The UERRA Cloud Cover Analysis Study: An Extension

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Structure of the talk

1. How this has started ...
2. Space-scale dependent decomposition
3. Brand Ensemble
4. Why Low Clouds Cover in Summer Afternoon?
5. Scales of variability in high-resolution ensemble
6. Lessons learned from this study
How this have started

**UERRA : cloud cover fraction analysis**

"**super-observations** (so)"

- Polarorbiting GAC polar data
- Composite
- Geostationary
  - CLAAS
  - SARAH

**Horizontal resolution**: 5.5km

**Time resolution**: every hour (1982-2013)

**Observations**: superobservations of cloud mask/cloud probability from AVHRR and SEVIRI

**First guess**: HIRLAM CCF reanalysis 22 km

\[
CCF = \frac{\sum w_i CM_i}{\sum w_i}
\]
D = d_{so}^{T} \cdot d_{so}^{b}, R = d_{so}^{T} \cdot d_{so}^{b}, B = d^{a} \cdot d_{so}^{b}

K = B / (B + R)

\[ x_{a}^{b} = x_{a}^{b} + dx_{a}^{b} \; ; \; dx_{a}^{b} = K(y_{so}^{b} - x_{a}^{b}) = Kd_{so}^{b} \]
One year average (365 days) 03 UTC

Cloud Cover Mask 2009
Space-Scale Decomposition

Cloud Cover Mask

Scale 1

Scale 2

Scale 3

Scale 4
“Brand” perturbations
10 members+control (2012061203 - 2012062718)

The Scheme: generation of perturbations with the structure of B-matrix covariance.
Domain and Flow situation

Temperature 850hPa

Specific humidity 850hPa

Surface pressure
Why Cloud Cover?

- Short waves radiation flux
- Medium Cloud Cover
- Parameterization
- Long waves radiation flux
- Low Cloud Cover
Why Low Clouds Cover In Summer Afternoon?

Structure functions ("KE spectra") of WRF and HARMONIE (2.5 km grid) over Iran (average of 2 cases)

Sensitivity experiments with HIRLAM over the same domain (5 km grid) – single case:

SISL (Semi-Implicit Semi-Langrangian) 60s
SISL 20s
SI 20s quadratic grid
SI 10s quadratic grid
Explicit 10s quadratic grid
Explicit 10s quadratic grid; reduced HD (0.1)
SI 15s quadratic grid Sundquist scheme
Ensemble of specific humidity 850 hPa
Dynamical consistency of evolution Ensemble member 4

Temperature 850hPa

Cloud water 850hPa

3h accumulated precipitation

Specific Humidity 850hPa

Low Cloud Cover
Advantages and Limitations

Variance of Cloud Water

Correlations of Cloud Water at Lev 47 (≈850 hPa) "x" location

+ Physically meaningful structures
- Sampling noise in particular for correlations with control variables

(Upside-down projection ...)

...with CW Lev 47

...with T Lev 47
Ensemble characteristics

Space-Scale Dependent Decomposition

Domain: 637x637 grid-points@2.5km
Cross-correlation between Cloud Water ("black box") and Temperature field (Model Level 47) ≈ 850 hPa
Auto-correlation between Cloud Water ("black box") and Cloud Water field (Model Level 47) \(\approx 850 \text{ hPa}\)
Lessons learned ....

- Space-scale decomposition is a powerful technique to extract different scales of variability => Guidance from the nature of the variability can be used to define the decomposition.

- HARMONIE AROME model is not able to create the meso-scale spectra in the free atmosphere above 500hPa => Despite of this the model is capable to spin-up cloud related processes relatively quickly in the lower atmosphere.

- The sampling error is a challenge when one is restricted to a small ensemble size => one possible way to progress is to improve sampling strategy (deterministic sampling approach)

- This is a challenge to extract a proper signal from the ensemble estimate of correlation when variables with different scales of variability are involved!

- Sampling error affect scales of low predictability => The small scales are not necessary related to a low predictability, in particular if processes are orography driven
Everything will be okay in the end.

If it's not okay, it's not the end!