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Copernicus Atmosphere Monitoring Service

Proposal for the update of McClear in the CAMS Radiation Service

From McClear v2 to McClear v3. Proposed by Armines to Transvalor

Issued by: Armines / Lucien Wald

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1 Description of the update reason

McClear v3 is a new clear sky model version being currently in the acceptance protocol and implementation phase. A clear sky model is a model that predicts the solar irradiance that reaches the surface in cloud-free conditions.

Currently, the time-series of irradiance delivered by the CAMS Radiation Service are obtained by the combination of the cloud-free irradiances and cloud properties using the approximation of Oumbe et al. (2014) (Qu et al., 2017). The cloud-free irradiances are themselves obtained with the McClear v2 model (Lefèvre et al., 2013).

The McClear model and its products are part of the CAMS Radiation Service and are used as such. For example, they are used to improve the quality of the HelioClim-3 database adopted by many professionals in solar energy following the method proposed by Qu et al. (2014) thus leading to the HelioClim-3v5 database. Several assessments of the quality of the outputs of McClear v2 have been made (Eissa et al., 2015; Lefèvre, Wald, 2016; Lefèvre et al., 2013; Qu et al., 2014). In addition, HelioClim-3v5 outputs have been exploited in several occasions to provide maps of solar radiation that are hosted by the Global Atlas at the International Renewable Energy Agency (IRENA).

Several drawbacks have been identified during these assessments and daily operations. The aim of the development of McClear v3 was twofold: correct the drawbacks and preparing future changes in the aerosol products foreseen in CAMS. In short, McClear v2 is a fast parameterization of the radiative transfer in the cloud-free atmosphere and it was intended to reproduce the results of the libRadtran code. This parameterization is based on the use of abaci that contain results of libRadtran for specified inputs. McClear v3 follows the same concept.

2 Partner providing the update proposal and staff

Armines.
Benoît Gschwind, with Philippe Blanc and Lucien Wald

3 Description of the update

The update consists in a new series of abaci and new algorithms. It is a major change compared to v2. It affects the McClear products as well as the CAMS Radiation Service products.

The abaci have been made available to Transvalor. A code was written by Armines that implements the new algorithms. Transvalor is testing the code within the operational chain.

Details are found in the deliverable “Status report on WP3 activities Jan – Jun 2017”, CAMS72_2015SC2_D72.4.6.1-2017_201706_Status_WP3_v1, delivered on 30/06/2017 by DLR to ECMWF.

4 Main achievements in the development of the McClear v3

McClear v3 aimed at removing discontinuities induced by abrupt changes in the aerosol mixtures due to the empirical algorithm. This request is now satisfied.

McClear v3 aimed at removing discontinuities in time due to abrupt changes from winter to summer and reciprocally in the adopted atmospheric profiles. This request is now satisfied.

By changing the treatment of the aerosols, McClear v3 aimed at better accommodating possible changes in the aerosol outputs by ECMWF. This request is now satisfied.

McClear v3 has adopted the latest version of libRadtran (V2.0.1).

McClear v3 has adopted a change in the solar constant (now, called total solar irradiance in many papers).

McClear v3 has removed the ambiguity induced by the use of the Angstroem exponent in conjunction with the mixtures.

McClear v3 has removed the discontinuities with solar zenith angles induced by the piece-wise MLB functions. In addition, McClear v3 has extended the estimation of the diffuse irradiance to solar zenith angle greater than 90°.

McClear v3 offers more consistent results with no more discontinuity. It is a significant step that prepares further improvements, especially about changes in modelling the aerosol optical depth.

The reduction of the size of each abacus and of the whole set of abaci yields an increase in the computational speed of McClear v3. However, more runs are needed to avoid discontinuities in time and space and there is no gain and no loss on the computational time.

This reduction in size offers opportunities for example in the extension of McClear to produce the spectral distribution of the irradiance, or in the adoption of a more detailed model for the radiative transfer in the atmosphere.

5 Specific tests performed and their results

The many aspects detailed above for McClear v3 have been tested with specific tests. The elements for the specific tests have been made available to Transvalor in the form of data files as well as graphs and tables.

As for the comparison against ground measurements performed in stations belonging to the BSRN network, the validation protocol and the associated tools are shared with Transvalor prior to the inception of CAMS.

6 References

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