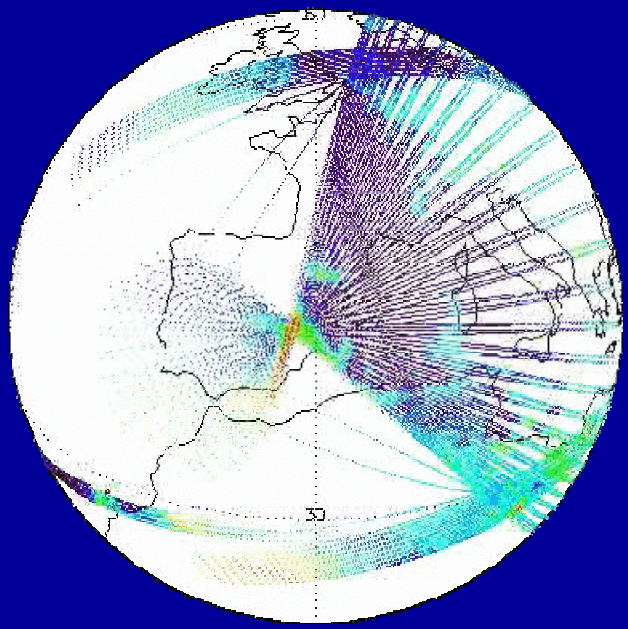
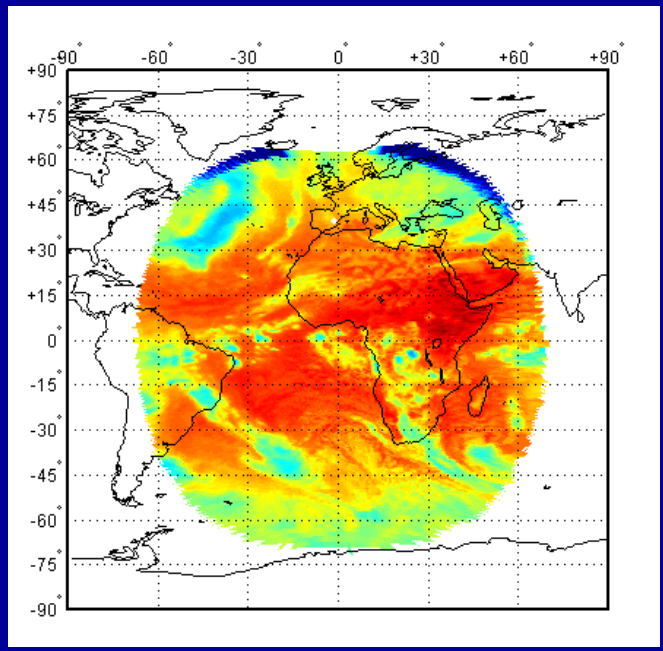
Validation Activities at the *VALENCIA ANCHOR STATION*

Almudena Velazquez, Ernesto Lopez-Baeza & the SCALES Project Team





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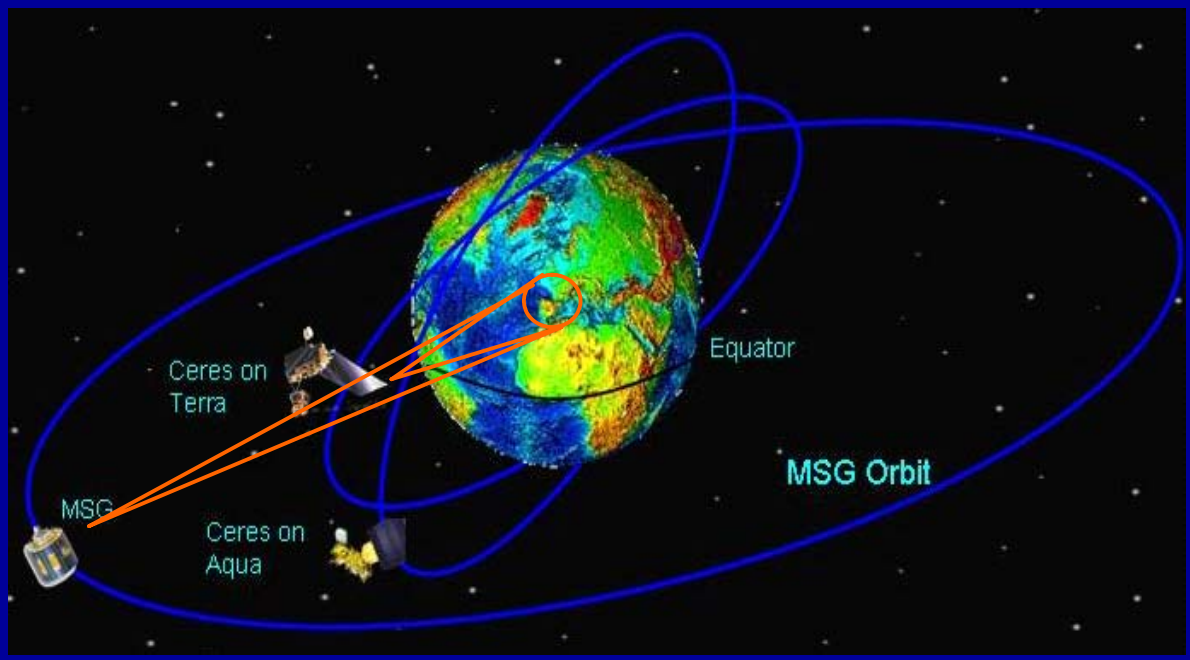
1. Objetives

- The principal aim of the SCALES project is:

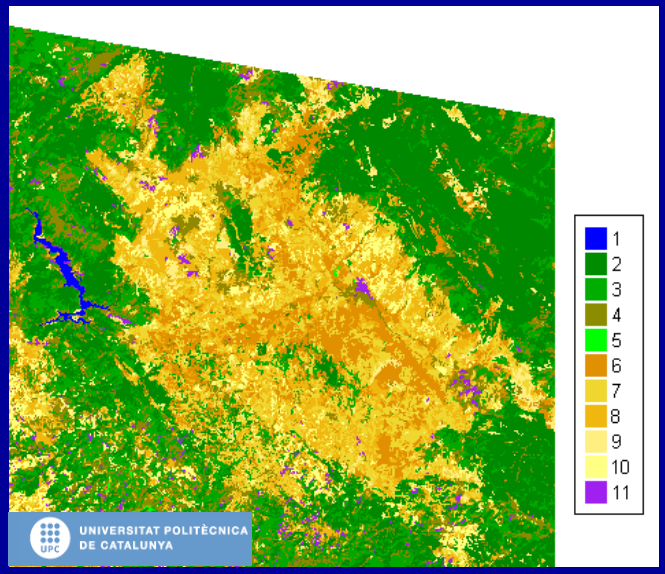
  to validate low spatial resolution remote sensing data and products from independent surface measurements.

  The natural application for this is the intercomparison between GERB and CERES when observing the same study area.

- To achieve that, we are simulating TOA CERES and GERB radiances and/or fluxes from VAS campaign measurements



Study area (I)



Land Use Classification

1: water
2: pine trees
3: low density pine trees and matorral
4: matorral
5: irrigated crops
6: vineyards
7: low density vineyards
8: very low density vineyards
9: herbal crops
10: bare soil
11: urban areas

In winter

(20x20 km² pixel)

76.6%: bare soil

23.4%: pine trees and shrubs

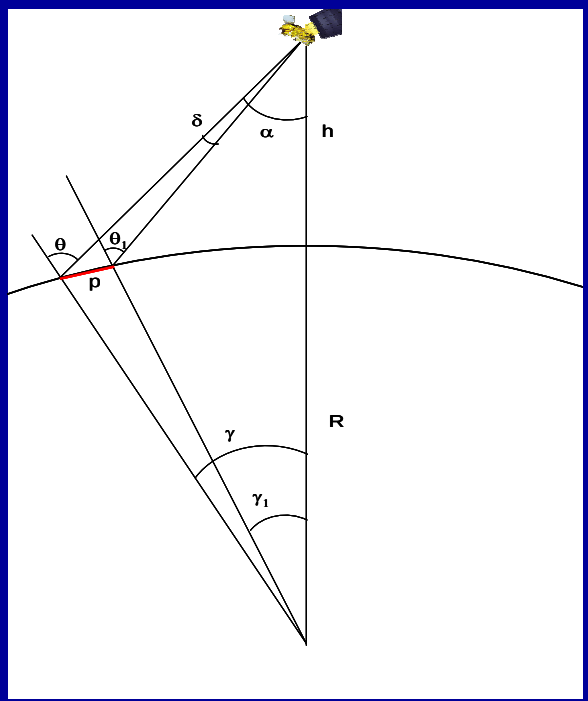
Study area (II)

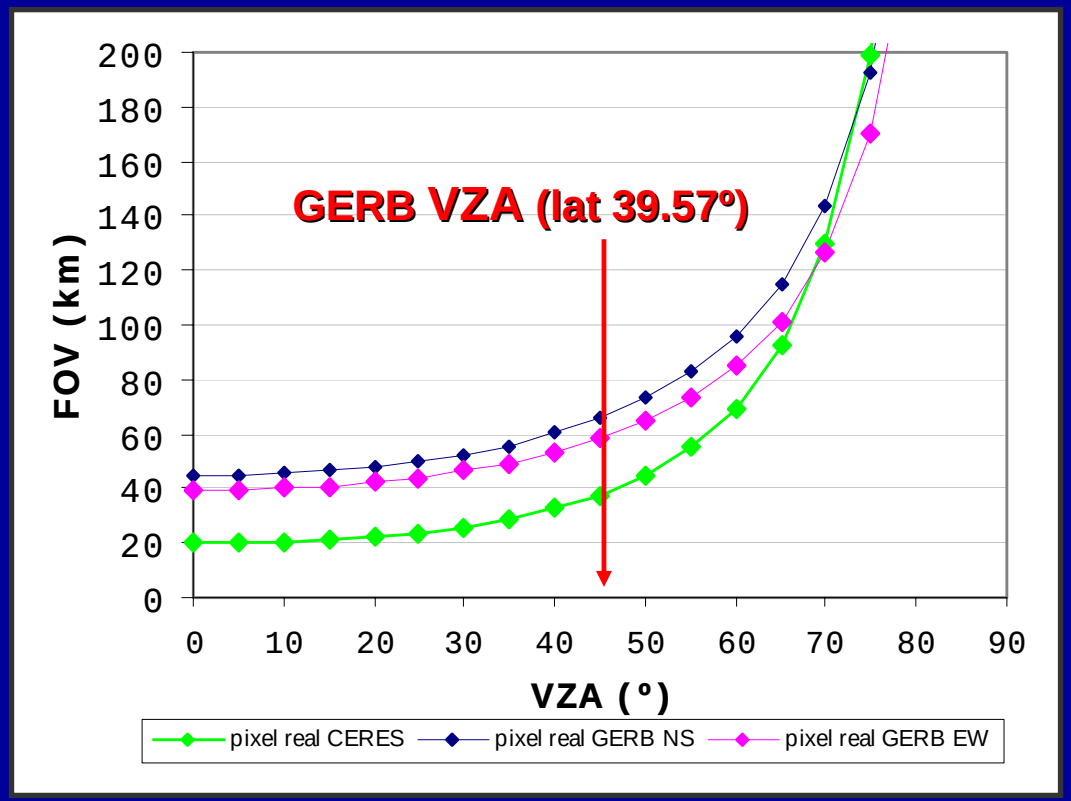
Ground Validation Campaign
February 2004

Ground Validation Campaign June 2003

Footprint size

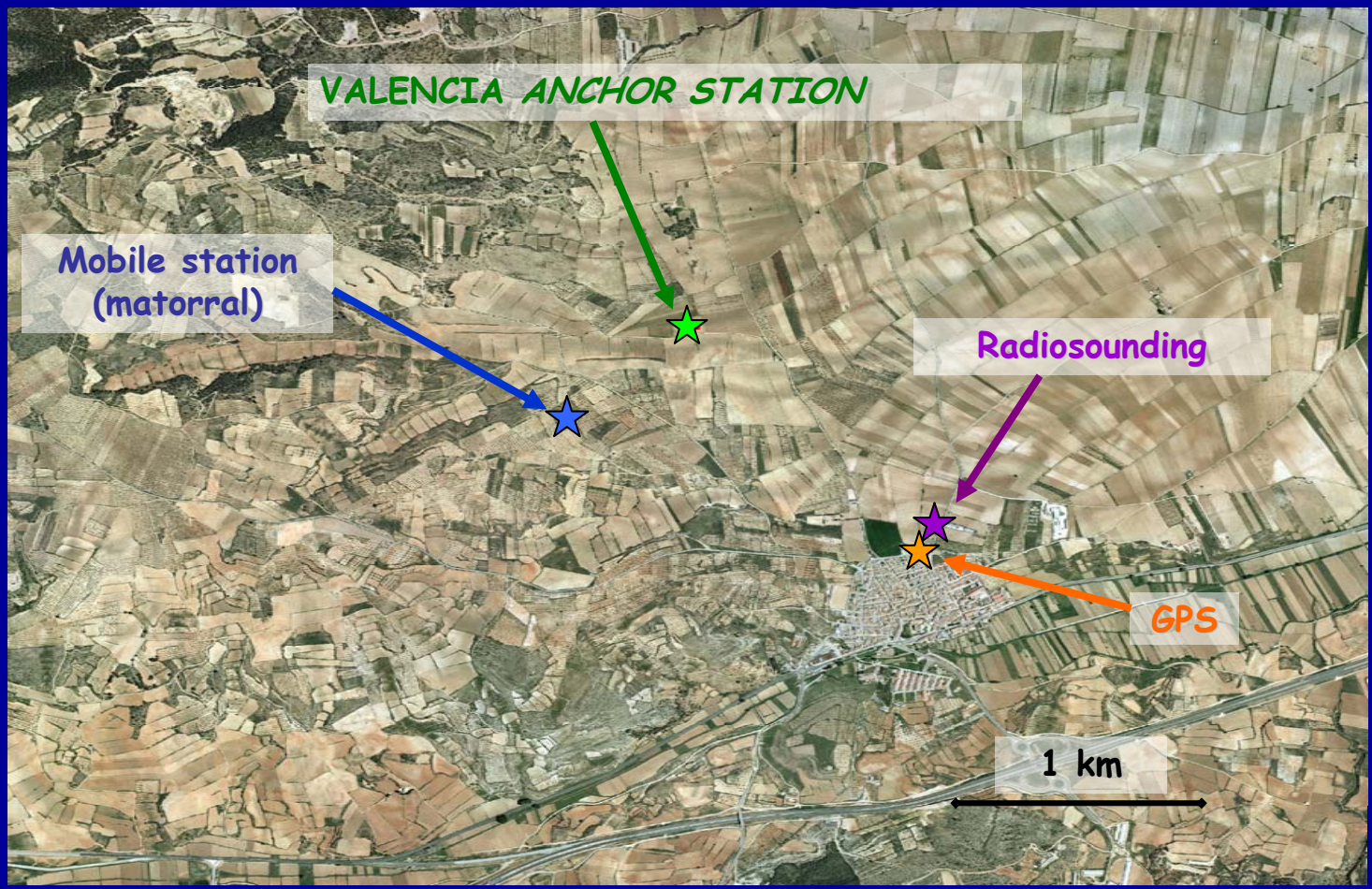
GERB and CERES pixel size vs VZA



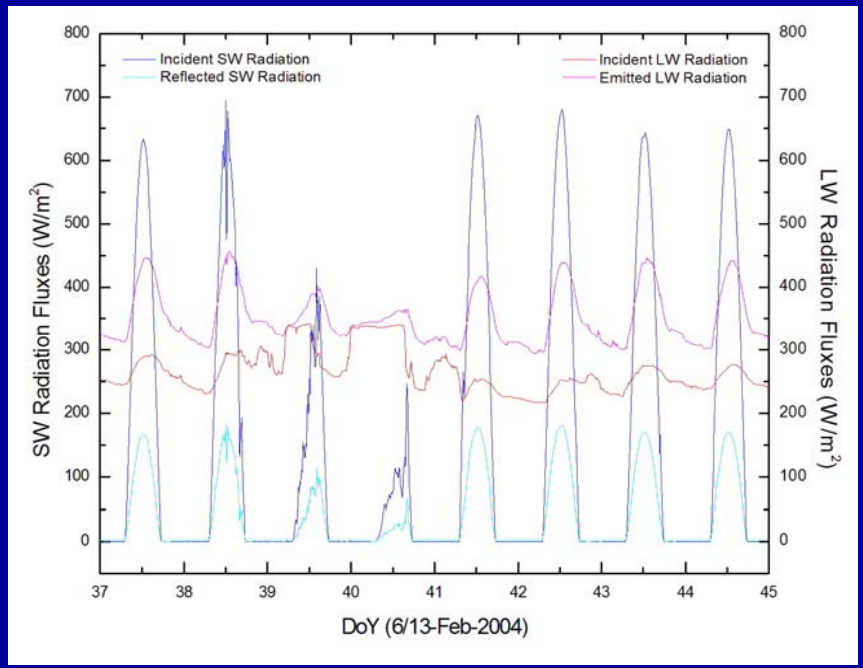


$$P \approx 2 \cdot p = R \cdot (\gamma - \gamma_1) = 2 \cdot R \cdot (\theta - \theta_1 - \delta) = 2 \cdot R \left(\cdot \theta - sen^{-1} \left(\frac{R+h}{R} \cdot sen(\alpha - \delta) \right) - \delta \right)$$

2. February 2004 Ground Validation Campaign outcome



Radiation fluxes measured at the VAS



NOAA images

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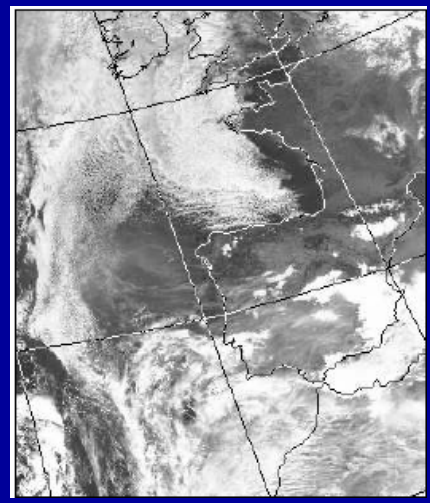

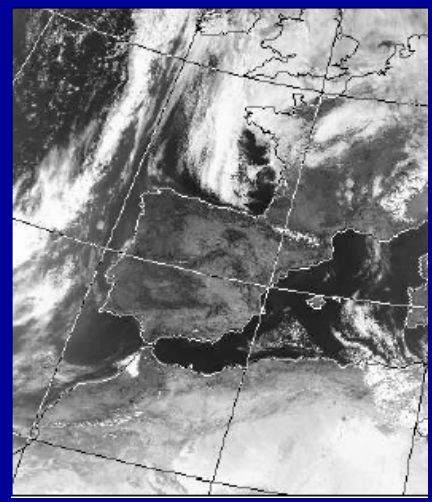

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Radiosounding data

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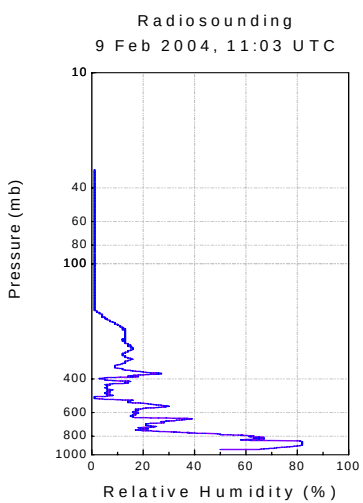

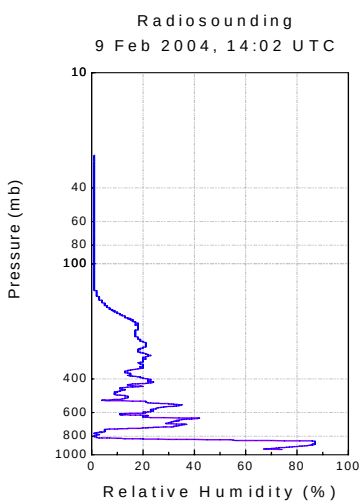

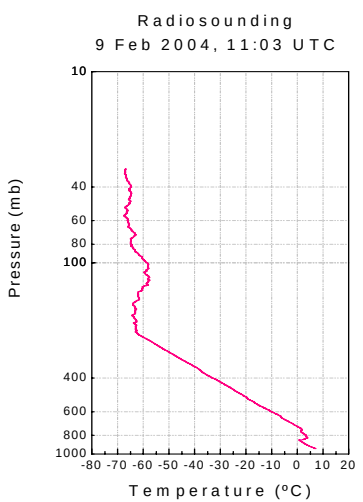

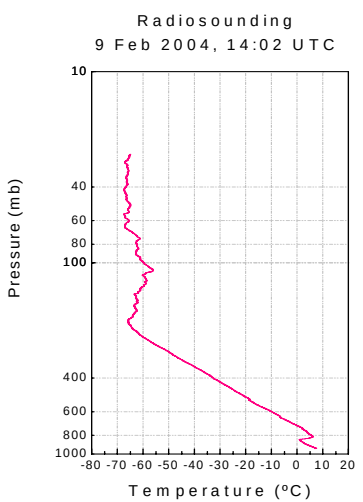

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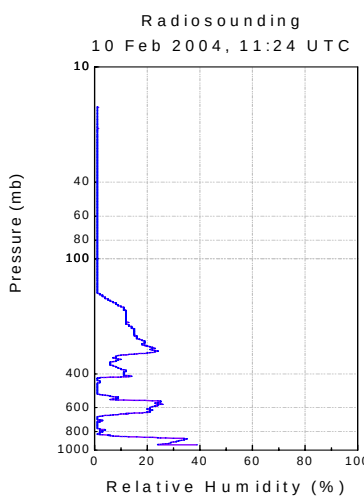

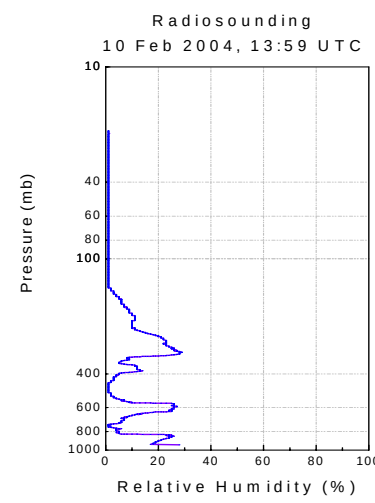

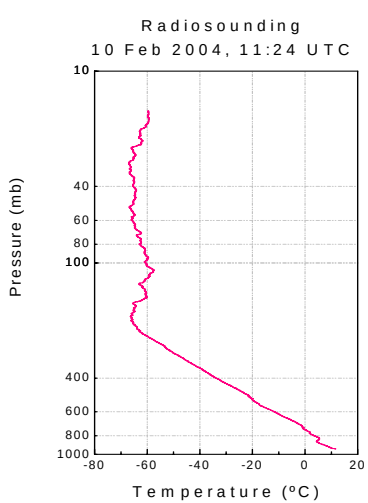

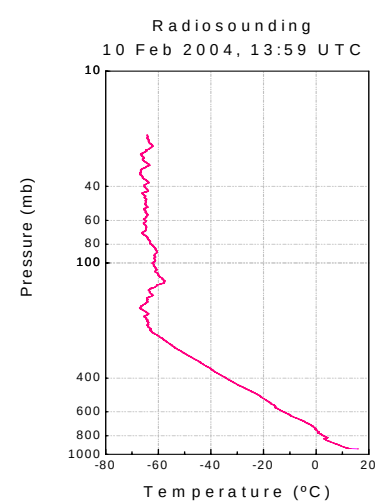

Radiosounding data

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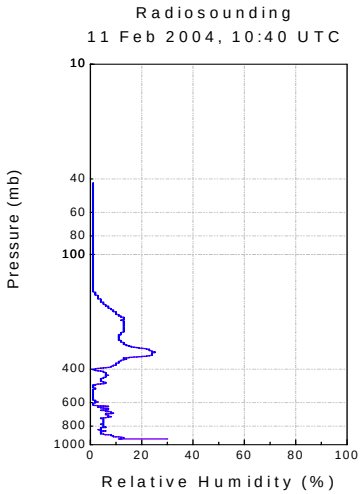

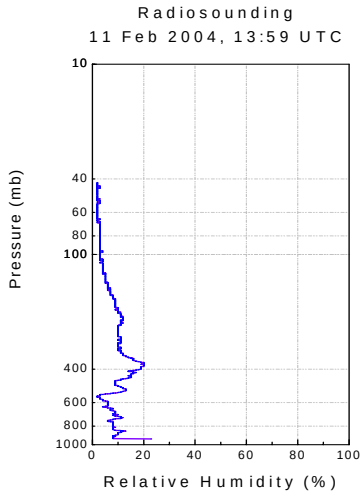

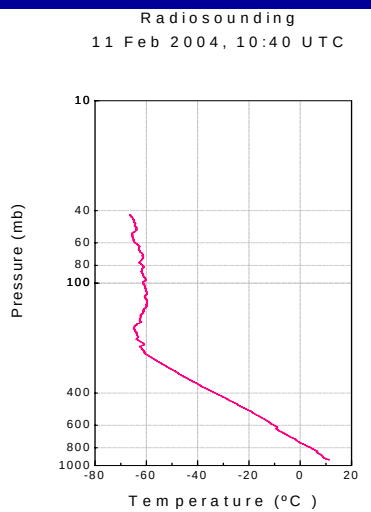

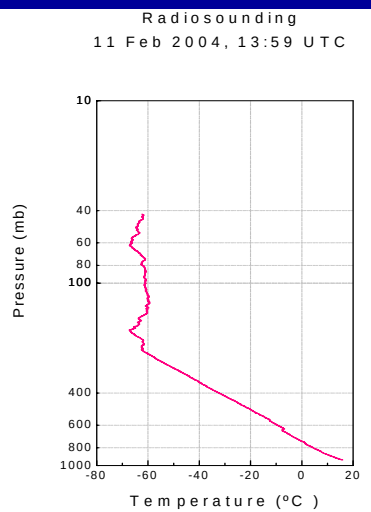

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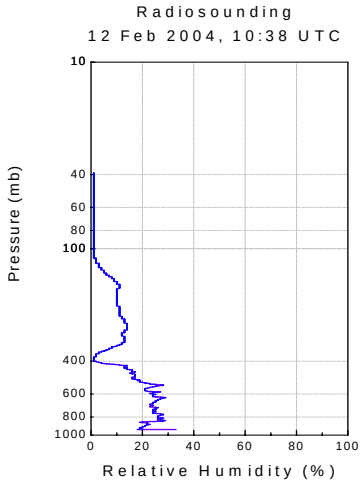
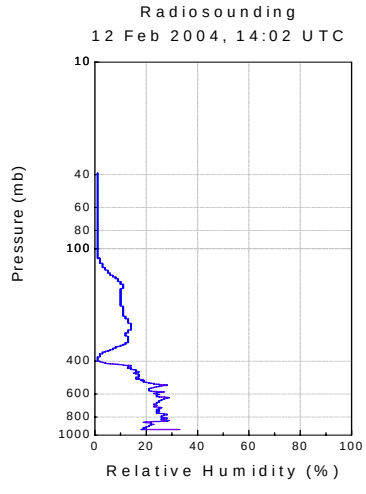
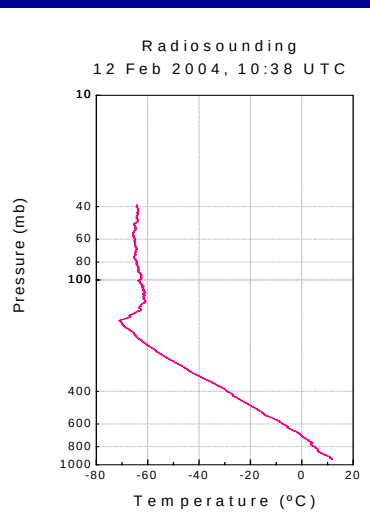
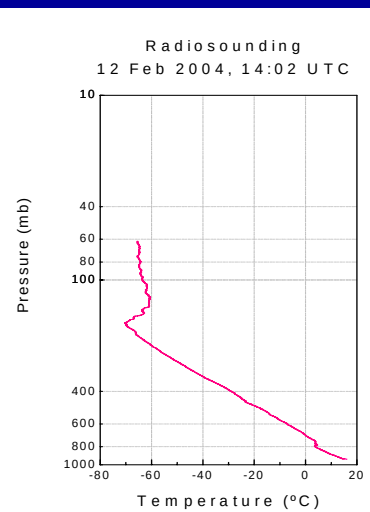


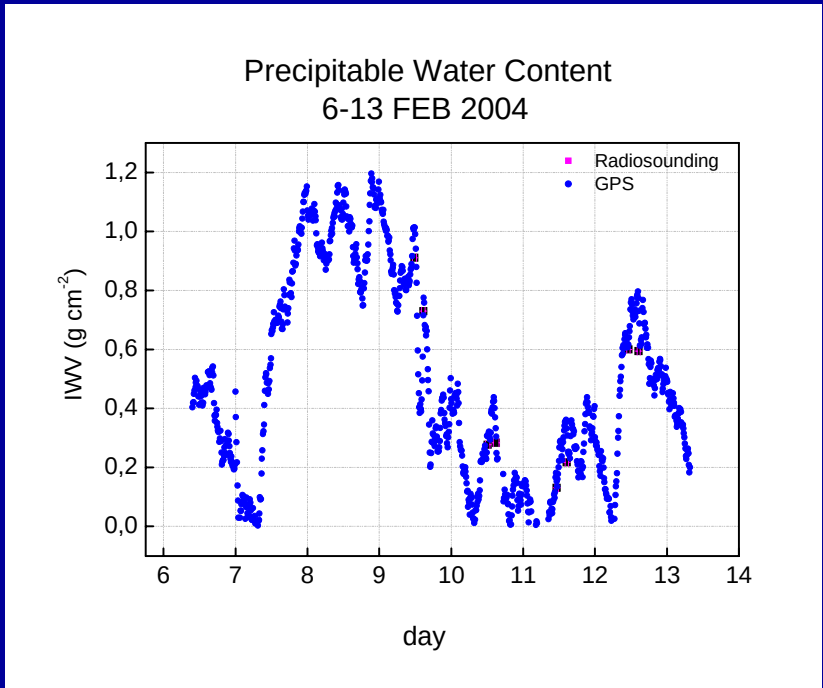






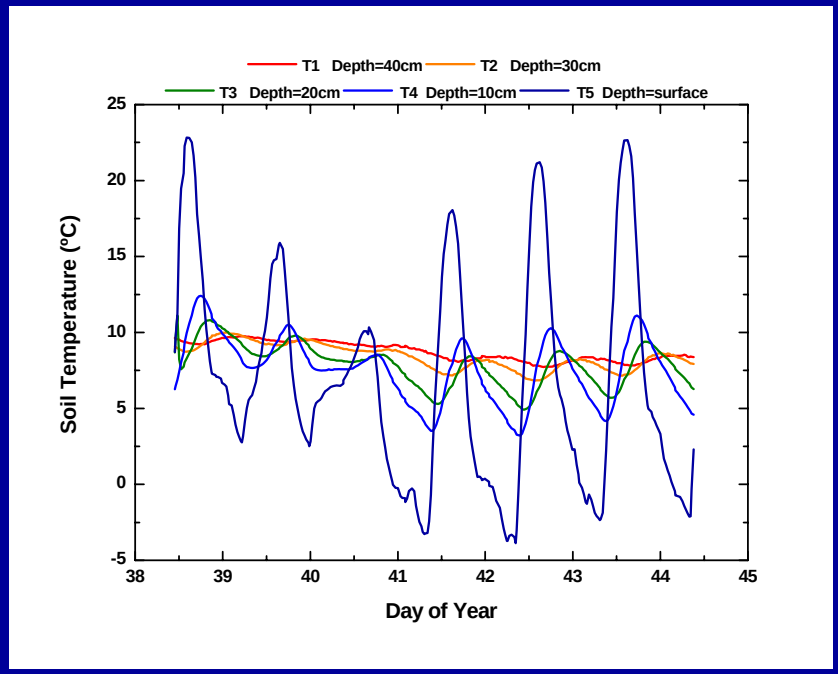
Integrated water vapour

Related to Zenith Tropospheric Delay of the signal received



GPS Antenna

Soil temperature

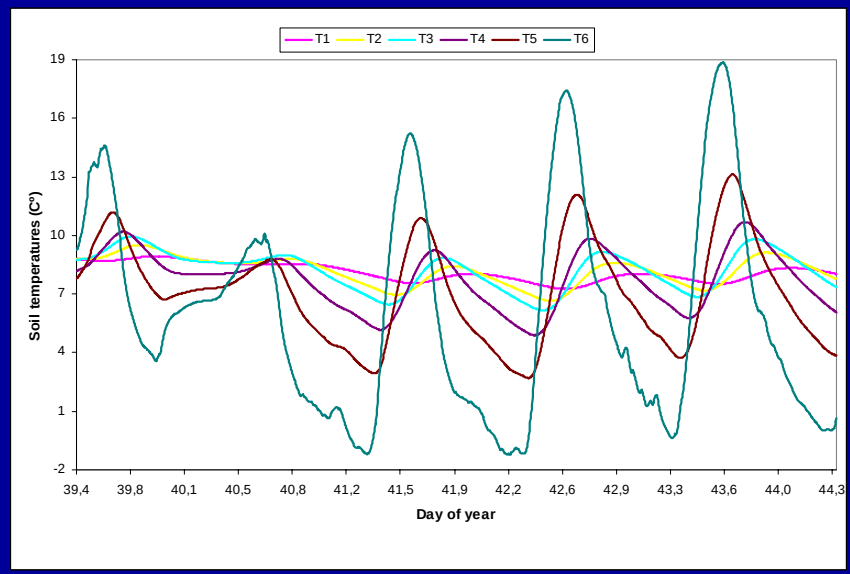


Valencia Anchor Station

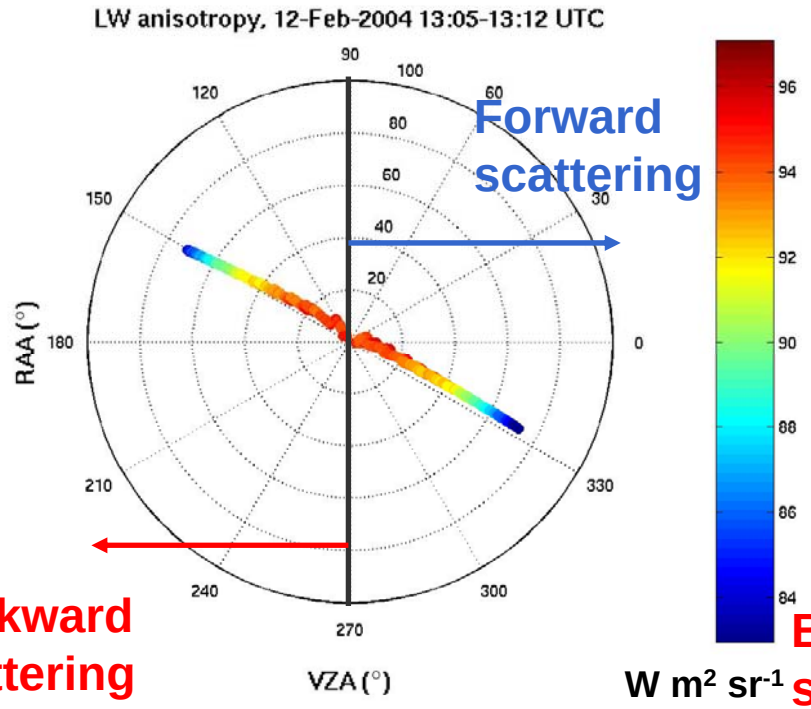
- T1: 40 cm depth
- T2: 30 cm depth
- T3: 20 cm depth
- T4: 10 cm depth
- T5: surface

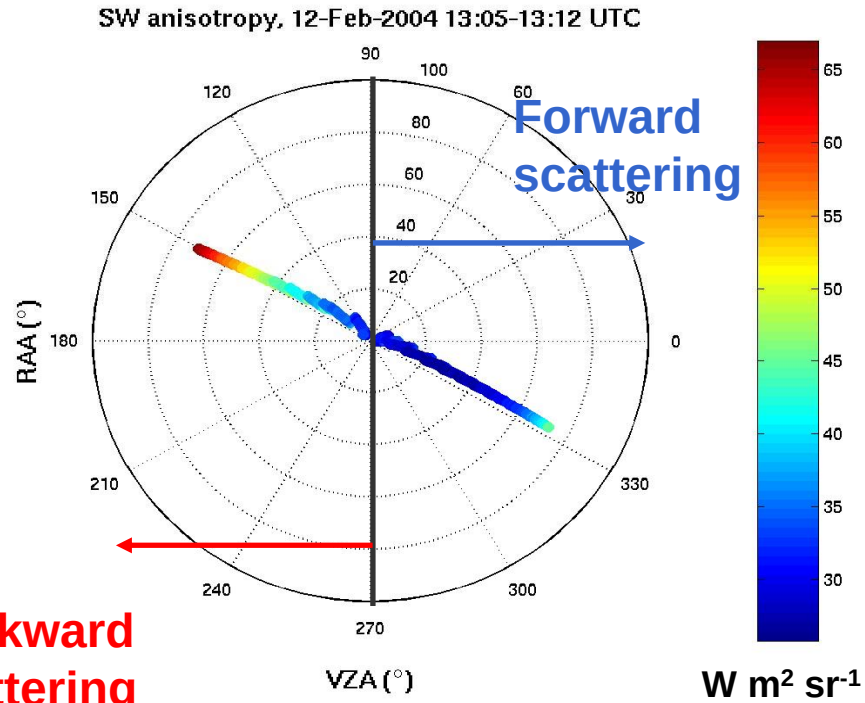
Mobile station

- T1: 30 cm depth
- T2: 20 cm depth
- T3: 15 cm depth
- T4: 10 cm depth
- T5: 5 cm depth
- T6: surface



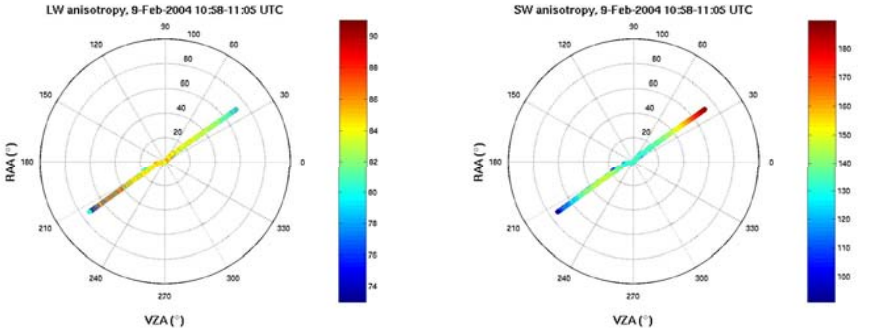
CERES TOA radiances over the study area (I)





CERES TOA radiances over the study area (II)

9 FEB 2004



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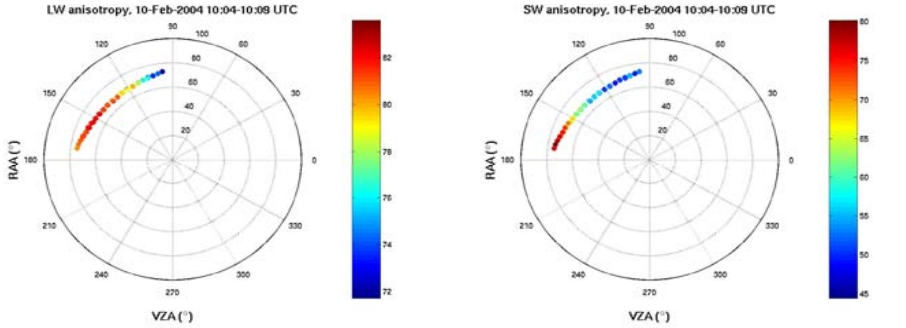

CERES TOA radiances over the study area (III)

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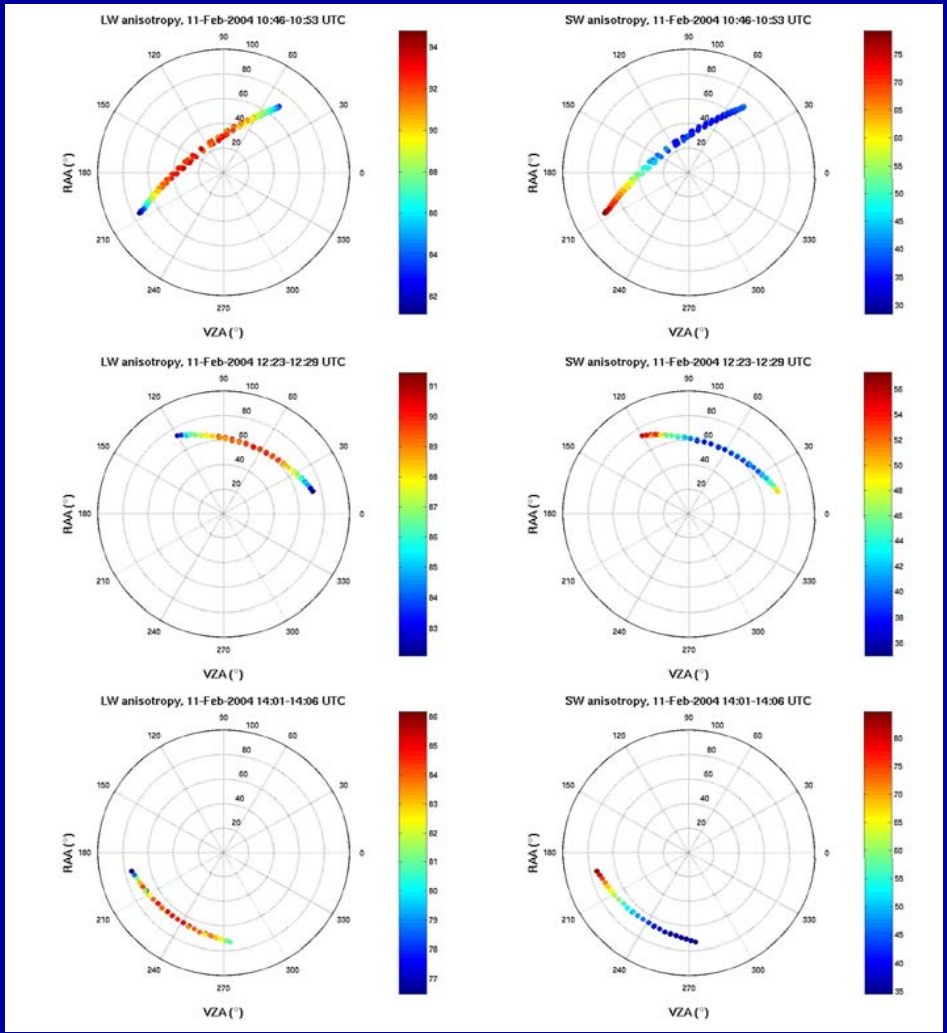

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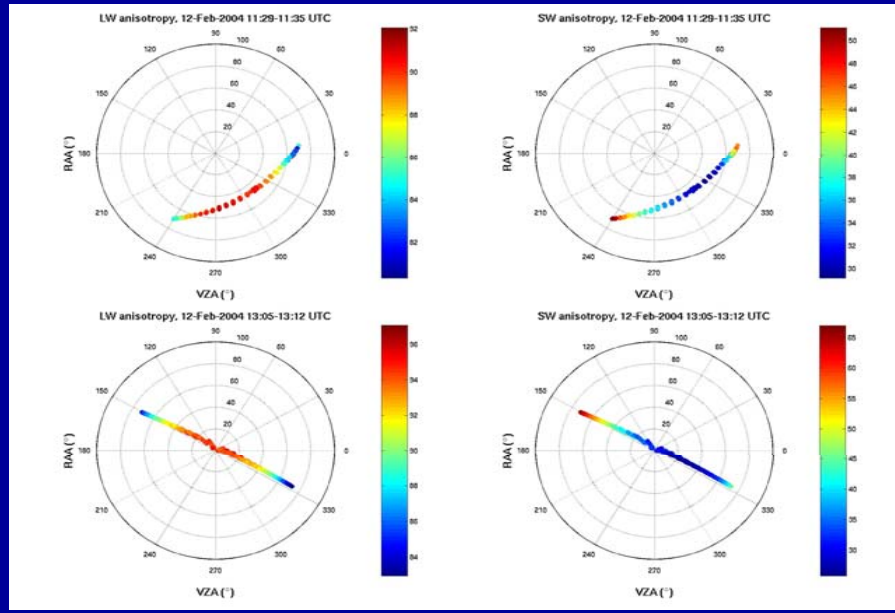


Parameter selection

Atmospheric profiles

a) **Water vapour, pressure and temperature**

Radiosounding water vapour scaled to the GPS IWV.

b) **Ozone profile**

Streamer MLW profile scaled to TOMS *(Total Ozone Mapping Spectrometer) value*

c) **Aerosols profile**

Streamer MLW profile + assume background tropospheric aerosols and background stratospheric aerosols.

Surface emissivity

From CERES/SARB data

Surface temperature

Measured temperatures at the VAS and the mobile station

BRDF

TOA radiances are sensitive to the anisotropy of the surface reflectivity and its diurnal changes.

It is necessary to know the spectral albedo and the bidirectional reflectivity

From the land use clasification: 76.6 % is bare soil

23.4 % vegetation

- Ahmad y Deering bare soil BRDF:

Bidirectional reflectances: each 10º in SZA and VZA and each 30º in RAA

2 spectral bands: red (0.662 μm) and near infrared (0.826 μm)

- Spectral albedo from Aster Spectral Library (JHU, John Hopkins University)
- Broadband albedo: weighted from the measured broadband albedo in the stations.

Study area BRDF

It is obteined from the broadband albedo measured at the VAS and the mobile station (a_0^{BB}), JHU spectral albedo (a_l^{JHU}) and the bidirectional reflectance from Ahmad y Deering for bare soil ($\rho_\lambda(\theta_0, \theta, \phi)$)

- **1. scale the JHU spectral albedo**

$$a'_\lambda = \frac{a_\lambda^{JHU}}{\int_{\lambda_2}^{\lambda_1} a_\lambda^{JHU} d\lambda} a_{BB}^0$$

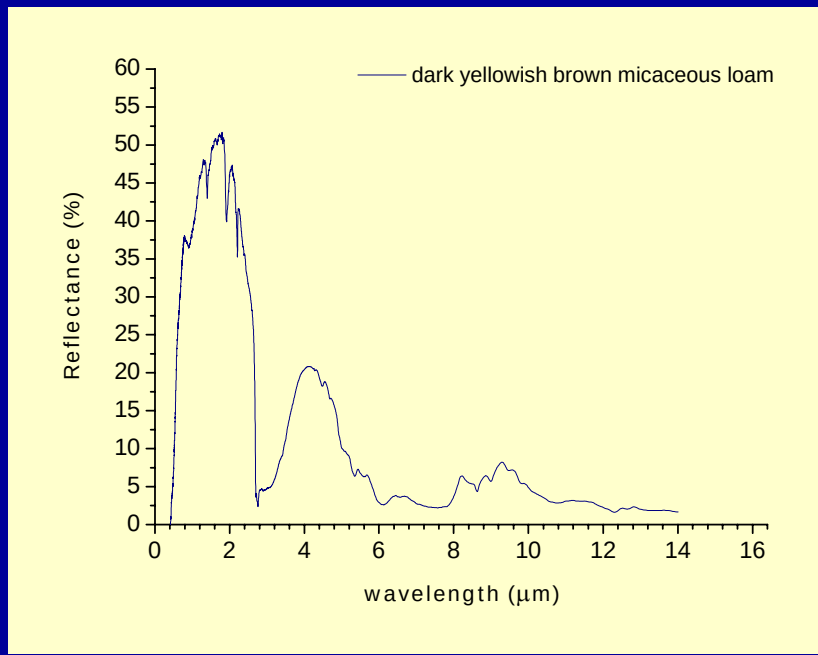
- **2. scale the bidirectional reflectances from the model**

$$s_{red} = \frac{a'_{\lambda\, red}}{\frac{1}{\pi}\int_0^{2\pi}\int_0^1 \rho_\lambda(\theta_0,\theta,\phi)\mu \cdot d\mu \cdot d\phi} = \frac{a'_{\lambda\, red}}{\rho_\lambda(\theta_0)}$$

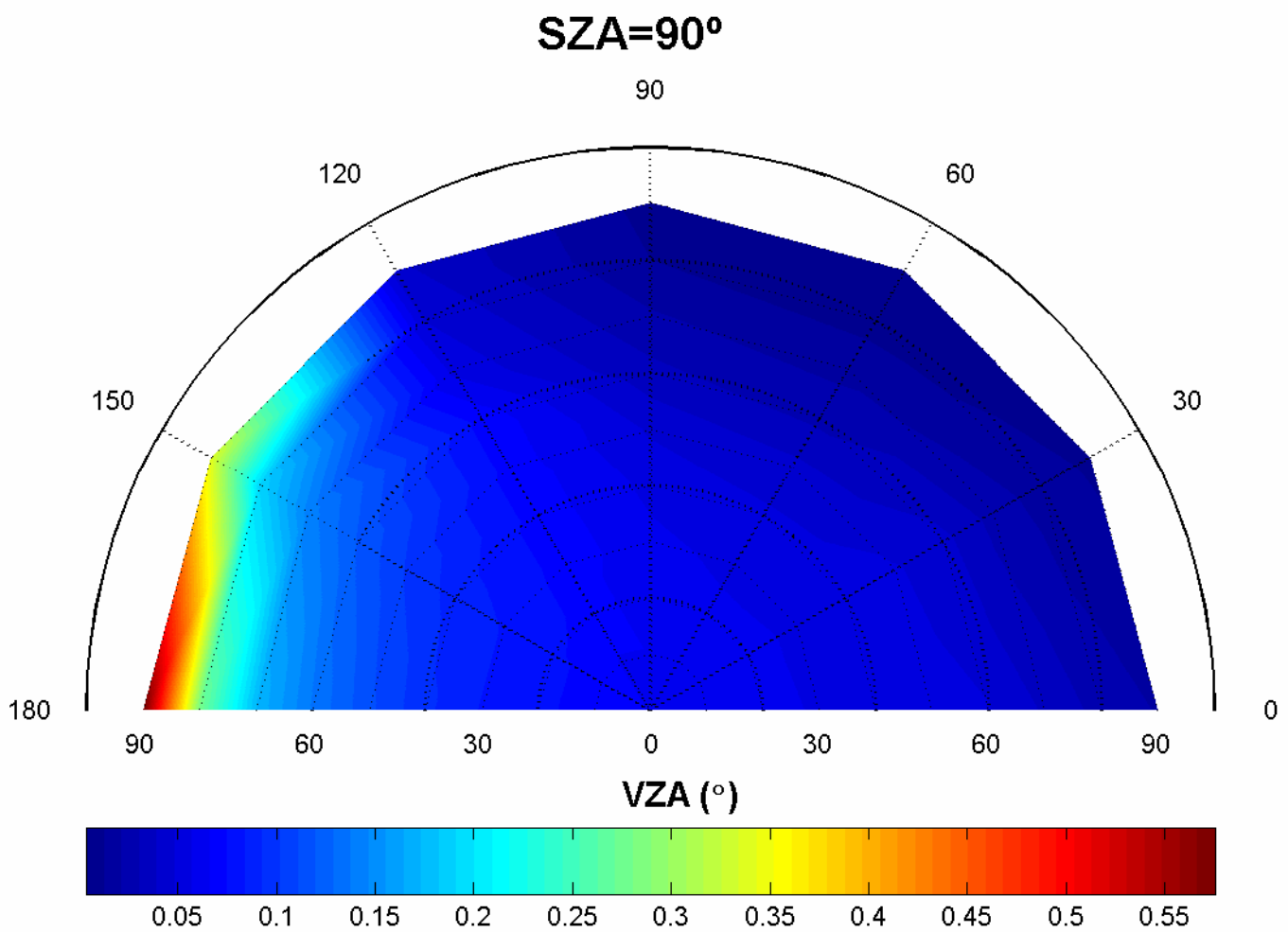
$$s_{NIR} = \frac{a'_{NIR}}{\frac{1}{\pi}\int_0^{2\pi}\int_0^1 \rho_\lambda(\theta_0,\theta,\phi)\mu \cdot d\mu \cdot d\phi} = \frac{a'_{NIR}}{\rho_{\lambda NIR}(\theta_0)}$$

Finite number of angles

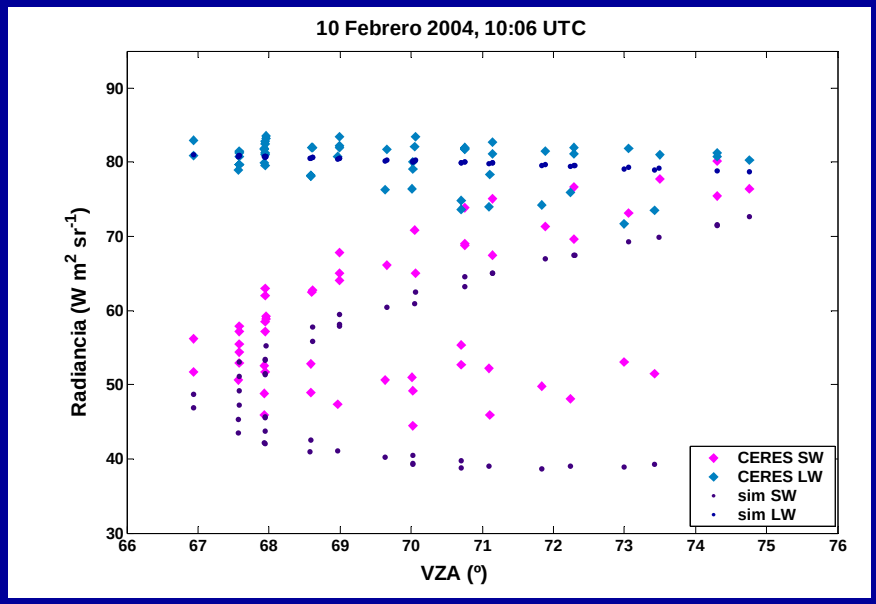
$$\rho_i = \sum_{k=1}(\phi_{k+1} - \phi_k)\sum_{j=1}\overline{\rho_i} \cdot (\sin^2\theta_{j+1} - \sin^2\theta_j)$$

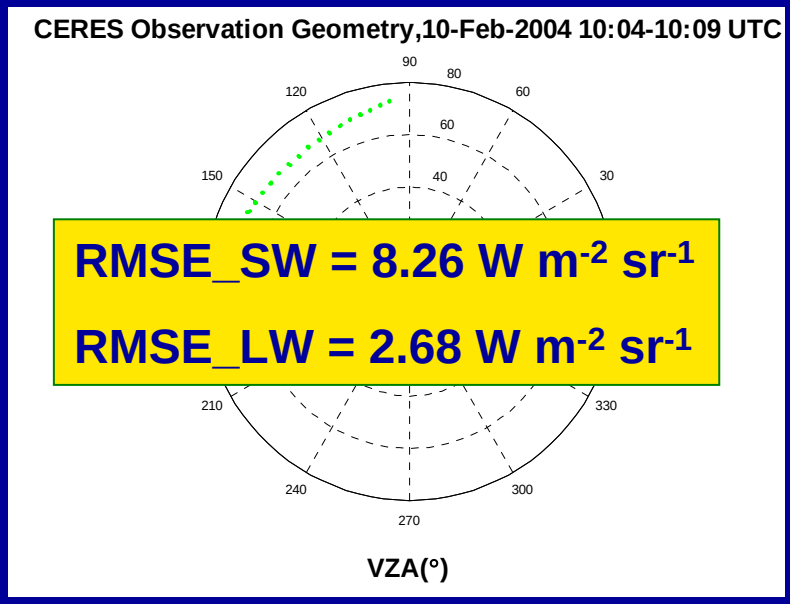


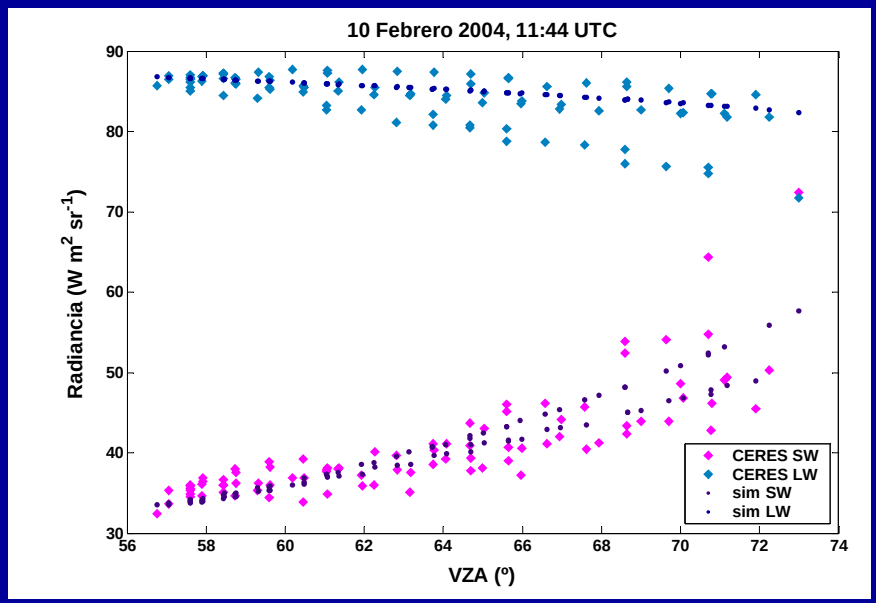
Bidirectional reflectivity

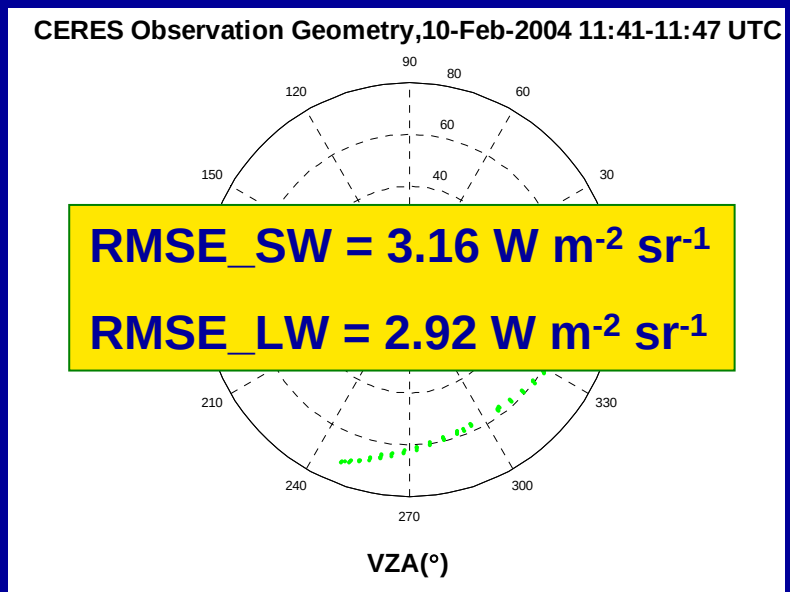


3. TOA CERES radiance simulations









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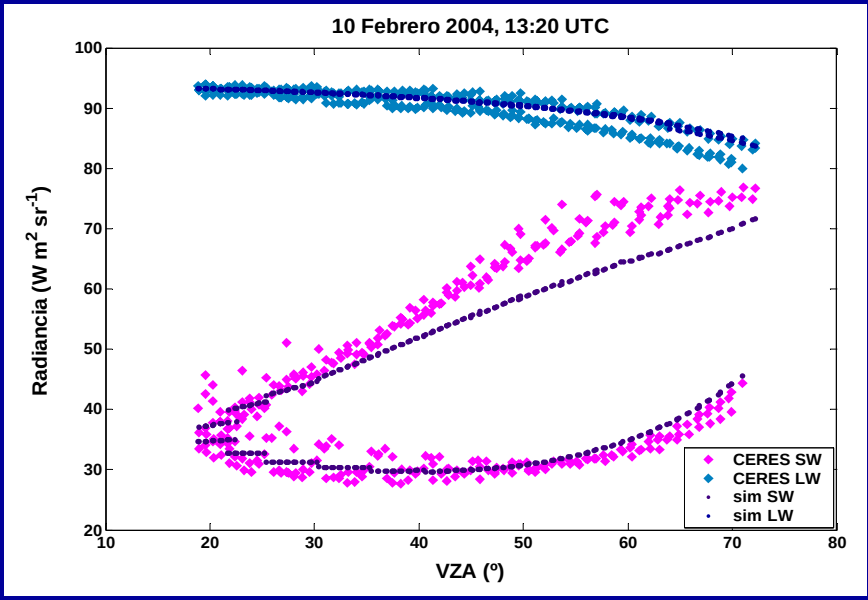
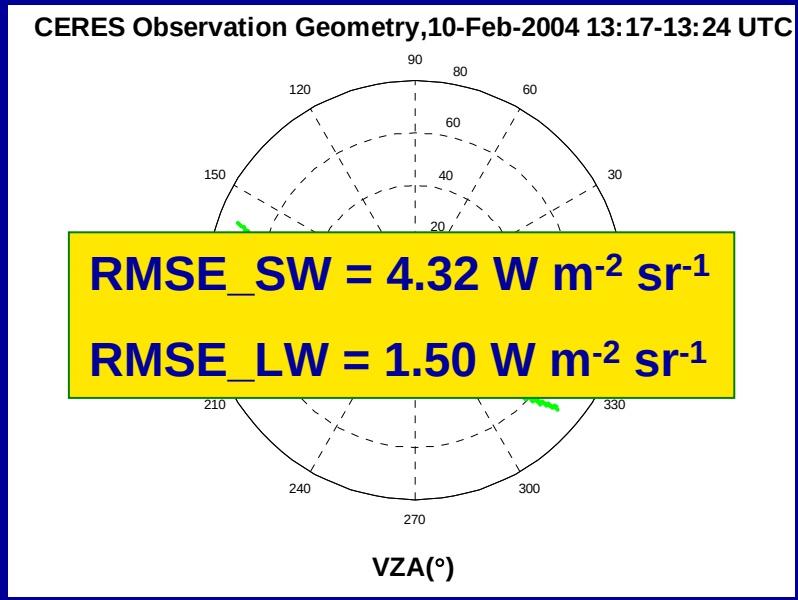
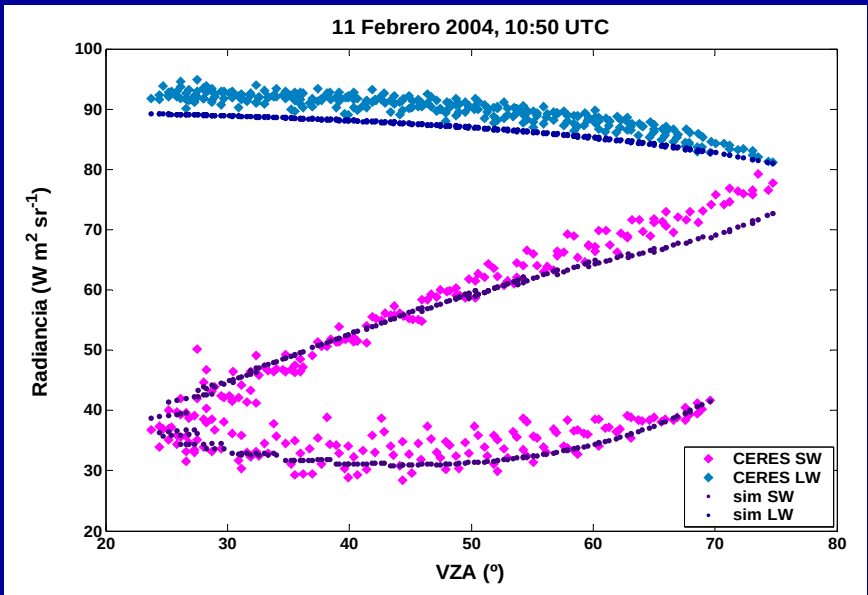
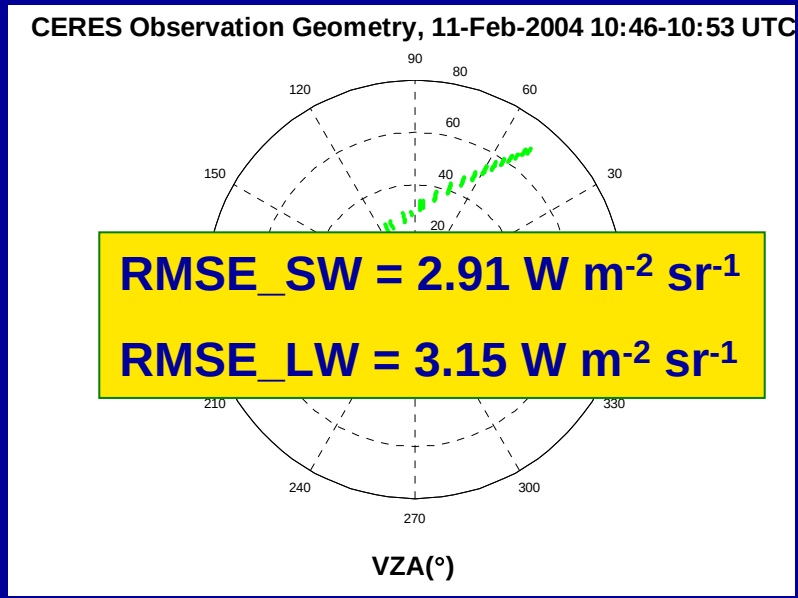




RMSE_SW = 4.32 W m^{-2} sr^{-1}

RMSE_LW = 1.50 W m^{-2} sr^{-1}





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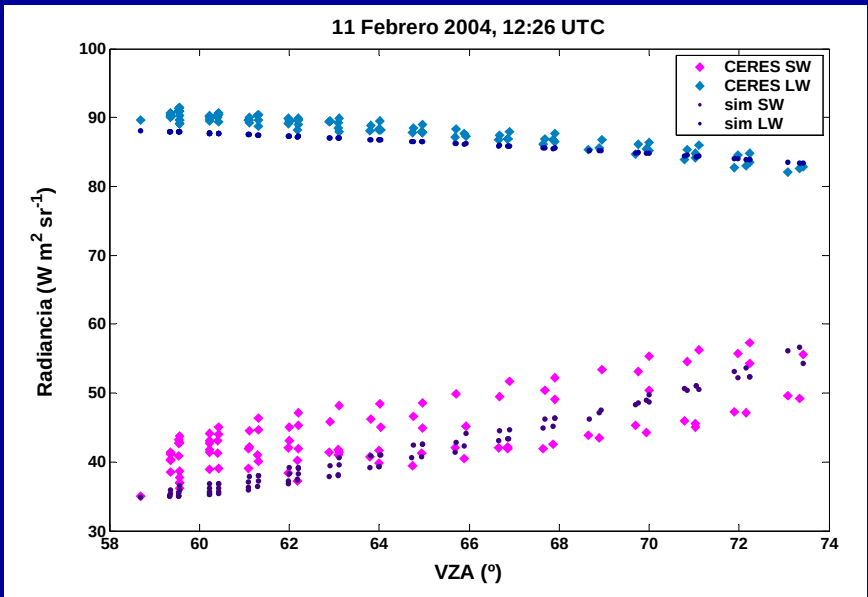
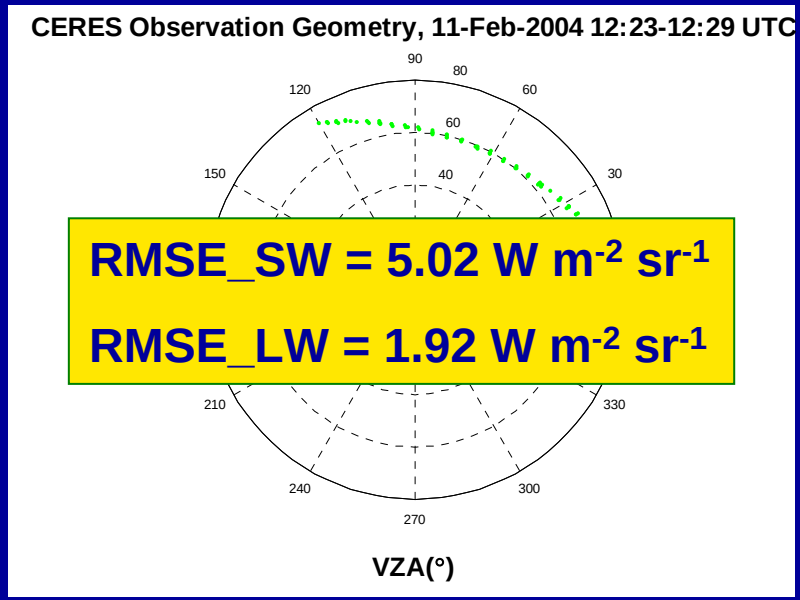
RMSE_LW = 3.15 W m^{-2} sr^{-1}

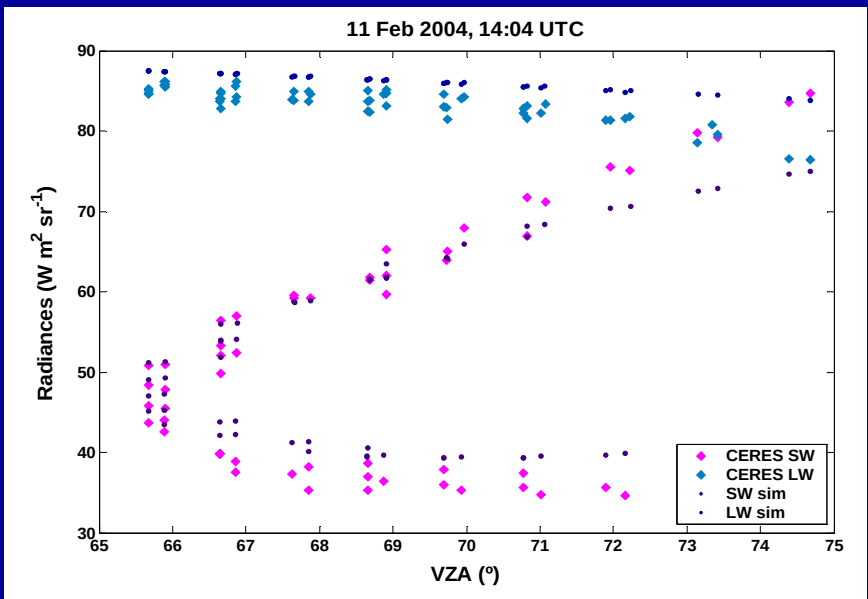
Results (III):

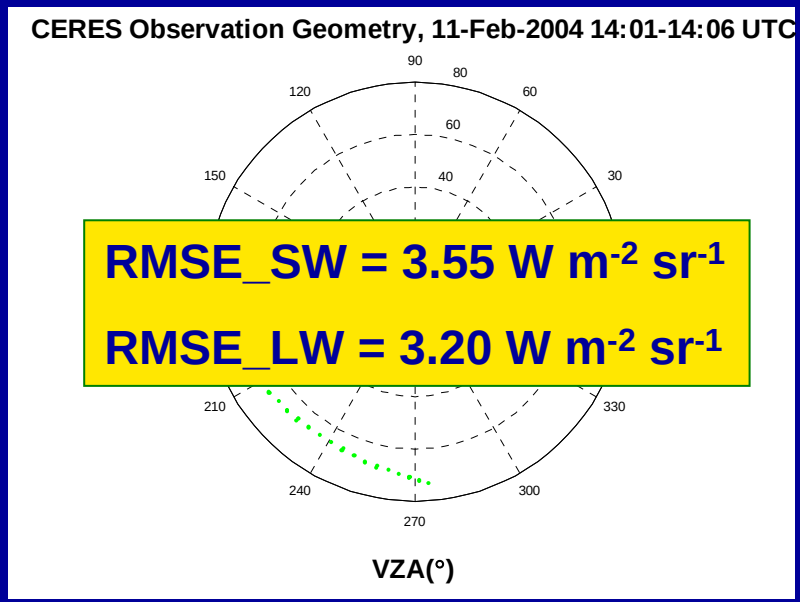




RMSE_SW = 5.02 W m^{-2} sr^{-1}

RMSE_LW = 1.92 W m^{-2} sr^{-1}

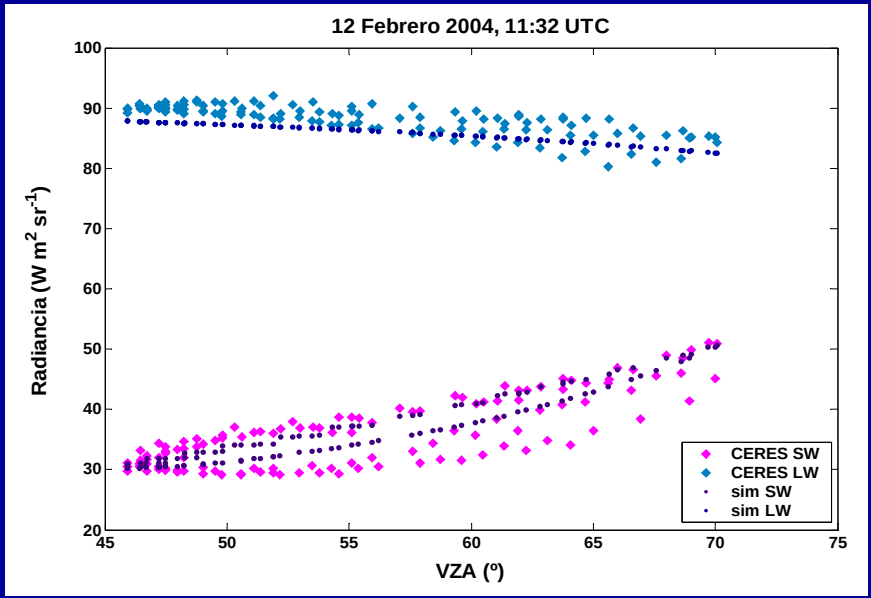


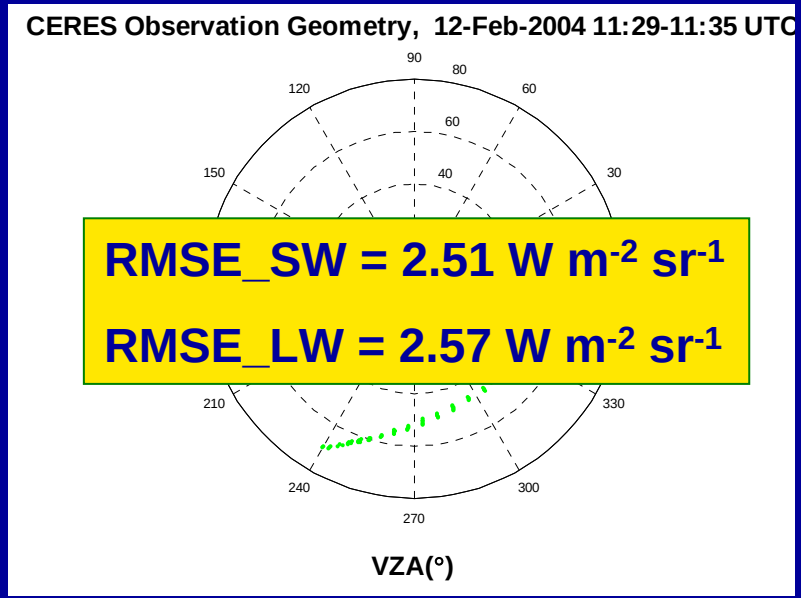


RMSE_SW = 3.55 W m^{-2} sr^{-1}

RMSE_LW = 3.20 W m^{-2} sr^{-1}

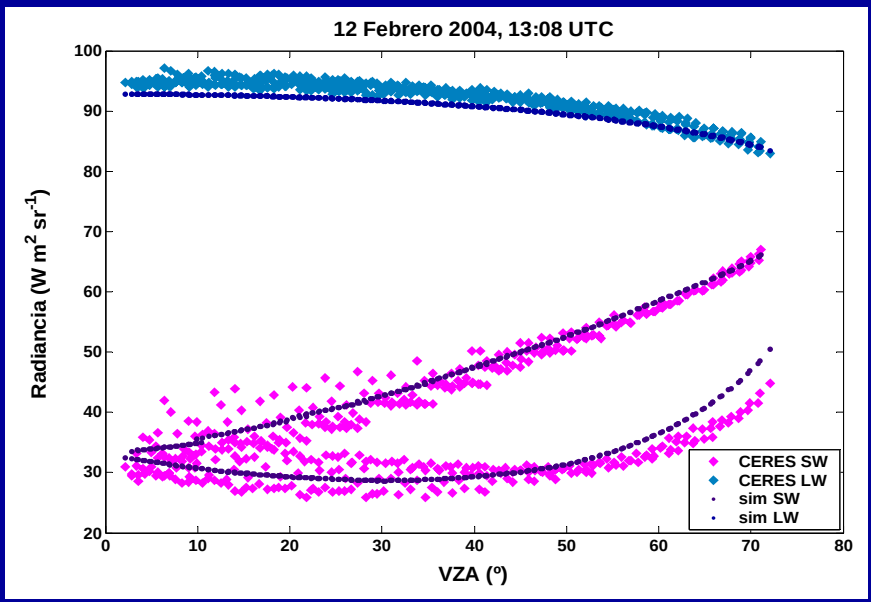
Results (IV):

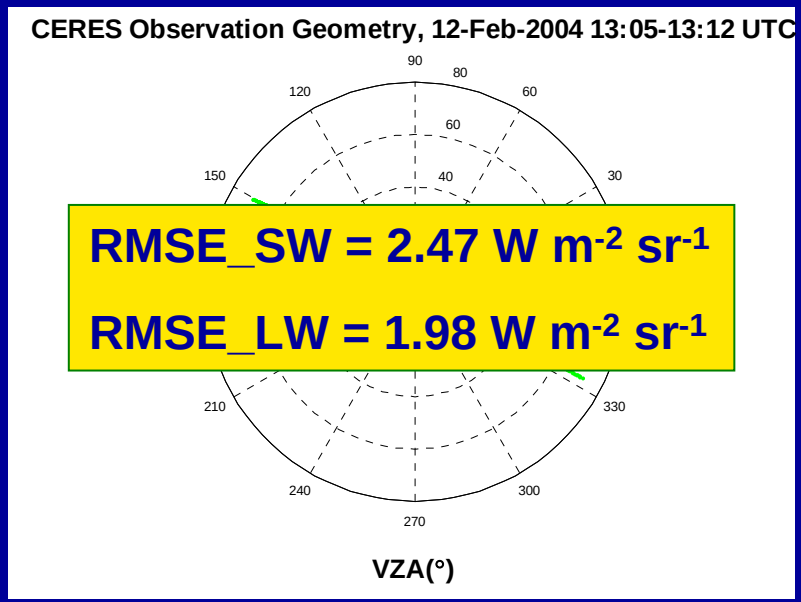




RMSE_SW = 2.51 W m^{-2} sr^{-1}

RMSE_LW = 2.57 W m^{-2} sr^{-1}

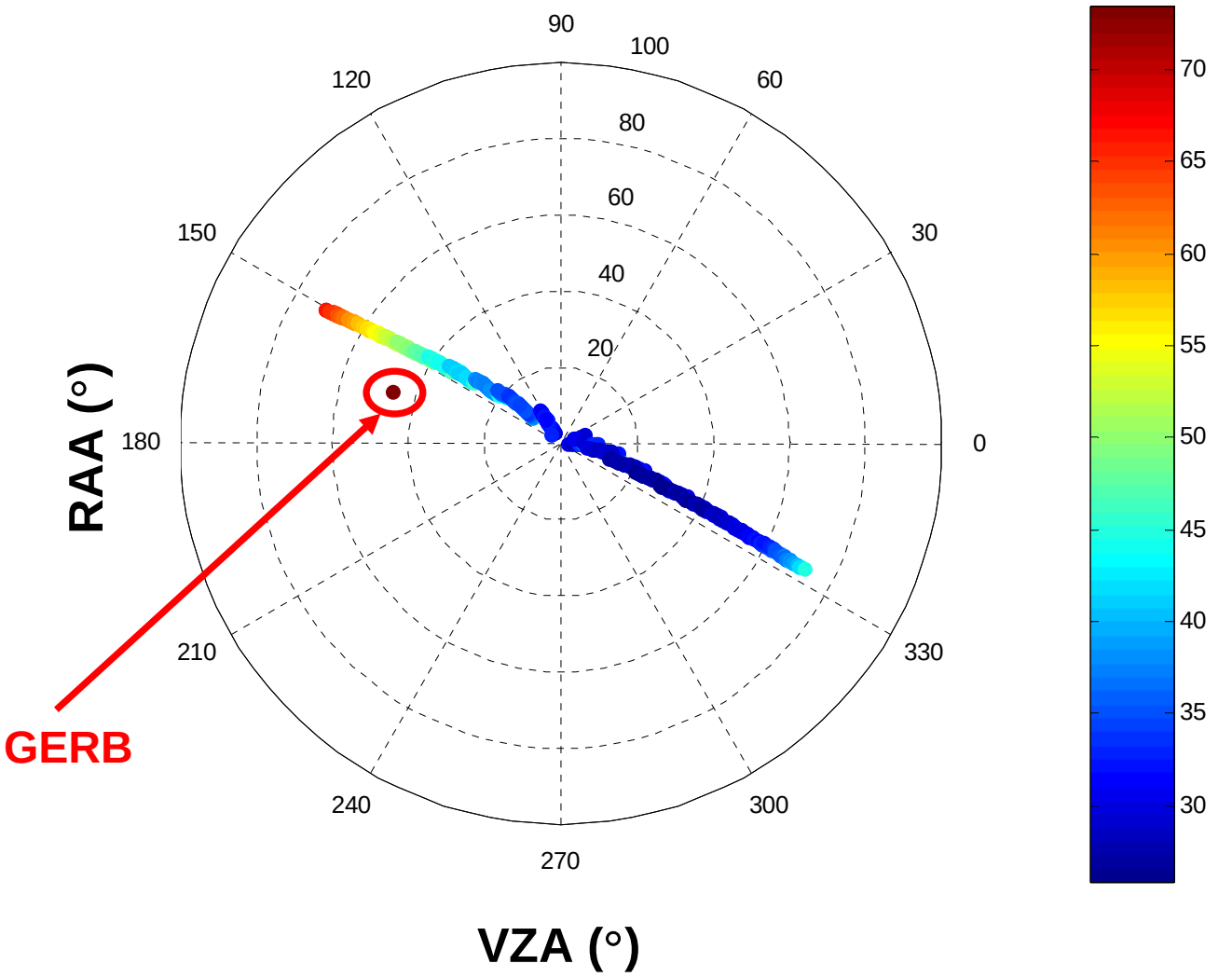




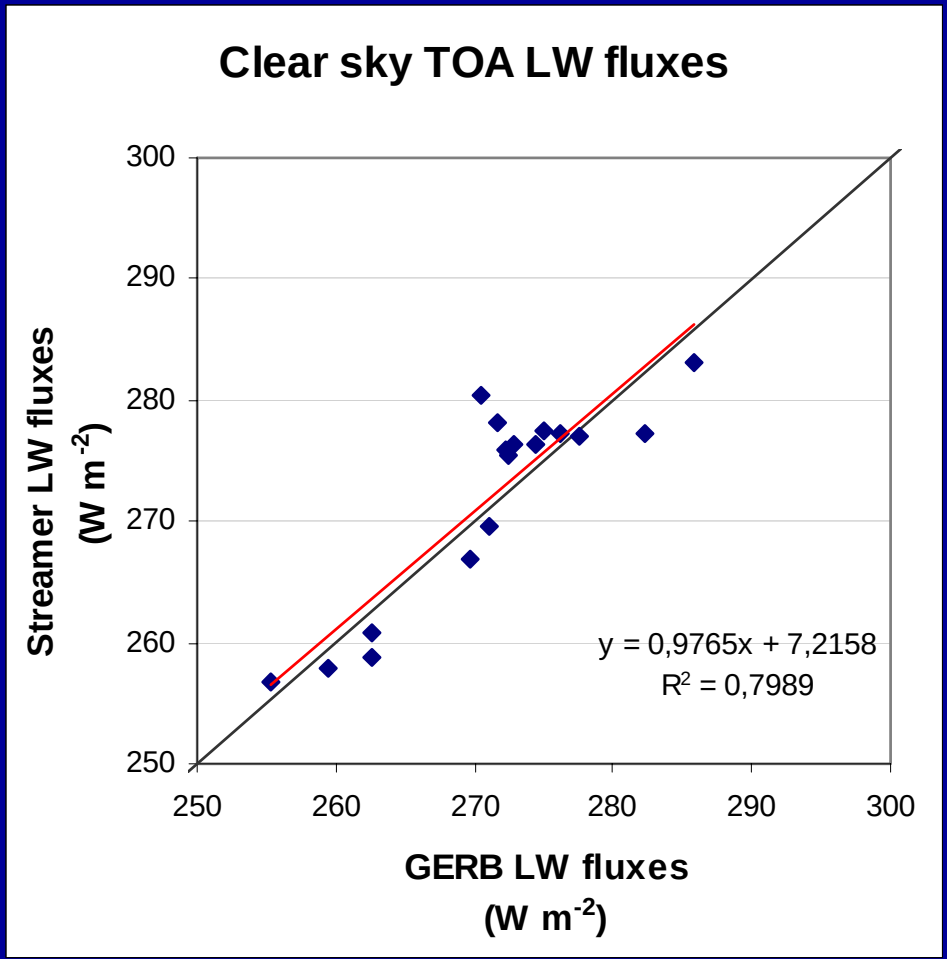
RMSE_SW = 2.47 W m^{-2} sr^{-1}

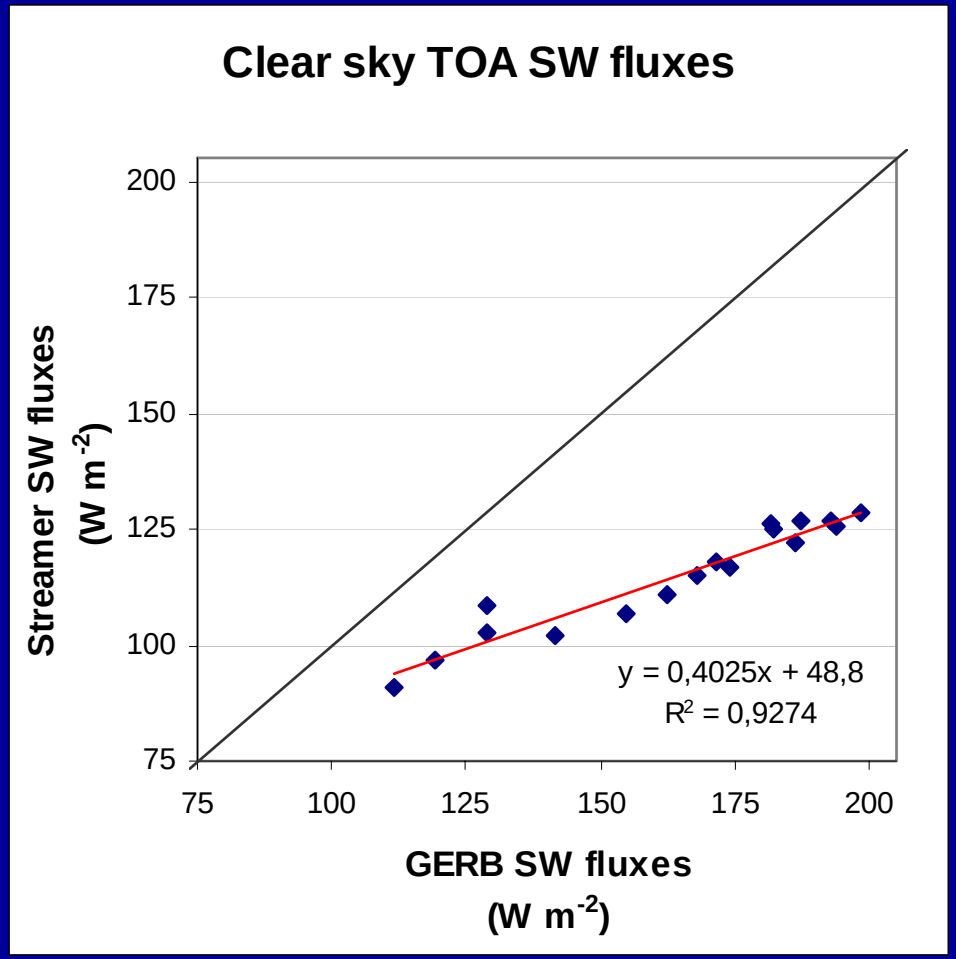
RMSE_LW = 1.98 W m^{-2} sr^{-1}

4. TOA GERB and CERES radiances comparisons on clear sky observations



5. TOA GERB fluxes simulations

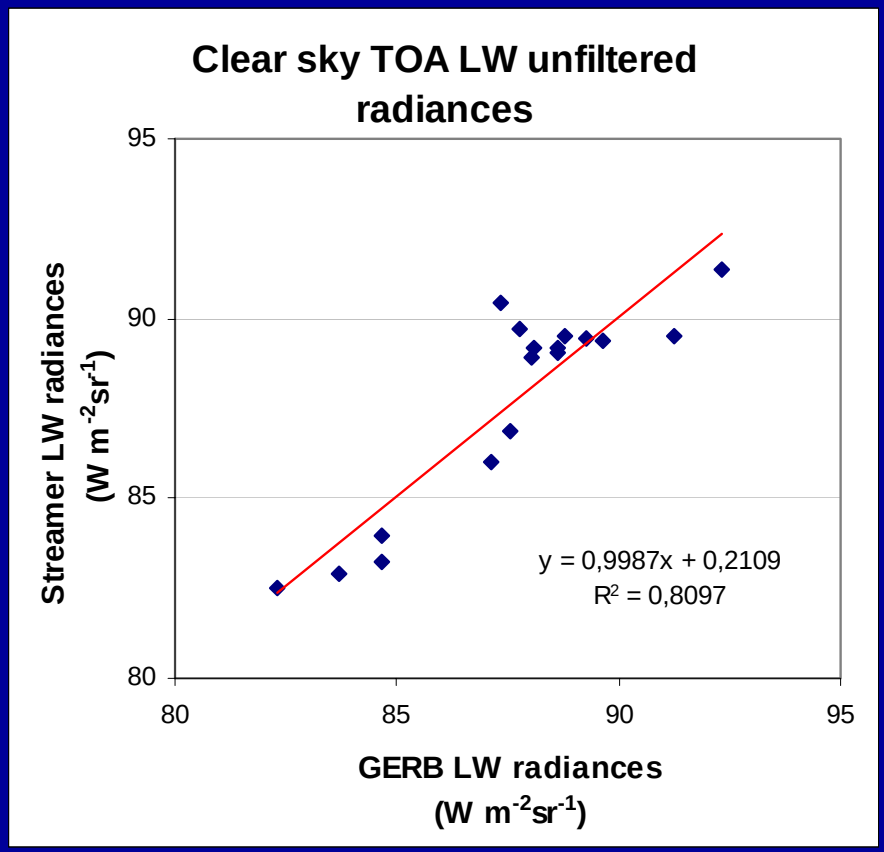


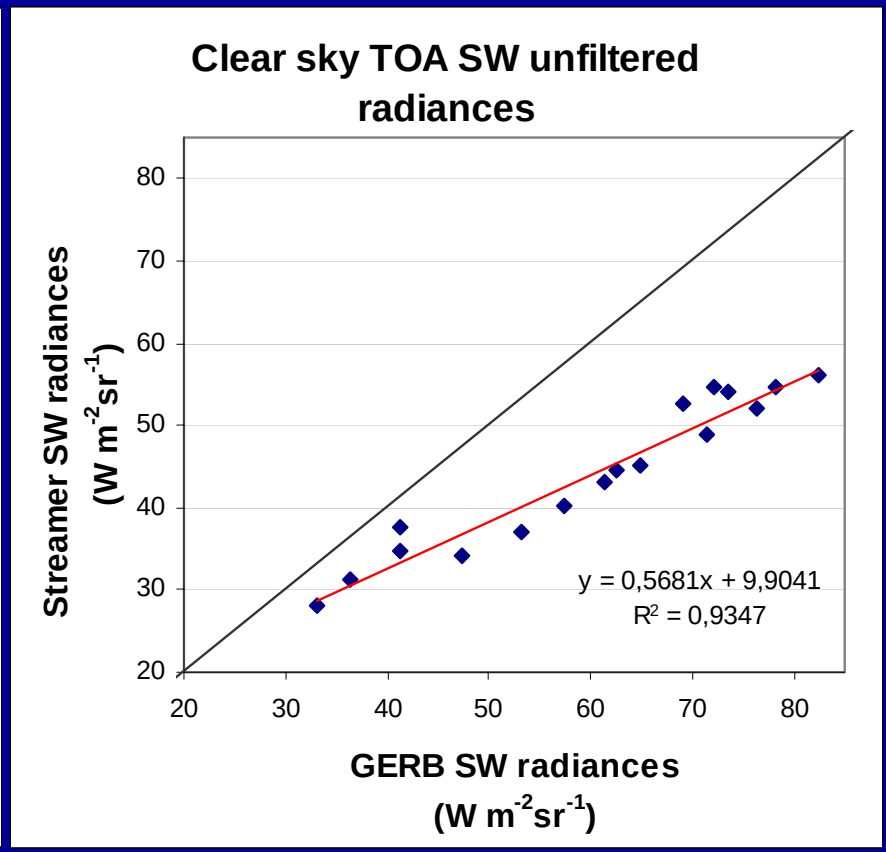


RMSE_SW = 51.17 W m^{-2}

RMSE_LW = 3.80 W m^{-2}

TOA GERB and Streamer radiance comparison

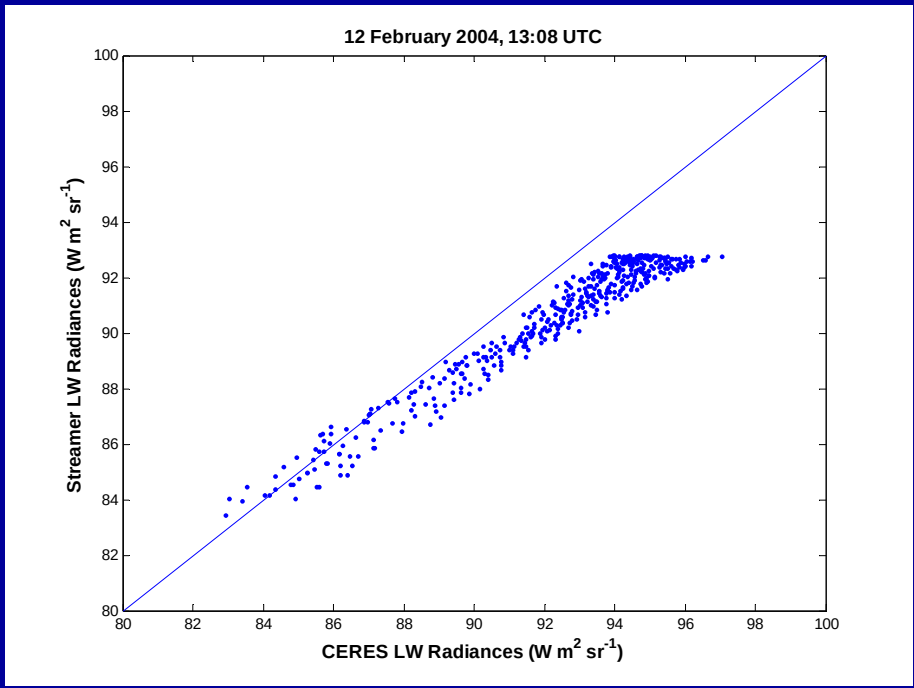


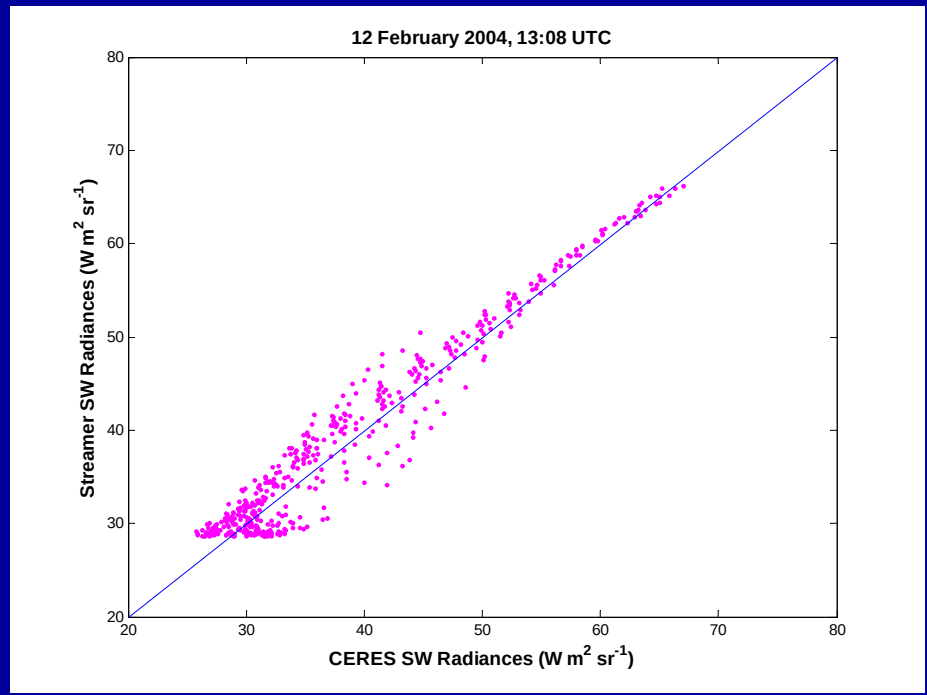


RMSE_SW = 17.42 W m^{-2} sr^{-1}

RMSE_LW = 1.22 W m^{-2} sr^{-1}

Comparing with the CERES simulations:

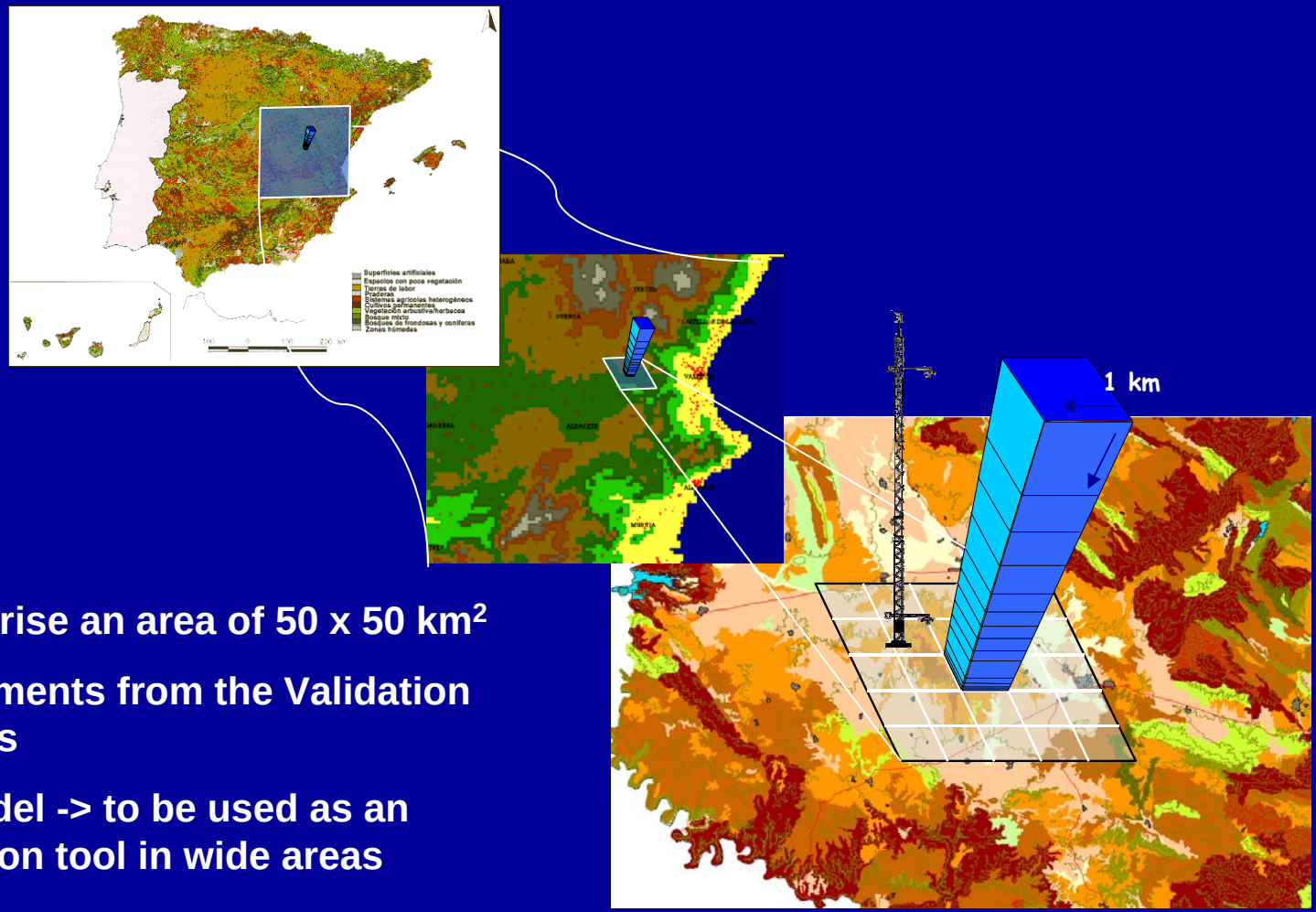




RMSE_SW = 2.47 W m^{-2} sr^{-1}

RMSE_LW = 1.98 W m^{-2} sr^{-1}

SCALES Methodology



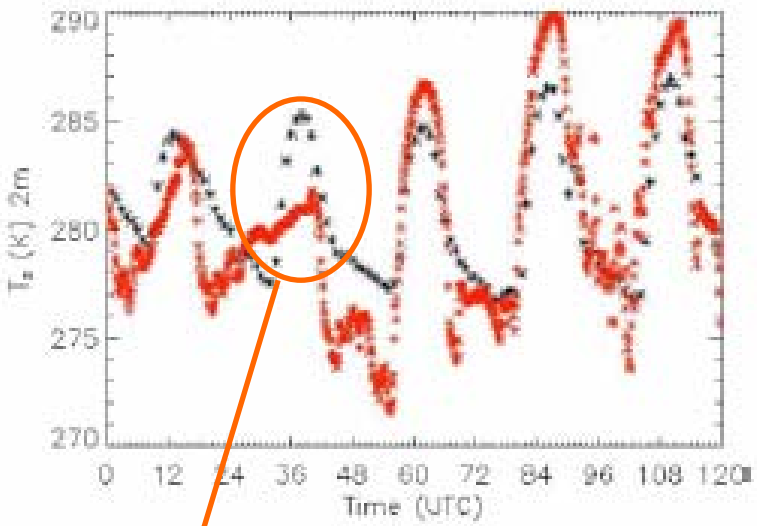
- Characterise an area of 50 x 50 km^2
- Measurements from the Validation Campaigns
- MM5 model -> to be used as an interpolation tool in wide areas

6. MM5 first results

2D comparisons (8th to 12th February 2004)

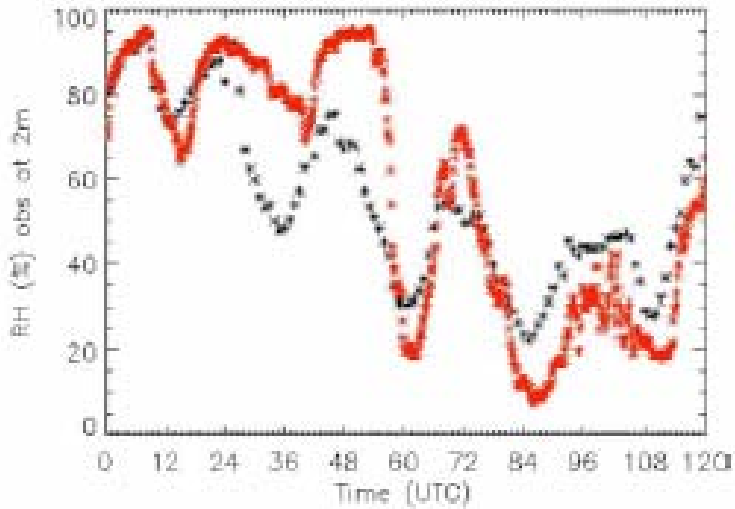
Simulation (black symbols) and observations (red symbols)

Temperature



Cloudy day

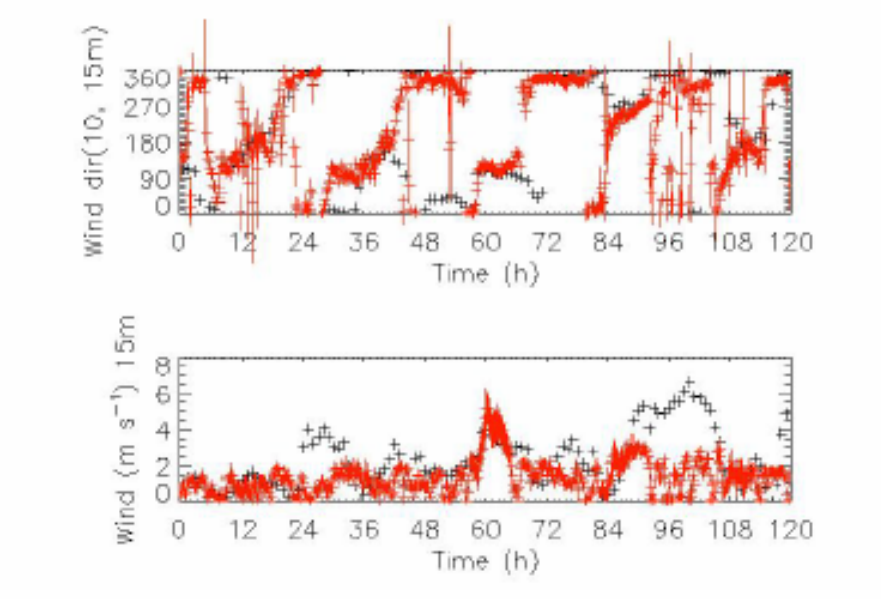
Relative Humidity



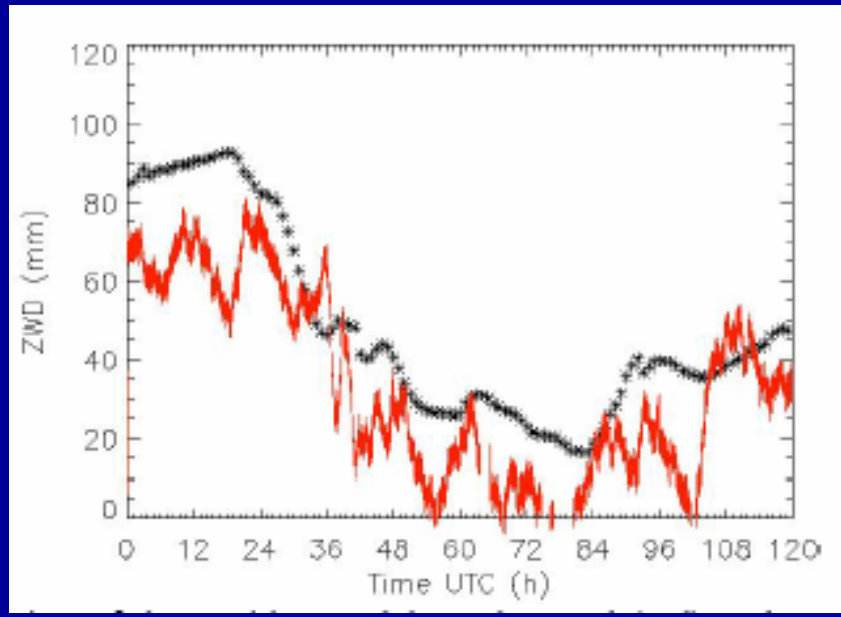
Good agreement for temperature at 2 m under clear sky conditions

During 10th the observations show a strong decline of RH (from 95% to 20%) which corresponds to the increase of temperature in this period

Wind



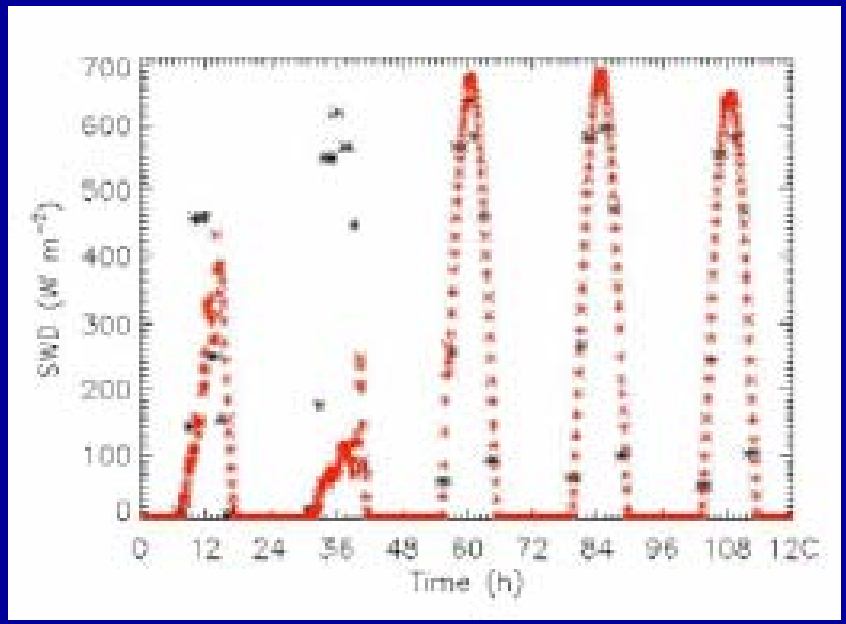
ZWD

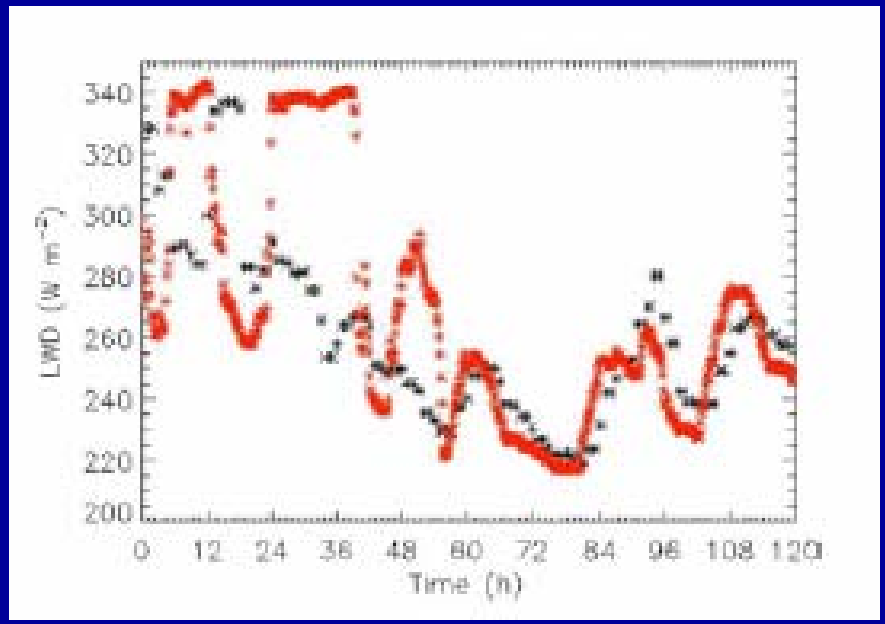


Good agreement for wind speed and direction

The model seems to overestimate water vapour content of the atmosphere. However the tendency of the observed ZWD is well reproduced.

Surface Downwelling Fluxes

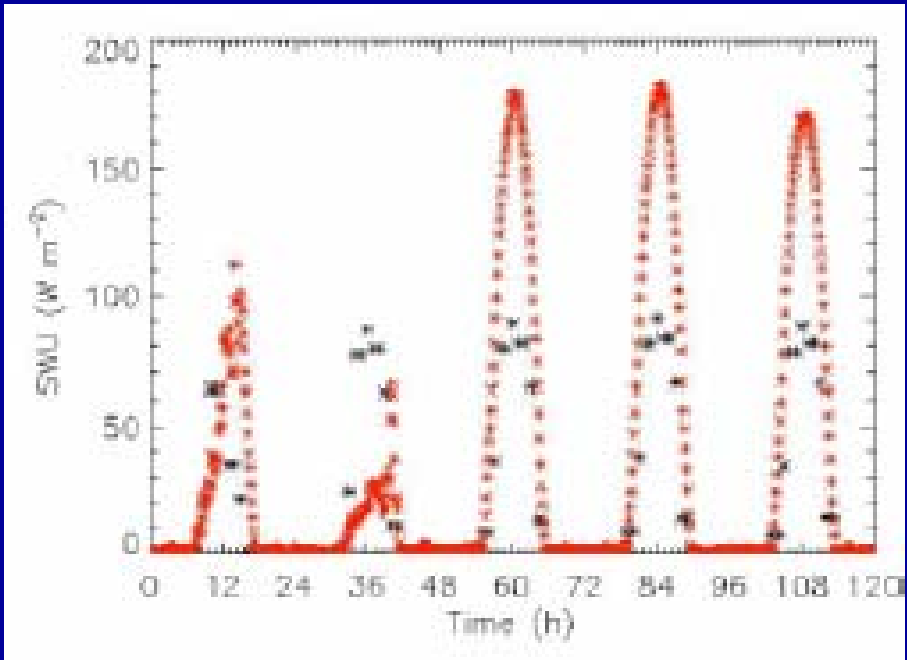


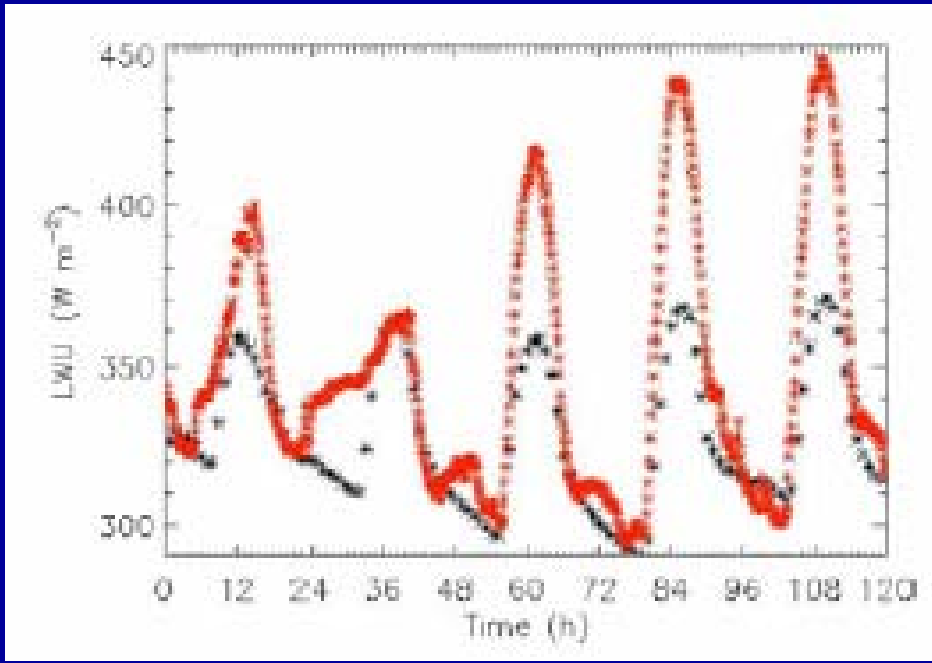


Good agreement for SWD y LWD at the surface except on the 8th and 9th (cloudy days).

IEEC

Surface Upwelling Fluxes

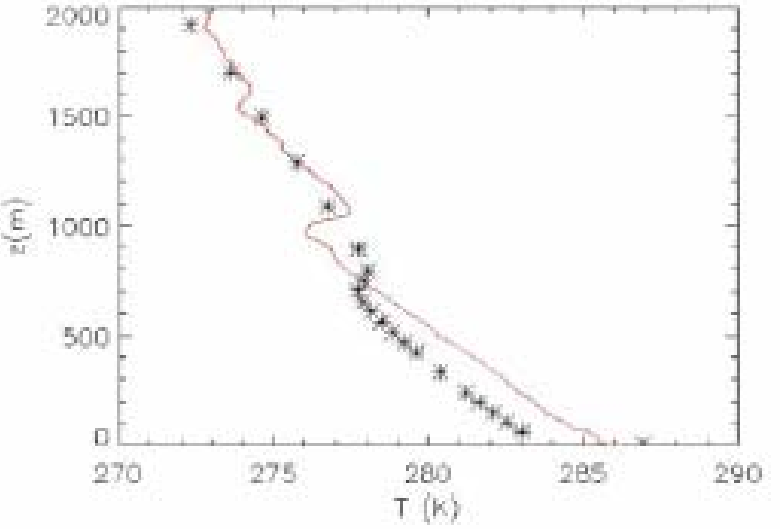




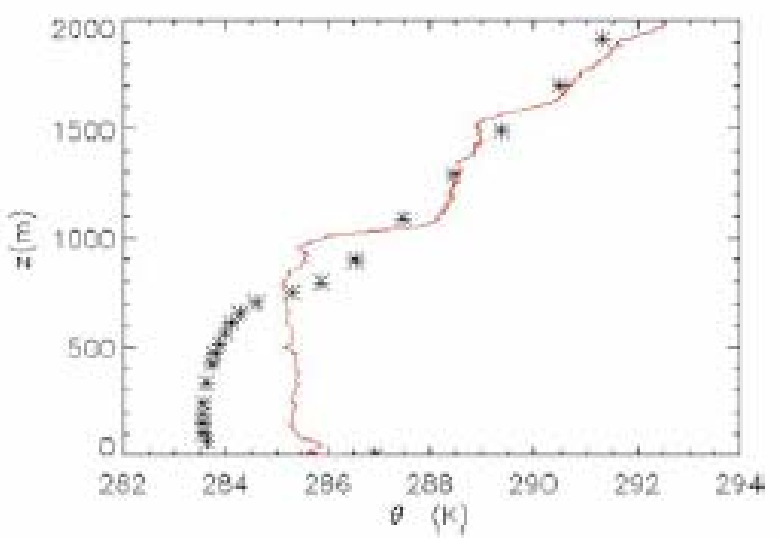
- The model underestimates the upward surface fluxes
- New albedo value has to be used in order to correct SWU
- The fit of LWU will improve with an accurate value of the soil emissivity

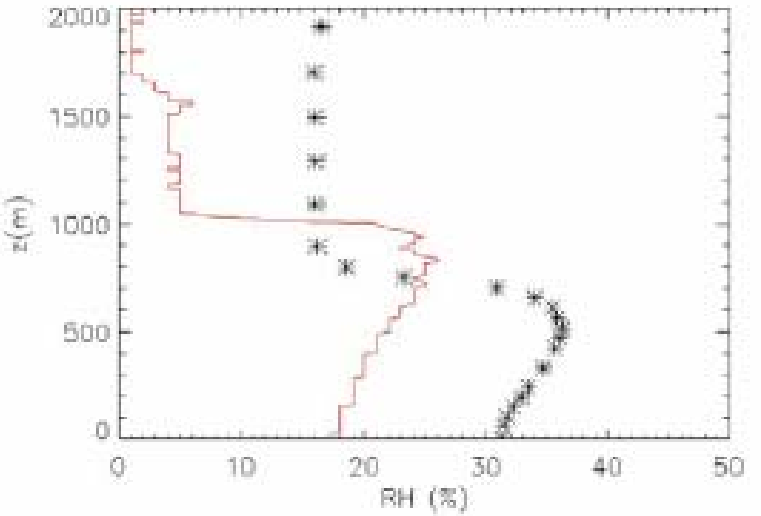
IEEC

Vertical profiles comparisons (10th February 13 UTC)

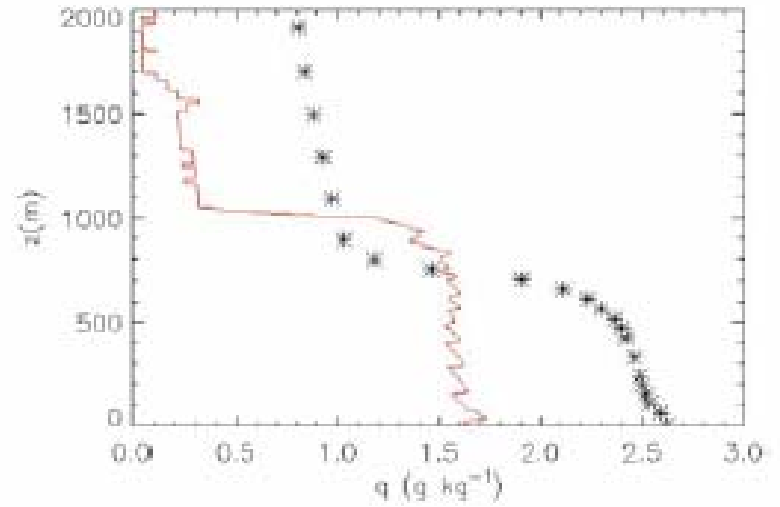


Temperature and θ





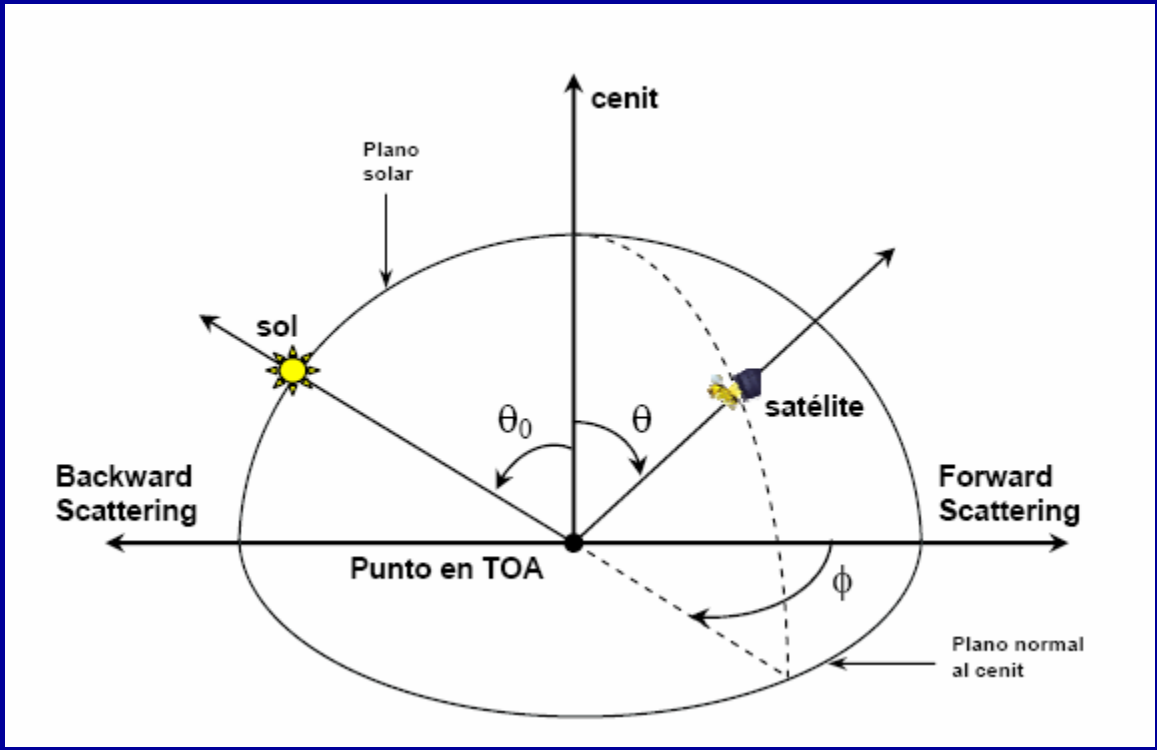
Humidity and q



7. Conclusions and future work

- Conclusions:
  - **Suitable methodology to simulate CERES radiances in the TOA**
  - **The analysis has been carried out under clear sky conditions**
  - **In winter, we can assume that the study area is mainly composed of bare soil and vegetation**
  - **A representative BRDF for our study area has been developed**
  - **MM5 seems to be adequate to be used as an interpolation tool, but needs some input adjustements (albedo, emissivity, cloud conditions…)**
- Future plans:
  - **Improve aerosol characterization**
  - **Include cloudy days in the simulations**
  - **Study limb darkening process in the LW**
  - **Use of MM5 as an interpolation tool**
  - **Use of BRDF measured from satellite or in situ BRDF**

Observation Geometry

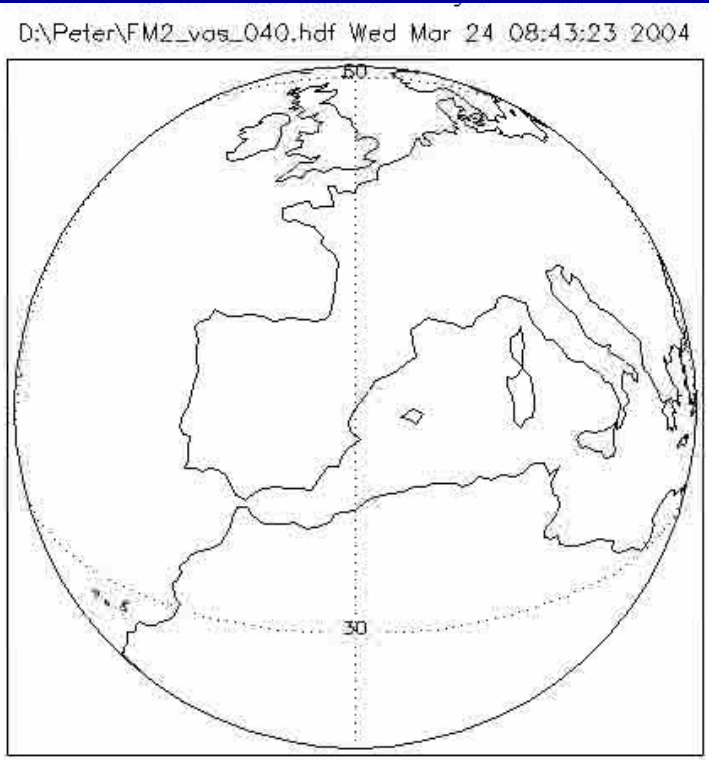
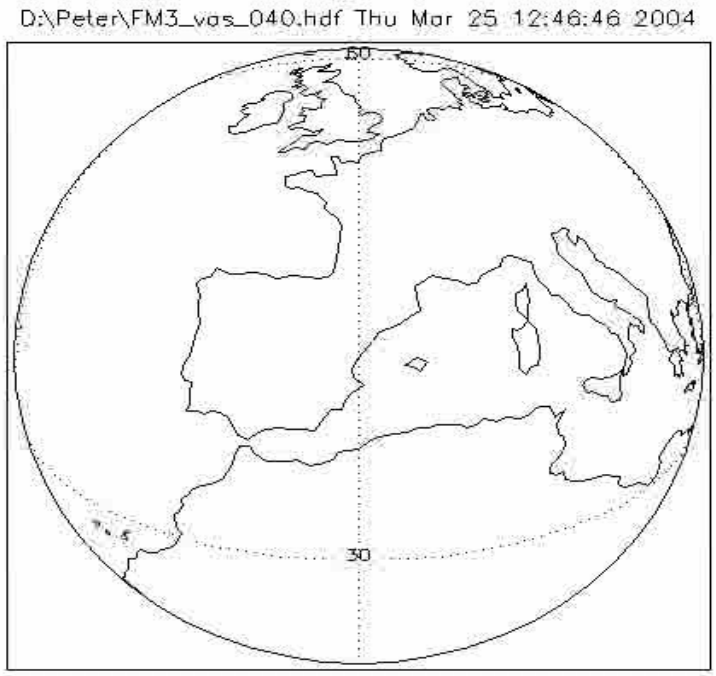


θ_0 es el ángulo solar cenital (SZA)

θ es el ángulo de visión cenital (VZA)

ϕ es el ángulo azimutal relativo (RAA)

CERES on Terra (FM2)
9 Feb 2004. SW radiances



CERES on Aqua (FM3)
9 Feb 2004. SW radiances