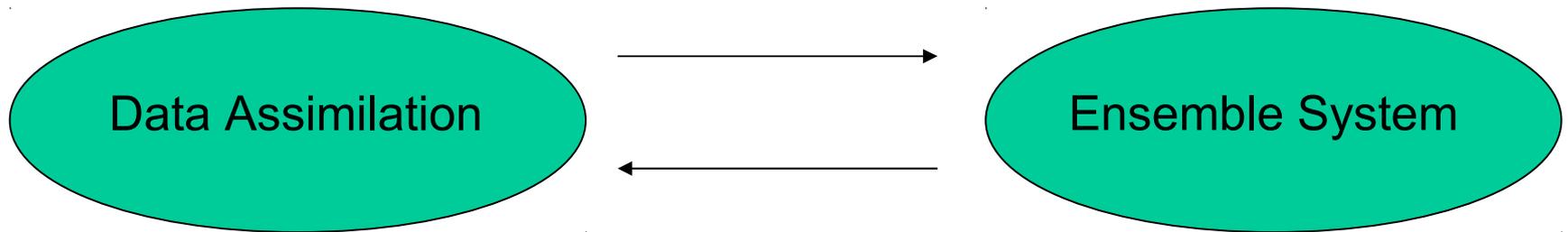


Impact of a Hybrid Ensemble-Variational Data Assimilation System on the Performance of an ETKF-based EPS System

Åke Johansson, Jelena Bojarova and Nils Gustafsson

Marriage



Time Period



17 JAN – 5 MAR 2008

Time Period

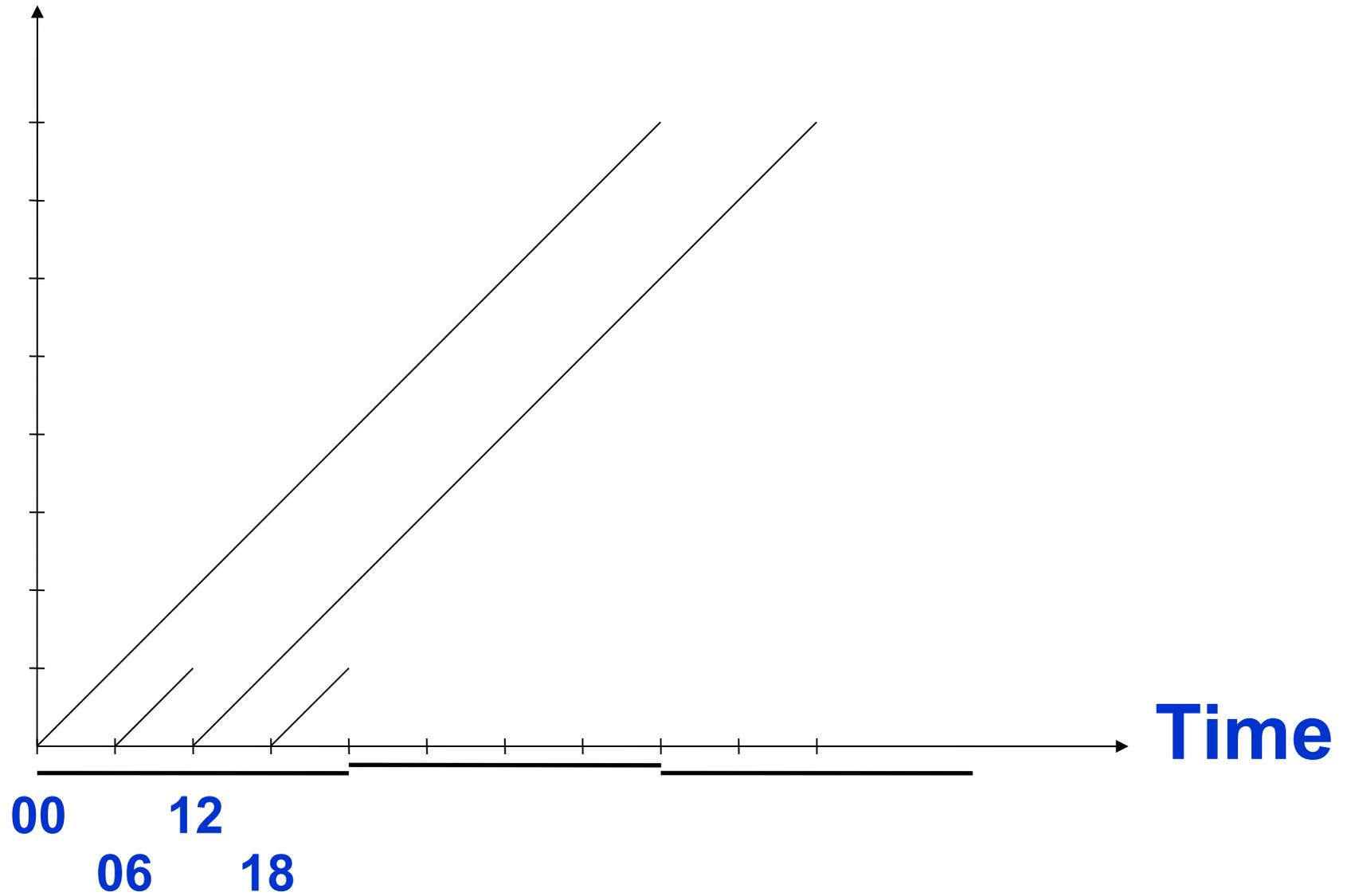


17 JAN – 5 MAR 2008



25 JAN – 6 FEB 2008

Forecast Lead Time



Horizontal Domain

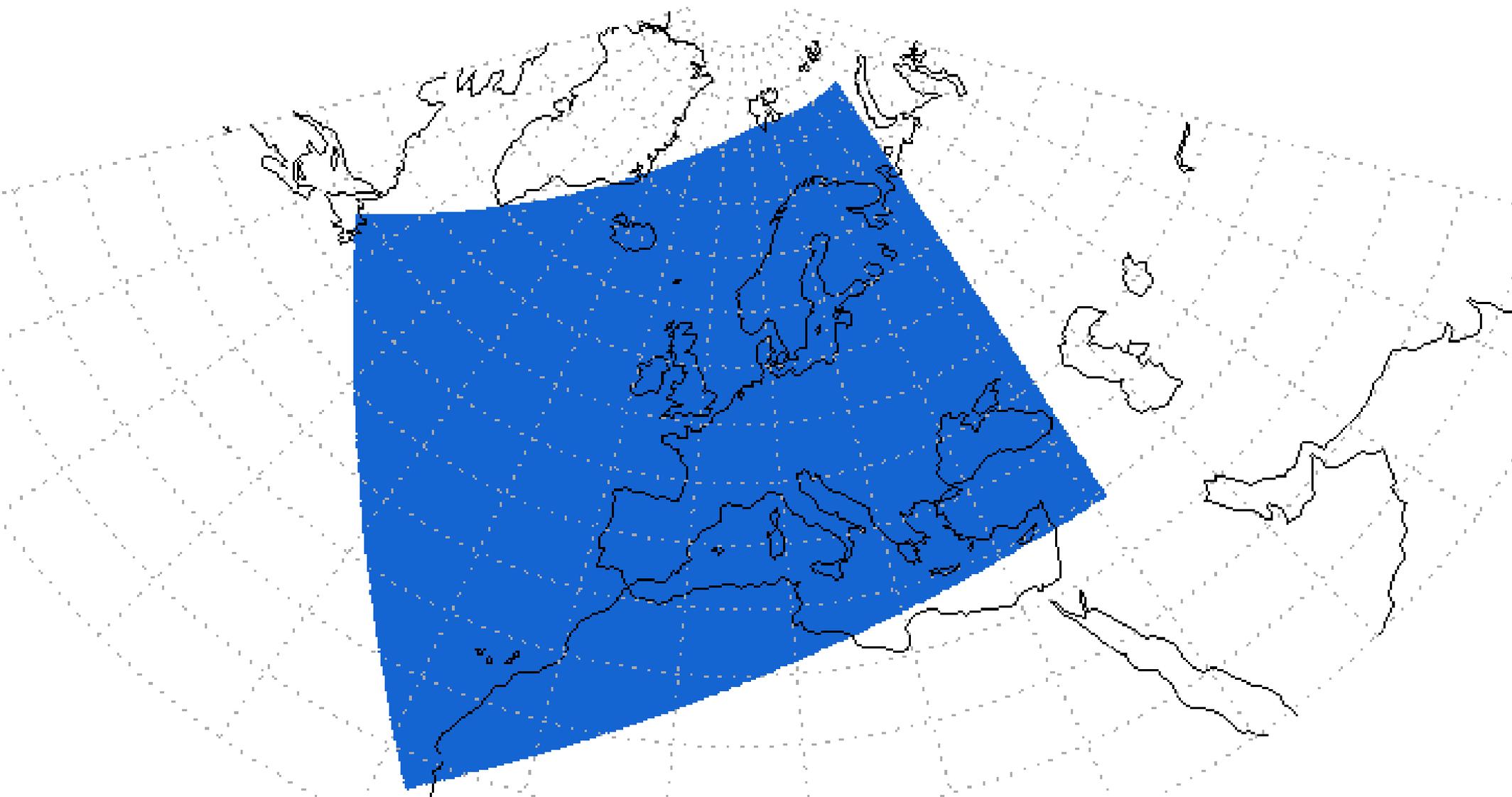
GLAMEPS_V1

486 X 378 points

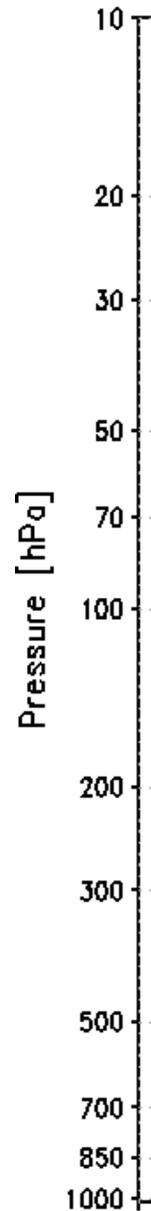
0.115 X 0.115

NLEV=40

DT=6 min



Vertical Domain



40 Levels

Boundary Conditions

EuroTEPS

Boundary Conditions

EuroTEPS

Zone at the Horizontal Boundaries

Layer at the top of the Model

Ensemble Characteristics

Size: 12 Members

Ensemble Characteristics

Size: 12 Members

Centering: Spherical Simplex

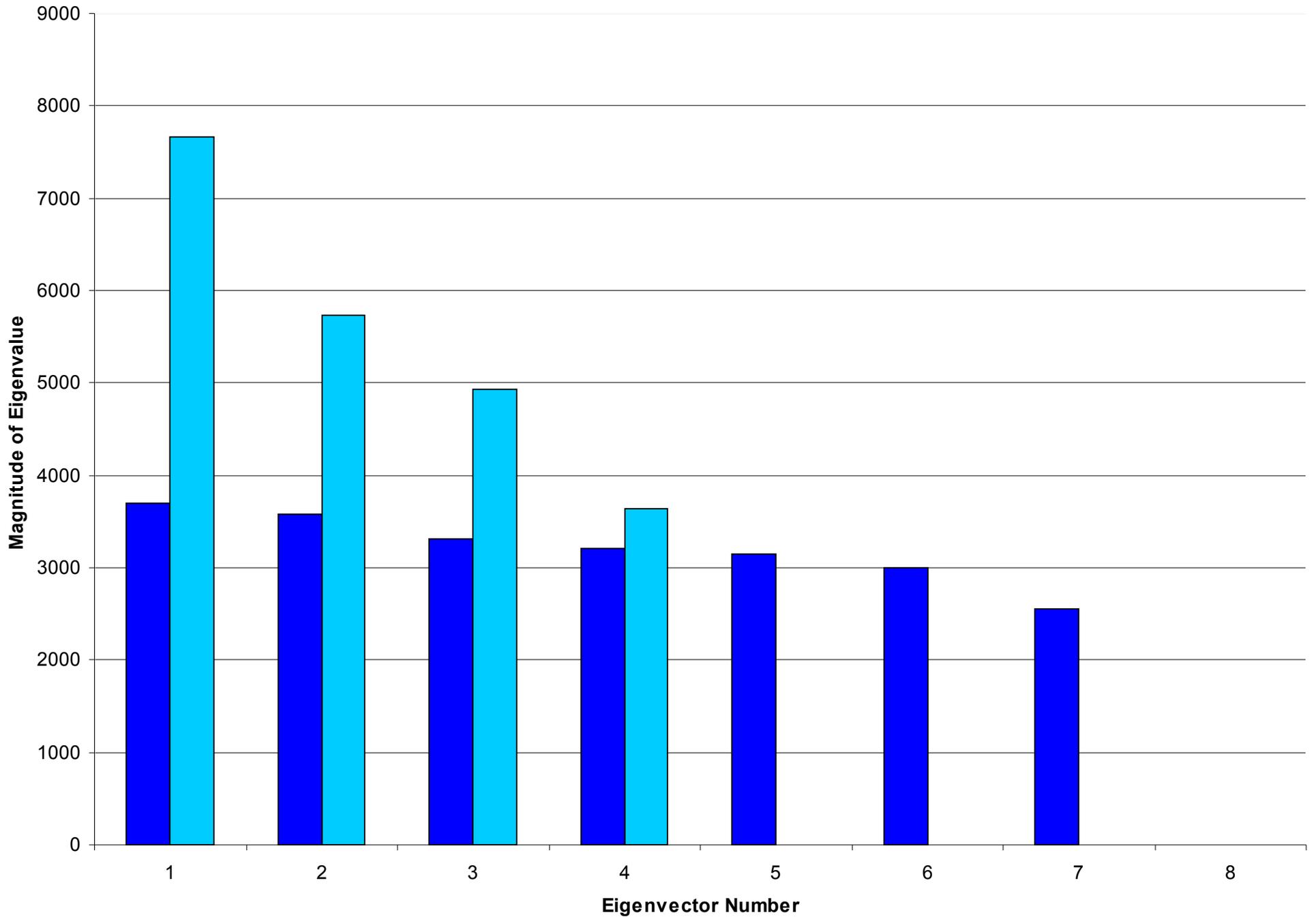
Ensemble Characteristics

Size: 12 Members

Centering: Spherical Simplex

**Inconsistent with the
BC from EuroTEPS
which are Paired**

ETKF vs TEPS Analysis



EXPERIMENT COMPARISON - 1

ETKF

vs

EuroTEPS

MODEL

HIRLAM Trunk APR 2010

Boundary Conditions

EuroTEPS

ETKF

20% EuroTEPS

80% ETKF

EuroTEPS

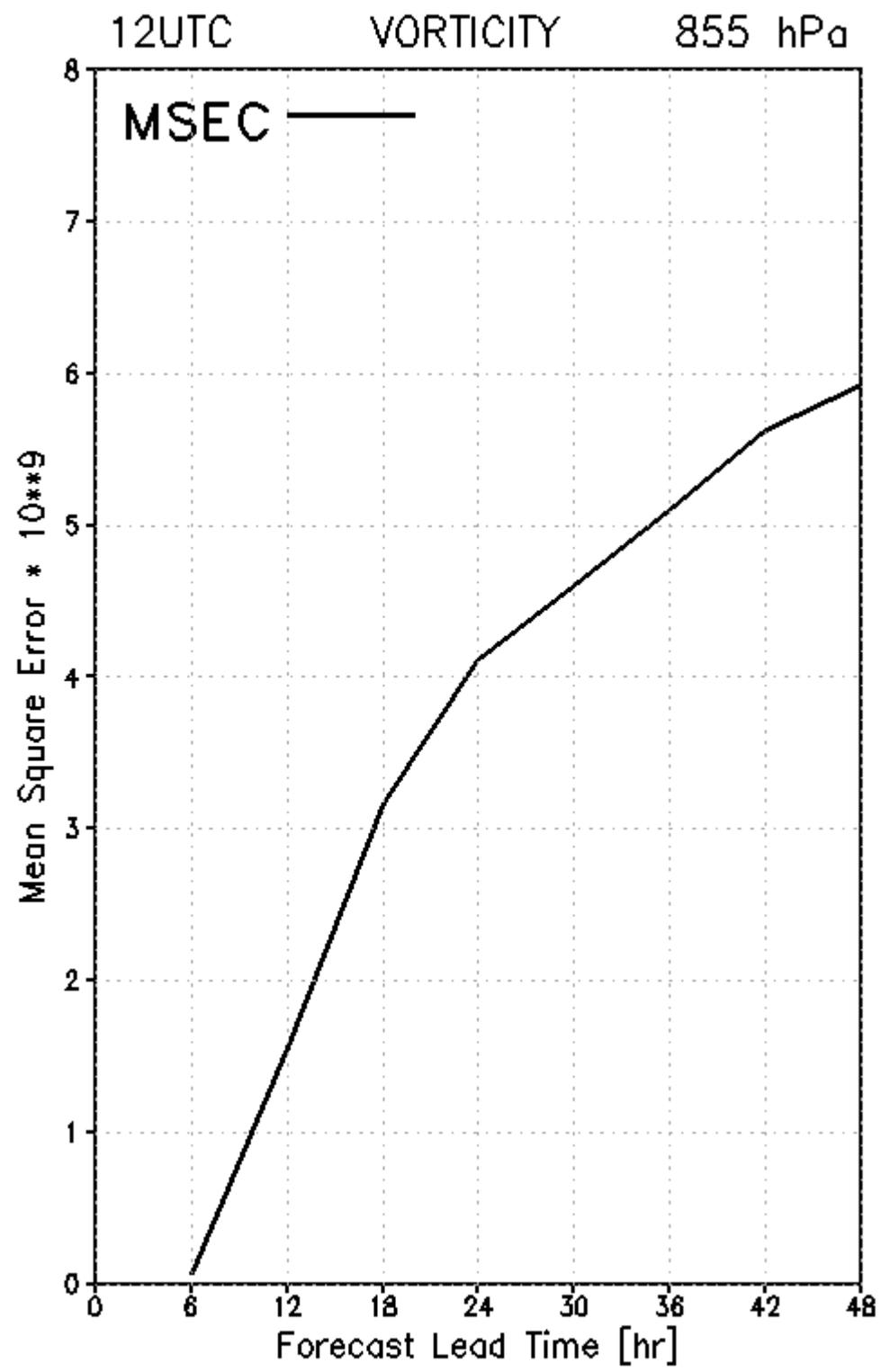
100% EuroTEPS

DATA and DA

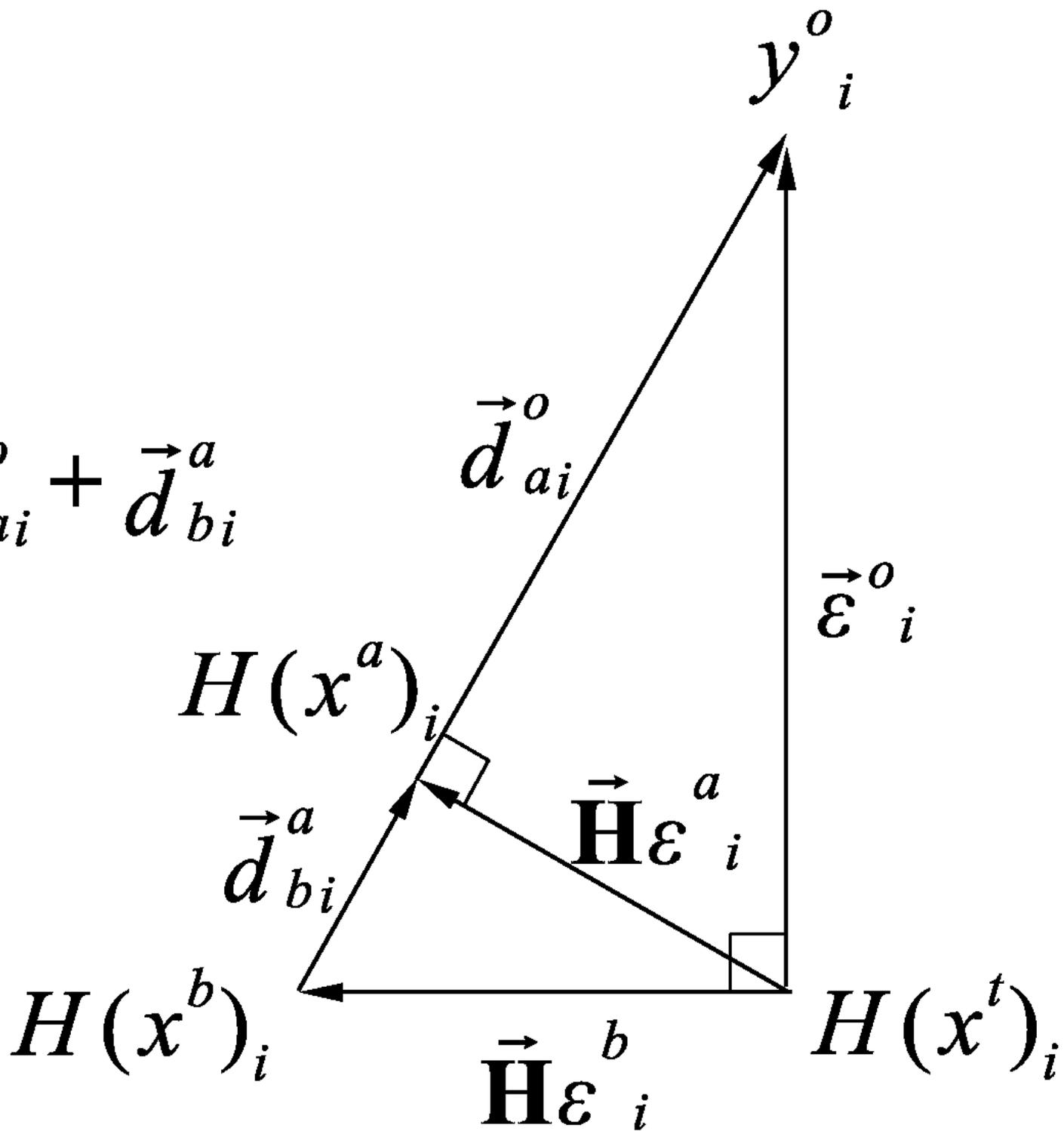
ONLY Conventional Data

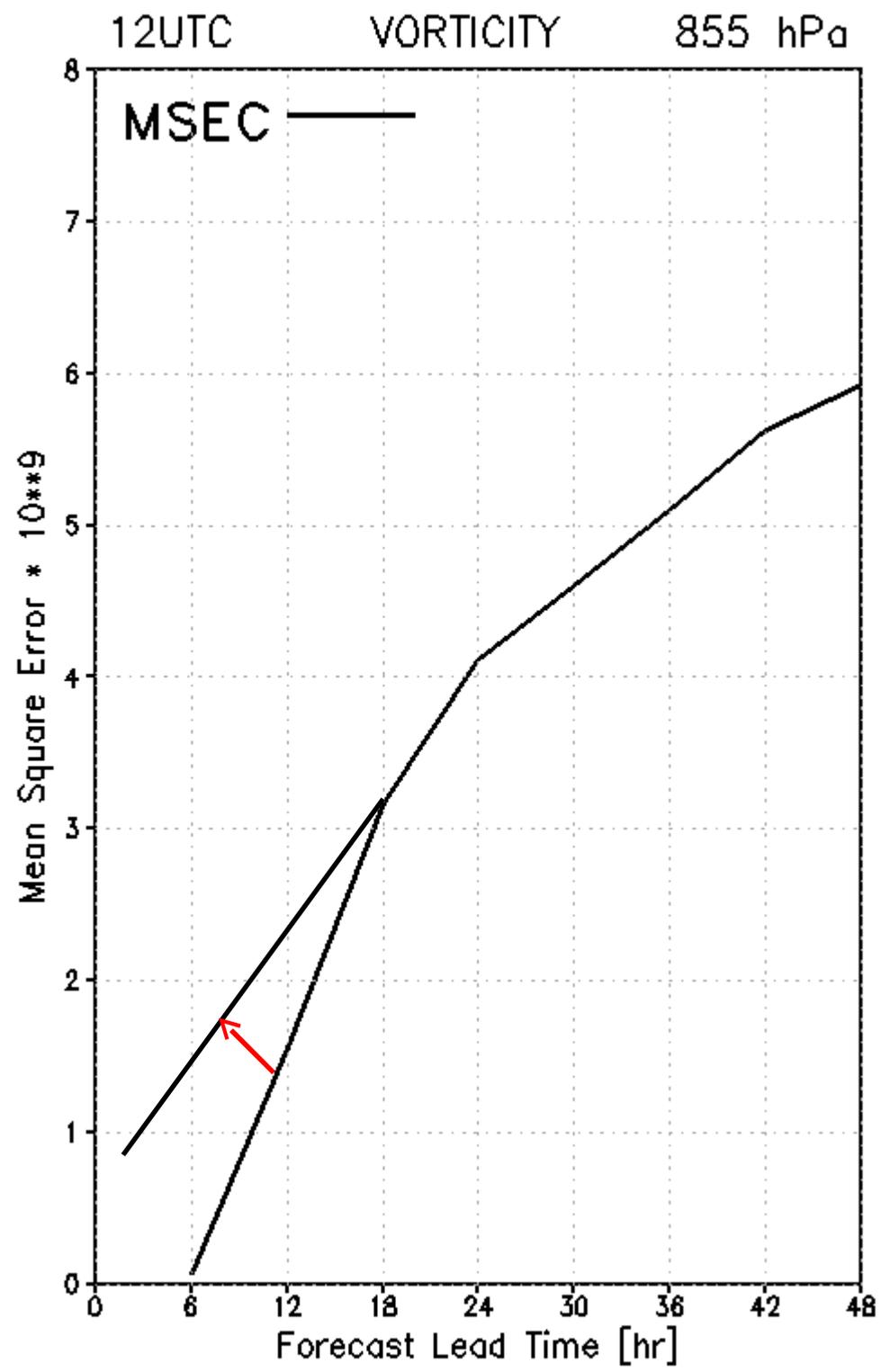
3D-VAR

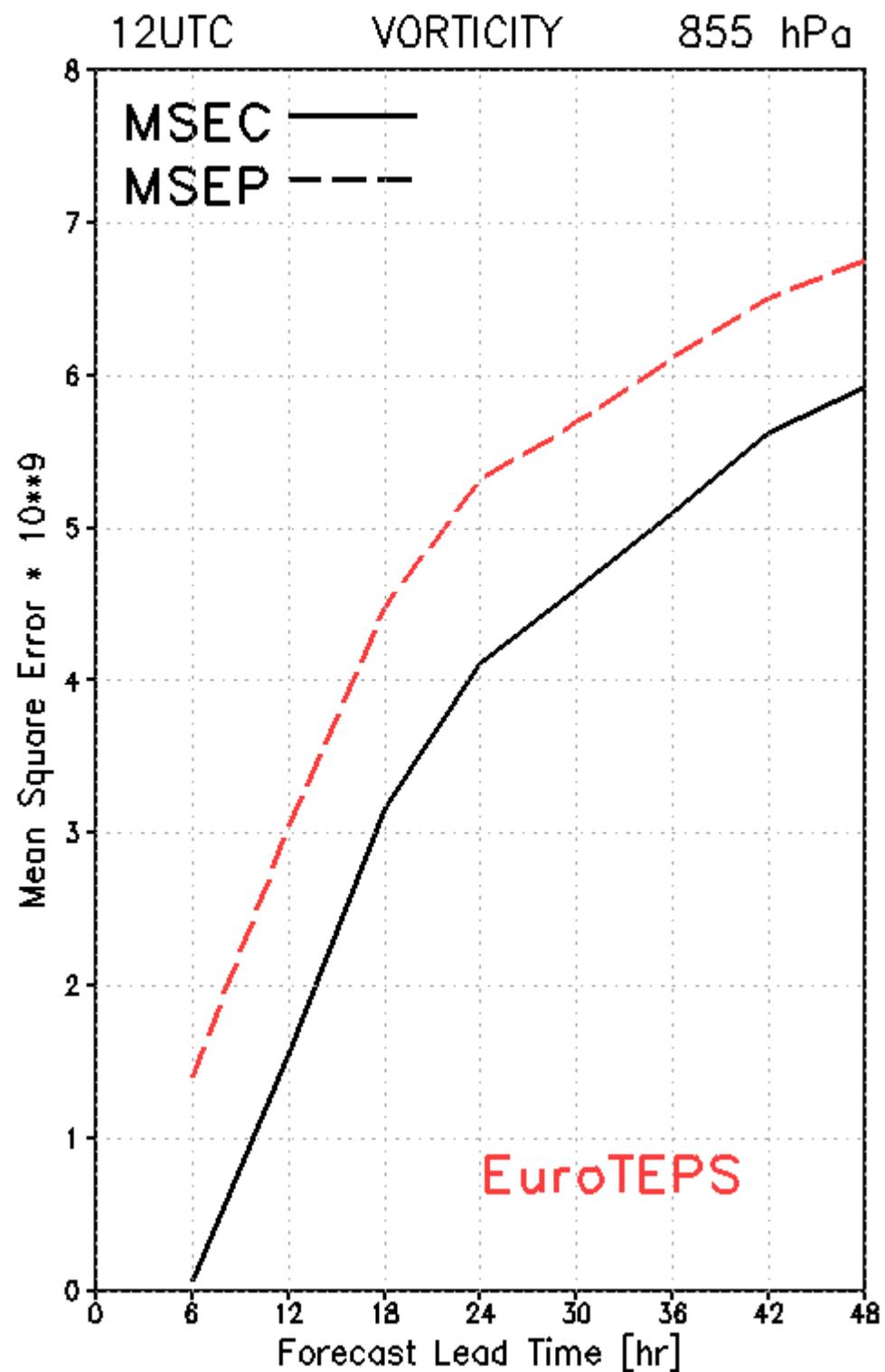
Error growth

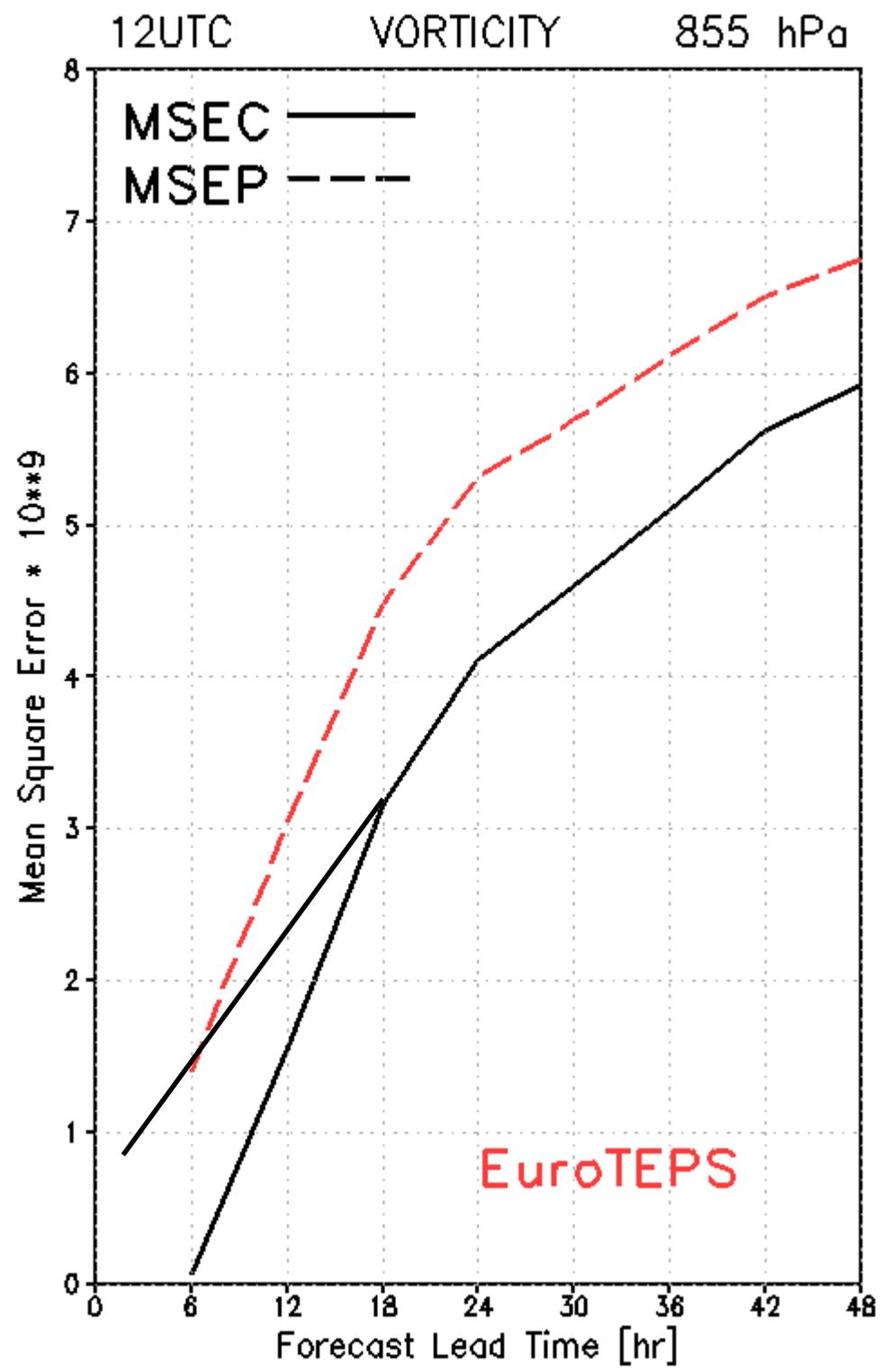


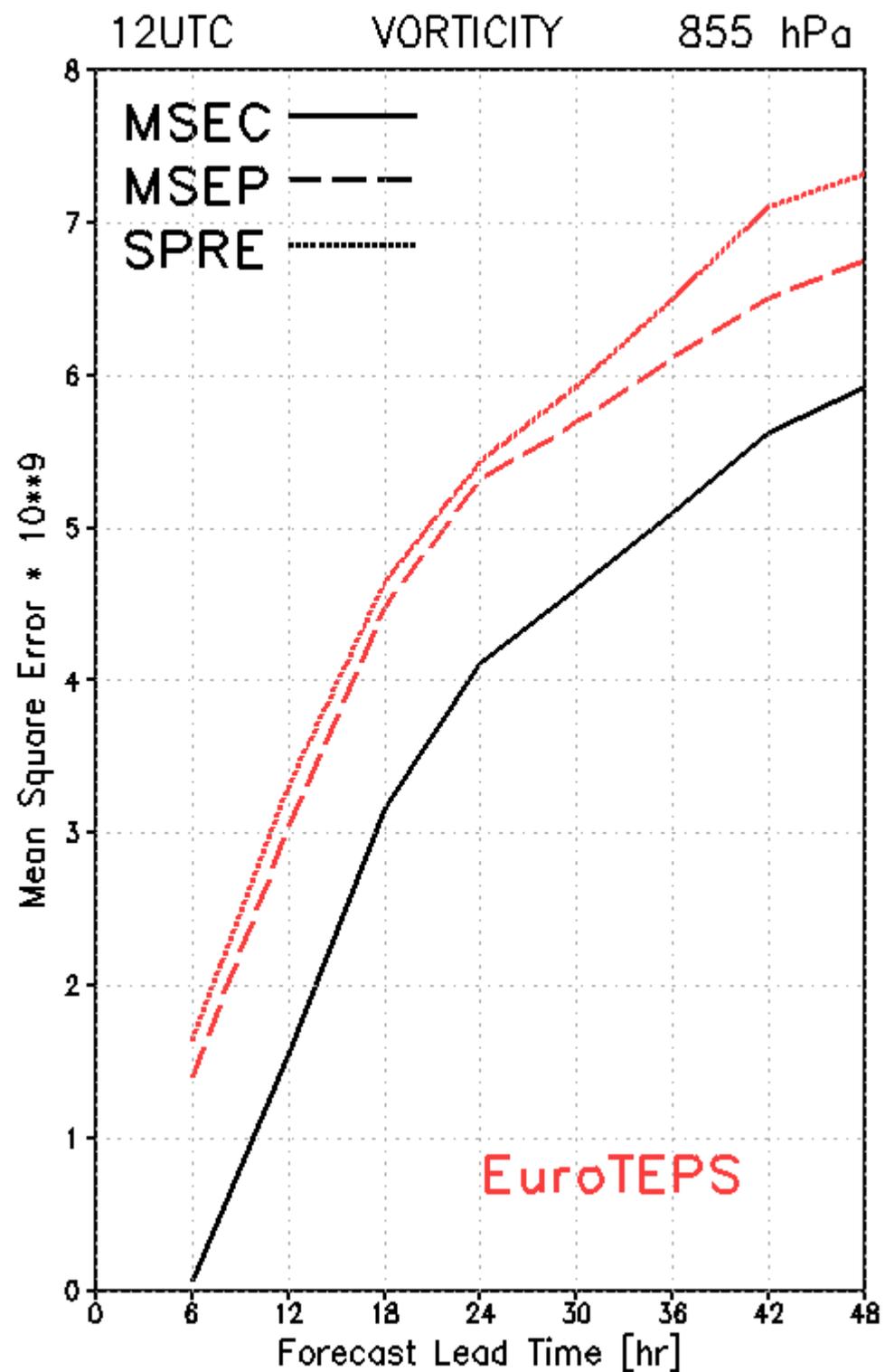
$$\vec{d}_{bi}^o = \vec{d}_{ai}^o + \vec{d}_{bi}^a$$

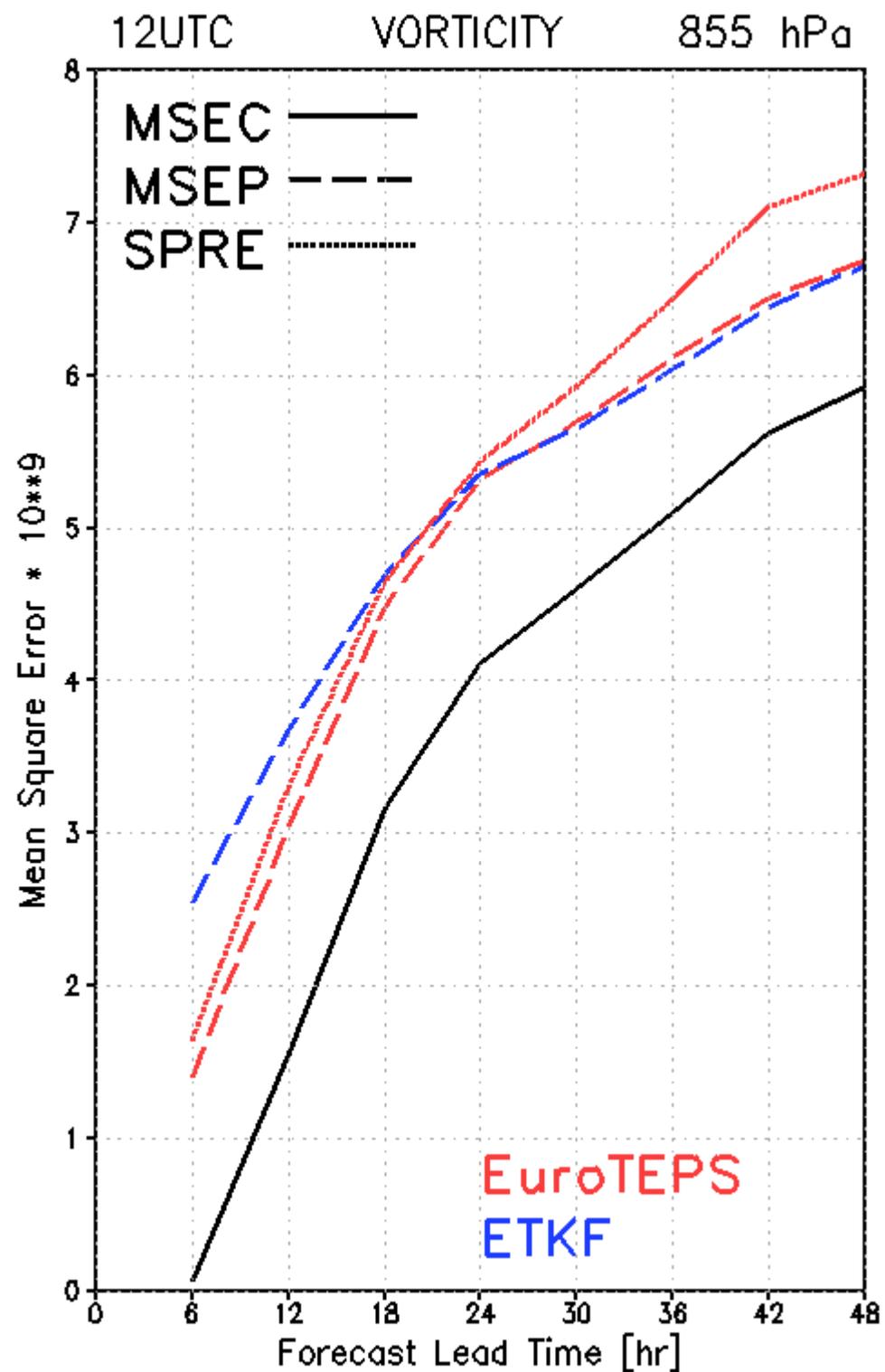


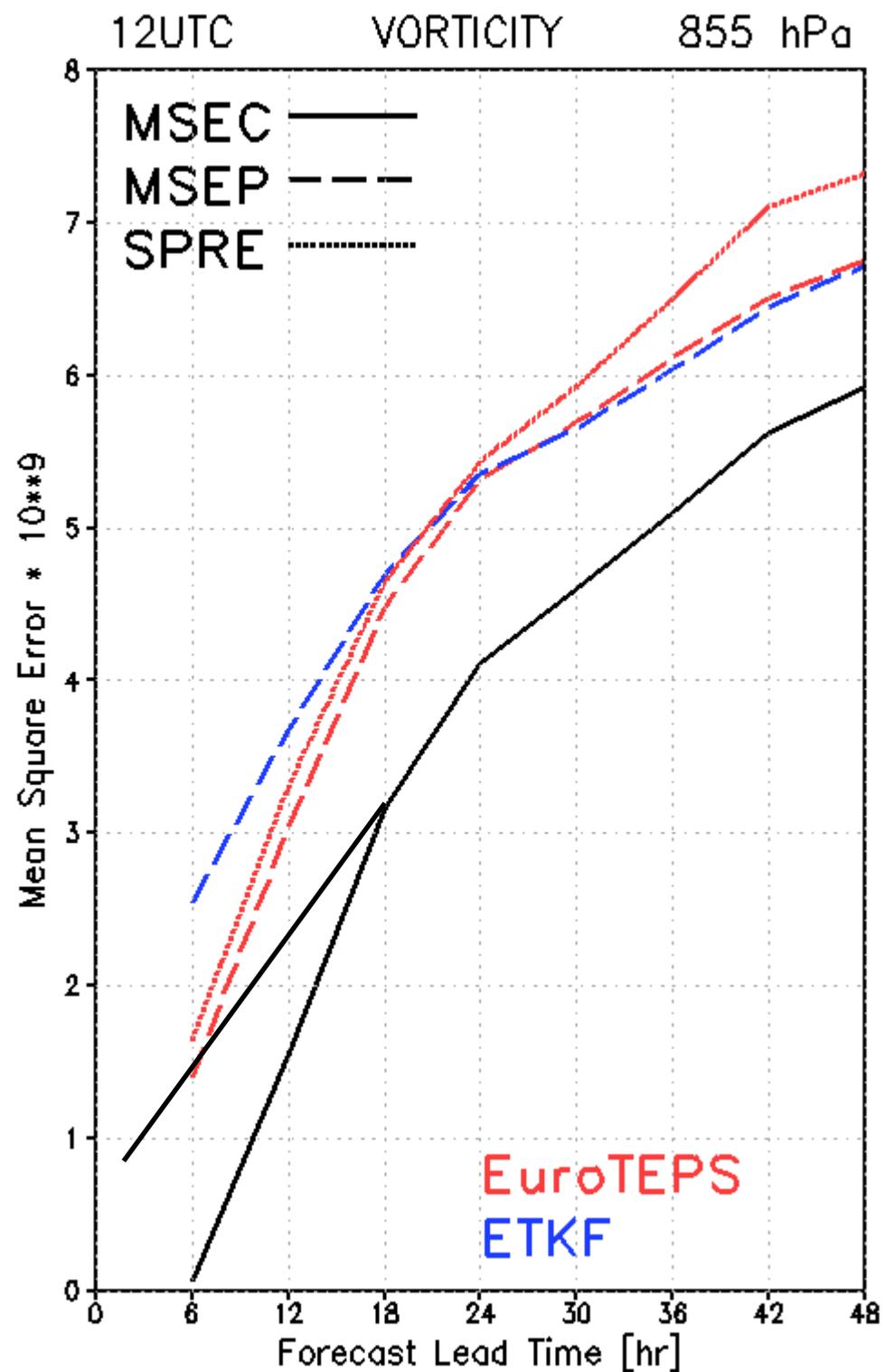


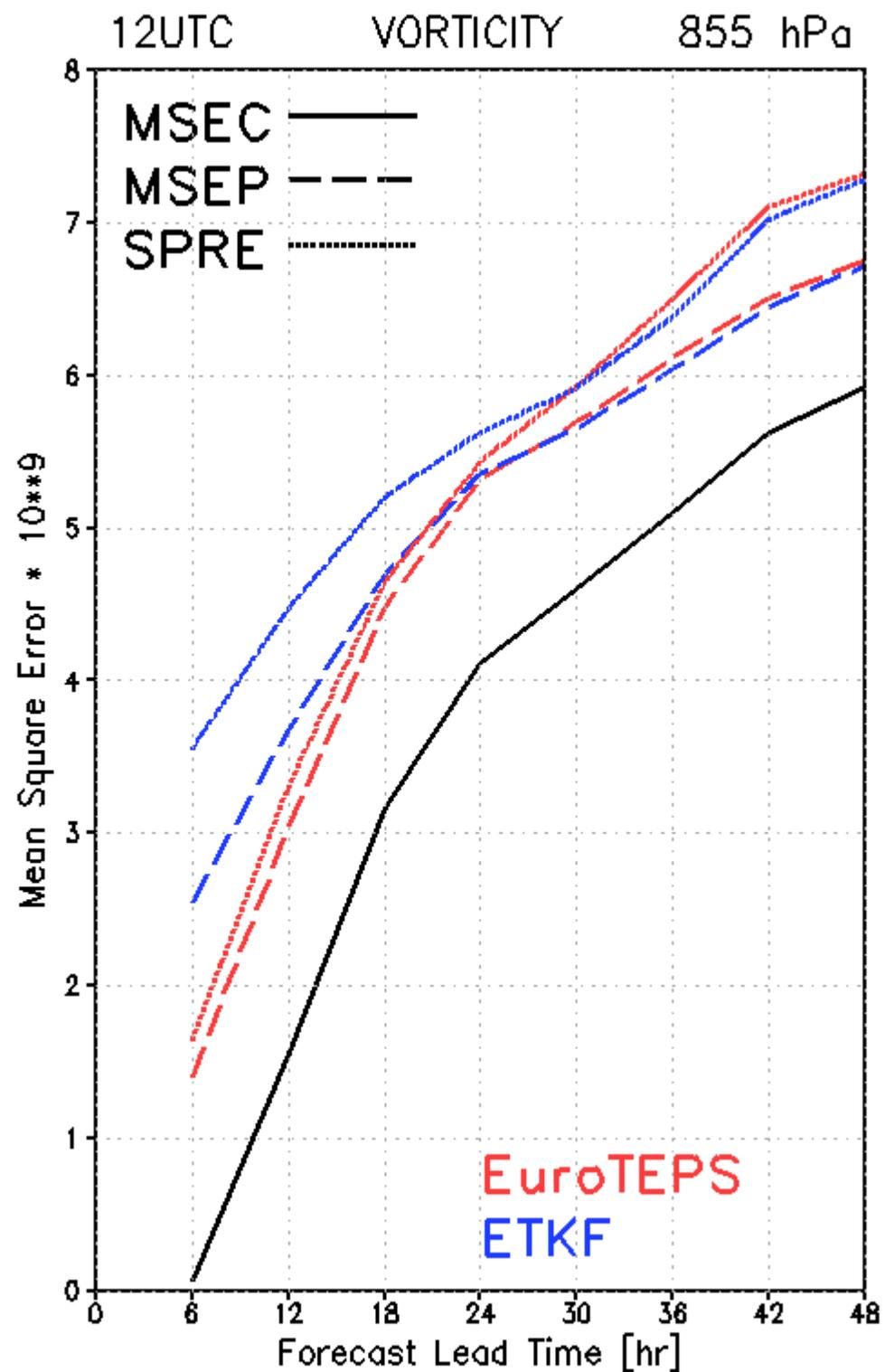












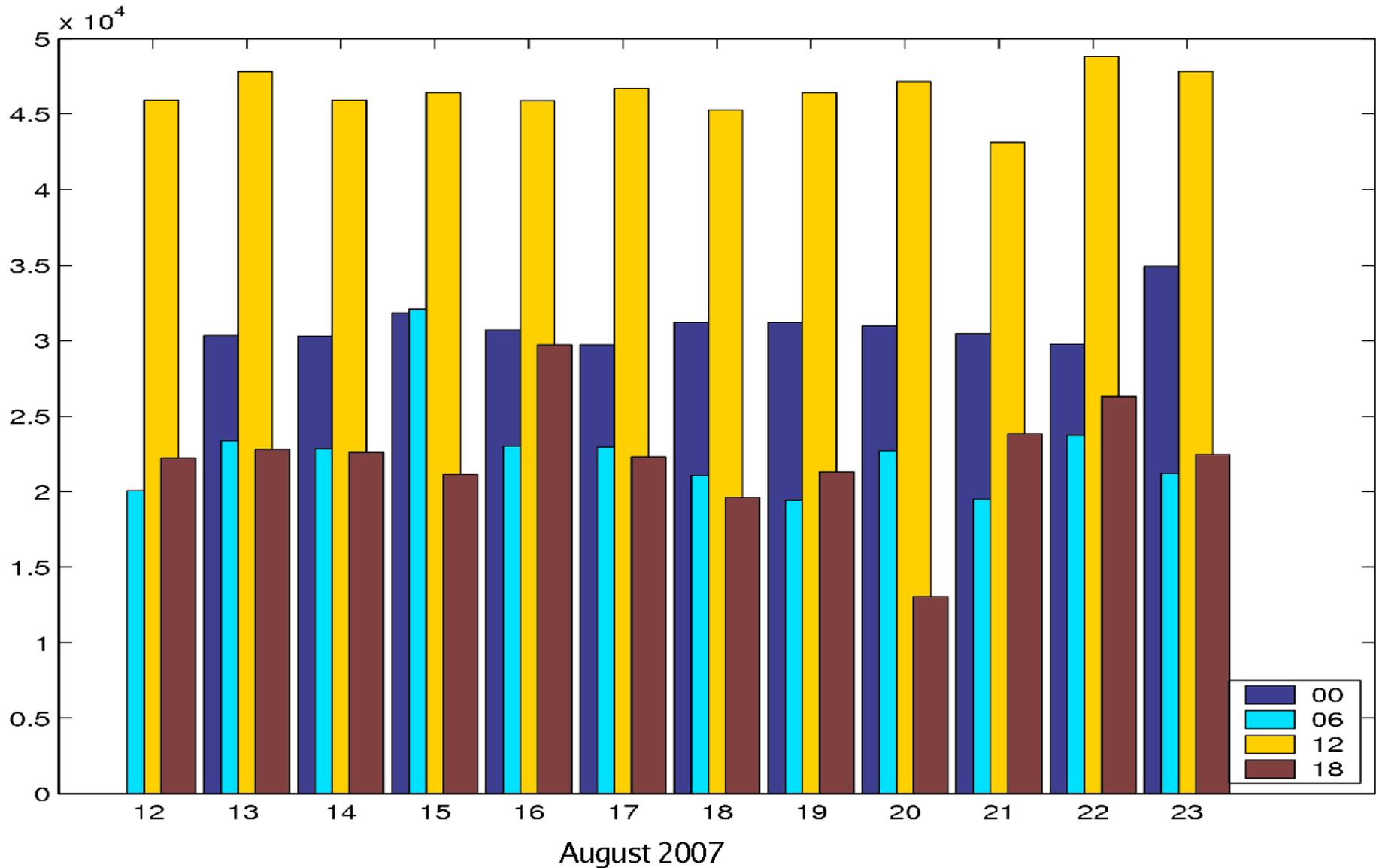
Vertical structure

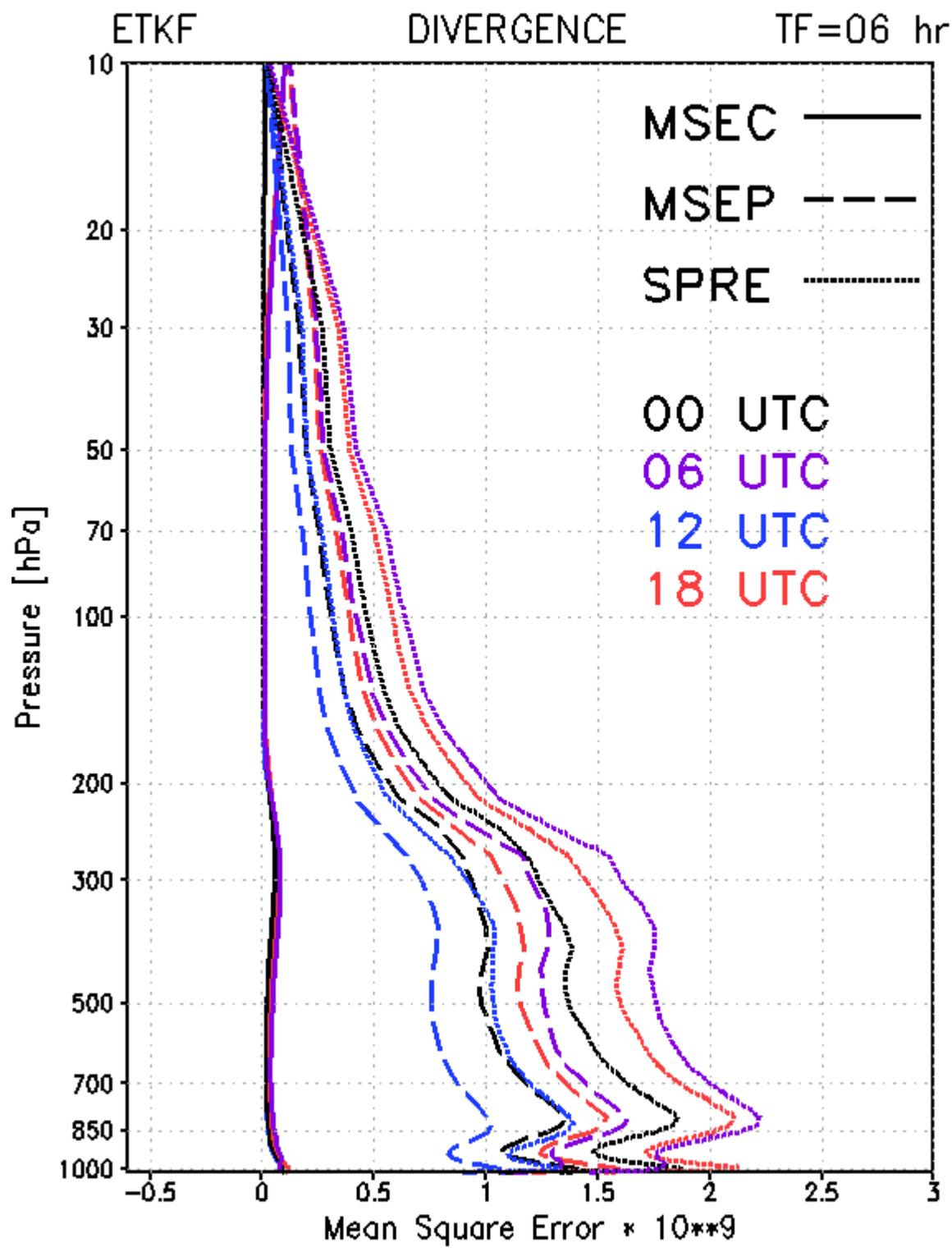
and

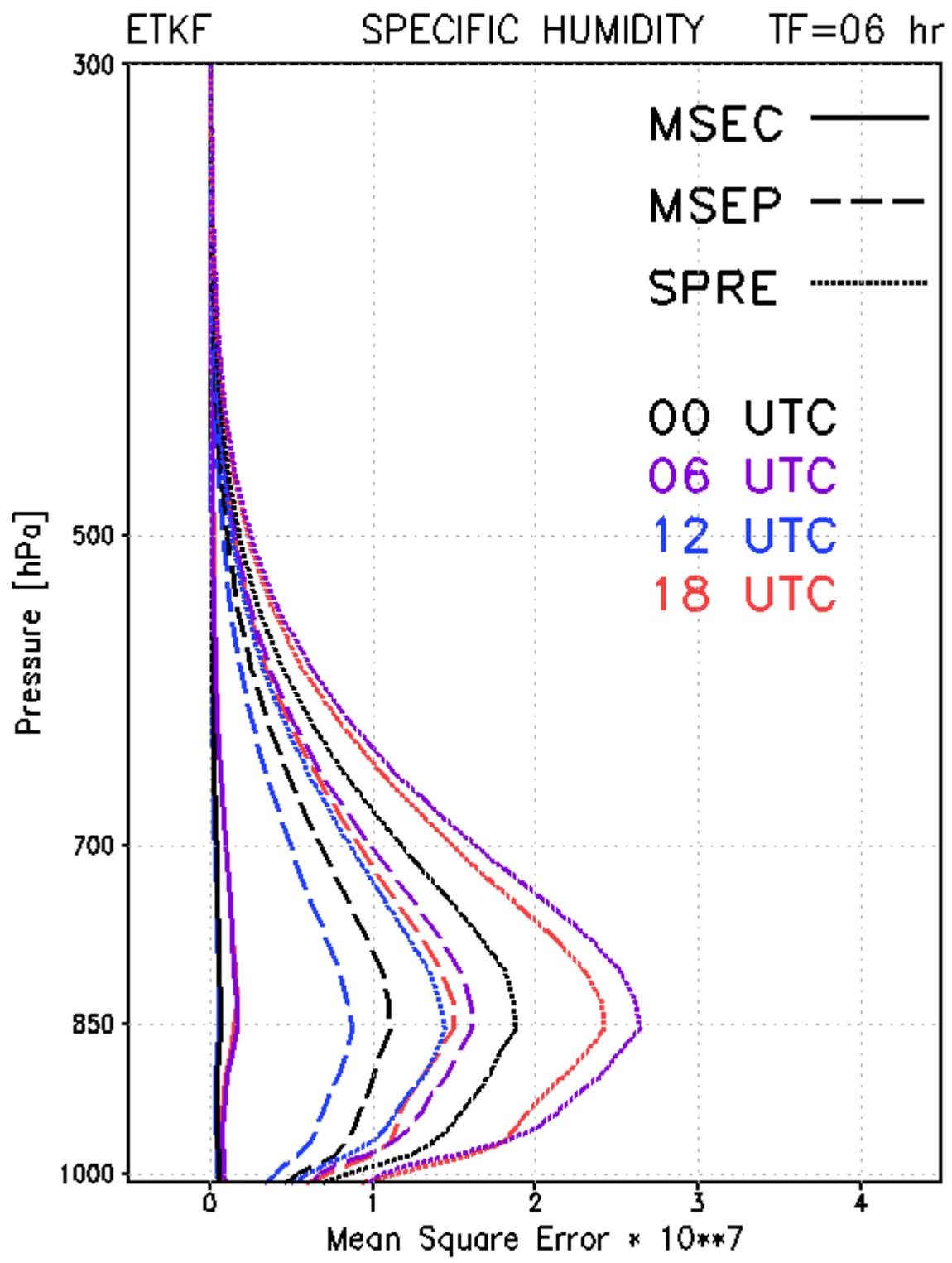
Amount of Observations

Total amount of assimilated observations

Large variations with cycle



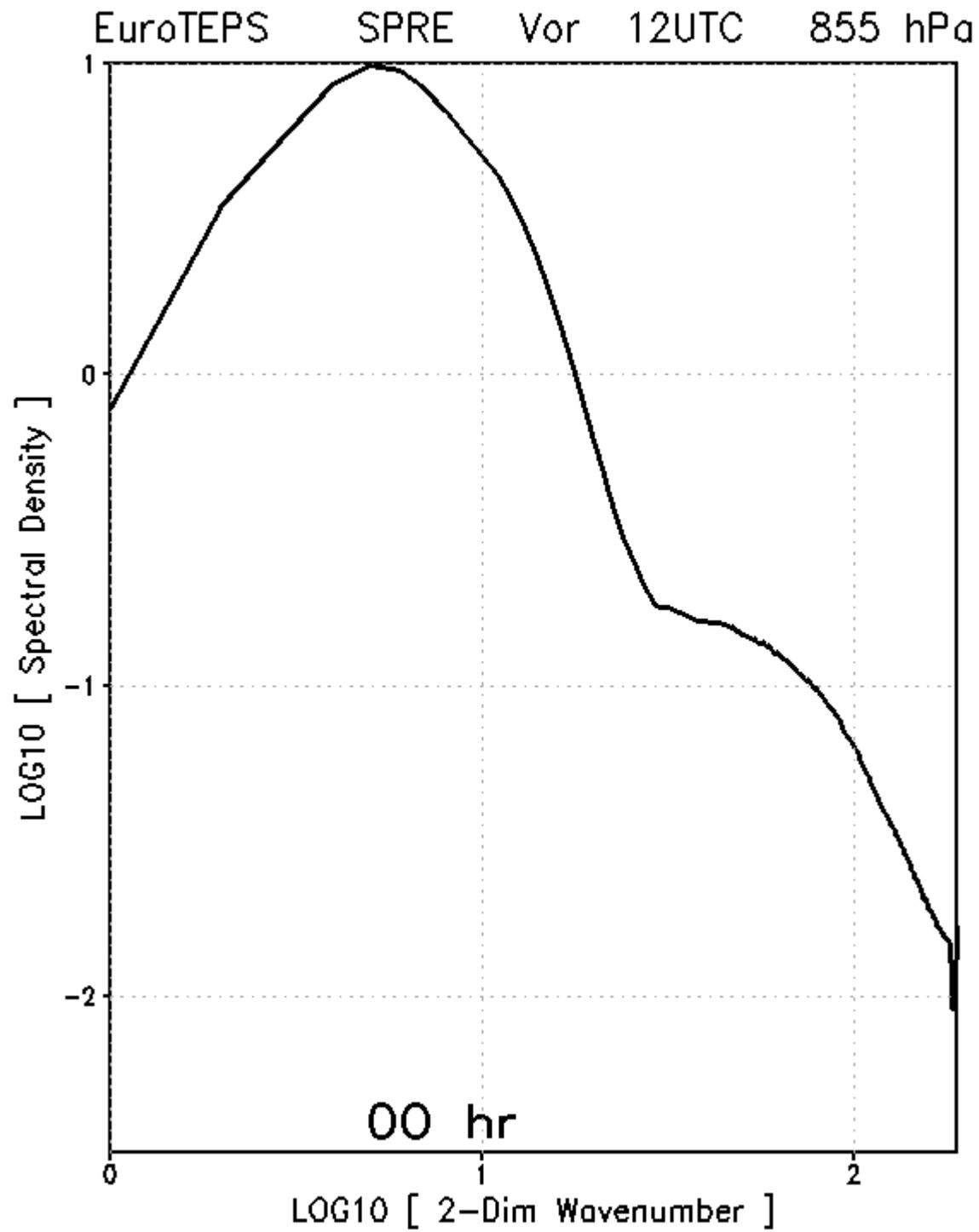


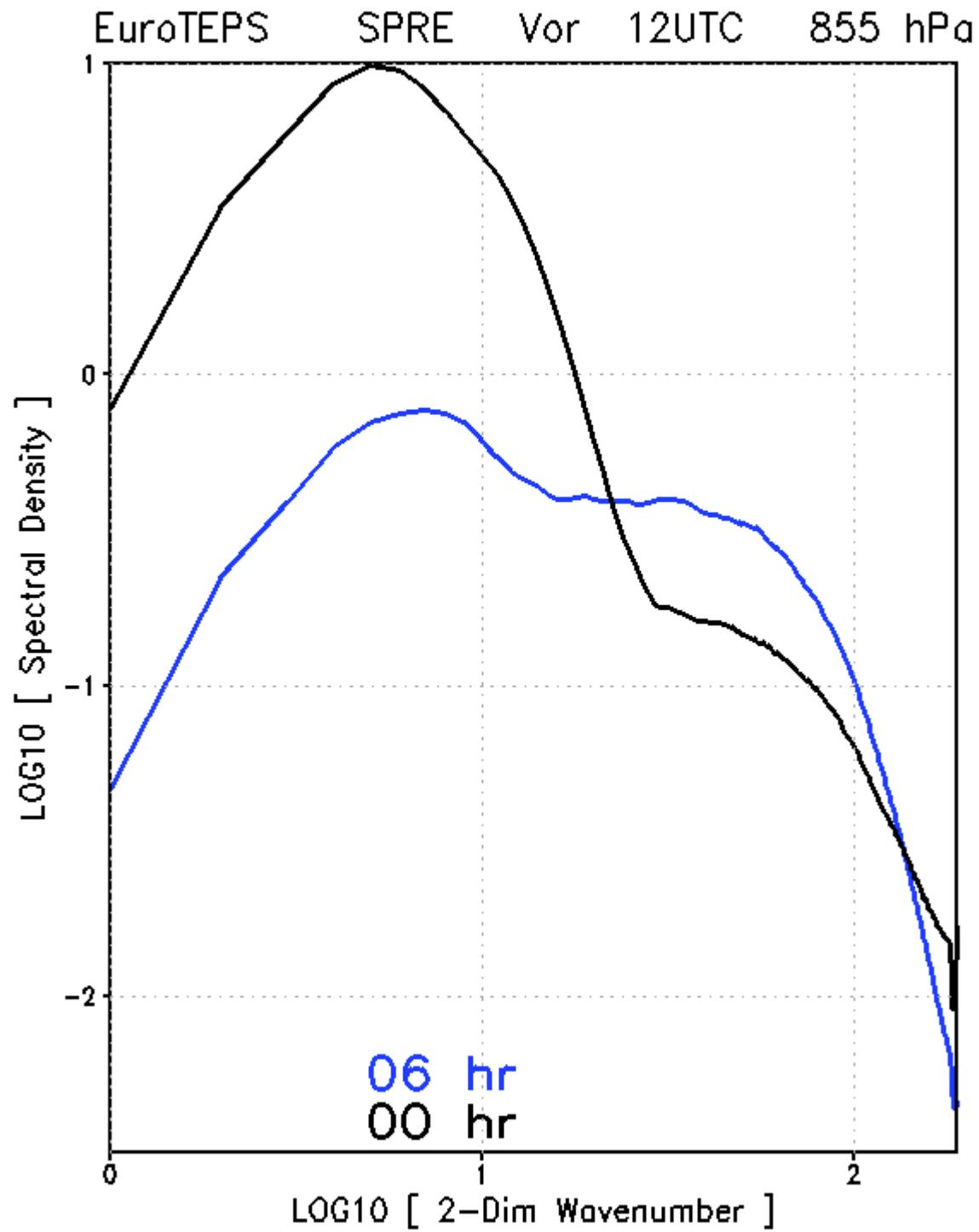


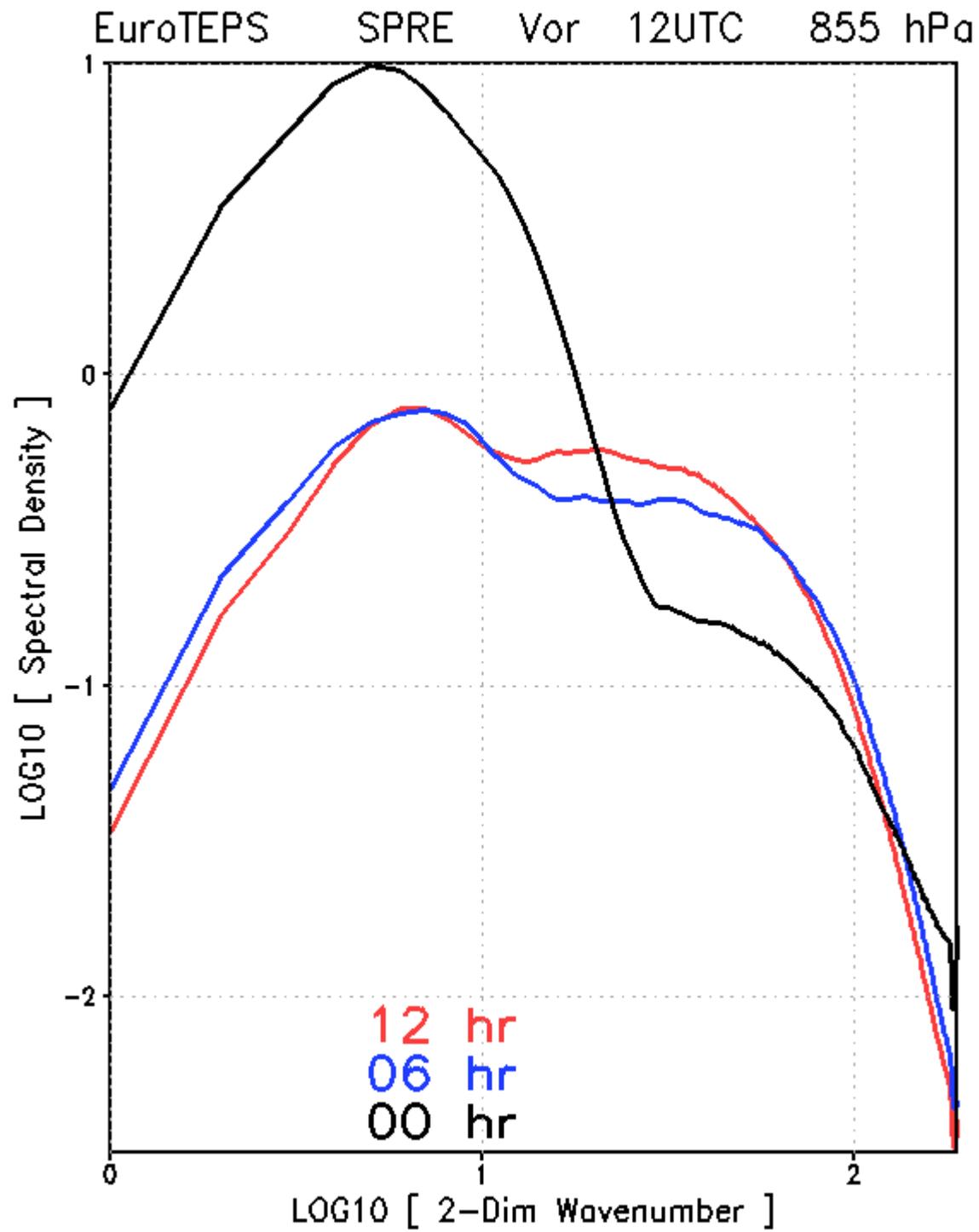
Spectra

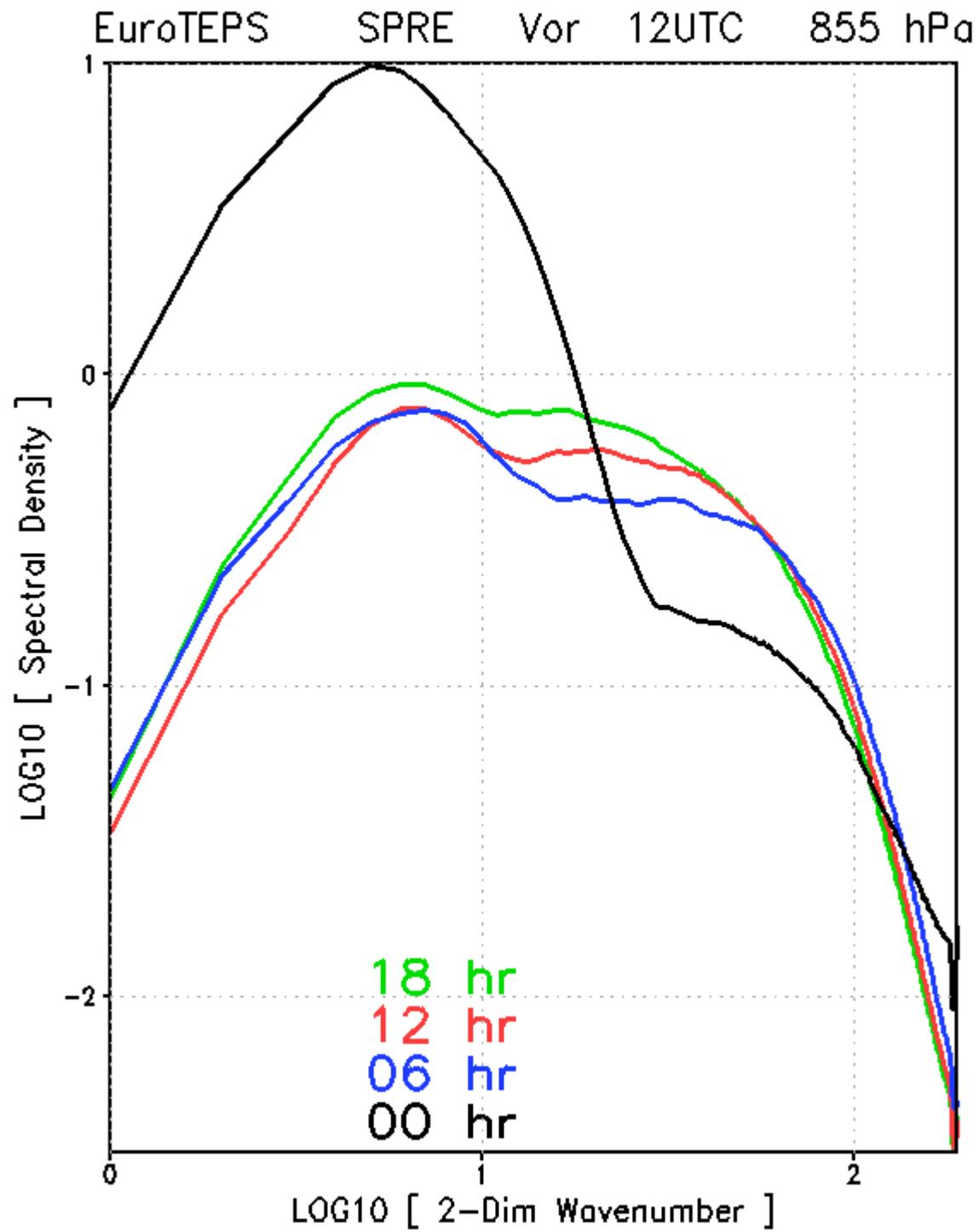
Spectra

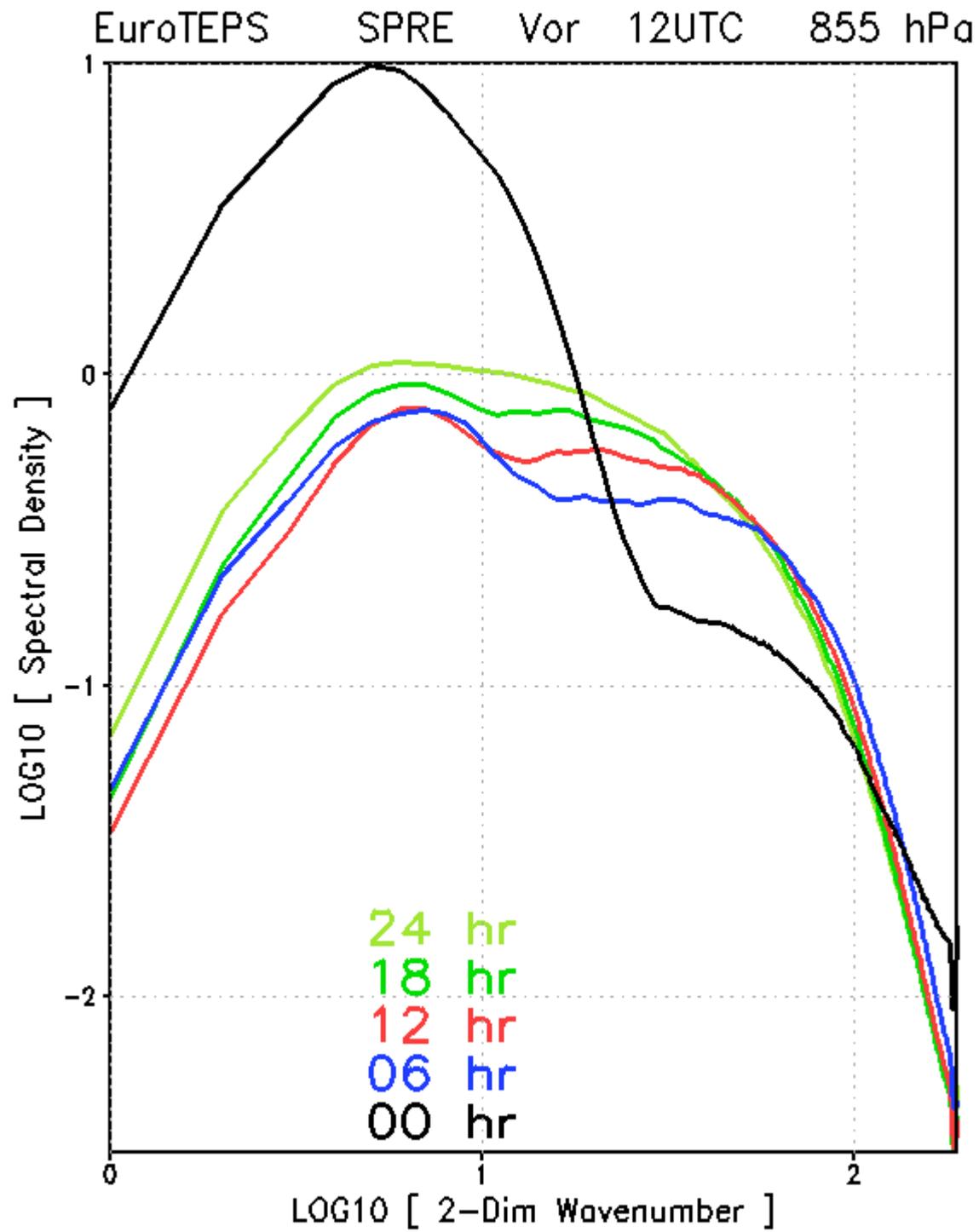
EuroTEPS

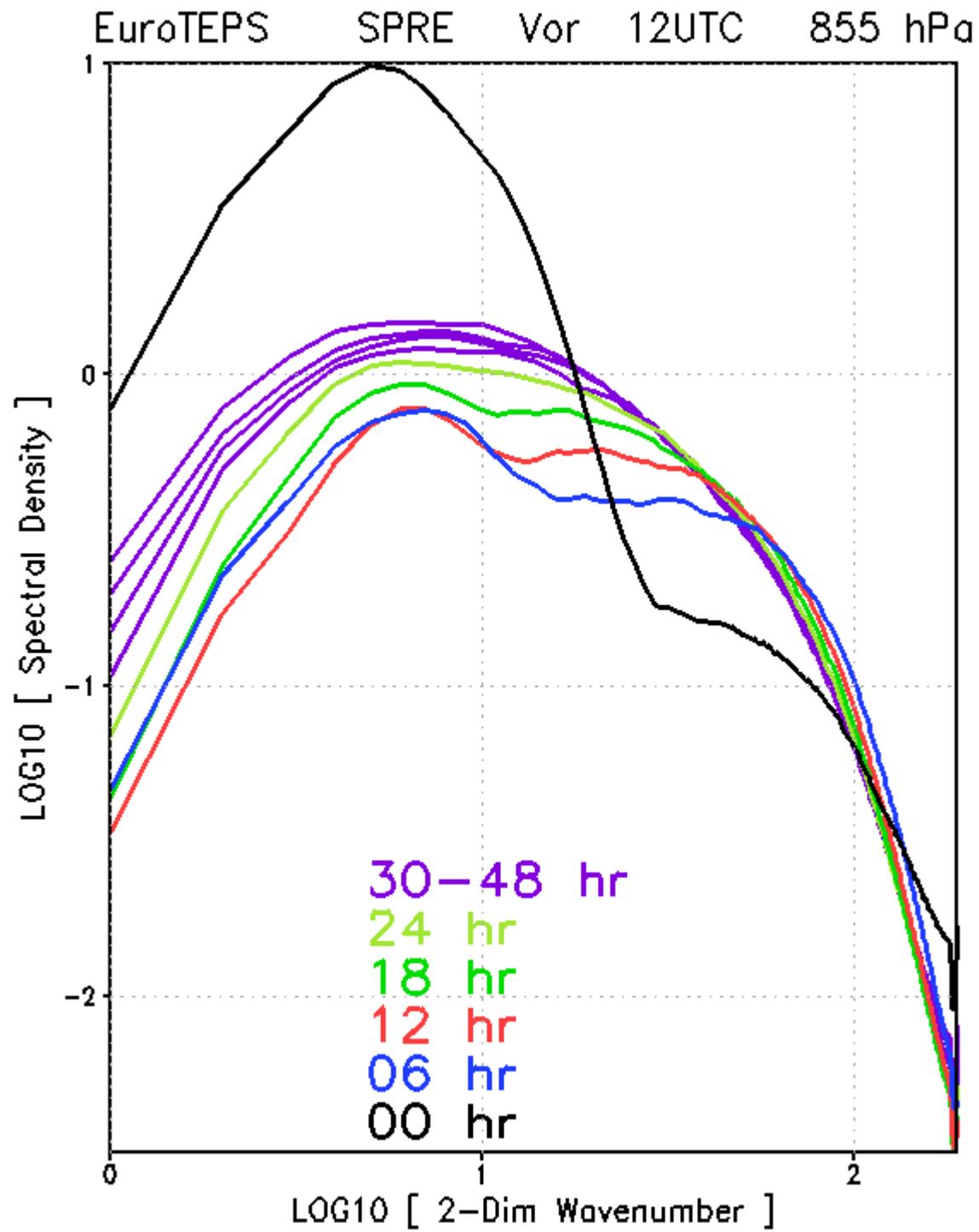


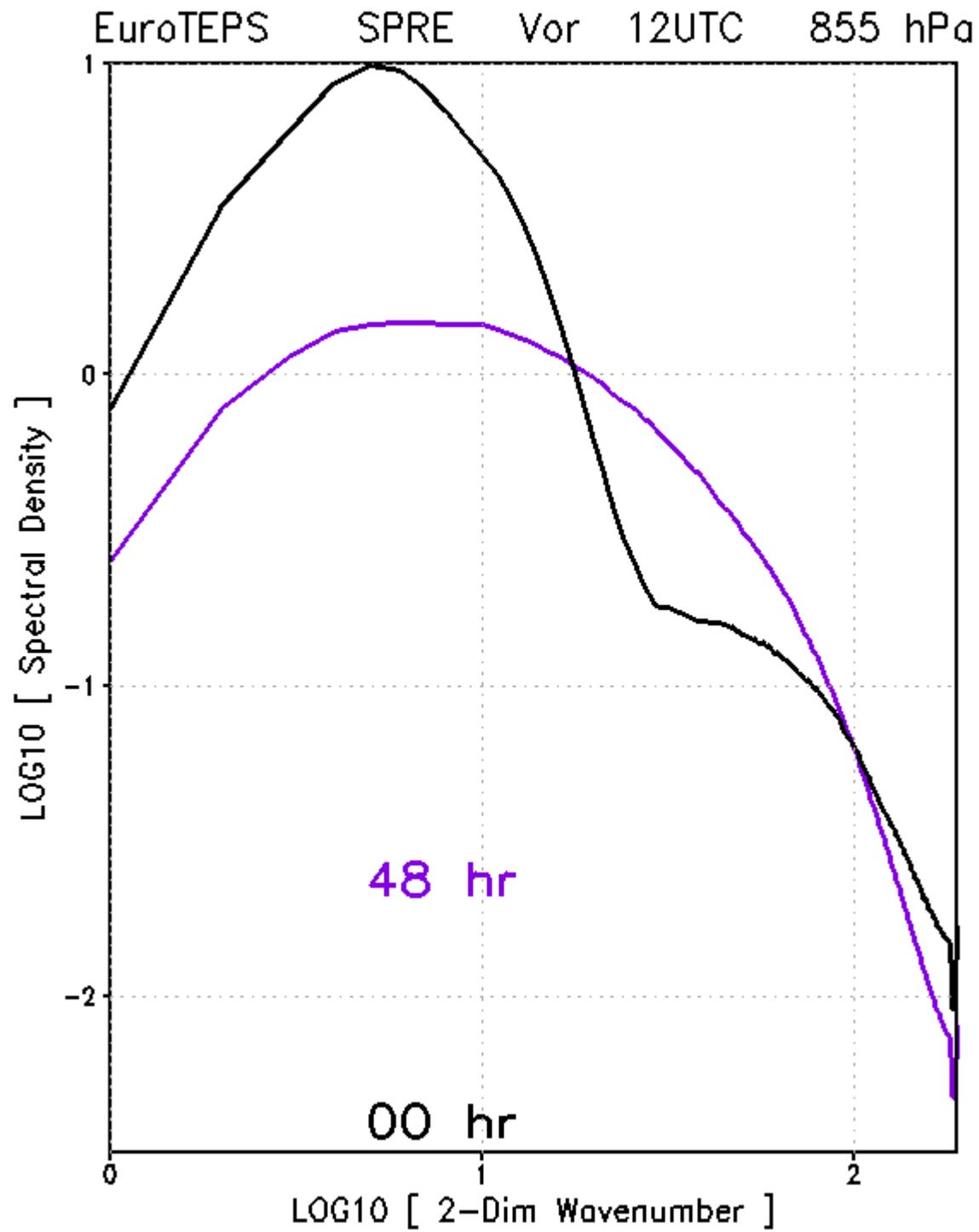




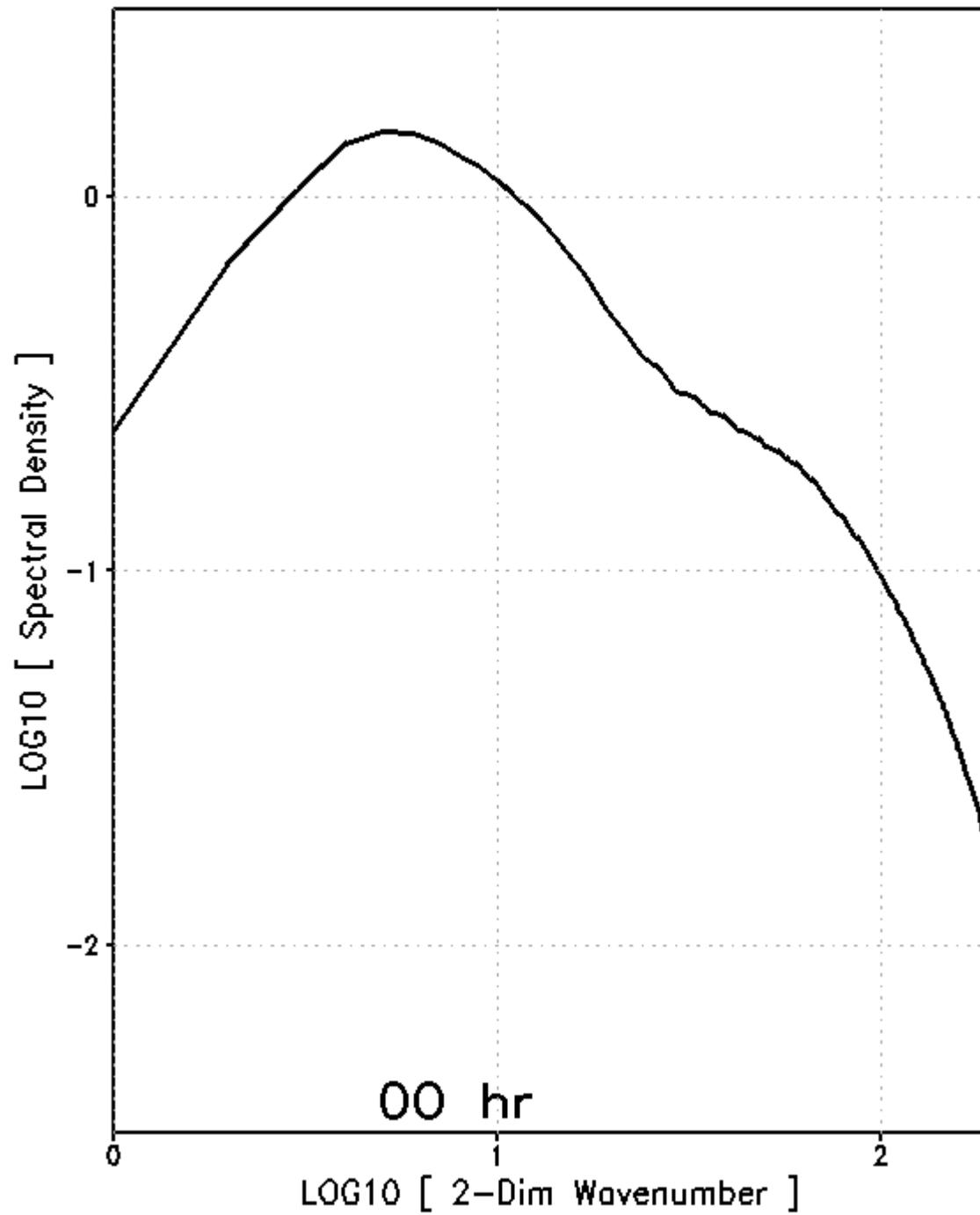




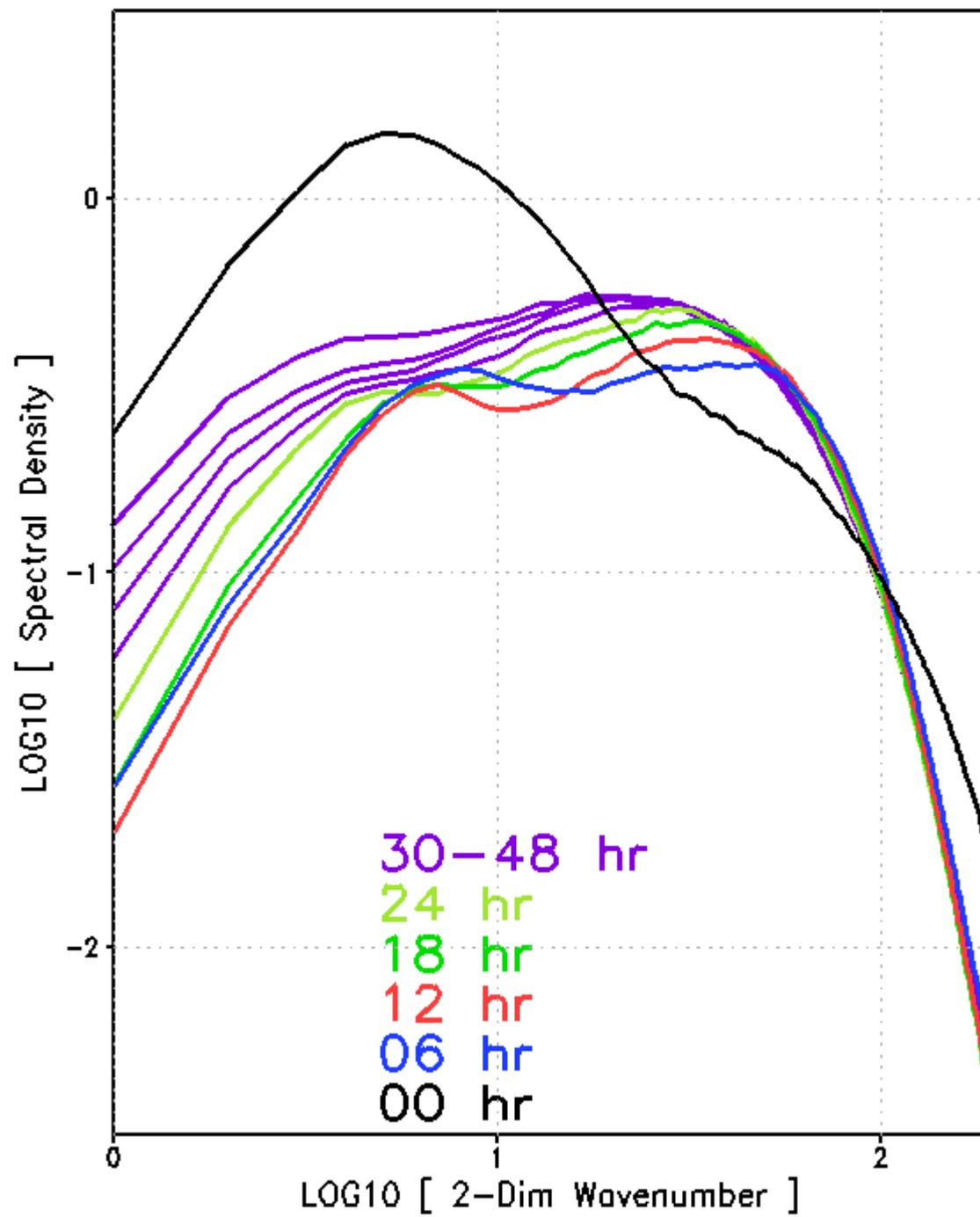




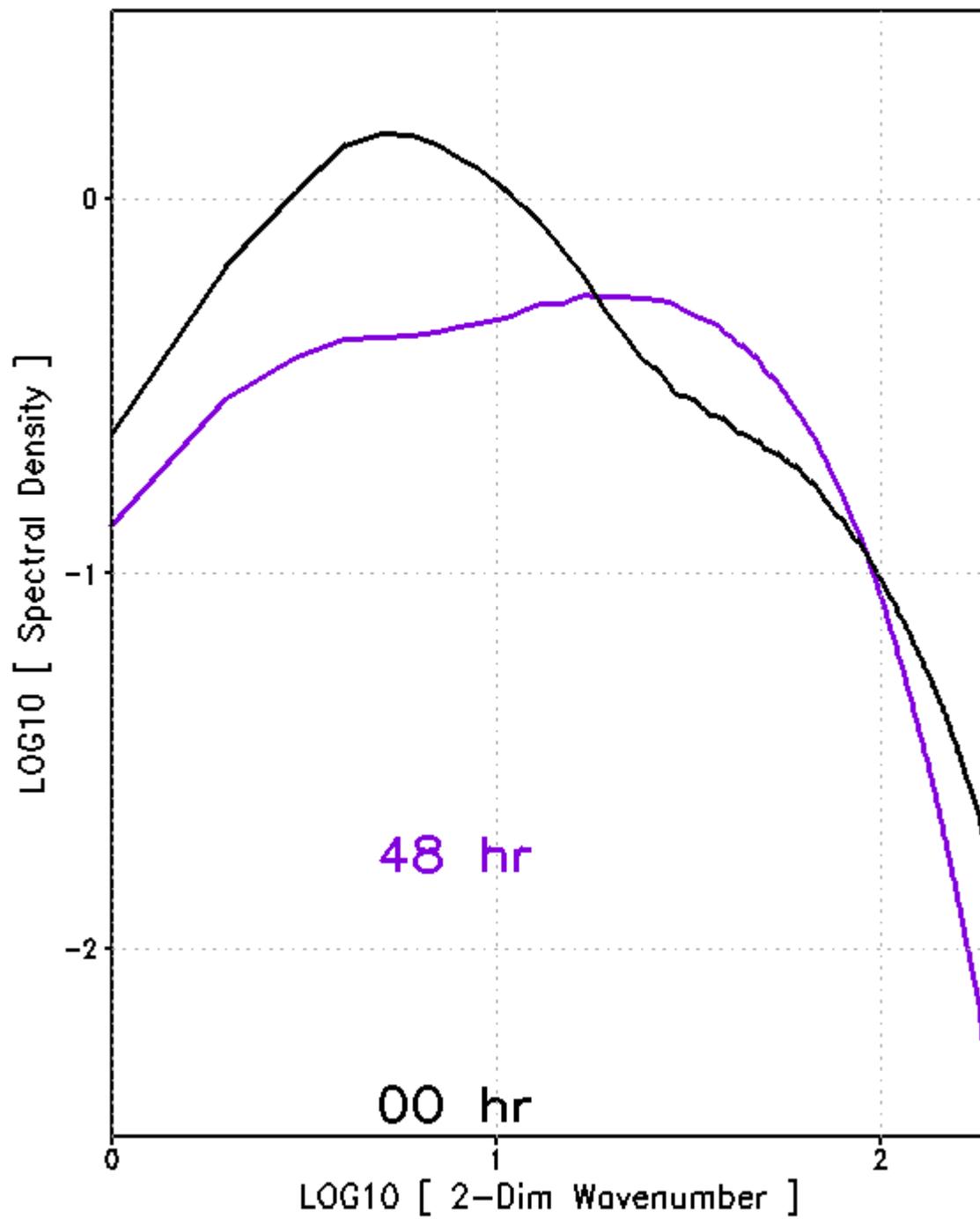
EuroTEPS SPRE Div 12UTC 855 hPa



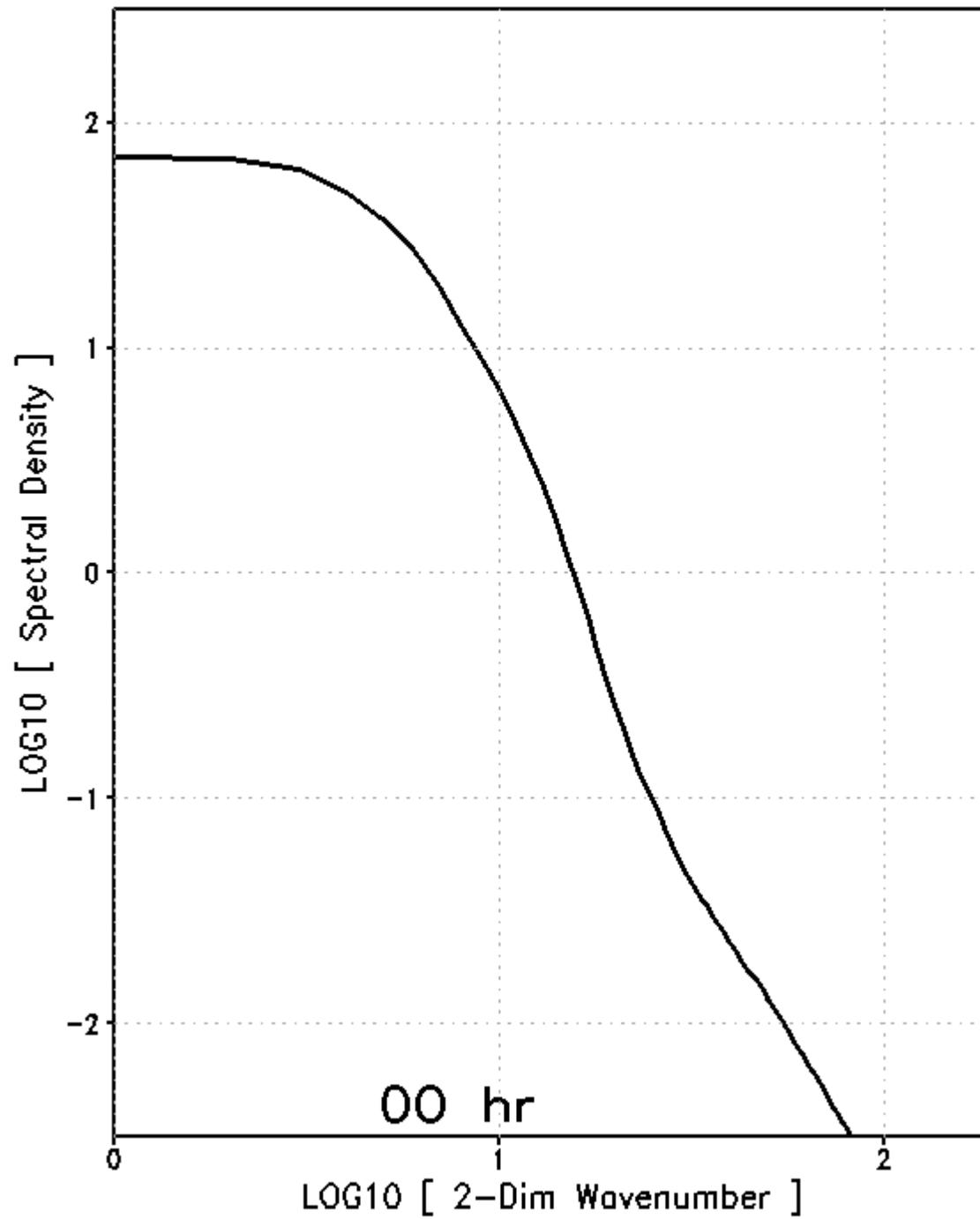
EuroTEPS SPRE Div 12UTC 855 hPa



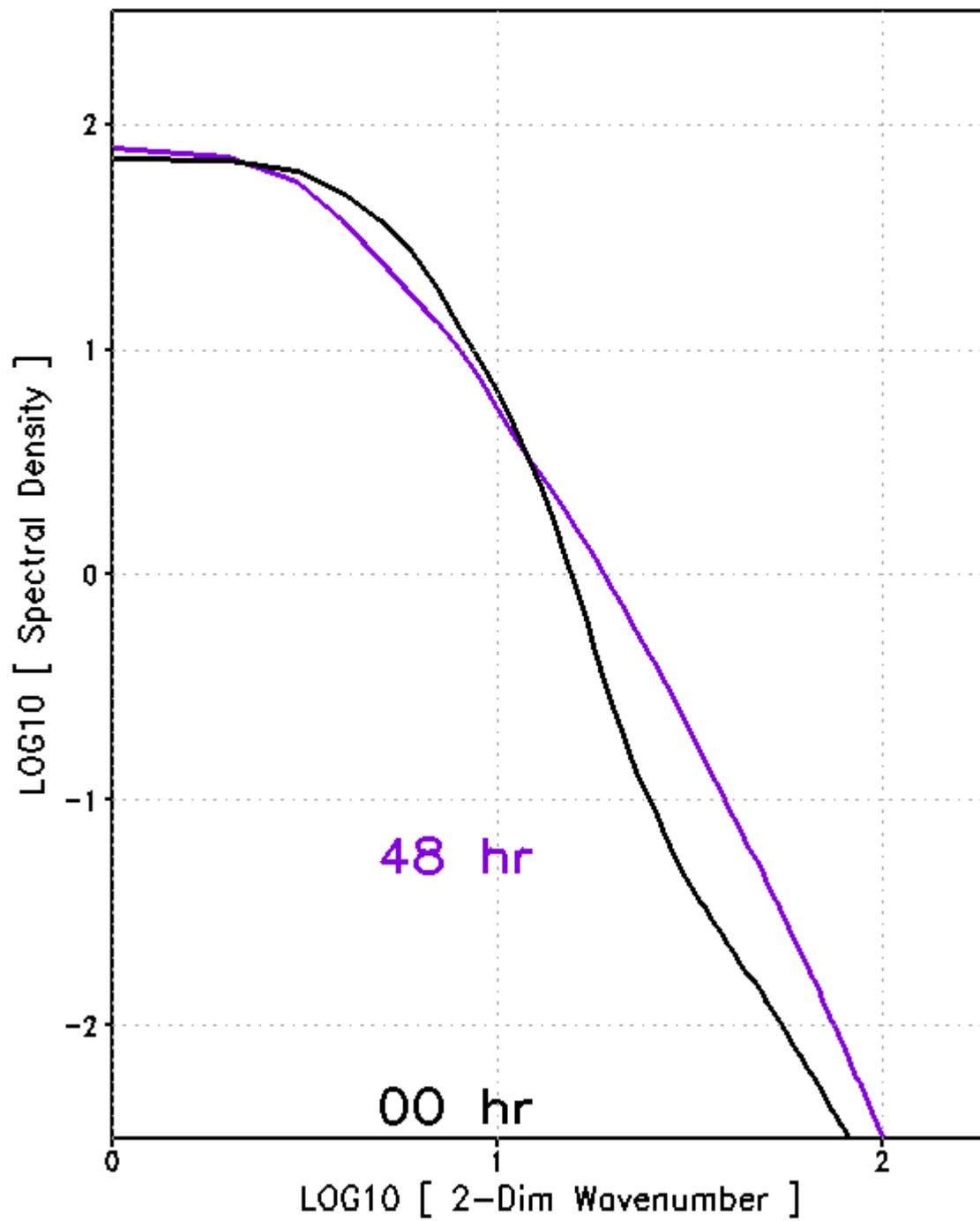
EuroTEPS SPRE Div 12UTC 855 hPa

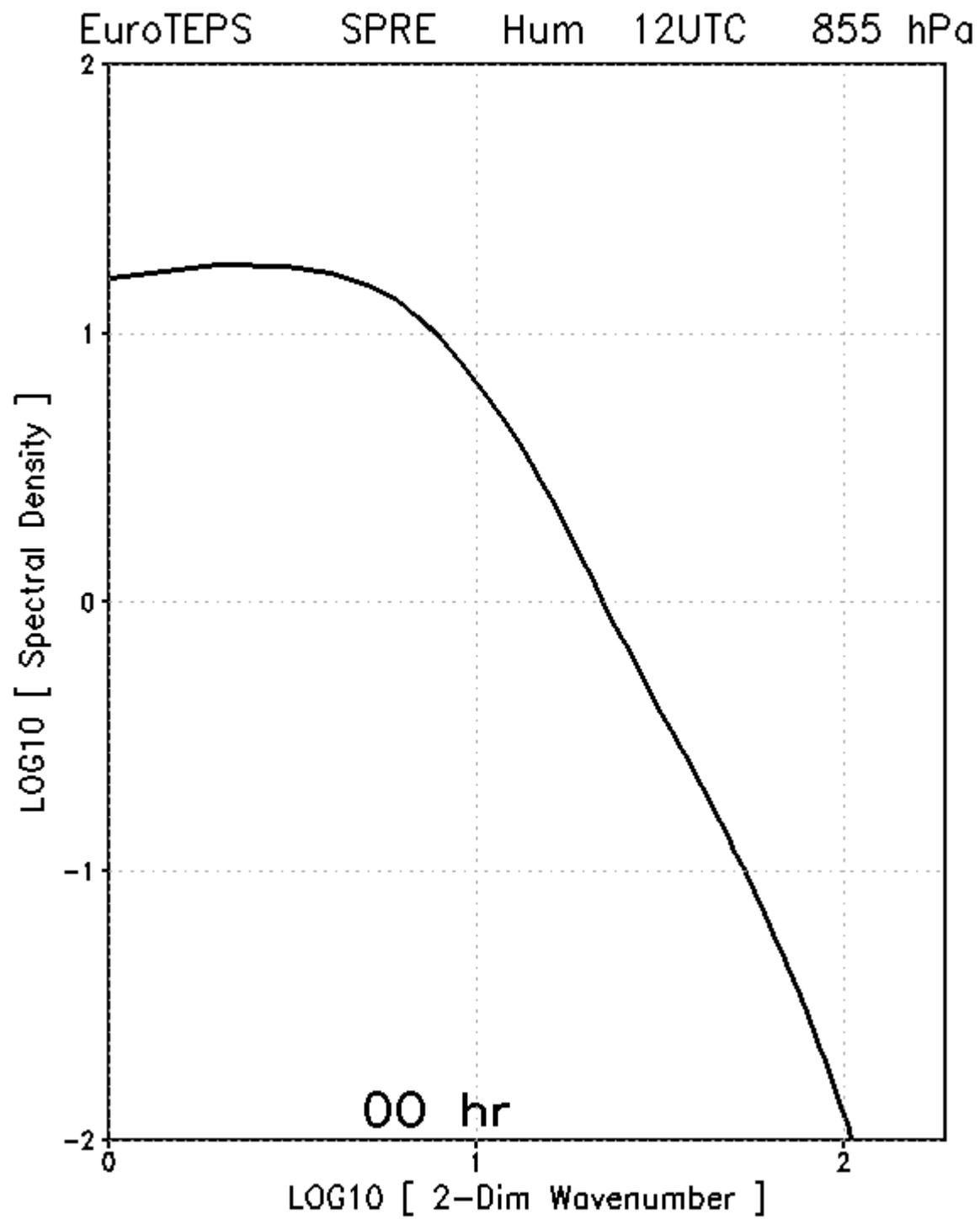


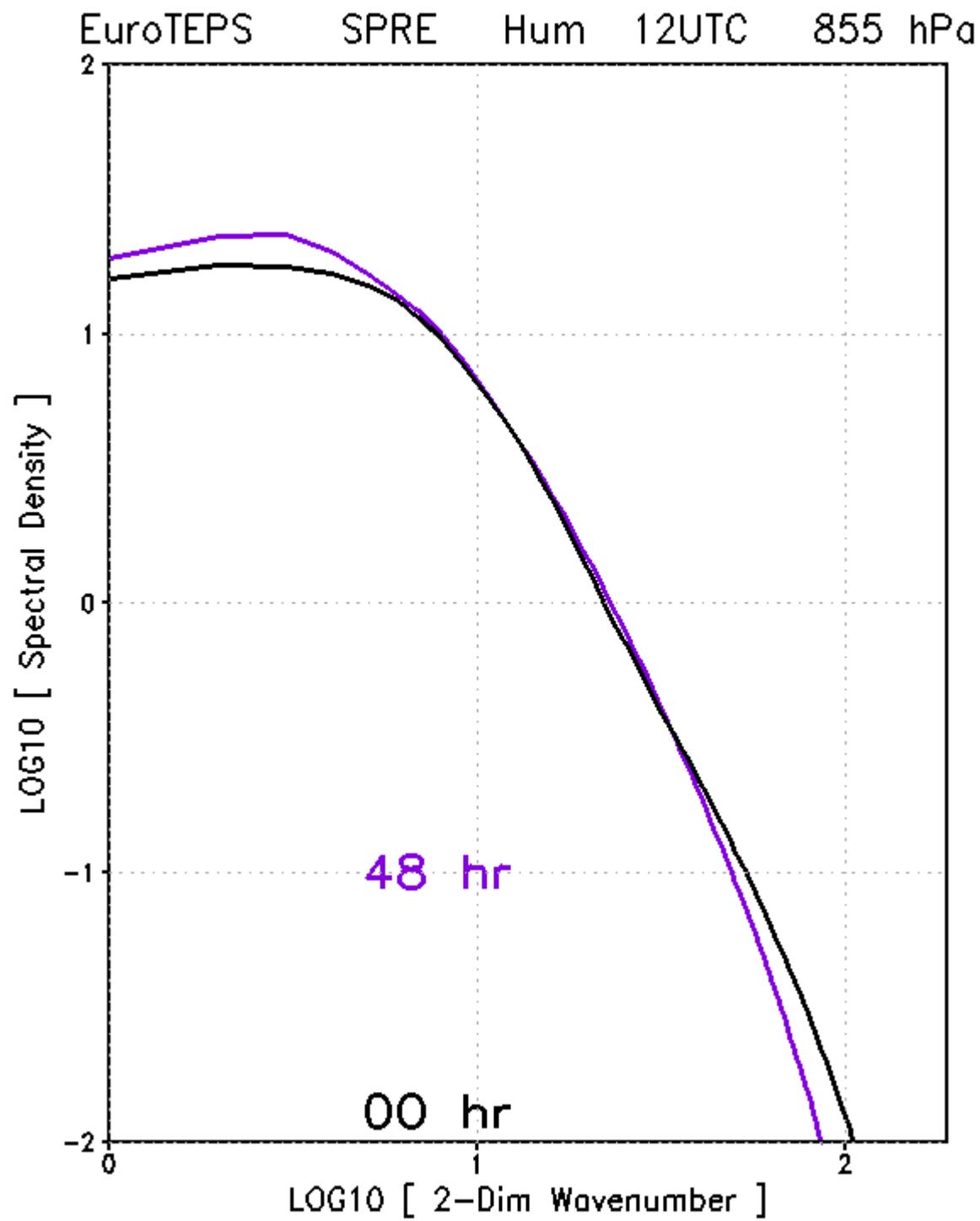
EuroTEPS SPRE Tem 12UTC 855 hPa



EuroTEPS SPRE Tem 12UTC 855 hPa

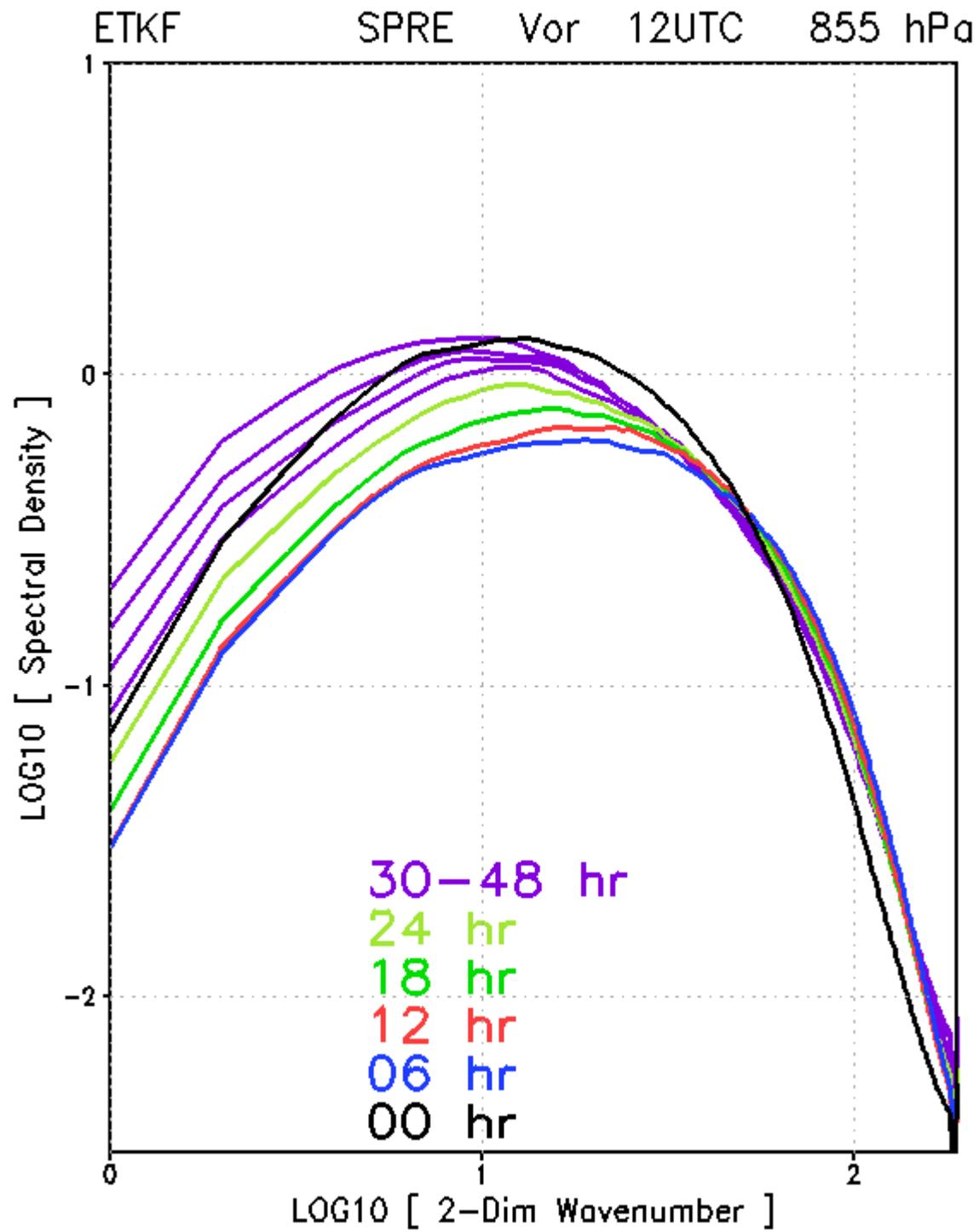


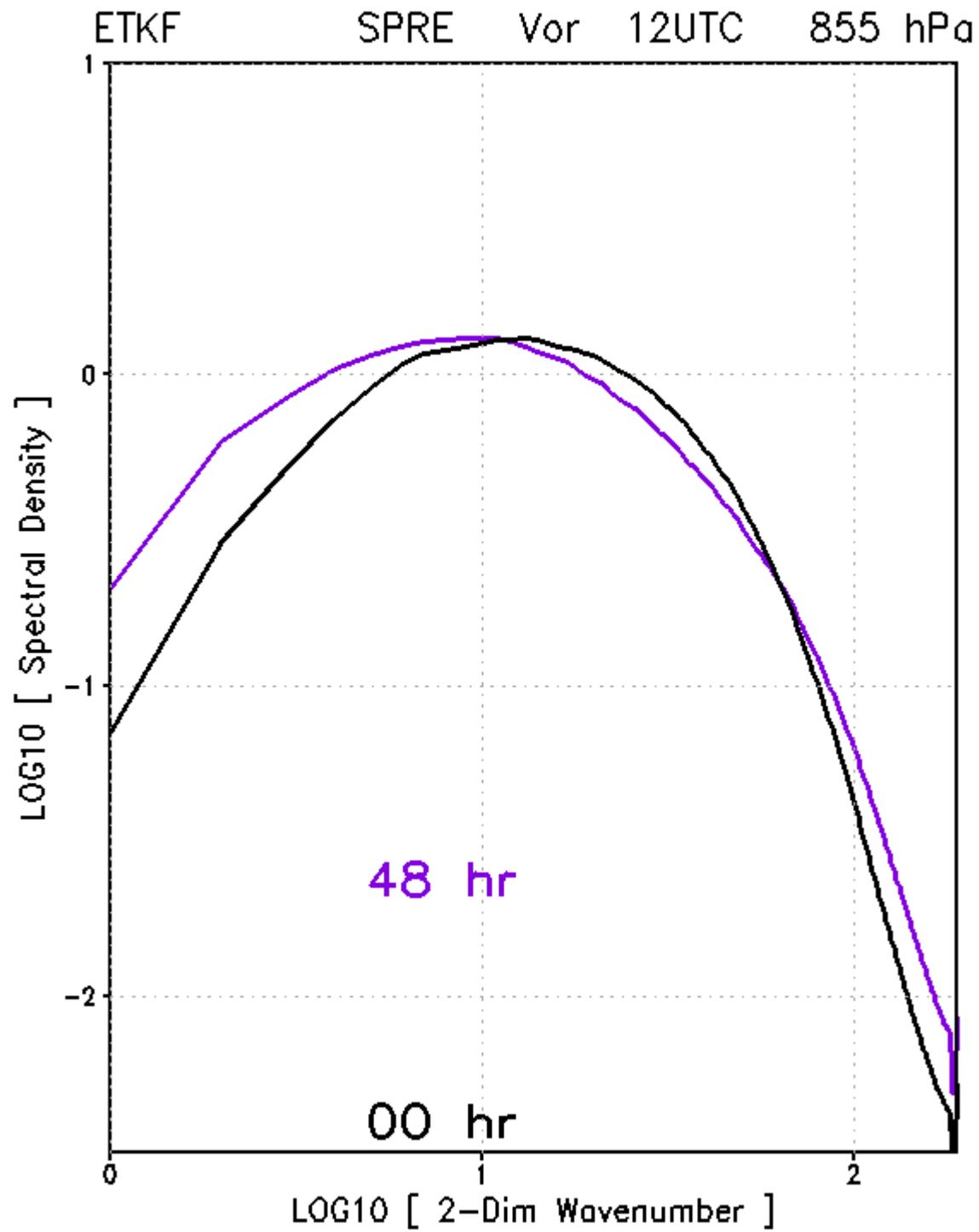


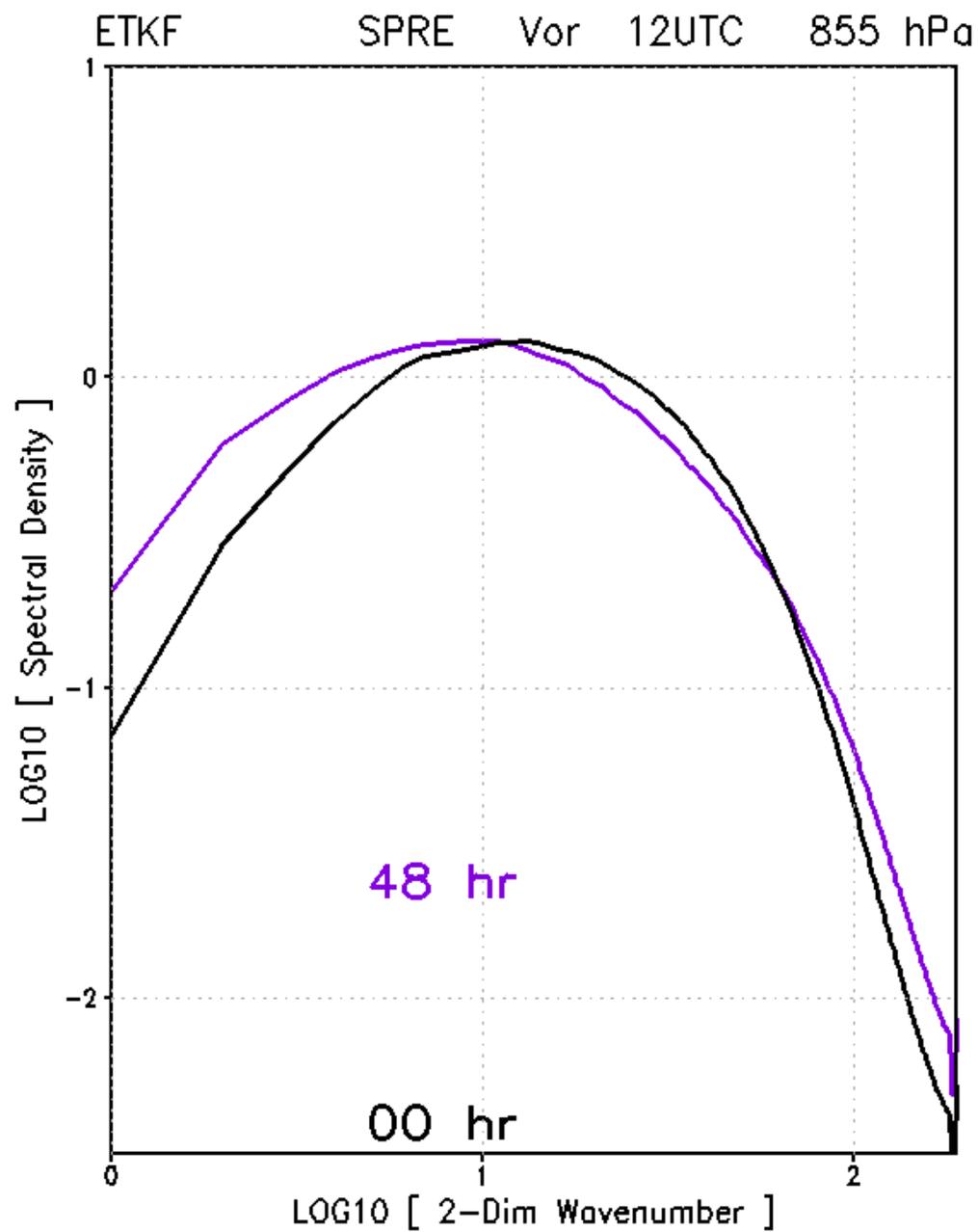
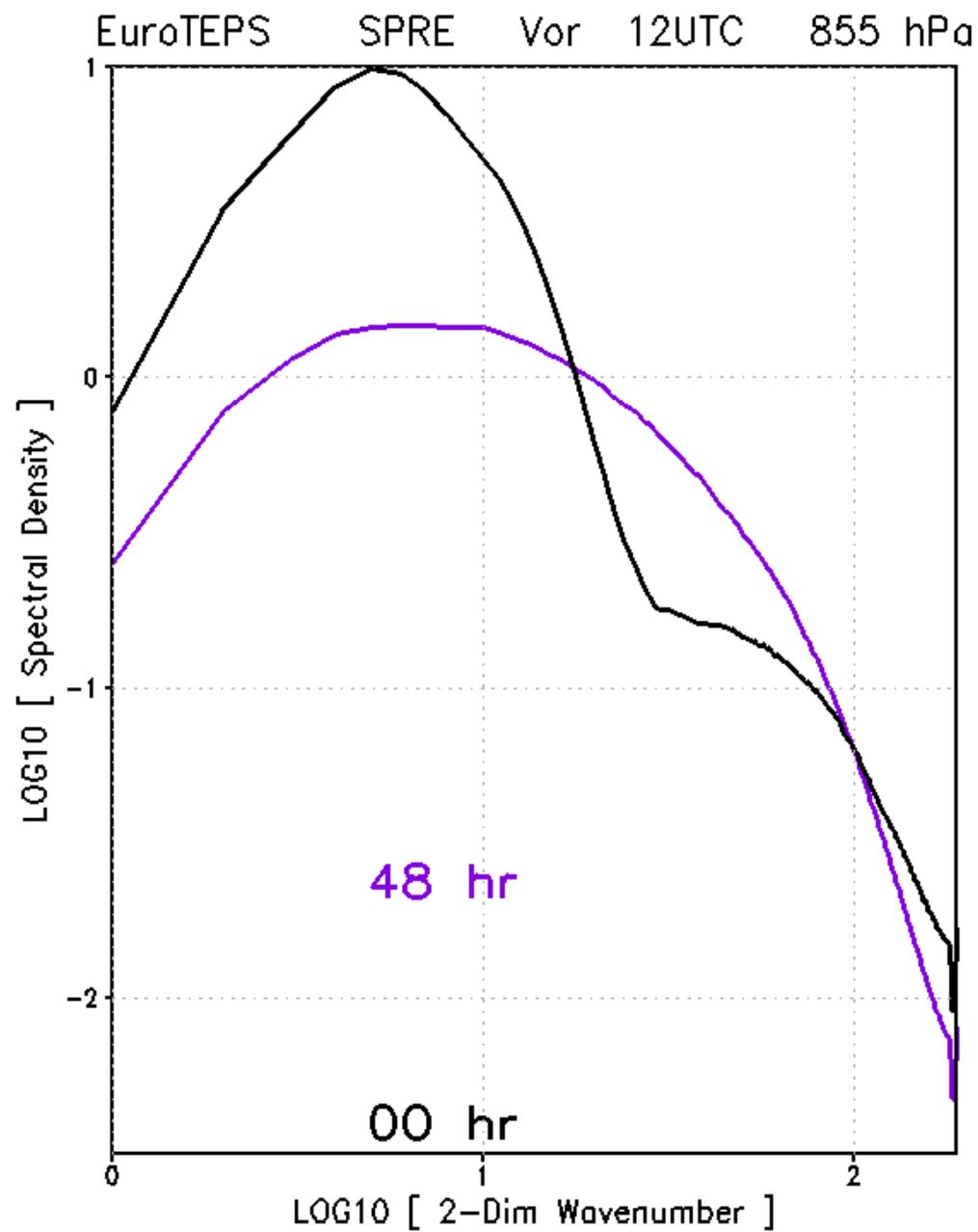


Spectra

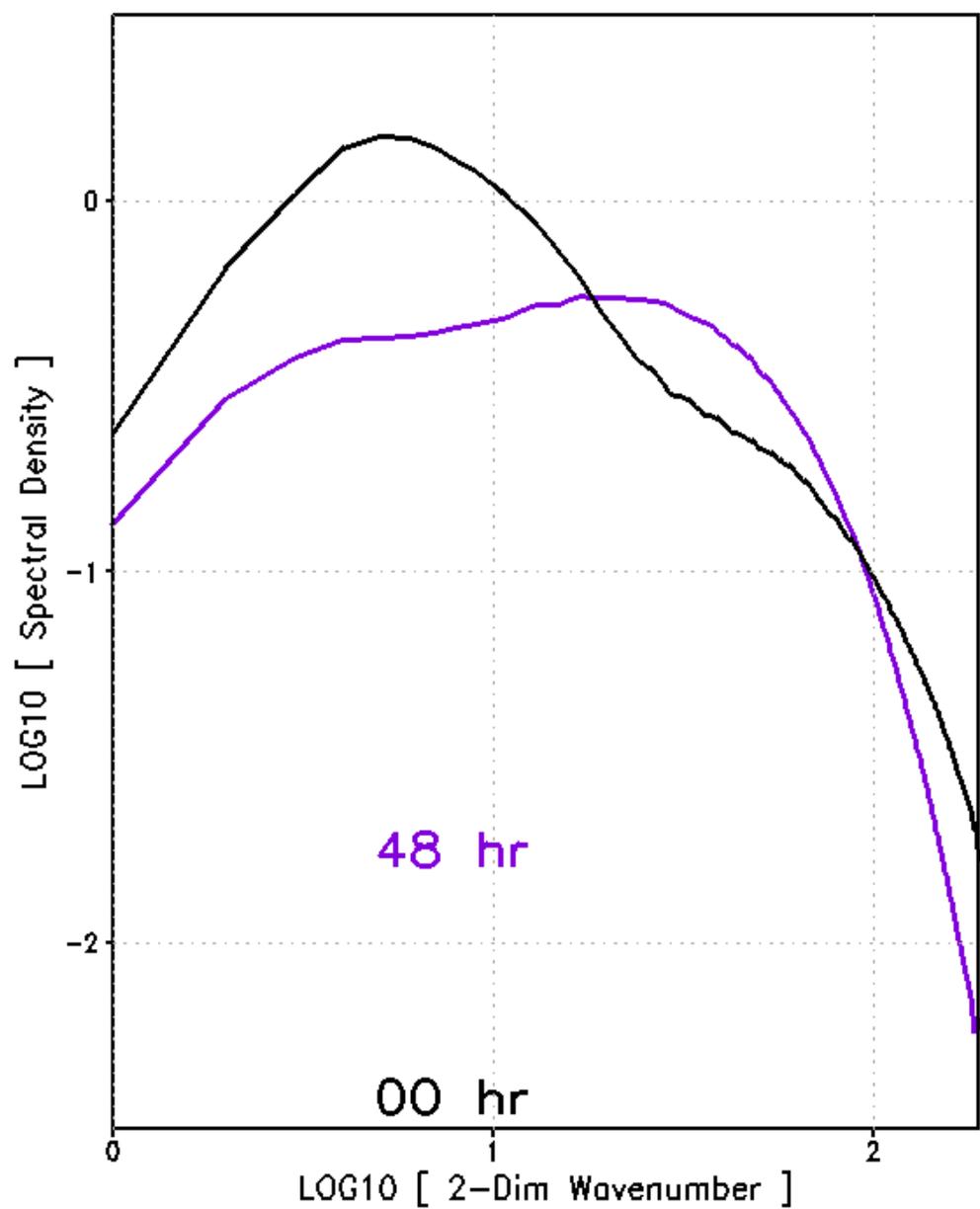
ETKF



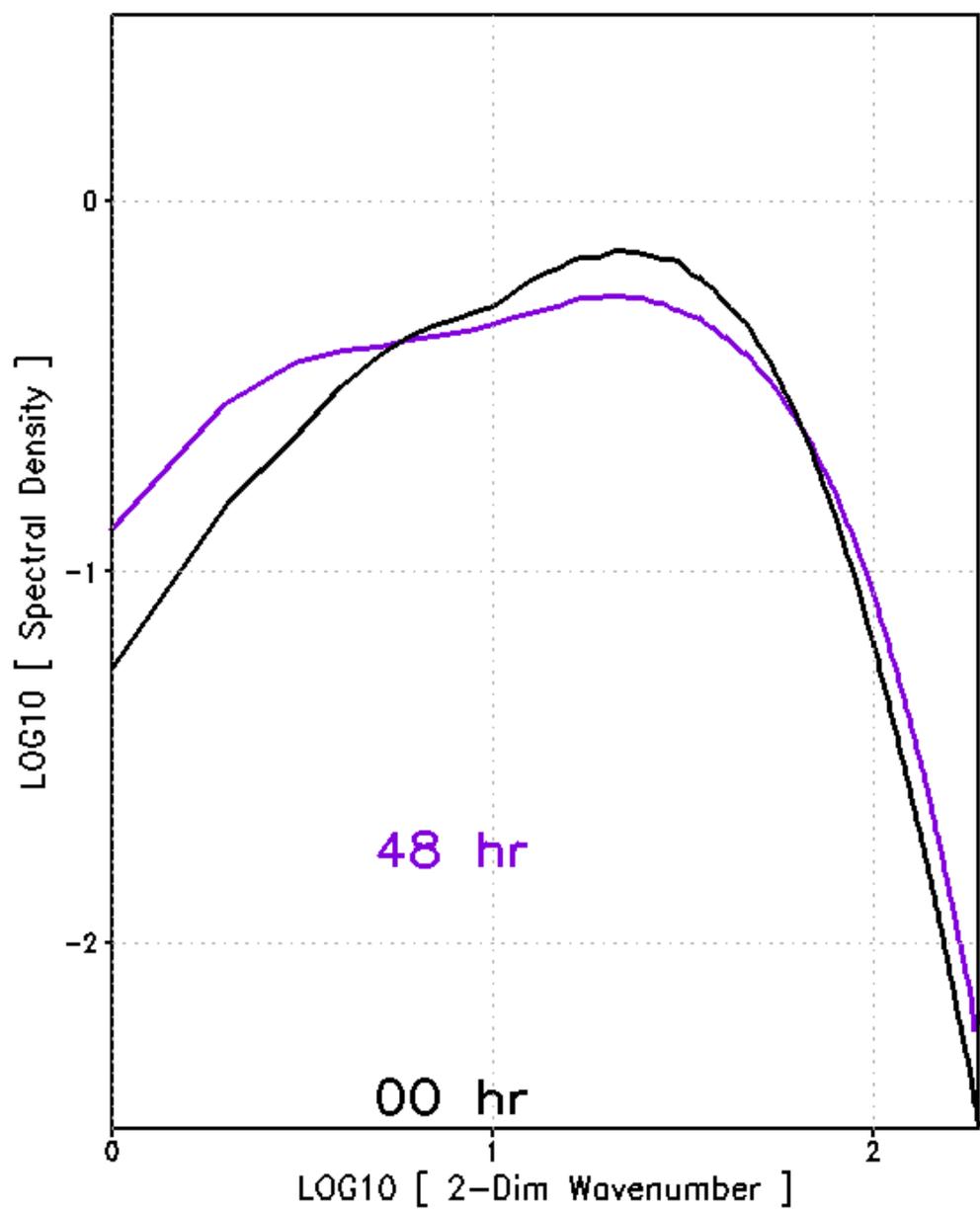




EuroTEPS SPRE Div 12UTC 855 hPa



ETKF SPRE Div 12UTC 855 hPa



EXPERIMENT COMPARISON - 2

ETKF

vs

ETKF Hybrid

MODEL

HIRLAM Trunk NOV 2010

Boundary Conditions

EuroTEPS

ETKF

20% EuroTEPS

80% ETKF

ETKF Hybrid

20 % EuroTEPS

80% ETKF

DATA and DA

Conventional Data + ATOVS

3D-VAR ± HYBRID

CAVEAT

Localization scale of implicit Schur product

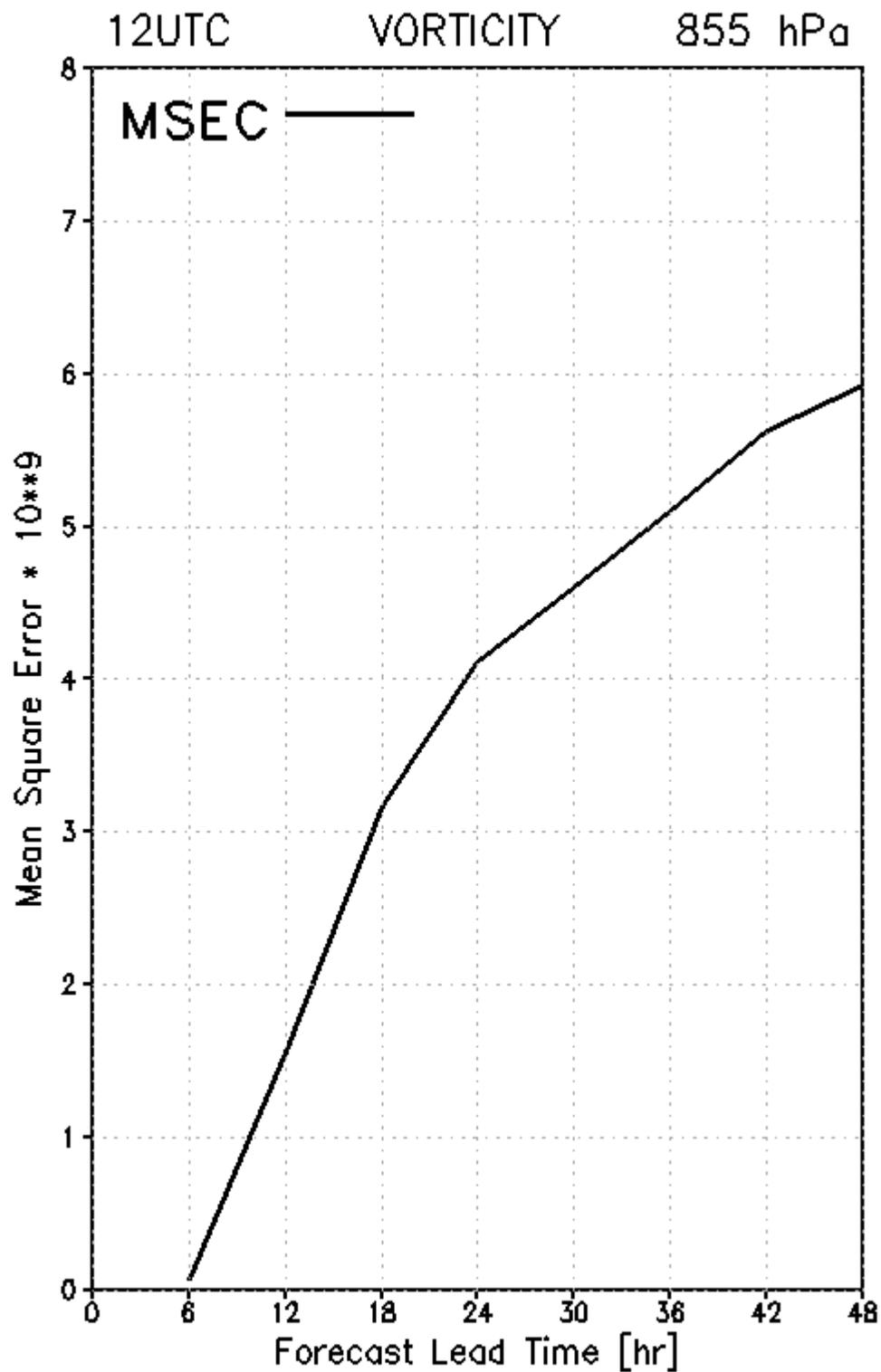
200 km → 500 km

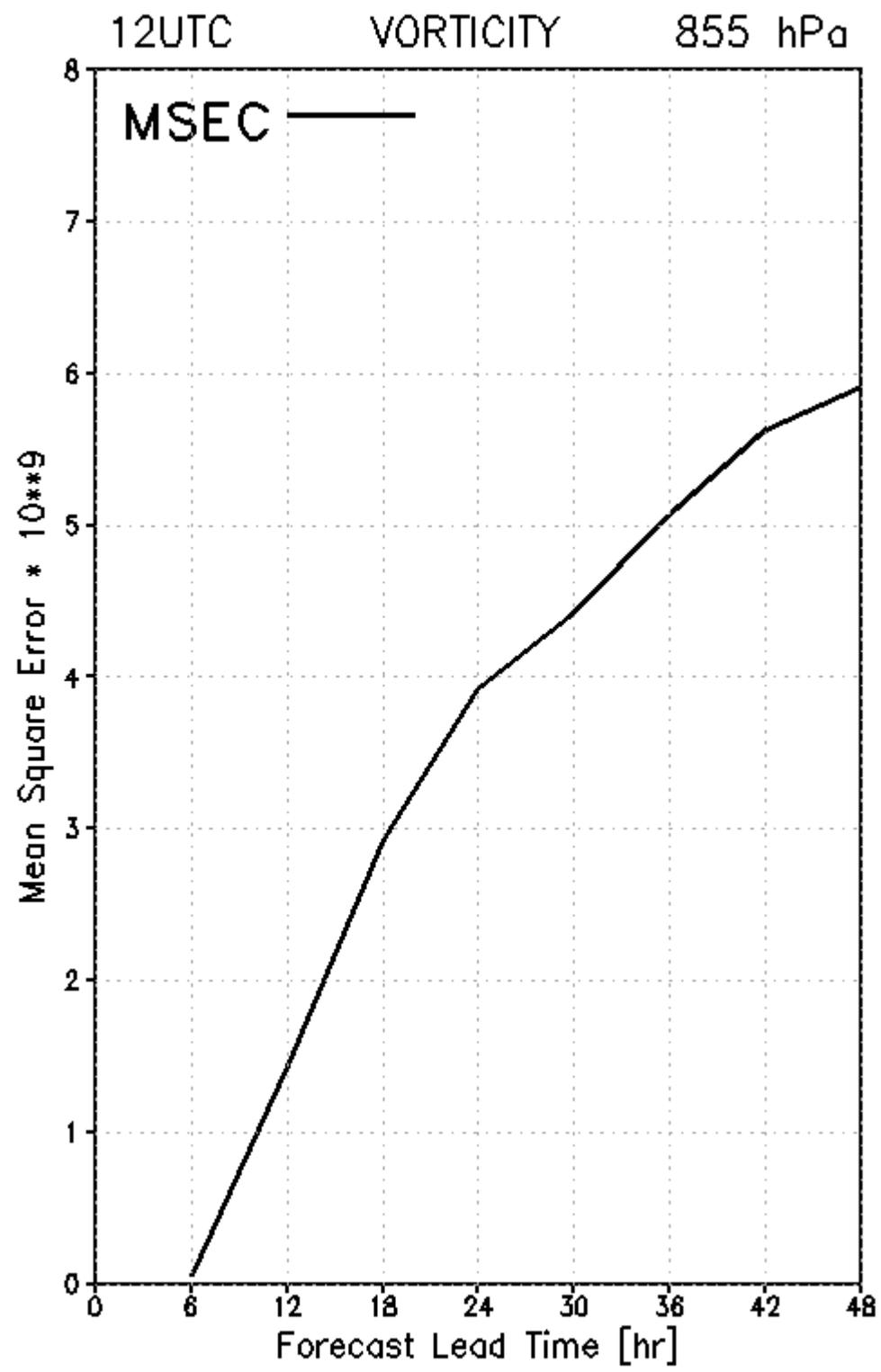
Localization Function

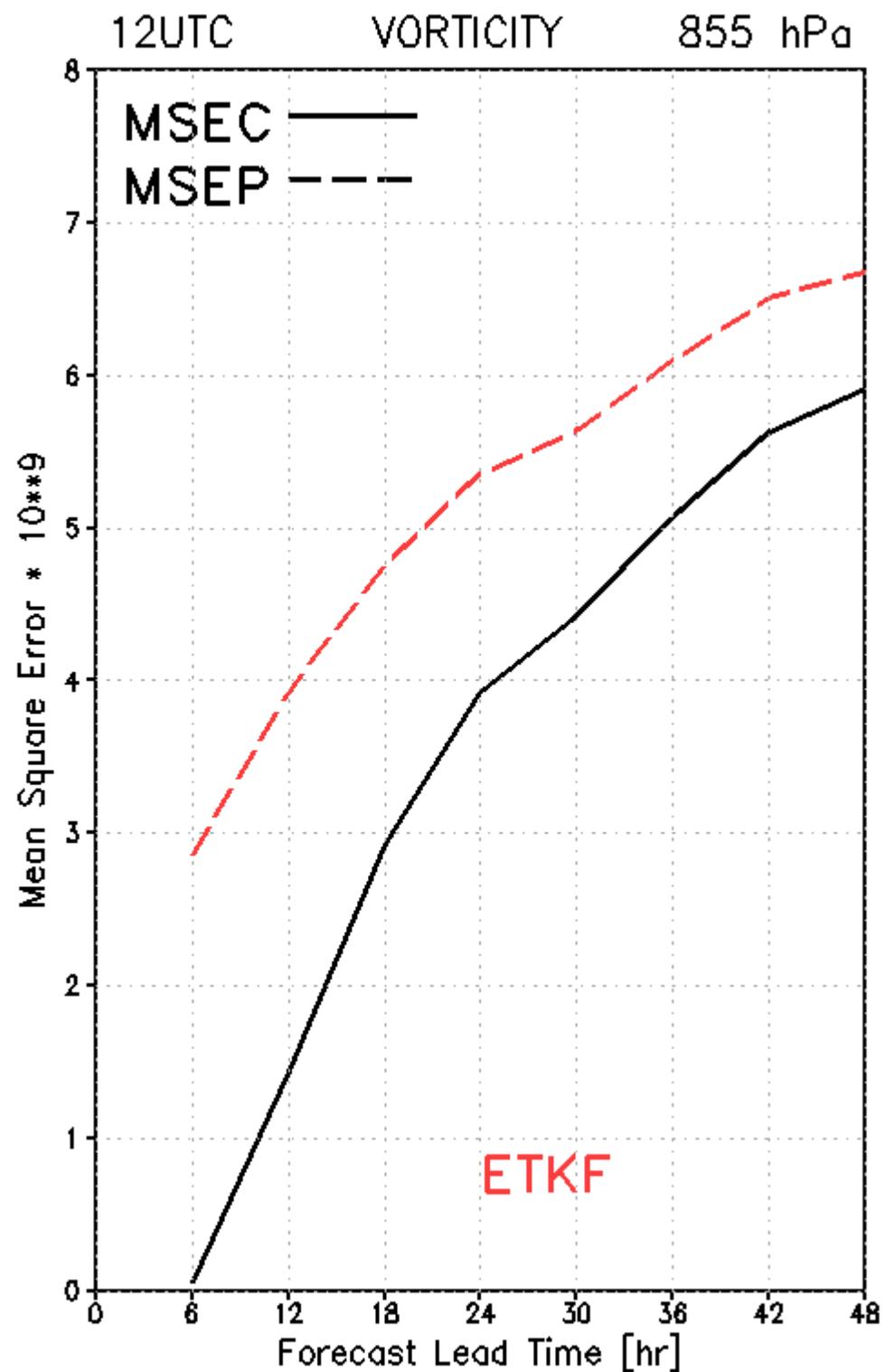
Compact support → Exponential Decay

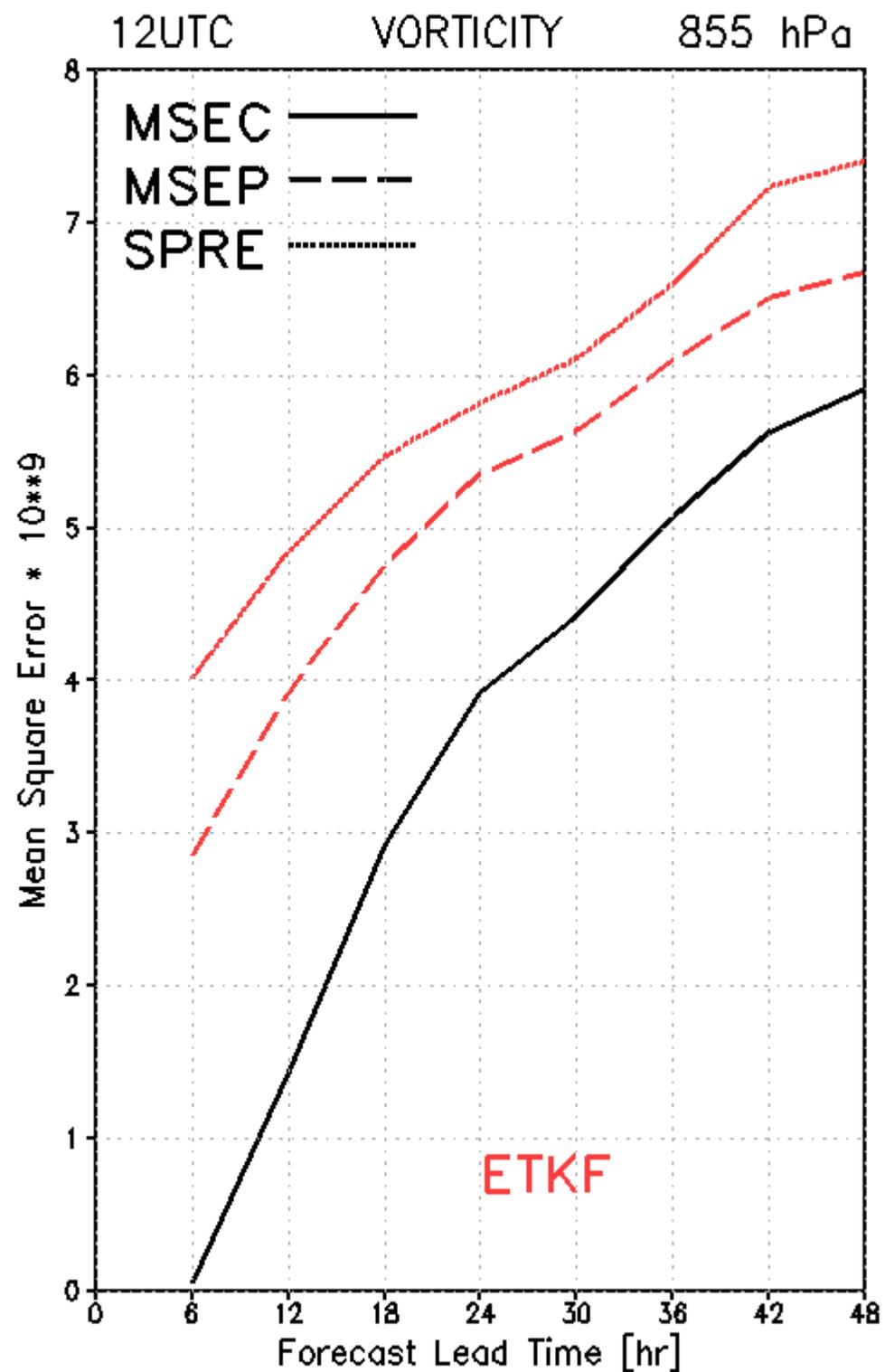
Error growth

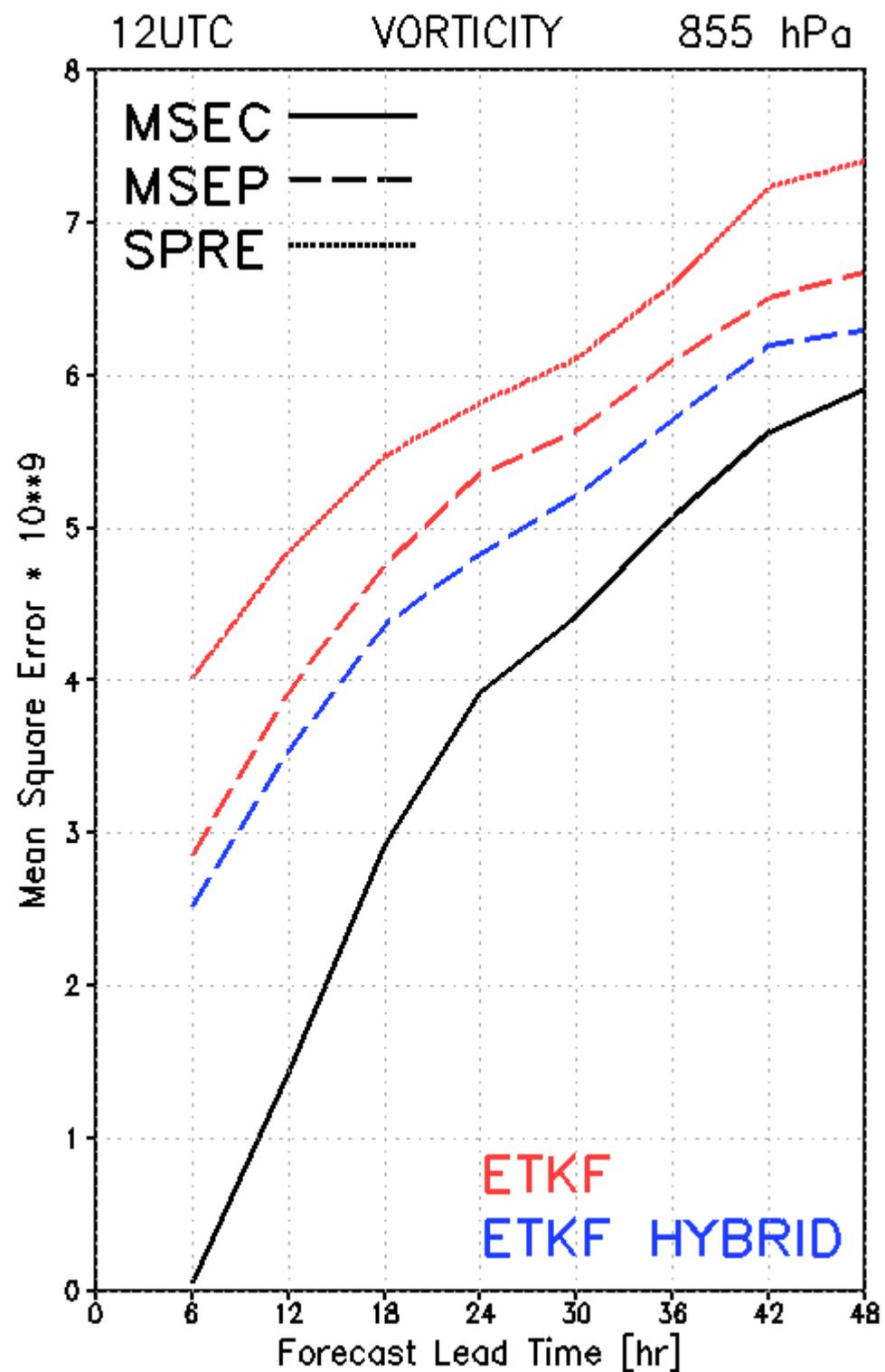
From
EXP 1

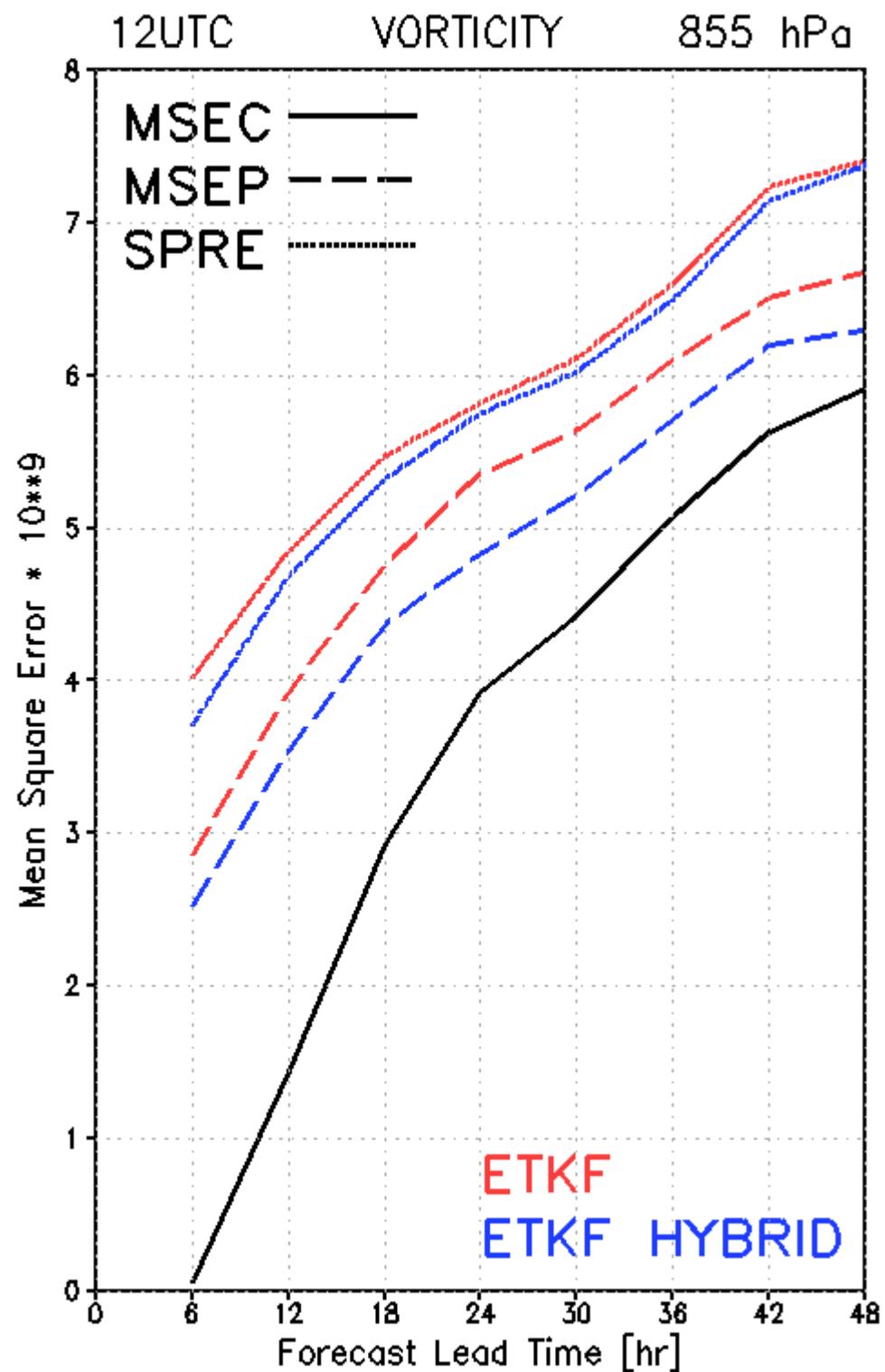


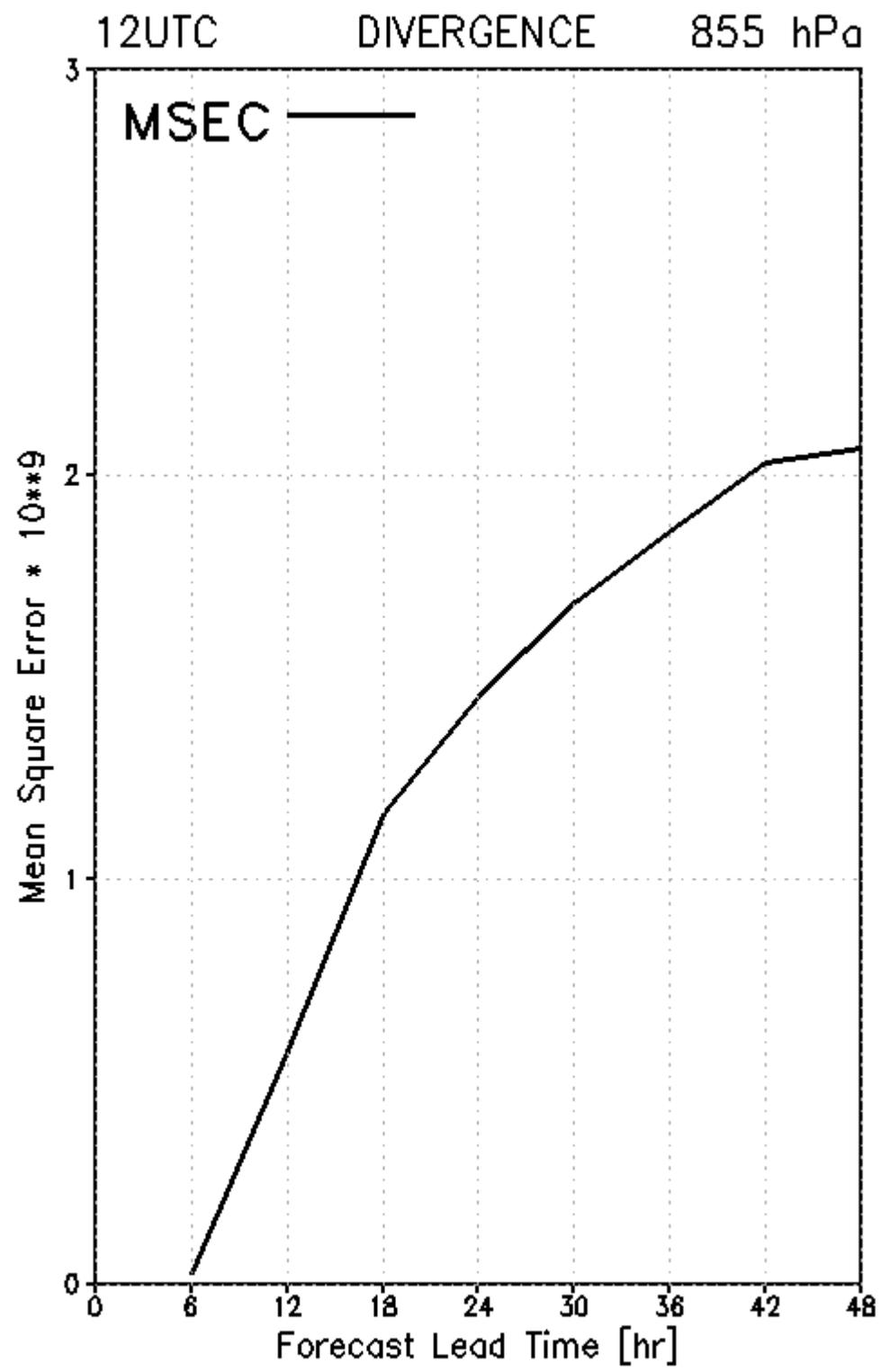


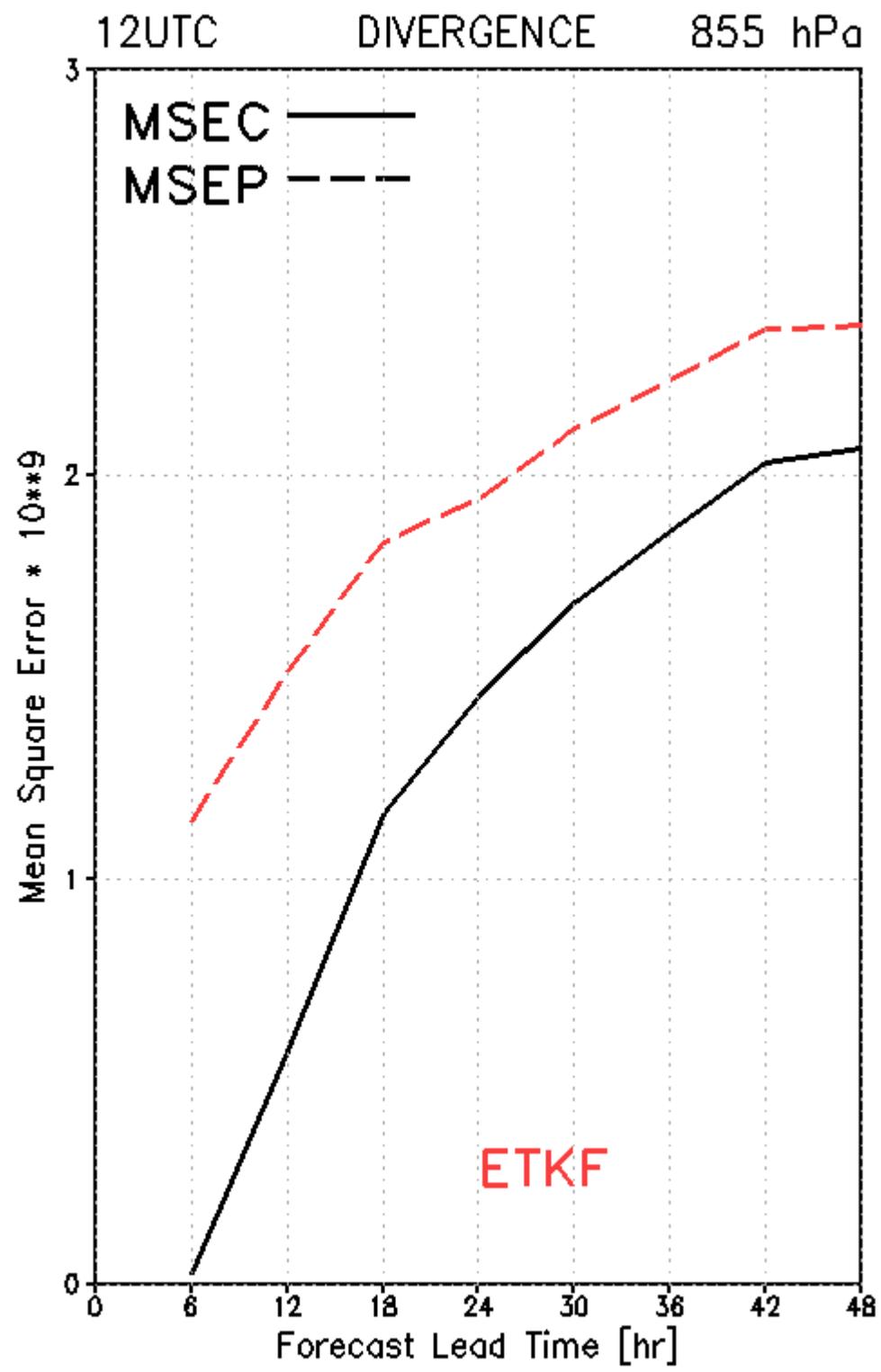


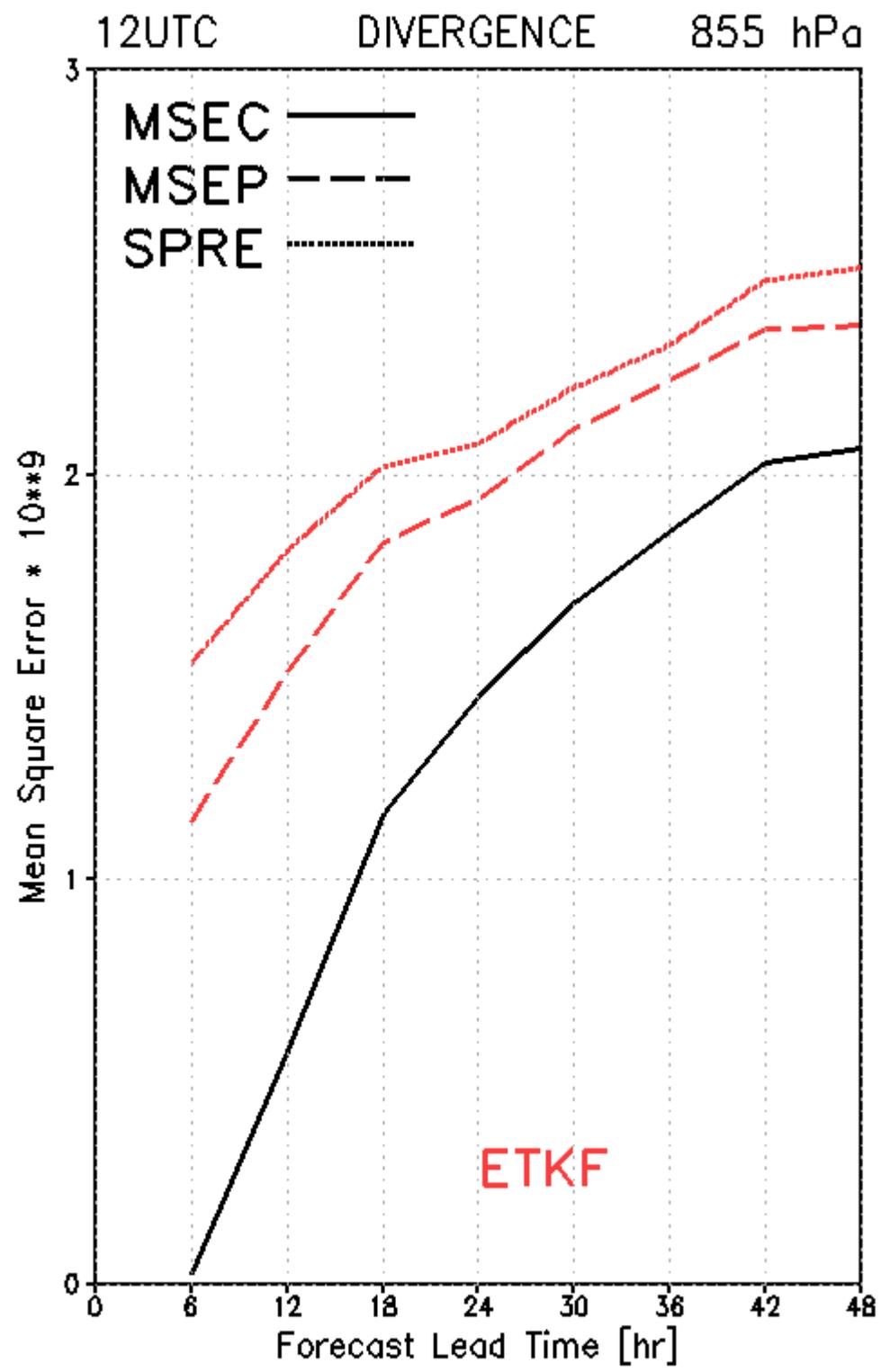


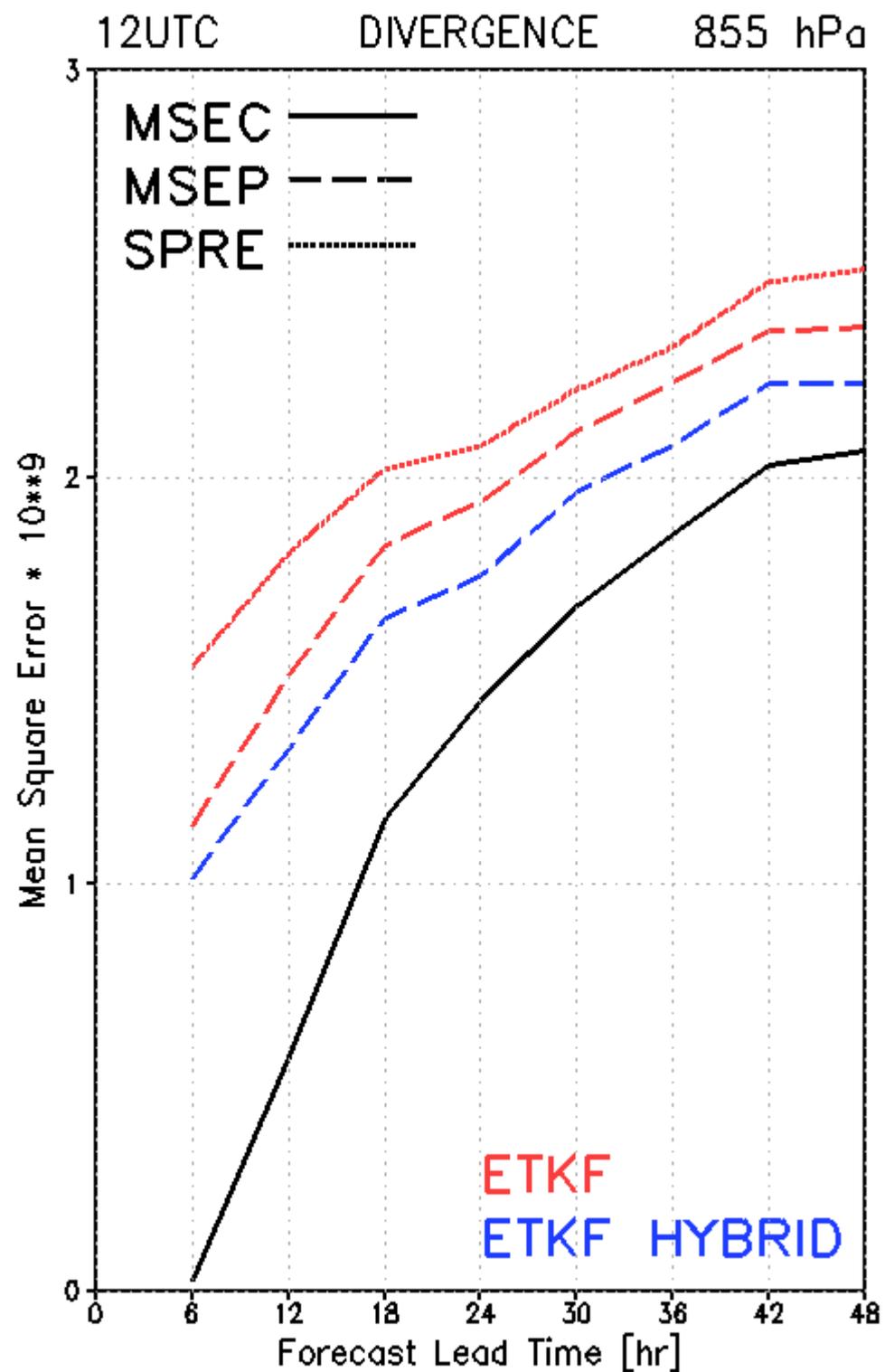


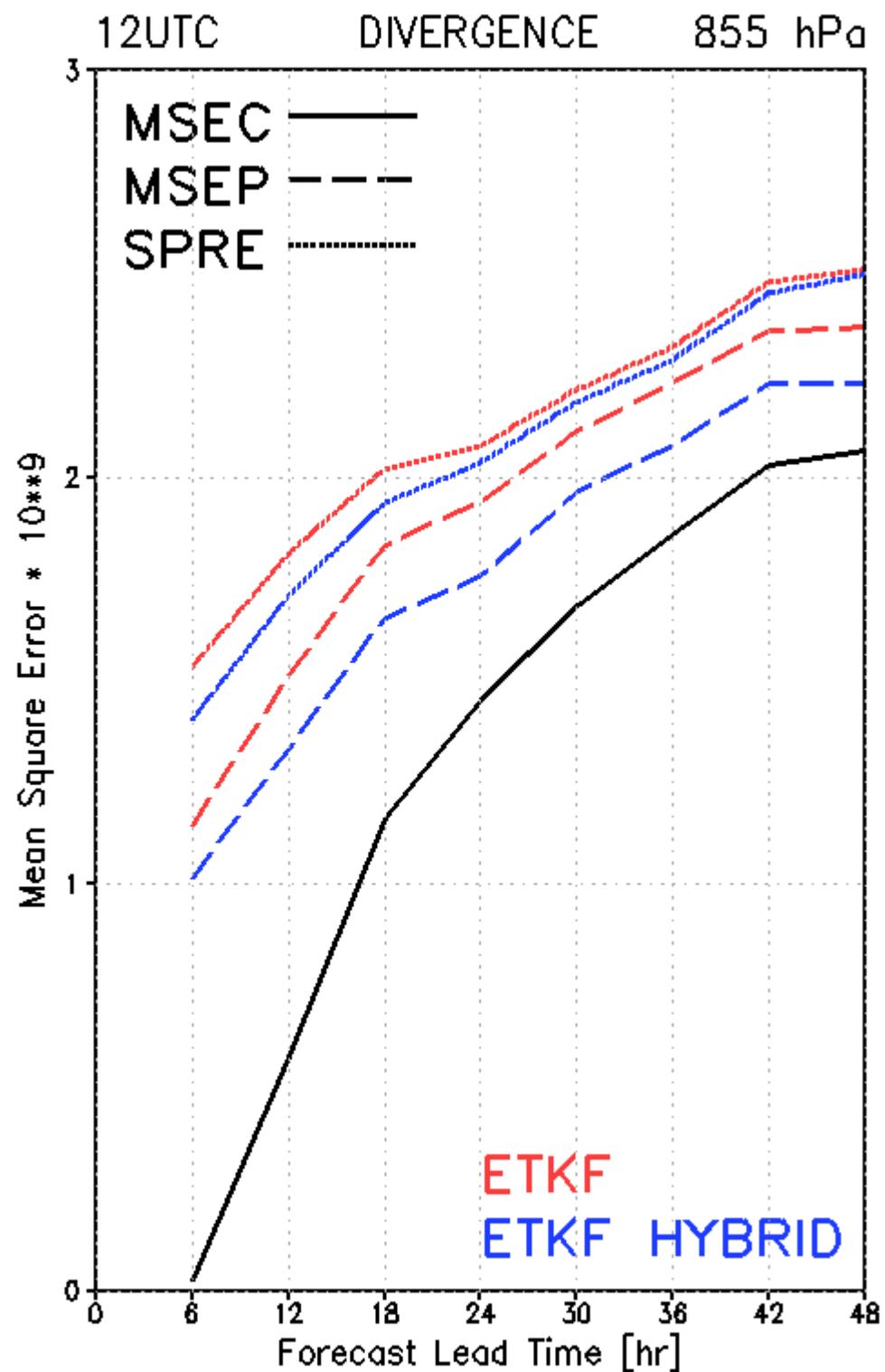


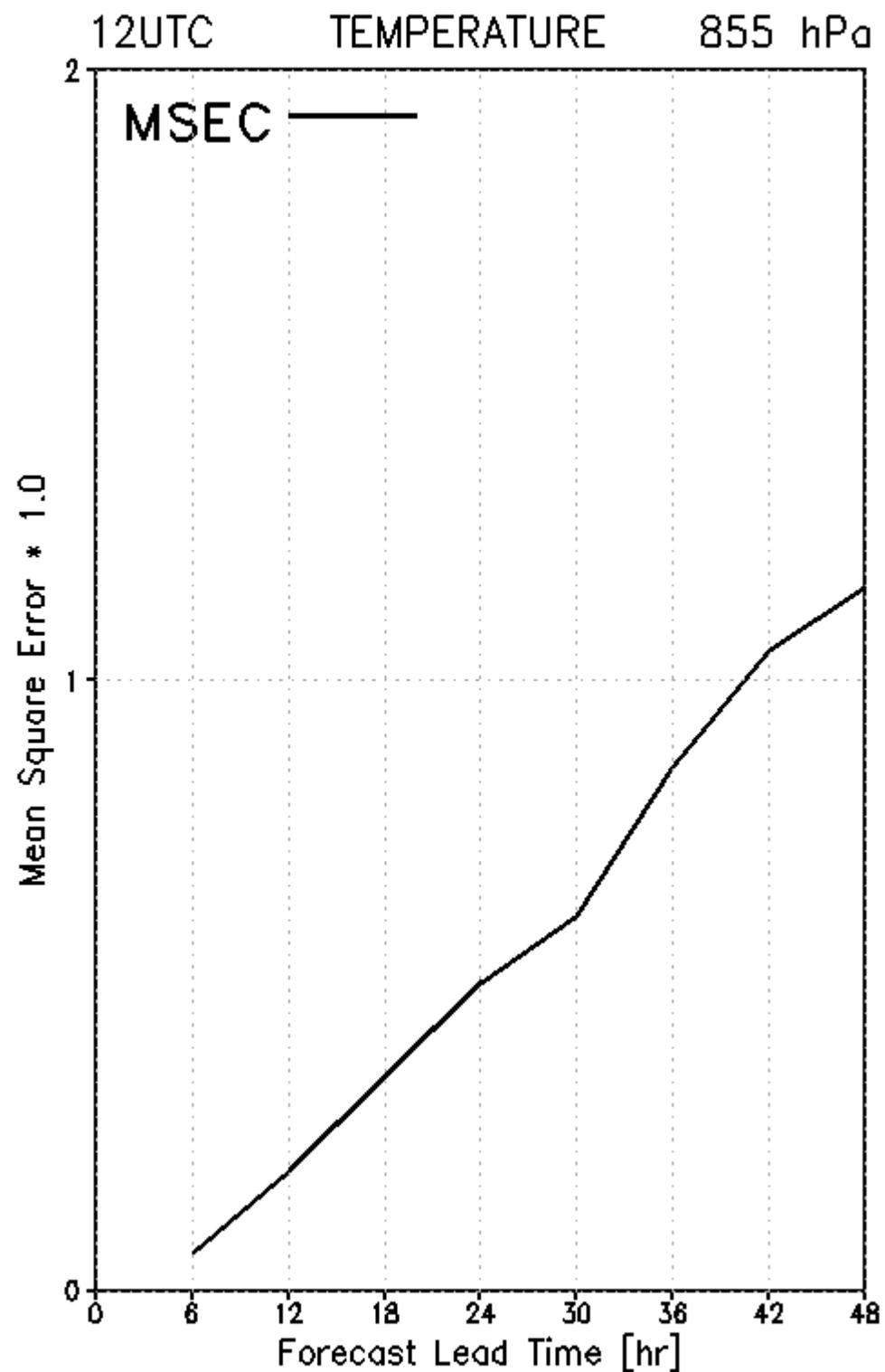


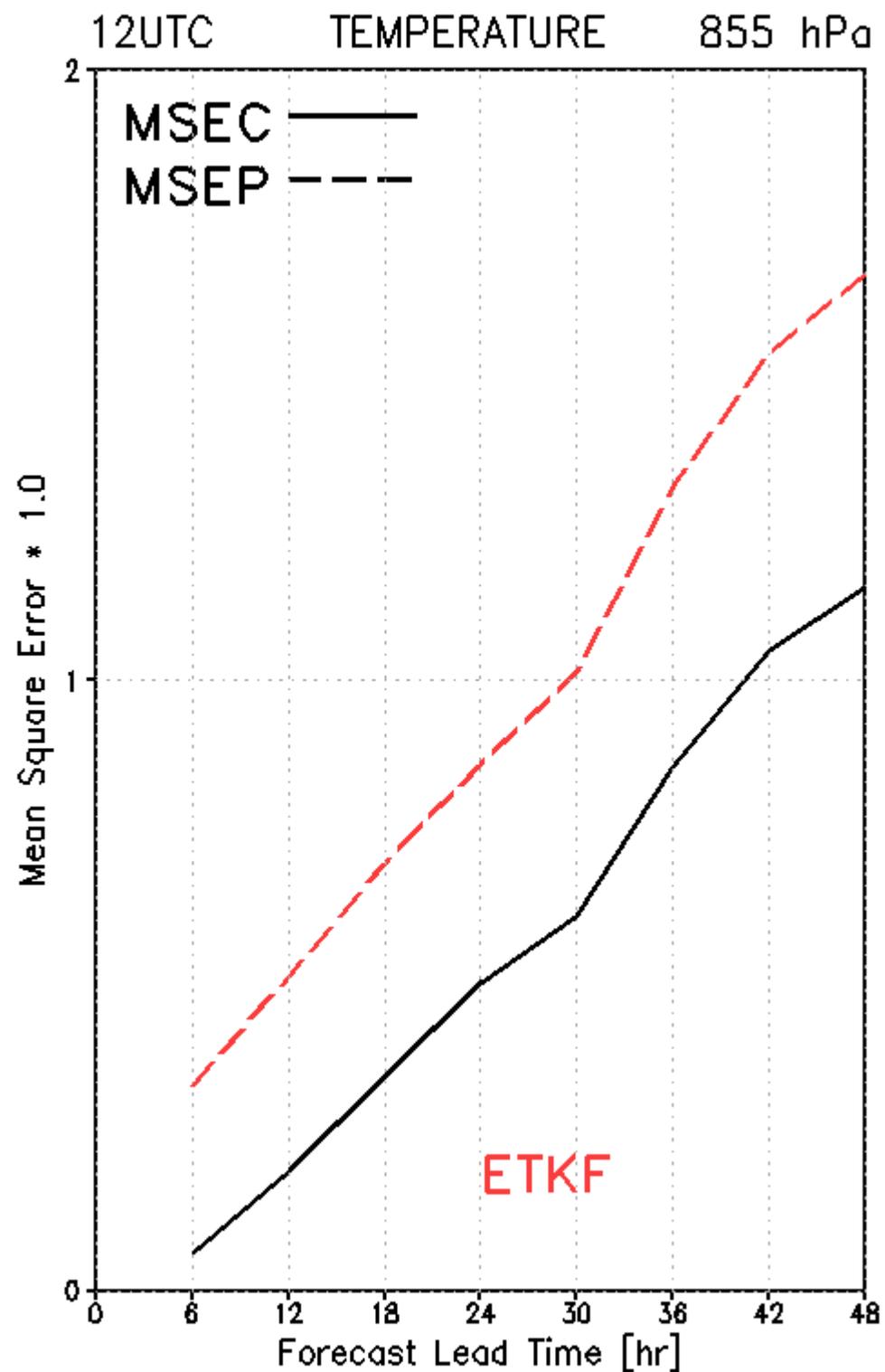


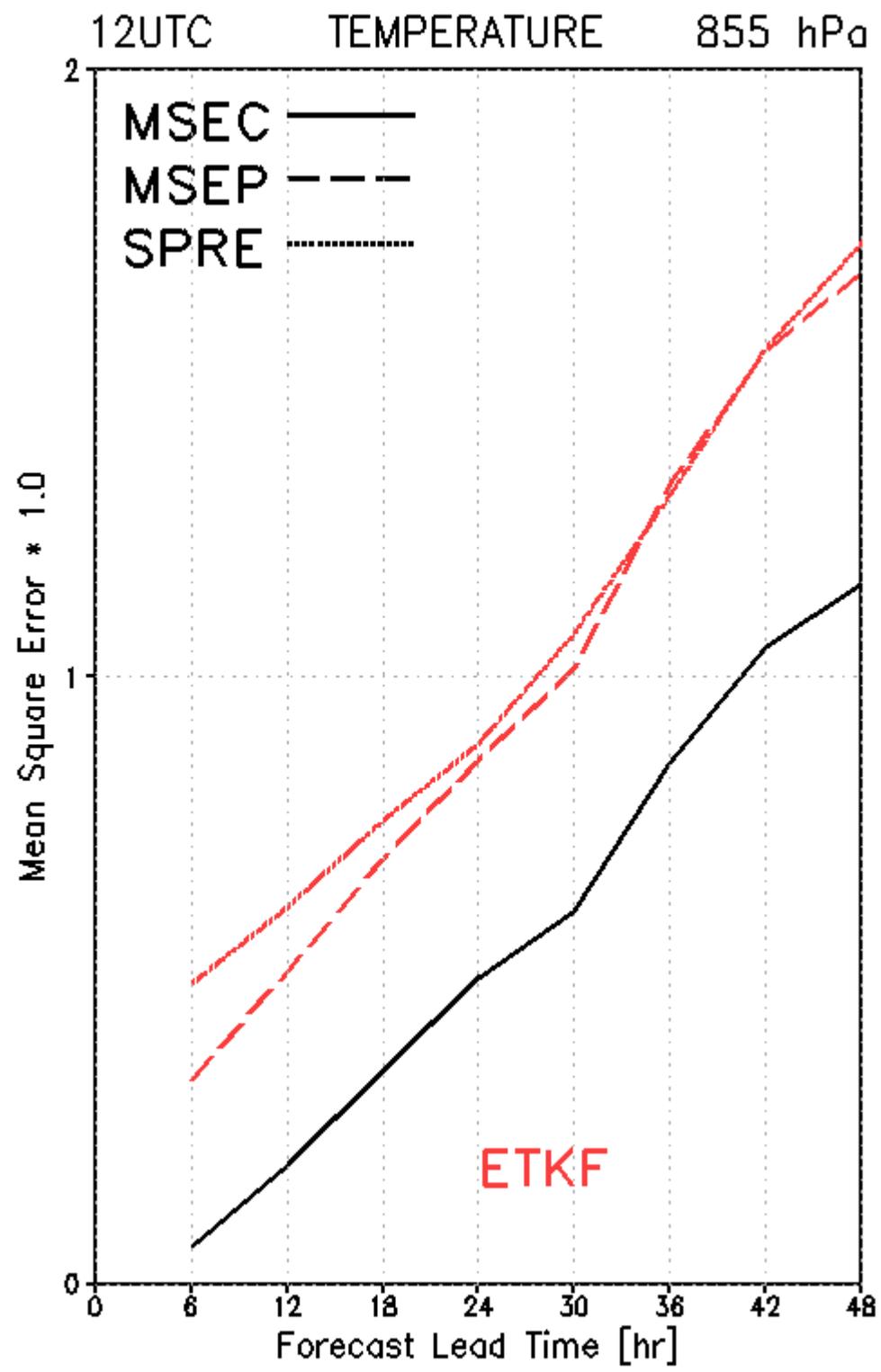


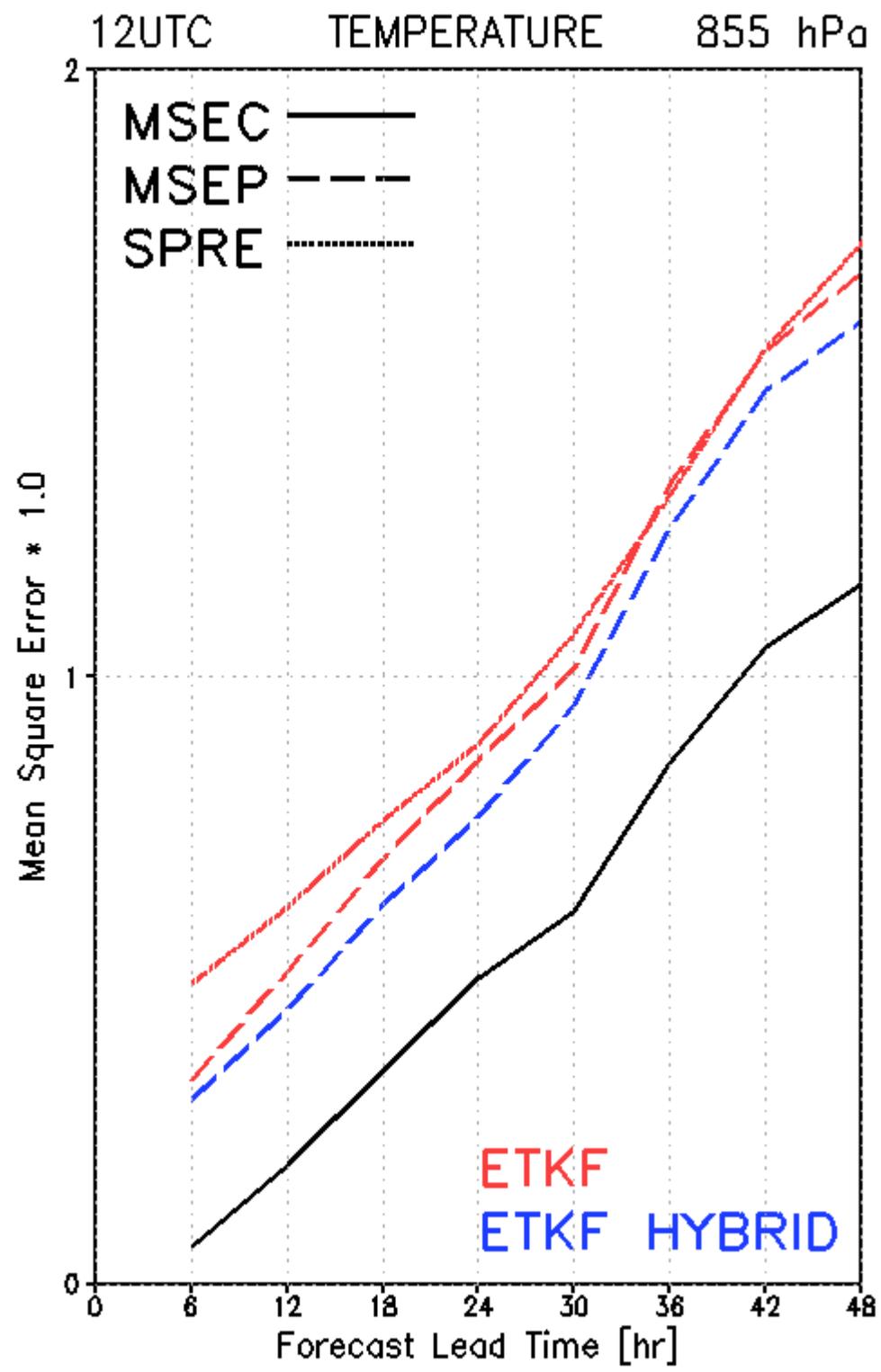


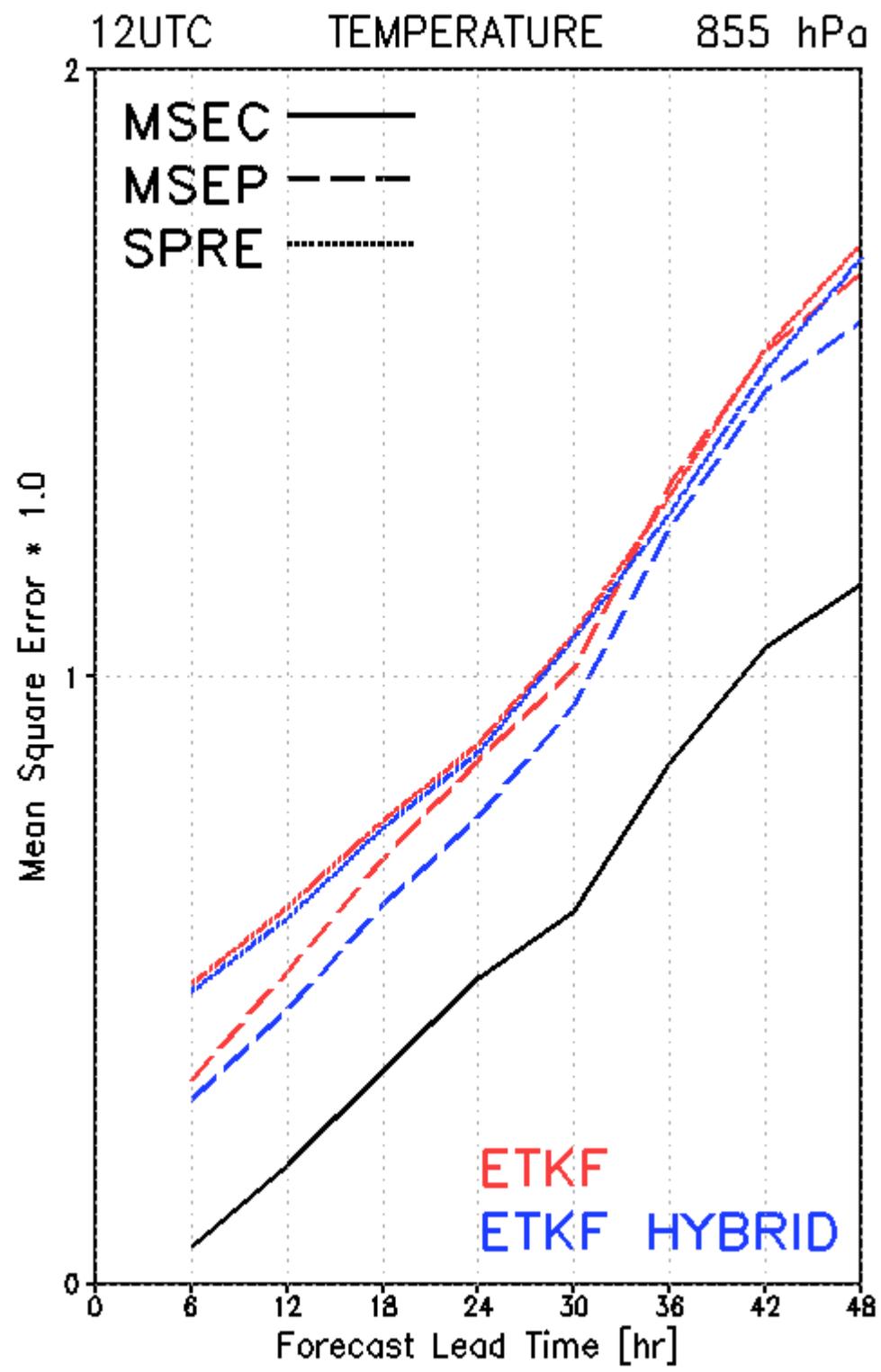




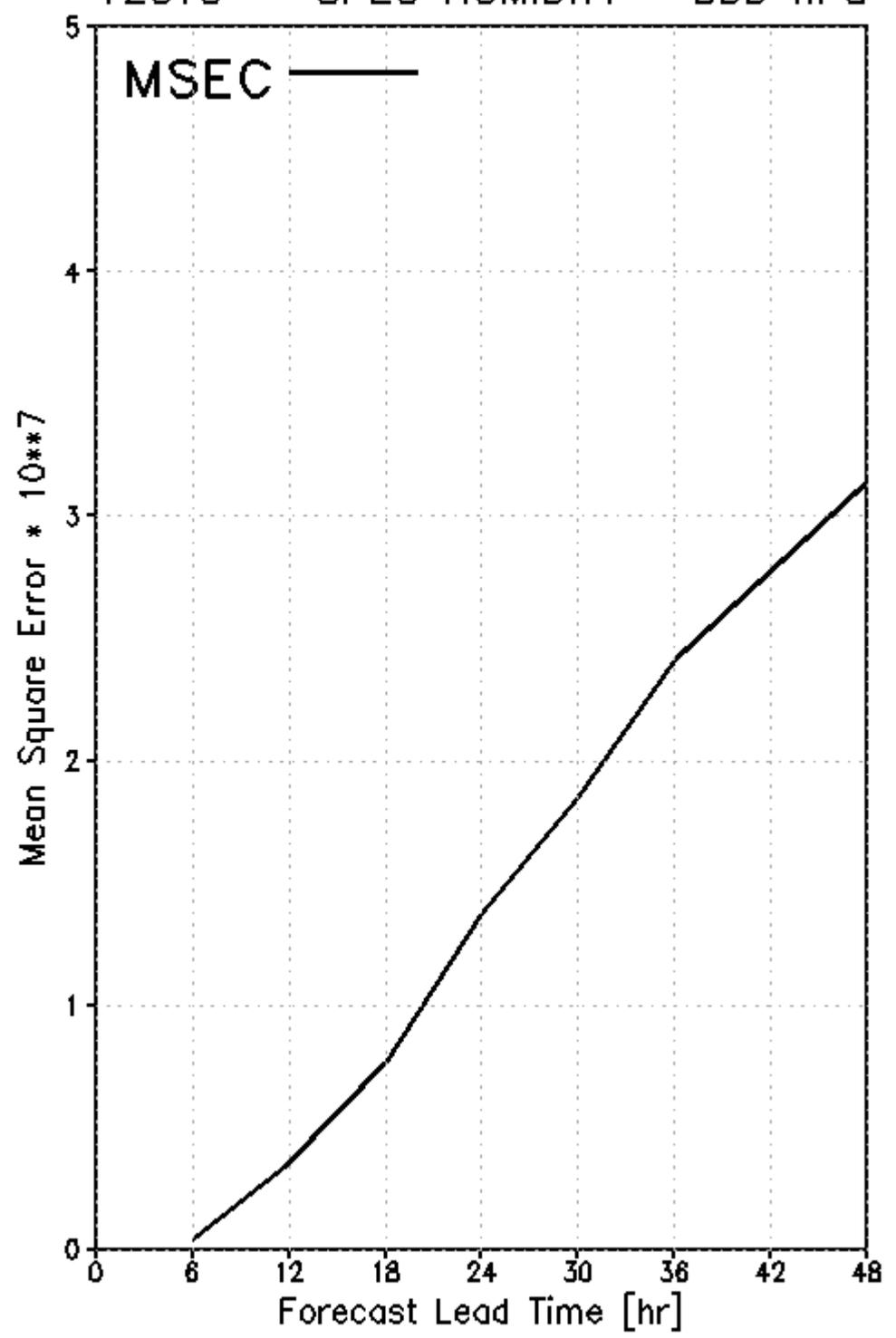




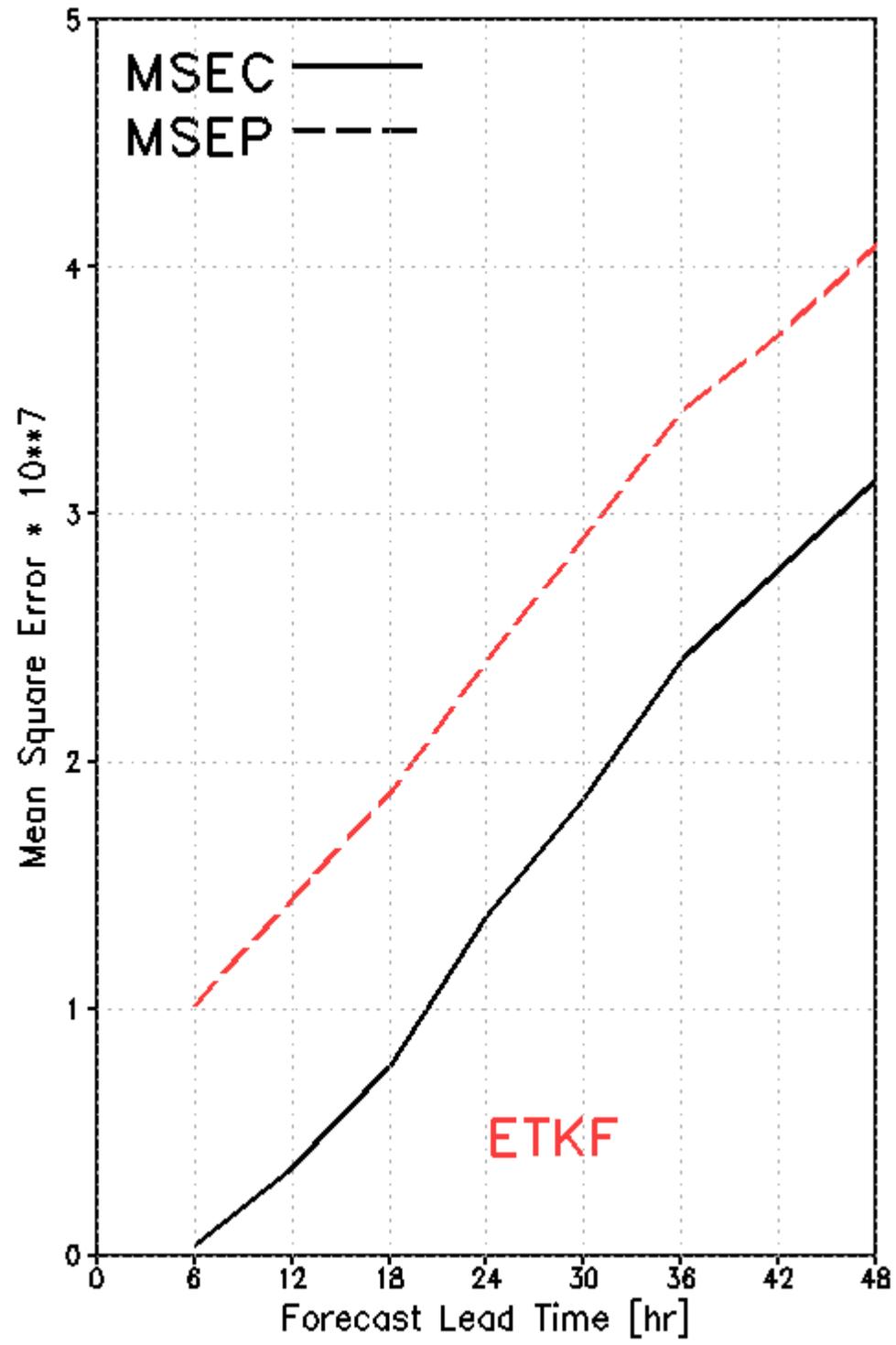




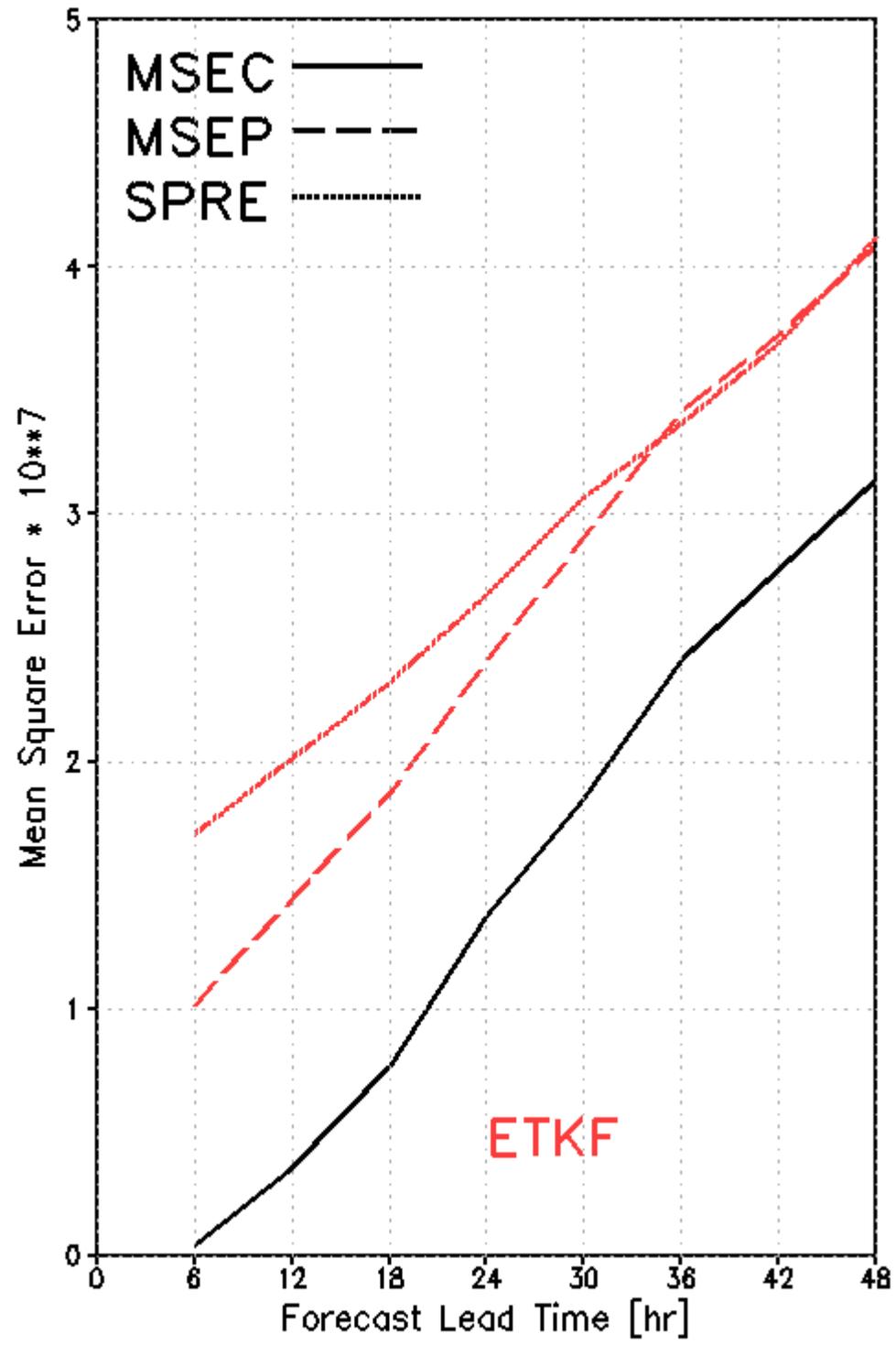
12UTC SPEC HUMIDITY 855 hPa

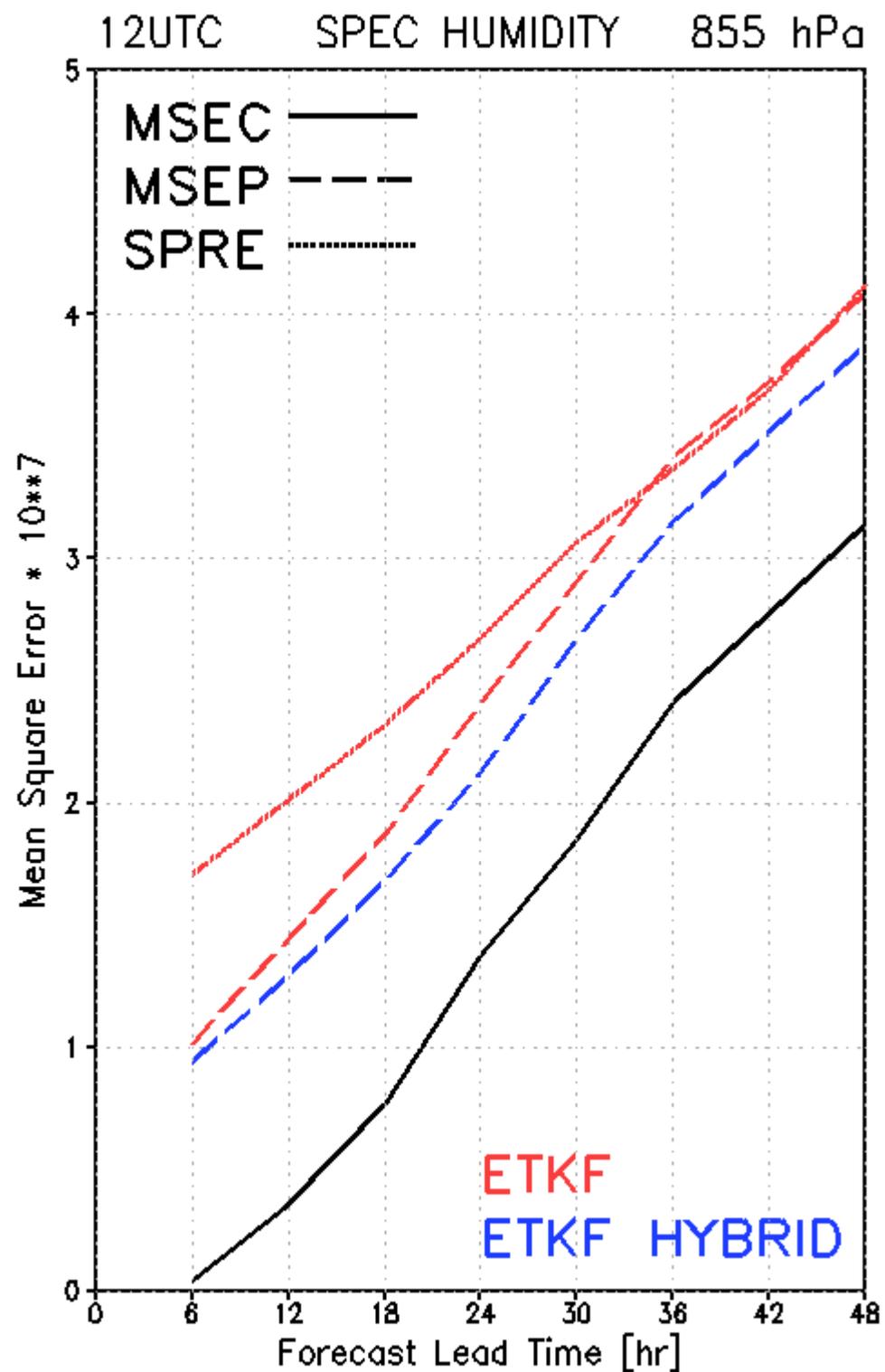


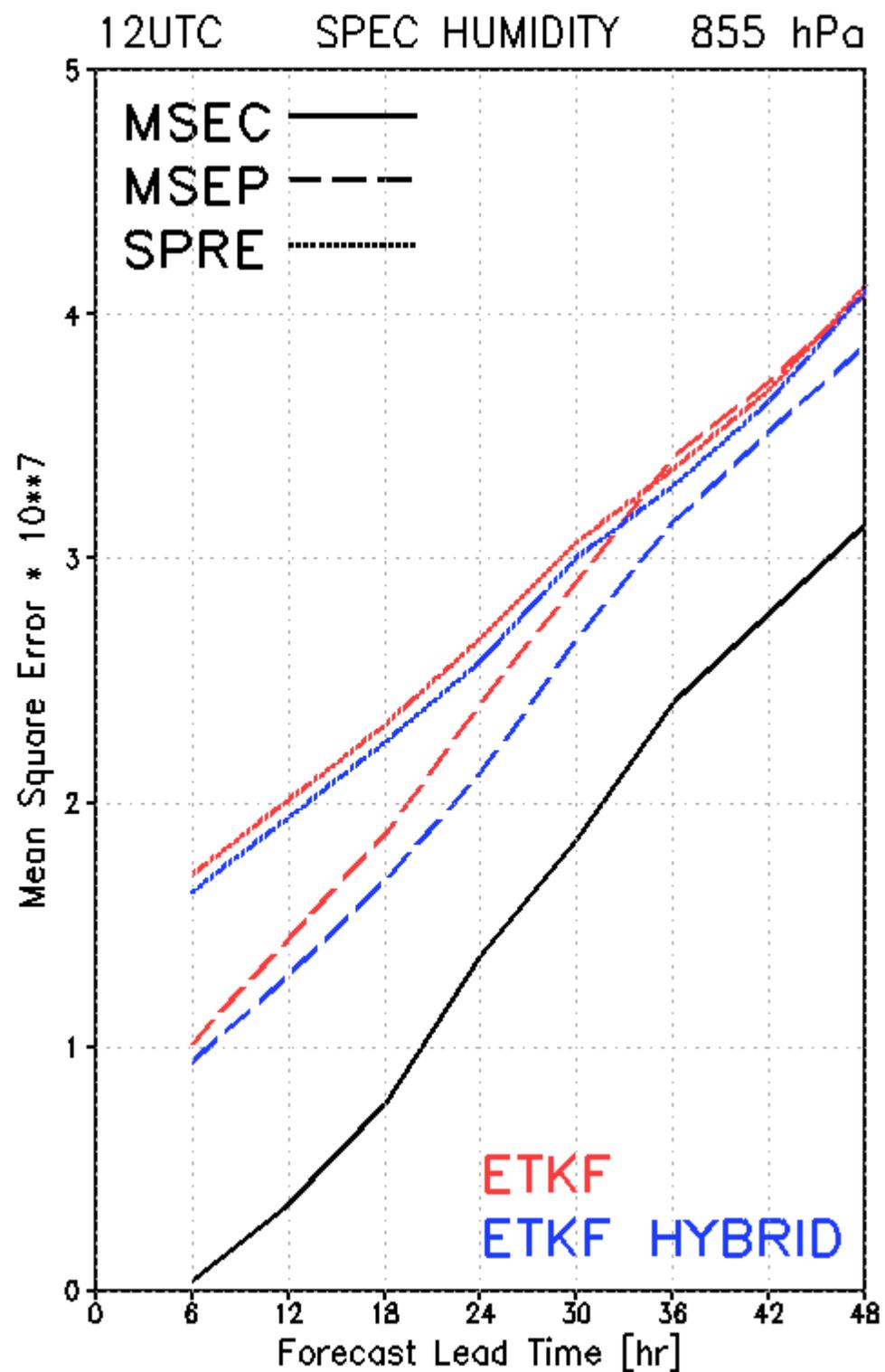
12UTC SPEC HUMIDITY 855 hPa



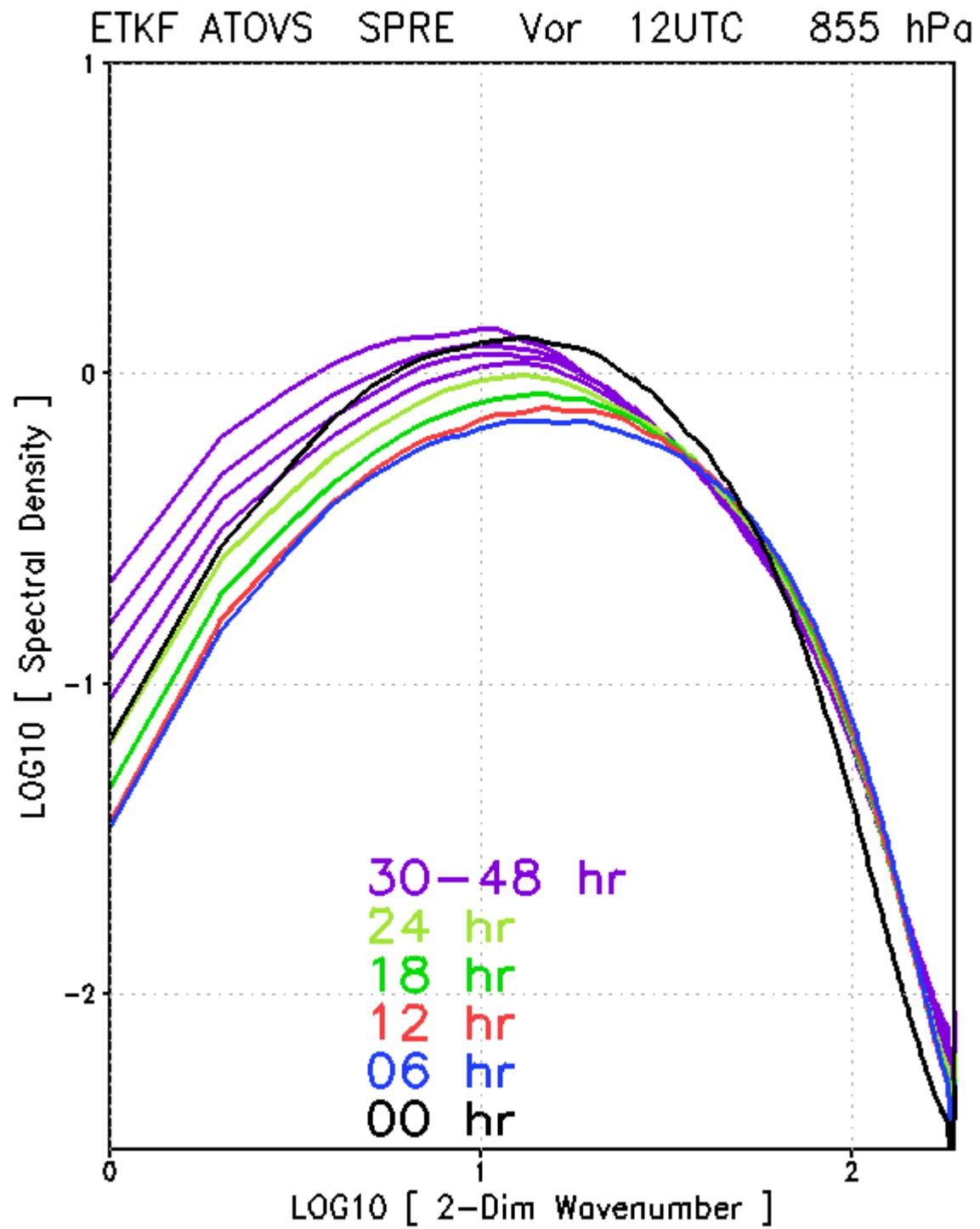
12UTC SPEC HUMIDITY 855 hPa



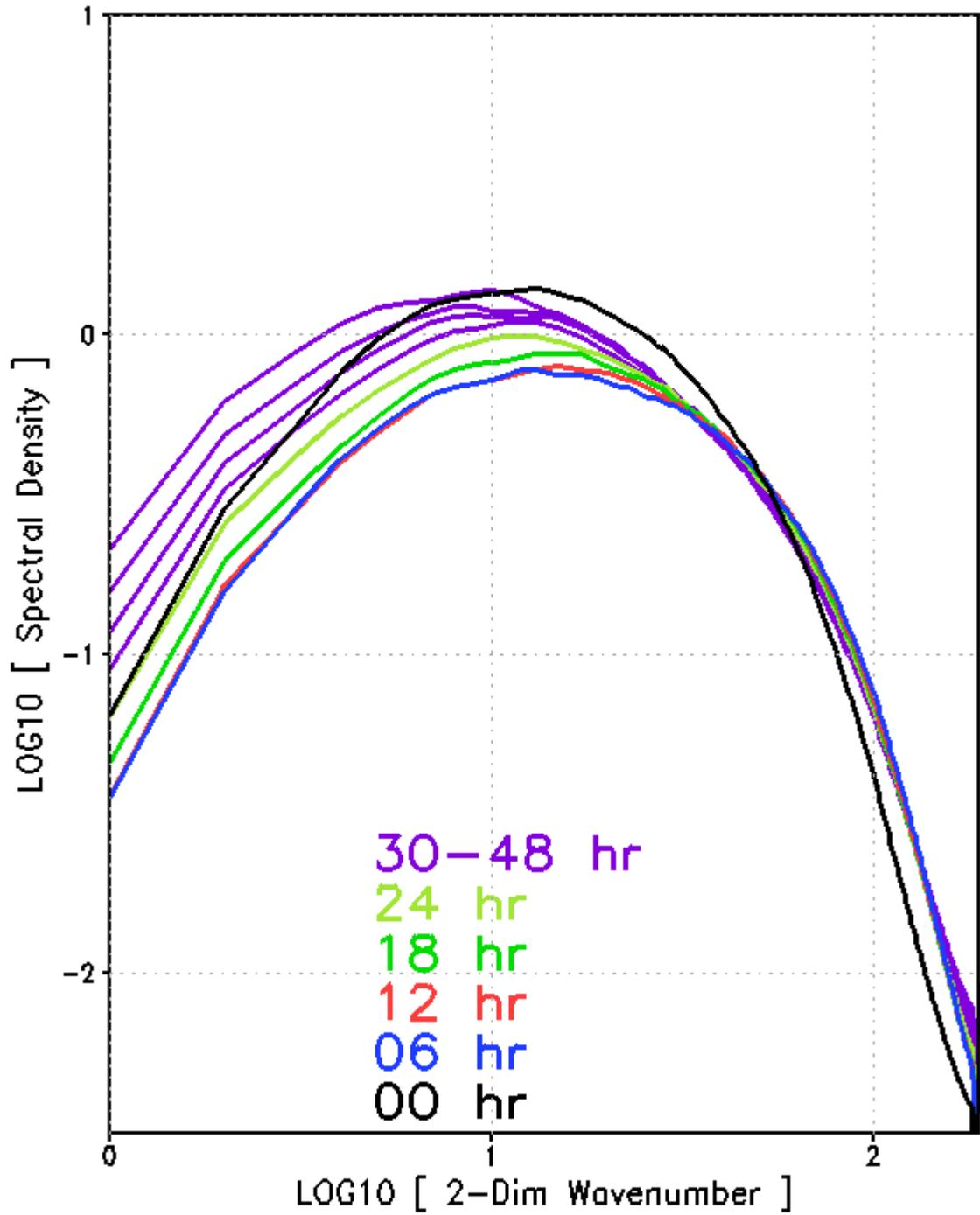




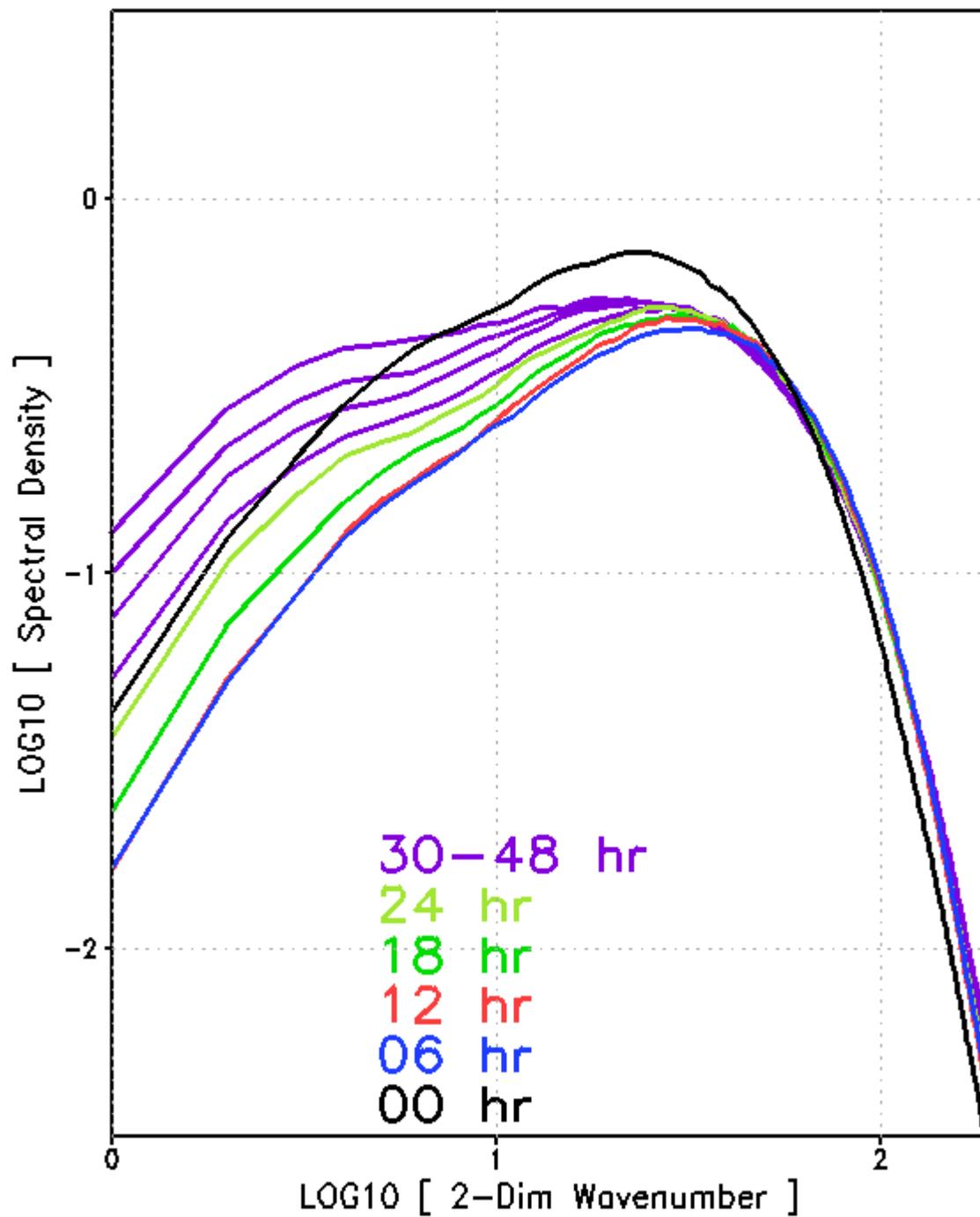
Spectra



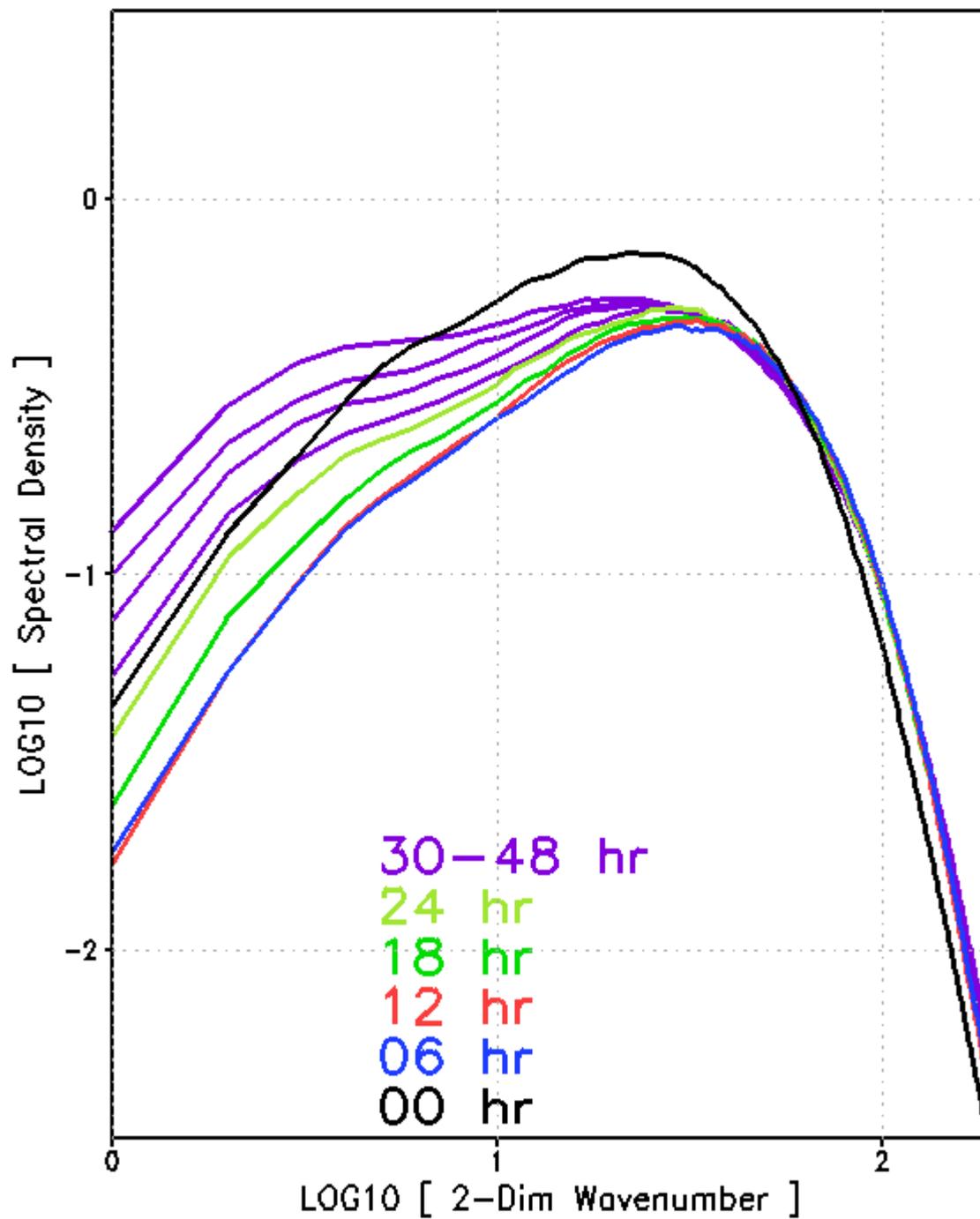
ETKF ATOVS HYBRID SPRE Vor 12UTC 855 hf



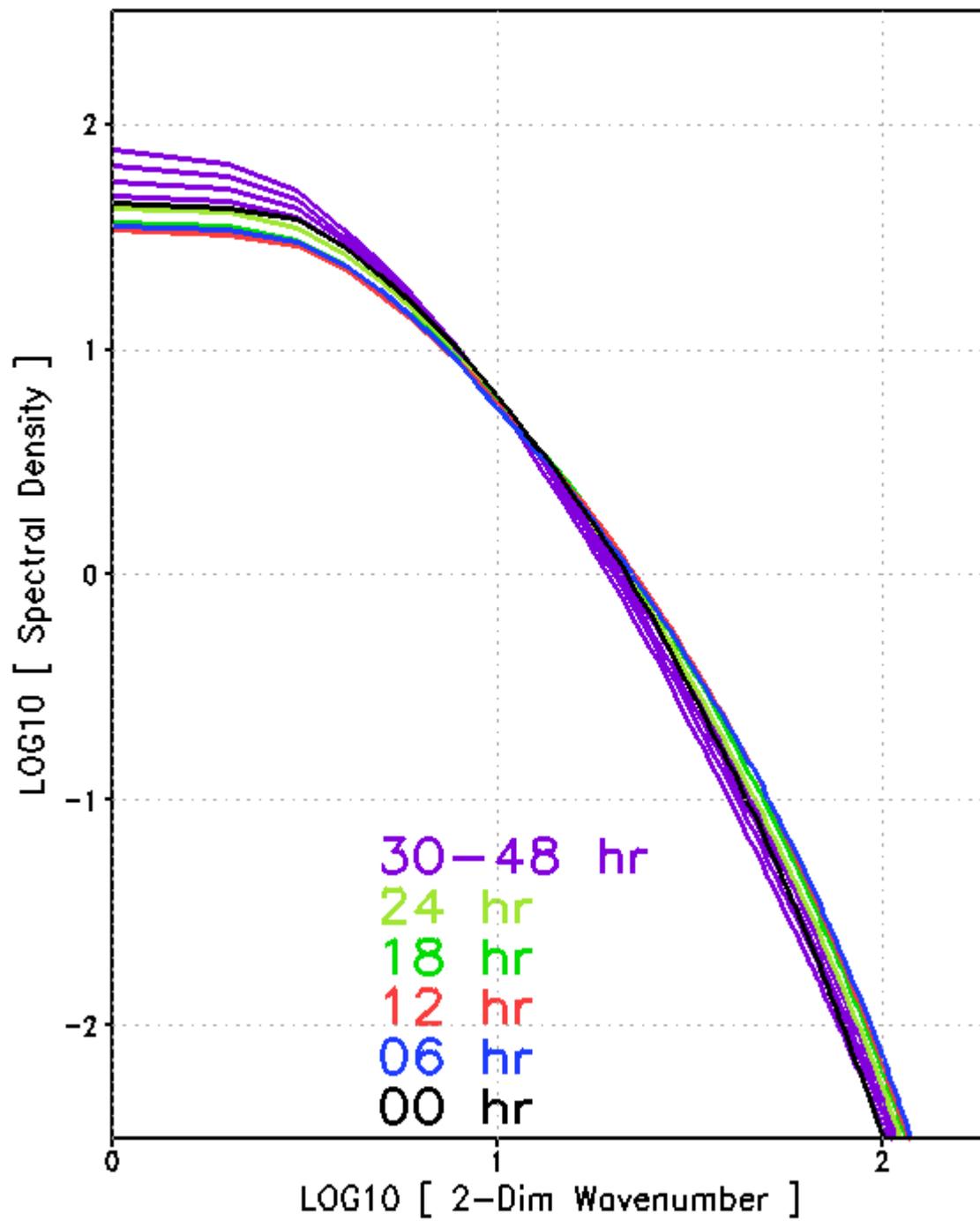
ETKF ATOVS SPRE Div 12UTC 855 hPa



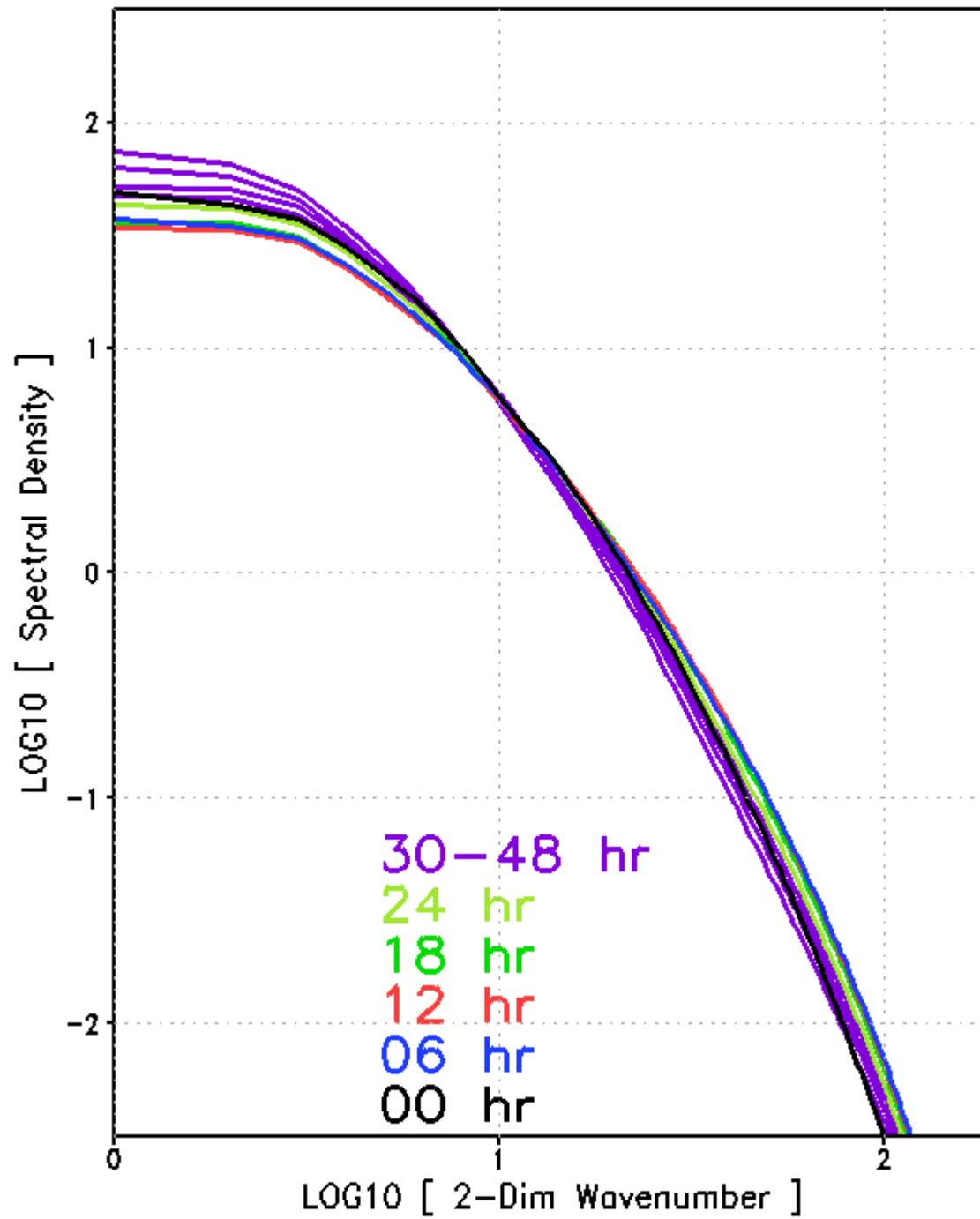
ETKF ATOVS HYBRID SPRE Div 12UTC 855 hF

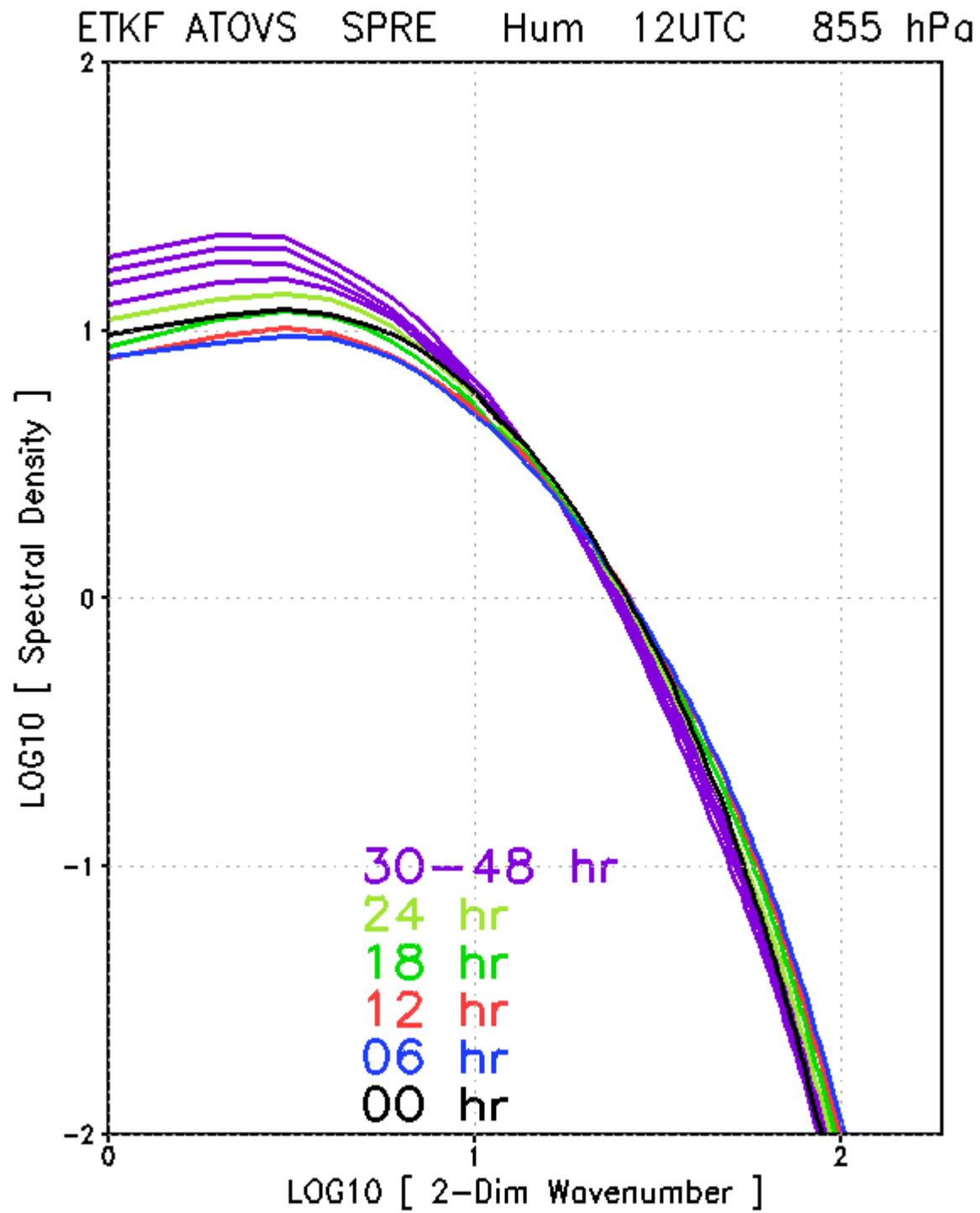


ETKF ATOVS SPRE Tem 12UTC 855 hPa

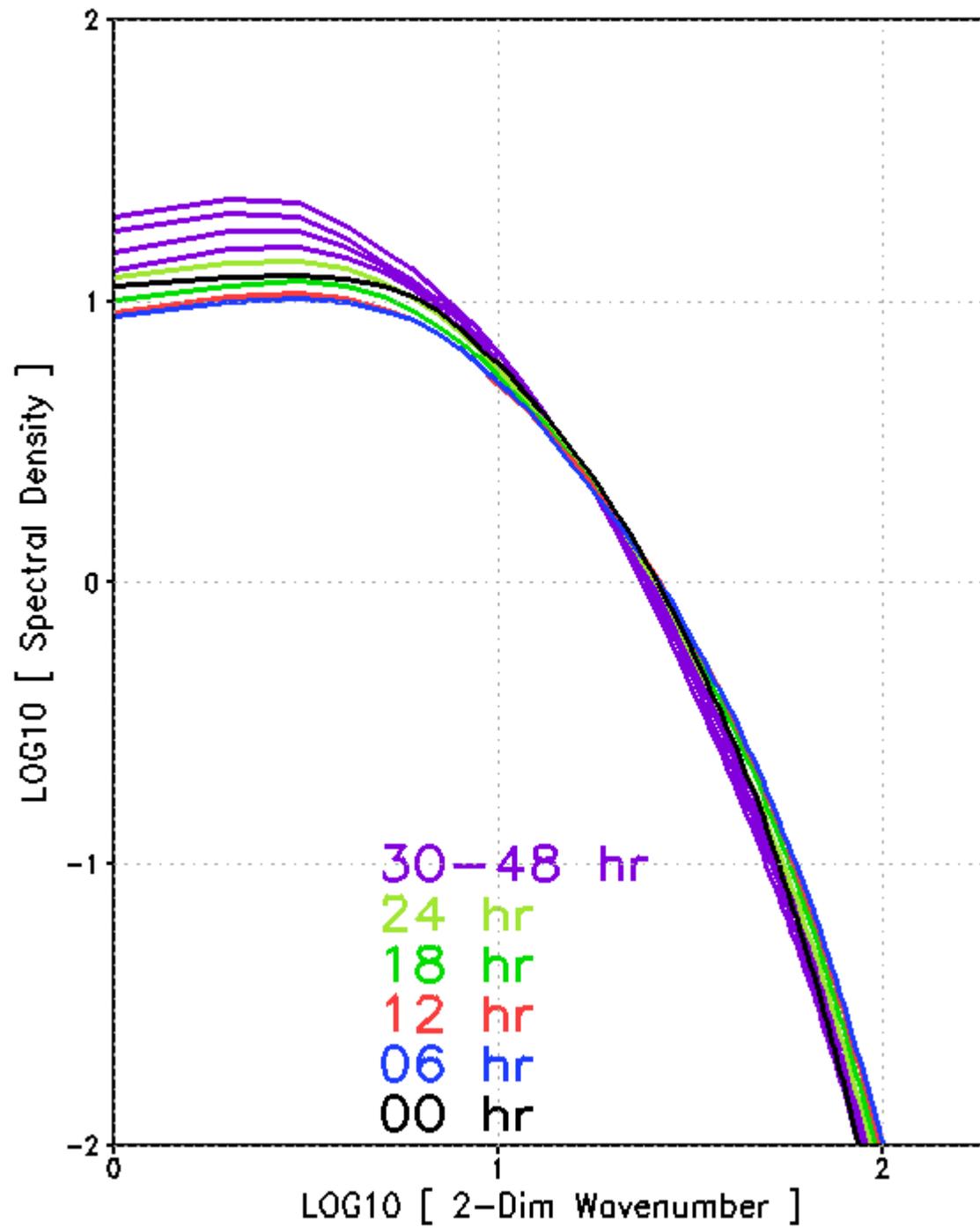


ETKF ATOVS HYBRID SPRE Tem 12UTC 855 h





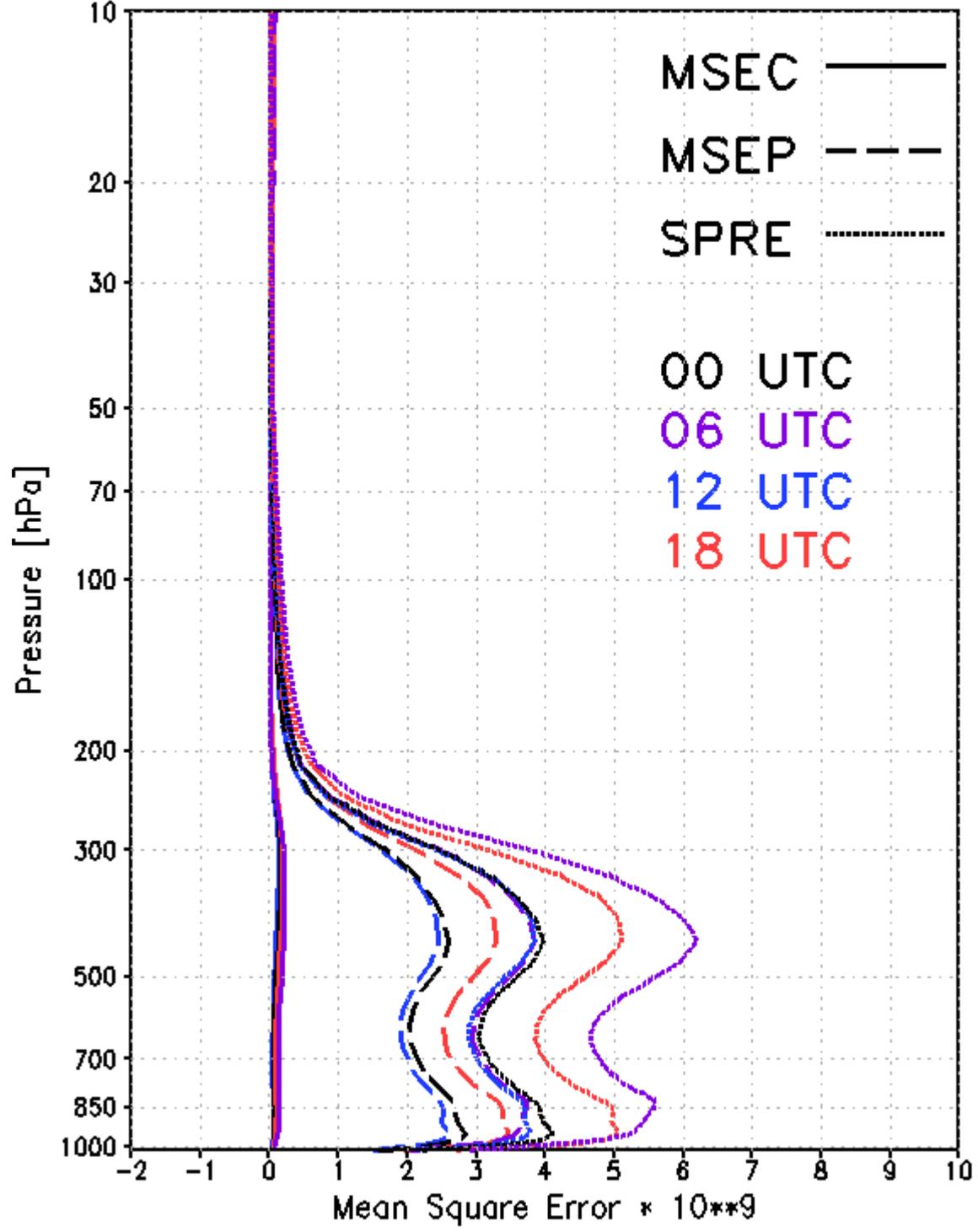
ETKF ATOVS HYBRID SPRE Hum 12UTC 855 h



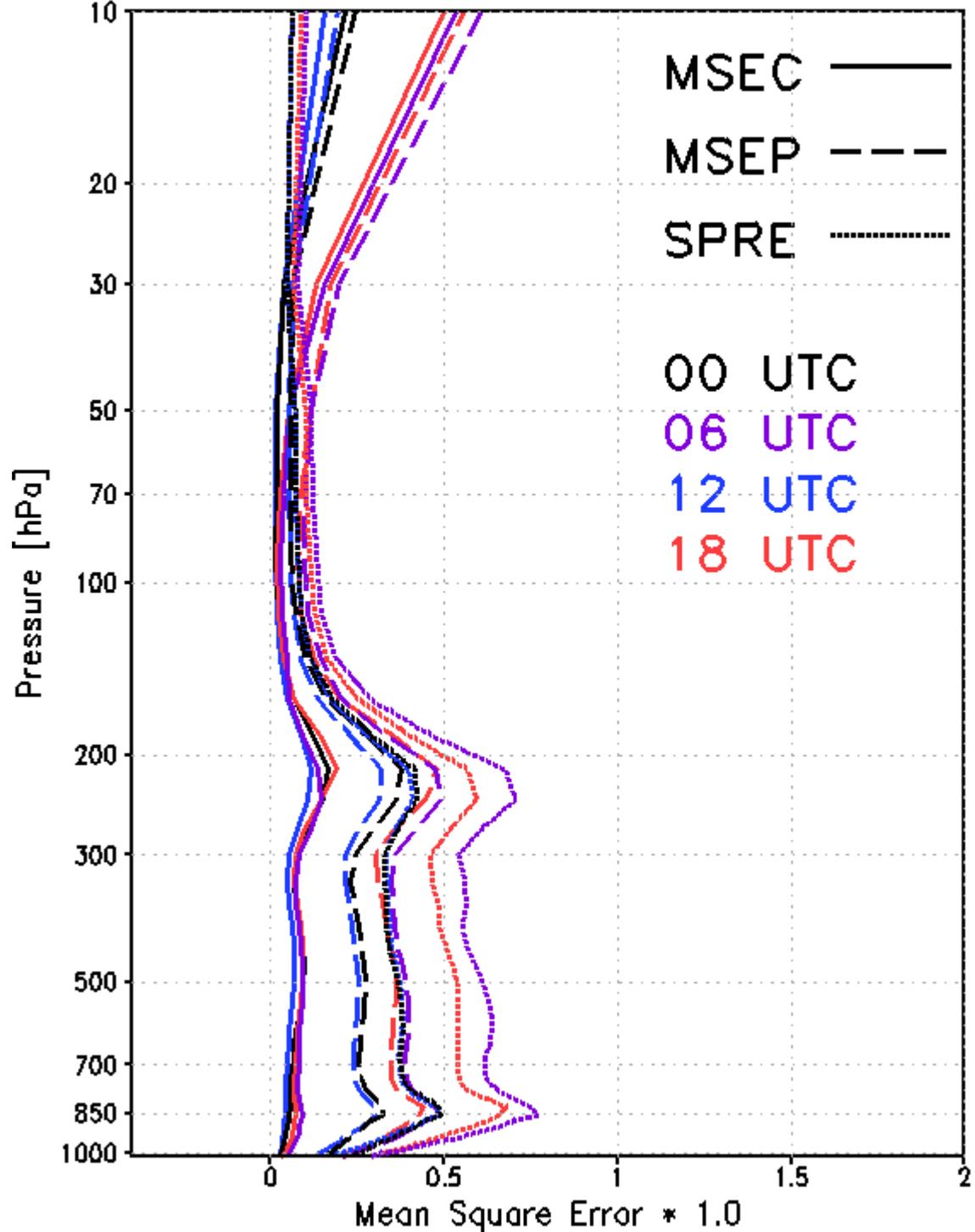
Vertical structure

and

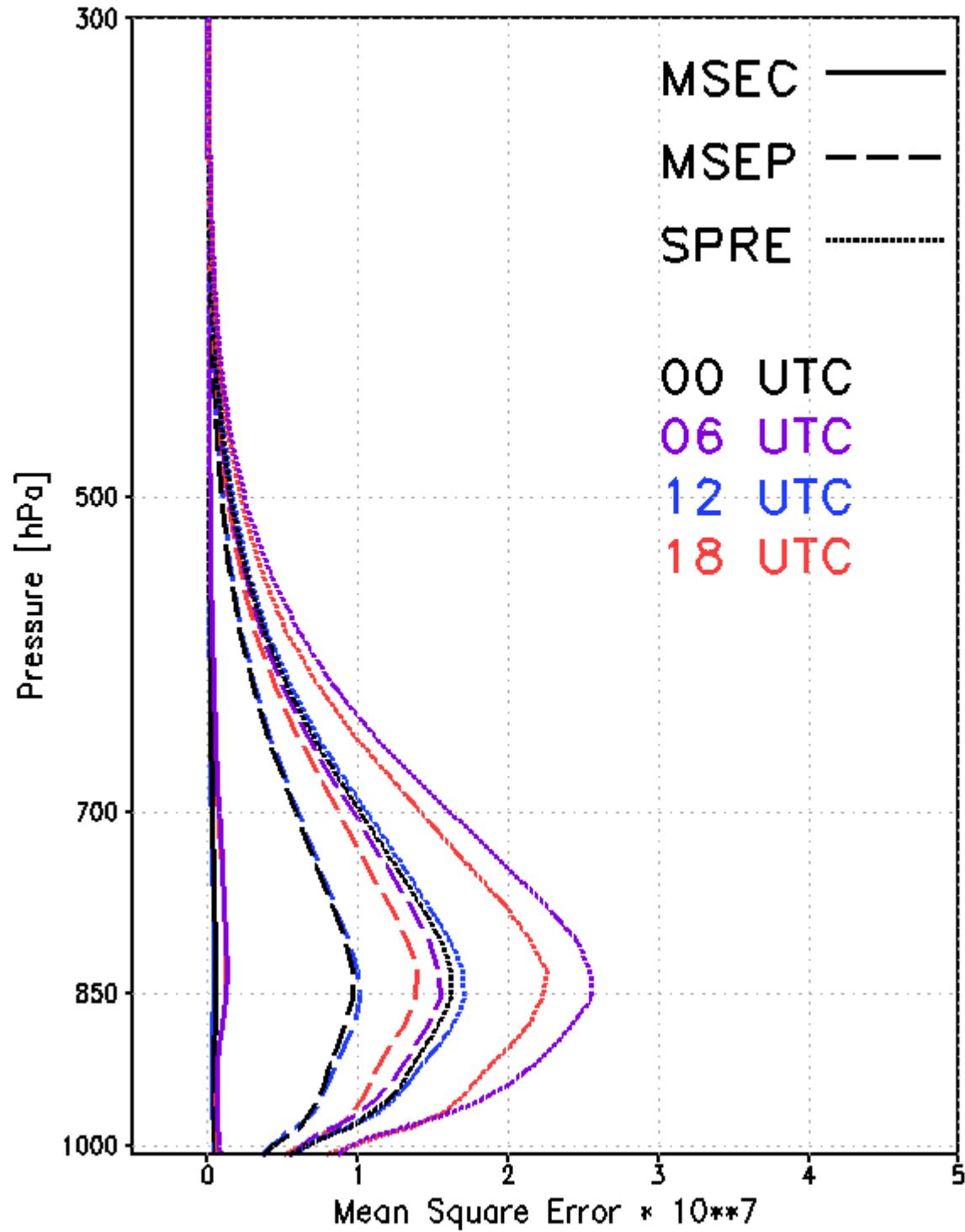
Amount of Observations



ETKF HYBRID TEMPERATURE TF=06 hr



ETKF ATOVS SPECIFIC HUMIDITY TF=06 hr



Conclusions

- **The Hybrid System improves some aspects of the ETKF performance**

Conclusions

- **The Hybrid System improves some aspects of the ETKF performance**
- **ATOVS data has a beneficial impact on the ETKF performance**

CAVEAT

- **Only 2 weeks diagnosed**

CAVEAT

- **Only 2 weeks diagnosed**
- **Only 12 members**

CAVEAT

- **Only 2 weeks diagnosed**
- **Only 12 members**
- **Climatological SST and Sea Ice**

CAVEAT

- **Only 2 weeks diagnosed**
- **Only 12 members**
- **Climatological SST and Sea Ice**
- **Only 1 ATOVS Channel**

CAVEAT

- **Only 2 weeks diagnosed**
- **Only 12 members**
- **Climatological SST and Sea Ice**
- **Only 1 ATOVS Channel**
- **Too strong localization**