MAGIC

2013-11-01 update

A newsletter for non-scientists (and scientists) interested in MAGIC

MAGIC is a field program funded and operated by the Atmospheric Radiation Measurement (ARM) Climate Research Facility of the U.S. Department of Energy. The ARM MAGIC webpage is http://www.arm.gov/sites/amf/mag.
All previous updates and other MAGIC information can be found at http://www.bnl.gov/envsci/ARM/MAGIC/.

The measurement aspect of MAGIC is completed, and there are nearly 200 days of data that await analysis (and hopefully contain many surprises–good ones, of course). Next week is the Atmospheric System Research (ASR) Fall Working Group Meeting, during which there will be a session with several scientists presenting preliminary analyses of MAGIC data. According to the ASR website, the U.S. Department of Energy's Atmospheric System Research Program is "an observation-based research program created to advance process-level understanding of the key interactions among aerosols, clouds, precipitation, radiation, dynamics, and thermodynamics, with the ultimate goal of reducing the uncertainty in global and regional climate simulations and projections." ASR is a companion to ARM: ARM makes the measurements (ARM deployed the instruments on MAGIC), and ASR funds the science research that will be based on these measurements (that's the "observation-based" part of the description). The goals of ASR: to understand, at a fundamental level, "aerosols, clouds, precipitation, radiation [referring to light, not radioactivity]," and some physics ("dynamics and thermodynamics") of the interactions among these, are remarkably similar to those of MAGIC (actually, those of MAGIC are similar to those of ASR).

At the MAGIC session, I will give a brief overview of the campaign, summarizing some of the statistics (nearly 200 days at sea, more than 550 successful balloon launch attempts–a success rate greater than 80%, etc.), highlighting synergistic activities (aerosol sampling by two different groups, other instruments that were deployed from other agencies, etc.), and discussing future plans. After this there are six other speakers, followed by a discussion. Unfortunately the time for each talk is extremely short–only ten minutes, so the presentations will be but a brief summary of the work these investigators have done.

The first presentation is by Xiaoli Zhou, a graduate student at McGill University in Montreal, entitled "Marine Boundary Layer Cloud Observations using AMF2 during MAGIC" (recall that AMF2 is the Second ARM Mobile Facility, which is the suite of instruments that was deployed). Xiaoli will give a summary of the variability and frequency of occurrence of different cloud types and precipitation events on each leg of MAGIC, based on an analysis scheme to identify these different cloud types. The next presentation is by Courtney Laughlin, a graduate student at Penn State, entitled "Retrieving Liquid Water Contents of Boundary-Layer Clouds at MAGIC using Dual-frequency Cloud Radars." There were two cloud radars operating during MAGIC: a W-band radar and a Ka-band radar. Different radar bands (as I'm sure you recall from previous updates) mean different frequencies, or wavelengths, at which the radars transmit and receive energy. These different frequencies, which can be thought of as different "colors" (although they are outside the range our eyes can detect), are attenuated differently in clouds, and these differences can be used to estimate how much water is in the clouds (i.e., how wet they are).

Ed Eloranta of the University of Wisconsin will give the next presentation, entitled "HSRL-KAZR Retrievals of Liquid Water, Particle Size, and Precipitation during MAGIC." The HSRL is the **H**igh **S**pectral **R**esolution **L**idar, and a lidar is like a radar except that it uses visible light instead of radio waves. The KAZR is the **K**a-band **A**RM **Z**enith **R**adar, one of the two cloud radars deployed during MAGIC (the "Z," for "zenith," means that it is pointing vertically, as opposed to scanning, as some radars do). Similar to the previous presentation, the combination of the HSRL and the KAZR allows observation of the clouds with two different frequencies, and as these two "colors" see clouds differently, these differences allow retrieval (i.e., determination) of the amount of liquid water in the clouds, how big the cloud drops are, and also some information about the precipitation.

The next presentation is by Patrick McBride, a postdoctoral researcher at NASA, entitled "Cloud Observations during MAGIC with the Solar Spectral Flux Radiometer (SSFR)." The SSFR is a NASA instrument that was deployed during MAGIC this summer. The "spectral" means that observations were made at a range of frequencies, and the "solar" means that these frequencies encompass the range that our eyes can detect (and a bit beyond). There is a common theme in the last several presentations: the use of multiple frequencies ("colors") to look at clouds. Just as more information can be obtained looking at a color photograph than from looking at a black-and-white one of the same scene, we can learn more about clouds by looking at them with a multitude of frequencies, which is why there were two radars, lidars, ceilometers (which use infra-red light), radiometers, and other instruments deployed during MAGIC.

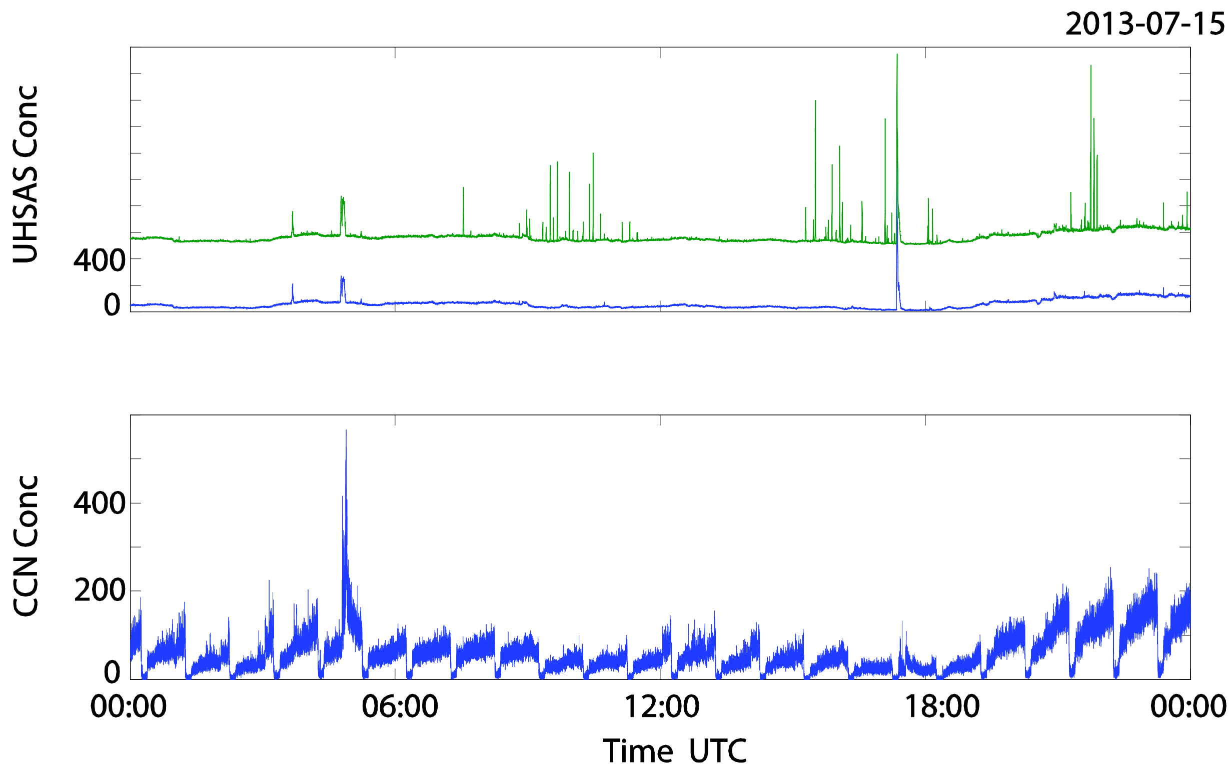
Rob Wood of the University of Washington, also a member of the MAGIC Science Team, will discuss "Cloud System Evolution in the Trades (CSET)." The "trades" (as in "trade winds") refer to a region near the tropics, and includes the MAGIC route (the term "trade" is from the Middle English and refers to "consistent," not the fact that sailing ships employed in trading have used the trade winds for centuries). CSET is a field program that Rob is leading that will involve flying a research aircraft equipped with a radar and a lidar between California and Hawaii to observe the same cloud system that MAGIC was investigating. This looks like an exciting program, and will complement the measurements made during MAGIC by looking at the clouds from above.

The final presentation is by Mary Jane Bartholomew of Brookhaven National Laboratory, entitled "MAGIC Data Needs and Desires," followed by a discussion on future plans and further data processing requirements. Mary Jane will be working on calculating so-called "data products" that might be of interest to a number of investigators, the idea being that rather than have different people reinvent the wheel several times over (and sometimes with different results), it is advantageous to have these products produced "officially" and made available to all. While many of the investigators are in the same place and thinking about MAGIC is a great time to decide needs and priorities for these types of products.

One example of a data product is the position (latitude and longitude) of the ship as a function of time. Data from all the instruments are labeled by date and time, but as MAGIC was not a fixed site but rather a mobile one, it is also necessary to know *where* the measurements were taken in addition to *when* they were taken. Another example is corrections for ship motion; i.e., how far off the vertical were the instruments pointing when the ship rolled. This would be of interest to any vertically pointing instrument, including radars, lidars, ceilometers, radiometers, and others.

Another example is one developed by Gunnar Senum, whom I've mentioned before in these updates. As Gunnar has the office next to me, he sometimes has difficulty escaping my numerous questions and suggestions, but he's been great to work with and made some wonderful plots for me, like the one below. The green line shows one day's worth of the number concentration (the number of aerosol particles in a given volume of air) measured by the UHSAS, which is an instrument that counts these particles. There are many spikes in the data, which means that the concentration (or abundance) of aerosol particles took on high values for very short times. These spikes are almost certainly the result of encountering exhaust plumes from other ships. While these may be of interest to some investigators, others may want to see only the background aerosol, so Gunnar came up with a clever way to remove most of the spikes. The values that result after Gunnar's reprocessing are shown in blue (the green and the blue are offset to aid visualization).

It can be seen that this technique removed most of the spikes, but there are still a few that remain. However, those that remain appear to be a bit wider, meaning that they extended over longer times, which in turn means that the plumes had more time to spread out, and that the aerosol particles in these plumes were in the atmosphere longer. Continuing along this line of thought, if the particles were in the atmosphere longer, they had more time to undergo chemical reactions and absorb gases that would make them more likely to form cloud drops. The bottom panel in the figure shows the concentration measured by the CCN, an instrument that determines how easily the particles form cloud drops (the upward-sloping lines are intrinsic in the operation of the instrument). Although the correspondence isn't perfect, the large spike at ~05:00 in the bottom panel lines up with the one in the top panel, and it appears that the spike near 18:00 might be visible also, providing evidence that the remaining spikes are indeed "aged" plumes. Other instruments besides the CCN can also be included in this analysis, but that will have to be a topic for future updates.



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