The Overland processor for atmospheric correction

Hervé Poilvé, Airbus Defence and Space

CEOS-WGCV ACIX II – CMIX 1st Workshop, 17 October 2018

AIRBUS DEFENCE & SPACE

Overland processor concept

Core processing algorithms initially developed to generate vegetation maps *(LAI, fCover, Chlorophyll)* from optical images *(satellite / airborne)* for Agriculture applications.

- operationally used since 2002 in Farmstar Precision Ag service.
- crop reflectance model based on SAIL/PROSPECT

Further extended to other applications by adding model features able to describe a wide range of canopies *(forests, shrubs, ..)* and other components of natural scenes *(soil, water, snow, burned areas..)*

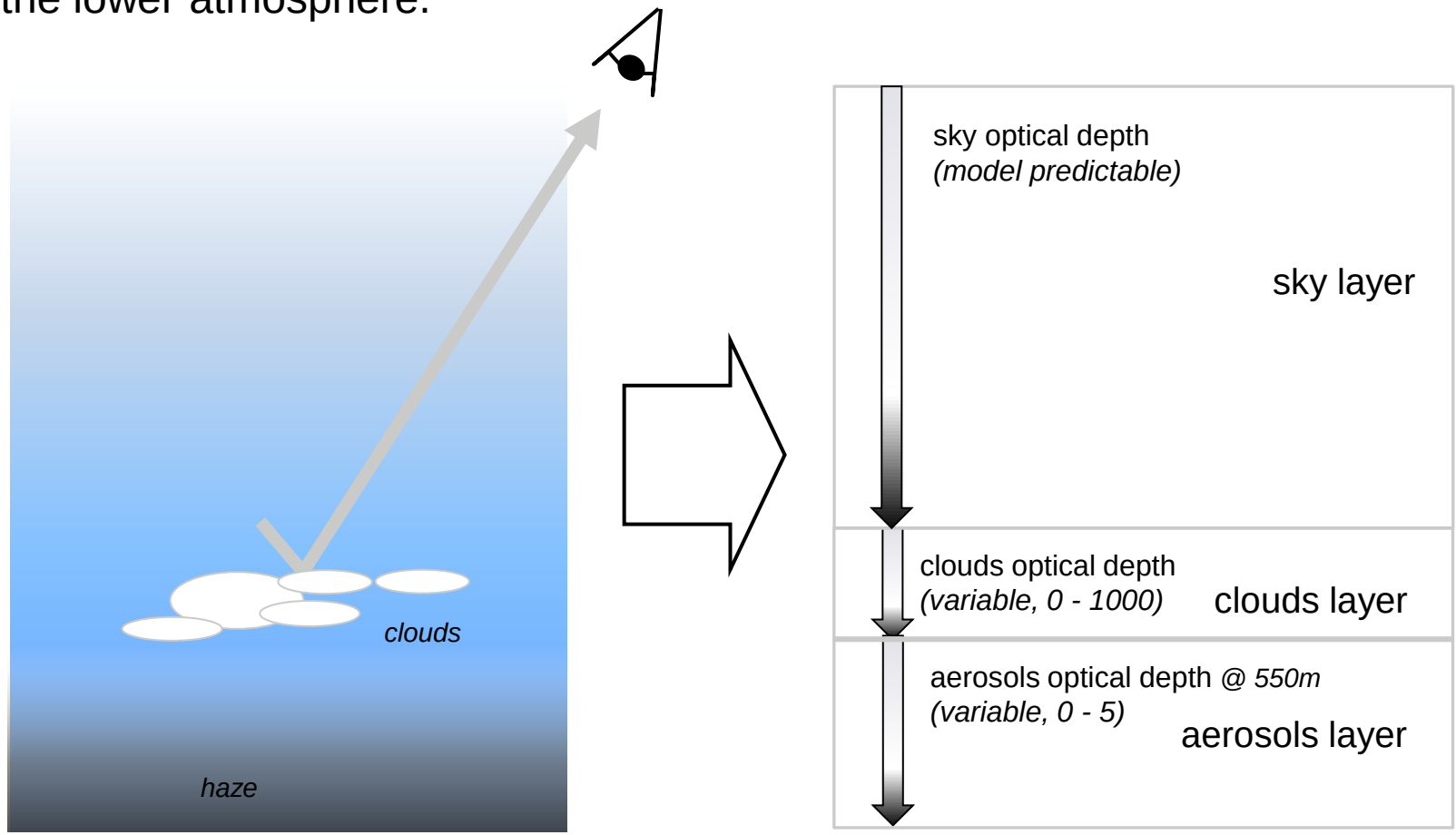
The Overland processor performs integrated and autonomous atmospheric correction; it combines calls to LOWTRAN with models of the different atmospheric layers. It performs common inversion of the coupled scene and atmospheric models .

Able to process a wide range of optical sensors, from HR/VHR to wide-swath *(MODIS/ Sentinel-3)*, airborne *(CASI /AISA)* and UAV. Performance of vegetation parameters actually depends on sensor spectral richness and data quality / calibration.

AIRBUS DEFENCE & SPACE

Overland atmospheric modelling

The atmosphere is represented as 3 successive layers of different altitude, corresponding respectively to the atmospheric column *(Rayleigh and absorptions)*, clouds, and finally the aerosols in the lower atmosphere.



AIRBUS DEFENCE & SPACE

Overland atmospheric modelling *(cont.)*

Cloud and aerosols layers are represented by turbid medium models. Both use the same 4-stream formalism as the SAIL model. The aerosol layer is calibrated from LOWTRAN calls.

As a result of this model, clarity or 'haze' of the atmosphere is actually attributed to 2 different factors with associated parameter

- aerosols characterized by AOT *(or distance of visibility / ground extinction / …)*
- cloud veils characterized by cloud optical depth *(or reflectance)*

Additional features :

- default aerosol LOWTRAN model is rural. Different and specific models applied for some regions *(e.g. having sand haze, harmattan, ..)*
- for Sentinel-2, Landsat-8 sensors having Cirrus band , this is used to estimate optical depth of a Cirrus layer as an additional layer to the main clouds *(further consolidated as 'total cloud optical depth' summing contribution from Cirrus)*.

AIRBUS DEFENCE & SPACE

Overland for image dehazing: objectives

In Overland thematic applications, estimation of atmospheric conditions is pixel-wise and made together with retrieval of vegetation parameters.

Another application is to develop a global dehazing solution, i.e. an automatic tool to remove or strongly reduce haze and cloud veils from Airbus (and other) images

- of particular interest for World regions that are plagued by hazy conditions, when not fully covered by clouds
- useful everywhere to retrieve some lower quality images, to help speed up completion of images coverage
- overall stabilizes rendering and ensures more homogeneity when producing image mosaics

Overland for image dehazing: specifications

Dehazing tool target specs :

- can be systematically applied without prior image qualification
  (clear -sky images to remain unchanged)
- autonomous processing performed on individual images
  (no cross-processing between neighbour images, no need of a scene reference)
- worldwide : applicable and robust to various landscapes and atmospheric conditions
- residual image variations expected to be limited to directional and seasonal effects *(evolution of the vegetation)*
- thick clouds to be maintained *(as well as attached cast shadows)*

AIRBUS DEFENCE & SPACE

Overland for image dehazing: process overview

Processing steps :

- select landscape model based on geographical area *(and possibly additional criteria)* and apply model inversion
- spatially filter maps of atmospheric parameters in order to improve estimation of cloud veils and aerosols *(mainly relying on information over land / also applicable to coastal areas)*
- perform corresponding correction of reflectance from TOA to ground *(without correction of adjacency)*
- apply correction of adjacency effects for the 3 successive layers: sky *(Rayleigh)*, clouds and aerosols.
- restore thick clouds *(or alternatively mask corresponding areas)*

The whole dehazing process developed by Airbus DS has been patented

AIRBUS DEFENCE & SPACE

Comments / questions on validation protocol

- As validation protocol only refers to AOT values *(aerosol optical depth)*, for Overland outputs shall we consolidate optical depth estimations from both aerosols and cloud veils?
- Overland does not process thermal bands for Landsat
- Validation protocol does only consider point-wise or statistical comparisons with ground measurements. Yet a lot of information on method performance and limitations can be actually collected from visual inspection of corrected images …

Thank you for your attention