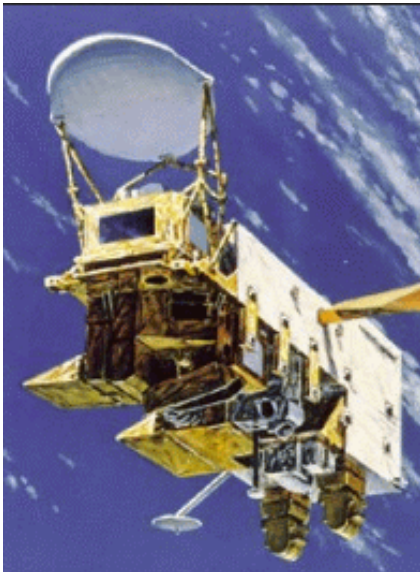


Use of satellite data for climate characterization

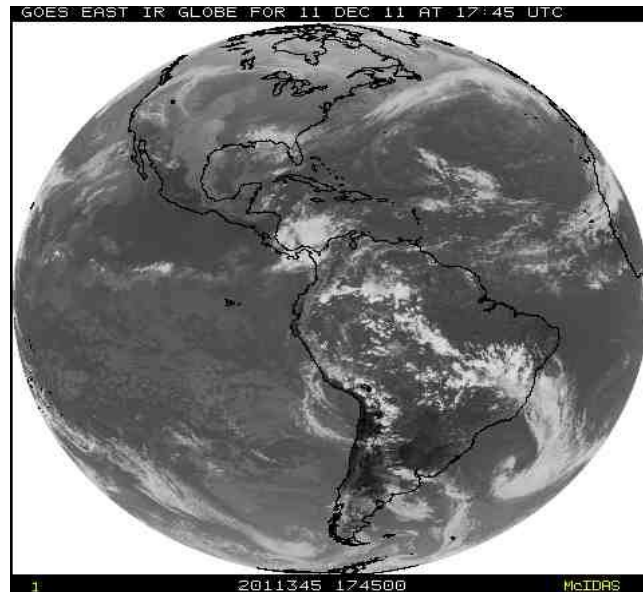
Petr Janeček, Institute of Physics, Prague

Polar



MODIS:
Both sites

Geostationary



GOES (South, West, East):
Armazones



METEOSAT:
La Palma

Geostationary vs. polar satellites

Polar satellites:

- much closer to the Earth, better resolution, possibility of use of wider range of instruments (e.g. lidars)
- but – typically only one or two data points per day, and thus poor temporal resolution

Geostationary satellites:

- far away – poorer resolution, limited range of instruments (multi-band imagers)
- but – very good temporal resolution (e.g. Meteosat takes one image per 15 minutes) and very wide field of view

GOES

Two data sources:

- **Space Science and Engineering Center (SSEC)**, Univ. of Wisconsin-Madison
- **ESO**, provided by Marc Sarazin from ESO, based on custom-made weather forecast code used at ESO in Chile, developed by **Andre Erasmus et al.** during ~2000-2004, uses extra information about temperature and pressure data from the **ECMWF global NWP model**

GOES ESO

The screenshot shows the ECMWF (European Centre for Medium-Range Weather Forecasts) website. The main content area displays a satellite image of a weather system over Europe, dated 2013.05.10 11:45 UTC. The image shows a large, dark, swirling cloud mass over the Atlantic and Europe. Two labels, 'o Paranal' and 'o La Silla', are visible on the right side of the image, indicating the locations of the ESO observatories. The website's navigation bar includes links for Home, Your Room, Login, Contact, Feedback, Site Map, and Search. The sidebar contains sections for Info (Site Map, Phone Directory, Contact, Feedback), News & Events (Calendar, Training, Annual Seminar, Meetings, Workshops, Press Releases, Employment), and Forecasts (Free access to deterministic medium-range (3-6 days) weather).

<http://www.eso.org/gen-fac/pubs/astclim/forecast/meteo/ERASMUS/>

GOES ESO

- provided by Marc Sarazin from ESO
- custom-made weather forecast code used at ESO in Chile
- realized by Andre Erasmus in ~2000-2004, unmaintained and rather a black box; fairly complex code (30k lines of c++ code in > 130 files)
- not only the satellite data: *Erasmus' model uses extra input from the ECMWF global model*
- forecast every 3 hours (GOES data), ECMWF model every 6 hours

GOES ESO cloud coverage analysis:

- resolution – default **circular area with 20 sub-pixel radius**, sub-pixel is one half of the pixel ($\sim 2 \times 2$ km)
- very large area! (80 km diameter)
- (we had to use smaller one for our analysis due to problems with misidentified surface features)
- extra information from ECMWF data: temperature at 400, 500, 600 mBar, surface pressure, saturation vapor pressure (based on temperature)
- modification to provide **coverage for Armazones** already **possible** (done for the site selection work)

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GOES SSEC

- **SEC archive contains only “mapped” products with 10 x 10 km resolution per pixel** (all products ranging from cloud masks through cloud types and temperatures up to cloud albedo and AOD potentially available) – *one measurement per hour (but sometimes only one measurement every 3 hours)*
- *data for years 2008-2012 for South America and also 2008-2012 for North America – unfortunately, significant systematic offsets at night*

METEOSAT

- **Resolution down to 3x3 km per pixel** (full-resolution of SEVIRI imager), **1 hour time resolution**
- for the site selection work, regional subsets of data around the candidate sites kindly provided by Deutsche Wetterdienst (DWD) – CM SAF project: 1 pixel, 3x3 pixels, 5x5 pixels and 7x7 pixels
- **good** agreement for East sites (Tenerife. . . try La Palma?)
- Paranal, Armazones etc. – edge of FOV, parallax

MODIS

Cloud products (and water vapor products) from the public archive

Long time series (since **2000 for MODIS Terra, since 2003 for MODIS Aqua until Jun 2013**) available

Full resolution of the satellite – 1 km at nadir

However: **Cloud product resolution – only 5 km x 5 km** at nadir (*cloud fraction in percent available, contains information from single pixels, thus steps by 4 percent*)

Typically **two data points per night**

Data validation & lessons learned from site selection

- the satellite data products are less reliable than we have initially expected
- the typical analysis is tuned for lowland areas around cities, and without the visual channel it can easily fail during night-time in mountainous area
- **the cross-check with the ground-based monitoring devices is thus essential**
- for the satellite data we have used **validation using All-sky cameras**
- after toy MC simulations (John Carr) we have set the threshold for **required agreement on simultaneous data on 70%**
- **pragmatic approach**: do not bother too much with potential problems (e.g. high inclinations, surface features) – **if data pass the validation cut, just use them**