HGF-VI ACI

Processes, Cloud and Climate Modeling

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Second Year Summary of WP M1-M3

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HELMHOLTZ GEMEINSCHAFT

Ludwig Maximilians Universität München LMU

DLR

Recall milestones: Process-oriented modeling (WP 1)

M1A Cirrus parameterization scheme available for use in ECHAM (DLR, month 6).

M1B Model runs on aerosol mixing state in cirrus finished (DLR, month 12).

M1C Validated microphysical models, expressions and parameterizations regarding CCN activation for selected aerosol systems (IfT, month 12)

M1D Ice nucleation properties in mixed-phase clouds assessed (FZK, month 18).

M1E Ice nucleation properties in cirrus clouds assessed (DLR, FZK, month 24).

M1F Process model with new ice nucleation schemes applied to cirrus data sets (ICG-I, month 24).

M1G Validated microphysical models, expressions and parameterizations regarding freezing temperatures for selected aerosol systems (IfT, month 24)

Year 2—Summary: Process-oriented modeling (WP 1)

Objective and Status

Improve cirrus microphysics in global models.

M1A Cirrus parameterization scheme available for use in ECHAM. **m6**

Scheme available for use in ECHAM4 (*JGR, 2006*).

Investigate role of (aviation) soot aerosols in cirrus cloud formation.

M1B Model runs on aerosol mixing state in cirrus finished. **m12**

Results published (*ACP, 2007*).

Provide tools for CCN growth and activation for use in large-scale models.

M1C Validated microphysical models, expressions and parameterizations regarding CCN activation for selected aerosol systems available. **m12**

Model describing hygroscopic growth and activation in LACIS available (organic: UNIFAC, inorganic: Pitzer).

Ongoing data analysis from campaigns IN-11 / AIDA (hygroscopic growth and activation) and FROST / LACIS (temperature-dependent ice-activated fractions).

Provide data base for process modelling.

Assessment of available IN parameterisations using process model MAID.

M1D Ice nucleation properties in mixed-phase clouds assessed. **m18**

First campaign finished (11/2007); second campaign finished (10/2008).

Data base complete. Comparison of model calculations and experimental data initiated.

Year 2—Summary: Process-oriented modeling (WP 1)

Objective and Status

Provide parameterized heterogeneous ice nucleation rates from AIDA measurements.
Provide improved parameterization for homogeneous freezing in cirrus conditions.

M1E Ice nucleation properties in cirrus clouds assessed. **m24**

Effect of SOA coating on ice nucleation of dust investigated.
Paper on effect of SOA coating on heterogeneous ice nucleation published.
Test of novel parameterizations by means of AIDA data and process model MAID.

Improve understanding of cirrus formation and microphysics.

M1F Process model with new ice nucleation schemes applied to cirrus data sets. **m24**

MAID available for use of different IN schemes and cirrus data sets.
MAID applied to contrail data sets.

Provide tools for determining freezing temperatures for use in large-scale models.

M1G Validated microphysical models, expressions and parameterizations regarding freezing temperatures for selected aerosol systems. **m24**

Model simulating freezing experiments in LACIS under development:
understanding the behavior (activation, super-cooling, evaporation) of droplets inside LACIS.
Analysis of first data from FROST campaign LACIS (04/2008). Ice fractions determined and parameterized. Publications in progress.

Recall milestones: Cloud modeling (WP 2)

M2A Lagrangian ice particle tracking module for Large Eddy simulations of cirrus clouds developed (DLR-IPA, month 12).

M2B Ice microphysics module for small and regional-scale contrail studies developed (DLR-IPA, month 12).

M2C Case studies on cirrus clouds obtained during field campaigns (ICG-I, ETH, month 12).

M2D TAU-2D model runs finished (Uni-TA, IMK-AAF, month 30).

M2E Cloud-resolving model runs using the multi-scale dynamical model EULAG finished (DLR-IPA, month 30).

M2F Investigation and interpretation of field measurements using idealized and realistic set ups (ETH, ICG-I, month 36).

Year 2—Summary: Cloud modeling (WP 2)

Objective and Status

Develop a state-of-the-art 2D/3D model for benchmark simulations and basic UTLS studies.

M2A Lagrangian ice particle tracking module for Large Eddy simulations of cirrus clouds developed. **m12**
Validated model EULAG-LCM available (PhD thesis completed. Paper in preparation).

Study and categorize contrail-to-cirrus transition.

M2B Ice microphysics module for small and regional-scale contrail studies developed. **m12**
Results on contrail evolution available (PhD thesis completed. Paper in preparation).

Investigation of frontal cirrus clouds.

M2C Case studies on cirrus clouds obtained during field campaigns. **m12**
Results on frontal cirrus clouds / instabilities available (Paper in preparation).

Year 2—Summary: Cloud modeling (WP 2)

Objective and Status

	Investigate effect of new IN parameterisations on cloud and precipitiation development.	
M2D	TAU-2D model runs finished. Effects of changing environmental conditions vs changing CCN/IN-profiles on surface precip with new statistical method studied and published (*JGR, 2008*). Paper on parameterization of IN rates derived from laboratory data published (*ACP, 2008*). Testing effects on IN parameterization in WRF using 3D spectral microphysics initiated.	**m30**
	Study and analyze cirrus formation and evolution.	
M2E	Cloud-resolving model runs using the multi-scale dynamical model EULAG finished. First applications to GEWEX case study (M2A) and contrail-to-cirrus transition (M2B).	**m30**
	Develop new heterogeneous nucleation parameterizations for cloud-resolving modeling.	
M2F	Investigation and interpretation of field measurements using idealized and realistic set ups. Ongoing research, first results available (Paper in preparation).	**m36**

Recall milestones: Climate modeling (WP 3)

M3A	Fully coupled parameterization of cirrus cloud formation implemented in ECHAM (DLR, month 12)
M3B	Subgrid-scale parameterization for contrail-cirrus ready in ECHAM (DLR, month 12)
M3C	Simulations with varying mineral dust composition (ETH, month 18)
M3D	Global impact of contrail-cirrus on cirrus cover and properties quantified (DLR, month 30)
M3E	Impact of natural and anthropogenic ice nuclei (including aviation soot) on global cirrus cloud properties quantified (DLR, month 30)
M3F	Simulations with changed freezing efficiency due to aged aerosols (ETH, month 36)

Year 2—Summary: Climate modeling (WP 3)

Objective and Status

Enable climate model to simulate IN effects realistically.

M3A Fully coupled parameterization of cirrus cloud formation implemented in ECHAM. **m12**

Scheme implemented and tested in ECHAM (Paper in preparation).

Enable climate model to simulate contrail-cirrus self-consistently.

M3B Subgrid-scale parameterization for contrail-cirrus ready in ECHAM. **m12**

Scheme implemented in ECHAM and compared with observations (Paper in review).

Investigate global impact of mineral dust composition on ice nucleation in mixed-phase clouds.

M3C Simulations with varying mineral dust composition. **m18**

Results on effects of dust with different composition published *(ERL, 2008).*

Year 2—Summary: Climate modeling (WP 3)

Objective and Status

	Study and analyze effects of contrail-cirrus on high cloudiness and climate.	
M3D	Global impact of contrail-cirrus on cirrus cover and properties quantified.	**m30**
	Simulations with the contrail cirrus parameterization ongoing.	
	Study and analyze effects of natural and anthropogenic IN on global cirrus cloud properties.	
M3E	Impact of natural and anthropogenic ice nuclei (including aviation soot) on global cirrus cloud properties quantified.	**m30**
	Obtain robust statistics of IN-induced cirrus changes and RF by tracking of perturbed clouds.	
	Investigate global impact of aged aerosol on ice nucleation in mixed-phase clouds.	
M3F	Simulations with changed freezing efficiency due to aged aerosols.	**m36**
	Enable simulation of coating of aerosols in ECHAM.	