Ocean & Sea Ice SAF

Tutorial for Sea Ice Products

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v 0.1			Draft version
v 0.2	07.02.2011	Minor	Updated logo
v 0.3	15.06.2011	TL	Added LRSID Python example

CONTENTS

1. Introduction

1.1 Overview

The Ocean & Sea Ice Satellite Application Facility (OSI SAF) is producing on an operational basis a range of air-sea interface products, namely: Sea Ice characteristics, Wind, Sea Surface Temperatures (SST) and radiative fluxes, Surface Solar Irradiance (SSI) and Downward Longwave Irradiance (DLI).

Sea ice products are produced at the OSI SAF High Latitude processing facility (HL centre), operated jointly by the Norwegian and Danish Meteorological Institutes.

This document is dedicated to the use of the sea ice products and gives examples of how the different OSI SAF sea ice products can be imported in various tools. Since the sea ice products are available on different formats, this document tries to cover also all the formats. The different tools described in this document is limited to the tools used by the development team, as well as feedback we get from users.

This document is an annex to the OSI SAF Sea Ice Product User Manual. More information about the products can be found in that document, available through our web portal:

http://osisaf.met.no/docs

Section 2 is dedicated to NetCDF files, section 3 to HDF5 files and section 4 to GRIB files.

1.2 Acknowledgement

This document has been put together with contributions from the following persons:
- Sebastian P. Luque (Fisheries and Oceans Canada)
- Inga Koszalka (University of Oslo, Norway)
- Johannes Roehrs (University of Hamburg, Germany)

1.3 Glossary

AVHRR	Advanced Very High Resolution Radiometer
DMI	Danish Meteorological Institute
GRIB	GRIdded Binary form
HDF	Hierarchical Data format
HL	High Latitudes
met.no	Norwegian Meteorological Institute
SAF	Satellite Application Facility

1.4 Reference Documents

All the Product User Manuals are available from http://osisaf.met.no/docs
[RD.1] OSI SAF Sea Ice Product User Manual
[RD.2] OSI SAF Low Resolution Sea Ice Drift Product User Manual

2. Use of NetCDF files

This chapter describes how the OSI SAF Sea Ice products on NetCDF format can be imported in different tools. The OSI SAF Sea Ice NetCDF format for ice concentration, edge and type is described in [RD-1], and [RD-2].

2.1 Sea Ice Concentration in GMT

This example of importing Sea Ice Concentration files in NetCDF format in the GMT tool (the Generic Mapping Tool, available through http://gmt.soest.hawaii.edu/) was provided by Sebastian P. Luque (Fisheries and Oceans Canada).

The code reads the ice concentration field as well as latitude and longitude fields. First the whole field is plotted in `ice_full.ps`. Then the near neighbor algorithm with an octant search was used to produce the grid in lon/lat and extract an sub area around the Hudson Bay area (50N-65N, 95W-76W), plotted in `ice.ps`.

2.1.1 Code

```
# Set enough output precision
gmtset D_FORMAT=%.10g

# Create a simple color map
makecpt -T0/100/1 -Z > /tmp/ice.cpt

# Full grid, in cartesian coordinates (note y-axis values need to
# be reversed)
grdmath "ice_conc_nh_200901051200.nc?ice_concentration" FLIPUD \
    = /tmp/ice_new.grd
grdimage /tmp/ice_new.grd -C/tmp/ice.cpt -JX10c -B100 > /tmp/ice_full.ps

# Longitude and latitude are stored as separate variables in NetCDF file
grd2xyz "ice_conc_nh_200901051200.nc?lon" | cut -f3 > /tmp/lon
grd2xyz "ice_conc_nh_200901051200.nc?lat" | cut -f3 > /tmp/lat
# Set any ice concentration values outside 0-100 to NaN for plotting
grd2xyz "ice_conc_nh_200901051200.nc?ice_concentration" | awk '{
        if ($3 > 100 || $3 < 0) {
            print "NaN"
        } else print $3}' > /tmp/ice
# Grid the Hudson Bay area with 10 km resolution within a region slightly
# larger than desired output, using octant search. Plot using an Albers
# Equal Area projection and B-spline interpolation.
paste /tmp/lon /tmp/lat /tmp/ice | \
    nearneighbor -G/tmp/ice.grd -R-96/-75/49/66 -I10k= -N8/1 -S10K -V
grdimage /tmp/ice.grd -C/tmp/ice.cpt -R-95/-76/50/65 \
    -JB-85.5/50/65/70/10c -K -V -Sb > /tmp/ice.ps
pscoast -R -J -B5/2.5 -Wfaint -A0/0/1 -G235/235/210 -O >> /tmp/ice.ps
```

2.1.2 Example result

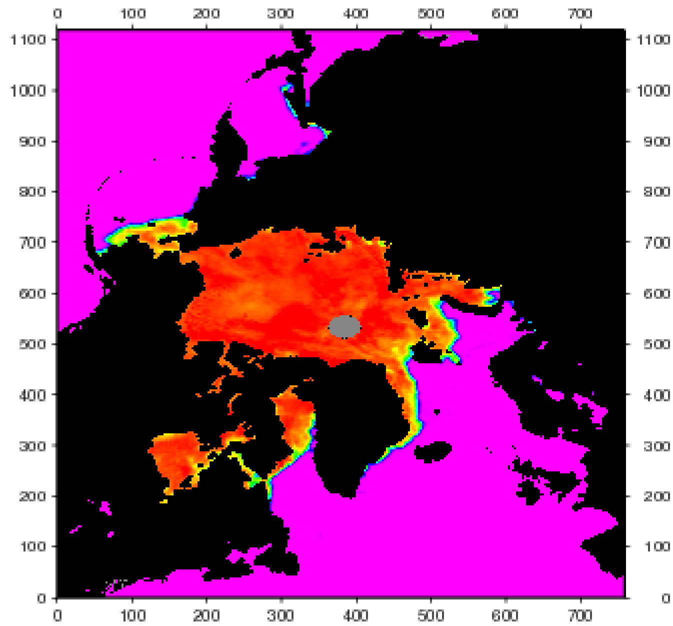

Figure 1: ice_full.ps

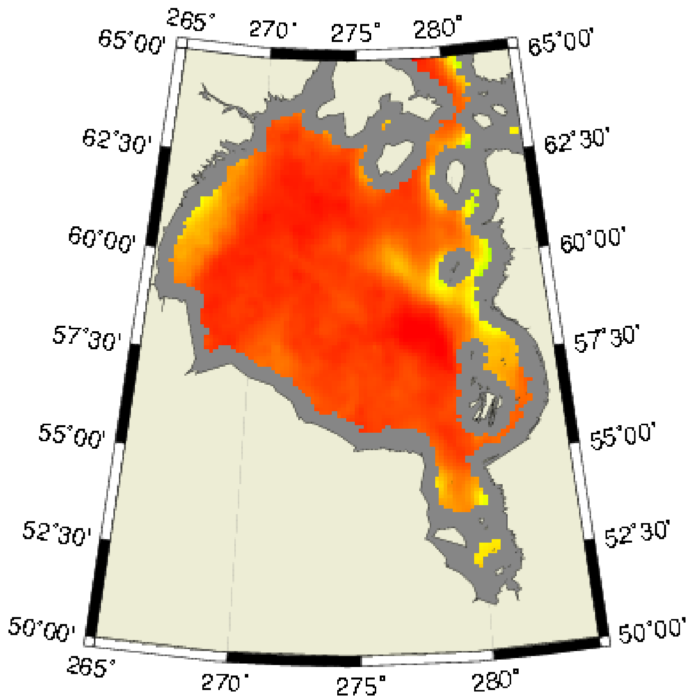

Figure 2: ice.ps

2.2 Low Resolution Sea Ice Drift in Python

This example is contributed by Johannes Roehrs (at that time University of Hamburg, now met.no) and aims at displaying the low-resolution sea ice drift product (OSI-405, netCDF) using Python 2.6 (and package matplotlib for visualization).

2.2.1 Code

```
import scipy as sp # scientific Python
import numpy.ma as ma # handling of masked arrays
from netCDF4 import Dataset # reading of netCDF files
from matplotlib.pyplot import title,figure,show,savefig,colorbar
from mpl_toolkits.basemap import Basemap # a map projection tool
from matplotlib import cm                         # colormap

#The function Dataset reads the netCDF file and stores it as a file object:
filename='ice_drift_nh_polstere-625_amsr-aqua_200703261200-200703281200.nc'
file=Dataset(filename, 'r', format='NETCDF3')

#The displacement vectors are stored as origin and destination points of
# each detected displacement and are selected from the file object:
lon0=sp.array(file.variables['lon'], dtype=float)
lat0=sp.array(file.variables['lat'], dtype=float)
fv = file.variables['lon1']._FillValue
lon1=ma.array(file.variables['lon1'][0,:],dtype=float,fill_value=fv)
lat1=ma.array(file.variables['lat1'][0,:],dtype=float,fill_value=fv)

#Note that the destination points lon1 and lat1 are provided as masked
# arrays, taking missing data into account. The missing data masks need to
# be set:

lon1.mask=lon1.data==lon1.fill_value
lat1.mask=lat1.data==lat1.fill_value

#The calculation of the displacement vectors cannot be done in the lat/lon
# domain but must be done in cartesian koordinates. Therefore, a coordinate
# system must be defined. The same map projection is choosed as in which
# the gridded AMSR-E data is available. To define such a map
# projection, the matplotlib tool Basemap is used:

Dmap = Basemap(projection='npstere',lon_0=315.,boundinglat=69,\
               lat_ts=70, resolution='l',rsphere=(6378273.,6356889.))


#The origin and destination points of each displacement vector can now
# easily be computed in the native map projection grid. Difference yields
# the displacement vectors:

x0,y0=Dmap(lon0,lat0)
x1,y1=Dmap(lon1,lat1)
u=x1-x0
v=y1-y0

# The length of the displacement vectors can be computed
l_km=pow((pow(u,2) + pow(v,2)),0.5) / 1000
x_l=x0 - 0.5*62.5*1000
y_l=y0 + 0.5*62.5*1000
l_max = 50
l_label = 'Displacement after 48 hours'

#Each displacement vector can be plotted using quiver, requiring its origin
# x0 and y0.
Only records, whose mask is not flaged as missing value shall be
```

```
# plotted. We can also add the Length as color field.

Dmap.fillcontinents(color='grey')
col=Dmap.pcolor(x_l,y_l,l_km,vmin=0,vmax=l_max,cmap=cm.jet)
colorbar(col, format='%2.0f', orientation='horizontal', shrink=0.5,
pad=0.05).set_label(l_label)
Dmap.quiver(x0[~u.mask],y0[~u.mask],u[~u.mask],v[~u.mask])
title('OSISAF ice drift, 2007-03-27')
savefig('lrsid.png', bbox_inches='tight')

show()
```

2.2.2 Example result

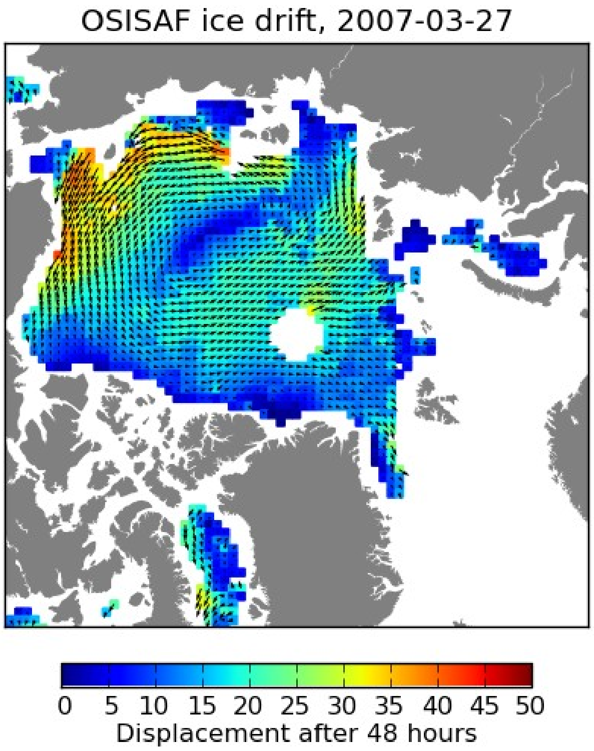

Figure 3: lrsid.png

3. Use of HDF5 files

This chapter describes how the OSI SAF Sea Ice products on HDF5 format can be imported in different tools. The OSI SAF Sea Ice HDF5 format for ice concentration, edge and type is described in [RD-1]. More details about the The OSI SAF HDF5 format is described in Godøy (2005).

3.1 Use of Sea Ice Edge in Matlab

This example of importing the Sea Ice Edge files in HDF5 format in the Matlab® tool (http://www.mathworks.com/products/matlab/) was provided by Inga Kozalka (Univeristy of Oslo, Norway). This example makes use of a HDF5 file with the latitude and longitude fields of the sea ice grid. These files are available on request from osisaf-manager@met.no.

3.1.1 Code

```
%-----------Example how to handle SAF ICE data in matlab-----------------
%  1) Interpolates OSIHDF5 ice edge data (11/Oct/2008) on specified
%     positions (a track in the Arctic Ocean).
%     Uses nearest neighbor method with the value of the nearest location
%  2) Draws a map of ice edge field with the track superimposed
%  3) Plots time series of ice edge data on the track
%
%  DATA:
%  "Ice data"  -> "ice_edge_nh_200710011200.hdf"
%  "Grid data" -> "grid.hdf5"
%
%  Example track (synthetic):
%  lon=[-10:.2:18.8];
%  lat=[70:.2:90,90:-.2:81.4];
%
% ATTENTION (FOR DRAWING A MAP)
% You need "m_map" matlab toolbox (http://www.eos.ubc.ca/~rich/map.html)
%
% Inga Koszalka / UiO, Oslo, Norway / Sep 15, 2008
%
% inga.koszalka@geo.uio.no
%
clear all;warning off;
%Ice and grid fields:
filename=['ice_edge_nh_200710011200.hdf'];
gridname=['grid.hdf5'];
%
clear dset;
dset=hdf5read(filename,'/Data/data[00]');
[m,n]=size(dset);
ice_data=reshape(dset,n,m)';
%
clear dset data*
dset=hdf5read(gridname,'/Data/data[00]');
[m,n]=size(dset);
lat_ice=reshape(dset,n,m)';clear dset;
%
dset=hdf5read(gridname,'/Data/data[01]');
[m,n]=size(dset);
lon_ice=reshape(dset,n,m)';
%
%  Example track:
lon_track=[-10:.2:18.8];
```

```
lat_track=[70:.2:90,90:-.2:81.4];
% Restrict the area of search to a smaller ice-data patch around the track
% to speed up the process
dlat=0.1;dlon=0.1;
lonmin=min(lon_track)-0.1;lonmax=max(lon_track)+0.1;latmin=min(lat_track)-
0.1;latmax=max(lat_track)+0.1;
ff=find(lon_ice>lonmin&lon_ice<lonmax&lat_ice>latmin&lat_ice<latmax);
lon_patch=lon_ice(ff);
lat_patch=lat_ice(ff);
%
ice_data_patch=ice_data(ff);
% For the each position from the track sequence, search for the closest
% position of the restricted ice field
%
for kk=1:length(lon_track)
%take the kk-record of the track:
x_o=lon_track(kk);y_o=lat_track(kk);
% Calculate the distance between each position of the ice-data pack and the
% kk-record of the track
dis_x=lon_patch-x_o;dis_y=lat_patch-y_o;
disxy=sqrt(dis_x.*dis_x + dis_y.*dis_y);
% Choose the closest point in the patch. If the data for some reason is
% missing, assign an error flag 999:
[sd,ind]=sort(disxy,'ascend');
ice_track(kk)=ice_data_patch(ind(1));
end
%---------------------------------------------------%
%-------------PLOTTING------------------------------%
%---------------------------------------------------%
% Plot the time series of the ice data on the track
figure;
plot(ice_track,'.','markersize',16);hold on;grid on;
title(upper('1=ice free, 2=open ice, 3=closed ice, 0=no data (NORTH
POLE)'));
xlabel('TIME (YOUR UNITS)');ylabel('ICE DATA');
name='ice_on_track';
print('-djpeg','-r200',name);
% Plot the ice field with the track juxtaposed on it.
%!!! You need "m_map" matlab toolbox to make a map!!!!%
%!!!(http://www.eos.ubc.ca/~rich/map.html)!!
%!!! You might want to play with the colors to get all the shading!!!
figure;
m_proj('stereographic','lat',90,'long',0,'radius',25);
m_coast('patch',[0.5 0.5 0.5],'edgecolor',[0.5 0.5 0.5]);
m_grid('linestyle','none','linewidth',0.01);hold on;
m_contourf(lon_ice,lat_ice,ice_data,3);colorbar;%shading flat;
m_line(lon_track,lat_track,'color','y','linewidth',2);hold on;
%starting point%
name='ice_track_map';
print('-depsc2','-r600','-painters',name);
% Only *.eps figures seem to get colors correctly; you might need to
% convert%
```

3.1.2 Example results

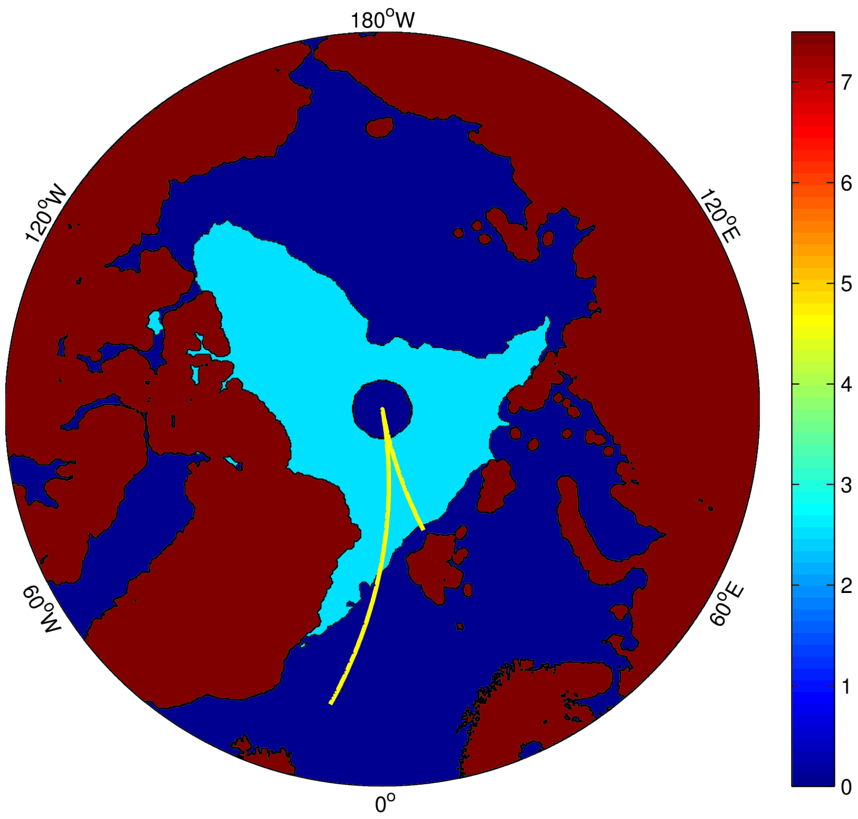

Figure 4: ice_track_map.eps

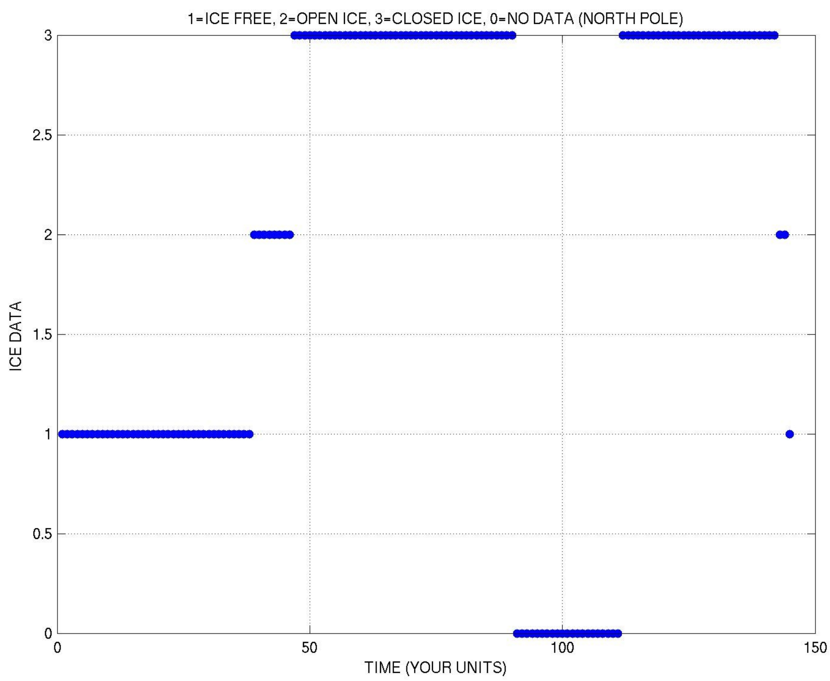

Figure 5: ice_on_track.jpg

4. Use of GRIB files

This chapter describes how the OSI SAF Sea Ice products on GRIB format can be imported in different tools. The OSI SAF Sea Ice GRIB format for ice concentration, edge and type is described in [RD-1].

4.1 Windows viewer for sea ice conc, edge and type

A Windows tool called “Sea-Ice and SST viewer” has been implemented by David Taylor (United Kingdom). This tool can display Sea-Ice and SST GRIB files from the OSI SAF with some additional functionality.

The tool is available at http://www.satsignal.net/.

5. References

Godøy, Ø. (2005): Description of the osihdf5 format. Norwegian Meteorological Institute. 8 pages. Available at [http://osisaf.met.no/docs].

Andersen, S., L.A. Breivik, S. Eastwood, Ø. Godøy, M. Lind, M. Porcires and H. Schyberg (2007): OSI SAF Sea Ice Product User Manual. 35 pages. Available at [http://osisaf.met.no/docs].