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Alexander von Humboldt's legacy in Earth System Science

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In this lecture I will first review some of Alexander von Humboldt's studies on the importance of vertical and latitudinal temperature gradients and surface processes in the context of mountain building and thereby highlight his seminal contributions to Earth System Science. In a second step I will briefly comment on his influence beyond science, including public outreach and the general public's Earth science literacy – in the face of fake news and distrust in scientific method and discourse, an issue more timely than ever.

The past decades have witnessed a radical shift in human perception of Earth and nature; climate change and increased competition for natural resources combined with human vulnerability to natural hazards have moved environmentalism from the fringes of public awareness to governmental policies. This shift in awareness was presaged by paradigmatic shifts in Earth Science leading to the modern view of Earth as a dynamic system of interactive physical, chemical and biological processes, and ultimately to establishment of the integrative field of Earth System Science. To a certain extent, this point of view and the realization that research across disciplinary boundaries is important and necessary to understand geoprocesses at a variety of time and length scales and in the context of linkages between the different spheres was already the fundament of Humboldt's thinking and research philosophy during the first half of the 19th century: "The principal impulse by which I was directed was the earnest endeavor to comprehend the phenomena of physical objects in their general connection, and to represent nature as one great whole." Alexander von Humboldt, *Kosmos*, I, ch. VII, 1845. Although Humboldt wrote this sentence 176 years ago, it reveals his early recognition of the importance of interdisciplinary and transdisciplinary approaches in science. In this regard Humboldt clearly was ahead of his time and most research areas of modern Earth System Science had already been touched upon by him. From mineralogy, geology, volcanology, stratigraphy and paleontology to climatology, biogeography and geobotany, and oceanography he had addressed many aspects research in an integrative, non-isolationist approach. Although Humboldt published his work very early on in disciplinary journals, he followed a holistic approach in science, where inherent processes, their connections across spheres, and feedbacks between them were addressed. Consequently, he also analyzed the influence of humans on the environment, particularly with regards to changes in microclimate, erosion, and biodiversity. By recognizing these relationships he truly followed an early Earth System Science approach, thus linking the geosphere and the anthroposphere. Interestingly, during his career Humboldt devoted himself increasingly to the transfer of knowledge to the general public, which not only resulted in regular public lectures, but also had a

far-reaching influence in the art world. Taken together, Humboldt therefore paved the way for an integrative approach to the exploration of the Earth's systems beyond disciplinary boundaries, and with a strong commitment to share knowledge and educate the public.