Cloud detection using SEVIRI IR channels for the GERB processing

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Overview

Motivations

Constraints

Algorithm
- Physics
- Assumptions
- Scheme
- Initialization

Comparisons

Further work

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- GERB is a broadband radiometer measuring TOA radiances in SW and TW
- Processing based on radiance–to–flux scheme using CERES TRMM ADMs (solar)
- ADM selection by basic SEVIRI scene identification (surface, CM, CP & COD)
- GERB scene identification only relying on visible channels
- Visible SEVIRI bands affected by sun glint over ocean

▶ Degraded cloud mask within sun glint area
▶ Cloud mask unavailable at night time

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Constraints

- GERB is an operational service (EUMETSAT)
- GERB & SEVIRI measurements every 15 min.
- GERB processing must run in near real–time
- GERB aim is to study climate
- GERB products must remain stable

- Limited use of *uncontrolled* ancillary data (NWP)
- Use of persistent SEVIRI channels during day & night for temporal stability

- Implementation of an IR cloud detection scheme instead of using MPEF or NWCSAF

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Physics

- SEVIRI IR 10.8, 8.7 & 12.0 μm channels are the most sensitive to clearsky & clouds
- Clouds are characterized by lower radiances (temperatures) than clearsky surfaces (warmer) except for snow & sea ice surfaces
- Aerosols are *generally* lowering IR radiances
- IR radiances are varying with viewing zenith angle, history (precipitation, cloud shadow) and state of atmosphere (profiles)

Assumptions

- Considering time–series of pixel–based BTs
- Temporal window for time–series is set to 60 days
- Samples in time–series can be grouped into 3 classes:
  1. thick cold clouds (low BTs)
  2. thin or low clouds (high BTs)
  3. clearsky conditions (highest BTs)
- Tails of upper classes are overlapping
- No realtime ancillary data such as NWP fields

► Cannot be applied to snow & sea ice surfaces

Scheme

- Perform a *modified* k–means clustering:

  1. Initialize the μ_n and σ_n for the 3 clusters
  2. If initialization fails goto step 1 with 2 clusters and so on...
  3. Classify all 60 BTs according to their nearest cluster with $d(T, \mu_n, \sigma_n)$
  4. Update μ_n and σ_n
  5. Repeat from step 3 until all μ_n do not significantly change ($\Delta\mu_n < 0.01$ K)

- ▶ Metric $d(T, \mu_n, \sigma_n) = (T - \mu_n)^2/\sigma_n^2 + \ln \sigma_n^2$ if values in each class follow $p_n(T) = N(\mu_n, \sigma_n)$
- ▶ Initialization driven by physics (climatology)

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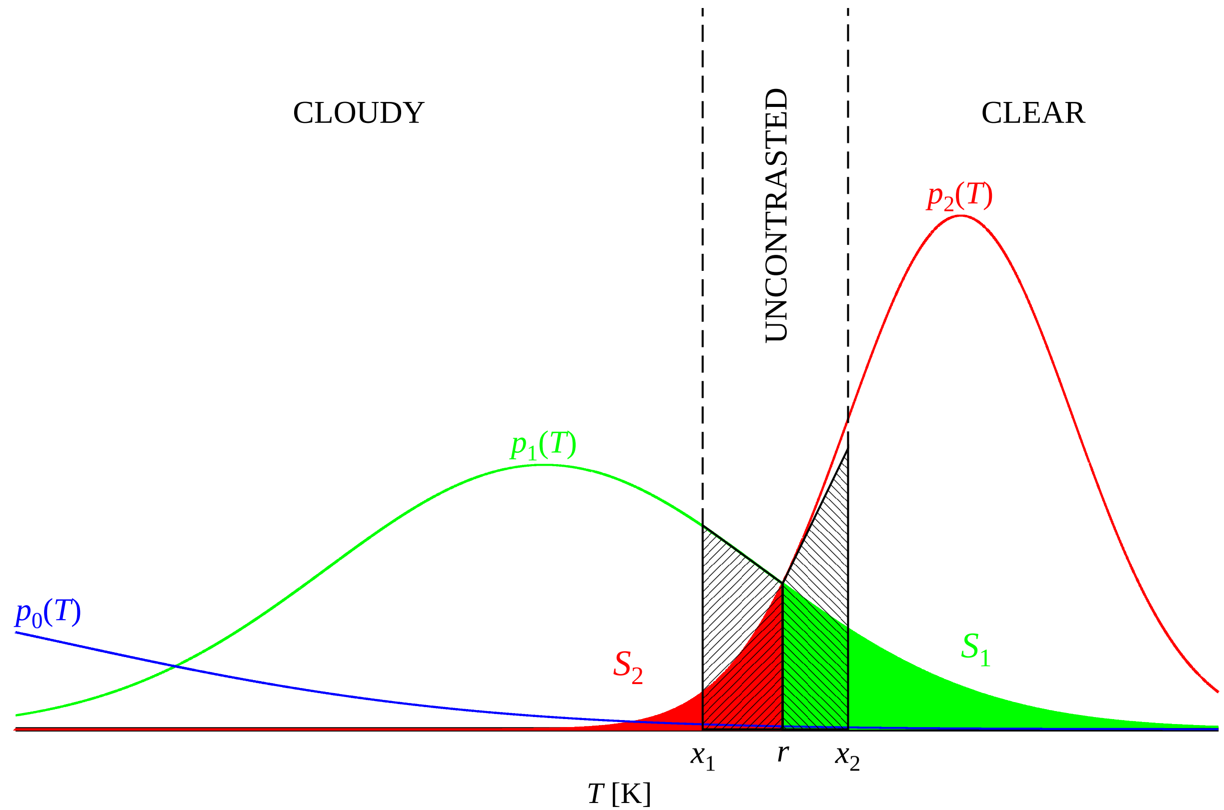
Final classification (of the most recent sample):



- Hashed surfaces are the probabilities of false rejections

Initialization

- Assume that clearsky class is Δ wide
- Cloudy classes evenly distributed over remaining T range
- Δ is only needed for starting the clustering
- Single cluster case associated to clearsky

Δ is estimated from climatology:

- 10 years of 6–hourly ERA–40 surface skin temperatures T
- Compute δ over 60–days period at pixel level
- Δ is set to the median of δ for pixels with the same surface type

Preliminary comparisons

- Reference is MPEF & NWCSAF common cloud mask during night time
- For March 11 2007 at 0:00 UTC* (86.90 %)

Band [μm]	3.9	8.7	10.8	12.0
POD [%]	90.69	90.94	90.49	88.02
fcl [%]	4.90	2.87	2.52	2.49
fCL [%]	1.64	2.24	2.59	4.24

- For March 17 2007 at 0:00 UTC (88.05 %)

Band [μm]	3.9	8.7	10.8	12.0
POD [%]	87.82	89.62	89.67	88.03
fcl [%]	7.03	3.06	2.26	1.89
fCL [%]	1.92	3.00	3.66	5.45

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- ECMWF surface skin temperatures should be converted to TOA temperatures according to atmospheric path
- Δ should be parametrized according to latitude for ocean and land
- Increase sensitivity to low water clouds (fronts): apply method to $T_{10.8} - T_{3.9}$?
- Merging of the individual channel cloud masks
- Length of time–series varying from pixel to pixel
- Use of asymmetrical distributions $p_n(T)$ instead of $N(\mu_n, \sigma_n)$
- Comparisons during day time