**Minutes V0.1**

**OCO-TROPOMI-GOSAT CALIBRATION MEETING**

Friday 4 June 2021

Chaired by JAXA

**Participants**

**JAXA:** Akihiko Kuze (Chair), Kei Shiomi, Hiroshi Suto, Masakatsu Nakajima, Nobuhiro Kikuchi, Mayumi Shigeto, Fumie Kataoka, Koji Akiyama

**NIES:** Tsuneo Matsunaga, Tatsuya Yokota

**NASA:** Rob Rosenberg, David Crisp, Dejian Fu, Carol Bruegge

**SRON:** Tim Van Kempen

**ESA:** Claus Zehner

**Welcome and Objectives**

Akihiko Kuze (JAXA) welcomed everyone to the OCO-TROPOMI-GOSAT CALIBRATION meeting. He noted today’s objective was to share RRV2021 plan which the JPL team will leaving for next week, Analysis status of RRV2020 and 2021, TSIS for solar model, and VCAL portal site, and to have a discussion.

**RRV 2021**

Akihiko Kuze (JAXA) thanked JPL team for going to the RRV to measure surface albedos next week. He reiterated the meeting objective which was to discuss the forward calculation using the measured surface albedo data and the new solar data in addition to intercomparisons.

* A key point for the forward calculation is different footprints and different geometries among the 5 instruments. This means the surface BDRF correction is needed.
* The data obtained on 3 April is good one we only have so far and JAXA has decided to use the data for GOSAT vicarious calibrations.
* The data which will be observed by JPL team on 7-8 June is expected to apply all 5 instruments. Furthermore, 8 June would be a golden day so that OCO and GOSAT-1 &-2 will measure the site.

**BRDF Correction**

Akihiko mentioned that MODIS products they are using have some issues in case of bright surface. However, AOT over RRV is very low so that they can use the RRV data even in case of a bright surface.

JAXA checked both a special product and a nominal new product (V061) from UMASS carefully and found that they are very similar. JAXA is going to apply the special product first for RRV2020 and RRV2021 April campaigns.

JAXA will use JAXA/EORC GOSAT forward model because level 2 retrieval is used for the model and 2 liner polarizations are used for the level 2 retrieval so that they can include vector models for the forward calibration.

There is still a challenge that GOSAT-2 and TROPOMI have 2.3 micron but MODIS does not, so an extrapolation would be needed.

JAXA is planning to re-process or re-analyze old data since 2009. However, there is no special product for them at this point. Therefore, they are planning to use MODIS V061 product once it becomes available.

**MET data for RRV2020 and 2021 analysis**

Radiosonde data are available between RRV2009-2018. That means MET model has to be used after 2019 and JAXA tried to intercompare HRRR and GPV. As a result, HRRR would be better because RRV is located in the mountainous area and it may represent such kind of topographic condition even though there is no significant difference between them.

**Radiance Degradation Factor (RDF) Estimation**

Akihiko explained JAXA’s current situation on their forward calculation:

* At present, JAXA uses CSU model (vector) for their analysis and the calculation is made based on the OCO spectral range. With them, JAXA has started to analyze 13-year data.
* Vector EORC forward model is used for partial-column product and GOSAT two linear polarization will be used for the vector model. As of a solar model, JAXA had chosen TSIS-HSRS for the presentation afterward but we need to discuss it.
* GOSAT and GOSAT-2 are ready for ILS and polarization response and it would be best if NASA and ESA could provide JAXA with their instrument Mueller matrix of OCO-2, OCO-3, and TROPOMI. However, JAXA can do it with a scalar model if those matrixes are not available.
* The original CSU model has OCO-2 spectral range but JAXA decided to calculate with a wider range to cover the full GOSAT range and extend the range to 2.3 microns for TROPOMI and GOSAT-2.
* We also need to discuss the line parameter.

**Radiance Degradation Factor (RDF) of GOSAT**

Akihiko presented the recent calculation result for RRV2021 April using the EORC model:

* GOSAT band 1 was used because of the wideness and the site average was 0.425. UMASS special products were used for BRDF correction. April 3 IFOV average was 0.441 and the correction factor was 1.039.
* The difference between the CSU model and JAXA’s new model is how they use the BRDF correction.
* The new estimation was within certainties and there was no significant degradation.

**TSIS HSRS Solar model**

Akihiko explained their current understandings about TSIS model:

* GOSAT estimated using Toon model showed about 4% higher than OCO-2.
* TSIS irradiance is lower than the current solar data especially at 2 microns.
* If we apply our TSIS model, we have to modify our current best estimated radiances because the radiances of our level 1 product are based on the RRV analysis using Toon model.
* As a result, GOSAT showed larger RDF when TSIS data was applied.
* If we apply the TSIS, RDF and our best-estimated radiance in level 1 products will change. However, surface albedo and XCO2, XCH4 retrieval do not change when we use the same solar model of the level 1 product for RDF calibrations and level 2 analysis.

**VCAL portal site**

Akihiko shared the current status on VCAL portal site:

* JAXA has made a test site which has not been completed yet. It will include how to measure surface albedo, observations patterns obtained from RRV campaigns, some documentations, photos, and movies.
* Now, the site is preliminary one so those who try to log in need an ID and password. After the summer campaign, JAXA wants to open the site if possible.
* JAXA wants to present the site as one of our team’s outcomes to CEOS WGCV plenary meeting if other team agencies agree.

David Crisp (NASA) mentioned it will be good to track everything and probably is going to a critical part of the interaction.

Carol (NASA) mentioned the OCO project has also tried to make the surface reflectance data public. Akihiko suggested to make a link between those sites for reference for each other. Carol took it as an action to check the current status on the Goddard site.

JAXA will contact ESA to add the link in CEOS WGCV site which is in control by ESA. NASA supported the idea to make the link between the sites.

Carol suggested that she is going to suggest that they link information about how to access MISR BRF data. Akihiko supported the idea.

**TSIS-SIM**

Dejian Fu (NASA) explained about the work on making use of TSIS data set for their calibration work:

* Got 5 files which consist of different spectral resolutions from TSIS-SIM web. They plotted the data to see unit convergence of OCO and GOSAT through a software.
* Solar spectrum irradiance for the four different spectral resolutions covers from UV to the infrared.
* In regard to OCO-2 ratio of VicCal/ARP on April 2021 data, RDF agreement between VicCal and ARP is within 3.6% for O2A band and within 8% for WCO2 and SCO2 band. The difference of retrieved RDFs using B10 L2FP and B9.2 L2FP agree with the difference of solar irradiance.
* In regard to OCO-3 ratio of VicCal/ARP on April 2021 data, RDF agreement between VicCal and ARP is within 3.5%.

David added that the lesson there is that they have been using an incorrect solar flux for many years and now have to go back and re-evaluate. They also found that they were very sensitive to the absolute radiometry in the O2A band but were not very sensitive to the absolute radiometry in the weak and strong CO2 bands. The change actually introduced is very tiny one in XCO2 and probably XCH4 as well, which is fortunate.

**Radiometric and Vicarious Calibration TROPOMI-SWIR**

Tim Van Kempen (SRON) presented the degradation on SWIR which monitors on the Sun and has two onboard lights to check the degradation. It seems that the SWIR channel is not degrading at all down to about 0.1%, they are not sure how much they can trust the figure at this moment though. Other three channels do degrade a little but it is negligible.

SRON tried to compare the spectrum from TROPOMI to a simulated spectrum using the reflectance measured at RRV with their own radiative transfer code. At continuing wavelengths, 2313 nm window would be the best suitable and the most of the works went quite well. The biggest factor is a norm\_BRF of the angles that need to be changed.

Tim showed RRV measurement/TROPOMI-SWIR 2313 nm in the past few months. When he extracted all the data from the RRV campaign and compared that to TROPOMI, it agrees pretty well within 5 to 10%. TROPOMI always has a large deviation at larger angles. They can see big differences above 60 degrees. He has not solved this and cannot explain why the ratio is always so big at 2.3 microns. It seems that we see this when TROPOMI sees in the southern RRV sites. The northern and central parts are much more representing what TROPOMI sees.

Tim reported the progress on the nBRDF correction a SWIR with three methods. The big question in the March meeting was how do we need to average these MODIS and VIIRS products. Within 50 degrees zenith angle, we seem to get results in about 10% validation., which is Pro. But the large angles above 60 are always off. TROPOMI is always larger than the reflectance we gave. When they skew it to have the deviation as low as possible with even the most extreme models from MODIS, they still got at least 10% difference between TROPOMI and the simulation, which is Con. That is a problem but there is not really a solution. As a result, all methods have pros and cons.

Tim also explained the comparison of GOSAT-2 to TROPOMI because they have the coincidental band which means that they can get more data. There is a quite regular interval between the satellites which they can use to compare. He also presented the result to try to overplot.

Next steps are:

* To process GOSAT-TROPOMI for all orbits available
* MISR alternatives
* RRV2021 ‘Silver’ Day

Tim added he checked April data and found that TROPOMI, GOSAT, and ground data are exactly same. He will report on that next time around.

Carol questioned if his table in the slides show the time difference between the time that the ground data was taken and the time that TROPOMI actually saw the target. Tim answered it typically varies around 130 RFP with a spread of about 45 minutes or so, decently close but the last few percent might be actually vital. Carol added they tend to take data starting a half hour before the overpass and ending no more than a half hour after the overpass because their studies showed how the surface native viewing reflectance changes with the time but the difference is pretty minimal as long as within a half hour.

**AOB**

Target date for the next meeting: in August