MODIS Collection 6 Clear Sky Restoral: Filtering cloud mask “not clear” pixels

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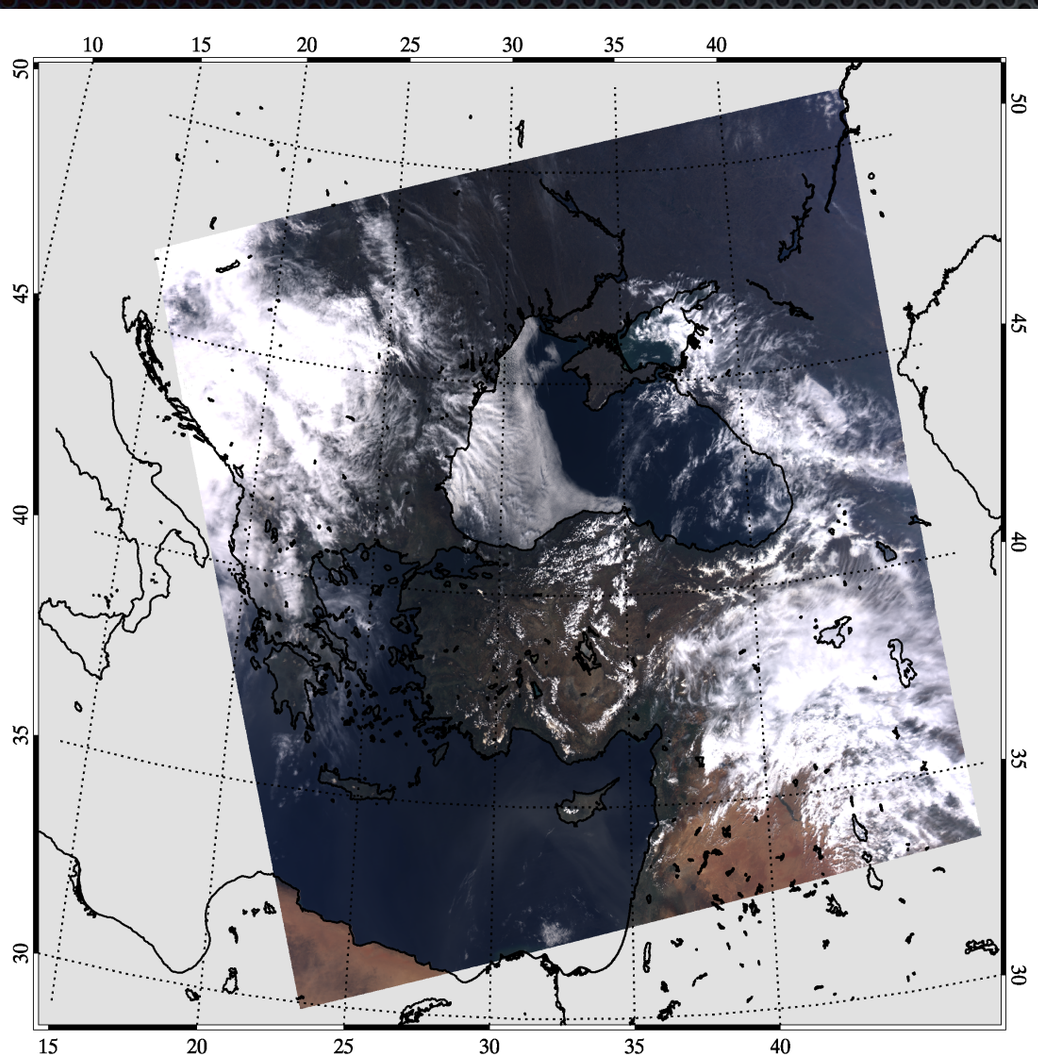
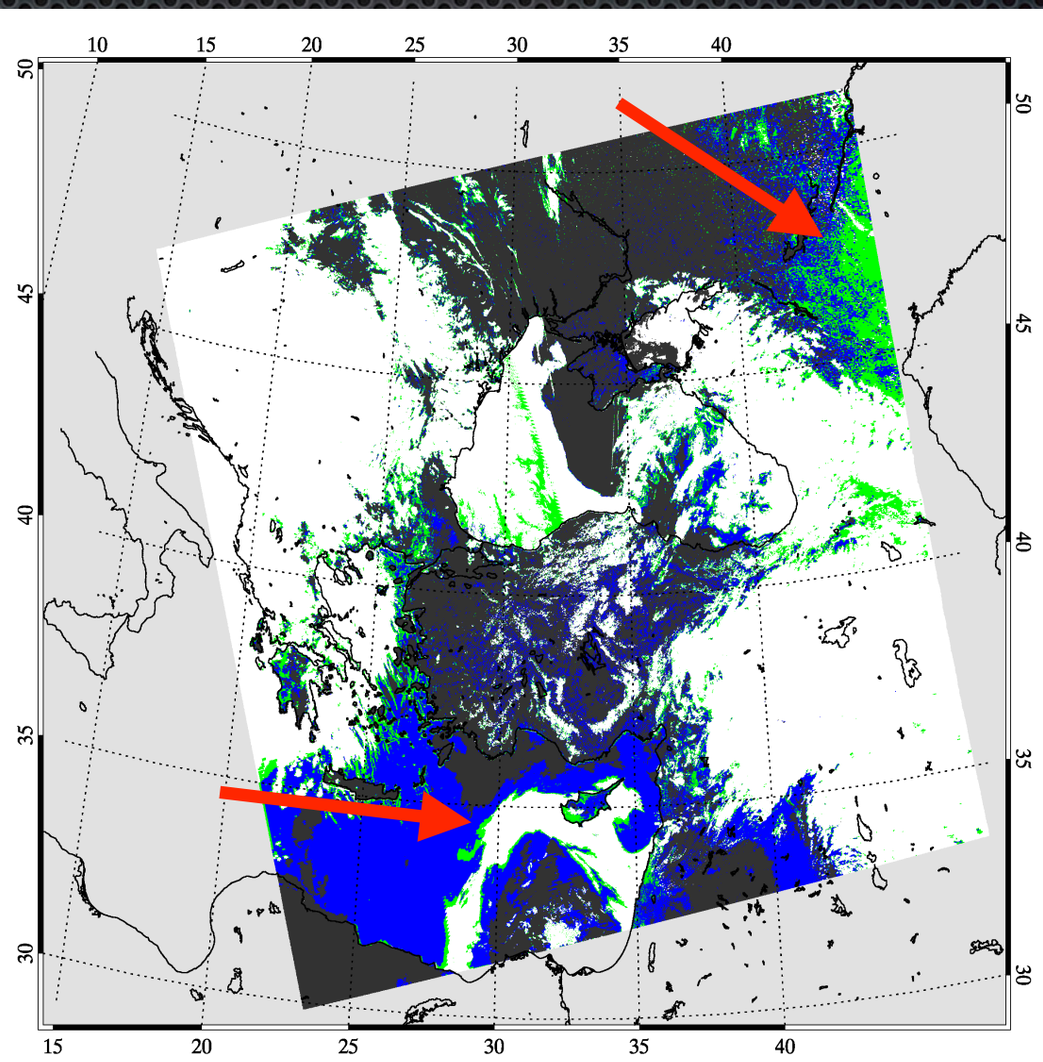
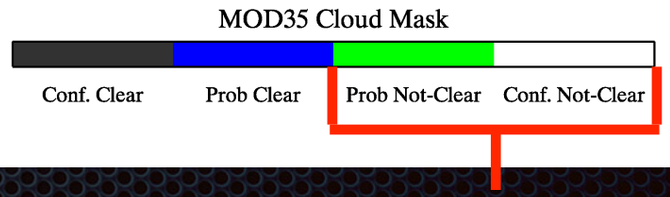
Motivation





Aqua MODIS, 9 April 2005 (1050 UTC)



MOD06 Retrievals

Meyer et al., CREW-4 2014

Clear Sky Restoral (CSR)

- Attempt to identify cloud mask “not clear” pixels that are poor retrieval candidates.
  - Three categories: not cloud (e.g., sun glint, thick smoke or dust), partly cloudy, or cloud edge.
- Introduced in MOD06 Collection 5.
  - All pixels in above categories were “restored to clear sky” (i.e., thrown out) => not part of the level-2 (or level-3) retrieval population.
  - Pixel CSR designations buried as a QA bit flag.
- CSR is more visible in C6.
  - **Partly cloudy and cloud edge retrievals are now reported and aggregated independently for level-2 and level-3 (*_PCL SDS).**

Meyer et al., CREW-4 2014

CSR Details

```
if (not clear) then
    if (glint, smoke, dust) then
        CSR = 2
    else if (partly cloudy) then
        CSR = 3
    else if (cloud edge) then
        CSR = 1
    else
        CSR = 0, overcast
    end if
end if
```

Meyer et al., CREW-4 2014

CSR Details

```
if (not clear) then
    if (glint, smoke, dust) then
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        CSR = 1
    else
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    end if
end if
```

- Cloud altitude test
- $R_{1.38}$ threshold
- $R_{0.86}$, $R_{1.24}$, $R_{2.1}$, $R_{1.38}$ monotonic/curvature test
- Dual-threshold spatial variability
- Aerosol sanity check (new)

Meyer et al., CREW-4 2014

CSR Details

```
if (not clear) then
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        CSR = 3
    else if (cloud edge) then
        CSR = 1
    else
        CSR = 0, overcast
    end if
end if
```

- 250m cloud mask fraction
- Over ocean only

Meyer et al., CREW-4 2014

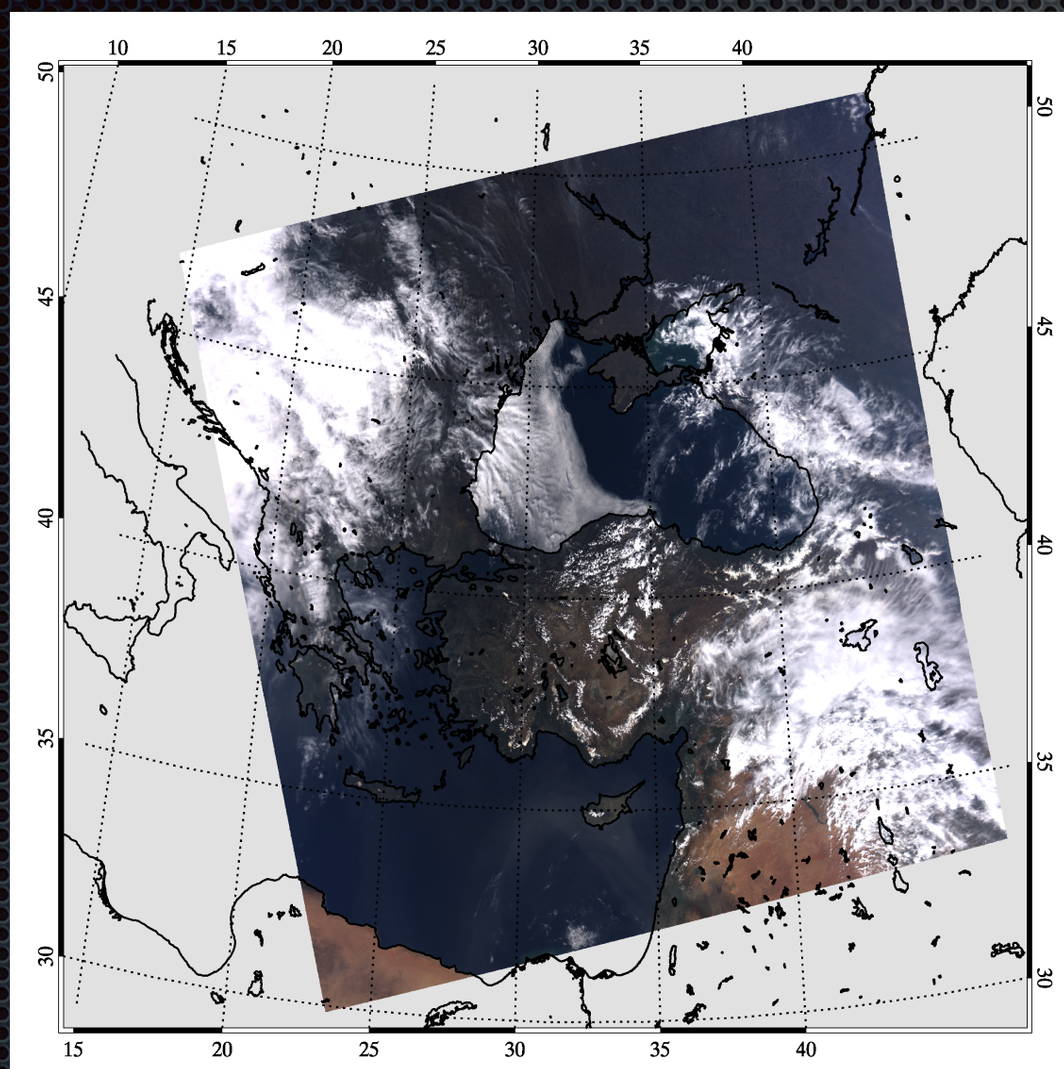
CSR Details

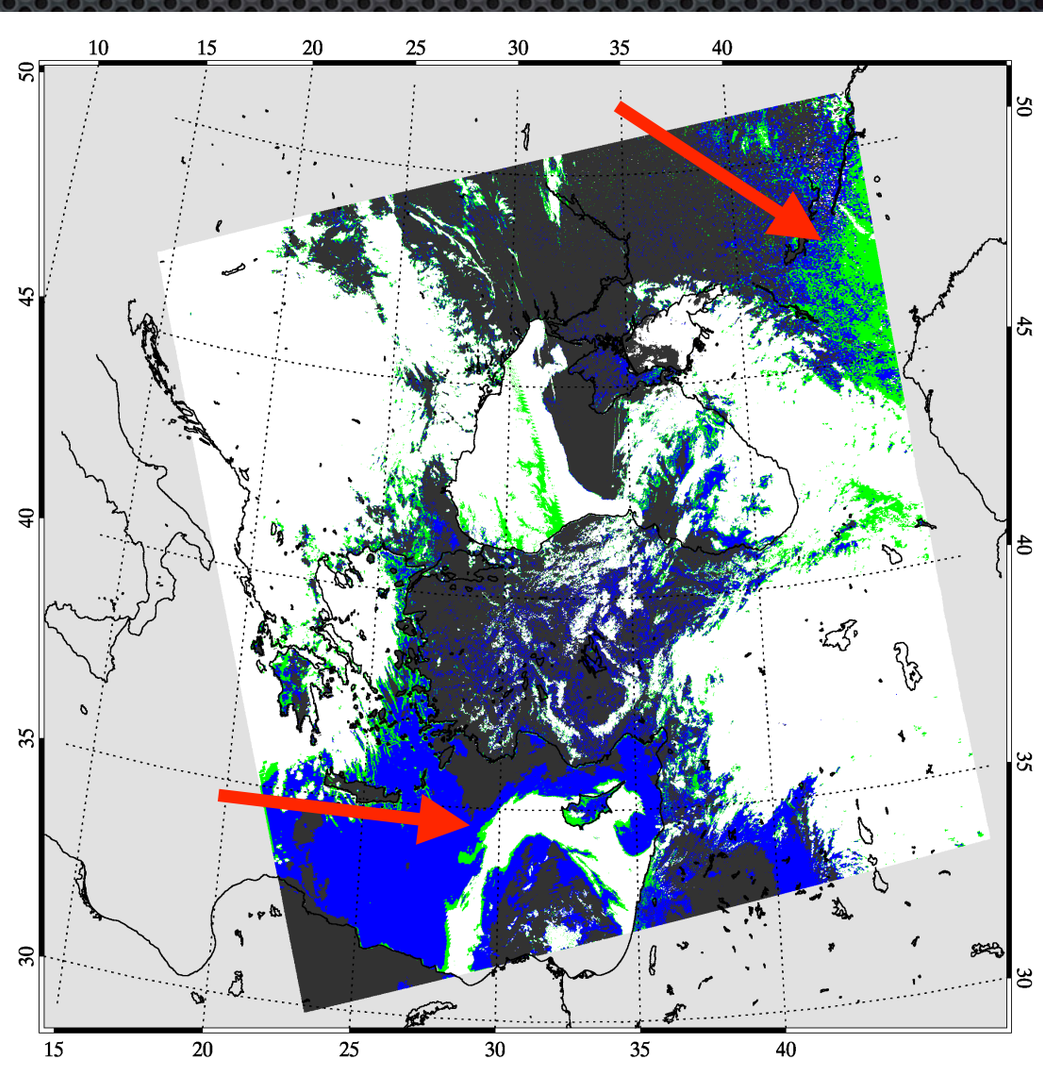
```
if (not clear) then
    if (glint, smoke, dust) then
        CSR = 2
    else if (partly cloudy) then
        CSR = 3
    else if (cloud edge) then
        CSR = 1
    else
        CSR = 0, overcast
    end if
end if
```

- Clear sky adjacency test

Meyer et al., CREW-4 2014

CSR Example





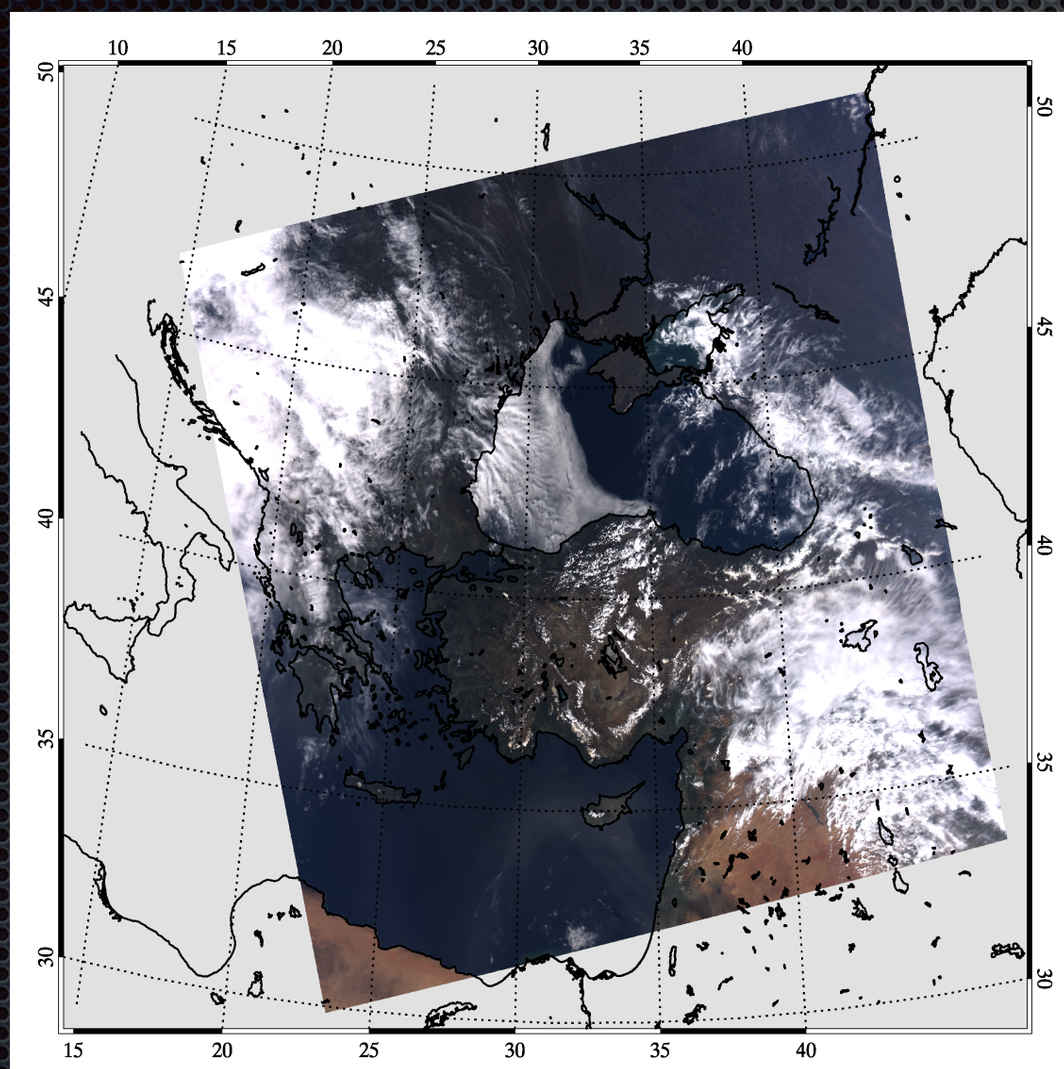
Aqua MODIS, 9 April 2005 (1050 UTC)

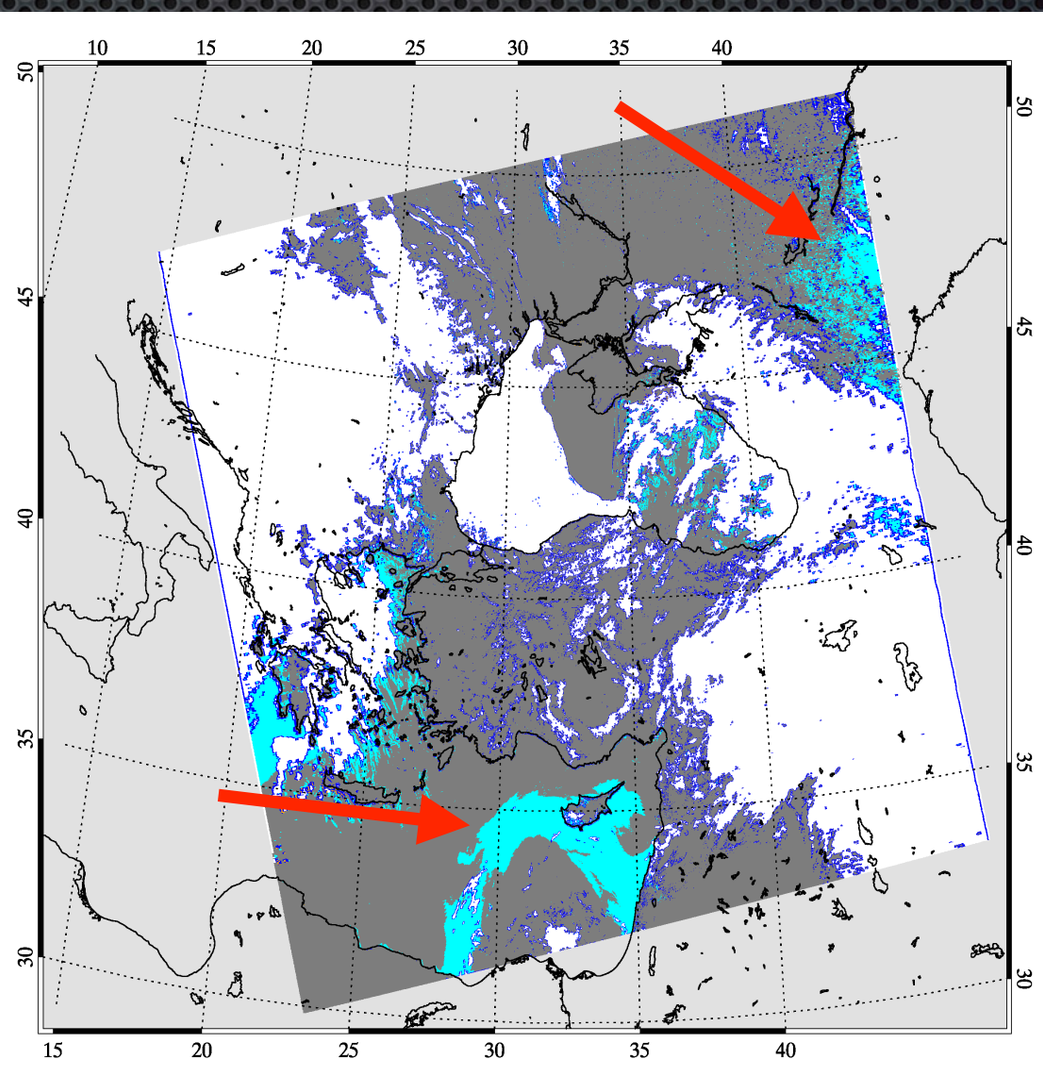
MOD35 Cloud Mask

Conf. Clear | Prob Clear | Prob Not-Clear | Conf. Not-Clear

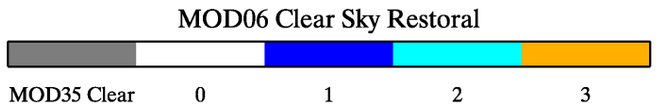
Meyer et al., CREW-4 2014

CSR Example



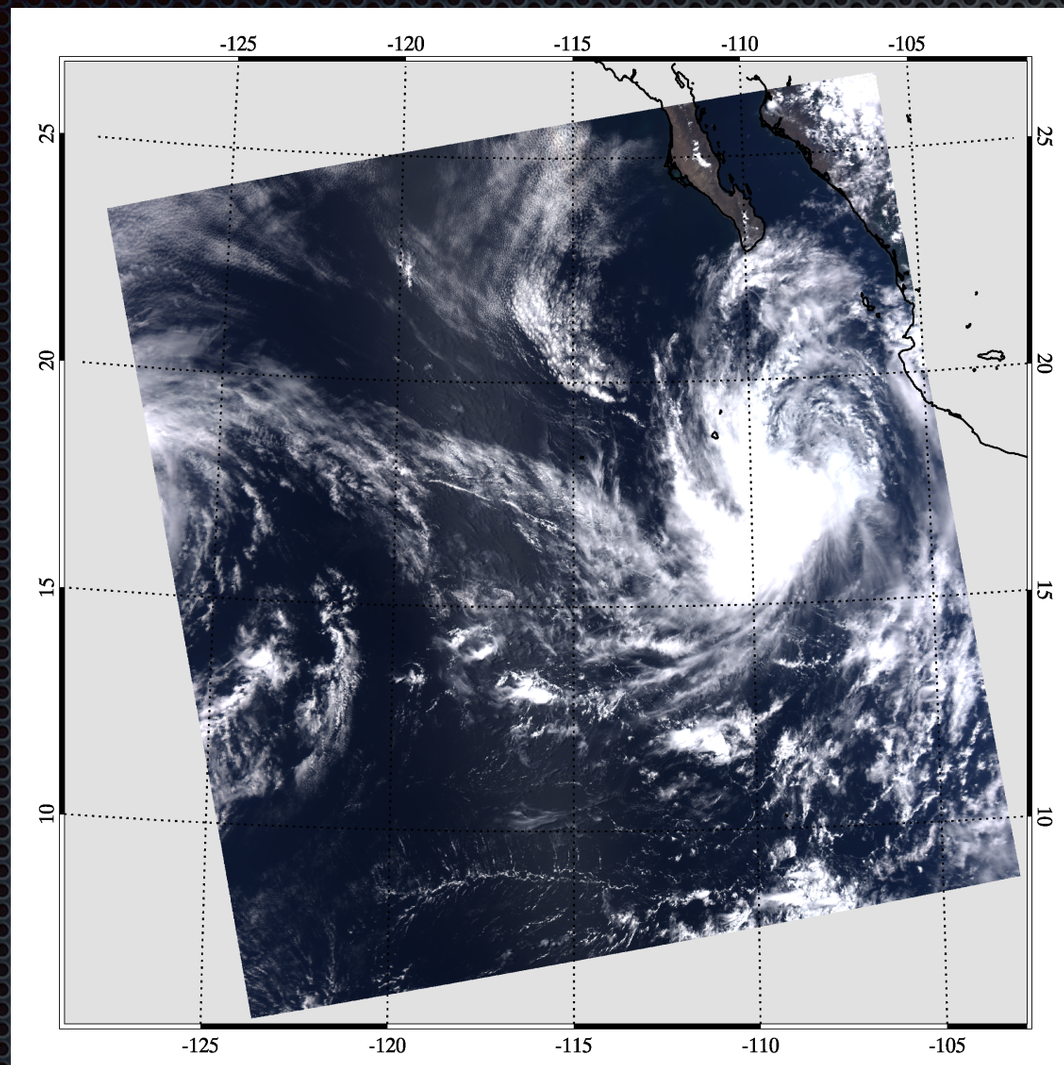


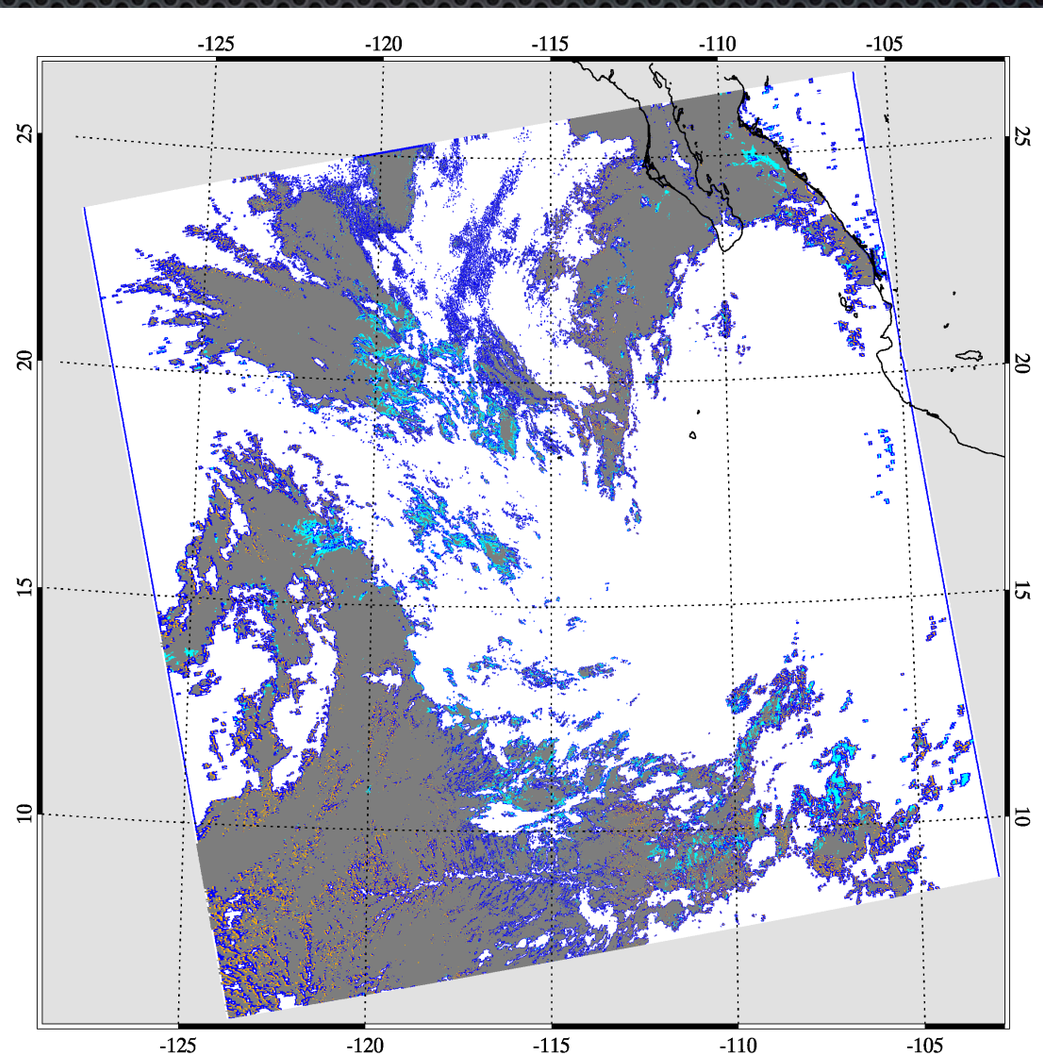
Aqua MODIS, 9 April 2005 (1050 UTC)



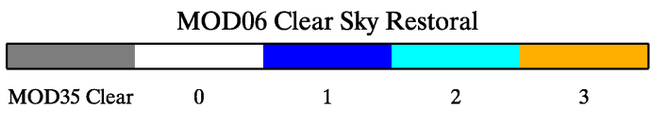
Meyer et al., CREW-4 2014

CSR Filtering





Aqua MODIS, 2 July 2008 (2105 UTC)



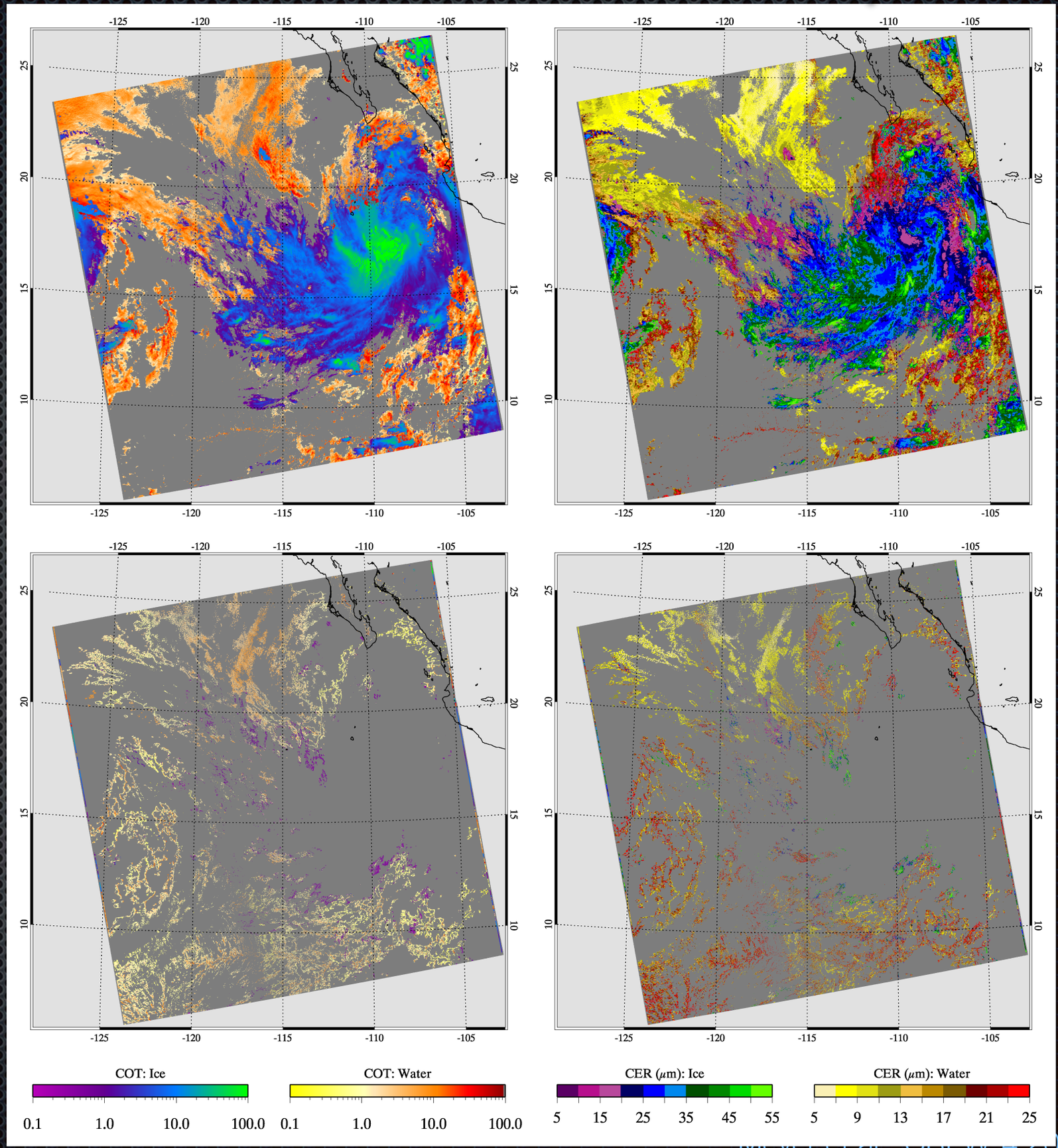
Meyer et al., CREW-4 2014

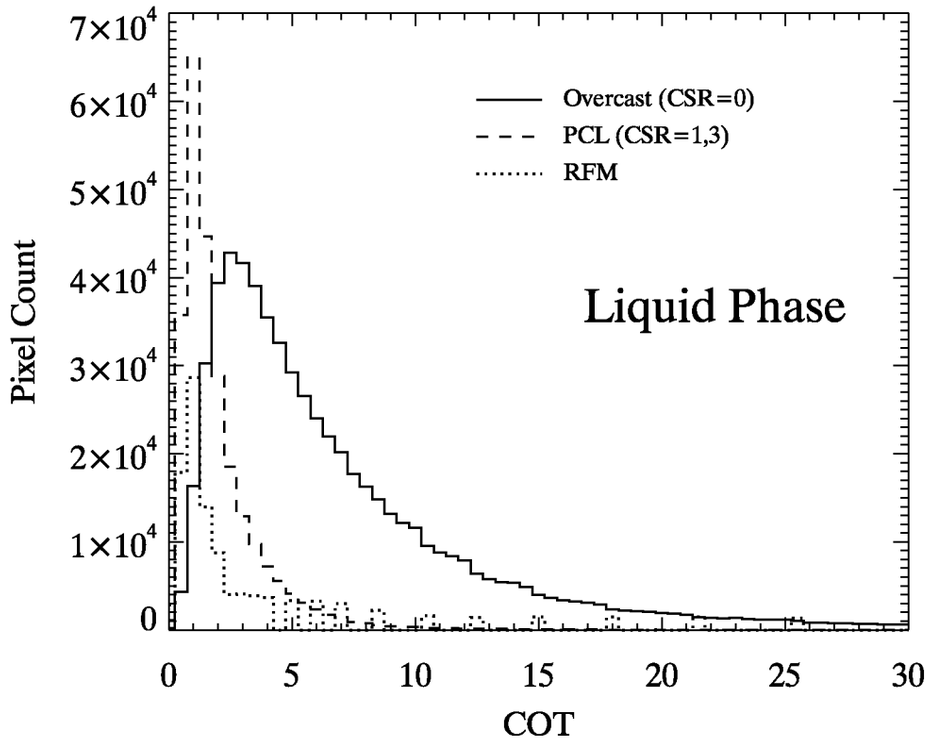
COT

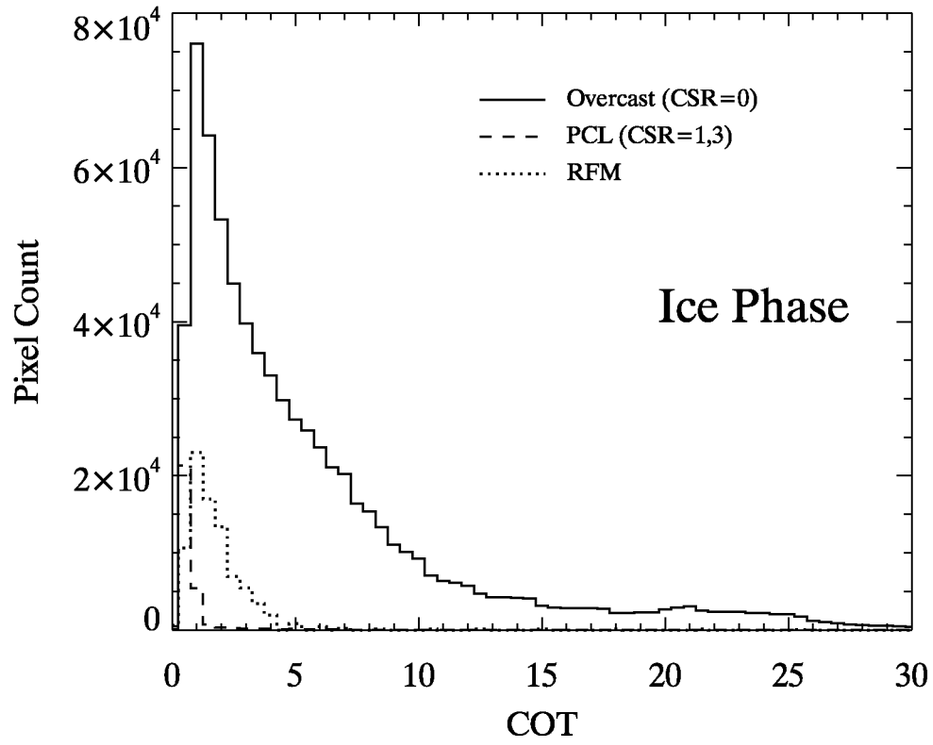
CER 2.1μm

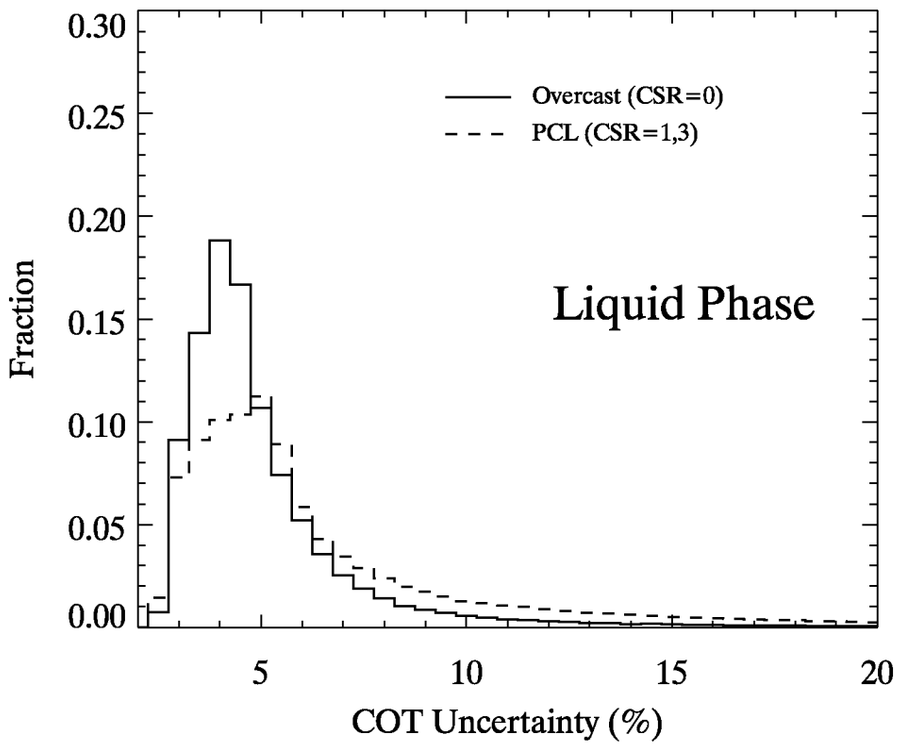
Overcast
(CSR=0)

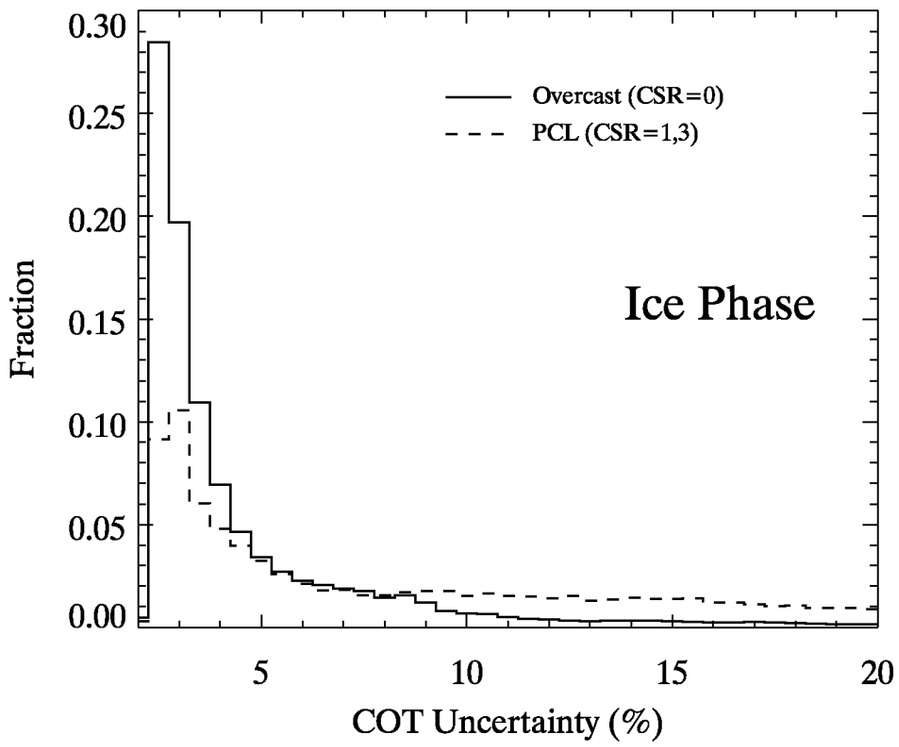
Partly Cloudy (PCL)
(CSR=1,3)



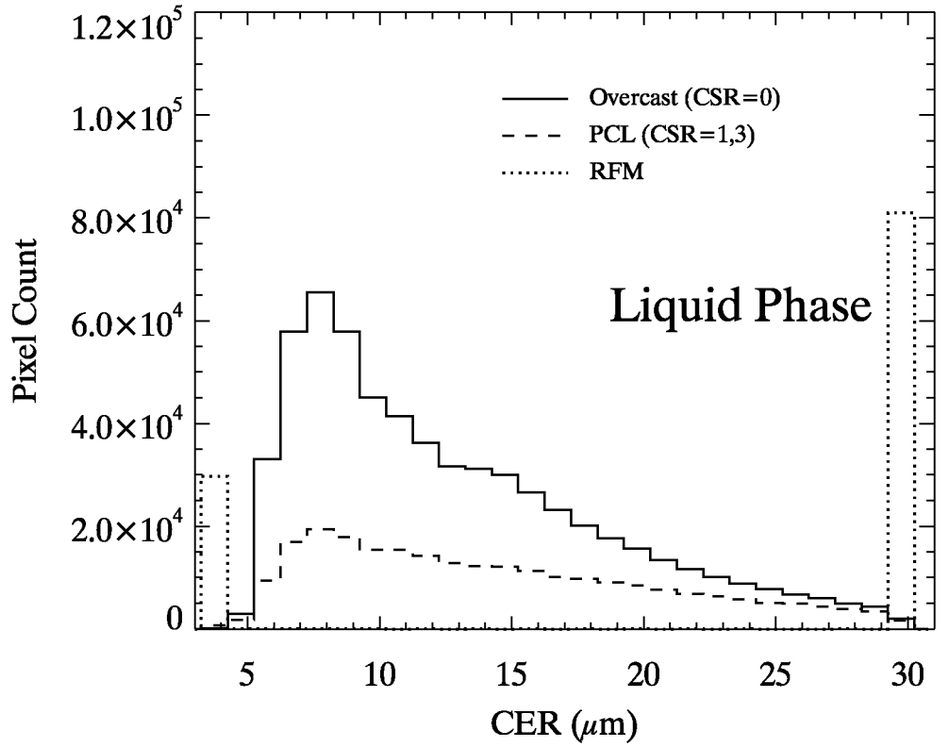


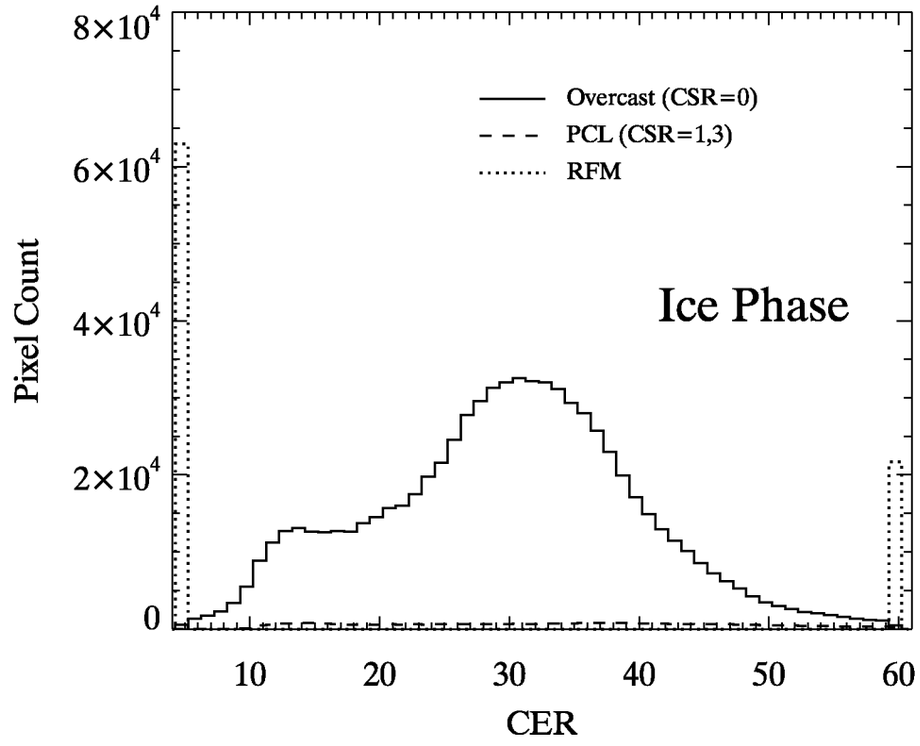


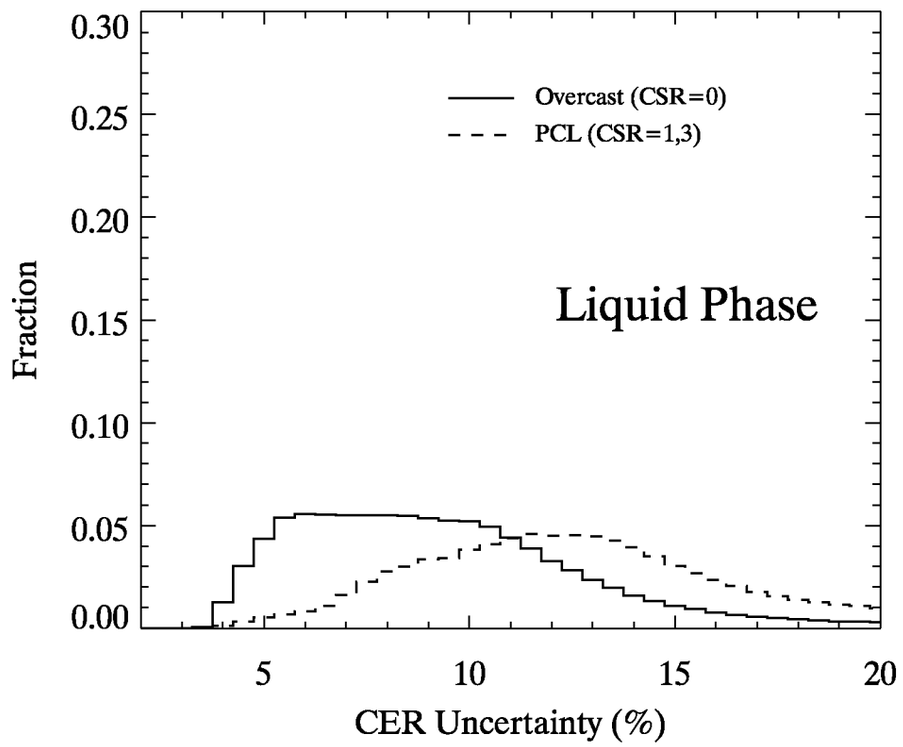


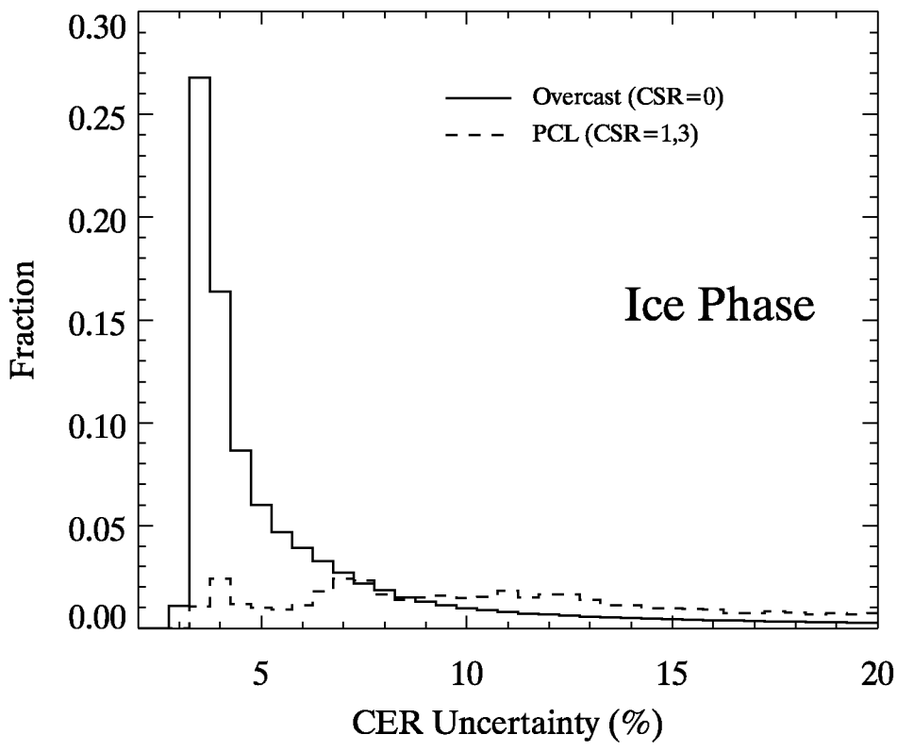


Meyer et al., CREW-4 2014









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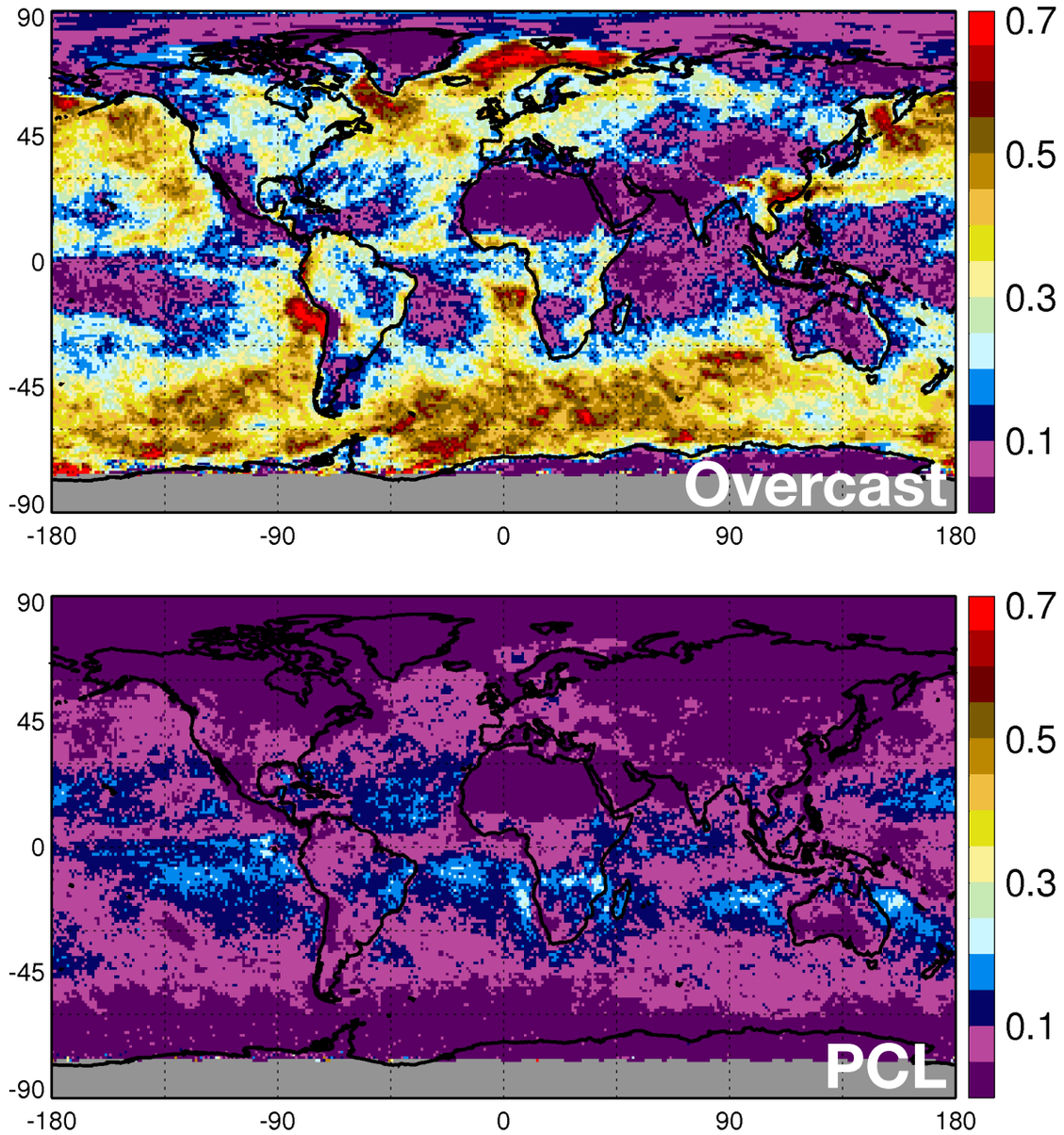
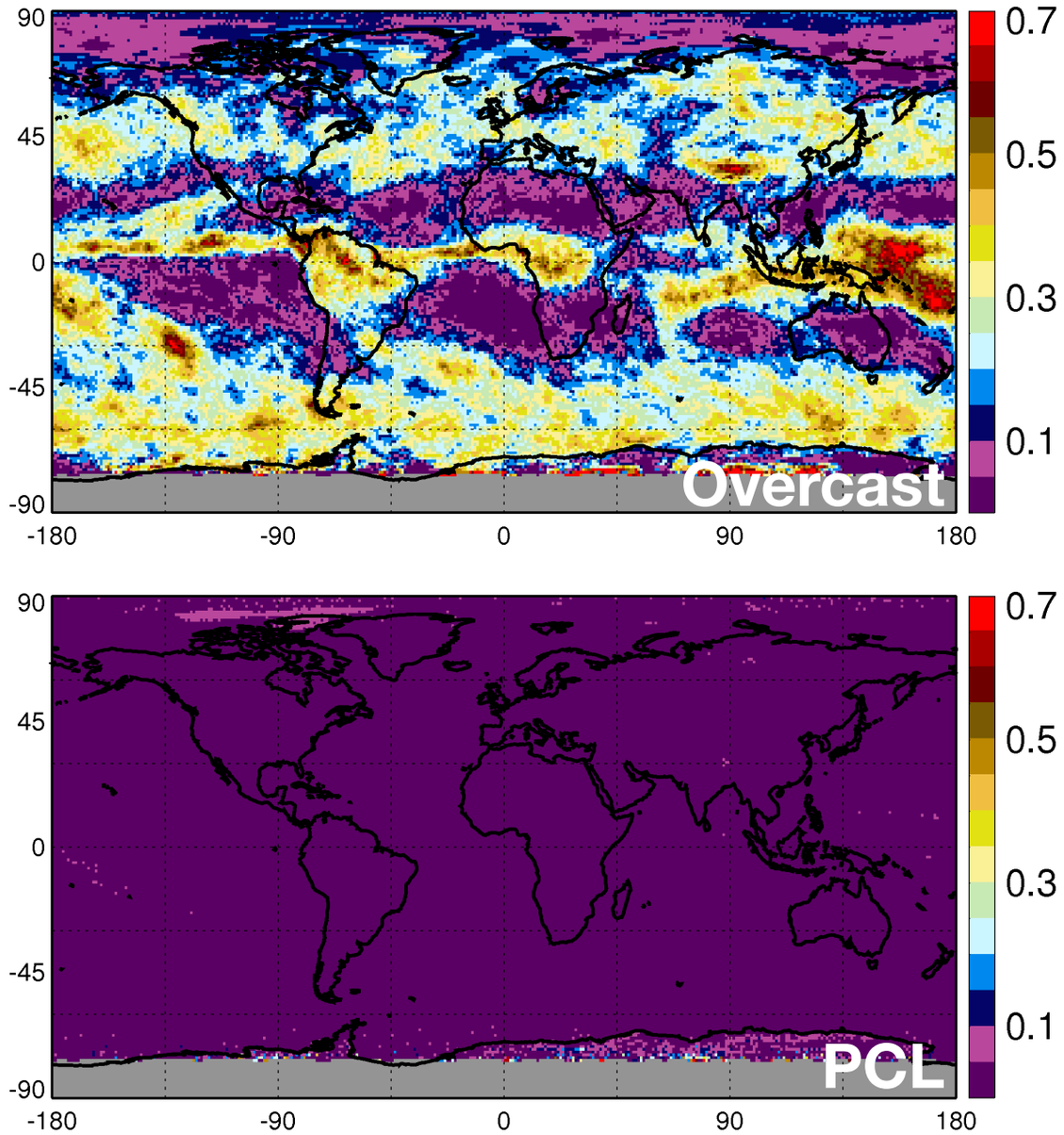
Liquid Phase



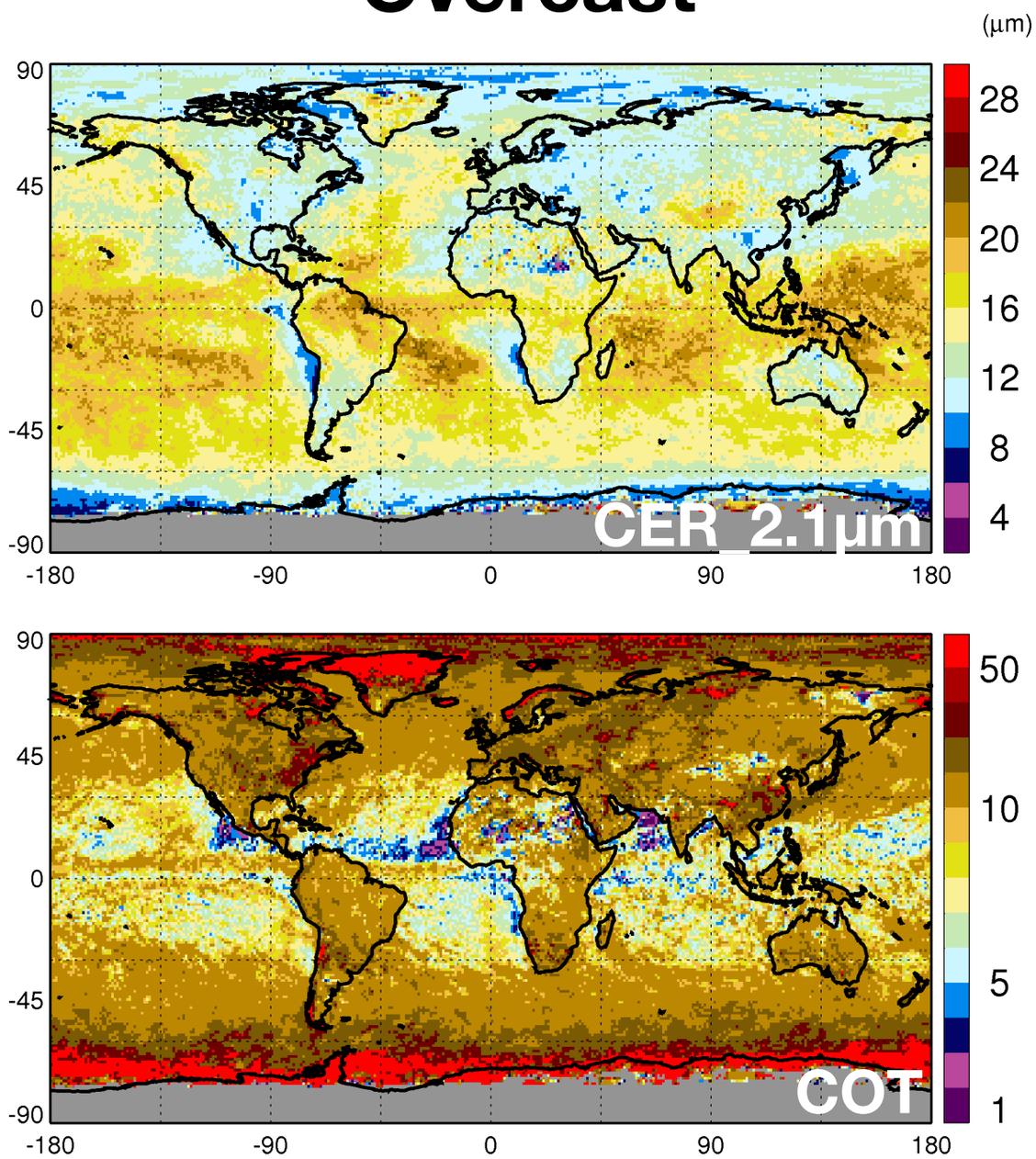
Ice Phase



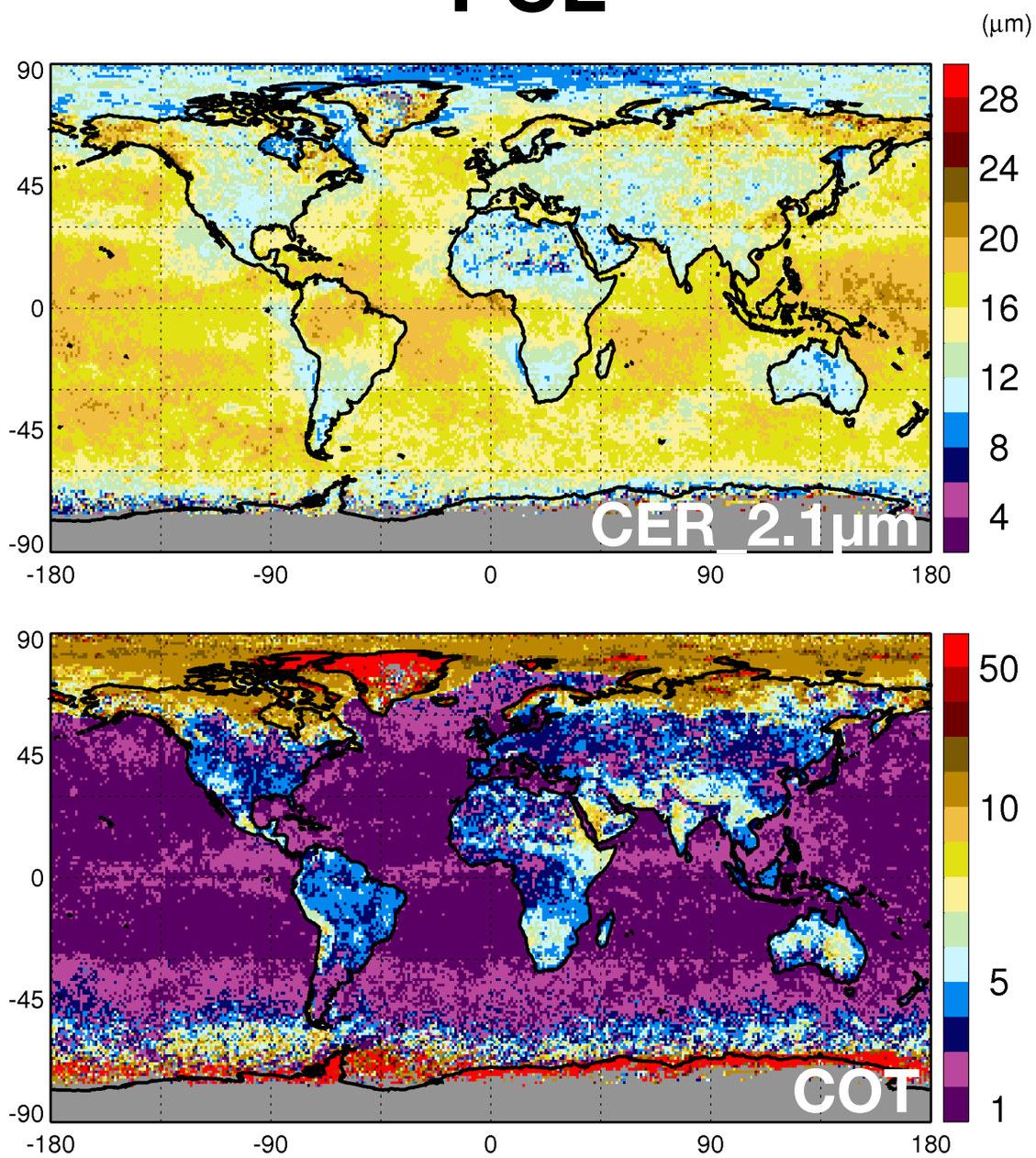
Aqua MODIS April 2005, Cloud Retrieval Fraction

Meyer et al., CREW-4 2014

Overcast



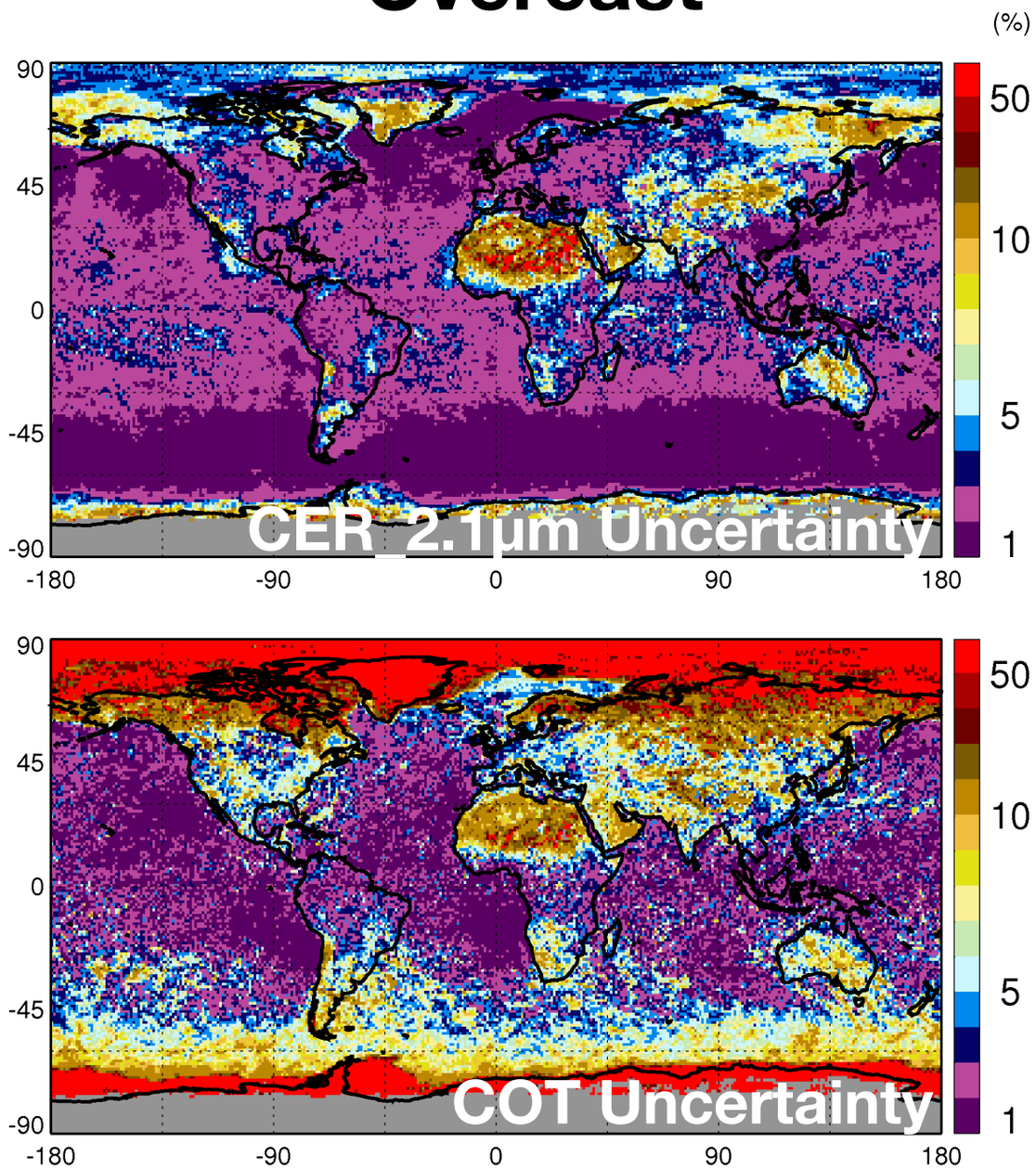
PCL



Aqua MODIS April 2005, Liquid Phase

Meyer et al., CREW-4 2014

Overcast



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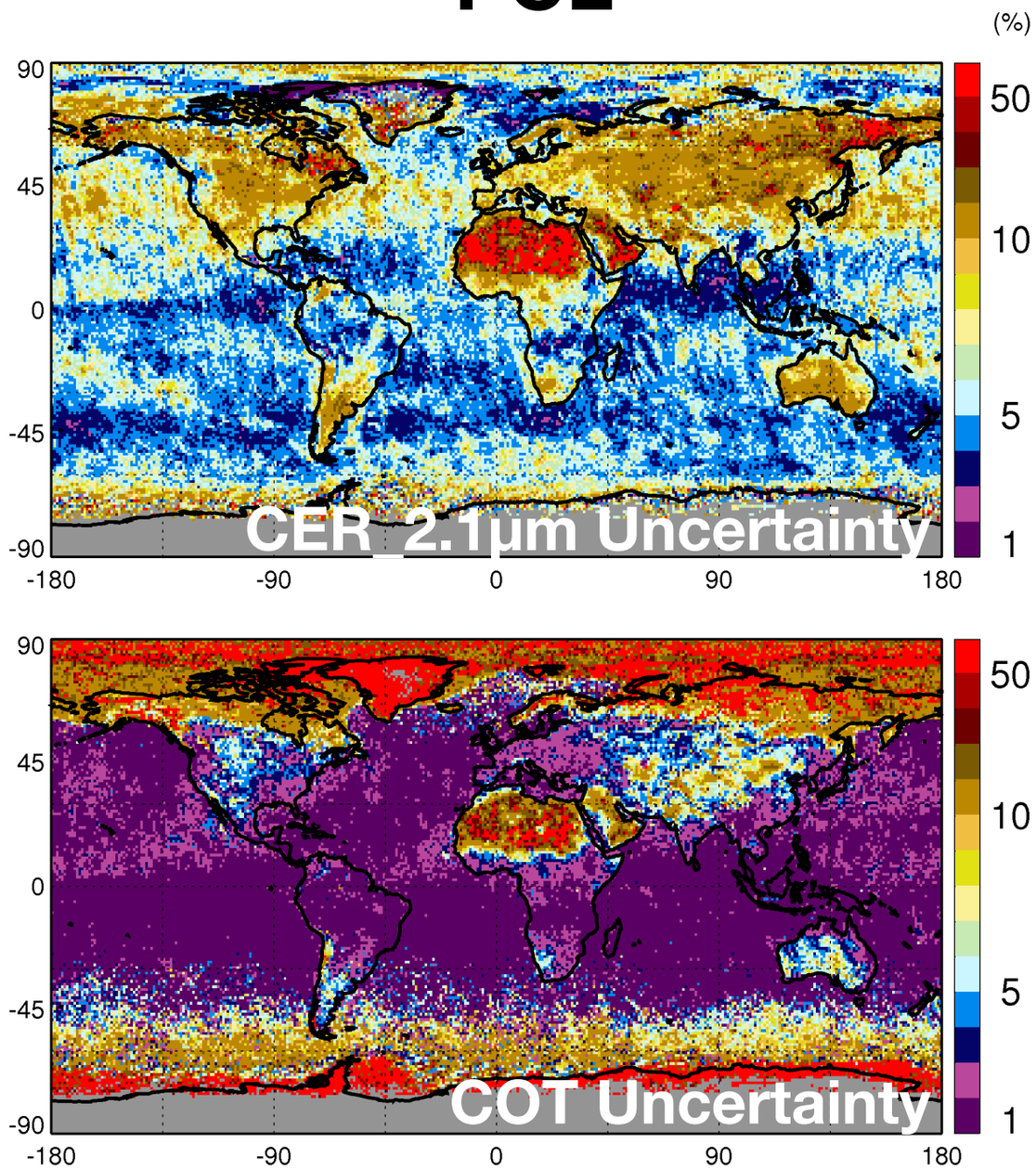
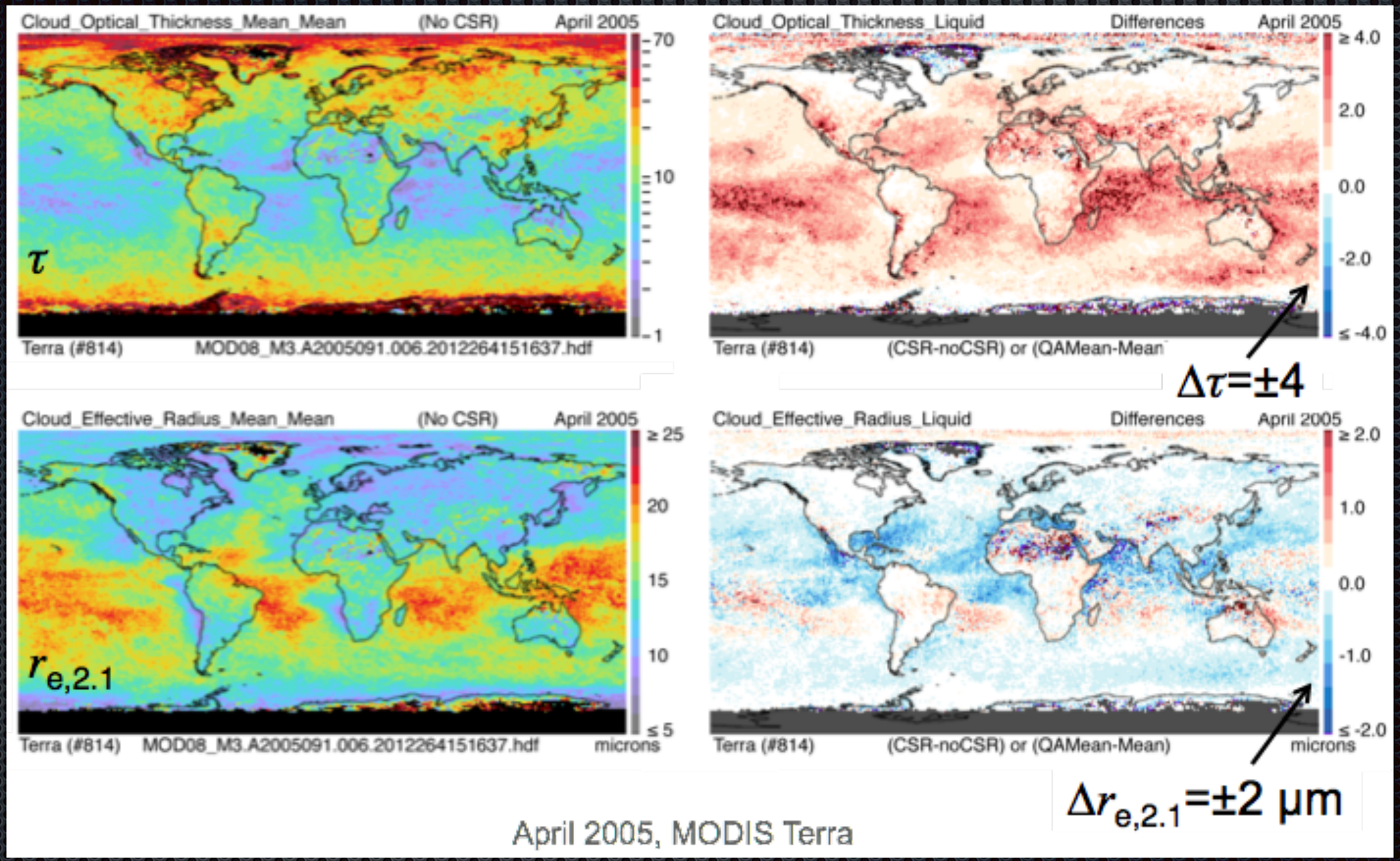


Aqua MODIS April 2005, Liquid Phase

Meyer et al., CREW-4 2014



Meyer et al., CREW-4 2014

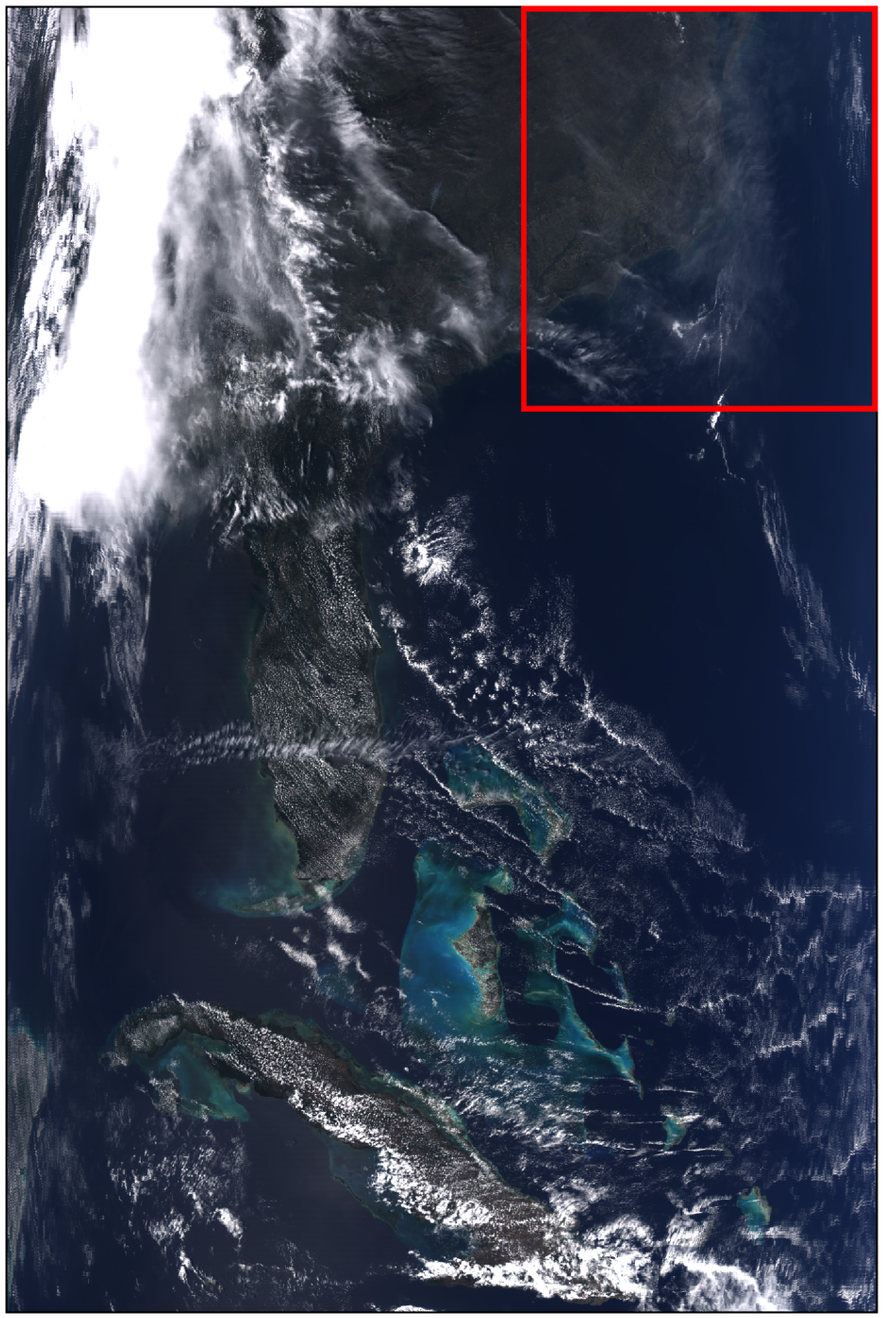
Take-Home Messages

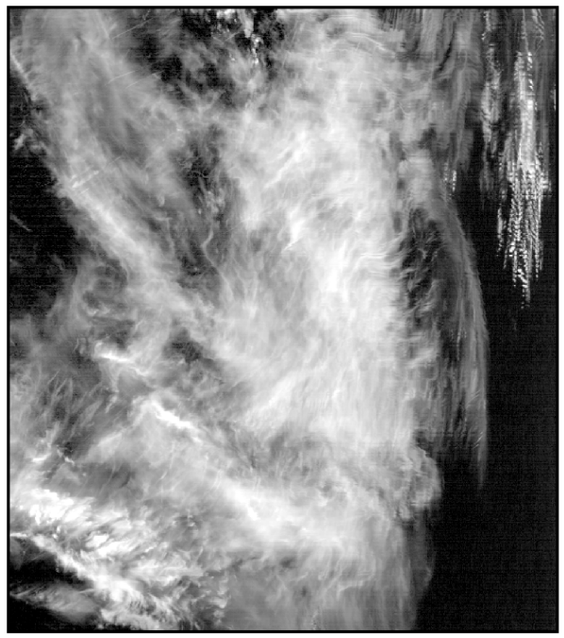
- For C6 MOD06, partly cloudy and cloud edge pixel retrievals are now reported, though separately (*_PCL).
- The overcast and PCL populations are quite different.
  - Retrieval statistics, CER uncertainties and failure rates.
  - Including/excluding PCL pixels in L3 aggregation can yield different statistics.
- Our motivation for CSR filtering:
  - Not all cloud mask “cloudy” pixels are clouds.
  - Our COT/CER retrievals live in a 1-D plane-parallel world, and partly cloudy pixels generally do not conform.

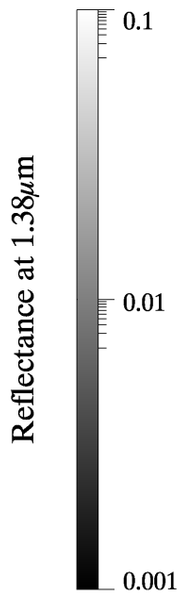
Meyer et al., CREW-4 2014

Meyer et al., CREW-4 2014

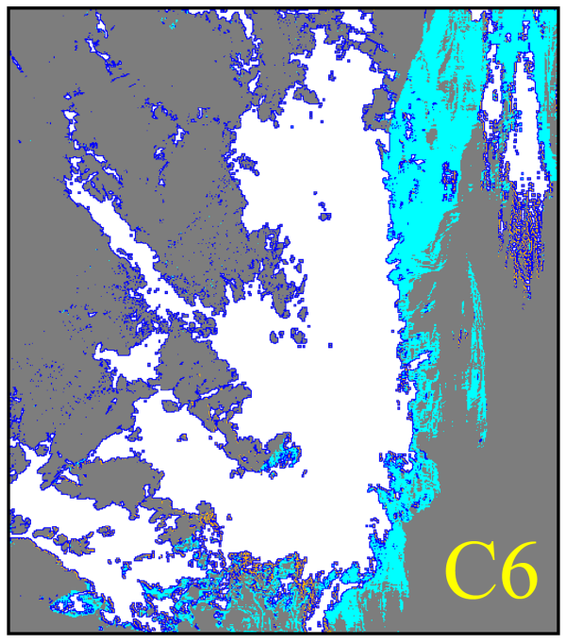
Known Issues - Thin Cirrus

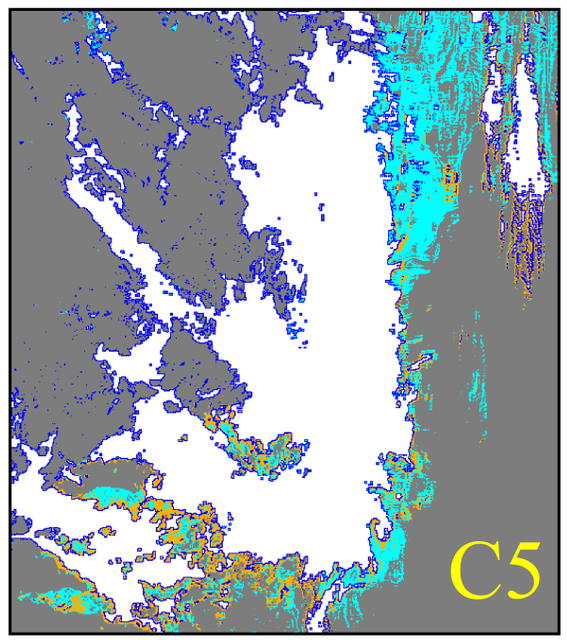


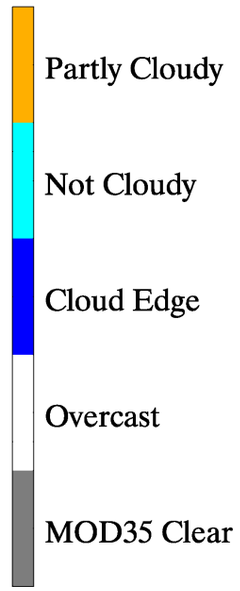




Aqua MODIS
6 April 2005 (1830 UTC)

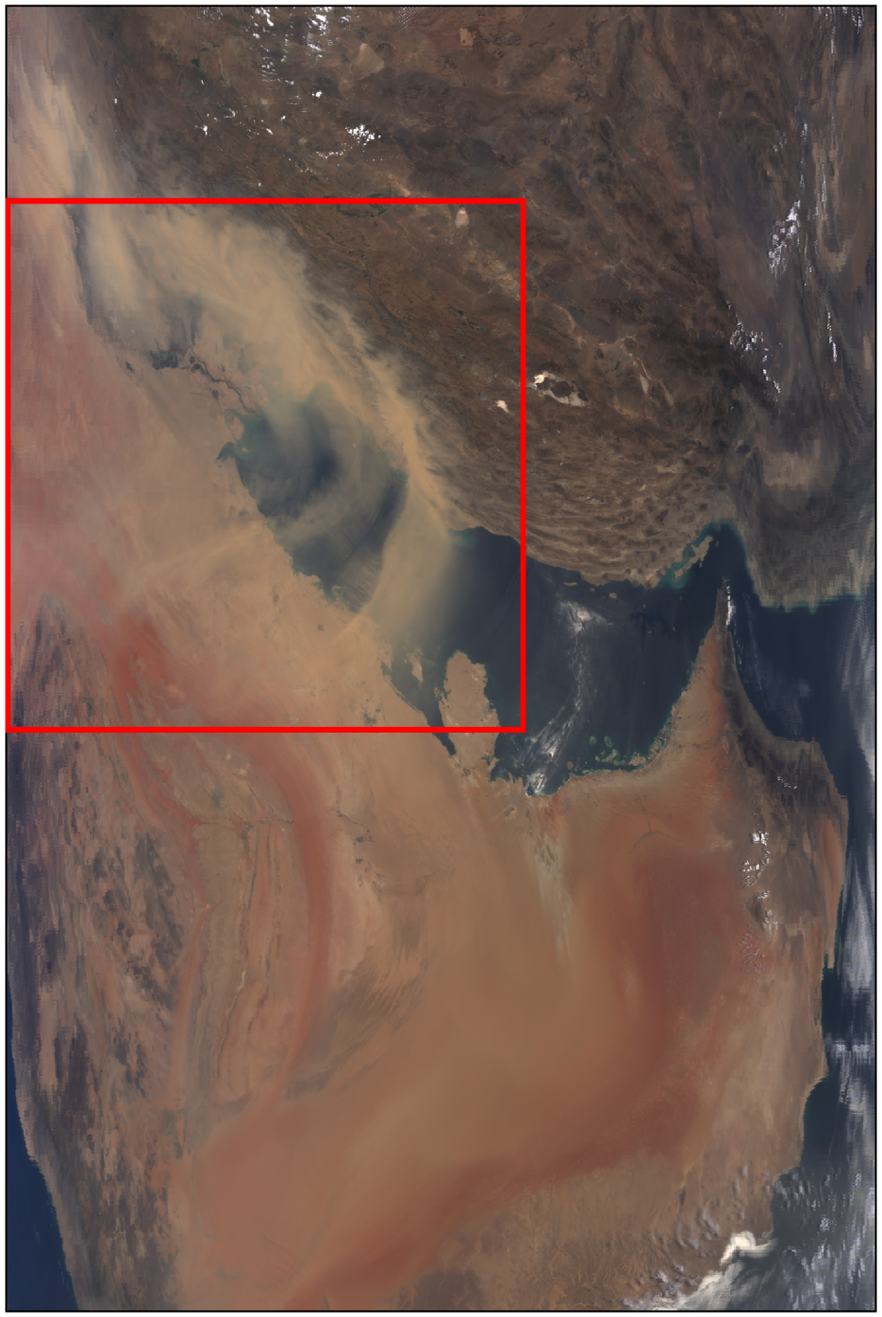


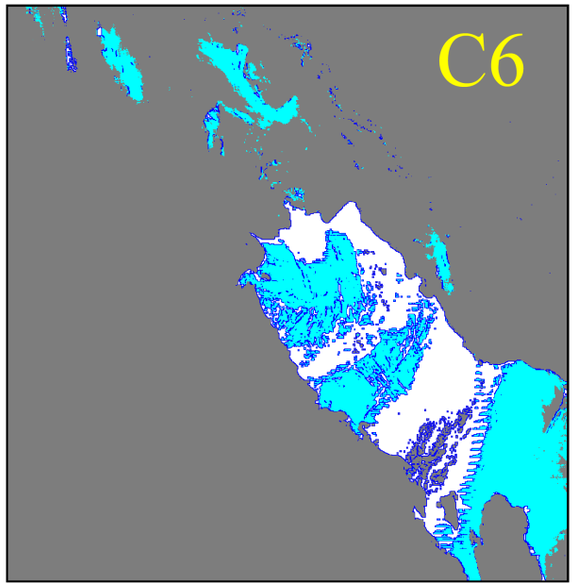


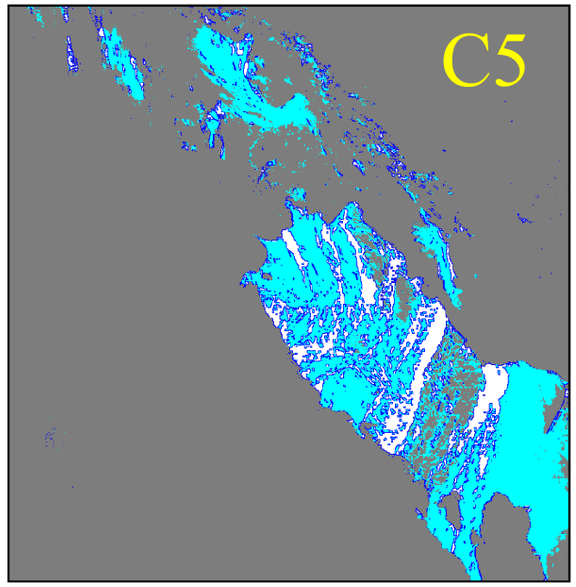


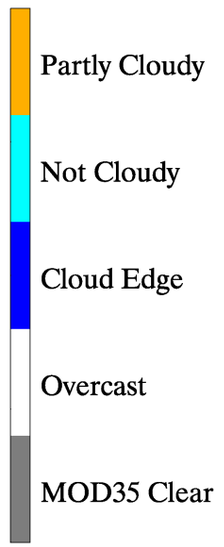
Meyer et al., CREW-4 2014

Known Issues - Thick Dust





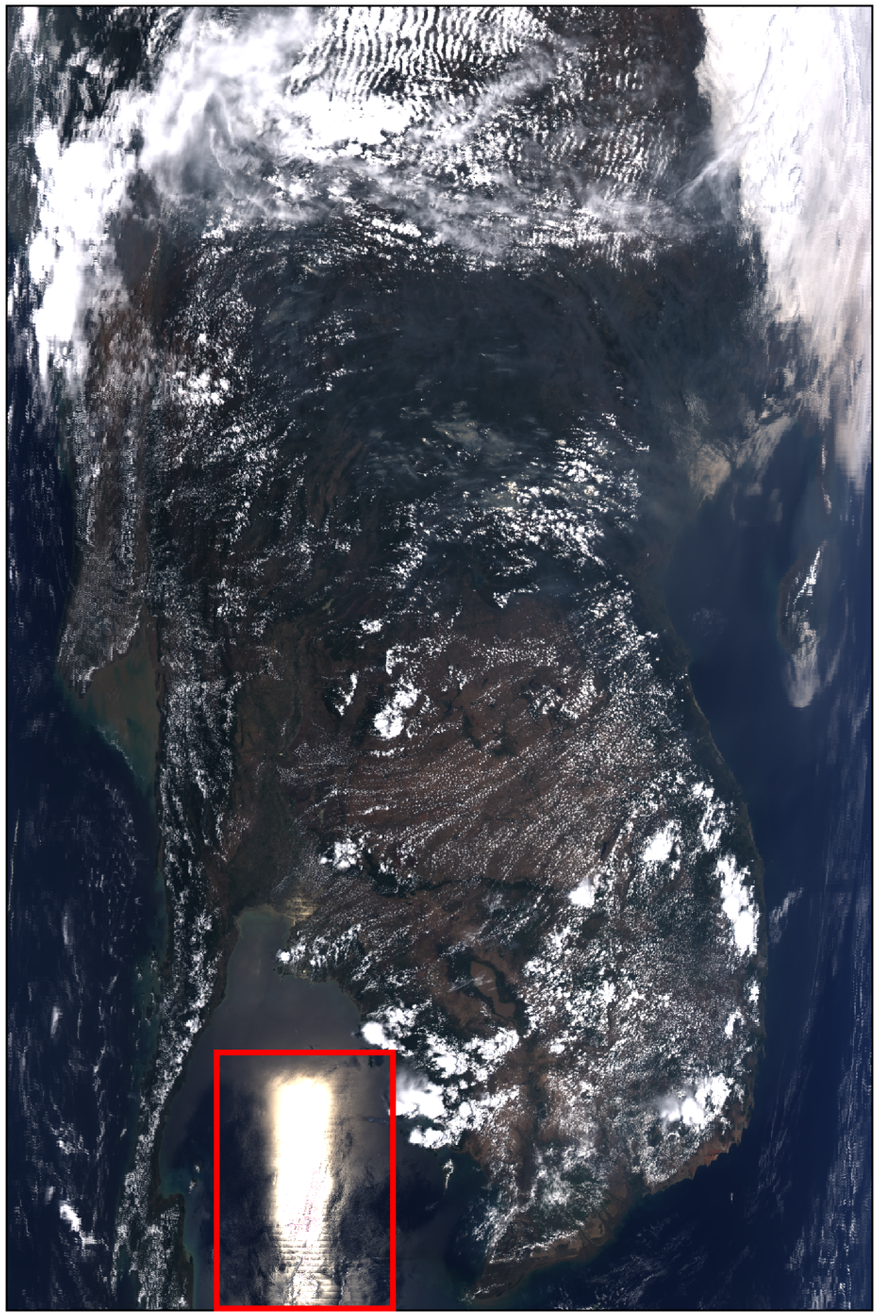


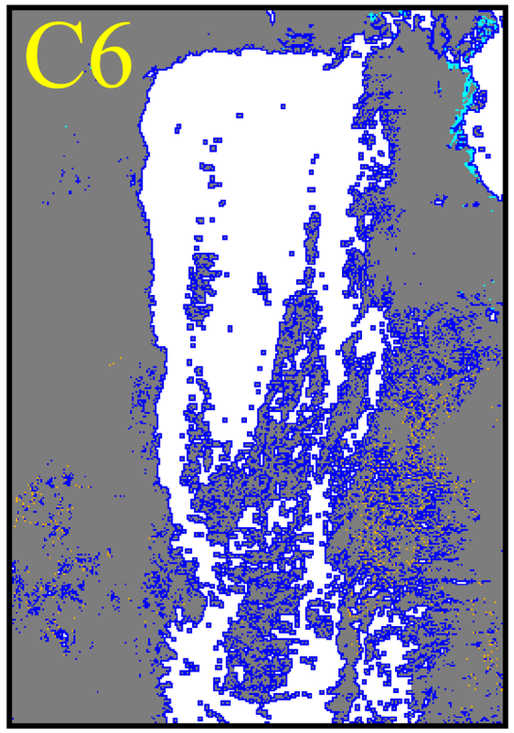


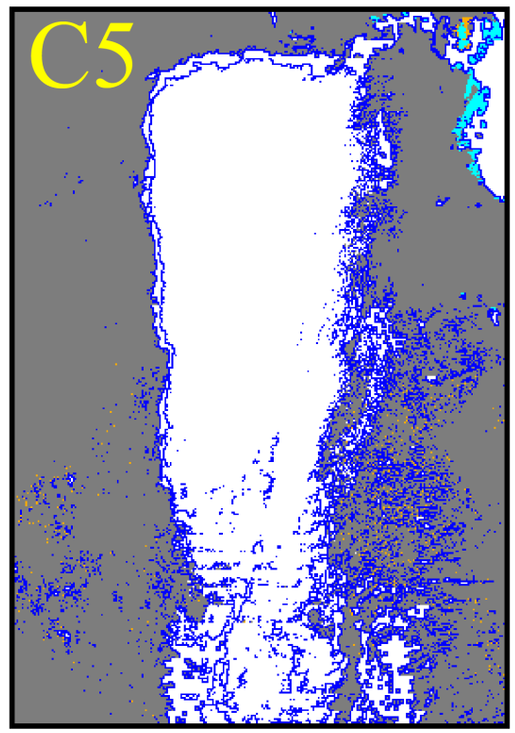
Terra MODIS
1 July 2008 (0720 UTC)

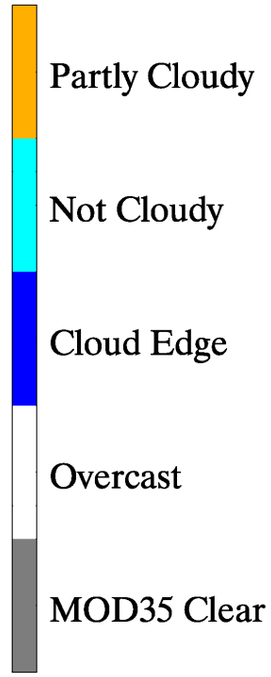
Meyer et al., CREW-4 2014

Known Issues - Sun Glint









Aqua MODIS
10 April 2005 (0630 UTC)

Meyer et al., CREW-4 2014