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The overarching scientific objective of TR 172 is to identify, investigate, and evaluate the key processes contributing to Arctic Amplification, improve our understanding of the major feedback mechanisms, and quantify their relative importance for Arctic Amplification.

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The Transregional Collaborative Research Centre TR 172 provides a unique research environment to study the increase of Arctic near-surface temperature during the last decades, which is commonly referred to as **Arctic Amplification**, from complementary viewpoints, bridging various observations and modelling approaches.


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# TRANSREGIO TR 172

LEIPZIG | BREMEN | KÖLN

**A**rcti**C** **A**mplification:
**C**limate Relevant **A**tmospheric and Surfa**C**e Processes, and Feedback Mechanisms **(AC)³**


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UNIVERSITÄT LEIPZIG
Universität Bremen
Universität zu Köln
TROPOS Leibniz Institute for Tropospheric Research
AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

# TRANSREGIO TR 172 – (AC)³

A TRANSREGIONAL COLLABORATIVE RESEARCH CENTRE COORDINATED BY UNIVERSITY OF LEIPZIG

The Transregional Collaborative Research Centre (TR 172; (AC)³) was established on January 1st 2016 to address the great challenge of identifying the key processes contributing to Arctic Amplification. (AC)³ brings together the necessary broad scientific expertise from three universities – University of Leipzig, University of Bremen, and University of Cologne – and two external research institutes – Alfred-Wegener Institute for Polar and Marine Research, and the Leibniz Institute for Tropospheric Research.

The Arctic is one of the most scientifically interesting regions on Earth for a variety of reasons. Within the last 25 years a remarkable increase of the Arctic near–surface air temperature exceeding the global warming by a factor of two has been observed. This phenomenon is commonly referred to as **Arctic Amplification**. The warming results in rather dramatic changes of a variety of climate parameters. For example, the Arctic sea ice has declined significantly. This ice retreat has been well identified by satellite measurements. However, coupled regional and global climate models still fail to reproduce it adequately; they tend to systematically underestimate the observed sea ice decline. This model–observation difference implies that the underlying physical processes and feedback mechanisms are not appropriately represented in Arctic climate models. Thus, the predictions of these models are also likely to be inadequate. It is mandatory to identify the origin of this disagreement.

## OVERARCHING OBJECTIONS

- Exploiting high-quality measurements over the Arctic Ocean with innovative technologies and using powerful infrastructures
- Enhancing the predictive skills of a hierarchy of modern numerical models


Alfred-Wegener-Institut / Thomas Krumpen (CC-BY 4.0)

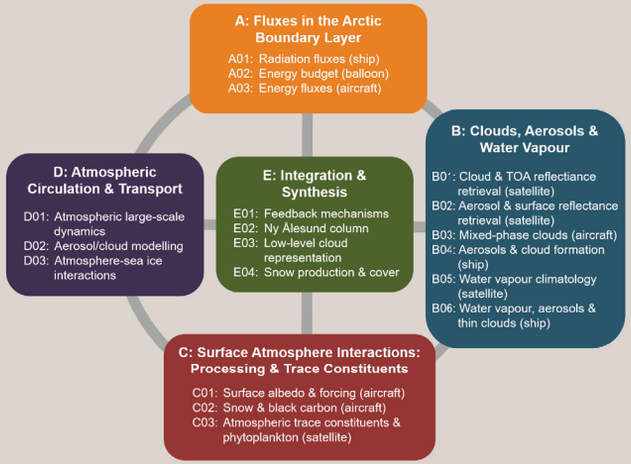

Alfred-Wegener-Institut / Jürgen Graeser, 2013

TROPOS / Holger Siebert, 2015

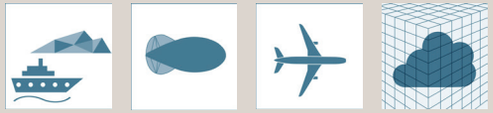

Alfred-Wegener-Institut / Michael Fischer (CC-BY 4.0)

# RESEARCH PROFILE OF (AC)³

(AC)³ ADRESSES FIVE MAJOR SCIENTIFIC FOCUS AREAS REPRESENTED BY FIVE PROJECT CLUSTERS A-E




## CLUSTER A: FLUXES IN THE ARCTIC BOUNDARY LAYER



This Cluster investigates clouds and aerosol impact on profiles of turbulent and radiative energy fluxes. The three projects deal with measurements, simulations, and parametrizations of the fluxes in the atmospheric boundary layer (ABL). The overall hypothesis to be tested is that "Detailed in-situ observations in the cloudy Arctic ABL are essential to detect model drawbacks and to improve flux parametrizations".

## CLUSTER B: CLOUDS; AEROSOLS & WATER VAPOUR

The topic of this Cluster consisting of six projects is to investigate the macro- and microphysical properties of Arctic clouds, aerosols and water vapour, together with their energetic forcing. Satellite, airborne, and ground-based observations are applied to characterize small-scale and large-scale distributions. The hypothesis of this Cluster is that "Atmospheric water (vapour, liquid water or ice) and aerosol properties play a dominant role for feedback mechanisms between ocean, sea ice and the Arctic atmosphere".

## CLUSTER C: SURFACE ATMOSPHERE INTERACTIONS: PROCESSING & TRACE CONTITUENTS

This Cluster quantifies the surface spectral reflectance, the impact of natural/anthropogenic constituents and the changing phytoplankton functional types. The three projects adresses surface-atmosphere interactions and processes from satellite, airborne, and ground-based observations. The overarching hypothesis is that "There is feedback between changing surface conditions, oceanic phytoplankton and near-surface chemical composition".

## CLUSTER D: ATMOSPHERIC CIRCULATION & TRANSPORT

Cluster D quantifies the contributions to Arctic Amplification from atmospheric large-scale circulation and key regional forcing and feedback processes. The three projects deal with distinct contributions from varying atmospheric large-scale circulation models and key regional process models. The overall hypothesis to be tested is that "Large-scale atmospheric dynamical processes and regional forcing and feedback processes are major drivers of Arctic Amplification".

## CLUSTER E: INTEGRATION & SYNTHESIS

The four projects in Cluster E integrate and synthesize the different aspects of Arctic Amplification in order to test the overall hypothesis "Combining models and observations on various scales provides essential information on feedback mechanisms of Arctic Amplification". The focus on low-level clouds and the role of snowfall where climate model simulations are known to show serious deficits and observational records are strongly limited.


Alfred-Wegener-Institut / Mario Hoppmann (CC-BY 4.0)


Alfred-Wegener-Institut / René Burgi, 2015