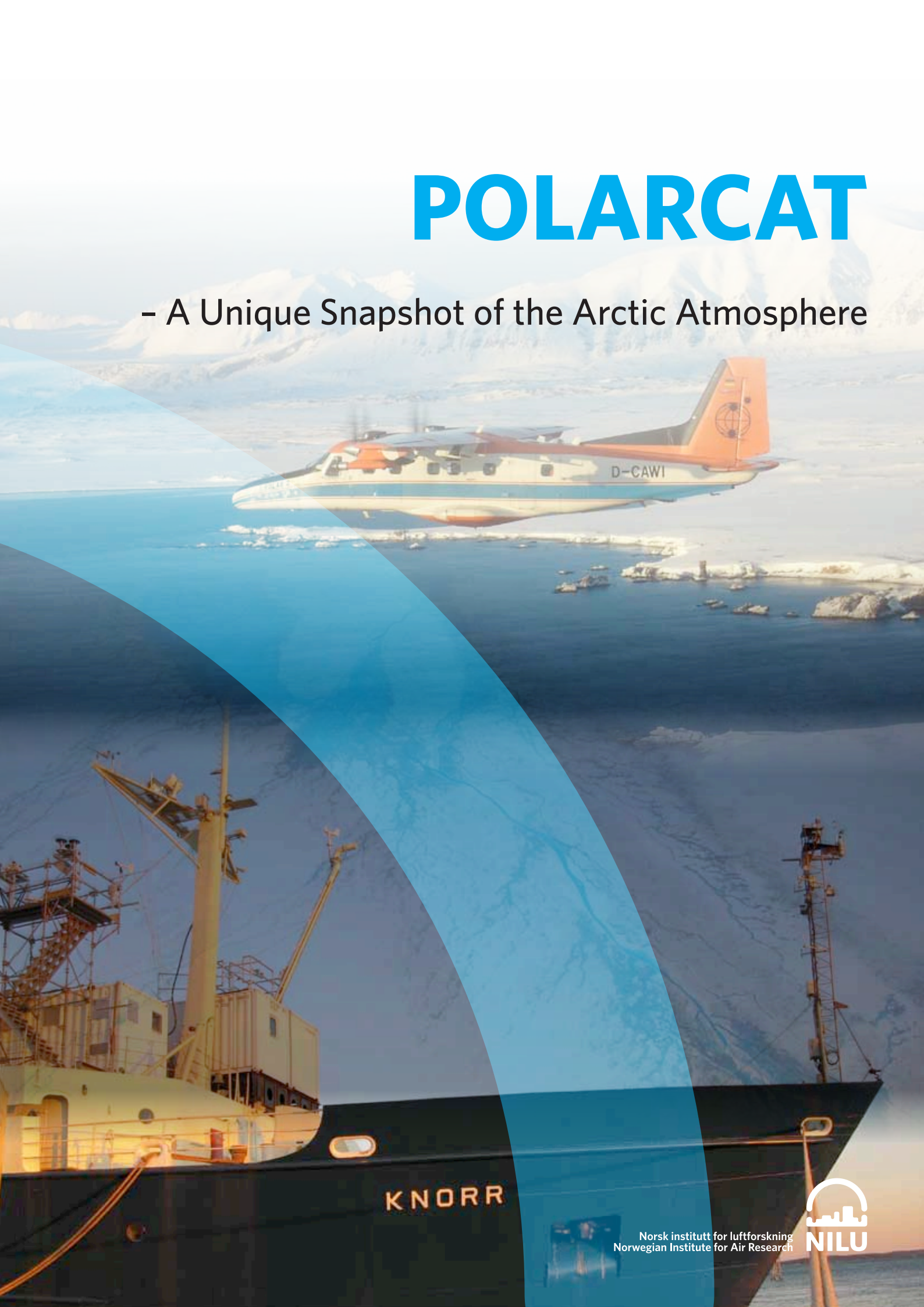
POLARCAT

– A Unique Snapshot of the Arctic Atmosphere



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Content

POLARCAT

POLARCAT is an extensive research project under the International Polar Year (IPY), studying the transport of pollutants and climate forcing agents into the Arctic.

POLARCAT is one of the largest projects in the International Polar Year. More than 20 countries have been participating in the study, and all available methods such as aircraft, remote sensing, surface measurements and modeling have been used.

Katherine Law, Service d'Aeronomie CNRS, and Andreas Stohl, NILU – Norwegian Institute for Air Research, are the project coordinators of POLARCAT.
www.polarcat.no

NILU – Norwegian Institute for Air Research is an independent, non-profit institution established in 1969.

Through its research NILU increases the understanding of processes and effects of climate change, of the composition of the atmosphere, of air quality and of hazardous substances.

Based on its research, NILU markets integrated services and products within the analytical, monitoring and consulting sectors. NILU is concerned with increasing public awareness about climate change and environmental pollution.
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The Research Council of Norway

Carbon Monoxide in the Arctic Atmosphere

Data from two POLARCAT aircraft campaigns proves that fossil fuel from Asia is the dominant source of Arctic carbon monoxide pollution in the free troposphere, while Asian and European sources play equal roles closer to the surface.

By Jenny Fisher, Ph.D. Candidate, Harvard University

For more than 50 years, pollution from industrial regions has been observed in the Arctic every winter and early spring. While the sources are undoubtedly distant, their distribution is widely debated.

Now data from two POLARCAT aircraft campaigns, along with observations from the AIRS satellite instrument and simulations from the GEOS-Chem chemical transport model have shown that fossil fuel from Asia is the dominant source of Arctic carbon monoxide pollution in the free troposphere, while Asian and European sources play equal roles closer to the surface.

Jenny Fisher

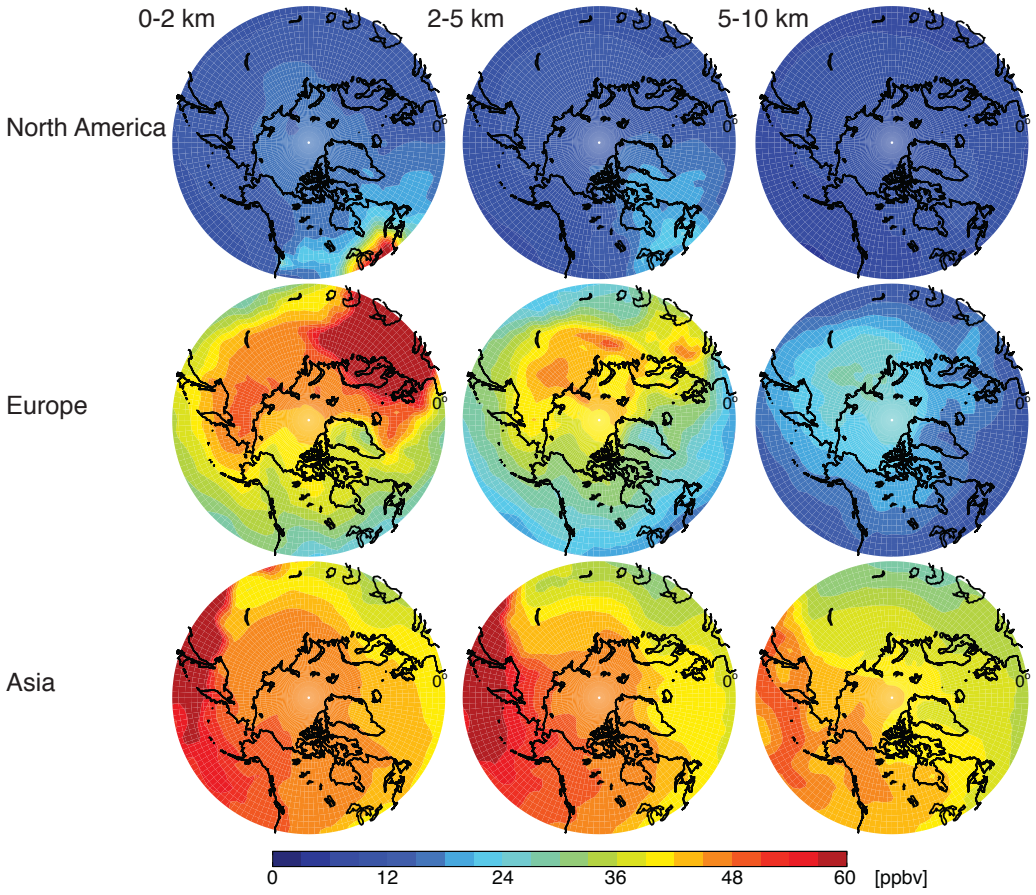
A receptor for pollution

The Arctic has long been known to be a receptor for pollution from distant anthropogenic activities, but the sources influencing the Arctic remain uncertain. Early studies in the 1970s and 1980s attributed the pollution to industrial activity in Europe and the former U.S.S.R. Over the past 20 years, however, the collapse of the Soviet Union, strict emission controls in Europe, and the rapid industrialization of Asia have led to dramatic changes in the global distribution of pollutants, and recent studies disagree as to the sources responsible for Arctic pollution.

Better understanding of these sources was the primary goal of two POLARCAT aircraft campaigns based in Fairbanks, Alaska in April 2008: NASA's Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) and NOAA's (National Oceanic and Atmospheric Administration) Aerosol, Radiation, and Cloud Processes affecting Arctic Climate (ARCPAC).

Unique experience

I was in the field as part of the flight planning team for ARCTAS, interpreting model forecasts to help determine the flight paths and analyzing early data to ensure the mission objectives were being met. As a modeler, working alongside the experimenters in Fairbanks provided me with an enhanced understanding of the in-situ datasets, along



Contributions of different mid-latitude source regions to CO pollution in the Arctic in April 2008, as indicated by the GEOS-Chem simulation. Results are shown as mean CO mixing ratios in altitude bands of 0–2, 2–5, and 5–10 km.

with the chance to experience firsthand the Arctic environment.

Wide Range Samples

Both ARCTAS and ARCPAC measured carbon monoxide (CO), which serves as an excellent indicator of pollution. CO is emitted by incomplete combustion – fossil fuel and biomass burning – and has an atmospheric lifetime of weeks to months, long enough to track long-range transport but short enough to remain distinct from the background atmosphere.

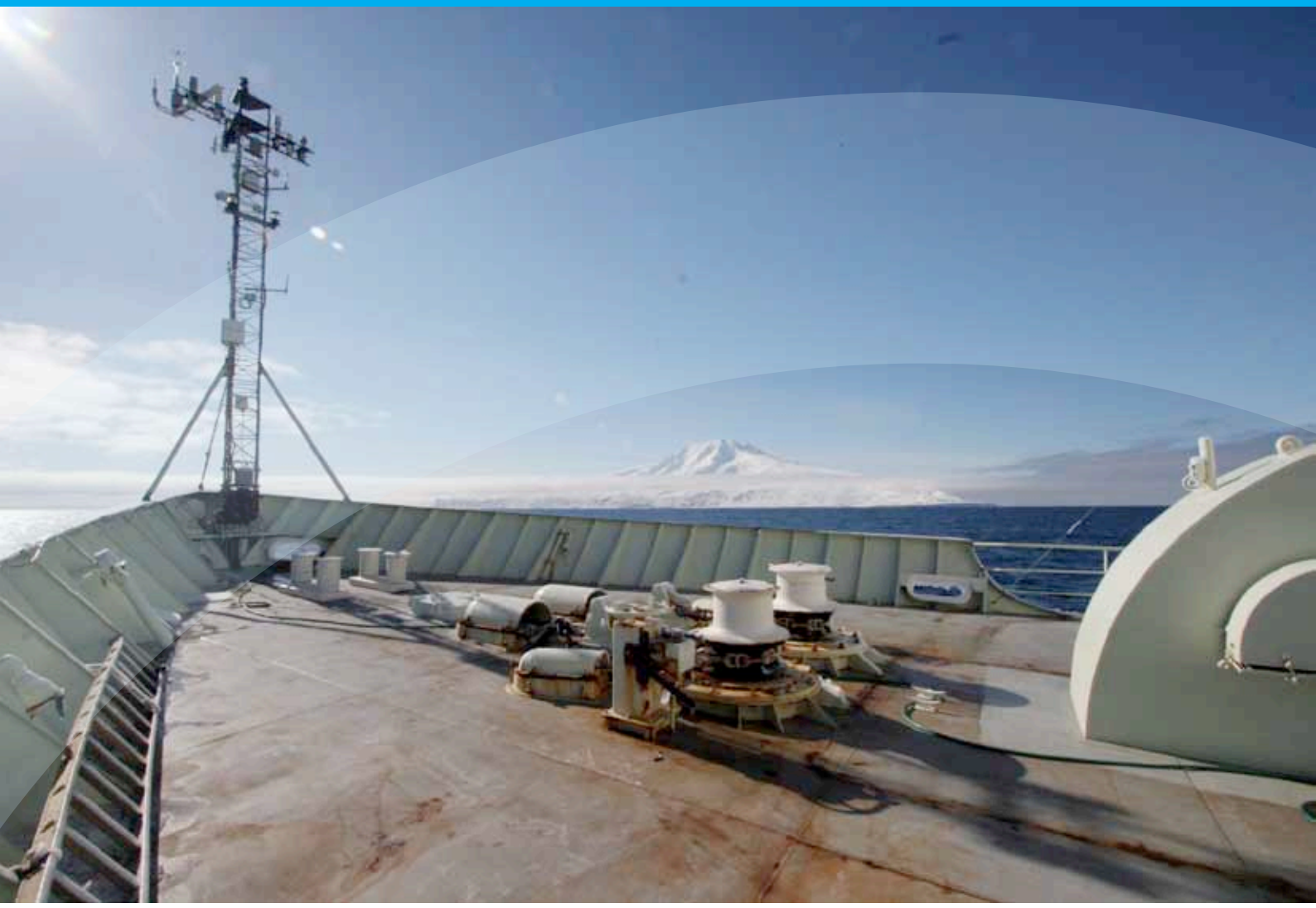
The aircraft sampled a wide range of conditions, ranging from clean background air to fossil fuel and smoke plumes. We used the aircraft observations as constraints for GEOS-Chem, a chemical transport model that uses our best understanding of CO sources and processes to predict CO concentrations. The data showed that while GEOS-Chem reproduced the qualitative pollution features observed by the aircraft, the simulated CO concentrations were consistently too low. By fitting the modeled concentrations to the observed CO, we found that the state-of-the-science fossil fuel emissions used in GEOS-Chem are underestimated by 50 percent for Europe and by 20 percent for Asia.

Asian pollution dominant

With improved estimates of CO emissions, we used GEOS-Chem to quantify the sources affecting Arctic pollution during spring 2008. The figure shows the simulated impact of fossil fuel burning in North America, Europe, and Asia on CO pollution in the Arctic. Asian pollution was clearly dominant at all altitudes, although European pollution had an equivalent influence near the surface. In contrast, North American pollution had virtually no impact on the Arctic. Forest fires in Russia, which were anomalously intense during the campaigns, were largely unimportant for Arctic CO concentrations.

Long-term perspective

Satellite observations of CO offer a longer-term perspective, providing context for the 2008 results. Data from the Atmospheric InfraRed Sounder (AIRS) satellite instrument show that CO over Alaska was lower than average in April 2008 and that it is correlated with the strength of El Niño. Meteorological changes associated with El Niño, enhance transport of Asian pollution to Alaska. This result suggests that the impact of Asian pollution on the Arctic, already dominant, could be even greater during a strong El Niño event.



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