Monitoring Arctic Ice drift from Space

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Introduction

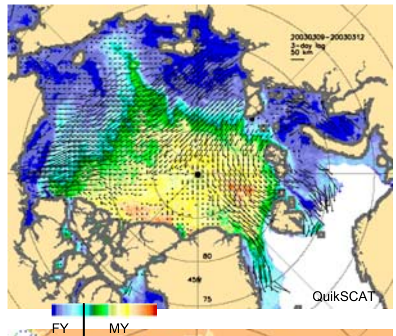
Monitoring Ice drift with space borne sensors is not new. Many different instruments and algorithms have been used (see for example Ref.1, 2, 3, 4, 5, 6). Here, we present how merging scatterometer and radiometer derived drift improves the quality, the density and the duration of observations. The recently launched AMSR radiometer enables increasing the drift grid resolution by a factor of two

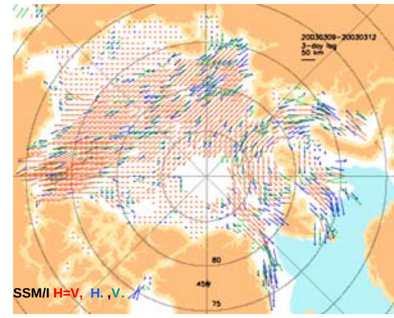
The sensors & Algorithms

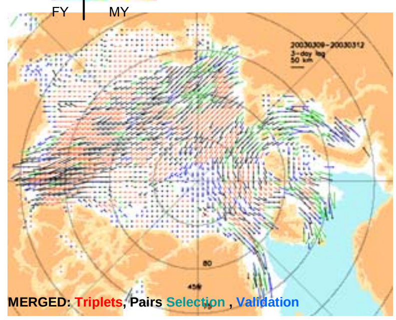
The SeaWinds scatterometer on QuikSCAT provides sea ice backscatter data (H and V. polarized) which are daily mapped on the 12.5 x 12.5 Km grid used by NSIDC to distribute the daily SSMI 85GHz brightness temperatures (H. and V. pol.) also used here. The two backscatter maps are averaged to decrease the noise level of each pixel. This is not feasible for the two Tb's maps since their information differ too much. These three daily maps are the basic inputs to estimate ice drift from each of these sensors.

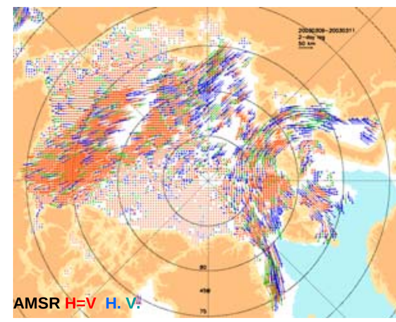
Ice drift is estimated by a cross-correlation technique applied on pairs of the field of Laplacian either of the backscatter maps or Tb's maps lagged by 3 and 6 days. Each of the three drift map are validated by comparison to the space-interpolated and timed averaged ECMWF wind field. Local consistency of the drift field is also verified.

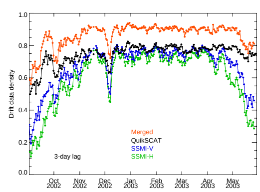
The merging algorithm relies on a local cost function which tests, at a drift grid node, each possible solution against the neighboring and already validated vectors of the merged drift grid (14 different cases have to be considered). Weighting coefficients accounts for the confidence in each drift vectors and on the distance to the tested grid node. The initial backbone of the merged drift grid is composed of the triplets and pairs of identical drift vectors. Grid nodes with a single solution are validated with a local consistency test.

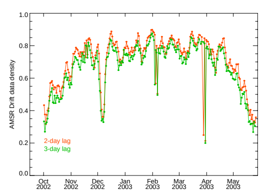












QuikSCAT derived drift increases the time window by 3 weeks both in early fall and in spring . Merging scatterometer and radiometer drift increases the data density up to 88% of the drift grid. Fluctuations of drift data density are smoothed by the scatterometer compared to the radiometers.

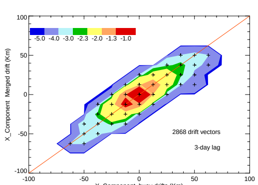
The resolution of AMSR Tb's enables a 2-day lag.

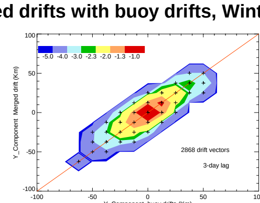
Data available at:
http://www.ifremer.fr/cersat

Data Quality

Color scale= log10[n/(N+1)]

• Validation of satellite derived merged drifts with buoy drifts, Winter 1999-2000

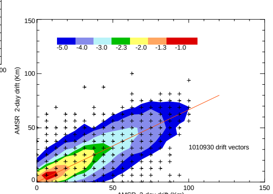




For each component: Noise level: 5.5 Km ρ≈0.82 - Extracted variance: 92 %

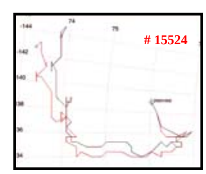
Absolute noise level due to pixel size:
QuikSCAT & SSMI :5.1 Km

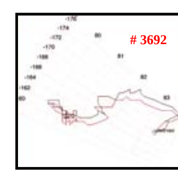
AMSR: 3.6 Km



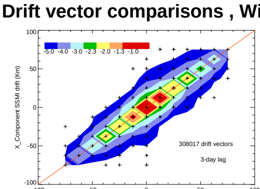
AMSR 2-day vs. 3-day lag
Optimal slope: 0.72 # 2/3 (2-day lag picks up transient events)
Geophysical + 2*Noise level: 3.8 Km ρ≈0.89
Extracted variance: 95%

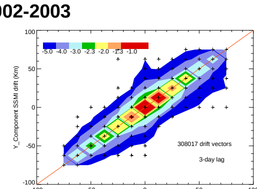
• Samples of QuikSCAT (black) and buoy (red) trajectories





• Drift vector comparisons , Winter 2002-2003





Careful in statistics interpretation: Data sets are NOT independent
For each component: Noise level: 1.4 Km ρ≈0.98 Extracted variance: 99%

The level of confidence in the results makes it possible to construct a 20 year long time series of drift maps using the SSMI historical data

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