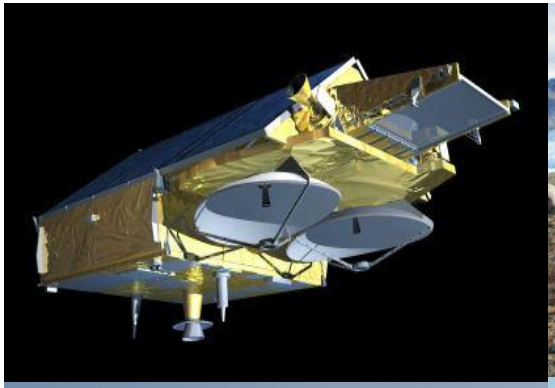
DTU Space
National Space Institute

DTU Technical University of Denmark

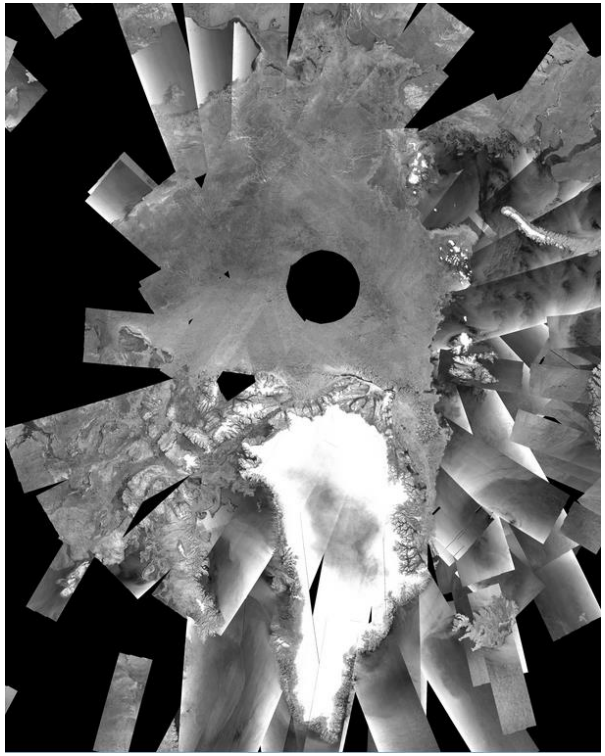
www.space.dtu.dk

Is- og geodynamik med satellitdata, fly og droner

Rene Forsberg, DTU Space



Sentinel-1 dækning, 31 Oct 2016
(3-dages mosaik, seaice.dk)

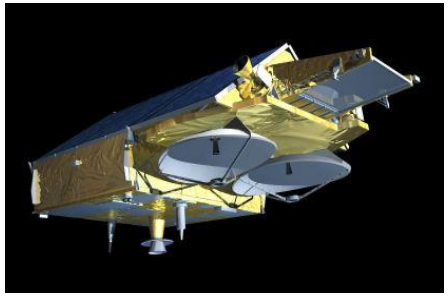


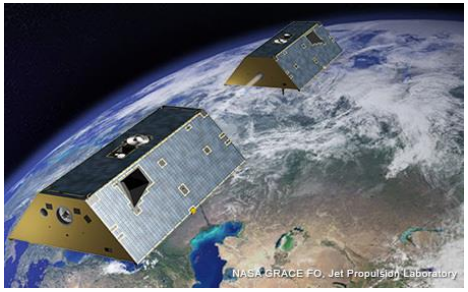
Nye satellitter styrker overvågning af klima og kryosfæreændringer

- EU/ESA Copernicus constellation (Sentinel-1, -2, -3: ishastigheder, isudbredelse, højdeændringer) … *sandtids monitering: 6 dages ishastigheder er nu mulige*

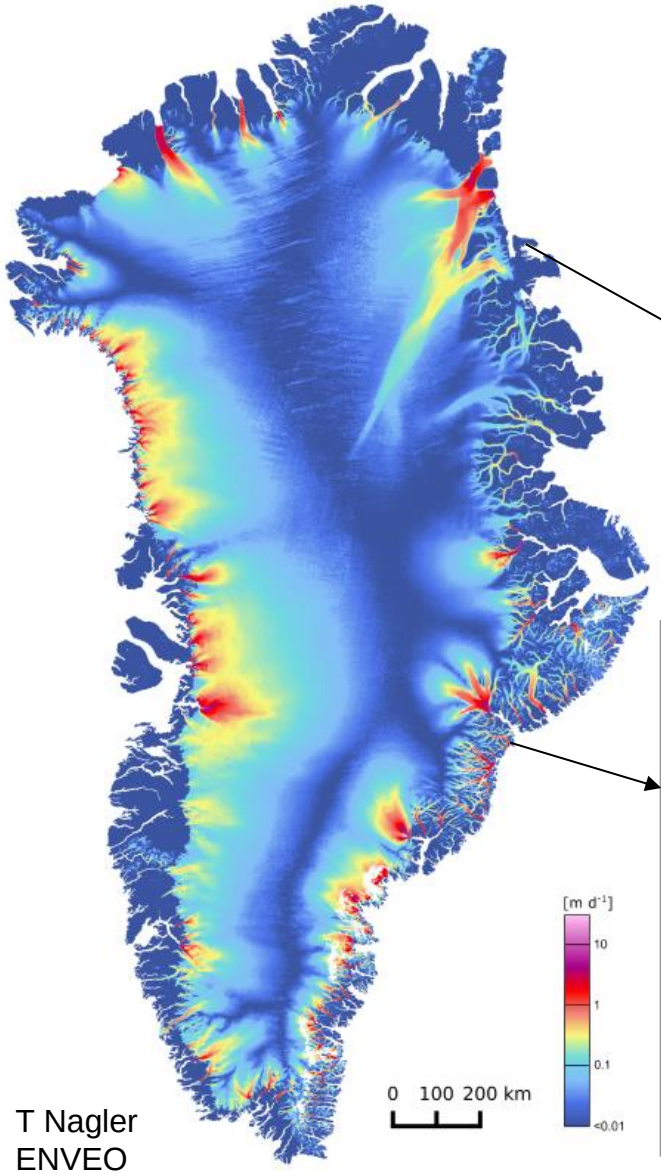
- NASA IceSat-2, NASA/DLR GRACE, GRACE follow-on: højde- og masse- ændringer … *månedligt, nye laser teknologier (laser SST, photon counting ..)*

Mere og bedre data til rådighed …. f.eks. Sentinel-2 10-m optiske billeder dagligt for det arktiske område, daglge ishastigheder i det arktiske ocean …





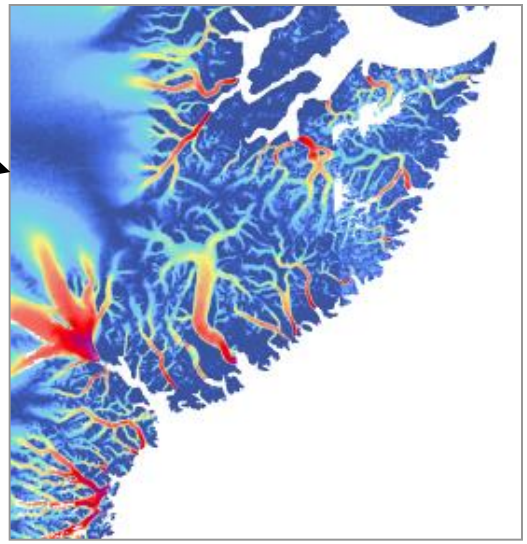
ESA Greenland Climate Change Initiative project … digested/gridded EO data …

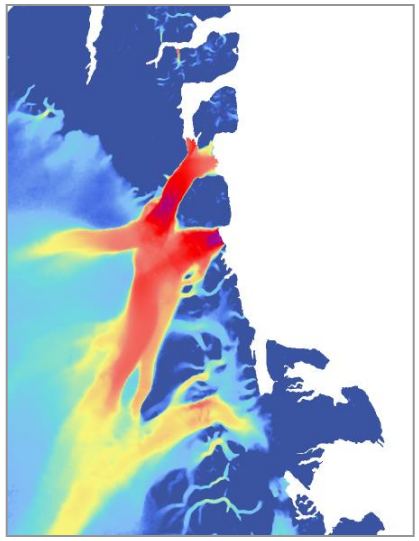


- **IV**: Ice velocity – greenland-wide and coast-near regions
- **SEC**: Surface elevation changes, ERS/Envisat/CryoSat, 1991-present
- **GLL**: Grounding lines from SAR, main northern floating glaciers 1991-present
- **CFL**: Calving front locations - 20+ main outlet glaciers 1991-present
- **GMB**: Gravimetric mass balance from GRACE

ECV grid/line data	SEC	IV	GLL	CFL	GMB
- Horizontal resolution	5 km	500 m	200 m	200 m	50 km
- Temporal resolution	1 yr	1 yr (12 days)	5 yr	1 yr	1 month
- Accuracy	0.1 m/yr	20 m/yr	1 km	200 m	20 GT

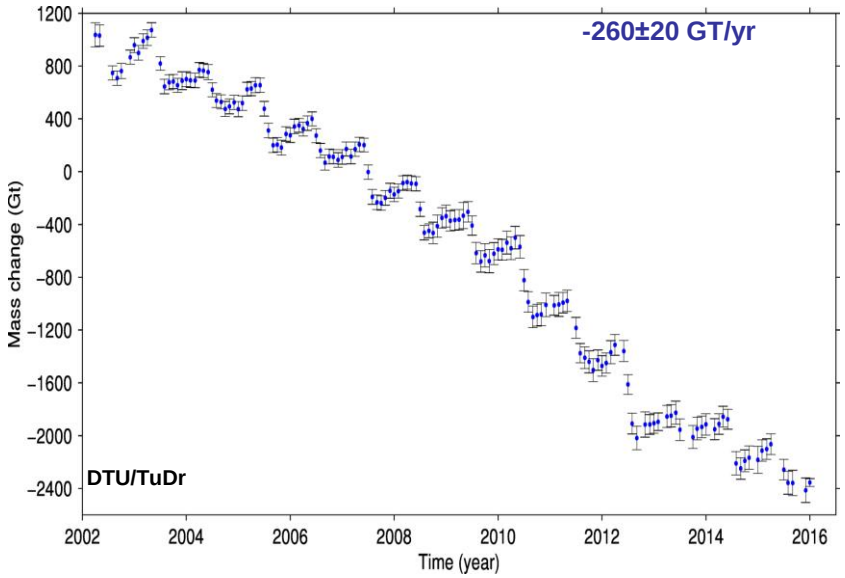
http://www.esa-icesheets-greenland-cci.org



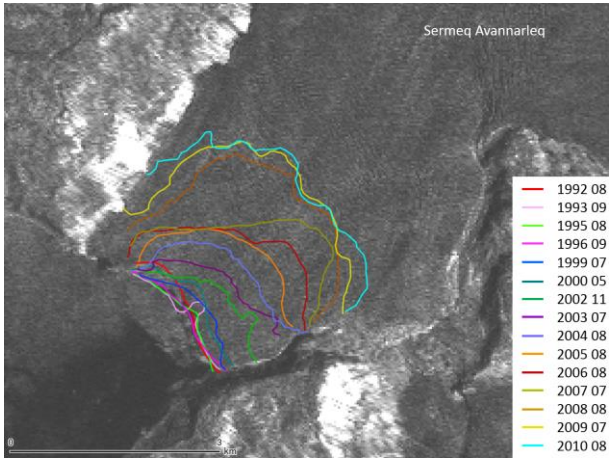


T Nagler
ENVEO

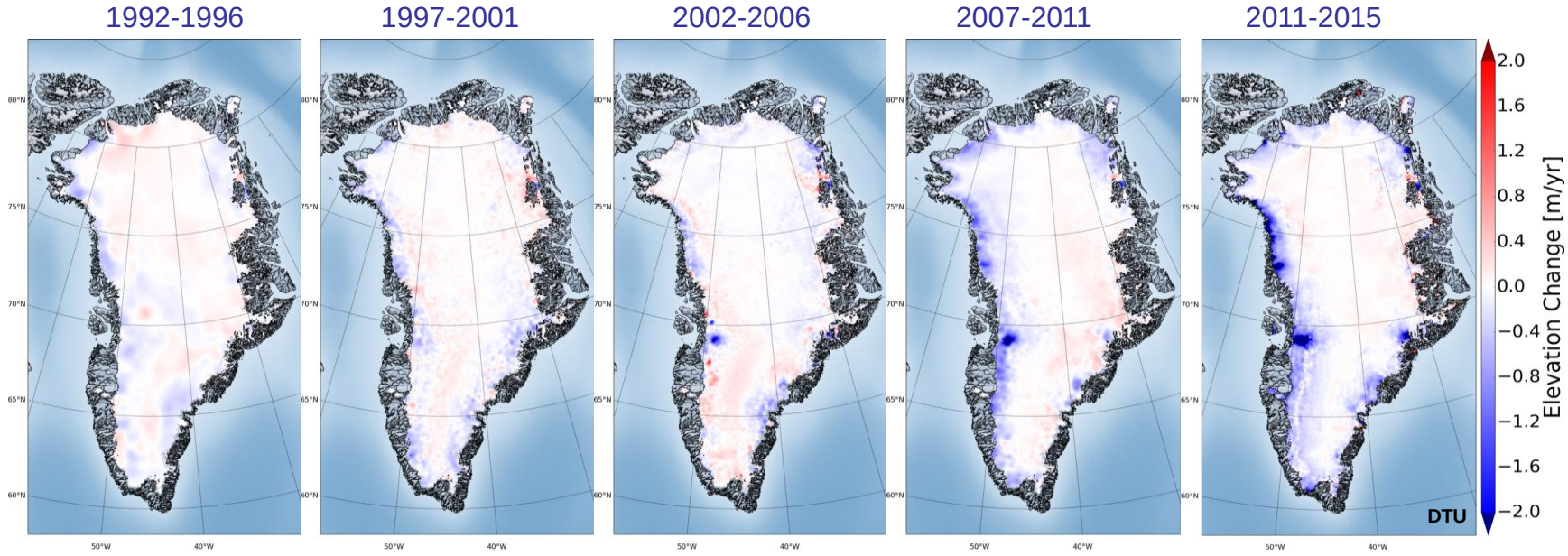
Overall mass change of the Greenland ice sheet



Variation in outlet glacier calving fronts



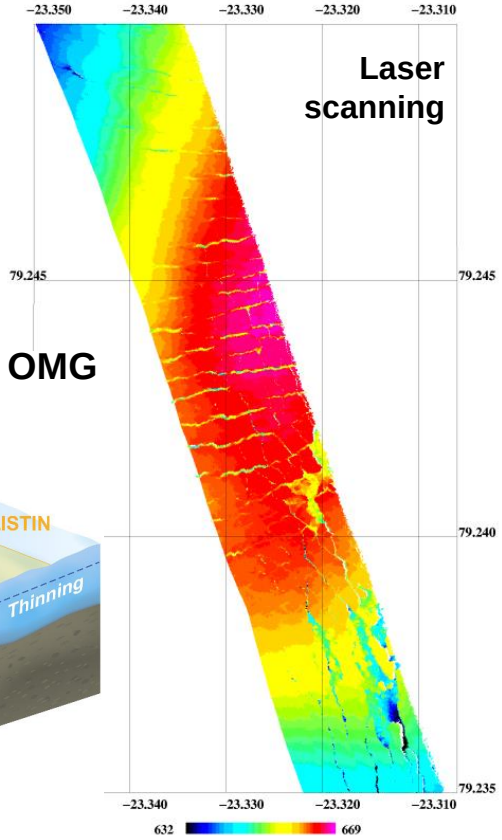
Elevation changes from radar altimetry 1992-2015

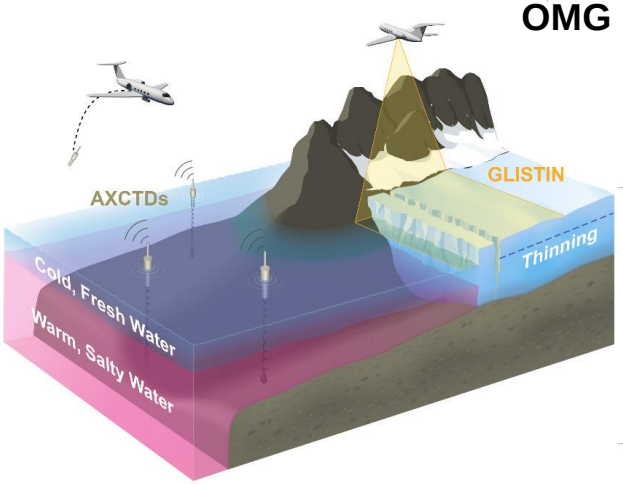


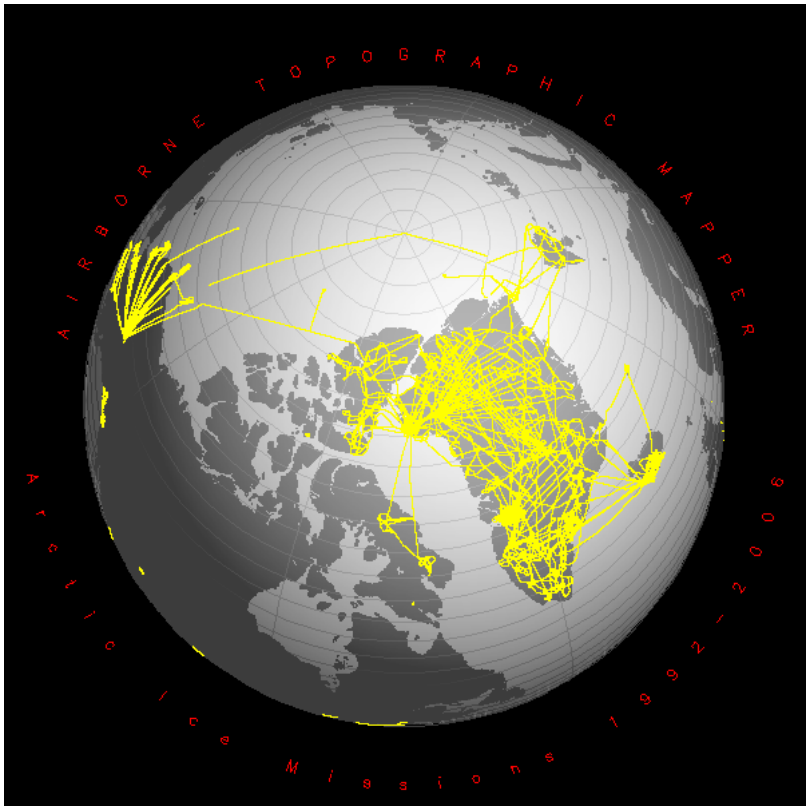
Satellitterne giver overblik – validering med fly og droner .. og bedre istykkelser

- NASA IceBridge 2010-15: 50 mio USD+
- NASA OMG (Oceans Melting Greenland): 30 M$
- European activities: *DTU-Space, AWI, BAS ..*

- laser scanning, various radars for satellite validation and glaciology, airborne gravity, magnetics for sub-ice structures and geology …

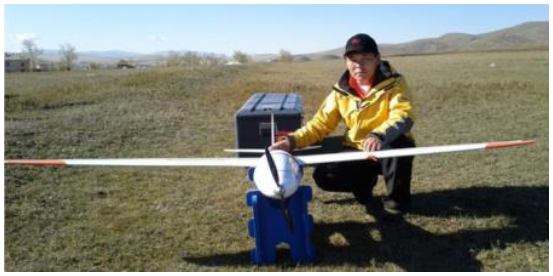




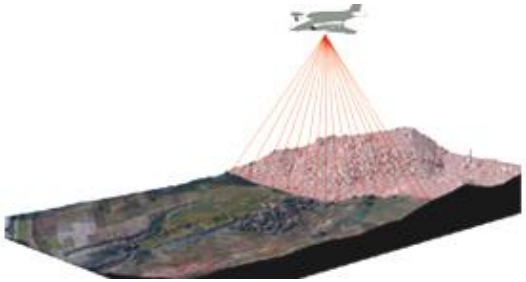


Droner – lokalt og regionalt supplement ..
Mange i dansk (polar)forskning

• Små droner (f.eks.E-bee) … kameraer, video .. processering … *forsker-opererede, visual line of sight, low-cost, standard sensorer, off-the-shelf 3D DEM software*
- Begrænset rækkevidde (<1 time)
- Mange applikationer i kortlægning, arkæologi, ..
Godt forskningsværktøj ..



• Medium droner (f.eks. Penguin-B, Hawkeye ..)
Kræver erfaren/professionel operatør … dyre i drift
- Mulighed for BVLOS operation
- Lang rækkevidde (4-10 timer), ok til is-overvågning
- Egenudviklede/kommercielle sensorer (f.eks. lidar, sporstoffer, atmosfærekemi, magnetik, tyngdefelt sensorer)
Gode forskningsmuligheder – nye sensorer ..



• Store droner (f.eks. GlobalHawk)
- Ekstremt kostbare operationer
- Storskala overvågning (>24 timer endurance)
- Sensorer fuldt "konkurrencedygtige" med fly sensorer
Uden for rækkevidde af dansk forskning ..