

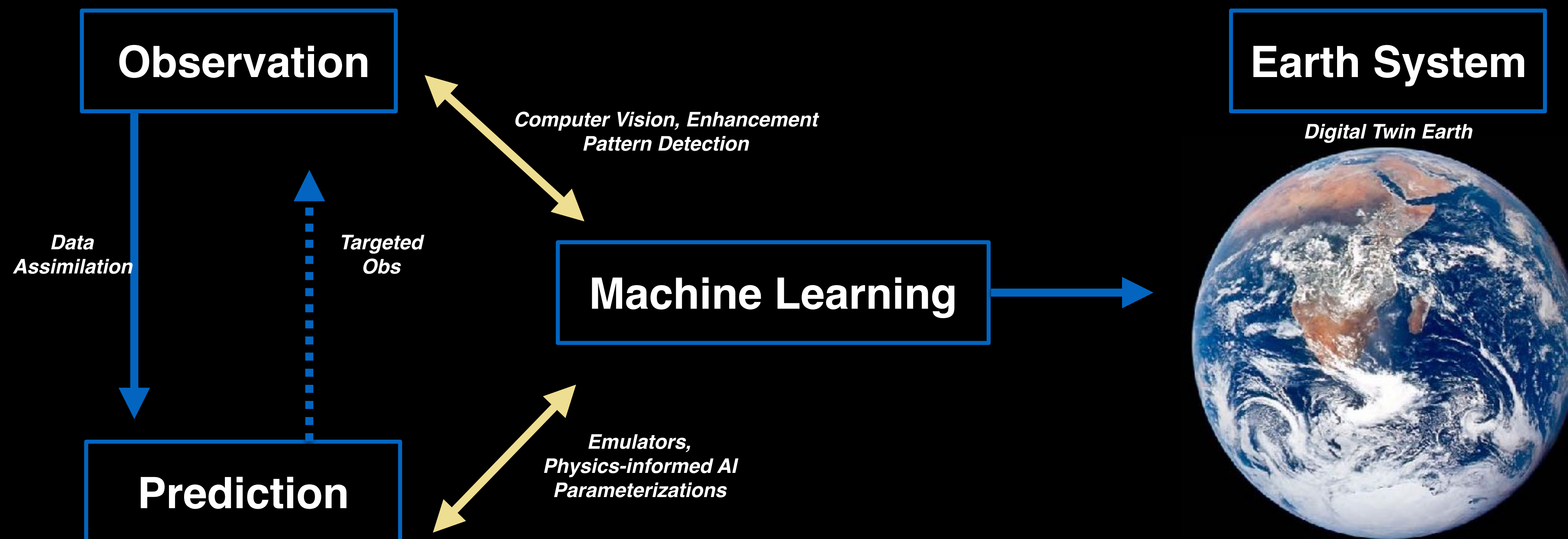
ESA-ECMWF WORKSHOP

Machine Learning for Earth System Observation and Prediction

15-18 November | ESA-ESRIN | Virtual Event | Free to attend

Why?

- New Tool in Toolbox
- Multidisciplinary Community
- Amazing Speed of change



Multi-Sensors EO Landscape - System of Systems



Earth Explorers

Meteo Satellites

Sentinels

Scouts

IoT

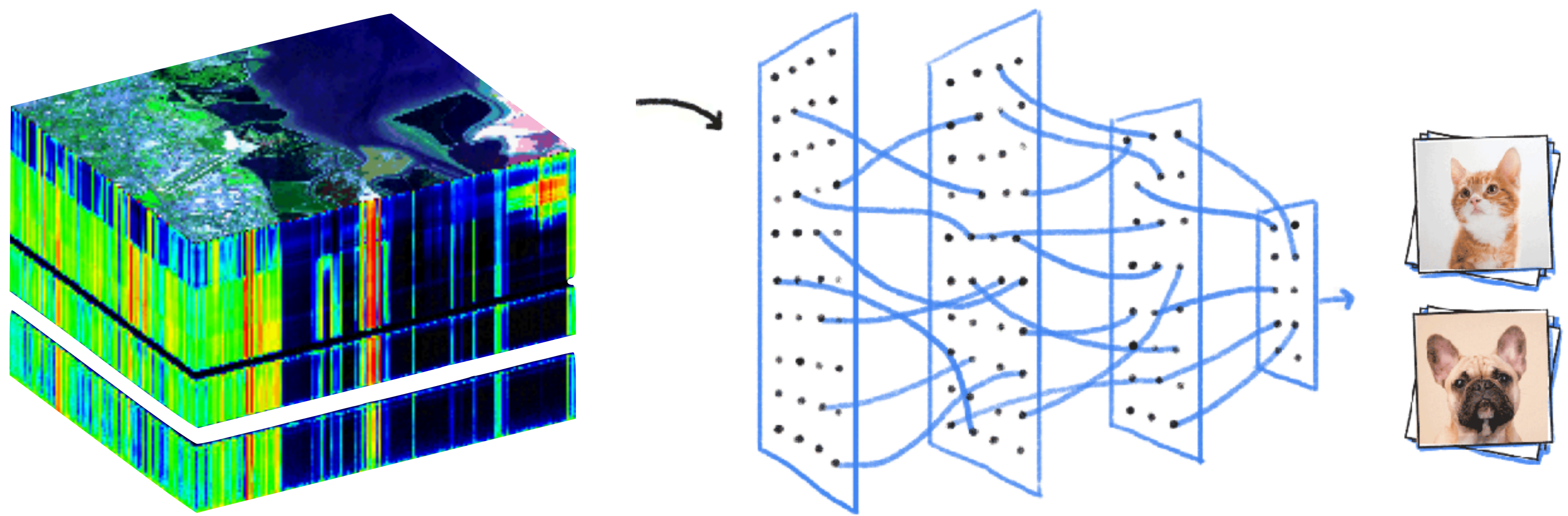
Constellations

HAPS

Drones



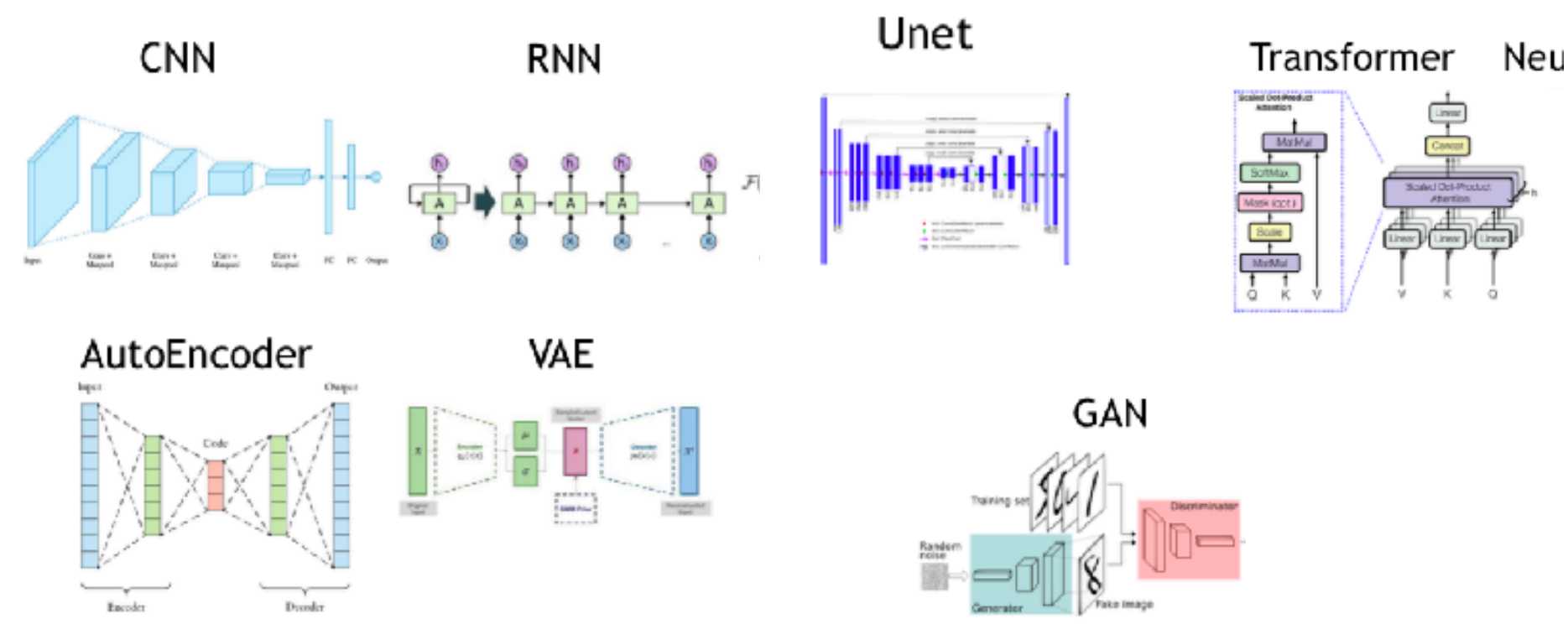
Why Machine Learning ? The Deep Learning Big Bang



- Computer Vision
- Pattern Detection
- Enhancement - inPainting
- Enhancement - Super res
- Parameterization



- Label/Annotation (gaming)
- Invariant
- Cubifying Data
- Gridding



ML = Automatic Computer Programming

- Versatility - Transfer Learning
- Scalability - Feed big Data
- Automatic - Continuous learning
- Black Box - Stats vs Physics



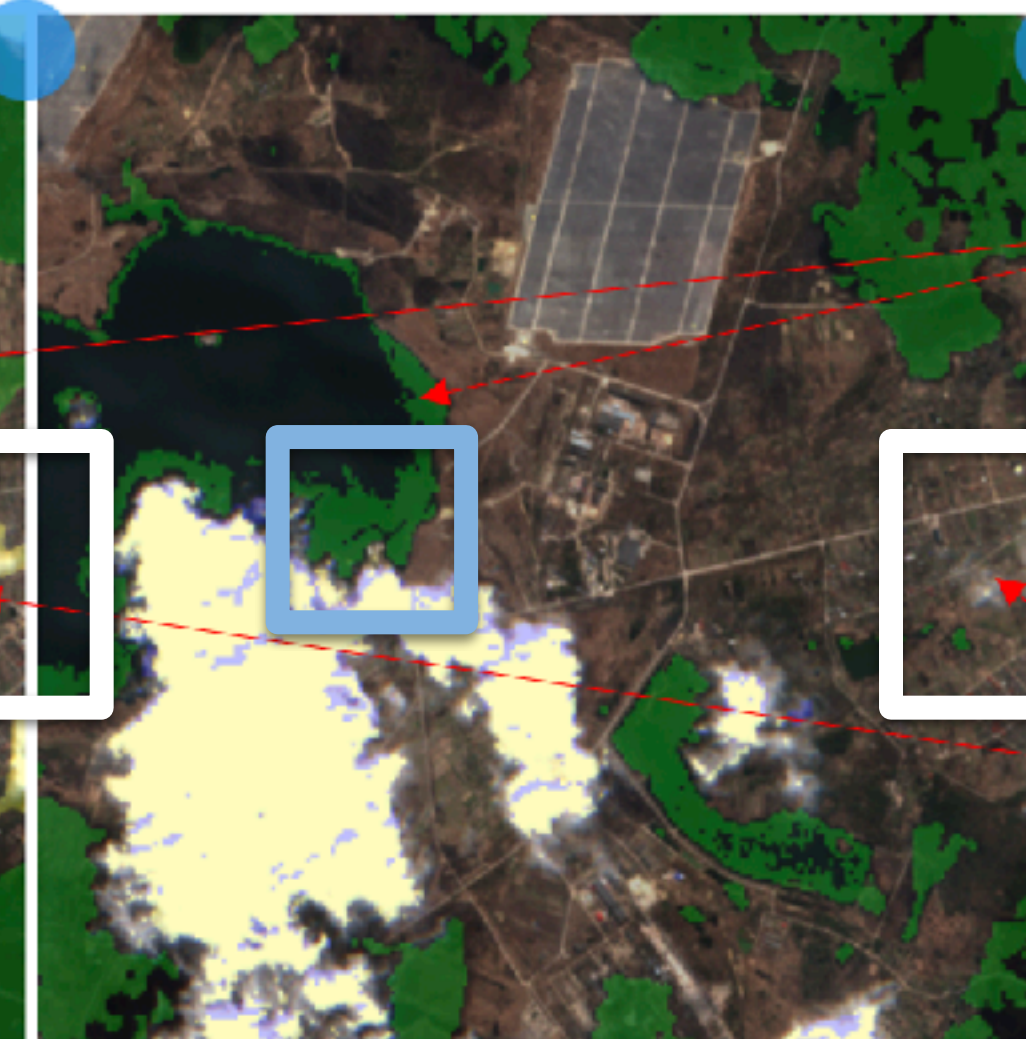
Sentinel-2 image



KappaMask (AI)



Sen2cor (rule based)



Water misclassified
as cloud shadow

Small fragmented
clouds undetected

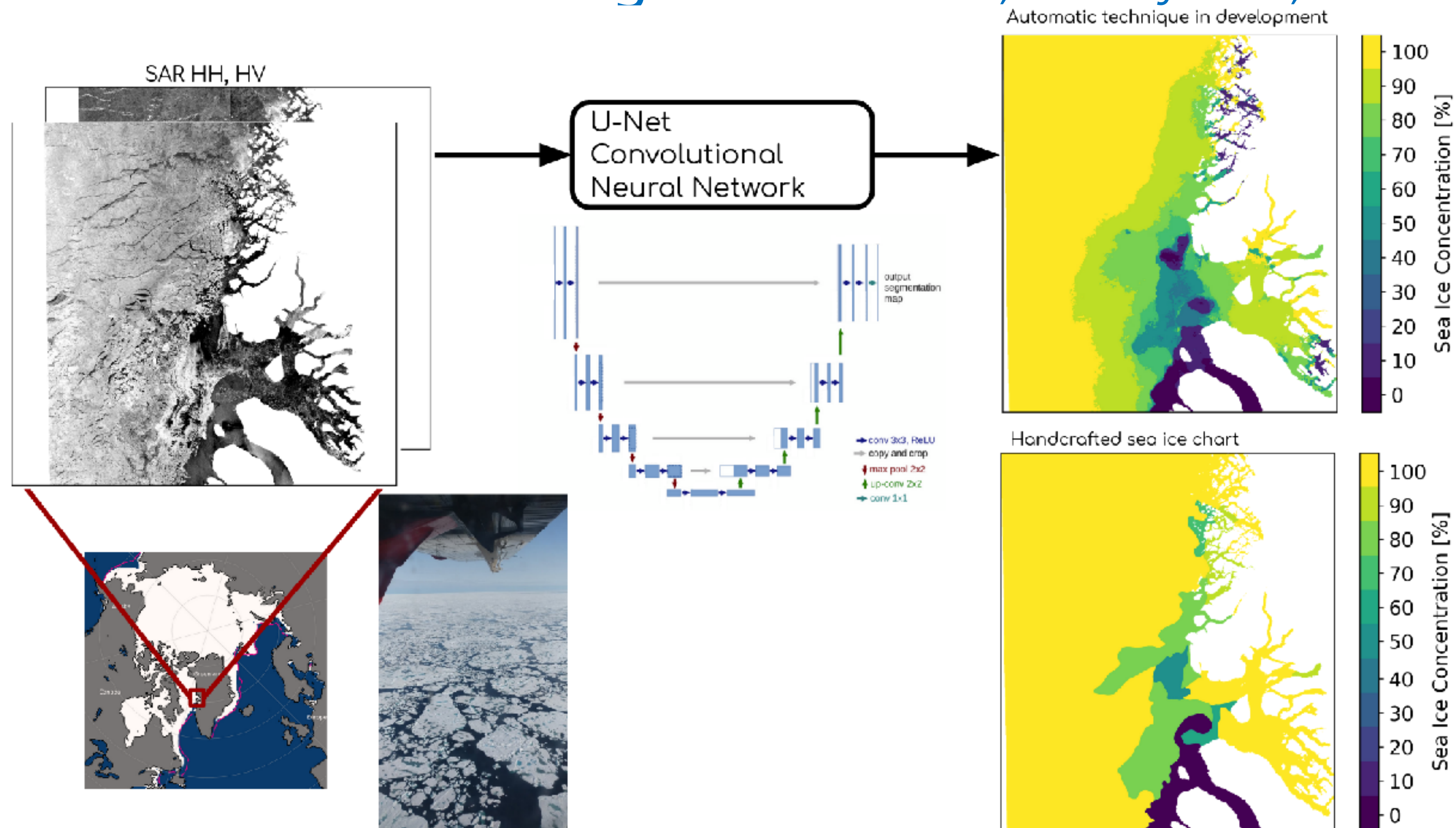
- See more at: <https://kappazeta.ee/cloudcomparison>

KAPPAZETA

Legend:
Yellow – cloud
Green – cloud shadow

Earth Observation and Artificial Intelligence for Automatic Arctic Sea Ice Charting

Andreas Stokholm, Andrzej Kucik,
Nicolas Longépé



- Map sea ice automatically from satellite imagery for use in operational maritime navigation

- Investigate approaches to overcome ambiguous

SAR signatures

- Technical University of Denmark
- Danish Meteorological Institute



ESA UNCLASSIFIED - For Official Use



→ THE EUROPEAN SPACE AGENCY

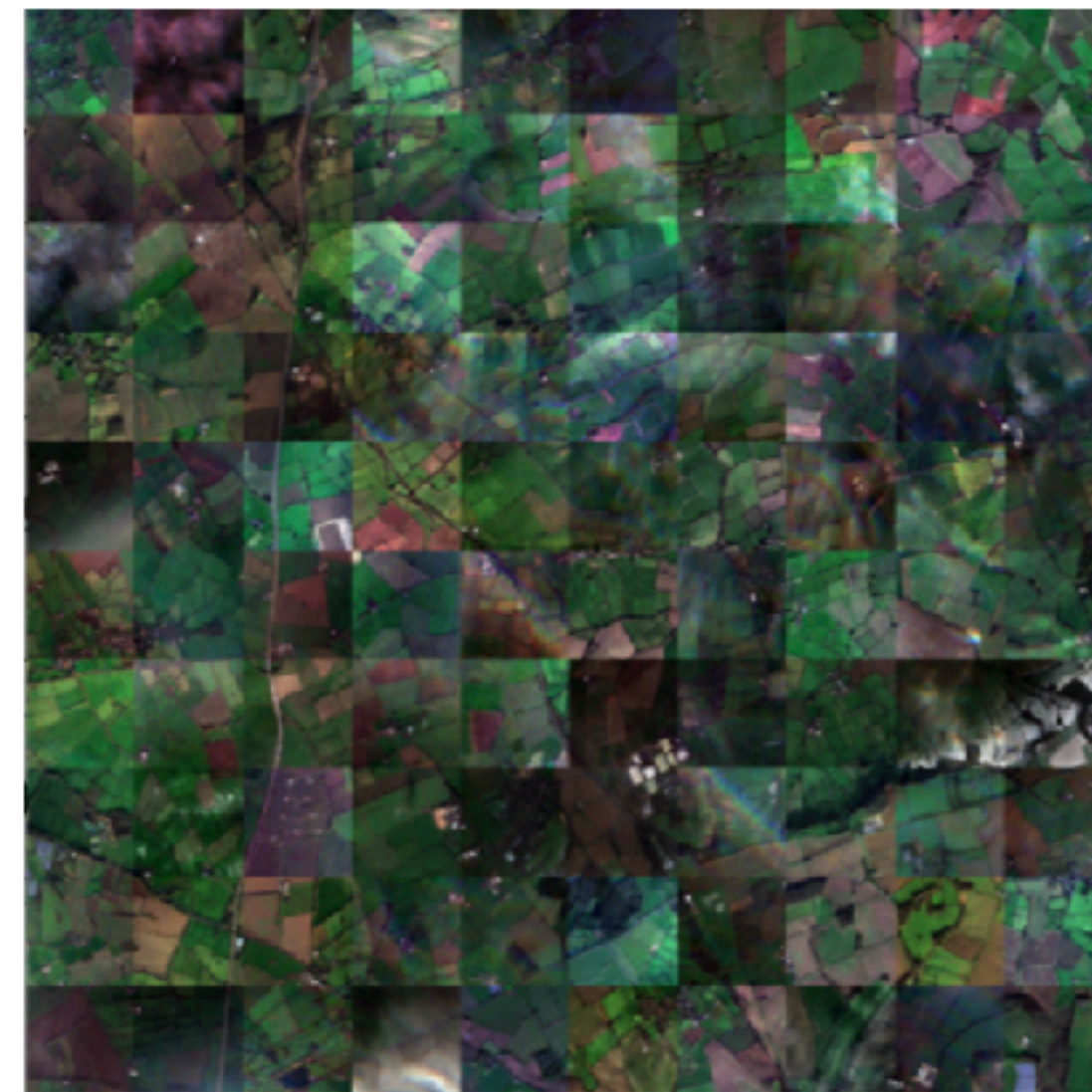
UNSUPERVISED LEARNING



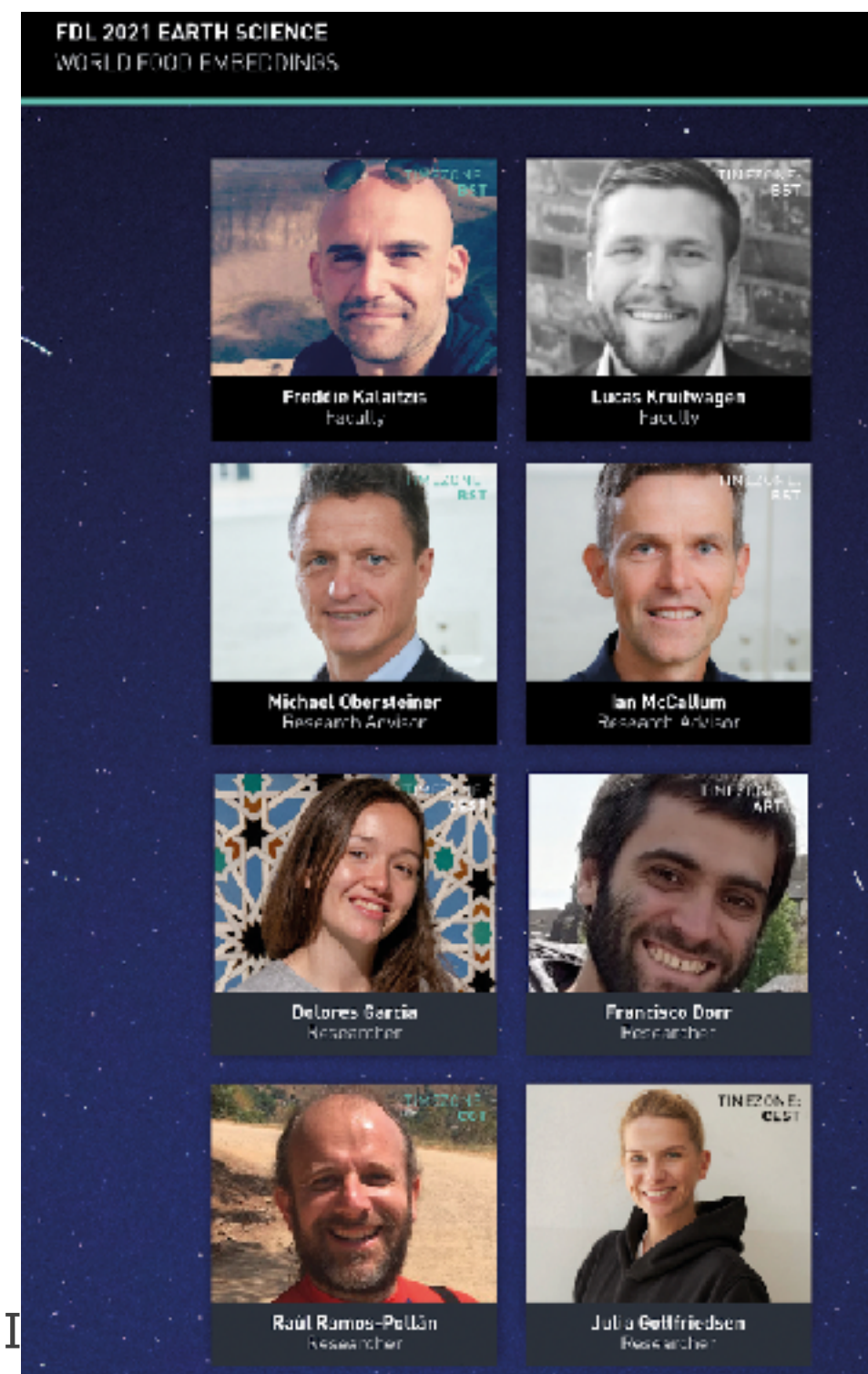
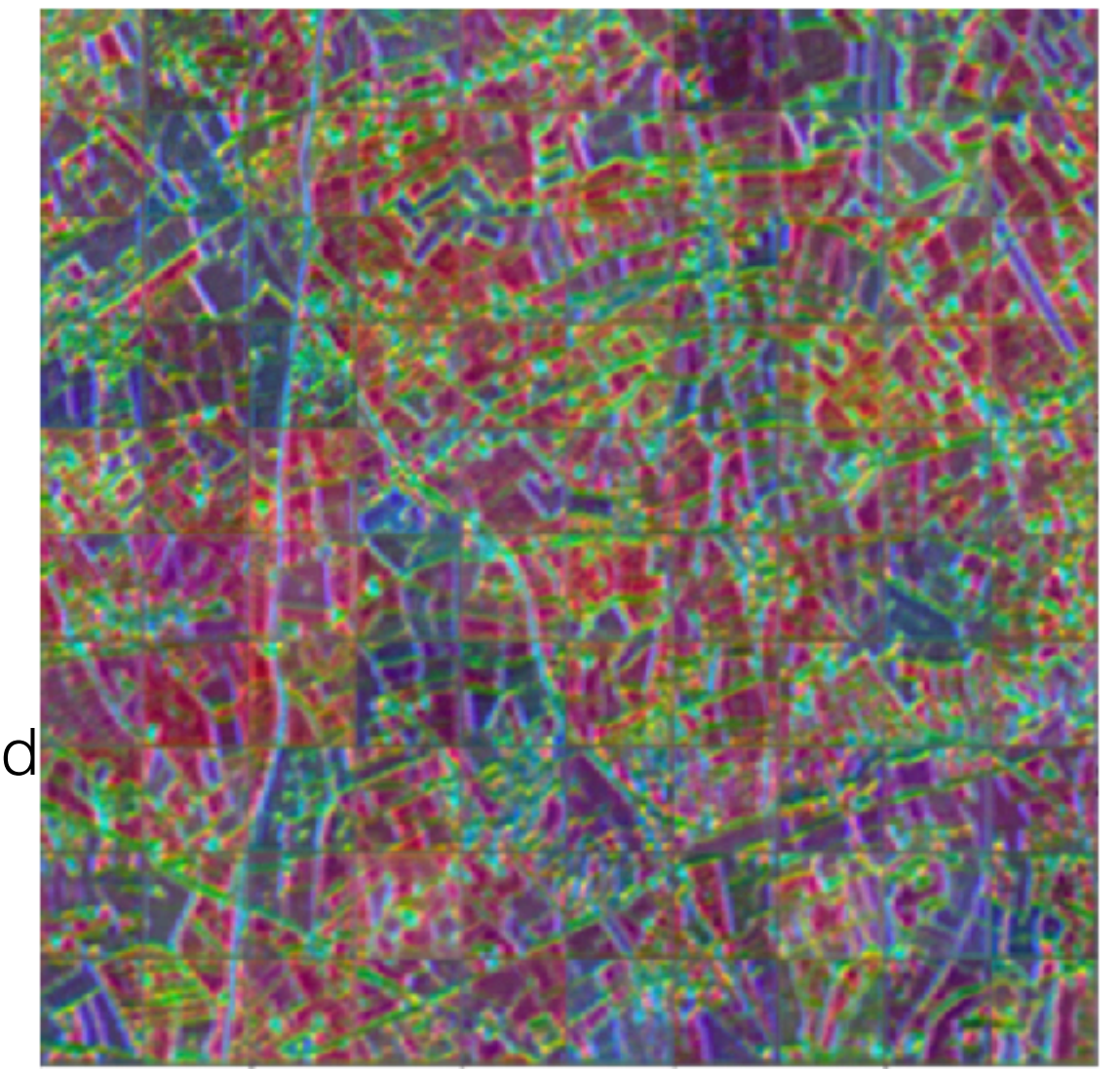
fdleurope.org

Sentinel-2

Embeddings



Self
Supervised
Learning



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Google Cloud



SCAN



AIRBUS

CATAPULT



European Space Agency

PREDICTION EMULATOR



FDL EUROPE 2020 DIGITAL TWIN EARTH

RESEARCHERS

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Piotr Bilinski	BST
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Freddie Kalaitzis	BST

FDL TIMELINE

- BOOTCAMP WEEK 0 15 - 19 JUN
- EXPLORATION WEEK 1 22 - 26 JUN
- DEVELOPMENT WEEK 2 29 JUN - 3 JUL
- DEVELOPMENT WEEK 3 6 - 10 JUL
- CALIBRATION WEEK 4 13 - 17 JUL
- IMPROVEMENT WEEK 5 20 - 24 JUL
- IMPROVEMENT WEEK 6 27 - 31 JUL
- WRITE UP WEEK 7 3 - 7 AUG
- DIGITAL SHOWCASE WEEK 8 10 - 14 AUG

esa FDL 2020 FRONTIER DEVELOPMENT LAB

Logos: NVIDIA, SCAN, Google Cloud, IBM, AIRBUS, pioner, IWW, uap, CALTOKI, esa

Observed Radiances



GCM
Model Emulator



Atmospheric
State
Forecast



fdleurope.org



Towards Hybrid Climate Models pipelines

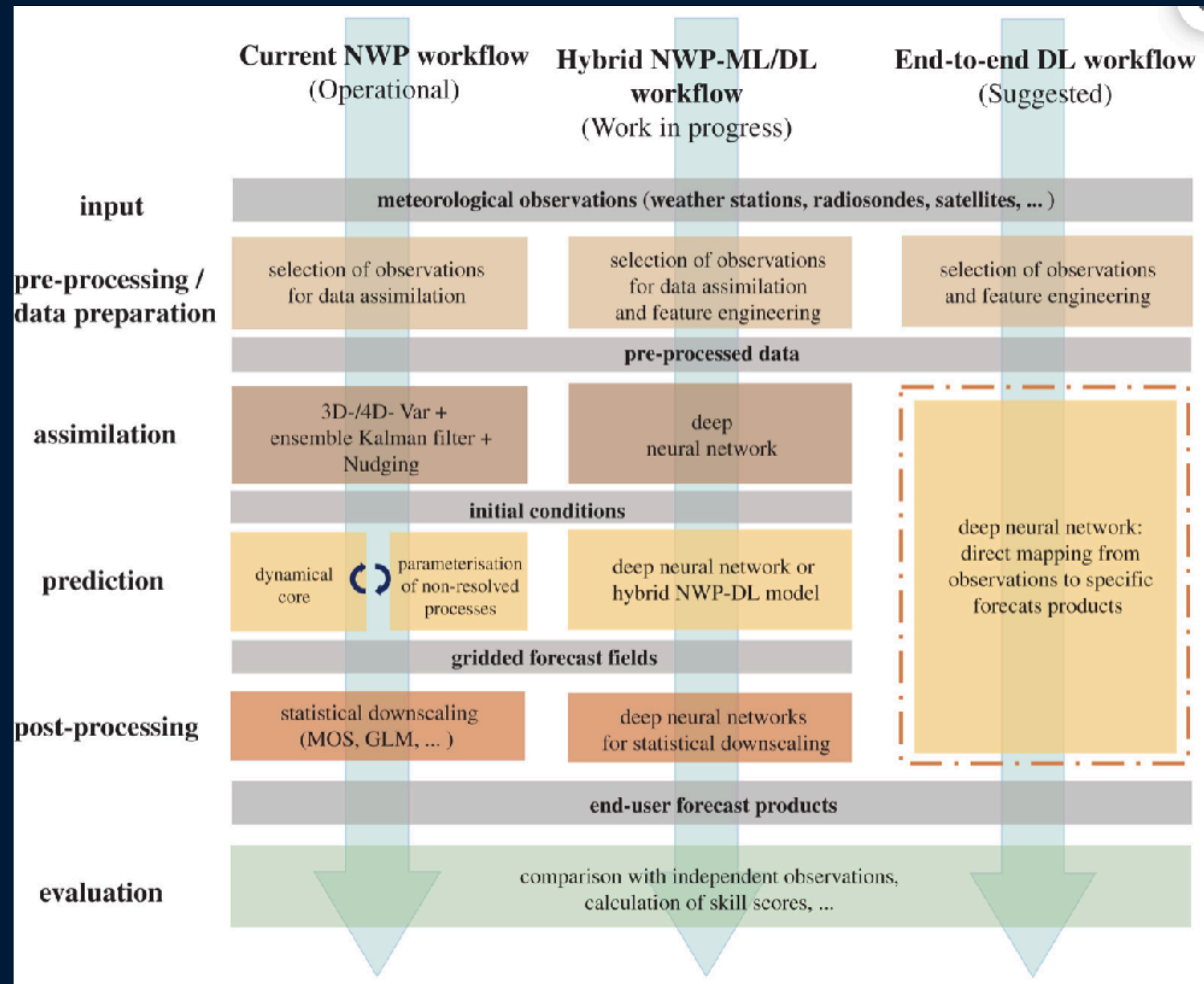
Opinion piece

Can deep learning beat numerical weather prediction?

M. G. Schultz ✉, C. Betancourt, B. Gong, F. Kleinert
, M. Langguth, L. H. Leufen, A. Mozaffari and
S. Stadtler

Published: 15 February 2021

<https://doi.org/10.1098/rsta.2020.0097>



Workshop Aims

ESOP still has many exciting challenges to overcome with the support of ML/DL techniques. This workshop aims to demonstrate where and how this fusion between traditional ESOP techniques and new ML/DL methods reached a remarkable impact but also identify the remaining issues to be further explored. Presenters will demonstrate their contributions to this challenge and expand the discussion to provide a general overview of the subject. After the first three days covering the state-of-the-art, the working groups will work in parallel to discuss the limitations of the current status and suggest how to advance, extracting more value from this powerful fusion. The output of the workshop is in the form of working group reports, to be summarised in a technical memorandum or a paper.

Working Groups - Thematic areas

WG1 - Enhancing Satellite Observation with ML

Chairs: Begüm Demir and Bertrand Le Saux

WG2 - Hybrid Data Assimilation - ML Approaches

Chairs: Rossella Arcucci and Alan Geer

WG3 - Geophysical Forecasting with ML and Hybrid Models

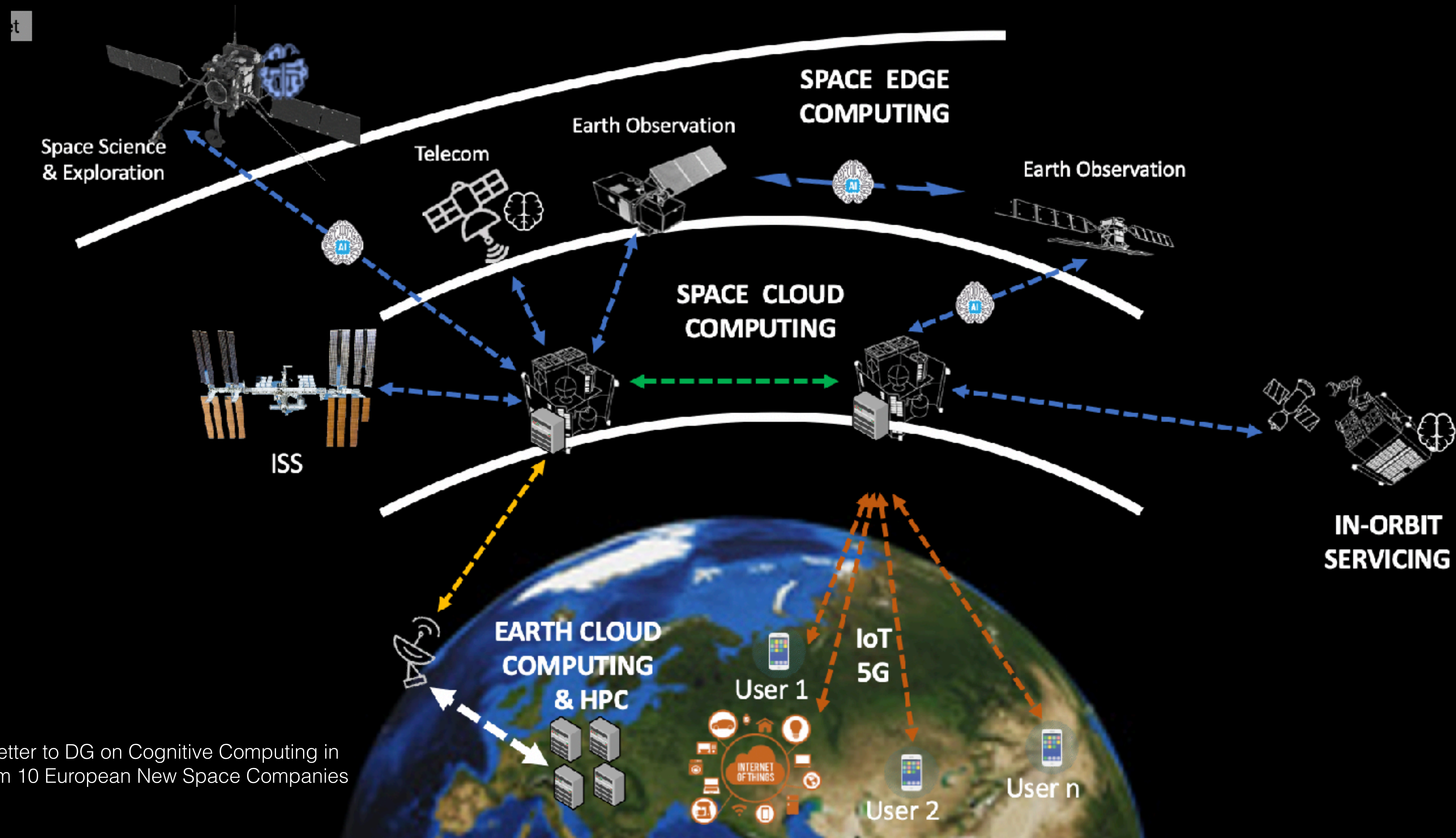
Chairs: Claudia Vitolo and Peter Dueben

WG4 - ML for Post-Processing and Dissemination

Chairs: Rochelle Schneider and Massimo Bonavita



Cognitive Cloud Computing in Space



Source: Letter to DG on Cognitive Computing in Space, from 10 European New Space Companies

Europe has some precursor: Cloud Computing Node in Space running suite of Machine

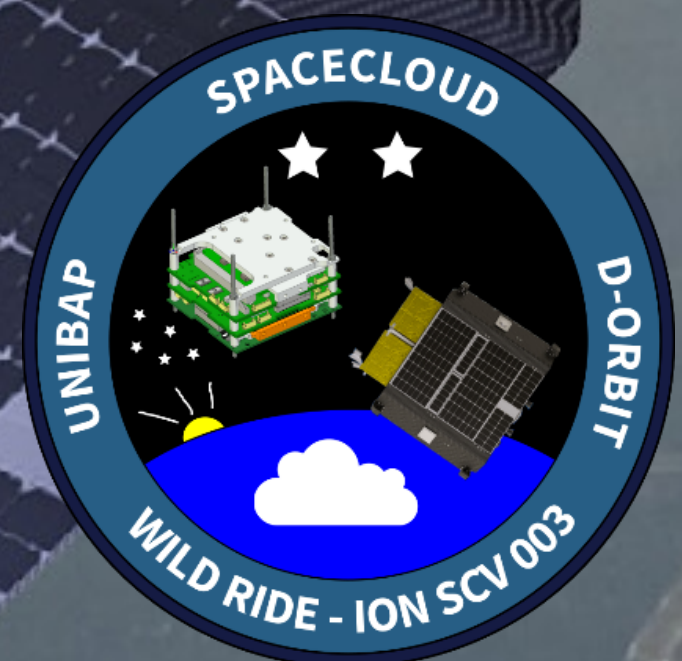
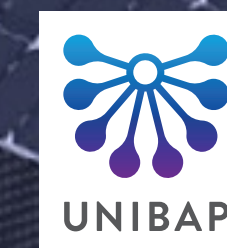


Nebula payload
On-orbit Cloud
Computing Node
(UNIBAP SpaceCloud)

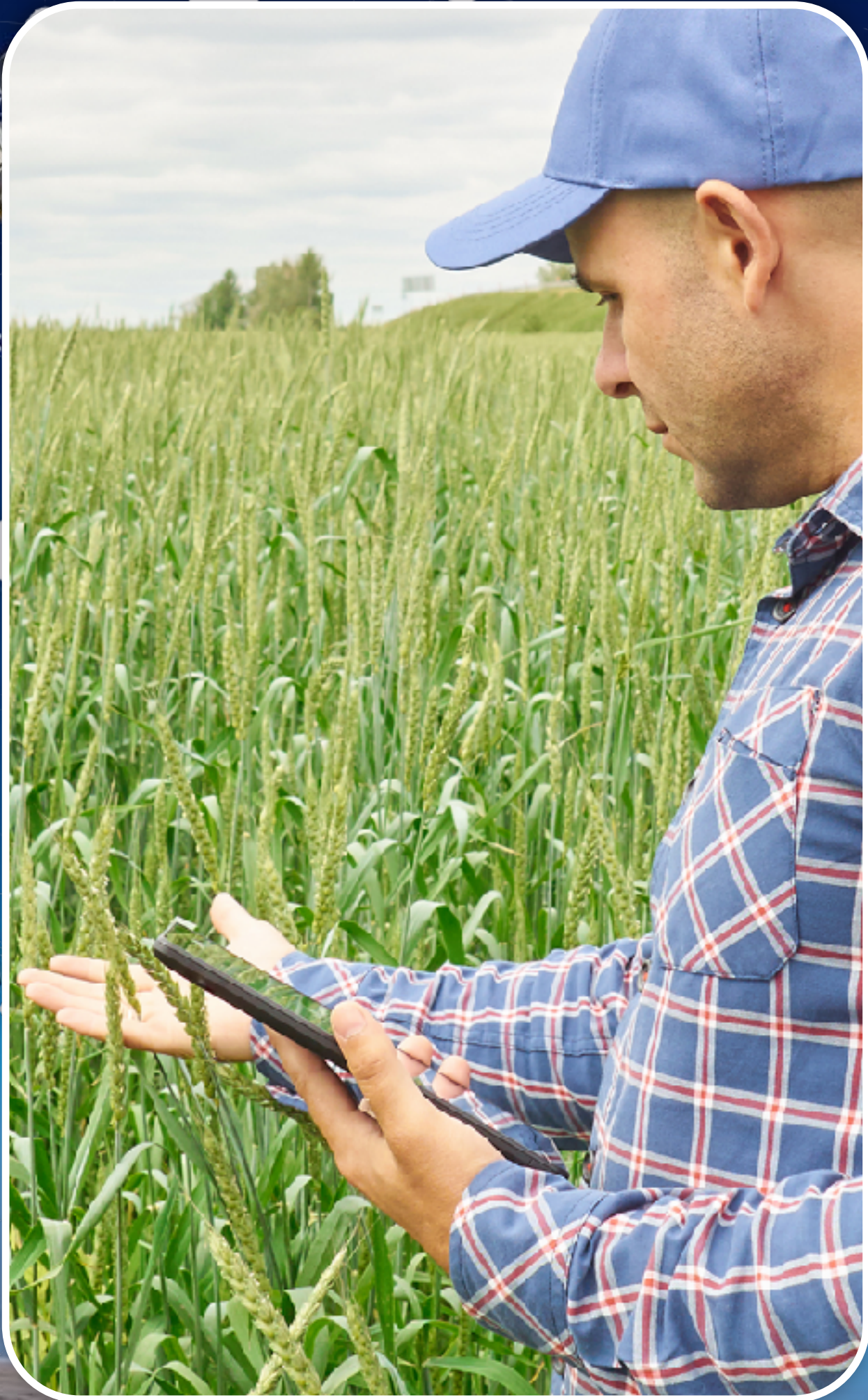


Re-programmable
AI Brain

D-Orbit Wild Ride Mission, launched 30 June 2021
ION Platform with 6 cubesats, 20+Machine Learning Apps on SpaceCloud



System of Systems



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MAKE SPACE FOR EUROPE

#SpaceAmbition

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www.esa.int