Enhancing the Sea Ice Concentration Climate Data Record

A. Windnagel, T. Stafford, S. Stewart, F. Fetterer, W. Meier

National Snow and Ice Data Center, Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder

https://nsidc.org/data/data-programs/noaa-nsidc

INTRODUCTION

The current Sea Ice Concentration CDR is

- A rule-based combination of ice concentration estimates from two well-established algorithms: the NASA Team algorithm and the NASA Bootstrap algorithm.
- A consistent, daily and monthly time series of sea ice concentrations from 25 October 1978 to the present for both the north and south polar regions on a 25 km polar stereo grid.
- Well suited for evaluating climate variability and change.
- Transparent, reproducible, consistent, continuous, and long-term record (>40 years).

GOALS

1. Create a new enhanced Sea Ice Concentration CDR (ECDR) product:
   - Begins with AMSR2 (Jul 2012 to present) daily product on a 12.5 km polar stereographic grid.
   - Extend with AMSR-E (Jun 2002 to Oct 2011).
   - Extend to a true CDR by adding 25 km SMMR, SSM/I, and SSMIS. Will need to resample those data to 12.5.
2. Write code in a modularized fashion that allows for easier customization of algorithm steps and make it open source.
3. Long-term goal: Use the new ECDR as input to the Sea Ice Index.

RATIONALE

Why enhance the product?

- AMSR series provides the opportunity to increase the resolution from 25 km to 12.5 km.
- The current 25 km CDR is at risk of ending because it uses the DMSP SSMIS instrument for input data but the DMSP suite of satellites is aging (Fig 1).
- AMSR series of instruments will continue into the future (Fig 1).

INTERESTING FINDINGS

- Bootstrap weather filter coefficients are inadequate for automated removal of weather effects – both DMSP and AMSR2 show residual weather effects.
- NASA Team weather filter coefficients appear to work well.
- Methodologies that don't scale well:
  - Bootstrap land spillover correction does not work well for higher resolution; it considers grid cell adjacencies instead of geographic distances from land.
  - NASA Team land spillover was designed for the 25 km SSM/I footprint size that won't work on higher resolution AMSR2.

Fig 1. Timeline of passive microwave instruments

RESULTS

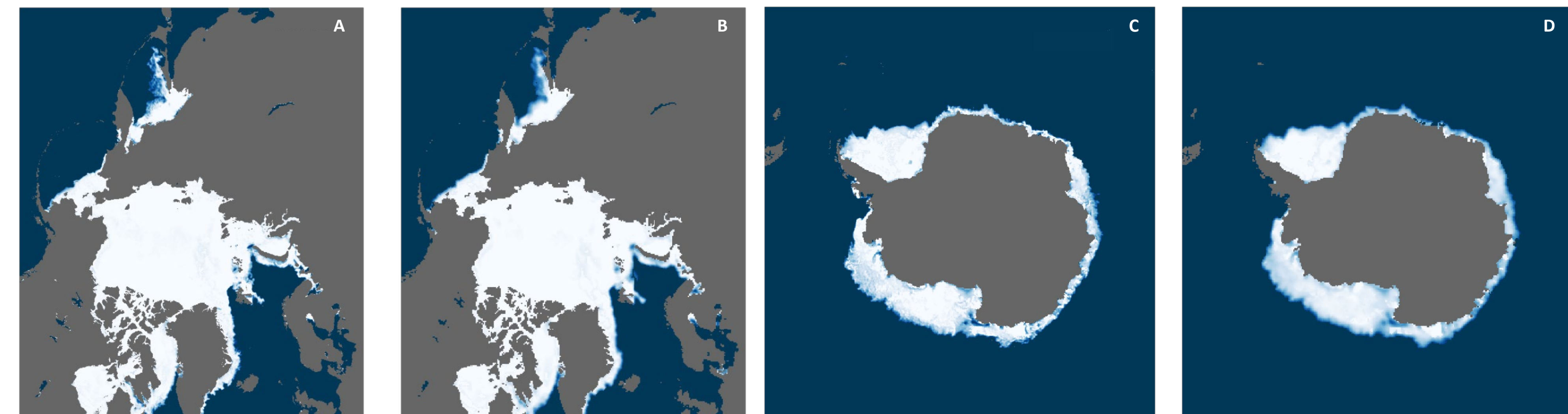**1** Increased resolution allows for better discrimination of the ice edge

Fig 2. 1 April 2021 sea ice concentration for the Arctic from 12.5 km ECDR (A) and 25 km CDR (B) and for the Antarctic from 12.5 km ECDR (C) and 25 km CDR (D)

Fig 3. A comparison of sea ice concentration off the NE coast of Greenland for 30 July 2021 for the 25 km CDR (A), 12.5 km ECDR (B), and 500 m MODIS visible band image (C). This close up view shows the improvement of the ECDR over the original CDR to capture features in the ice pack that are visible in the MODIS image.

2 Improved land-spillover correction

Example data from 12 August 2012

- Fig 4 Panel A: Shows the 25 km Sea Ice Index with false ice around the coast in Hudson Bay. Sea Ice Index uses the original NASA Team land-spillover correction.
- Fig 4 Panel B: Shows the 12.5 ECDR with AMSR2 as input with less false ice in the Hudson Bay than the Sea Ice Index. The ECDR is higher resolution and uses the NASA Team 2 land-spillover correction.
- Fig 4 Panel C: Shows the 4 km MASIE product used as validation data showing an ice free Hudson Bay – it is produced from input files that are manually created by US National Ice Center analysts.
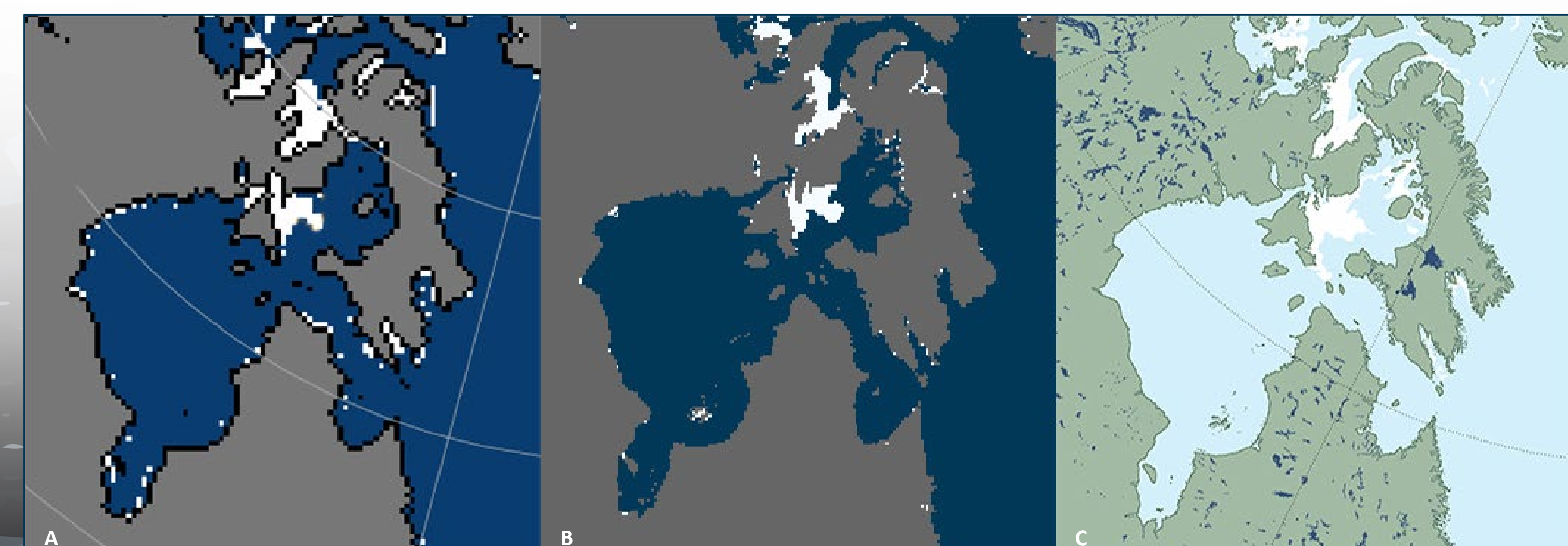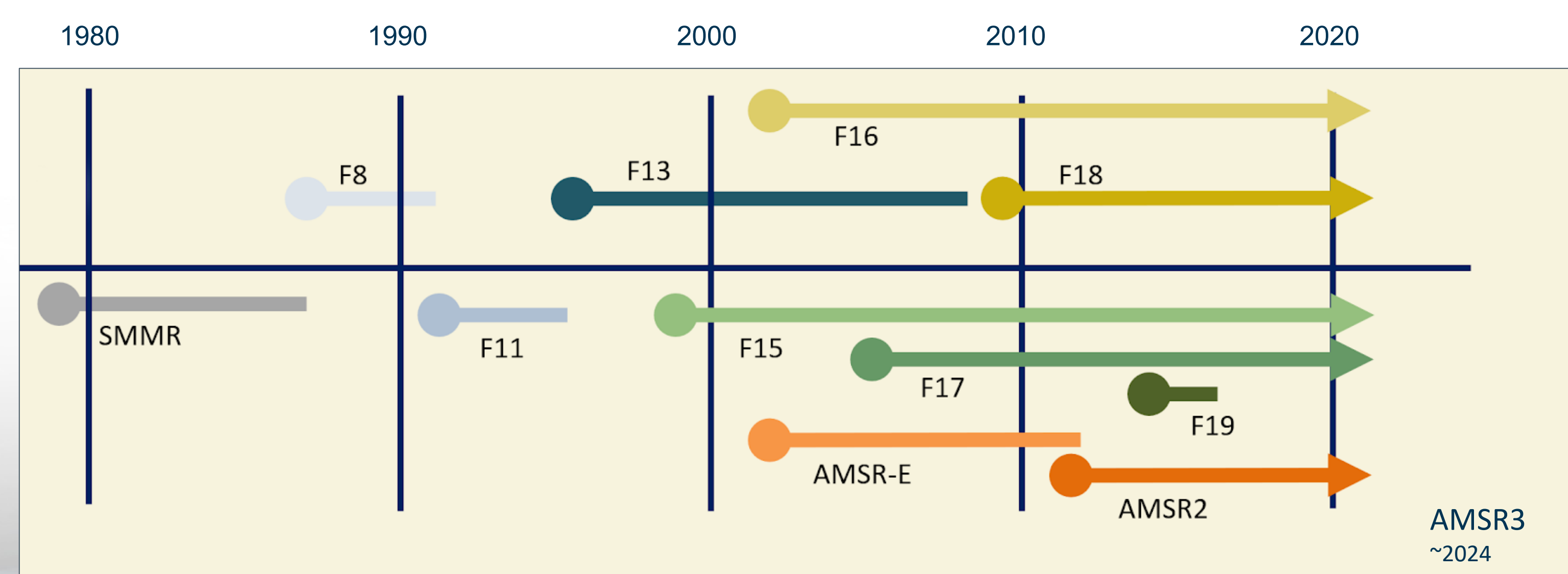

Fig 4 Sea ice extent from three sources for 12 August 2012: 25 km Sea Ice Index (A), 12.5 km ECDR (B), 4 km MASIE (C).