Aeolus L1B/2A & L2B algorithm consolidation – task update

date: 8 July 2009

Ref. 1: Contract ESA/18366/04/NL/MM, 'Aeolus Campaign and Algorithm Support', including CCNs

Ref. 2: Contract ESA /18555/04/NL/MM, 'Implementation of Aeolus L2B/2C Processing Facility', including CCNs

Attachment 1 — Comments on Aeolus L1B Master Algorithm Document AE.SW.ASU.GS.023 Issue 5, dated 15 May 2008

Date: 29 May 2008

ASU responses dated 11 June 2008

ESA responses dated 17 June 2008 (blue/underlined text)

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Purpose

This note shall compile high priority tasks related to pre-launch algorithm consolidation, validation and overall performance characterization. Tasks shall build up on prototyping and testing work conducted under Ref. 1, Ref. 2. It is assumed that tasks not yet covered under the existing contracts currently in place will be considered for inclusion in upcoming contract extensions.

List of pre-launch tasks

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I. Instrument simulation, performance aspects

1. incorporate updates of Aladin characterization database (radiometric, spectral performance, transmission characteristics, ...) and instrument settings
2. update calibration scenarios (timelines, spatial & spectral sampling, ...)
3. conduct simulations on specific aspects:
   - LOS mispointing effects, bias, drift & random type errors
   - systematic calibration errors (errors in spectral response slope, offset, non-linearity;)
4. update E2S sub-models if required (T&R optics, spectrometers & detection chains, terrain model, Earth background model, calibration modes ...)

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II. Level 1B wind mode processor

Mie core processing

1. revise SNR threshold for invoking Simplex algorithm. Could SNR threshold be lowered below 10 dB, to ensure that backscatter ratio profiles are available over larger areas (e.g. to support L2A processing)
2. check convergence behaviour of Simplex algorithm (e.g., do fit parameters tend to oscillate during iterations?). Should step size be
   - user input?
   - adjusted automatically during iterations?

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3. check Mie core performance for extreme cases, e.g.
   - very high & low SNRs
   - large Doppler offsets (+/- 100 m/s)
   - Mie signal broadened (+ asymmetric) due to winds shear or interference between ground echoes and atmospheric signals
4. flag Mie profile points invalid for bins below GE detection bin
5. consolidate utilization of Mie core algorithm (Simplex algorithm) outputs as quality indicators (starting from results obtained in the VAMP study).

Rayleigh core processing

1. consider SNR threshold for execution of Rayleigh response computation (avoid numerical problems in case A+B ~0)

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2. check enhancements to Rayleigh core algorithm: instead of simply adding pixels for A and B, use an analytical model for the Rayleigh channel: for example, assume that ACCD signals can be modelled by the sum of two Gaussians, each with a fixed width and location on ACCD. A Simplex algorithm (similar as for Mie) could be used to fit simultaneously amplitudes and residual signal offset, using all 16 ACCD pixels. Remark: such an approach might enhance the performance in case of
   - low A+B signals (bit quantization errors start to dominate)
   - non-perfect offset correction (using only pixel 20!) and background correction.

   Other advantages:
   * all 16 pixels rather than only 8 pixels used in the fitting
   * residual error available as additional error quantifier.
3. flag Rayleigh profile points invalid for bins below GE detection bin
4. investigate utilization of Rayleigh core processing outputs as quality indicators.

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Ground echo detection

1. revise algorithm to compute valid/invalid flag for ground echoes. Define error/confidence parameter taking into account SNR, mismatch expected <-> detected ground bin.
2. verify / characterize performance for
   - full range of expected ground albedos (land / sea / ice)
   - for sea echoes: expected variations with wind velocity (wave heights)/direction, sub-surface reflectances (if data available, e.g. from A2D campaigs)
   - different cases of surface winds and GE bin heights
   - off-nadir & nadir (IRC mode) viewing

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3. assess enhancement of GE detection performance using terrain model.

L1B end to end performance

1. define set of standard test cases (in terms of E2S simulation parameters, observational scenario, atmospheric/ground targets, auxiliary inputs, algorithm settings) to be used for verifying the end to end performance after major algorithm updates.
2. conduct performance tests for
   - 'ideal' conditions (noise-free calibration data, no mispointing, ...); cover both homogeneous and non-homogeneous atmospheres
   - 'noisy' conditions (all noise sources on, standard/homogeneous atmosphere)
   - 'perturbed' conditions (all noise sources & mispointing on, variable atmospheres with

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clouds,); include case of a homogeneous, cloud-free atmosphere
Characterize
a) coverage of successful Mie / Rayleigh core retrievals (i.e. valid M&R wind velocities)
b) end to end wind velocity errors
c) systematic & random errors in ZWC data
d) global statistics on valid GEs & rate of 'false' GE detections.

3. *A2D campaign data:* If feasible, run critical L1B processing functions with observational data collected during ground based or airborne campaigns (including upcoming Iceland airborne campaign).
Specific attention to be given to M & R core processing, response calibration, ground echo detection, scattering ratios.

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III. Calibration chains

L1B related processing

1. AUX_ZWC: check if additional error quantifiers are required. Error quantifiers could be used by the Harmonic Bias Estimator to assign individual weights to retrieved ground echoes (e.g. high SNR & no bin mismatch -> smaller error)
2. *AUX_CSR updater:* revise choice of unknowns in fitting routine.
   Currently: width of tophat function, W
   alternative 1: W + asymmetry parameter (tophat modulated by linear slope)
   alternative 2: slope (a) and response offset (b) of correction function so that

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csr (f) = isr(f) + a*f + b
more alternatives ??

3. refine overall decision logic for
   - updating CSR curve fit
   - re-schedule ISR calibration
   define corresponding threshold checks
4. update calibration scenarios (timelines, spatial & spectral sampling, ...)
5. A2D: if feasible, generate calibration data (MRC, RRC, ...) from available, re-conditioned A2D campaign data (both ground-based and airborne)

Quality control & monitoring tasks

(work to be performed in collaboration with instrument developer (ASF))

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1. revise choice of parameters for validation checks for different calibration tasks (which parameters shall be used in threshold checks?)
2. revise choice of parameters for long-term monitoring tasks (e.g., checks against begin of mission values or running means)

L2 related processing (AUX_CAL_L2, AUX_RBC, AUX_PAR_L2, ...)

1. Definition of settings, flags, parameters in L2 aux. files
2. revise methods in determination of K_{ray}, K_{mie}, C_1-C_4, required input data
3. assess required accuracies; are current IRC, ISR scenarios appropriate?
4. assess overall impact of AUX_CAL_L2 inaccuracies on L2A and L2B data products; could AUX_CAL_L2 be dropped in routine L2B processing?

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IV. Level 2A processor

1. verify performance for optically thick clouds in field of view (is a GE detection algorithm required to avoid optical parameter retrievals below optically thick layers?)
2. check performance of critical L2A functions,
   - feature finder / scene classification
   - SCA, ICA / filling case retrievals

   for different conditions, especially
   - low/high SNR
   - horizontal heterogeneities
   - variable mismatch between range bins and cloud/aerosol layer boundaries

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- large vertical gradients, variable geometrical thickness of aerosol layers
- multiple layers
- errors due to correlation effects in the vertical sampling (ACCD read-out affect)
- variable errors due to missing or incorrect cross-talk effects (worst case, realistic case, ideal case)
- variable optical thickness of aerosol layers & optically thick layer

3. conduct performance tests for selected cases defined for L1B (see items II, III above), in particular cases with instrument noise, pointing errors and perturbed calibration data.

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MAD will be updated

V. Level 2B/C processor

1. verify Mie core processing: incorporate updates of Aladin characterization database (radiometric, spectral performance, transmission characteristics, ...) and instrument settings
2. refine set of standard test cases (in terms of E2S simulation parameters, L1B inputs observational scenario, algorithm settings)
3. characterize L2B end-to-end wind error e calibration scenarios (timelines, spatial & spectral sampling, ...)

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4. check performance of L2b scene classification (L1b scattering ratio vs more elaborated optical properties retrieval).

VI. End-to-end error budgets

1. refine/expand set of standard test cases (in terms of E2S simulation parameters, atmospheric target scenes, observational scenarios, algorithm settings) for use
   a) as reference cases to validate enhancements in L1B/L2A/L2BC algorithms
   b) to assess end-to-end error budgets.
   Test cases should include:
   - 'ideal' case (noise-free calibration data, no instrument noise, no mispointing,

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homogeneous atmosphere,...)
- 'noisy' case (all noise sources on, standard/homogeneous atmosphere)
- 'noisy/perturbed' cases for calibration data (e.g., instrument noise switched on, Rayleigh response data processed with erroneous aux. Met inputs)
- 'perturbed' case (all noise sources & mispointing on, variable atmospheres with clouds, noisy/perturbed calibration data); additional run to be conducted for a homogeneous, cloud free scene.

2. generate reference data set for all processors (L1B, L2A, L2B products and calibration aux data) for initial baseline algorithms. For a given processor, repeat tests with prototyped enhancements / different configuration settings and compare results against reference data sets.
3. estimate error budgets by comparing product outputs against true reference (i.e., E2S input wind profile, aerosol / cloud parameters, ...)

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4. generate end-to-end error budgets using
   - repeated, identical runs with different noise samples
   - repeated runs with different combinations of systematic errors; take into account expected ranges of response calibration errors, LOS mispointing, ...
   - runs with different height grid settings in Mie and Rayleigh channels (variable overlap between M & R bins, sampling of ground echoes and SNR)
5. assess overall robustness of the L1b - L2A and L1B – L2B/C processing chains for different observational scenarios, in particular
   - changes in vertical sampling (bin thickness and height offset)
   - variable sampling grids along orbit (latitude band concept)
   - accumulation settings N, P (impact on SNR in L1B)

   Test cases should also permit the testing of selected sampling scenarios defined in the VAMP study.

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VII. Observational scenarios: CalVal & routine operation

This task shall aim at definition of detailed observational scenarios for calibration, validation and routine wind mode activities, covering both in Phases E1 (commissioning) and E (routine operation).
This task shall base on

- *results obtained during completion of tasks I - VI above*
- *results generated in the frame of a parallel study on observational scenario optimization (VAMP), ESA contract number 20940, final report*
- *Aeolus IOCV Plan, AE-PL-ASU-SY-026*

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- *Aeolus Commissioning & CalVal Plan, AE-PL-ESA-SY-002.*

This task has not yet started.

- end of list –

Compiled by H. Nett, ESTEC / EOP-PEP

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