

## Sea Ice Outlook, July 2011

*Contribution by Walt Meier, Julienne Stroeve, Mark Serreze, Ted Scambos  
National Snow and Ice Data Center*

### Summary

This statistical method uses previous years' daily extent change rates from July 1 through September 30 to calculate projected daily extents starting from June 30. The September daily extents are averaged to calculate the monthly extent. Rates from recent years are more likely to occur because of the change in ice cover. Thus, the official project is based on the rates for 2002-2010, yielding a **September 2011 average of 4.72 million square kilometers**; the range however is still quite large with a **standard deviation of 560,000 square kilometers**. Using all years (1979-2010) yields a slightly higher estimate of 5.09 million square kilometers, but a similar range of 520,000 square kilometers. Two out of the 32 scenarios (using rates from 2007 and 2008) would yield a new record minimum September extent. This suggests the **chance for a record low this year is ~6%**, though this probably underestimates the probability because recent years have tended to follow faster decline rates. Thus, **a new record low September extent this year is unlikely, but not out of the realm of possibility**. However, there is a **very high probability that this year will be among the five lowest** of the satellite record.

### Details

This is a purely statistical method that applies daily rates of extent change (every other day for 1979-1986) to project 2011 daily extents from the June 30, 2011 daily extent. The limitation in the method is that there are no physics involved and the assumption must be made that conditions this year will be enveloped by conditions over the previous 32 summers. However, this is not the case as we know that sea ice is younger and thinner than in previous years. Thus any estimate is more likely to be too high rather than too low. Another limitation is that with two or more months left in the melt season, there is still a lot over variability in the weather – winds, clouds, temperatures, etc. Thus it yields a wide range (standard deviation) in estimates. This range will shrink in coming days and weeks as the availability of solar insolation continues to decrease and the end of the melt season closes in.

However, this method provides an envelope of potential extents that should be reasonably constrained because it encompasses ice losses due to a variety of weather conditions through the remainder of the melt season. Though it does not provide an estimate that is highly precise, it does provide an envelope of possibilities that is very likely to encompass this year's conditions.

The estimates range from just above 6 million square kilometers (using 2001 rates) to under 4 million square kilometers (using 2007 or 2008 rates). Table 1 below shows the number occurrences (out of 32 total years, 1979-2010) of various ranges of September 2011 extent outlooks. There are a couple things of note in the table. First, the average is considerably lower using the recent years, which is not surprising. Six of the 7 occurrences of extents > 5.5 million square kilometers and 12 of 14 with extents of 5.0 – 5.5 million square kilometers result from using pre-2002 rates. Two thirds (6 of 9) of the recent years yield a 2011 extent below 5.0 million square kilometers and the two potential record-breaking

rates have happened in the past four years. These all suggest that the statistics are not stable and that a faster rate (and lower September extent) is more likely than a slower rate of decline. Oddly, no projections yield an extent in the 4.0 – 4.5 million square kilometer range. This is likely simply a statistical quirk, but is interesting.

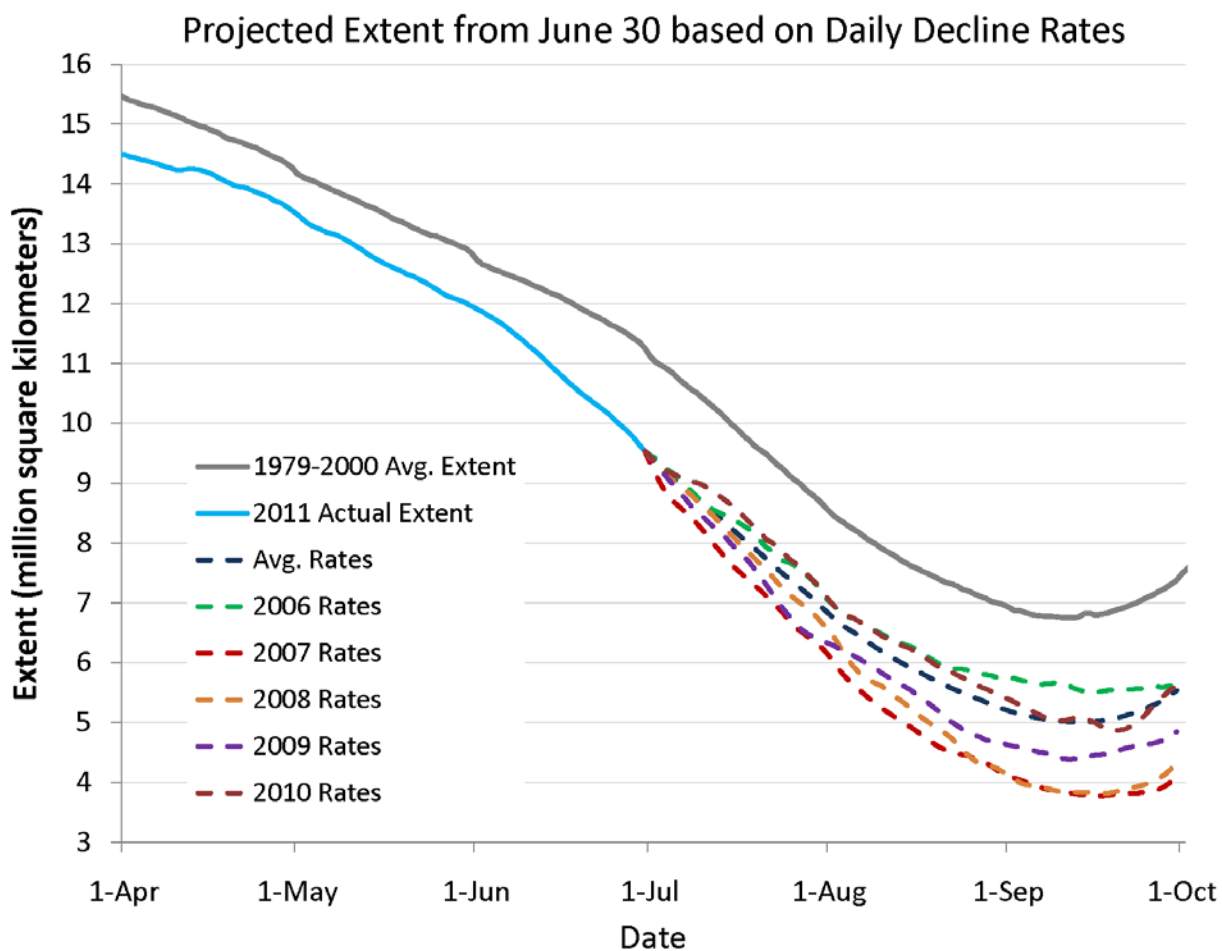
Based on all years, there is a 2 in 32 chance of a new record, or about 6%. However, those two occurrences are using rates from the last 9 years (2007 and 2008), suggesting that the probability of a record is higher than 6%. However, 2007 and 2008 are notable outliers, even among recent years, so the probability is not as high as might be indicated using only more recent years (i.e., rates from 2 of the last 4 years set a record, or a 50/50 chance). Based on a subjective interpretation of these statistics and a qualitative assessment of the state of the ice cover and the weather patterns so far this year, the chances are deemed here to be 10-15% for a record low September extent.

Regardless of whether a new record low occurs, it is very likely that this year’s extent will be among the five lowest in the satellite record (Table 2). Over all years, 27 of the 32 years yield a “bottom 5” extent, including 8 out of the last 9 years. The one recent year that doesn’t exceed the 5<sup>th</sup> lowest (5.57 million square kilometers in 2005), using 2006 rates, is so close (5.61 million square kilometers) as to be considered within the margin of error of the extent estimates.

| <i>Range/Category<br/>(million sq km)</i> | <i>All Years (1979-2010)<br/>32 total years</i> | <i>Recent Years (2002-2010)<br/>9 total years</i> |
|---|---|---|
| Average [St. Dev.]                        | 5.09 [0.52]                                     | 4.72 [0.56]                                       |
| Maximum [Year]                            | 6.06 [2001]                                     | 5.60 [2006]                                       |
| > 5.5 (# occurrences)                     | 7   | 1   |
| 5.0 – 5.5                                 | 14  | 2   |
| 4.5 – 5.0                                 | 9   | 4   |
| 4.0 – 4.5                                 | 0   | 0   |
| < 4.0                                     | 2   | 2   |
| Record Low (< 4.30)                       | 2   | 2   |
| Lowest 5 (< 5.57)                         | 27  | 8   |
| Minimum [Year]                            | 3.88 [2007]                                     | 3.88 [2007]                                       |

**Table 1.** Average, maximum, minimum and ranges of potential extents based on extent rates from all 32 years (middle column) and the most recent 9 years (right column).

An image of the trajectories of sea ice extent for the remainder of the melt season (through September 30) is provided in Figure 1. For clarity trajectories are only provided from the past 5 years. However, it is clear that no trajectory approaches the average climatological values, even for years not shown. The maximum projected September average (using 2001 rates) is almost a million square kilometers below the 1979-2000 average of 7.04 million square kilometers and over a half million square kilometers below the 1979-2010 average of 6.58 million square kilometers. Table 2 provides the 2011 extent projection for each year’s extent decline rates.



**Figure 1.** Timeseries of daily total sea ice extent with projections using extent change rates from the previous five years (2006 – 2010).

| <i>Earliest to Latest</i> |                         | <i>Largest to Smallest</i> |                         | <i>Rank</i>      |
|---------------------------|-------------------------|----------------------------|-------------------------|------------------|
| Year of Extent Rate       | Sept. Avg. (mill sq km) | Year of Extent Rate        | Sept. Avg. (mill sq km) | Extent 1979-2011 |
| 1979                      | 5.03                    | 2001                       | 6.06                    | 9                |
| 1980                      | 5.77                    | 1980                       | 5.77                    | 6                |
| 1981                      | 5.02                    | 1988                       | 5.72                    | 6                |
| 1982                      | 5.32                    | 1986                       | 5.61                    | 6                |
| 1983                      | 5.21                    | 2006                       | 5.60                    | 6                |
| 1984                      | 5.02                    | 1996                       | 5.56                    | 5                |
| 1985                      | 5.11                    | 1998                       | 5.55                    | 5                |
| 1986                      | 5.61                    | 1994                       | 5.47                    | 5                |
| 1987                      | 5.19                    | 1997                       | 5.45                    | 5                |
| 1988                      | 5.72                    | 1992                       | 5.37                    | 5                |
| 1989                      | 5.05                    | 1982                       | 5.32                    | 4                |
| 1990                      | 4.88                    | 1983                       | 5.21                    | 4                |
| 1991                      | 4.84                    | 1987                       | 5.19                    | 4                |
| 1992                      | 5.37                    | 1999                       | 5.18                    | 4                |
| 1993                      | 4.90                    | 2010                       | 5.13                    | 4                |
| 1994                      | 5.47                    | 1985                       | 5.11                    | 4                |
| 1995                      | 4.99                    | 2003                       | 5.07                    | 4                |
| 1996                      | 5.56                    | 1989                       | 5.05                    | 4                |
| 1997                      | 5.45                    | 1979                       | 5.03                    | 4                |
| 1998                      | 5.55                    | 1981                       | 5.02                    | 4                |
| 1999                      | 5.18                    | 1984                       | 5.02                    | 4                |
| 2000                      | 4.84                    | 1995                       | 4.99                    | 4                |
| 2001                      | 6.06                    | 2005                       | 4.94                    | 4                |
| 2002                      | 4.64                    | 1993                       | 4.90                    | 3                |
| 2003                      | 5.07                    | 1990                       | 4.88                    | 3                |
| 2004                      | 4.74                    | 1991                       | 4.84                    | 3                |
| 2005                      | 4.94                    | 2000                       | 4.84                    | 3                |
| 2006                      | 5.60                    | 2004                       | 4.74                    | 3                |
| 2007                      | 3.88                    | 2002                       | 4.64                    | 2                |
| 2008                      | 3.93                    | 2009                       | 4.54                    | 2                |
| 2009                      | 4.54                    | 2008                       | 3.93                    | 1                |
| 2010                      | 5.13                    | 2007                       | 3.88                    | 1                |

**Table 2.** September 2011 average extent projection using rates of extent change for each year, 1979-2010 in order of: (left two columns) earliest to most recent, and (middle two columns) highest to lowest extent. The right column gives the rank of the projected extent (out of 33 years) in order from highest to lowest.