AQ Constellation Targets:
Harmonization to improve data product quality and usage

- During 2013, the CEOS ACC AQ Constellation leads developed recommendations for harmonization to mutually improve data quality and facilitate widespread use of the data products (see next slide)
- Includes LEO and GEO: LEO observations are a common transfer standard to link the GEO observations
- Progress to date includes:
  - Sharing of instrument requirements influenced instrument specifications, which may facilitate harmonization of data products
  - Advocating open data policy (including L1B) with common formats to facilitate broad usage
  - Sharing L1B and L2 format specifications to easily exchange data
  - Establishment of new GSICS UV-Vis subgroup
  - AQ Constellation "Geophysical Validation Needs" document is in preparation

Open Data Policy and Common Cal/Val Standards: Recommendations

1. **Apply best practices (lessons learned) for UV-Vis spectrometer calibration, characterization, and validation**
   - Share calibration/characterization plans and invite cross participation in reviews of such plans
   - Develop longer term recommendations for common post-launch cal/val strategies (e.g. supersite instrumentation round-robins, joint airborne campaigns)
2. **Radiometric consistency**
   - Pre-launch: highest priority is per-instrument calibration/characterization as completely as possible (common absolute radiance calibration is secondary)
   - Post-launch: more work needed on approaches (eg LEO vicarious intercalibration or Earth scenes)
3. **Sharing and consistency of data products (format, content, metadata)**
   - Share specification documents
   - Share instrument characterization/calibration databases and Level 1-b data, in a common format, to allow wide application of algorithms to all datasets
   - Identify and produce common constellation data products (may differ from standard products)
4. **Consistency in retrieval algorithms**
   - Cross participation in ATBD reviews
   - Jointly improve retrieval algorithms by conducting inter-comparisons on common radiances
5. **Consistency of spectroscopy**
6. **Support scientific collaboration**

"Geophysical Validation Needs" document outline

Thanks to Ben Veihelmann & Jean-Christopher Lambert for initial draft

- Identification of Common Parameters in L1b and L2 Products
- Lessons Learned from LEO heritage missions
- Common Geophysical Validation Needs (by mission phase)
- Inter-Mission Geophysical Validation Needs (by mission phase)
- Development Needs for New Validation Infrastructure or Approaches

Level 2 Products: Potential Constellation Products (as of 4/2015)

Potential constellation products include the standard products common to all missions

	Europe Sentinel 4	USA TEMPO	Korea GEMS	Europe Sentinel 5 Precursor TROPOMI
Tropospheric O_3	Standard	Standard	Possible	Standard
Total O_3	Standard	Standard	Standard	Standard
Total NO_2	Standard	Possible	Standard?	Standard
Tropospheric NO_2	Standard	Standard	Standard?	Standard
Tropospheric H_2CO	Standard	Standard	Standard	Standard
Total SO_2	Standard	Likely	Standard	Standard
AOD	Standard	Likely	Standard	Standard

Level 2 Products: Potential Constellation Products (as of 4/2015)

Challenges for common constellation products

- Differing instrument specifications
  - Differing fields of regard => direct inter-calibration and inter-validation of L1b is not possible
  - Differing radiometric performance
  - Differing native horizontal resolutions; consider spatial representativeness
- Retrieval algorithm differences
  - Different approaches in standard algorithms
  - Probably different methods for total/trop separation
  - Differences in standard cloud/aerosol screening (e.g., S-4 & S-5P will make use of NIR)
  - TEMPO Trop O3 will make use of visible band
- Etc. Etc.

What products, to what accuracies (precisions?), validated how?

Quality Assurance

- Traceability of Requirements
- Traceability of data generation process
- Traceability of quality assurance process
  - Reference measurements
  - Validation methods
- Availability of uncertainty budgets and metrics
- Possible framework, methods, tools being established in QA4ECV
- In order to:
  - Support the development of algorithms and data products
  - Provide quality assured data to users
  - Entrain new users

Concluding thoughts

- Data harmonization activities are underway
  - Mission leads have been sharing specifications
  - Pre-launch instrument characterization requirements necessarily vary by instrument
  - GSICS UV-Vis working group is off to a good start
  - AQ Constellation Geophysical Validation Document is being prepared with the goal of guiding mission specific requirements being developed by the respective agencies
- Next: identify goals/approaches for common constellation products and their validation
- Past and upcoming airborne field campaigns offer potential for ongoing collaborative GEO mission preparation and possibly early S-5P cal/val
  - AROMAT Romania 2015, 2016 (ESA)
  - KORUS-AQ Korea 2016 (Korea NIER, US NASA)
- An AQ Constellation session has been proposed for the Dec 2015 Fall AGU Meeting, to include all facets of preparation

BACKUP

Funded tropospheric chemistry mission parameters (as of 4/2015)

	Europe Sentinel 4	USA TEMPO	Korea GEMS	Europe Sentinel 5 Precursor TROPOMI
Orbit	Geostationary	Geostationary	Geostationary	Low-Earth
Domain	Europe and surrounding	North America	Asia-Pacific	Global
Revisit	1 hour	1 hour	1 hour	1 day
Status	Detailed Design, Phase C	Instrument CDR July 2015	Instrument CDR complete	Instrument delivery 2015
Launch	2021 (Flight Acceptance Review first instrument)	No earlier than 11/2018 No later than 11/2021	2018	Early 2016
Payload	UV-Vis-NIR 305-500, 750-775 nm	UV-Vis 290-490, 540-740 nm	UV-Vis 300-500 nm	UV-Vis-NIR-SWIR 270-500, 675-775, 2305-2385 nm
Products	O_3, trop. O_3, NO_2, SO_2, HCHO, AAI, AOD, height-resolved aerosol	O_3, trop. O_3, 0-2km O_3, NO_2, HCHO, SO_2, CHOCHO, AOD, AAI	O_3, NO_2, SO_2, HCHO, AOD	O_3, NO_2, SO_2, HCHO, AAI, AOD, height-resolved aerosol, CO, CH_4
Spatial Sampling	8 km x 8 km at 45N	≤ 2.22 km N/S x 5.15 km E/W @35N	3.5 km N/S x 8 km E/W @38N	7 km x 7 km nadir
Nominal product resolution	8.9 km N/S x 11.7 km E/W @40N	≤ 8.88 km N/S x 5.15 km E/W @35N	7 km N/S x 8 km E/W @38N (gas), 3.5 km N/S x 8 km E/W @38N (aerosol)	7 km x 7 km nadir
Notes	Two instruments in sequence on MTG-S; use TIR sounder on MTG-S (expected sensitivity to O3 and CO). Synergy with imager on MTG-I w.r.t. aerosol and clouds.	GEO-CAPE precursor or initial component of GEO-CAPE. Synergy with GOES-R/S ABI w.r.t. aerosol and clouds.	Synergy with AMI and GOCI-2 instruments w.r.t. aerosol and clouds.	In formation with S-NPP for synergy w.r.t. clouds and O_3.

Lessons learned from UV spectrometer experience

- Calibration and characterization are very instrument dependent
  - We cannot dictate common calibration practices for instruments of different design, but can share techniques
  - Standardize the “outcome” of calibrations, not the actual calibration procedure
- We always wish we had more pre-launch characterization data
  - Always have to sub-sample the sensor spatial and spectral domains
  - The more sparse the sub-sampling, the harder it is to diagnose unexpected on-orbit performance
  - The amount of sampling often gets scaled back to reduce cost
  - We should at least recommend where to not cut corners
- One opinion: “With LEO instruments, we used to do a lot of common inter-calibration. Now everyone does calibration so well that we may not need to focus so much on inter-calibration anymore.”
- Others?