ECMWF forecasting system - research and development

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ECMWF

ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS
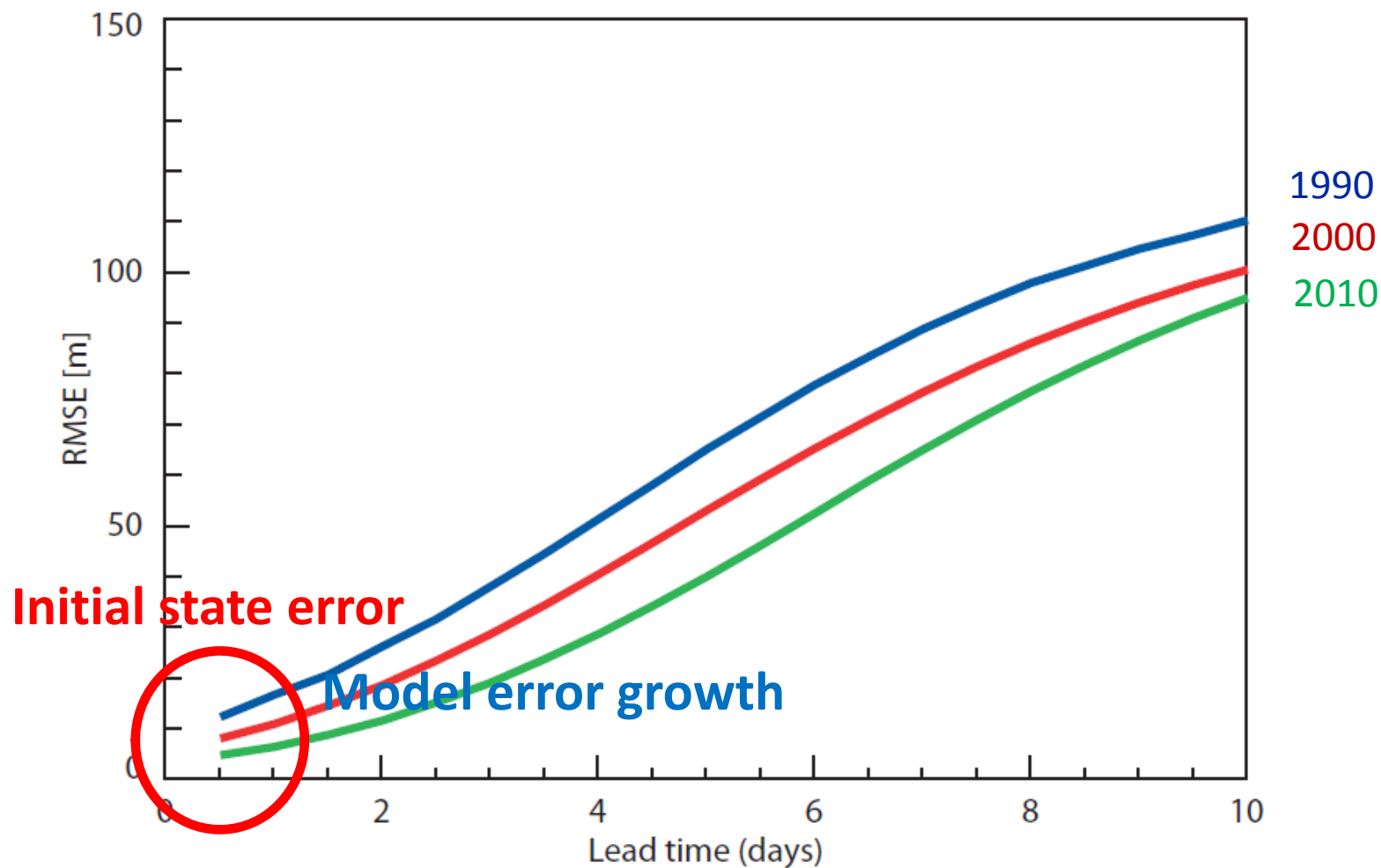
Observations → assimilation → forecast

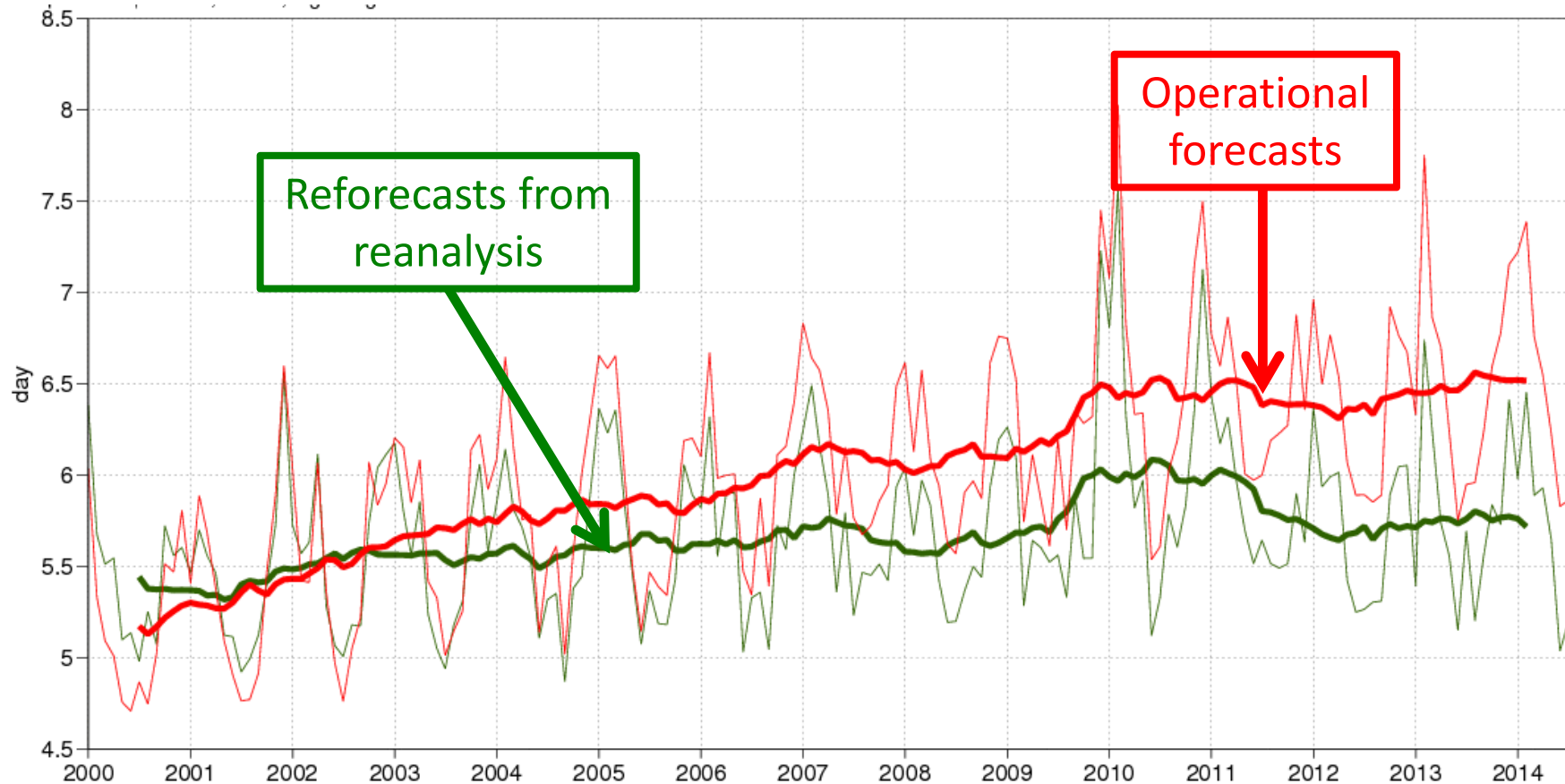# Data assimilation at ECMWF
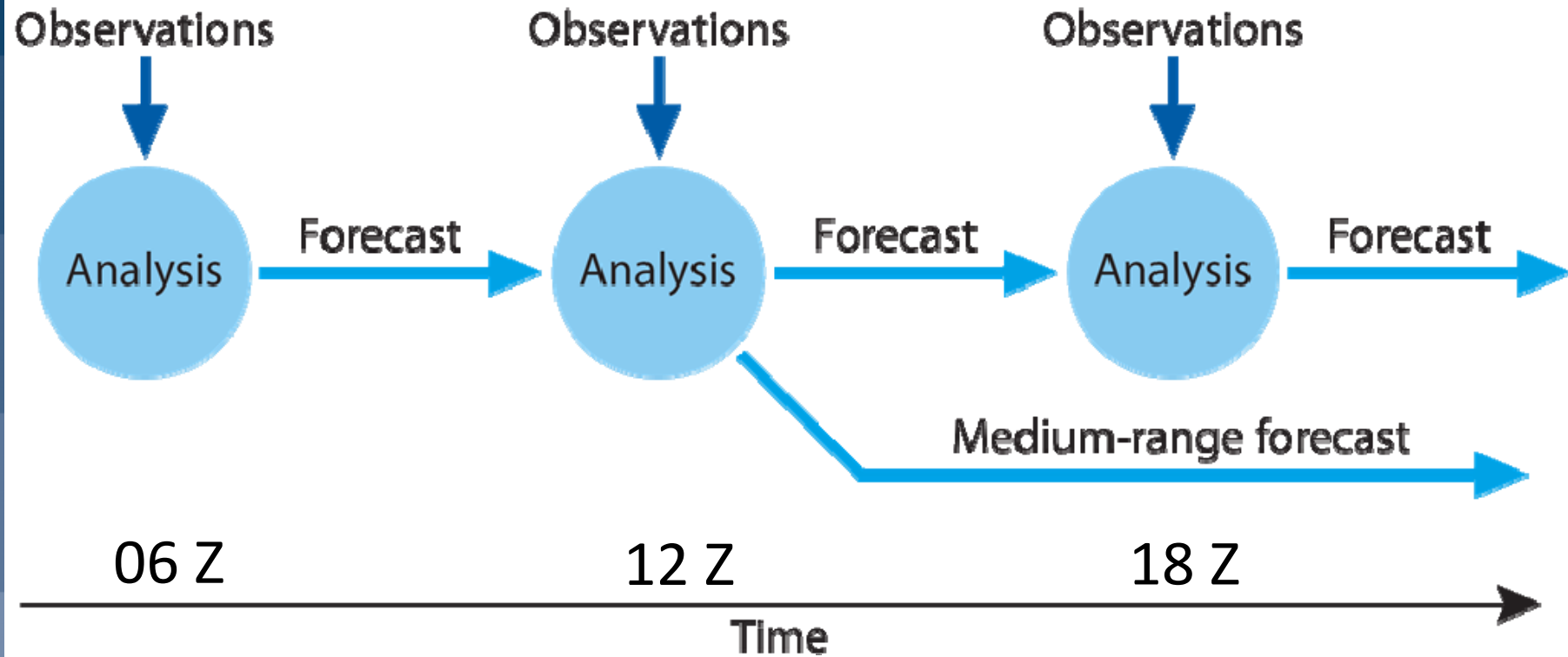
RMS error of 500 hPa height field Northern Hemisphere

ECMWF Headline Forecast Score
Z500, Time series of ACC=0.8, N.Hem
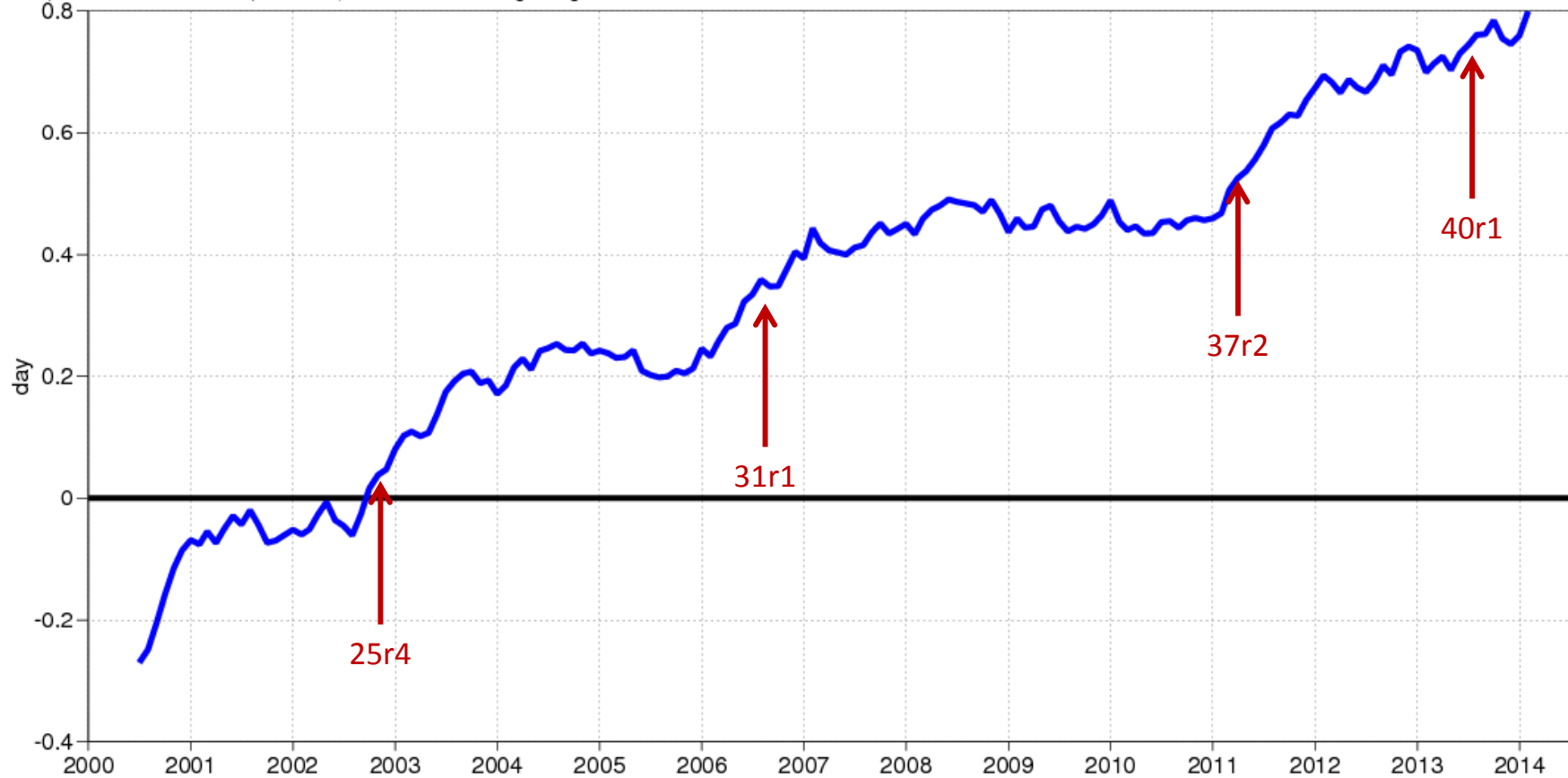
Z500 N hemisphere HRES v ERA-I

HRES - ERA
500hPa geopotential
Anomaly correlation
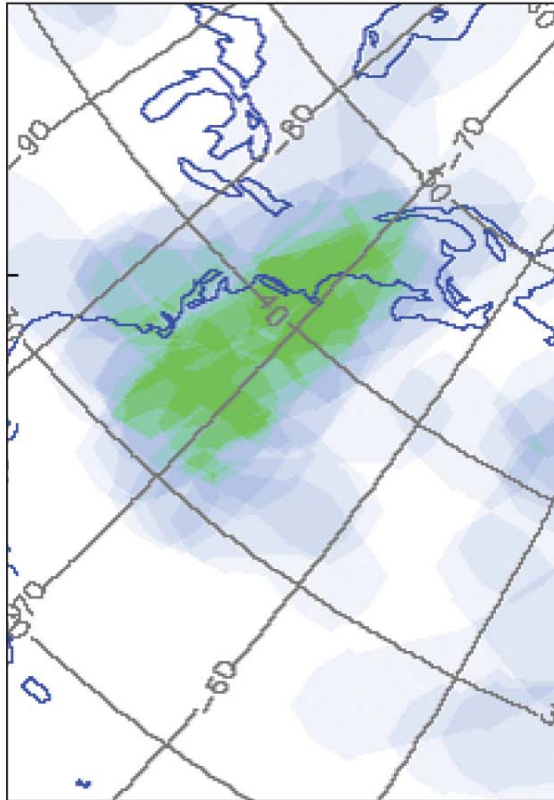NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)

T+0 T+12 ... T+240
oper_an-era_an od-ei oper 0001 | 00UTC,12UTC,beginning

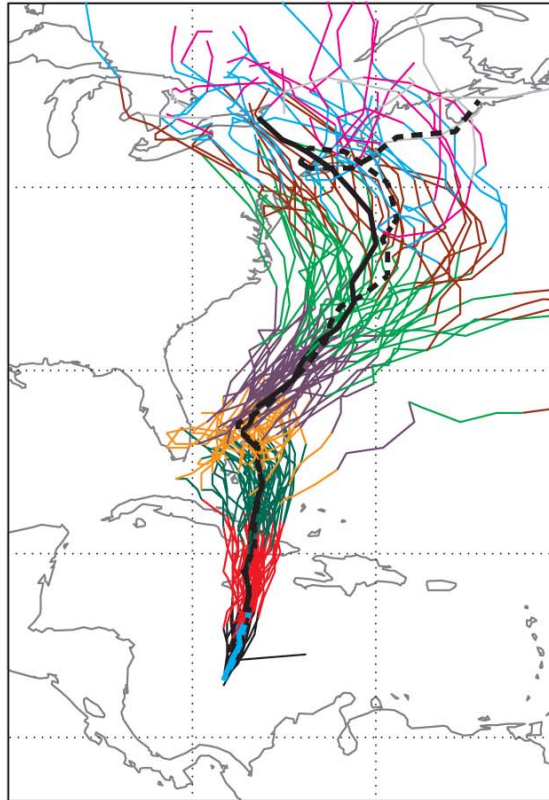ECMWF EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS
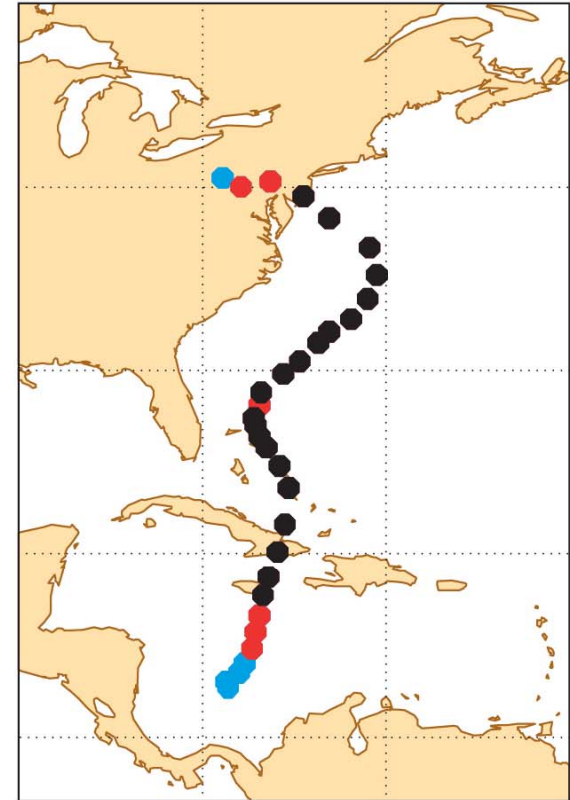
Superstorm Sandy

Probability of a wind storm
9.5 days before landfall

Track forecasts
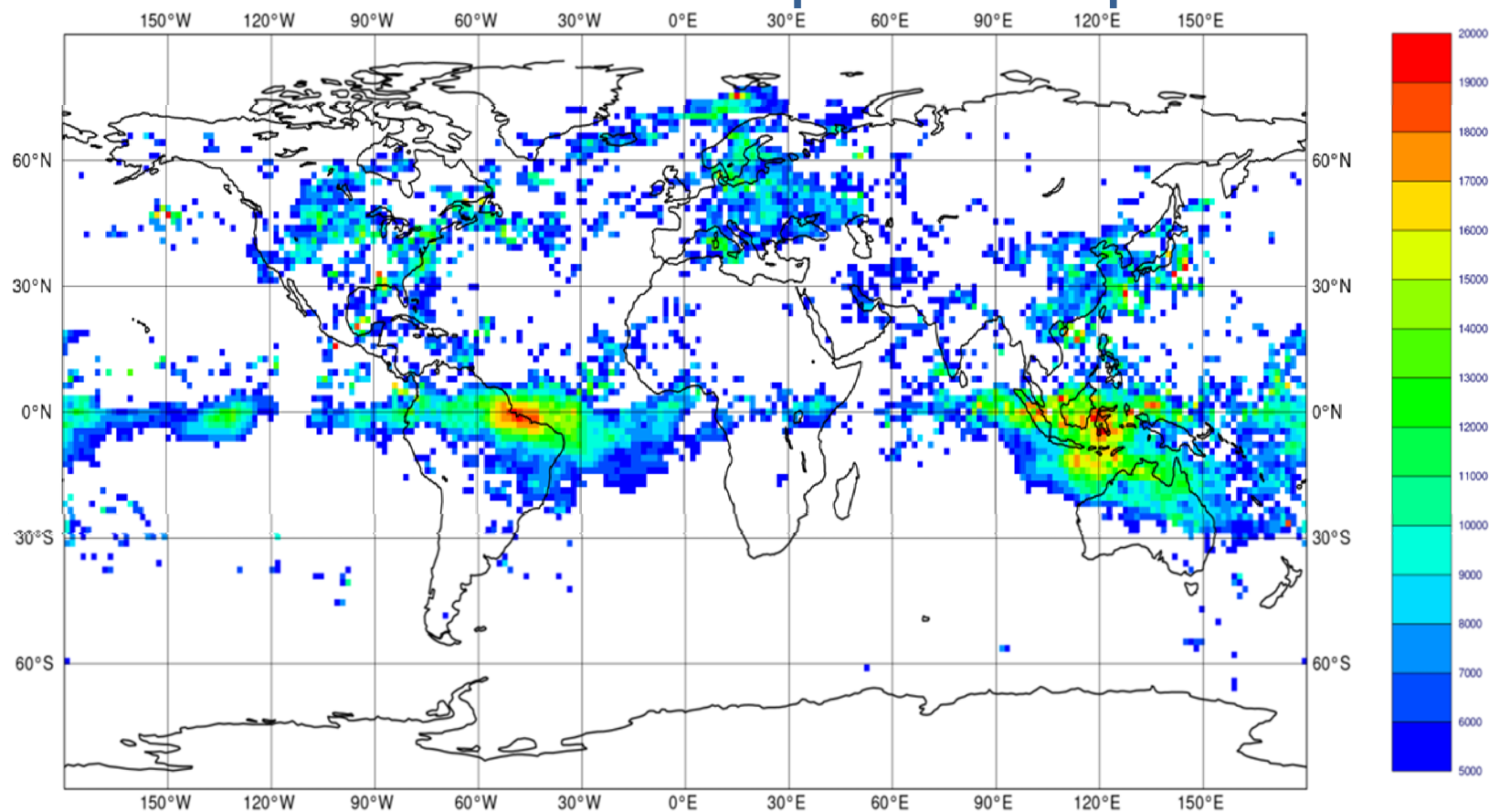6.5 days before landfall

Observed track of Sandy

Two days before Sandy formed (9.5 days before landfall in New Jersey) there was
already a significant probability (25%) of a severe wind storm affecting the North-Eastern USA.

Aeolus Doppler wind Lidar (launch 2016)
(ESA Earth Explorer Mission)

Aeolus Doppler wind lidar

Aeolus wind profile impacts

Horizontal resolution

Increased resolution in 2015

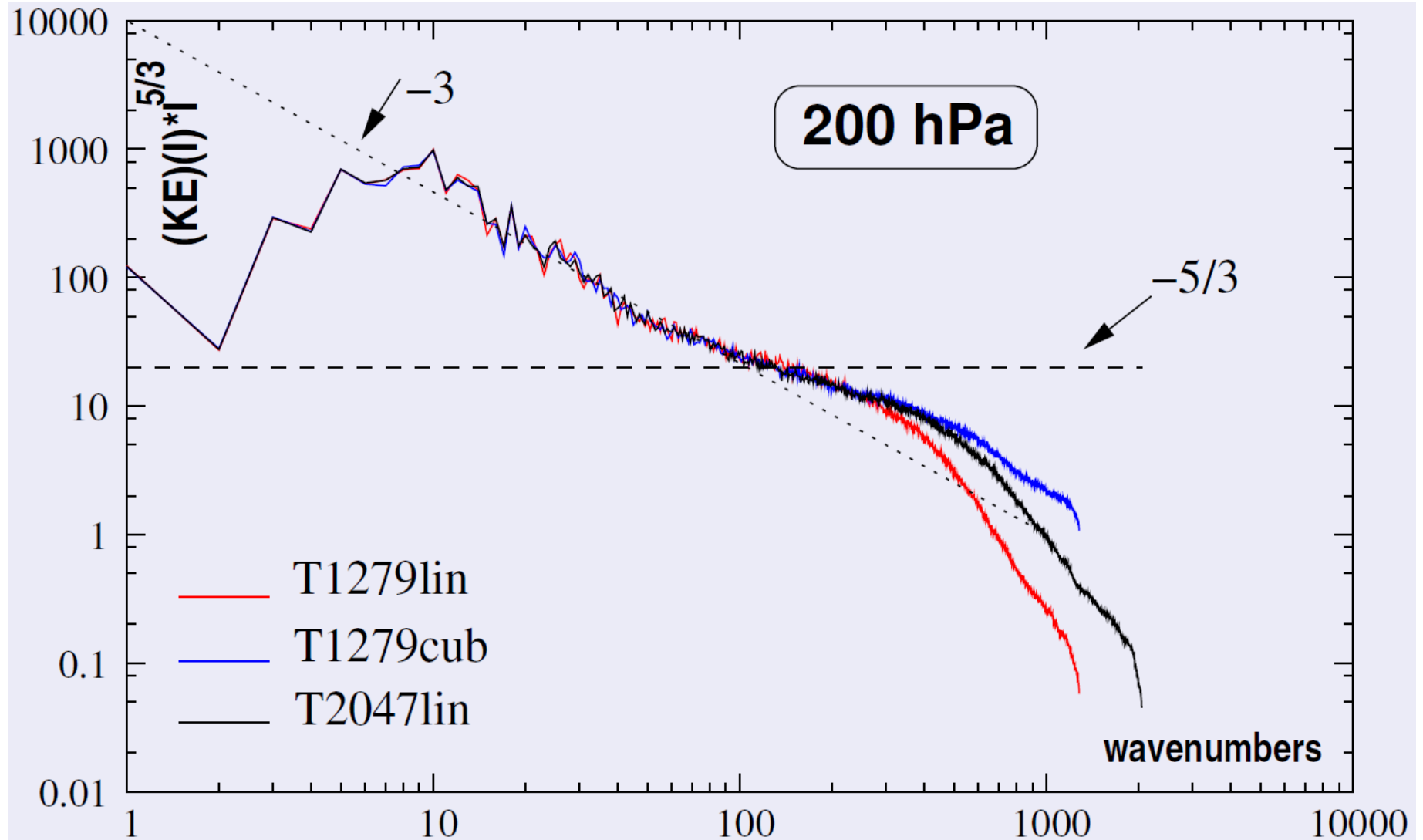- 16 km $\rightarrow$ 8-10 km

Gridpoint representation of spectral fields:

- Linear grid (T_L 1279, 16 km)
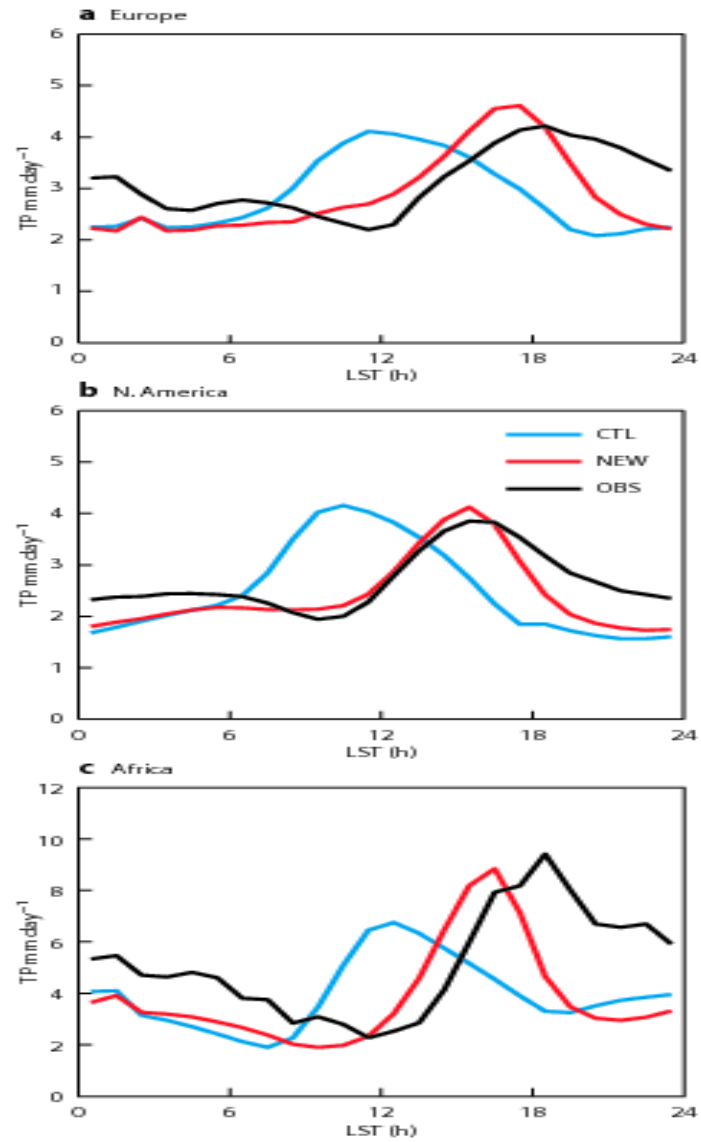- **Cubic grid (T_C 1279, 8 km)**
- **Linear grid (T_L 2047, 10 km)**

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Kinetic energy spectra at 200 hPa

Convection

Composite diurnal cycle: Model vs Obs

High resolution CO_2 forecast

Total column average atmospheric CO_2: September 2013

CO_2 SURFACE FLUXES:
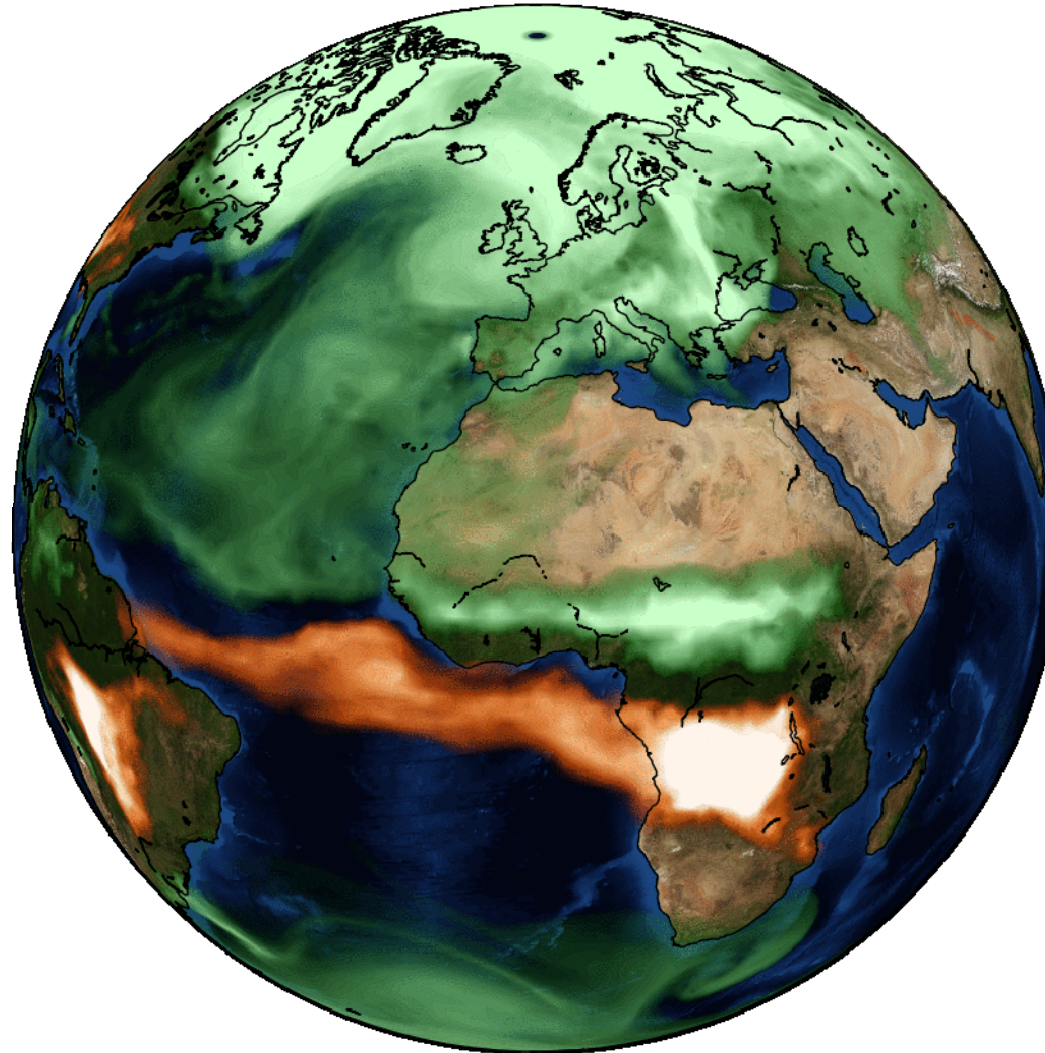Vegetation   (CTESSEL)
Fires   (GFAS)
Ocean   (inventory)
Anthropogenic   (inventory)

IFS TRANSPORT
PBL mixing
Advection
Convection

CHEMISTRY
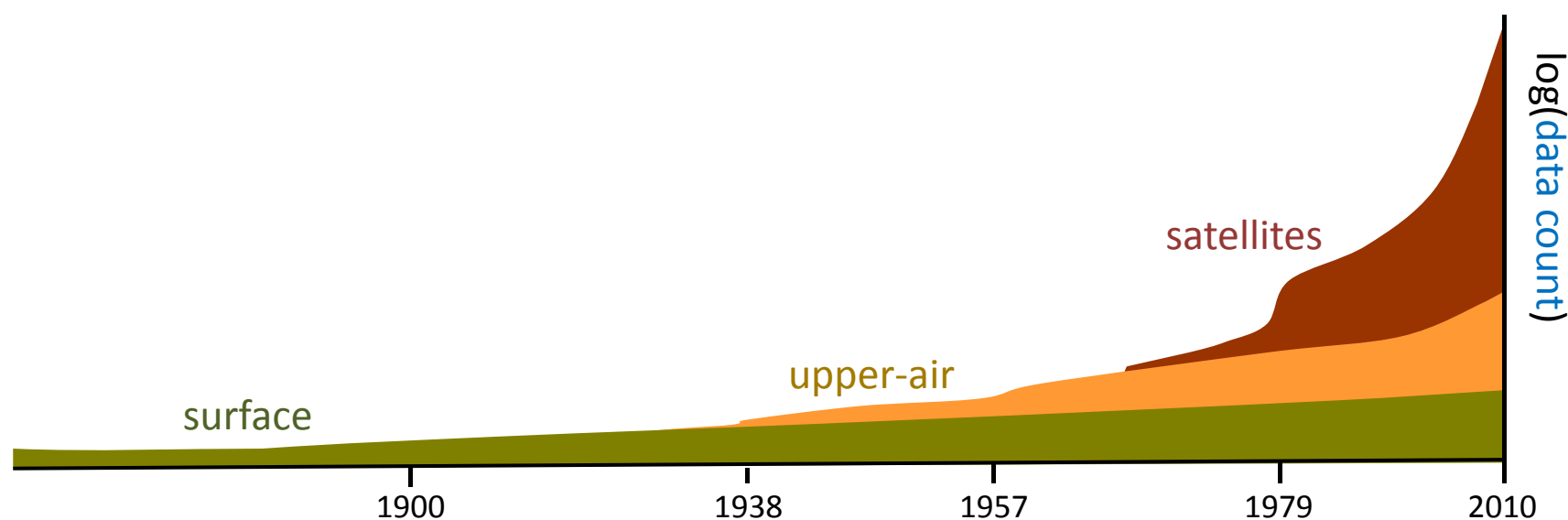Oxidation of CO
(not yet represented in model)

[ppm]

Above background CO_2

402
401
400
399
398
397
396

Below background CO_2

393
392
391
390
389
388

ECMWF — EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS

Two types of reanalysis products

Reanalyses of the modern observing period (~30-50 years):

- Produce the best estimate at any give time
- Use as many observations as possible, including from satellites
- Closely tied to forecast system development (NWP and seasonal)
- Near-real time product updates suitable for climate monitoring

satellites

upper-air

surface

log(data count)

1900   1938   1957   1979   2010

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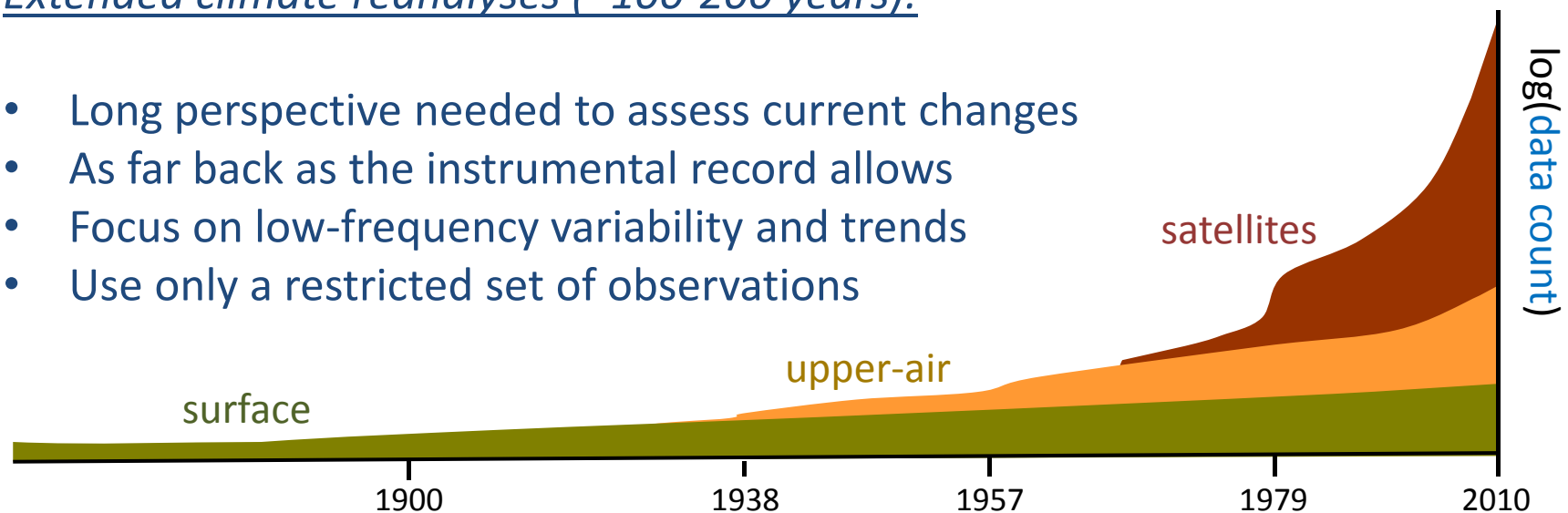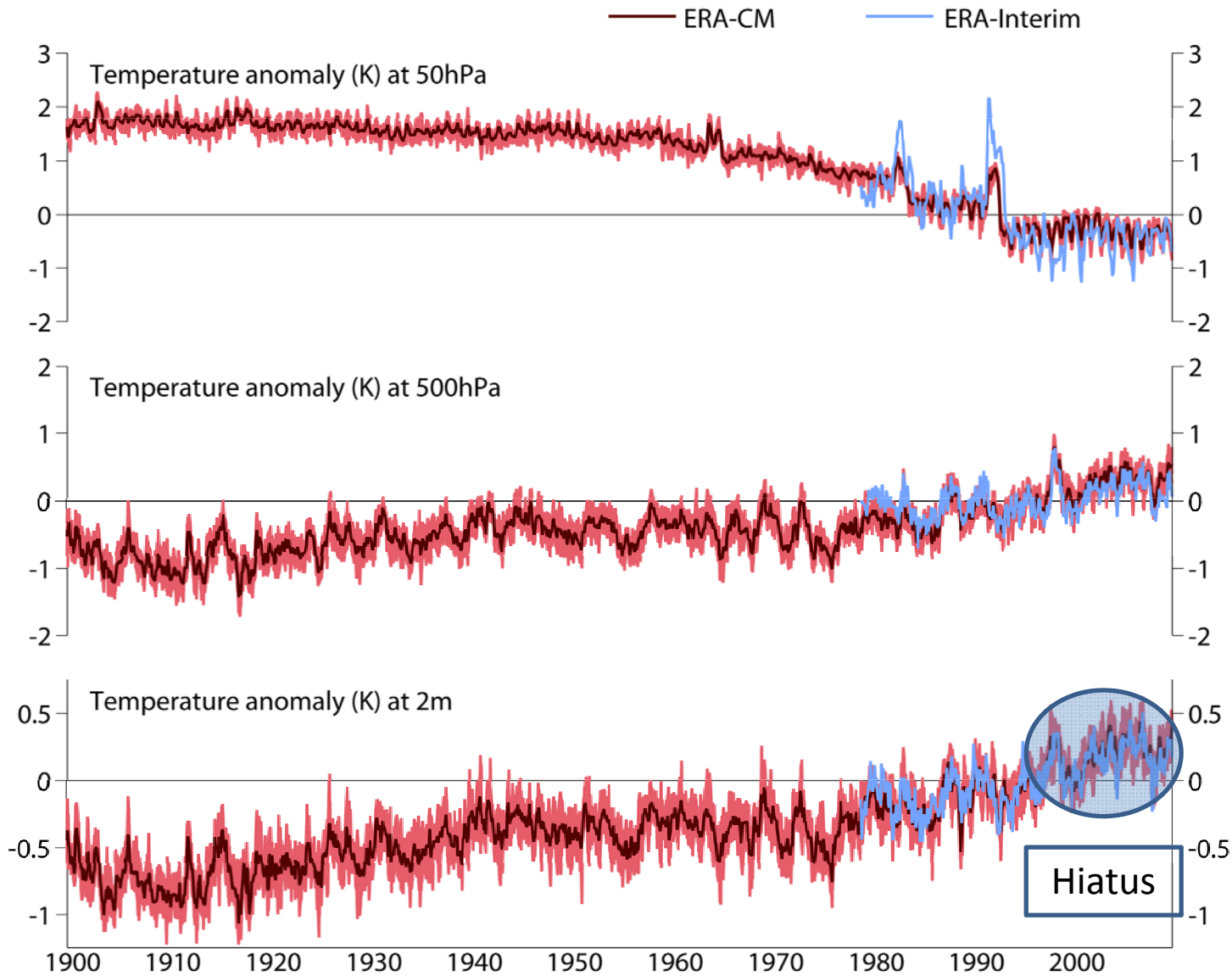- Near-real time product updates suitable for climate monitoring

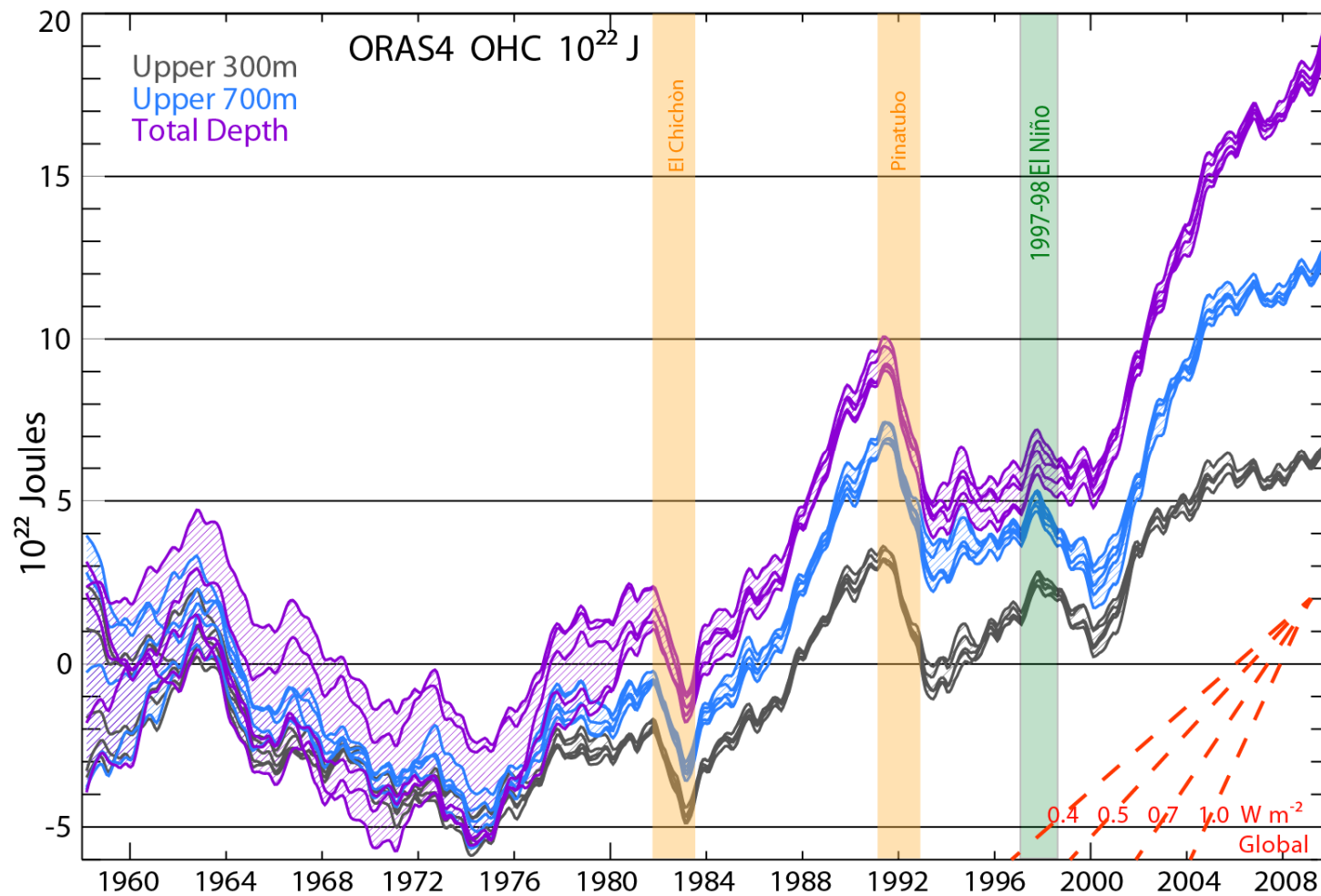*Extended climate reanalyses (~100-200 years):*

- Long perspective needed to assess current changes
- As far back as the instrumental record allows
- Focus on low-frequency variability and trends
- Use only a restricted set of observations

satellites

upper-air

surface

log(data count)

1900   1938   1957   1979   2010

ERA-20CM: Consistency with ERA-Interim

ORAS4: Changes in ocean heat content

ORAS4 OHC 10^{22} J

Upper 300m
Upper 700m
Total Depth

El Chichòn
Pinatubo
1997-98 El Niño

10^{22} Joules

0.4 0.5 0.7 1.0 W m^{-2}
Global

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Conclusions

Forecast improvement at ECMWF:
– Initial error reduction
– Model improvements

Ensemble forecasting

Chemical composition forecasts

Reanalyses provide temporally and spatially consistent climate data sets