"Lessons Learned"

7/3/2007

- This list is provided as a guide to ASP scientists getting ready to go in the field. It is simply a list of things that were done right before and during CHAPS, things we might have done better and a wish list of things to address in future campaigns. It was prepared on the last day of the campaign during an informal and free wheeling discussion in the television room of Greenwood Aviation in Ponca City, Oklahoma. It is not a polished document and readers will find some redundancy. Additional modifications were made based on e-mail correspondence with those involved and more revisions are expected as we have further reflection on the campaign.
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1. The Science Plan should contain a Plan "C" for uncooperative weather. The CHAPS plan had a plan "B," for clear conditions, but we did not anticipate the record setting precipitation during this campaign.
2. All instruments to fly on the campaign should be fully tested and operational on the G-1 prior to the arrival of the G-1 in Ponca City. Although allowances can be made for "new" or "exploratory" measurements based on available resources and PI approval, such instruments must not interfere with meeting program goals. An "all on" flight during integration is essential to test for heat load, inter-instrument interferences and to refine operational procedures.
3. We were fortunate to have senior scientists acting as "data evaluators" during the first two weeks of the campaign and need to have such an individual for future ASP campaigns. This may not be the chief scientist or any of the PI's who, realistically, will be busy with flight planning and large-scale logistics. These individuals should also identify periods on each flight that were "interesting" so as to facilitate closer examination by the instrument mentors. A running chart of instrument/data status should be maintained (not just a list). Data availability and problem identification have improved over the years, but more improvement is needed.
4. The detailed checklists for recent campaigns have proven a boon, improving both operations and providing a record of operations beyond that stored in the data system. The G-1 operation has fewer operators doing more responsibilities than ever and these checklists have greatly helped in getting by with fewer people. We would like to see hard copies of these lists put into PDF format and permanently stored for easy access copies by PIs on the campaign.
5. Another thing done right…having an administrative support person was invaluable. This individual was our interface with the FBO, provided meals to the flight crew and ground crew when things got hectic, took care of office needs, took care of broken fax machines, helped with shipping, helped with receiving orders…etc. Having an admin to support the campaign freed up time for the scientific staff to focus on getting the science job done.
6. Another thing done right…having a computer support person onsite. We relied heavily on a network configuration to maintain communication between the ground crew and the flight crew during our airborne missions, and to communicate with each other when everybody was on the ground. A person knowledgeable about both workstations and networks was essential to keep the program moving forward towards its scientific goals.
7. Although a webpage, an ftp site, and cell phone communication were used, there was still room for improvement in communication. The distribution of M300 files has never been better (a success story that keeps getting better thanks to hard work from all). Once operational (it took a

while…) the ftp site was ideal for data exchange between PIs. In the future we want to set up these electronic resources prior to deployment; doing so will save energy and frustration in the field. The E-mail traffic during the CLASIC/CHAPS campaign sometimes got overwhelming and we may have been able to make better use of regular web page postings.

8. Even with the increased efficiency of the G-1 crew, we would like to have more staff for both the day-to-day operations of the G-1 while in the field, and during the preparation stage of the G-1 (and associated instruments) prior to deployment in the field. Our G-1 crew, separate from the pilots, consisted of two people who served in the role of instrument mentors, ground support, flight scientist, and flight engineer. No other research aircraft operation has this slim a team to support an operation the size of the G-1.
9. The M300 data collection system was used more extensively than ever, but has even more potential since even near the end of the CHAPS program, not all the data sources were integrated. Working to get all data streams onto the M300 requires considerable setup work but yields big benefits. The data system, being as important as it is, must have adequate resources dedicated to it, including collaborative planning and programming/testing prior to field deployment.
10. We had a conspicuous gap in the size range of particles coming through the CVI inlet (too high) and the isokinetic inlet (too small) that precludes a large number of important size particles from being sampled by the AMS. We'd like to have resources to close this gap between the inlets and also to install an optical particle counter on the isokinetic inlet.
11. On the topic of inlets, it was found in the field that the pressure in the isokinetic inlet was higher than the static pressure…this issue needs to be resolved.
12. We were worried about the high rate of sampling needed to capture information on individual clouds and would therefore like to have had all instruments on the G-1 sampling at 10Hz (or faster).
13. We had two people in the field during the first two weeks to deploy and monitor the AMS and PTR-MS. This worked great when both were there. It was hard to keep both working and to check on the data when only one person was available in the field.
14. Tracking the position of the G-1 via the Iridium satellite down-link was terrific but we would like to extend this capability to tracking not only the position of the G-1 but to also having the capability to transmit key measurements such as onboard winds, CO, or PCASP total number. However, given the small bandwidth available to us, we would want to consider sequencing the transmissions so, for example, we'd get one second to transmit G-1 coordinates, a second to transmit parameter x, a third second to transmit parameter y, and then cycle through again starting with coordinates.
15. Another plus for the campaign was using instant messaging for communications between the surface and the G-1. This was invaluable to convey such critical information to the flight crew as METAR information, updates on weather radar and profiler data, etc. However, it was very unreliable. We want to find a better means of communication between the ground and G-1 team. It was also noted that the satellite communication station must be physically separated from M300 to avoid congestion.
16. Heating continues to be an issue on the G-1. We would like to find a way to use the G-1 air conditioning unit to cool the plane while on the ground rather than use the external AC unit presently so as to get a better idea of how efficient the cooling would actually be when airborne (we think the external unit masked many of the problems encountered aloft). Heat was noted in the A-Panel (?) during flight and we'd like to identify this source and find a remedy for its cause. If resources were available, we'd also like to install a semi-permanent heat monitoring panel with multiple sensors (for racks, motors, instruments, AC in, AC out. This idea came up in the cabin when temperatures approaching 98°F were noted during the days without clouds (few and far between during CHAPS, but a more likely occurrence in future ASP campaigns!). Such high

temperatures compromise instrument performance and reduce operator effectiveness. Along these same lines, it was noted that the G-1 facility would benefit from a study to determine:

1) Power availability (total watts, watts during shore power, taxi and in-flight, Panel A, B, C and 28 V-DC, phase lag tolerance, in-rush capability for motor starting as well as spike/lag monitoring/recording) and
2) Heat load versus temperature rise under conditions of a) ground operation with AC, b) taxi with/without AC, c) in-flight pressurized/unpressurized.

17. More on heating problems…we would like to quantitatively determine how much net cooling can be provided by the G-1 air conditioner and evaluate the extent to which the heat problem is due to the science package relative to heat generated by G-1 equipment. Another area in the cabin that is always a heat producer is the radio-rack, which gets quite warm. It may be possible to empirically quantify the heat problem through a ground experiment in which resistive radiators are deployed throughout the cabin.
18. The G-1 team would like to redesign and modify the power distribution/switching system, replacing the G-1 power outlet boxes with units that have real-time current and power factor monitoring and recording by computer. There are unused sections in Panels A, B and C that could potentially be made smaller and lighter and easier to operate. We currently have four inverters, each on 110 and 220 VAC, and it is not clear that this is the best configuration. Perhaps two busses to split the load between large motors and electronics would be better.
19. When worrying about the heating problems during CHAPS it was noted that the PTRMS uses a heavy, hot transformer to go from 220 to 110 prior to its UPS. In retrospect, we would like to have replaced this old transformer with a new UPS that would directly take 220 and provide 110.
20. It was realized, after set up that we have a proliferation of UPS. There were UPS units on the PTRMS, AMS, CVI (?), and M300, each one being heavy, generating heat and taking up space. We would like to have had a central UPS (located out of the way of foot traffic within the cabin) with computer-controlled switching of outlets for graceful shutdown of individual systems?
21. Based on this campaign and campaigns in the past, it was again suggested that we move all the pumps to the back of the G-1 and have one (or more) manifolds into which all of the instruments could be connected. Different pumps (and manifolds) would draw different levels of flow. This is attractive ONLY if the rear compartment could be thermally isolated and conductive losses through the long tubes are minimal. It is not practical for all systems but could possibly be useful for some pumps. Proper sizing of pumps, using the lightest, most efficient pumps would be essential for this work. The strategy of using whatever is available doesn't serve us well. Also, all large pumps should have a mechanism to shed their heat load to the outside (whether we're flying pressurized or not). Operation on the ground and particularly during taxi should be minimized whenever possible. An electrical engineer should be consulted about motor sizing and startup currents, particularly the effect on the inverters and ramifications for other instrument computers.
22. Instrument mentors, especially those flying for the first time, should bring a plethora of spare parts for critical components that are most likely to fail and that cannot be acquired in the field. If in doubt, bring it out!
23. Can we consolidate laptops onboard the G-1? There were 9 or 10 during the campaign, each using 50-100 W, all of which contributed to the G-1 power and heat load issues. Future campaigns look for ways to combine computer operations and to use the smallest embedded computers available.
24. Our data systems (the M300 and the CVI computers) were reliable and crash-free (yes!!) but it would have been nice to see all computers having fully cloned hard drives for rapid recovery in case of crashes. Hard drives are low cost items and cloning software rapid. A true computer failure would be catastrophic.
25. The G-1 instruments have never done better at achieving time synchronization to an accurate standard. Most clocks were accurate to $\pm$~1 s. But as ASP moves into more precision measurements where timing is critical we'd like to see the standard move to $<\pm$ 0.1 s.

26. Kudos to the secretaries and admins who developed the personnel contact sheet …it was invaluable.
27. A concern about field logistics…we had to be split up during CHAPS but a central office would have greatly facilitated all communication. As with any other field campaign, security in the offices were a concern although, fortunately, we did not have any thefts this time). Staff should be reminded to bring cable locks for their laptops, clones of hard drives, remote backups/storage, etc. All would guarantee against theft, crashes, and other loss of data.
28. Although it was not an issue on this trip, future operations (in foreign countries) have some staff concerned about material and personal security.
29. Administrative headaches with computer data security–centrally mandated security practices are coming on line in the national laboratories and other organizations. Among field scientists there was a universal complaint as to the inappropriateness and counter-productivity of many policies that really don't apply to us. Hard drive encryption, frustratingly frequent password-protected screen savers, firewall obstacles to central facilities, single-user-only computer logons were all commonly voiced complaints. While certainly a much bigger issue than the G-1, local efforts are recommended to have field laptops that do not contain classified or personal information recategorized as "science only" computers exempted from the more onerous security "features."
30. The frequent safety reminders at the preflight meetings were brief and appreciated. It was also appreciated that these meetings were succinct and informative. It was thought entirely appropriate to remind staff that fatigue and driving are the greatest hazards in the field. Future campaigns should look for ways to control these hazards. One situation imposed on the CHAPS campaign that was frustrating, but probably helpful in the long run, was that access to the G-1 was limited from 07:00 to 19:00 on most days. In spite of our initial reservations, this schedule seemed to promote more productivity and helped safety by making it harder for staff to work more than 12-hour days. Congestion in the cabin during ground operations was well managed and should be encouraged in future campaigns. The cooperation between researchers is a real strength of the ASP field crew.