MAGIC

2013-10-09 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/.

I leave shortly to catch my flight to Long Beach. The *Spirit* arrives in port tomorrow morning, and the AMF2 and all MAGIC instruments will be removed from the ship, taken to a warehouse, and prepared for their journey to Finland, where they will remain for most of 2014 for another field campaign. It's hard to believe that the measurement phase of MAGIC is completed – it seemed like just the other day when it all started. It's been an incredible ride, and it has succeeded beyond my wildest expectations. We've been incredibly fortunate in many ways. So far we've installed the instruments on the ship twice and removed them once, and we've been blessed with perfect weather each time. The forecast for the rest of the week is for sunny skies also, so our good fortune continues.

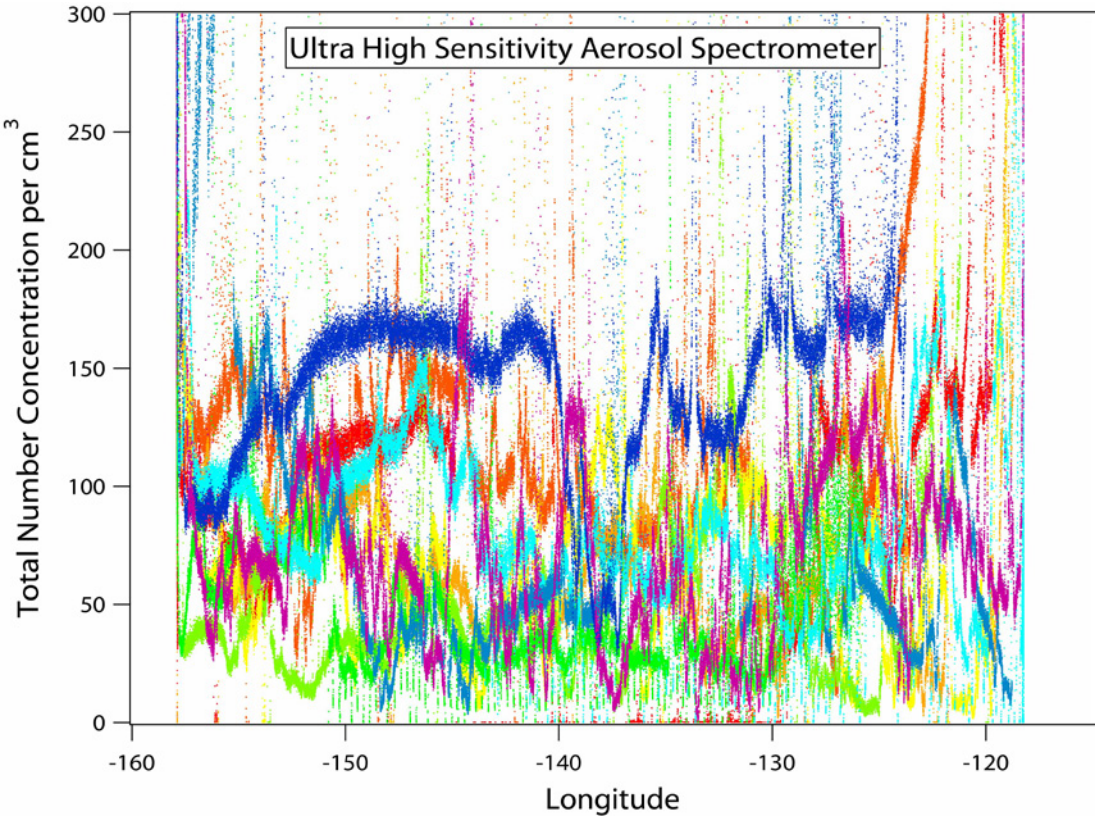

Mace Head, Ireland

Looking toward the east.

Now comes more fun – figuring out what we can learn from all the measurements we've taken over the last year. There are many people I know who have already started, or have expressed an interest in, working on MAGIC data, but there are many others who are probably not aware of all that MAGIC has to offer. I am doing all I can to remedy this situation. I was in Ireland last week at a conference on sea spray aerosol production, and I used the opportunity to discuss the MAGIC campaign and MAGIC

measurements, both of clouds and of aerosols. It was great to see colleagues with whom I had previously written papers on sea spray, and to meet others who are working on this topic. There was considerable interest from those in attendance on the MAGIC data I presented, and I look forward to collaborations based on these discussions. There was also a trip to Mace Head, an atmospheric research station on the coast about an hour from Galway. It's one of the few (if not the only) site that has long-term aerosol measurements that are predominantly of marine aerosol. As I had heard of Mace Head for many years and had used data from there, it was great to see it in person. The photographs above show some of the instruments, but there are also several buildings, radars, and other instruments that measure meteorological quantities and aerosol and gas properties.

The graph below gives one example of MAGIC aerosol data. Gunnar, in the office next to me, made this at my request – thanks Gunnar! This graph shows the number concentration of aerosol particles with optical diameter greater than 60 nanometers measured by the Ultra High Sensitivity Aerosol Spectrometer (UHSAS) on several legs of MAGIC, each transect from Los Angeles (near longitude -120) to Hawaii (near longitude -160) being shown in a different color. Don't worry, I'll translate all this below.




The UHSAS is an instrument that counts particles that pass through a laser beam and determines their diameter by how much light they scatter (large particles scatter more light). As the diameter is

determined by light scattering, it is termed the “optical diameter;” other instruments determine particle diameter by different techniques. Particles that are too small (diameter less than 60 nanometer, or roughly 1/1000 the diameter of a human hair) don’t scatter enough light to be detected. Thus, the value graphed is not really the “Total Number Concentration” (as stated on the left axis), but the number concentration of those particles with optical diameter greater than 60 nanometers. There are other particles too small for the UHSAS to detect but which can be detected by other instruments, and for MAGIC there were typically about half as many particles with diameters less than 60 nanometers as there were with diameters larger than this value. The number concentration is the number of particles in a given volume of air; for the units here, this volume is approximately equal to that of a sugar cube. Thus, the blue line, for instance, shows that in each volume of air the size of a sugar cube there are roughly 150 particles that are sufficiently large to scatter enough light to be detected by this instrument.

What do these data tell us as scientists? Several conclusions can be drawn from this graph. First, the magnitudes of the values are quite low – this is clean air! Concentrations range from 50 to around 150, whereas typical values for an urban area might be ten times as high. Secondly, there is much variability from one leg to the next (each color is a different trip). Third, there appears to be no definite longitudinal trend, as might be expected if the concentration were strongly controlled by factors like sea surface temperature or cloud cover that are expected to increase or decrease along the Los Angeles to Honolulu transect. There are other observations that can be made also. The large dips in the blue and purple lines near -140 degrees longitude, at which concentrations drop to very low values (10 to 40) are probably caused by precipitation, which removed particles from the atmosphere. This hypothesis could be checked by looking at results from other instruments such as the radars. There are also spikes in the data when large values occur for very short times. My hypothesis, shared by others with whom I have spoken, is that these are exhaust plumes from other ships. Comparison of data from some of the other aerosol instruments would assist in determining if this is correct. If it is, other interesting questions result. What is the fate of these particles? As their chemical composition is likely quite different from other aerosol particles, especially those produced from the ocean surface, how does this difference impact their ability to form cloud drops? Additionally, if these spikes result from ship tracks and individual spikes can be correlated with individual ships upwind, then this information might be used to determine atmospheric mixing rates (i.e., how do these plumes move and spread out as they are transported downwind), for instance.

As discussed last time, a major field of investigation for sea spray aerosol particles (i.e., those produced at the sea surface) is their production flux –how fast are they produced at the ocean surface, what are their sizes, and what factors determine the production rate of a given particle diameter? These are

very difficult questions, as what is measured is concentrations of all aerosol particles, which include not only sea spray particles but also particles transported from continents, those resulting from ship exhaust, etc. Additionally, concentrations are what result after the particles are produced, then transported, and removed along the way through clouds, precipitation, or falling out to the sea surface. Although concentrations don't directly provide answers to these questions on production, they do provide some information. For instance, knowledge of the number of particles in a given size range that are measured (i.e., the concentration), can be used to give an upper limit on how many particles are produced, and sometimes even this information is helpful.

MAGIC updates will continue, so until next time, when you stop and smell the roses, remember to look up and observe the clouds too!

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2013-10-09
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