MAGIC

2013-03-14

It's been nearly two months since we removed the AMF2 containing our instruments from the Horizon *Spirit* before it left for dry dock, but somehow we've managed to remain busy during this time (funny how it always works that way!). Nicki and Mike, the Argonne team in charge of AMF2, went to Finland (where AMF2 will go after MAGIC) to look over the site and determine all the logistical stuff that is required (and at which they are so good) for this next deployment: power, space, lodging for technicians, import/export issues, etc. The technicians have been in Los Angeles at the warehouse cleaning, calibrating, and refurbishing instruments so that they will be ready when we re-install AMF2 on the *Spirit* upon its return. Mike Reynolds is at his home in Seattle repairing, calibrating, and updating meteorological and radiation instruments (and a few others), in addition to handling my email requests for information, data, advice, etc. I have been here in the office catching up on the non-MAGIC aspects of my job, as well as preparing for a conference next week. This will be the first opportunity to present MAGIC data to investigators sponsored by the U.S. Department of Energy's Atmospheric System Research Program, whose mission is to use data obtained by the ARM Climate Research Facility (who own and operate AMF2 and other facilities) to study climate.

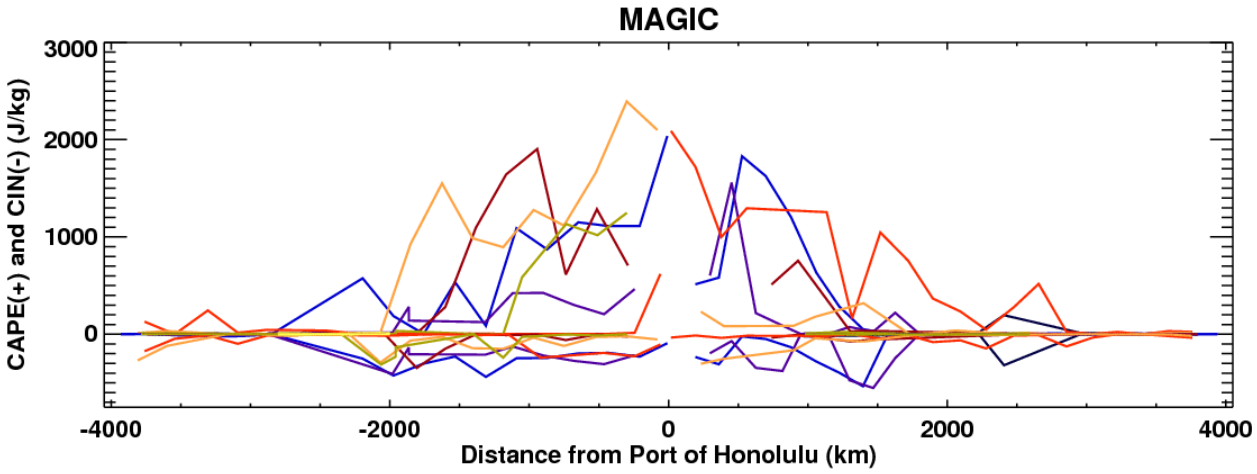
The conference lasts Monday through Thursday and is organized into three broad areas: aerosols, clouds, and aerosol-cloud interactions. As you may recall from the 2012-01-20 MAGIC update (and if not, all previous updates are available on the website listed at the bottom of the page), every cloud drop forms around an aerosol particle, which is any microscopic particle in the atmosphere (such as a small seawater drop that was injected into the atmosphere from a breaking wave). Among the major goals of MAGIC is to measure properties of clouds and aerosols, so MAGIC fits into all three areas. The conference is packed, with sessions scheduled from 8:00 am continuously to 8:30 pm (and conversations, collaborations, and discussions occurring after that time), and there is often more than one session running concurrently, meaning that I won't get to attend all the interesting sessions I would like. I am leading a session on MAGIC, which I'm sure will be well attended (as there is great interest in this project within the DOE community), but one of the challenging aspects of this is the time allotted for presentations. The session is 90 minutes, and after a 15-20 minute presentation by me on an overview of MAGIC, its current status, and future plans (which I will discuss in a future update), there are 7 other speakers–that's about 10 minutes per

presentation. Imagine telling a scientist who has been working on what he/she thinks is very exciting stuff for months and finally has a chance to present results to colleagues that he/she has only 10 minutes. Each presentation could easily go an hour or more. Unfortunately, I don't know a way around this; there's just too much interesting science to cover all of it in one week.

As an aside, I find the phrase "he/she" a bit awkward, but there isn't really an alternative. Of the seven others (besides myself) who are presenting during the MAGIC session, three are women–I think that's a pretty good ratio. Another item to report: we have two undergraduate students who will be working on MAGIC data while doing an internship here at Brookhaven National Laboratory this summer, and they are both female. Also, both of them grew up near the lab here on Long Island. We're excited to have them in the program, and I will write more about them in future updates.

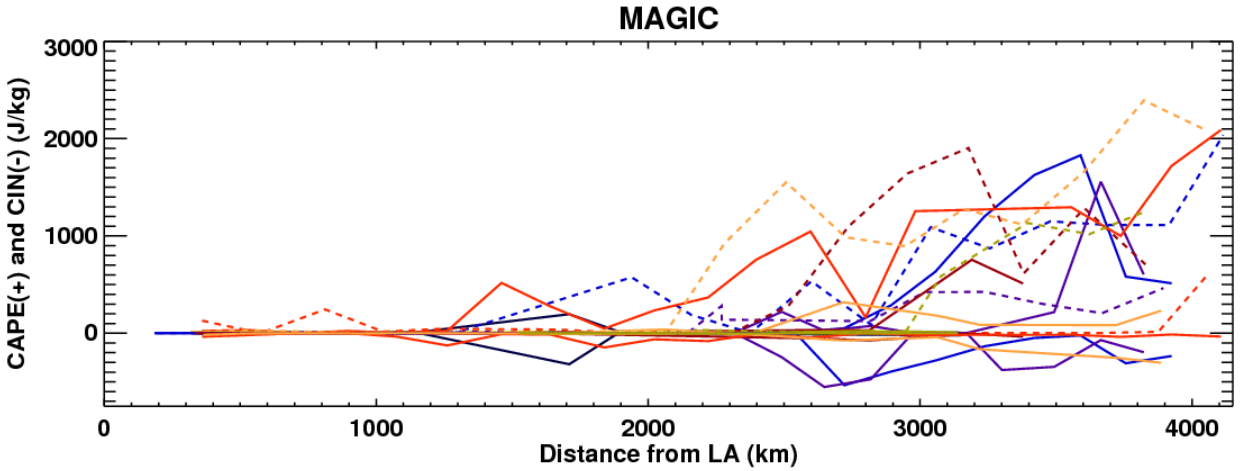
The means of graphing scientific data can be very important in assisting an investigator to find patterns, trends, anomalies, etc. I was trying to envision the best way to present MAGIC data, and the evolution of my thought process is the topic of this update. MAGIC has completed 9 legs (round trips between Los Angeles and Hawaii), and we have data from most instruments on most of these legs. It would be preferable to all data for a given quantity from all legs on a single graph (if possible), as this will allow for visualization of how the quantity under consideration varies between Los Angeles and Honolulu and also the amount of variability in this quantity from one leg to the next. This latter aspect highlights the difference between weather and climate (discussed in the 2011-11-22 update): to what extent are the values we measured what normally occurs as opposed to just what happened at that time? Obviously some data such as radar reflectivity (as shown in the graphs in the 2013-01-07 update) cannot be easily plotted this way, as there is too much information; i.e., these are three-dimensional data (distance, height, and reflectivity value). However, two-dimensional data–those quantities for which a measurement yields a single value at any one time or location (such as pressure, number concentration, or cloud height)–are well suited to this type of presentation.

There are various ways to uniquely identify when/where a measurement was taken during a MAGIC leg: date and time, distance from Los Angeles (or Honolulu), latitude, or longitude are all possibilities. For some quantities that have a large diurnal signal, such as solar intensity, time would be the best choice (see for instance the graphs of fluxes in the last update on 2013-02-19). However, as the main focus of MAGIC is the transition of cloud regimes that occurs between Los Angeles and Honolulu, some measure of distance would be best. My first thought was distance from Honolulu, such as shown in the figure below.

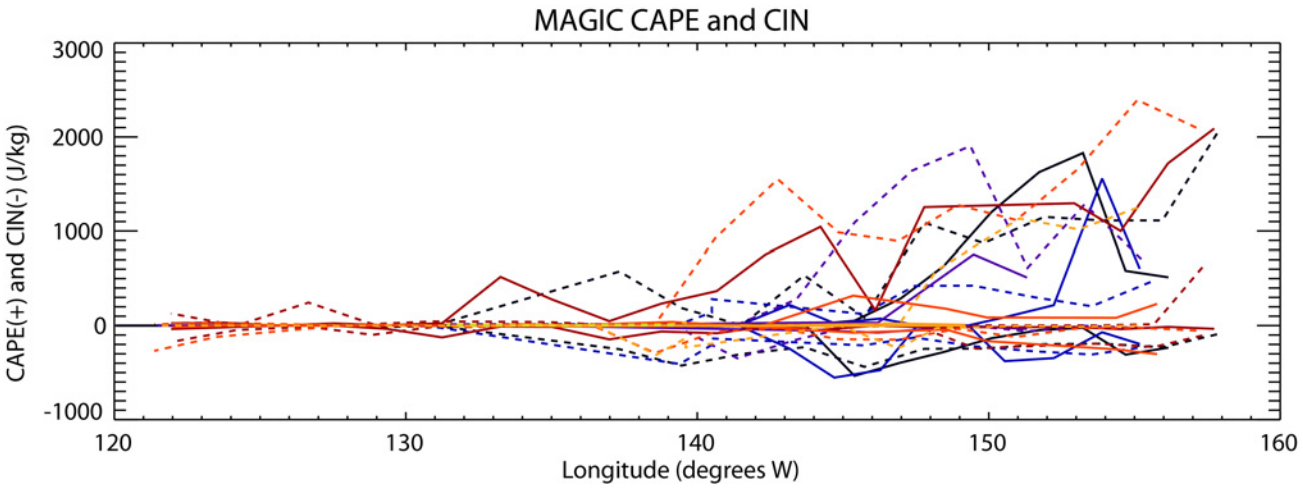


The quantity being plotted is CAPE (if it is positive) or CIN (if it is negative). The meaning of these quantities is a great topic for a future update, but for now I want to discuss only the means of presenting data, so I won't discuss what these are. The lower axis, going from left to right, corresponds to Los Angeles (near -4000 km), then Honolulu in the middle (at 0), then LA again on the right (near +4000 km). Each leg is shown in a different color, so each line corresponds to one round trip from Los Angeles to Honolulu and back. Thus, all CAPE and CIN data that have been measured so far during MAGIC are shown on this one graph. It can clearly be seen that CAPE is near zero for the first half of the way between Los Angeles and Honolulu, and then changes rather abruptly at around -2000 km and +2000 km. The variability from one leg to another is also evident.

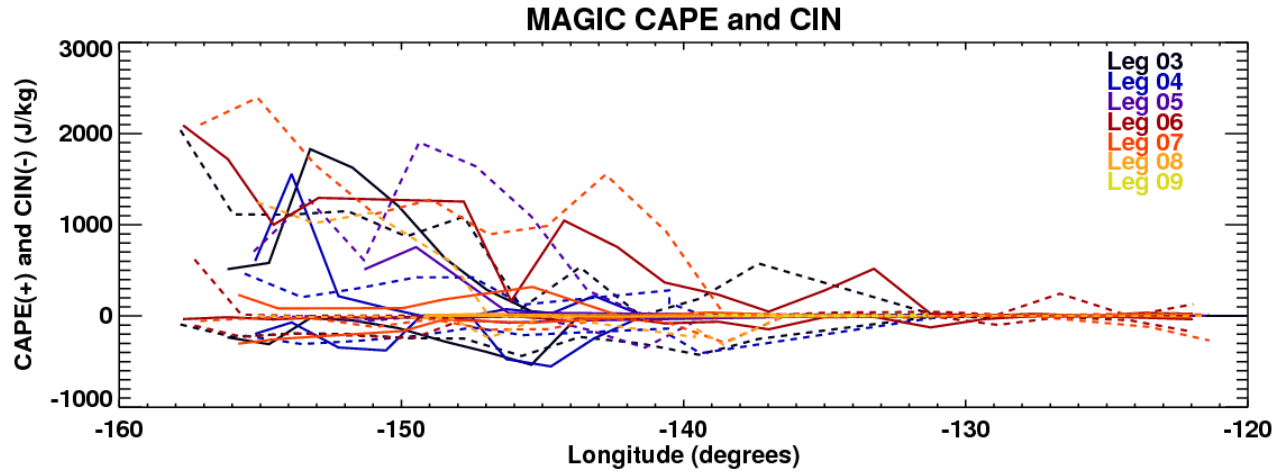
One of my colleagues pointed out that it would be better to have the graph folded so that the return legs overlaid the forward legs, as nature doesn't care which way we are traveling. The graph below shows data plotted in this manner. The lower axis is the distance from Los Angeles (Hawaii is on the right). Dashed lines refer to trips from LA to Hawaii, and solid lines are for the return.



This graph shows the same data and also displays the leg-to-leg variability, and I think it's better. However, upon further reflection it occurred to me that distance from LA, although a valid option, might not be the best one. The core measurements we have for each leg are date/time, latitude, and longitude, and computing the distance from from LA using lat/lon values requires an additional step. This is really unnecessary, and might be done differently by different investigators. Also, each additional step introduces the possibility of error. Both lat and lon change continuously in one direction on each trip, so either would work as a lower axis, but LA-Hawaii is more east-west than north-south, so longitude would be a better choice, as shown in the graph below.



This graph also contains the same data as the previous two. The lower axis goes from Los Angeles on the left (near 120°W longitude) to Hawaii on the right (near 160°W longitude). Although this graph is nearly there, it further dawned on me that it would be better if the lower axis were reversed, so that Los Angeles would be on the right and Hawaii would be on the left, similar to how these are located on a map. This would make it a bit easier to view the data and to think about how these data vary spatially. This is done in the graph below.



This last graph is the final version. The lower axis goes from Los Angeles on the right to Hawaii on the left; thus these are in the same relative positions as they would be on a map. There is clearly a transition that occurs about halfway between these two locations, with CAPE being much greater in the region nearer Hawaii than in the region nearer Los Angeles. The color scheme is also shown on the graph, and the axes are labeled (with units), the title is clear, etc. I give this one an A+!

On hindsight, making the graph in this way seems like an obvious choice, but like many things in science, this was an evolving process that entailed my own thought processes and discussions with others. To me, this latter aspect–the interactions with others–is one of the most enjoyable aspects of my involvement with MAGIC. I would especially like to thank Tami Toto for doing the data analysis and making the graphs, and especially for being so patient with my constant requests for revisions–thanks Tami!

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2013-03-14
Please address any questions or comments to elewis@bnl.gov.
All updates and other MAGIC information can be found at http://www.bnl.gov/envsci/ARM/MAGIC/.