

I am now aware of GEO Forum!!!

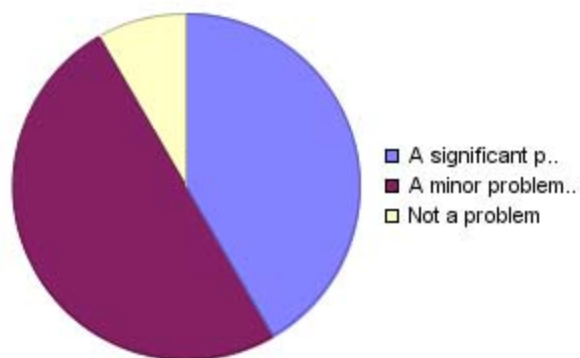
With limited resources it may be wiser to concentrate on web development in this area, which give all students equal access. Efforts to promote the web resources are important too and for this local forums are useful.

that is a weak yes.

You should really advertise these programs to a wide audience of students. Maybe put a link for these web pages on your <http://www.rap.ucar.edu/weather> page. Every student worth their salt visits that page at least once a week.

Probably, but DC is good for us.

4.1 Some members of the community have expressed concern that there is not enough effort in the universities being devoted to the development of instrumentation or to education on the sources and use of observational data. What is your estimate of the degree of this problem?



Option	Count	Percent
1. A significant problem	230	41.59%
2. A minor problem	277	50.09%
3. Not a problem	46	8.32%
Total	553	100%

Median: 2.0 Minimum value: 1
 Total responses: 553 Maximum value: 3

4. If you think that this issue is important, what could the universities, funding agencies, and UCAR do to remedy the problem?**Free text**

Our university has added a course in instrumentation and data sources tied to data analysis.

Universities: improve education in this area Funding agencies: support training opportunities that are less geared to underserved communities (i.e. SOARS). While SOARS is great, we need to be encouraging training across the board. UCAR: Continue to provide opportunities for participating in field programs, etc.

Focus more funding on applied research so that scientists can fully understand how accurate these remote observations are. Place greater emphasis into educating the operational community about the benefits of these quasi-experimental remote observations.

Partnerships with industry to promote the use of instruments and tools would be a great way to attract students who want to use the latest in technology.

Put senior people at universities and UCAR with expertise in these areas to attract qualified students

develop small projects to improve the instruments

promote observations instead of seeing these as secondary to computer simulations

after all the main thing about instrumentation and observational data is learning by doing, and that goes best when you're young and naive enough to just try different things. so, students should start as early as possible 'playing' with instruments and real data - that's something one doesn't need too much education for

Too many field experiments are funded, and not enough instrumentation development is funded.

Universities need to instruct students on how and why models and forecasts work the way they do.

this is a money issue--there are plenty of students who would undertake instrumentation or observational studies

Provide longer term funding to support high-risk ideas

The university can open special course for this issue.

To provide instruments to schools, both to College level as well as to high school or even elementary school.

the ease of working with model output has made classic data analysis much less attractive. the lack of critical review of the shortcomings of model data sets has encouraged students to believe they are sufficient.

Integrate usage into undergraduate curriculum in interesting ways.

The entire focus of instrumentation has been the intellectual challenge of doing more with the highest technology, rather than cheap, massively replicable and easily dispersed instrumentation. There is a huge fantasy in this: that a new kind of measurement is better than a big set of an old kind. The professional rewards are all for the novelty, rather than the diligent collection of the old, so we have very little effort going into some kinds of measures, and a lot of the output consists of "Wow! IF we did this new thing a whole lot, we'd learn a great deal.... But, I can't get tenure for that, so I'll invent something new and then we won't do that either!" I call this the "New-and-Improved Rolls-Royce for \$500,000 versus the whole lotta Volkswagen bugs" problem. The new one-off super duper Rolls is great fun, and you get one for your half million dollars. For the same amount, you could get 250 old Bugs, and carry about 250 times the people... sometimes, the Rolls is the right choice. But, every time? If the task is getting people from A to B, maybe not. Air quality modeling and health problems are stymied on political resistance and lack of serious mass measures, but they could be advanced radically if we wanted to take it on. Imagine the number of anemometers that could be employed for the same technological and financial expenses as the climate reference stations. Obviously, we need the reference measures, but not only them..

Devote classes to the matter

Improve access to field support and instrumentation development support resources.

Provide instructional internships at ATD. Link to instrumentation faculty support from NSF.

Funding agencies need to realize that instrument development is both expensive and risky but necessary. I'm not sure UCAR can really do anything. Universities could add classes in instrument development.

There needs to be more movement of individuals between Universities/NCAR and agencies/companies with key responsibilities in instrument design, data assimilation and observational network design.

Create courses on how to be a scientist and adequately recognize assumptions and problems/limitations of data (see Richard Feynman)

As a heavy user of instrumental and observational data, I find it appalling how little some fellow grad students have access or experience. Models are great, but they are meaningless without observation data to assimilate, parameterize, compare and test. This field was built on observations and we are losing much of this heritage among current students. Universities should require field methods as part of graduate curricula. They should also provide lab space, field prep space, and update their undergraduate lab classes. We lack all this at Penn State. I don't have enough experience to recommend what UCAR or agencies should do - maybe provide more opportunities to participate in field campaigns, fund small exploratory observation grants.

Workshops on how to access, visualize, analyze the data.

Observations are the key to the analysis. With the increasing number of remote sensors, it is imperative that the students early in the atmospheric science courses learn how to read, process and determine the errors associated with each observation type.

Identify people and programs that have good researchers in this area and fund them.

Put more money and time into it.

Make more money available for instrument development.

Fund laboratories, instrument capabilities. Develop curricula.

Data "training" workshops.

By funding for additional observational platforms, the funding agencies can to some extent provide remedy to the above problem. Experiments in Atmospheric Sciences are invariably related to field campaigns and require huge funding, skilled manpower and organizational support.

One possibility that I've not seen would be to develop materials (data sets, readings/lab exercises, etc.) that could be used in university-level biology courses (ecology, vector-borne disease biology, epidemiology, forestry, etc.)

Easily share data and related software

run a workshop on data characteristics for instructors of introductory and forecasting courses

Provide workshops at NCAR for faculty and students.

Focus coursework on observations and data assimilation techniques.

Make atmospheric science more visible to students

Have more hands on classes, specifically for instrumentation. Focus on RAobs, surface data, profiler. An entire semester focusing solely on instrumentation would be good.

Design programs or curricula in observational science.

yes

Increase incorporating observational data analyses in classes.

help fund and create courses make prototypes and course modules available

Well, some of these efforts are not being funded.

Better training at the undergraduate level related to identifying sources of scientific information, critiquing such sources, and recognizing that science is not just about data collection but about the best ways of collecting and interpreting data.

Some areas, such as cloud physics research laboratories, have languished in US universities in the past two decades. It requires more than a standard NSF grant to keep such facilities going. Not every university can have such facilities, but it is important to continue to have a critical mass of educational activity in this area. UCAR could help universities by joining them in encouraging NSF to provide adequate ongoing and long-term support to experimental and instrument development facilities in universities. If this is not done, where are our future instrument developers going to come from?

focus education on the application of data to resource management

Funding agencies need to fund instrument development.

Support programs similar to the Climate Affair Program

The realization of the need for new instrumentation comes about from understanding the uncertainties associated with current measurements or the complete lack of knowledge of a given quantity. There is probably sufficient activity to address the latter but not the former. Universities could develop courses that focus on the uncertainties associated with measurements and the effect of their propagation into various analyses. Such classes and UCAR organized fora would be useful to faculty and established researchers alike, as the effect of errors is probably not well understood. As for the development of instrumentation, I believe most funding agencies have developed SBIR/STTR programs that allow teaming between universities and small businesses. I am not sure these are well utilized by the university community. Advertisement and enhancement of these opportunities would certainly be beneficial.

More emphasis on remote sensing in courses would eventually lead to more instructors. For the time being, schools must rely on course materials developed elsewhere -- this is where funding agencies & perhaps UCAR can help: insure excellent course material is available and subsidize its use.

Workshops/symposia; increased GeoEd funds at NSF for educational/classroom/undergraduate research support for instrumentation; more research support for proper use of data; i.e. - for data assimilation.

No suggestion

Make users of current data stress the need of improvements to funding agencies

To establish courses in Atmospheric Science Programs, dealing with measuring techniques and statistical data handling.

More monitoring/ direct measurement of all levels of the atmosphere.

Encourage and assist universities in developing curricula including these topics

Support both the building of these instruments AND increase support for the analysis of data collected with these instruments.

Greater emphasis on the connections between modeling, remote sensing and observational facilities.

increase funding of laboratory and university research related to observations

My background is much more focused on computational modeling; so, this question is difficult for me to address. However, without continued observational effort to gain a better understanding of processes, science can not move forward. Someone else would need to address whether the observational effort and capability (e.g. instrumentation) is in place to address questions.

Refocus on the fundamental basis for solving scientific hypotheses, improving understanding, improving forecast capabilities still depend ultimately on the efficient use of a diverse set of remotely sensed and insitu observations (and their use in models).

not sure

funding levels for new instruments are far too low. We are moving to a situation where only government labs have the ability to support new instruments.

I have commented about this earlier. NCAR should spend resources in having graduate students use the instruments - when they are not used. A good example is programs carried out by Dr. Hallett of the Desert Research Institute.

More collaboration

Identify problem areas and establish programs to fund innovative instrument development

education, documentation

provide more and keep opportunities to develop instrumentation

workshop on teaching

Unfortunately instrumentation in science is expensive to develop or buy, maintain, staff and too easily cut. There is a critical need for hands on opportunities - data downloads aren't enough.

Yes, I am a modeller, but must say that what good is looking at a model if we have no or poor observations for validation. Also, LONG TERM MONITORING is critical and no one wants to pay for this. This is where NCAR can, as a base funded institute, play a critical important role. We know so much about the climate of the last 100 years because people took measurements in the past. Also, some of the basic measurements could be incorporated into school science curricula. Robust, inexpensive basic weather stations could be placed world-wide at secondary schools to produce a network on daily observations that will help us understand climate better. I have thought for many years that this could be a project to do with the Peace Corps and the WMO. I think high-tech next generation observational apparatus must be developed.

acknowledge that not all answers can be given by models: * models need data for validation * models need observations to guide their development The problem is that the design and execution of a good atmospheric experiment is very difficult and expensive. This explains the tendency to vest all our hope on models *

insufficient information

At least not at the University of Colorado.

Too many universities and students are moving down the path of digital data instantly available over the Internet. They get the data quickly, analyze the data quickly, and never have a clue how the data were collected and what the limitations of the data are, in terms of observation time, instrument accuracy and bias, etc. I think more schools need to have more field work and training as part of their curriculum. Since it can be expensive, to own, operate and maintain weather stations; at a minimum, there should be field trips to places like the LTER permanent sites, for multiple days so the students can see close-up how the data are collected, QCed and analyzed, and learn what the instrument environments are like. It would be even better if each University Meteorology department owned and operated an automated weather station AND a cooperative observer site. A network of all the sites into one database would be an excellent laboratory. Students could learn to do single and multiple station QC, both automated and by visual observation of data displays. They could learn about comm systems, calibration, maintenance and the little nuisance problems of weather stations - (birds nesting in rain gauges, pecking net radiometer domes, rodents chewing on wires, etc.)

In general, observations are underused and analyzed. It takes particular people with a unique mind set to be good at dealing with observations. Those people need to be identified and rewarded. Usually, they are not rewarded for their efforts.

Make equipment grants more available to institutions

Encourage Universities to offer courses in instrumentation, and perhaps offer to have UCAR / NCAR scientists whose research is in the area of instrumentation visit the universities to teach about their research.

Developing teaching materials that can easily be used in the classroom.

We need to better balance observational analyses with modeling. We have, for example, papers published on modeling of climate 50 years into the future which cannot, of course, be verified until then. While some observational tests are completed retrospectively, these is much more observational work that can be completed, and we need to better educate students on this approach.

Just need to educate students that observational data are the foundation of the science.

Universities could make "remote sensing" courses be required course work for graduation.

Not all obs are created equal. We need to devote resource and education to the understanding of instruments and to the appreciation of data analysis.

observed data using

Closer links between universities and operational nwp centers.

Atmospheric science is still largely observation driven. Satellites are going to provide some data on a global scale in the near future but there is still a need for in situ measurements to study the detail. This calls for additional instrumentation and platforms. It is a great shame that NASA has decided to decommission its research aircraft and rely almost totally on satellites. There is considerable scope for NCAR here to take a lead role in in-situ observations of atmospheric composition.

Encourage programs in engineering disciplines as well as atmospheric science disciplines

more partnership w/ the private sector, in which this industry largely resides. My company is a good example.

Provide more support in this area, with funding agencies putting up the money, while UCAR participates in collaborations with university teachers and students.

Need more hands-on classes in the university

Short courses at LAOF facilities.

Sponsor workshops or Web resoures on the instrumentation.

I do think observational data are used for member of the community. I don't think this is a problem. I don't know if there is not enough effort in developing instruments.

Universities could offer and teach a class (lecture and laboratory) in meteorological instrumentation, including in situ instruments and remote-sensing systems. We seem to do somewhat better with remote-sensing (in my experience) than with in-situ instruments. The latter seem "lost" or even inappropriately dismissed as antiquated and no longer useful.

Get university departments to partner with people working on instruments. Good luck.

Make the data easy to access and promote it's use.

need a good book on atmopsheric remote sensing for undergraduates with lots of examples.

Observational data are only useful if they represent meaningful fields that add to the understanding of atmospheric phenomena; if they are reliable, accurate, and available to the appropriate precision; if they are available in sufficient spatial and temporal resolution to study the phenomena at the appropriate scales; if the data are timely; and if the target "users" are aware the data exists and can freely access the data. Universities, funding agencies, and UCAR need to work together to ensure that all of the above criteria are met if they want a viable instrumentation/observation program.

Have engineers and meteorologists interact on this issue.

Fellowships for students to participate field programs, independent of their research and their advisors interests. Summer programs on instrumentation and field data (including satellite data)

more data collection and analysis programs and emphasis on operational research.

put models in perspective - they are NOT better than observations, and can never replace observations, as some have proposed.

Train more of the faculty to pursue these lines - -the students will go along with them.

More funding towards educational workshops for scientists/educators to attend. The development of instruments and observational data is rapid and if you are not directly involved, it can become difficult to keep up. Attending workshops/tutorials (including online versions) that are frequently updated mwould be useful. Our field depends heavily on data, so if funding agencies can increase their funding towards instrument development or data collection programs, that would be beneficial. More hurricane field programs would be specifically worthwhile as would the development and coordination of local surface-based mesonets across the country.

Allocate more dollars

We live today in a difficult funding period. However, to remedy this problem funding agencies need to increase their efforts in providing additional funding to further improve or enhance the instrumentation and educational activities.

Develop a program for students to learn the issues with instrument development.

Fellowships

To my knowledge there are no training courses offered specifically for Advanced Instrumentation techniques for Atmospheric Sciences. AMS has short term courses, but is this enough?

-

Provide instrumentation (or funding) to universities and help establish a curriculum. I taught a course in instrumentation at the University of North Carolina - Asheville (UNC-A). As I put together the course I was shocked at the lack of material (textbooks/workbooks) on the subject.

1. Support the development of IT support. 2. Fund synoptic related proposals at a level where departments would want to hire synoptic faculty

partner better with private companies so there is more financial incentive to establish new methods for observing the atmosphere- tech transfer

Clarify and disseminate to the community the role of instrumentation development in the progress of the science, and the difficulties in sustaining such efforts.

Make the subjects more attractive or in other words advertisement should play a more important role.

Instruments produce data. Models produce output. More funding needs to be available for universities to purchase large equipment for the purposes of education.

Need to get some of this equipment onto university campuses. Blackboard meteorology only carries you so far. Need to make universities produce students qualified to be operational weather forecasters. Align curricula with NWS job requirements.

Provide more direction and support for innovation in this area.

This is just one of a large number of areas where there is not enough going on due to the Admin keeping the climate change budget essentially level dollar funded for more than a decade--it is disgraceful.

Cultural shift to look at data analysis as valuable work (on a par with instrumentation / model development)

Hire people who are experts in this field.

Provide a university outreach program similar to unidata/comet that targets use and development of observing systems.

Make it a priority; outreach with select private organizations that are developing similar technologies

increase direct funding of instrumentation development

Courses on observational science, so that students recognize its strengths and weaknesses, would help.

Support development of new instrumentation along with plans to use the instrument. Spend some additional money supporting research with everyday observations in addition to the field campaigns.

there seems to be a tendency to look at models at the expense of "looking out the window"

enhance the multi-institutional planning and development of instruments and observational network infrastructure

Unidata helped us all obtain weather data when getting it individually was prohibitively expensive. A similar effort is needed to allow purchases and maintenance of suites of instrumentation.

mandatory classes in earth or atmospheric science

It doesn't get a lot of attention because it is generally not publishable and thus, again, you can't get points with funding agencies. They must change their tune about the nature of a "contribution".

internships

Develop easily used software to read data

direct more surveys to students and faculty

provide more training, funding, and strategic emphasis

More emphasis on integrating disparate data sets. This requires a sound understanding of each observation source

I believe there is too much emphasis on instrumentation

Observations represent the foundation upon which much of our field is built.

More easily accessible data and software on the web, especially for the public and educational sectors.

Since state-of-art instruments are beyond the scope for many students, summer workshops on design-build-deploy might be very helpful.

Reflect the need for appropriate measurement technology and observation programs in development of budget priorities.

Host instrumentation workshops at NCAR. Record the presentations and parts of the workshops in anticipation of distributing the information to the many that cannot attend the workshop.

Programs to support computer software and hardware for departments and programs which are underfunded.

Help observational activities as much as possible.

Atmos/ocean sciences need to work MUCH more closely with engineering and IT depts to develop a broader community interest in observing system technology. We are facing exactly this issue in ocean sci.

on instrumentation: target graduate student fellowships with this topic. AS is not well-suited to developing instrumentation without specific labs dedicated to this area. It is typically a physics measurement type discipline. AS focuses on using the data and not on producing it. Funding agencies could fund specific centers for research of this type and thus get a concentration of researchers in several key labs. It seems that the only location for this research is at NCAR. Re: education on sources and use of observations: organize workshops. get people involved with taking the data. Most people view data as something downloaded from a website.

Part of the problem is inadequate resources to give students hands on measurement experience. There also may be a disconnect between theory (esp. radiative transfer) and application.

not sure

Universities need to hire a critical mass of faculty who are capable of teaching the students to use the data.

Expanded small equipment grants for use in instrumentation courses would be helpful. At this time, many of the instruments that we use in such courses are those borrowed from our research projects.

The universities need to provide education, and the funding agencies need to increase their level of support, particularly in instrument development.

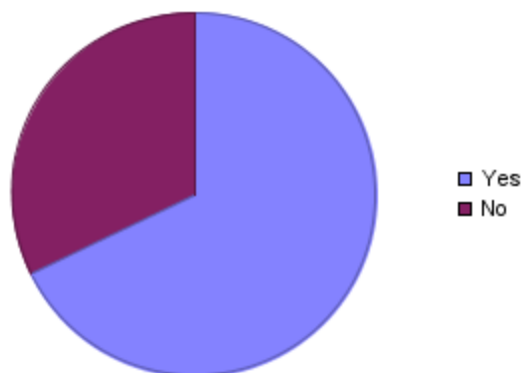
Support long term development of instrumentation - less emphasis on immediate results

Prepare a selection of Case study reports on infamous failures/processing errors in existing observational systems, e.g 1982-83 El Nino, Antarctic Ozone Hole, WOCE Altimeter Algorithm,...

Sponsor (i.e., pay) scientists to visit schools to give a short course to students.

EOL/ATD can take a lead in bringing together the principals to see what needs to be developed. EOL/ATD can serve the community by doing the development.

4.3 More generally, is the distribution of research effort, at UCAR and in the universities, appropriately divided among field research, modeling, theory, and laboratory work?



Option	Count	Percent
1. Yes	335	67.81%
2. No	159	32.19%
Total	494	100%

Median: 1.0 Minimum value: 1
 Total responses: 494 Maximum value: 2

Free text (If you think there's a present or likely future imbalance, what should UCAR/NCAR do in response?)

Support more small scale field projects.

Support activities and continue development of shared facilities that are difficult for universities to handle on their own

Perhaps sponsor workshops featuring hands-on experience with instrumentation.

lacking in theory and laboratory research. look to hire people in these areas and have mechanism to integrate their capabilities with those in other areas

There are too many modeling works around, which we don't have enough observational data to support. More field campaigns and less modeling work will be better.

I don't know.

there seems to be a general problem in the whole community (i.e. not just UCAR/NCAR) that not enough time is spent on the interpretation of data from field campaigns. often this is due to the fact that the grant money often only includes carrying through the actual campaign but not so much working with the data that was obtained.

While I think the distribution among the areas is about right, I think there should be more interaction between the areas. This can be a thankless task, and often seems to be under appreciated. Hence, anything that increases recognition for interaction between these areas will help (eg in hiring, funding, and awards).

spend the money to train better grad students and postdocs

Continue to press on field work

Do not grow modeling and climate programs at other programs expense.

More application and interaction between the different groups is needed.

This is actually hard to judge from the outside, so the answer is flip, but I will comment that I'm depressed by what I've seen as you may surmise from previous answers if they are read. Certainly, universities are absurdly split into "land grant" applied versus "serious research" grant-seeking models, and they're not going to change without a bitter struggle, judging by the last 25 years of rehashed rhetoric without any serious change beyond some marketing gimmicks for students. For what it's worth, with a dead serious commitment to not be so dead serious -- so to speak -- UCAR/NCAR could take leadership and create some slack for new efforts and risk-taking.

There is too much support for analysis of data by people who didn't collect it and not enough for analysis by those who do collect it.

Improve the diversity of field support equipment.

Fewer field programs and more but longer term laboratory based science initiatives

UCAR/NCAR seems to overly emphasize modeling.

UCAR/NCAR needs to enable university researchers to do basic research on the systems that are used by the centers with a federal responsibility to make forecasts and construct policy.

not sure - at some level, the pendulum swings on these kinds of things. Eventually, we will find models unable to do what we need them to do without obs and then obs will get popular again, etc...

I'm not sure. It's just too easy to run a model, even when there is inadequate observational support for it, so modeling theses are often chosen.

Field research is hard pressed for funding and is often times limited in scope compared to what could be done. While there is always a need to remain focused, many unforeseen events occur which should be deemed worthy of study but go largely unobserved because the primary objective of the field experiment will take a temporary back seat.

My sense of the issue is that there is a shortage of field research. I'm not sure that's UCAR/NCAR's problem--more likely the universities that use UCAR/NCAR resources.

Too much field work, not enough analysis of the data.

develop modules provide seed grants

Laboratory work in universities is subcritical. UCAR/NCAR could at its annual meeting or in another meeting get universities to discuss this balance and if it is agreed that there is an imbalance, a plan should be developed to correct it.

My impression is that there is too much low-quality modeling work done in universities. Standards for publication should be raised in this area.

Reduce funds for field research and concentrate on a smaller number of field programs to focus on questions that are likely to be answered at current level of knowledge/technology.

UCAR could be a stronger advocate of field programs. NCAR has done yeoman's work in providing facilities not otherwise available to university researchers and I think that should be strengthened at the expense of NCAR theoretical and/or smaller scale programs that could easily be carried out in universities.

No suggestion

Yes, but never perfect--more integration and cross-fertilization to be sure instrumental capabilities are justified--can't measure everything, too expensive.

Meanwhile, the interrelations between theory and modeling is too weak. The same is true in the case of field research and laboratory work.

balance!!

laboratory work seems to be underfunded.

Emphasis is on modeling. It is less expensive, less complicated and less 'testable'. UCAR/NCAR can take the lead in providing real data sets which fit in form and content to the needs of the modeling community.

I had to pick an answer, but I don't really know. However, again, how would you know if there isn't a central mission against which one could develop metrics?

The problem is often within institutions. By the nature of the way in which the field is set up (organized around big facilities or programs) it is often difficult for individual programs to balance theory, modeling and field research. Formalizing exchanges between institutions which are strong in one of these areas might help.

Universities focus too much on theory - because it is cheap.

Future imbalance. I already see more folks leaving the observational side because of the difficulty to maintain funding.

Actually, I am not sure about how to answer this.

Too much support goes to modelers.

in fact, don't know, since we (in de Netherlands) are not part of UCAR

maybe need to fill in the gap between GCM studies and basic theories

insufficient information

laboratory work should be enhanced in UCAR/NCAR

No. With the exception of agricultural meteorology programs, there is very little field or observational experience. Emphasize getting students into the field for launching balloons, and taking observations - particularly for large UCAR or NSF field campaigns. There are so many "staff and faculty" researchers involved, the use of students to work and LEARN is undervalued. Often when students are used, they are simply cheap labor to launch balloons. They should be there to help and to learn.

see above

The more that simulation is seen as an equal with observation/experiment and theory, the more important it will become. NCAR's leading the way in this, and I say "lead on."

There are undesirable imbalances, some of which I know about and most of which I presumably don't know about. But they may be less problematical than other limitations.

Laboratory work should be encouraged, as there is precious little of it in atmospheric sciences right now, despite the potentially interesting projects.

Perhaps encourage more basic research into how the Earth system works.

modeling, laboratory work

More observational studies. These studies should more extensively use the diversity of observational analyses that already exist. Modeling is essential, but its value is in process studies and assessment of predictability, not on multi-decadal climate prediction.

Making constructive use of climate science for society depends on field research involving continuing interactions with decision makers.

Too much emphasis on the modeling, not enough on the theory.

Encourage/require students involve in field studies and data analysis work.

It is essential to keep a balance between theoretical and experimental studies. Theoretical studies are cheaper but carry enormous risk if not validated by measurement.

Probably too much theory and modeling and not enough field research and lab work. Too much reliance on software "packages" such that a lot of basic meteorological calculations become black boxes. Not enough lab- and field-based demonstrations/process-explanations accompanied by actual measurement experience.

UCAR/NCAR needs to target and encourage certain areas of research, such as data assimilation and general numerics.

don't know

Summer special courses on subjects not covered by regular curricula of universities.

funding, more laboratory work.

put modeling in perspective

Many people work on instrument development and data collection, but they always seem to be underfunded. Additionally, sometimes it is difficult to locate the owners/collectors of the data and share. A central storage database for everyone to access would be a terrific resource. Something like FSL's MADIS which uses a uniform format and provides software to access the data.

spend more time on funding observation networks and less on modeling

More observations.

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I'm not sure that it is the role of UCAR to dictate a balance or correct an imbalance. It is probably best to recognize that there is an imbalance and work to identify those schools who are the experts in these various disciplines.

Support theoretical work more

Modeling seems to be cheap, therefore, it is the focus of most organizations. Hold an "X-obs" competition with a substantial prize designed to spur observations with some challenging aspect (parameter or engineering constraint) that will show a pay-off in Atmos Sci. Similar to some of the prizes that have been awarded in aviation.

i think we need to rethink graduate education. while graduate education has and always should train people to lead science, i feel that graduate education is also great training for many roles in our society outside of "hard science." wouldn't we be better off as a society if some of this great intellect actually made it outside of research centers?

Increase field work

Promote well organized, well focused, high quality field measurement campaigns

Need curricula to include a weather forecasting course taught at a local NWS office. Students should be weather forecast interns.

more interpretation and use of data / models to improve knowledge

So where in this list is interfacing with users about applications and addressing the needs of society? UCAR needs to think more broadly about what science is and how it is made useful for society.

More resources need to be directed at instrumentation side.

Look into this more if it's perceived to be a problem, and please coordinate with other gov't organizations. Marching ahead on your own only causes headaches for everyone else.

provide more opportunities for field research facilities

Modeling seems to be taking over from field students.

Not enough laboratory and field work.

Need more emphasis on interpreting data and models and progress on understanding how the atmosphere works.

combined workshops

Set up a forum each year to address this problem.

study the impact of the imbalance and begin to put remedies in place

more focus on applied research

UCAR should not pretend it is a university, it has a very different role to serve.

more field research

The question of imbalance needs consistent evaluation during all priority-setting exercises.

Students need more of an awareness of field research.

Laboratory work and observations in general have taken a back seat the the advances made possible by the march of computer technology. That trend is showing signs of slowing by itself, but a change needs some consious support as well.

It is largely a function of the community culture. It is also largely personality driven. Perhaps a bit more of the european model could balance things out.

Too much field work. These experiments may seem like science, but really, not much comes of them.

Constant emphasis on integrating modeling and observational research.

More lab studies, less computers