Aerosol-Related Data Products and VAPS

JOHN SHILLING

PNNL

ASR Science Team Meeting 2020

New Data Products

- ► ACSM b-1 datastream
  - ■ Currently available for SGP and ENA data October 2019 – present.
  - ■ Runs daily and provides ACSM calibrated species concentrations, an ACSM volume, and QA/QC checks.
  - ■ Assumes CE = 1.

- ► Ozone b-1 datastream
  - ■ Provides calibrated, background corrected O_3 concentration.
  - ■ Available for SGP, OLI, ENA.

- ► CCN average datastream
  - ■ Computes the average CCN concentration at multiple SS setpoints.

- ► CCN spectra datastream
  - ■ Fits to describe CCN number as a function of supersaturation.

New Data Products – Size Distributions

▶ We have generated (by FY20 end) harmonized b-level datastreams for:
- Nano-SMPS
- SMPS
- UHSAS
- APS

▶ These harmonized datastreams standardize variable names and units, including:
- Size distributions in dN/dlogDp units.
  - This will facilitate size distribution inter-comparison.
- Size bin diameter midpoints and upper and lower bounds
- Integrated number concentration, volume, and surface area.
  - Will facilitate inter-comparison.
- QA/QC checks on the data.

SP2 Processing: BC size distributions (Led by Scot Collis Group at ANL)

- Modernizing legacy IGOR code for SP2 processing in Python

- Calculating BC mass and diameter to get size distributions.

- Current status: Implementing filtering and comparing vs. IGOR

- Need to calibrate size calculation

Code at: https://github.com/rcjackson/PySP2
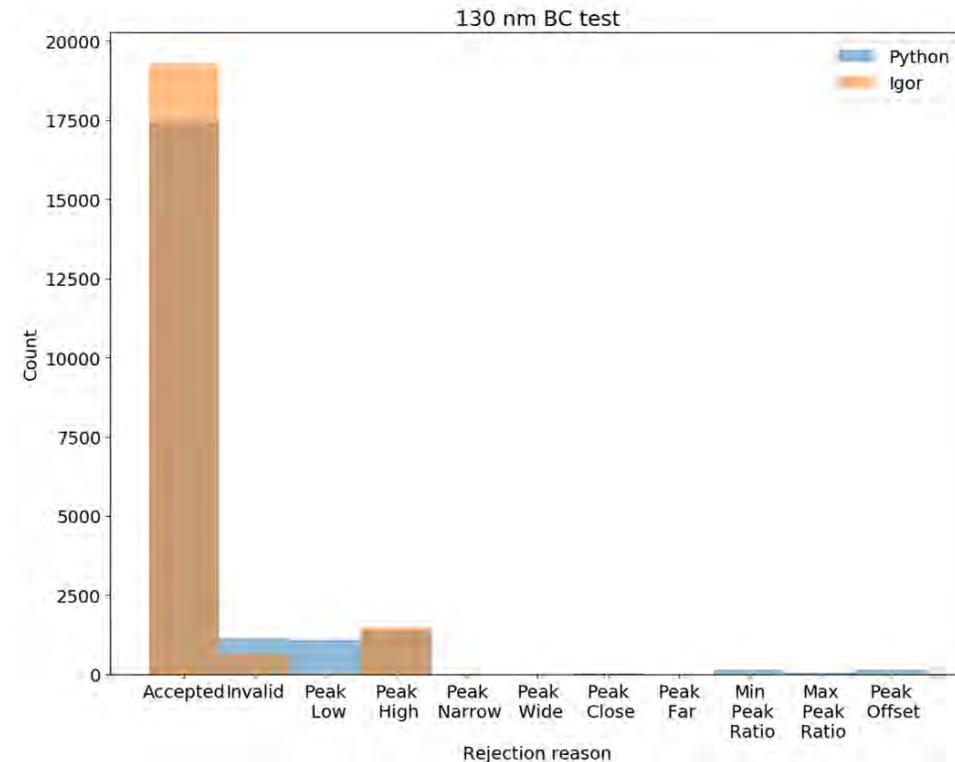
Operational VAPS: Aerosol Optical Properties (AOP)

► Combines PSAP extinction and Neph scattering data to calculate: aerosol absorption coefficient, SSA, angstrom exponents, asymmetry parameter, corrected scattering, etc.

■ Calculations are provided for different PSAP correction algorithms.

► AOP VAP is operational and data are available for almost all sites and field campaigns.

► Recently updated the algorithm to detect and correct for PSAP filter changes.

■ Should improve data availability.

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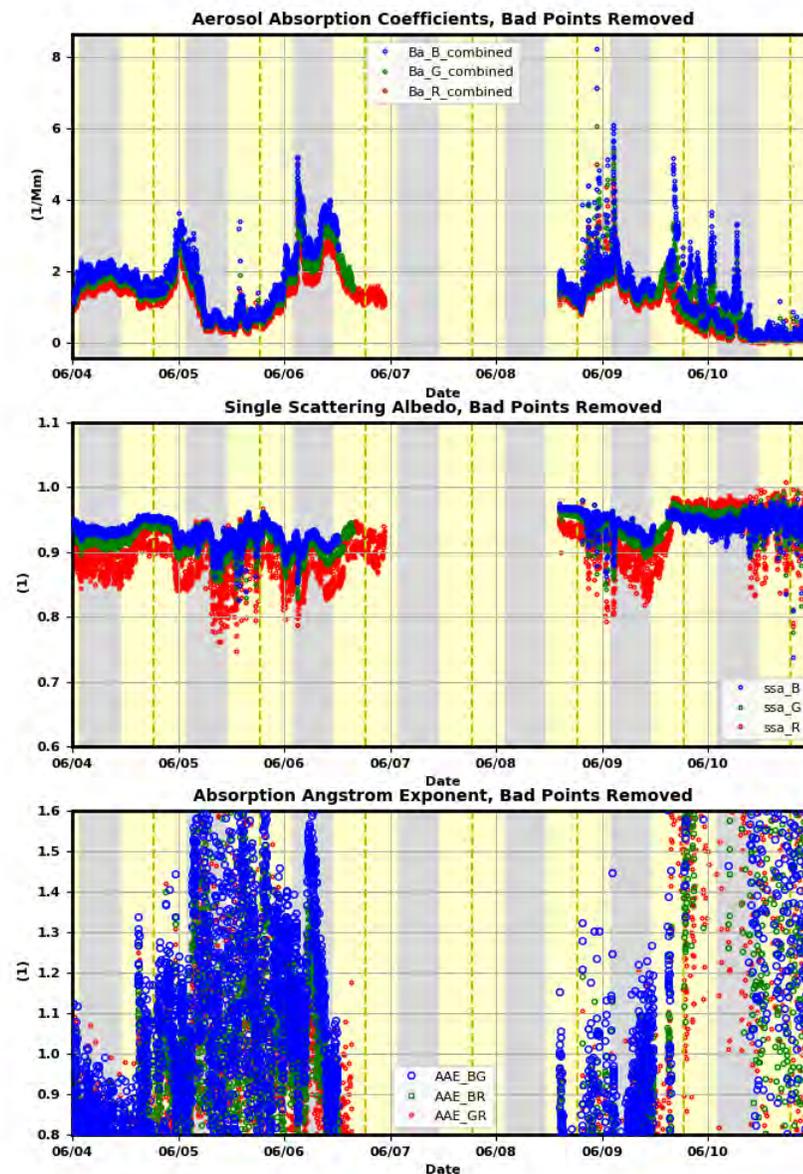
Operational VAPS: Aerosol Optical Depth (AOD)

▶ Uses MFRSR data to retrieve aerosol optical depth at 7 wavelengths from 415 - 1625nm.

- Recently added a 1.6 um channel to MFRSR and we are updating VAPS to include this channel.
- Runs autonomously at some sites, but needs some hand-processing at challenging sites with frequent cloud cover.
- Will update Langley every 6 months for ENA, NSA, MCQ (challenging sites).
- ENA and MCQ will be processed this FY.
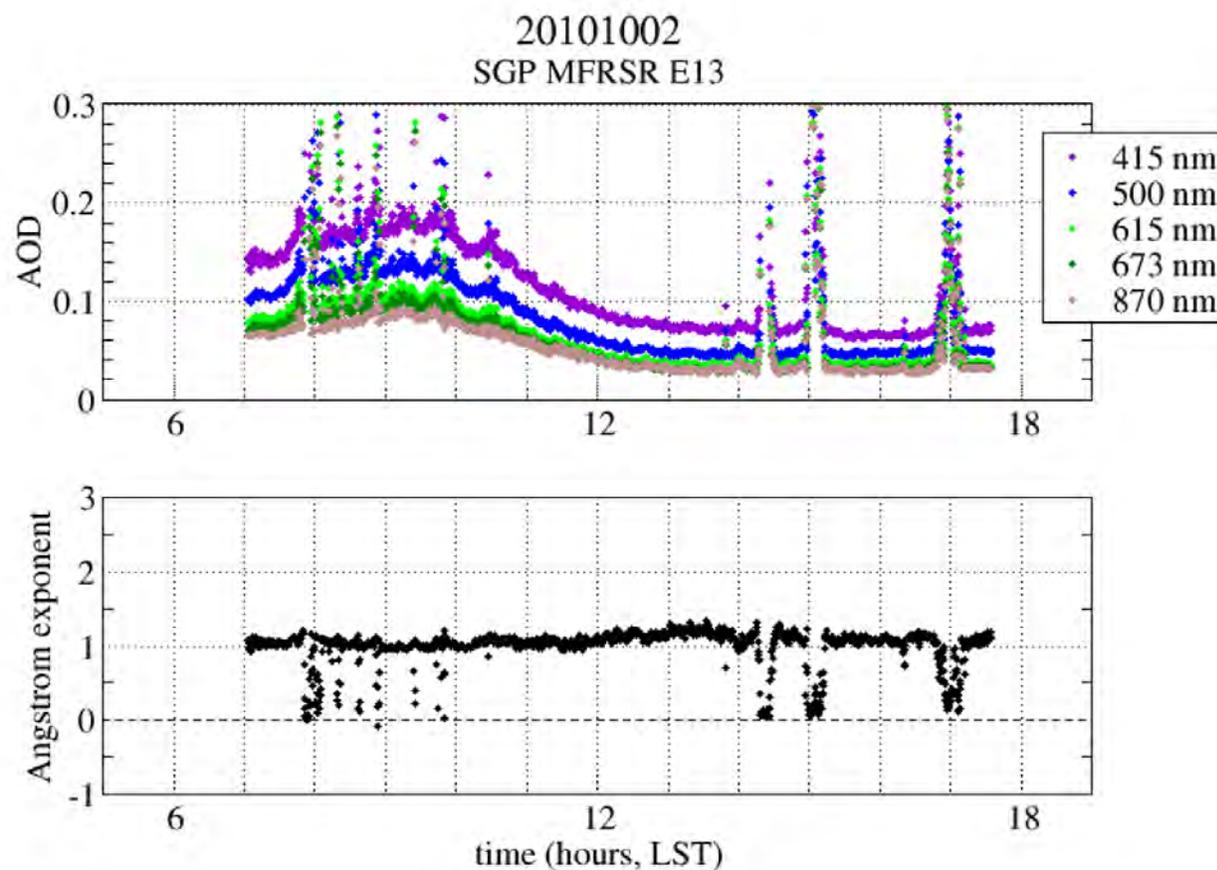
# New This Year: Quality Control Aerosol Optical Depth (QCAOD) VAP

► Individual AOD products vary in continuity, data quality, and temporal resolution due to differences in instrument design and data processing.

► The QCAOD VAP integrates four AOD products and generates nearly-continuous combined AOD.

   ■ Reports AOD at two wavelengths, 500 and 870 nm.

   ■ High temporal resolution (1-min) for 21-yr period (1997-2018) at SGP.

   ■ Recently available.
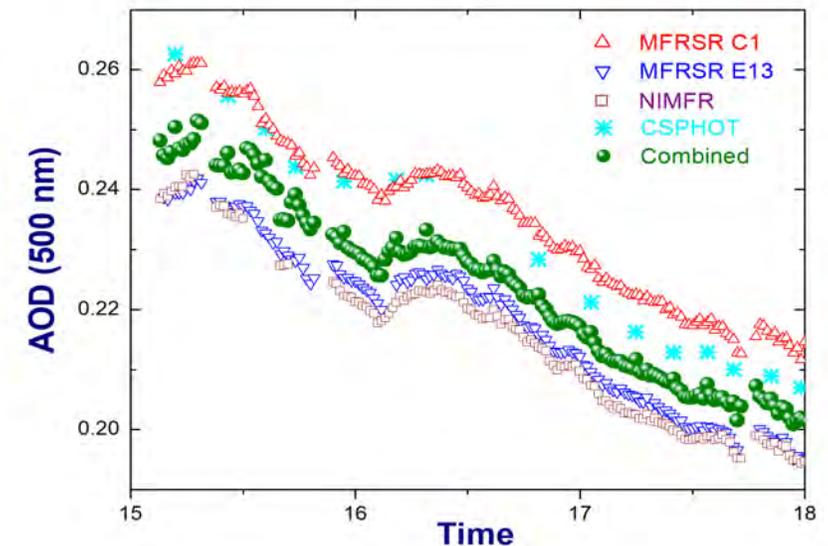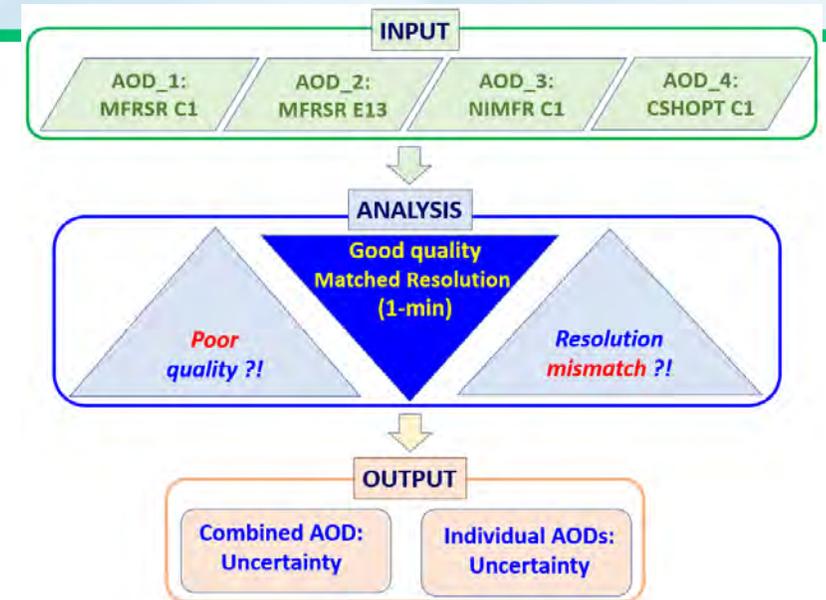
New This Year: ACSM Composition Dependent Collection Efficiency VAP

▶ We have applied the composition dependent collection efficiency calculation from Middlebrook et al. 2012 to the autonomous ACSM b1 data.

▶ This will generate an ACSM_CDCE datastream, which will run in near real-time.

▶ In general, the CDCE algorithm significantly improved the ACSM/SMPS comparison at SGP, but it isn't perfect.

  ▪ Need to look into other sites.

▶ Should be available for SGP by end of FY20.
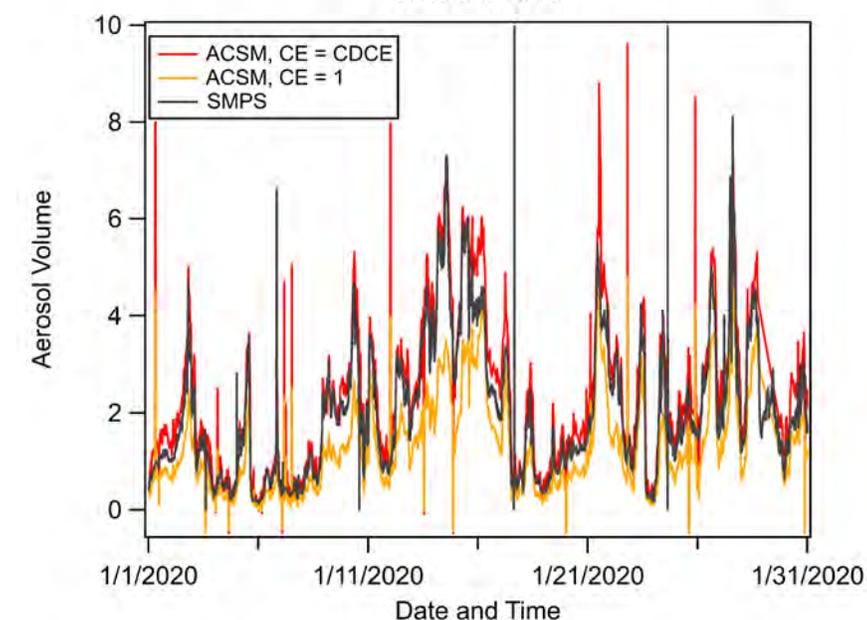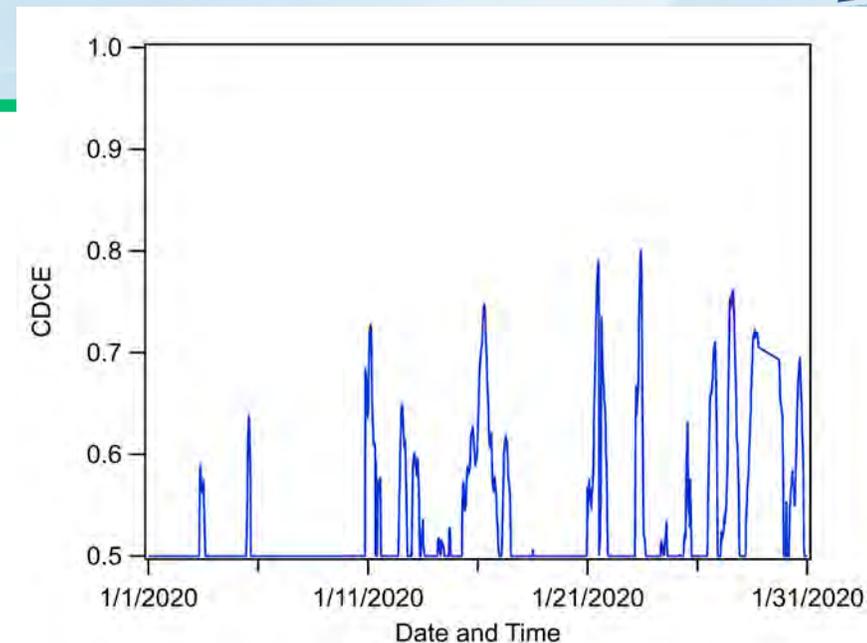
New This/Next year: CCN Kappa VAP

Size distribution

ARM

▶ We are calculating a parameterized, bulk hygroscopicity (kappa) value by combining CCN and SMPS data.

▶ Kappa value is calculated for each value of SS.

▶ We expect data will be released late FY20/early FY21 for SGP.
  - ■ Will work on ENA data next.
    - ● UHSAS measures size instead of an SMPS.

$$N_{\text{CCN, measured}}(\text{SS}, t) = \int_{D_{\text{crit}}(\text{SS},t)}^{\infty} N(D_p, t)\, dD_p$$

$$\text{SS}_{\text{crit}} = \left[\frac{4}{\kappa D_p^3} \left(\frac{4\sigma M_{\text{w}}}{3RT\rho_{\text{w}}} \right)^3 \right]^{1/2}$$

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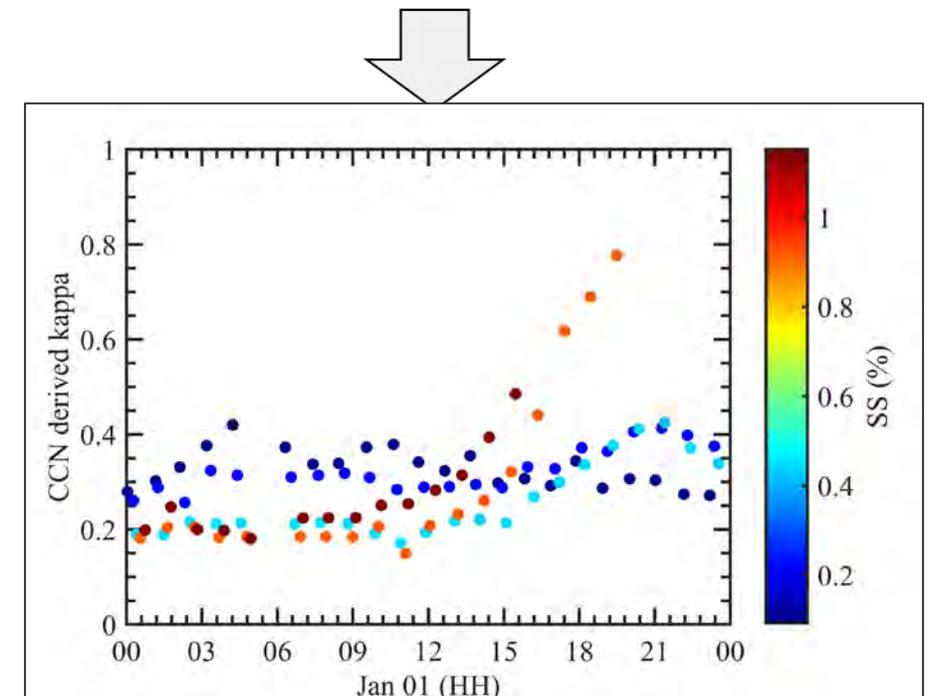
► We are rebooting a CCN vertical profile VAP developed by Ghan, McFarlane, Collins.

- ■ VAP generates the vertical profile of CCN at SS values measured by the CCNC.
- ■ Valid up to cloud base

► Will run autonomously at sites with a CCNC and a lidar.

► Data will be available starting in FY21.

- ■ We are currently developing this VAP for the SGP site.
- ■ Will validate VAP with aircraft data.
- ■ Will work on ENA site next.

Reference: Ghan, SJ and DR Collins. 2004

Aerosol particle humidification factor at the surface

$f(\text{RH}(z, t))$

CCN concentration vertical profile

$\text{CCN}(z, t, s)$ ← $E_d(z, t)$ ← $\text{RH}(z, t)$

Dry extinction profile

$\text{CCN}(0, t, s)$ $E(z, t)$

CCN concentration at surface   *Extinction profile at ambient humidity*

sgpr1ccnprof2ghanC1.c1 for 20160901

Cloud condensation nuclei at supersaturation step 1

* -9999 values masked, plotted in dark gray

Version: vap-ccnprof2-0.0-0.dev0.dirty.el6
Creation Date: Fri Jun 12 22:00:00 2020

max = 32392.436
min = 0.0
mean = 752.814
median = 0.0
stdev = 2408.041

Plans for FY 2021

New VAPS starting next year:

► AOD Best Estimate – evaluates multiple AOD datastreams and provides an evaluation of the best estimate at 5 wavelengths.

► Merged Size Distribution – will merge size distributions from multiple instruments (initially nano-SMPS, SMPS, APS)
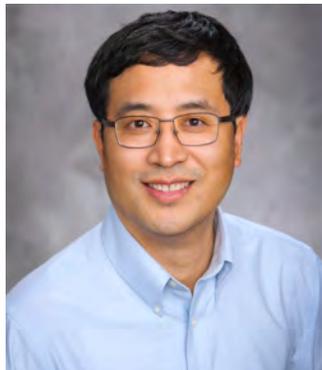
VAPS expected to come online FY20/FY21:

► ACMS CDCE expected to be extended to most sites and field campaigns

► CCN Kappa for SGP and ENA.

► CCN Vertical profile for SGP and ENA.

► AOD for NSA.

New datastreams:

► b1 processing of CO and SO_2.

► b1 data for ACSM AMF deployments.

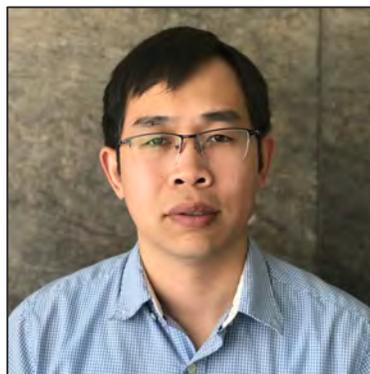# Science Product Development Led by a Team of Scientists

ARM

Translator Group

Shaocheng Xie
Lead Translator
Modeling POC

John Shilling
Aerosol POC
TRACER POC

Damao Zhang
High-latitude POC
MOSAiC POC

Scott Collis
Convective POC
CACTI POC

Scott Giangrande
Warm Clouds POC
COMBLE POC

Krista Gaustad
Software
Development

Ken Kehoe
Data Quality