Stochastic Physics in MOGREPS and plans for perturbations of surface fields

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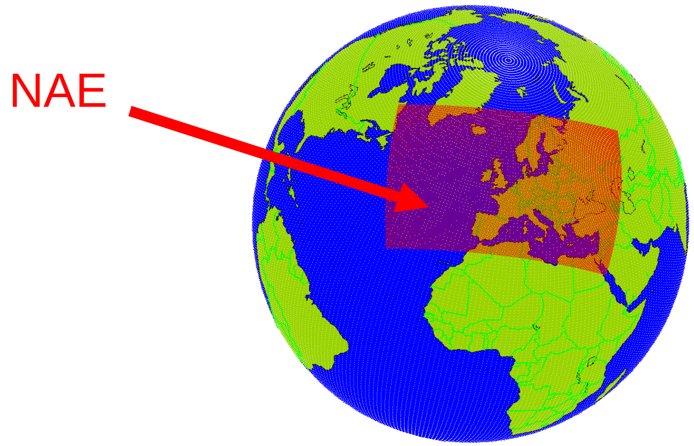
MOGREPS – current status

- 24-member ensemble designed for short-range forecasting
  - Global ensemble:
    - N144L38 (~90km) to T+72
    - Also T+15 days at ECMWF for THORPEX TIGGE archive
  - Regional ensemble:
    - NAE 24km, 38 levels to T+54
  - MOGREPS-G run at 0Z and 12Z: MOGREPS-R run at 6Z & 18Z
  - ETKF for initial condition perturbations (global only)
  - Stochastic physics:
    - SKEB1 (global only)
    - Random Parameters

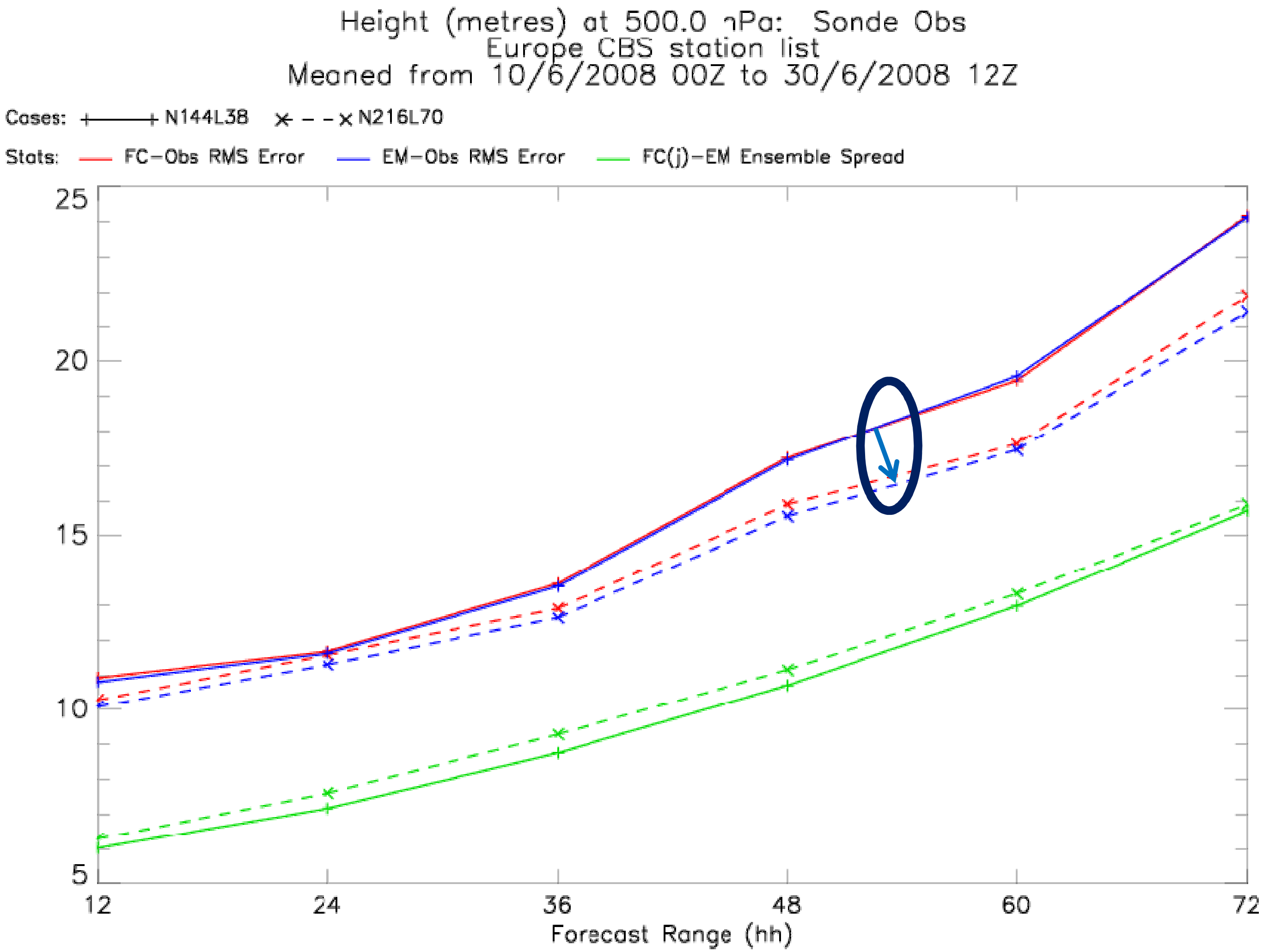


MOGREPS became fully operational in Sep 2008 after 3 years of trials

MOGREPS – new developments

- Resolution upgrade (Jan 2010)
  - Global: ~90km L38 -> ~60km L70
  - Regional: 24km L38 -> 18km L70
- Model error estimation
  - Random Parameters: Perturb physics scheme coefficients, e.g. Critical RH for condensation
  - Backscatter of kinetic energy to resolved scales from unresolved convection and excessive numerical advection scheme diffusion
  - Perturb surface fields: SST, soil moisture, others…
  - Stochastically Perturbed Parameterisation Tendencies (similar to ECMWF)

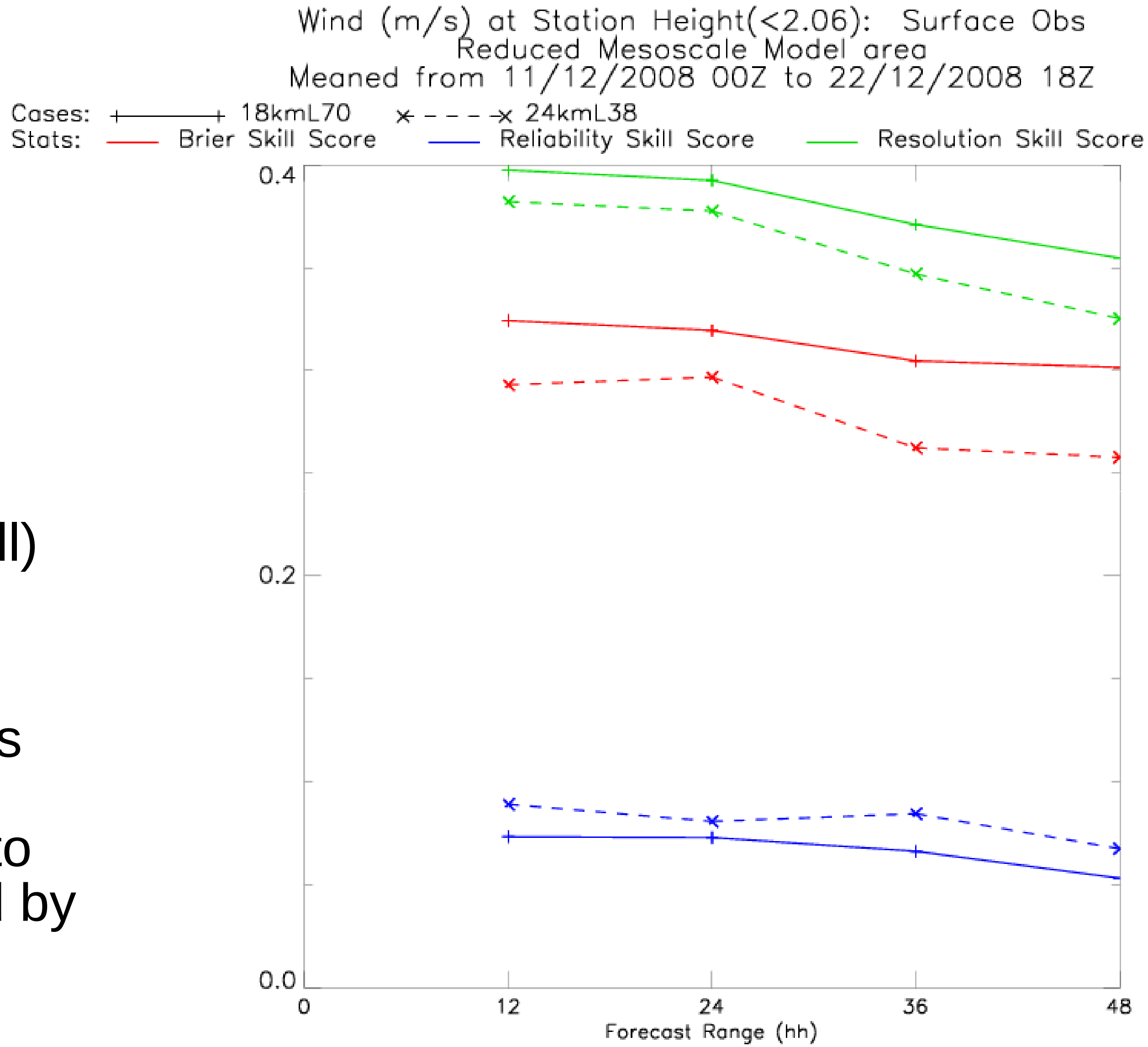
Global EPS Resolution upgrade



On resolution upgrade:

- decreased RMSE against observations in control and ensemble mean (blue arrow)
- increased spread

Regional system resolution upgrade



On resolution upgrade:

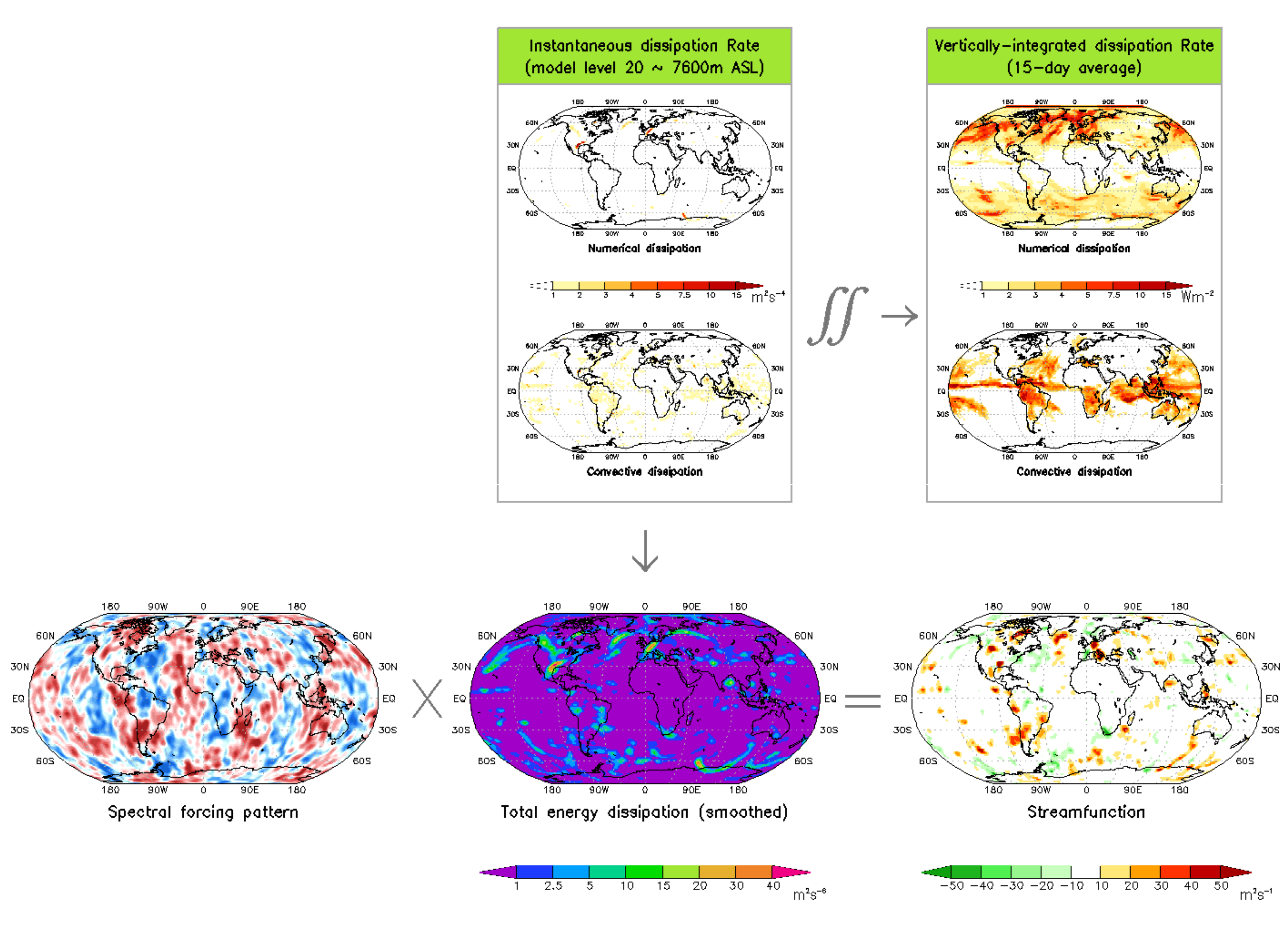
• improved Brier Scores (in each component) for various (but not all) parameters

• notice how the reliability improves with lead-time (possibly related to initial bias caused by start data?)

New Stochastic Physics Scheme (testing now completed):

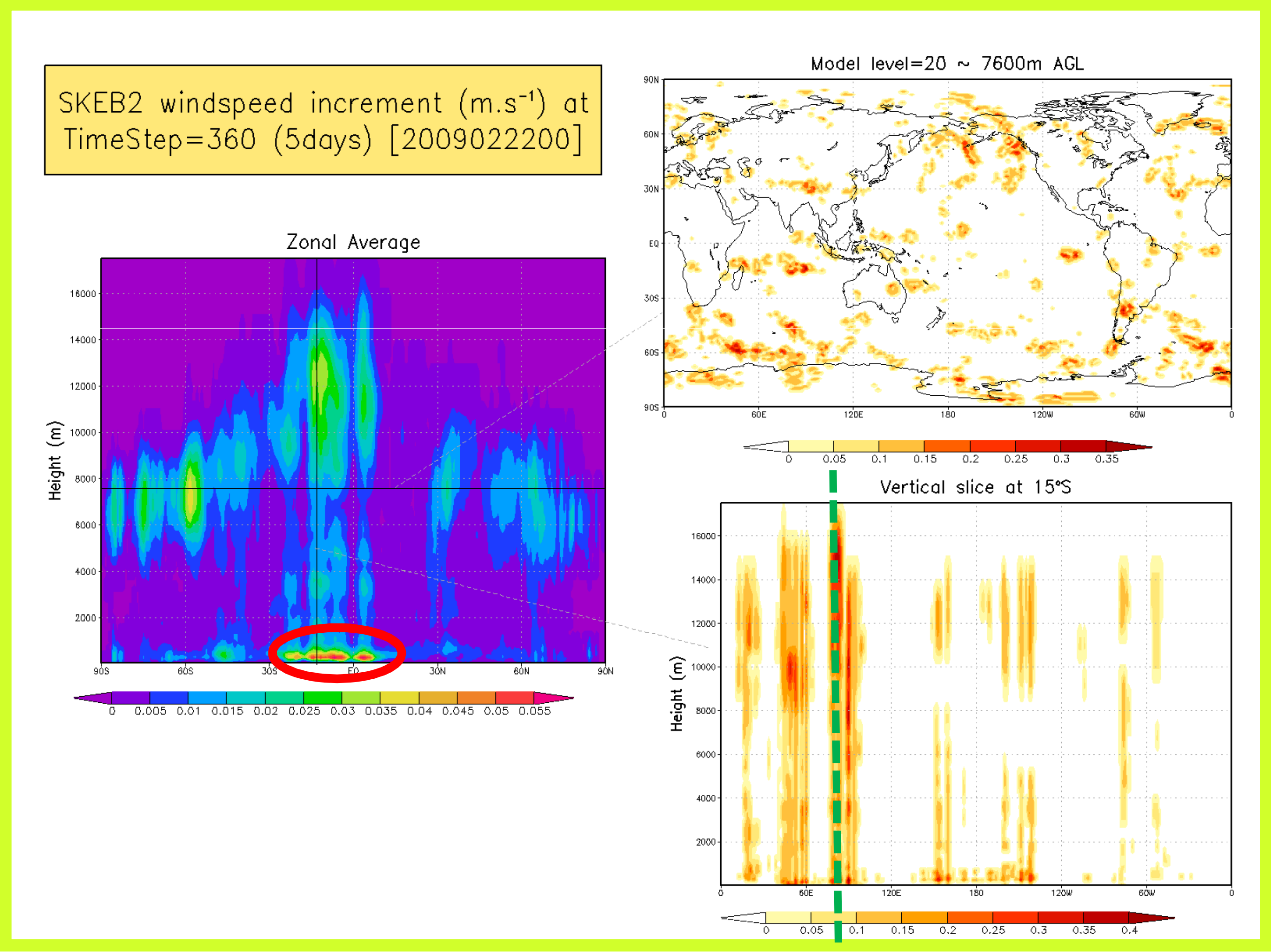
SKEB2 – Stochastic Kinetic Energy Backscatter version 2

- Generates a wind-increment field at each time-step
- This forces the large resolved scales with kinetic energy thought to be lost due to excessive dissipation in numerical advection and also not fed back from convection schemes
- Energy dissipation calculated using Smagorinsky-Lilly 2D turbulence and vertical mass flux
- Stochastic forcing provided through a spectral field with evolving wave components

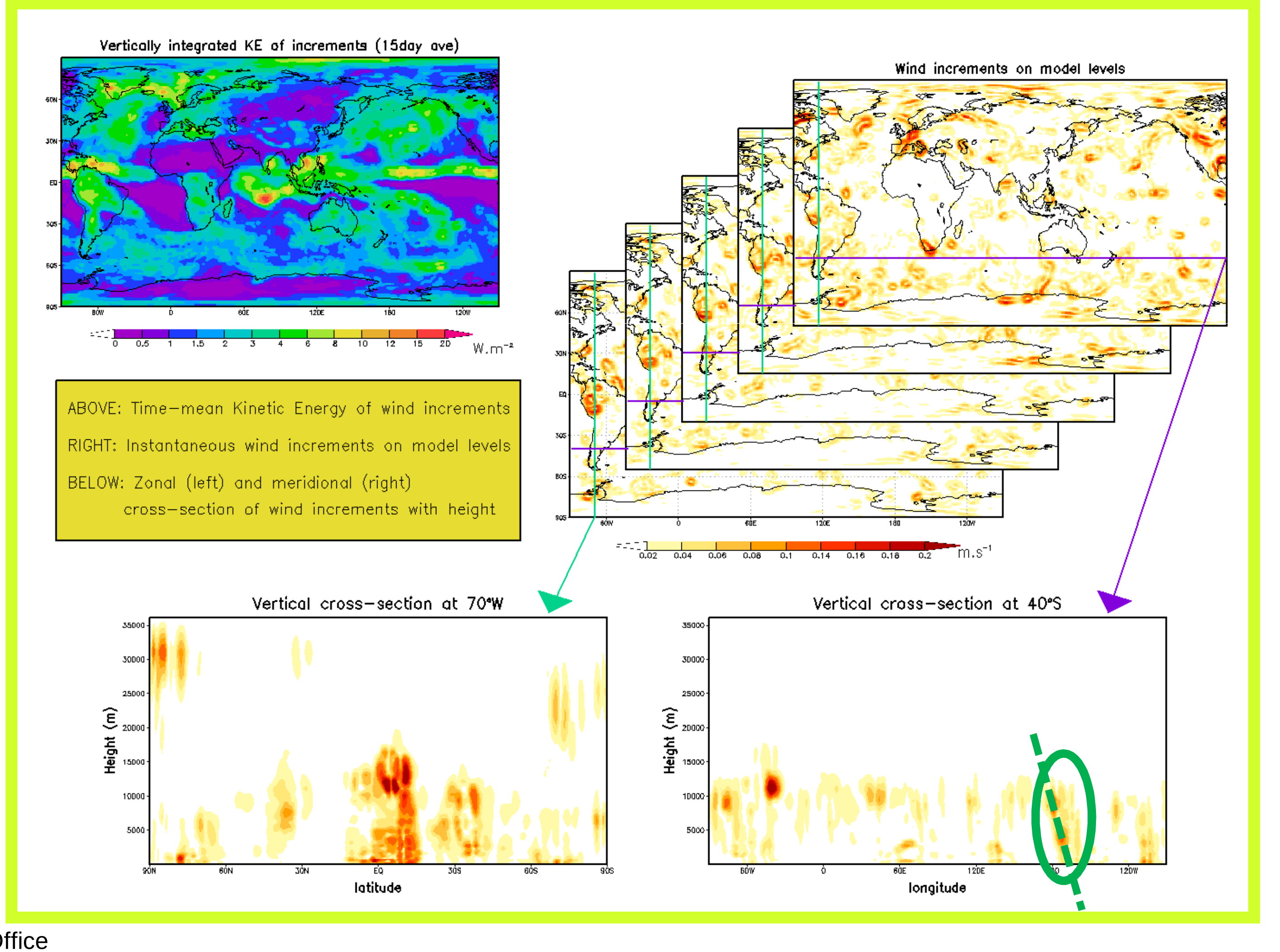


Instantaneous dissipation Rate
(model level 20 ~ 7600m ASL)
Numerical dissipation
Convective dissipation
Vertically-integrated dissipation Rate
(15-day average)
Numerical dissipation
Convective dissipation
Spectral forcing pattern
Total energy dissipation (smoothed)
Streamfunction

SKEB2 status at SRNWP in June 2009



SKEB2: Improved vertical structure in forcing pattern



Plans to test surface perturbations

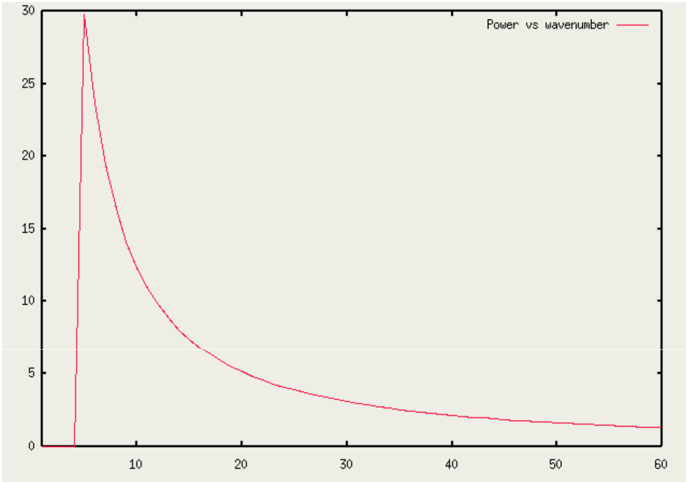
SST perturbations

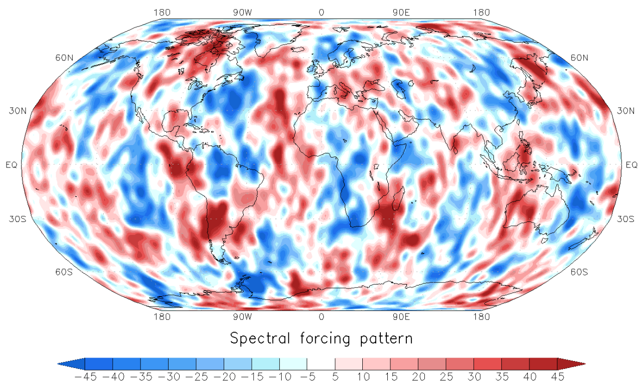
- Impose a random perturbation unique to each ensemble member at the start of run
- Keep this constant during the forecast
- The perturbation should be able to change the anomaly sign without adversely affecting the regional heat balance

Soil-moisture and surface-type perturbations

- Sharpen gradients to increase impact
- Need to consider how these would vary during the run

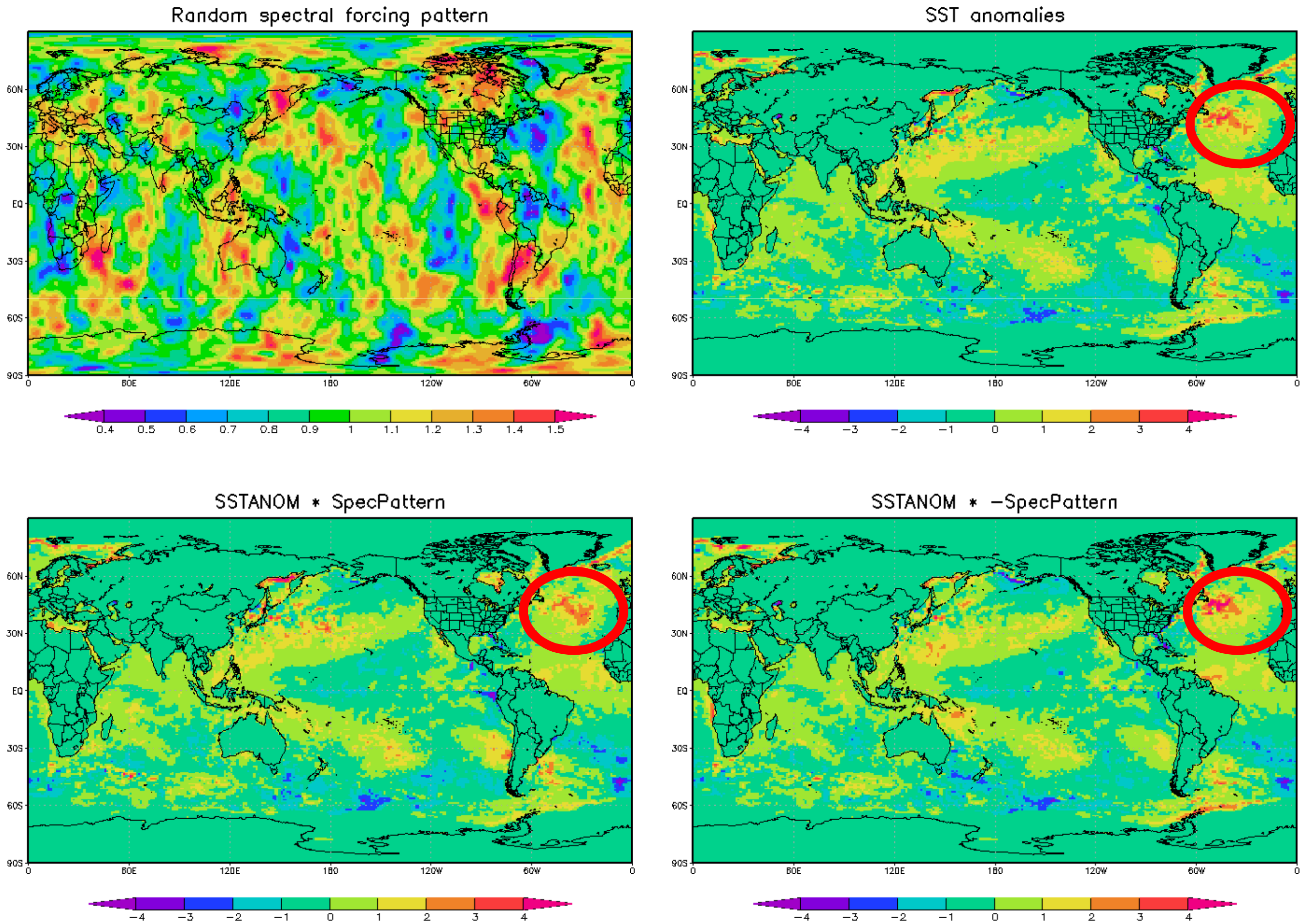
Stochastic forcing pattern





- Start with a prescribed power spectrum
- Draw wave coefficients from a uniform random distribution
- Generate a spherical harmonic pattern
- Same technique used in the backscatter scheme

SST anomaly perturbations from spectral pattern



Results

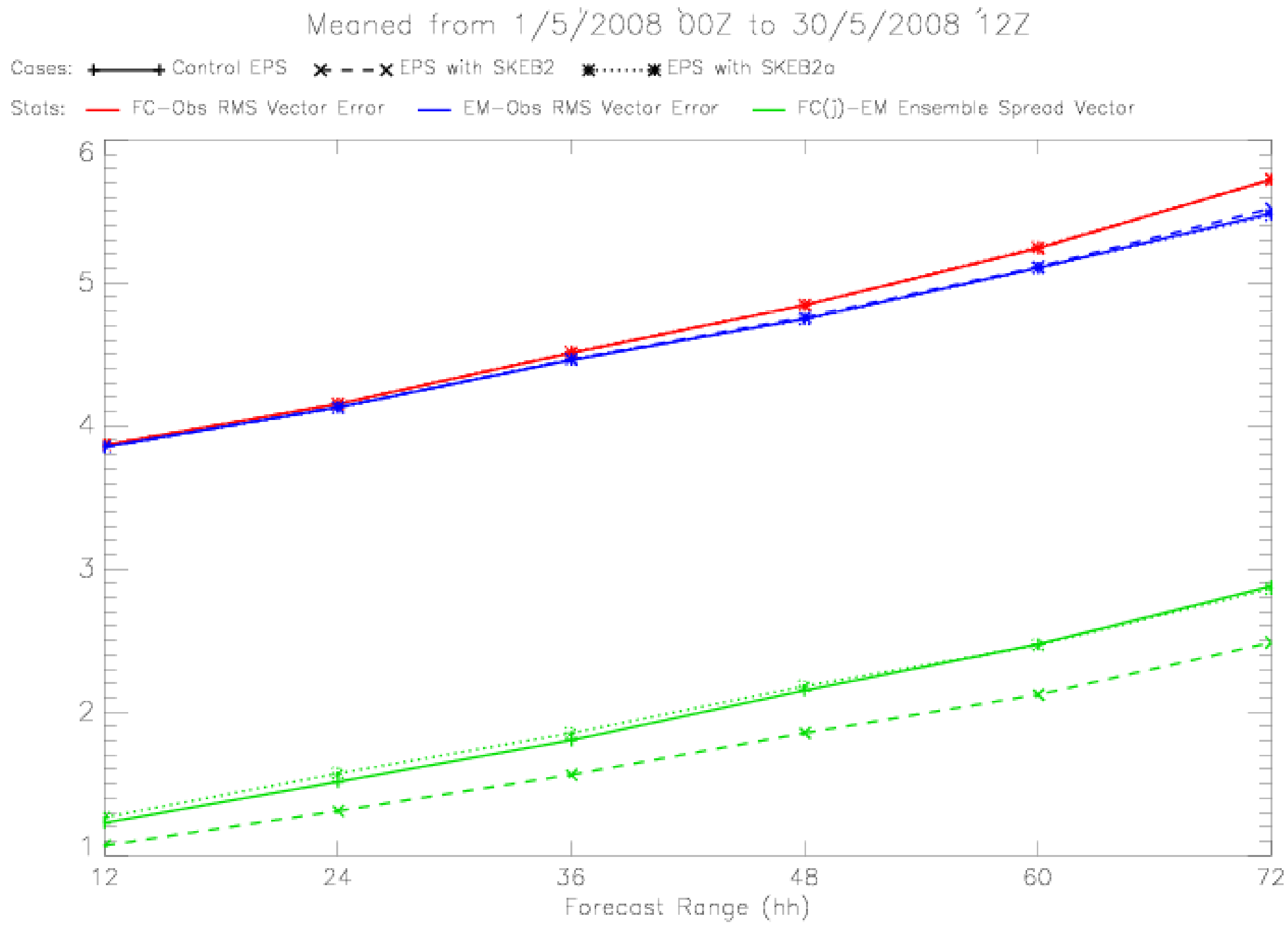
Verification of global system

- Month-trial statistics against observations

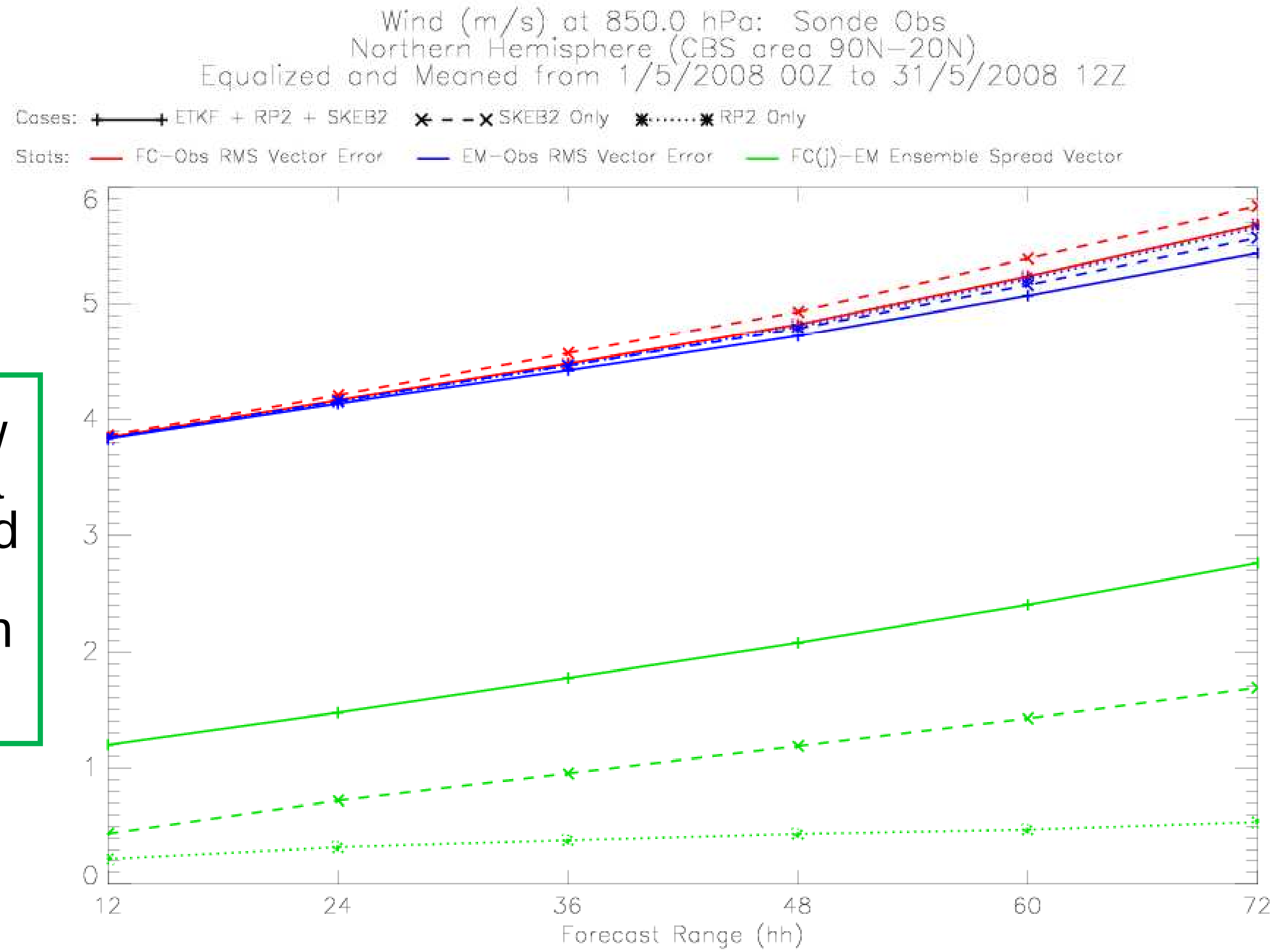
Case study of mid-latitude cyclone “Klaus”

- Impact of SKEB2 on global system and subsequent impact on regional system

Impact of SKEB2 on NH 850hPa Winds (shown at SRNWP in June 2009)

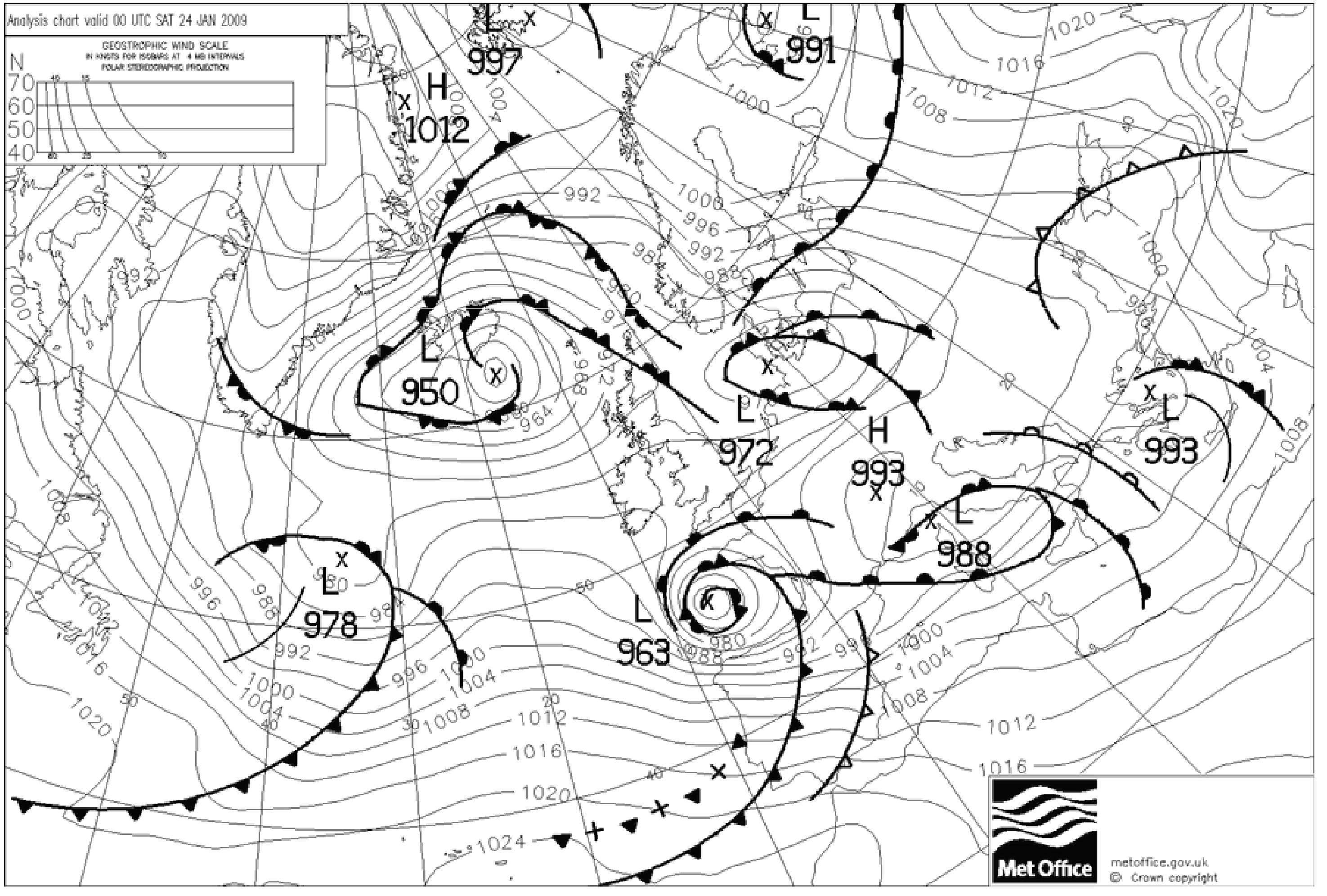


Relative contributions of Initial perturbations and Stochastic Physics to EPS spread/skill



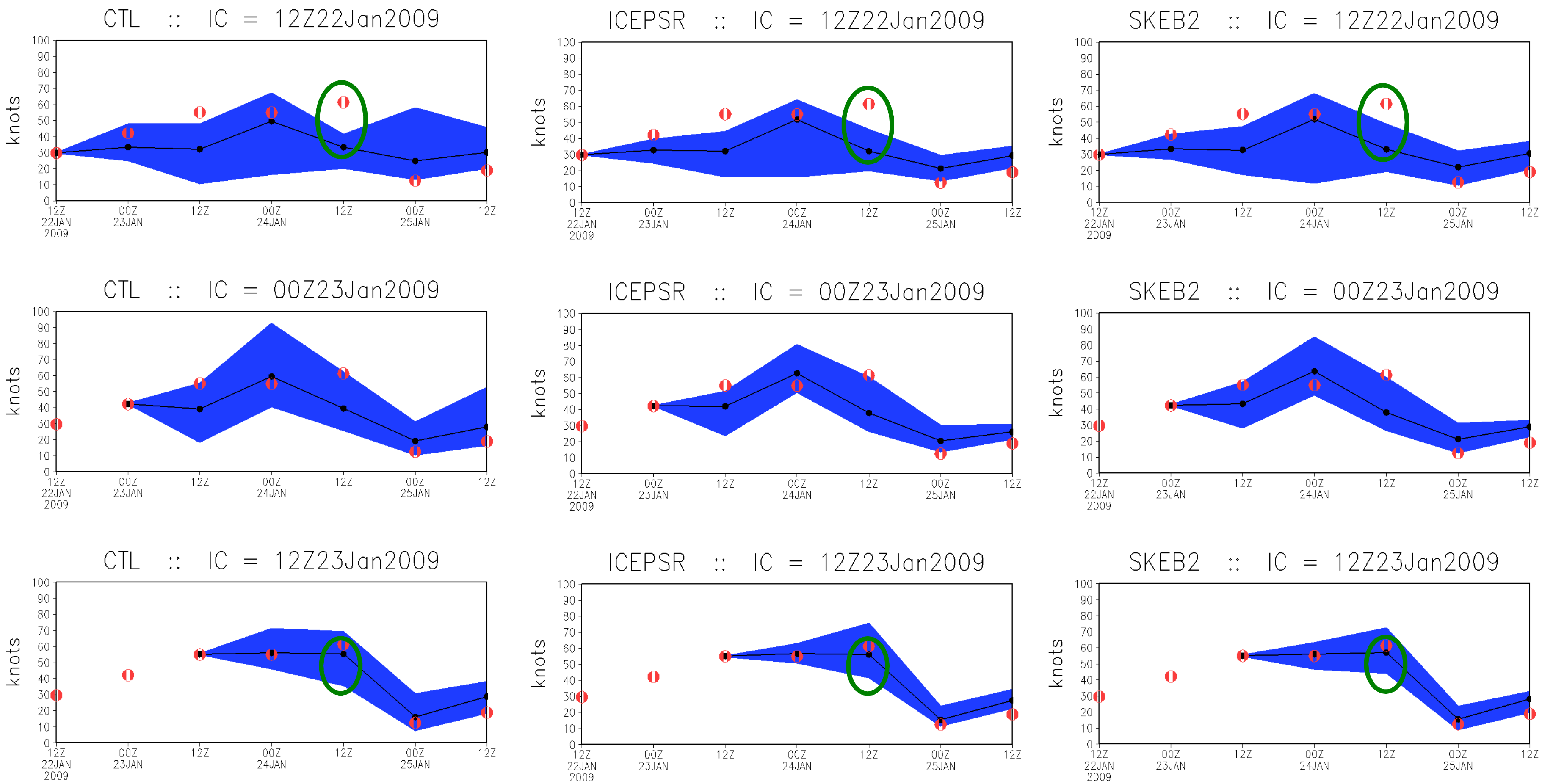
SKEB2 now generates a good spread growth rate, especially in the tropics.

Case Study :: Storm winds in N Spain/S France – Jan 2009

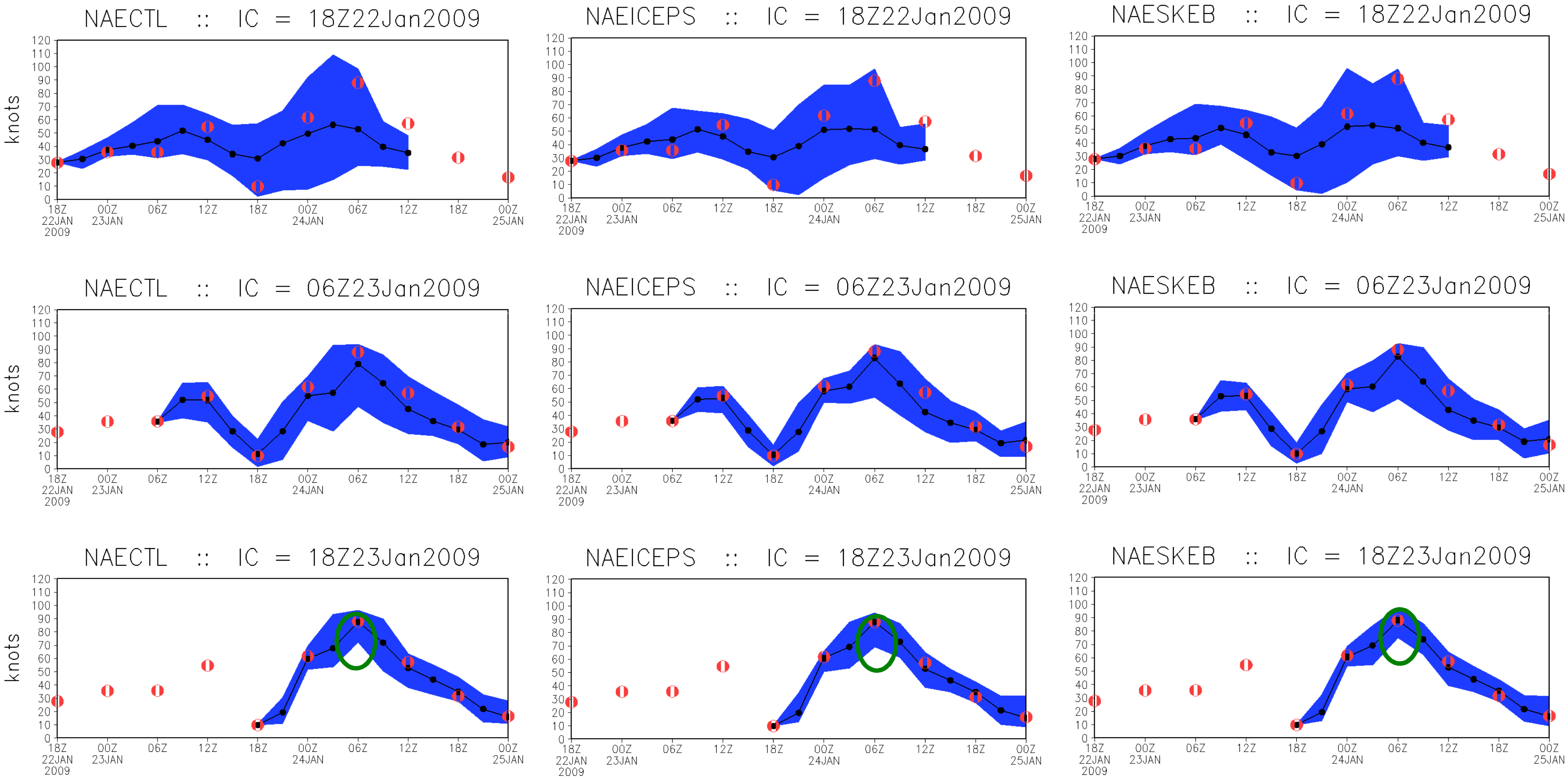


Wind-speed plume **43.5N 1.6W**

(Global Model Forecast)



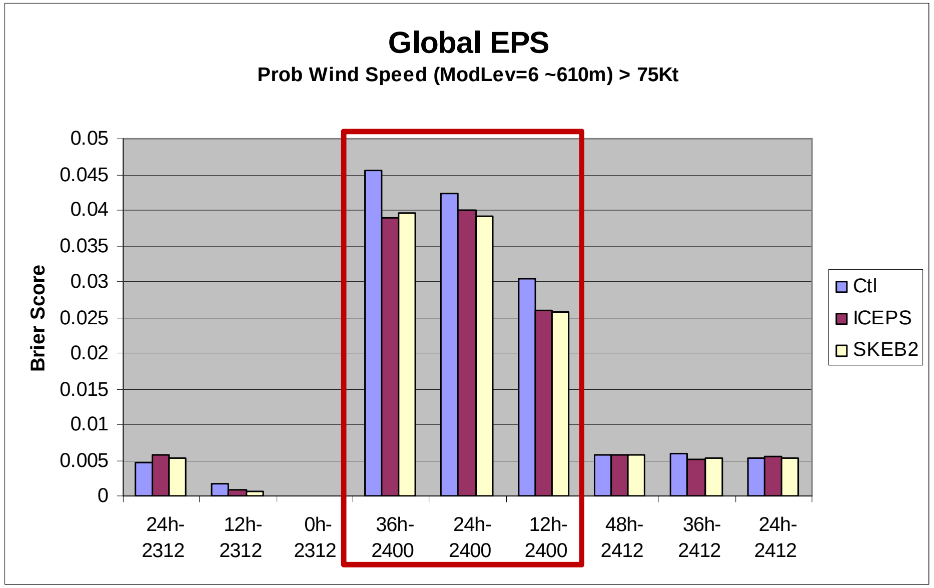
Wind-speed plume **43.5N 1.6W**
(Regional Model Forecast)

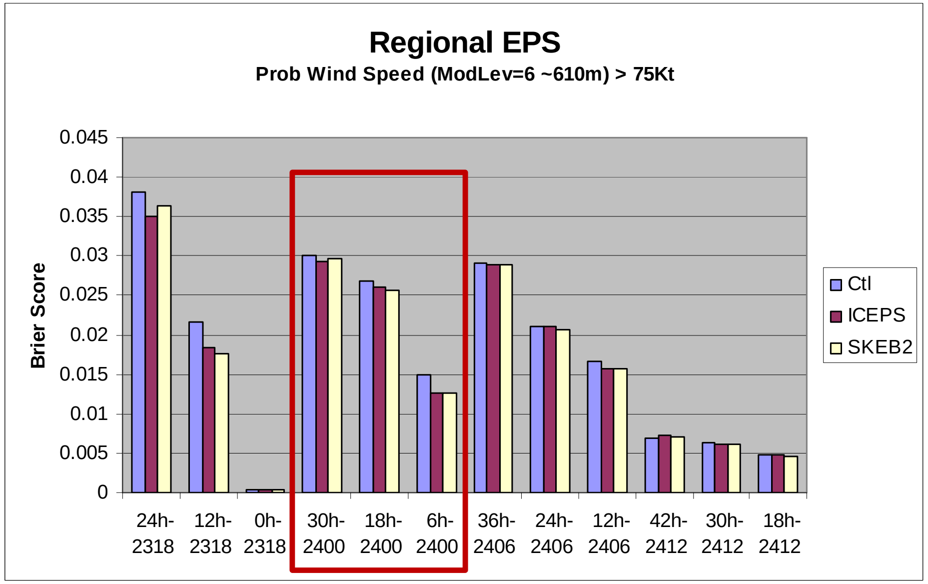


Area-averaged Brier Score for different forecast lead-times of event: WindSpeed > 75 Kts at model_level=6

1. At longer lead-times the accuracy of the regional EPS system mirrors that of the global system.

2. At shorter lead-times this is less evident





Conclusions

- Resolution upgrade suggests good impact on MOGREPS

- SKEB2 has a positive impact on the MOGREPS-G with downstream impact on MOGREPS-R

- Plans to investigate impact of surface perturbations on MOGREPS spread, especially for near-surface variables