ALIVE (Aerosol LIDAR Validation Experiment)
SGP Sep 11 – 22, 2005

Motivation and Status Report

PI: Beat Schmid, BAER Institute
Co-I: Richard Ferrare, NASA LaRC
Co-I: Connor Flynn, PNNL
Co-I: Dave Turner, PNNL

Purpose

- Validate Aerosol Extinction Profiles over ARM CRF in Oklahoma derived from ground-based Raman and Micropulse Lidars
- Validate Aerosol Extinction Profiles derived from ARM Cessna 206 in-situ aerosol plane (IAP)

Aerosol Lidar Validation Experiment (ALIVE)

Sky Research J-31

NASA Ames Airborne Tracking 14-channel Sun photometer (AATS-14)

Research Scanning Polarimeter (RSP)
Navigational and Meteorological Parameters

Cessna 206

Raman Lidar

Micro Pulse Lidar

DOE
Oklahoma, Sep 11-22, 2005
Lead Scientist: B. Schmid

ARM Aerosol IOP – May 2003

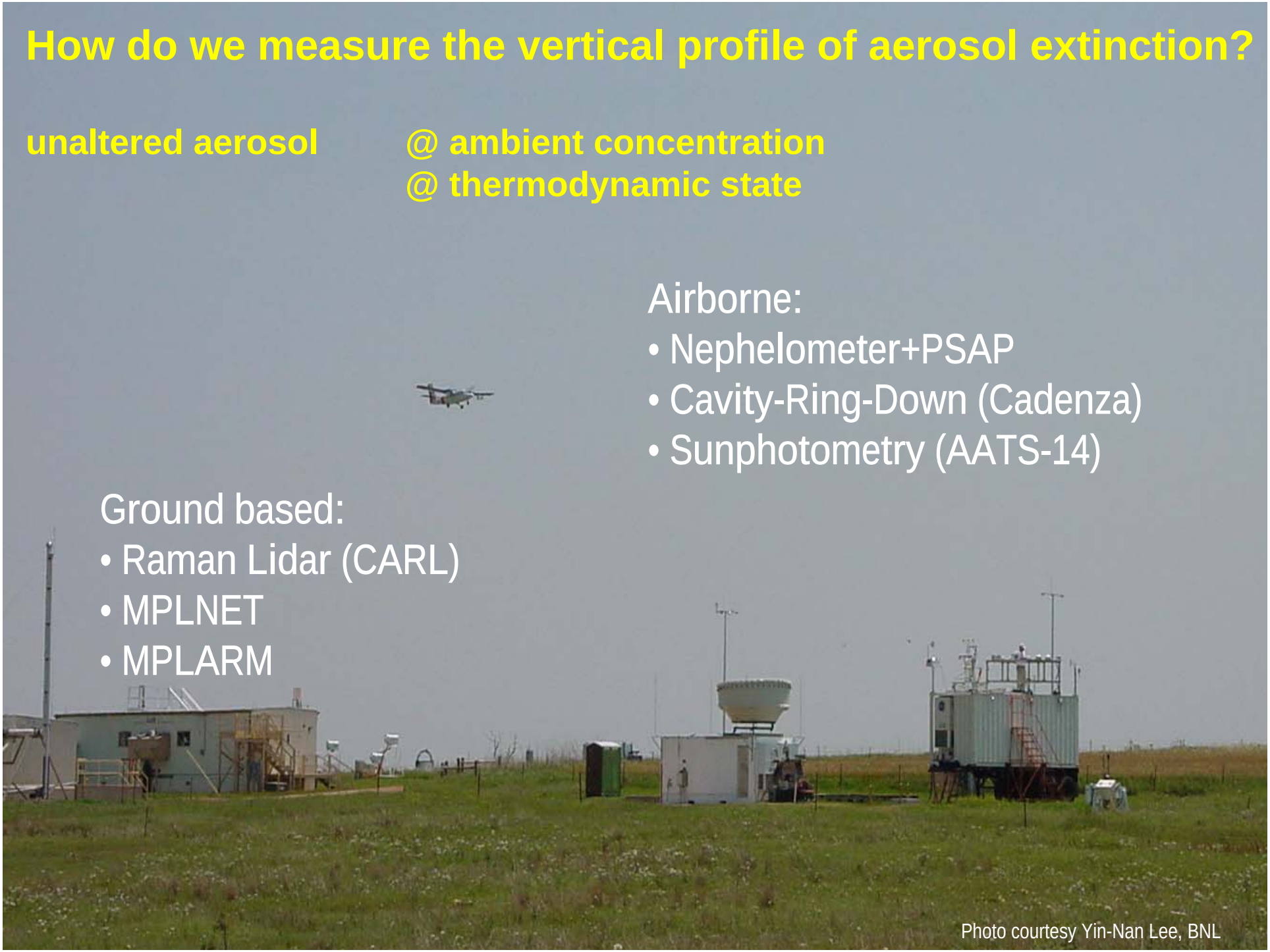
PI: R. Ferrare

CIRPAS Twin Otter (Platform Scientist B. Schmid)

- Twin Otter data used in 10 (8 in press, 2 in revision) publications for AIOP JGR special issue.

How do we measure the vertical profile of aerosol extinction?

unaltered aerosol **@ ambient concentration**
@ thermodynamic state



Airborne:
- Nephelometer+PSAP
- Cavity-Ring-Down (Cadenza)
- Sunphotometry (AATS-14)

Ground based:
- Raman Lidar (CARL)
- MPLNET
- MPLARM

Photo courtesy Yin-Nan Lee, BNL

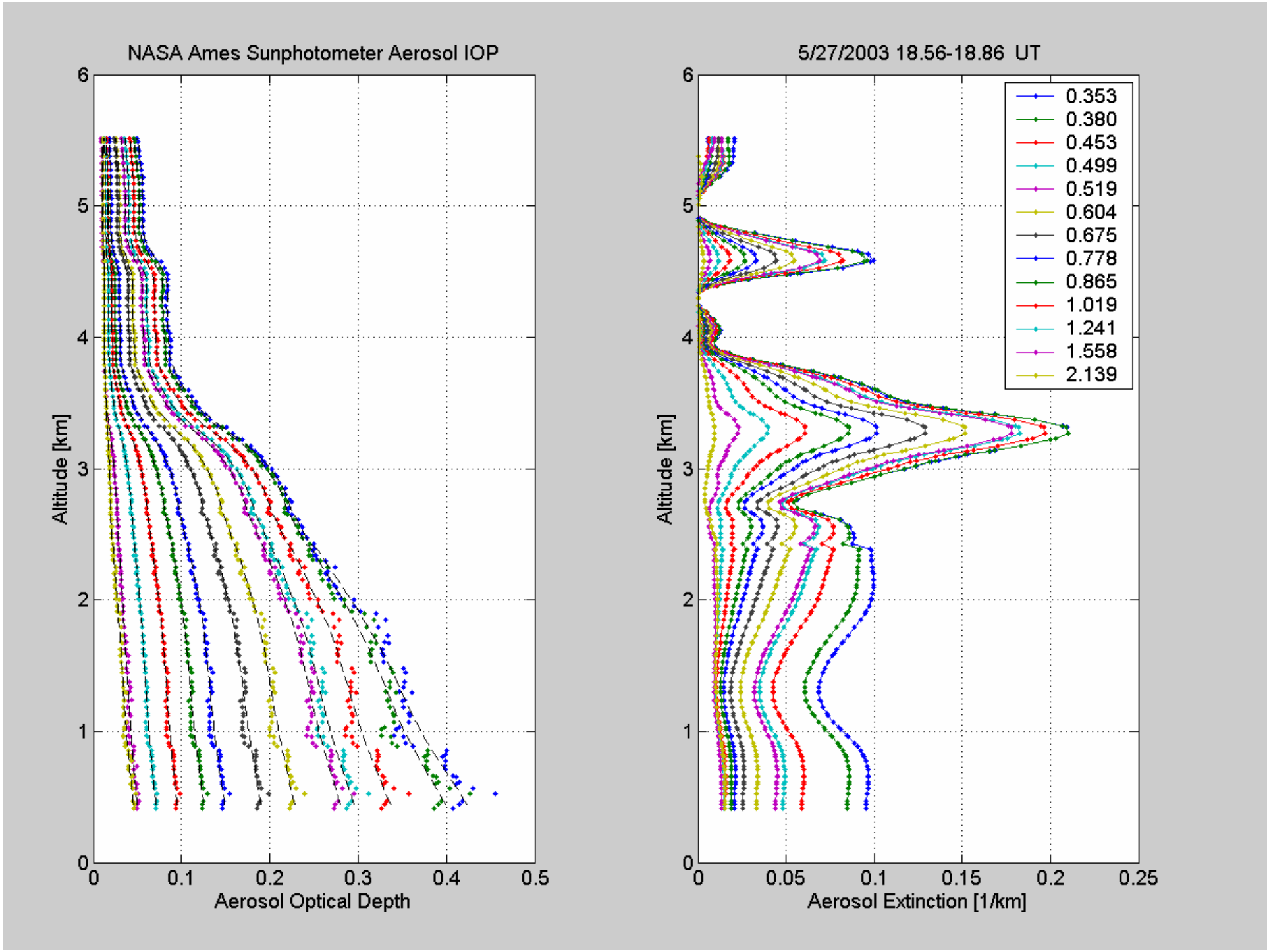
14-channel Ames Airborne Tracking Sunphotometer (AATS-14)

Measures: Solar direct-beam transmission, T, at 14 wavelengths, λ, 353-2139 nm

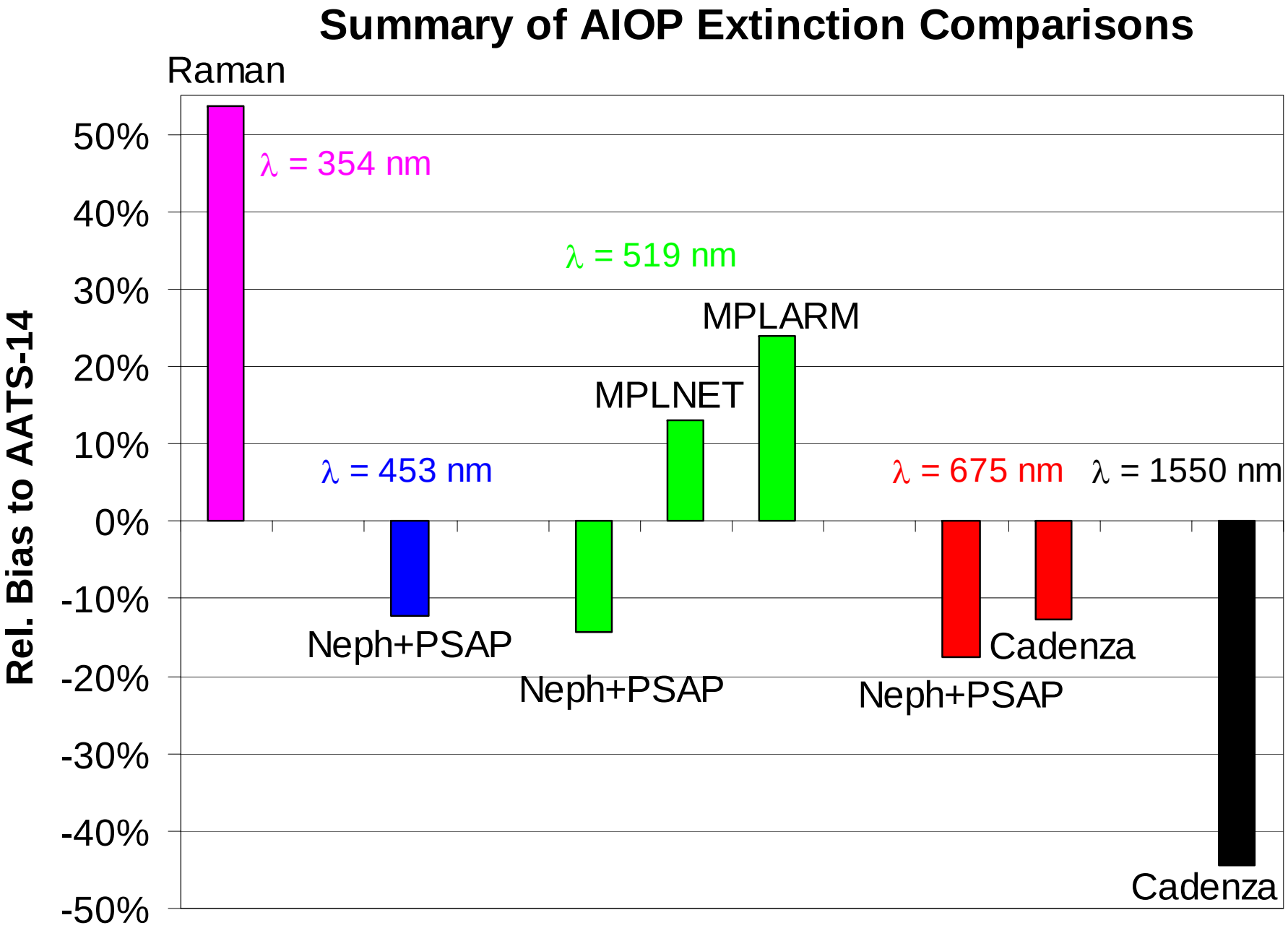
Data products

- Aerosol optical depth (AOD) at 13 λ, 353-2139 nm
- Water vapor column content [using T(940 nm)]
- Aerosol extinction, 340-2139 nm
- Water vapor density

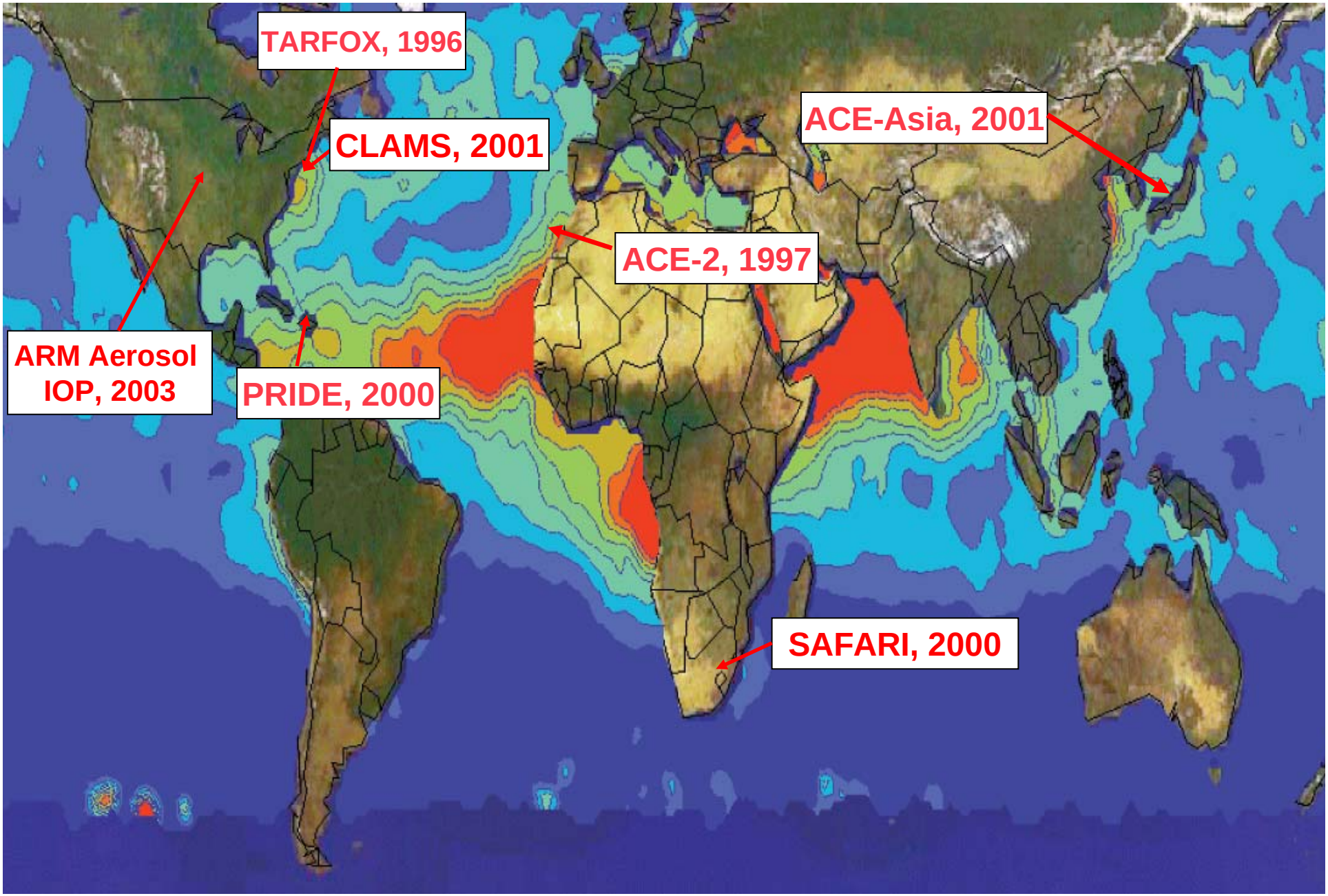
} When A/C flies vertical profiles


NASA Ames Sunphotometer Aerosol IOP
Altitude [km]
Aerosol Optical Depth
0
0.1
0.2
0.3
0.4
0.5
1
2
3
4
5
6
5/27/2003 18.56-18.86 UT
Aerosol Extinction [1/km]
0.05
0.15
0.25
0.353
0.380
0.453
0.499
0.519
0.604
0.675
0.778
0.865
1.019
1.241
1.558
2.139

x	*y*	*# profiles*	*# data points*
AATS-14	Neph+PSAP	26	3484
AATS-14	Cadenza	26	2856
AATS-14	MPLNET 2.0	13	587
AATS-14	MPLARM	19	2073
AATS-14	Raman Lidar	11	468


Summary of AIOP Extinction Comparisons
Rel. Bias to AATS-14
50%
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
Raman
λ = 354 nm
λ = 453 nm
Neph+PSAP
λ = 519 nm
MPLNET
MPLARM
Neph+PSAP
λ = 675 nm
Cadenza
Neph+PSAP
λ = 1550 nm
Cadenza

Extinction comparisons in previous field campaigns

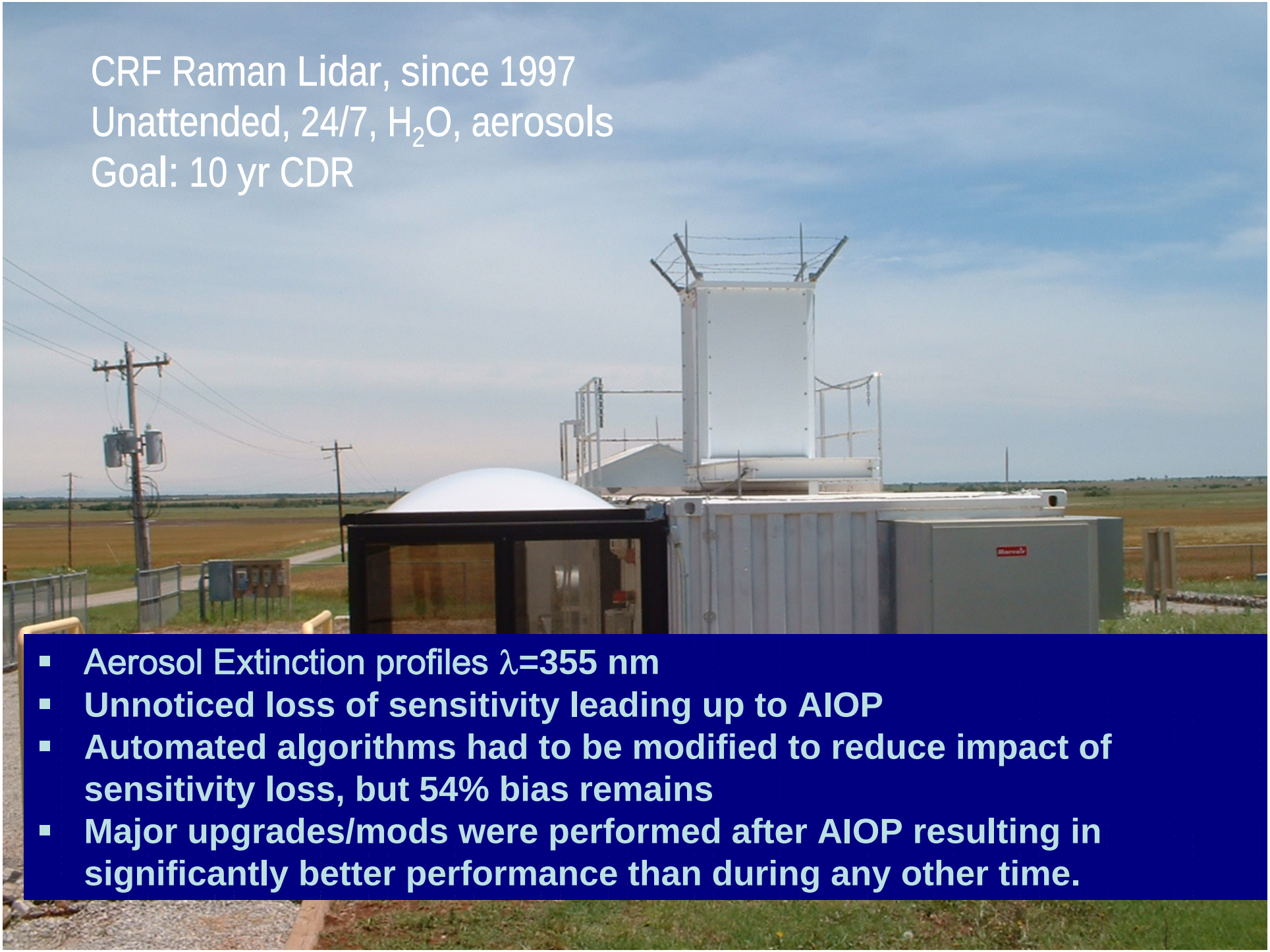


Comparison of layer AOD between AATS-14 (or -6) and Nephelometer+PSAP from 6 campaigns

Campaign	Year	Location	Airplane	Study	n	λ(nm)	bias diff(%)
TARFOX	1996	US East Coast	U. Wash. C-131A	Hegg et al., 1997	14	450	-24
				Hartley et al., 2000	11	450	-13
ACE-2	1997	Canary Islands	CIRPAS Pelican	Schmid et al., 2000	2 2 2	450 530 700	-10 -17 -31
SAFARI 2000	2000	Southern Africa	U. Wash CV-580	Magi et al., 2003	15	550	-5
ACE-Asia	2001	Eastern Asia	NCAR C-130	Redemann et al., 2003	28	550	-4
			CIRPAS Twin Otter	Schmid et al., 2003b	14	550	-9
CLAMS	2001	US East Coast	U. Wash CV-580	Magi et al., 2005	14	550	-33
ARM AIOP	2003	Oklahoma	CIRPAS Twin Otter	Schmid et al., 2005	26 26 26	453 519 675	-16 -18 -21
						mean	-17

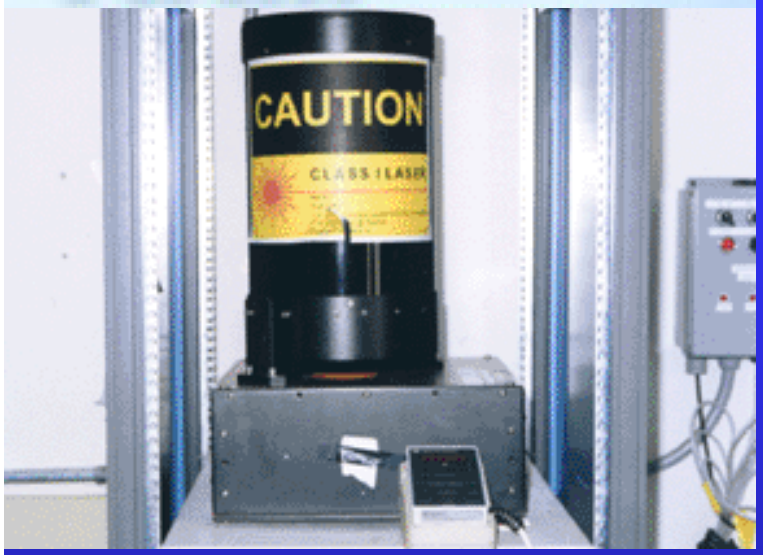
Comparison of extinction from airborne AATS-14 (or -6) and lidars from 6 campaigns

Campaign	Year	Location	Study	y	λ(nm)	bias
TARFOX	1996	U.S. East Coast	Ferrare et al., 2000	GSFC SRL (ground)	355	++
			Ferrare et al., 2000	LASE (ER-2 aircraft)	815	+
ACE-2	1997	Canary Islands	Schmid et al., 2000 Welton et al., 2000.	MPL (ground)	523	0
			Livingston et al., 2000	LMU (ship)	525	++
PRIDE	2000	Caribbean	Livingston et al., 2003	MPLNET (ground)	525	++
SAFARI 2000	2001	Southern Africa	Schmid et al., 2003a McGill et al., 2002 Kaufmann et al., 2003	CPL (ER-2 aircraft) MPLNET (ground)	532 1064 523	+ 0 0
ACE-Asia	2001	Eastern Asia	Murayama et al., 2003	TUMM RL (ground)	532	n/a
ARM AIOP	2003	Oklahoma	Schmid et al., 2005 Ferrare et al., 2005	CARL (ground) MPLNET (ground) MPLARM (ground)	355 523 523	54% 13% 24%



CRF Raman Lidar, since 1997
Unattended, 24/7, H_2O, aerosols
Goal: 10 yr CDR

- Aerosol Extinction profiles λ=355 nm
- **Unnoticed loss of sensitivity leading up to AIOP**
- **Automated algorithms had to be modified to reduce impact of sensitivity loss, but 54% bias remains**
- **Major upgrades/mods were performed after AIOP resulting in significantly better performance than during any other time.**



Micro Pulse Lidars

- Aerosol Extinction profiles λ=523 nm are a new product in β-stage (C. Flynn)
- First validation in AIOP over SGP
- Would like larger dataset for validation

Deployed at:
- SGP
- NSA (pol.)
- AMF (pol.)
- TWP Manus
- TWP Nauru
- TWP Darwin
- & several spares

Aerosol Lidar Validation Experiment (ALIVE)

Research Scanning Polarimeter

PI: Brian Cairns, NASA GISS

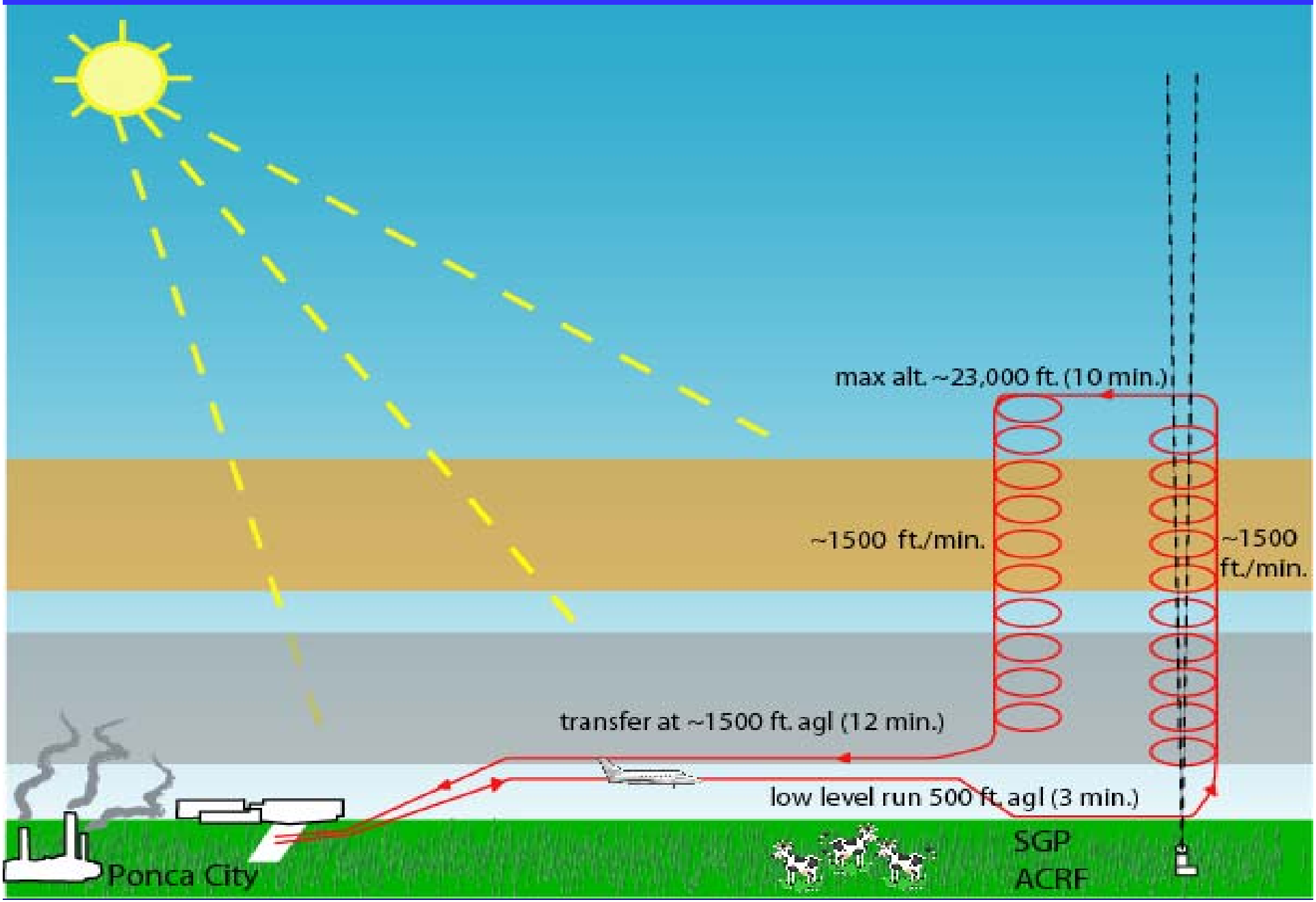
- Measures upwelling polarized radiation
- ±60° angular scan
- 410, 470, 555, 670, 865, 960, 1590, 1880, 2250 nm

Goal: Derive aerosol optical properties by combining AATS-14 and RSP measurements.

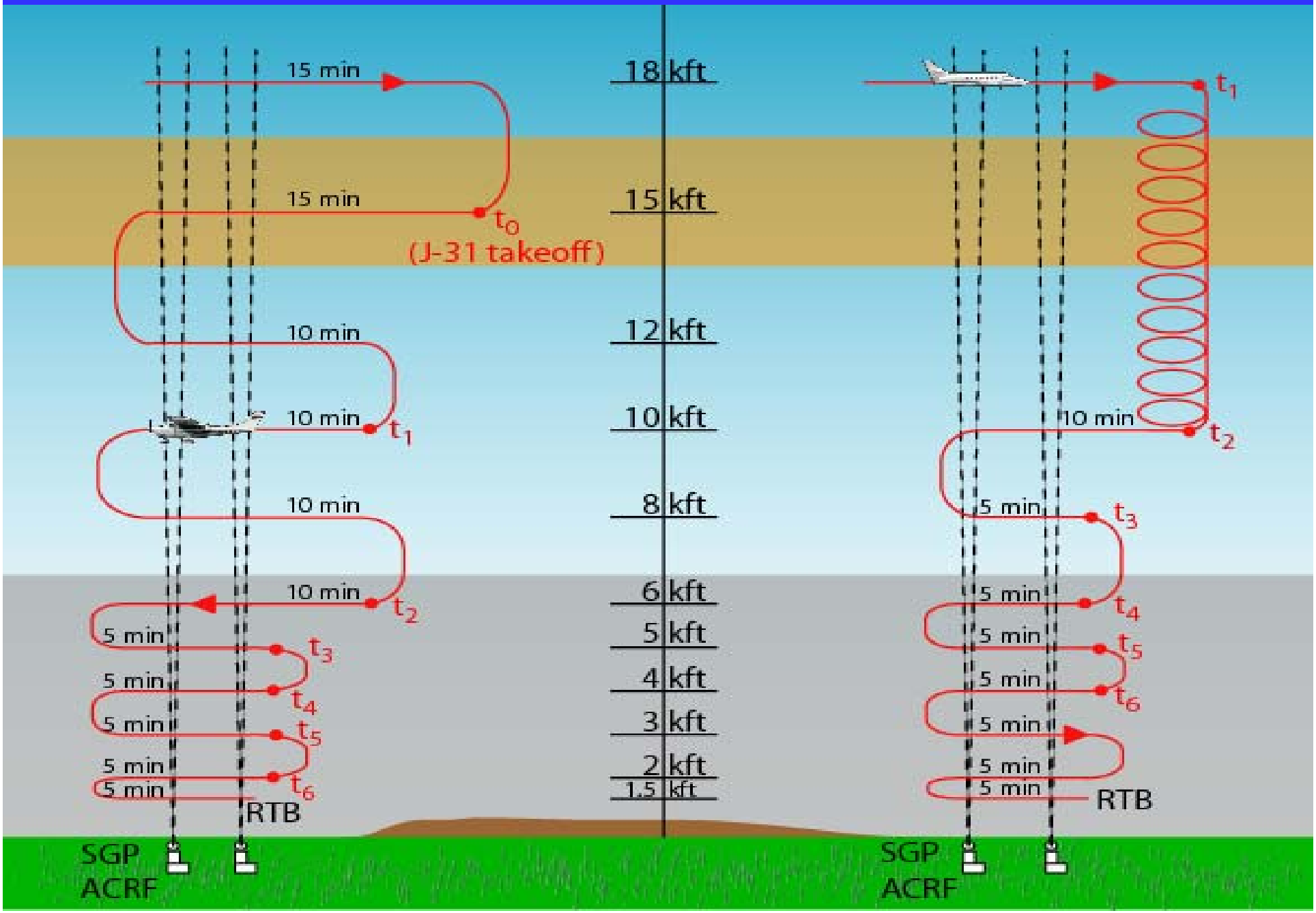
Preparations

- J-31
  - Various DOE and NASA Safety Reviews
  - AATS-14: Pre-mission calibration Mauna Loa, HI, Aug 16-25.
  - RSP: Successfully integrated and test flown Aug 8-10, Ashland, OR.
  - Full payload: Reintegration and test flight Sep 8-10, Moffett Field CA.
- C206:
  - Arrived in Ponca shortly before ALIVE.
  - C172 payload, humid. nephelometer late
- Raman Lidar:
  - Lots and lots, … mirrors replaced days before ALIVE
- MPL:
  - 2 systems deployed.

Type 1: Regular ALIVE Flights

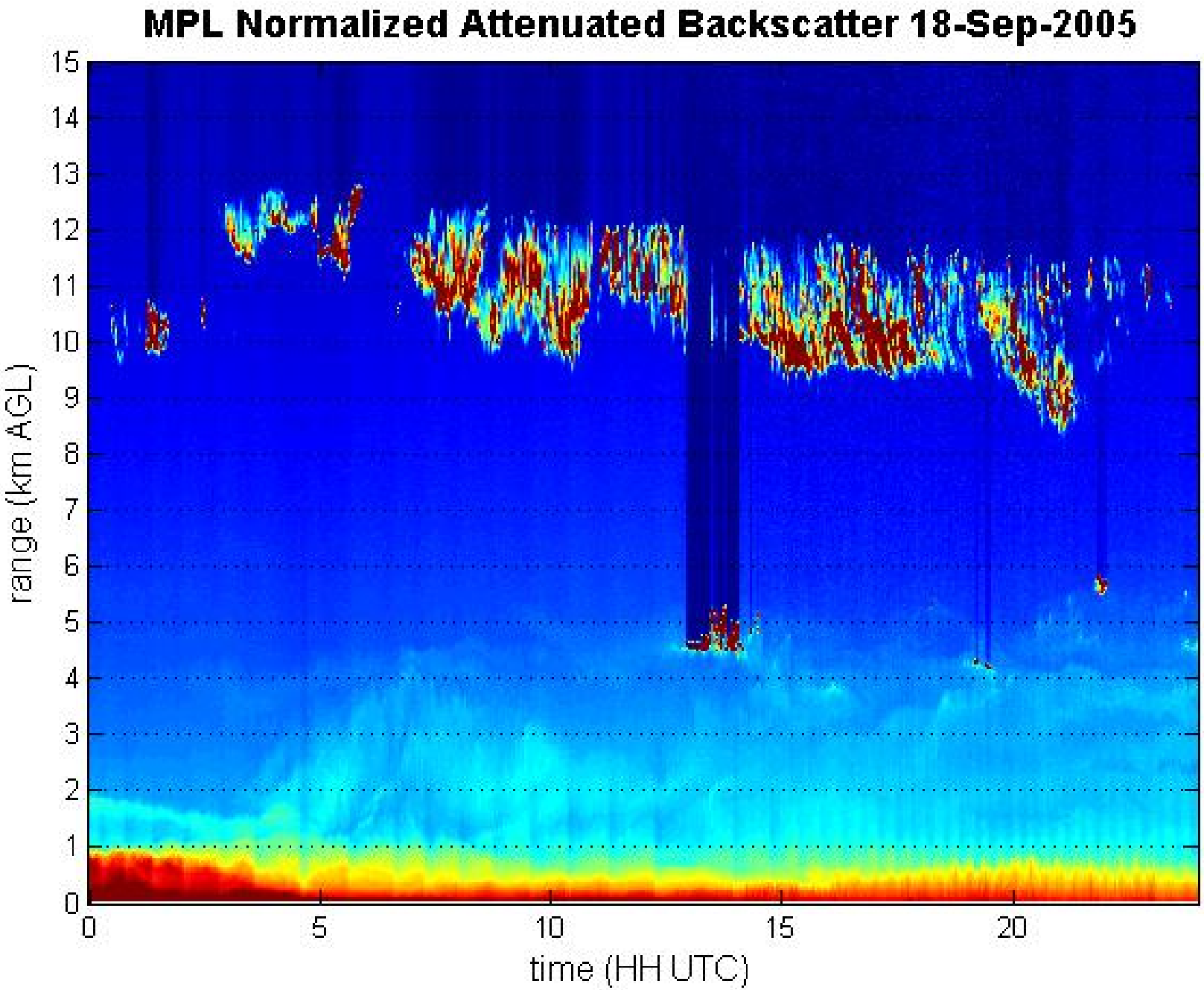


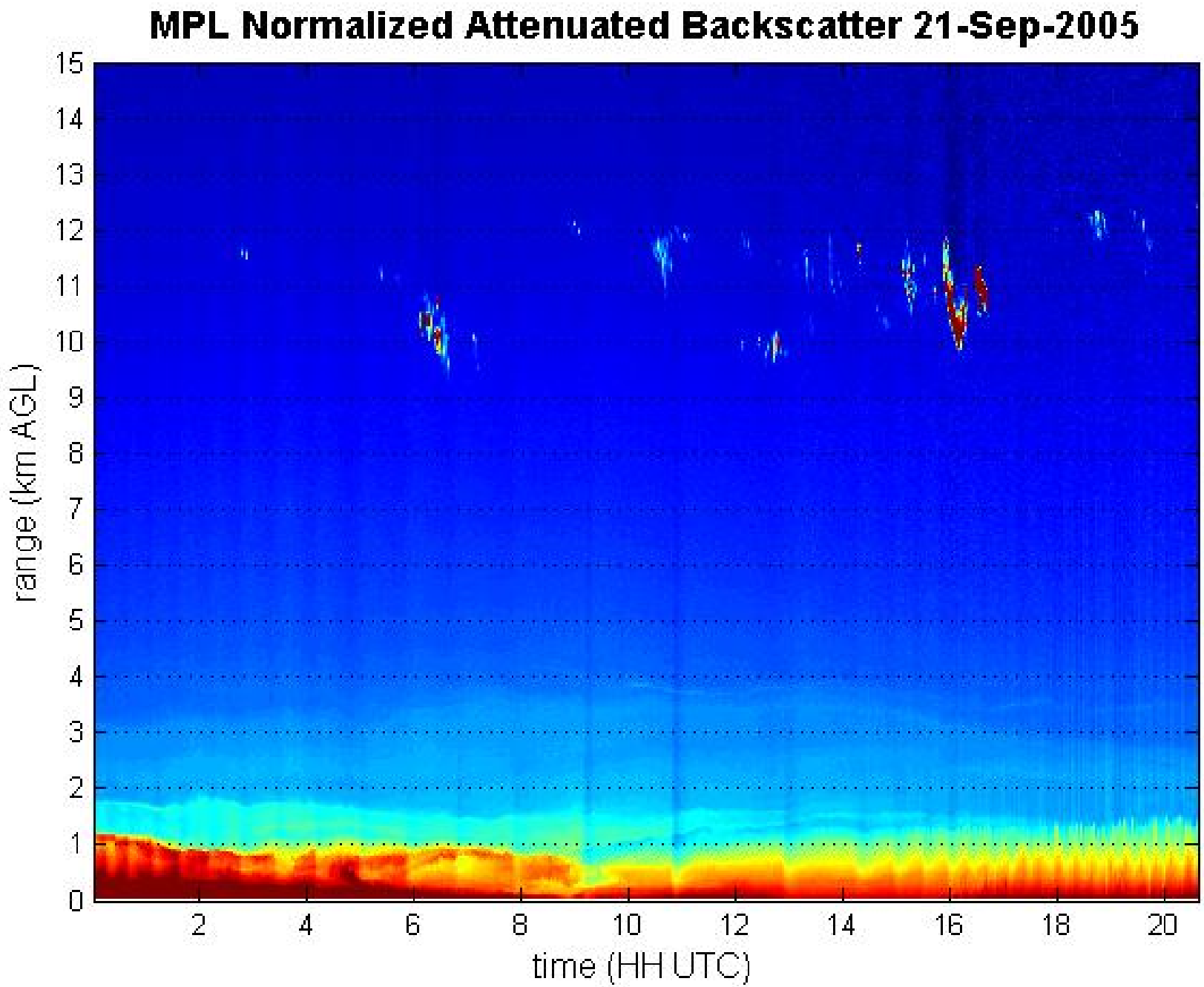
Type 2: Intercomparison Flights



J-31 Operations Summary

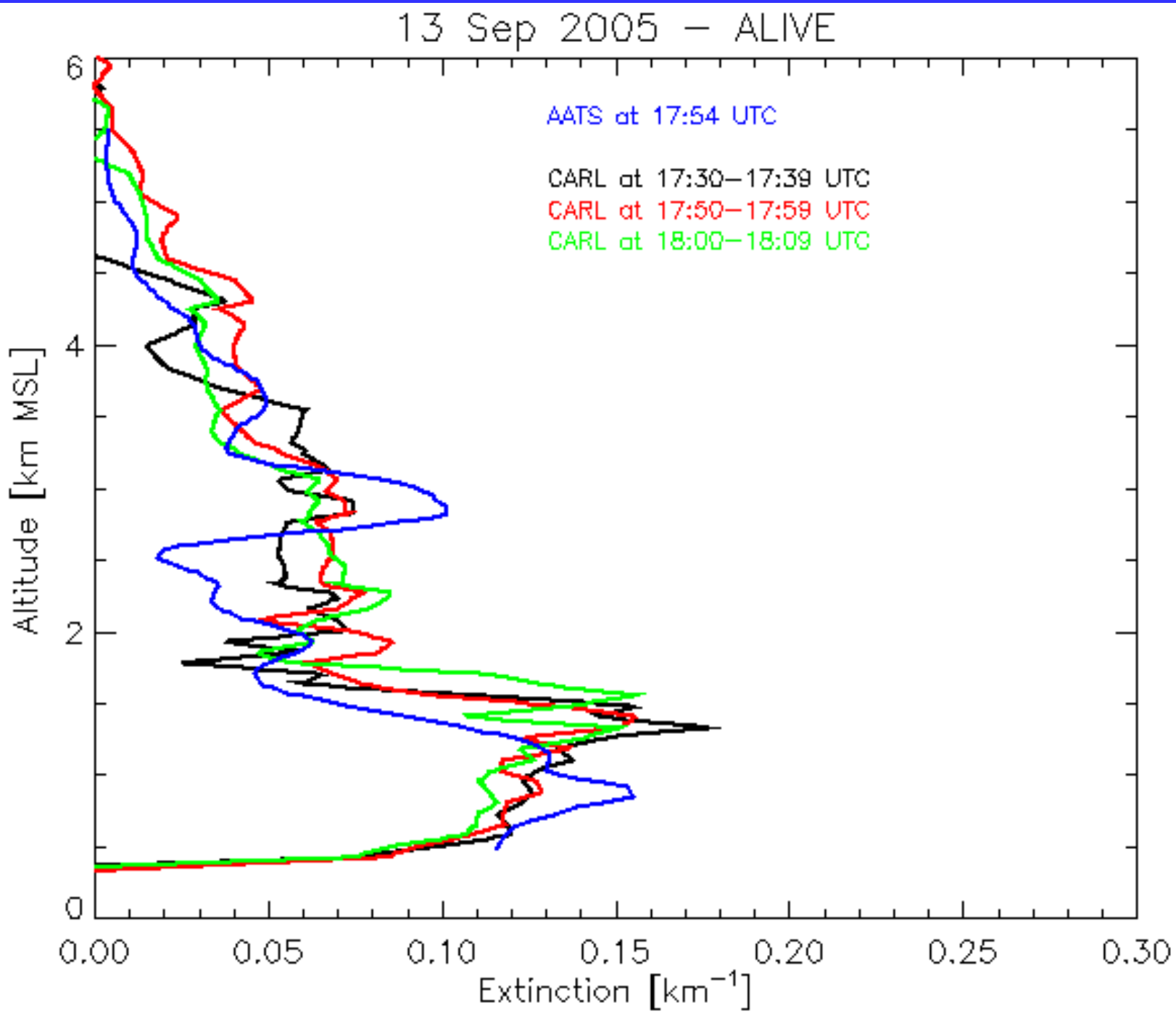
- **Flights centered on SGP CF 36.60°N, 97.48°W**
- **Timeframe: Sep. 11 – 22, 2005**
- **23 research flight hours (incl. 1 h test flight, excl. transit)**
- **12 flights over SGP on 8 days**
- **5 coordinated flights with C206**
- **Flight duration: 45 – 150 min**
- **Altitude range: 500 ft agl – 23’000 ft**
- **~40 vertical profiles over SGP CF (lidars OK all except 1)**
- **Several profiles coordinated with radio sondes**
- **Cirrus clouds**


MPL Normalized Attenuated Backscatter 18-Sep-2005
range (km AGL)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
0
5
10
15
20
time (HH UTC)


MPL Normalized Attenuated Backscatter 21-Sep-2005
range (km AGL)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
2
4
6
8
10
12
14
16
18
20
time (HH UTC)

Data Status

Instrument	Calibration	Processing	Archival
Raman	Final	In process	Not yet
MPL004	Ongoing	Data staged	Not yet
MPL102	Nearly complete	Data staged	Not yet
RSP	Between Flights	In process	Not yet
AATS-14	Pre/post MLO, high altitude legs, near final	In process	Not yet
J-31 Nav/Att	Complete	Complete	Final
J-31 Met	Complete	Complete	Not yet
MFRSR, NIMFR	Waiting	Waiting	Waiting
Cimel	Prelim	Prelim	Prelim
Sondes	Complete	Complete	Final


13 Sep 2005 – ALIVE
AATS at 17:54 UTC
CARL at 17:30–17:39 UTC
CARL at 17:50–17:59 UTC
CARL at 18:00–18:09 UTC
Altitude [km MSL]
Extinction [km^{-1}]
0
2
4
6
0.00
0.05
0.10
0.15
0.20
0.25
0.30

PI and Co-I's also thank …

- Joseph Hovelman, Gene Fish, Kevin Zimmerer, Tammi Raikes, Anne Sky
- David Groff, Dan Rusk
- Beverly Johnson, Bob Hannigan, Rosemary Ross, Jimmy Voyles
- Chuck Greenwood
- Albert Mendoza, Diane Petty
- John Ogren, Betsy Andrews, Pat Sheridan, Anne Jefferson, Bob Frisco, Kelly White
- Roy Johnson, Nicholas Truong, John Livingston, Stephanie Ramirez, Phil Russell
- Brian Cairns, Kirk Knobelspiesse, Ben Herman, Ed Russell
- Rose Dominguez, Bob Billings
- Warren Gore, Karl Schramm, Tony Trias
- Geary Tiffany, T J Forsyth, David Brown, Chris Scofield

ARM
Aerosol Working Group Meeting

Nov 30 - Dec 2, 2005

NOAA, Boulder, CO