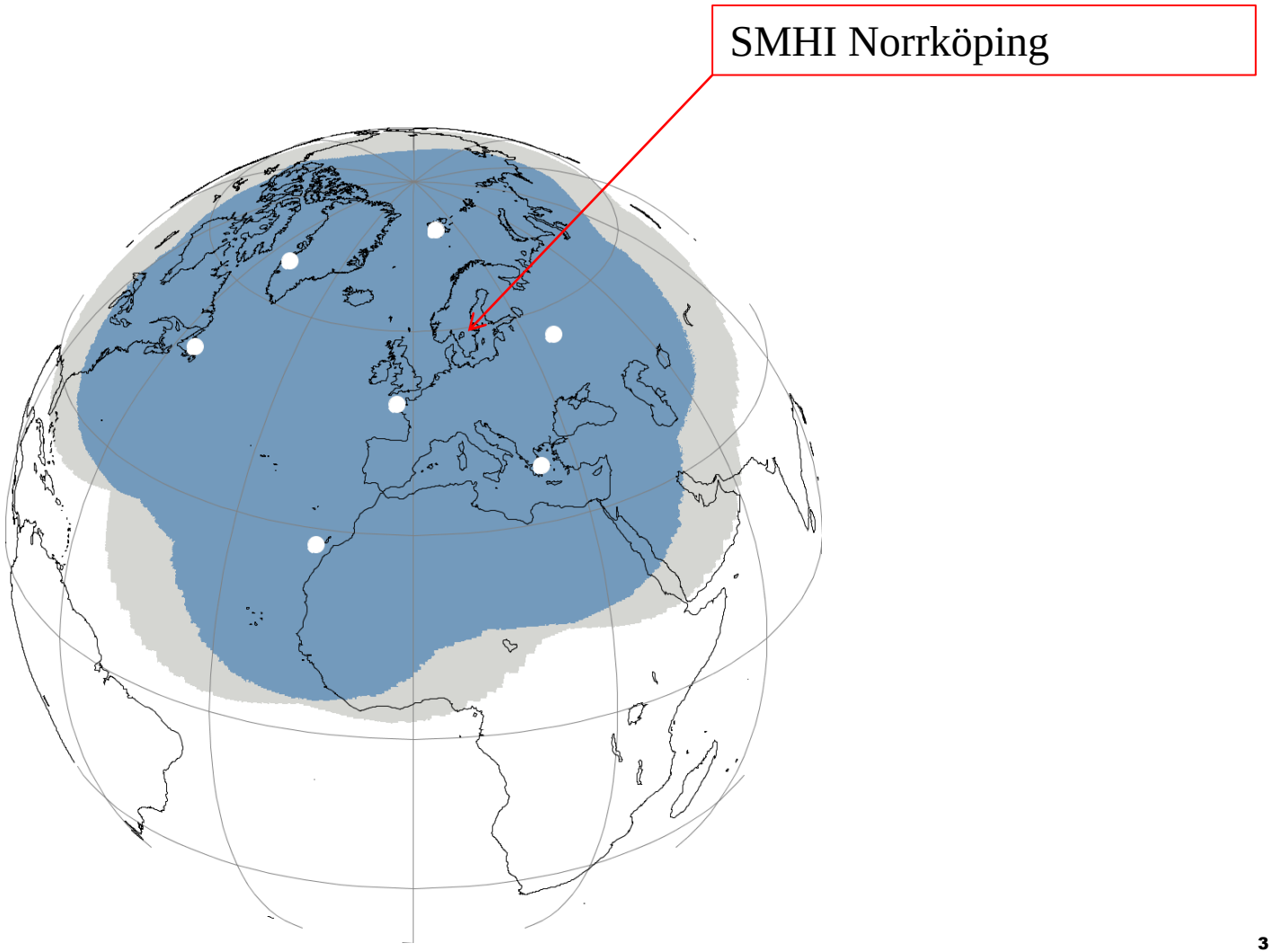
Anna Eronn, SMHI Sweden

NoWCasting SAF – Event Week 2013
PPS Cloud Products

- ✓ Anna Eronn
- ✓ Swedish Meteorological and Hydrological Institute, SMHI
- ✓ Meteorologist with focus on satellite
- ✓ Headquarter in Norrköping

Where are You?



Content

- Overview of the PPS
- The PPS cloud products
  - Cloud mask
  - Cloud type
  - Cloud top temperature pressure and height
  - Precipitation clouds
- The cloud physical properties
- Future

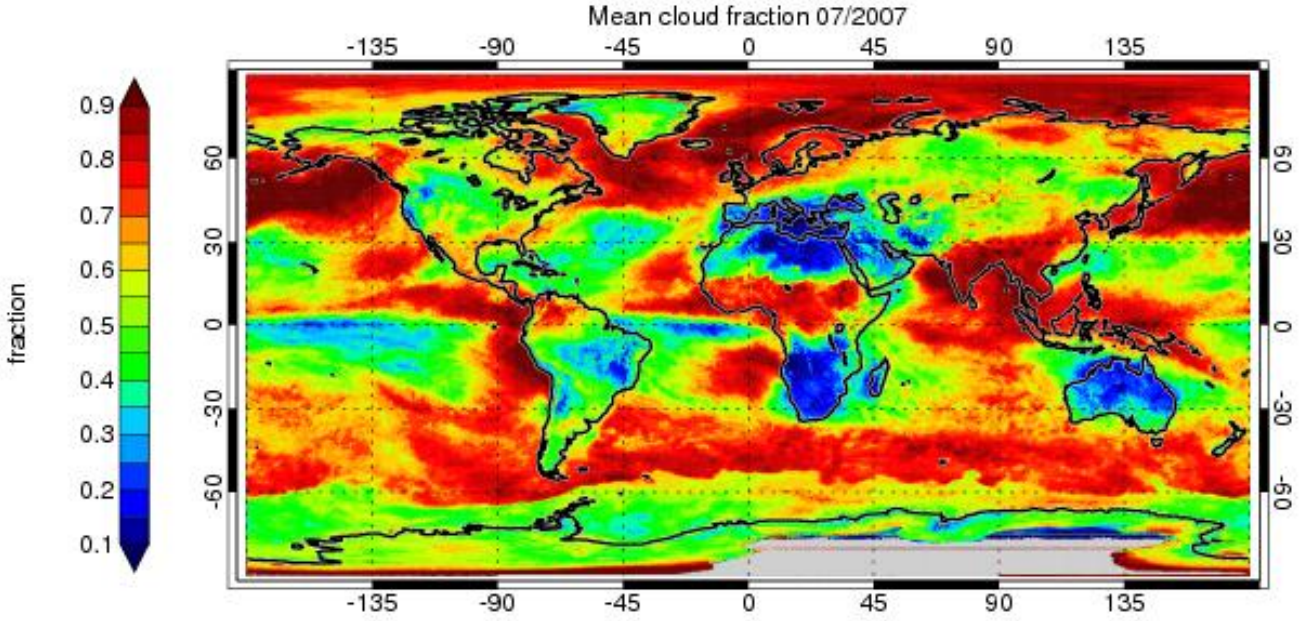
PPS – Polar Platform System Package

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

PPS – Polar Platform System Package

- **Used not only for Nowcasting, but also for Climate SAF (global products), Ocean and Sea Ice SAF and Land SAF (regional products)**

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



What's new in PPS?

Already in v2012 release

- VIIRS processing

Version 2012 - patches

- Handling Metop-B data
- Handling NWP data up to 137 levels
- Parallell processing

Coming in v2014 release

- Faster/more complete CTTH processing
- Use of surface reflectivity for getting more accurate threshold table
- Better tuning
- Updated emissivity data set over land

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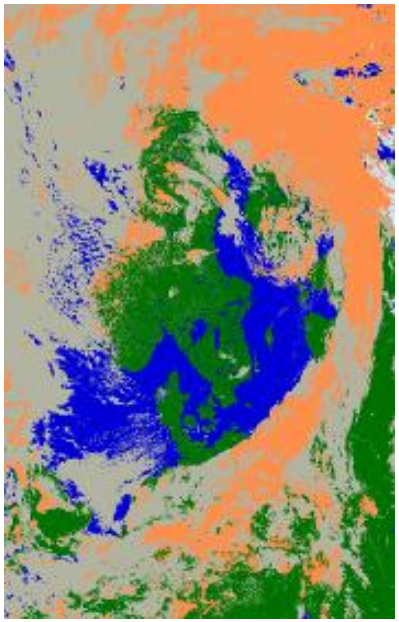
PPS – Polar Platform System Package

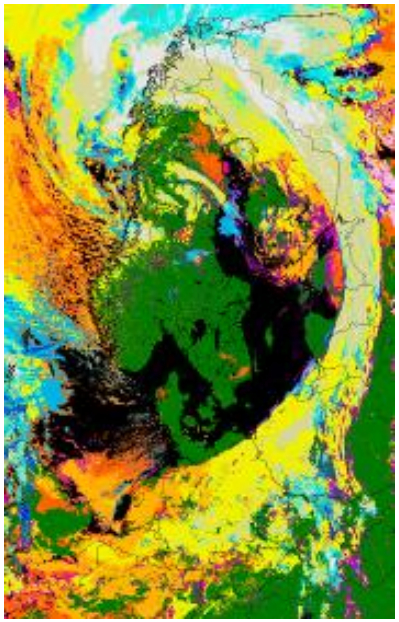
Algorithms and software for automatic image classification.

The four original products are:

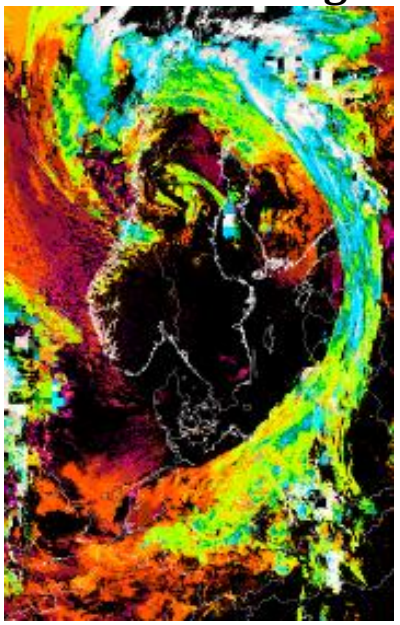
Cloud Mask



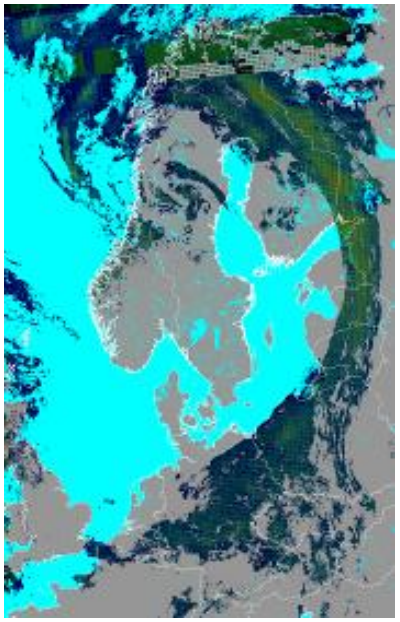
Cloud Type



Cloud Top Temperature Pressure and Height



Precipitation Clouds



NOAA15 2008 10 06 04.45z

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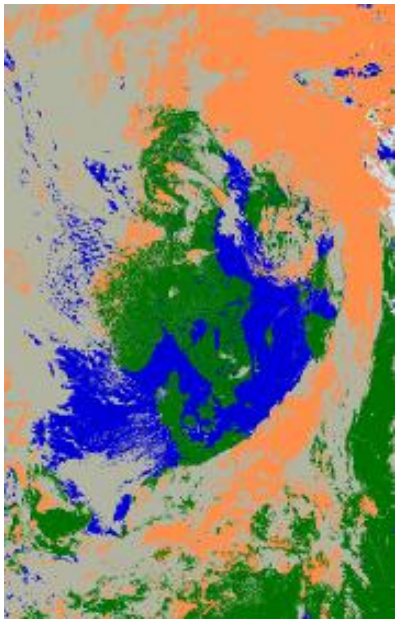
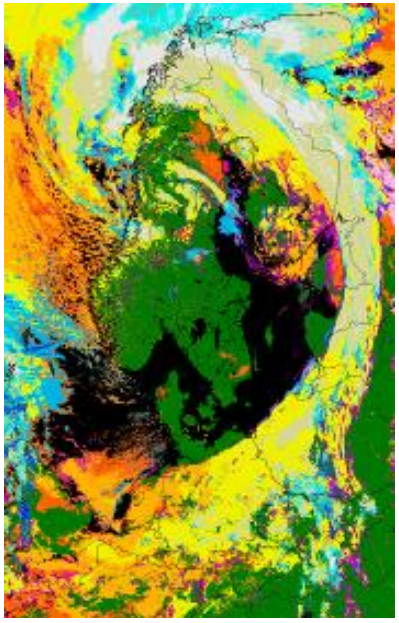
PPS – Polar Platform System Package

Have you ever used one of these products? If yes – make a star/mark on that product please.

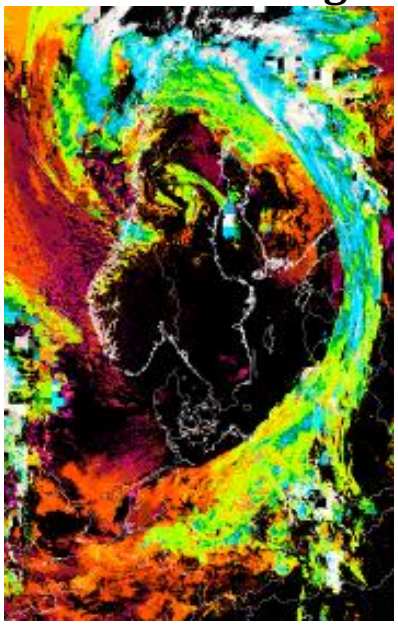
Cloud Mask



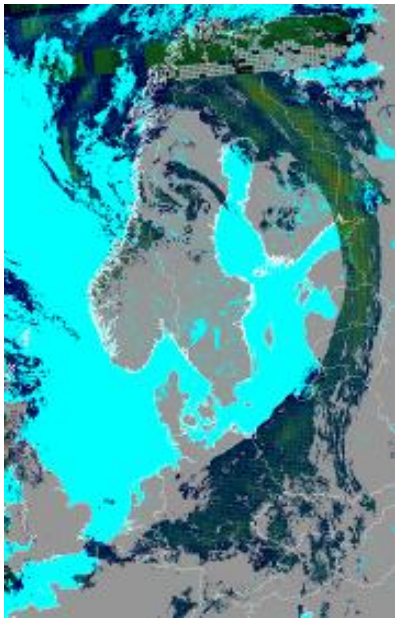
Cloud Type



Cloud Top Temperature Pressure and Height



Precipitation Clouds



NOAA15 2008 10 06 04.45z

No, this is new for me:

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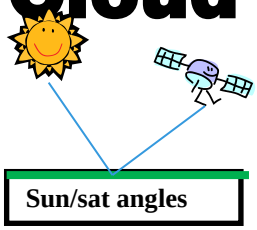
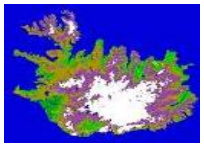
Cloud Mask – what do we need?

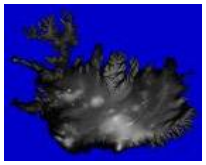


→ Night / Day / Twilight / Sunglint

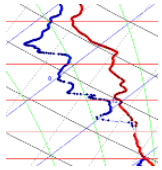
→ Emissivity / reflectivity



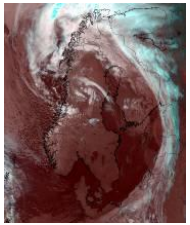
→ Land / Sea / Coast



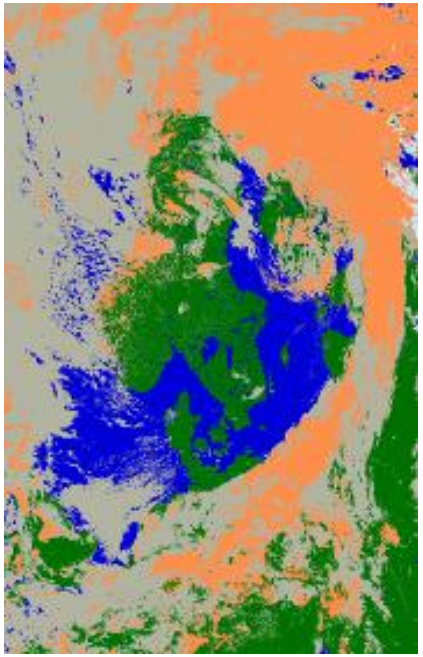
→ Terrain details



→ NWP: Temperature / Moisture



→ AVHRR, VIIRS & MODIS data



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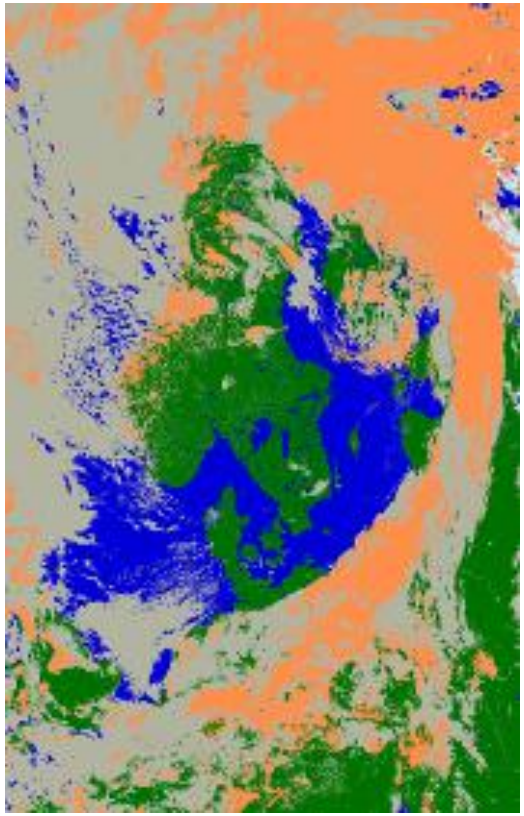
Cloud Mask – output



Goal: Delineate absolutely cloud free pixels.

- Unprocessed
- Cloud free land
- Cloud free sea
- Cloud contaminated
- Cloud filled
- Snow / ice
- Unclassified
- Low quality

Processing flags

Threshold test flags

Cloud phase flags

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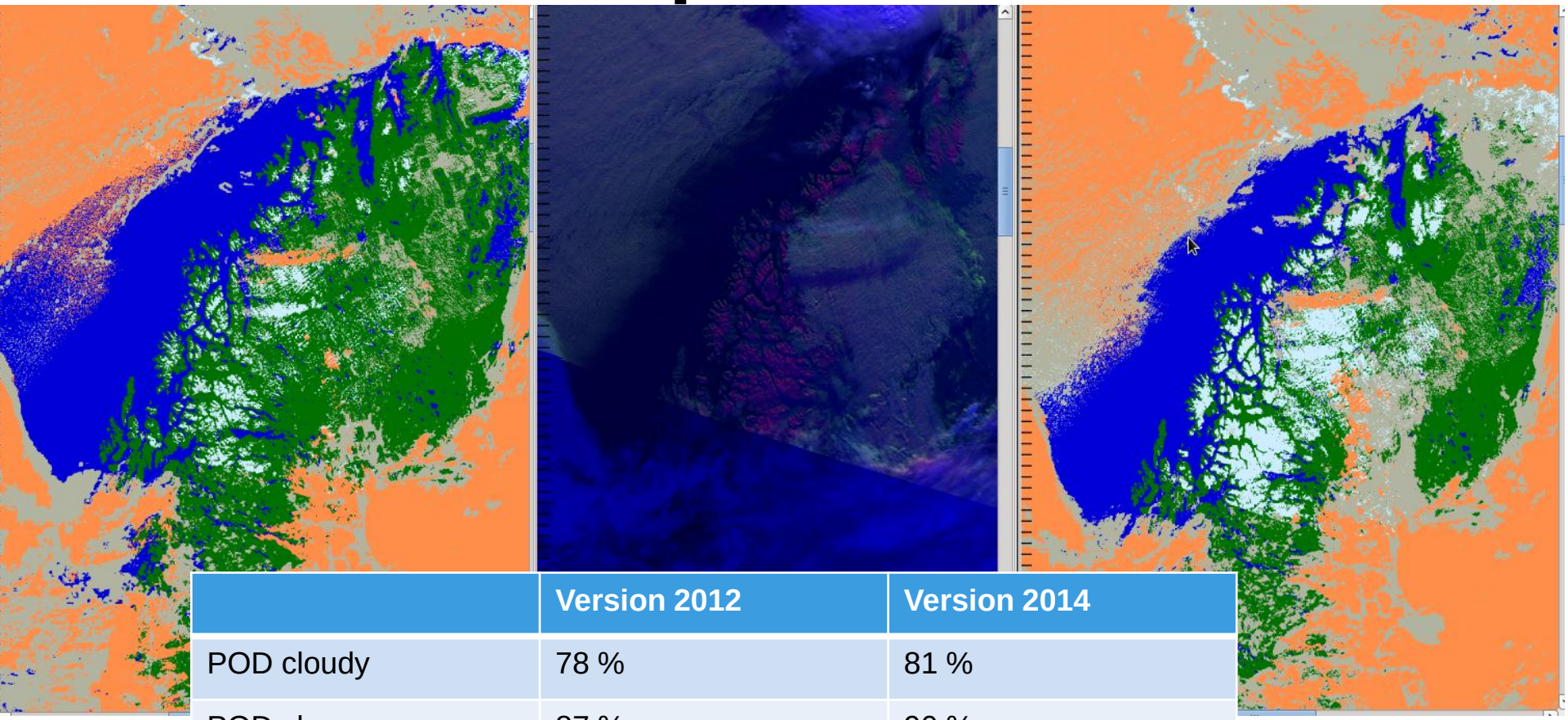
Validation - example



	Version 2012	Version 2014
POD cloudy	78 %	81 %
POD clear	87 %	90 %
Kuipers	0.65	0.70
Hitrate	0.80	0.83

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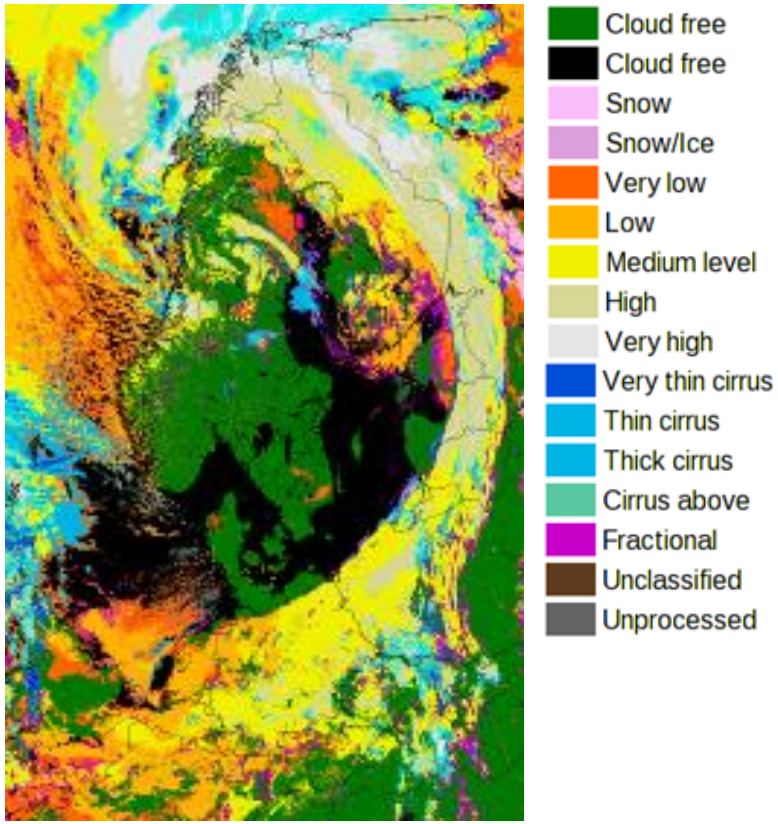
Cloud Type



- **Cloud Mask as input**
  - **Use cloudy pixel from CM and assign cloud type**

Objectives:

- **Distinguish between opaque and thin clouds**
- **Distinguish between water and ice clouds**
- **Rough estimate cloud top height**
- **Highest priority to the identification of:**

low, medium and high clouds

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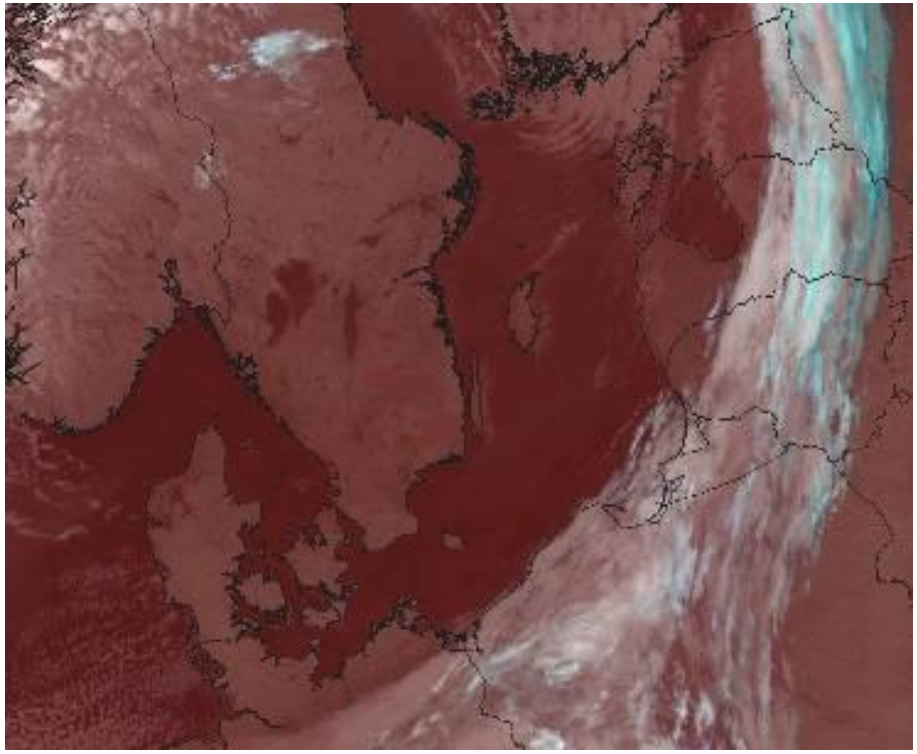
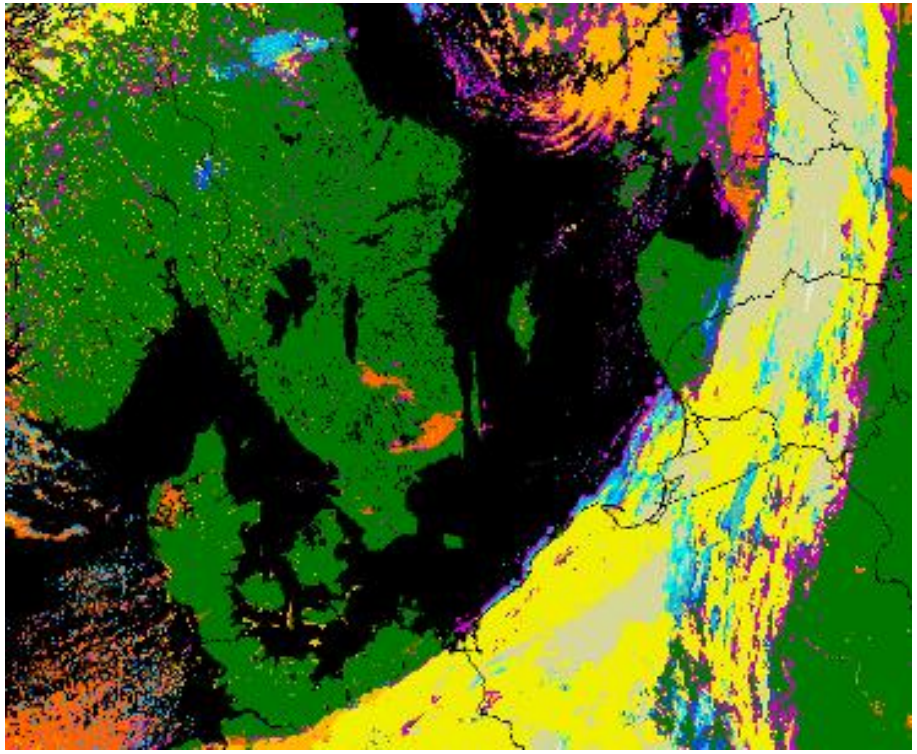
Cloud Type - advantages





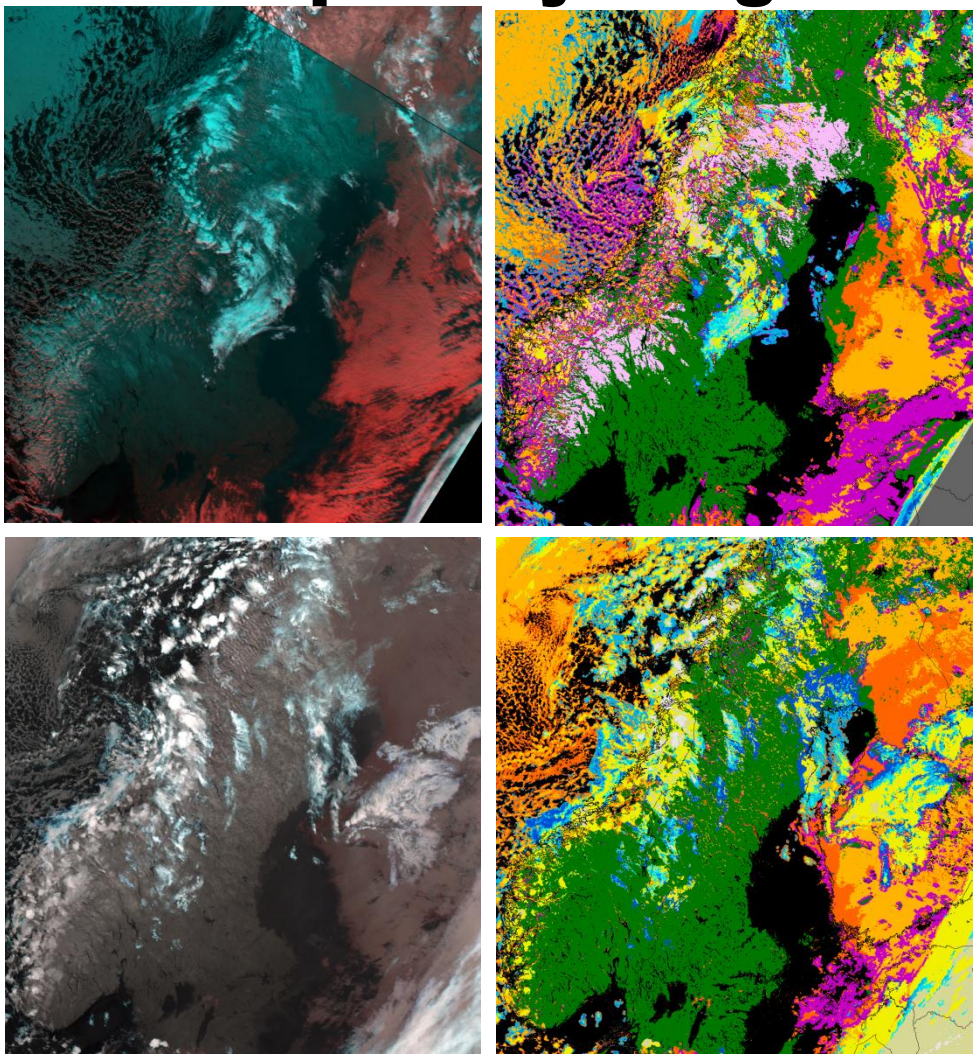
Example: night-time and fog.

NOAA15 2008 10 06 04.45z

AVHRR (3Bi, 4i, 5i), (3.7, 10.8, 12.0)

Disadvantage: no snow and ice analysis when night-time

Example day – night



Day
Metop B 20131113 1032utc

Snow and ice only at day time!

Snow
Snow/Ice

Night
NOAA19 20131113 0222utc

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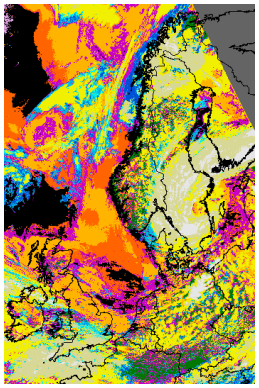
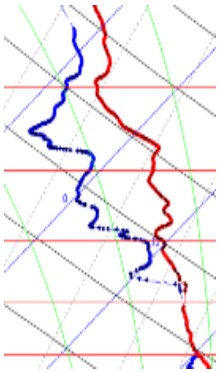
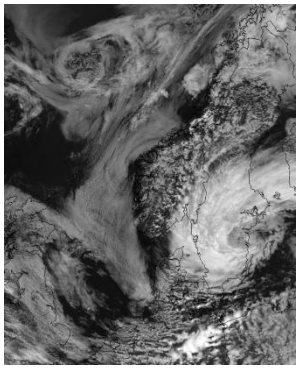
Cloud Top Temperature Pressure and Height, CTTH

Algorithm description:

Cloud type + NWP data + T11, T12

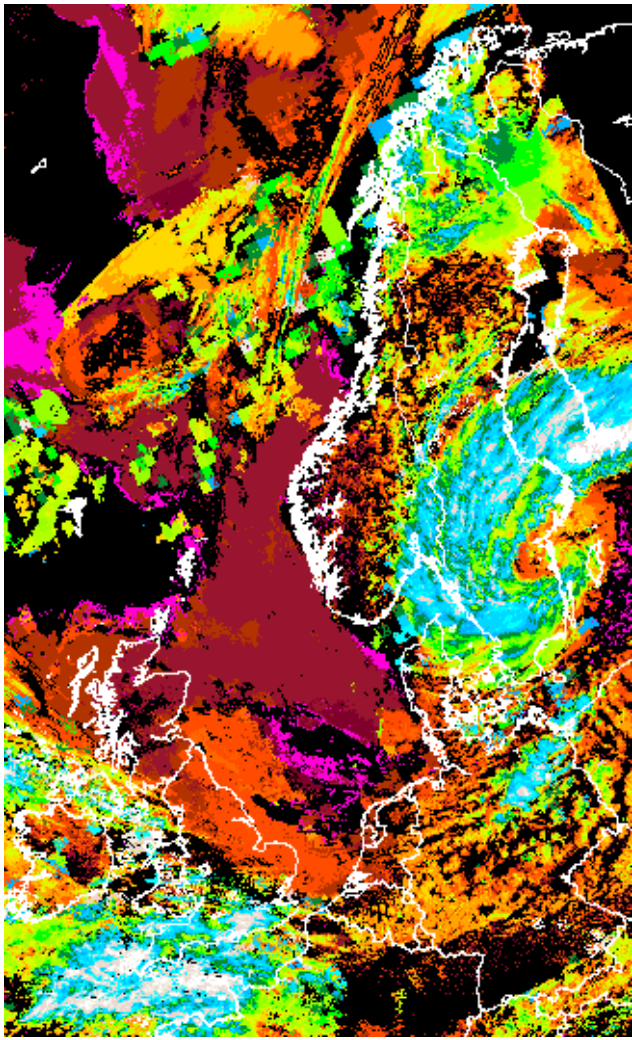






Opaque algorithm

Semi-transp algorithm



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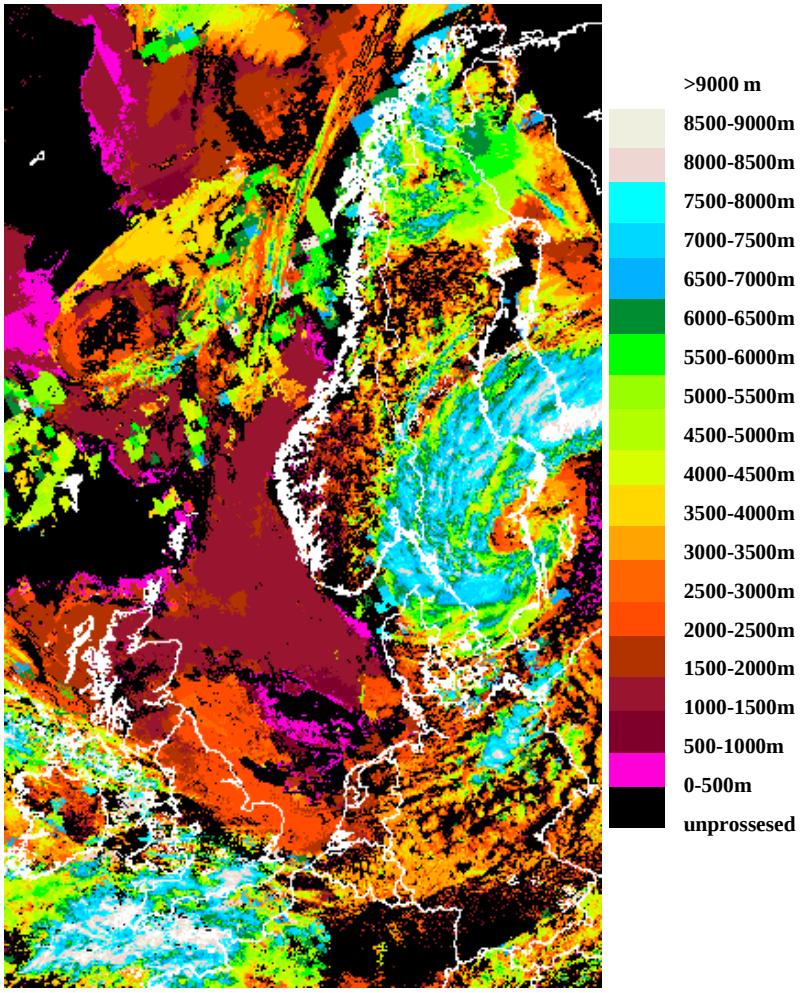
Cloud Top Temperature Pressure and Height, CTTH



What to we get from CTTH?

- Cloud top temperature
- Cloud top pressure
- Cloud top height

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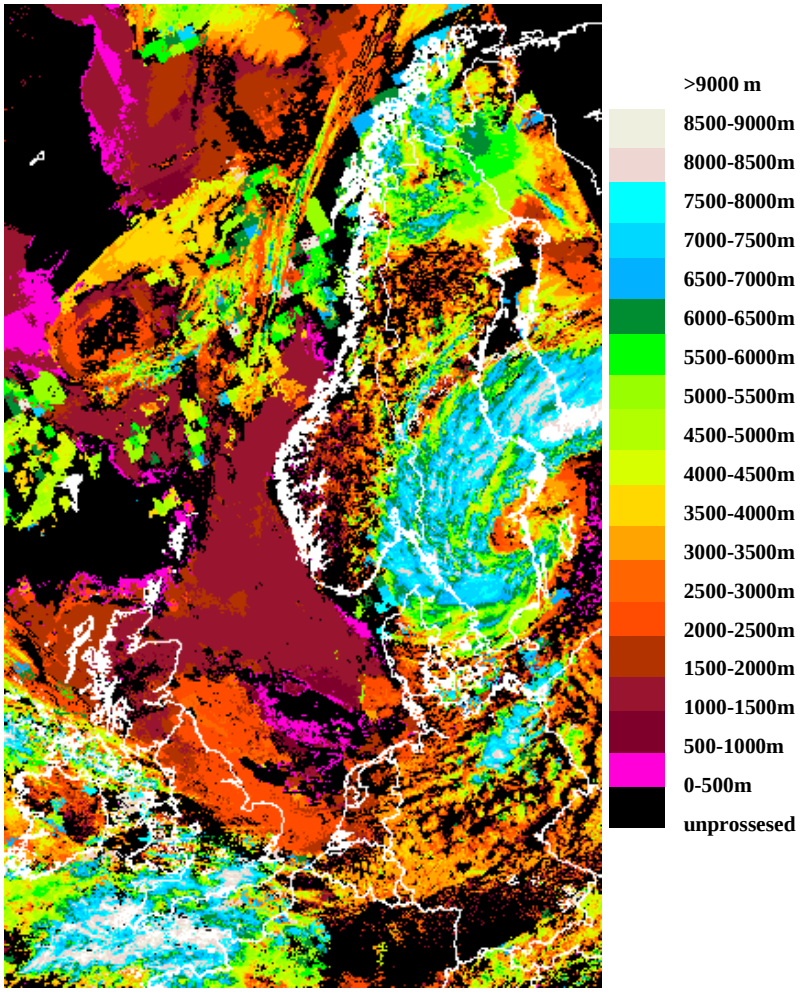
Cloud Top Temperature Pressure and Height, CTTH



Why CTTH?

- Analysis and early warning of thunderstorm development
- Height assignment for aviation forecasting
- Input to mesoscale models
- Climatologies

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Validation: CTTH v2012 and v2014 compared to Calipso

	CTTH v2012	CTTH v2014
Retrieval rate height	72 %	97 %
Mean error low clouds	600 m	500 m
Mean error medium clouds	-600 m	-400 m
Mean error high clouds	-3.5 km	-3.0 km
RMSE low clouds	1.10 km	1.15 km
RMSE medium clouds	1.45 km	1.35 km
RMSE high clouds	4.05 km	3.65 km

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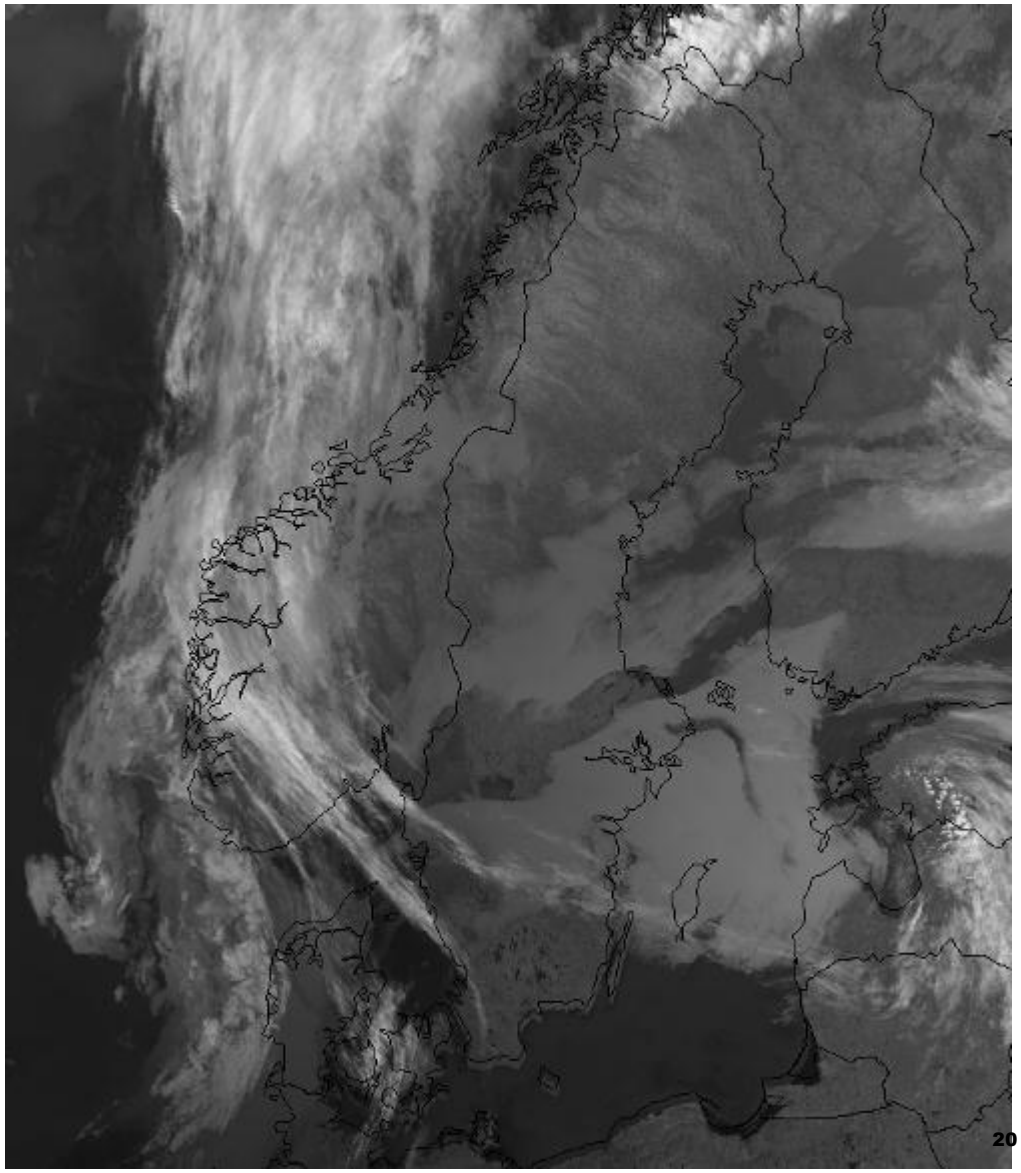
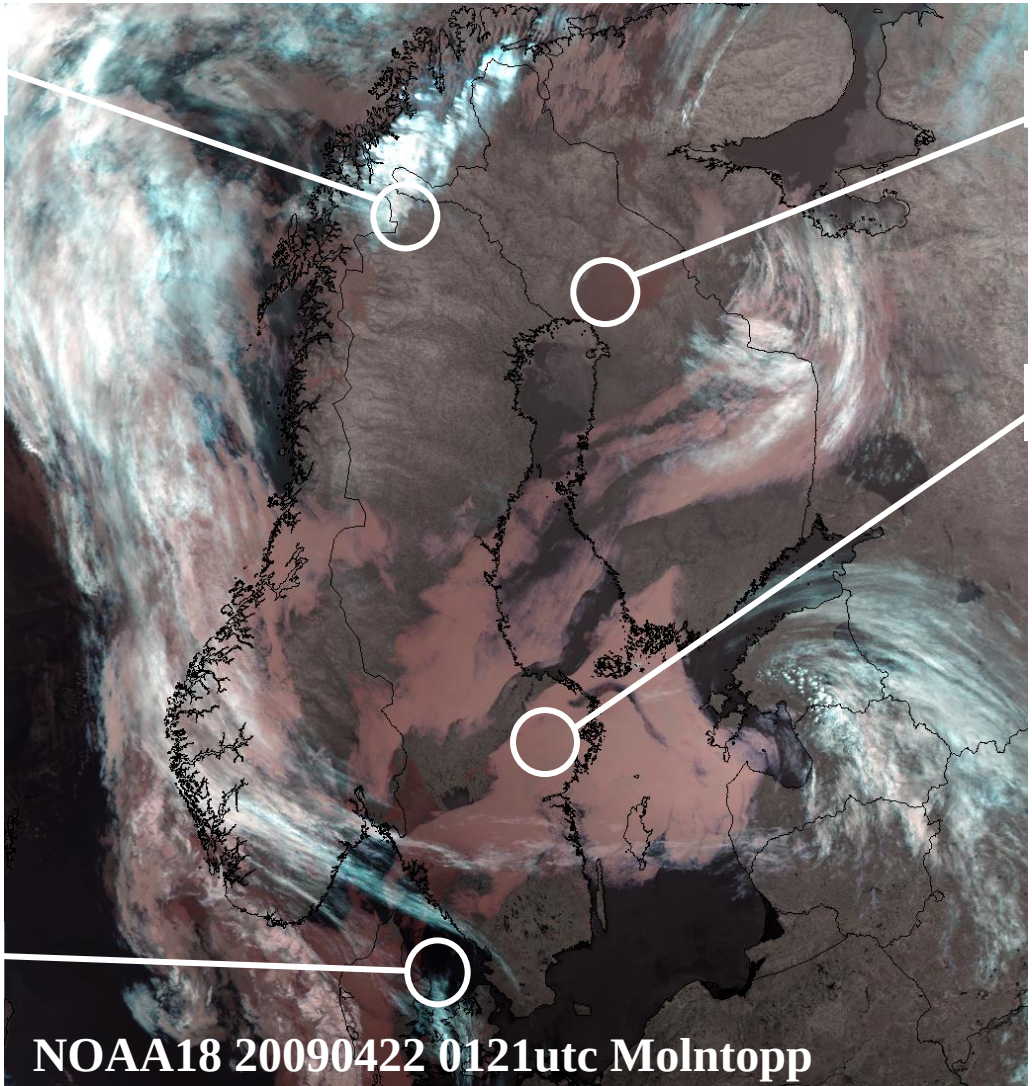
Brightness temperatur not the same as temperature.

How wrong can it be?



Brightness temperature, AVHRR channel 4 IR10.8 µm



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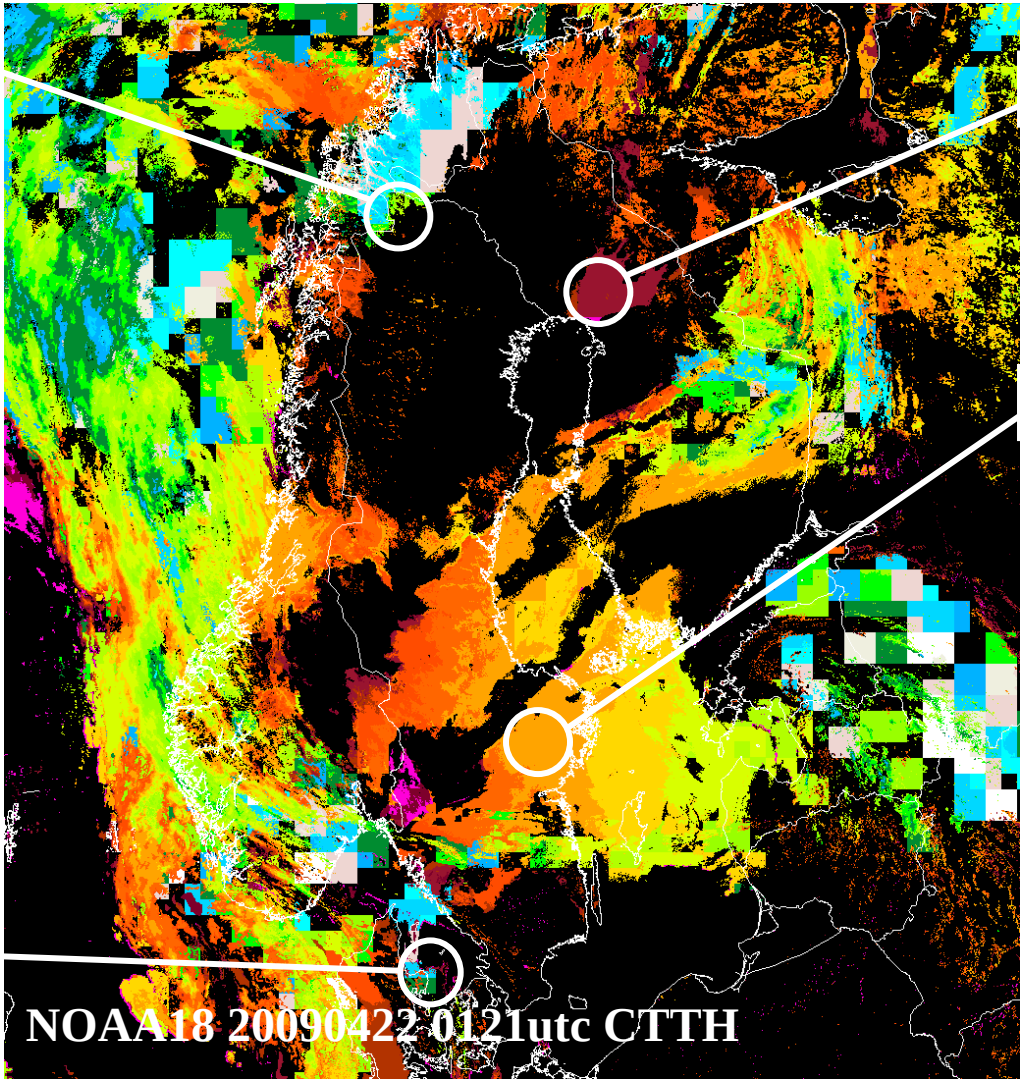
CTTH

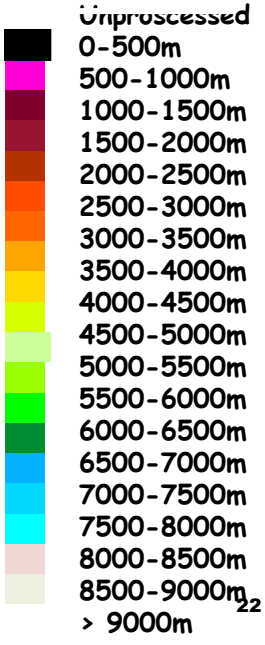
T11=261,7K

T11=268,5K

T11=261,7K

T11=265,8K





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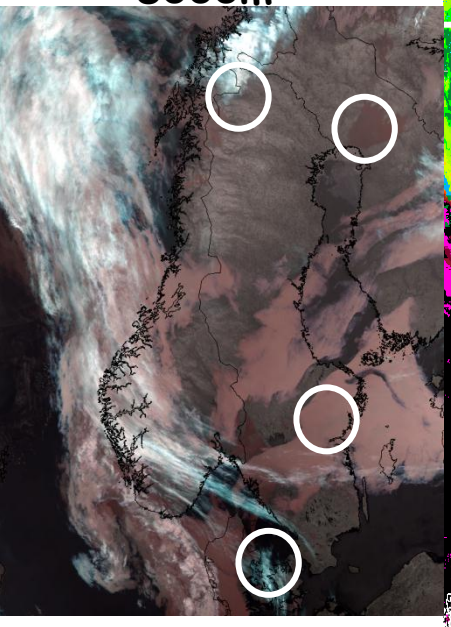
CTTH

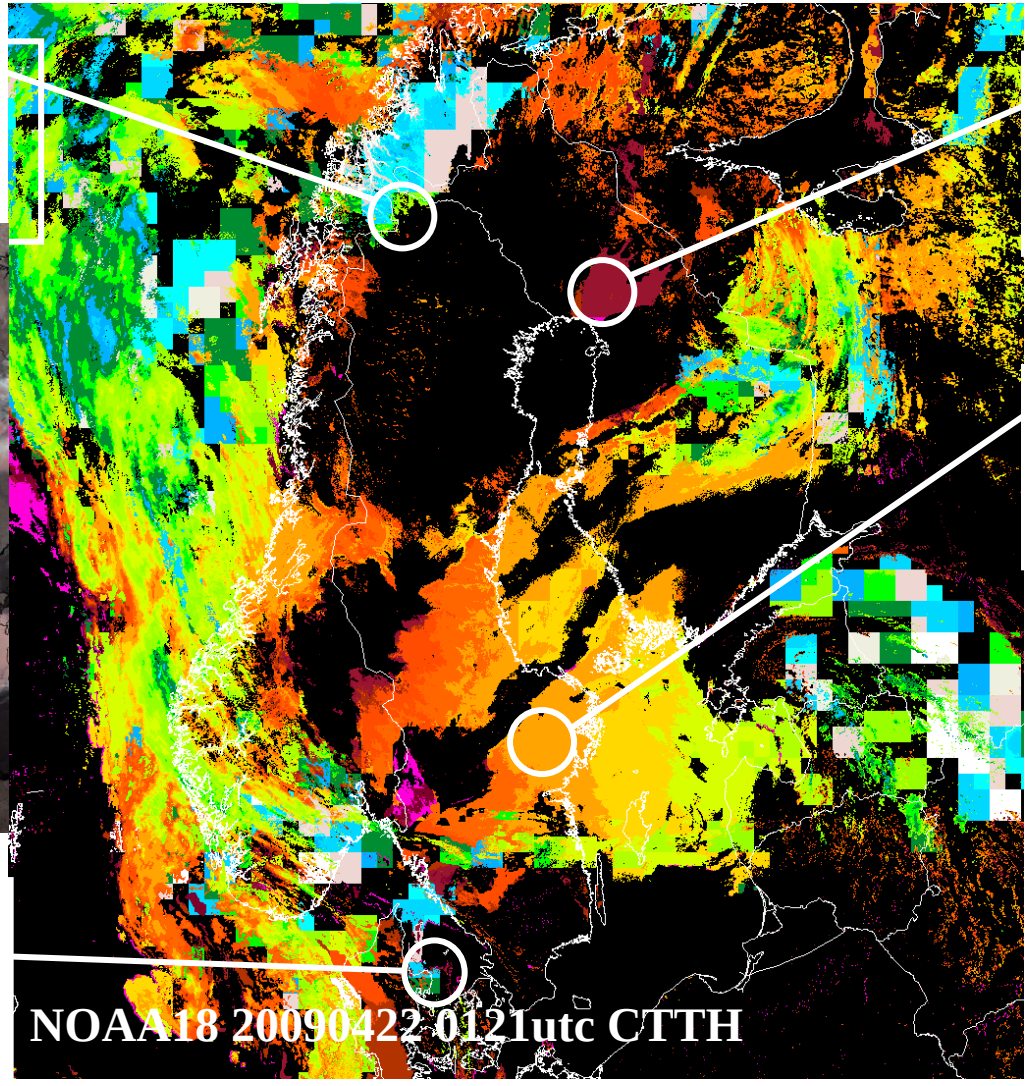
T11=261,7K

CTTH: **220.0K**
8000m



T11=265,8K

CTTH: **235.0K**
7200m



T11=268,5K

CTTH: **269.0K**
1400 m

T11=261,7K

CTTH: **262.0K**
3200 m

2000-2500m
2500-3000m
3000-3500m
3500-4000m
4000-4500m
4500-5000m
5000-5500m
5500-6000m
6000-6500m
6500-7000m
7000-7500m
7500-8000m
8000-8500m
8500-9000m
> 9000m

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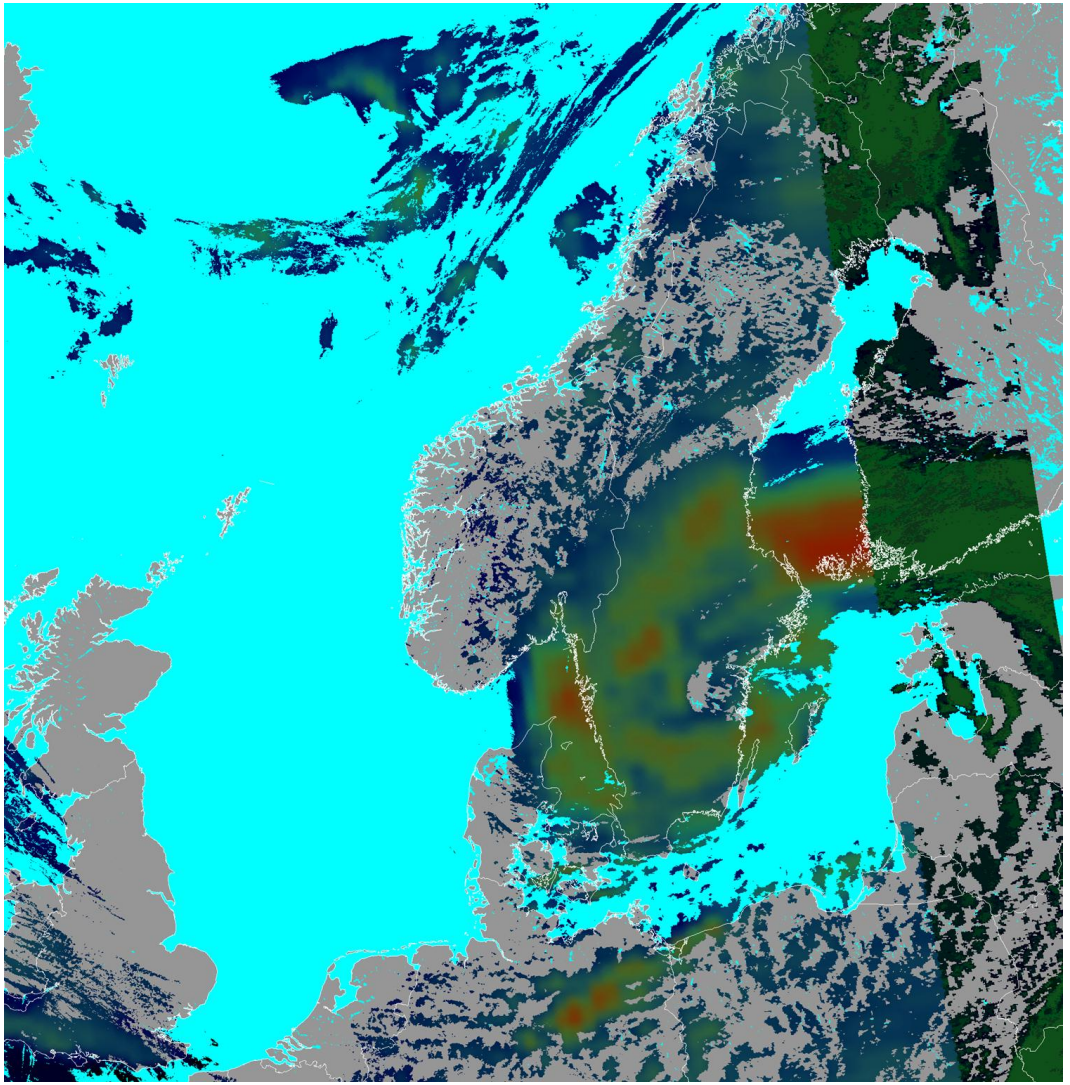
Precipitating Clouds

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)**

AVHRR/VIIRS and microwave data

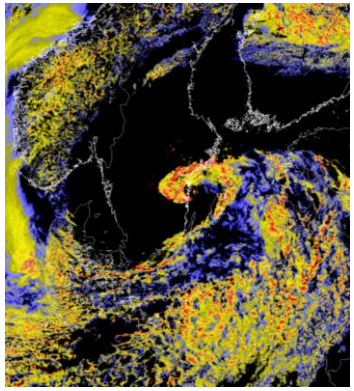


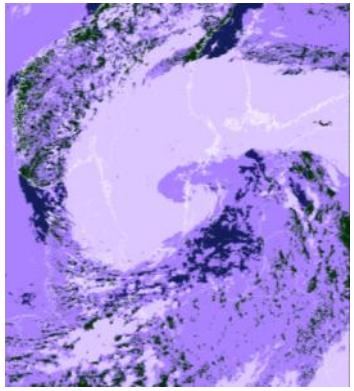
Cloud Physical Properties, CPP

Official:

Liquid water path, LWP

Cloud thermodynamic phase, CPH



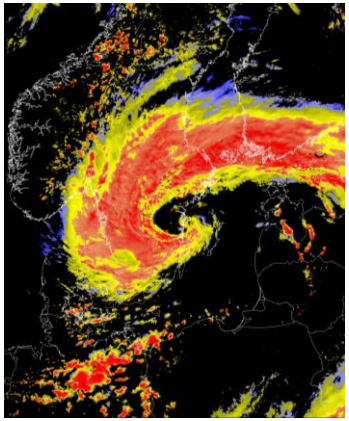


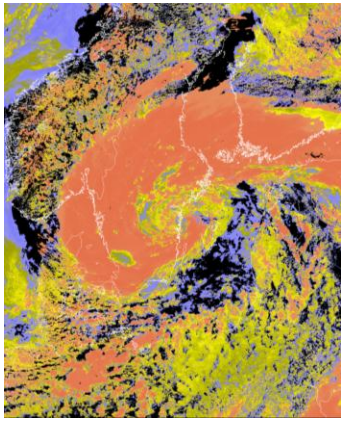
Additional:

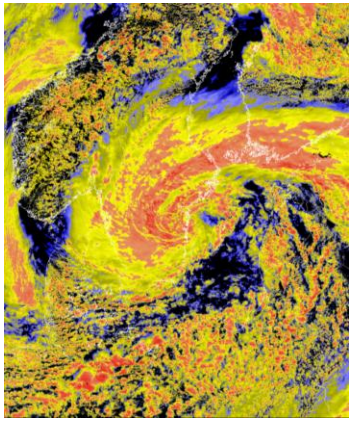
Ice water path, IWP

Effective radius, Reff

Cloud optical thickness, COT







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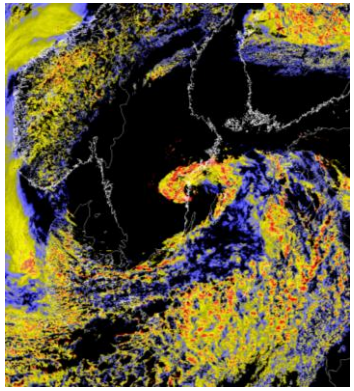

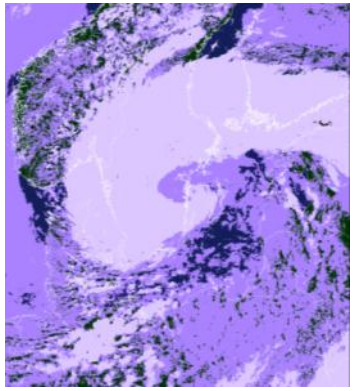

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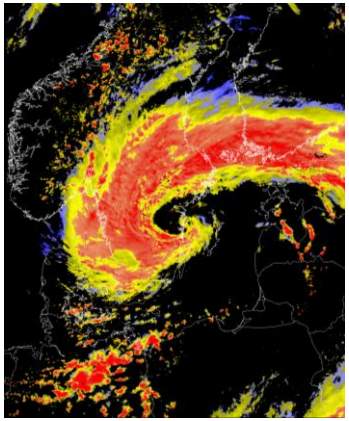

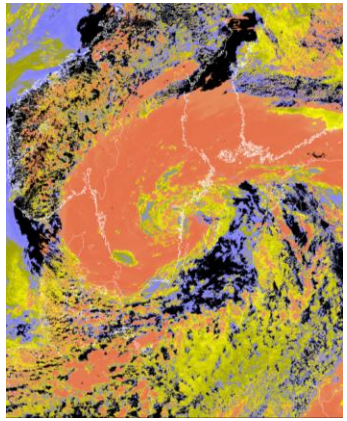

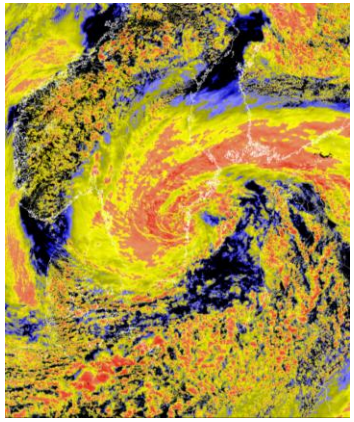

Have you seen any of these products before?

Yes	No

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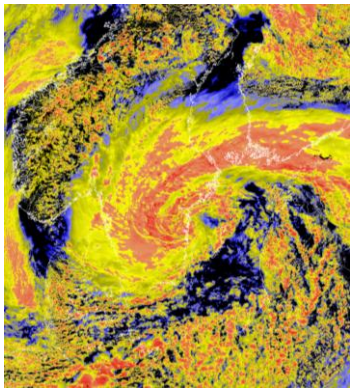
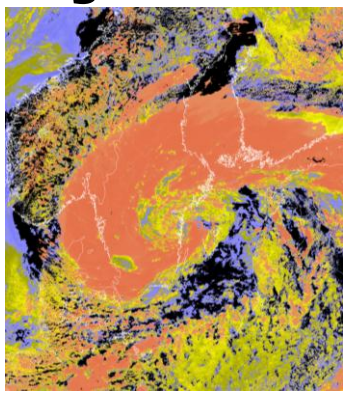
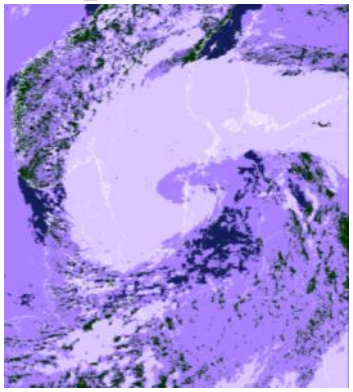
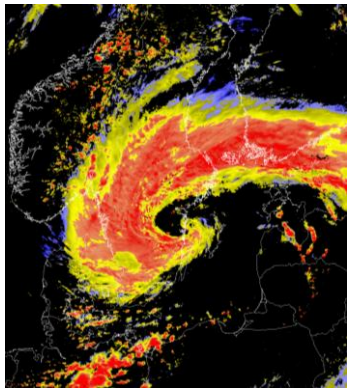
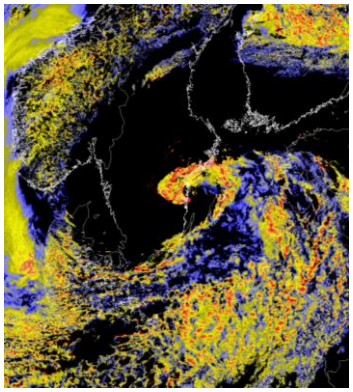
Cloud Physical Properties, CPP


Cloud optical thickness


Effective radius


Cloud thermo. phase

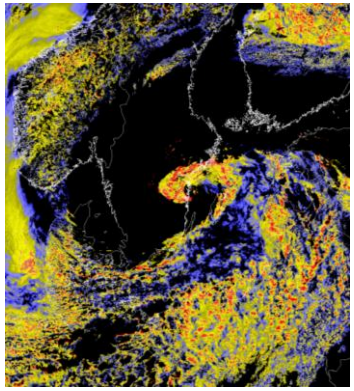
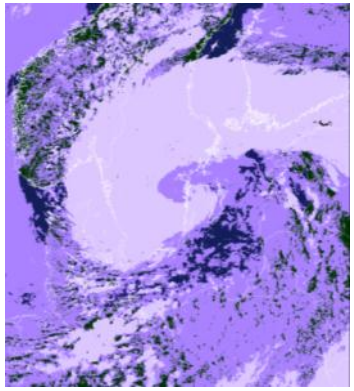
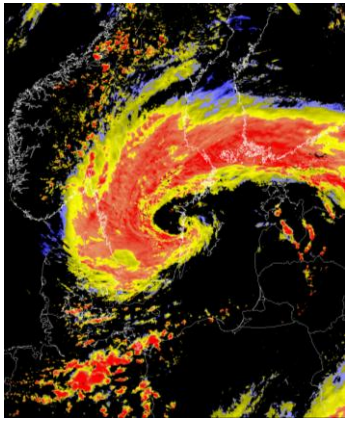
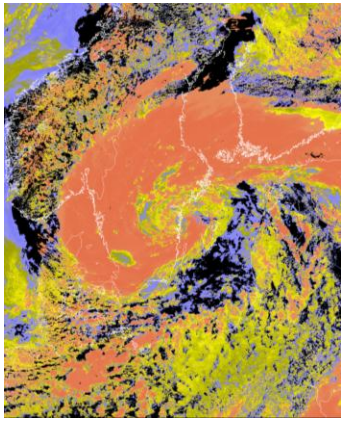
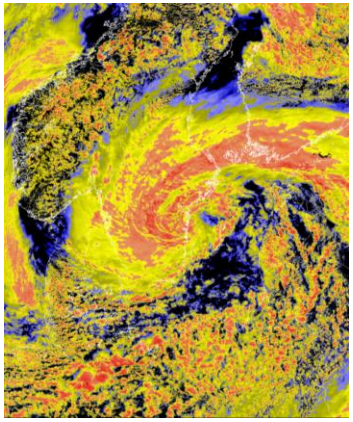

Ice water path


Liquid water path

Input data:
AVHRR or VIIRS: 0.6, 10.8 and 1.6 or 3.7 µm
Cloud mask
NWP
1 km GIS data

Cloud Physical Properties, CPP

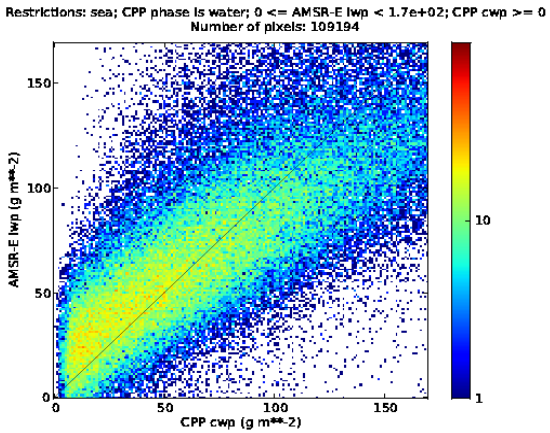
Daytime only!!

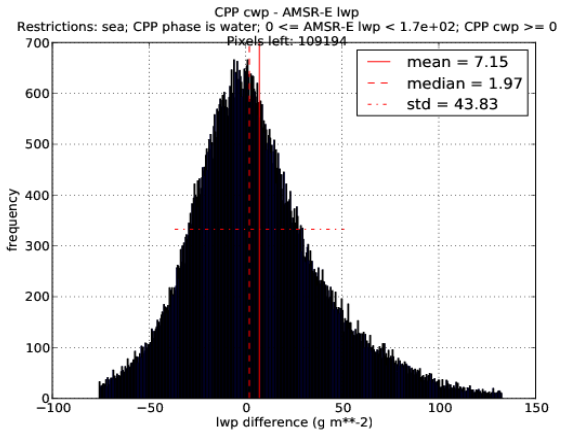






CPP Validation of LWP and Cloud Phase

performed against AMSR-E for lwp and Calipso for cph

LWP





LWP bias = 7 g/m2

LWP RMS error = 44 g/m2

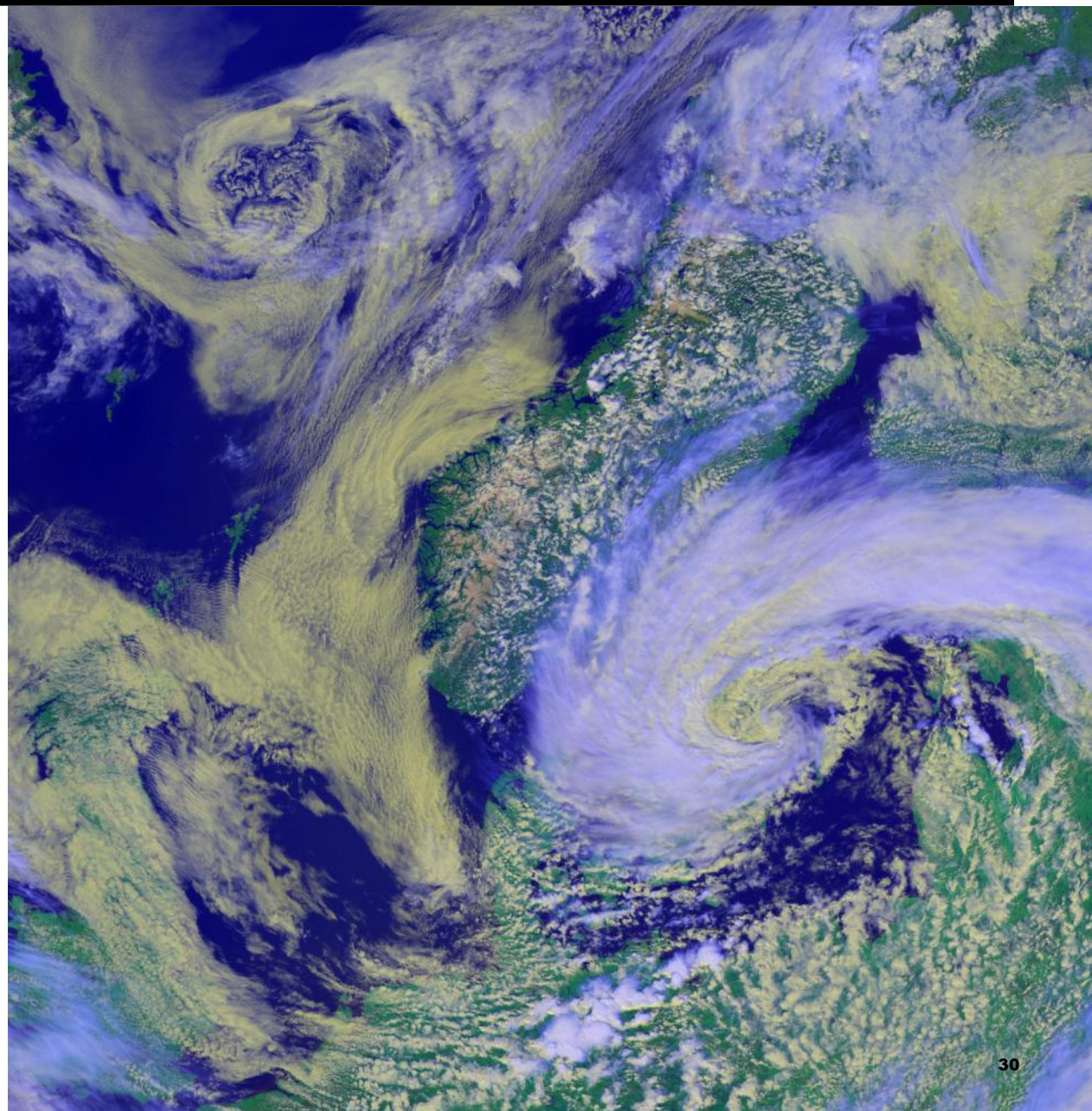
Phase

	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.

SMHI

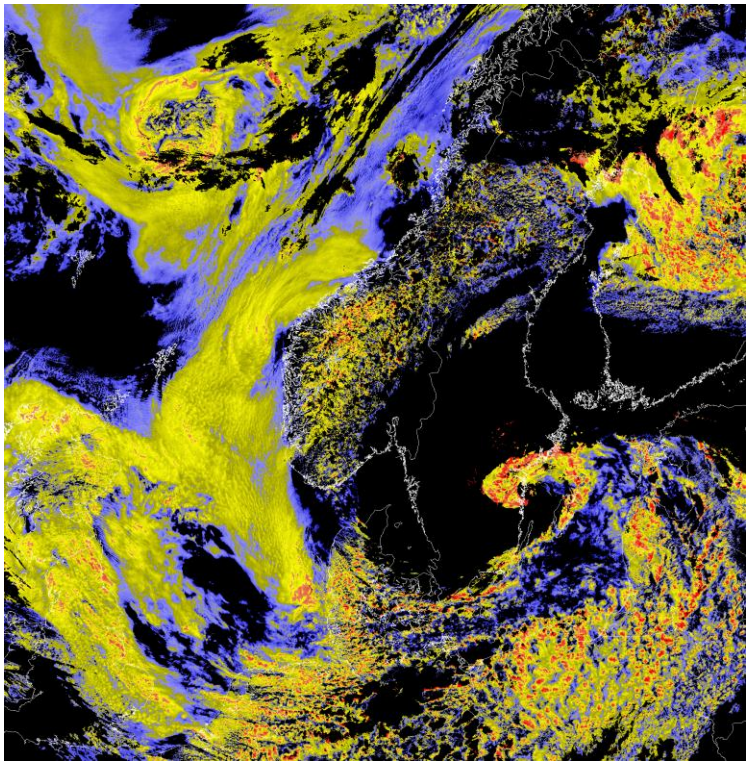
Example:
25 June 2012
11.48utc



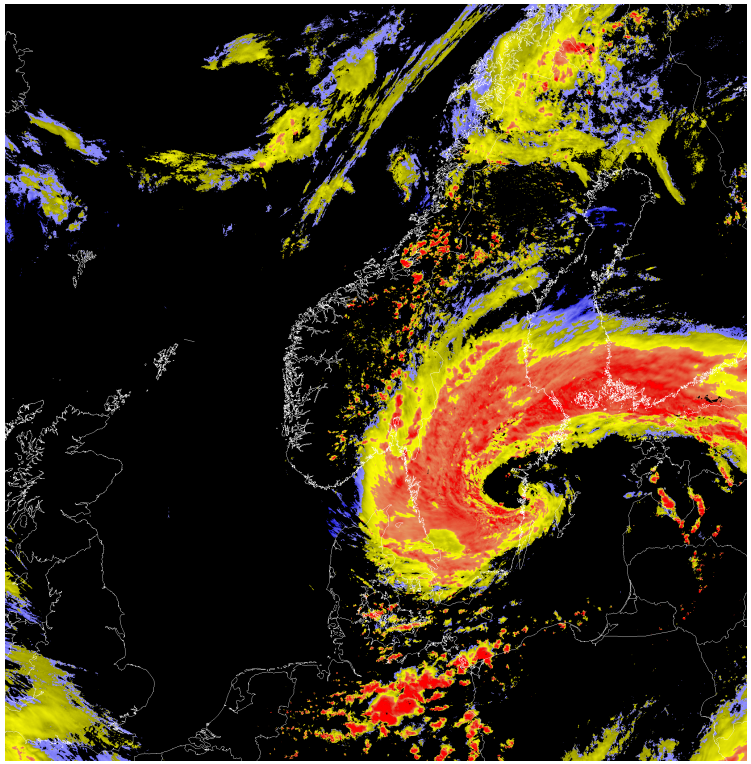
SMHI

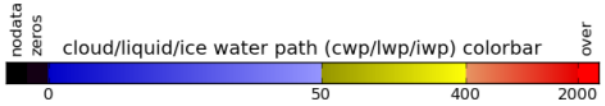
CPP (Cloud Physical Properties) from VIIRS

Liquid Water Path [kg/m²]

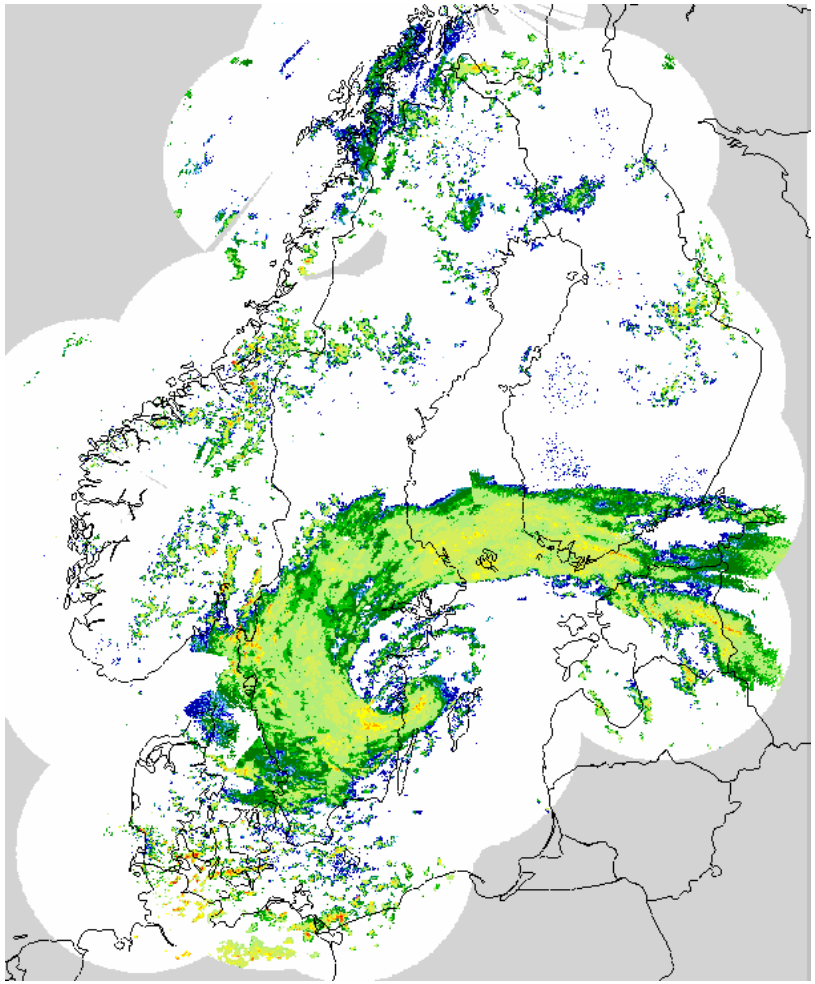


Ice Water Path

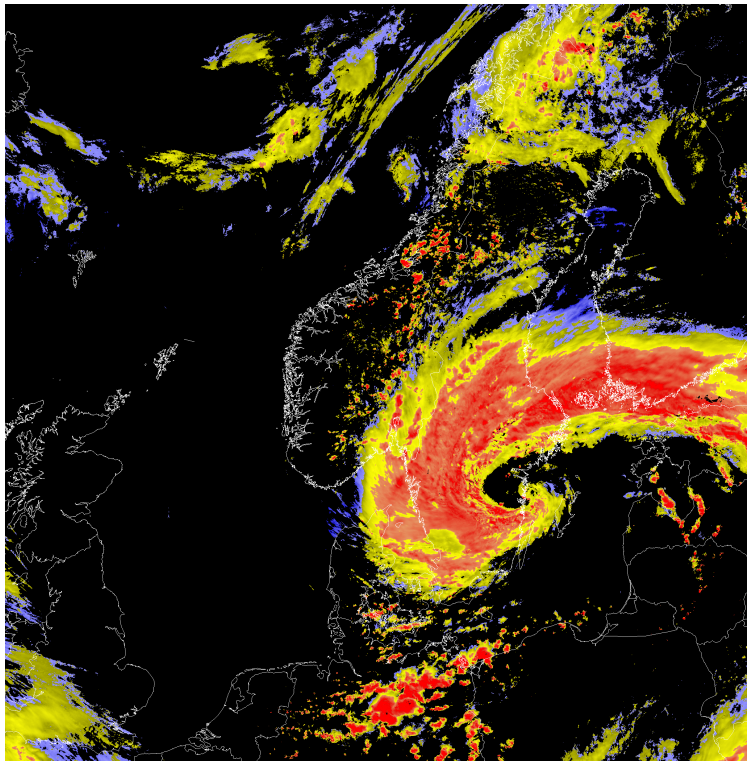


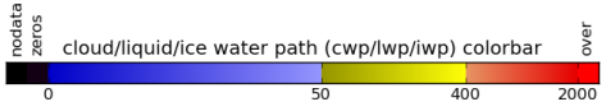


VIIRS 2012-06-25, 11:48 UTC



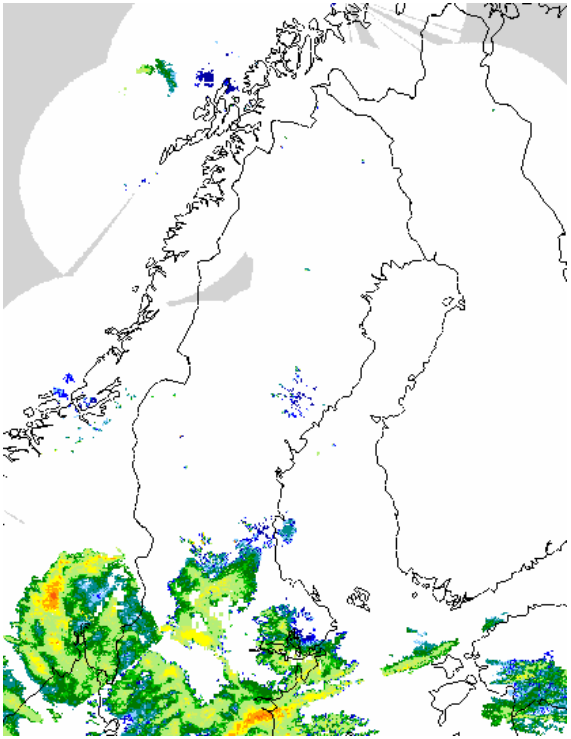
Ice Water Path



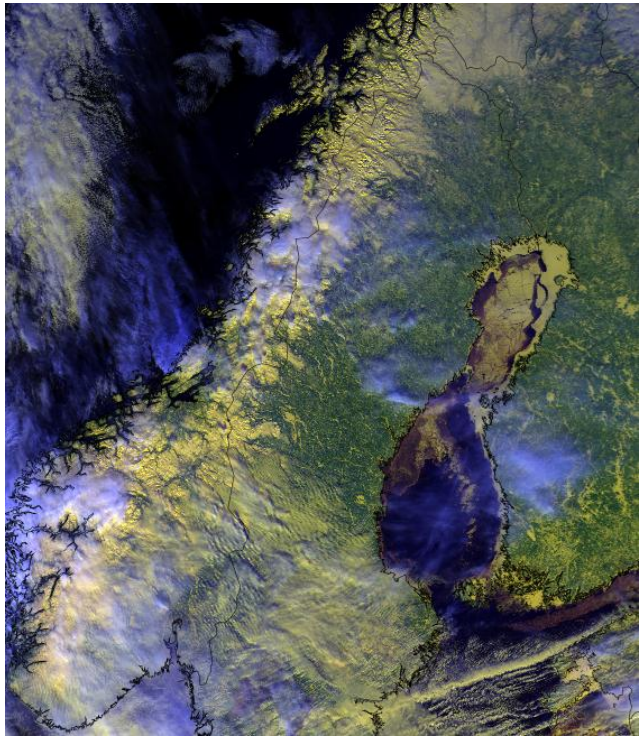


VIIRS 2012-06-25, 11:48 UTC

Example 2 Microphysics



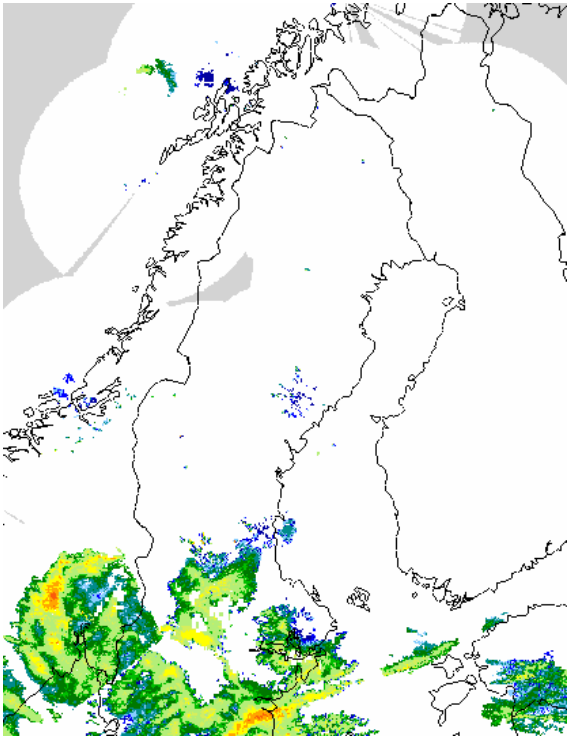
Radar composite 11.45 utc



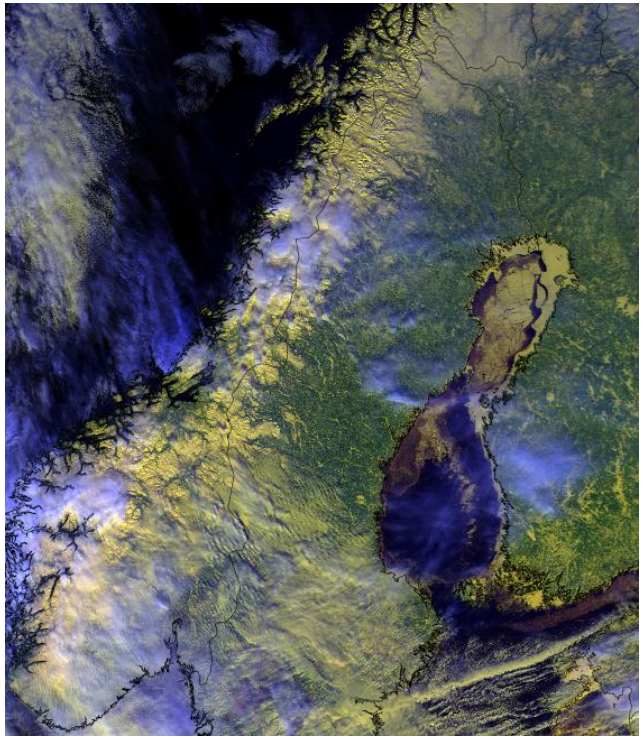
NOAA19 11.33utc

0.6, 0.8, 10.8i

Example 2 Microphysics

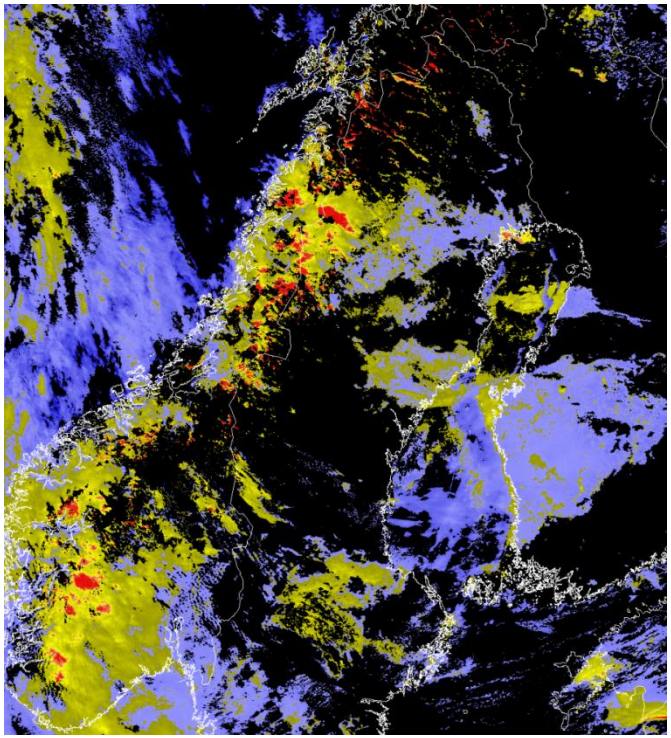


Radar composite 11.45 utc

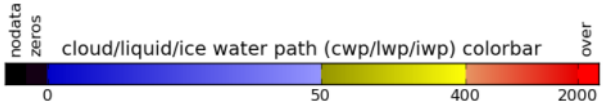


NOAA19 11.33utc

0.6, 0.8, 10.8i



Ice Water path [kg/m^2]



What's coming next

PPS version 2014

Improved Cloud Mask

- Use of surface reflectivity for getting more accurate threshold table
- Better tuning
- Updated emissivity data set over land

Binary Cloud Mask; cloudy or clear only

Improved CTTH

- Less data loss
- Faster CTTH processing

Improved CPP

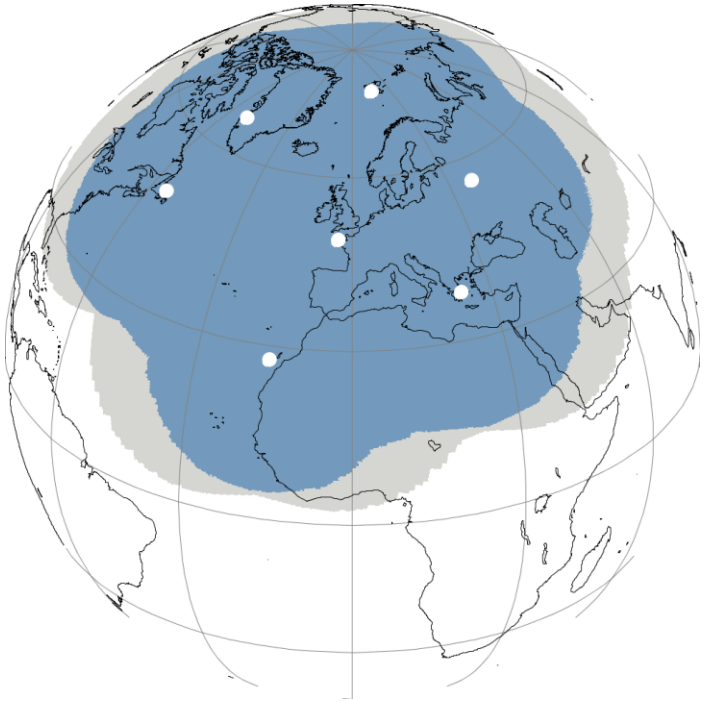
New output format; netCDF in addition to hdf

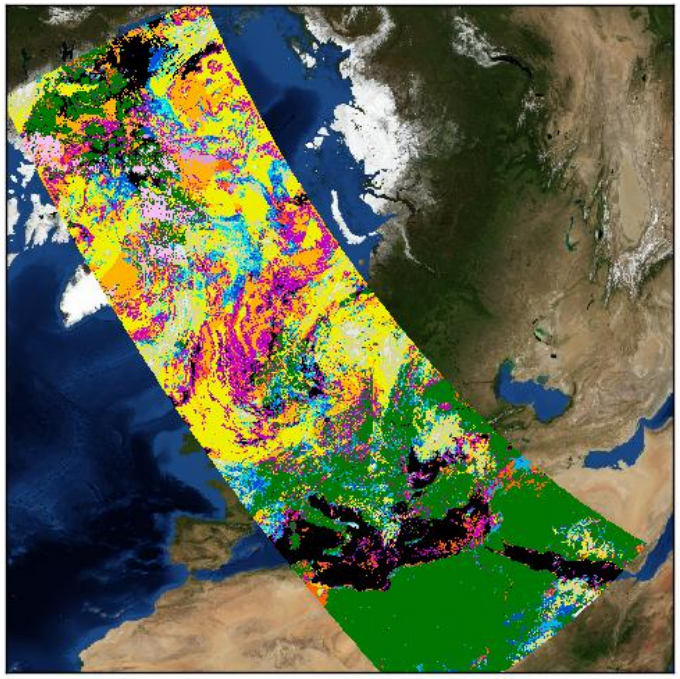
New filenames; using CF conventions etc

Easier installation (binary packaging)

Cloud Products from EARS-NWC service

- Cloud Mask, Cloud Type and CTTH
- AVHRR (Metop-A and NOAA 19)
- More next presentation by Thomas Heinemann





Thanks!