Testing the theory of HARMONIE-AROME cloud thermal radiation parametrizations

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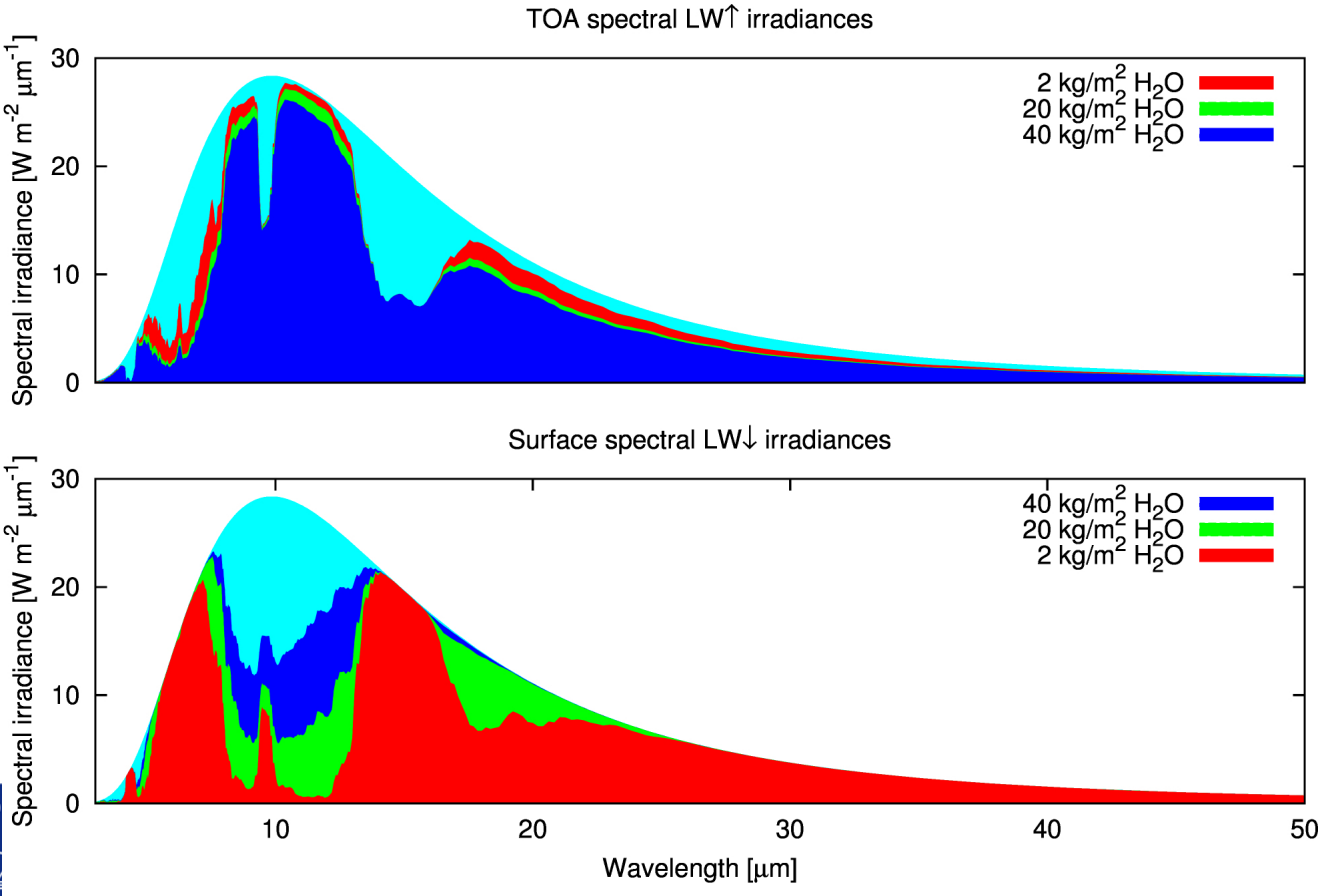
Hypothesis:

To test the theoretical background for recent KNMI empirical results regarding cloud thermal radiation interaction.

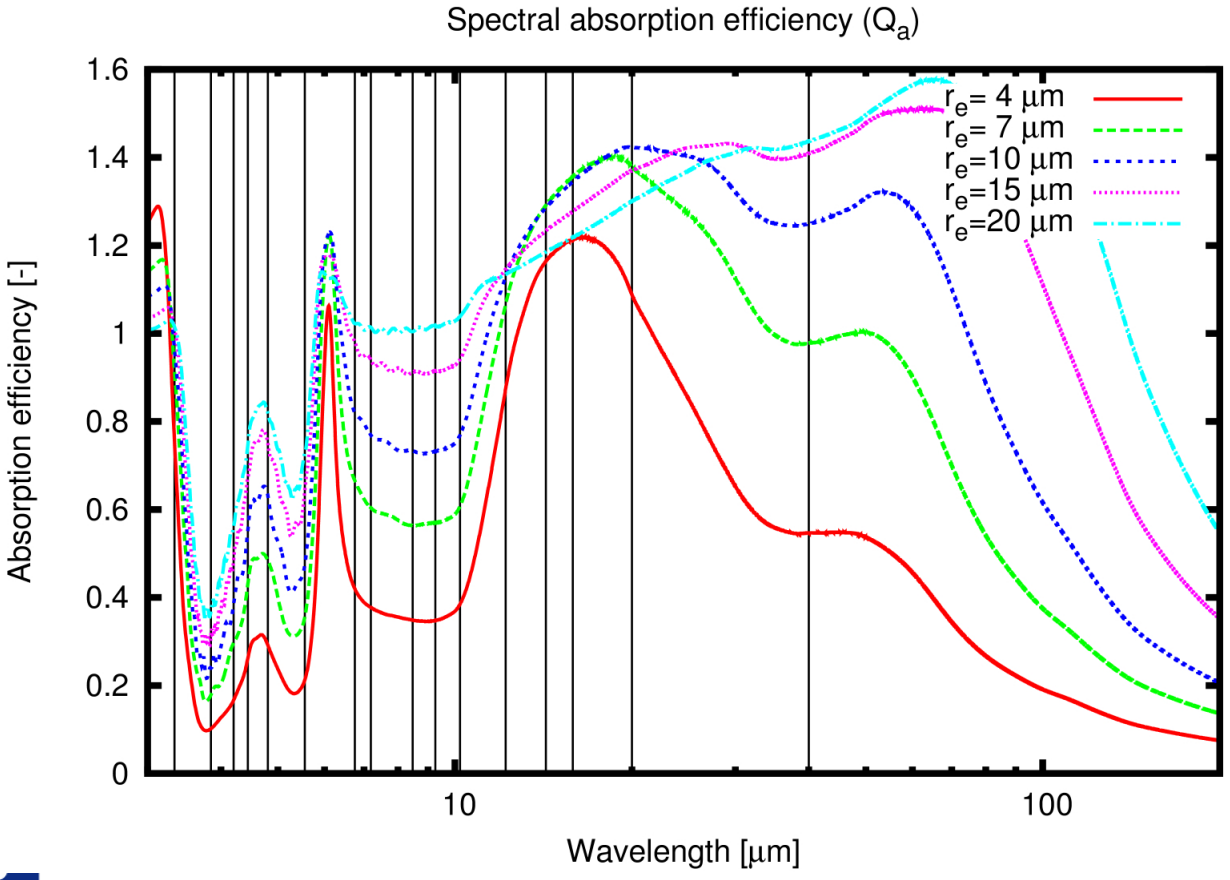
Spectrally resolved atmospheric thermal (LW) radiation



DMI

HIRLAM Limited Area Model

Mie computations of LW cloud-radiation interactions



(Mie 1908; Wiscombe 1980). The lines mark 16 LW spectral bands.

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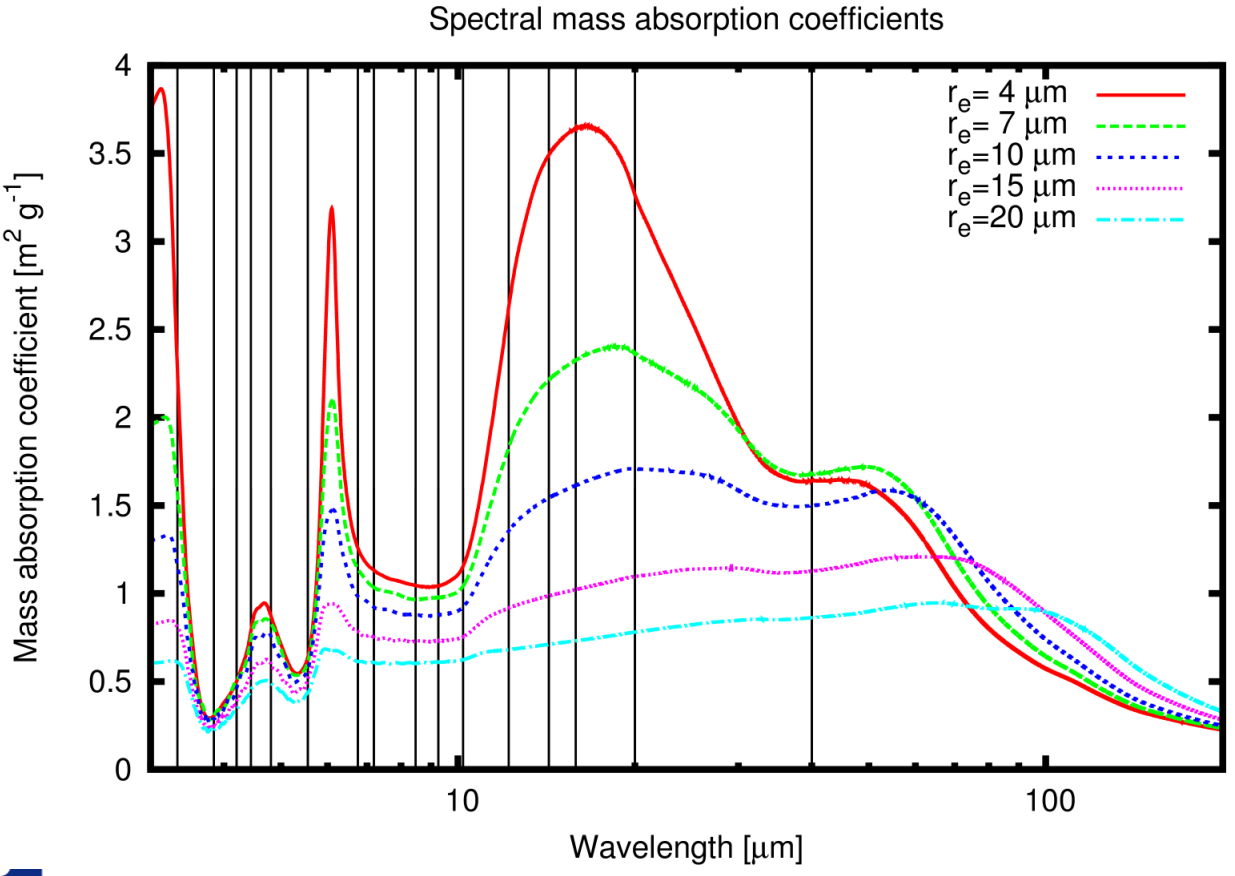
Mie computations of LW cloud-radiation interactions



(Mie 1908; Wiscombe 1980). The lines mark 16 LW spectral bands.

Band averaged absorptance/emissivity

$$\overline{\mathrm{Abs}}^{i}_{\mathrm{band}} = 1 - e^{-(1-\omega_{\mathrm{band}})\psi_{\mathrm{band}}\mathrm{LWP}} \qquad (1)$$

(Lindner & Li 2000)

ω **is the single scattering albedo**
ψ **is the mass extinction coeffiecent in** m^2/g
LWP is the liquid water path in g/m^2

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Empirical absorptance/emissivity vs LWP

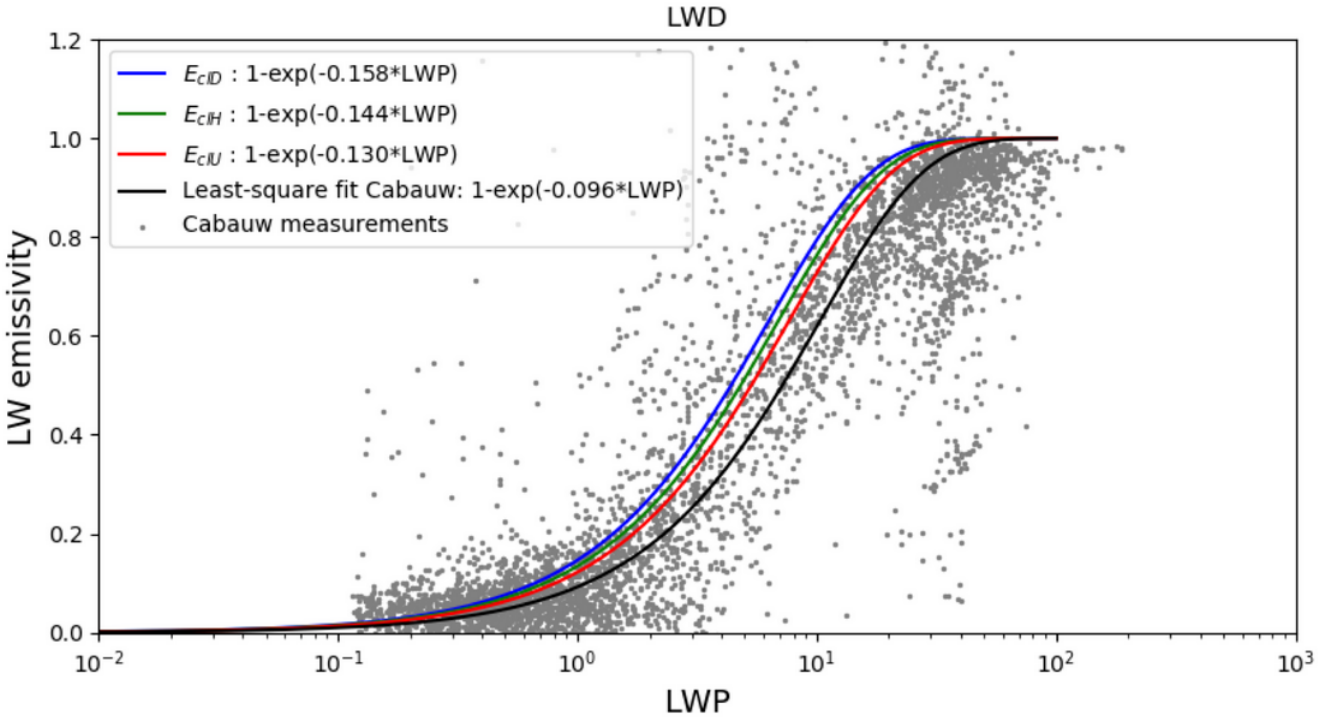

Figure 8: Emissivity/absorption as a function of cloud water path in Cabauw from 2012-2019 for all fog cases.

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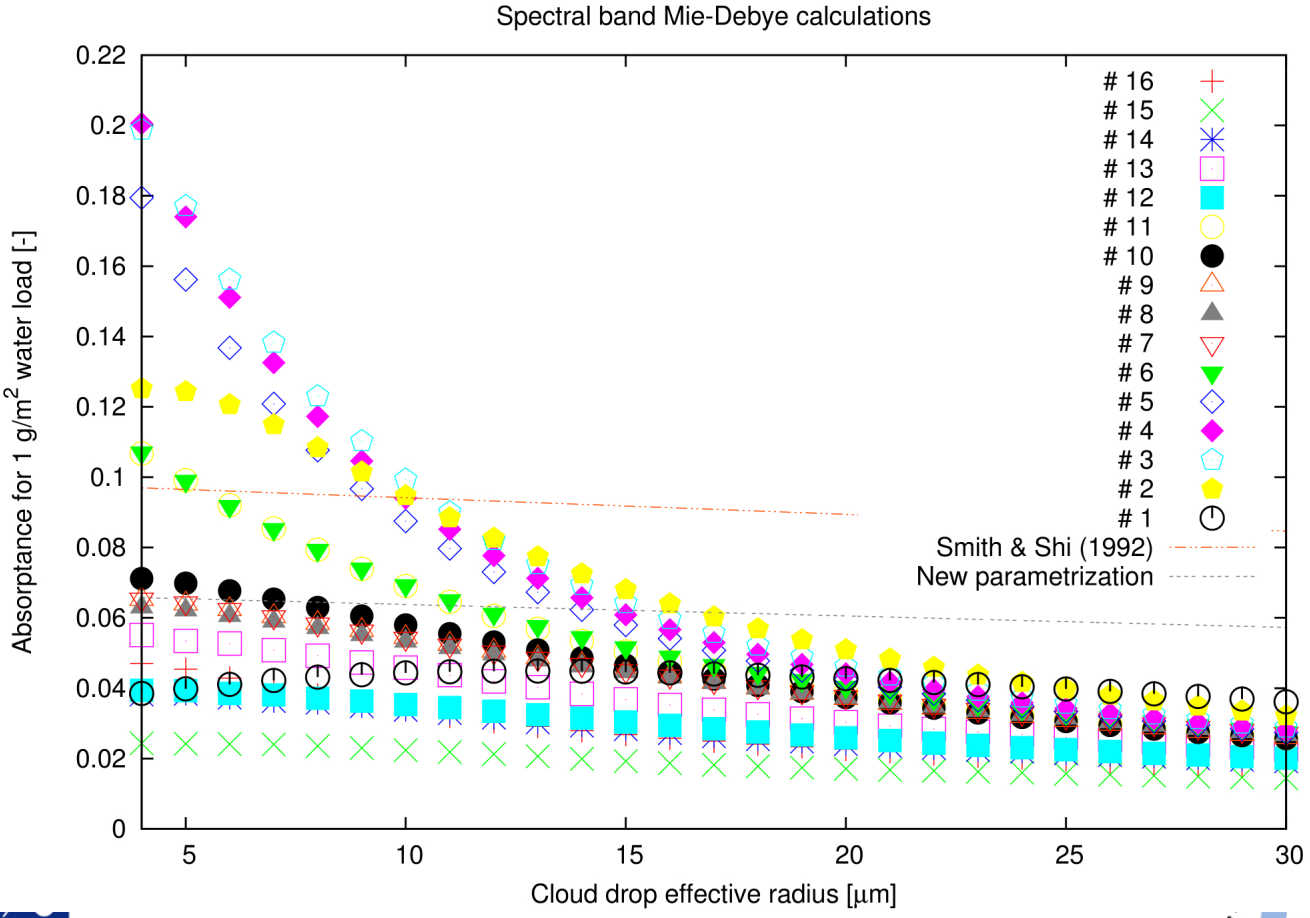
Spectral absorptance/emissivity for LWP = 1 g/m^2



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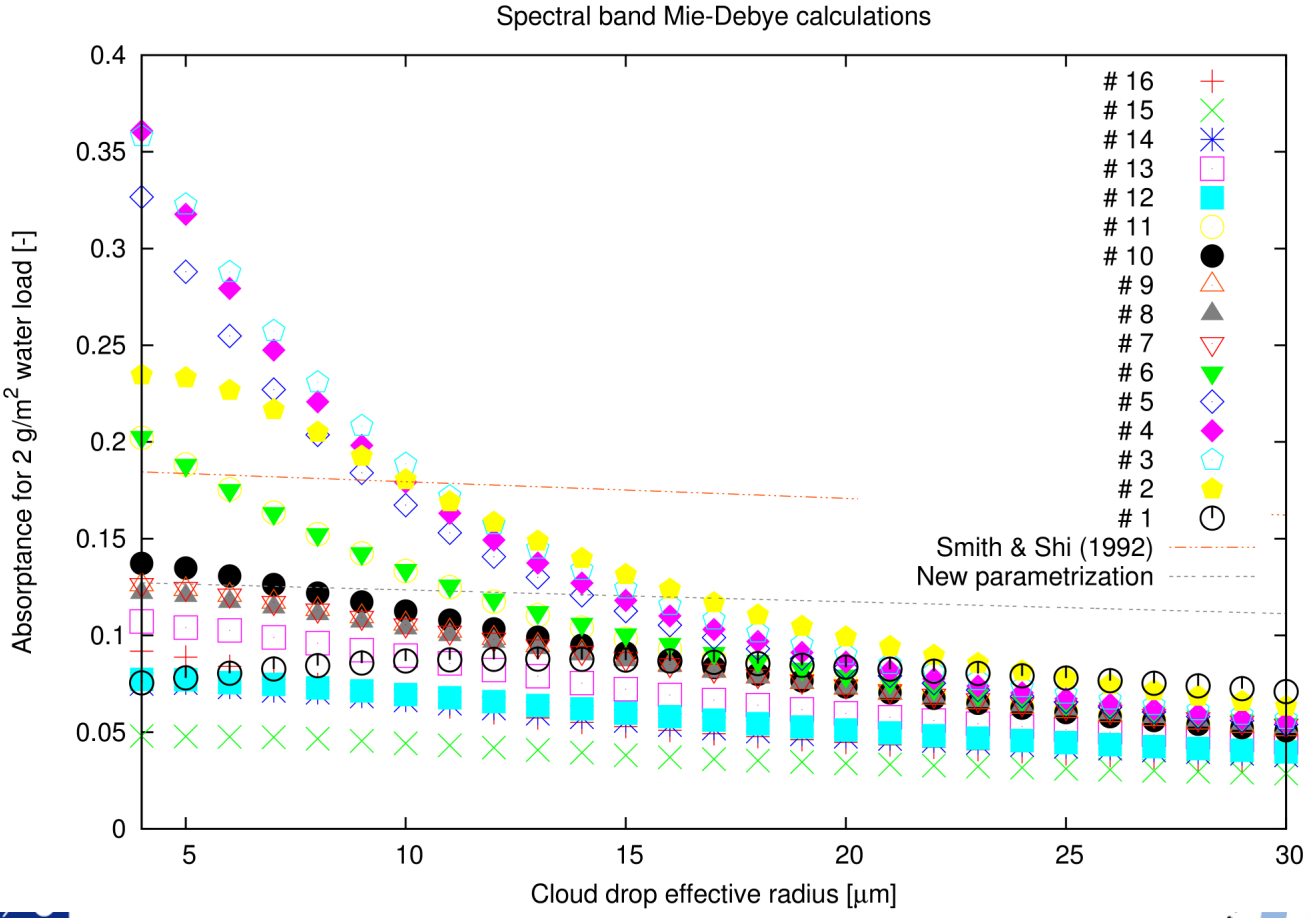
Spectral absorptance/emissivity for LWP = 2 g/m^2



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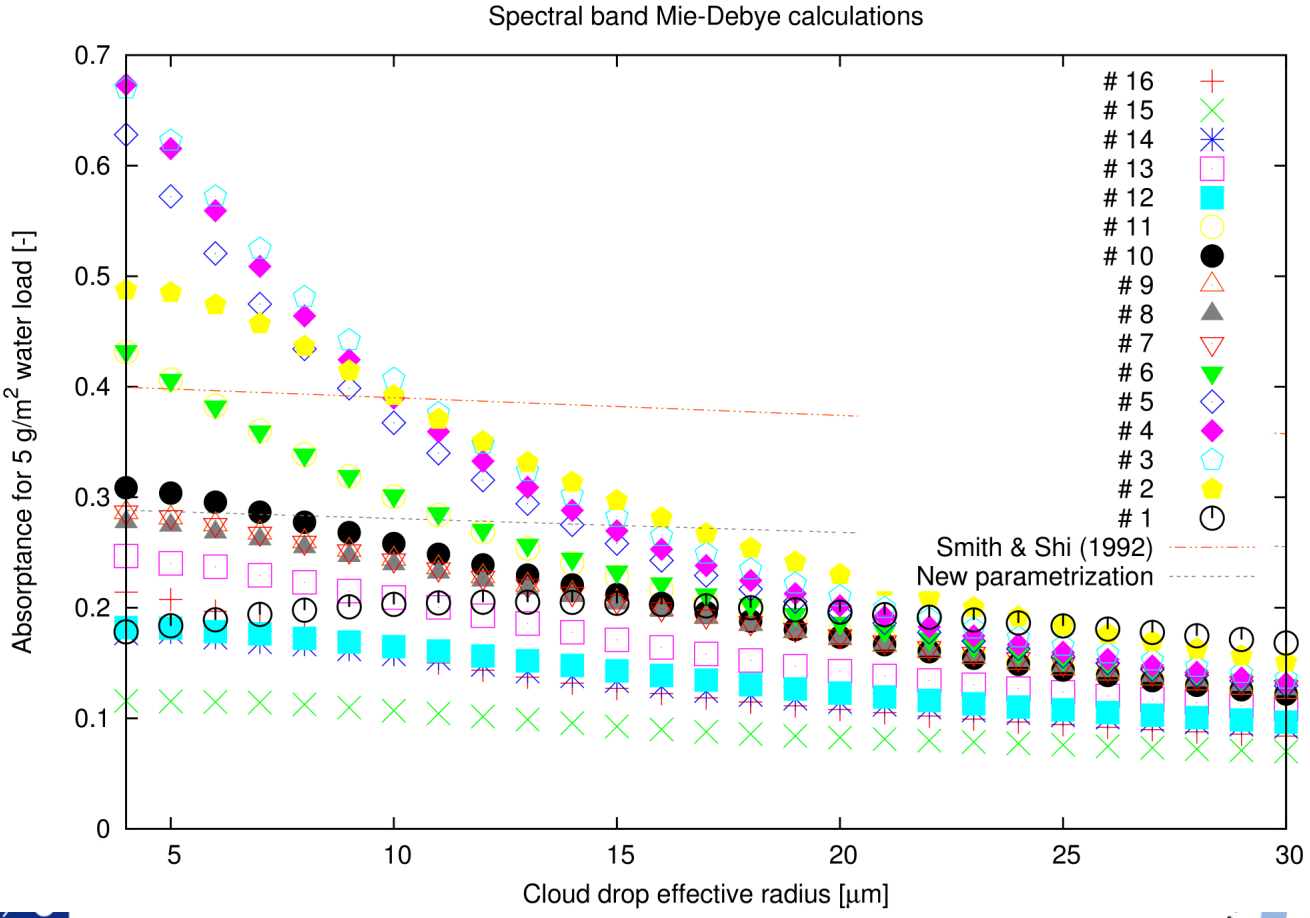
Spectral absorptance/emissivity for LWP = 5 g/m^2



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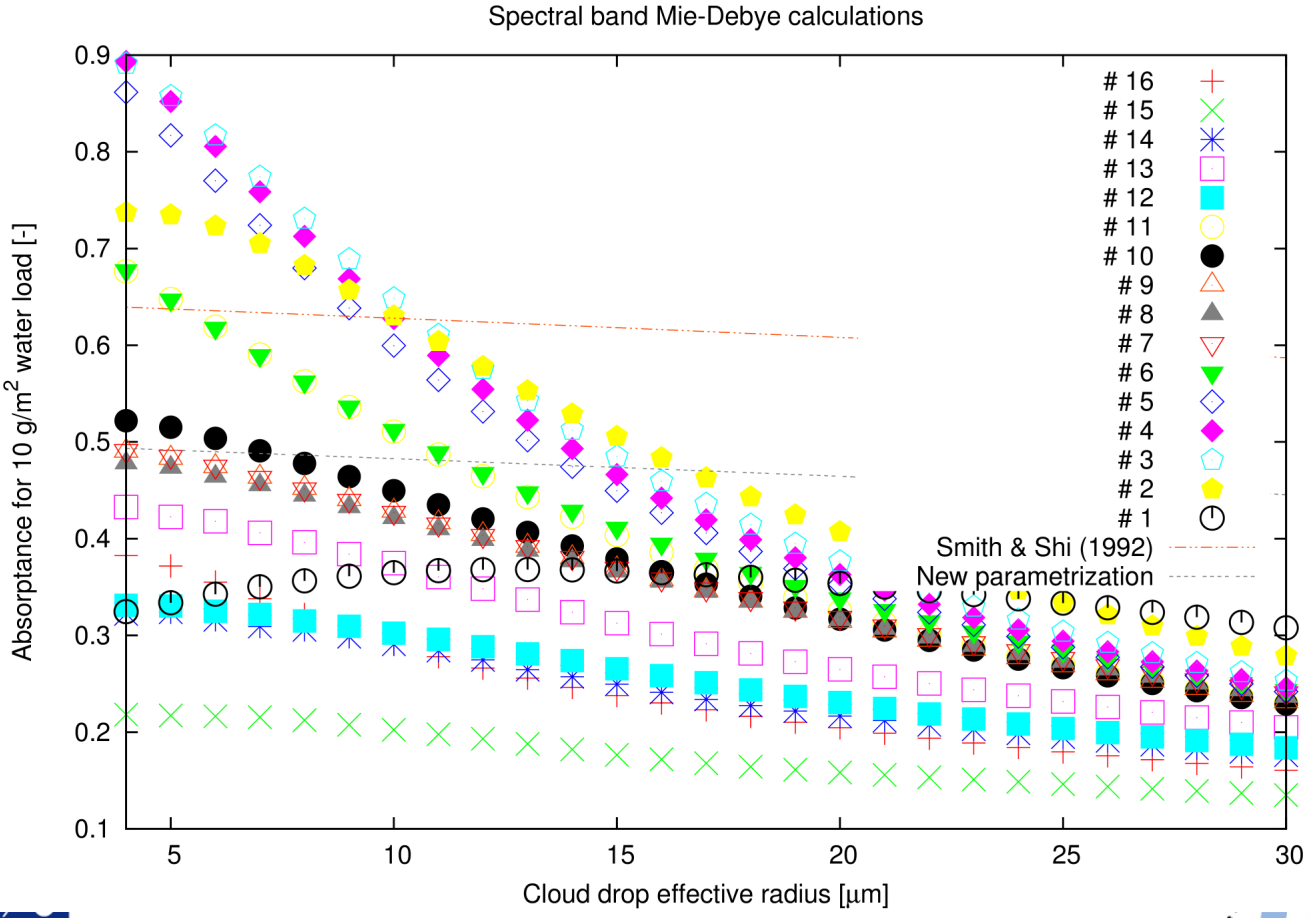
Spectral absorptance/emissivity for LWP = 10 g/m^2



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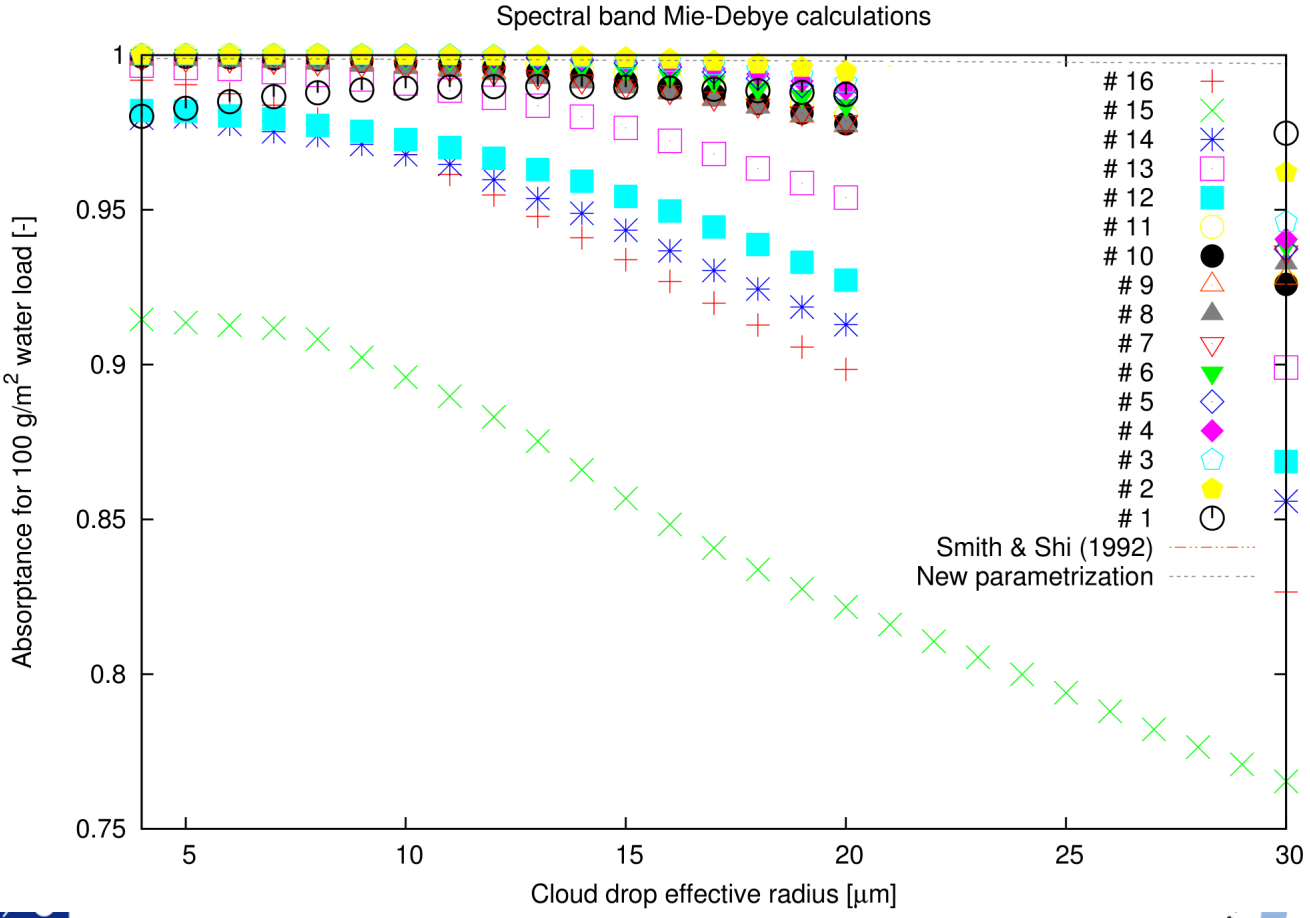
Spectral absorptance/emissivity for LWP = 100 g/m^2



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Conclusions:

- **Theoretical analyses confirms that the current HARMONIE-AROME LW cloud emissivity is too high.**
- **The spectrally resolved LW cloud emissivity should be accounted for.**

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