A Critical Review of the Preetham Skylight Model

Georg Zotti,

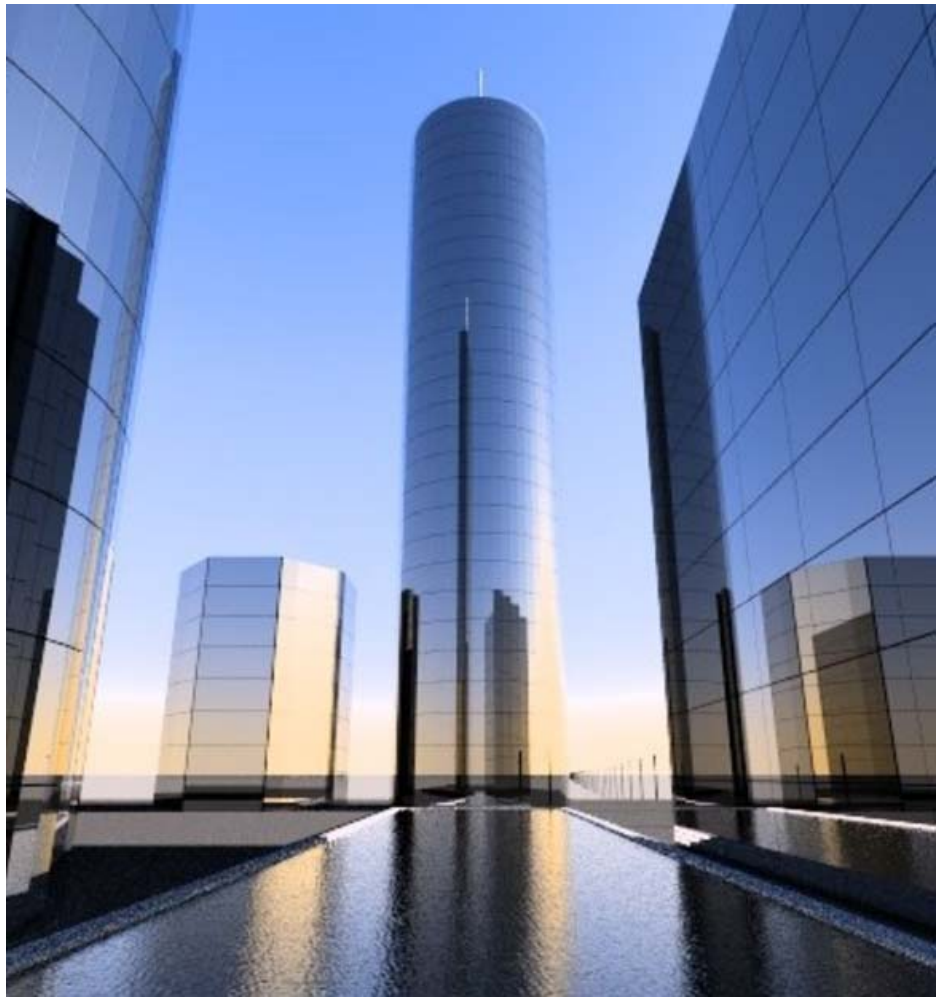
Alexander Wilkie

and Werner Purgathofer

Institute of Computer Graphics and Algorithms

Vienna University of Technology

Motivation



[Wilkie, Tobler, Ulbricht, Zotti, Purgathofer; EGSR 2004]

- **Predictive Rendering** requires reliable skylight model
- Apparently most used model: *A Practical Analytic Model for Daylight* [Preetham, SIGGRAPH 99]
  - BUT: Apparent problems near horizon

A Practical Analytic Model for Daylight

[A.J. Preetham et al., SIGGRAPH 1999]

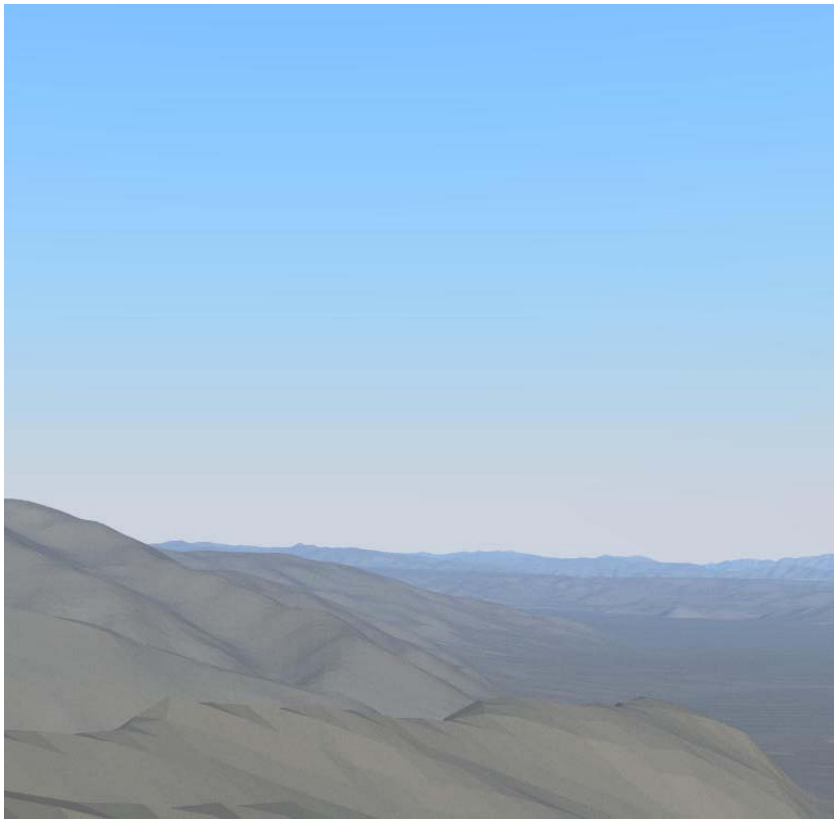


Image from: [Preetham, 1999]

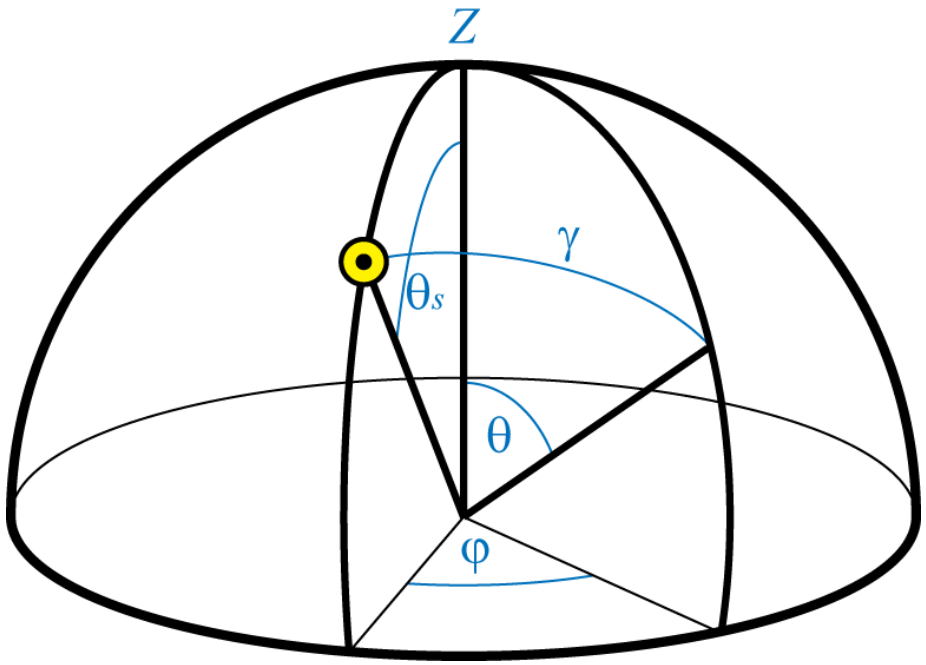
- Nice Images
- Easy Implementation
- Fast
- Apparently for all cloudless sky conditions…

or so the reader may think…

Preetham's Formulae for Skylight Distribution

$$Y = Y_Z \cdot \frac{F(\theta,\gamma)}{F(0,\theta_s)}$$

Y_Z … Zenith Luminance



Similar for chroma (x/x_z, y/y_z)

Perez Equation:

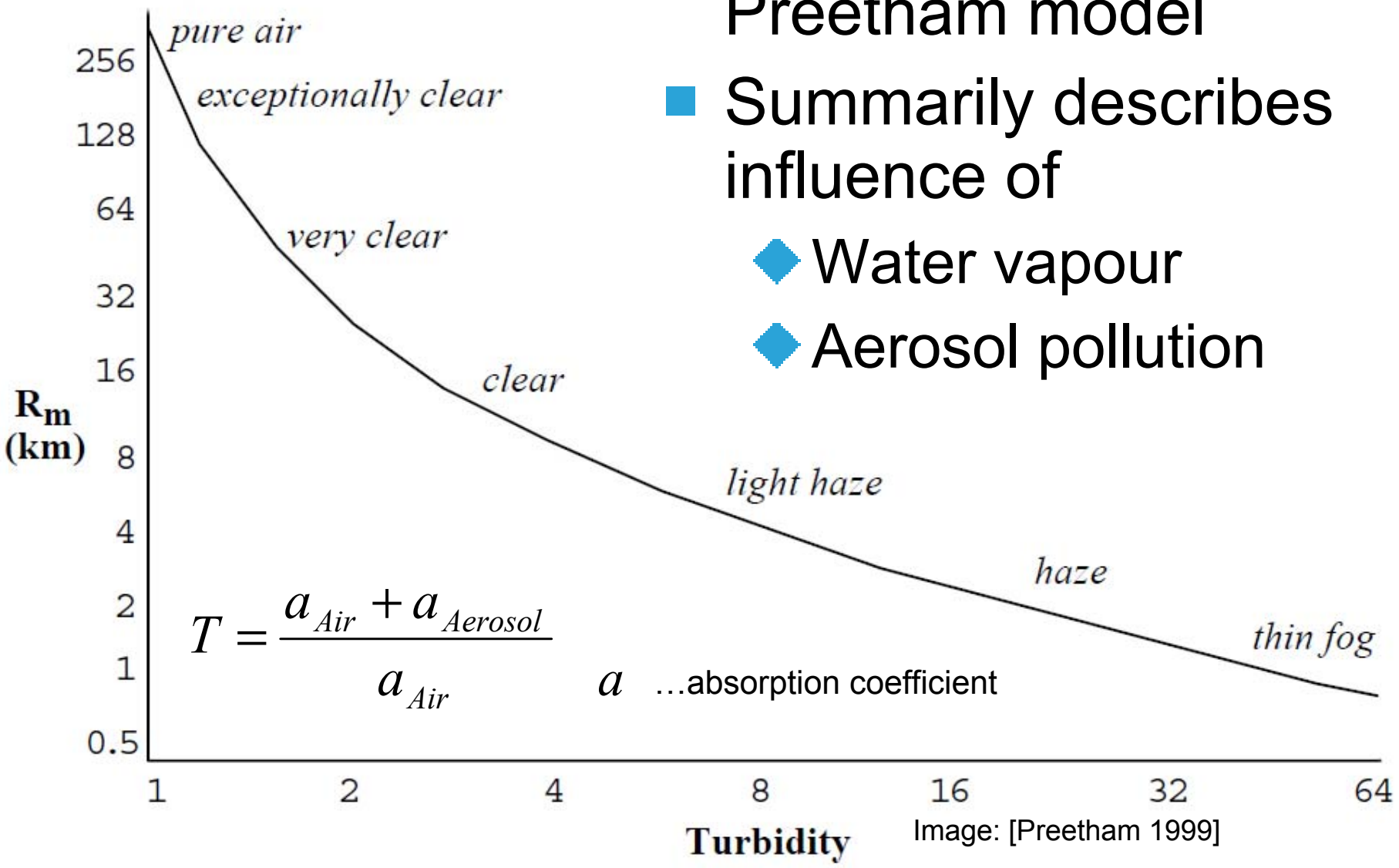
$$F(\theta,\gamma) = (1 + A \cdot e^{B/\cos\theta})(1 + C \cdot e^{D\gamma} + E \cdot \cos^2\gamma)$$

A, B … radial distribution around zenith Z

C, D, E … circumsolar brightening

Turbidity

- Key parameter T for Preetham model
- Summarily describes influence of
  - Water vapour
  - Aerosol pollution



$$T = \frac{a_{Air} + a_{Aerosol}}{a_{Air}}$$

a …absorption coefficient

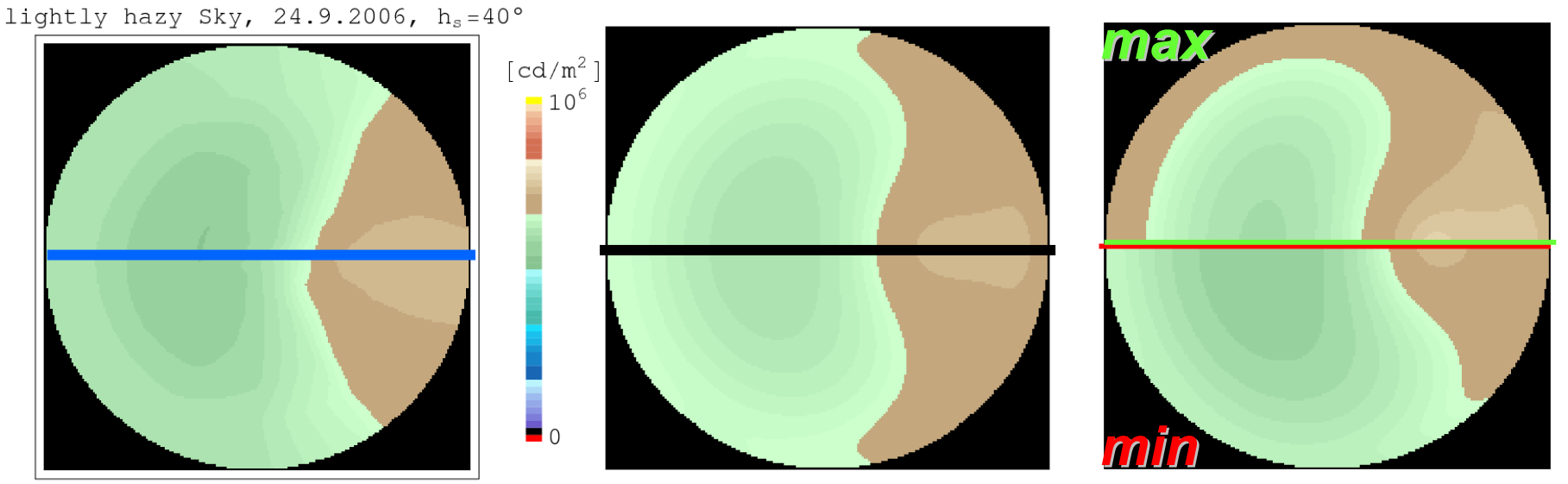
Image: [Preetham 1999]

Preetham vs. CIE2003 Standard General Sky

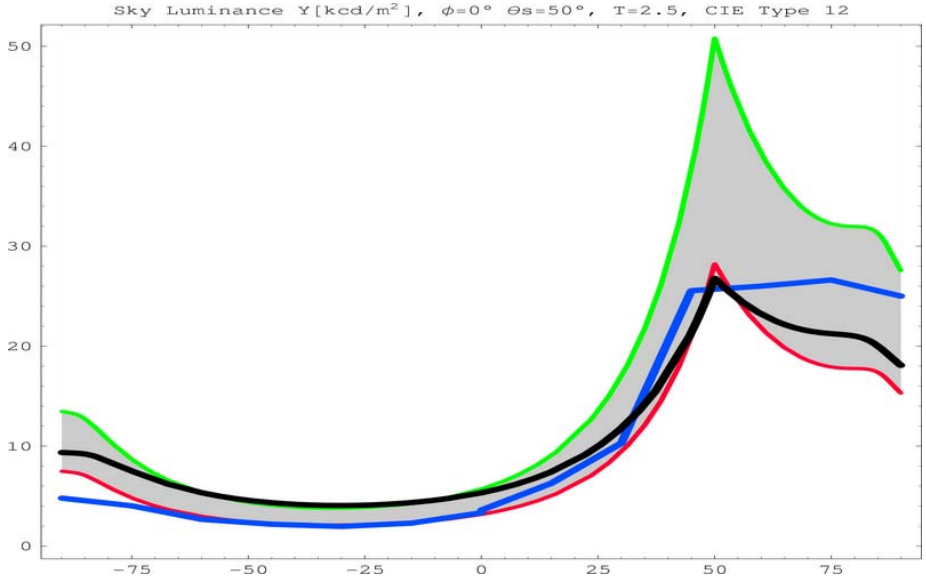
- Preetham — Luminance and Chroma
  - $F_{\mathrm{Pr}99}(\theta,\gamma) = (1 + A \cdot e^{B/\cos\theta})(1 + C \cdot e^{D\gamma} + E \cdot \cos^2\gamma)$
  - T ➔ A, B, C, D, E
  - Absolute Zenith luminance and chroma

- CIE2003 — Only Luminance Model
  - $F_{CIE2003}(\theta,\gamma) = (1 + A \cdot e^{B/\cos\theta})(1 + C \cdot (e^{D\gamma} - e^{D\frac{\pi}{2}}) + E \cdot \cos^2\gamma)$
  - Tabulated A, B, C, D, E *for* 15 distributions
  - **No absolute zenith luminance!**
    But recommendations by [Kittler, Darula 2004]

Comparisons with CIE 2003 and Measurements (1)



Measured **Preetham, T=2.5** **CIE Type12 (low turb.)**



Measured

Preetham

CIE2003 max. recommended

CIE2003 recommended range

CIE2003 min. recommended

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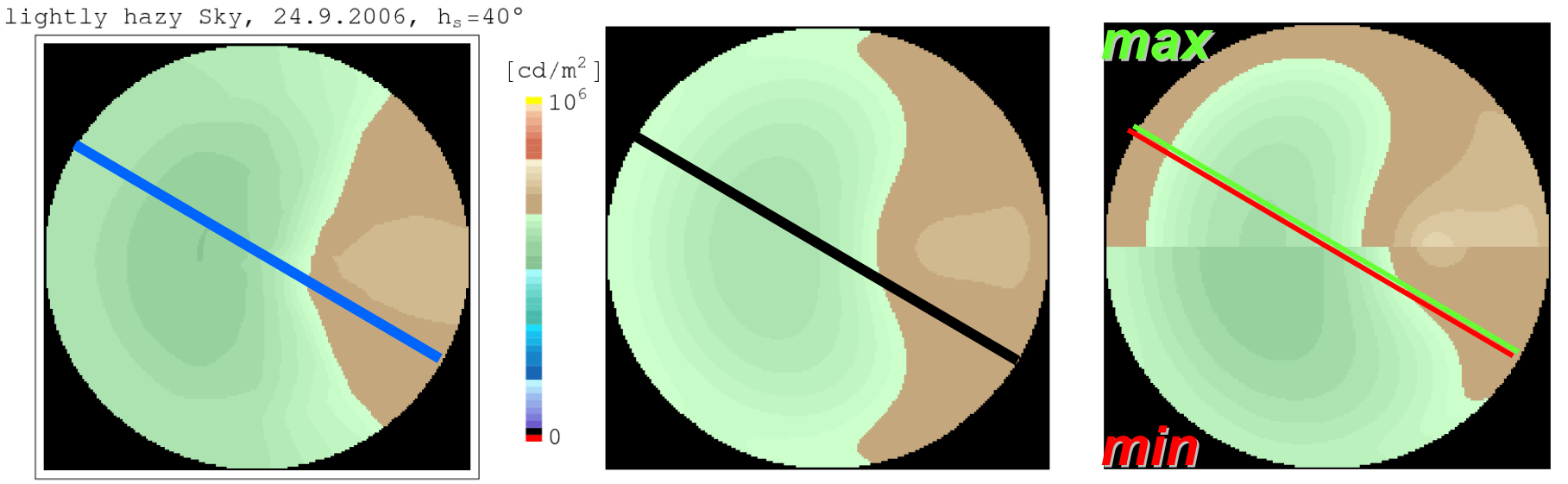
Comparisons with CIE 2003 and Measurements (1)



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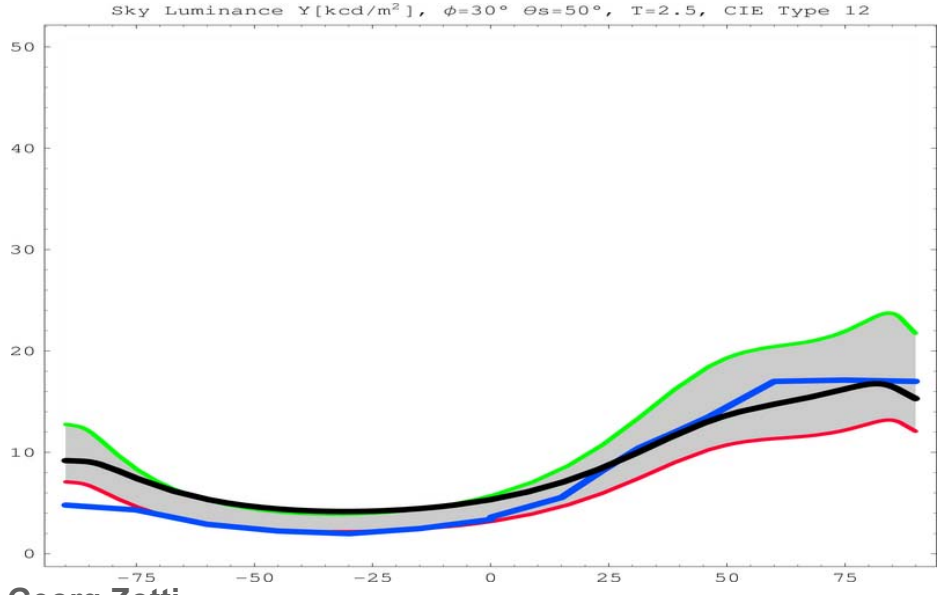

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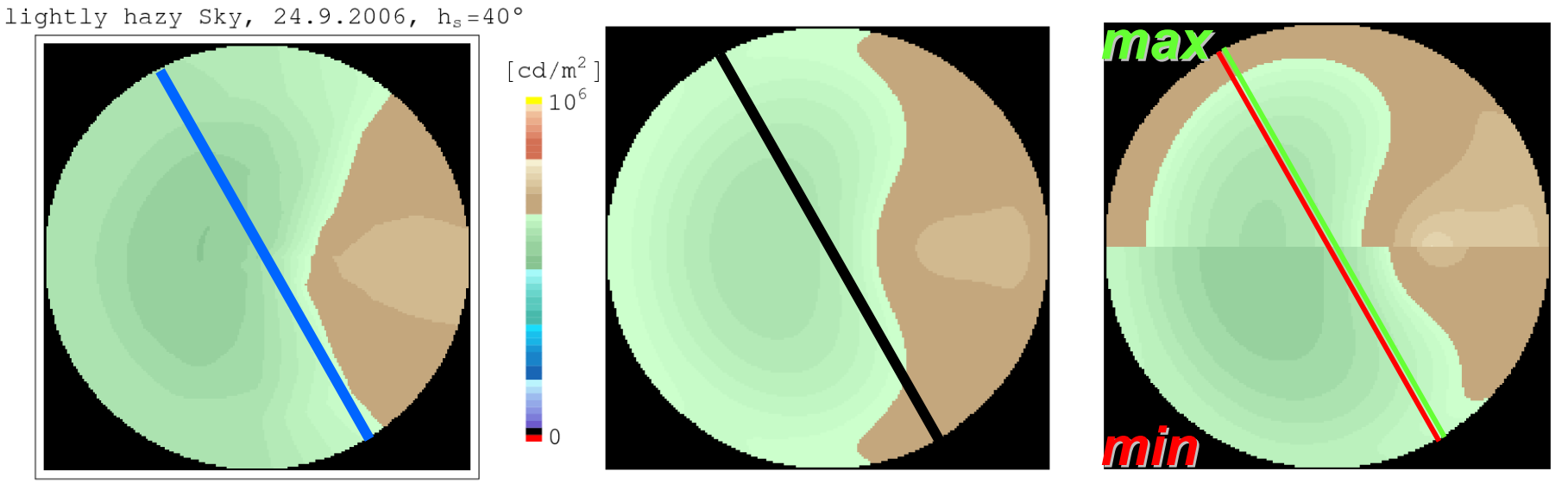

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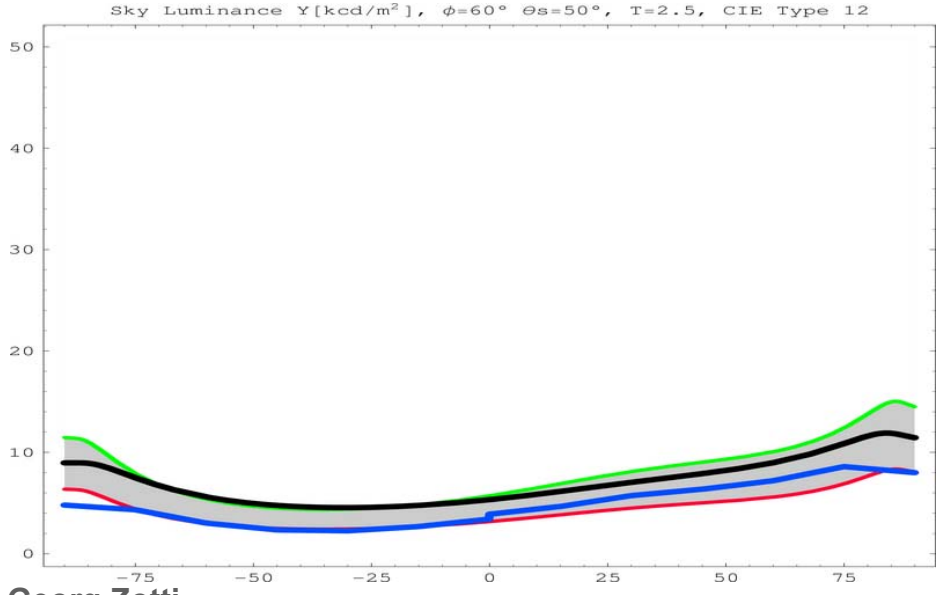

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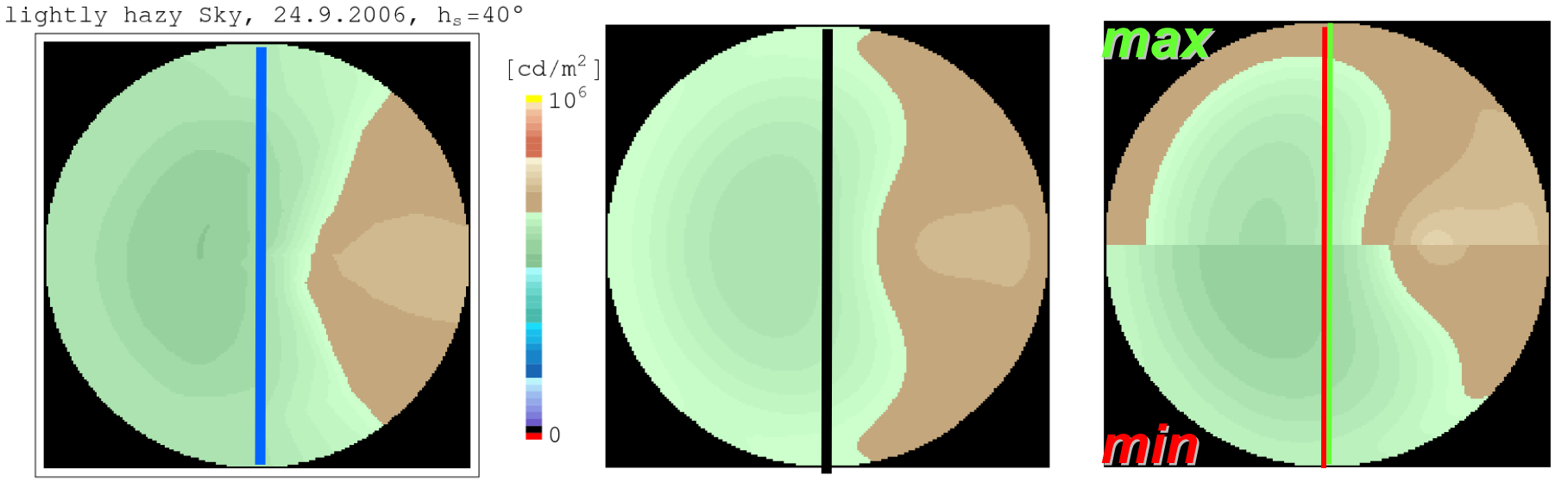

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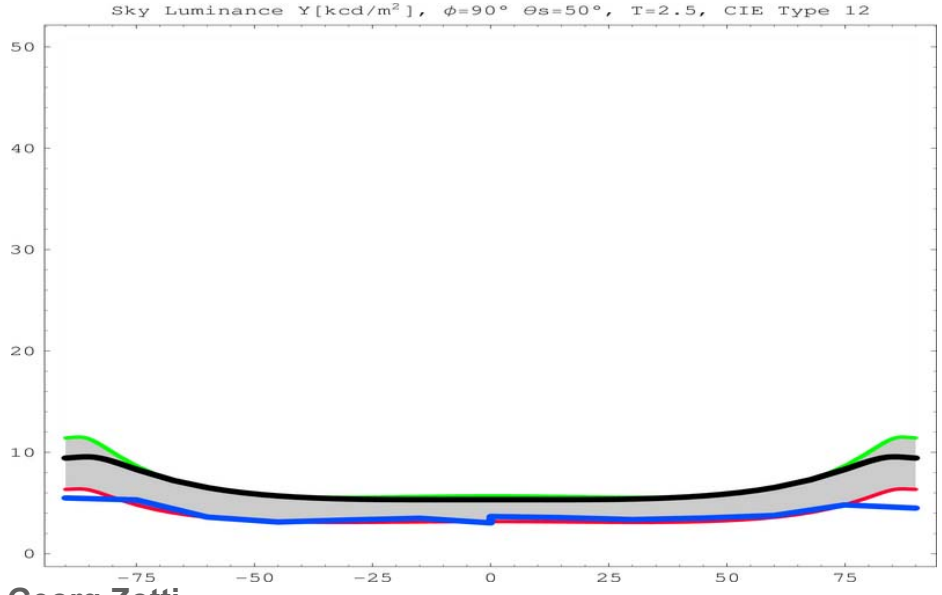

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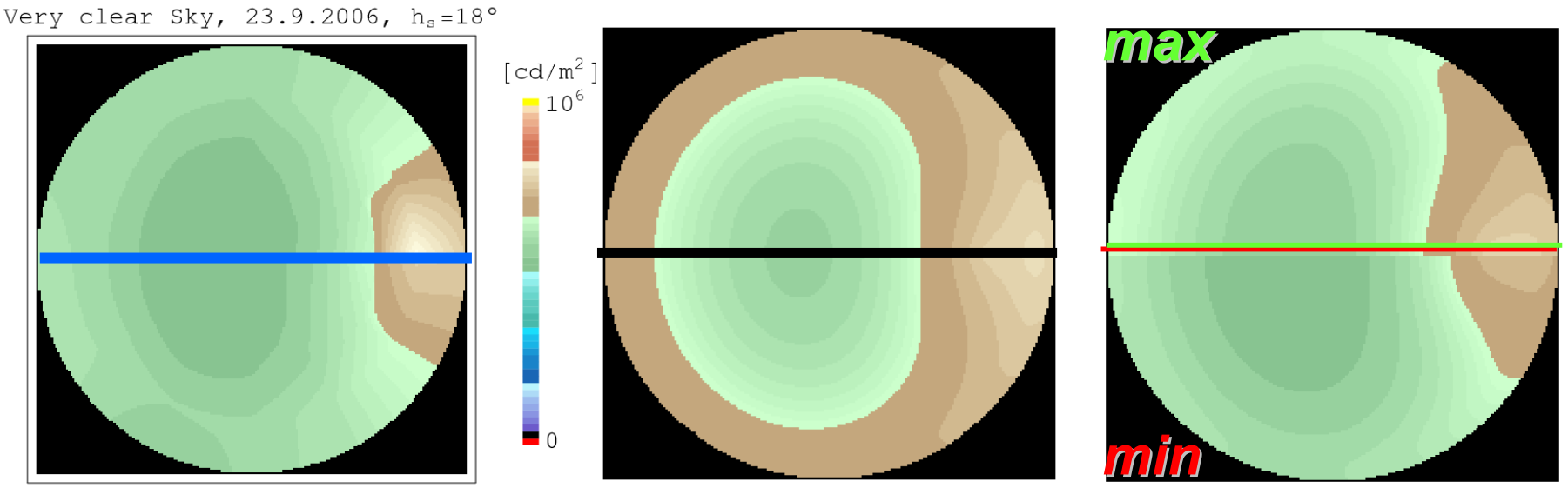
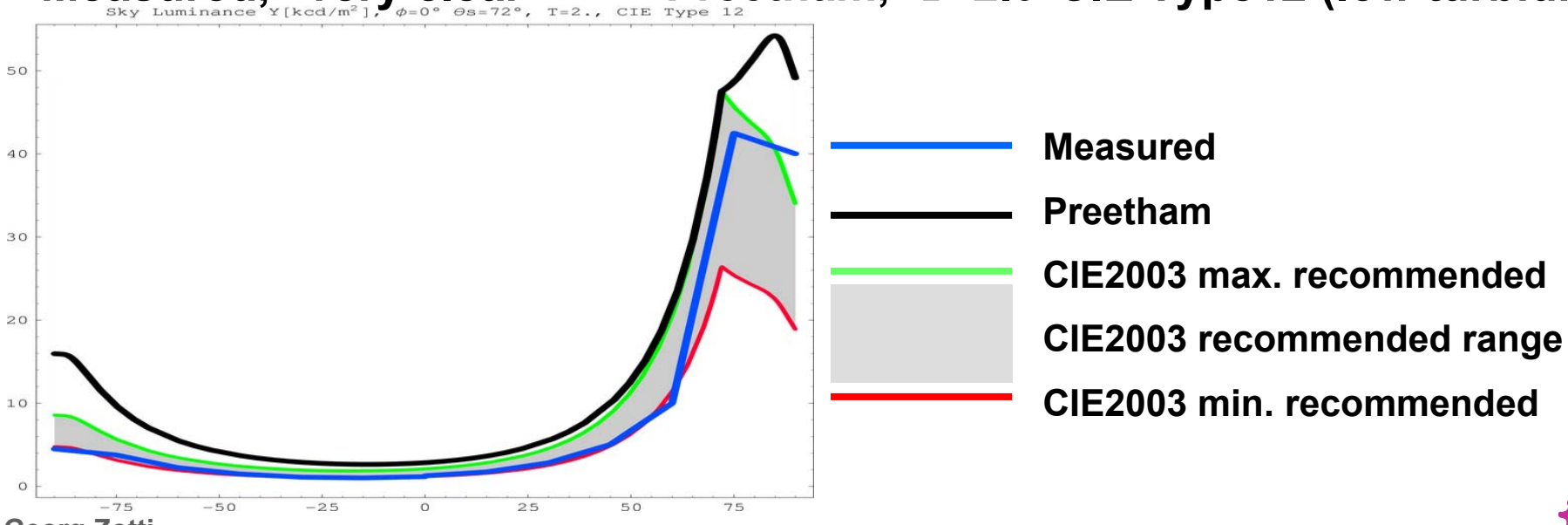
Comparisons with CIE 2003 and Measurements (2)



Measured, "very clear" **Preetham, T=2.0 CIE Type12 (low turbidity)**



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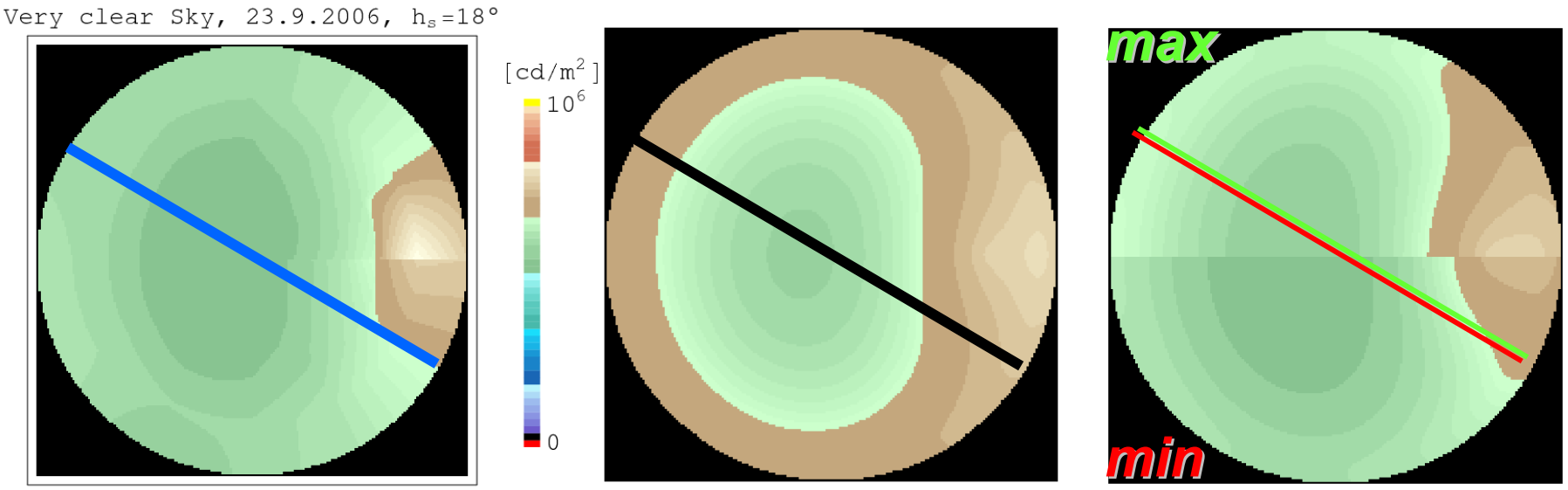

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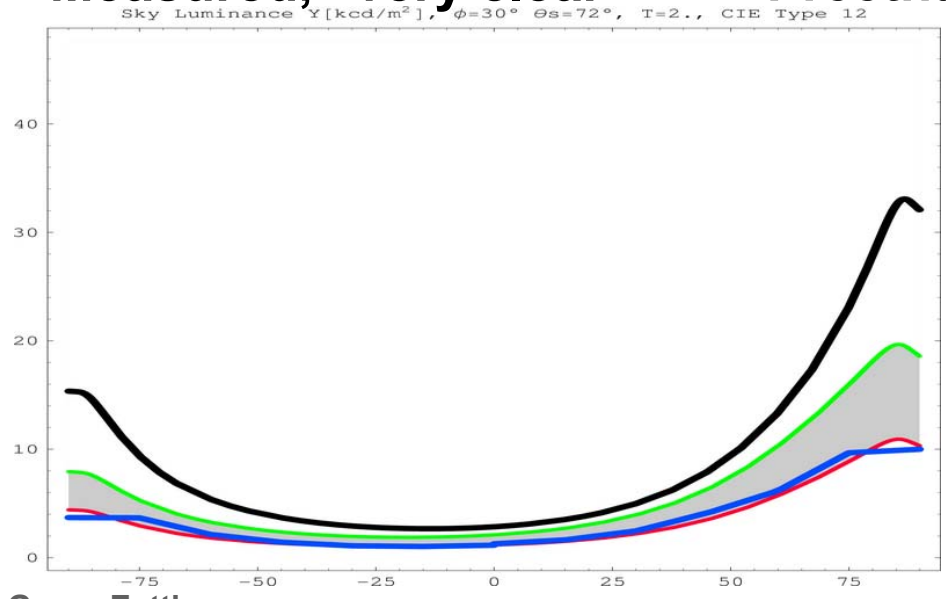

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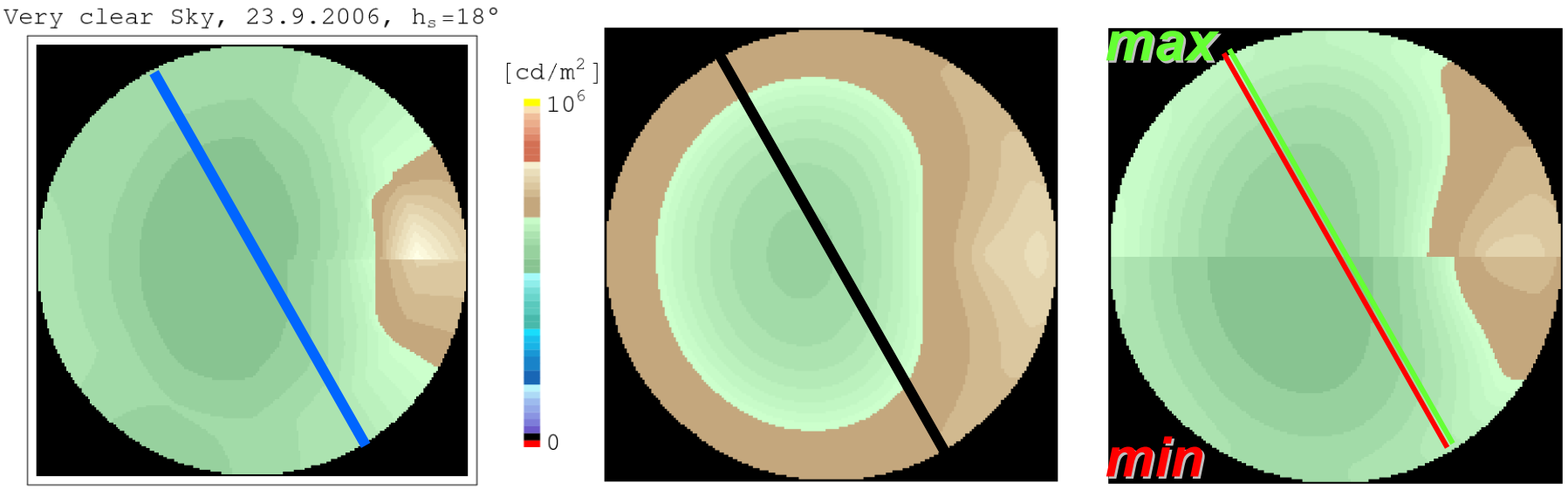

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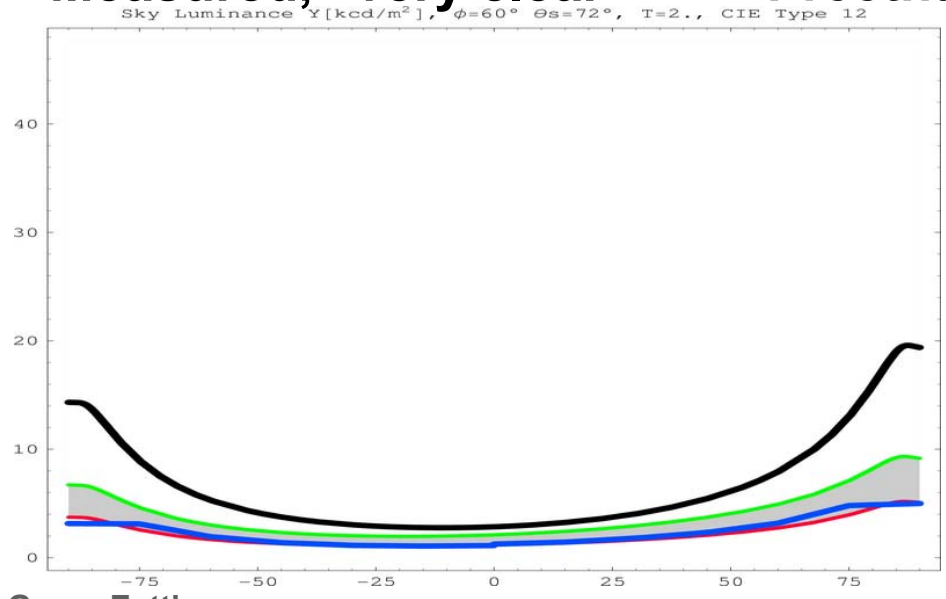

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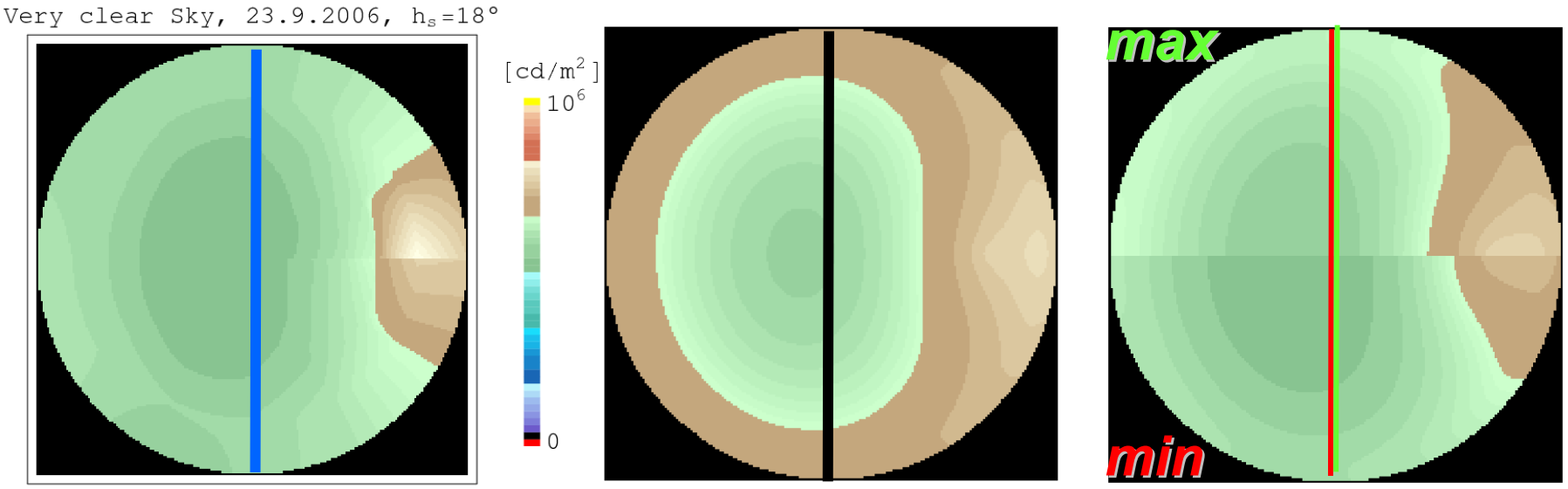

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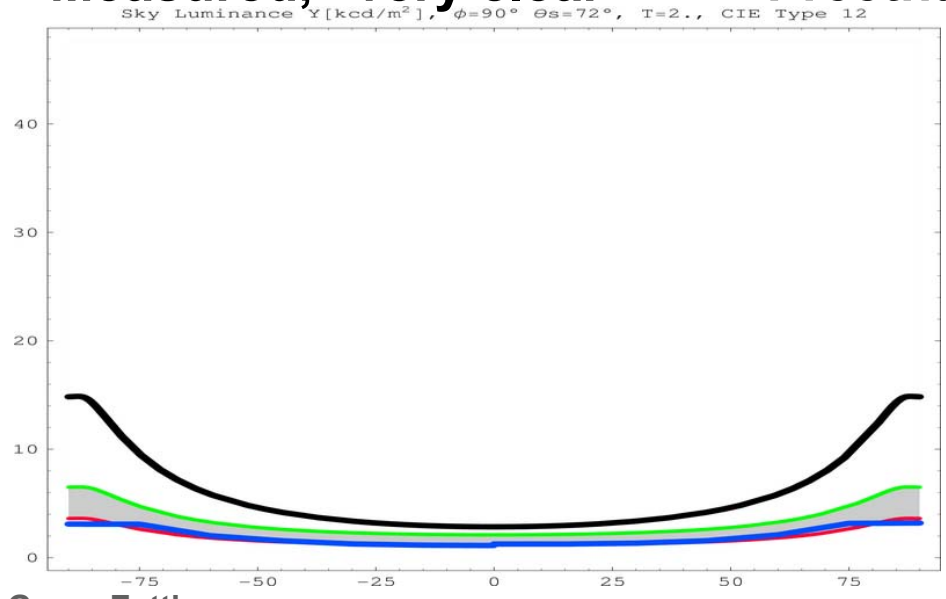

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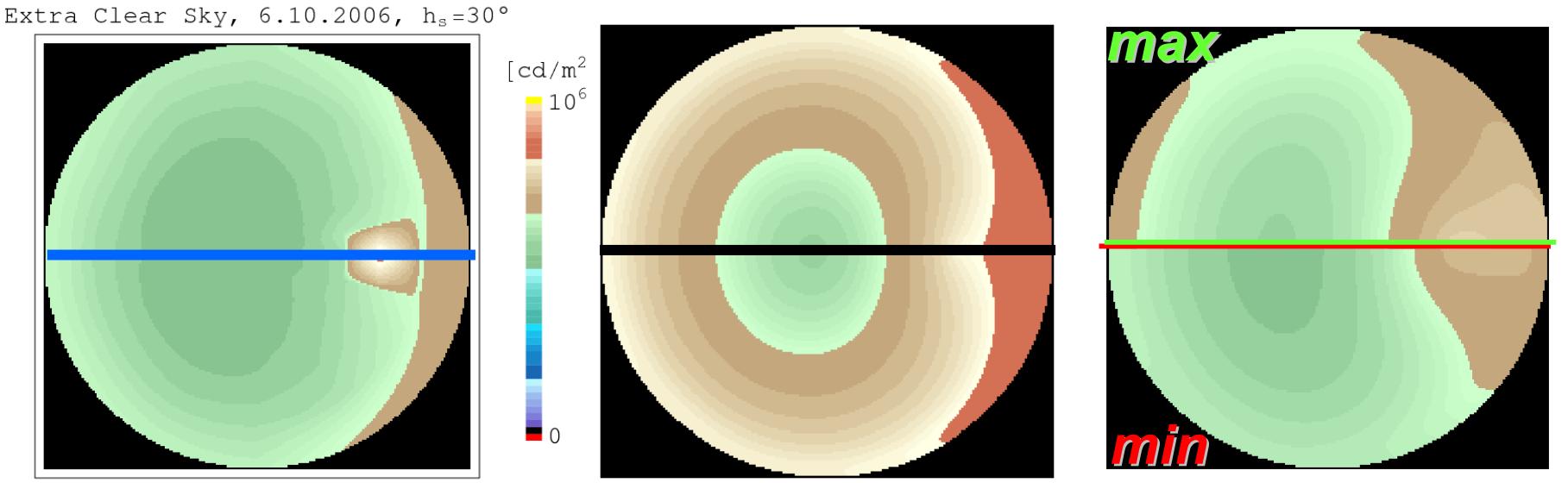
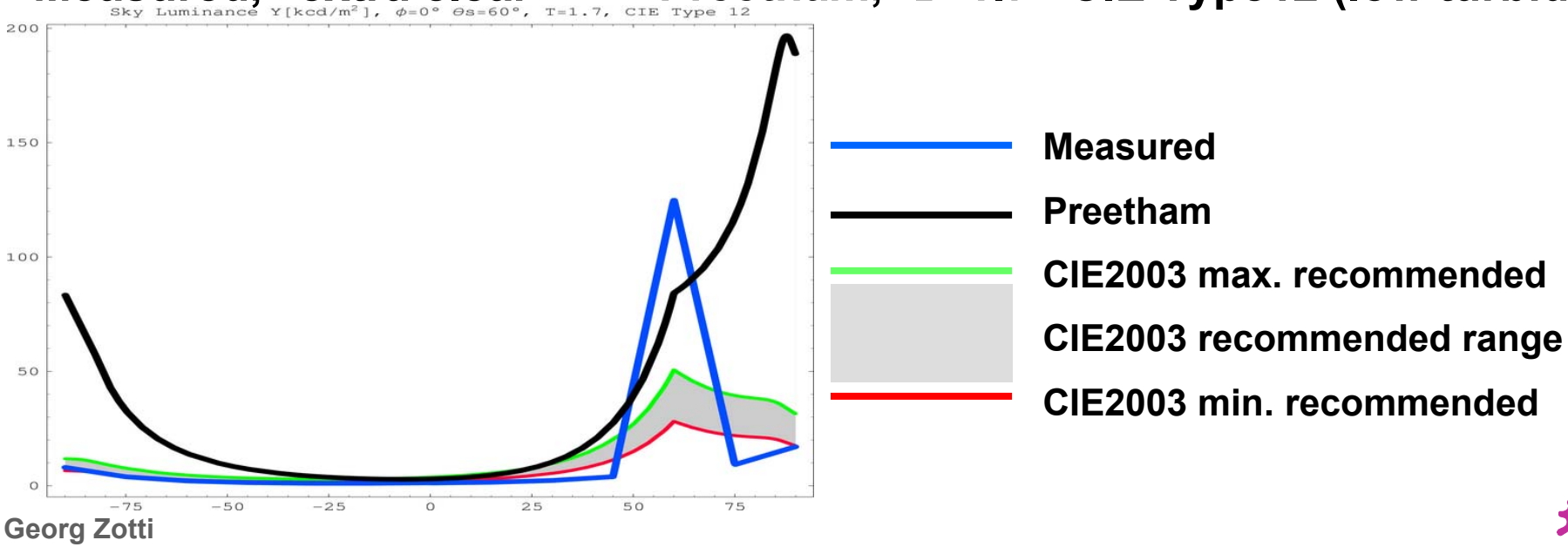
Comparisons with CIE 2003 and Measurements (3)



Measured, “extra clear” **Preetham, T=1.7** **CIE Type12 (low turbidity)**



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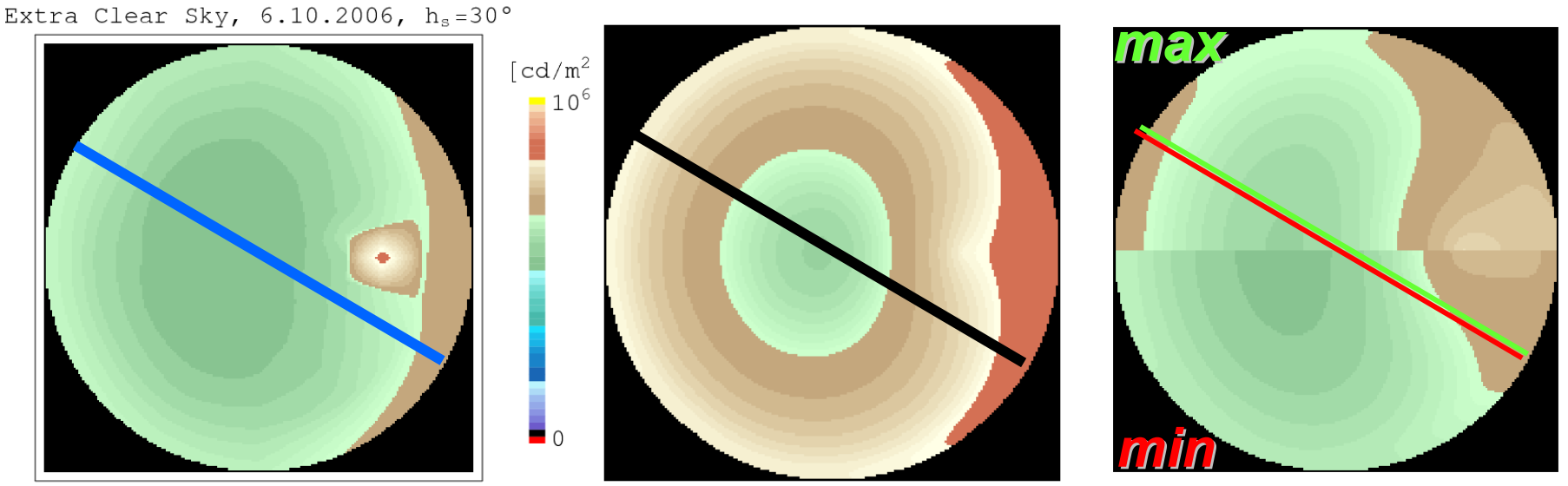

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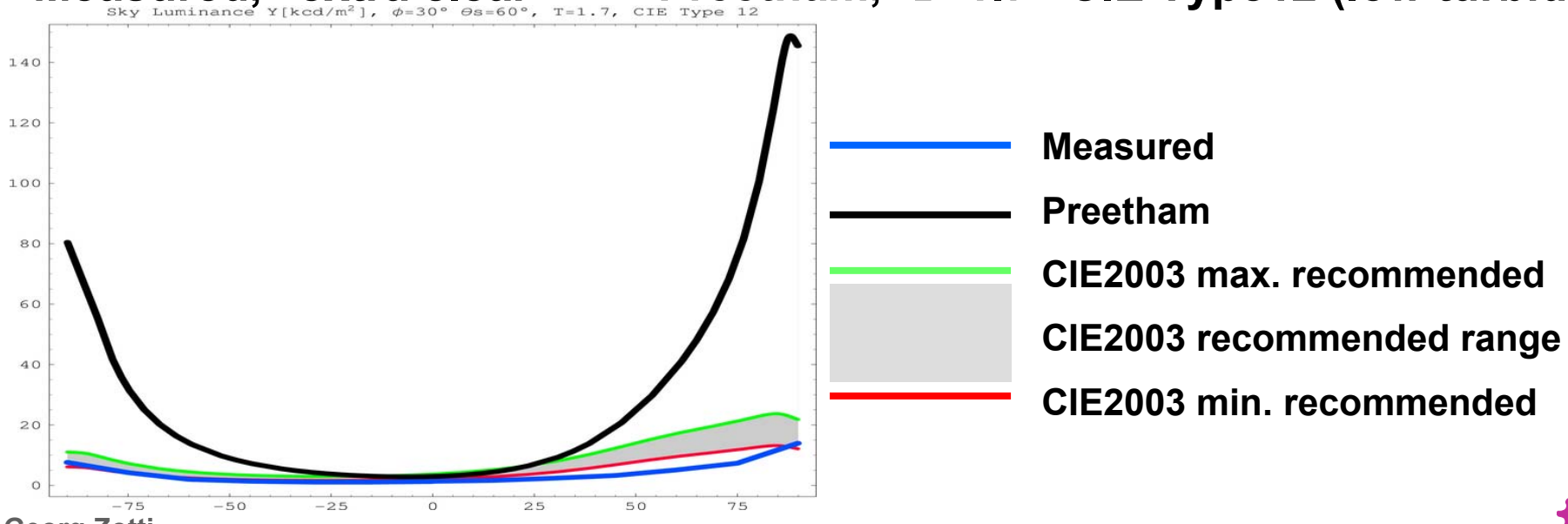

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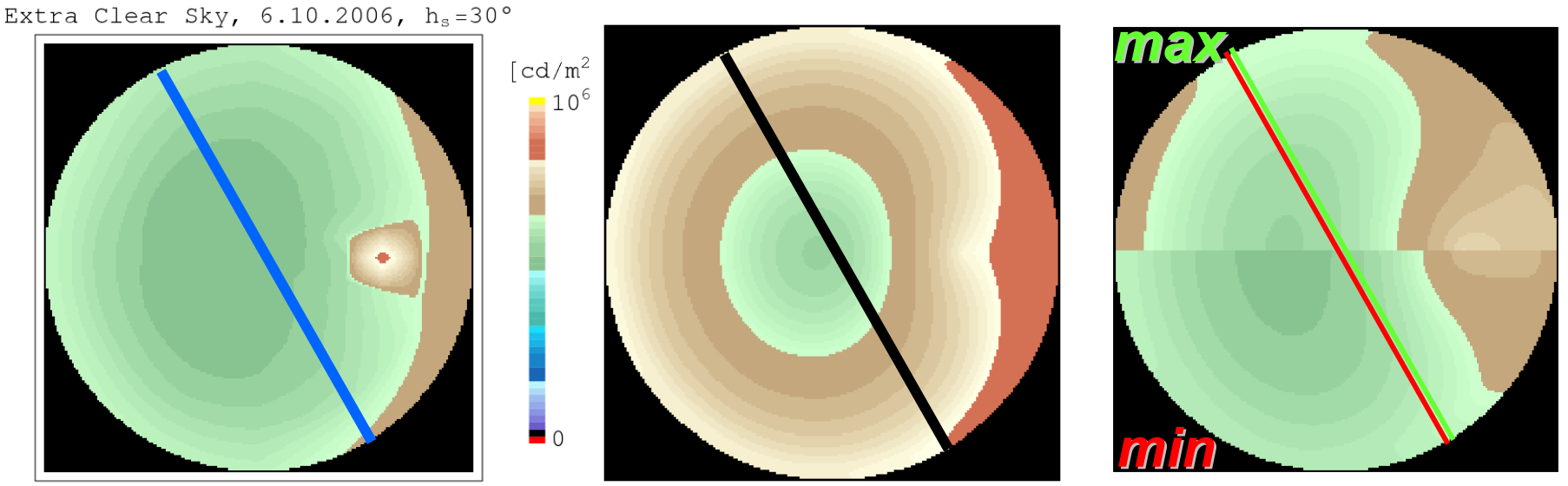

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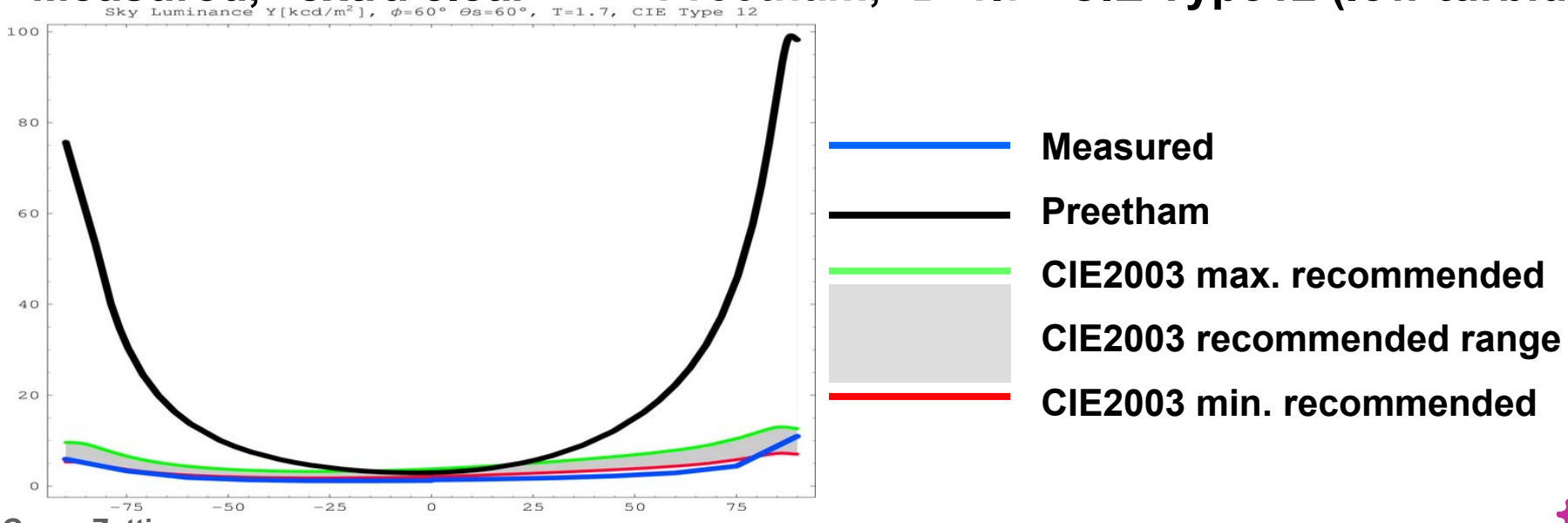

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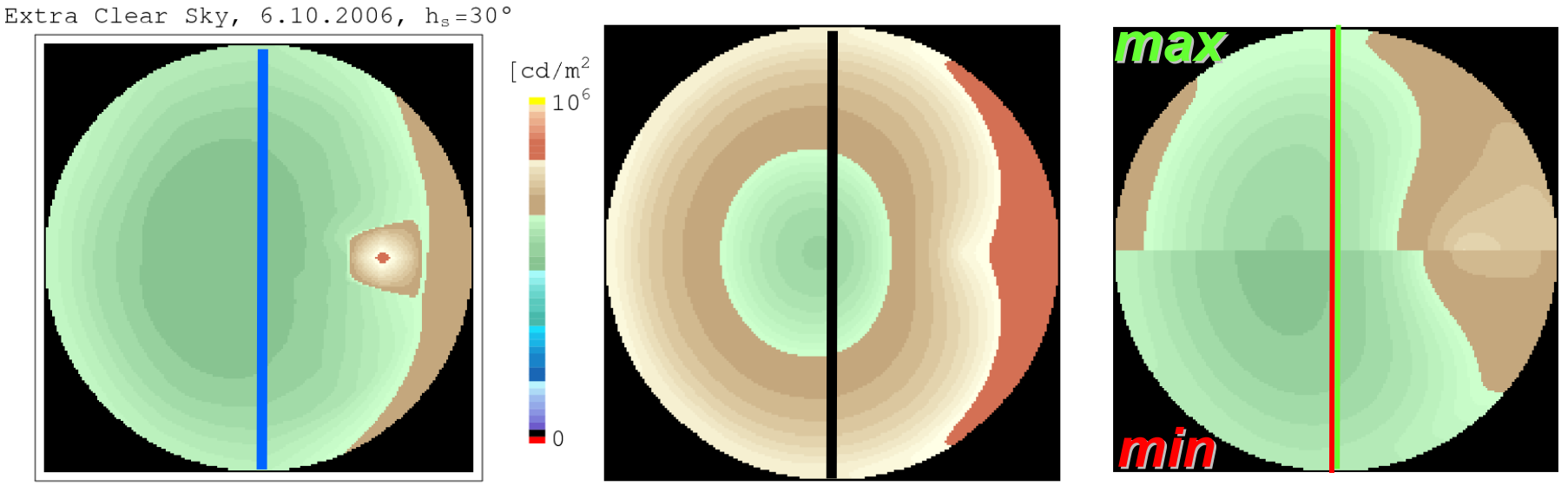

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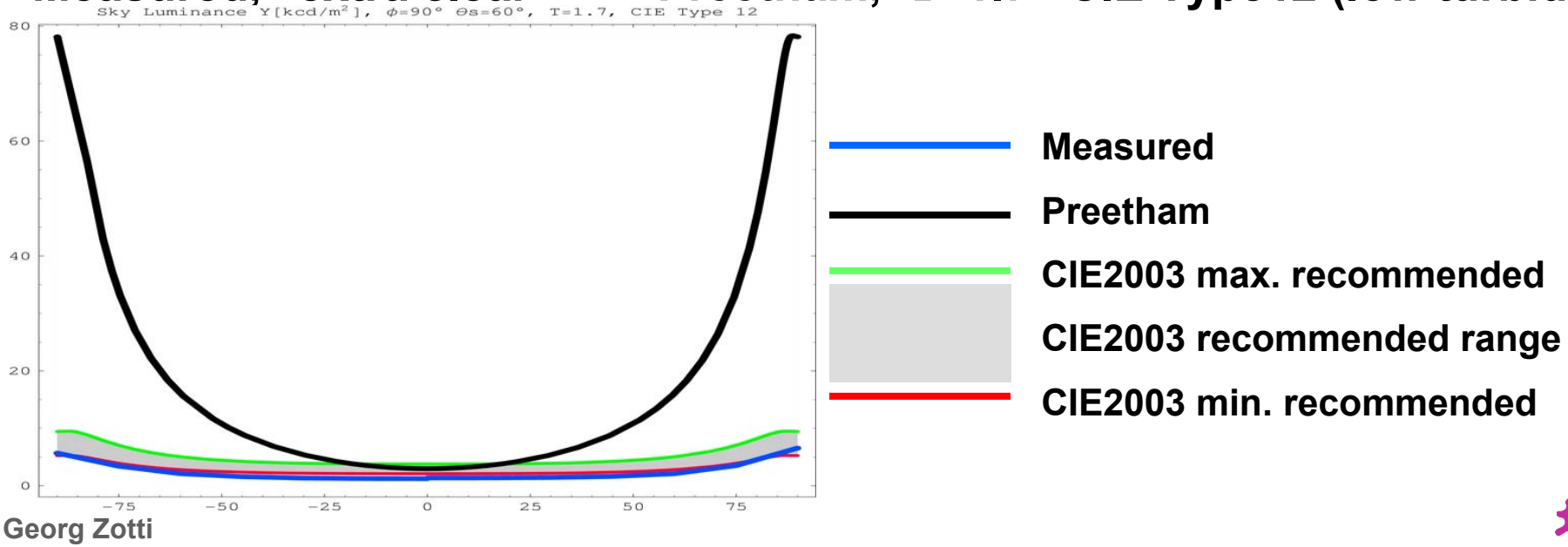

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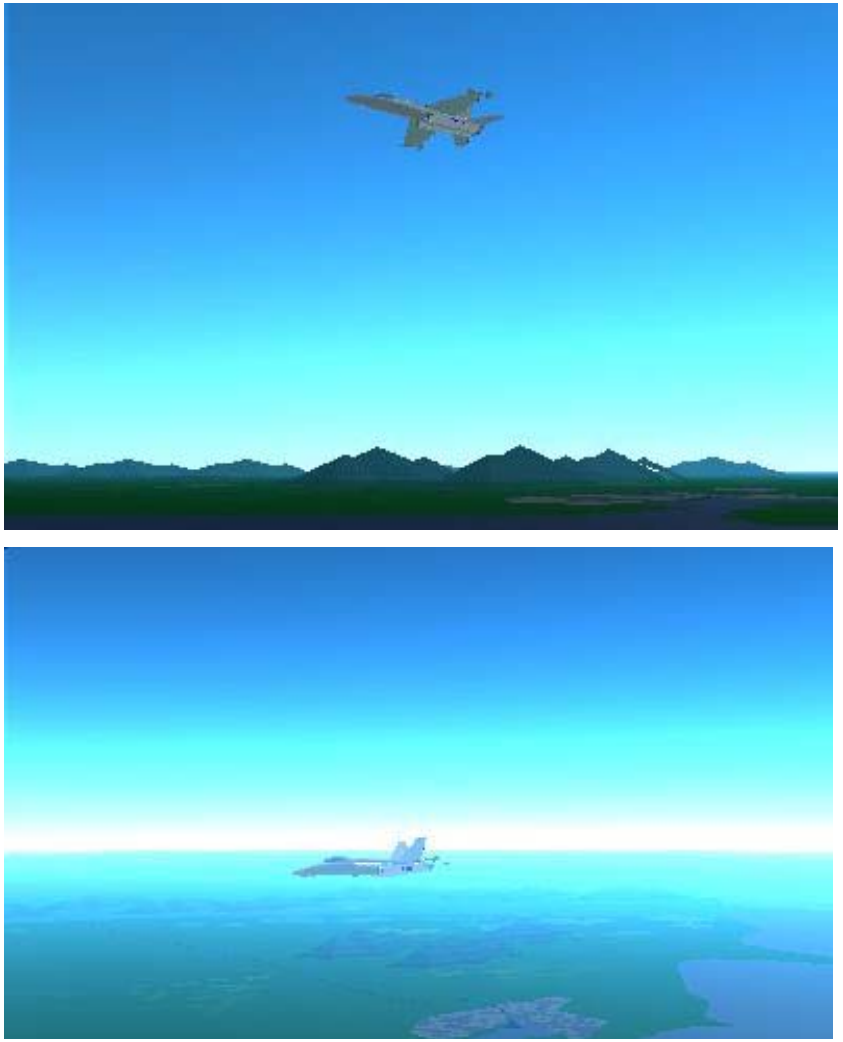
Possible Reasons for Bad Behaviour



Images from [Nishita et al., 1996]

- Model based on [Nishita et al.; Pacific Graphics 1996]
- Data fit only for $2 < T < 6$
- No validation by measurements

Conclusions

- Preetham model to be used with caution
  - OK for humid sky, $T > 2.4$
  - **UNUSABLE** for really clean, blue sky ($T<2$)
- CIE 2003 models more reliable for low T
  - BUT: still lack colour information
- Better simulation basis required

Thank You for Your Attention!

<gzotti@cg.tuwien.ac.at>