REQUEST FOR LAOF FACILITY SUPPORT
MESOSCALE PREDICTABILITY EXPERIMENT (MPEX)
NCAR/EOL - SPRING 2012 OFAP MEETING

Submitted on 27 December 2011

PART I: GENERAL INFORMATION

A. Corresponding Principal Investigator(s)

Name	**Dr. Morris L. Weisman**
Institution	NCAR
Address	Boulder, CO
Phone	303-497-8901
Email	weisman@ucar.edu
Co-Investigator(s) and Affiliation(s)	Dr. Jeff Trapp, Purdue University; Drs. Chris Davis, Chris Snyder, Glen Romine, Jenny Sun, Tom Galarneau, NCAR; Drs. Lance Bosart and Ryan Torn, The University at Albany/SUNY; Drs. Clark Evans and Paul Roebber, University of Wisconsin/Milwaukee; Dr. Russ Schumacher, Colorado State University; Drs. David Stensrud, Jack Kain, Mike Coniglio, NOAA National Severe Storms Laboratory; Drs. John Brown and David Dowell, NOAA; Dr. Charles Doswell III, CIMMS

B. Project Description

Project Title	**MPEX (Mesoscale Predictability Experiment)**
Location of Project	JeffCo
Start and End Dates of Field Deployment Phase	**15 May 2013 – 15 June 2013**
NSF Facilities requested	**GV, GPS Dropsondes, MTP**
Funding Agency and Program Officer Name(s)	**NSF/AGS**
Proposal(s) affiliated with this request	**See attached list**
Proposal Status	In preparation (x), submitted (), funded ()
Do you expect other, non-NSF support? If yes, from whom?	No
Is this a resubmission of a previous request?	No
Is this a multi-year deployment or a request for a follow-on field campaign?	No

C. Abstract of Proposed Project

(Please attach the one-page summary of your NSF/agency proposal)

This proposal outlines our request for the use of the NCAR GV, along with the new Airborne Vertical Atmospheric Profiling System (AVAPS) dropsonde system and the Microwave Temperature Profiling (MTP) system, for a field project named the Mesoscale Predictability Experiment (MPEX) to be conducted within the U.S. Great Plains during the late spring/early summer of 2013. MPEX is motivated by the basic question of whether experimental, sub-synoptic observations can extend convective-scale predictability and otherwise enhance skill in regional numerical weather prediction over a roughly 6 to 24 hour time span.

The region of interest extends from Nevada eastward to the Mississippi River, and South Dakota/Wyoming southward through Texas (e.g., Fig. 1; approximately 32.5°- 42.5° N latitude, 90°-115°W longitude). Basic operations will tentatively involve two missions a day: an early morning mission (~3:00 am – 10:00 am) primarily over the intermountain region and high plains, and a late-afternoon and early evening mission to the lee of the mountains. The morning dropsonde and MTP data will offer us an unprecedented opportunity to examine the practical predictability of convective storms later that day for a region of the country that is especially prone to severe convective weather. The observations in the evening will provide us with documentation/verification of the evolution of mesoscale and subsynoptic features to the lee of the mountains as well as offering unique insight into how different storm types modify their nearby environments and influence the development of subsequent convective storms.

Our experimental plan is guided by the following two scientific hypotheses:

Hypothesis 1: Enhanced synoptic and sub-synoptic scale observations over the intermountain region during the early morning will significantly improve the forecast of the timing and location of convective initiation as well as convective morphology and evolution during the afternoon and evening to the lee of the mountains and over the High Plains.

Hypothesis 2: Enhanced sub-synoptic scale observations in the late afternoon, over regions where the atmosphere has been/is being convectively disturbed, will significantly improve the 12-24 hr forecast of convection initiation and evolution in downstream regions. Enhanced observations of convective storm-environmental feedbacks will correspondingly improve the synoptic-scale forecast.

We will be interested in conducting operations such that we sample environments supportive of, and then disturbed by, a range of convective organization, scale, intensity, and areal coverage. A project of 4 weeks duration, from 15 May to 15 June, is proposed. This time period is preferred due to the known high frequency of significant convective outbreaks over the Great Plains region during this period (an average of 15 per year), and also due to the fact that such outbreaks are still often associated with synoptic and sub-synoptic scale forcing features propagating eastward from the nominally poorly sampled intermountain regions. Thus, we would be confident on being able to collect data on at least 10 days, which will be sufficient for our respective research interests.

Our proposed observational strategy will be to release 28 to 32 dropsondes each mission from an altitude of about 40,000 ft over a grid of spacing ~ 75-200 km. MTP observations will continuously sample the temperature structure through the mid- and upper troposphere in conjunction with the dropsonde data, enhancing the representation of any mesoscale or sub-synoptic scale features along the plane's path. The dropsonde and MTP data will be incorporated into data assimilation experiments using a variety of techniques (3DVAR, ENKF, etc.) to establish the potential benefits of such enhanced observations.

D. Experiment Design

(Please provide details about the experiment design. How will the instruments/platforms requested be used to test the hypotheses and address the objectives? What previous experiments of similar type have been performed by you or other investigators? 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. If this is a re-submittal of a request, please address all concerns and questions raised in the "Confidential Comments and Feedback to PI" portion that was provided with the notification letter.)

Our experimental design requires observations that are sufficiently dense (typical spacing ~75 to 200 km) to sample short-wave troughs and ridges, low-level jets, dry intrusions, potential vorticity streamers, and other mesoscale phenomena in the pre-storm environment, as well as the modification of environment proximate to active and decaying storms. Operational full-tropospheric kinematic and thermodynamic measurements are too sparse, especially over the intermountain regions, to resolve many of these features thought to be critical for convective forecasting (e.g., Fig. 1). Although satellite-derived profiles are a promising mesoscale data source, these profiles do not yet have the vertical resolution thought to be necessary for convective forecasting.

Therefore, an observational strategy involving in situ (dropsondes) and MTP measurements is proposed. GPS dropsondes deployed from aircraft represent the best technology available for targeting different geographical regions from day-to day, and obtaining the required horizontal and vertical resolution of observations throughout the troposphere to meet the MPEX scientific objectives. The successful use of dropsondes during BAMEX (e.g., Davis et al., 2004; Davis and Trier, 2007; Trier and Davis, 2007; Storm et al., 2007) and PREDICT (Montgomery et al., 2012) demonstrates the value and feasibility of this observational strategy.

Airborne MTP measurements offer an additional capability of obtaining a continuous vertical profile of atmospheric temperature (or potential temperature), extending 6-8 km above and below the aircrafts altitude, along the aircrafts path. This technique has been quite useful in identifying the height of the tropopause as well as identifying mid-tropospheric baroclinic zones. During PREDICT, it was shown that MTP observations could also identify more subtle (e.g., 1-2 K) temperature variations (Chris Davis, personal communication), as might be critical for identifying the type of weaker mid- and upper-tropospheric mesoscale features thought to be important for convective triggering. As such, MTP data will likely be able to significantly enhance the characterization of atmospheric structure between dropsondes, thereby increasing the effective resolution of the observational data set even further.
In conjunction with this, we also hope to take advantage of d-value mapping of the difference between pressure altitude and GPS, to provide further fine scale measurements of the pressure field along the

flight path. Accessing MTP and the d-value data in realtime would be especially useful for identifying and refining regions for enhanced dropsonde density during flights, as described further below.

The NSF/NCAR Gulfstream V (GV) is the requested platform for deploying dropsondes and MTP during MPEX. Since two major deployments of the dropsonde aircraft, separated by 3-4 h, are being requested, a double crew will likely be needed to support dropsonde deployments.

The nominal daily schedule for data collection is as follows:

- Early morning (~09-17 UTC): Pre-convective dropsonde (**D-R**) and MTP deployment to establish upstream conditions for anticipated later convection. (See Fig. 1)

- Late afternoon and evening (~21-03 UTC): pre-storm and post-storm dropsonde (**C-A, C-B**) and MTP deployment to resample the upstream storm environment in the lee of the mountains, and to sample the modified mesoscale environment surrounding existing storms or storm systems. (See Fig. 2)

The dropsonde and MTP deployments will occur for all days for which a significant convection is anticipated. Dedicated dropsonde coordinators will guide the various deployment efforts from an MPEX operations center at JEFFCO. The various deployment strategies are described in detail below.

A. Type **D-R** (regional)

The goal of deployment (**D-R**) is to establish upstream early morning conditions for anticipated later convection. Observations will be taken between 09 and 17 UTC to enhance the standard NWS operational 12 UTC analysis. This strategy supports Hypothesis 1.

The full domain of interest for this deployment is depicted on Fig. 1, and primarily includes eastern Utah, eastern Arizona, Wyoming, Colorado, New Mexico, Texas, along with Nebraska, Kansas and Oklahoma. A sub-domain of roughly 600 by 1000 km will be chosen for each typical one day Intensive Observing Period (IOP) depending on the meteorological scenario (mean flow direction and speed, moisture source, etc.) as well as specific features of interest (e.g., regions of enhanced upper tropospheric PV, persistent cloud bands evident from satellites, etc.). Given a mean propagation speed for a sub-synoptic feature of 10-15 m s^{-1}, observations would be needed 400 to 600 km upstream of the anticipated region of convective initiation for a 12-h forecast. Thus, features as far west as eastern Utah and Arizona and south-central Texas could be candidates for the enhanced observations.

The Type **D-R** strategy (Fig. 1) involves dropping 28-32 sondes on a variable grid covering the specified sub-domain, with the drop spacing ranging between 75 and 250 km, with the highest density of dropsonde observations being centered on a targeted subsynoptic feature of interest. A 75-km grid spacing for dropsondes will nominally be able to resolve features with a scale of 300 km or greater, which is much finer than is allowed by the existing observational NWS sounding network over the region of interest (e.g., Fig. 1). The addition of MTP data will help to further refine the thermodynamic structure of any features of importance along the aircraft path. Such a density of full tropospheric observations has never been available for such purposes upstream of the high and central Plains of the US. This observing strategy will be able to document the suspected role of poorly observed and/or initialized sub-synoptic features over the intermountain region on subsequent severe convective outbreaks.

Although a uniform and or nested grid of dropsondes at this scale is preferable, the investigators understand that adjustments may be necessary in identified no-drop zones based on population, military, or domestic en route or approach air traffic flow constraints without significantly compromising the value of the dataset. We will work with EOL RAF flight personnel to identify the key no-drop zones ahead of time to ease with project planning and feasibility assessments. Also, drop sites will be chosen so as to not overlap with existing NWS sites to maximize the value-added of the deployment strategy. We have read the RAF policy on dropping objects from aircraft and will work with the RAF to make sure the policy and procedures are followed for MPEX.

A flight altitude of 12 km (40000 ft) is requested for all drops to allow for the sampling of deep-layer shear, stability, and moisture, as well as to characterize upper/mid tropospheric features that may be important for subsequent convective initiation. Given a 600 x 1000 km grid and an aircraft speed of 440 kt, the proposed distance covered would be about 5000 km, and would take approximately 6.5 h to complete (plus approximately 2 hours for takeoff, ferry, and landing). The requested drop increment would generally range from 6 min for specific targeted features to 20 min for the coarser drop regions, as noted above. MTP observations would be taken continuously along the aircraft track to help characterize the atmospheric structure between dropsonde locations, and to help make in-flight modifications of droposonde density.

Go-no go decisions for day 2 Type **D-R** deployments will be based on 24-36 h forecasts from the 12 UTC operational and experimental forecast models, and will be decided by 18 UTC on day 1. An initial grid of requested specific east-west legs and drop locations will be available by 21 UTC, but it would be beneficial to be able to further adjust the drop density on the pre-specified east-west legs in the morning, to account for updated observations for any specific features of interest. A nowcaster and PI will continuously monitor the weather during the morning flight, to adjust dropsonde locations within any predetermined constraints and also to avoid any potentially hazardous flight conditions. Since convective activity tends to be minimal over the intermountain region at that time of the day, weather-related hazards are generally not expected to be a significant concern during these early morning flight patterns. IOP days will be selected based on a moderate/high expectation of significant convective weather to the lee of the mountains and on the High Plains later in the afternoon and evening.

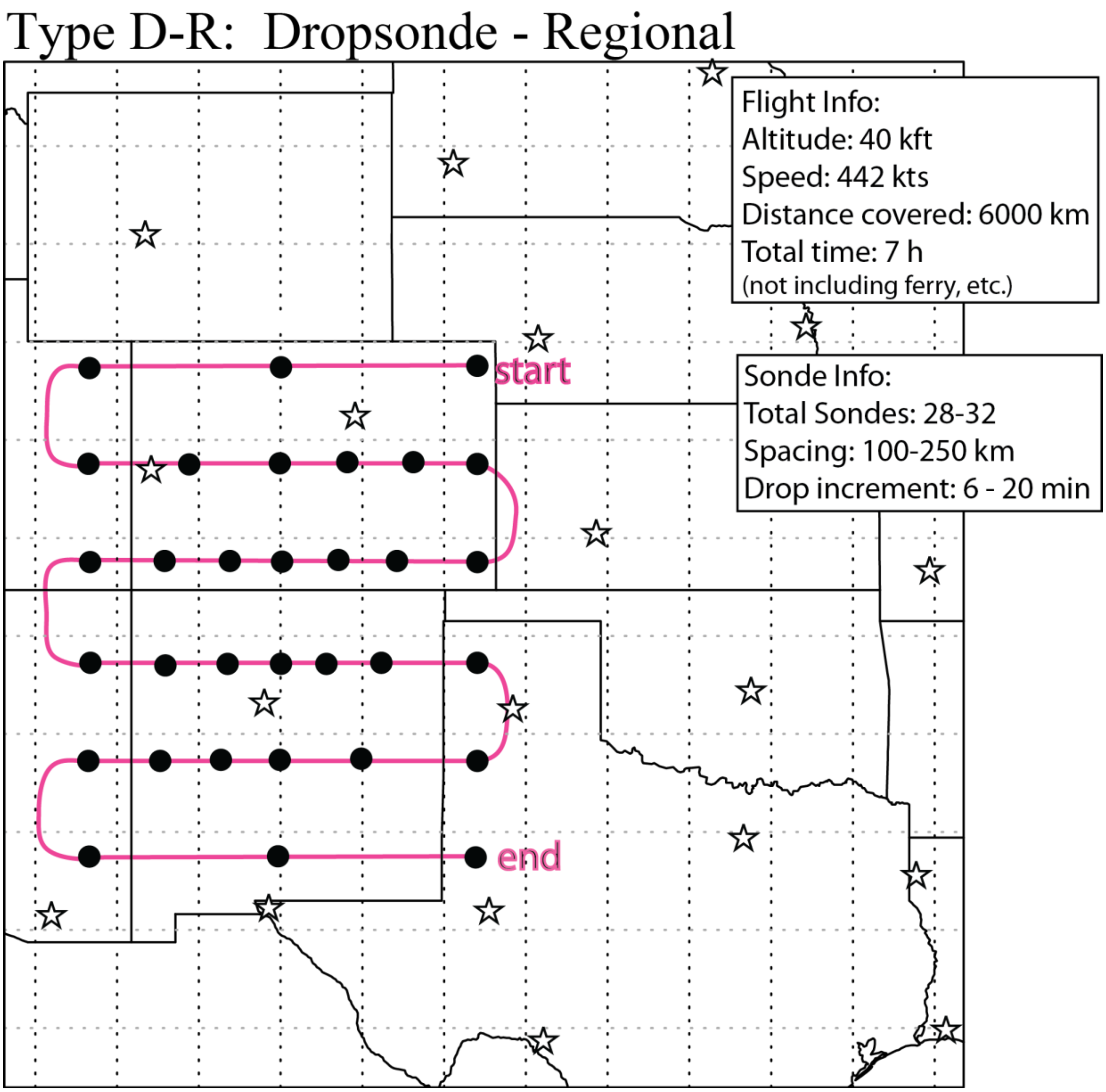


Figure 1. Example flight pattern and GPS dropsonde locations for the Type D-R deployment strategy. Actual sonde locations can be shifted to account for local factors (e.g. population centers, airports, etc.). Stars indicate locations of existing operational National Weather Service soundings. MTP observations would be requested continuously along the aircraft path.

Type **C-A** (pre-storm-environment)

The goal of the Type **C-A** deployment is to sample the mesoscale environment in the mid-to-late afternoon on the plains to the lee of the mountains over a region targeted for anticipated convective initiation. This strategy supports Hypotheses 1-2.

The Type **C-A** strategy (Fig. 2) would request the dropsonde aircraft to fly at 12 km (40000 ft) AGL, to observe the nearly full tropospheric structure prior to convective initiation. However, a flight level of 29000 ft or slightly lower could be considered to avoid conflicts with en route air traffic. The MPEX investigators will work with the RAF pilots to consider viable options for dropsonde releases supporting this objective.

The flight pattern would consist of a roughly square spiral focusing in towards the expected location of convective initiation. Approximately 12 sondes would be dropped using a nominal spacing of 100 - 175 km and drop increment of 8 - 13 min. The total distance covered by the spiral would be approximately 1400 km. Assuming an airspeed of 440 kt, it is anticipated that this pattern would take about 2 h to complete, not including ferry time, etc.

Targeted regions for this afternoon flight could be located anywhere within the regional domain included in Fig. 2.1, in the lee of the mountains, but will generally be located downwind of the morning observational domain. An initial target, with proposed dropsonde locations, will be identified by 9:00 am, but it would be beneficial to be able to update this plan just prior to aircraft takeoff, to account for evolving weather conditions. Anticipated takeoff time for this flight would generally be between 1:00 and 2:00 pm, but could be delayed to as late as 3:00 pm. Nowcasting support will be critical for monitoring and avoiding developing convection.

Type **C-B** (storm-environment modification)

The goal of the Type **C-B** deployment is to sample the mesoscale environment in the mid-to-late afternoon or evening surrounding storms once they develop. This strategy supports Hypothesis 2 and related questions regarding storm-environment feedbacks.

The Type **C-B** strategy (Fig. 3) represents a continuation of Type C-A plan, once convection has begun to develop and is considered appropriate for further sampling (e.g., relatively isolated, etc.). A flight level of 40000 ft AGL would again be considered optimal for observing the nearly full tropospheric modifications produced by the convection. However, a flight level of 29000 ft could again be considered if air traffic issues were a concern. The basic flight pattern would consist of an outward square spiral surrounding the developing and maturing convective cells. Approximately 18 sondes would be dropped using a nominal spacing of 75-125 km and drop increment of 6 - 12 min. Nowcasting support will be critical for monitoring and avoiding active convective regions. In flight strategy adjustments would likely be needed to avoid electrically active regions and newly developing convective cells. The total distance covered by the spiral would be approximately 1400 km. Assuming an airspeed of 440 kt, it is anticipated that this pattern would take about 2 h to complete, not including ferry time, etc. If convection does not develop as anticipated in the targeted region, or becomes too widespread for observational purposes, then the C-B plan will be aborted, and the G-V will return to base. Flight operations will all be completed before sunset.

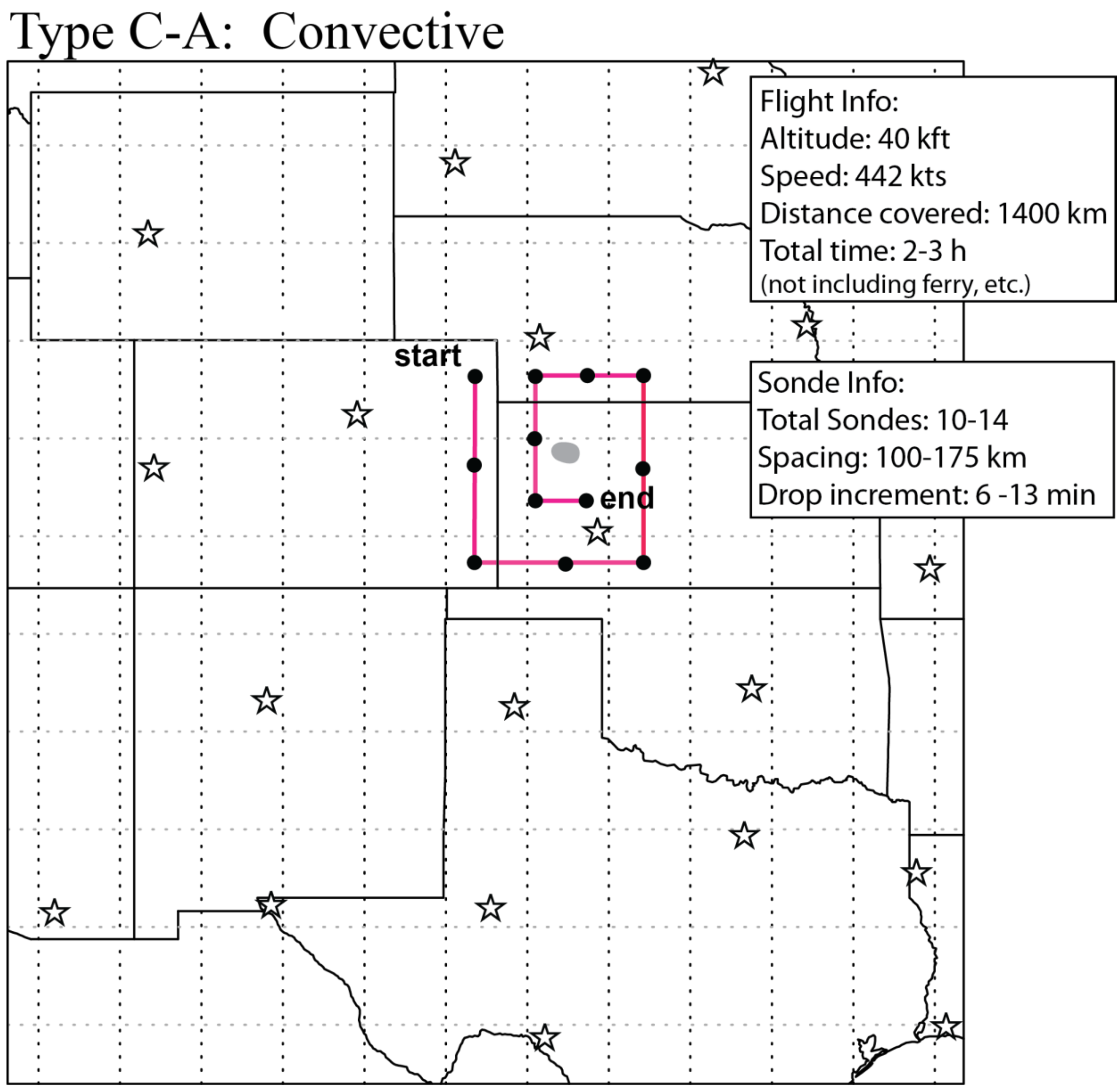


Figure 2. Example flight path and GPS dropsonde locations for the Type C-A strategy, which focuses on documenting the pre-storm environment for a targeted region during the mid- to late-afternoon observational period. The small shaded region indicates the anticipated location for initial convective development. Actual sonde drop locations can be adjusted to take into account local factors (e.g. population centers, airports, etc.).

Type C-B: Convective

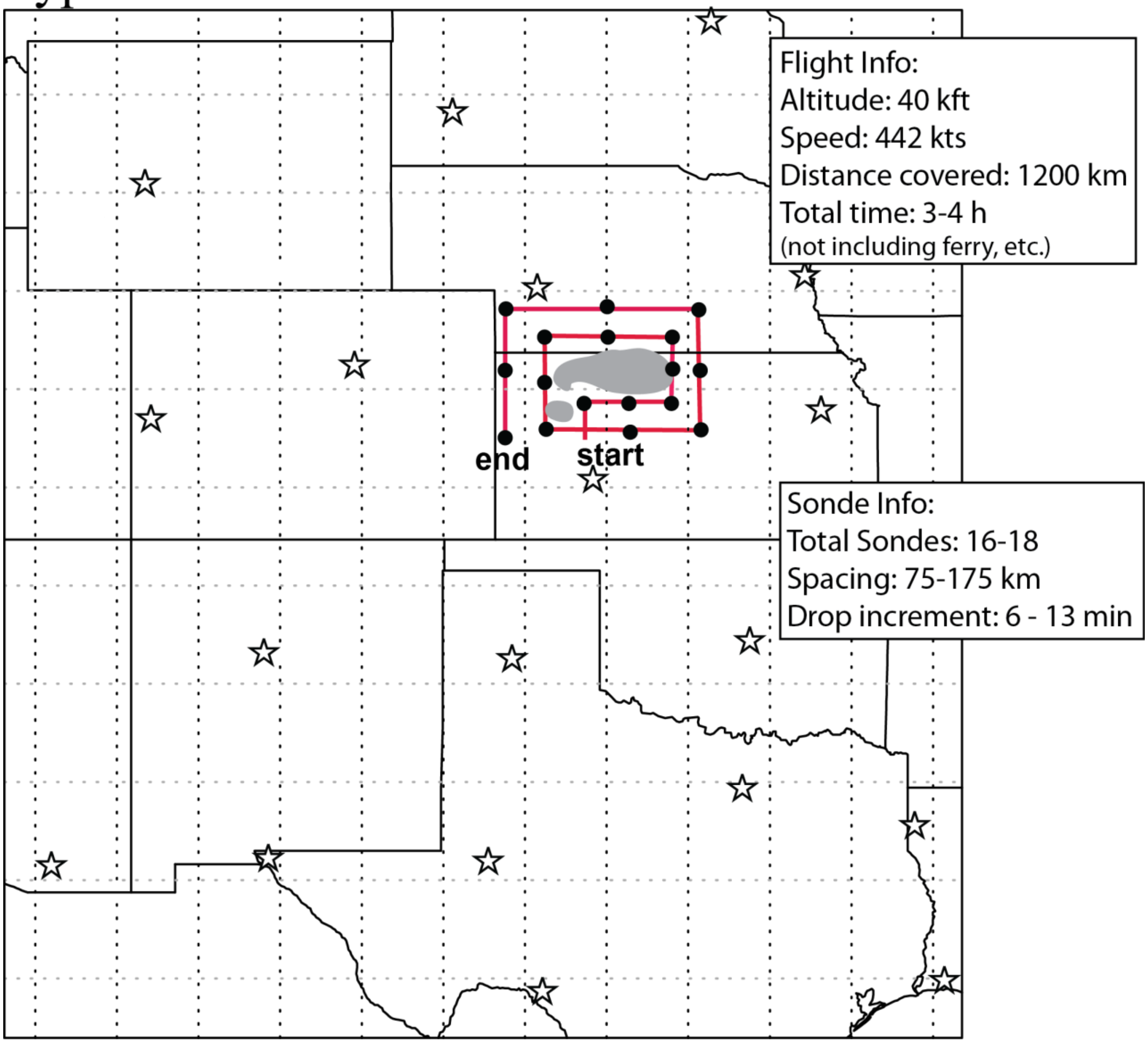


Figure 3. Example flight path and GPS dropsonde locations for the Type C-B strategy, which focuses on storm-environment feedbacks for the targeted region identified in Fig. 2, once convection begins to develop. The shaded regions depict a hypothetical maturing convective storm, with a new storm developing to its southwest. Actual sonde drop locations can be adjusted to take into account local factors (e.g. population centers, airports, etc.).

<u>Total number of dropsondes and flight hours required</u>

We are requesting 10 IOPs for the **D-R** deployment. Assuming 30 dropsondes per deployment, this would require 300 dropsondes. At 8 hours per mission, a total of 80 flight hours is requested for the 10 IOPs

We are requesting 10 IOPs for the **C-A, C-B** deployments. Assuming 25 dropsondes per deployment (given that several of the C-B missions may be aborted due to either a lack or excess of convective development), this would require approximately 250 dropsondes. At 6 hours per mission, a total of 60 flight hours is requested for the 10 IOPs

Total Dropsonde Request: (Type **D-R**, **C-A and C-B** deployments)
Flight Hours: 140
Dropsondes: 550

Finally, as with all field campaigns, there is some uncertainty in our deployment strategies, and therefore we will conduct a pre-field phase exercise. This real-time dry run exercise will be used to help build experience in dropsonde domain identification and otherwise refine the strategies.

Publications resulting from EOL support (including EOL-managed data) within the last five years:

Project Name and Year	Facilities used	Publication Citation
BAMEX	Lear Jet, Dropsondes, MGAUS, P3, Eldora	Davis et al. 2004: The bow echo and MCV experiment (BAMEX): Observations and opportunities. Bull. Amer. Meteor. Soc., 85, 1075-1093.
PREDICT		

E. Educational and Outreach Activities

(Please 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, how you plan to enhance undergraduate or graduate classes with hands-on activities and observations related to this project; and if you will conduct outreach activities for K-12 and the public.)

Graduate students will be involved in the pre-field phase exercise, data collection, analysis, and subsequent model experimentation. K-12 and public outreach activities centered about the G-V will be coordinated through UCAR Communications.

(Do you require assistance with additional education and outreach activities?) *NO*

PART II – OPERATIONAL CONSIDERATIONS & LOGISTICS

Approx. how many people will be involved in the field campaign? *Please specify number of participants and location(s).*	30 (not all at OPS Center)
What other facilities/platforms outside the EOL suite will be deployed? Are any of them non-US facilities?	None
Are complex inter-facility or inter-agency permissions required for flight operations and/or other facility operations that would benefit from EOL leadership and experience?	No
Is there a need for integrated diplomatic arrangements? *(e.g., customs, immigration, focal point with local hosts/governments)*	No
If there are multiple instrumentation/operations sites, is there a need for operational coordination?	No
What kind of real-time data display and project coordination needs do you anticipate?	Field catalog, mission coordinator display, communications coordination
Is forecasting support required for project operations?	Yes. We will supply.
What kind of communications capabilities do you expect on site? *(e.g., bandwidth)*	Communication between OPS center and aircraft (voice and data)
Will operations center and real-time display and coordination services be required? [1]	Yes
Will you require work space? *(e.g., office, lab and storage space)*	No
Will you require system administration support on site?	No
Is there a need for coordinated shipping, lodging or transportation? *(especially if this is an international project)*	No
Will you be shipping hazardous/radioactive material?	No
Will you be shipping expendables? (e.g., radiosondes to local NWS offices)	No
Do you require assistance with various planning and support activities/services? *(e.g., help with Air Traffic Control, organizing of workshops, meetings, site surveys, leases, permits)*	Yes. Assistance with Air Traffic Control, approval for dropsonde locations, Mission coordinator display, etc.

[1] *A basic data/analysis center with LAN connections to the EOL computers and access to the Internet will be provided in the field by EOL. Support will include real-time communications links to the facility via "chat" and real-time display of selected variables via web site links. Access to forecasting tools and preparations of operational forecasts are not usually included as part of this service. These services are presently not supported by the NSF Deployment Pool. Funds to support its deployment currently must be obtained from separate sources, such as NSF Special Funds. For more information, please contact the CDS Facility Manager.*

PART III: DATA MANAGEMENT

What operational data do you need? *(e.g., satellite, upper air, radar, surface, oceanographic, hydrological, land characterization, model products)*	**Satellite, upper air, radar, surface, model products**
Do you have any specific real-time data needs to aid in your data collection activities?	**Real time aircraft tracks overlaid on satellite and radar displays**
Is there a requirement for a local satellite receiver to acquire local or real time polar orbiter or high resolution geostationary satellite data?	**No**
Beyond the EOL dataset, will you or your Co-PIs provide additional research data to the project?	**Perhaps**
What data analysis products will you provide during the deployment?	**Real time, high resolution convective forecasts with WRF-ARW**
What other research data and products do you need?	**None**
Is an EOL Field Catalog needed to provide real-time information management, reporting, decision dissemination, data exchange and resource monitoring?	**Yes.**
Do you plan on moving a large amount of data back to your home institution during the project?	**No**
What arrangements have been made for a comprehensive data archive, including the management and distribution of data from non-EOL platforms?	**Will request EOL/CDS support**
Do you intend to request restricted data access? [2]	**No**

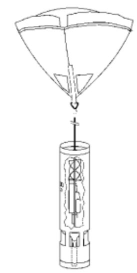
[2] *Please note that EOL policy will make all EOL data publicly available once the data are quality controlled. If a PI wants to have exclusive access to these data for the first year, s/he has to officially request such a restriction via email from the EOL Division Director (wakimoto@ucar.edu) eight weeks prior to the start of an experiment. The burden will fall on the requesting PI to request the restriction and also to "police" data distribution and access to the data once the restrictions are in place.*

PART IV: FACILITY SPECIFIC REQUEST FORMS

The following forms are available:

GPS Dropsonde
GAUS – GPS Advanced Upper Air System
ISS – Integrated Sounding System
ISFS – Integrated Surface Flux System
SPOL – S-band Dual Polarization Doppler Radar
ELDORA on NRL P3 – Electra Doppler Radar
WCR – Wyoming Cloud Radar
NSF/NCAR C130
NSF/NCAR GV

GPS DROPSONDE
AVAILABLE ON C-130, G-V AND NRL P-3



Contact: Terry Hock
Email: hock@ucar.edu; Phone: (303) 497-2066
http://www.eol.ucar.edu/rtf/facilities/dropsonde/gpsDropsonde.html

If you plan to drop sondes from either the C130 or GV, please refer to Appendix I for RAF's position on dropping objects from NSF/NCAR aircraft.

Proposed dropsonde aircraft:	**GV**
Number of dropsonde systems requested:	**1**
Total number of dropsondes requested:	**500**
Planned number of dropsondes to be released on each mission:	**28-32**
Frequency (i.e., time between drops) at which dropsondes will be released:	**6 – 18 minutes**
Altitude at which dropsondes will be released:	**40000 ft**
Geographic location where dropsondes will be released:	**A grid of approximately 30 locations over the High Plains and intermountain region**
Do you plan to drop sondes over land? If yes, does geographic location cover heavily populated areas, national parks or national wilderness areas?	**Yes. Sensitive areas can be avoided.**
Will you provide one or more operators for the dropsonde system and if so, do they have previous experience?	**No, unless necessary**
Are you aware of other sondes, either launched from the ground or other aircraft that may cause frequency interference?	**NWS and ARM radiosondes**
Please specify your data access needs. Do you need any real-time data, i.e., skew-T, x-y plots, hard copy, data to be sent to GTS?	**Skew-T, x-y plots, dropsonde data to be sent to GTS**
Do you have any special requirements that pertain to EOL support?	**No**
If the request is for a non-EOL aircraft, will an aircraft data system be available?	**Not applicable**
Which EOL staff was consulted to help complete this request?	**Al Cooper, Jim Moore**

NSF/NCAR HIAPER G-V

Contact: Dr. Jorgen Jensen
Email: jbj@ucar.edu, Phone: (303) 497-1028
http://www.eol.ucar.edu/instrumentation/aircraft/G-V

Operational Considerations

Preferred flight period	15 May -15 June 2012
Total number of research flight hours requested	140
Total number of flights requested	20
Estimated duration of each flight	6-8 hours
Total number of flights per week	4-8
Particular part(s) of day for flights	Companion flights: 0900 – 1700 UTC; 2000 – 0300 UTC
Do you plan to fly night missions?	Early morning…see above
Preferred base of operation	JeffCo
Alternate base	None
Is JeffCo Airport (near Boulder) acceptable as your operations base?	Yes
Average flight radius from base	600 km
Desired flight altitudes(s)	40000 ft
Will there be operations in foreign or military airspace?	Military airspace can be avoided unless advantageous to drop sondes
Number of scientific observers for each flight	1 per flight
Will you require air to ground communications	Yes
Will you require satellite communications above base level? (see Appendix IV)	no

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

Airborne Scientific Instrumentation

Each research payload is unique and will typically consist of some combination of EOL and User-supplied instrumentation. Review the following tables for available sensors and indicate the priority of each measurement in addressing your research goals. Basic information on possible wing store configurations, rack space requirements and operator status is included. Detailed information on specific systems and platform infrastructure related to mounting User equipment can be found in the GV Handbook, available on the RAF web site (www.eol.ucar.edu/about/our-organization/raf).

Different instruments require differing levels of support. Many of the specialized chemistry measurements on the following lists require significant levels of support and are made available by special arrangement with the CARI group – a joint EOL/ACD collaboration. When considering requesting any systems marked with the CARI label, please contact Frank Flocke (ffl@ucar.edu) for performance capabilities and system limitations.

Inclusion of any "Special Request" systems will be coordinated via discussions with RAF management and the EOL science support teams assigned to those systems. Inclusion of any "Instrumentation under Development" will depend upon the timing of your deployment and the projected status of the system in question. It is recommended that contact be made with RAF prior to submitting the final request form.

a) GV Standard Instrumentation

		Data		**Sensor**
Description		**Rate(s)**	**Location**	**Quantity**
Aircraft Attitude (IRU)		1 / 25 sps	electronics bay	2
Aircraft Position & Ground Speed (IRU)		1 sps	electronics bay	2
Aircraft Position & Ground Speed (GPS)		1 sps	ads rack	2
3 - Dimensional Wind Fields		1 / 25 sps	radome	1 set
Ambient Temperature		1 sps	fuselage	2 - 4
Static Pressure		1 / 25 sps	fuselage	2
Dynamic Pressure		1 / 25 sps	radome	2
Cabin Temperature		1 sps	electronics bay	1
Cabin Pressure		1 sps	electronics bay	1
Dew Point Temperature		1 sps	radome	2
GPS Altitude (MSL)		1 sps	ads rack	2
Gas Dump Manifold Pressures		1 sps	wall tubes	2
Fwd Digital Video		1 sps	wing pylon	1
SATCOM		N/A	ads rack	
XCHAT		N/A	N/A	
Real Time Data Transfer to Ground		variable	N/A	

b) GV Instrumentation by Request

Can be added to the research payload without added expense or extra deployment staffing.
Standard data processing with output included in primary data set.

Description	Data Rate(s)	Location	Rack Space	Priority 0 - 1 - 2
Fast Ambient temperature	1 / 25 sps	radome	0	
CDP Cloud Droplet Probe #1	1 / 10 sps	wing pod canister	0	
CDP Cloud Droplet Probe #2	1 / 10 sps	wing pod canister	0	
OAP 2D Precipitation Probe (25 um)	Auto	wing pod canister	0	
OAP 2D Precipitation Probe (10 um)	Auto	wing pod canister	0	
OAP 2D Precipitation Probe (200 um)	Auto	wing pod canister	0	
UHSAS Aerosol Probe	Auto	wing pod canister	2-U	
CN Concentration - water	1 / 25 sps	cabin rack	1/4	
Differential GPS w/ ground station	1 / 10 sps	cabin rack	0	1
Digital Video - alternate views	1 sps	partial aperture	0	
HIMIL Chemistry Inlet (std)	N / A	std aperture	0	
HIMIL Chemistry Inlet (heated)	N / A	std aperture	2-U	
VCSEL TDL Hygrometer	1 sps	std aperture	0	
King Probe Liquid Water Content	1 / 25 sps	wing hard point	0	
Icing Rate	1 sps	wing hard point	0	
One unit of rack space is equivalent to one standard GV rack				
There are three basic wing store configuration options:				
configuration 1: 6 pylons (12 cannisters)				
configuration 2: 2 pylons (4 cannisters)				
configuration 3: 6 pylons (8 cannisters + 2 large pods)				
Priority code: (0 = un-necessary; 1 = required; 2 = desired but optional)				

c) GV Instrumentation by Special Request

Adding these systems will require an added expense for expendables
Adding these systems will require additional support crew for a field deployment
Special data processing required by Science staff or outside participant

Description	Inlet	Location	Rack Space	Num Oper	Priority 0 – 1 - 2
Counterflow Virtual Impactor (CVI)	special	cabin w/ aperture	2	1	
Airborne Whole Air Sampler	simple	cabin w/ aperture	1	0 / 1	
Fast Ozone (CARI)	simple	cabin w/ aperture	1	1	
Carbon Monoxide (CARI)	simple	cabin w/ aperture	1	0	
QCLS	HIMIL	cabin w/ aperture	1	0 / 1	
NO-NOY (CARI)	special	cabin w/ aperture	1	1	
Small Ice Detector - II (SID-2)	N/A	wing pod canister	1/4	0	
Microwave Temperature Profiler	N/A	wing pod canister	1/4	0	1
TDL Hygrometer (CARI)	N/A	std aperture	0	0	
RDMA	simple	cabin w/ aperture	1	1	
Wet/Dry Nephelometers	simple	cabin w/ aperture	1/4	0	
VCSEL TDL Hygrometer	N/A	std aperture	0	0	
HARP Radiometer Package	N/A	tail & special aper	1	1	
Airborne Oxygen Analyzer (AO2)	HIMIL	cabin w/ aperture	1	1	
Medusa Flask Sampler	HIMIL	cabin w/ aperture	1	1	
Mission Coordinator Station	N/A	cabin	1	0 / 1	1
HSRL Lidar	N/A	cabin / Optic Win	4	1	
GISMOS	N/A	cabin w/ windows	1	0 / 1	
One unit of rack space is equivalent to one standard GV rack					
There are three basic wing store configuration options:					
configuration 1: 6 pylons (12 cannisters)					
configuration 2: 2 pylons (4 cannisters)					
configuration 3: 6 pylons (8 cannisters + 2 large pods)					
Priority code: (0 = un-necessary; 1 = required; 2 = desired but optional)					

d) GV Instrumentation Under Development

Adding these systems will require an added expense for expendables
Adding these systems will require additional support crew for a field deployment
Special data processing required by Science staff or outside participant

			Rack	Num	Priority
Description	**Inlet**	**Location**	**Space**	**Oper**	**0 - 1 - 2**
Photometric Ozone Analyzer	HIMIL	cabin w/ aperture	1/4	0	
3V-Cloud Particle Imager	N/A	wing pod pylon	1	1	
HOLODEC-II Cloud Particle Imager	N/A	wing pod canister	1/4	1	
Carbon Dioxide (CARI)	HIMIL	cabin w/ aperture	1/2	0	
T of F Aerosol Mass Spectrometer	HIMIL	cabin w/ aperture	1	1	
CIMS	special	cabin w/ aperture	1	1	
TOGA	HIMIL	cabin w/ aperture	1	0	
Laser airspeed sensor (1D)	N/A	wing pod canister	1/4	0	
Wind Gust Pod	N/A	wing pod canister	0	0	
HIAPER Cloud Radar	N/A	lrg wing pod	1	1	
One unit of rack space is equivalent to one standard GV rack					
Priority code: (0 = un-necessary; 1 = required; 2 = desired but optional)					
These Instruments are under development and will be made available in the future					
Check with an RAF point of contact for more information on current instrument status					

e) User-supplied Scientific Payload [3]

Please provide the following information for each user-supplied scientific instrument:

Instrument Name:	
Primary Contact Name:	
Primary Contact Institution:	
Primary Contact Phone:	
Primary Contact Email:	
Individual weight of all components:	
Complete size dimensions of all components:	
Rack-mountable 19” panel space required (Note: depth beyond 25” will overhang in back):	
Supplying your own 19” rack (yes/no): (Note: racks must survive 9G crash load.)	
Hazardous material required:	
Radioactive sources or materials:	
Power required (watts, volts, amps):	
Type of power (DC, 60 Hz, 400 Hz):	
External sensor location (if any):	
Are signal(s) to be recorded on RAF’s Aircraft Data System (yes/no)?	
If yes: Signal format (digital, analog, serial):	
Full-scale Voltage:	
Range:	
Resolution:	
Sample Rate (1, 5, 250 sps):	
Need real-time, in-flight, RAF-measurement, serial data feed (RS-232, RS422)?	
Need IRIG time-code feed?	
Special sensor calibration service required?	
Need full-time operator during flight?	
Number of lap-top computers for on-board use:	
Will NCAR support be required in preparing the instrument(s) for use on the aircraft (other than inspection, installation and power hook-up)? EOL/RAF can provide design and fabrication support for hardware and electronic interfaces. *(If so, specify type and lead time).*	

[3] *Note: All user-supplied equipment must meet RAF safety and design specifications. Refer to RAF Bulletin No. 3, No. 13 and the Design Guide RAF-DG-00-001 on the EOl website (http://www.eol..ucar.edu/raf/Bulletins) and the G-V Investigators Handbook.*

Will you be using your own recording system?	
What additional recording capability is needed? Please give us details on the number of signals, their characteristics, format, synchronous, fire-wire, ethernet, etc. (We may not be able to accommodate any and all signals.)	
If nonstandard output formats and/or data rates are required, how often are the measurements needed? Note: The standard format for processed, RAF output data is net CDF. The standard output media are CD/DVD and ftp transfer. (Nonstandard rates and/or formats will be considered as special processing requests.)	
On-site data access requirement:	

Please identify mission critical instruments in order of importance:

Supporting Services

	Preflight needs	Postflight needs	Routine Maintenance
	On flight days	On flight days	On non-flight days
Access (hrs)			
Power (hrs)			
Special Support Needs			

Appendix I: RAF Position on Dropping Objects, such as Dropsondes from NCAR/NSF Aircraft

The Federal Air Regulations allow for dropping objects from aircraft with the following restriction (FAR 91.5):

No pilot in command of a civil aircraft may allow any object to be dropped from that aircraft in flight that creates a hazard to persons or property. However, this section does not prohibit the dropping of any object if reasonable precautions are taken to avoid injury or damage to persons or property.

The International Civil Aviation Organization (ICAO) Annex 2 Rules of the Air Part 3.1.4: Dropping or Spraying

"Nothing shall be dropped or sprayed from an aircraft in flight except under conditions prescribed by the appropriate authority and as indicated by relevant information, advice and/or clearance from the appropriate air traffic services unit."

This regulation is the basis for the RAF policy on dropping objects (dropsondes). While dropping dropsondes over the high seas is simply an air traffic separation and potential diplomatic problem, dropping over land significantly raises the complexity of this issue and reflects upon the liabilities of the U.S. Government, the National Science Foundation, and the National Center for Atmospheric Research. Therefore, we will take all reasonable precautions to avoid damage to persons or property. To accomplish this task requires that, as a minimum:

(a) The RAF pilot in command will have a final say in the release of dropsondes on any given flight.
(b) Dropsondes shall not be dropped over congested areas, including cities, major highways, etc.
(c) Dropsondes shall not be dropped over airways or other areas of heavy air traffic, unless positive locations of other aircraft can be identified and avoided.
(d) The RAF pilot in command shall take reasonable and appropriate precautions to identify the locations of other aircraft and persons or property on the ground for all drops. Reasonable precautions shall include, but may not be limited to:
    i. Locating drop locations during project/mission planning sessions in order to coordinate the release points with the FAA (or other authority) and the property owner(s) concerned.
    ii. Assuring that diplomatic clearances to release instrumentation in foreign airspace are obtained, when required.
    iii. Obtaining real-time clearance from the FAA (or other appropriate controller) to separate the drop from other known aircraft traffic.
(e) RAF pilots shall be responsible for determination of any additional precautions that are required to avoid damage to persons or property (e.g. altitude restrictions, clearances from the Air Traffic Control (ATC)). They are responsible for communicating extraordinary restrictions not implicitly contained within this policy to EOL project management personnel in time for appropriate NSF review.

Additional restrictions may also be a factor in dropsondes releases (e.g. export controls and wilderness area restrictions).

Prospective PI's that intend to request the aircraft for dropping objects are responsible for understanding the limitations and regulations that pertain to dropping objects, which will constrain what aircraft support they can successfully request. This memo is intended to provide guidance in this regard, but may not contain all the regulations that might apply to dropping in a specific location. Prospective investigators are encouraged to discuss their plans for dropping objects with RAF staff well in advance of the submission of a request for aircraft support, so that RAF staff can assist the investigators in this area.

APPENDIX III: NSF / NCAR G-V

EOL/RAF Standard Airborne Scientific Measurements

For details about instrument type and performance, consult the G-V Investigators Handbook on the HPO website at www.hiaper.ucar.edu/handbook.

I. TIME

Name	*Units*	*Description*
Time	sec	Offset from Reference Start Time (units is reference time)

II. INERTIAL REFERENCE SYSTEM

Name	*Units*	*Description*
LAT	degree_N	Inertial Latitude
LON	degree_E	Inertial Longitude
THDG	degree_T	Aircraft True Heading Angle
PITCH	degree	Aircraft Pitch Angle
ROLL	degree	Aircraft Roll Angle
ACINS	m/s2	Aircraft Vertical Acceleration
VSPD	m/s	IRS-Computed Aircraft Vertical Velocity
ALT	m	IRS-Computed Aircraft Altitude
GSF	m/s	Inertial Ground Speed
VEW	m/s	Inertial Ground Speed Vector, East Component
VNS	m/s	Inertial Ground Speed Vector, North Component

III. GLOBAL POSITIONING SYSTEM (GPS)

Name	*Units*	*Description*
GGLAT	degree_N	GPS Latitude
GGLON	degree_E	GPS Longitude
GGVEW	m/s	GPS Ground Speed Vector, East Component
GGVNS	m/s	GPS Ground Speed Vector, North Component
GGMODE	none	GPS Mode
GGSTAT	none	GPS Status

IV. ALTITUDE AND POSITION

Name	*Units*	*Description*
GALT	m	GPS Altitude
PALT / F	M / feet	NACA Pressure Altitude
LATC	degree_N	GPS-Corrected Latitude
LONC	degree_E	GPS-Corrected Longitude

V. AIRCRAFT AND METEOROLOGICAL STATE PARAMETERS

Name	*Units*	*Description*
ATTACK	degree	Attack Angle, Reference
SSLIP	degree	Sideslip Angle, Reference
PCAB	mbar	Interior Cabin Static Pressure – expected by 3/1/06
PSX	mbar	Raw Static Pressure, Reference
PSXC	mbar	Corrected Static Pressure, Reference

QCX	mbar	Raw Dynamic Pressure, Reference
QCXC	mbar	Corrected Dynamic Pressure, Reference
TTX	deg_C	Total (Recovery) Temperature, Reference - Deiced
DPX	deg_C	Dew/Frost Point Temperature, Reference
DPXC	deg_C	Dew Point Temperature, Reference

VI. THERMODYNAMIC MEASUREMENTS

Name	*Units*	*Description*
ATX	deg_C	Ambient Temperature, Reference - Deiced
TASX	m/s	Aircraft True Airspeed, Reference
TASHC	m/s	Aircraft True Airspeed, Humidity Corrected
EDPC	mbar	Ambient Water Vapor Pressure, Reference
THETA	K	Potential Temperature
THETAE	K	Equivalent Potential Temperature (Bolton)
TVIR	deg_C	Virtual Temperature
RHUM	%	Relative Humidity
RHODX	gram/m3	Absolute Humidity, T-Electric, Reference
SPHUM	gram/kg	Specific Humidity
MR	gram/kg	Mixing Ratio, T-Electric

VII. WINDS

Name	*Units*	*Description*
UIC	m/s	GPS-Corrected Wind Vector, East Component
VIC	m/s	GPS-Corrected Wind Vector, North Component
WIC	m/s	GPS-Corrected Wind Vector, Vertical Component
WSC	m/s	GPS-Corrected Horizontal Wind Speed
WDC	degree_T	GPS-Corrected Horizontal Wind Direction
UXC	m/s	GPS-Corrected Wind Vector, Longitudinal Component
VYC	m/s	GPS-Corrected Wind Vector, Lateral Component

XVII. DIGITAL VIDEO RECORDING

Name	*Units*	*Description*
D_video	images	Digital images from forward looking camera (1 image per second)

Appendix IV: Base Level SATCOM Support

All projects will get a base level of SATCOM support which will include “Chat” (IRC), a simple data feed to the ground and file transfer in both directions. Additional services can be arranged through CDS at extra cost. Please contact us early to discuss requirements and allow for scheduling.

The base level deployment fund allocation is currently $120 per hour. Actual cost to transfer data is 4.7 cents per kilobyte. A typical uncompressed satellite image is around 120 kilobytes (or $5 to transfer). Data feed to the ground tends to be the largest portion of data transfer involved in a project. This can be optimized by adjusting the number of variables sent and the frequency they are sent. e.g. 12 variables sent every second is the same amount of data as 36 variables sent every 3 seconds.