Value Added Procedures at the ARM Experiment Center

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Introduction

Unlike many other scientific projects, the Atmospheric Radiation Measurement (ARM) Program collects data in an ongoing, continuous manner. Because of the volume of these perpetual data streams, traditional case study methods for analyzing these data are not very effective. The concept of Value Added Procedures (VAPs) was developed to fit the need for an automatic analytical approach to ARM data streams. A VAP creates a "second generation" data stream by using existing ARM data streams as inputs and applying algorithms or models to them. A VAP is run continuously in the ARM Experiment Center, and the output generated is treated as a new ARM data stream (Figure 1).

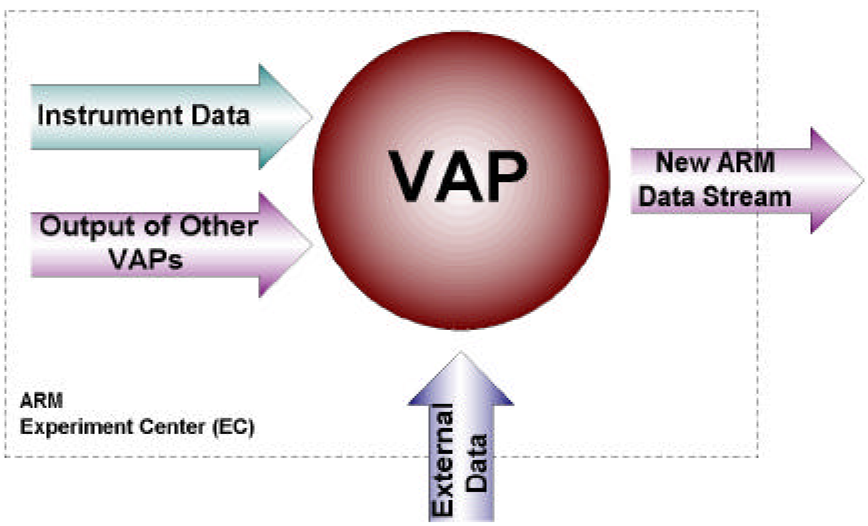

Figure 1. VAP data flow. Note that VAPs output new data streams, which can in turn be used as input for other VAPs.

Many of the scientific needs of the ARM Program are met through VAPs. Physical models that use ARM instrument data as inputs are implemented as VAPs and can help fill some of the unmet measurement needs of the program. A special class of VAPs called Quality Measurement Experiments (QMEs) compare different data streams, allowing continuous assessment of the quality of ARM data or comparisons between instruments and models (Miller et al. 1995). Therefore, VAPs are the tools by which the ARM Program can validate and enhance both instrument and model performance.

New VAPs or suggestions for improvements or modifications to existing VAPs come from all parts of the ARM Program (e.g., science team members, instrument mentors, data and science integration team members, site scientists). A primary function of the ARM Science Applications Group (SAG) is to oversee the development of VAPs for each Geophysical Focus Area (GFA) within ARM. Each focus area has been assigned a member of SAG to work with the lead scientist to facilitate collaborations within the GFA and to coordinate intensive observation periods (IOPs), in addition to overseeing the VAP development for the GFA. Table 1 lists the lead scientists and the infrastructure liaison for each GFA. Tables 2 through 5 list the VAPs currently in production, active development, or near-term development. The symbols on the left of each VAP indicate the primary GFA(s) customers. The listed points of contact can provide more information on each VAP.

Table 1. VAP contacts for each GFA.

GFA	Infrastructure	Science Team
Shortwave Radiation	Don Slater	Warren Wiscombe
Longwave Radiation	Tim Shippert	Bob Ellingson
Cloud Characterization	Dan Rodriguez	Steve Krueger
Water Vapor	Dave Turner	Hank Revercomb
Aerosols	Meng-Dawn Cheng	Steve Schwartz
Surface Energy Exchange	Ric Cederwall	Chris Doran
Single-Column Models	Ric Cederwall	Dave Randall

Example Flow Diagram: Raman Lidar Best-Estimate

The data flow in the ARM Experiment Center can quickly become very complicated. For example, Figure 2 illustrates the complexity of the input processing required in order to run the Raman Lidar best-estimate (RL PROF BE) VAP. Many VAPs require input from multiple sources, including data directly from the instrument as well as other VAPs, and thus changes in a data stream can have large impacts on the downstream processing.

Conclusion

As the ARM Cloud and Radiation Testbed (CART) sites transition from development to operational states, the level of importance of VAPs is going to increase. The science applications group through interactions with the geophysical focus area working groups and lead scientists, are working to develop new ideas for VAPs, prioritize them, and implement them in the operational ARM environment. The process would not be possible without the feedback from the science team via the GFA working groups. More information on Value Added Producers can be found on the ARM web site at *http://www.arm.gov/docs/research/vap_ homepage/vap.html*.

Table 2. VAPs currently in production at the ARM Experiment Center.

In Production

	Contacts	
BE SW *Best-estimate shortwave radiation products: total, diffuse, direct, etc.*	Contacts: Shippert	Wiscombe
LBL ASTI *Shortwave clear-sky radiance calculations at Absolute Solar Transmittance Interferometer (ASTI) resolution from the Line-By-Line Radiative Transfer Model (LBLRTM).*	Contacts: Shippert	Clough/Brown
LBL CLOUD E *Effective longwave cloud emissivity derived from Atmospheric Emitted Radiance Interferometer (AERI) and LBLRTM measurements.*	Contacts: Shippert	Clough/Brown
LBL MWR *Clear-sky brightness temperature calculations at Microwave Radiometer (MWR) frequencies from LBLRTM.*	Contacts: Shippert	Clough/Brown
LBL RTM *Longwave clear-sky radiance calculations at AERI resolution from the LBLRTM.*	Contacts: Shippert	Clough/Brown
LS SONDE *Radiosonde profiles where the relative humidity (RH) profile is scaled to match MWR's precipitable water vapor (PWV).*	Contacts: Turner	Clough/Brown
MWR PROF *Temperature and water vapor profiles retrieved from MWR, Radio Acoustic Sounding System (RASS), & Surface Meteorological Observing Station (SMOS) observations.*	Contacts: Halter	Westwater
QME AERI/LBL *Statistical analysis of AERI - LBLRTM residuals by process, bin, etc.*	Contacts: Turner	Clough/Brown
QME AERI/LBL CLOUDS *State of the atmosphere information to facilitate QME AERI/LBLRTM analysis.*	Contacts: Turner	Clough/Brown
QME AERI PROF *Statistical comparisons of the AERI PROF retrievals to radiosondes.*	Contacts: Halter	Feltz/Smith
QME ASTI LBL *Comparison of ASTI instrument and LBL model radiances.*	Contacts: Shippert	Clough/Brown
QME MWR COL *Comparison of MWR brightness temperatures to an instrument model.*	Contacts: Halter	Liljegren
QME MWR PROF *Statistical comparisons of the MWR PROF retrievals to radiosondes.*	Contacts: Halter	Westwater
RWP TEMP *Merged virtual temperature profiles from the 915-MHz RASS and 50-MHz RASS.*	Contacts: Christy/Shippert	Coulter
TWR MR *Water vapor mixing ratio at surface, 25-m, and 60-m tower heights.*	Contacts: Turner	Turner
W RE SONDE *Processed wind data from radiosondes.*	Contacts: Yio	Cederwall

Table 3. VAPs currently in production at the ARM Experiment Center, but which are also undergoing further development. The development cycle for a VAP typically includes many such revisions.

In Production and Development

(G)AERI PROF *Temperature and water vapor profiles physically retrieved from AERI radiance.*	Contacts: Halter/Feltz	Feltz/Smith
LANGLEY *Total optical depths from Multifilter Rotating Shadowband Radiometers (MFRSRs) using Langley plots.*	Contacts: Shippert/Halter	Barnard
LBL RSS *Shortwave radiance calculations at Rotating Shadowband Spectroradiometer (RSS) filter wavelengths from LBLRTM.*	Contacts: Shippert	Clough/Brown
MPL NOR *Micropulse Lidar (MPL) backscatter profiles normalized and cloud detection routine applied.*	Contacts: Turner	Campbell/Hlavka
QME RSS LBL *Comparison of RSS instrument and LBL model radiances.*	Contacts: Shippert	Clough/Brown

Table 4. VAPs currently in development at the ARM Experiment Center.

In Development

ARSCL *Best-estimate cloud location from active remote sensors & Millimeter-Wavelength Cloud Radar (MMCR) moments data.*	Contacts: Clothiaux/Turner	Clothiaux
BA EBBR *Bulk aerodynamic estimates of sensible & latent heat fluxes to complement the Energy Balance Bowen Ratio (EBBR).*	Contacts: Christy/Shippert	Coulter
RL PROF MR *Mixing ratio profiles, RH profiles, and PWV from the Raman Lidar.*	Contacts: Turner	Ferrare/Turner
RL PROF ASR *Aerosol scattering ratio and backscattering coefficient profiles from the Raman Lidar.*	Contacts: Heilman/Turner	Ferrare/Turner
RL PROF DEP *Depolarization profiles from the Raman lidar.*	Contacts: Turner	Ferrare/Turner
RL PROF EXT *Aerosol extinction profiles and aerosol optical thickness from the Raman Lidar.*	Contacts: Turner	Ferrare/Turner
RL PROF BE *Best-estimate state of the atmosphere product from the Raman Lidar and AERI+Geostationary Observational Environmental Satellite (GOES).*	Contacts: Turner	Ferrare/Turner

Table 5. VAPs that are planned for future development and release into production at the ARM Experiment Center. This is not an exhaustive list, but is a representative sample of the kinds of products we hope to produce in the following year.

Future Work

VAP	Contacts	
CLD MICRO ICE 1(2)MACE *Ice cloud microphysics derived from MMCR reflectivities (moments) and AERI radiances*	Contacts: Halter	Mace
CLD MICRO LIQ 1MACE *Liquid water cloud microphysics derived from MMCR and MWR.*	Contacts: Halter	Mace
CLD MICRO LIQ 1DONG *Liquid water cloud microphysics derived from MMCR, radiosondes, and pyranometer*	Contacts: Halter	Dong
MFRSR AOD 1CHENG *Aerosol optical depth retrievals from the MFRSR.*	Contacts: Shippert	Cheng
MWR LIQ 1LILJ *Cloud liquid water path retrievals from the MWR.*	Contacts: Halter	Liljegren
SW F ANALYSIS *Shortwave analysis: clear-sky flux and cloud fraction estimates, albedo, and QC.*	Contacts: Shippert	Long

Reference

Miller, N. E., J. C. Liljegren, T. R. Shippert, S. A. Clough, and P. D. Brown, 1995: Quality measurement experiments within the Atmospheric Radiation Measurement Program. In *Proceedings of the Fourth Atmospheric Radiation Measurement (ARM) Science Team Meeting*, CONF-940277. U.S. Department of Energy, Washington, D.C.

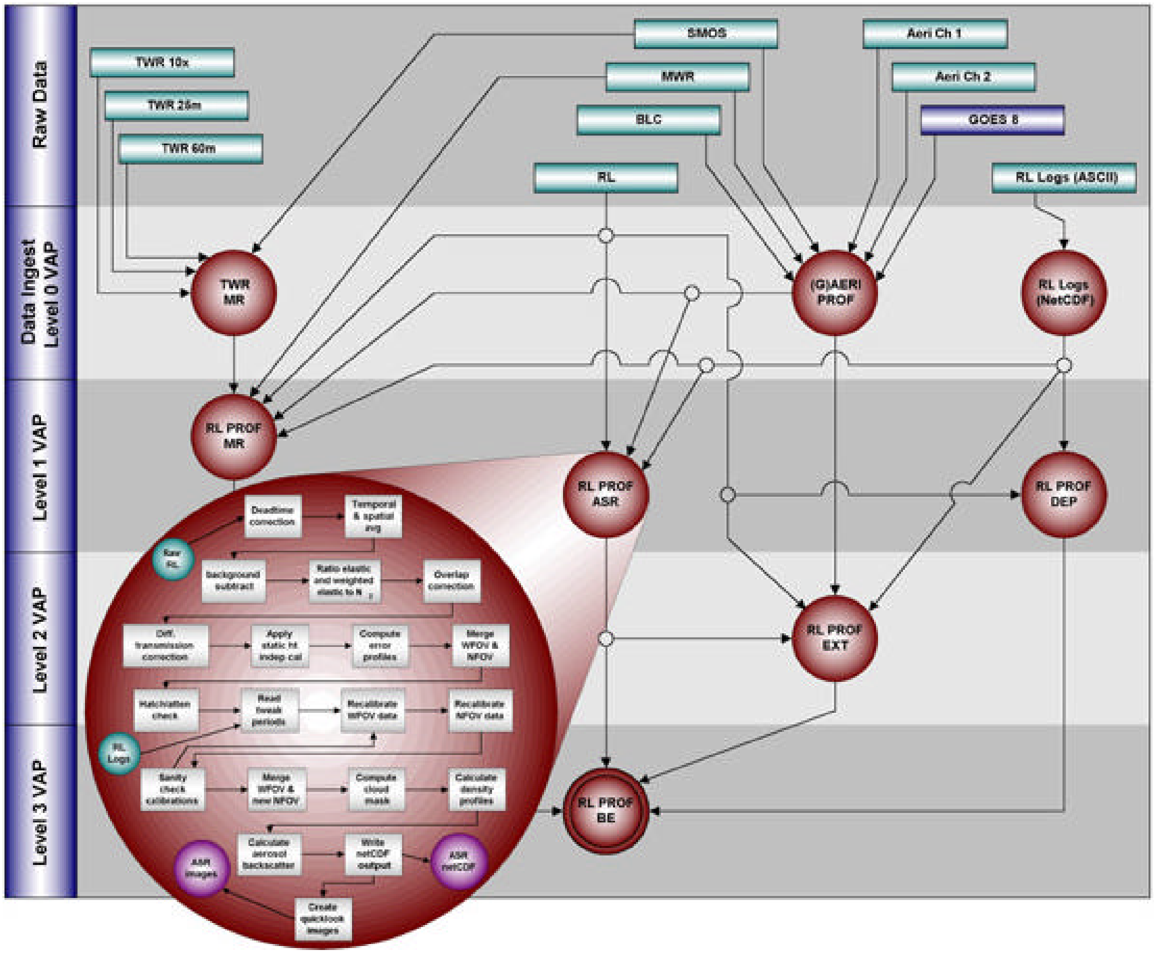

Figure 2. Raman Lidar best-estimate flow diagram. Green boxes are ARM instrument data streams; the purple box (GOES-8) is an external data stream. Red circles are VAPs. The blow-up of the RLPROF ASR VAP shows the level of complexity that can exist inside each VAP.