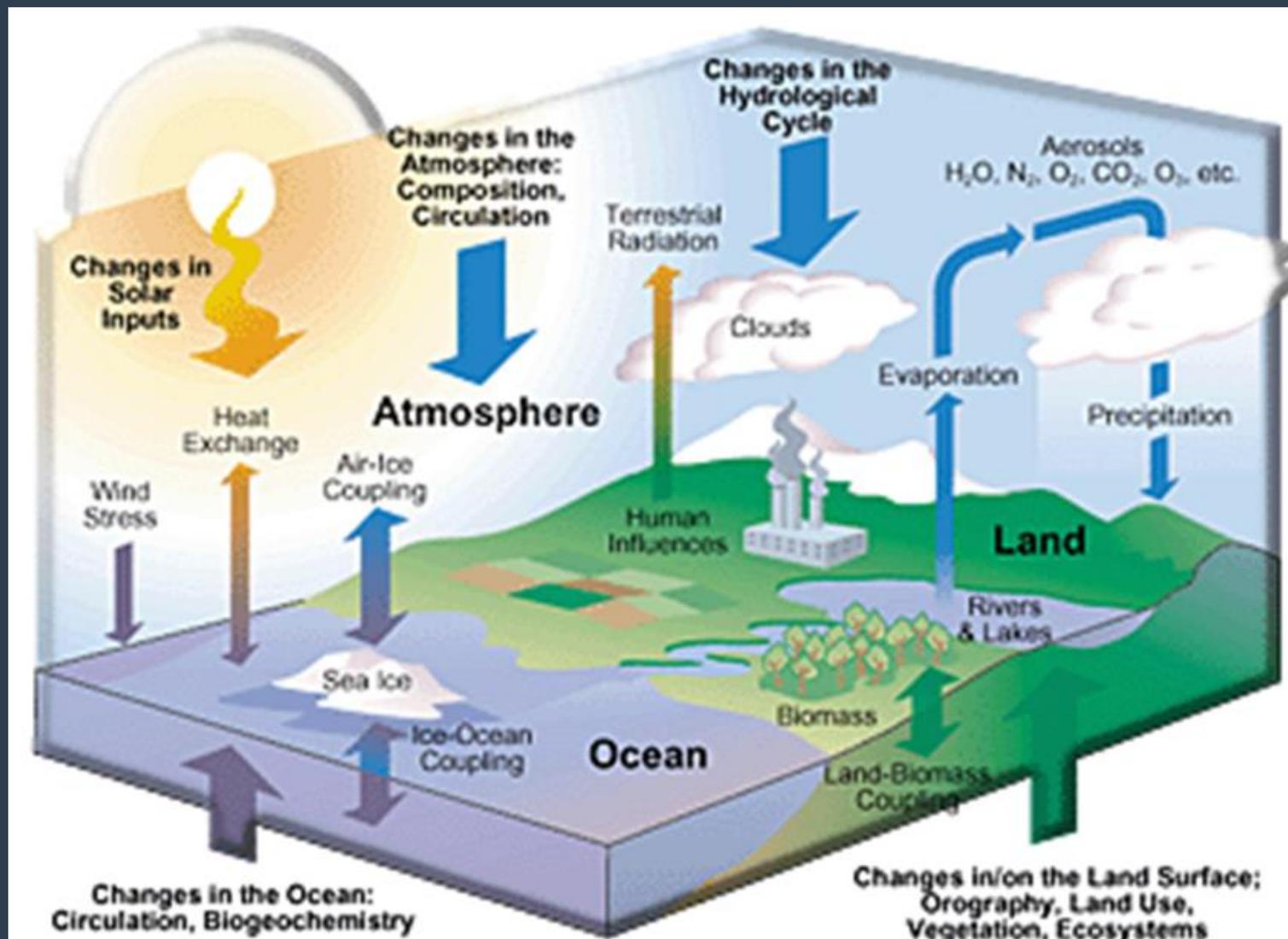




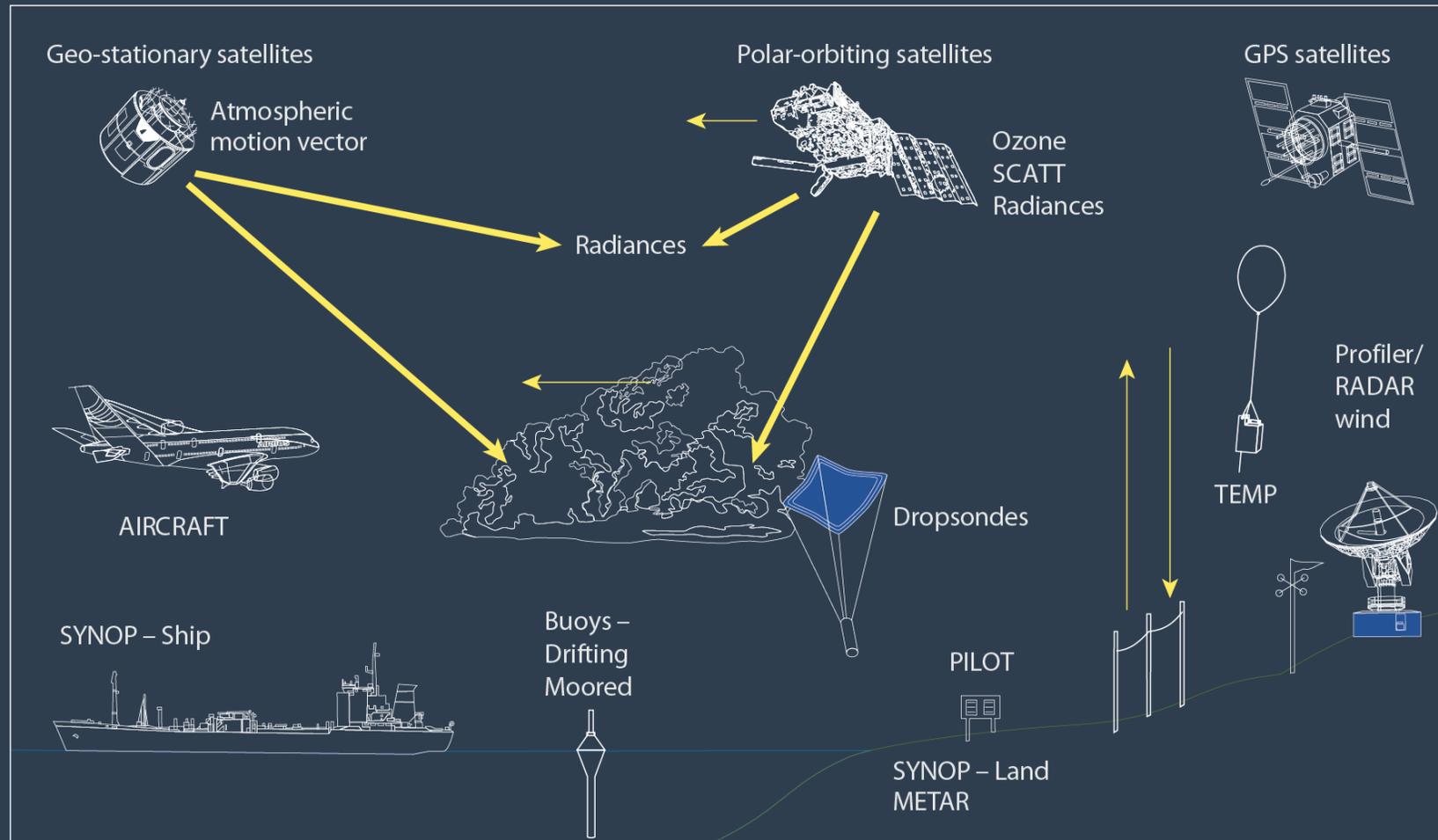
Future Earth System model and assimilation developments

Erland Källén, ECMWF

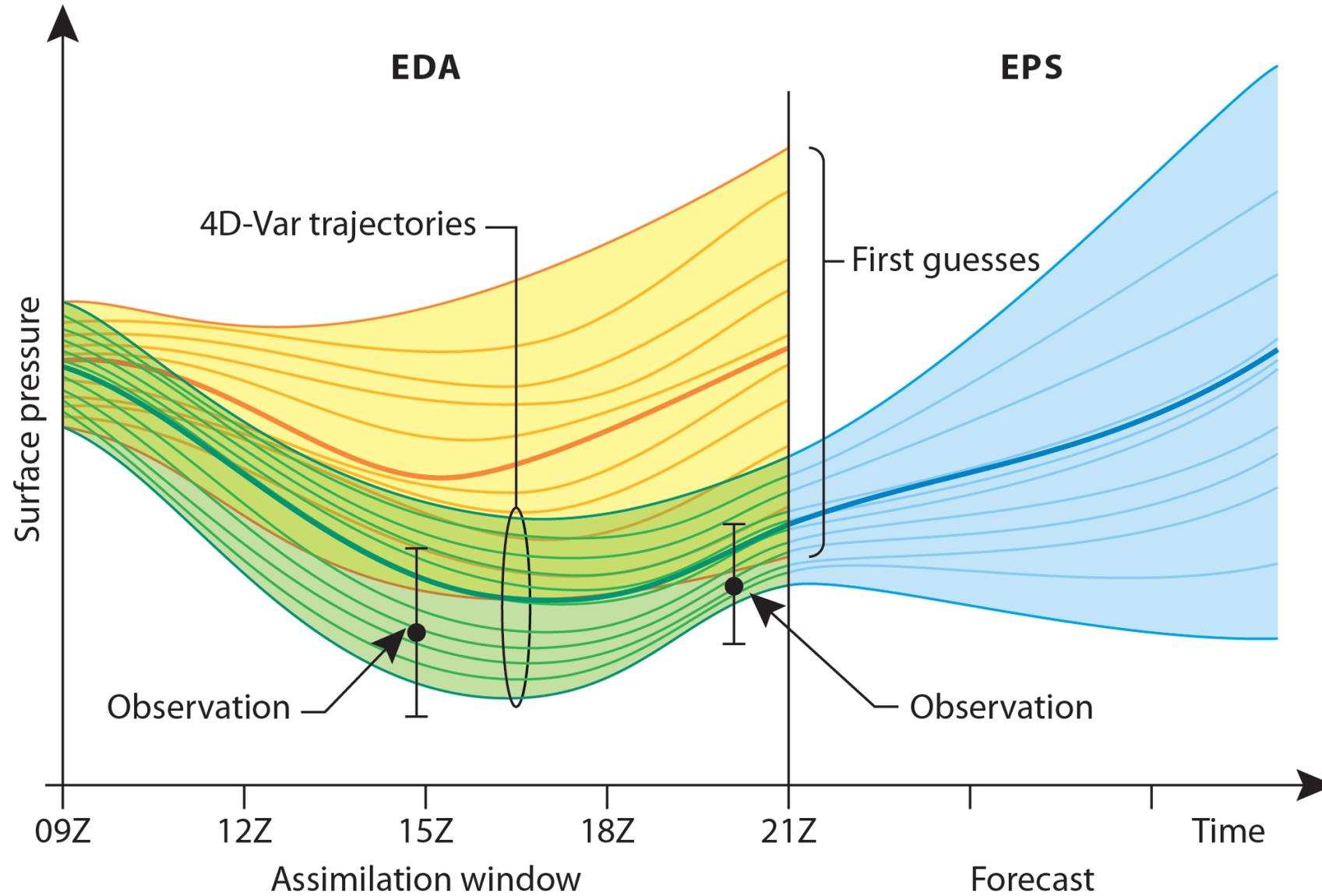
Earth System modelling



Mission-driven science: 40 million observations processed every day

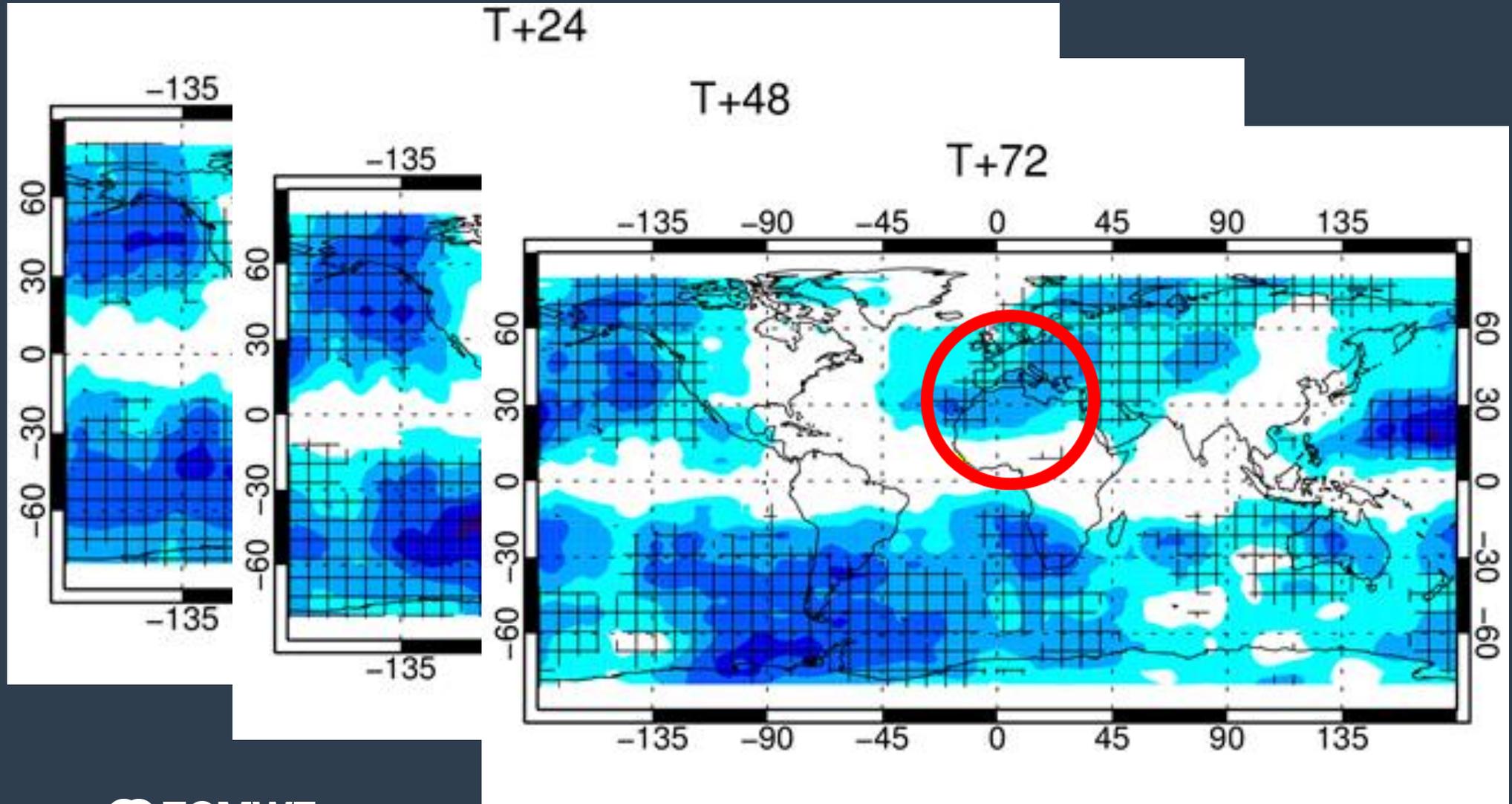


Ensemble assimilation and prediction



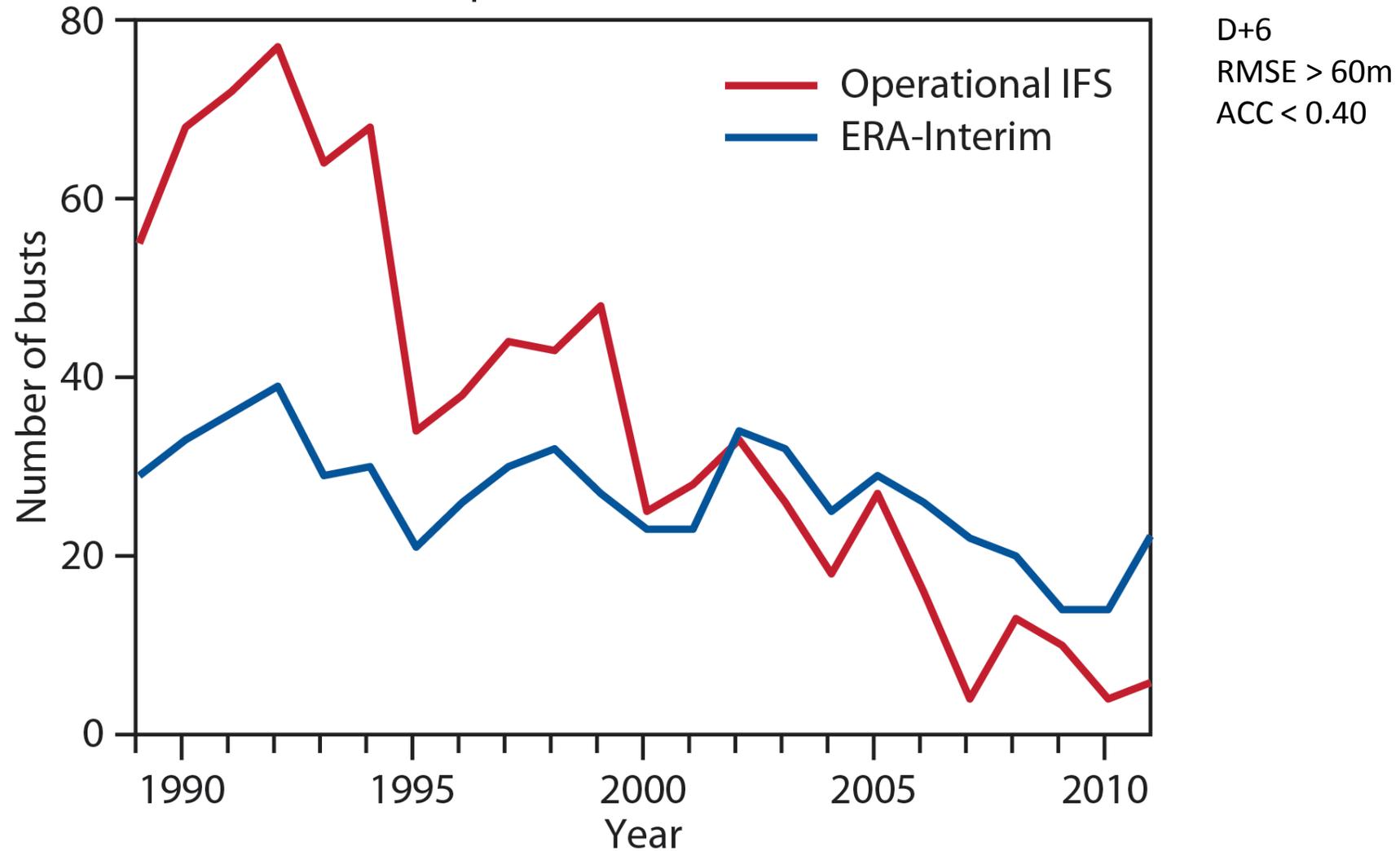
All sky satellite data assimilation

Microwave humidity sounder impact



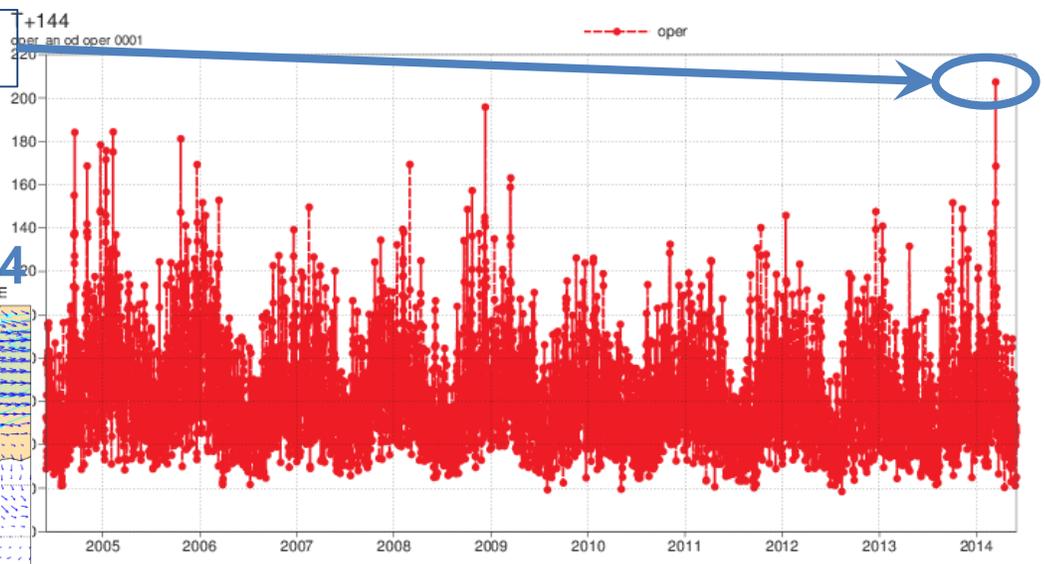
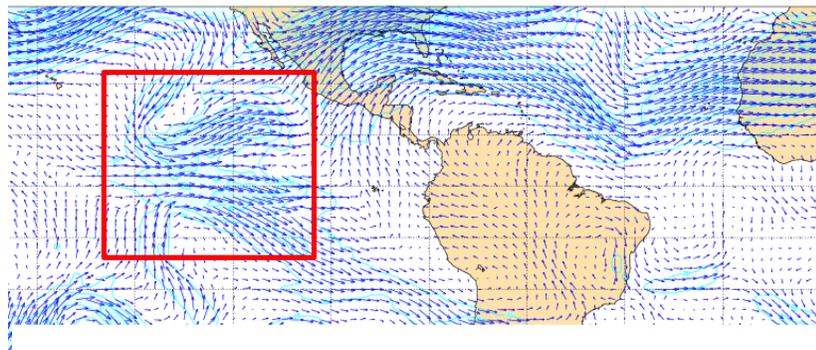
Forecast busts over Europe

a Number of European busts

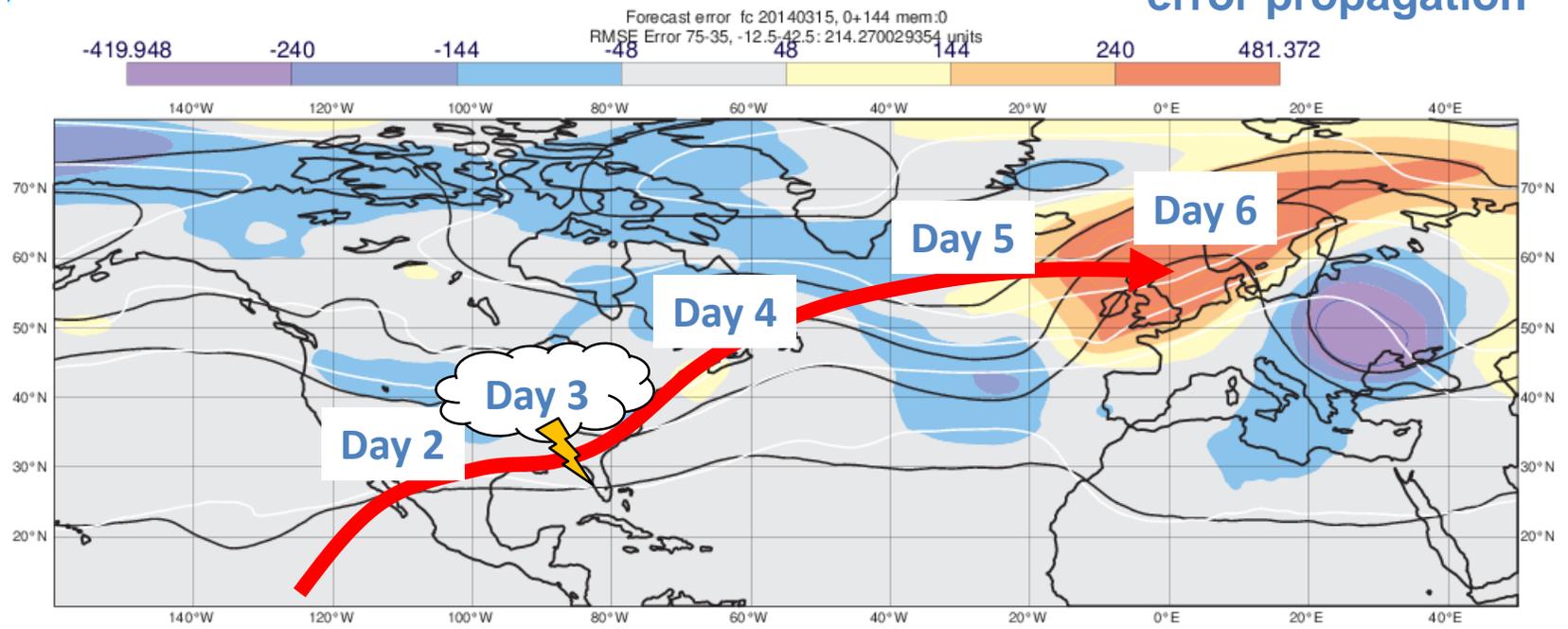


A poor forecast

200 mb winds on 15 March 2014



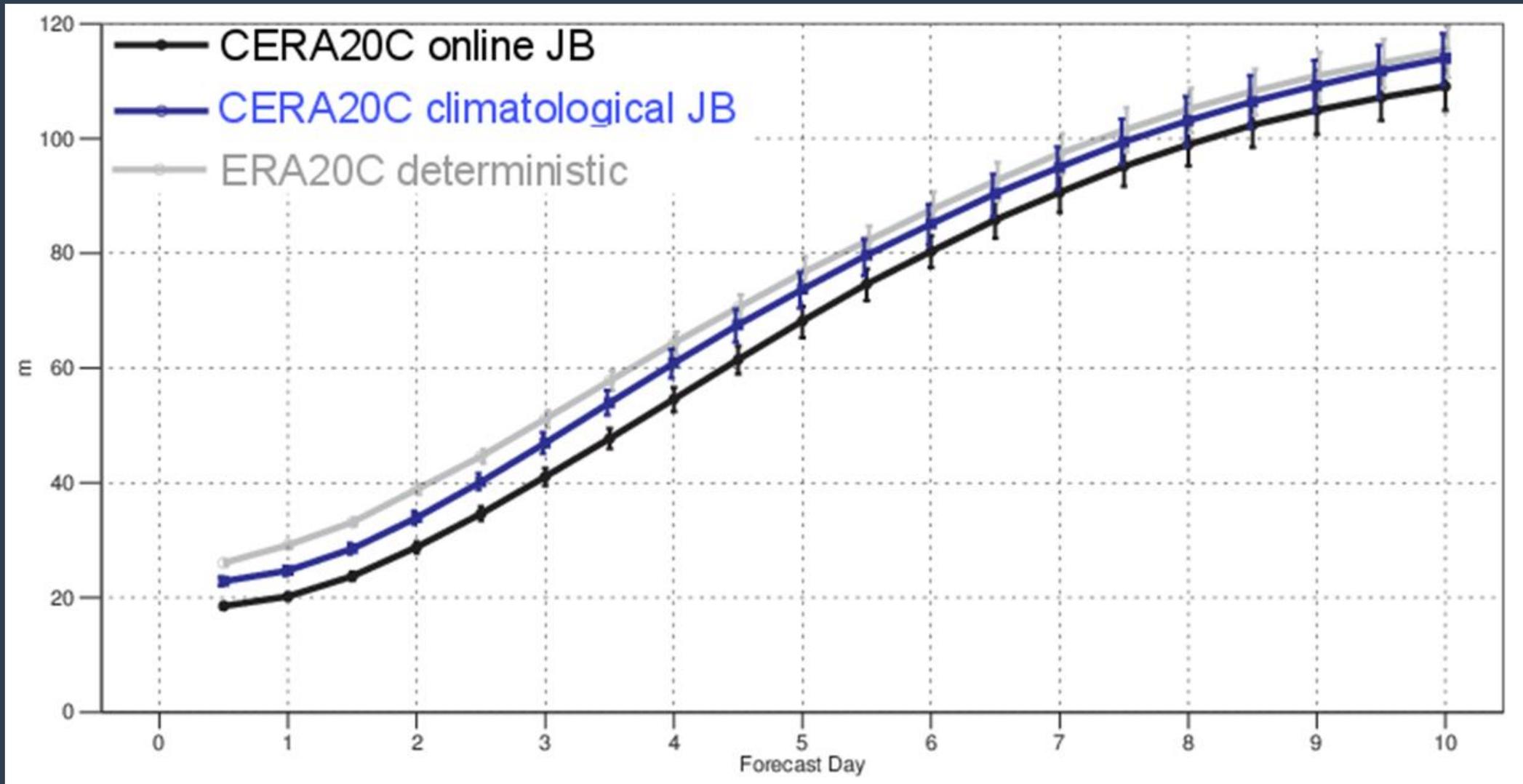
error propagation



Aeolus Doppler wind Lidar (launch 2017) (ESA Earth Explorer Mission)

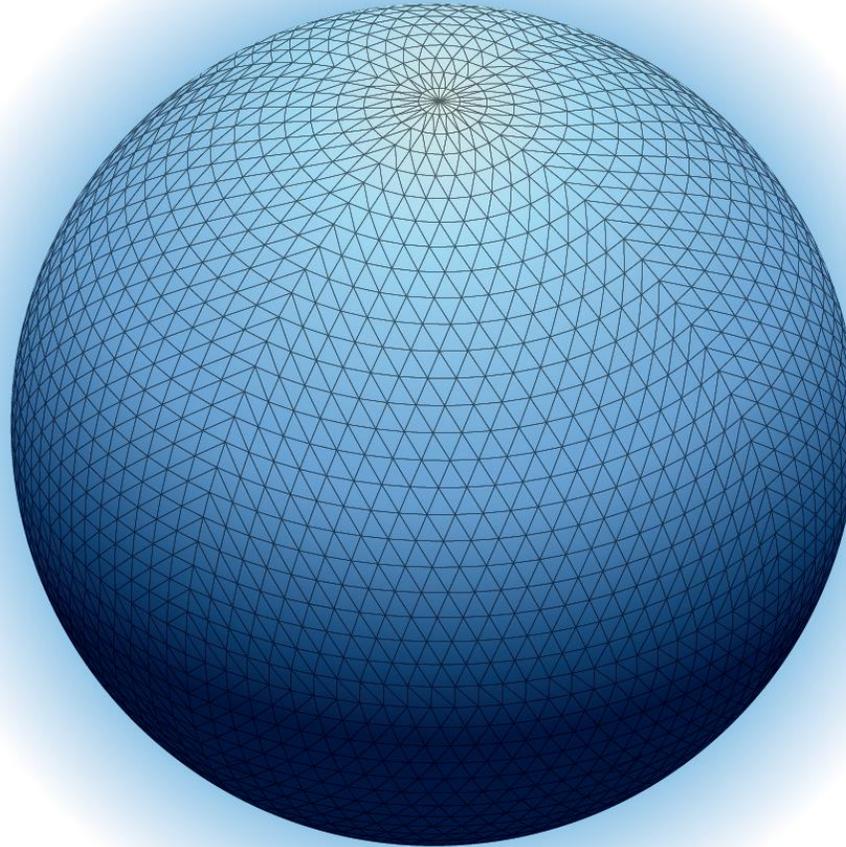


Coupled ocean-atmosphere assimilation

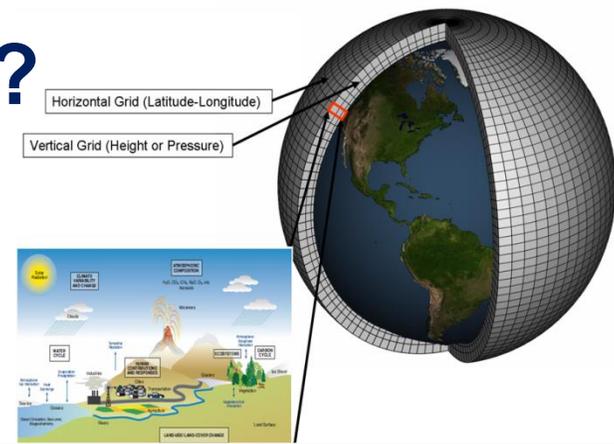


Forecast model – Octahedral 9 km grid, 137 levels

- Wind
- Temperature
- Pressure
- Humidity
- Clouds
- Precipitation



What is the challenge?



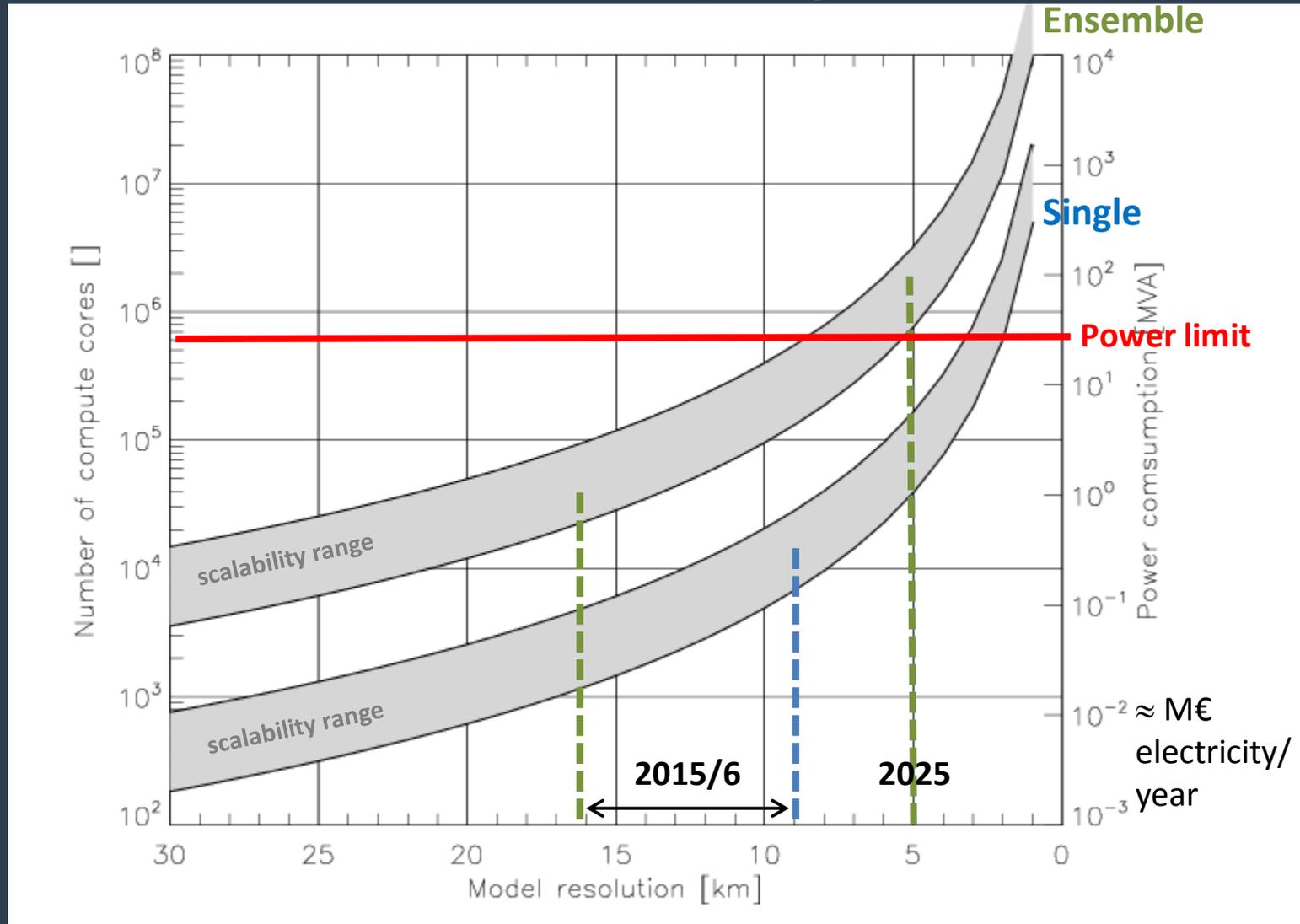
Today:

	Observations	Models
Volume	40 million = 4×10^7	10 million grid points 100 levels 10 prognostic variables = 1×10^{10}
Type	98% from 60 different satellite instruments	physical parameters of atmosphere, waves, ocean

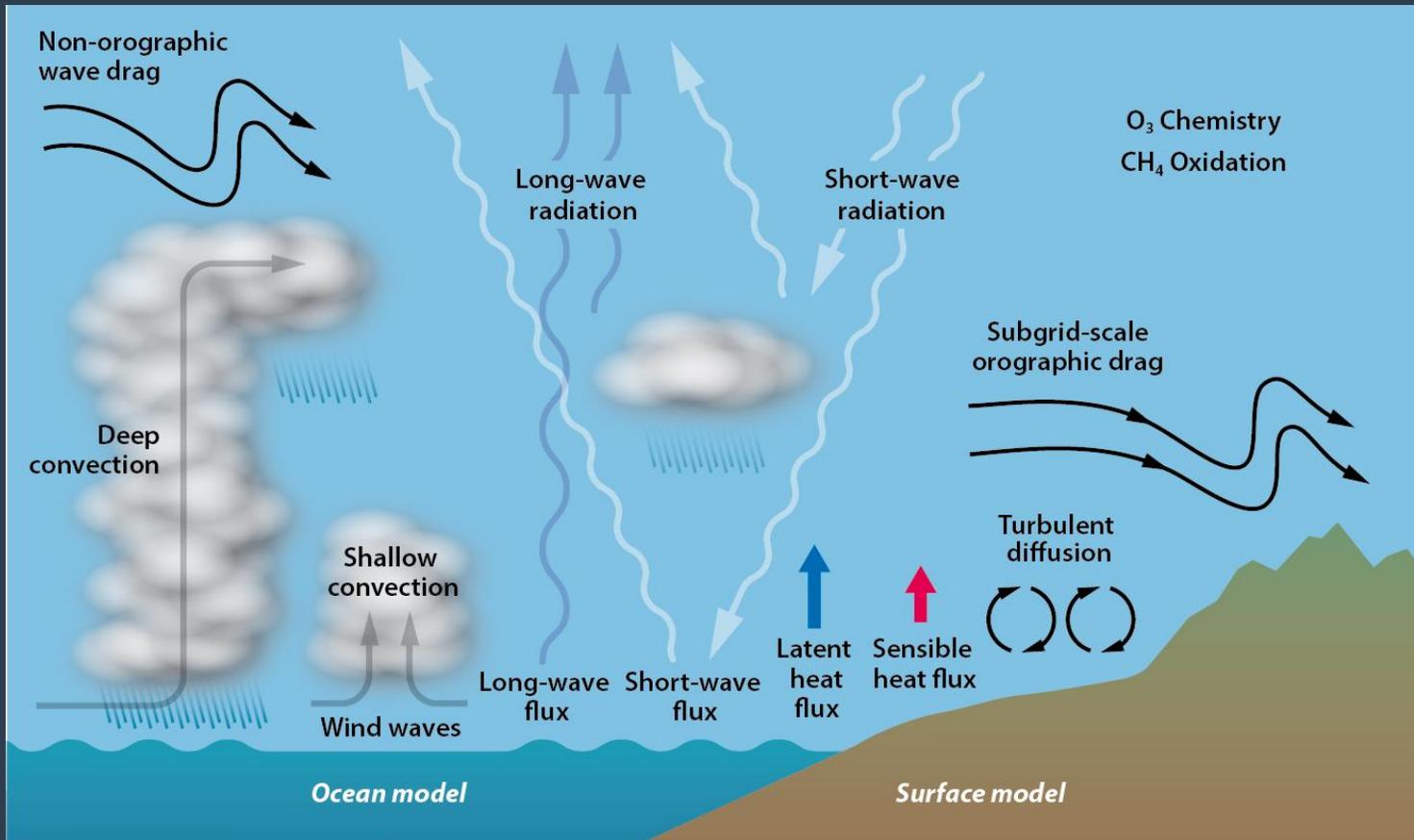
Tomorrow:

	Observations	Models
Volume	100-200 million = $1-2 \times 10^8$	500 million grid points 200 levels 100 prognostic variables = 1×10^{13}
Type	98% from 80 different satellite instruments	physical and chemical parameters of atmosphere, waves, ocean, ice, vegetation

Efficiency gains



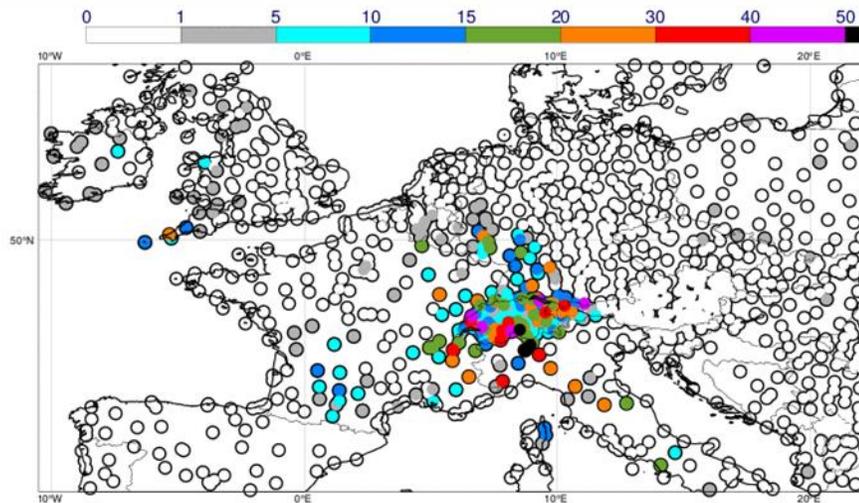
Physical processes in the ECMWF model



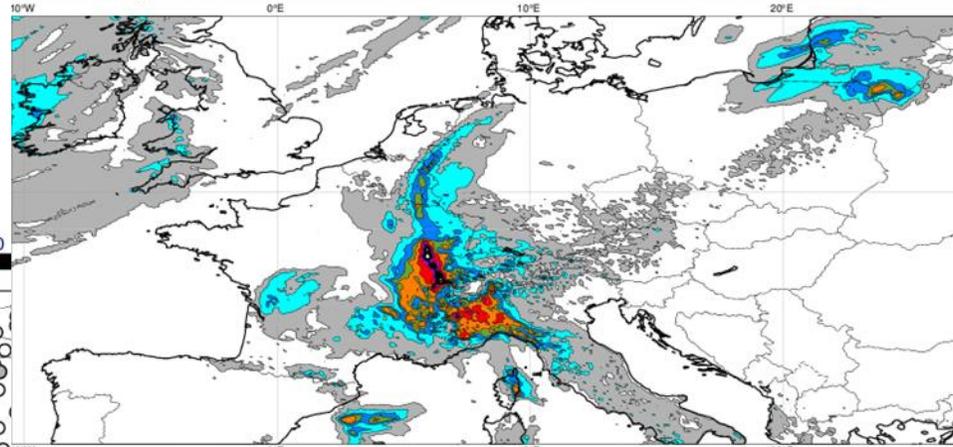
Convection parameterisation at 5 km resolution

Precipitation forecasts

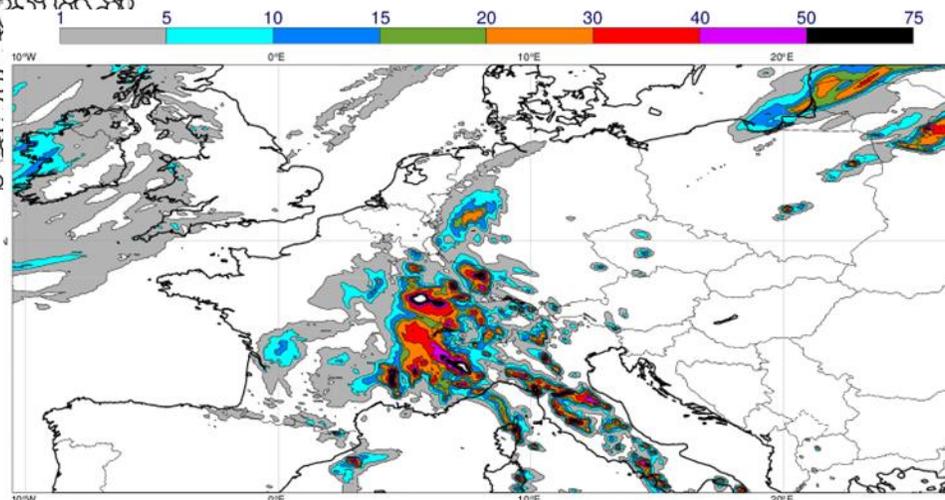
Obs 9 Aug 2015



Cy42r1 TCo1999 5 km scaled Mfl

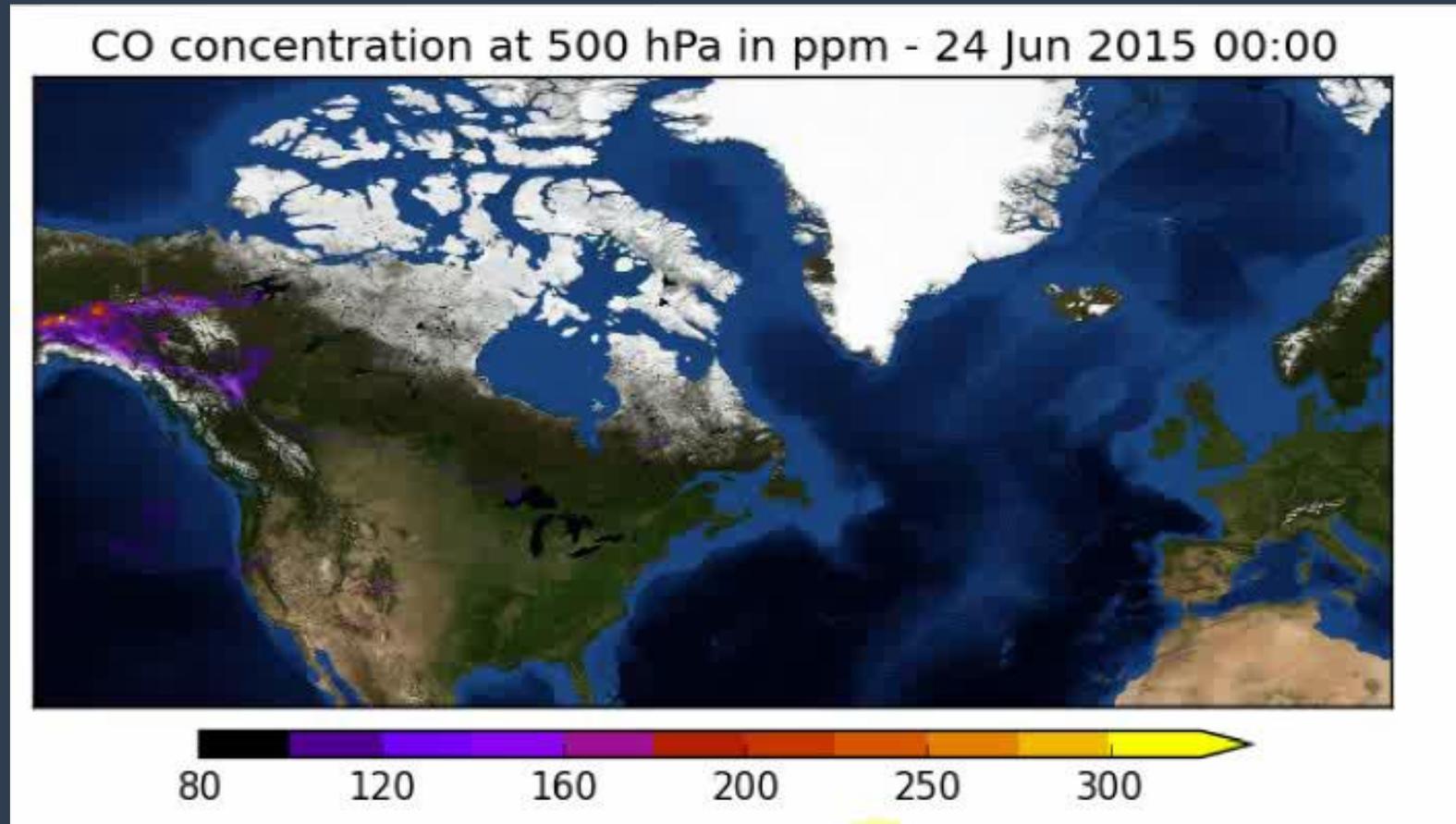


Cy42r1 Tco1999 no deep

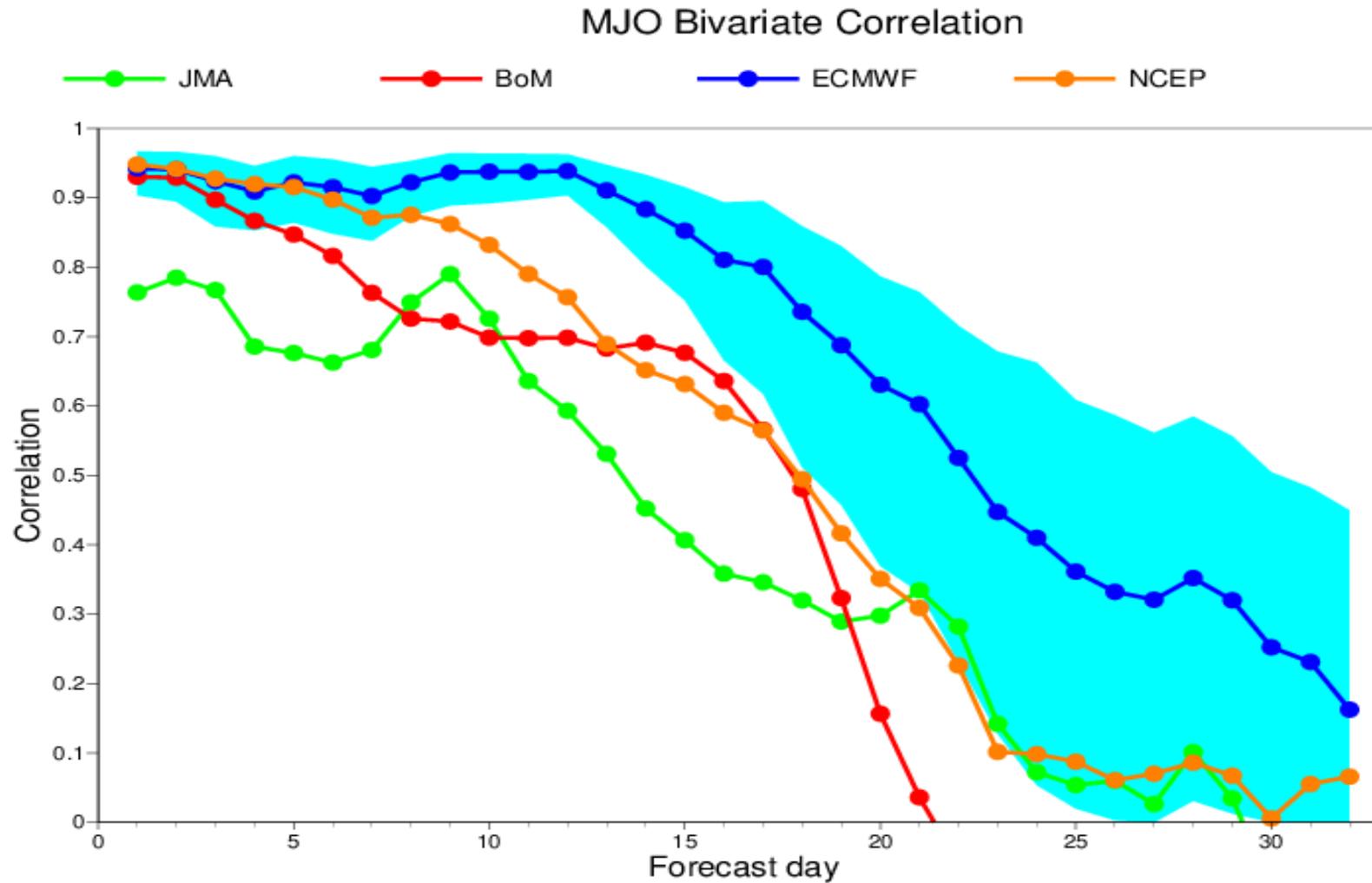


Atmospheric composition:

CO concentration at 500 hPa in ppm – 24 June 2015



Madden-Julian oscillation correlations (TIGGE)



Summary

- Earth System modelling and assimilation
 - Initial state accuracy
 - Model accuracy
- Scalability
- Doppler wind lidar in space 2017 (Aeolus)

