Practicing Discovery in Science: The power of community, the opportunities of our time

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Dongsha Atoll, South China Sea
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0 10 20 30 40 50

Depth (m)

DTS Water Temperature

Distance in meters from reef crest

200 400 600

19:00 21:00 23:00

05 June 2014

0 10 20 30 40

Distance in meters from reef crest

0 0.0 0.2 0.4 0.6 0.8 1.0

0.5

0.1

0.3

0.7

0.9

0.5

0.3

0.7
First things first:
A community of discovery!

People to thank (last few years):

- Ali Arnon (Israel, Dead Sea dynamics)
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- Dani Or (Switzerland, Soils)
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- Chet, Manuel and Mitch (OSU OPeNS)
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- Michael Wing (UAS)
- Chad Higgins (Atmospheric processes)
- Leonor Rodriguez, Javier Benitez (Spain, Soil Moisture)
- Zheng et al. (China Rivers)
- Steve Drake (Acoustic Permeameter)

many more
Science: Ignacio Rodriguez-Iturbe

Have three great questions ready in case God walks into your office
Harry Selker’s Rules of Research

• Only problems that can change the world

• Problems uniquely you can address

• Have fun!

Having a fun meal in the field in Brittany
My Recipe: WUMPT

- **Wonder** *(fascination – 5 wows/day)*
- **Unknown or I don’t know?** *(1:10)*
- **Does it Matter?** *(life is short – 1:10)*
- **Potential for advancement** *(1:10)*?
- **Form a Team**

10 WUMPT/year of 2,000 wonders, work with about 15 teams

*then work a few thousand hours*
Example WUMPT: Canopy Interception

Wonder: Pine beetle and water?

Unknown? To a surprising degree ✓

does it Matter? Yup: Water supply ✓

Potential advancements?

Team? Rupp, Lane, Abou-Najim, F Selker, Lintz, Krueger, Hut, van de Giesen, van Emmerik, Wagner, Friesen, Steele-Dunn
Canopy Interceptometer

Step 1: Calibration

- Steel Bolt to fix instrument to the trunk
- Potentiometer to measure displacement changes
- Quartz rod (1 m long) as an extension for the potentiometer

Graph showing displacement over time with different loads.
Does water hit the ground?
What do satellites see?

• The African water imbalance…
Rain followed by Evaporation
But that was WAY too hard!
Leaf-out mass increase: 240%
WUMPT?
Questions for God?
What you are uniquely best at?

Be true to your goals and character

Advancement comes from people seeking with passion & leveraging personal skills
Beyond directed research: cracking open opportunities through methods and community structure

- Advancement through innovative tools
- Transformative vs traditional laboratories
- Social structures as vehicles for advancement
Seeking Transformational Measurements

Rayleigh Scattering

Amplitude/Intensity

Wavelength

incident light
Maisbich, Luxembourg
20 million measurements reveal Stream Temperature Dynamics
Walla Walla River
Explained the location of 3,000 salmon
Non-Heated Cable Temperature (°C)

2m Elevation - Night
DTS vs Sonic Wind Speed

Wind Speed (m/s)

Time (5.5 s time step)

2 m

0.5 m

Sonic (m/s)
Watching wind speed: 2,000 points

[Graph showing wind speed over location]
Science = community

Science is the collective undertaking to understand nature and the human experience.

Lend a hand, lend a hammer: Center for Transformative Environmental Monitoring Programs CTEMPs.org

Bring new disciplines and technologies to the community: Openly Published Environmental Sensing Open-sensing.org

Look for problems of importance and opportunity: Trans-African Hydrometeorological Observatory TAHMO.org

Leverage the web: Soil Hydrology & Biophysics – OSU/ETH open-access
Lend a hand, lend a hammer:
Share Expertise and Resources
CTEMPs in The Dead Sea

The Top 10 Worst Jobs In Science
Bring new disciplines and technologies to the community:
Seek new Approaches Together
Look for problems of importance and opportunity:
The Trans-African HydroMeteorological Observatory (TAHMO.org)
“Good luck will not favor those who haven’t prepared their minds”

Have we prepared for the African Century?
Why Africa?

60% world’s uncultivated arable land!
Silent Weather Stations

Percentage of reports received:
- 90 to 100 percent (2912 stations)
- 45 to 90 percent (697 stations)
- Less than 45 percent (325 stations)
- Silent stations (350 stations)
Shocking loss of observations
Ground truth or blue sky?

\[ y = 0.2046x + 5.2169 \]
\[ R^2 = 0.0384 \]
Opportunity for IMPACT
Doing the math on feasibility

• **Value?** African weather market: $50,000 M/yr

• **Cost?** 20,000 stations at $2000/station = $40M
  Operations cost $50/mo/station = $1M/mo

• **TAHMO:** $40M in establishment, and $12M/yr
  4,000:1 payback ratio

• **Is there money?** African Dev bank to spend $660 M
  on meteo in 11 countries (TAHMO: 2% of price)
Instruments: 30 km spacing across Africa (20,000)
Education: make math, science, geography real
Data: Free to Government, Research
Features:

- Solar powered
- 6-mo reserve battery
- GSM communication
- GPS and compass
- Temp (3 ways)
- Relative Humidity
- Accelerometer
- Sonic wind (0.1 to 60 m/s)
- Drip-count rain (0.02 mm)
- Shortwave solar
- Barometer
- Lightning detector

New – no cables, no moving parts, once piece

Old: cables; 3 moving parts; 5 pieces
Fixing a broken economic chain

Clients: purchase rights

- TAHMO CLIENT (e.g., crop insurance provider)
  - Data to TAHMO
  - Payment from TAHMO

- Products to farmers, NGO’s, ...

- TAHMO CLIENT
  - Payment to TAHMO
  - Data from TAHMO

Data free to
Host Governments and
Research
Deep partnerships

MoU’s
Kenya
Ghana
Malawi
Benin
Togo
Mali
Burkina Faso
Uganda
Ethiopia
Tanzania
Rwanda
Nigeria
South Africa

And close to complete with
Ivory Coast
Cameroon
Zambia
Student access to the weather across Africa, and beyond!
(Adam’s School, Corvallis!)
Leverage the Web:
Publish/Teach openly and creatively
Soil Hydrology and BioPhysics
John Selker OSU and Dani Or ETH Zurich

- Open-Access
- Compelling illustrations
- Definitive content (all the math is there!)
- 4 levels of learning: Concepts to Practice
- Crossing scales: from grains to landscapes
- Video and hands-on lessons
Classroom Community

Turning certain failure into roaring success

A two-color twist on test taking

Test taking is a humiliating experience for many students, with no perceived direct educational benefit. That need not be.

www.physicstoday.org

As you can imagine, they find most of their mistakes themselves and correct them, so I generally have much less work trying to figure out what they did wrong and how many points it should be worth. Students have told me that they leave the exam having figured out what they didn’t understand, filled in the gaps, and strengthened their relationships with their peers. An easy win-win for a busy professor.

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Drawing this together: Visualize and Grasp the Opportunities of Today

- **Observation**: signal/(noise-dollar) is blowing up
- **WUMPT!** *Practice* the art of discovery *together*
- **Community**: Reach across disciplines to solve today’s complex problems
- **Dream big**: Ideas in action will change the world:
  
  *If we don’t, who will?*
Questions?
Flow rotation on baseflow recession: model recession

Change in flow direction during drainage?

Master thesis: Elisabeth Jachens, Oregon State University
Who is John Selker?

• 7th child in a logging town – no money, lots of fun!

• Studied physics, sculpture, electronics

• 1981-87 carpentry, engineering, development
  – African/Asian cookstoves
  – Kenya for 1985 drought: moved to water
Textural Interfaces: Salty water

- The Hanford site looks like this:
- What happens if we put salty (say 10 molar) liquid here?
Textural Interfaces: Multiphase flow

• Let’s look at three oil spill cases
  – no water flowing
  – little water flowing
  – lots of water flowing
Gas Sparging: Components

- Radial Near Injection Source
- Buoyant Strands of Percolation
- Vertical Strand Upward with Random lateral noise
Getting sparging right...

\[ y = 1.0088x \]

\[ R^2 = 0.9534 \]
The 3-D Error-Bessel Fit

- Figure 9. Fit disk-source dispersion using STANMOD to the experimental data of Hein et al.’s (1997) Table 2, with source radii computed using equation 11. Diamonds are from the 62 lpm test; triangles from the 187 lpm test; and circles from the two 283 lpm tests. Fitted dispersivities were 2.1, 3.7, and 3.7 cm-1 respectively.