Numerical Simulations of Snowpack Augmentation for Drought Mitigation Studies in the Colorado Rocky Mountains

Summary of 2nd Project Meeting (conference call)
Hosted by the CWCB
December 16, 2003
And related information for discussion and reference

List of attendees:

Name	Agency	phone	email
Brenda Thompson	CSU	970-491-8593	brenda@atmos.colostate.edu
Dr. Bill Cotton	CSU	970-491-8593	cotton@atmos.colostate.edu
Gustavo Carrio	CSU	970-491-8500	carrio@atmos.colostae.edu
Ray McAuelly	CSU	970-491-8341	raymc@atmos.colostate.edu
Larry Hjermstad	WWC	970-247-8813	westernweather@sprynet.com
Curt Hartzell	Consultant	320-222-8780	curtjoan@en-tel.net
Ross Williams	Consultant	719-473-7333	rawscoe@adelphia.net
Joe Busto	CWCB	303-866-4807	joe.busto@state.co.us

Project members unavailable to participate in conference call
Paul Mielke, CSU; Steve Schmitzer & Becky Dechant, Denver Water

Project Status and Payments
WDMP Grant awarded from USBR to the CWCB – October 2003
State Grant review form – Approved by Governor's office November 17, 2003
Curt Hartzell State purchase order for project management – issued November 18, 2003
Ross Williams State purchase order for GIS services – being processed by CWCB
USBR extended performance for Grant through December 2004 – letter dated December 2, 2003.
CSU/CWCB contract - signed December 9, 2003
First CSU invoice submitted to CWCB – December 16, 2003

Clarification and Action Items by Task

Task 1 – ***Set up RAMS over the Denver Water Department operational cloud seeding areas and over the locations of the ground-based generators.***

The summary from the October 22, 2003 meeting included: "… the required figure will include topography that is easy to visualize, WWC ice-nuclei generator sites, NRCS Snotel & snowcourse sites, ski area precipitation gauge sites, NWS precipitation measurement sites (gauge and cooperative observer), and any other precipitation observation sites located within or surrounding the project's target area for operational seeding."

Renaming of Generator sites - Ross Williams, Greg Bryant (Denver Water GIS Coordinator) and Joe Busto will be working with Larry Hjermstad to rename generator sites from initials of the operators to a numbering system. This will be official for Denver Water and their numbers scheme should be built into the studies GIS and graphics.

Action item 1.1 - Greg Bryant of Denver Water will present a new Microsoft Excel Spreadsheet to CWCB and Western Weather Consultants that will ask Larry to present the seeding operational data in this format. The numbering scheme and format will be incorporated in the RAMS modeling study databases and maps. Good progress is being made on this action item; a draft spreadsheet has been completed for review by Larry/WWC. This task of renaming the generator sites and revising the spreadsheet should be completed before the end of January 2004. The new Excel spreadsheet for cloud seeding generator locations has been completed by Denver Water and is attached. A Special thanks goes out to Greg Bryant, Denver Water's GIS coordinatior, who on behalf of the Denver Water program and the CWCB has created an Excel spreadsheet that will be the basis for future reporting and analysis. This is an attempt to standardize all reporting to the state and project funders from the cloud seeding contractors in a GIS friendly format. We hope to implement this type of form with the Gunnison County/Upper Tributaries program run by Don Griffith, North American Weather Consultants out of Utah. Basically all the reporting data will be on one sheet. Joe Busto spoke with Mike Hjermstad, Larry's son for an hour on 1/13/2004. Mike will assist Larry in quality control/checking/verifying all generator locations and then a final copy of the reconciled Excel spreadsheet will be provided to Denver Water, CWCB, and the Numerical Simulations Study Group. In order to keep all the information together new columns will be added for each generator that are the types of information that is reported back to the CWCB and funders. I.E. (start time, stop time, seeding rate, total hours, total generator output, primary target, etc.).

Identification of all precipitation observation sites - Ray and Larry will collaborate on the development of the list of precipitation observation sites within and around the research project area needed for evaluation studies.

Action item 1.2 – During the December 16th conference call, Ray stated that he would prepare a list of precipitation observation sites that he has and email it out to the project participants for review. Ray, have you sent out this list of sites?

Action item 1.3 - Larry will contact the ski areas in central Colorado and Climax Mine and request copies of observations they make during the 2003-2004 winter season. Larry said he would contact Knox Williams at the Colorado Avalanche Information Center. In an email dated January 7, 2004, Larry stated, "I am still waiting for information from the CAIC on the GPS locations of the better quality ski area data sites. Knox tells me that it will be available over the Web shortly." Ray, are you checking for these data on the CAIC Web site?

Action item 1.4 – List of observation sites: Data will come from SNOTEL, snow course, NWS climate and cooperative sites, and State CoCoRaHS sites. Make sure we don't have too much data on the map. In emails between Ray and Larry on January 7, 2004, Larry ended with the following note of concern:

> "It is beginning to sound like the number of observation site of different types will get to the point of totally cluttering the map at the scale it is currently OR will all this location data be under the analysis? Maybe keeping the present locators on this more operational map would be the best and when you do all the data analysis for the selected days you would create a special map for those occasions. OR maybe I am not seeing it the same way you are??"

RAMS grid incorporated into GIS – Ross needs latitude/longitude file of RAMS grid (corners OK) for each 3-km grid point (Ray said that there were 98 x 98 grid points). An email from Greg Bryant (Denver Water) to Joe Busto dated January 12, 2004 included the following: " it appears from Larry's email dated 12/24/03 talks about "slight difference" between the target area polygons he had Denver Water develop and the one Ross Williams developed, that in his mind the target area may still be under development. We should discuss which existing polygon to use." **Is this a problem?**

Action item 1.5 - In an email from Ross to Curt/Joe dated January 10, 2004, Ross stated that he still has the following needs:

> "1) The correct locations in latitude / longitude of the cloud seeding generators being used only in this study, and as updated through coordination between Larry and Greg Bryant of the Denver Water Board. **There appears to be some miscommunication between groups, as my generator sites do not match those I believe are being used solely for this study.**
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> 2) The correct locations in latitude / longitude of the SNOTEL and snow course sites being used in this study. Joe had asked me to do some looking for these sites, but a busy school and work schedule has kept me from this. **I ask that this information come from the person in this study who is responsible for collecting the SNOTEL and snow course data.** That person should have a comprehensive list of these sites.
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> 3) If they are being utilized in the study, the correct locations in latitude / longitude of any **NWS cooperative stations** (like Leadville, Hartsel, Dillon, etc) being used for extra data collection. **I have EarthInfo NCDC station data if only the names of the stations can be provided - I can find the rest.**
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> 4) Ray, at CSU, sent me the corner coordinates of the final RAMS grid being used for final results in this study. **I have tried to convert these coordinates into a replica of the RAMS grid, but the results are less than satisfactory.** I need to talk one-on-one with Ray to let him know just what it is I need in order for the GIS replica to look right. There appears to be some miscommunication between us as to just what it is that I need.
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> Greg Bryant and I discussed many of these issues 12/09/03 on the phone and via e-mail. He, like I, recognizes the need for completed and up-to-date records of all the different aspects of this project. He has been working with Larry to get the generator sites up to date, but the rest of the necessary data must come from the study team at this time. I am pleased that my new GIS model of the target area has been adopted for this study. It took a lot of time and effort to research and create it, so it looks like my efforts paid off. I am also personally pleased with the terrain grid I have made for the base maps. It is made using 30-meter DEM data and is the largest I have made to date.
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> I don't mean to sound difficult at this time, but I have asked for these items in the past with little or no response to my requests. I know everyone is very busy with work, home, the holidays, etc, but **I think the data I am asking for could be gathered, edited, and sent to the team members with not a lot of effort. Once these items are in my possession, I should be able to put together a very nice GIS for use in the remainder of this study**

and in the final report. When other results are available from CSU, I would like to include those in the GIS as well. I think output grids from the RAMS model can be formatted as ASCII files, which I can import into the GIS."

The above issues raised by Ross need to be discussed during our January 14th conference call.

Task 2 – ***Implement algorithms simulating cloud seeding generators as sources of IFN at specified ground-based sites.***

Gustavo and Ray were going to do a test run of RAMS, viz. the 3-d case from February 4, 2003. There were uncertain about what generator locations should be used. Larry will communicate with Ray and provide needed clarifications.

Action item 2.1 – At the time of the conference call, this was still to be completed. On December 16th after the conference call, Ray sent an email to Larry with two Excel files attached (list of 55 sites with ID, lat, lon, & elev; and the WWC operations report for this storm). Ray asked a couple of questions in his email. I did not see a reply from Larry to this email. What is the status of this task?

Task 3 - *Perform simulations of Lagrangian transport of seeding materials on selected days covering a range of wind and stability regimes.*

Larry also wanted to go further upstream and include upper-air sounding data from Tucson, AZ, Boise, ID, Elko and Las Vegas, NV.

Action item 3.1 - CSU project web site being built probably in January and will archive all data and model runs for the project. Any meteorological or created information for the weather or for seeding will be archived there. Larry puts together a list of everything that he uses and gives to Ray.

Quality Control - NRCS SNOTEL and snow course data: Mike Gillespie from NRCS said that there was about a one-week delay before the initial quality control.

Action item 3.2 – NRCS data collection and archiving: Ray will download selected SNOTEL and snow course data from the NRCS web site and add to our project web site.

Langranian Analyses – This task involves selecting meteorological regimes that impact the transport and dispersion of seeding material, and identifying case study days that represent those regimes. The analyses will be for selected days and selected generator sites for various observed wind and stability regimes during operational cloud seeding periods.

Action item 3.3 - Larry and Ray should start identifying the meteorological regimes and picking out case study days for possible use in the study.

Task 4 – *Perform forecasts for seeded and non-seeded days.*

Real time runs - Starting the evening of December 1, 2003, CSU switched the real time 00z forecast cycle from the faster cluster to a slower one. This was due to an impending deadline of another research project that required the greater memory and processing speed of the faster cluster. It looks like no/minimal snow in the mountains this week, so we hope this doesn't adversely effect Larry's seeding operations. The forecast products should still get to the web page (but at a 3x slower rate than usual), and the model output will be archived as usual -- we expect that there will be no interruption of the daily real time/no-seed/control runs in whatever period remains before the new cluster is ready.

Need model output faster. When do you anticipate high speed runs using new clusters? Bill Cotton – technical problem computers will not be in before end of year. Other project will be winding down in next week or two. Switch back to faster computer cluster in early January. Is someone coming in on Saturdays to input 00Z data? Will it be 7 days a week? Every day the RAMS model has been running and has been archiving the data, with automatic refresh from our web people. Ray – understand that there are some problems with our end. Only noticed it onetime when it was a tough forecast.

How did this effect WWC seeding operations? In an email to CSU dated January 7, 2004, Larry asked, "When are you planning on returning to the fast data runs on the 00Z data? When I need data in the evening following the input of the new 00Z info, I can't get any meaningful data until the next morning, which doesn't help for the night's operations. I usually am forced to use the NOAA ETA Model data when yours isn't available or current." Ray responded stating, "The fast cluster has been in critical, almost non-stop use for 2 other projects since early December. That work is finishing up this week, and I plan to switch the real time 00Z runs back to that cluster this weekend, beginning with Sunday night's run at the latest. **The real time runs should continue on this fast cluster until the project's new cluster is ready to go (hopefully by about Feb 1), when we'll begin using it for both the real time runs and the seeding runs."**

The RAMS 00Z real time forecast runs were subsequently switch back to the faster cluster effective the evening of January 10, 2004.

Action item 4.1 - January 10 - February 10 will be high-speed 00Z runs on a real time basis. A full month will still be a good test. If we try for that it will be acceptable. Larry needs to make good daily notes during this period of how he is using the RAMS data in WWC's cloud seeding decision making.

Action item 4.2 – In January, Larry/WWC should provide a list containing all generator operation information to-date (dates, times, rates by site) to the CWCB, CSU and Curt/project coordinator. It is understood that these monthly lists could include some estimates due to generator operators not submitting their operations logs to WWC in a timely manner.

Task 5 – ***Perform evaluations of model predictions of precipitation using MRBP.***

Action item 5.1 - Gustavo, Ray, Paul, Larry and others collaborate on precipitation sites; narrow it down to specific sites. Some of these were also talked about in Task 1.

Task 6 – ***Research study supervision and reports.***

Quarterly Progress Reports - The first quarterly technical progress report is due to Reclamation during early February, 2004. The solicitation states the requirement as follows:

Section B.2.1 Quarterly Technical Progress Reports

The Recipient shall provide three (3) quarterly progress reports. These reports shall be submitted within 30 days following the last day of the 3rd, 6th, and 9th month after award of this agreement. Quarterly technical progress reports shall be letter-style reports. They shall include a narrative summary both of completed activities and activities in progress, a calculation of percent of completed work based on work identified in the RWP, the reason for slippage if objections or milestones are not met, a prediction of future activities and how they will be accomplished, and a discussion of issues and problems which may impact the ability to complete the work on time or within budget. Recommendations to overcome problems shall also be provided.

Section C.6.2 Program Performance Reports

(a) Interim Reports – Recipients shall submit an original and two copies of program reports on a quarterly basis within 30 days following the end of the reporting period. Program performance reports shall contain the following:

(i) A comparison of actual accomplishments with the goals and objectives established for the reporting period;

(ii) Where project output can be quantified, a computation of the cost per unit of output;

(iii)When appropriate, reasons why goals and objectives were not met; and

(iv) Other pertinent information, when appropriate, analysis and explanation of cost overruns or high unit costs.

Action item 6.1 - The CSU-CWCB contract requires a draft of this technical progress report to be prepared and submitted to Curt/Joe for review by January 31, 2004. However, it would be good if an outline for the technical progress report was submitted by Friday, January 23, 2004.

Action item 6.2 – Larry should draft text on how WWC has used the RAMS daily forecast runs in their operational cloud seeding decision making, and email to project team by January 23, 2004.

Action item 6.3 – Ross should draft a summary on the GIS development, and email to project team by January 23, 2004.

Denver Water's and the Central Rockies Cloud Seeding Program - Vail ends on the January. 10th middle park – Blue River, Williams fork ends 10th of February, south park area end the march 31st. This year approaching 40% over in these estimates. Denver is more worried that they are over. The pressure will be on Denver Water by end of February then will make a decision. Going on the concept of fixed price contract. Middle Park ending early. Denver water has shortened its

cloud seeding season so it's essential to have good forecast runs by mid-January through mid-February for this study.

NPR Cloud Seeding Story - Action item for Joe Busto find the NPR numerical cloud seeding group. Story was emailed to the group by Joe Busto 12/22/03.

Mid-project meeting at CSU - Dates to propose mid-project meeting to the USBR - February 11th Wednesday, and February 18th Wednesday. **Curt emailed Reclamation 12/16/03. The mid-project meeting was subsequently scheduled to be held at the CSU facility on Thursday, February 19, 2004, starting around 10:30 AM.**

Next Project Meeting (conference call) – Wednesday, January 14th @ 10:00 AM.