



THE THIRD WORKSHOP ON ATMOSPHERIC COMPOSITION AND THE ASIAN SUMMER MONSOON (ACAM)

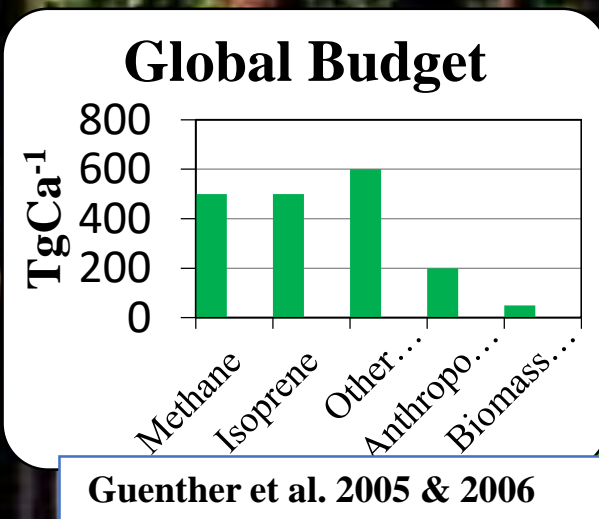


Evidence for high biogenic isoprene emissions in the North-Western Indo-Gangetic plain



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INDIA

Importance of Isoprene



Atmospheric chemistry relevance

1. Reactivity is important for ozone and air quality
2. Isoprene chemistry can affect atmospheric oxidizing chemistry

Major oxidation products

The dominant first generation oxidation products of isoprene are formaldehyde, MVK and MACR.

Why do plants emit isoprene?

1. Thermo-tolerance
2. Oxidative stress tolerance
3. Plant defense

Isoprene

India

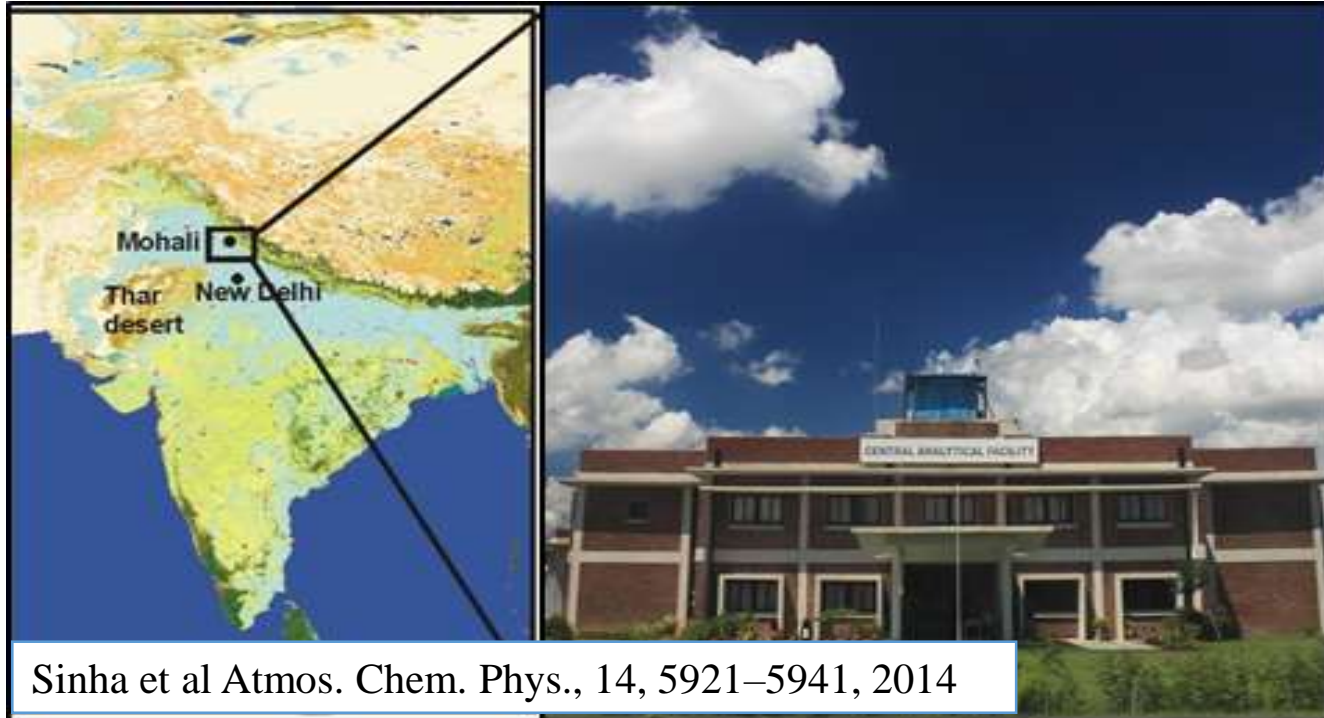
Ambient Isoprene measurements commenced only from August 2011 (Sinha et., al 2014)

Objectives

- What are the **ambient isoprene concentrations** in the north-west IGP?
- What is their diel and seasonal **variability over a full year**?
- What are the drivers of high daytime biogenic isoprene?
- How realistically does **WRF-CHEM** simulate ambient isoprene measurements?

V. Kumar, V. Sinha IJMS,374 (2014) 55–63

Data set used: **March 2012 to February 2013**



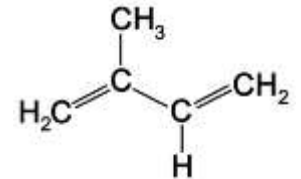
Sinha et al Atmos. Chem. Phys., 14, 5921–5941, 2014

Proton Transfer Reaction-Mass spectrometer (PTR-MS)

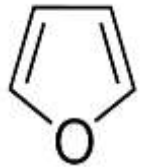
VOCs



Isoprene

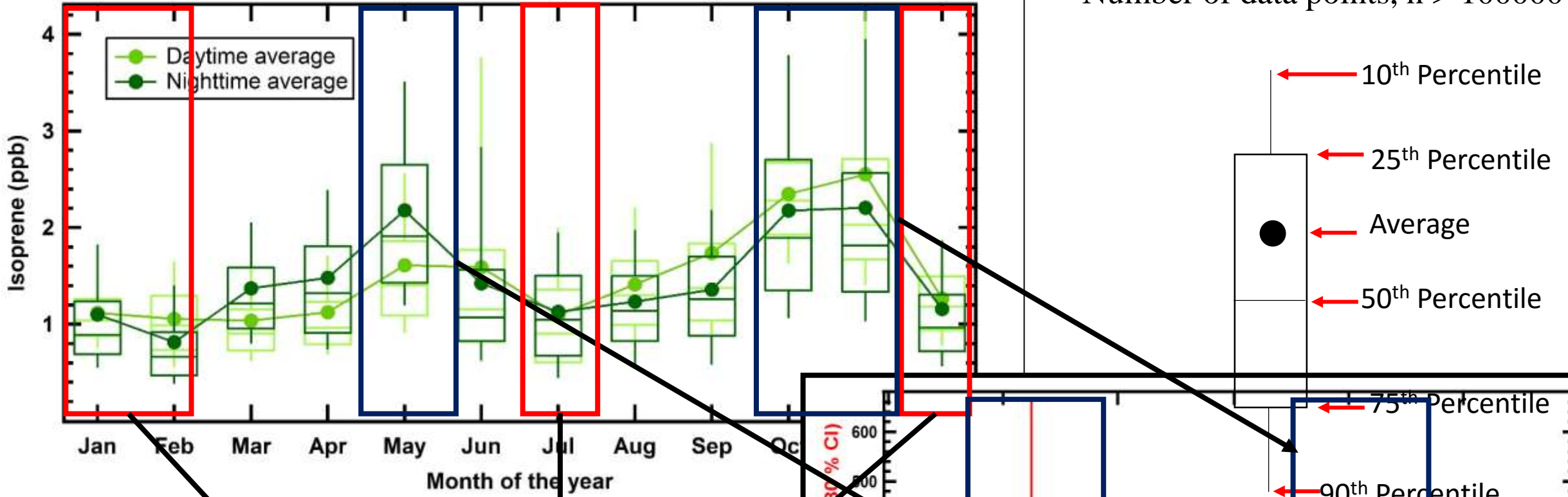


Furan

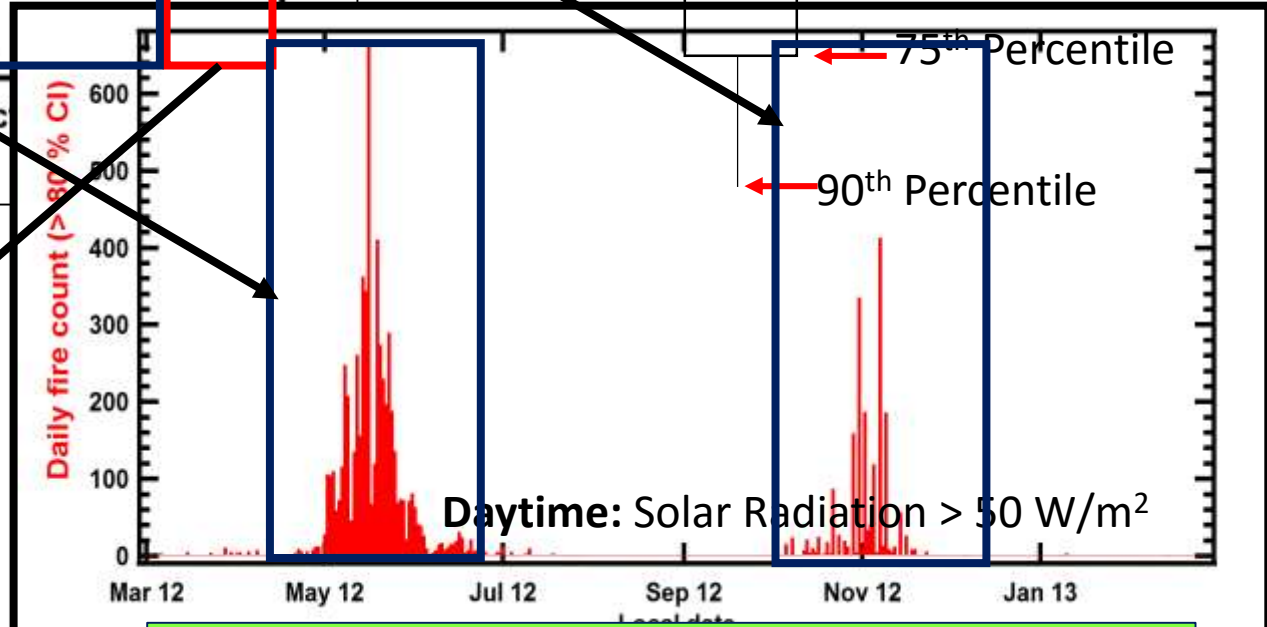


What are the ambient isoprene concentrations in the north-western IGP?

Number of data points, $n > 100000$



Less solar radiation
=> Less Isoprene

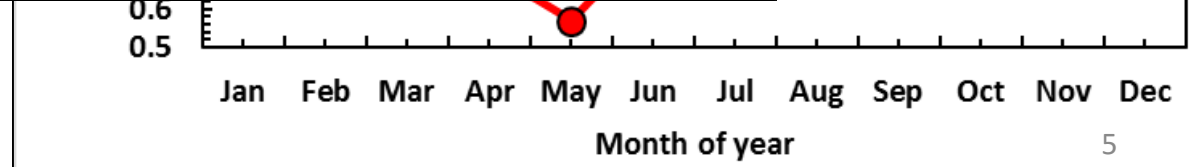
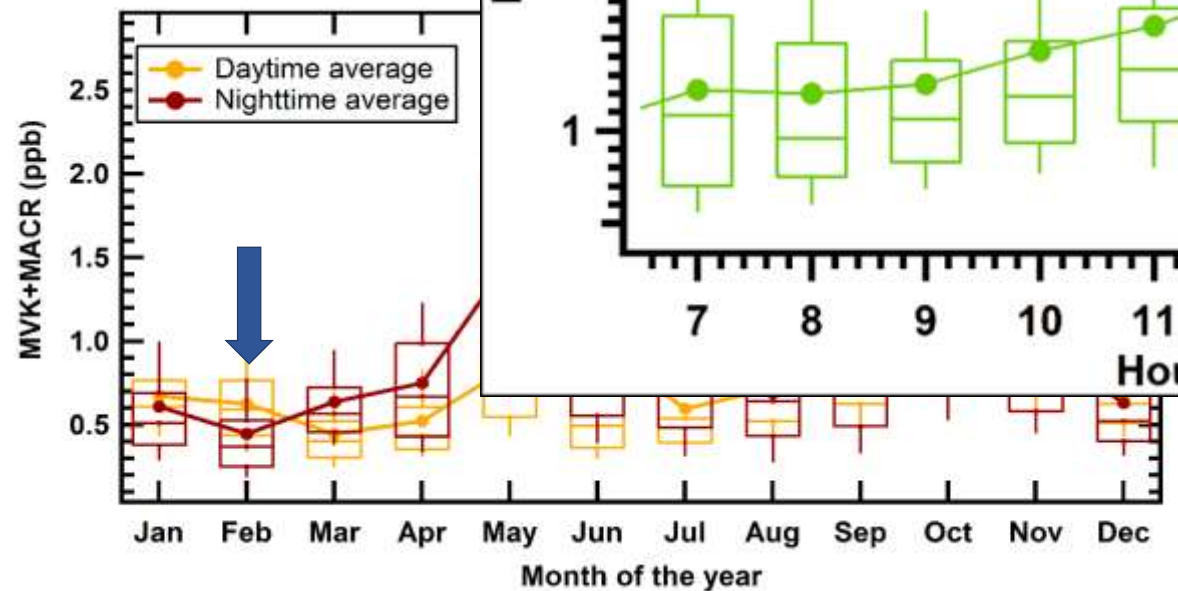
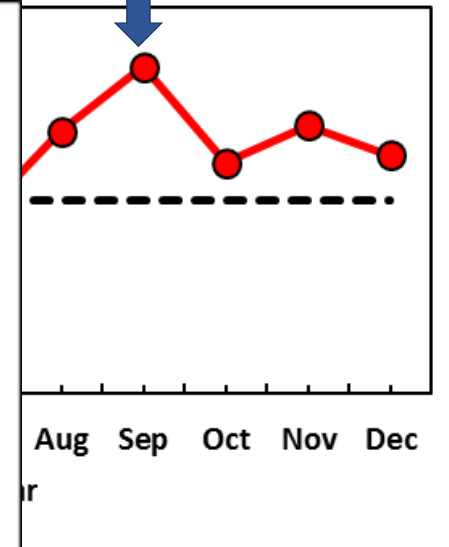
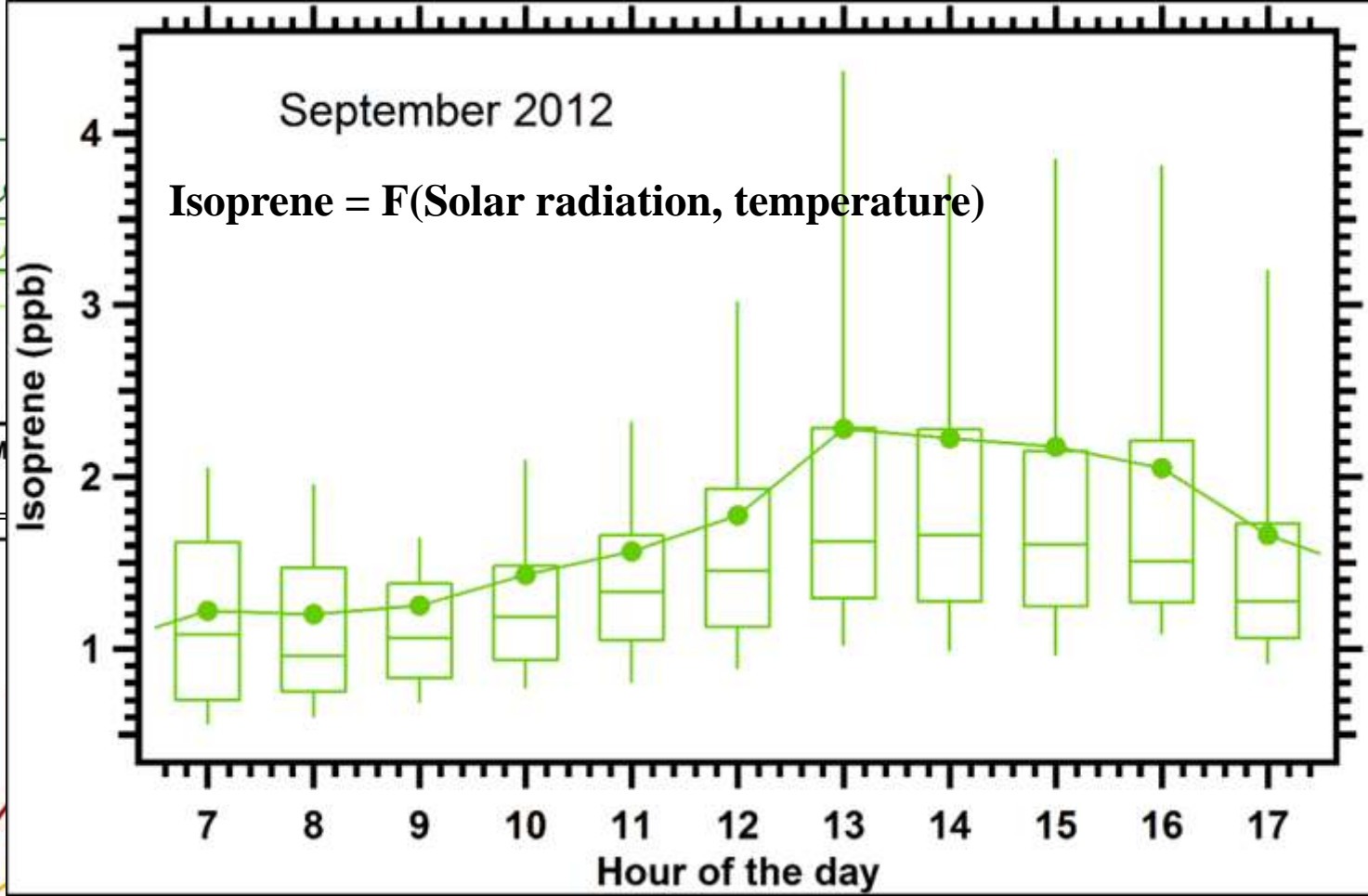
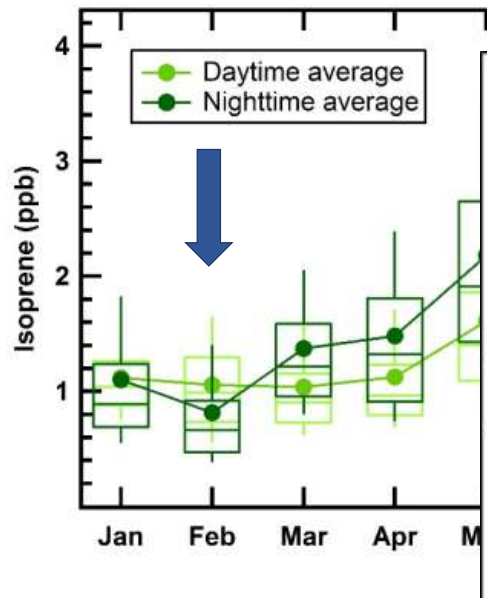


Daily fire-count data from 1 Mar 2012-28 Feb 2013

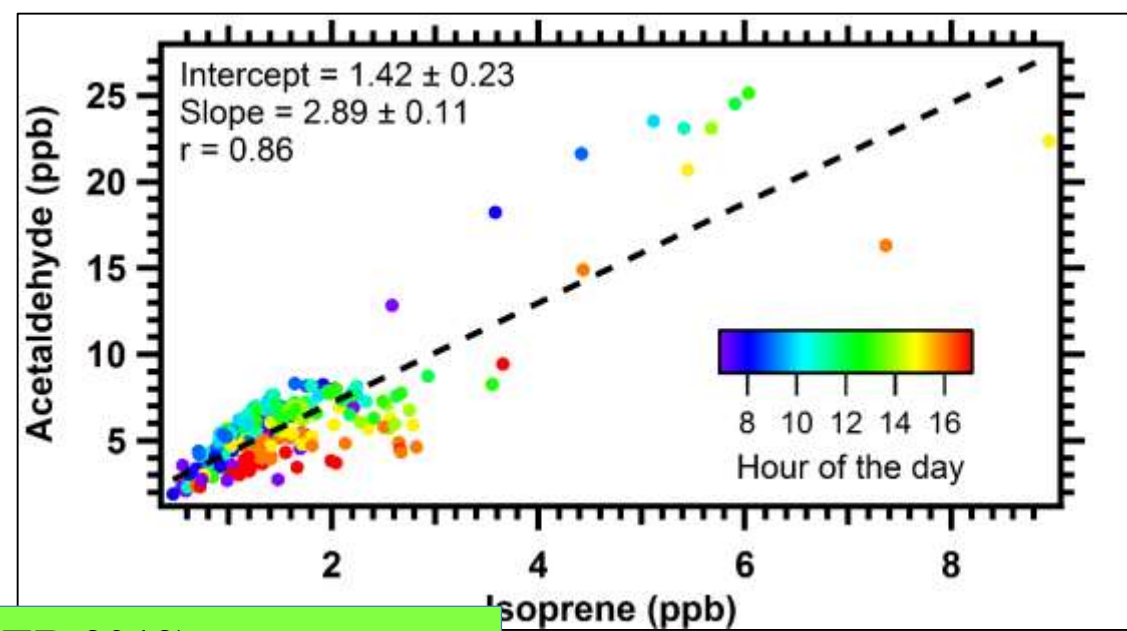
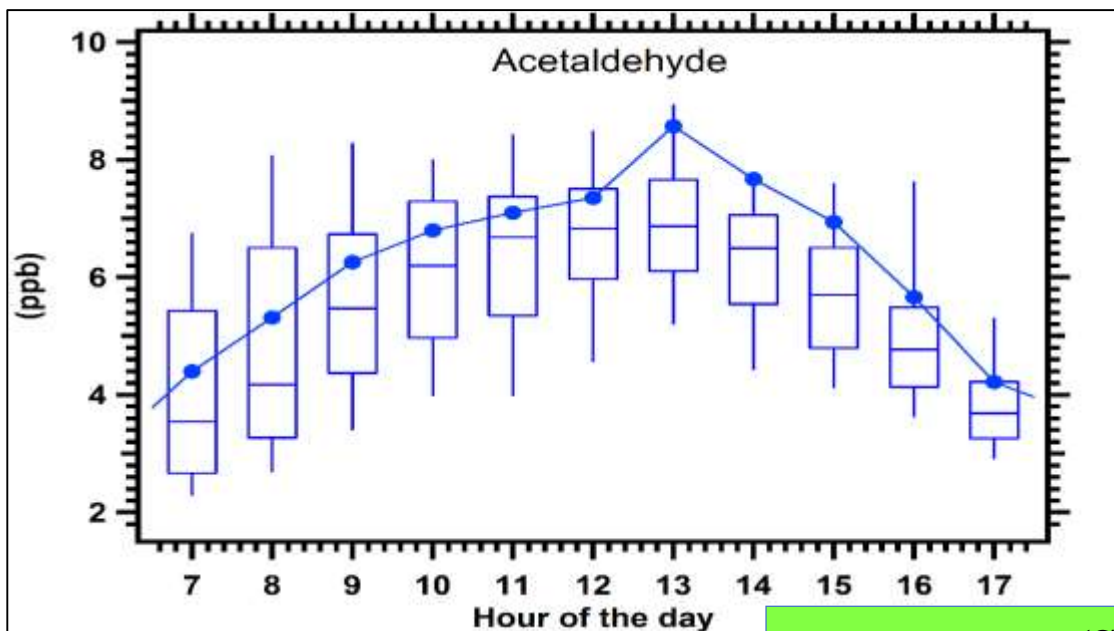
Kumar et., al, J. Geophys. Res. Atmos., 121,
doi:10.1002/2015JD024308.

Biogenic Isoprene Emissions: Month-wise daytime/nighttime concentration ratio

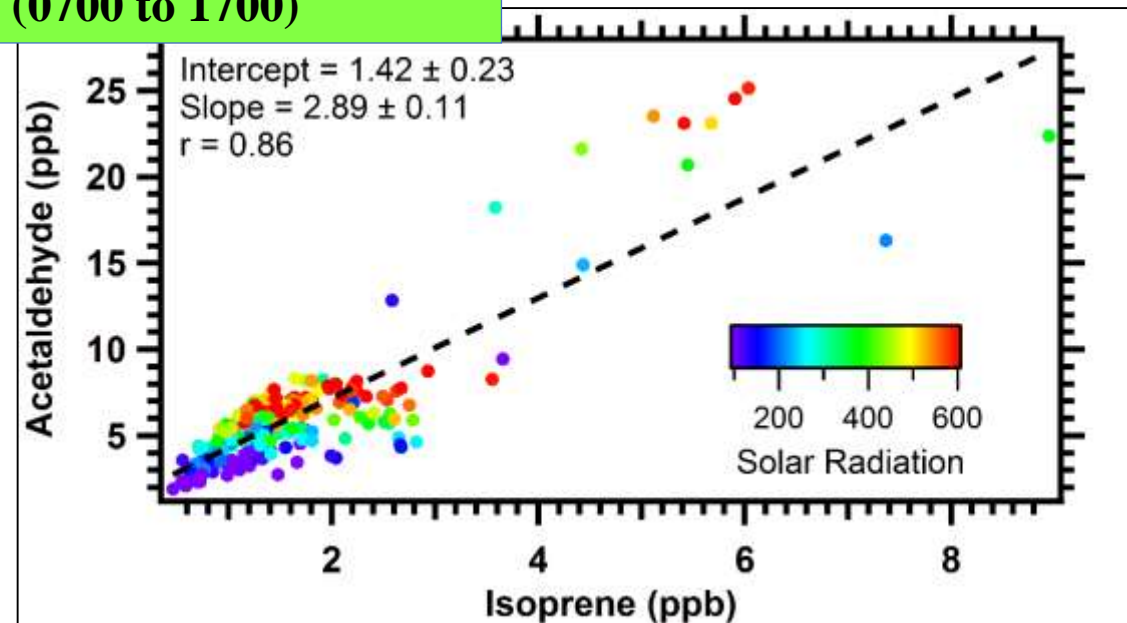
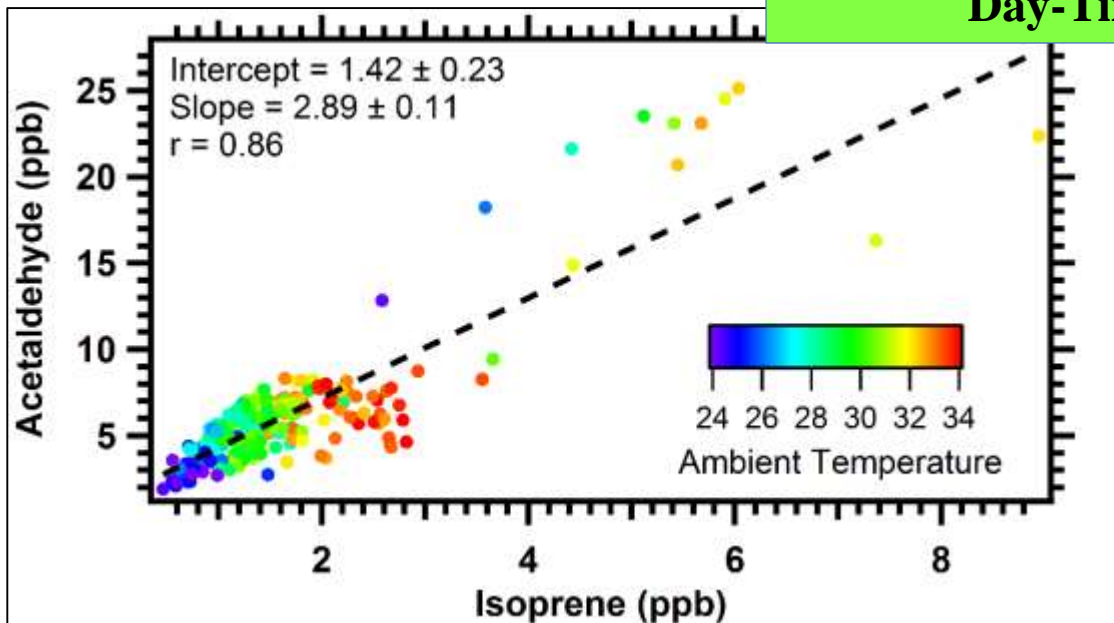
Ratio of Day & Night time mean Isoprene concentration



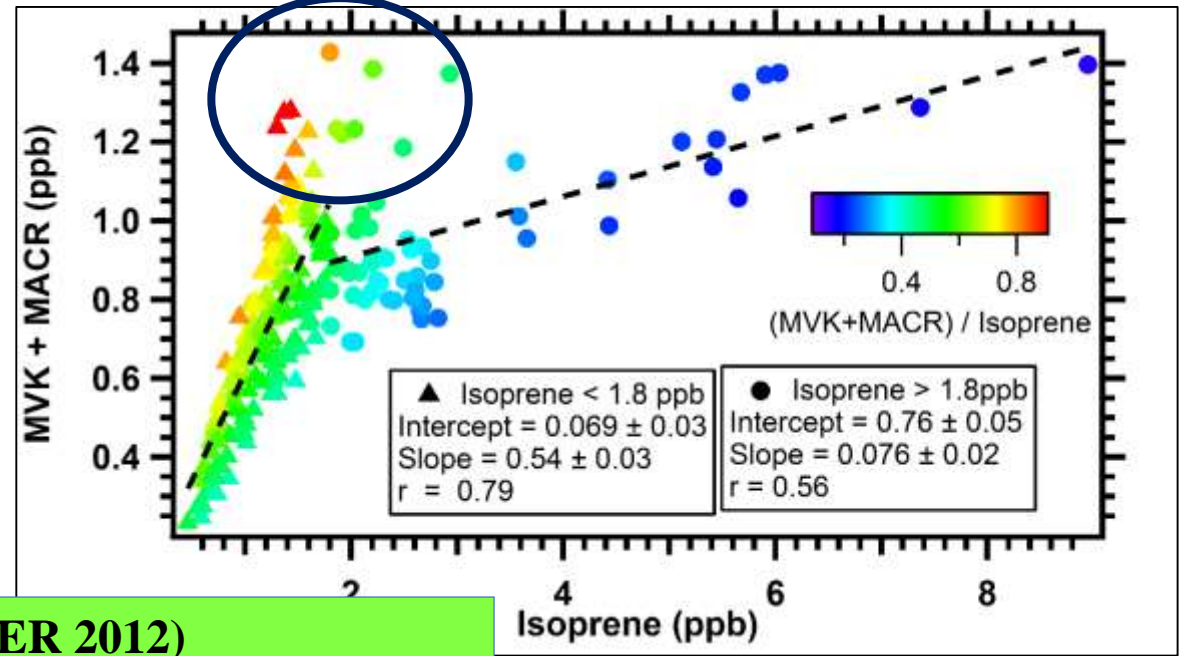
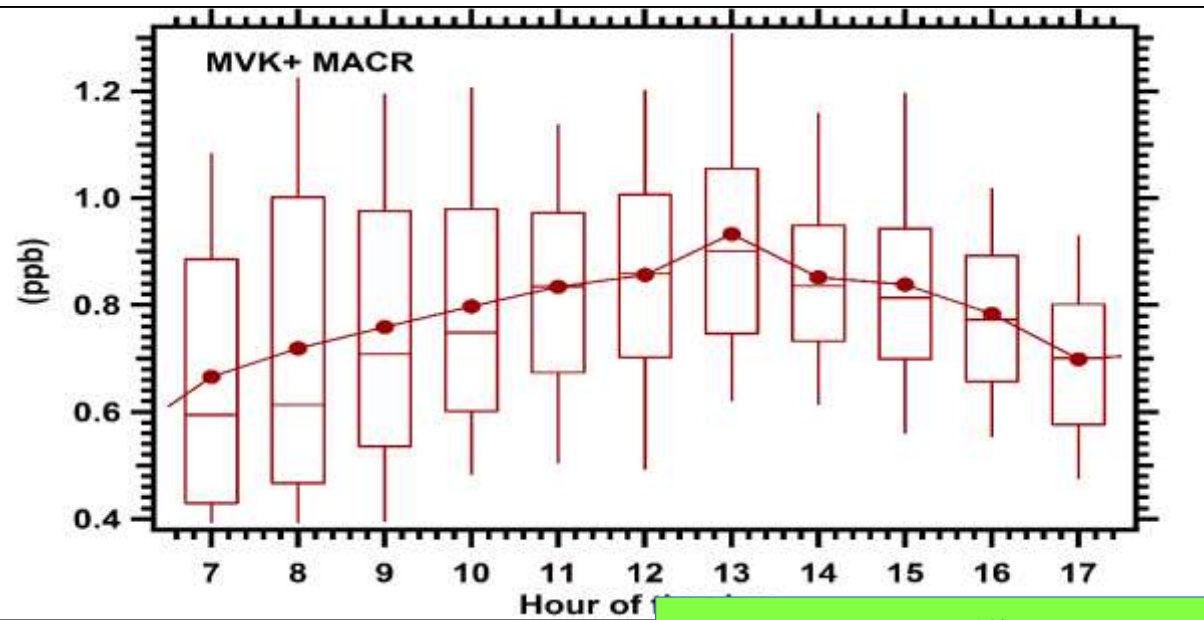
Profile of another VOC which can be co-emitted biogenically from leaves: Acetaldehyde



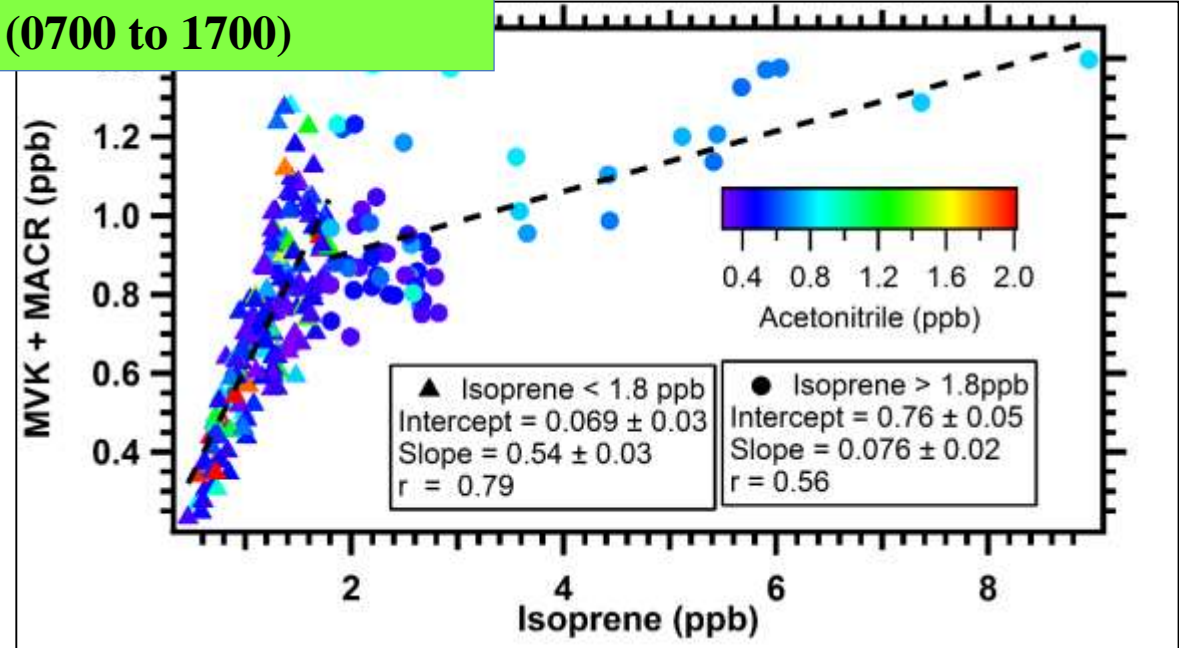
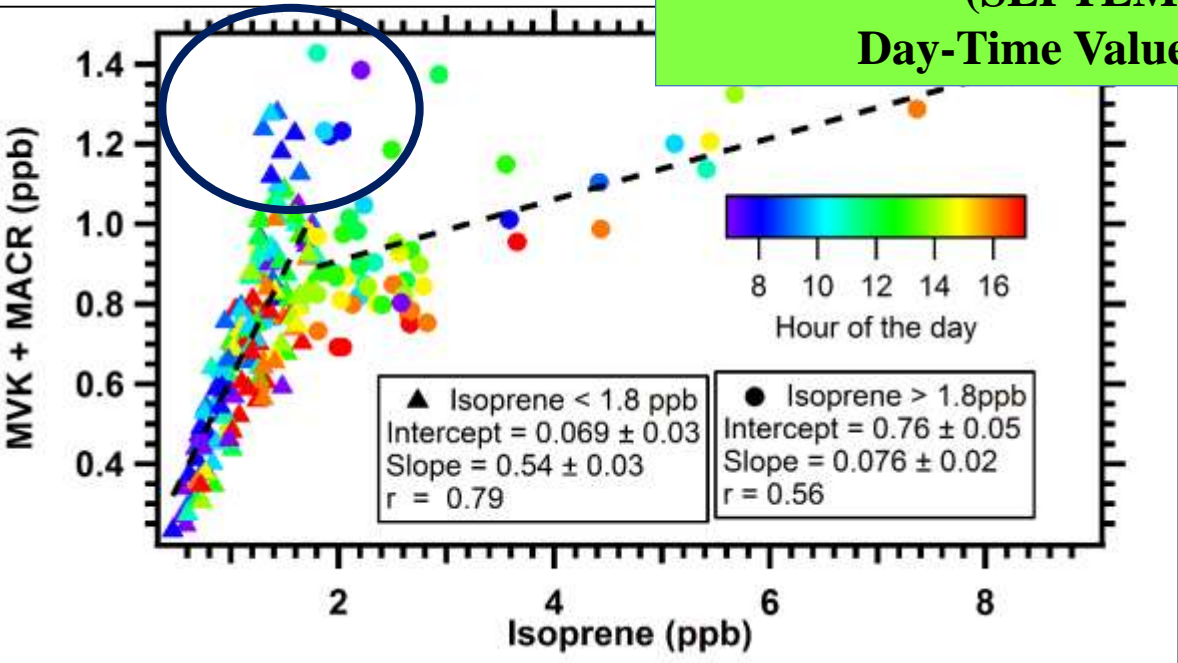
(SEPTEMBER 2012)
Day-Time Values (0700 to 1700)



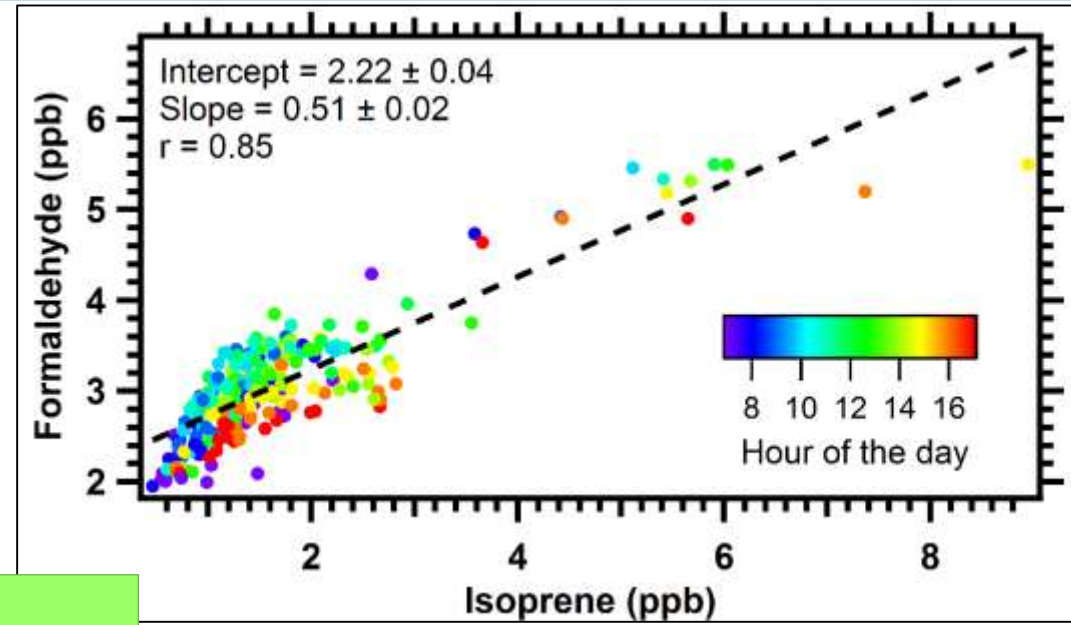
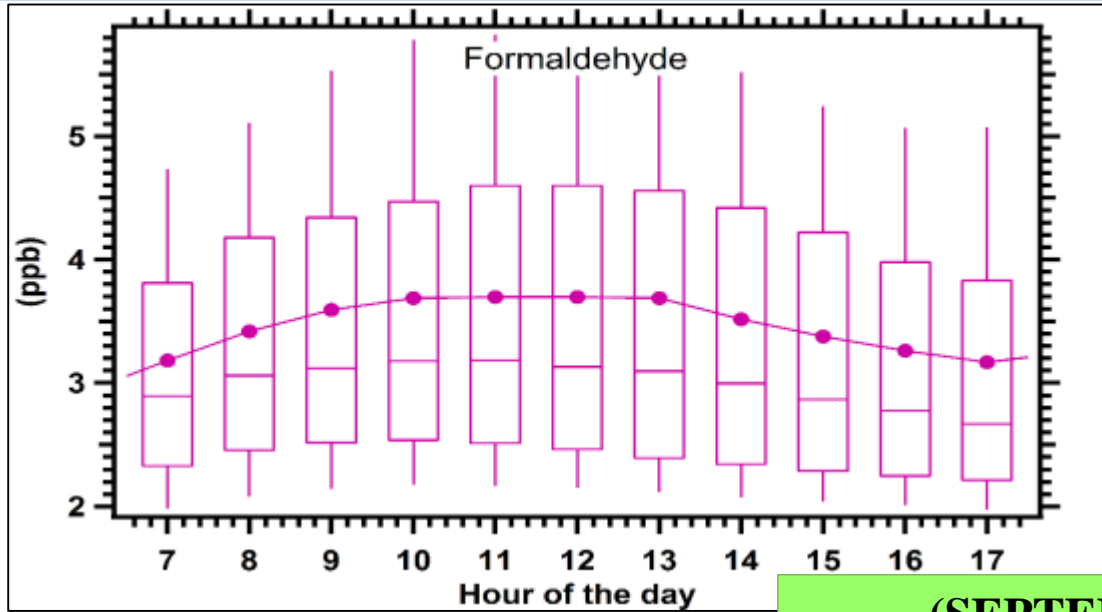
Isoprene and its major daytime oxidation products: MVK+MACR



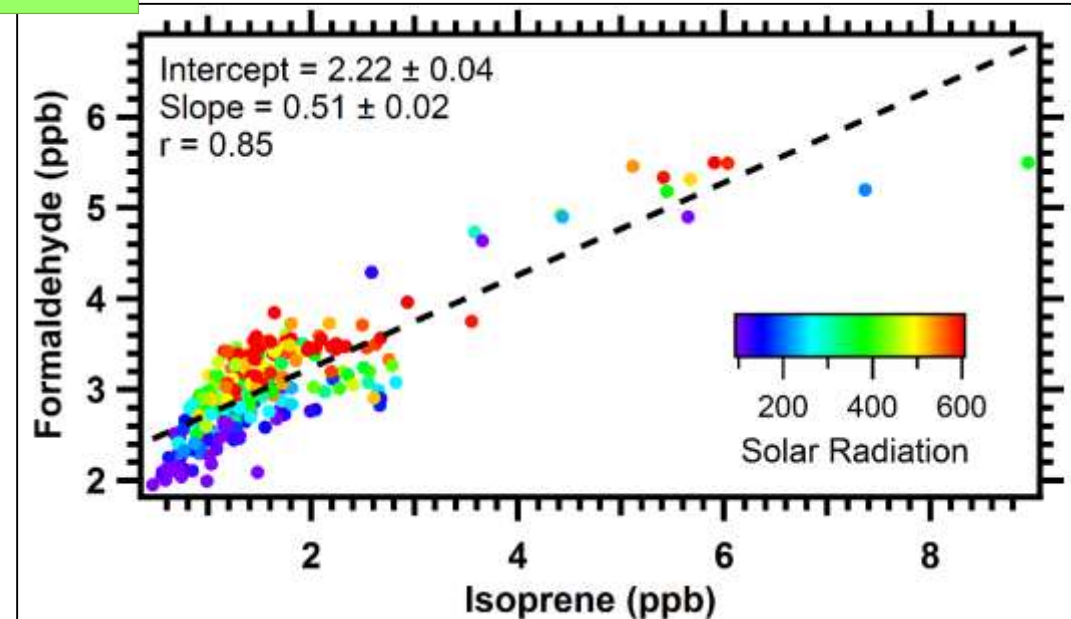
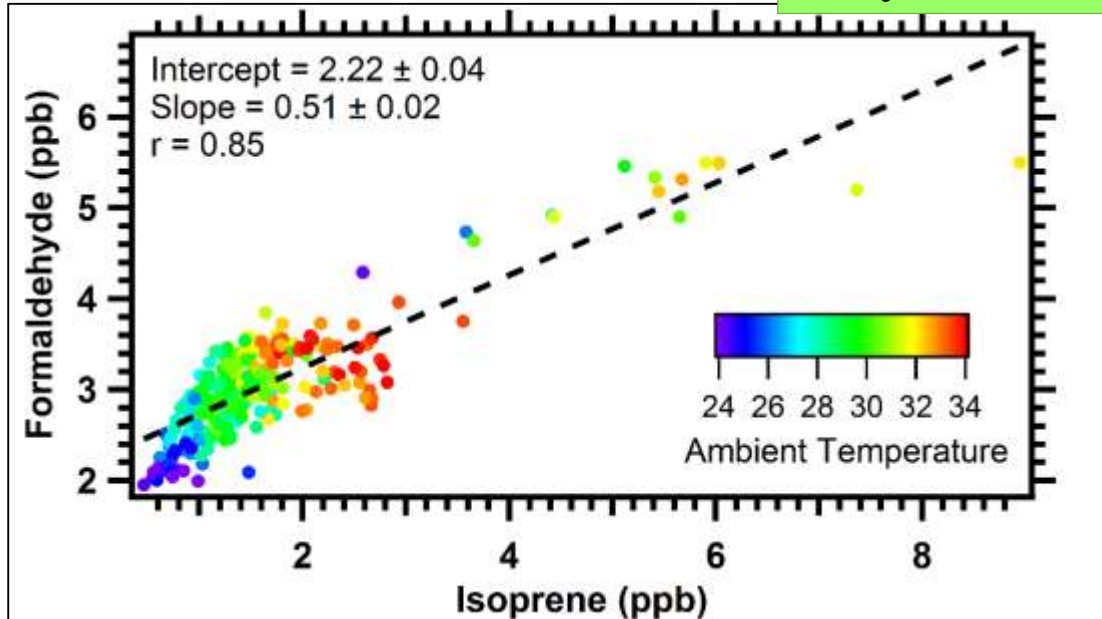
(SEPTEMBER 2012)
Day-Time Values (0700 to 1700)



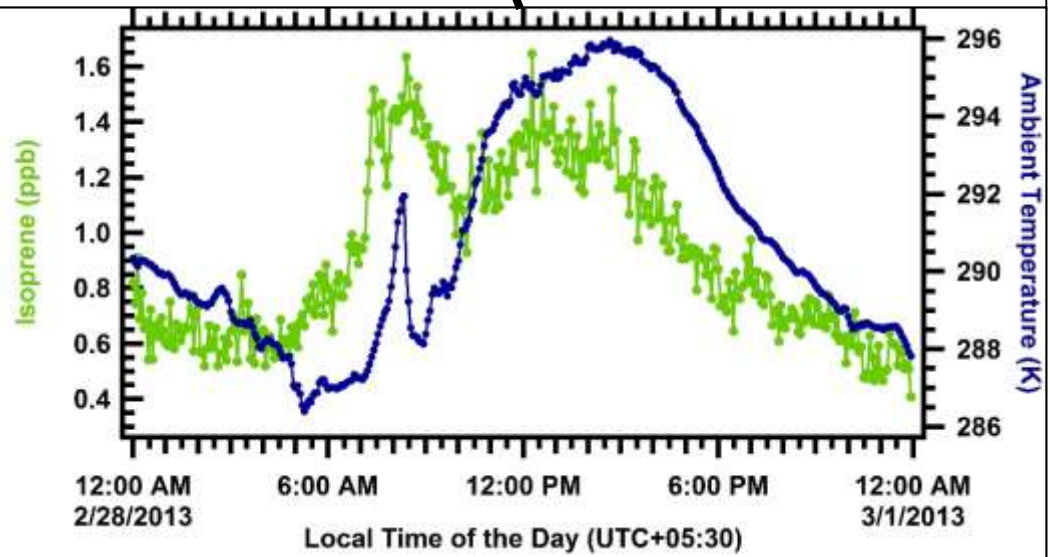
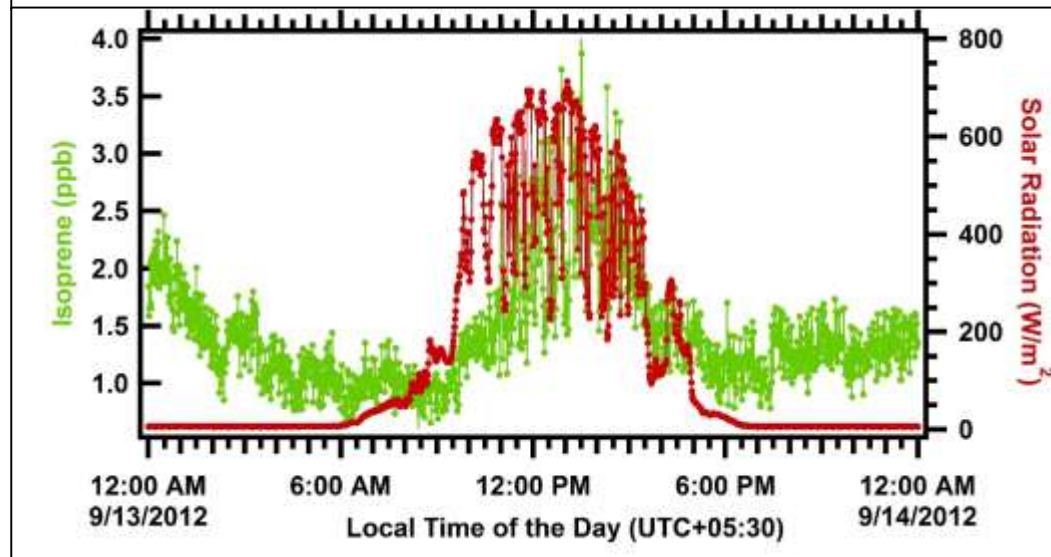
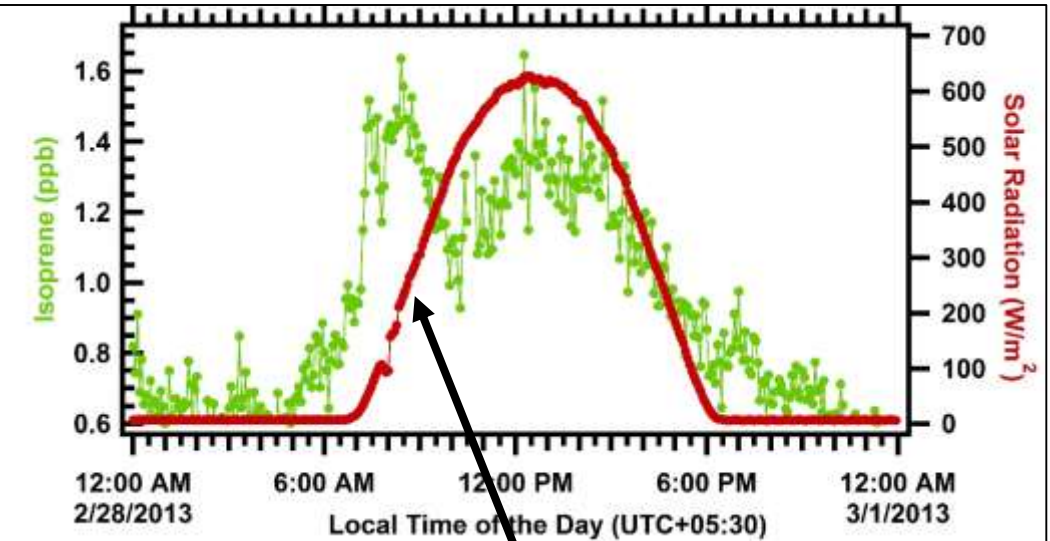
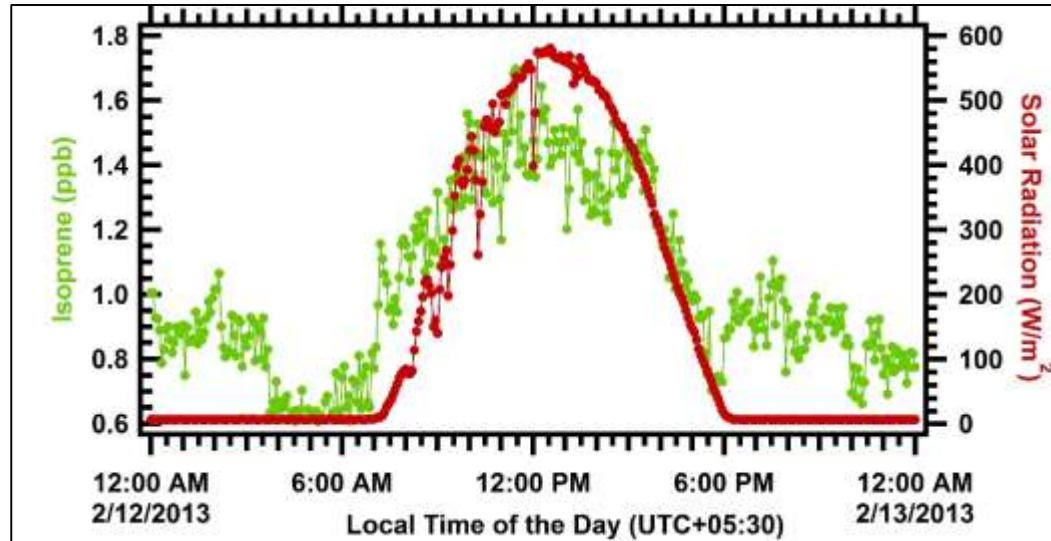
Analysis of an oxidation product of isoprene : Formaldehyde



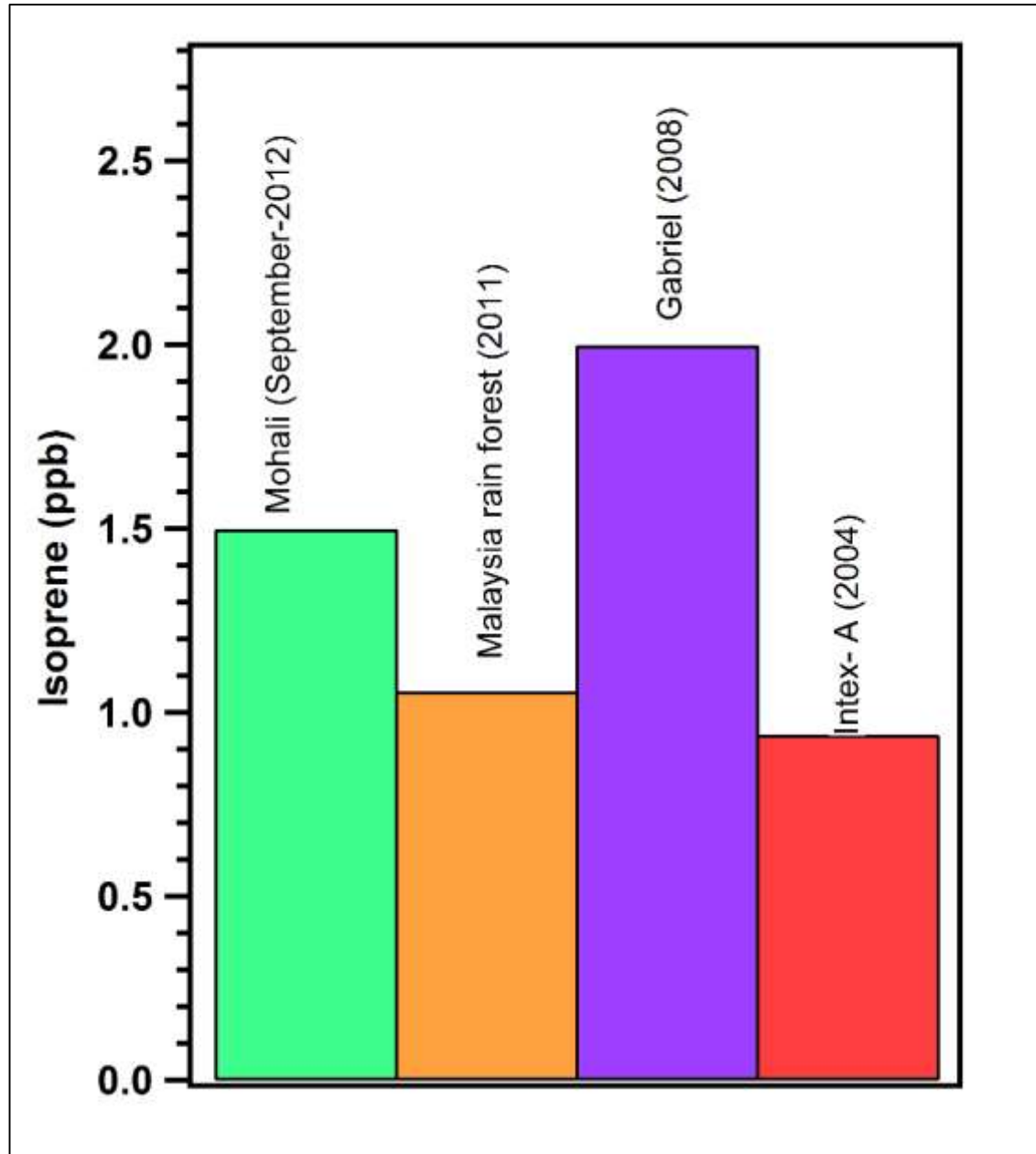
(SEPTEMBER 2012)
Day-Time Values (0700 to 1700)



Drivers of ambient bioogenic isoprene concentrations: Radiation and temperature



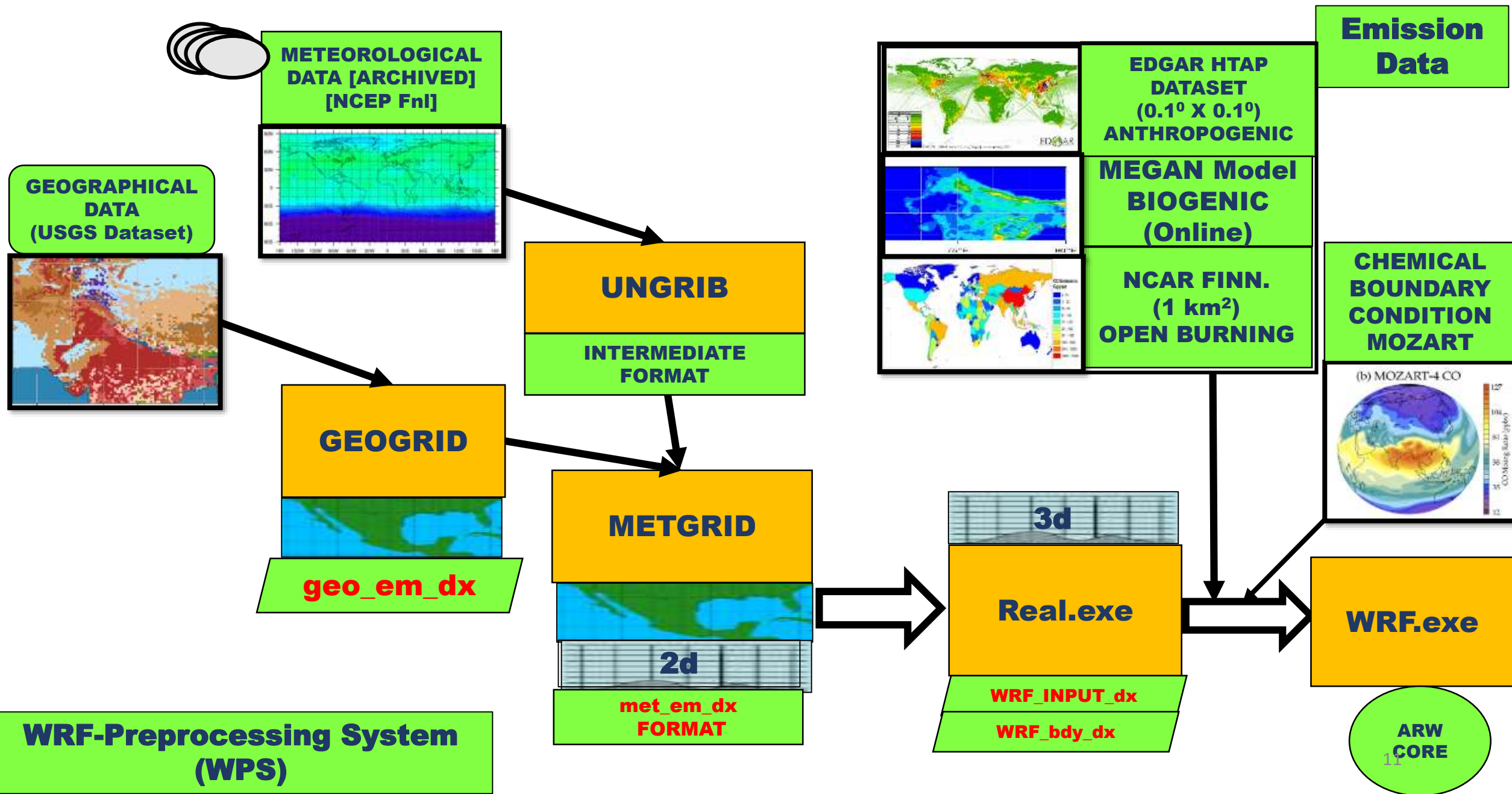
Comparison of ambient isoprene mixing ratio with other sites



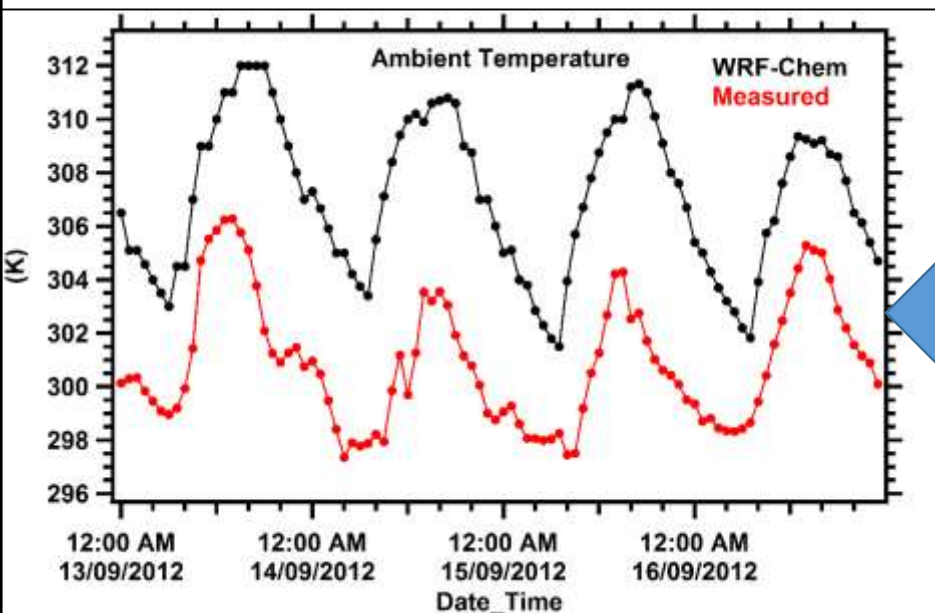
C. E. Jones et,al Atmos. Chem. Phys., 11, 6971–6984, 2011

Butler et,. al Atmos. Chem. Phys., 8, 4529–4546, 2008

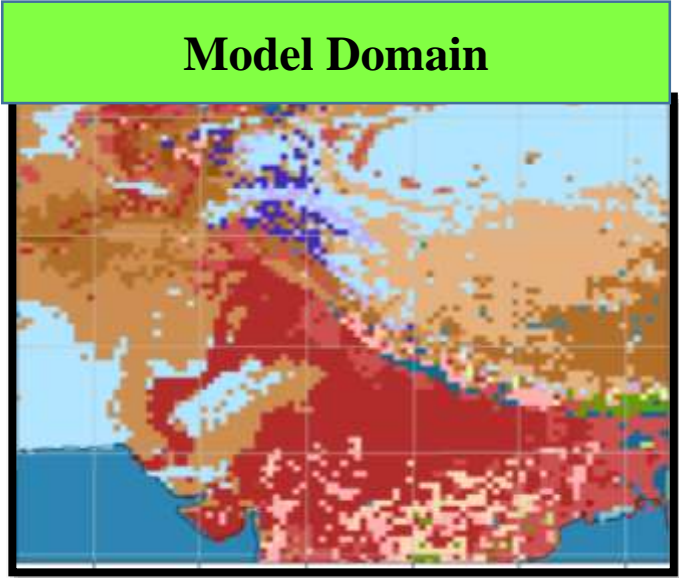
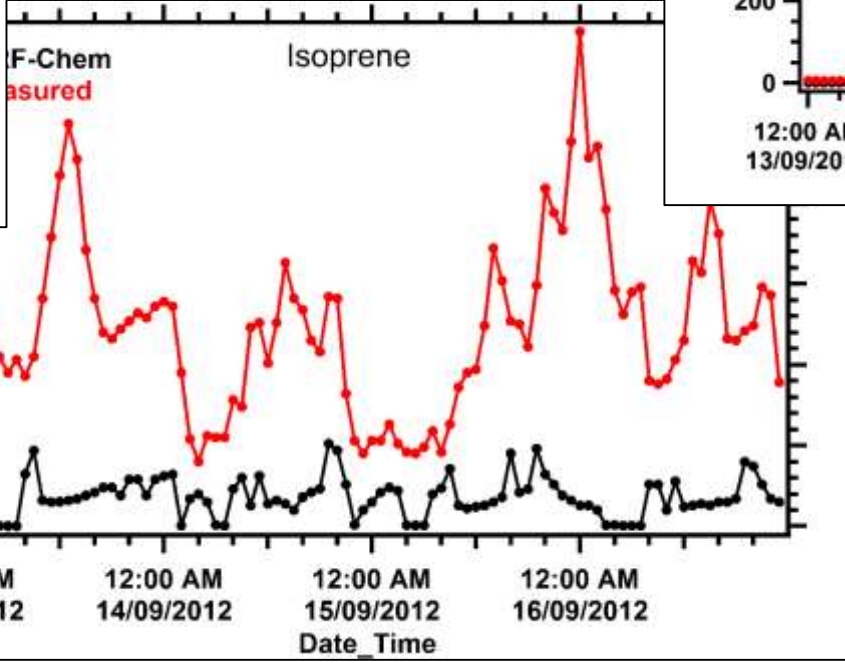
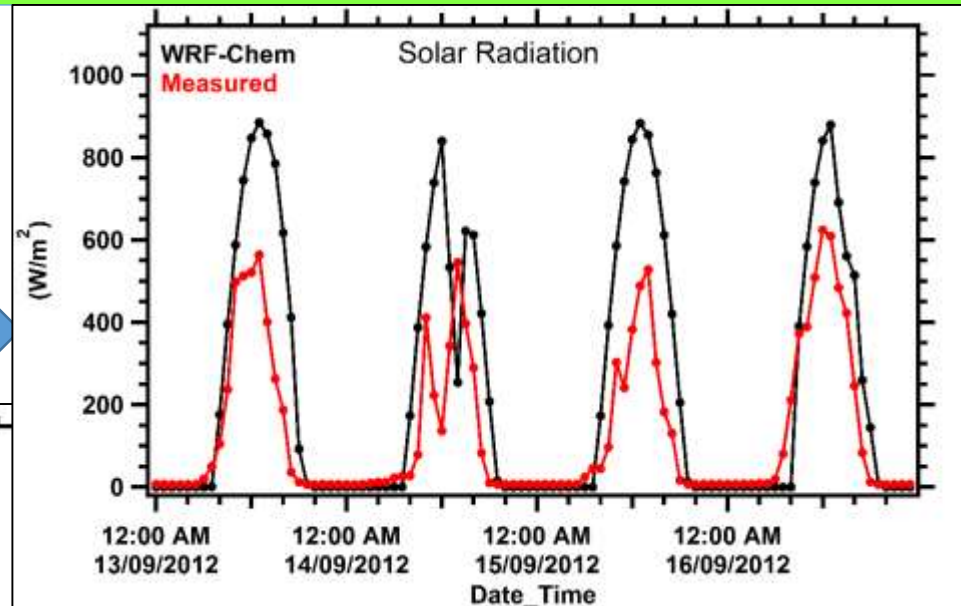
WRF-CHEM



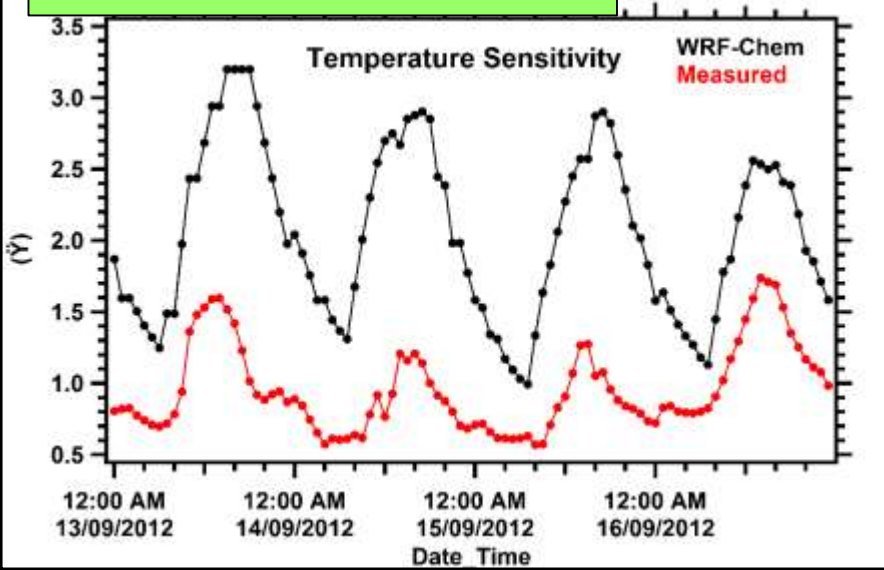
WRF-CHEM simulation of ambient levels of isoprene



Driving factors



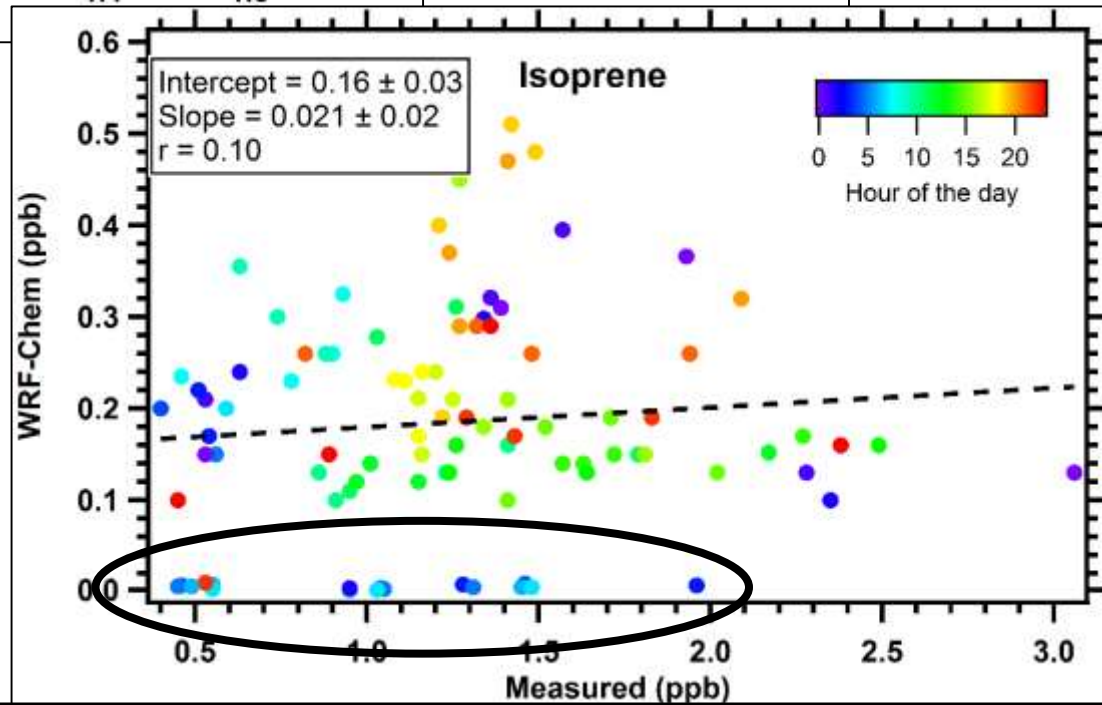
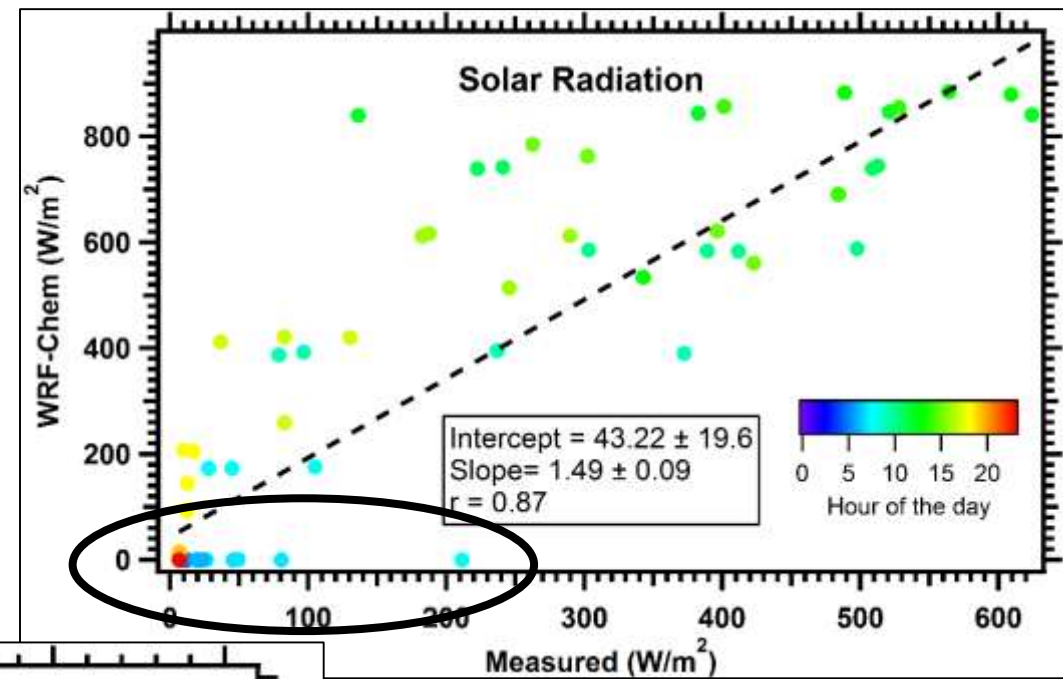
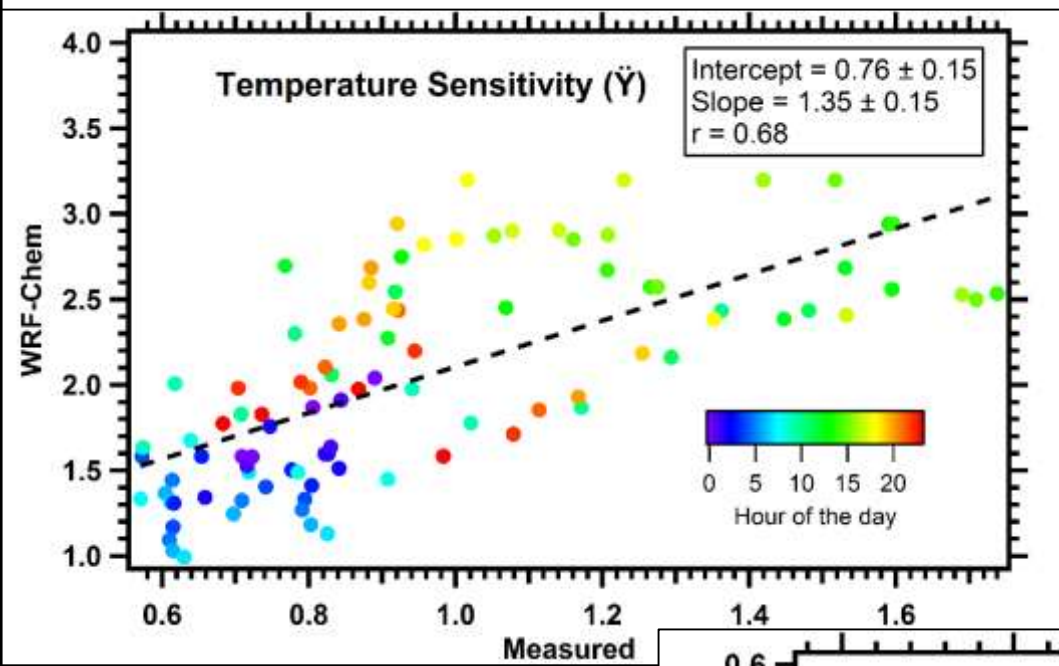
Eq. (5,8 & 14) Guenther et al., 2006



Driving factors

Model vs Measurements

Comparison (WRF-CHEM model vs measurements)



Eq. (5,8 & 14) Guenther et al., 2006

Take home message

Months of February & September exhibit higher emissions of biogenic isoprene

Major oxidation products were consistent with daytime emissions of biogenic isoprene

Ambient isoprene concentrations are comparable to those reported from forested sites

WRF-CHEM underestimates ambient isoprene emissions at our site

ACKNOWLEDGEMENTS



Dr. Vinayak Sinha



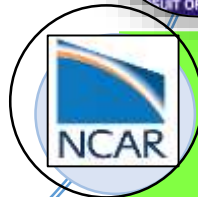
ACAM and all organizers



Dr. Bärbel Sinha and all my group members



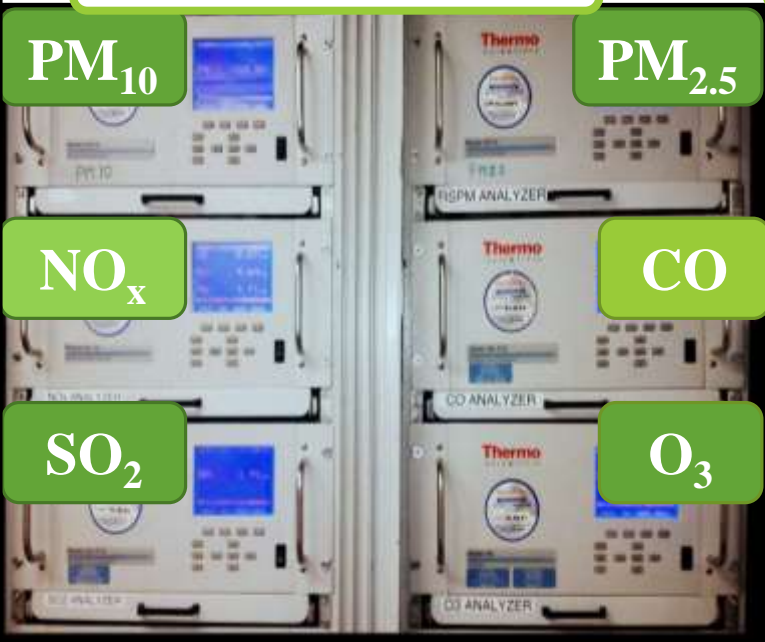
IISER Mohali



Dr. Rajesh Kumar and Dr. Mary Barth for help in setting up WRF-CHEM

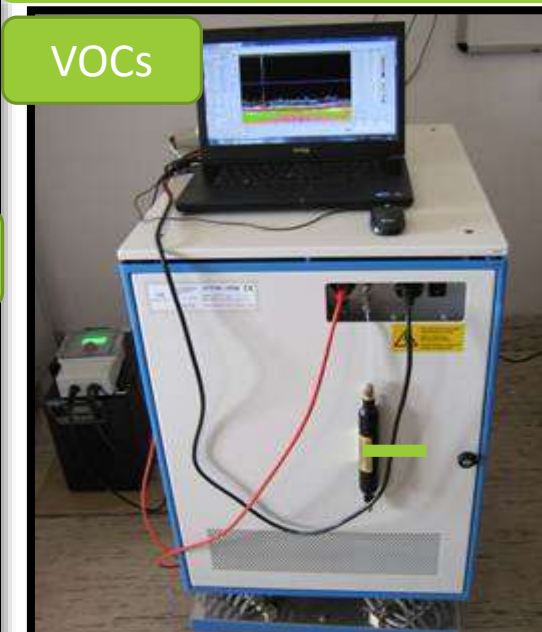
IISER Mohali Atmospheric Chemistry Facility

Air Quality Station



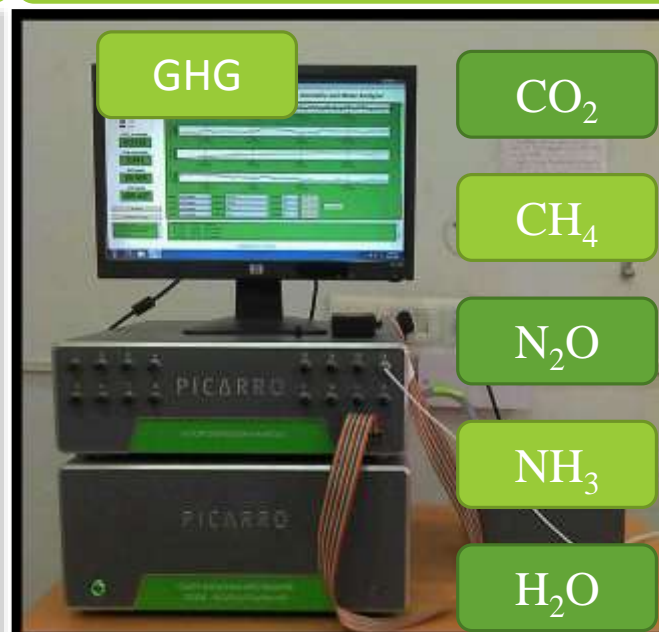
Aug 2011

(PTR-MS)



Aug 2011

CRDS



Oct 2015

TD GC FID



2016

Thank you

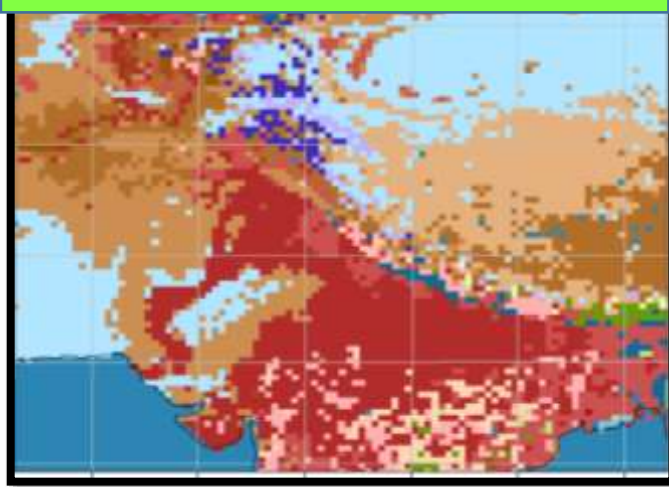
For further information visit: <http://14.139.227.202/faculty/vinayak/index.php/vsinha>

For data request: vsinha@iisermohali.ac.in



Simulation details

Model Domain



WRF Version-3.7.1

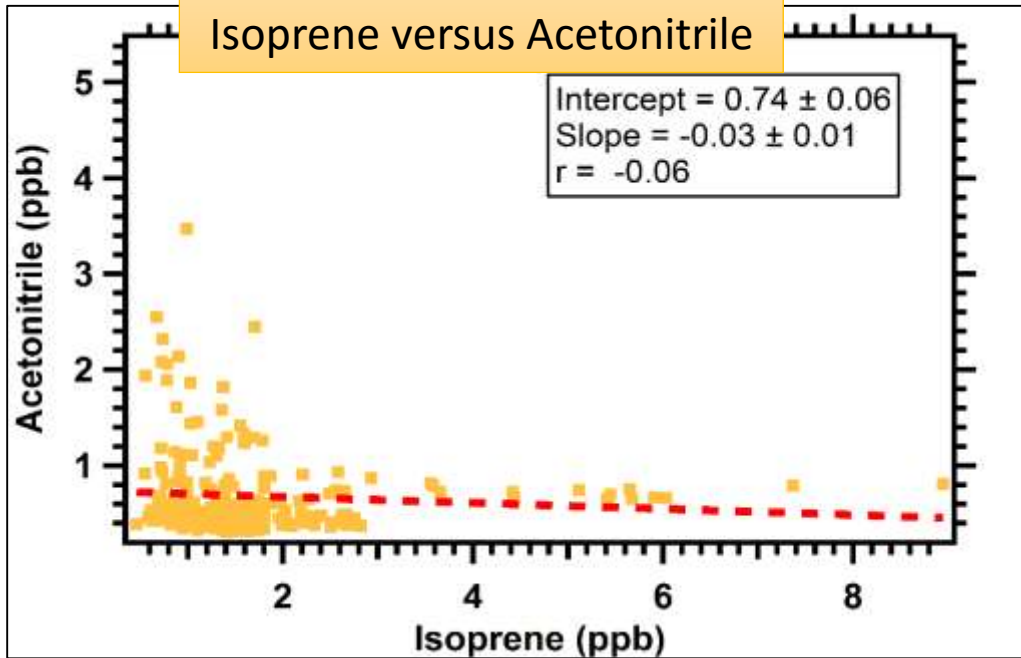
- Model domain defined on **Mercator projection**
- **90 grid points in east west direction and 120 grid points in north south direction**
- Horizontal grid spacing of **20km X 20km**
- **51 vertical levels** (surface 10hpa ~ 30 km)
- Model spin up time: 3 days

Resolved Scale Cloud Physics	Thompson Microphysics
Convective & Shallow Cloud (Sub-grid)	Kain-Fritch Convective scheme
Long & short wave radiation transfer	RRTM (Mlawer et., 1997)
Surface Processes	NOAH land surface model
PBL Parametrization	YSU (Yonsei boundary layer scheme)

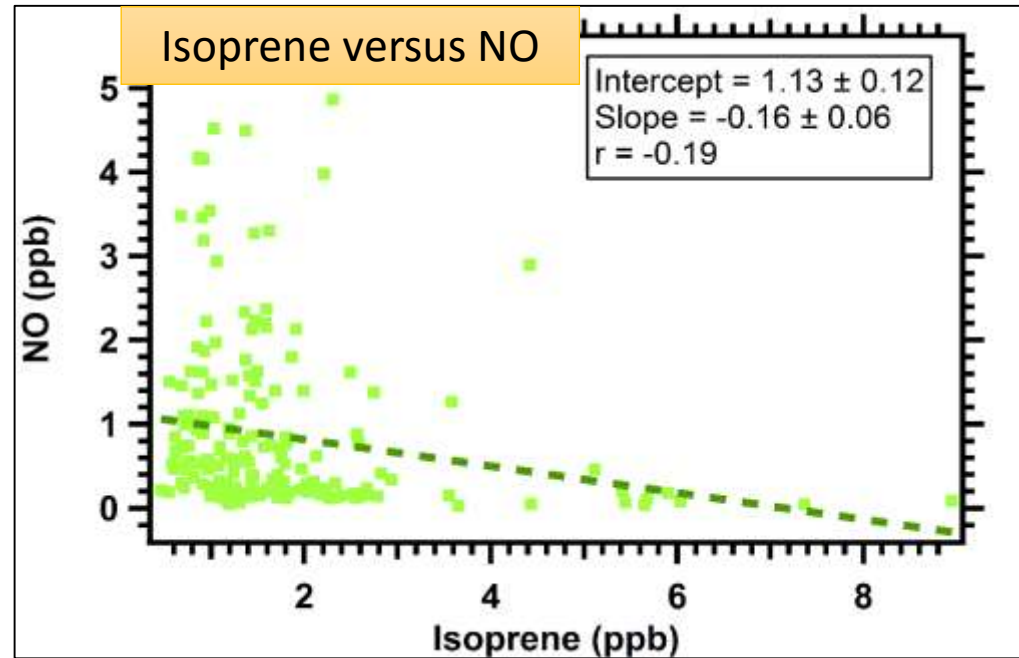
Timeline: 09th September 2012 to 17th September 2012

Correlation of daytime Isoprene with Acetonitrile, NO and CO

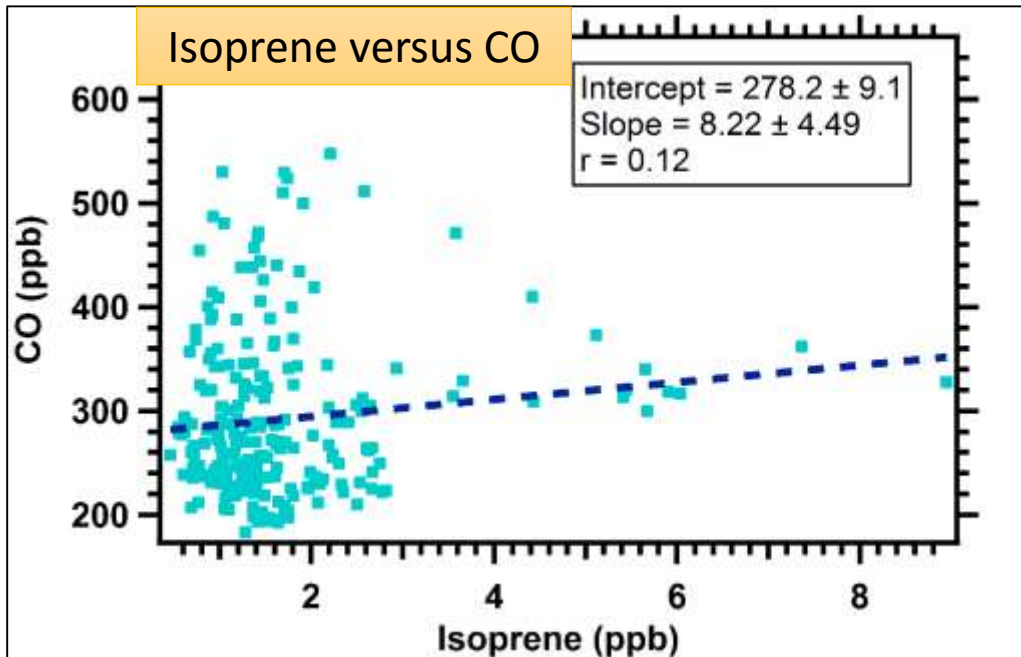
Isoprene versus Acetonitrile



Isoprene versus NO



Isoprene versus CO



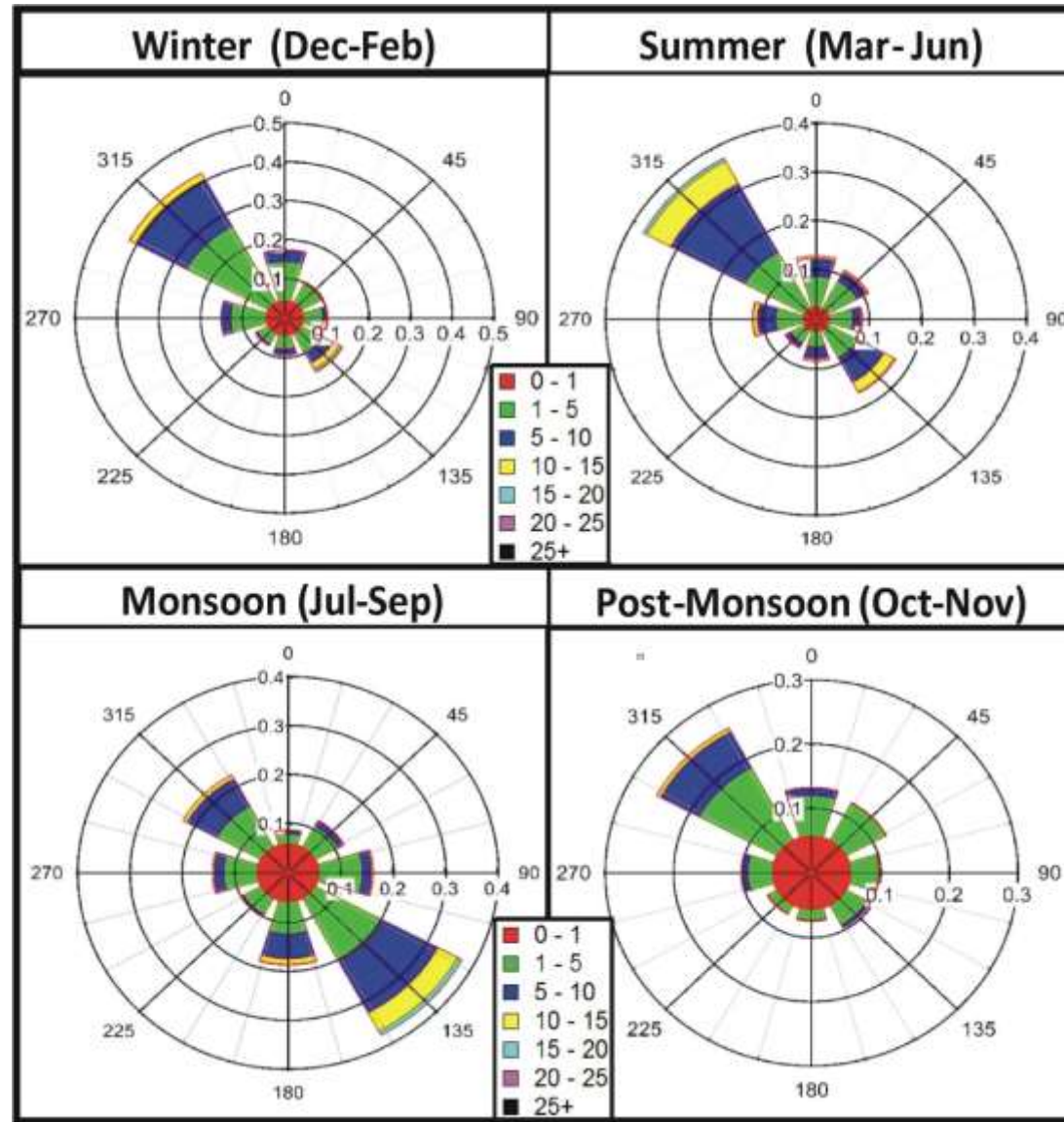
- **Poor correlation observed between daytime**
- **Isoprene (in September) with combustion tracers like CO , NO and acetonitrile**

4.5 %

31.4 %

5.2 %

38.7 %



2.5 %

48.8 %

8.7 %

19.9 %

Wind-rose plot for the period of August 2011 to June 2013.

North-west or south-east is the dominant wind direction.

Calm conditions account for < 9% in all seasons.

Rapid transport of air masses occurs frequently.

Periods of calm (Wind Speed < 1ms⁻¹) Periods of rapid transport of air masses (Wind Speed > 5ms⁻¹)

Strong dependence of isoprene concentrations on temperature and radiation

