EVAPOTRANSPIRATION ESTIMATION THROUGH SATELLITE REMOTE SENSING

Implications for *AquaCrop*

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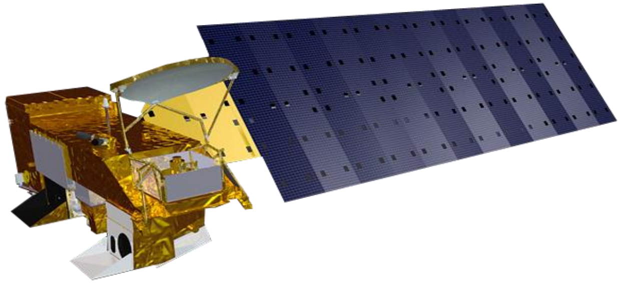
ITALIAN AGENCY FOR DEVELOPMENT COOPERATION

PREAMBLE

Quantifying **Evapotranspiration** (ET) in space and time is fundamental for several purposes, including **water accounting** of various land systems, determination of **crop water productivity**, **yield prediction** through models, assessment of **agricultural drought**, **sustainable management** of water resources

Field methods to measure ET have been developed over time, but scaling them up to larger areas is prohibitive

For large area coverage, the only feasible and affordable methods for ET determination are through **Satellite Remote Sensing** (SRS)



CATEGORIES OF SRS METHODS FOR ET DETERMINATION

Based on core algorithm

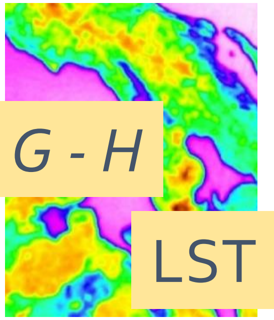
- Surface Energy Balance
- Penman-Monteith
- Psychrometry
- Priestley-Taylor

If one-sources or two-source

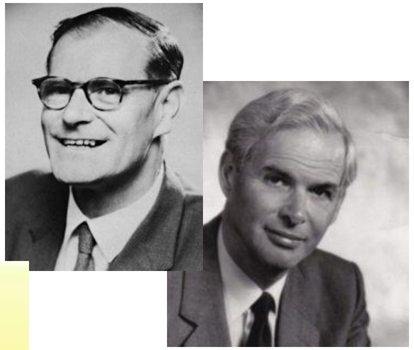
Based on spatial resolution and coverage

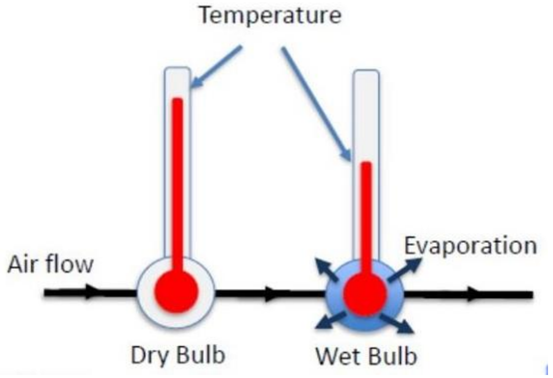
(e.g., coarse or fine resolution, with global or local coverage)

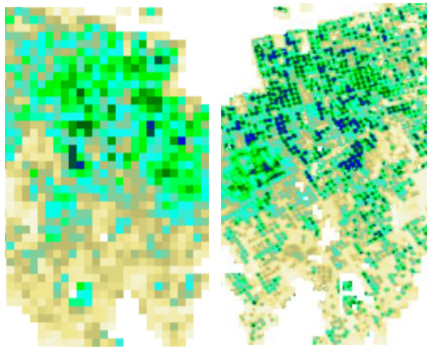
$$\lambda E = Rn – G - H$$

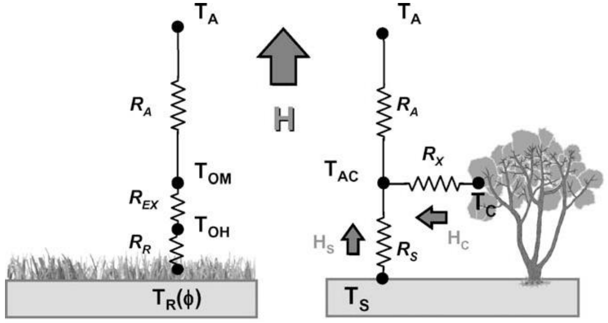


$$ET = \alpha \frac{\Delta}{\Delta + \gamma}(R_n - G)$$









However, the various RS ET models may fall in more than one category

SOME SRS ET MODELS

SEBAL (Surface Energy Balance Algorithm for Land) by Wim Bastiaanssen

METRIC (Mapping ET at high Resolution with Internalized Calibration) by Rick Allen

ALEXI/DisALEXI (Atmosphere-Land Exchange Inverse) by Martha Anderson

SSEBop (Simplified Surface Energy Balance – Operational) by Gabriel Senay

ETLook by Wim Bastiaanssen, Henk Pelgrum and Annemarie Klaasse

ETMonitor by Li Jia

ETWatch by Bingfang Wu

PT-JPL (Priestley-Taylor from Jet Propulsion Lab) by Joshua Fisher

SOME ET DATABASES/PORTALS FREELY ACCESSIBLE

FEWSN (USGS Famine Early Warning Systems Network, with ET from SSEBop)

WaPOR (The FAO Water Productivity Open-access portal, with ET from ETLook)

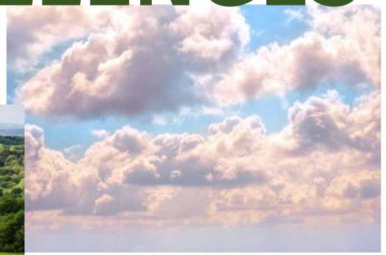
GloDET (Global Daily ET; with ET from ALEXI/DisALEXI)

EEFlux (Earth Engine ET Flux; with ET data from METRIC)

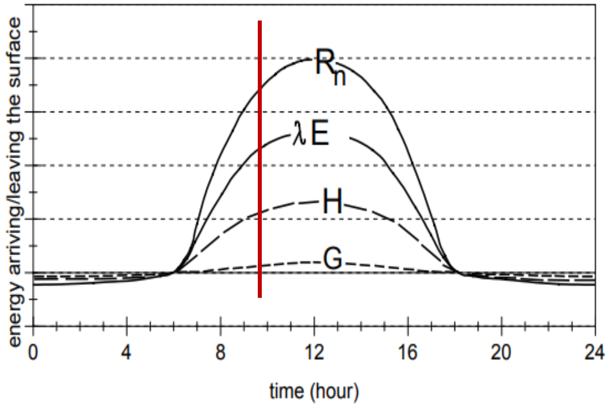
OpenET (with ET data from an ensemble of models, currently including SEBAL, METRIC, SSEBop, ALEXI-DisALEXI, PT-JPL and SIMS)

They differ for: spatial and temporal resolution; time series; geographical coverage; latency; …other

SRS DETERMINATION OF ET IS NOT WITHOUT CHALLENGES



- spatial differences in cloud, aerosols, dust, and smoke contamination (▶ Rn)
- non-uniform underlying land surface (▶ roughness & LST)
- atmospheric stability (▶ r_{ah})
- insufficient spatial representation of some meteorological variables (e.g., wind, e_a ▶ r_a, r_c)
- time integration of ET over the day hours, and interpolation of daily ET values over the period in between two satellite overpass
- lateral flow/advection/oasis effect (flux footprint)
- operator understanding & skills
- calibration of the various model parameters
- processing for 'data sharpening', 'data fusion', 'cloud masking'



Quite intertwined sources of errors involved in the input variables

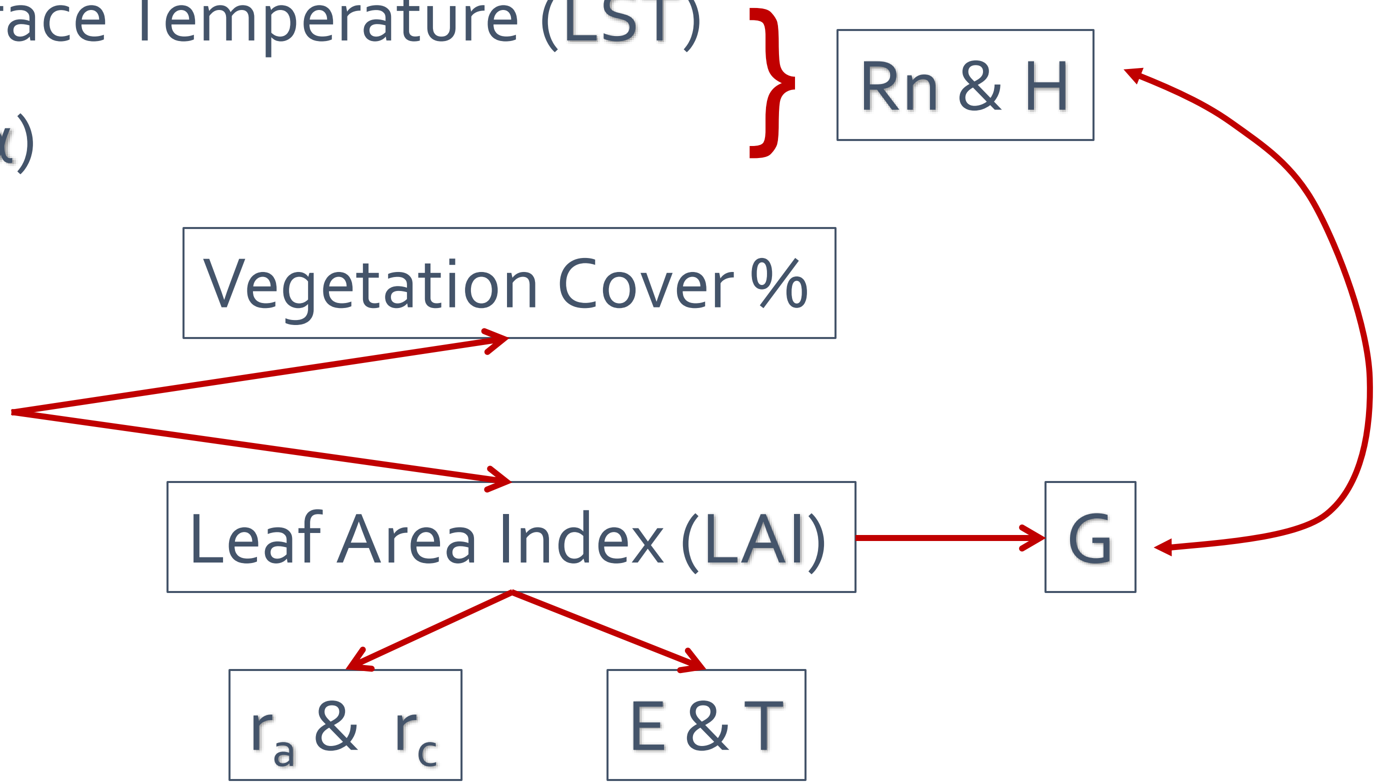
WHAT IMPLICATIONS FOR *AQUACROP*?

SRS algorithms for ET determination retrieve several types of wave-length data within the electromagnetic spectrum. Here are four key wave-lengths:

Thermal Infrared >>> Land Surface Temperature (LST)

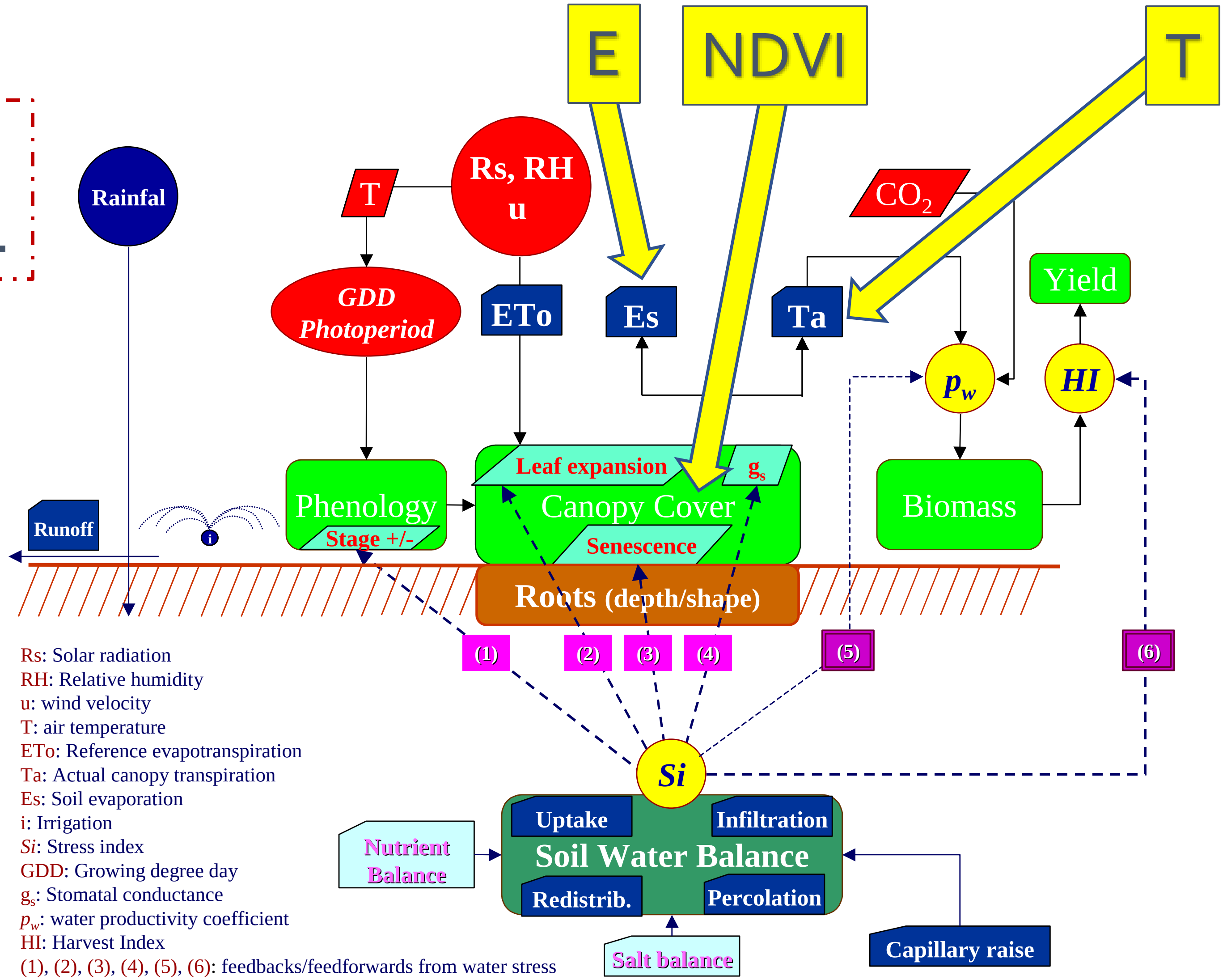
Solar >>> Albedo (α)

Near Infrared & Red >>> NDVI



Gridded data

T_a, Rain, ETo, etc.



IMPLICATION # 1

NDVI

Direct determination of canopy cover % (CC%)

This can be used for 'data assimilation' & 'reanalysis'

SRS can provide *AquaCrop* with the field data of CC%

AquaCrop simulations of CC% can be adjusted periodically to improve predictions (CC% calibration on the go)

IMPLICATION # 2

T

Using the well calibrated "normalized biomass WP", SRS can provide not only large-scale maps of actual ET, but also of actual biomass production & WP

CONCLUDING REMARKS

There has been an accelerated growing demand for *AquaCrop* to be up-scaled from individual plots and field to larger land surfaces

This demand has been in part addressed by the Plug-in and the GIS versions of *AquaCrop*

Nevertheless, the missing window for a "quantum leap" in extended up-scaling of *AquaCrop* is the one offered by SRS

Linking *AquaCrop* to SRS is the way forward

THANK YOU