



## **NCL - a workhorse for data analysis and visualization in climate research**

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Coupled earth system models are used for simulating the climate system. In the context of international climate assessment and model intercomparison projects, extensive simulation data sets are produced and have to be analyzed. Supercomputers and storage systems are used over years to perform the simulations, but the data analysis usually takes even more time. Different classes of tools are used for the analysis and visualization of these big data sets. In this PICO, we focus on NCL (NCAR Command Language), an interpreted language developed at the National Center for Atmospheric Research in Boulder, Colorado. NCL allows performing standard analysis operations and producing graphical output in batch mode loosely coupled with the simulations. Thus, for visual monitoring of their simulations, many of DKRZ's users have integrated NCL into their modeling workflows. We present application examples from the tutorial we have developed that focus on typical visualizations of climate model data.

Since NCL supports rectilinear, curvilinear and even unstructured grids, it is well prepared to facilitate the visualization of today's climate model data without prior interpolation. NCL includes many features common to modern programming languages, such as types, variables, operators, expressions, conditional statements, loops, and functions and procedures. It provides more than 600 built-in functions specifically for climate model data, facilitating analysis of scalar and vector quantities as well as numerous state-of-the-art 2D visualization methods (contour lines, filled areas, markers, wind arrows or barbs, weather symbols and many more). Important for Earth scientists is also NCL's capability to display data together with the corresponding map background and a choice of the map projection.