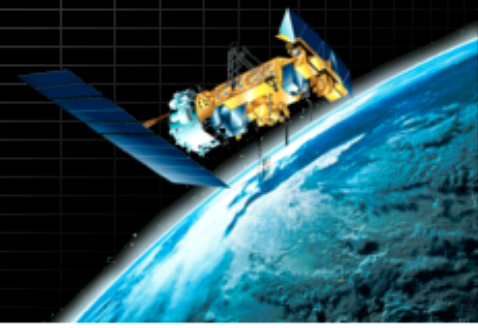


# **Enhancing the PPS cloudmask confidence in the polar night with the VIIRS DNB**

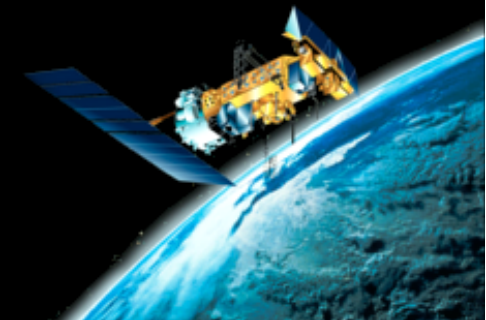
Adam Dybbroe & Ronald Scheirer, SMHI

CREW-4, Grainau, Germany, March 2014



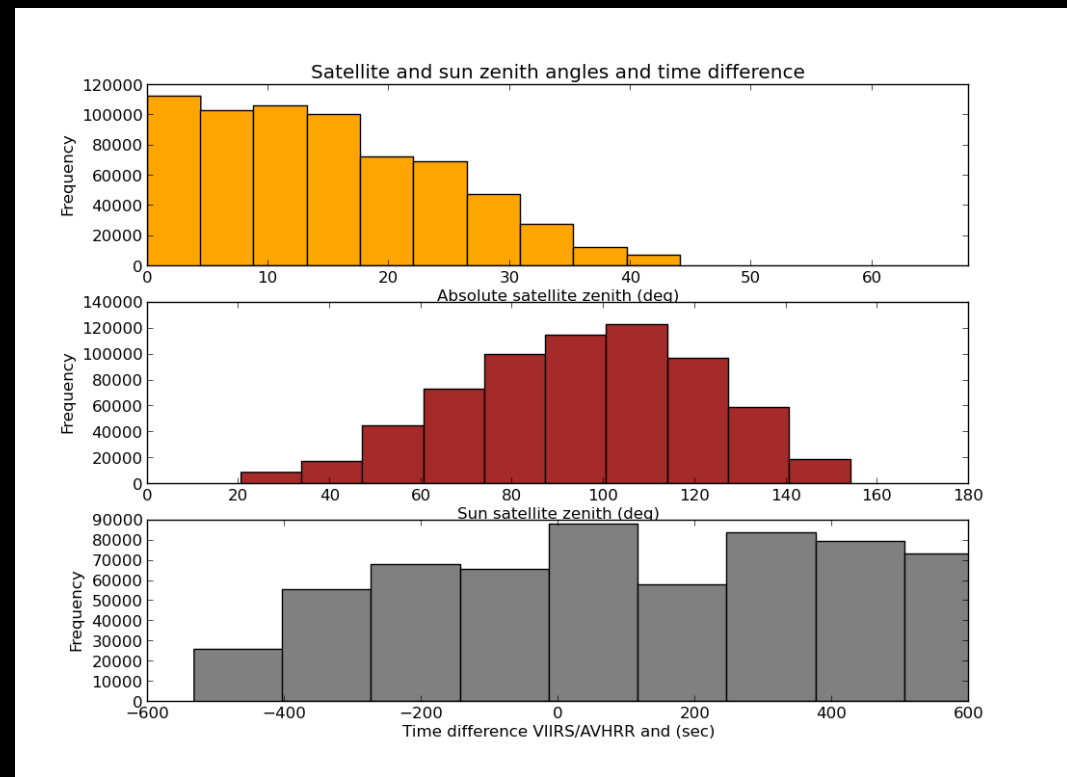
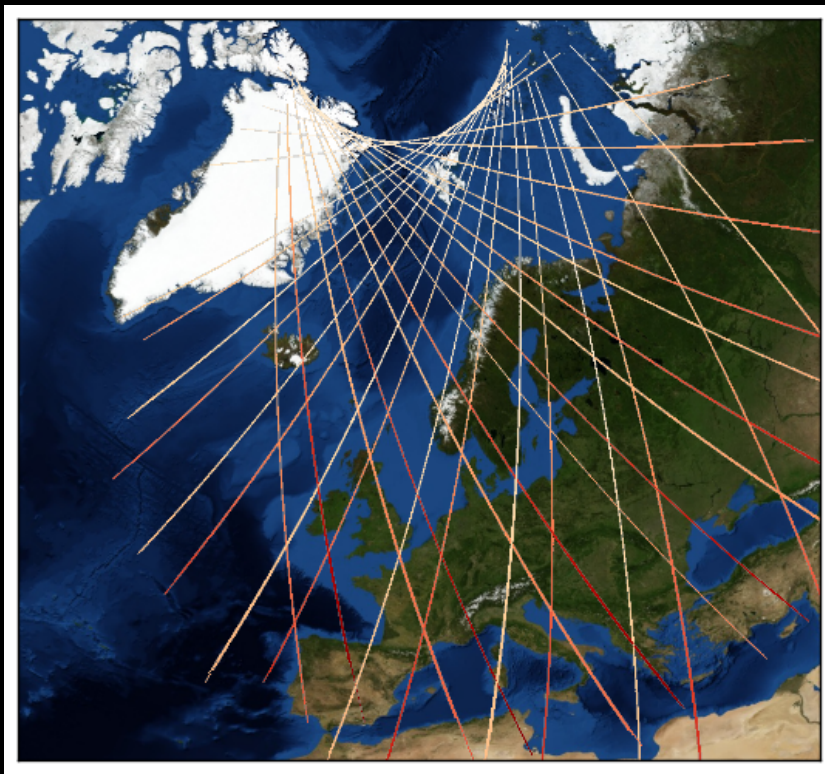
# Outline

- Current performance of PPS
- When nighttime detection is hard
- Using DNB data over sea
- What about land?
- Conclusion



# PPS v2014 cloudmask performance

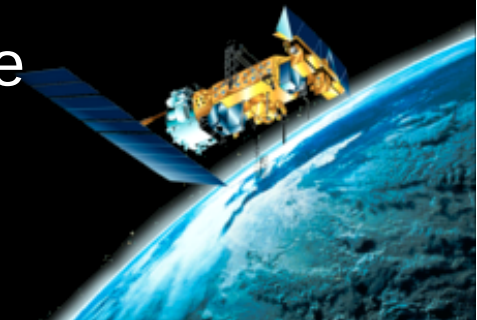
From one year of locally received S-NPP, N18 and N19 at Norrköping, Sweden, co-located with Calipso



# PPS v2014 cloudmask performance against Caliop

	Bias (%)	HR	POD	FAR	N
All	-10.3	0.84	82.4	4.3	796127
All ( $\tau > 0.2$ )	-7.6	0.87	85.4	4.5	744634
Day	-5.5	0.87	88.0	5.0	296080
Night	-12.1	0.83	79.6	4.0	360476
Twilight	-15.7	0.80	77.2	3.4	139571

$\tau > 0.2$ : An observation is considered cloudy only if the Caliop cloud optical thickness is greater than 0.2



# Significant drop in cloud detection at night and twilight

	Bias (%)	HR	POD	FAR	N
All	-10.3	0.84	82.4	4.3	796127
All ( $\tau > 0.2$ )	-7.6	0.87	85.4	4.5	744634
Day	-5.5	0.87	88.0	5.0	296080
Night	<b>-12.1</b>	<b>0.83</b>	<b>79.6</b>	4.0	360476
Twilight	<b>-15.7</b>	<b>0.80</b>	<b>77.2</b>	3.4	139571



## Over sea:

	HR	POD	FAR	N
Day	0.89	94.8	11.2	30150
Night	0.81	73.5	5.6	34838
Twilight	0.83	81.3	8.6	12672

### Open Water pixels only

	HR	POD	FAR	N
Day	0.91	98.5	10.2	25943
Night	0.93	94.4	3.3	16793
Twilight	0.87	87.7	2.8	3520

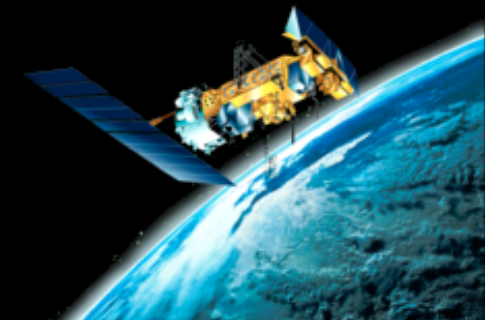
### Sea Ice pixels only

	HR	POD	FAR	N
Day	0.73	60.9	7.3	3185
Night	0.69	40.2	2.2	16100
Twilight	0.82	77.4	10.0	8414

*All data filtered using the requirement  $\tau > 0.2$*

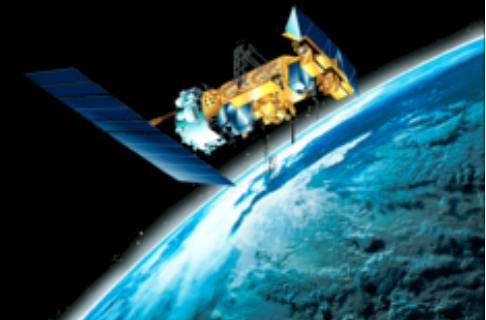
## When IR-only detection is hard

- Sea ice
- Cold land (NWP often too warm)
- Thin cirrus over low clouds
- Low (warm) water clouds with large droplets
- Low (warm) mixed phase clouds



## Two examples

- Barents and Kara Seas – Sea ice, Moonglint, Straylight, Aurora Borealis,
- North Atlantic

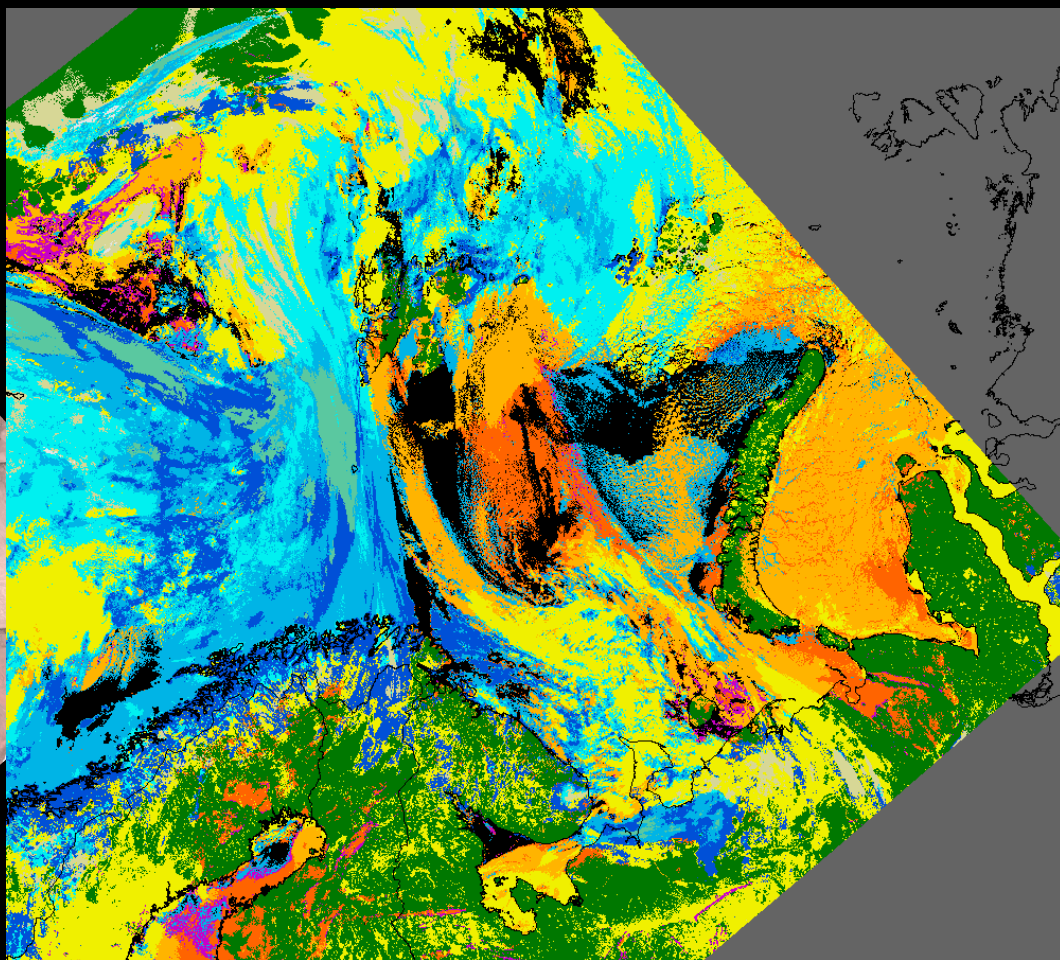
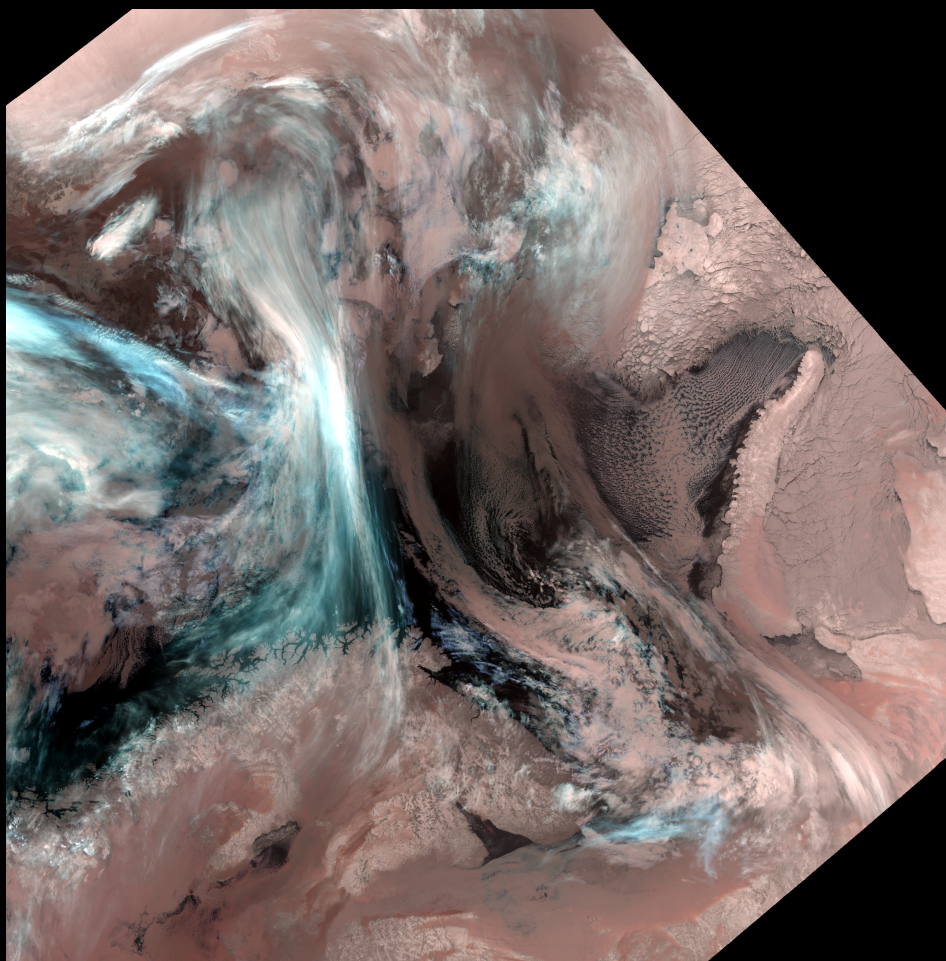




# Barents and Kara Seas

RGB: 3.7;11;12 $\mu$ m

PPS Cloud Type

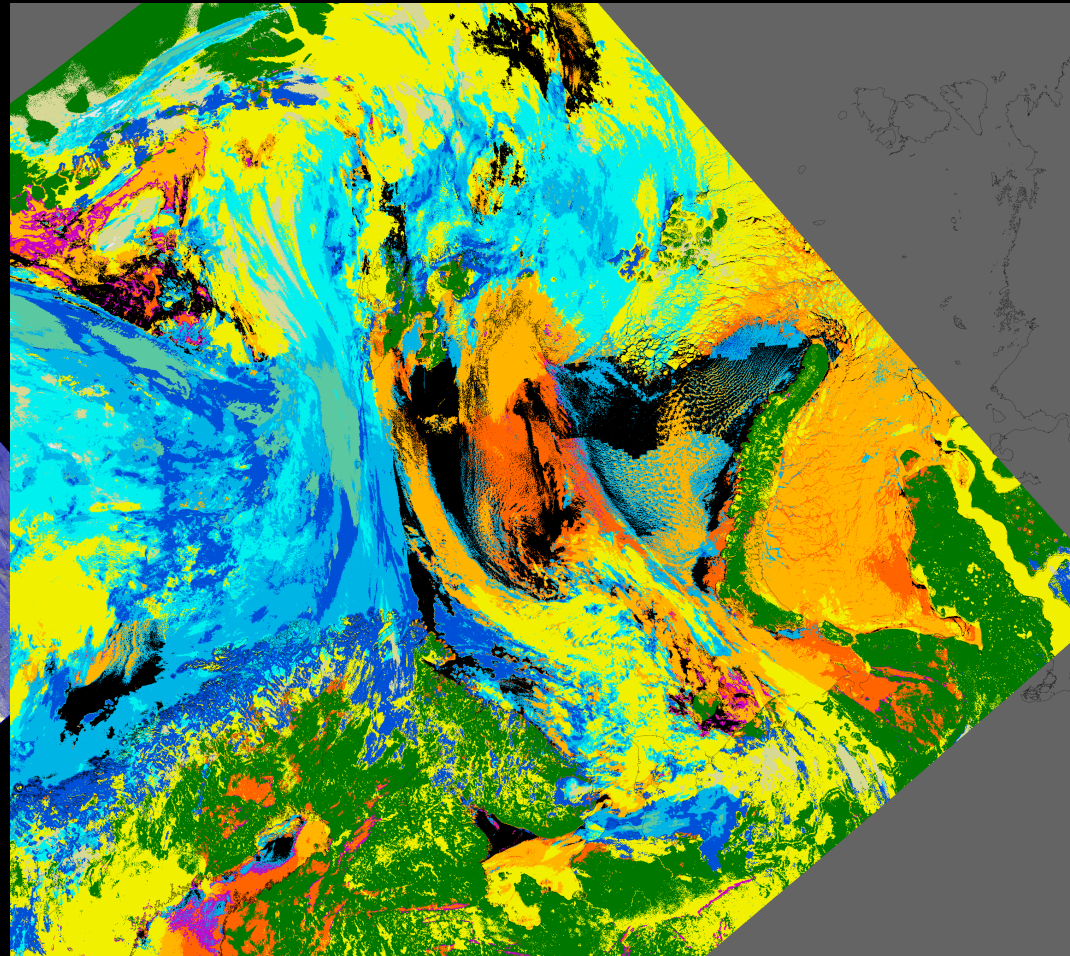
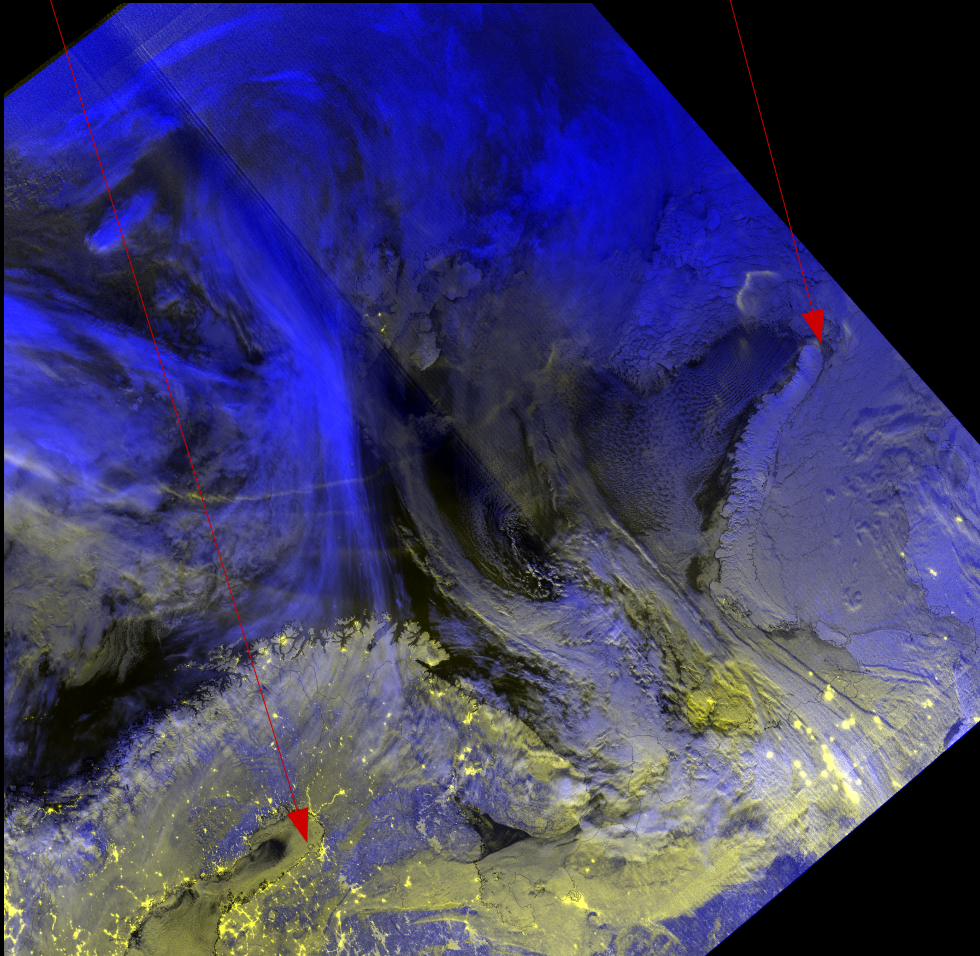


S-NPP 2014-01-22 02:01 UTC

# Barents and Kara Seas

Moon elevation  $18^\circ$

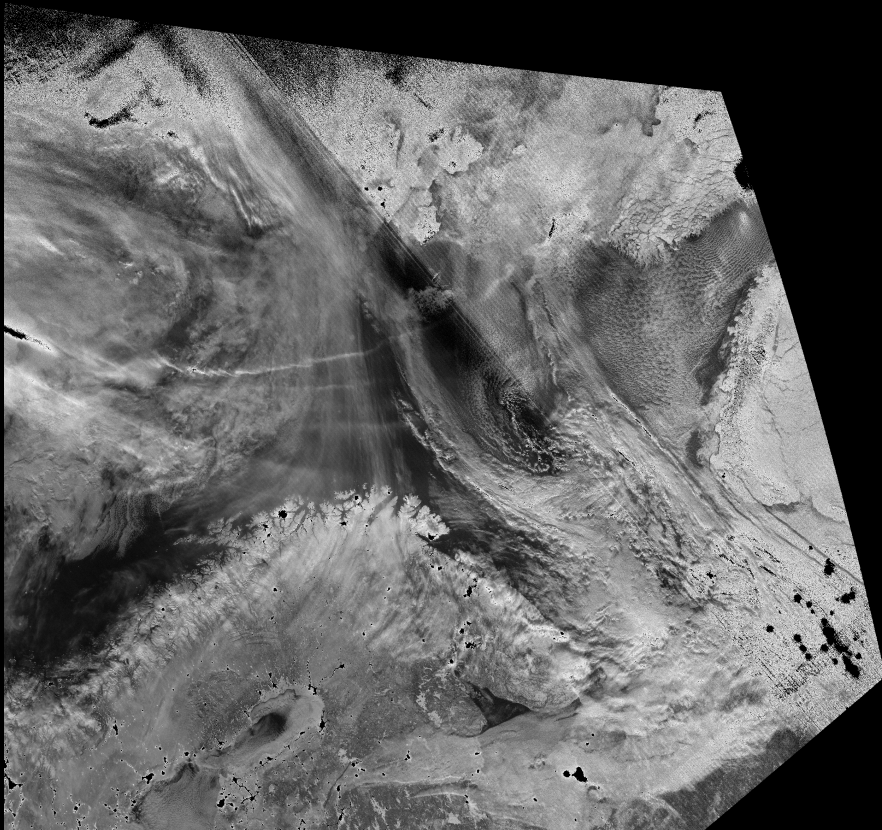
Moon elevation  $5^\circ$



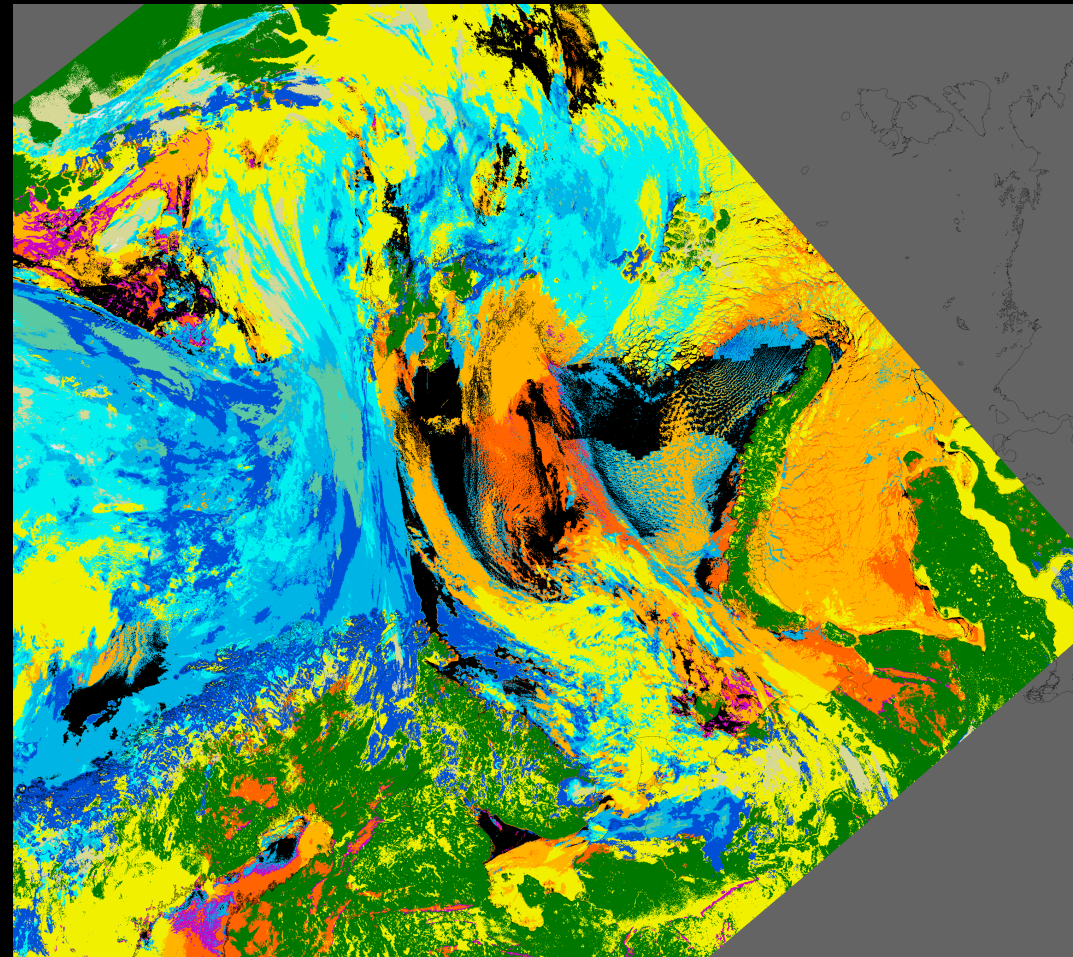
Moon phase =  $65^\circ$

# Barents and Kara Seas

DNB lunar reflectance



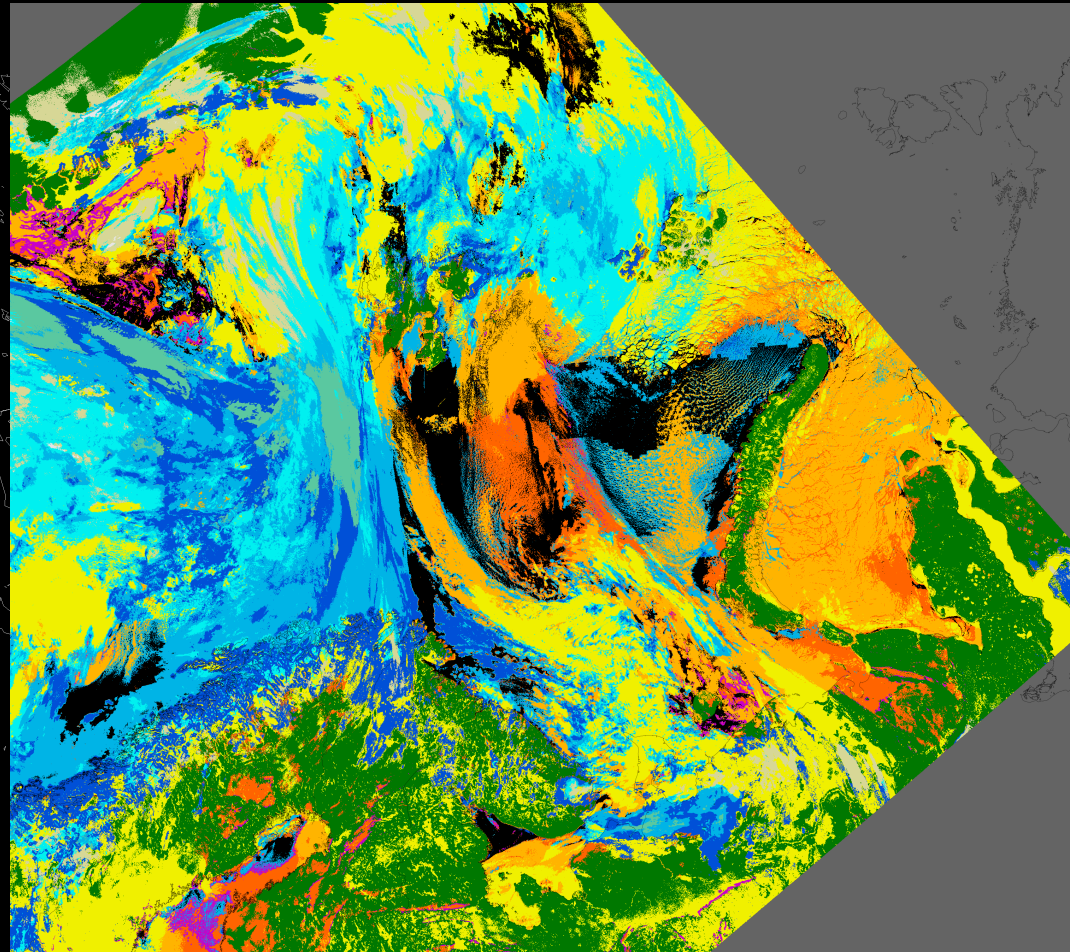
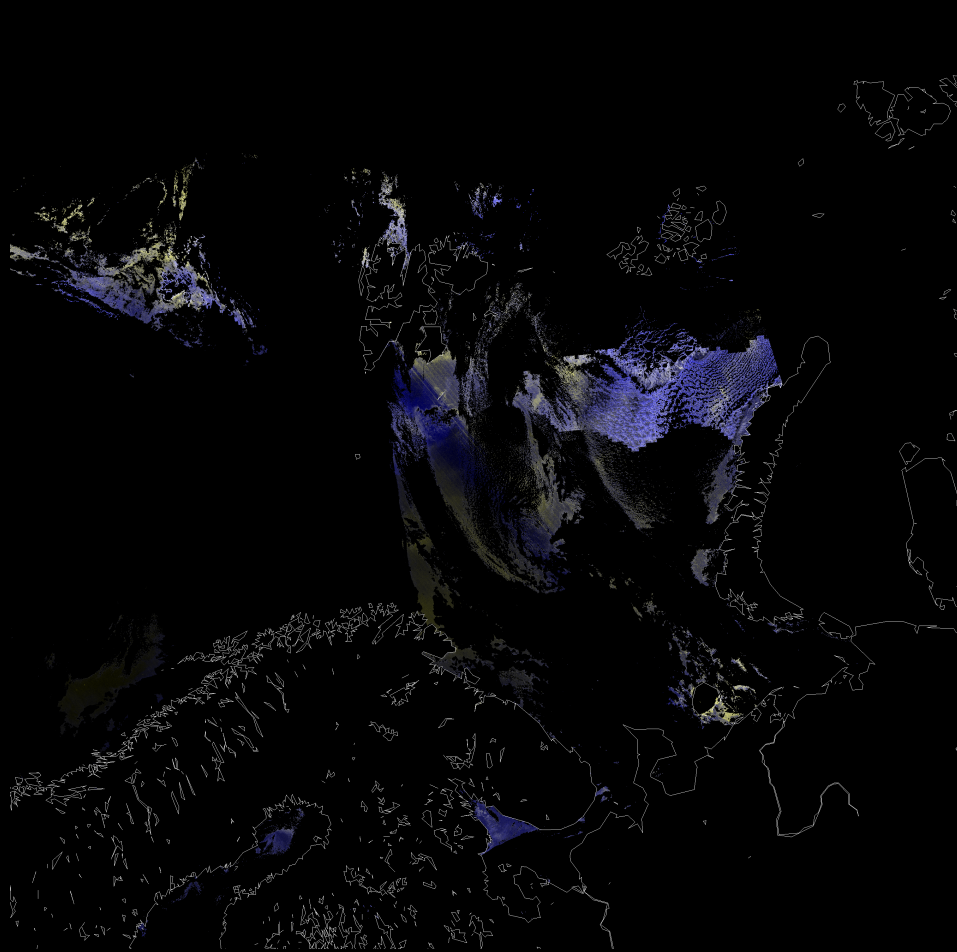
PPS Cloud Type



# Barents and Kara Seas

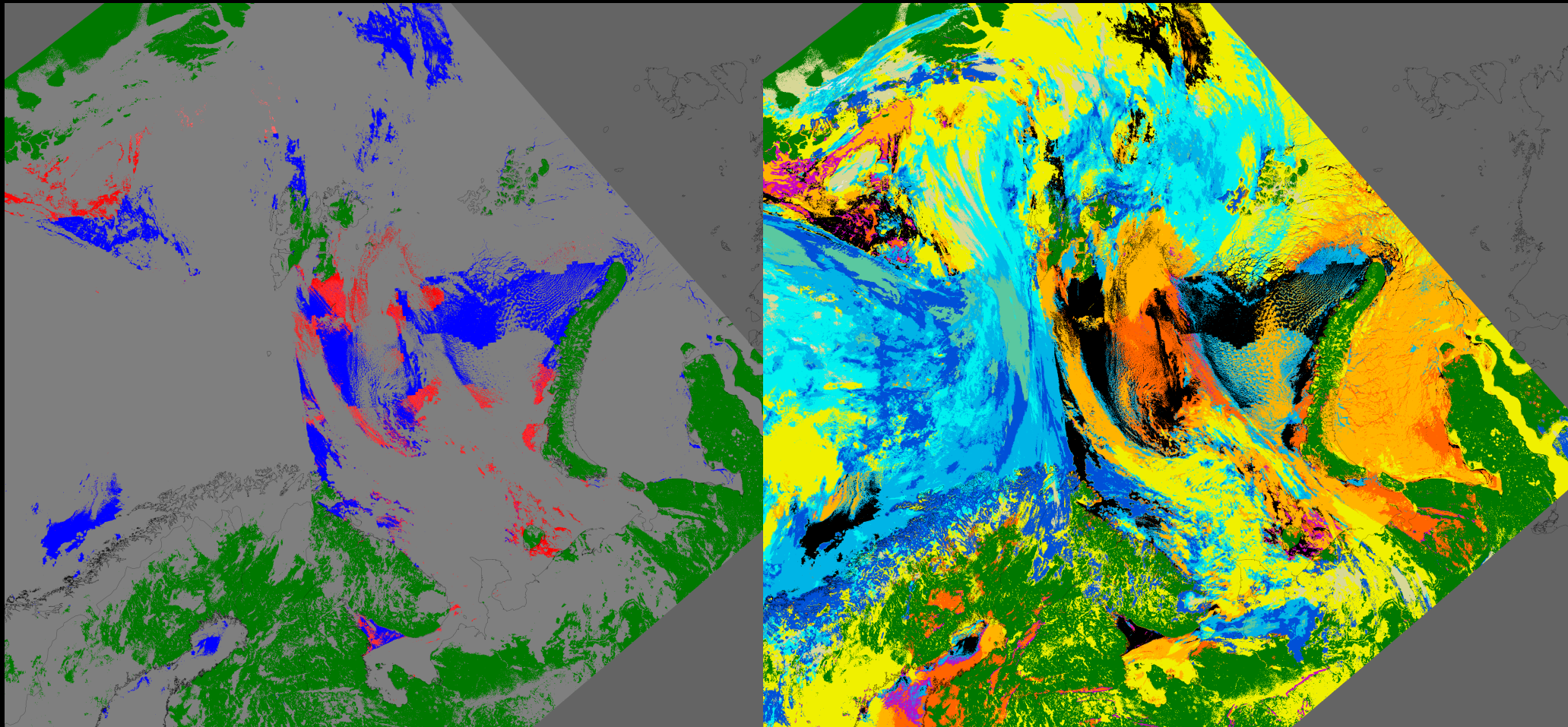
RGB: DNB, DNB, M15

PPS Cloud Type



# Barents and Kara Seas

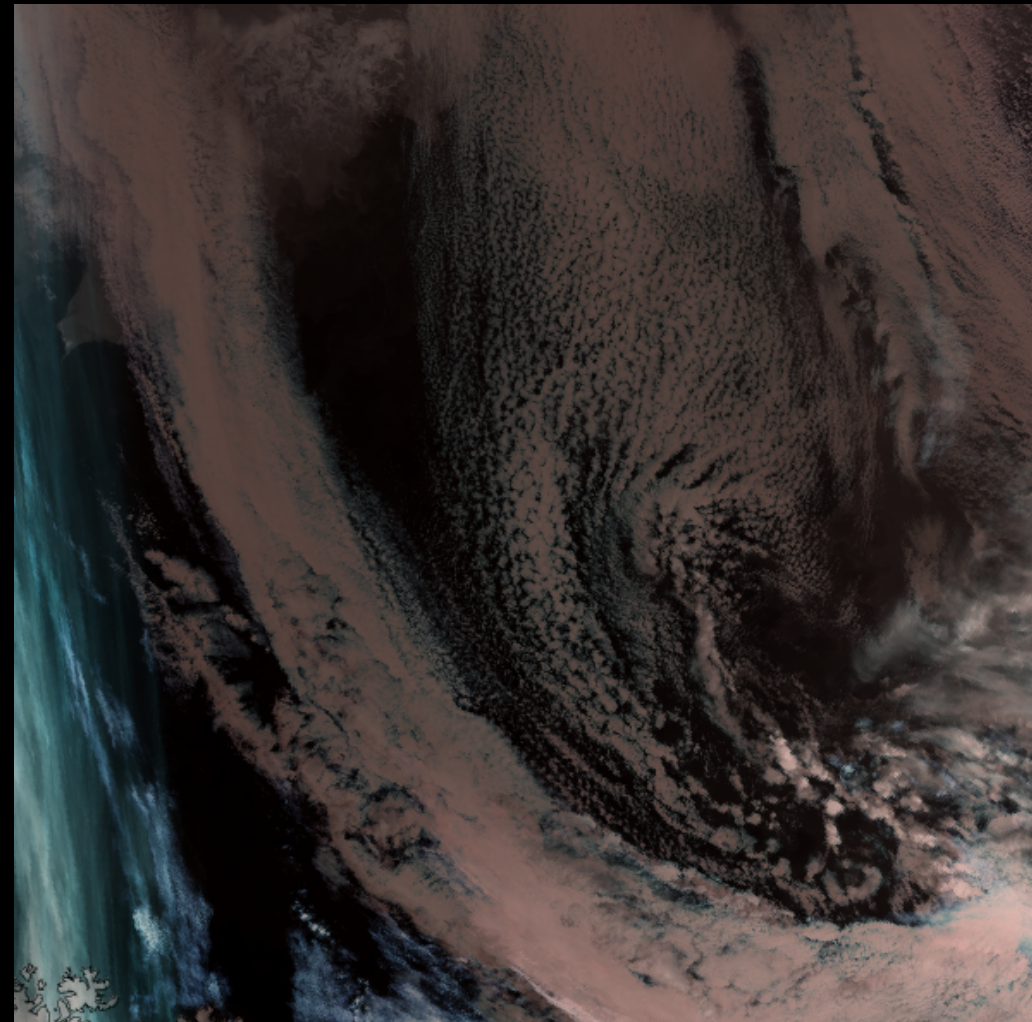
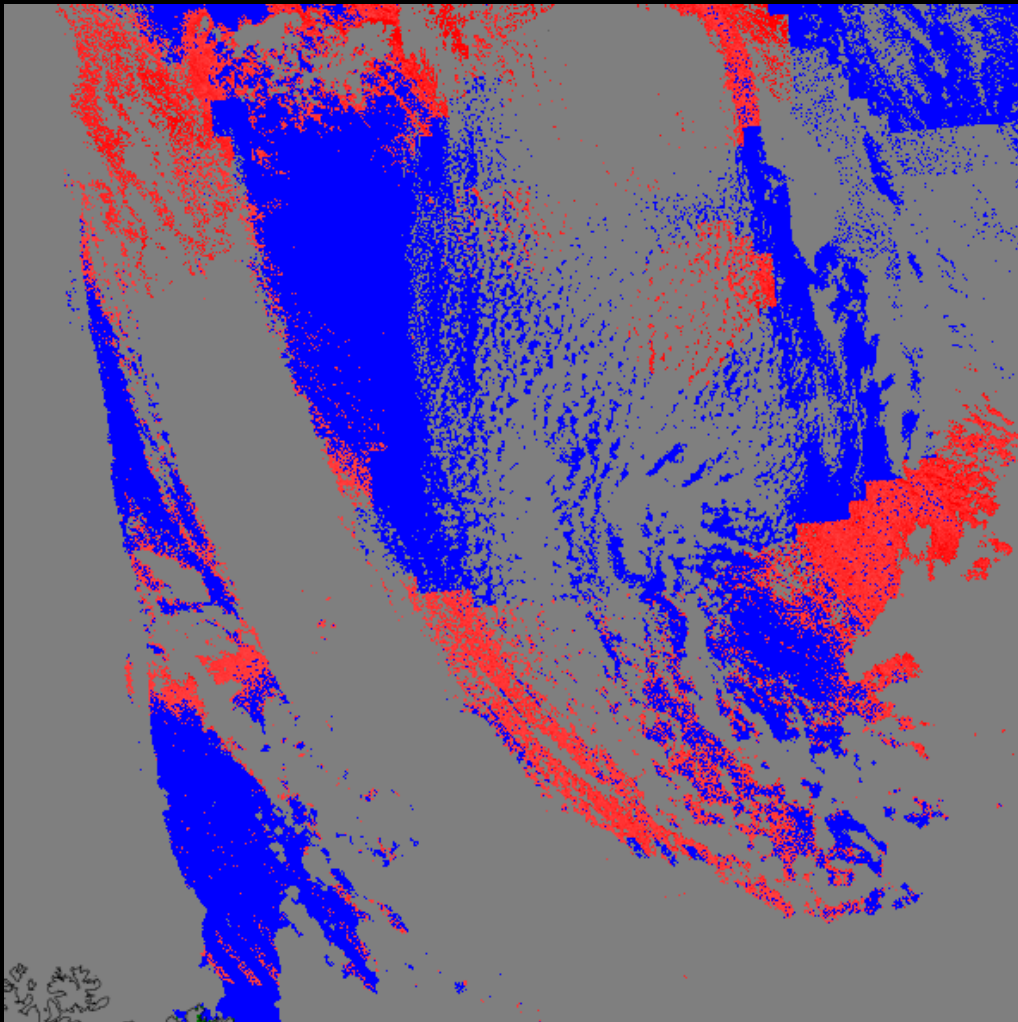
Highlighting the cloudfree (sea ice free and moonglint free) pixels with high lunar reflectance ( $r > 0.25$ ):



# Barents and Kara Seas

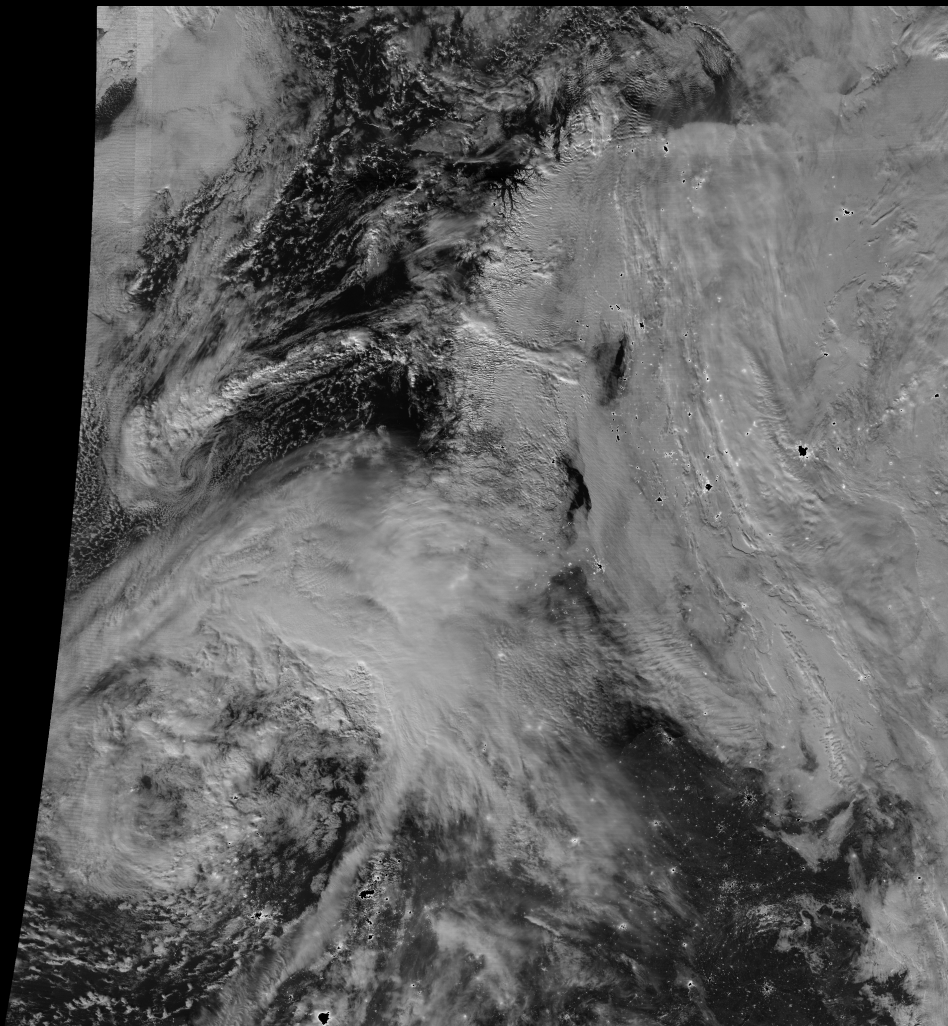
Grey=Cloudy according to PPS  
Redish=High lunar reflectance

RGB: 3.7, 11, 12  $\mu\text{m}$

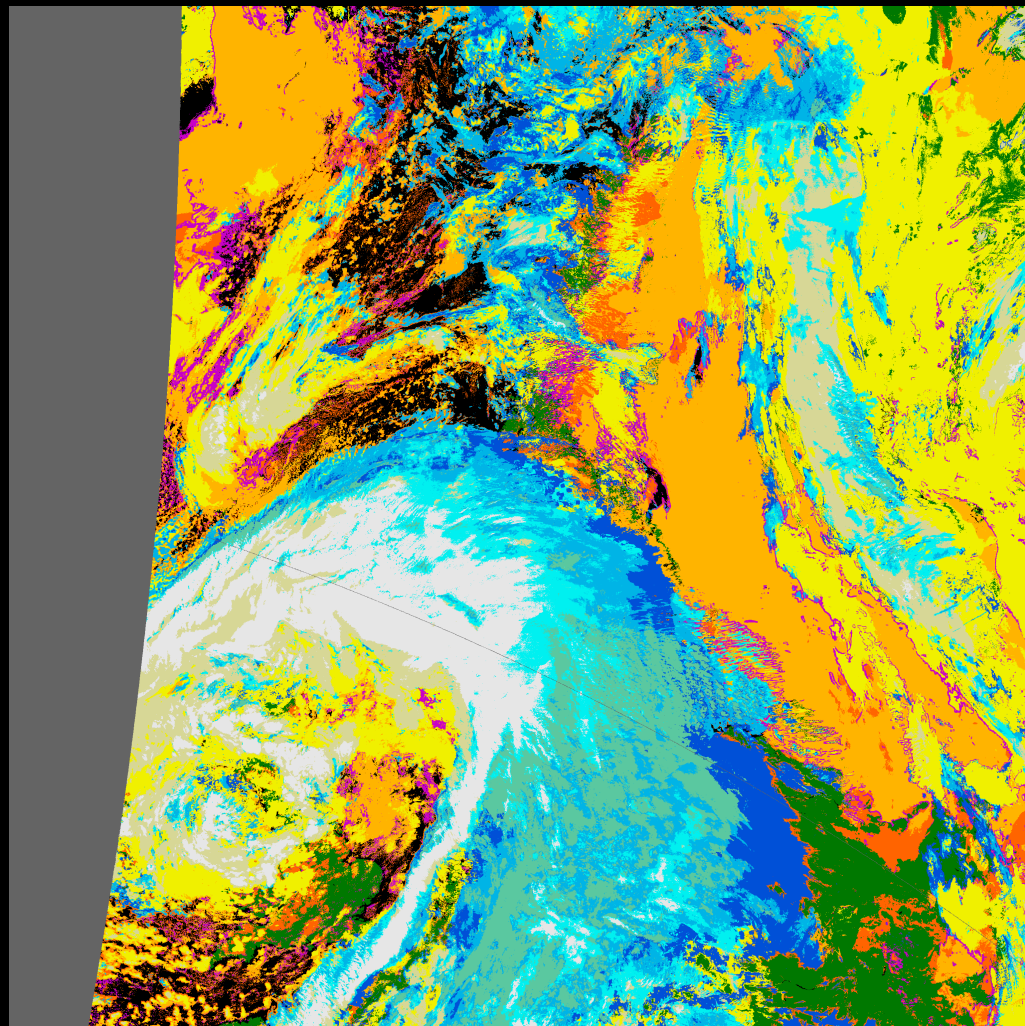


# North Atlantic

DNB lunar reflectance



PPS Cloud Type

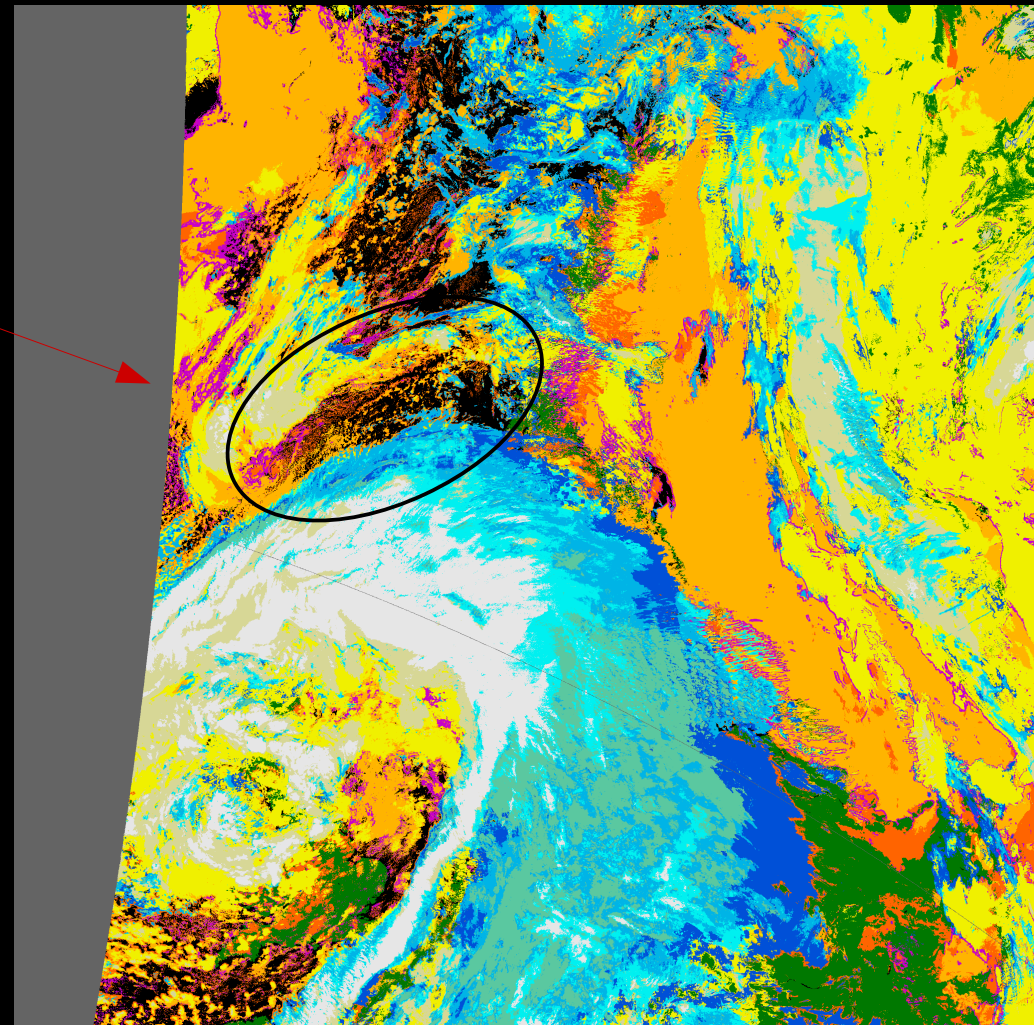


S-NPP 2014-02-15 01:11 UTC

# North Atlantic

PPS Cloud Type

Zoom in on partly missed low broken clouds over the Norwegian Sea



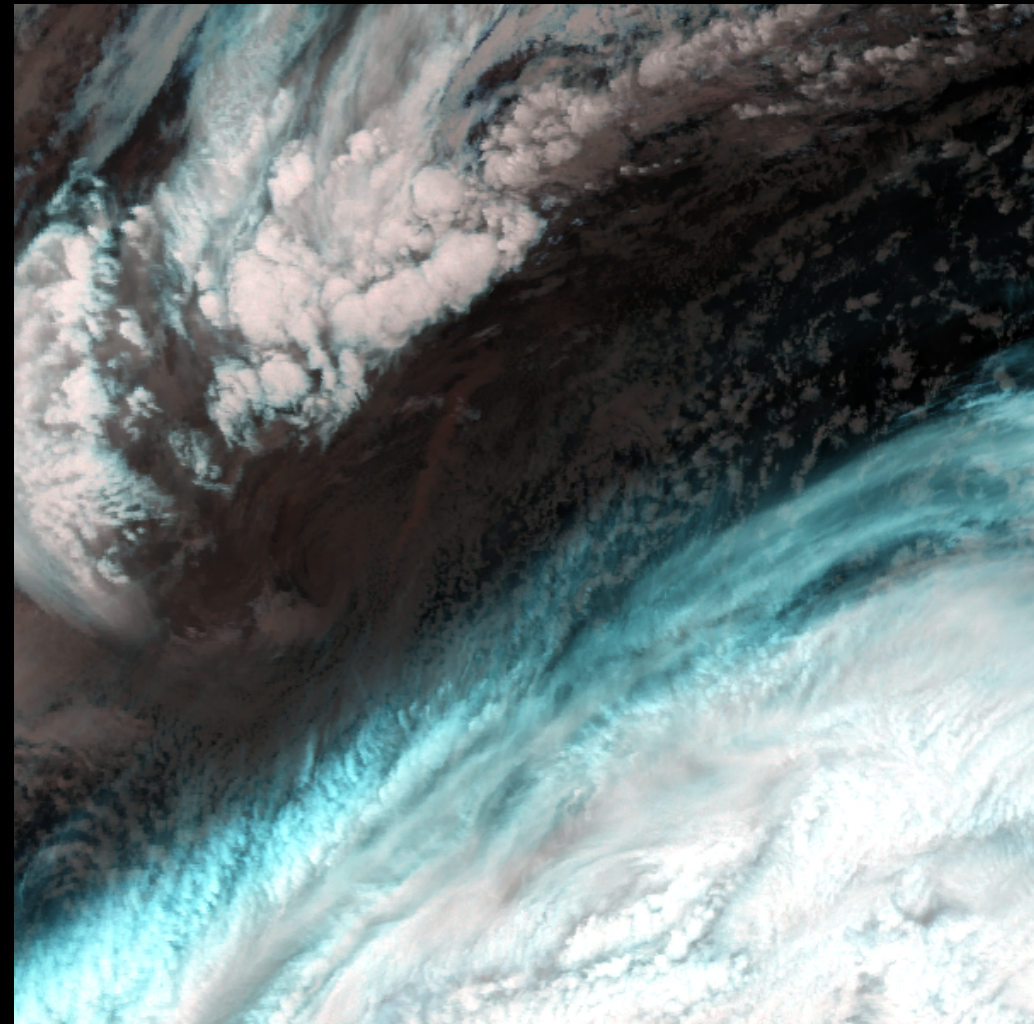
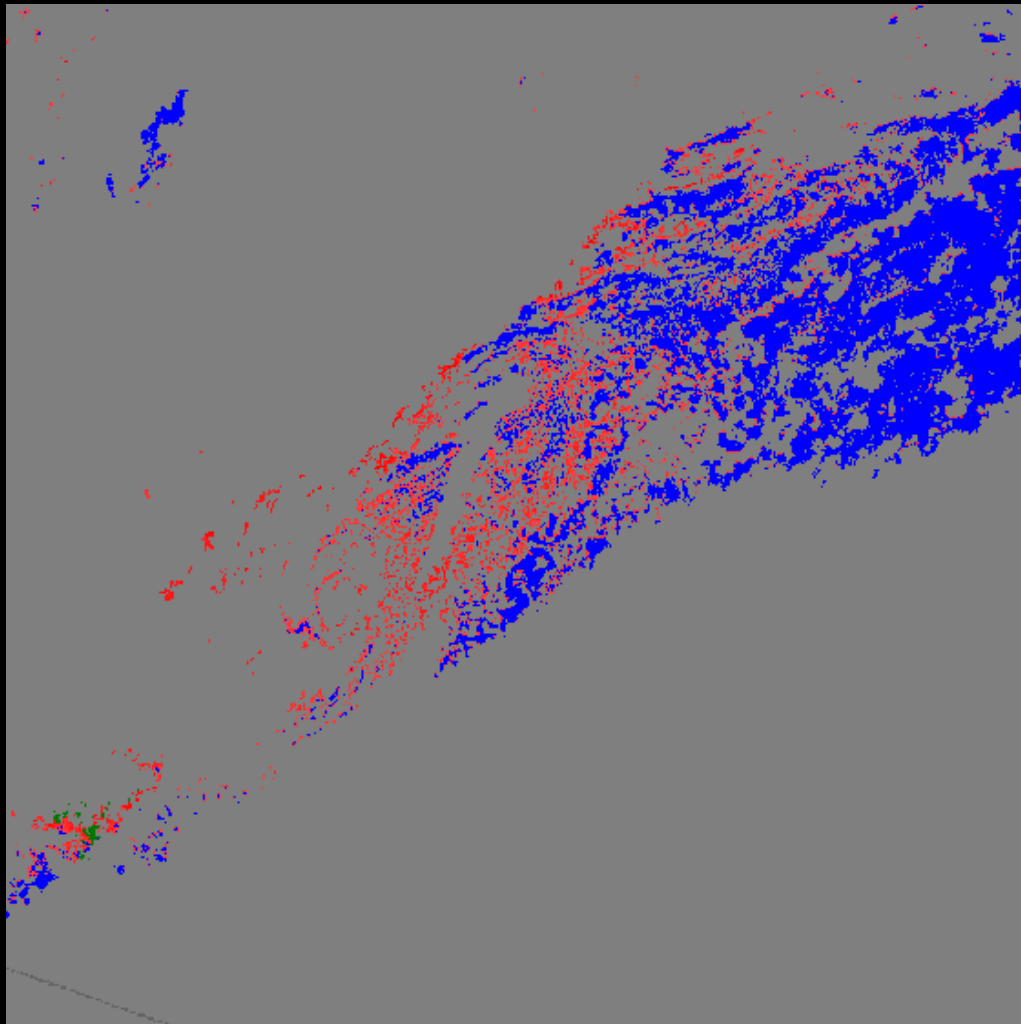
S-NPP 2014-02-15 01:11 UTC



# Missed low broken clouds

Grey=Cloudy according to PPS  
Reddish=High lunar reflectance

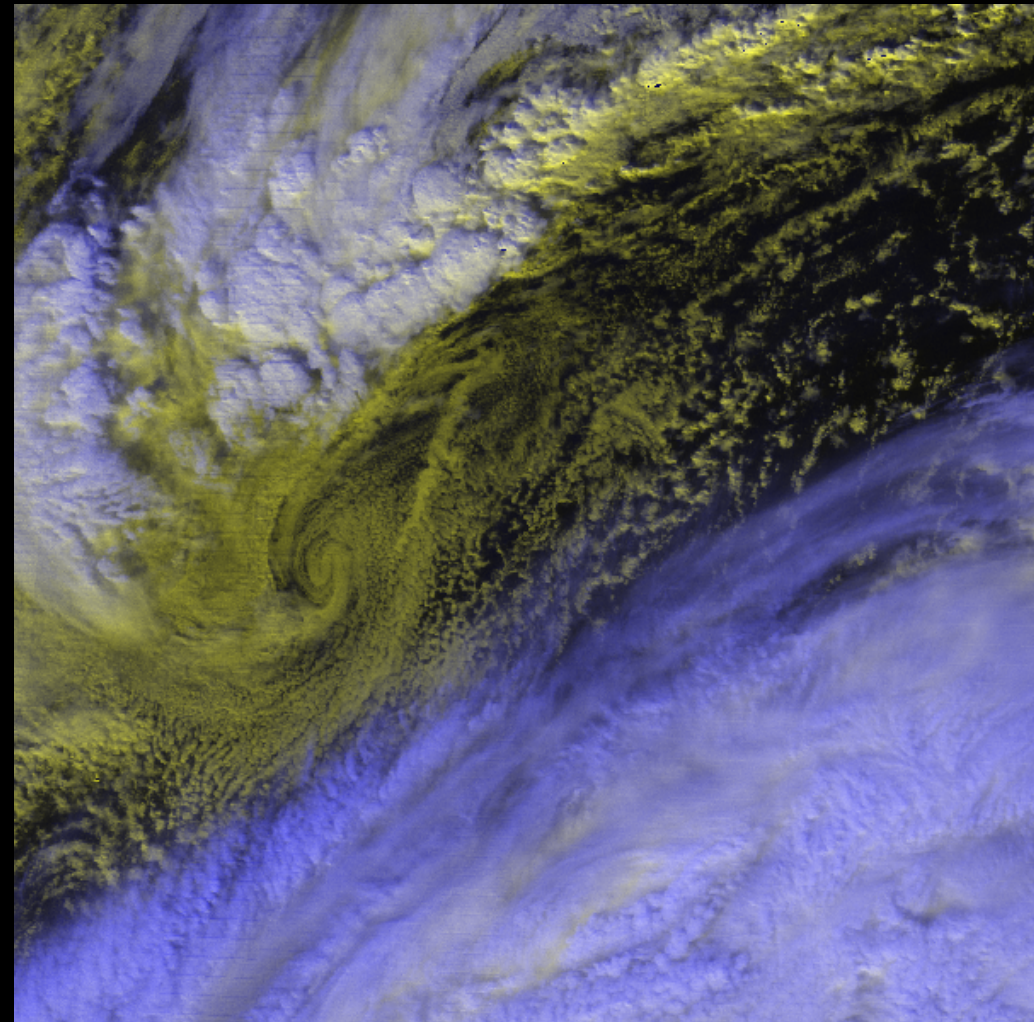
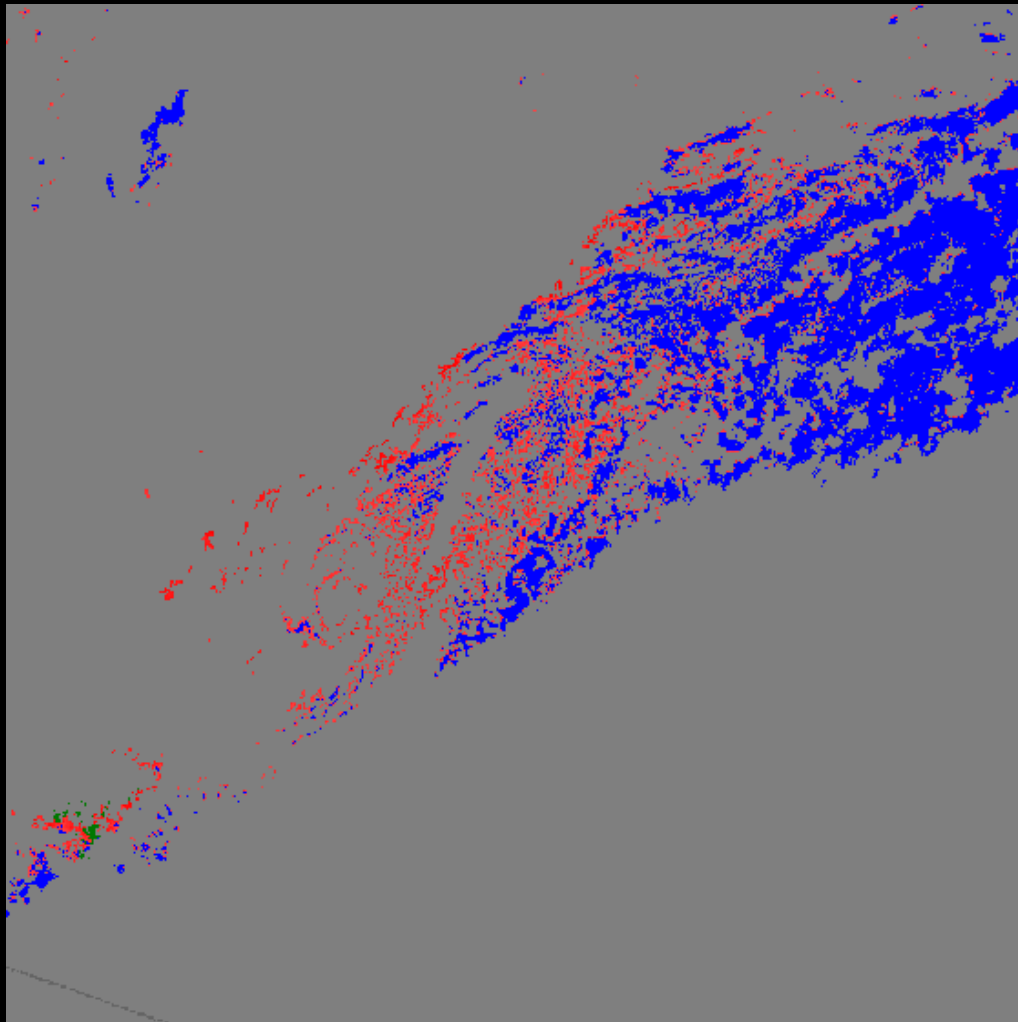
RGB: 3.7, 11, 12  $\mu\text{m}$



# Missed low broken clouds

Grey=Cloudy according to PPS  
Reddish=High lunar reflectance

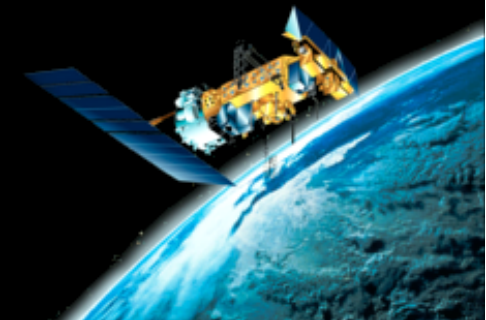
RGB: DNB, DNB, M15



# Lunar reflectance data aiding cloud detection over open water at high latitudes

Prominent error sources:

- Auroras
- Lights from ships and off shore industry
- Straylight
- TOA lunar irradiance model
- Moonglint



# Aurora forecasting

www.gi.alaska.edu/AuroraForecast/NorthPolar/2014/01/22



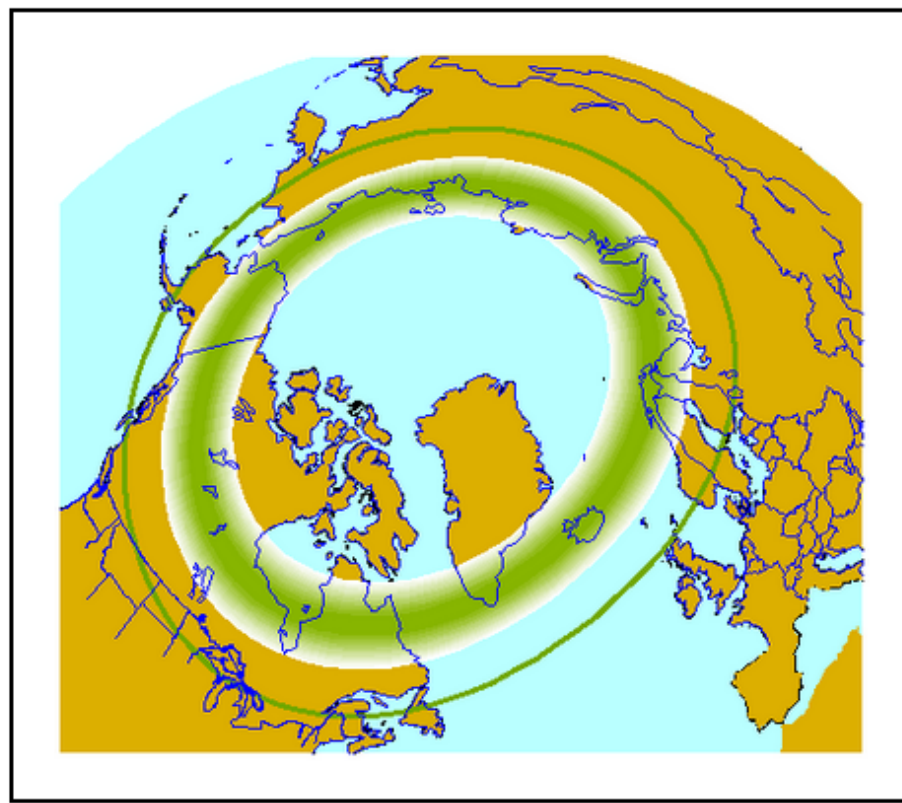
Aurora prediction

## Aurora Forecast for Wednesday, January 22, 2014

<< Previous

Next >>

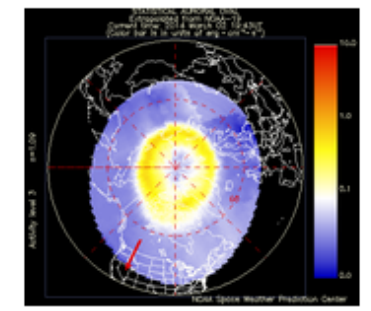
- Can I see the Aurora?
- Viewing the Aurora in the Northern Summer
- Interpreting the Forecast
- Traveler's Guide to the Aurora
- Online Aurora Forum
- Aurora Links
- Aurora Alerts Sign-up
- FAQ
- Mobile Apps



### Short term (1hr) Aurora Forecast

Sorry, the short-term forecast is out of date. Please try again later.

### Current Aurora Activity



NOAA/POES

### Auroral Activity by Solar Rotation



Select a Map

Moderate: 0 1 2 **3** 4 5 6 7 8 9

**Forecast:** Auroral activity will be moderate. Weather permitting, moderate

## Land?

- Snow: Need for accurate land surface reflectance map (snow cover is a proxy but may be insufficient)
- City lights and other man made light sources – can be masked to some extent but may also be a source of information



# Persistent light sources

Average radiance under  
cloudfree and dark  
conditions (no moon & no  
sun) – composite from 73  
S-NPP scenes from May to  
Oct 2013

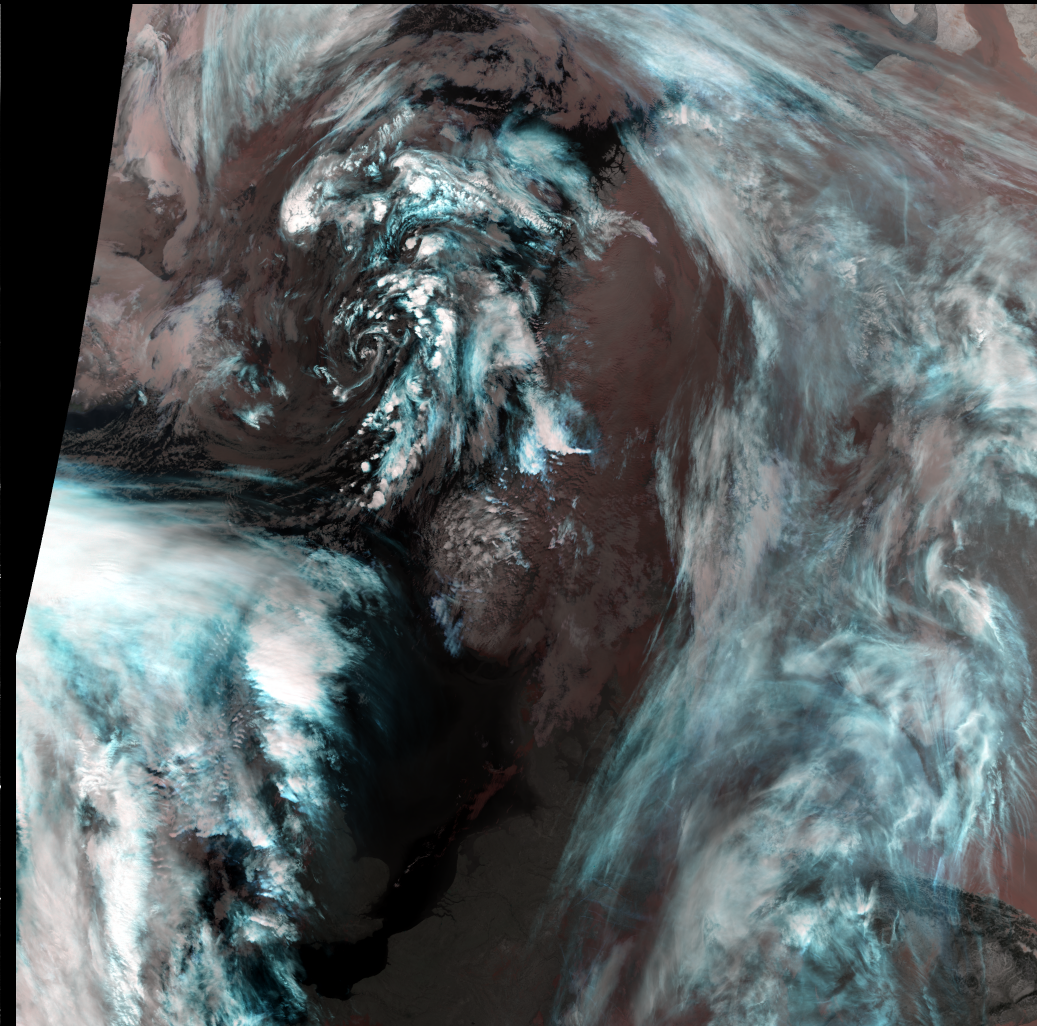


# Clouds obscure and scatters the light



DNB radiance: 2014-02-03 01:36 UTC

# Clouds obscure and scatters the light



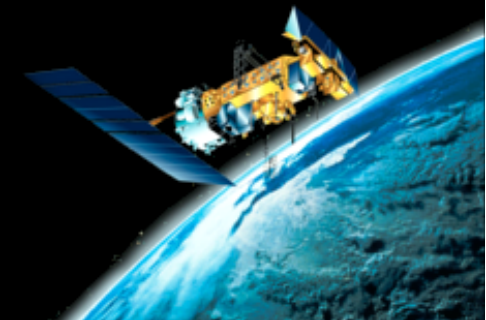
DNB radiance: 2014-02-03 01:36 UTC

RGB 3.7;11.12  $\mu\text{m}$



## Conclusion

- There is scope for improving the PPS cloudmask over sea using lunar reflectance data
- Mainly picking up undetected cloudy pixels
- Moonlight is required – the polar winter night is favored by moonlight



## Conclusion

- The usefulness of DNB data in cloud masking over sea ice and land is less obvious
- ...but the full potential of these data are yet to be uncovered

*Acknowledgments: Andi Walther and Steven Miller*

