The application of the AMS for understanding chemical/physical processes in the atmosphere through measurement field campaigns and laboratory studies.
EC’s First AMS

June 2002 – received Q-AMS

July 2002 - C-SOLAS project, Mexican Research vessel El Puma in the sub-arctic NE Pacific ocean

First AMS measurements in a remote-marine environment


EC’s Second AMS – on CRUISER
Canadian Regional & Urban Investigation System for Environmental Research
PI: Jeff Brook/Gang Lu

WEATHER
- 10 m electronically deployed tower
- temperature, pressure, relative humidity, wind speed and direction

COMMUNICATIONS
- satellite connection
- check concentrations over the internet from the office
- unattended operation of equipment

GASES
- Ozone (O₃)
- Sulphur Dioxide (SO₂)
- Oxidized Nitrogen Compounds (NO, NO₂, NOₓ)
- Carbon Monoxide (CO)
- Carbon Dioxide (CO₂)
- Volatile Organic Compounds (VOC)

PARTICLES
- Size counts from 0.01 to 30 μm
- Light scattering (related to visibility)
- Black Carbon (photoacoustic)
- Major chemical constituents (AMS)

ADVANCED EQUIPMENT
The Aerodyne Aerosol Mass Spectrometer (AMS)
- High time resolution (~5 min) information on particle composition and size (includes sulphate, nitrate, organic matter, ammonium)

The Ionicon Proton-Transfer Reaction Mass Spectrometer (PTR-MS)
- High time resolution (~5 min) information on selected VOC compounds
• Quick deployment of a comprehensive suite of measurements
• Capture of measurements from source-impacted locations to specific plumes
  – Source profiles, source apportionment
  – Assessment of emissions
• Lagrangian studies and assessment of airmass aging
• Unprecedented insight into small scale variability in source impacts, exposure patterns, model sub-grid variability
Systematic Mapping of a Ship Plume

Plumes stay in tact for long distances

G. Lu et al., Atmos. Environ., 40, 2767-2782, 2006
POSTER AT BACK OF ROOM – Gang Lu et al.

ICARTT Summer 2004
Cloud Study – Q-AMS downstream of a CVI sampling from a NRC Convair580 aircraft

A Unified Regional Air-Quality Modelling System (AURAMS)
First ‘field’ application of EC’s model used in forecasting mode
Nitrate enriched in the cloud water compared to sulphate

Nitrate in cloud droplet residuals found in smaller sizes compared to sulphate

Aerosol-cloud parcel model supports separation due to process differences: nitrate governed by gas-phase mass transfer; sulphate due to nucleation scavenging


Lethbridge NH₃ Study Sept 2005

Q-AMS on 1) Cessna 207
2) CRUISER
NH₃ concentrations N/NE of Lethbridge

PM Response to NH₃
(Flight#9 Track 5: Sept 21/05 afternoon)

Transition points/regions (of slopes to fitted curves) used to assess degree of PM sensitivity to NH₃ changes
April 2006 - HR-ToF AMS received

April/May 2006 – Whistler peak, BC field study INTEX-B; to characterize aerosol sources and processes at this location.

Photo courtesy AM Macdonald


INTEX-B 2006

Coarse dust particles during Asian transport accumulates sulphate, nitrate and organic PM in larger particles.


BAQSMet Summer 2007

June 2007 - Q-AMS upgraded to CToF AMS following loss of electronics in plane crash

June/July 2007 - BAQSMet field study in SW Ontario to examine lake effects on air quality; deployed on Twin Otter aircraft.
Inlet design – John Jayne, Aerodyne

inlet lens pressure, 1.29 Torr

low pressure region, 470 Torr

Identification of lake breeze fronts: June 25/07
Processing differences across regimes: June 25/07

Early Afternoon (11:30-12:45 LT)

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Late Afternoon (16:00-17:45 LT)

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- separation of air masses due to the lake breezes
- LE more regionally aged vs urban-influenced

ACSM at Whistler, B.C.

Carbon PM from forest fires

Carbon PM from tree gases (controlled by valley temperature)

 Sulphur PM from volcano in Russia or Asian pollution?

Slide/data: R. Leaitch

Aug 17 – volcano eruption
Laboratory Studies


- significant reactive uptake to PM
- formation of oligomers


-heterogeneous loss as important as gas phase loss mechanisms

Uptake of ambient organic gaseous mixtures to laboratory generated aerosols

J. Liggio and S.M. Li

- Organics normalized by SO₄ to account for wall losses
- Organics in aerosols increase slowly over time
- Possible reactive uptake
Future Studies

• Laboratory chamber studies - uptake and reaction mechanisms of VOCs and SVOCs on aerosols
• Laboratory studies on chemical and physical evolution of primary particles from automotive engine emissions (ETC, Ottawa)
• Laboratory flow tube studies – chemical processes in aerosol formation (York University)
• W-ToF AMS to CalNex, California, Summer 2010 (along with SP2 and PTR-ToF) (Aerodyne)
• AMS to Darwin, Australia for High-IWC Study project (aircraft and ground-based) Jan-Mar 2011
• AMS to Whistler, BC, Spring/Summer 2010 – cloud study