Estimating Riparian ET through Remote sensing

By

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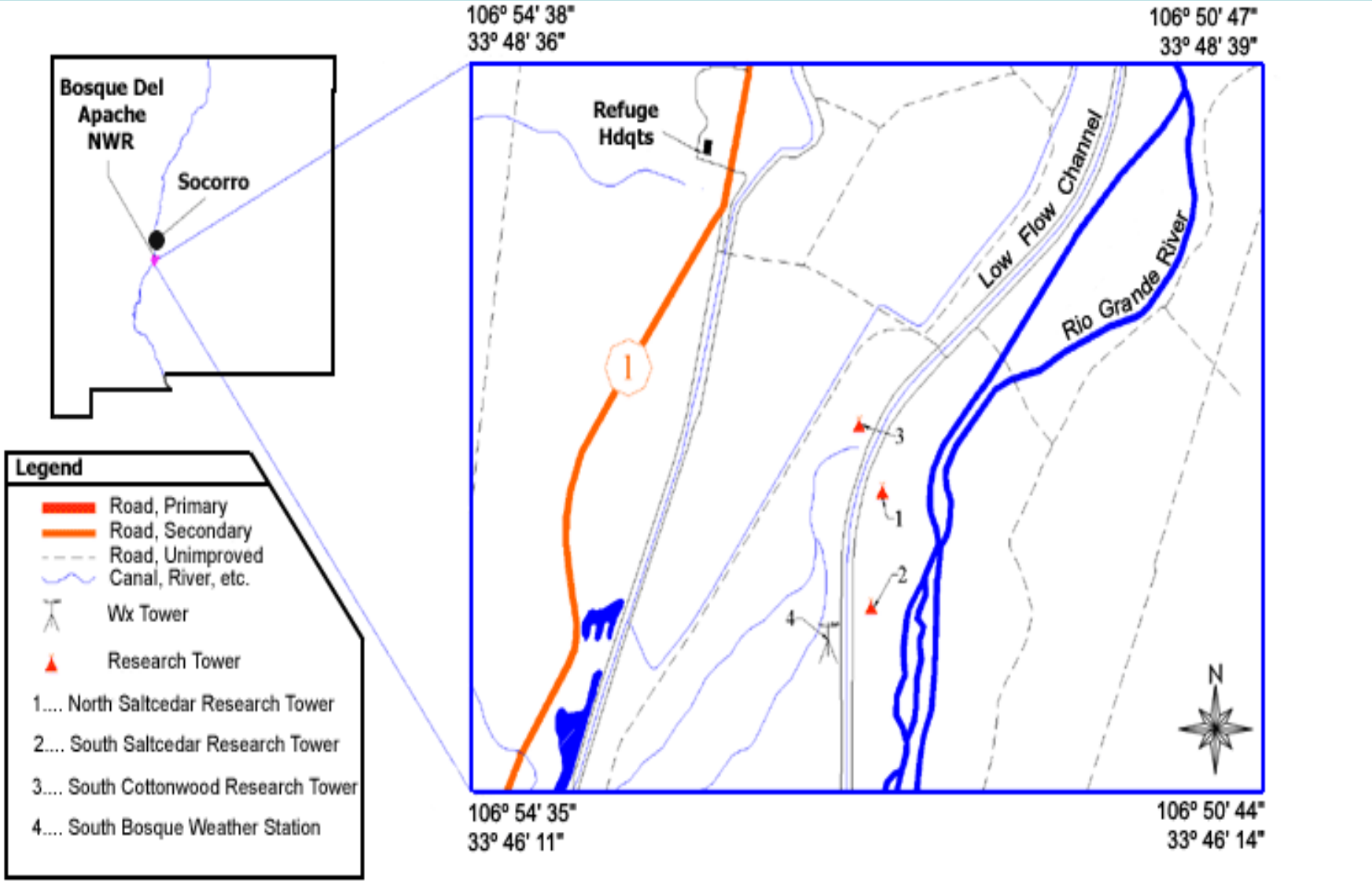
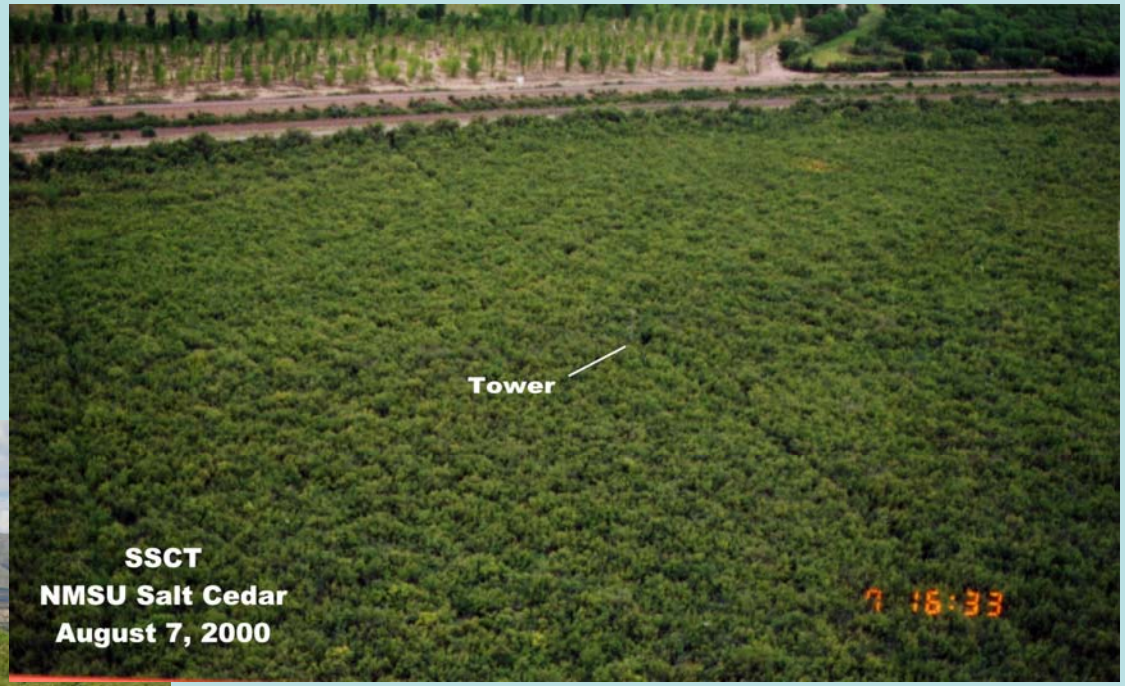
Rio Grande River
Spring, 2003


Bosque Del Apache NWR
Socorro
106° 54' 38"
33° 48' 36"
106° 50' 47"
33° 48' 39"
Refuge Hdqts
Low Flow Channel
Rio Grande River
1
2
3
4
N
106° 54' 35"
33° 46' 11"
106° 50' 44"
33° 46' 14"
Legend
Road, Primary
Road, Secondary
Road, Unimproved
Canal, River, etc.
Wx Tower
Research Tower
1.... North Saltcedar Research Tower
2.... South Saltcedar Research Tower
3.... South Cottonwood Research Tower
4.... South Bosque Weather Station

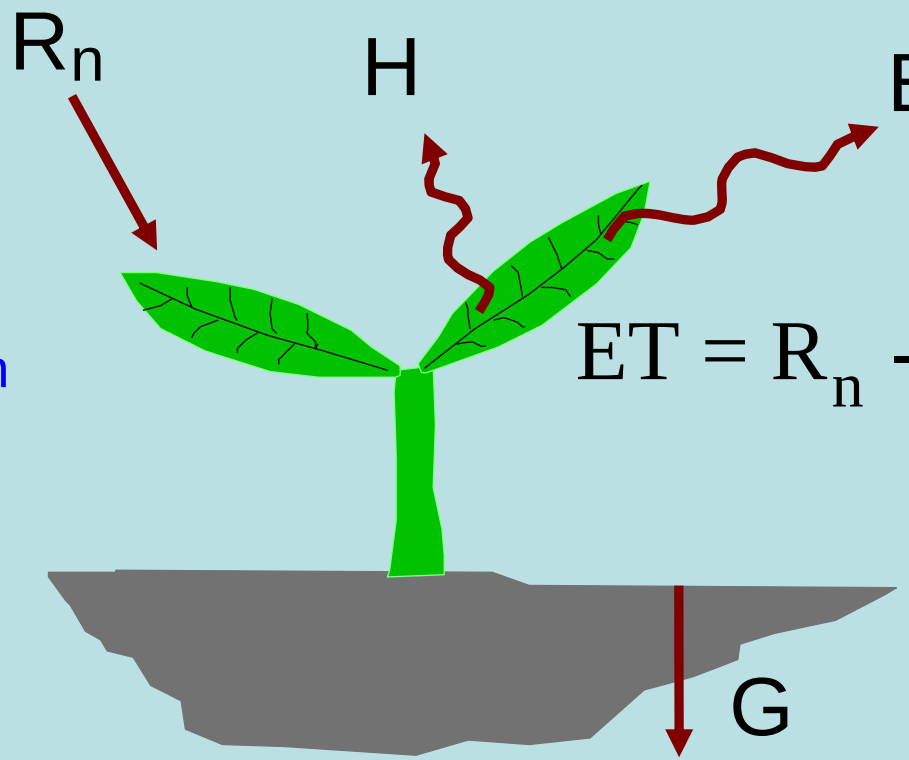
Rio Grande Riparian Vegetation



ColorIR Satellite Image of Bosque del Apache NWR

Energy Balance for ET

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

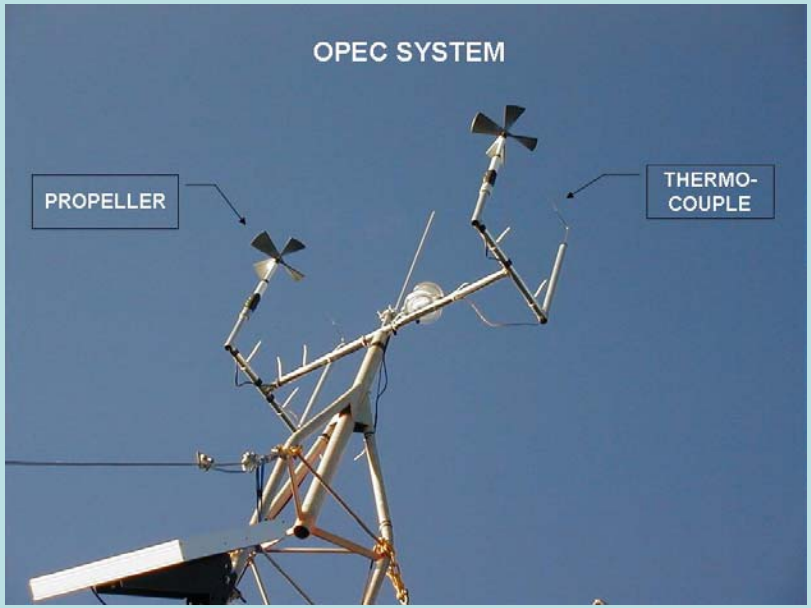


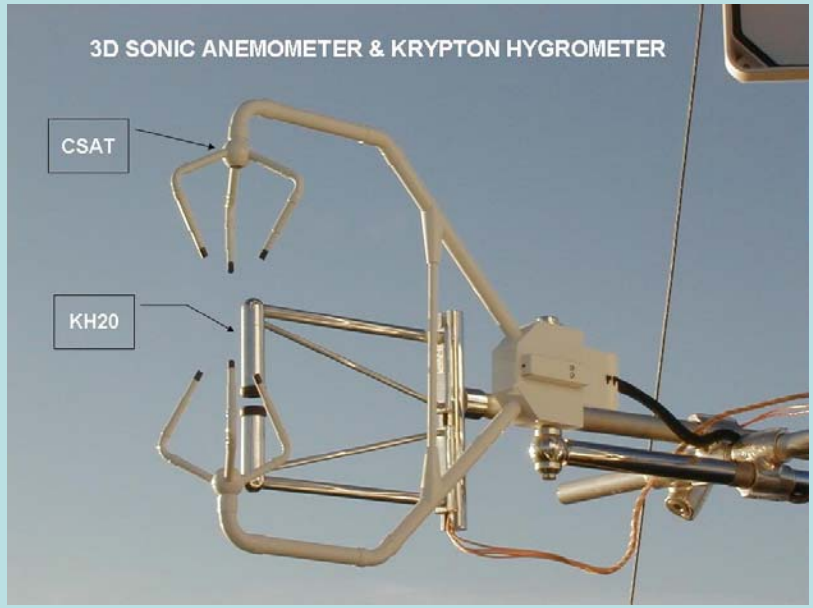
$$ET = R_n - G - H$$

Evaporation consumes Energy

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

Ground ET Measurements





Eddy Covariance

$$H = \rho c_p COV[wT]$$

$$LE = \lambda COV[wq]$$

Why Satellites?

$$ET = K_c \cdot ET_o$$

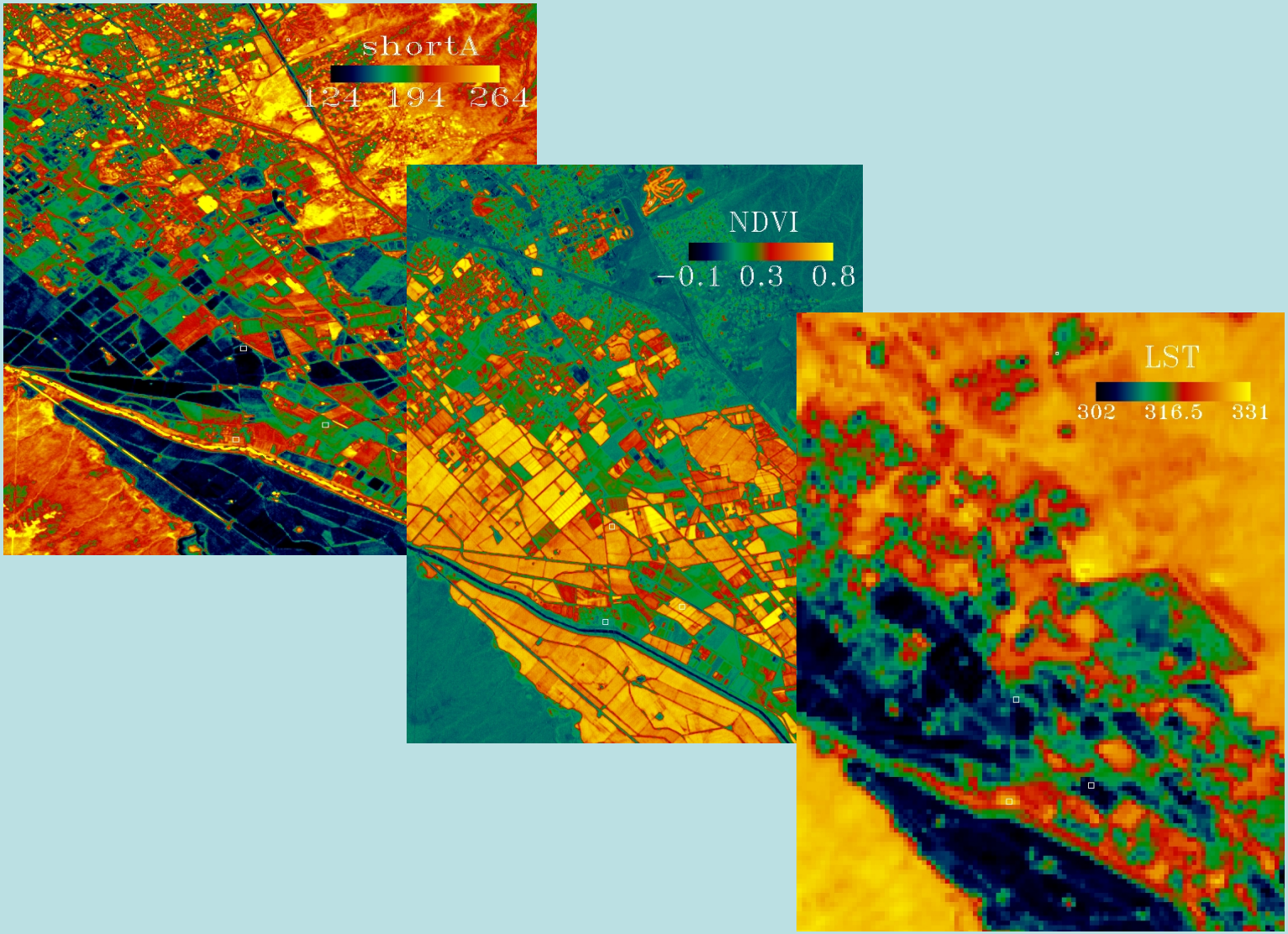
- Traditional method for ET:
  - **ET_o** is calculated from weather data (weather station)
  - **K_c** assume **"well-watered"** situation ***(impacts of stress are difficult to quantify)***
  - **K_c** for most riparian vegetation is **not available**

Net Radiation

Net Surface Radiation = Gains – Losses

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

Albedo, NDVI, LST



How It Works

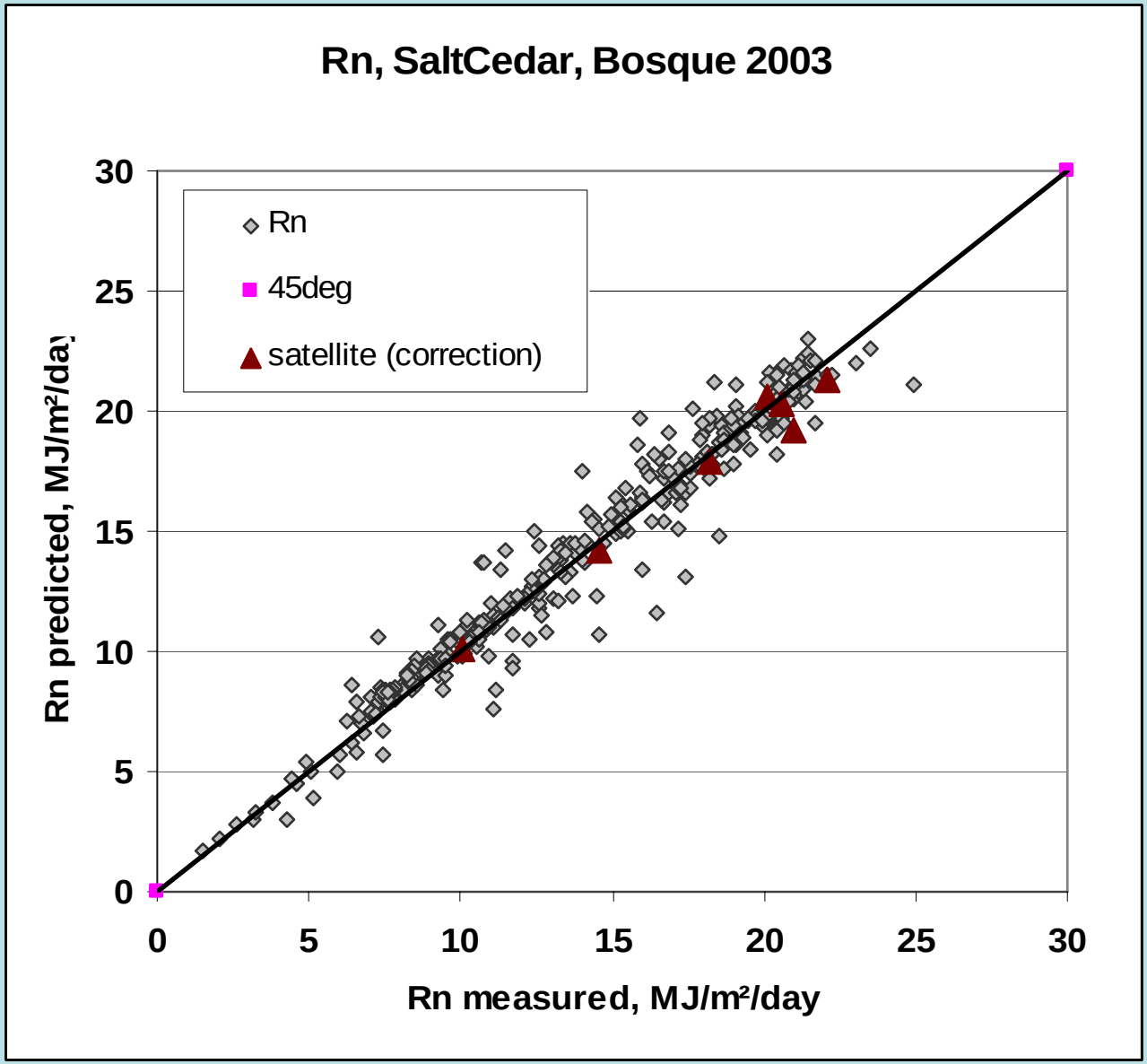
Parameters from Satellite:

- Albedo
- Vegetation indices (NDVI)
- Surface temperature
- Wind speed *(from ground station)*

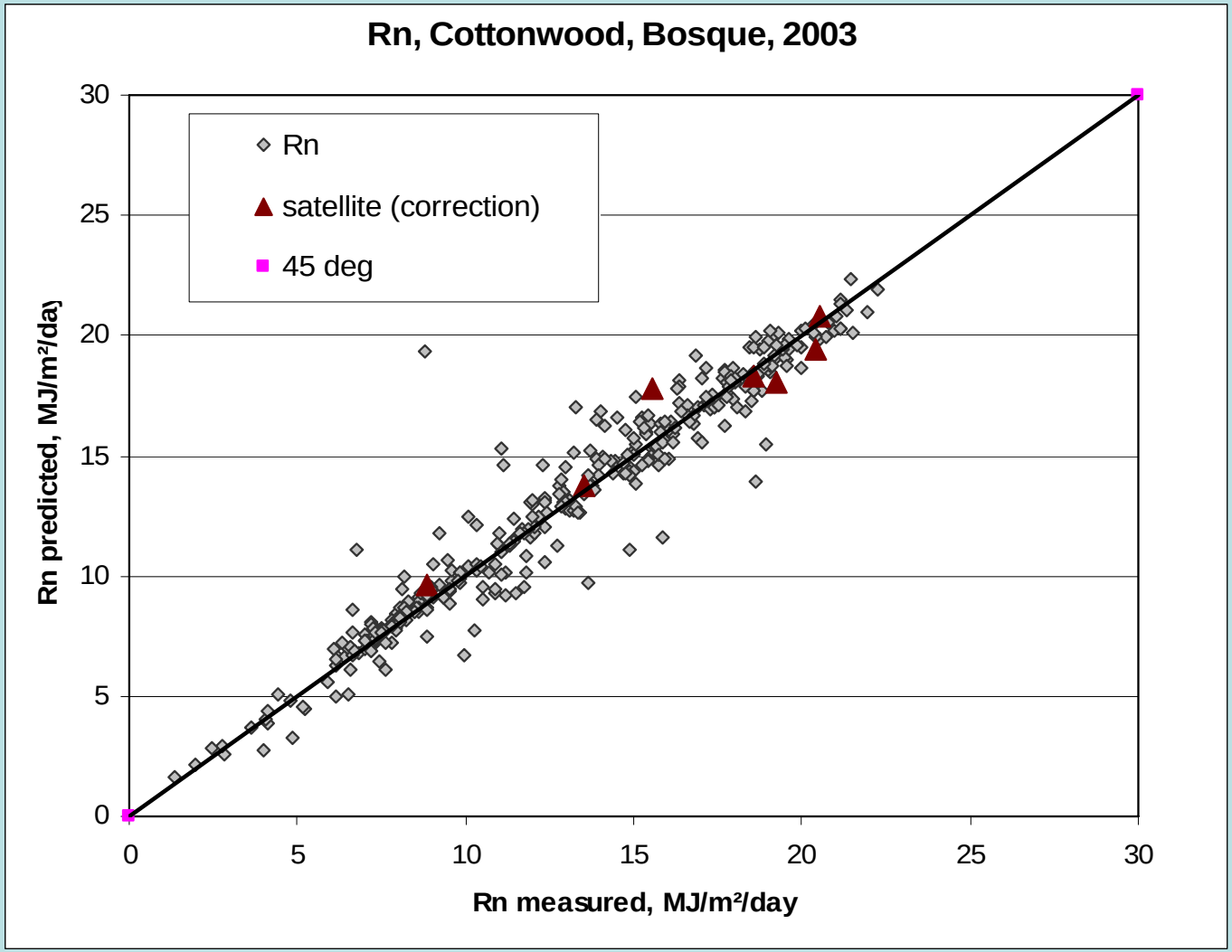
Satellite

- 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 *(Terra, Advanced Spaceborne Thermal Emission and Reflection Radiometer)*- since 1999

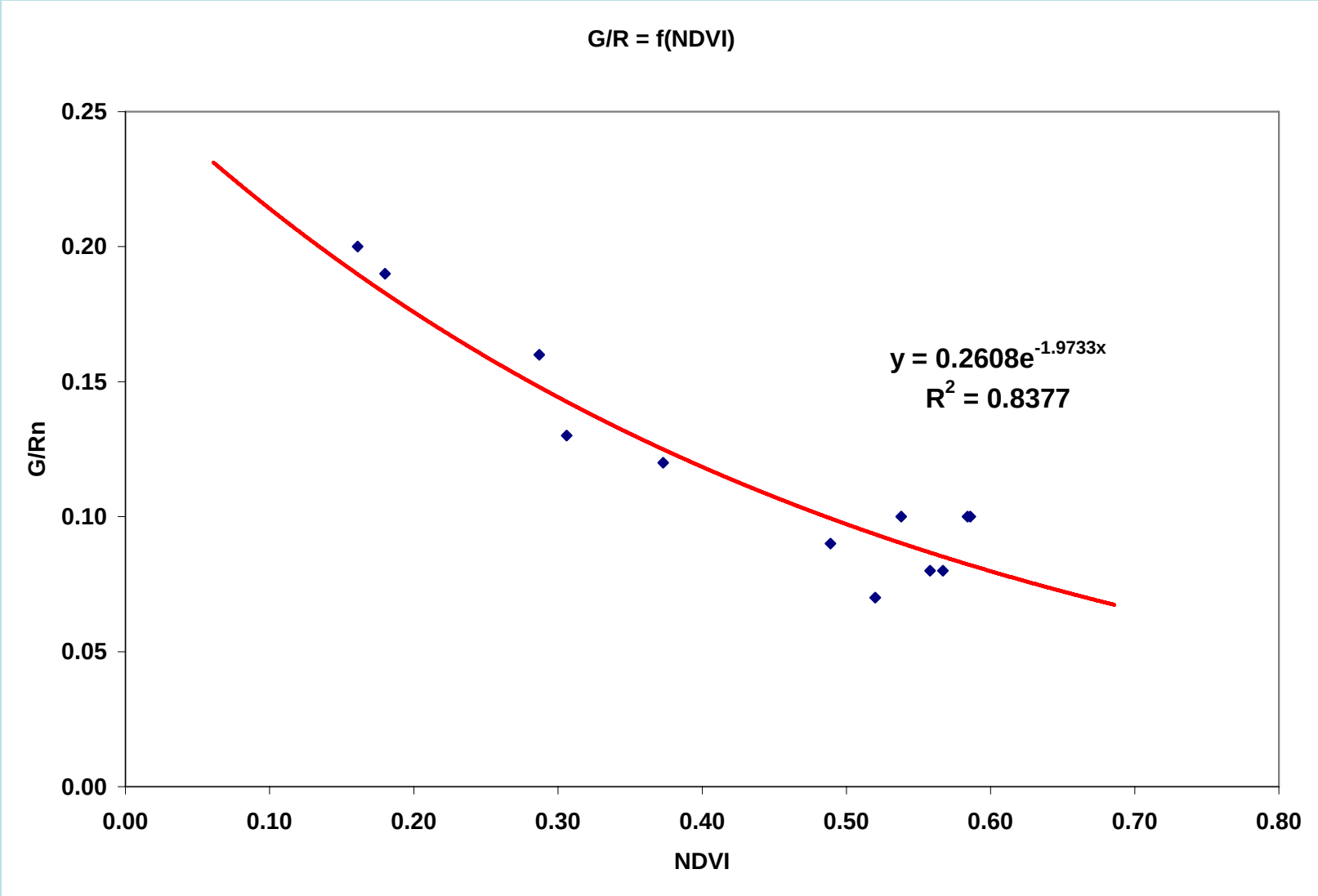
Predicting Net Radiation



Predicting Net Radiation



Estimating Ground Flux, Gn



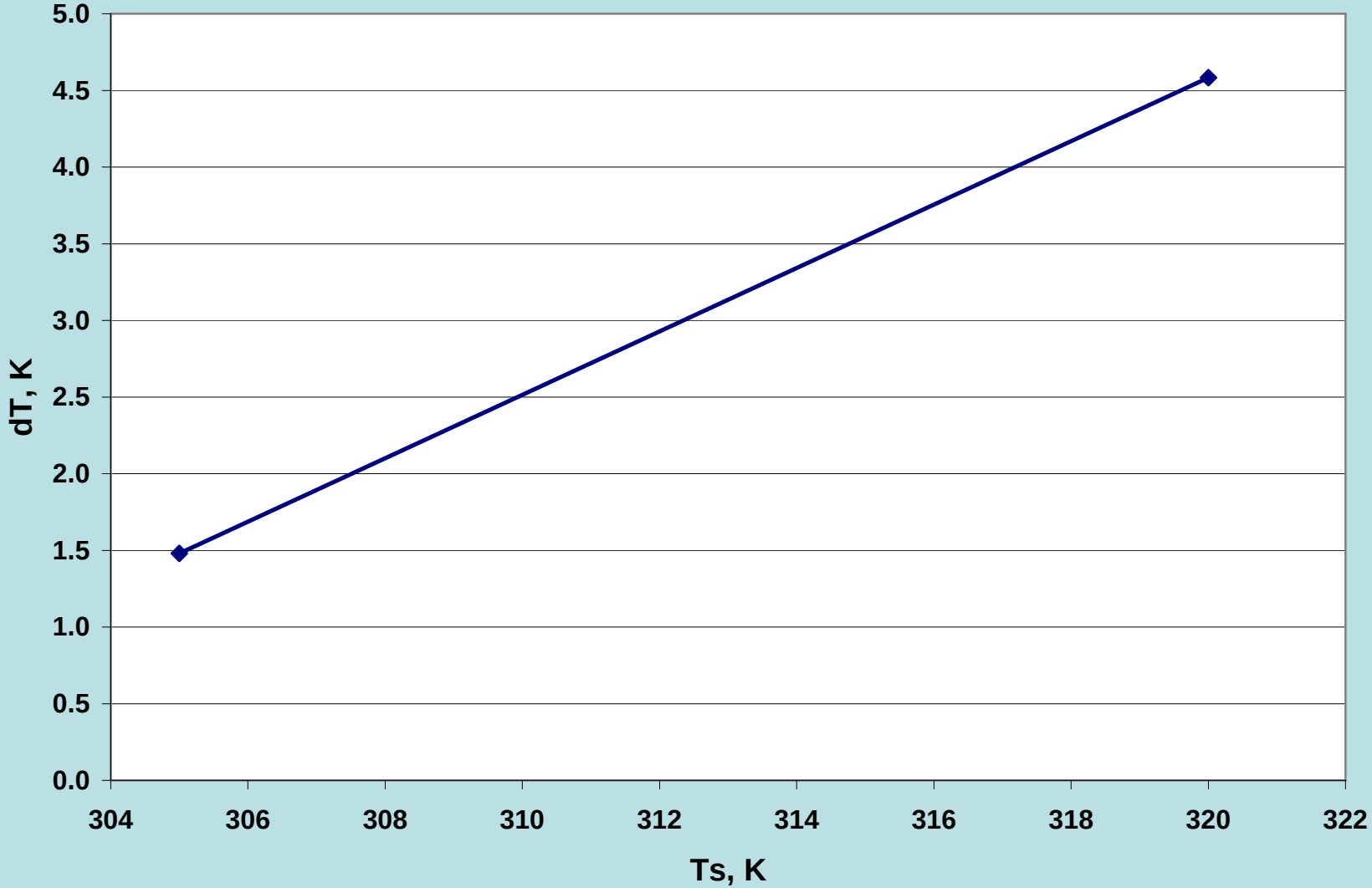
Sensible Heat is calculate at anchor points

$$ET = Rn - G - H$$

$$H = Rn - ET - G$$

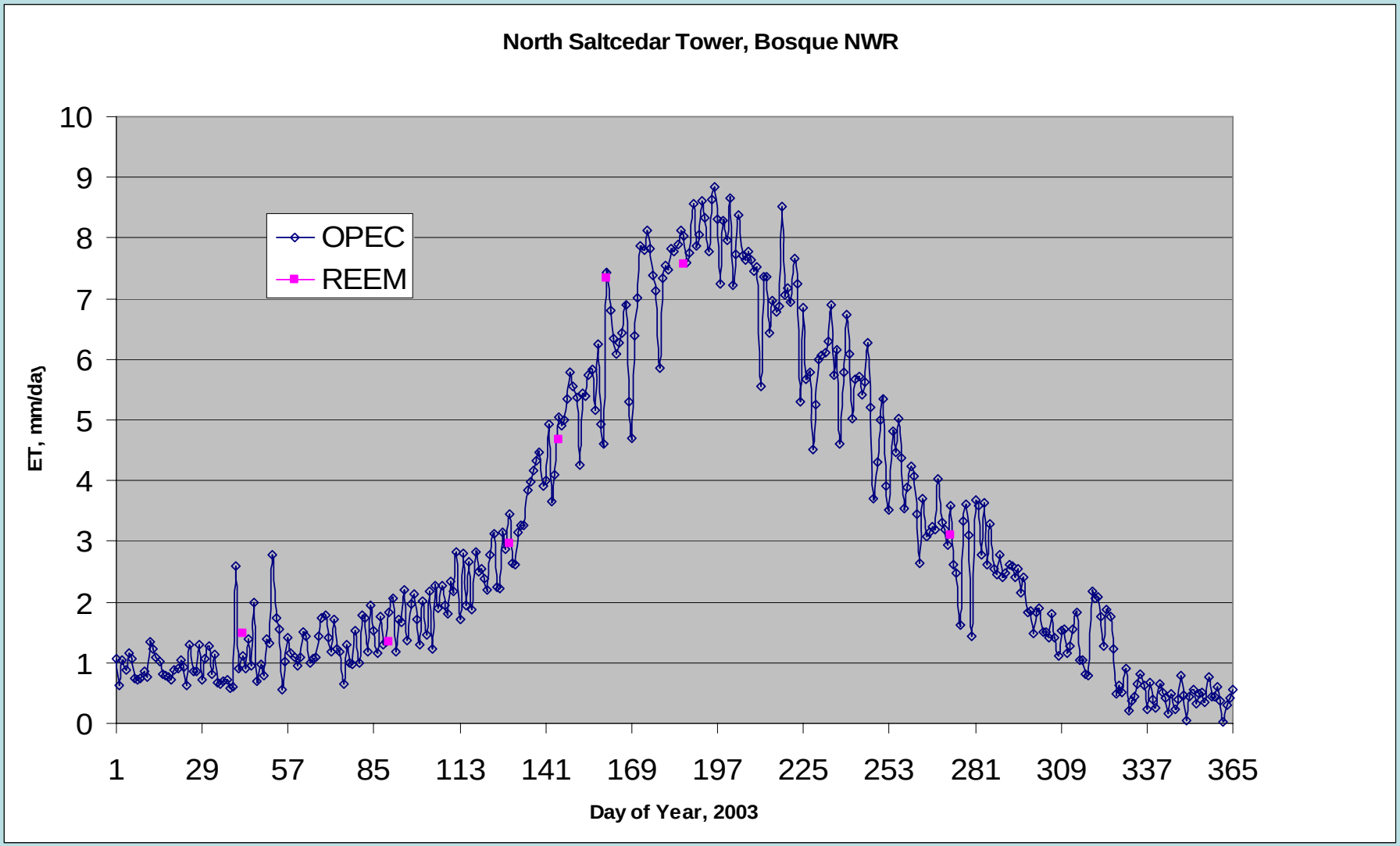
$$H = \frac{\rho . Cp . dT}{rah} + \text{Monin-Obukhov Similarity}$$

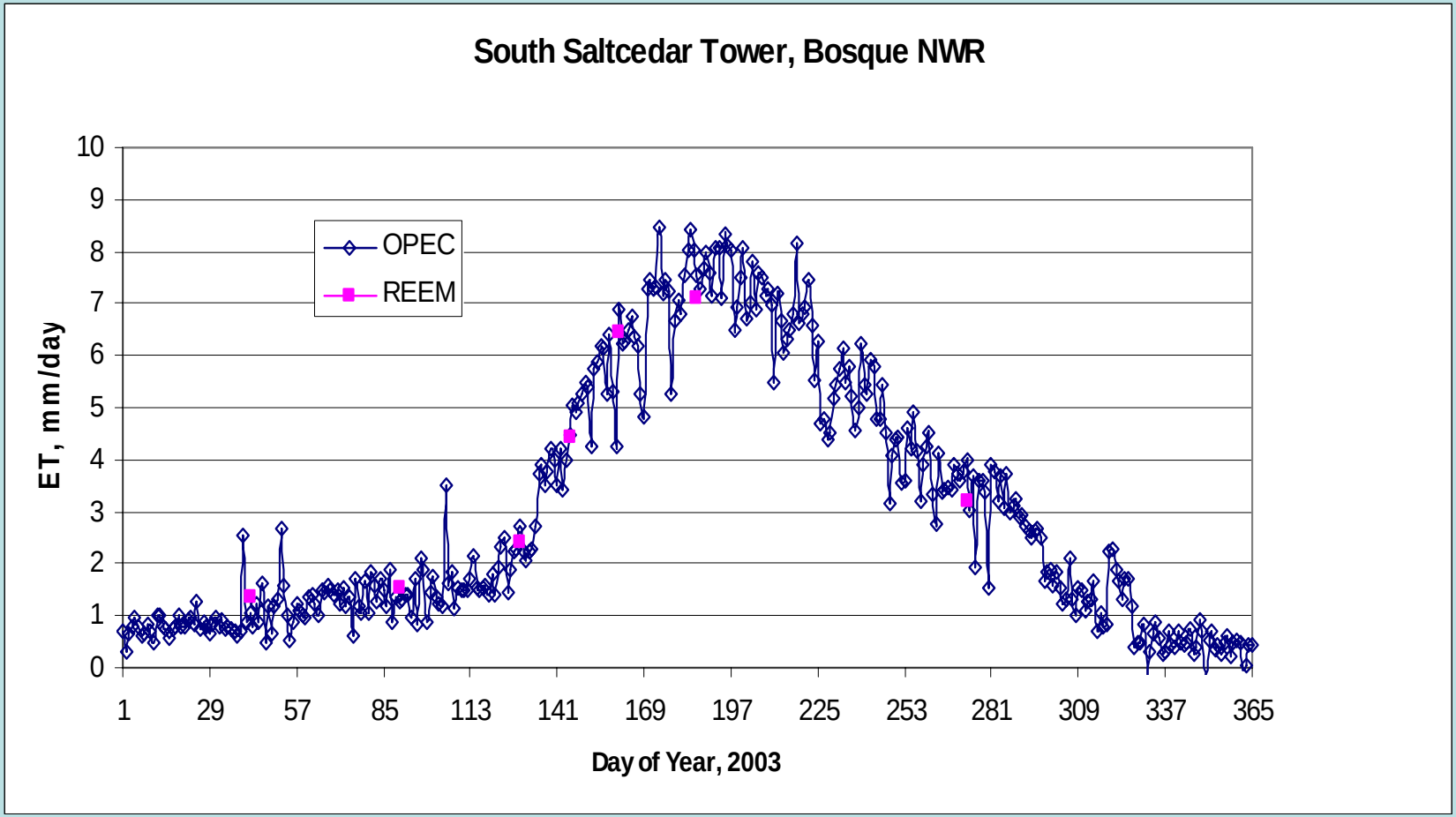
Temperature Gradient Versus Surface Temperature



Calculating Evaporative fraction, Ef

$$E_f = \frac{R_n - G - H}{R_n - G}$$


North Saltcedar Tower, Bosque NWR
ET, mm/day
Day of Year, 2003
OPEC
REEM
0
1
2
3
4
5
6
7
8
9
10
1
29
57
85
113
141
169
197
225
253
281
309
337
365


South Saltcedar Tower, Bosque NWR
ET, mm/day
Day of Year, 2003
OPEC
REEM
0
1
2
3
4
5
6
7
8
9
10
1
29
57
85
113
141
169
197
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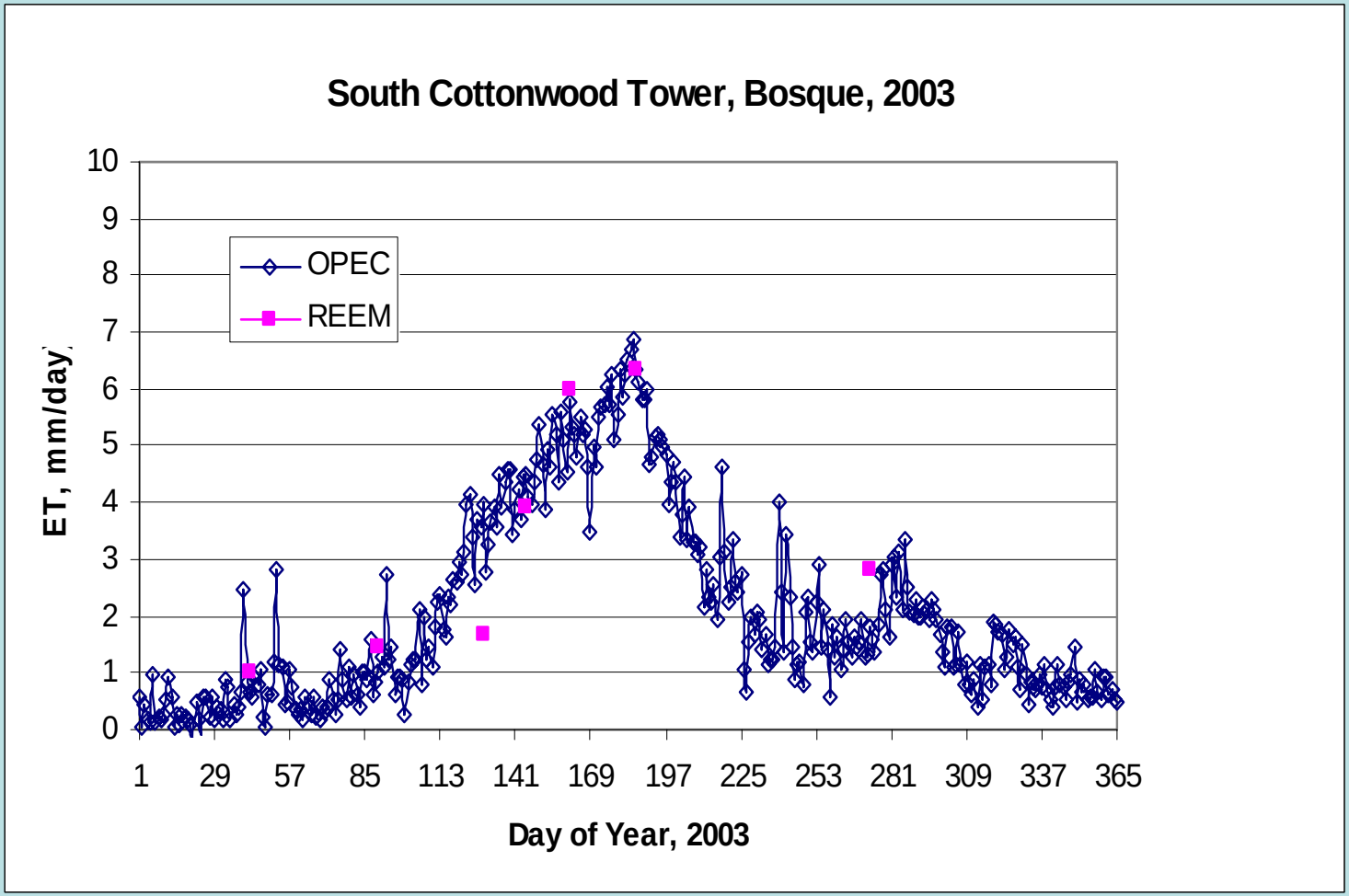
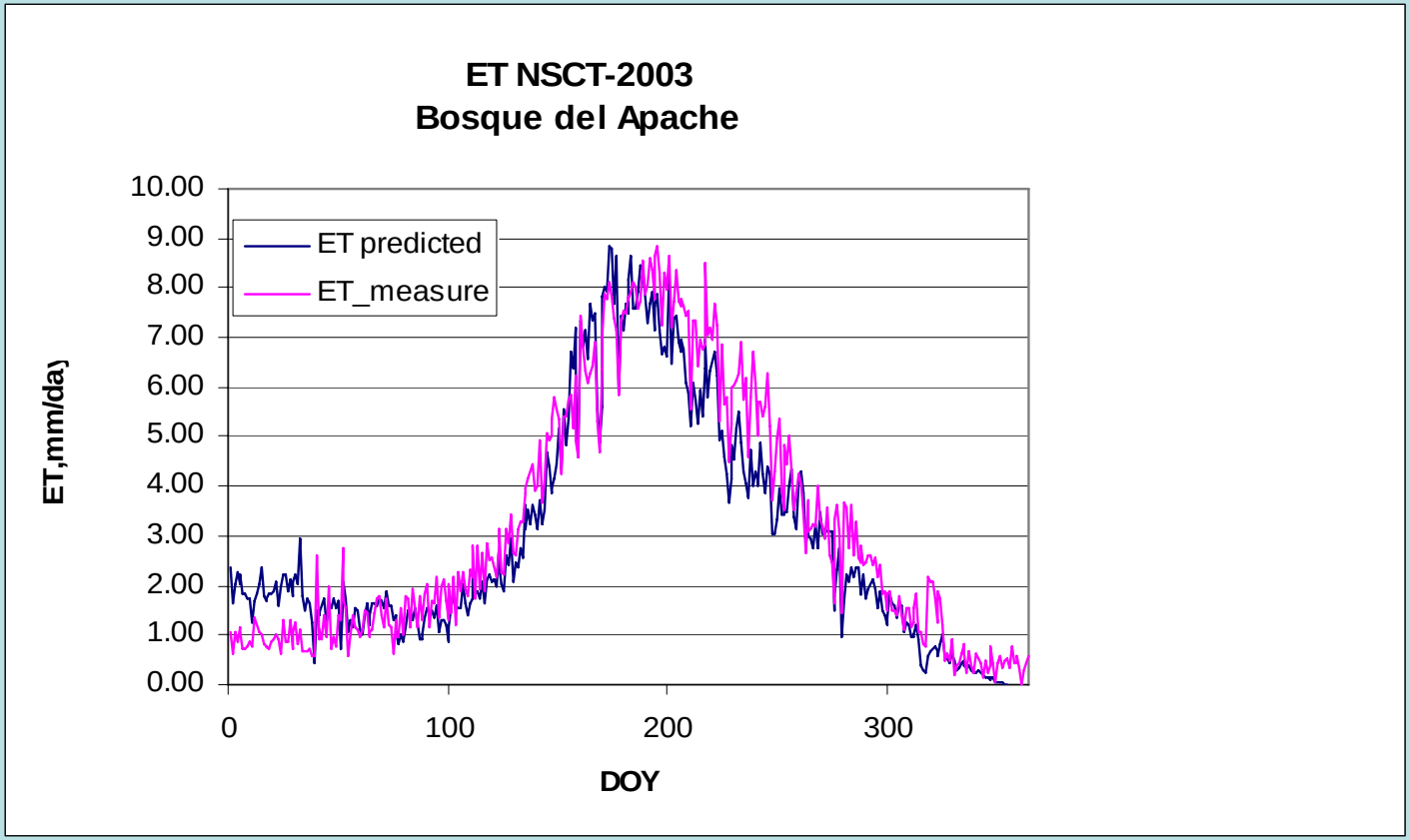
281
309
337
365


South Cottonwood Tower, Bosque, 2003
ET, mm/day
OPEC
REEM
10
9
8
7
6
5
4
3
2
1
0
1
29
57
85
113
141
169
197
225
253
281
309
337
365
Day of Year, 2003


ET NSCT-2003
Bosque del Apache
ET predicted
ET_measure
ET,mm/day
DOY
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0
100
200
300

Regional ET, Bosque, 2003