Applications and Lessons Learned *using data from the* Atmospheric Infrared Sounder

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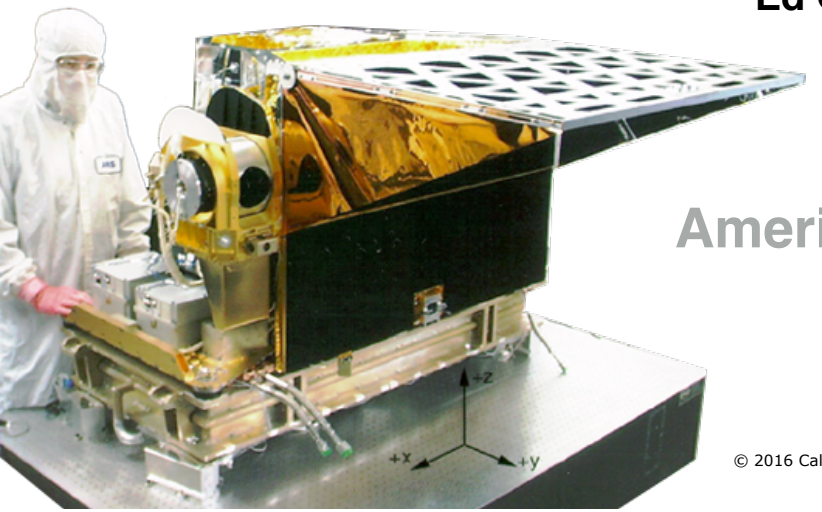

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Aqua in TRW highbay. El Segundo, California, 3/17/01

Atmospheric Infrared Sounder *on* NASA's Aqua satellite

Launched May 4, 2002

sun synchronous polar orbit

1:30am / 1:30pm daily overpasses

14.5 km instrument resolution

2378 spectral channels

Temperature
Water Vapor
Carbon Monoxide
Carbon Dioxide
Ozone
Outgoing Longwave Radiation
Surface Properties – *skin temperature, air temperature, emissivity and reflectance*
Cloud Properties – *cloud thermodynamic phase, ice cloud optical thickness, and ice cloud effective diameter*
Tropopause Derived from Temperature
Geopotential Height
Top of Boundary Layer

AIRS Level 4 Applications Catalog – *FLUID!*

DROUGHT

- Vapor Pressure Deficit
- Standardized Relative Humidity Index

FIRE

- Fire Danger Assessment System
- Indonesia Fires Seasonal Threshold

HEALTH

- Influenza
- Zika
- Dengue Fever
- Temperature Inversion

AIR QUALITY

- Air pollution CO tracer
- Ozone intrusion from stratosphere into troposphere

AVIATION

- JPL internal volcanic alert system
- SO2 BT Diff
- Dust Score
- SO2 Loading
- Ash/dust Loading
- Cold Air Aloft
- Deep Convective Clouds

OTHER

- Global Extremes from AIRS L2 Data
- Heat/Comfort/Misery Index

Lessons learned, 2 years in

Defining “Applications”

it’s NOT research

it’s NOT PR

it’s NOT Outreach

NASA Applied Sciences Program

"Welcome to the NASA Applied Sciences Program. *The Program funds projects that enable innovative uses of NASA Earth science data in organizations' policy, business, and management decisions.* The project results and enhanced decision making improve the quality of life and strengthen the economy."

"Discovering innovative and practical uses of Earth observations"

Applications

Science products that are
used by decision makers
or are in a
decision making pipeline

Converting science information into products for use by decision makers

“Applications are about decision-making”

Decision-making pipeline

Path that starts with data and ends with decision-maker

Task: **Identify the steps in between**

Why know the decision pipeline?

You can identify where your product would have relevancy, and who might be interested in it
You can determine who can provide feedback & guidance on your concept

You can ask people in the know about the M.O. of the decision makers
DM needs may be less refined than what you assume

Can determine if you're going to step on toes

- *See conduits to appropriate organizations*
- *Gain trust—when introducing a product, it shows you've done your homework, you know the context*

RELATIONSHIPS MATTER

and they must be cultivated

- **Organization/groups along a decision pipeline are often a tight knit community**
- **People know each other, trust is key**
- **Trusted workflow and network is already in place**
  They won't necessarily use a product that appears on the scene *(if you build it, it's likely to be ignored)*

Benefits

Save time and money

Make a better product

Cultivate partners, advocates

Improve chance of successful outcome

Multiple Volcano Decision Pipelines*

	Data Source	Operational Services	Decision Makers
U.S.	USGS Volcano Observatories	National Weather Service Anchorage and Washington DC VAACs	FAA Department of Homeland Security VDAP
U.S.	USGS UK Met Office other data suppliers	USAF Air Weather Service	DOD Agencies
U.K.	*Data suppliers*	UK Met Office London VAAC	CAA & NATS Airline SRAs
Int'l	ICAO & WMO		

*Note:
These pipelines are used to understand the pathway to decision-makers. AIRS products are not currently in these pipelines.

U.S. Volcanic Emissions Decision Pipeline

Data Source	Operational Services	Decision Makers
USGS Volcano Observatories	National Weather Service Anchorage and Washington DC VAACs	FAA Department of Homeland Security VDAP

USGS VOs

- 5 observatories monitor/ report on eruptive behavior
- Develop research models of ash dispersion and ashfall
- Sends reports to the NWS

NOAA NWS

- Run operational ash dispersion models
- Formal guidance about what to do comes from the NWS
- NWS gets *its* guidance and information from the USGS

NOAA Volcanic Ash Advisory Centers

- Only deal with ash—they report the extent and movement of ash
- The National Weather Service is really the VAAC

FAA

Looks at NWS products and makes aviation-related decisions

Department of Homeland Security

Decides on whether there should be an evacuation

Volcanic Disaster Assistance Program

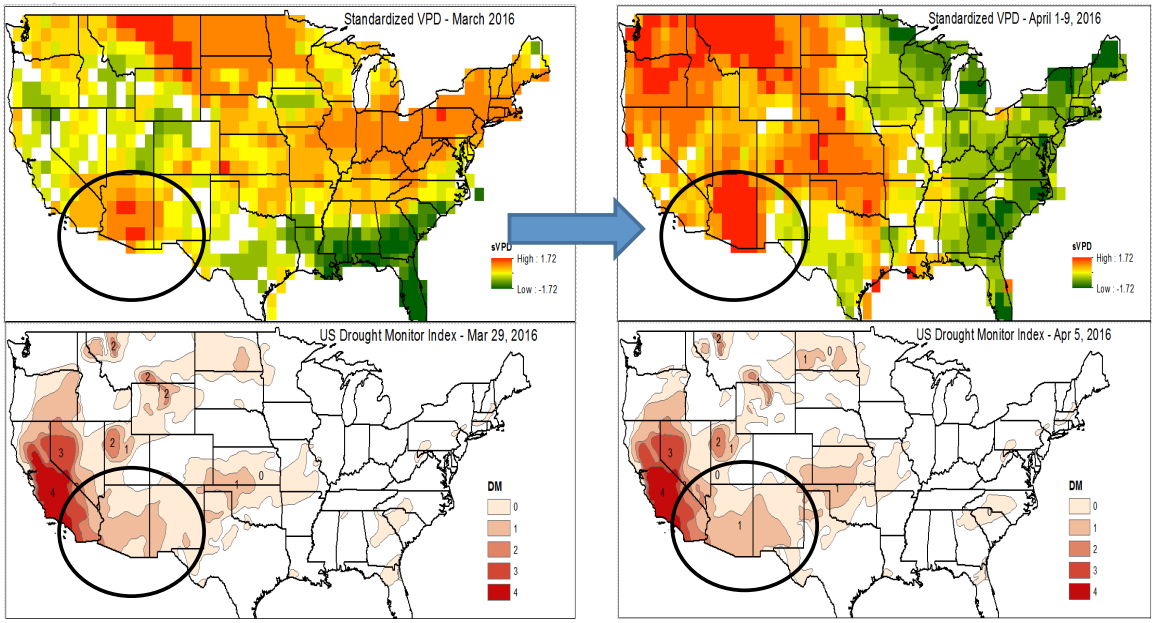
- USGS + Office of Foreign Disaster Assistance partnership, developed/ funds VDAP
- Developing countries contact US State Dept which contacts VDAP
- Responds to select volcanic crises worldwide, works to reduce fatalities, economic loss
- Works through USAID, USGS scientists rapidly respond with consultation, forecasting, remote sensing data, monitoring equipment
- Between crises VDAP works with international partners to build/ improve volcano monitoring systems; conducts joint activities to reduce volcanic risk and improve understanding of volcanic hazards
- Jewel in the crown of the USGS

To contribute to aviation, AIRS volcanic emission products would fit in the pipeline here

AIRS & Drought I Standardized Vapor Pressure Deficit

Stephanie Granger, Ali Behrangi, *Jet Propulsion Laboratory*

- **AIRS-derived standardized vapor pressure deficit (VPD) can determine contribution of temperature and humidity in tendency of atmosphere to wick moisture from land**
- **AIRS SVPD is valuable for the monitoring and early detection of meteorological drought**
- **Near real-time monitoring of temperature and humidity can contribute to the early detection of drought, its development & dynamics**



Credit: Ali Behrangi

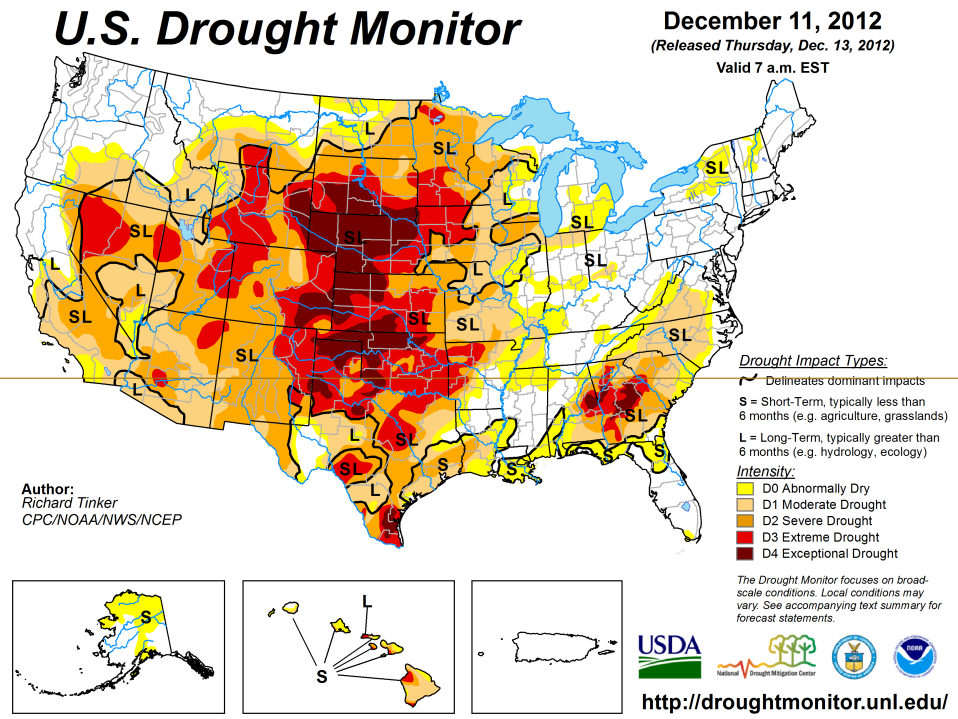
- Large anomaly in AIRS VPD in March 2016 over Arizona while USDM shows weak signals.
- In April, USDM begins to show wide-spread drought.
- USDM has difficulties in capturing rapid dynamics of drought due to inclusion of many variables that may change slowly.

OBJECTIVE

Analysis and development of customized products based on AIRS near surface temperature and relative humidity to:

1) Support the National Drought Mitigation Center's (NDMC) assessment of AIRS products for potential inclusion in the United States Drought Monitor (USDM)

2) Evaluate the use of these products as indicators of environmental conditions that are pre-cursors of drought, increased fire danger, and vegetation health



- Policymakers use USDM in allocating drought relief
- USDA used USDM to distribute ~ $1.64 billion from 2008–2011 through Livestock Forage Disaster Program
- IRS uses USDM to determine replacement period for livestock sold due to drought
- In response to drought of 2012, USDA streamlined process for drought declarations– now based on severe drought identified by USDM for eight consecutive weeks

NDMC 's products of interest for AIRS

- **United States Drought Monitor**
  - Weekly summary of drought conditions across US & Puerto Rico
  - Combines variety of data-based drought indices/ indicators/local expert input into single composite drought indicator
- **VegDri/QuickDri**
  - Vegetation Drought Response Index: Weekly depiction of vegetation stress across contiguous US at seasonal scale
  - Quick Drought Response Index: NDMC 4-year NASA-funded project–complements VegDRI by detecting drought's effects on vegetation at time intervals of a month or less
  - ***QuickDRI missed 2012 drought, AIRS products anticipated it***

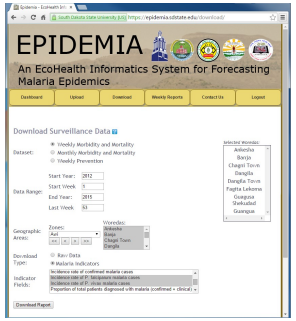
- **Granger/Behrangi site visit at NDMC to showcase AIRS VPD, RH products**
- ***Agreement secured:***
  NDMC to evaluate AIRS VPD products for 18-24 months. If utility demonstrated, AIRS products to be used in generation of USDM.
- **Next focus will be Veg/QuickDRI**

When it comes to applications,
“The perfect is the enemy of the good”

Mike Wimberly & EPIDEMIA:
An applications development model

South Dakota State's integrated system for surveillance and forecasting of malaria epidemics

Mike Wimberly, Professor of Natural Resource Management and a Senior Scientist in the Geospatial Sciences Center of Excellence at South Dakota State University



EPIDEMIA system:

public health interface
uploading/querying weekly surveillance reports

algorithms
automatically validate incoming environmental and epidemiological data and update database

surveillance database

1st
Saw the need and had the contacts in Ethiopia

2nd
Talked about the idea
with Ethiopian contacts to determine if they were interested

3rd
Requirements workshop

Ethiopia collaborators & scientists
- Nonprofit executive director helped identify key players
- Participants: *scientists, programmers, Ethiopian university collaborators, doctors, and health workers*

Hashed out req's/needs/issues
- Ignorance from both sides
- *Ethiopians didn't know what was possible*
- *Scientists didn't know what was needed*

After the workshop

- *"We kept in touch all the time"*
- First year, live forecasting – SDSU sent emails about epidemiological data, then reports sent every week during malaria season

Product refined along the way

- Misinterpretations with forecast reports– worked with end users until reports interpreted accurately

Validation issues

- Health bureau uploads patient data into the system (weekly at district level)
- *"It ain't perfect, there are time lags (1 week latency) and problems with spatial points"*

Deal with data uncertainty

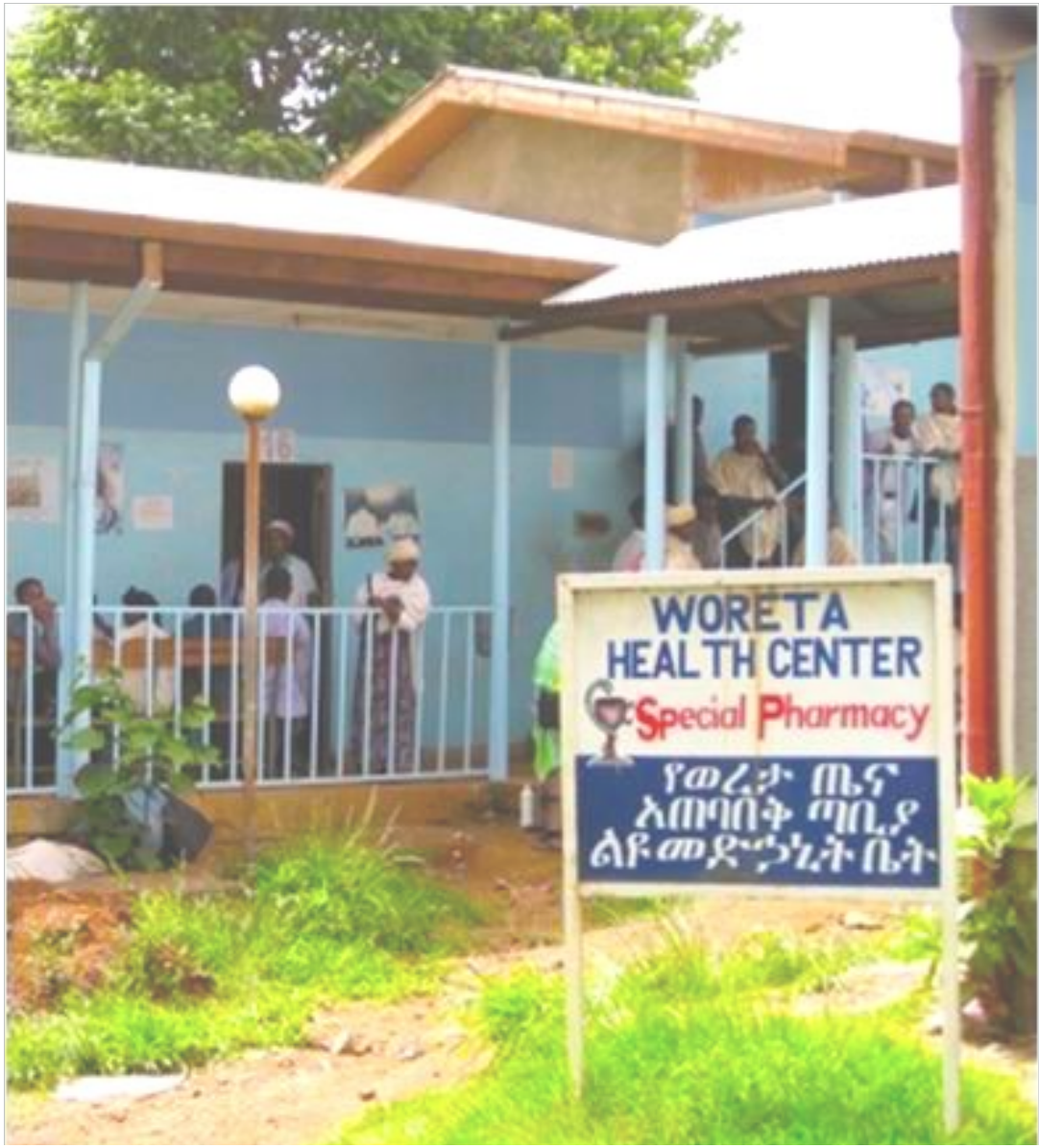
- No error estimates–*"We don't give error estimates with weather forecasts, and people are comfortable with that"*
- Pushed out forecast *"We knew it wasn't great but we linked it to validation"*
- Every week model was validated

Transition Plan

- Ultimately want to transfer system to Ethiopia, needs capacity building
- Possibility NIH continues funding research and USAID runs tool
- *"We need to brainstorm the transition plan…"*

“Ultimately you just gotta start doing something. At a certain point you just have to blunder in and do this. If you wait until you have a perfected model, you end up not doing anything. The perfect being the enemy of the good. Look at the history of weather forecasting, they just jumped in and did it.”

— Mike Wimberly



A chat with David Green – *Program Manager, NASA Applied Sciences Disasters Program*

Rethink "end user"
Intermediary groups or brokers often better suited to reach decision makers (NGOs, commercial companies…)

New types of partners
Think about non-traditional partners that deal with economic impacts, social impacts, or 2nd or 3rd order effects that result from the actual environmental event

Collaborate from the get-go
Stressed the importance of including brokers or end users at the beginning of the process to inform how the application is developed

Good enough is ok

"Applications don't need to be perfect products. Make a messy demonstration product and get in the dirt with it. This is where the fun is."

4 takeaways

1

Applications are about decision making

2

Decision pipelines

3

Good enough is OK

4

Transition Plan