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climate change initiative

→ LAND SURFACE TEMPERATURE

Cloud detection stability for Land Surface Temperature Climate Data Records

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land surface temperature cci

Why is cloud detection stability important?

Cloud detection is a necessary pre-processing step for infrared LST data records:

- LST can only be retrieved in the infrared for clear-sky scenes
- Any undetected cloud will affect the retrieved land surface temperature
- Cloud detection is imperfect, so there will always be some cloud contamination

Any changes in the cloud detection performance over time could therefore cause changes in LST with time:

- This is important when we want to observe the climate signal
- Cloud detection algorithms often vary from sensor to sensor
- There may be step changes between sensors or trends in LST during the lifetime of a sensor that are the result of changes in cloud detection performance.

Single Sensor Infrared LST CDR: (split-window retrieval algorithm)

ATSR-2

data.globalchange.gov

+

AATSR

data.globalchange.gov

+

MODIS Terra

https://ioccg.org/sensor/modis-terra/

+

SLSTR-A

https://sentinels.copernicus.eu/web/sentinel/user-guides/sentinel-3-slstr/overview

2000 2005 2010 2015 2020

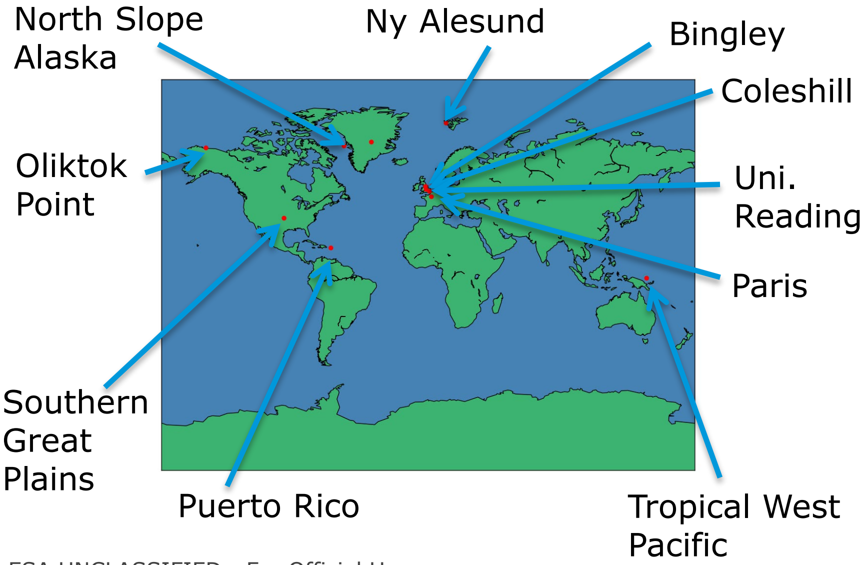
08/1995 08/2002 04/2012 08/2016 12/2020

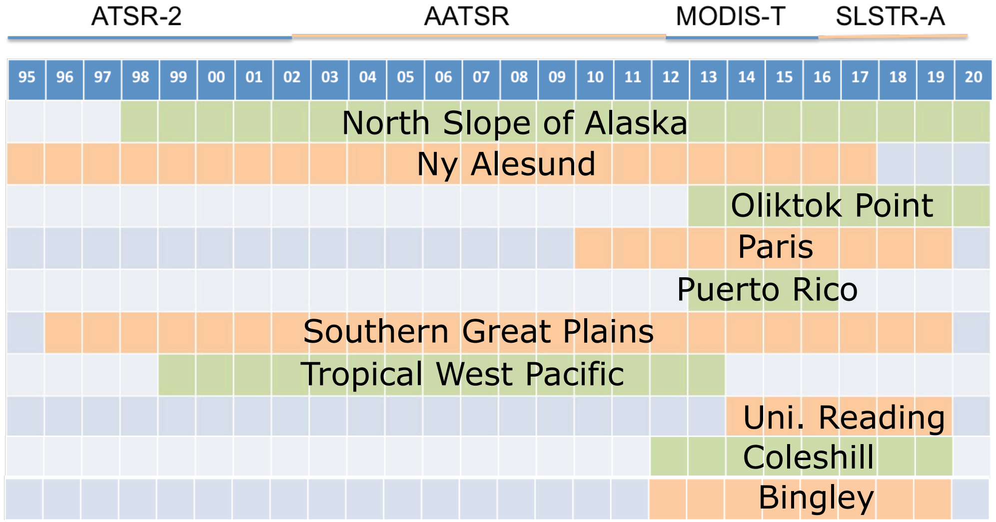
Cloud Detection Algorithms

	Bayesian	Probabilistic	Operational
Type	Full Bayesian	Naive Bayesian	Threshold
Channels (day)	0.6,0.8,1.6,11,12 μm	11,12 μm	Most available (sensor dependent)
Channels (night)	3.7,11,12 μm	11,12 μm	Most available (sensor dependent)
Radiative Transfer	RTTOV 12.3	RTTOV 12	-
Application	All sensors	All sensors	SADIST: ATSR-2,AATSR MOD35: MODIS Basic: SLSTR
Developer	University of Reading	University of Leicester	RAL, NASA

Ceilometer Data

Cloud base height from ceilometer data can be used to assess satellite cloud mask performance.





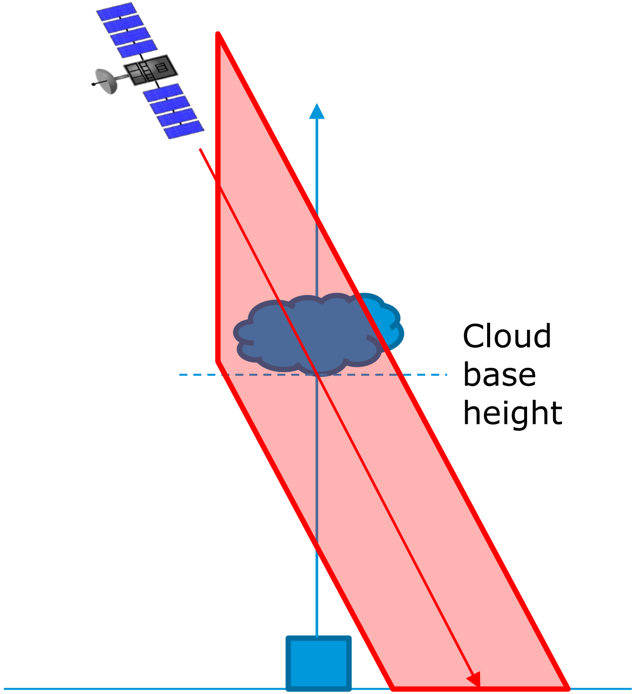
Satellite data are matched to ceilometer:

- Within 1 km
- Within 5 mins

Data matching

Matching satellite and ceilometer data:

- The ceilometer looks straight up and provides the cloud base height of the lowest cloud level in view.
- The satellite viewing geometry means that the atmospheric path observed by the satellite is often at an oblique angle with reference to the ceilometer.
- We match the satellite pixel in which the cloud is observed to the ceilometer observation.



Cloud masking consistency in sensor overlaps

How consistent is the performance of the operational cloud masks between sensors?

Can we improve on this?

Hit Rate: percentage of cloudy ceilometer pixels correctly identified as cloud by the satellite cloud screening algorithm

Sensor overlaps:

ATSR2/AATSR: 09/2002 - 03/2003

AATSR/MODIS: 02/2011 - 03/2012

MODIS/SLSTR: 06/2016 - 07/2017

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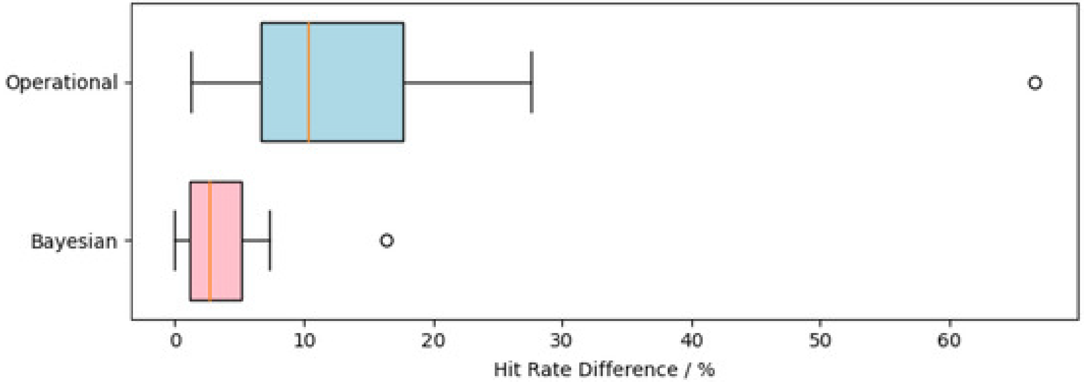
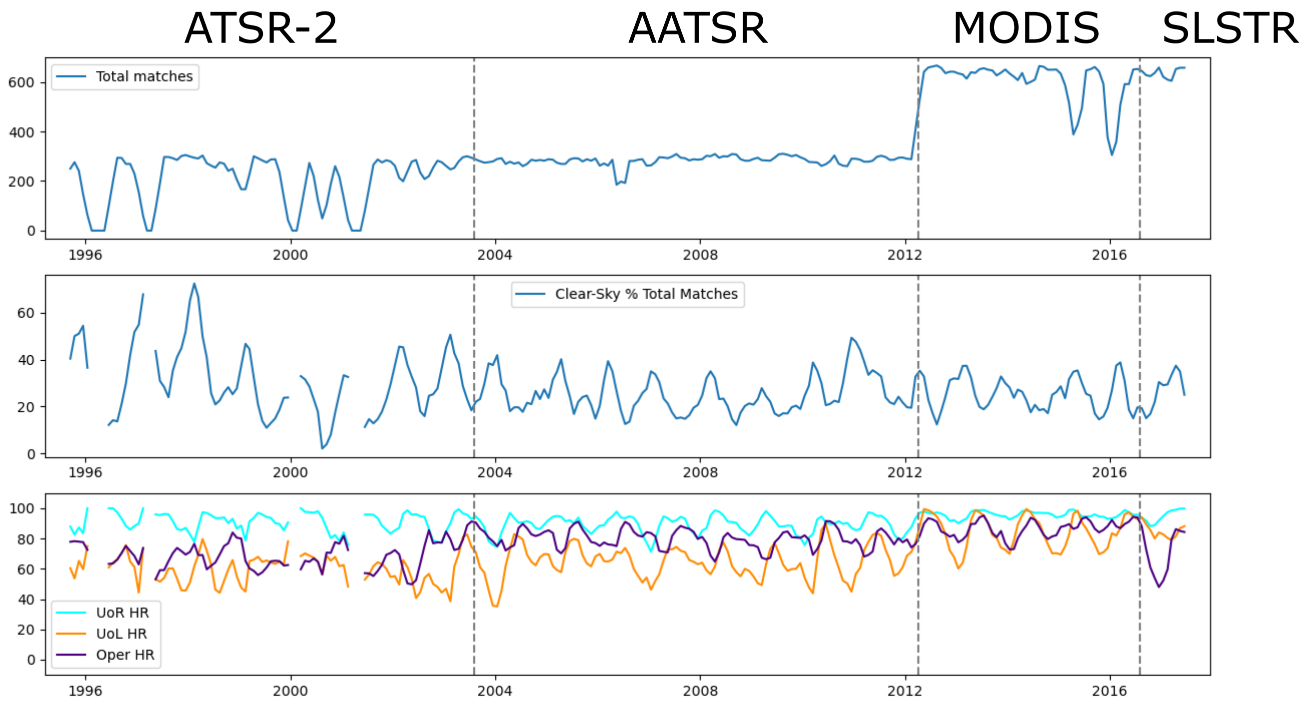


Ny Alesund, Norway

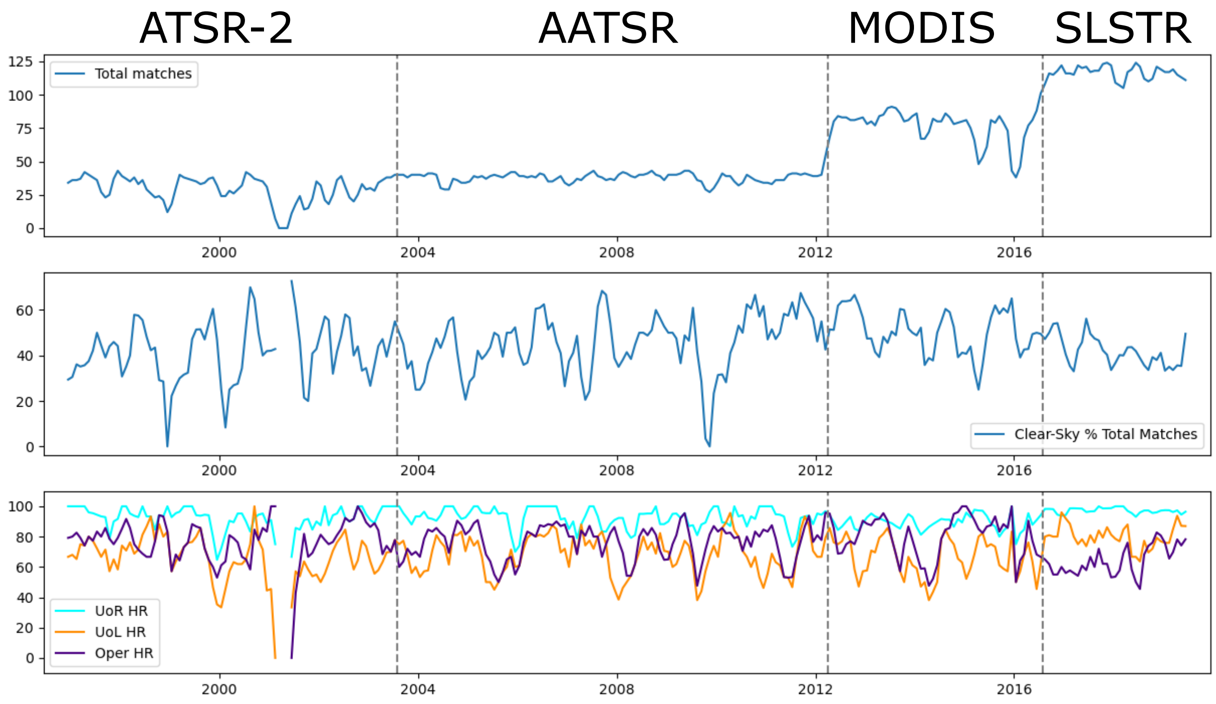
- 3-month rolling means



Timeseries analysis (2)

Southern Great Plains, USA

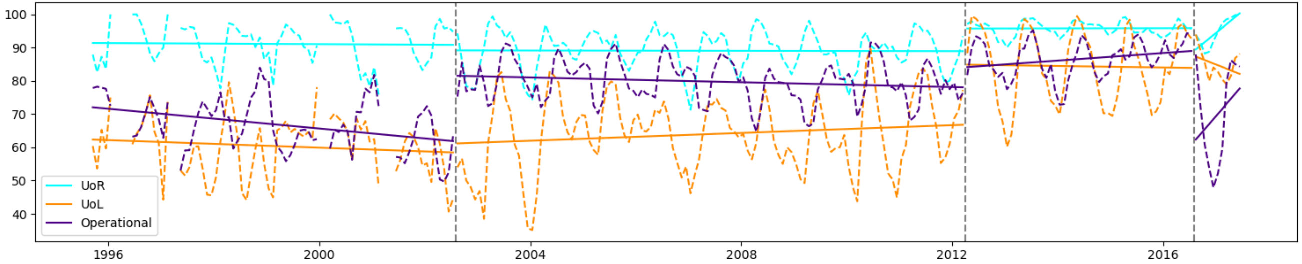
- 3-month rolling means



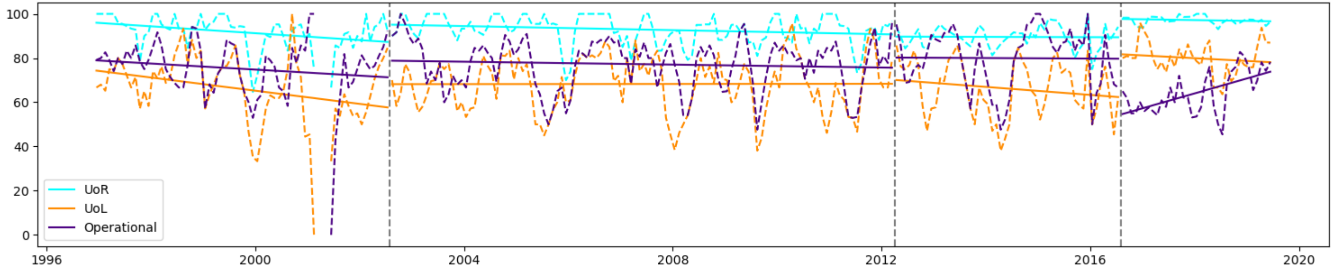
Cloud detection hit rate trends

ATSR-2 AATSR MODIS SLSTR

Ny Alesund, Norway



Southern Great Plains, USA



Next steps

The next steps include:

1. Understanding the temperature signal in LST CDR's relating to cloud mask instability:
    - Assessing impact of cloud detection on LST in the sensor overlap periods
    - Identifying cloud base height of the missed cloud
    - Assessing other contributing factors such as land cover (location dependency)
2. Reduce cloud masking instability where possible (e.g. using a consistent cloud detection algorithm)
3. Quantify the remaining uncertainties introduced in the CDR trends due to cloud mask instability