Questions and/or consultation available through the facility manager, Dr. Al Rodi, at phone number (below) or through email: rodi@uwyo.edu

Dept. of Atmospheric Science
PO Box 3038
Laramie, WY 82071
Ph: (307) 766-4945
Fax: (307) 766-2635

REQUEST FOR UNIVERSITY OF WYOMING KING AIR SUPPORT

ASP SUMMER COLLOQUIUM

1/15/2009

GENERAL INFORMATION

Corresponding Principal Investigator

Name	**Wen-Chau Lee (EOL), Jorgen Jensen (EOL), Steven Oncley (EOL), Al Rodi (Univ. Wyo.), Steve Rutledge (CSU)**
Institution	NCAR/EOL
Address	PO Box 3000, Boulder, CO 80307
Phone	303-497-8814
FAX	303-497-2044
Email	wenchau@ucar.edu

Project Description

Project Title	**ASP Summer Colloquium**
Co-Investigator(s) and Affiliation(s)	
Location of Project	**Front Range, CO**
Start and End Dates of Field Deployment Phase	**5-6 June, 2009 +/-2 days**

Abstract of Proposed Project

(See EOL Request, atttached)

PROPOSAL SUMMARY

What are the scientific objectives of the proposed project?

Primarily educational. See EOL Request, attached.

What are the hypotheses and ideas to be tested?

Several pedagogical science questions will be investigated. See EOL Request, attached.

What previous experiments of similar type have been performed by you or other investigators?

The observations and analyses are similar to those done by the Colloquium organizers, who all are directly connected to at least one of the LAOF facilities.

Give references of results published and explain how the proposed experiment and the use of the requested facilities go beyond what has already been done.

The NSF LOAF have been used for educational purposes in the past, but never, to our knowledge, with a comprehensive suite of facilities deployed specifically for instruction.

What (if any) additional facilities (aircraft, sounding systems, radars, etc.) are expected to be used in the proposed project?

NCAR/EOL: C-130, S-Pol, ISFS, MISS
CSU: CHILL
We also will utilize operational data sets, including NWS surface observations and soundings, radar and satellite observations, and perhaps NOAA profiler network data.

How will the instruments/platforms requested be used to test the hypotheses and address each of the objectives?

Students will use to use all facilities, including experiment planning, deployment, operation, data analysis, and scientific interpretation.

What results do you expect and what are the limitations?

Future users of LOAF facilities!

Expected publication date and journal(s):

The colloquium will be documented on the WWW, including an archive of all data collected and material presented, so that they may be used for future educational uses.

Provide details about the experiment design:

See EOL request, attached, and supplemental documentation.

EDUCATIONAL BENEFITS OF THE PROJECT

List anticipated number of graduate and undergraduate students who will be involved directly and in a meaningful way in field work and/or data analysis related to this project. Briefly describe the involvement.

We expect 25 graduate students to participate.

Do you plan to enhance undergraduate and/or graduate classes with hands-on activities and observations related to this project? If yes, describe.

Developing hands-on activities are a critical element of this colloquium. These activities will be documented and made accessible for future educational use.

Do you plan any outreach activities to elementary and/or secondary school students and/or the public related to the project? If yes, please describe.

No.

Will information about the project's activities, results, data, and publications be made available via the Internet? If yes, where?

Yes, on the NCAR/EOL and/or NCAR/ASP WWW site.

PREVIOUS RESEARCH EXPERIENCE

Past airborne research support *(include all NCAR/EOL, Wyoming and other aircraft-supported projects)***:**

Aircraft	**Project Name, Year**
NCAR Electra	STREX, 1980
NCAR King Air	Momentum Flux Intercomparison, 1992
NCAR Electra, Wyoming King Air, NOAA Long-EZ	BOREAS, 1994
NASA P-3	PEM-Tropics, 1999
NCAR C-130	ACME, 2004
NCAR GV	DOCIMS, 2005

Publications resulting from past airborne research:

Parish, T.R., M.D. Burkhart, **A.R. Rodi**, 2006: Determination of the horizontal pressure gradient force using Global Positioning System onboard an instrumented aircraft. *J. Atmos. Ocean. Tech.*, **24**, 521-528.

Lawson, R.P., and **A.R. Rodi**, 1993: A new airborne thermometer for atmospheric and cloud physics research: Part 1: Design and preliminary flight tests. *J. Atmos. Oceanic Tech.* **9**, 556-574.

Brenguier, J.L., **A.R. Rodi,** G. Gordon, and P. Wechsler, 1993: Real-time detection of performance degradation of the Forward Scattering Spectrometer Probe. *J. Atmos. Oceanic Tech*, **10**, 27-33.

Rodi, A.R., J.C. Fankhauser, and R. Vaughan, 1991: A method for correcting biases in velocity, position, and wind measurements from aircraft inertial navigation systems. *J. Atmos. Oceanic Tech.*, **8,** 827-834.

Rodi, A. R., and T. R. Parish, 1988: Aircraft measurement of mesoscale pressure gradients and ageostrophic winds. *J. Atmos. Ocean. Tech.* **5**, 91-101.

Parish, T.R., **A.R. Rodi**, and R.D. Clark, 1988: A case study of the summertime Great Plains Low Level Jet. *Mon. Wea. Rev.* **116,** 94- 105.

Lemone, M.A., R.L.Grossman, R.L.Coulter, M.L.Wesely, G.E.Klazura, G.S.Poulos, W.Blumen, J.K.Lundquist, R.H.Cuenca, S.F.Kelly, E.A.Brandes, S.P.Oncley, R.T.McMillen, and B.B.Hicks, 2000, “Land-atmosphere interaction research and opportunities in the Walnut River watershed in southeast Kansas: CASES and ABLE", Bull.Amer.Meteor.Soc., bf 81, 757-779.

Oncley, S.P., D.H.Lenschow, K.J.Davis, T.Campos, and J.Mann, 1997, "Regional-scale surface flux observations across the boreal forest during BOREAS", J.Geophys.Res., 102, D24, 29147 29154.

Dobosy, R., T.Crawford, I.MacPherson, R.Desjardins, R.D.Kelly, **S.P.Oncley**, and D.H.Lenschow, 1997, "Intercomparison among the four flux aircraft at BOREAS in 1994", *J.Geophys.Res*., **102**, D24, 29101-29112.

Sun, J., D.H.Lenschow, L.Mahrt, T.L.Crawford, K.J.Davis, **S.P.Oncley,** J.L.MacPherson, Q.Wang, R.J.Dobosy, J.L.Desjardins, 1997, "Lake-induced atmospheric circulations during BOREAS". *J.Geophys.Res.*, **102**, D24, 29155-29166.

Kiemle, C., G.Ehret, A.Giez, K.J.Davis, D.H. Lenschow, and **S.P.Oncley**, 1997, "Estimation of boundary-layer humidity fluxes and statistics from airborne DIAL", *J. Geophys.Res.*, **102**, D24, 29189-29204.

Davis, K.J., D.H.~Lenschow, **S.P.Oncley**, C.Kiemle, G.Ehret, A.Giez, and J.Mann, 1997, "The role of entrainment in surface-atmosphere interactions over the boreal forest", *J.Geophys.Res.*, **102**, D24, 29219-29230.

Houze, R. A., Jr., S. S. Chen, B. F. Smull, **W.-C. Lee,** M. M. Bell, 2007: Hurricane intensity change and eyewall replacement. *Science*. **315,** 1235-1239.

Colon-Robles, M., R. M. Rauber, and **J. B. Jensen**, 2006: Influence of low-level wind speed on droplet spectra near cloud base in trade wind cumulus. *Geophys. Res. Lett.*, **33**, L20814.

Rauber, R. M., B. Stevens, H. T. Ochs III, C. Knight, B. A. Albrecht, A. M. Blyth, C. W. Fairall, **J. B. Jensen**, S. G. Lasher-Trapp, O. L. Mayol-Bracero, G. Vali, J. R. Anderson, B. A. Baker, A. R. Bandy, F. Burnet, J.-L. Brenguier, W. A. Brewer, P. R. A. Brown, P. Chuang, W. R. Cotton, L. di Girolamo, B. Geerts, H. Gerber, S. Goke, L. Gomes, B. G. Heikes, J. G. Hudson, P. Kollias, R. P. Lawson, S. K. Krueger, D.H. Lenschow, L. Nuijens, D. W. O'Sullivan, R. A. Rilling, D. C. Rogers, A. P. Siebesma, E. Snodgrass, J. L. Stith, D. C. Thornton, S. Tucker, C. H. Twohy and P. Zuidema, 2007: Rain in (Shallow) Cumulus Clouds over the Ocean - The RICO Campaign. *B. Amer. Met. Soc*., **88**, 1912-1928.

Rauber, R. M., B. Stevens, J. Davidson, S. Goke, O. L. Mayol-Bracero, D. Rogers, P. Zuidema, H. T. Ochs III, C. Knight, **J. Jensen**, S. Bereznicki, S. Bordoni, H. Garo-Gautier, M. Colon-Robles, M. Deliz, S. Donaher, V. Ghate, E. Gzeszczak, C. Henry, A. M. Hertel, I. Jo, M. Kruk, J. Lowenstein, J. Malley, B. Medeiros, Y. Mendez-Lopez, S. Mishra, F. Morales-Garcia, L. A. Nuijens, D. O'Donnell, D. L. Ortiz-Montalvo, K. Rasmussenn, E. Riepe, S. Scalia, E. Serpetzoglou, H. Shen, M. Siedsma, J. Small, E. Snodgrass, P. Trivej and J. Zawislak, 2007: In the Driver's Seat - RICO and Education. *B. Amer. Met. Soc*., **88**, 1929-1938.

Young, L.-H., D. R. Benson, W. A. Montanaro, S.-H. Lee, D. C. Rogers, **J. Jensen**, J. L. Stith, C. A. Davis, T. L. Campos, K. P. Bowman, W. A. Cooper and L. R. Lait, 2007; Enhanced new particle formation observed in the northern midlatitude tropopause region, *J. Geophys. Res.*, **112**, D10218.

Lee, S.-H., L.-H. Young, D. R. Benson, M. Kulmala, H. Junninen, T. Suni, T. L. Campos, D. C. Rogers and **J. Jensen**, 2008: Observations of nighttime new particle formation in the troposphere. *J. Geophys. Res. - Atmos.*, **113**D10, D10210.

Benson, D. R., L. H. Young, S. H. Lee, T. L. Campos, D. C. Rogers and **J. B. Jensen**, 2008: The effects of airmass history on new particle formation in the free troposphere: case studies. *Atmos. Chem. and Phys*., **8**, 3015-3024.

Smith, R. B., B. K. Woods, **J. Jensen**, W. A. Cooper, J. D. Doyle, Q. Jiang and V. Grubisic, 2008: Mountain waves entering the stratosphere. *J. Atmos. Sci*., **65**, 2543-2562.

FUNDING AGENCY INFORMATION

Funding Agency	NCAR/ASP
Contract Officer	Maura Hagan
Contract Identification	
Proposal Status	Funded
Approximate Amount Budgeted (total research)	60K (participant support)
Is support for deployment expected through NSF-LAOF deployment pool (see note below)?	Yes
If answer to above is no, provide amount budgeted for deployment costs:	

NOTE: NOT ALL NSF-FUNDED PROJECTS ARE ELIGIBLE FOR SUPPORT THROUGH THE LAOF DEPLOYMENT POOL

DATA ACCESS POLICY

UWYO King Air policy will make all King Air data publicly available once the data are quality controlled. If a PI wants to have exclusive access to these data for the first year, s/he has to officially request such a restriction via email from the flight facility manager (rodi@uwyo.edu) eight weeks prior to the start of an experiment.

Do you intend to request restricted access? No

AIRCRAFT OPERATIONS

Preferred flight period	5-6 June 2009
Number of flights required	2-4
Estimated duration of each flight	~4 hours
Number of flights per day	1-2
Preferred base of operation	Rocky Mountain Regional Airport, Colorado
Alternate base	No
Is Laramie Airport acceptable as your operations base?	No – hard to transport students in a short time period.
Average flight radius from base	50—200 nm
Desired flight altitudes(s)	500' through 25,000'
Particular part(s) of day for flights	Daytime, especially mid-afternoon (to sample convective clouds)
Statistically, how many days during specified period should be acceptable for flight operations?	2
Number of scientific observers for required each flight	As many as possible.

If the preferred base of operations is in a foreign country, is the PI aware of any factors that could impact operations from this location? Health and safety issues in particular should be noted.

N/A

Scientific rationale for the use of this aircraft in the proposed project:

See EOL request.

Description of desired flight pattern(s), priorities, and estimate number of flights for each:
(Please include graphics and flight pattern images as needed.)

Please see EOL request with five example flight plans. The flight plans are only examples as the Colloquium participants will decide on the flight plans as part of the activity. The King Air can do essentially the same flight legs as the C-130 with a small modification to account for normal research speed differences.

STANDARD AND OPTIONAL STANDARD UWYO KING AIR AIRBORNE SCIENTIFIC INSTRUMENTATION AND MEASUREMENTS

Standard Measurements

The list in Appendix 1 shows the UWYO King Air's standard measurements that are provided automatically when the King Air is allocated for a project.

Additional instruments available upon request (Optional Standard)

Before requesting optional standard instruments in this section, please consider some require additional resources and may need special data handling. The number and/or combination of instruments may exceed UWYO's personnel and/or hardware resource limits. Mark these extra, **Needed** *instruments with "yes."*

Instrument	Measurements Available	Needed
Cloud Properties		
Rosemount 871FA	• Icing Rate	Yes
DMT LWC-100	• Cloud Liquid Water	Yes
Gerber PVM-100	• Cloud Liquid Water, • Droplet Surface Area, • Droplet Effective Radius	Yes
PMS FSSP-100	• Cloud Particle Size Distribution (0.5 – 47μm; selectable) • Total Concentration, • Derived Liquid Water Content, • Derived Droplet Effective Radius, • Derived Droplet Surface Area, • Derived Mean Volume Radius	Yes
PMS OAP-200X (1DC)	• Cloud Particle Size Distribution (12.5 – 185.5 μm)	Yes
PMS OAP-2DC	• Cloud Particle Images (>25 μm) • Cloud Particle Size Distribution	Yes
PMS OAP-2DP	• Precipitation Particle Images (>200 μm) • Precipitation Particle Size Distribution	Yes

(optional standard instruments continued)

Instrument	Measurements Available	Needed
Radiative Properties		
Eppley PSP (Pyranometer)	• Up-welling and Down-welling Radiation (0.285 – 2.800 μm)	Yes
Eppley PIR (Pyrgeometer)	• Up-welling and Down-welling Radiation (3.50 - 50 μm)	Yes
Heimann KT-19.85 (Radiative Thermometer)	• IR Radiometric Surface Temperature	Yes
Exotech 100BXT 4-channel Spectrometer	• Upwelling Radiation (456 – 521 nm) • Upwelling Radiation (456 – 521 nm) • Upwelling Radiation (456 – 521 nm) • Upwelling Radiation (456 – 521 nm) *viewing angle may be set for 1 or 15 degrees by changing lenses*	
Miscellaneous Properties		
VHS Video recording	• Down-looking with date/time stamp (toggle between standard forward-looking video, *see Appendix 1*)	Yes

NON-STANDARD INSTRUMENTATION GROUPINGS

The following instrument groupings are considered non-standard and may require additional resources for preparation, maintenance, and data processing. If any of the additional measurements available in a given group are ***needed*** *mark with "yes." For each grouping that is marked yes, please fill in instrument group specific information found later in this request.*

Instrument Grouping	Measurements Available in Grouping	Needed
Fast Response Instrumentation Suitable for Flux Measurements	• Fast Response Temperature, Carbon Dioxide, and Water Vapor	Yes
Trace Gas Chemistry	• Nitrogen Oxides, Sulfur Dioxide, Ozone, Sulfur Hexafluoride, Hydrogen Peroxide	
Aerosol Properties	• Aerosol Size Distribution (0.02 to 3 μm), Total CN and CCN Concentration, Light Scattering Coefficient, Elemental Black Carbon	Yes

WYOMING CLOUD RADAR (WCR)

The Wyoming Cloud Radar is available for deployment on the UWYO King Air or other platforms with support through the LAOF Deployment Pool. Deployment of the WCR on the UWYO KA requires considerably more resources than the UWYO King Air alone. Requests for the WCR require additional information pertaining to both operational considerations and scientific justification.

Specific Technical Questions may be addressed to:
Dr. Samuel Haimov
Email: **HAIMOV@UWYO.EDU**; *Phone: (307) 766-2726*
http://www-das.uwyo.edu/wcr/

Are you requesting deployment of the WCR on the UWYO King Air for this project? *(if yes, then please fill out the remainder of this section)*

YES

RADAR OPERATIONS

Scientific rationale for the use of WCR in the proposed project:

The WCR will be used to map cumulus cloud structure for the cloud experiments. Basic measurements of

Weather events during which collection is desired:

Late spring/early summer cumulus congestus

Estimated number of flights for which the radar will be used:

2-4

Desired radar configuration and parameters *(if known)***:**

Antenna configuration (*pick one*):

Single antenna (single or dual-polarization): ____ side/up (use mirror to re-direct the beam)
Two antennas (single linear polarization): ____ down (near nadir) and down-fore
Two antennas (single or dual polarization*): ____ side/up and side-fore
Three antennas (single/dual-polarization*): __x__ side/up, down, and down-fore
Four antennas (single polarization): ____ side/up, side-fore, down, down-fore

* dual linear polarization available for side/up antenna only

Maximum range (3-4 km typical): __4__
Number of Gates (100 to 200 typical): _150___
Sampling along the beam (15 to 75 m typical): _30-70___
Sampling along the flight track (3-5 m typical): _5-20___
Minimum Sensitivity Needs (dBZ at 1 km): __-10 or better__

Scientific rationale for desired radar parameters:

Students will use data from the WCR to put into context the microphysical measurements from the aircraft. WCR measurements will provide a measurement of overall cloud depth, cloud top height, and vertical wind structure of the cloud.

SUPPORTING AND DATA SERVICES

Multiple radar coordination requirements:

If WCR will coordinate with other radars (airborne or surface), please provide brief details

Loosely. We would want S-Pol or CHILL to scan the same clouds as WCR whenever possible.

Summary of on-site radar data access and analysis requirements:

24 hour turn-around of basic radar products, reflectivity factor, aircraft-corrected Doppler velocity; availability of software to visualize radar products.

Processed data made available after quality control include 'typical' radar parameters such as reflectivity, Doppler velocity (corrected for aircraft motion), polarization parameters (ZDR, LDR, if appropriate), and three dimensional spatial reference (location and beam pointing directions). Additional products that require more extensive analyses may be available through special arrangement with UWYO but require additional funding from the project. Please contact the facility manager or the WCR radar technical contact for consultation.

Do you intend to request WCR special products?

No

Note: *Consultation with the facility manager or WCR scientist is encouraged before submitting a request that includes the WCR*.

SUPPORTING SERVICES

Will you require air-ground communication? *(If so, specify location of base station and operating frequencies, some limited communications may also be available through sat phone connections on the UWYO King Air.)*

Satcom-based

What real-time display and data services are required?

A basic data/analysis center with LAN connections to the UWYO computers and access to the internet will be provided in the field by UWYO. Support, ***if requested,*** *may include real-time communications links to the aircraft via "chat" and real-time display of selected variables through UDP data forwarding, currently supported through NCAR JOSS. Access to forecasting tools and preparations of operational forecasts are not usually included as part of this service.*

On-site data access requirement:

FAST-RESPONSE INSTRUMENTATION SUITABLE FOR FLUX MEASUREMENTS

Specific Technical Questions may be addressed to:
Dr. Robert Kelly
Email: **RKELLY@UWYO.EDU**; *Phone: (307) 766-4955*
HTTP://FLIGHTS.UWYO.EDU/BULLETIN1.HTML

Instrument	Measurements Available	Needed
*Friehe-type Air Temperature Probe w/ UWYO modifications *(Developmental)*	• Fast Response Temperature	Yes
Licor 6262	• Water Vapor • Carbon Dioxide	Yes

Please note that UWYO does not provide computation of fluxes, but rather measurements suitable for the computation of fluxes.

**Developmental instruments may require additional support*

Scientific rationale for the use of special fast response instruments in the proposed project:

We will want to describe the profile of fluxes throughout the boundary layer,

Summary of any special requirements that pertain to fast response measurements, include frequency resolution (or spatial resolution) required:

Note: *Consultation with the facility manager or technical contact is often useful and therefore encouraged before submitting a request that includes measurements utilizing the special fast-response instrumentation.*

TRACE GAS CHEMISTRY

Specific Technical Questions may be addressed to:
Dr. Jefferson Snider
Email: **JSNIDER@UWYO.EDU***; Phone: (307) 766-2637*
HTTP://FLIGHTS.UWYO.EDU/BULLETIN1.HTML

Instrument	Measurements Available	Needed
TEI model 49	• Ozone (0-1000 ppbv)	
TEI model 42S	• Nitrogen Oxides (0.1-100 ppbv)	
TEI model 43bs	• Sulfur Dioxide (1-100 ppbv)	
Scientech model LBF3	• Sulfur Hexaflouride (0-20 ppbv)	
UWYO Enzyme-fluorometric	• Hydrogen Peroxide (0-20 ppbv)	

Scientific rationale for the use of special trace gas chemical instruments in the proposed project:

Summary of any special requirements that pertain to trace gas chemistry measurements, please include spatial resolution, accuracy and precision requirements:

Note: *Consultation with the facility manager or technical contact is often useful and therefore encouraged before submitting a request that includes measurements of trace gas chemistry.*

AEROSOL PROPERTIES

Specific Technical Questions may be addressed to:
Dr. Jefferson Snider
Email: **JSNIDER@UWYO.EDU**; *Phone: (307) 766-2637*
HTTP://FLIGHTS.UWYO.EDU/BULLETIN1.HTML

Instrument	Measurements Available	Needed
TSI 3025 CPC	• UFN Concentration (> 5 nm)	Yes
TSI 3010 CPC	• CN Concentration (> 15 nm)	Yes
*TSI 3936L10 SMPS Spectrometer *(Developmental)*	• Aerosol Size Distribution (0.02-0.5 μm; 64 size bins)	
PMS PCASP-100X w/ DMT Signal Processing Package	• Aerosol Size Distribution (0.12-3.0 μm; 30 size bins)	Yes
UWYO CCNC-100A	• CCN Concentration (0.2% - 1.6% S)	
Radiance Research M903 Nephelometer	• Light Scattering Extinction Coefficient @ 530 nm	
*Magee Scientific AE16 Aetholometer *(Developmental)*	• Elemental Black Carbon	

**Developmental instruments may require additional support*

Scientific rationale for the use of special trace gas chemical instruments in the proposed project:

Summary of any special requirements that pertain to trace gas chemistry measurements, please include spatial resolution, accuracy and precision requirements:

Note: *Consultation with the facility manager or technical contact is often useful and therefore encouraged before submitting a request that includes measurements of aerosol properties.*

APPENDIX I: UWYO KING AIR

Standard Airborne Scientific Measurements

Instrument list with range, accuracy, and resolution can be found at:
http://flights.uwyo.edu/base/InstList.pdf

I. TIME

Name	*Units*	*Description*
HOUR	hr	Slaved to GPS time (GMT)
MINUTE	min	Slaved to GPS time (GMT)
SECOND	sec	Slaved to GPS time (GMT)
TIME	hhmmss	Slaved to GPS time (GMT)
DATE	yymmdd	Slaved to GPS time (GMT)
base_time	s	Reference Start Time (UNIX time format)
time_offset	s	Offset from Reference Start Time

II. INERTIAL REFERENCE SYSTEM (Honeywell Laseref SM IRS)

Name	*Units*	*Description*
hlat, LAT	degree_N	Inertial Latitude
hlon, LON	degree_E	Inertial Longitude
hthead	degree_T	Aircraft True Heading Angle
hpitch	degree	Aircraft Pitch Angle
hroll	degree	Aircraft Roll Angle
hyawr	radian s^{-1}	Aircraft Yaw Angle Rate
hpitchr	radian s^{-1}	Aircraft Pitch Angle Rate
hrollr	radian s^{-1}	Aircraft Roll Angle Rate
hlata	g	Aircraft Lateral Acceleration (body axis)
hlonga	g	Aircraft Longitudinal Acceleration (body axis)
hnorma	g	Aircraft Normal Acceleration (body axis)
hivs	m s^{-1}	IRS-Computed Aircraft Vertical Velocity
hgs	m s^{-1}	Inertial Ground Speed
htrk	degree_T	Inertial Ground Track Angle
hewvel	m s^{-1}	Inertial Ground Speed Vector, East Component
hnsvel	m s^{-1}	Inertial Ground Speed Vector, North Component

III. GLOBAL POSITIONING SYSTEM (GPS, Ashtech Z-Sensor)

Name	*Units*	*Description*
GLAT	degree_N	GPS Latitude
GLON	degree_E	GPS Longitude
GALT	m	GPS Altitude

IV. ALTITUDE AND POSITION

Name	*Units*	*Description*
ralt1	m	Geometric (Radar) Altitude (King) (0-610 m)
ralt3	m	Geometric (Radar) Altitude (APN232)
z, PALT	m	Pressure Altitude (Std Atm)
ztrue	m	Altitude (Hypsometric)
hi3	m	IRS Altitude, (Baro-loop corrected)
LATC	degree_N	IRS Latitude, GPS-Corrected
LONC	degree_E	IRS Longitude, GPS-Corrected
xdist	km	Distance East from ‘Center Coordinate’
ydist	km	Distance North from ‘Center Coordinate’
xerr	km	Position Error (east component); IRS-GPS difference
yerr	km	Position Error (north component); IRS-GPS difference

V. VELOCITY AND ACCELERATION

Name	*Units*	*Description*
hacz3	$m\ s^{-2}$	Vertical Acceleration (Baro-loop corrected)
hwp3	$m\ s^{-1}$	Vertical Speed (Baro-loop corrected)
uerr	$m\ s^{-1}$	Velocity Error (east component; subtract from ‘hewvel’)
verr	$m\ s^{-1}$	Velocity Error (north component; subtract from ‘hnsvel’)

VI. AIRCRAFT AND METEOROLOGICAL STATE PARAMETERS

Name	*Units*	*Description*
alpha	degree	Attack Angle
beta	degree	Sideslip Angle
pmb	mb	Static Pressure (Rosemount 1201)
ps_hads_a	mb	Static Pressure (Rosemount HADS)
ps_had_b	mb	Static Pressure (Rosemount HADS)
dpa	mb	Differential Pressure Normal (body axis)
dpb	mb	Differential Pressure Lateral (body axis)
dpr	mb	Differential Pressure (approximately Q for zero sideslip and attack)
aias	knots	Indicated Airspeed, pilot pitot
bias	knots	Indicated Airspeed, co-pilot pitot
tas, TASX	m/s	Aircraft True Airspeed
torque	ft lbs	Left Engine Torque
turb	MKS	Turbulence

VII. THERMODYNAMIC MEASUREMENTS

Name	*Units*	*Description*
trf	C	Ambient Temperature (Reverse-Flow)
trose	C	Ambient Temperature (Rosemount 102)
tdp	C	Dew Point Temperature (Cambridge model 137C3 chilled mirror)
thetad	K	Potential Temperature (dry)
thetae	K	Equivalent Potential Temperature
rh	%	Relative Humidity
mr	$g\ kg^{-1}$	Mixing Ratio

VIII. WINDS

Name	*Units*	*Description*
hu	m s	Wind Vector, East Component
hv	m s	Wind Vector, North Component
hw	m s	Wind Vector, Vertical Component
hwf	m s	Wind Vector, Vertical Component (high-pass filtered)
hwmag	m s	Horizontal Wind Speed
hwdir	degree_T	Horizontal Wind Direction
ux	m/s	Wind Vector, Longitudinal Component
vy	m/s	Wind Vector, Lateral Component

In addition to the above listed standard measurements, also provided are the following as part of the standard flight log:

VHS Video recording	Forward-looking with date/time stamp (may be replaced with down-looking video; see optional standard measurements section)
Audio recording	Full flight record of King Air intercom and radios
Event markers	Multiple event markers set by flight crew