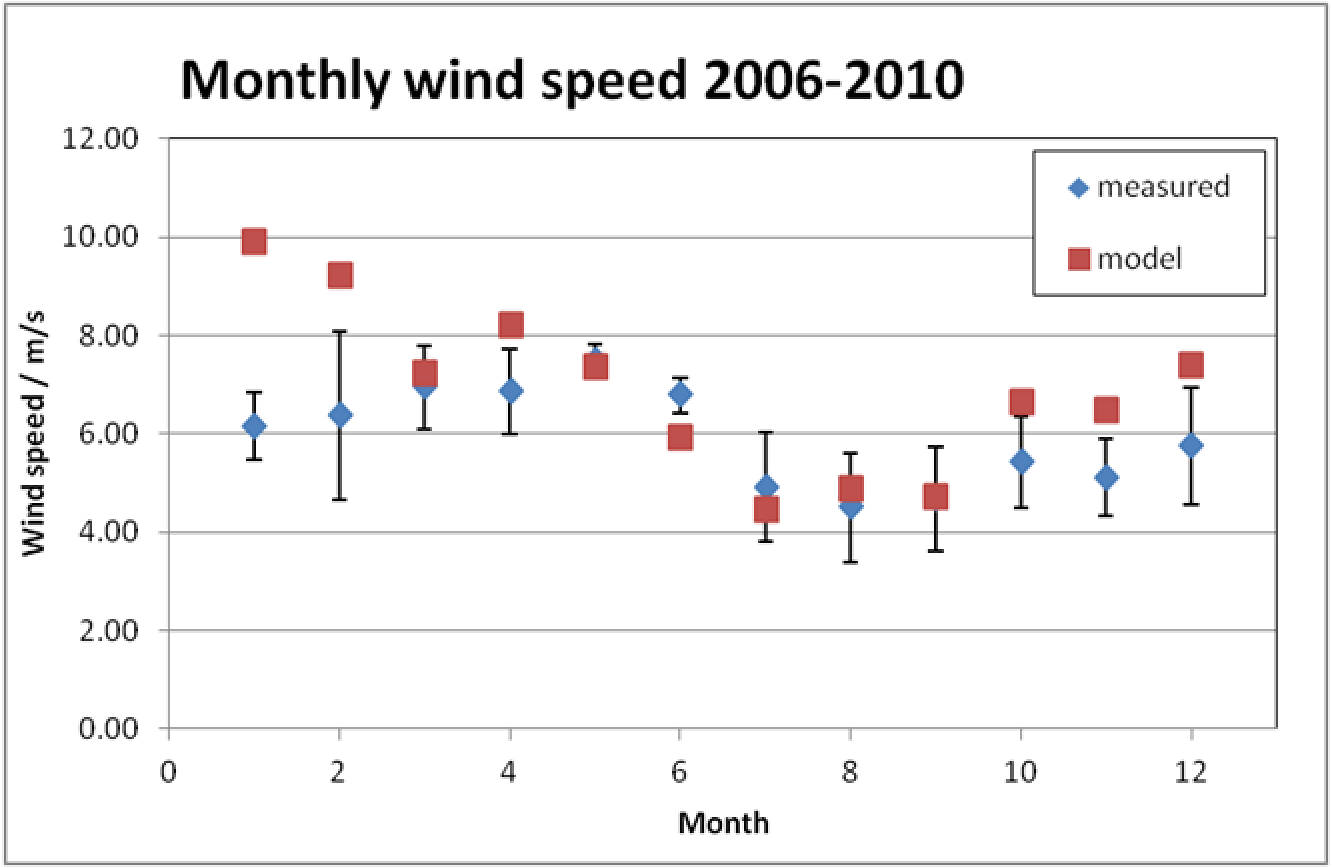
Helder Lopez

meteo.CV

Modelled (GEOS-5) and measured wind speed



•With a squared wind dependence for sea-air fluxes, the difference between 10 m s^{-1} and 6 m s^{-1} is a factor ~3.