

Background and guidelines for contributors to the
Sea Ice Drift Forecast Experiment
(SIDFEx)

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*Feedback to this document and to SIDFEx generally to
sidfex<AT>polarprediction<DOT>net is more than welcome.*

Background

The Sea Ice Drift Forecast Experiment (SIDFEx, 2017–2020) is a community effort to collect and analyse Arctic sea ice drift forecasts at lead times from days to a year, based on arbitrary methods, for a number of sea-ice buoys and, ultimately, research icebreaker *Polarstern*, on a regular basis.

SIDFEx is motivated in part by the need to determine an optimal deployment position of the research icebreaker *Polarstern* when she will start her year-long drift across the Arctic in autumn 2019 (Multidisciplinary drifting Observatory for the Study of Arctic Climate – MOSAiC; <http://www.mosaicobservatory.org>). Specifically, it is unclear whether forecast systems that account for initial conditions and provide forecasts of the evolving atmosphere, ice, and ocean system, can provide additional skill over drift forecasts made using historical sea ice velocity fields. The MOSAiC drift provides a template for assessing the capabilities to forecast sea-ice drift for a range of applications, ranging from logistics support for future field experiments to potential search and rescue operations. The examination of sea ice drift forecasts provides an integrated assessment of many aspects of the coupled atmosphere-ice-ocean system and will motivate in depth investigations into how key variables are measured, modeled, and forecast. In particular, we expect coordinated drift forecasts to draw attention to the interaction between sea ice physics and boundary layer physics in both atmosphere and ocean. We expect that a systematic assessment of real drift forecasting capabilities will improve our physical understanding of sea ice and enable us to identify and resolve model shortcomings and identify limits of predictability.

SIDFEx is the result of discussions in the context of the Year of Polar Prediction (YOPP; <http://www.polarprediction.net/yopp-activities/>), MOSAiC, the Sea Ice Prediction Network (SIPN; <https://www.arcus.org/sipn>), the Forum for Arctic Modeling and Observations Synthesis (FAMOS; <http://famosarctic.com/index.html>), and the International Arctic Buoy Program (IABP; <http://iabp.apl.washington.edu>).

Timeline

Forecasts are invited starting at the beginning of June 2017 simultaneous with both the start of the 2017 SIPN Sea Ice Outlook (SIO) season and the launch of the Year of Polar Prediction Core Phase (mid-2017 – mid-2019). Forecasts targeting selected Arctic sea-ice buoys (Phase 1) will be collected on a regular basis. Beginning summer of 2019, specific forecasts will be solicited to help optimise the MOSAiC drift start (Phase 2). Subsequent forecasts (autumn 2019-2020) through autumn 2020 will project the *Polarstern* trajectory as well as the trajectories of selected buoys of the Distributed

Network around *Polarstern* (Phase 3). Phase 1 trajectory forecasts will continue through the end of the project (2020) to allow for broader spatial assessment of forecast skill.

Forecast Targets

In *Phase 1* (June 2017 – mid-2019) 5 to 10 selected sea-ice buoys of the International Arctic Buoy Program (IABP) are targeted. These buoys are listed on a dedicated page of the website of the International Arctic Buoy Program (IABP; <http://iabp.apl.washington.edu/SIDFEX.html>), including near-real-time information on their position. A text file that can be used to automate the process of identifying which buoys are current SIDFEx targets, and which buoys have been targets from when to when in the past (to be used for re-forecasts), can be found in the SIDFEx target table at https://swift.dkrz.de/v1/dkrz_0262ea1f00e34439850f3f1d71817205/SIDFEx_index/SIDFEx_targettable.txt).

Information on the retrieval of buoy positions are provided in the *Appendix*. This phase serves as a baseline during which experience is gained, model and forecast method shortcomings are diagnosed, and forecast quality can be assessed.

Phase 2 (summer/autumn 2019) will add additional forecast targets with relevance for the planning of the upcoming *Polarstern* drift. These targets will be virtual points distributed in the broader region of the possible drift start and will be determined in collaboration with MOSAiC planners, announced through <http://www.polarprediction.net/yopp-activities/sidfex>, and included in the SIDFEx target table (see link above).

Phase 3 (autumn 2019 – autumn 2020) will include the *Polarstern* drift trajectory as the primary target with ship locations providing initial positions for forecasts. In addition, buoys that are part of the Distributed Network around the ship will be targeted so that information on large-scale ice deformation can be derived. It is anticipated that the drift and deformation forecasts will be of considerable value to support MOSAiC operations, e.g., for the planning of supply operations, the ordering of satellite imagery, and possibly as “early warning” indicator of events with high ice pressure or lead opening. All MOSAiC-related targets will be included in the SIDFEx target table as well (see link above).

Note that Phase 1 trajectory forecasts will continue until the end of the project (tentatively autumn 2020) to allow for broader spatial assessment of forecast skill and method/model biases.

Forecast methods and lead times

SIDFEx is open to any forecast methods as long as forecast method and source are identified and forecasts follow formatting conventions (see below). Example methods include drift trajectories derived from historical drift records (satellite, buoys, models), free-drift using atmospheric wind forecasts, as well as trajectories predicted from complex prognostic models. Following SIPN Sea Ice Outlook tradition, “heuristic” forecasts are also invited if the basis of the prediction (e.g., variables considered) are provided.

Timeliness of submissions

Forecasts can be submitted at any time and with any delay between the time of initialisation (initial buoy position and, if applicable, initialised physical model state) and the time of submission. We encourage submissions with as little delay as possible – ideally in (near-)real-time – because only then will they be useful to support the MOSAiC

campaign. However, re-forecasts are encouraged, too, as they can provide a better basis for forecast evaluation and system/method intercomparison.

Forecast range, initial time, and temporal resolution

The lead-time range, initial time, and temporal resolution of forecasts are not prescribed, but each contributor can determine these based on individual requirements and considerations. However, the practice so far has revealed two main clusters of forecast types, described in the following. Adjusting new contributions to correspond to one of these clusters helps to streamline the subsequent analyses and use of the forecasts.

Many of the seasonal-to-annual contributions are initialised on the respective first day of a month (at 00:00 UTC). This includes modelling groups participating in the SIPN Sea Ice Outlook that contribute to SIDFEx by computing trajectories based on their simulated ice velocity fields. The temporal resolution of these longer-term trajectories is typically daily.

Another cluster of forecasts are shorter-term (typically 10-day) forecasts initialised daily at 00:00 UTC, often submitted in (near-)real-time. Some of these forecasts have a daily trajectory resolution, whereas others provide a higher temporal resolution. Most contributions in this cluster also provide re-forecasts to enhance the data basis for evaluation.

Ensembles

As described below, it is possible and encouraged to submit ensembles of trajectories instead of only single (deterministic) forecasts. So far, all of the (sub)seasonal-to-annual contributions have provided ensembles of varying size (up to 50 members), whereas the shorter-term forecasts are so far all deterministic. However, we encourage to submit ensembles also for shorter-range forecasts where that is possible.

Individual forecast trajectories belonging to the same ensemble should be different from each other only in terms of the ensemble member number (and the evolution of the trajectory after the initial time, of course). Ensembles that are based on lagged-time initialisation complicate subsequent analyses because for these it is not straight forward to determine which individual forecasts comprise an ensemble, and the computation of ensemble statistics is complicated. Lagged-time initialisation ensembles are thus not recommended, but still possible.

IDs and forecast output format

Each contributing group (or individual) is assigned a **GroupID** (a short unique text string) in consultation with the SIDFEx team (contact *sidfex<AT>polarprediction<DOT>net*). Each group or individual can define and “register” one or more **MethodIDs** that should be short (< ~20 characters, avoiding fancy ones) and more or less meaningful. For each MethodID a concise method description should be sent to *sidfex<AT>polarprediction<DOT>net*. **TargetIDs** are identical with IABP BuoyIDs in case of those. TargetIDs for other types of targets in Phases 1 and 2, related to the MOSAiC drift, will be communicated in due course.

Forecasts shall be provided in simple ASCII text files that follow the below described file naming convention and content format.

File naming convention:

<GroupID>_<MethodID>_<TargetID>_<InitYear>-<InitDayOfYear>_<EnsMemNum>.txt

Example:

GroupX_MethodY_300234060834110_2017-61.417_001.txt

File content (example for a 12-day buoy drift forecast):

--- example file begins below this line

GroupID: GroupX

MethodID: MethodY

TargetID: 300234060834110

InitYear: 2017

InitDayOfYear: 61.417

InitLat: 85.24160

InitLon: 26.39600

EnsMemNum: 001

end of header

Year	DayOfYear	Lat	Lon
2017	62.000	85.22420	26.40660
2017	63.000	85.21800	26.00540
2017	64.000	85.30060	25.86140
2017	65.000	85.20860	26.14940
2017	66.000	85.05520	26.85060
2017	67.000	84.97160	27.07000
2017	68.000	84.87860	26.95040
2017	69.000	84.76520	27.44780
2017	70.000	84.68420	27.60120
2017	71.000	84.61000	27.05020
2017	72.000	84.56660	27.68280
2017	73.000	84.55160	27.62280

--- example file ends above this line

In case of single (“deterministic”) forecasts, the ensemble member (*EnsMemNum*) number shall be *001*. In case of ensemble (“probabilistic”) forecasts, one file for each member shall be submitted. The table may or may not contain the initial time and location of the target. Note however that, if an initial location is not included in the table, the initial location information from the header is used to generate a forecast trajectory starting from forecast time zero, meaning that the header information must be consistent with the trajectory in the table. ***If your forecast trajectory actually starts from a slightly shifted location, e.g. because you use some nearest-neighbour point of an ice/ocean model grid to start the tracing, either the InitLon and InitLat must denote that shifted location, or the shifted initial location must be included in the table*** (“contradicting” the header information which may then point to the actually observed location). Only then is it possible to detect and correct for the initial shift (which is automatically done by the SIDFEx tools).

Following the IABP convention, all *DayOfYear* values start from *1.000* at the beginning of January 1st of each year.

The data table must start after the row “### end of header” with the column names provided in the example. The table can be space or tab delimited.

Apart from numeric values, the *Lat* and *Lon* columns may contain only the string “NaN”.

The file name elements must exactly match the corresponding elements provided in the file header.

The format will be checked automatically for any submission and must be followed carefully. Those familiar with the programming language *R* may use the function

`sidfex.checkfileformat()` provided in a corresponding script on the SIDFEx website, to check their files ahead of submission.

After submission (and a successful format check), five lines of the form

`SubmitYear: 2017`

`SubmitDayOfYear: 62.621`

`ProcessedYear: 2017`

`ProcessedDayOfYear: 62.643`

`### end of auto header`

will be added automatically as first lines to the file header to document the submission time.

Forecast submission

Forecasts can be submitted through the cloud service of the German Climate Computing Centre (DKRZ) at any time. Permissions and instructions for the submission (e.g., using the UNIX tool `curl`) can be obtained by contacting `sidfex<AT>polarprediction<DOT>net`.

Note that the time of upload is noted and added automatically to enable a later assessment from a real-time and timeliness perspective.

If a submission does not pass the automatic file format check, no processed file will appear under the link provided below. Instead, the contributor will be contacted by the SIDFEx team with instructions as soon as possible. If a processed file appears, the format check was successful. When contributing for the first time, it is advisable first to submit only one file to see whether it passes the format check. It is also possible to check the file format in advance using the function `sidfex.checkfileformat()` of the SIDFEx R-package, available here: <https://github.com/helgegoessling/SIDFEx>.

Getting and exploring the forecast data

After submission, each forecast is automatically processed and made publicly available in real-time (<2h delay) at the Cloud Service of the German Climate Computing Centre. Individual files, ordered by contributor GroupIDs, can be obtained from this link:

https://swiftbrowser.dkrz.de/public/dkrz_0262ea1f00e34439850f3f1d71817205/SIDFEx_processed/.

In addition, a tar.gz archive of all forecasts and an index of these (in R binary as well as plain text (csv) format) are available here:

https://swiftbrowser.dkrz.de/public/dkrz_0262ea1f00e34439850f3f1d71817205/SIDFEx_index/.

The SIDFEx R-package available at <https://github.com/helgegoessling/SIDFEx> allows one to download and analyse the SIDFEx forecast and corresponding observational data. The package is still under development and not yet sufficiently well documented, but R enthusiasts are particularly invited to use the package already. Also under development is a web tool (based on R-Shiny and the SIDFEx R-package) that will allow exploring the SIDFEx data in a very easy way. The release of these tools will be announced in due course.

Contact

For any questions related to SIDFEx, please contact the SIDFEx team at `sidfex<AT>polarprediction<DOT>net`.

SIDFEx lead team: Helge Goessling, Axel Schweiger, Ed Blanchard-Wrigglesworth, Thomas Krumpfen, Marcel Nicolaus, Robert Grumbine, Ignatius Rigor, Frank Kauker, Rüdiger Gerdes, and Simon Reifenberg.

Appendix: Retrieving observed positions

Observations of the current and past positions of all SIDFEx targets can be obtained from this URL (e.g., with *wget*), where <TargetID> needs to be replaced by a valid TargetID (as listed in the SIDFEx target table (see link above), e.g., 300234060834110):

https://swift.dkrz.de/v1/dkrz_0262ea1f00e34439850f3f1d71817205/SIDFEx_index/observations/<TargetID>.txt .

(The same data but only for IABP buoys can be obtained from this URL:

<http://iabp.apl.washington.edu/WebData/<TargetID>.dat> .)