



Christian Michelsen Research



# Enlighten-web - interaktiv visuell analyse for bedre forståelse av geofarer

Tor Langeland 25. April 2018  
Universitetet i Bergens IT-forum Solstrand



European Plate Observing System  
Europeisk infrastruktur program



Den norske implementeringen av EPOS

*«Kort fortalt skal EPOS samle data om jordobservasjoner som jordskjelv, vulkanutbrudd, tsunamier og andre prosesser i jordens indre, fra forskningsmiljøer og måleinstrumenter over hele Europa.*

*Prosjektet kan bidra til bedre forståelse for slike naturkatastrofer, og raskere respons fra myndigheter når de oppstår.»*

Kuvvet Atakan til geoforskning.no 31.10.2016

Enlighten-web – EPOS-N komponent for interaktiv visuell analyse av data relatert til geologi og geofysikk

# Oversikt

- Litt om CMR
- EPOS
- EPOS-Norway
- Enlighten-web for visualisering av data relatert til geologi og geofysikk
- Enlighten-web under panseret
- Jupyter Notebook og Jupyterhub
- Veien videre – The European Open Science Cloud

# About Christian Michelsen Research (CMR)



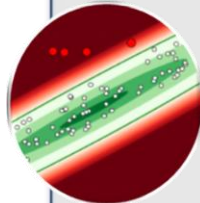
Technical and industrial research institute founded in 1930

Research into demonstrators, prototypes and commercial products.

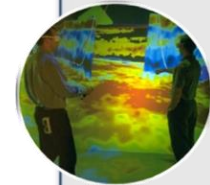


Measurement technology and platforms

Smart sensors and Data science



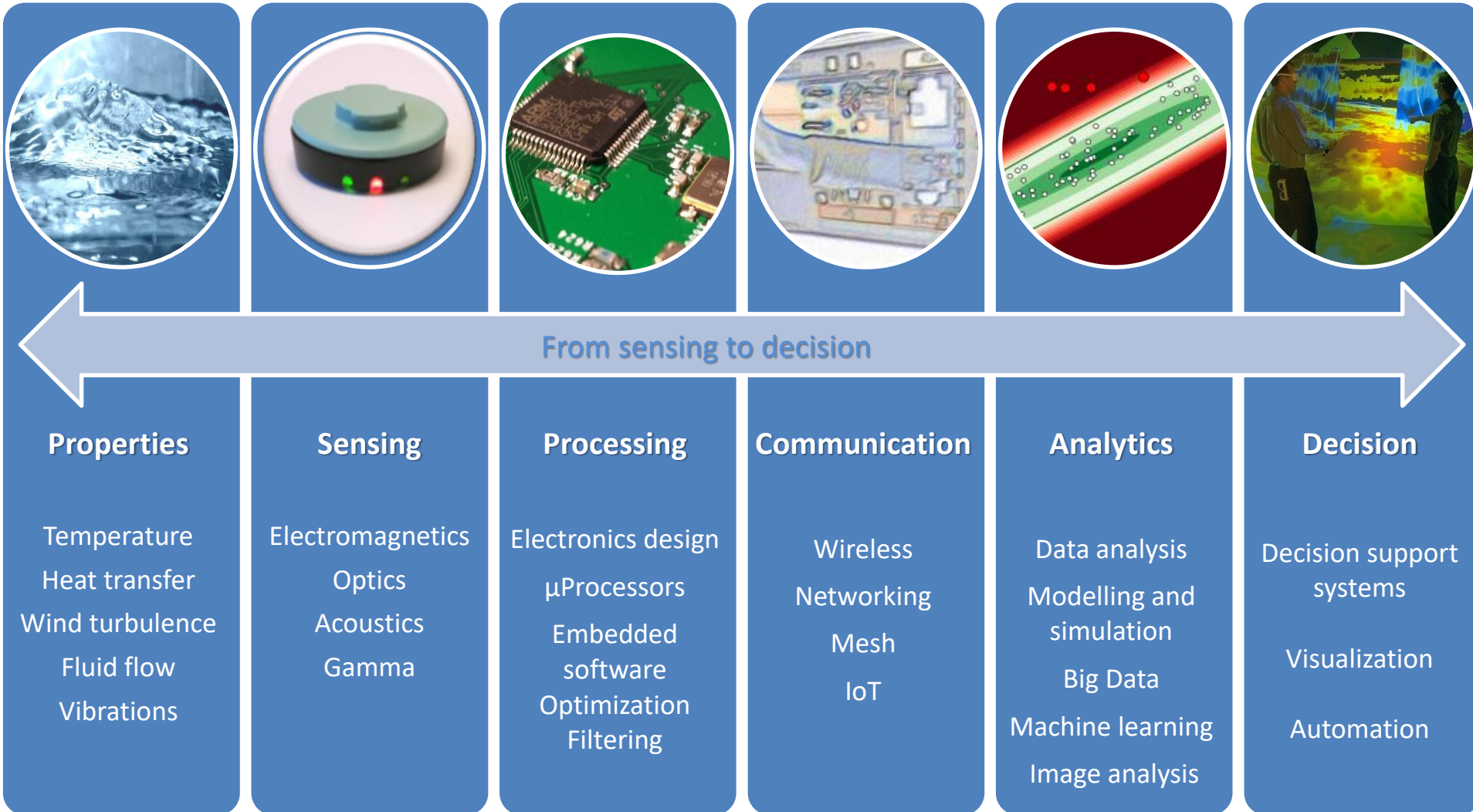
Market areas like Oil & Gas, Renewable energy, Marine and Environment, Health and medicine, Traffic and transport,...



CMR is a non-profit organization, owned by Norce AS.

Norce is a newly established company owning CMR, UNI Research, IRIS, Teknova and Agderforskning.

# CMR Science & Technology competence areas





# CMR Science & Technology - Market areas



## Oil and gas

- Flow, flow assurance and test facilities
- Fluid characterization
- Subsea leak detection
- Subsea pipeline inspection
- Visualization tools



## Renewable energy

- Offshore Wind - measurements, analysis and decision support
- Geothermal Energy – distributed energy systems
- CO<sub>2</sub> Storage and monitoring
- Energy Systems



## Marine and environmental observations

- Autonomous sensors and platforms
- Decision support systems for aquaculture and fisheries
- Advanced software for stock assessment
- Simulation and measurement systems for aquaculture
- Modelling, monitoring and data analysis



## Maritime, transport and rescue

- Traffic monitoring systems
- Real time monitoring and analysis for vessel traffic and logistics
- Decision support for search and rescue operations
- Visualizing and analyzing big data



## Medicine and health

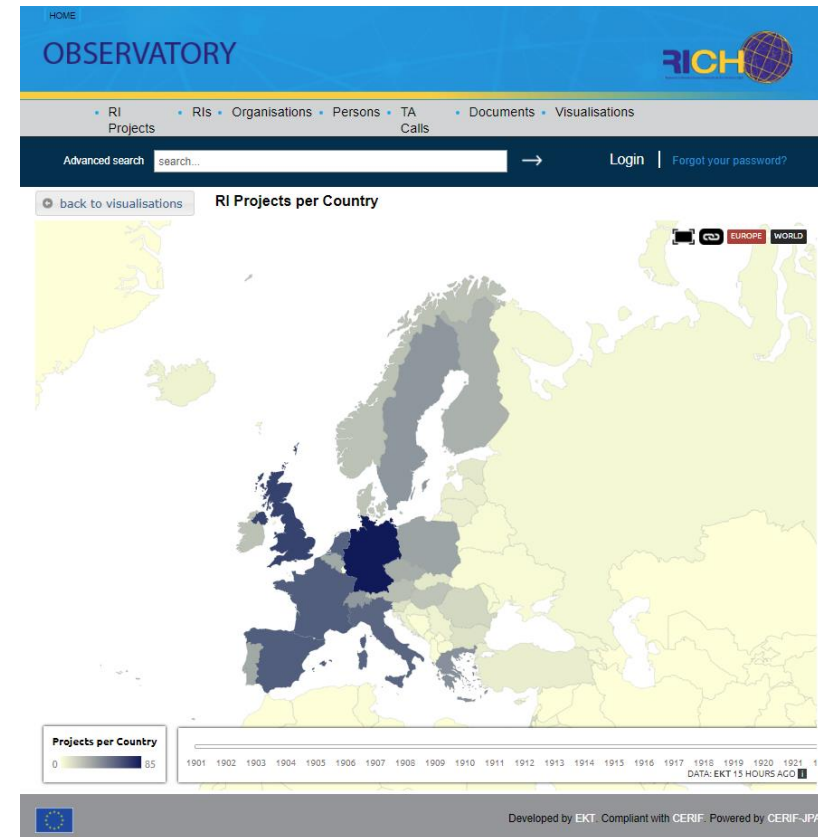
- Medical visualization tools for healthcare professionals
- Development of sensor/demonstrator for clinical studies
- Medical technical equipment for rehabilitation
- Modelling, image analysis and visualization



# EPOS er et ESFRI prosjekt

ESFRI = European Strategy Forum on Research Infrastructures “

- ...a coherent and strategy-led approach to policy-making on research infrastructures in Europe...”
- ESFRI Roadmap
- Finansiering: FP7, Horizon 2020, ESI Funds
- Horizon 2020: 2,5 Mrd. Euro mellom 2014 og 2020





# ESFRI Roadmap

ESFRI PROJECTS							
	NAME	FULL NAME	ROADMAP ENTRY (YEAR)	OPERATION (YEAR)	LEGAL STATUS (AS OF 10 MARCH 2016)	CONSTRUCTION COSTS (M€)	OPERATIONAL ANNUAL BUDGET (M€ YEAR)
ENERGY	ECCSEL	European Carbon Dioxide Capture and Storage Laboratory Infrastructure	2008	2016	ERIC under preparation	80-120	1**
	EU-SOLARIS	European SOLAR Research Infrastructure for Concentrated Solar Power	2010	2020*	ERIC under preparation	120	3-4
	MYRRHA	Multi-purpose hybrid Reactor for High-tech Applications	2010	2024*		NA	100
	WindScanner	European WindScanner Facility	2010	2018*		45-60	8
ENVIRONMENT	ACTRIS	Aerosols, Clouds and Trace gases Research Infrastructure	2016	2025*		190	50
	DANUBIUS-RI	International Centre for Advanced Studies on River-Sea Systems	2016	2022*		222	28
	EISCAT_3D	Next generation European Incoherent scatter radar system	2008	2021*		74	6
	EPOS	European Plate Observing System	2008	2020*	ERIC under preparation	53	15
	SIOS	Svalbard Integrated Arctic Earth Observing System	2008	2020*		80	2-3
HEALTH & MEDICINE	ANABEL	Infrastructure for Analysis and Experimentation on Ecosystems	2010	2018*		200	2-3**
	EMBRIC	European Marine Biological Resource Centre	2008	2016	ERIC under preparation	4.5	6
	EMPHASIS	European Infrastructure for multi-scale Plant Phenomics and Simulation for food security in a changing climate	2016	2020*		73	3.6
	ERINHA	European research infrastructure on highly pathogenic agents	2008	2018*		NA	NA
	EU-OPENSREEN	European Infrastructure of Open Screening Platforms for Chemical Biology	2008	2018*	ERIC under preparation	7	1.2
	Euro-Bioluminescence	European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences	2008	2017*	ERIC under preparation	NA	1.55
	ISBE	Infrastructure for Systems Biology Europe	2010	2018*		30	7.2
	MIRRI	Microbial Resource Research Infrastructure	2010	2019*		6.2	1
	CTA	Cherenkov Telescope Array	2008	2023*		297	20
	EST	European Solar Telescope	2016	2026*		200	9
PHYSICAL SCIENCES & ENGINEERING	KM3Net 2.0	KM3 Neutrino Telescope 2.0: Astroparticle & Oscillations Research with Cosmics In the Abyss	2016	2020*		92	3
	E-RHIS	European Research Infrastructure for Heritage Science	2016	2022*		4	5

\*expected

\*\*for contracted services

NA= Not Available

ESFRI LANDMARKS							
	NAME	FULL NAME	ROADMAP ENTRY (YEAR)	OPERATION (YEAR)	LEGAL STATUS (AS OF 10 MARCH 2016)	CAPITAL VALUE (M€)	OPERATIONAL ANNUAL BUDGET (M€ YEAR)
ENERGY	JHR	Jules Horowitz Reactor	2006	2020*		1,000	NA
	EMSO	European Multidisciplinary Seafloor and water-column Observatory	2006	2016	ERIC under preparation	108	36
	EURO-ARGO ERIC	European contribution to the international Argo Programme	2006	2014	ERIC, 2014	10	8
	IAGOS	In-service Aircraft for a Global Observing System	2006	2014	AISBL, 2014	25	6
ENVIRONMENT	ICOS ERIC	Integrated Carbon Observation System	2006	2016	ERIC, 2015	48	24-35
	LifeWatch	e-infrastructure for Biodiversity and Ecosystem Research	2006	2016	ERIC under preparation	66	10
	BBMRI ERIC	Biobanking and BioMolecular resources Research Infrastructure	2006	2014	ERIC, 2013	170-220	3.5
	EATRIS ERIC	European Advanced Translational Research Infrastructure in Medicine	2006	2013	ERIC, 2013	500	2.5
HEALTH & MEDICINE	ECRIN ERIC	European Clinical Research Infrastructure Network	2006	2014	ERIC, 2013	1.5	2
	ELIXIR	A distributed infrastructure for life-science information	2006	2014	ELIXIR Consortium Agreement, 2013	125	95
	INFRAFRONTIER	European Research Infrastructure for the generation, phenotyping, archiving and distribution of mouse disease models	2006	2013	GmbH, 2013 ERIC under preparation	180	80
	INSTRUCT	Integrated Structural Biology Infrastructure	2006	2012	International Consortium Agreement, 2012 ERIC under preparation	285	25
	E-ELT	European Extremely Large Telescope	2006	2024*	Programme of ESO	1,000	40
	ELI	Extreme Light Infrastructure	2006	2018*	AISBL, 2013 ERIC under preparation	850	90
	EMFL	European Magnetic Field Laboratory	2008	2014	AISBL, 2015	170	20
	ESRF UPGRADES	Phase I Phase II: Extremely Brilliant Source	2006	2015 2022*	Programme of ESRF	180 150	82
	European Spallation Source ERIC	European Spallation Source	2006	2025*	ERIC, 2015	1,843	140
	European XFEL	European X-Ray Free-Electron Laser Facility	2006	2017*	GmbH, 2009	1,490	115
FAIR	Facility for Antiproton and Ion Research	2006	2022*	GmbH, 2010	1,262	234	
HL-LHC	High-Luminosity Large Hadron Collider	2016	2026*	Programme of CERN	1,370	100	
ILL 20/20	Institut Max von Laue-Paul Langevin	2006	2020*	Programme of ILL	171	92	
SKA	Square Kilometer Array	2006	2020*	SKAQ, 2011	650	75	
SPIRAL2	Système de Production d'Ions Radioactifs en Ligne de 2e génération	2006	2016	Programme of GANIL	110	5-6	
SOCIAL & CULTURAL INNOVATION	CESSDA	Consortium of European Social Science Data Archives	2006	2013	Norwegian limited company, 2013 ERIC under preparation	NA	1.9
	CLARIN-ERIC	Common Language Resources and Technology Infrastructure	2006	2012	ERIC, 2012	NA	12
	DARIAH-ERIC	Digital Research Infrastructure for the Arts and Humanities	2006	2019*	ERIC, 2014	4.3	0.6
	ESS ERIC	European Social Survey	2006	2013	ERIC, 2013	NA	6
	SHARE ERIC	Survey of Health, Ageing and Retirement in Europe	2006	2011	ERIC, 2011	110	12
	PRACE	Partnership for Advanced Computing in Europe	2006	2010	AISBL, 2010	500	120

\*expected

NA= Not Available

# EPOS tidslinje



- ESFRI Roadmap entry: 2008
- UiB Geovitenskap partner i prosjektet
- I IP-fasen er UiB Geovitenskap leder for arbeidspakke 6
- Kuvvet Atakan sitter i Project Development Board for EPOS IP

# The EPOS infrastructure

**A long-term plan for the integration  
of research infrastructures for solid Earth Science in Europe**

**EPOS integrates the  
existing and future advanced  
European facilities into  
a single, distributed,  
sustainable infrastructure  
taking full advantage of new e-  
science opportunities  
for Open Science**

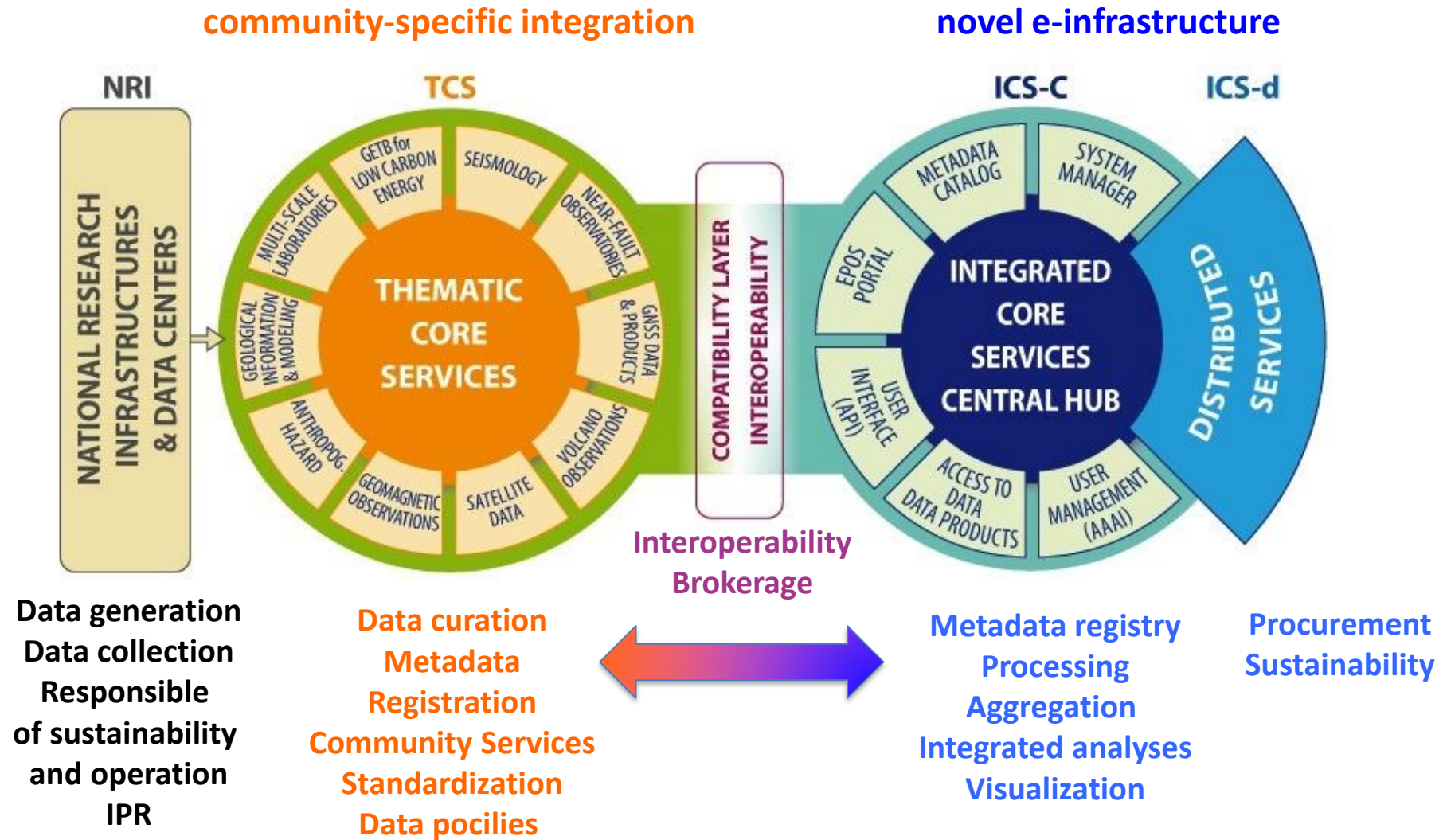


Several PetaBytes of solid Earth Science data will be available

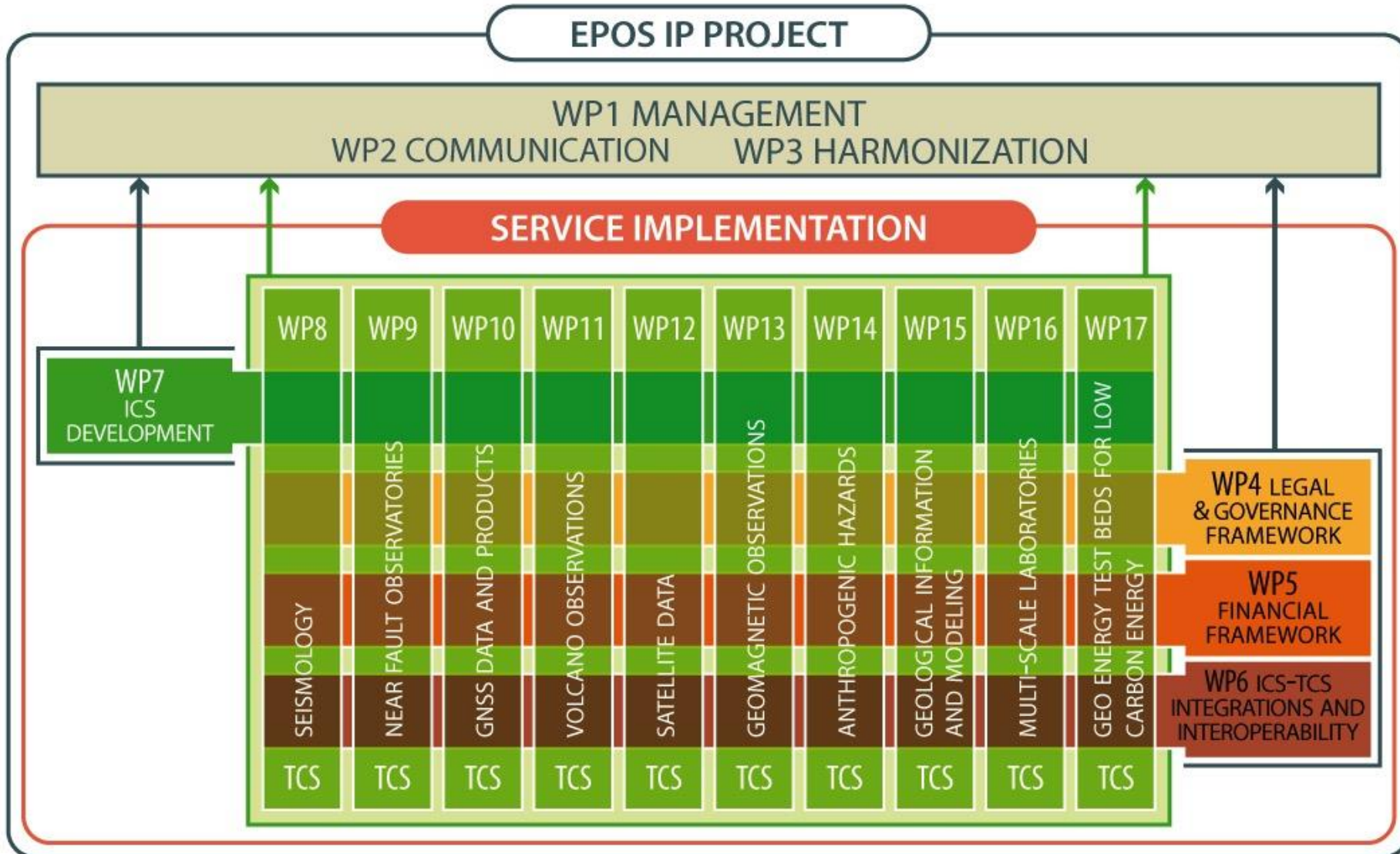
Several thousands of users expected to access the infrastructure



# EPOS Architecture for Implementation



# EPOS IP is a complex project with 46 partner institutions and 17 WPs





# EPOS ICS Portal

EPOS ICS
Select API: Non-authenticating | Feedback | 10 | Log in

Online

MAIN NAVIGATION

Discover

- Active Workspace >
- Workspace Content 0
- Spatial Visualisation 0
- Temporal Visualisation 0
- Processing Model 0

Person
Organisation
Webservice

Search
Reset

Search Results (15 Found)

Name ↓	Type ↓	Description ↓	Actions
Centre national de la recherche scientifique	Organisation		<a href="#">View information...</a> <a href="#">Show in map</a> <a href="#">Add to workspace...</a>
Deutsches GeoForschungsZentrum	Organisation		<a href="#">View information...</a> <a href="#">Show in map</a> <a href="#">Add to workspace...</a>
European-Mediterranean Seismological Centre	Organisation		<a href="#">View information...</a> <a href="#">Show in map</a> <a href="#">Add to workspace...</a>
GFZ German Research Centre for Geosciences	Organisation		<a href="#">View information...</a> <a href="#">Show in map</a> <a href="#">Add to workspace...</a>

server.
Version: 0.6.x Commit: baba2dd


- Integrert og enklere tilgang til data fra eksisterende seismiske og geodetiske nettverk, samt geologiske og geofysiske databaser.
- Bygge ut ny monitoreringsinfrastruktur med spesielt vekt på den arktiske dimensjonen.
- Fasilitere samarbeid på tvers av faglige disipliner, blant annet gjennom verktøy for visuell analyse av store tverrfaglige datasett.
  - Utfordring fordi EPOS omfatter stort mangfold av datatyper

# EPOS-N

EUROPEAN PLATE OBSERVING SYSTEM - NORWAY

- Finansiert av NFR 2016 – 2020 (implementeringsfase): ~51 MNOK
- Totalbudsjett 2016 - 2025: ~84 MNOK
- Prosjektledelse UiB



UNIVERSITY OF BERGEN



UNIVERSITY OF OSLO



Kartverket

# EPOS-N Components

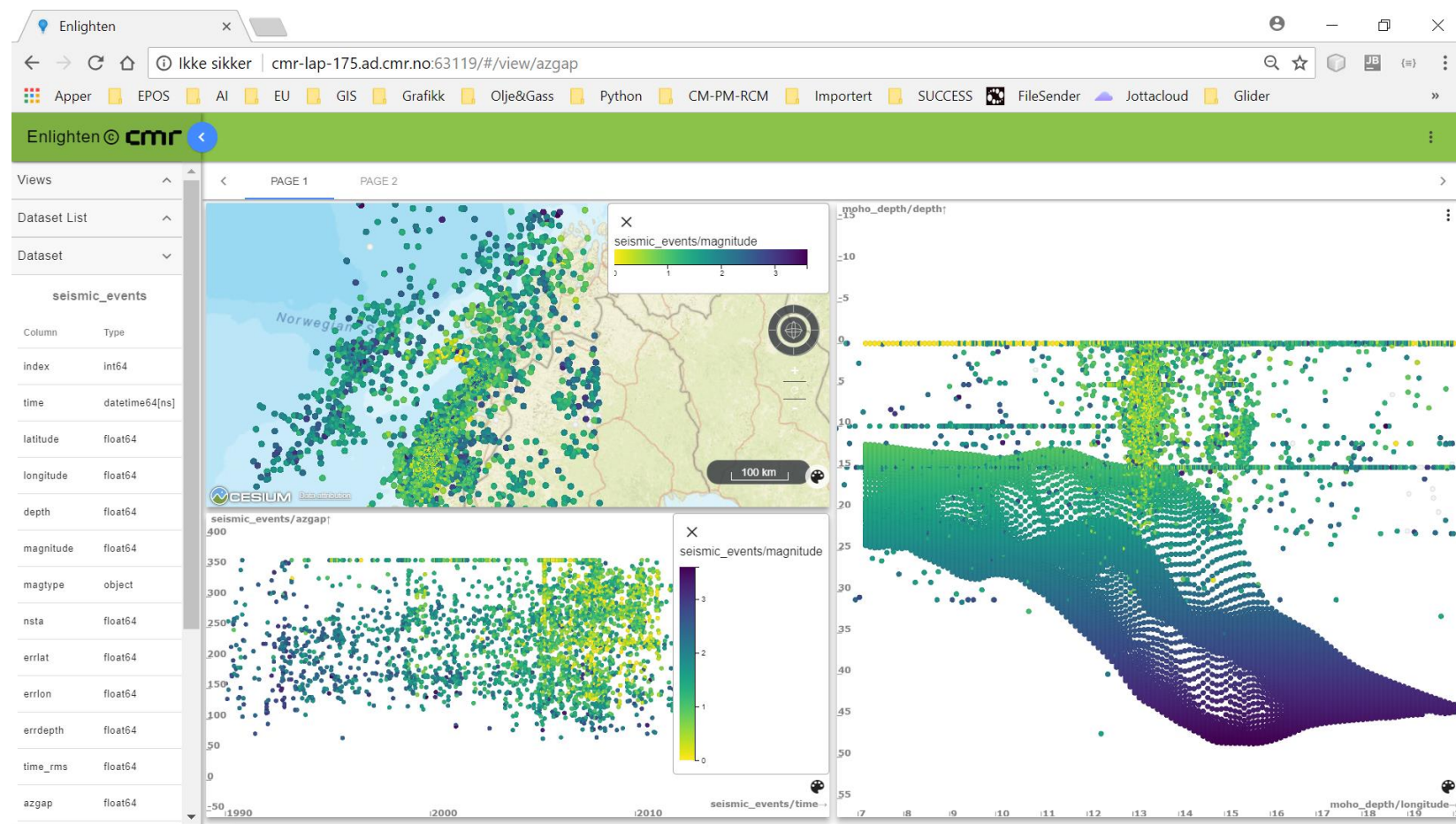
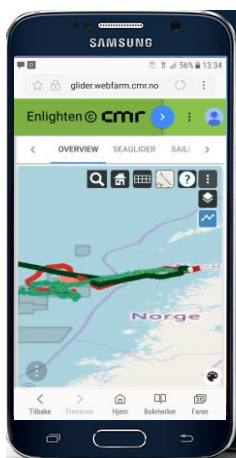
- **Component 1: E-infrastructure**
  - Data integration
  - Data analysis tools and visualization tools
  - National web portal
  - Data storage, hardware and maintenance
- **Component 2: Improved Observations in the Arctic**
  - Nordland (seismic and geodetic stations)
  - Svalbard (seismic and geodetic stations)
  - Jan Mayen (volcano observatory)
  - Bjørnøya (seismic array)
  - OBS – offshore surveys
  - Knipovich Ridge aeromagnetic survey
- **Component 3: Solid Earth Science Forum**
  - Solid Earth Science Forum Workshops
  - Training sessions

# Enlighten-web

Utviklet av CMR

Interaktiv Visuell  
Analyse

Web app



- Effektiv visualisering av store flerdimensjonale datasett
- Millioner av punkter – full interaktiv respons
- Interaktiv filtrering av data “Brushing and linking”





Views ^



PAGE 1



Dataset List ^

Dataset ^

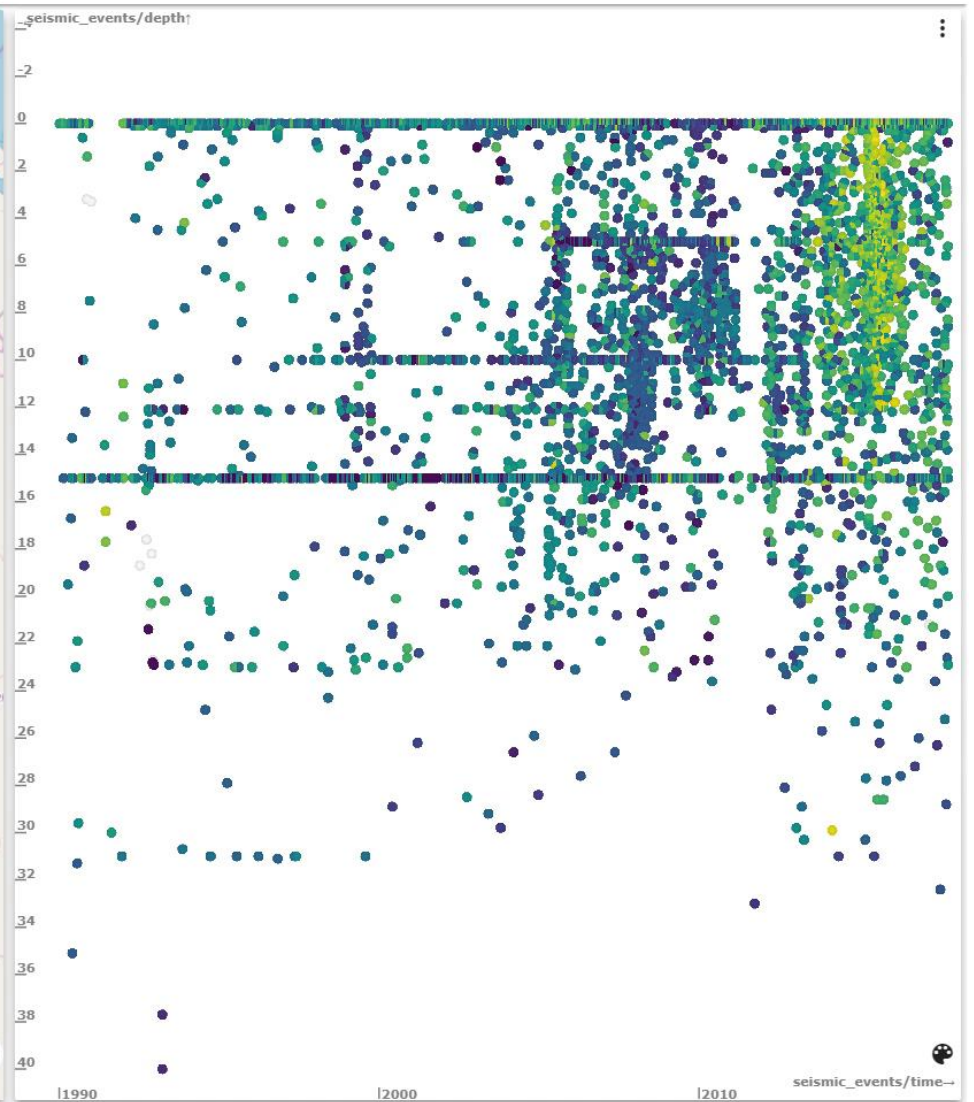
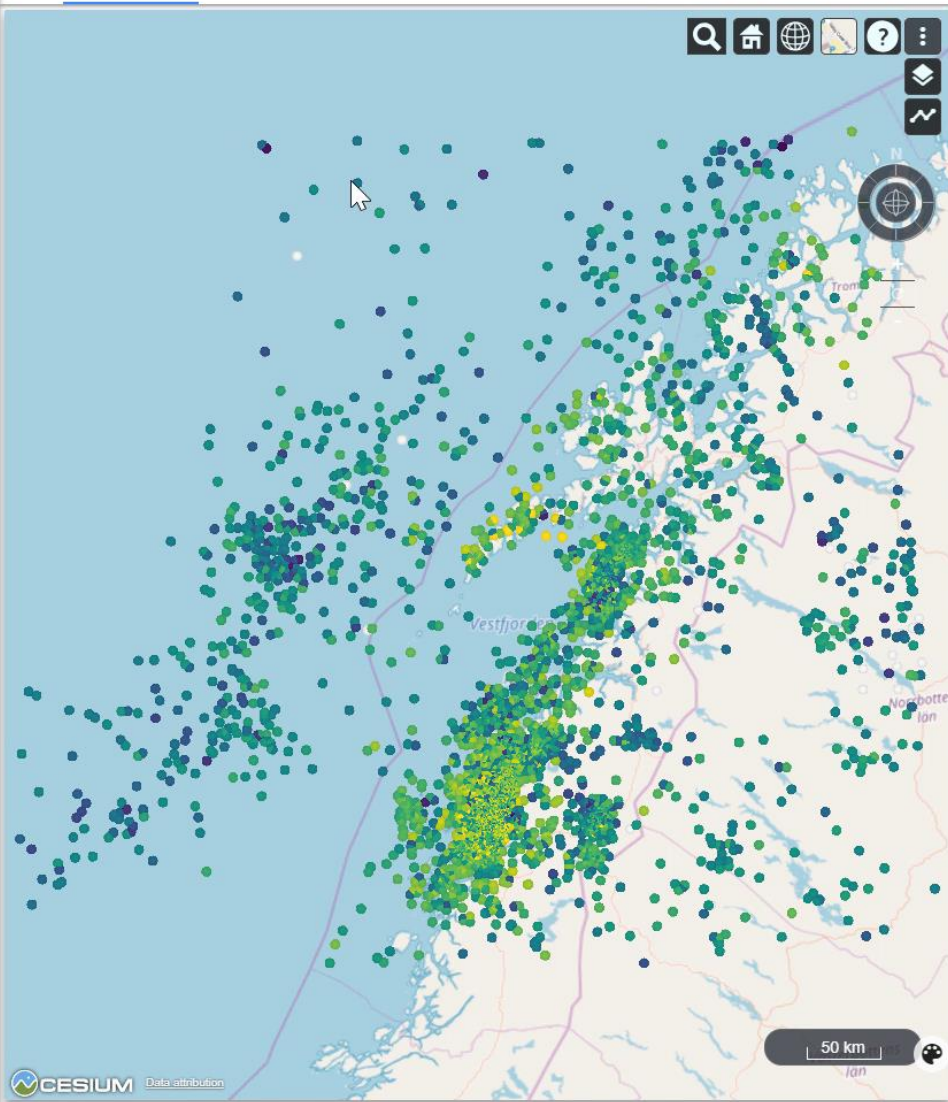




- gnss0 X
- Gliders X
- t2 X
- InSAR X
- seaglider X
- WaveGlider X
- nordic\_stations X
- azgap X
- gnss1 X
- Seismic0 X
- Report 2017 X
- cesiumtest X
- uib-it-dagene2018 X
- uib-it-dagene2018 -2 X

Dataset List ^  
Dataset ^

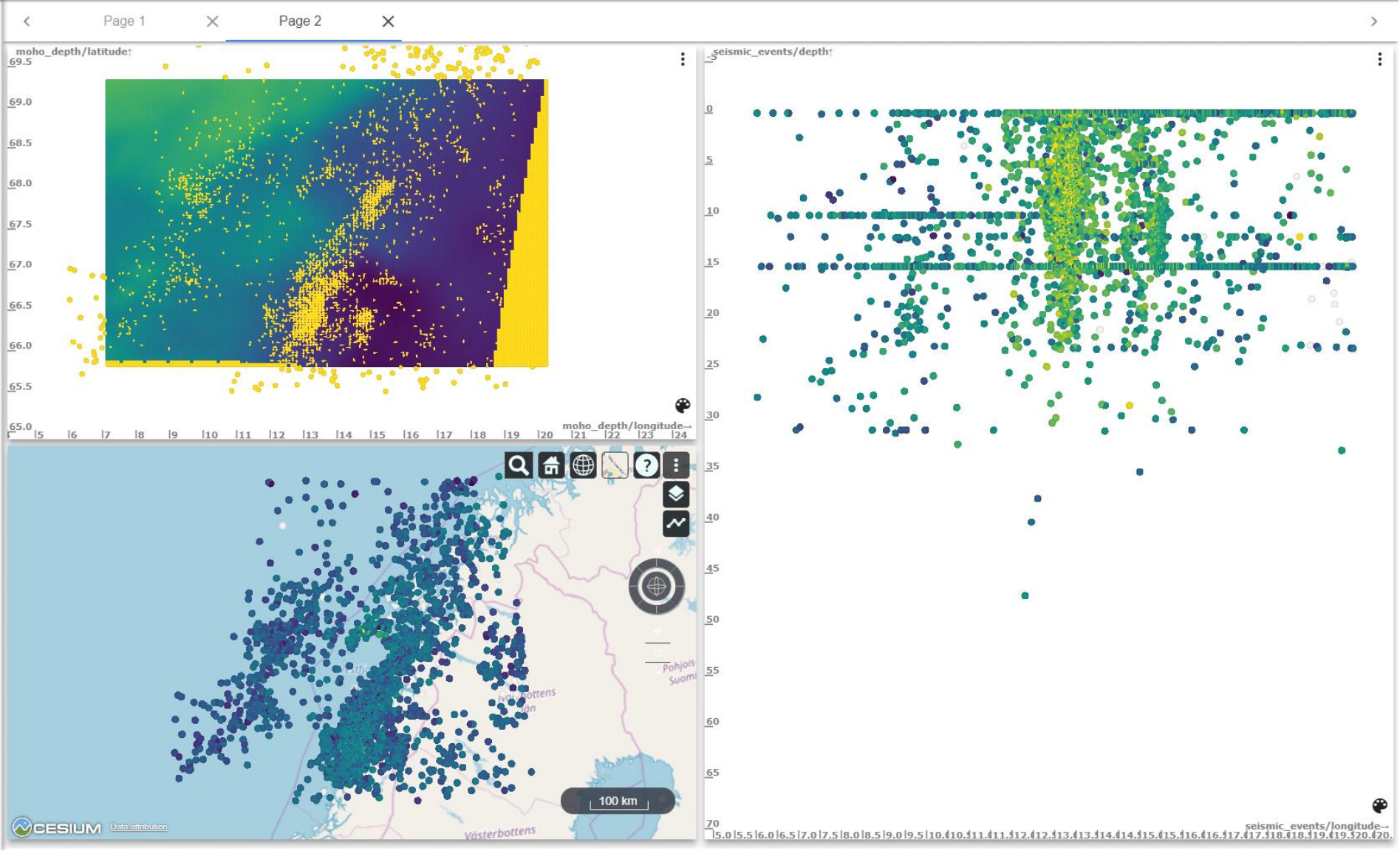
PAGE 1



- moho\_depth 14K
- sediment\_thickness 578K
- seismic\_events 6K
- top\_basement\_depth 338K
- Adm. regions
- BerggrunnN50WMS
- BerggrunnWMS
- GeofysikkWMS2
- GeokjemiWMS
- MarinBunnsedimenterWMS
- MarinGeofarerWMS
- NPD factmaps
- SkredUstabileFjellpartiWM

Dataset

moho_depth	
Column	Type
index	int64
longitude	float64
latitude	float64
depth	float64

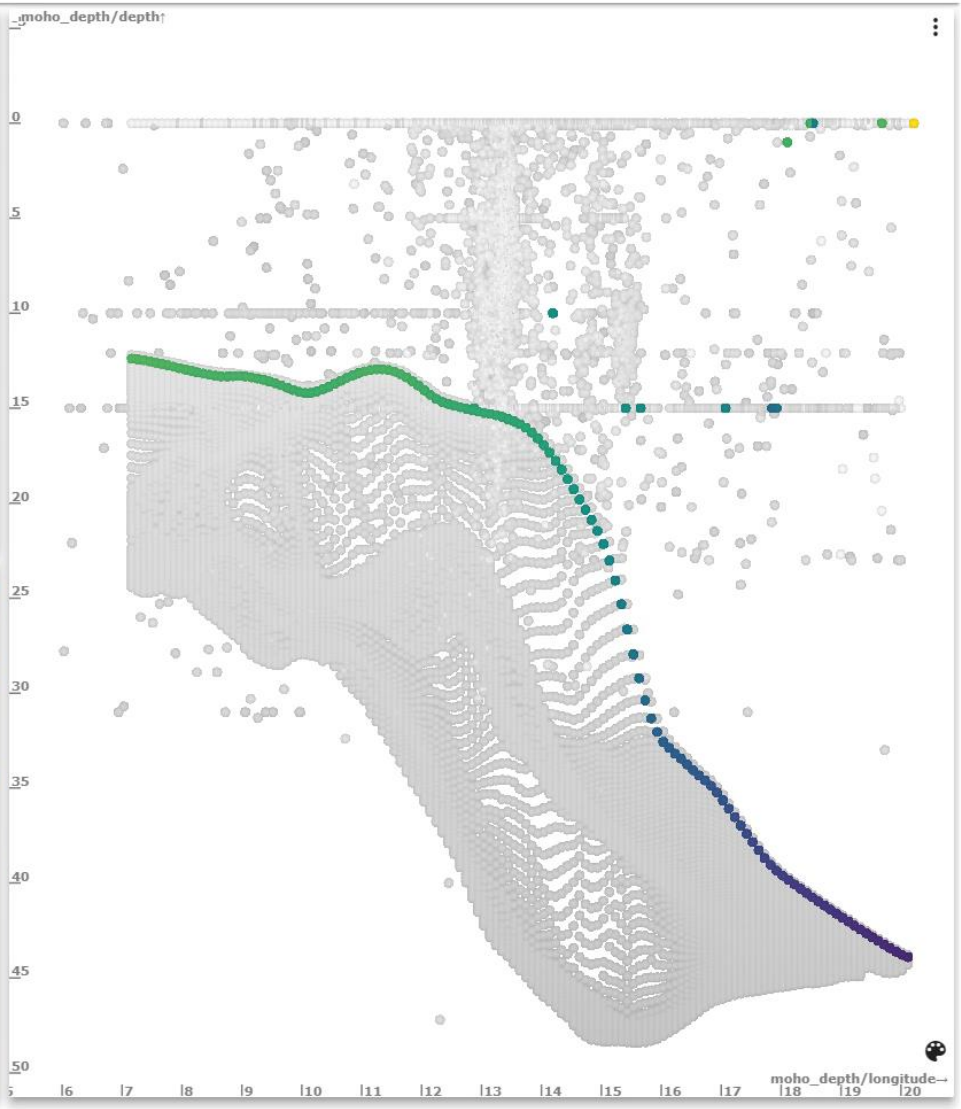
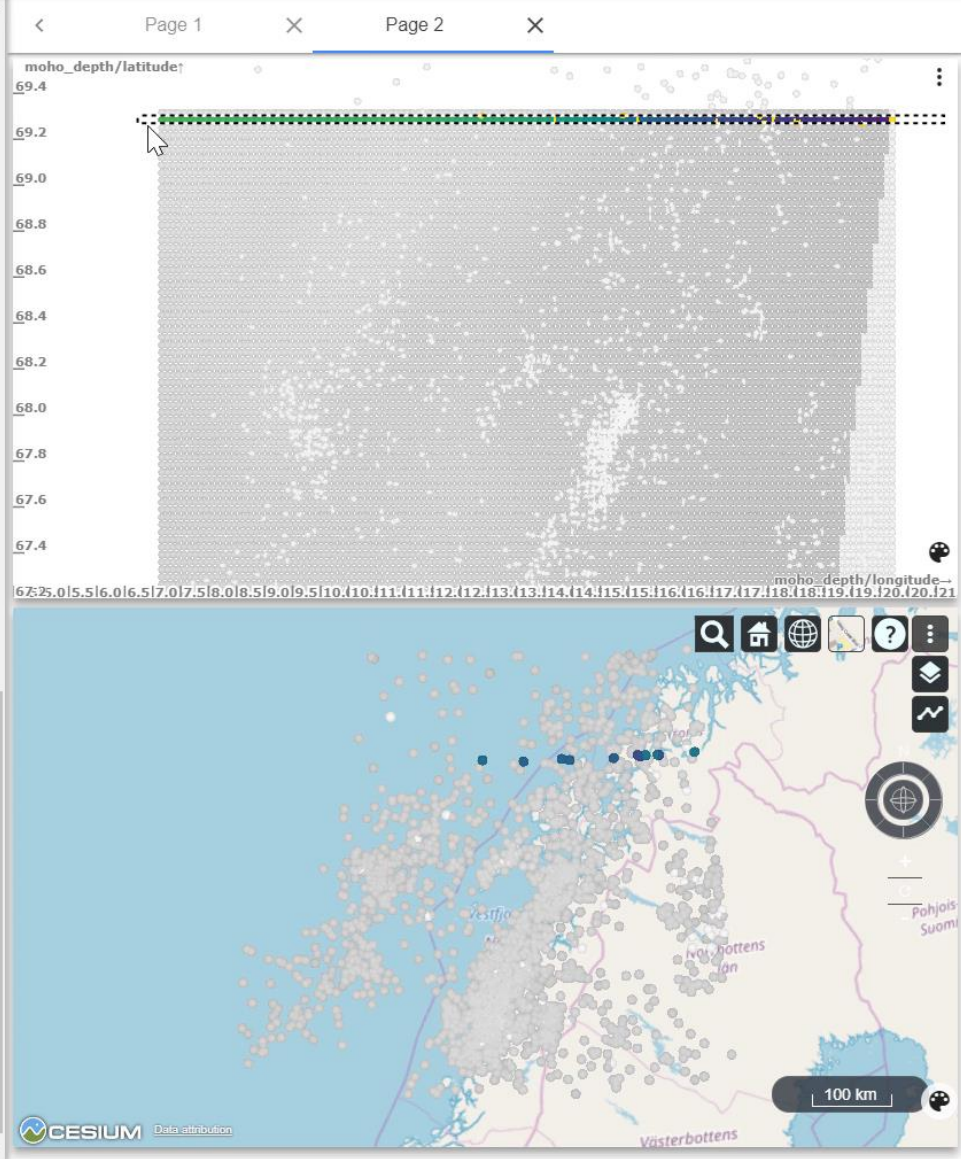




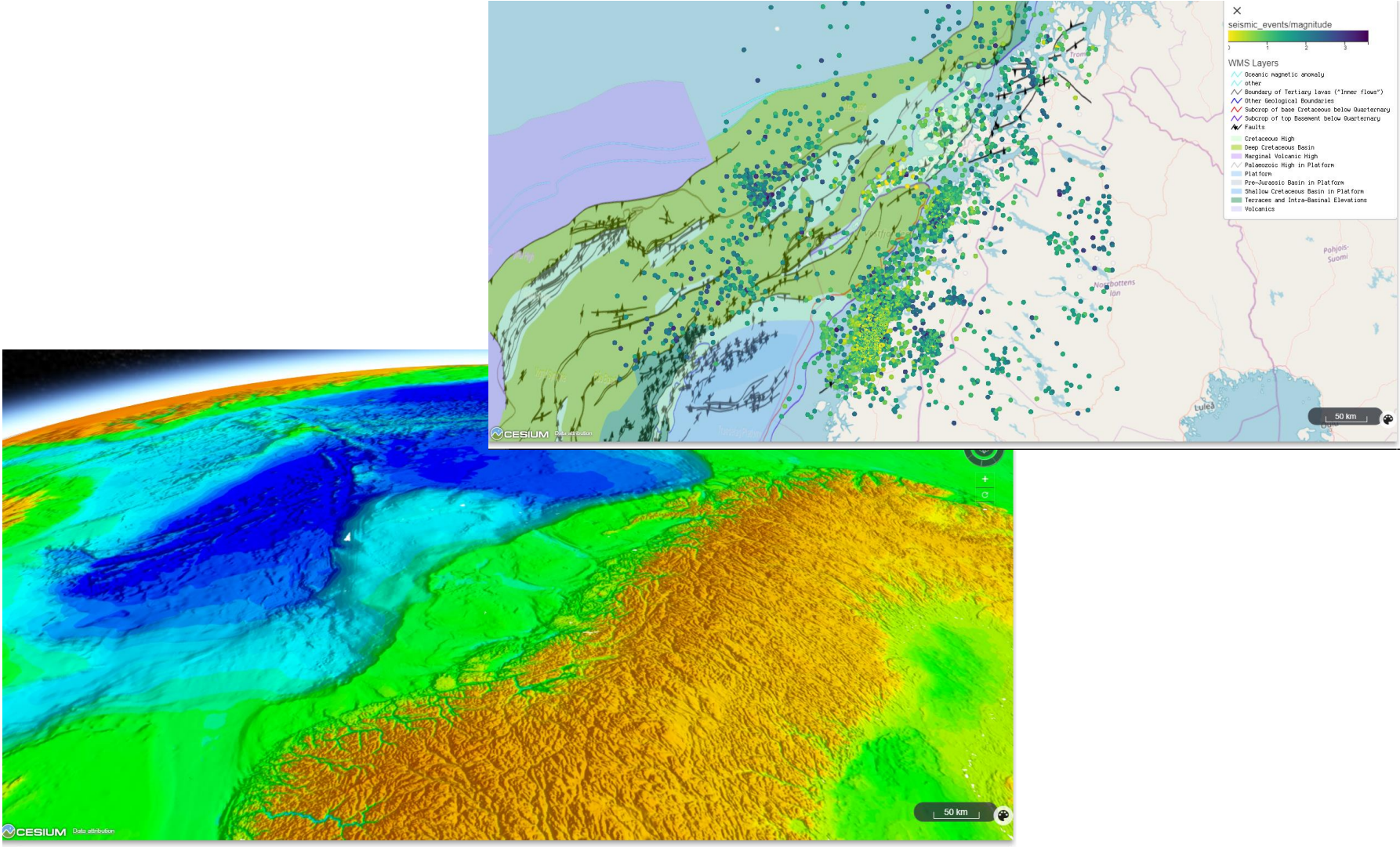
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Dataset

moho_depth	
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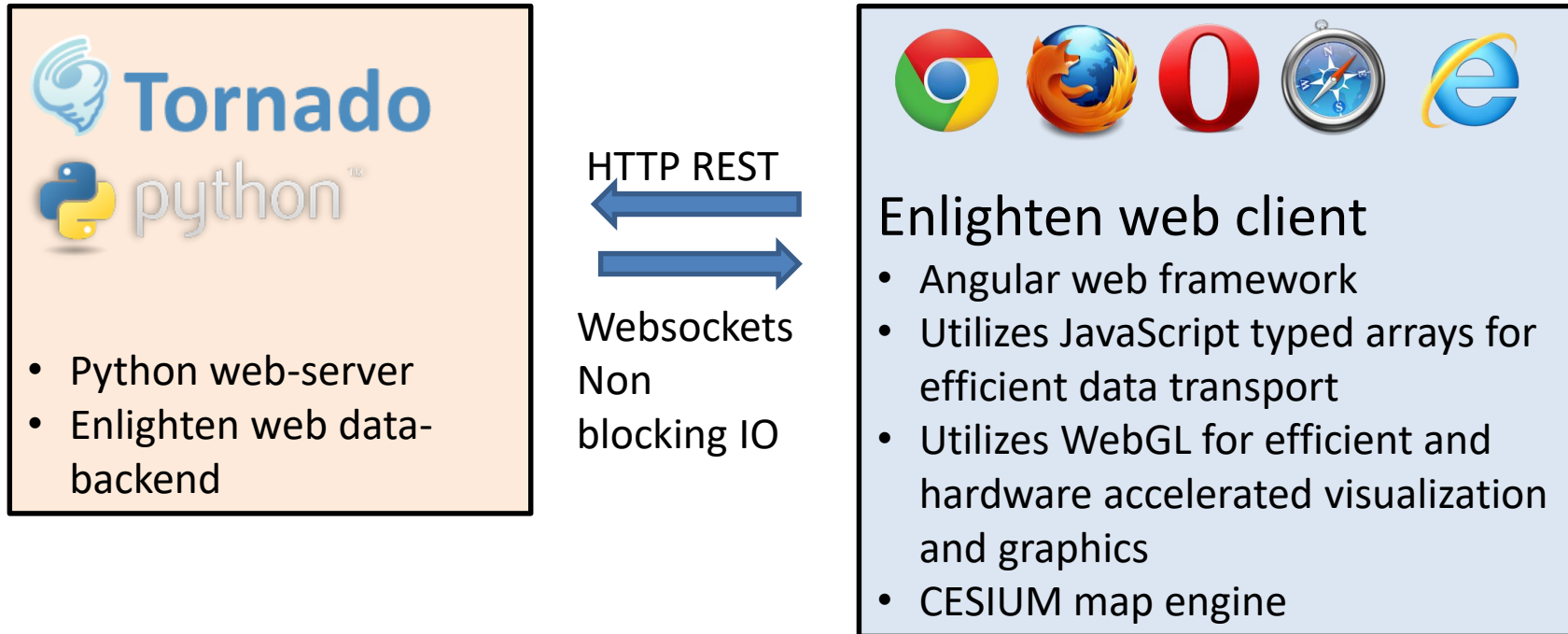


# Støtte for WMS





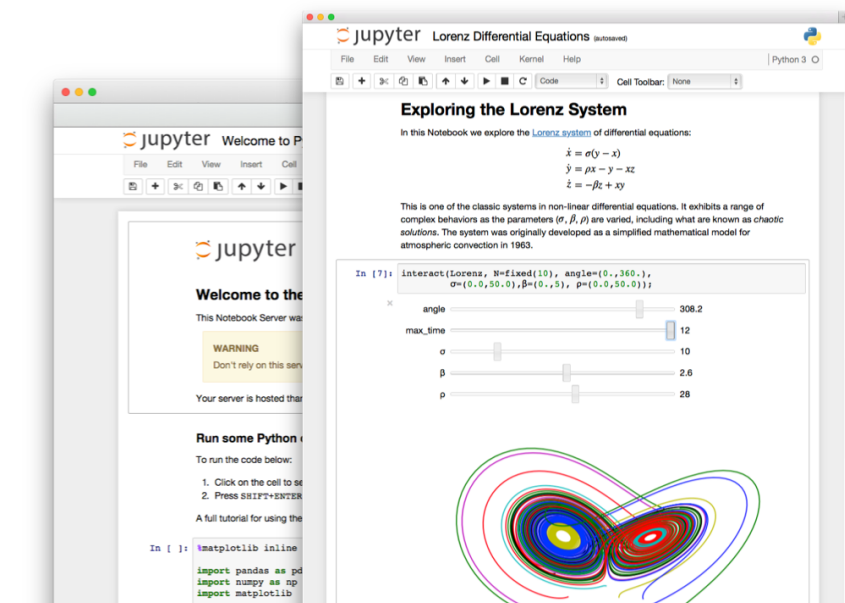
# Enlighten-Web under panseret



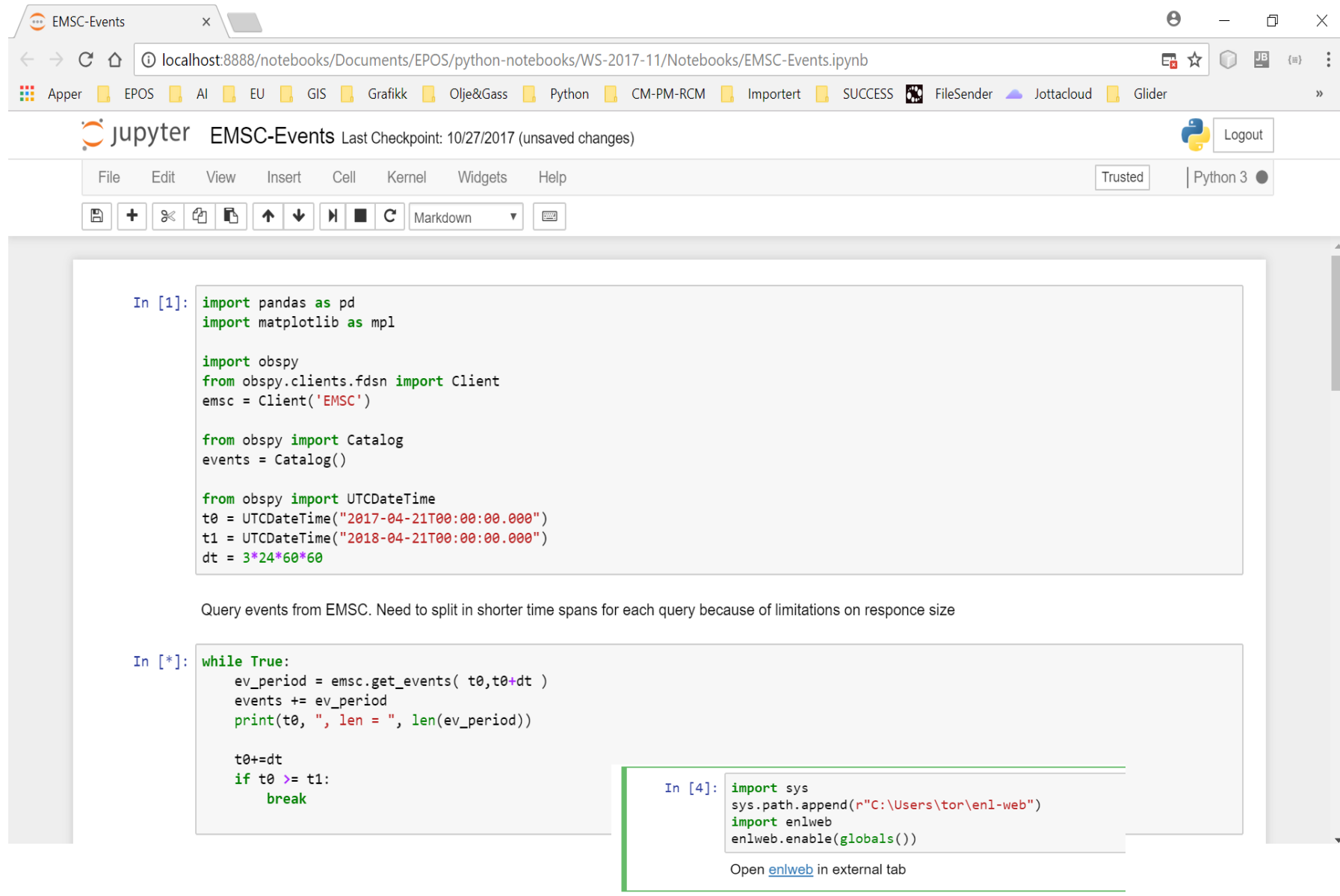
Adapts rendering load on client to performance

# Jupyter Notebook

- En web applikasjon som lar deg opprette og dele dokumenter med kode, beregninger og forklarende tekst eller presentasjoner
- Programmering i nettleser, mer enn 40 språk å velge mellom, Python, R C++, Fortran...
- <http://jupyter.org/>



# Notebook example



The screenshot shows a Jupyter Notebook interface in a web browser. The browser address bar shows the URL: localhost:8888/notebooks/Documents/EPOS/python-notebooks/WS-2017-11/Notebooks/EMSC-Events.ipynb. The notebook title is "EMSC-Events" and it indicates "Last Checkpoint: 10/27/2017 (unsaved changes)". The interface includes a menu bar (File, Edit, View, Insert, Cell, Kernel, Widgets, Help) and a toolbar with various icons for file operations and execution. The notebook content consists of three code cells:

```
In [1]: import pandas as pd
import matplotlib as mpl

import obspy
from obspy.clients.fdsn import Client
emsc = Client('EMSC')

from obspy import Catalog
events = Catalog()

from obspy import UTCDateTime
t0 = UTCDateTime("2017-04-21T00:00:00.000")
t1 = UTCDateTime("2018-04-21T00:00:00.000")
dt = 3*24*60*60
```

Query events from EMSC. Need to split in shorter time spans for each query because of limitations on response size

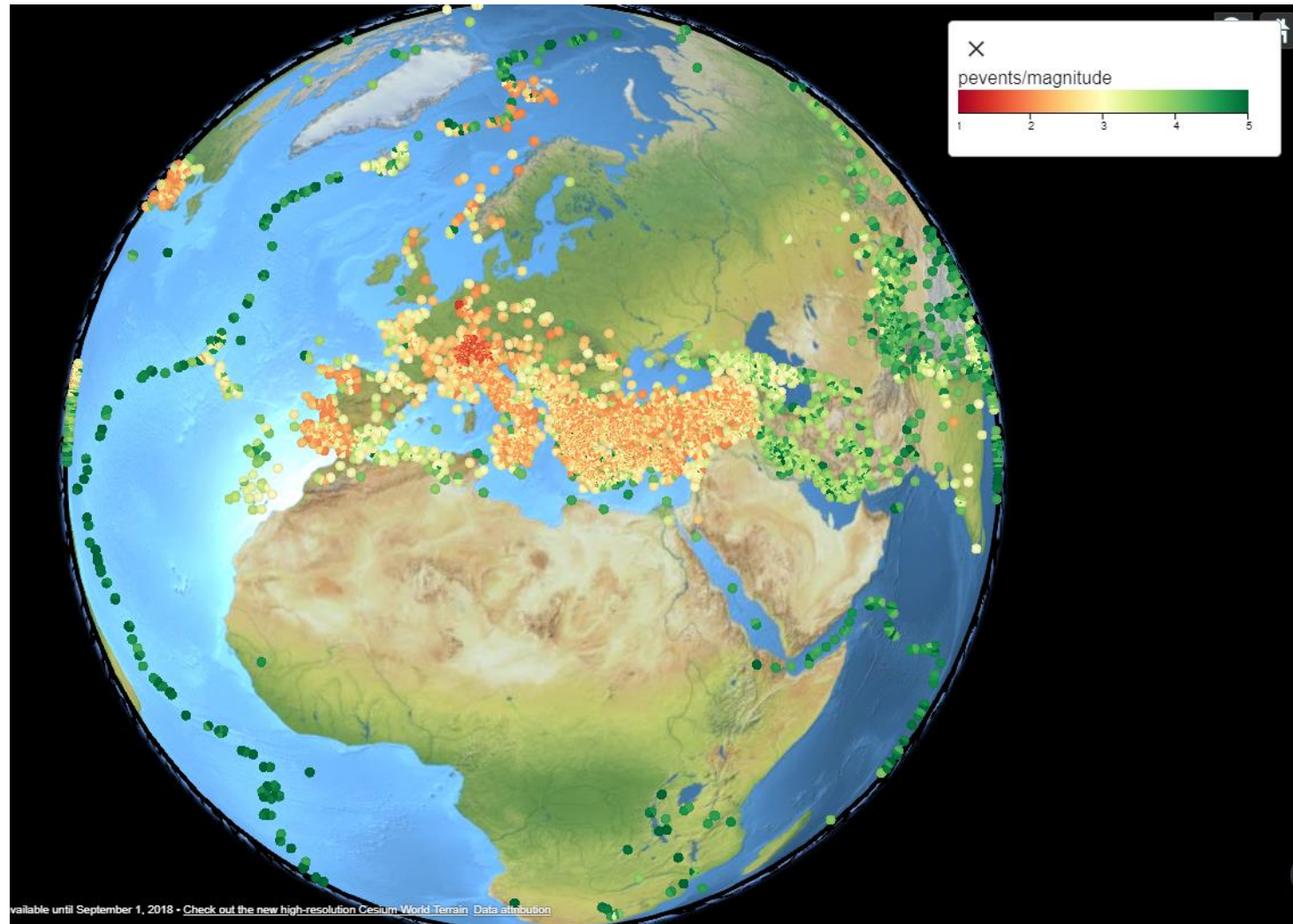
```
In [*]: while True:
    ev_period = emsc.get_events( t0,t0+dt )
    events += ev_period
    print(t0, ", len = ", len(ev_period))

    t0+=dt
    if t0 >= t1:
        break
```

```
In [4]: import sys
sys.path.append(r"C:\Users\tor\enl-web")
import enlweb
enlweb.enable(globals())
```

Open [enlweb](#) in external tab

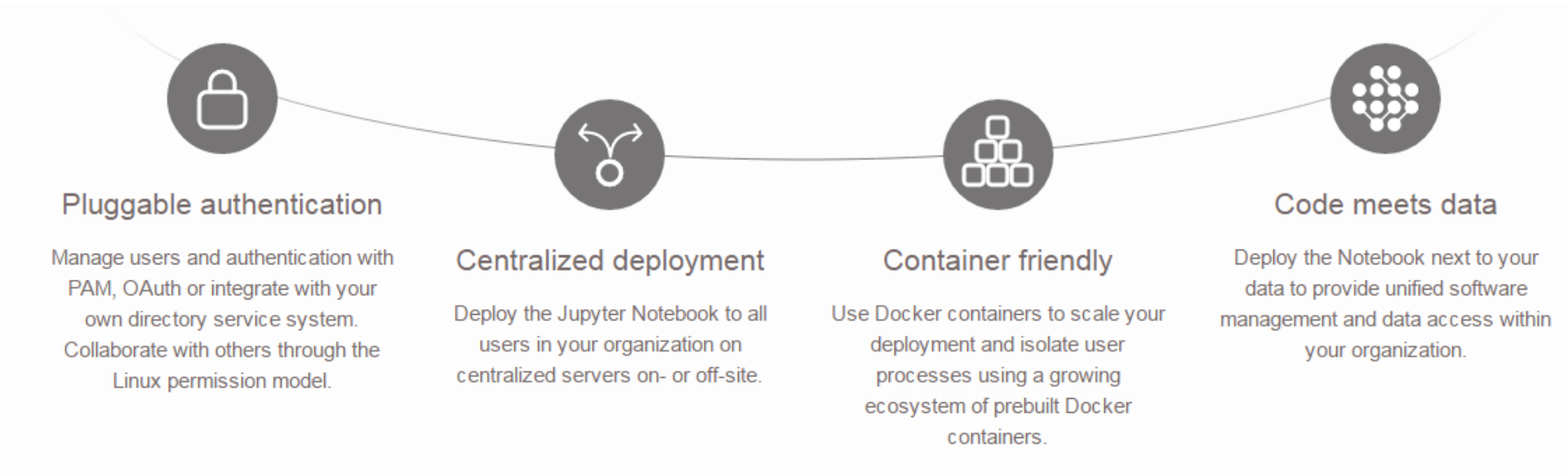
# Visualisering i Enlighten-web



available until September 1, 2018 - Check out the new high-resolution Cesium World Terrain - Data attribution

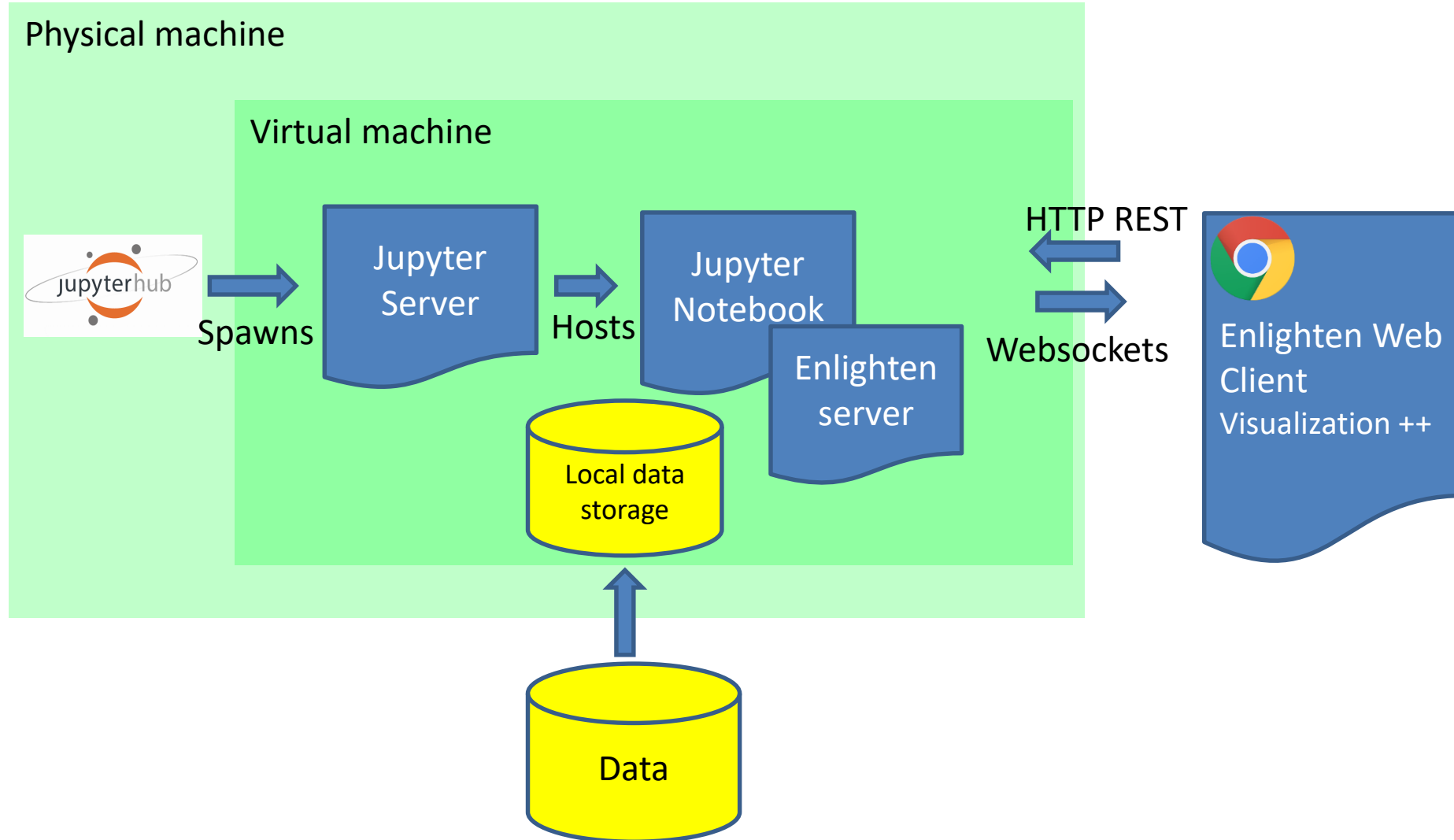


- Jupyterhub er en flerbrukerversjon av Jupyter Notebook
- For implementering på tjenere på universiteter, bedrifter, skoler, forskningslaboratorier etc.





# Enlighten-Web Virtual Research Environment



# EPOS-N/SESF Workshop

Solid Earth Science Forum (SESF) Workshop i november 2017

- Dag 1: Scientific Python introduksjon
- Dag 2: Deltagerne anvendte Enlighten-web for å løse vitenskapelige oppgaver forberedt av SESC
- Dag 3: Deltagerne kombinerte Jupyter notebooks og Enlighten-web (egne data)
- Positive tilbakemeldinger og mange gode forslag for videre utvikling



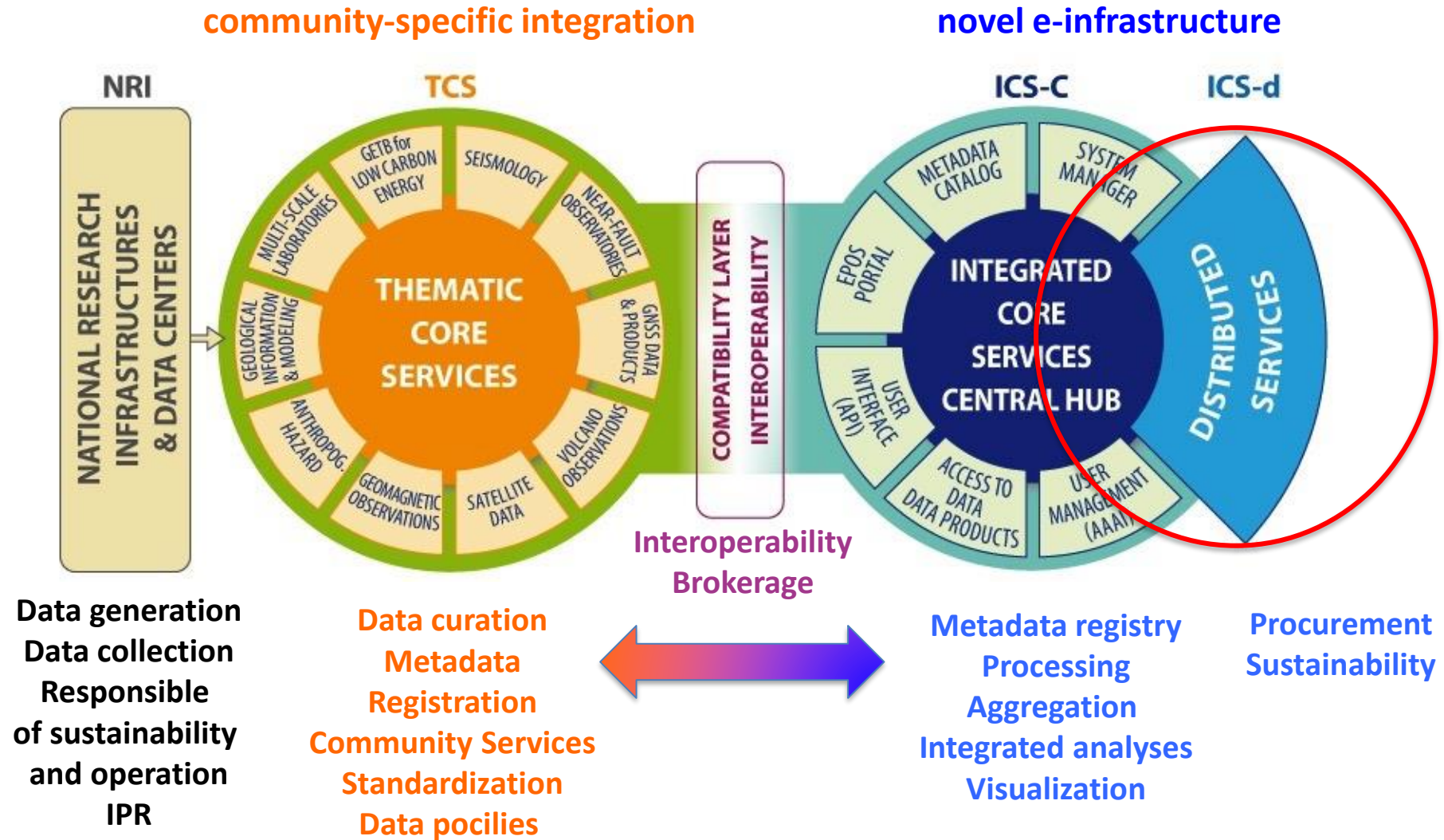
# Veien videre

- **Component 1: E-infrastructure**

- Data integration
- Data analysis tools and visualization tools
- National web portal
  - bygget på Enlighten-web
  - Interaktiv visuell analyse av metadata (data om data)
- Data storage, hardware and maintenance

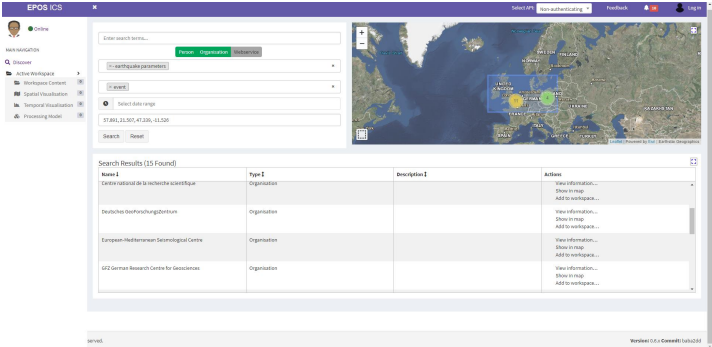
- Enlighten-web som ICS-D

# EPOS Architecture for Implementation

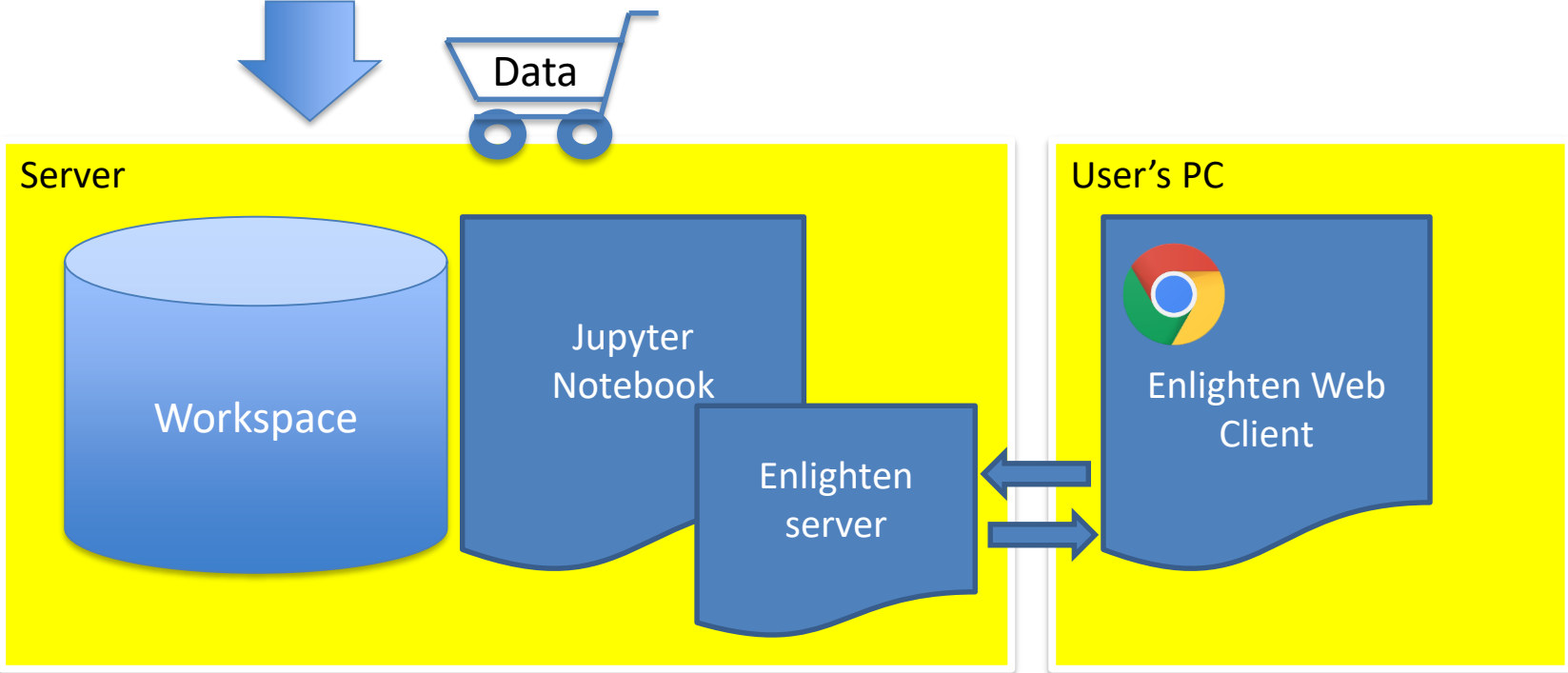




# Enlighten-web som ICS-D



EPOS ICS Portal



# EOSC – The European Open Science Cloud

“...(EOSC) will offer 1.7 million European researchers and 70 million professionals in science and technology a virtual environment with open and seamless services for storage, management, analysis and re-use of research data, across borders and scientific disciplines by federating existing scientific data infrastructures, currently dispersed across disciplines and Member States.”

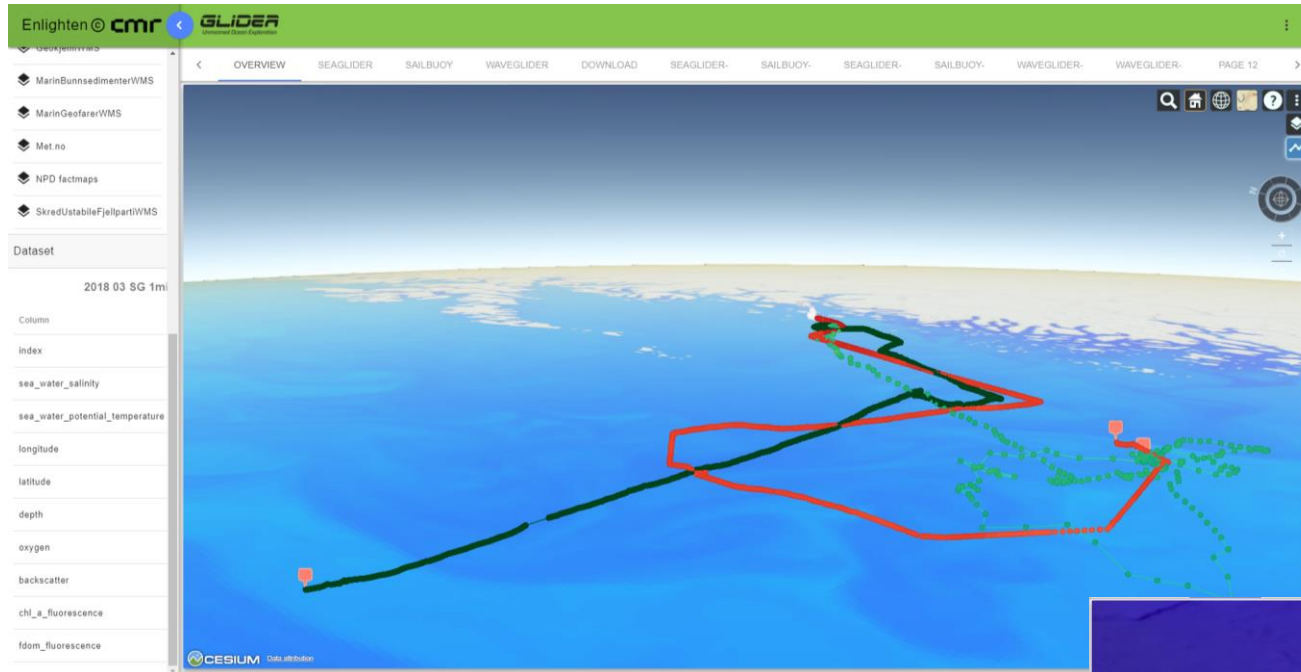
Digital Single Market Strategy

EC H2020 Call INFRAEOSC-04: Connecting ESFRI infrastructures to EOSC through Cluster Projects

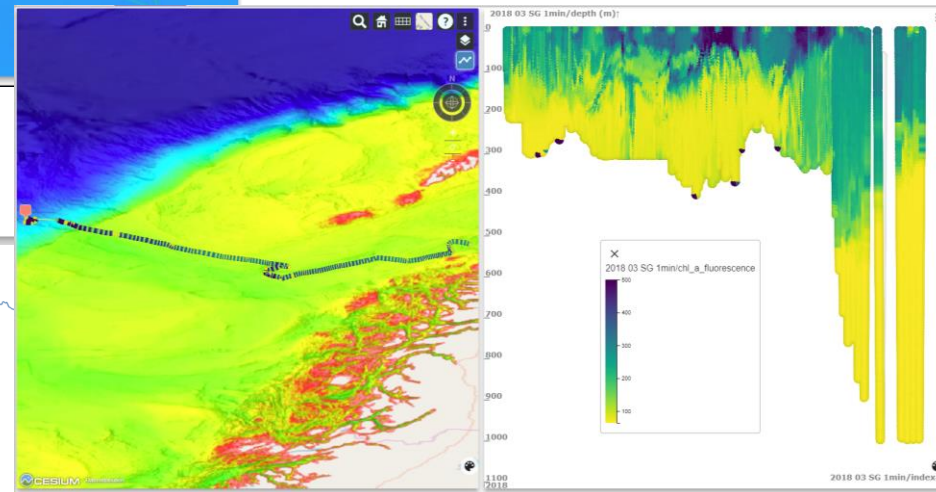
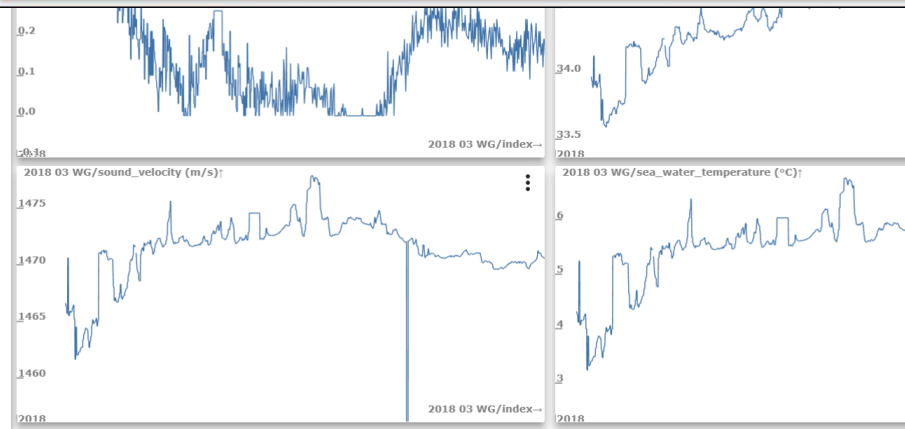
# ENVRI FAIR – Connecting ESFRI infrastructures to EOSC through Cluster Projects

- EPOS deltar med arbeidspakken “Implementation SOLID EARTH Subdomain”
- UiB Geovitenskap (CMR «linked party»): Implementation of FAIR roadmap in ICS-D services
- FAIR prinsippene -“Findable, Accessible, Interoperable, and Re-usable”
- (<https://www.force11.org/group/fairgroup/fairprinciples>)

# Enlighten-web i andre prosjekt



- Demo 2000
- ConocoPhillips, NFR
- Akvaplan-niva
- 3 autonome glidere på tokt
- Operativ web portal







Christian Michelsen Research

Spesiell takk til  
Kuvvet Atakan (UiB) og Ove Daae Lampe (CMR)

Takk for oppmerksomheten!