The EUMETSAT Network of Satellite Application Facilities

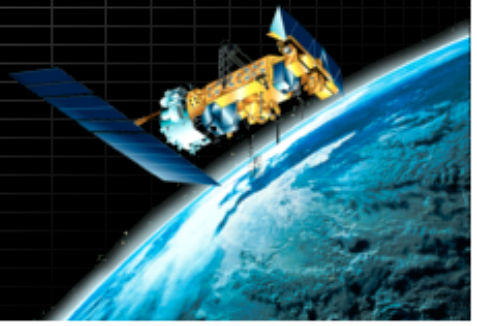
NWC SAF

Support to Nowcasting and Very Short Range Forecasting

SMHI

PPS
A DR package for the retrieval of cloud properties from AVHRR and VIIRS

Adam Dybbroe



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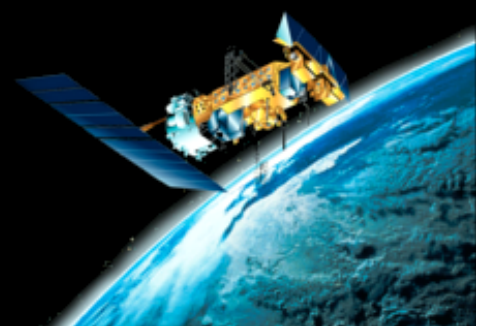
PPS Team

Ronald Scheirer, Sara Hörnquist, Nina Håkansson, Joseph Sedlar, Anke Thoss, Adam Dybbroe, Karl-Göran Karlsson, Abhay Devasthale, Erik Johansson, Martin Raspaud

Thanks to Jan Fokke Meirink *and colleagues at* KNMI



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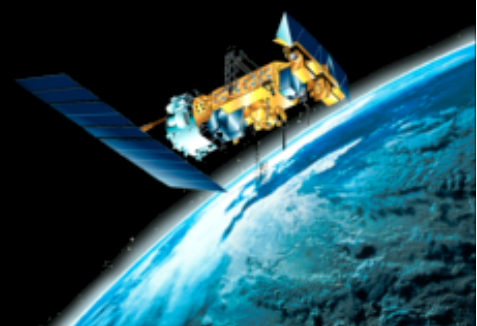
Outline

- What is PPS?
- What is new in PPS?
- VIIRS
- Future
- VIIRS processing at SMHI



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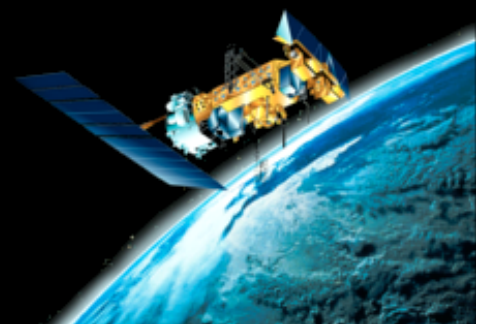
What is PPS?

- Processing package for cloud and precipitation products, developed by the NWCSAF
- Originally designed for local processing of Direct Readout data from AVHRR
- Adapted to other input formats, as for example AVHRR GAC
- Recently adapted to VIIRS



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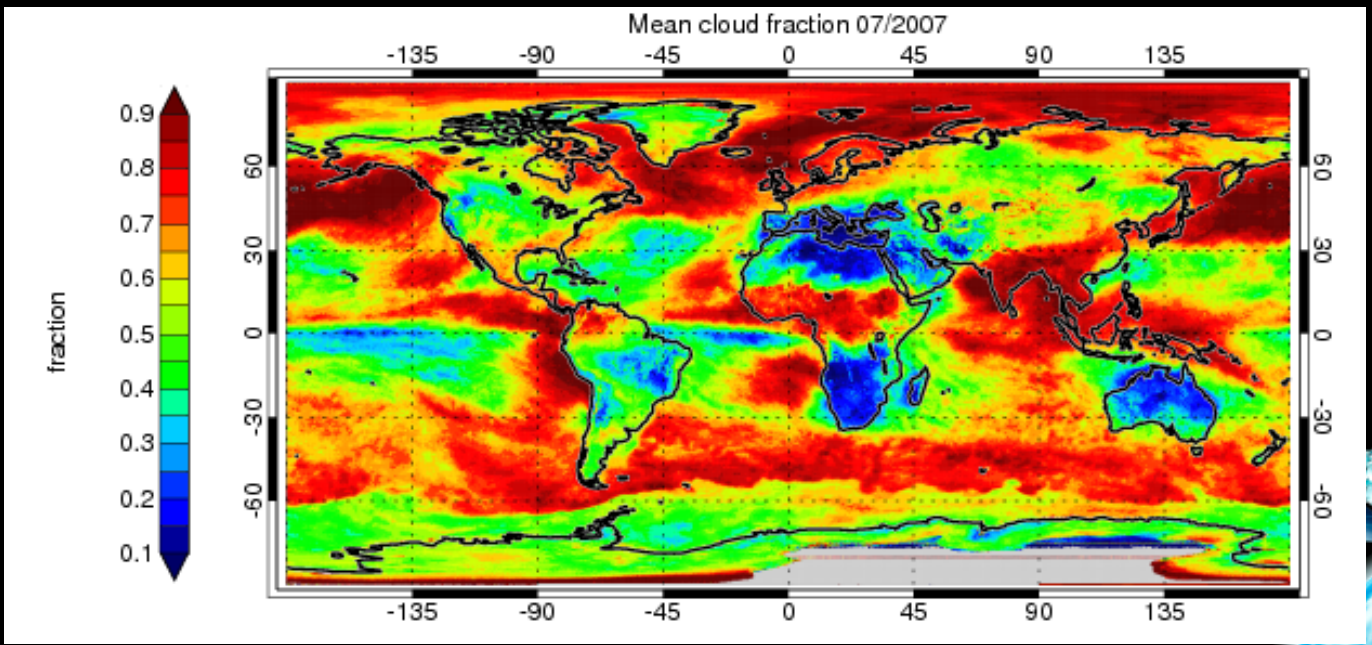
What is PPS?

- Used not only for Nowcasting, but also by CMSAF (global products), OSI SAF and Land SAF (regional products)

Mean cloud fractional coverage for July 2007, derived from NOAA 15, 16, 17 and 18:



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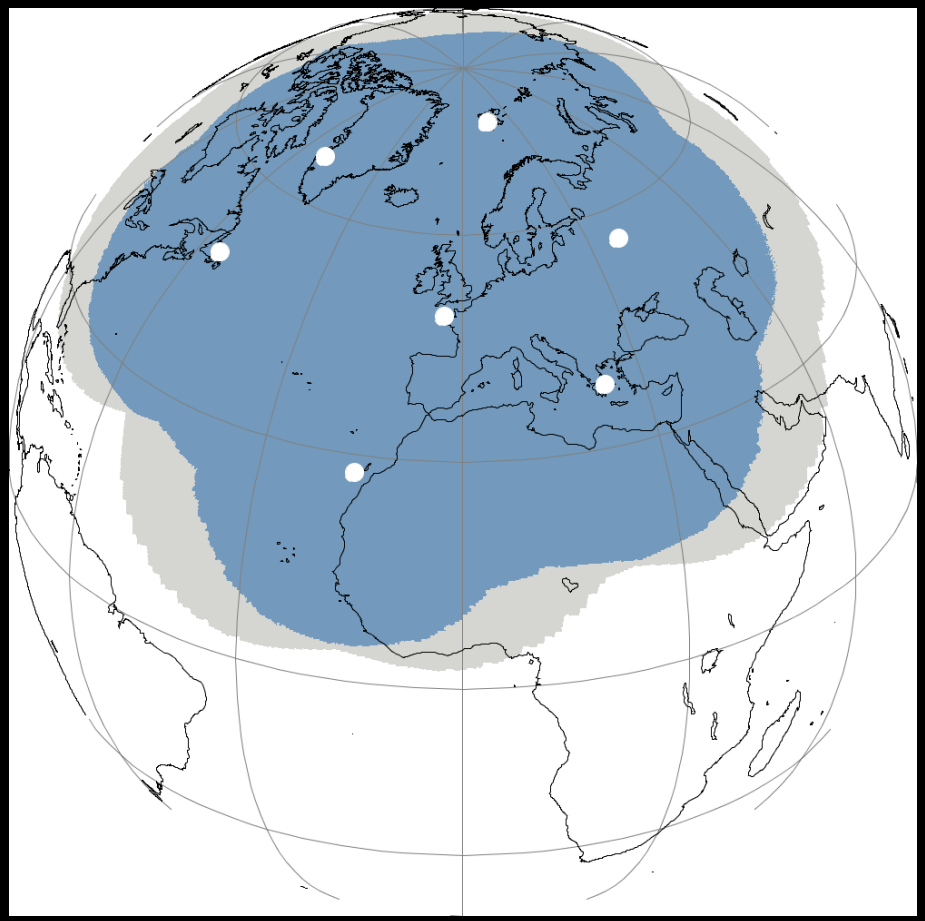
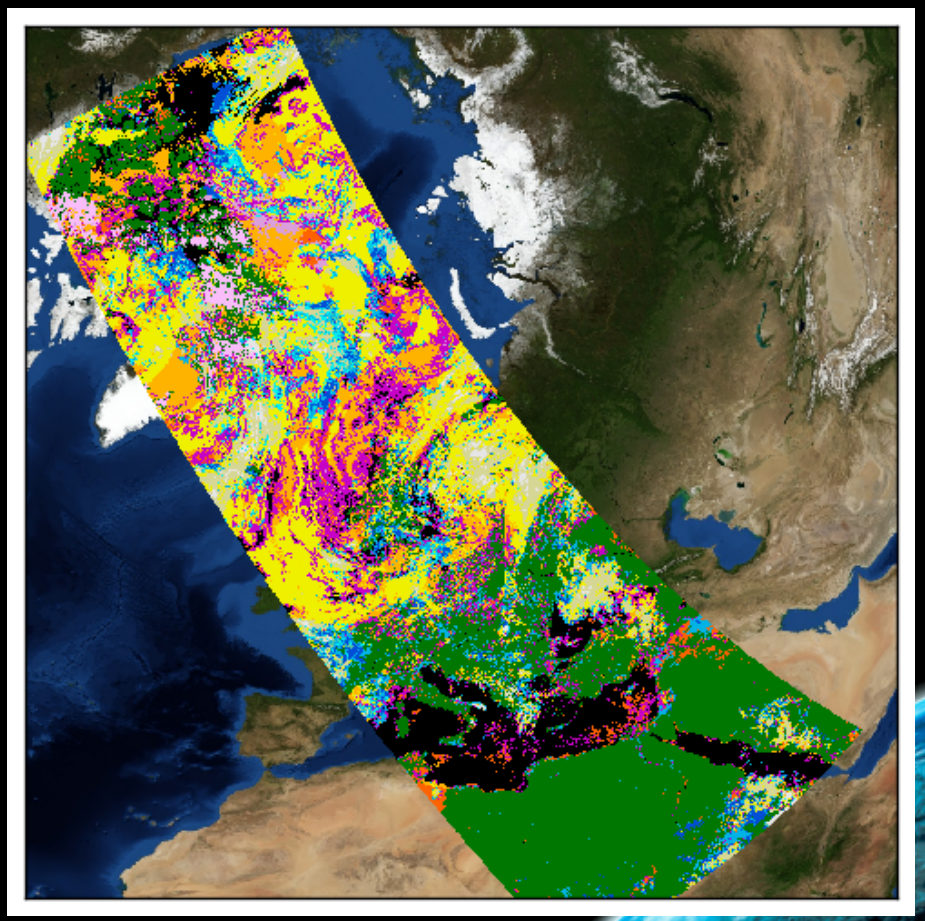
What is PPS?

- Now also used for processing cloud products in the new EARS-NWC service





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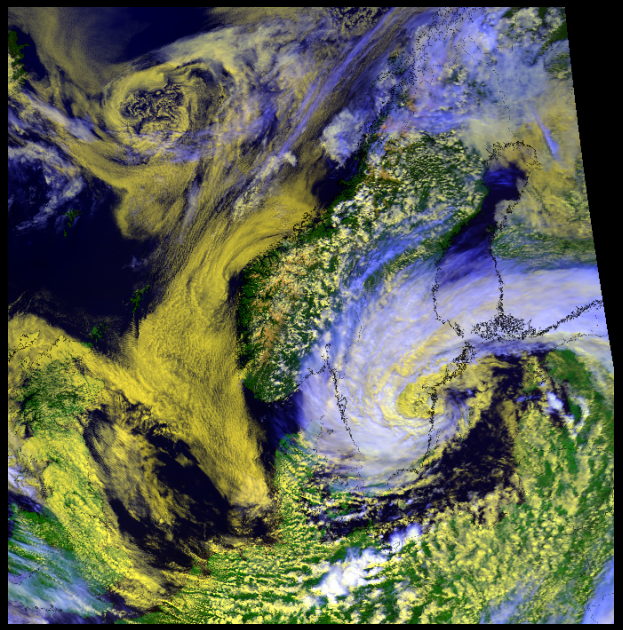
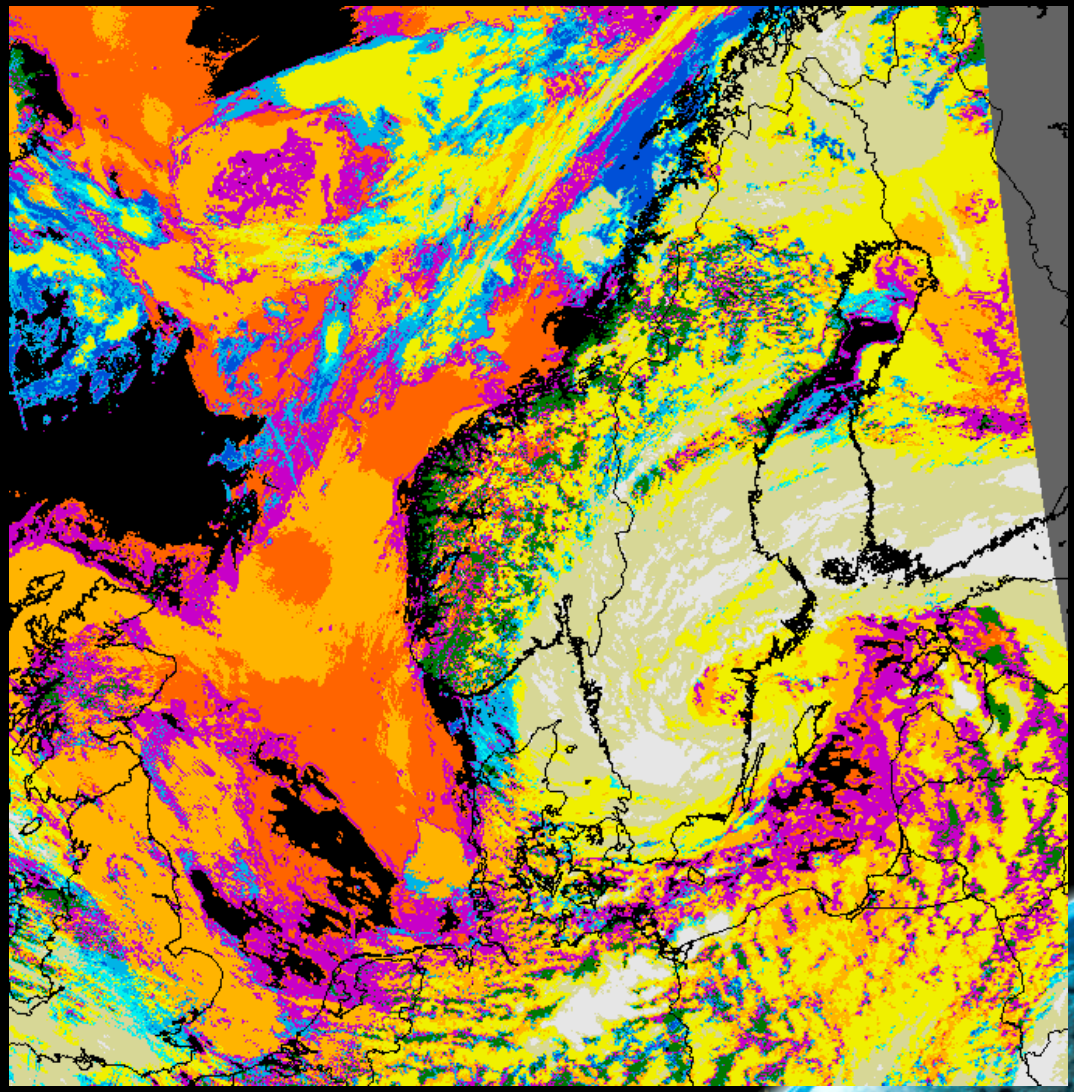
Cloud Mask & Type



Cloud free	Very high
Cloud free	Very thin cirrus
Snow	Thin cirrus
Snow/Ice	Thick cirrus
Very low	Cirrus above
Low	Fractional
Medium level	Unclassified
High	Unprocessed

NOAA 19 2012-06-25 12:22 UTC



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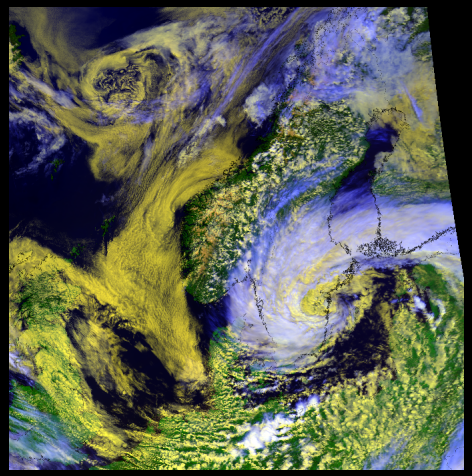
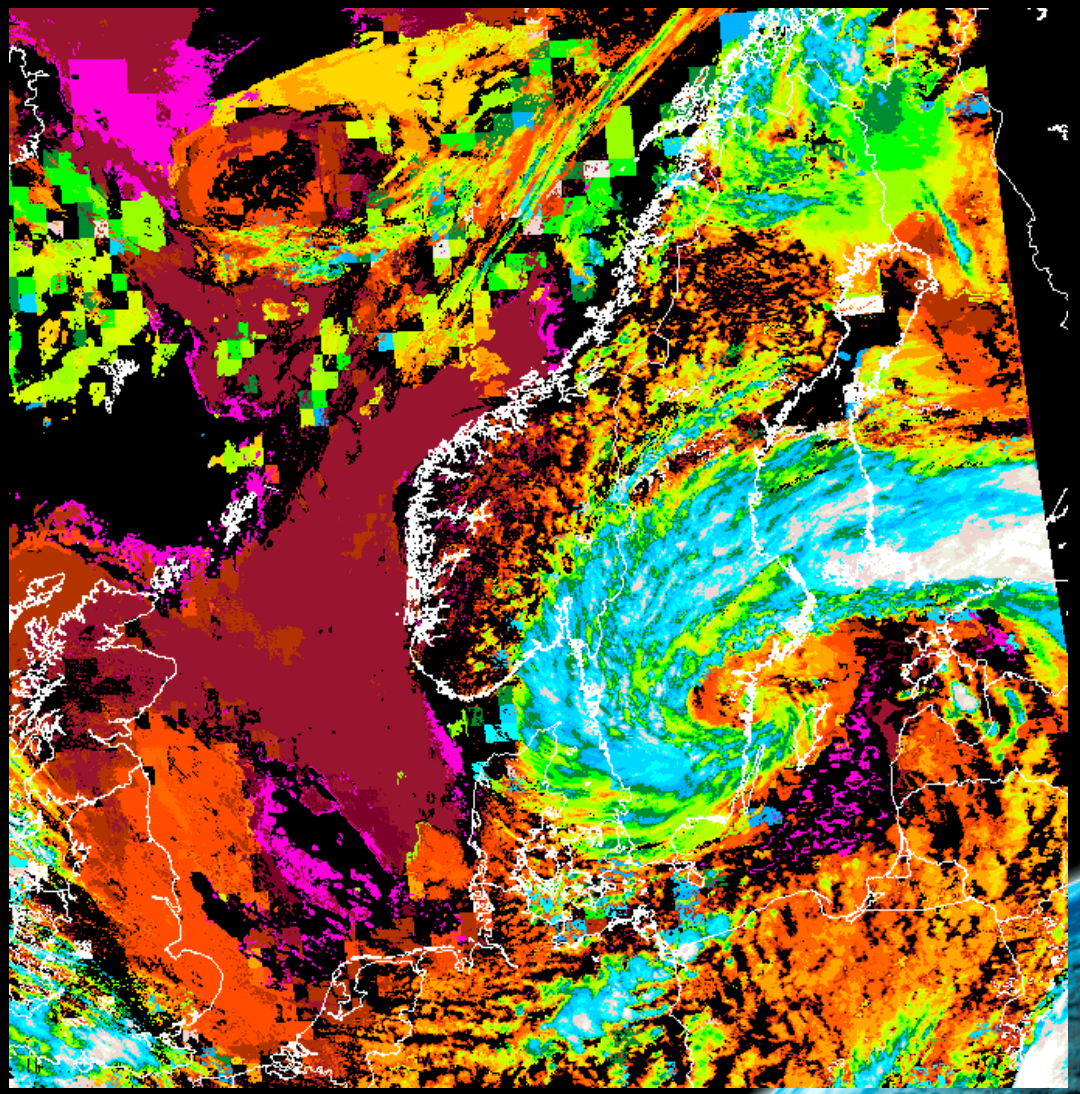
Cloud Top Temperature and Height

NOAA 19 2012-06-25 12:22 UTC



- Unprocessed
- 0-500m
- 500-1000m
- 1000-1500m
- 1500-2000m
- 2000-2500m
- 2500-3000m
- 3000-3500m
- 300-4000m
- 4000-4500m
- 4500-5000m
- 5000-5500m
- 5500-6000m
- 6000-6500m
- 6500-7000m
- 7000-7500m
- 7500-8000m
- 8000-8500m
- 8500m -



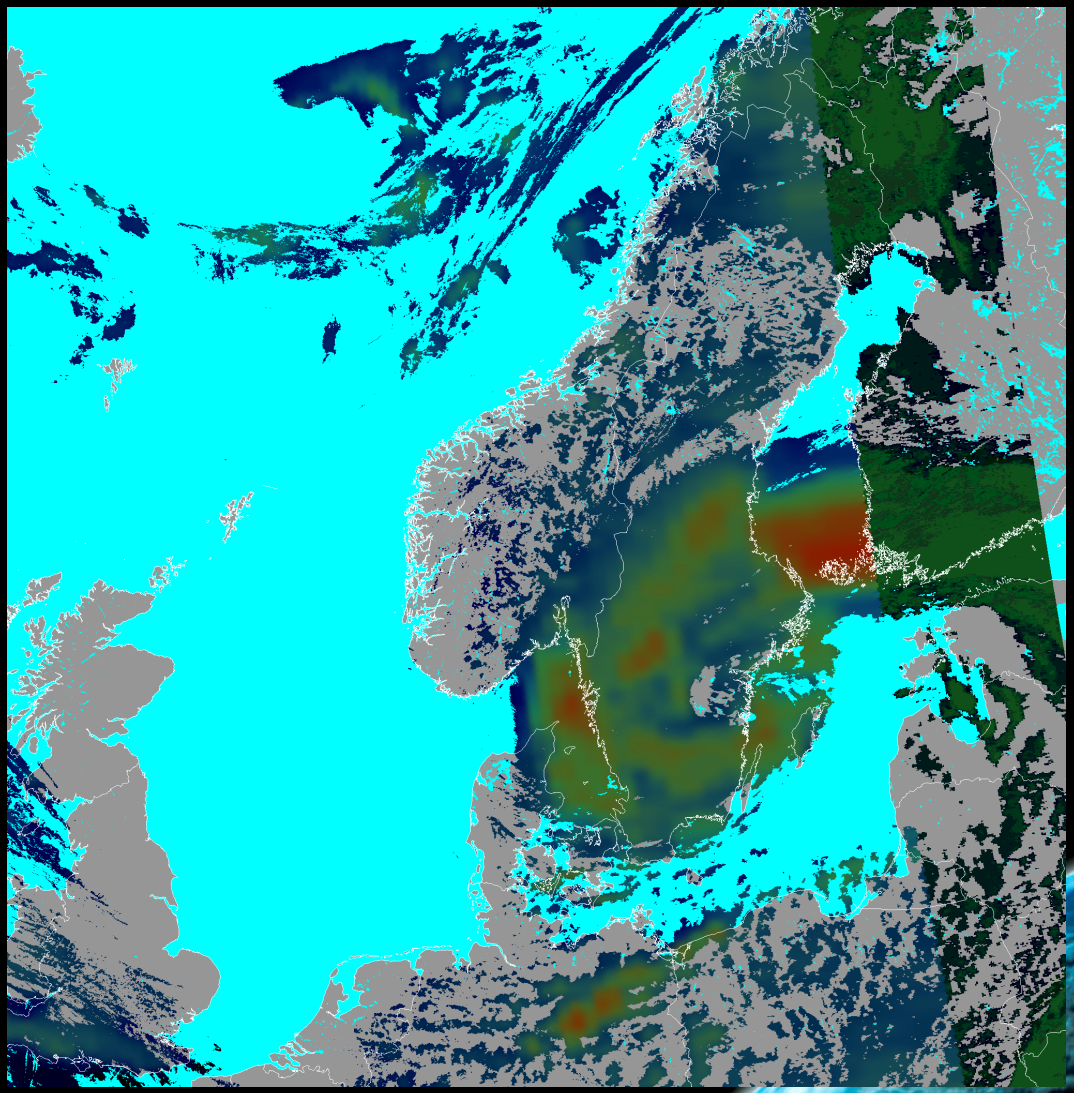
Precipitating Clouds

RGB of likelihood for precipitation in intensity classes

- Red: Intensive (> 5mm/hr)
- Green: light/mod (0.5-5 mm/hr)
- Blue: very light (0.1-0.5 mm/hr)

Based on MHS channel 1, 2 and 4 and AVHRR channel 4 & 5

NOAA 19 2012-06-25 12:22 UTC



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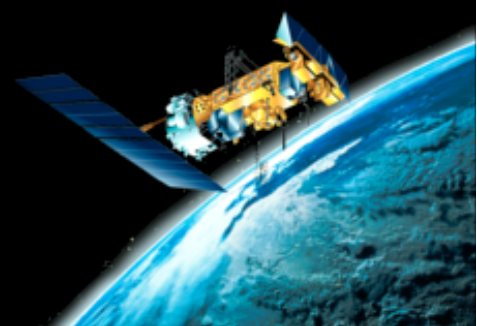
Recent enhancements

v2012: Released May 2012

- Cloud Physical Properties – CPP
  - Developed by KNMI within the CMSAF
  - Adapted to PPS standards and level 2 validation
  - Framework for future cooperation
  - Released as NWCSAF software
- Support for VIIRS on Suomi NPP



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CPP – Cloud Physical Properties

Daytime only!

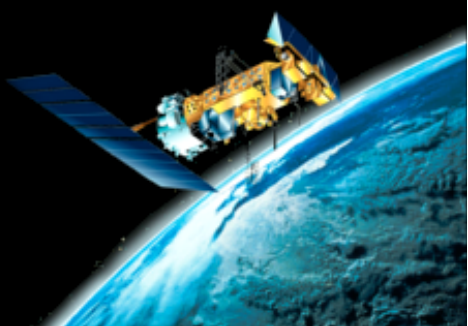
Parameters:

official

- Cloud Thermodynamic Phase – CPH
- Cloud Liquid Water Path – LWP

additional

- Ice Water Path – IWP
- Effective Radius – reff
- Cloud Optical Thickness – COT



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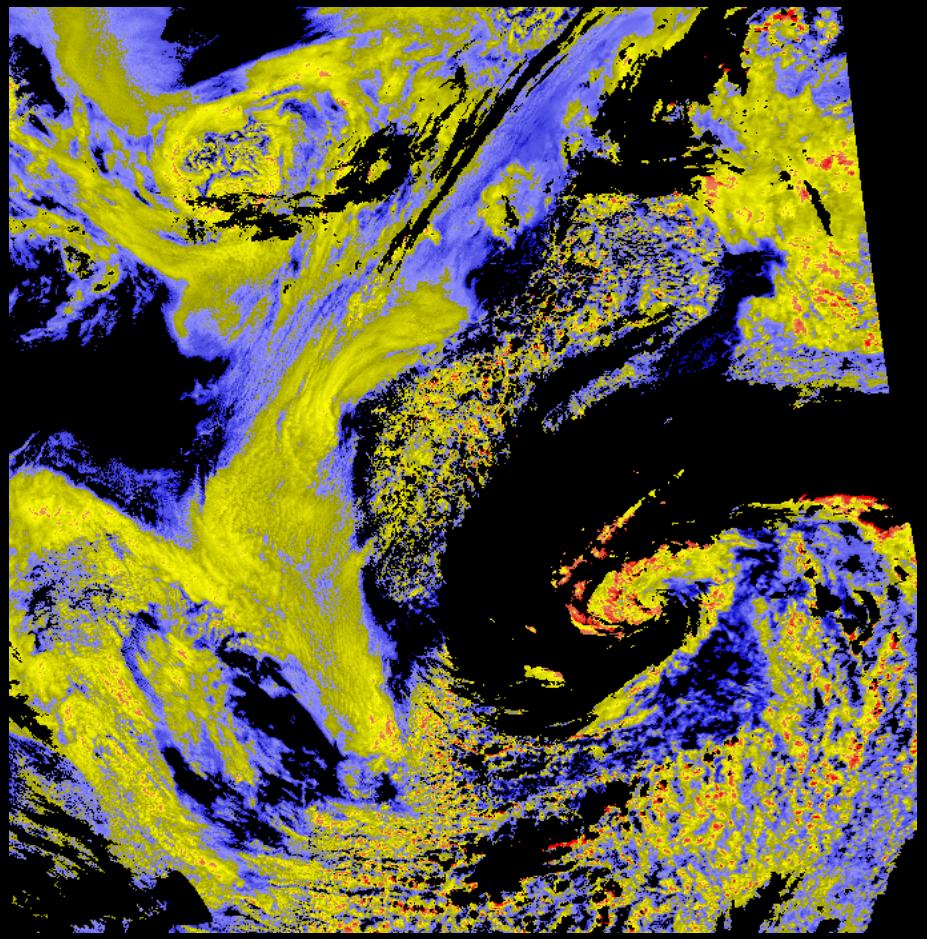
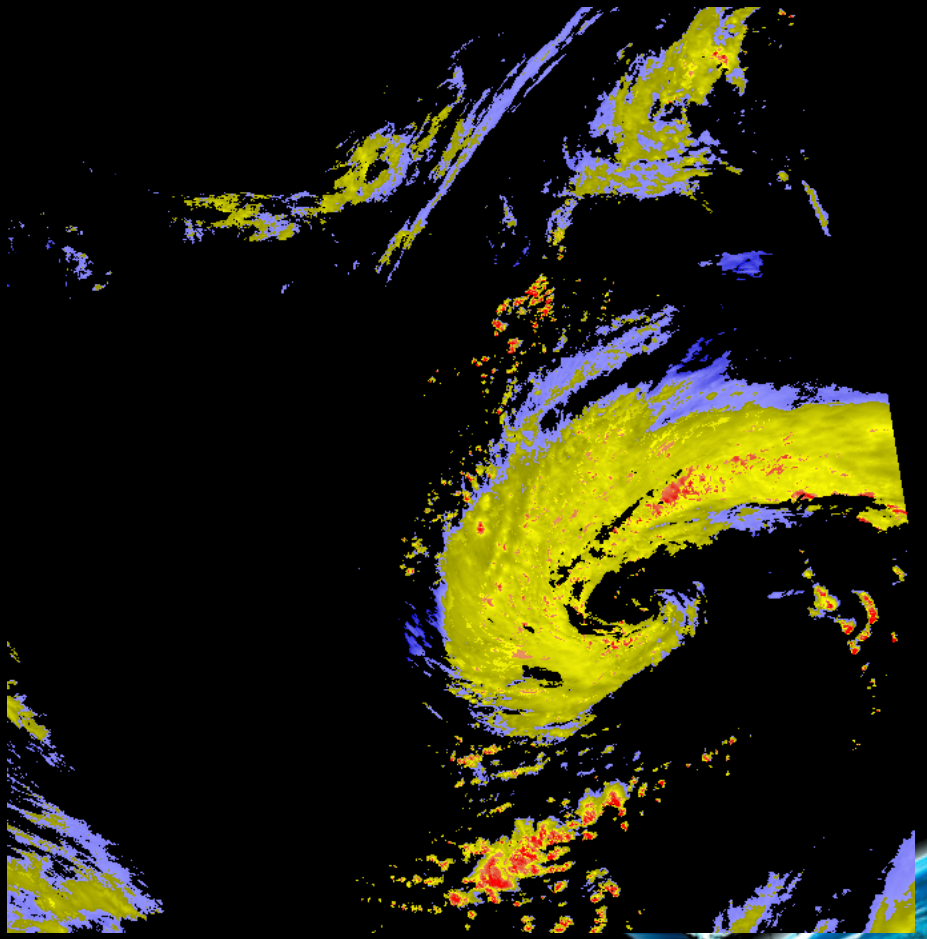
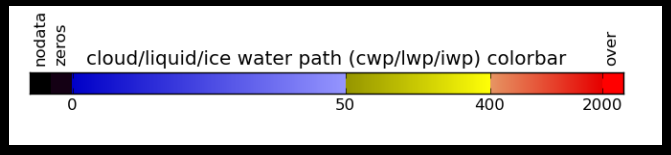
CPP products

LWP



IWP





Unit: g/m2

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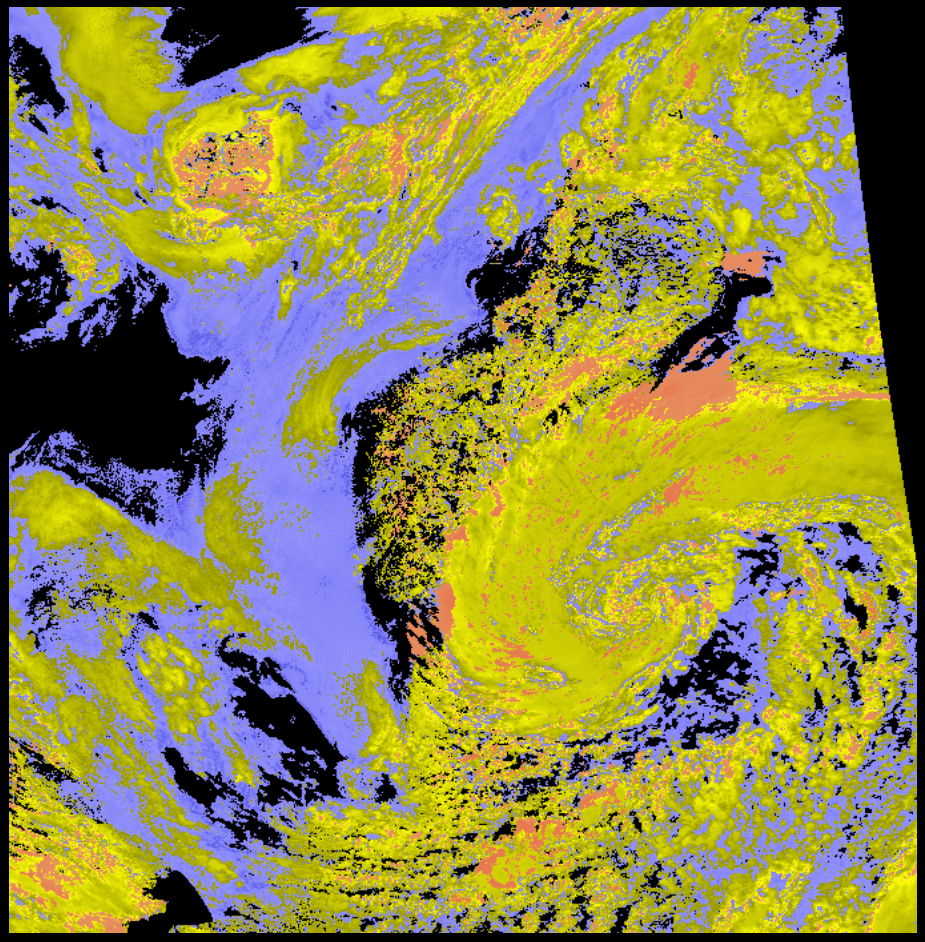
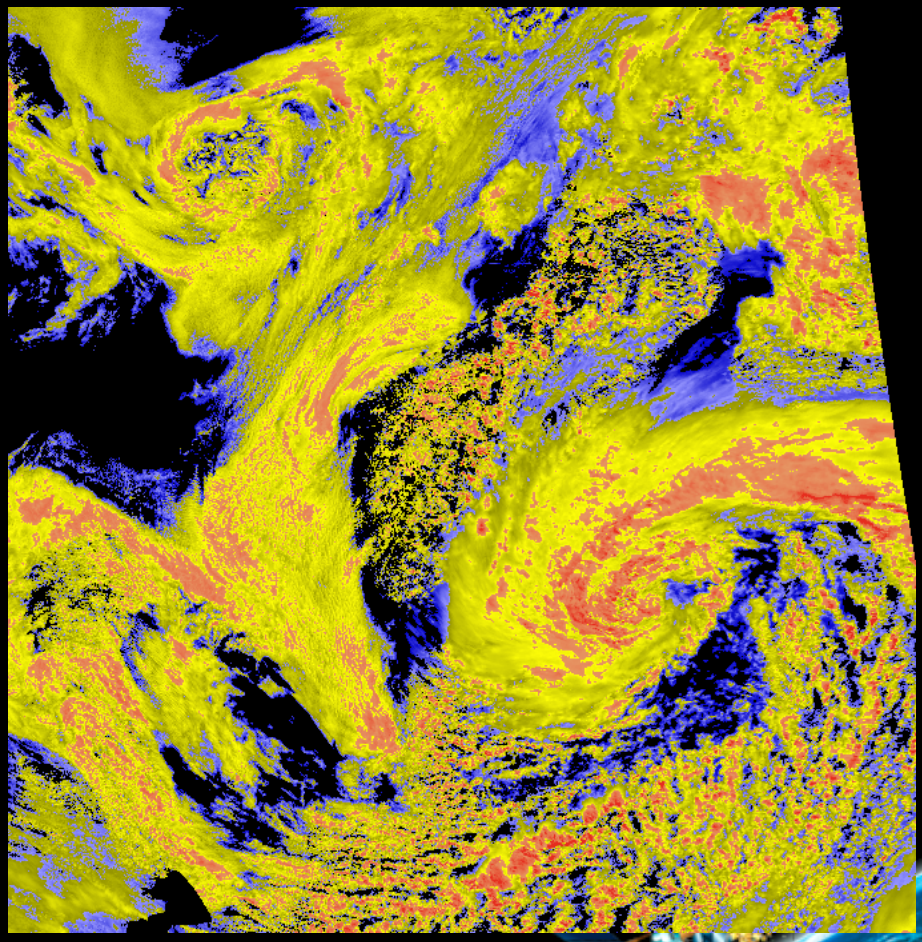
CPP products

Effective radius



Cloud Optical Thickness



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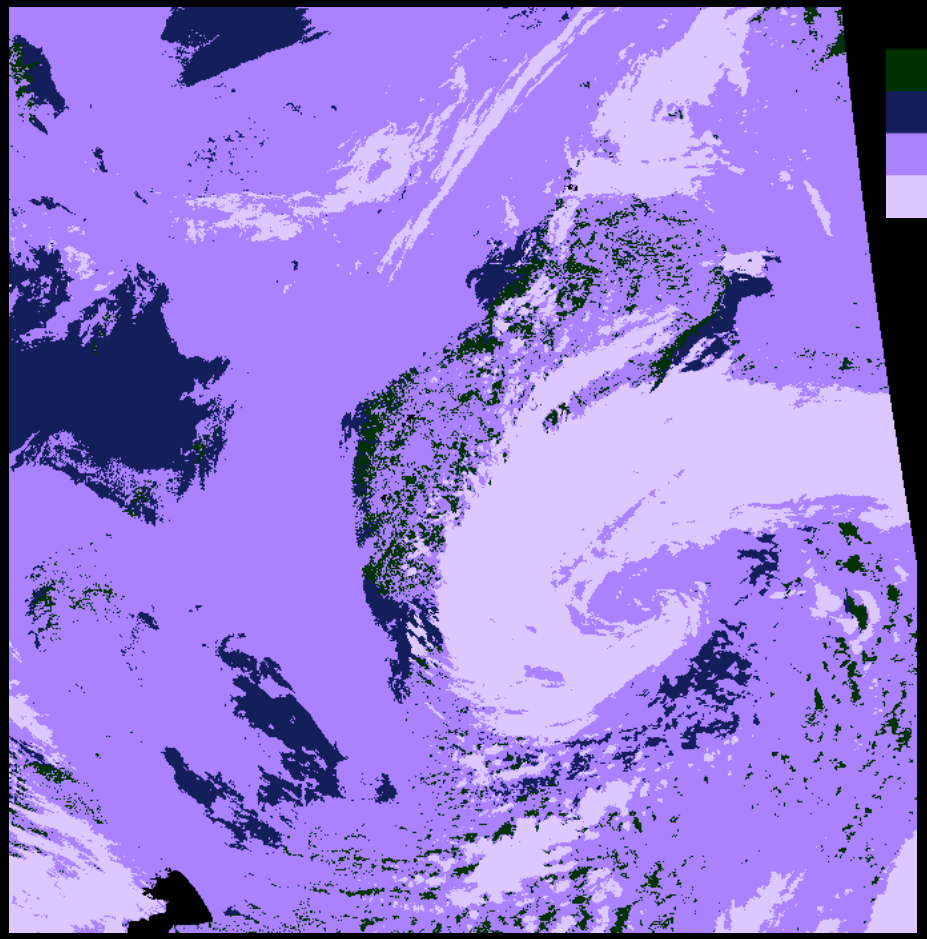
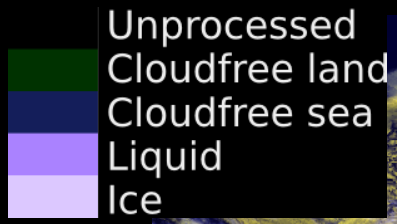
CPP products

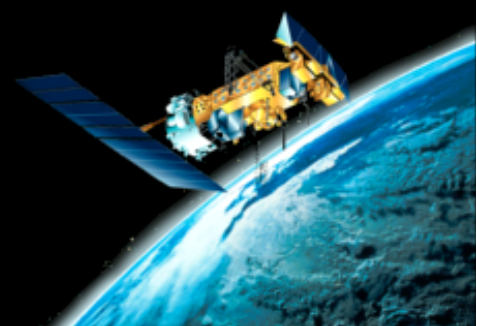
Cloud Phase





VIIRS in PPS

- All moderate resolution AVHRR heritage channels + 8.6 µm
- CSPP used to go from RDR to SDR
- No valid precipitation product until v2014



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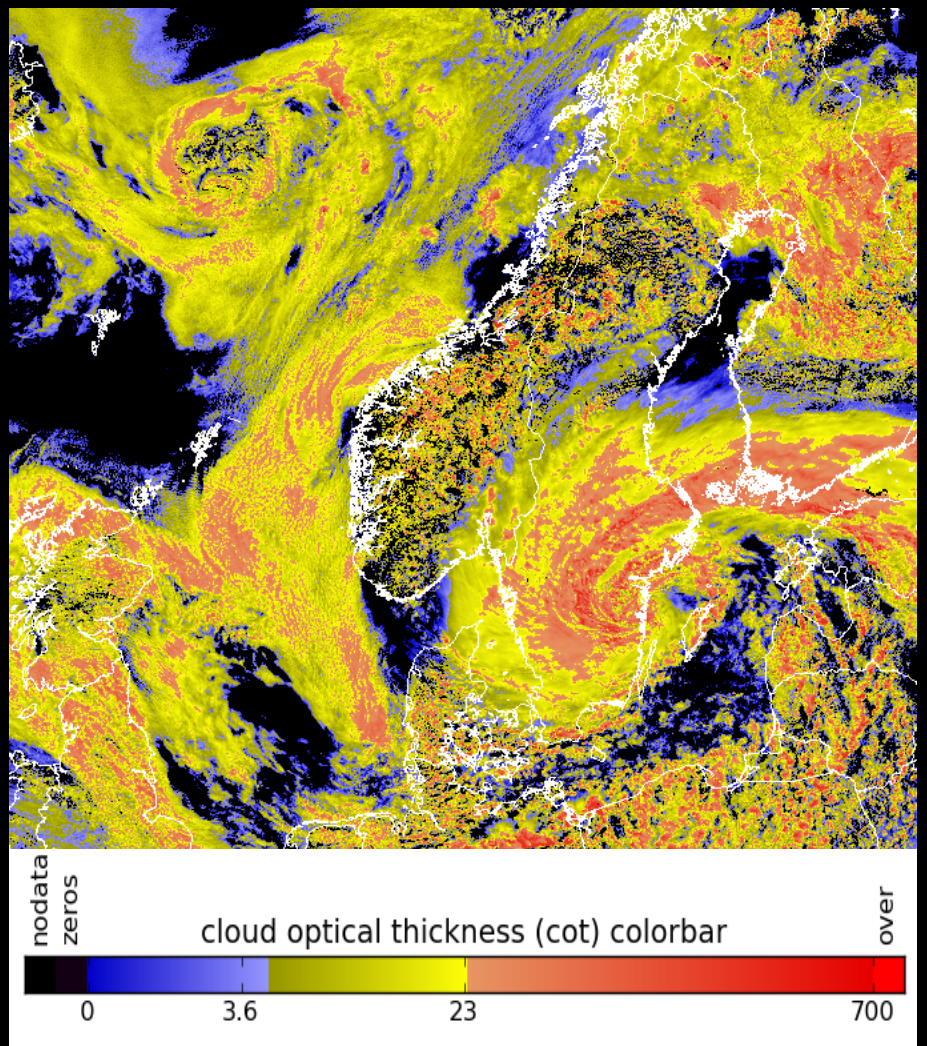
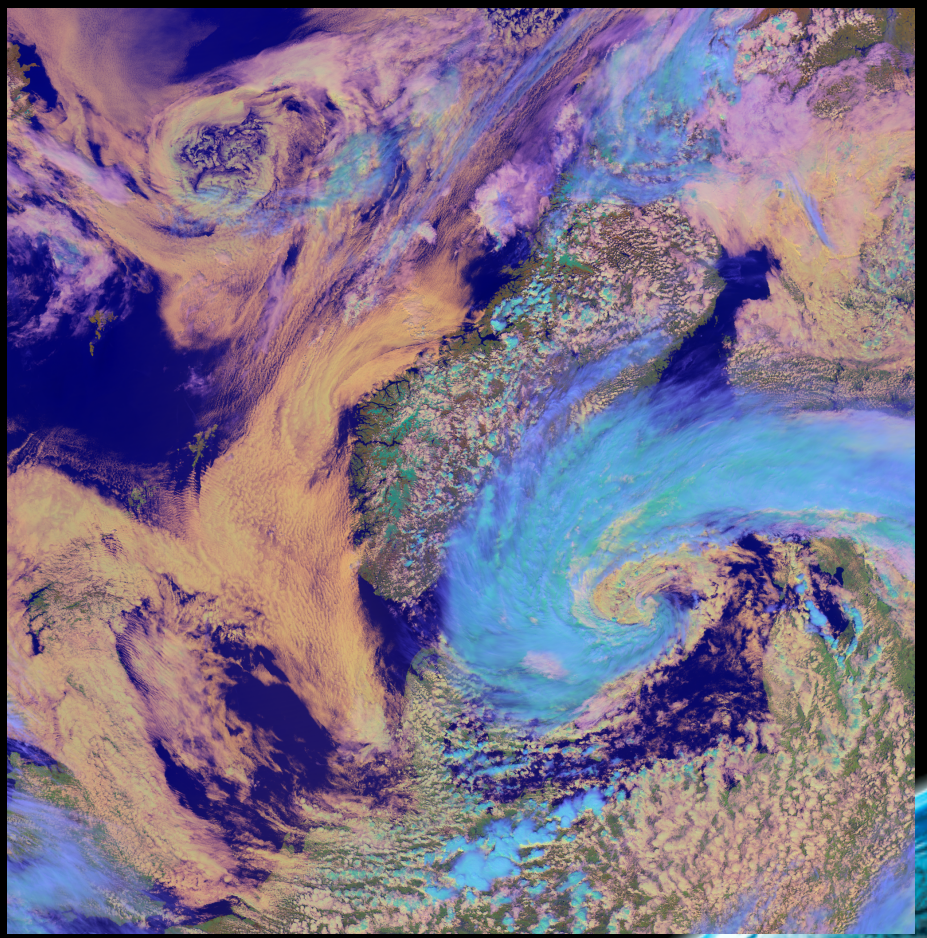
VIIRS products

Cloud Optical Thickness



VIIRS: June 25 11:49 UTC, 2012



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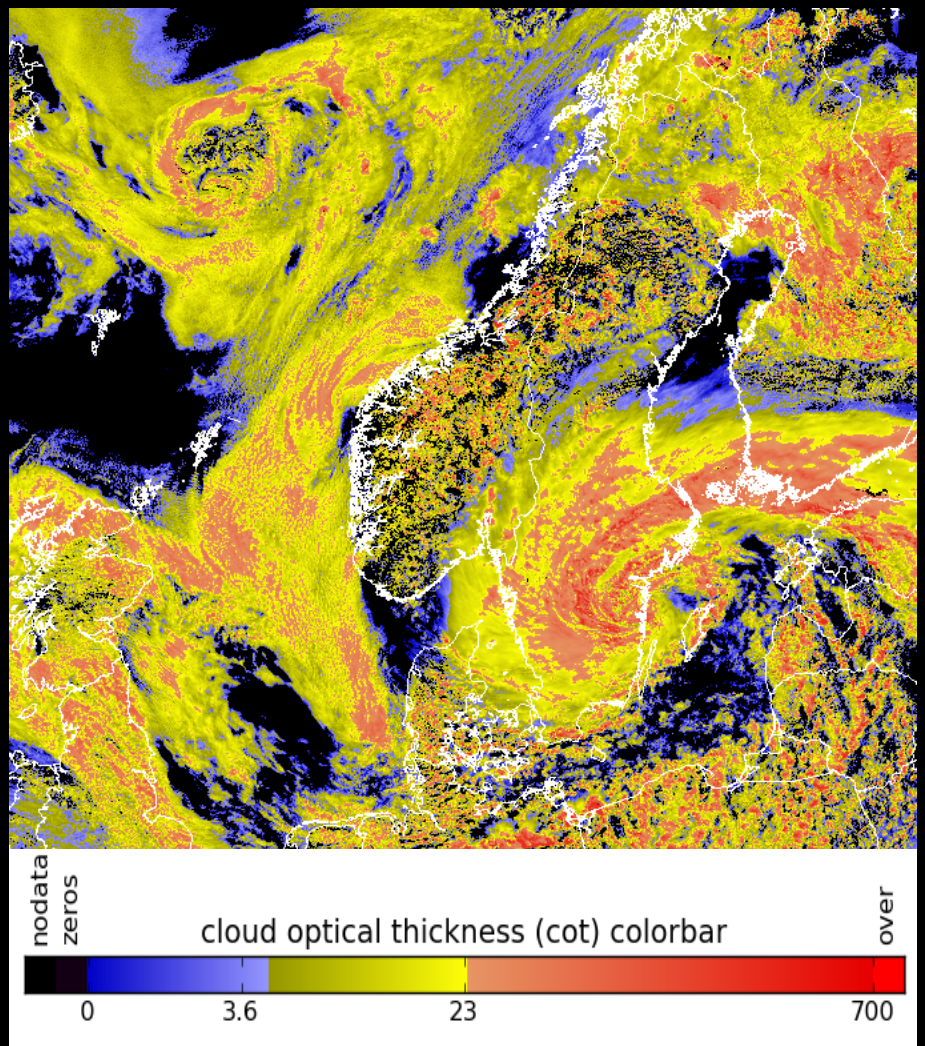
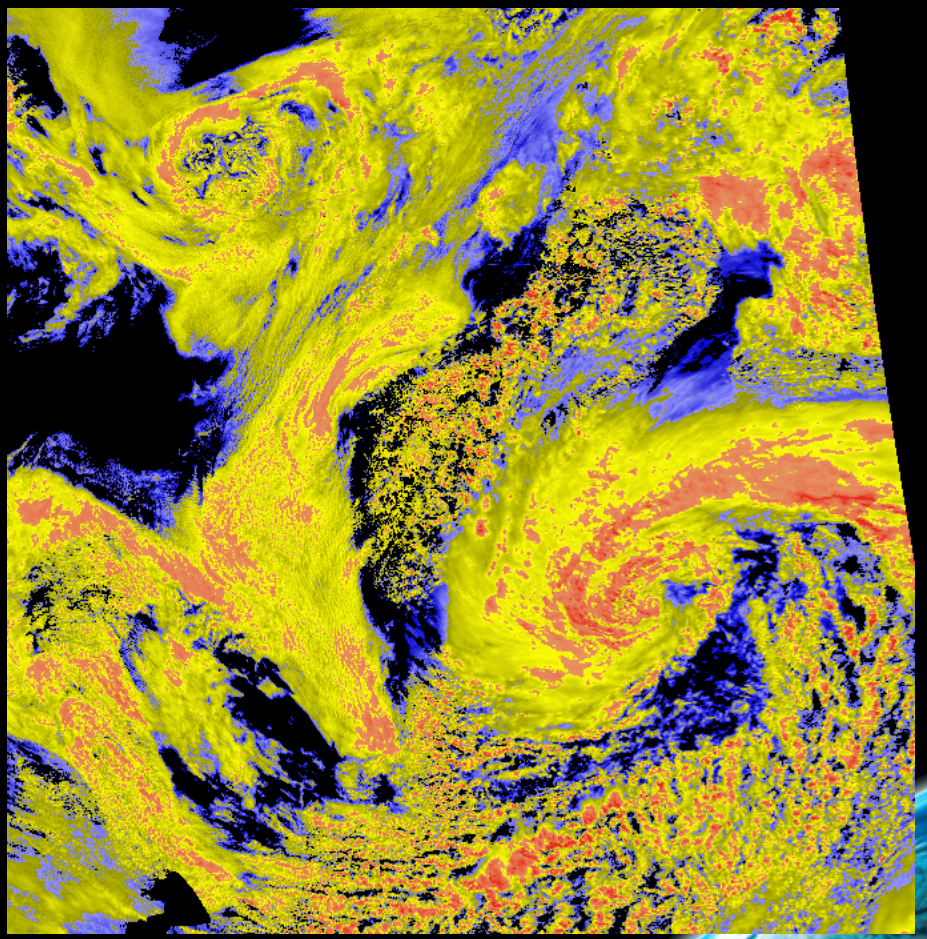
VIIRS versus AVHRR products

Cloud Optical Thickness

VIIRS: June 25 11:49 UTC, 2012



AVHRR: June 25 12:22 UTC, 2012



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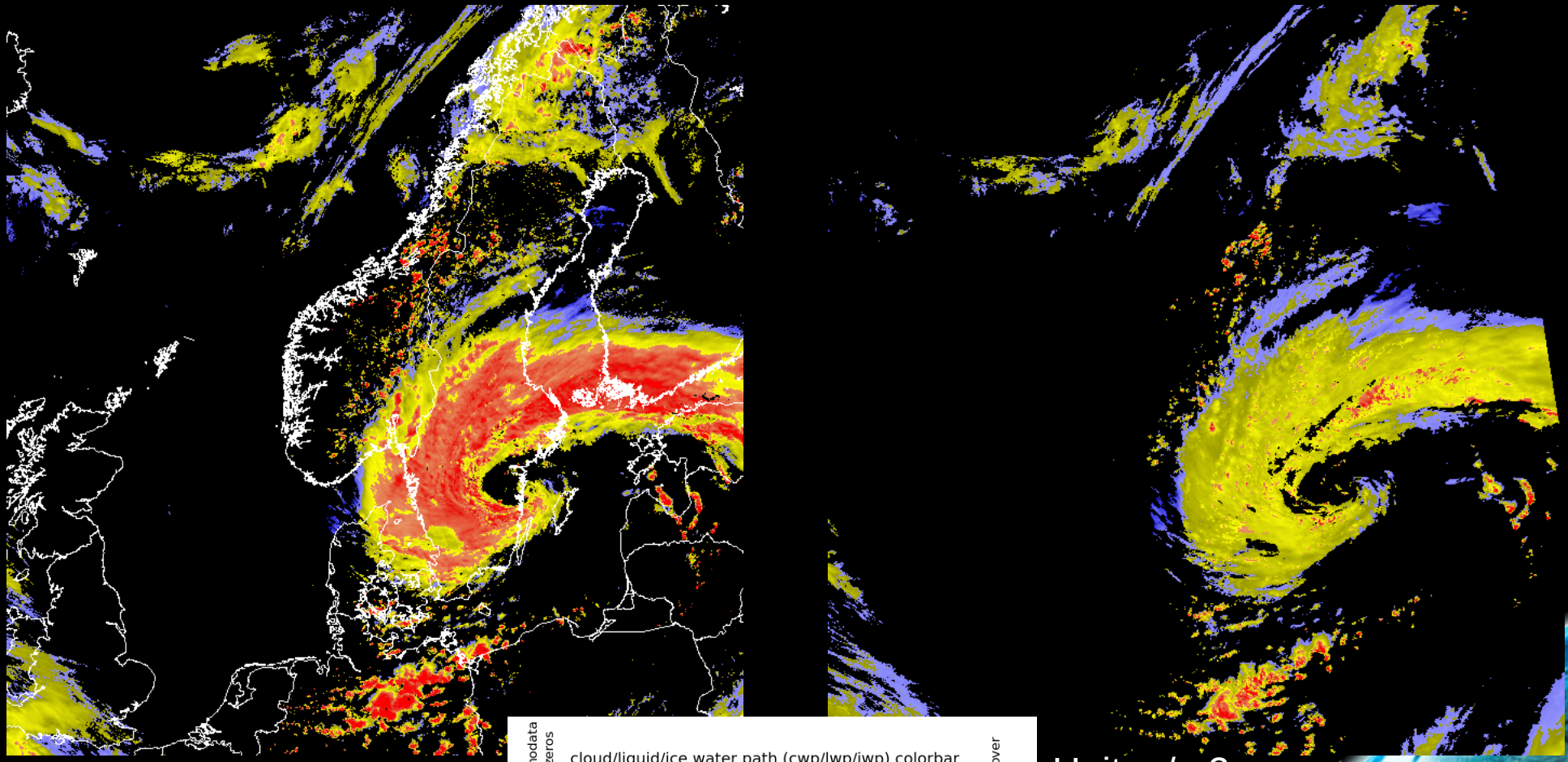
VIIRS versus AVHRR products

Ice Water Path

VIIRS: June 25 11:49 UTC, 2012

AVHRR: June 25 12:22 UTC, 2012



Unit: g/m2

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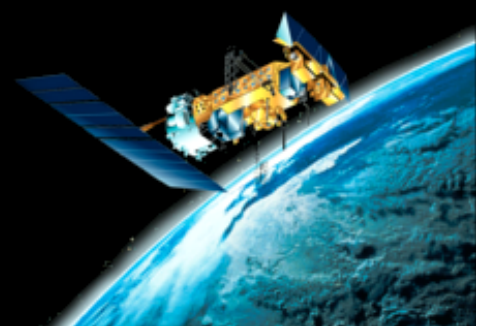
VIIRS in PPS

- VIIRS cloud products generally in good agreement with AVHRR (NPP & N19)
  - More ice phase and cirrus seem to be detected



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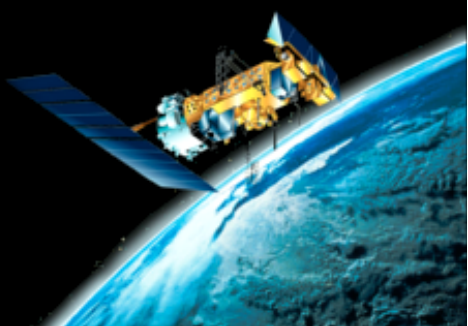
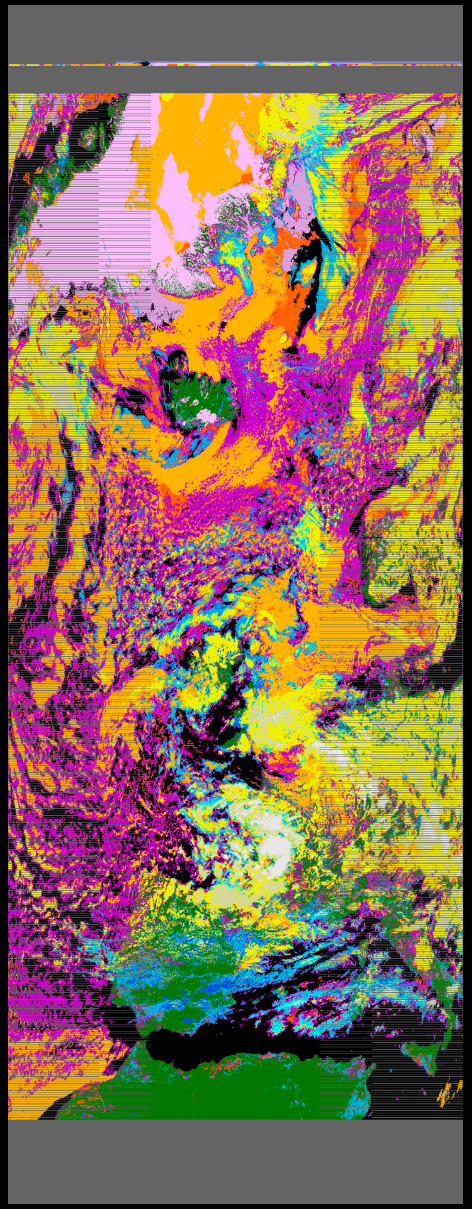
PPS on VIIRS – Validation using CALIOP

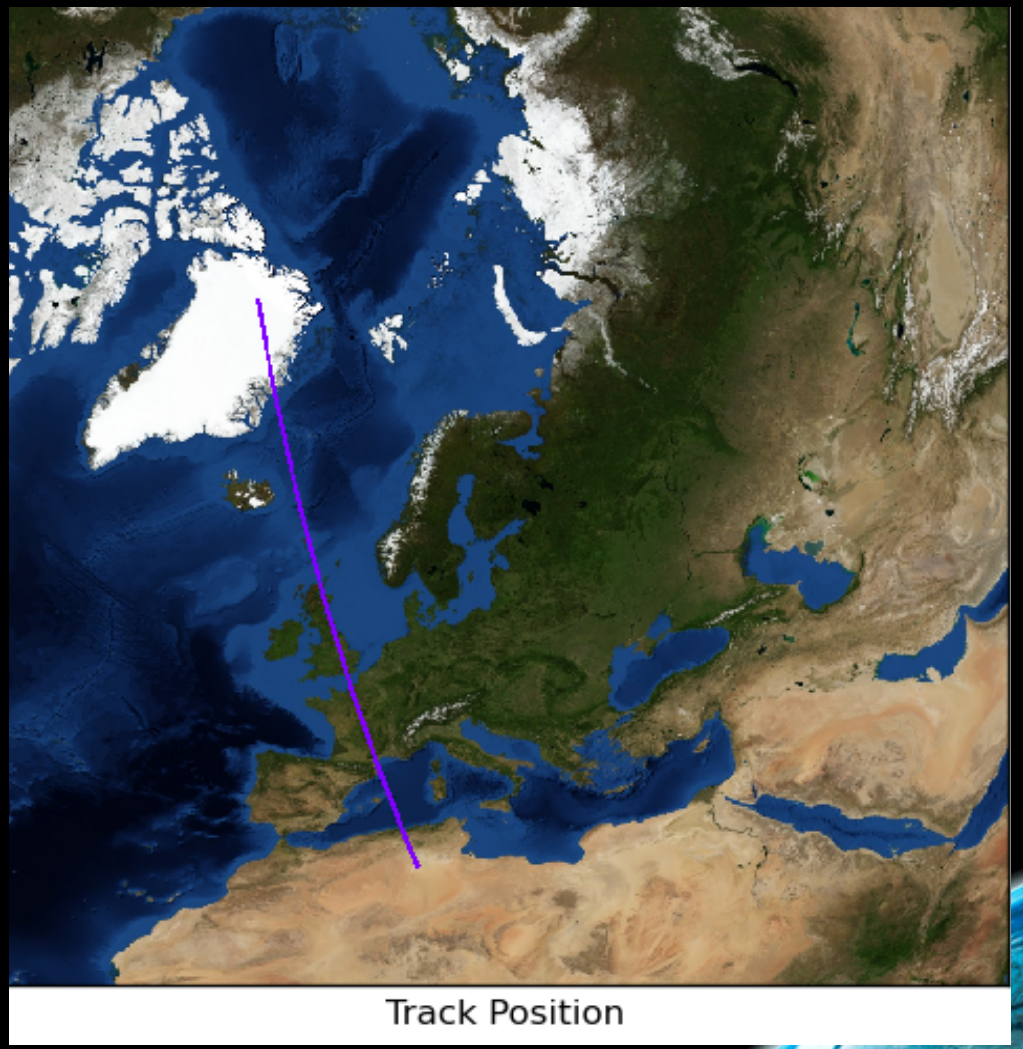
- First comprehensive validation completed
- Co-locating CALIOP and VIIRS
- 6 months (May till October 2012)
- 34 scenes from Norrköping station
- Time difference < 10min
- ~150 000 observations



VIIRS-CALIOP matchup

Suomi NPP scene:
June 11
12:53 UTC,
2012





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PPS on VIIRS – Validation using CALIOP

- Parallax not accounted for
- Account for differences in observations:
  - VIIRS: Passive imager with limited capability of detecting thin clouds
  - CALIOP: Active instrument highly capable of detecting very thin high clouds

Filtering as introduced in *Karlsson and Johansson*, 2013: doi:10.5194/amt-6-1271-2013

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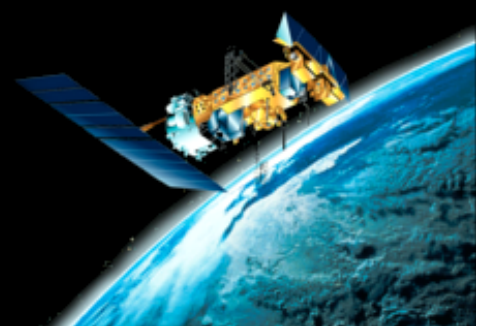
Cloud Mask

	Bias	HR	POD	FAR	POD clear	FAR clear	N
All	**-9.0**	**0.84**	**83.2**	**5.5**	85.6	37.1	149549
Day	-3.8	0.92	92.9	2.7	86.5	30.3	49888
Twilight	-16.4	0.79	77.7	3.1	87.9	55.0	38773
Night	-8.5	0.80	77.2	10.7	84.6	31.0	60888



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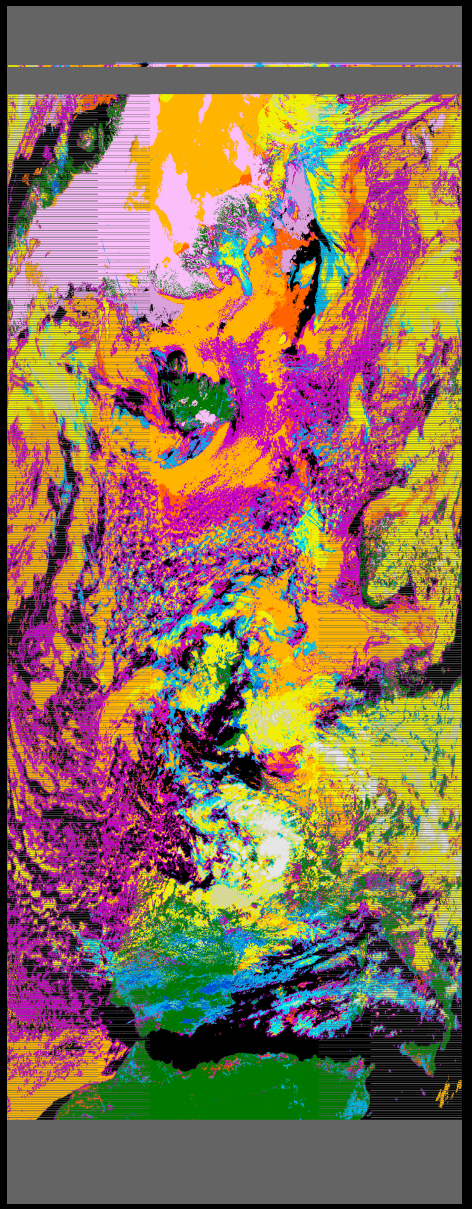
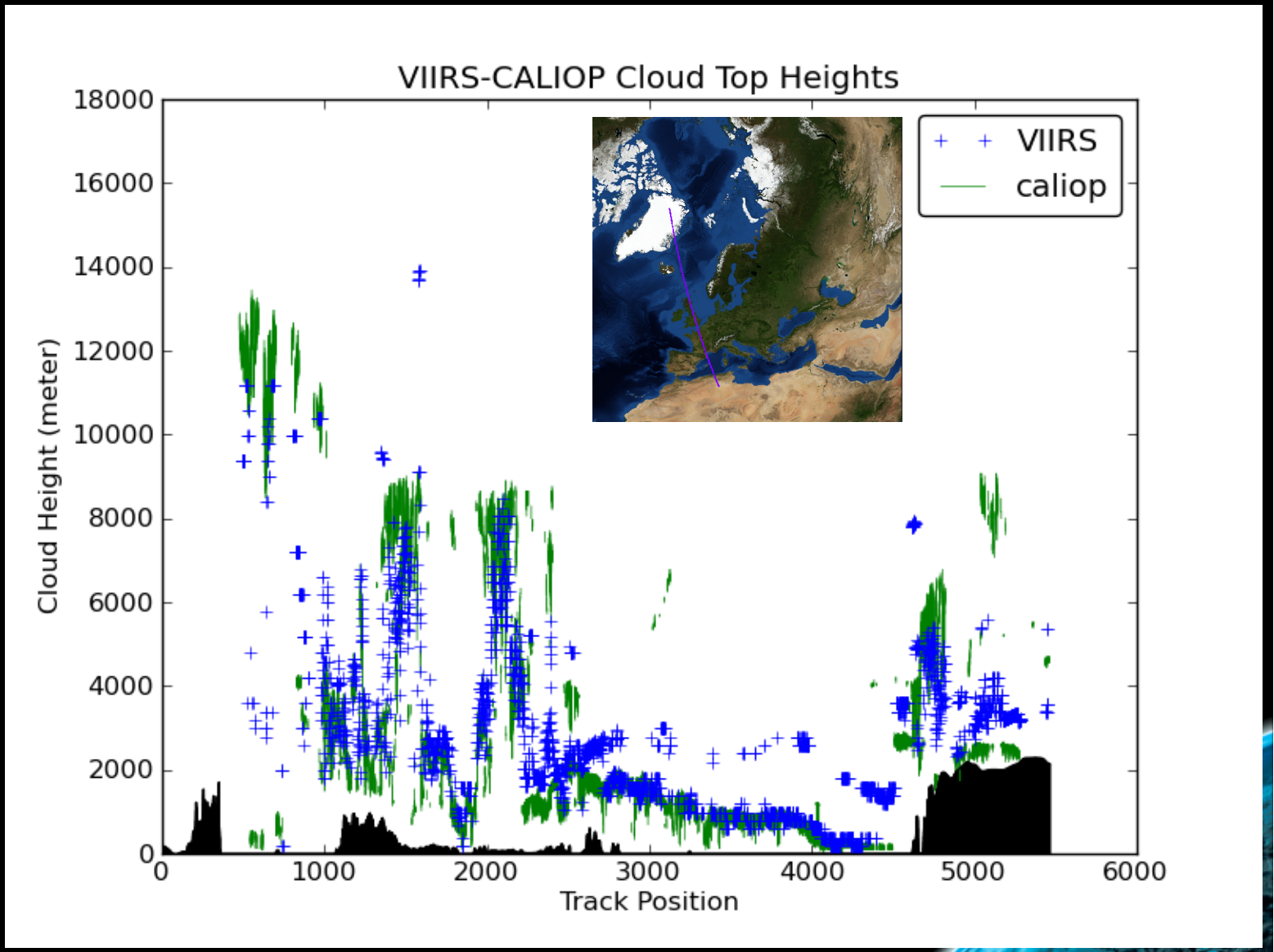
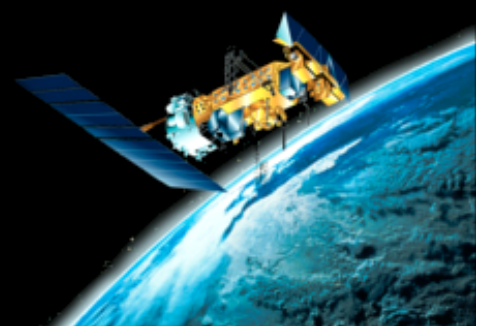
VIIRS Cloud Top Height





Future



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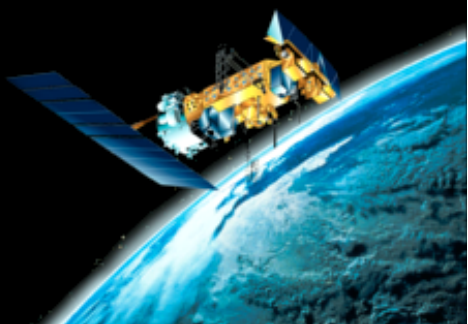
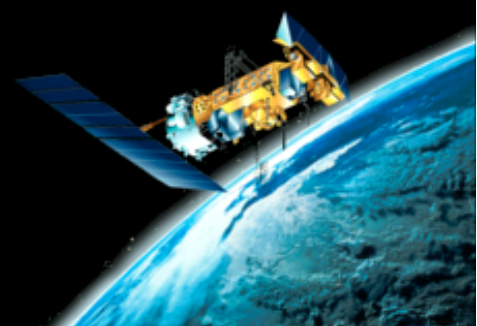
What's coming next?

- RPM and Debian based installation
  - Q3 2013
- v2014 scheduled for March 2014
- V2016
- CDOP2 ends February 2017



v2014

- New output format:
  - netCDF - CF
- Cloud Mask: Revised surface treatment to reduce biases found over some semi-arid regions



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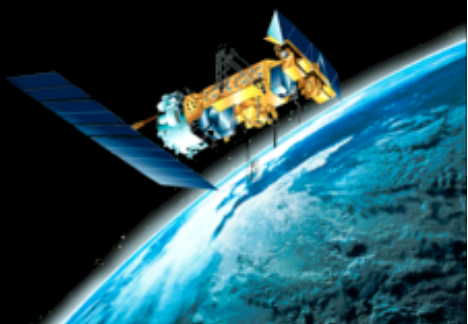
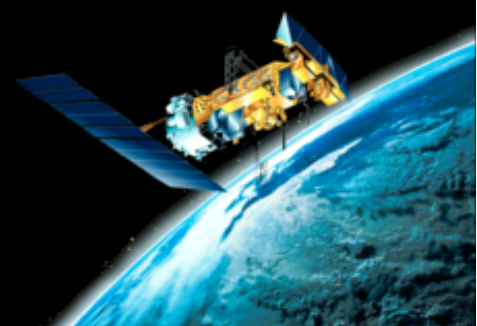
v2014

- Improved Cloud Top Height
  - Smaller bias and RMS. Prototyping with CALIOP data
  - Speeding up semi-transparent retrieval and picking up more Cirrus cloud heights



v2014

- Precipitating Cloud: Add rain rate using cloud microphysical products (daytime only). AVHRR & VIIRS



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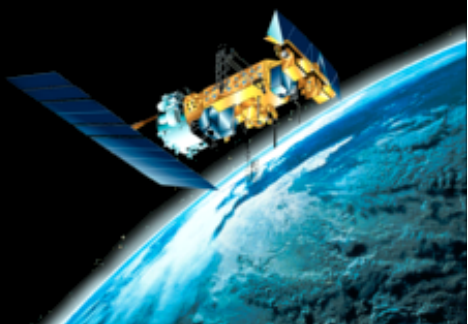
Direct Readout processing at SMHI with VIIRS



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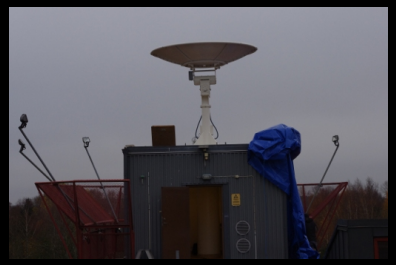
DR processing at SMHI with VIIRS

- X/L-band station installed Nov 2011
- Running RT-STPS-CSPP-PPS-Pytroll pre-operationally since Spring 2012
- In operation since Dec 18, 2012

Nov 8 08:56

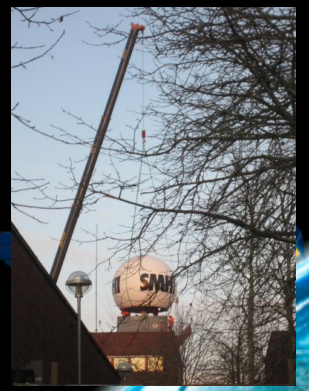
Nov 8 10:27



Nov 8 13:53

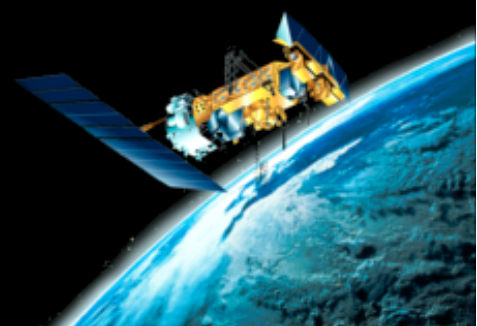
Nov 15 13:05

Nov 16 16:20



DR processing at SMHI with VIIRS

- Due to timeliness issues Suomi NPP is currently prioritized low



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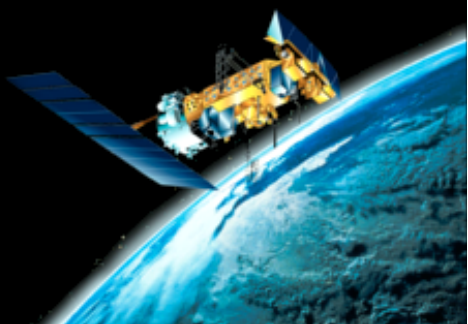
DR processing at SMHI with VIIRS

- VIIRS only
- The VIIRS DNB and I-band RGBs have proven very useful in the SMHI Ice Charting Service



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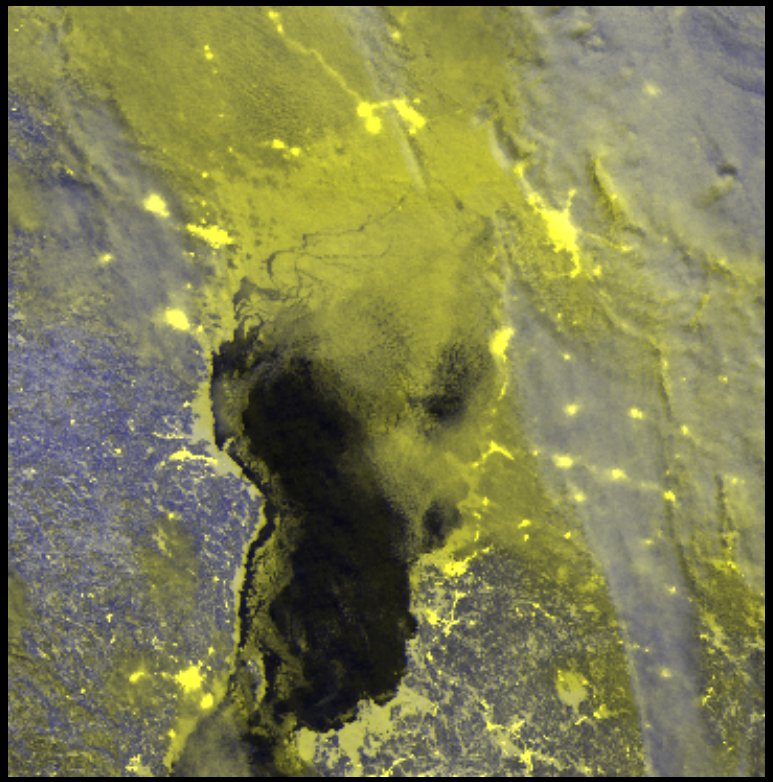
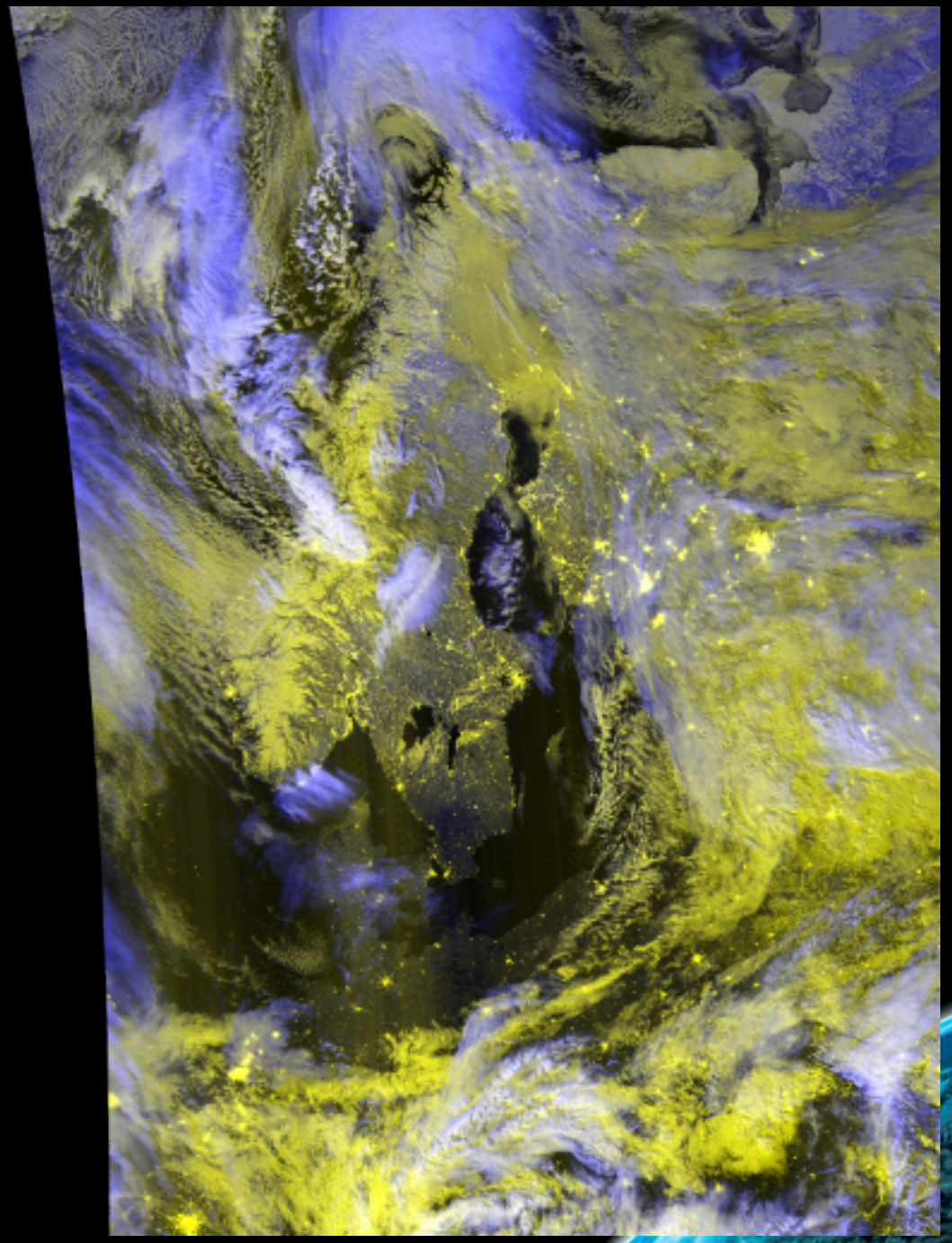
When Radarsat SAR data are unavailable VIIRS is indispensable



Bothnian Bay in Moonlight: Dec 28, 2012, 00:28 UTC



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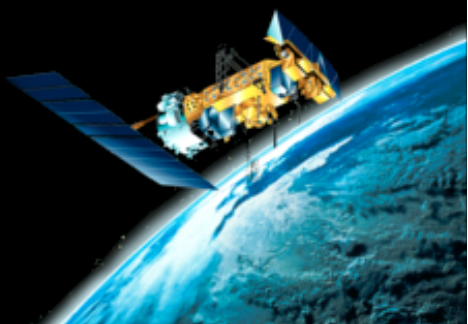
DR processing at SMHI with VIIRS

- RT-STPS 5.3 with streaming patch (DB6) as of May 13
- CSPP 1.3



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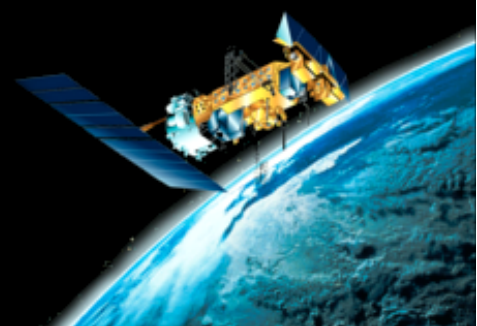
SDR timeliness

- RT-STPS: ~2-3 minutes for one swath
- CSPP: ~20-21 minutes



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File Edit View Search Terminal Help

```
top - 13:20:44 up 44 days,  5:25,  3 users,  load average: 1.38, 1.84, 2.17
Tasks: 703 total,   2 running, 701 sleeping,   0 stopped,   0 zombie
Cpu0  :  1.0%us,  5.2%sy,  0.0%ni, 63.1%id, 30.0%wa,  0.0%hi,  0.7%si,  0.0%st
Cpu1  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu2  :  0.3%us,  0.0%sy,  0.0%ni, 99.7%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu3  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu4  :  0.7%us,  0.0%sy,  0.0%ni, 99.3%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu5  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu6  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu7  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu8  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu9  :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu10 :  0.0%us,  0.3%sy,  0.0%ni, 99.7%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu11 :  0.0%us,  0.0%sy,  0.0%ni, 99.7%id,  0.0%wa,  0.0%hi,  0.3%si,  0.0%st
Cpu12 :  0.7%us,  0.7%sy,  0.0%ni, 98.3%id,  0.3%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu13 :100.0%us,  0.0%sy,  0.0%ni,  0.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu14 :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Cpu15 :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
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Cpu21 :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
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Cpu23 :  0.0%us,  0.0%sy,  0.0%ni,100.0%id,  0.0%wa,  0.0%hi,  0.0%si,  0.0%st
Mem:  49359100k total, 22976876k used, 26382224k free,     7216k buffers
Swap: 51576824k total, 12102620k used, 39474204k free, 10946032k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  COMMAND
14116 safusr.u  20   0 7186m 3.8g  17m R 99.6  8.2   0:52.20 ProSdrViirsCont
22338 root      20   0     0    0    0 S  6.0  0.0  16:30.41 flush-253:5
 2673 safusr.u  20   0  788m 8188  824 S  3.0  0.0 763:24.76 python
 4617 safusr.u  20   0 26432 1888 1048 R  0.7  0.0   0:08.15 top
  154 root      20   0     0    0    0 S  0.3  0.0   1:19.25 kblockd/0
 2635 root      20   0     0    0    0 S  0.3  0.0  19:29.07 kondemand/0
 7511 safusr.u  20   0  626m 4376 1388 S  0.3  0.0  91:27.41 python
17979 safusr.u  20   0  567m 4184 1424 S  0.3  0.0  42:28.11 python
```

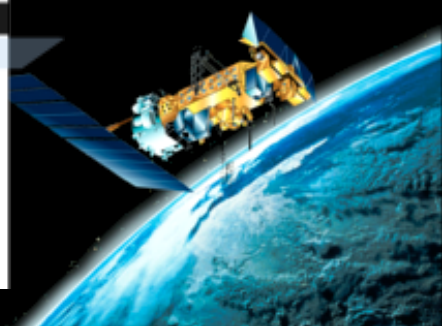

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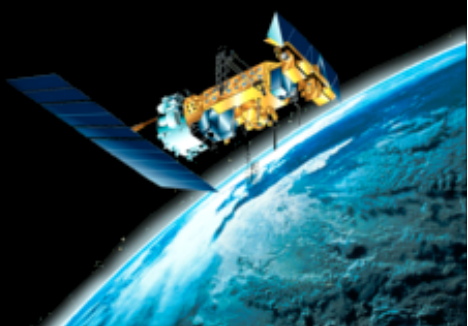
RT-STPS streaming and granule processing with CSPP

- 2met! streams CADU data directly to RT-STPS during reception
- RT-STPS makes 86s granules
- RDRs are dispatched in real time to processing servers



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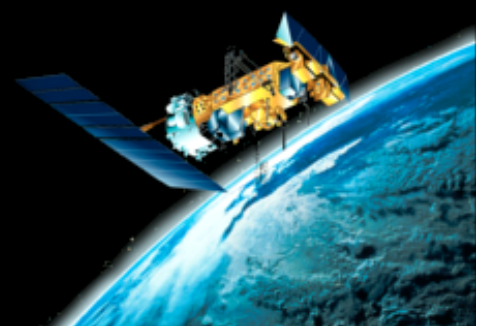
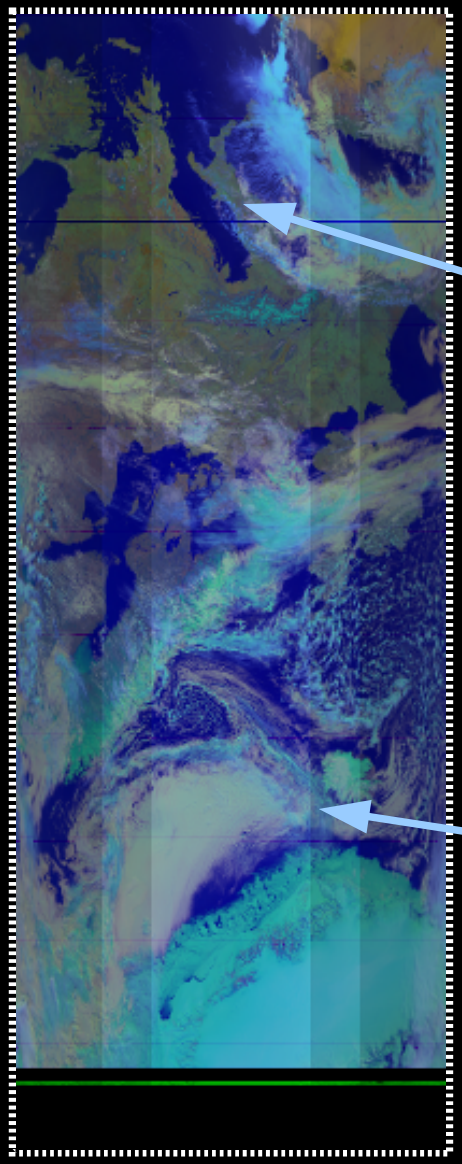
RT-STPS streaming and granule processing with CSPP

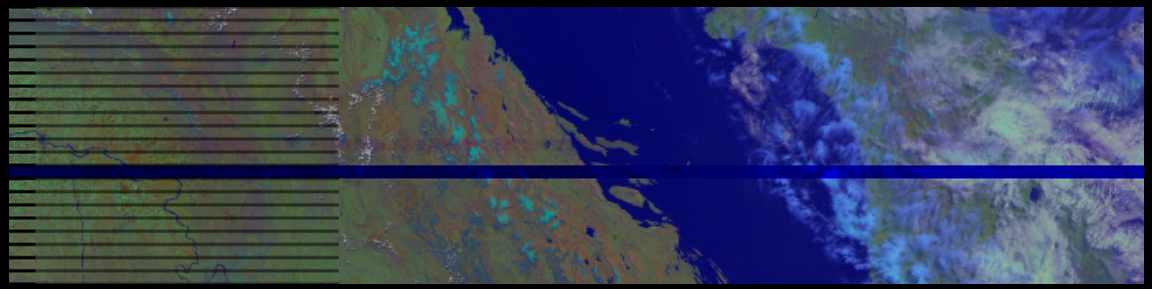
- CSPP is triggered on sets of 3 granules
  - Keeping only the SDRs of the middle granule
- Timeliness improved from ~23min to ~10min



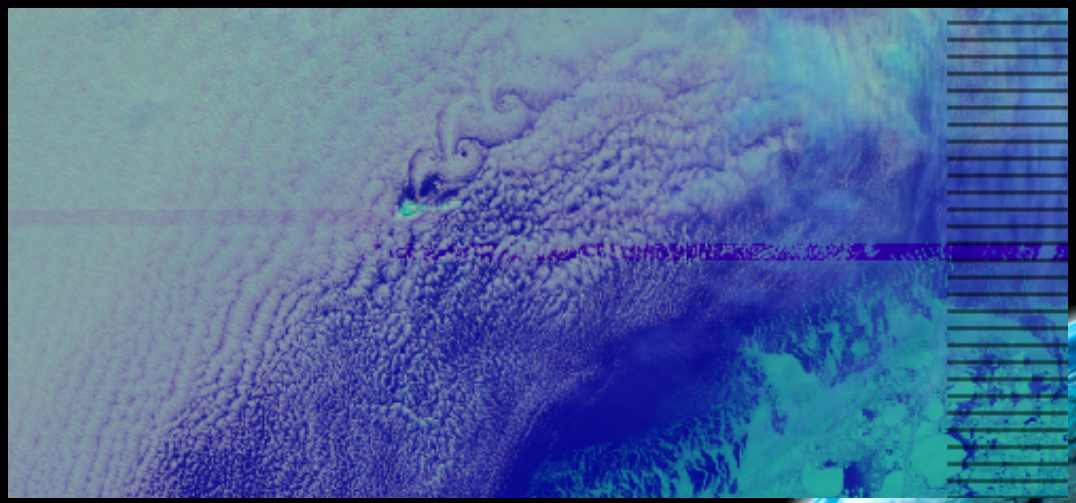
Why run on sets of 3 granules?



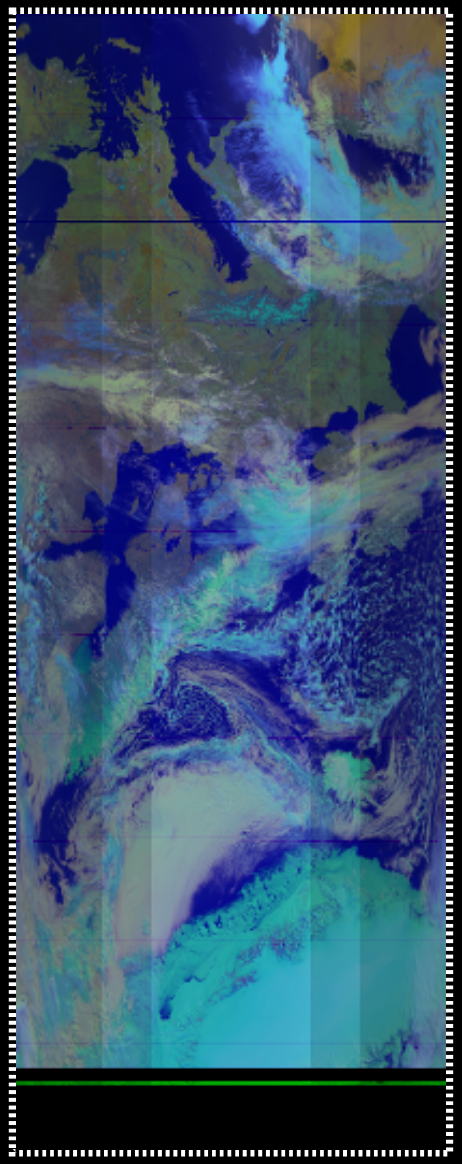
Complete dropout of all short wave channels on one scan:



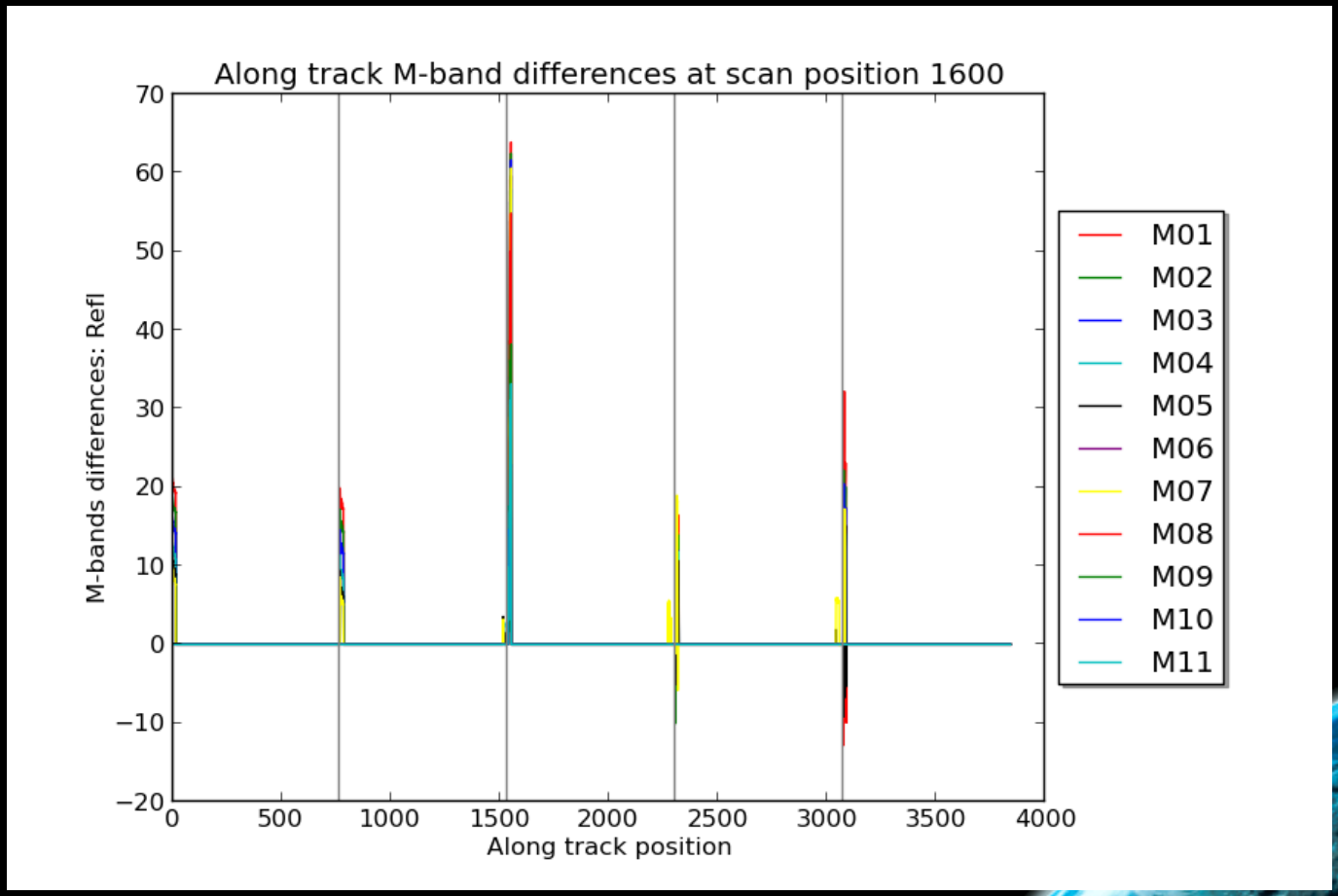
Seamless distortions on parts of scans only



Why run on sets of 3 granules?



Only an issue with short wave bands



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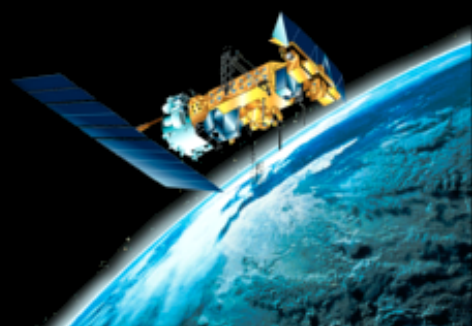
Thanks!
Questions?

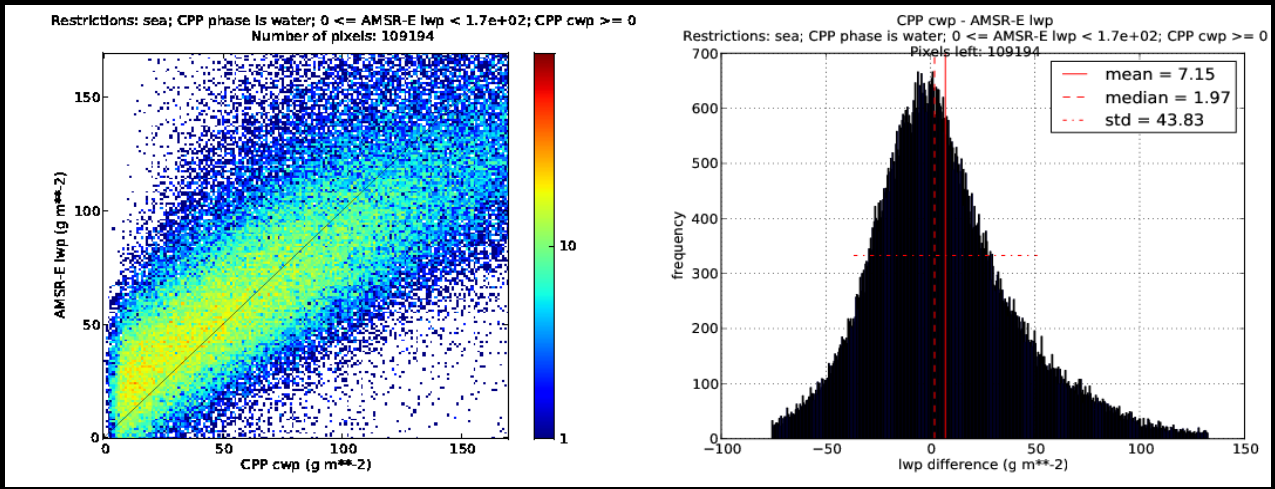
http://www.nwcsaf.org
http://nwcsaf.smhi.se



CPP Validation of LWP and Cloud Phase

performed against AMSR-E for lwp and Calipso for cph

LWP



LWP bias = 7g/m2

LWP RMS error = 44g/m2

Phase

	CALIOP liquid	CALIOP solid
CPP liquid	18327	5556
CPP solid	1693	9827

	POD	FAR
liquid	0.92	0.23
solid	0.64	0.15

Both liquid water over ocean and cloud phase perform well within specifications

VIIRS versus AVHRR products

Ice Water Path:

Somewhat higher IWP values in VIIRS compared to AVHRR