ISSUE PAPER

In Response To

THE NATIONAL SEVERE STORMS LABORATORY FORMAL REVIEW

June 22 and 23, 1999

1. Accomplishments of Norman NOAA public Affairs Coordinator, January to October, 1999

- Responded to hundreds of local, national and international media inquiries, especially following the May 3 tornado outbreak, by setting up media interviews with the appropriate NOAA/Norman representatives, including directors, scientists and forecasters. NOAA/Norman organizations have been featured in stories on all the major networks and in many national publications. In Oklahoma, NOAA has appeared on the front pages of the local papers more than 15 times.

- Worked with at least five production companies doing programs on tornadoes and severe weather this spring and summer for The Learning Channel, the Discovery Channel and the BBC. Examples include live broadcasts for the BBC and The Discovery Channel ("Twister Week"); a "Discovery Magazine" program on tornadoes that aired on The Discovery Channel in October; an "Understanding Weather' program that aired Nov. 14 on The Learning Channel; and a program on tornadoes that will air in four one-hour segments in February on The Learning Channel produced by Pioneer Productions.

- Improved previously established relationships with local media contacts and established new relationships with national and local television and newspaper reporters that resulted in frequent coverage.

- Increased awareness of all four NOAA organizations in Norman by establishing a name for the group (NOAA Weather Partners) and writing news releases and articles published nationally and locally. For example, the NSSL news releases included:
  - Kimpel Named AMS President Elect
  - StormLink Seeks Severe Weather Reports
  - Lilly Elected to National Academy of Sciences
  - Partnership Formed to Improve Weather Warning System
  - Tornado Myths debunked *(Norman Transcript* supplement)
  - Hometown news releases for each of the 10 Research Experiences for Undergraduates (REU) students who participated in the summer program

- NOAA Scientists, Research Aircraft and Doppler Lidar Join Massive Weather Research Study in Europe
- Experts Provide Updated Lightning Safety Recommendations (AMS release distributed locally)
- NSSL to Receive "Phased Array" Spy-1 Radar *(NOAA Report)*

▪ National Weather Service news releases included:

- January Tornado Number Breaks National Records
- Feb. 28 - March 6 Proclaimed Severe Weather Awareness Week in Okla,
- Storm Spotter Training Planned
- NOAA Marks 20th Anniversary of Red River Tornadoes
- NOAA Weather Radio Transmissions Expand to Woodward and Altus
- Early Warnings Save Lives (June *NOAA Report)*
- Radar Troubleshooters Receive Vice President's Hammer Award
- NWS Forecasters Receive Governor's Humanitarian Awards
- Hams Present Award to Chief Meteorologist
- 1999 Oklahoma Tornadoes Break Record
- Federal Help Desk Registry Established

- Suggested story and photo ideas to area media that resulted in significantly increased coverage. Examples: coverage of the unsafe rebuilding in Oklahoma City and Chuck Doswell's work with the Building Performance Assessment Team by Transcript, Oklahoman and ABC affiliate; photo of Dave Evans visiting NSSL; photo of Col. French (Air Force Weather Agency) visiting NEXRAD Operational Support Facility.

- Coordinated NOAA Weather Partners' participation in Aerospace America, the annual Oklahoma City air show held in June attended by about 75,000 people.

- Coordinated and publicized NOAA Weather Partners Open House held Oct. 30.

Plans in the near future call for a tornado season kick-off media event somewhat like the hurricane season and winter weather outlook events, and a severe weather information weekend for broadcast meteorologists. Also, if producers decide to make a sequel to the movie TWISTER, our PA Coordinator will be heavily involved with that project.

We at NSSL believe the PA experiment in Norman has been a resounding success. Ms. Tarp has done an excellent job in serving all four NOAA organizations simultaneously. One-half of the funding for this position is provided by the NOAA public Affairs Office. Our agreement expires at the end of FY00. At this point in time, we believe the funding arrangement should become permanent.

2. Collaborative Environment Between NSSL and Norman NWS Organizations and Between NSSL and the University of Oklahoma

NSSL has strong collaborations with the other three members of the "Norman NOAA Weather Partners", namely; the Storm Prediction Center (SPC), the WSR88D Operational Support Facility (OSF) and the Norman Weather Forecast Office (WFO). NSSL and the SPC share the same facility and the resulting high level of interaction was highlighted in the formal NSSL Review of June 1999. Therefore, this section will focus on the collaborations with the OSF and WFO and with the academic and service groups at the University of Oklahoma (OU).

A. NSSL Interaction with the Norman NWS Units Not Co-Located with NSSL

- Collaboration with the WSR-88D Operational Support Facility (OSF)

NOAA Director, Dr. John Byrne, made the decision to locate the newly created OSF in Norman, Oklahoma primarily to take advantage of the expertise at NSSL. NSSL developed the prototype Doppler radar system including the hardware, and software necessary to detect severe weather features in convective storms. NSSL scientists and engineers researched and developed pre-production algorithms, display systems, and test and evaluation procedures. Early on, NSSL provided most of the education and training on the value of Doppler radar to the severe storm problem, and on the use of such a system in prototype operational environments. As the OSF spun-up in Norman, several scientists and engineers left NSSL to pursue advancement opportunities in the OSF.

This early collaboration has continued throughout the past decade and is focused on continual improvements to the WSR-88D system. The most notable projects currently underway are:

- The Open Radar Products Generator (ORPG) : to create and implement a non-proprietary stream of existing and improved products;

- The Open Radar Data Acquisition (ORDA) system: to transition the radar data stream from a proprietary to a non-proprietary data set;

- Dual-polarization of the radar signal: to develop hardware and software for transmitting and receiving alternating horizontal and vertical energy pulses to better identify hydrometeors (targets). The primary goal is to improve quantitative precipitation estimates (QPE);

- Algorithm enhancement: and development to improve automated detection of severe weather, and

- Lightning protection: to reduce the outages and damage costs to WSR-88D systems due to lightning strikes.

Preliminary plans call for OSF involvement with NSSL in the reengineering of the Navy SPY-1 phased array radar for conversion to a weather research radar system. The OSF and NSSL also collaborate on several outreach activities, supervising the Public Affairs Coordinator, hosting joint seminars, and NWS training initiatives. NSSL has approximately $4 M per year in NWS contracts in the area of WSR-88D improvement.

- Collaboration with the Norman Weather Forecast Office (WFO)

The Norman WFO was the first Forecast Office co-located with an OAR research laboratory. The Norman WFO was an integral partner in the operational testing that led to the eventual procurement of the WSR-88D system by the tri-agency consortium of DOC/DOD/DOT. The Norman WFO and its predecessor, the Oklahoma City WSFO has over 15 years of experience with real-time Doppler weather radar displays. Results on May 3rd, 1999 received national acclaim and resulted in A DOC Silver Medal award for NSSL's WDSS development group.

Notable projects with the WFO include:

- Testing of the NSSL's Weather Decision Support System (WDSS): the WFO provides operational tests of WDSS. Results on May 3, 1999 received national acclaim including a DOC Silver Medal;

- Jointly staffed the first Experimental Forecast Facility in the nation resulting in the testing of new forecast techniques and support for field programs;

- Early tests of research results: NSSL scientists keep WFO forecasters appraised of research results prior to publication. For example results from VORTEX have been used by WFO forecasters;

- Early feedback on prototype systems: WFO forecasters have provided useful feedback on the ergonomic design of WDSS displays; and

- Coordinated outreach: NSSL and the OSF hold joint Open Houses (annually), and national events such as the 50[1]" Anniversary of the First Tornado Forecast (1998), and a media kickoff weekend for severe storm season (2000).

Over the years, mutual respect has developed between NSSL researchers and NWS WFO personnel. Many are friends and participate in informal discussions, conference publications, seminars, and meetings of the AMS and NWA. NSSL researchers are more likely to tackle problems of concern to the operational forecaster, and the WFO forecasters are likely to try new research results on their own.

B. NSSL Interaction with the University of Oklahoma - 1995 through 1999

- OU Graduate Student Committee Service

    - 11 NSSL researchers have served as the Chair for MS degree students, while 16 served as a committee member.

    - 7 NSSL researchers have served as the co-Chair for Ph.D. degree students, while 20 served as a committee member.

- OU Course Instruction

    NSSL employees have taught 16 course at the University of Oklahoma and several Directed Study courses. During spring semesters of '95, '96, '98, and '99, one NSSL researcher was an instructor for a lecture at OU Center for Continuing Education as part of the "Mornings with the Professor" series.

- Textbook Publication Stemming from OU Teaching

    - Doviak, R. and D. Zrnic, 1993: Doppler Radar and Weather Observations (2nd Ed.), Academic Press, San Diego, 562 pp.

    - MacGorman, D. and W. D. Rust, 1998: The Electrical Nature of Storms, Oxford Press, New York, 422 pp.

- Joint Publications with OU Scientific Personnel

    NSSL employees have co-authored 51 refereed papers, and 97 non-refereed papers with University of Oklahoma personnel.

- Research Collaboration with OU Scientific Personnel Funded by or Through OU

    - One NSSL researcher was involved with the EPsCORE project on rain characterization and with the NSF hydrometeor identification project. Together these projects_ resulted in one co-authored refereed and three co-authored, non-refereed papers.

- Many (more than 10) NSSL researchers and support staff were involved with VORTEX 94 & 95 and SubVORTEX 97, 98, and 99. Together these projects resulted in at least 11 co-authored refereed and 19 co-authored non-refereed papers.

- Two NSSL researchers were involved with the NSF project on electric field, charge density, and MCS structure. Two researchers were involved with the NSF project on the electrical structure of storms systems producing positive cloud to ground lightning. Together these NSF projects have resulted in at least 12 co-authored refereed and 20 co-authored non-refereed papers.

- One NSSL researcher was involved with an NSF satellite studies project, an NSF ensemble forecasting project, and worked with another NSSL colleague on the Atmospheric Radiation Measurement (ARM) Program. Together these projects resulted in at least 6 co-authored refereed and 6 co-authored non-refereed papers.

- Other Collaborations

  - NSSL has worked directly with OU to get WSR-88D radar data directly into the University for research purposes at CAPS.

  - Several NSSL researchers have worked collaboratively with OU on the Research Experience for Undergraduate (REU) program funded by NSF.

  - Two NSSL technicians have worked with OU personnel in the development and fabrication of the Mobile Mesonet and Doppler on Wheels (DoW) vehicles used in the VORTEX experiments.

C. <u>Advantages to NOAA through Co-location with the University of Oklahoma</u>

Co-location of NOAA elements with the University of Oklahoma (OU) will strengthen and extend a unique, synergistic government-university partnership wherein resources and expertise in the University will significantly augment (double the resources) our NOAA programs. NOAA will also gain from its access to the academic communities' unique facilities (e.g., Mesonet, Supercomputers, Calibration Lab, etc.)

In an era of reduced funding to support research and facilities, it has become very important to build collaborative relationships in order to accomplish our research and maintain the first-class NOAA services our Nation has come to expect. In addition, the operational elements (Storm Prediction Center (SPC), Operational Support Facility (OSF) and Weather Forecast Office (WFO) have been reduced in staffing during the NWS modernization and no longer have the capacity to engage independently in extensive research and development activities. While some of these needs are being met by the co-location with the National Severe Storms Laboratory (NSSL), NSSL has been leveled funded for many years and in real dollars is loosing its capability to meet the operational research and development needs. Co-location allows for easy access to research faculty and students help to augment NOAA staff and reduce the effects of these resource reductions.

- Our vision of a new building housing both OU and NOAA components provides an environment that:

    - Encourages scientific discussion among faculty, students, and NOAA staff in an informal and open setting, while facilitating a quality research environment.
    - Frames basic research and development within the backdrop of operational applications.
    - Places theoretical, computational, field, and laboratory investigations under the same roof as operational forecasters.
    - Creates a greater sense of educational training and purpose among students via frequent interactions with scientists and forecasters.
    - Provides advanced facilities for training, teaching, and research.
    - Reduces the time to transfer technology from research to operations.
    - Serves as a model of the benefits of having research, education, and operations in one facility for the State, Nation and World.
    - Operational Forecasters can provide the benefit of their expertise to the people tasked with providing forecasts to field experiments.
    - Operational forecasters can provide research meteorologists with real-time examples of the various problems that they face.
    - Students gain operational experience by being part time volunteers at the SPC and WFO.
    - Students gain research experience by being part time employees/volunteers at the NSSL.
    - Forecasters can pursue advanced meteorological coursework.

- Numerical model developers can work in real-time with operational users to tune and adjust their product.

- Students can gain operational knowledge by participating in the operational, daily map discussions.

- Benefits Analysis:

    - Access to expertise at OU.

By locating NOAA's components with the meteorological components of the University of Oklahoma, NOAA leverages the OU staff and resources to work on NOAA problems. Two excellent examples are:

- (CAPS), which received over $20 M to develop an operational mesoscale forecasting model; and

- The DOE supported Atmospheric Radiation Measurement (ARM) program, which invested more than $25 M in equipment and science to establish baselines for the radiative properties of clouds in climate models.

Collocation will also allow operational forecasters and research meteorologists to work side-by-side during field programs. The VORTEX (1994, 1995) and the MeaPRS (1998) field experiments illustrate the value of these types of interactions. The VORTEX effort studied the operationally critical relationships between CAPE, CIN, helicity, rotating supercells and tornado genesis. The operational impact of this effort is reflected in the steady rise in SPC skill at forecasting "significant" severe thunderstorm events.

The VORTEX results illustrate another positive aspect of operational forecasters participating in collaborative projects. The meteorological research community works on the premise that it takes seven years for research results to propagate from a field program through publication to operational implementation. However, forecasters who were active participants in an experiment will use techniques that were helpful during the field program in their operational forecasts even if they have not been formally published. This short-circuits the "seven year cycle." Formal publication is still needed so that forecast techniques are propagated to the entire community, but the payback begins much sooner, within a couple of years in the case of the helicity, CAPE, CIN results.

Similar performance improvements would result also from the Norman WFO and SPC co-location with OU. These improvements save lives and property, but it is hard to quantify the exact value of this relationship.

To estimate the value of OU expertise to NOAA, lets assume that 80% of the research performed at OU directly relates to solving NOAA problems and that 50% of these 200 staff and student's time is devoted to research. Then, approximately 80 staff years would be working on NOAA problems. If the cost per staff year were an average of $80K, then NOAA would obtain the equivalent of $6.4M per year in research at no cost. In addition, OU averages over $10M per year in externally funded research. If only 50% of this research is directed at NOAA problems, then $5M extra resources would be devoted to solving our problems. Thus, in 20 years, NOAA would have benefited from between $128M to $228M of research because of the co-location with the University.

- Access to unique facilities:

  - Mesonet: The State of Oklahoma has established a 154 station Mesonet through out the state. NOAA's access to this data has been free and could continue to be free if we are co-located with OU. Annual cost to purchase this data is $100K per year over 20 years equals $2M.

  - Super Computing: Researchers at NSSL have a need for access to supercomputing. One of the biggest problems in working with supercomputers is access to the databases required to initialize model runs. Being co-located with the OU supercomputing would solve this problem and provide free to minimum cost access to supercomputing. Cost savings to NOAA per year would be $50K. Thus, a savings of $1 M over 20 years.

  - Calibration Laboratory: Being co-located, we would not have to build our own equipment calibration facility at a cost of $100K for equipment only. The annual cost of personnel with expertise to run the calibration facility is $100K per year. Thus, a cost savings of $2M over 20 years.

  - Very High Speed Networking: Being co-located with OU gives us access to Internet II with a cost savings of $150K per year or $3M over 20 years.

  - Distance Learning Center: Co-location would provide NOAA with access to a planned state-of-the-art distant learning center. The cost of a "high-tech" studio is over a million dollars. In addition, a shared NOAA/OU center would result in lower communication costs and provide access for development of new technologies and delivery systems. This could result in improved training for NWS forecasters that might not otherwise be affordable. Although exact costs are not available, the potential savings on a shared studio and production expertise would be $1 M or more.

- Facilities Sharing: NOAA has a need for certain facilities, such as conference rooms and observation area along with improved facilities such as a library, cafeteria, Joint Mobile Research Facilities, etc.. Again, actual cost savings are hard to quantify, but would result in savings to NOAA.

▪ Opportunities lost based on not being co-located:

Over the years, we have had many opportunities to work closely with OU. During this time, it is the collective opinion of the Oklahoma Weather Center, that many projects would have been much more successful if we had been co-located in the same facility. For example, the development of the ARPS model and transfer to the NWS; the creation of a Natural Hazards Research Center; a prototype of regional collection and distribution of WSR-88D level II data; expansion of OK-First nationally; implementation of numerical forecasting and analysis into Weather Decision and Support Systems; knowledge and distributed intelligence effort; management of the Joint Mobile Research Facility; and research into short-range and storm-scale ensemble forecasting.

Additional projects that could fall into this category are making ARPS a part of the next operational model at NCEP, developing dual-polarization for NEXRAD, phased-array radar development, hydrological studies, a new science and technology center for regional/mesoscale climate, economic and societal impacts, operational testing of short-term NWP, prototype real-time WSR-88D Level II ingest and processing distant learning and commercialization of technology. These missed opportunities or near misses are hard to quantify, but have resulted in real losses of resources both lives and property due to slowed developments in improved warnings and forecasts.

- Future opportunities.

The NOAA community in Norman believes that there will be many future opportunities to advance the science of meteorology and lead to improvements in NOAA's services that will be greatly aided by co-location. These include: a National NWP test facility for all scales of models; development of coupled hydro-meteorological models using soil moisture initialization; real-time storm-scale prediction; development of a national prototype for the centralized collection and redistribution of real-time WSR-88D data; training classes for NWS's WFO and SPC personnel; and joint supercomputing and four-dimensional data assimilation systems as well as many of the projects listed above. Again, it is hard to estimate a value for each and every project and what they might be worth, if completed and implemented successfully. All these projects mentioned above would benefit from co-location and all these projects are important to NOAA's future. If we can improve the environment that produces our best science and this leads to our best warnings and forecasts, then NOAA ought to take the opportunity to build the most supportive environment possible for producing the best scientific results.

- Conclusion:

Based on the analysis above, NOAA should take this once-in-a-lifetime opportunity to co-locate the National Severe Storms Laboratory, Storm Predication Center, Norman Weather Forecast Office and portions of the Operational Support Facility with the University of Oklahoma at a new facility to be build on the South Campus of OU. In the words of the Independent Review Panel, who visited Norman and reviewed the Norman Project: "The Panel sees strong potential benefits for the South Campus consolidation that is worth an economic premium. The benefits to the nation are financial savings, enhanced scientific productivity and technology transfer. The Panel believes that both NOAA and OU have an extraordinary opportunity of creating an exceptional University/Government partnership".

3. Continuation of the Pan American Climate Studies (PACS) Position at NSSL

A small portion of NSSL's weather research is related to climate. In a broad sense this is appropriate, since climate information and the evidence of any climate change come from and are seen in weather observations. This joint NSSL/OGP research seeks to help understand the variations in climate in Latin America and improve the applicability of NOAA-generated climate forecasts to other countries. This in turn, benefits long-term planning and should reduce costs associated with disaster relief activities related to meteorological / climatological events such as El Nino. Also, NSSL's PACS activities have a strong emphasis on using the observations for short-range forecasting within each country. This stimulates the meteorological services in the region to maintain and expand their observing networks, ultimately benefiting global weather and climate forecasting. NSSL has excellent facilities and expertise to support this type of activity. Specifically, NSSL has radiosonde systems, tethered balloons, various experimental sounding systems, and personnel to lead deployment of such systems into the field. For example, our work with rawinsonde and pibal networks in remote and logistically challenging regions has been a key component of PACS.

Other NSSL PACS research is on modulation of the subtropical jetstream relevant to severe springtime convection and low-level moisture fluxes (and other subtropical/midlatitude interactions) that drives the southwest monsoon. Both topics relate to improved seasonal to interannual prediction of warm-season rainfall and attendant severe weather. Severe weather over the continental U.S. is not only forced by disturbances propagating in the midlatitude westerly flow, but is also subject to influences from lower latitudes. Several studies have pointed to the importance of interactions of the tropical/subtropical jets in forcing deep convection. The subtropical jetstream that flows over Oklahoma every spring originates directly over the PACS study region. While the time scales are quite different, both storm-scale/mesoscale studies and large-scale studies are required to successfully predict the risk to life and property stemming from severe convective storms.

The vast majority of NSSL's involvement in PACS is funded by OGP. Support from EPRI funded PACS-related work in the recent past. The scientist partially funded through OGP does not officially fill a "PACS Position". We were asked to list our NSSL FTEs against NOAA Strategic Planning Elements as part of the NSSL Review process. We estimated that 1.0 FTE at NSSL participates in the NOAA Improving Seasonal and Interannual Climate Forecast element. The two paragraphs immediately above justify that level of commitment. How this 1.0 FTE became a "NSSL PACS Position" during the Review is unknown. Suffice it to say that if OGP funding should cease, the scientist will be redirected to the Improve Short Term Forecasts and Warnings element.

4. Increasing NSSL's Expertise in the Use of Satellite Data for Analysis and Assimilation Into Models

NSSL agrees with reviewer comments that satellite information could play a larger role in our research involving data analysis and data assimilation into models. Balancing Doppler radar and satellite inputs has been a difficult issue for quite some time. NSSL's approach has been to have a resident expert in-house for OU scientists to collaborate with on satellite issues, and to maintain strong linkages to other organizations more focused on satellite themes. We believe this strategy has worked well in the past. The main question here is "how much satellite work is enough?"

The National Severe Storms Laboratory has a long-term collaboration with the Cooperative Institute for Mesoscale Satellite Studies (CIMSS) at the University of Wisconsin and with CIRA/RAMM at Colorado State University. The most significant collaboration we have had is one of our scientists, Dr. Robert Rabin spent 3 years at CIMSS in the early 1990s and he now spends 50% of his time in Wisconsin working with CIMSS scientists and 50% of his time working in Oklahoma with NSSL scientists. The information below details some of the joint studies he, NSSL scientists, and collaborators have performed during the past few years.

- Information from Dr. Bob Rabin:

"To my knowledge, the strongest emphasis on assimilation of satellite data into models is taking place at CIMSS (in collaboration with NESDIS/ORA and FSL). In terms of mesoscale models, assimilation techniques and impact studies have/are being developed with the RUC-2, ETA, and CIMSS models. Bob Aune (NESDIS), Gail Baylor and Bill Raymond (CIMSS) are key people involved in this work at Madison. They are contributing to planning studies for the future North American Observing System (which will determine, for example, what future rawinsonde coverage is needed when satellite data are fully assimilated into models). However, I'm not aware of much being done to assimilate satellite data into storm scale models. Some preliminary work has begun to use cloud scale models (with Greg Tripoli, UW-Madison) to learn more about the mechanisms for storm top signatures such as the enhanced-V and warm wakes. None of these projects are currently tied into modeling efforts at NSSL. However, it should be pointed out that Dave Stensrud and Todd Crawford are involved in a project to develop improved assimilation of land surface data (some from satellite) into mesoscale models. This work has some relation to remote sensing of surface fluxes, a topic of research that I, George Diak, and John Norman have been involved with at CIMSS".

"I'm not as familiar with the projects at CIRA/RAMM, but I don't think they have been involved in data assimilation into models as much as CIMSS".

- Summary of NSSL Satellite-Based Activities: 1989-1999

Dr. Rabin is an Honorary Fellow with the Cooperative Institute for Meteorological Satellite Studies (CIMSS) at the University of Wisconsin-Madison. He has interacted as visiting scientist on numerous projects. In addition to receiving competitive funding from NOAA/OGP and NASA, he has received NESDIS funding from the GOES-NEXT Product Assurance Program for the last 3 years for collaborative work with NSSL.

    - Studies of the Evolution of Atmospheric Moisture

Use of passive microwave (SSM/I) and infrared (GOES) in mapping moisture and stability in synoptic and mesoscale weather events. Developed "blended product" of moisture fields from satellites and ETA model for Synoptic Analysis Branch of NESDIS in collaboration with Rod Scofield.

Articles published:

Rabin, R.M., L.A. McMurdie, C.M. Hayden, G.S. Wade, 1991: Monitoring precipitable water and surface wind over the Gulf of Mexico from microwave and VAS satellite imagery. Weather and Forecasting, 6, 227-243.

Rabin, R.M., L.A. McMurdie, C.M. Hayden, G.S. Wade, 1992: Layered precipitable water from the infrared VAS sounder during a return-flow event over the Gulf of Mexico. Journal Applied Meteorology, 31, 819-830.

Rabin, R.M., L.A. McMurdie, C.M. Hayden, G.S. Wade, 1993: Evaluation of the

atmospheric water budget following an intense cold-air outbreak over the Gulf of Mexico-Application of a regional forecast model and SSM/I observations. Journal Applied Meteorology, 32, 3-16.

- Studies of Land Surface Effects on Convective Clouds

Funding was received from the NOAA CGC program to conduct an observational study using GOES data. Observations have shown that frequency of shallow cumulus can vary inversely with vegetation cover and soil moisture when topographic effects are small. Areas of deforestation in the Amazon have been observed to enhance frequency of cumulus coverage in the dry season.

Articles published:

Rabin, R.M., S.J.Stadler, P. Wetzel, D.J.Stensrud, M.Gregory, 1990: Observed effects of landscape variability on convective clouds. Bulletin American Meteorology Society, 71, March with figure on cover.

Raymond, W.H., R.M. Rabin, G.S. Wade, 1994: Evidence of an agricultural heat island in the lower Mississippi floodplain. Bull. Amer. Meteor. Soc., 71, 1019-1025.

Rabin, R.M., D.W. Martin, 1995: Satellite observations of shallow cumulus coverage over the central United States: An exploration of land use impact on cloud cover. J. Geophy. Res.-Atmospheres., 101, D3, 7149-7155.

Cutrim, E., D.W. Martin, R.M. Rabin, 1995: Enhancement of cumulus clouds over deforested lands in Amazonia. Bull. Amer. Meteorol. Soc., 76, 1801-1805.

Segal, M., R.W. Arritt, C. Clark, R. Rabin, J. Brown, 1995: Scaling evaluation of the effect of surface characteristics on potential for deep convection over uniform terrain. Mon. Wea. Rev., 123, 383-400.

- Remote Sensing of Surface Fluxes Using Satellite Data

Funding was received from NASA to investigate the use of SSM/I and GOES data. Techniques were developed and demonstrated. Relations of fluxes to vegetation cover and antecedent precipitation were developed. Also, the techniques have been applied to regions with significant spatial variability in surface heating which may influence the initiation of deep convection.

Articles published:

McNider, R.T., A.J. Song, D.M. Casey, P.J. Wetzel, W.L. Crosson, R.M. Rabin, 1994: Toward a dynamic-thermodynamic assimilation of satellite surface temperature in numerical atmospheric models. Mon. Wea. Rev., 122, 2784-2803.

Diak, G.R., R.M. Rabin, K.P. Gallo, C.M. Neale, 1995: Regional-scale comparisons of NDVI, soil moisture indices from surface and microwave data and surface energy budgets evaluated from satellite and in-situ data. Remote Sensing Reviews, 12, 355-382.

Hane, C.E., H.B. Bluestein, T.M. Crawford, M. E. Baldwin, and R.M. Rabin, 1997: Severe thunderstorm development in relation to along-dryline variability: A case study. Mon. Wea. Rev., 125, 246-266.

Rabin, R.M., B. Bums, C. Collimore, G. R. Diak, W. Raymond, 1999: Relating remotely-sensed vegetation and soil moisture indices to surface energy fluxes in vicinity of an atmospheric dryline. Submitted to Remote Sensing Reviews.

- Short-term Forecasting of Convective Intensity by Combining Radar, Satellite and In-Situ Data

Developed and applied cloud tracking techniques to obtain trends of size/temperature of cloud tops associated with thunderstorm clusters. Explored the utility of environmental data from satellite and radar in forecasting the decay of ongoing mesoscale convection. Developing new algorithms to identify and track single-storm top signatures relevant to storm severity (penetrating tops, enhanced V's, warm wakes, etc.).

- Provided Technical Assistance on the Use of Satellite to Data to NSSL and SPC

Dr. Rabin presented numerous lectures on radiative transfer and the GOES sounder at the COMET Satellite Meteorology courses. Provided input to COMET training materials.

- Utilizing satellite data together with radar, lightning, gauge and environmental data for improved estimation of rainfall

Working with NESDIS and SSEC (Bill Hibbard) on applications of VisAD for visualization of multisensor data and algorithm development with funding from USWRP and NOAA HPCC programs.

- Current Activities:
  - Use of GOES water vapor winds (and soundings) in mesoscale analysis and nowcasting cloud formation/dissipation.
  - Analysis of convective tendencies from radar, and satellite data
  - Multi-sensor algorithm for improved estimation of heavy precipitation

events.

- Use of VisAD (visualization tool) from development of rainfall algorithm
- Surface flux estimation using GOES and mesonet data.
- Identification of thunderstorm induced fires using radar reflectivity, lightning, satellite-detected fires, and environmental conditions.
- Sea surface temperature in the Gulf of California and evolution of atmospheric moisture in the Southwest Monsoon using GOES observations.

Furthermore, Ms. Daphne Zaras, of NSSL/CIMMS and Dr. Rabin, worked with CIRA/RAMM to develop an application for RAMSDIS that automatically detected and tracked cold thunderstorm tops over time. The goal of that application was to provide information to forecasters on the time trend of the area and minimum temperature of thunderstorm tops.

In addition, NSSL has a full-time employee, Mr. Lakshmanan who, as part of his PhD Dissertation, is developing a very sophisticated storm cell tracking application that utilizes satellite and radar data to detect and track thunderstorms.

Also, Messrs. Ken Howard and J.J. Gourley are developing a satellite and radar-based algorithm that utilizes the strength of both sensors to perform Quantitative Precipitation Estimation (QPE). They have focused on the mountainous west for their initial testing and have found that, not only do they get much more accurate precipitation estimates, but they can determine also the height of the rain/snow line accurately using their technique.

Our plan to enhance our links with NESDIS (including CIMSS and CIRA/RAMM) is to have a joint meeting during the first quarter of CY 2000 with all groups to determine how we can best enhance our joint efforts. From this meeting we will set a strategy to enhance our interactions and we will define a number of joint projects that we will embark upon.

We will provide minutes from this meeting to you by the end of March, 2000 along with our jointly defined strategy to enhance collaboration between all of our organizations.

5. Improving NSSL interactions with Other Appropriate OAR Laboratories (now due: December 17, 1999)

In Response To

THE NATIONAL SEVERE STORMS LABORATORY FORMAL REVIEW

June 22 and 23, 1999

5. Improving Interactions Between NSSL and the Other OAR Research Laboratories

In hindsight it was probably a mistake not to highlight our collaboration with other OAR Laboratories during the NSSL Review. Our responses to questions on this topic suffered from a lack of preparation. We will be better prepared in future reviews. NSSL does have significant interactions with OAR's other "weather labs", namely, AOML, ETL, GFDL, and FSL. Collaborations could be improved and there are many opportunities in the near term, which demand attention. NSSL conducted an internal survey during November 1999 to identify all collaborative activity with the laboratories mentioned above. Personal contact was initiated in December 1999 with the Directors of these four laboratories on improving interactions.

On the whole, the level of cooperative effort between NSSL and each of the other OAR Weather Laboratories appears adequate. Missions of the OAR Weather Laboratories have evolved over the years so that each laboratory has its own niche, and the core science accomplished by an individual laboratory has little overlap with another. In the long run this is probably good and, if nothing else, minimizes competition for scarce resources on duplicative efforts. The interactions that do occur thus are focused on interdisciplinary science and the sharing of a particular ability and/or facility.

- Ongoing Interactions With The Other OAR Weather Laboratories

The following is a brief summary of the ongoing interactions with other OAR Weather Laboratories as identified by the NSSL internal survey.

- AOML - joint research on hurricanes at landfall (HAL) employing NSSL's Mobile Mesonet facilities, and some work on heavy precipitation using existing WSR-88D algorithms and methods.

- ETL - participation in the evaluation of ETL's acoustic sensing techniques for the identification of tornadoes, data analysis from

CALJET, FASTEX, NORPEX, and ensemble forecasts of convective weather.

- FSL - data analysis from NORPEX, four-dimensional data assimilation (especially radar data), preliminary work on incorporating NSSL's WSR-88D Open Radar Products Generator (ORPG) into the NWS AWIPS, and early planning for participating in the development of the Weather Research and Forecasting (WRF) model.

- GFDL - upscale effects of long-lived convection on the global circulation.

- Future Expectations

Consultation with Directors Katsaros, Clifford, MacDonald and Mahlman indicate that there are several strategic opportunities for increased interaction between NSSL and each of the other OAR Weather Laboratories. These are summarized below:

- AOML - observational studies of hurricanes at landfall (HAL), improved estimates/forecasts of heavy precipitation (QPE/QPF) employing dual – polarized radar techniques, and coupled QPE/QPF runoff modeling.

- ETL - joint participation in the conversion of NSSL's SPY-1 phased array radar (PAR) to a weather radar platform, and the test and evaluation of PAR capabilities.

- FSL - incorporation of the Open Radar Data Acquisition (ORDA) software into the NWS AWIPS, incorporating dual – polarization techniques into operational systems, many aspects of the WRF project, and the Hazardous Weather Reduction Initiative.

- GFDL – data assimilation, ensemble methods and techniques, and convective parameterization.

Coordination of these opportunities ideally will occur among scientists with similar interests and during, and as sidebars to, meetings of the newly constituted OAR Senior Research Council (SRC). While most of NSSL's science is directed toward NOAA's short-term forecast and warning strategic planning element, some fraction of our facilities, field programs, data analysis, data assimilation, and modeling efforts, have application to both seasonal and interannual, and climate elements. NSSL expects to play a large role in OAR's science future.