Recent results of ACI02 campaign and a first comparison with MAID model calculations

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Campaign ACI-02

Objectives

- heterogeneous ice nucleation of particles with different surface area and roughness
- temperatures: $\sim$ -44°C (first two weeks); $\sim$ -28°C (last week)
- aerosols: Monospheres, BCR, ATD, GSG soot (only last week)
- coatings: sulfuric acid, SOA
- effect of different coating thicknesses on CCN and IN particle properties

Campaign ACI-02

Partners and Instrumentation

- University of Frankfurt
  - IN chamber FINCH
  - Filter sampling for FRIDGE
- ETH Zurich
  - HOLIMO
- University of Manchester / Aerodyne
  - Cloud Particle imager CPI
  - TOF-AMS + SP-2 detector

Campaign ACI-02

Partners and Instrumentation

- MPI for Chemistry, Mainz
  - Single particle MS SPLAT, ALABAMA
  - SP-2 soot detector
- Forschungszentrum Jülich
  - TOF-AMS
- IfT Leipzig
  - LACIS-mobile, CCN counter (from Jülich)
- University of Darmstadt
  - TEM grid sampler

Experiments with Arizona Test Dust (ATD)

ACI02	14	IN_Ref	0	P2 60%	17.10.2008 09:30:00	1008.0	244.9
ACI02	15	IN_ATD	0	P2 60%	17.10.2008 12:00:00	1009.0	245.0
ACI02	16	IN_ATD	0	80 m^3/h	17.10.2008 14:01:00	1008.0	245.0
ACI02	17	IN_ATD+SOA(ext)	0	80/100 m^3/h	17.10.2008 16:30:00	1008.0	245.1
ACI02	18	IN_Ref	0	P2 60%	20.10.2008 09:33:00	1007.1	244.7
ACI02	19	IN_ATD+SOA6	0	P2 60%	20.10.2008 16:15:00	1005.0	244.8
ACI02	20	IN_ATD+SOA6	0	P2 60%	20.10.2008 17:47:00	1005.0	244.9
ACI02	21	IN_Ref	0	P2 60%	21.10.2008 09:33:00	1000.0	244.7
ACI02	22	IN_ATD+SOA0.4	0	P2 60%	21.10.2008 13:25:00	1000.0	244.8
ACI02	23	IN_ATD+SOA2.0	0	P2 60/80%	21.10.2008 16:55:00	1000.0	244.8
ACI02	24	IN_Ref	0	P2 60%	22.10.2008 09:30:00	1008.0	244.9
ACI02	25	IN_ATD+SA60	0	P2 60%	22.10.2008 13:30:00	1009.0	244.9
ACI02	26	IN_ATD+SA60	0	P2 60%	22.10.2008 16:30:00	1012.0	245.0
ACI02	27	IN_Ref	0	P2 60%	23.10.2008 09:31:00	1018.1	244.9
ACI02	28	IN_ATD+SA80	0	P2 60%	23.10.2008 13:31:00	1018.0	245.0
ACI02	29	IN_ATD+SA80	0	P2 60%	23.10.2008 16:50:00	1016.0	244.7

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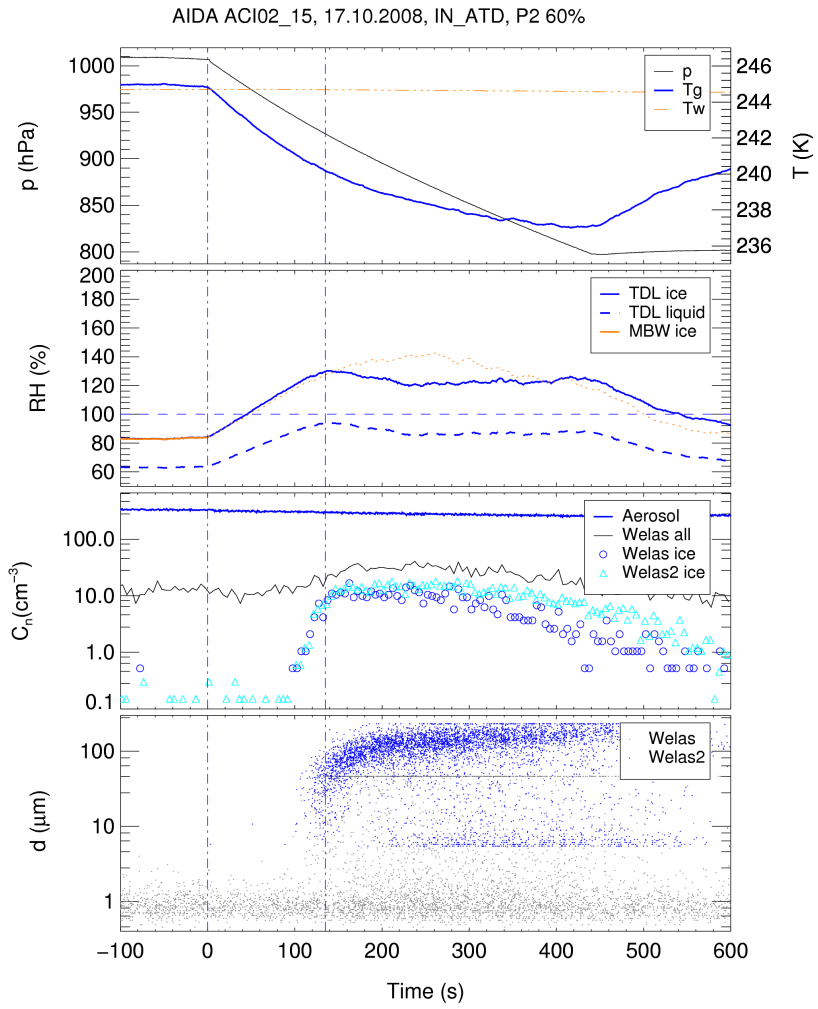
Pure ATD

initial temperature: -28°C; initial pressure: 1009 hPa



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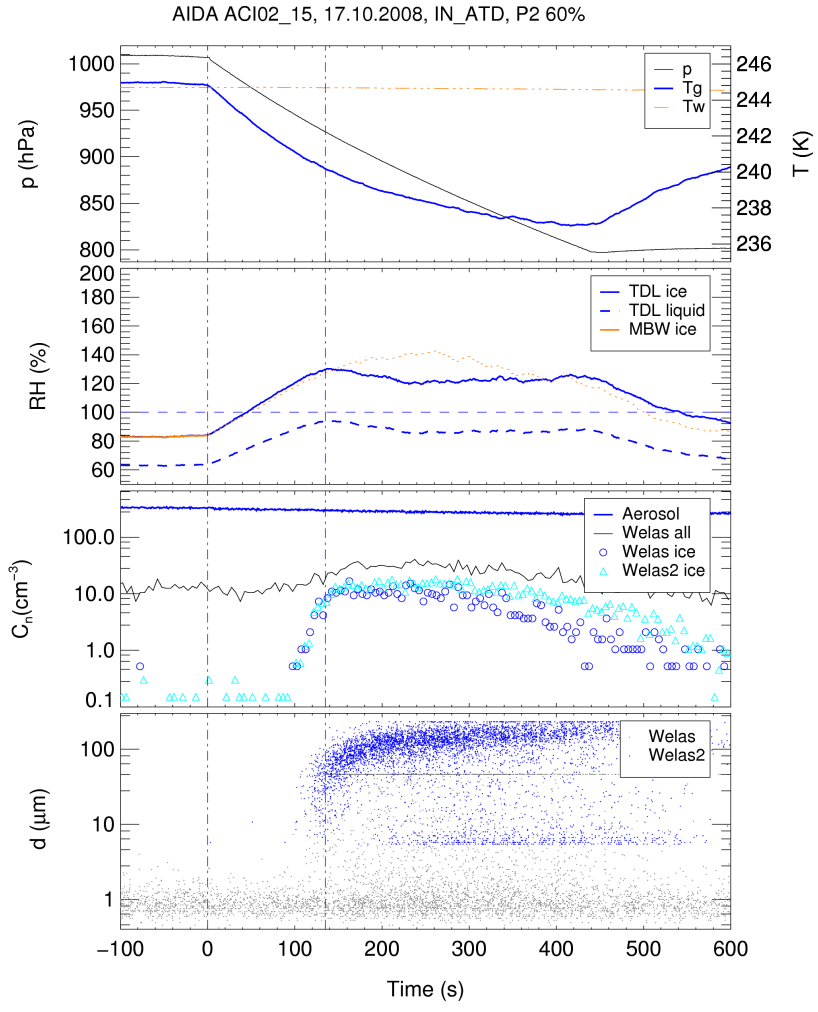
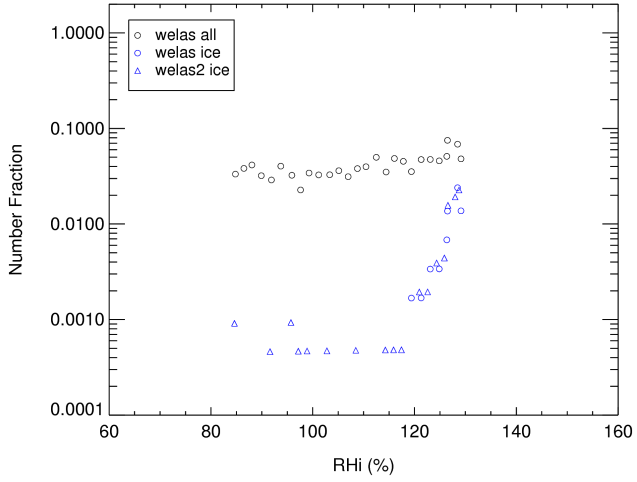
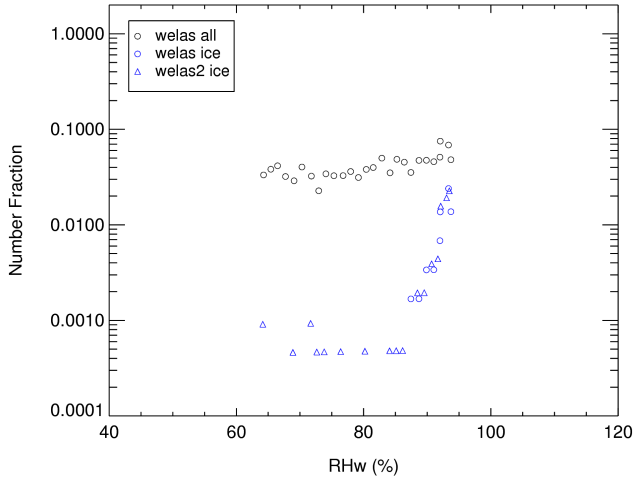
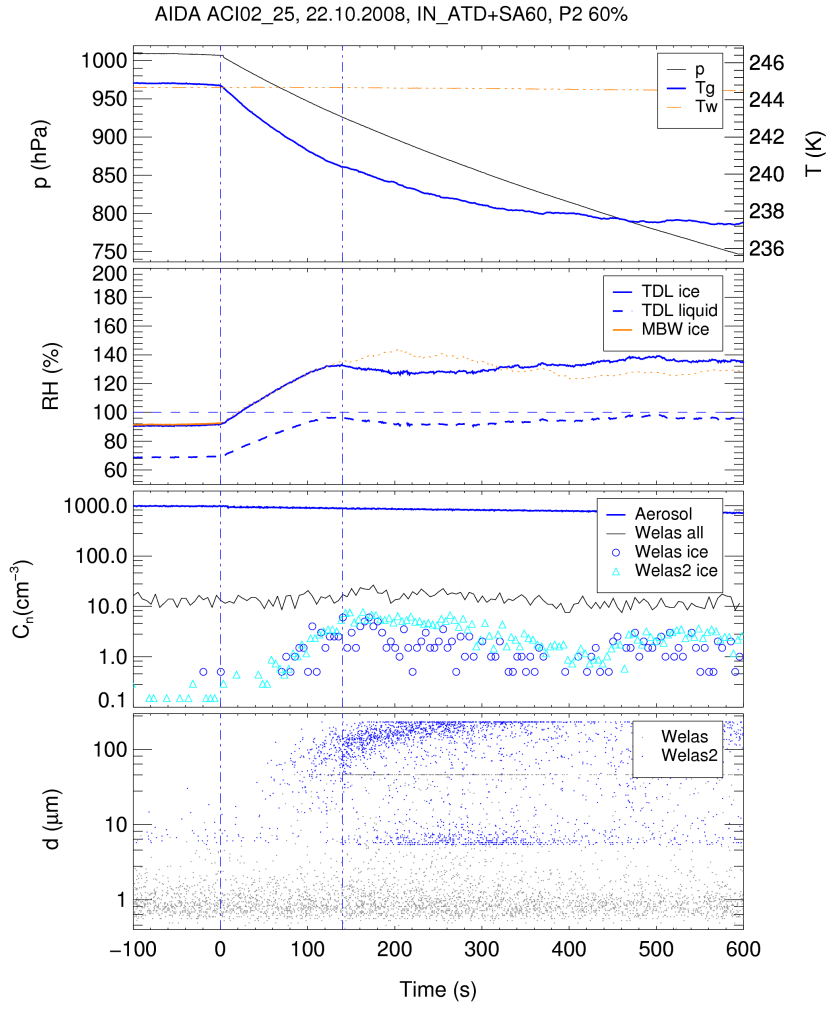






ATD + H_2SO_4 (thin coating)

initial temperature: -29°C; initial pressure: 1009 hPa



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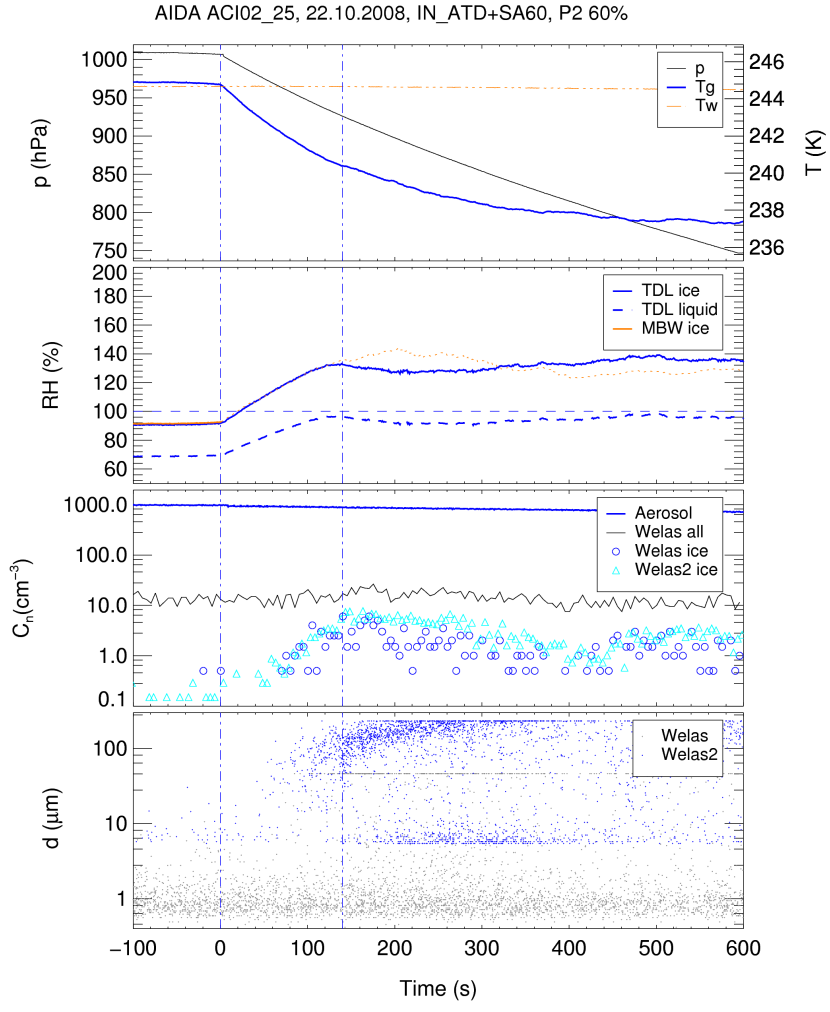

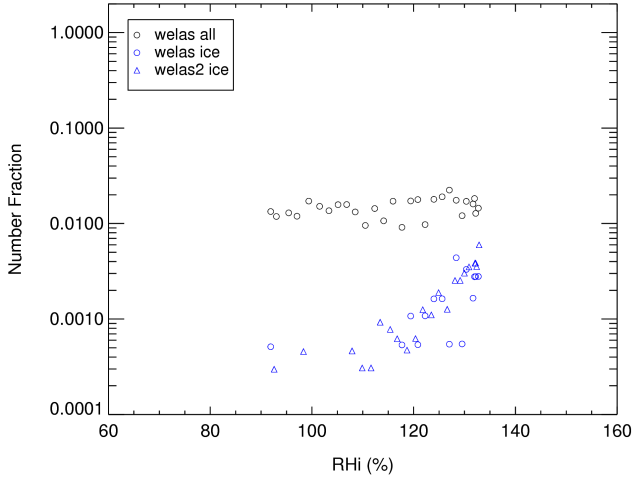

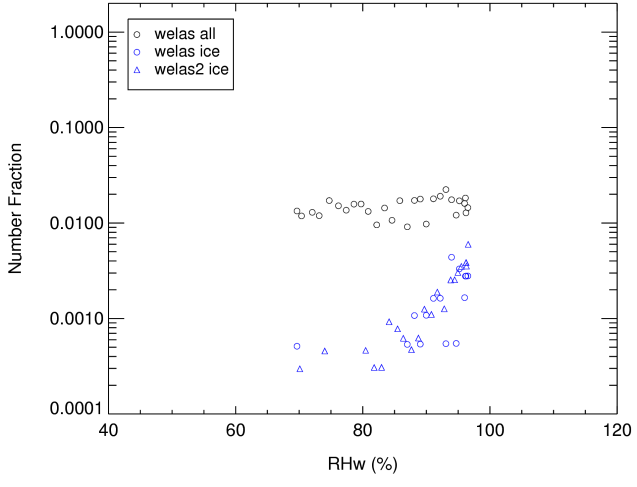

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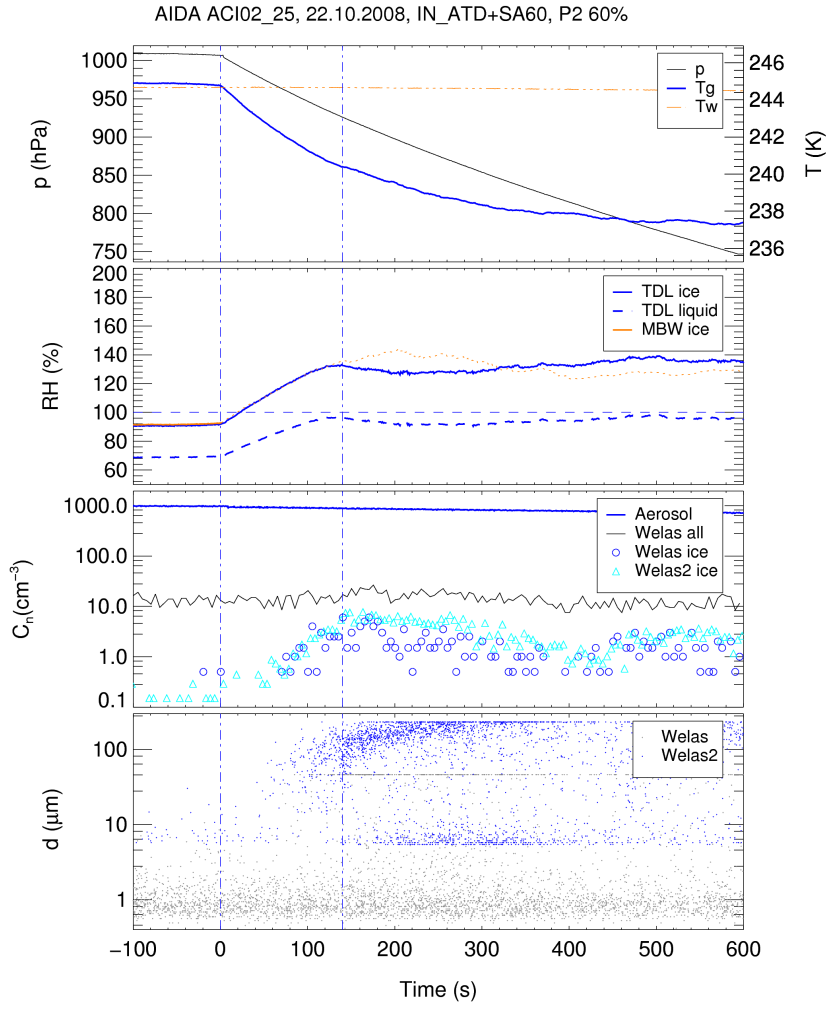

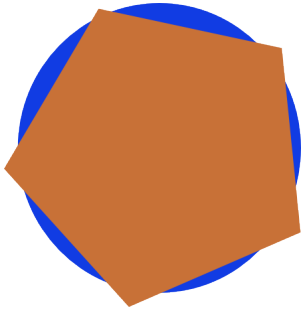

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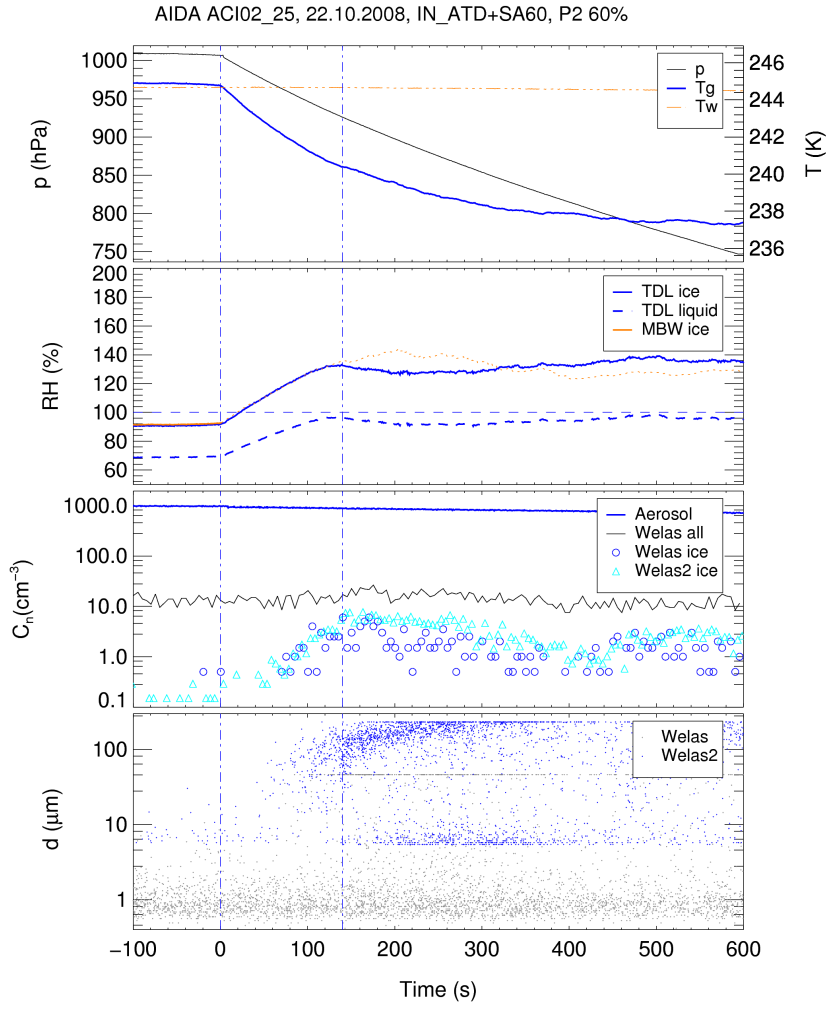

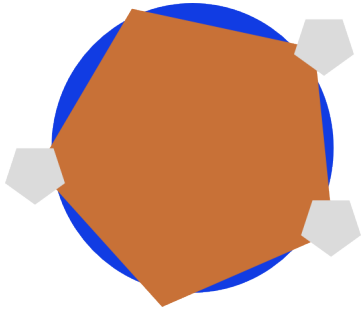

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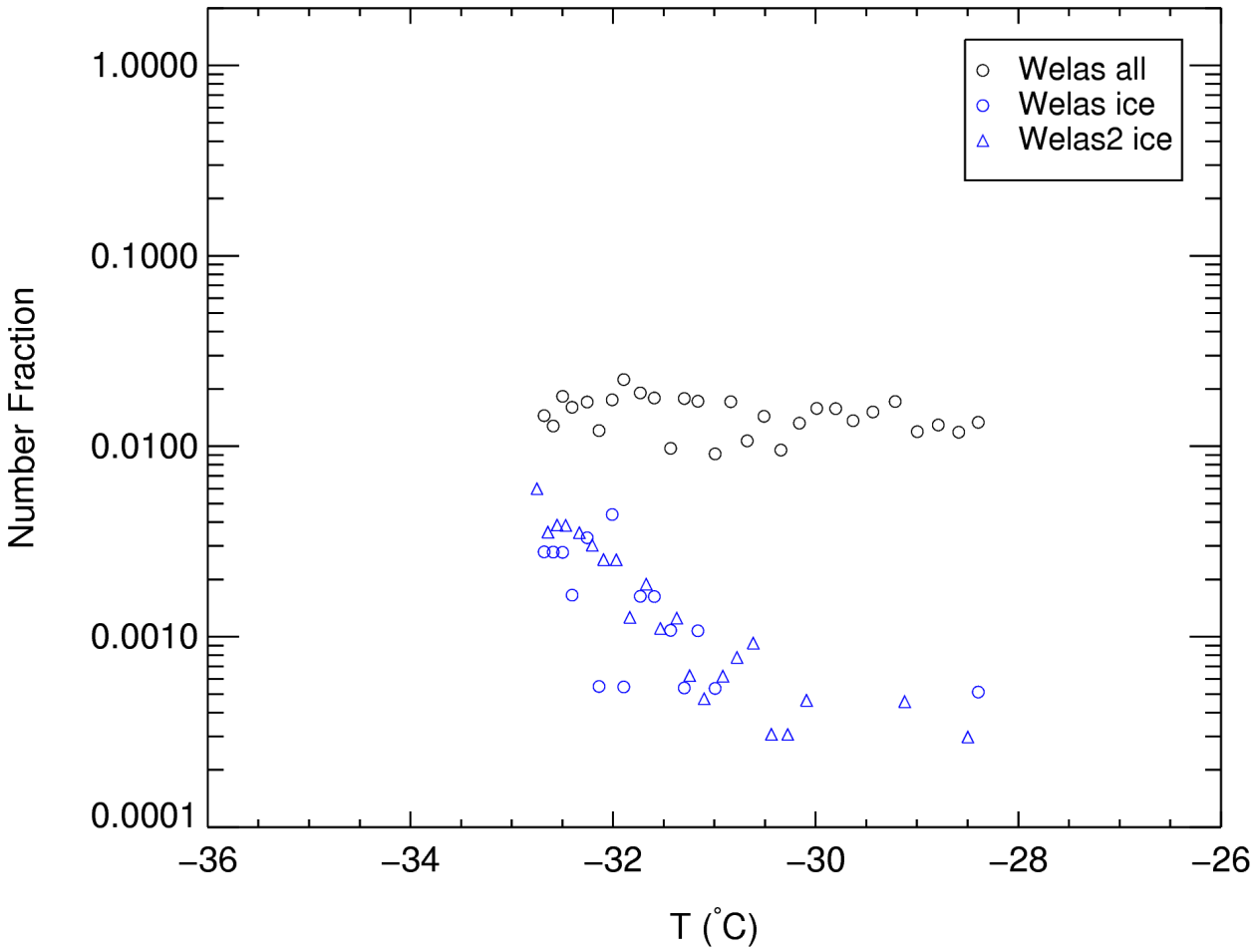

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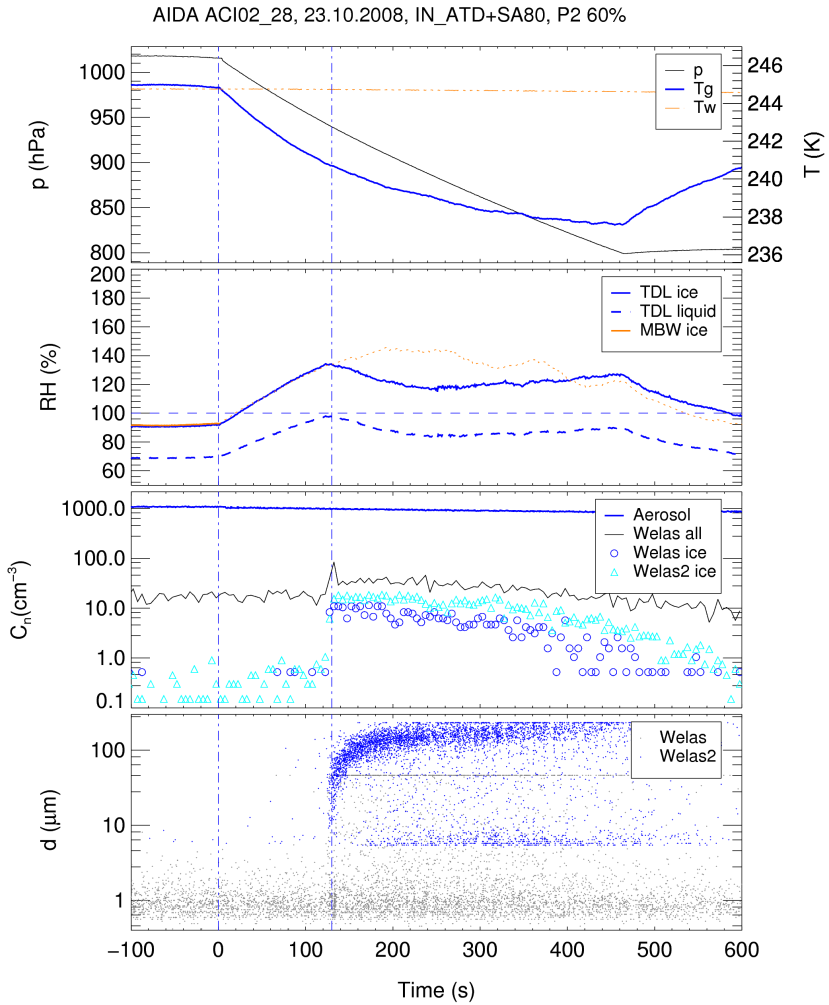

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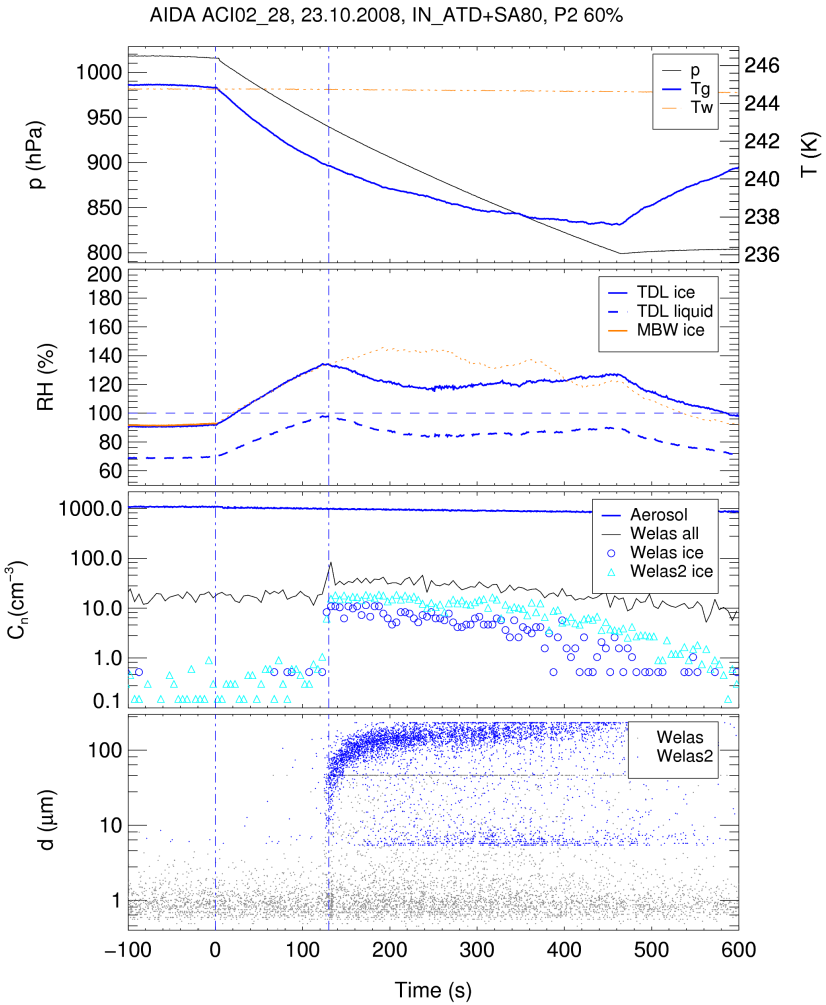

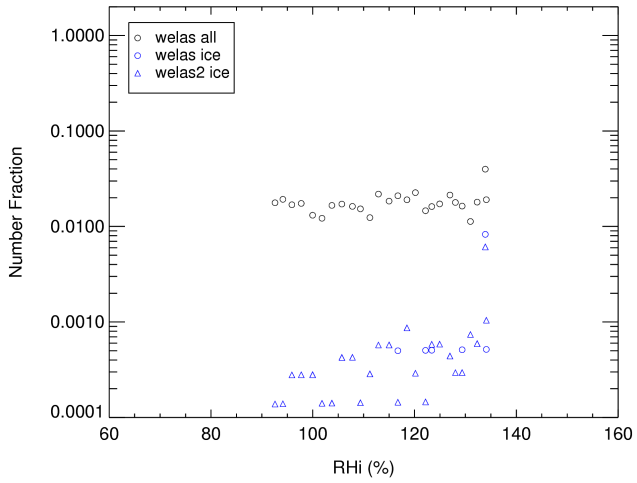

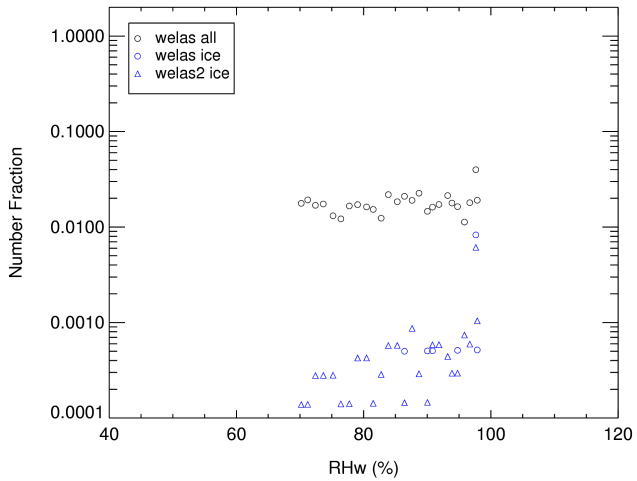

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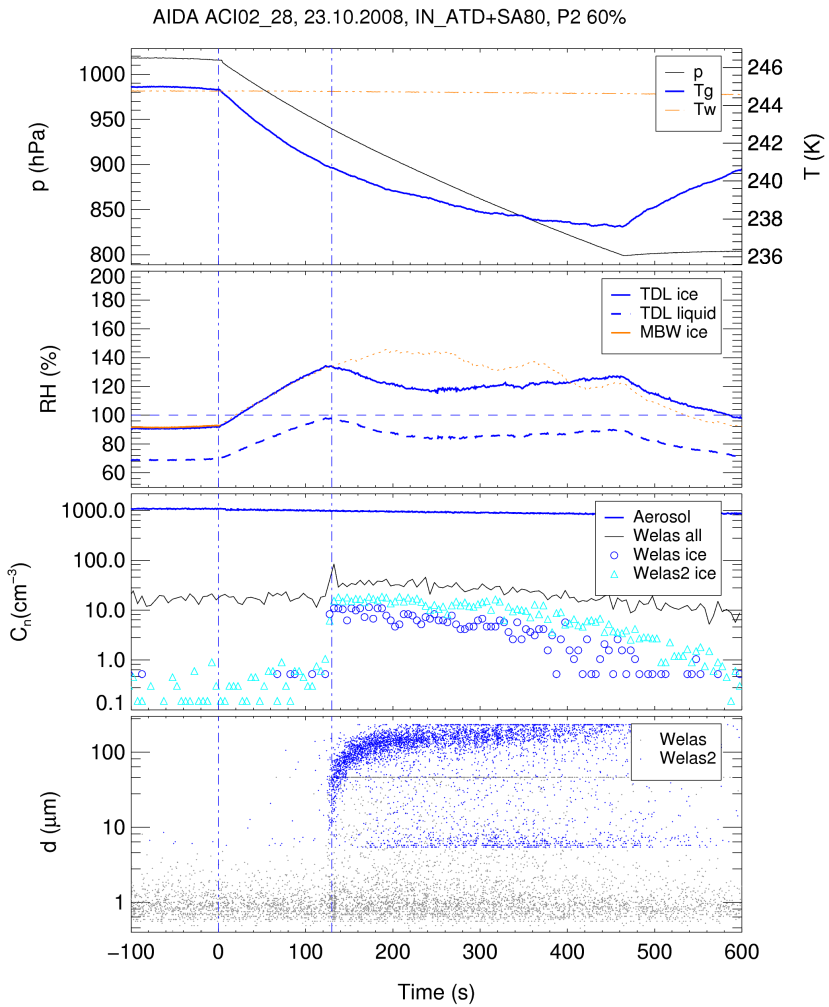

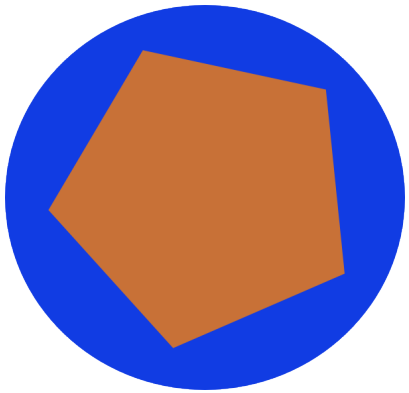

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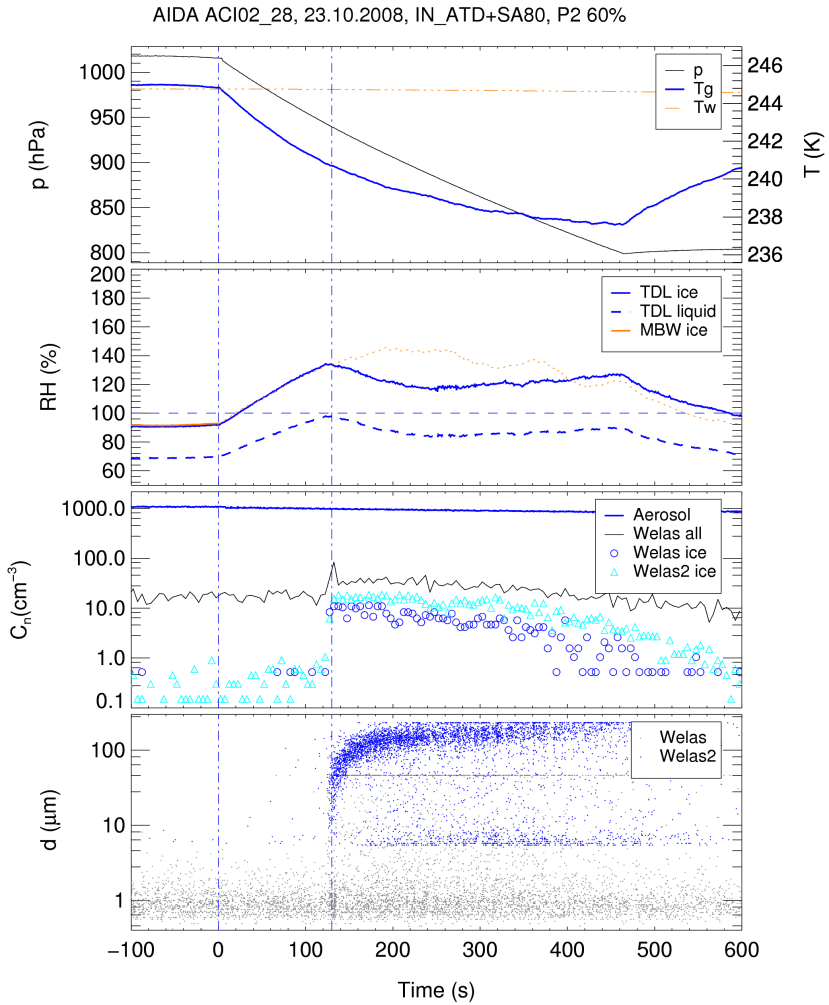

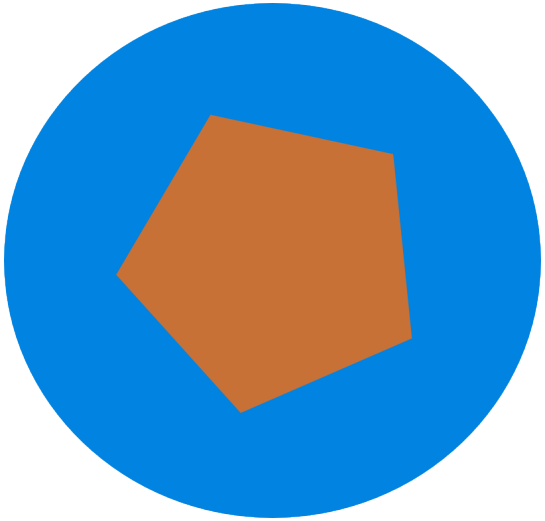

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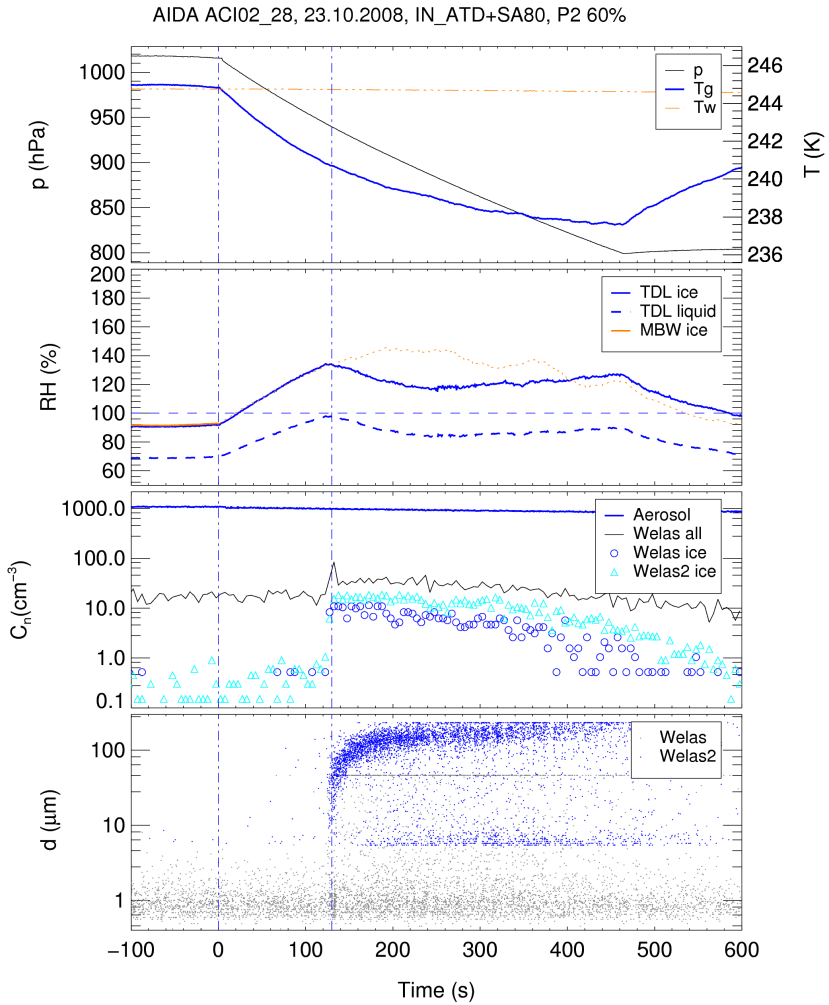

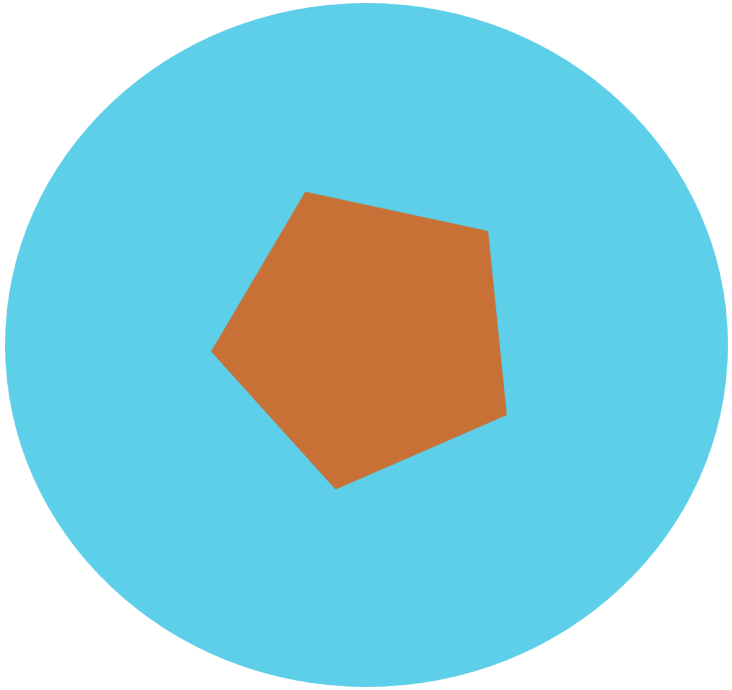

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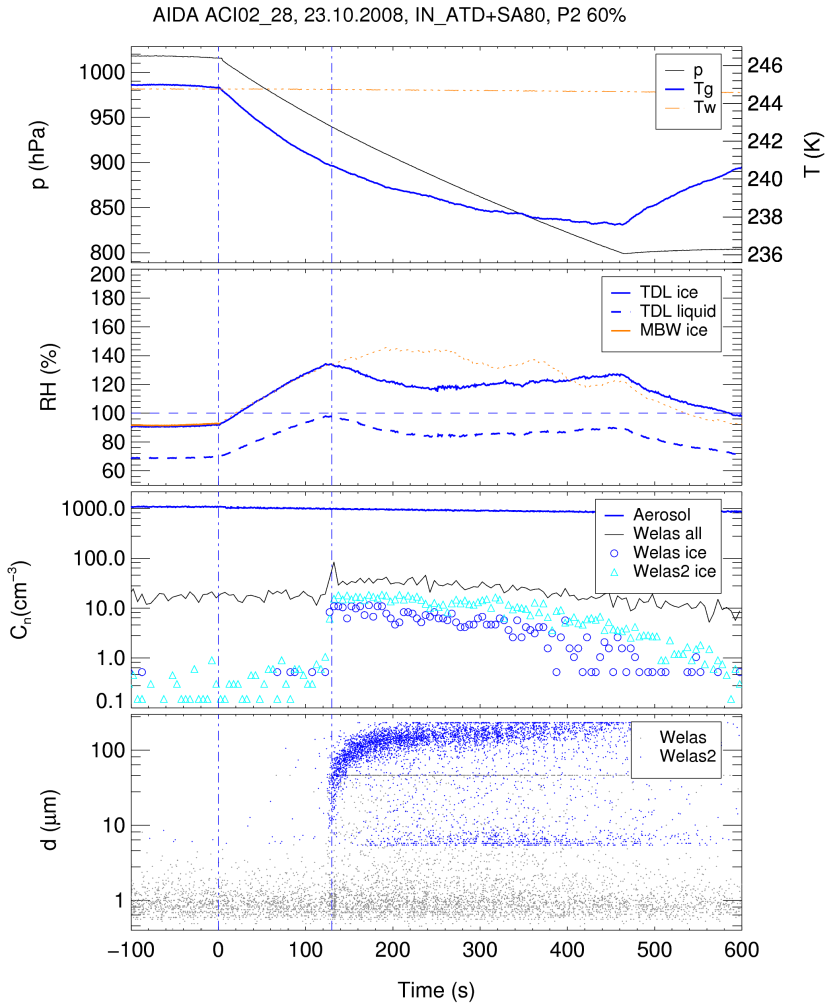

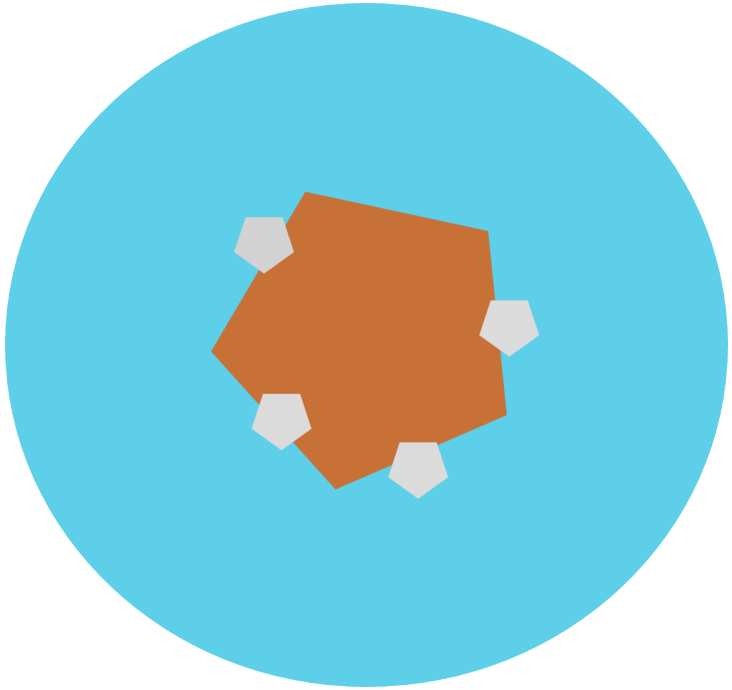

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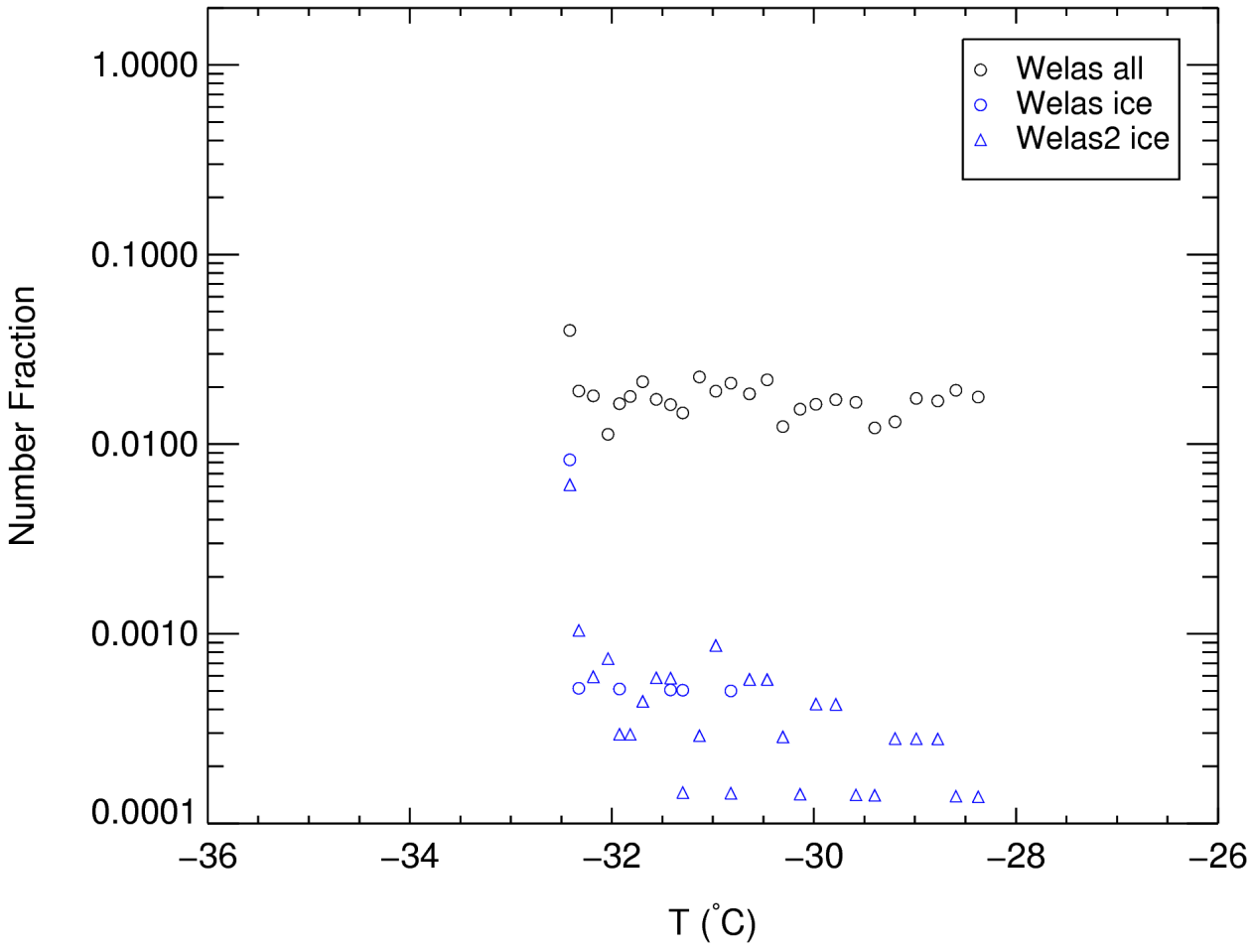


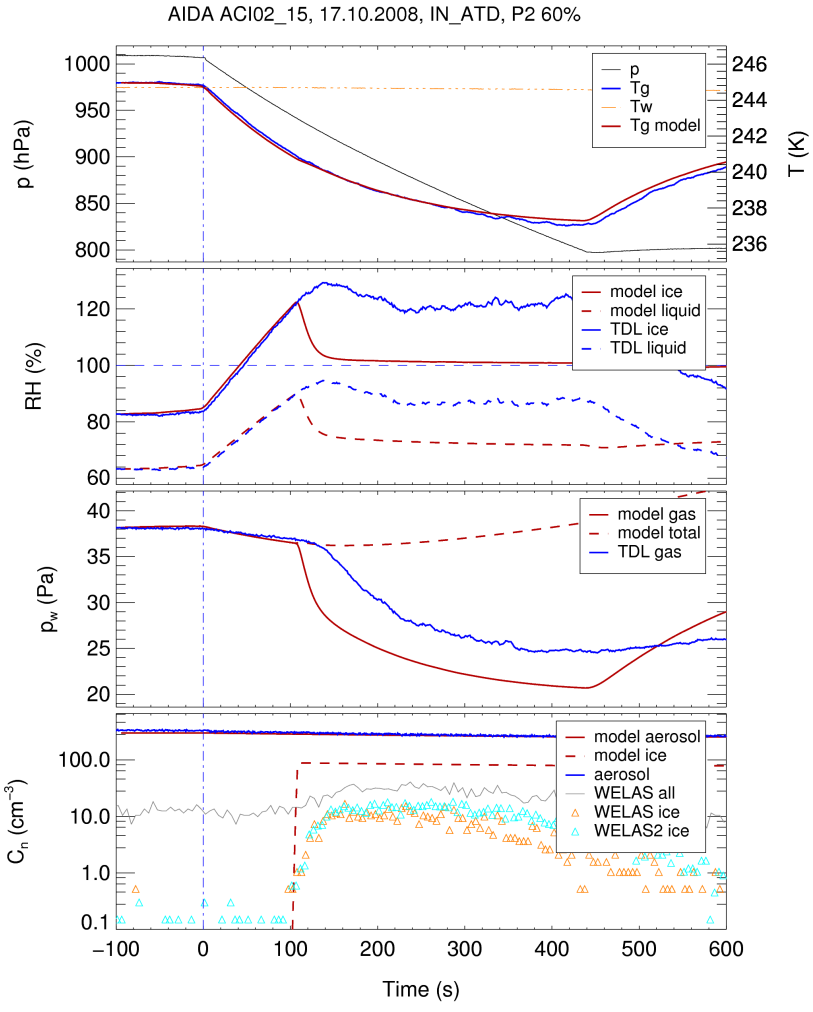
Model versus Experiment

Ice nucleation experiment with pure ATD

→ 'shifted activity' parameterization by Kärcher and Lohmann (2003)

- RH_{cr}^{het} = 115% initialized

- model results are red!

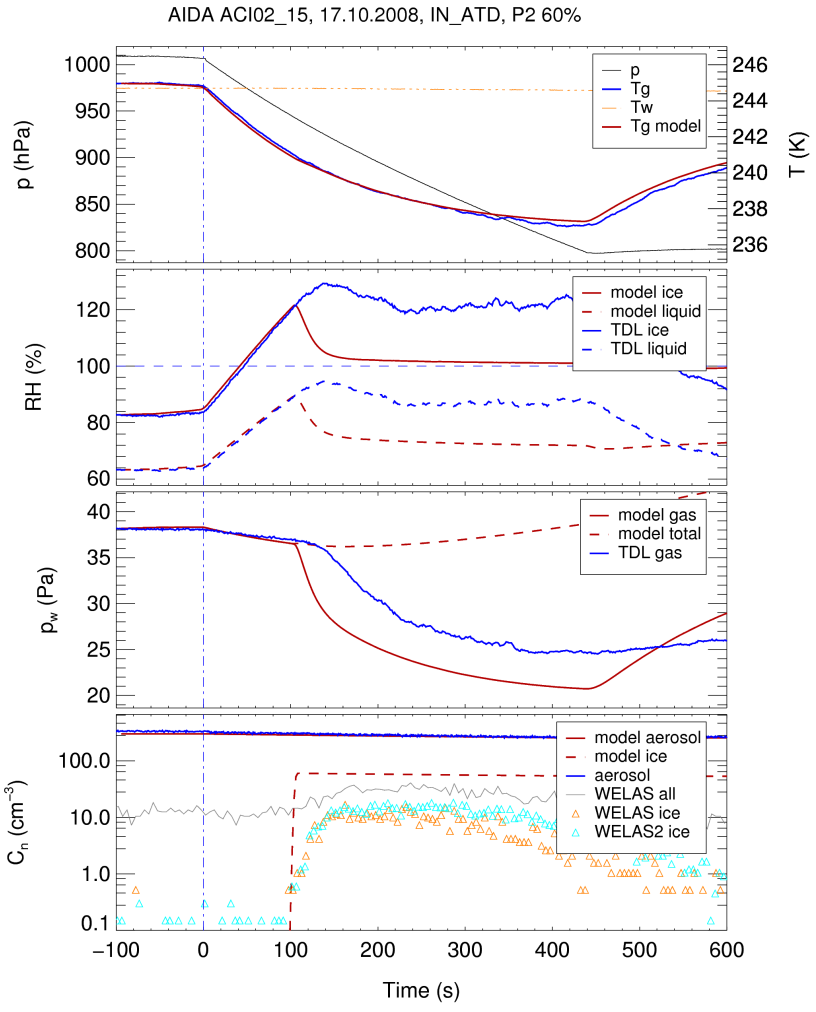


Model versus Experiment

Ice nucleation experiment with pure ATD

→ parameterization ('contact angle approach') by Fletcher (1958)

- θ = 17° initialized

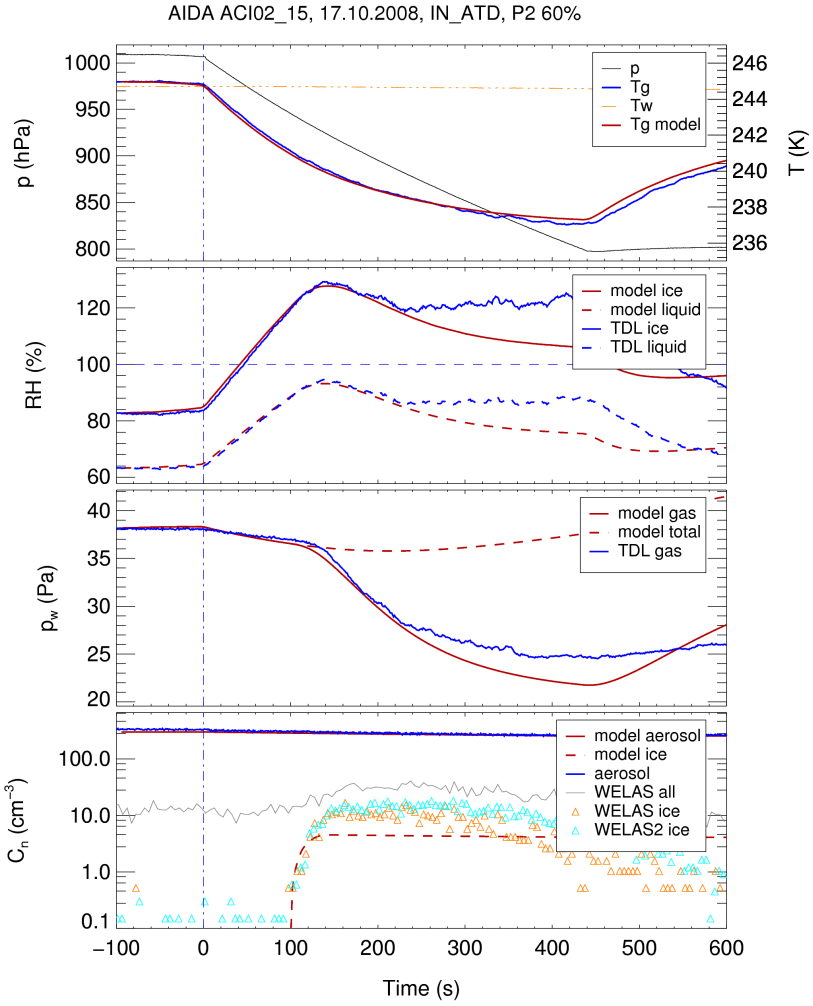


Model versus Experiment

Ice nucleation experiment with pure ATD

→ parameterization ('exponential fit') by Möhler (2006)

- $f_i = exp[a(S_i - S_0)] - 1$
- RH_{cr}^{het} = 115%
- a = 0.3 initialized



Summary

- first comparison of model calculations with experimental data was presented
- model overestimates ice formation rate at given temperature and pressure

- Outlook
  - further comparison of MAID model calculations with experimental data
  - test concept of surface number density of active sites (Connolly et al., 2009)
  - development of new parametrizations for heterogenous ice nucleation