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BoM Himawari-8 AHI Cloud/SST/SSES Algorithms

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NOAA-BoM SST Workshop,

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Introduction

- BoM is moving towards provision of Himawari-8 (H08) products on the IMOS Australian regional grid.
  (July 2018 committed release date, near real-time, for research)
- H08 products are currently *as originally released* and largely unchanged from mid 2015.
- Target products (on IMOS domain):
  - L3U 10 mins (probably not generally available due to data volume)
  - L3C hourly, L3C before sunrise daily (to merge with L3S)
- Long standing "problems".
  - Estimating uncertainties
  - Clouds
  - Time trends

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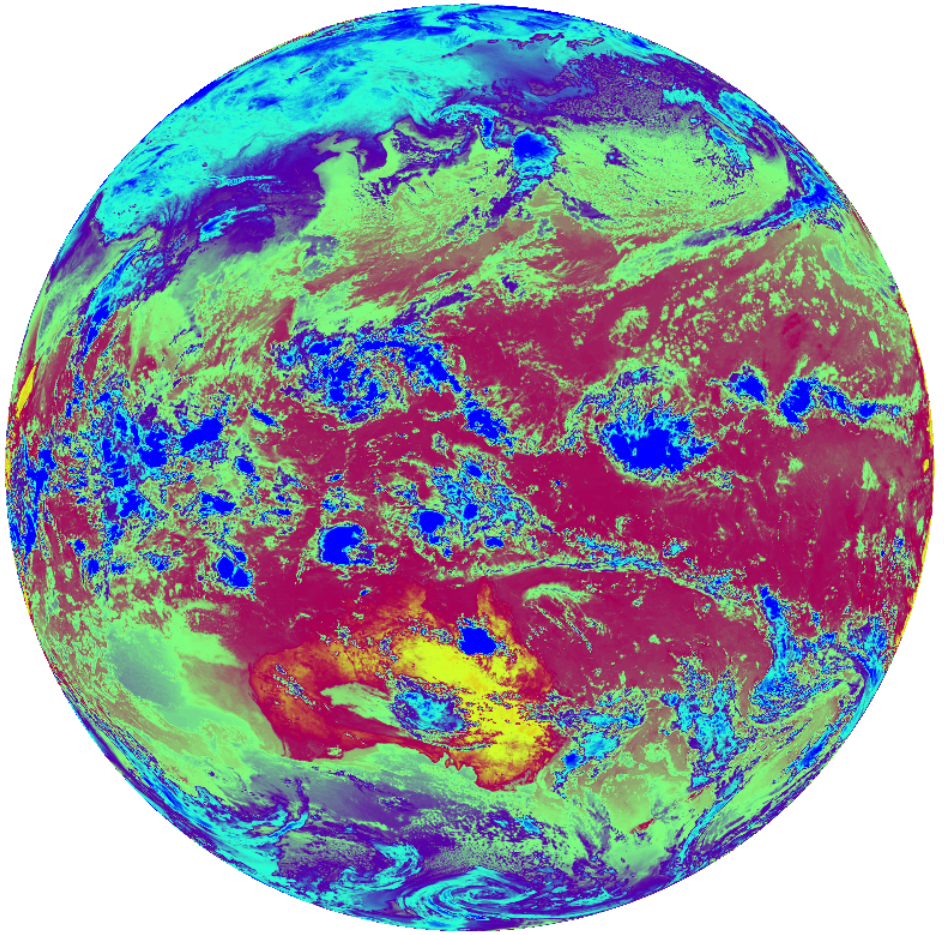
H08 GHRSST products – Current Status

- First cut VIIRS cross tuned H08 product (single epoch of calibration, 20150721)
- Clouds from GEOCAT, SEVIRI cloud properties algorithm.
- Errors estimated based on "local SST variability"
- Quality based on distance assessment to cloud and size of estimated error.

$$q_{\text{sses}} = \frac{1}{\sqrt{2}}\sqrt{\max\left(\left(\frac{\sigma_{\text{sses}}}{\sigma_0}\right)^2 + \left(\frac{\mu_{\text{sses}} - \mu_0}{\sigma_{\text{sses}}}\right)^2 - 1, 0\right)}$$

$$q_s = \lfloor 5 \exp^{\eta q_{\text{sses}}} \rceil$$



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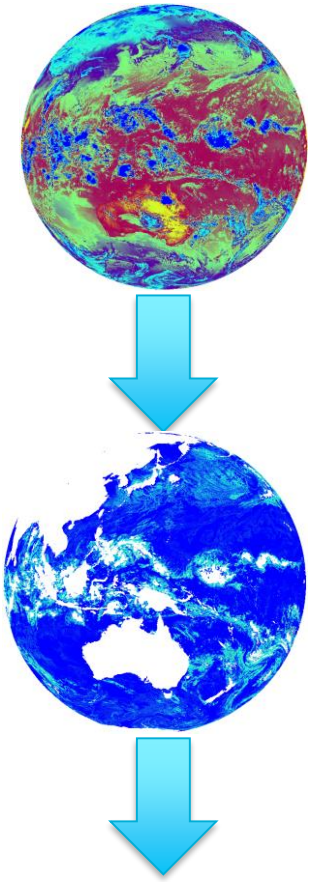
A list of things that are desirable

- Open loop characterization.
  Applied iteratively.
- Quality determination is potentially from a disparate source to sses error estimate – considered non-parametric.
- Highest spatial resolution possible, even if it means that we have *noise*.
- Exploit temporal "correlations" or persistence, to guide selection of measurement.
- Consistency of approach between GEO/POLAR.
- Having a measurable means to identify how closely we meet objectives.



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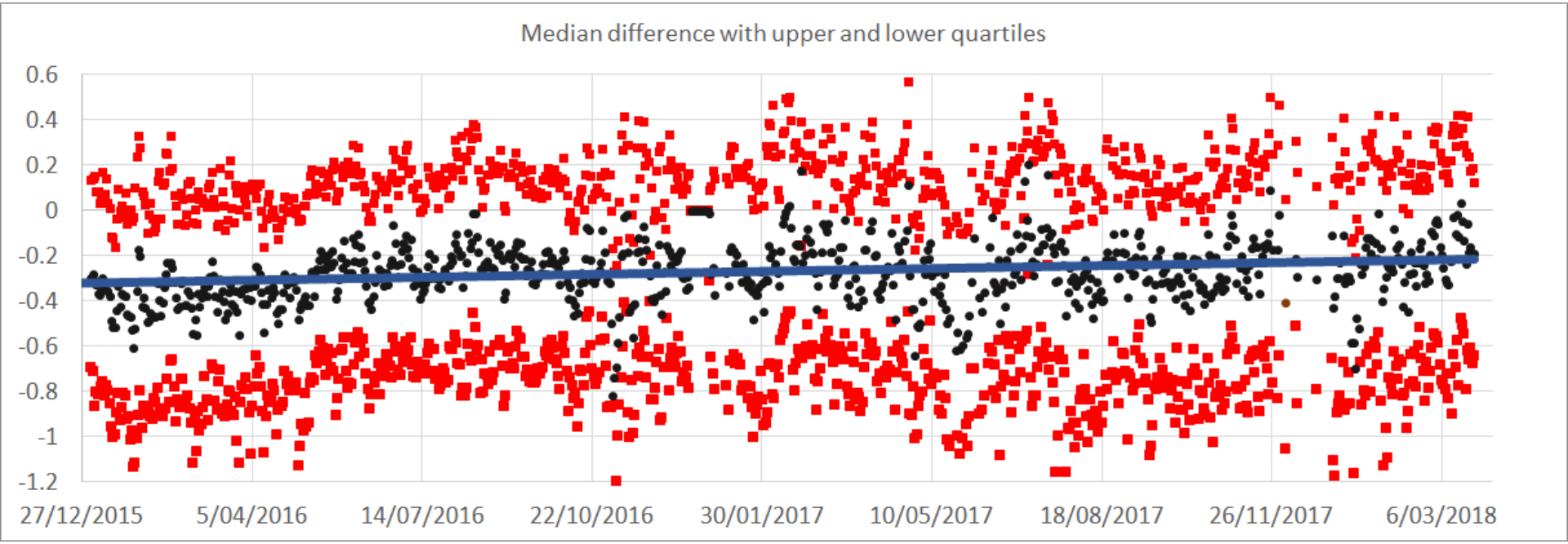
How have things been tracking ?



- H08 vs DRIFT+TROPICAL MOORINGS, DAILY VERIFICATION
- Median Bias has shifted (expect cool skin).
- Cold tail is obvious.
- Retuning and/or dynamic bias correction required.

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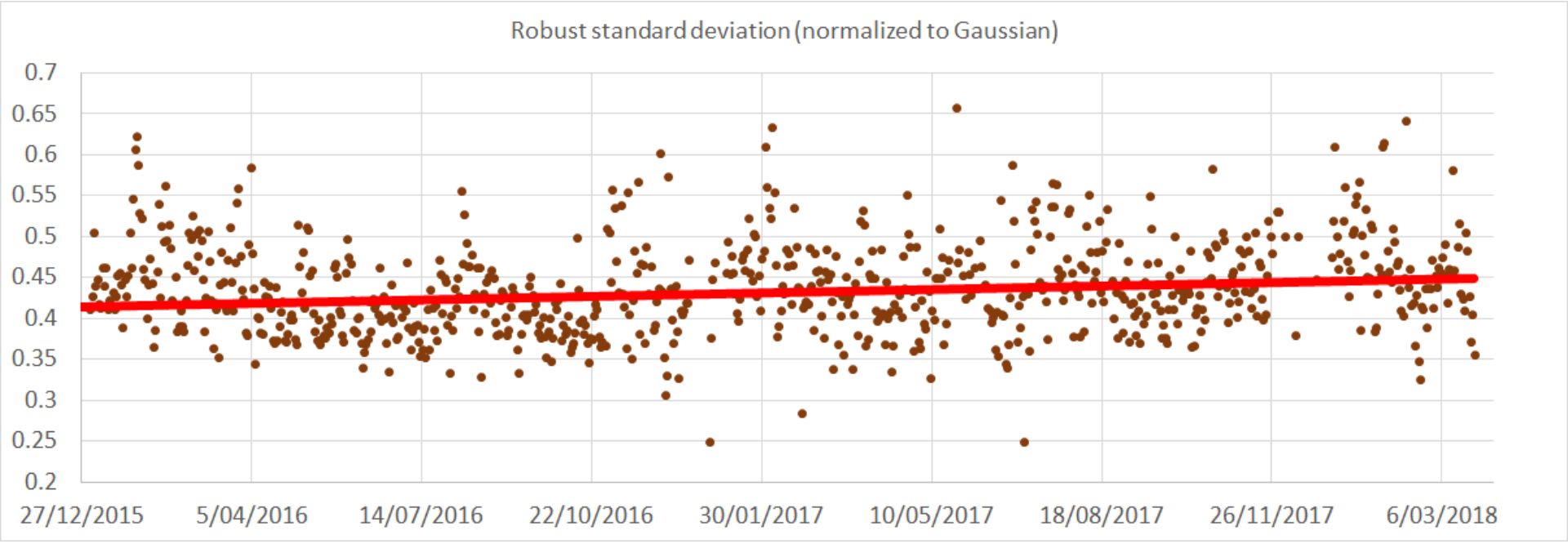
How have things been tracking ?



- Points to need to better bias correction on sub-groups of SST retrievals
- Points to need to include retuning.

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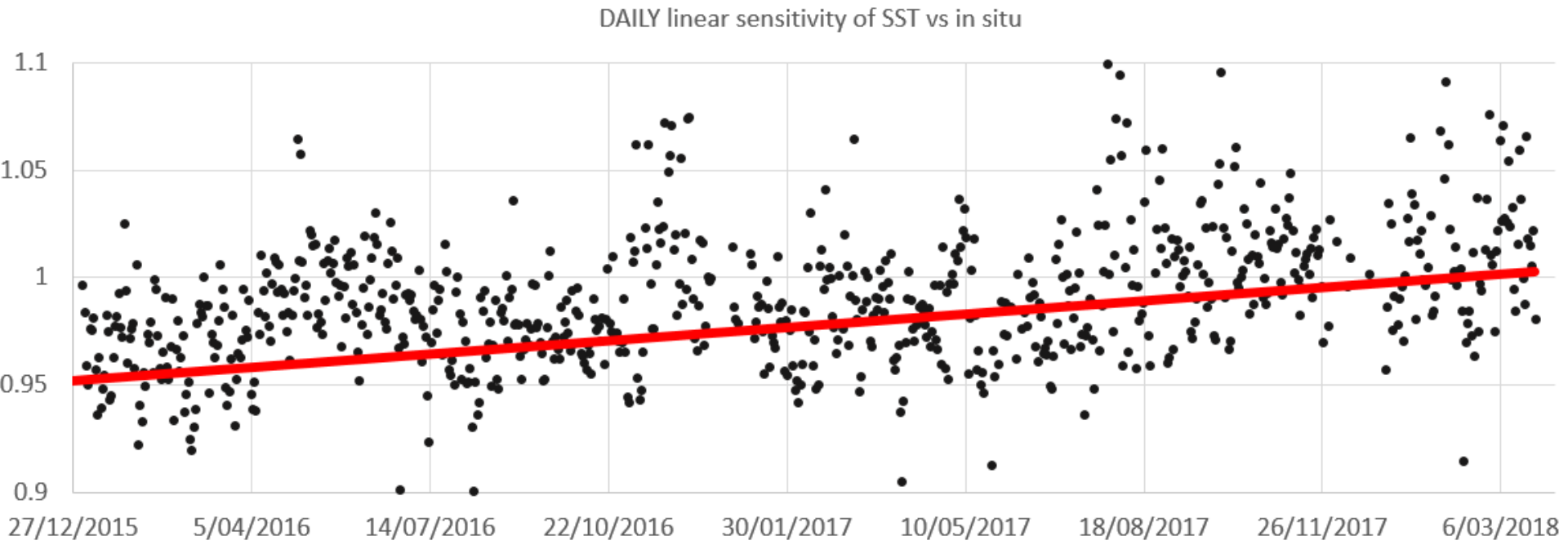
How have things been tracking ?



- Same comments as before.
- On average, the linearity / sensitivity looks really good.

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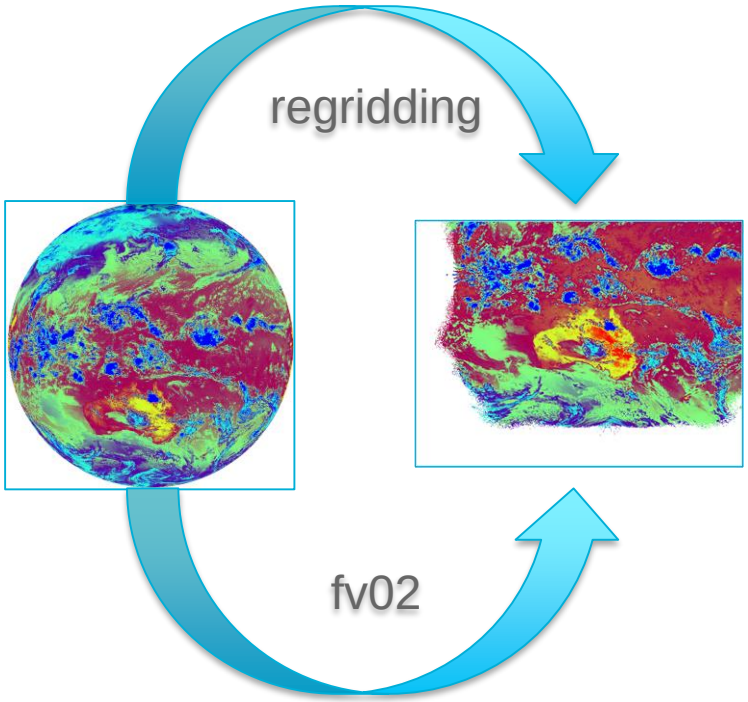
What we need to do !

- Consistent Error model on existing L2P
  - Implement fv02 error model.
- Consistent regridding
  - What L2P information is available at a given L3U pixel, and how should it be weighted ?
- Identifying misclassified SST cloud.
- Working with temporal information.
- Validation data produced in parallel. (probably on delayed near real time)



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Consistent error model

- Bias and standard deviation evaluated on 5 dimensional fv02 model over a rolling time period.
- Ensure time of day information degrees of freedom are enlarged for H08.
- *Tuned* against buoys.
- Independent of regressors and L4
  - don't try to milk too much from the data
- Standard deviation should be subject to two lower limit(s)
  - NE∆T
  - σ(ISAR - buoys)

$$n = n_{\text{swath}} g_n$$
$$\mu = \mu_{\text{swath}} + g_\mu$$
$$\sigma = \sigma_{\text{swath}} g_\sigma$$

Swath Component:

- Satellite Zenith Angle
- Time of day
- Quality Level

Geographic Component:

- Latitude
- Longitude
- Time
- Quality Level

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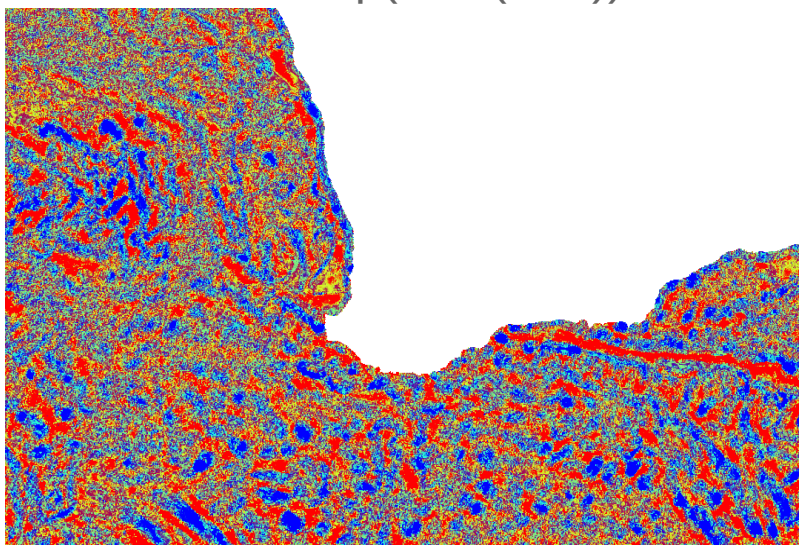
Consistent re-gridding

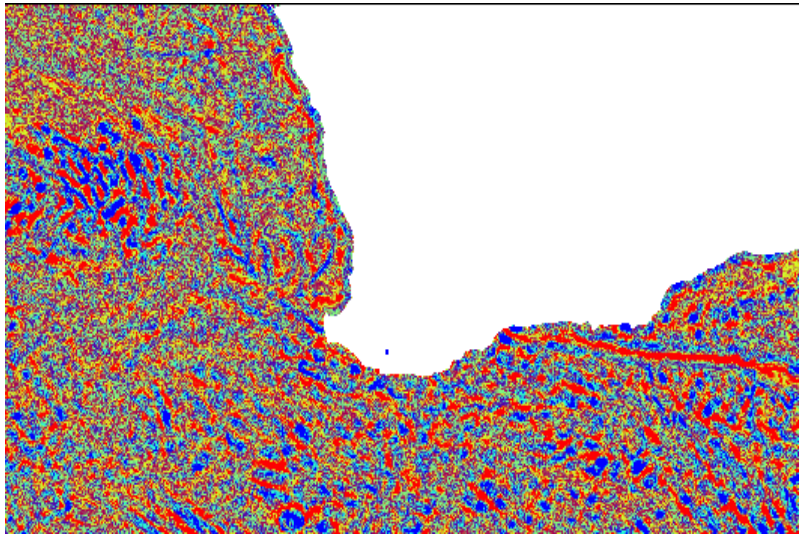
Verification of re-gridding method:

- With all pixels at the same quality level, measure
  - relative spatial correlation length (SCL) ?
  - image gradient ?, laplacian ?

remap(SCL(L2P))



SCL(remap(L2P))



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Misclassified cloud

- By *cloud* we mean atmospheric interference that prevents a surface temperature observation.
- A few ideas about what might help.
  - Spatial scales
    - 500m – scale for formation of features
    - 20km – scale for decorrelation of effects such as precipitation
    - 1000km – scale of maximum extent
    - Multifractal shape properties.
  - Distribution based clustering.
  - Planar clustering.
  - Blob classification.
  - Temporal classification.

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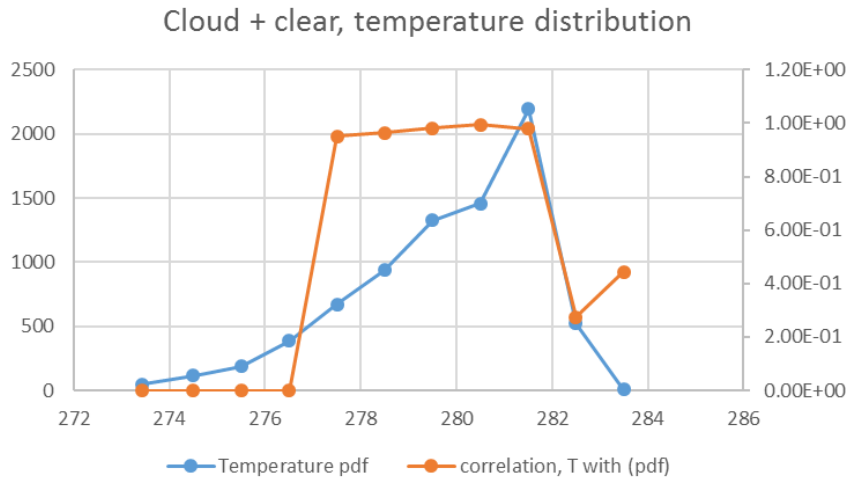
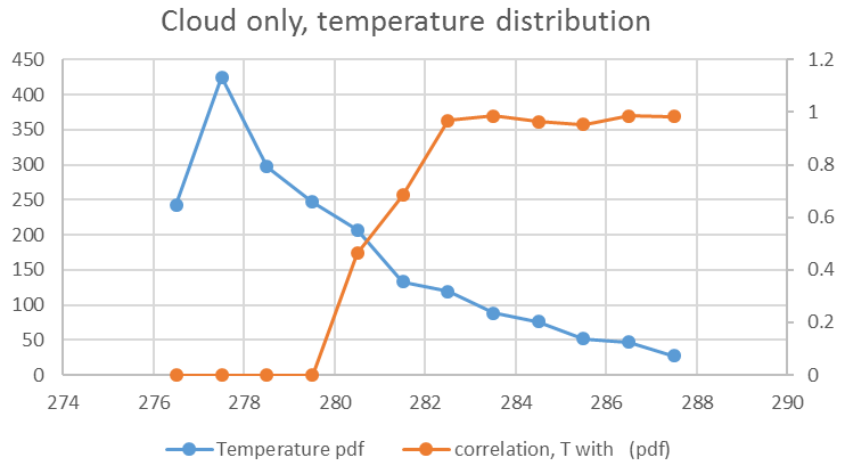
Misclassified cloud #1

Distribution based classification

- Cloud temperature distributions have *fat* and even *linear* tails
- May aid in determination of edge temperatures for cloud.
- Need to be aware of this if using classification algorithms which assume Gaussian distributions.





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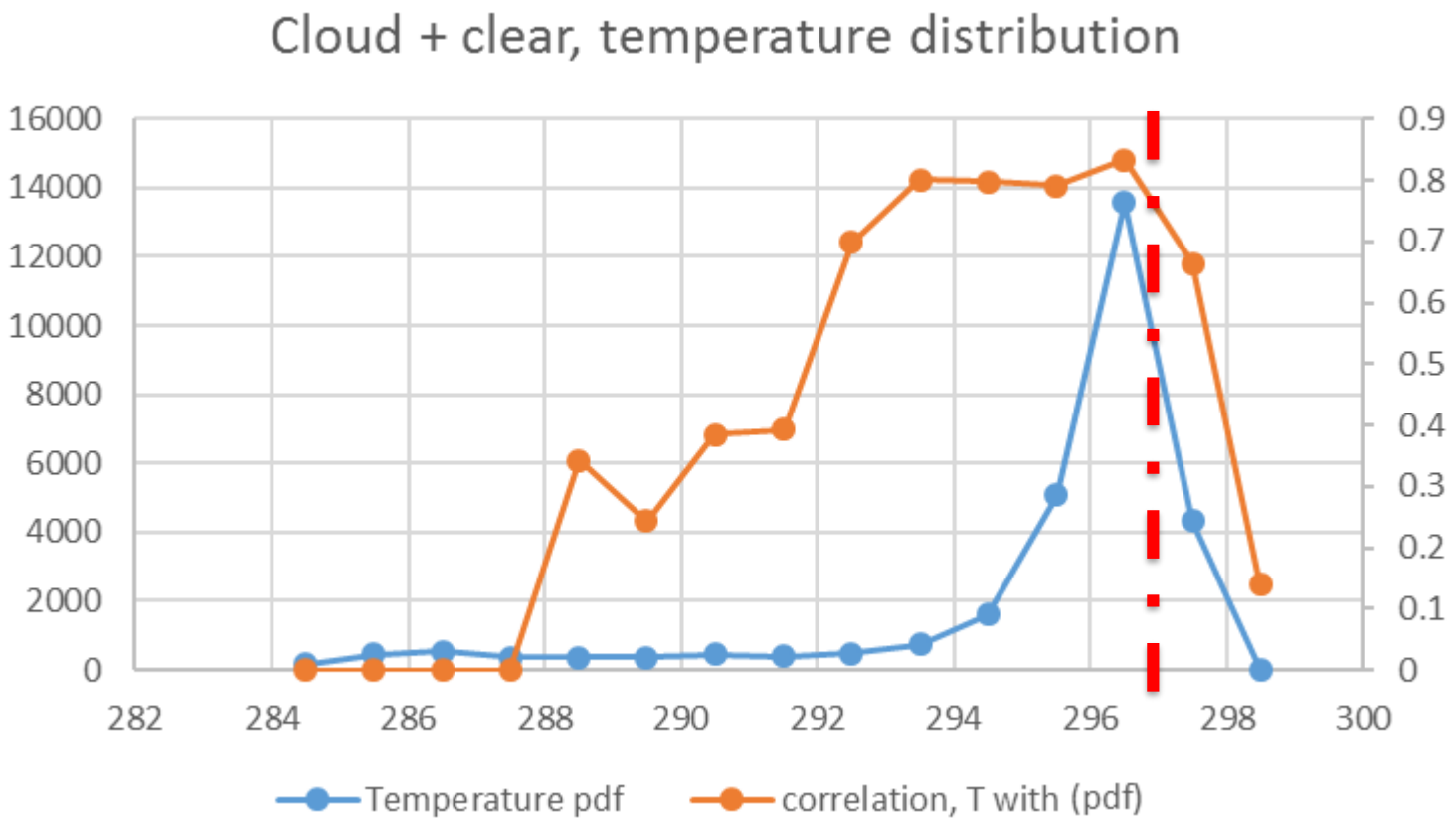
Misclassified cloud #1



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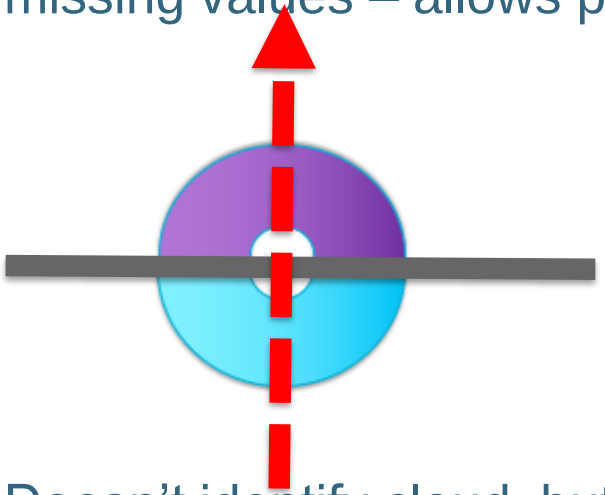
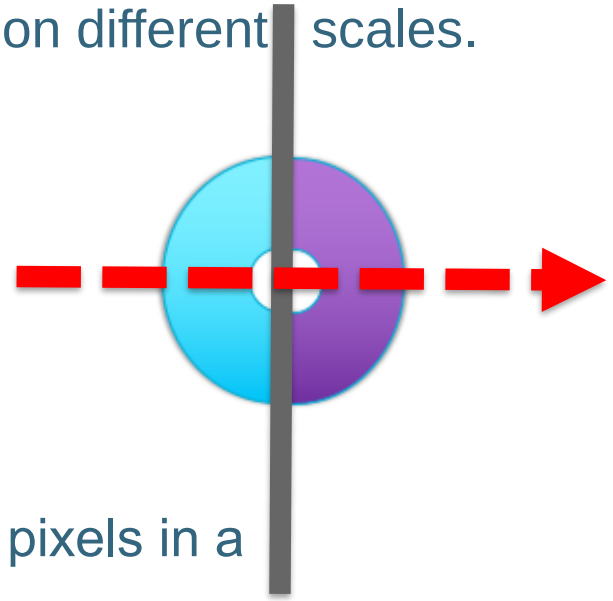
Misclassified cloud #2

Blob classification

- Classification of similar pixels based on stable SST values (edge partitioned gradients)
- Use edge partition algorithm that includes spatial scale and is robust to missing values – allows partitions to be applied on different scales.



$$\frac{dT}{dx} = \sum \frac{T}{d.\hat{}x}$$



- Doesn't identify cloud, but does suggest that all pixels in a blob be treated the same way !

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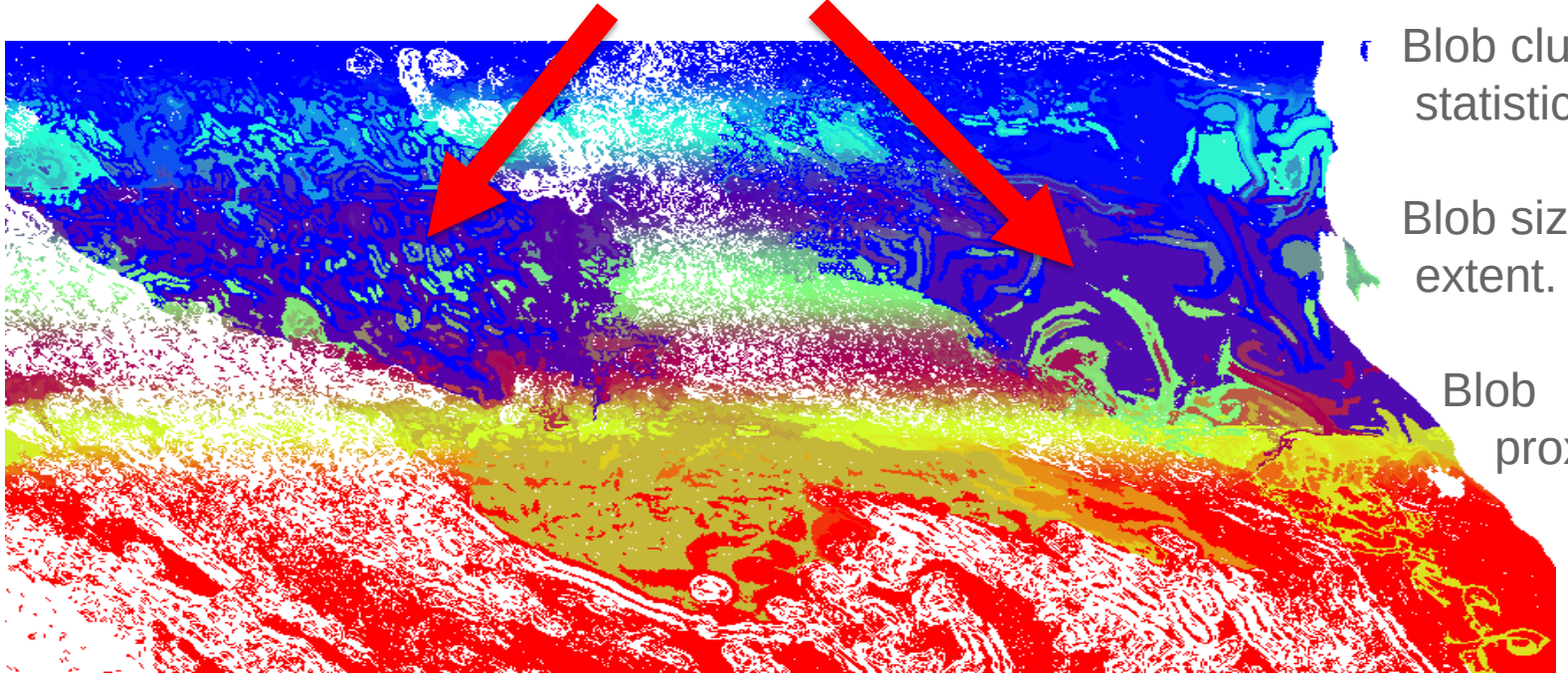
Misclassified cloud #2

Blob classification

- Small blobs represent unstable regions – can be easily identified.
- Larger blobs are stable regions (not necessarily cloud or surface)
- Blob structure varies for cloud vs sea



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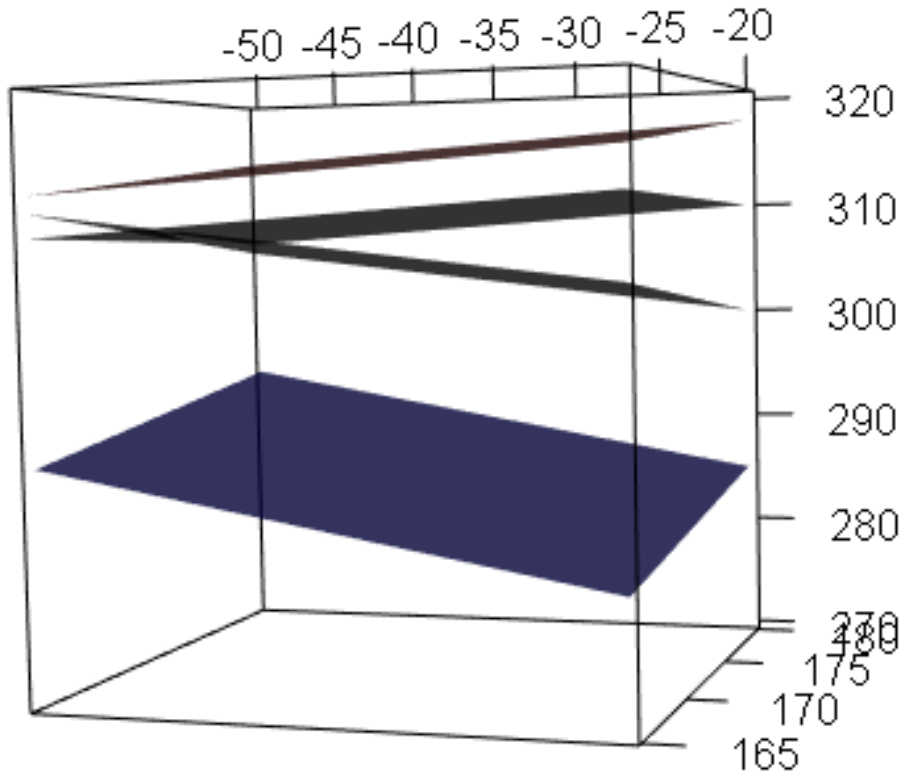
Misclassified cloud #3

Planar classification

- Similar to k-means clustering.
- Allows large scale structures to be identified.
- Fixed computational complexity independent of scale.
- Scales of 1,000,000km^2 are probably practical.
- Needs some *tricks* to ensure convergence.
  - Exploit cloud distribution
  - Exploit blob properties



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Misclassified cloud #4

Time series classification

- 10min is a very short time scale compared to most SST phenomena
- Simple time based difference
  - Pixels that become suddenly cold are cloudy
    (not assumed to be true of the reverse)
- Robust trend can be extracted from data and forward interpolated.
  (allows trended temporal cloud edge detection)
  - Refitting planar classification with time as an additional parameter.
- Blob flow
  - Consistency of trending in blob located regions.
- Optical flow
  - Identify fast flowing regions.

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Methodology

- Find a bunch of things that might work

  (As discussed, a largely unfinished exercise at the moment)

- Fit them to verified cloud observations, physical retrievals of cloud properties, etc.

  (Fit with traditional or trendy methods)

- Predictor is probability of cloud

  (Independent verification data)

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Thank You !

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