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Putting the "vap" into evaporation

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In the spirit of the EGU special session to which it contributes, this presentation documents the origin and development of the science of natural evaporation from land surfaces over the last 30-35 years, since the "*A View from the Watershed*" symposium was held to commemorate the opening of the new Institute of Hydrology (IH) building. Important subsequent technical progress includes the ability routinely to measure the diurnal cycle of near-surface meteorological variables using automatic weather stations, and of surface energy and momentum exchanges using automated implementations of the Bowen Ratio/Energy Budget technique and the Eddy Correlation technique, along with the capability to estimate the "fetch" for which these measurements apply. These improvements have also been complemented by new methods to measure the separate components of evaporation, including: the interception process using randomly relocated below-canopy gauges; transpiration fluxes from individual leaves/shoots using porometers and from plants/plant components using stem-flow gauges; and soil evaporation using micro-lysimeters and soil moisture depletion methods. In recent years progress has been made in making theory-based area-average estimates of evaporation using scitillometers, and model-based area-average estimates by assimilating many streams of relevant data into Land Data Assimilation Systems. Theoretic progress has been made in extending near-surface turbulence theory to accommodate the effect of the "excess" boundary layer resistance to leaf-to-air transfer of energy and mass fluxes relative to that for momentum, and to allow for observed shortcoming in stability factors in the transition layer immediately above vegetation. Controversy regarding the relative merits of multi-layer model and "big leaf" representations of whole-canopy exchanges has been resolved, with the latter approach now preferred. Important gaps in the theory of canopy-atmosphere interactions have been filled, including recognizing the need to separately represent dry-canopy and wet-canopy evaporation in models; the capability to describe wet-to-dry canopy transitions; and the ability to describe sparse vegetation canopies which only partly cover the underlying soil. There is progress in methods used to estimate crop water requirements, but an important recommendation of this paper is that this progress should continue by introducing use of an effective stomatal resistance rather than crop factors. The paper draws attention to relevant theoretical insight on this issue. Progress in theoretical understanding of evaporation processes has been used in the creation of numerous Land Surface Parameterizations (LSPs), the models used to represent land-surface interaction in climate and weather forecast models, and there have been important steps forward in describing the behaviour of plant stomata in LSPs. A major investment over the last 25 years in Large-Scale Field Experiments conducted to better measure, understand, and model coupled land-surface/atmosphere interactions has resulted in improvements in the capabilities of global climate models and the ability of mesoscale meteorological models to describe the enhanced circulation resulting from different forms of land-surface heterogeneity. Progress in understanding why early equations for potential evapotranspiration can be adequate in certain conditions is reviewed. The paper concludes with recommendations for future research.