Ground-based imaging of winds

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High-resolution optical Doppler spectroscopy of airglow and auroral emissions has been used since the 1960's for remote sensing of winds and temperatures in Earth's thermosphere. By far the instrument most often used for this purpose is the ground-based Fabry-Perot spectrometer, although a small number of space-based systems have also been operated. Ground based Doppler spectrometers are well suited for monitoring the temporal evolution of winds in one location. But they have only limited ability to map the wind's spatial variation, for two reasons. First, most historical instruments have only been able to monitor one narrow-field look direction at a time and, second, the Doppler technique only measures the line-of-sight component of the wind vector along that one look direction. This talk will describe how both these limitations are now being overcome. Over the last 20 years Fabry-Perot instruments have gradually been developed using a combination of wide-field optics, fast imaging detectors, and a separation-scanned etalon to view almost the whole sky at once, and to resolve independent Doppler spectra from tens to hundreds of separate sub-fields across it. This allows the Doppler spectrum to be measured simultaneously at many contiguous geographic locations in the thermosphere. In the last several years we have begun deploying arrays of these instruments, such that many of the geographic locations are also viewed along several different look directions at once. This allows unambiguous determination of all three vector wind components simultaneously at each location. That is, we can now make two-dimensional geographic maps the complete thermospheric wind vector, and observe how these maps evolve over time. Examples of recent data will be shown, and plans for future expansion of the observing array will be described.