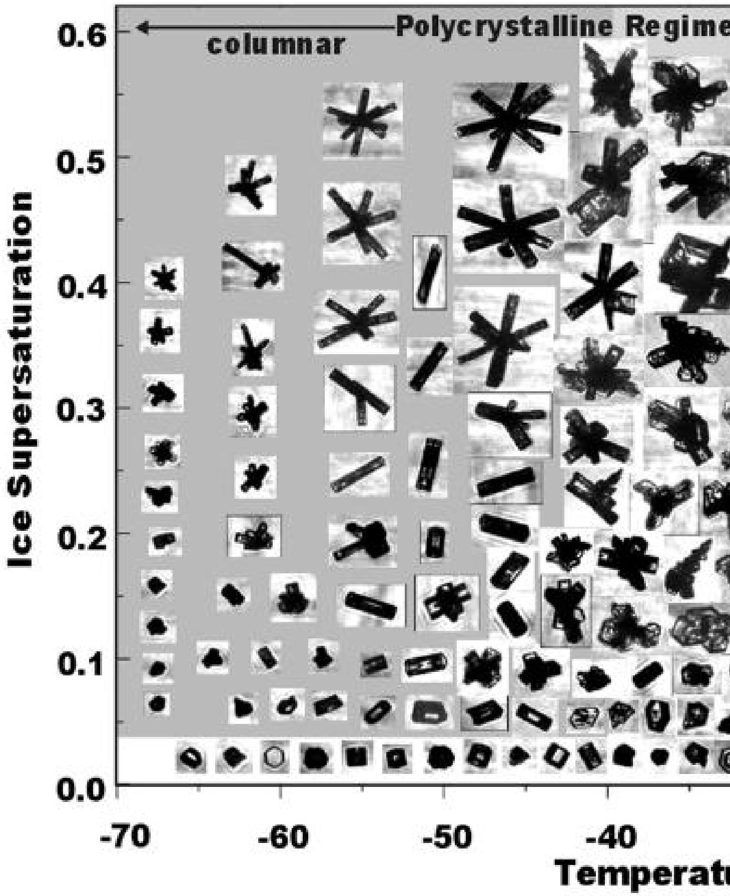
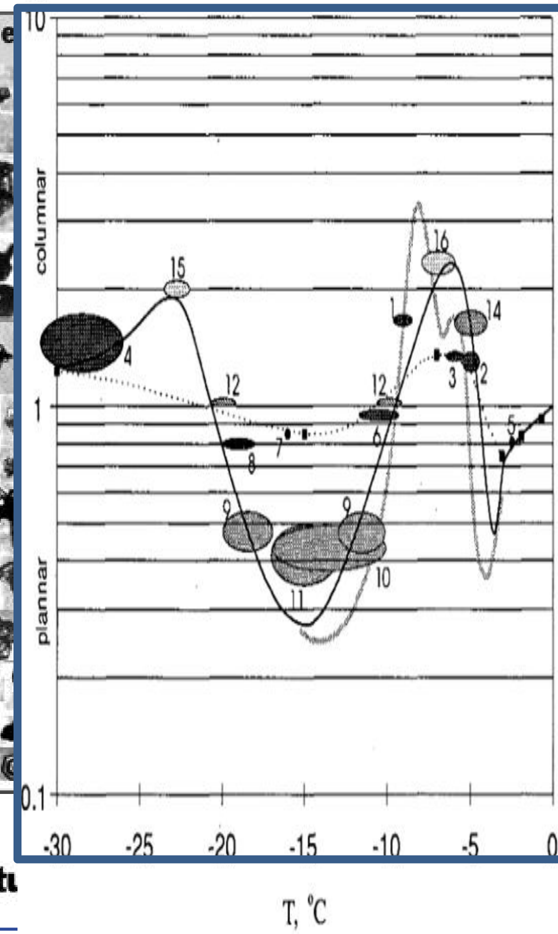
How good is the Inherent Growth Function?

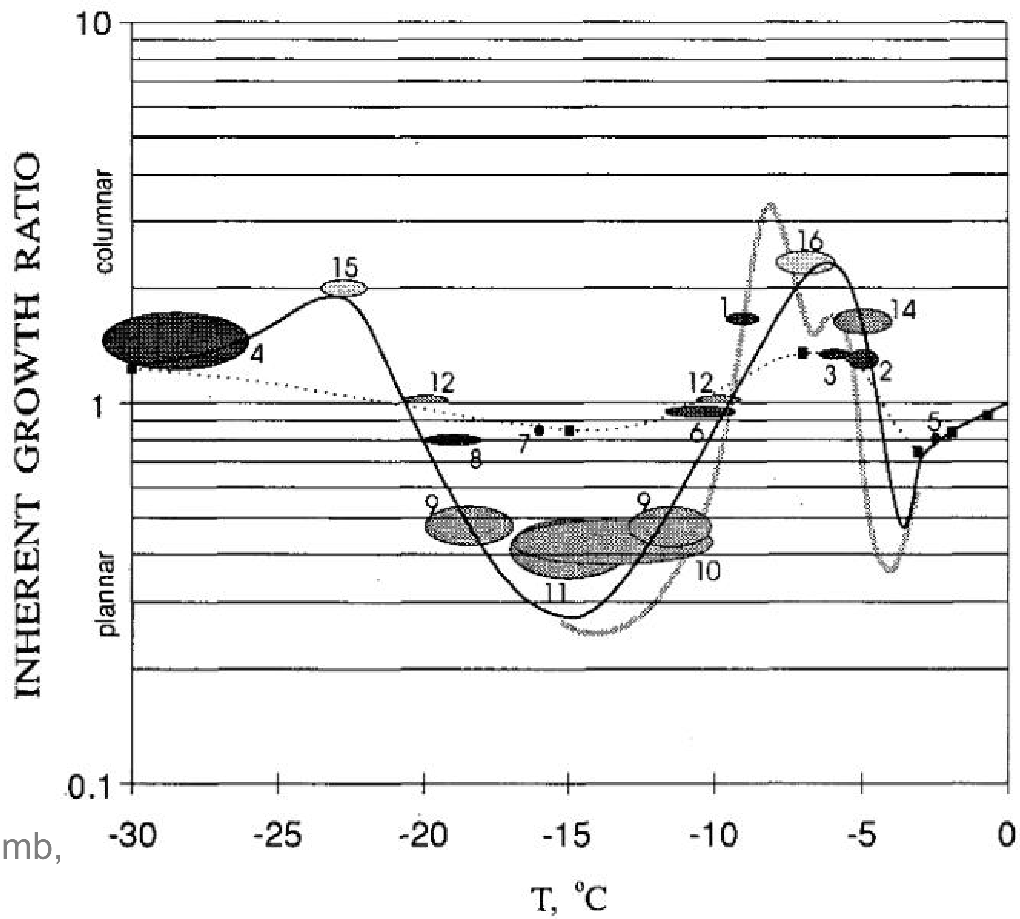
Jan-Niklas Welss, Alexander Myagkov, Stefan Kneifel, Axel Seifert, Leonie v. Terzi, Christoph Siewert





Bailey & Hallett 2009

The origin of all pro- & oblates



Chen & Lamb, 1994

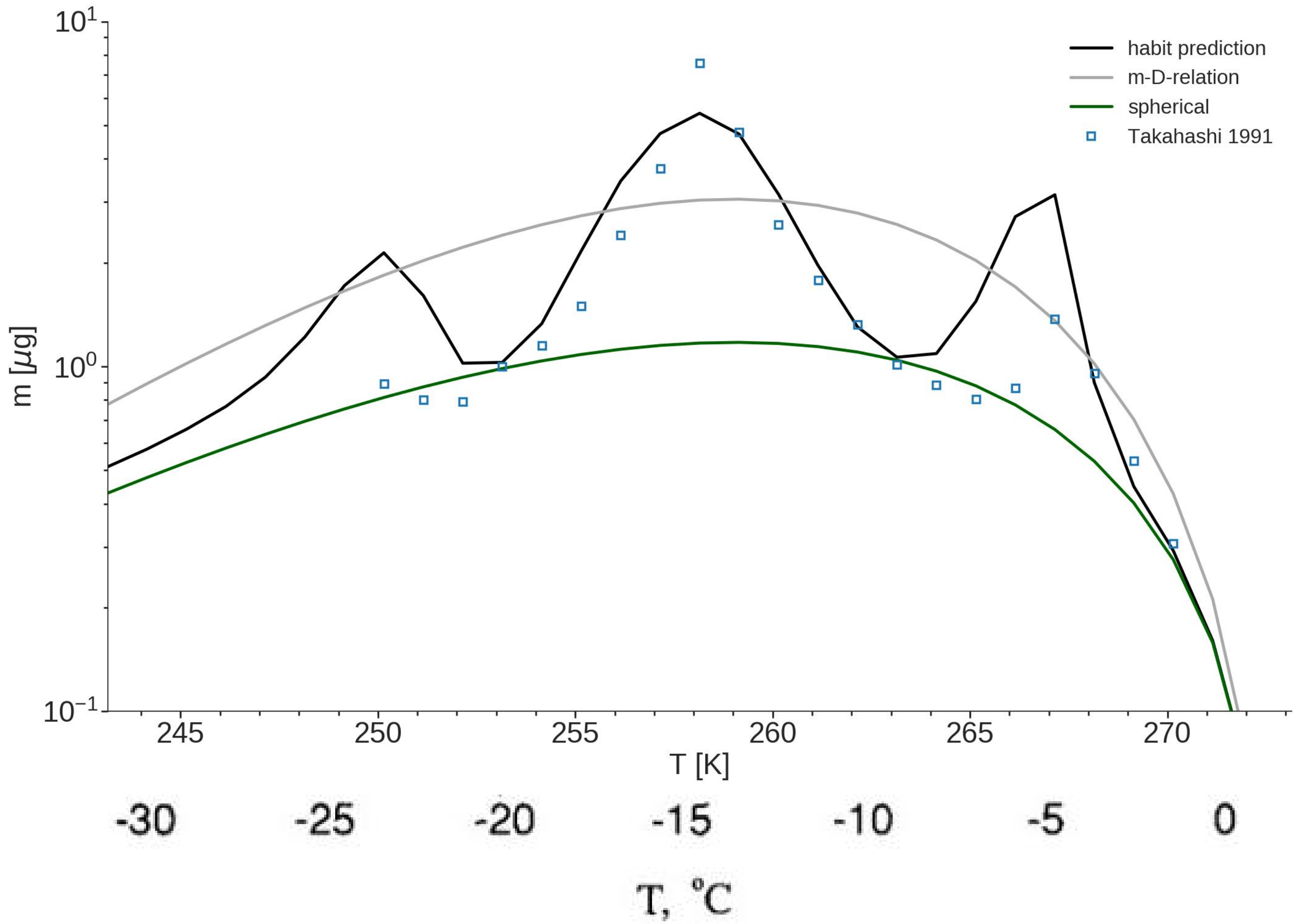
FIG. 3. Comparisons between the experimental and observational values of the inherent growth ratio. The thick line is from Lamb and Scott (1972); dotted line is from Sei and Gonda (1989) with actual data points denoted as filled squares. The shaded ellipses 1 to 8 are from Ono (1970), 9 to 14 from Auer and Veal (1970), 15 from Heymsfield and Knollenberg (1972), and 16 from Jayaweera and Ohtake (1974). The thin solid line is the best-fit values proposed in this study.

General caveats:

- Only monomers
- Supersaturation-dependency unclear
- For certain T-ranges dependent on single observation

First hints on problematic regimes

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



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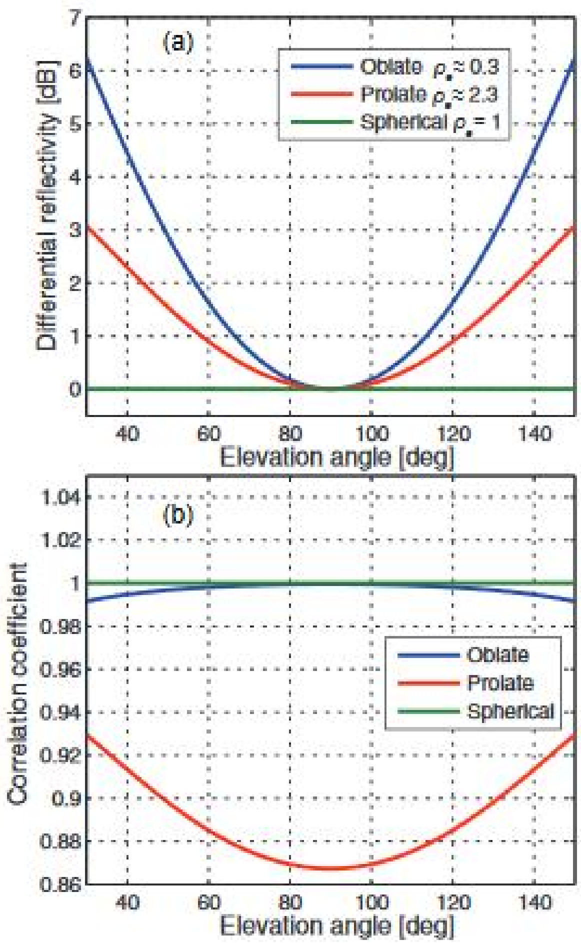
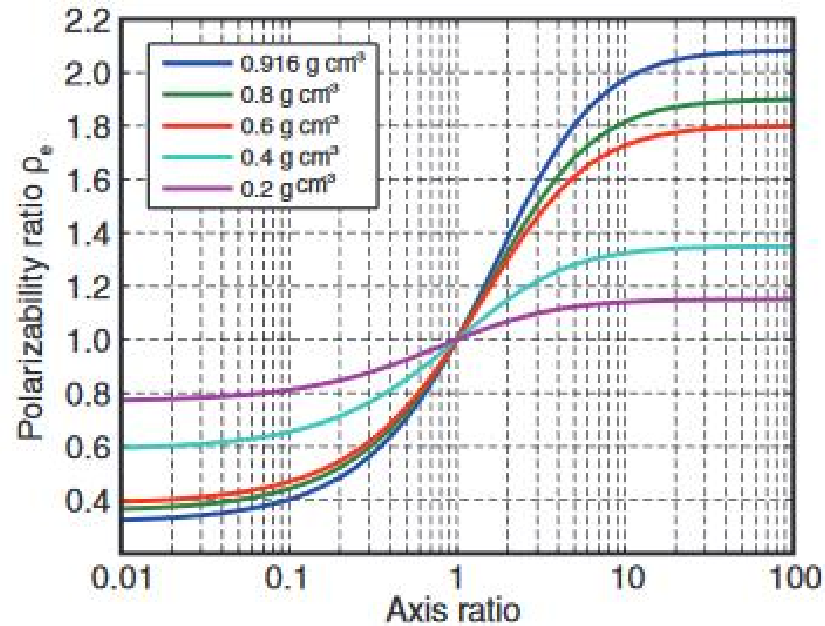
The polarizability ratio

Function of geometric shape and the dielectric properties

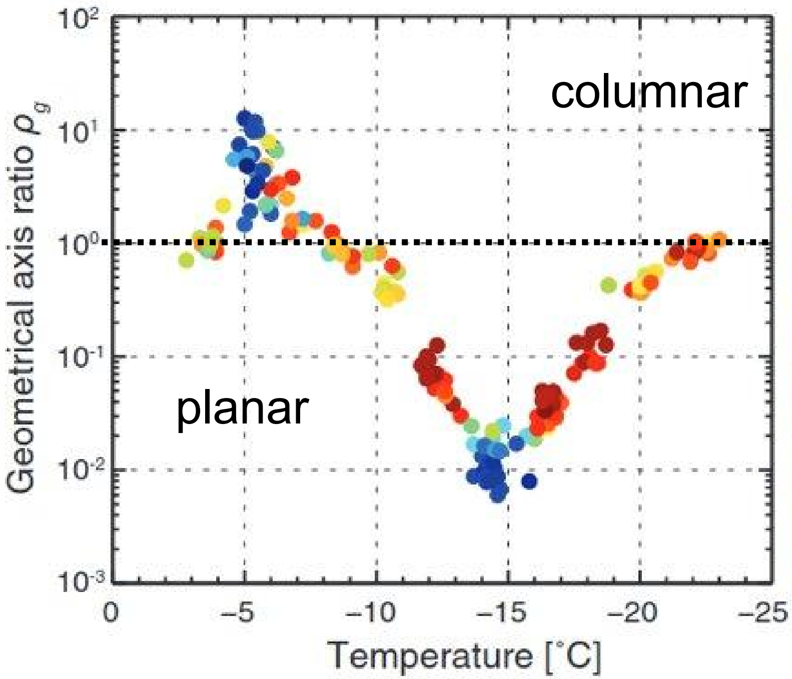




Myagkov et al., 2016

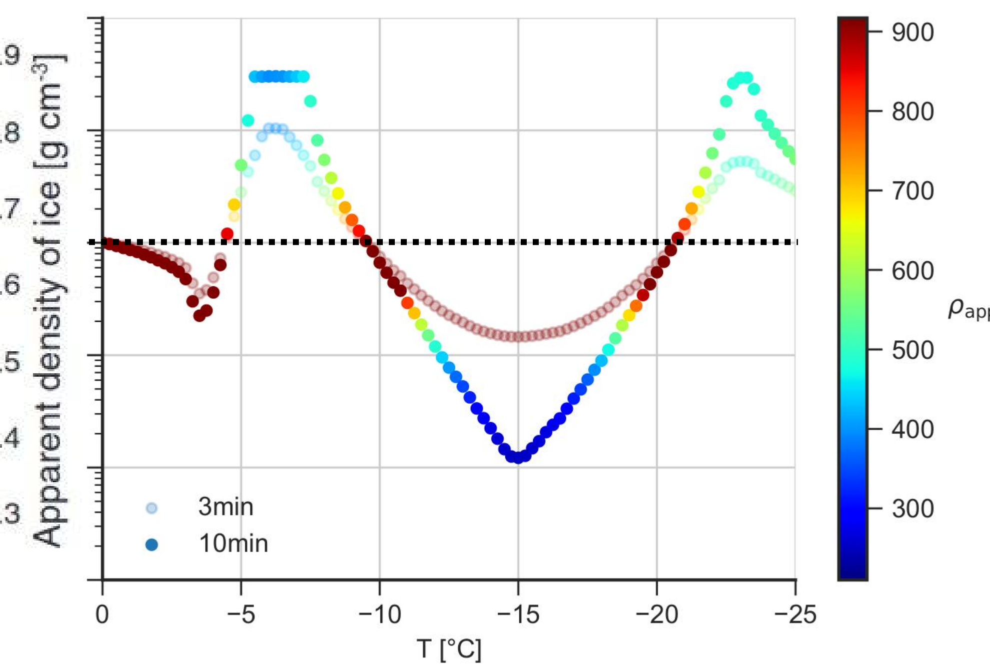
Setting expectations

Laboratory



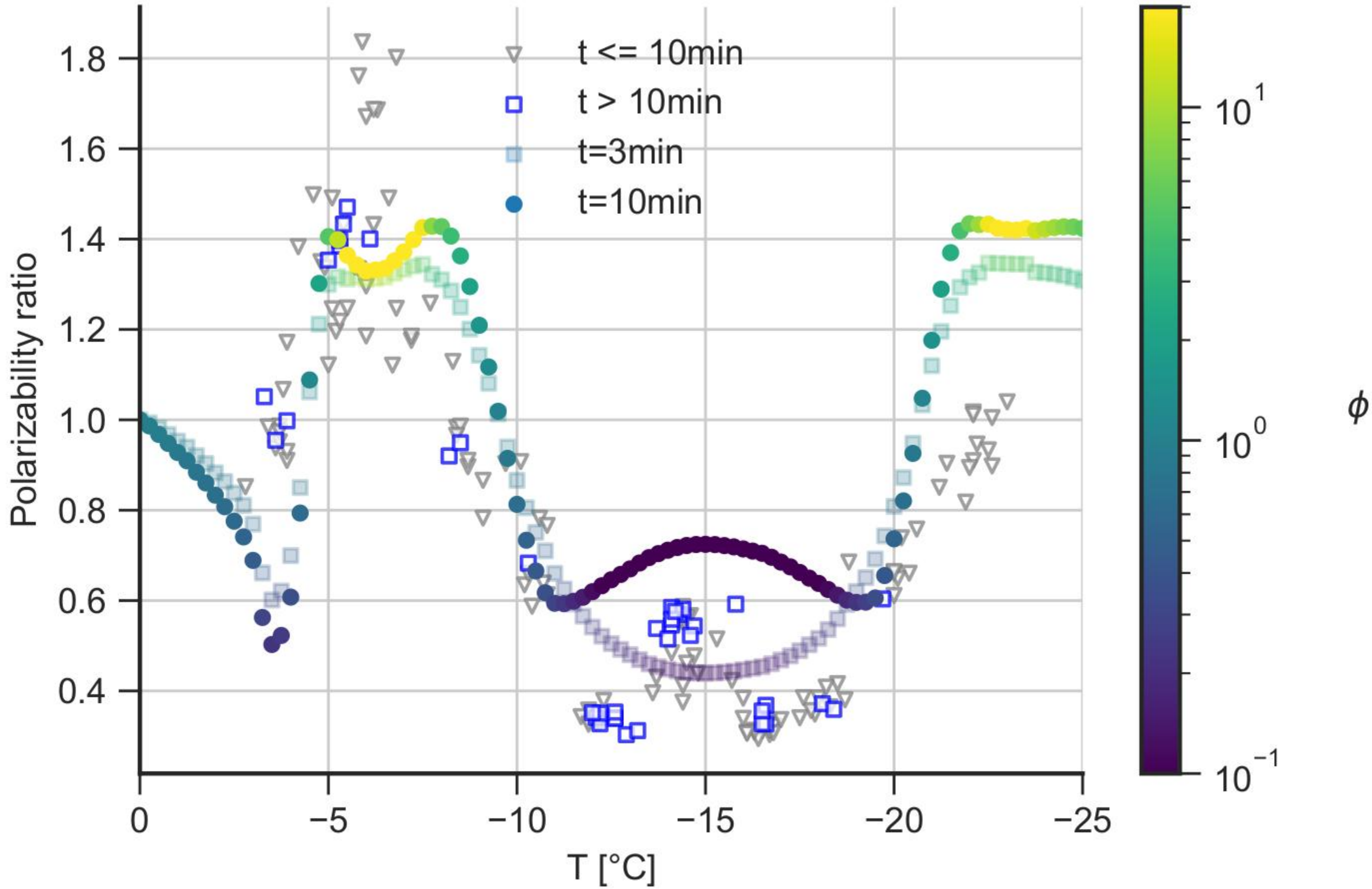
Myagkov et al., 2016
Lab results: Takahashi

McSnow



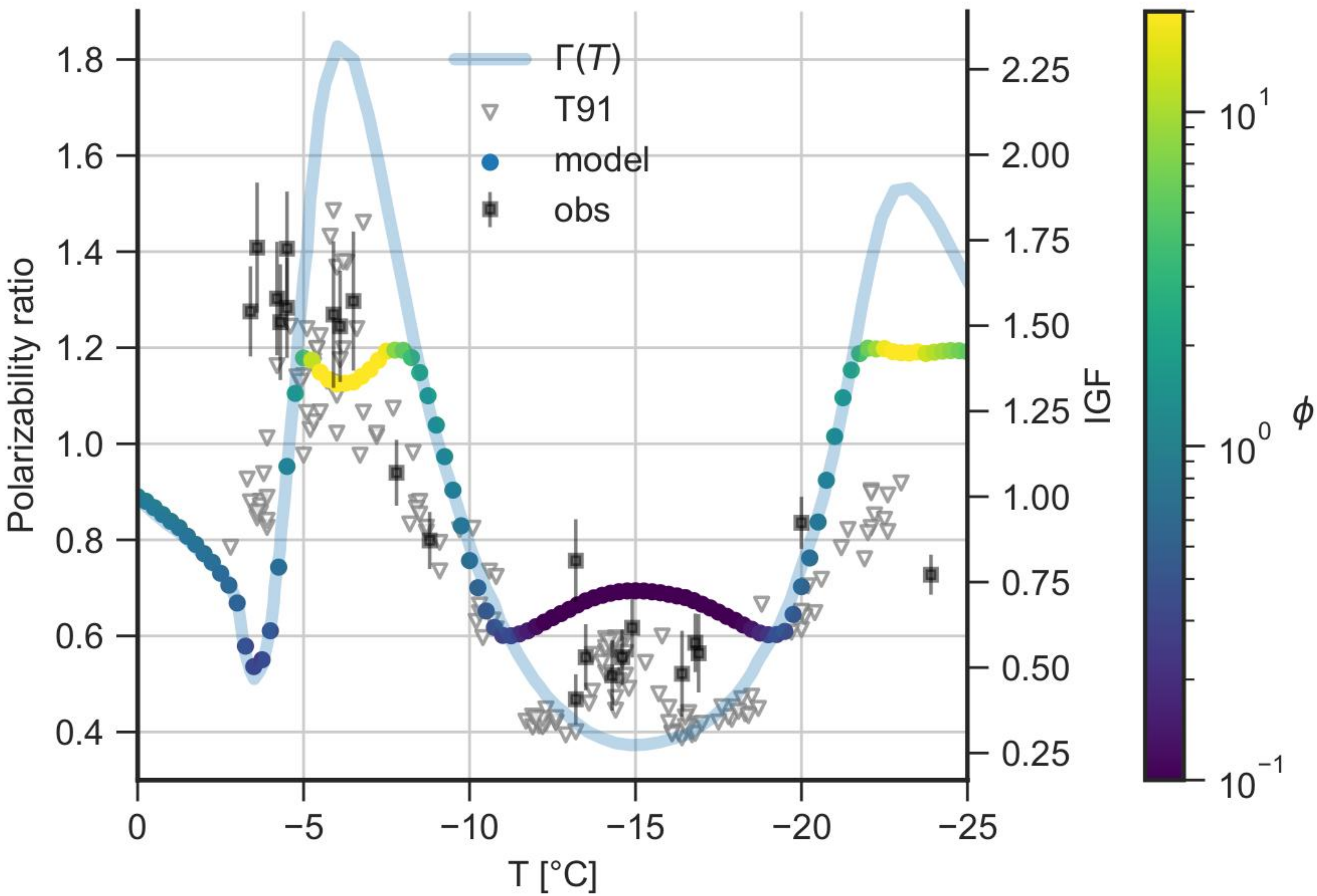
Habit-dependent ventilation included

Impact of Secondary Habits



Extreme AR show problems

Deutscher Wetterdienst
Wetter und Klima aus einer Hand



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For the Future

- Modification of IGF / Inclusion of more recent results
  - T < -20°C: change to (more) planar growth
  - ation effect

T (°C)	Observed aspect ratio, $\phi = \frac{c}{a}$	Standard $\Gamma(T)$ and $\phi = \frac{c}{a}$	Modified $\Gamma(T)$ and $\phi = \frac{c}{a}$
−5	~5.5	1.40 (4.50)	–
−10	~ 1/8	0.90 (0.55)	0.60 (1/8)
−15	~ 1/50–1/30	0.45 (1/50)	–
−20	~1/20	0.75 (0.50)	0.55 (1/15)
−25	~1/20	1.60 (5.00)	0.55 (1/10)
−30	~1/5	1.20 (2.00)	0.70 (1/3)

Connolly et al., 2012

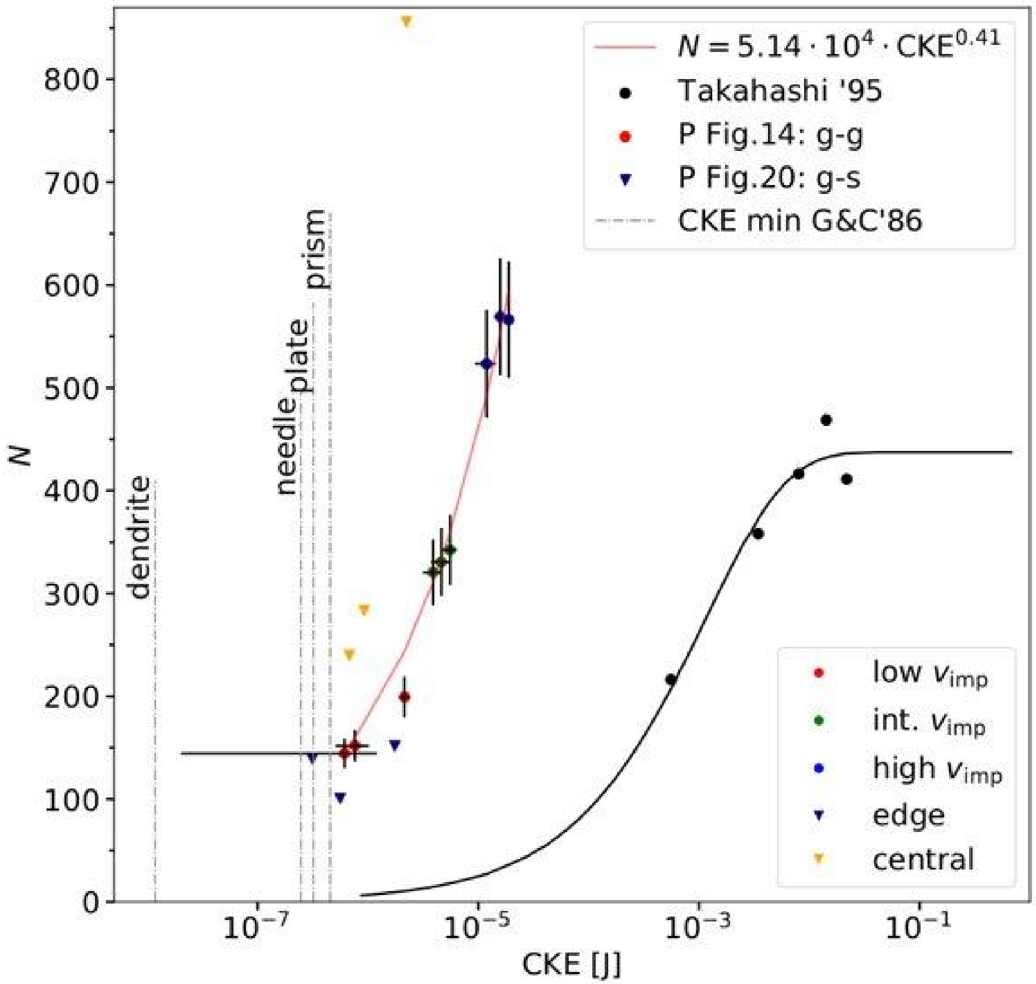
T (°C)	t (min)	m (g)[a]	a (mm)[b]	c (mm)[c]	Crystal shape
−20.1	<12	$3.8\times10^{-8}t^{1.44}$	$5.4\times10^{-2}t^{0.54}$	$2.6\times10^{-2}t^{0.44}$	Thick plate (C1h)
−22.0	<12	$3.4\times10^{-8}t^{1.42}$	$4.0\times10^{-2}t^{0.49}$	$3.6\times10^{-2}t^{0.48}$	Thick plate (C1h)

Takahashi, 1991

  - Around -5°C: complex interplay of primary and secondary habit

- Collecting more observational information to validate IGF

Sneak Peek: FRAGILE



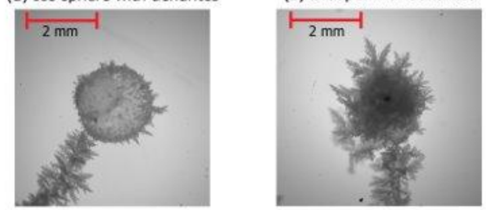
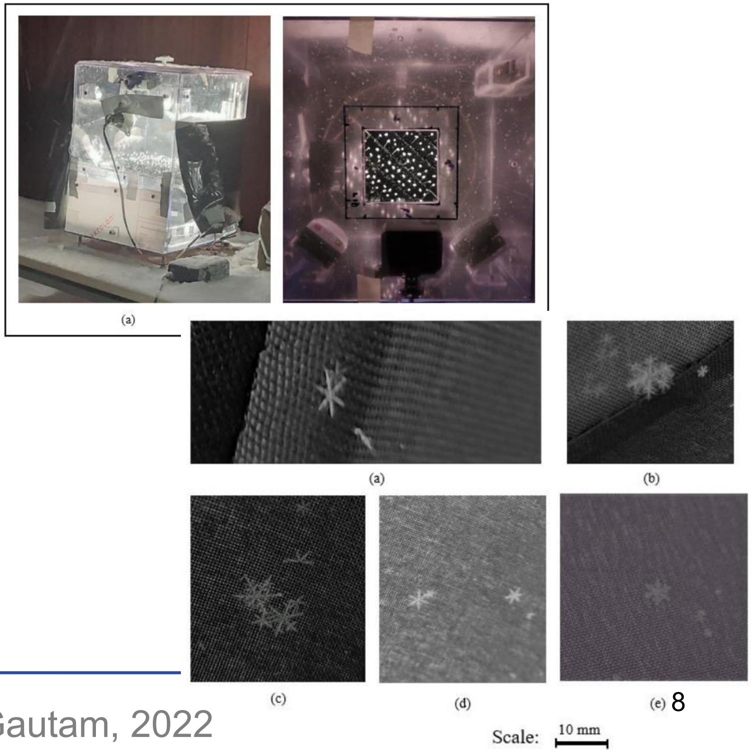


Fig. 13: Dendritic growth comparison between an ice sphere and a graupel

Grzegorczyk, 2022



Gautam, 2022

Sneak Peek: FRAGILE – Slide 2

$$\mathcal{N} = \alpha A(\mathbf{M})\left(1 - \exp\left\{-\left[\frac{CK_0}{\alpha A(\mathbf{M})}\right]^{\gamma}\right\}\right) \qquad C = \frac{b_2(1-q^2)\Gamma(1+1/\gamma)}{\langle G_{\mathrm{break}}\rangle}$$

Generalize original scheme using a new categorization based on shape & fragility:

1. Plates,
2. Columns,
3. Dendrites, and
4. Aggregates

Work in Progress … but looks promising!

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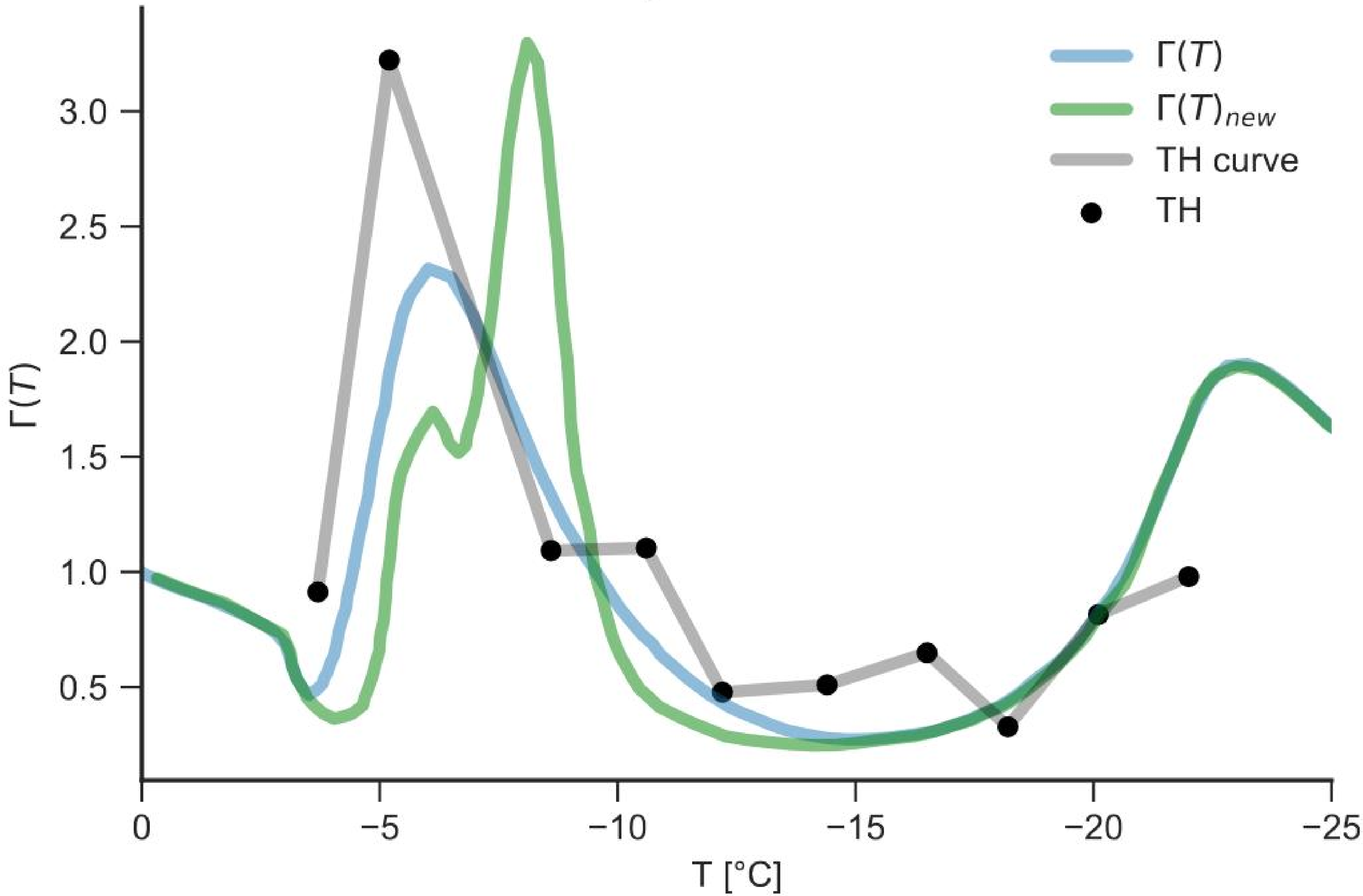
3.0
2.5
2.0
1.5
1.0
0.5
Γ(T)
0
−5
−10
−15
−20
−25
T [°C]
Γ(T)
Γ(T)new
TH curve
TH