New techniques, instruments and methods overview

Steven S. Brown

New research tools: a critical component of the process that connects scientific / environmental issues to end-user results

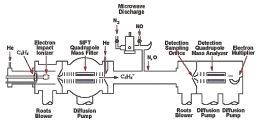
New research tools provide a feedback that serves to identify new scientific opportunities

New tools development cuts across themes of stratosphere, air quality and climate

CSD is a world leader in the development of tools to measure and model atmospheric composition to address the Nation's needs to understand stratospheric ozone, climate and air quality

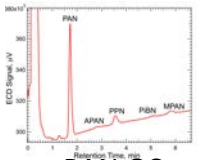
Development of Instruments, Platforms and Models

Ingrained in the culture of CSD (and the Aeronomy Lab)



Flowing Afterglow

Ground Based Spectroscopy



PAN GC

HNO_3 CIMS

Ron Brown

H_2O CIMS

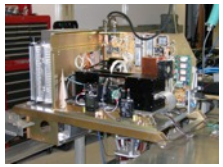
Balloon Sampling

ER2

O3 LIDAR

N_2O_5 Ring Down

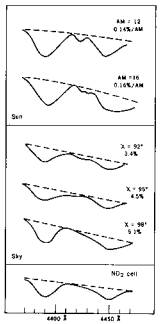
Optical Properties



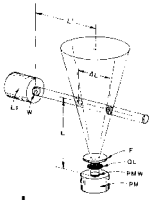
SP2

Small UAS

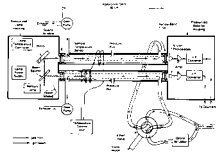
1970s | 1980s | 1990s | 2000s | 2010s



Atmospheric Spectroscopy



Lyman α H_2O



O_3 Absorption

P3

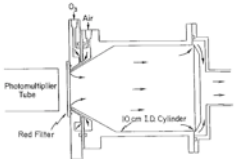
Acid CIMS

Twin Otter

PALMS

LIDAR

BAO Tower



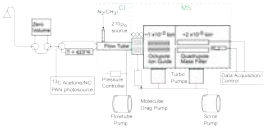
OH LIF

Evaluation of a Catalytic Reduction Technique for the Measurement of Total Reactive Odd-Nitrogen NO_y in the Atmosphere

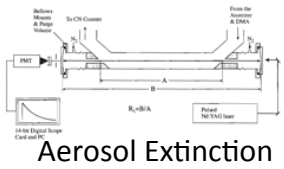
D. W. FAHEY, C. S. EUBANK, G. HÜBLER, and F. C. FEHSENFELD

Aeronomy Laboratory, National Oceanic and Atmospheric Administration, Boulder, CO 80303 U.S.A.

NO_x, NO_y Chemiluminescence



PAN CIMS



Aerosol Extinction

Global Hawk

Development of Instruments, Platforms and Models

Ingrained in the culture of CSD (and the Aeronomy Lab)

Stratospheric/Upper Troposphere Chemistry and Composition

Lower Troposphere Chemistry and Air Quality

Cloud and Aerosol Microphysics, Chemistry

1970s

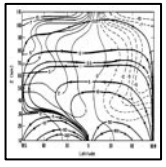
1980s

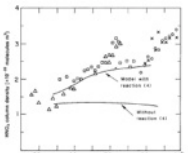
1990s

2000s

2010s

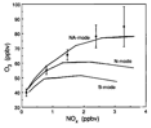
2D middle atmosphere



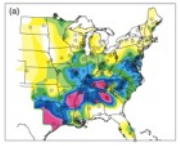


Heterogeneous Chemistry, Stratospheric O_3 Depletion

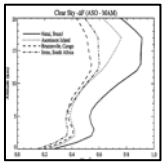
Photochemical 0-D & 1-D Models



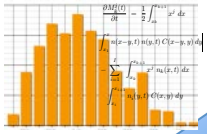
Regional 3D model



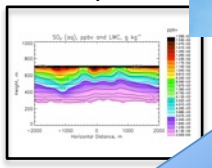
Line-by-Line RT code



Bin microphysics

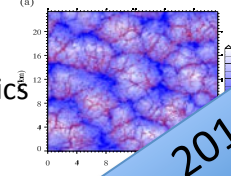


LES + aq. chem



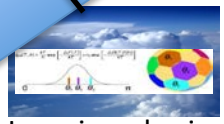
Cirrus Microphysics

Cloud Holes/ Entrainment

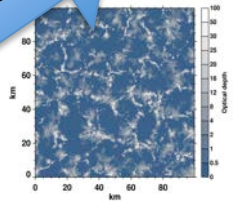


Aqueous organic chemistry

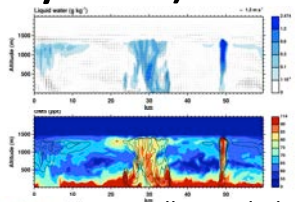
Ice microphysics



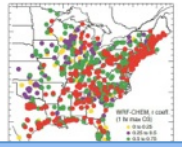
Closed- to open-cellular stratocumulus transition



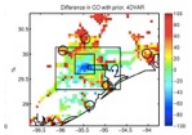
Fully coupled chemistry – aerosol – cloud model at high resolutions



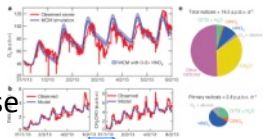
WRF-Chem: Coupled Meteorology-Chemistry



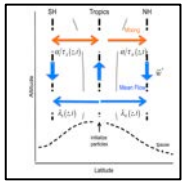
Mesoscale Inverse Model



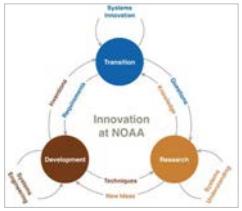
Master Chemical Mechanism



Tropical Pipe Model



Mapping NOAA's Core R&D Values to CSD's Culture of Research Tools



Innovation

Sustained investment in R&D promotes excellence – *our history speaks for itself*

CSD tools: Excellence that exemplifies the value of sustained investment

Integrity

For science to be useful, it must be credible – CSD has always emphasized *credibility*

CSD tools: Leadership in both methods development and methods *reliability*

Collaboration

Extramural and cooperative research brings flexibility and diversity

CSD tools: Partnerships with industry, universities, other federal R&D centers, etc.

Integration

A holistic approach to understanding the Earth System

CSD: Research need → Concept → Instrument / Platform / Model → Data → Analysis → User Information

Balance

Pursue the breadth of R&D required to meet immediate & emerging needs of the Nation

CSD tools: Field instruments, laboratory methods, models and platforms

CSD research tools development exemplifies NOAA priorities:
Investing in Observational Infrastructure, Achieving Organizational Excellence

New Tools at CSD: Advantages & Unique Capabilities

Long term institutional knowledge

Deep expertise to support instruments, methods & models

Synergy between instruments (models) *and* measurement (computing) platforms

Platform development occurs simultaneously with instrument / model development, and instruments / models can be designed & tested specifically for platforms

Patience & risk tolerance

Core values to see through long term development and to undertake high risk / high payoff projects

Relevance, timeliness & responsiveness

Mandate to develop new tools within the context of pertinent scientific issues that are relevant to societal needs and that provide information when it is needed

Scientific leadership

CSD's initiatives serve as a template or guiding principle for the scientific community

CSD's advantages and unique capabilities in research tools meet OAR values of Quality (institutional knowledge, synergy, patience), Performance (scientific leadership) and Relevance (responsiveness)

The Future: Guidance for Development of New Research Tools

Technology transfer

Develop technology in partnership with others *and* make CDS's innovations widely available

Miniaturization, speed & cost effectiveness

Stay at the forefront in a world of increasing information content and increasingly small and inexpensive platforms

Versatility & robustness

Strive to make new tools broadly applicable to different scientific problems and measurement environments

Identification of new scientific issues

Identify important, new scientific issues in parallel with new capabilities

Accessibility

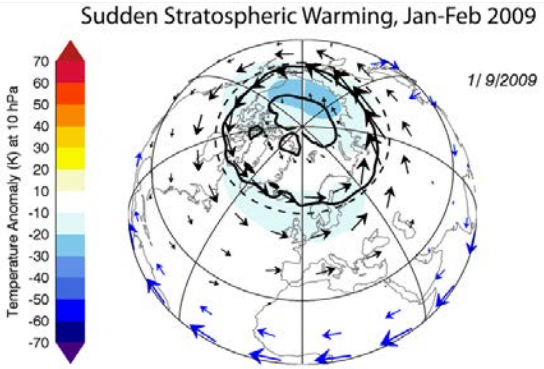
Make results from CSD R&D readily available to stakeholders and the public

New research tools are essential to meeting the environmental scientific challenges of the future

6-1. Amy Butler: Climatology of stratospheric warmings

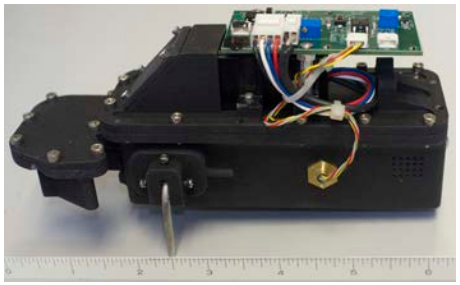
Model platform development: Sudden stratospheric warmings are a relatively unrecognized phenomenon that has potential to significantly improve weather forecasts, especially for extreme cold outbreaks.

Accessibility: The SSW atlas will be comprehensive and publicly available for model evaluation and improvement.



6-2. Ru-Shan Gao: New detectors for unmanned aerial systems

Miniaturization: UAS are increasingly available but require a smaller, lighter, low power consumption instruments to be viable for atmospheric sampling.

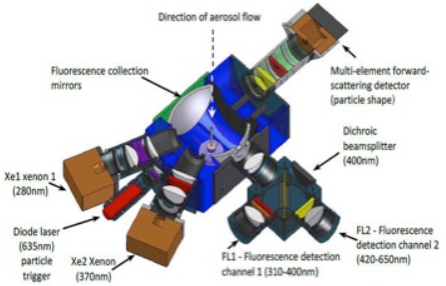


Cost effectiveness: A new generation of smaller instruments and automated measurements may be a much less expensive future paradigm.

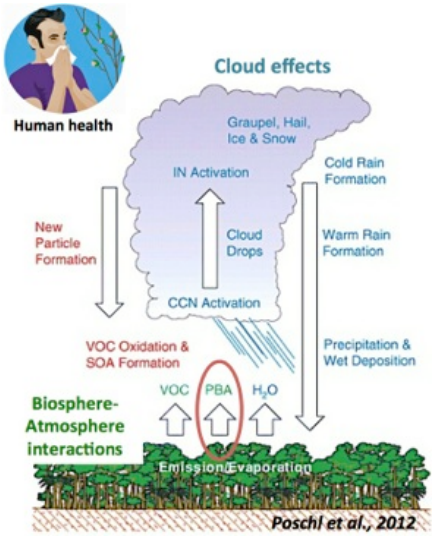
6-3. Anne Perring: Identifying atmospheric bioaerosol

Identification of new issues: Bioaerosol are ubiquitous and influence numerous atmospheric processes, but are not well characterized.

Technology transfer: Instrument development driven through public – private partnership



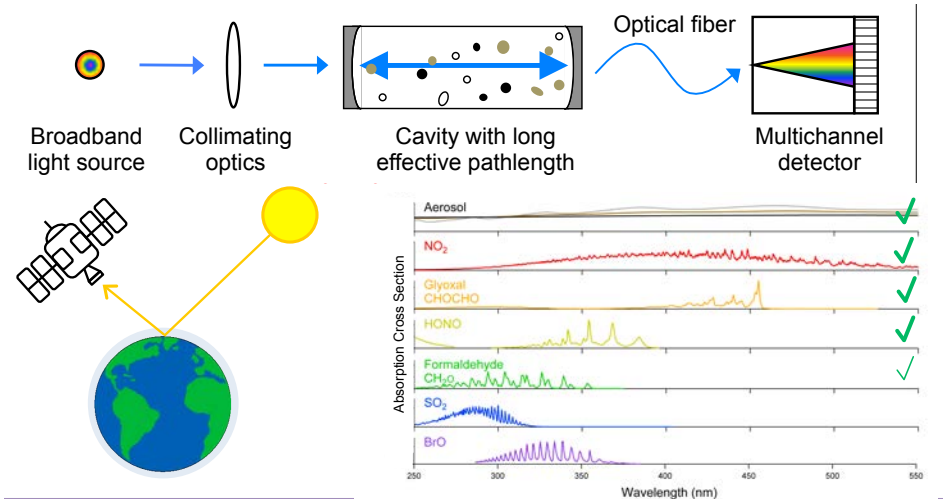
The wideband integrated bioaerosol sensor



6-4. Rebecca Washenfelder: New cavity enhanced detection methods for aerosols and gases

Innovation: CSD has pioneered applications of this technique in atmospheric science.

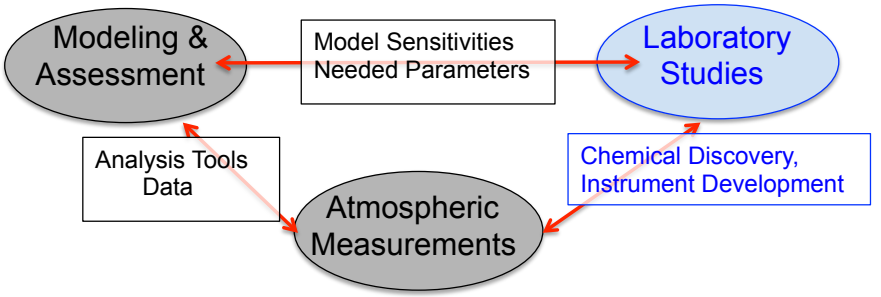
Versatility: A method with wide applicability to numerous trace gases and aerosols with the potential to augment satellite validation efforts.

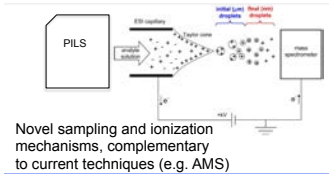


6-5. Jim Roberts: Future directions in laboratory studies

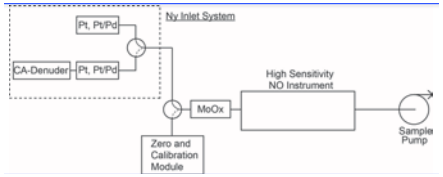
Integration & Balance: CSD has a long history and strong commitment to the future of laboratory studies as an integral part of atmospheric science.

Risk / reward: CSD intends to undertake development of new and untested methods, beginning with the laboratory setting.





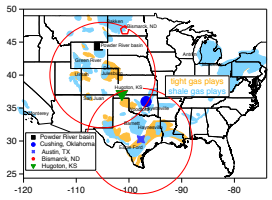
Novel sampling and ionization mechanisms, complementary to current techniques (e.g. AMS)

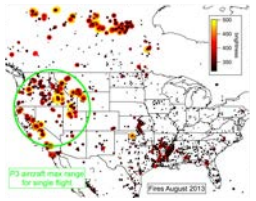


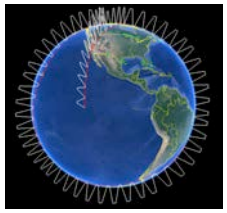
7-1. Shuka Schwarz: Current and future aircraft missions

Scientific Leadership: CSD's organization of aircraft-based field studies has addressed important national needs and nucleated efforts of a broad community of state, federal and university stakeholders and scientists.

Collaboration: CSD organizes aircraft missions in partnership with other federal agencies (NSF, NASA) and universities.



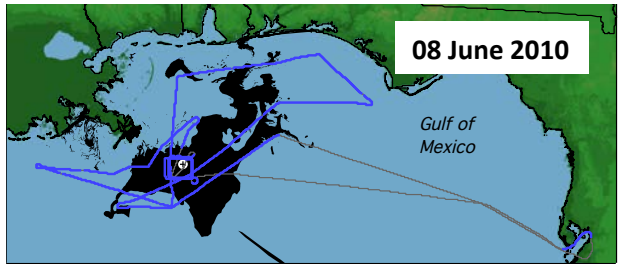


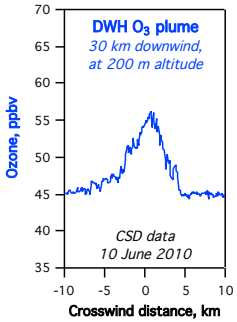


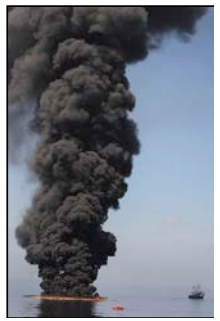
7-2. Tom Ryerson: Airborne chemical measurements to assess offshore blowouts

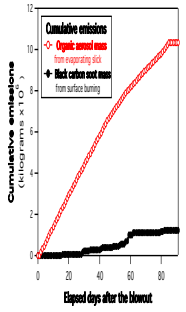
Responsiveness: CSD responded to the 2010 Deepwater Horizon blowout with instrumented aircraft flights that addressed important policy (flow rate) and scientific (ozone, aerosols) questions.

CSD stands ready to implement a rapid response capability for future emergencies.







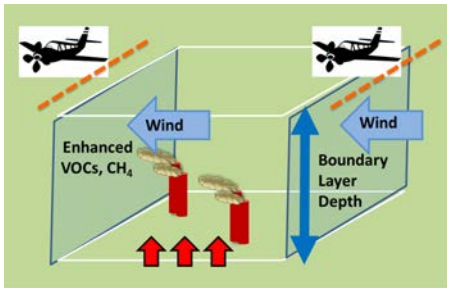


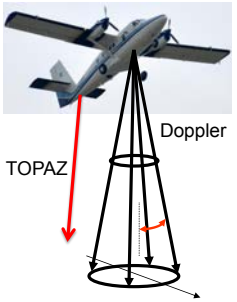
7-3. Andy Neuman: Quantification of agricultural emissions

Platform development: Agricultural emissions are increasingly recognized in terms of impacts to air quality, climate and stratospheric ozone. Their widespread, diffuse nature requires the development of diverse platforms for accurate emissions measurements.

7-4. Alan Brewer: Observing boundary layer dynamics for urban scale flux measurements

Long term knowledge: CSD maintains cutting edge expertise in LIDAR technology that is applicable to a wide variety of issues, including new efforts to understand urban scale fluxes of various trace gases, including greenhouse gas emissions and ozone.





7-5. Yelena Pichugina: Wind profiling to support renewable energy development

Relevance: The Nation's needs in atmospheric science include understanding the impacts of energy production *and* developing solutions. CSD's deep expertise in LIDAR technology is vital to the optimization of wind energy sources.

7-6. Chris Ennis: Research to applications: CSD leadership and contributions in scientific assessments

CSD has a long history in translating its scientific findings to a language accessible to stakeholders.