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Observations of meso-scale neutral wind interaction with auroral precipitation in the thermosphere

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We report on observations of E- and F-region neutral wind fields and their interaction with auroral precipitation at meso-scale spatial resolution from EISCAT radar measurements and Fabry-Perot Interferometer optical observations at 557.7 and 630 nm. At EISCAT-KST, this was achieved using the UHF tri-static radar and 3 Fabry-Perot interferometers located near each radar station. At EISCAT-ESR, this was achieved by using a scanning Doppler imager, which can observe thermospheric neutral line-of-sight winds and temperatures simultaneously over a wide field of view. In the case of an auroral arc, the background E-region wind field was initially perpendicular to the arc before it appeared. When the arc appeared, it caused the wind direction within ~50 km of the arc to rotate 90-degrees and flow parallel along the arc in less than 15 min. When the arc disappeared, the wind direction reverted back to the original flow direction in the same amount of time. Also, as the auroral arc propagated from the horizon toward the local zenith, the background E-region wind field became significantly weaker in the region where it had passed through, but remained unaffected in other regions. We demonstrate through modelling that these effects cannot be explained by height changes in the 557.7 nm emission layer. The most likely explanation seems to be greatly enhanced ion drag associated with the increased plasma density caused by the particle precipitation, and the localised ionospheric electric field associated with the Pedersen closure current of auroral arcs. In all cases, the F-region neutral wind appeared only slightly affected by the auroral arc.

Keywords: neutral wind, aurora, meso-scale, thermosphere, polar region, EISCAT