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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MATISSE-v1.4: 4 computation modes

« Imaging » mode

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

Direct computation

LOS mode

API

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

HSR mode (LOS)

High spectral resolution thermal radiance and transmission
Contributors

Observed radiance

Atmospheric emission and scattering

Cloud emission and scattering

Atmospheric variability

Ground emission and reflection

Atmospheric variability
Atmospheric emission and scattering

• Atmospheric emission and absorption → CK model
  765 → 3300 cm⁻¹ (3 → 13 μm) / δσ = 5 cm⁻¹ / step 5 cm⁻¹

• Atmospheric multiple scattering → DOM

• Atmospheric data
  → thermodynamic data
  ➢ 1D profiles database : AFRL + TIGR (1760 profiles)
  ➢ 2D profiles database : 2D climatology
  ➢ 3D profiles scene ⇒ atmospheric variability
    ➢ User atmospheric profile

  → aerosols data
  ➢ GADS climatology database (D’Almeida & al)
    ⇒ aerosols variability
  ➢ “AFRL” aerosols : Rural / Urban / Fog / Maritime / Tropospheric
  ➢ AP (DRDC collaboration) : Marine Boundary Layer Aerosols
Two options

1/ Partial coverage of Sc clouds (imaging mode)
   - cloud shape generator
   - IPA + (BRDF, BTDF, $\varepsilon$)
     \(\Rightarrow\) cloud radiance spatial variability
     (but time consuming)
   - Option : radiance texture model (PSD)

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)

- 1D Ground thermal model
  - Periodic radiative energy deposit → Fourier Method
  - Solar energy deposit : 2 streams model

- ASST (sea temperature)
Spectral radiance and transmission
(or integrated with apparatus function)

765 → 3300 cm\(^{-1}\) (3 → 13 \(\mu\)m) / \(\delta \sigma = 5\) cm\(^{-1}\) / step 5 cm\(^{-1}\) / CK model
LOS modes
Propagation in the Marine Boundary Layer

Maritime aerosol model AP (DRDC)

Surface Data
- $P_{\text{air}}$, $T_{\text{air}}$, $T_{\text{mer}}$, HR,
- $V_{\text{moy}}$, fetch, visi, Ma, $H_{\text{vagues}}$, ...

Radio-sounding
- Temp / American

AP

- Thermodynamic profile
- Aerosols profile
- $C_n^2$ profile:

Sea Surf $\rightarrow$ $Z_{\text{max}} \sim 3$ km

Extrapolation:
- Thermo. Profile + climatology
- AP Aerosols profile + AFRL

Sea Surf $\rightarrow$ TOA

$\text{MBL} = 30$ m

High accuracy path modeling
- Multiple path propagation (DRDC)
High spectral atmospheric thermal radiance and transmission along a LOS

765 → 3300 cm⁻¹ (3 → 13 μm) / \(\delta \sigma \approx 10^{-2} \text{ - } 10^{-4} \text{ cm}^{-1}\)

2 independent modes:
→ all molecules
→ all molecules excepted H₂O and CO₂

Refraction

- All MATISSE thermodynamic profiles (including 3D profiles)
- No aerosols
- No ground radiation
**Computers**

- **Workstations**
  - SUN / Solaris 2.8
  - IBM / AIX 4.3

- **PC Windows (2000 / XP)**
  - Full version
  - Light version (1 DVD)
    ⇒ limited functionalities
  - LOS only (CK and HSR)
  - No large databases (no GADS / no 3D thermodynamic scene / no DTED)
Results
Geostationary satellite
- 15/06/2005 12h00 UTC
- US Std / Rural 23 km
- long. 2. W
- Nadir angle : 7°
- FOV : 1.2°x1.2°
- 200 x 200 pixels
- Multiple scattering on

- Total computation time for 1 wavelength (1250 cm\(^{-1}\)) ~ 34 ' Sun Workstation
- Thermal model computation time ~ 30 ' Sun Workstation (# ground facets ~ 5.10\(^6\))
Integrated over sensor bandwidth radiance images

Waveband 3 – 5 µm  ~ 6.5 h Sun Workstation
(260 spectral elements)

Waveband 8-12 µm  ~ 2.5 h Sun Workstation
(84 spectral elements)
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
Summary

• MATISSE-v1.4
  – Imaging mode / LOS mode / HSR mode / API mode
  – SUN / IBM / PC Windows

• MATISSE-v2.0 (2008)
  – Sea images (high spatial resolution)
  – Irradiance computation

• MATISSE-v1.5 ? (2007)
  – Fast multiple scattering computation
  – Improvement thermal model computation
  – visible

http://matisse.onera.fr