Royal Netherlands
Meteorological Institute
*Ministry of Infrastructure
and Water Management*

A fast cloud retrieval algorithm from the oxygen B-band for GOME-2 measurements

Marine Desmons, Ping Wang, Maarten Sneep, Piet Stammes, Gijs Tilstra

Outline

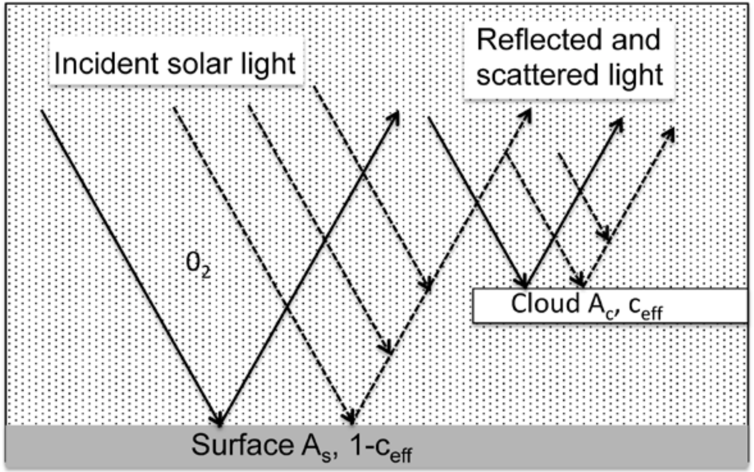
- Introduction on FRESCO
- Why using FRESCO in the oxygen B-band?
- Comparisons between FRESCO-A and FRESCO-B
- Directional dependence of surface LER climatology
- Conclusions - perspectives

Intro : Fast REtrieval Scheme for Cloud from the Oxygen A-band

- Retrieving cloud altitude from O_2 absorption (Vanbauce 1998, Preusker 2007, Lelli 2012…)
  - Depends weakly on temperature profile,
  - Sensitive to low clouds,
  - Retrieve cloud optical mid-level altitude

- FRESCO : (Koeleimeijer 2001, Wang 2008)
  - Retrieves cloud properties from reflectances measured in the 02 A-band
    - cloud effective fraction + cloud pressure
  - Used operationnally (http://www.temis.nl/fresco/)
    - input for in trace gas and aerosols retrievals

Fast REtrieval Scheme for Cloud from the Oxygen A-band



- Hyp: Cloud and surface are lambertian
- A_c, A_s: Albedos of cloud and surface, A_c =0.8
- C_{eff} : Effective cloud fraction
- T_s, T_c : Two-ways O2 transmissions
- R_c, R_s : Single Rayleigh scattering reflectances

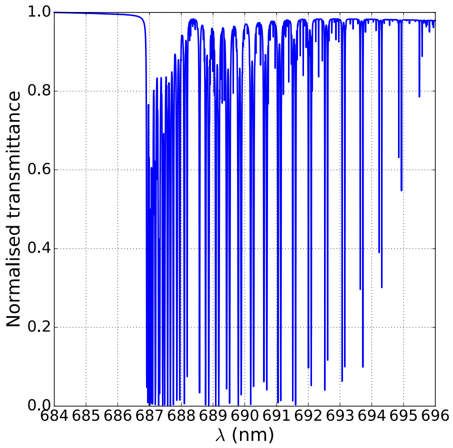
$$R_{sim} = c_{eff} T_C A_C + (1 - c_{eff}) T_S A_S + c_{eff} R_C + (1 - c_{eff}) R_S$$

Minimizing the difference between simulated and measured reflectances (Levenberg-Marquardt nonlinear least-square method

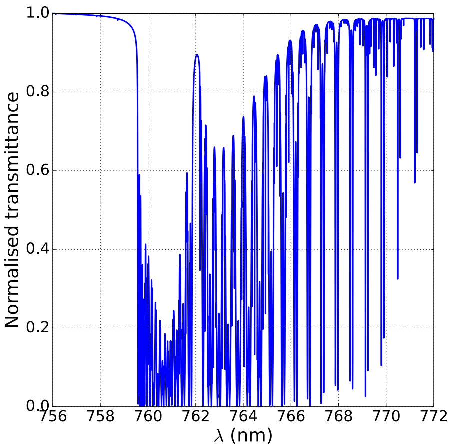
Why using FRESCO in the oxygen B-band ?

- The O2 B-band (686-690 nm) is less deep than the O2 A–band (758-772nm)

O_2 B-band



O_2 A-band



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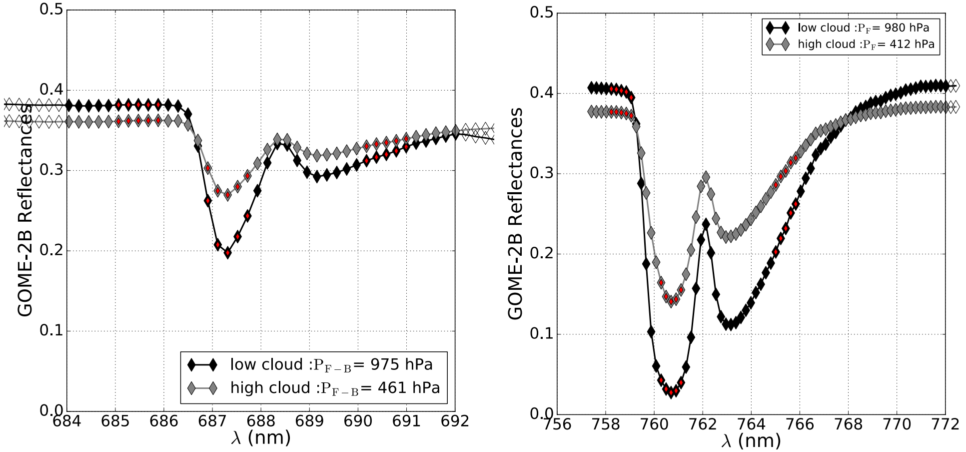
O_2 B-band **O_2 A-band**



GOME-2
- Spectrometer on board MetOp A/B
- Mesurement in UV-VIS-NIR (240-800nm) to monitor atmospheric composition

➡ The difference of pressure retrieved with O_2 A and B bands can provide information on cloud vertical structure.

Why using FRESCO in the oxygen B-band ?

- The O2 B-band (686-690 nm) is less deep than the O2 A –band (758-772nm)

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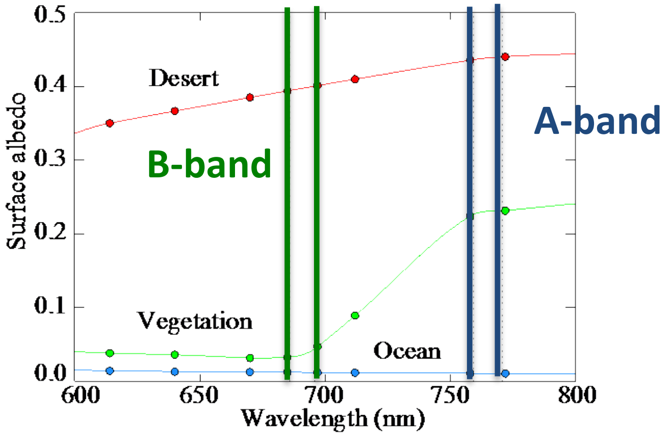
- Vegetation albedo is lower in the O2 B-band



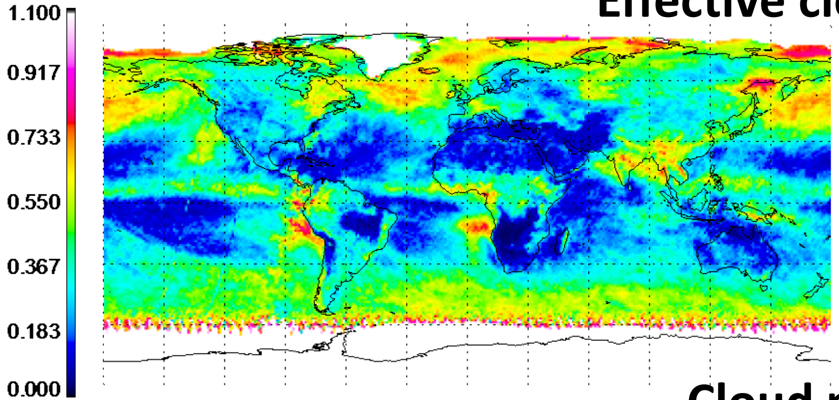
➡ Vegetation cover :
Retrievals in the B-band might be more accurate than in the A-band.

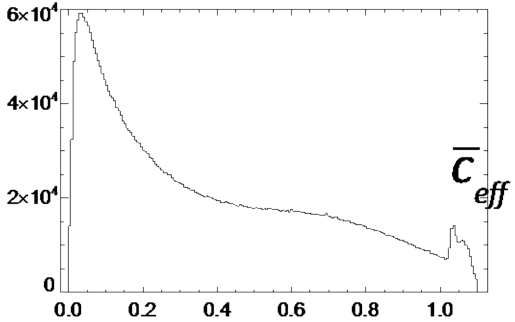
First results of FRESCO-B

Effective cloud fraction

July 2014

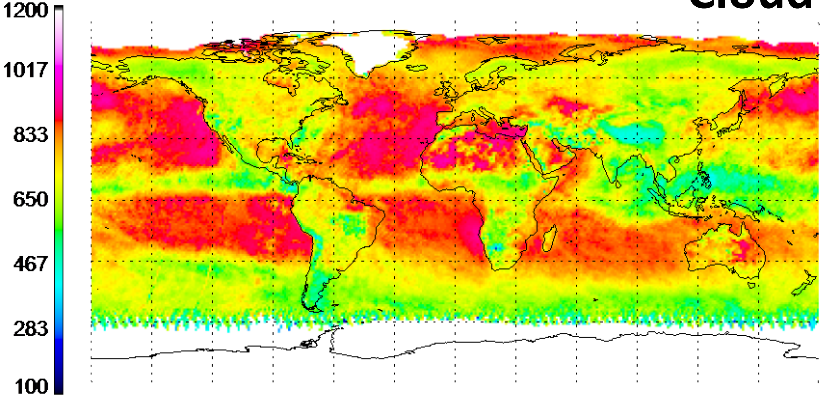
4 208 125 pi.

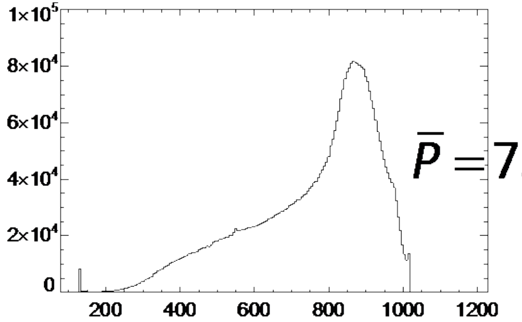




$$\overline{c}_{eff} = 0.389 \pm 0.304$$

Cloud pressure

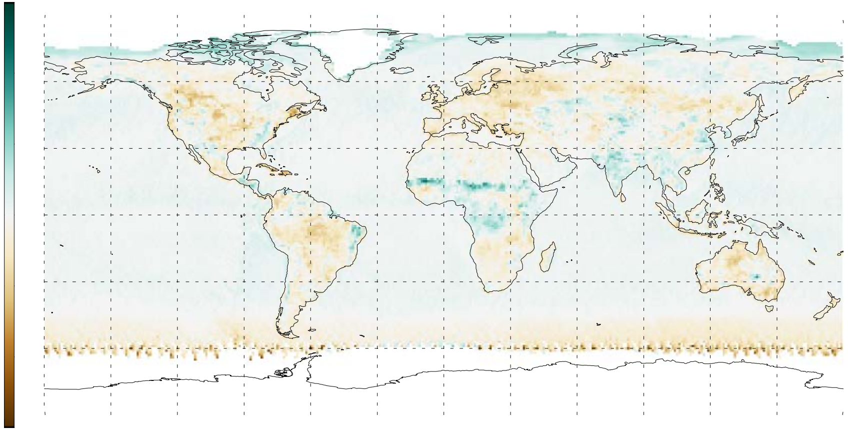




$$\overline{P} = 736 \pm 195^{HPa}$$

Comparison between FRESCO-A and FRESCO-B cloud effective fractions

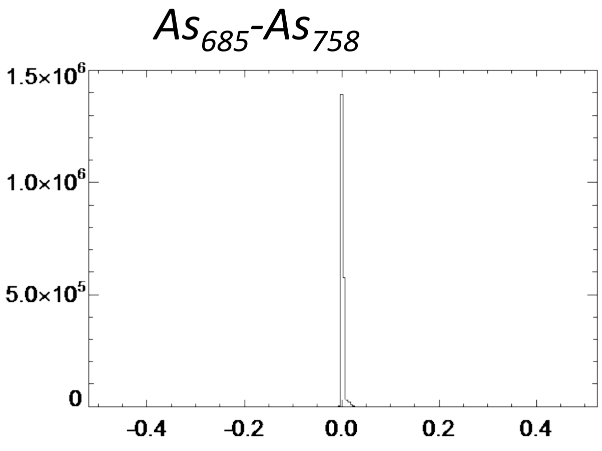
$c_{eff,FRESCO-B} - c_{eff,FRESCO-A}$

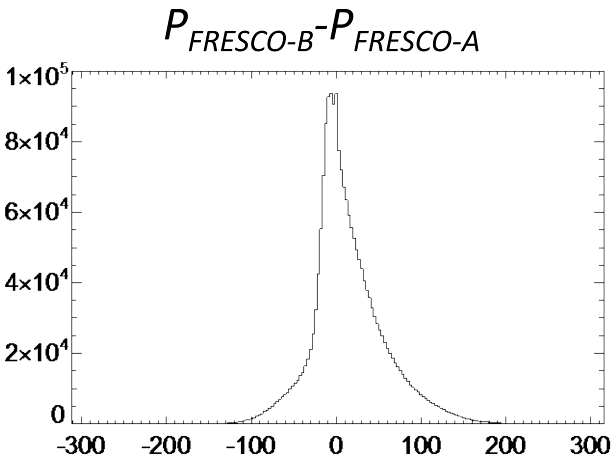


Mean effective cloud fraction:
- very similar with both methods,
- whatever the underlying surface is

	All surfaces	Ocean	Vegetation
A-band	0.387±0.297	0.388±0.294	0.390±0.310
B-band	0.389±0.304	0.395±0.298	0.380±0.320

Comparison between FRESCO-A and FRESCO-B cloud pressures





Over Ocean
2 032 709 pi.

$$\overline{P}_{FRESCO-A} = 749 \pm 199$$

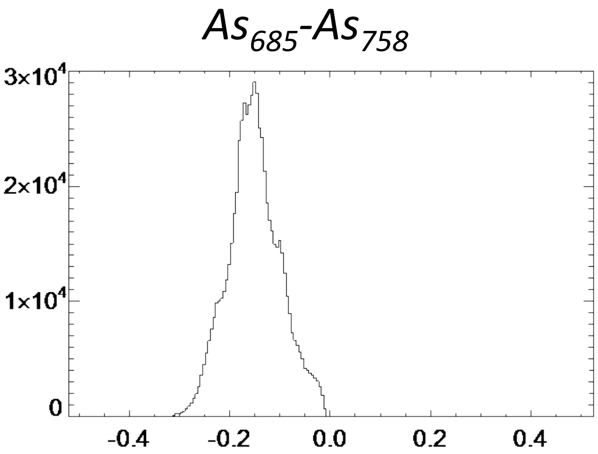
$$\overline{P}_{FRESCO-B} = 763 \pm 179$$

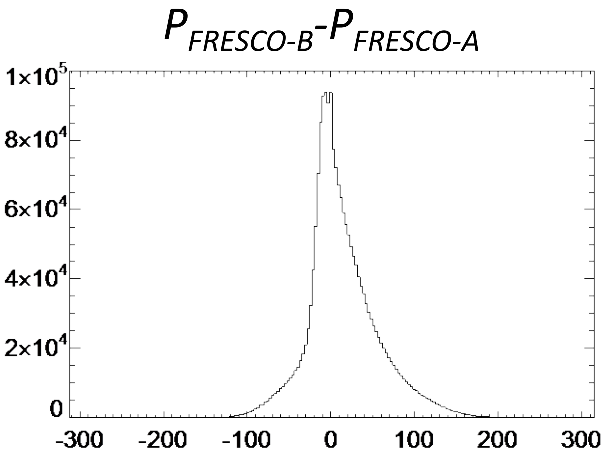
$$\overline{\Delta P} = 13.9 \pm 42.1$$

- Over Ocean, differences between $P_{FRESCO\text{-}A}$ and $P_{FRESCO\text{-}B}$ are only due to a difference of transmission

➡ $P_{FRESCO\text{-}A}$ and $P_{FRESCO\text{-}B}$ indicate 2 differents altitudes in the cloud layer

Comparison between FRESCO-A and FRESCO-B cloud pressures





Over Vegetation
651 903 pi.

$$\bar{P}_{FRESCO-A} = 681 \pm 174$$

$$\bar{P}_{FRESCO-B} = 689 \pm 157$$

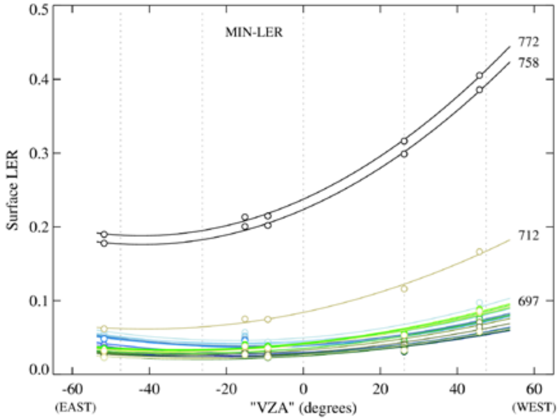
$$\overline{\Delta P} = 8.52 \pm 50.2$$

- Difference is more complex

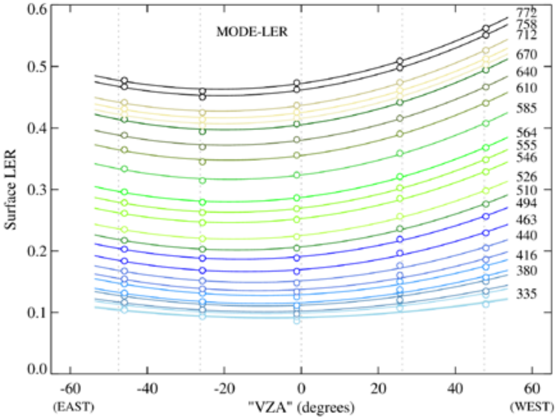
➡ The difference of pressure can be due to difference of transmission or difference of surface albedo

Directional dependence of surface LER climatology

LER Over Amazony



LER Over Sahara

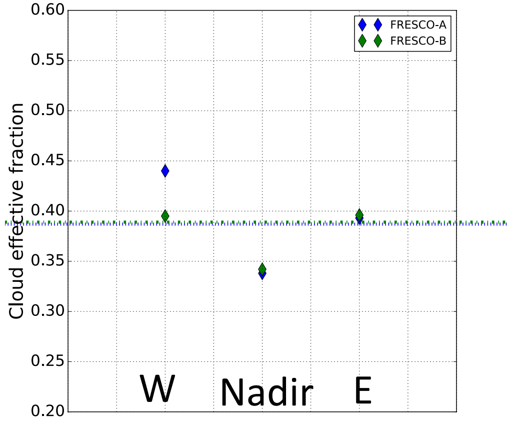


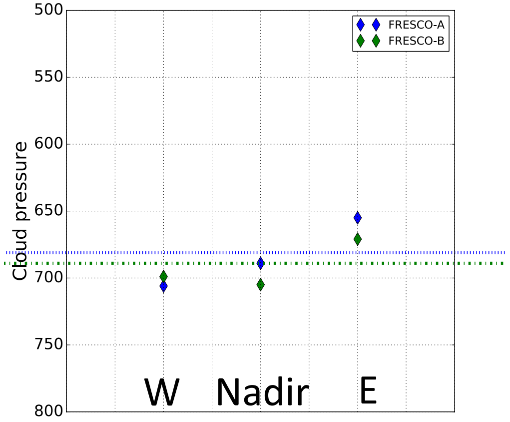
- Stronger over vegetation
- Stronger in the A-band

➡ Overestimated LER and consequences on cloud products

(Lorente et al., 2018)

Directional dependence of surface LER climatology
Consequences on cloud retrievals





GOME-2 swath :
24 pixels

- Bias in the retrieval of cloud properties (Western pixels) due to BRDF effect
  - Ceff: Difference we don't expect between FRESCO-A and FRESCO-B
  - Cloud pressure : Smaller difference

➡ Necessity to correct this effect with a directional LER dataset

Conclusions - Perspectives

- Fast cloud retrieval algorithm from the oxygen B-band for GOME-2 measurements
  - Good performances compared to FRESCO
  - More accurate cloud pressure over vegetation cover
    - **Next step: Combine pressures obtained in A and B-bands**

- Will be applied to TROPOMI on-board Sentinel-5P
  - UV-VIS-NIR-SWIR spectrometer
  - Smaller spatial resolution than GOME-2 (40*80 km^2 -> 3.5*7 km^2)
    - **Validation through campagn based comparisons**