‘Deep Blue’ aerosol update: MODIS Collection 6 and SeaWiFS version 4

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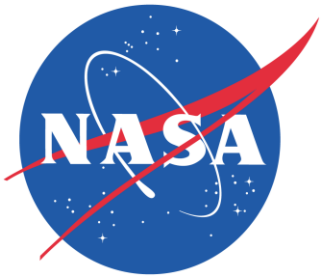

For those who want to get back to checking emails, here are the main points:

- Two new Deep Blue dataset versions coming soon (no, really):
- MODIS Collection 6
  - Expanded to all snow-free land surfaces
  - Better than Collection 5
- SeaWiFS version 4
  - ‘Maintenance’ release, modest changes
  - Better than version 3
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- I’ll talk largely about datasets, rather than algorithms
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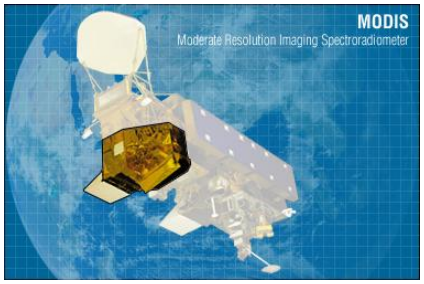
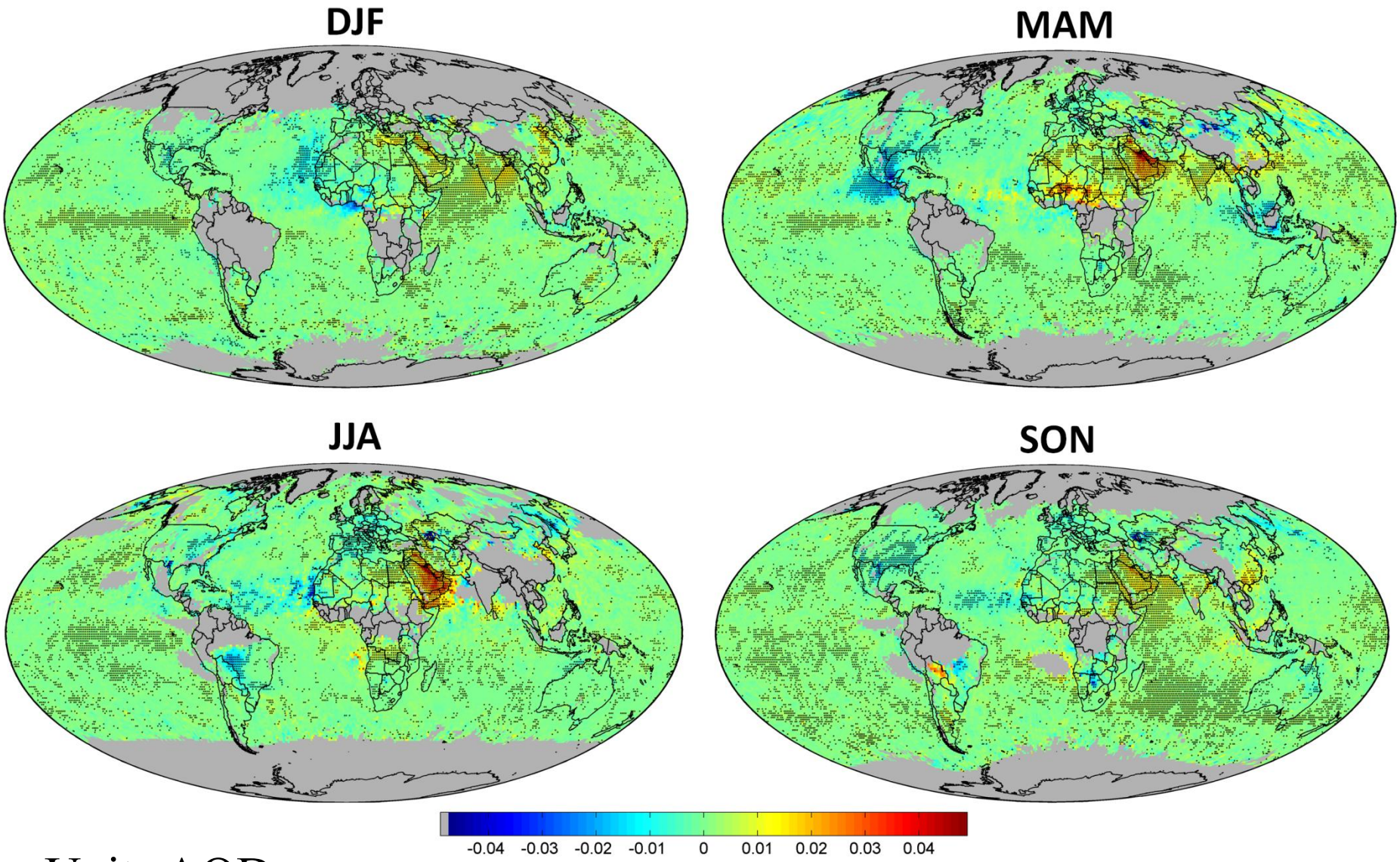


MODIS vs. SeaWiFS Deep Blue

MODIS	SeaWiFS
Two sensors: MODIS Terra (2000 onwards) and MODIS Aqua (2002 onwards)	One sensor aboard the SeaStar satellite (1997-2010, a few gaps)
Cloud-free snow-free land surfaces only	Cloud-free snow-free land surfaces (Deep Blue algorithm) Cloud-free ice-free non-turbid water (SOAR algorithm)
Main data product is AOD at 550 nm Also provides AOD at 412/470/670 nm, Ångström exponent, and SSA (for heavy dust)	Main data product is AOD at 550 nm Over land, also provides AOD at 412/490/670 nm, Ångström exponent, and SSA (for heavy dust) Over water, also provides AOD at 510/670/865 nm, Ångström exponent, and fine mode fractional volume
'Level 2' products at nominal 10 km x 10 km resolution, ~2,330 km swath	'Level 2' products at nominal 13.5 km x 13.5 km resolution, ~1,500 km swath (in global mode)
'Level 3' 1° aggregates at daily, 8-day, and monthly resolution	'Level 3' 0.5° and 1° aggregates at daily and monthly resolution
Distributed by MODIS LAADS Level 3 visualisation through Giovanni	Distributed by GES DISC Level 3 visualisation through Giovanni

SeaWiFS 550 nm AOD linear trends/changes, 1998-2010

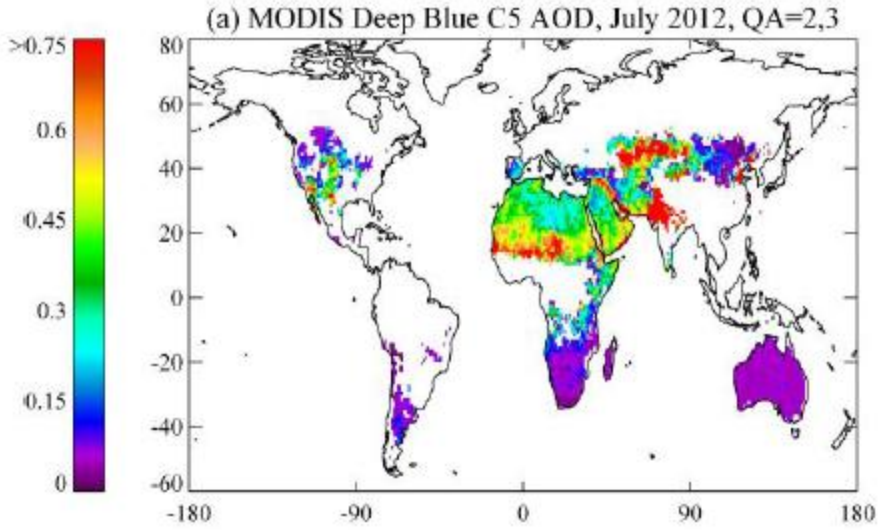


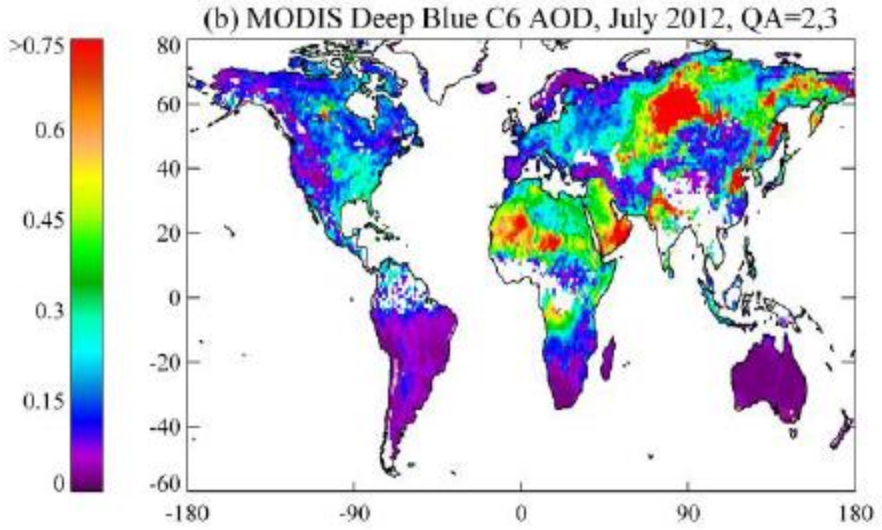
- Units AOD per year
- Dots indicate statistical significance at the 95% confidence level

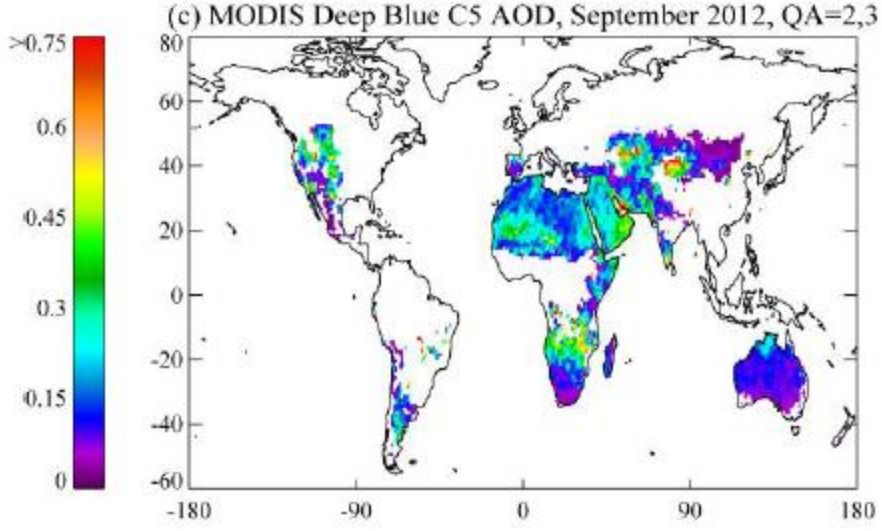
MODIS C6: Main developments

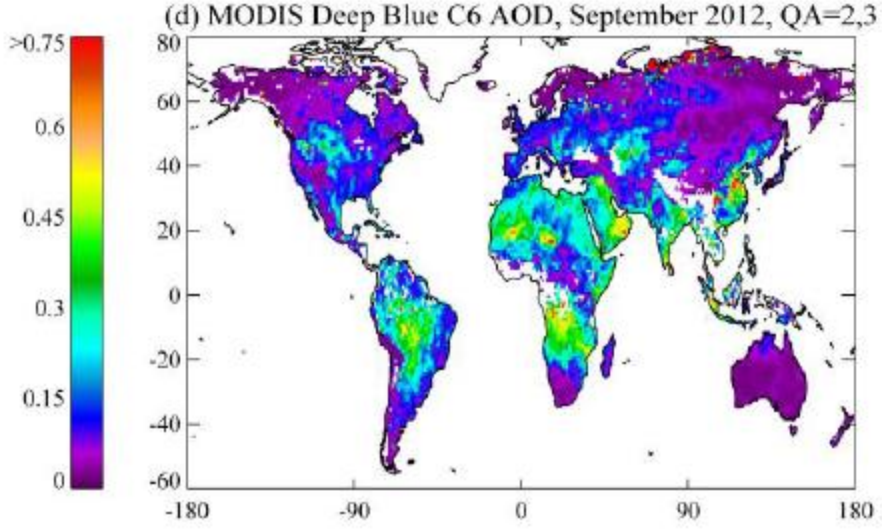
- Collection 6 refinements to Deep Blue:
  1. Extended coverage to vegetated surfaces, as well as bright land
  2. Improved surface reflectance models
  3. Improved aerosol optical models
  4. Improved cloud screening
  5. Simplified quality assurance (QA) flags
  6. Calibration improvements will mean that Deep Blue can be applied to the whole MODIS record
  7. Merged Deep Blue – Dark Target aerosol SDS, to provide a dataset with fewer gaps, for visualisation purposes
- Collection 6 Deep Blue papers:
  - Hsu *et al.*, Enhanced Deep Blue Aerosol Retrieval Algorithm: the 2nd Generation, *J. Geophys. Res.* (submitted)
  - Sayer *et al.*, Validation and uncertainty estimates for MODIS Collection 6 `Deep Blue' aerosol data, *J. Geophys. Res.* (submitted)

MODIS C6: Extended spatial coverage

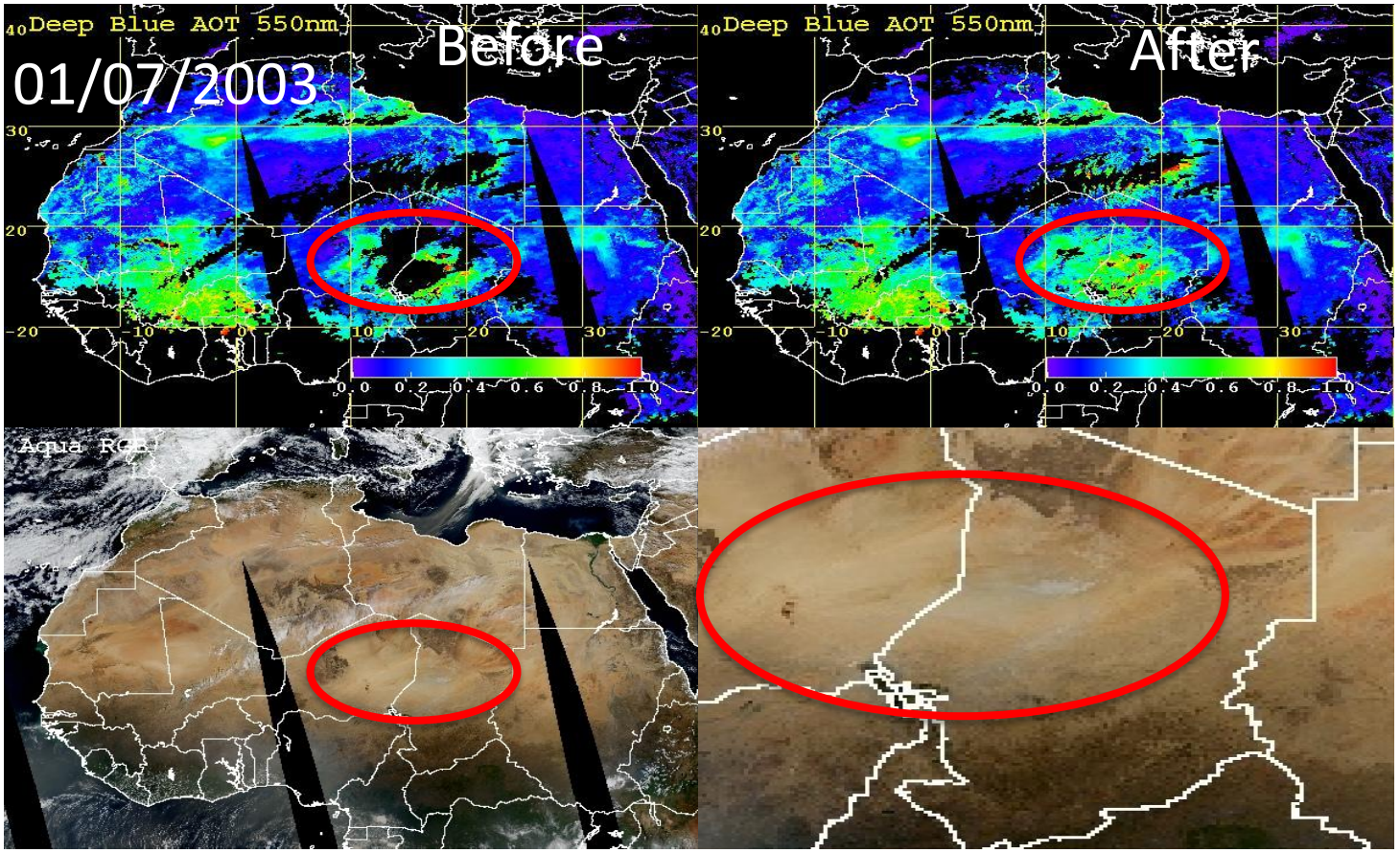








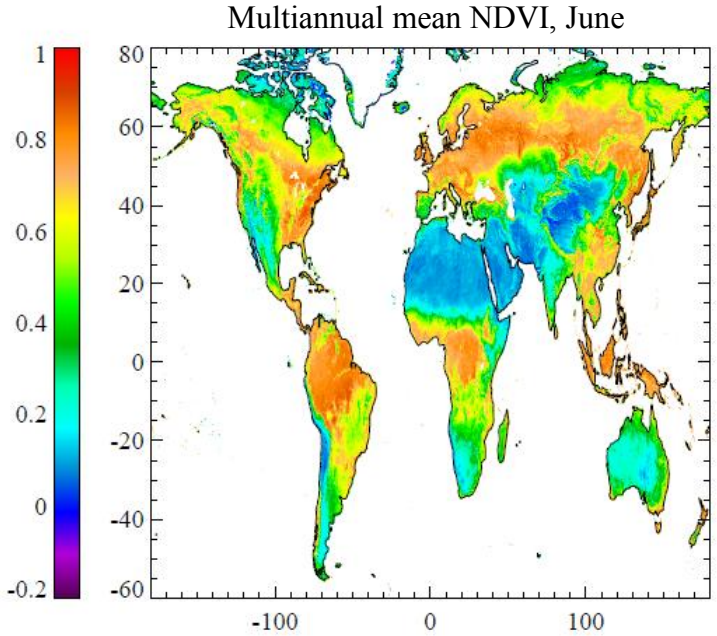
Cloud screening

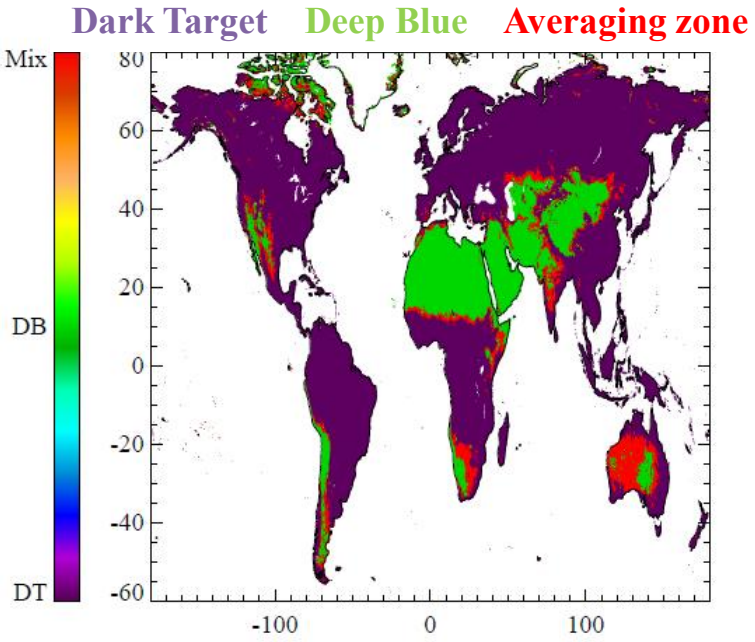


- In Collection 5, some cloud-free areas were flagged as cloudy by the 1.38 micron (cirrus/high cloud) test
  - Combination of high surface reflectance, aerosol, and low columnar water vapor
  - Fix in C6 typically gives more high-AOD events
- Missed clouds also decreased through refinement of other cloud tests and QA flags

Merged dataset

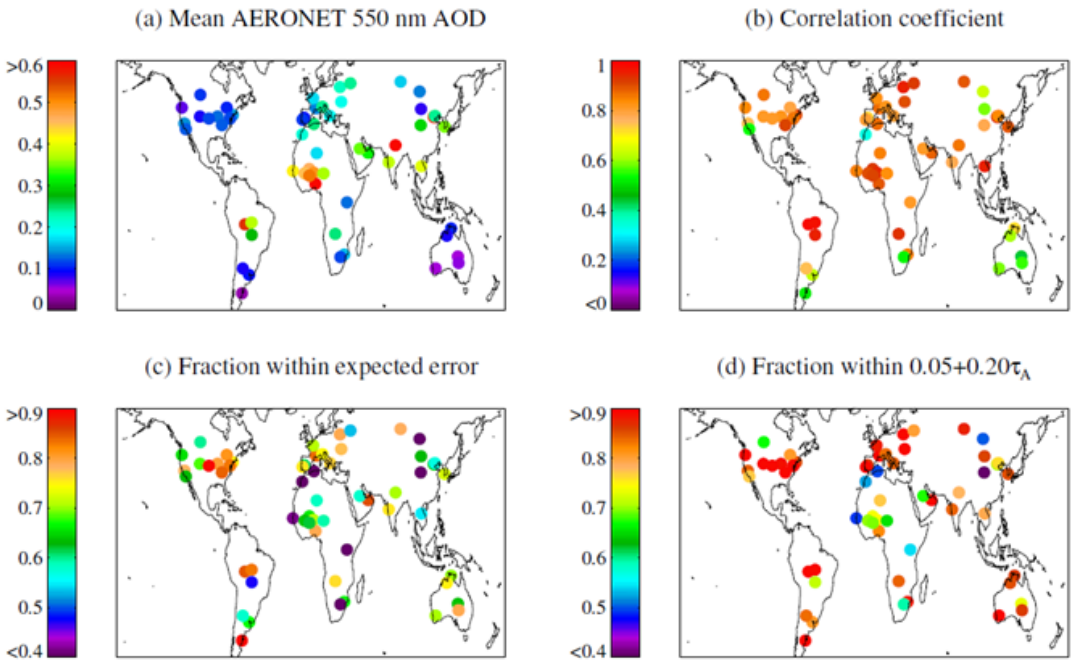
- C6 will include a new SDS of merged 550 nm AOD from the Deep Blue and Dark Target algorithms.
  - Mostly for imaging
  - Users need to be thoughtful for scientific analyses!
- To minimize pixel-level discontinuities and for simplicity/clarity, pixels will be assigned to either algorithm based on climatology of NDVI
  - Note SDS will also include the ocean algorithm retrievals
  - 'Averaging zone' where retrievals will either be averaged (if the same QA) or that with higher QA flag chosen

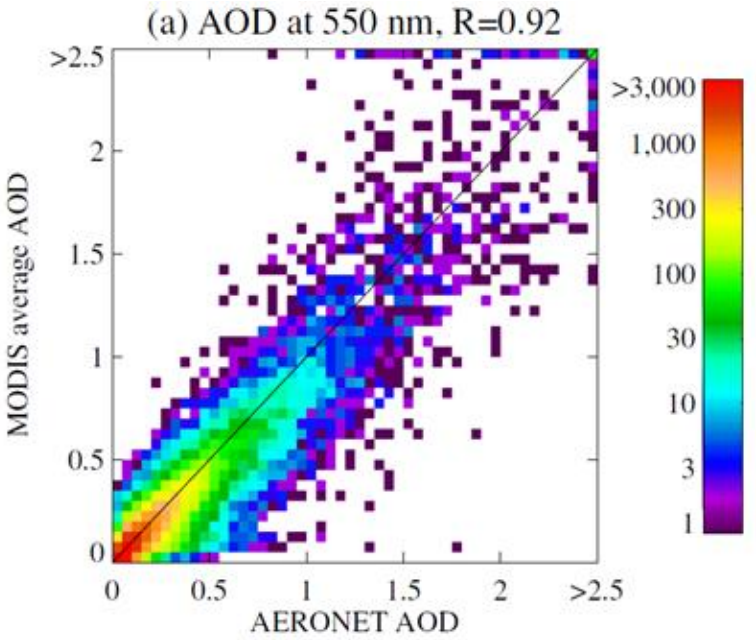




C6 AOD validation

- Validated Aqua data against AERONET at 60 sites
- One-sigma absolute uncertainty estimates provided for each retrieval, dependent on viewing geometry and AOD
  - For typical geometries, absolute expected error (EE) ~0.03+20%
- Performance poorer for spatially heterogeneous sites, and complex aerosol mixtures
- For sites where both C5 and C6 perform retrievals, C6 data have:
  - Better data volume (factor of ~2)
  - Better correlation with AERONET (0.93 vs. 0.86)
  - Smaller errors (bias ~halved, RMS error decrease by ~30%)

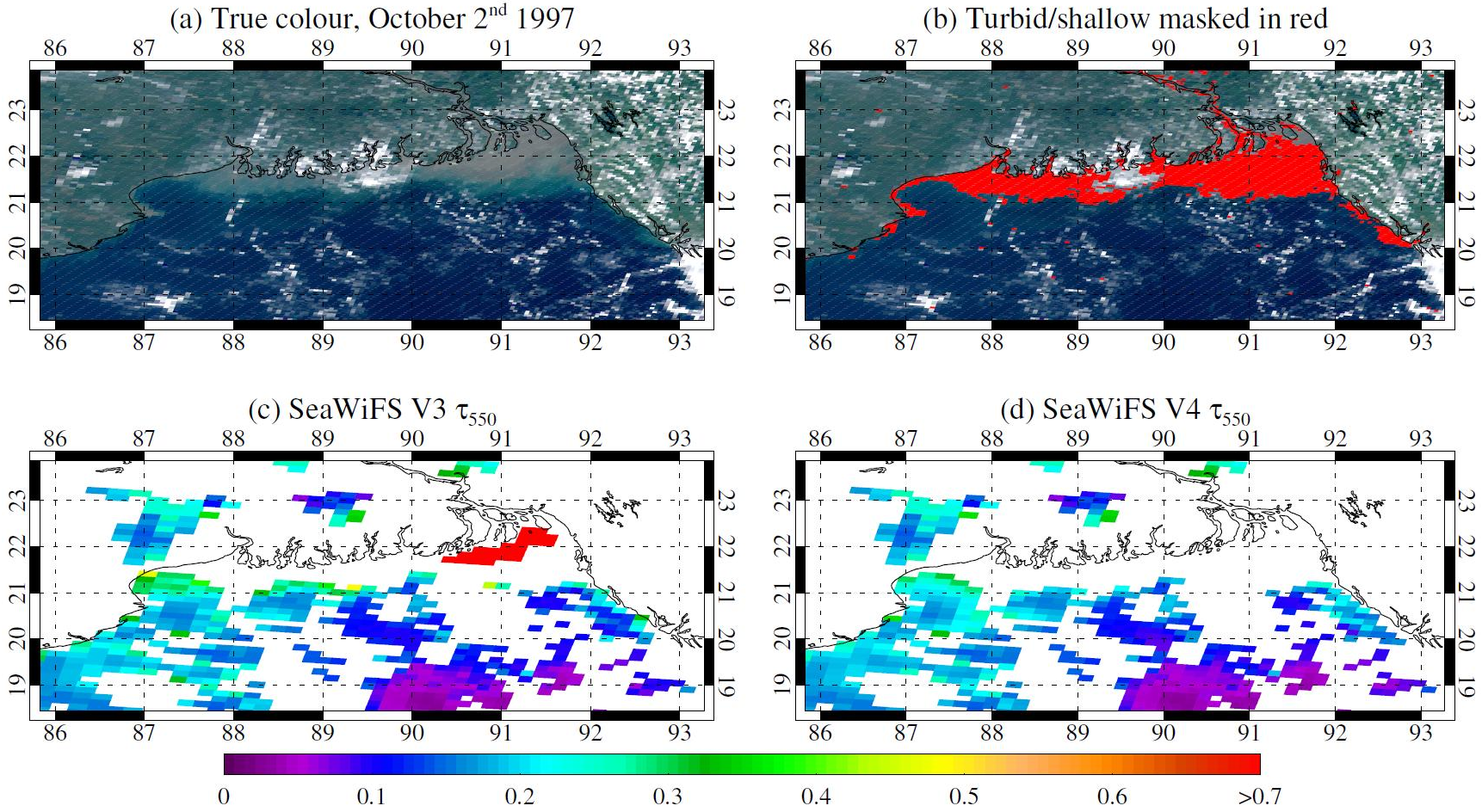




SeaWiFS v4: Main developments

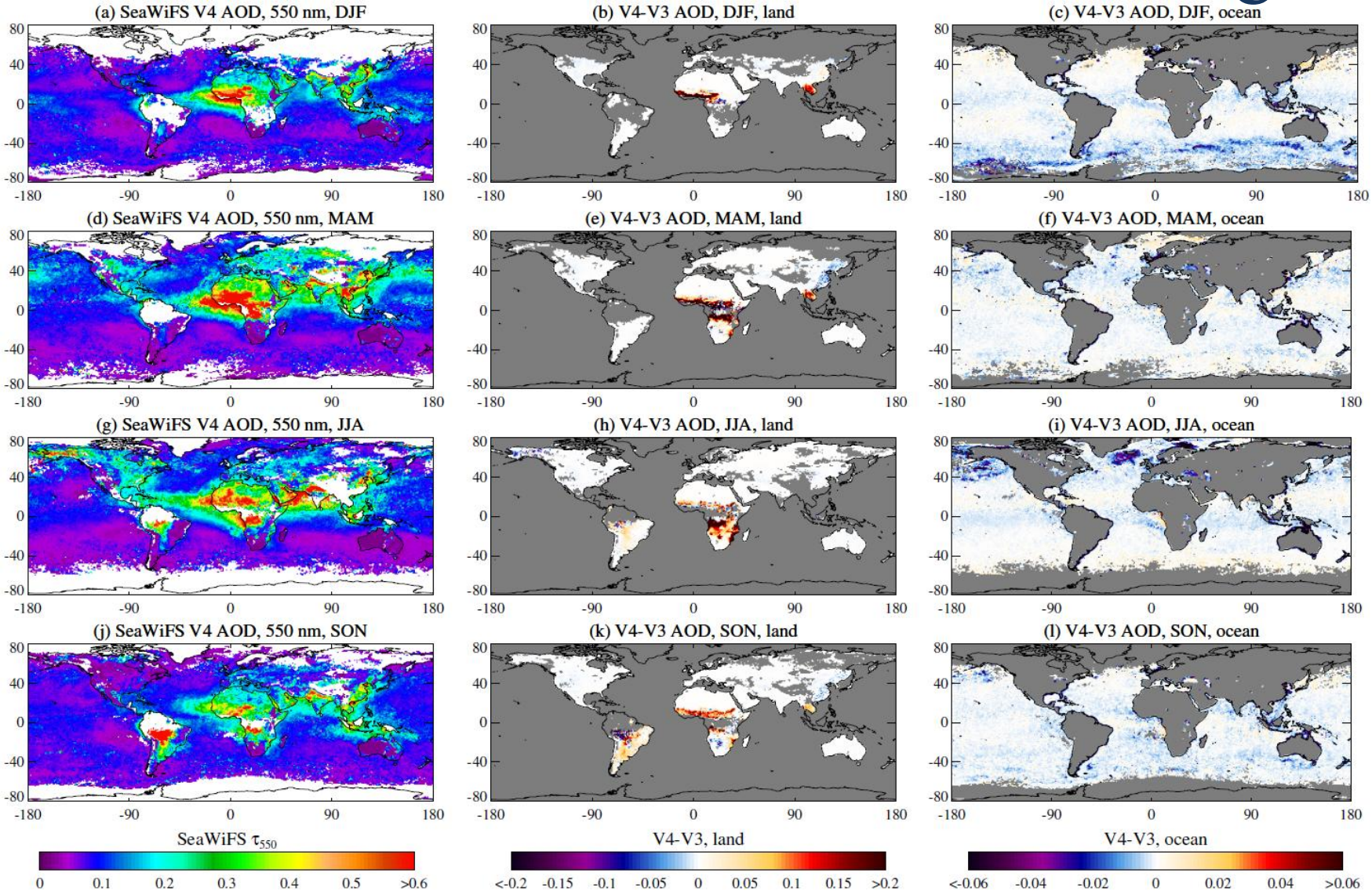
- Minor refinements rather than huge changes
- Retrievals over water:
  - Improved turbid water detection
  - Fixed a coding error, which led to retrieval results being reported slightly incorrectly in some cases
- Retrievals over land:
  - Updated aerosol model selection in some regions, to address some previously-identified biases
- Updated metadata, level 3 aggregation

Turbid/shallow water detection



- Near coasts, particularly near mouths of rivers, water can be turbid
- In very shallow waters (e.g. the Bahamas), satellites can see the bottom
- Both situations violate the algorithmic assumption that water is blue
  - Leads to persistent (generally positive) biases in retrieved AOD
- The turbid/shallow water test in v3 failed in some cases; this has been improved in v4

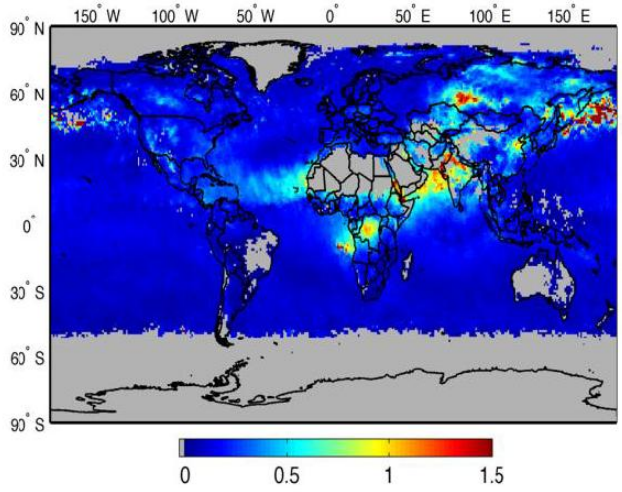
SeaWiFS: How much have the data changed?



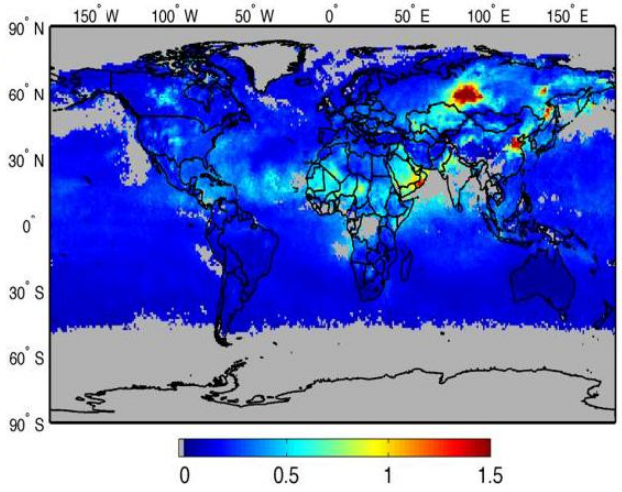
- Left: Seasonal mean AOD at 550 nm from SeaWiFS V4 for the year 2004
- Middle: V4-V3, over land
- Right: V4-V3, over ocean

The Future: VIIRS

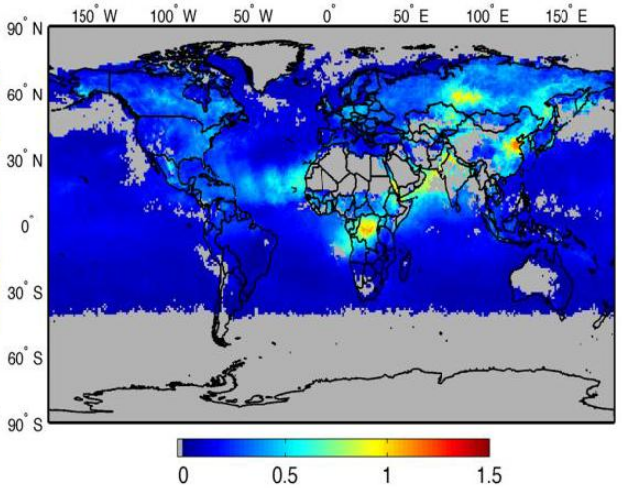
MODIS Aqua, Dark Target/ocean



VIIRS, Deep Blue/our ocean



VIIRS, NOAA algorithms



- Visible and Infrared Imaging Radiometer Suite (VIIRS) launched on Suomi-NPP in late 2011
  - In terms of characteristics relevant for AOD retrieval, VIIRS is similar to MODIS
- Developing Deep Blue and an ocean algorithm for VIIRS
  - Example shown for July 2012
  - Preliminary, but looks reasonable

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