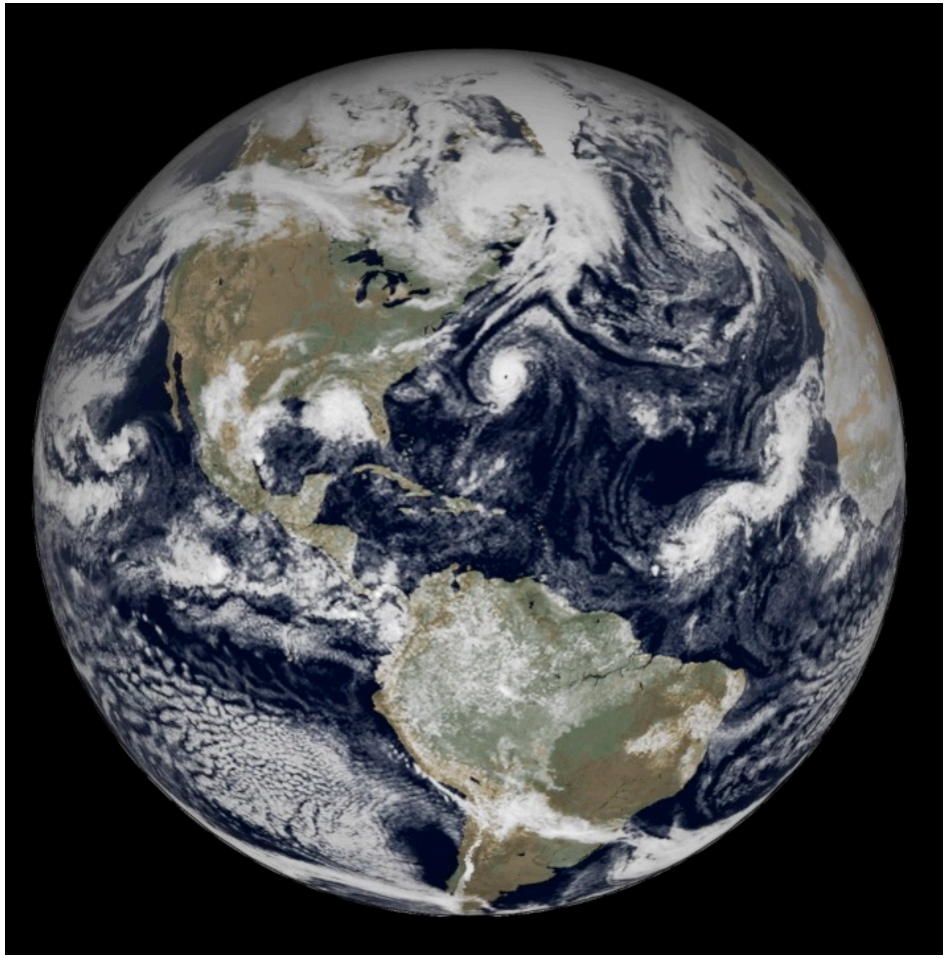
ECMWF selected highlights 2021

Nils P. Wedi
European Centre for Medium-Range Weather Forecasts (ECMWF)

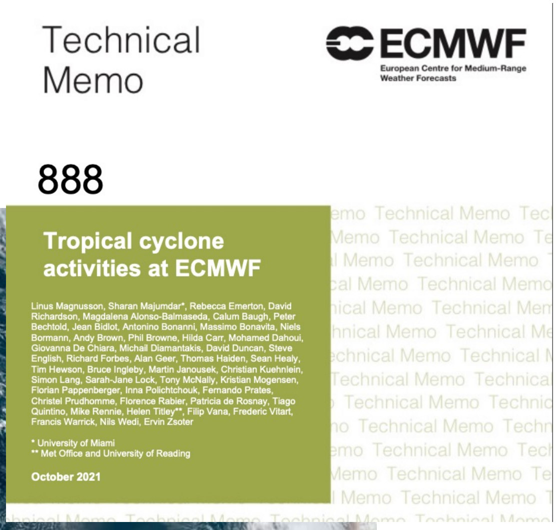
This is only a small and subjective selection of the many ECMWF activities

ECMWF Ensemble Forecasting

Simon Lang



TCo1279L137 51 Ensemble members 20200913 00 UTC + 41 h



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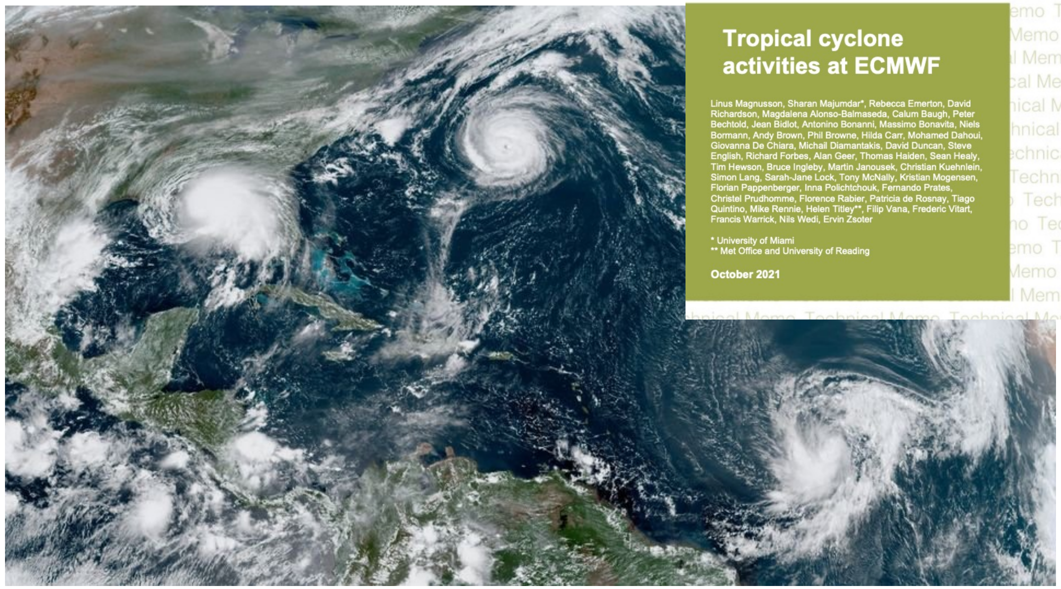
Tropical cyclone activities at ECMWF

Linus Magnusson, Sharan Majumdar*, Rebecca Emerton, David Richardson, Magdalena Alonso-Balmaseda, Calum Baugh, Peter Bechtold, Jean Bidlot, Antonino Bonanni, Massimo Bonavita, Niels Bormann, Andy Brown, Phil Browne, Hilda Carr, Mohamed Dahoui, Giovanna De Chiara, Michail Diamantakis, David Duncan, Steve English, Richard Forbes, Alan Geer, Thomas Haiden, Sean Healy, Tim Hewson, Bruce Ingleby, Martin Janousek, Christian Kuehnlein, Simon Lang, Sarah-Jane Lock, Tony McNally, Kristian Mogensen, Florian Pappenberger, Inna Polichtchouk, Fernando Prates, Christel Prudhomme, Florence Rabier, Patricia de Rosnay, Tiago Quintino, Mike Rennie, Helen Titley**, Filip Vana, Frederic Vitart, Francis Warrick, Nils Wedi, Ervin Zsoter

* University of Miami
** Met Office and University of Reading

October 2021



NOAA

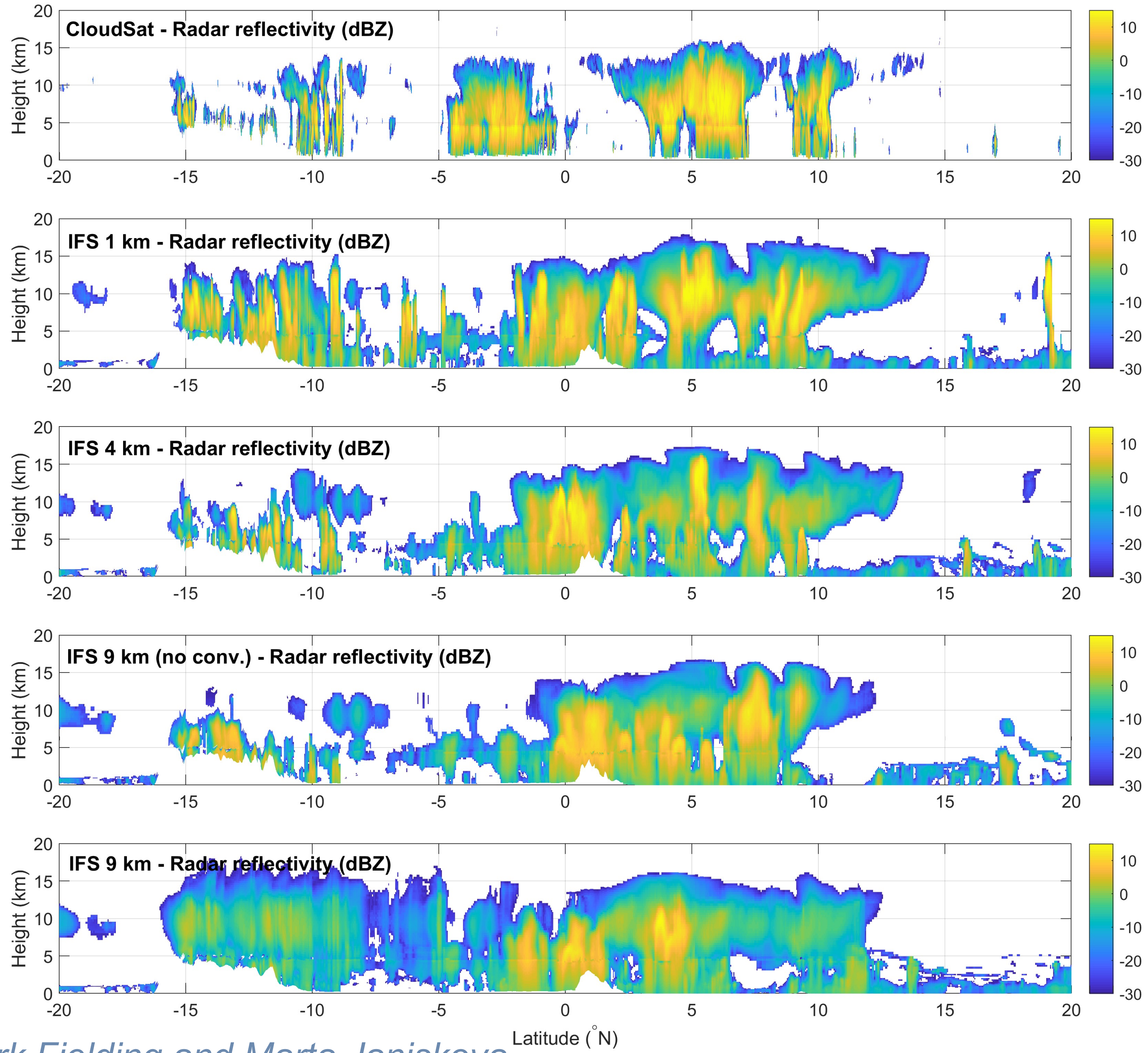
Relevant developments:

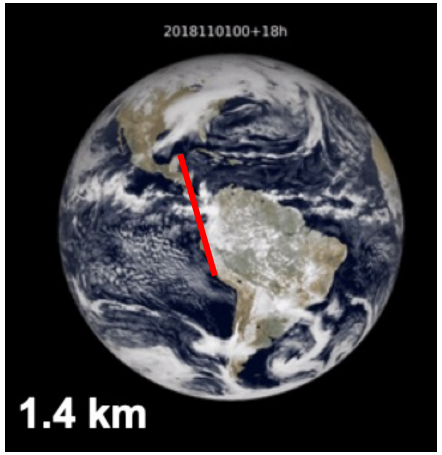
Ensemble size: How suboptimal is less than infinity?
Leutbecher, QJR, 2019

Exploring a representation of model uncertainty in the IFS due to the transport scheme
Lock et al (Annual Seminar 2020)

Revision of the SPP model uncertainty scheme in the IFS
Lang et al, QJR 2021

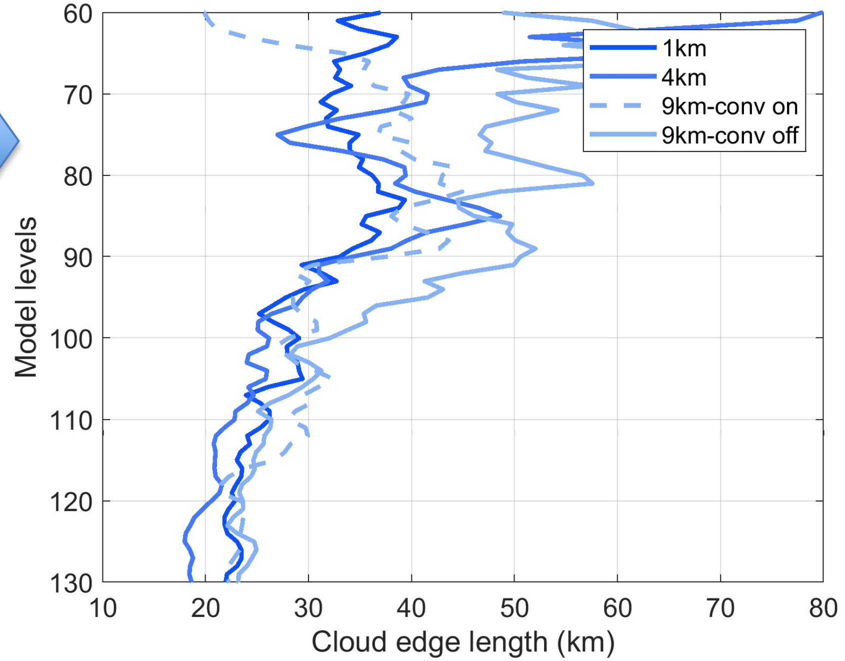
Using CloudSat / EarthCARE observations in the evaluation of global km-scale simulations…





Courtesy: P. Lopez

- Radar observation operator is highly effective tool for evaluating convection in high-resolution model forecasts



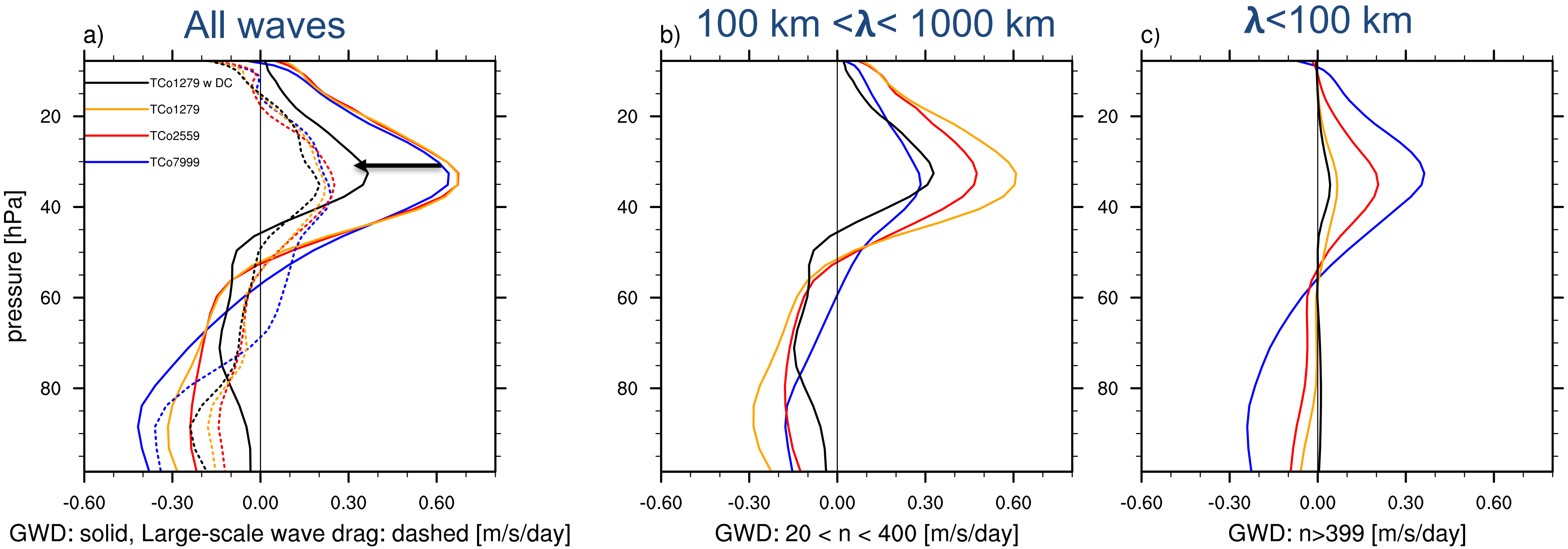
Unpicking the effects of resolution and convection parameterization on 3D structure

Mark Fielding and Marta Janiskova

Learning lessons from km-scale simulations: Resolved convective GWs

1. Deep convection (DC) parametrization inhibits convective GW generation. BUT if DC is switched off at TCo1279 and TCo2559 resolutions, long- and meso-scale GWs are artificially enhanced.
2. When DC is off, the total GWD is almost unchanged across horiz. resolutions, but at TCo1279 and TCo2559 resolutions the GWD in long- and meso-scale waves is too strong compared to TCo7999 (1km).

Conclusions: TCo2559 horizontal resolution not enough to resolve the full convective GW spectrum. Parametrization of deep convection required even at TCo2559 resolution AND GWD from smaller-scale GWs with **λ**<100 km should come from non-orographic GWD parametrization.



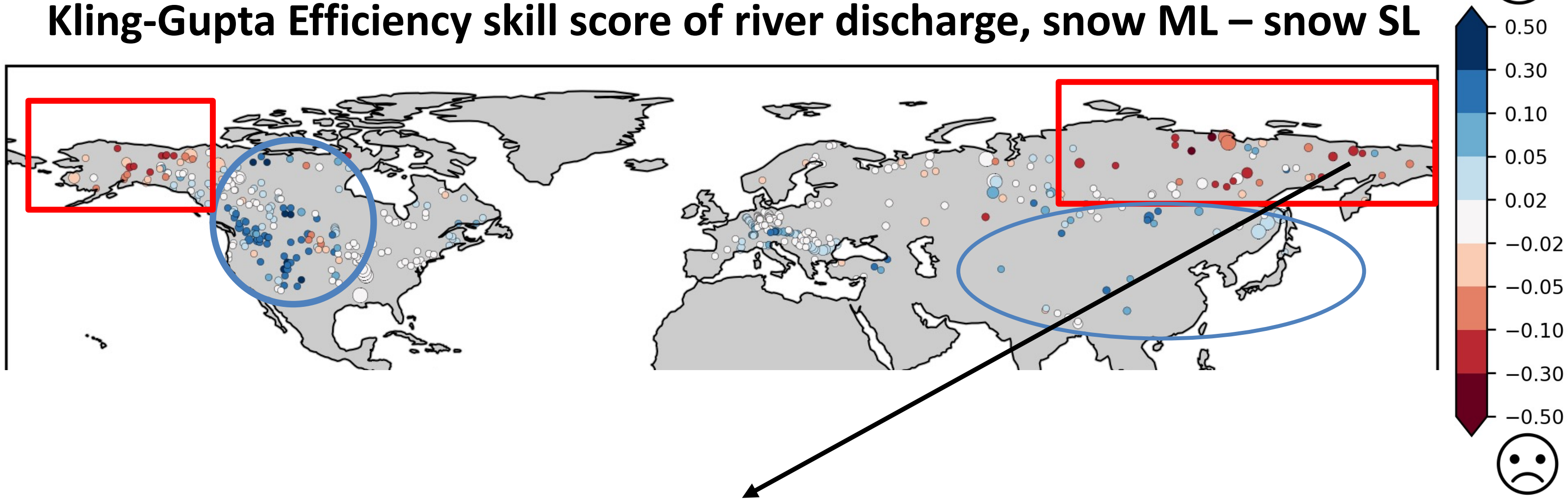
10N-10S averaged resolved GWD for 5-15 Nov 2018.

Polichtchouk, Wedi & Kim (QJR, 2021)

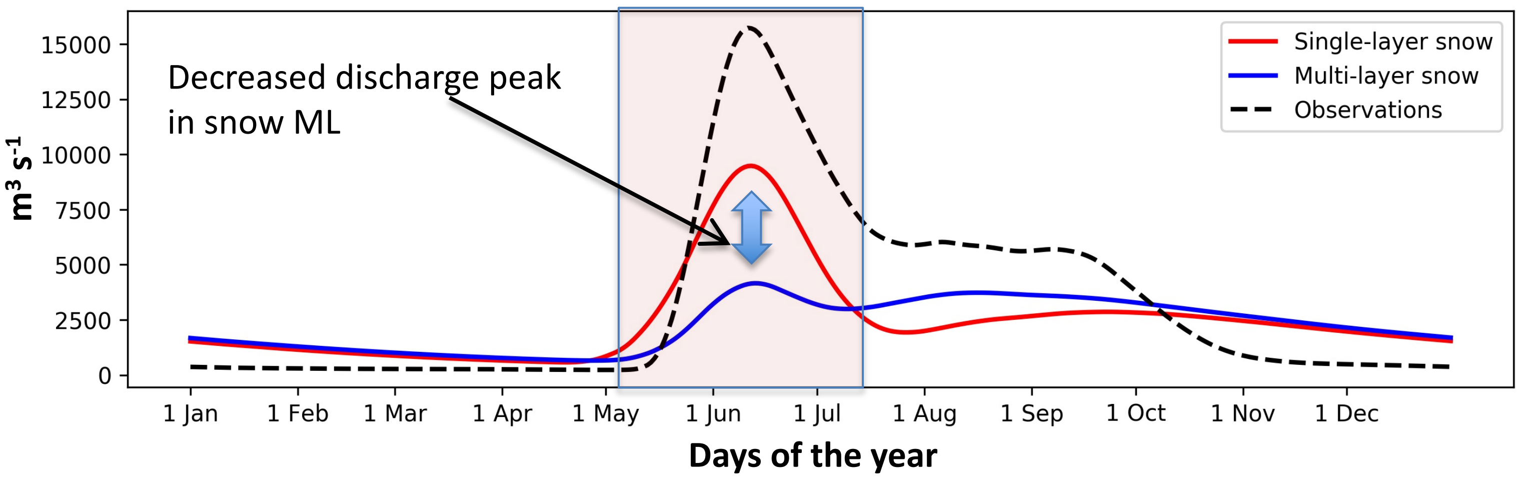
Wedi et al (James, 2020)

Novel evaluation of land-surface model developments with hydrology, the example of the multi-layer snow scheme

Kling-Gupta Efficiency skill score of river discharge, snow ML – snow SL



Daily mean annual cycle of river discharge for Kolyma river, lat=68.72; lon=158.71



Global hydrology workshop 2021

- More catchments show improvements, in particular over Rockies and mid-latitude Eurasia
- Many catchments in cold climates show lower skills (permafrost regions)
- In permafrost areas, the increase in water infiltrating into the soil due to warmer soil temperature in snowML, amplifies river discharge biases.
- Different parametrizations for frozen soil currently under testing

Zsoter, Arduini et al. in preparation

C3S global reanalysis: ERA5 and ERA5-Land

60,000 users in the C3S Climate Data Store, ~ 400 Tb weekly downloads

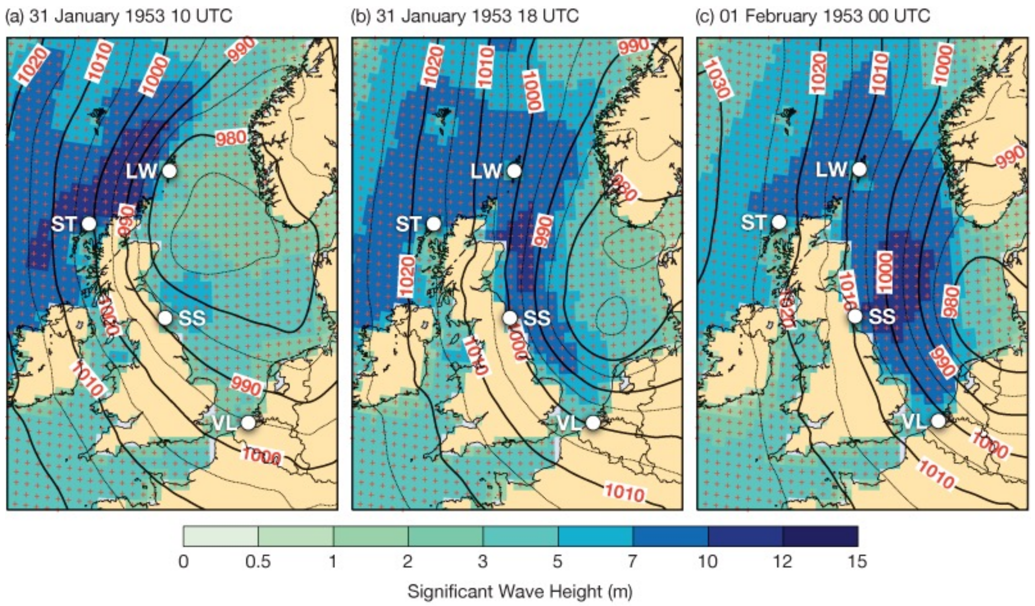
ERA5: *A full-observing-system global reanalysis for the atmosphere, land surface and ocean waves*

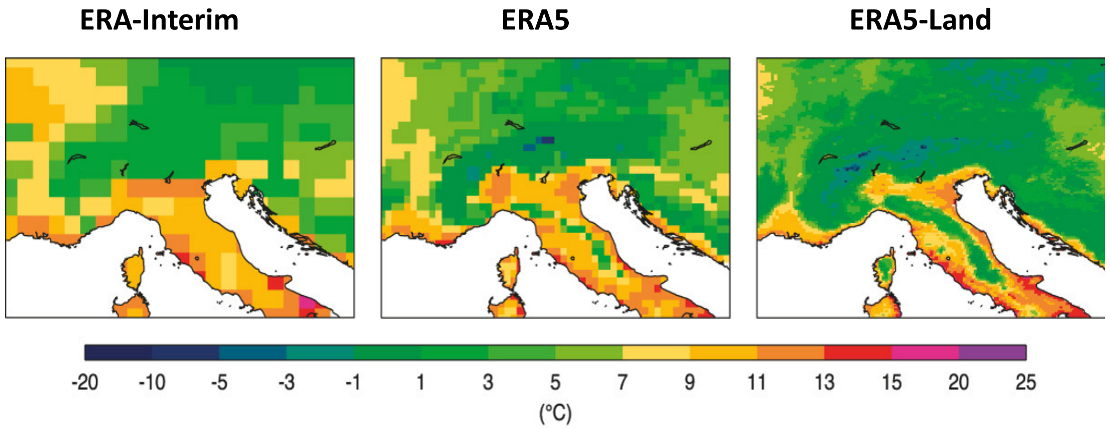
- Daily updates **5 days behind real time from 1979 onwards**
- Hourly snapshots at 31km resolution up to about 80km height
- Uncertainty estimate from a 10-member ensemble at reduced resolution

end 2020: *publication of the ERA5 back extension (1950-1978)*

- Has in general good characteristics, suitable for many users
- However sub-optimal for tropical cyclones (extremes)
- The production of the improved version is well underway.
- 1959-1978 (Shinfield Park), **1940**-1958 (Bologna)

The North Sea Storm of February 1953





ERA5-Land: *Dynamical down scaling to 9km*

- No additional data assimilation and no coupling with the atmosphere
- Cost-effective offline run

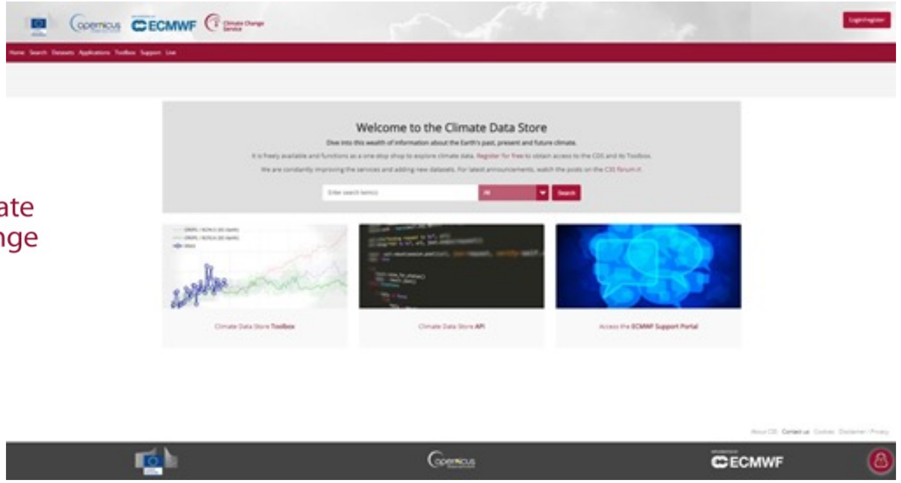
September 2021: *publication of the back extension (1950-1980)*

ECMWF: Copernicus Climate and Atmosphere Data Stores

Continuous evolution in terms of functionality, available content and users.

Shared infrastructure, supporting teams and operational tools

Climate Change

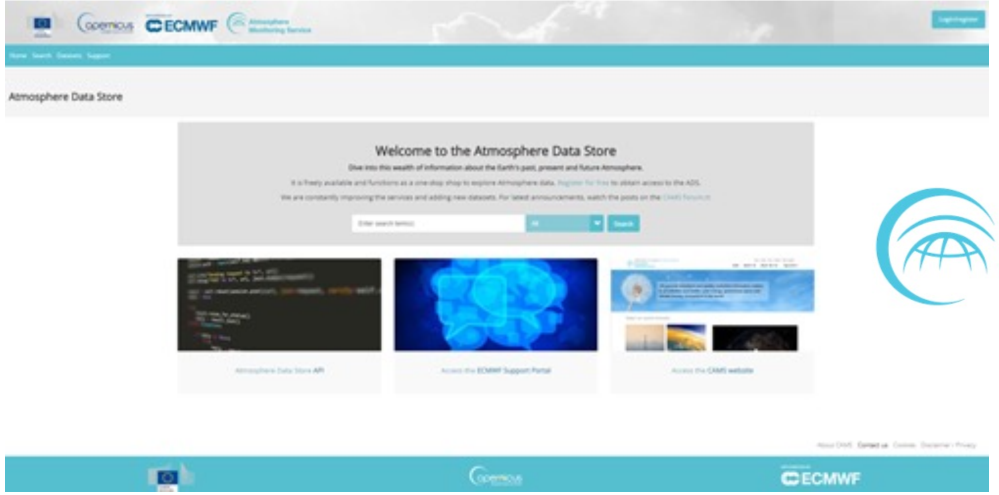


Climate Data Store (CDS)

100.000 registered **users**
1500 users, **75 PB** and **500k requests** daily
119 catalogued **Datasets**
24 Public applications

Atmosphere Data Store (ADS)

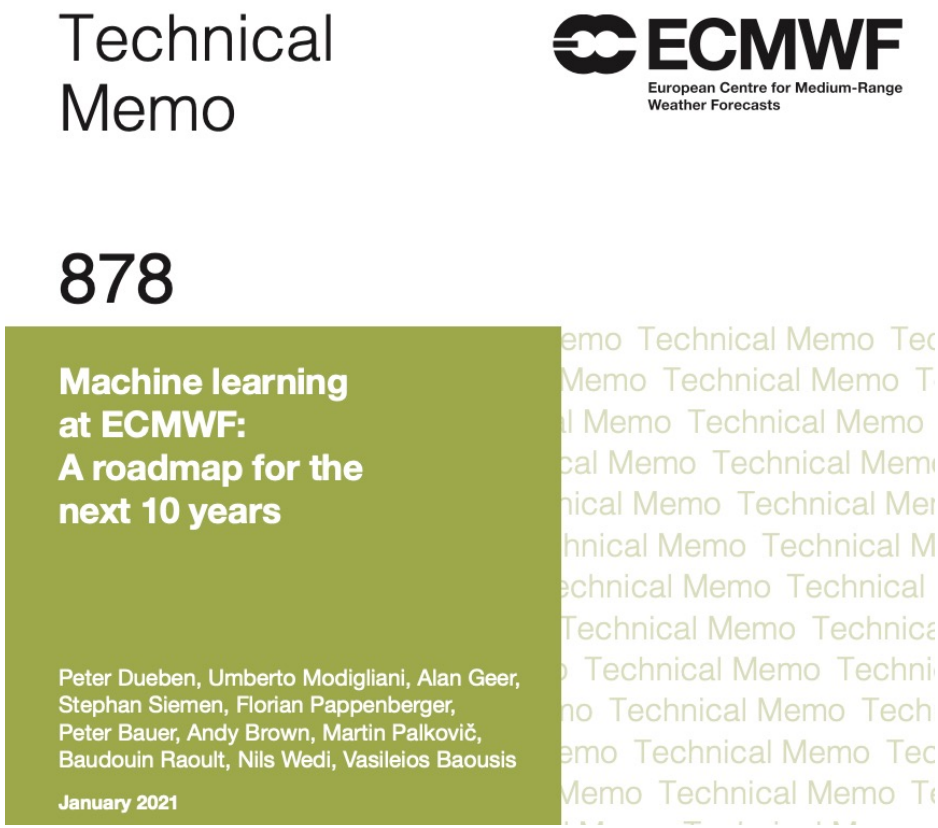
6.400 registered **users**
140 users, **2 TB** and **20k requests daily**
12 catalogued **datasets**



Atmosphere Monitoring

Dueben et al, 2021

A large range of machine learning efforts started at ECMWF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Machine learning at ECMWF: A roadmap for the next 10 years

Peter Dueben, Umberto Modigliani, Alan Geer, Stephan Siemen, Florian Pappenberger, Peter Bauer, Andy Brown, Martin Palkovič, Baudouin Raoult, Nils Wedi, Vasileios Baousis

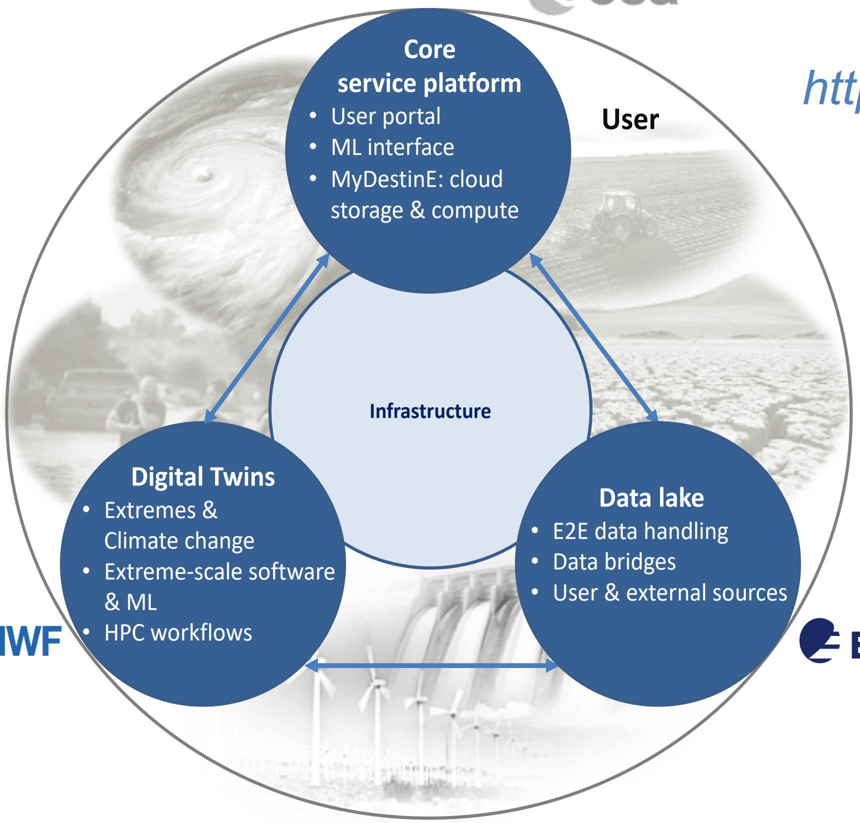
January 2021

- **Objective 1** Explore machine learning applications across the weather and climate prediction workflow and apply them to improve model efficiency and prediction quality.
- **Objective 2** Expand software and hardware infrastructure for machine learning.
- **Objective 3** Foster collaborations between domain and machine learning experts with the vision of merging the two communities.
- **Objective 4** Develop customised machine learning solutions for Earth system sciences that can be applied to various applications and at scale on current and future supercomputing infrastructure.
- **Objective 5** Train staff and Member and Co-operating State users and organise scientific meetings and workshops.

Destination Earth (DestinE) – Digital Twins – EuroHPC

Destination Earth aims to develop a high precision digital model of the Earth to model, monitor and simulate natural phenomena and related human activities.

https://digital-strategy.ec.europa.eu/en/policies/destination-earth



Connecting data & people in support of Earth stewardship