Cloud fraction determination for GOME-2 A/B with OCRA V3.0

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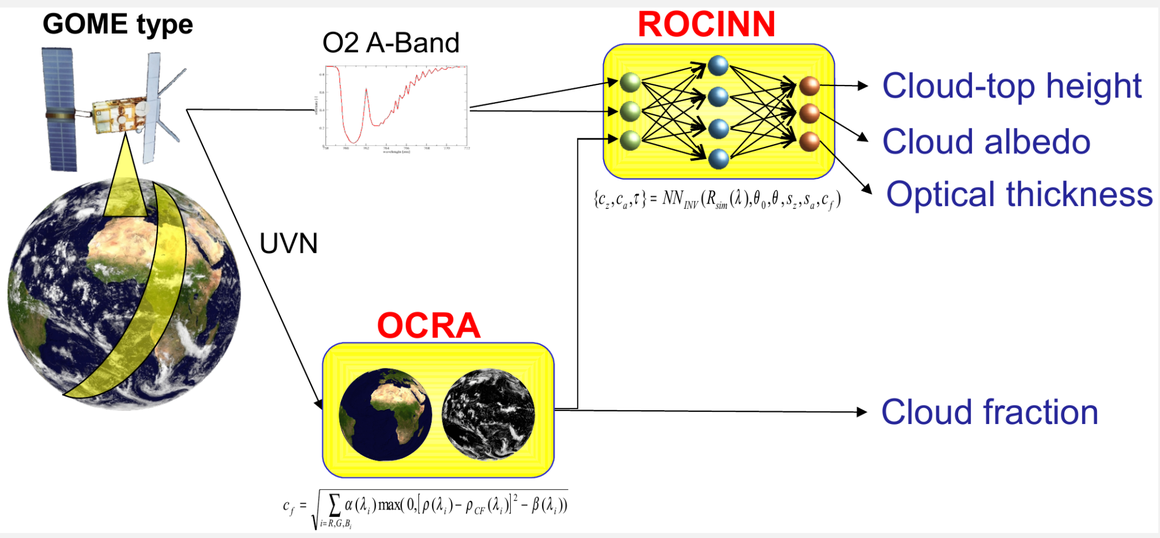
Introduction

- Precise cloud information is mandatory for accurate trace gas retrievals
- OCRA–ROCINN cloud retrieval algorithms operational for GOME-2 on Metop-A and -B and GOME on ERS-2
- **OCRA**: **O**ptical **C**loud **R**ecognition **A**lgorithm
- Cloud fraction (CF) retrieval using a RGB color space approach
- Main improvements in V3.0:
  - New corrections for PMD instrumental degradation
  - New corrections for scan-angle dependency and latitudinal dependencies
  - Improved sun-glint flagging and removal & retrieval over snow/ice
- **ROCINN**: **R**etrieval **O**f **C**loud **I**nformation through **N**eural **N**etworks
- Retrieval of cloud height (CH), cloud albedo (CA) and cloud optical thickness (COT)
- Two cloud models used in ROCINN V3.0:
  - **CRB**: **C**louds as **R**eflecting **B**oundaries
  - **CAL**: **C**louds **A**s scattering **L**ayers
- Main improvements (see talk of S. Gimeno Garcia on 10.06.)
  - New corrections for O_2 A-band instrumental degradation
  - New inversion scheme: Tikhonov regularization for CRB & CAL

OCRA–ROCINN cloud retrieval algorithm

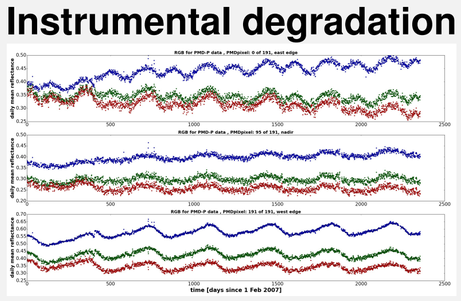


- OCRA divides a scene into a cloud free background and a contribution due to clouds

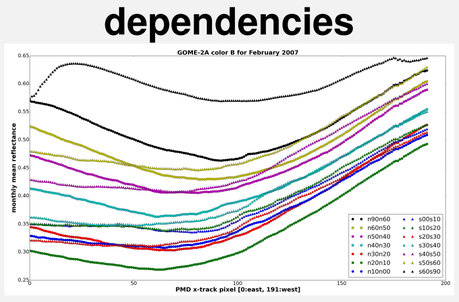
Reflectance corrections

- Correction factors are calculated as function of time, λ-band, latitude and viewing zenith angle (VZA)

Instrumental degradation



Scan angle and latitudinal dependencies

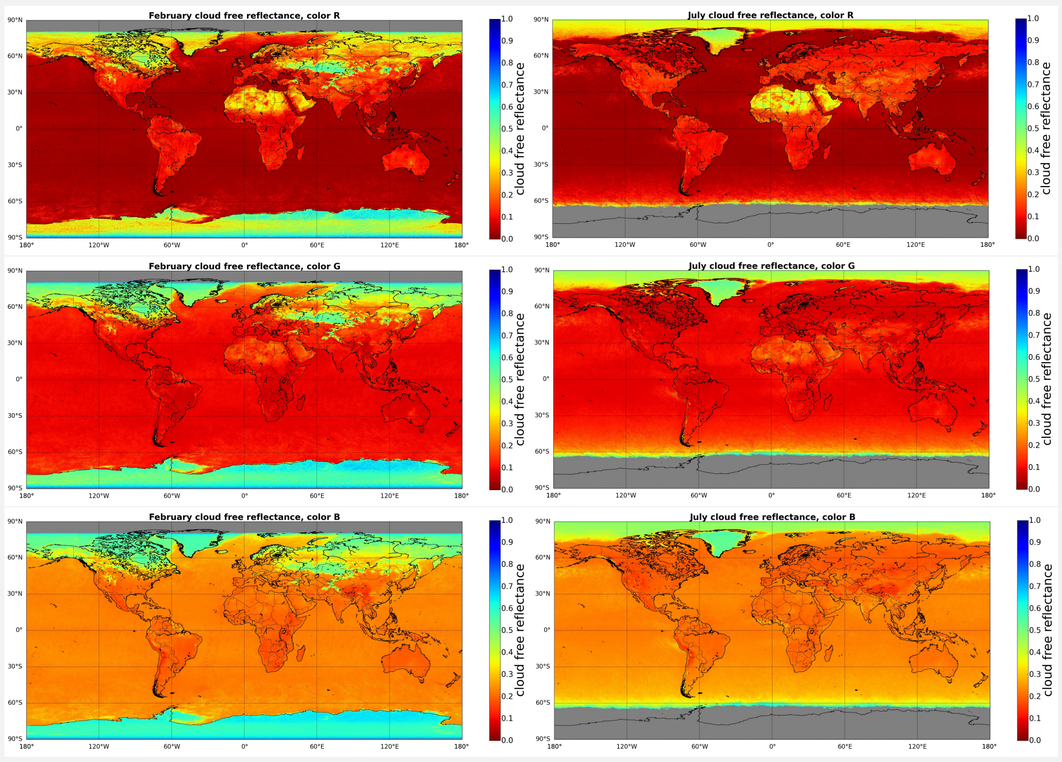


- 3rd order polynomial for long term degradation (left)
- 4th order polynomial for scan angle and latitudinal dependencies for each month of the mission (right)

OCRA cloud fraction

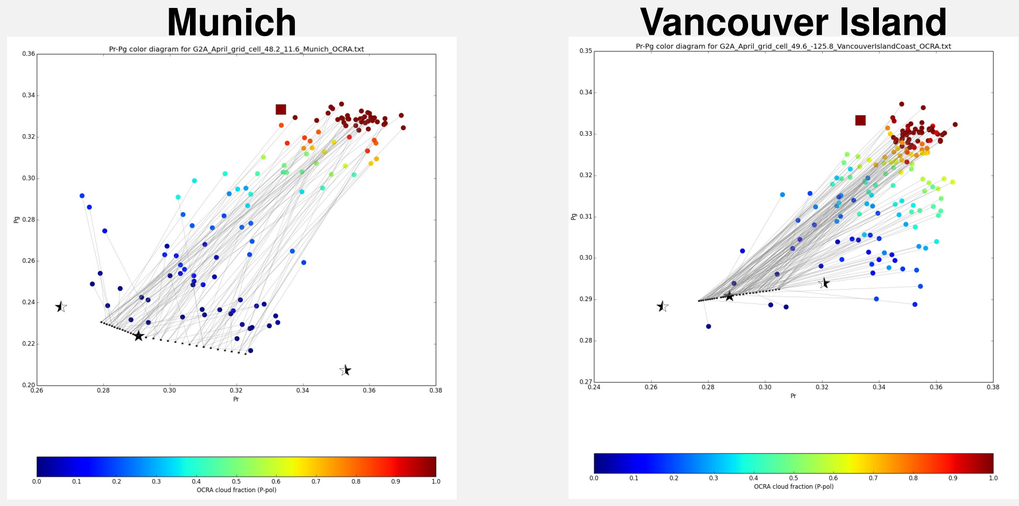
- Inputs: measured reflectance and cloud free reflectance
- $f_c = \sqrt{\sum_{i=R,G,B} \alpha(\lambda_i) \cdot \max\left\{0, \{\rho(\lambda_i) - \rho_{free}(\lambda_i) - \beta(\lambda_i)\}\right\}^2}$
- measured reflectance $\rho = \frac{\pi \cdot I}{I_0 \cdot \cos\Theta_0}$
- cloud free reflectance ρ_{free} from cloud free maps (see top right panel, maps available for each month of the year)
- scaling factor $\alpha(\lambda_i) = \frac{1}{(\rho(\lambda_i) - \rho_{free}(\lambda_i))^2_{0.99}}$ via histogram analysis
- offset $\beta(\lambda_i) = (\rho(\lambda_i) - \rho_{free}(\lambda_i))_{\text{mode}}$ via histogram analysis

Cloud free background



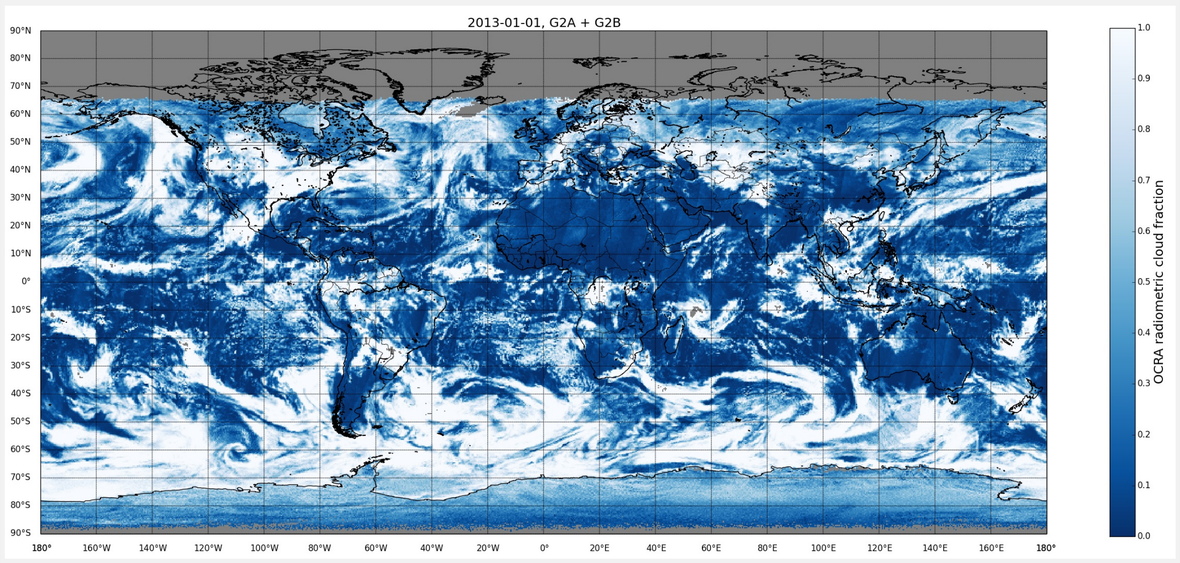
- TOA cloud free reflectance background maps with 0.2 degree resolution for February and July for colors RGB: Red (569-804 nm), Green (400-557 nm), Blue (321-384 nm)

Normalized rg-color diagrams



- GOME-2A PMD measurements from 2007 to 2013 for the month April for a 0.2 x 0.2 degree grid cell near Munich (left) and Vancouver Island (right)
- Each measurement (dot) is connected with its corresponding cloud free value (star) and color coded with its resulting OCRA cloud fraction. The red square marks the white-point at (1/3,1/3)

OCRA cloud fraction map (GOME-2 A/B)



Summary

- OCRA uses a RGB color space approach, which can easily be adapted to other sensors. Cloud free maps and CF have also been calculated for the Ozone Monitoring Instrument (OMI)
- OCRA will be used for the operational TROPOspheric Monitoring Instrument (TROPOMI) cloud fraction.