REQUEST FOR HIAPER, ISS, MGLASS, ISFF, DROPSONDE AND SONDE SUPPORT FOR

T-REX

NCAR/ATD -MAY 2005 OFAP MEETING

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PART I: GENERAL INFORMATION

Corresponding Principal Investigator

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Project Description

Project Title	**Terrain-induced Rotor Experiment (T-REX)**
Co-Investigator(s) and Affiliation(s)	Facility PIs: Vanda Grubišić, DRI Joachim Kuettner, NCAR James Doyle, Naval Research Laboratory Greg Poulos, NCAR Ronald Smith, Yale University David Whiteman, University of Utah Other Co-Investigators (major contributors to science planning): Robert Banta, NOAA/ETL David Fritts, CoRA Larry Armi, UCSD/SCRIPPS Andy Heymsfield, NCAR Andy Weinheimer, NCAR Ben Balsley, University of Colorado Robert Street, Stanford University Sharon Zhong, University of Houston A complete list of expected participants appears in Table 1 of the Science Overview Document (SOD)
Location of Project	**Owens Valley, Independence, California**
Start and End Dates of Project	March 1 – April 30, 2006

ABSTRACT OF PROPOSED PROJECT

The Terrain-induced Rotor Experiment (T-REX) is the second phase of a coordinated effort to explore the structure and evolution of atmospheric rotors---intense low-level horizontal vortices that form along an axis parallel to, and downstream of, a mountain ridge crest---and associated phenomena in complex terrain. The initial, exploratory phase of this effort is the Sierra Rotors Project, which completed its Special Observation Period (SOP) in early spring 2004 in Owens Valley, California. Recent theoretical studies and observations of rotors, including the Phase I observations, show that rotors are strongly coupled to both the structure and evolution of overlying mountain waves and the underlying boundary layer. Consequently, the main scientific objectives of T-REX are focused on improving the understanding and predictability of the coupled mountain-wave/rotor/boundary-layer system. In addition, complementary scientific objectives include understanding the role of mountain waves in stratospheric-tropospheric exchange, structure and evolution of the complex terrain boundary layer in the absence of rotors, and wave cloud phase transitions and layering.

In order to achieve its scientific objectives, the T-REX program has two main observational thrusts:

- Comprehensive ground-based and airborne, in situ and remote sensing measurements during strongly perturbed conditions favoring rotor formation, and
- Comprehensive observations of complex-terrain boundary layer structure and evolution from undisturbed to strongly perturbed conditions.

T-REX field activities will take place in Owens Valley in March and April 2006. Owens Valley lies to the east of the southern Sierra Nevada, which is the tallest, steepest, quasi two-dimensional topographic barrier in the contiguous United States. Mountain waves and attendant rotors are known to reach particularly striking amplitude and strength there. Climatological studies, including results from Phase I, show that the months of March and April have the highest frequency of rotor events. Together, these two months include many days with conditions favorable for generation of mountain waves and rotors (we anticipate documenting at least 10-15 wave and rotor events of differing strength), and also many days when it will be possible to document terrain-induced boundary-layer circulations in Owens Valley under more quiescent conditions. The field operations will be supported by real-time mesoscale model forecasts, and ensuing field research will be tightly coupled with numerical modeling studies.

Ground-based and airborne, in situ and remote-sensing measurements will be conducted both upwind and within Owens Valley. Some of the planned measurements will be met through intensive observational periods (IOP) (e.g. aircraft and manually-operated instrumentation), whereas others will be met through continuous operation. We propose to use three aircraft (NSF/NCAR HIAPER, University of Wyoming King Air, UK BAe146), two equipped with aerosol lidars, atmospheric chemistry instruments and microphysics probes (HIAPER and UK BAe146), and all three equipped with dropsonde systems to document the mesoscale structure and evolution of the upper parts of the rotor coupled system over Owens Valley as well as the kinematic and thermodynamic structure of airflow up- and downstream of the valley centerline. Dropsondes will be used to obtain velocity and thermodynamic data both upwind of the Sierra Nevada as well as over Owens Valley below the planned high-altitude cross-mountain and mountain-parallel flight tracks. An array of fixed and mobile ground-based instruments, including lidars, wind profilers, sodars, sounding systems, dense networks of automatic weather stations, microbarographs, and temperature data loggers, flux towers, and an instrumented car, will be used to document the lower portions of the rotor coupled system under strongly perturbed conditions favoring rotor formation as well as the flow and thermodynamic structure of the PBL in absence of rotors.

PROPOSAL SUMMARY

What are the scientific objectives of the proposed project?

To improve the understanding of:

I) Dynamics and Structure of the Rotor Coupled System

(A) Role of Upstream Flow Properties
(B) Wave/Rotor Dynamic Interactions
(C) Internal Rotor Structure
(D) Rotor/Boundary-Layer Interactions
(E) Upper-Level Wave Breaking and Turbulence

II) Complementary Scientific Issues

(A) Stratosphere-Troposphere Exchange
(B) Boundary-Layer Structure and Evolution in Absence of Rotors
(C) Wave Cloud Phase Transitions and Layering

To achieve improvements in:

III) Mesoscale and Microscale Modeling

(A) Predictability
(B) Physical Parameterizations
(C) Representation of Steep Terrain
(D) Mesoscale Verification

IV) Prediction

(A) Aviation Hazards
(B) Downslope Windstorms
(C) Aerosol Transport and Dispersion

What are the hypotheses and ideas to be tested?

Leading hypotheses for the rotor coupled system:

(a) Properties of the upstream inversion, including its strength, depth, and the wind shear across it, play a significant role in determining the rotor types, location, and their intensity, as well as the lee wave structure above the rotor,

(b) Characteristics of the upstream moisture and latent heating profiles influence the resonant mountain wave response and the rotor structure,

(c) At least two types of rotors exist: Type I that forms underneath the crest of a mountain wave, and a rare Type II that bears a strong resemblance to an internal hydraulic jump,

(d) The small-scale cohesive vortices or "sub-rotors" that are generated along the shear interface along the leading edge of the "parent" rotor are a manifestation of shearing instability. The magnitude of horizontal vorticity in the sub-rotors is substantially larger than in the parent rotor and represents a potential significant aviation hazard,

(e) Rotors are the boundary-layer separation phenomenon that are sensitive to the surface and boundary layer heat, momentum and moisture fluxes,

(f) Mountain wave breaking and related turbulence is enhanced above jet streaks in layers of strongly reversed shear, and suppressed below the jet stream within the forward shear zone.

Some of the hypotheses for the complementary objectives:

(a) Significant stratosphere-troposphere exchange is induced by irreversible mixing associated with mountain wave breaking occurring at the upper-tropospheric/lower-stratospheric altitudes,
(b) Diurnal mountain wind systems (slope and valley flows) evolve normally in the deep valley during undisturbed periods. Over a 24-hour period, winds turn clockwise on the west sidewall of the valley and counterclockwise on the east sidewall of the valley,
(c) In undisturbed nighttime conditions, the growth of the temperature inversion in Owens Valley can be explained by the mass convergence of drainage flows coming from the opposing sidewalls,
(d) During undisturbed daytime conditions, temperature inversions in the valley are destroyed several hours after sunrise as sensible heat released at the sidewalls drives convection and upslope flows in the convective boundary layer to remove air mass from the inversion,
(e) Thermodynamic stability plays a role in producing the fine layering of wave clouds.

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

Sierra Rotors (2004), CASES-99 (1999)

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.

Grubišić, V., and J. P. Kuettner, 2004: Sierra rotors and the Terrain-induced Rotor Experiment (T-REX). *11th Conf. on Mountain Meteorology and Annual Mesoscale Alpine Program (MAP) Meeting*, AMS, June 2004, Bartlett, NH, Online preprint http://ams.confex.com/ams/11Mountain/techprogram/paper_77384.htm

Grubišić, V., and S. A. Cohn, 2004: Sierra Rotors Project: Preliminary findings. *11th Conf. on Mountain Meteorology and the Annual Mesoscale Alpine Programme (MAP) Meeting*. AMS, June 2004, Bartlett, NH, Online preprint http://ams.confex.com/ams/11Mountain/techprogram/paper_77364.htm

The Sierra Rotors Project (SRP), smaller in its scientific objectives and observational scope, was the initial, exploratory, phase of a coordinated effort to explore the structure and evolution of atmospheric rotors and associated phenomena in complex terrain. The SRP Special Observation Period (SOP) was completed in early spring 2004 in Owens Valley, California. Experience gained and data collected in the SRP SOP have been instrumental in formulating both the scientific objectives and experimental design of T-REX. The T-REX suite of instruments, more comprehensive due to the additional complication of significant terrain relief and physiographic heterogeneity, will also advance the understanding of the stable boundary layer structure beyond what has previously been measured in CASES-99.

T-REX will extend Sierra Rotors in the following ways:

1) Use of research aircraft and airborne remote sensors (lidars),
2) Use of dropsondes to document mesoscale thermodynamic structure of the atmosphere upwind of the Sierra Nevada and the rotor coupled system downwind,
3) Use of multiple ground-based Doppler and aerosol lidars,
4) Use of flux towers for detailed surface flux and energy budget measurements,
5) Extended ground-based networks of weather stations, and additional networks of microbarographs, temperature data loggers, and soil moisture sensors,
6) Assimilation of surface measurements (e.g. soil moisture) in high-resolution LES complex-terrain simulations,

7) Focus on predictability of waves and rotors.

Poulos, G. S., W. Blumen, D. C. Fritts, J. K. Lundquist, J. Sun, S. P. Burns, C. Nappo, R. Banta, R. Newsome, J. Cuxart, E. Terradellas, B. Balsley and M. Jensen, 2002: CASES-99: A comprehensive investigation of the stable nocturnal boundary layer. *Bull. Amer. Meteor. Soc.*, **83**, 555-581.

CASES-99 was very successful at characterizing the near-flat terrain boundary layer but therefore did not provide data applicable to many parts of the earth where complex terrain dominates the landscape. So, while the scientific progress in boundary layer studies garnered was significant, its applicability is limited. Scientific breadth of CASES-99 was smaller compared to T-REX. The tall flux towers and associated network of pre-existing towers in T-REX would leverage the CASES-99 experience to provide an unprecedented multi-tower data set for a complex terrain region. Not only will compare-contrast scientific goals be viable, but also, by nature of the cross- and along- valley orientation of the three tall towers, an assessment of the representativeness of mean values, statistics, turbulent quantities and surface energy balance calculations.

The T-REX multi tall-tower deployment will improve on the CASES-99 by:

1) Providing an assessment of flux-profile representativeness and heterogeneity (a limitation of the single CASES-99 tower),
2) Adding hot-film anemometry at the lower levels to improve flux estimates below 4 m AGL (particularly for large bulk dynamical stability near the surface) and to improve surface energy balance calculations (flux loss due to path-length averaging was a problem at these levels during CASES-99),
3) Providing an extension of the CASES-99 results to complex terrain.

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

Leading hypotheses for the rotor coupled system:

(g) Properties of the upstream inversion, including its strength, depth, and the wind shear across it, play a significant role in determining the rotor types, location, and their intensity, as well as the lee wave structure above the rotor (**MGLASS and aircraft GPS dropsondes will be used to obtain high-resolution vertical sounding data from the upstream side, to be correlated with the detailed ground-based and airborne observations of the wave structure on the lee side),**

(h) Characteristics of the upstream moisture and latent heating profiles influence the resonant mountain wave response and the rotor structure (**MGLASS and GPS dropsonde data, satellite imagery, coupled with ground-based and airborne observations of the wave structure on the lee side**),

(i) At least two types of rotors exist: Type I that forms underneath the crest of a mountain wave, and a rare Type II that bears a strong resemblance to an internal hydraulic jump (**ground-based remote sensing observations from Doppler lidars (NOAA, DLR and ASU), aerosol lidars (REAL, NRL)**, **and wind profilers (ISS) will be used in conjunction with high-resolution real-data numerical simulations by mesoscale models)**

(j) The small-scale cohesive vortices or “sub-rotors” that are generated along the shear interface along the leading edge of the “parent” rotor are a manifestation of shearing instability. The magnitude of horizontal vorticity in the sub-rotors is substantially larger than in the parent rotor and represents a potential significant aviation hazard (**ground-based Doppler lidars will be a key instrument platform for documenting the internal rotor structure)**

(k) Rotors are the boundary-layer separation phenomenon that are sensitive to the surface and boundary layer heat, momentum and moisture fluxes (**ISFF, as well as other smaller PI-provided flux towers, will be a key instrument platform in providing the data on heat, momentum and moisture fluxes to be coupled with high-resolution surface pressure measurements by the existing and proposed surface station networks)**

(l) Mountain wave breaking and related turbulence is enhanced above jet streaks in layers of strongly reversed shear, and suppressed below the jet stream within the forward shear zone (**an airborne lidar in conjunction with detailed information on the upstream atmospheric profiles from GPS dropsondes)**.

What results do you expect and what are the limitations?

The comprehensive set of measurements in T-REX has been designed to document the three-dimensional nature of the coupled mountain-wave/rotor/boundary-layer system in unprecedented detail.

Provide details about the experiment design:

The heterogeneous physiographic characteristics and locally severe relief in and upwind of Owens Valley require a tightly coordinated experimental design, which draws substantially from the early meteorological field campaigns in Owens Valley and the recent Phase I activities.

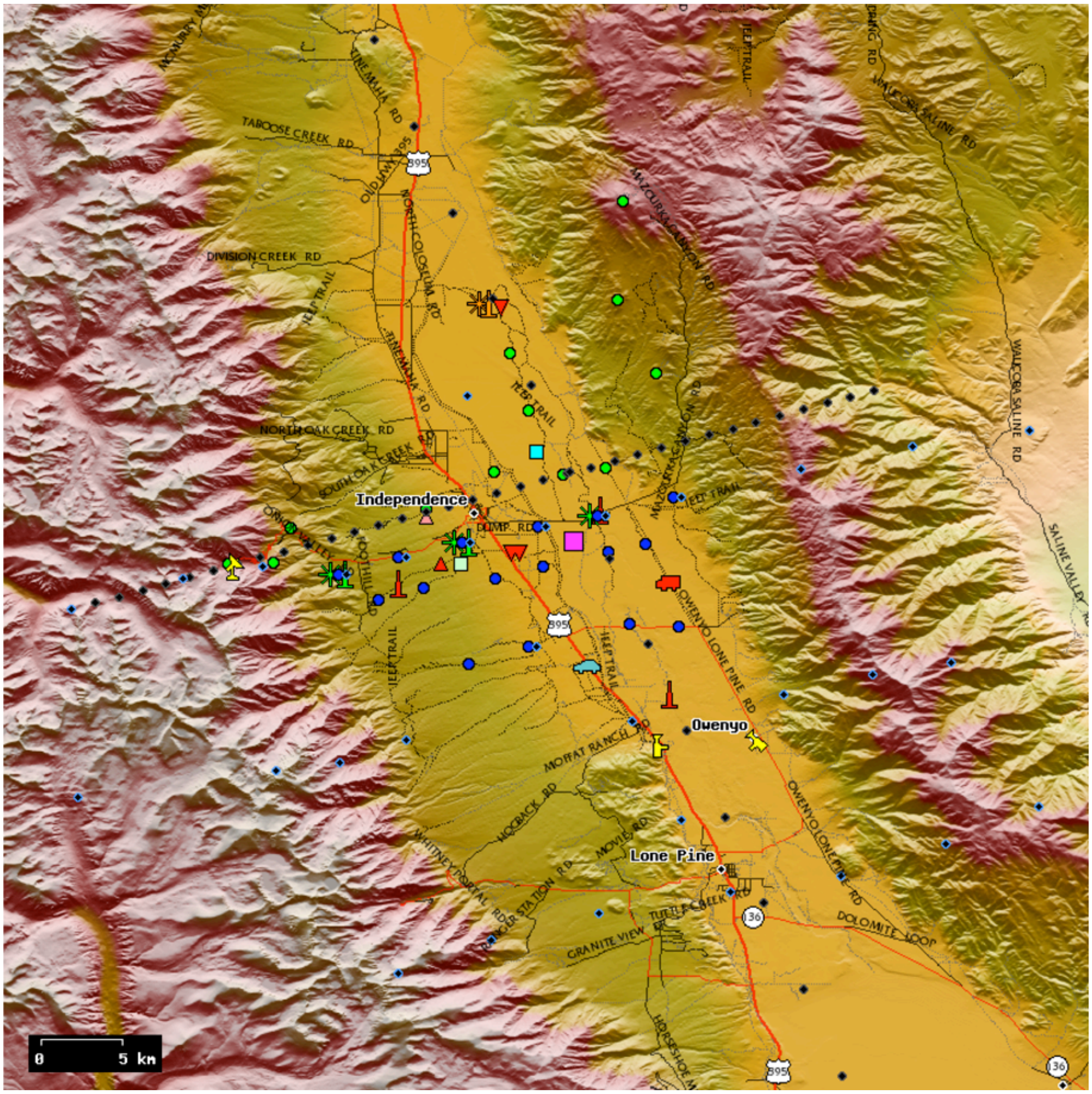
The T-REX observational strategy is comprised of two main observational thrusts:

(1) Comprehensive ground-based and airborne, in situ and remote sensing measurements during strongly perturbed conditions favoring rotor formation, and
(2) Comprehensive observations of complex-terrain boundary layer structure and evolution from undisturbed to strongly perturbed conditions.

(1) Strongly perturbed conditions favoring rotor formation

The primary method of observing the structure and evolution of the coupled mountain-wave/rotor/boundary-layer system under rotor conditions is based on utilizing the in situ and remote-sensing capabilities of research aircraft (Figures 2.1 and 2.2 in Part II) in conjunction with ground-based instrument systems including lidars, wind profilers, sounding systems, dense networks of automatic weather stations and microbarographs, flux towers, and measurements from an instrumented car (Figure 1 below). In addition, time-lapse photography, GOES satellite imagery, and cloud cover will be collected continuously during the entire T-REX period.

Densely sampled thermodynamic and velocity data for documentation of airflow over Owens Valley as well as up- and downstream of the valley centerline will be obtained by research aircraft in cross-mountain traverses of up to 300 km in length as shown in Figure 2.1. The University of Wyoming King Air 200T will cover flight levels from the ground up to 28,000 ft, whereas the NSF/NCAR HIAPER will be used to reach upper-tropospheric/lower-stratospheric levels. The remote sensors on board the mid- and upper-air aircraft, primarily up- and down-looking lidars on board the UK BAe146 and HIAPER, the latter equipped with SABL or a new eye-safe lidar, will be the primary tools for documenting gravity wave breaking in clear air and turbulence within cloudless rotors. The capability of airborne lidars to document these turbulent zones will depend on the aerosol concentration within and over Owens Valley. The aerosol concentration is known to be high during strong wave events due to significant dust lifting from the dry Owens Lake bed and other naturally dry soil surfaces in the valley. Additional chemical tracer measurements (CO, ozone, water vapor, CO2 and CH4 on board of HIAPER) will provide evidence of turbulent mixing. The information provided by these tracer measurements will be enhanced with the information from an upward looking lidar onboard the mid-altitude aircraft (BAe146). All aircraft will be equipped with dropsonde systems. Curtains of dropsonde releases for obtaining velocity and thermodynamic data in the air volume below flight tracks are planned along high-altitude cross-mountain and mountain-parallel flight tracks. Generic vertically stacked cross-mountain flight tracks at a range of possible flight track altitudes are shown



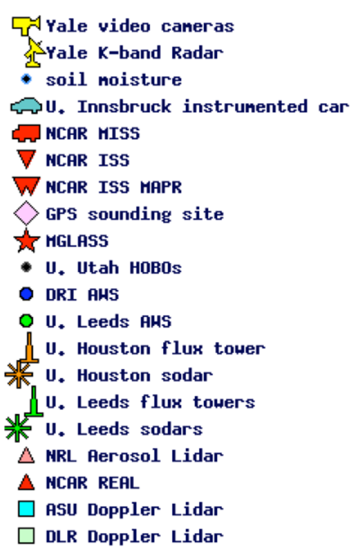


Figure 1
Color relief map of the central portion of Owens Valley showing the T-REX field campaign area and the proposed ground-based instrumentation. A GPS sounding site at NAS Lemoore and the MGLASS base at Fresno, CA will be the same as in the Sierra Rotors project (cf. Figure 2.1). The regular NWS upper-air sounding locations in the surrounding area: Oakland, CA, Vandenberg AFB, CA, and Reno, NV are also shown in Figure 2.1.

in Figure 2.2 of the SOD. The flight design strategy will build on the experience gained in the recent Mesoscale Alpine Programme (MAP) experiment, and will include repeated passes along a selected small number of flight tracks. All research aircraft flights will be coordinated with the operation of ground-based fixed and mobile instrumentation.

Lidars represent a core component of the overall pursuit of the rotor coupled system scientific objectives, since they will routinely scan the atmospheric volume from the surface to many kilometers aloft in both the along- and cross-valley directions. Lidars will provide visualization of rotor and other local flow/shear instability phenomena, aerosol transport, the relationship between the height of the boundary layer and the aerosol depth, 3-D velocity and rotor characterization, and vertical motions within the valley atmosphere.

Aerosol lidars, including the Raman-shifted Eye-safe Aerosol Lidar (REAL), which resolves aerosol-based structures at 3.5 m resolution over a 5-10 km range (possibly higher depending on aerosol concentration and extinction), will be deployed to measure the temporal and spatial structure of phenomena over the ground station networks and in the vicinity of the aircraft tracks, and to discern the detailed, diurnally-evolving rotor structures that are a key component of the wave/rotor hypotheses of T-REX. Similarly, but providing crucial velocity information at larger scales, a Doppler lidar has proven to be an effective tool for studying flows in mountainous and other complex terrain, including mountain waves and windstorms. Such lidar systems have been built with maximum ranges of 5 to 20 km and range resolutions from 30 to 300 m. They are thus ideally suited to study flows and flow variability in a valley that is ~20 km across, such as Owens Valley. Doppler lidar systems, such as 2 μm lidars, offer high range resolution and high velocity measurement accuracy. It is anticipated that all these systems should be operating at close to their optimum, because of the dryness of the air and significant lofting of dust by the winds in this region, producing an especially high aerosol loading. Several Doppler lidar groups will be proposing to participate in T-REX, raising the likelihood of dual or even multiple Doppler lidar coverage.

The ground station networks, including dense networks of automatic weather stations and microbarographs, will be used to monitor boundary-layer separation at the surface as well as rotor and wave-induced flows within the valley and on the adjoining mountain slopes. As the experience from Phase I shows, only the strongest rotor cases are likely to be documented by the ground station wind measurements. However, with measurements of surface pressure gradients, it should be possible to capture a pressure signal at the surface from a rotor aloft, and determine whether this signal is present before the boundary layer separates, and thus tell whether the boundary layer controls the rotor. Part of the answer on the origin and nature of the presumed Type II rotors, will come from observing how the rotor behavior changes under different boundary-layer conditions. Probably the most important amongst these conditions is the surface heat flux, to be measured in detail at flux towers but also measured using flux-gradient assumptions at many of the AWS sites.

In addition to providing wind profiles to characterize the atmospheric state during and between wave/rotor events, the ISS wind profilers will collect high-resolution measurements of Doppler spectral moments. As a continuation of work begun during the Phase I SOP, during which vertical motions in mountain waves were unambiguously observed with profilers, the vertical velocity and spectral width of wind profiler Doppler spectra will be examined for signatures of mountain waves, rotors, and the related turbulence. Special wind profiler observations will be provided by the NCAR Multiple Antenna profiler (MAPR), an advanced boundary layer wind profiler capable of making wind measurements on time scales as short as a few minutes. Such fast wind measurement capability is ideal for capturing rapid evolution of waves, and especially rotors. MAPR can also be run in RIM (Range IMaging) mode, a frequency hopping technique, to improve the range resolution of the profiler down to around 20 meters. With the presence of both fixed and mobile wind profilers, the vertical velocity and spectral width fields will be examined both along and across the valley axis. Together with the spatial coverage from scanning lidars, the special wind profiler modes will be used to probe within the greater rotor structure.

The effect of changes in the upstream conditions on the formation of waves and rotors will rely on rawinsondes launched at frequent intervals during IOPs from special fixed and mobile platforms in the Central Valley of California, and from the existing network of continuously operating radar wind profilers (RWP) and Radio Acoustic Sounding Systems (RASS). The RWP provide continuous soundings of wind speeds and directions through a depth of ~3 km, while the RASS can provide soundings of virtual temperature through depths of ~1 km. Additionally, dropsondes will provide upwind temperature, wind and humidity soundings that can identify and monitor the mountaintop-level capping inversion layer upwind of the Sierra Nevada and the blocked flow layer below.

(2) Transitions from undisturbed to strongly perturbed conditions

A ground-based observing strategy, based primarily on observations from the continuously operating fixed networks of remote and in situ sensors similar to that presented above, will be used to document the boundary-layer structure and its evolution in Owens Valley in the absence of waves and rotors.

The structure and evolution of lee-side boundary layers in Owens Valley will be monitored continuously with networks of instrument systems including automatic weather stations, Doppler sodars, Radio Acoustic Sounding Systems (RASS), and Integrated Surface Flux Facilities (ISFF) (heavily instrumented tall towers) (cf. Figure 18 of the SOD). In addition to these, surface-based microbarographs and cross-barrier lines of temperature sensors will be used to monitor the cross-mountain pressure gradients and cross-valley airmass contrasts. These latter instrument systems will also be able to monitor the diurnal evolution of the upstream boundary layer structure. A tethered lifting system will be used to directly observe winds, atmospheric stability, and small-scale turbulence within the lower levels of the valley atmosphere (Figure 21; Balsley et al. 1998, Frehlich et al. 2004). Doppler lidars will provide critical information on the structure of the various flows in the valley down to fine scales, as they have in many previous field experiments. The structure of the boundary layer during the rotor onset phase will be monitored with four Doppler sodars.

In order to characterize the heterogeneity of surface/boundary layer, the existing Phase I surface meteorological tower array will be enhanced. The proposed tall towers, heavily instrumented with sonic anemometers, thermocouples, and a full suite of surface energy balance equipment, including very high-rate (100 Hz) momentum flux measuring devices very close to the surface, will provide unprecedented data on the evolution of temperature, humidity, and momentum flux divergence during wave/rotor and non-wave/rotor days. These tall flux towers, along with the existing network of surface towers, and other smaller flux towers will help to identify physical limitations of high-resolution numerical modeling studies within the T-REX program.

With these instruments, uniquely comprehensive observations will be made of diurnal wind fields in the valley, flow channeling, stable boundary layer evolution including cold pools and their destruction by growing convective boundary layers, turbulent erosion, mass removal or buildup by slope flows, large-scale disturbances to local wind fields, and near-surface and boundary-layer fluxes of heat, momentum and moisture. The continuously operating networks of meteorological sensors will also allow investigation of transitions between non-rotor and rotor conditions. Special instrument systems such as dual Doppler lidars, wind profilers, and rawinsondes may be used also to supplement the continuously operating networks during special boundary layer IOPs.

Details on the project location and operations are given in Section 6 of the T-REX Scientific Overview Document and Experiment Design.

PREVIOUS OFAP INFORMATION REQUEST

If this is a re-submittal of a request, a second or third year request for continuation of a program or a facility request following an advance reservation that has been previously considered by an OFAP, please address all concerns and questions raised in the "Confidential Comments and Feedback to PI" portion that was provided with the notification letter.

EDUCATIONAL BENEFITS OF THE PROJECT

Please note that the OFAP members decided during the April 2001 meeting that investigators should be encouraged to incorporate an array of educational activities into their projects, if appropriate. The educational scoring guidelines were modified accordingly and can be viewed at http://www.atd.ucar.edu/dir_off/OFAP/info/score.html.

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.

A number of graduate students and a few undergraduate students will be involved in the field phase and in the data analysis and research effort. These will come from DRI (1-2), University of Utah (1-2), University of Houston (1-2), Yale (1-2), Stanford, Arizona State University, University of Colorado, and the North Carolina State University. The total number of students expected to be involved in T-REX is around 10. We are planning also to entrain undergraduate students in T-REX research activities through the SOARS program at NCAR and the NSF EPSCoR Young Scholars program in Nevada.

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

Nearly all the universities listed above will do so.

Will you develop new curricula that will be related to the project? If yes, please describe.

The DRI/UNR and the University of Utah tentatively plan to develop new curricula related to the project.

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.

As in the Sierra Rotors Project, we expect to have an outreach component entraining students from the Owens Valley Unified School District. In particular, we plan to continue our working relationship with the Independence Middle/High School. Given the scope of T-REX, we are likely to reach out to other schools in the area, such as the Bishop High and the Big Pine and Lone Pine elementary and secondary schools. In addition, lectures for the public are likely to be organized at the White Mountain Research Station in Bishop, a field station of the University of California system that maintains a regular public lecture series.

Do you plan to have any interactions with primary and secondary school educators to involve them in the project? If yes, please describe.

In T-REX, we plan to continue and extend the working relationships with the Owens Valley Unified School District that was established during the Sierra Rotors Project.

Given that the main building of the Independence Middle/High School is the site of the base station of the DRI automatic weather station network in Owens Valley, and is the location where the communication/data line of that network connects to Internet, we have been working closely with the school Superindendant, Mr. Arthur LaCues, and the science teacher, Mr. Adrian Sears. Example of the activities we have undertaken in the Sierra Rotors Project include an installation of an automatic weather station at the school by DRI (data from that station is available online at http://www.wrcc.dri.edu/weather for use by their students, teachers and anyone else in the community), and a field trip to the NCAR ISS installations near Independence we have organized for the school upper-level classes.

Are you cooperating with an agency outreach program during this project? If yes, which one?

No.

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

Yes.

PREVIOUS RESEARCH EXPERIENCE

Past ATD support:

Vanda Grubišić
Projects: HaRP (1990), MAP (1999), Sierra Rotors (2004)
Facilities: Electra, SABL, GPS droposondes, NCAR Integrated Sounding Systems (ISS)

Publications resulting from past ATD support:

Grubišić,V., and S. A. Cohn, 2004: Sierra Rotors Project: Preliminary findings. 11th Conf. on Mountain Meteorology and the Annual Mesoscale Alpine Programme (MAP) Meeting. AMS, June 2004, Bartlett, NH, Online preprint http://ams.confex.com/ams/11Mountain/techprogram/paper_77364.htm

Grubišić,V., 2004: Bora-driven potential vorticity banners over the Adriatic. *Quart. J. Roy. Meteor. Soc.*, **130**, 2571-2603.

Grubišić,V., 2001: Structure of wake north of the Alps: PV banners during an episode of deep south foehn. *Proceedings. 9th Conf. on Mesoscale Processes*, Ft. Lauderdale, FL, Amer. Meteor. Soc., 180-183.

Smith R. B., and V. Grubišić, 1993: Aerial observations of Hawaii's wake. *J. Atmos. Sci.,* **50**, 3728-3750.

Joachim Kuettner
Projects: BOMEX (1969), GATE (1974), MONEX (1978/9), ALPEX (1982), GALE (1986), Convection Wave Project (1986/7), TAMEX (1988), CEPEX (1993), INDOEX (1999), MAP (1999)
Facilities: Queen Air, Sabreliner, King Air, Electra, C-130

Publications resulting from past ATD support:

The BOMEX Project (with J. Holland), 1969, *Bull. Amer. Meteor. Soc.,* **50**, 394-402.

GATE: Report on the Field Phase (with D. Parker), 1976, Bull. Amer. Meteor. Soc., 57, 11-27.

GATE Observational Strategy: A Look in Retrospect. Chapter 2 of the GARP Atlantic Tropical Experiment (GATE) Monograph, GARP Publications Series No. 25, Geneva, 1982, 15-26.

Report on the Summer MONEX Field Phase (with J. Fein), 1980, *Bull. Amer. Meteor. Soc.*, **61**, 461-474.

Onset mechanism of the Indian summer monsoon (with M. Unninayar), 1982, *Inter-national Conf. on the Scientific Results of the Monsoon Experiment, Densapar, Bali, Indonesia.* WMO Publication, JPS, 13, Geneva, 3-25 to 3-32.

Easterly flow over the cross-equatorial island of Sumatra and its role in the formation of cyclone pairs over the Indian Ocean. 1989, *Wetter and Leben (J. Appl. Met)*, **41**, 47-55.

The ALPEX field phase, *WMO Bulletin*, October 1982, 312-320.

ALPEX preliminary Scientific Results (Ed.), 1982, *WMO Pub.,* GARP-ALPEX No. 7, 266 pp.

The aim and conduct of ALPEX. Scientific Results of the Alpine Experiment (ALPEX). 1986, GARP Publication No. 27, **11**, 501-508, WMO.

What did we learn from ALPEX? *Proc. 21st International Conf. on Alpine Meteorology (ITAM)*, 1991, vol. 2 Publ. Swiss Inst. of Met. 49, 33-44.

Genesis of Atlantic Low Experiment (GALE): An Overview (with R. Dirks and J. Moore), 1988, *Bull. Amer. Meteor. Soc*., **69**, 147-160.

Convectively forced gravity waves: Results from two-dimensional numerical experiments (with T. Clark and T. Hauf), 1986, *Quart. J. Roy. Met. Soc.,* **112**, 899-925.

Convection waves: Observations of gravity wave systems over convectively active boundary layers (with P. Hildebrand and T. Clark), 1987, *Quart. J. Roy. Met. Soc.,* **113**, 445-467.

Convection wave studies over land and sea (with R. Grossman). 1991, *DLR Publication series, F.B.* **91-30**, 125-140.

Convection waves: Momentum flux and flux divergence (with R. Grossman and H. Melfi), 1992, *Proceedings. 5th Conf. on Mesoscale Processes*, AMS, 24-29.

Central Equatorial Pacific Experiment (CEPEX): Experiment Design (Co-Ed.), 1993, *Monograph, Scripps Inst. of Oceanography*, C-4, 56 pp.

Scientific Objectives and Conceptual Formulation (with V. Ramanathan), 1994, *Proceed. CEPEX Santa Fe Workshop*, 1-10.

INDOEX: A multi-agency proposal for a field experiment in the Indian Ocean, Scripps Inst. of Oceanography, 1996, 83 pp.

The MAP Special Observing Period (with P. Bougeault et al.), 2000, *Bull. Amer. Meteor. Soc.,* **82**, 433-462.

James D. Doyle
Projects: GALE (1986), ERICA (1989), FASTEX (1997), MAP (1999), Sierra Rotors (2004)
Facilities: Electra, SABL, GPS dropsondes, NCAR Integrated Sounding Systems (ISS)

Publications resulting from past ATD support:

Doyle, J. D., and T. T. Warner, 1990: Mesoscale coastal processes during GALE IOP 2. *Mon. Wea. Rev.* **118**, 283-308.

Doyle, J. D., and T. T. Warner, 1991: A Carolina coastal low-level jet during GALE IOP 2 *Mon. Wea. Rev.* **119**, 2414-2428.

Doyle, J. D., and T. T. Warner, 1993: A numerical investigation of coastal frontogenesis and mesoscale cyclogenesis during GALE IOP 2. *Mon. Wea. Rev.* **121**, 1048-1077.
Doyle, J. D., and T. T. Warner, 1993: A three-dimensional numerical investigation of a coastal low-level jet during GALE IOP 2. *Mon. Wea. Rev.* **121**, 1030-1047.
Doyle, J. D., and T. T. Warner, 1993: Nonhydrostatic simulations of coastal mesobeta-scale vortices and frontogenesis. *Mon. Wea. Rev.* **121**, 3371-3392.
Doyle, J. D., and T. T. Warner, 1993: The impact of the sea-surface temperature distribution on mesoscale coastal processes during GALE IOP 2. *Mon. Wea. Rev.* **121**, 313-334.
Doyle, J. D., and M. A. Shapiro, 1999: Flow response to large-scale topography: The Greenland tip jet. *Tellus*, **51A**, 728-748.
Doyle, J. D., and R. B. Smith, 2003: Mountain waves over the Hohe Tauern. *Quart. J. Roy. Meteor. Soc*., **129**, 799-823.
Jiang, Q., and J.D. Doyle, 2004: Gravity wave breaking over the central Alps: Role of complex terrain. *J. Atmos. Sci.*, **61**, 2249-2266.
Jiang, Q., R.B. Smith, and J.D. Doyle, 2003: The nature of the Mistral: Observations and modeling of two MAP events. *Quart. J. Roy. Meteor. Soc*., **129**, 857-875.
Smith, R.B, Q. Jiang, M. G. Fearon, P. Tabary, M. Dorninger, J.D. Doyle, R. Benoit. Orographic precipitation and airmass transformation: An Alpine Example, 2003. *Quart. J. Roy. Meteor. Soc*., **129**, 433-454.
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Warner, T. T., L. N. Lakhtakia, J. D. Doyle and R. A. Pearson, 1990: Marine atmospheric boundary layer circulations forced by Gulf Stream sea surface temperature gradients. *Mon. Wea. Rev.* **116**, 358-367.
Warner, T. T., Y.-H Kuo, J. D. Doyle, J. Dudhia, D. R. Stauffer, Y.-H. Kuo, and N. L. Seaman, 1992: Nonhydrostatic mesobeta-scale real-data simulations with the Penn State University/National Center for Atmospheric Research mesoscale model. *Meteor. Atmos. Phys.* **49**, 209-227.

Gregory S. Poulos

Projects: MAP (1999), CASES-99 (1999)
Facilities: Electra, King Air, ISFF

Poulos, G. S., W. Blumen, D. C. Fritts, J. K. Lundquist, J. Sun, S. P. Burns, C. Nappo, R. Banta, R. Newsome, J. Cuxart, E. Terradellas, B. Balsley and M. Jensen, 2002: CASES-99: A comprehensive investigation of the stable nocturnal boundary layer. *Bull. Amer. Meteor. Soc.*, **83**, 555-581.

A number of papers resulting from CASES-99 appear in two special journal issues:

Poulos, G. S. (guest editor), 2002: CASES-99 – A study of the nocturnal boundary layer utilizing field measurements in south-east Kansas, U.S.A. during October 1999. *Bound. Layer Meteor.*, **105**.
Moeng, C.-H., G. S. Poulos, and M. A. LeMone (guest editors), 2003: William Blumen Memorial CASES-99 Special Issue. *J. Atmos. Sci*., **60**.

Ronald B. Smith

Projects: ALPEX (1982), ERICA (1989), Chemical Layering in the Lower Stratosphere (1991), MAP (1999)
Facilities: Electra, Sabreliner, SABL, GPS dropsondes, (DLR Falcon)

Publications resulting from past ATD support:

Smith R.B., S. Skubis S, J. D. Doyle, A. S. Broad, C. Kiemle , H. Volkert, 2002: Mountain waves over Mont Blanc: Influence of a stagnant boundary layer. *J. Atmos. Sci.,* **59**, 2073-2092.
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Schaer C., M. Sprenger, D. Luthi, Q. F. Jiang, R. B. Smith, R. Benoit, 2003: Structure and dynamics of an Alpine potential-vorticity banner. *Quart. J. Roy. Meteor. Soc.,* **129**, 825-855.
Salathé, E. and R. B. Smith, 1992: In situ observations of temperature microstructure above and below the tropopause. *J. of Atmos. Sci*., **49**, 2032-2036.
Smith, R. B. and V. Grubisic, 1993: Aerial observations of Hawaii's wake. *J. of Atmos. Sci.*, **50**, 3728-3750.
Smith, R. B., 1992: Deuterium in North Atlantic storm tops. *J. of Atmos. Sci.,* **49**, 2041-2057.
Tosi, E., R. B. Smith, and M. Bradford, 1987: Aerial observations of stratospheric descent in a Gulf of Genoa cyclone. *Meteor. Atmos. Phys.,* **36**, 141-160.
Smith, R. B., 1987: Aerial observations of the Yugoslavian Bora. *J. Atmos. Sci*., **44**, 269-297.

Robert Banta
Projects: SPACE (1977), MAP (1999), CASES-99 (1999)

Publications resulting from past ATD support:

Banta, R. M., and W. R. Cotton, 1981: An analysis of the structure of local wind systems in a broad mountain basin. *J. Appl. Meteor*., **20**, 1255-1266.

Banta, R. M., 1984: Daytime boundary-layer evolution over mountainous terrain. Part I: Observations of the dry circulations. *Mon. Wea. Rev.,* **112**, 340-356.

Banta, R. M., 1985: Late-morning jump in TKE in the mixed layer over a mountain basin. *J. Atmos. Sci.*, **42**, 407-411.

Banta, R. M., 1986: Daytime boundary-layer evolution over mountainous terrain. Part II: Numerical studies of upslope flow duration. *Mon. Wea. Rev.,* **114**, 1112-1130.

Flamant, C., P. Drobinsky, L. Nance, R. Banta, L. Darby, J. Dusek, M. Hardesty, J. Pelon, and E. Richard, 2002: Gap flow in an Alpine valley during a shallow south foehn event: Observations, numerical simulations and hydraulic analog. *Quart. J. Roy. Meteor Soc.*, **128**, 1173-1210.

Durran, D. R., T. Maric, R. M. Banta, L. S. Darby, and R. M. Hardesty, 2003: A comparison of ground based Doppler lidar and airborne in situ wind observations above complex terrain. *Quart. J. Roy. Meteor Soc.*, **129**, 693-713.

Weissmann, M.D., G.J. Mayr, R.M. Banta, and A. Gohm, 2004: Observations of the temporal evolution and spatial structure of the gap flow in the Wipp Valley on 2 and 3 October 1999. *Mon. Wea. Rev.,* **132**, 2684-2697.

Banta, R. M., R.K. Newsom, J.K. Lundquist, Y.L. Pichugina, R. L. Coulter, and L. Mahrt, 2002: Nocturnal low-level jet characteristics over Kansas during CASES-99. *Boundary-Layer Meteor.,* **105**, 221-252.

Banta, R.M., Y. L. Pichugina, and R. K. Newsom, 2003: Relationship between low-level jet properties and turbulence kinetic energy in the nocturnal stable boundary layer. *J. Atmos. Sci.*, **60**, 2549-2555.

Banta, R. M., L. S. Darby, J. D. Fast, J. O. Pinto, C. D. Whiteman, W. J. Shaw, and B. D. Orr, 2004: Nocturnal low-level jet in a mountain basin complex. I: Evolution and implications to other flow features. *J. Appl. Meteor.,* **43**, 1348-1365.

Laurence Armi
Projects: CODE II (1982), MAP (1999)
Facilities: Queen Air, Electra, SABL, GPS dropsondes, (NOAA P-3)

Publications resulting from past ATD support:

Flament, P., Armi, L. and Washburn, L., 1985: The evolving structure of an upwelling filament, *J. Geophys. Res*., **90**, 11, 765-11, 778.

Armi, L. and Flament, P., 1985: Cautionary remarks on the spectral interpretation of turbulent flows, *J. Geophys. Res.,* **90**, 11, 779-11, 782.

Mayr, G. J., Armi, L., Arnold, S., Banta, R. M., Darby, L. S., Durran, D. R., Gabersek, S., Gohm, A., Mayr, R., Mobbs, S., Nance, L. B., Vergeiner, I. Vergeiner, J. and C. D. Whiteman, 2004: GAP flow measurements during the Mesoscale Alpine Programme. *Met. and Atm. Phys.,* **86**, 99-119.

Dave Fritts
Projects: CASES-99 (1999), MAP (1999)
Facilities: King Air, Electra, SABL, GPS droposondes, NCAR Integrated Sounding Systems

Publications resulting from past ATD support:

Blumen et al., 2001: Turbulent statistics of a Kelvin-Helmholtz billow event observed in the nighttime boundary layer during the CASES-99 field program, *Dyn. Atmos. Oceans*, **34**, 189-204.

Doyle, J. D., A. Broad, D. C. Fritts, G. S. Poulos, R. B. Smith, and H. Volkert, 2001: Mountain waves over the Alps, *NRL Review*, 254 pp.

Poulos, G. S., W. Blumen, D. C. Fritts, J. K. Lundquist, J. Sun, S. P. Burns, C. Nappo, R. Banta, R. Newsom, J. Cuxart, E. Terradellas, B. Balsley, and M. Jensen, 2002: CASES-99: A Comprehensive Investigation of the Stable Nocturnal Boundary Layer, *Bull. Amer. Meteor. Soc*., **83**, 555-581.

Balsley, B. B., D. C. Fritts, R. G. Frehligh, M. Jones, S. L. Vadas, and R. Coulter, 2002: Up-gully flow in the Great Plains region: A mechanism for perturbing the nighttime lower atmosphere?, *Geophys. Res. Lett.,* **20** (19), 10.1029/2002GL015435.

Fritts, D. C., et al., 2003: Analysis of ducted motions in the stable nocturnal boundary layer during CASES-99, J. Atmos. Sci., 60, 2450-2472.

Fritts, D. C., and M. J. Alexander, 2003: Gravity dynamics and effects in the middle atmosphere, *Rev. Geophys.,* **41**, doi:10.1029/2001RG000106.

Fritts, D. C., C. Bizon, J. A. Werne, and C. K. Meyer, 2003: Layering accompanying turbulence generation due to shear instability and gravity wave breaking, *J. Geophys. Res*., **108**, D8, 8452, doi:10.1029/2002JD002406.

Expected publication date and journal:

Journal of the Atmospheric Sciences

FUNDING AGENCY INFORMATION

Funding Agency	National Science Foundation
Contract Officer	Stephan P. Nelson
Contract Identification	
Proposal Status	
Approximate Amount budgeted	

DATA ACCESS POLICY

ATD policy will make all LAOF 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 ATD Division Director (carbone@ucar.edu) eight weeks prior to the start of an experiment.

Do you intend to request restricted access?

Yes. We plan to request exclusive access to the T-REX data for the first year.

OPERATIONS IN FOREIGN COUNTRIES

Is the PI aware of any factors that could impact operations from this location? Health and safety issues in particular should be noted.

PART II: FACILITY-SPECIFIC REQUESTS

AIRCRAFT: NSF/NCAR HIAPER G-V

Please list your requirements below.

AIRCRAFT OPERATIONS

Preferred flight period	1 March – 30 April 2006
Number of flights required	12
Estimated duration of each flight	10 hours = 6 hours over the project area + 4 hours ferry time
Number of flights per day	Maximum 2, with landing at a suitable nearby airport
Average flight radius from base	Distance Boulder , CO – Bishop, CA
Desired flight altitudes(s)	30 – 46 kft
Particular part(s) of day for flights	mid-morning and late afternoon
Statistically, how many days during specified period should be acceptable for flight operations?	10-15 We are requesting 120 hours of flight time for approximately 12 research flights to account for a possibility of a very good year in terms of climatology of the Sierra Wave events
Number of scientific observers for each flight (Maximum is 4.)	2-3

Scientific rationale for the use of this aircraft in the proposed project: (*Please insert text or attach documentation*):
The NSF/NCAR HIAPER with the NCAR SABL (or a new eye-safe airborne lidar) is the key high-altitude research platform needed for documentation of the upper portions of the wave/rotor system that for large amplitude Sierra Waves can easily extend to upper-tropospheric/lower-stratospheric altitudes. Additionally, aircraft observations of stratospheric and tropospheric tracers (e.g., O_3 and CO) and microphysical measurements in conjunction with other *in situ* and remote sensing measurements with HIAPER will offer an opportunity to quantify mountain wave contributions to stratosphere-troposphere exchange processes, and ice initiation processes within wave clouds.

Description of desired flight pattern(s), priorities, and estimate number of flights:
(Please insert graphics and flight pattern images as needed.)
Densely sampled thermodynamic and velocity data for documentation of airflow over Owens Valley as well as up- and downstream of the valley centerline will be obtained by research aircraft in cross-mountain traverses of up to 300 km in length as shown in Figure 2.1 below. Additionally, some supporting atmospheric chemistry measurements (for documentation of the subtropical jet) will be conducted during the ferry flight segments between the Jefferson County Airport in Broomfield, Colorado and Owens Valley.

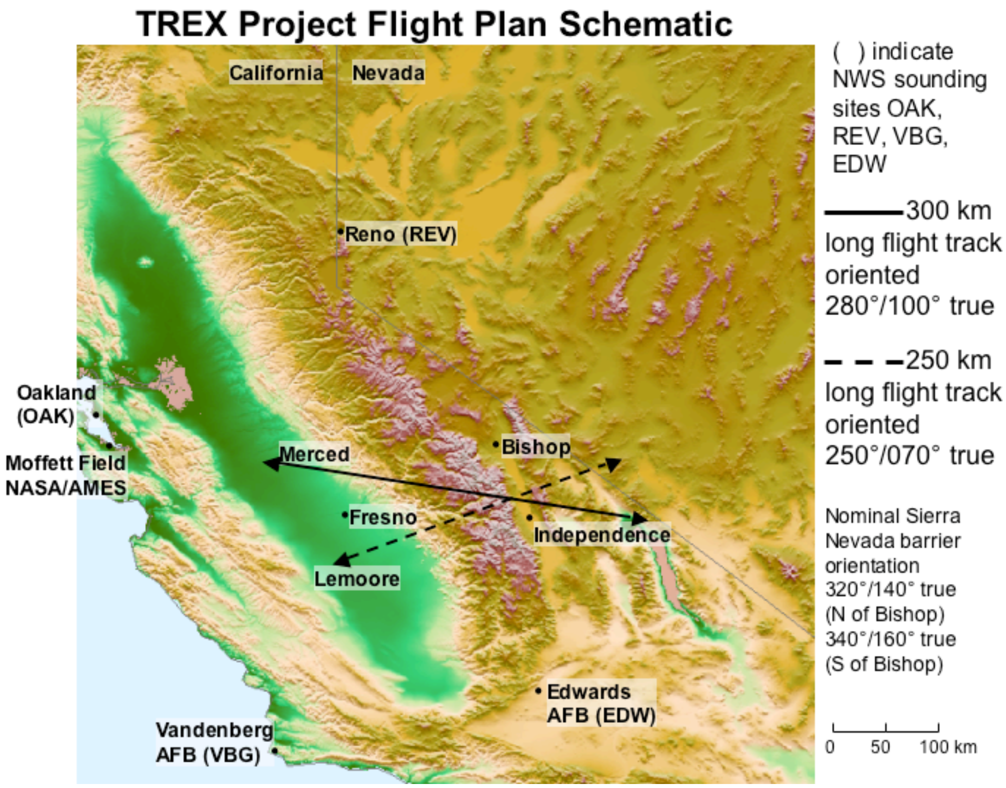

Figure 2.1

T-REX flight-plan schematic showing the orientation of possible cross-mountain flight tracks over the Sierra Nevada and the White-Inyo range. Base map created by the UCAR Joint Office of Scientific Support.

Owing to the cross-barrier and along-valley orientation of the atmospheric phenomena to be studied, both cross- and along-barrier sampling strategies will be used. Generic vertically stacked cross-mountain flight tracks at a range of possible flight track altitudes are shown in Figure 2.2. The flight design strategy will build on the experience gained in the recent Mesoscale Alpine Programme (MAP) experiment, and will include repeated passes along a selected small number of flight tracks.

All research aircraft flights will be coordinated with the operation of ground-based fixed and mobile instrumentation.

We expect to conduct between 8 and 12 research flights, depending on the number of strong wave events that will occur during this two-month period in 2006. As the existing climatology of the Sierra Wave events indicates, there is a significant interanual variability of the number of Sierra Wave events. With a request for 120 research flight hours, and a plan for 12 research flights, we will have sufficient resources to document all strong events in case of a climatologically excellent year.

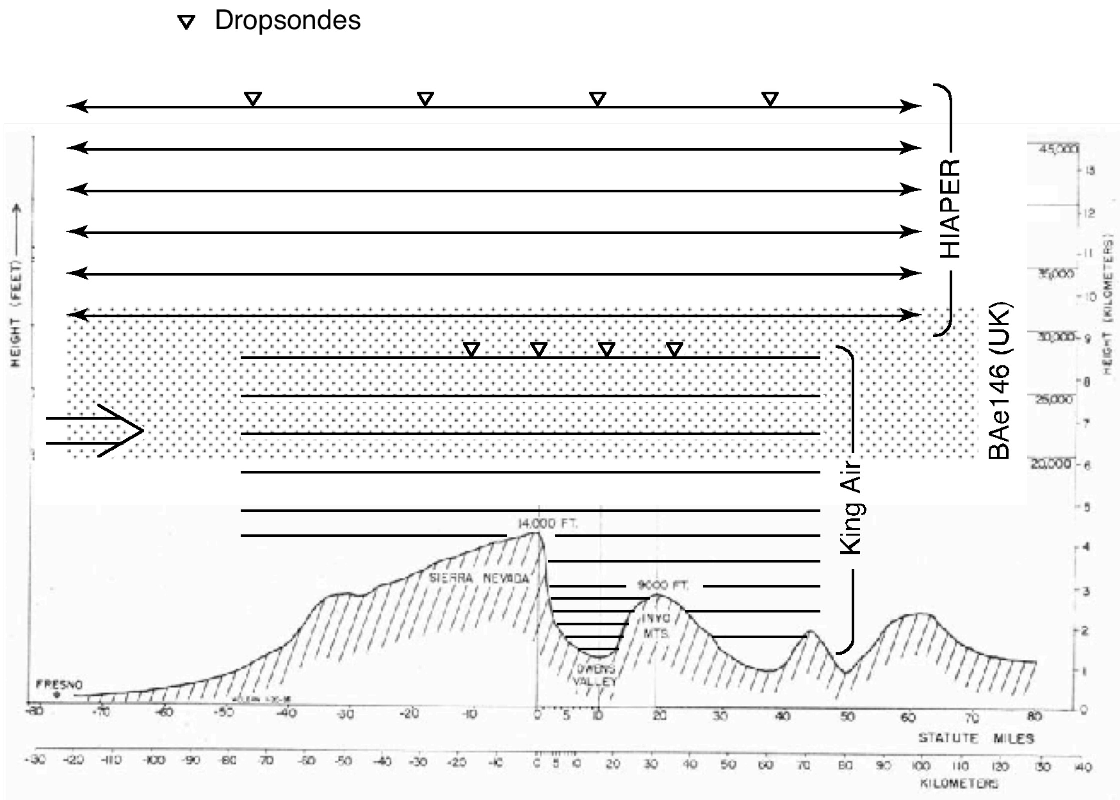

Figure 2.2
Generic cross-mountain flight tracks with dropsonde releases and the vertical range of all three planned aircraft shown in relation to the terrain, in the vertical cross-section whose base line is indicated with a bold dashed line in Figure 1.

ATD/RAF AIRBORNE SCIENTIFIC INSTRUMENTATION

USER-SUPPLIED SCIENTIFIC PAYLOAD

Note: All user-supplied equipment must meet RAF safety and design specifications. Refer to RAF Bulletin No. 3(http://raf.atd.ucar.edu/Bulletins/bulletin3.html), RAF Bulletin No. 13 (http://raf.atd.ucar.edu/Bulletins/bulletin13.html), Design Guide RAF-DG-00-001 (http://raf.atd.ucar.edu/Bulletins/Design_Guide.html) and the G-V Investigators Handbook Please provide the following information for each user-supplied scientific instrument:

Instrument Name:	**Harvard CO/CH_4/CO_2**
Individual weight of all components:	CO/CH_4: 75 lbs. CO_2: 50 lbs. Electronics: 65 lbs.
Complete size dimensions of all components:	CO/CH_4: 17.2" x 25.2" x 12" CO_2: 17.2" x 25.2" x 12" Electronics: 17" x 20" x 12"
Rack-mountable 19" panel space required (Note: depth beyond 25" will overhang in back):	40 vertical inches
Supplying your own 19" rack (yes/no): (Note: racks must survive 9G crash load.)	No
Hazardous material required:	Compressed gases
Radioactive sources or materials:	None
Power required (watts, volts, amps):	700 W @ 28 VDC
Type of power (DC, 60 Hz, 400 Hz):	28 VDC
External Sensor Location (if any):	Rear-facing standard inlet
Are Signal(s) to be recorded on RAF's Aircraft Data System (yes/no)?	No, but can be provided if desired
If yes: Signal format (digital, analog, serial):	N/A
Full-scale Voltage:	N/A
Range:	N/A
Resolution:	N/A
Sample Rate (1, 5, 250 sps):	N/A
Need real-time, in-flight, RAF-measurement, serial data feed (RS-232, RS422)?	No
Need IRIG time-code feed?	No
Special sensor calibration service required?	No
Need full-time operator during flight?	No
Number of lap-top computers for on-board use:	1

Instrument Name:	**RAF VUV Fluorescence CO**
Individual weight of all components:	Instrument: 60 lbs.; pump: 40 lbs.
Complete size dimensions of all components:	Instrument: 19" x 24" x 10" Pump: 19" x 24" x 9"
Rack-mountable 19" panel space required (Note: depth beyond 25" will overhang in back):	19 vertical inches
Supplying your own 19" rack (yes/no): (Note: racks must survive 9G crash load.)	No

Hazardous material required:	Non-toxic compressed gases
Radioactive sources or materials:	None
Power required (watts, volts, amps):	75 W (2.6 A @ 28 VDC) + 330 W (3 A @ 110 VAC
Type of power (DC, 60 Hz, 400 Hz):	28 VDC and 110 V, 60 Hz
External Sensor Location (if any):	Rear-facing inlet
Are Signal(s) to be recorded on RAF's Aircraft Data System (yes/no)?	Yes
If yes: Signal format (digital, analog, serial):	Analog
Full-scale Voltage:	10 V
Range:	10 V
Resolution:	16 bit
Sample Rate (1, 5, 250 sps):	1 sps
Need real-time, in-flight, RAF-measurement, serial data feed (RS-232, RS422)?	No
Need IRIG time-code feed?	Yes
Special sensor calibration service required?	No
Need full-time operator during flight?	No, but on-board operator may be required to initiate and terminate power to instrument
Number of lap-top computers for on-board use:	0

Instrument Name:	**CAPS**
Individual weight of all components:	29 lbs (probe) + 12 pounds (canister)
Complete size dimensions of all components:	Canister+Rack mount
Rack-mountable 19" panel space required (Note: depth beyond 25" will overhang in back):	computer
Supplying your own 19" rack (yes/no): (Note: racks must survive 9G crash load.)	no
Hazardous material required:	no
Radioactive sources or materials:	no
Power required (watts, volts, amps):	3x15 amps, 28 volts (deiced)
Type of power (DC, 60 Hz, 400 Hz):	DC
External Sensor Location (if any):	PMS canister or equivalent
Are Signal(s) to be recorded on RAF's Aircraft Data System (yes/no)?	No
If yes: Signal format (digital, analog, serial):	Digital
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?	none
Special sensor calibration service required?	No
Need full-time operator during flight?	Yes
Number of lap-top computers for on-board use:	1

DATA RECORDING AND PROCESSING REQUIREMENTS

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.)
None.

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 netCDF. The standard output media are magnetic tape and ftp transfer. *(Nonstandard rates and/or formats will be considered as special processing requests.)*
N/A

Will you be using your own recording system?

No.

SUPPORTING SERVICES

Will you require air-ground communication? *(If so, specify location of base station and operating frequencies.)*

Will NCAR support be required in preparing this instrument for use on the aircraft (other than inspection, installation and power hookup). ATD/RAF can provide design and fabrication support for hardware and electronic interfaces. *(If so, specify type and lead time.)*

GROUND SUPPORT NEEDS FOR USER-SUPPLIED INSTRUMENTATION

Preflight needs (prior to take-off) on flight days:

Access	2 hrs
Power	2 hrs

Postflight needs (after landing) on flight days:

Access	1 hrs
Power	1 hrs

Special support needs on flight days (and comments):

None anticipated.

Routine Maintenance on non-flight days:

Access	1 hrs
Power	1 hrs

Special support needs on non-flight days (and comments):

None anticipated.

On-site data access requirement:
Need access to dropsonde data for potential in-flight planning.

Summary of any special requirements which pertain to RAF support:
None.

Has an ATD scientist/engineer/project manager been consulted to help complete this request?
Yes, several of the instrument PIs as well as the proposal PIs have spoken with Jorgen Jensen.

AIRBORNE INSTRUMENTATION:
SCANNING AEROSOL BACKSCATTER LIDAR (SABL)

SABL is presently not supported by the NSF Deployment Pool. Funds have to be obtained from separate sources. For more information, please contact the ATD Director or the RTF Facility Manager.

LIDAR OPERATIONS

Scientific rationale for the use of SABL in the proposed project

The remote sensors on board the mid- and upper-air aircraft, primarily up- and down-looking lidars on board the UK BAe146 and HIAPER, the latter equipped with SABL (or a new eye-safe lidar), will be the primary tools for documenting gravity wave breaking in clear air and turbulence within cloudless rotors. The capability of airborne lidars to document these turbulent zones will depend on the aerosol concentration within and over Owens Valley. The aerosol concentration is known to be high during strong wave events due to significant dust lifting from the dry Owens Lake bed and other naturally dry soil surfaces in the valley.

Where will SABL be installed?

On board the NSF/NCAR HIAPER.

SUPPORTING SERVICES

Is a Scientific Project Manager needed for the project?

Yes.

Summary of any special requirements that pertain to EOL

Real-time access to the SABL data and integration into the Real-time Display and Coordination Center (RDCC) would be highly desirable for real-time flight coordination.

Has an EOL scientist/engineer/project manager been consulted to help complete this request?

Yes.

AIRBORNE INSTRUMENTATION:
GPS DROPSONDE (INCL. USE AS UPSONDES (MCASS))

SYSTEM OPERATIONS

Number of Systems requested:

2

Number of Sondes requested:

750

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

It is planned that all aircraft in T-REX be equipped with dropsonde systems. The two dropsonde systems requested here are for the high-altitude NSF/NCAR HIAPER, flying at altitudes between 30,000 and 46,000 feet, and for the University of Wyoming King Air, reaching the maximum flight level of 28,000 feet. Curtains of dropsonde releases for obtaining velocity and thermodynamic data in the air volume below flight tracks are planned along high-altitude cross-mountain and mountain-parallel flight tracks. We expect that dropsondes will yield much needed thermodynamic data from the rotor interior, which have been lacking thus far. Dropsondes will also be important for mapping out the spatial, along range, variability of the upwind temperature and velocity profiles, in particular documenting the spatial variability and the wind shear structure of the mountain top inversion.

Approximately how many dropsondes will be released on each mission flight?

The expected number of sondes to be dropped during a NSF/NCAR HIAPER research flight is about 30, and for the King Air flight is about 20.

With NSF/NCAR HIAPER flying at 40,000 ft, sondes will require about 25 minutes to reach the ground. With the dropsonde system using 4 frequency channels simultaneously and the aircraft flying at approximately 200 m s^{-1}, the temporal spacing between individual sondes (assuming equidistant spacing between all dropsondes on a given flight segment) is about 8 minutes (to account for additional time needed to prepare sodes for the launch and to postprocess the sounding), corresponding to about 90 km horizontal spacing between sondes. The maximum number of drops that could be launched with this system during a 5-6 hour HIAPER research flight is 40-45.

With King Air flying at 25,000 ft at approximately 100 m s^{-1}, sondes will require about 15 minutes to reach the ground. With the same assumption as above, the minimum spacing between the sondes is 5.5 minutes or 33 km.

At which frequency (i.e., time between drops) will the dropsondes be released?

Our estimate is that drops will be 8 minutes apart if released from HIAPER at 40,000 ft, and 5-6 minutes apart if released from King Air at 25,000 ft.

What is the general location in which the dropsondes will be dropped?

Dropsondes are planned upwind of the Sierra Nevada (away from the populated areas of San Joaquin

Valley), and over sparsely populated Owens Valley.

SUPPORTING SERVICES

Will you provide an operator for the dropsonde system?

We will require the same support that was available for operating the dropsonde systems in MAP.

Is an EOL Scientific Project Manager needed for the project?

Yes.

Summary of any special requirements that pertain to EOL support

In-flight communication among the aircraft and with T-REX Operations Center is needed. It will be highly desirable to have the capability to view the dropsonde data in near real time.

Has an EOL scientist/engineer/project manager been consulted to help complete this request?

Yes. We have consulted Terry Hock on the details of this request.

GROUND-BASED SYSTEMS:

GPS/LORAN ATMOSPHERIC SOUNDING SYSTEM (GLASS) AND MOBILE GLASS

SYSTEM OPERATIONS

Number of Systems requested:

1 MGLASS

Number of Sondes requested:

70

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

The primary purpose of the MGLASS unit is to document the evolution of the environment upstream of the Sierra Nevada on finer temporal and spatial scales that can be provided by the aircraft dropsones or by the existing sounding operations in the San Joaquin Valley. (The regular NWS upper-air sounding stations upwind of the project area in Oakland, CA and at Vandenberg AFB, CA, and are located too far north and south of the project area to provide pertinent information on the upstream environment). The mobility of MGLASS will allow us to always have it positioned within the direction of the mean cross-mountain flow in order to obtain critical information on the temporal variation of features such as upstream inversions and low-level blocking that have critical impact on the strength and structure of waves and rotors over Owens Valley. These soundings will be critical to help with deployment decisions and for post analysis and numerical simulation studies. It is intended that the MGLASS unit be based in Fresno, CA. The total radius of movement of this unit is expected to be 100 km, primarily in the NNW to SSE direction parallel to the Sierra Nevada. Its location during Intensive Observation Periods (IOP) will be determined during the pre-IOP planning process. During IOPs the location of the unit will change only if directed by the Operations Director. It is anticipated that the serial soundings will be taken at 3 to 6 hour intervals during wave and rotor events.

SUPPORTING SERVICES

Is a RTF Scientific Project Manager needed for the project?

No.

Summary of any special requirements that pertain to EOL support:

We require real-time transmission of the soundings to the T-REX Operations Center.

Has an EOL scientist/engineer/project manager been consulted to help complete this request?

Yes.

GROUND-BASED SYSTEMS:

SPECIAL REQUEST FOR ADDITIONAL GPS SONDES

SYSTEM OPERATIONS

Number of Systems requested:

0

The additional fixed GPS sounding site that is anticipated in T-REX will be located at the Naval Air Station (NAS) Lemoore. Most of the costs of operation of the NAS Lemoore launches, including personnel and equipment costs, will be secured through the cooperative agreement between NAS Lemoore and Dr. James Doyle at the Naval Research Laboratory in Monterey as it was the case in the Sierra Rotors Project. If needed, some of the operating costs (e.g. helium supply), will be requested through a proposal to NSF by Dr. Vanda Grubisic of DRI.

Number of Sondes requested:

70

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

The additional sondes are requested for augmentation of the soundings from the NCAR MGLASS system at a special fixed GPS sounding site at the Naval Air Station (NAS) Lemoore. The additional upper air information is essential for documenting the spatial variation of features in the upstream profiles of the cross-barrier wind speed, temperature, and moisture.

GROUND-BASED SYSTEMS:

INTEGRATED SOUNDING SYSTEM (ISS)

SYSTEM OPERATION

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

We will use ISS to obtain continuous wind profiles and rawinsonde data during IOPs at several sites in Owens Valley to characterize the atmospheric state during and between wave and rotor events. As a continuation of work begun during the Sierra Rotors project, which showed that vertical motions in mountain waves can be unambiguously identified with wind profilers, the vertical velocity and spectral width of wind profiler Doppler spectra will be obtained during wave/rotor events and examined for signatures of mountain waves, rotors, and the related turbulence. With the presence of both fixed and mobile wind profilers, we will be able to examine the vertical velocity and spectral width fields both along and across the valley axis. Together with the spatial coverage from scanning lidars, the special wind profiler modes will be used to probe within the greater rotor structure.

Number of Systems requested:

3
MAPR, MISS, and a regular ISS

Will you require balloon launches? If yes, how many sondes are needed? At what frequency over which time period will the sondes be launched?

Yes.
90 sondes, 30 for each ISS unit.
It is intended that sondes in Owens Valley will be lauched during Intensive Observation Periods (IOPs). During IOPs with strong wave and rotor activity, we plan to have the serial sonde launches at 3 to 6 hour periods, depending on the forecasted length of individual wave events and their temporal variability.

Is the RASS system needed? If so, will noise be an issue for the RASS operation (i.e., near residential areas)?

The RASS system is needed and is being requested. Its intended use is primarily during quiescent conditions in Owens Valley, during which a good signal return is expected up to 1 km. During strong wind conditions, the RASS signal retrieval is likely to be severely diminished.

The noise generated by the RASS operation is not expected to be an issue for ISS units placed further away from Independence. In case the mobile system (MISS) will again be based at the Independence airport (at the northern end of town) as it was in the Sierra Rotors Project, that RASS will not be able to operate at night.

Do you have any special scanning requirements for the profilers?

No.

Do you have experience in the analysis of profiler data? Are software tools available?

Two ISS systems (MAPR and MISS) were deployed in the Sierra Rotors field project in spring of 2004. High temporal and altitude resolution vertical velocity measurements by wind profilers showed cases of persistence over time as well as great variability in measured velocity during strong wave events. Persistent features were also observed in the wind profiler Doppler spectra, which are related to velocity variance, i.e., turbulence. We are actively gaining more experience in using wind profiler data in diagnosing wave and rotor motions. This study is being actively pursued by the PI Grubisic in collaboration with ATD scientists Steve Cohn and Bill Brown.

Is the MAPR system required? If so, why?

The MAPR system will be beneficial to document mountain waves surrounding the rotor and the turbulence within the rotor. Given a highly variable nature of rotor circulation, the capability of MAPR to make wind measurements on time scales as short as a few minutes is essential for capturing the rapid evolution of rotors. If run in RIM (Range IMaging) mode, the range resolution of MAPR can be improved down to around 20 meters, which is important for documenting the rotor substructure.

Do you plan to conduct Intensive Observing Period (IOPs)? Under which circumstances?

Yes. IOPs are primarily planned to take place during conditions favoring the Sierra Wave and rotor formation over Owens Valley. Those are prefrontal situations with a trough located off the California coast producing strong and sustained SW-WSW cross-barrier flow of at least 30-35 knots at 700 hPa. Some IOPs are also planned to take place during a more quiescent conditions in Owens Valley, with, for example, a synoptic high-pressure system over the area, in order to document in detail thermally forced flows and other boundary-layer circulations in Owens Valley in absence of rotors.

SUPPORTING SERVICES

Is an EOL Scientific Project Manager needed for the project?

Given the size of this facility request and the length of the deployment period, the project would significantly benefit from an EOL Scientific Project Manager.

How many of your staff will be available full time to help operate the system?

The investigators, post-docs and students will be available to assist ISS staff as needed during T-REX and its IOPs.

Summary of any special requirements that pertain to EOL support:

Availability of a quick-look dataset in near-real time is essential.

Has an EOL scientist/engineer/project manager been consulted to help complete this request?

Yes. This request has been discussed with Steve Cohn and Bill Brown of EOL/RTF.

GROUND-BASED INSTRUMENTATION:
RAMAN-SHIFTED EYE-SAFE AEROSOL LIDAR (REAL)

REAL is 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 EOL Associate Director or the RTF Facility Manager.

What is the scientific rationale for the use of REAL in the proposed project? What are the phenomena and measurements of interest?

The dry lakebed at the southern end of Owens Valley is a prodigious source of fugitive dust under strongly perturbed mountain wave conditions favoring rotor formation. Under such conditions, an aerosol lidar such as REAL, which resolves aerosol-based structures at 3.5 m resolution over a 5-10 km range (possibly even higher depending on aerosol concentration and extinction), can be used to measure temporal and spatial structure of airflow over the ground station networks and in the vicinity of aircraft tracks, and to discern detailed circulations within diurnally-evolving rotors.

Where and for how long will REAL be deployed? What are the characteristics of the site you expect REAL to deploy to (wooded, urban, mountainous etc.)?

We anticipate that REAL will be deployed for two months (March and April). The site selected for REAL is located on the gently sloped alluvial fan on the western side of Owens Valley, in between stations of the DRI automatic station network (cf. Map). The vegetation at the site is sparse consisting predominantly of sagebrush.

How do you desire for REA L to be operated (24/7, for IOPs only, autonomously)? What scanning strategies will you use and why?

Please describe your data access needs (real-time, in coordination with any other measurement systems, post-processed data only etc.).

Availability of a quick-look data set in real-time is desirable.

SUPPORTING SERVICES

Is a Scientific Project Manager needed for the project?

No

Please summarize any special requirements that pertain to this deployment.

N/A

Has an ATD scientist/engineer/project manager been consulted to help complete this request? If so, who?

Yes. Shane Mayor.

GROUND-BASED SYSTEMS:

INTEGRATED SURFACE FLUX SYSTEM (ISFF)

RATIONALE

Scientific objectives to be addressed using the ISFF:

The ISFF measurements will be important for documenting the role of the boundary layer in the evolution of the coupled rotor system [objective I(D)], and investigating the boundary layer structure and evolution in Owens Valley in absence of rotors [objective II(B)].

Using dense arrays of surface meteorological towers and microbarographs for detecting adverse pressure gradients, surface-based remote sensing, and flux towers, T-REX offers an opportunity to investigate the degree to which surface boundary-layer properties, such as heat, momentum and moisture fluxes, and roughness lengths determine the characteristics of rotors, including separation, rotor strengths and depths, the strength of reversed flows at the surface, and the state of the mountain-wave/rotor/boundary-layer system coupling. This will allow us to answer fundamental questions such as whether the hypothesized Type II rotors are simply a response of the free atmosphere to the boundary layer separation at a hydraulic jump, or whether the rotor is part of a more complex free atmosphere wave/rotor system generated by the mountains and the separation is a boundary layer response to the rotor.

In order to characterize the heterogeneity of surface/boundary layer, the existing Phase I surface meteorological tower array will be enhanced. The proposed tall towers, heavily instrumented with sonic anemometers, thermocouples, and a full suite of surface energy balance equipment, including very high-rate (100 Hz) momentum flux measuring devices very close to the surface, will provide unprecedented data on the evolution of temperature, humidity, and momentum flux divergence during wave/rotor and non-wave/rotor days. These tall flux towers, along with the existing network of surface towers, and other smaller flux towers will help to identify physical limitations of high-resolution numerical modeling studies within the T-REX program.

The requested ISFF facilities will be used in conjunction with lidars by conducting coordinated scans near the tall towers to: 1) discover and/or render the phenomena responsible for turbulence (intermittent turbulence in the stable boundary layer), and 2) validate and verify turbulence quantities inferred from spectral analysis of lidar data to ensure the viability of broader use of the lidar measurements throughout the valley.

Data analysis methods to be used:

The calculation of the instantaneous and time-averaged surface energy balance including radiative components (radiative flux divergence calculations, if possible, would be of great value in assessing BL evolution), the validity of surface layer theory at various heights (up to 30 m) for intercomparison with numerical model parameterizations at different vertical grid spacing, a variety of turbulence statistics and various averaging methods for model data assimilation and verification.

MEASUREMENTS

Number of measurement sites:

We are requesting 3 primary tall tower (at least 32 m, up to 50 m) locations, with up to 27 (30 total) supplementary soil moisture/temperature sites.

Minimum/maximum separation of these sites:

The minimum separation of the 3 tower sites is 4 km and the maximum is 25 km. The supplementary soil sites will have a minimum separation of 250 m and a maximum of 20 km. The three towers are to be configured in the along and cross-valley directions in an 'L' shape (Figure 2.3).

Number and type of measurement at each site (e.g., 2 moisture flux, 5-level temperature profile):

In the following description, please reference Figures 2.3 and Figure 1 in Part I, which show the existing DRI automatic weather station sites (in cross-valley lines) in Owens Valley, the tall tower locations and the soil sensor locations.

Each of the three 32 m towers is expected to have a sonic anemometer/thermometer every 5 m to 30 m (5, 10, 15, 20, 25 and 30), with slow response RH and P (first-level only), and high-rate 3-component hot-film anemometers for momentum flux below 5m at 2 or 3 levels (0.25 m, 1.0 m and 2.5 m above roughness elements) without significant, or to characterize, flux loss. A standard meteorological station at 2.0 m is requested. These towers should be outfitted for the full surface energy balance (including radiation, and radiative flux divergence at < 10 m, if possible) and each would have 15 member thermocouple chains along their length (one every 2 m or so) for temperature profiling and rotor/other turbulent phenomena identification (0.5 Hz or better). ISFF is currently experimenting with an expansion of their facility into hot-film anemometry and would have to borrow/purchase the thermocouples, so our expectations with regard to these instruments are somewhat lower than for their standard systems. This array of sensors amounts to an improved, complex terrain analogue to the CASES-99 experiment that simultaneously and synergistically addresses a broad array of T-REX science goals (see T-REX SOD). We have chosen the 32 m height based on the existing limitations in the ISF Facility for tall tower construction and sheer volume of instrumentation, although extending the towers to 50 m would be desirable to better close the instrumentation gap between the top of the towers and remote-sensing and airborne instruments and to better test LES models (output and initialization), surface layer theory and parameterization. The ISFF staff has been made aware of this desire and will assess its viability, including the potential increase in the total number of sensors (generally through borrowing).

With regard to location, we would place one tall tower in the vicinity of DRI station 5 (see blue dot 32-1 in Figure 2.3). The purpose is to have it in a flat area adjacent to, but not in the river bottom itself (~100 m ENE of tower 5 is one of many scientifically viable examples), where very strong stable layers are expected to form at night and the mid-valley CBL could be sampled during the day. This takes advantage of the nearby towers for context and is the vertex of an inverted ~ 'L' of 32 m towers. The second tall tower (32 m) would be placed about 15 km SSE of the first tall tower, or 3-4 km SSE of DRI station 15 (cf. Figure 2.3). Again, near, but not too near the river bottom and in the flats. This tower would enable the assessment of statistical representativeness of tower 1 (flat-vs.-flat), provide information on valley and rotor-flow heterogeneity, and allow for coordination with along-valley lidar RHI or staring scan strategies. The third tall tower, which completes the ~'L' shape, would be to the west of the first tower in a valley perpendicular direction, hopefully near DRI stations 2, 8 and 9 in Figure 2.3. It would not be in the flats but on the uniform slope, allowing for cross-valley lidar RHI intercomparisons, and assessment of vertical heat flux in rotor evolution and flat-vs.-slope flux profile and statistical representativeness assessments.

In addition to the request for these towers, we request 30 soil moisture/temperature sensors for deployment around the valley (at the rough locations shown in Figure 1 in Part I, generally off the grid in non-real-time in most cases) at generally 3-5 cm below the soil surface (a few exceptions to 1 m below) to sample soil moisture distribution. We are in discussion with the surface group regarding a radiative flux divergence measurement at one of the sites.

Number and description of NCAR-supplied nonstandard sensors (see www.atd.ucar.edu/sssf/facilities/isff/sensors/):

This request may require borrowing or the purchase of up to 45 or more thermocouples, up to 9 3-axis hot-film systems, and up to 20 additional soil moisture and temperature probes.

Number and description of user-supplied sensors

Give power requirements, data output (e.g,. RS232 ASCII or 0-1V analog), and data handling (e.g,. sampling rate, sorting by valve position). *Providing user-supplied sensors to EOL for pre-experiment testing is highly desirable.*

In cooperation with the RTF surface group that operates ISFF, the T-REX PIs will deploy hot-film anemometers, thermocouples and additional soil sensors. These anemometers are under evaluation and potential transition to use within ISFF as part of the facility to enable sufficient momentum flux measurements at high stability and/or near the surface. If made available, they could become a permanent part of the ISFF.

Logistics requirements for each location

(e.g., power, phone, vehicle access, owner permission):

Grid power or generator power is likely to be required at each heavily instrumented tall tower site, with vehicle access to within 250 m or so likely. Owner permission will be required at all sites, although near co-location with existing tower sites is expected to simplify this process. Soil moisture sites along steeper valley walls and requiring 1 m depths will need to be evaluated on a case-by-case basis.

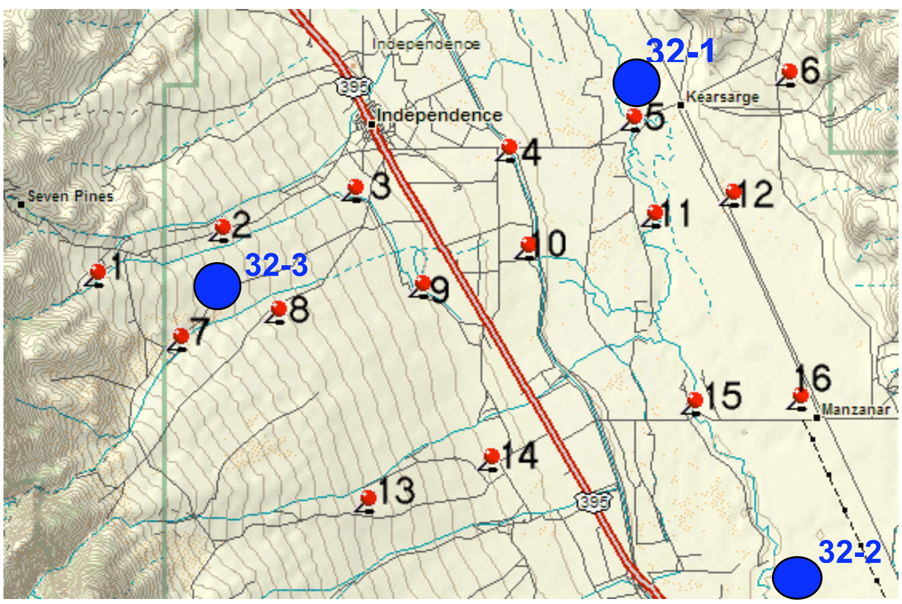

Figure 2.3

Existing DRI network of automated weather stations in Owens Valley (red dots) and the approximate locations of the requested 32 m towers (larger, blue dots marked 32-x). The southernmost east-west line of sensors is approximately 8 km south of the northernmost cross-valley line of sensors.

OPERATIONS BASE

Will an operations base be available or should EOL supply one?

The T-REX Operations Center, as in the Sierra Rotors project, will be located in Bishop, CA (see Figures

2.1 and 2.5). Space will be available for ISFF.

Location of the base relative to measurement sites:

The operations center will be approximately 80 km north of centroid of the measurement sites.

Logistics requirements at the base site:

(e.g., power, phone, network, vehicle access, owner permission)

The T-REX Operations Center will be in Bishop (see Figure 2.5) where the ISFF team can set up infrastructure, including internet access. This site may not have sufficient access for their purposes, and this will have to be assessed.

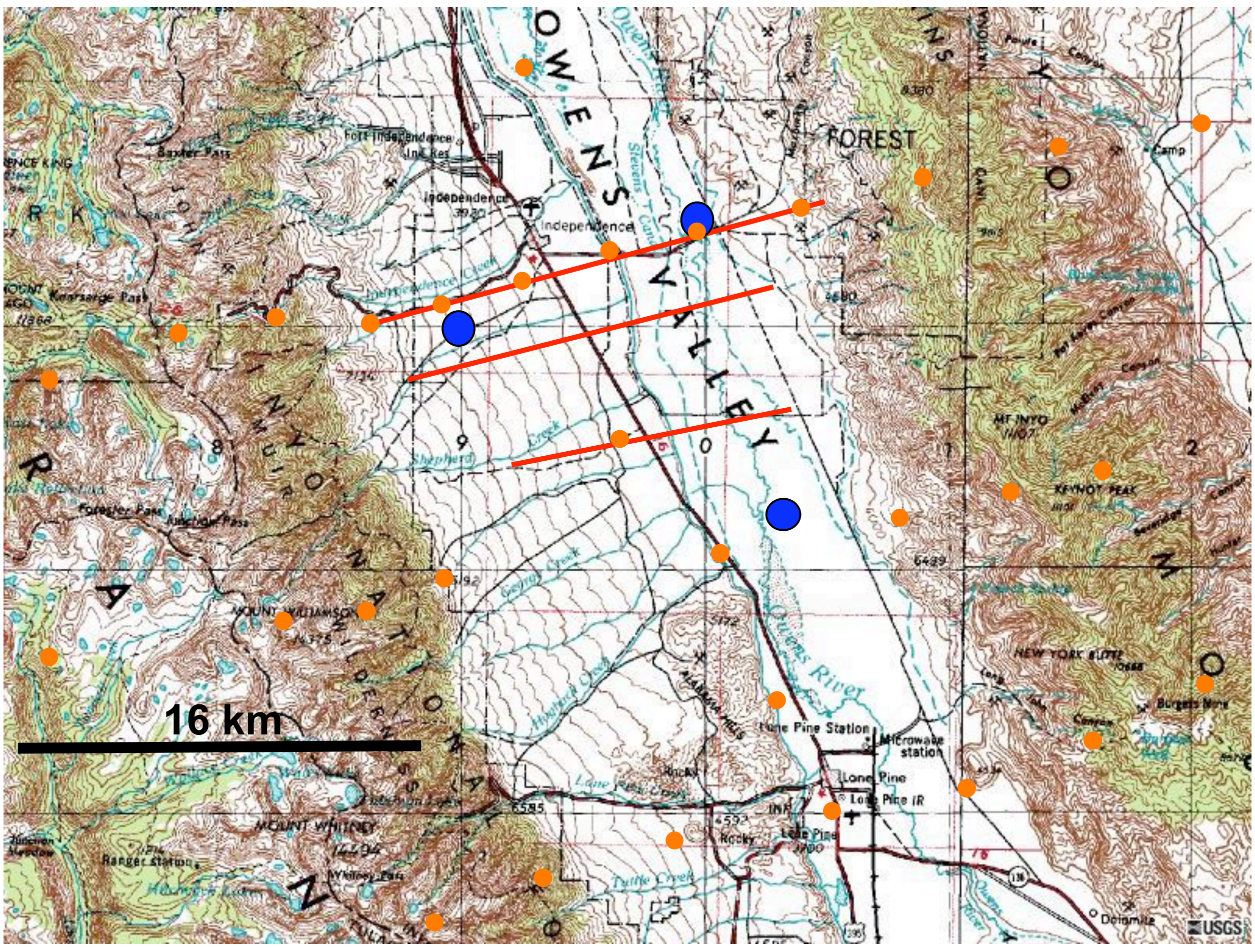

Figure 2.4

A larger scale plot (200 foot elevation contours) of southern Owens Valley, with topography and other features shown. The existing AWS weather station 'lines' are shown in red, with the three 32 m towers (blue dots). The proposed locations for soil moisture/temperature measurements along- and across-valley (off-the grid, generally) are shown with orange dots.

DATA NEEDS

Is archiving of high-rate (each sample) data needed or are time-averaged statistics sufficient?

High-rate data is required for all instruments requested.

Averaging needed for statistics (ISFF default is 5 min.)?

Please provide 1 minute and 1 hour averaged statistics as well.

What data products are needed in real time? How should these be made available (e.g. WWW, display in base)?

5 minute averages and min and max value in the 5 minute period.

Post-project: EOL typically distributes statistics via the WWW. What additional data products (plots, high-rate data, derived products) are desired? Is WWW distribution acceptable?

We would like quality controlled high-rate data as soon as feasible (less than 3 months, preferably) after the field experiment ends. For the 1 minute, 5 minute and 1 hour averages (per above) we believe the standard variables and derived products are sufficient. However, we will work with the ISFF team. Yes, www distribution is fine.

Special data requirements:

The PI will work with ISFF in the analysis of non-standard data sets.

OPERATIONS

Will there be intensive observation periods requiring 24-hour staffing?

(ISFF data are collected continuously in any case.)

No, but staff availability in case of emergency failure is requested.

Availability of investigator-supplied staff:

We encourage investigators and their students to participate in ISFF deployments, including reviewing data on-site.

The investigators, post-docs and students will be available to assist ISFF staff as needed during T-REX and its IOPs.

OTHER

Has EOL/RTF staff been consulted to help complete this request?

Consultation with EOL staff is strongly encouraged before submitting this request.

Steve Oncley, Tom Horst and Steve Semmer have been contacted at various times during the creation of this request.

Other requirements:

We expect that at least one of the sodars from collaborating investigators from the University of Leeds (U.K., Stephen Mobbs) will be deployed at tall tower 32-1 (see Figure 1 in Part I and Figure 2.3). We request the sharing of power for this sodar, or at least, the sharing of logistical efforts in securing power. According to Dr. Mobss, there is no problem in principle in using solar power for sodars. For solar systems, about 10 m^2 of panels is needed. There are two ways to provide the power: directly from the battery system, drawing power from 0, 12 and 24 V. This is the most efficient, but the difficulty we have had is that the power drawn from the 0-12V part of the system is different to that from the 12-24V part. Hence one set of batteries is drained quicker than the other, but the least drained batteries slow the rate of charging of the most drained ones. A very easy and slightly less efficient system is to use Scintec's own mains power supply, connected via a mains inverter (a device to turn 12 or 24V DC into 110V AC). Since shipping large items out to the US from Europe is very expensive (less important) and extremely bureaucratic (moreimportant), sharing NCAR power or identifying power systems which we can loan, borrow, rent, etc. in the US would be highly advantageous.

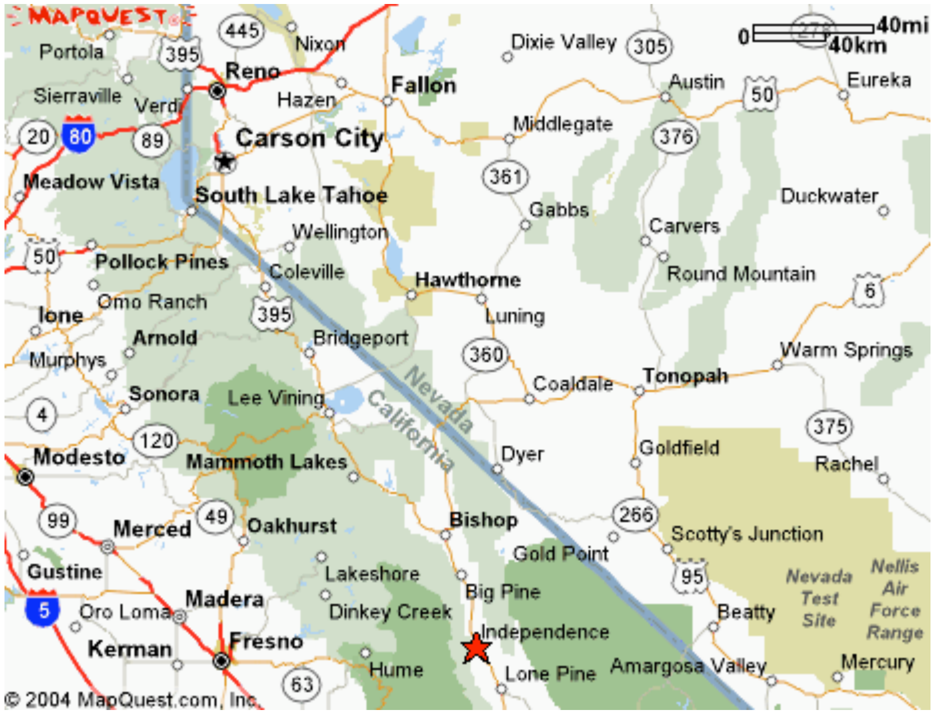

Figure 2.5

General vicinity of the T-REX area showing major roads and larger towns. Reno and Fresno are nearby cities with a large number of commercial flights and carriers landing at their airports. Note, however, that Tioga Pass on Route 120, the only road over the High Sierra, is closed until late May. There are also smaller airstrips in Owens Valley itself. The distance from Bishop, where the T-REX Operations Center will be, to the town of Independence, near the requested ISFF deployment site, is about 80 km.