MATISSE : version 1.4 and future developments

Advanced Earth Modeling for Imaging and the Simulation of the Scenes and their Environment

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For optronic systems specification and preliminary design

- Backgrounds radiation spatial variability (ground, clouds, atmosphere)
- Global databases of atmospheric and background environments (force projection)
- Target / background contrasts, hot plumes propagation
- Quality management and V&V

**MATISSE History**

**1995**
- MATISSE Proto
  - LOS (moderate resolution Band Model)
  - atmospheric variability
  - atmospheric profiles databank

**2000**
- MATISSE-v1.1
  - imagery mode
  - CK model for propagation
  - heterogeneous clouds (Sc)
  - ground thermal model
  - HSR transmission (LOS)

**2002**
- MATISSE-v1.2
  - LOS mode (MSR)
  - Cirrus clouds
  - New ground thermal model
  - HSR thermal emission (LOS)

**2004**
- MATISSE-v1.3
  - New refraction models

**2005**
- MATISSE-v1.4
  - Maritime Boundary Layer (MBL) mode
  - improved rendering
  - computation speed

**2006**
MATISSE-v1.4: Overview

Atmospheric variability

Observed radiance

Cloud emission scattering

Atmospheric extinction

Ground emission and reflection

Atmospheric emission and scattering
MATISSE-v1.4: 4 computation modes

« Imagery » mode

Radiance and transmission Images / $\Delta \sigma = 5$ cm$^{-1}$

Direct computation

LOS mode

API

Radiance and Transmission along a LOS / $\Delta \sigma = 5$ cm$^{-1}$

HSR mode

High spectral resolution thermal radiance and transmission
Atmospheric emission and scattering

- Atmospheric emission and absorption → CK model
  \[ 765 \to 3300 \text{ cm}^{-1} (3 \to 13 \text{ µm}) / \delta \sigma = 5 \text{ cm}^{-1} / \text{step 5 cm}^{-1} \]

- Atmospheric scattering → Discrete Ordinate method

- Atmospheric data
  → 1D profiles database : AFRL + TIGR 1760 profiles
  → aerosols
    - GADS climatology database (D’Almeida & al) ⇒ aerosols variability
    - “Modtran” aerosols : Rural / Urban / Fog / Maritime / Tropospheric
    - AP (DRDC collaboration) : Marine Boundary Layer Aerosols
Atmospheric variability

2D database
one profile for each latitude band

3D database
one profile at each grid point

Aerosol database (GADS)
horizontal spatial resolution: 5° × 5°

User defined spatial resolution

DOTA
Two options

1/ Partial coverage of Sc clouds
   - cloud shape generator
   - IPA + (BRDF, BTDF, ε)
     use RTRN21 → databank
   - Radiance texture model (PSD)

⇒ cloud radiance spatial variability
⇒ but time consuming

2/ Total coverage of Sc or Ci clouds (no horizontal variability)
   • direct radiative computation
Ground data sets and radiance

- DTED → 30” global coverage
  3” Europe

- Land use / (r,ε) → global 30”
  (IGBP-DISCover + ASTER)

- Ground thermal model
  - 1D, Periodic radiative energy deposit
    → Fourier Method
  - Solar energy deposit : 2 streams model
  - ASST (sea temperature)

- Radiance texture model
  - uses PSD
Other functionalities

- Multiple scattering (On/off)
- Sensor spectral characteristics
- Intermediate images computation along the LOS (imagery mode)
Spectral radiance and transmission
(or integrated with apparatus function)

$765 \rightarrow 3300 \text{ cm}^{-1}$ (3 $\rightarrow$ 13 $\mu$m) / $\delta \sigma = 5 \text{ cm}^{-1}$ / step 5 cm$^{-1}$ / CK model
LOS modes
Maritime Boundary Layer (DRDC)

- Propagation along a LOS in the Marine Boundary Layer
  - New maritime aerosol model AP (DRDC)
  - User atmospheric profile generator
  - High accuracy path modeling
  - Multiple path propagation

MBL ≈ 30 m
LOS Modes
High spectral resolution (LBL)

\[765 \rightarrow 3300 \text{ cm}^{-1} (3 \rightarrow 13 \text{ \mu m}) / \delta \sigma = \approx 10^{-2} - 10^{-4} \text{ cm}^{-1}\]

2 independent modes: \(\rightarrow\) all molecules
\(\rightarrow\) all molecules excepted H\(_2\)O and CO\(_2\)

- All MATISSE thermodynamic profiles (including 3D profiles)
- No aerosols
- No ground radiation
• Workstations
  – SUN / Solaris 2.8
  – IBM / AIX 4.3

• PC Windows (in beta test)
  – Light version (1 DVD) ⇒ limited functionalities
    • LOS only
    • No large databases (no GADS / no 3D thermodynamic scene)
    • LBL mode
    • User’s profiles generator
Results
Spectral radiance images
(or integrated over sensor bandwidth)

- 15/06/2005 12h00 UTC
- US Std / Rural 23 km
- long. / lat. : 2.5 E / 48.6 N
- observer altitude / elevation : 300 km / -90°
- FOV : 80° x 80°
- 40000 spatial elements

- Total computation time for 1 wavelength (1250 cm\(^{-1}\)) ~ 7'
- Thermal model computation time ~ 3.5' (# ground facets ~ 10\(^6\))
Spectral radiance and transmission along a LOS
Future works: MATISSE-v2.0
(end 2008)
MATISSE-v2.0: main functionalities

- Spatial variability at high resolution (metric)
- Background physical properties generators
- Multi-resolution approach for sea and land
- Sea radiance spatial variability models
  - Sub-metric variability of the radiance
  - Solar glint effect
  - Time dependence
Solar glint

\[ \Omega_{\text{sun}} \]

\[ \Theta_{\text{sun}} \]

\[ \Theta_{\text{obs}} \]

\[ 512 \times 512 \]
http://matisse.onera.fr