SCINTILLOMETER APPLICATIONS FOR MEASUREMENT OF EVAPOTRANSPIRATION

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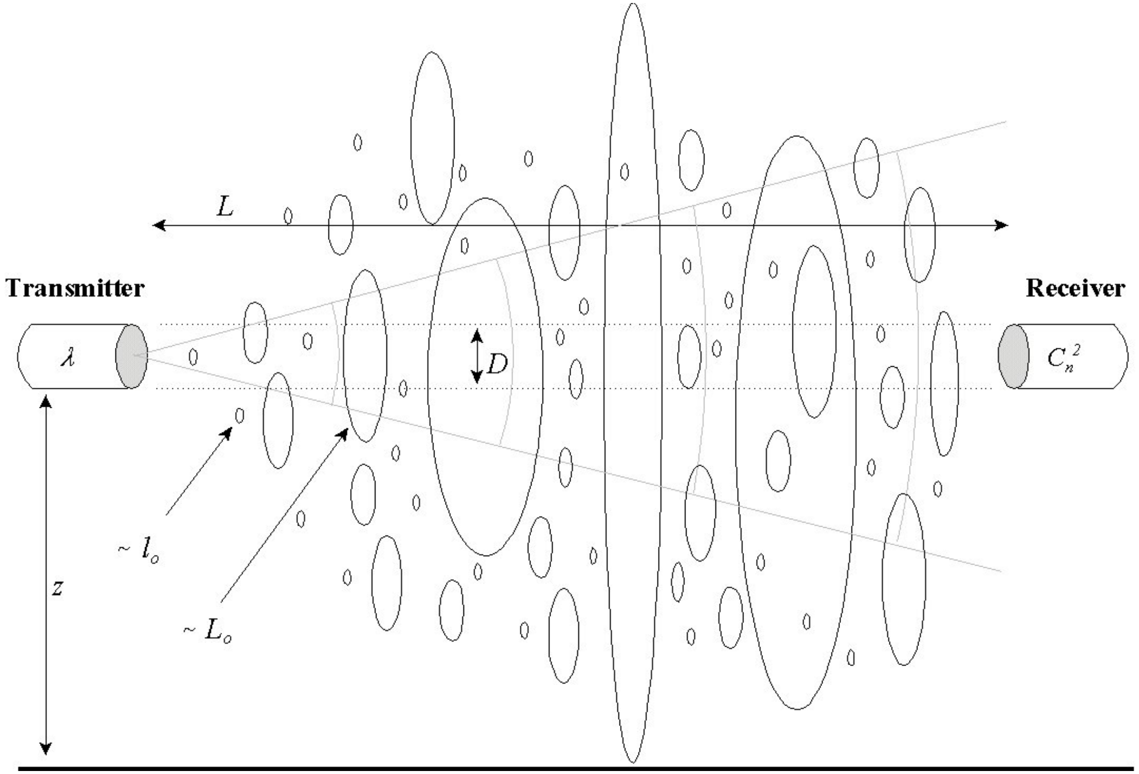
Scintillations

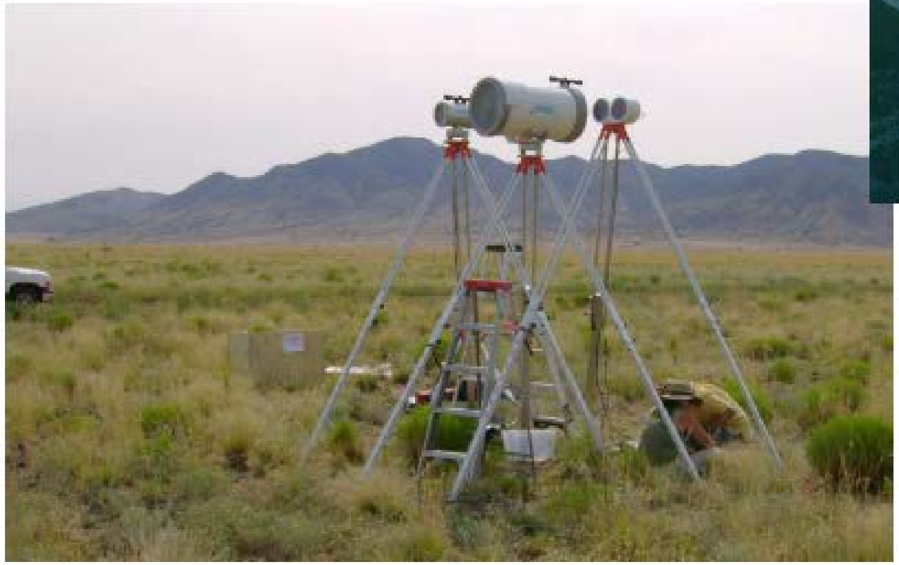
A large aperture scintillometer (LAS) is an instrument that consists of a transmitter and a receiver. The receiver measures intensity, *I*, fluctuations in the radiation emitted by the transmitter caused by refractive scattering by turbulent eddies in the LAS path. For LAS, the observed intensity fluctuations are a measure of the structure parameter of the refractive index, C_n^2 .



$$C_n^2 = 1.12\sigma_{\ln I}^2 D^{7/3} L^{-3}$$

Optical part: Large Aperture Scintillometer (LAS)

Kipp and Zonen
Delft, the Netherlands

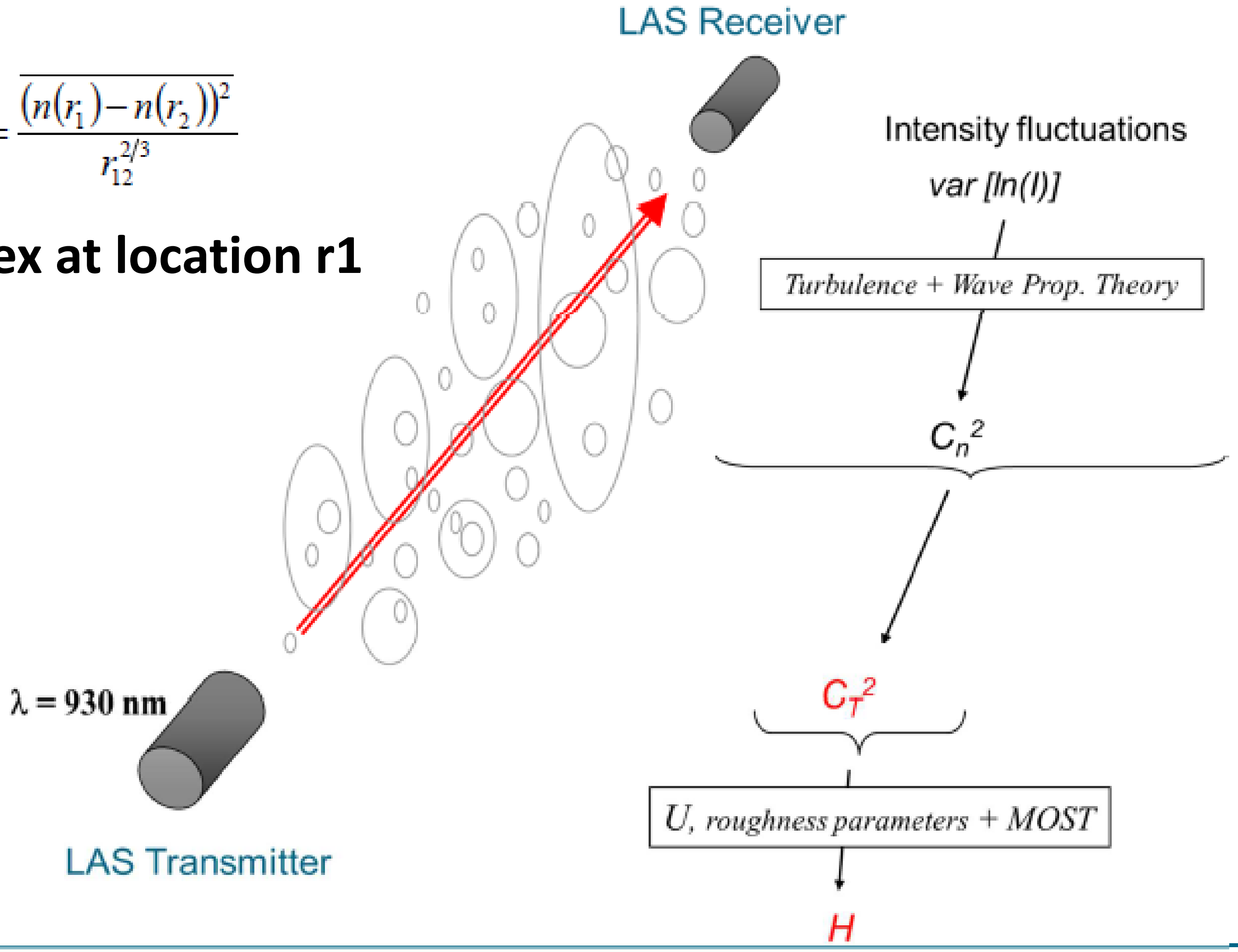


Scintec AG,
Rottenburg, Germany

Optical part: Large Aperture Scintillometer (LAS)

$$C_n^2 = \frac{\overline{(n(r_1) - n(r_2))^2}}{r_{12}^{2/3}}$$

n_{r1} = refractive index at location r1



H = sensible heat flux but we really want LvE = latent heat flux

II C_n^2 to $C_T^2 + C_q^2$

$$C_{n\_\lambda}^2 = \underbrace{\frac{A_{T\_\lambda}^2}{\overline{T}^2} C_T^2}_{A} + \underbrace{\frac{2A_{T\_\lambda}A_{q\_\lambda}}{\overline{T}\,\overline{q}} C_{Tq}}_{B} + \underbrace{\frac{A_{q\_\lambda}^2}{\overline{q}^2} C_q^2}_{C}$$

One Equation, Three (!) unknowns: C_T^2, C_q^2 and C_{Tq}

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λ optical → *A* dominant, *B* & *C* can be ignored/parameterized

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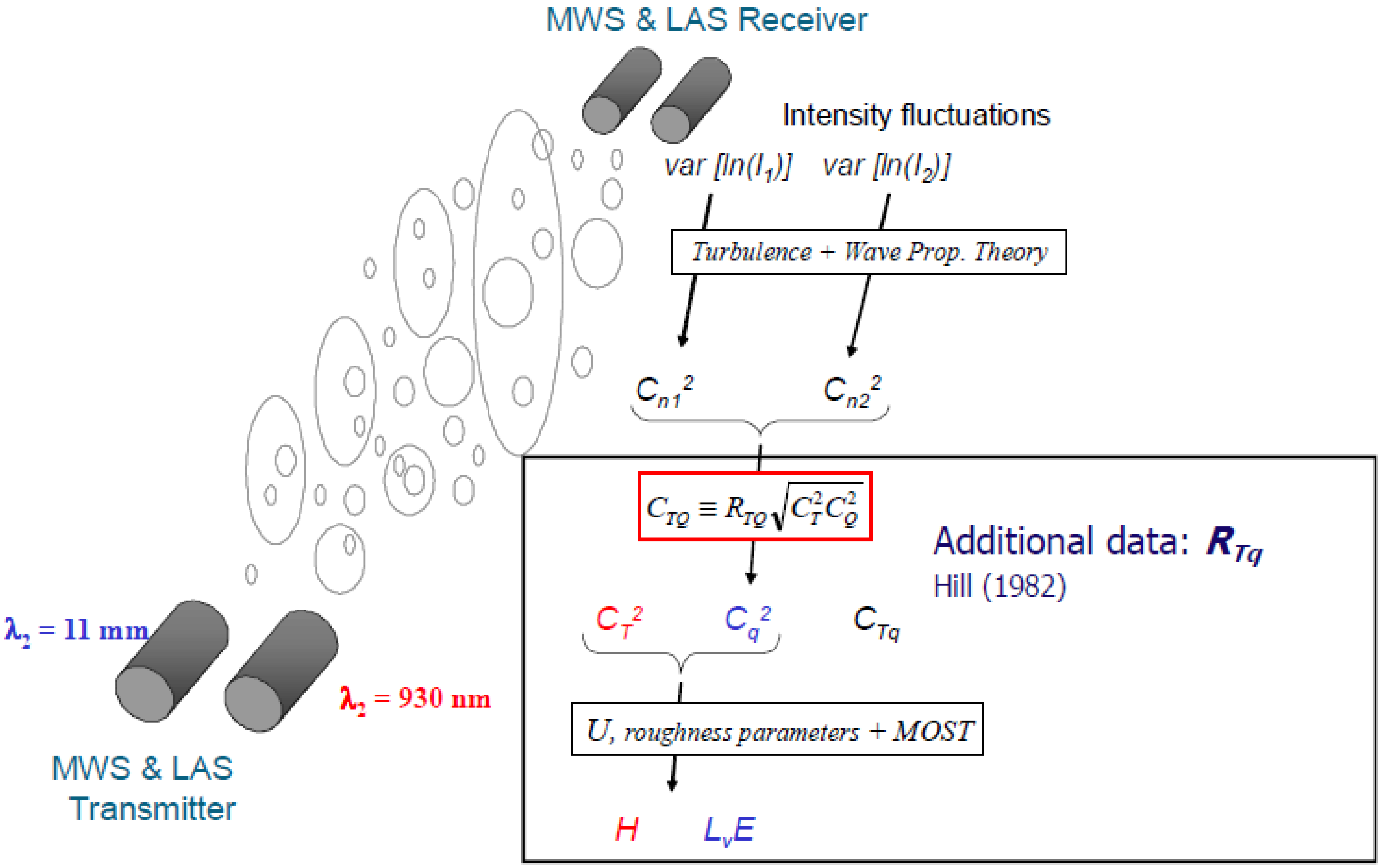
1. $C_n^2{}_{opt}$ + $C_n^2{}_{mm}$ + Third equation: $C_{TQ} = R_{TQ}\sqrt{C_T^2 C_Q^2}$

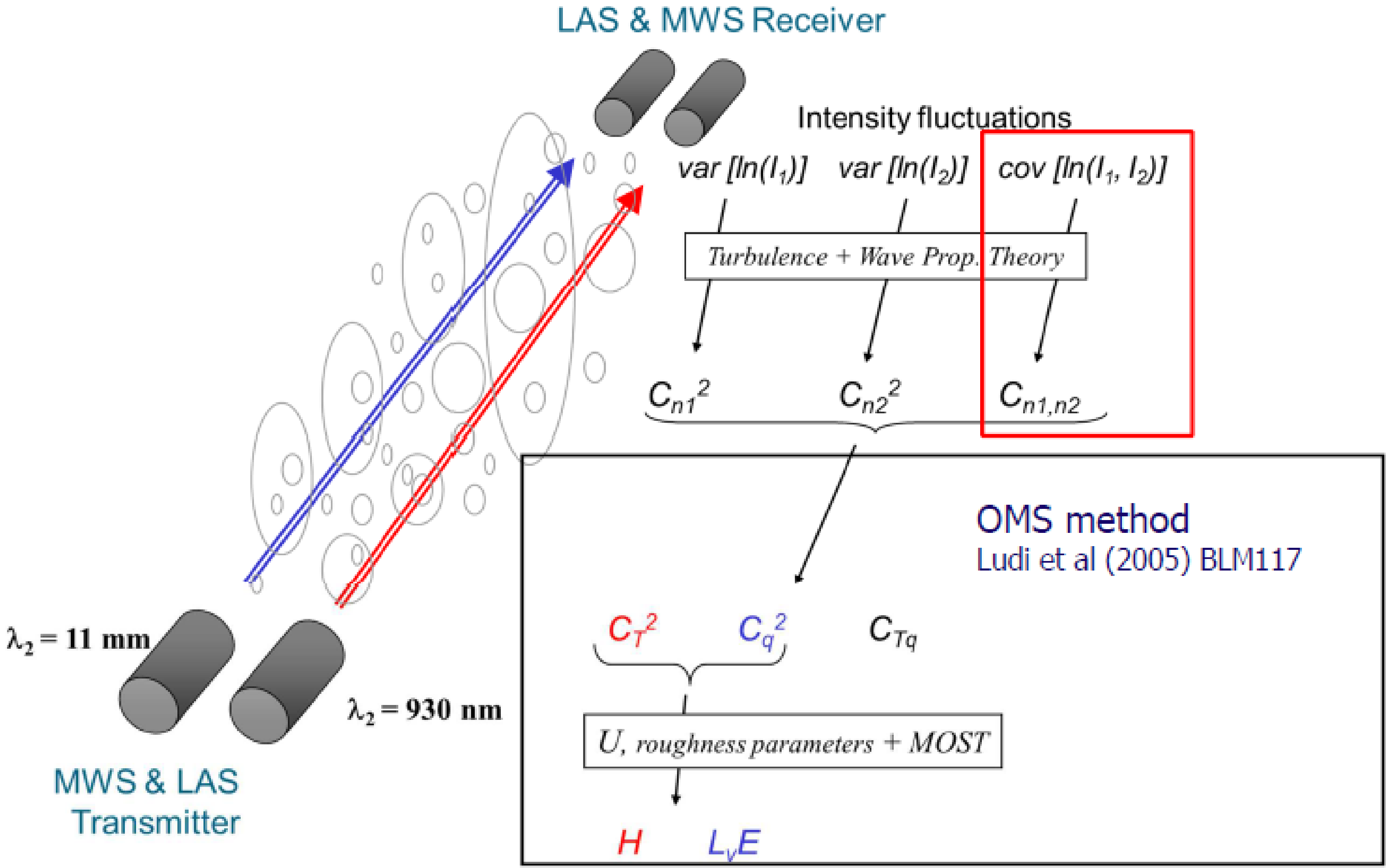
   → $R_{TQ} = \pm 1$ Often, but not always ok

2. $C_n^2{}_{\_opt}$ + $C_n^2{}_{\_mm}$ + $C_{n\_opt\text{-}n\_mm}$

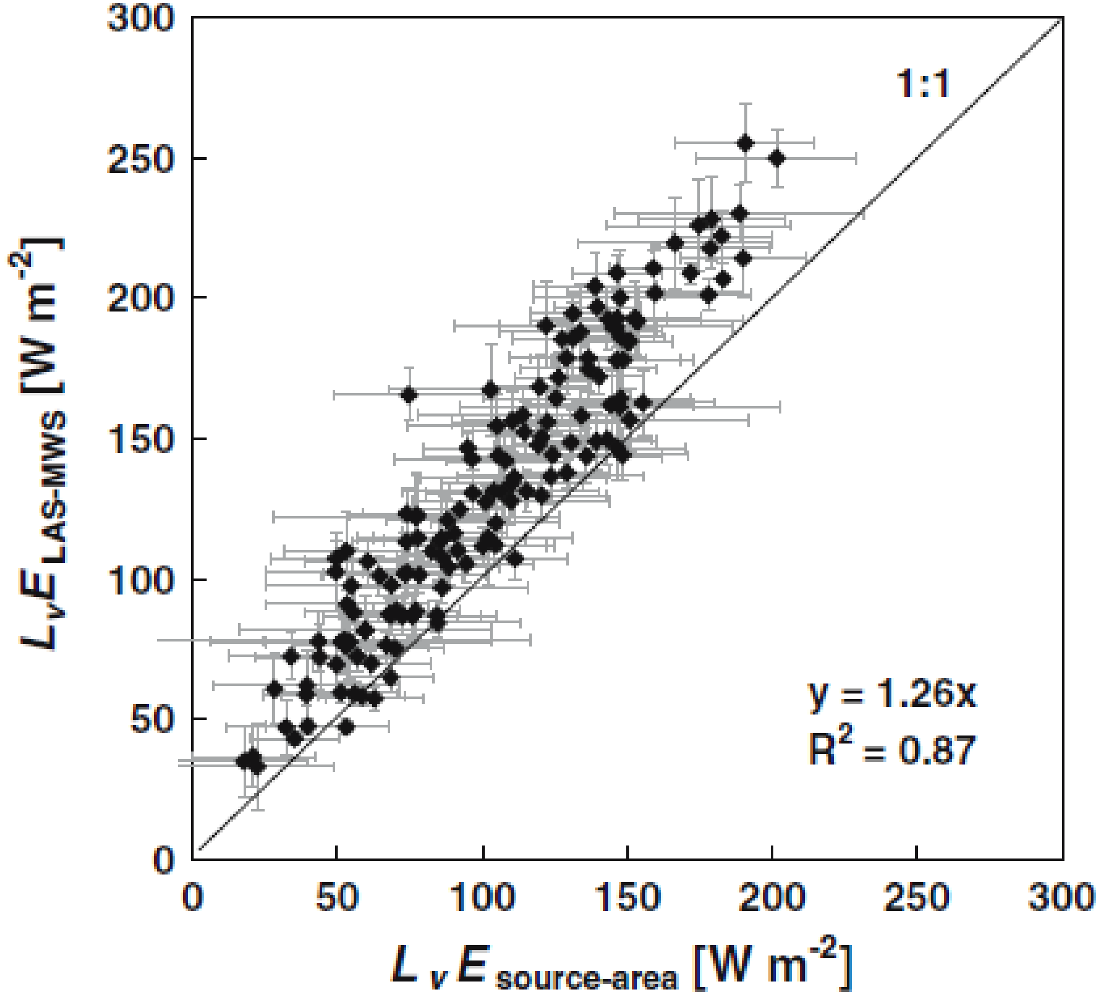
OMS system – Third Equation – R_{Tq}



OMS System Description



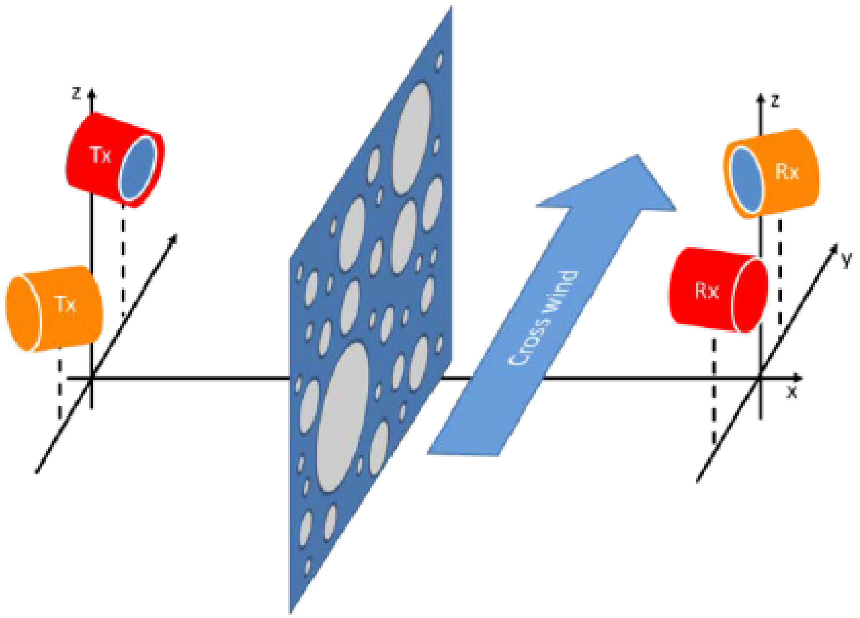
km spatial scale



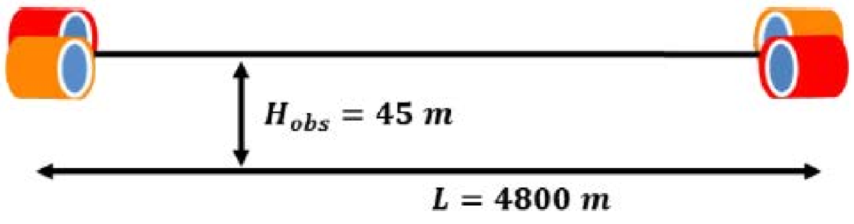
Meijninger et al. 2005

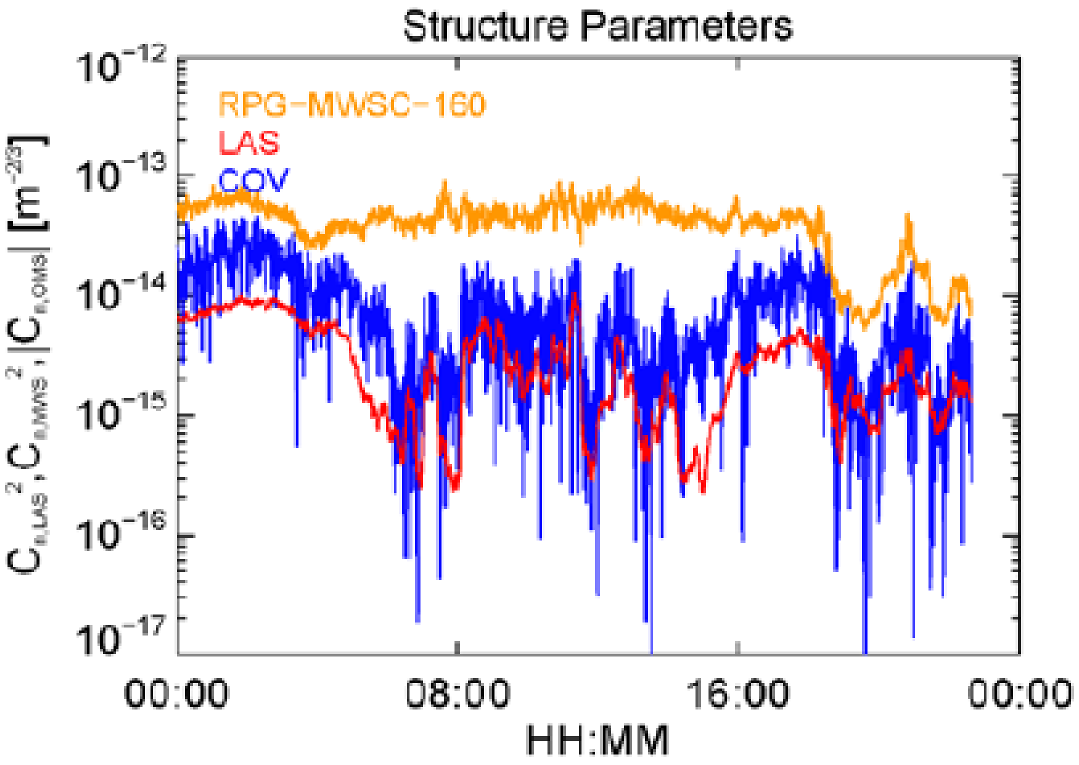
L = 4700 m, Heigth = 43 m

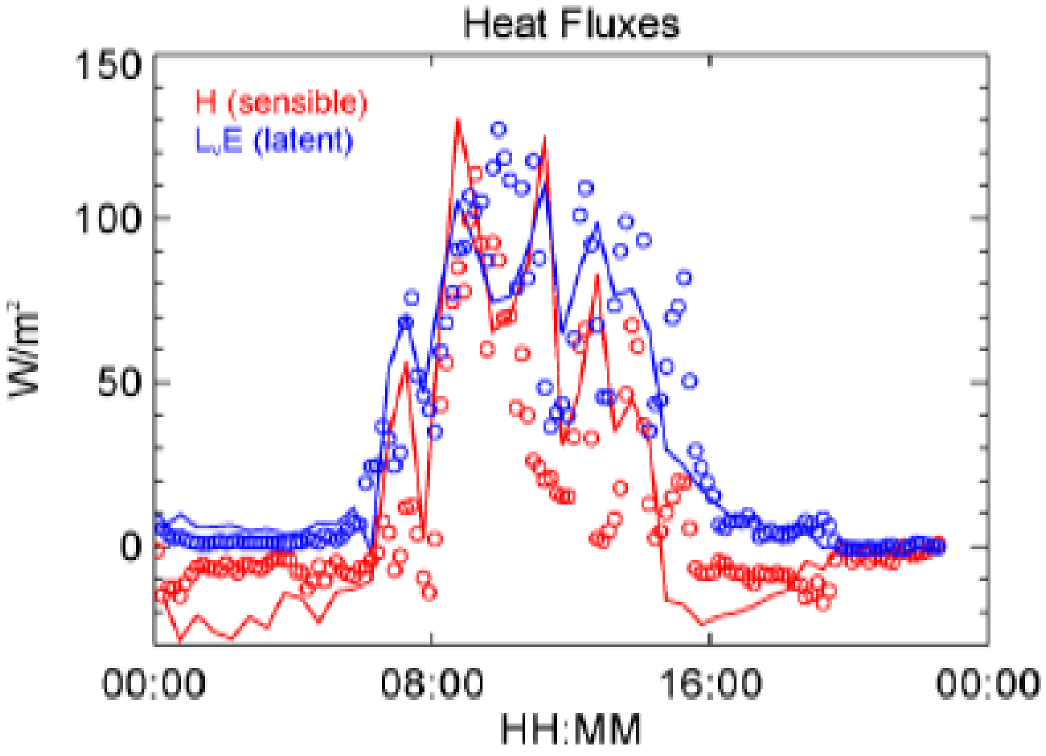
Lindenberg, Germany RPG-MWSC-160 was tested in mid-latitude continental climate. It was operated in combination with two LAS systems (Wageningen University and Scintec BLS900) over a long signal path between two measurement towers with an observation height of approximately 45 m. The setup is characterized by inhomogeneous landscape with patches of woodland, lakes and crops. The combined scintillometer measurements provide heat fluxes with a Bowen ratio around 1. Measurements are in good agreement with Eddy-Covariance (EC) station data.



Setup of combined *MWS* and *LAS* system with crossing signal beams. The turbulence field is shifted through the beams by the mean wind across the measurement path.







Radiometer Physics
A Rohde & Schwarz Company

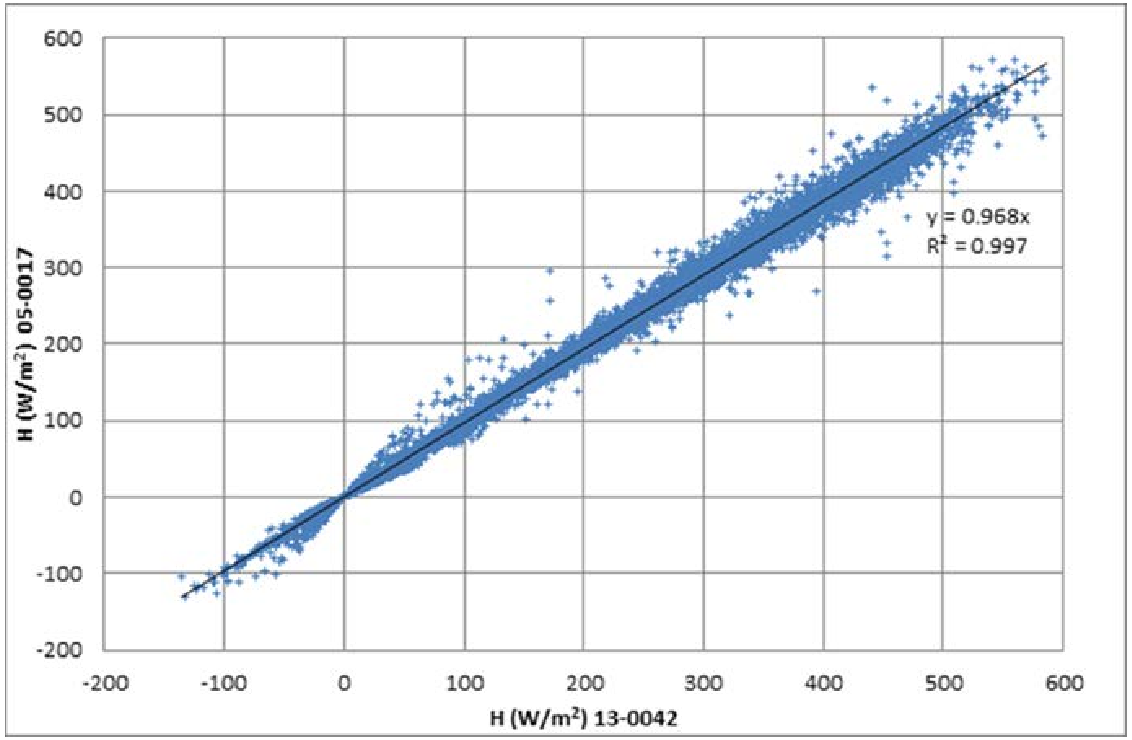
Microwave Scintillometer
RPG-MWSC-160

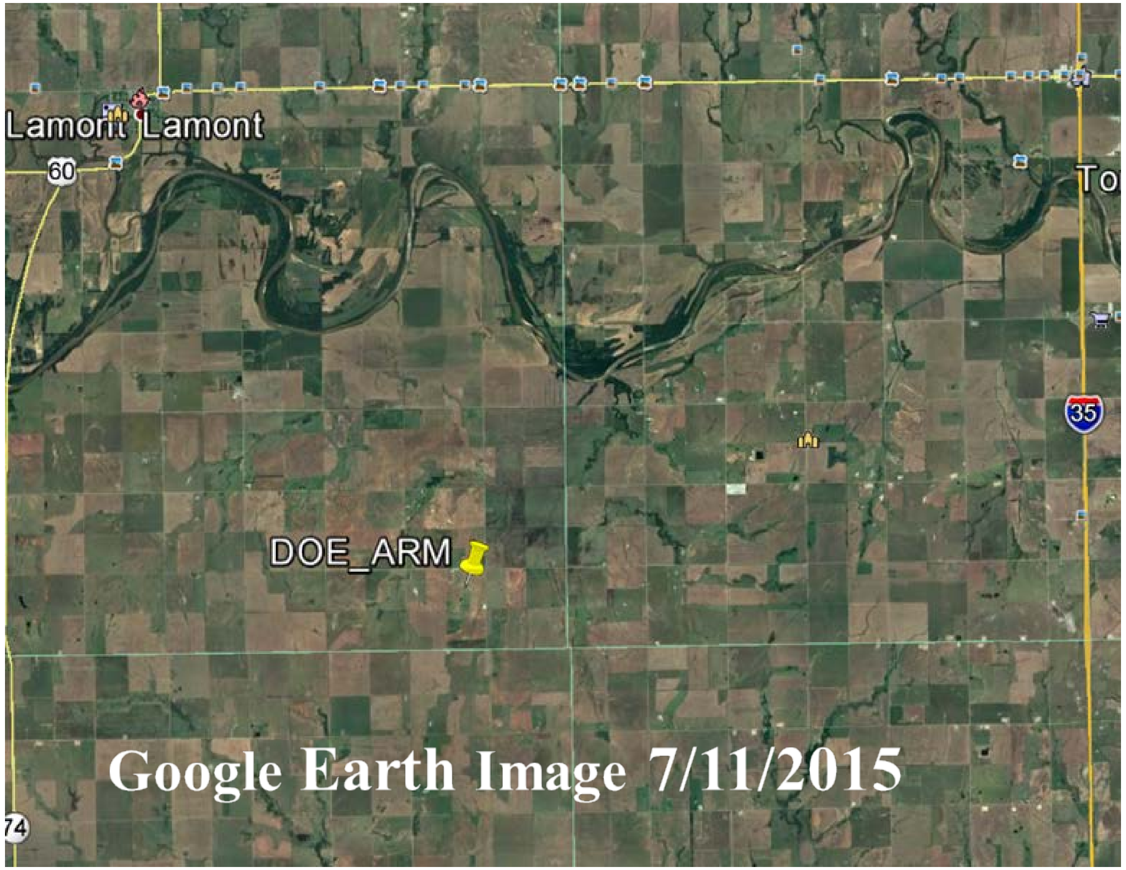
The Optical Microwave Scintillometer provides hydrology with another tool to measure the latent heat flux directly

BUT the OMS costs about $132,000; about 100K for the microwave scintillometer and 32K for the optical scintillometer

Solution: use an optical scintillometer to measure the sensible heat flux H and find the latent heat flux L_vE from the energy balance: $L_vE = R_n - G - H$

There are two types of optical scintillometers: the first generation analog MkI optical scintillometer and the second generation digital MkII optical scintillometer. The first generation analog MkI needs to be calibrated before use; the second generation digital MkII needs no calibration.

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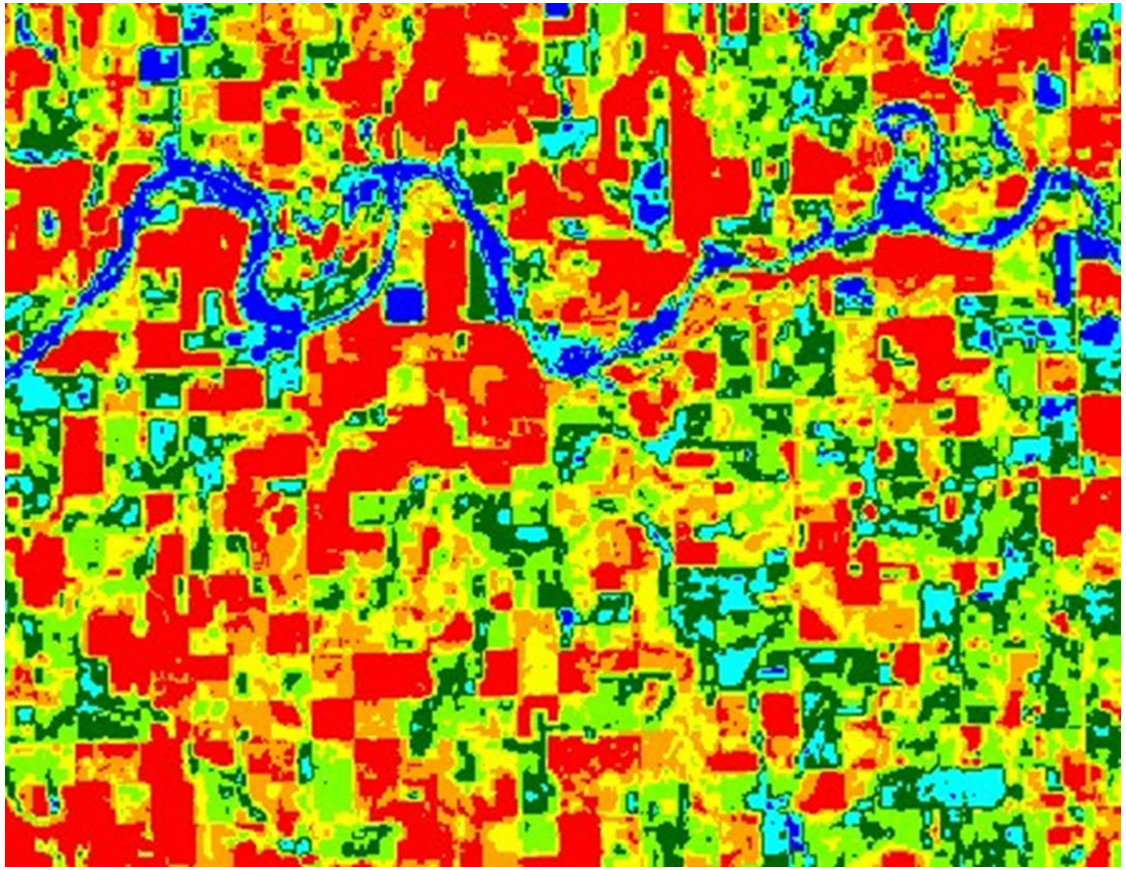
DOE_ARM
Google Earth Image 7/11/2015


Landsat 8 Image 6/25/2015



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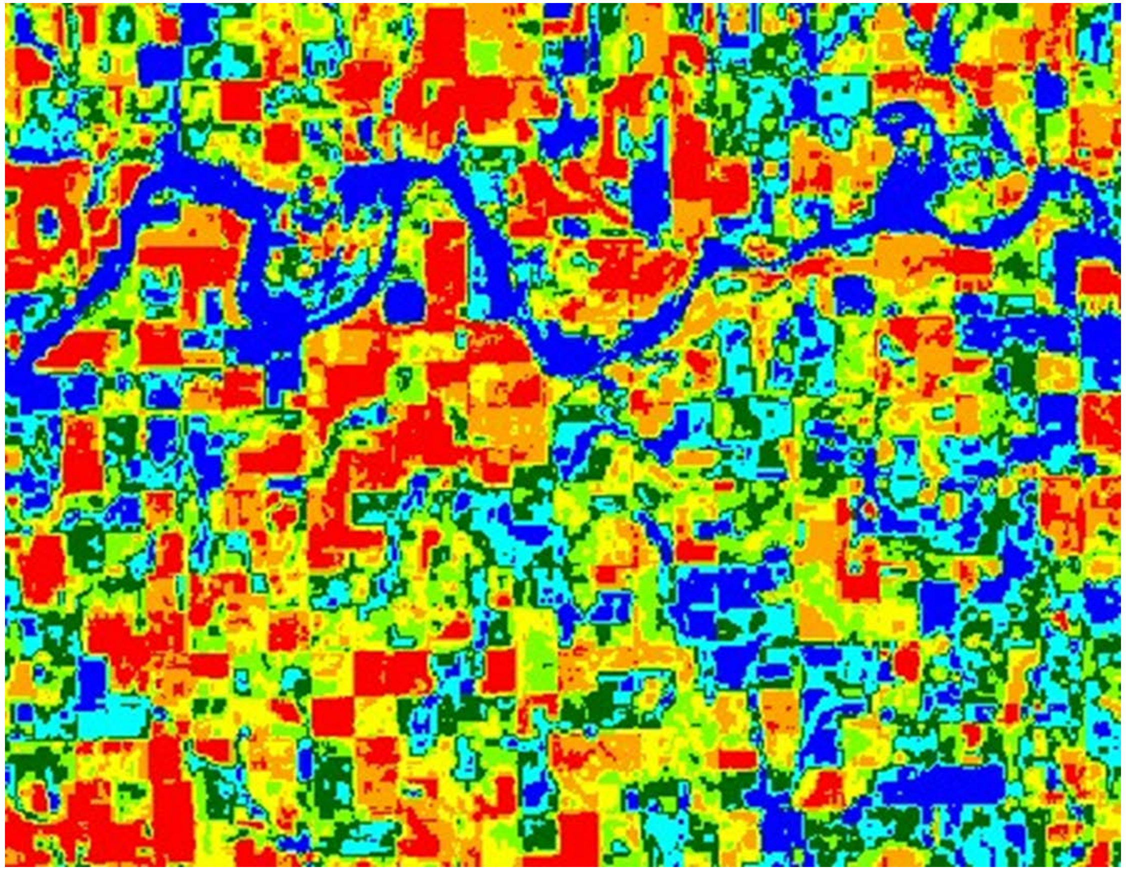

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Thank You