IOP Workshop Minutes

1. **Overview – session moderator:** Jeremy Werdell

   The focus of this session was to set the stage for the discussions at the workshop. A review of the goals of the workshop (as presented in previous email communication and posted on the workshop website) was given. Agreement by the participants as to their understanding of said goals.

   Participants agreed that the summaries of the semi-analytical algorithms (SAA) as posted on the website were accurate.

   A description of the evaluation process was given and accepted by the group with a recommendation made that attention be paid to the data ranges used to evaluate failure conditions.

   Topics brought up under discussion included:
   a) bb/a vs. bb/a+bb – research may be useful for uncertainties – what works best?
   b) large uncertainty in scattering correction in blue for absorption measurements; biases in the vectors may exist due to these uncertainties; adg – sum of two exponents is not entirely accurate.
   c) How do we balance the needs of global with regional algorithms? Mark Dowell to present more tomorrow – options can be made to vary by optical water class. Limitations are with in situ data sets necessary to define the optical water classes; mechanistic versus empirical definition of water classes is important to consider if we hope to capture changes
   d) Need to keep in mind that the current approaches may not be similar to future directions
   e) Inelastic scattering not accounted for in these models, an approach to include such in the future should be investigated

2. **End User Perspectives – session moderator:** Mike Behrenfeld

   The focus of this session was to provide context from the perspective of an 'end-user' of the IOP products. What will an end user want?

   How good to the products have to be? The answer to the question of uncertainties/bias dependent upon the question asked.

   It was noted that SAA may be more susceptible to drift in sensor than empirical algorithms. SAA allow separation of biomass from physiology – this is where sensitivities increase dramatically. Physiology: carbon (bb) to chl (aph) ratio – most of variation due to acclimation

   SAA are attractive in the increased diversity of products which can be derived. There are other

desirable products that are not yet being produced by these algorithms (e.g., beam c; fluorescence). A hierarchy of products to produce is difficult as depends upon the science question. It was agreed that the current products (e.g. adg, atotal, aph, bbp) are adequate to go forward.

Phase-function affects f/Q – important if we hope to get accurate bbp and thus beam-c. Wind effects on air/sea transmission may be more important that f/Q

VSF/bb transmissometers affected by acceptance angle in coastal waters – near-forward angles are the problem if not accounted for…

Issues – limitation of comparison data sets
Without adequate field data for comparison, we can look at behavior of retrievals – need to compare to expectations of relationships (e.g. to chl)
bbp for chls <0.1 are suspect?

Differences (e.g. QAA, GSM) in scattering retrievals need to be examined

Before trying to improve product, perhaps we need to improve understanding of uncertainties, not only of algorithm retrievals – but also in situ measurements

Salinity effects/ Raman effects might be the issue?

3. **Operational Implementation strategies – session moderator:** Bryan Franz

The focus of this session was to outline the current strategy for implementation of the SAA within the context of the operational production environment at NASA.

The Generalized IOP (GIOP) model was presented.

Acceptable data ranges were discussed:

Increase bbp high cut-off to 0.25 from 0.015
Include 670 in tests
Low end should be proportional to uncertainties of the measurement
0.01 m^{-1} for absorptions
Negative Rrs – Allow within SNR
For matrix inversion, set to slightly positive value
Weight Rrs by uncertainties for inversions
Test if removing negatives introduces a bias to the data

Zhongping Lee presented a bb/b ratio -> phase function approach to get f/Q

It was suggested that to extract information on phytoplankton functional groups (PFG) would require that aph not be assumed. An alternative was presented, suggesting that one can use fixed aph, and look at differences in reconstructed Rrs vs. input Rrs to get at PFG

information

LM convergence criteria not extremely important as it converges quickly. In general, algorithm efficiency was not a major concern, as all variants performed with acceptable speed.

Use 6 bands or not? Use of 670 not critical on global scale, but can be important in productive waters. The band set used can be determined by water class.

Flagging:
Hierarchy of products, a and bb primary, aph, adg subordinate.
Binning strategy would have to change to allow product specific L3 retrievals

A consensus understanding of how Rrs is retrieved was agreed upon, using the Lee et al. (2002) function for transmission through the air-sea interface.

Temperature and salinity corrections are needed, however source for salinity needs to be identified (NODC?)

The l3gen concept was presented – this code allows algorithms to be run on L3 binned reflectances.

4. **Discussions on uncertainties – session moderator:** Emmanuel Boss

The focus of this session was on the determination of uncertainties in the derivation of IOPs from the various SAA models.

Presentations were made by Antoine Mangin and Zhongping Lee

It was suggested that the input reflectances be weighted by their respective uncertainties. It was acknowledged that there is a need to better define these input uncertainties.

It was agreed that we have a requirement for uncertainties. Groundwork was laid for strategy to get uncertainties of inputs and model outputs.

A question was raised about outputting products at different wavelengths since uncertainties will vary by wavelength/parameter.

5. **Regional adjustment of SA parameterization – session moderator:** Mark Dowell

The focus of this session was to introduce the concept of regional (or other) parameterization for the SAA. A presentation of the 'fuzzy logic' approach developed by Mark Dowell and Tim Moore was given. There was a general consensus that this approach should be explored in

parallel with other ongoing SAA algorithm development.

6. **New Directions – session moderator:** Samantha Lavender
   The focus of this session was to identify possible future directions with the SAA algorithms. Several ideas were proposed:

   1) inclusion of inelastic scattering; Raman, CDOM fluor, chl fluor.
   2) Modelers – what do they want? They want to do the 'modeling' within their forecast numerical model.
   3) Differential optical absorption spectroscopy (DOAS) – atmospheric chemists need to know ocean component for CO2/NH4
   4) Neural Net?
   5) Extend SAA modeling into the NIR?
   6) Cross-sensor modeling – is it possible for SAAs?
   7) "exact" normalization … f/Q

   It was agreed that Raman and chl fluorescence are likely the most practical in the near-term.

   Catherine Brown presents her 'end-user perspective'

Workshop wrap-up … Moving Forward

Products to output: a, bb, adg, aph
Algorithm to implement must allow flexibility
Number of wavelengths – uncertainties vary by wavelength; bb impacted by absorption
Optionally output the slopes for bbp, adg
Metrics:

1) quality 'assured' in situ data with uncertainties
2) Hydrolight simulations may provide a means of assessing impact of changes to SAA parameterization
3) Non-data driven metrics
   a. Agreement with field data **within the uncertainties of the field data**
   b. Coverage (% as well as maps)
   c. Processing speed
   d. Maintainable, evolvable – FLEXIBLE!
   e. Sensitivity to 'bad' inputs – robustness.
   f. Sub-sample evaluation data set to match global histograms
   g. Error propagation
   h. Does the retrieval match mean trends (e.g. vs chl)

Ability to calculate uncertainties needs to be included
Documentation of SAA needs to be made available (e.g. ATBD)

Consensus Algorithm:

1) eta via Lee reflectance ratio
2) aphi* via Maritorena's latest Bricaud based parameterization via NOMAD
3) S developed based on NOMAD
4) bbp(55X), adg(443)
5) f/Q – start w/Morel, consider evolution – possibly LUT ala PML
6) Class based approach ala Dowell/Moore
7) Salinity/Temperature correction

Uncertainties:

1) INPUT UNCERTAINTIES!!!
    a. In situ comparisons
2) L/M retrieval statistics
3) GlobColour approach

It was tentatively agreed that a follow-on workshop should be held in the autumn of 2009.