Progress in Understanding Interactions between Aerosols and Arctic Mixed-Phase Clouds

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(2) NOAA

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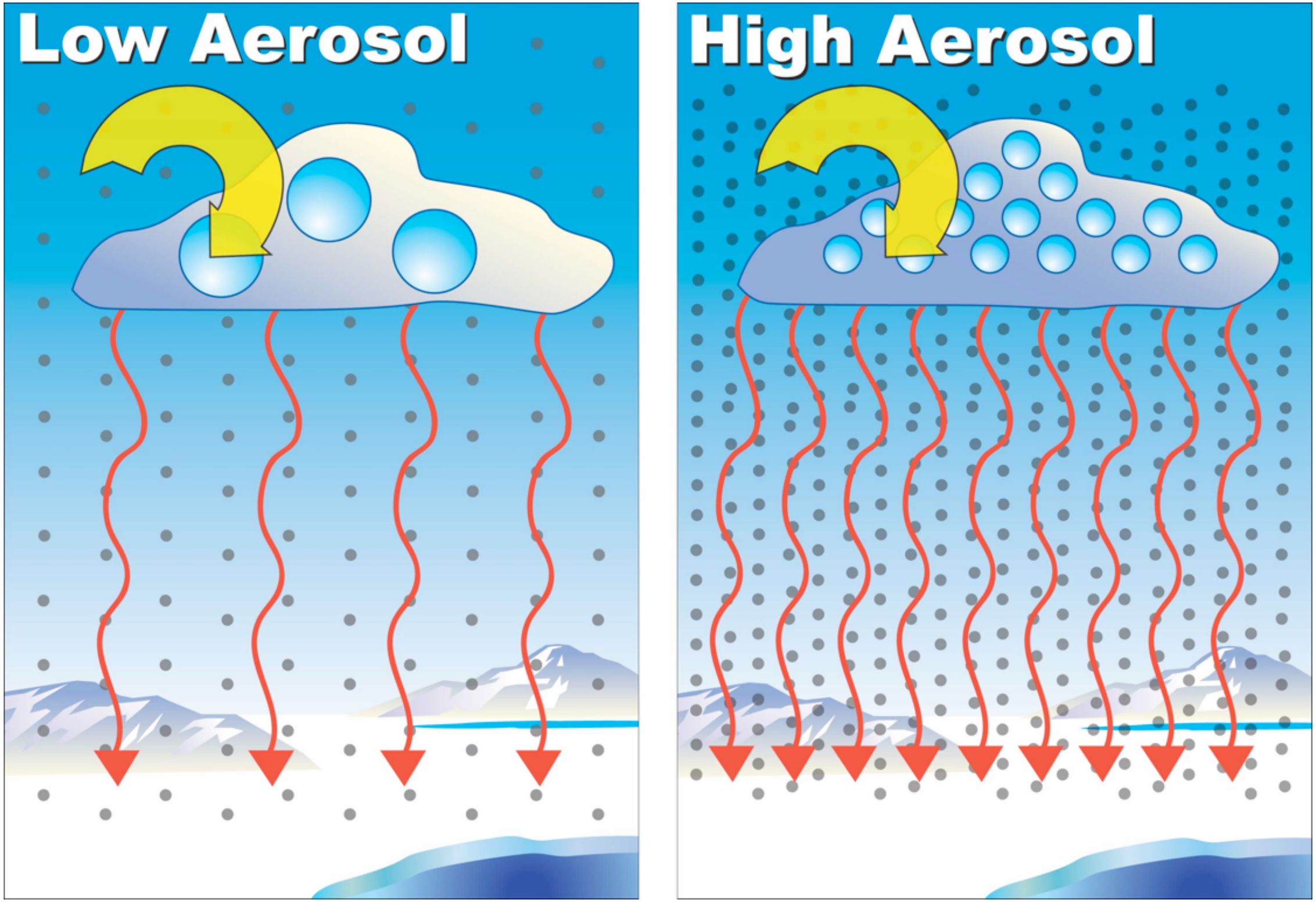
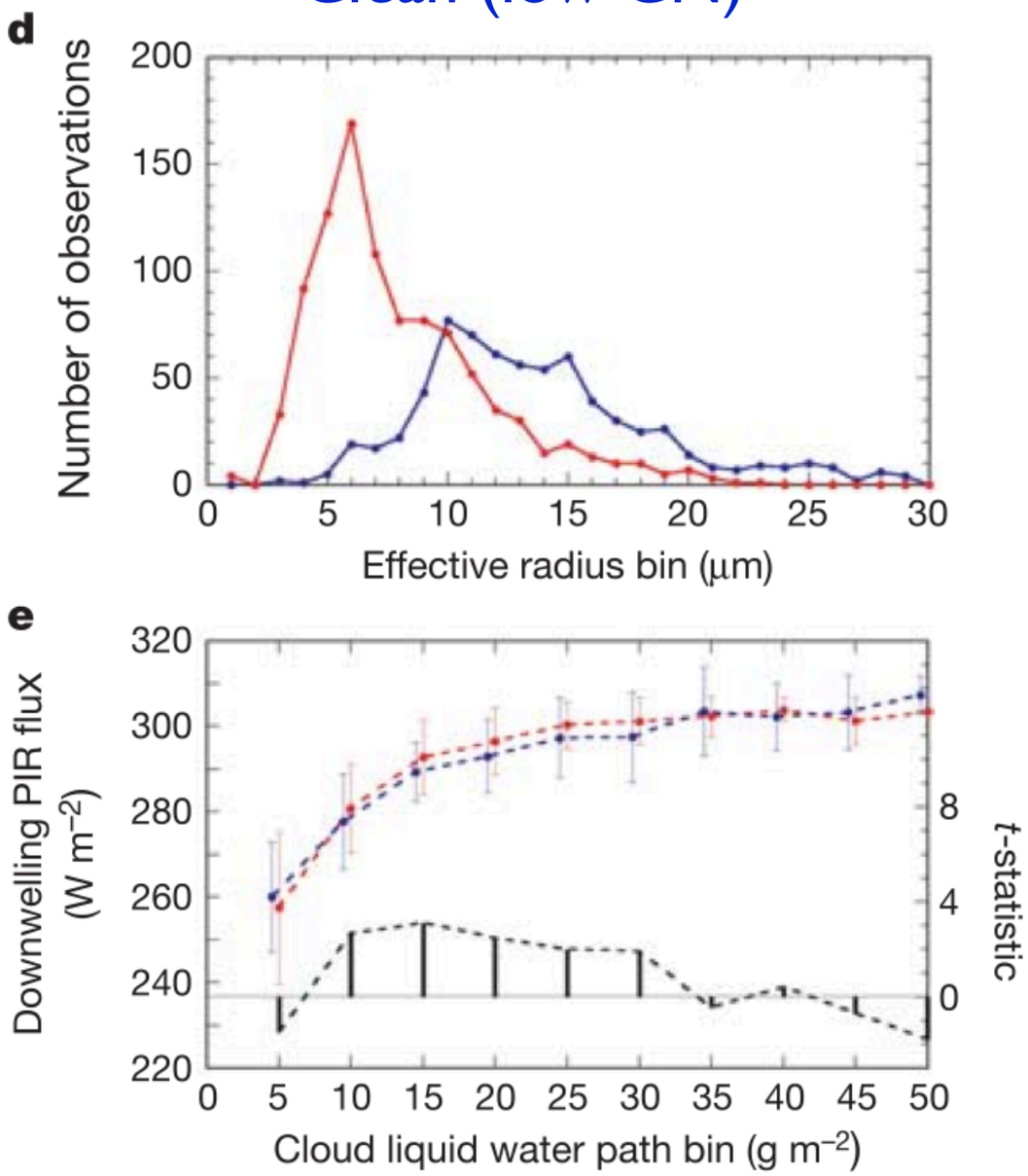
Introduction



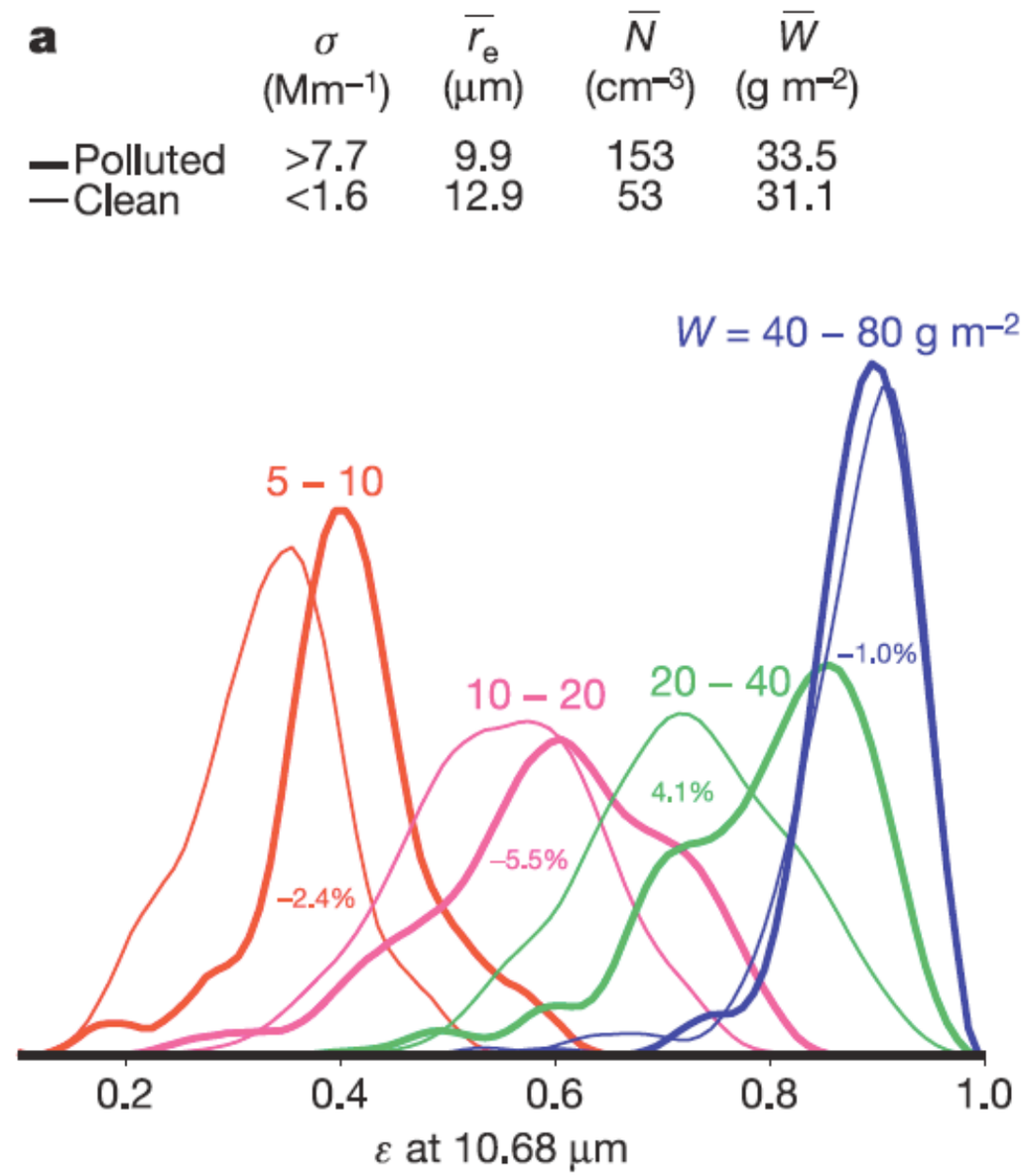
(Figure from Brookhaven National Laboratory)

Introduction

Polluted (high CN)
Clean (low CN)



(Lubin and Vogelmann, 2006 [Nature])



(Garrett and Zhao, 2006 [Nature])

Work in Progress

1) The Role of Ice

$$r_e = \left[exp\left(3\sigma_d^2\right) \frac{3LWP}{4\pi\rho_w N h} \right]^{1/3}$$

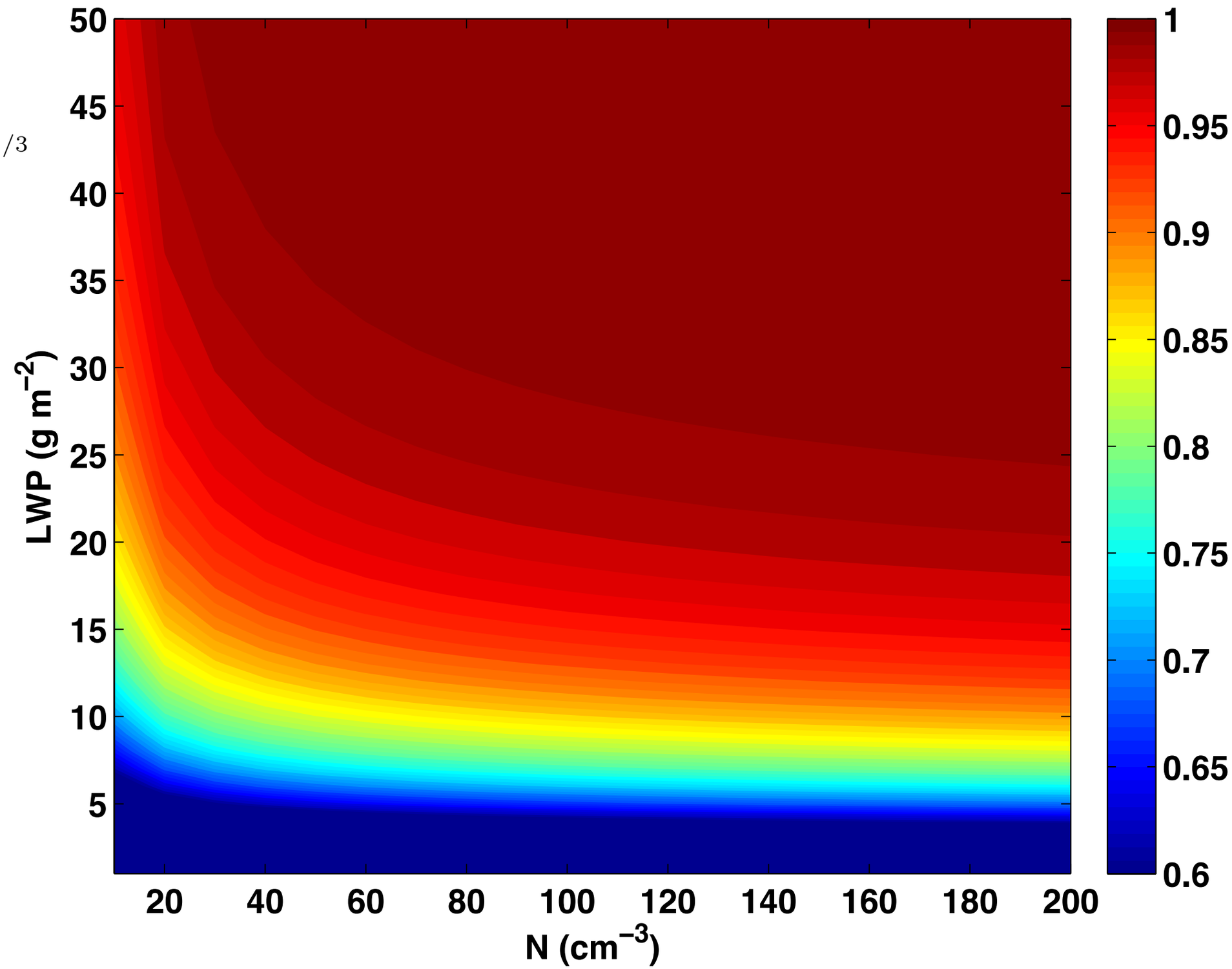
$$\sigma_d = 0.27$$

[Garrett et al., 2004, GRL]

$$k = 0.31 exp\left(-0.08 * r_e\right)$$

[Morrison et al., 2008, JGR]

$$\epsilon = 1 - exp(-kLWP)$$



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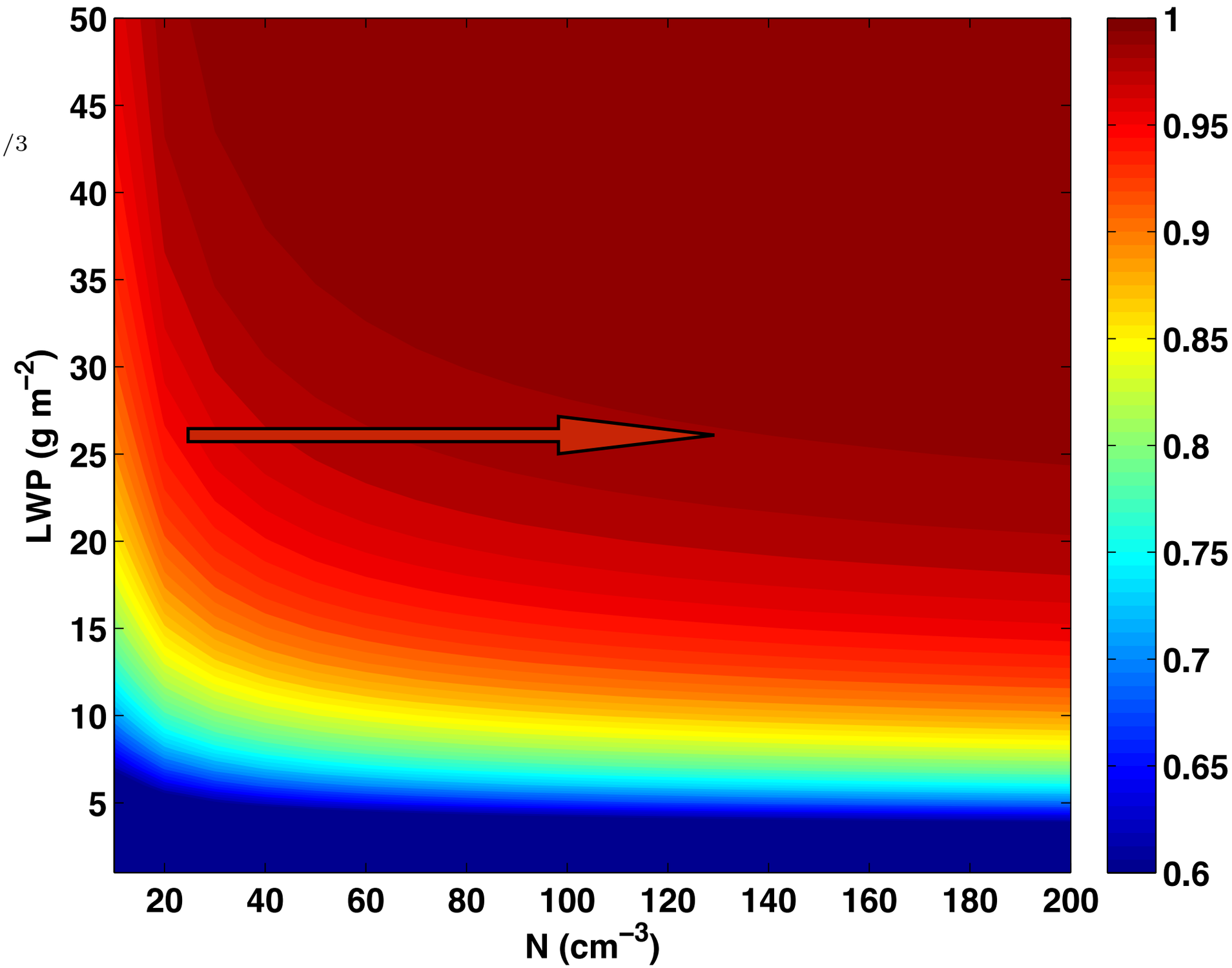

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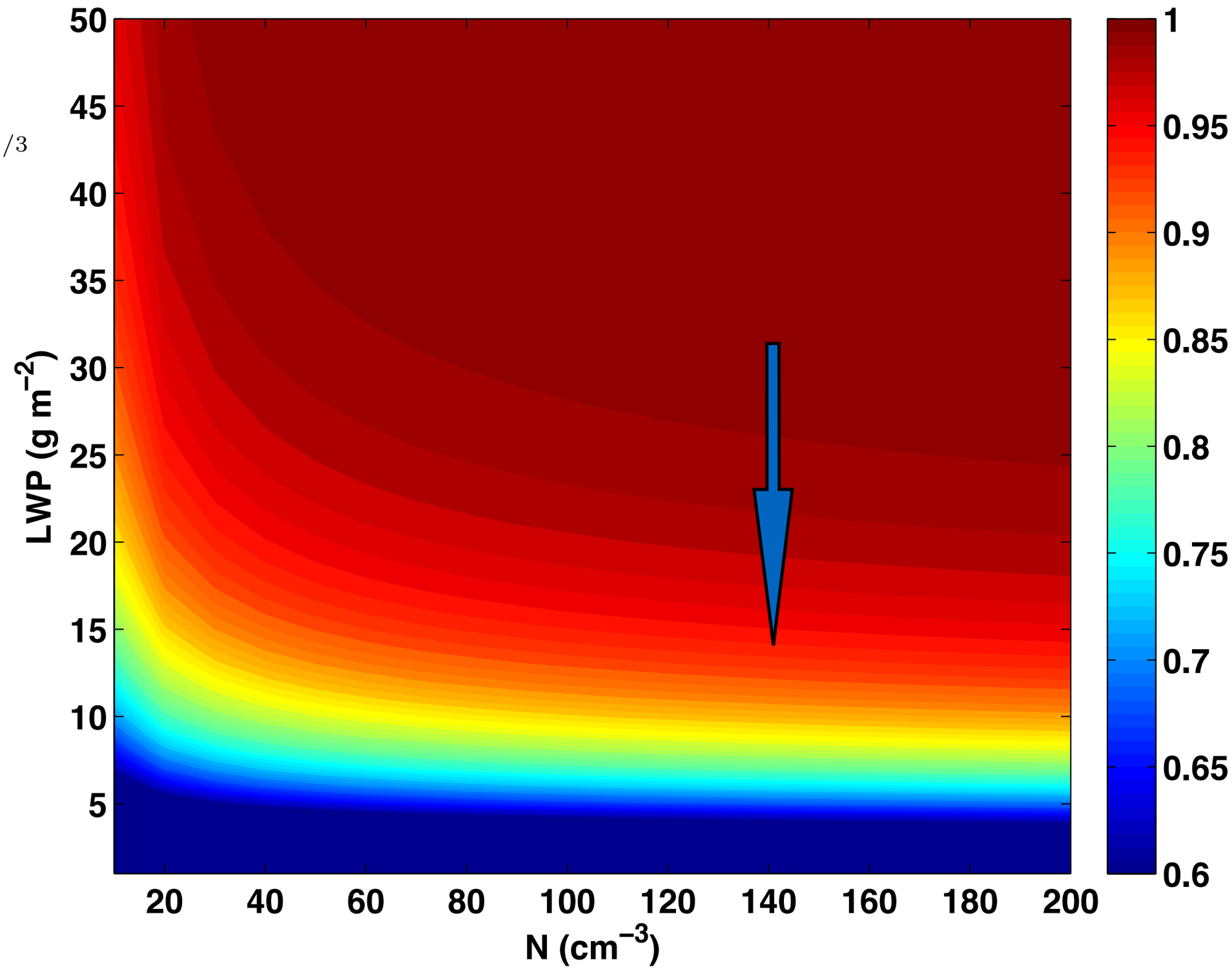

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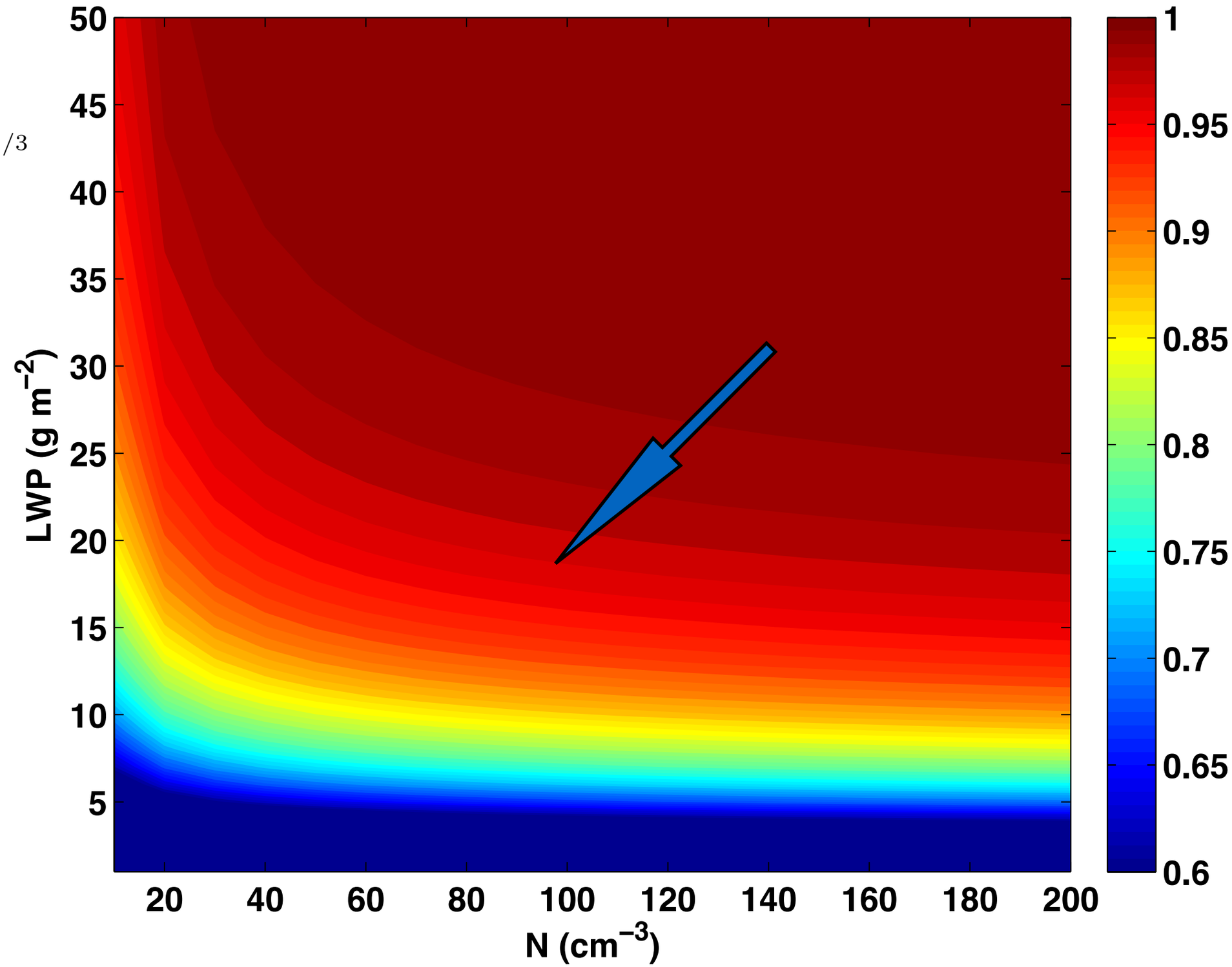

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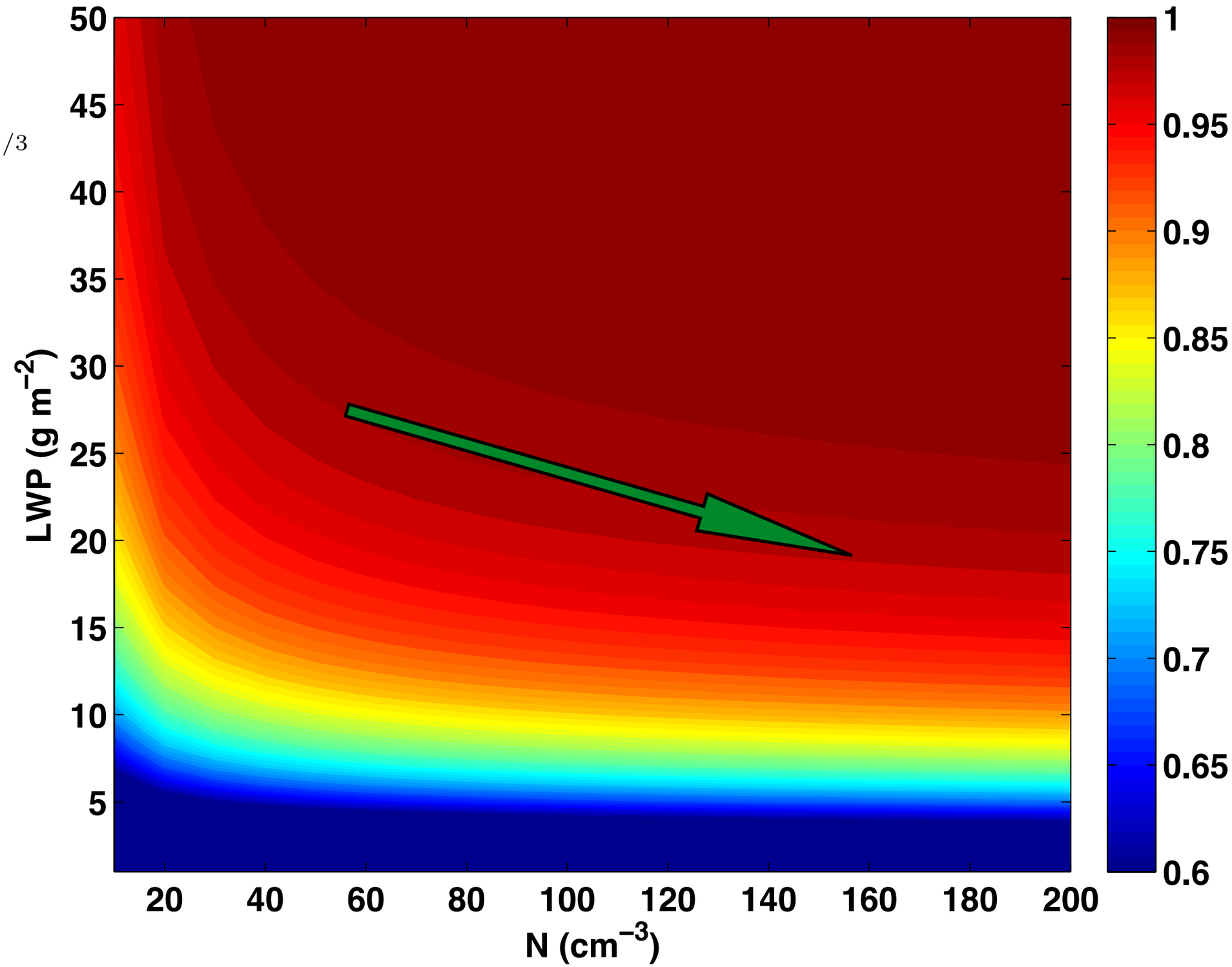

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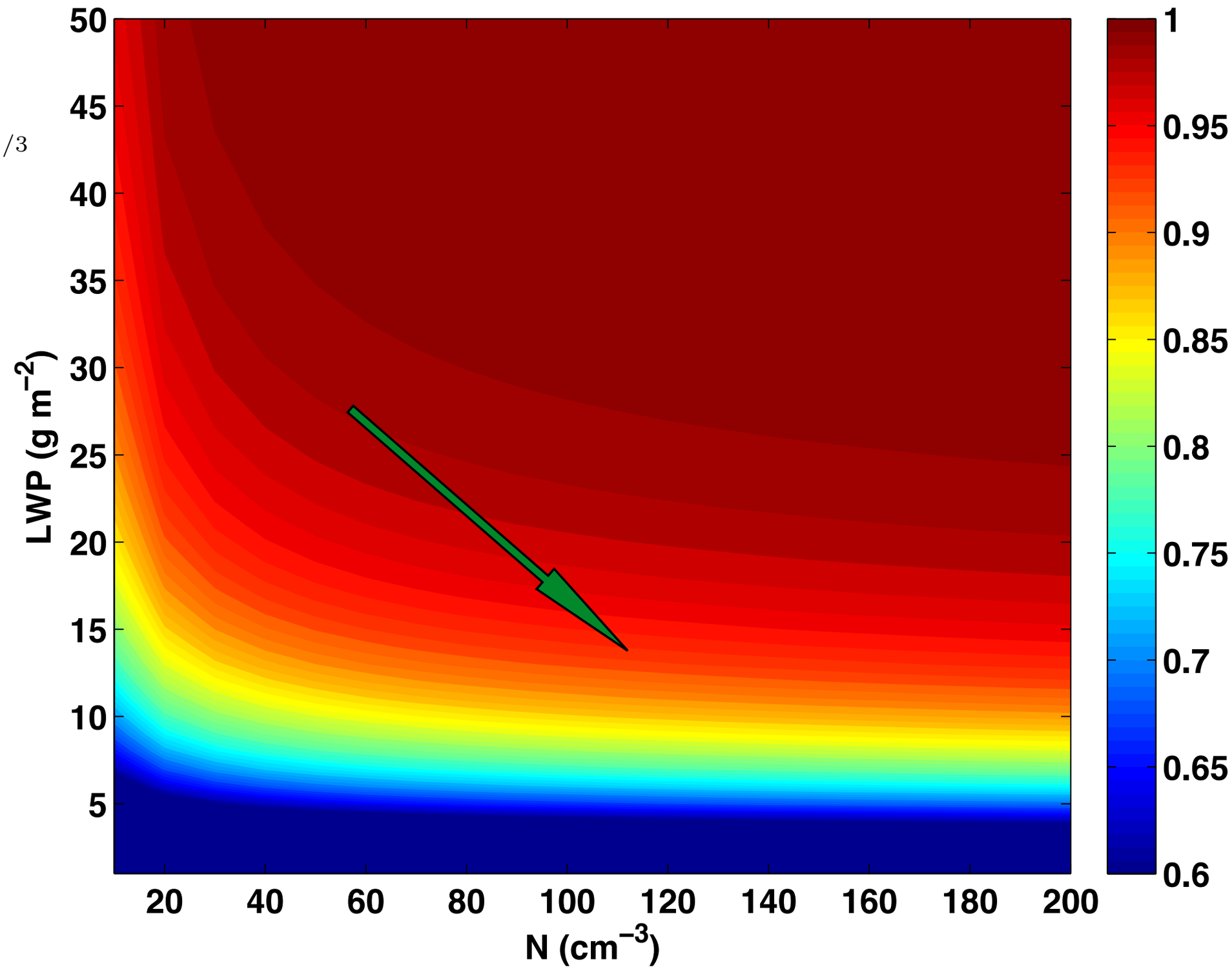

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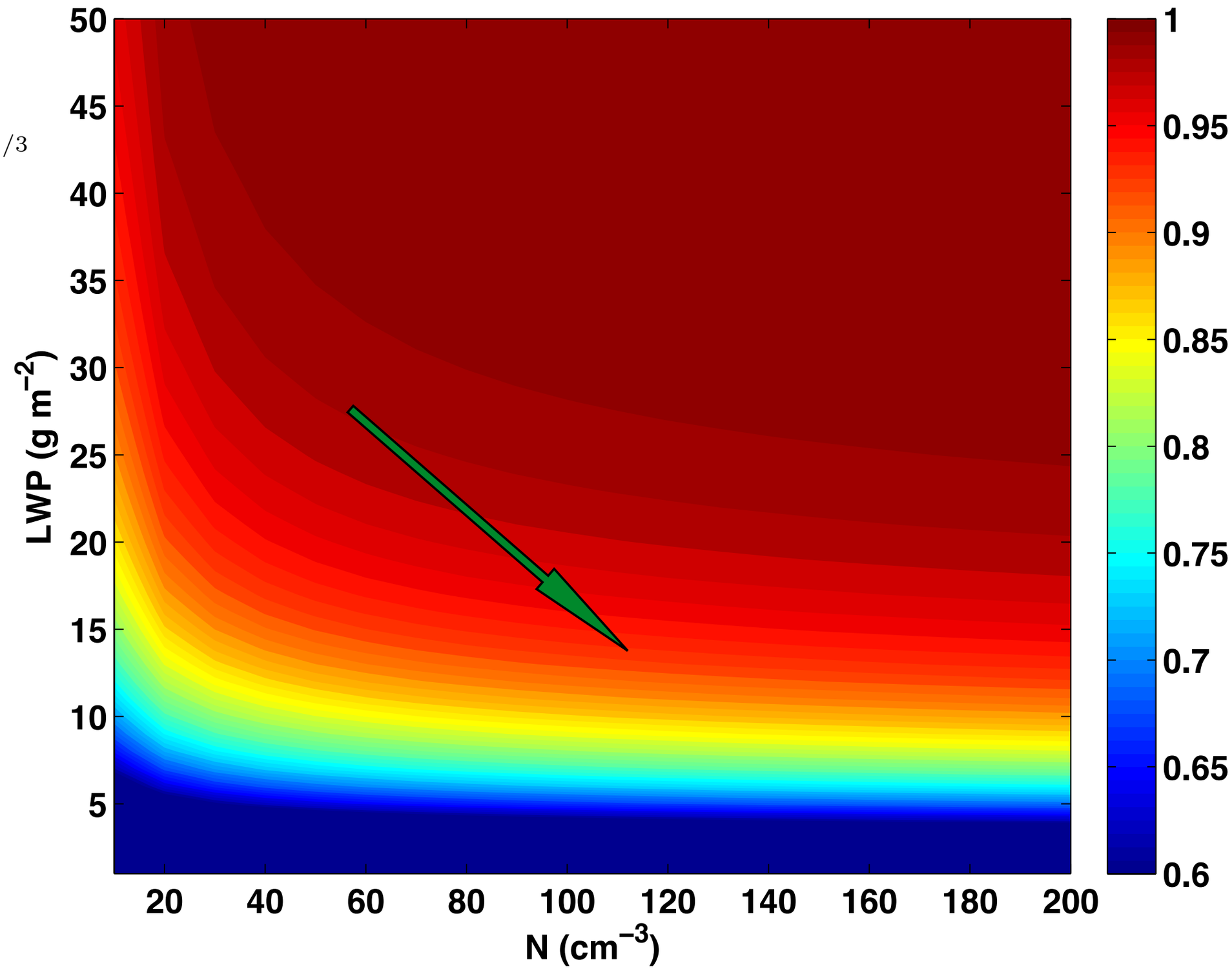

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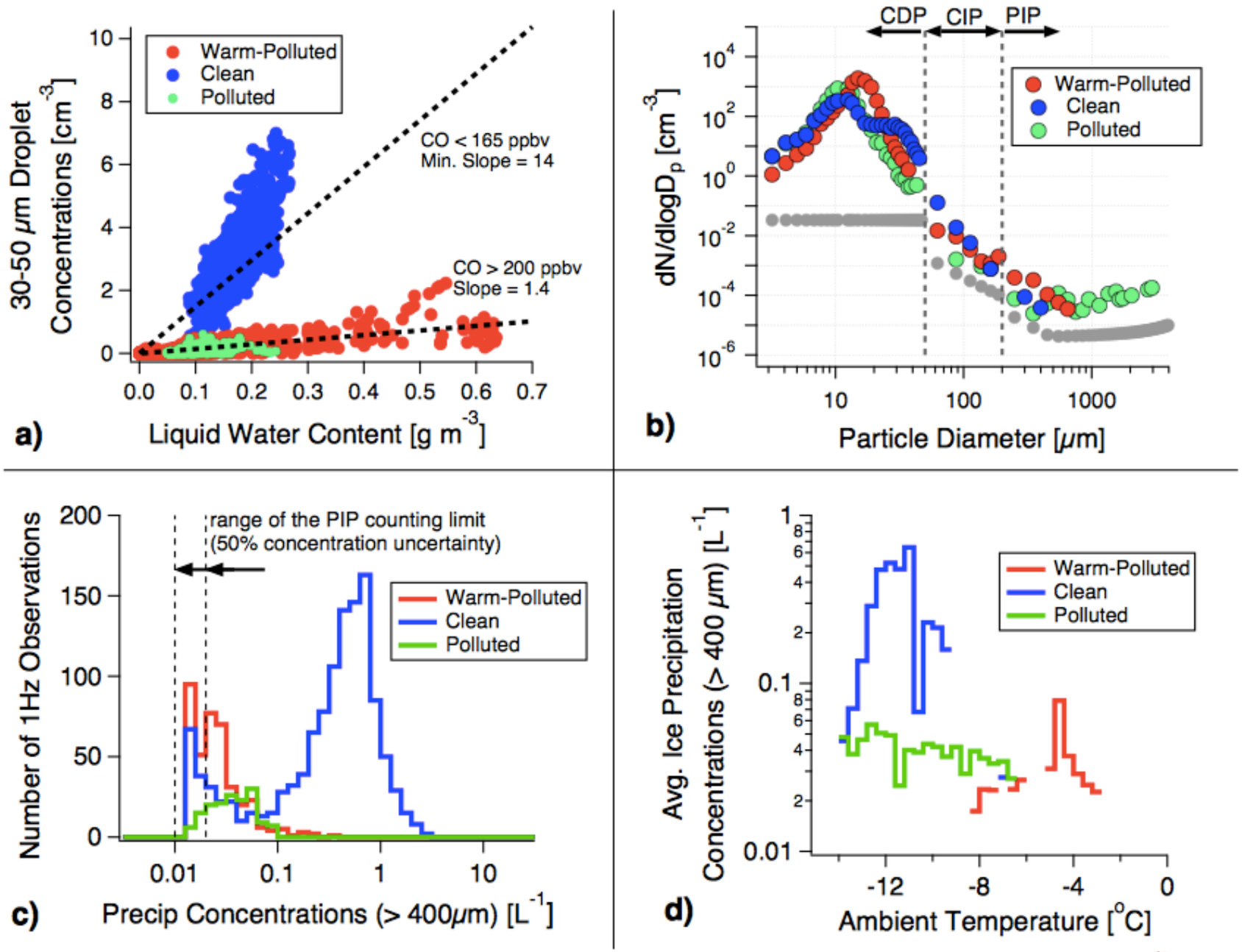
1) The Role of Ice

What is the relative ratio of IN to CCN when aerosol concentrations increase?



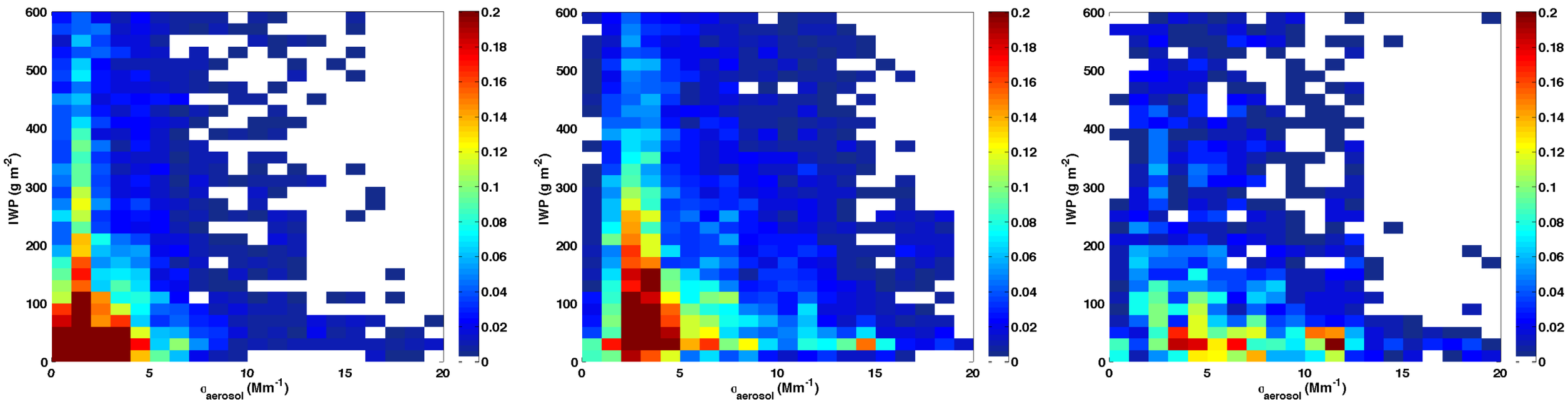
(Lance et al., 2011)

Work in Progress

1) The Role of Ice

What is the relative ratio of IN to CCN when aerosol concentrations increase?
Is there more ice associated with increased aerosol concentrations?

Warm → **Cold**

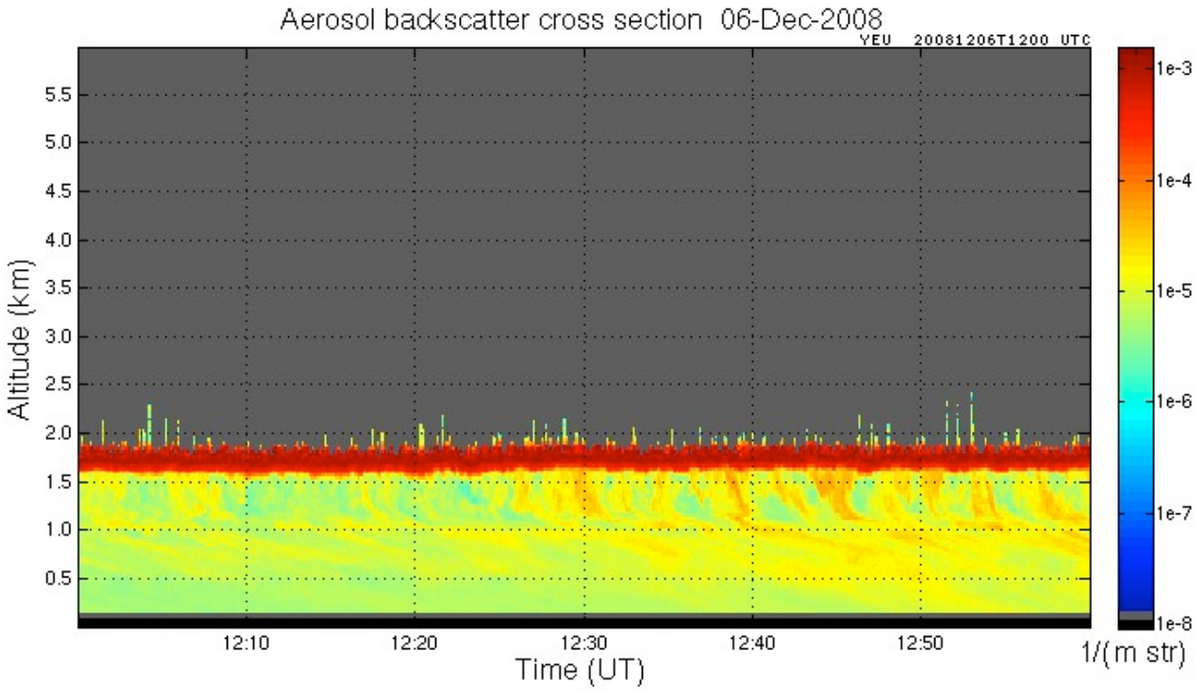


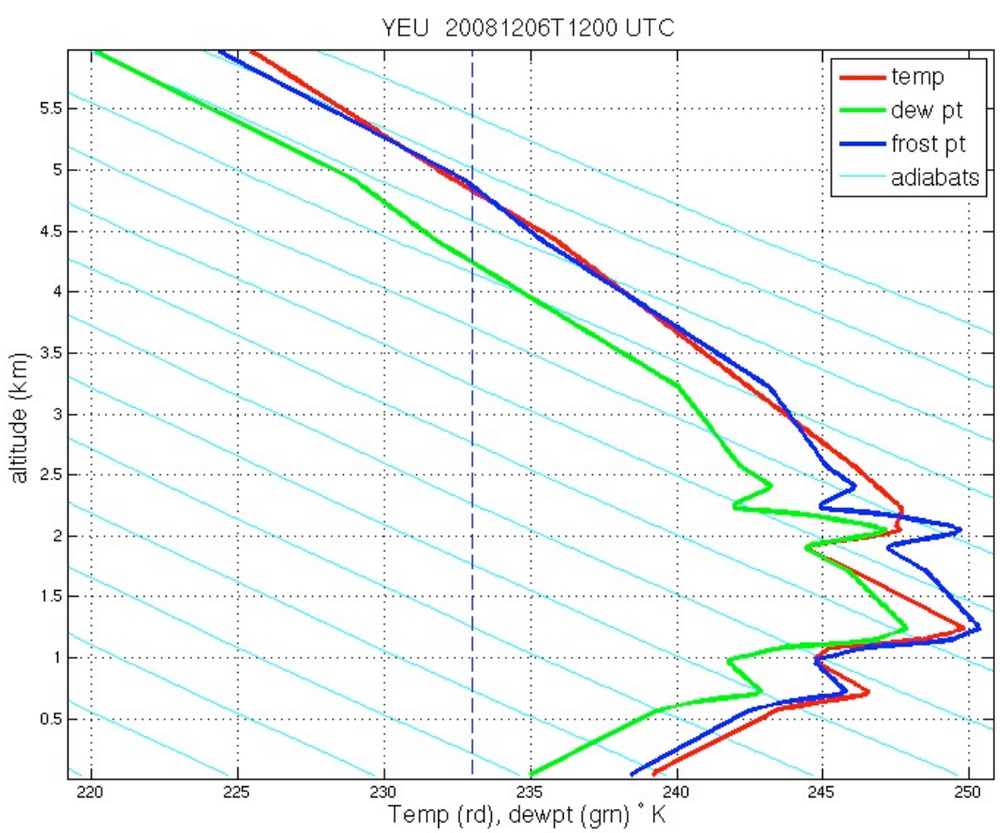
$-11<T_{ctop}<0$ | $-22<T_{ctop}<-11$ | $-33<T_{ctop}<-22$

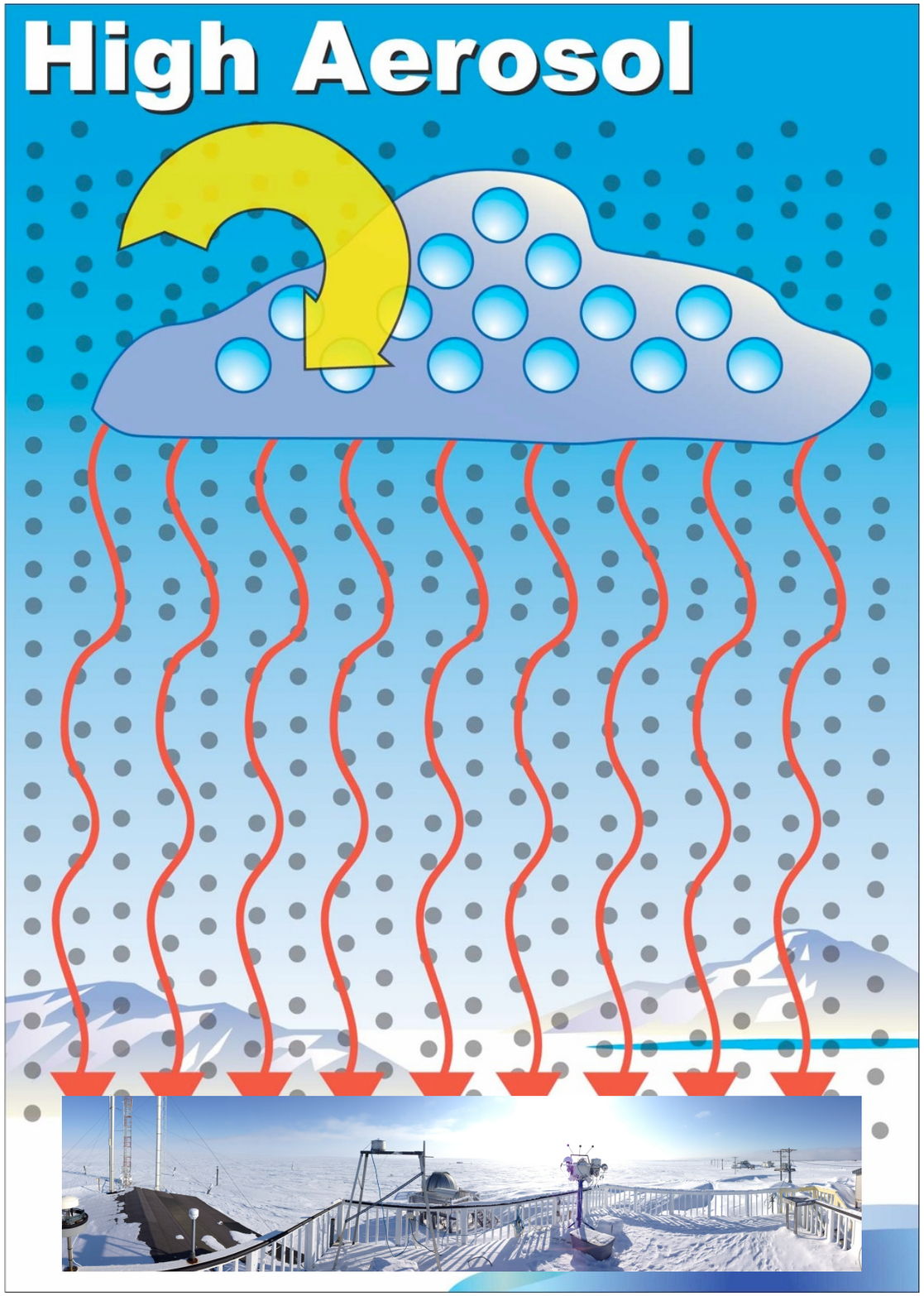
2000-2003

Work in Progress

2) The role of lower atmospheric stability







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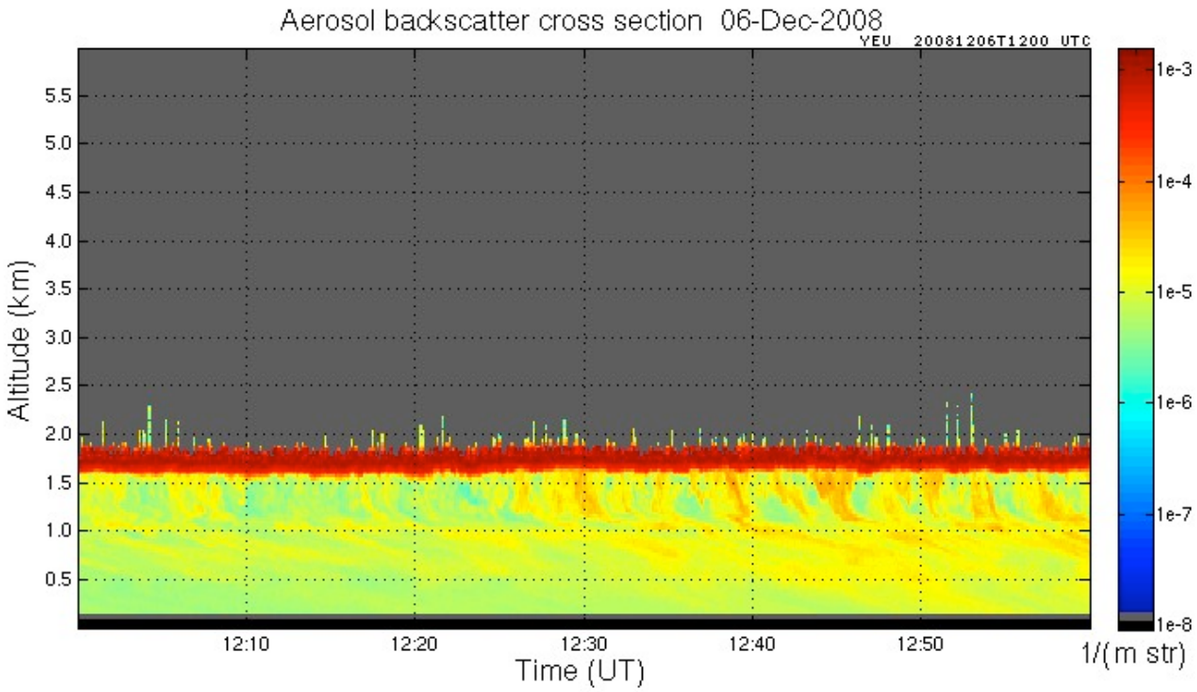

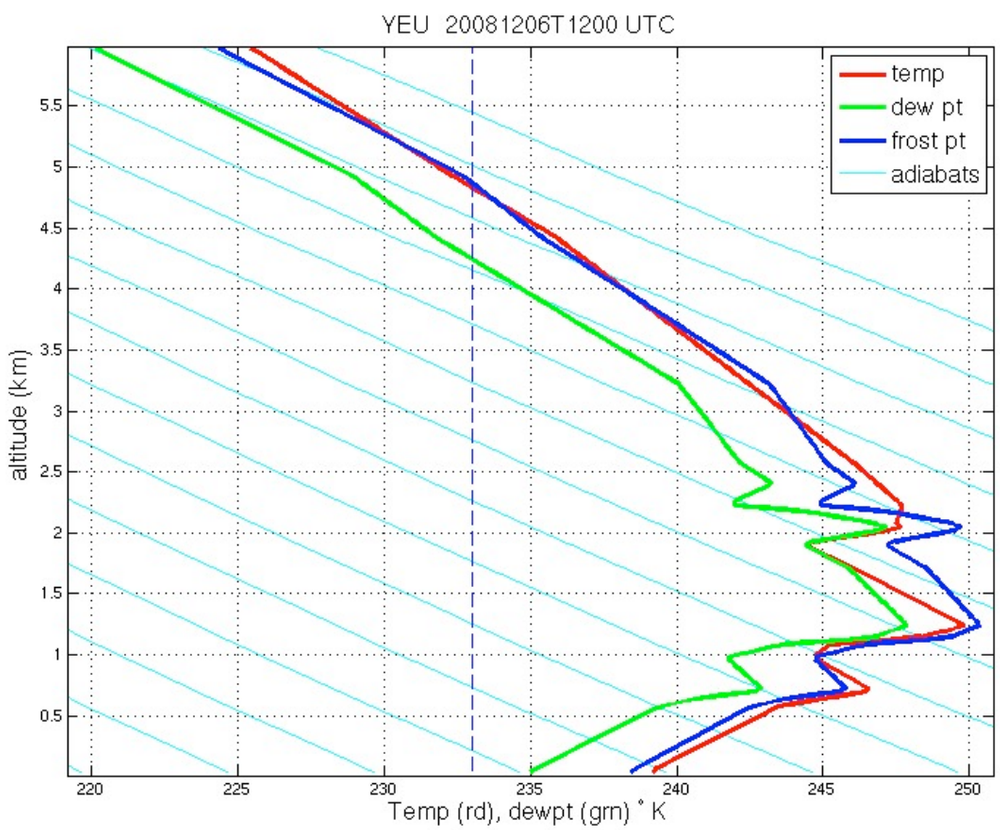

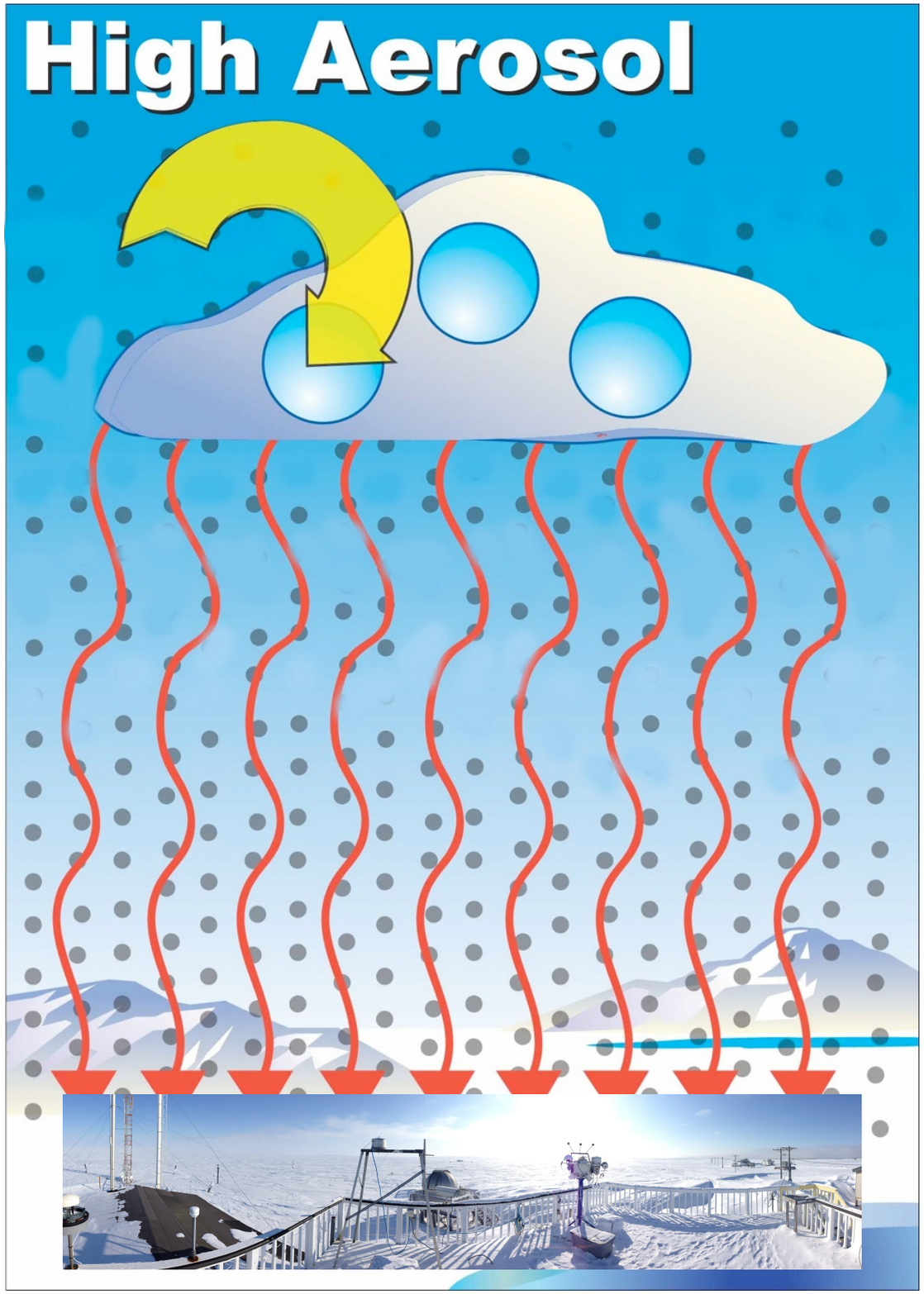

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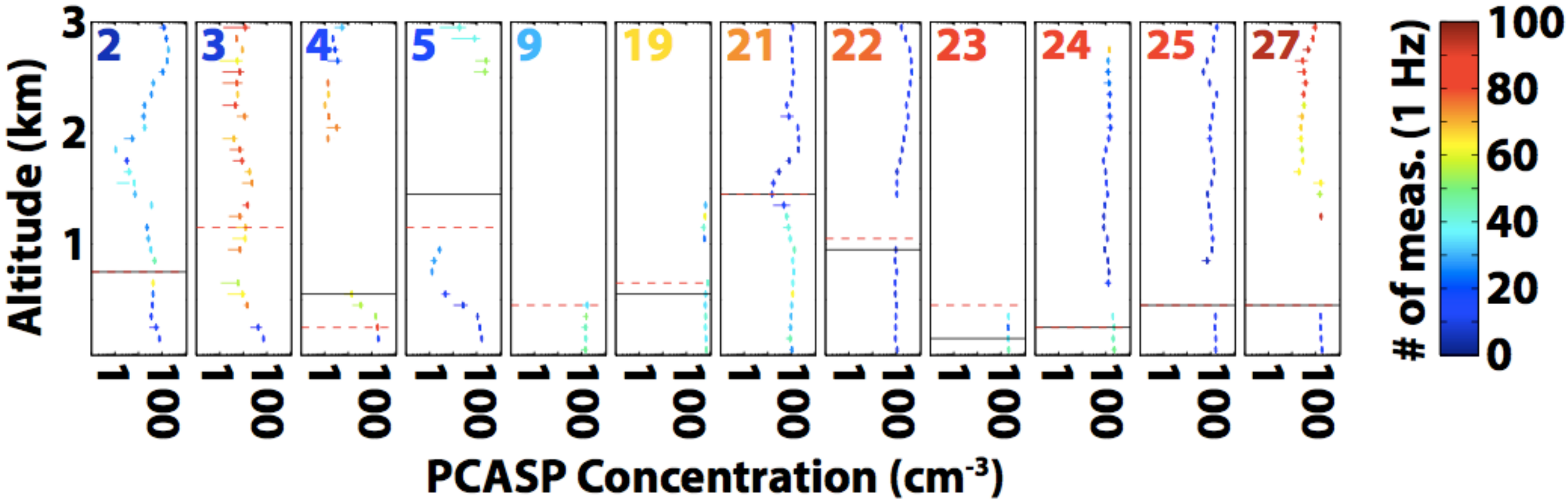

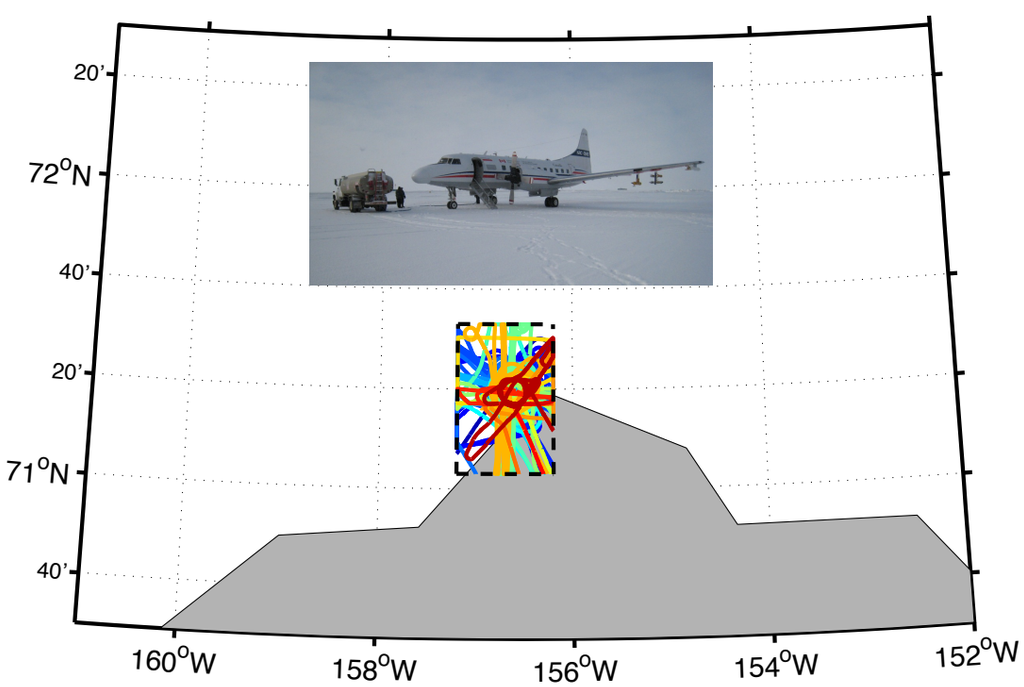

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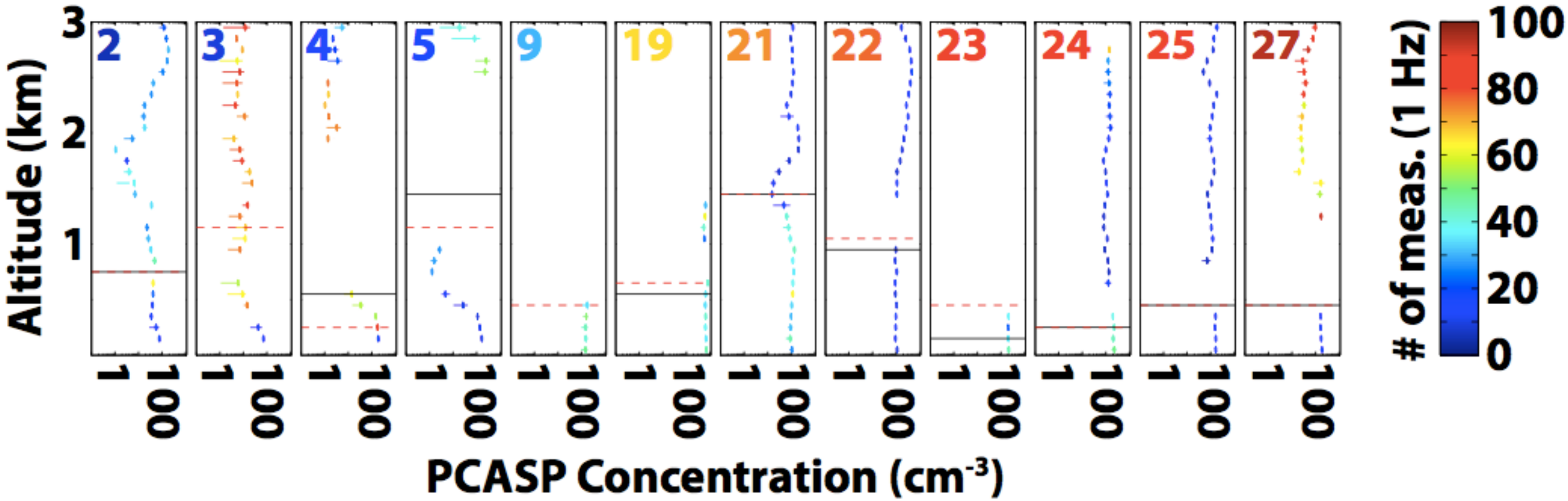

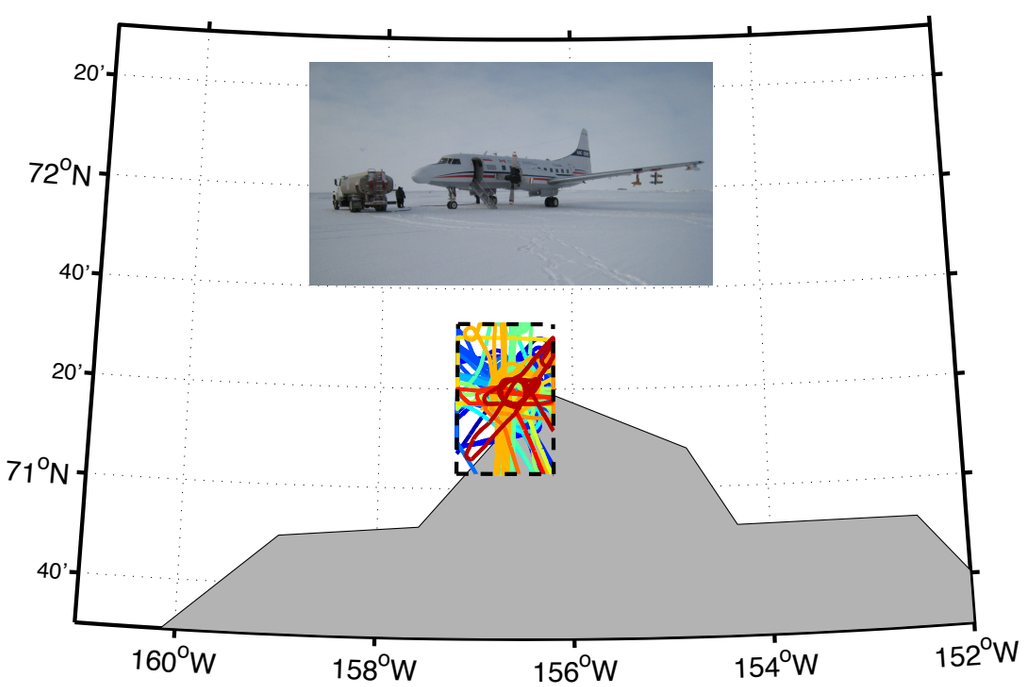

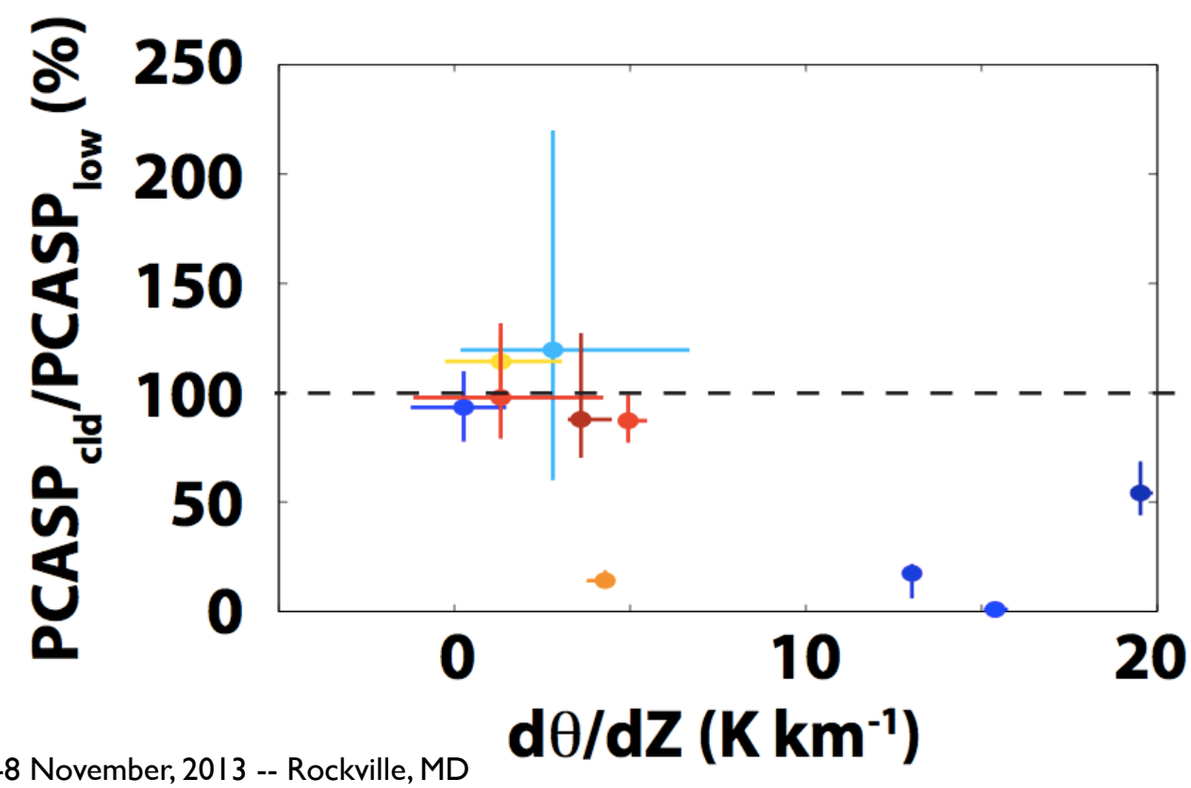

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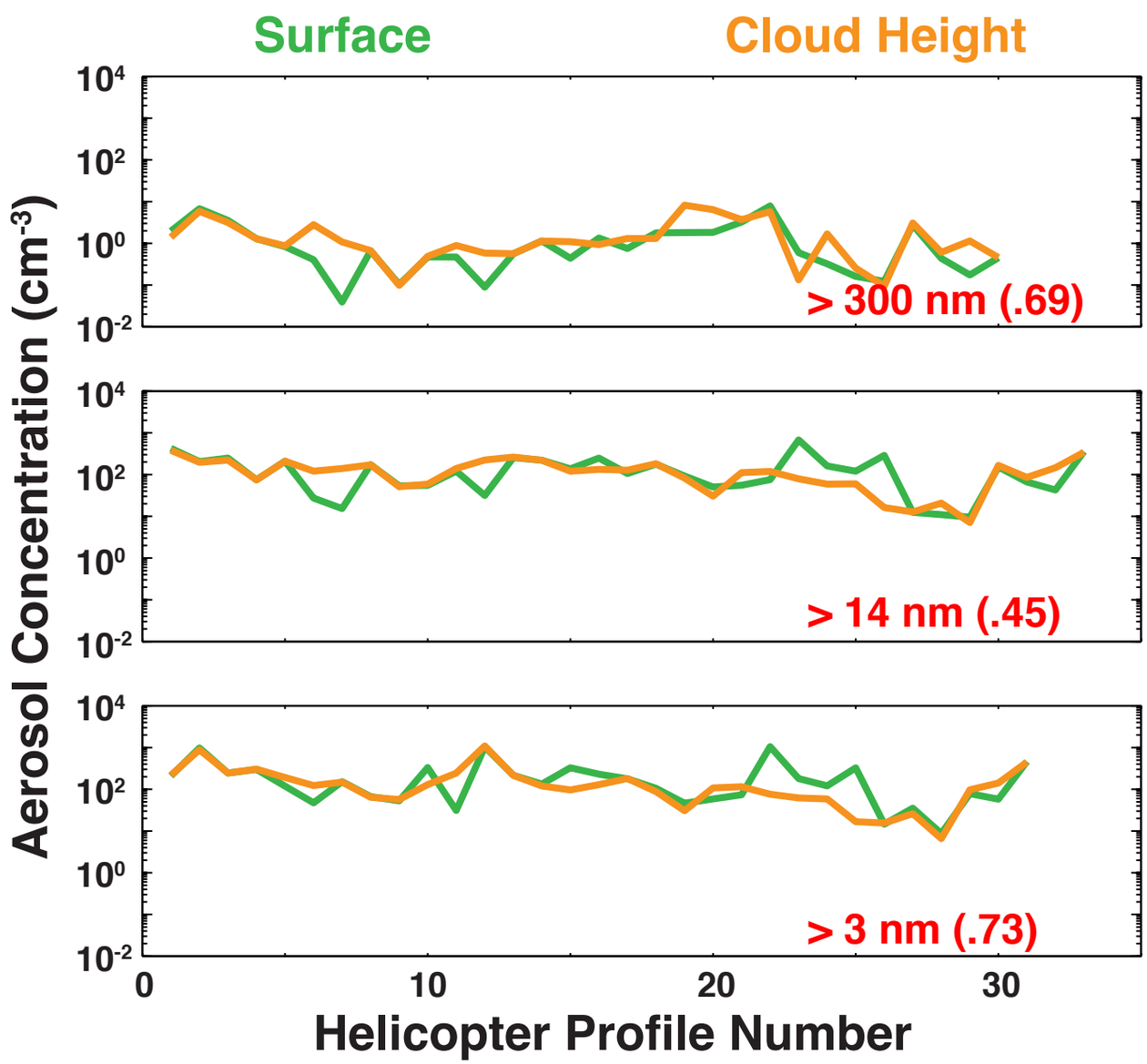

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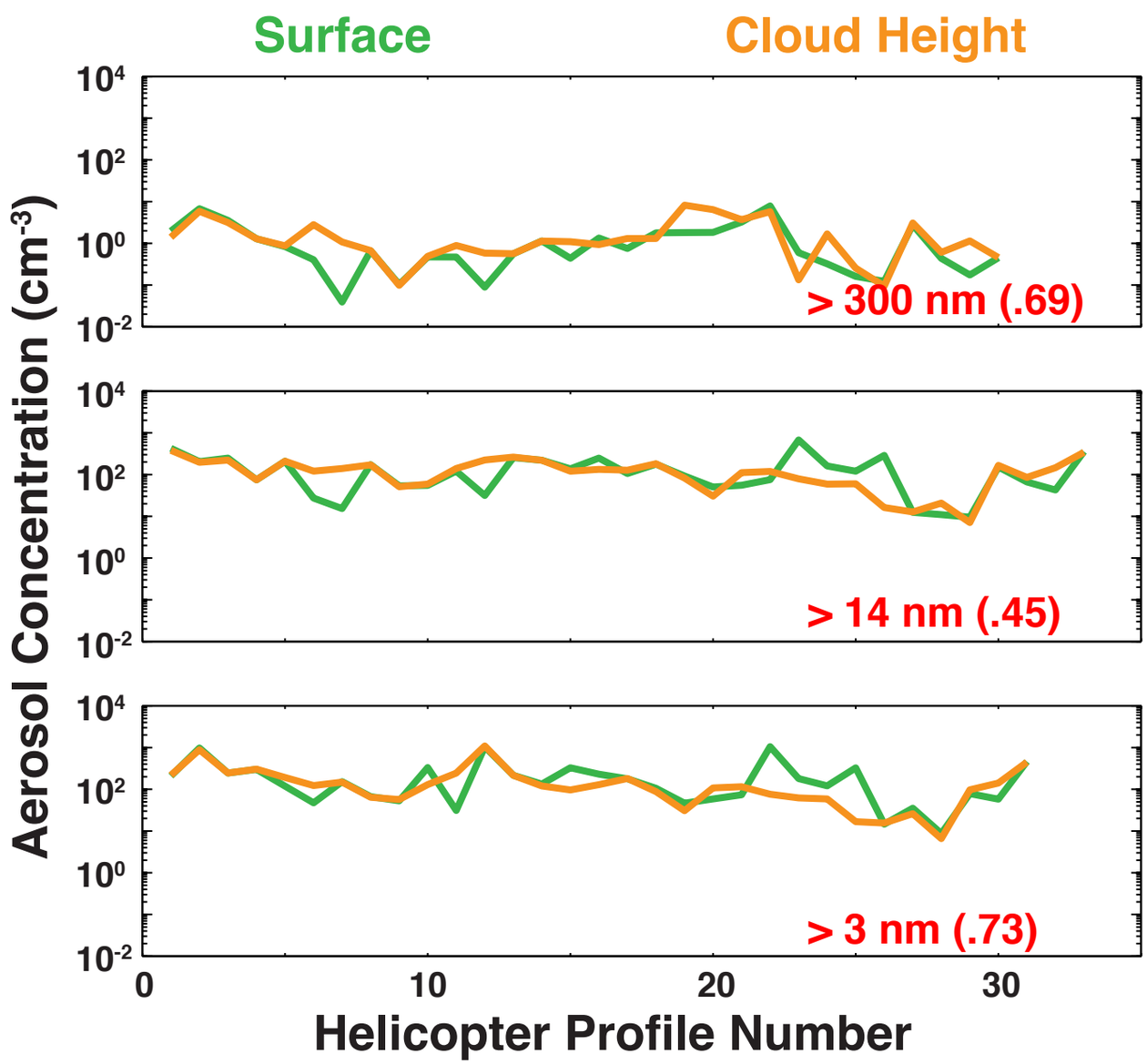

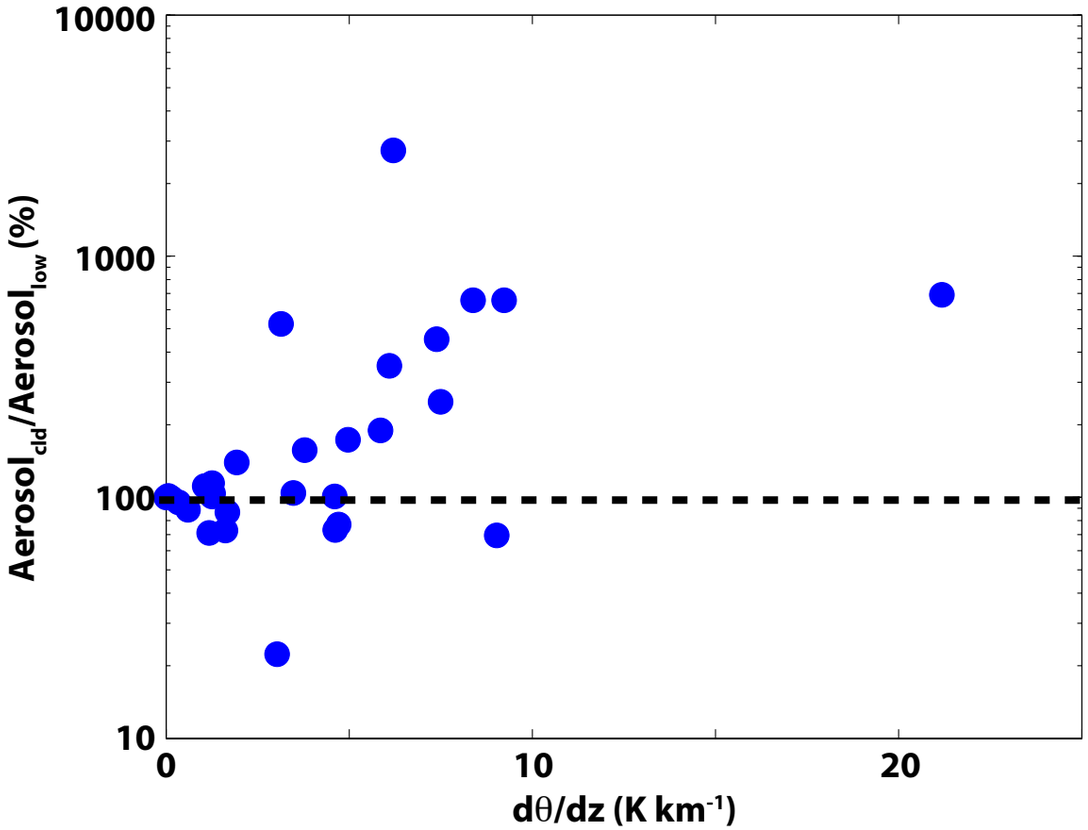

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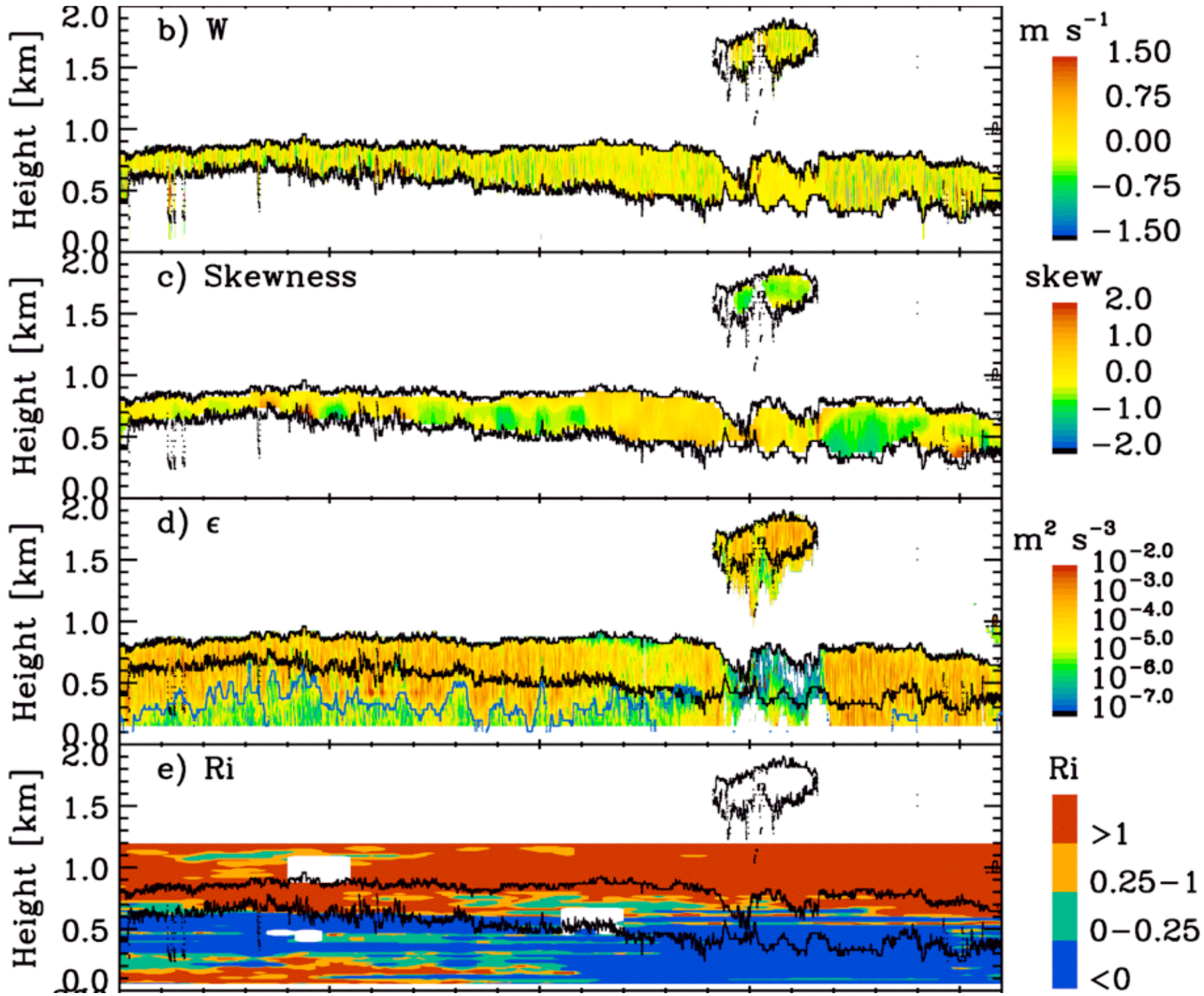

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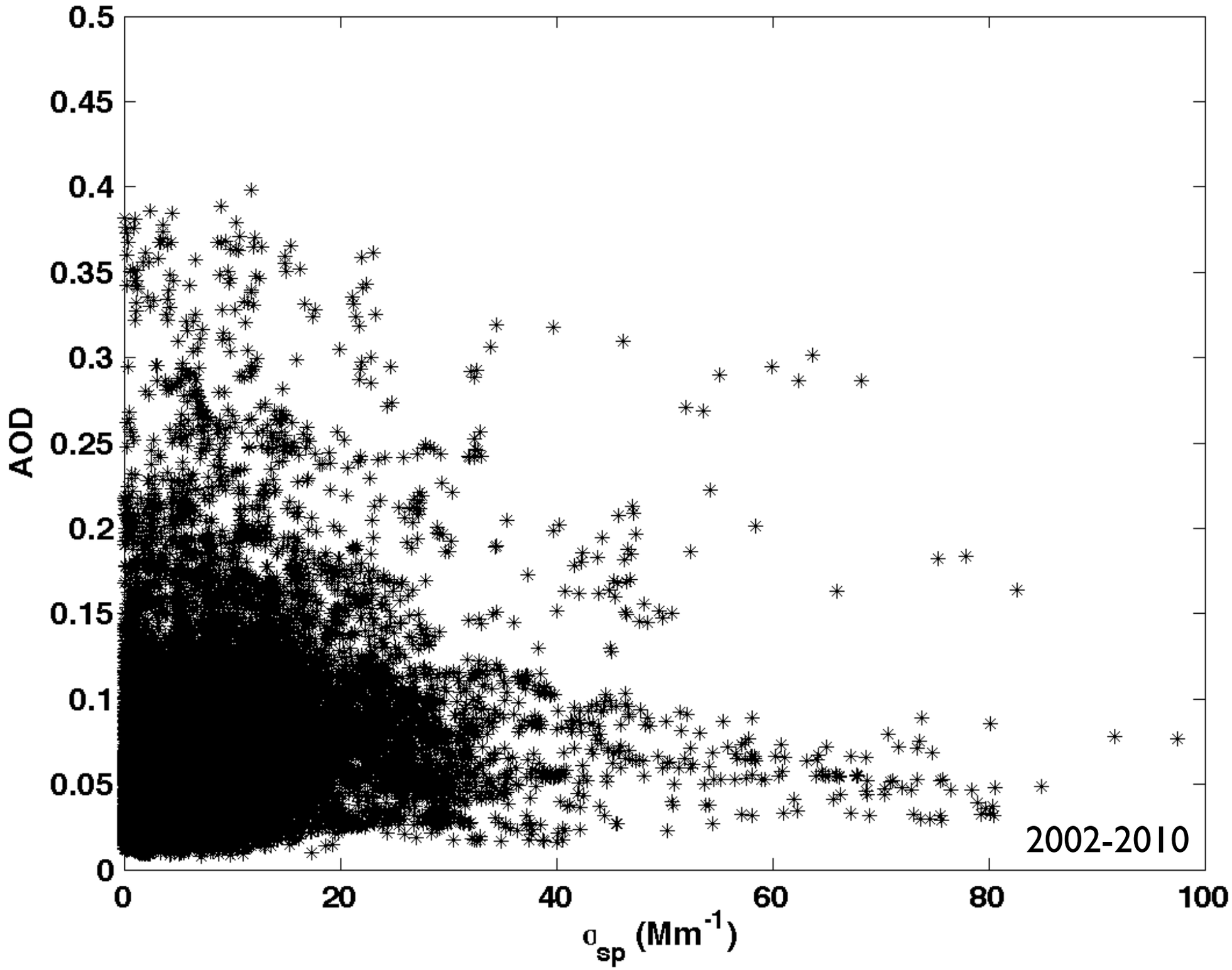

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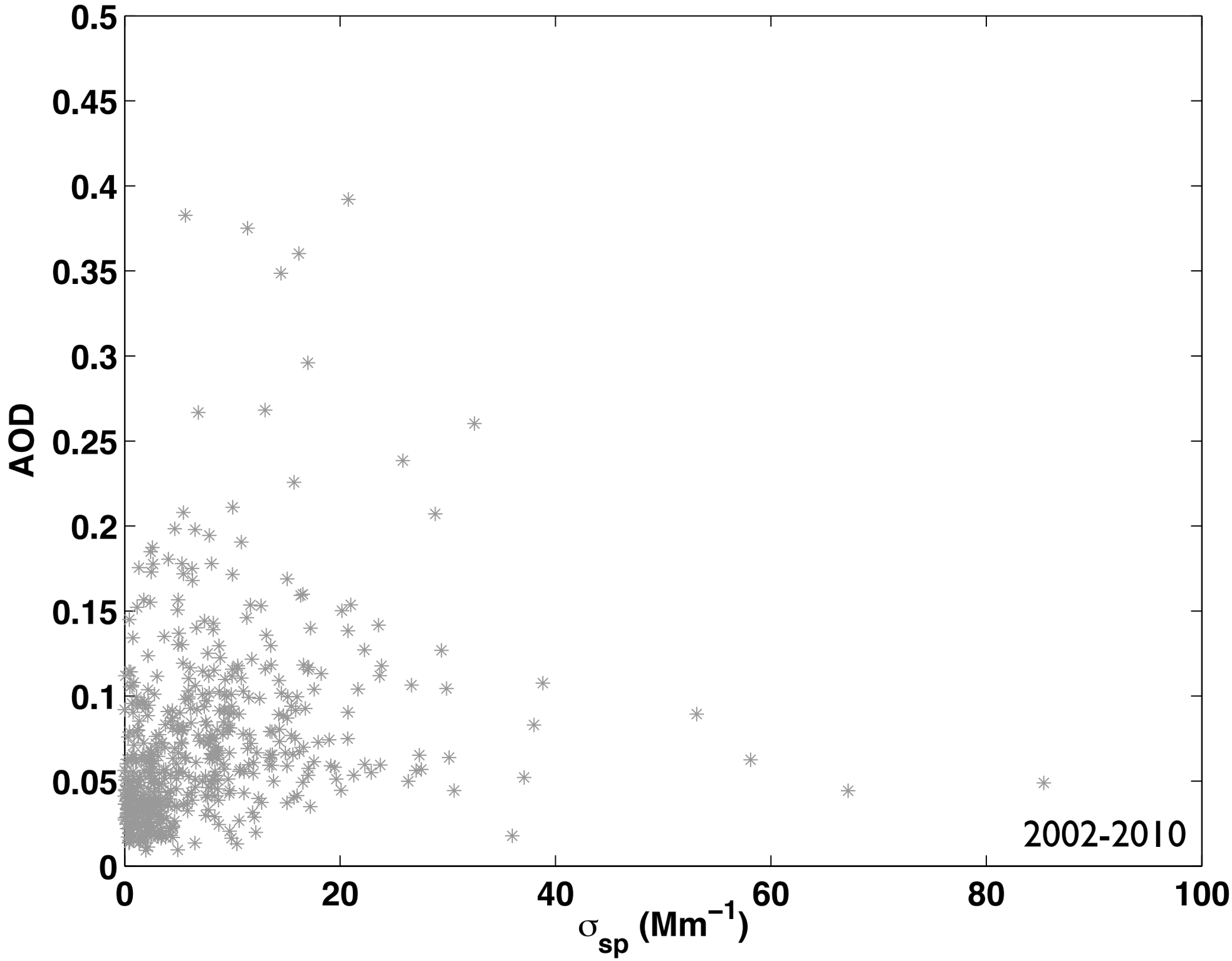

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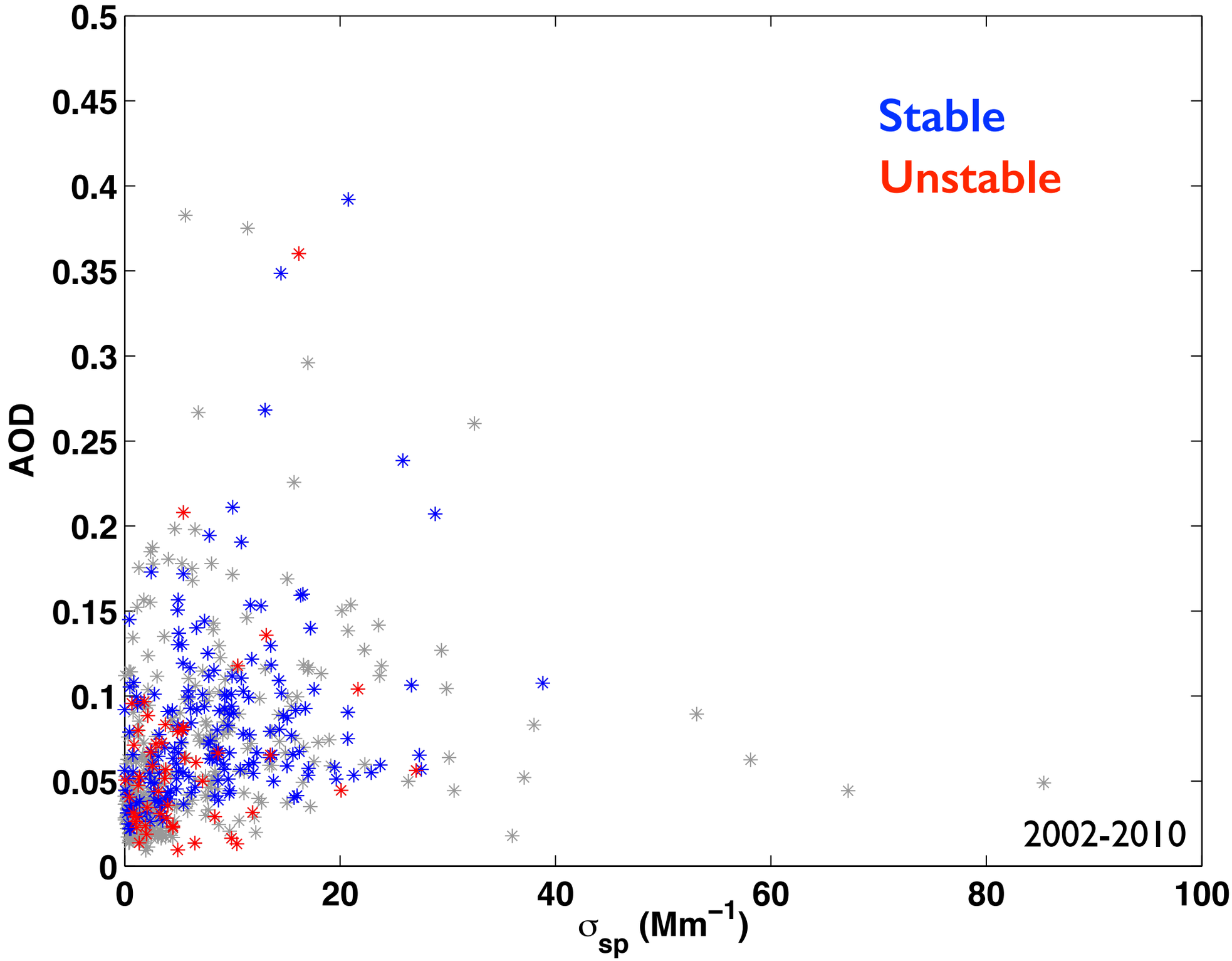

Summary

- Aerosol indirect effects in mixed-phase clouds include complex interactions between liquid and ice

- Current efforts are focused on understanding the partitioning of cloud phase relative to aerosol perturbations and preliminarily, there is little evidence for increased ice nucleation with increased aerosol loading

- Additionally, work is underway to improve existing estimates of aerosol indirect effects on thin mixed-phase clouds by limiting evaluations to periods where surface aerosol measurements are relevant to the cloud level

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