Actual Evaporation Data System for COSMOS-UK

COSMOS-UK
UK Soil Moisture Monitoring Network

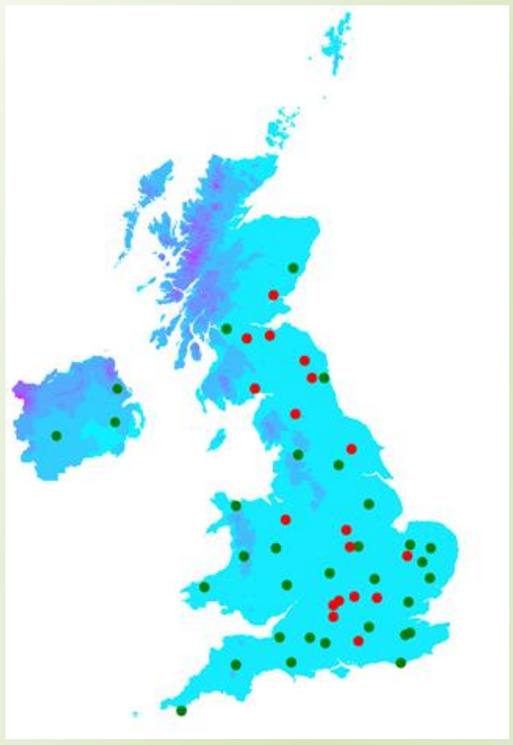
David Crowhurst, Ross Morrison, Jonathan Evans, Hollie Cooper, Alex Cumming, Matthew Fry, David Boorman

Centre for Ecology and Hydrology (CEH), Wallingford, United Kingdom.

Contact:
david.crowhurst
@keble.ox.ac.uk

COSMOS-UK Environmental Monitoring Network

The COSMOS (Cosmic Ray Soil Moisture Observing System) UK project has established, and continues to grow, a long term network of hydrological monitoring sites across the UK. Data from the network have the potential to transform our understanding of the natural environment.



Actual Evaporation (AET)

Actual evaporation (AET) is the amount of water vapour which transfers from the land surface into the atmosphere in response to atmospheric demand for moisture. AET couples the energy and water balances, and is driven by weather conditions, soil water and plant transpiration.

Importance:

- AET is the predominant variable needed for water management in agricultural food production. AET determines the amount of irrigation required so that applied water approximates water lost.
- AET plays a critical role in driving weather and climate patterns on local scales, affecting turbulence, cloud formation, convection and ultimately precipitation.

COSMOS-UK has recently developed an automatic AET data system, which currently ingests radiation, soil heat flux and sensible heat flux from 32/50 sites through telemetry. The system derives AET in near real time at a 30 minute resolution as a residual of the energy balance:

$$AET\ (up) = R_n\ (down) + G\ (down) - H\ (up)$$

Net Radiation (R_n)

Net radiation is calculated using measurements from a four component radiometer, which consists of an upward and downward facing pyranometer (shortwave), and an upward and downward facing pyrgeometer (longwave).

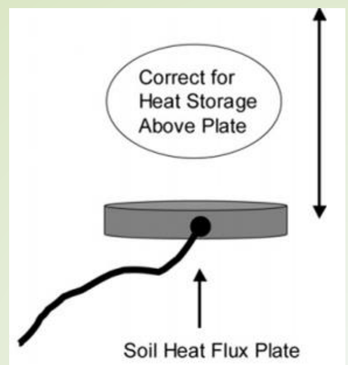
$$R_n = (LW_{down} + SW_{down}) - (LW_{up} + SW_{up})$$

Hukseflux four component radiometer

Soil Heat Flux (G)

Soil heat flux is calculated as the sum of a soil heat flux plate measurement at 0.03 metres, plus a correction to account for the change in energy storage in the layer above.

This correction depends on the change in measured soil temperature between timesteps, and the moist soil heat capacity (derived from SoilGrids estimates of site soil properties, and TDT volumetric water content measurements).



Hukseflux HFP01 soil heat flux plate

Sensible Heat Flux (H)

Sensible heat flux is derived from sonic anemometer measurements as follows:

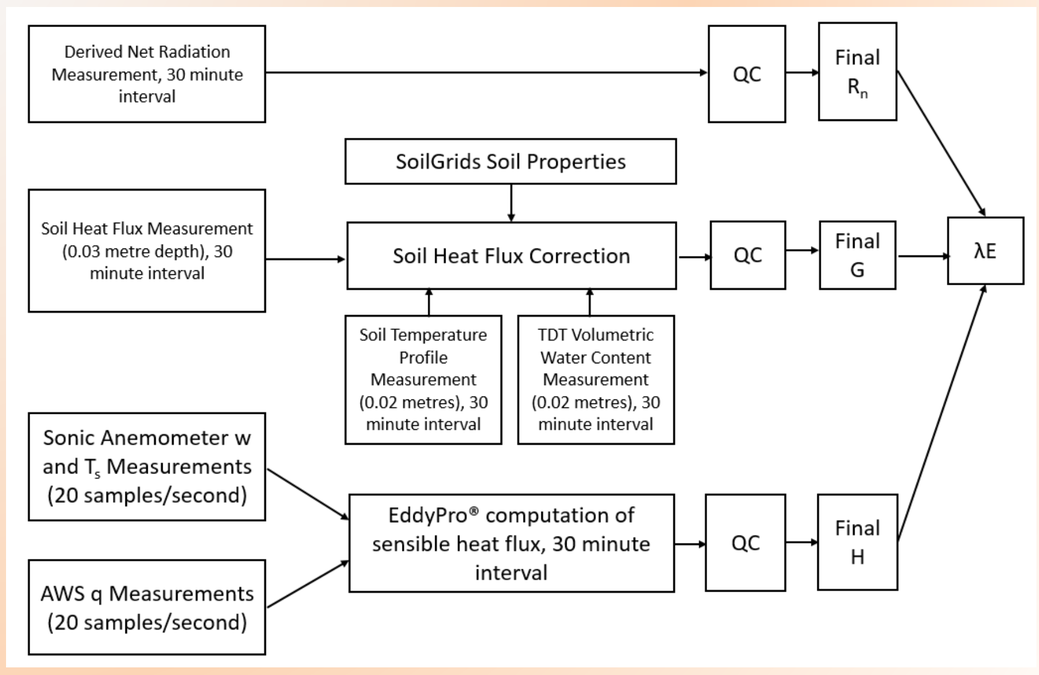
$$H = \rho\ C_p\ \overline{w'T'}$$

where $\overline{w'T'}$ is the covariance between turbulent fluxes of vertical wind speed and air temperature over a 30 minute interval.

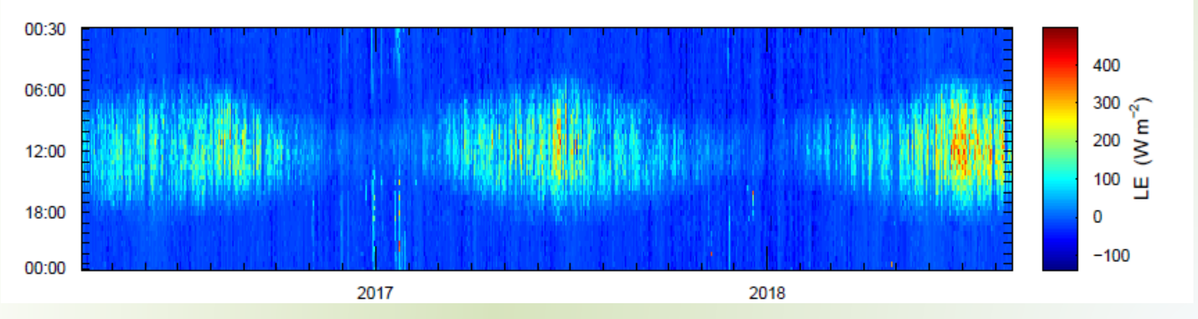
Raw wind and sonic temperature measurements are processed into sensible heat flux using EddyPro® software, in order to apply several corrections which improve the accuracy of the final flux.

Gill WindMaster 3D Sonic Anemometer

AET (λE) Data System



AET Data (Euston site)



Output and Impact

Historical evaporation data from 2014-2019, and data produced through the live system, will be submitted to the Environmental Information Data Centre (EIDC). The dataset will be the first in situ (derived) AET dataset from a UK environmental monitoring network. We anticipate a wide range of applications, including from the agricultural and biodiversity sectors, and weather and climate research.

Acknowledgement:
COSMOS-UK is funded by NERC through UK-SCAPE. We gratefully acknowledge the financial support from Hydro-JULES which enabled David Crowhurst to work on this project at CEH Wallingford in Summer 2019.

Hydro-JULES UK-SCAPE NERC SCIENCE OF THE ENVIRONMENT

http://cosmos.ceh.ac.uk