Progress in Geostationary SSTs and cloud detection

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Geostationary SSTs

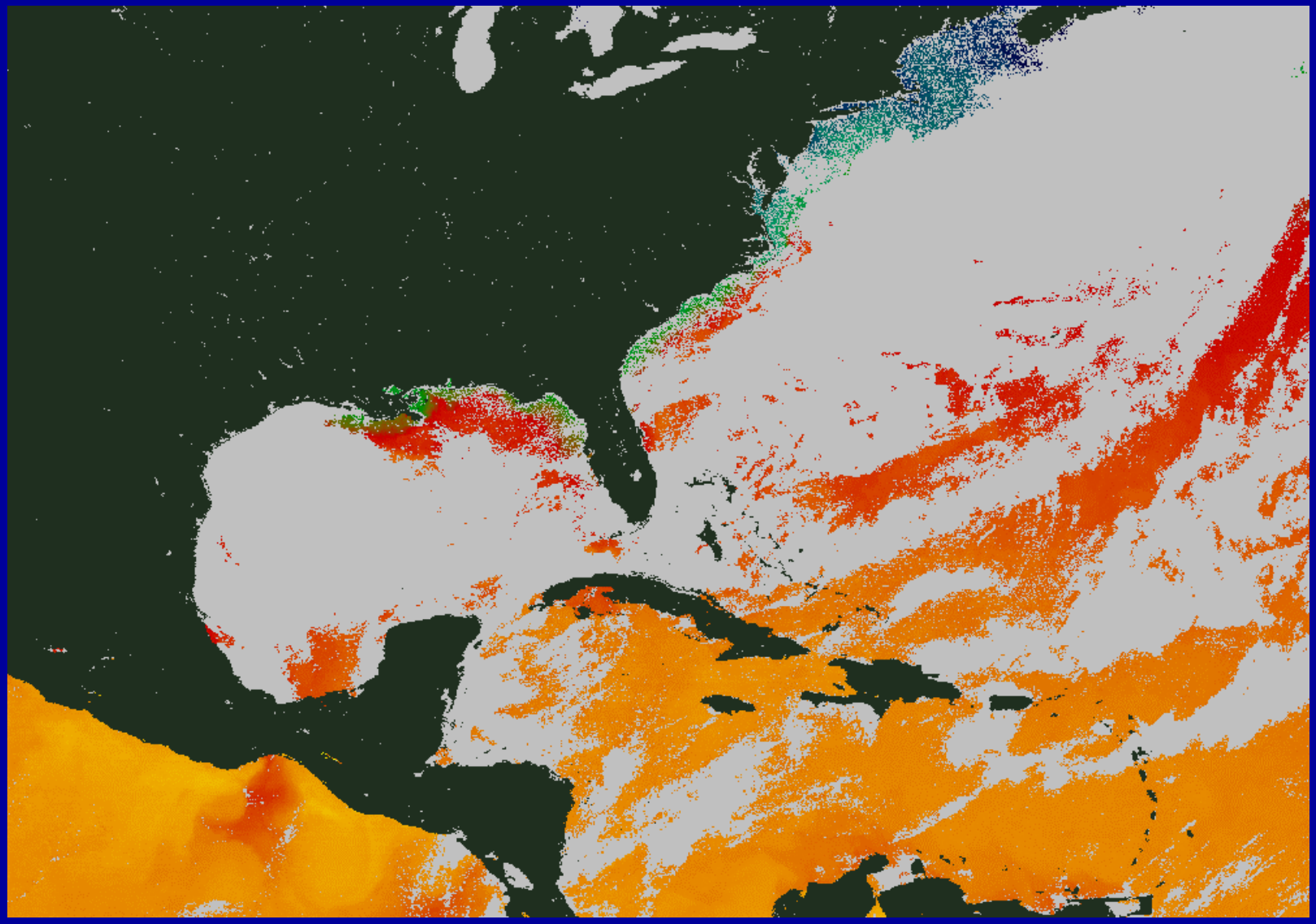
"Truly" SST-capable geostationary sensors have existed since 1994 (GOES-8)

Primary requirements are accurate calibration, low noise, and multiple channels in thermal IR windows

First products developed at Univ Wisconsin, became operational in December 2000

What's so good about geostationary SSTs?

March 2002 SSTs



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Trouble in Paradise

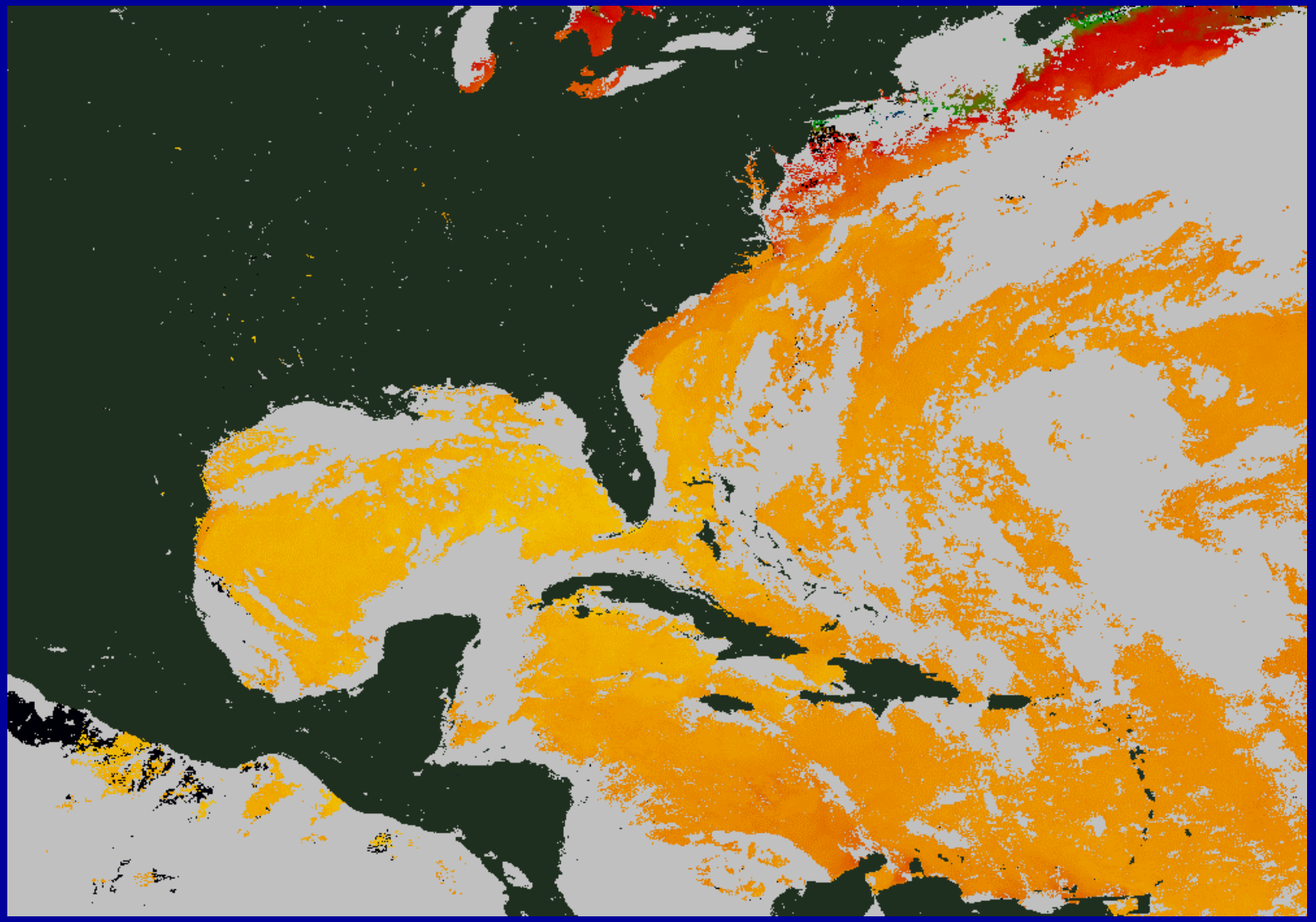
GOES-I to M, sensor has been modified. Key 12 µm channel replaced by 13.3 µm

Daytime retrievals depend on availability of 11 and 12 µm data

Solution has been to use 3.9 µm data in the daytime

- *Significant solar contribution must be accounted for*
- *Sunglint from ocean surface is screened*
- *Scattered clear-air component is accounted for*
- *Residual cloud may cause warm bias!*

September 2003 SSTs



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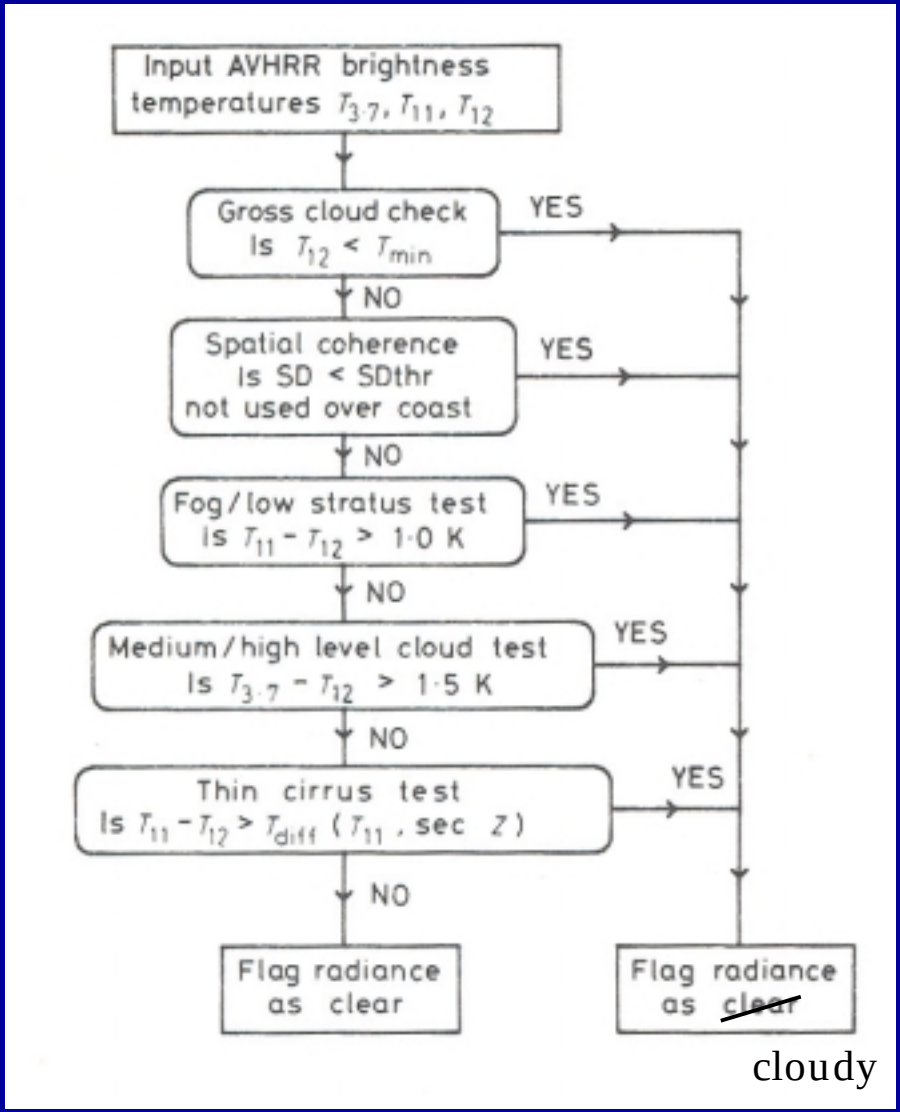
Traditional cloud screening: threshold tests

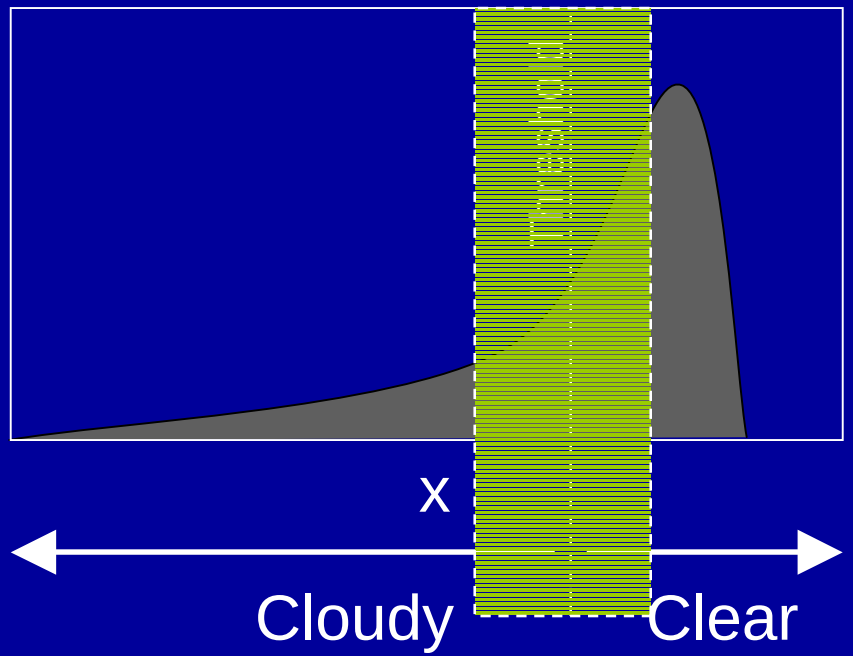


- E.g., APOLLO, Saunders & Kriebel (1988)

“Typical” cloud test

Some test parameter **x**

Scene has a distribution of values for **x**



Where to put the threshold?

- *‘Relaxed’ = more retrievals*
- *‘Stringent’ = less risk of contamination*
- *N.B. may be determined dynamically*

A better approach – assign a probability

Bayesian approach

- Estimate the clear-sky probability
  - given the observations
  - given prior SST & atmosphere
    - climatology or NWP
  - using fast forward model
- Physically based, probabilistic
- Suited to operational context

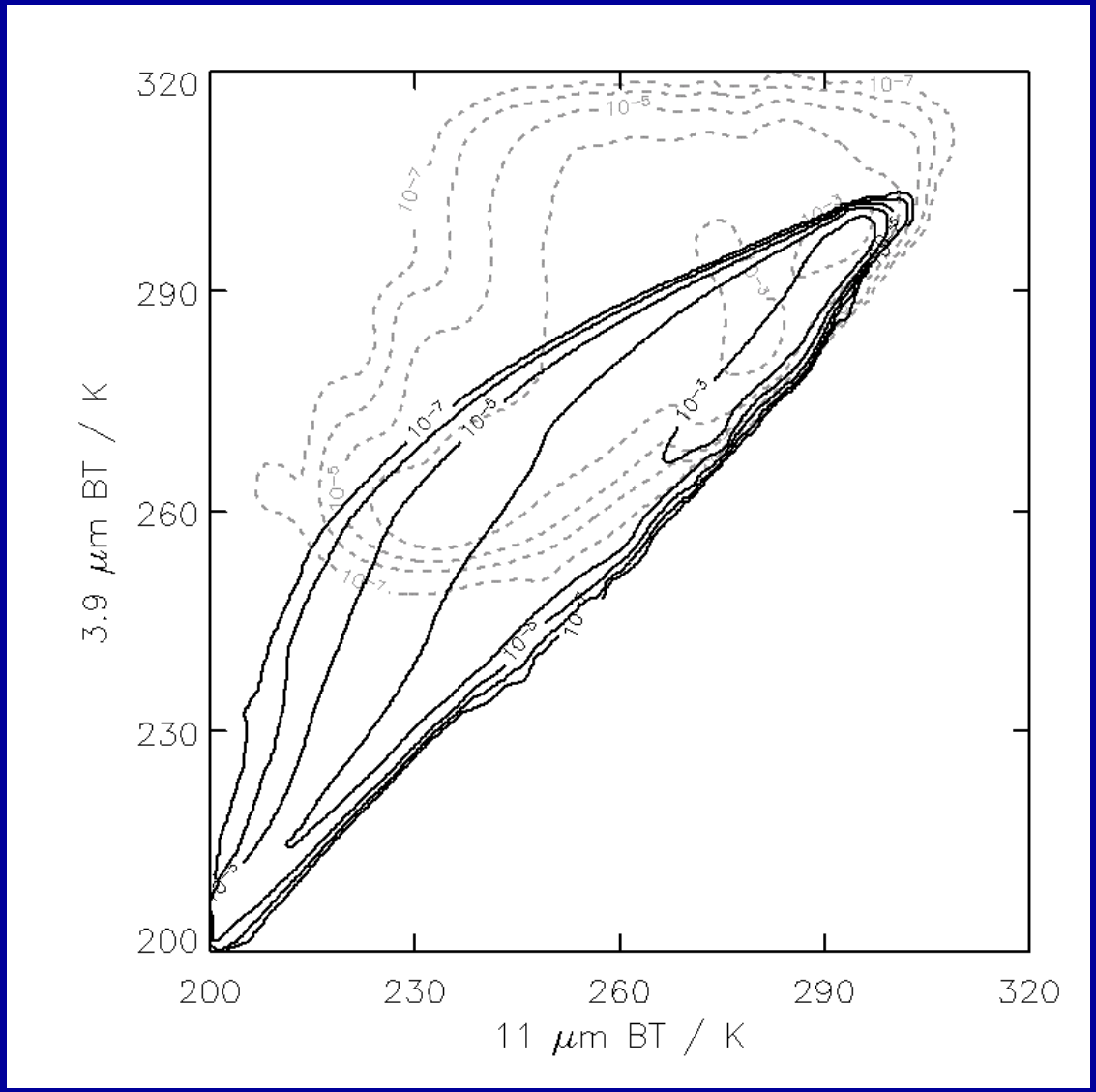
Bayes' theorem

- Prior → FFM → $\mathbf{y}^b(\mathbf{x}^b) \pm \varepsilon^b$ e.g. BTs, 3x3 SDs, ...
- Observation $\mathbf{y}^o \pm \varepsilon^o$
- Calculate $P(\mathbf{y}^o \mid \mathbf{x}^b, c)$
- Empirically $P(\mathbf{y}^o \mid \mathbf{x}^b, \neg c)$

- Clear-sky probability is

$$P\left(c \mid \mathbf{y}^o, \mathbf{x}^b\right) = \left\{1 + \frac{P(\neg c)P(\mathbf{y}^o \mid \mathbf{x}^b, \neg c)}{P(c)P(\mathbf{y}^o \mid \mathbf{x}^b, c)}\right\}^{-1}$$

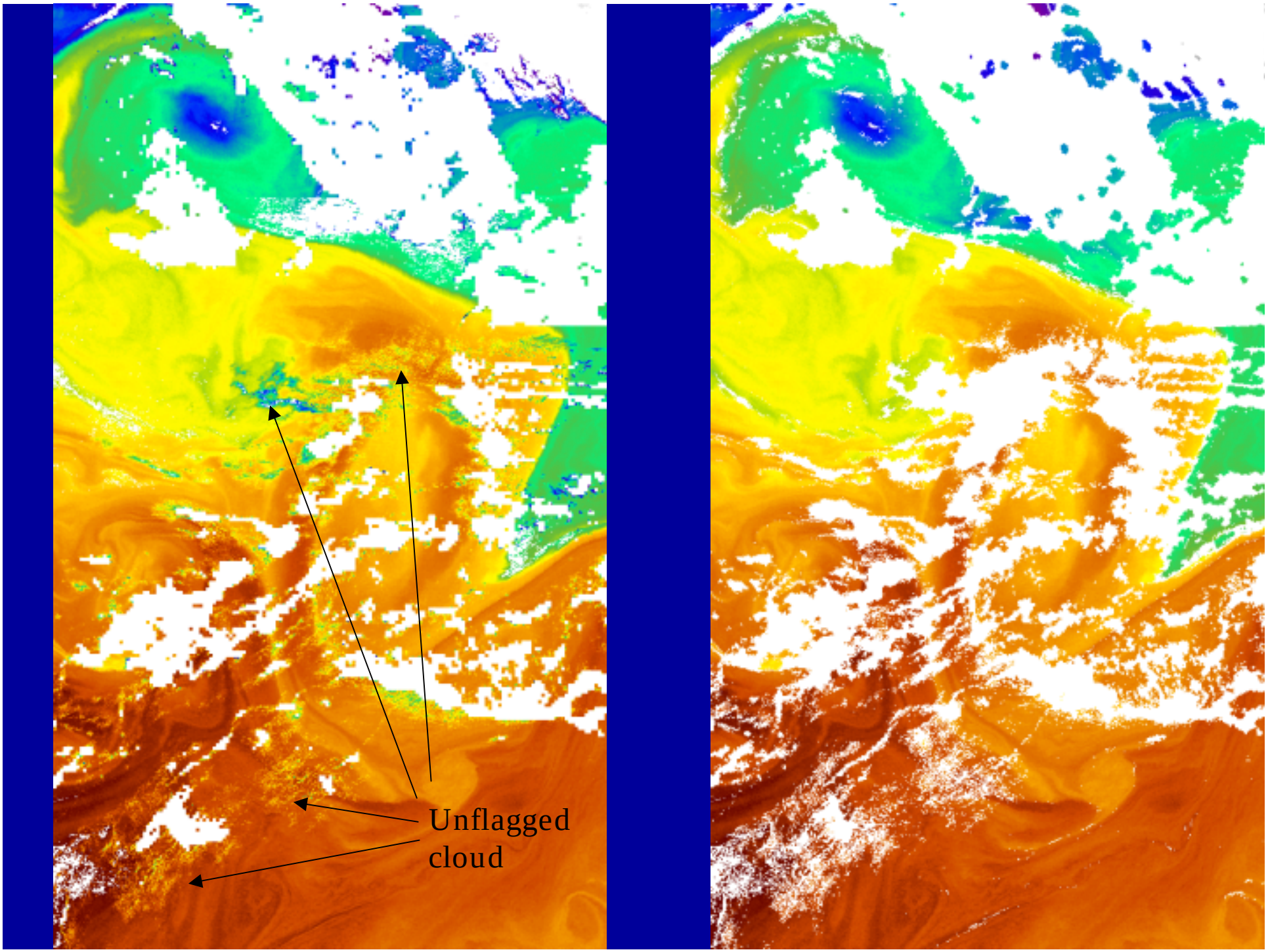
Empirical prior for cloudy state



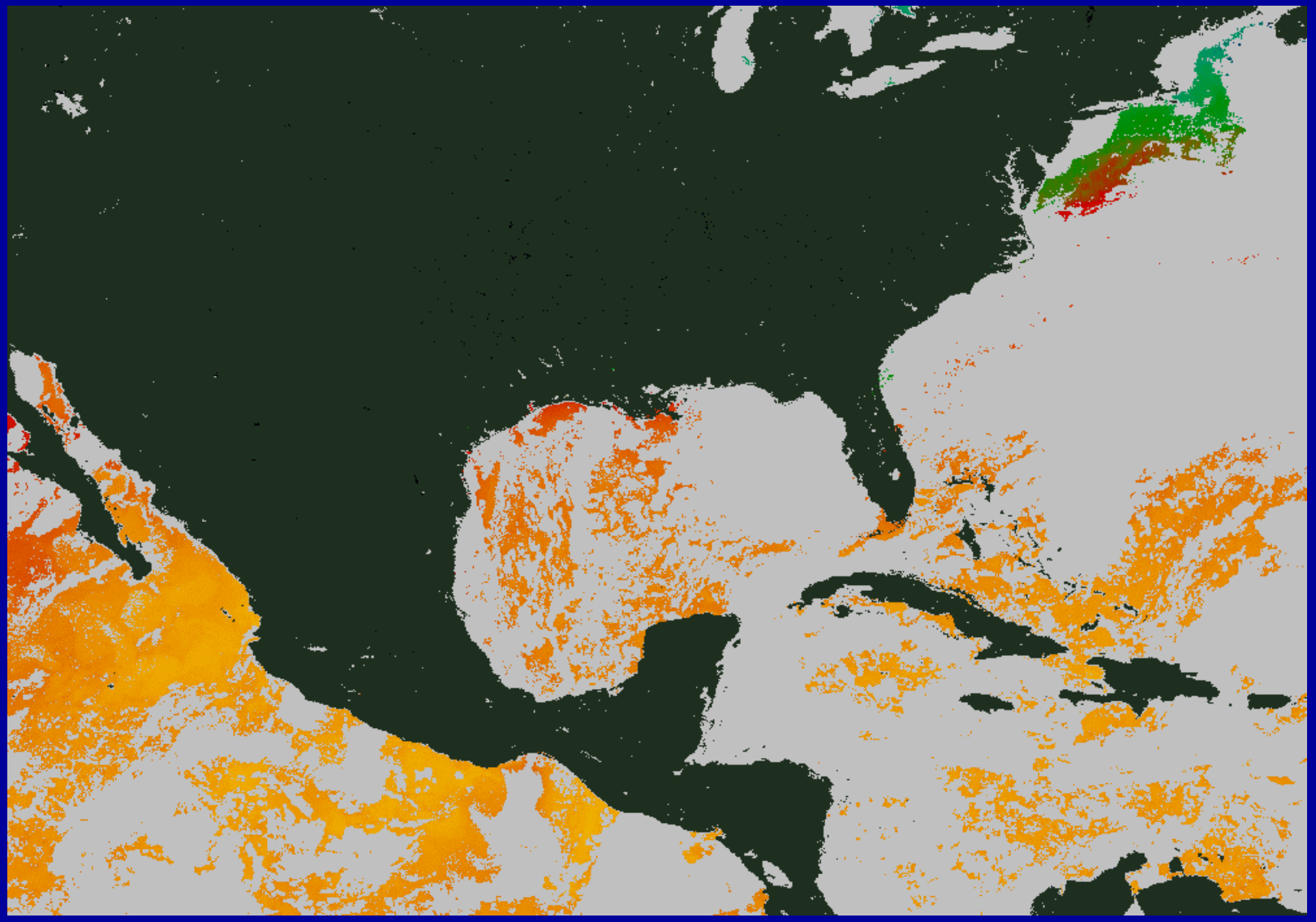
Observed from imagery

Only use 3.9 and 11 μm channels (GOES-12)

Daytime PDF includes solar contribution


Unflagged
cloud

SST animation



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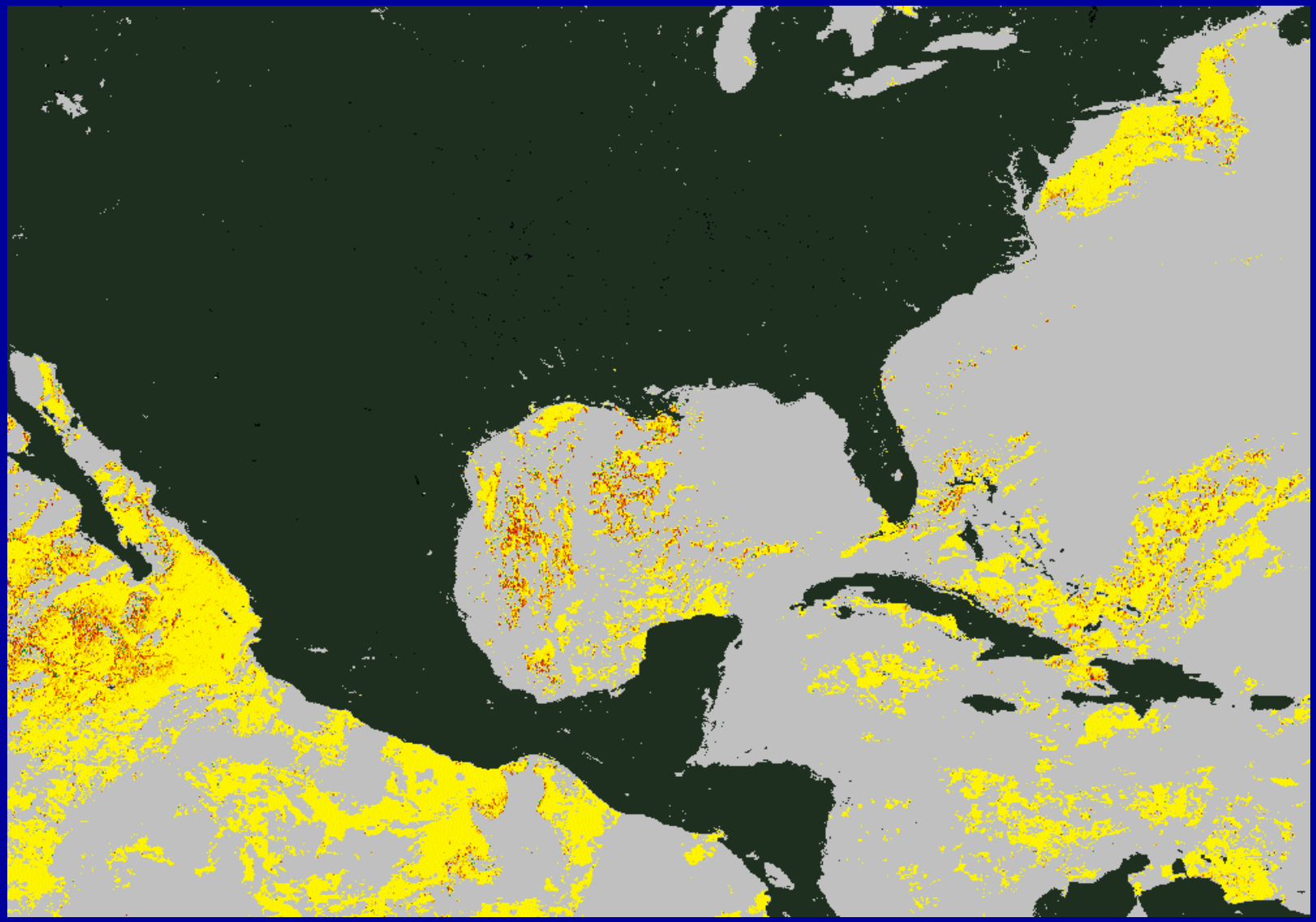
Probability animation



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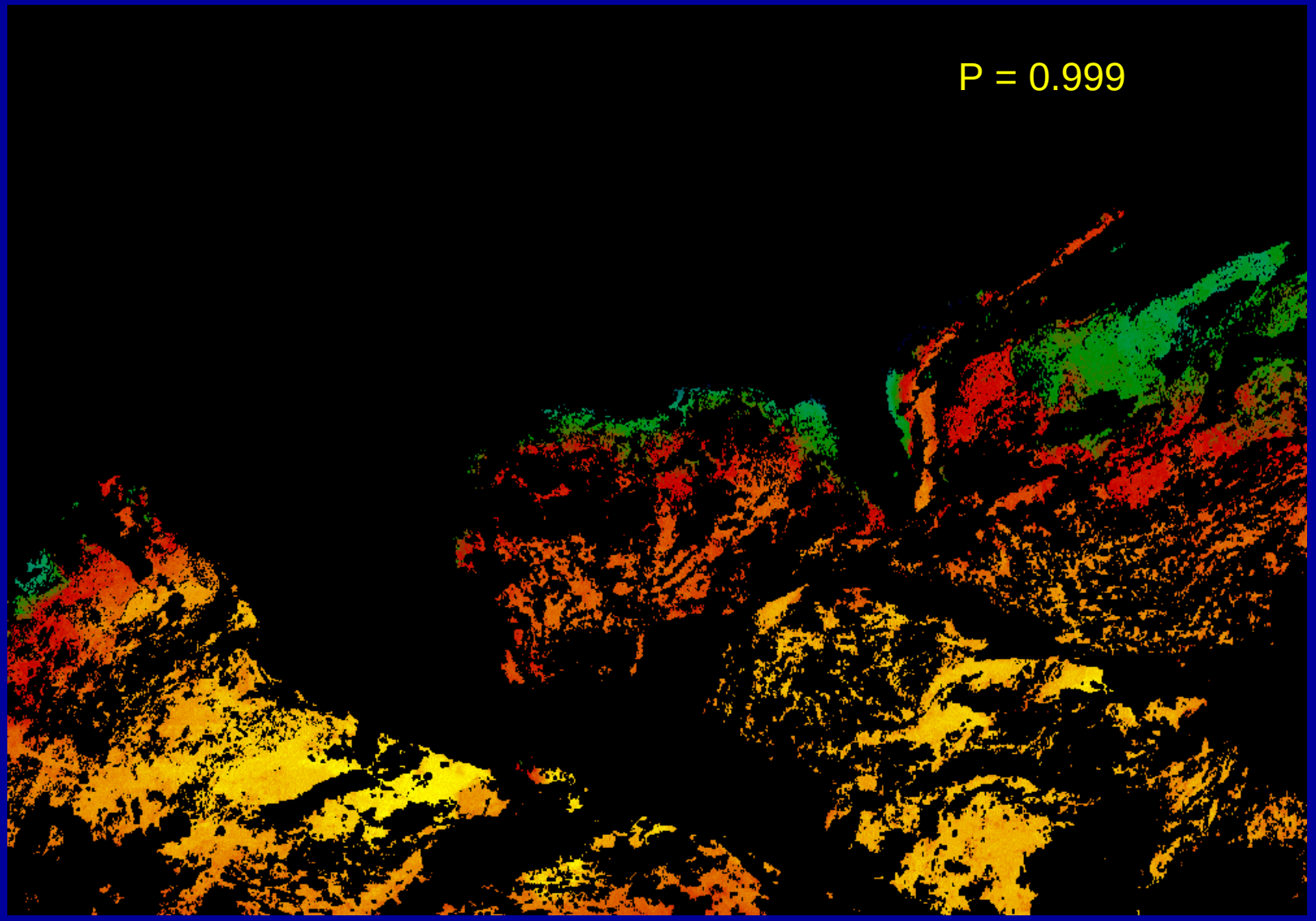
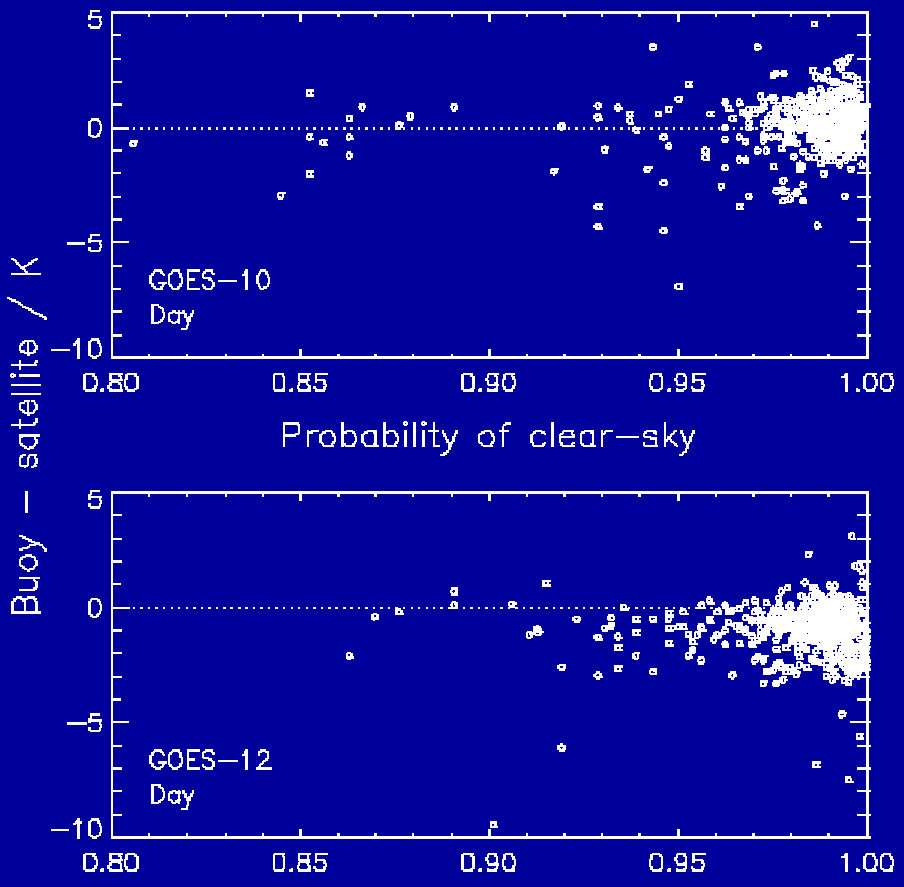
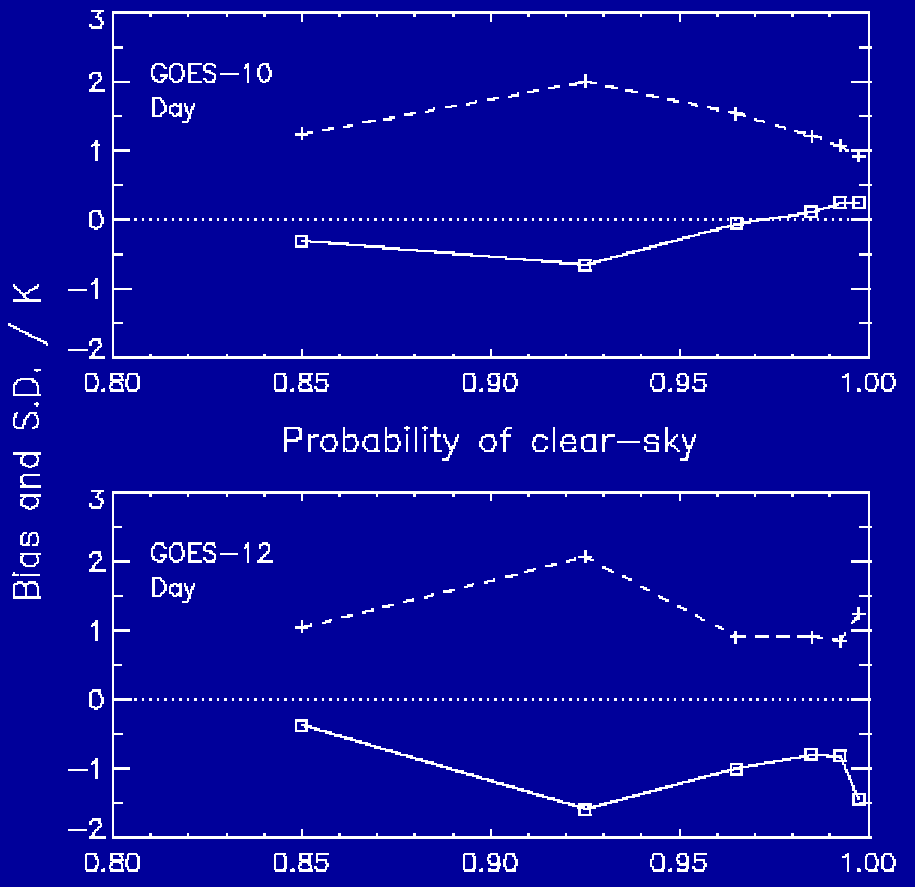
Changing the probability threshold

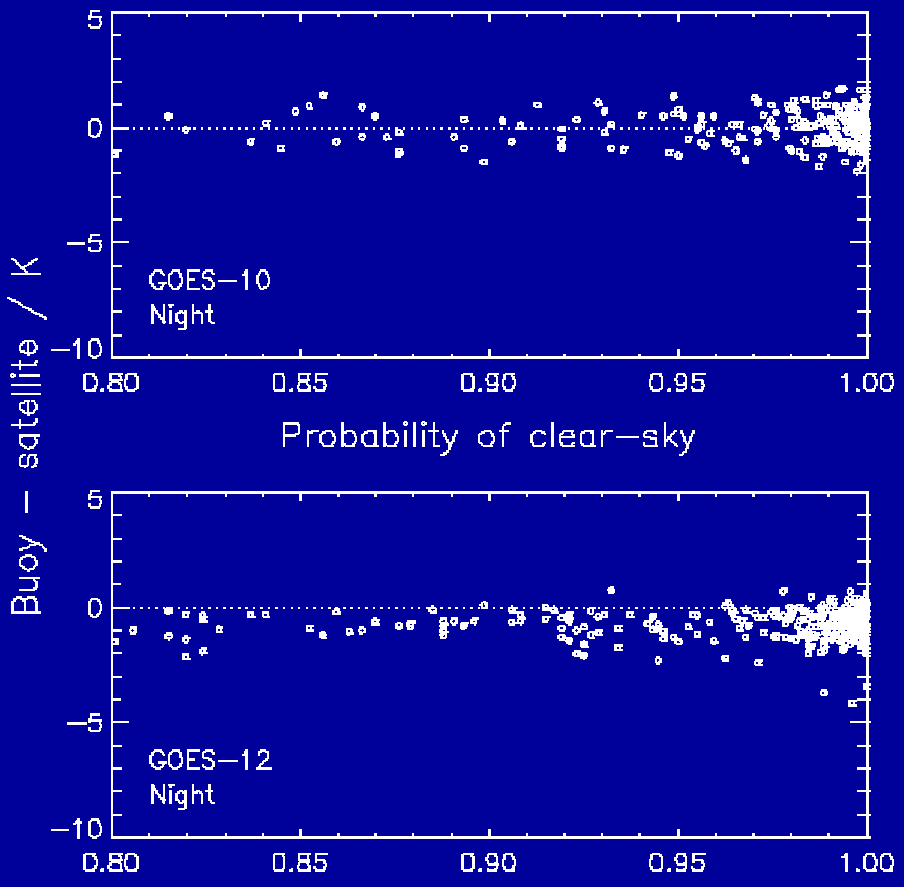


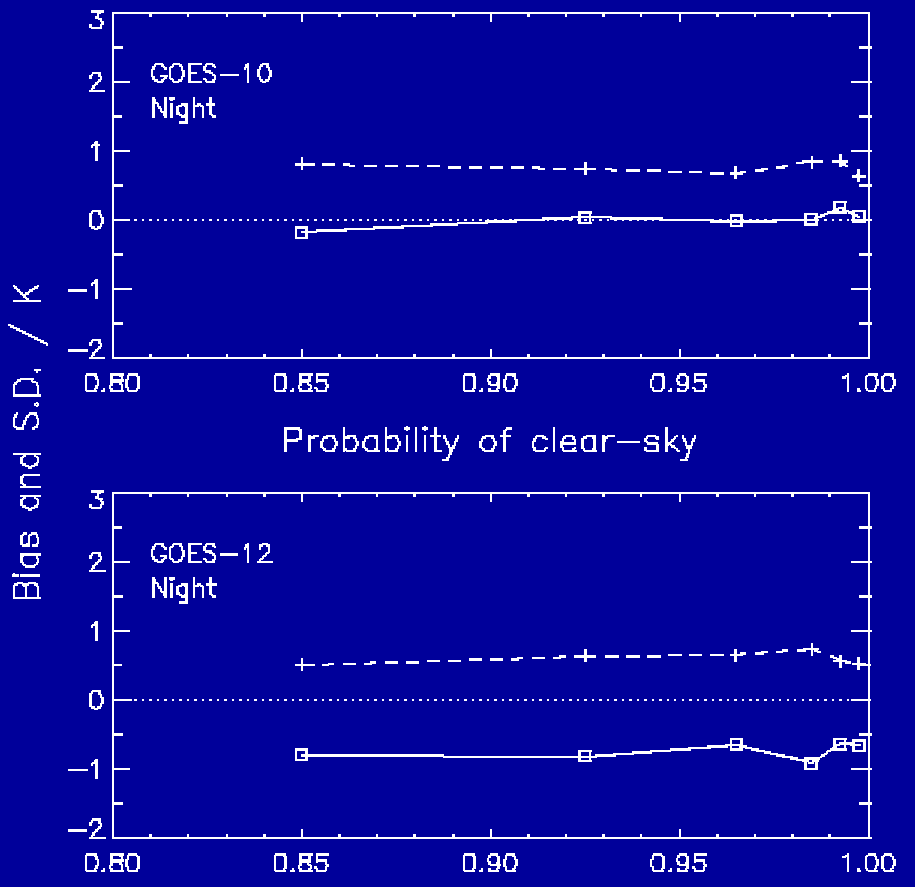
Daytime results





Nighttime results





Conclusions

Some work still to do in refining RT for GOES-12

Bayesian priors need to be refined

- *Consider using a multi-pass process*
- *OPTRAN RT model due for inclusion of shortwave*

Error distributions for probabilities can be built up over time

Plans to reprocess all GVAR data back to launch of GOES-8 (~100 TB of data)