Making the old new: Adapting the ORAC retrieval to SLSTR

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Talk outline

- Introduction to the Optimal Retrieval of Aerosol and Cloud
- New developments
- Comparing satellites and models over various domains

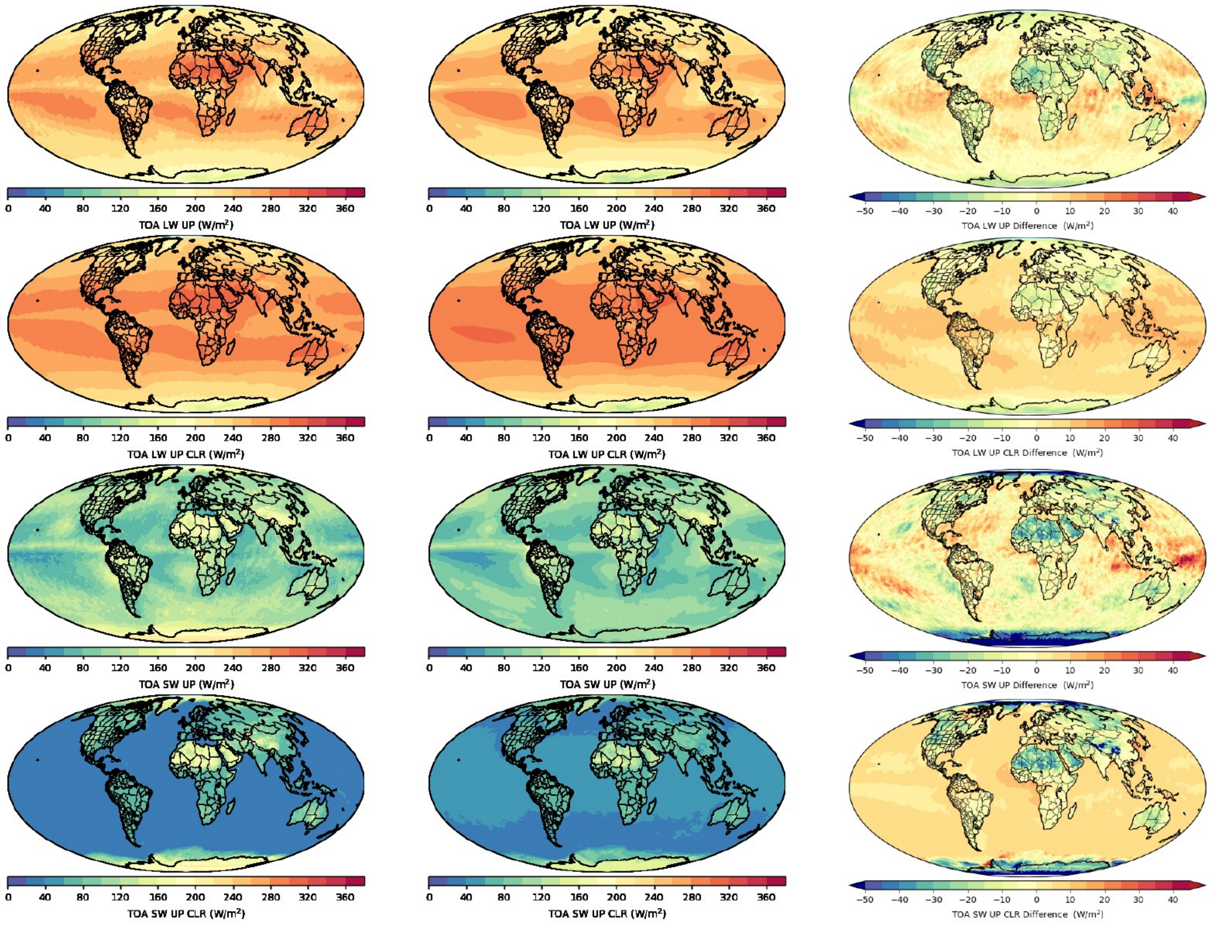

Image credit: Caroline Poulsen, Monash, doi:10.5194/essd-2019-217

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Optimal Retrieval of Aerosol and Cloud

- The Optimal Retrieval of Aerosol and Cloud (ORAC) estimates the optical thickness and effective radius of particulates in the atmosphere given the refractive index and size/shape distribution.
  - Aerosol and cloud are just treated as two different types of particle.
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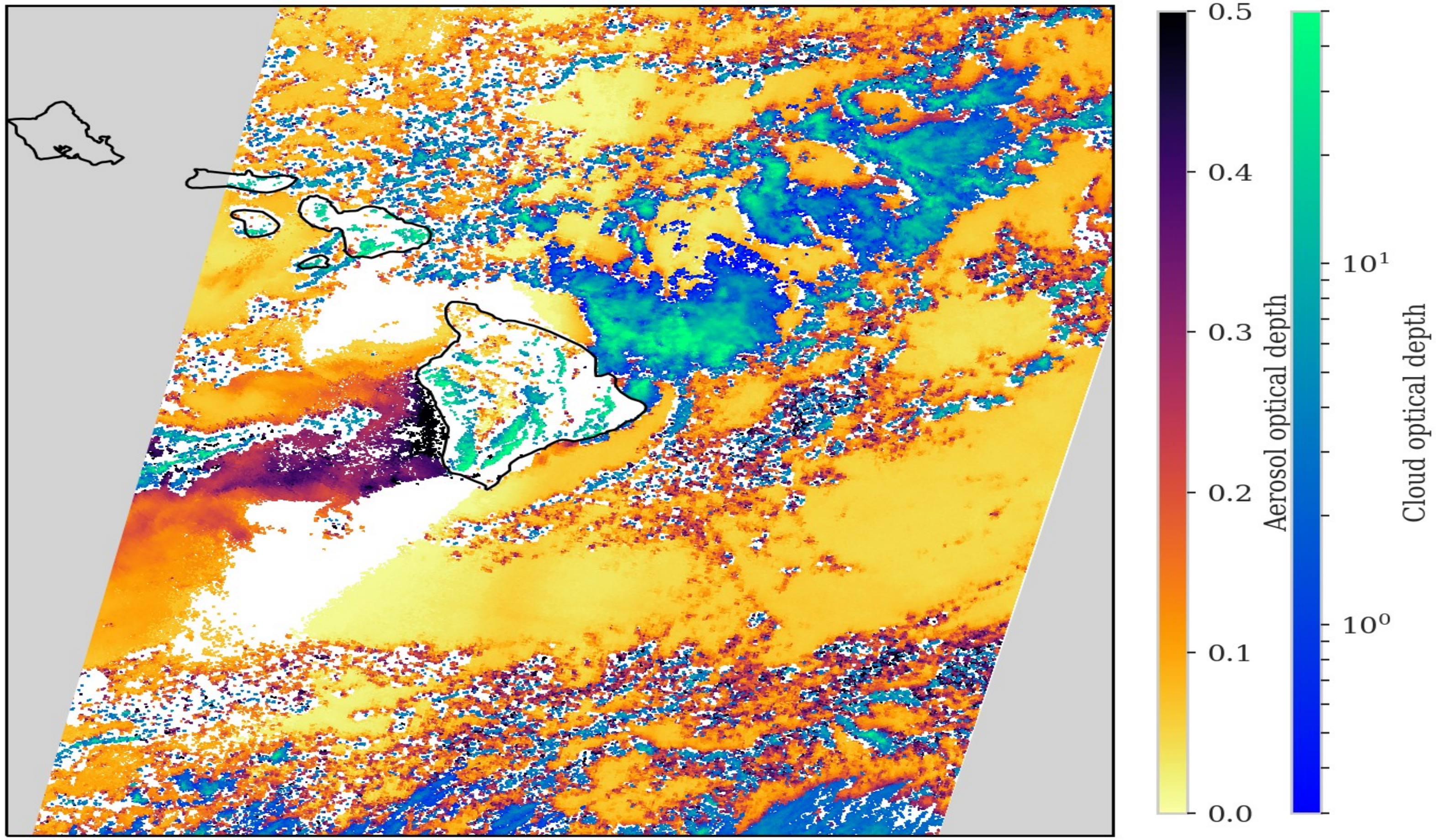
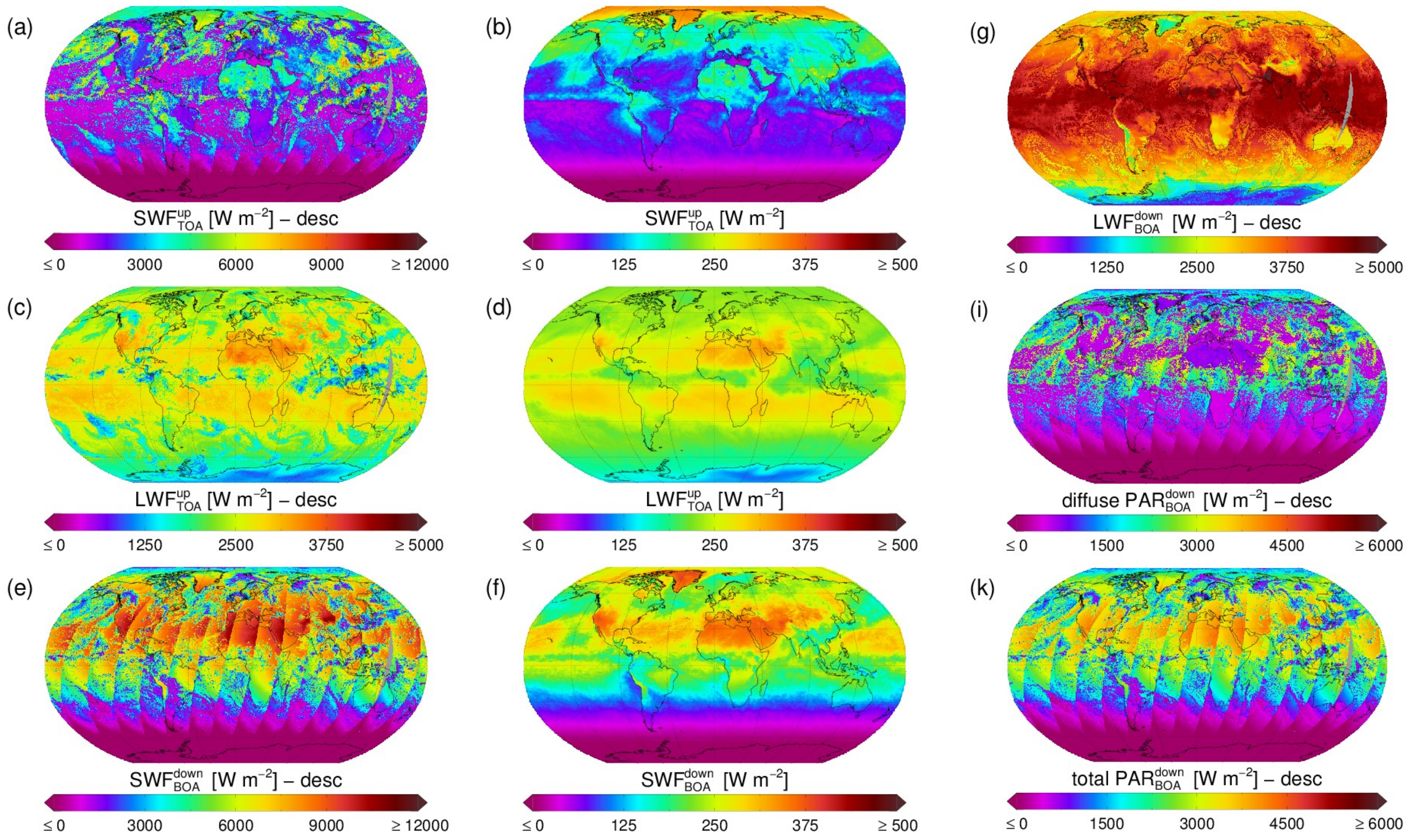


ORAC retrievals around Kilauea on 9 Sep 2008.

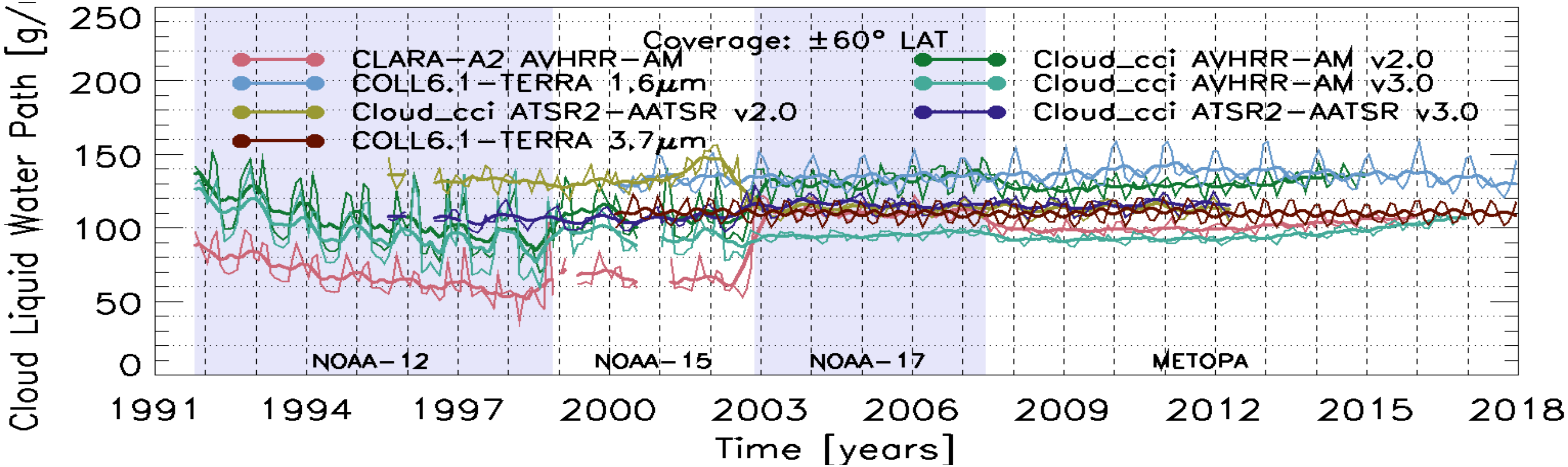
Optimal Retrieval of Aerosol and Cloud

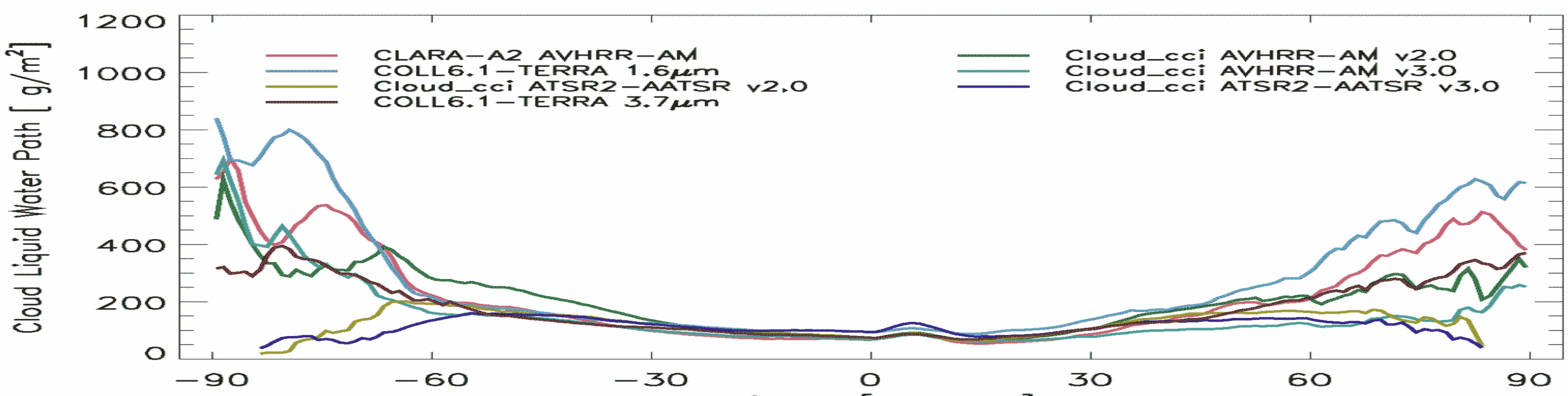
- The Optimal Retrieval of Aerosol and Cloud (ORAC) estimates the optical thickness and effective radius of particulates in the atmosphere given the refractive index and size/shape distribution.
  - Aerosol and cloud are just treated as two different types of particle.
- By combining these outputs with meteorological profiles, we can calculate radiative fluxes at the top and bottom of atmosphere.



Various radiative fluxes observed by AATSR in June 2008

Comparison of Cloud_cci AVHRR-AM v3 and ATSR2-AATSR v3 LWP





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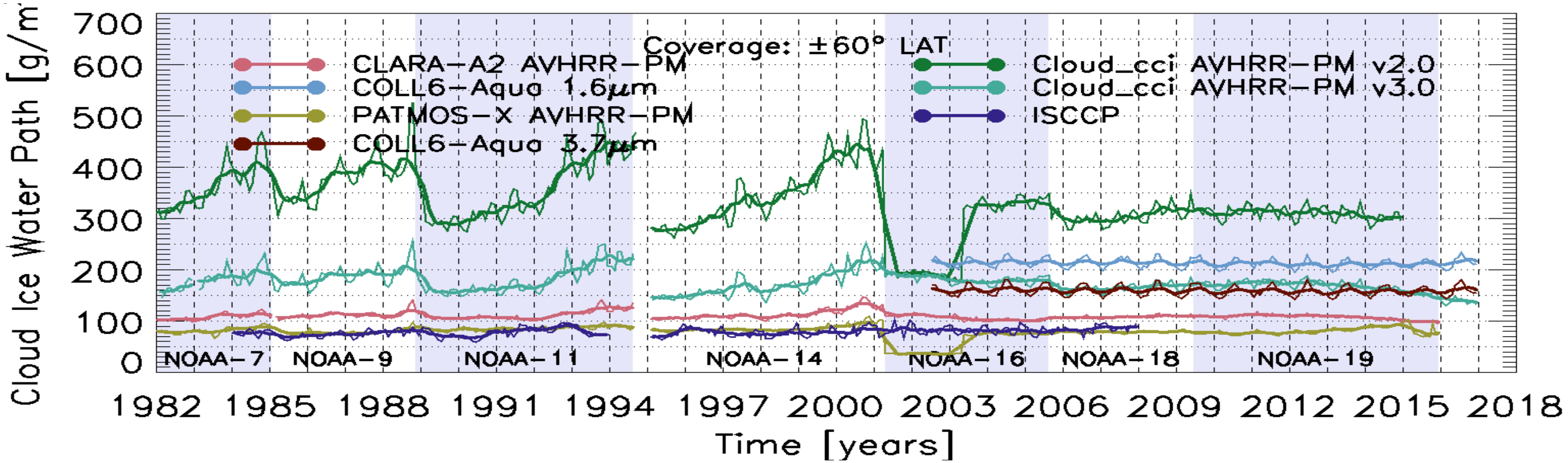
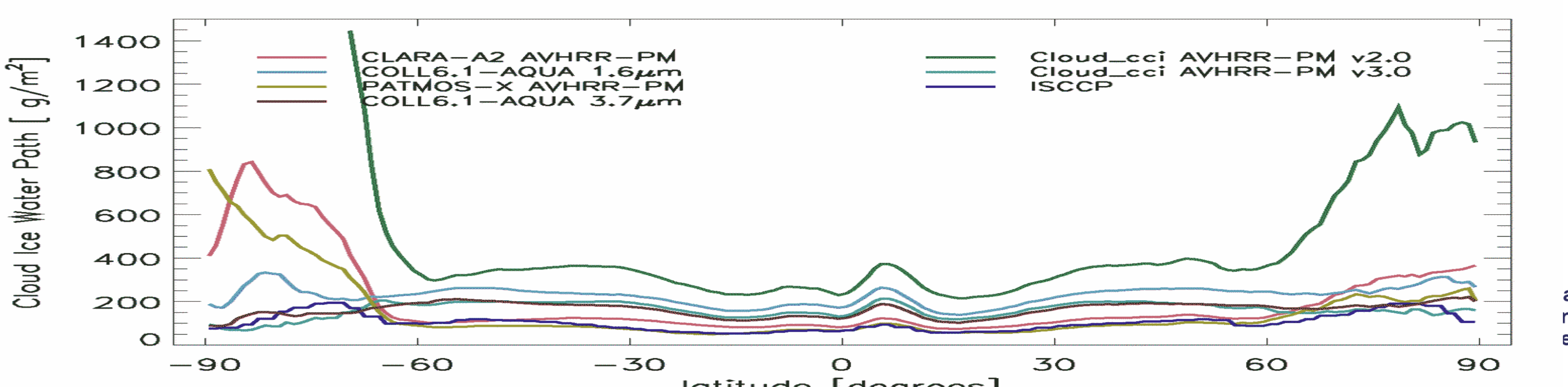
Comparison of Cloud_cci AVHRR-AM v3 and ATSR2-AATSR v3 IWP





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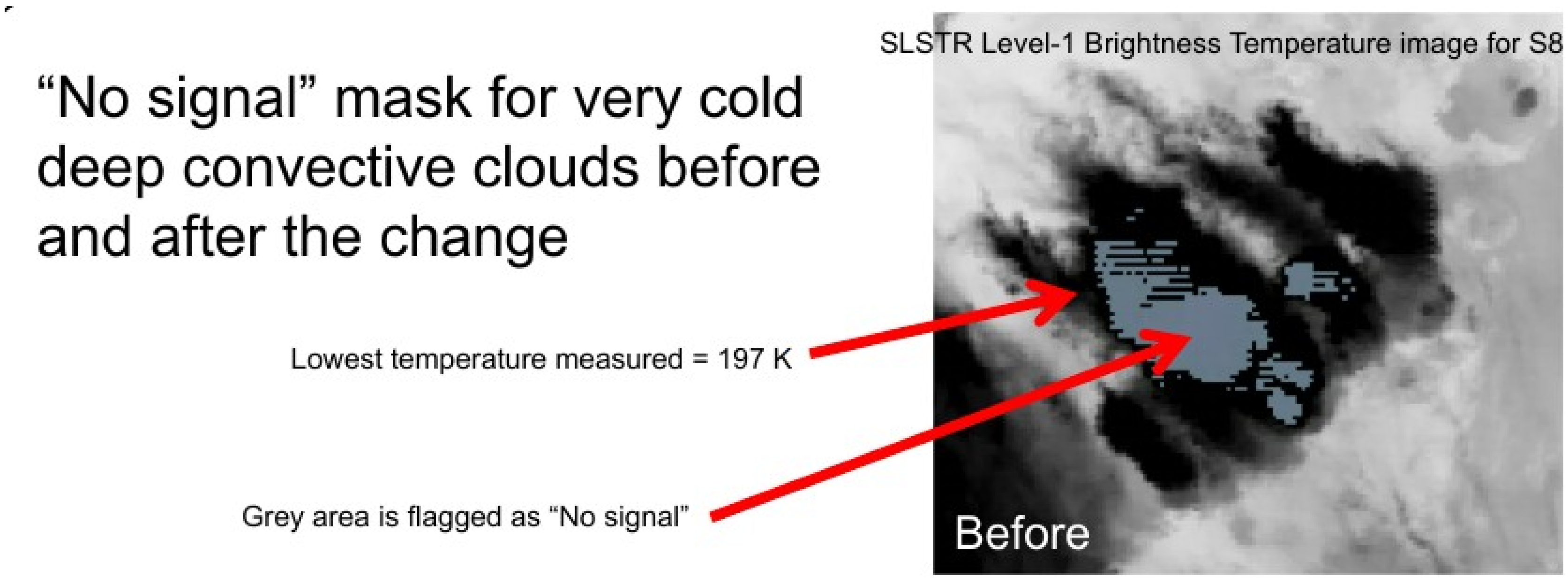
Deep convective clouds

- There were difficulties with retrieving deep convective clouds in the initial SLSTR data as the cloud top temperature fell beneath the detector’s dynamic range.



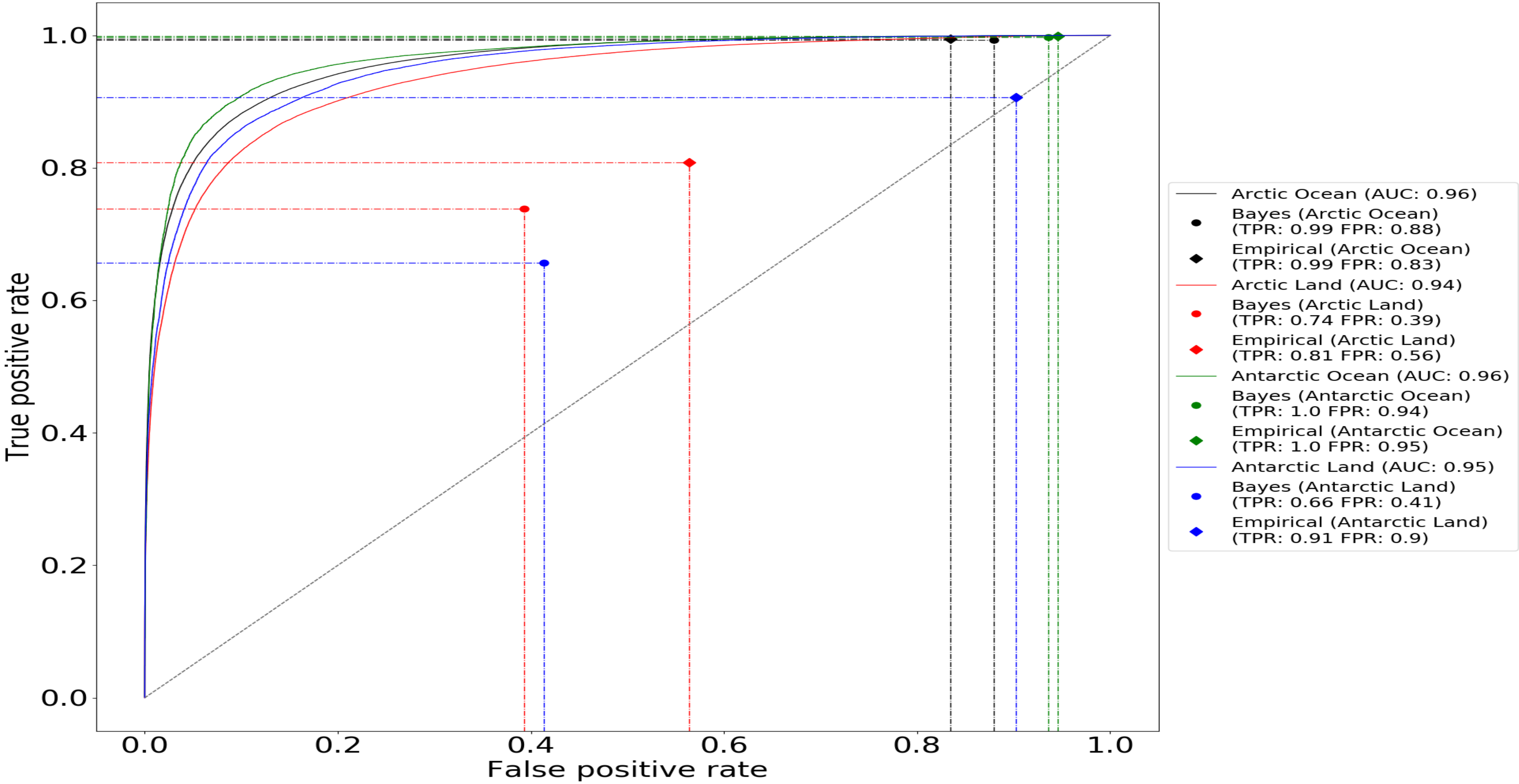
Deep convective clouds

- There were difficulties with retrieving deep convective clouds in the initial SLSTR data as the cloud top temperature fell beneath the detector’s dynamic range.
- Ed Polehampton determined that the the low temperature cutoff in the 10.8 um channel could be reduced from ~200 K to ~183 K, sufficient to achieve reasonable cloud products.

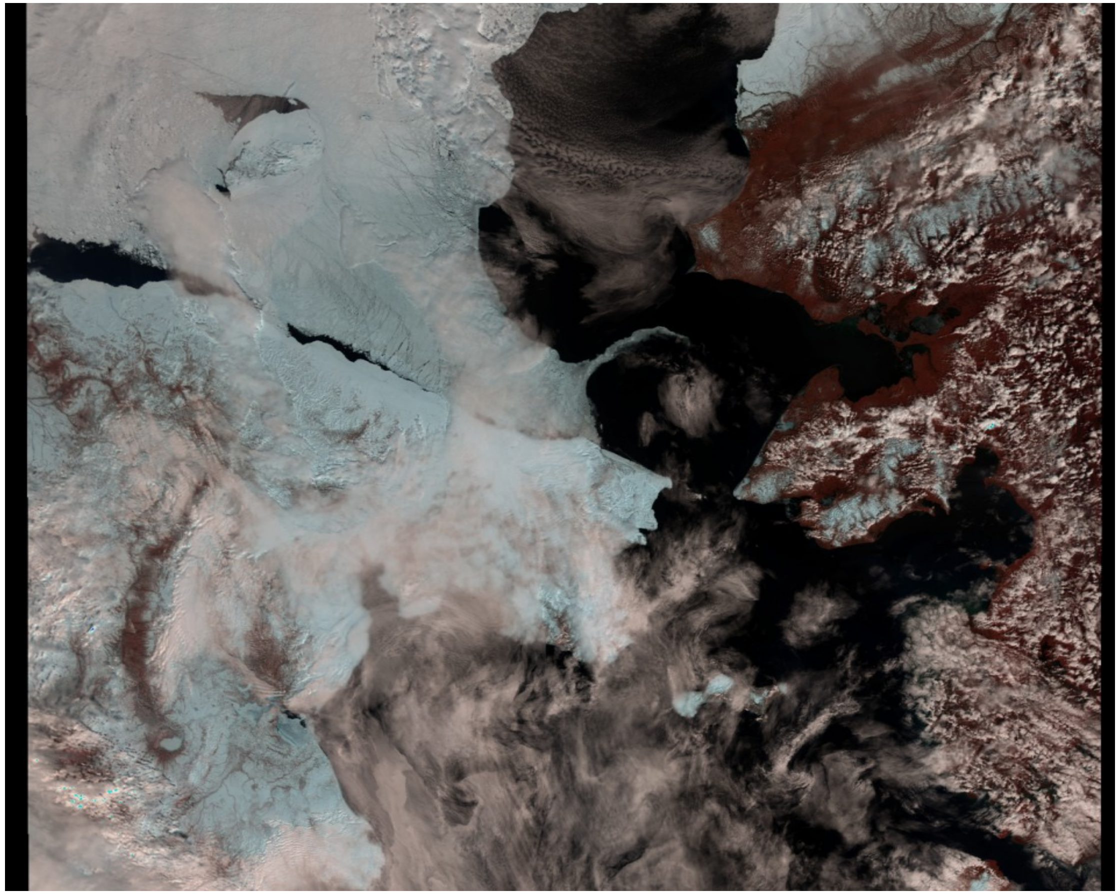
After the update, the limits are more consistent between the two S8 detectors.

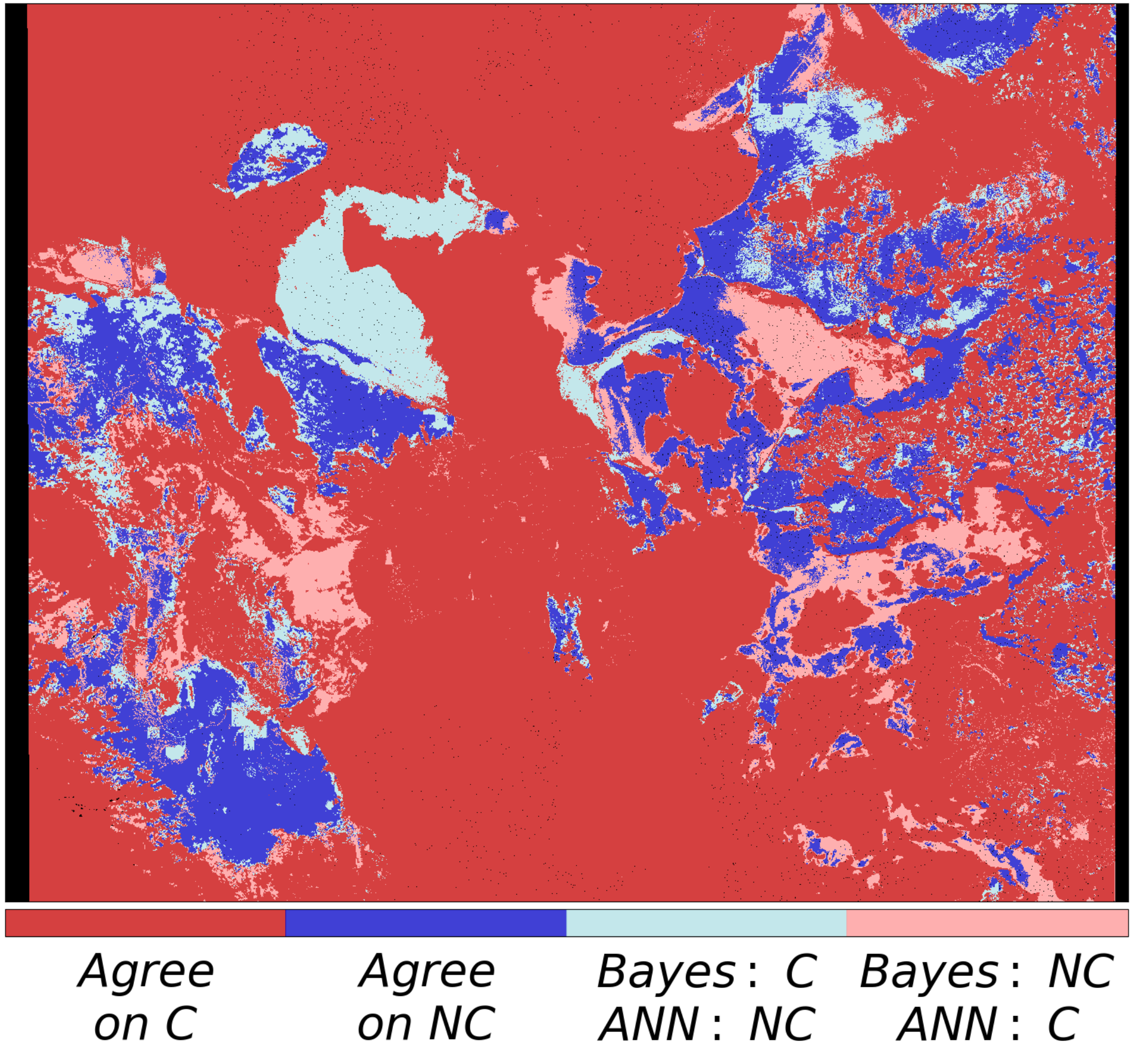
Improving the cloud mask using SLSTR's additional channels

- True positive vs false positive rate for various cloud masks.
- Dots show the performance of the current mask.
- Lines show the range of performance possible from neural networks.
- Colours distinguish different surface types.



Improving the cloud mask using SLSTR's additional channels





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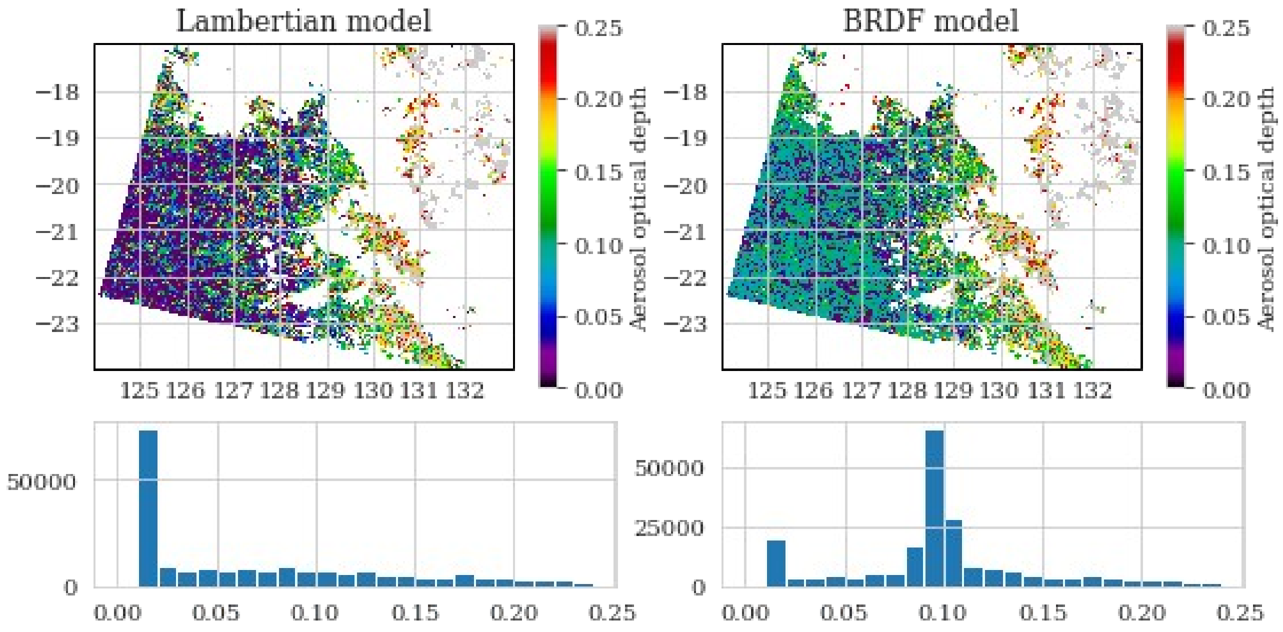
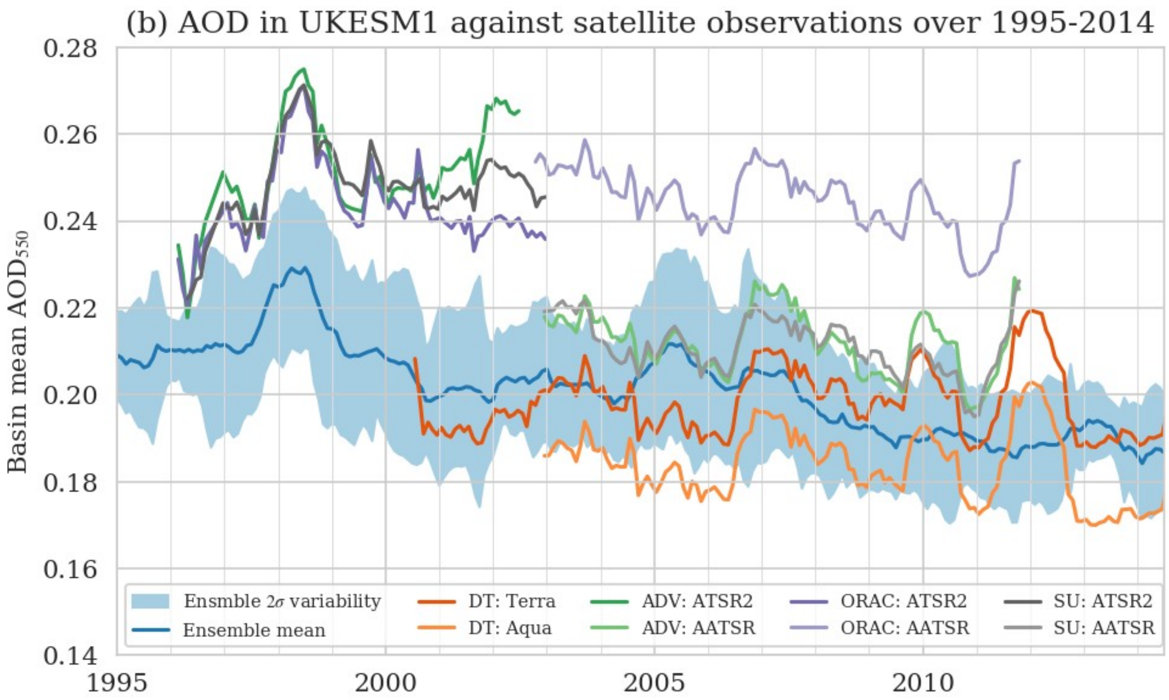
A new surface model

- Over land, ORAC currently uses the parameterisation for surface reflectance developed by Peter North et al. In the late 1990’s: $$\rho=(1-D)\left[ps+\frac{g\gamma s}{1-(1-\gamma)s}\right]+D\frac{\gamma s}{1-(1-\gamma)s}$$
  - While this accounts for the diffuse fraction illumination (through D), it is used within our forward model for a Lambertian surface.
  - Our standard processing uses a single value for the prior, while other surface models take the MODIS surface products as a prior. (A climatology has been produced but not yet used routinely.)
- Using the physical means of those terms, we can use this parameterisation with our forward model that fully resolves BRDF.

$$\rho_{0v}=ps\,;\rho_{dd}=\frac{\gamma s}{1-(1-\gamma)s}\,;\rho_{0d}=\frac{\gamma(1-\gamma)s^2}{1-(1-\gamma)s}$$



Comparing the UKESM to an ensemble of observations



- A simple evaluation of the output can be made by comparing the global mean AOD calculated to that observed.
  - This is a vastly oversimplified comparison but annoyingly common because it is easily understood.
  - Shown opposite are global, annual means from UKESM (black), MODIS (blue), and three AATSR algorithms. While the magnitudes of the various sources differ significantly, the tendency over time is quite similar. For example, all examples catch the El Nino in 1998.
- One can do a little better by focusing on a particular region and/or shorter timespans.
  - Here we highlight monthly mean AOD over the north Atlantic basin.

Summary

- ORAC cloud products are, after over a decade of development, now performing at least as well as the other major cloud products.
  - Improved coverage over the poles.
- As the C3S cloud processor, ORAC is a proven operational processor.
  - Continued development, including applying ORAC to SEVIRI and refining use of the additional channels on SLSTR, is funded through Cloud CCI and national sources.
  - Code already written to support AVHRR, ATSR, SLSTR, MODIS, VIIRS, SEVIRI, Himawari, and GOES.
- ORAC products are versatile.
  - Easily combined with radiatively consistent aerosol retrievals.
  - Outputs high resolution radiative fluxes at the top and bottom of the atmosphere.
  - The greater coverage from SLSTR will, for example, provide the ability to monitor tropical storms and typhoons at a different overpass time to MODIS.