Outreach/Education 2005-2006

Wade Fisher

Fermi National Accelerator Laboratory

Outline

- Current activities
  - Early career counseling, advising for college freshmen
  - FNAL Today Result of the Week author
- Goals
  - High-school level student projects
    - Project description
    - Cost / time estimates

Counseling/Advising for College Freshmen

- General idea: at the early college freshman level, physics is rather nebulous (or at least not very inspiring)
  - Force diagrams, inclined planes, moments of inertia, etc.
  - Physics as a career choice can be very hard to grasp
- Approach: engage students about their interests
  - What do physicists do?
    - Academic, industrial, financial, etc.
  - How are specialized engineering tasks represented in physics?
    - Electrical, computer, mechanical, and software engineering (etc)

Progress

- University of Minnesota: based on 8 gatherings (July-August 2005, June 2006)
  - Observed a 45% increase in declared physics majors
  - Observed a 30% increase in retention of physics majors
- University of Chicago: so far, 2 gatherings (May 2006)
  - ...too early for feedback...
- Gatherings are meetings with 10-15 students, 1-2 hours, with a free lunch. No lecturing, just question and answer sessions. When possible I'll invite a grad student, postdoc, or young professor.

FNAL Today
Result of the Week

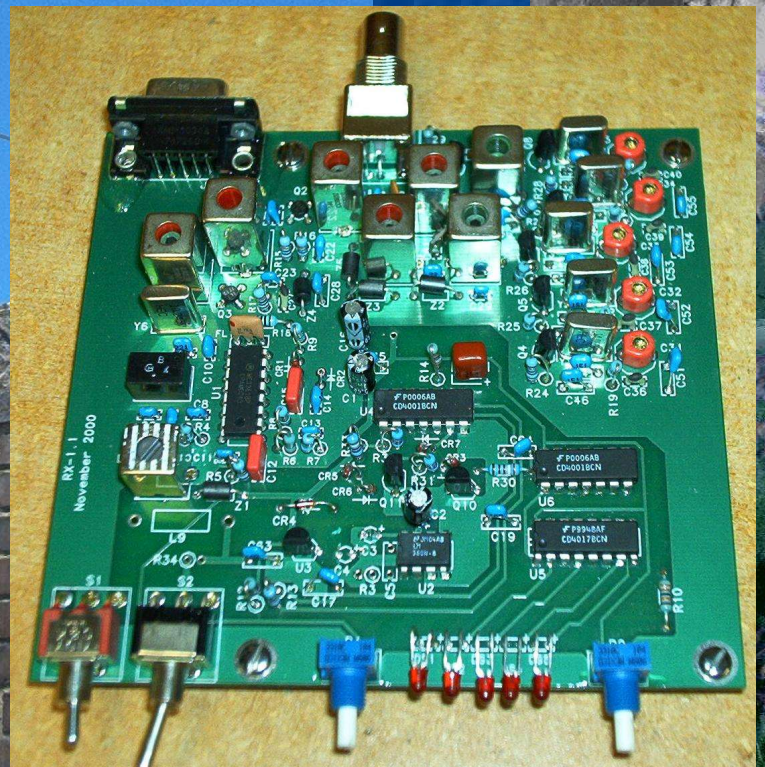
- As of April 27th, 2006 I've taken over the editor/coordinator role for the DZero ROWs
  - Weekly spotlight on a high profile physics result
  - Goal is to provide descriptions for laypersons and physicists alike
- Since I've taken over, we've pushed hard to get the style to a more accessible level
  - Please take a look and see what you think...

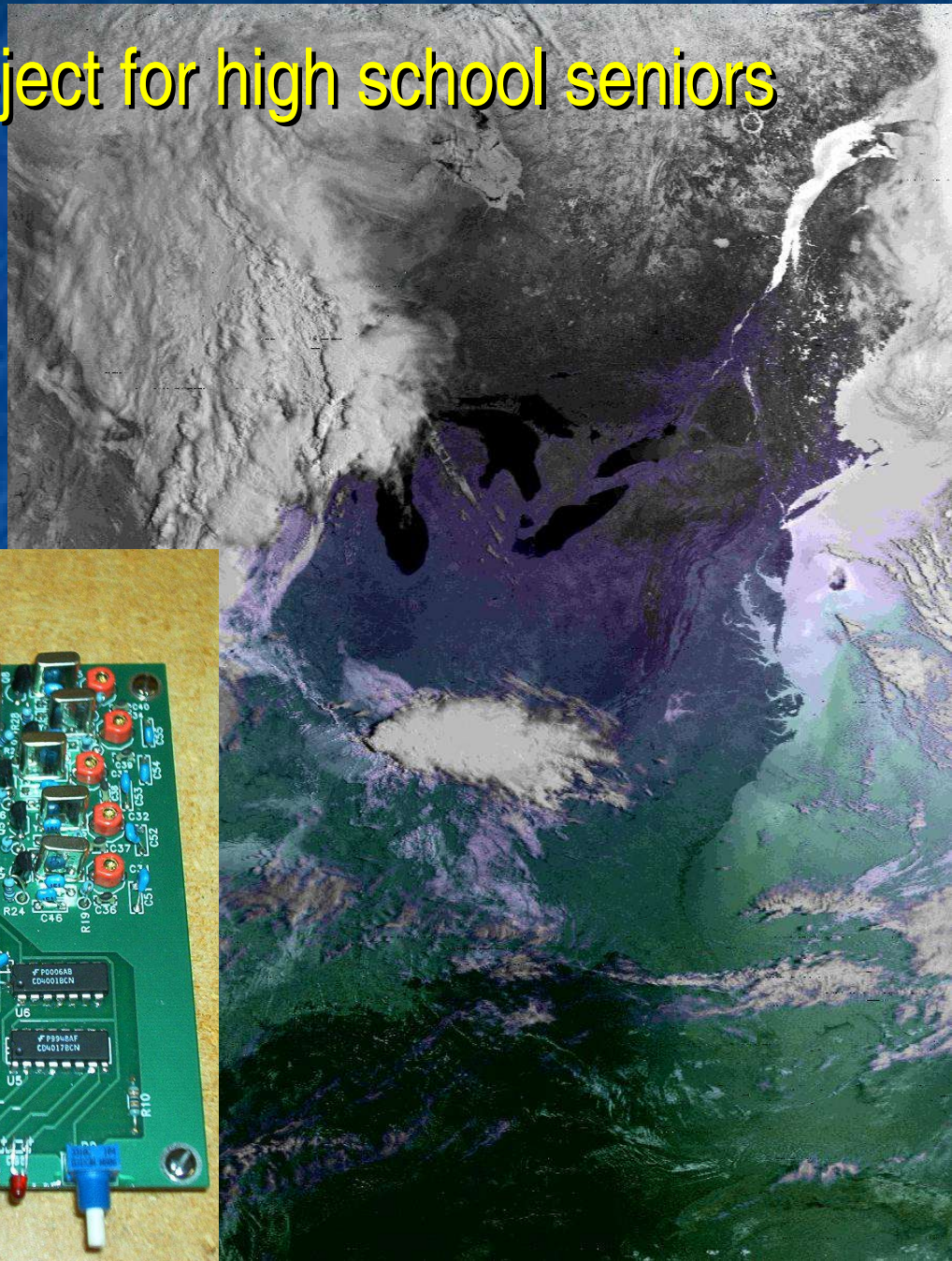
Above: Andy Haas of Columbia University has worked on this analysis. **Below:** Paul Padley (left) of Rice University has coordinated DZero's Result of the Week articles for the past three years. He is handing this responsibility over to Wade Fisher (right) of Fermilab.

Result of the Week Archive

(Near) Future project

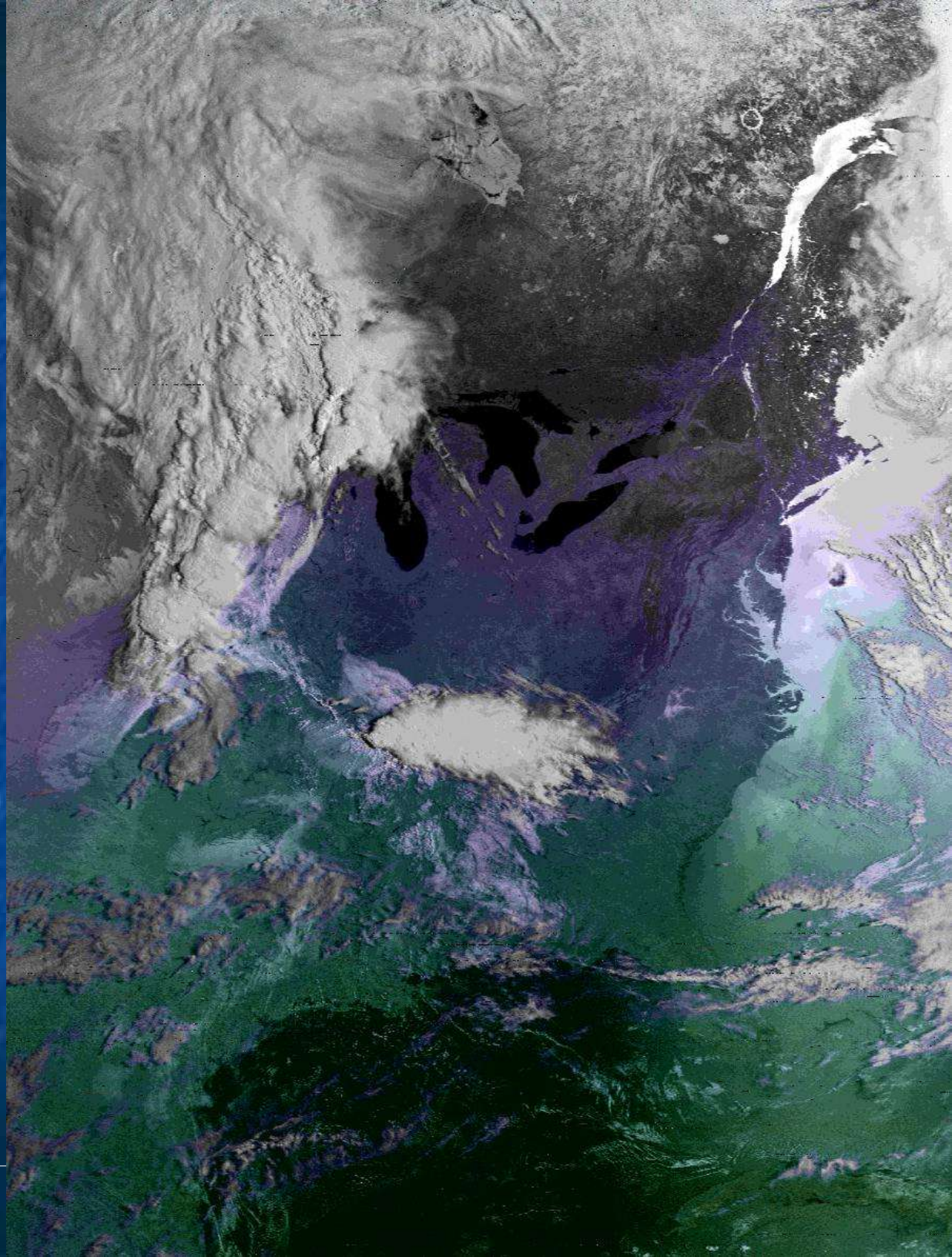
- Weather satellite imaging project for high school seniors





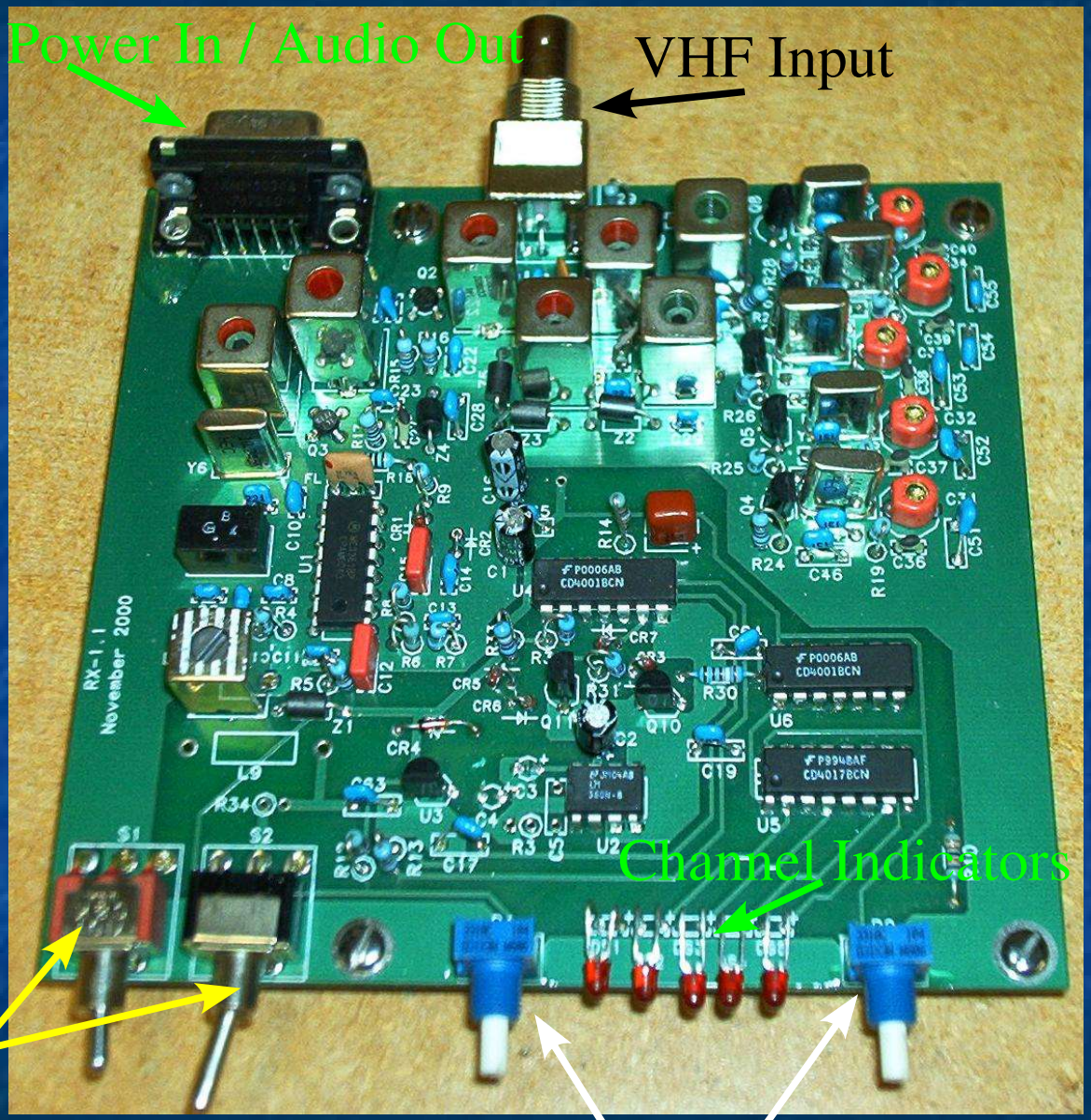
Project overview

- Polar orbit environmental satellites (POES)
  - ~800km, 90min orbit
- Satellites broadcast visible + IR data obtained from dual radiometers
- This image: NOAA 12
  - Resolution enhanced via visual/IR spectra combination



“Rx Tiger”

- 5-channel VHF reciever and FM demodulator
- Input: 137 MHz FM carrier signal
- Output: AM audio

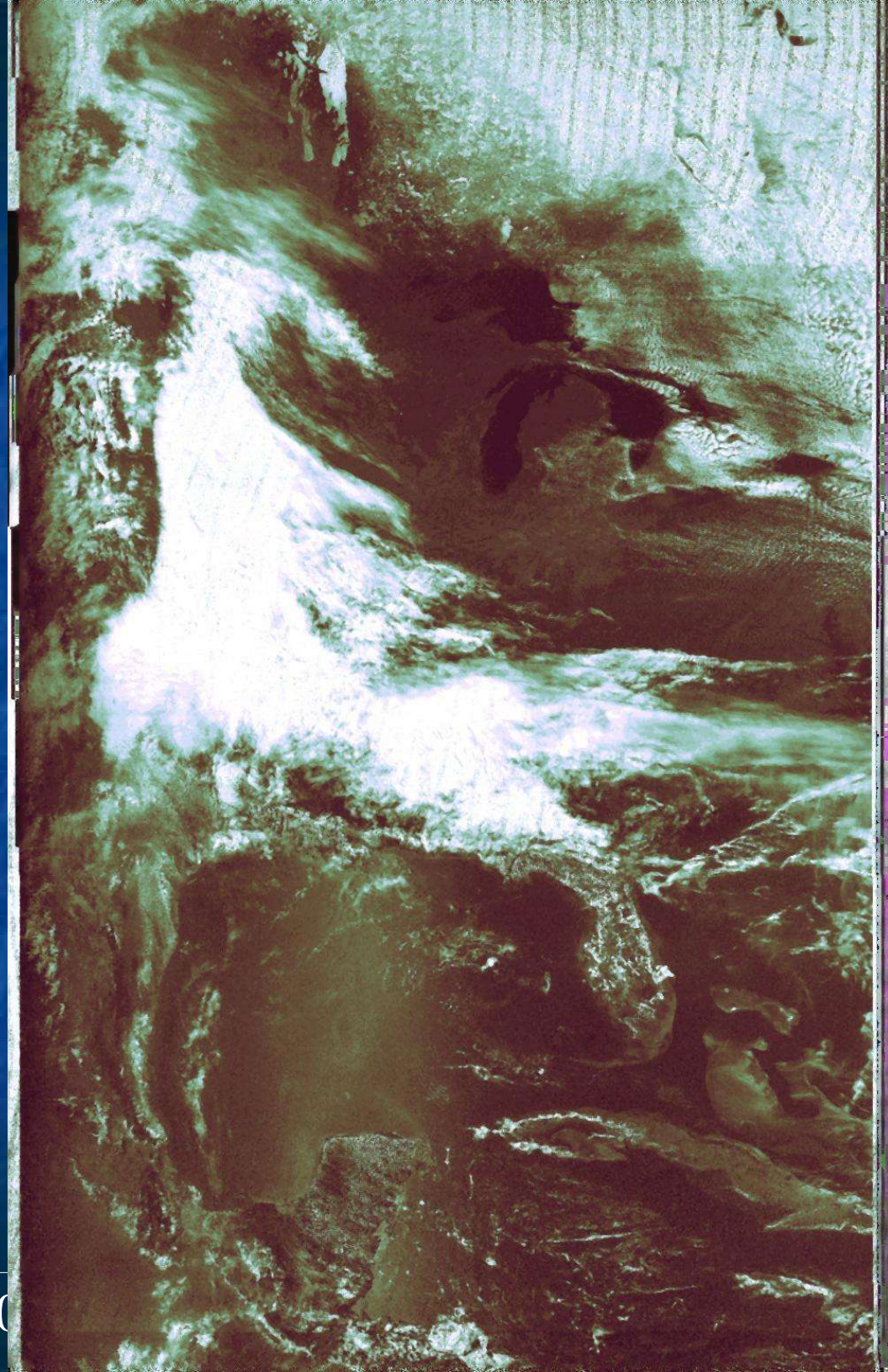


“Yagi-Uda” Antenna

- Omnidirectional VHF antenna made from twin dipole elements
- Design dimentions based on carrier frequency: 137 MHz
  - Preamp may be needed depending on placement

Analysis

- AM audio signal from receiver fed to PC
  - Amplitude gives white/black contrasts (hot/cold for IR)
- Freeware processing software used to decode signals and track satellites
- This image: Russian Meteor 9
  - Nice view of the Yucatan penninsula



Logistics

- Assuming one 3-hour session per week
  - 1-1.5 hrs lecture, 1.5-2 hrs hands-on, (0.5-2 prep hours)
  - 6-8 week duration
- Requires semi-dedicated workspace
  - Radios will require some “preassembly”
  - Need rooms for lecture, assembly, computer analysis
- Requires antenna mounting location
  - Depends on line of sight. Preamp for long cable runs
- Required equipment
  - GHz signal generator(s), DVMs, soldering irons, computers

Suggested Weekly Curriculum

1) "Basics" of EM waves: RX/TX, interference
2) "Basics" of signal processing: Fourier, digital/analog
3) "Basics" of circuitry: LCR circuits, PCBs, soldering
4) Tuning the radio: More on LCR circuits
5) "Design" and build antenna: More on RX/TX, interference
6) Image Acquisition
7) Image Acquisition
8) Final project: build a portfolio of personally acquired images

Cost estimate ($$ and human)

- Assume 30 students working in pairs
  - Radio (PCB, housing, components) $30-35
  - Antenna (PVC, coax, alum rod): $10
  - Preamp and PS (optional): $20
  - **$675 – 1000: $22-35 / student**
- Requires 3-4 “teachers” to cover ~5 hrs per week, ~12 weeks
  - 2 people per session minimum, rotate/backup?
- Assumes we have GHz signal generator(s), DVMs, soldering irons, computers

Outlook

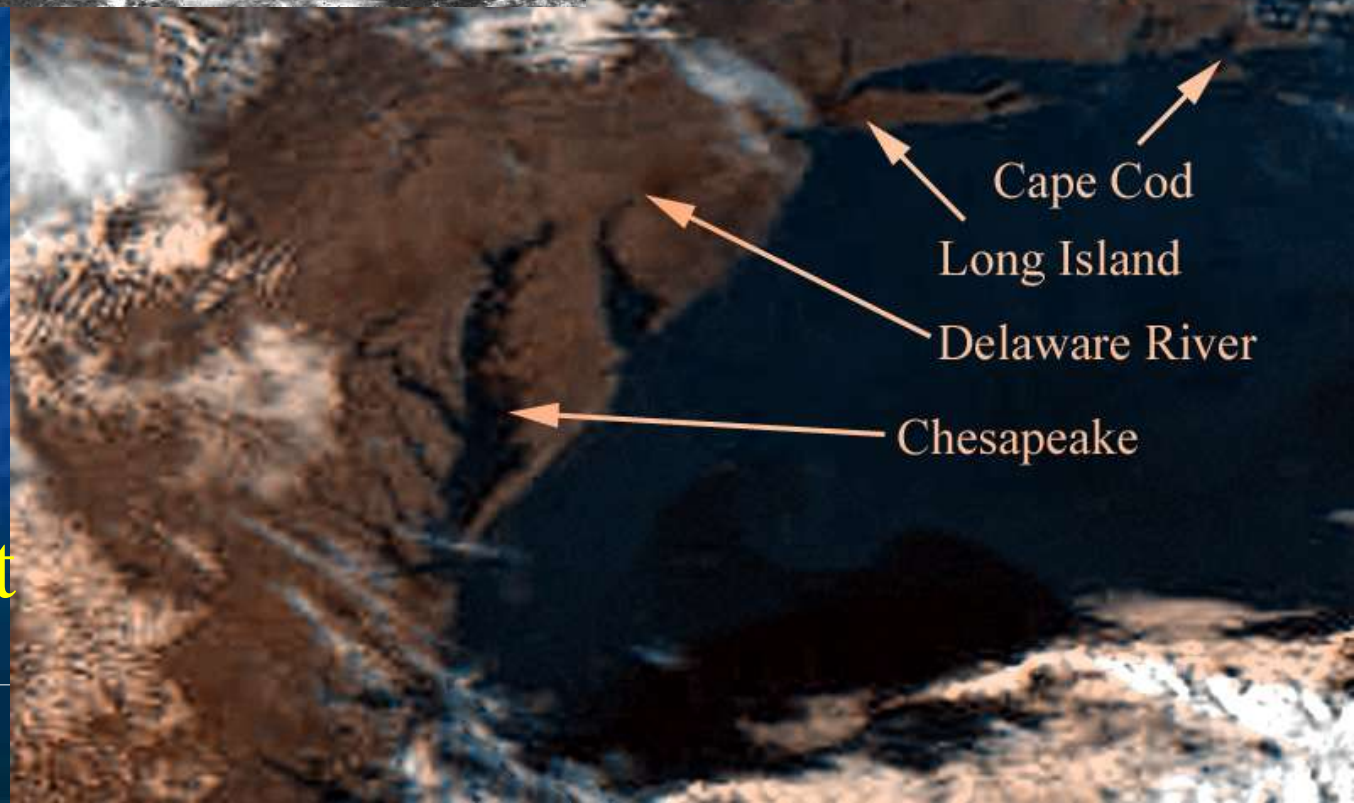
- Much summer remains for required prep work
  - Orders for PCB, JFETs, housings, etc. (3-5 weeks)
  - Gross assembly of receivers, antennas, etc. (2-5 weeks)
  - Arrangements for expensive equipment (GHz signal generators)
  - Finding FNAL volunteers
- Assuming contact with high schools can proceed prior to September
  - Haven't decided what's more desireable: On- or off-site
- Goal would be to complete course by mid-october
  - Students could/should present work at their schools

Other “fun” tasks

- Measurement of doppler shifts in satellite trasmissions
  - A few ways to do this: FFT, phase drift (clock corrected), etc
- A cycling weather display
  - Loop through enhanced (vis+IR) images for a particular day, noon-time images for a week/month, etc...
- Studies of ground-temp / cloud-cover corellations
  - Great ISEF projects!

Yucatan Penninsula

Exibits "clock drift"



Enhanced East Coast

Wade Fisher, FNAL