Analysis of the diurnal cycle of vegetation using active and passive microwave satellite observations

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Contents

I. INTRODUCTION

- **General context**
  - Microwave observations – useful - vegetation analysis
    - Less affected by clouds than visible & infrared
    - Operate - day & night
  - Diurnal change: vegetation structure/ water content, moisture, skin temperature, etc.
  - Previous studies: Active /or Passive

Project objectives

- Global Precipitation Measurement (GPM)
- Both active & passive modes => diurnal cycles
- Compare to other studies; analyze passive vs active relationship

II. DATASETS

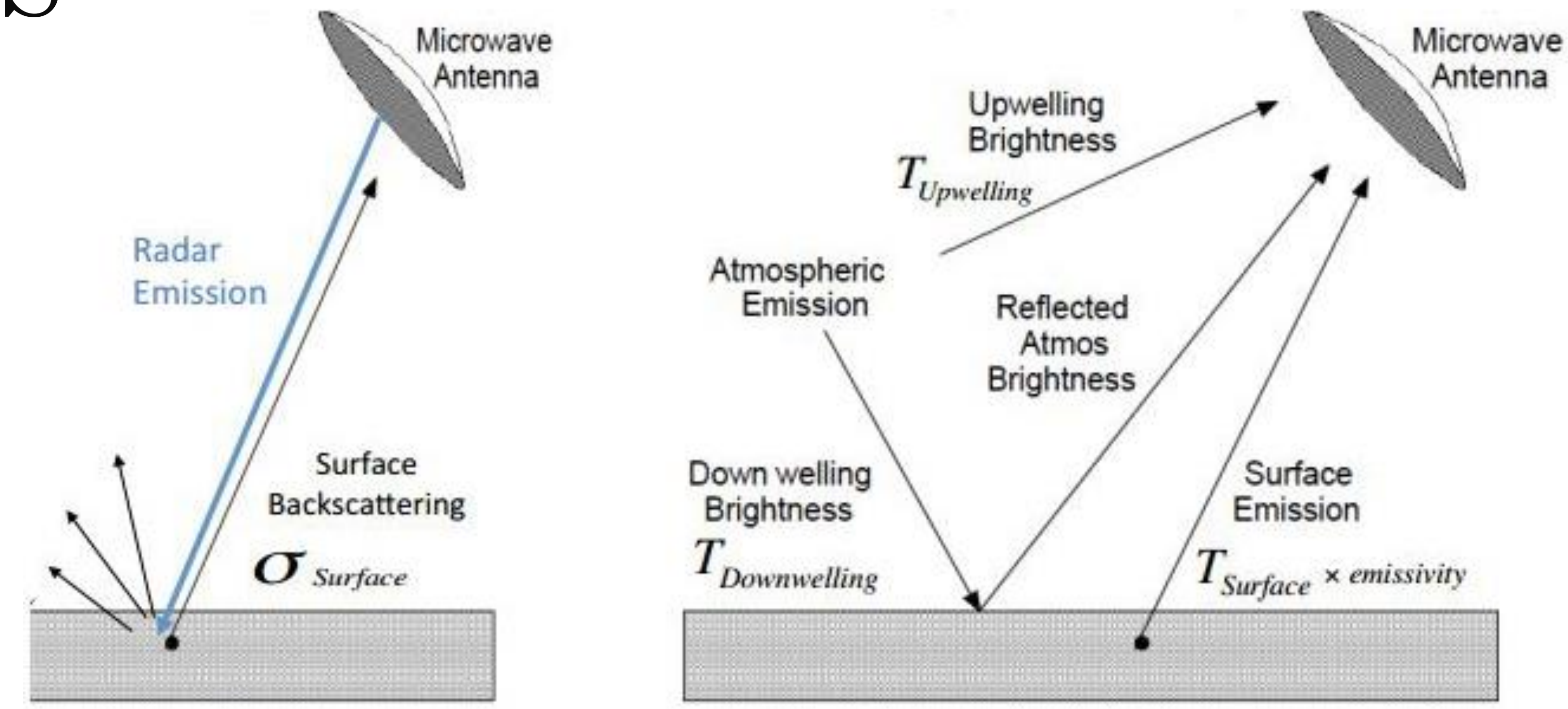
- **Active mode**
  - backscatter (dB)
  - reflection of the signals

- **Passive mode**
  - emissivity (unitless)
  - effectiveness in emitting energy

- **Calculation**

$\boldsymbol{\sigma^0 = \sigma_{Surface}}$

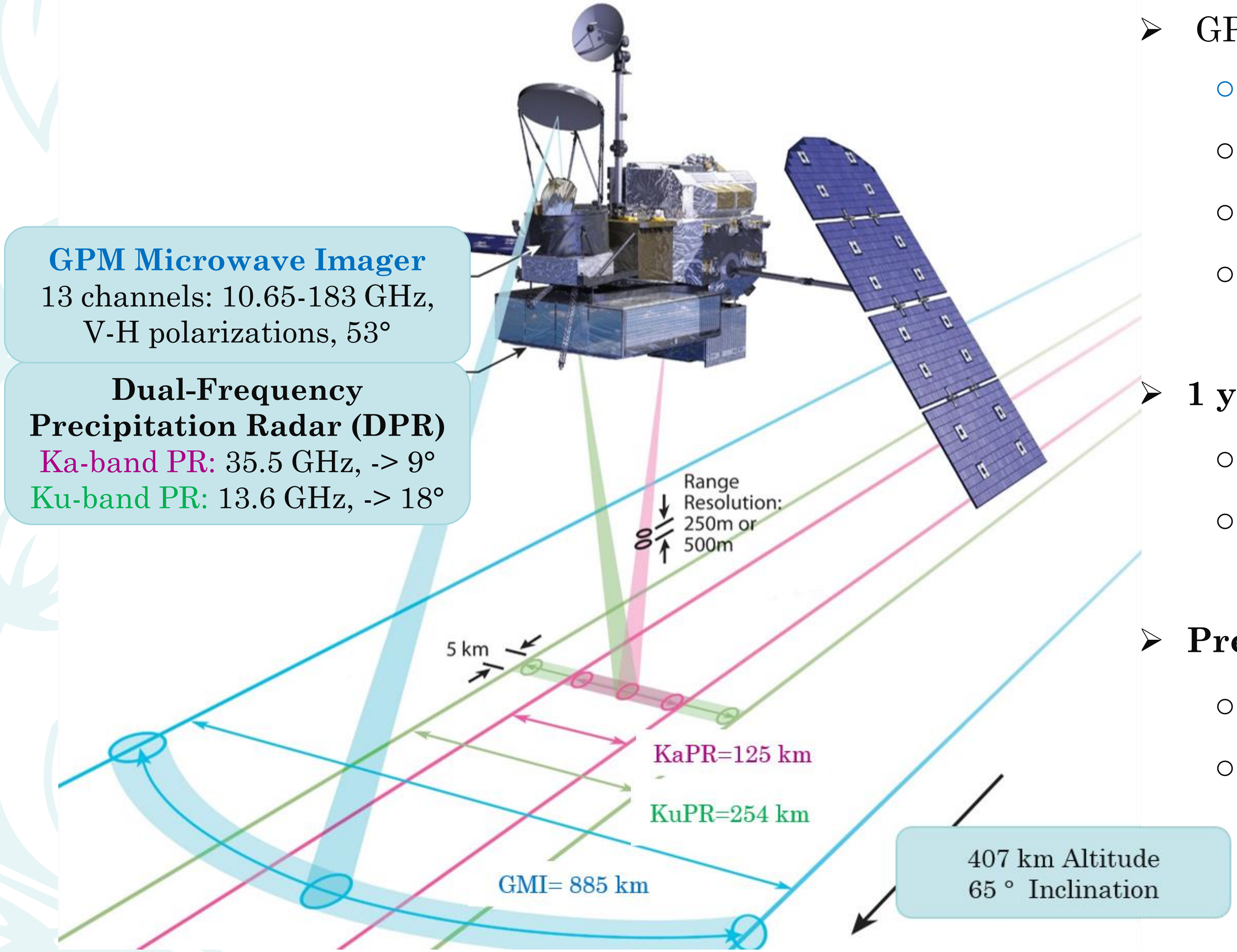
$T_b = T_s \times e \times \tau + T_{Upwelling} + T_{Downwelling} \times (1 - e) \times \tau$



Active mode
DPR
2 bands: Ka and Ku

Passive mode
GMI
13 bands: from 10.65 to 183 GHz

II. DATASETS



- GPM -> Precipitation Measurement
  - σ^0 and e -> good source
  - Feb 2014 - NASA & JAXA
  - A non-Sun-synchronous orbit
  - 65'S – 65'N
- **1 year dataset** (2015) – NASA
  - high volume data: 62 Go/month (uncompressed)
  - => optimize Matlab code
- **Pre-processing data**
  - Grid: *0:25°* × *0:25°*
  - Average: every 3hours over 1 month & 3 months

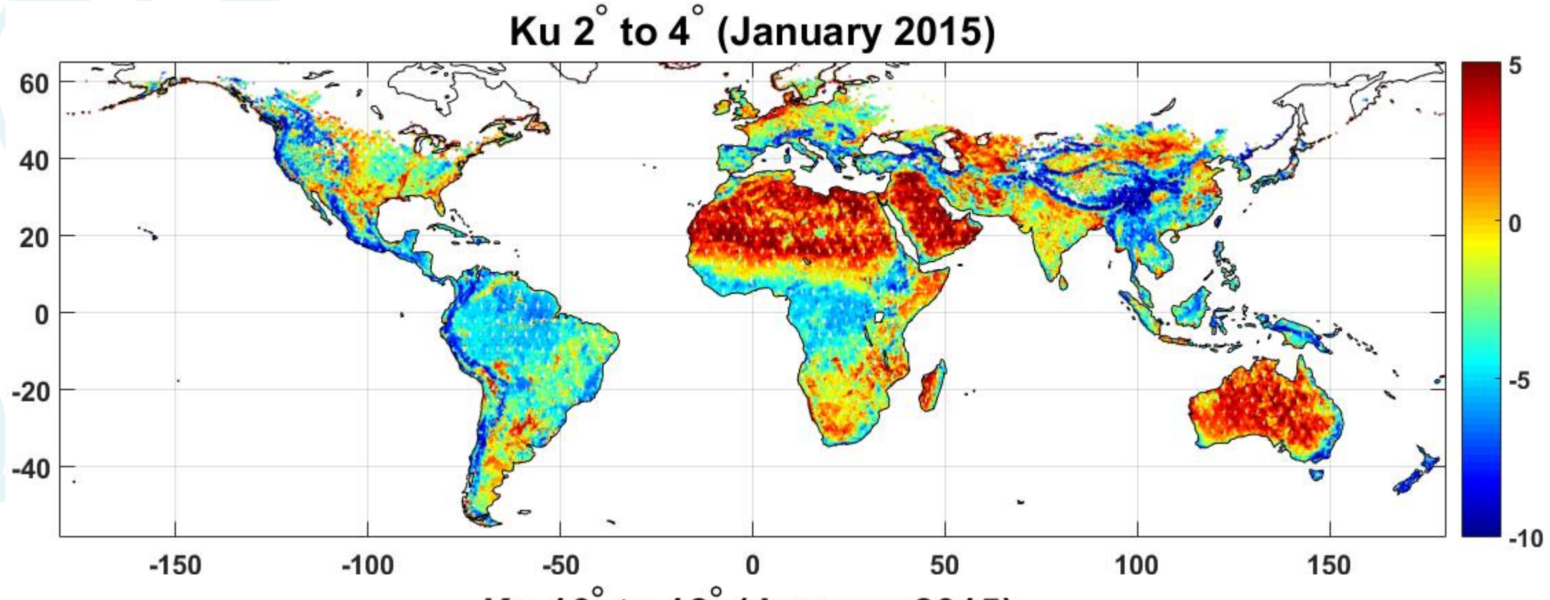
III. GENERAL ANALYSIS

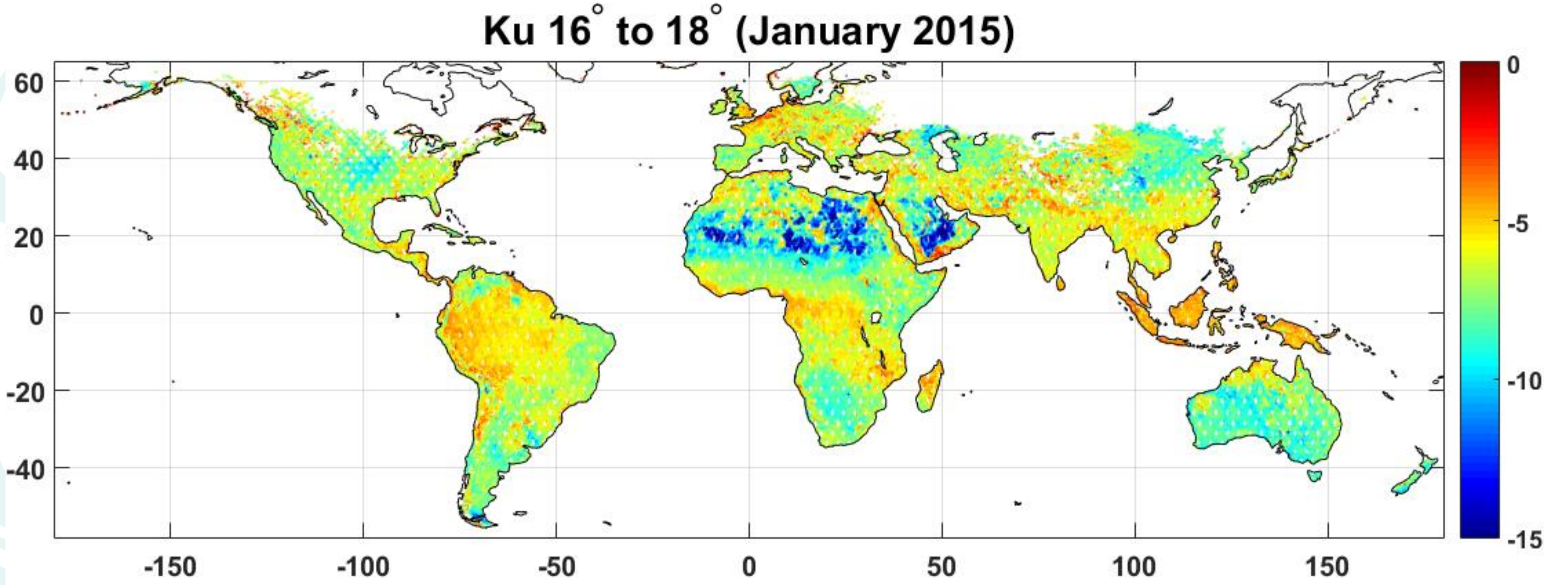
1. The active mode

2. The passive mode

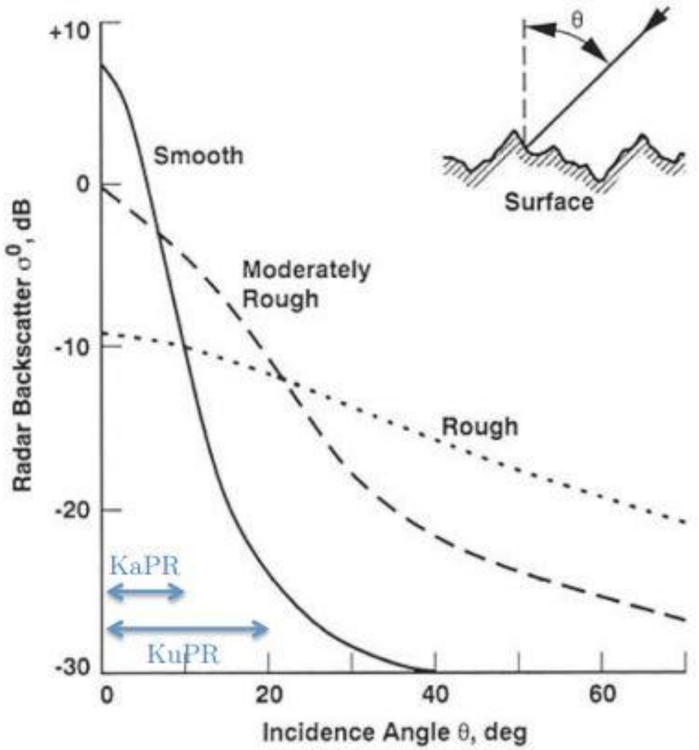
3. Vegetation

III.1. The active mode

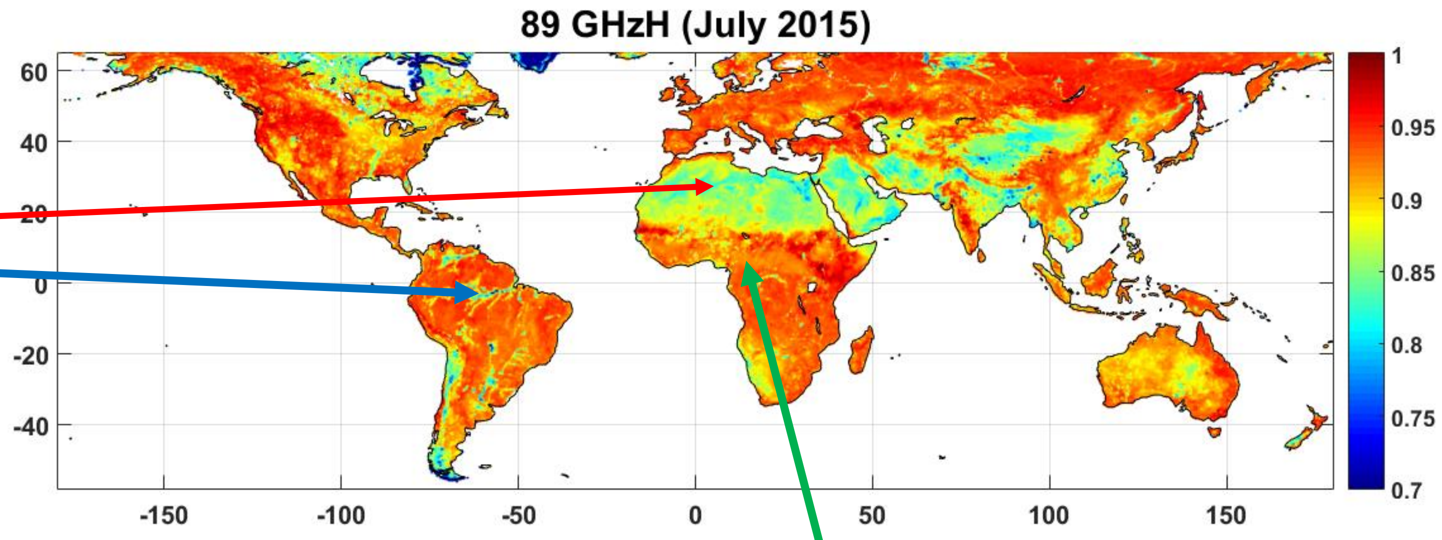




- Snow-cover in January
- Small angle: σ^0 # vegetation
- Large angle: $\sigma^0 \ll$ at soil interface
- A good indicator for surface roughness

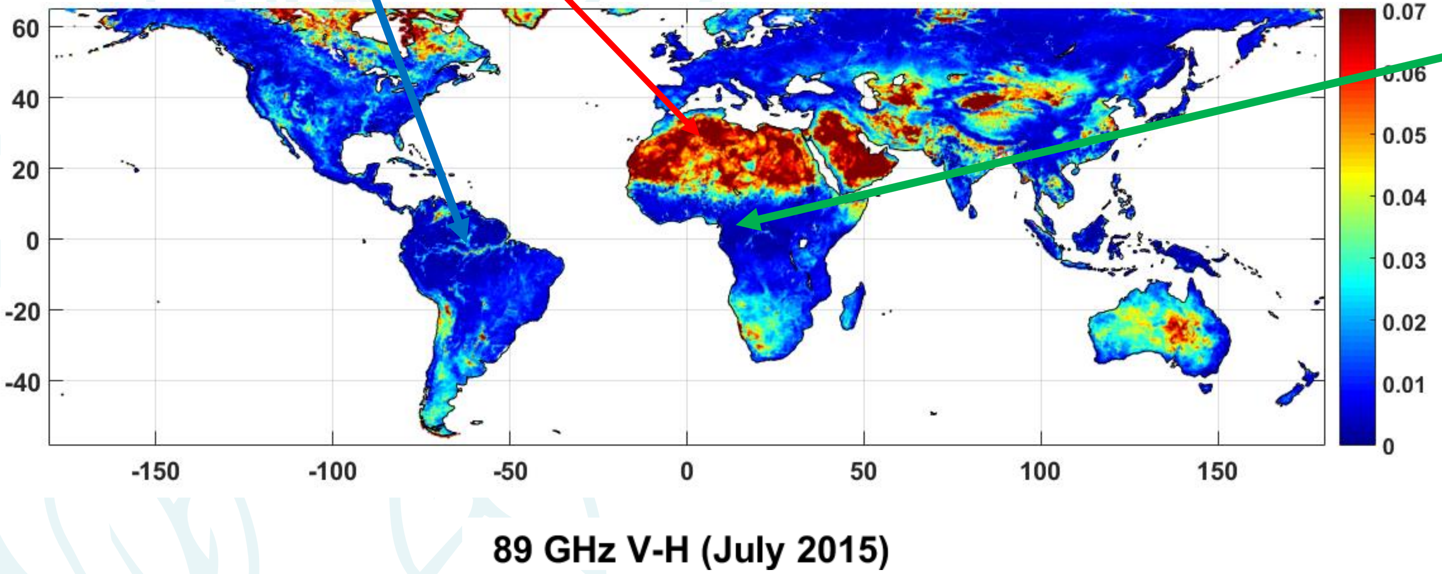


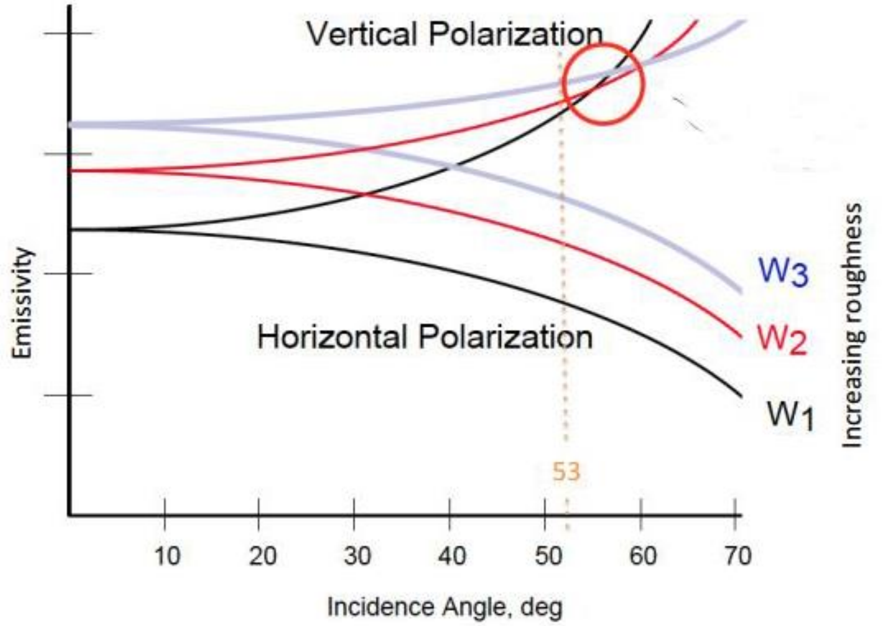
III.2. The passive mode



Desert & water areas:
- Low emissivities
- High emissivity polarization differences

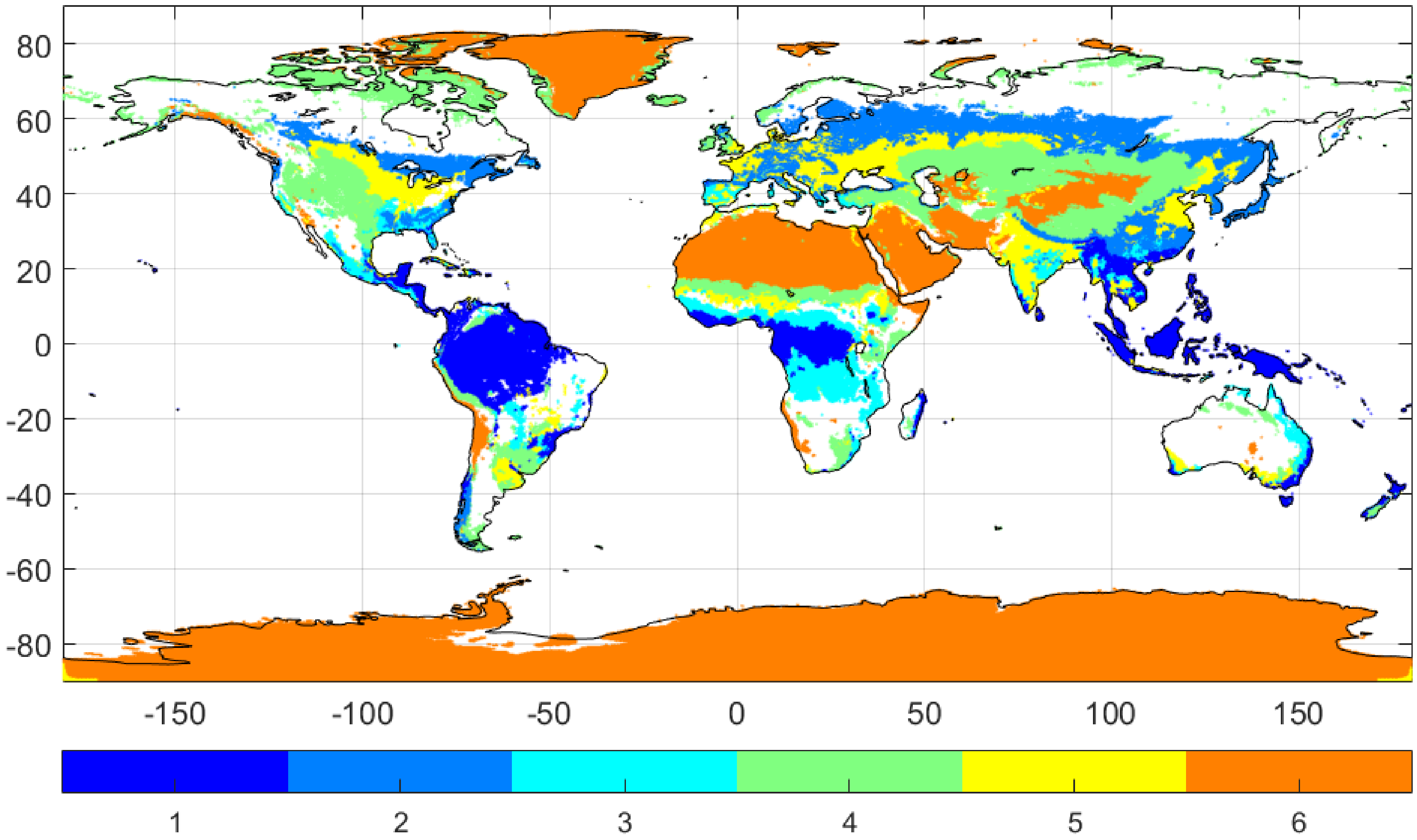
Vegetation:
- Large emissivities
- Low emissivity polarization differences





III.3. Vegetation

International Geosphere-Biosphere Programme (IGBP)



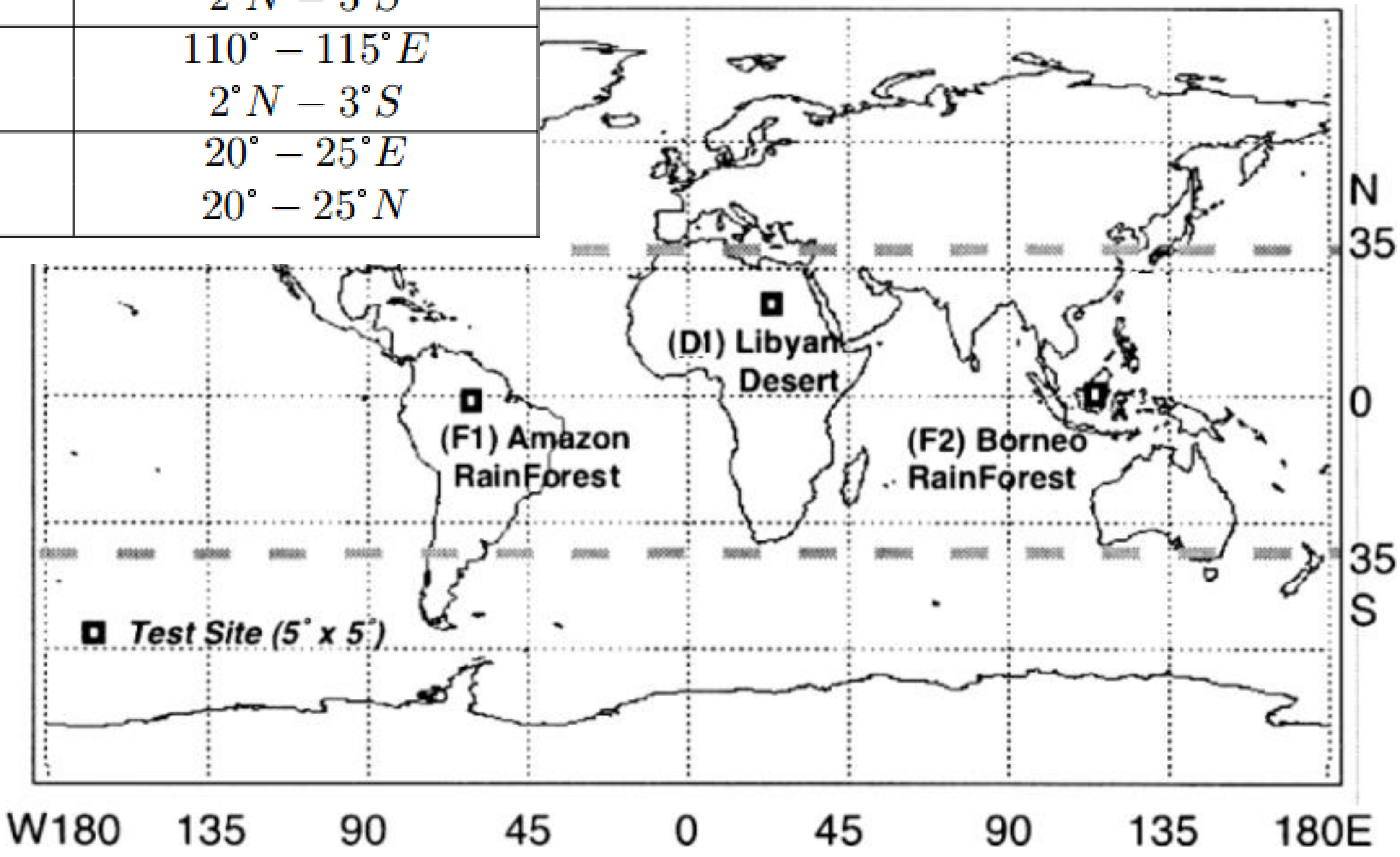
1. Evergreen broadleaf forests
2. Mixed forests
3. Woody Savannas (Lat < 50°)
4. Grasslands
5. Croplands
6. Barren or sparsely vegetated areas

IV. ANALYSIS OF THE DIURNAL CYCLE

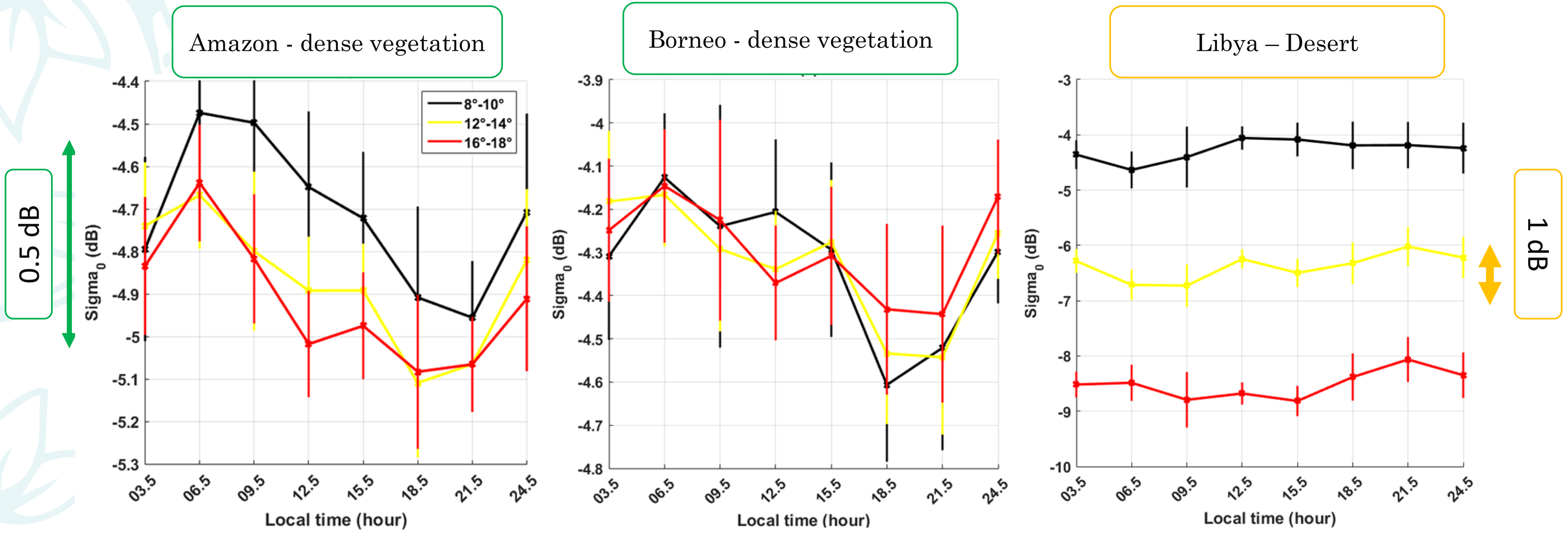
1. Analysis of the diurnal cycle of the backscattering coefficient ***(σ^0)***
2. Analysis of the diurnal cycle of the emissivity ***(e)***
3. Comparison of diurnal cycle backscattering coefficient and emissivity

III.1. Analysis of the diurnal cycle of the backscattering coefficient

ID	Surface Type	Area Name	Location (Long.,Lat.)
E1	Rain Forest	Amazon	$62^\circ - 67^\circ W$ $2^\circ N - 3^\circ S$
E3		Borneo Island	$110^\circ - 115^\circ E$ $2^\circ N - 3^\circ S$
D1	Desert	Lybia	$20^\circ - 25^\circ E$ $20^\circ - 25^\circ N$



III.1. Analysis of the diurnal cycle of the backscattering coefficient



Evergreen broadleaf forests:

- ○ maximum – morning ; minimum – evening
- ○ σ^0(Borneo) – σ^0(Amazon)= 0.5 dB
- ➢ Borneo contains other type of surfaces

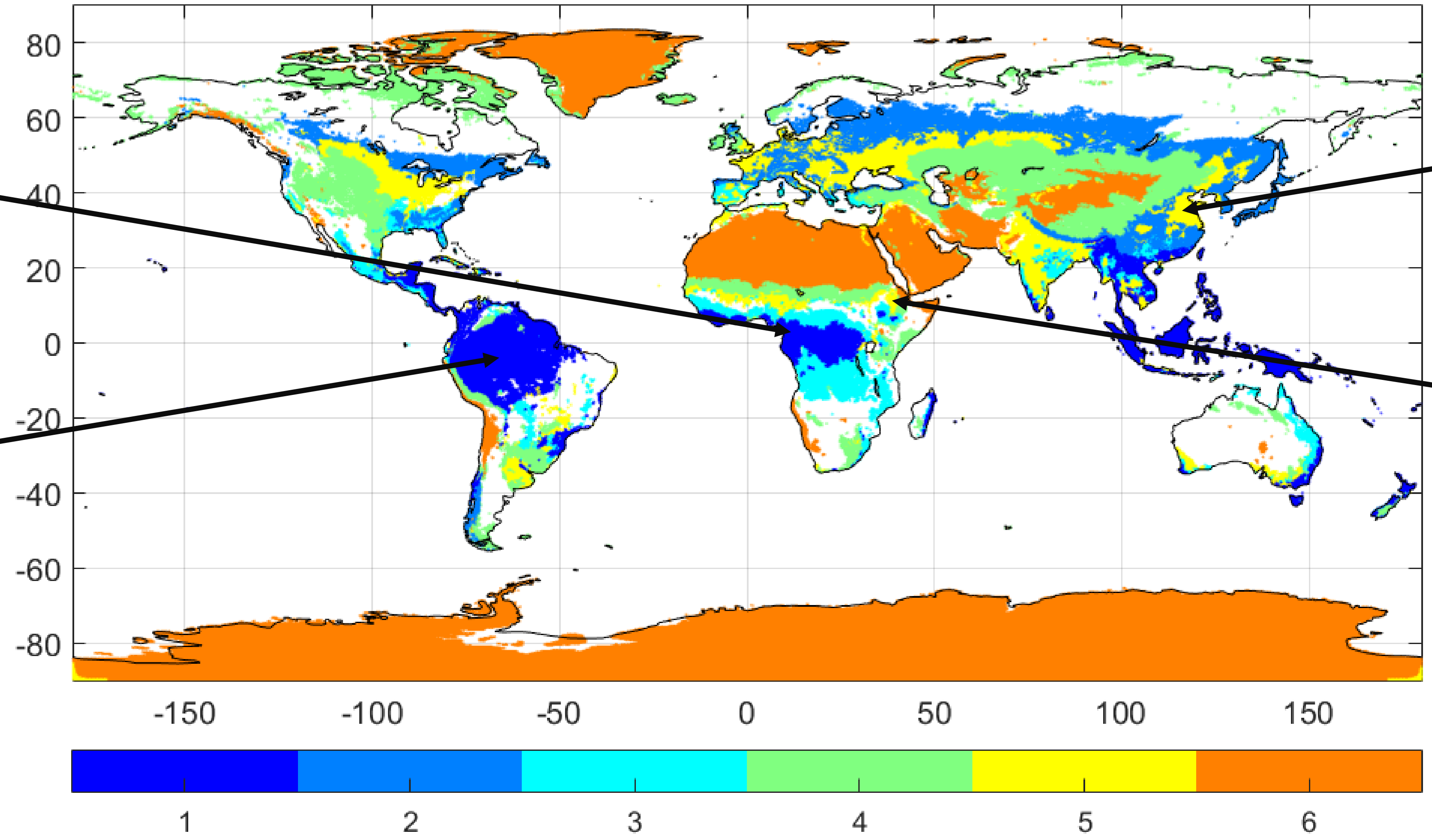
Barren or sparsely vegetated areas:

- ○ 2 dB # for 2◦ increase of θ_{Inc}
- ✓ [14] *Satake et al.*, Tropical Rainfall Measurement Mission PR
- ✓ [16] *Frolking et al.*, Sea Winds scatterometer, 0.5 - 1.0 dB difference, over the Amazon

III.2. Analysis of the diurnal cycle of the emissivity

Evergreen broadleaf forests:

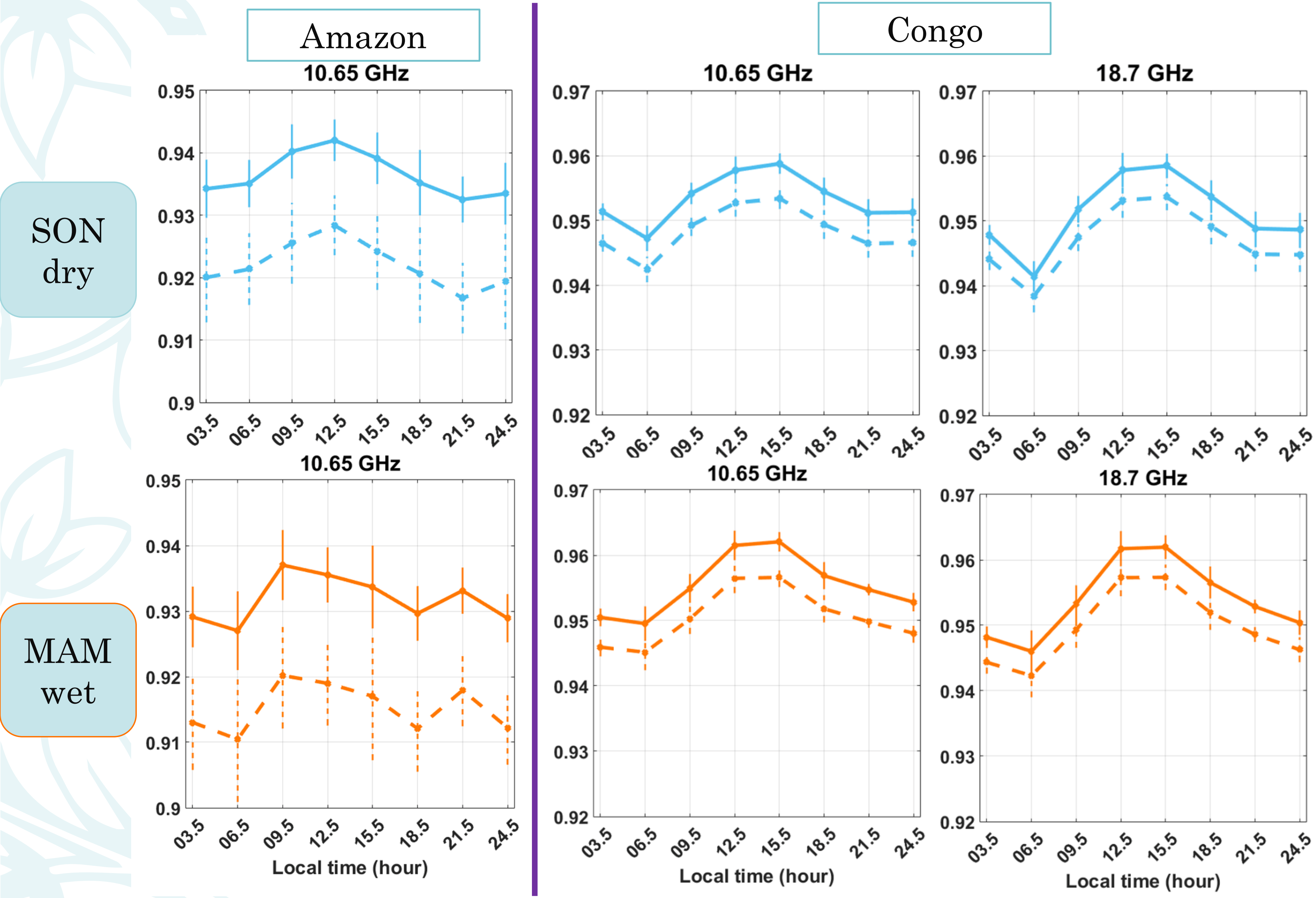
Congo
Amazon



Croplands:
Shangdong
Ethiopia

Test size: 5° Long. by 2° Lat

III.2. Analysis of the diurnal cycle of the emissivity



- **Evergreen broadleaf forests:**
  - same tendency for diff frequency , V-H
  - diurnal difference ~ 0.01
  - maximum – mid-day;

    low – morning
  - dry > wet (Amazon)

- ✓ [24] *Norouzi et al.,*

  AMSR-E: ~ 0.01
- ✓ [25] *Li & Min,* AMRS-E & MODIS :dry>wet

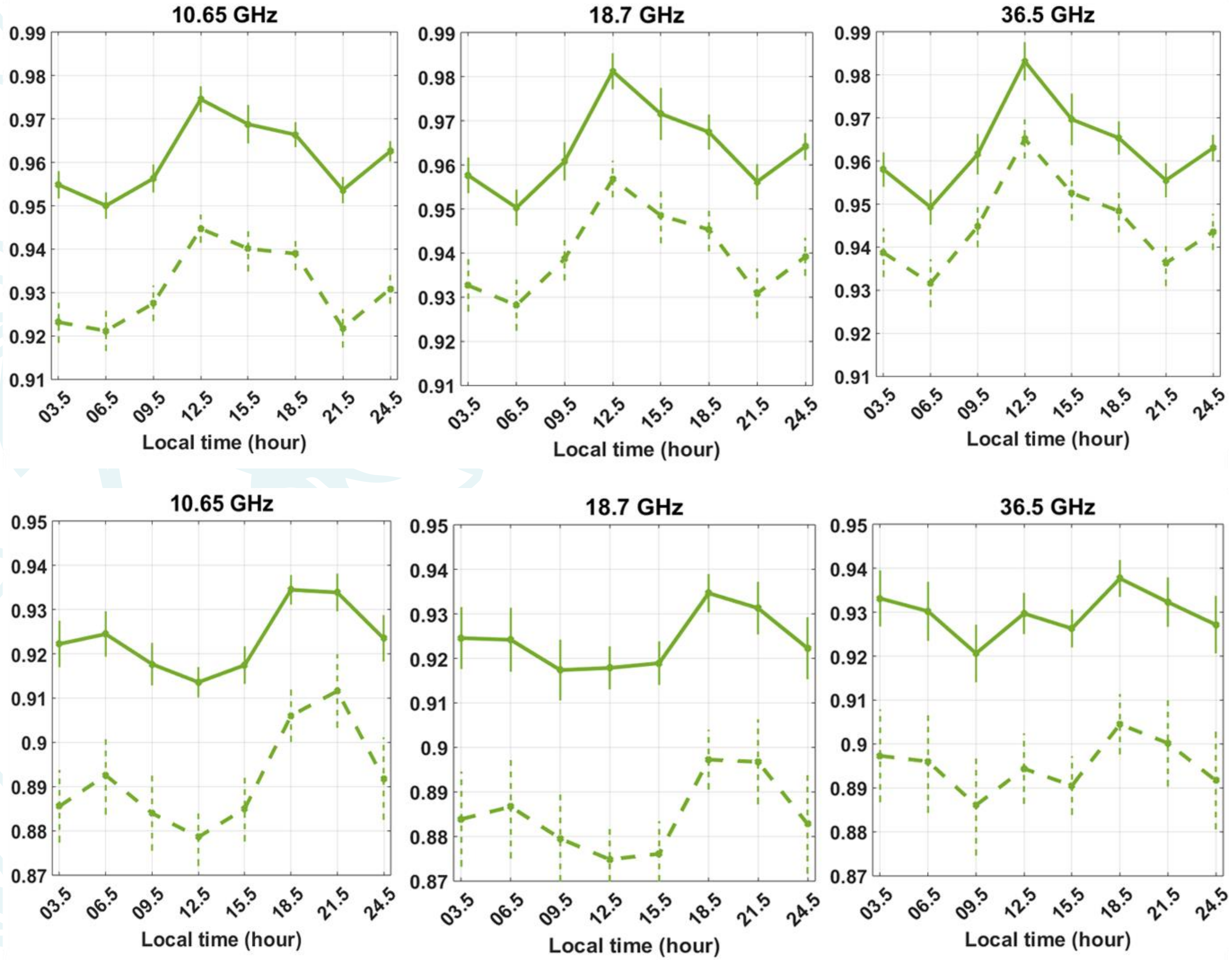
  - V-H difference:

    Amazon > Congo

III.2. Analysis of the diurnal cycle of the emissivity

SON [C1] Ethiopia

SON [C2] Shangdong



- **Croplands:**
  - large diurnal difference
  - 18.7 GHz : 0.03 in [C1] ;
    0.02 in [C2].
  - diff type of cropland, diff diurnal response

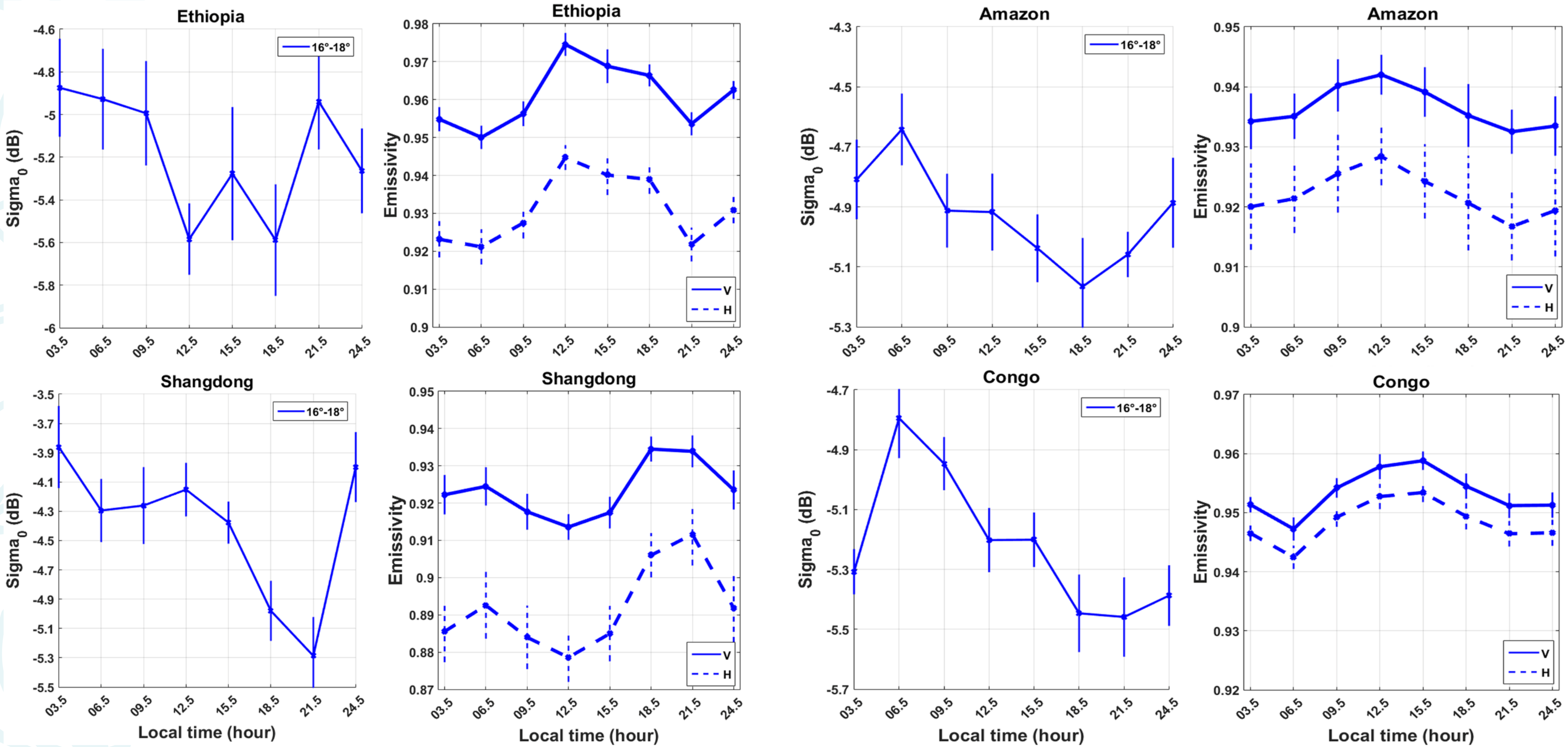
3. Comparison of diurnal cycle backscattering coefficient and emissivity

- **First time** – study both active & passive

- Comparison:
  Backscattering: Ku band (16°-18°) - 13.6 GHz
  Emissivity: 10.65 GHz

- Expectation:
  $\sigma^0 \sim \Gamma = 1 - e$;
  → **anti-correlation** btw e & σ^0

3. Comparison of diurnal cycle backscattering coefficient and emissivity



✓ Anti-correlation

? T_s could impact e

V. CONCLUSIONS

- ✓ Vegetation dependence
- ✓ The diurnal cycle

} of the backscattering coefficient & emissivity

- ✓ Comparison –active vs passive signals –**first time**
- ✓ Check the consistency with other studies -> diurnal , not noise, instruments
- ❖ Reasons: change of vegetation (types, water content/stress), moisture, surface temperature

PERSEPECTIVES: understand the link btw e & σ^0, the vegetation responses

- ➢ Extend the datasets – inter-annual cycle
- ➢ Other datasets (NDVI, Fluorescence (GOME), etc.)

Thank you for your attention!