## Aerodyne AMS Users Meeting, Lund, 24-25 August 2019

<table>
<thead>
<tr>
<th>Year</th>
<th>Meeting Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>1st/2nd AMS Users Meeting Portland / Aerodyne</td>
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<tr>
<td>2002</td>
<td>3rd Aerodyne</td>
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<tr>
<td>2003</td>
<td>4th Caltech</td>
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<td>2004</td>
<td>5th GaTech</td>
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<td>2005</td>
<td>6th Juelich</td>
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<td>2006</td>
<td>7th Minnesota</td>
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<td>2007</td>
<td>8th DRI, Reno, NV</td>
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<td>2008</td>
<td>9th Manchester</td>
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<td>2009</td>
<td>10th Toronto</td>
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<td>2010</td>
<td>11th Hyytiälä</td>
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<td>2011</td>
<td>12th Orlando</td>
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<tr>
<td>2012</td>
<td>13th Minnesota</td>
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<tr>
<td>2013</td>
<td>14th Prague</td>
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<td>2014</td>
<td>15th Korea / Orlando</td>
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<tr>
<td>2015</td>
<td>16th Milan</td>
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<td>2016</td>
<td>17th Portland</td>
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<td>2017</td>
<td>18th AMS/CIMS PKU, Beijing</td>
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<td>2018</td>
<td>Nanjing Chinese AMS Clinic CIMS(UWash.)</td>
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<tr>
<td>2019</td>
<td>8th NOAA CIMS (Boulder)</td>
</tr>
</tbody>
</table>

AMS #20 (Lund, EAC)

[2020 International AMS (CIMS) China]
AMS Introduction
Doug Worsnop

AMS Users Meeting

- Aerodyne
- Caltech
- Georgia Tech
- FZ - Juelich
- University of Minnesota
- Desert Research Institute
- Manchester

- Toronto \(\rightarrow\) Hyytiala \(\rightarrow\) Orlando \(\rightarrow\) Minnesota \(\rightarrow\) Prague \(\rightarrow\) Busan

- October 2001/2002
- October 24, 2003
- October 8, 2004
- 25 August, 2005
- 16 September, 2006
- 29 September, 2007
- 5 September 2008
- October 2009 \(\rightarrow\) September 2010 \(\rightarrow\) October 2011 \(\rightarrow\) October 2012 \(\rightarrow\) 2013 \(\rightarrow\) 2014 \(\rightarrow\) 2015

- Portland 2016; Beijing, 2017
- St Louis, 2018
- Lund 2019

PMF/ME-2 \(\rightarrow\) “source apportionment”

“Molecular Revolution” \(\rightarrow\) Better PMF
Size and (elementally) chemically resolved sub-micron aerosol composition

“A simple molecular beam mass spectrometer”

Jayne et al, 2000; Drewnick et al, 2005; DeCarlo et al., 2006; Onasch et al, 2012
Inorganic ($SO_4, NO_3$) ~ Organic (OOA)

$O/C \sim 0.7$

Jimenez et al, Science, 2009
Highly Time- and Size-Resolved Characterization of Submicron Aerosol Particles in Beijing, using an Aerodyne Aerosol Mass Spectrometer

Junying Sun*, Yangmei Zhang, Xiaochun Zhang, Xiaoye Zhang
Nga L. Ng, Manjula R. Canagaratna, John T. Jayne, Douglas R. Worsnop, Yele Sun, Qi Zhang,

CAMS 2006

Atmospheric Environment (2009)
Observed ‘Urban’ and ‘Remote’ Size Modes

Urban Site Bi-modal
Local Sources

Remote Site Mono-modal
Aged-Transported

Aerodynamic Diameter (nm)

Edinburgh, Scotland
November, 2000

Cheju-Do Island, Korea
April, 2001

dM/dlogD (µg m$^{-3}$)

Accumulation mode

‘Traffic’ mode

Accumulation mode

Scotland SASUA-3

ACE ASIA

Allan, Alfarra et al. (U. Manchester)
Organic Mass Distributions

- Small mode, hydrocarbon-based, primary traffic organic PM
- Accumulation mode oxidized organic PM
Gas-phase oxidation

Nucleation

Aq-phase rxn

Particle EMISSIONS

Gaseous organic EMISSIONS

Secondary Aerosol

Primary Aerosol

PM-phase rxn

Secondary Organic >> Primary Organic

Gas-phase oxidation

Particle EMISSIONS
Correlation of secondary organic aerosol with odd oxygen in Mexico City

Scott C. Herndon,¹ Timothy B. Onasch,¹ Ezra C. Wood,¹ Jesse H. Kroll,¹ Manjula R. Canagaratna,¹ John T. Jayne,¹ Miguel A. Zavala,²,³ W. Berk Knighton,⁴ Claudio Mazzoleni,⁵ Manvendra K. Dubey,⁵ Ingrid M. Ulbrich,⁶ Jose L. Jimenez,⁶ Robert Seila,⁷ Joost A. de Gouw,⁸ Benjamin de Foy,⁹ Jerome Fast,¹⁰ Luisa T. Molina,²,³ Charles E. Kolb,¹ and Douglas R. Worsnop¹

\[ O_x = O_3 + NO_2 \]
Primary Emission

SO$_2$ \(\rightarrow\) H$_2$SO$_4$

Secondary Formation

VOC \(\rightarrow\) OOA

“Volatile Organic Compounds” \(\rightarrow\) “Oxygenated Organic Aerosol”

“one compound” \(\rightarrow\) “1,000’s compounds”

Analytical Challenge:

AMS mass spectra simplify classification of too many organic compounds to identify
Urban organic aerosol is a mixture of hydrocarbon and oxygenated components.

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration (µg/m³)</th>
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<tbody>
<tr>
<td>Ammonium</td>
<td>4.8</td>
</tr>
<tr>
<td>Nitrate</td>
<td>5.8</td>
</tr>
<tr>
<td>Sulphate</td>
<td>9.4</td>
</tr>
<tr>
<td>Organics</td>
<td>13.4</td>
</tr>
<tr>
<td>Chloride</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Mexico City 2/2002
\[ C_{n\,H_m\,O_y} \rightarrow H_2O^+ \, CO^+ \, CO_2^+ \]

\[ 18 \quad 28 \quad 44 \quad 43, \, 55 \]

**f44 vs O/C**

- **Oxalic Acid**
- **Fulvic Acid**
- **AMS Observations**
- **PSI Chamber**
- **Oleic Acid + Ozone**

600C, e^−
A high-resolution mass spectrometer to measure atmospheric ion composition

Atmospheric (pressure) Ions

Sample Air

API-ToFMS (Tofwerk)

Mikael Ehn, Heikki Junninen
Negative ion spectra from Hyytiälä
A large source of low-volatility secondary organic aerosol

ELVOC (HOMs) “highly oxygenated molecules”

C10,C20 in the gas phase O/C > 0.7

Nucleation, Clusters Nanoparticle growth
< ppt → ppt → ppb (ppm)

Ultrafine aerosol sink (coagulation)

Vapor sink (condensation)

Background aerosol

>10^{-7} m

10^{-9} m

10^{-6} m

10^{-3} m

Growth by condensation

Vapor source (e.g. oxidation)

Ultrafine aerosol source (e.g. nucleation)

VOCs POA

Ilona Riipinen
A large source of low-volatility secondary organic aerosol

Mikael Ehn1,2, Joel A. Thornton2,4, Einhard Kleist4, Mikko Sipila2, Heikki Jokinen1, Ida Pullinen1, Monika Springer1, Florian Rubach1, Ralf Tillmann1, Ben Lee7, Felipe Lopez-Hilfiker3, Stefanie Andreoni1, Ismail Halki Acir5, Martti Rissanen4, Tuula Jokinen1, Siegfried Schobesberger2, Juha Kangasluoma2, Jenni Kontkanen7, Tiina Nieminen4, Theo Kurten1, Lasse R. Nielsen3, Solveig Jorgensen6, Henrik G. Kjaergaard6, Marjuta Caragata6, Miljka Dal Maso7, Torsten Berndt6, Tuukka Petja6, Andreas Wahn6, Veli-Matti Kerminen1, Markku Kulmala1, Douglas R. Worsnop2,7, Jürgen Wildt6 & Thomas F. Mentel1

1 Centre for Earth and Environmental Research, University of Helsinki, Finland; 2 Swedish University of Agricultural Sciences, Sweden; 3 University of Illinois at Urbana-Champaign, USA; 4 University of Graz, Austria; 5 Instituto de Astrofísica e Ciências do Espaço, Portugal; 6 Helmholtz-Zentrum Geesthacht, Germany; 7 Department of Chemistry, University of Toronto, Canada.
Inter-comparisons of four aerosol mass spectrometers during the summer time of 2018 in an urban site, Beijing, China

Jian Zhao, Yao He, Weiqi Xu, Yele Sun
NR-PM$_1$ vs. NR-PM$_{2.5}$
HR-ToF-AMS (colored line) vs. ToF-ACSM2 (grey line)

Org, SO$_4$, NO$_3$, NH$_4$, Chl

Slope=0.69  $r^2=0.86$

Slope=0.56  $r^2=0.83$

Slope=0.62  $r^2=0.92$

Slope=0.55  $r^2=0.89$

Slope=1.55  $r^2=0.86$

Date & Time
NR-PM$_1$ vs. NR-PM$_{2.5}$

The diagram shows the comparison of PM$_1$ and PM$_{2.5}$ concentrations over time from May 6 to July 1. The top graph displays the mass concentration of PM$_1$ and PM$_{2.5}$ measured by ToF-ACSM and TEOM. The middle and bottom graphs highlight the slopes and correlation coefficients ($r^2$) for the linear relationship between PM$_1$ and PM$_{2.5}$:

- PM$_1$ vs. PM$_{2.5}$ ToF-ACSM: Slope = 0.62, $r^2 = 0.88$
- PM$_1$ vs. PM$_{2.5}$ TEOM: Slope = 0.80, $r^2 = 0.62$

The graphs indicate a strong positive correlation between the two particulate matter sizes, with PM$_1$ concentrations showing a slightly higher slope compared to PM$_{2.5}$ in the ToF-ACSM measurements.
The second ACTRIS inter-comparison (2016) for Aerosol Chemical Speciation Monitors (ACSM): Calibration protocols and instrument performance evaluations

Evelyn Freney, Yunjiang Zhang, Philip Croteau, Tanguy Amodeo, Leah Williams, François Truong, Jean-Eudes Petit, Jean Sciare, Roland Sarda-Esteve, Nicolas Bonnaire, Tarvo Arumae, Minna Aurela, Aikaterini Bougiatioti, Nikolaos Mihalopoulos, Esther Coz, Begoña Artinano, Vincent Crenn, Thomas Elste, Liine Heikkinen, Laurent Poulain, Alfred Wiedensohler, Hartmut Herrmann, Max Priestman, Andres Alastuey, Iasonas Stavroulas, Anna Tobler, Jeni Vasiliecsu, Nicola Zanca, Manjula Canagaratna, Claudio Carbone, Harald Flentje, David Green, Marek Maasikmet, Luminita Marmureanu, Maria Cruz Minguillon, Andre S. H. Prevot, Valerie Gros, John Jayne & Olivier Favez

Laboratory and field evaluation of the Aerosol Dynamics Inc. concentrator (ADIC) for aerosol mass spectrometry

Sanna Saarikoski¹, Leah R. Williams², Steven R. Spielman³, Gregory S. Lewis³, Arantzazu Eiguren-Fernandez³, Minna Aurela¹, Susanne V. Hering³, Kimmo Teinilä¹, Philip Croteau², John T. Jayne², Thorsten Hoehn², Douglas R. Worsnop³, and Hilkka Timonen¹

Atmos. Meas. Tech., 12, 3907–3920, 2019
https://doi.org/10.5194/amt-12-3907-2019
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Evaluation of a New Vocus Reagent-Ion Source and Focusing Ion-Molecule Reactor for use in Proton-Transfer-Reaction Mass Spectrometry

Jordan Krechmer\textsuperscript{1,*}, Felipe Lopez-Hilfiker\textsuperscript{2,*}, Abigail Koss\textsuperscript{3,4,5,6}, Manuel Hutterli\textsuperscript{7}, Carsten Stoermer\textsuperscript{2}, Benjamin Deming\textsuperscript{3,5}, Joel Kimmel\textsuperscript{1,2}, Carsten Wameke\textsuperscript{3,4}, Rupert Holzinger\textsuperscript{7}, John Jayne\textsuperscript{1}, Douglas Worsnop\textsuperscript{1}, Katrin Fuhrer\textsuperscript{2}, Marc Gonin\textsuperscript{2}, Joost de Gouw\textsuperscript{3,5,*}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{mass_spectrum.png}
\caption{A mass spectrum of ambient air from one 2-Hz saved spectrum (24 September 2017, 18:48:34 UTC) at m/Q = 105 Th. With a mass resolving power m/\Delta m = 12,000, 5 peaks were resolved in the deconvolution. The same mass spectrum was then down-sampled to lower resolving powers of 5,500 and 1,200.}
\end{figure}
10% of global population lives here

There are more people living inside this circle than outside of it.
Welcome to CIAAS 2019!

The 2019 conference was successfully held in March 2019. We thank the IIT Delhi and IIT Tirupati for the excellent organization. We thank the all attendees and our sponsors for their support.
Real-time measurements of ambient aerosols in a polluted Indian city: Sources, characteristics, and processing of organic aerosols during foggy and nonfoggy periods

Abhishek Chakraborty¹, Deepika Bhattu¹, Tarun Gupta¹², Sachchida N. Tripathi¹², and Manjula R. Canagaratna³

¹Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India, ²Center for Environmental Science and Engineering, Indian Institute of Technology Kanpur, Kanpur, India, ³Aerodyne Research, Billerica, Massachusetts, USA
Smog envelops buildings on the outskirts of the Indian capital New Delhi in November, 2014. Credit Roberto Schmidt/Agence France-Presse — Getty Images
“Aerodyne (MS) Product Line”

ACSM
ToF-ACSM
Mini-AMS
HR-ToF-AMS
LToF-AMS

PM2.5 Lens, ePToF, Capture Vaporizer, ADQ
SP- Module
Thermo-denuder
Aerosol Dryer / Sampling System
PAM Flow Reactor

APi-TOF IMR (I-), NO3- Module, EESI-ToF
IMS-ToF
GC-ToF TAG Module

Vocus-PTR-ToF