# Updating the California Irrigation Management Information System (CIMIS).

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# Overview

- CIMIS
  - Introduction and history.
  - Stations and data.
  - Users and uses.
  - Data gaps.
- Spatial CIMIS (CIMIS-GOES)
  - The CIMIS-GOES project.
  - Data collection and calculations.
  - Model refinements and future plans.
  - Demonstration.

# What is CIMIS?

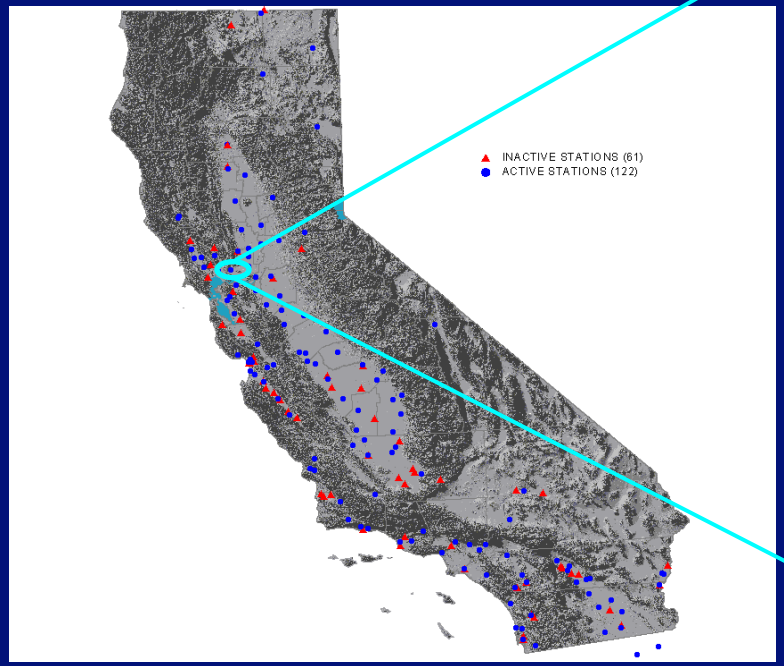
- A network of over 130 fully automated weather stations that collect weather data throughout California and provide estimates of reference evapotranspiration (ETo) to the users.

# What is ETo?

- ETo is evaporation plus transpiration from well-watered grass surfaces over which the stations stand.
- Crop coefficients (Kc) are used to convert ETo into actual ET for a specific crop (ETc).
- CIMIS uses the Modified Penman and the Penman-Monteith equations to calculate ETo.

# CIMIS station locations.

- Spatial data gaps exists.



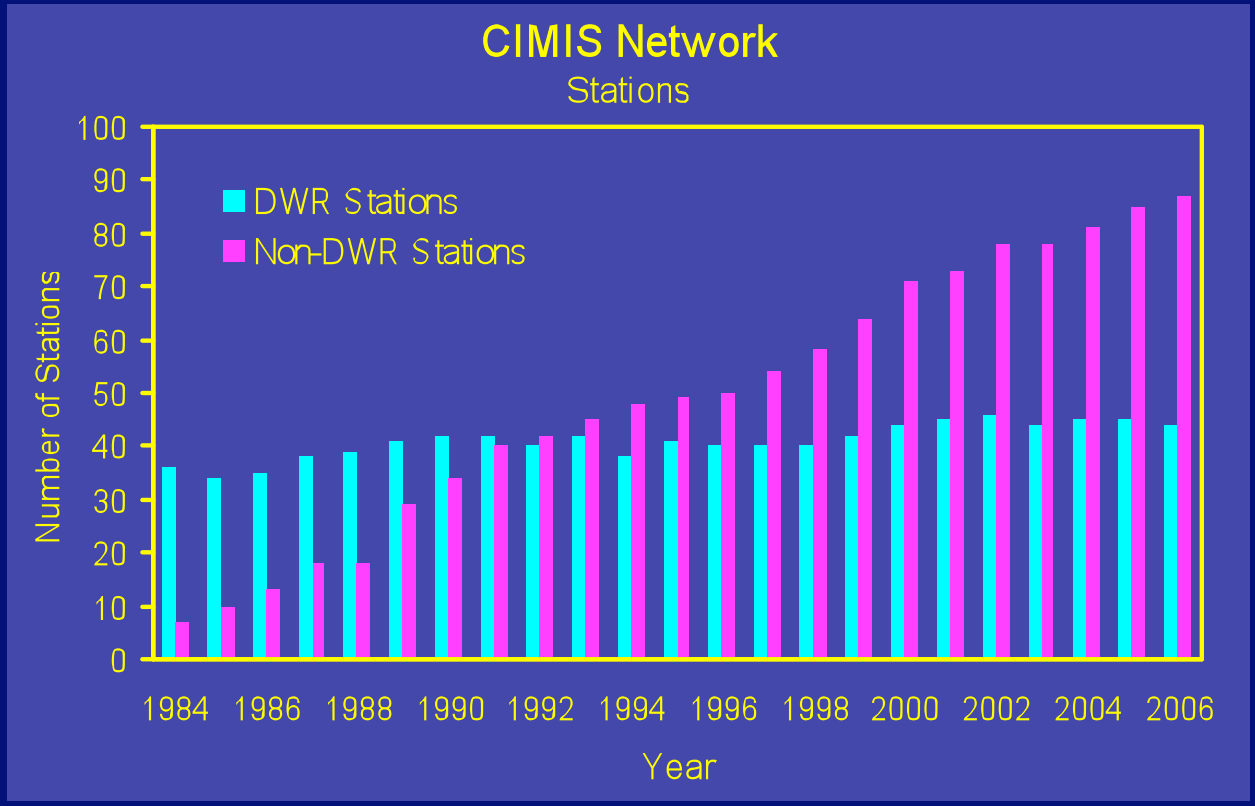
# Brief History.

- 1982 - CIMIS was developed by DWR and the University of California Davis.
- 1985 - DWR assumed control of all the management and operations of the CIMIS program.
- 2002 – data access changed to web only with FTP site for automated downloads.
- 2009/2010 – significant CIMIS upgrade.

# Ownership.

- Some CIMIS stations are owned by DWR.
- Others are owned by cooperators, such as:
  - Local water agencies.
  - Universities.
  - Cities.
  - U.S. Department of Agriculture (USDA).
  - U.S. Bureau of Reclamation (USBR).
  - Conservation Districts (CD)..
  - Private industries.

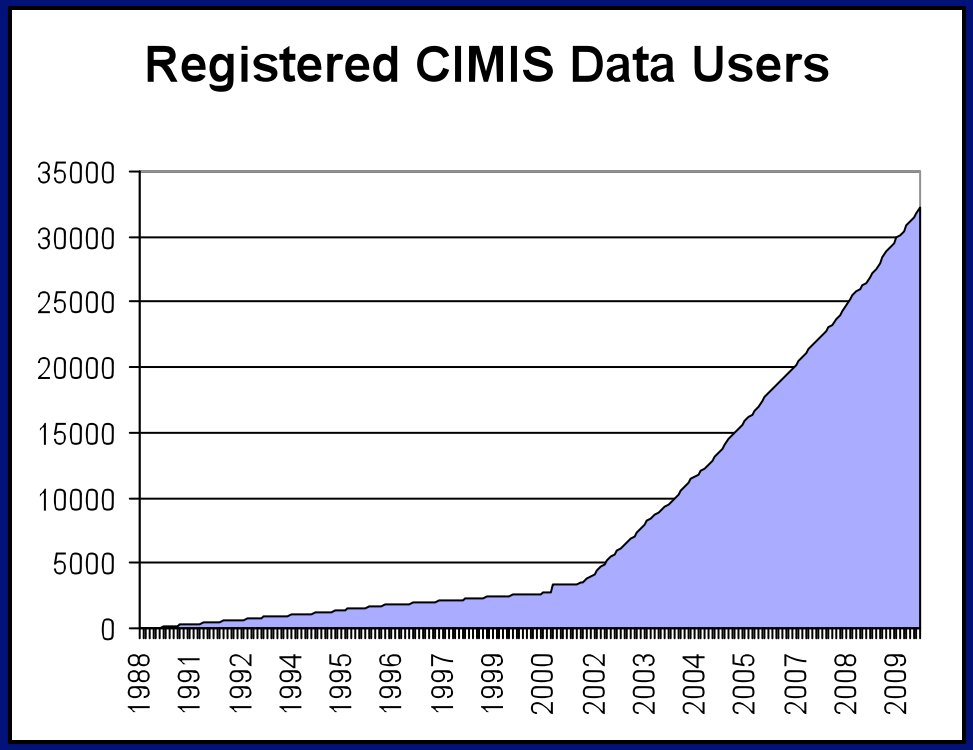
# Ownership (cont.)



# Who uses CIMIS data?

- Growers.
- Consultants.
- Water agencies.
- Public agencies.
- Home owners.
- Researchers.
- Firefighters.
- Investigators

# Registered Primary Users



# For what purposes?

- Irrigation scheduling.
- Pest management.
- Air quality monitoring.
- Firefighting.
- Modeling.
- Energy generation.
- Engineering designs.
- Weather forecasting.
- Research.

# How does CIMIS work?

- Dataloggers poll the sensors every minute.
- Solar radiation (Rs), air temperature (Ta), wind speed (U2), and Relative Humidity (RH) are measured.
- Sixty minute-by-minute readings are averaged/totaled to produce hourly data.
- Daily maximum, minimum, average, and total values are calculated by the end of each day.

# How does … (cont.)

- The CIMIS computer calls all stations every six hours and retrieves data.
- Reference evapotranspiration (ETo) is calculated.
- Data goes through quality control (QC) procedures.
- Measured and calculated parameters are stored in the CIMIS database.

# Spatial CIMIS/CIMIS-GOES

- Is a project that CIMIS initiated with UC Davis to explore the potential for using remotely sensed data for the estimation of ETo (to mitigate the spatial data gap).
- The Geostationary Operational Environmental Satellites (GOES) were selected, hence CIMIS GOES.
- Provides spatially distributed daily ETo values at 2-km resolution.

# ETo estimation.

- The ASCE version of the PM equation is used:

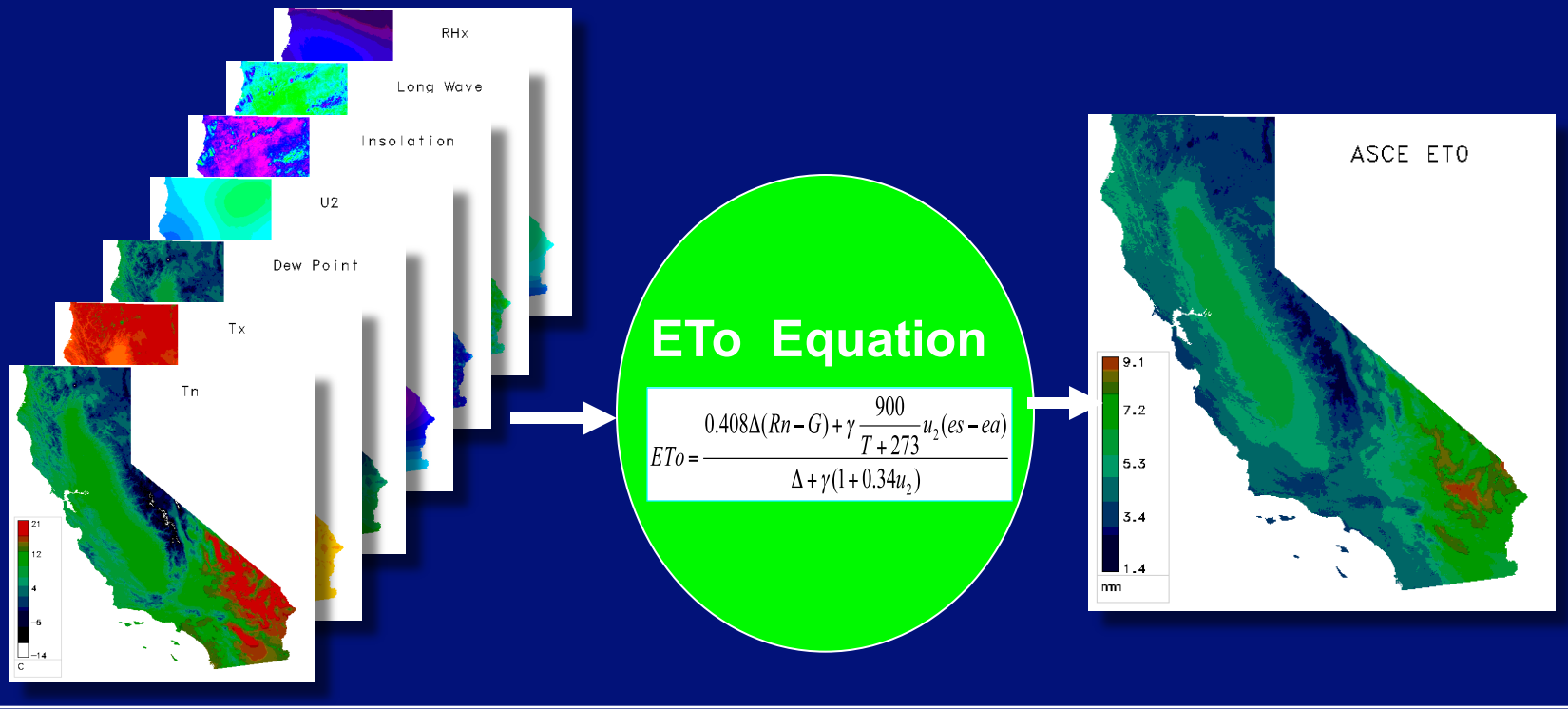
$$ETo = \frac{0.408\Delta(Rn - G) + \gamma \dfrac{900}{T + 273} u_2 (es - ea)}{\Delta + \gamma(1 + 0.34u_2)}$$

- Net radiation (Rn) is calculated from net shortwave (Rns) and net longwave (Rnl) radiations.
- Rns is calculated from solar radiation (Rs), which is in turn derived from the GOES.

# ETo Estimation (cont.)

- Rnl is calculated from air temperature, vapor pressure, and solar radiations (actual and clear sky).
- Air temperature, relative humidity, and wind speed are interpolated from CIMIS stations
- There is a plan to use the WRF model to derive some of these parameters and to forecast ETo.

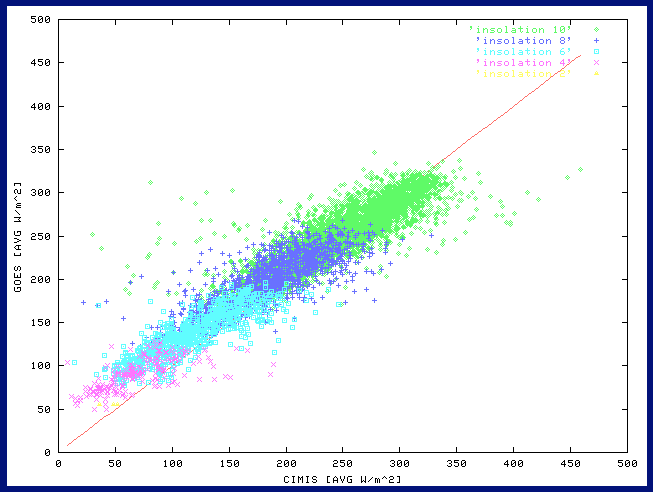
# ETo Estimation (cont.)



# Solar Radiation.

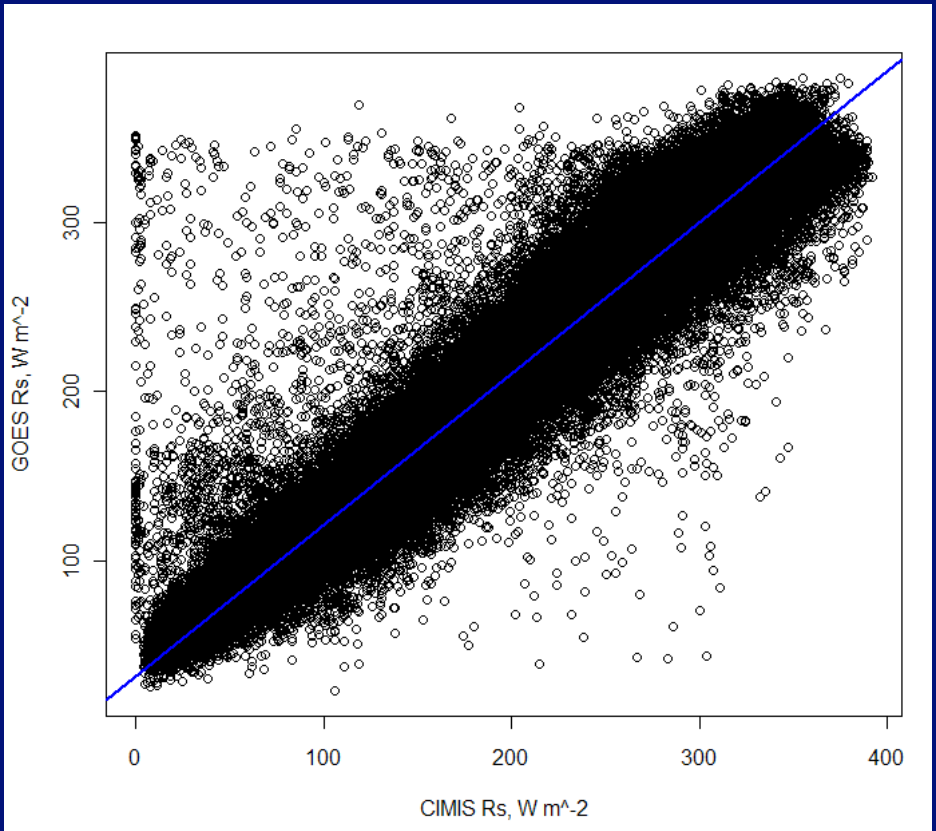
- Heliosat II model is used to estimate solar radiation.
- Cloud brightness (n) is estimated from GOES visible images.
- Clear sky factor (K) is calculated as a function of cloud brightness, K = f(n).
- Rs is then calculated from K and clear sky solar radiation (Rso).
  - Rs = K*Rso

# Solar Radiation (cont.)




- Using 3 years worth of data for comparison, the GOES Rs was higher by about 2% with an $R^2$ of 0.99.

# Solar Radiation (cont.)




$$Rsg = 0.89\,Rsc + 31.9$$

$$r^2 = 0.94$$

# Ta, RH, and U2.

- Two interpolation methods were used; DayMet and Spline.
- DayMet - generates daily surfaces of temperature, humidity, precipitation, and radiation over large regions of complex terrain using truncated Gaussian weighting filter.
- Spline – fits a surface through or near known points using a function with continuous derivatives

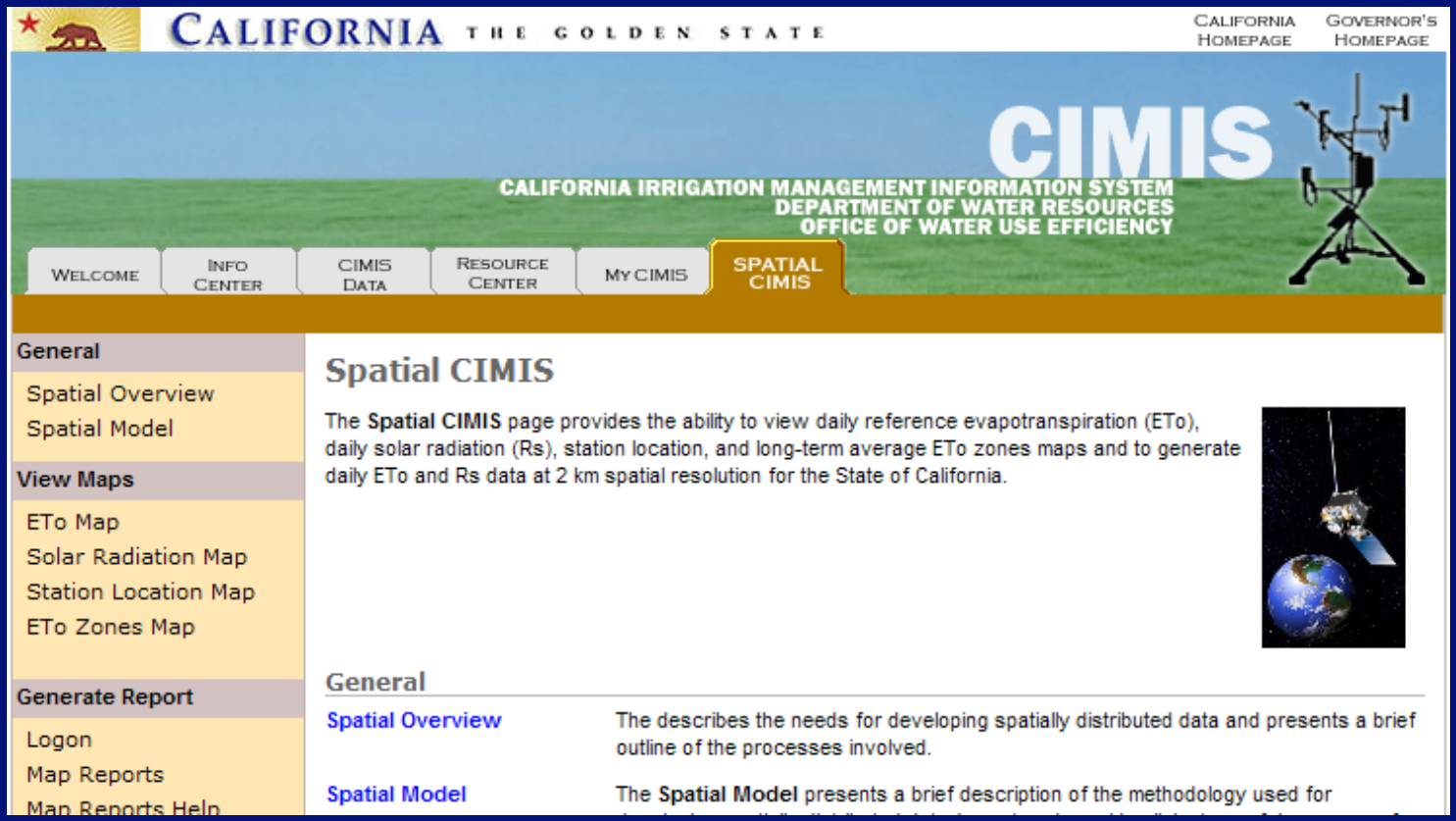
# Model Refinements.

- Snow versus cloud.
- Surface reflectance (albedo) values.
- Turbidity.
- Interpolation versus model.

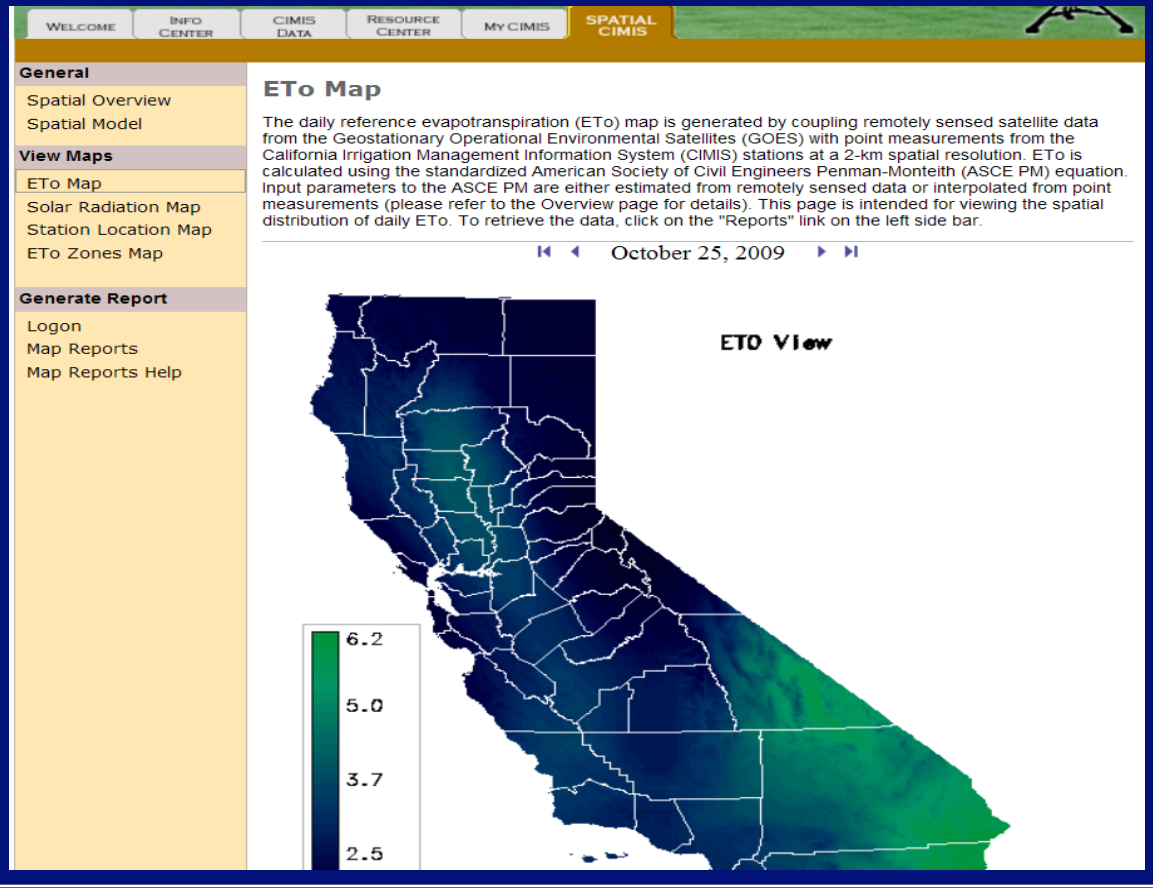
# Future Plans.

- ETo forecast.
- Land use and crop-coefficient (Kc) maps.
- Interactive data delivery with improved features.

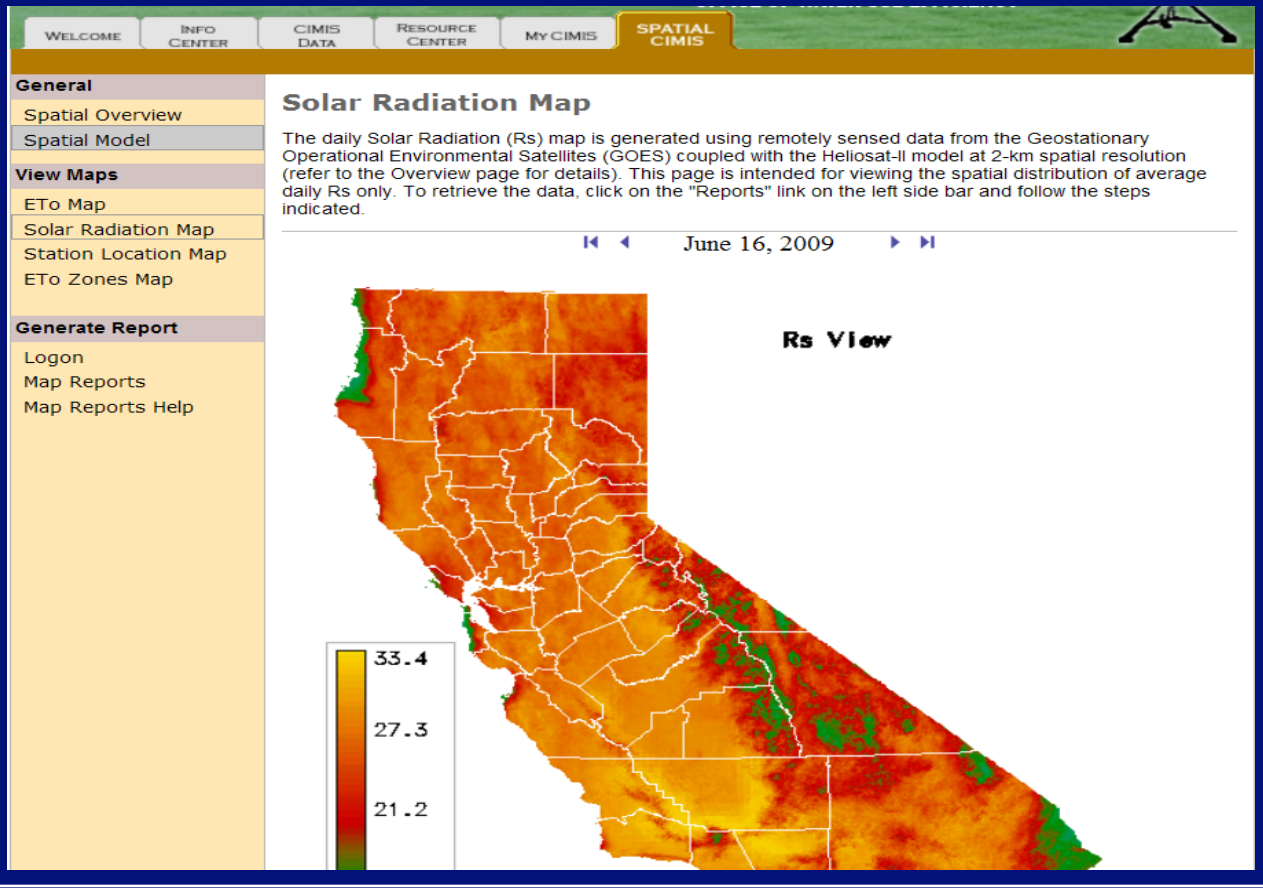
# Spatial CIMIS.



# View ETo Map.


WELCOME
INFO CENTER
CIMIS DATA
RESOURCE CENTER
MY CIMIS
SPATIAL CIMIS
General
Spatial Overview
Spatial Model
View Maps
ETo Map
Solar Radiation Map
Station Location Map
ETo Zones Map
Generate Report
Logon
Map Reports
Map Reports Help
ETo Map
The daily reference evapotranspiration (ETo) map is generated by coupling remotely sensed satellite data from the Geostationary Operational Environmental Satellites (GOES) with point measurements from the California Irrigation Management Information System (CIMIS) stations at a 2-km spatial resolution. ETo is calculated using the standardized American Society of Civil Engineers Penman-Monteith (ASCE PM) equation. Input parameters to the ASCE PM are either estimated from remotely sensed data or interpolated from point measurements (please refer to the Overview page for details). This page is intended for viewing the spatial distribution of daily ETo. To retrieve the data, click on the "Reports" link on the left side bar.
October 25, 2009
ETO View
6.2
5.0
3.7
2.5

# View Rs Map.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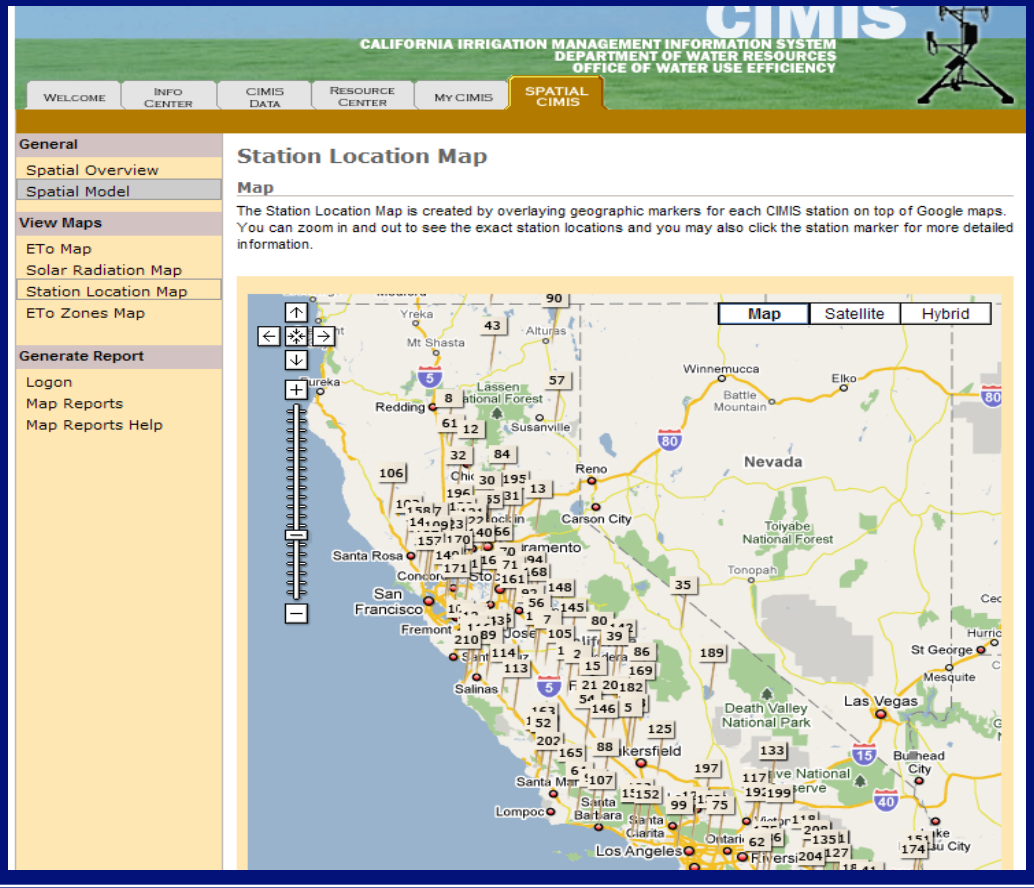
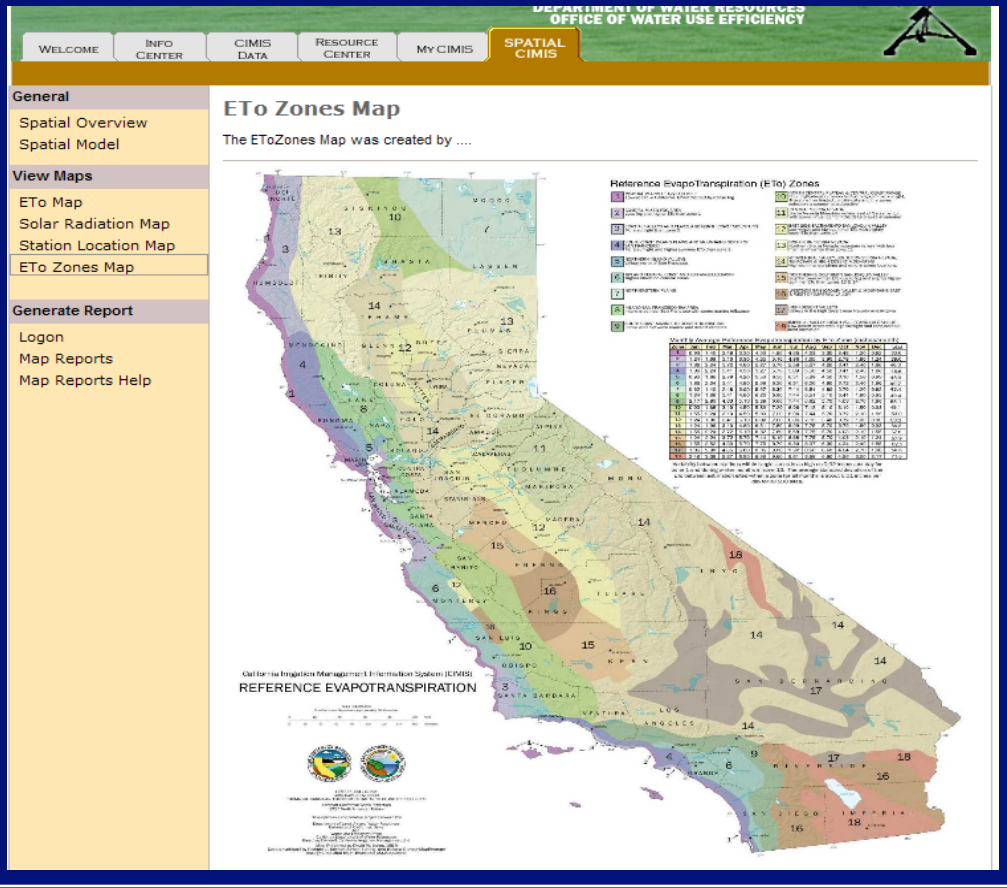
Map Reports
Map Reports Help
Solar Radiation Map
The daily Solar Radiation (Rs) map is generated using remotely sensed data from the Geostationary Operational Environmental Satellites (GOES) coupled with the Heliosat-II model at 2-km spatial resolution (refer to the Overview page for details). This page is intended for viewing the spatial distribution of average daily Rs only. To retrieve the data, click on the "Reports" link on the left side bar and follow the steps indicated.
June 16, 2009
Rs View
33.4
27.3
21.2

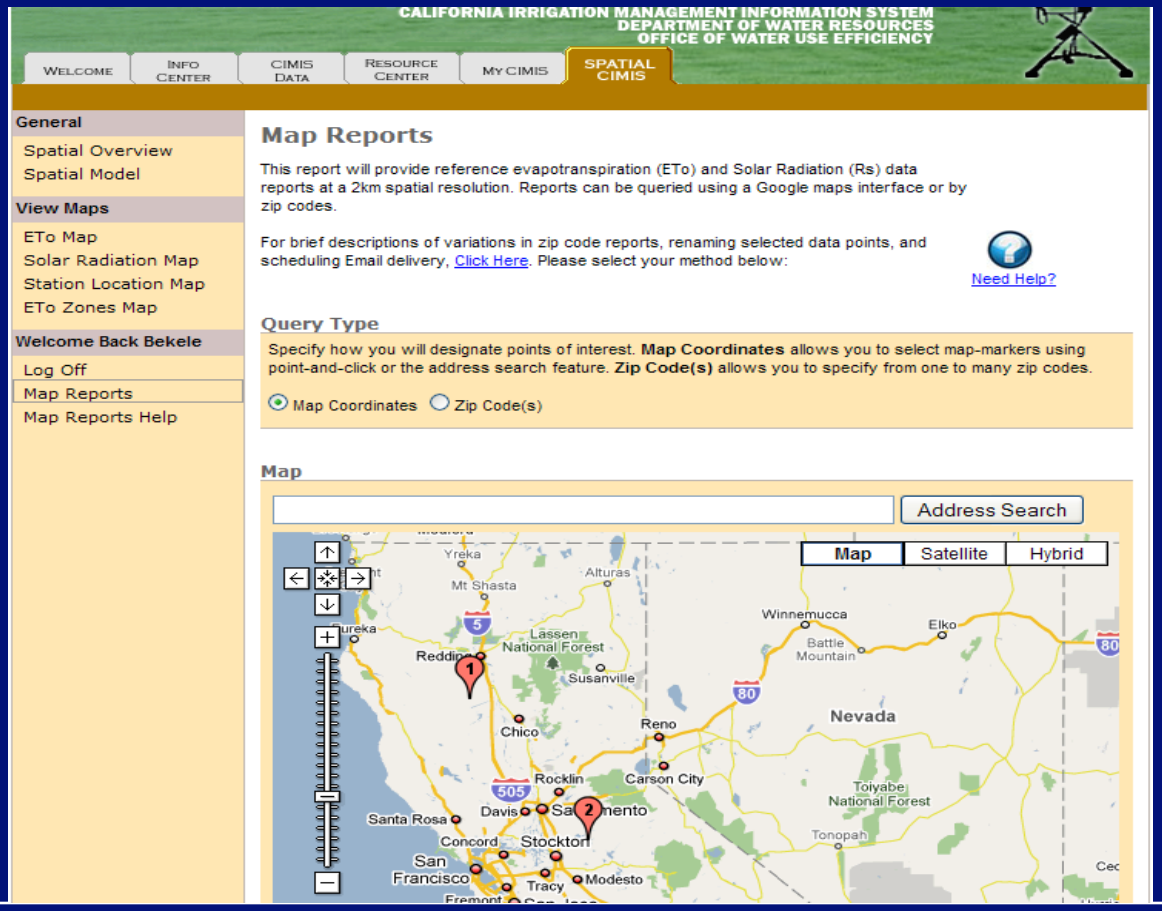
# View Station Locations.



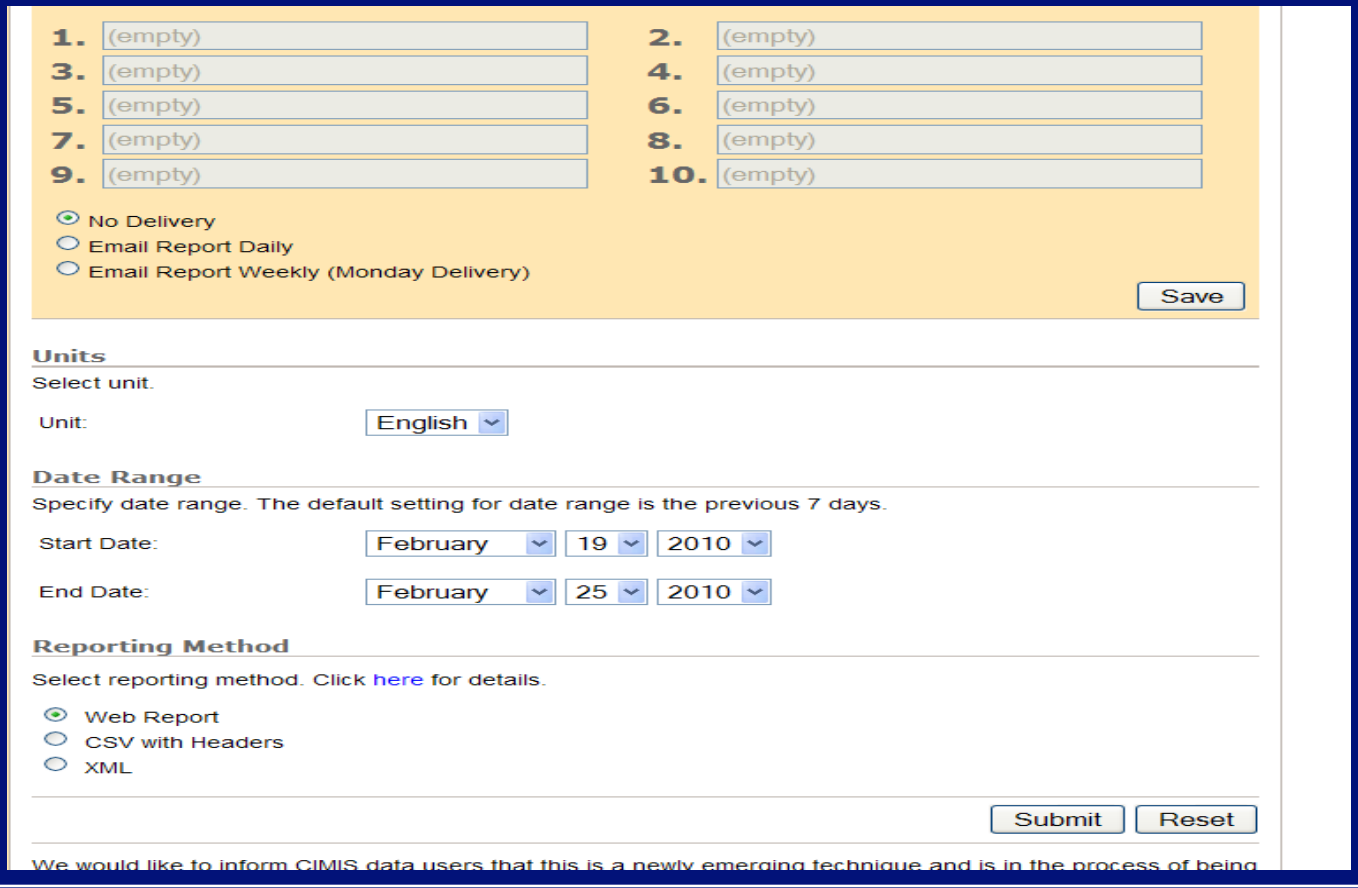
# View ETo Zones Map.



# Map Reports.


CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEM
DEPARTMENT OF WATER RESOURCES
OFFICE OF WATER USE EFFICIENCY
WELCOME
INFO CENTER
CIMIS DATA
RESOURCE CENTER
MY CIMIS
SPATIAL CIMIS
General
Spatial Overview
Spatial Model
View Maps
ETo Map
Solar Radiation Map
Station Location Map
ETo Zones Map
Welcome Back Bekele
Log Off
Map Reports
Map Reports Help
Map Reports
This report will provide reference evapotranspiration (ETo) and Solar Radiation (Rs) data reports at a 2km spatial resolution. Reports can be queried using a Google maps interface or by zip codes.
For brief descriptions of variations in zip code reports, renaming selected data points, and scheduling Email delivery, Click Here. Please select your method below:
Need Help?
Query Type
Specify how you will designate points of interest. Map Coordinates allows you to select map-markers using point-and-click or the address search feature. Zip Code(s) allows you to specify from one to many zip codes.
Map Coordinates
Zip Code(s)
Map
Address Search
Map
Satellite
Hybrid
Yreka
Mt Shasta
Alturas
Lassen National Forest
Susanville
Chico
Reno
Nevada
Winnemucca
Elko
Battle Mountain
Rocklin
Carson City
Toiyabe National Forest
Davis
Santa Rosa
Concord
Stockton
San Francisco
Modesto
Tracy
Tonopah

# Map Reports (cont.)



# Spatial CIMIS Report.

Return to Report Criteria

CIMIS (California Irrigation Management Information System)

## CIMIS-GOES Report

Rendered in English Units.
August 26, 2009 - September 01, 2009
Printed on September 02, 2009

### Point #1 - (40.3060, -122.5708)

| Date | ETo (in/day) | Rs (Ly/day) |
|---|---|---|
| 08/26/2009 | 0.23 | 581.98 |
| 08/27/2009 | 0.22 | 576.86 |
| 08/28/2009 | 0.16 | 312.21 |
| 08/29/2009 | 0.26 | 570.89 |
| 08/30/2009 | 0.24 | 568.06 |
| 08/31/2009 | 0.22 | 566.06 |
| 09/01/2009 | 0.19 | 556.51 |
| Totals/Avgs | 1.52 | 533.23 |

### Point #2 - (38.4829, -120.8729)

| Date | ETo (in/day) | Rs (Ly/day) |
|---|---|---|
| 08/26/2009 | 0.23 | 580.81 |
| 08/27/2009 | 0.24 | 568.59 |
| 08/28/2009 | 0.22 | 502.00 |
| 08/29/2009 | 0.26 | 585.75 |
| 08/30/2009 | 0.27 | 567.02 |
| 08/31/2009 | 0.23 | 562.96 |
| 09/01/2009 | 0.23 | 571.08 |
| Totals/Avgs> | 1.67 | 562.60 |

# Contacts.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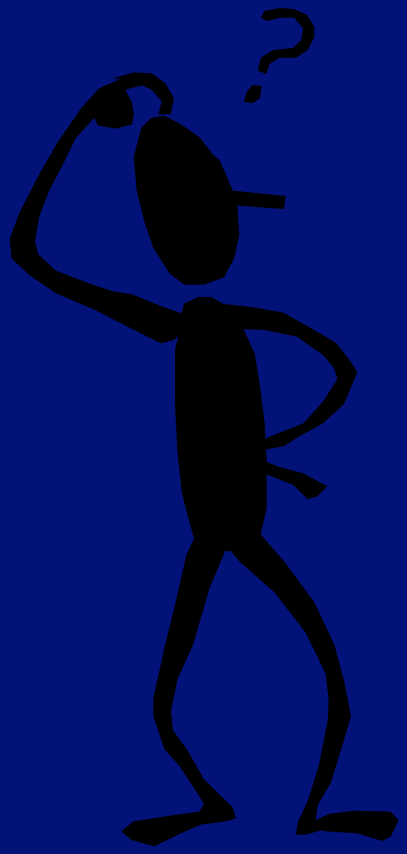
# Questions?