ATSR CLOUDS

Global Retrieval of clouds And Product Evaluation-GRAPE

Caroline Poulsen, Richard Siddans, Barry Latter and Brian Kerridge, Chris Mutlow, Andy Sayer\(^2\), Chris Arnold\(^2\), Don Grainger\(^2\)(PI), Gareth Thomas\(^2\), Elies Campany\(^3\) and Phil Watts\(^1\)

Space Science and Technology Department
Rutherford Appleton Laboratory
UK
1. **Now at EUMETSAT**
2. **University of Oxford**
3. **Now at NASA GISS**
A climatology of cloud properties from ATSR

- ATSR instrument
- Cloud Measurements
- Intercomparison
- Applications
- Conclusions and Future
Time line of ATSR (vis/nir and IR) instruments

channels: 0.55 0.67 0.86 1.6 3.7 11 12 (1.38 2.25)
ATSR Channels and retrieved parameters

Optimal Estimation aims to use all channels together

ATSR SLSTR
- 0.55 µm
- 0.67 µm
- 0.87 µm
- 1.6 µm
- 3.7 µm
- 11 µm
- 12 µm
- 1.38 µm
- 2.25 µm

Cloud Parameters Retrieved
- Cloud top pressure/height
- Cloud fraction
- Cloud optical depth
- Cloud effective radius
- Cloud phase

From the above retrieved parameters we derive
- Cloud liquid water path
- Cloud ice path
ATSR cloud algorithm-Optimal Estimation

- Quality control check of the goodness-of-fit on the solution (retrieval ‘cost’).

\[ J = [y_m - y(x_n)] S_y^{-1} [y_m - y(x_n)]^T + [x_n - x_b] S_x^{-1} [x_n - x_b]^T \]

- Estimates of the uncertainty on retrieved parameters.

\[ S_{\text{solution}} = J''_{\text{solution}} = (S_x^{-1} + K^T S_y^{-1} K)^{-1} \]

- Use of a priori information on the surface and atmospheric state.

  - Here, MODIS data are used for the surface albedo and ECMWF for the atmospheric profile.
Cloud optical depth

Cloud optical depth at 550 nm
Cloud effective radius, pressure, phase
Cloud top temperature and Optical depth
Time series of global averages ±70°

Data plotted for spatially coincident ATSR and MODIS
Cloud liquid water path
Comparison of effective radius of water clouds
Indentifying ship tracks

Publication: Elies Campany et al.
ACP, 2009.
Evidence of indirect effect in cloud tracks

- **Relative cloud optical depth**
  - Graph showing the relative value decreasing as the distance from the nearest track pixel increases.

- **Relative cloud effective radius**
  - Graph showing the relative value increasing as the distance from the nearest track pixel increases.
Conclusions

• First climatology of cloud properties available from ATSR-2
• Processing of AATSR data underway with same algorithm
• Data available from:
  – http://badc.nerc.ac.uk/data/grape/
• Optimal Estimation also provides errors on retrieved properties
• Cloud properties evaluated by comparison with ground based and satellite
  – Performance is competitive and already providing new information.
• Results are being compared with other climatologies through Gewex
Future developments

– Multi layer Algorithm developments in progress
– Posthoc selection of cloudy scenes
– New representation of ice crystal properties
– Utilisation of forward view
  • Inclusion in current framework
  • Stereo cloud top height information (PhD UCL)
– Synergy with MERIS
Spatial and Temporal Patterns in Cloud Properties in the ASTR-2 Grape Dataset

Introduction
The Global Assimilation of ASTR Cloud Assessment (GACAS) project aims to validate and evaluate cloud models by comparing them with retrievals from the ASTR-2 satellite. The project focuses on two main cloud properties: occurrence and vertical extent of cloud. A new dataset, ASTR-2 Grape, was created to assess the cloud occurrence and vertical extent over the African region.

Cloud Occurrence
Time series of cloud occurrence across the African region shows a clear pattern of seasonal variation. During the wet season, cloud occurrence is higher, while it is lower during the dry season. The ASTR-2 Grape dataset provides a comprehensive view of cloud occurrence across the region, enabling a better understanding of cloud dynamics.

Further information:
http://www.atmosphericphysics.org
http://astr-2.grape.net

Cloud Vertical Extent
The ASTR-2 Grape dataset includes information on cloud vertical extent, which is crucial for understanding the impact of clouds on climate. The dataset provides detailed information on cloud top heights, allowing for the assessment of cloud vertical extent across different regions.

Using forward-view data from ASTR-2
The ASTR-2 satellite provides forward-view data, which is particularly useful for studying cloud properties in the lower atmosphere. The dataset includes information on cloud top temperatures and water vapor content, which are essential parameters for understanding cloud microphysics and their effect on the Earth's radiation balance.

This information is critical for improving climate models and understanding the complex interactions between clouds and the Earth's atmosphere.
Monthly animations of cloud retrievals

Cloud fraction 1996-2001

Cloud top temperature 1996-2001

Cloud optical depth 1996-2001
Modelling multi layer cloud

- OCA-Optimal Cloud Analysis code for SEVIRI cloud retrievals used to test multi layer cloud model
- Validated with Cloud sat and Calipso data
Time series in the North Atlantic Ocean

Cloud fraction
Cloud effective radius
Cloud optical depth
Cloud top pressure
Cloud top temperature
Time series over Europe

- Cloud fraction
- Cloud effective radius
- Cloud optical depth
- Cloud top pressure
- Cloud top temperature
Utilising the forward view of ATSR

C. Arnold PhD

PDF of cloud top pressure

N

Normalised number of points

Cloud top pressure (Pa)

Nadir view
Forward view
Seasonal patterns in cloud data

Averages are over sea and land
Cloud fraction

Comparison of ATSR-2 with MODIS (collection 5:MOD08_M3)

• ATSR-2 data quality controlled & smoothed over sea