On the estimation and use of land surface microwave emissivities

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Co-authors

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Satellite measurements more used in NWP models over ocean than over land

Both accurate skin temperature and emissivity are needed

What can we do about emissivity ?

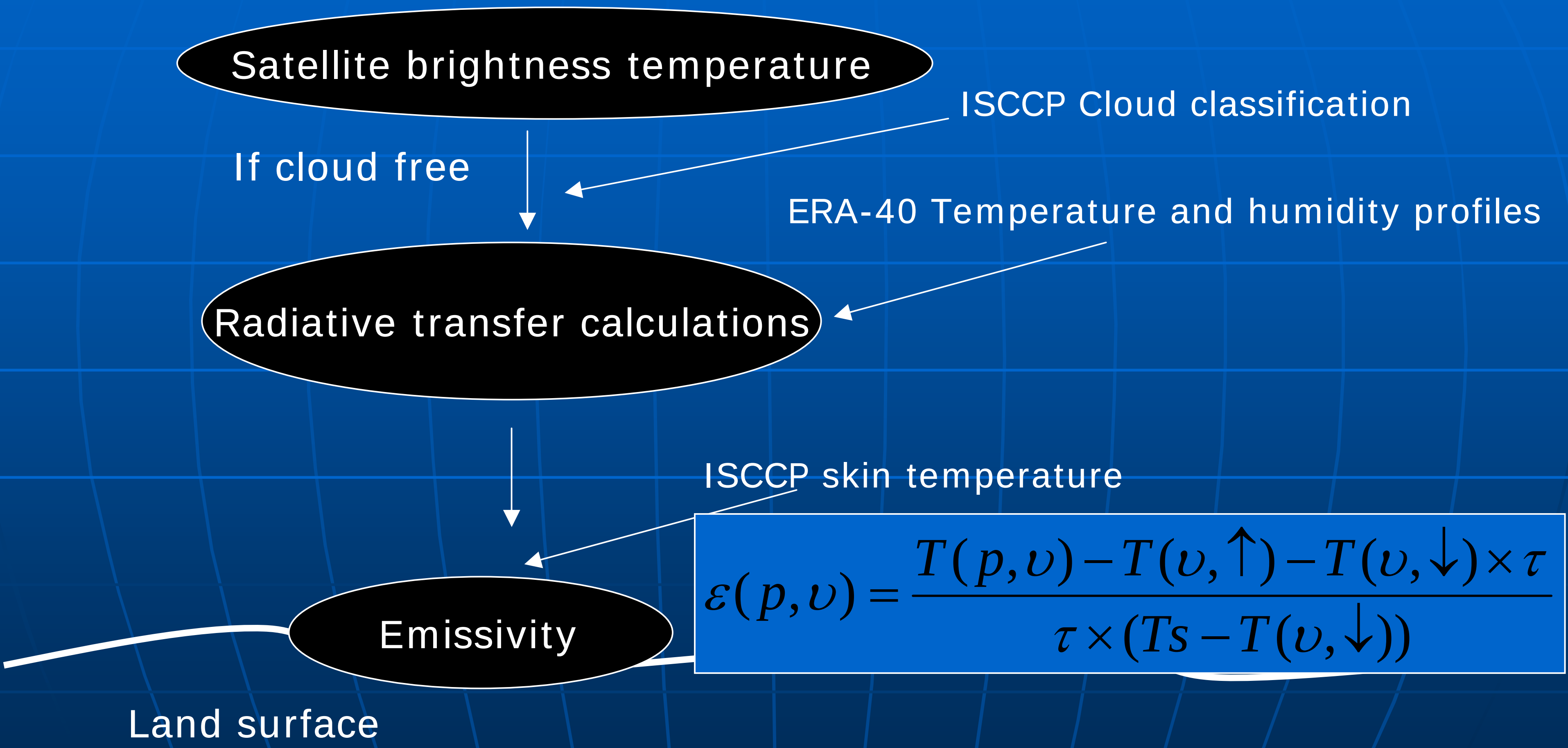
Solution ?

Calculate land surface emissivities directly from satellite observations

This talk :

- methodology to calculate the emissivities from the satellite obs
- evaluation / comparison of these emissivities
- applications to passive microwave retrieval over land (SSM/I,AMSU)

Emissivity estimation



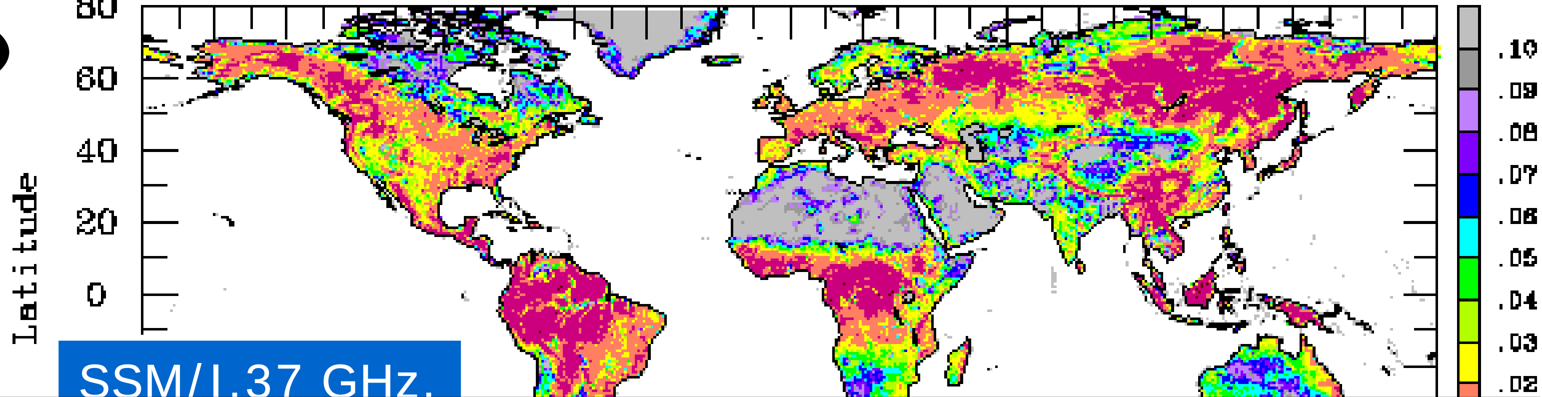
$$\varepsilon(p,\upsilon) = \frac{T(p,\upsilon) - T(\upsilon,\uparrow) - T(\upsilon,\downarrow) \times \tau}{\tau \times (Ts - T(\upsilon,\downarrow))}$$

Application to SSM/I and AMSU observations

- SSM/I: 19, 22, 37 and 85 GHz, at 53°, for both H and V polarizations (except 22 GHz, only V).
  8 years of SSM/I emissivity calculated (06/92-06/2000)

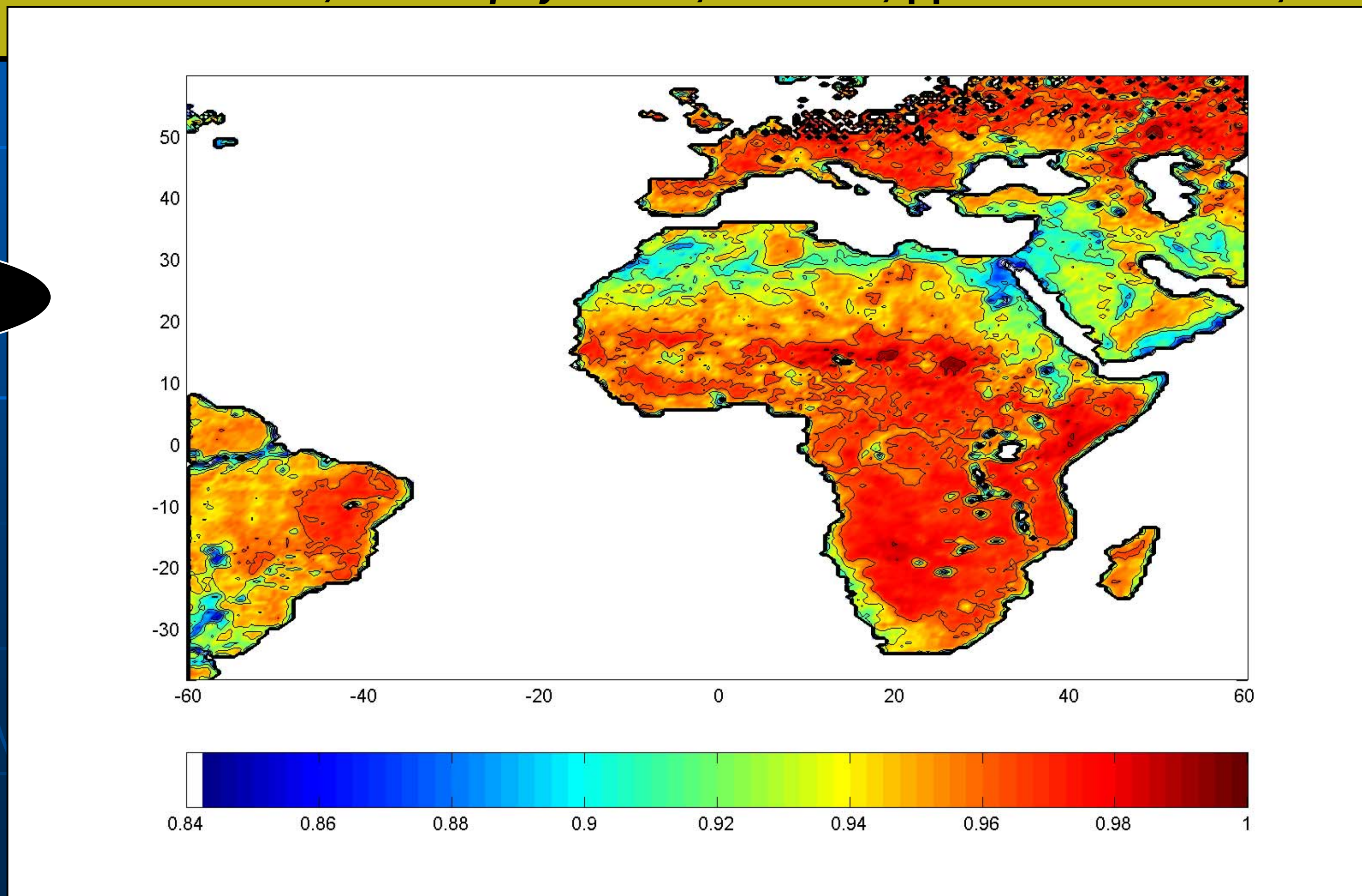
- AMSU: 23, 31, 50, 89, 150 GHz, from -58° to 58° (AMSU-A scan positions)
  mixture of H and V
  Emissivity calculations for year 2000.

SSM/I



Prigent, C, W.B. Rossow, and E. Matthews, "Microwave land surface emissivities estimated from SSM/I observations," *J. Geophys. Res.*, vol. 102, pp. 21 867-21 890, 1997.

AMSU



AMSU

Effective emissivity →

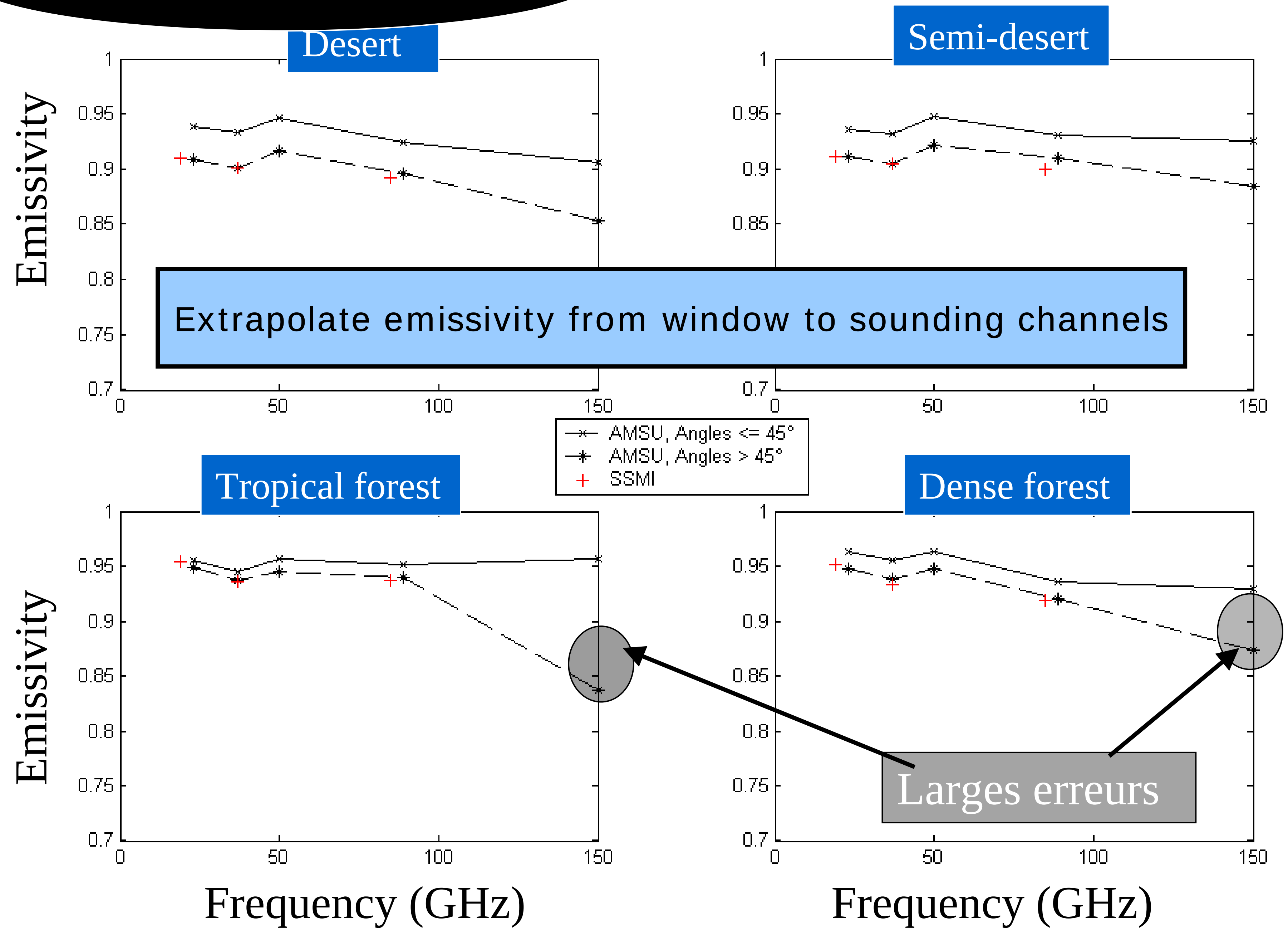
- no in situ measurements
- check consistency: frequency, observing angle
- study error spectrum
- instrument comparison

uncertainties — **5 days, 1 parameter alteration**

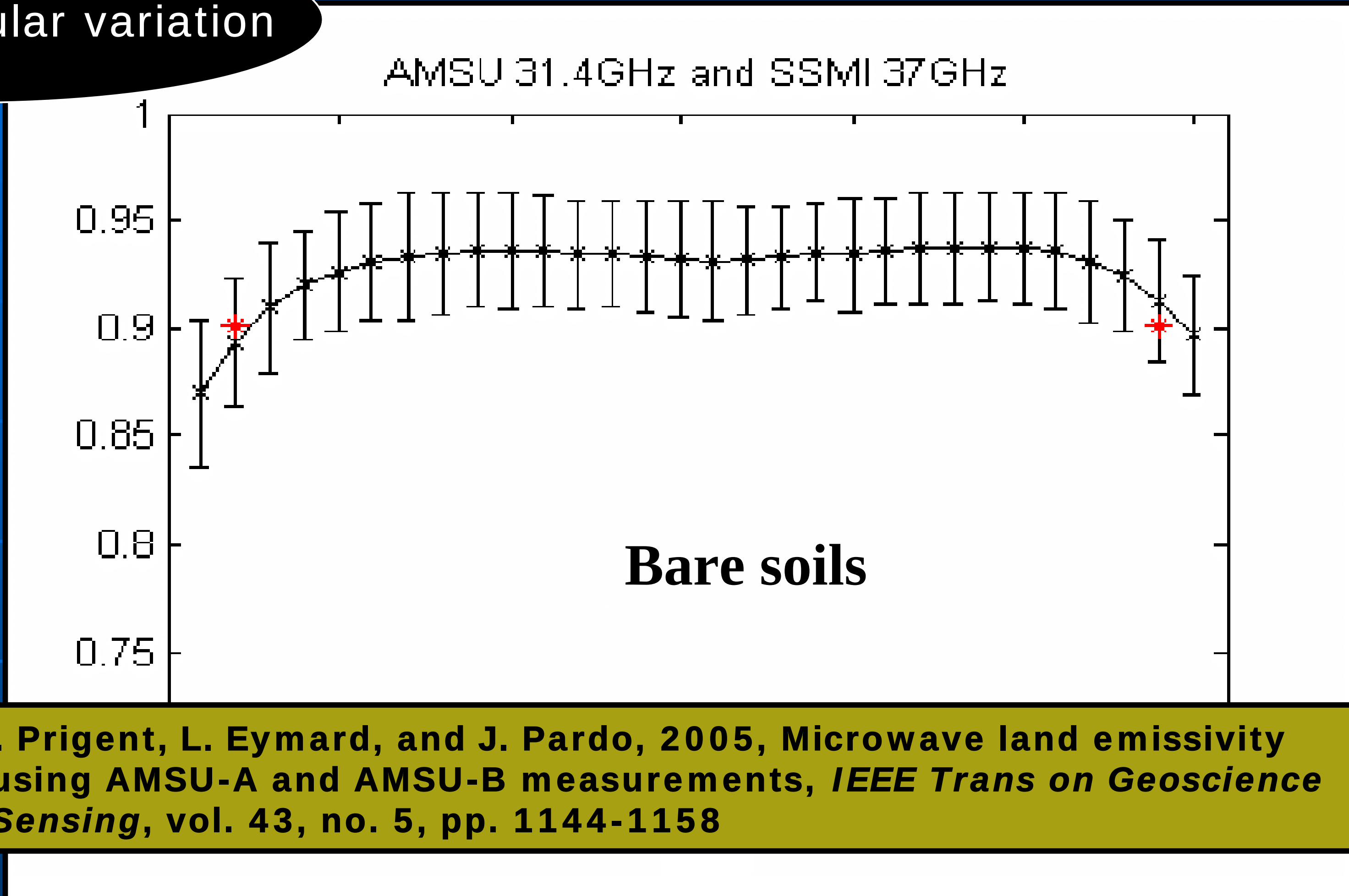
- Ts: **+/- 4 K → 3%**
- Humidity profiles: **+/- 15 % → 3% 150 GHz**
- Temperature profiles: **+/- 1 K → 1%, 50 GHz**
- Brightness temperature: **+/- 1 K → negligible effect**
- specular/lambertian surface: **0.9 < E < 1 → < 1%**

Std over a month → within 2% variety of frequencies and observing angles

Emissivity spectral variation

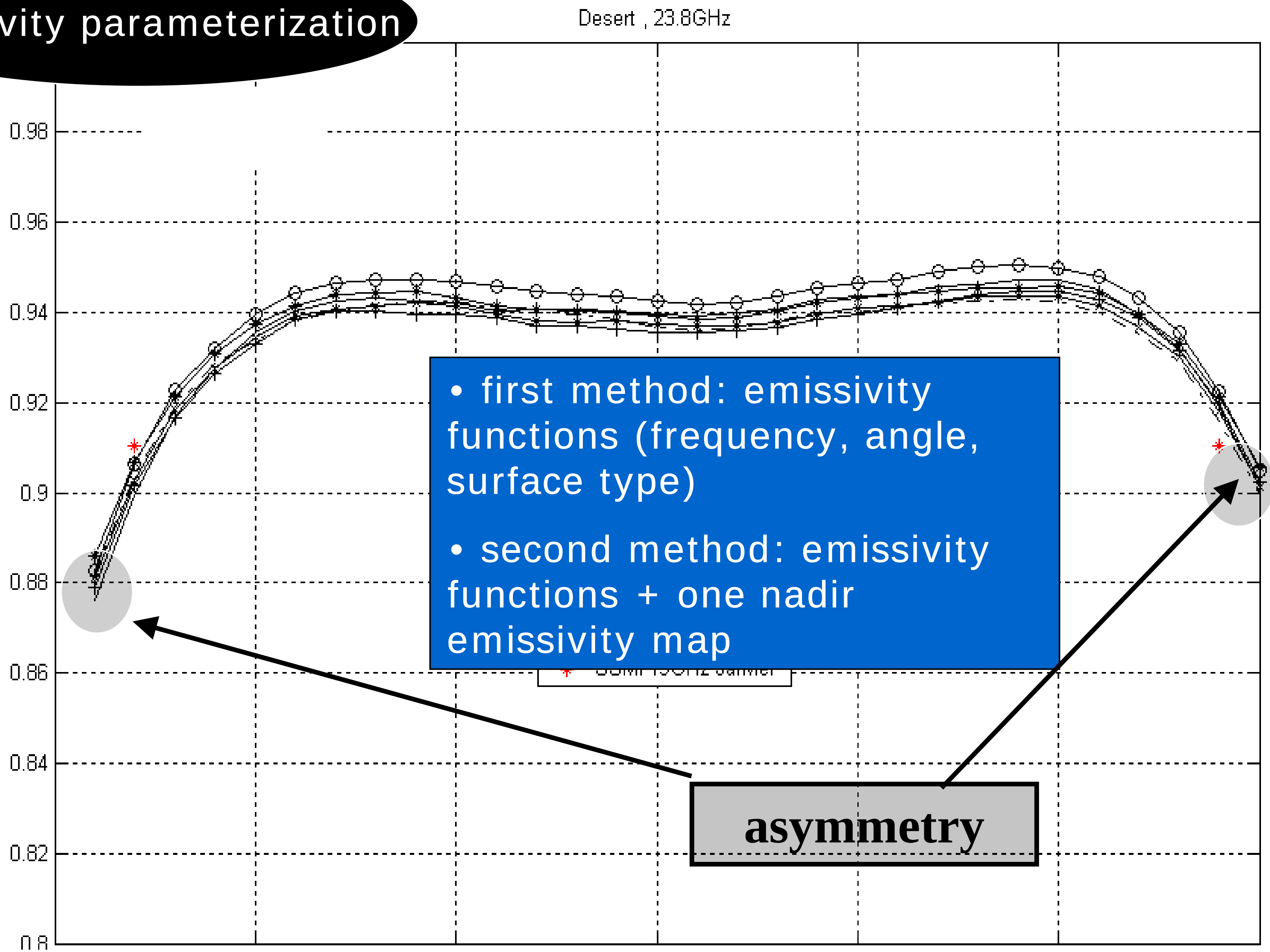


Emissivity angular variation



Karbou, F., C. Prigent, L. Eymard, and J. Pardo, 2005, Microwave land emissivity calculations using AMSU-A and AMSU-B measurements, *IEEE Trans on Geoscience and Remote Sensing*, vol. 43, no. 5, pp. 1144-1158

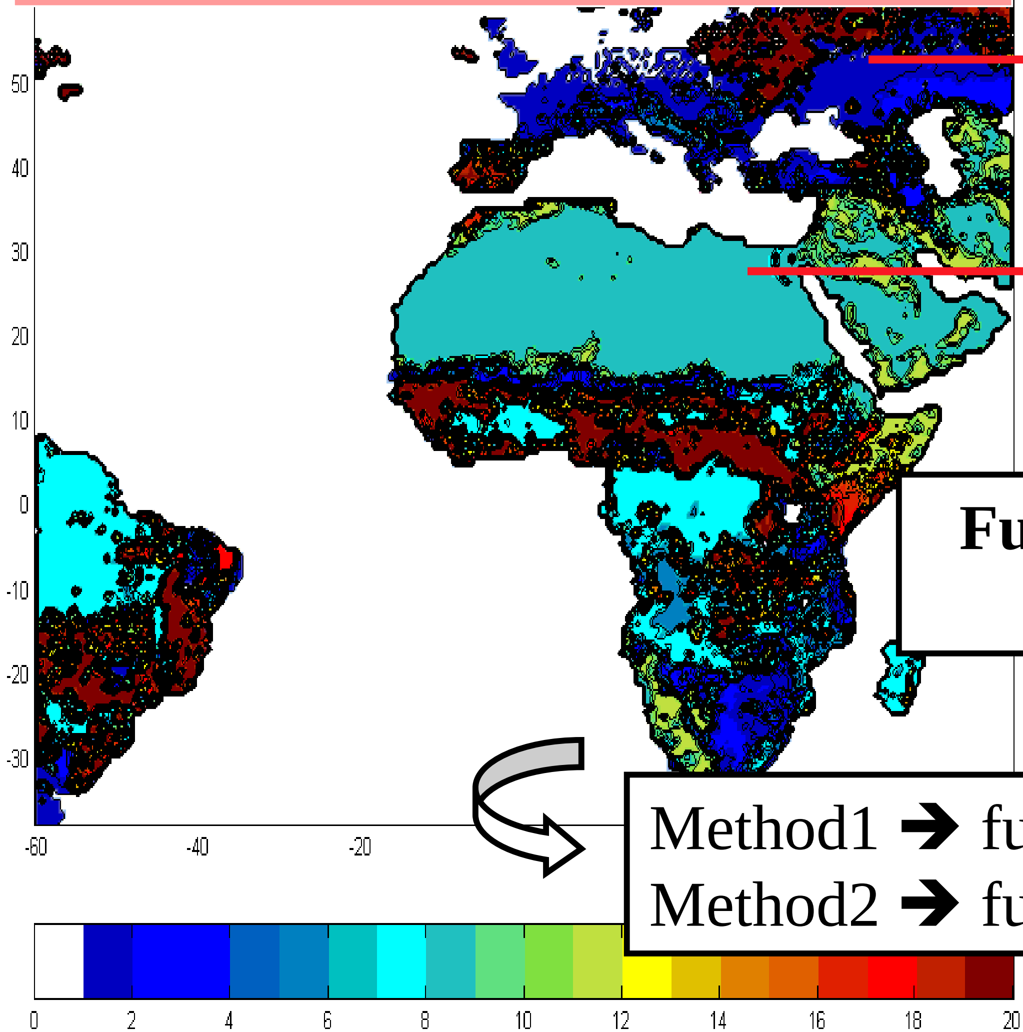
Emissivity parameterization



- first method: emissivity functions (frequency, angle, surface type)
- second method: emissivity functions + one nadir emissivity map

Méthode

Surface type classification



F1(angle, frequency)

Fi(angle, frequency)

Functions Fi (i=1:20), data from February 2000

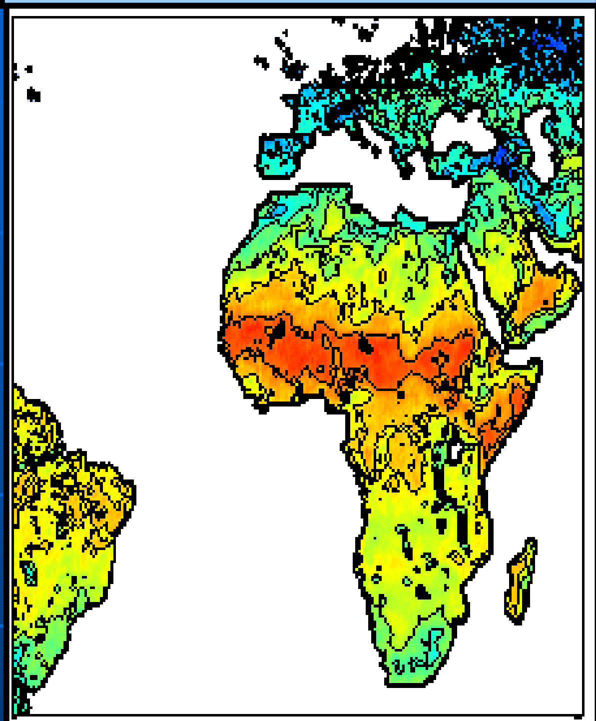
Method1 ➔ functions Fi

Method2 ➔ functions Fi + mean emissivity map

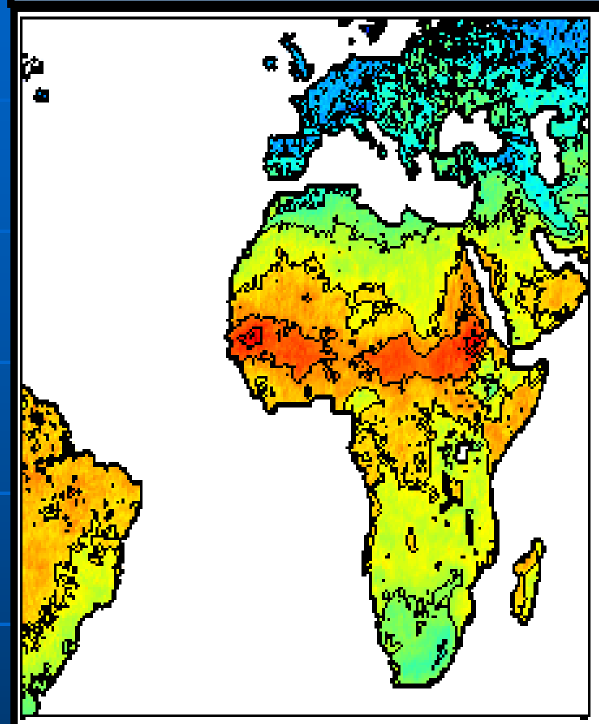
Emissivity parameterization

Results for TBs, April 2000, 50 GHz, All zenith angles

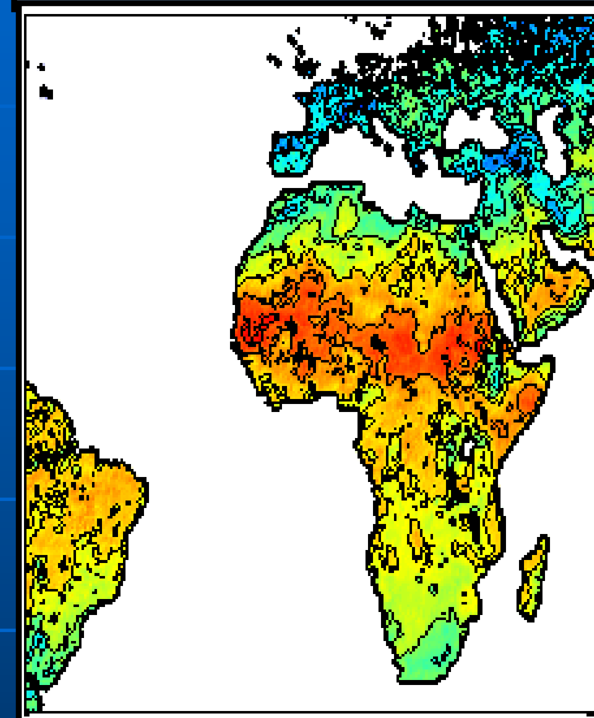
Observations

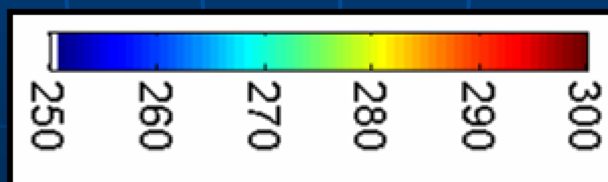


Simulations: 1st method



Simulations: 2nd method





Application to atmospheric parameter retrieval over land

-SSM/I:

NN inversion with first guess
Simultaneous retrieval of Ts, IWP, ICW, emissivities
8 years of retrieved products
'all weather' Ts estimates
(Aires et al., 2001, Prigent et al. 2001-2005, other publications)

-AMSU:

NN inversion for atmospheric temperature/humidity profiles over land
(Karbou et al., 2005)
Assimilation of AMSU-A & -B raw radiances over land in the 4dvar system at Météo-France
(Poster session, A24)

Conclusion

- direct and reliable way to estimate microwave land emissivities

- long time record (1992-2000) for the SSM/I emissivities (with also applications to surface characterization)

- surface and atmospheric retrieval over land possible based on these estimates from SSM/I, AMSU

- potential for assimilation in NWP

- method directly applicable to AMSR and SSM/IS

- in progress: development of an emissivity model for global application, anchored on the calculated emissivities, for the 10-200 GHz range, all angles, H and V polarizations.

http://aramis.obspm.fr/~prigent/publication.html

http://www.cetp.ipsl.fr/~karbou/welcome_an.html

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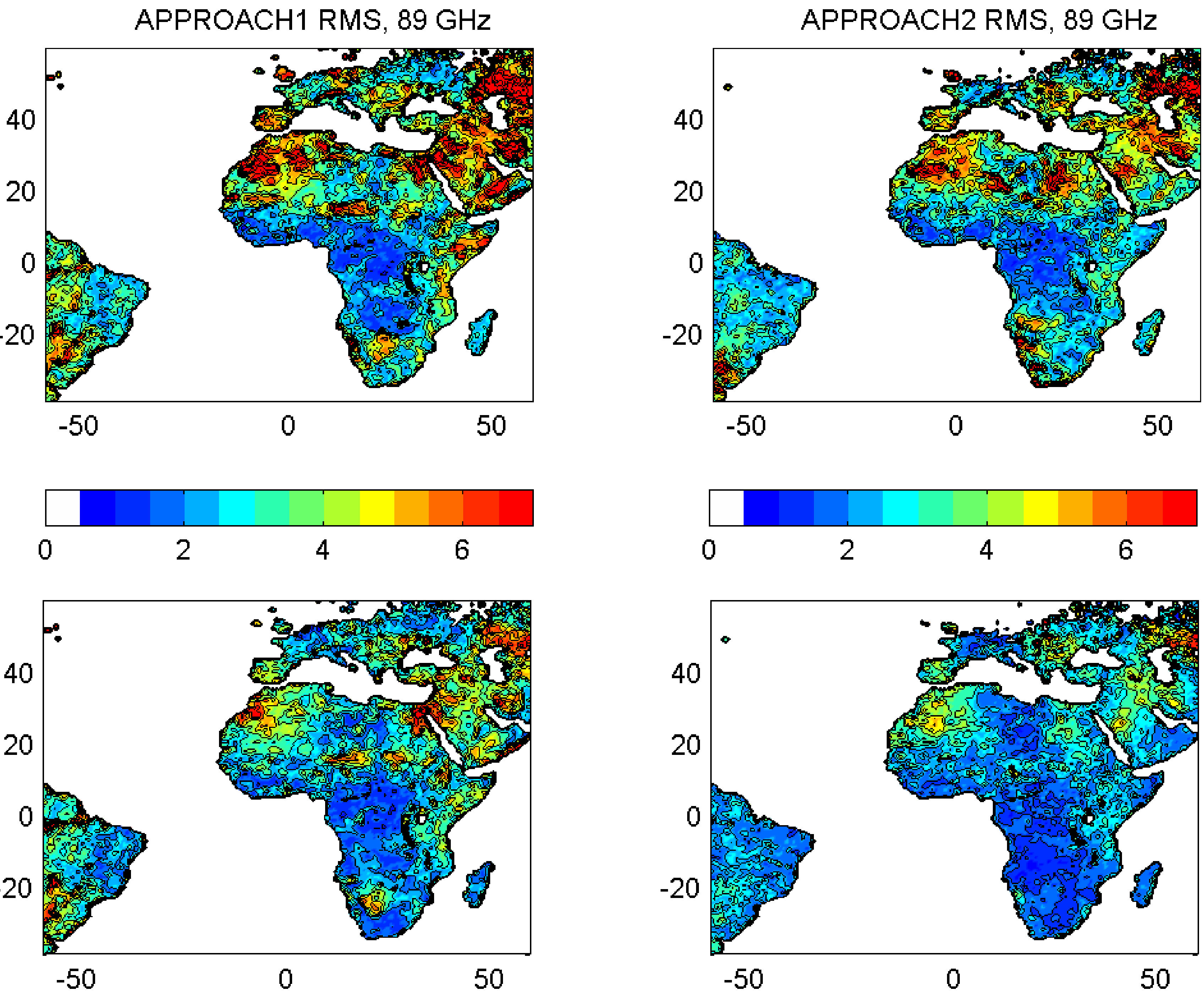
APPROACH1 RMS, 89 GHz
APPROACH2 RMS, 89 GHz
40
20
0
-20
-50
0
50
0
2
4
6