Analysis and Diagnostic Studies from SMN Radar and Related Data in Support of NAME

Principal Investigators:
Dr. Timothy J. Lang, Colorado State University
Dr. Richard E. Carbone, National Center for Atmospheric Research

Co-Principal Investigator:
Steven A. Rutledge, Colorado State University

Co-Investigators:
Stephen W. Nesbitt, Colorado State University
Arturo Valdez-Manzanilla, Juarez University

I. Introduction

This grant focuses on providing quality control, processing, and analysis of SMN (Mexican weather service) radar data in support of NAME, the North American Monsoon Experiment. It is a collaborative effort between Colorado State University (CSU) and the National Center for Atmospheric Research (NCAR). Analysis of the SMN data will be directed at improving our understanding of convective processes within Tier I (the innermost domain) for NAME. These observations will be made during the extended observation period (EOP) currently scheduled for JJAS 2004. The SMN radars are part of a dense network of soundings, profilers, raingauges, and radars in Tier I of NAME for the purpose of describing and understanding the structure of the diurnal cycle of precipitation in the core region of the North American Monsoon (NAM). These objectives include understanding the regimes associated with intra-seasonal variability and the influences of topographic heating and blocking, surges, jets, and surface fluxes. A critical element of the Tier I network is the retrofit of four SMN 5-cm Doppler radars located at Cabo San Lucas, Gusave, Obregon, and El Palmito. The radars cover the coasts surrounding the Gulf of California and the Sierra Madre Occidental mountain range. The upgraded SMN radars will provide quantitative statistics on precipitation amount and distribution, fractions of both convective and stratiform precipitation, and convective airflow organization (in a 2-D sense) within 100-150 km range of the radars. This upgrade of the SMN radars is currently underway, thus ensuring the acquisition and archival of research-quality reflectivity and velocity data.

II. Project Goals

Specific scientific objectives of this grant are split into two parts: Data acquisition and quality control, and basic science.

1. Data acquisition and quality control

Ensure the acquisition and thorough quality control of all data from the four SMN radars in the NAME Tier I region. Then create a merged and gridded radar product that

provides accurate rainfall, reflectivity, and kinematic statistics at high temporal and spatial resolution for the entire NAME EOP, and provide these products to the NAME community.

2. Basic science

Using the merged radar product, perform basic diagnostic studies, such as precipitation diurnal cycle analyses, that can be incorporated in research by other NAME investigators. Also, use the merged radar product to analyze satellite rainfall estimation biases in this region.

III. Methodology

Work on this grant will be carried out at two institutions, NCAR and CSU. NCAR will oversee SMN radar data collection during the NAME EOP, and a CSU student will do quality control of the collected data and development of the merged radar product under NCAR supervision. The remainder of the basic science analyses under this grant will be performed at CSU.

1. Data acquisition and quality control

a) <u>SMN radar field operations</u>

A continual scientific presence at SMN radars is crucial, since the technician-operators of SMN radars are not accustomed to the procedures and needs of research data acquisition. We plan for a continual roving presence of one scientist at the four SMN radars, and periodic visits by other investigators on this project.

b) <u>Quality control of SMN radar data</u>

The SMN radar data fields, in addition to rainfall echo and Doppler radial velocity, will contain various artifacts such as ground and sea clutter, anomalous propagation, bird migrations, insect echoes, etc. Such issues will need to be addressed by our quality-control efforts. Usable reflectivity data from low elevation angles then will need to be converted to accurate rainfall estimates so that useful precipitation science may be done with them. Therefore, strenuous quality control and rainfall-estimate calibration, individualized to address each radar's unique placement, will be required to ensure accurate characterization of convective structure and rainfall. Polarimetric radar data from S-POL and rain gauge measurements will be used to develop accurate Z-R relationships that can be used with the SMN radars.

c) <u>Merged radar product</u>

The radars in Tier I will operate in research mode nearly 24 h per day for at least 6 weeks during JJAS 2004. The individual radars will acquire massive amounts of data, in the native spherical coordinate system. NAME objectives focus less on individual

radar case studies and more on regional-scale processes, such as the meso- to large-scale dynamics controlling the diurnal cycle and intra-seasonal variability of precipitation. Therefore, NAME objectives will require regional composites of observations from the radar network in Tier I, including the four SMN radars. These composites will be available at high temporal resolution (≤ every 15 minutes is ideal) in an easily understandable and manipulated gridded format. The variables that will be available will include radar-estimated rainfall, radar reflectivity factor, and Doppler radial velocity. A merged radar-rain gauge rainfall product also will be developed.

d) Distribution of products to NAME community

Because the primary focus of NAME in Tier I is precipitation, merged radar products, which will include rainfall maps and gridded volumes of convective echo at high temporal resolution, will be of great value to accomplishing the objectives of all NAME researchers. We plan to provide the merged and gridded data via the web and the UCAR/JOSS archive. We anticipate delivery of the fully processed radar products to the NAME community in Fall 2005 or possibly later. However, individual cases identified as priorities by the NAME community could be delivered much sooner, if necessary.

2. Basic science

With the merged radar products completed, a number of additional tasks are planned at CSU under this grant's support, focusing less on instrumentation and quality control, and more on basic science. Each of the following tasks advance NAME Tier I objectives and flow naturally from the creation of the merged radar products:

a) Basic diagnostic studies

Basic diagnostic studies using the merged radar products will play an important role in addressing basic NAME objectives. These diagnostic studies are not intended to be detailed research projects that test particular hypotheses. Rather, they are focused on developing secondary data products that can be shared with the NAME community. They also can be used to help investigators on this grant to address research problems in other work. Some of the diagnostic studies include, but are not limited to:

- Apply quantitative rainfall estimation at a number of different spatial and temporal scales.
- Develop basic statistics of the diurnal cycle, such as areally averaged rain rate and convective echo area/volume throughout the day.
- Use convective/stratiform partitioning to address research questions regarding basic precipitation structure in the region.
- Develop basic storm evolution, structure, and propagation statistics, which are important for understanding convective processes in the region.

b) Evaluation of satellite biases

Many remote sensing algorithms exist to estimate precipitation over land and ocean. However, validation datasets (i.e., spatially dense research quality rain gauges or calibrated ground radars) in the NAME region are lacking. The NAME observing system, including gauge transects crossing the varying elevations of the SMO, along with radar coverage from the upgraded SMN radars and the S-POL polarimetric radar, will allow gauge- and polarimetrically tuned rain maps to be generated. These will allow the evaluation of climatological and instantaneous satellite rain estimates.

IV. Accomplishments and Results

This work is just beginning. However, investigators have been working with the people and institutions responsible for the upgrade of the SMN radars to ensure that it is accomplished smoothly and in time for the start of the NAME EOP in summer 2004.

V. Publications Resulting from this Work

No publications to date.

VI. Contacts

Principal Investigators:
Timothy J. Lang
Department of Atmospheric Science
Colorado State University
Fort Collins, CO 80523
(970) 491-6944
tlang@atmos.colostate.edu

Richard E. Carbone
National Center for Atmospheric Research
P.O. Box 3000
Boulder, CO 80307
(303) 497-8926
carbone@ucar.edu