



ESA Ice Sheets CCI

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Product: *Ice Sheet elevation changes, supplemented by fields of ice velocity and ice mass change. (for mass-balance determination)*

Requirements for satellite instruments and satellite datasets:

- *FCDR of appropriate altimetry, for example through laser altimetry.*

Supplemented by:

- *Radar measurements, for example through consideration of the use of SAR, especially InSAR, to provide intermittent sampling of ice velocity.*
- *Satellite-based gravity field measurements, which should be further explored to detect time-varying changes in mass of water and ice on land.*

GCOS (target) observational requirements:

Variable/ Parameter	Application	Horizontal Resolution	Temporal Resolution	Accuracy	Stability
Surface Elevation change	Mass balance determination	100m	30 days	0.1m/yr	0.1m/yr
Ice velocity	Mass balance determination	1 km	30 days	10m/yr	10m/yr
Mass change	Mass balance determination	50 km	30 days	0.5km ³ /yr	0.5km ³ /yr

- Definition: “Ice Sheets” = **the continental Ice Sheets** of Greenland and Antarctica **including** their outlet ice streams and the ice-shelves they feed.
 - Glaciers and ice caps have their own CCI
- The geographical focus of the Ice Sheet CCI **shall** be **Greenland**.
 - A geographically limited area on Antarctica **may** be covered on a trial basis.
- The **primary ECVs** to be produced for ice sheet mass balance determination **shall** be:
 - **Surface Elevation Change (SEC)**
 - Main FCDR: ESA radar altimetry from 1991 onwards
 - **Ice Velocity (IV)**
 - Main FCDR: ESA SAR (& InSAR) from 1991 onwards
- Additional auxiliary ECVs **shall** be produced depending on feasibility:
 - These auxiliary ECVs are producible from the FCDRs required for the primary ECVs with **relatively small extra effort**.
 - The auxiliary ECVs **shall** include at least:
 - **Grounding line location** (from InSAR)
 - **Glacier front location for ice streams** (from SAR)
 - **Iceberg calving rate** (from SAR)

ESA Ice Sheets CCI: Satellite datasets



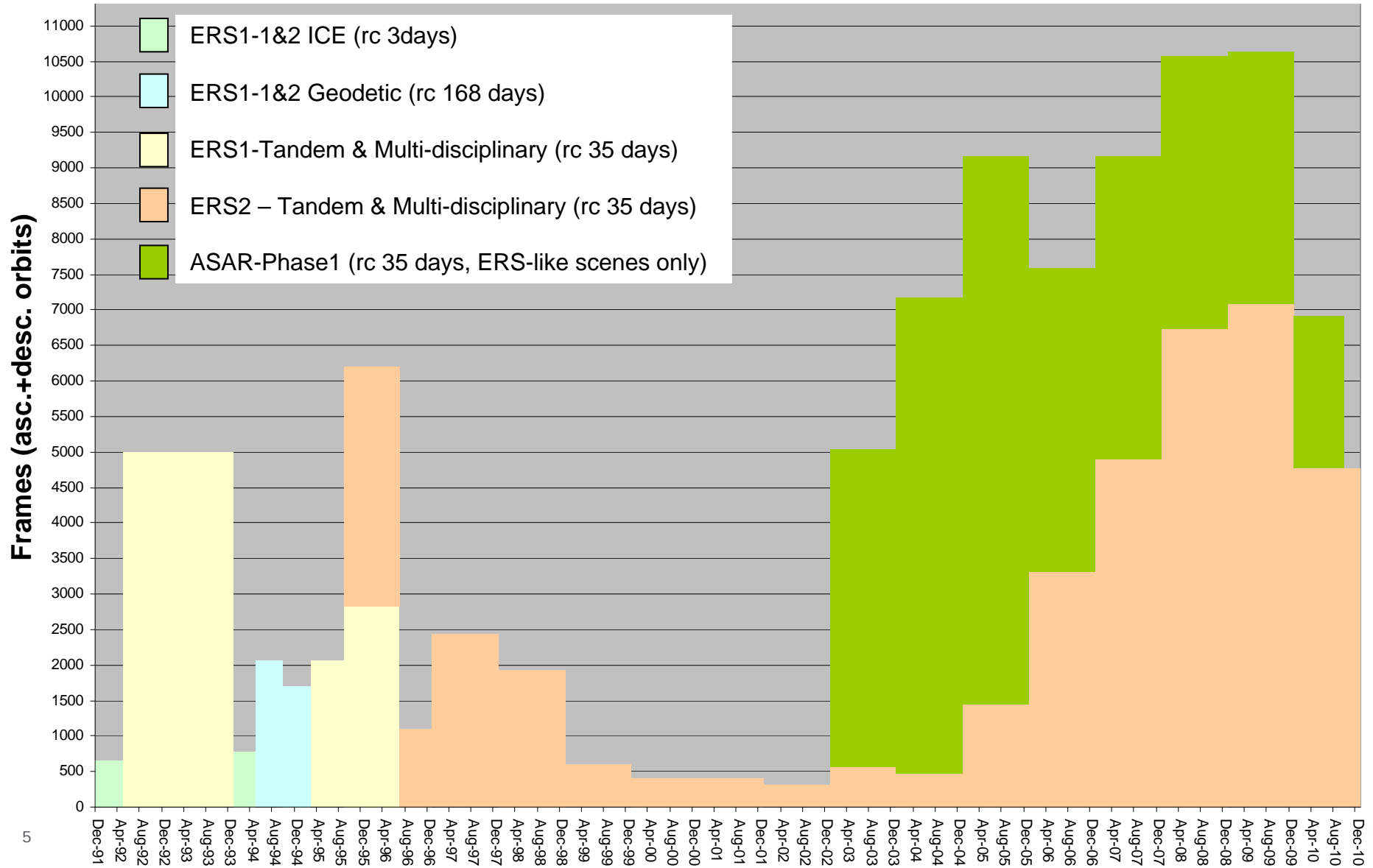
Altimetry

Satellite	Instrument	Note	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
ERS-1	RA		█																									
ERS-2	RA						█																					
ENVISAT	RA-2														█													
CryoSat-2	SIRAL	SAR & InSAR mode																					█					
Sentinel-3	SRAL	SAR & InSAR mode																									█	
IceSAT	GLAS	Laser altimeter														█												

SAR & InSAR

Satellite	Repeat Cycle	Note	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015			
ERS-1	mostly 35-days	AMI/C-band	█																											
- Ice Phases	3-days		█		█																									
ERS-2	35-days	AMI/C-band					█																							
- ERS-1/2 Tandem	24-hours						█																							
- Proposed ice-phase	3-days																													
ENVISAT	35-days	ASAR/C-band													█															
- ERS-Envisat Tandem	28-minutes	X-InSAR Antarctica																					█							
Sentinel-1a	12-days	C-Band																								█				
Sentinel-1b	12-days	C-Band																										█		
- Tandem 1a+1b	6-days																										█			
TerraSAR-X (1st unit)	11-days	X-band																			█									
TerraSAR-X (2nd unit)	11-days	X-band																					█							
- TanDEM-X	0 (single-pass)	Global DEM																					█							
Radarsat-1	24-days	C-band					█																							
- Antarctica Mapping	24-days	Left-looking																												
Radarsat-2	24-days	C-band																				█								
- Antarctica Mapping	24-days	Left-looking																												
JERS-1	44-days	L-band	█																											
ALOS	44-days	PALSAR/L-band																		█										

ESA Ice Sheets CCI : ESA SAR Coverage over Greenland 1991-2010



SAR & InSAR for Ice Velocity

- Data availability & processing effort
 - Spatiotemporal coverage over Greenland
 - Need for 3rd party SAR data for part of the time-period
- Processing effort
 - Processing of +100kframes of SAR data
 - InSAR-processing for ERS-1/2 Tandem and 3-day repeat data (-> grounding-line location), offset-tracking for the rest.

Radar altimetry for Surface Elevation Change

- Cross-calibration between altimeters
 - ERS-1/2, Envisat, Cryosat
- Necessary corrections for mass balance
 - Dry atmospheric mass correction + water vapour
 - Ionosphere
 - Tides
- Method?
 - Crossover-method well established
 - Along-track method could be tested.
 - A suitable DEM required.

