

## ***Interactive comment on “Validating the MYSTIC three-dimensional radiative transfer model with observations from the complex topography of Arizona’s Meteor Crater” by B. Mayer et al.***

**B. Mayer et al.**

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Received and published: 1 September 2010

We thank referee #1 for the comments which we address in the following. The referee comments are printed in italics.

*Page 13375, line 23: The expression “parametric study” sounds unfamiliar to me. I would replace it with “sensitivity study”.*

Changed.

*Page 13376, line 13: The word “classification” should be changed to something like “characterization”.*

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Changed.

*Page 13376, line 28: I recommend describing either in the main text or in an appendix the way coefficients  $a$ ,  $b$ ,  $c$ , and  $d$  are calculated from the set of available  $z(x,y)$  values.*

We phrased it more clearly in the text by adding a sentence.

*Page 13377, line 1: It is not clear to me how this alternative method would work. I suggest either expanding its description or deleting the mention of this alternative method altogether.*

While it is generally not possible to connect four points with a plane surface, it is always possible for three points. We tried to clarify that by rewriting:

“alternatively one could have split each grid cell into two triangles and thus describe the surface by a set of  $2N$  triangular planes instead of  $N$  bent surfaces”

*Page 13377, line 12: I’d change “polar angles” to “zenith angles”.*

Changed.

*Page 13377, line 13: I wonder if measured BRDFs could be extended to zenith angles greater than 90 degrees by simply considering zenith angles not with respect to the vertical direction, but instead with respect to the direction normal (perpendicular) to the local slope.*

This is an important point which we already considered. For some surfaces it might be possible to rotate the coordinate system. However, in many cases (including e.g. vegetation in general) the BRDF is caused by the geometry of the trees and plants which usually grow straight upward and not normal to the surface. At least some difference is to be expected and the magnitude of the difference is hard to estimate without measuring it. Thinking about it, it could actually be possible but we need to discuss that first with the experts (<http://rami-benchmark.jrc.ec.europa.eu/HTML/RAMI-IV/RAMI-IV.php>)

*Page 13379, lines 1-3: Can it be explained why backward Monte Carlo simulations are*

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*not affected by the 1/cosine term that creates much of the noise in forward simulations?*

The mathematical reason is that the 1/cosine term simply doesn't appear in the backward calculation. Backwards the photons are simply emitted from the surface and conversion factors are not needed.

*Page 13384, line 27: I wonder what the most likely reasons may be for the offsets.*

For all sites combined, the mean offset of incoming longwave radiation is  $-3.5 \text{ Wm}^{-2}$  and therefore within the instrument uncertainty of  $5 \text{ Wm}^{-2}$ . Only at one site (West Upper) the offset is  $-8.3 \text{ Wm}^{-2}$  and thus above the instrument uncertainty. The offsets are all negative (or near zero). This could indicate that the atmospheric temperatures used to drive the model may have been slightly underestimated. We added more information about uncertainty determination to section 3 of the manuscript.

*Page 13385, line 7: The word "accordingly" should be changed to "similarly".*

Accordingly (in consequence) is meant here.

*Page 13385, line 15: I suggest replacing "parametric simulations" with something like "sensitivity tests".*

Changed.

*Page 13387, line 17: It would help to clarify what is meant by "surface temperature mask".*

Sorry, this was a typo. MYSTIC allows the user to prescribe a two-dimensional surface temperature map for the model domain, defining the surface temperature for all pixels, instead of using the atmospheric temperature (one-dimensional, only varying with height). We now write: "For the present study we used a constant temperature profile which means that inversion layers or superadiabatic near-surface layers can not be prescribed in detail. As an improvement, a two-dimensional surface temperature map could be used in these situations, prescribing the surface temperature across the

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entire model domain and thus improving the representation of the outgoing longwave irradiances."

*Page 13387, line 25: I suggest replacing "parametric studies" by "sensitivity studies".*

Replaced by "parameter studies". It is a bit more than just sensitivity tests, e.g. the influence of basin shape etc.

*Page 13388, Equation A1: The variables p and q need to be defined somewhere.*

Equation A1 is simply the vector description of a straight line where p is the starting point and q the direction vector. Added this to the text.

*Page 13389, line 10: What does selecting the smallest positive value mean physically?*

That means the first that the first crossing with the surface is taken. If the value would be negative, the crossing would be behind the starting point (which is not possible) and if both values are positive, then the smaller is the point where the photon hits the surface and, if traced below the ground, the second is the point where the photon would leave the cross the surface again. Added this to the text.

*Page 13397, Figure 4 labels: The words "Easting" and "Northing" sound unfamiliar to me; they should be replaced by something like "East-West distance" and "North-South distance".*

The terms easting and northing are a bit unusual but they are the official terms for geographic Cartesian coordinates of a point and we decided to leave them in the text. See e.g. [http://en.wikipedia.org/wiki/Easting\\_and\\_northing](http://en.wikipedia.org/wiki/Easting_and_northing)

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Interactive comment on Atmos. Chem. Phys. Discuss., 10, 13373, 2010.

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