MSG Cloud Physical Properties

retrieval and visualization

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The MSG-CPP Project

Goal:

Provide an operational service for all products that are derived from the Meteosat Second Generation Cloud Physical Properties algorithm and make them user friendly available on the internet

- Started in July 2010
- W-OND as customer & funder with KS-AK co funding
- Project members from all 3 KNMI sectors:
  (Research > Development > Operations)
- Procured hardware is placed in the Richardson computer center
- Functional and technical maintenance is placed at I-ID and I-ICT
- Processing of the complete mission is in progress
- Portal in place with free access to the data

http://msgcpp.knmi.nl/
Acknowledgements

- Rob Roebeling (EUMETSAT, Darmstadt)
- Hartwig Deneke (IfT, Leipzig)
- Seethala Chellappan (Scripps, San Diego)
- Erwin Wolters (KS-KA)
- Wouter Greuell (KS-AK)
- Brent Maddux (KS-AK)
- Paul de Valk (W-PPI)
- Ian van der Neut (I-RD)
- Ernst de Vreede (I-RD)
- Robert van Versendaal (I-ID)
- Arthur Knopper (I-ICT)
- Henk Kalle (I-ICT)
- Jasper Spit (I-ICT)
- Joeri Mastop (I-ICT)
- Hans den Braber (I-ICT)
Overview

• Part 1: Observations (Jan Fokke)
  – Introduction
  – Satellite & Retrieval algorithm
  – Validation
  – Applications

• Part 2: Visualization (Maarten)
  – The Open Geospatial Consortium
  – Web Map Service (WMS)
  – Network Common Data Form (NetCDF)
  – Netherlands Atmospheric Data Center (NADC)
  – Demonstration
Clouds in the climate system

Global Energy Flows W m$^{-2}$

Cloud properties

Surface incoming solar radiation

K. Trenberth
SEVIRI

- MSG: Meteosat 8 + 9
- 2004-present
- Channels:
  - 3 VIS/NIR
  - 8 IR
  - 1 HRVIS
- Nominal spatial resolution: 3x3 km²
- Temporal resolution: 15 minutes

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CPP algorithm overview

SEVIRI radiances: 0.6; 0.8; 1.6; 3.9; 8.7; 10.8; 12.0 µm

cloud mask

cloud top height

ancillary data: surface reflectance, total column water vapour, ...

DAK radiative transfer model \(\rightarrow\) look-up tables

cloud phase, optical thickness, effective radius, liquid/ice water path

liquid water clouds

cloud droplet number concentration, geometrical thickness

precipitation occurrence and rate

surface incoming solar radiation global / direct / diffuse
Validation

- Liquid Water Path (LWP)
- Precipitation
Validation LWP: Europe

ground-based Microwave Radiometer (MWR)

Roebeling et al., GRL, 2008

http://msgcpp.knmi.nl/
Validation LWP: West Africa

Overall:
Accuracy: \(\sim 15 \text{ g m}^{-2}\)
Precision: \(\sim 25 \text{ g m}^{-2}\)
Validation LWP: marine stratocumulus clouds

Seethala Chellappan, 2011
Inter-comparison LWP with MODIS

Overall: Bias: ~20%  Std.dev.: ~20%
Validation: precipitation (triple collocation)

- E-OBS gridded dataset (≈5000 rain gauges)
- SEVIRI retrievals (1 satellite)
- Radar composite (≈194 European radars)
Validation: precipitation

- Reasonable spatial correlation SEVIRI with rain gauges (E-OBS)
- Weather radar spatial inconsistency: different radar types / retrieval algorithms

Roebeling et al., submitted to J. Hydromet.
Applications

- GCM evaluation
- Climatologies
- Process studies (e.g., cloud-aerosol interaction)
- Nowcasting
- Data assimilation
Applications

- **GCM evaluation**
- Climatologies
- Process studies (e.g., cloud-aerosol interaction)
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Evaluation regional climate model RACMO

Top-of-atmosphere Albedo

MSG/GERB  

RACMO

RACMO – GERB

Greuell et al., J.Clim., 2011
Evaluation RACMO

Cloud Cover

MSG/SEVIRI

RACMO

RACMO – SEVIRI

Greuell et al., J.Clim., 2011
Evaluation RACMO

Greuell et al., J.Clim., 2011
Applications

- GCM evaluation
- **Climatologies**
- Process studies (e.g., cloud-aerosol interaction)
- Nowcasting
- Data assimilation
Climatological maps: surface solar radiation

2005-2009

SEVIRI

kJ/cm²

Langjarig gemiddelde 1981-2010
Gemiddelde jaarlijkse hoeveelheid globale straling

klimaatatlas

Brent Maddux, 2011

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Climatological maps: precipitation

2005-2009

SEVIRI mean rain rate (mm/hr)

Klimaatatlas accumulated precip (mm/yr)

Brent Maddux, 2011

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Data access with OGC Web Services

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What are webservices?

- Many things are webservices!
  - SOAP, REST, WSDL

- From Wikipedia:
  - A web service is typically a Web API that is accessed via HTTP and executed on a remote system

This presentation will be about Webservices from the

Open Geospatial Consortium (OGC)
(webservices for geographical data)
Introduction to OGC services

- OGC – Open Geospatial Consortium
  - currently ~450 organizations
  - standards for geospatial content and services
  - GIS data sharing and processing

- Services used within the ADAGUC project:
  - ADAGUC: Atmospheric Data Access for the Geospatial User Community, was finished in 2009
  - Web Map Service (WMS) - for images
  - Web Feature Service (WFS) - for vector data (features)
  - Web Coverage Service (WCS) - for raster data (coverages)

- WMS is primarily for visualization

- WFS and WCS are for getting the data
Web Map Service - WMS

- A WMS is used to generate visualizations of geospatial data in the form of 2D images suitable for transfer over the World Wide Web.

![Map Image](image-url)

2 metre temperature (K)
Web Map Services: From data to images

- NetCDF Data (big, 5.5Gb)
- PNG images (small, 180Kb)
- Combined geographically

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Example: Meteosat and radar

- **Meteosat HRVIS:**
  - Satellite view projection
  - Resolution: 3520 x 4660

- **Radar precipitation:**
  - Polar stereographic projection
  - Resolution: 700 x 765
Combined in Dutch Rijksdriehoekstelsel projection

Dutch Rijksdriehoekstelsel
Resolution: 1000 x 605
Web Map Service Requests

Server

Client

GetCapabilities

GetMap

GetLegendGraphic

GetFeatureInfo

(HTTP GET requests)

Cloud Top Temperature (K)

ctt = air temperature at cloud top

2012-03-18T10:41:00Z: 221.8 K

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KNMI WMS Viewer (ADAGUC)

- WMS GetCapabilities
- WMS GetMap
- WMS GetFeatureInfo
- WMS GetLegendGraphic
Web Coverage Service - WCS

- Similar to WMS, but returns *data* instead of images
  - Returns observations in a regular spaced grid in many projections
  - Generates data in geotiff, ascii, netcdf 3/4, HDF5, etc...

Web Map Service: *images*

Web Coverage Service: *data*
ADAGUC: Server, viewer and data standard

Server

- Web Map Service
- Web Coverage Service
- Contouring, shading, vectors
- Dimensions: time, pressure, ...
- PostgreSQL, GDAL, Cairo, GD, Proj
- C++

http://adaguc.knmi.nl/
Used data format: ADAGUC - NetCDF4-CF

- NetCDF4 with Climate and Forecast conventions (CF conventions)
  - Standard names, standard units
  - Identify and compare data
  - Self describing data
  - ISO19115

NADC Processing Suite

Netherlands Atmospheric Data Center (NADC) is an in-house data & processing handling system developed for various satellite instrument missions like Sciamachy, OMI, Gome2 to generate KNMI products.

NADC is capable of:
Handling multiple data sources, combine them in higher order products by user defined and flexible processing rules and archiving strategies and disseminate these to external parties. All these aspects are being performed in the context of: in an as fast as possible manner, via maintenance user interfaces, and a robust implementation on hardware, data and control level.
MSG-CPP processing chain at KNMI

System is running on 8 dedicated HP blades in high availability configuration
MSG-CPP data can be accessed freely by:

- NetCDF Data Archive
- ADAGUC
- OGC
- THREDDS
- OpenDAP
- WMS
- WCS
- FTP
- unidata
- esri
DEMO

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