

Pytroll

• • •

Rome, October 3rd 2017

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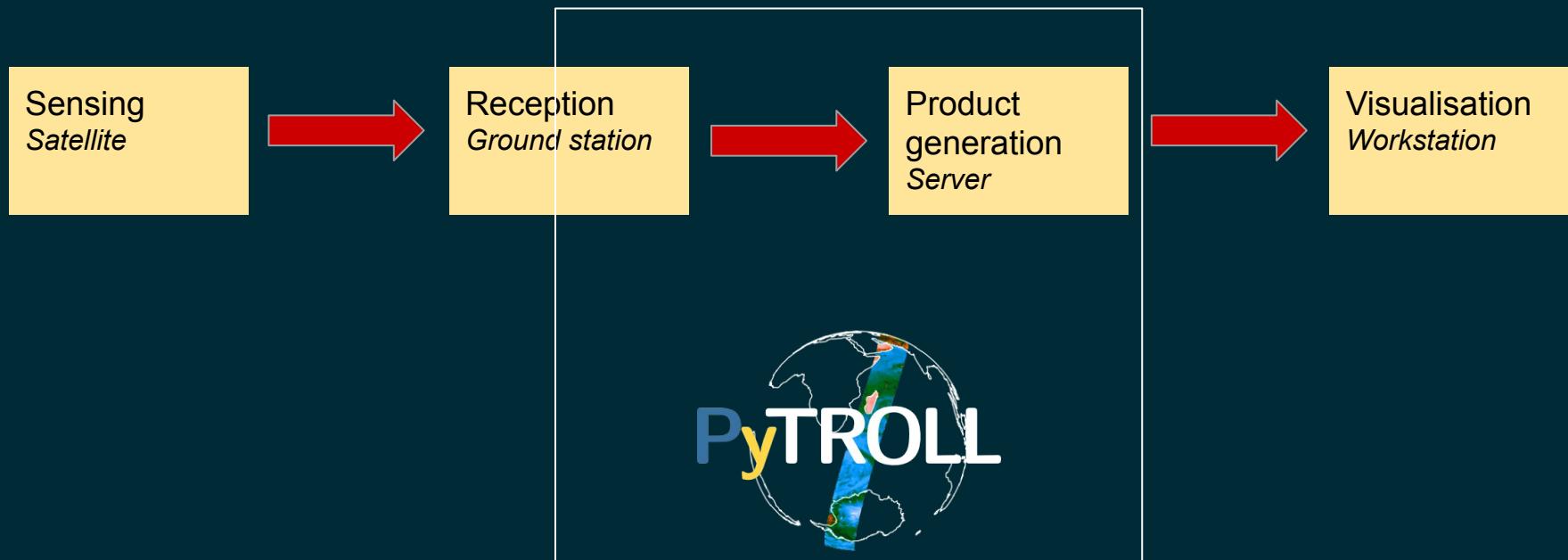
Adam.Dybbroe@smhi.se

What is Pytroll ?

- Collection of FOSS python packages
- For processing of earth observation satellite data



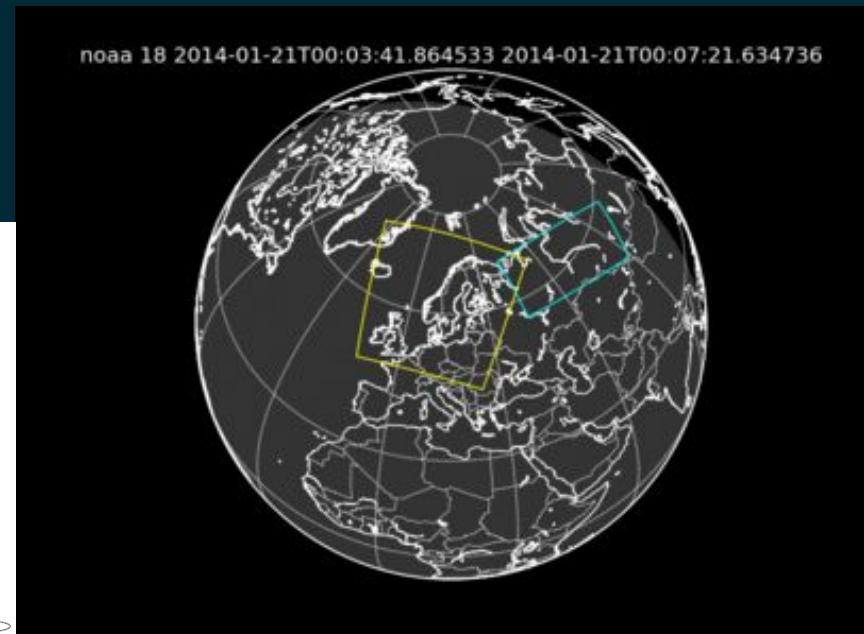
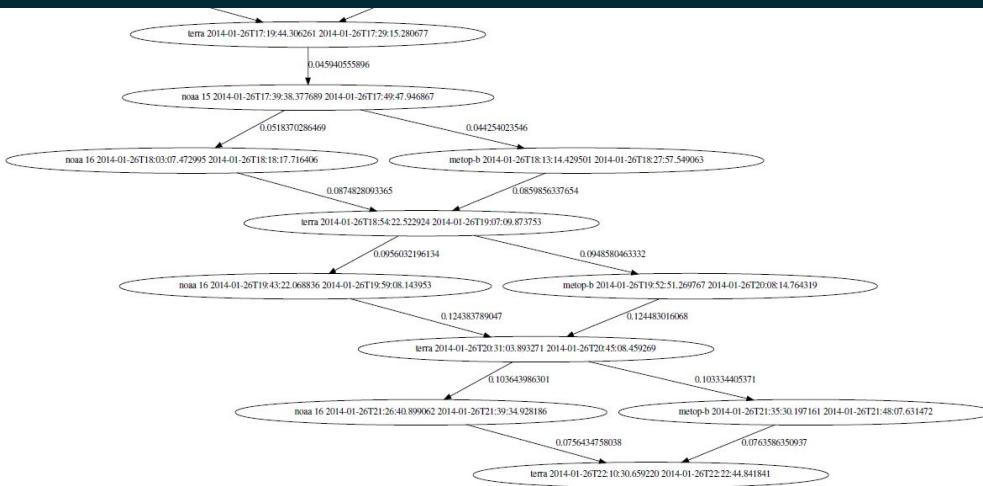
Usual workflow



Reception

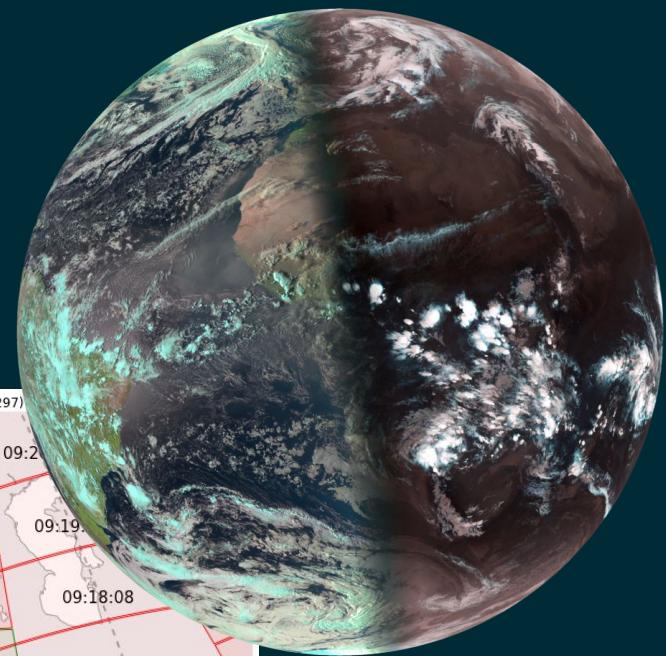
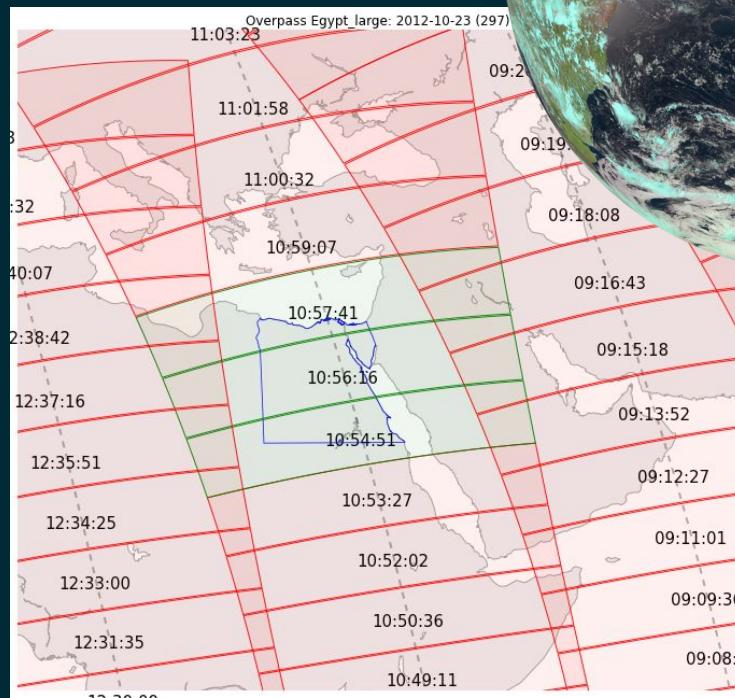
Pytroll-Schedule: Know when to look up

- Based on area of interest
- Give a different weight to each satellite

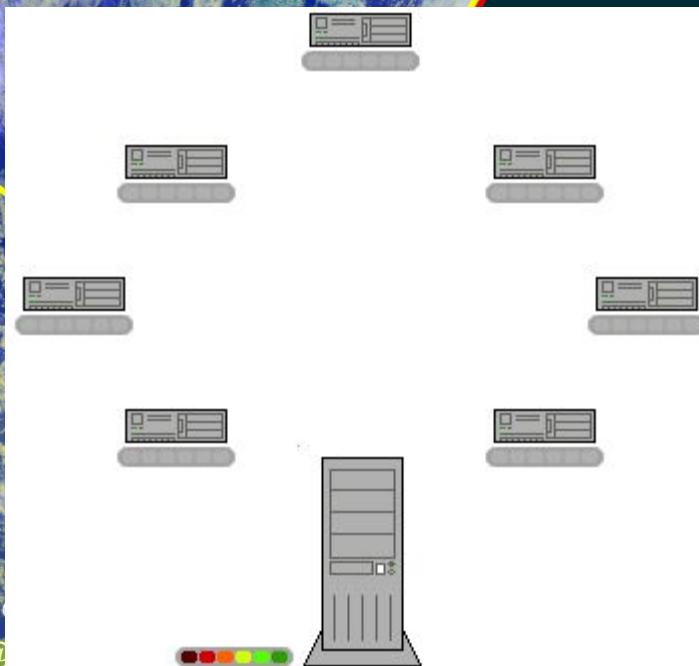


Pyorbital: get to know your satellite

- Use SGP4 to compute satellite position and velocity
- Within 3.5mm
- Astronomical computations



Trollcast: Sharing the raw data



- BitTorrent-inspired data sharing
- Zero timeliness
- Peer-to-peer

Trollcast: Sharing the raw data

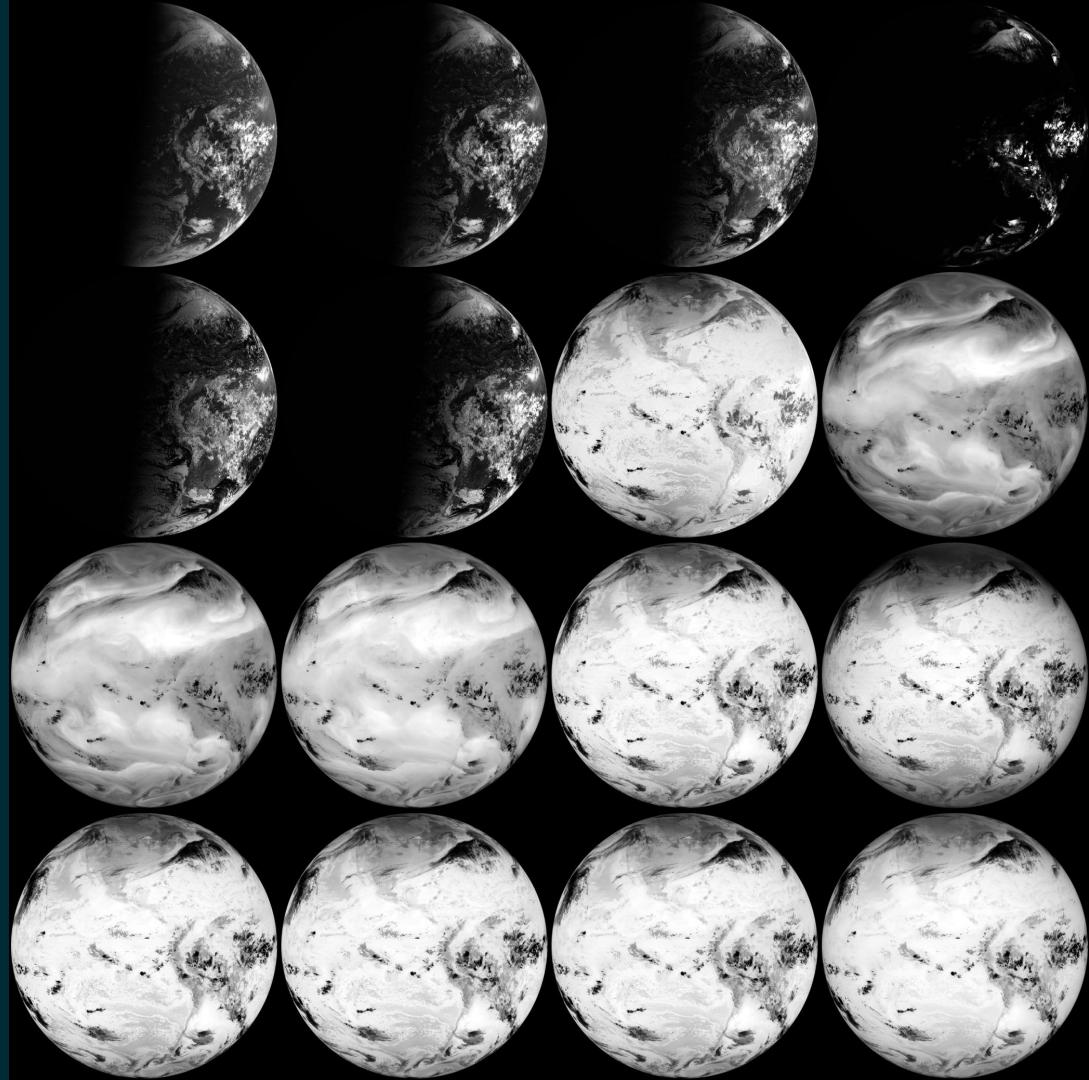
- Works with HRPT (NOAA satellites)
- Prototyped with CADU (Metop, EOS, S-NPP, FY3, ...)

Running in Finland, Norway, Sweden, Iceland, Latvia

Processing

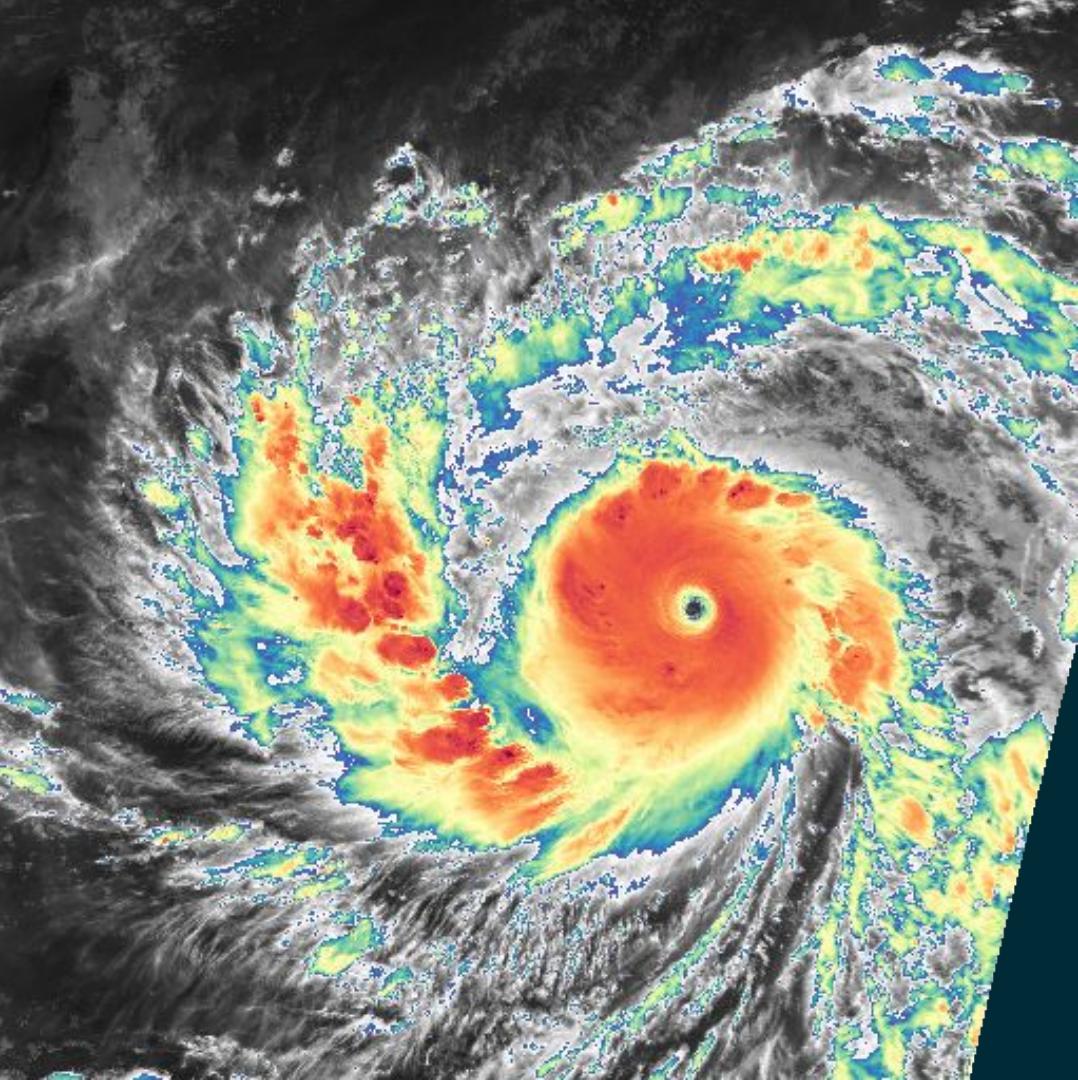
Satellite Data

- Each channel covers a narrow frequency band
- Different frequencies expose different features

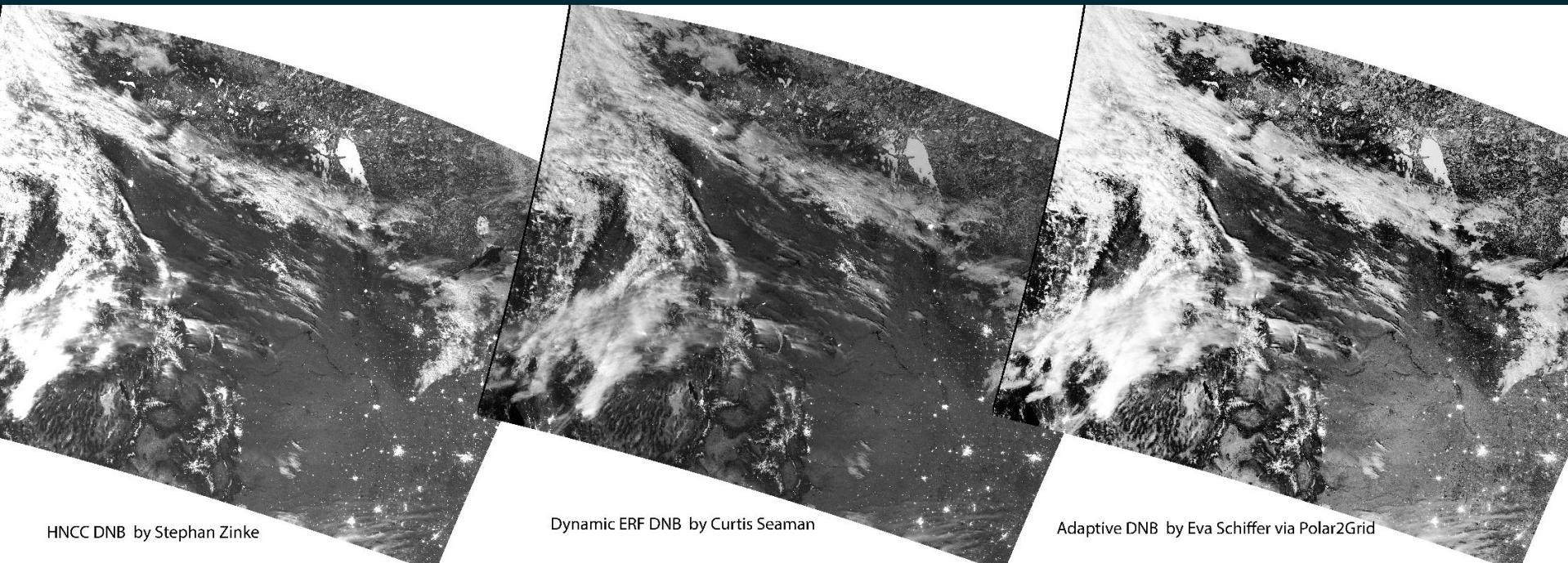


Satellite Data

Look at a single channel for some feature



Satellite Data



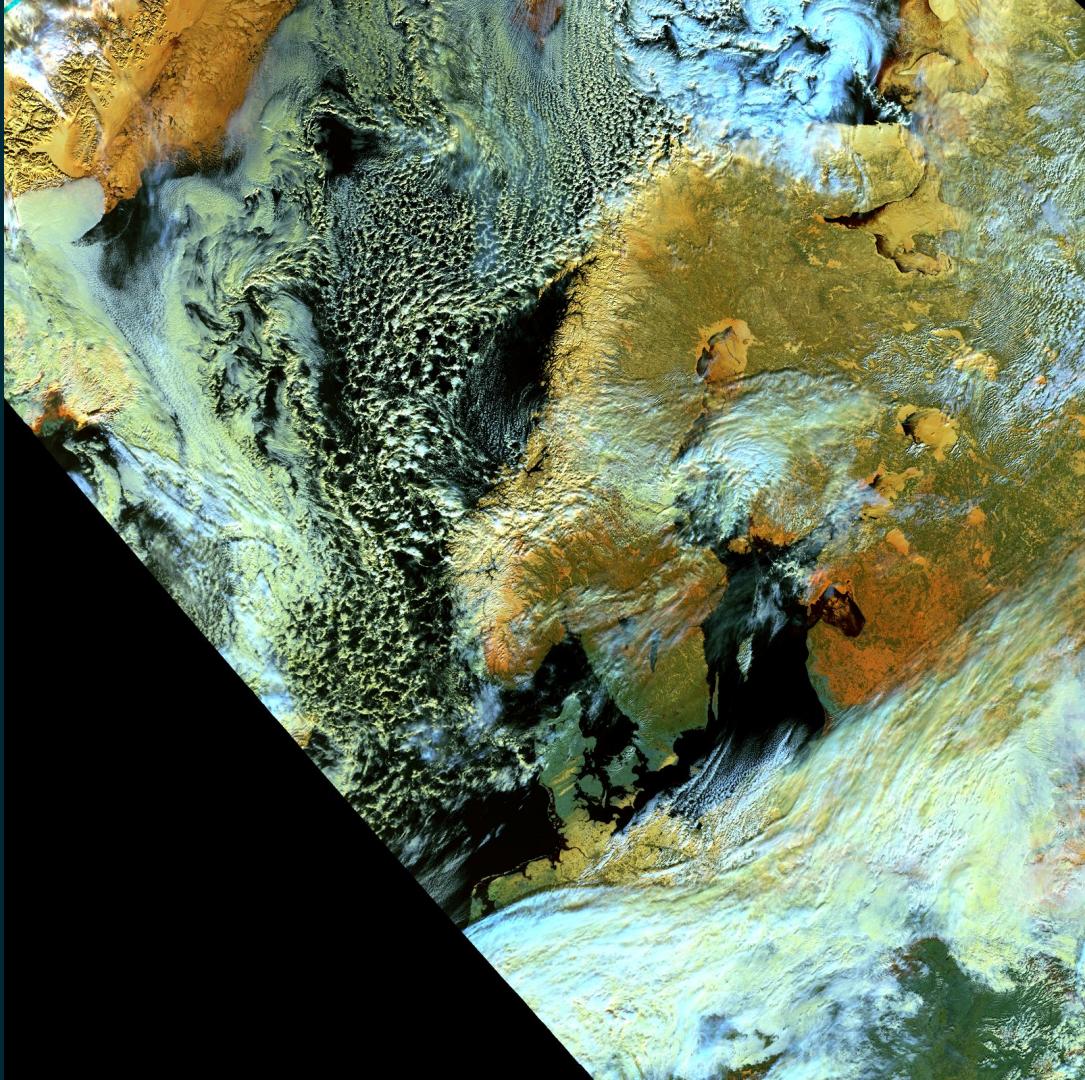
HNCC DNB by Stephan Zinke

Dynamic ERF DNB by Curtis Seaman

Adaptive DNB by Eva Schiffer via Polar2Grid

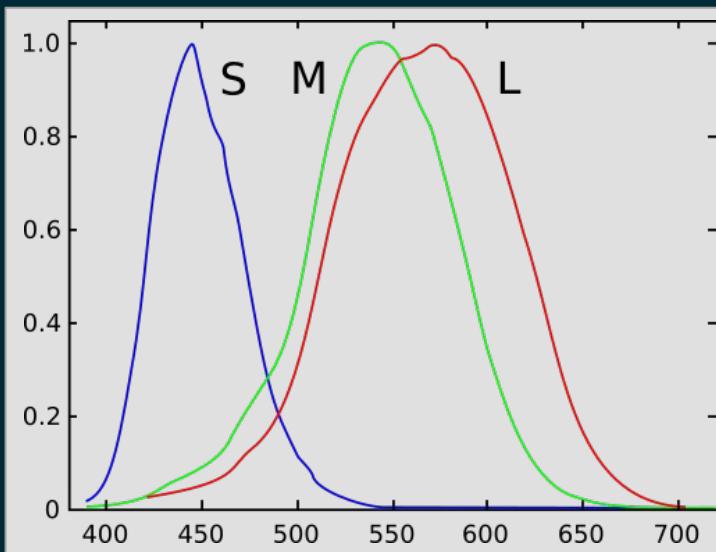
Satellite Data

Combine channels for more features



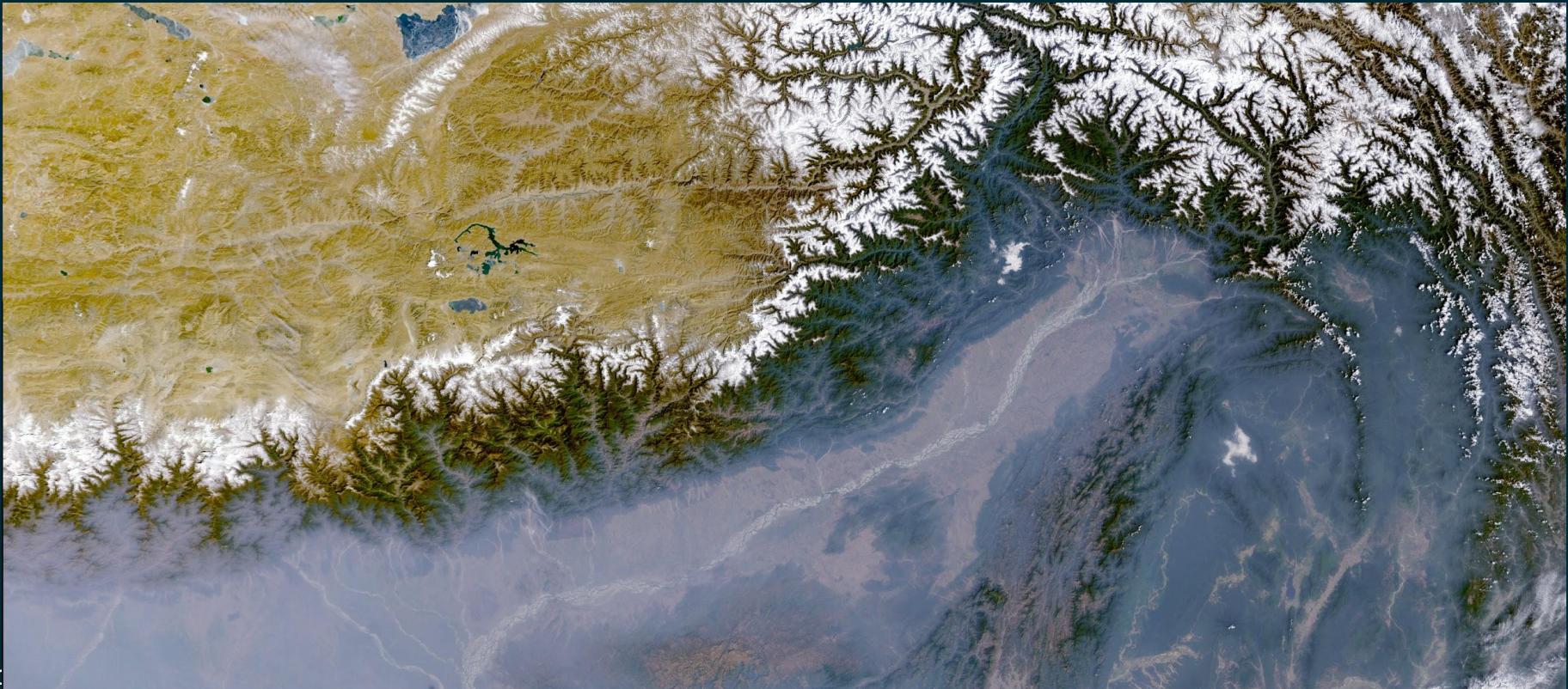
RGB Images

- Based on the tristimulus theory



1911 by Sergei Mikhailovich Prokudin-Gorskii

RGB Images



Satellite Data

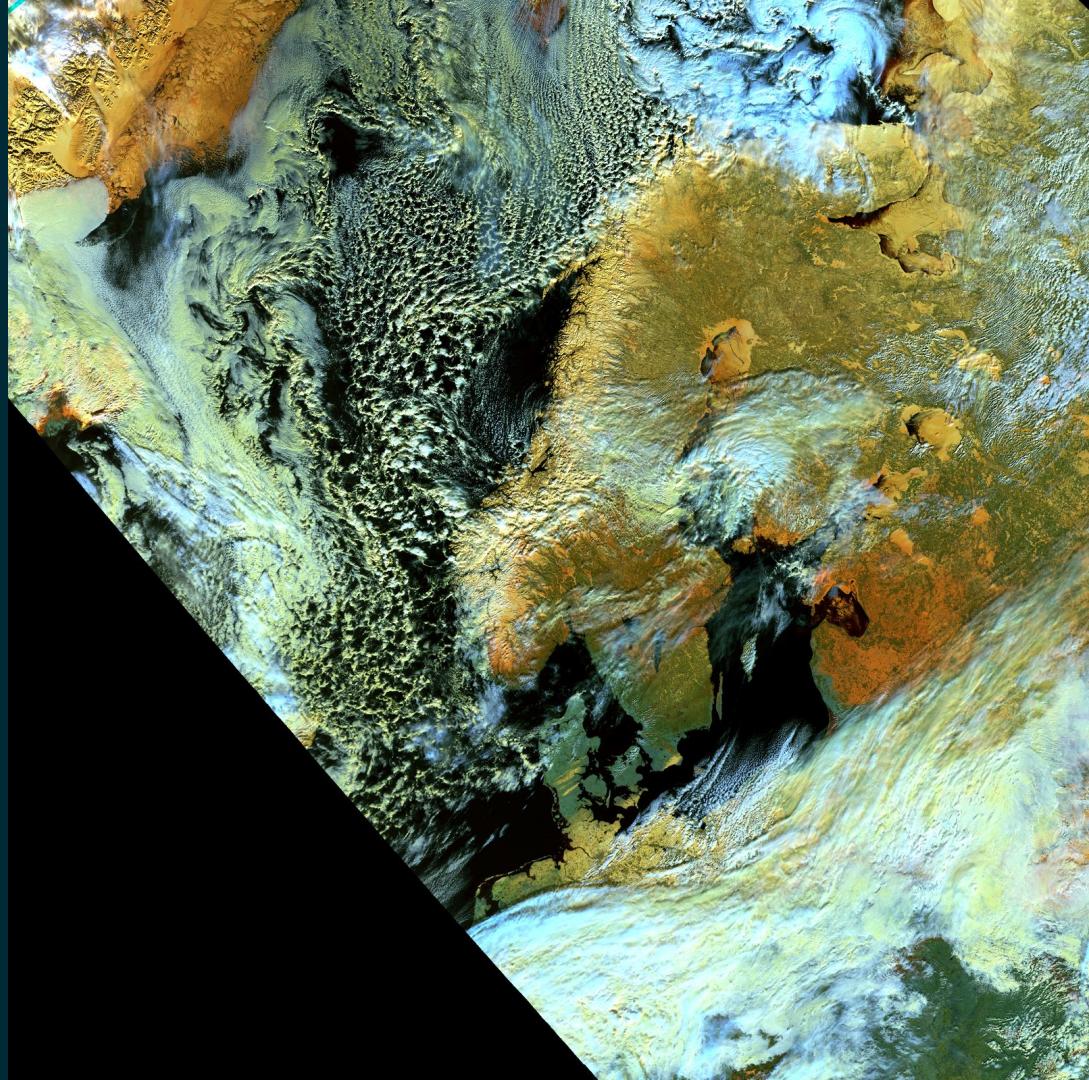
Combine channels for more features

Example: Snow Age Composite

“A Snow RGB composite for Suomi NPP VIIRS”

B. Bellec, J. Vidot, P. Roquet and P. Brunel

Presented at the CSPP UGM 2015

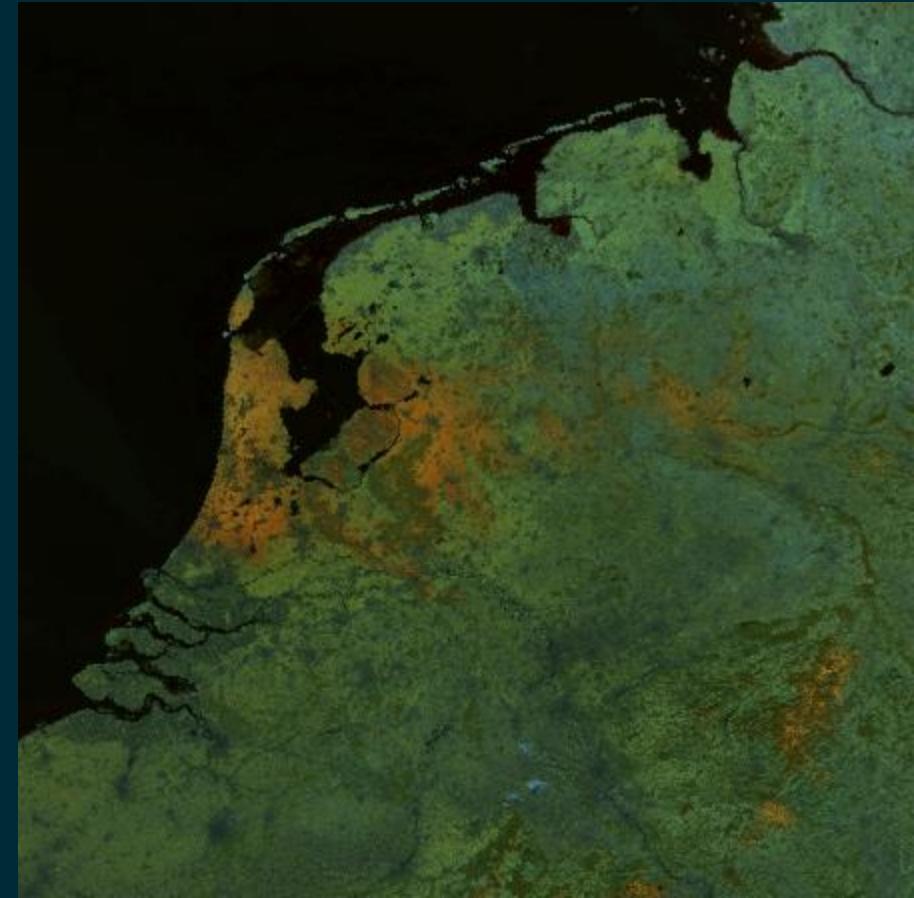
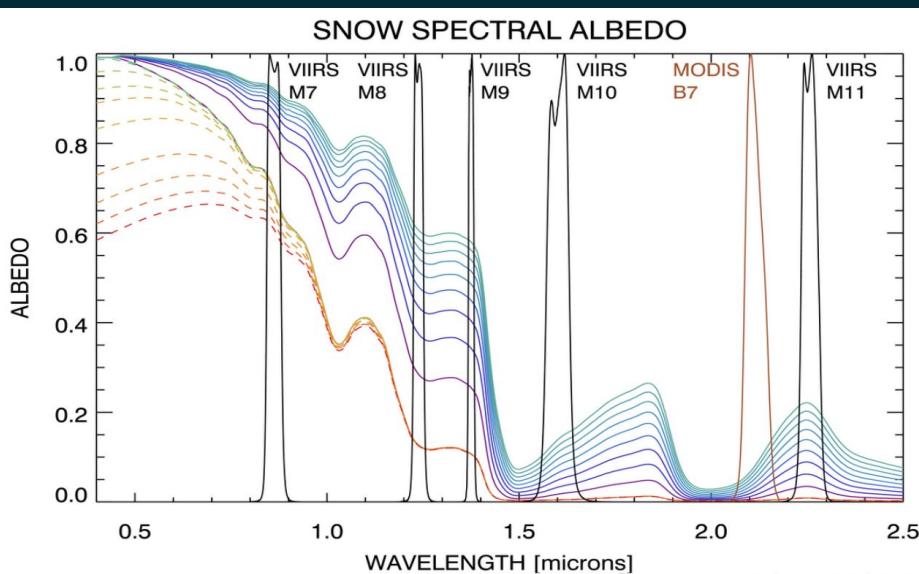


Example: Snow Age Composite

R: M7 - M9 + ...

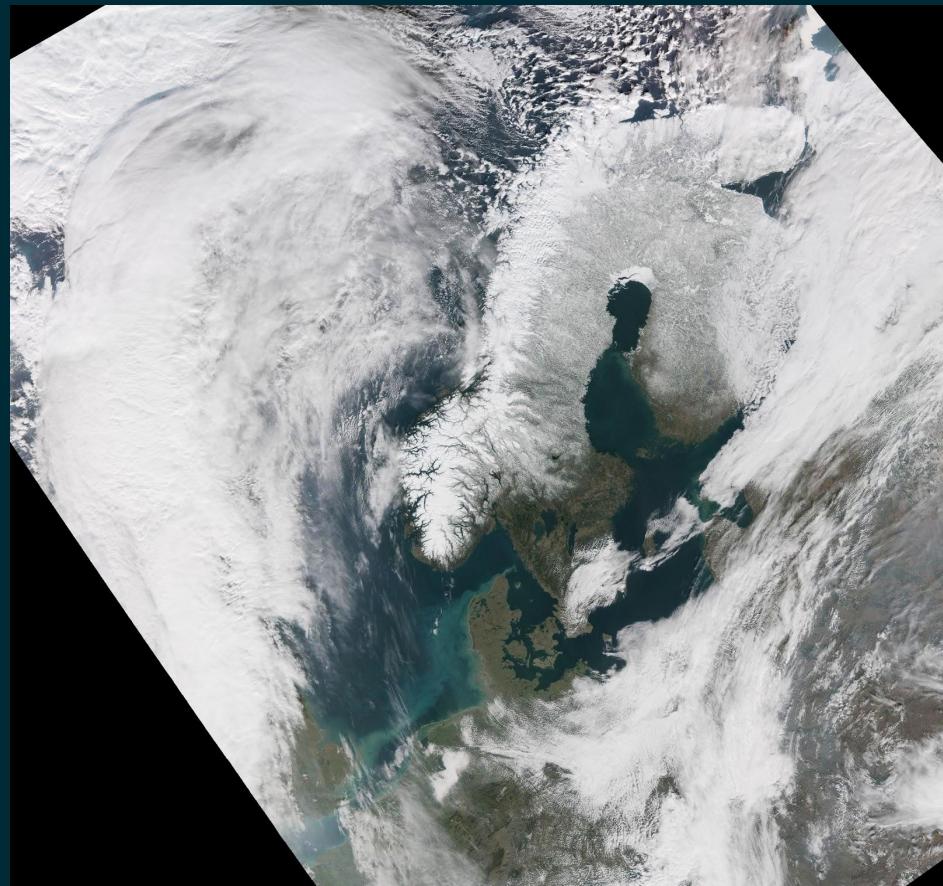
G: M8+M9 + ...

B: M9+M11 + ...



SatPy

- High level processing for satellite data
- Both GEO and LEO
- Indexing by name or wavelength
- Many built-in composites
- Read many input formats
- Write many output formats
- Resample data to any PROJ.4 projection



SatPy example

```
from glob import glob
from satpy.scene import Scene

# Load data by filenames
files = glob("/data/viirs_data/*.h5")
scn = Scene(reader="viirs_sdr", filenames=files)
```

SatPy example

```
# Automatically load composites and their dependencies
scn.load(["true_color"])

# Resample multi-band data to a uniform grid
rs_scn = scn.resample("euron1")

# Save RGB geotiff
rs_scn.save_dataset("true_color")
```

SatPy example

```
# Load single channels  
scn.load(["M15", 0.6])  
  
# Show a channel  
scn.show("M15")  
  
# Channel arithmetics  
array = scn["M15"] + scn[0.6]
```

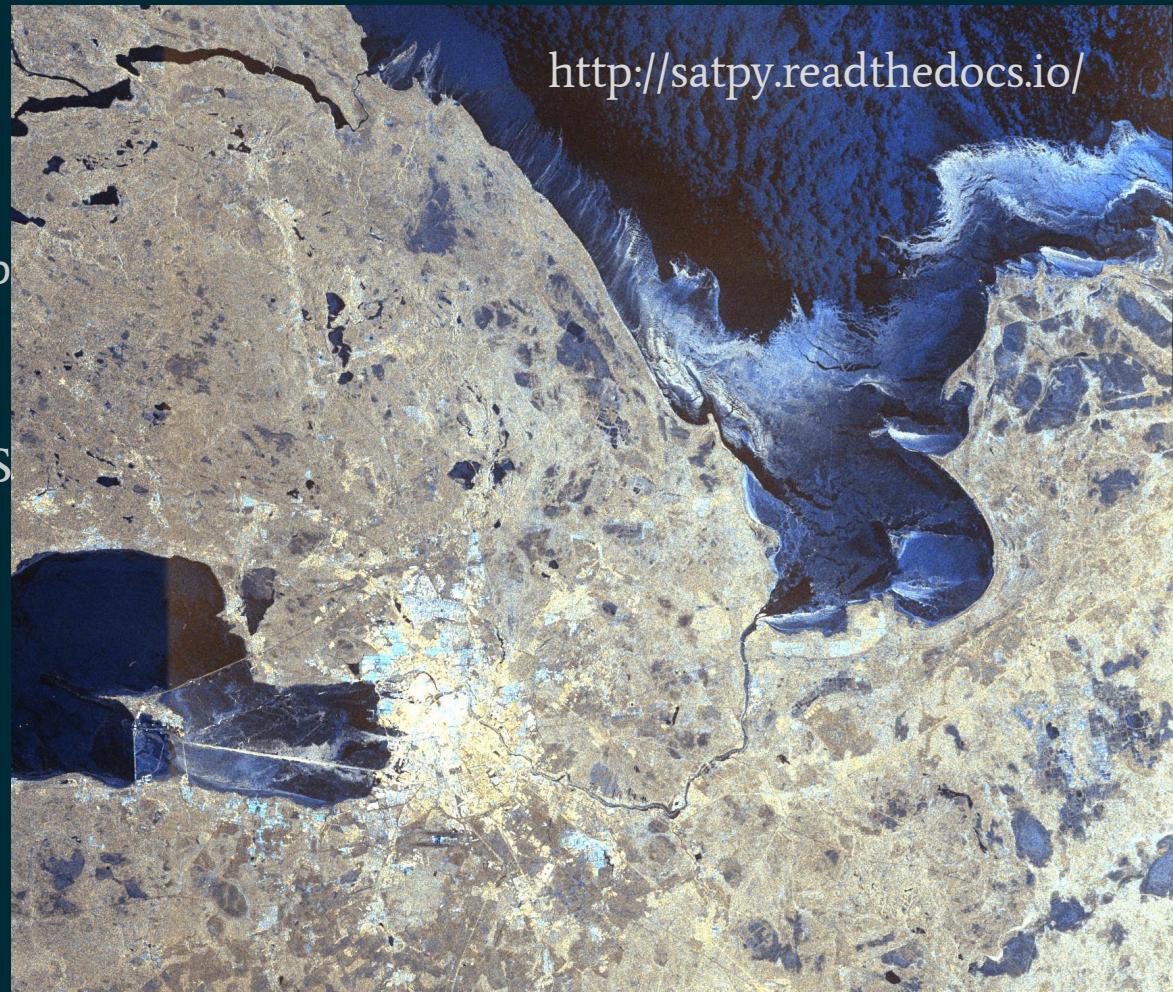
How does it work ?

- Standard interfaces for readers, writers, composites, and resampling methods
- Default (usable) configuration files included
- Default RGB combinations included

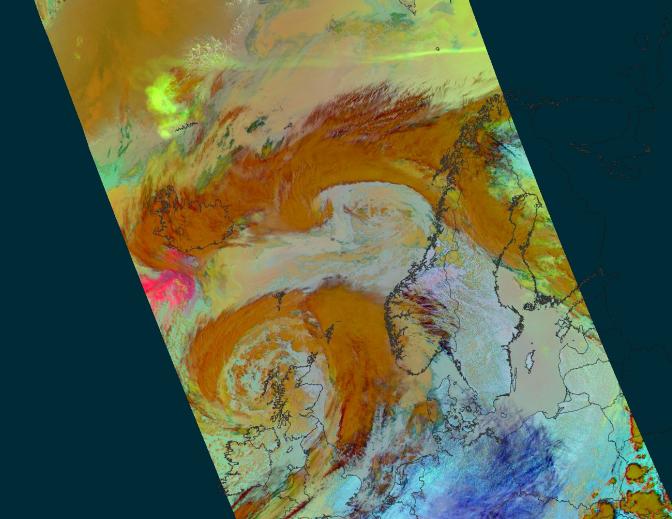
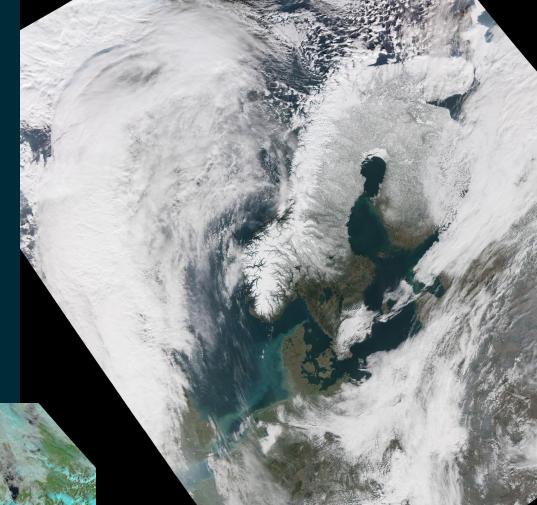
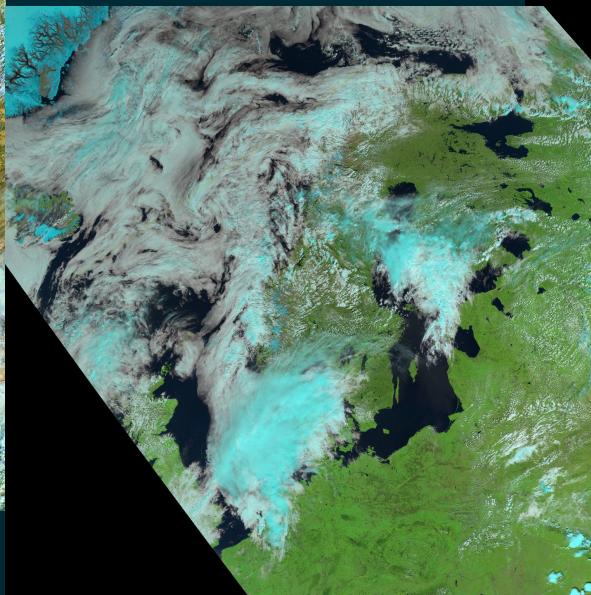
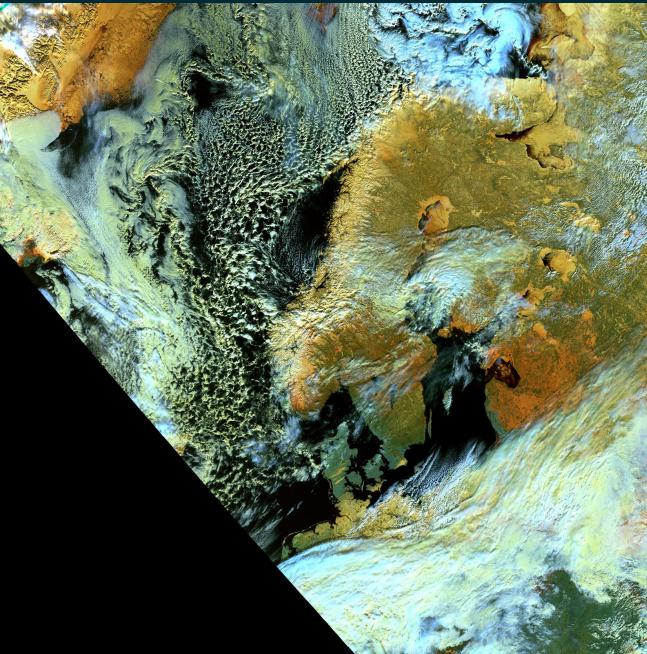
Satellite data formats

- HDF4 - MODIS L1B
- HDF5 - VIIRS (SDR, Comp)
- HDF5 - FY3
- NetCDF - NWCSAF
- NetCDF - Sentinel & GOES
- AAPP
- NOAA GAC
- Metop PDF
- HRIT/LRIT
- SAR
- **Add your own reader!**

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SatPy built-in composites



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Adam.Dybbroe@smhi.se

Kontakt Om SMHI Blogg - Väderleken In English

Sök

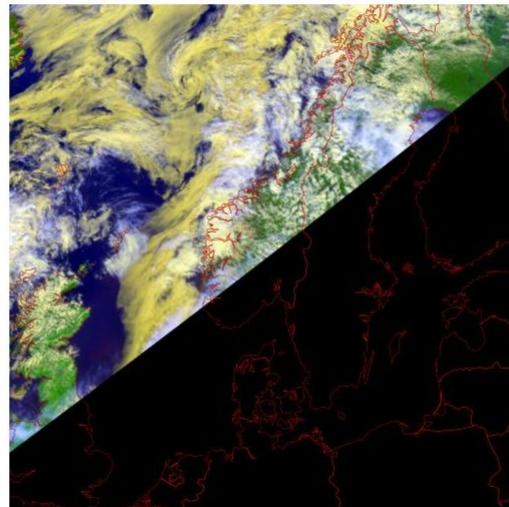
SMHI Väder Klimat Data Professionella tjänster Kunskapsbanken Forskning Risk Sverige

Väder i Sverige
Varningar
10-dygnsprediction
Meteorologens kommentar
Snödjup
UV-index idag
Årstidskarta
Flödesläget
Brandriskprognos - 5 dygn
Observationer
Max/minvärden
Vattenföring
Vattenstånd i de stora sjöarna
Väder i Sverige (tidigare version)
SMHIs väder för mobila enheter

Nederbörd och molnighet
Radar/blitz, Sverige
Radar, Norden
Satellit, Norden
Satellit, Europa
Satellit, Jorden

Hav och kust
Hav- och kustväder
Kustväder
Sjöväderprognos
Havsobservationer
Havsvattenstånd
Havsvågor
Kustobservationer
Alg situationen
Is till havs
Luftkvalitet
Marknära ozon

Fjäll
Fjällväder



BILDER FRÅN POLÄRA SATELLITER

06-23 16:07
06-23 15:41
06-23 14:59
06-23 14:39
06-23 14:01
06-23 13:54
06-23 13:52
06-23 13:19
06-23 13:03
06-23 12:58
06-23 12:13
06-23 11:41

IR-bilder

FÖRKLARING

Blåvitt = höga moln, ofta tunna
Vitt = medeldjupa moln, tjocka höga moln eller nysnö/glaciär
Gult = låga moln, is eller "gammal snö"

PROFESSIONELLA TJÄNSTER

Varningssystem för eldistributörer
Var förberedd på extremt väder med kundanpassade sms- och e-postvarningar för kraftig blåst, snö och åska.
[Larmtjänst för åska, kraftig blåst och snö](#)

LÄR DIG MER

Typ av satelliter
SMHI tar emot data från de europeiska satelliterna METEOSAT och MetOp samt de amerikanska NOAA satelliterna.
[Typ av satelliter](#)

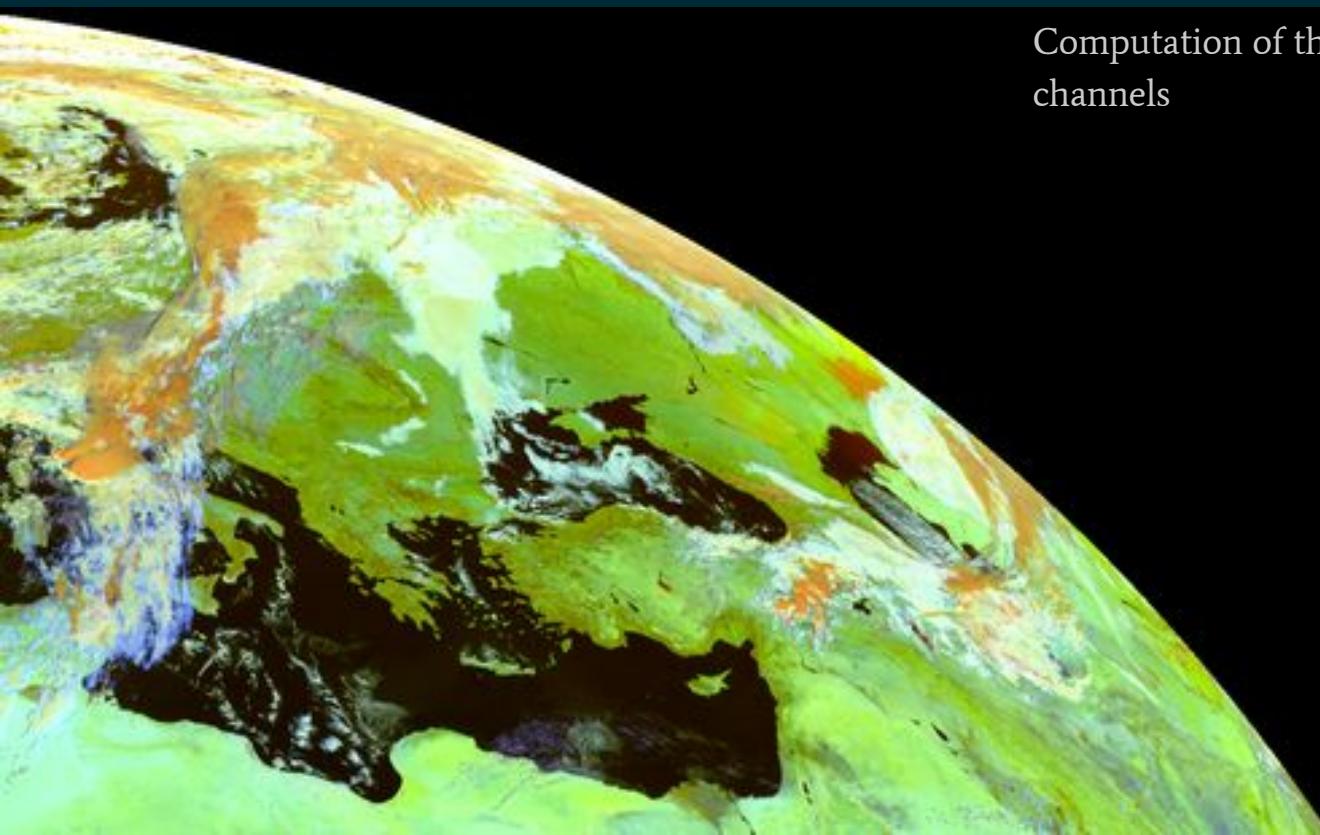
FORSKNING

Forsknings inom vädersatellit
Inom SMHIs forskning för fjärranalys drivs flera projekt inom satellit och radar. De flesta är samarbeten mellan olika länder främst inom Norden eller Europa.
[Forsknings inom vädersatellit](#)

Output data formats

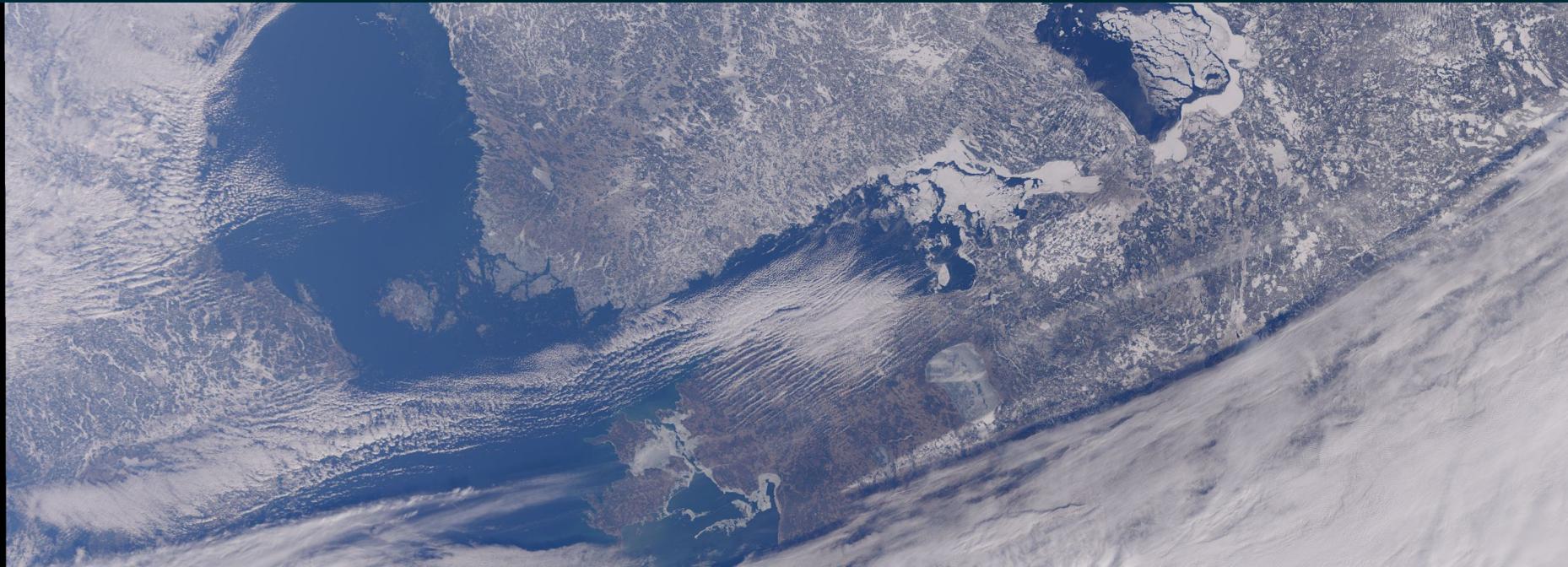
- NetCDF/CF
- GeoTIFF
- NinjoTIFF
- Flat Binary
- PNG, JPeG, ...
- AWIPS SCMI

Pyspectral:



Computation of the reflective part of 3.x μm channels

Pyspectral: Corrections to channels



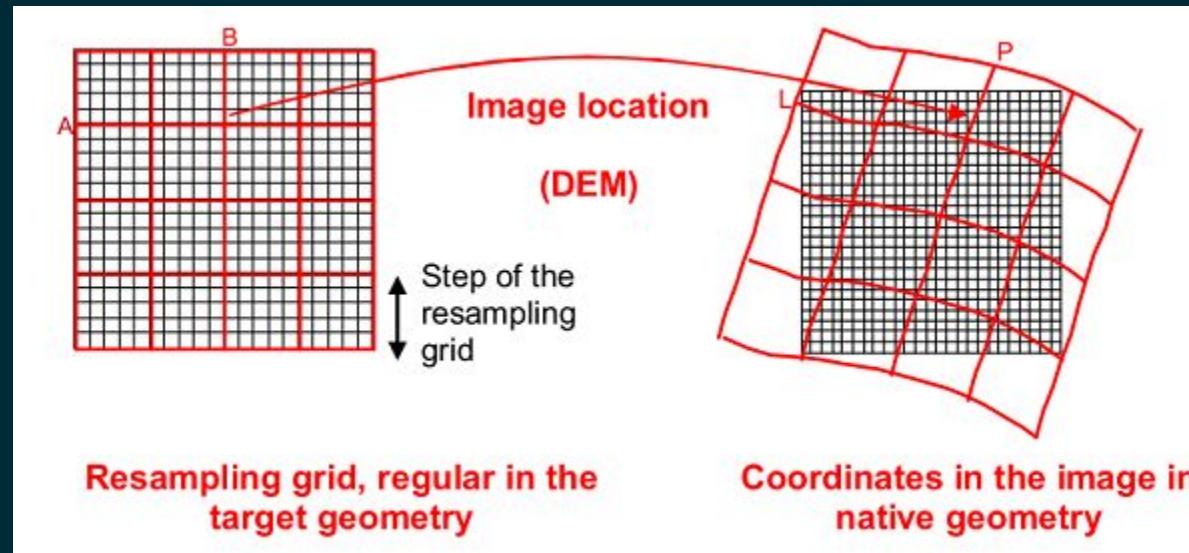
Pyspectral: Corrections to channels



Pyspectral: Corrections to channels



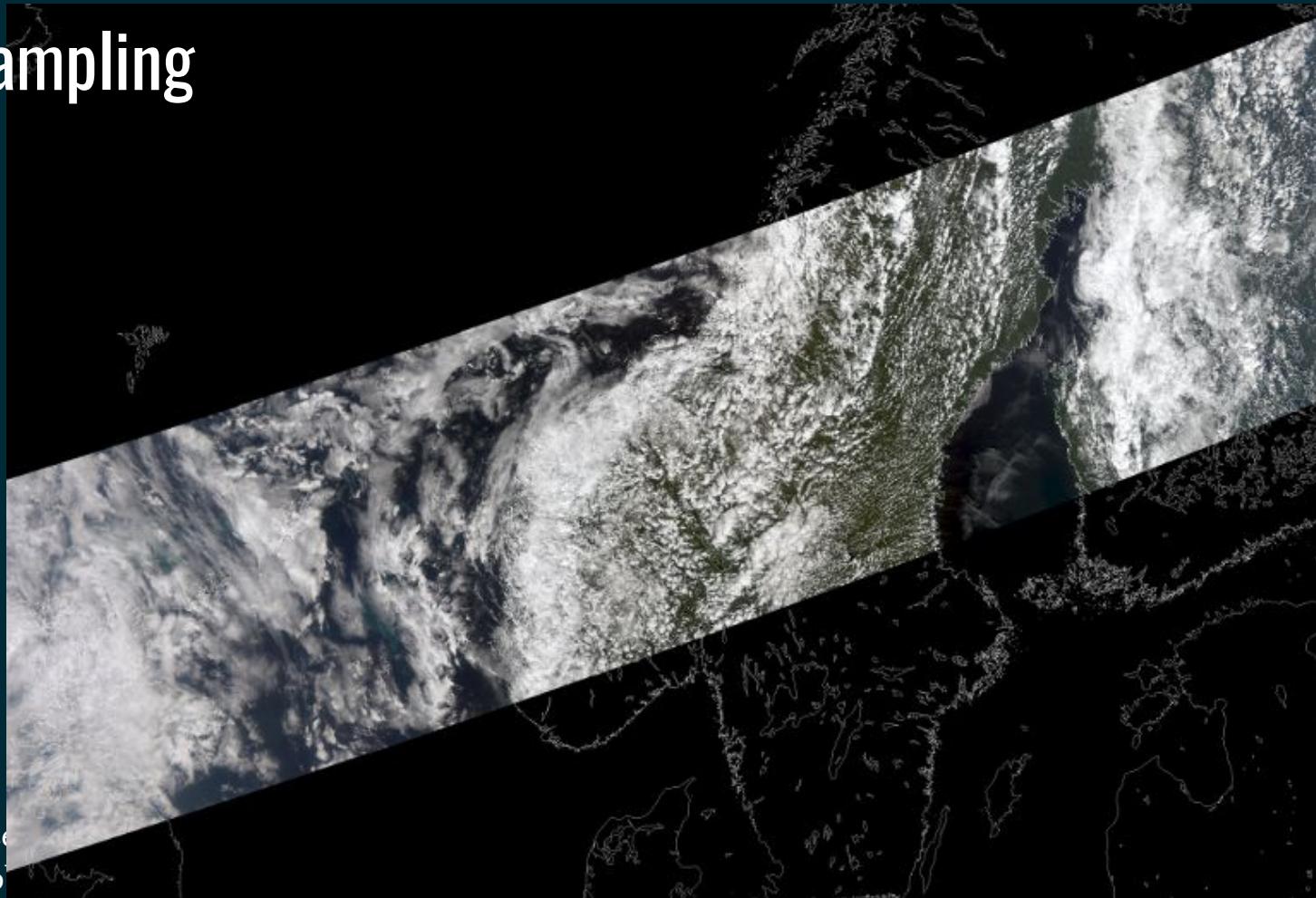
Resampling



Resampling

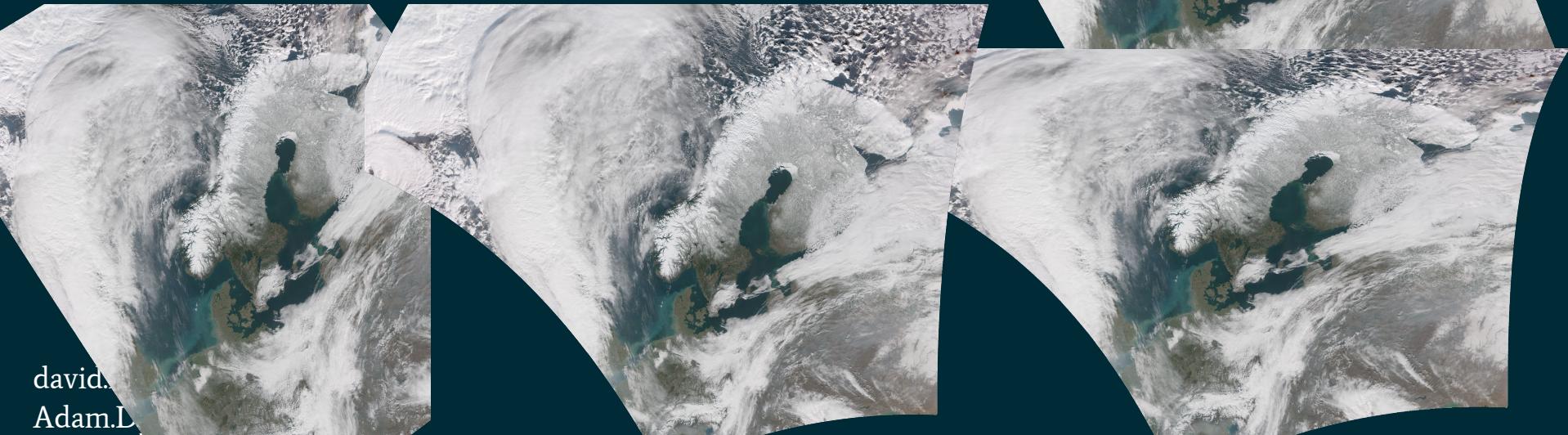


Resampling

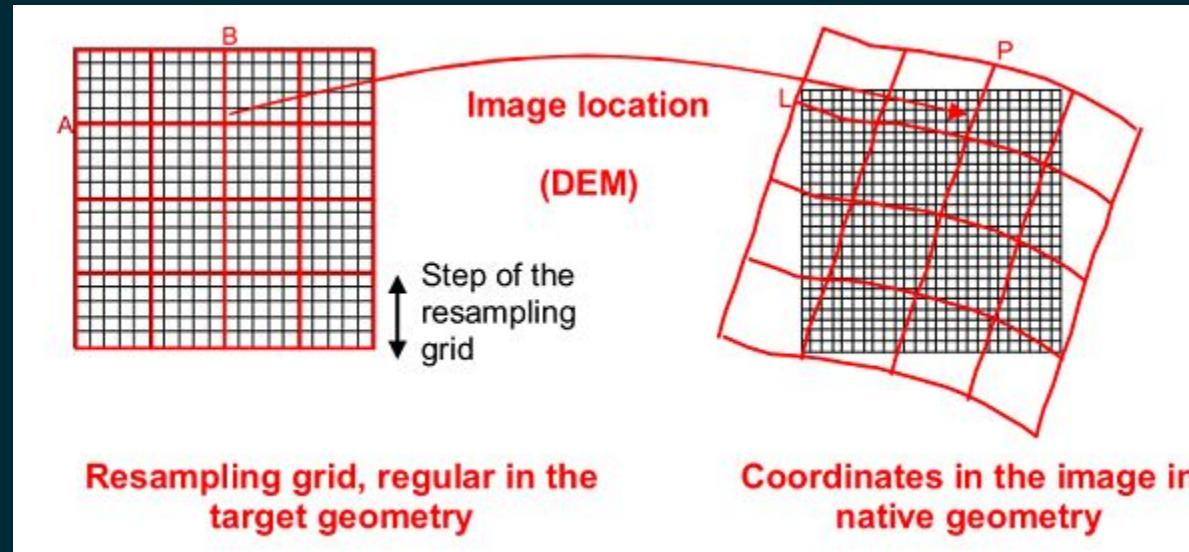


Pyresample for resampling

- Unprojected & Grid
- Proj.4, more than 130 different projections

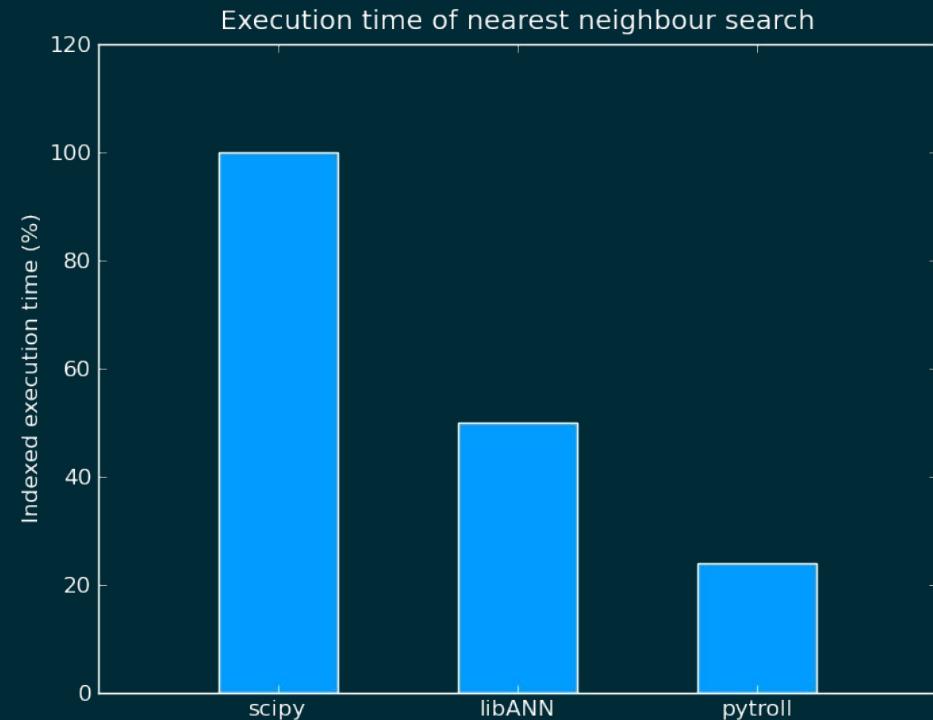


Pyresample for resampling



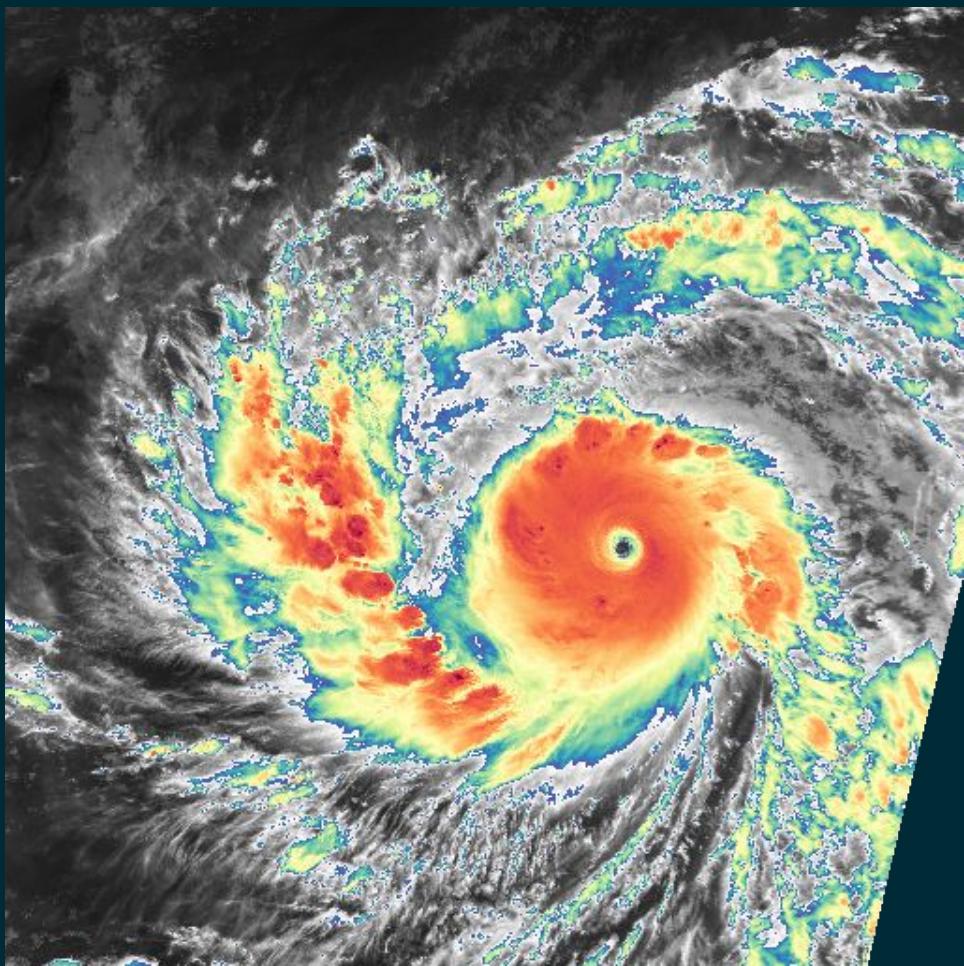
Pyresample for resampling

- Nearest-Neighbour (KDTree)
- NN -> Bilinear
- EWA
- (Gradient search)



Trollimage

- Image object
- Some Image enhancements
- Colorization



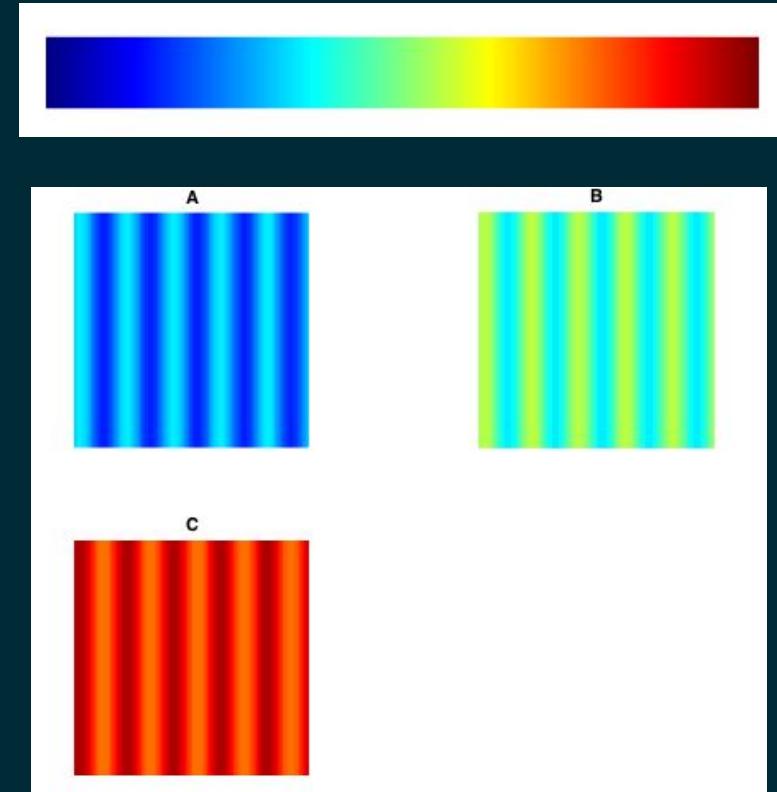
About colormaps

David Borland, Russell M. Taylor II, 2007

Rainbow Color Map (Still) Considered
Harmful

Brewer, et al., 2009.

ColorBrewer 2.0:
Color Advice for Cartography



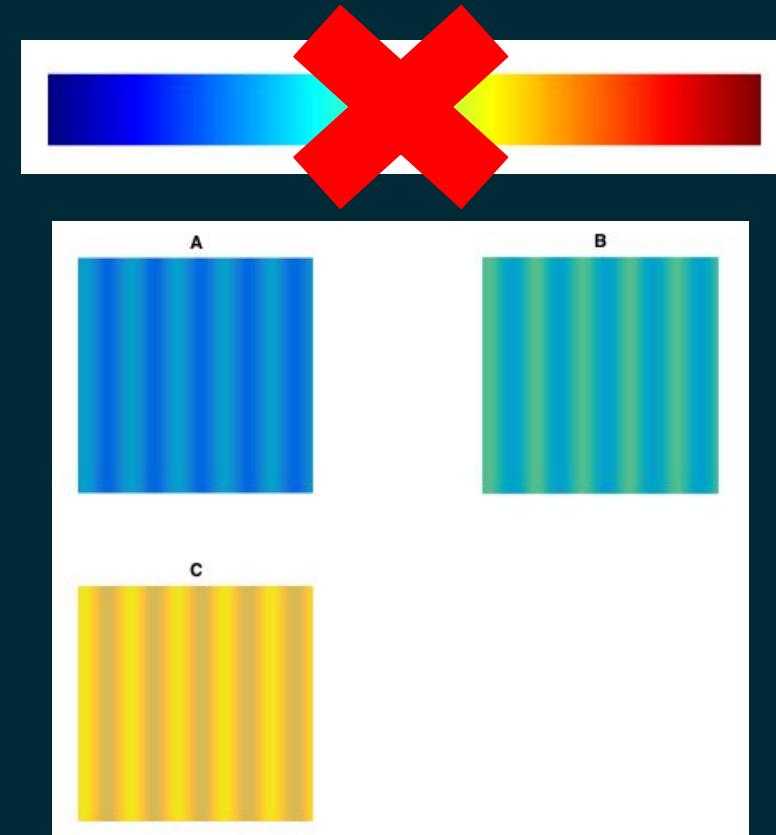
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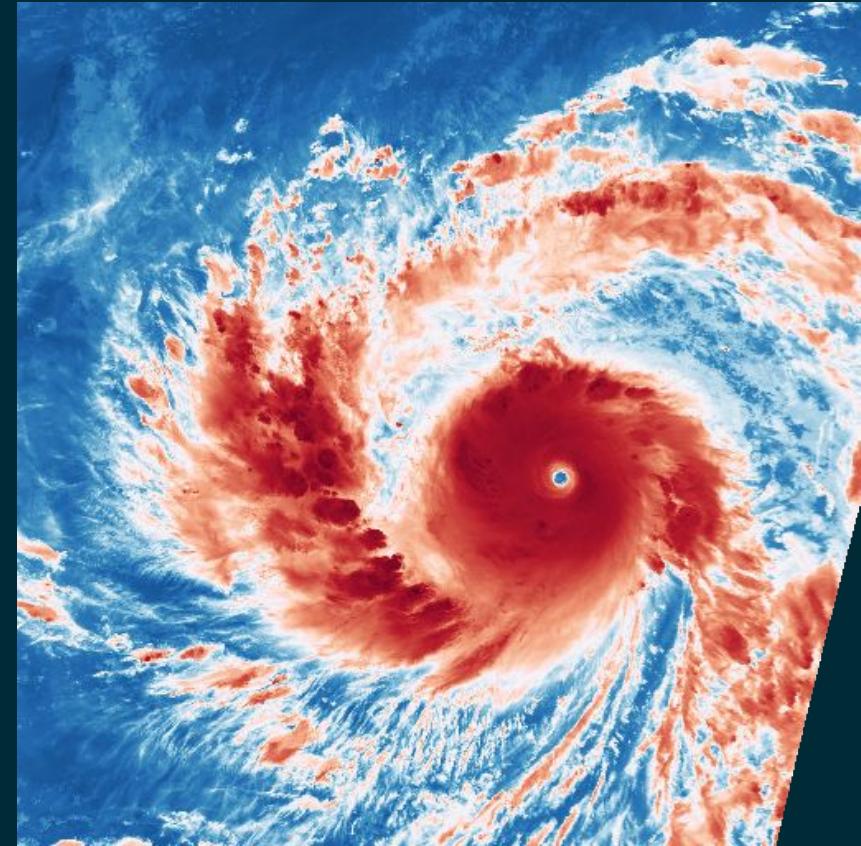
Trollimage

David Borland, Russell M. Taylor II, 2007

**Rainbow Color Map (Still) Considered
Harmful**

Brewer, et al., 2009.

**ColorBrewer 2.0:
Color Advice for Cartography**



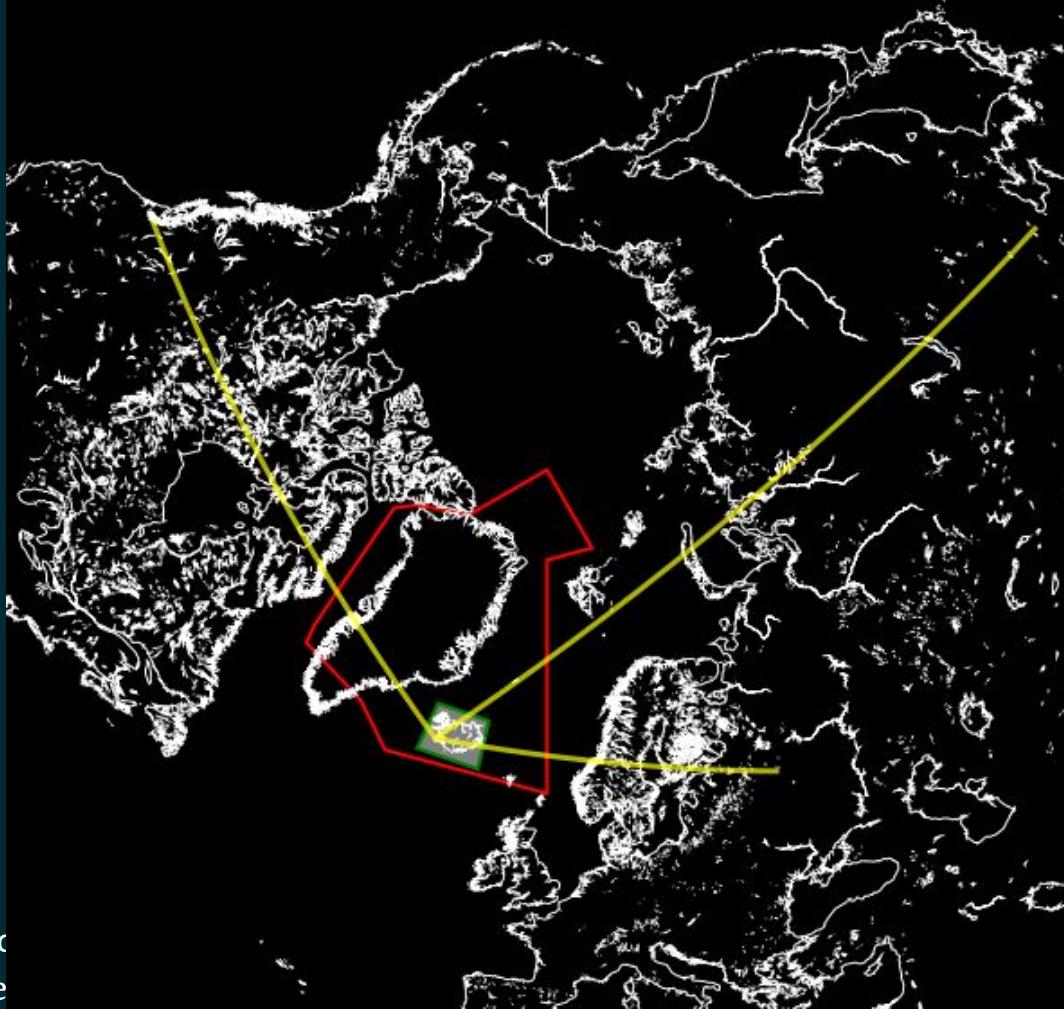
Pycoast



Pycoast



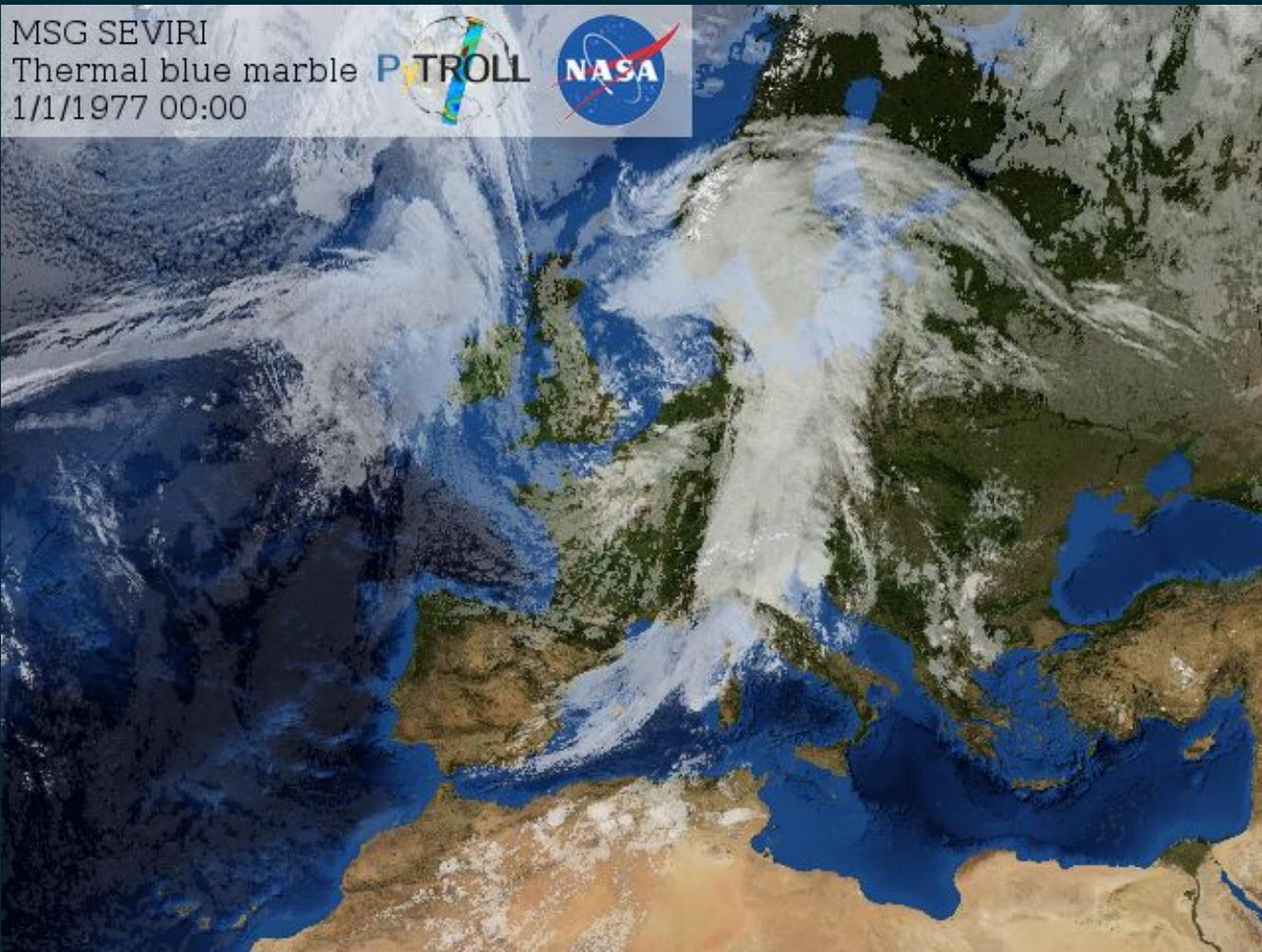
Pycoast



david.hoese@ssec.wisc.edu

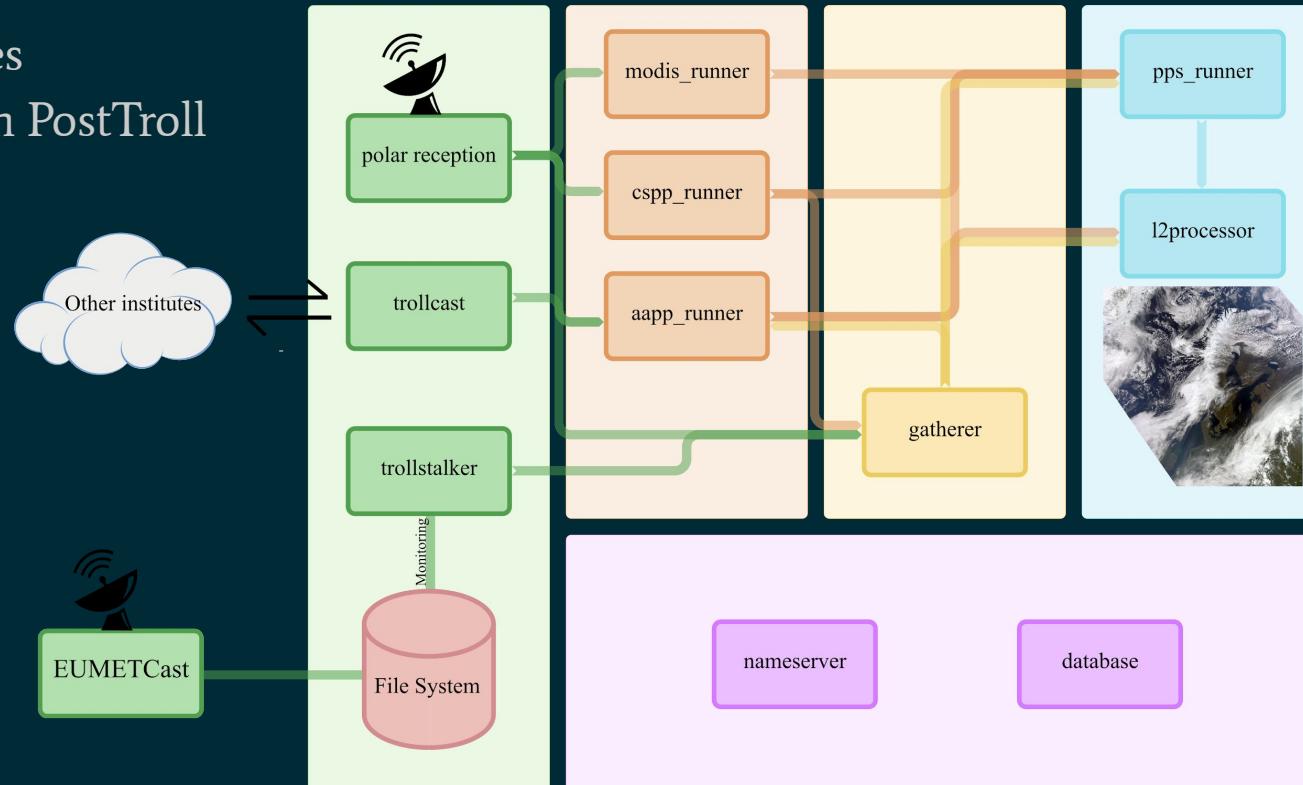
Adam.Dybbroe@smhi.se

Pydecorate



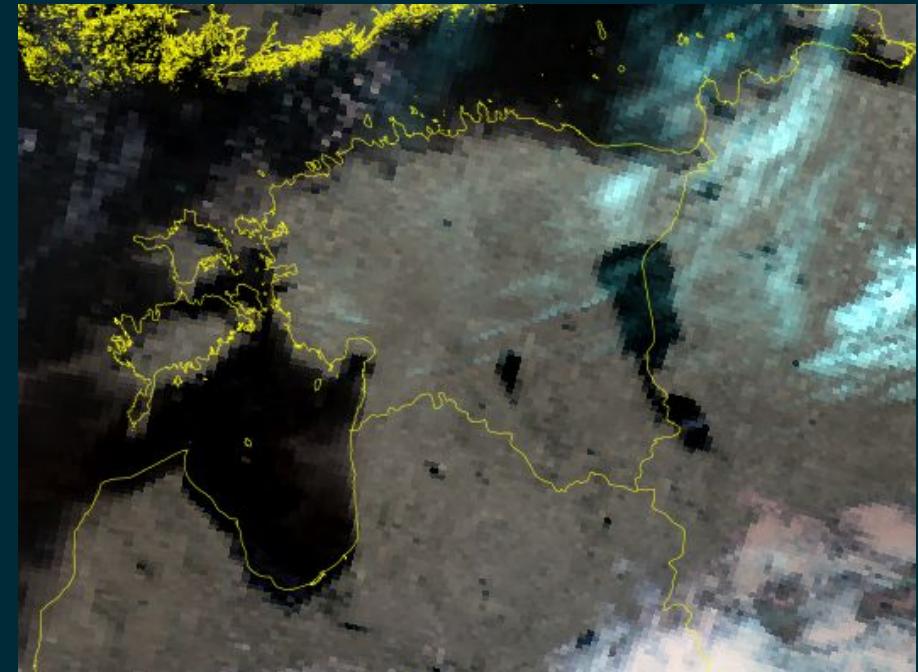
Trollflow for batch processing

- Independent modules
- Communication with PostTroll



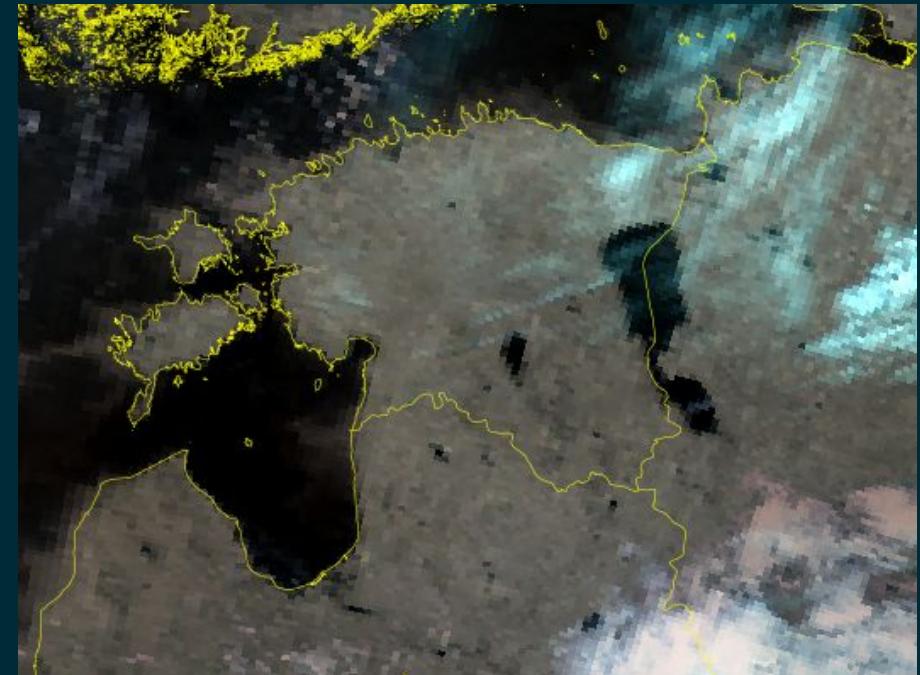
PyGAC

- Off line processing of NOAA AVHRR Global Area Coverage (GAC) data
- Apply post navigation



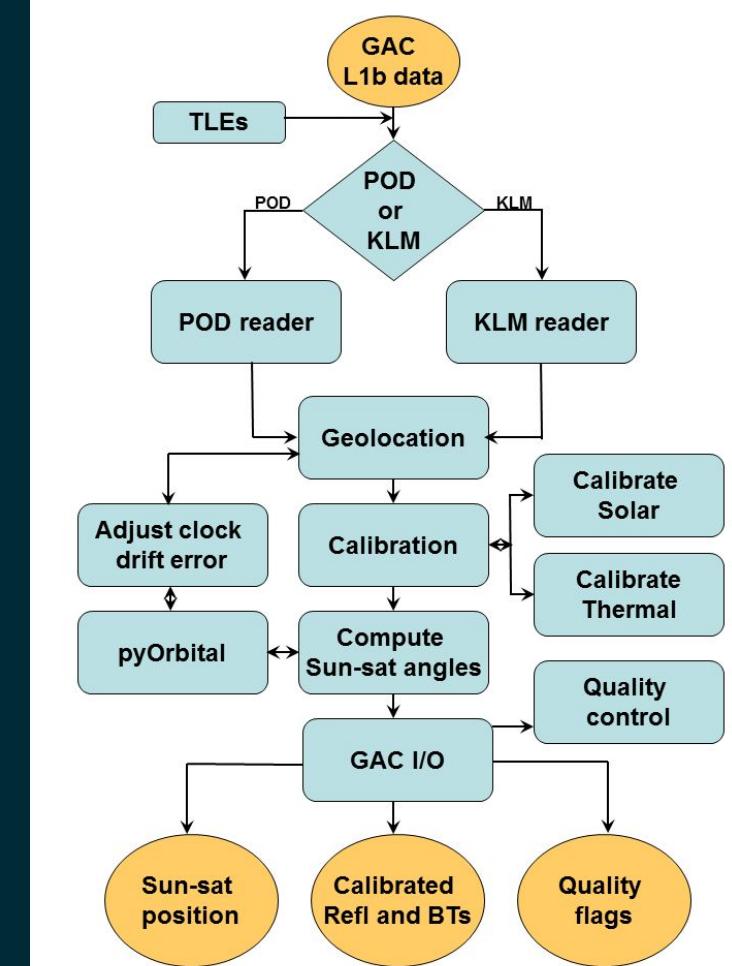
PyGAC

- Off line processing of NOAA AVHRR Global Area Coverage (GAC) data
- Apply post navigation
- Apply state of the art calibration



PyGAC

Devasthale, A., M. Raspaud, C. Schlundt, T. Hanschmann, S. Finkensieper, A. Dybbroe, S. Hörnquist, N. Håkansson, M. Stengel and K-G. Karlsson. **PyGAC: An open-source, community-driven Python interface to preprocess nearly 40-year AVHRR Global Area Coverage (GAC) data record**, GSICS Quarterly Newsletter, Vol. 11, No. 2 (Sept. 2017): 3-5. DOI: 10.7289/V5R78CFR.



Development

Background

- Small teams
- Same needs
- Same tools

Principles

- Modularity
- Reusability
- Maintainability
- KISS

Ease of use

Pytroll doesn't support [some feature/format] !

DIY

- Tutorials
- Look at the code
- Talk to us for help (slack, mailing list)

Sharing your work

- Talk to us
- Github is great

The screenshot shows a GitHub repository page for the project `pytroll / satpy`. The repository has 1,490 commits, 2 branches, 0 releases, and 9 contributors. The `develop` branch is selected. A recent commit by `davidh-ssec` is highlighted, adding an OMPS so2_trm dataset. The page lists various commits across files like `doc`, `etc`, `satpy`, `utils`, and `setup.cfg`, along with configuration files for Travis CI and bumpversion.

File	Description	Time Ago
<code>doc</code>	Document the <code>__init__.py</code> files also	4 months ago
<code>etc</code>	Add OMPS so2_trm dataset	an hour ago
<code>satpy</code>	Rename "scaling_factors" to "factor" in reader configuration	18 hours ago
<code>utils</code>	Script to generate external calibration files for AVHRR instruments	a year ago
<code>.bumpversion.cfg</code>	Rename to satpy	4 months ago
<code>.gitchangelog.rc</code>	Add config files for release utilities	6 months ago
<code>.gitignore</code>	Add <code>.gitignore</code> with python and C patterns	2 months ago
<code>.travis.yml</code>	Post travis notifications to <code>#satpy</code>	4 months ago
<code>LICENSE.txt</code>	Fix rpm building	a year ago
<code>MANIFEST.in</code>	Fix the manifest file to include the config files.	7 months ago
<code>README</code>	Add symlink from <code>README.rst</code> to <code>README.</code>	4 years ago
<code>README.rst</code>	Rename to satpy	4 months ago
<code>changelog.rst</code>	Rename to satpy	4 months ago
<code>setup.cfg</code>	Fix rpm building	a year ago

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Pytroll is FOSS

Release early, release often

Packages available on

- PyPI
- Github

> pip install satpy

david.hoese@ssec.wisc.edu
Adam.Dybbroe@smhi.se

This screenshot shows the GitHub repository page for `pytroll / satpy`. The repository has 1,490 commits, 2 branches, 0 releases, and 9 contributors. The `feature-yaml` branch is currently selected. A list of recent commits is displayed, with the latest commit being `davidh-ssec Add OMPS so2_trm dataset` at 811f023 an hour ago.

Commit	Message	Time Ago
<code>doc</code>	Document the <code>__init__.py</code> files also	4 months ago
<code>etc</code>	Add OMPS so2_trm dataset	an hour ago
<code>satpy</code>	Rename "scaling_factors" to "factor" in reader configuration	18 hours ago
<code>utils</code>	Script to generate external calibration files for AVHRR instruments	a year ago
<code>.bumpversion.cfg</code>	Rename to satpy	4 months ago
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<code>changelog.rst</code>	Rename to satpy	4 months ago
<code>setup.cfg</code>	Fix rpm building	a year ago

Pytroll is tested

Unit testing

- Travis-CI
- Appveyor

System testing

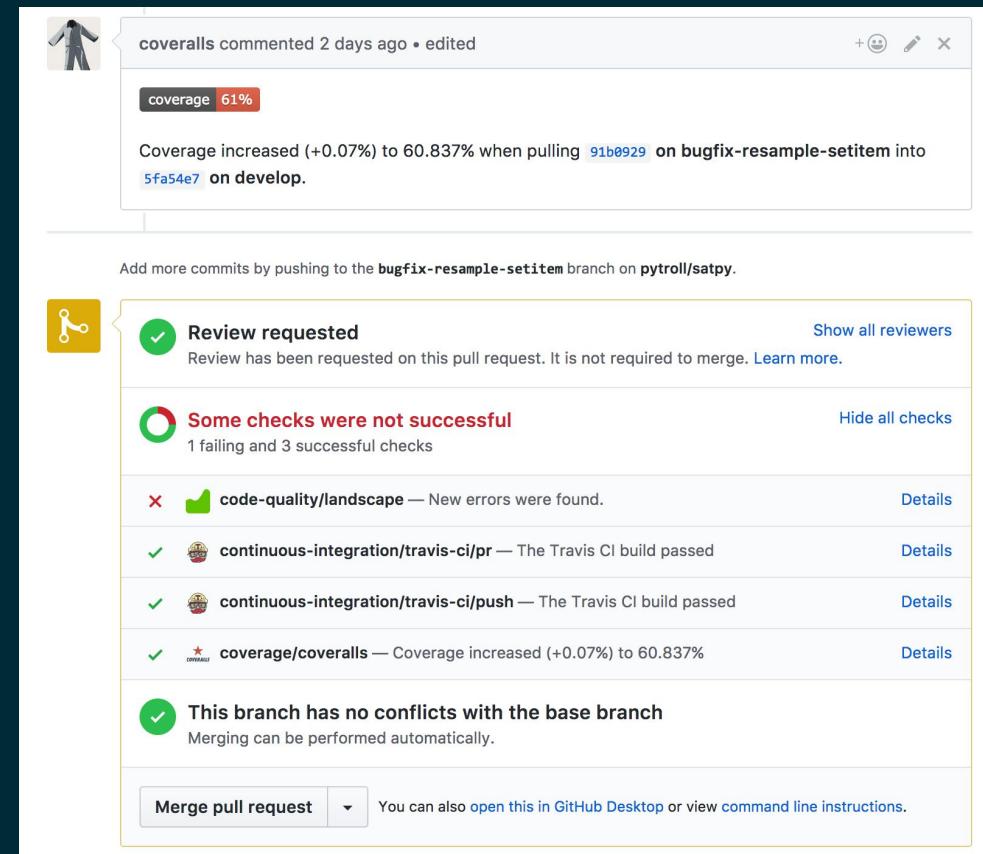
- Jenkins

Code style and quality assurance

- Landscape
- Coveralls

david.hoese@ssec.wisc.edu

Adam.Dybbroe@smhi.se



A screenshot of a GitHub pull request interface. At the top, a message from 'coveralls' indicates coverage increased to 60.837% when pulling commit [91b0929](#) on branch `bugfix-resample-setitem` into commit [5fa54e7](#) on branch `develop`. Below this, a note says to add more commits by pushing to the `bugfix-resample-setitem` branch on `pytroll/satpy`.

The main area shows several status items:

- Review requested** (Green checkmark icon): Review has been requested on this pull request. It is not required to merge. [Learn more.](#)
- Some checks were not successful** (Yellow circle icon): 1 failing and 3 successful checks. Details:
 - code-quality/landscape** — New errors were found. [Details](#)
 - continuous-integration/travis-ci/pr** — The Travis CI build passed. [Details](#)
 - continuous-integration/travis-ci/push** — The Travis CI build passed. [Details](#)
- coverage/coveralls** — Coverage increased (+0.07%) to 60.837%. [Details](#)
- This branch has no conflicts with the base branch** (Green checkmark icon): Merging can be performed automatically.

At the bottom, there is a 'Merge pull request' button with a dropdown arrow, and a note saying you can also open this in GitHub Desktop or view command line instructions.

International collaboration

Pytroll Workshops

- SMHI
- DMI
- FMI
- SSEC
- DWD
- MeteoSwiss
- KNMI
- Met.No
- ...



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Adam.Dybbroe@smhi.se

Posters & Talks

- (1.13 - Thursday 15:00) *A general approach to filter the Rayleigh signal from shortwave satellite channels*, Adam Dybbroe
- (7.17, #527) *NOAA series satellites clock drift error estimation and correction in SCOPE-CM AVHRR FCDR Project*, Karl-Göran Karlsson
- (1.14, #151) *Polar2Grid - Reprojecting Satellite Data Made Easy*, David Hoes

www.pytroll.org

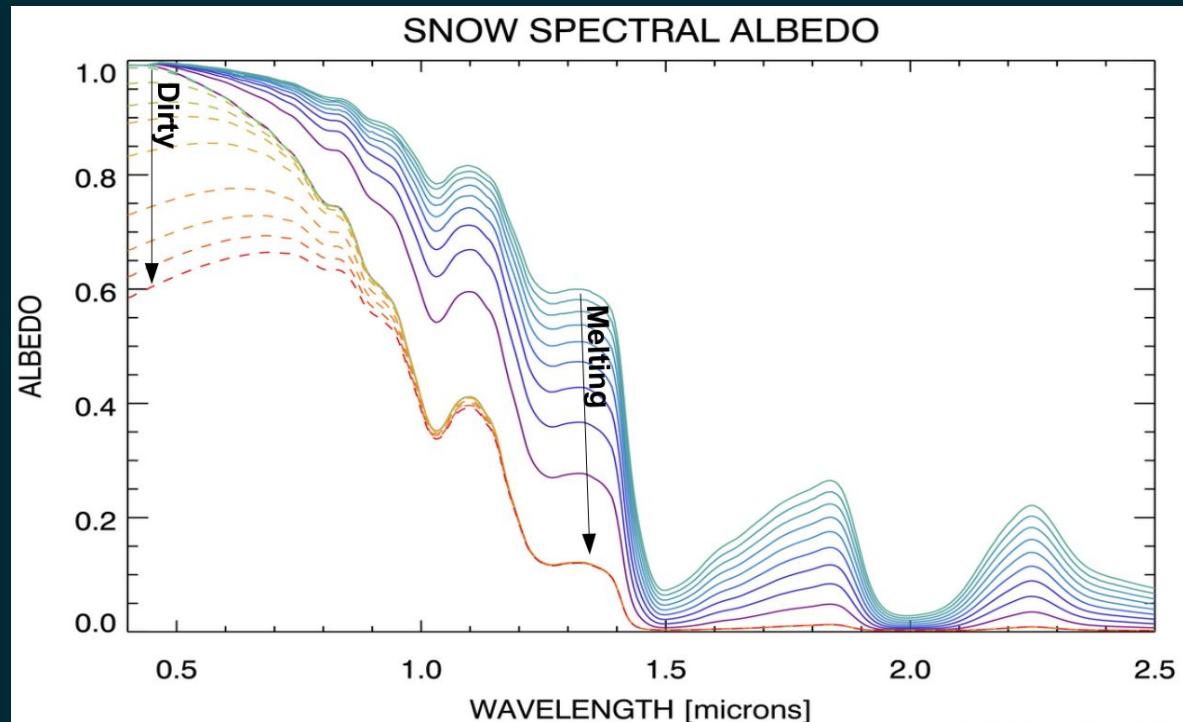
[Pytroll@Slack](#)

[Pytroll@Github](#)

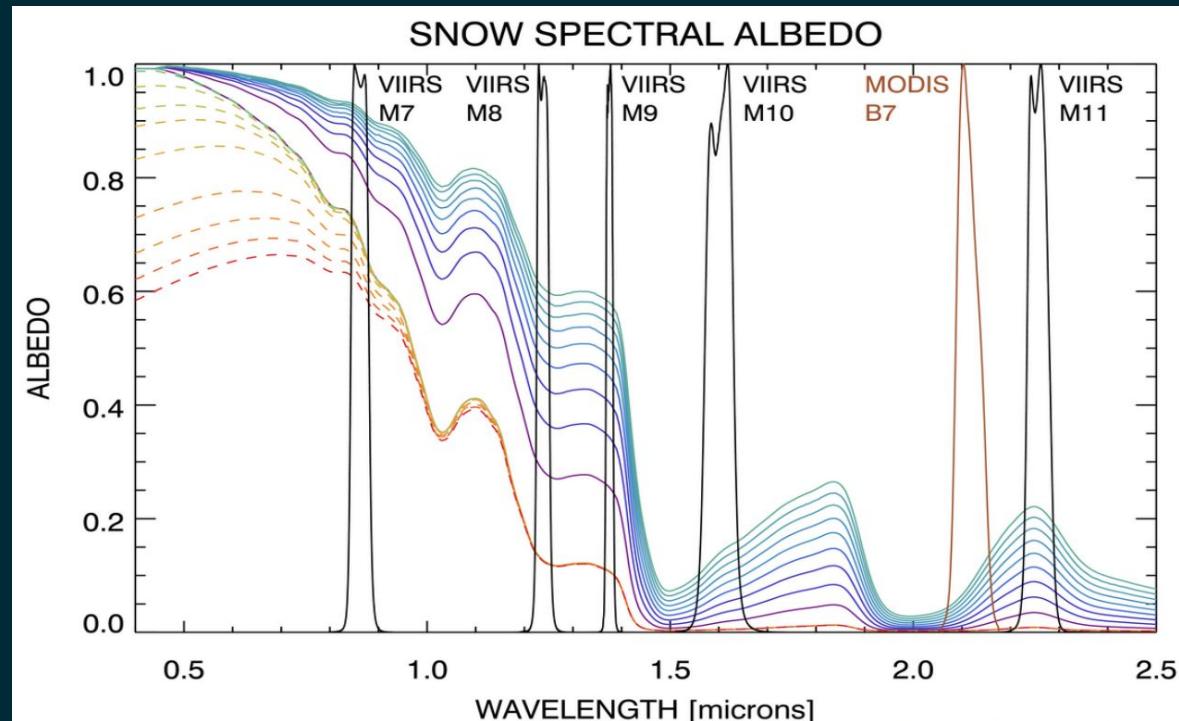
[pytroll@googlegroups.com](#)

Grazie

Example: Snow Age Composite



Example: Snow Age Composite



Example: Snow Age Composite

R: M7 - M9

G: M8+M9

B: M9+M11

