Progressi nelle previsioni ECMWF a scala globale in supporto all'allertamento di eventi estremi

A 25 anni dall'alluvione del Piemonte del 1994

I progressi fatti nella previsione degli eventi estremi e quanto resta ancora da fare

6 novembre 2019
Aula magna DISIT, ore 9.30
Alessandria, V.le T. Michel 11

Coordinamento scientifico: **Prof. Enrico Ferrero**
Dipartimento di Scienze e innovazione tecnologica, UPO

Interventi:

Dino Zardi (AISAM e Università di Trento) *La meteorologia in Italia oggi: situazione, opportunità e prospettive*; **Renata Pelosini** (ARPA Piemonte), *L'inquadramento dal punto di vista meteorologico dell'evento alluvionale*; **Fabio Luino** (IRPI – CNR), *L'evento alluvionale del 5-6 novembre 1994: luogo, bacino del Tanaro*; **Carlo Cacciamani** (Dipartimento della Protezione Civile), *Il sistema di previsione e allerta per gli eventi alluvionali*; **Francesco Della Corte** (CRIMEDIM, UPO), *Le conseguenze di interesse sanitario negli eventi alluvionali*; **Gianpaolo Balsamo** (ECMWF), *Progressi nelle previsioni meteorologiche alla scala globale e prospettive future*; **Federico Grazzini** (Meteorological Institute, München/ Arpae Bologna), *Classificazione degli eventi di precipitazione estrema: il novembre 1994 come precursore di scala*; **Giorgio Melchioni** (Coordinamento Protezione Civile Provincia di Alessandria), *Il volontariato della Protezione Civile di Alessandria*.

Confronto tra le simulazioni dell'evento alluvionale fatte con i modelli odierni e quelle fatte con i modelli di allora. Presiede **Roberto Buizza** (Scuola Universitaria Superiore Sant'Anna di Pisa); **Massimo Milelli** (ARPA Piemonte), *Il modello di area limitata (Lokal Modell, LM)*; **Silvio Davolio** (ISAC-CNR), *La modellistica previsionale del CNR*; **Antonio Parodi** (Fondazione CIMA), *La modellistica meteo-idrologica previsionale di Fondazione CIMA*; **Valerio Capecchi** (Consorzio LAMMA), *La modellistica previsionale del LAMMA*; **Riccardo Bonanno** (RSE), *Il dataset di rianalisi meteorologica MERIDA (Meteorological Reanalysis Italian DAtaset)*; **Gianpaolo Balsamo** (ECMWF), *Previsione ensemble in ricordo dell'alluvione del Piemonte 1994 con riprodotti i risultati con la versione di ECMWF-2019*; **Claudio Cassardo** (Università di Torino), *La modellistica previsionale del Dipartimento di Fisica*; **Stefano Alessandrini** (NCAR), *Simulazioni meteorologiche ad alta risoluzione dell'alluvione del 1994*.

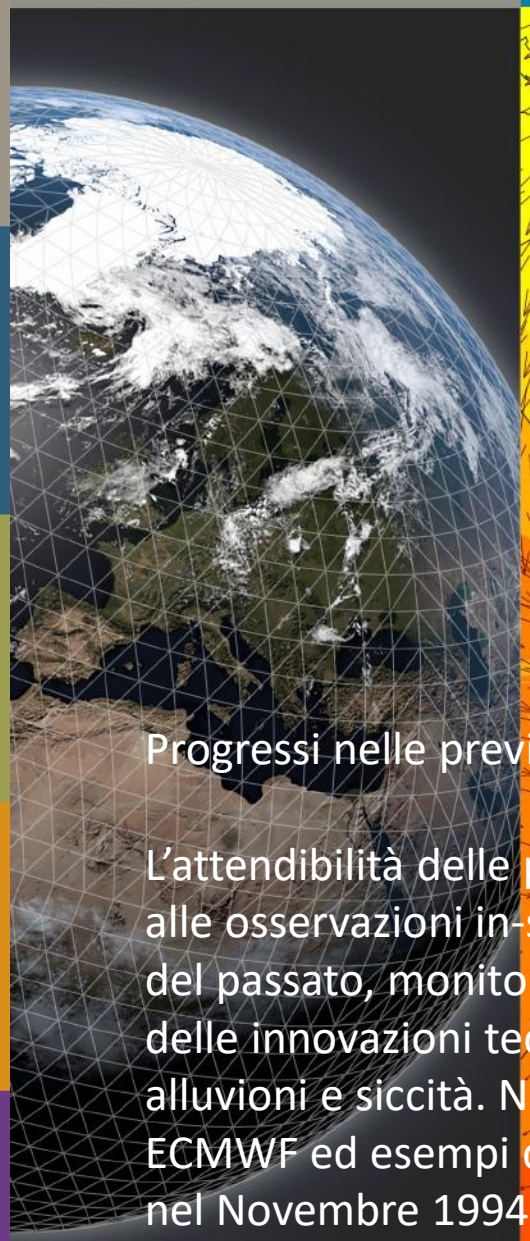
Con il supporto di:

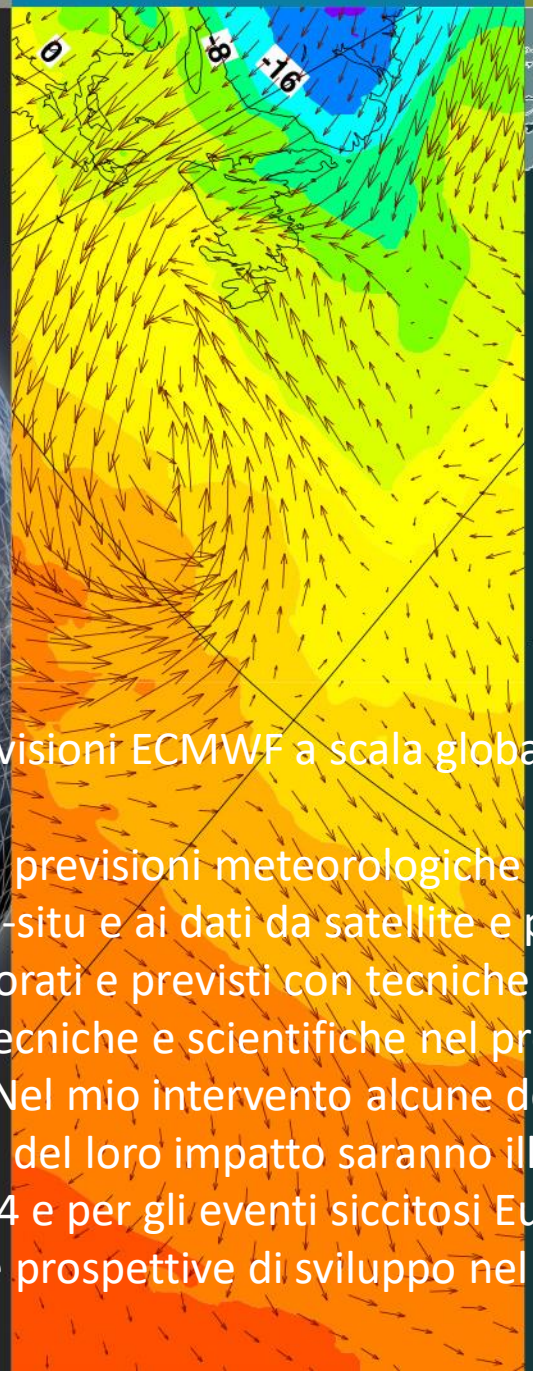
Con il patrocinio di:

Gianpaolo Balsamo, partecipazione al Convegno UPO 6-Novembre 2019

NWP SCIENCE | GLOBAL FORECASTS | SERVING METEOROLOGY | SUPERCOMPUTING | ENVIRONMENTAL SERVICES

ECMWF OGGI

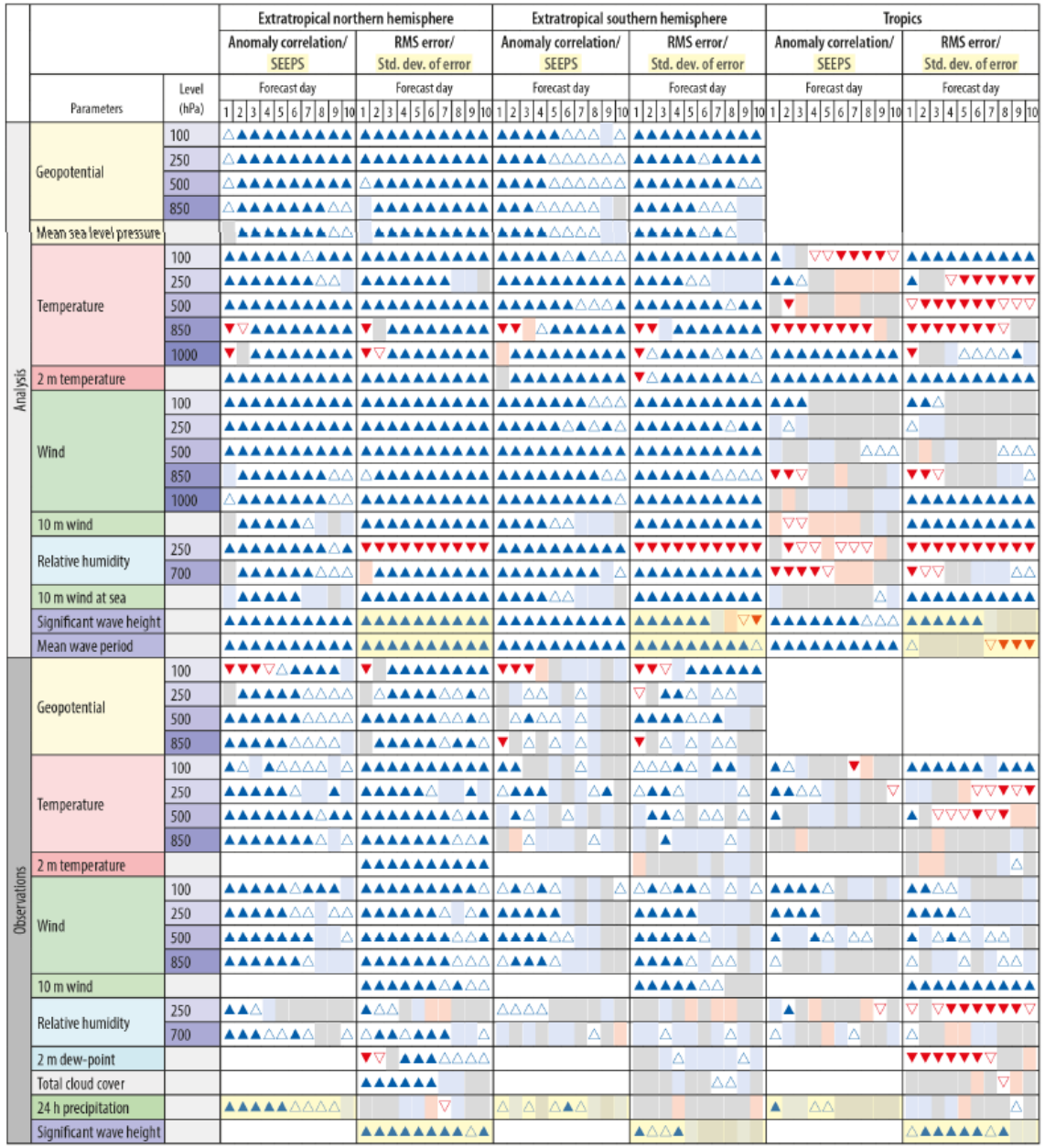


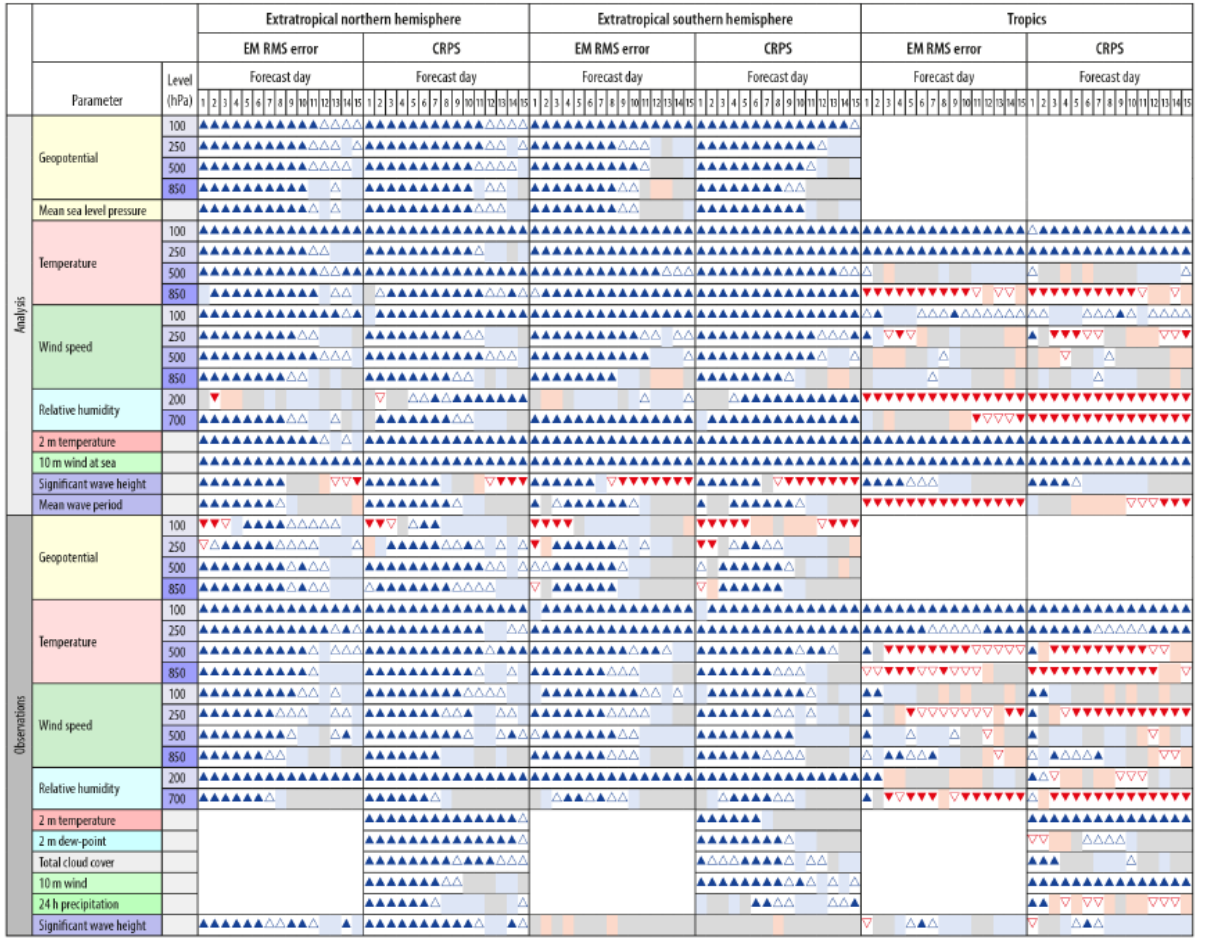


Progressi nelle previsioni ECMWF a scala globale in supporto all'allertamento di eventi estremi.

L'attendibilità delle previsioni meteorologiche a scala globale avanza in maniera progressiva e verificabile grazie alle osservazioni in-situ e ai dati da satellite e permette di confrontare la qualità delle previsioni per eventi estremi del passato, monitorati e previsti con tecniche e modelli attuali. Questo esercizio consente di dimostrare l'impatto delle innovazioni tecniche e scientifiche nel prevedere, allertare e mitigare gli effetti di eventi estremi quali alluvioni e siccità. Nel mio intervento alcune delle innovazioni introdotte nella modellistica del sistema Terra ad ECMWF ed esempi del loro impatto saranno illustrati in particolare per l'evento alluvionale che colpì il Piemonte nel Novembre 1994 e per gli eventi siccitosi Europei del 2003, 2010 e 2018 al fine di illustrare il progresso fatto fin qui ed alcune delle prospettive di sviluppo nel prossimo futuro.

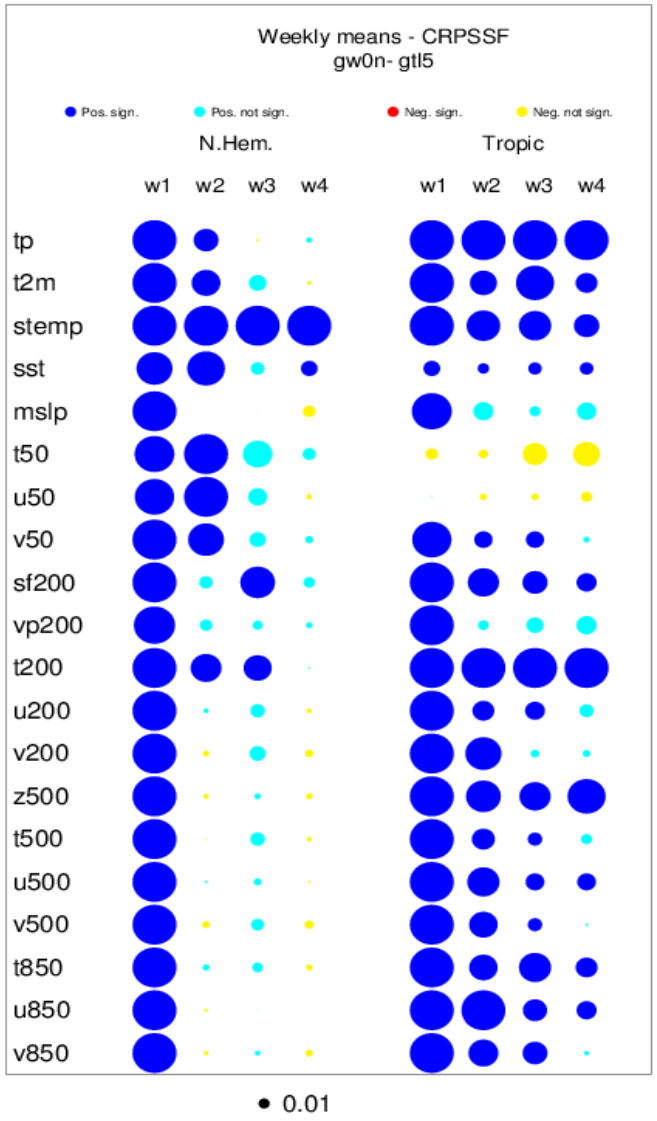
Delivering global predictions: IFS cycle 46r1 June 2019





Use of ERA5 to initialize Subseasonal Re-forecasts (CY46R1, June 2019)

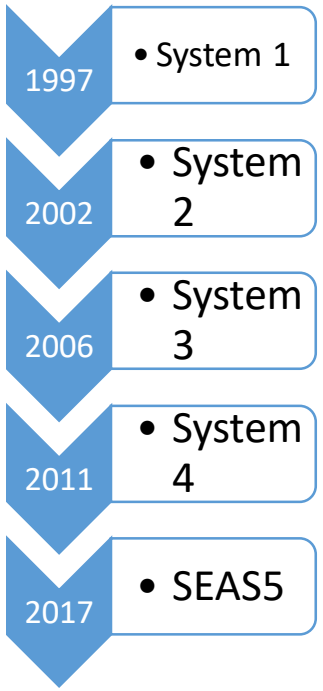
Scorecard
ERA5 vs EI initialization

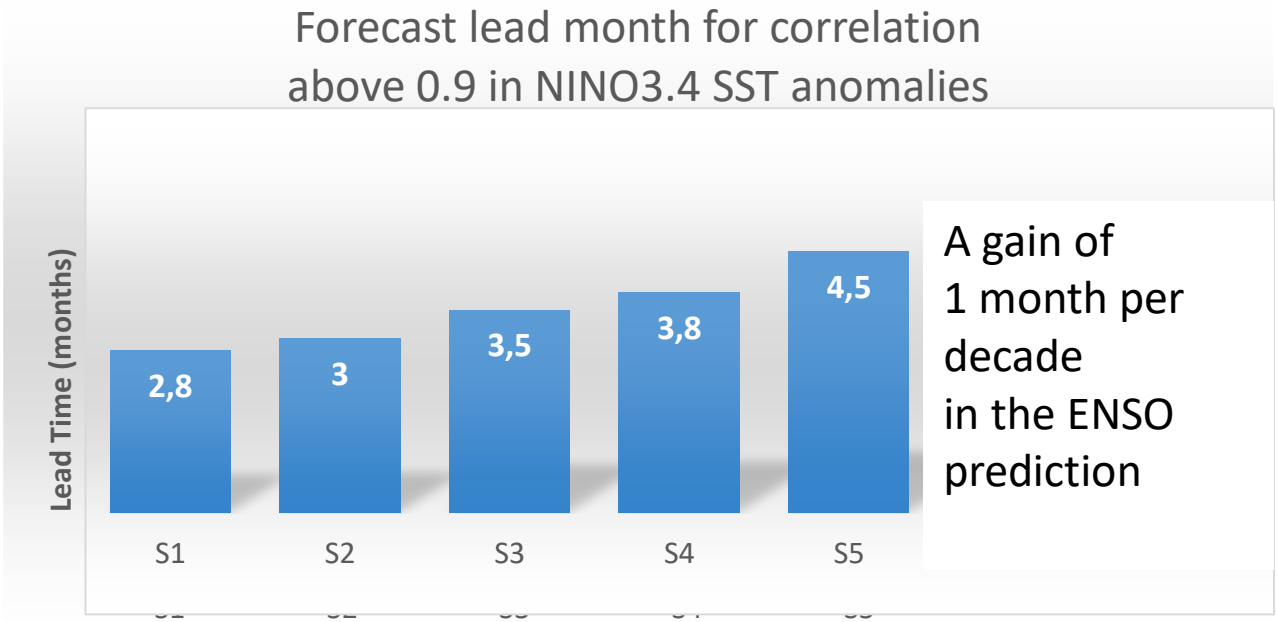


Changes introduces in 46R1:

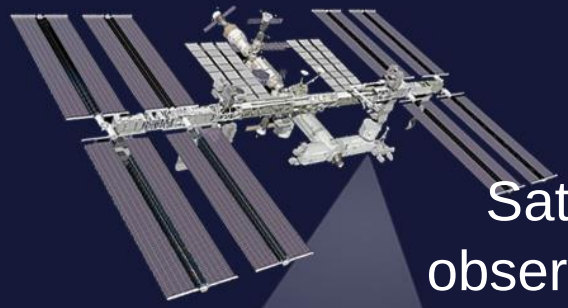
- ERA5 is now used to initialize the re-forecasts
- ERA5 EDA is used to perturb initial conditions
- Land surface is initialized from ERA5 instead of from an offline re-analysis

Progress in ENSO prediction at ECMWF in SEASONAL systems





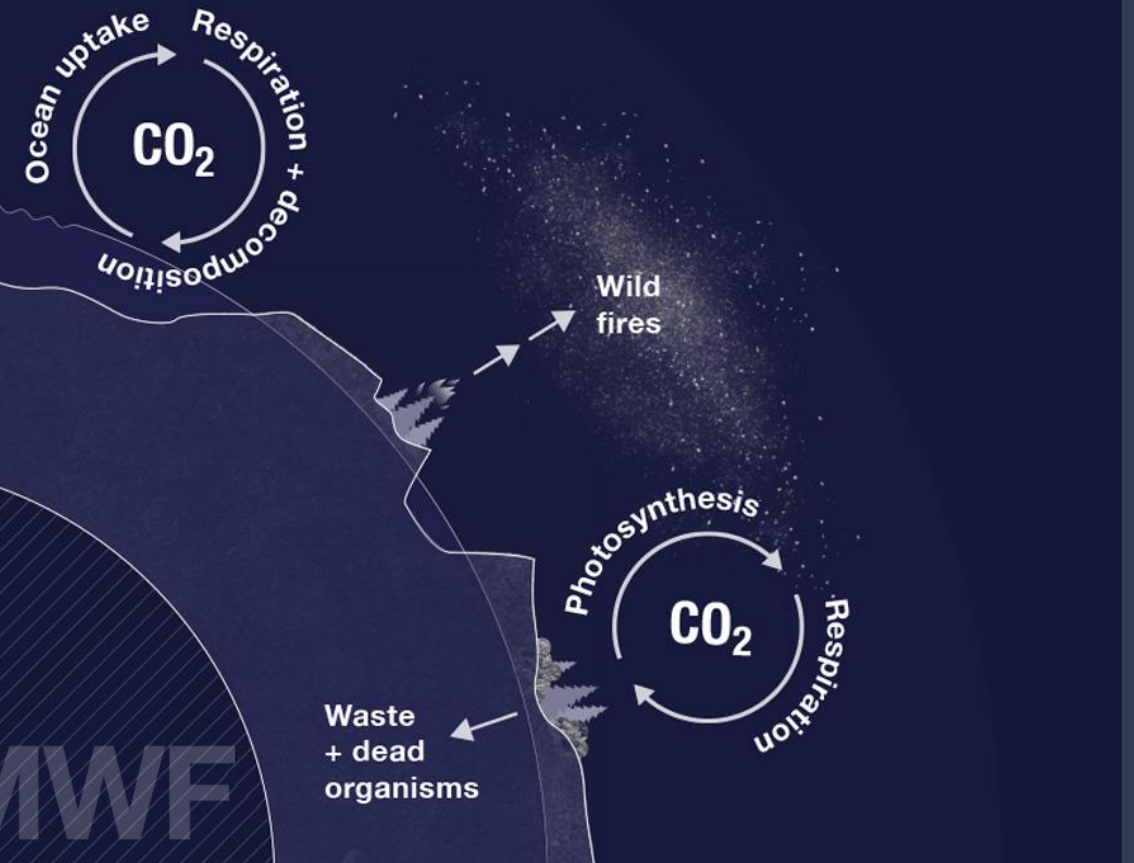
Mid-latitude seasonal skill and teleconnections more challenging



Satellite observations

Earth System Models with CO_2

In-situ observations



Quanta strada è stata fatta in 25 Anni dal 1994

ECMWF has a long experience with reanalysis

Atmosphere/land *including ocean waves*

1) 1979 - 1981 FGGE	2) 1994 - 1996 ERA-15	3) 2001 - 2003 ERA-40	4) 2006 - … ERA-Interim	5) 2016 - … ERA5

Ocean *including sea ice*

2006 ORAS3	2010 - … ORAS4	2016 - … ORAS5

ERA CLIM / ERA CLIM 2

Centennial *Coupled*

2013 - 2015 ERA-20CM/20C	2016 CERA-20C	2017 CERA-SAT

Enhanced land

2012 ERA-Int/Land	2014 ERA-20C/Land	2018 - … ERA5L

Atmospheric composition

2008 - 2009 GEMS	2010 - 2011 MACC	2017 - … CAMS

Climate Change Service
climate.copernicus.eu

ERA5 has now replaced ERA-Interim

ERA-Interim not available for dates beyond **August 2019**

Migration to ERA5 has (mostly) completed

Skill of ERA5 re-forecasts:

Up to one day gain with respect to ERA-Interim

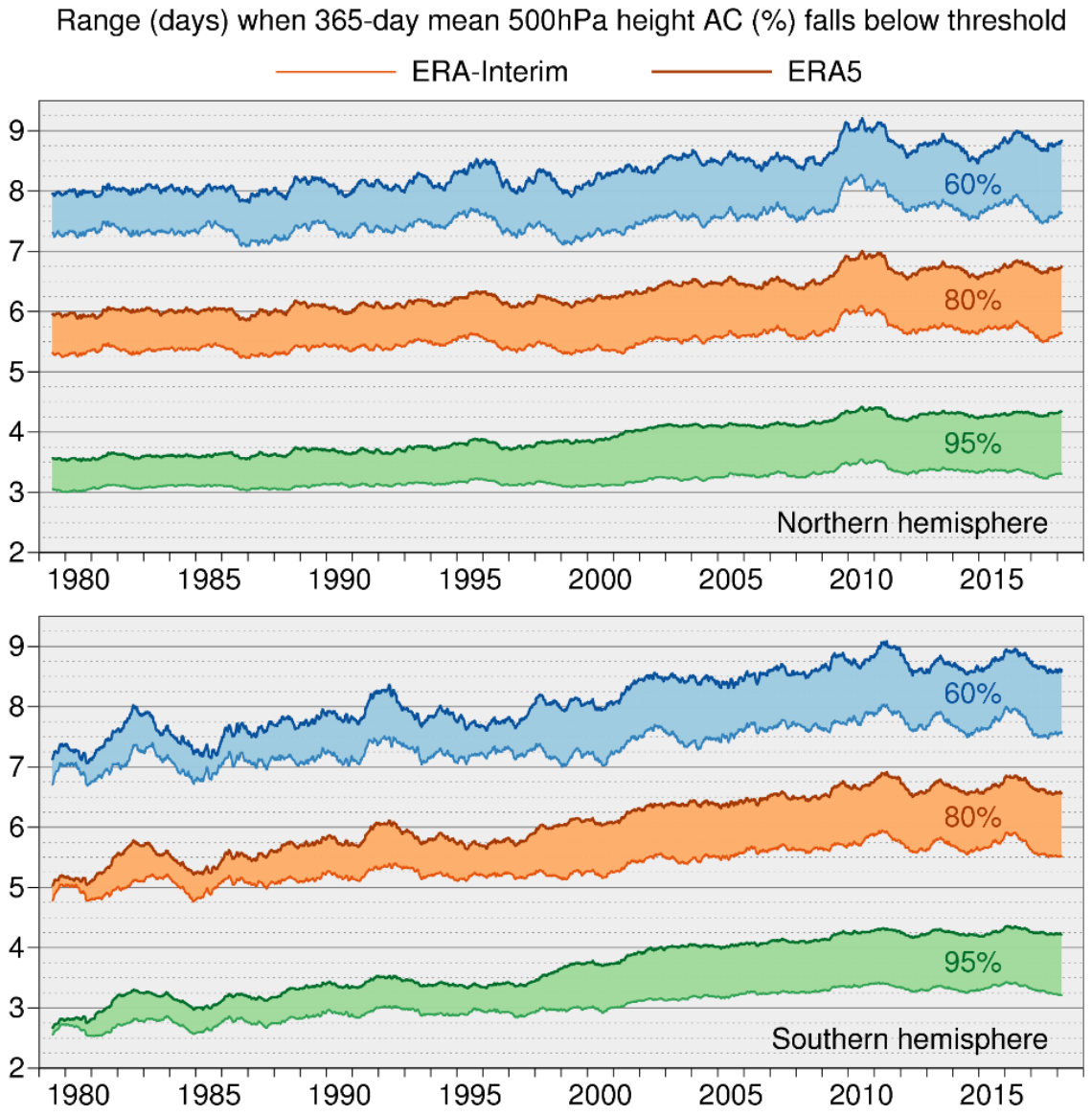
Improvements compared to ERA-Interim:

- Benefit from 10 years model development (2006 to 2016)
- Much higher resolution; **31km** versus 80km
- More and better input data
- **Hourly output**
- 10-member EDA-based **uncertainty estimate** (at 63km)

ERA5 is available in the C3S climate data store (CDS):

Currently: **1979 onwards**, 2-3 months behind real time

By end 2019: **timely updates**, ERA5T, 2-5 days latency

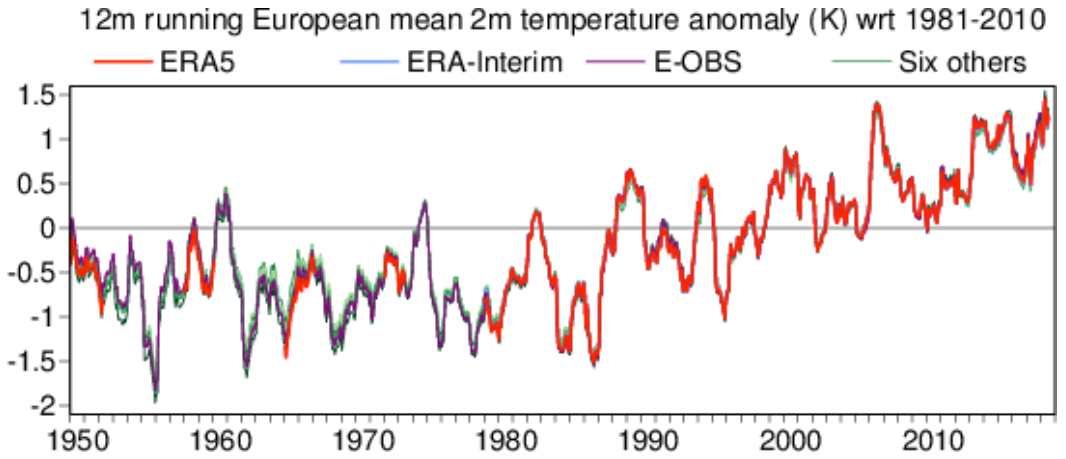


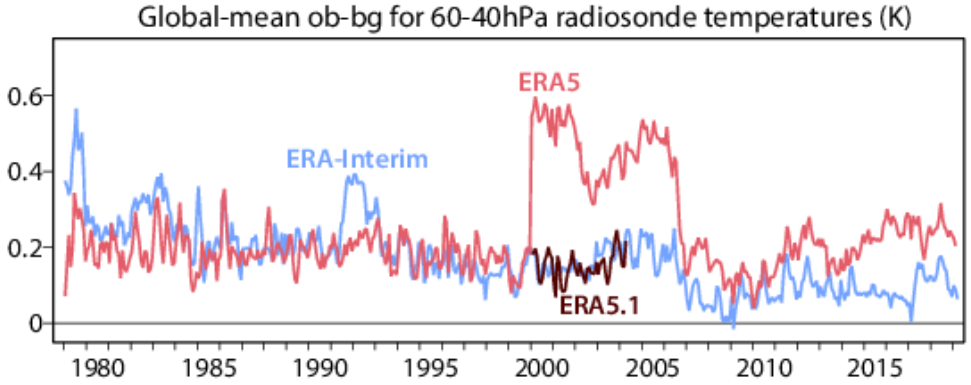
ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

The back extension and other ERA5 datasets

ERA5 back extension:

1950-1978, to be available **2020 Q2**





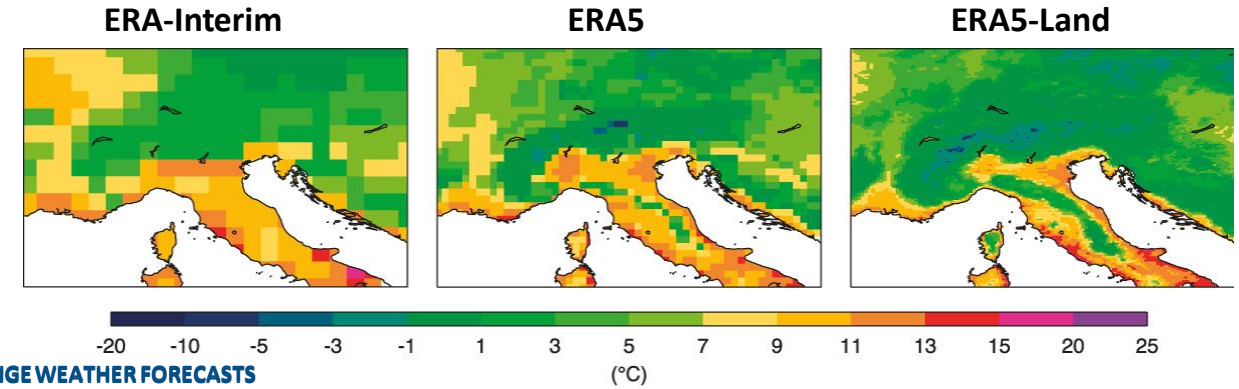
ERA5.1: period 2000-2006, to be available **2020 Q1**.

- ✓ restore climate quality for stratospheric temperature
- ✓ Use more appropriate background correlation lengths
- ✓ Need: until availability of COSMIC GNNS-RO 2006

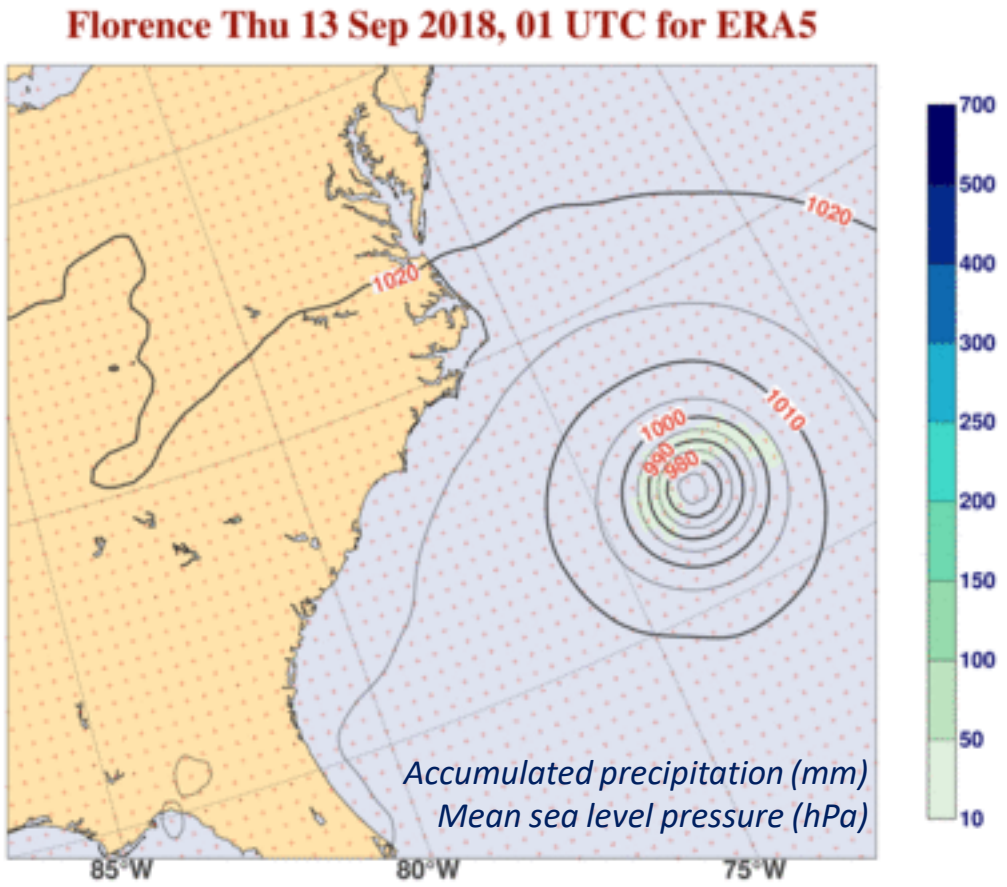
ERA5 land: available in the CDS from 2001

1981-2000 later this year; **2020**: back to 1950

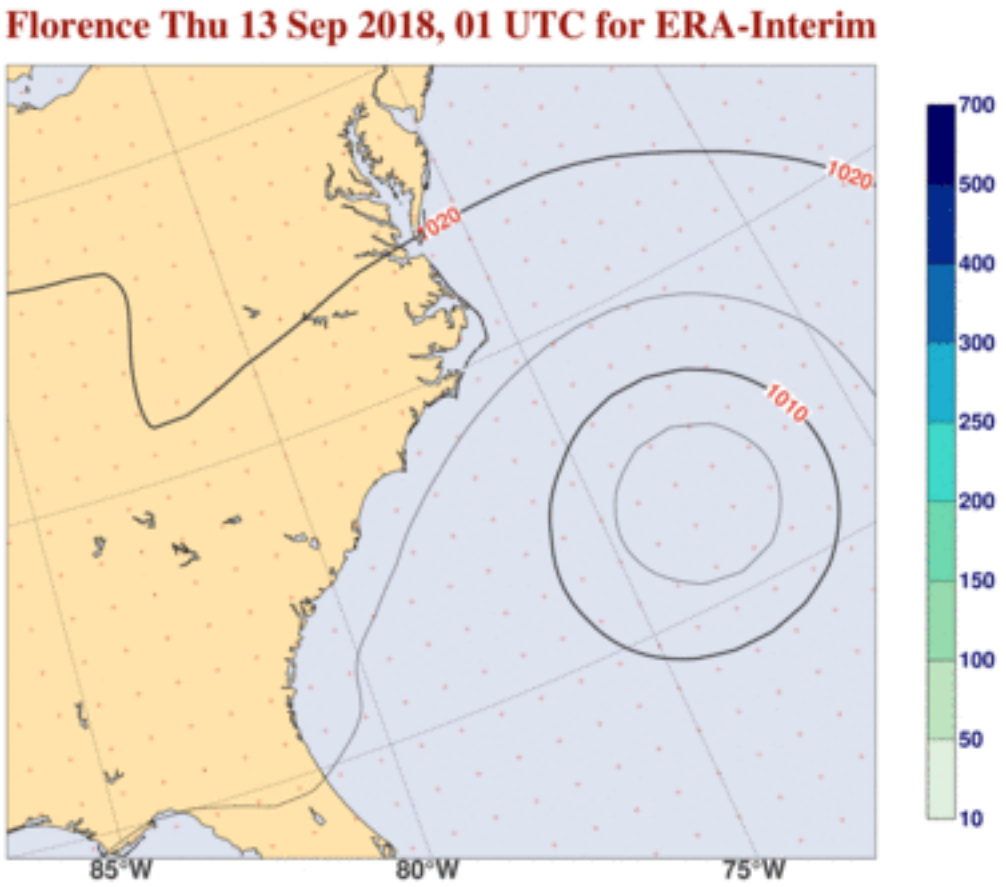
9km Land downscaling from ERA5



Better model, better and more observations, higher resolution
New: hourly output



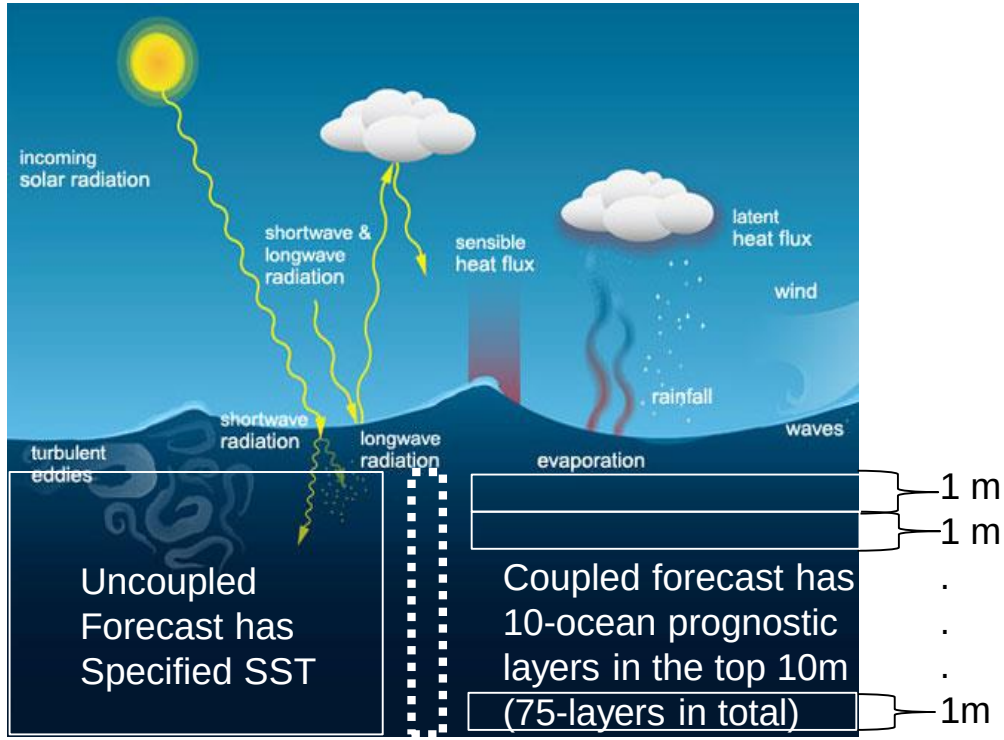
ERA5

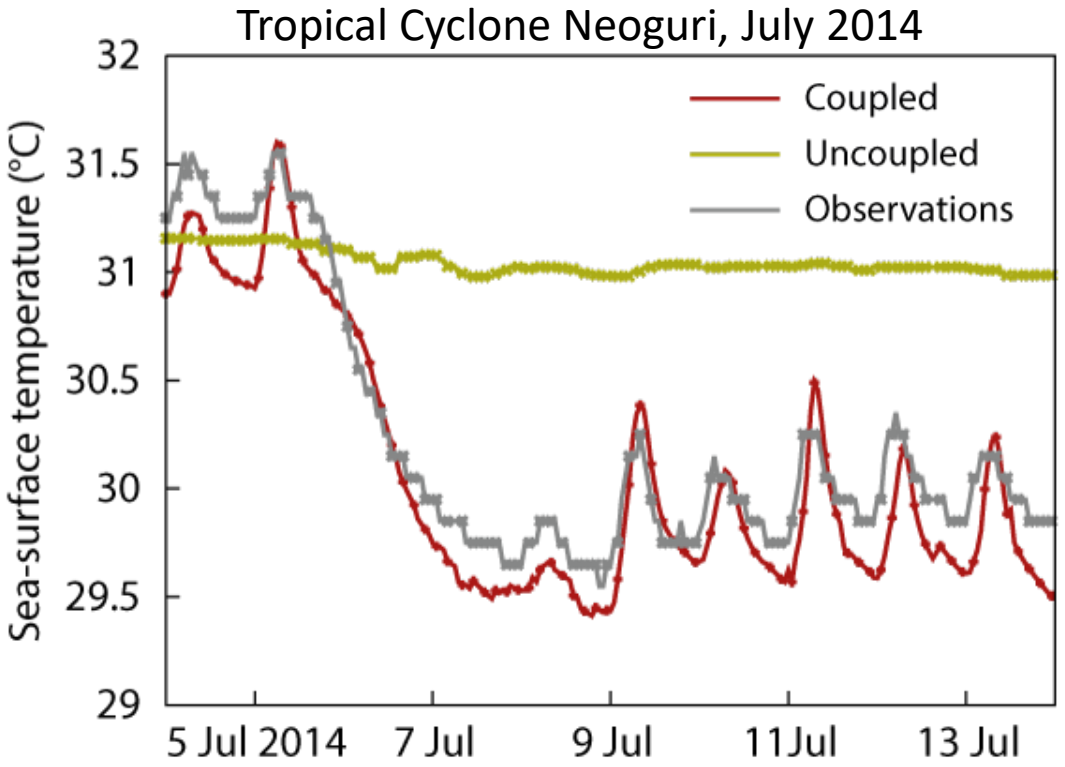


ERA-Interim/ERA-40

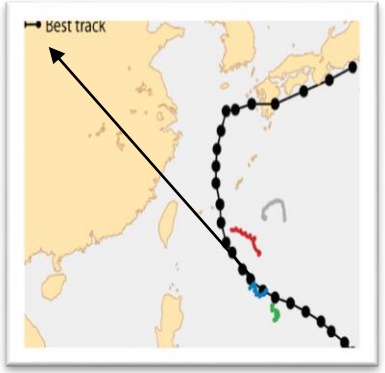
La Ricerca di ECMWF per migliorare la performance in eventi estremi

Ocean-coupling and sea surface temperature (SST) validated with in-situ





- The ECMWF Ocean-coupled (red) model is better simulate the cool wake after the passage of Tropical cyclone Neoguri. A more realistic response is observed comparing the 10-day forecast with an on-track DRIBU observation of SST, both for TC passage and diurnal cycle

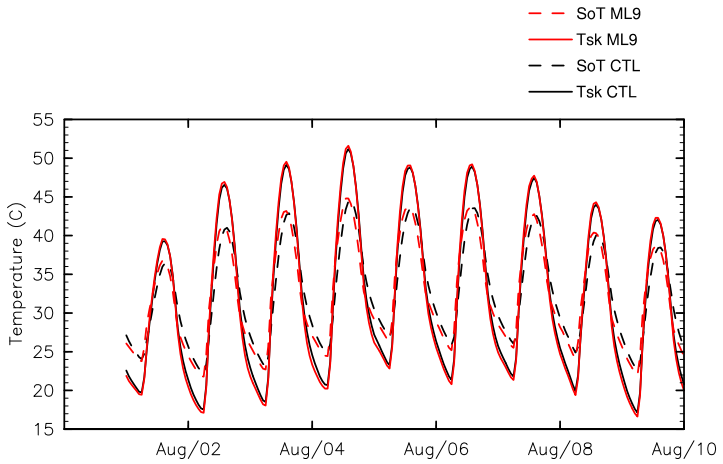


Mogensen et al 2018

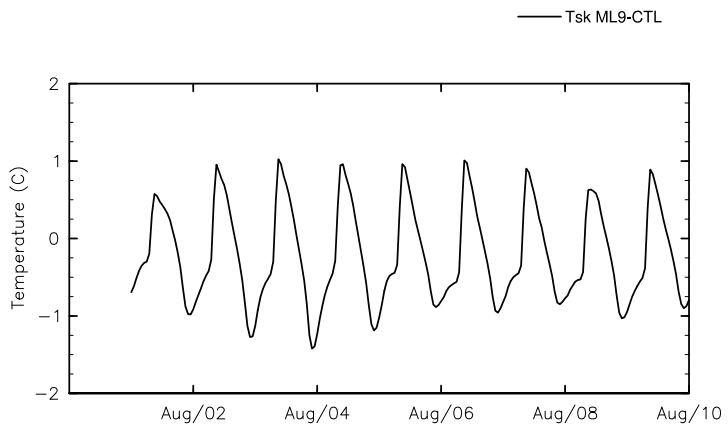
Impact of the soil model vertical resolution: heatwaves severity

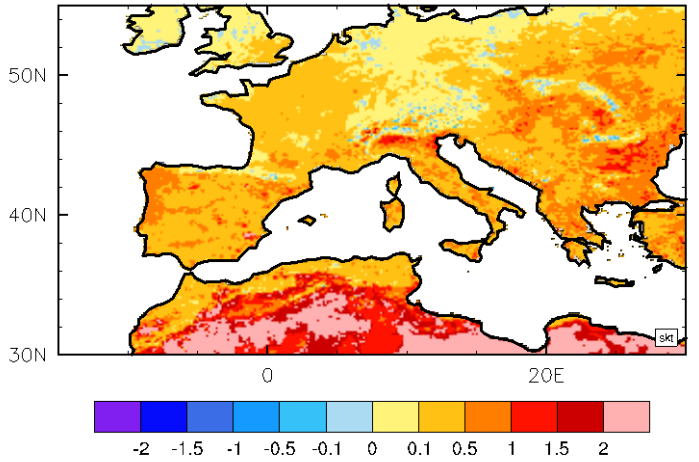
During summer 2017 the effect of multi-layer is examined for European heatwave, here shown for Cordoba (Spain) where temperatures went above 40º Celsius on the 6th of August 2017

ECMWF Land model ML9 & ML4 (offline)



Difference ML9-ML4 soil model (offline)





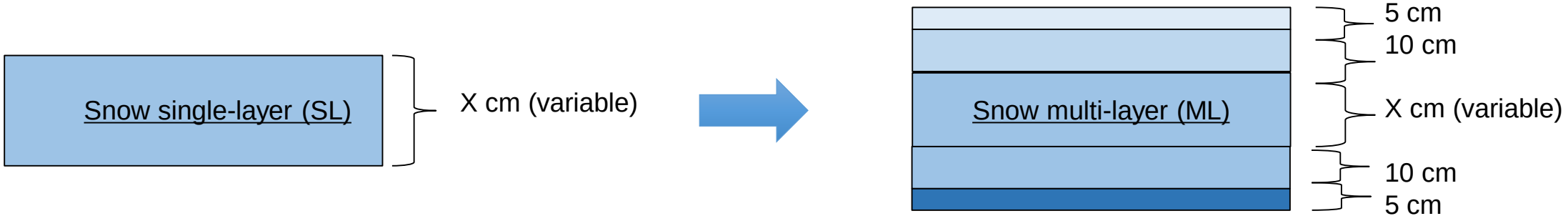
Differences in the maximum skin temperature ML9-ML4

An enhanced soil vertical discretisation is increasing the amplitude of the diurnal cycle. Extremes heatwave are up to 1 K hotter

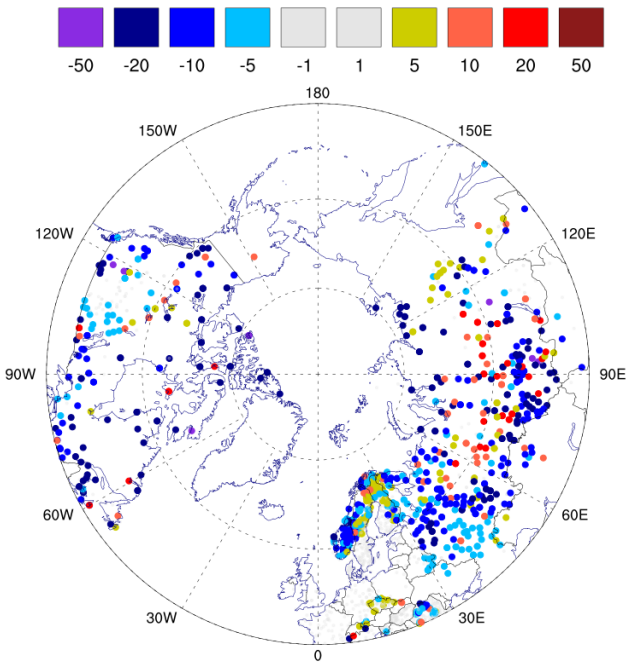
Thanks to Gabriele Arduini

Increased snow model vertical resolution: impact in cold regions climate

Increased vertical discretization of the H-TESSEL snowpack (**up to 5 layers**) permits a better physical processes representation

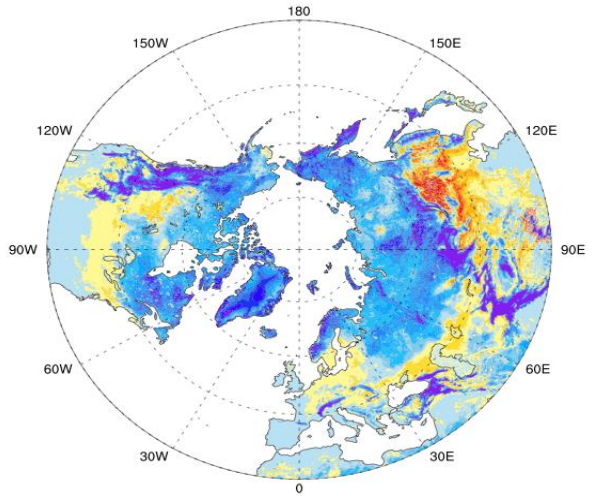


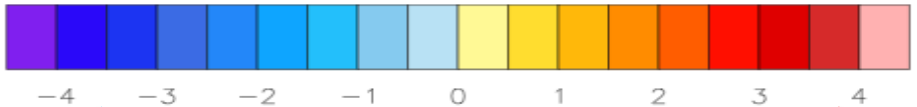
Difference ML- SL in Snow depth RMSE winter (DJF)



An improved snow depth (ML – SL) evaluated with in-situ SYNOP snow depth.
RMSE of 0.19m (0.23m) in ML (SL).
This is 17% RMSE error reduction in snow depth.

Difference ML - SL in T_{skin} minimum winter (DJF)





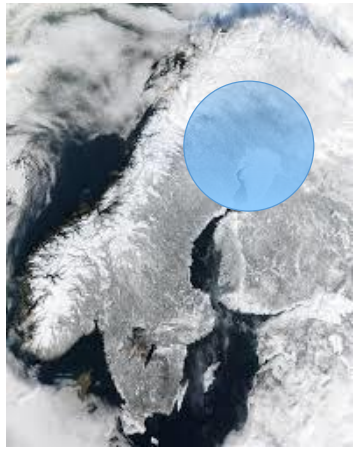
Reducing — Increasing

Winter reduction of the 2m minima temperatures with increasing diurnal-cycle.
DIFF Tmin 2-4 K colder in ML compared to SL snow.
Increased variability

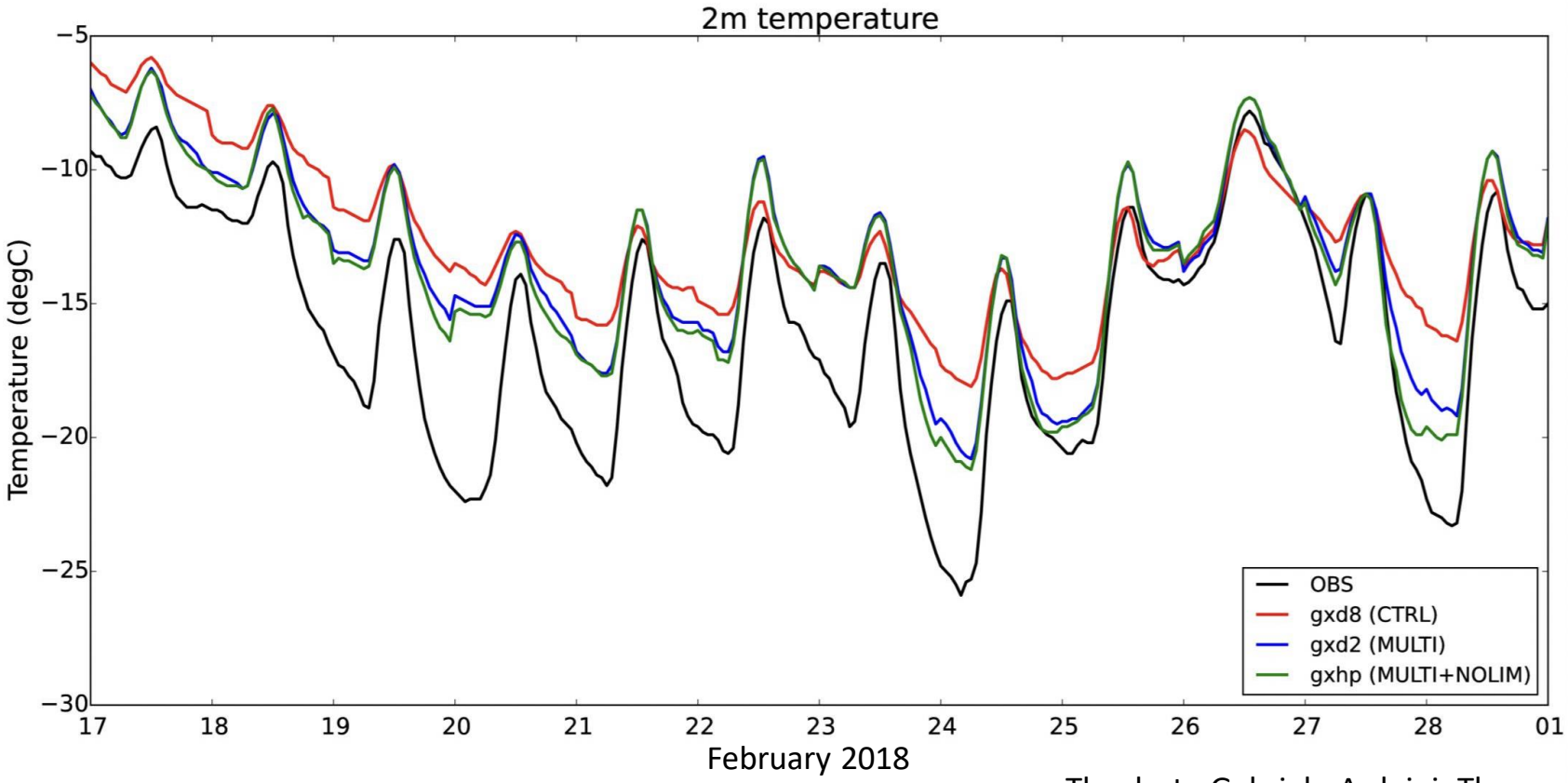
Thanks to Gabriele Arduini, Jonny Day, Linus Magnusson

Impact of snow model vertical resolution increase on near surface temperature

Increased vertical discretization of the snowpack (**up to 5 layers**) permits a better 2-m forecast: here hourly day-2 forecasts are shown for 24-hour to 47-hour ahead, concatenated to form a continuous time-series



T2m Observations, T2m forecast (current snow, SL), T2m forecast (ML)



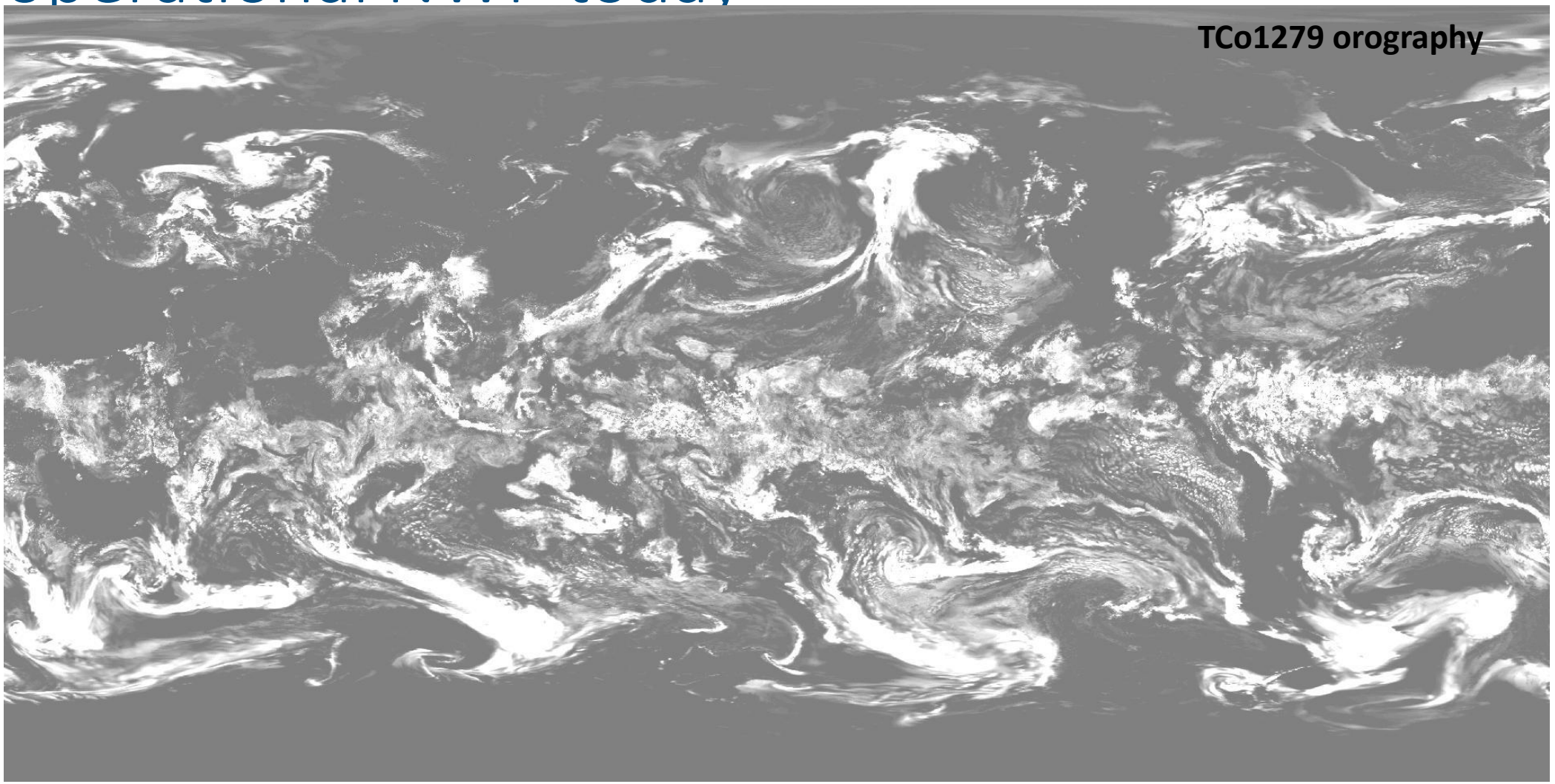
In clear-sky the MULTI-layer snow scheme is capable to produce stronger winter inversions improving observation match.

The increased variability in the diurnal cycle is beneficial for ensemble forecasting.

Thanks to Gabriele Arduini, Thomas Haiden, Irina Sandu & USURF Team

Uno sguardo verso il futuro di ECMWF

Current km-scale: TCo1279 (~9km) highest global operational NWP today

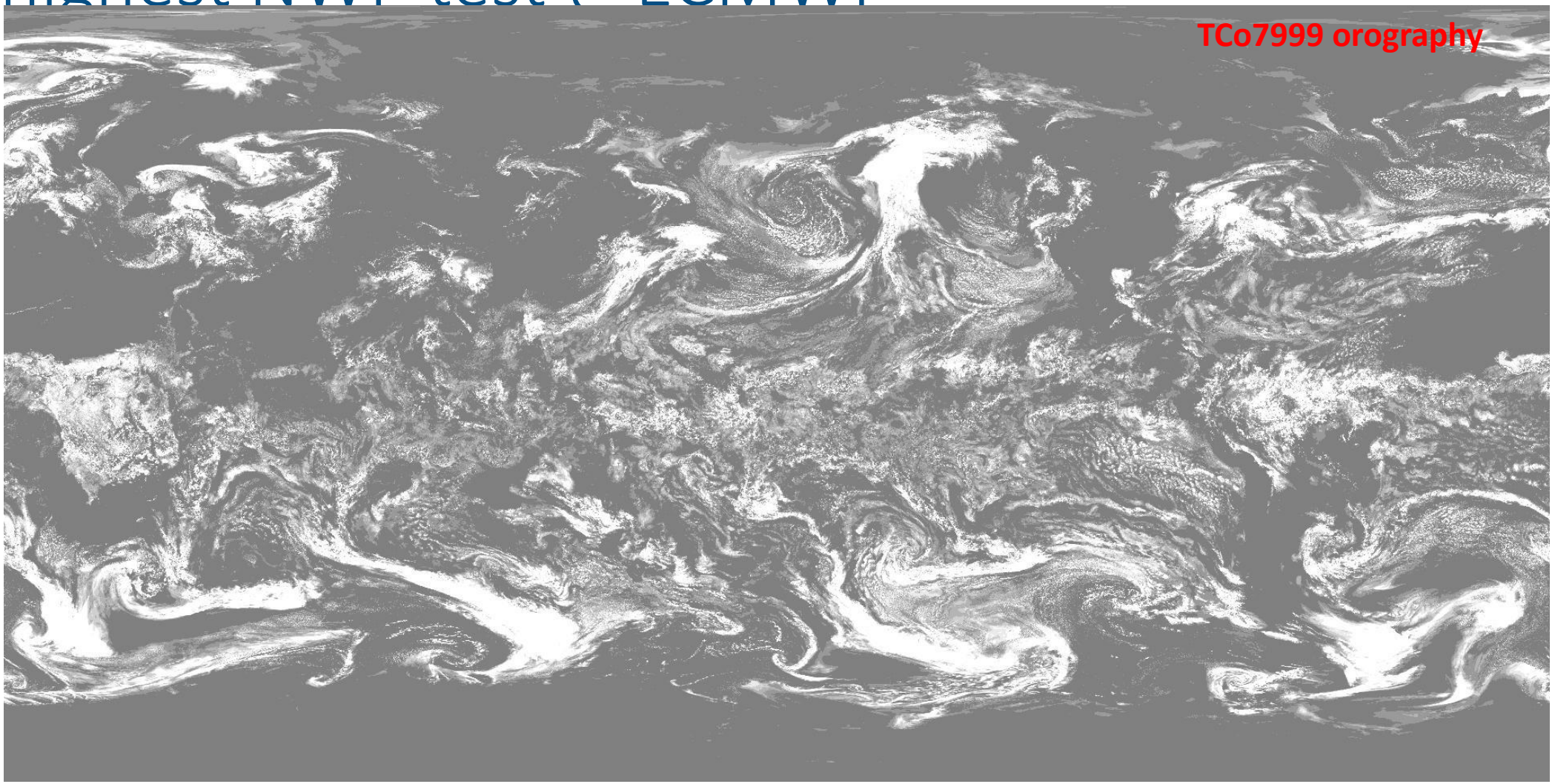


(12h forecast, *hydrostatic*, with deep convection parametrization, 450s time-step, 240 Broadwell nodes, ~0.75s per timestep)

ECMWF

Equivalent to 6.6 Megapixel camera

Towards km-scale: TCo7999 test-case (~1.3km) highest NWP test @ECMWF



(12 h forecast, *hydrostatic*, no deep convection parametrization, 120s time-step, 960 Broadwell nodes, ~6s per timestep in SP)

ECMWF

Thanks to Nils Wedi and NM-Team

Equivalent to 256 Megapixel camera

Il valore aggiunto di ECMWF per gli Stati Membri

Un quarto di secolo dal 1994 ha permesso di:

passare da risoluzioni di 100km (300km ENS) a 9 km (18km ENS)
migliorare la qualità previsionale a medio terming di oltre 2 giorni
migliorare le capacità previsionali alla scala stagionale di 1mese
migliorare il monitoraggio tramite reanalisi climatiche operative
estendere le capacità alla previsione ambientale multi-hazards