MAGIC

2012-12-17

The Spirit left Los Angeles this last weekend and MAGIC is now into Leg08A. All three radars are up and running, and the other instruments are also continuing to acquire data. The techs are doing a wonderful job. Pat and Brett got off in LA last weekend, and Tom and Mark are now riding with the ship. With the large number of instruments we have there are a fair number of repairs (remember, most of the instruments are research grade and push the limits of what can be measured, and they are challenging to keep running well even under laboratory conditions), but all the guys have been extremely diligent in keeping the instruments running well, and they unfailingly do so in good cheer. I can't say enough good things about them. Tom and Mark will be on the ship over Christmas – I'm trying to think of what I can do for them.

The weather balloon launches are going well too. On Leg06, there were 38 successful launches out of 45 attempts, and on Leg07 there were 35 successful launches out of 48 attempts. Having seen the conditions under which launches occur, I think this is fantastic. When I look over the table to see why some of the attempts failed I see a common pattern – the vast majority of the unsuccessful launches were attempted when the relative wind speed was greater than 35 mph! What's more amazing is that the techs were able to achieve successful launches at relative wind speeds above 45 mph! It's not just the fact that the winds are high, there are structures all around so that the wind isn't steady, and there are containers looming very nearby ready to burst balloons or break our sensors. And, launches occur every 6 hours around the clock, so some of them are at night.

I've been to two conferences since the last update and I'm pleased to see the interest in MAGIC in the atmospheric science community. It's been great talking to everyone about MAGIC, and I've used the opportunity to learn more about a number of topics from the experts. As I'm not a cloud or radar person, or a climate modeler, I still have much to learn about all sorts of topics related to MAGIC, but it's been a fun process. It was also nice talking to non-scientific friends whom I saw before and after the conferences. Many wanted to know what great discoveries had been made so far, and what the measurements will tell us. Excellent questions both, which I will attempt to address.

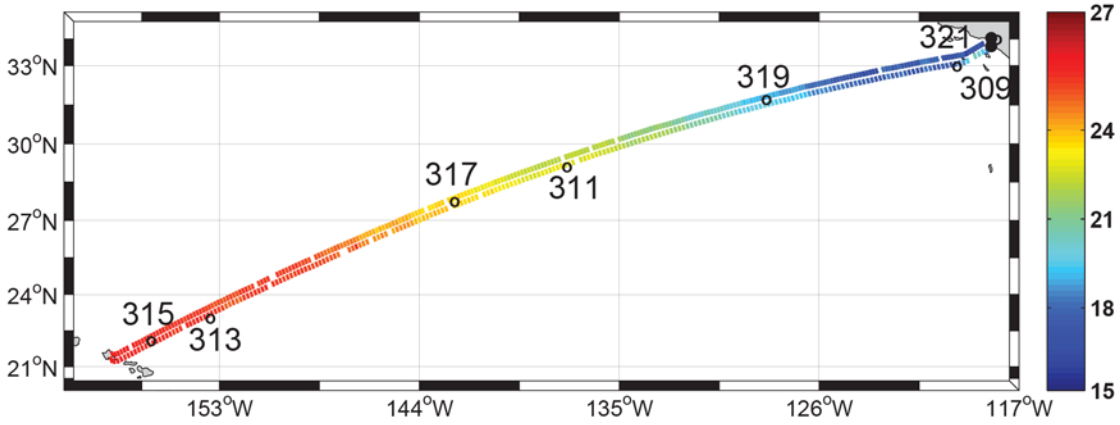
In a discussion with a colleague regarding MAGIC, she pointed out that different aspects of scientific research can be classified as either transformational and incremental. Transformational

science refers to those groundbreaking findings that change the way we see the world (Einstein with his results on space and time come to mind here). Transformational science is exciting stuff, the stuff that appears on the news ("Is there life on Mars" type of stuff). Obviously, the majority of scientific research doesn't fall into that category. In most fields of science we have discovered the basic rules that explain the broad picture. For instance, in atmospheric science, we know the equations that govern the motion of the air, the basic processes by which aerosol particles form clouds, the different forms in which water can occur (vapor, liquid, ice), and so forth. However, knowing the basic rules and knowing all the details are two different things entirely. Much scientific research is incremental in that it involves making more complete or more accurate measurements which aren't likely to change the underlying paradigms. This type of research is certainly no less important or interesting. Collecting measurements of a multitude of atmospheric and oceanic quantities 24/7 over a repeated transect to capture seasonal differences is crucial to be able to establish a climatology so that we actually know how often certain types of clouds occur, check hypotheses, validate and refine computer models of cloud behavior, and so forth. I don't expect we will discover any new cloud types in MAGIC (that would be quite transformational), but taking solid measurements to an extent that has never been done before in this region is extremely valuable. The instruments on MAGIC are more extensive, and the measurement period longer, than any previous study in this region of which I am aware.

Exactly what is being measured? One set of quantities consists of those that describe the state of the atmosphere (meteorological parameters), such as temperature, pressure, relative humidity, wind speed and direction, precipitation amount and extent, and so forth. The weather balloons allow many of these quantities to be measured throughout the air column instead of only near the surface. Another category is cloud properties, and parameters that are measured are cloud fraction, cloud bases, heights, and thicknesses (there might be multiple layers of clouds), cloud type (liquid water or ice), liquid water path (how much water is in the cloud), drop sizes, etc. A third category is aerosol properties. Recall that aerosol particles are the small particles (most of the ones that we are measuring over the ocean are between 4 and 6 millionths of an inch in diameter) that are ubiquitous in the atmosphere, and that every cloud drop has an aerosol particle about which it forms. Aerosol properties measured include the sizes and numbers of particles, how the particle sizes increase with increasing relative humidity, how well the particles can form clouds (we have instruments that essentially act like miniature cloud chambers), how well the particles scatter and absorb light, and so forth. These last several measurements allow some inferences to be made on the composition of the particles. Another category is radiation properties (recall that radiation in this sense refers to visible,

infra-red, and ultra-violet light). The intensity of light as a function of wavelength (i.e., color) and whether the energy is coming directly from the sun or is diffuse (which is why it appears so bright on an overcast day) are two types of measurements that are being made.

Sea surface temperature is also an important property, and is being measured remotely from the ship using highly sensitive infra-red thermometers (these are the ones that tell the temperature by merely looking at an object). The figure below (courtesy of Mike Reynolds, whom I have discussed before in these updates) shows this quantity for Leg05. The numbers on the graph refer to day of the year; the numbers with the color bar on the right are temperatures in degrees Celcius. A similar graph for the current leg can be found at http://www.rmrco.com/proj/isar/images/spirit_track.pdf.



Highly accurate measurements of sea surface temperature are important because the evaporation rate of the oceans depends on the temperature difference between the ocean surface and the overlying atmosphere, and on the relative humidity. As the temperature of the air above the ocean is very nearly equal to that of the ocean surface, this difference is typically a small quantity, and small inaccuracies in measurement of the temperatures will result in a large relative error (for instance, if the temperature difference is 1°C, an inaccuracy of 0.1°C, although small, is nonetheless 10%). The evaporation rate of the ocean is extremely important as this determines the amount of moisture in the atmosphere, and moisture is required to form clouds.

As always, I can't say enough good things about the captains and crew of the *Spirit*. They have been enthusiastic and supportive from the start, and we (literally) couldn't do it without them. I wish all of them, and you, a happy holiday season!

Ernie Lewis
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Please address any questions or comments to elewis@bnl.gov.
All updates and other MAGIC information can be found at http://www.ecd.bnl.gov/MAGIC.html.