Predicting Direct and Other Irradiance Components

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Chaining the models from a satellite image to diffuse or direct radiation components has the disadvantage to carry over the biases and dispersions from one components to the other. The study of the relationship between satellite count, global irradiance and other solar and illumination resource components will be presented, bringing a particular attention to low solar elevation situations (below 20∞) which are very important in northern latitudes. The investigation is based on data from two geostationary satellites, METEOSAT and GOES, backed by ground measurements in Europe and the northeastern USA.

The study of different clear sky normalizations lead to the conclusion that a linear correlation between the global clearness index and the irradiance (like the heliosat method) would be inaccurate for low solar elevations, and therefore for high latitude regions. We developed a model that directly relates an elevation dependent clearness index to the cloud index. This methodology presents a definite advantage because it can be generalized to address the clearness index of other solar radiation components, besides global irradiance, such as direct irradiance, diffuse illuminance, etc.

The correlations described in the presentation were developed on the data from Geneva and evaluated on other independent data sets (from Europe and United States). The use of independent data for the derivation and the validation of the models shows that those can be used in a wide range of locations, even if the applicability has to be assessed for other specific climates.

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Satellites for Solar Energy Assessment

Prediction of non-global irradiance components

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Introduction
The direct way
The multiparameter model
The models
The results

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From satellite image to ground component

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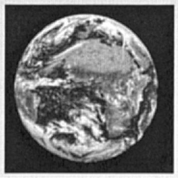

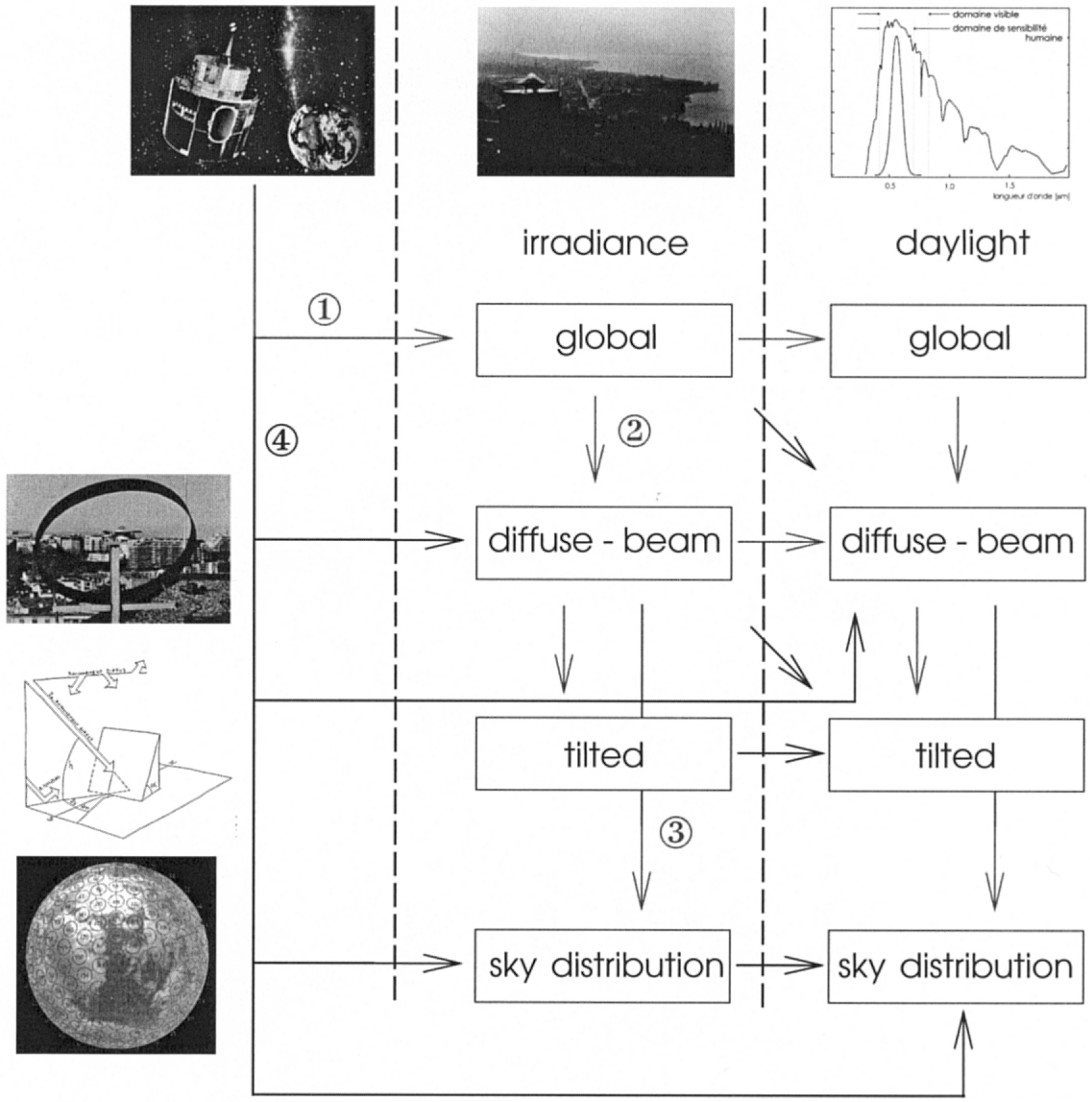

① traditional or improved heliosat method
② global-to-diffuse or to-beam model
(Perez, Skartveit & Olseth, etc.)
③ luminance & radiance distribution model
(Perez, Kittler, CIE, Brunger, etc.)
④ direct way from pixel to irradiance and daylight components

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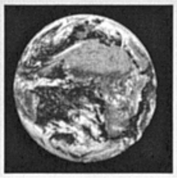
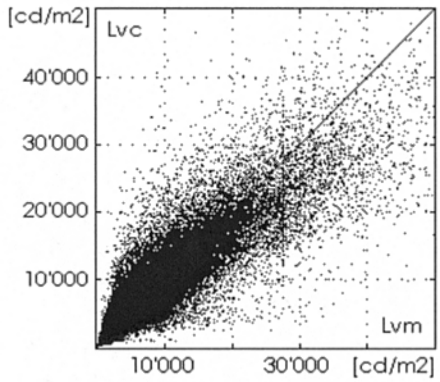


Why to follow the direct way?

1st motivation

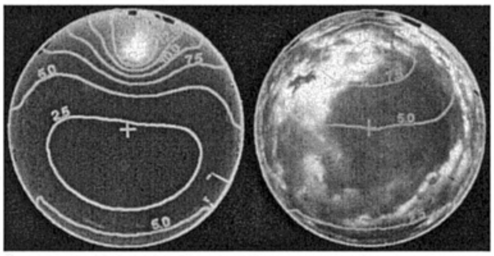
- the modelled sky radiance/luminance distribution has a high dispersion



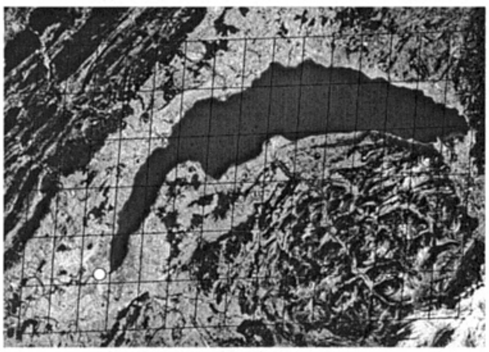
the models are usually symetric to the sun direction,

the cloud distribution is site dependent (*random?*),

geostatistical model (Perez), but they need local statistical informations



- the satellite image has a directional property



use of the surrounding pixels to take into account the cloud distribution

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Radiance/luminance distribution from satellite image

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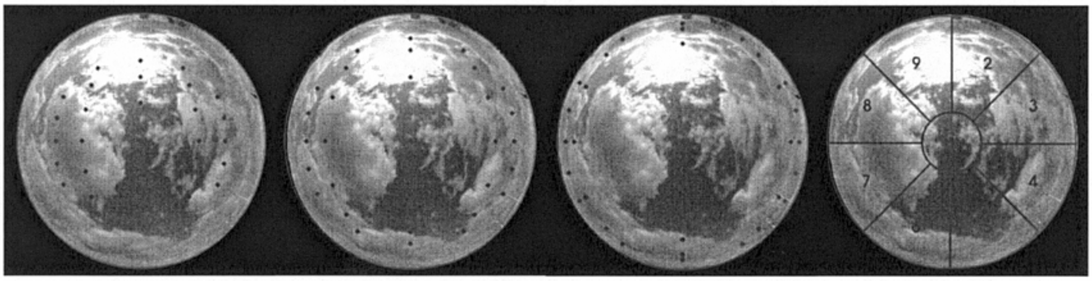
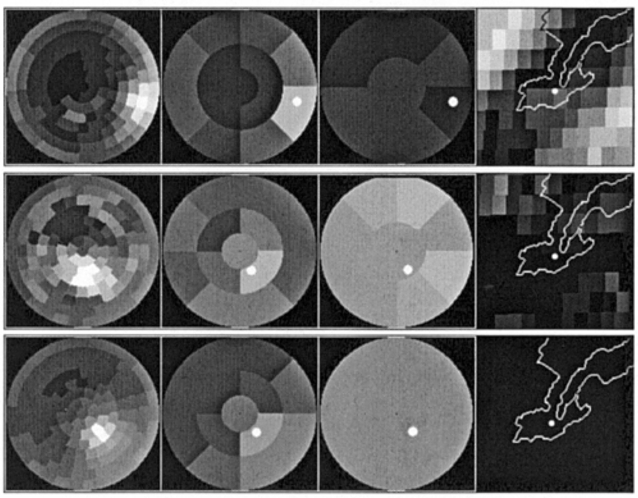
- the *apparent position* of the pixel depends on the cloud altitude:



clouds at 10'000m | at 5'000m | at 1'000m | the 9 zones

- the results obtained with a luminance model



145 zones | 13 zones | model | cloud index

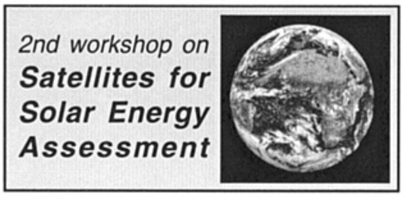
- the model does not take into account the influence of the sun (circumsolar diffuse),
- the cloud altitude is difficult to evaluate even with the IR channel.

Conclusions

the use of a traditional model on the *heliosat global* gives better results!

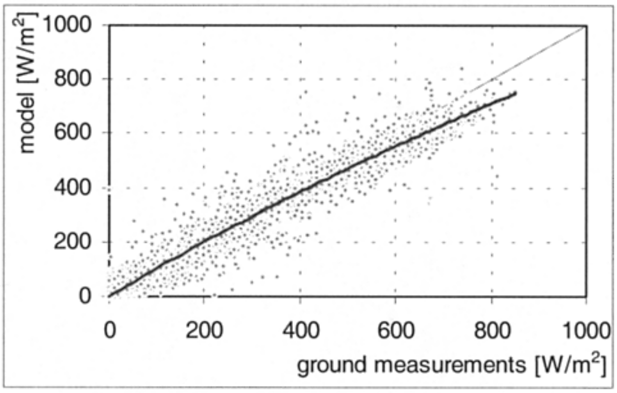
we developed a luminance model => diffuse model

Why to follow the direct way ?

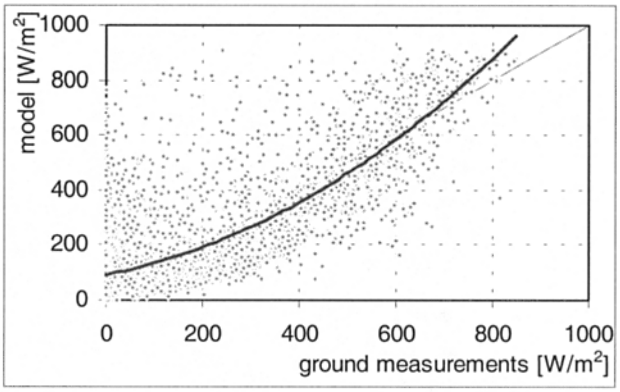


2nd motivation

- the heliosat method gives the global component with a precision of about 30%.
- the use of a global-to-direct (or diffuse) model gives good results on ground measurements:



- the chaining of the two models enhances the dispersion:



- the derivation of a direct way model will avoid the cumulative bias and dispersion.

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Why a multiparameter model?

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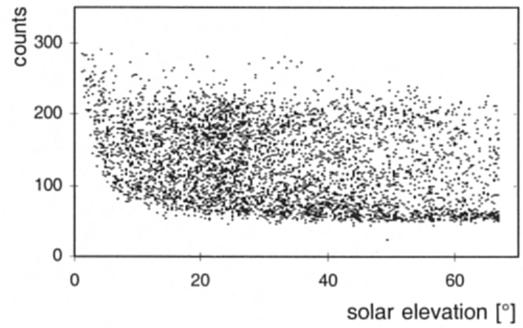
- the raw counts are retrieved from the satellite image



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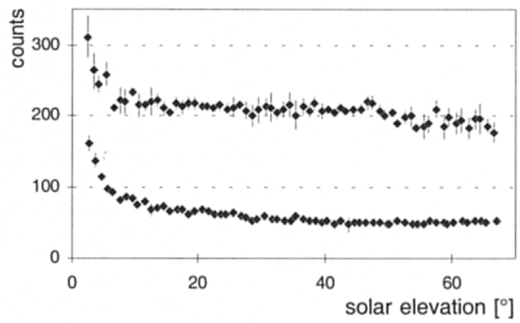
- the upper and lower boundaries are determined by extracting the 10% highest and lowest count values



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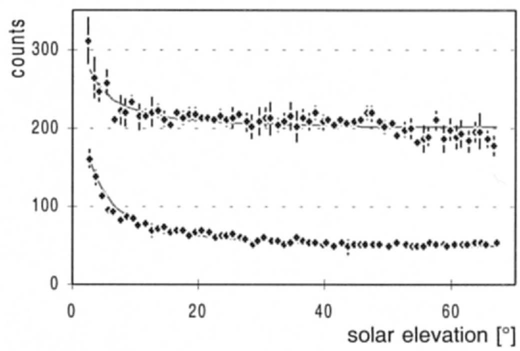
- a best fit is done on the two series of points



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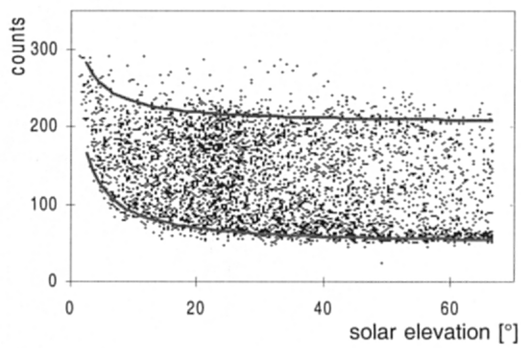
- the two curves represent the influence of the optical air mass on the measured reflectance



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