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High resolution precipitation and wind record from the Southern Hemisphere Westerly Zone, based on speleothem proxies

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Holocene changes in the position and intensity of the Southern hemispheric westerly wind belt are crucial to evaluate interhemispheric atmospheric linkages, but archives with sufficiently high resolution and reliable age constrains are rare in this region. We present the first high resolution stalagmite record from the southernmost Andes at 53˚S for the last 5000 years which has been dated by 16 U/Th ages. The stalagmite was sampled in a small cave which was eroded along a fracture zone between granodioritic and metasedimentary rocks. The drip rates and temperature in the cave are closely linked with the regional climate, especially the precipitation and westerly wind intensities. Our record includes three predominately drip-rate dependent proxies which, however, reacted independently: 1) δ^{18}O and δ^{13}C values that are highly correlated (r^2= 0.81) due to a kinetically controlled isotope fractionation, performed at 2.5 year resolution. 2) The contents of insoluble trace elements (e.g. Y and heavy Rare Earth Elements), performed at 40 year resolution, are associated with fine-grained silicate detritus in the stalagmite, which has been flushed into the cave preferentially during intervals of high drip rates. 3) The concentrations of soluble elements (Mg, U and Sr) in calcite, controlled by increased dilution of drip water during periods of strong precipitation, leading to low Mg/Ca, U/Ca and Sr/Ca ratios. Relatively low drip rates were recorded during the Little Ice Age (∼700 to 150 years before present) and also during the presumably cold period from 3500 to 2500 years, while the highest

drip rates occurred during the Medieval Warm Period from 1200 to 900 years and at around 2000 years before present. The drip rate proxies indicate short periods of a few years with very high precipitation at solar-related periodicities of 230 to 200 years especially from 4500 to 3500 and from 2500 to 750 years before present. Wavelet analyses also reveal sun spot cyclicities (88, 22 and 11 years) in the C and O isotope data, as well as the Mg/Ca ratios. Compared to other precipitation records from the southern Andes across the westerly wind belt from 33 to 55˚S, our record indicates that the whole westerly zone was affected by strong intensity variations, rather than by a “simple” North-South shifting. On centennial to millennial time scales, intervals of weaker westerlies are linked to periods with more frequent El Niño events, suggesting a significant link between tropical and mid-latitude atmospheric circulation.