MATISSE:
MODELISATION AVANCEE de la TERRE pour l 'IMAGERIE et la SIMULATION des SCENES et de leur ENVIRONNEMENT

« Advanced Earth Modelisation For Imagery and Scene Simulation »

VERSION 1.1

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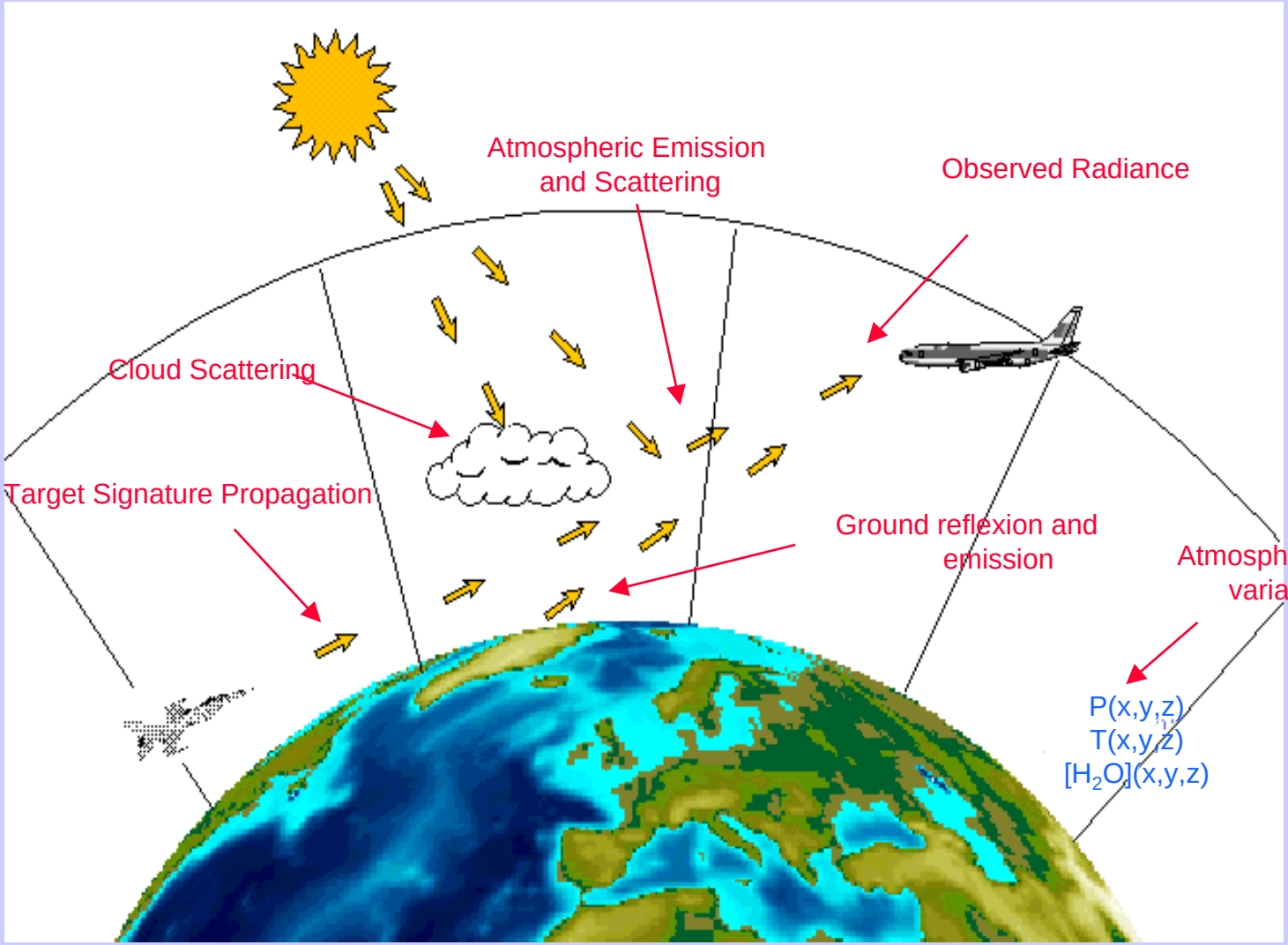
Goal of MATISSE : Radiance images



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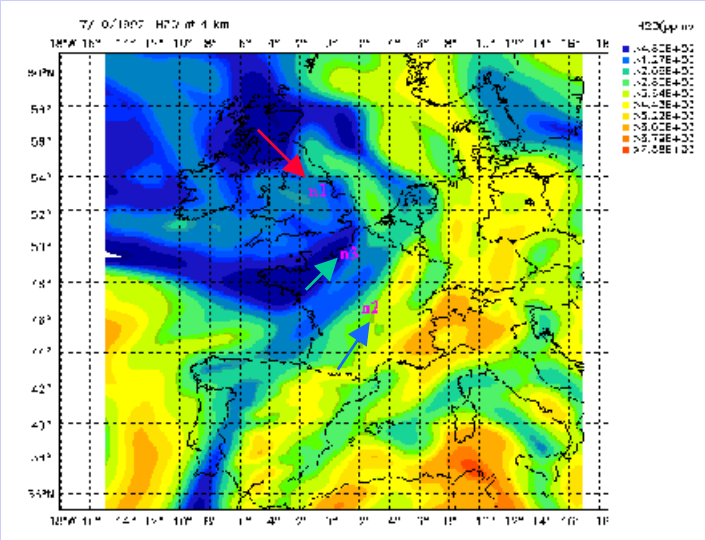
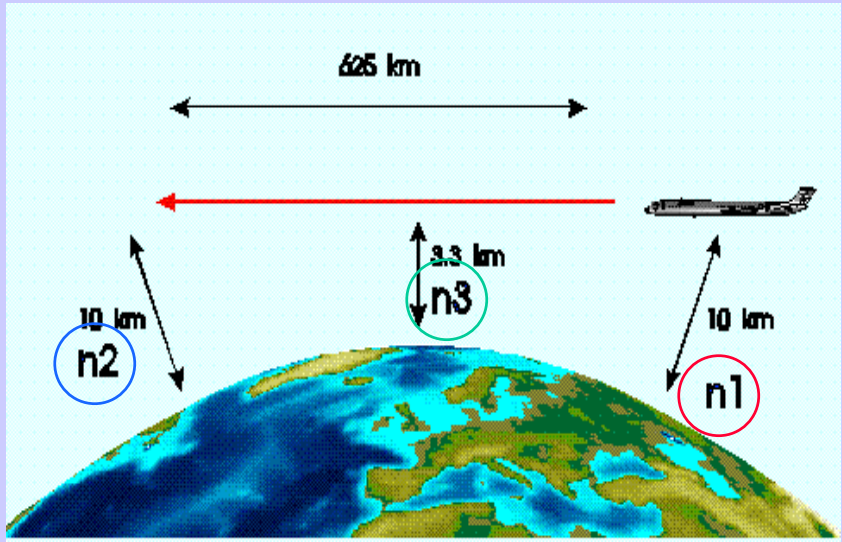
Why MATISSE ?

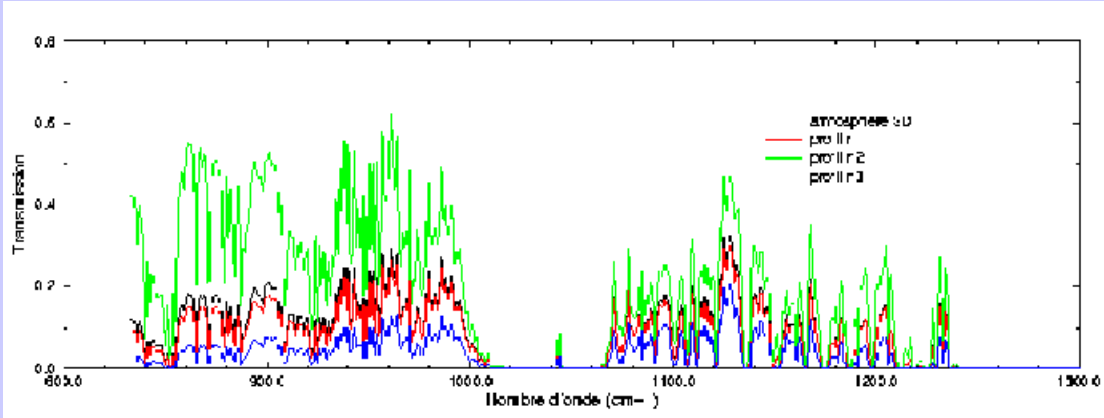
- **Coherent radiance images**
  - target detection studies
  - contrast of natural background
- **Atmospheric spatial variability computation**
- **New functionalities**
- **Insertion of the code in computation chains**

Why Matisse ?

Atmospheric Spatial variability (prototype results)







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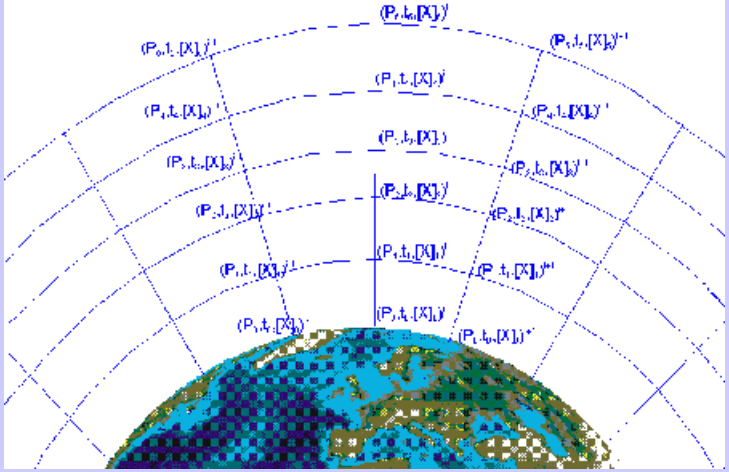
Description of the code

- **Core**
  - General method
  - Transmission model
  - Source function computation
- **Natural backgrounds**
  - Ground modelisation
  - Cloud modelisation
- **Target signature transmission**
- **Language and computer**
- **Secondary Data Bases**

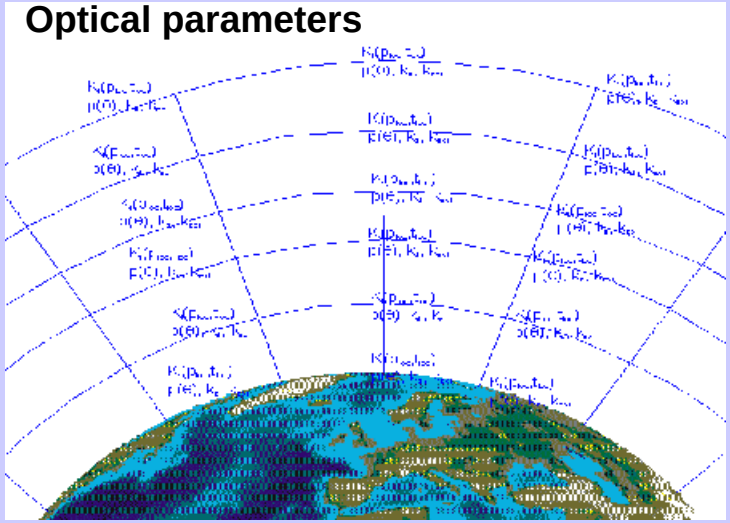
General method

Source functions computation

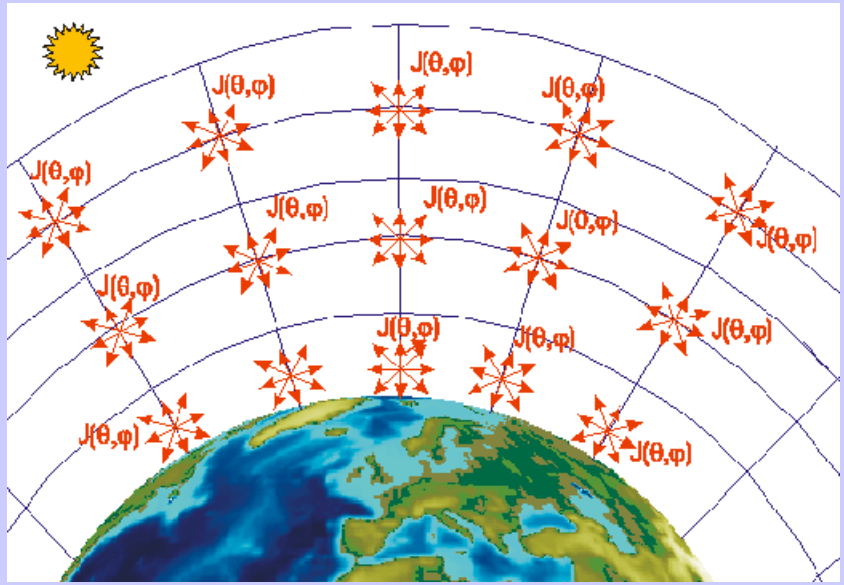
Atmospheric profiles



Optical parameters



Total Source Functions



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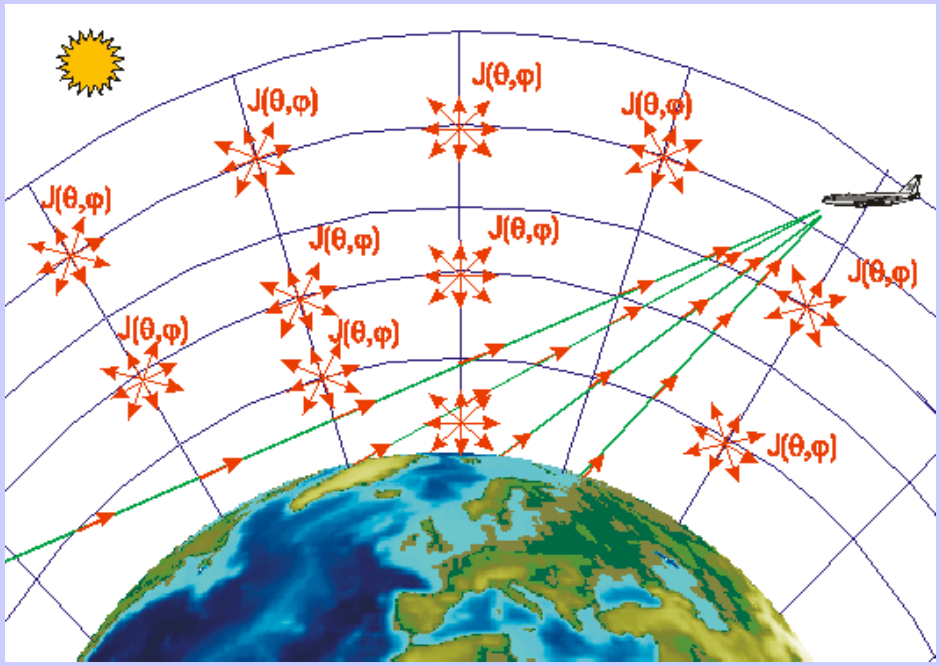
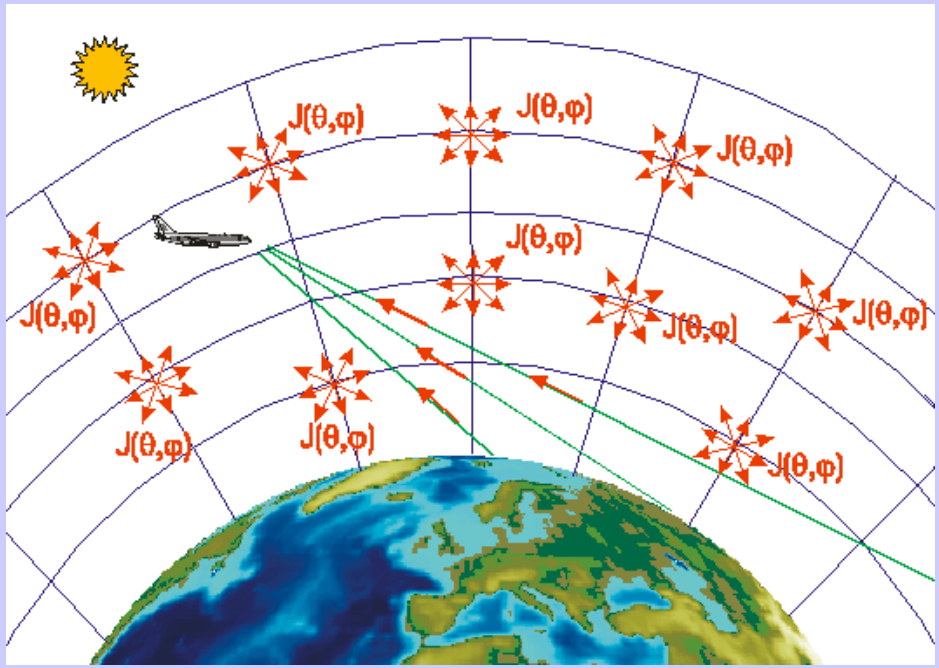
General method

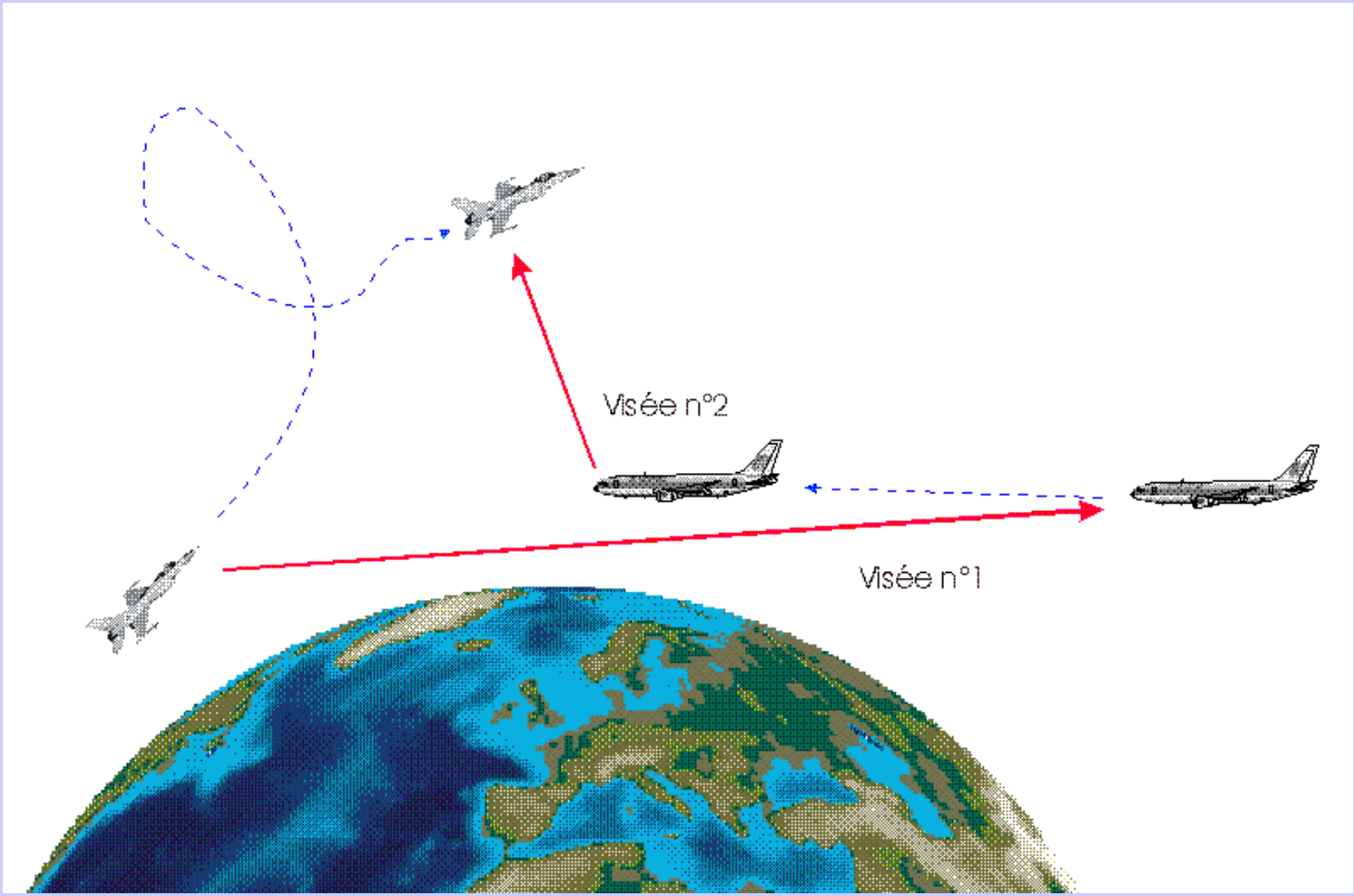
Source functions propagation





⇒ all the radiatives parameters (sources functions, surfaces radiances, absorption coefficients, ...) are stored

Application



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Need to use Beer ’s law

→ **LBL method**

→ **K distribution method**

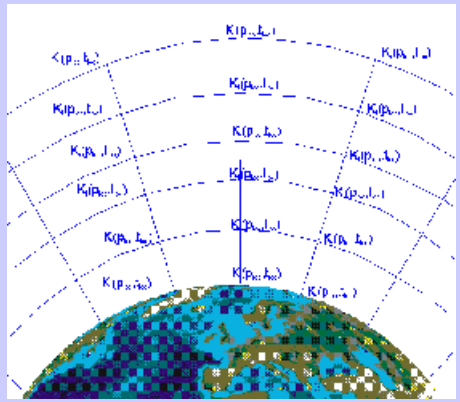
Transmission model
CK model (1/3)

- **Advantages**
  - Beer 's law
  - molecular absorption / aerosols scattering coupling

- **Method**

Atmospheric profiles → LBL model (Lpma/Snecma/ Onera) → CK profiles stored in a Data Base

Hitran 96 data base



- **Characteristics**
  - spectral range (MATISSE 1.1) : 3 - 13 µm
  - spectral resolution : 5 cm^{-1}

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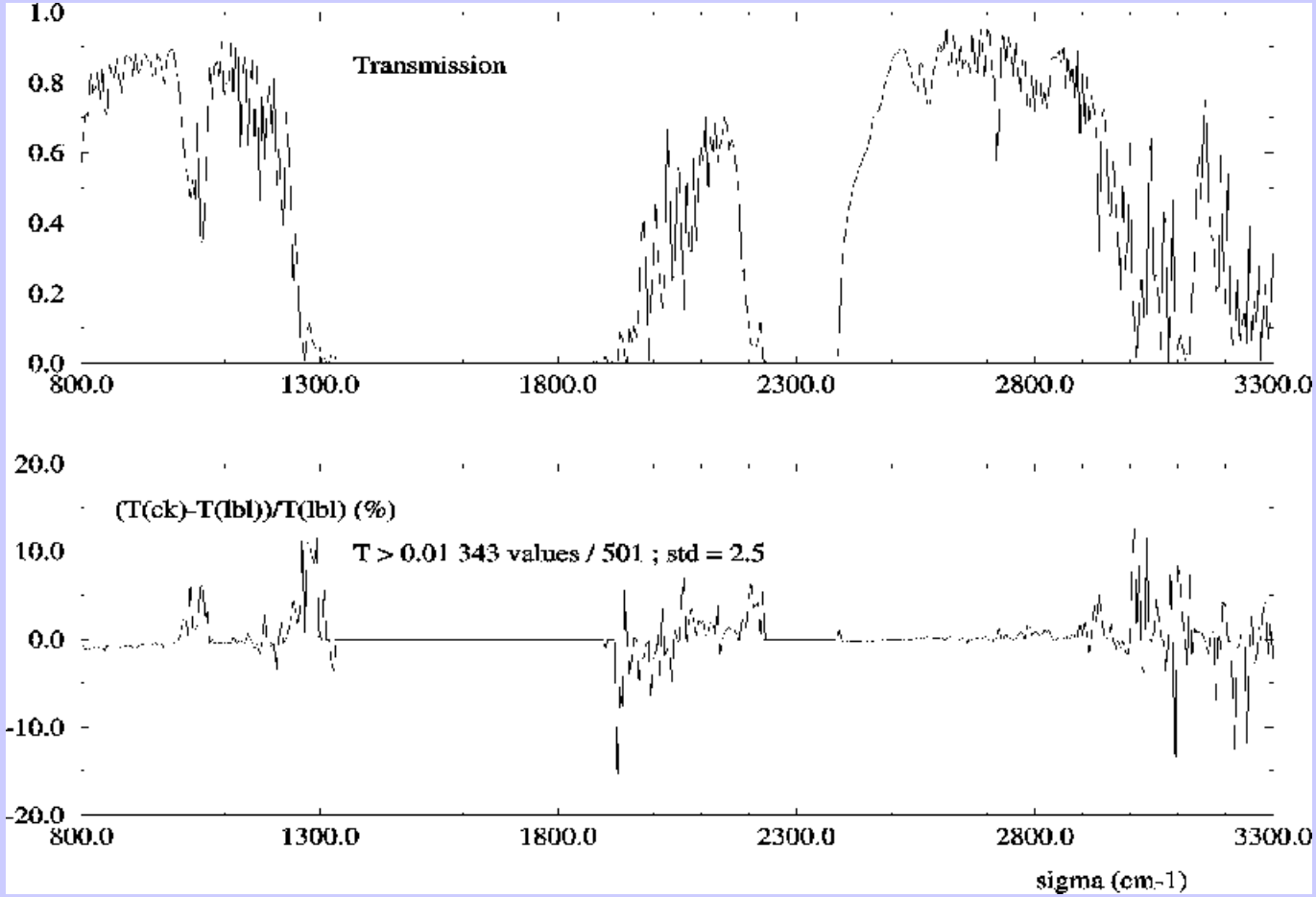
Transmission model
CK model (2/3)



US Standard / 0-15km / ZA = 45°

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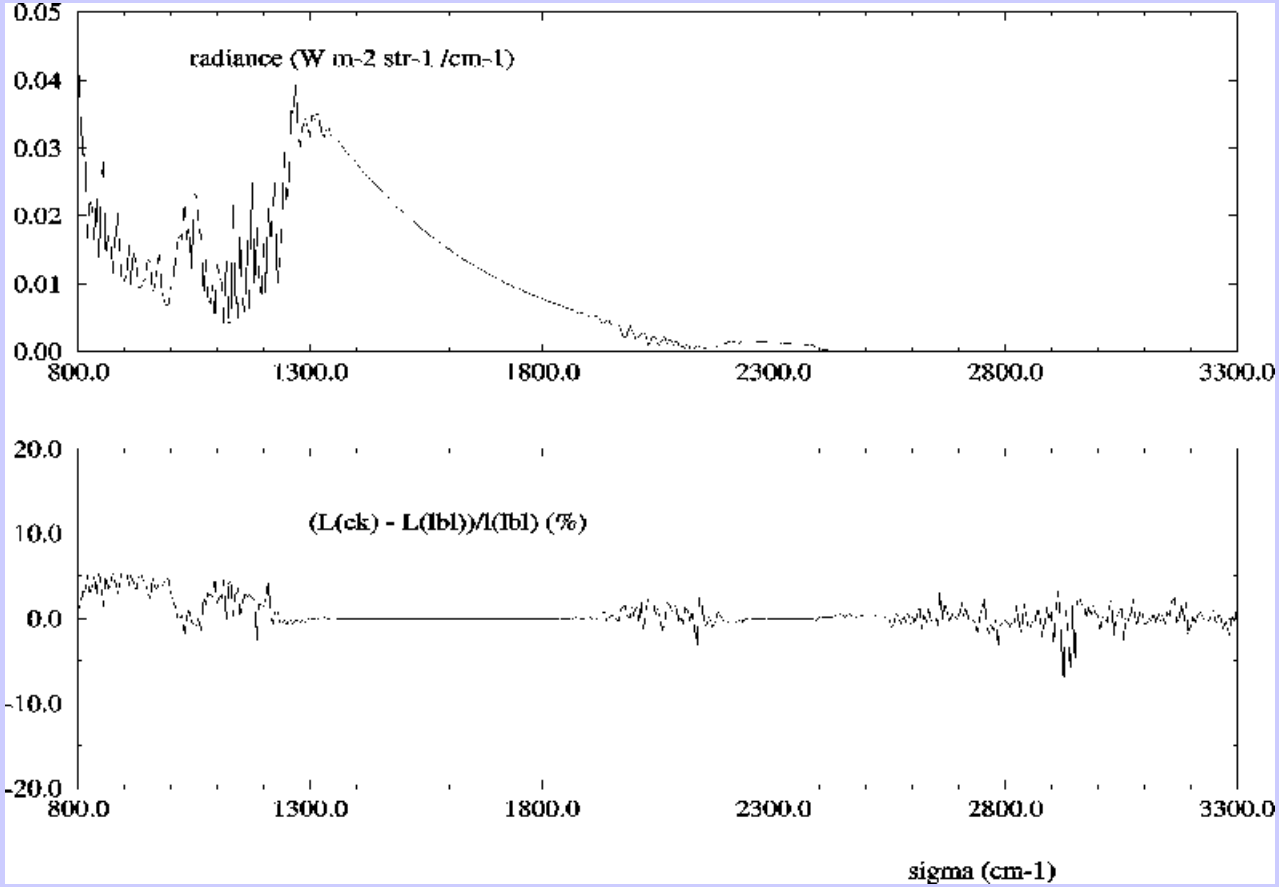
Transmission model
CK model (3/3)



US Standard / 0-15km / ZA = 45°

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Source functions computations (1/2)

$$J_{tot}(\theta,\varphi) = J_{ss}(\theta,\varphi) + J_{th} + J_{ms}(\theta,\varphi)$$

Two ‘ horizontal ’ spatial resolutions

→ High resolution (0.25°x0.25°)

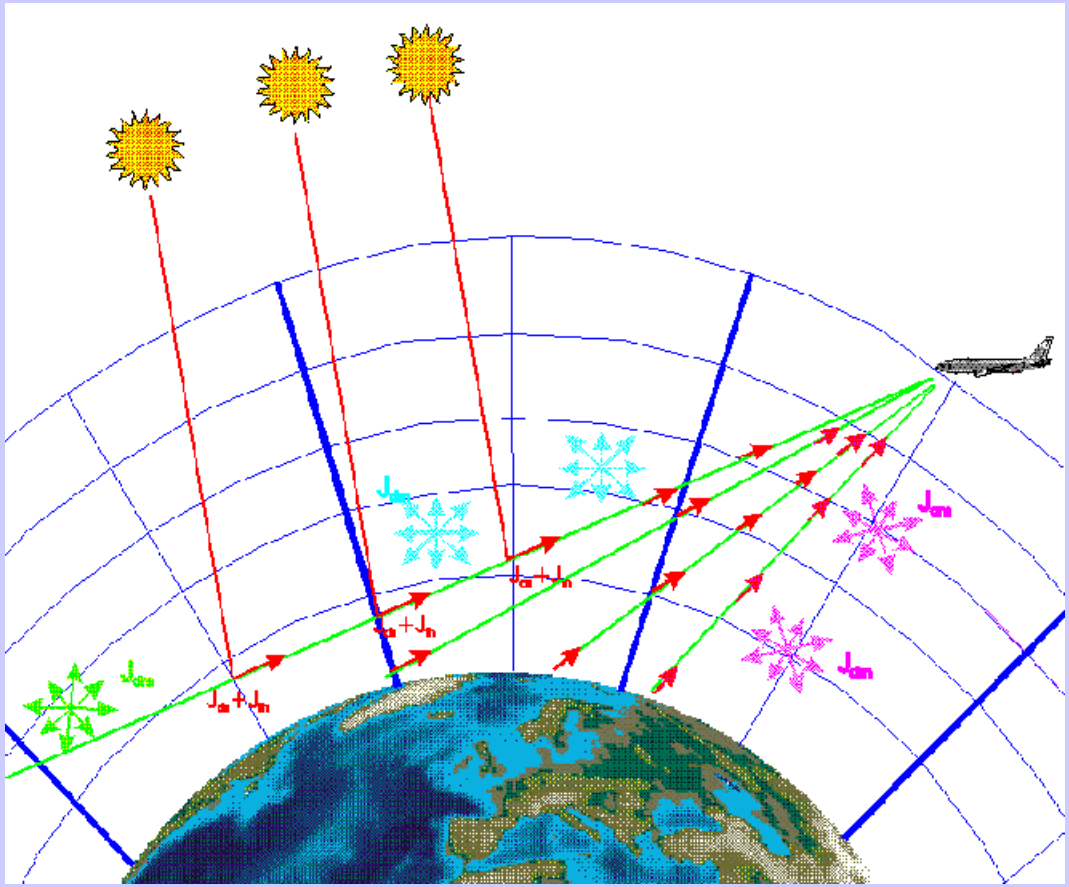
- Single scattering : $J_{ss}(\theta,\varphi)$
- Thermal emission : J_{th}

→ Low resolution (5°x5°)

- multiple scattering : $J_{ms}(\theta,\varphi)$

→ RTRN21 (Nakajima) : DOM + TMS

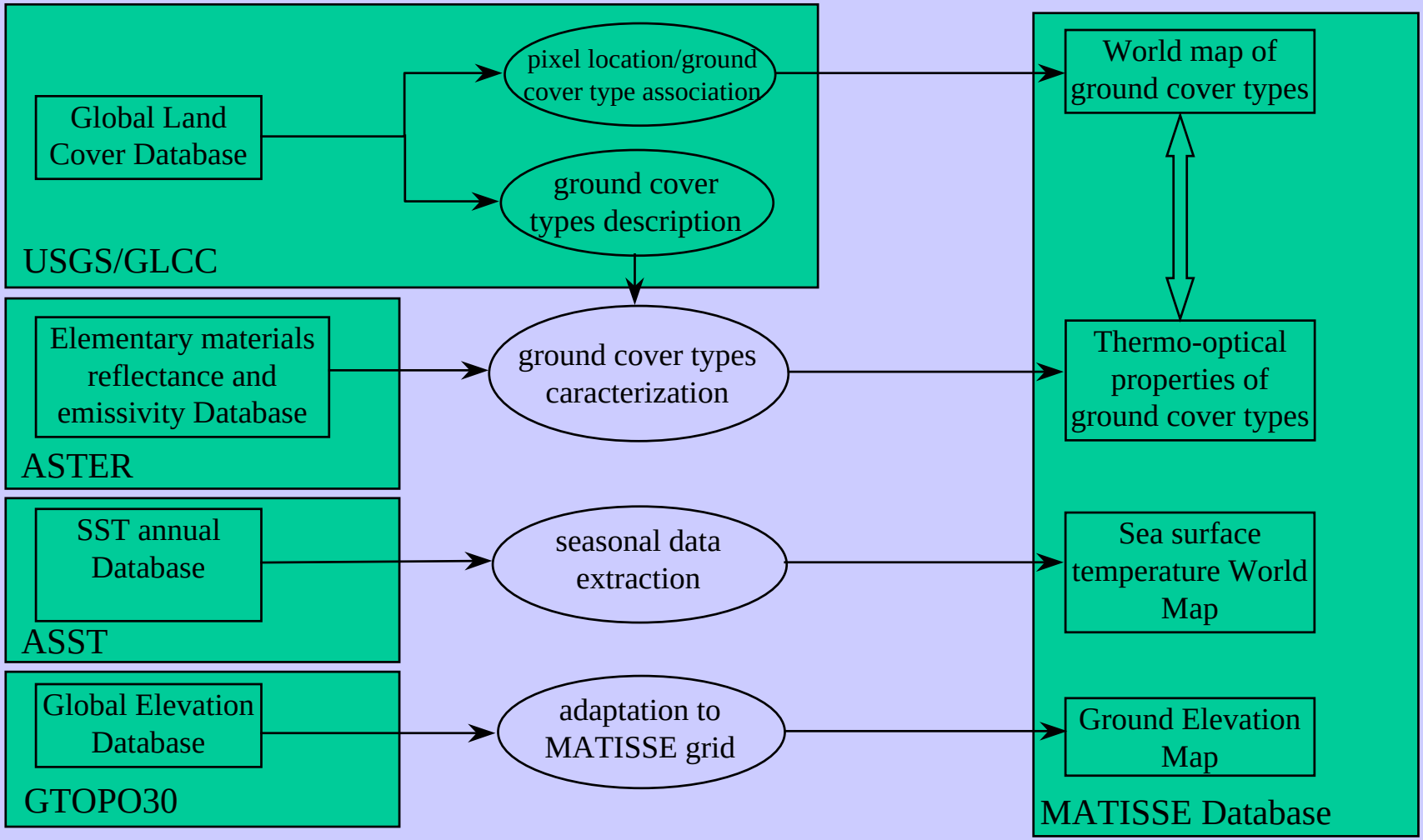
Source functions computations (2/2)



Ground description (1/2)

- **Geometrie**
  - WGS84
  - Digital terrain elevation : USGS-GTOPO30 (30 ")
  - Shadowing and hidden surfaces : OpenGL routine
- **Ground temperature**
  - thermal model
- **Land-use data base**
  - USGS/GLCC + ASTER

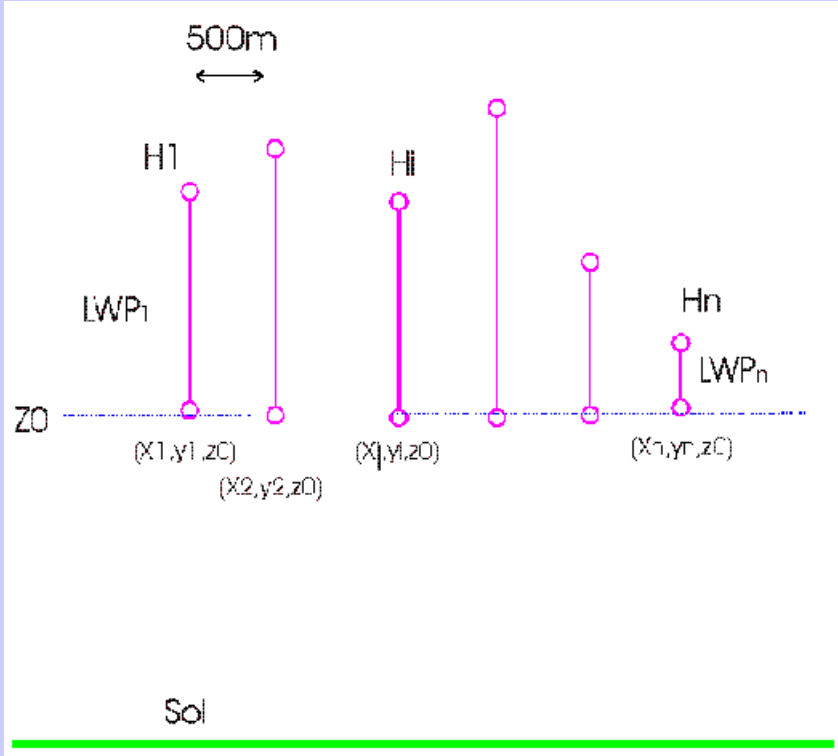
Ground description (2/2) :
Land use data base construction



Cloud description (1/2) : Generation

Stratocumulus Clouds

– Thickness and shape : statistical generation
– LWC(z) : Feddes method
– Vertically homogeneous
– n(r) = constant



Spatial fluctuations : LWC, ∆h

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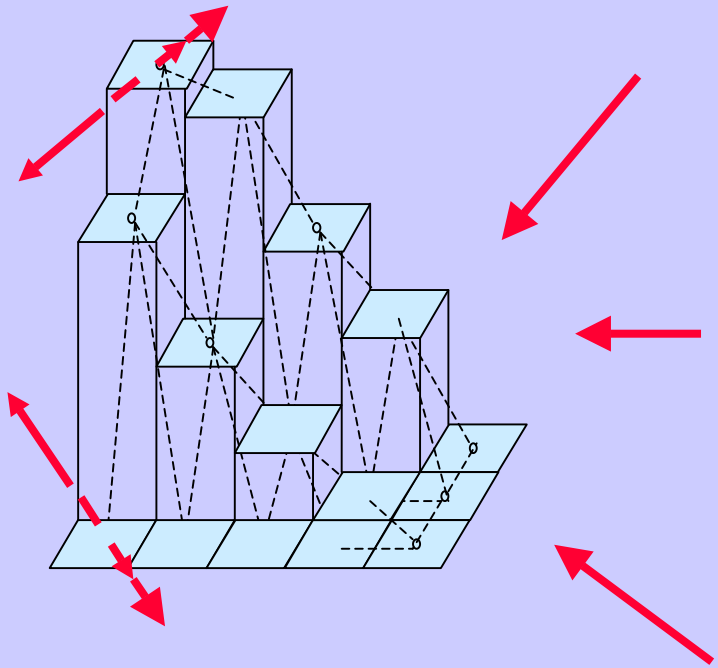
Cloud description (2/2) : Radiation

- **Radiative transfer : IPA + BRDF**

  → **Use of RTRN21 (Nakajima)**
  - DOM + TMS
  - Plan parallel

  $BRDF(\Theta_{sol}, \Theta, \Delta\varphi, \sigma, \omega,\tau)$
  $BTDF(\Theta_{sol}, \Theta, \Delta\varphi, \sigma, \omega,\tau)$
  $\varepsilon(\Theta, \sigma, \omega,\tau)$



- **Shadowing and hidden surfaces : OpenGL routine**

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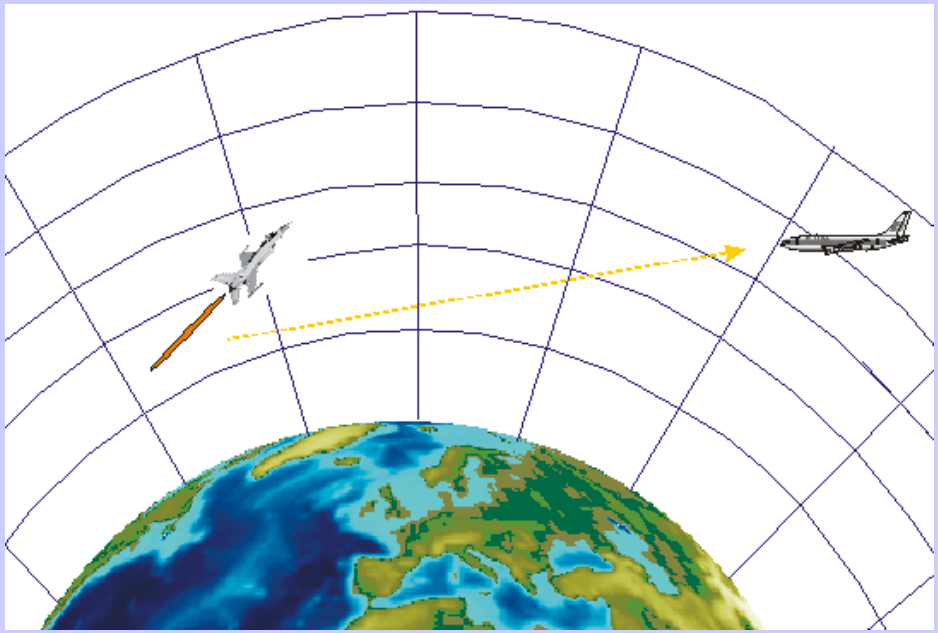
Target signature transmission Method



$p\ (x,y,z)_i$
$t\ (x,y,z)_i$
$[X]\ (x,y,z)_i$
σ_1, σ_2

→ LBL model → $T(\sigma_i)$

$+$ → $E_{\Delta\sigma}$

$I(\sigma,\Omega,p)$

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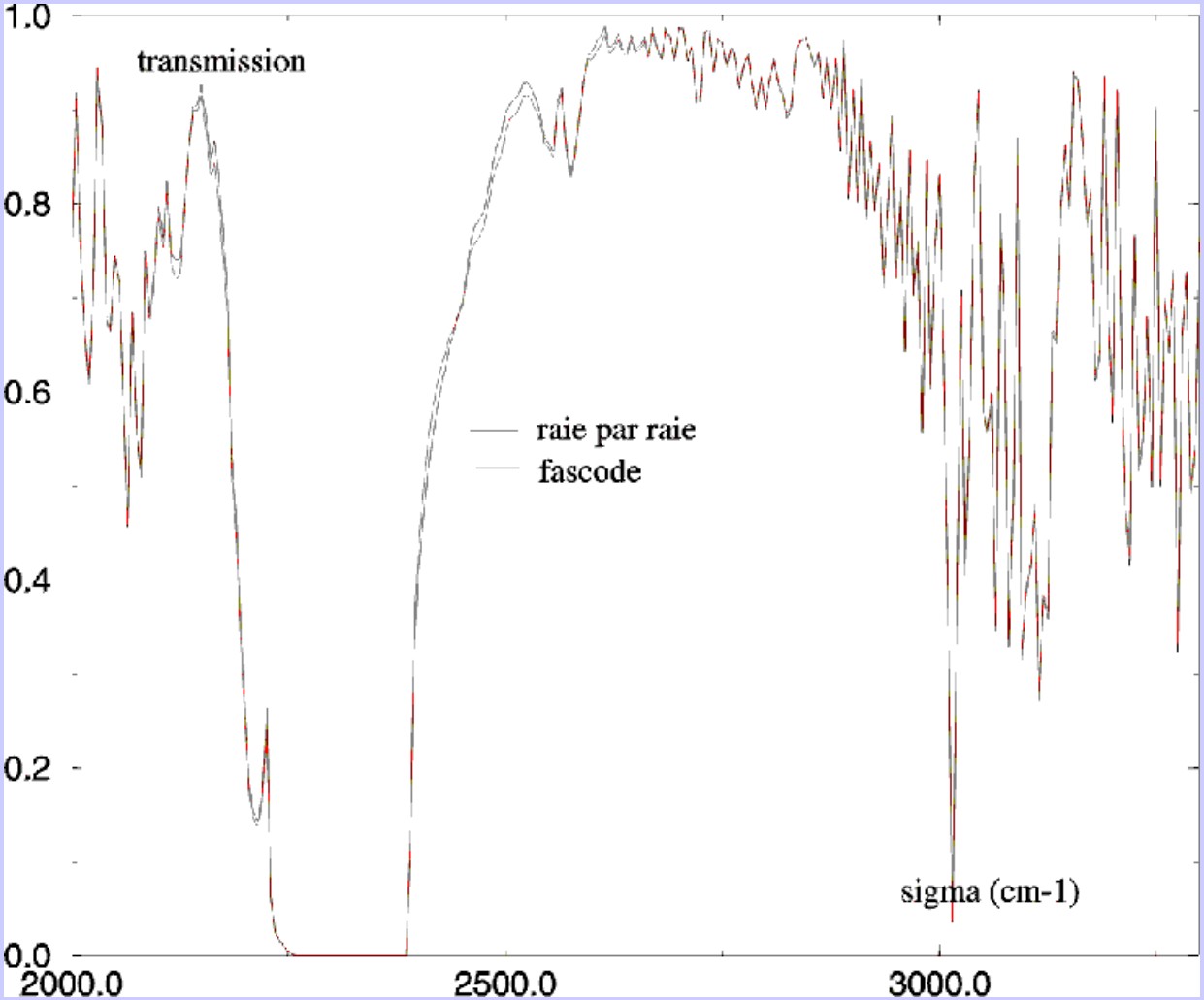
Target signature transmission
Line by Line / FASCOD3 comparisons



- **Nadir viewing : 0 → 100 km**
- **US STANDARD**

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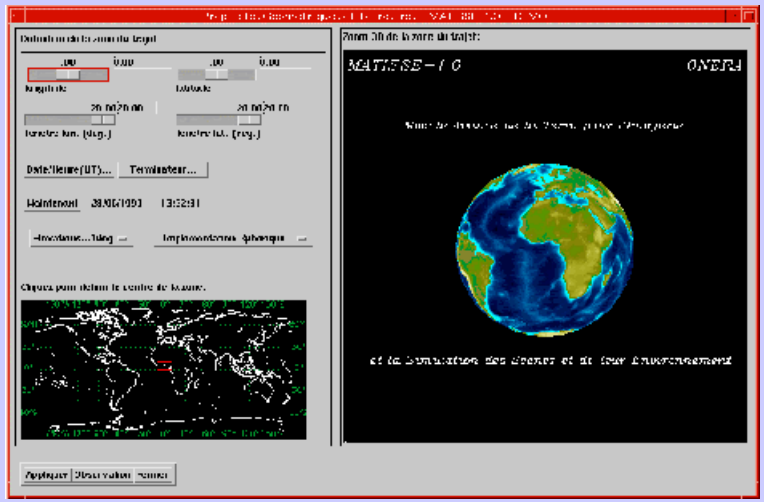
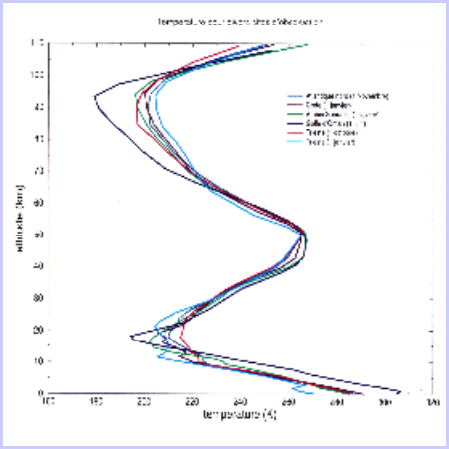
Language and computer

- **Language**
  - Main programme : C
  - Routines : C, F90
  - GUI : PV-Waves 6.21
  - Quality approach

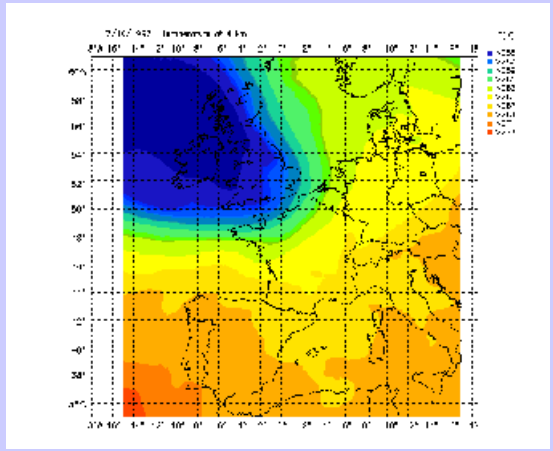


- **Computer**
  - SUN Ultra 80
  - 2 processors ULTRA SPARC 450MHZ
  - MEMORY : 2 Go
  - Disk storage : 40 Go

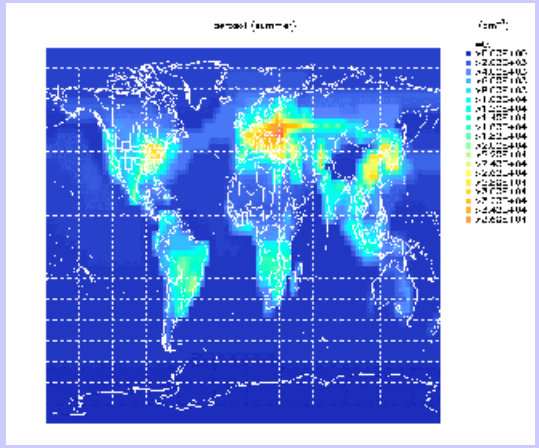
Secondaries Data Bases



Atmospheric Profiles 1D,2D
(>1800)



Atmospheric profiles 3D
0.25° x 0.25°



Aerosols profiles (GADS)
5° x 5°

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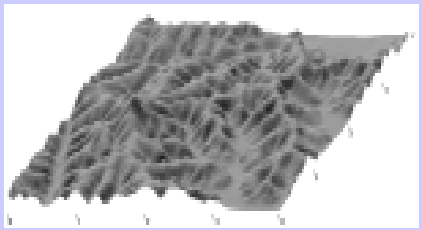

- DTED (30'')
- Land-use

Clouds BRDF, BTDF, ε

Radiative transfer

- CK parameters
- Line by line data
- Solar spectrum

MATISSE 1.1 : Summary (1/2)

- **Coherent radiance images**
- **Atmospheric radiative transfer : CK / 3-13µm / $\delta\sigma/\sigma$ = 5 cm^{-1}**
- **Aerosol + molecule scattering : (DOM for MS)**
- **Atmospheric Spatial Variability for all the LOS**
- **Clouds Emission and Scattering : Scu / IPA + (BRDF,ε)**
- **Ground Emission and Reflectance : T_{ground} + BRDF + ε**

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MATISSE 1.1 : Summary (2/2)

- **3D Ground (DTED) + cloud shadowing**
- **Target signature propagation**
- **GUI**
- **High resolution spatial Variability**
- **Refraction along only one line of sight**

Release of MATISSE 1.1 : May 2002

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Future works

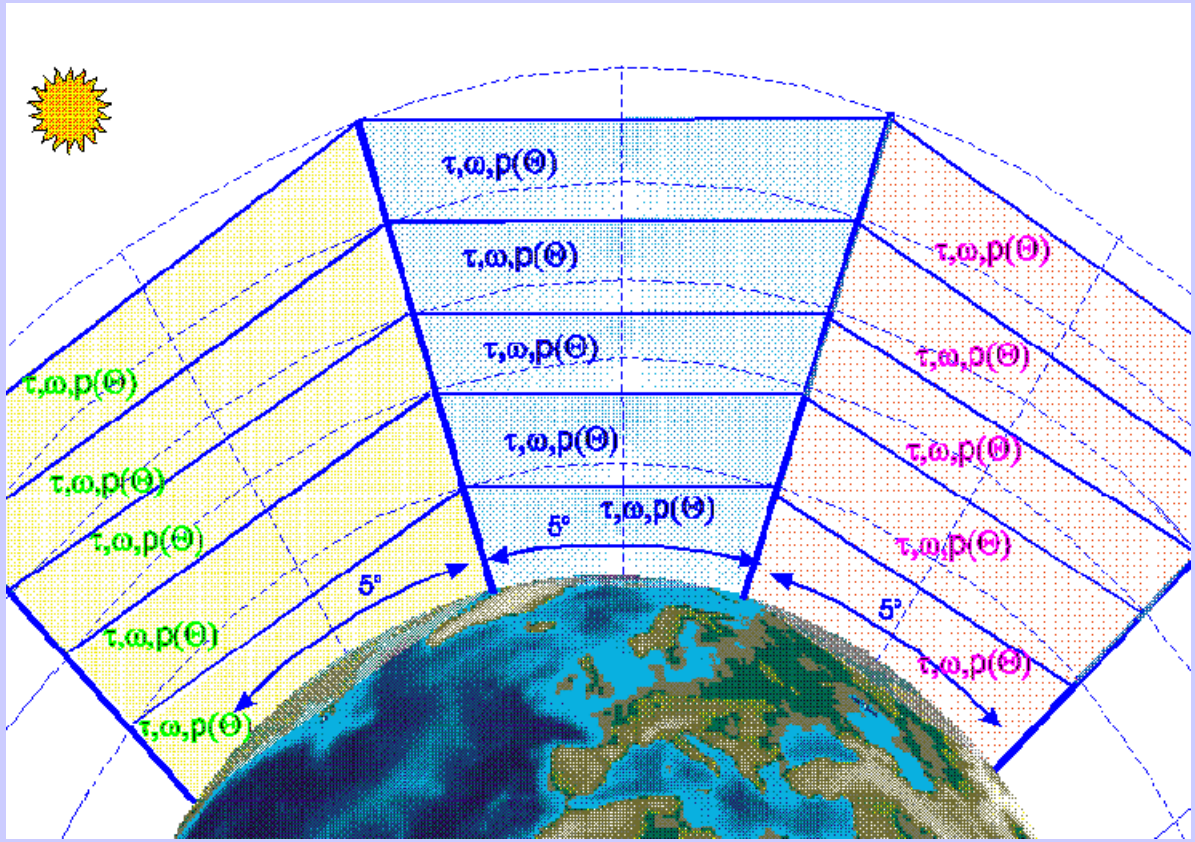
- Sea surface model
- Cirrus clouds
- CK ’s spectral domain and resolution
- Adjacencies effects
- NLTE
- Refraction for all the LOS in the image
- Coupling with high spatial resolution radiative codes

Group

P. Simoneau	**: Project manager**
L. Labarre	**: Development manager, architecture, GUI, OpenGL**
R. Berton	**: Geometry, cloud generation, high resolution spatial variability, refraction**
K. Caillault	**: Ground thermal model, high resolution spatial variability**
G. Durand	**: Atmospheric source function computations**
T. Huet	**: CK development, target signature transmission**
C. Malherbe	**: Cloud radiative transfer**
C. Miesch	**: Land use data base construction**

Matisse 1.1 is sponsored by the 'Délégation Générale de l'Armement'

Multiple scattering source function computation



- **5°×5°** horizontal resolution
  Only one type of aerosol

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Multiple scattering source function computation