Comparing NWP methods to evaluate climate models

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NWP techniques for climate models

Two approaches are proposed:

- Transpose-AMIP (Phillips et al. 2004)

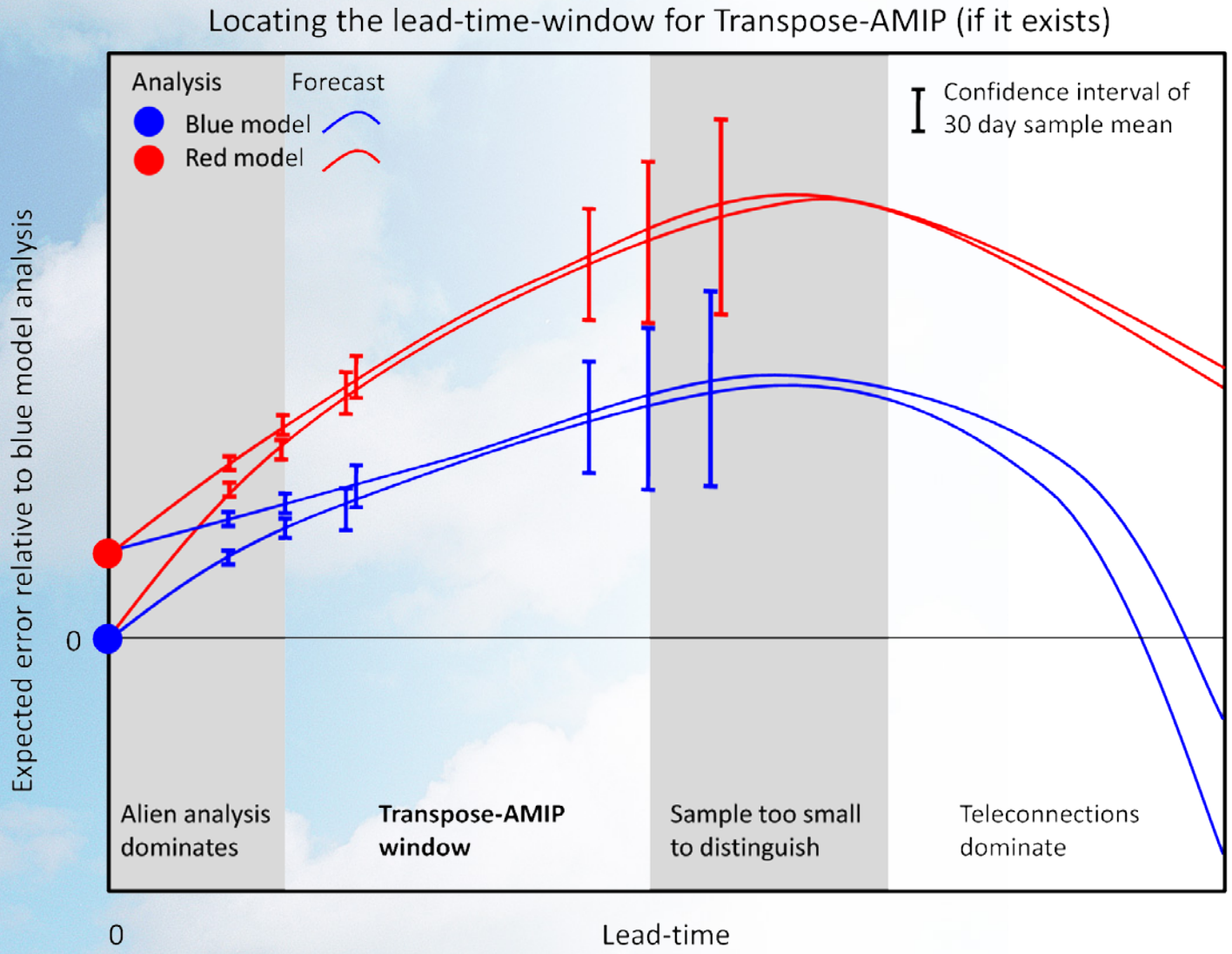
  Use an analysis produced with an alien model to initialize forecasts

- Initial tendencies (Rodwell & Palmer 2007)

  Produce own analysis with data assimilation

- What can be learned using those methods?
- What are the limitations and potential problems?

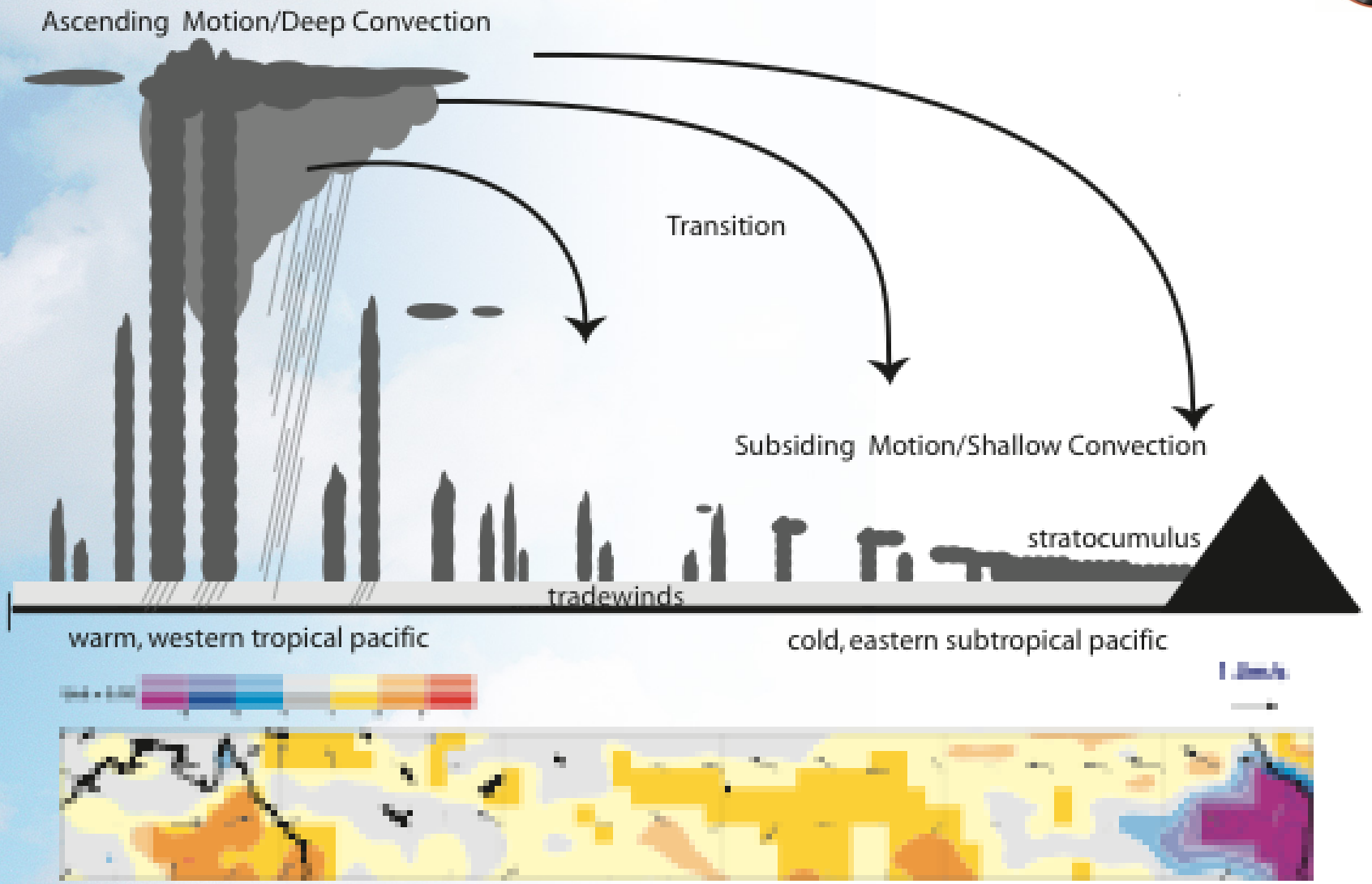
What is the right time scale?



Optimistic:
Initial shock

Pessimistic:
Fast physics error

The test field



Assimilation increment (inverse of the forecast error)

Adapted from Stevens, who adapted from Arakawa

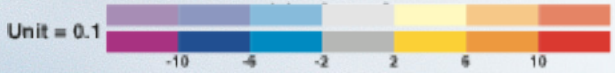
- CY37R2, April-May 2011, four forecasts a day in T159L91, dt=30min and radiation is called every hour. Dealiasing is used for less noise in the tendencies over high orography.

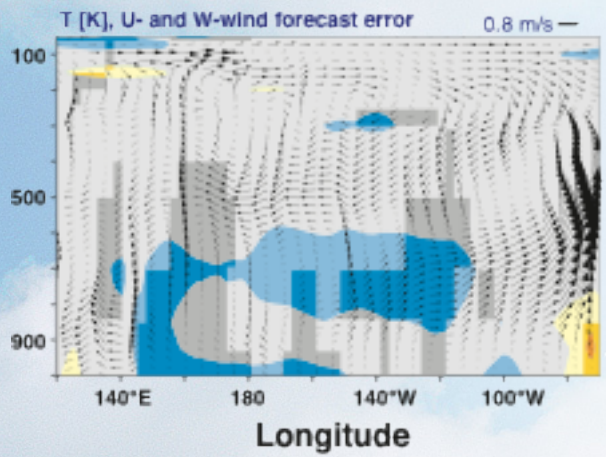
- 6 hour data assimilation windows centred at 00, 06, 12, 18 UTC
  - Each forecast initialization is informed by new observations

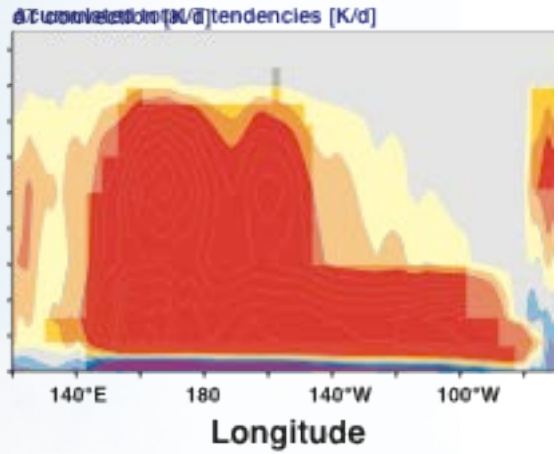
- Alien analysis from UKMO, same dates, but only 12 UTC (from amap)

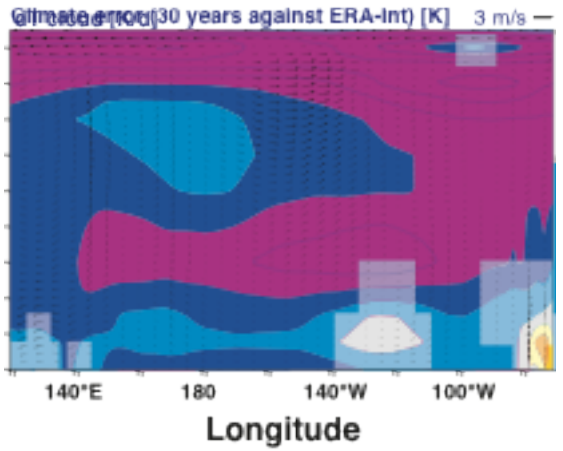
  Only T, U, V, RH are used (IFS P_s is used in the interpolation) on 15 pressure levels.

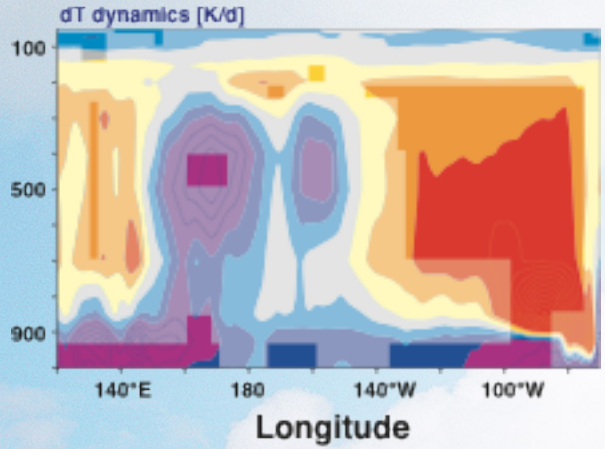
0h to 24h

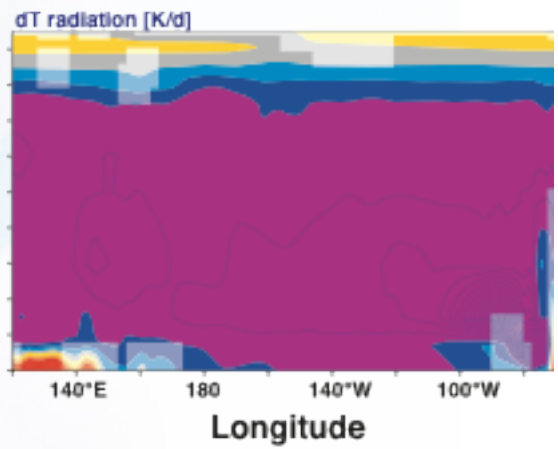


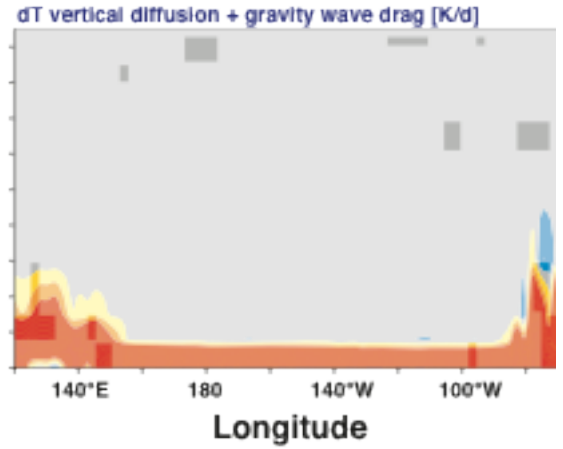






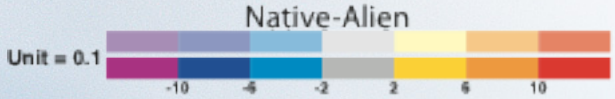


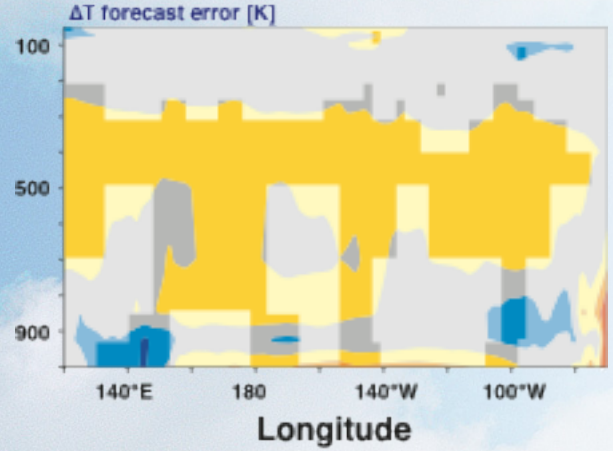


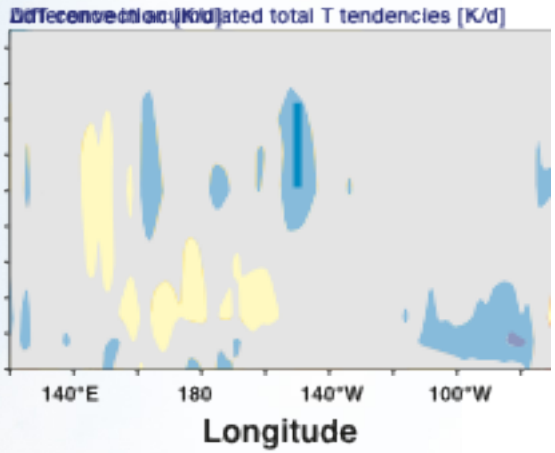


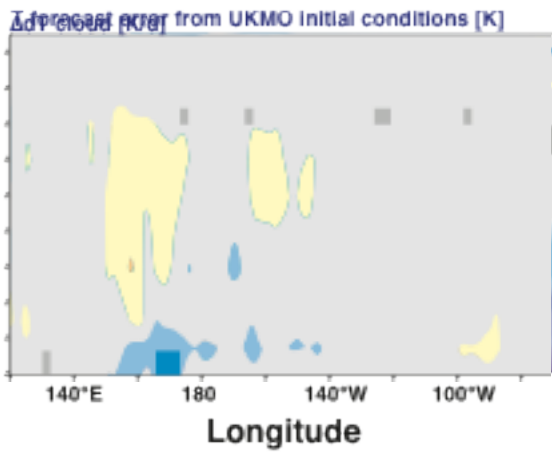
The ‘true’ error

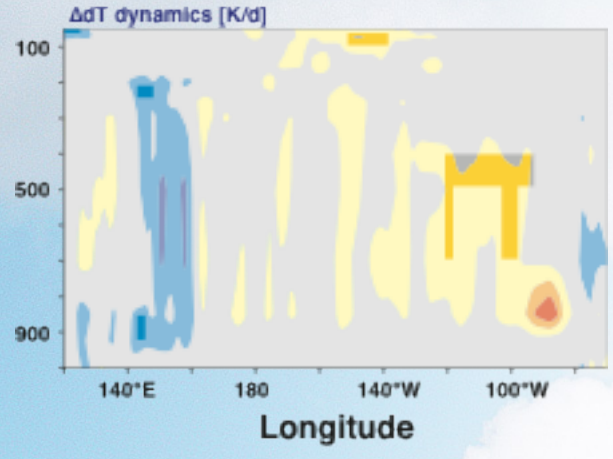
0 to 24h

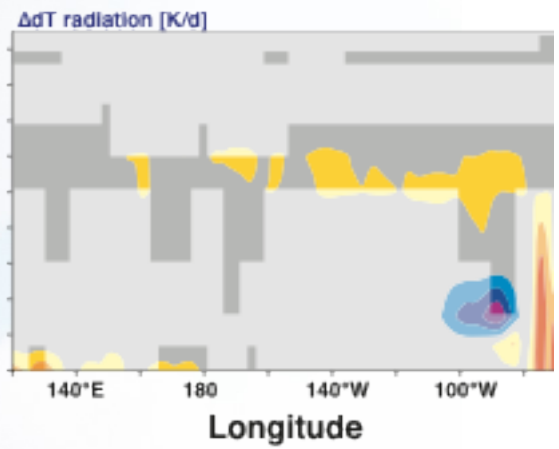


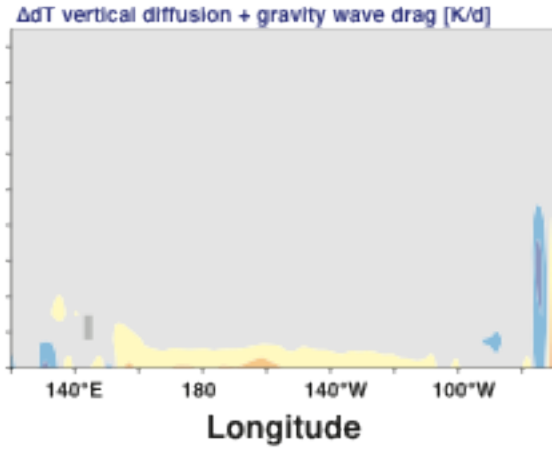






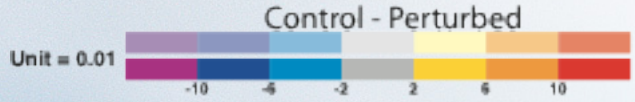


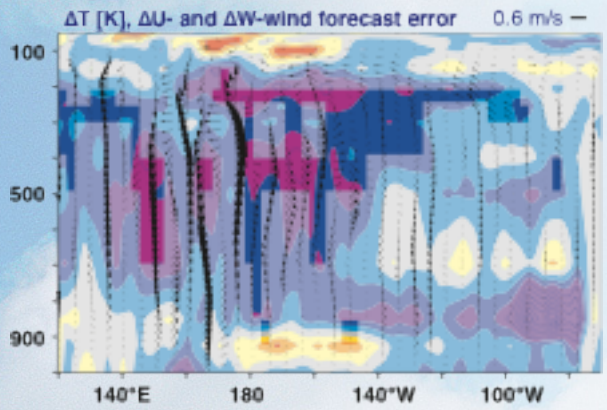


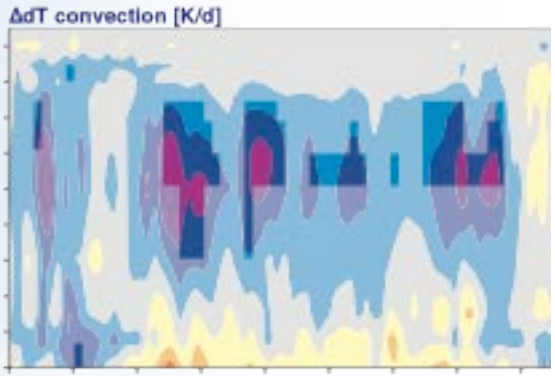


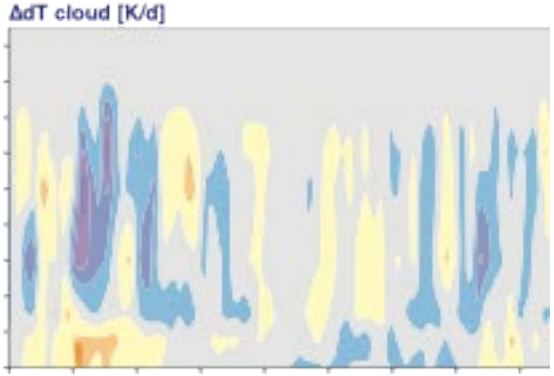
Too cold (which is in the initial conditions)

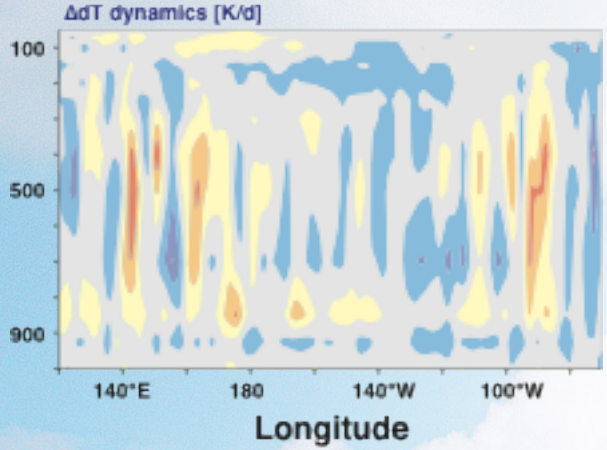
0 to 6h (*4)

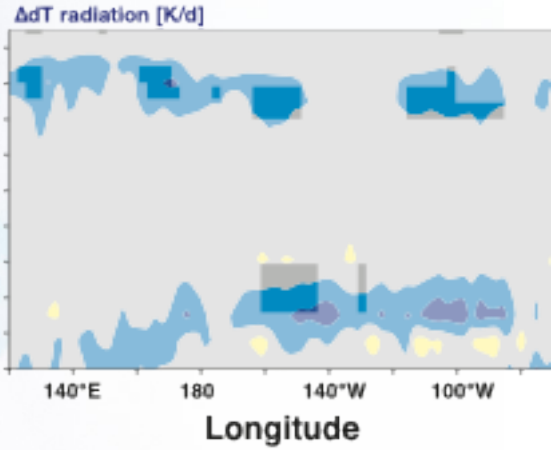


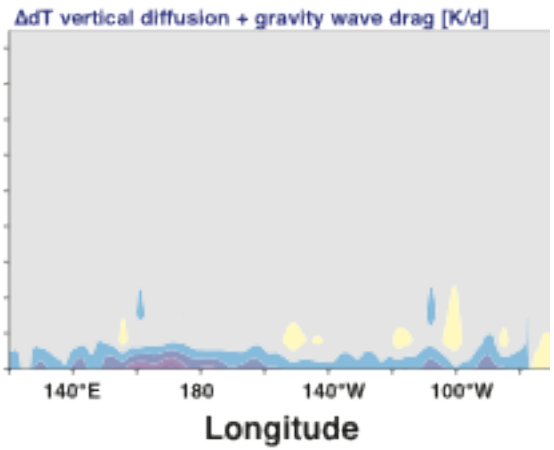






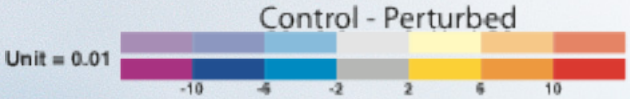


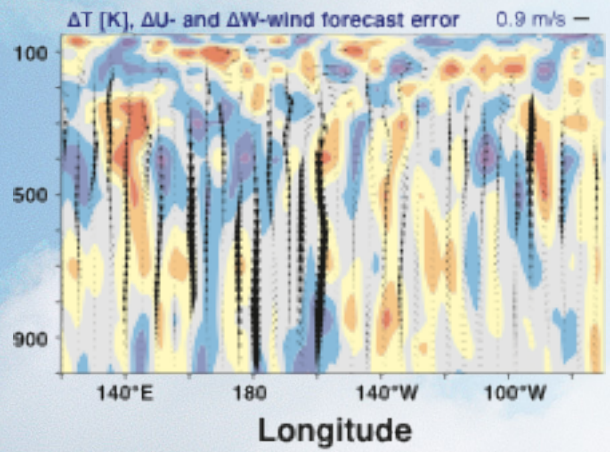


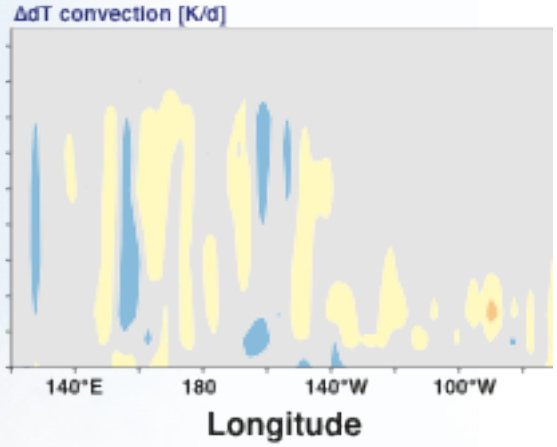


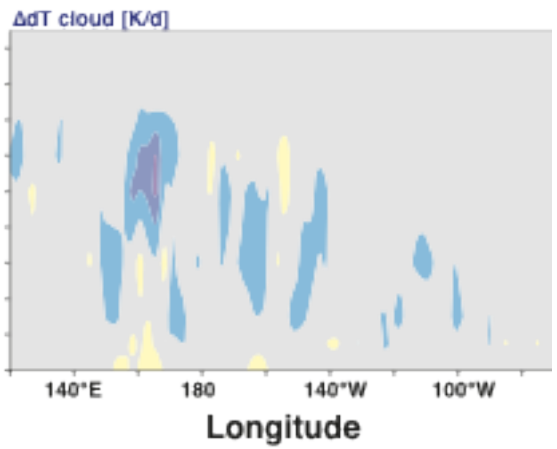
Decreased entrainment (ε/3) -> warmer

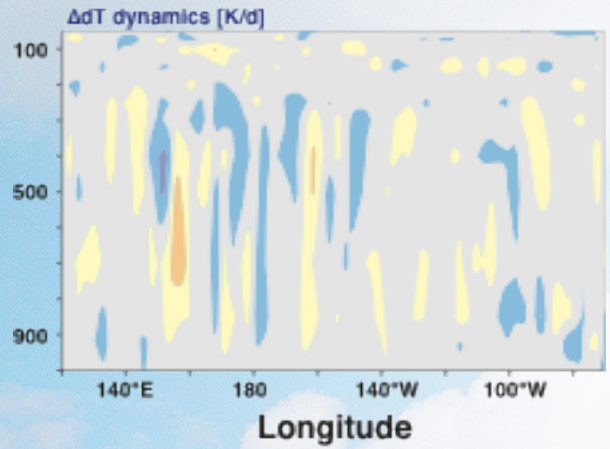
Day 5-4.75 (*4)

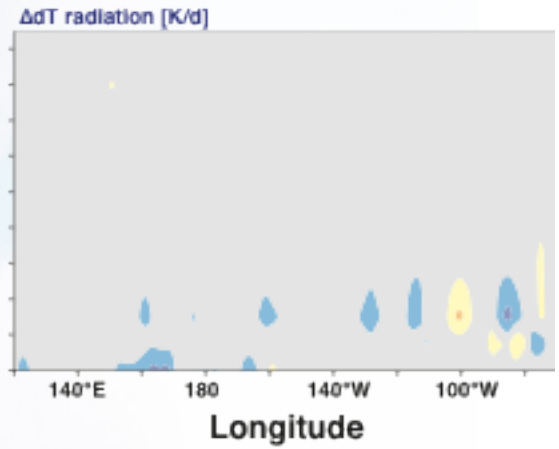


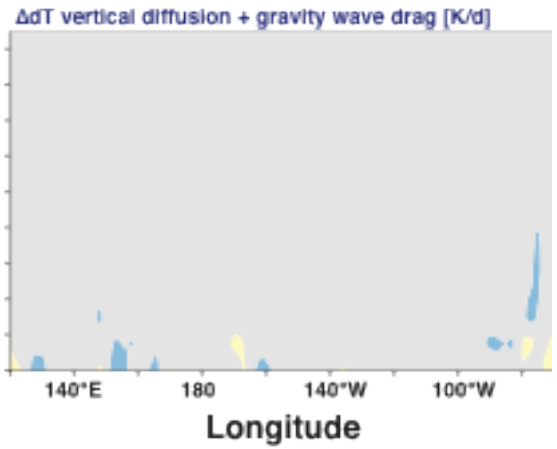






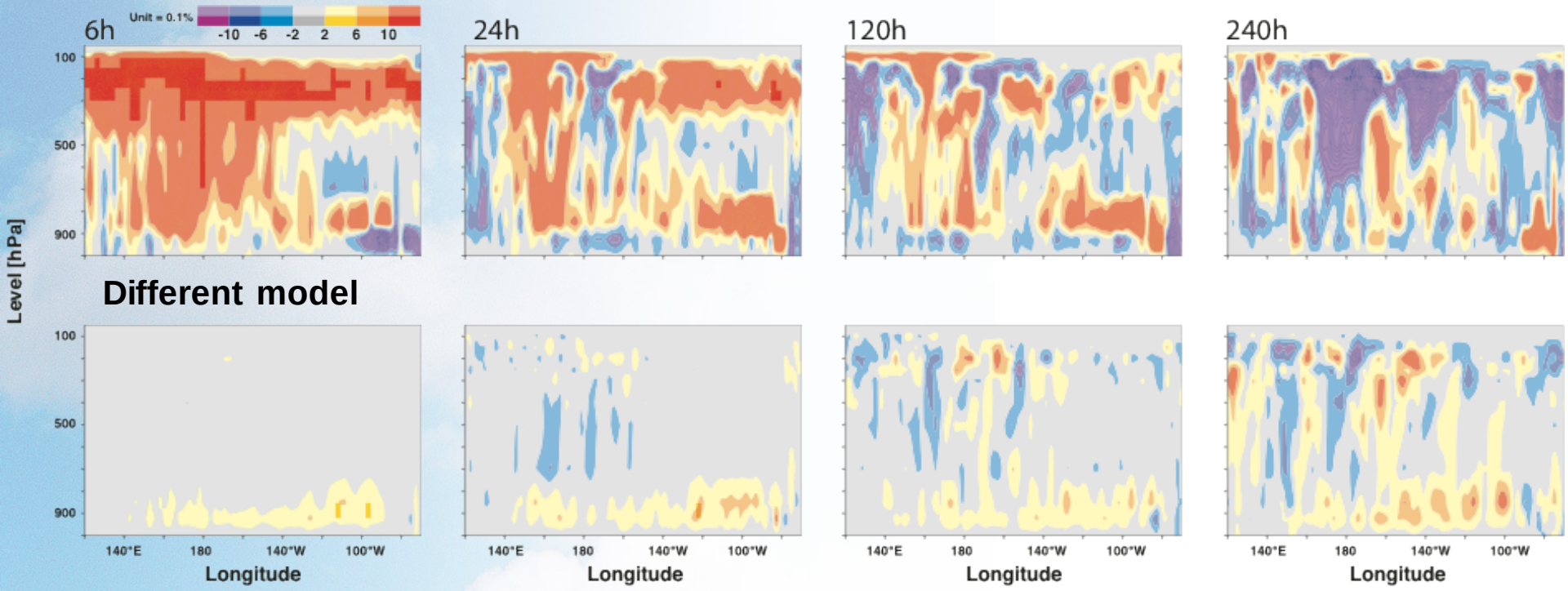




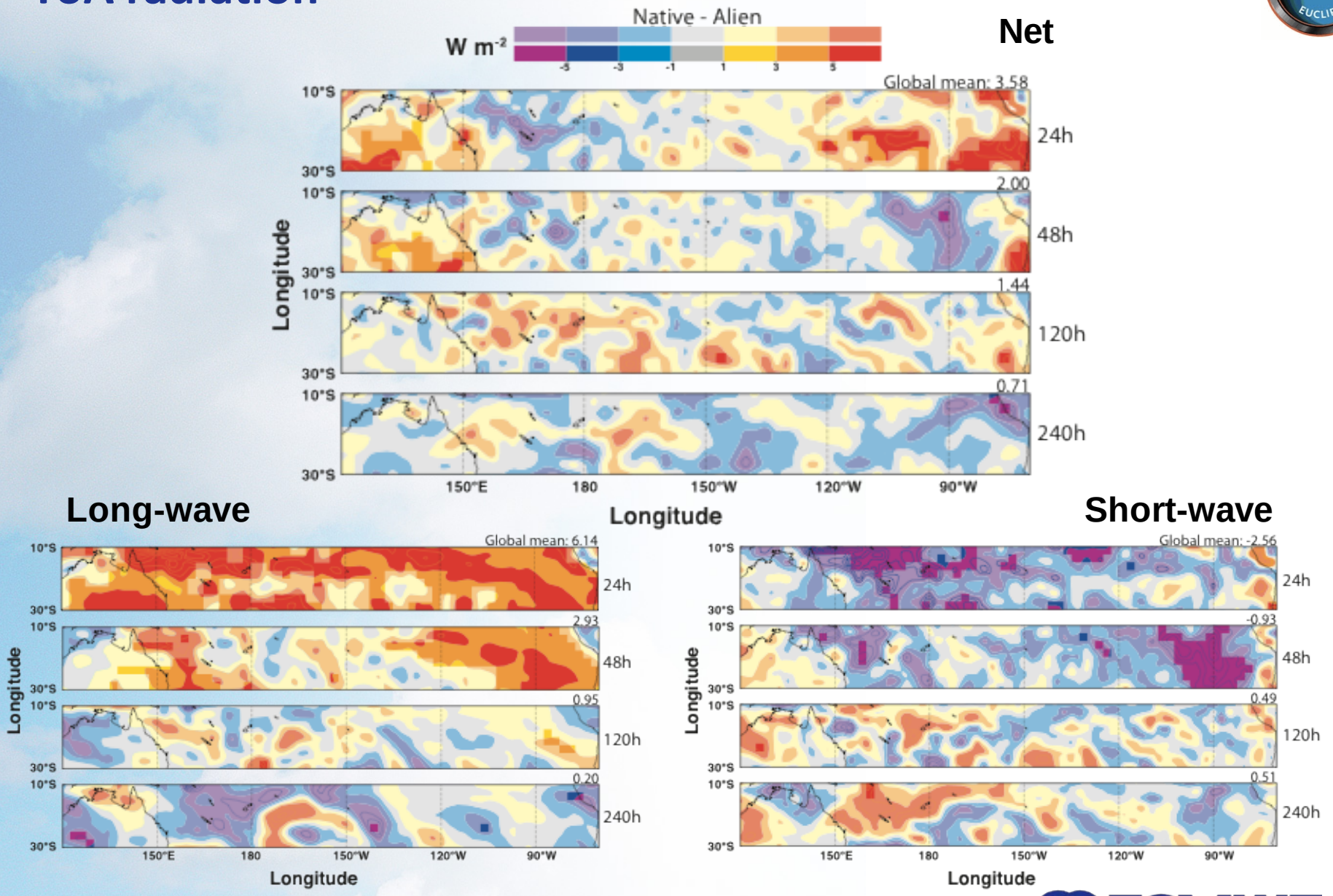


Signal in the mean state and tendencies disappears

What does that mean for clouds?



ToA radiation



Conclusions

- Fast physics are relevant from short time scales to climate change signals.

  They should be assessed before they interact/feedback with other processes.
- There is some potential that NWP techniques help to make climate projections converge.
- Perturbations introduced by initial conditions produced with an alien forecast model can introduce spurious ‘errors’ larger than the model error.
- With the ‘truth’ absent, it is impossible to know if the ‘error’ is an error.
- Individual tendencies are large, but they balance. The sum of all tendencies are identical to the model forecast error in a certain variable.
- Tendencies can be attributed to single processes in order to identify the error source. (also the error is often hidden in the interplay of several processes).
- At longer lead times error sources get hard to identify, as processes interact and feedback on each other.

Outlook

- Similar tendency experiments with climate GCMs could reveal differences in fast processes (nice example on Monday by Tomoo Ogura), which might be related to the long term climate response.
  - No truth, but relative differences can be assessed.
- Compensating errors, relative ‘work’ of processes can be revealed.
- Response of processes to perturbations can be compared without a maybe dominating effect of the atmospheric state.

- More tomorrow….