# Tropical Diagnostics for NWP

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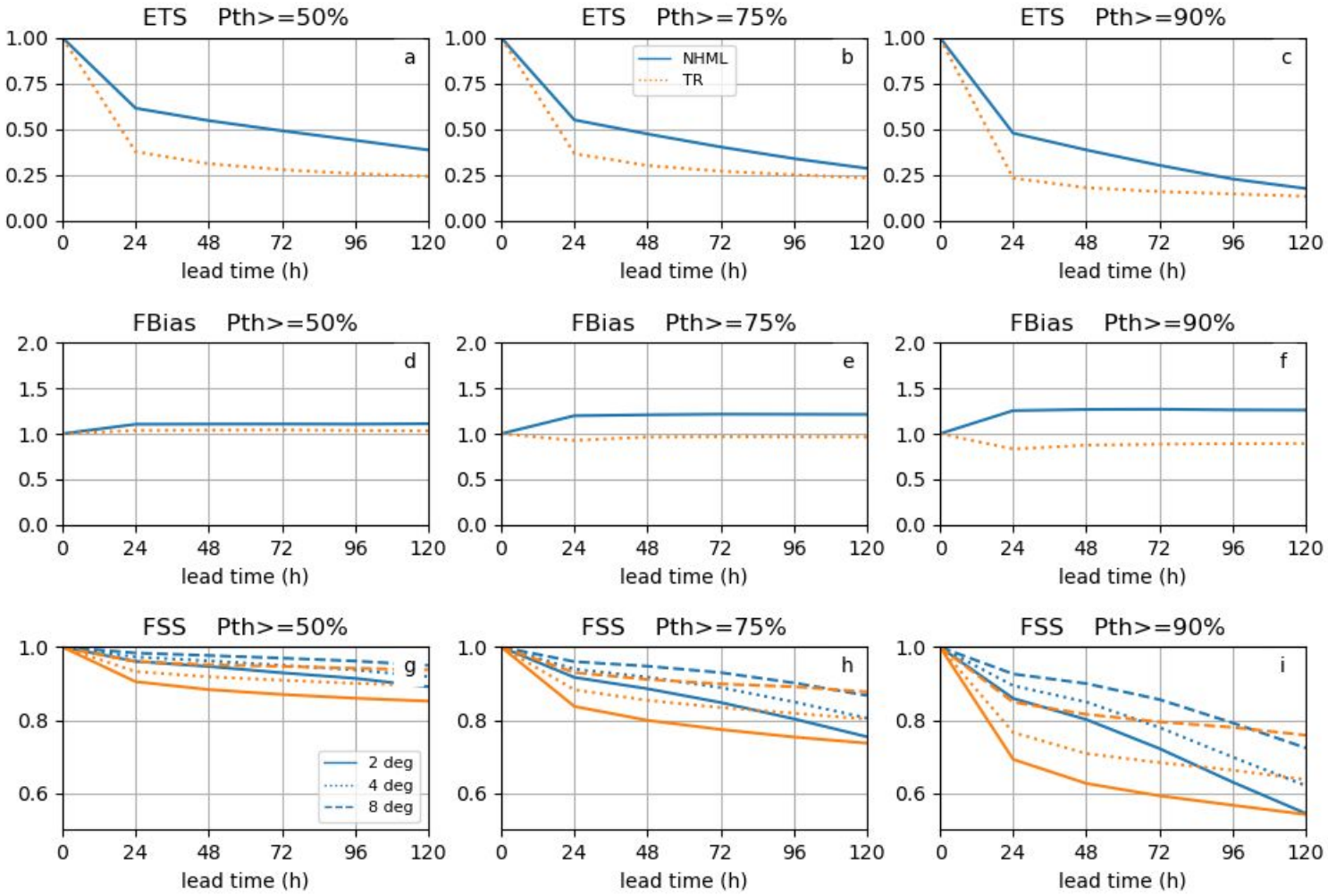



NWP models tend to perform better in mid-latitudes than in the Tropics.

- The underlying dynamics of are different in the Tropics and mid-latitudes.
- Convection is main driver of precipitation in the Tropics.
- Convective parameterization has a larger impact on precipitation in the Tropics.

# Tropical Diagnostics for NWP

- Develop metrics and diagnostics for NWP in the Tropics.
  - Better understanding of NWP model behavior with respect to tropical convection.
  - Focus on process-oriented diagnostics.
- NWP evaluation presents different challenges than climate model evaluation.
  - Forecasts are shorter: days-weeks.
  - Model versions change frequently.
  - It is rare to have long (multi-year) time series of operational model runs.

Development of diagnostics are focused on FV3GFS and the S2S database together with ERA Interim and observed precipitation data sets.

Consider diagnostics as a function of lead time.

If certain phenomena are initialized correctly, how long is the model able to keep that information?

# Diagnostics

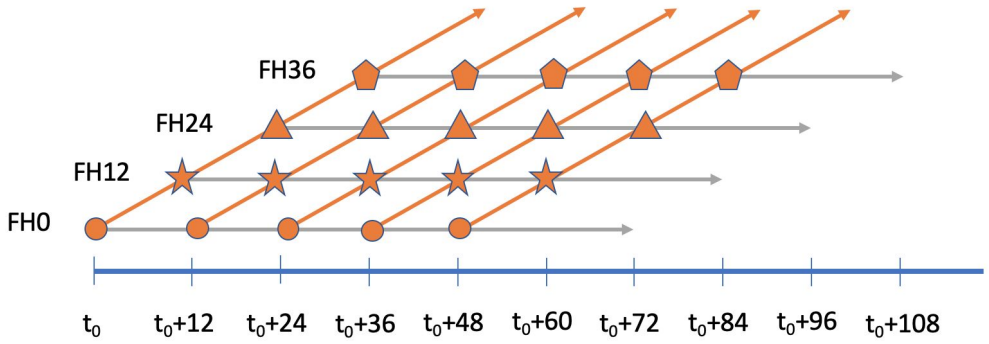
- Hovmoeller diagrams and pattern correlation

  (propagation)
- Space-time coherence spectra

  (scales of coupling to moisture)
- Vertical structure of coherence between precipitation and dynamical fields

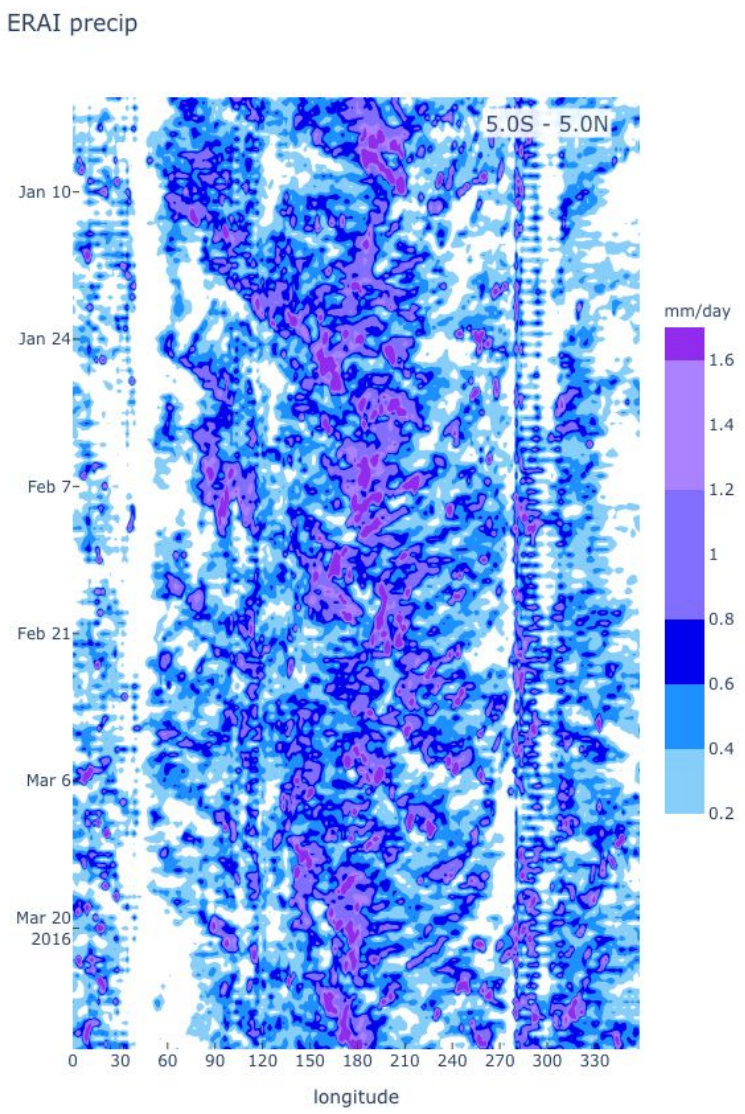
  (vertical structure and phase relationship within CCEWs)
- Convectively coupled wave activity and skill

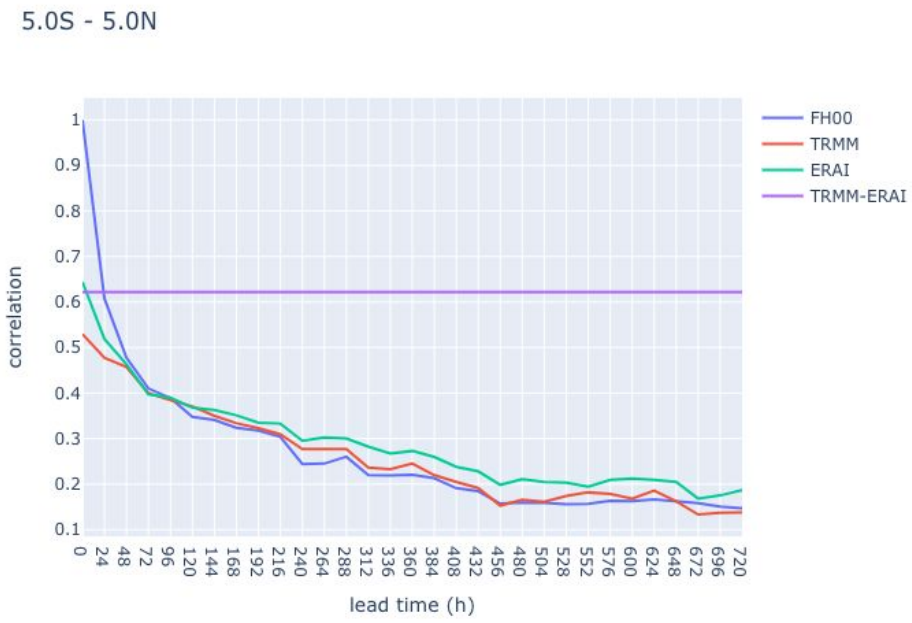
  (CCEW propagation)




FV3GFS V15.1.1 with GFS physics run at C128 with SSTs relaxed to climatology. Initialized every day from 20151101 to 20160331 (152 forecasts) and run out to 30 days.
S2S model forecasts used as well to test the diagnostics.
For verification we use TRMM3B42 and PERSIANN CDR precipitation and ERA Interim reanalysis.

# Hovmoeller diagrams and pattern correlation



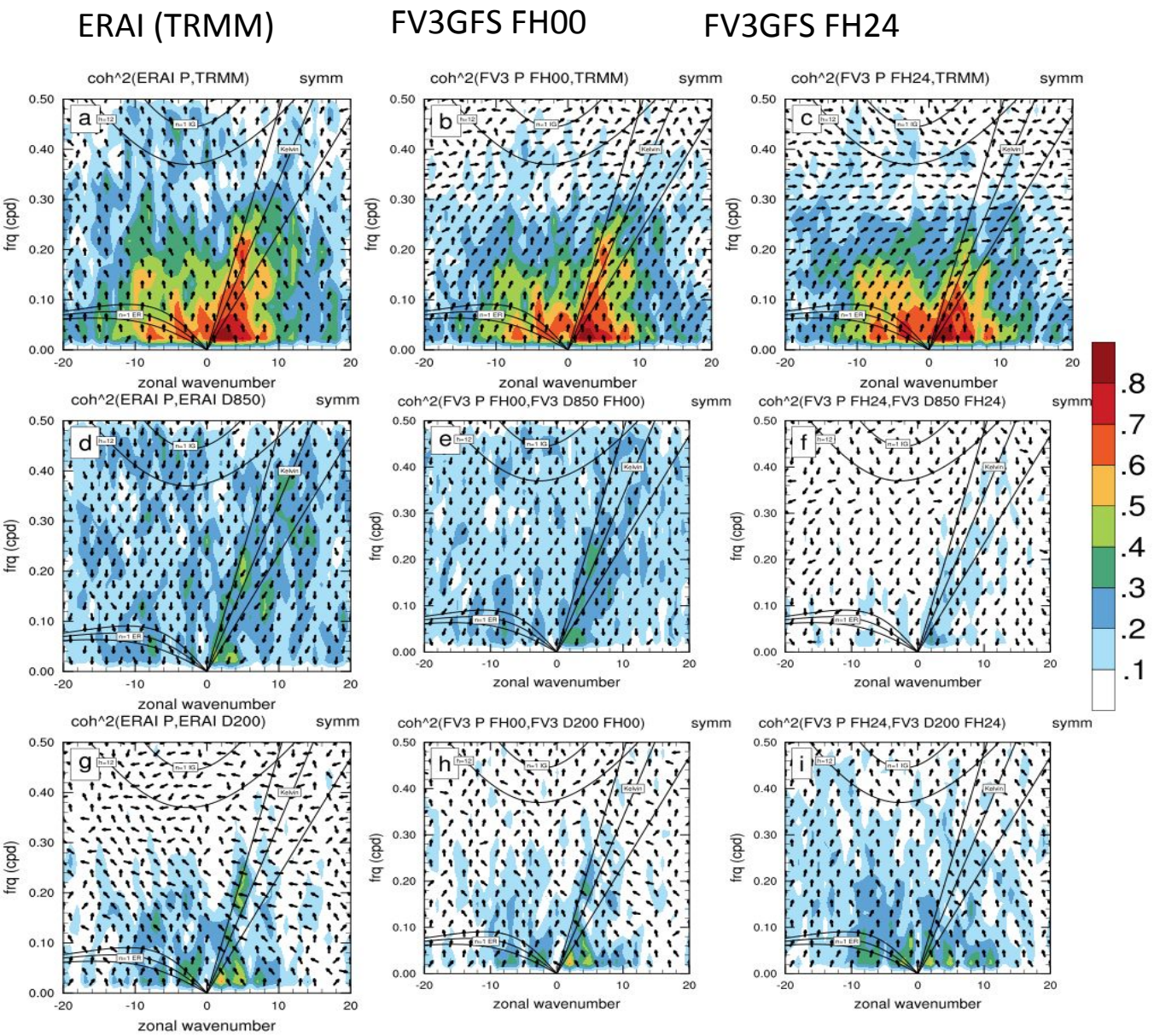




Assess the zonal propagation of convective features.

Pattern correlation between forecast and 'truth' can be used as a skill score.

- Example of C128 (1degree) FV3GFS forecast compared to FH00, ERAI and TRMM precipitation.
- FV3GFS precipitation forecast quickly diverges from FH00 precipitation.
- Pattern correlation is below 0.5 by FH48.

# Space-time coherence spectra




$Coh2(P_{obs},P_{fcst})$

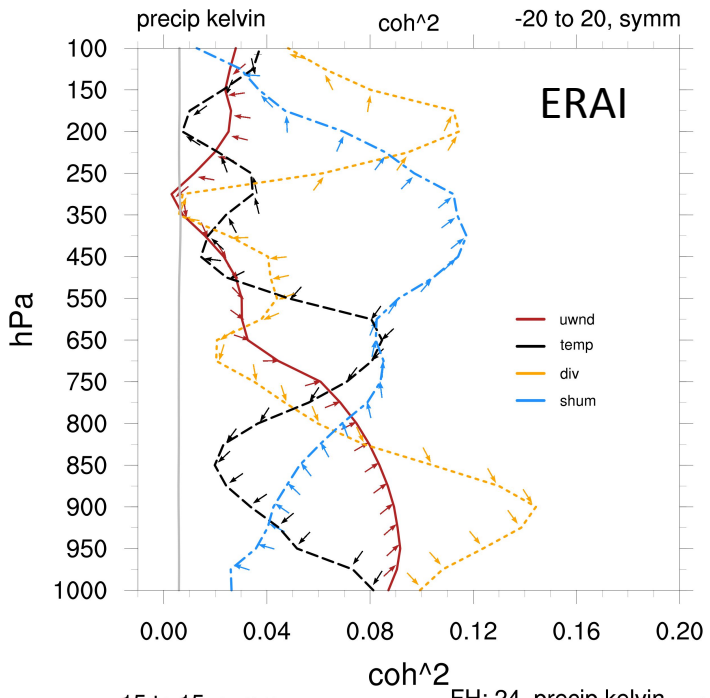
$Coh2(P,D_{850})$

$Coh2(P,D_{200})$

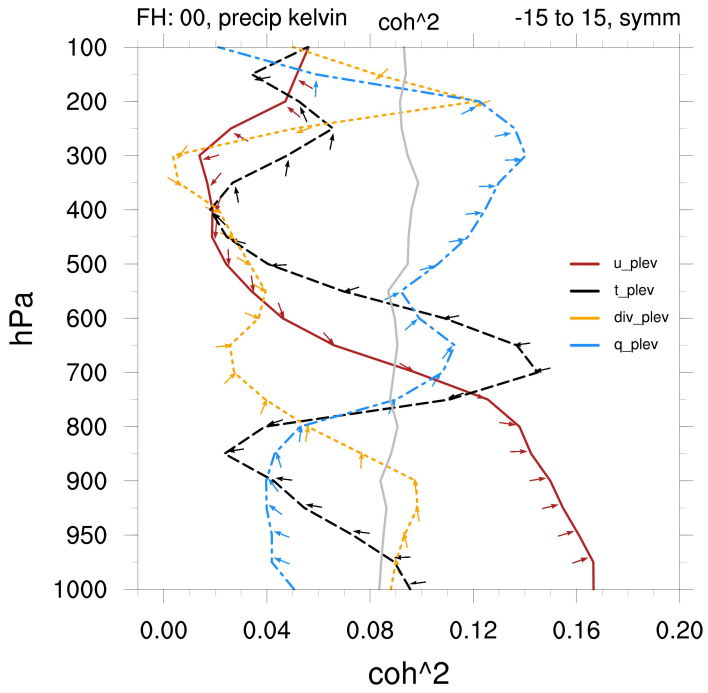
- How well do models initialize and propagate CCEWs?
- Coherence spectra show space-time regions of tropical variability without having to estimate a background.
- Evaluate the consistency in variability between modeled and observed precipitation at a range of spatial and temporal scales.
- Possible to evaluate precipitation – dynamics relationship strength and how it changes with lead time.

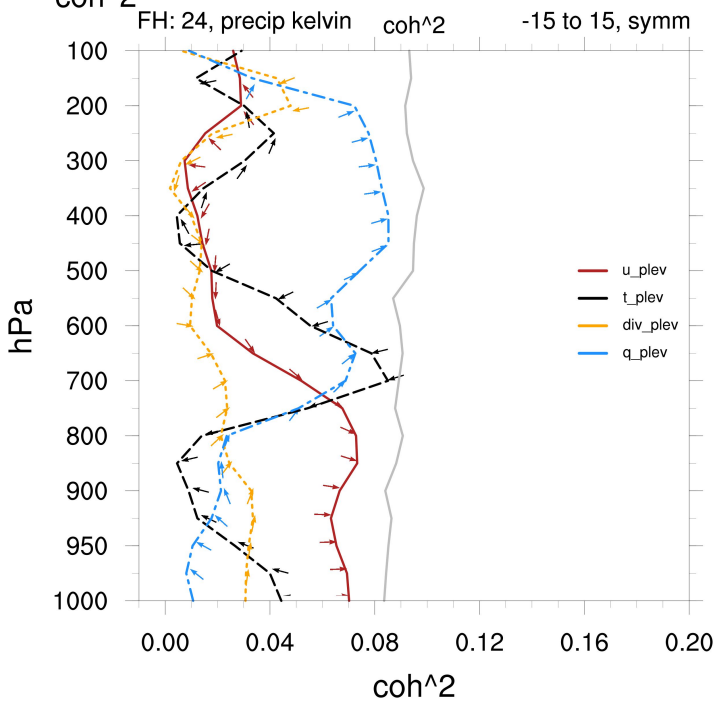
# Vertical structure of coherence

- Proxy for vertical profile of latent heating associated with deep convection.
- Filtered P is used to compute coherence with dynamical variables at all vertical levels.




Results point to issues in the coupling between large-scale dynamics and convection.
The divergence coherence appears too weak and decreases with lead-time.
Vertical structure of wave coherence is well represented at initialization.



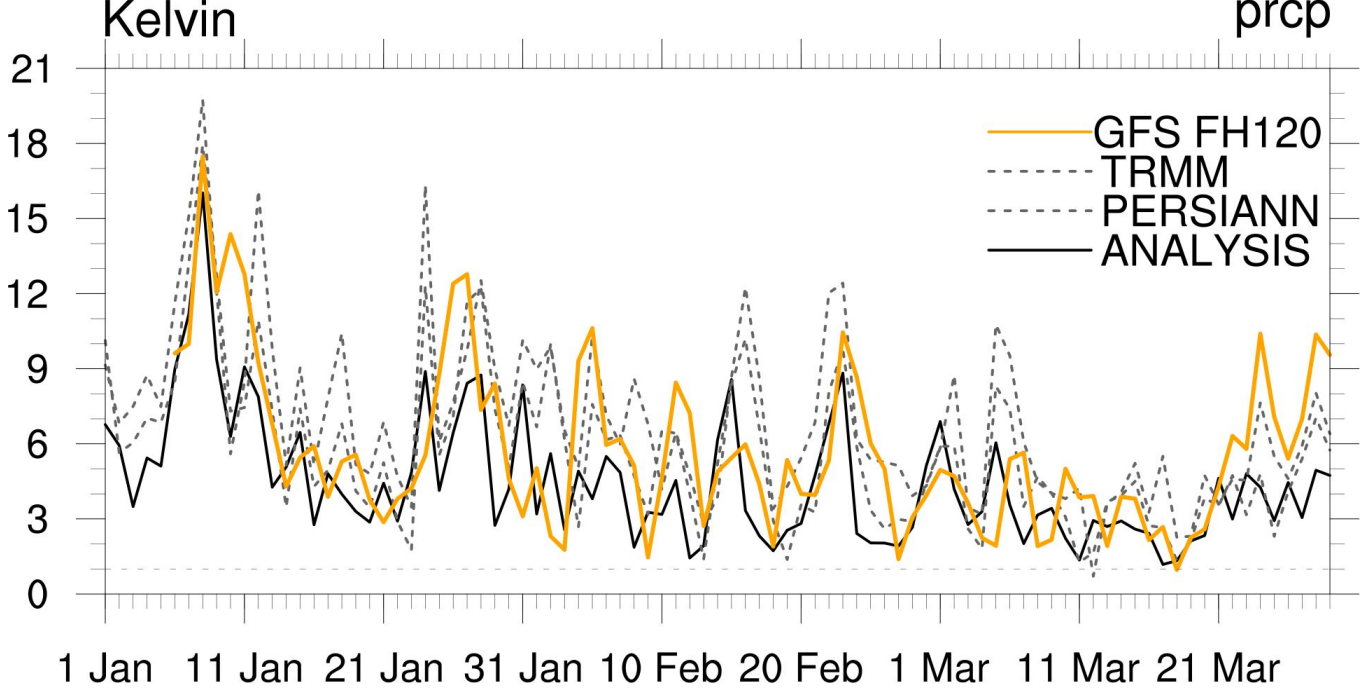
# CCEW activity

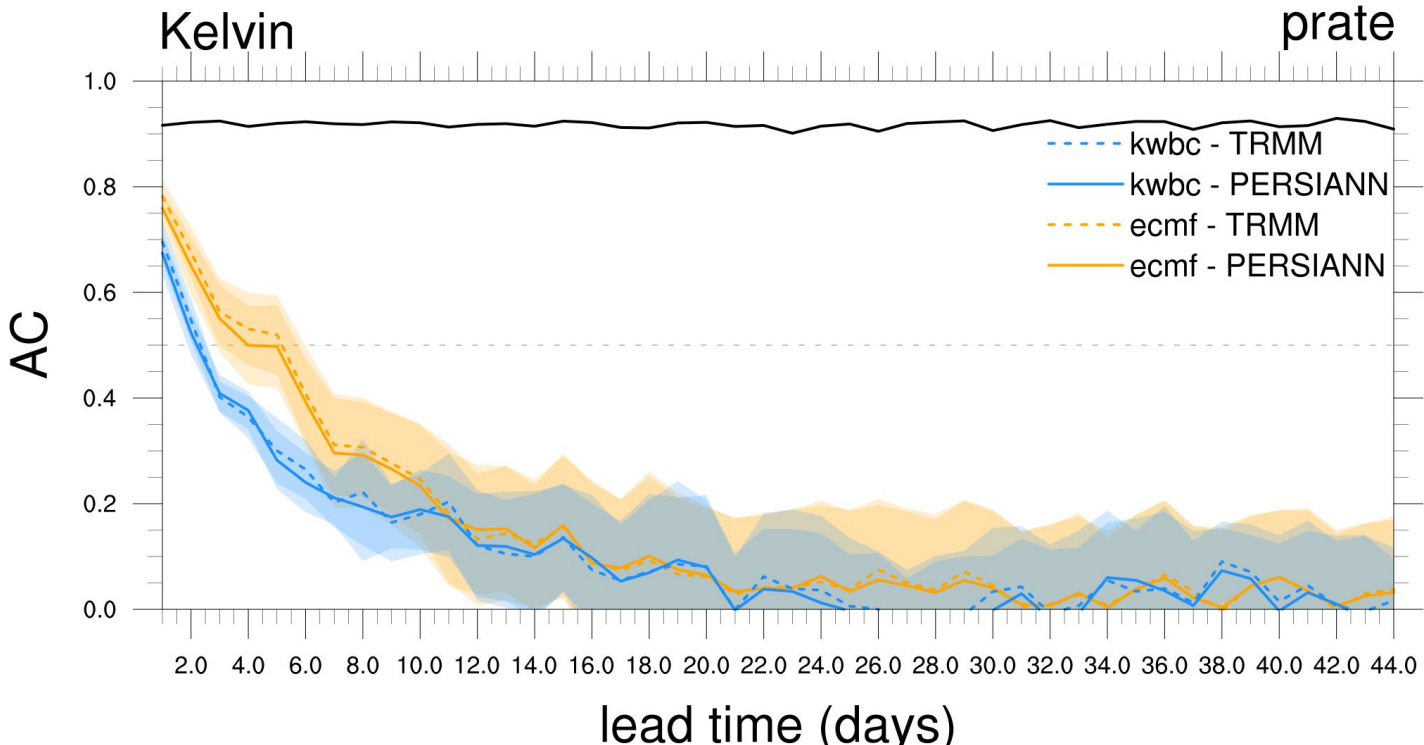
How long and how well can the model predict CCEWs?

1. Use long time series (30+ years) of observed filtered precipitation to compute EOFs describing CCEW signal.

2. Project the model precipitation at each forecast hour onto these EOF patterns and compute a CCEW activity index.

3. Compute anomaly correlation between the observed and model index.



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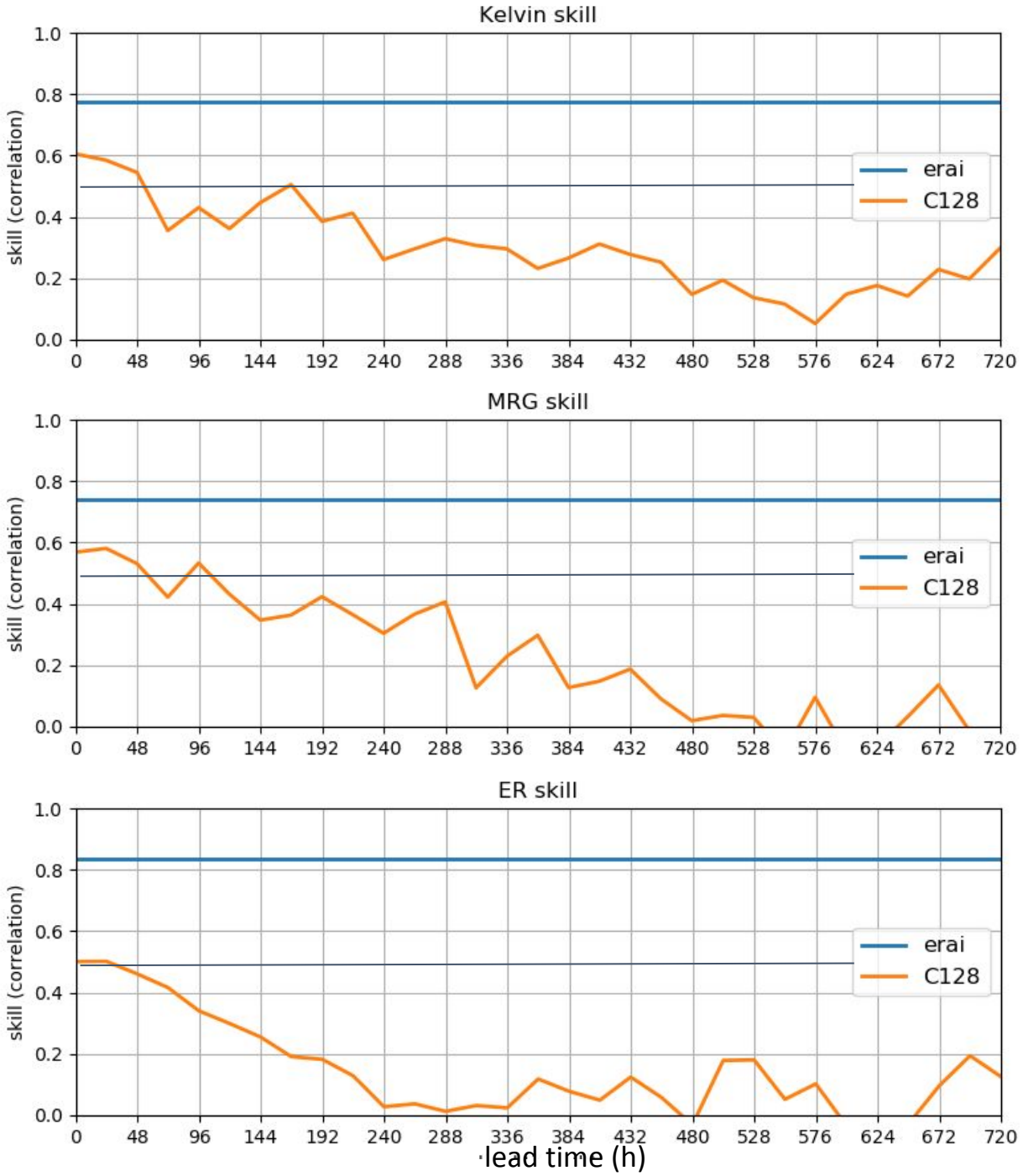
Kelvin and MRG activity forecasts are skillfull past 48h, ER forecasts are skillful for 24h. MJO forecasts are not skillful based on this metric.



# Summary

- Diagnostics for NWP model evaluation in the tropics for NOAA's NGGPS.
- Focus here is on finding ways to assess the models' behavior on time scales longer than a few days, using only short NWP model forecasts.
- Consider diagnostics as a function of lead time in order to assess origins of forecast errors (e.g. initial conditions vs model error).
- Currently working on building a python module for these diagnostics.
  - Easier sharing of the toolbox.
  - Planning on adding these capabilities to METplus and MDTF.
- A python github repo for these diagnostics exists and will be made public in the future.

Thank you