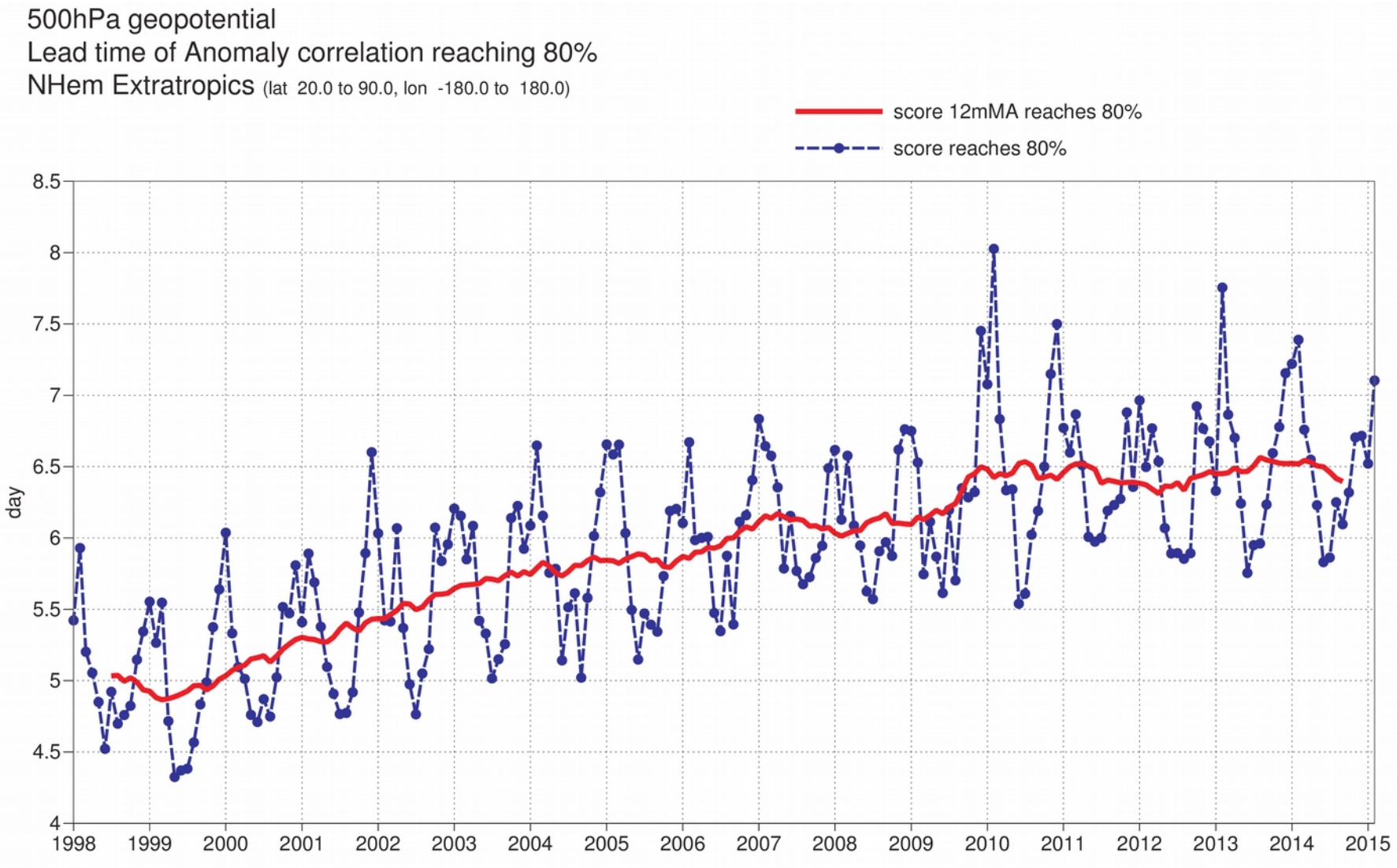
Research developments at ECMWF

Erland Källén
ECMWF

Research highlights

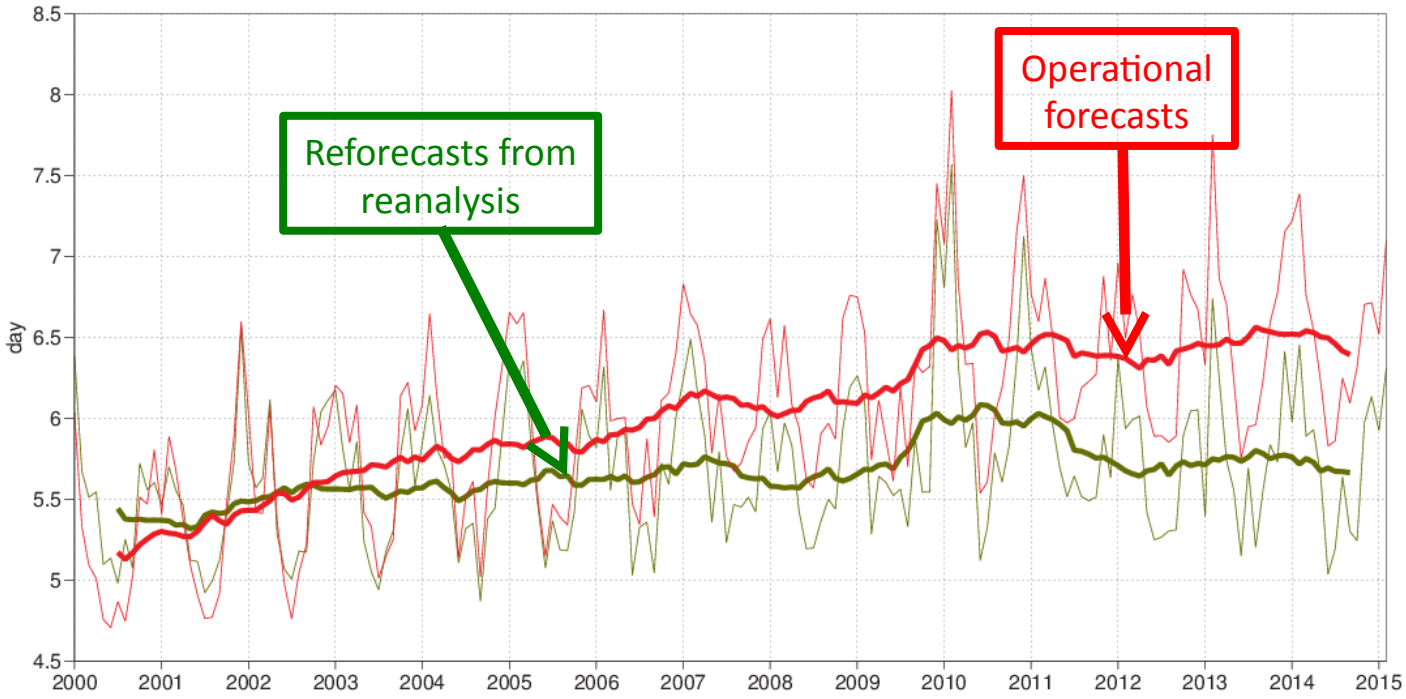
- Forecast scores
- Data assimilation
- Physics developments
- Cubic octahedral spectral grid
- Scalability

HRES headline score

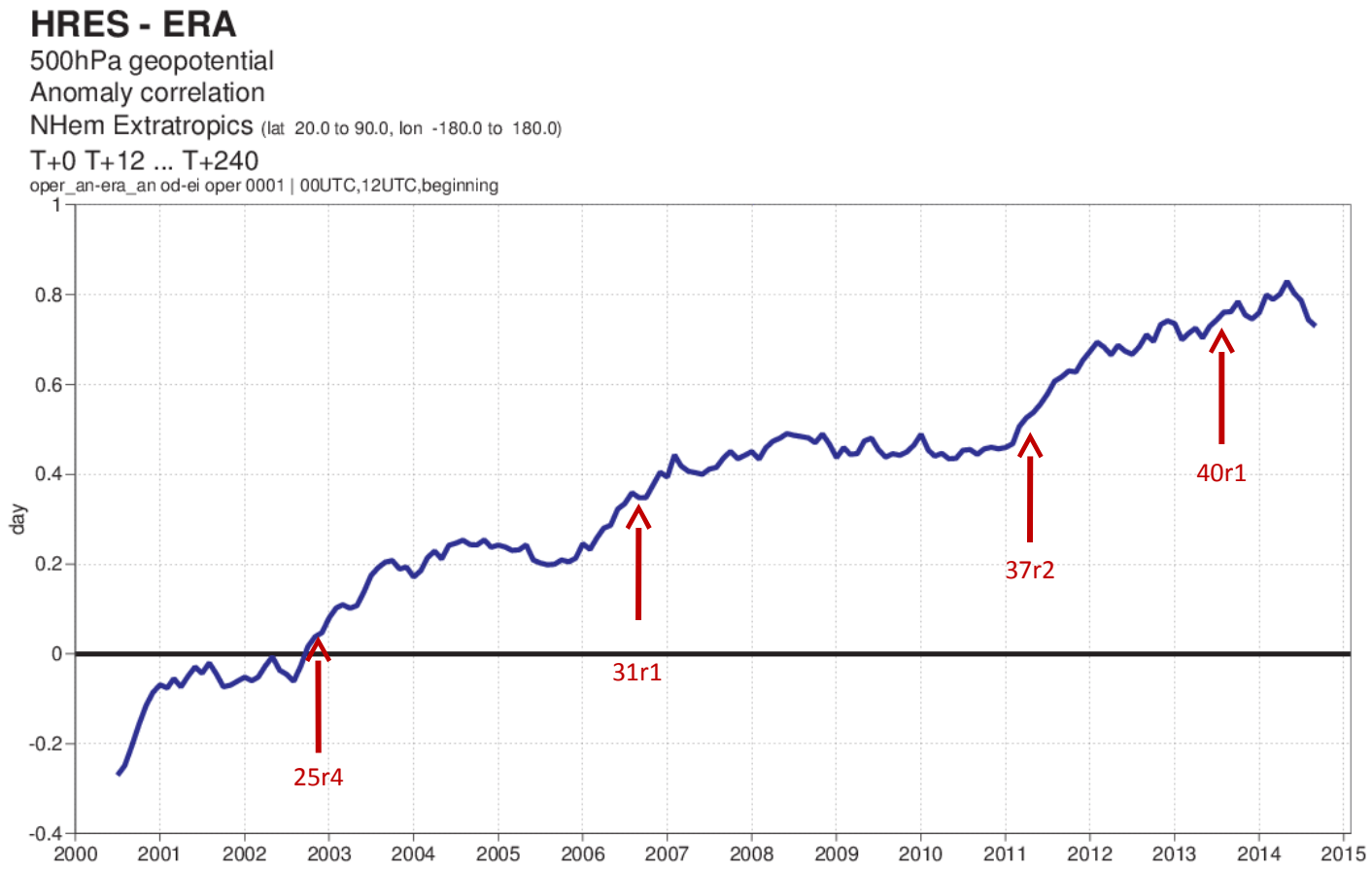


ECMWF Headline Forecast Score

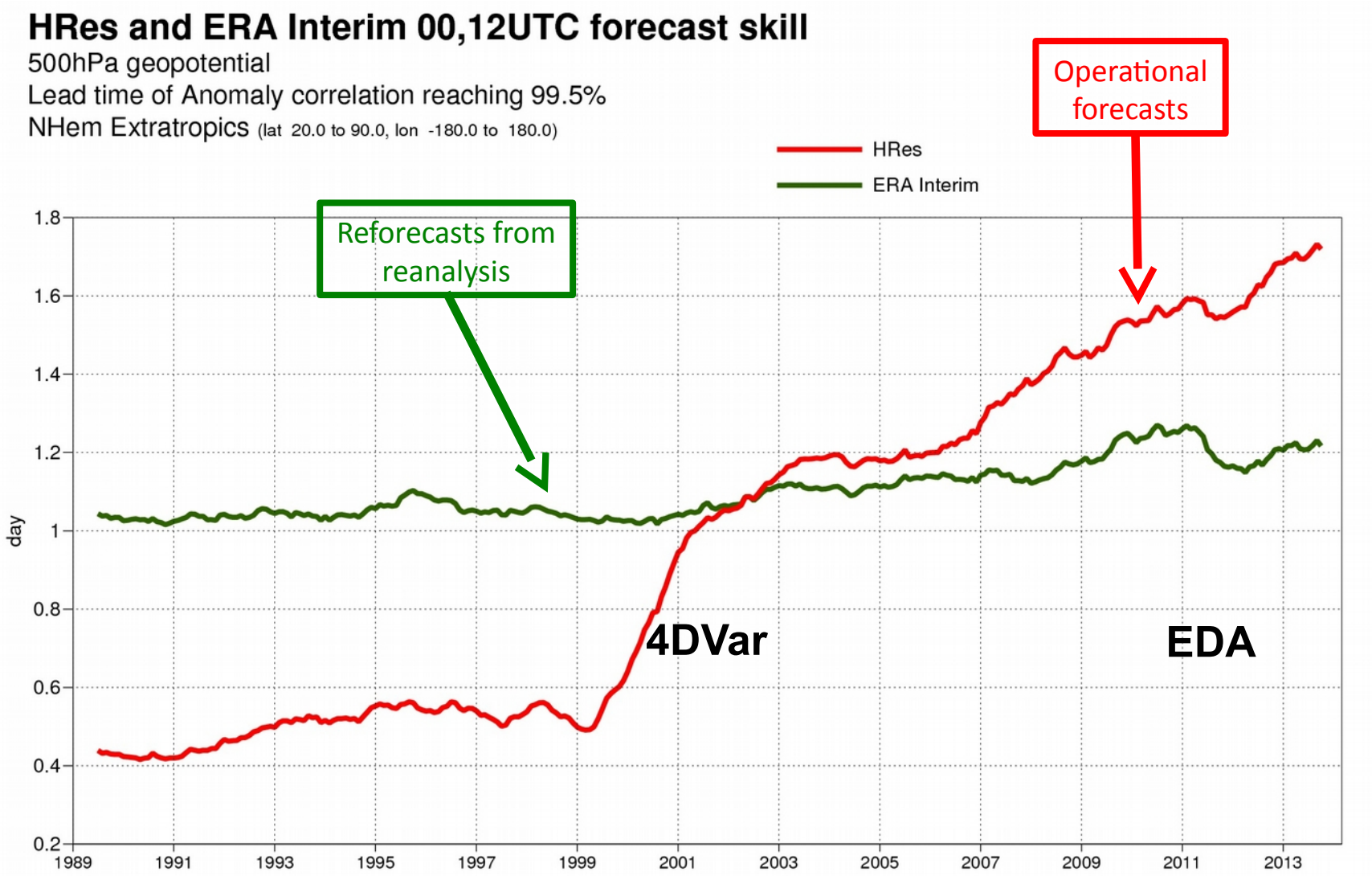
Z500, Time series of ACC=0.8, N.Hem



Z500 N hemisphere HRES v ERA-I



Initial state error reduction



Strategy for data assimilation

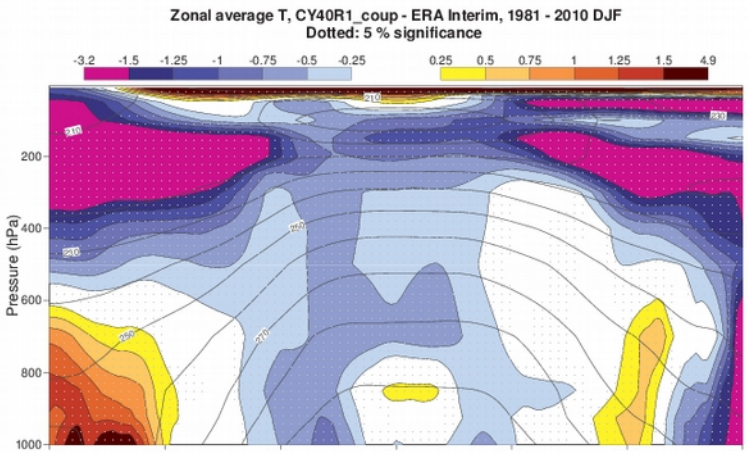
- Maintain hybrid 4DVar methodology
  - Consistent treatment of model/obs operators
  - Remote sensing data well handled
- Extend 4DVar window length
  - Model error
  - Scalability
- Develop EDA/EnDA
  - Filtering of variances/co-variances
  - Hybrid Gain EnDA
  - Seamless EDA/ENS

Model Physics

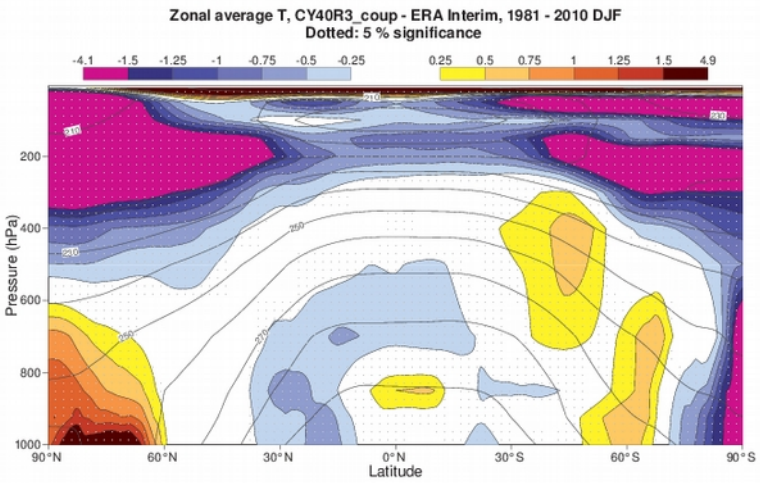
- Improved microphysics – supercooled liquid water
- Convection – detrainment formulation
- Boundary layer – surface properties
- Radiation accuracy
- Land surface modelling

Temperature biases

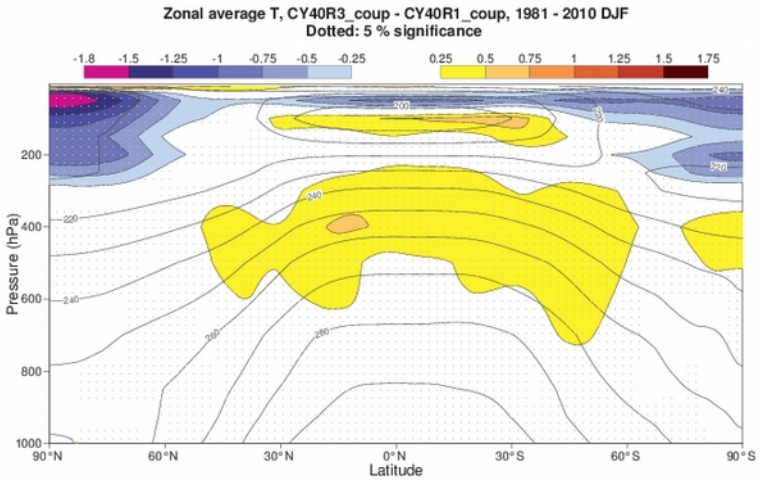
40r1-ERA



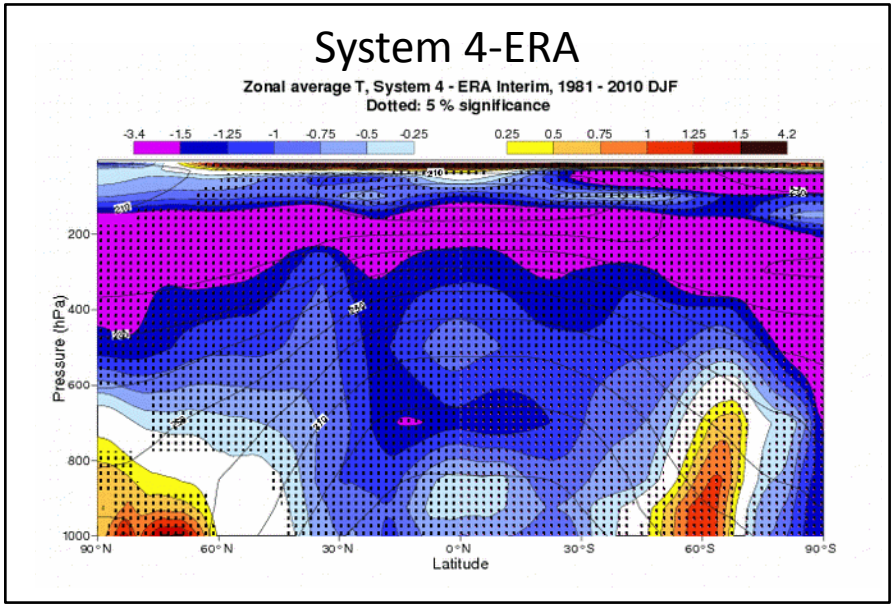
40r3-ERA



40r3-40r1



System 4-ERA



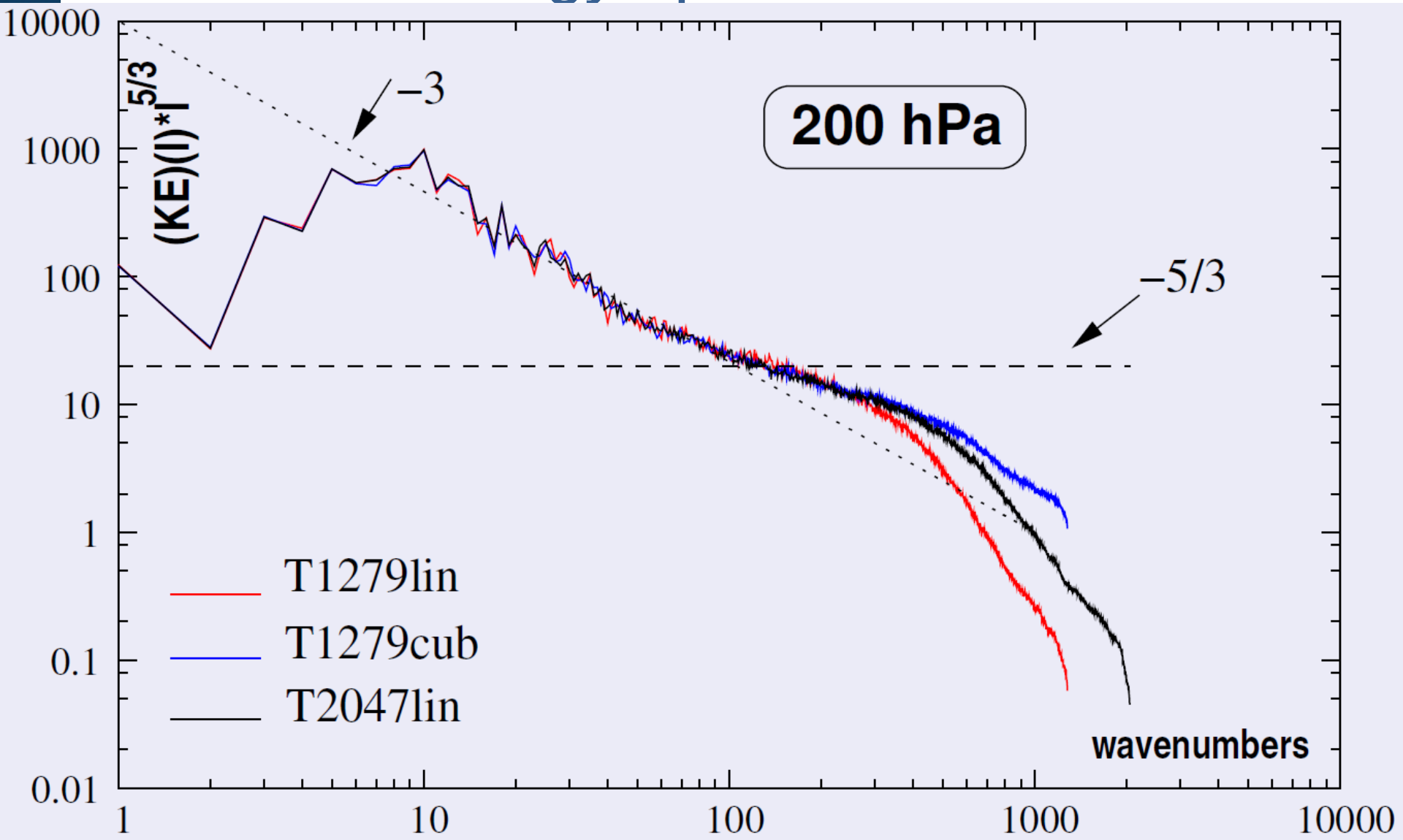
Model Numerics

- Resolution increases – improved surface fields
- Modified semi-Lagrangian scheme
- Dynamical core developments – scalability
- Cubic octahedral spectral grid

Horizontal resolution

- Increased resolution in 2015
  - 16 km → 8-10 km (atm)
  - 1 → ¼ deg (ocean)
- In the future:
  - ~5 km ensembles by 2025
- Computing requirements:
- 60 MW!! (Scalability)

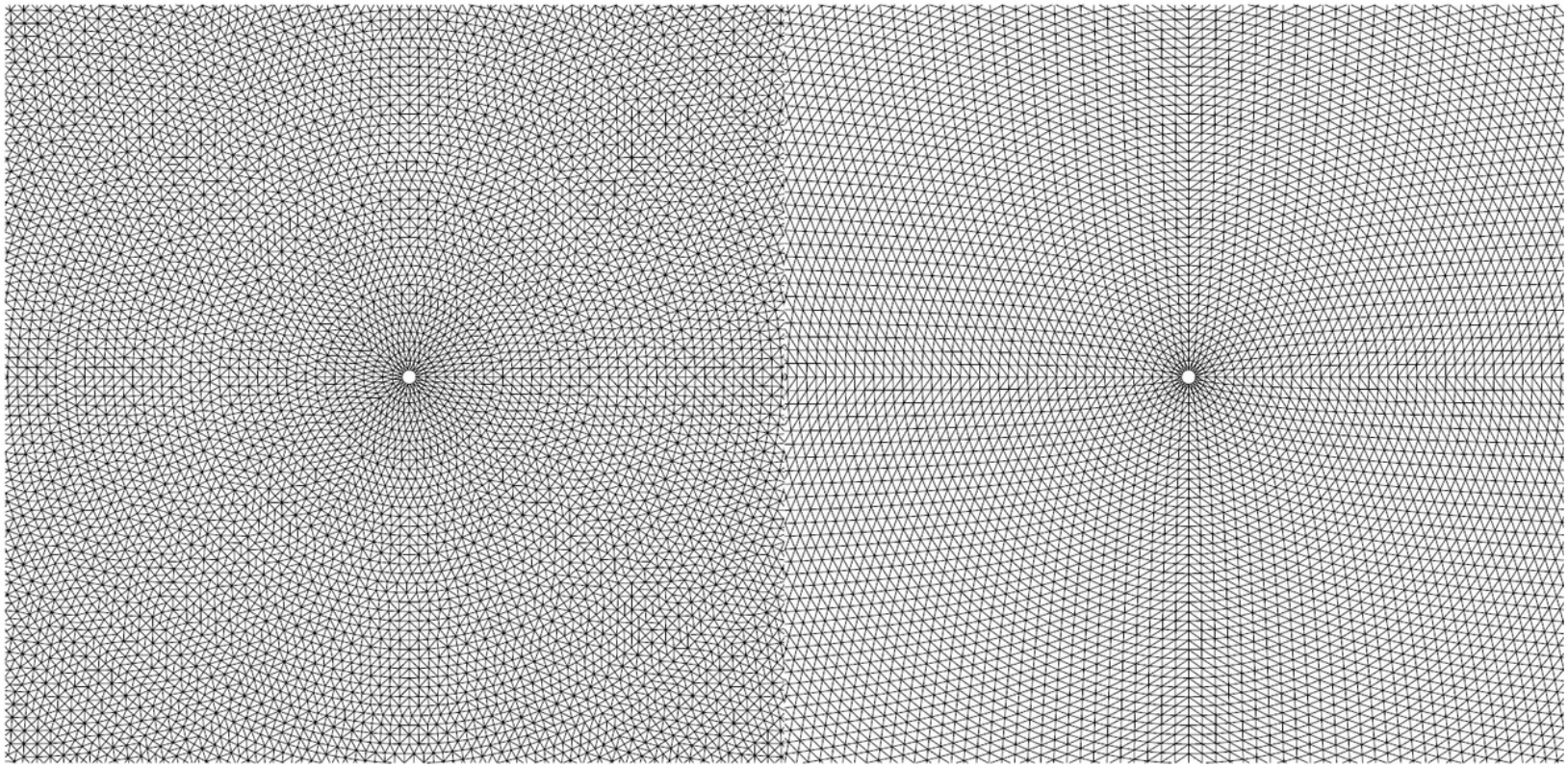
Kinetic energy spectra at 200 hPa



New Octahedral grid

Old

New



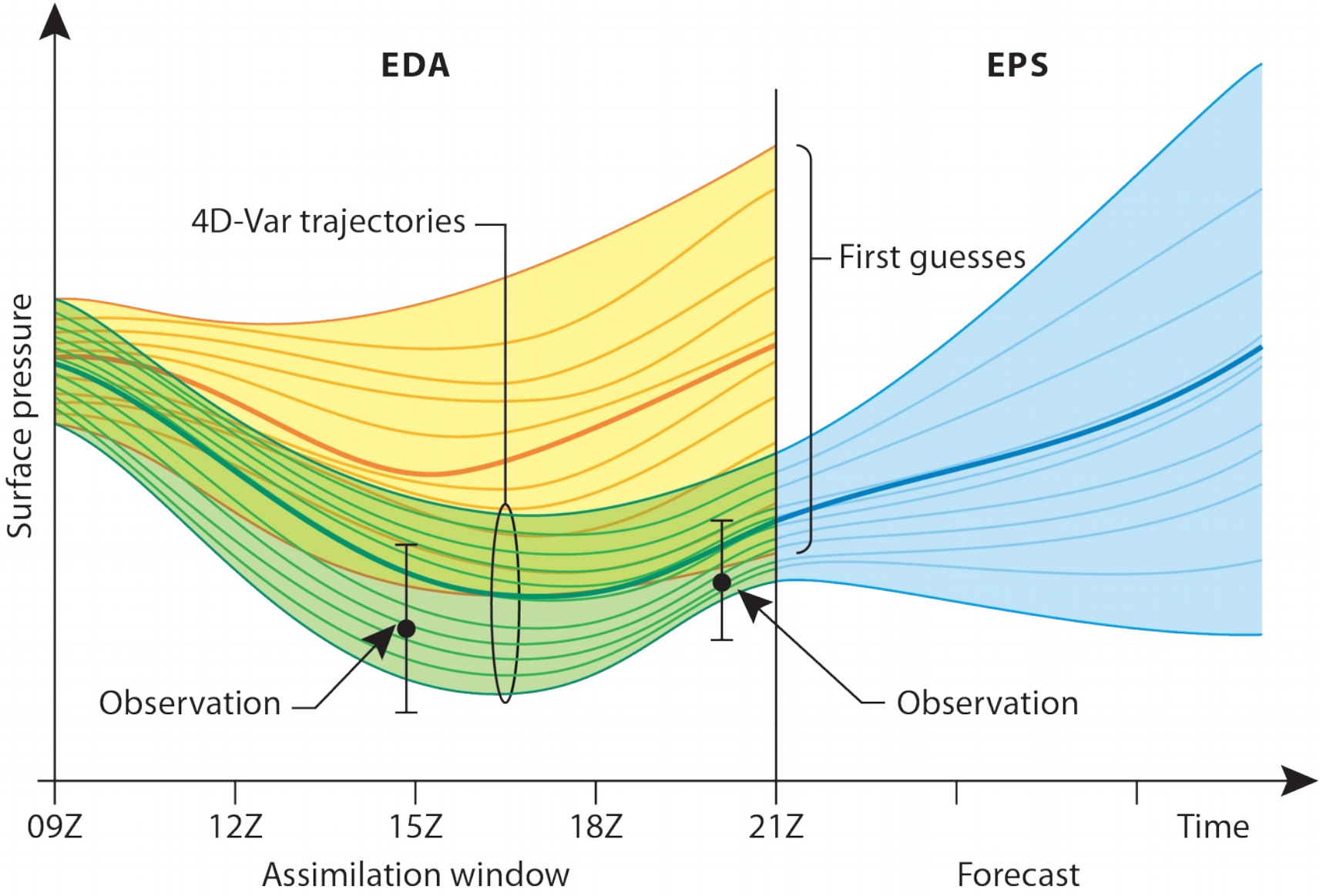
Scalability activities

- Preparation for future HPC architectures (2018 onwards)
  - Data assimilation (OOPS)
  - IFS dynamical core
  - Model code optimisation
  - Other code optimisations (observation handling)

Conclusions

- Scores continue to improve – slowdown of rate?
- Cubic, octahedral spectral grid
- Scalability

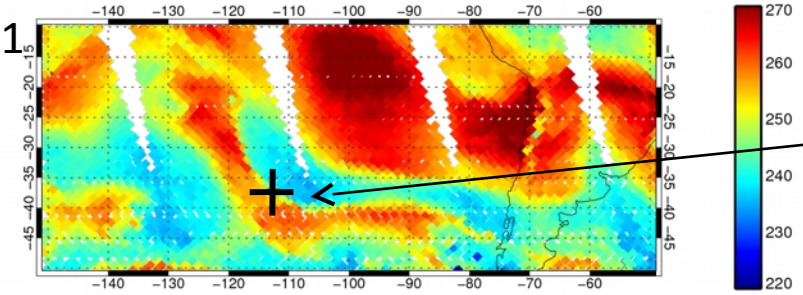
Ensemble assimilation and prediction



Water vapour in the presence of cloud

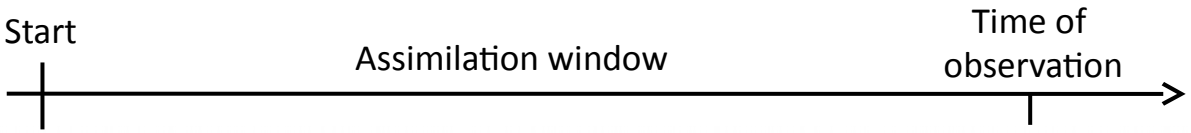
GOES 10μm
Dundee receiving station

Metop-B MHS 183±1 GHz



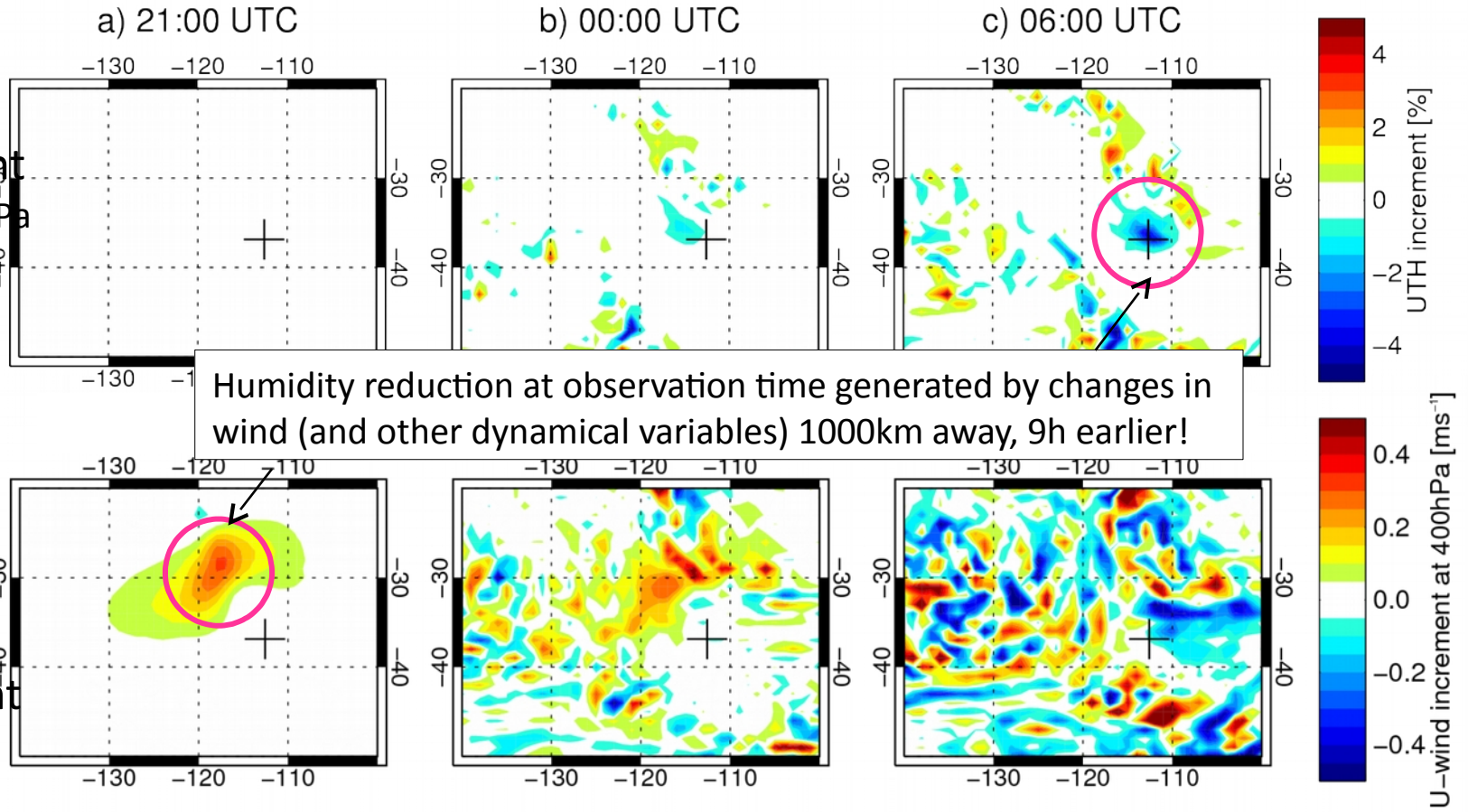
06Z, 15 Aug 2013
37°S 113°W
Observation rejected in old `clear-sky' approach

Water vapour in the presence of cloud - 183±1 GHz

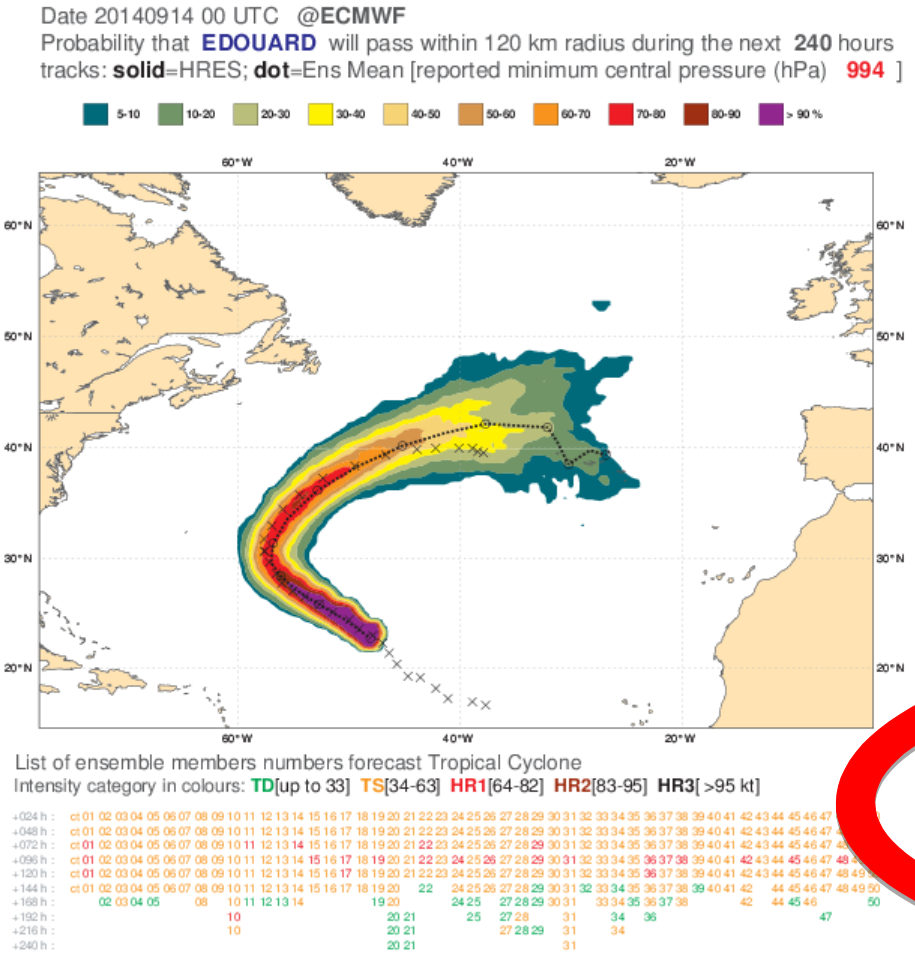


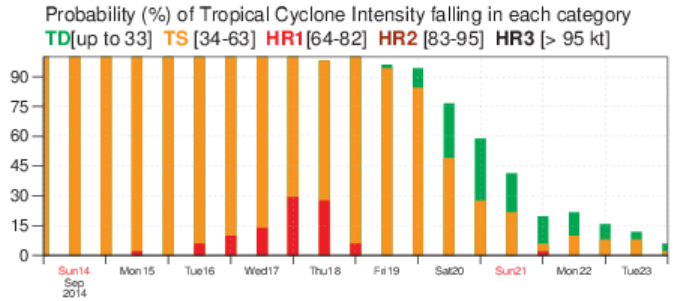
UTH increment (200-500 hPa mean RH)

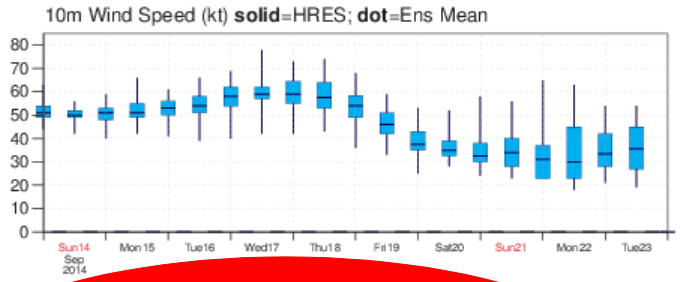
Zonal wind increment at 400 hPa

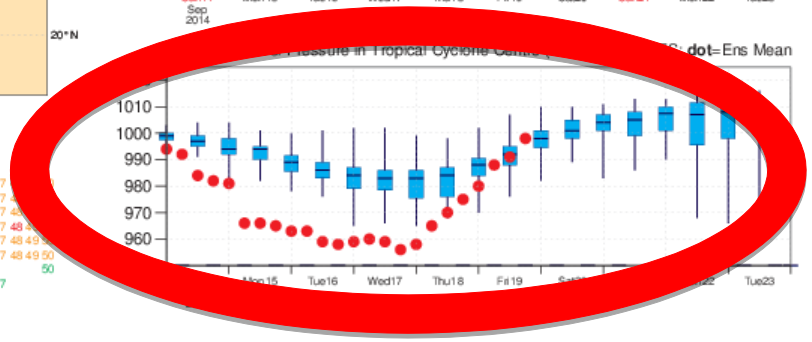


Humidity reduction at observation time generated by changes in wind (and other dynamical variables) 1000km away, 9h earlier!



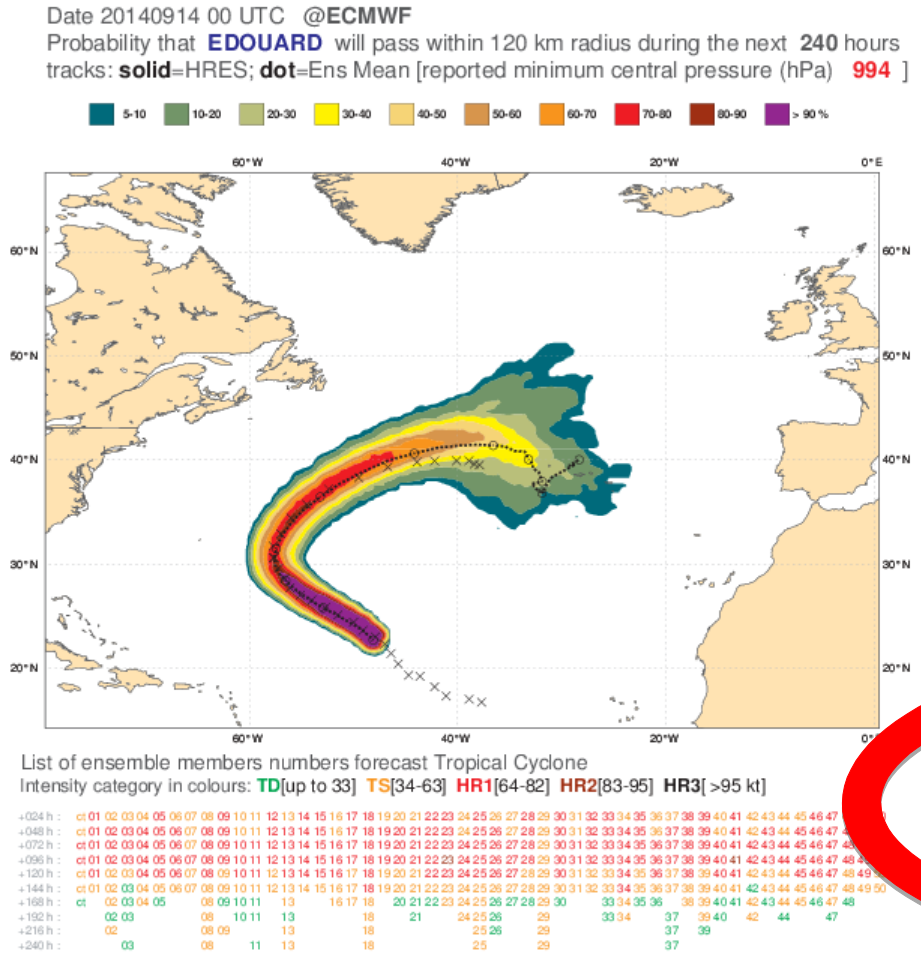


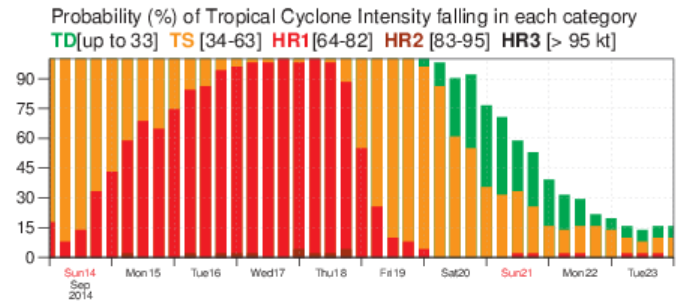


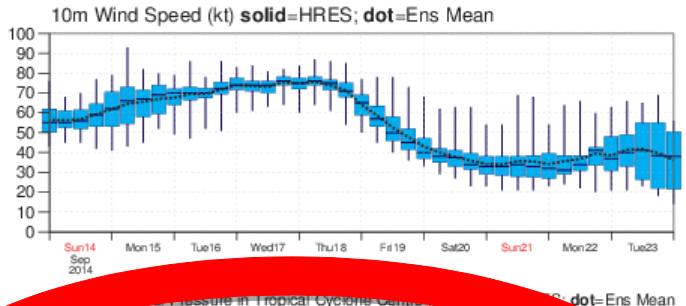


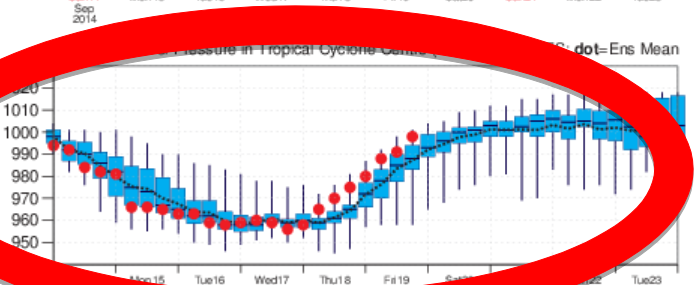
TL1279 An, TL399 EDA, TL639 ENS

Low spread and deepening not captured







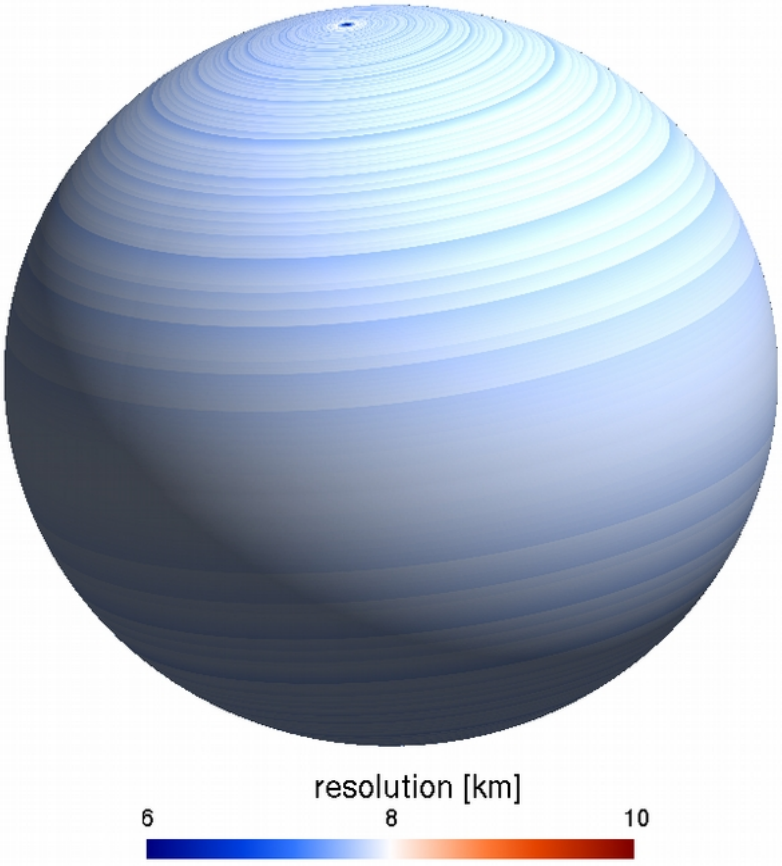


TL1279 An, 399 EDA, T639 ENS (new grid)

Deepening is captured and spread reflects uncertainty

Grid resolution

Old



New