Use of satellite data for climate characterization

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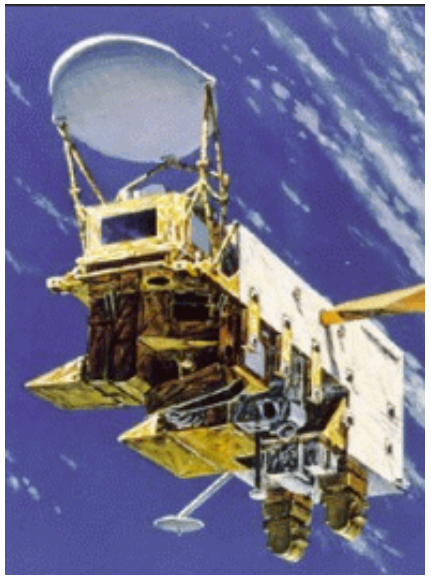
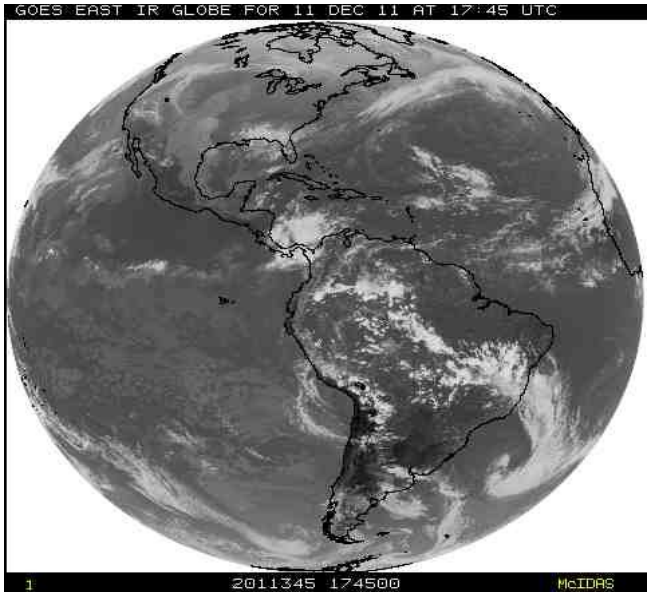
Polar

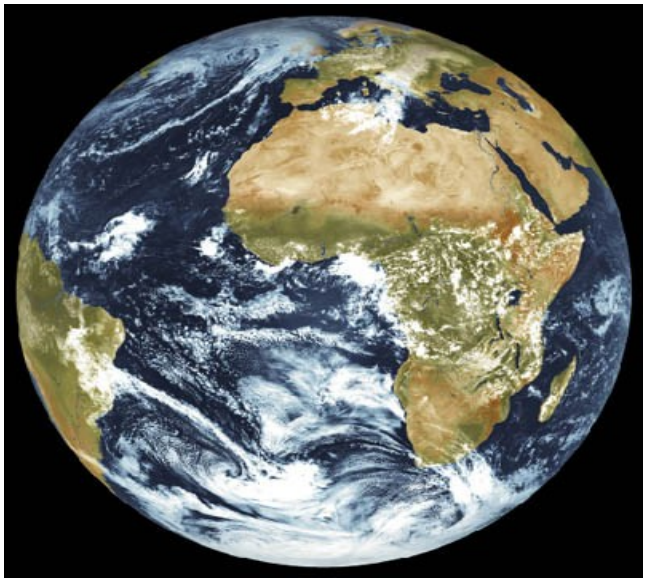


MODIS:
Both sites

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)

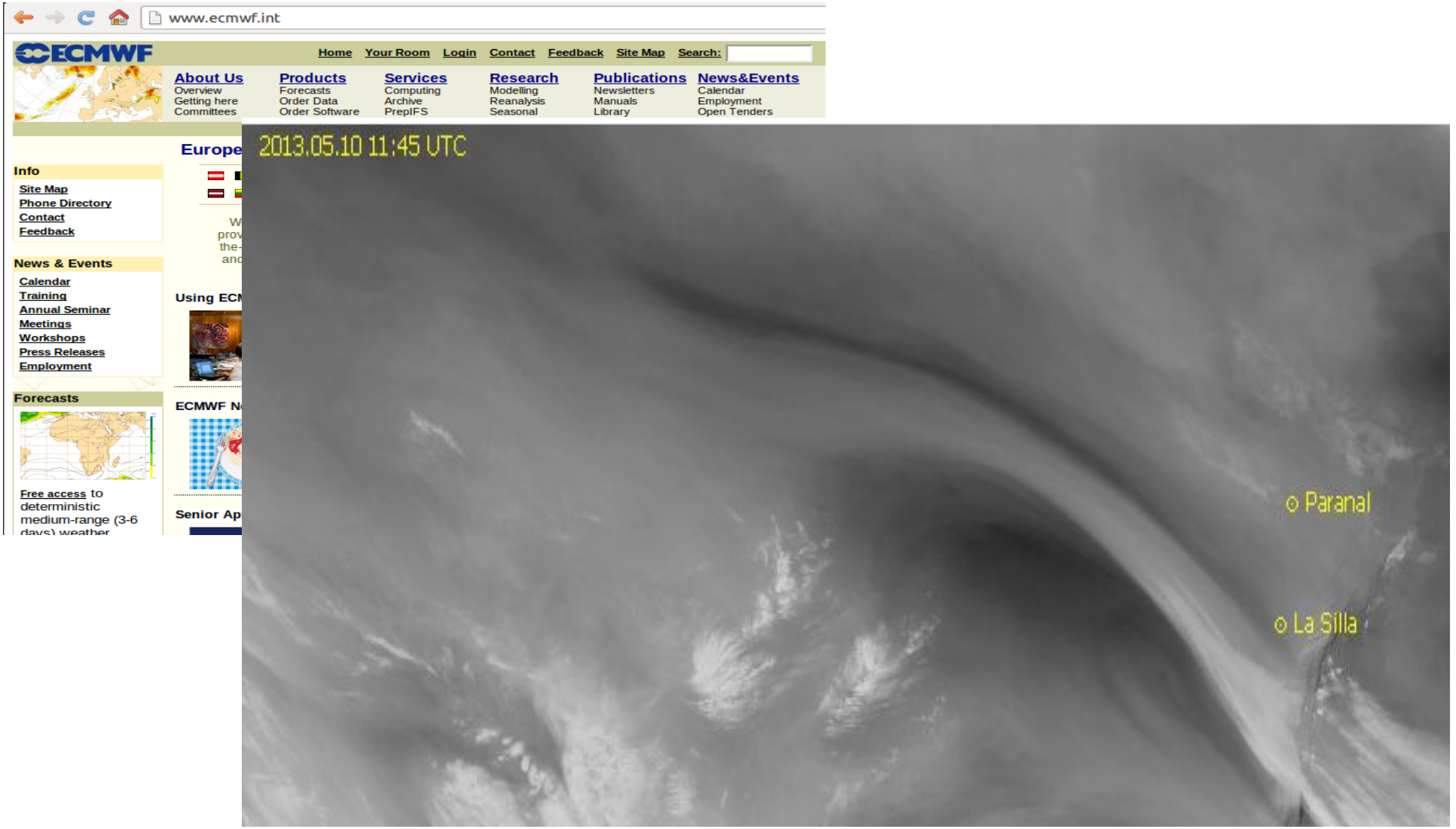
– but – very good temporal resolution (e.g. Meteosat takes one image per 15 minutes) and very wide field of view

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



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 (~ 2 x 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)

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 then 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**