Towards an Initiative in Evapotranspiration

GTN-H Meeting
Tokyo, Japan
March 11, 2011

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David Toll (NASA)

Roles that ET plays in the climate system:

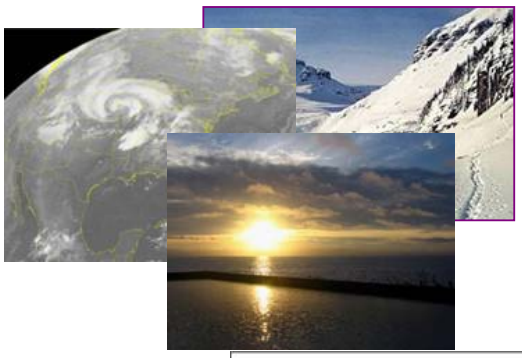
1) ET is a central element in the surface energy partitioning and consequently its role in atmospheric warming and weather behavior,
2) ET has a primary influence on and is an indicator of water storage and availability in hydrologic and water resources systems,
3) ET is a primary indicator of vegetation stresses and health under changing climate.

ECV Standard Reports

ECV Web Portal

http://www.fao.org/gtos/topcECV.html

- Web pages created for each terrestrial ECV
- Contains background, report, references and all other materials gathered.
- Allows greater stakeholder participation and review of documentation.



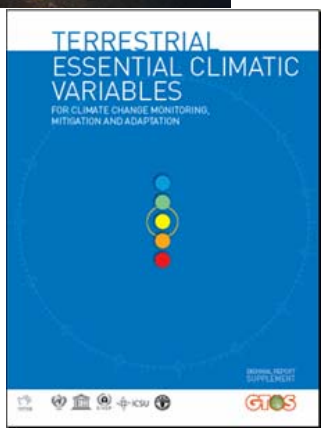
Review of ECVs also in GTOS Biennial report supplement:

- River discharge
- Water use
- Ground water
- Glaciers
- Permafrost

Missing: ET

- Albedo
- Land cover
- Lake levels
- Snow cover

- fAPAR
- LAI
- Biomass
- Fire disturbance



(from Paul Bulock)

Statistically Significant Drought Index Correlations by Category

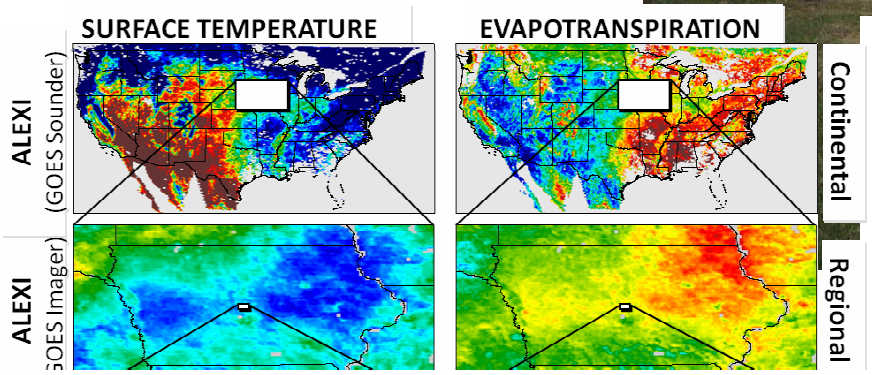
	AC Barrie	Superb
Water Supply Indices	0	3
Water Demand Indices	19	24
Water Balance Indices	14	18
Water Use Indices	7	7

Evapotranspiration provides a more accurate estimate of wheat yield and quality than precipitation and should be utilized for assessment of agricultural drought.

Observational ET Challenges:

In-situ measurements:

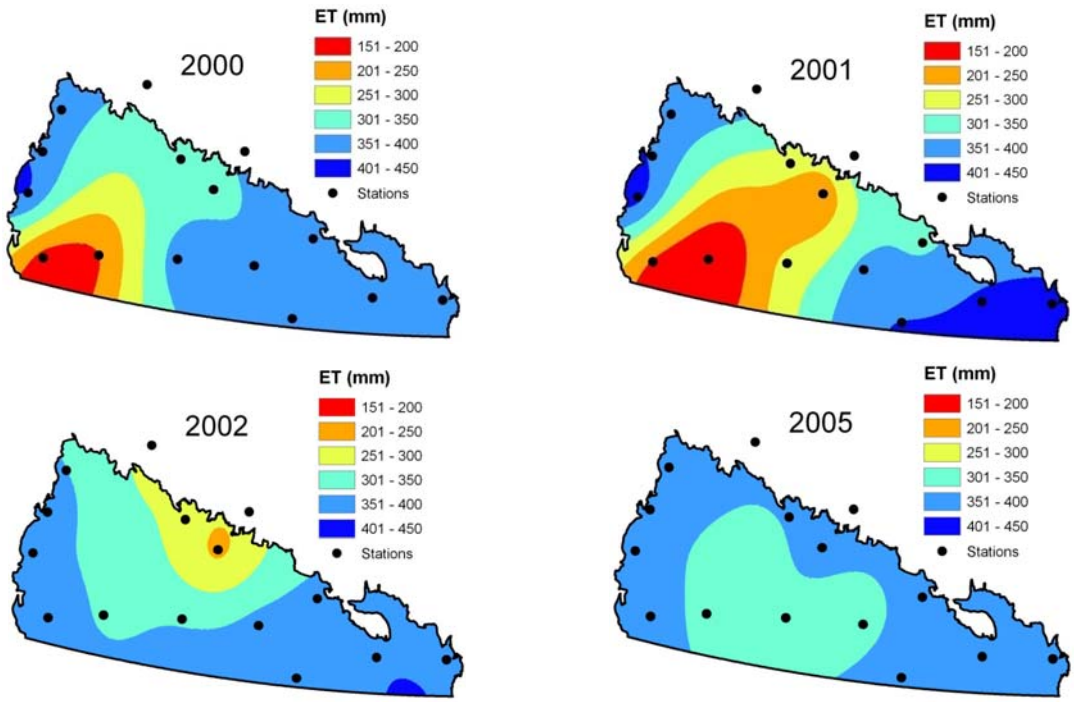
Closure of the water balance at Flux towers is a significant problem. In-situ FLUXNET measurements are not uniformly distributed around the Globe.



Remote Sensing:

-High resolution data are needed to develop information for many of the agricultural applications.
-Thermal IR sensor data are needed on an on-going basis.

Growing Season ET (after Armstrong)

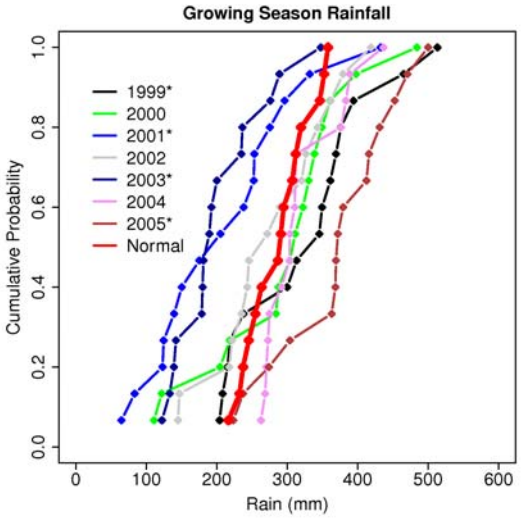


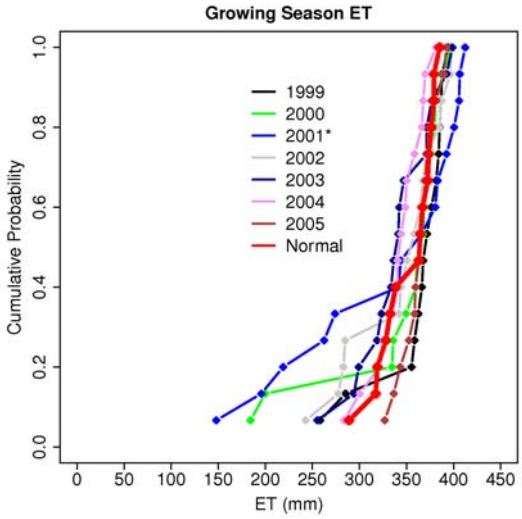
- Interpolation based on 15 stations shows general trends in ET but lacks information relative to the variability for the normal period

Spatial Variation of Rainfall and ET among Stations (after Armstrong)

(15 stations considered)

Rainfall more variable and dynamic from year to year than ET
Drought vs wet year: variability of ET increases, median >> mean





* Significant difference from Normal at 0.05 level (95%)

Water Productivity Mapping (WPM) using Remote Sensing

Increase Water Productivity of Existing Croplands

$$WP = \frac{\text{Crop Productivity}}{\text{Water use}}$$

WP is crop water productivity (kg/m3)/($/m3)
Crop Productivity in units of Biomass (kg/m2) or Yield (tonn/ha) or Value ($/ha)
Water use is seasonal actual ET (thousand m3/ha)

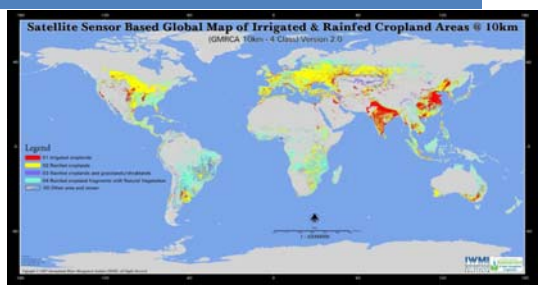
Crop Productivity = f (NDVI)

NDVI – Normalized Difference Vegetation Index (-), from satellite images:

NDVI = (NIR – Red) / (NIR + Red)

NIR and **Red** are reflectance in near-infrared and red bands

The best bet scenario is to continue to produce more (increase water productivity) food from existing croplands and water



NASA IT Infrastructure for Irrigation Monitoring / Forecasting

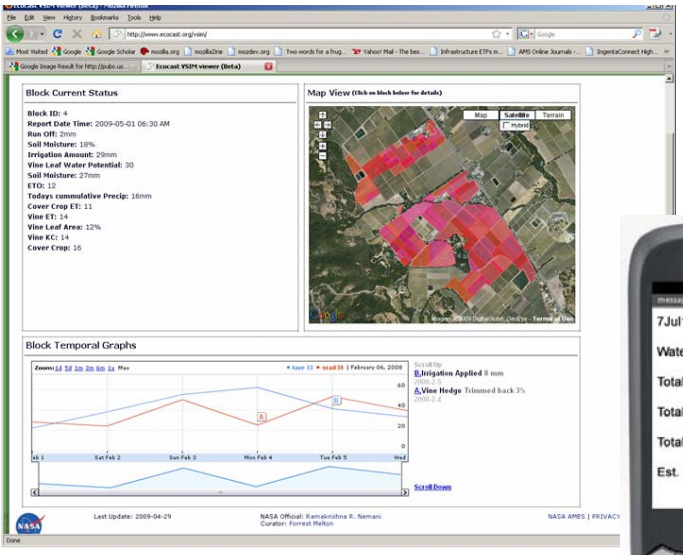



Image provided by USGS

- **Application of TOPS & SHEELS to integrate satellite and weather data to estimate ET, water balance, and irrigation demand**
- **Data exchange with users via applications for web and mobile devices**
- **Use of wireless soil moisture sensor networks for calibration / validation**
- **Collaborating with CA Dept. Water Resources, USDA-ARS, CSIRO, Agricultural producers**

Mapping Transpiration for the San Joaquin Valley

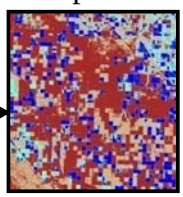
NDVI from satellite

From previous field studies

crop type from DWR/USDA maps

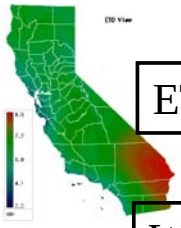
canopy cover

map: Kcb



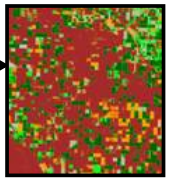
From previous lysimeter and field studies

basal crop coefficient Kcb



ETo from CIMIS

T = Kcb * ETo



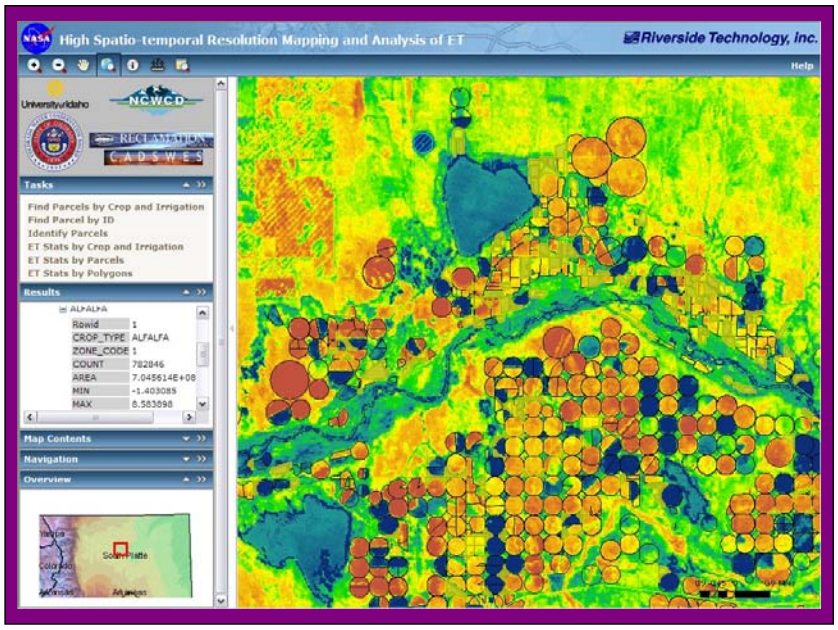
WRF forecast

map: T

Data distributed via web browser, OPeNDAP / web services

- Modeler can select an area of interest (e.g. return flow contributing area) by digitizing on-screen, and compute ET or water loss for that area.
- Example below is from using Landsat data to quantify the using a 'METRIC' evapotranspiration approach for agriculture and land cover.

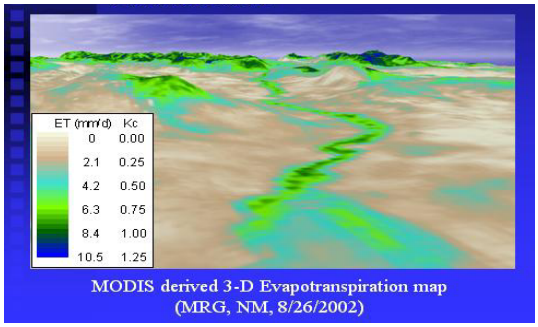
- One of several remote sensing based approaches to estimate consumptive water loss
- Developed for the Northern Colorado Conservancy District DSS



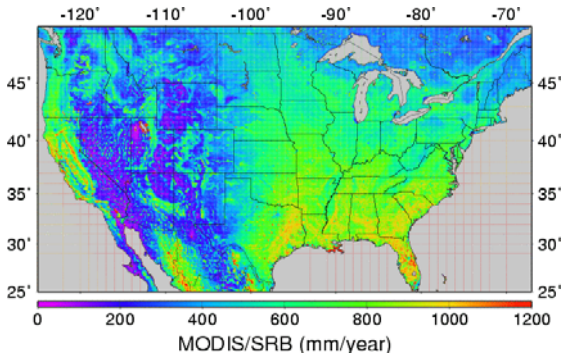
Riverside Technologies

NASA ET Satellite Products towards Real-Time & Global Applications

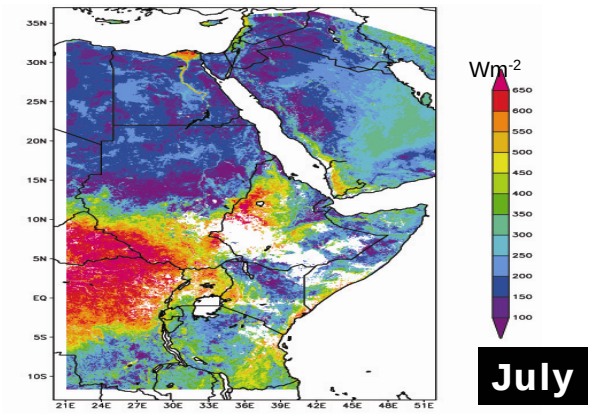
Translation of Landsat ET to MODIS ET for Local to Regional Applications (R. Allen)



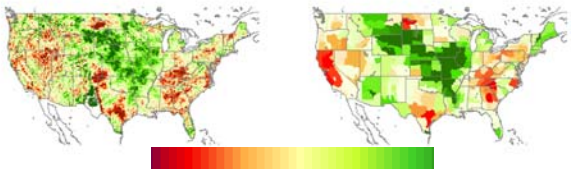
One of Two NASA MODIS & Related Products in Near Real Time towards a Global ET. U Wash. Continental US 2001-2009.(to 1-km)



Right – USDA-ARS 'Alexi-DisAlexi' for Regional to Loca ET. Applied to Nile. {30m – 25km}



Normalized Evaporative Stress Index USDA/ARS



Workshop on ET will be held on April 5 to 7, 2011 in Silver Spring, MD

ET Workshop Objectives:

1)To define the needs and requirements for evapotranspiration data in weather and climate studies, in natural and agro-ecoystem monitoring, and in water resource management.

2) To review the methods used to measure and model evapotranspiration.

3) To assess surface and satellite observation systems required to support ET measurement, modeling and evaluation.

4) To assess the feasibility of developing a proposal for a task on evapotranspiration for the 2012-2015 GEO Work Plan.

5) To explore the level of support and consensus for developing a strategy for establishing evapotranspiration as an Essential Climate Variable (ECV) within the Global Climate Observing System (GCOS) framework.

SUMMARY:

From the perspective of applications Evapotranspiration is an essential climate variable although it is not recognized as such by GCOS.

There are a number of merged products for ET that could serve as the basis for an integrated GEO water cycle product in the 2012-2015 work plan.

It is recommended that GEO adopt a data product related to ET as part of its work package.

GTN-H is invited to contribute to this effort in order to broaden the effort from research projects to operational data centres.