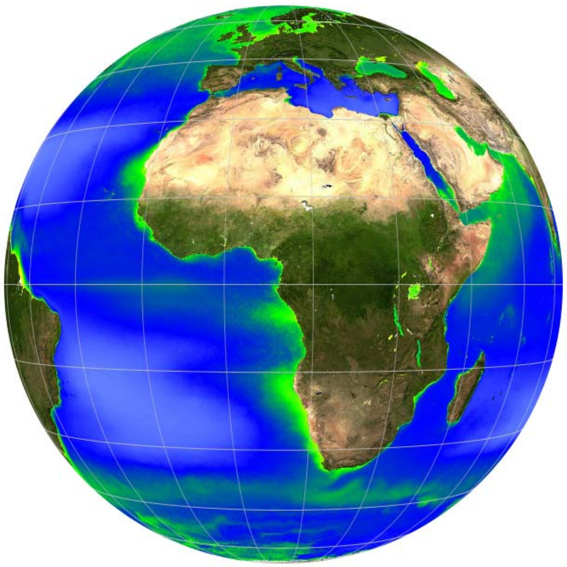
Some specificities in GEO OCR processing

Constant Mazeran, ACRI-ST



Splinter Session 3 – Geostationary ocean colour radiometry

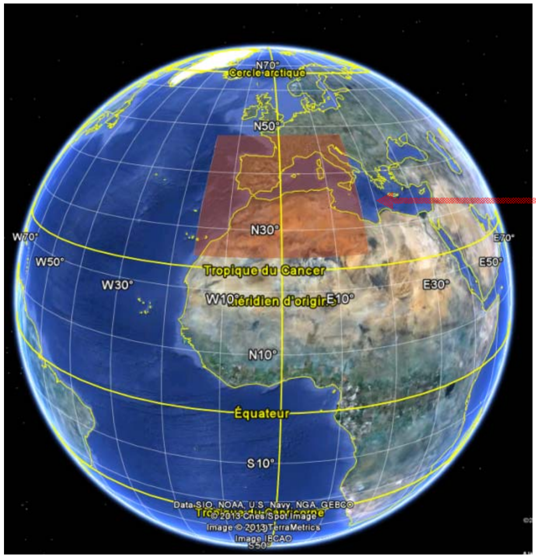
International Ocean Couleur Science Meeting

6th May 2013, Darmstadt

Outline

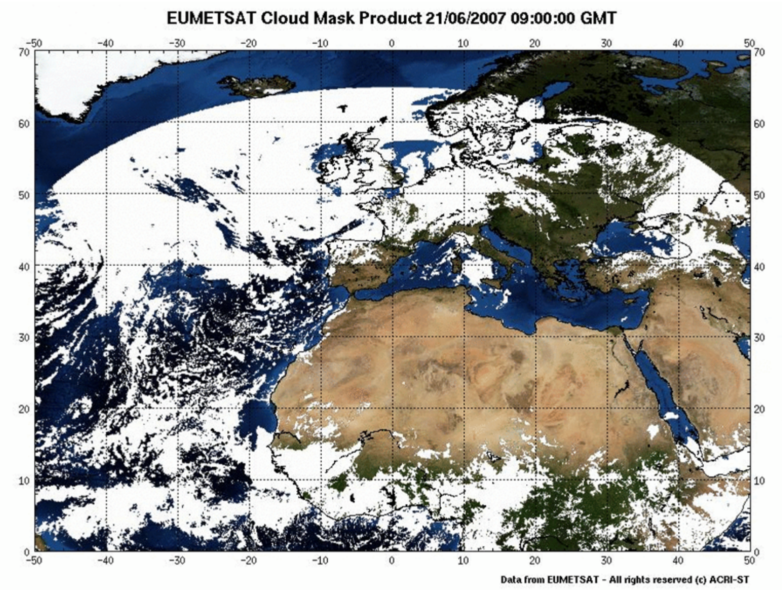
- **Geostationnary orbit brings us back down to Earth…**
  1. **Clouds are moving** → **coverage performance; quantity of data**
  2. **The Sun is behind us** → **sun glint pattern; backscattering geometry**
  3. **The Earth is round** → **air mass issue; RTM, atmospheric correction**
  4. **36 000 km is very high** → **MTF issue**

- **Focus on an mission with a large field of view (« OCAPI », « GEO-Oculus » , GOCI-2…) – issues not totally relevant in the GOCI observation**

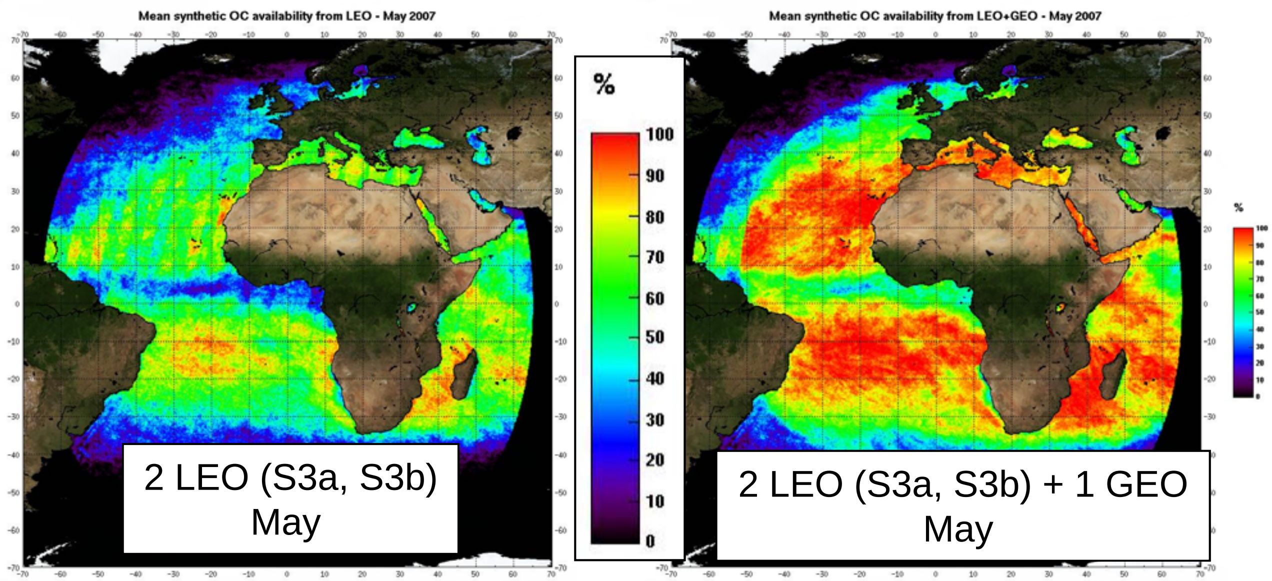


GOCI FOV as if over Europe

1. Coverage performance, acquisition and data



Coverage simulations, including constraints on cloud coverage, air mass, glint – see hereafter



See *IOCCG Report 12 (2012): Ocean-Colour Observations from a Geostationary Orbit.*

1. Coverage performance, acquisition and data

Huge amount of data

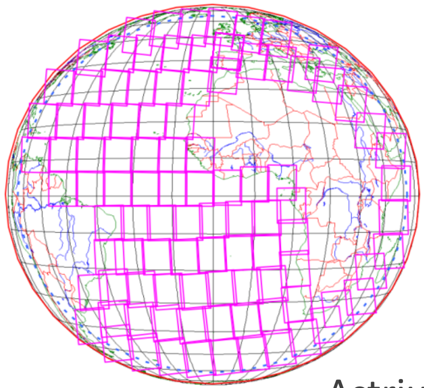
- Estimated size (OCAPI concept, 1 hour revisit) :

Level	Image (Mbytes)	Daily (Gbytes)
raw data	275	215
0	275	215
1b	316	245
2	458	358
Total	1324	**1033**

- → same order of magnitude than OLCI (global)
- Need for a daily L3 binned products

Try to optime acquisition scenario to minimise the data size?

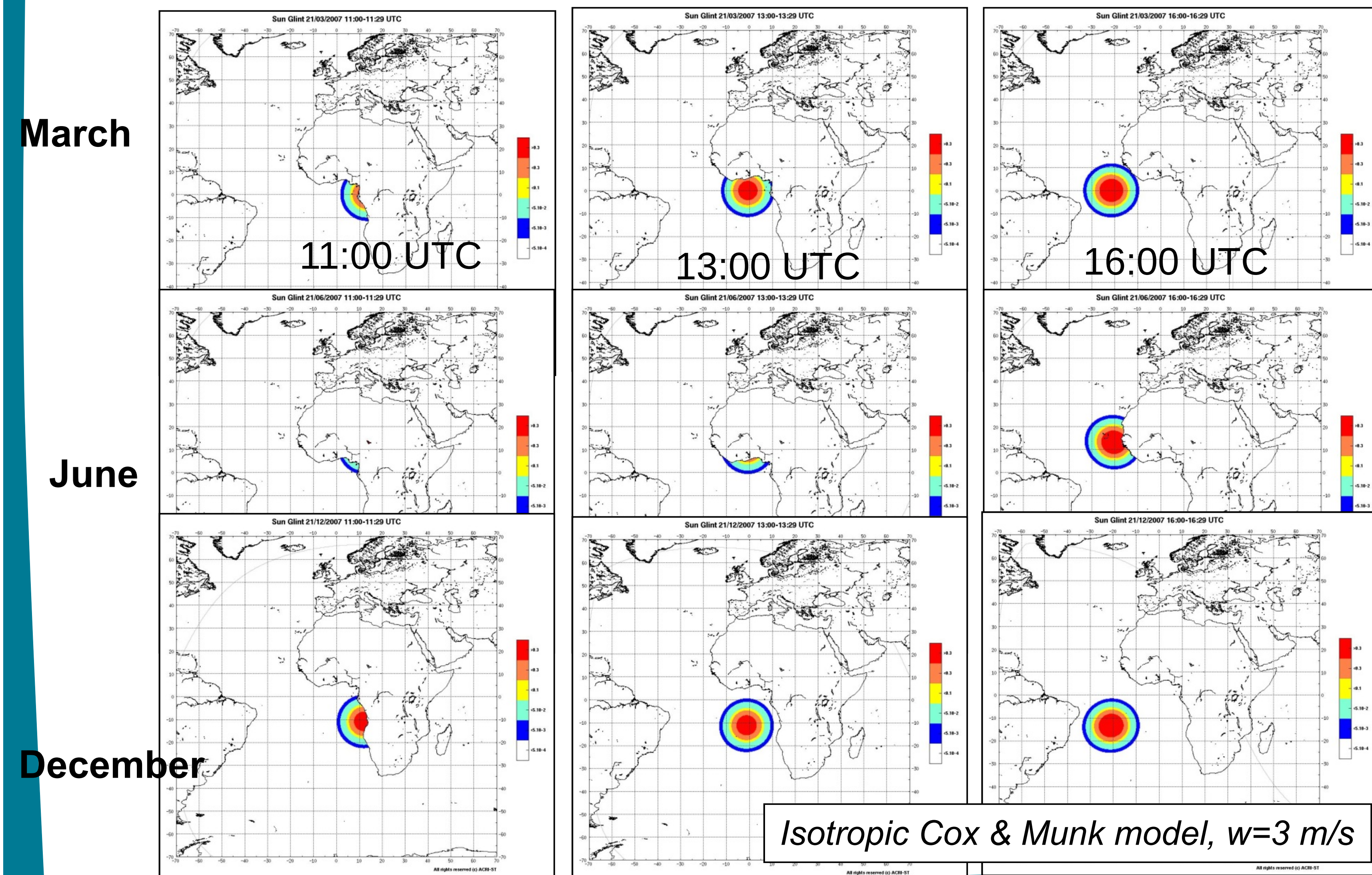
- Acquisition: step and stare approach, by slots
- Dynamic pointing with respect to cloud?



Astrium

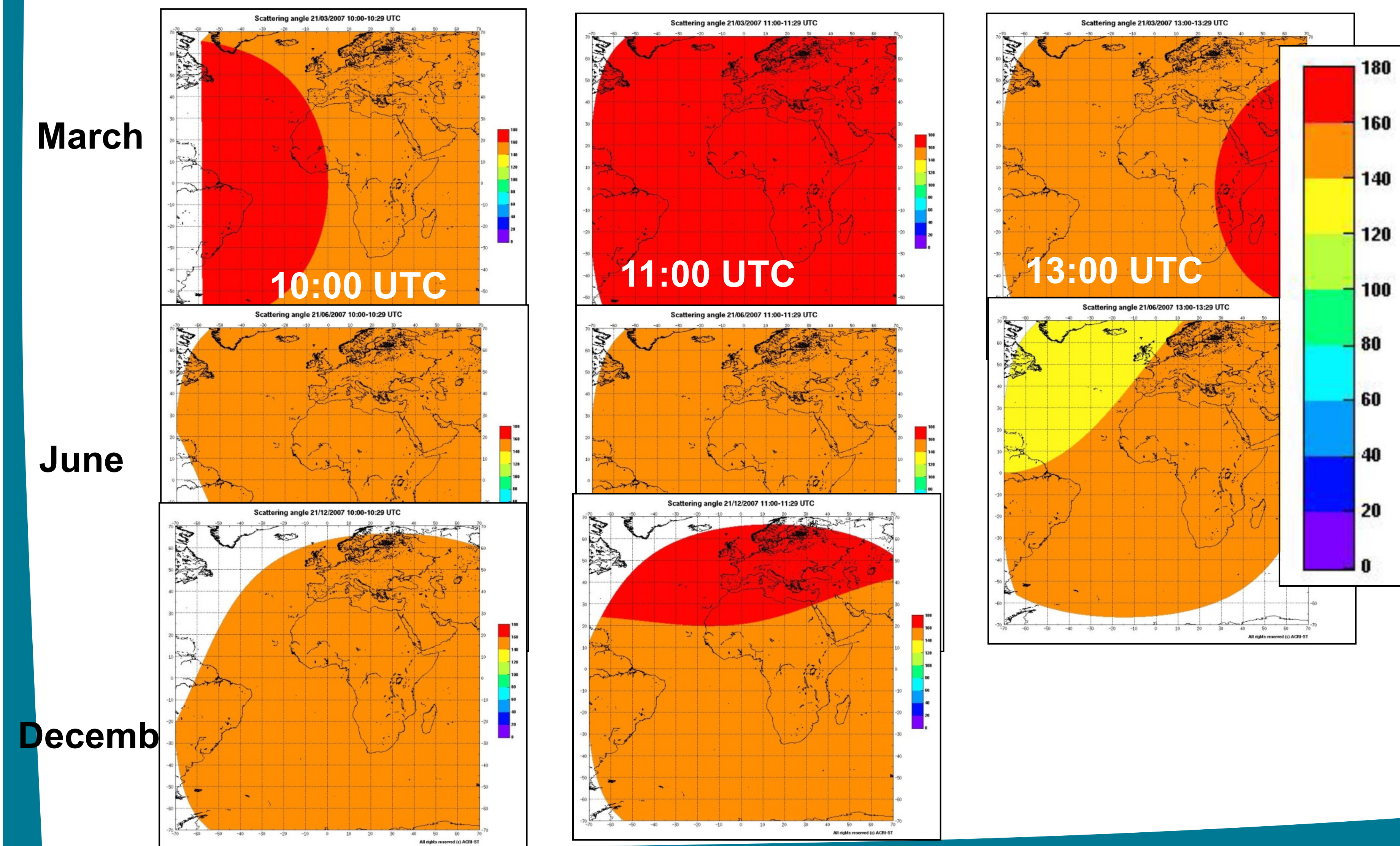
2. Sun glint pattern

- Glint avoided most of the place and most of the time → low priority on this problem



3. Backscattering geometry

❖ **Backscattering geometry most of the day**

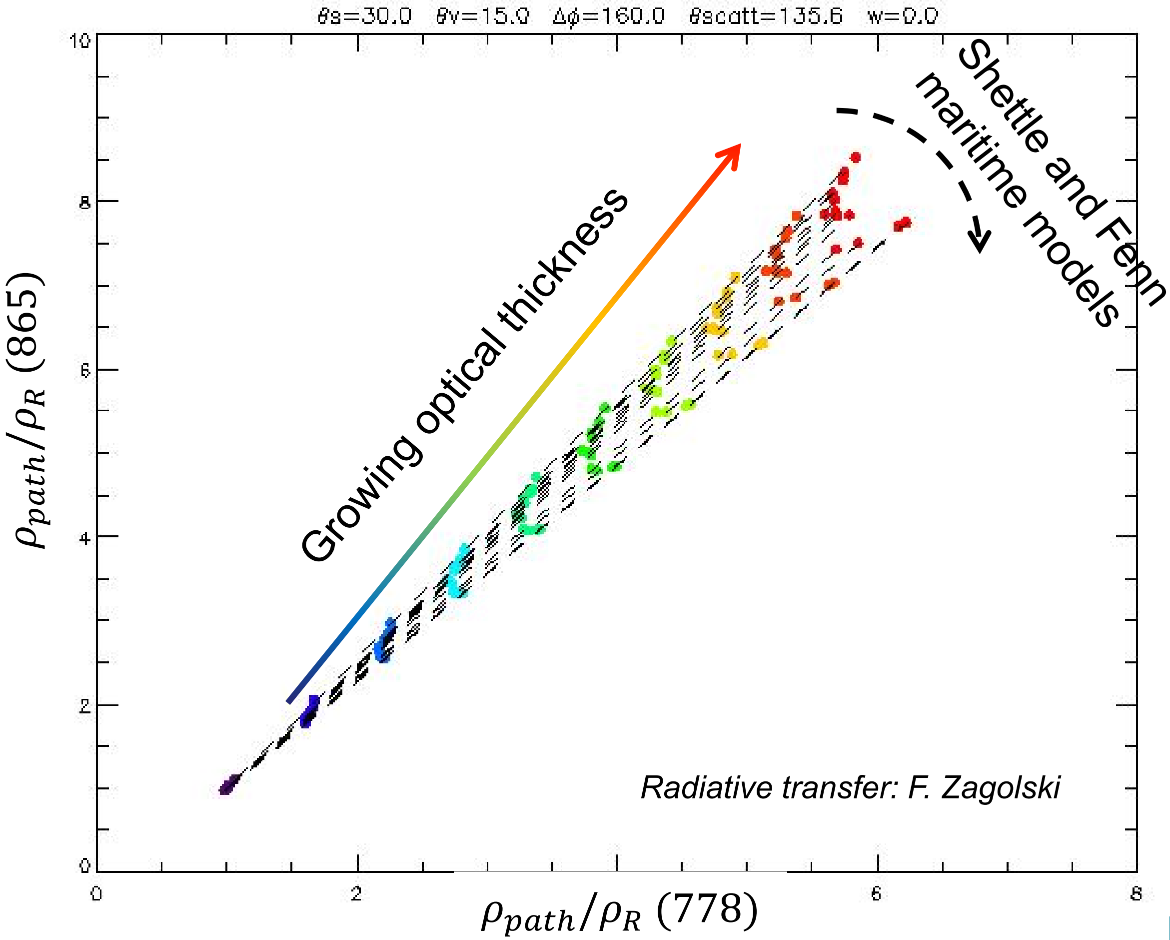


3. Backscattering geometry

- **Is aerosol detection more difficult in backscattering geometry?**
- **Atmospheric correction traditionnaly detects aerosol in the NIR with:**
  - **Two unknowns: aerosol optical thickness and aerosol model**
  - **Two bands. Example of the MERIS AC:** $\rho_{path}/\rho_R\ (778)$ **and** $\rho_{path}/\rho_R\ (865)$

$\theta_{scatt} = 135°$

It seems possible to find optical thickness and model in the (778, 865) plane



3. Backscattering geometry

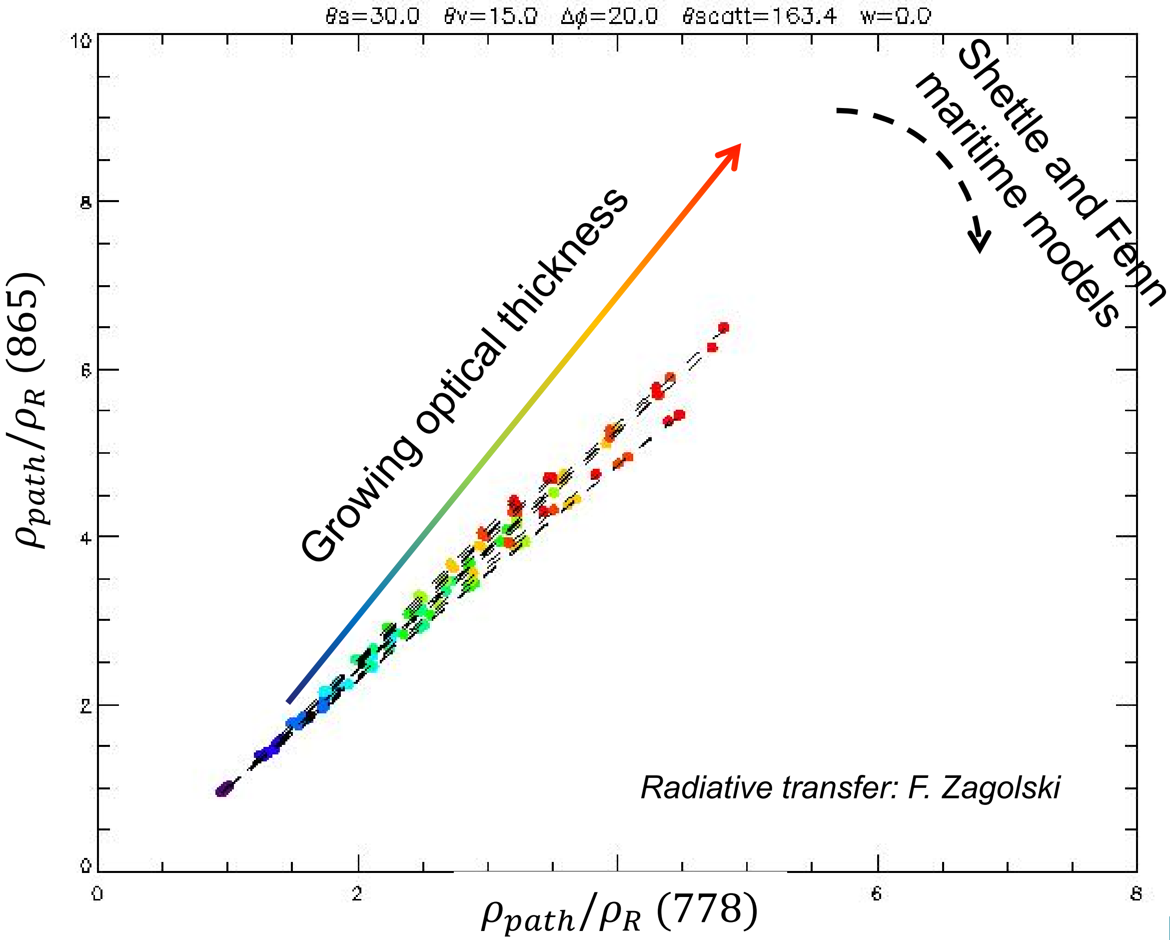
- **Is aerosol detection more difficult in backscattering geometry?**
- **Atmospheric correction traditionnaly detects aerosol in the NIR with:**
  - **Two unknowns: aerosol optical thickness and aerosol model**
  - **Two bands. Example of the MERIS AC:** ρ_{path}/ρ_R (778) **and** ρ_{path}/ρ_R (865)

$\theta_{scatt} = 163°$

Much harder to distinguish aerosol models and optical thickness

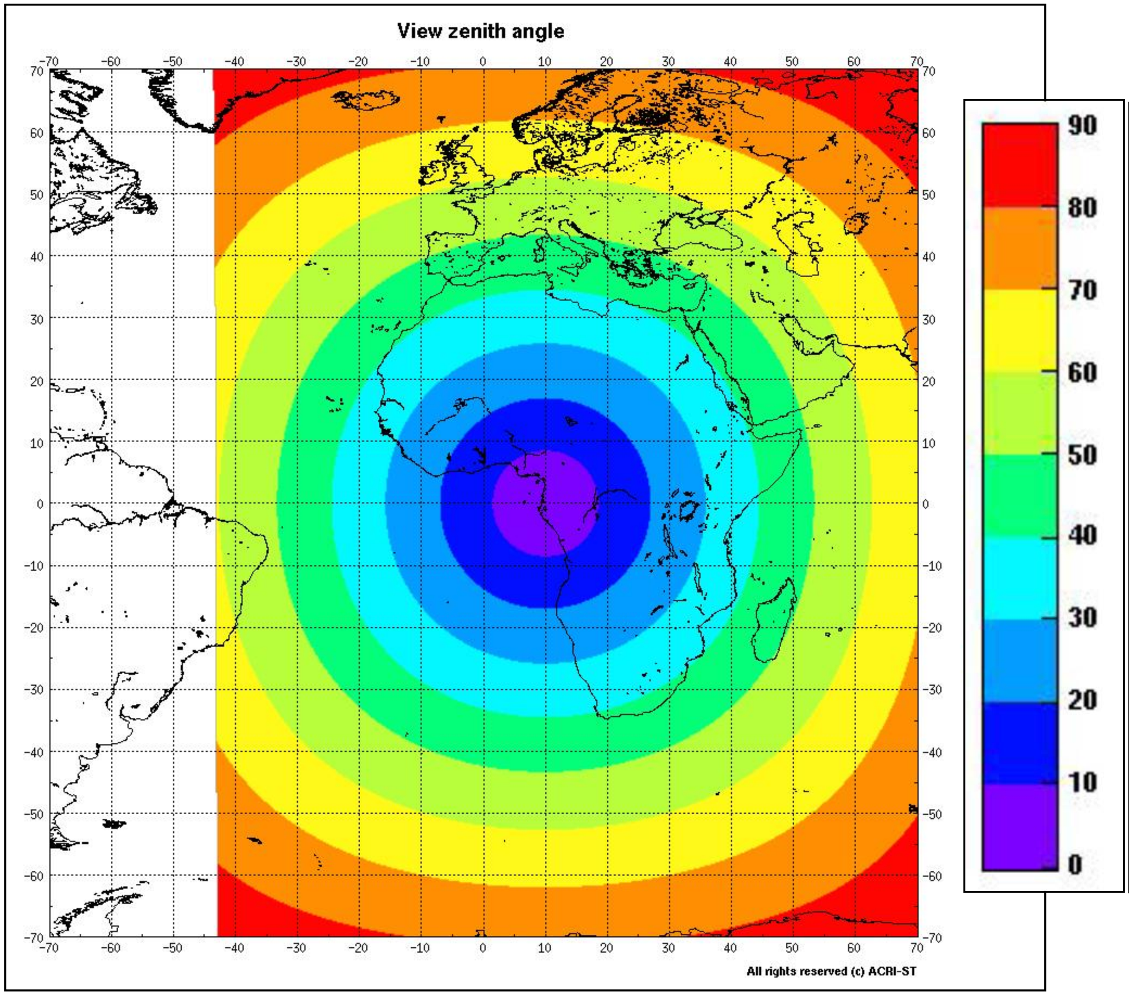
Note: GOCI AC uses only 3 models (M99, M50, C50):

Ahn et al 2012 : *"While the SeaWiFS atmospheric correction uses 12 aerosols models, GOCI adopts only three […] to reduce the processing time. In addition this […] can easily avoid the image discontinuity problem …*

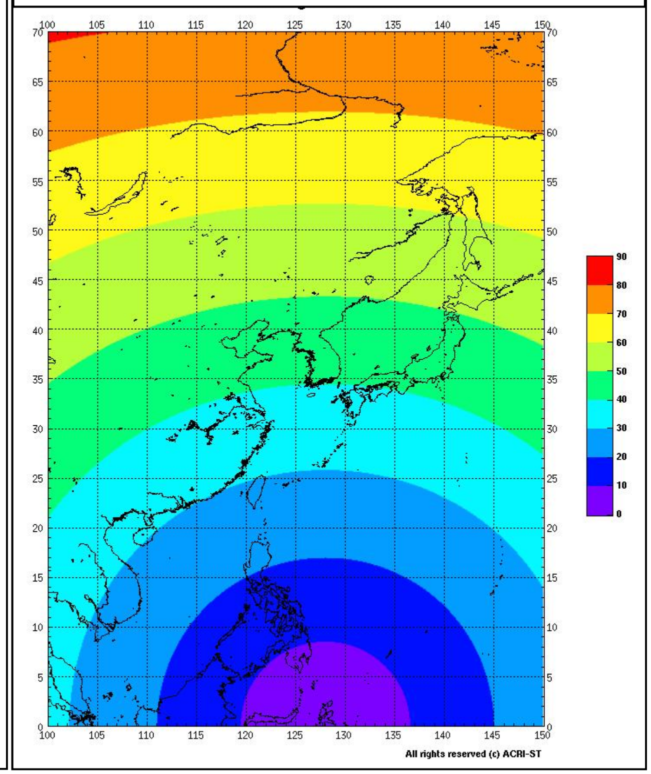


4. Air mass, Earth curvature

- **High viewing angle for many regions of interest**



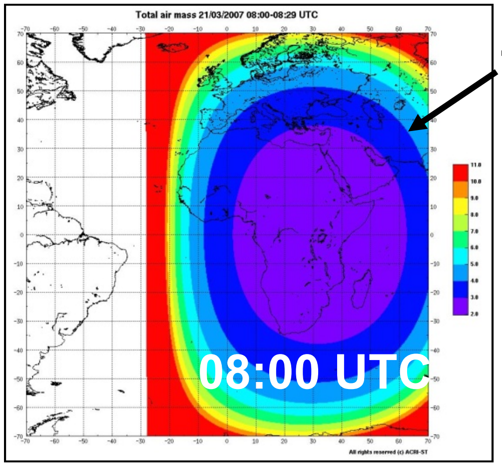
This problem is less crucial for GOCI (θ_v <50°)

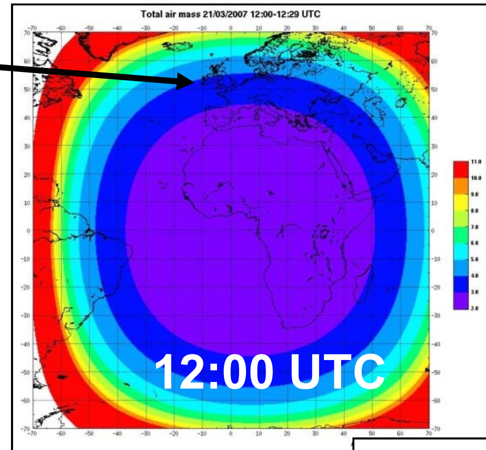


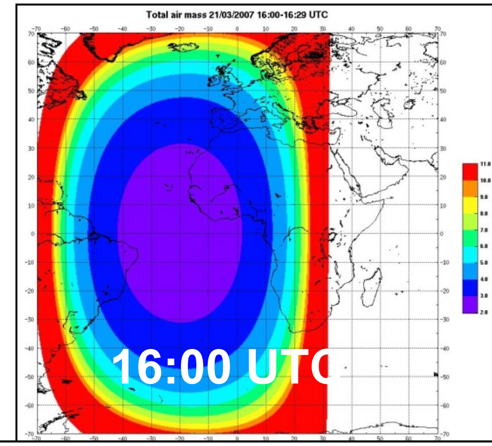
4. Air mass, Earth curvature

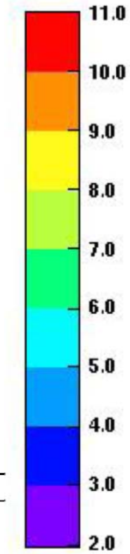
❖ **It results into a high total air mass fraction…**

March

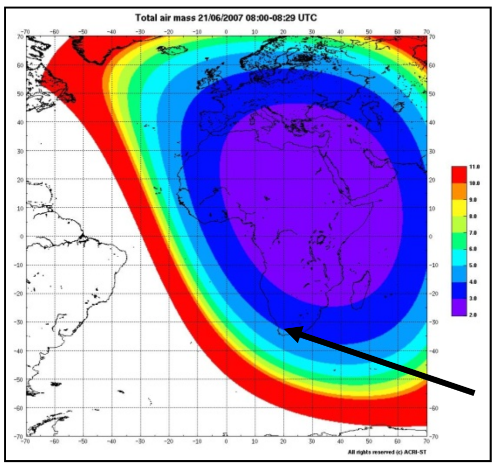


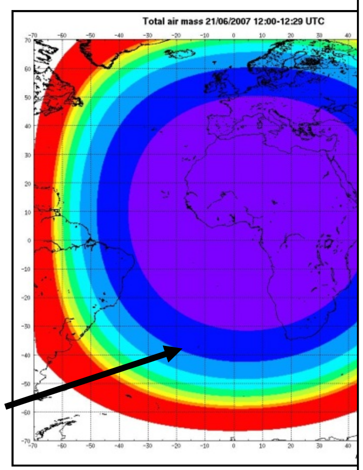




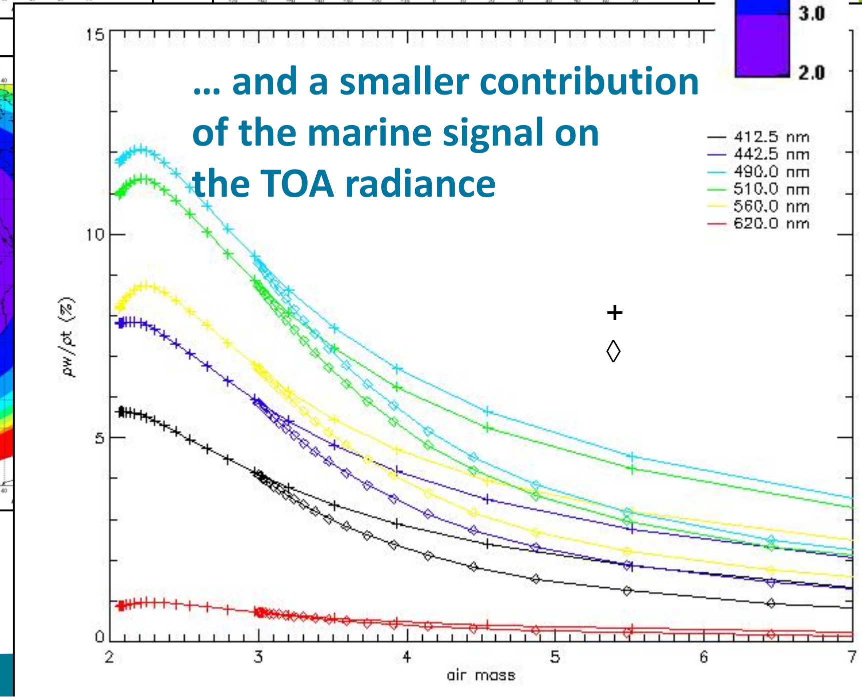


June





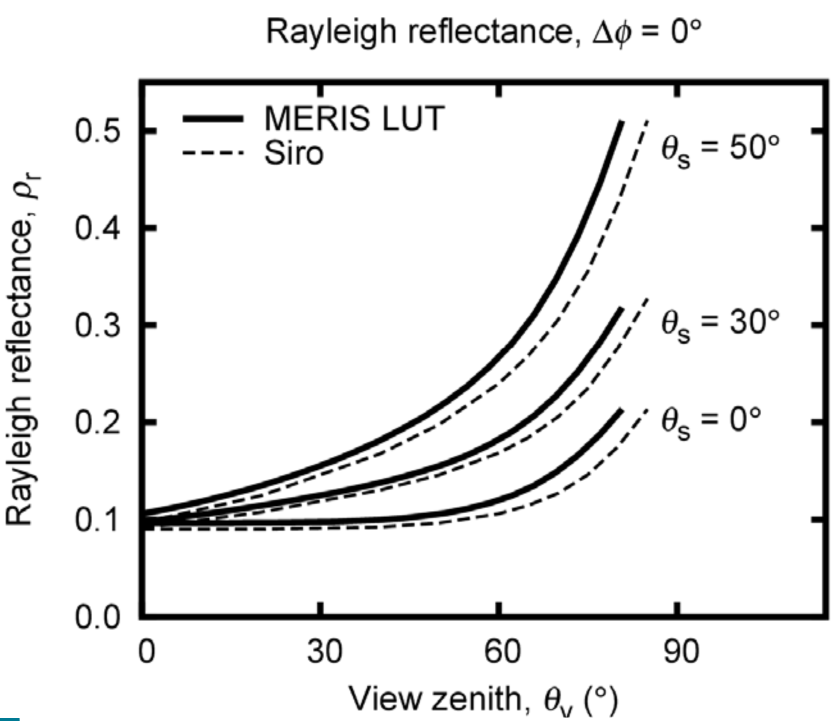
… and a smaller contribution of the marine signal on the TOA radiance



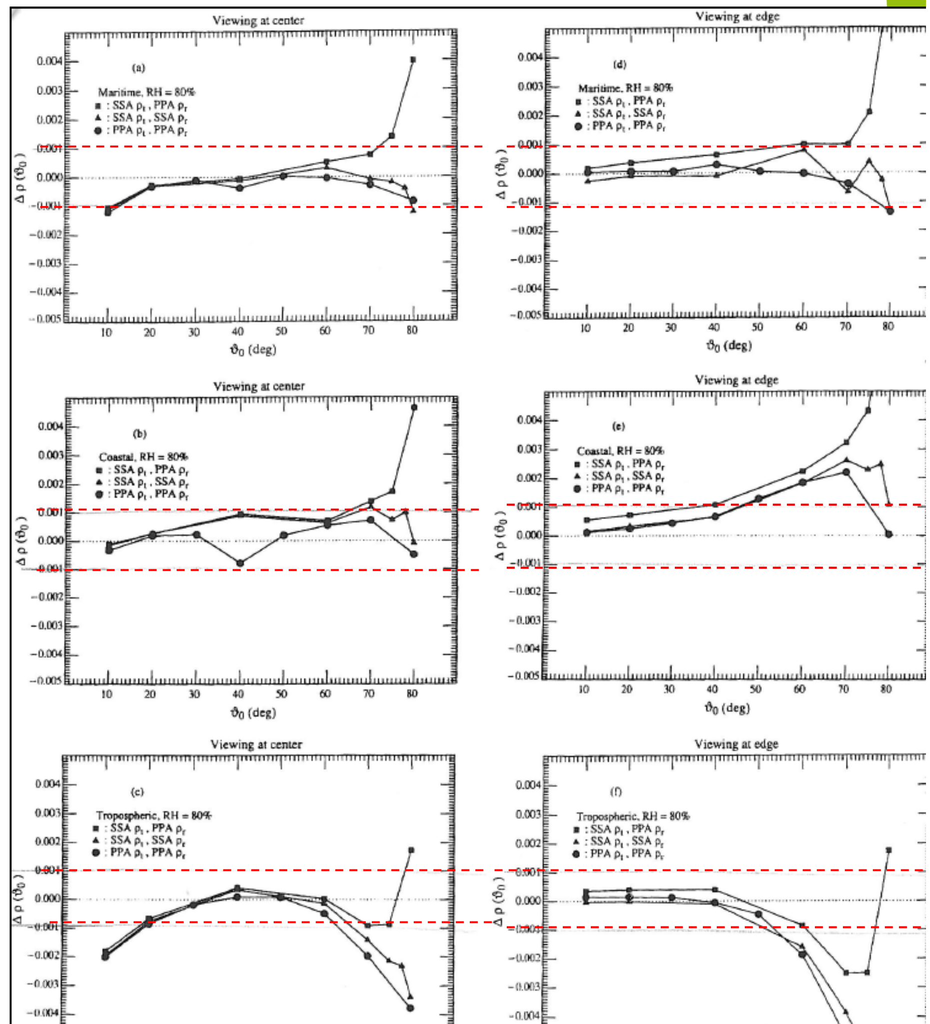
4. Air mass, Earth curvature

- **Atmospheric correction performance wrt airmass**
  - Mainly inspected for high Solar angle in LEO geometry
  - Ding & Gordon 94', Wang 03', Wang (IOCCG study)
  - Performance out of spec for air mass above ≈ 4
  - Need for RTC in spherical geometry (at least Rayleigh) for θv greater than ≈ 70°

- **On-going studies with ESA (resp. Marc Bouvet)**



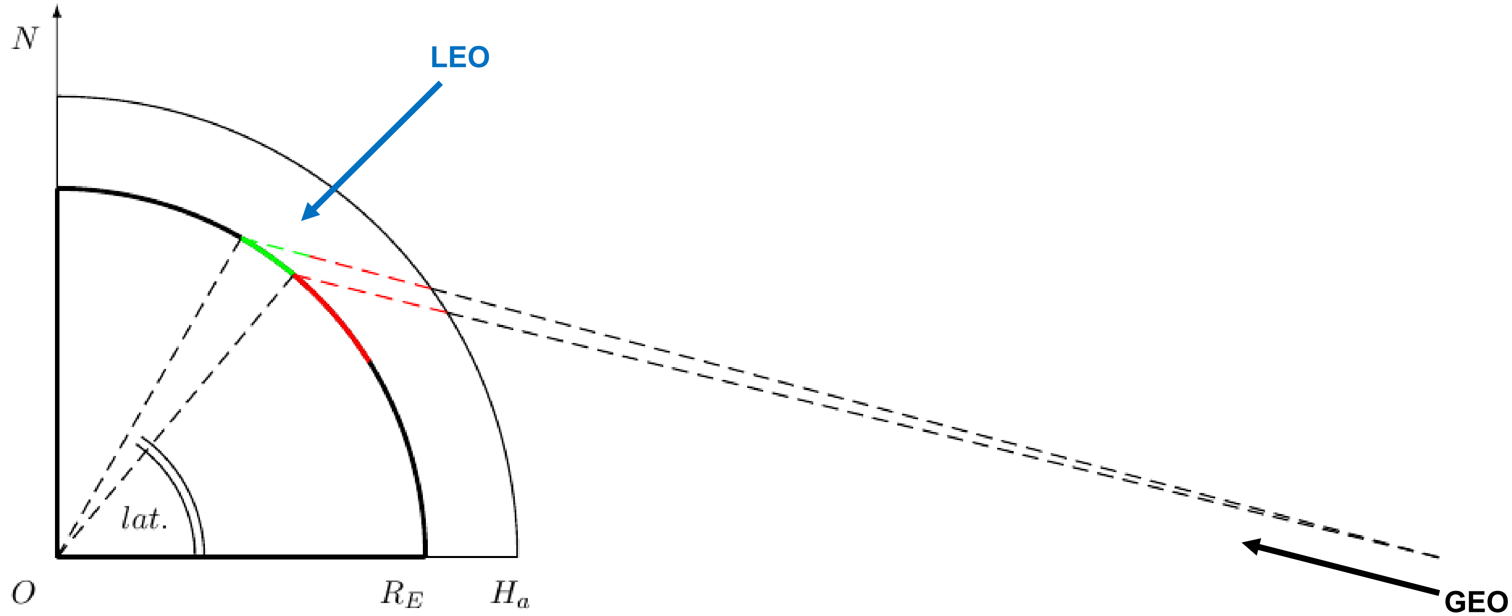
Data from ARGANS & FMI (Siro RTM) and ParBleu (MERIS LUT)

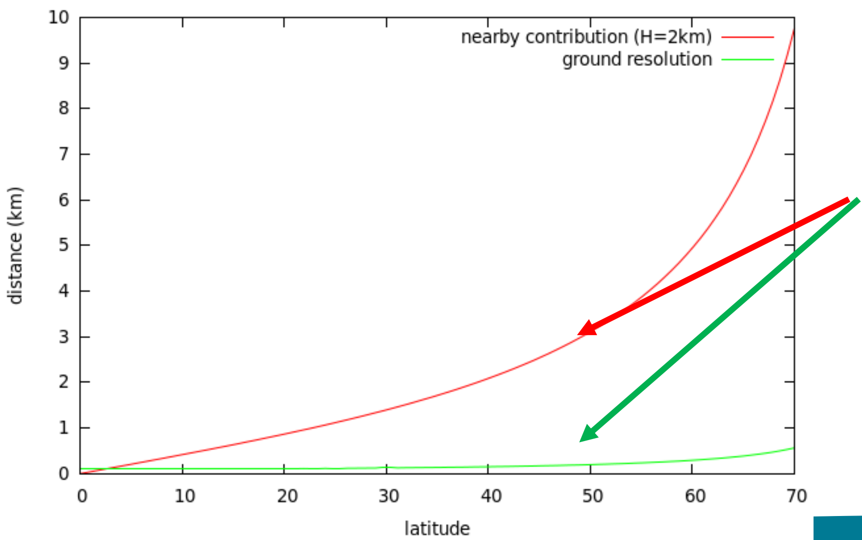


Source: Ding & Gordon 94'

4. Air mass, Earth curvature

❖ **Assumption of horizontal homogeneity (plane-parallel) to be reviewed?**





At 50° latitude, the atmospheric path to observe a 100m target comes mainly from a 3km surrounding area (for a 2km Ha)

Can a unique profile (pressure, gas…) represent it?

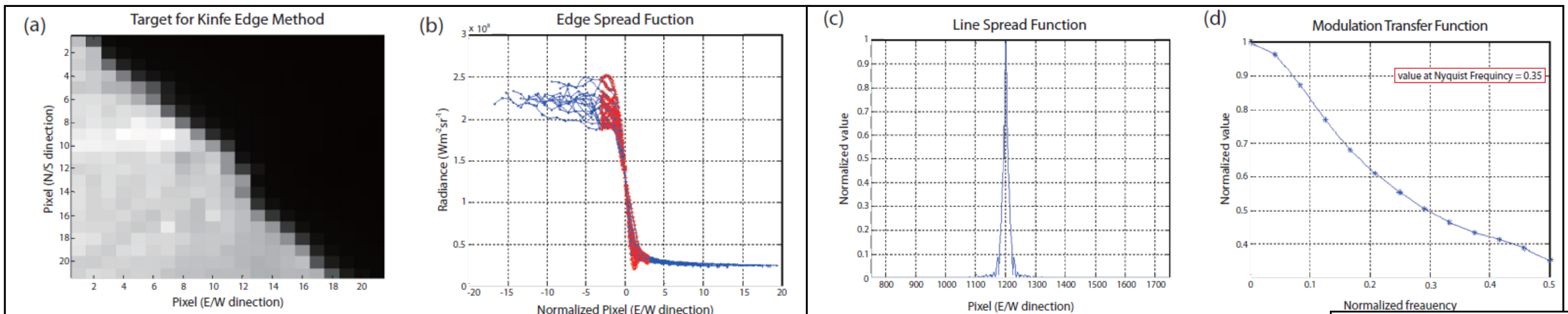
ACRI ST

5. MTF

- **Modulation Transfer Function: gives scale of details reachable by the sensor**
  - **Point spread function → Fourier Transform → Value at Nyquist frequency (~$\frac{1}{2}\frac{1}{GSD}$)**
  - **Important to detect fronts, structures…**

- **Total MTF is the combination of optical + mechanical MTF**
  - **Critical on GEO plateform because of pointing stability**

- **Goal: 0.3**
  - **Were does this specification come from?**
  - **Space manufacturers: today not reachable on a GEO plateform at 250m resolution**
  - **GOCI (500m) on-orbit MTF estimate (Oh et al 2012): ~0.32**



Source: Oh et al 2012

- **MTF isa compromise with the ground resolution and the signal to noise ratio**
  - **If an algorithm (e.g. atmospheric correction) is less sensitive to noise, SNR can be relaxed and MTF improved**

Summary of GEO issues

- Large amounts of data (~ OLCI but for a GEO disk)

- Reconsider the historical atmospheric correction scheme:
  - Possible issue in backscattering geometry
  - Possible issue for high air mass
  - Ideally need RTC in spherical shell geometry
  - Atmosphere modelling (horizontal homogeneity) possibly to be reviewed

- MTF to be justified; or SNR requirement relaxed with more robust algorithms?

- Other issues: BRDF, adjacency effects…