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ATLAS OF SEA ICE DRIFT IN THE ANTARCTIC

1. Introduction

To obtain a comprehensive view of sea ice motion around Antarctica, and to take advantage of the work already done in developing algorithms for ice drift using satellite data as well as the collection of measurement data from drifting buoys, the **Ice Drift Atlas** was planned. The Atlas is designed to achieve a widespread combination of georeferenced data on the Antarctic sea ice drift, allowing analysis and mapping of sea ice effects over long periods. Its objective is to provide consistent datasets for different temporal and regional scales and statistical examinations of 20 years of ice motion data.

2. Ice Motion Datasets:

Drift data from two complementary measurement principles are used in combination:

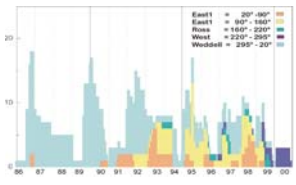

Figure 1: *Numbers of available buoys per month,divided in regions of appearance*

In-situ measurement data from drifting buoys from the **IPAB** Archive (International Programme for Antarctic Buoys) and additional buoy data from other times, collected at the **AWI** (Alfred Wegener Institut für Polar und Meeresforschung) have a high spatial and temporal resolution, while ice drift from satellite date are more continuous and cover large portions of the Southern Ocean.
Satellite **optimal interpolated ice drift** data from the SSMI Sensor on board the DMSP satellite series is used, including data from 37GHz and 85GHz Channel (Kwok et al.,1998) and buoy data when and where available (courtesy JPL, Polar Remote Sensing Group).

3. GIS Ice Motion Database Concept and Additional Data

All ice motion data is uniformly georeferenced in the same polarstereographic projection, so it is suitable for GIS analysis and it is easy to merge and blend vectors from different data types, which allows for example direct, regionwide examinations of the ice drift – wind forcing relation.

Additional used data sets are:
- Sea ice Concentration **Pelicon** *(Project for Estimation of Long-term variability in Ice Concentration)*
- Weather Data from **ECMWF** model (Sea level pressure and 10m wind)
- Seafloor Topography and Land Elevation Data

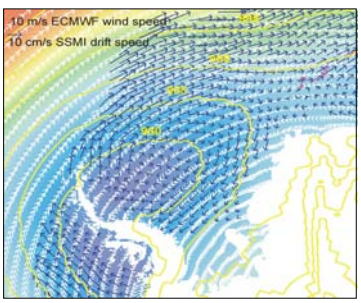

Figure 2: *September 94 Monthly mean ECMWF pressure and wind, buoy drift and SSMI_OI drift*

4. Ice Motion and Variation Fields

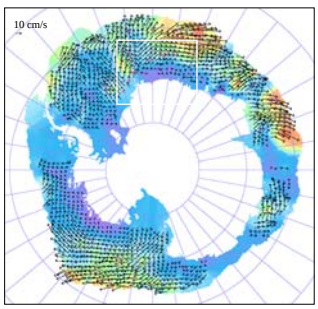

Figure 3: *Monthly mean drift velocity field for October 86. SSMI_OI data (black arrows),Buoy data (red arrows)*

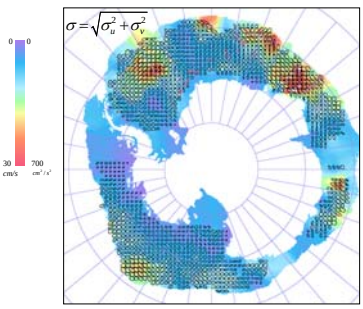

Figure 4: *Monthly mean drift variance for October 86 SSMI_OI data (black) Buoy data (red)*

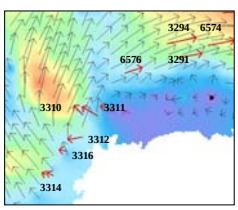

Figure 5: *Zoom Section from above with WMO-ID of the buoys*

Ice drift velocity and variance fields are calculated on different temporal and regional scales. To illustrate the variance fields, more detailed covariance ellipses are calculated and plotted, wherever satellite or buoy data is available. The satellite data is additionally interpolated in gridded velocity fields, within the boundary of the ice concentration fields.

For each buoy position, auxiliary data such as drift and variance parameters, WMO_ID and group name of the buoy field is included as vector attribute information and can be used for identification and direct comparison of selected parameters with the same parameters in gridded SSMI-OI Motion Fields.

5. Long Time Series Examinations

20 years of data could be used to create monthly, seasonal and annual means of the ice drift velocity, their single components and their temporal and spatial derivatives like divergence, vorticity and shear.
For the investigated domain, 5°x5° mean values for different latitude intervals are plotted to see, if eastward propagating anomaly structures, which have been previously detected in atmospheric and sea ice data (White and Petersen, 1996; Venegas et al., 2001), are evident in the database sea-ice velocities.

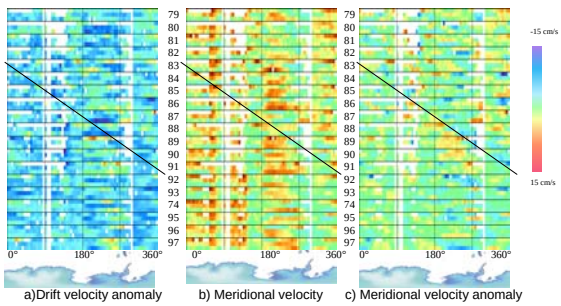

Figure 6: *Seasonal anomaly (lat70 – lat 65) of drift velocity (left) , seasonal meridional velocity (middle) and seasonal meridional velocity anomaly (right). Black lines show the direction of eastward propagating anomalies in sea ice extent and sea level pressure as in White and Peterson (1996).*

The minima and maxima of the absolute drift values in Fig.6a show a similar propagation as indicated by the black lines, which could suggest a relation to anomalies shown in atmospheric data. In the meridional velocity component (Fig.6b), the pattern is not so clear, but more dominated by regional dependance. The propagation of anomalies of the meridional velocity component in Fig. 6c agree well with directions of propagating anomalies in sea ice extend .
Because SSMI_OI drift data is only available for month 3-11, only three season blocks are built per year. Austral summer satellite ice drift products are not generated – as the ice surface decorrelates and prevents tracking during the melt season.

6. Conclusions

- The Ice Drift Atlas collects data from different sources, uniformly reprojected by the same methods.
- It gives an overview about the mean structure as well as variability of ice drift.
- It gives an indication of locations where satellite derived drift over/underestimates the true ice velocity.
- A gridded drift database can help to define the temporal variation in the spatial covariance of drift and atmospheric forcing
- Drift data can be used for initialization and evaluation of sea-ice models.
- The long record of data allows statistical examination of the variance of the drift in different temporal and regional scales.
- Presenting and processing the drift data together with atmospheric and topographic data in a GIS makes an areawide, combined analysis and classification of the different data directly possible.

7. References

Kottmeier, Ch., and L. Sellmann, 1996. Atmospheric and oceanic forcing of Weddell Sea ice motion, *J. Geophys. Res., 101(C9), 20809-20824.*
Kwok, R., A. Schweiger, D. Rothrock, S. Pang, and C. Kottmeier, 1998. Sea ice motion from satellite passive microwave imagery assessed with ERS SAR and buoy motions, *J. Geophys. Res., 103(C4), 8191-8214.*
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