Estimating Crop ET from Satellite

(Regional ET Estimation Model, REEM)

By

Zohrab Samani,Simon Nolin

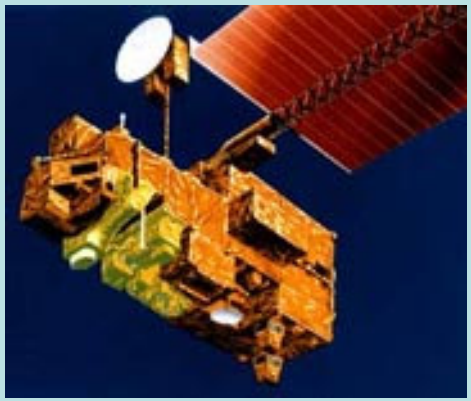
Max. Bleiweis, Rhonda Skaggs

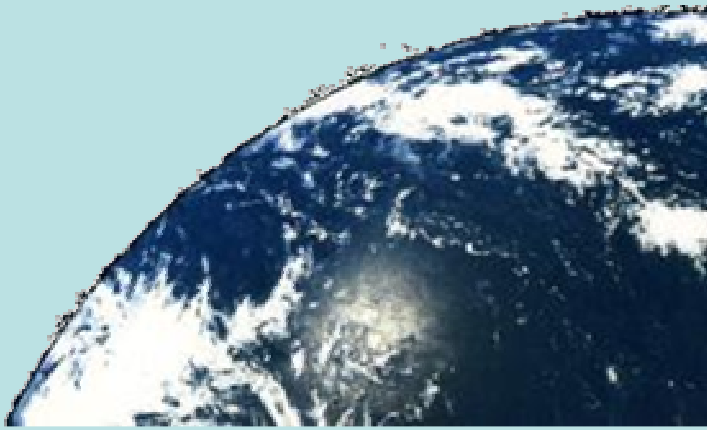
New Mexico State University

Water Is Precious in New Mexico

Rio Grande River
Sp. 2003

It is like watching TV



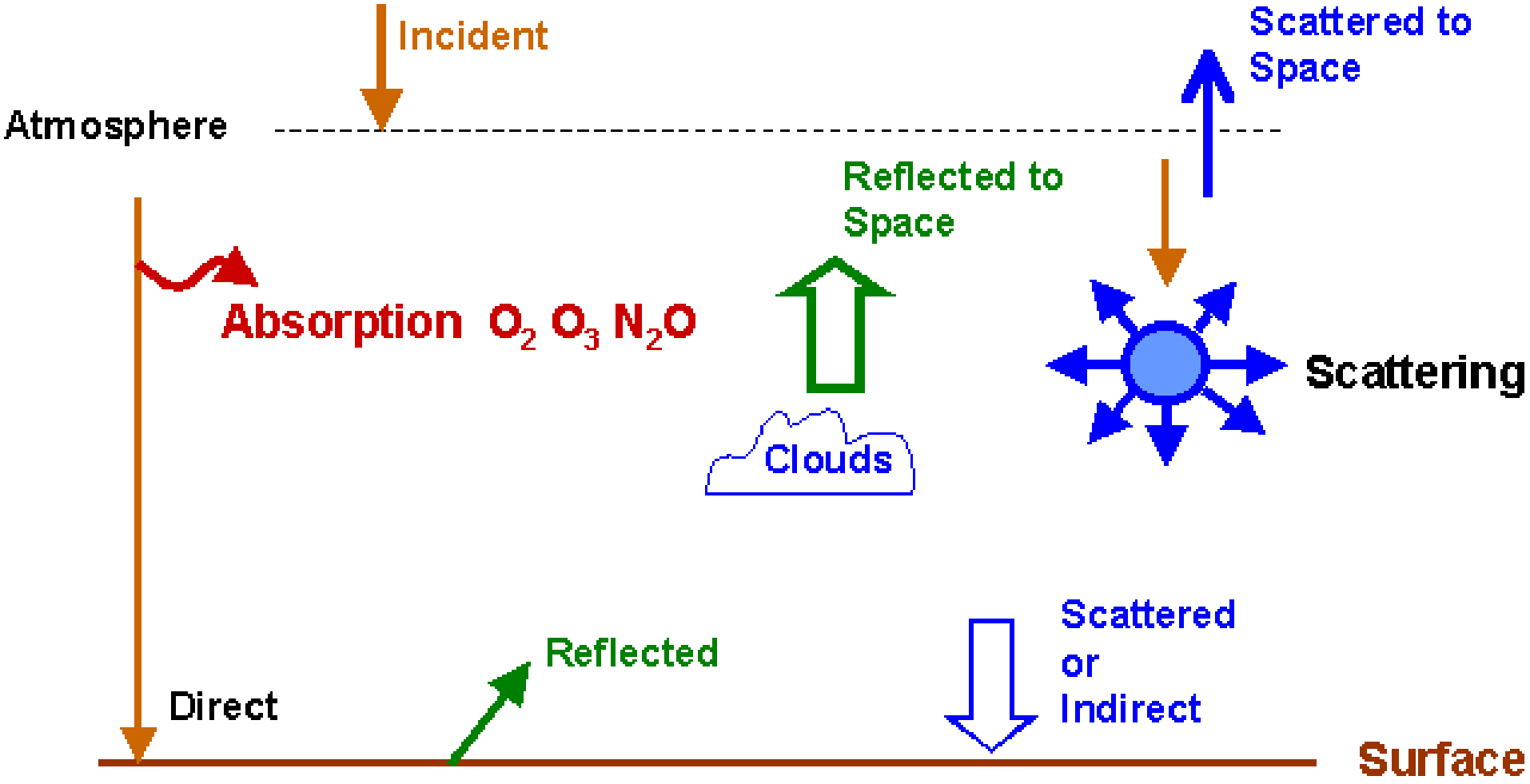


Why Satellites?

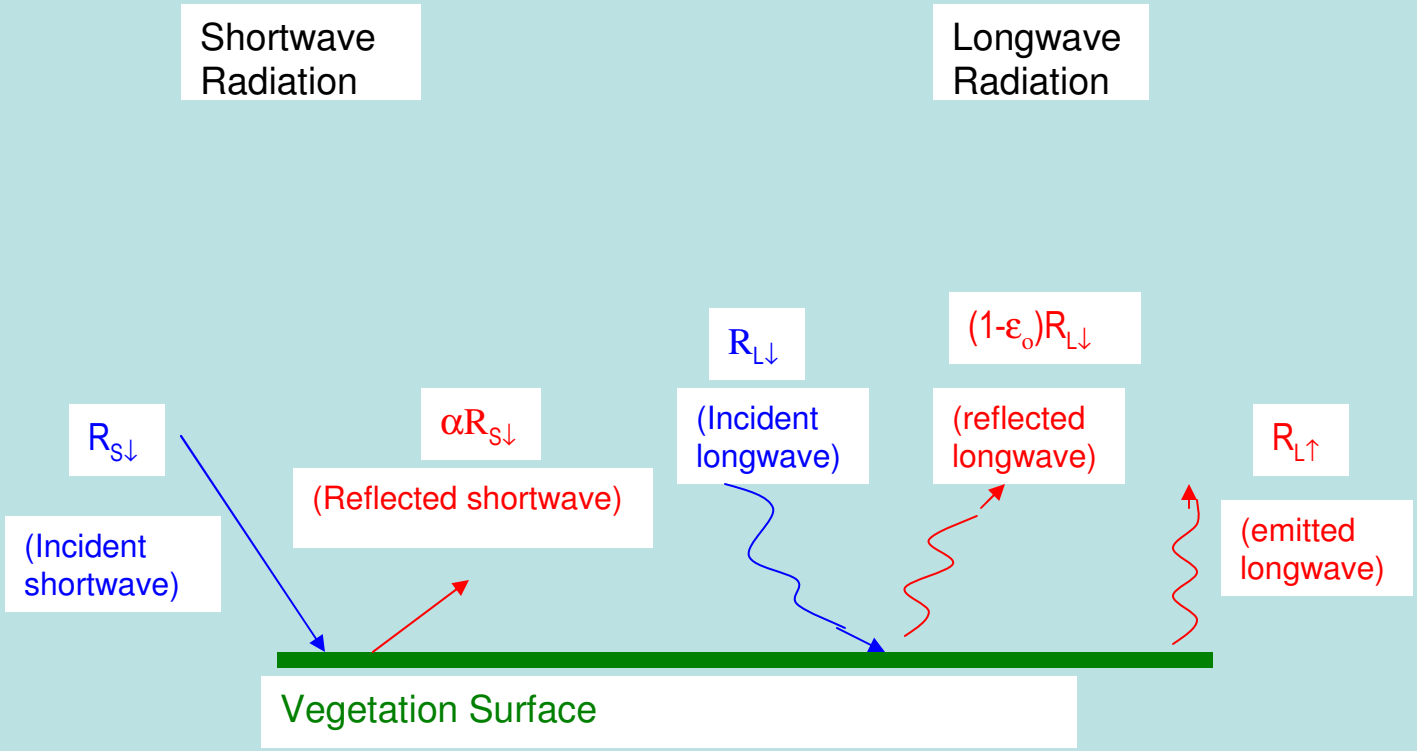
- Typical method for ET:
  - **weather data** are gathered from fixed points -- assumed to extrapolate over large areas
  - **"crop coefficients"** assume ***"well-watered"*** situation ***(impacts of stress are difficult to quantify)***

- Satellite imagery:
  - **energy balance** is applied at *each "pixel"* to map spatial variation
  - areas where **water shortage reduces ET** are identified
  - **little or no ground data** are required

Fates of Solar Radiation



Surface Radiation Balance

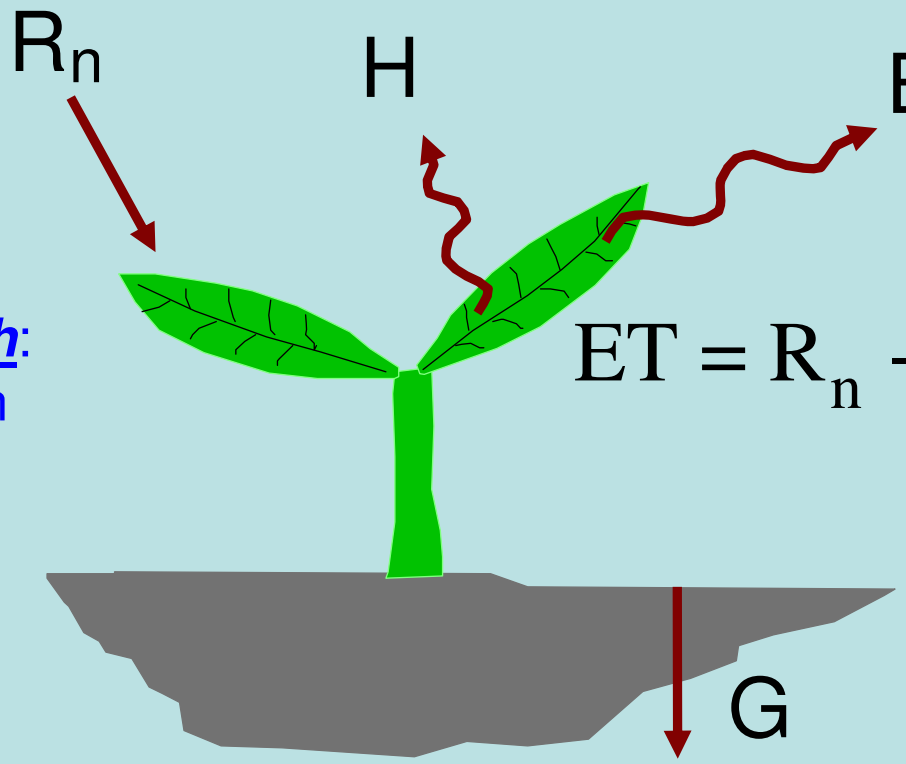


Net Surface Radiation = Gains – Losses

$$R_n = (1-\alpha)R_{S\downarrow} + R_{L\downarrow} - R_{L\uparrow} - (1-\varepsilon_o)R_{L\downarrow}$$

Energy Balance for ET

ET is calculated as a "residual" of the energy balance



Basic Truth: Evaporation consumes Energy

$$ET = R_n - G - H$$

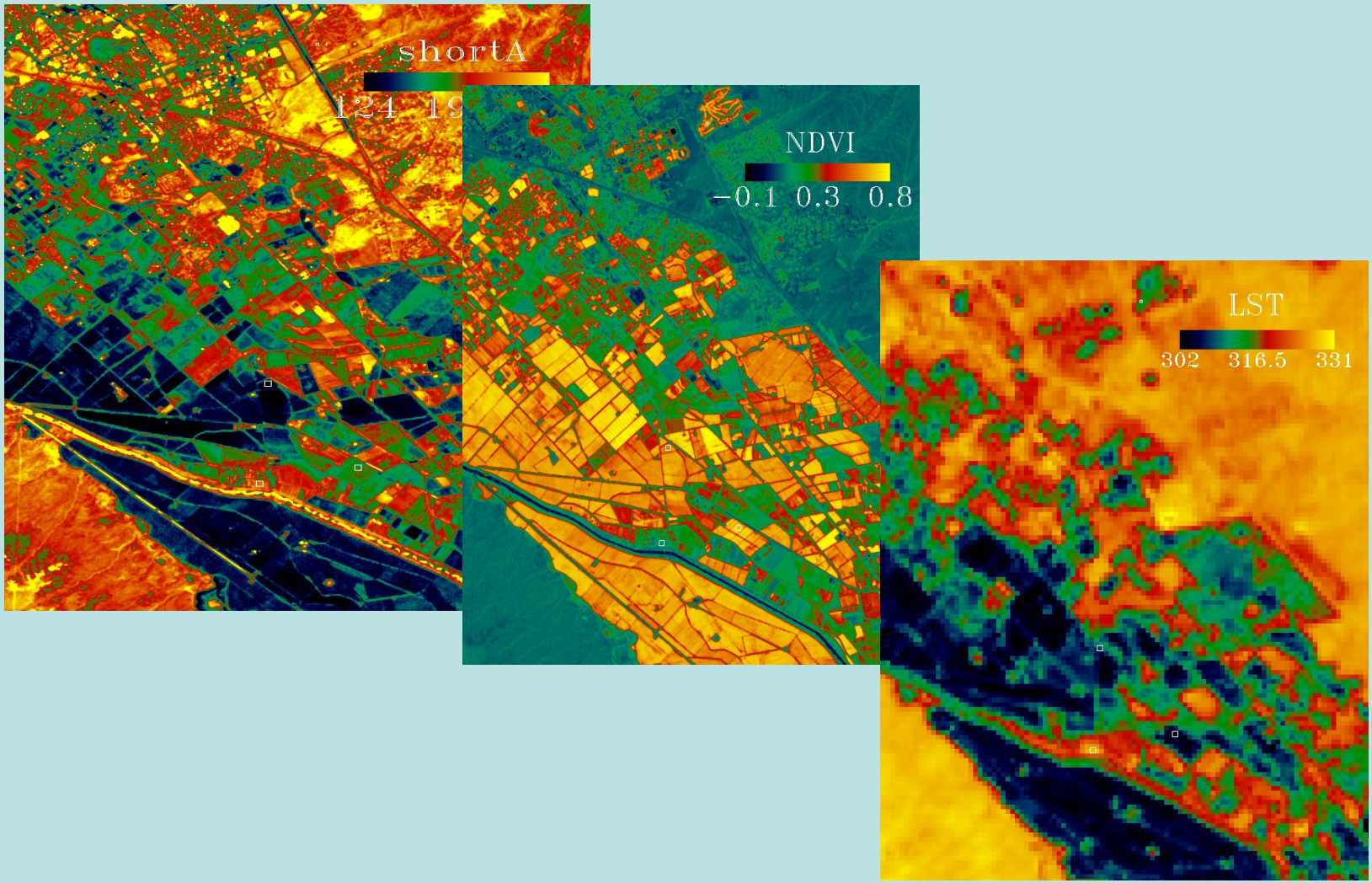
The energy balance includes all major sources (R_n) and consumers (ET, G, H) of energy

How It Works

Parameters from Satellite:

- Albedo
- vegetation indices (NDVI)
- surface temperature
- Wind speed *(from ground station)*

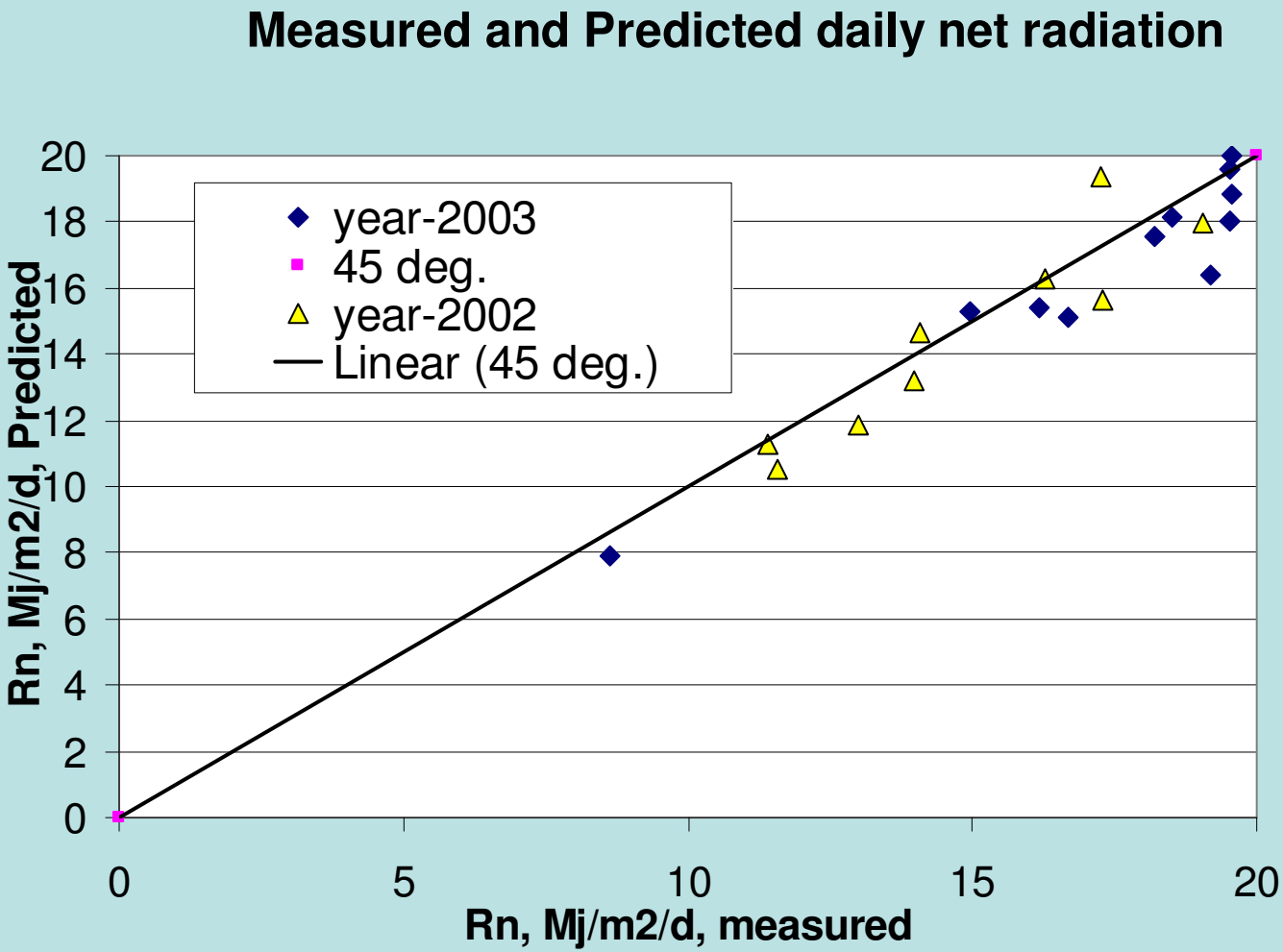
Albedo, NDVI, LST



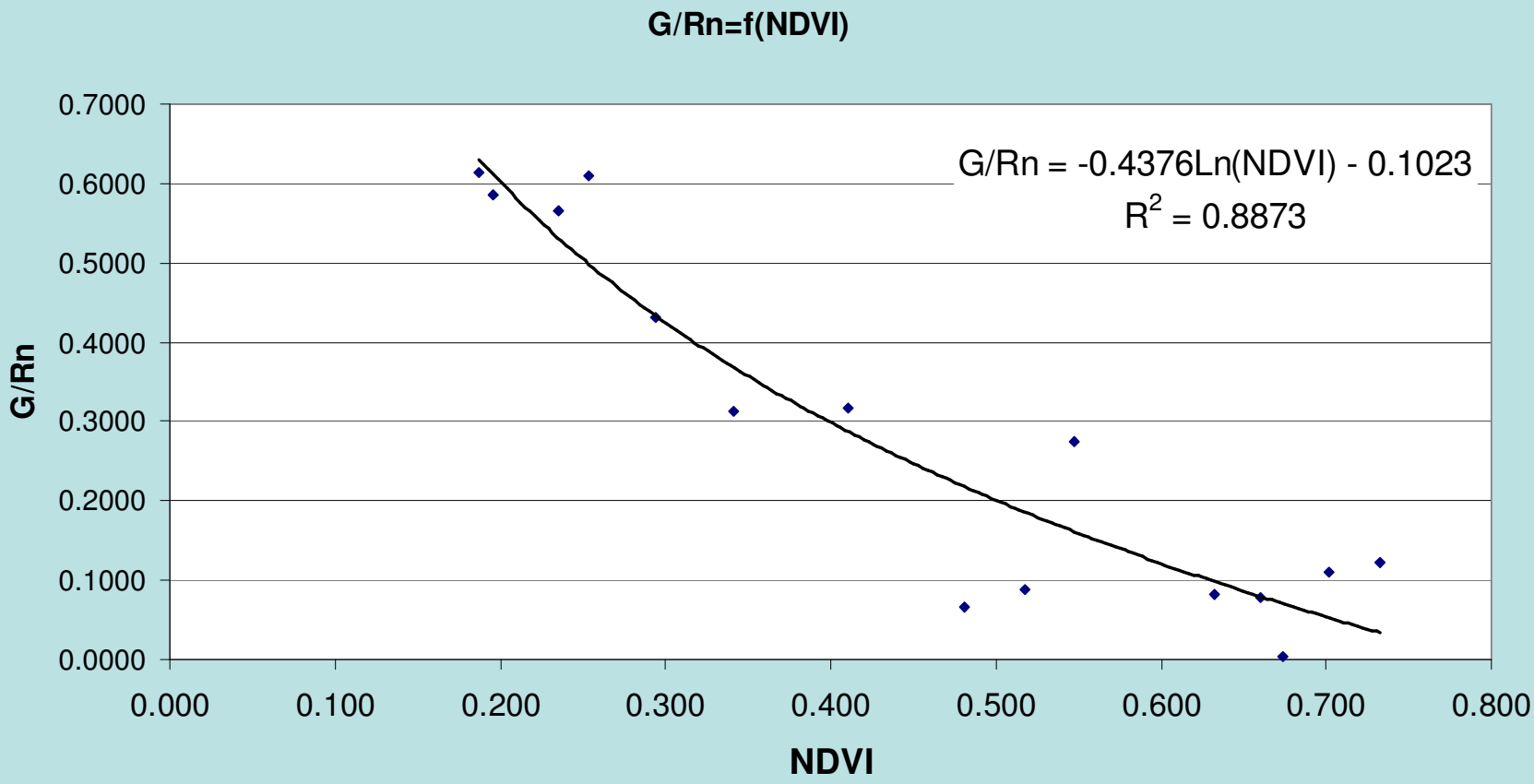
Satellite Compatibility

- Satellite Images are available from:
  - NASA-Landsat (30 m, every 16 days) - since 1982. Landsat 7 went dead in May 2003.
  - NOAA-AVHRR *(advanced very high resolution radiometer)* (1 km, daily) - since 1980's
  - NASA-MODIS *(moderate resolution imaging spectroradiometer), daily,* (250 m, for NDVI & ALBEDO, but 1 Km for Temp. - since 1999
  - NASA-ASTER *(Advanced Spaceborne Thermal Emission and Reflection Radiometer)* (Two weeks) - since 1999

Estimating Net Radiation

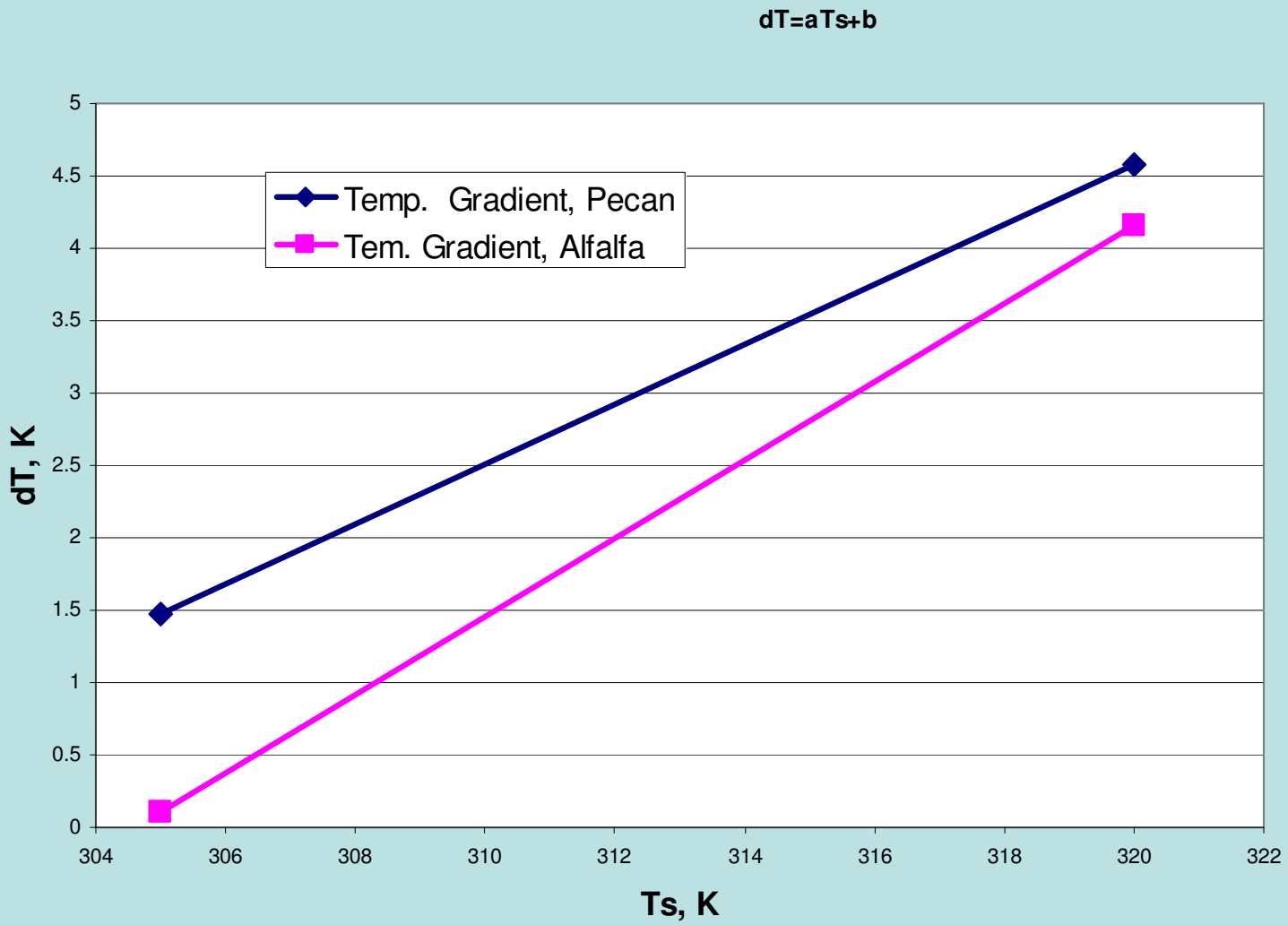


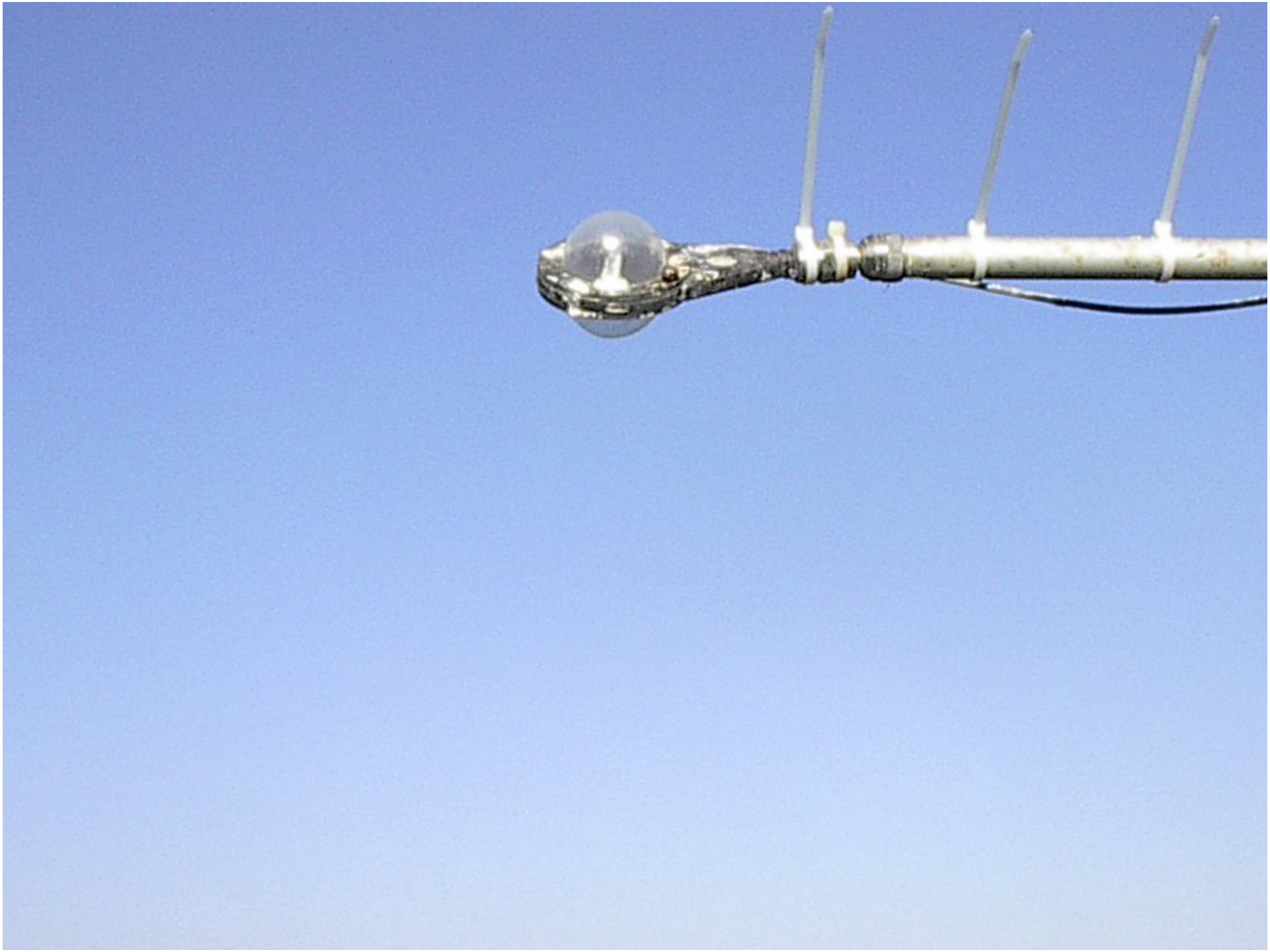
Estimating Ground Flux, Gn

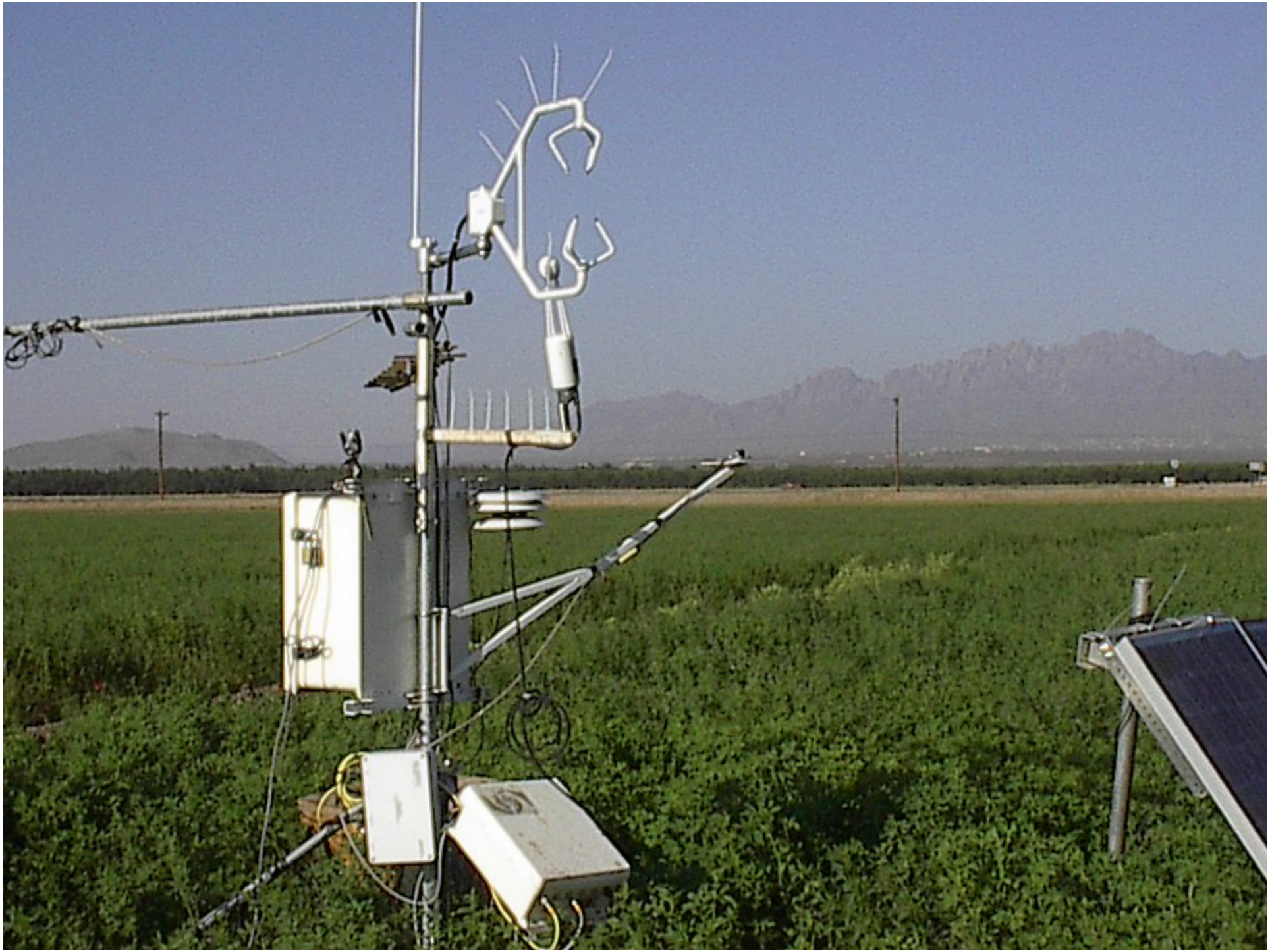


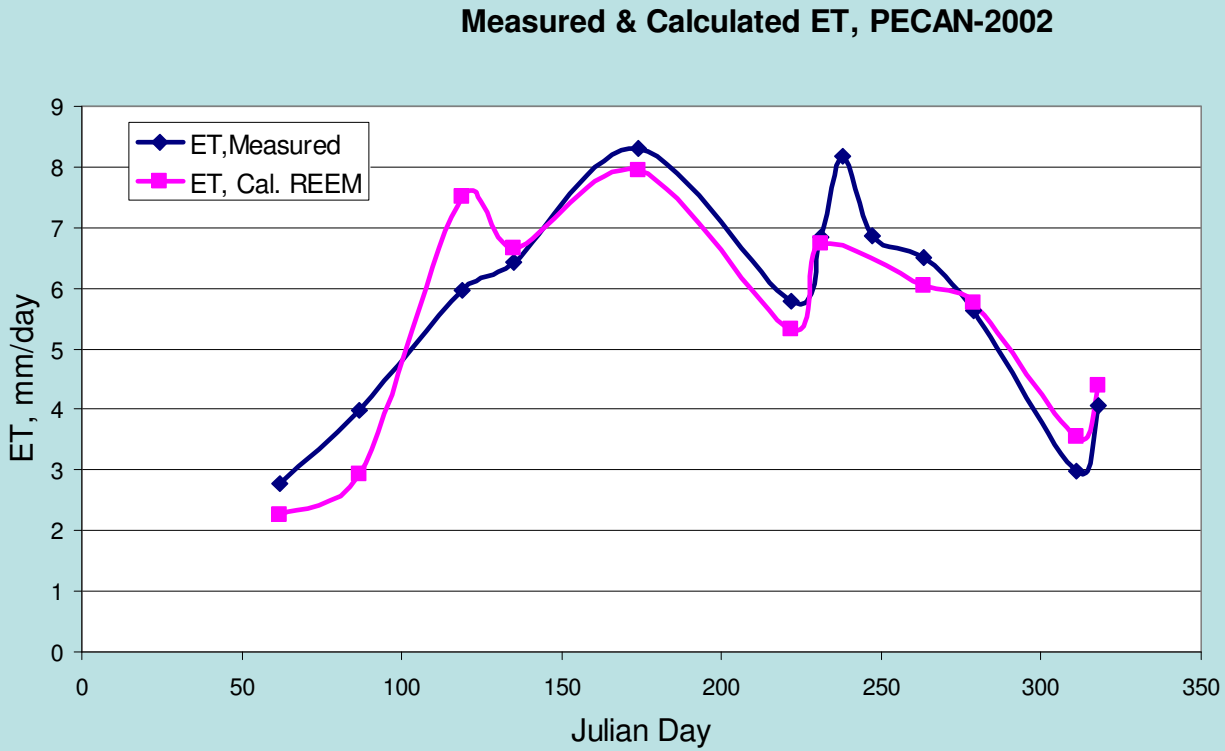
Sensible Heat, H

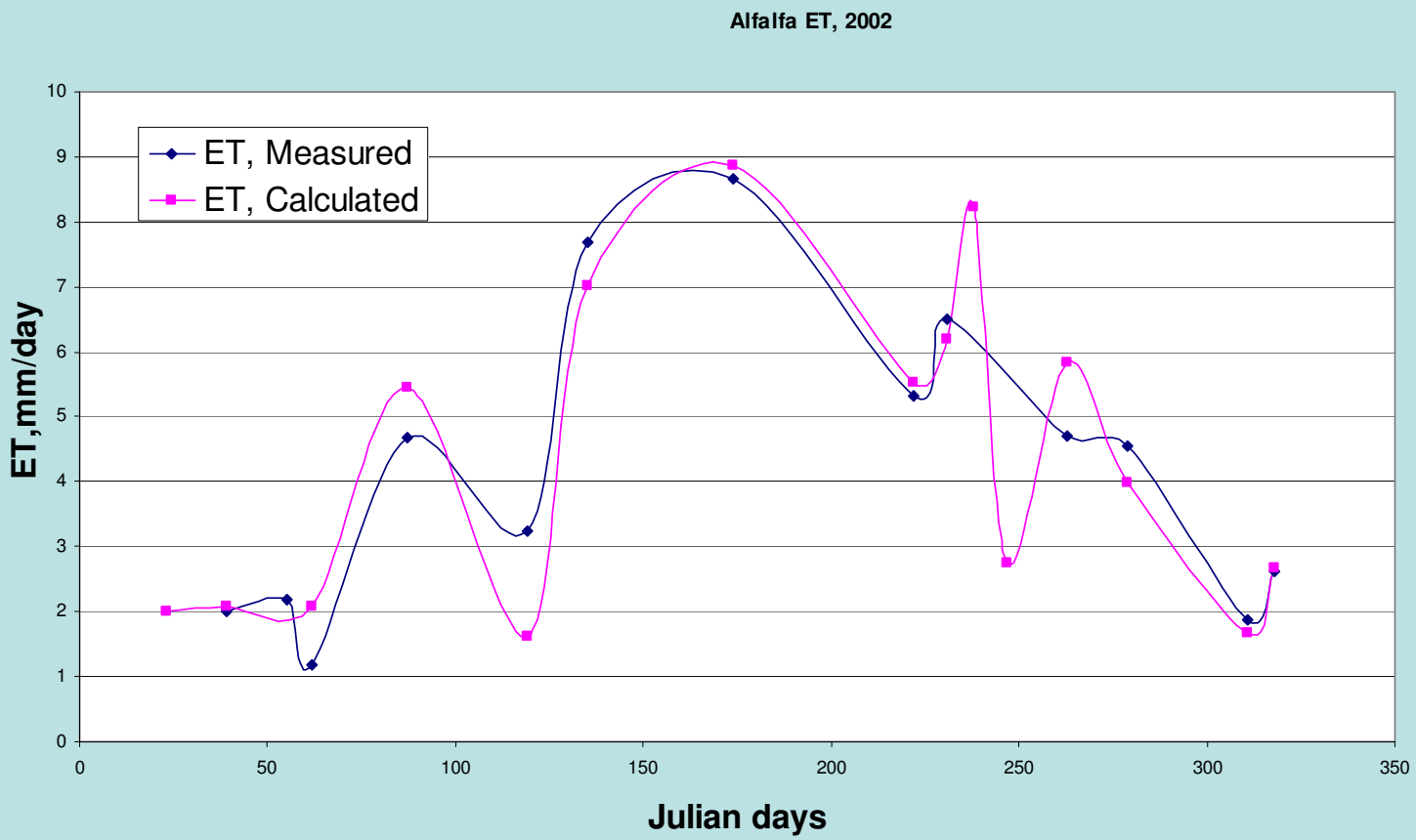
$$H = \frac{\rho . Cp . dT}{rah}$$


dT=aTs+b
Temp. Gradient, Pecan
Tem. Gradient, Alfalfa
dT, K
Ts, K
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
304
306
308
310
312
314
316
318
320
322

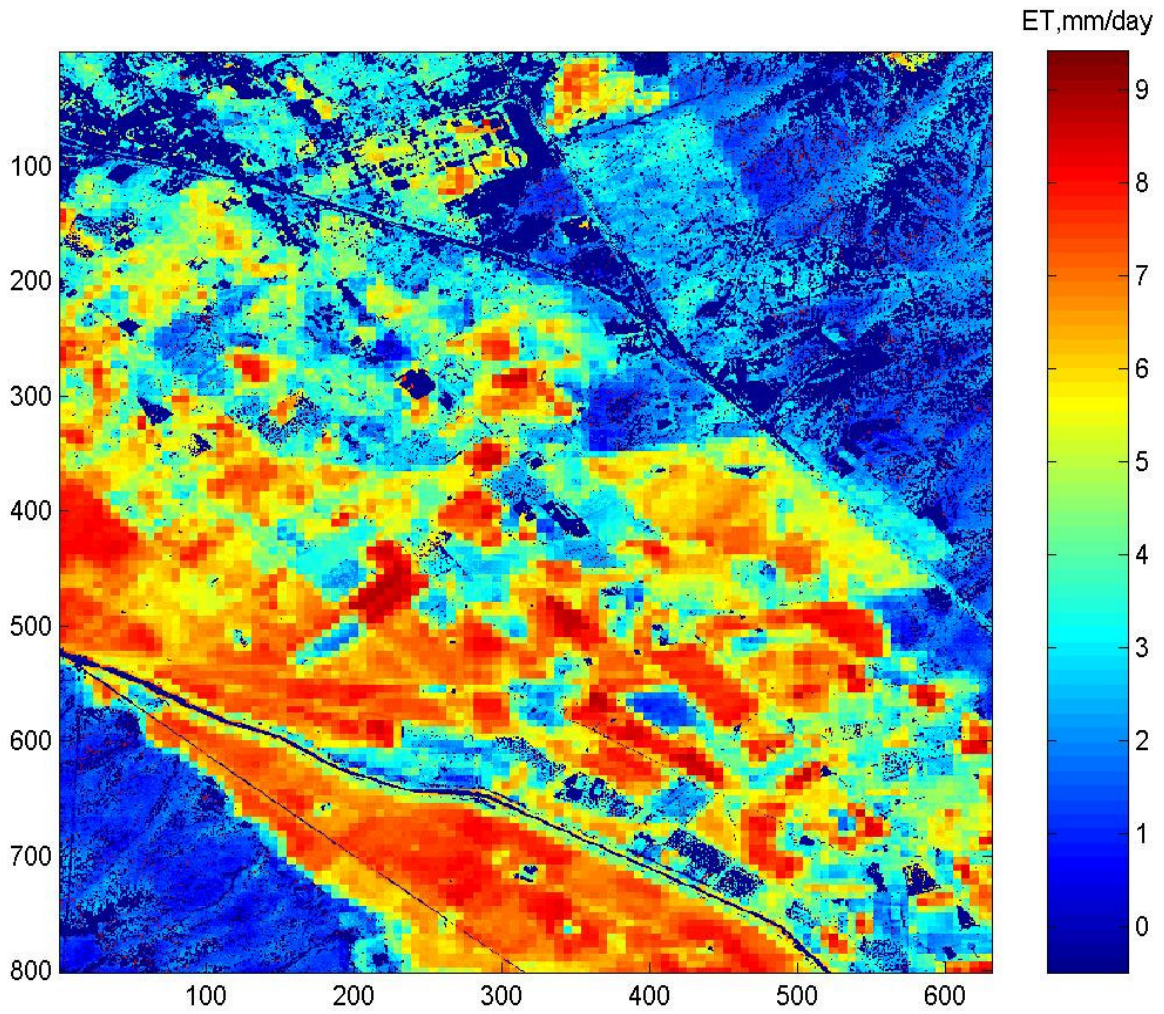





Measured & Calculated ET, PECAN-2002
ET,Measured
ET, Cal. REEM
ET, mm/day
Julian Day
0
1
2
3
4
5
6
7
8
9
0
50
100
150
200
250
300
350


Alfalfa ET, 2002
ET, Measured
ET, Calculated
ET,mm/day
Julian days
0
1
2
3
4
5
6
7
8
9
10
0
50
100
150
200
250
300
350

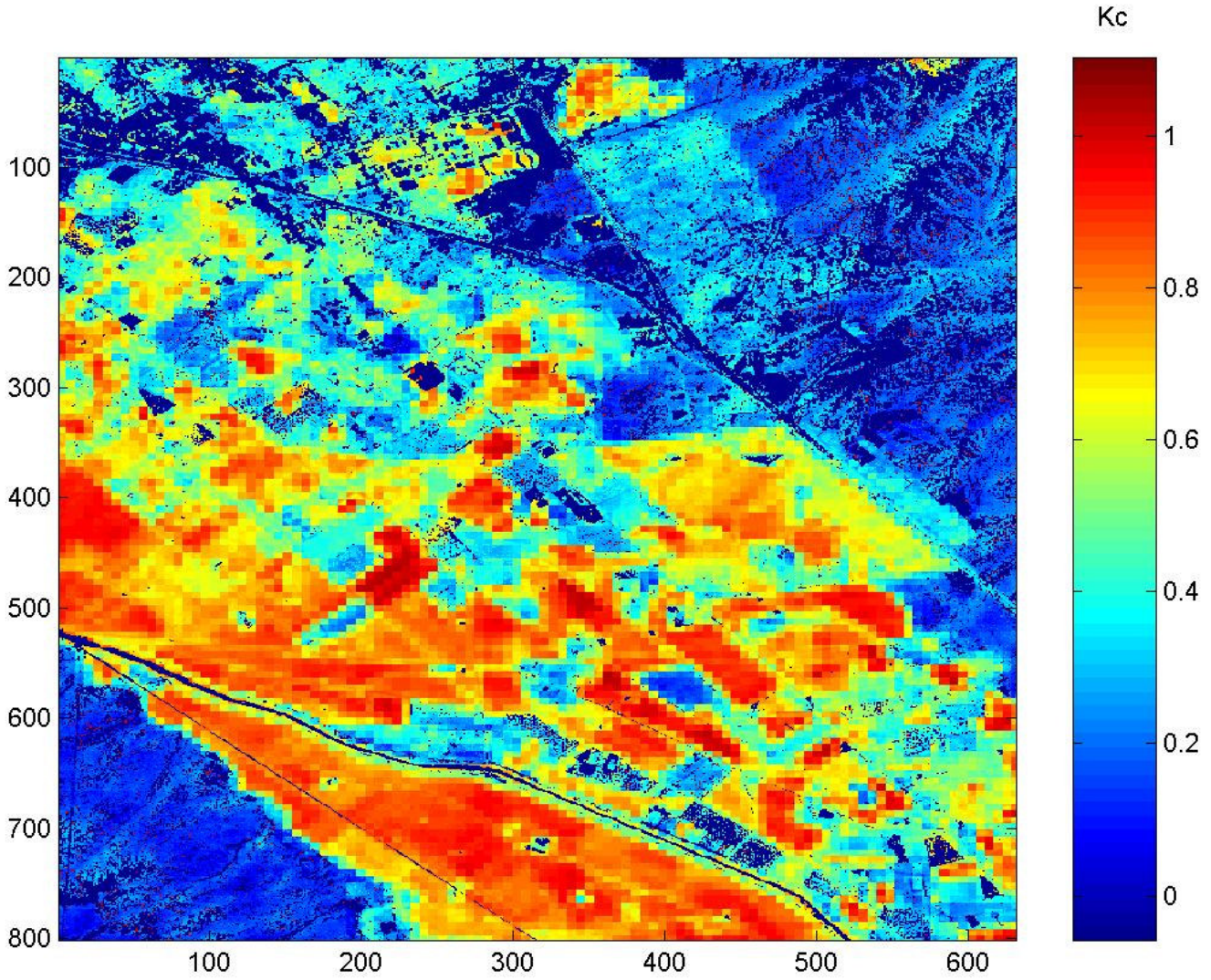
Crop Water use in Mesilla Valley,5/18/2003



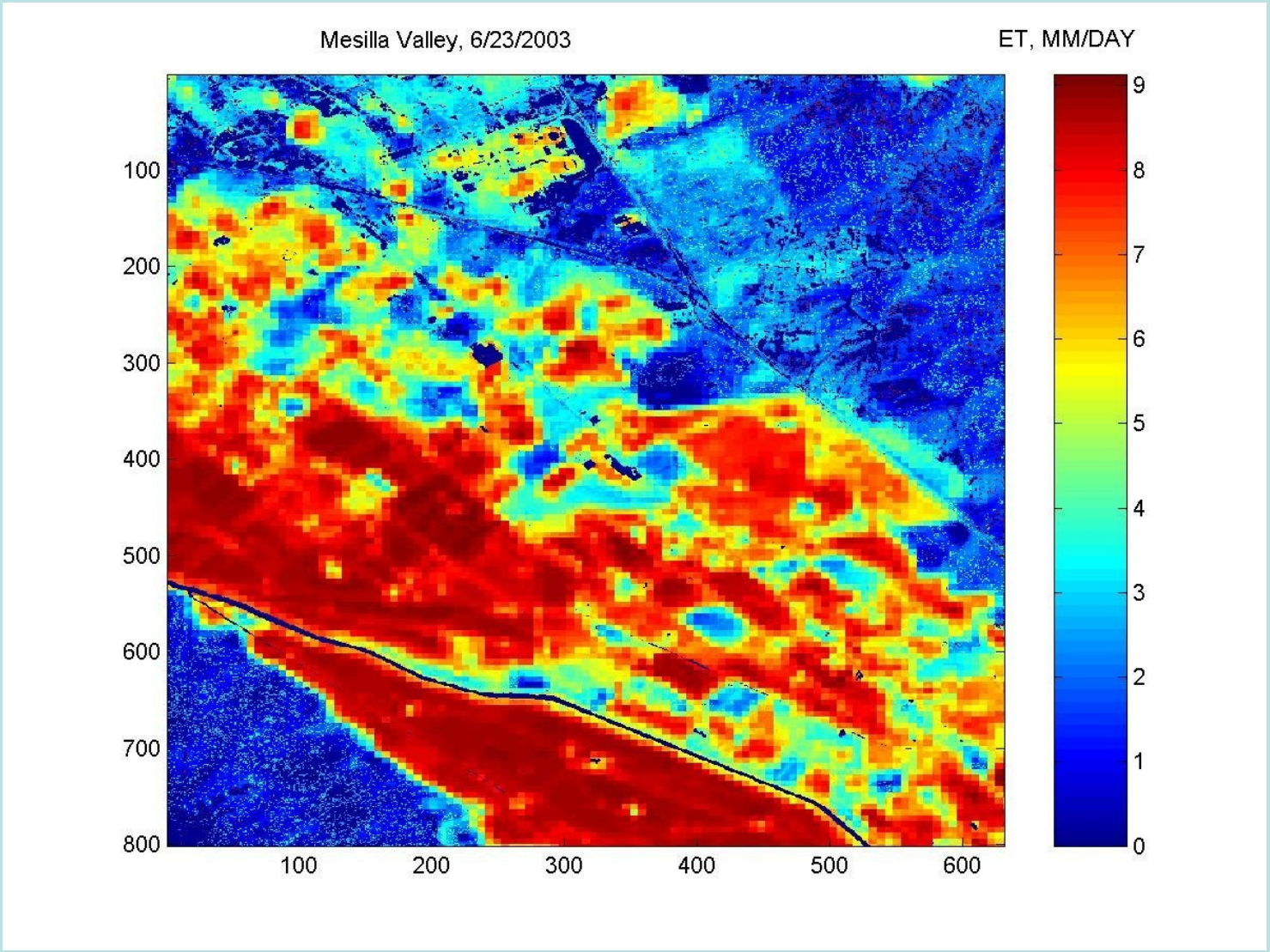
How Much Water Was Used at 5/18/2003?

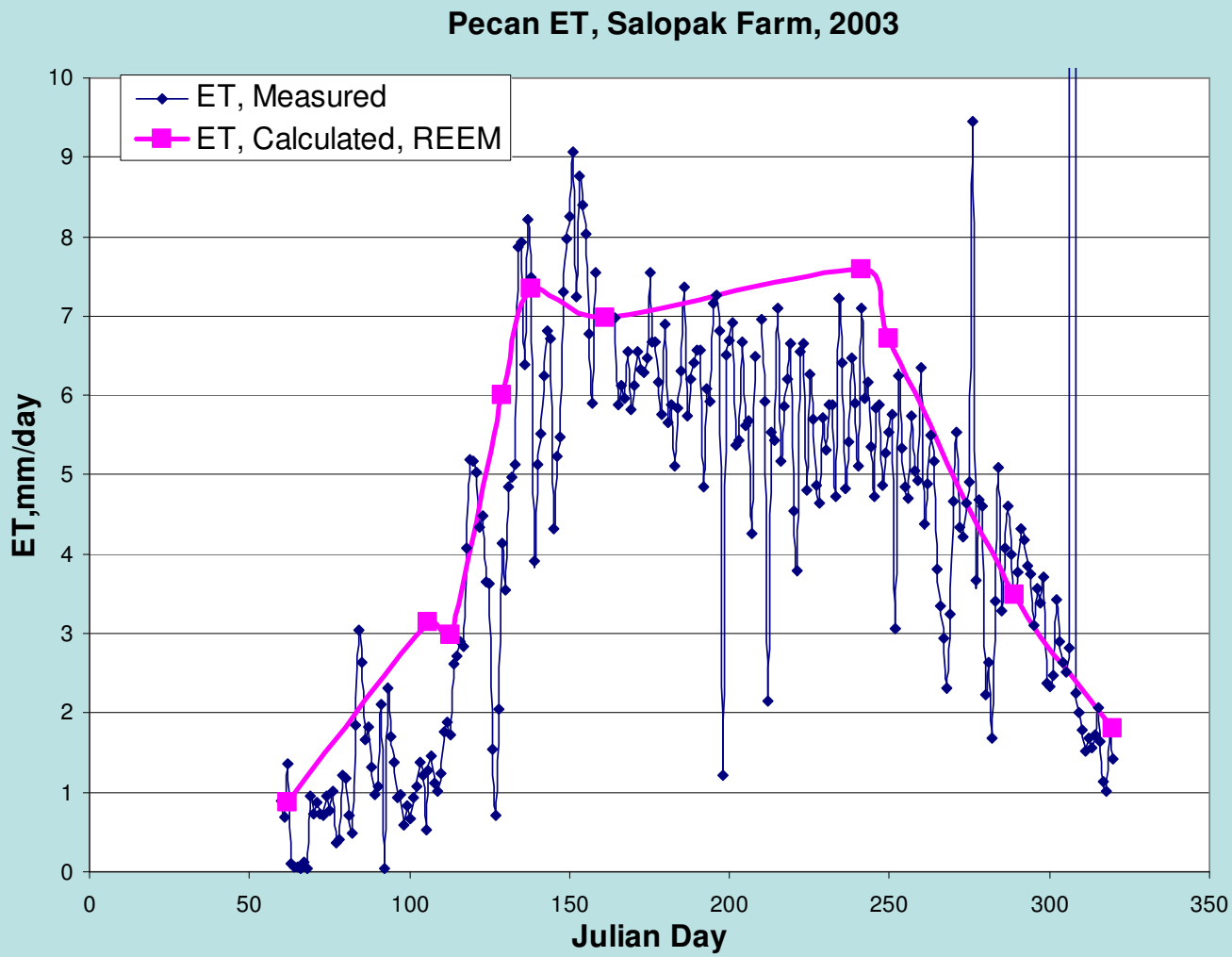
- SUM of ET*Area =585 A-F of water

Crop Coefficient, Kc, 5/18/2003



Crop Water Use in Mesilla Valley,6/23/2003




Pecan ET, Salopak Farm, 2003
ET, Measured
ET, Calculated, REEM
ET,mm/day
Julian Day
0
1
2
3
4
5
6
7
8
9
10
0
50
100
150
200
250
300
350

Application of REEM

- Real Time Irrigation Scheduling
- Water Right Adjudication
- Regional Estimate of non-beneficial water use
- Regional Impact of Water Conservation
- Biomass and Economic Return Estimates
- ET calculation for small farms
- Groundwater Withdrawal

MSU adapts satellite technology to measure water use in the Mesilla Valley

U

esearchers from New Mexico State University have developed a low-cost hod of determining agricul- l water use. The technology a variety of applications, helping farmers determine n to irrigate to pinpointing s where crops may be ssed due to problems such as ase or water shortage. lthough researchers at SU have been interested in problem of measuring water for many years, the technolo- or doing it became available three years ago. That's when earchers in the Netherlands ired out a way to take data hered by satellites and relate water consumption. Data d for the research includes face temperatures, how much t is reflected off the ground, l the density of plants. Yohrab Samani, a professor of il and geological engineering NMSU, and graduate student non Nolin wrote a software gram that could take this ellite data and relate it to the vironment in New Mexico. The ellite data is calibrated by tak- measurements of water use at NMSU's Leyendecker Plant Science Center in the Mesilla Valley. The ground station at Leyendecker farm, which is operated by professors Ted Sammis and David Miller of NMSU's Agronomy Department, measures the water use every 30 minutes and is the key element in calibrating the satellite data.

EYE ON RESEARCH

"All we have to do now is download data from a satellite and run it through our software," Samani said.

The data comes from a NASA satellite called TERRA. Max Bleiweiss, director of the Remote Sensing Center at NMSU, provides Samani with the data to run through his software.

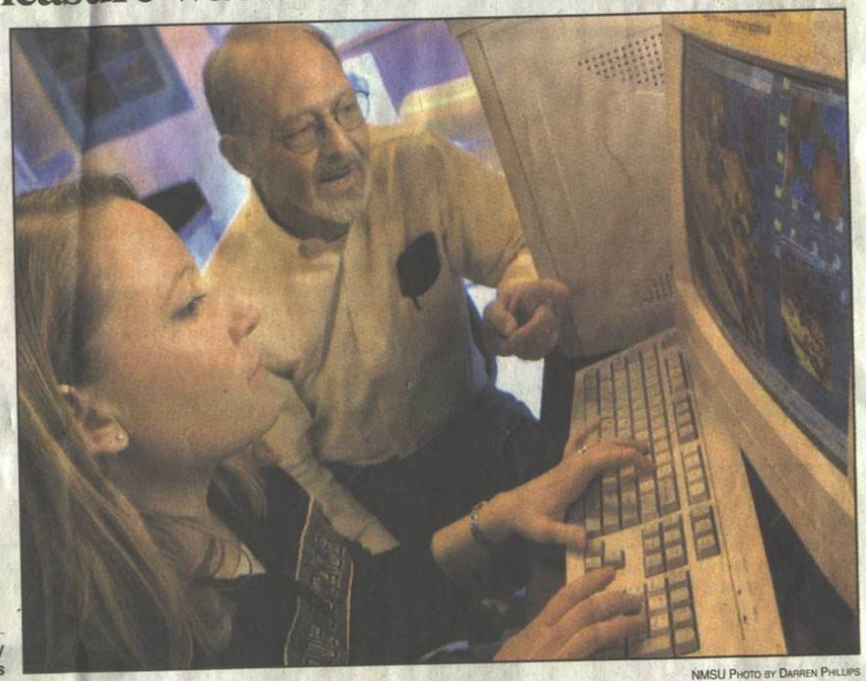
Samani said his goal is to put the information on the Internet on a weekly basis so farmers could use it to aid in irrigation scheduling. Farmers would simply need to type in the GPS (Global Positioning System) coordinates of their property and the program would tell them how much water they are using.

"This could be particularly valuable when water for irrigation is being restricted and farmers have to make up the difference by pulling water from the ground," Samani said.

Samani said the NMSU researchers have checked their estimates against actual water use and found them to be "surprisingly accurate." Currently, the only way to measure water use is a time-consuming process that involves putting meters in the soil or on the pumps or gates that let water into an irrigation system.

Bleiweiss, who also is an adjunct professor of entomology, plant pathology and weed science at NMSU, said the technology also will allow farmers to tell which parts of a field are using water more efficiently. "Sometimes part of a field may not be using water efficiently because it has a pest infestation, has a nutrient lacking or has too much salt," Bleiweiss said.

"Eye on Research" is provided by New Mexico State University. This week's feature was written by Ellen Davis of University Communications. Future columns will feature other research activities at the university.



NMSU PHOTO BY DARREN PHILLIPS

Max Bleiweiss, director of the Remote Sensing Center at NMSU, works with graduate student Joleen Atencio. The two download satellite data that can be used to help measure water use in the Mesilla Valley.

Las Cruces calendar

oday

Board of Adjustment meet- g: Canceled. For information ll 528-3043.

Selection Advisory Board:

patch: 9 a.m., Authority Board Meeting - MVRDA Conference. Room, 130 W. Lohman. For information call 523-4447.

MPO Policy Committee Meeting: 5 p.m., Council Cham-

In Las Cruces

Road closure scheduled in Anthony area

County road construction will close an Anthony-area road this week. Westside Road between Junction 183 and N.M. High-

relocate an existing fire hydrant at Amador Avenue and Compress Road.

Adjacent areas also may be affected. If water on your street is scheduled to be turned off, city crews will post a door hang-

Check in starts at 9 a.m. People need to preregister by calling 1-800-FightMS (press 2) during the month of March. Individuals and walking teams or clubs are most welcome.

City Hall, 1000 McNutt St., Suite A

- March 18 at Anthony Senior Center, 875 N. Main St.
- March 19 at Chaparral Multi-Purpose Building, 190 County Line Rd.

Property owners who wish to