System Vicarious Calibration: The Session

The Splinter Session on "**System Vicarious Calibration**" aims at:

i. Summarizing the state-of-art on satellite ocean color vicarious calibration

ii. Discussing the need for advances in support of future missions.

The session is structured in three parts:

i. ***Introduction*** (terminology and rationale);

ii. ***Targeted talks*** (current implementations, achievements, envisaged developments and in situ data requirements);

iii. ***Open discussion*** (driven by seed questions with limited time assigned to each topic).

System Vicarious Calibration: Terminology

The term **Vicarious Calibration** was introduced in the early 80's (see P. Koepke 1982 who cites Yates 1981) and currently **indicates a family of procedures for the indirect calibration of space sensors including**:

- **Inter-Band Vicarious Calibration** (e.g., calibration over bright clouds (Vermote and Kaufman, 1995)) utilized to verify the inter-band calibration. Expected top-of atmosphere inter-band calibration uncertainties are of the order of 2-3%, leading to inter-band calibration uncertainties easily exceeding 20-30% in L_w.
- **Radiometric Vicarious Calibration** (e.g., *calibration relying on RT modeling of Rayleigh scattering* (Vermote et al. 1992) or *calibration relying on in situ sky radiance measurements* (Gordon and Zhang, 1996)) utilized to verify the absolute calibration in the visible and infrared. Expected (absolute) top-of-atmosphere calibration uncertainties are 1-3%, leading to uncertainties of 10-30% in L_w.
- **System Vicarious Calibration** (e.g., *calibration relying on the use of highly accurate in situ measurements of L_w and the application of the RT code embedded in the atmospheric correction scheme, thus leading to the calibration of the entire system, i.e., the sensor plus the algorithms* (Gordon 1998)) specifically applied to perform (absolute) radiometric calibrations. Expected top-of-atmosphere calibration uncertainties are 0.3-0.5%, leading to uncertainties of 3-5% in L_w. It must be stated that these uncertainties are expected to be strictly valid for the "measurement" conditions which characterize the "system vicarious calibration" process.

"System Vicarious Calibration"

System Vicarious Calibration: Rationale

Following a note from Carol Johnson (National Academies Press, 2011), let's assume a maximum acceptable uncertainty of 5% in L_w determined from top-of-atmosphere L_T. If L_w is 10% of L_T, then the uncertainty in L_T needs to be lower than 0.6% (=5% x 10/90). The allowed uncertainty in L_T decreases to approximately 0.3% if L_w is 5% of L_T.

This means that "system vicarious calibration" is the only viable vicarious calibration for satellite ocean color when accounting for the 5% target uncertainty in L_w in the blue spectral region.

*Additionally, if vicarious calibration factors determined from independent in situ data sets exhibit (spectral) biases as low as 0.3-0.6%, their application may introduce a (spectral) **bias** of the order of the uncertainty considered acceptable for the derived radiometric data products.*

This suggests that in situ data sources for vicarious calibration of satellite ocean color sensors need to be carefully evaluated accounting for the actual application of satellite data products recognizing that the creation of CDRs imposes the most stringent conditions.

System Vicarious Calibration: Constrains

Legacy constrains for vicarious calibration data/sites

- Early indications on the appropriateness of *in situ* data/sites included (Gordon 1998):
  1. Cloud free, very clear, maritime atmosphere (τ_a<0.1 in the visible);
  2. Horizontally uniform L_w over spatial scales of a few kms;
  3. Oligotrophic-mesotrophic waters (to minimize *in situ* measurement errors of L_w in the blue);
  4. Coincident aerosol measurements.

- Additional main indications suggested (Clark et al. 2003):
  5. Hyper-spectral measurements to cover any ocean color spectral band;
  6. Fully characterized *in situ* radiometers;
  7. SI traceable measurements.

System Vicarious Calibration: Discussion Topics

- ***The revision of current VIS and NIR methods;***

(e.g., is there any alternative to the current method(s) relying on the vicarious calibration of VIS bands with respect NIR bands, using highly accurate in situ VIS data, and assuming space sensor sensitivity decay with time is accounted for elsewhere?)

- ***Traceability, uncertainty, temporal continuity, and data rate of in situ reference data;***

(e.g., is there any community consensus on the specifications for in situ reference measurements, implying consensus on measuring instruments and methods?)

- ***Environmental features of measurement site(s);***

(e.g., is it assured that that relaxation of constrains for some environmental quantities can still allow for the determination of vicarious calibration coefficients suitable for climate investigations?)

- ***Requirements for field instrument(s)/method(s);***

(e.g., by recognizing the major effort to assure the characterization of measuring systems like MOBy, is it assured that that relaxation of requirements for field instrument(s)/method(s) can still allow for the determination of vicarious calibration coefficients suitable for climate investigations?)

- ***Standardization of "system vicarious calibration" across the various space missions devoted to the generation of CDR's;***

(e.g., isn't that the need for generating CDRs by combining data products from fully independent space missions imposes the standardization of the vicarious calibration process for the various space sensors?)

- ***Relaxation of requirements for regional applications;***

(e.g., by recognizing that current operational schemes are targeted to oligotrophic-mesotrophic waters, is there any general vicarious calibration strategy that can be suggested for regional applications not requiring the delivering of climate quality data?)

System Vicarious Calibration: Talks

09:55-10:10 ***General overview of the method currently applied by NASA-OPBG with a focus on constrains for in situ reference data*** (Jeremy Werdell, NASA GSFC)

10:10-10:25 ***General overview of the method currently applied for MERIS with focus on the dual source of in situ reference data*** (Constant Mazeran, ACRI-ST)

10:25-10:40 ***Requirements for system vicarious calibration of future ocean color sensors with reference to sources of in situ data*** (Carlos Del Castillo, Johns Hopkins University)

10:40-12:00 ***Discussion*** *supported by seed questions linked to the above talks* (with limited time assigned to each topic).

12:00-12:15 ***Wrap-up*** *to recap any action(s) requiring community consideration*.