Summary Report of the Review of the National Severe Storms Laboratory 17-19 February 2009

Stephan P. Nelson, Chair
Site Visit Team
25 April 2009

I. Overview:

The review of the National Severe Storms Laboratory (NSSL) occurred on site in Norman Oklahoma 17-19 February 2009. The review focused on three research areas: Weather Radar Research; Hazardous Weather Forecasts and Warnings; Hydrometeorology. The ten members of the review team are listed in Table 1. The review team was provided with written materials before the site visit that included guidance to the reviewers, supporting documentation (Table 2), NOAA's Strategic and Research Plans, and access to the science presentations to be made during the site visit. During the site visit, the agenda (Figure 1) primarily consisted of presentations on the three foci, but a modest amount time was allotted for informal discussions with NSSL staff.

II. Structure of this Summary Report:

As requested, each reviewer prepared and forwarded to NOAA management an independent review. The purpose of this Summary Report is not to construct a consensus or analyze individual reviewer statements, but rather the Summary Report will identify themes that have emerged from the reviews. This summary requires some generalizations and grouping of themes on the part of the author. Any oversimplifications, significant omissions, errors or misstatements are strictly the fault of the author of this Summary Report and not of the individual reviewers. The process of identification of themes requires an emphasis on issues mentioned in more than one review. There is a danger in this approach since there may be important issues that are identified by only one reviewer. Additionally, in summarizing themes important nuances or sometimes even a dissenting opinion can be lost. To mitigate these potential pitfalls, verbatim copies of all reviewer recommendations are included. The author of this summary strongly recommends thorough study of all recommendations and a complete reading of all reviews.

The sections of this Summary Report follow the format of the template provided to the individual reviewers with sections on:

a. Additional Comments and Recommendations
b. Weather Radar Research
c. Hazardous Weather Forecasts and Warning Research
d. Hydrology Meteorology Research

Each section contains a summary of the identified themes followed by verbatim lists of all reviewer recommendations. An attempt has been made to group similar recommendations together. In some instances there was some disagreement among the reviewers as to which evaluation category some issues belonged under; therefore, by necessity, the author of this document made a determination by fiat of the appropriate categorization.

A. Additional Comments for OAR and Laboratory Management

This category contains comments that either are overarching or issues that do not fit under any of the three research categories. Note that under this category in the individual written reviews comments were solicited pertaining to the review **process** itself. Since these comments are not pertinent to the scientific review of NSSL, they are not summarized or repeated in this report.

SUMMARY OF THEMES:

- One theme that emerged in the reviews is that overall NSSL is a first rate laboratory that NOAA should be proud of.
- The staff was found to be enthusiastic and fully engaged in the activities of the laboratory.
- The physical plant of the new building is impressive and it is being used well. The collocation of the operational and research communities is a positive.
- While also mentioned under some research thrust areas, the reviewers believe that the Laboratory's external collaborations could be stronger.
- The aging workforce is almost uniformly seen to be a serious problem. While NSSL management is aware of this situation, a formal plan to address this issue did not appear to exist.

VERBATIM RECOMMENDATIONS (NOTE, MINOR EDITING HAS BEEN DONE FOR FORMATTING PURPOSES):

1. Address looming manpower issues.

2. Management must be held accountable to recruit, motivate, and retain a cadre of multi-disciplinary, world class scientists. NSSL should formulate and implement a viable strategy to recruit the high-caliber, diverse, and multi-disciplinary workforce needed to dramatically advance operational prediction of severe storms, heavy rains, floods, and high winds. NSSL should be encouraged to expand its scientific collaborations far beyond the local community of excellence within Norman, OK. NSSL should identify mechanisms to more effectively leverage the capabilities of ESRL's expertise in atmospheric remote sensing, data assimilation, and modeling to support NOAA's challenging weather and water research objectives.

3. **Recruiting talented, young scientists/engineers to NSSL:** NSSL has an aging and minimally diverse workforce. Also, it appears that many of the new hires come over from CIMMS. We recognize that the current NOAA environment restricts NSSL's ability to conduct open searches, but recommend that every effort be made to cast a wider and more diverse net for future hires. There has been a loss of several leading scientists, so a special effort needs to be made to recruit potential and rising stars. Efforts also need to be made to enhance interactions to universities beyond OU. Graduate fellowships should be instituted that involve students from other US universities and NSSL scientists.

4. Develop strategic goals, metrics and an execution plan for developing the next-generation NSSL technical staff population. Vet with this senior NOAA management and, where possible, resolve barriers to achieving the goals of this plan.

5. NSSL was clearly lacking in one important area – a Workforce Management Plan. This plan would address: 1) the impending retirement of senior staff (especially in radar and electrification); 2) the hiring strategy to replace these people (e.g., junior versus senior hires?, best athlete available or a disciplinary hire?); 3) strategy for introducing more diversity among the staff (e.g., currently there is little or no underrepresented groups or females among the senior leadership); 4) mentoring strategy; and 5) the possibilities of more long-term scientific visitors coming to NSSL than is currently the practice. There was a sense (which could be incorrect) that CIMMS was being used as a "grooming area" for future NSSL hires. It wasn't clear that, if true, this was the optimum hiring practice.

6. I consider the present situation at NSSL similar to a department at a university that one day finds out that all of their senior faculty are walking out the door. It is very difficult to replace these type of faculty. There are a few excellent mid-career people; however, you don't quite know how your junior hires will turn out. There are two recommendations that I would forward:

    1) To NSSL Management: Departments at universities often try desperately (and incorrectly) to "replace" (i.e., find a clone for) their top people. Some people are simply irreplaceable and there is nothing wrong if the emphasis of a program goes in a slightly different direction based on the new hire's expertise.

    2) To OAR Management: You may notice a low point in productivity during the transition between the senior people leaving and the junior hires trying to establish themselves. Please be patient during this period. NSSL will need time to mentor/nurture the new talent and, if they have made the right hires, the productivity will soon resume to levels that you have come to expect.

7. A summer- or semester-long graduate fellowship program, similar to that run by NASA, might be one mechanism by which NSSL could broaden its demographics over the next decade. Such a program could perhaps net the next big stars in the mesoscale or severe storms communities.

8. Develop mechanisms for increasing scientific interactions with academic community and NOAA entities external to the Norman area.

9. A visiting scientist program also could be a way to fill in some of the gaps in expertise that exist, e.g., in theoretical meteorology. Perhaps sabbatical leaves for NSSL scientists are another possibility that could be explored.

10. Establish processes encouraging cross-fertilization with researchers outside the Norman area. Possibilities include visiting scientist programs and internships for students and post-graduate

researchers who do not intend to make a career in Norman. Set hiring targets for staff with degrees and/or established research affiliations outside the Norman area.

11. Strategic plans/fallbacks if it appears pursuit of phased array radar research will not be productive for NOAA in the intermediate future.

12. A specific focus on educational activities should be made part of the general review process.

13. Recommit (at the leadership level) to supporting the FAA's aviation weather program. .

B. Weather Radar Research

SUMMARY OF THEMES:

Quality:

- Both past and current research in weather radar is considered to be of high quality.
- Opinions on the publication rate ranged from appropriate but not earthshaking to excellent.
- Interactions/collaborations with NOAA entities external to Norman and interactions/collaborations with academic institutions, other governmental agencies, foreign research groups and private industry in general are considered to be not as strong as they should be. This concern not only included partnerships in basic research, but it is believed that private industry and other entities will, by necessity, need to play an important future role in engineering, software and technical aspects of future radar development.

Relevance:

- The relevance of NSSL Weather Radar Research to the NOAA mission is considered high. It is noted that the NSSL serves very well its function as a national laboratory for radar research.

Performance:

- Leadership of this research thrust is considered to be of very high quality.
- The Laboratory's activities in technology transfer to NOAA operational entities are considered to be a strong plus. NSSL research appears to be an important factor in recent improvements in weather warnings/forecasts. It was stated, however, that the efficiency of some technology transfer could be improved through more emphasis on open software architecture and software standardization. The recent work on implementing dual polarization within the 88D system was noted.
- Generally, the Laboratory is considered to have clearly defined plans. The major concern noted is associated with the research thrust in phased array radar (PAR). PAR research is considered appropriate, but a high risk. The potential cost and technical limitations associated with phased array radar may make this technology unsuitable for operational use for many years. The reviewers are not against a high risk adventure, but reviewers were in favor of the laboratory developing a risk reduction plan with full exploitation of other technologies that might be of benefit to the operational radar system.

VERBATIM RECOMMENDATIONS (NOTE, MINOR EDITING HAS BEEN DONE FOR FORMATTING PURPOSES):

1. While as a radar laboratory NSSL has much to offer the outside community, conversely the community has much to offer NSSL. It is not clear that there are good mechanisms for the flow of information from the outside community to the Laboratory beyond individual researchers being familiar with the research results in the external community. Having formal mechanisms for entraining external research results to help NSSL fulfill NOAA's mission is desirable. Exploiting such information should be part of the Laboratory's strategic and annual plans. One example would be to establish a visitor's program that might bring, for example, expertise in adaptive sampling to the Laboratory. Additionally, the Laboratory should investigate having their staff serve as visitors to other groups. While such visitations can be difficult to arrange due to personnel issues, the payoff can be high.

2. There seem to be some occasional interactions with industry as the opportunity arises, but they don't seem to be tied to long-term strategic planning. It seems this creates an opportunity for NOAA leadership in coordination with NSSL leadership to rethink creatively their approach for technological development and demonstration, which might include deliberate partnerships with industry and/or other government agencies on specific aspects of technology development that can be shared by many different applications. This might also give NSSL access to highly-qualified (already trained) engineers without having to provide them with a career-track, while freeing human resources to focus on the elements of the research that need to be done to transfer the technology to specific weather-radar operations that are the unique province of the weather radar program. I offer this suggestion with some trepidation as I am not knowledgeable enough about the challenges in such partnerships (clearly not all NASA partnerships with the space industry are easy or equally successful for example). On the other hand, it is not clear that the R&D framework that worked so well for NEXRAD for example is optimal in the current context, especially in the light of NEXRAD success. For example, it seems unconceivable now that weather services could ever be provided without the observational advantage of a radar network. The public expects no less. This success created a market that industry may wish to lock into.

3. The work on short-wavelength and transportable systems has the potential for diluting the efforts of key staff, especially in the engineering arena. As other groups (e.g., CASA, DOWs, universities) are quite active in this area, any NSSL involvement should be kept modest and related to potential value to lab, NWS and NOAA missions.

4. I would suggest that their external collaborations could be stronger. There is a tendency for the collaborations to be internal with a strong focus on CIMMS.

5. Prototype alternate ways of utilizing Ph.D. Electrical Engineering talent. Waiting for someone else to come up with a solution for hiring Ph.D. EE talent as federal employees appears to be hampering PAR hardware development. Accept that the next Zrnic will likely not be a federal employee. They are more likely to be an engineer at an aerospace company or a university-based engineer whose primary office it not at NWC. The current and future US workforce and economy will likely require shifts within NSSL regarding what has to be done in house versus what can be contracted offsite. Recommend delegating parts of the

[suggested] engineering development tasks *[listed in recommendations #11 and 15, below]* to offsite commercial and university contracts.

6. Strongly recommend the development of active collaborations with the research arms of European meteorological agencies as several of these groups already have operational networks of dual-polarization radars. Information about lessons learned and access to data for meteorological conditions that have analogs in US would be of benefit to the development and use of dual polarization in the US.

7. Given the high priority of the PAR program and the large fraction of NSSL resources tied to PAR research and development, NSSL should develop risk-reduction measures. One example measure might be to organize an external PAR advisory committee

8. The MPAR effort is what would be best characterized as a moderate risk endeavor. This is not meant to imply that the effort shouldn't be undertaken. Indeed, it is entirely appropriate and exciting that NSSL is leading this program. The concern is that no Risk Mitigation Strategy was presented during the site visit (or is planned in the immediate future). This is standard procedure for any organization overseeing a large development project. Creating a detailed strategy was less of a concern with the development of the NEXRAD (WSR-88D) program; however, the risk with MPAR is greater.

9. Develop a plan for transitioning MPAR demonstration activities to a modern, active array-based testbed that will more fully demonstrate MPAR capability and implementation costs. It would be highly desirable to develop multiple MPAR testbeds so that parallel research could be conducted at other institutions around the U.S.

10. Low risk: How to use data sets based on adaptive scanning at each radar site to derive standard radar products site to site across the network. An important constraint is that there are other uses of operational radar data in addition to NWS real time use. Will a low elevation angle (0.5 deg) 360 deg azimuth scan always be part of the scan strategy to address hydrometeorology and convection initiation applications? What portion of the phased array scan strategy will be proscribed and what portion should be adaptive? How low can PAR scan? Feasibility studies can be done with SPY-1 PAR.

11. Medium risk: Weather radar phased array with modern components. There is a critical need for a prototype PAR system with modern components even if it does not include 360 deg scanning or dual polarization in the short term. This will serve both as an engineering and scientific test bed.

12. Medium risk: Related to *[#11,]* above: Determine methods to increase sensitivity of PAR to current standards for WSR-88D clear air VCPs. This is needed for observations of convection initiation and snow.

13. Medium risk: Obtain PAR data sets for other meteorological settings than Oklahoma in collaboration with NWS forecasters and researchers in other federal labs and at universities who have expertise on these types of storms. Clone system in *[#11]* into a portable system

(i.e. transportable in containers, it does not need to run while a truck is moving). There is a critical need to obtain data in other locations to specify NWS needs for fast updates in a variety of storm types and explore scientific/engineering issues in a wide variety of storm types and terrains. Ideally, leave the equipment in place for 3 or more months running as an internet appliance so it can be controlled at NSSL to minimize the need for on-site support. As part of this activity, collect data in a variety of locations such as: Miami, FL--small intense cellular convection, Seattle, WA--nimbostratus rainfall and mountains, Buffalo, NY--lake effect snow, Phoenix, AZ--monsoon thunderstorms and terrain, Portland, ME--hail in non-super-cell storm setting, Medford, OR--WSR-88D site on mountain top).

14. Related to *[#13]*, above: Need to determine if there are issues related to sidelobes and grating lobes when using PAR in regions with mountainous terrain.

15. High risk: Development of dual polarization PAR with modern components.

16. Recent and prospective hires need the space and appropriate mentoring to grow as scientists and engineers first. It was not clear to me that a couple of the small projects to demonstrate applications and products were central to the long-term core objectives/needs of the scientific and operational objectives of the weather research program, and younger scientist might be better off redirecting their efforts. Also, consider intensifying recruitment efforts at schools with strong radar research programs.

17. Increased focus is needed on the winter-weather applications of the -88D dual-polarization capability.

18. There is some concern regarding the "tuning" of QPE estimates using dual-polarization techniques in Oklahoma (e.g., the Kessler farm). While this is an important and logical first step; plans should be made to test this procedure at other locations around the United States.

19. Please make sure that any new radar data archive formats that NSSL helps create are vetted in the broader community. The radar research community must able to develop and have access to analysis tools that can easily read and synthesize the data. NSSL could facilitate (in partnership with other labs/universities) the development of common analysis tool/software packages that could be used by everyone. Hosting a workshop would be an excellent first step.

20. Update WSR-88D technology transfer processes. Specifically transition signal processing development activities to the Vaisala RVP-8 architecture in order to facilitate implementation within the ORDA. Secondly, strongly encourage meteorological algorithm developers to employ the Common Operational Development Environment (CODE) to facilitate transition of ORPG algorithms into the operational WSR-88D network.

21. Institutionalize externally monitored technical interchange meetings with national weather radar researchers to develop consensus on "best of breed" new signal processing (ORDA) and product generation (ORPG) techniques for the WSR-88D network. Validate these decisions through the NEXRAD Technical Advisory Committee (TAC).

C. Hazardous Weather Forecasts and Warning Research

SUMMARY OF THEMES:

Quality:

- The quality of research under this category is considered to be very high by all reviewers with the scientific productivity meeting reviewer expectations. While there is some divergence of opinion, many reviewers state that the quality of the staff and work is very high based on awards and publication history.
- Areas of research that were thought to have been very successful were efforts on visualization and algorithm development for decision support systems, research on probabilistic weather forecasting and the warn on forecast research thrust.

Relevance:

- The relevance to the NOAA mission of NSSL's research and activities are considered to be extremely high. It is clear that the NSSL has a good relationship with the relevant operational components of NOAA.
- A new area of research that was considered to be especially relevant was the warn on forecast thrust.
- Several other areas were deemed to be relevant to the NOAA mission, but these also were considered to be under-resourced to different degrees: heavy rainfall and flooding; winter weather; impact of climate change on severe local weather; aviation meteorology, social aspects of weather forecasts/warnings, dynamics of mesoscale convective systems, non-tornadic high winds, use of satellite and lighting information.

Performance:

- The Leadership of this research thrust is considered very good. Most reviewers note well defined objectives and strategies and the engagement of the staff in the research. One reviewer, however, observes that this thrust is organized around activities (e.g. Spring Experiment, HWT) rather than projects. "As such, the objectives, scope and methodologies are not as clearly defined as might be the case with specific projects directed toward well-defined objectives."
- Engagement with the operational community and technology transfer is a strength. The Hazardous Weather Testbed/Spring Experiments are considered to be an especially effective technology transfer tool.
- External connections in modeling to the university community and other NOAA laboratories were considered to not be as strong as they could be.

VERBATIM RECOMMENDATIONS (NOTE, MINOR EDITING HAS BEEN DONE FOR FORMATTING PURPOSES):

1. Increase the efforts to incorporate satellite and lightning data into the mix of inputs to the warning and forecast problem; such data have potential to assist with the lead-time issue.

2. Currently and historically, the main focus of NSSL has been on tornadoes and tornado warnings, and arguably rightfully so in the early period of the lab's history. However, it is time to reassess all modes of hazardous weather since NSSL is the only NOAA lab dealing with severe storms. It is appropriate to examine current and projected statistics regarding loss of life and property for all types of hazardous weather – tornadoes, hail, lightning, flash-flood-producing storms, cold-season storms, etc. – and determine the extent to which improved forecasts and warnings can reduce losses. Priorities for basic and applied research on these phenomena can then be established, and resources redirected to tackle all societal relevant weather-hazard problems. This broader approach to severe weather research should also serve to attract a broader range of outstanding young scientists. Right now, some promising prospects shy away because they think it is a lab just for "tornado chasers."

3. NSSL also should consider whether to increase their level of basic research in mesoscale convective systems and attendant hazards (e.g., high winds and flash floods). Most of the ongoing research on MCSs appears to be tilted more toward forecasting applications (e.g., looking for climatological sounding indicators of long-lived MCSs or damaging winds) rather than MCS dynamics (the recent research of Stensrud and Coniglio stands out as an exception). The applications research is, of course, critical to NSSL's mission, but I believe that the basic research component could be bolstered to better relate MCS dynamics to MCS-related hazards. For example, flash flood research seems largely limited to the radar detection of heavy rain and the hydrological aspects of flash floods, rather than also exploring what mesoscale dynamics produce convective systems capable of producing large precipitation accumulations. "

4. While it is understandable that NSSL will continue to focus on advancing technologies such as radar, visualization etc, for **"hazardous weather**" forecasting, it is important that the categories and elements of hazardous weather be broadened. For instance, there should be a greater emphasis on improving the quality of precipitation estimation from radar. There should also be a clear strategy to improve the quality of QPE much like the goals set for tornado forecasting.

5. This group indicated that its research efforts are relevant to four (4) of the objectives of NOAA's mission in weather and water. With respect to water," ***Increase lead-time and accuracy for weather and water warnings and forecasts"*** and ***"Improve predictability of the onset, duration, and impact of hazardous and severe weather and water events"*** are mentioned. However, reading the list of priorities for the 5 and 20 year research plans, it would be more convincing to see more specific items related to the **"water"** aspect. In my personal view, **improving the accuracy of precipitation measurement** should be a key priority. This should of course be a shared priority with the Hydrometeorology group.

6. Consider the inclusion of permanent social science expertise.

7. There was concern that very little was presented on non-tornadic high wind warnings. In addition, there was not much emphasis placed on understanding (e.g., dynamics) of mesoscale convective systems…..a very important phenomenon that is associated with flooding and high wind damage. The focus of the presentations was clearly on tornadoes and

supercells. NSSL might want to consider "balancing their portfolio" so that it includes increased research on other severe convective storm types.

8. There is also some concern that at least one research project (mountain cold pools) seemed misplaced and might be considered subcritical in terms of staffing. This led to an unclear view as to how priorities are set and how decisions are made to fortify areas that are the traditional labs strengths versus diversifying the lab's research interests into other areas.

9. Expand observation, analysis and modeling activities to the non-severe storm systems that are responsible for the majority of commercial aviation impacts, particularly in the congested airspace corridors of the eastern U.S.

10. Develop at least a moderate level of staff domain-knowledge in air traffic control processes, traffic flow management decision support technologies and FAA modernization priorities (i.e. the so-called Next Generation Air Transportation System or "NextGen" initiative).

11. Assign one or two senior staff or management personnel to develop a sustained relationship with FAA's aviation weather research management team. This should be in addition to the mid-level staff assigned to execute specific NSSL projects funded by the FAA.

12. Overall, the efforts covered under this topic are in good shape. The only concern is what appears to be a weak relationship with CAPS (and other external storm scale forecast groups). If this perception is correct, this is a substantial lost opportunity. It is recommended that NSSL management reevaluate the situation and take any needed steps to invigorate productive, collaborate efforts on storm scale numerical modeling with the external community.

13. Needless to say that there are many scientific challenges related to this research area which can only be solved through better observation, modeling and improved decision support systems, For instance, the goal of improving tornado forecast beyond the current level, which has been a primary goal of the this research group, will be most challenging. Judging from one of the graphs presented, it seems that since roughly 2002, the key statistics such as probability of detection and lead time have stayed at the same level. Of course time will tell, but at least the 5-year plan for the group should be examined more critically to ensure that the combination of research and development efforts in this area are in line with the goals of improving the three statistics being monitored.

14. Express Milestones (5-year Research Plan) in terms more definitive and subject to verification than "improve," "evaluate," "transfer up to …" and the like.

15. NSSL should consider how they can close the "theoretical gap". For example, NSSL lost one of the world's leading severe storms theoreticians in Robert Davies-Jones (retirement).

D. Hydrometeorology Research

SUMMARY OF THEMES:

Quality:

- The reviewers recognized that this is the newest research thrust at NSSL and probably the smallest research team. Some reviewers note this made the quality somewhat hard to judge. Others state that the publication productivity was somewhat low, but solid and of good quality.
- The research activity associated with the QPE was identified as being of high quality and importance.

Relevance:

- Relevance of this research thrust and importance of this topic to the NOAA mission was considered high by the reviewers.

Performance:

- Reviewers note the breadth of activities addressed by the hydrometeorology research group. Several reviewers, however, were concerned that the staff was not sufficient to attack all current problems and ones that likely would emerge in the future.
- The relationship of the Hydrometeorological research to that occurring in other NOAA entities was not clear to some reviewers. This includes the relationship to the HPC, RFCs, and other NOAA research laboratories. One reviewer, however, stated that NSSL was the only NOAA research laboratory that addressed both hydrometeorology and hydrology and, therefore, it fulfilled an important role.
- A theme emerged from some reviewers that due to the fact this group was supported by a high fraction of soft money, their research objectives might be diverted from NOAA goals.

VERBATIM RECOMMENDATIONS (NOTE, MINOR EDITING HAS BEEN DONE FOR FORMATTING PURPOSES):

1. Consider strengthen interdisciplinary research activities that are central to NOAA's strategic goals but require capacity in areas outside of NSSL's core expertise in Hydrometeorology by actively seeking collaborative partnerships within and outside NOAA, specifically at research universities with ongoing programs in the same areas.

2. More effectively collaborate with ESRL to improve QPE and QPF. Partner with the NWS and the academic community to advance hydrologic forecasting. Formulate and implement a more viable strategy to focus NSSL's limited hydrologic science expertise to the overall benefit of NOAA.

3. Coordination of NSSL's role and linkages with other agencies, labs: It is not clear in this reviewer's mind what the relative roles of ESRL and NSSL are with respect to precipitation estimation and forecasting, and how NSSL links up with the Hydrometeorological Prediction Center (HPC), the River Forecast Centers, and the NWS with regard to flash-flood prediction and warnings. Activities among these various entities may already be clarified and

coordinated, but I did not see it explained clearly at the review and it would be useful to define this coordination better.

4. Building on the strong relationship with the NWS and OHD, consider the potential benefits of expanding the scope of research priorities to include a stronger focus on the transition from QPE to QPF for hydrological forecasting.

5. NSSL has to work closely with OHD of NWS to set milestones for progress in precipitation estimation. It should also engage with NCEP and its hydrometeorology group with respect to QPE.

6. I admire NSSL efforts in working closely with the faculty and students at the University of Oklahoma. NSSL should capitalize on the expertise of Prof Hong Yang on making significant progress in its intended goal of combining radar/gage and satellite precipitation estimates.

7. NSSL should also extend its cooperation with other universities and ensure it brings on-board new ideas and also attract new talents from other universities. This comment applies not only to Hydrometeorology but to other areas as well.

8. Targets of opportunity such as debris flow, Hydro modeling etc., while valuable, should not detract from the main mission of improving precipitation estimation. Hydro-modeling effort should be closely connected to NWS/OHD. While this aspect was discussed, I did not get a strong feeling that this collaboration was as serious as one would hope for.

9. Should NSSL be doing hydrometeorological research with a focus on year-round CONUS products or would another lab or NOAA office be a better fit? Unlike tornado research where NSSL has clear expertise, the case for NSSL's hydrometeorological research is less clear even taking into account that this is a relatively new area for the lab. Unlike tornadoes detection and forecast where there is one primary customer, the NWS, real-time precipitation fields and forecasts for hydrological applications have many customers within the US government. NSSL has a good working relationship and record of technology transfer to NWS. However, NSSL has not historically had strong interactions with customers other than NWS. Recommend a NWS/OAR review to address the best fit among the NOAA labs and offices for the different aspects of hydrometeorology applied research including QPE and QPF.

10. One alternative is to more narrowly define NSSL's hydrological research away from year-round CONUS products toward applied research focused on warm season flash flood forecasts. A possible goal would be to do for the science and forecasting of flash flooding what NSSL has done for tornadoes. This research would include life cycle and trends of heavy precipitation storms that would build on related severe storm expertise within the lab. It would also require expertise on orographic precipitation which the lab does not currently have.

11. Heavy rainfall and flash flood short-term prediction and warning: NSSL's real strength is in radar observations and short-term predictions and warnings of severe weather. It has applied

these skills effectively to the tornado problem, leading to improvement of warning times for these storms. Integral to this achievement has been the development of basic theory, conceptual models, field campaigns, and numerical modeling related to tornadic storms. This same multi-pronged approach should be applied to flash-flood-producing storms so that a basic understanding is gained of the synoptic, mesoscale, and internal-storm conditions leading to extreme rainfall. Most storms do not produce extreme rainfall, so what is it about the environment and/or the internal dynamics/thermodynamics of the few outliers that make them such prolific rain-producers? This background knowledge, along with advances in theory and modeling, can then be combined with the Warn on Forecast concept to eventually aid in extending warning times for flash floods.

12. Hydrometeorology is defined differently by different groups and as such may result in pursing different research directions. I recommend that NSSL try to bring more focus to this area, rather than spreading its resources too thin by trying to do too many things (such as hydrologic modeling, Debris flow etc). NSSL can play a key role in improving precipitation products and that by itself will perhaps be the most important contribution to the HYDROmeteorology. In the hydrometeorology presentation, reference is made to the NOAA 5 & 20 year plans. Take the 5-year plan quoted from the material given to us:

    "5-YEAR RESEARCH PLAN Weather and Water

    Milestones for Improving Weather Forecasts and Warnings:

    Improve Radar Observations and Characteristics of Precipitation

    Milestones for Water Resources Forecasting:

    Improve Radar Estimates of Precipitation; Combine with Satellite Data"

    If NSSL would place the focus of its hydrometeorology research just on the two highlighted (red, *[bolded and underlined]*) areas, it will perhaps be the greatest service to the hydrologic services (both government and private sectors). Both QPE and Z-R issues are frequently cited as areas of priority. Like the milestones for tornado warning time, NSSL has to establish milestones for degree of improvements in QPE.

Table 1: List of Site Visitors

Reviewer	Institution
Stephan P. Nelson -- Chair	National Science Foundation
Ana P. Barros	Duke University
Gary Carter	NOAA, Office of Hydrologic Development
Richard Johnson	Colorado State University
Paul Markowski	Pennsylvannia State University
Paul Smith	South Dakota School of Mines and Technology
Soroosh Sorooshian	University of California, Irvine
Roger Wakimoto	NCAR, Earth Observing Laboratory
Mark Weber	Massachusetts Institute of Technology
Sandra Yuter	North Carolina State University

Table 2: Supporting Documents

- Publications (1a) - See the NSSL publications database for individual contributions
- Technology transfer and impacts (1b)
- Citations (1c)
- Awards (1d)
- Membership in scientific organizations (1e)
- Service in technical and scientific organizations (1f)
- Research products and impacts (1g)
- Collaborations (1h)
- Patents, transition to operations, CRADAS (1i)
- Other forms of recognition (1j)
- Contributions relating to data (1k)
- Education (2-5)

Other Information

- Budget
- Field Projects

1999 NSSL Laboratory Review

- Review Report
- Response to Report

Figure 1: Site Visit Agenda

Agenda – NSSL Lab Review – Feb 17-19, 2009

Location: National Severe Storms Laboratory
National Weather Center
120 David L. Boren Blvd
Norman, OK
Room 3910

Monday, Feb 16

8:00 – 9:00pm Committee Executive Session at Residence Inn (meet in S. Nelson's room)

DAY 1: Tuesday Feb 17, 2009 AM

7:00 - 7:30 Breakfast at the Marriott Residence Inn hotel with OAR AA, DAA, and Reviewers [Get breakfast at the buffet, and then proceed to the second floor of the hotel to the Community Room]

7:45 Meet in lobby for transportation to NSSL

8:00 Welcome by OAR AA (Spinrad)

8:15 Welcome & Introduction of Reviewers by OAR DAA for L&CIs (MacDonald)

8:30 Lab Director's Welcome & Overview (Kimpel)

9:00 Weather Radar Research (session 1 of 3)
- Introduction & Overview (Forsyth) (30 min)
- Innovative Techniques to Improve Weather Observations (Torres) (20 Min)
- Enabling the Development and Implementation of Science through Open Systems and Development tools (Jain) (20 min)
- Multi-sensor Data Mining (Lakshmanan) (20 min)

10:30 Break

10:45 Radar (session 2 of 3)
- Dual Polarization and Mobile Platforms for Weather Observations (Zrnic) (20 min)
- Meteorological Applications of Dual Polarimetric Radar (Ryzhkov) (20 min)
- Meteorological Observations in Support of Dual Polarization Research (Schuur) (20 min)
- Using Future Weather Surveillance Radars to Improve Understanding of the Atmosphere (Hondl) (20 min)

12:00 Lunch (Reviewers with NSSL Management and OAR HQ, room 2410)

DAY 1: Tuesday Feb 17, 2009 PM

1:00 Radar Demonstrations/ Electronic Posters (Development Lab) (10 min each)

- Toward longer warning lead times: demonstration of an innovative signal processing solution (Torres)
- Demonstration of Phased Array data and Comparisons to the WSR-88D (Heinselman)
- Visualization and demo of 3-D visualization in WDSS-II (Hondl)
- Live Demonstration of Phased Array Operations and User Interface (Priegnitz)
- Interactive Demonstration of vertical profiles of profiler data and KOUN Dual-polarization data (Schuur)
- Radar Engineering and Development (Zahrai)

2:15 Radar (session 3 of 3)

- Advances in Phased Array Engineering Paving the Way for MPAR (Curtis) (20 min)
- Applications of PAR Technology to Improve Warnings and Predictability of Hazardous Weather (Heinselman) (20 min)
- Summary of Weather Radar Research (Forsyth) (15 min)

3:10 Break

3:30 Hazardous Weather Forecasts & Warnings (session 1 of 3)

- Warning Introduction & Overview (Burgess)
- Advanced Storm Visualization Techniques (Stumpf)
- Nowcasting Applications (Smith)
- Probabilistic Hazard Information (Kuhlman)

4:45 Reviewer closed session discussion with NSSL Director

5:45 Reviewer closed session

6:30 Adjourn & Dinner with Reviewers and all out of town guests at Legends Restaurant (East Dining Room), 1313 West Lindsey, Norman. (405) 329-8888.

DAY 2: Wednesday Feb 18 AM

7:45 Breakfast with NSSL's NWS Collaborators (Reviewers and collaborators only at the National Weather Center in Room 2410)

8:45 Welcome and recap (Kimpel)

9:00 Hazardous Weather Forecasts & Warnings (session 2 of 3)

- Forecast Introduction and Overview (Stensrud)
- Science Infusion (Kain)
- Understanding Severe Weather Processes (Coniglio)
- Short-Range Ensembles and Ensemble Data Assimilation (Stensrud)

10:15 Break

10:30 Hazardous Weather Forecasts & Warnings (session 3 of 3)

- Electronic Posters in Hazardous Weather Testbed (40 minutes):
    - Hail Verification and Analysis Research (Ortega)
    - Circulation Detection and Analysis (Elmore)
    - Thunderstorm Electrification & Lightning Simulation (Mansell)
    - Mountain Valley Cold Pools (Reeves)

Sessions Resume in Room 3910

- Warn on Forecast and VORTEX2 (Wicker)
- Severe Weather and Climate Change (Brooks)
- Summary of Hazardous Weather Forecasts & Warnings (Stensrud)

12:15 Working Lunch (Reviewers only with NSSL scientists, no management, in room 2410)

1:30 PM Hydrometeorology Session 1

- Introduction & Overview (Jorgensen)
- Challenges in improving QPE directed toward improving flash flood warning guidance (Howard)
- Q2 Description, Results, and Plans (Zhang)

3:00 Break

3:15 Hydrometeorology Session 2

- Local Testbeds & Field Results (Gourley)
- Project CI-FLOW (Coastal, Inland FLood Observation and Warning) (Van Cooten)
- Hydrometeorology Summary & Discussion (Jorgensen)

4:15 Parallel Sessions:

- Reviewer closed session
- Line Office Representatives Report-out to NSSL/OAR Management

5:30 Reviewers leave NSSL for dinner alone (semi-private room at Whispering Pines Bed & Breakfast, 7820 East Highway 9, Reservation is 6:00)

DAY 3: Thursday Feb 19 AM

Breakfast on your own (e.g., at the Marriott Residence Inn hotel)

8:00 Meet in hotel lobby and depart to North Base

8:10 MPAR Tours

8:50 Depart from North Base for NWC

9:10 Wrap-up Formal Sessions (Kimpel, Kelleher, Division Chiefs)

10:00 Reviewer Closed Session (begin to write)

11:00 Lunch (Reviewers only in room 2410)

12:00 Reviewers Report-Out to OAR & NSSL Management

1:00 Thank Reviewers and Adjourn

1:15 Mobile Research Facility Tour (~30min)
X-Band Dual-Polarized Radar
SMART- R
Mobile labs
Mobile Mesonets