LST and EM retrievals from SEVIRI onboard Meteosat:

Algorithms, uncertainties, and validation

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Outline

- The LandSAF
- Land Surface Emissivity
  - ✓Algorithm & Errors
- Land Surface Temperature
  - ✓Algorithm & Errors
  - ✓In-situ Validation
- LST & LSE Product Characteristics

LandSAF

AIM → Develop techniques that allow an effective use of MSG and EPS data related to:

- **LAND**
- **LAND-ATMOSPHERE Interactions**
- **BIOSPHERIC Applications**

Provide Products

+

User Support

FMI

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LandSAF - Products

Surface Radiation Budget

- LST
- Albedo
- ↓ LongWave Flux
- ↓ ShortWave Flux

Surface Water Balance

- Snow Cover
- Evapotranspiration

Vegetation

- Fraction Veg Cover
- LAI
- FAPAR

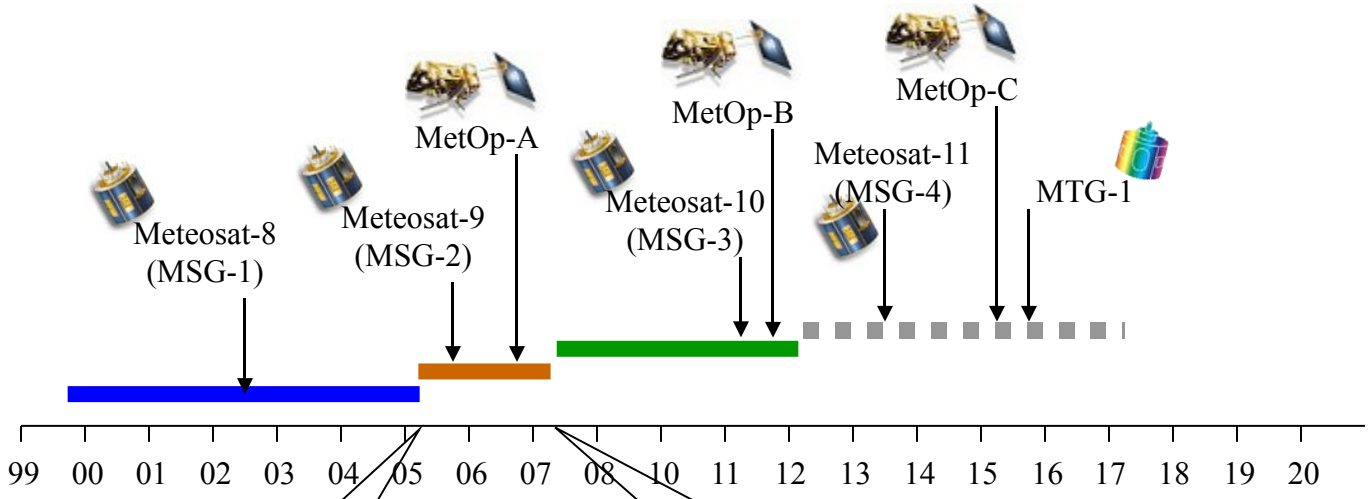
Wild Fires

- Fire Detection
- Fire Radiative Power
- Fire Risk (Europe)

SEVIRI/Meteosat

AVHRR, ASCAT/MetOp

Chronogram



Initial Operations Phase Feb 2005

Continuous Development & Operations Phase Mar 2007

LSE – Algorithm

Vegetation Cover Method [Caselles et *al.*]

Effective LSE $\rightarrow \varepsilon_{eff} = \varepsilon_{veg} FVC + \varepsilon_{bg}(1 - FVC)$

FVC → Fraction of **V**egetation **C**over

- Each IR channel / Broad Band
- Each Land-Cover Classes (IGBP classification)
- Using spectral library values + SEVIRI response functions

Associated Uncertainties $\rightarrow d\varepsilon_{eff} = 4\langle d\varepsilon \rangle FVC(1 - FVC)$

Simplification of equation

Excess emissivity due to multiple internal reflections

Trigo, I. F. *et al.* (2008) *in* IEEE Trans. Geosci. Remote Sens., 46.

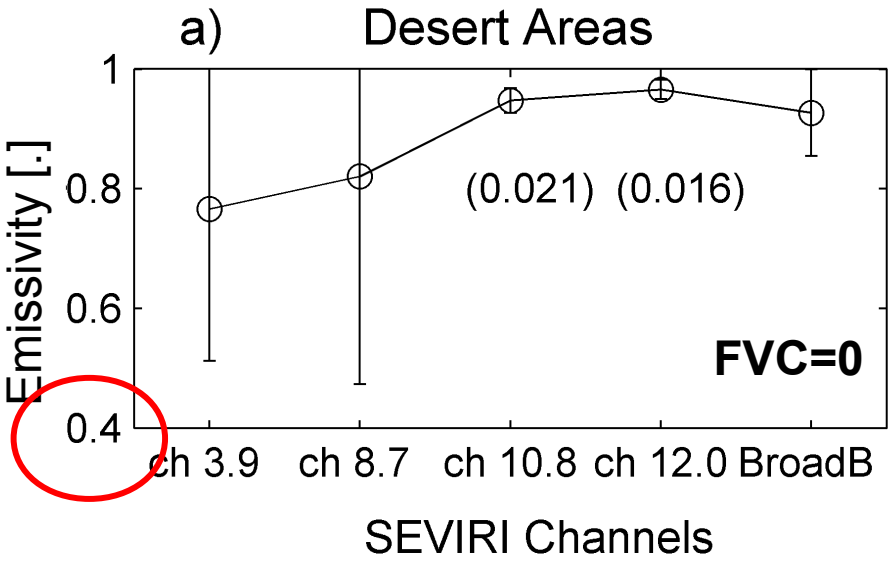
LSE – Algorithm

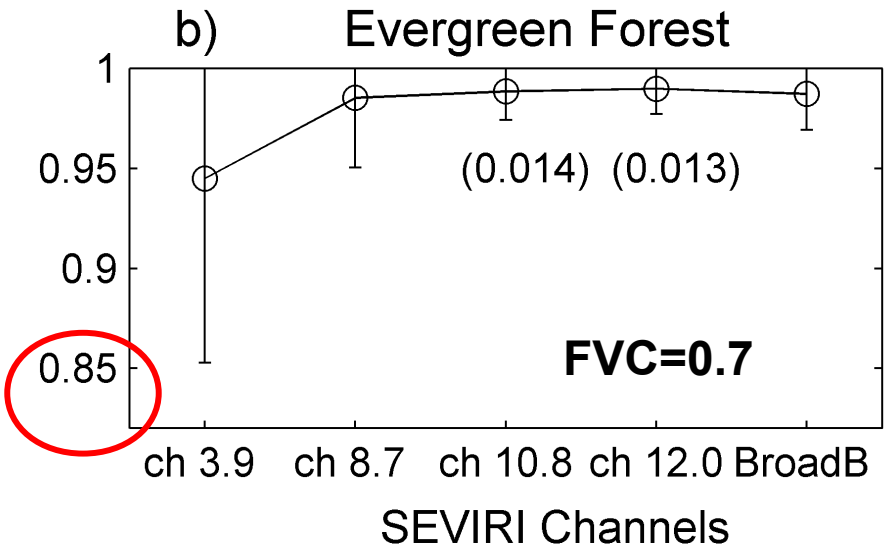
Error Bars

$$\delta\varepsilon_{eff} = \left[\left(FVC\,\delta\varepsilon_{veg}\right)^2 + \left((1-FVC)\,\delta\varepsilon_{bg}\right)^2 + \left(\left(\varepsilon_{veg} - \varepsilon_{bg}\right)\delta FVC\right)^2 + d\varepsilon_{eff}^2\right]^{1/2}$$

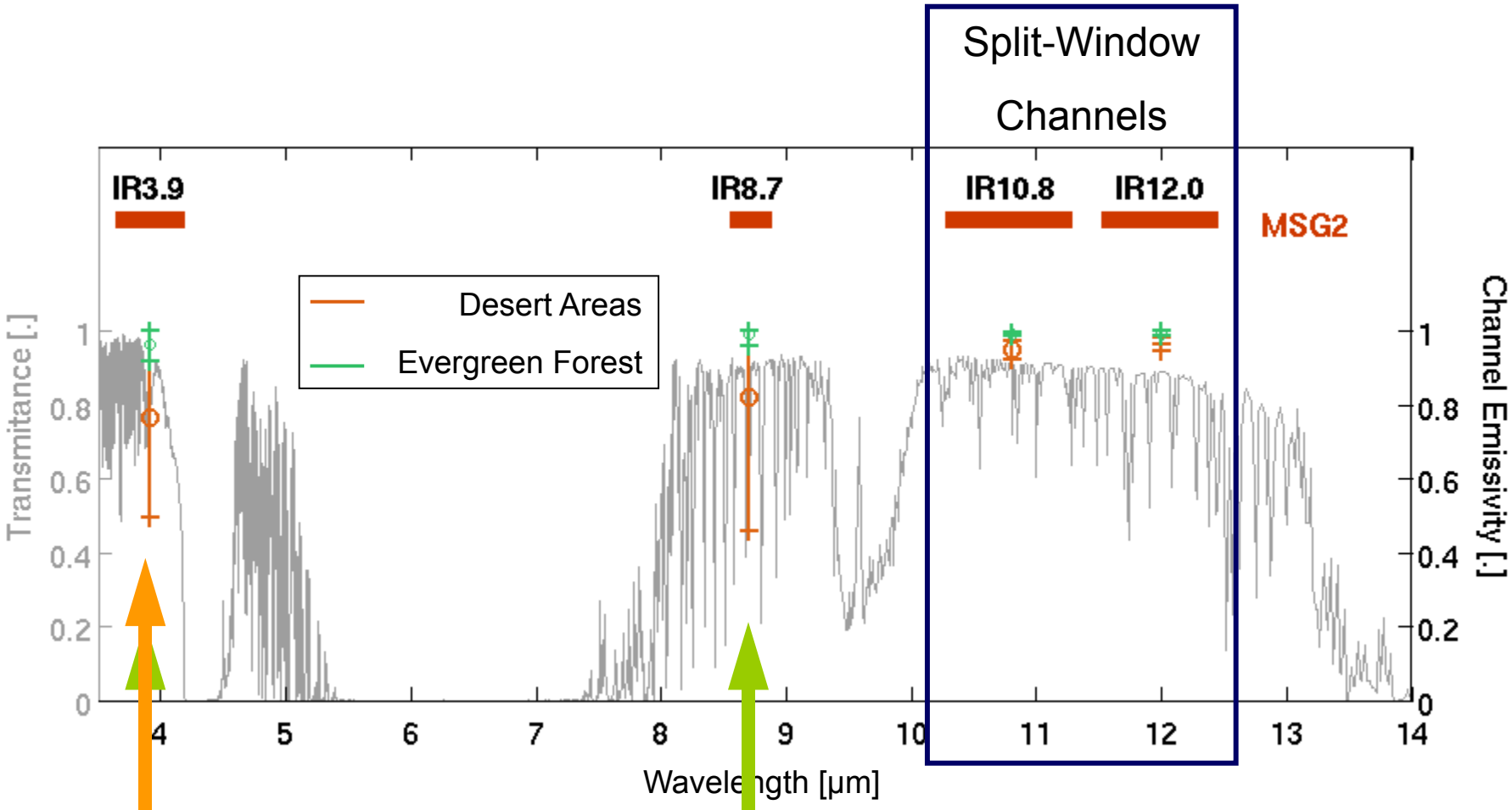
Vegetation / baresoil variability within each Land-Cover class

FVC Uncertainty





SEVIRI channels & LST



LST - Algorithm

- Generalised Split-Window → 10.8μ m and 12.0μ m

  Trained using **CLEAR SKY** synthetic SEVIRI/MSG data

$$LST = (A_1 + A_2 \frac{1-\varepsilon}{\varepsilon} + A_3 \frac{\Delta\varepsilon}{\varepsilon^2}) \frac{T_{10.8} + T_{12.0}}{2} + (B_1 + B_2 \frac{1-\varepsilon}{\varepsilon} + B_3 \frac{\Delta\varepsilon}{\varepsilon^2}) \frac{T_{10.8} - T_{12.0}}{2} + C$$

GSW parameters depend on:

1. total column water vapour
2. viewing angle

ECMWF fc

LST depends explicitly on LSE IR10.8 & IR12.0:

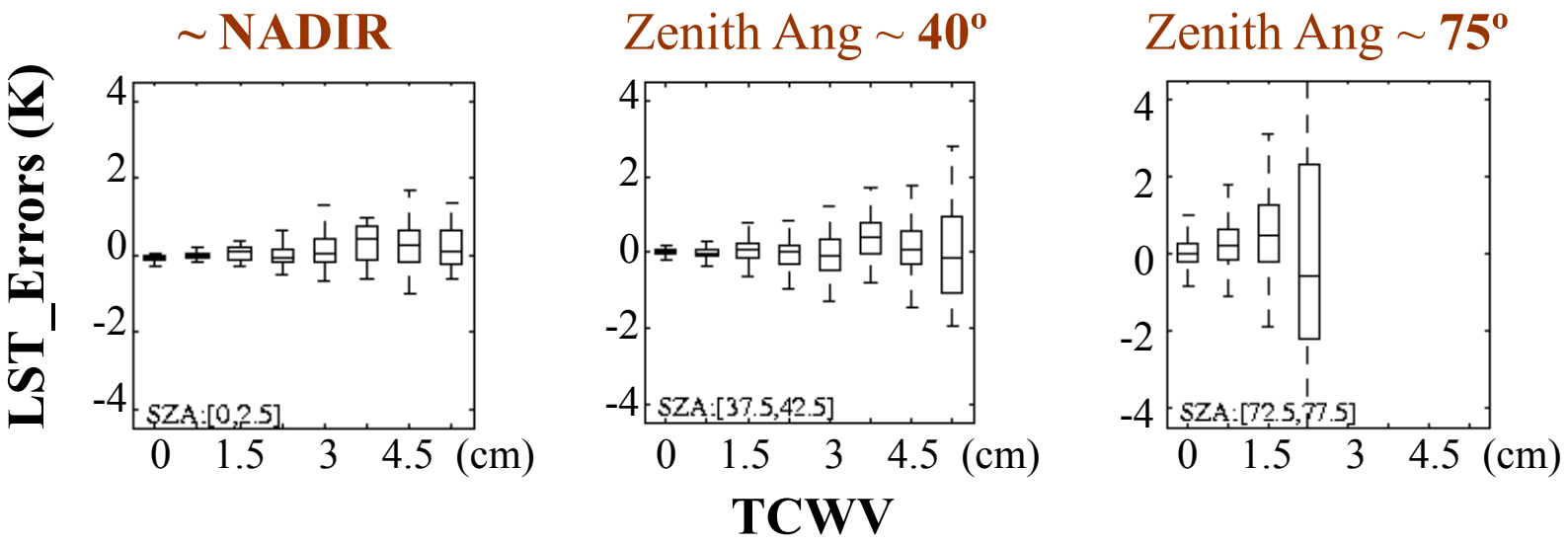
$$\varepsilon = \frac{1}{2}\left(LSE\_IR10.8 + LSE\_IR12.0\right) \qquad \Delta\varepsilon = LSE\_IR10.8 - LSE\_IR12.0$$

LST – Algorithm Uncertainty

- Generalised Split-Window

  Verified against independent dataset (~ 15 700 profiles).

Algorithm uncertainty increases with **view angle** & **water vapour**, i.e., with **optical path**.



- Assuming well known inputs ↔ without errors

LST – Error Propagation

Errors Bars

$$S_{LST}^2 = \sum_i \left(\frac{\partial f}{\partial X_i} \right)^2 \sigma_{X_i}^2 + \sum_j \left(\frac{\partial f}{\partial \theta_j} \right)^2 \sigma_{\theta_j}^2 + \Delta LST^2$$

Explicit input variables

↓

Sensor noise & Emissivity

Algorithm uncertainty

↓

Retrieval conditions

Implicit input variables

↓

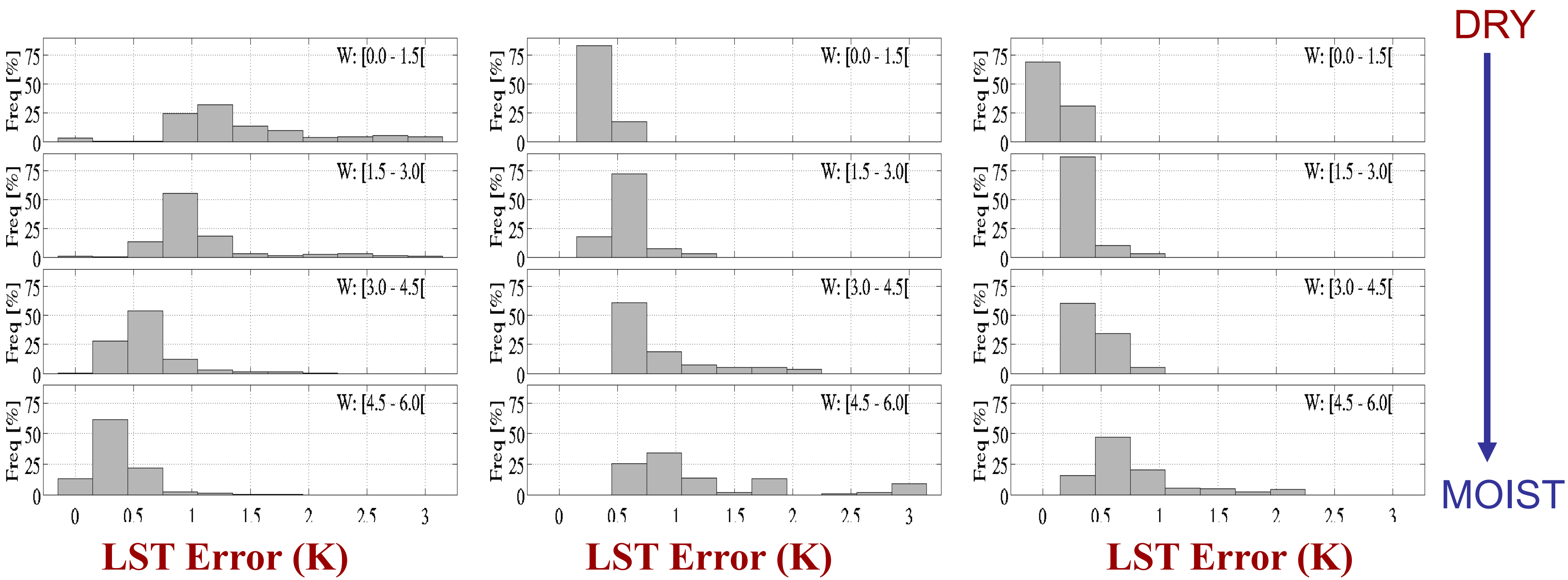
TCWV (uncertainty on ECMWF fc) & View angle

LST – Error Propagation

Errors Bars

$$S_{LST}^2 = \sum_i \left(\frac{\partial f}{\partial X_i}\right)^2 \sigma_{X_i}^2 + \sum_j \left(\frac{\partial f}{\partial \theta_j}\right)^2 \sigma_{\theta_j}^2 + \Delta LST^2$$

EMISSIVITY **SENSOR NOISE** **WATER VAPOUR**



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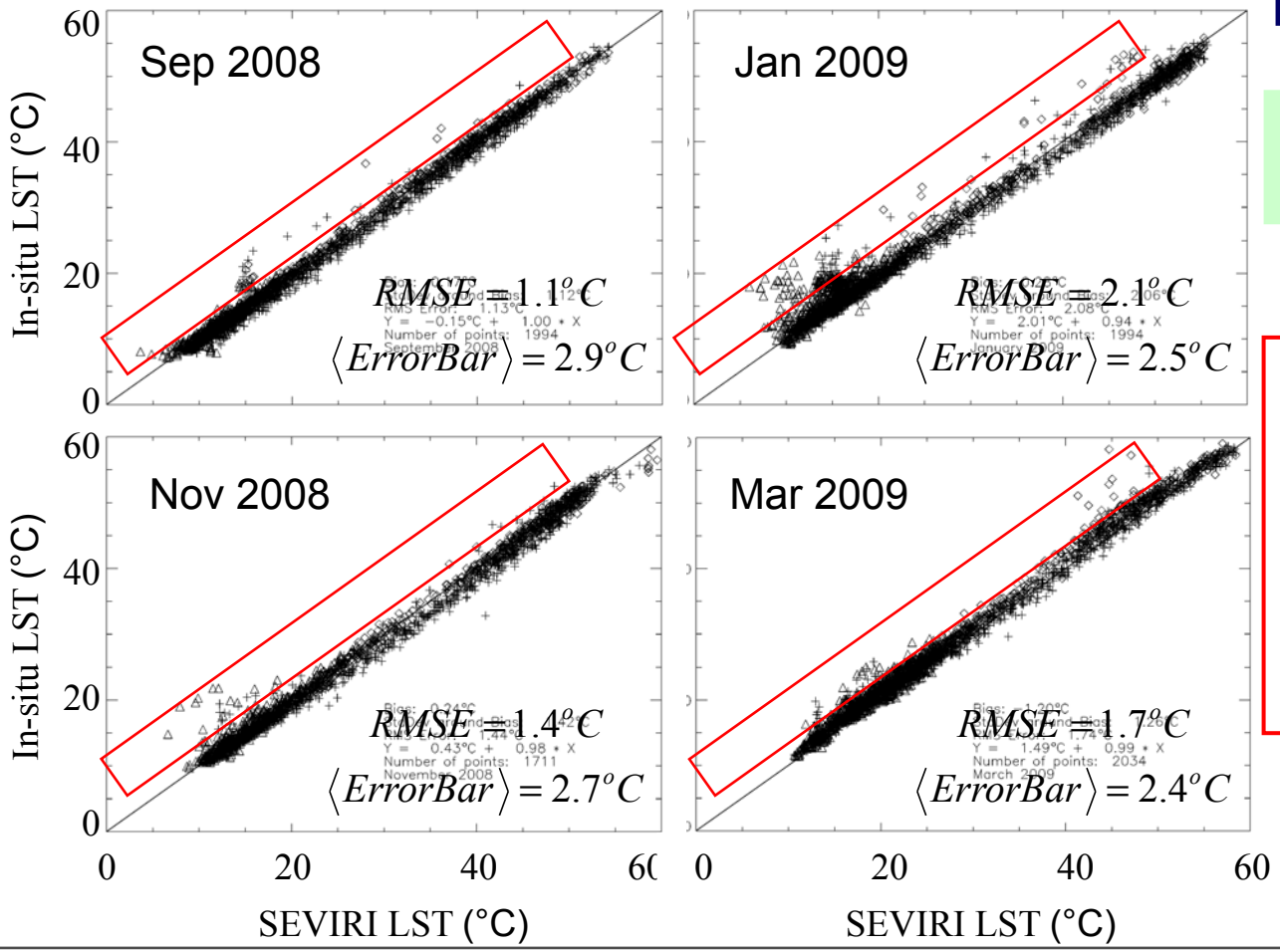
SEVIRI LST vs In-situ data

Validation Site - Homogeneous & dry region

Gobabeb – Namibia - large gravel plains

Main source of errors:

uncertainty on bare ground Emissivity



RMSE < Monthly Average of ErrorBar

Higher Discrepancies

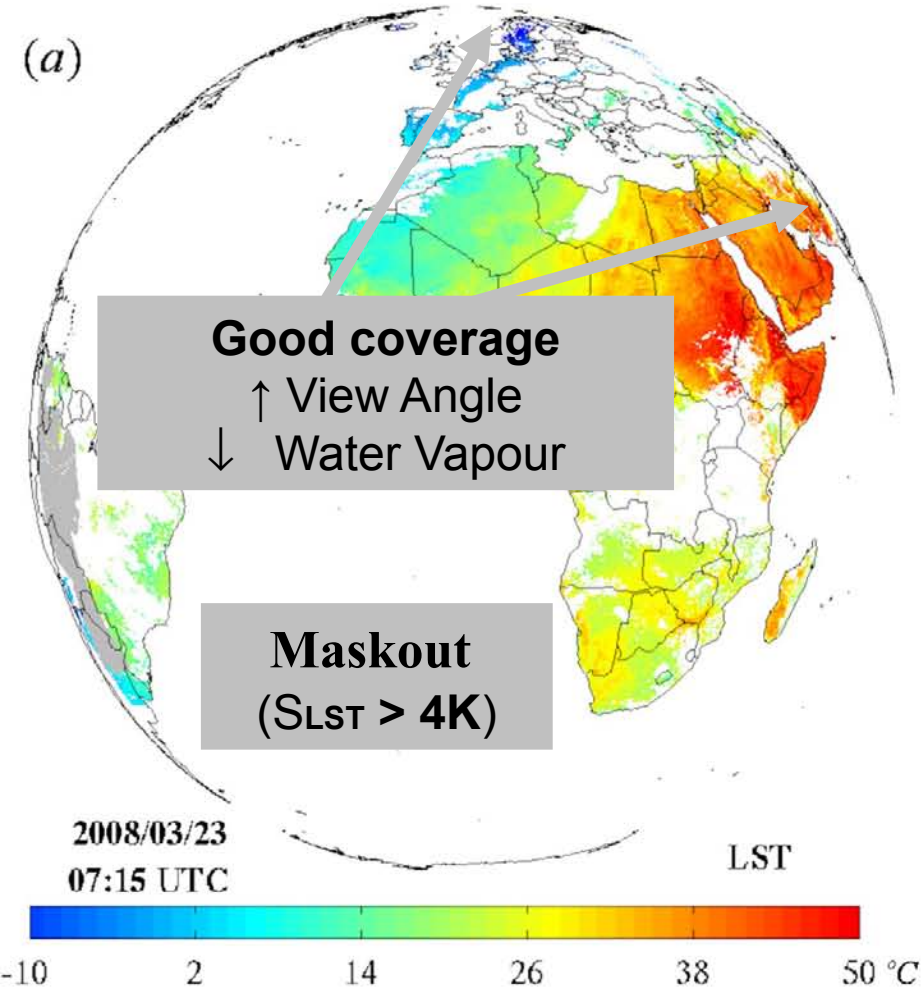
SEVIRI LST << In-situ LST

↑

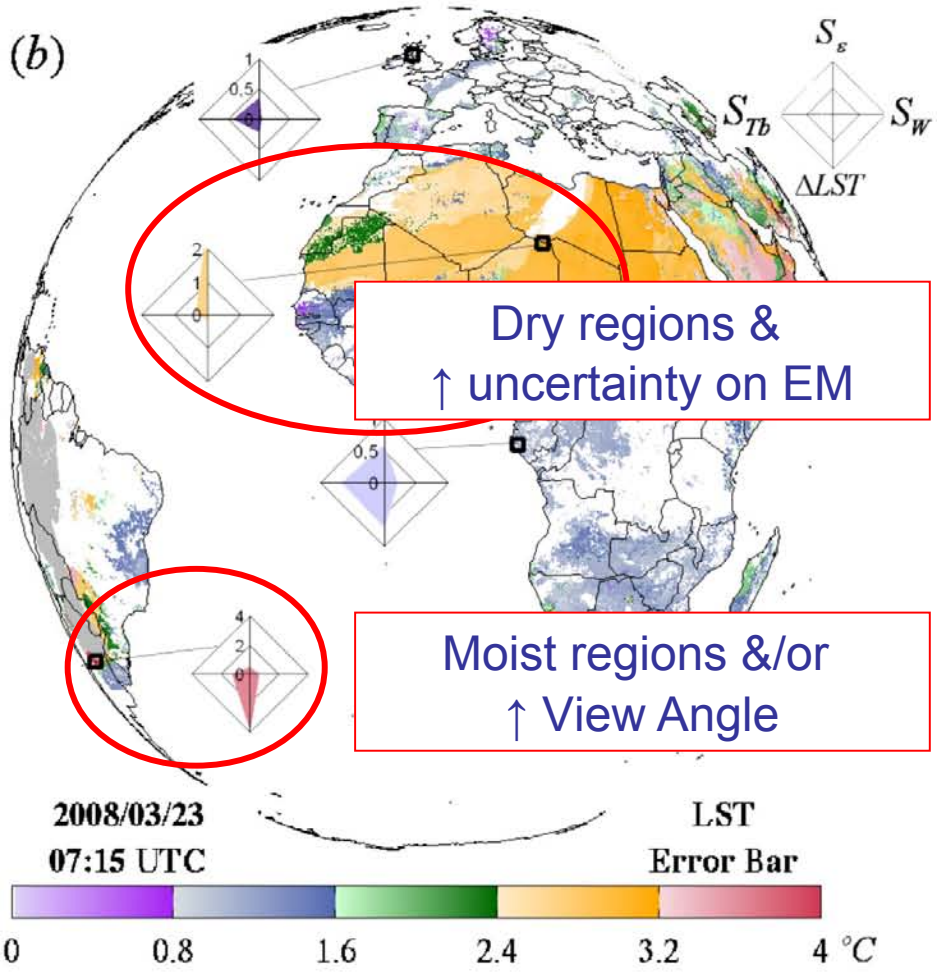
Clouds Contamination or Shadows

LST - Product Characteristics

LST

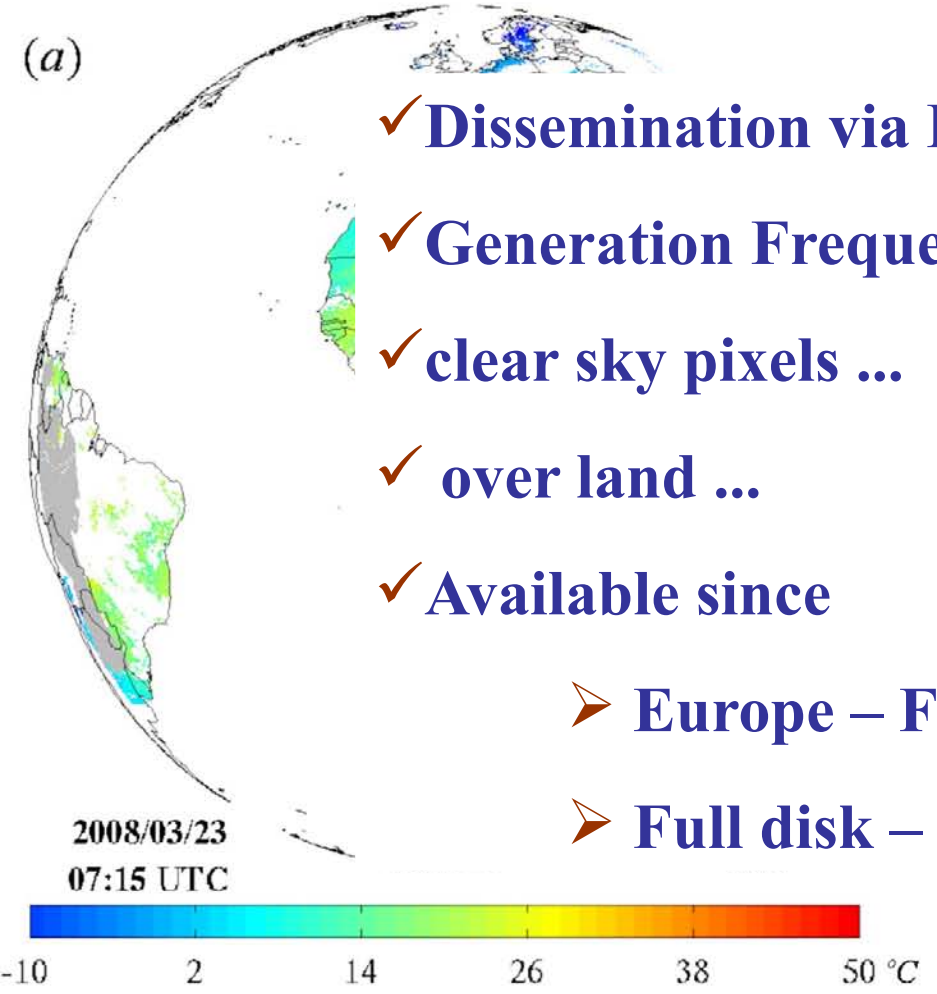


LST Error Bars

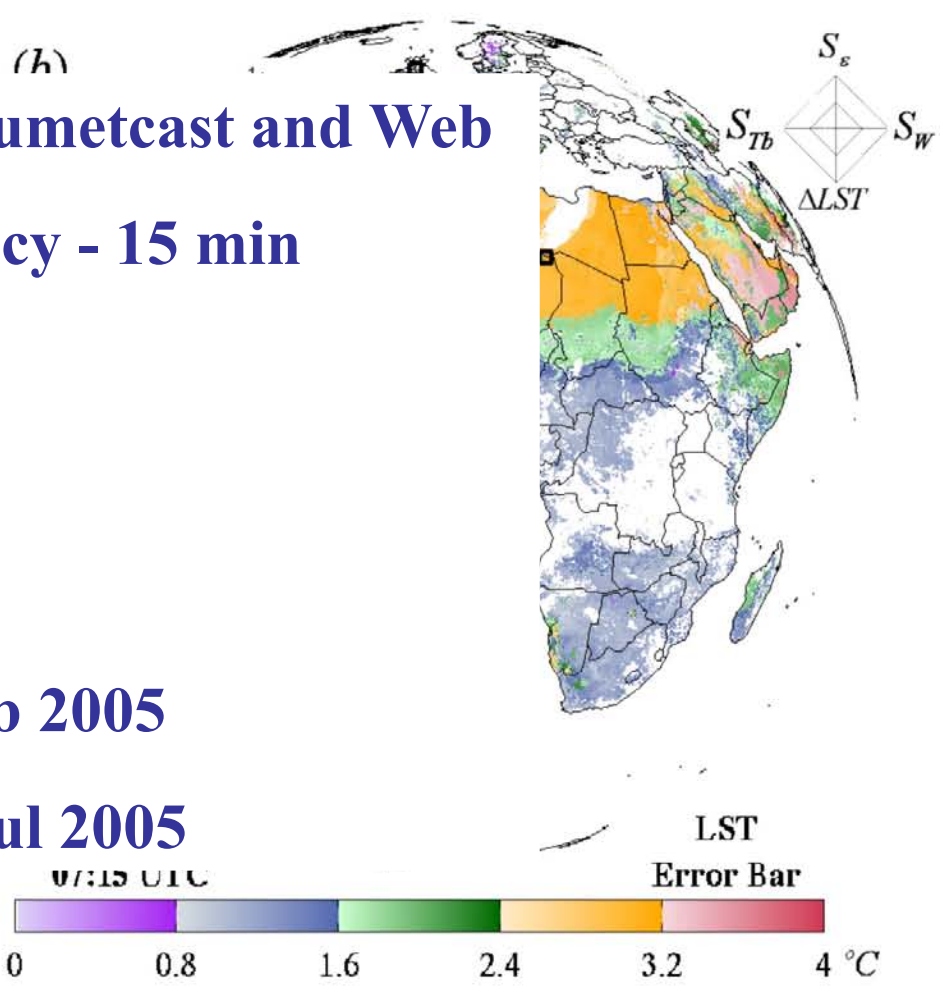


LST - Product Characteristics

LST



LST Error Bars



- ✓ Dissemination via Eumetcast and Web
- ✓ Generation Frequency - 15 min
- ✓ clear sky pixels ...
- ✓ over land ...
- ✓ Available since
  - ➢ Europe – Feb 2005
  - ➢ Full disk – Jul 2005

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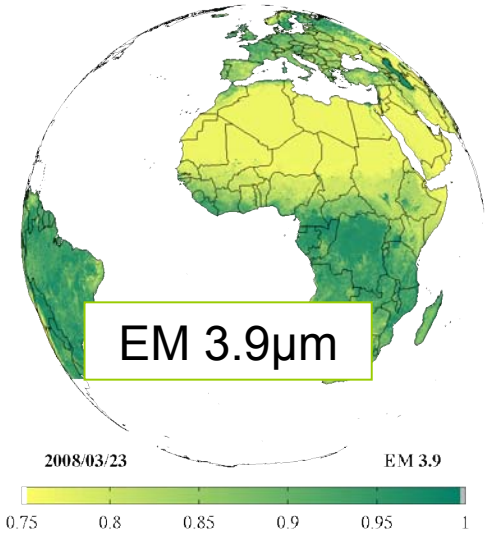
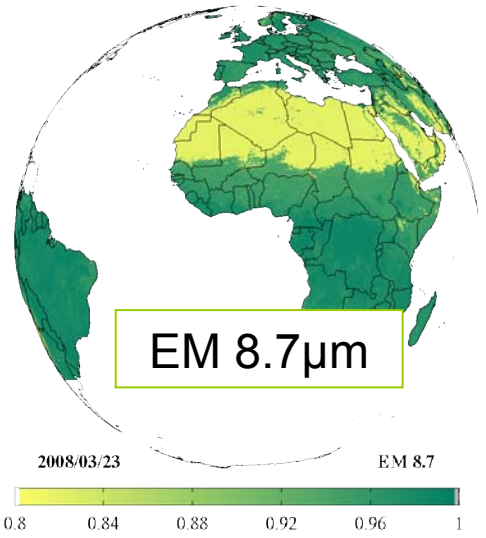
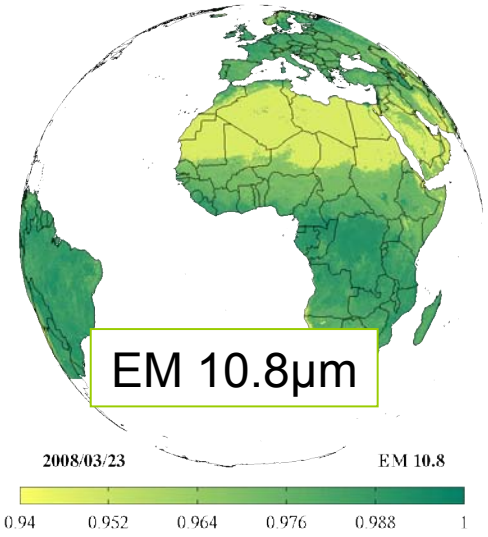
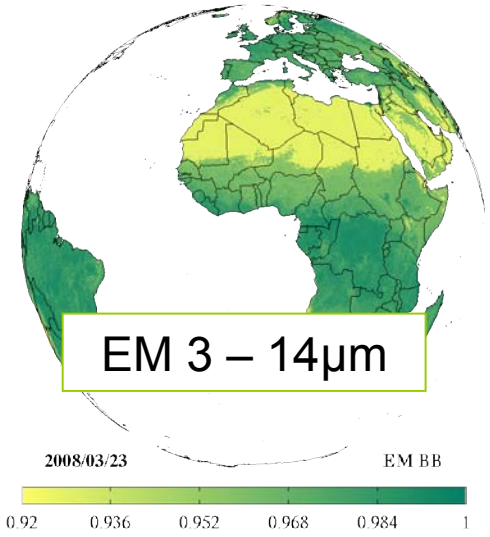
LSE – Product Characteristics

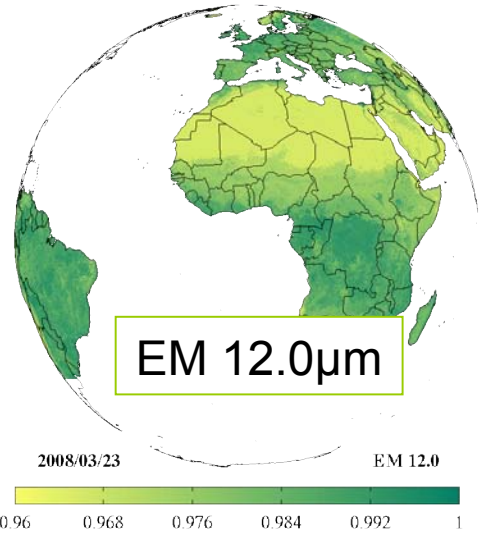
- ✓Dissemination upon request
- ✓Generation Frequency – daily
- ✓LSE & Error Bars
- ✓over land ...
- ✓Available since Jan 2008











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