Problem Set #5. 2.682   Due at end of finals period.

Problem 1. Scattering. Scattering problems are either too hard or too easy. As it is the end of the semester, let me err on the "too easy" side, and ask you to look at some fun physics, rather than grunting out a lot of math (which is inevitable in scattering problems). Since optics and acoustics are pretty much related as far as scattering is concerned, except for polarization, which we will ignore here, we can look at some phenomena in light scattering by a rough sea surface, phenomena very much in keeping with our common experience. The same phenomena occur for sound, so we can safely say we're "staying on topic!"

Below are three photos, the first from an airplane looking at the moon reflecting off the sea, and the next two taken from shore of the sun reflecting off the water. They show similar, but not exactly all the same, phenomena.

For each phot, explain in detail: 1) what the reflected intensity distribution looks like in both the vertical and horizontal directions (of the photo!), including "interesting features", 2) why you see what you do in terms of the rough surface's properties, and 3) how do the dimension(s) of the sources (each about ½ degree diameter in the sky) and the position of the viewer affect things? The more detail you can include, the better – there are a LOT of things to see in these photos! (PS...these are copyrighted photos, so we can look, admire and ponder, but not distribute! Thank you!)

Moon light reflection on the sea

Taken through the window of an airplane.

Canon EOS 5D ,Canon EF 24-105mm f 4L IS USM
1/8s f/4.0 at 40.0mm iso3200 full exif

other sizes: small medium original
previous | next

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bill friedlander   09-Jul-2010 21:35
Amazing night shot through the airplane window, and iso 3200! Good catch of the city lights in
the background. v

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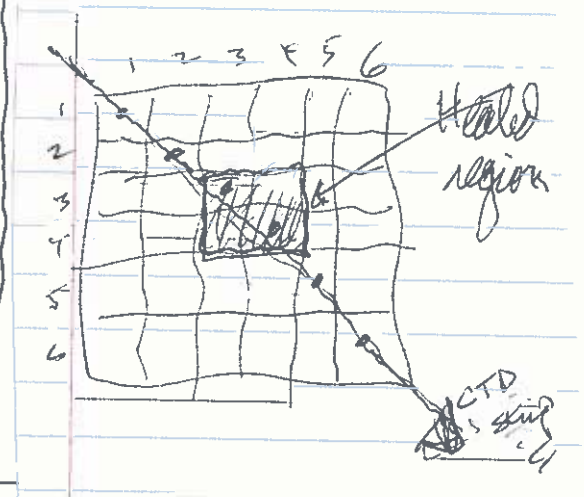
Picture of the sunlight reflecting off the Irish Sea at Blackpool

PROB #1

PROB #2 FIGORE

Problem #2. EOF's and Objective analysis. Again, there are unlimited inverse problems to consider, but a realistic, interesting system would take up a full problem set worth of effort. Nah, we won't go there at this point! But we can at least take a quick look at EOF's and Objective analysis with a toy problem example. Here goes!

As a practical joke, a party of alien oceanographers from Tralfamador used a very advanced type of IR beam to heat up the ocean in a square block by 2 degrees C to exactly half the water depth. (To first order, the ocean is well mixed and isothermal in this region, at around 15 deg C.) The butt of the joke is to be a party of Terran physical oceanographers who are doing CTD surveying, and will be going diagonally across this "new feature." (see figure below). 1) Suppose the Terran oceanographers are doing a 4-layer EOF analysis of the casts they made. What are the EOF modes they come up with? 2) Not by coincidence, the Tralfamadorians made the length size of the square exactly equal to the (full width) gaussian correlation length of the local ocean. The Terran oceanographers also know the local (Rossby radius) correlation scale, and use it in a Gauss-Markov (objective analysis) interpolation of their CTD data. They interpolate the EOF mode coefficients to get the temperature at each of the 36 grid centers

in our figure. (If there is a data point in a given grid point, they just use that, obviously!) To do the GM/OA interpolation, they use 3-4 nearest neighbor (to the desired grid point) data points in their matrices. What does their map look like? Please show a plot. 3) Did the Terrans see the "unnatural" feature as such, and thus infer the existence of alien lifeforms? (There have been numerous similar observations of such peculiar features on land, by the way. Corn fields seem to be especially attractive to the Tralfamadorians.)

From ufoevidence.org

2.682 Acoustical Oceanography

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