Medium case benchmark: Double-gyre NEMO configuration

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Model description

Square-box (SQB) configuration of the NEMO model:
a square and 5000 m deep flat bottom ocean at mid latitude

- domain: $24° - 44°$ N, $30° - 60°$ W
- horizontal resolution: $\frac{1}{4}°$
- vertical levels: 11 levels between ~ 152 m and 4613 m in depth
- time integration: a leap frog scheme with time step 900 s
- calendar: 30 days per month (360 days/year)
- spin up time: 40 years

http://www-meom.hmg.inpg.fr/Web/Projets/SANGOMA/Benchmarks/MediumCase

Model state vector

17 variables:

Previous time (b : before)	Current time (n : now)	Variable description	Dimension
$gcxb$	gcx	?	2
ub	un	zonal velocity	3
vb	vn	meridional velocity	3
tb	tn	temperature	3
sb	sn	salinity	3
$rotb$	$rotn$	rotational of horizontal velocity	3
$hdivb$	$hdivn$	divergence of horizontal velocity	3
$sshb$	$sshn$	sea surface height	2
	$rhop$	?	3

Assimilation settings

- Timing parameters:
  - analysis frequency: 2 days
  - duration: one year (360 days)

- Assimilation tool:
Ocean Assimilation Kit (OAK)

http://modb.oce.ulg.ac.be/mediawiki/index.php/Ocean_Assimilation_Kit

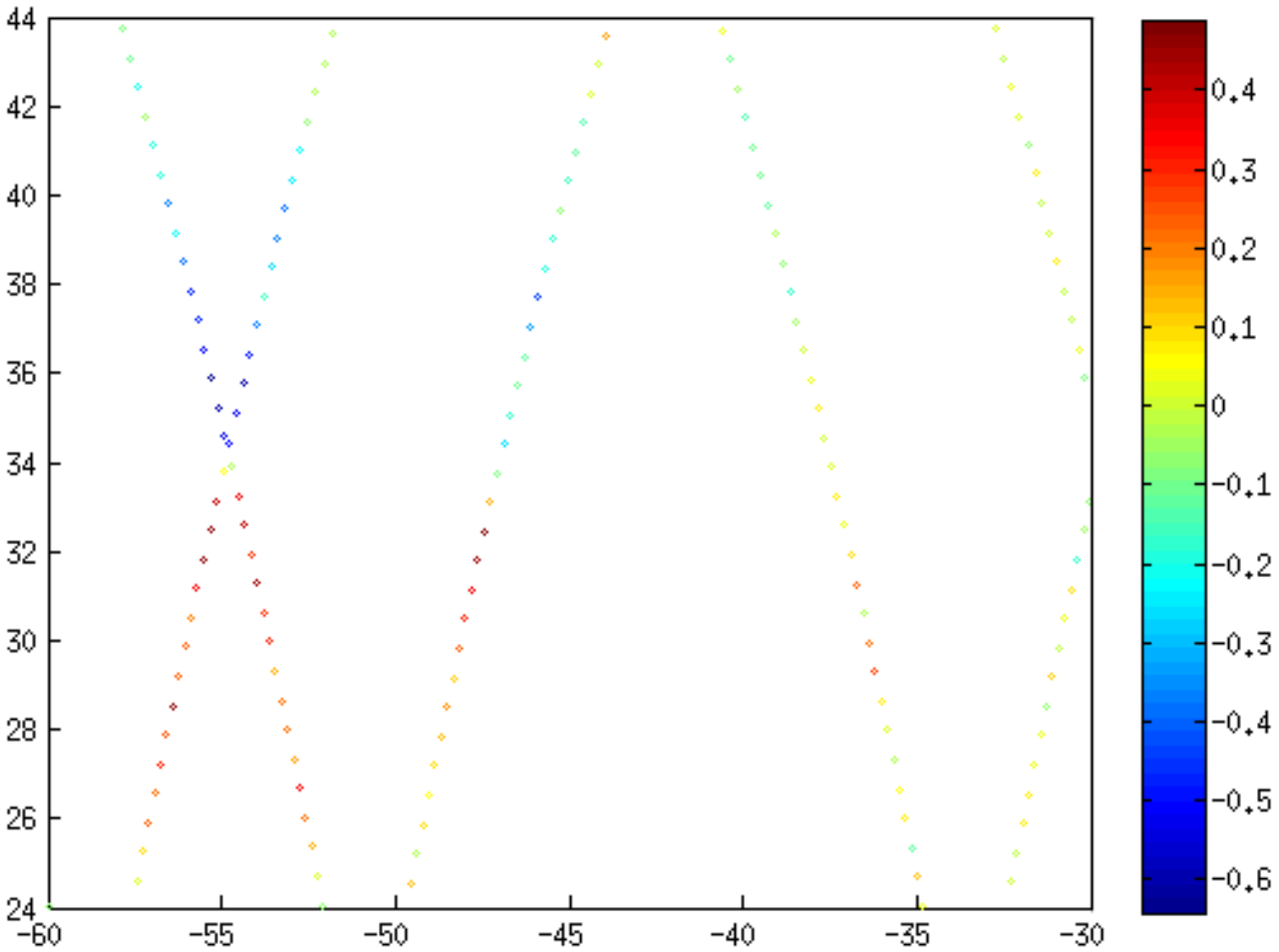
- Assimilation scheme:
local assimilation (water column by water column)

Observation generation

- Truth: model output of the year 75 from spin up
- Observations = truth + spatially uncorrelated Gaussian noise with given standard deviation (σ)
- Observation types: sea surface height (SSH) and temperature
  1. SSH:
     - σ = 6 cm
     - observation grid: simulation of satellite track (ENVISAT, Jason-1)
  2. temperature
     - σ = 0.3°
     - observation grid: simulation of ARGO profile, average spacing $3° \times 3°$

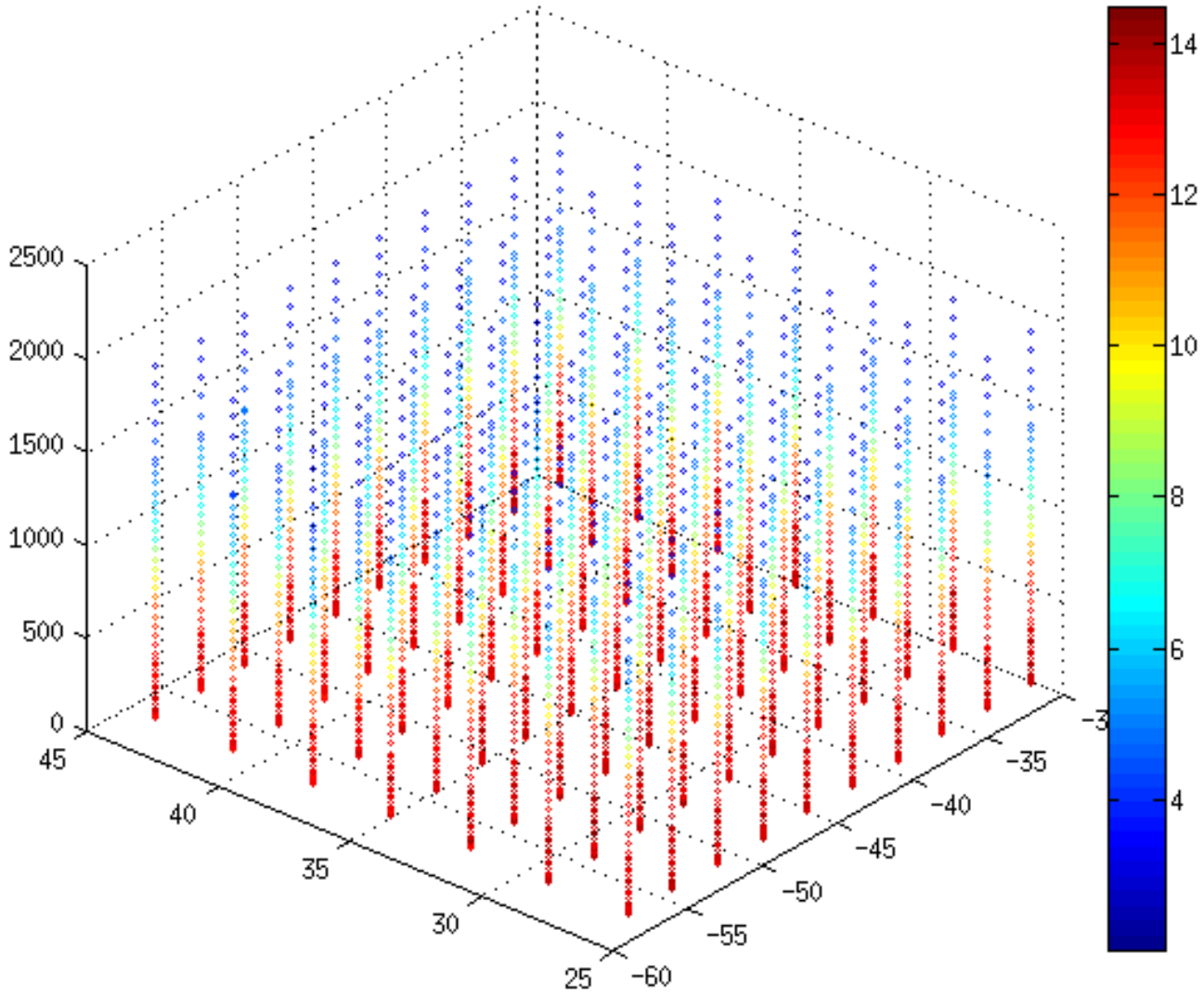
Sea surface height (m)

ENVISAT, 2009-01-01



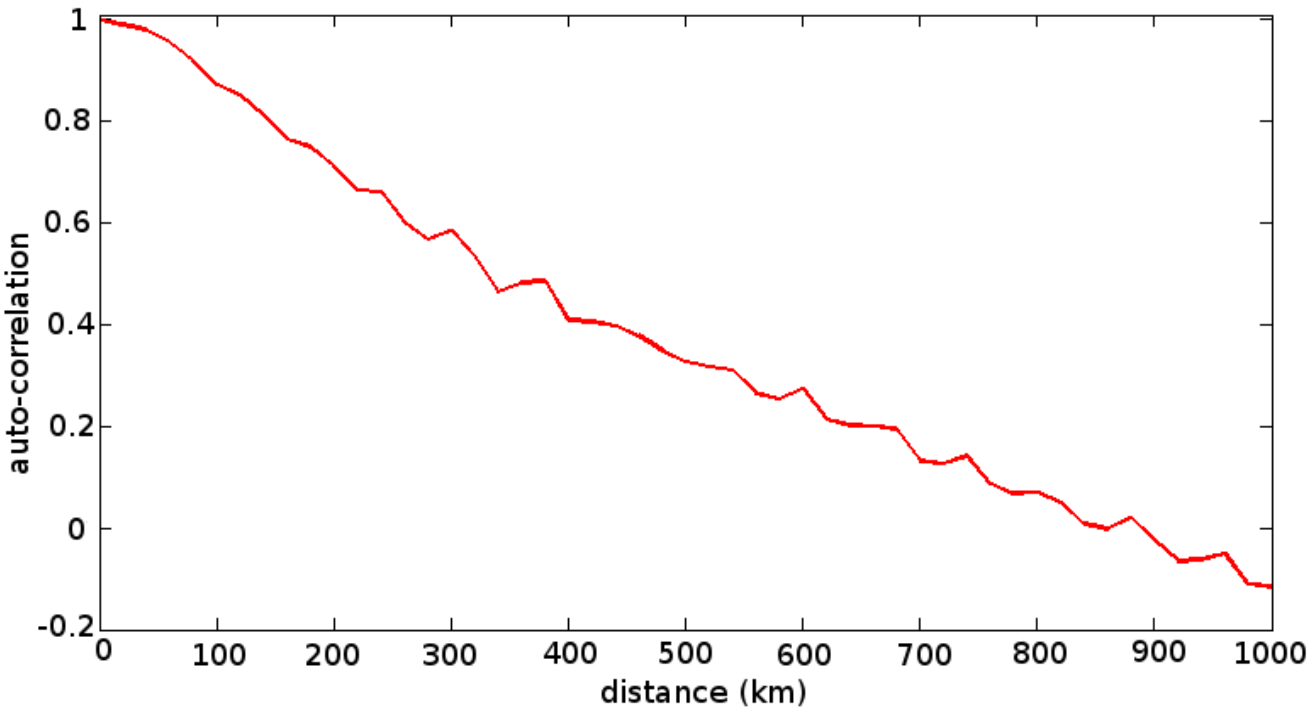
Temperature (○)

2009-01-01



Observation localization

- Observation weight function: $exp(-\frac{r^2}{d^2})$
  (d: correlation length, r: distance from the considered water column)
- Localization length-scale (correlation length): 250 km
- Maximum correlation length: 2500 km



auto-correlation

Ensemble generation

- 100 members:
  A 10 years interval, years 41 - 50 (far away from the truth) of the free model simulation with output every 30 days is used to initialize the assimilation experiment (the last 100 outputs).

- 40 members:
  Use SVD truncation to generation 40 ensemble members from the initial 100 members.
  Normalization norm:
  - sum of barotropic potential energy and available potential energy (Barth et al. 2007)
  - volume and sample averaged variance (Lermusiaux et al. 1999)
  - ?

  Which one to take?

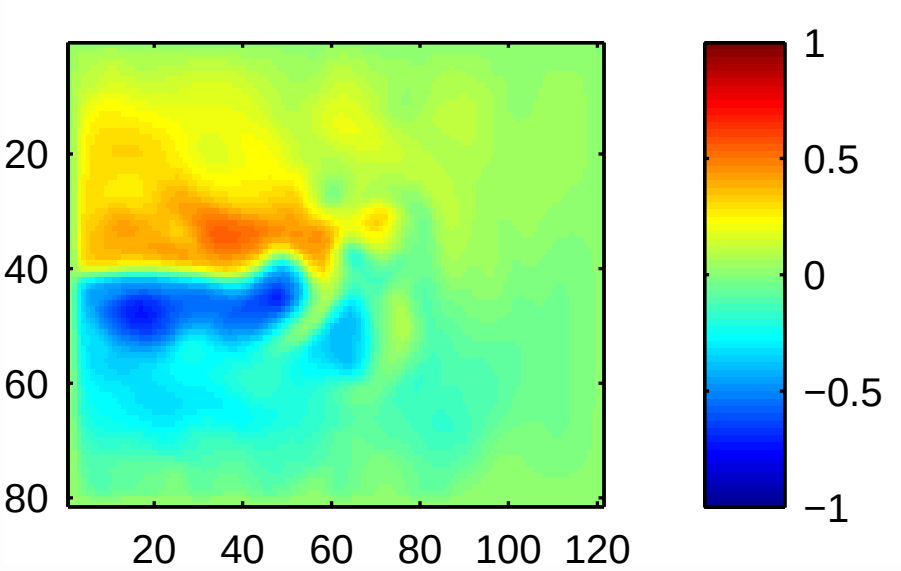
Assimilation setups

3 cases:

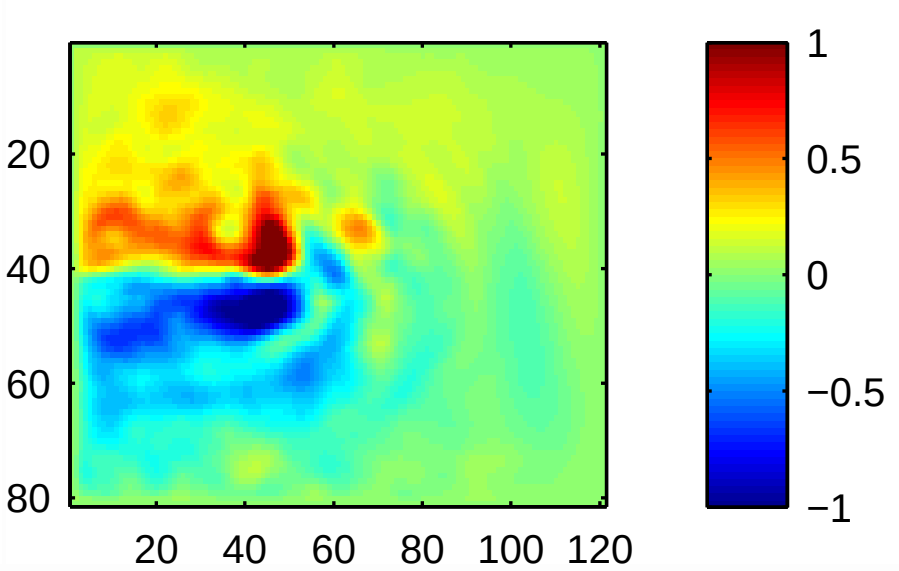
1. ENVISAT SSH + temperature, 100 ensemble members (reference case)
2. ENVISAT, Jason-1 SSH + temperature, 100 ensemble members
3. ENVISAT SSH + temperature, 40 ensemble members

Truth & Analysis (SSH)

truth

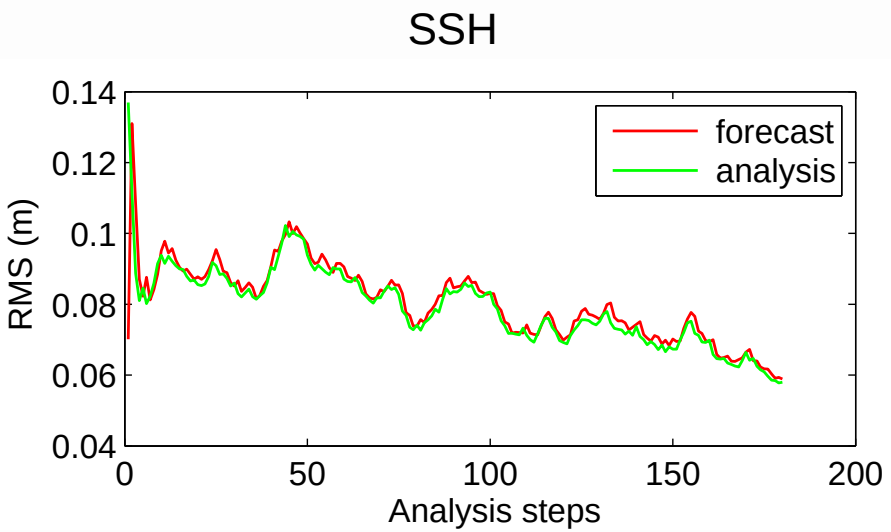


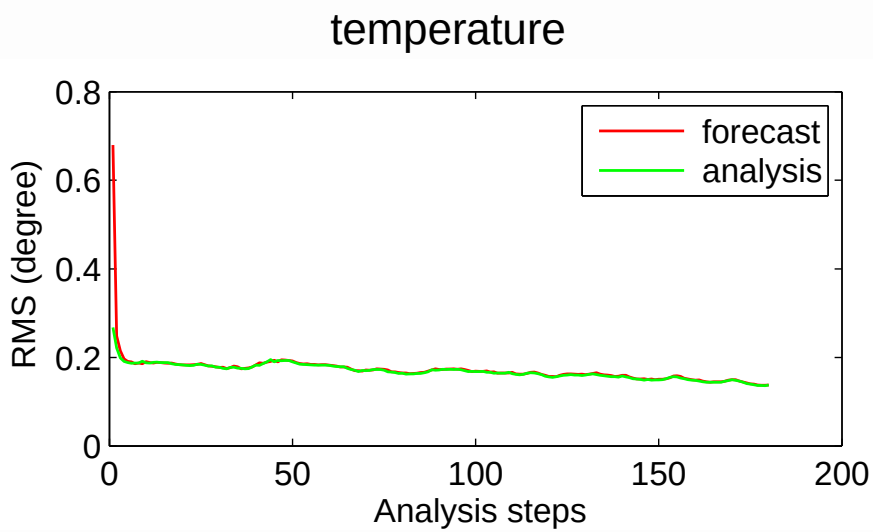
analysis

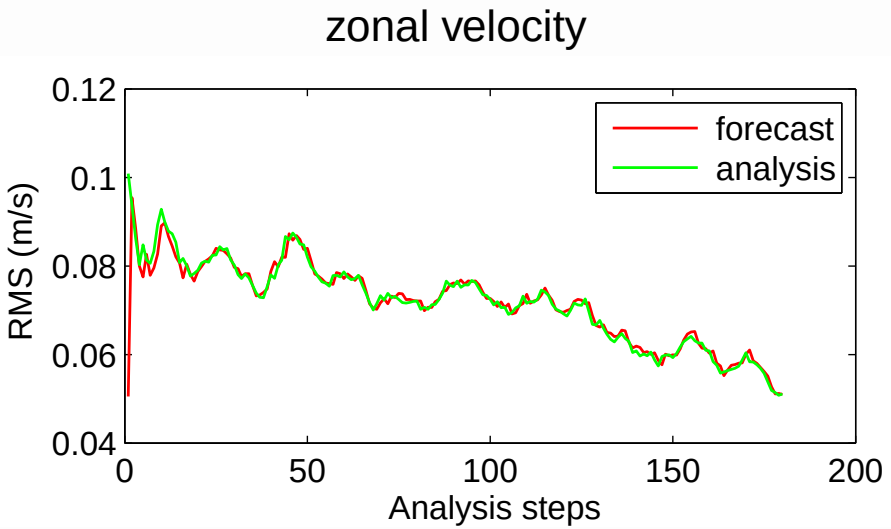


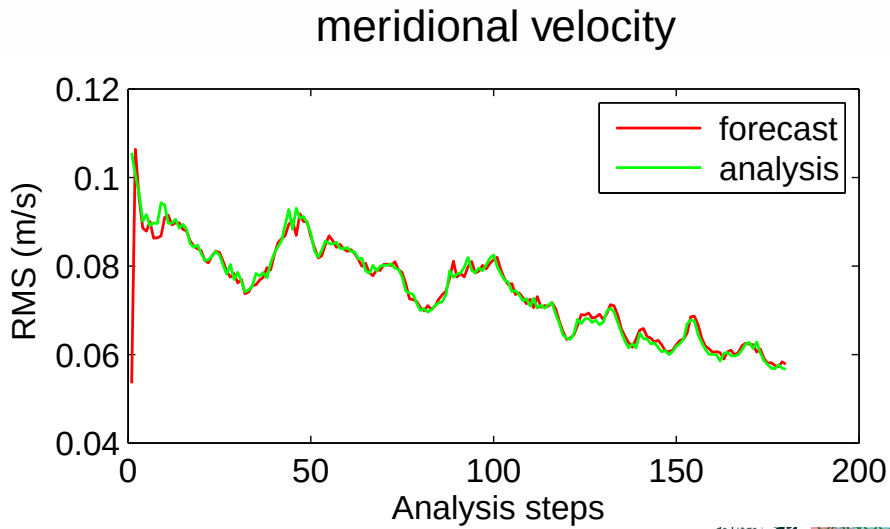
snapshot every 3 steps

RMS: ensemble mean - truth



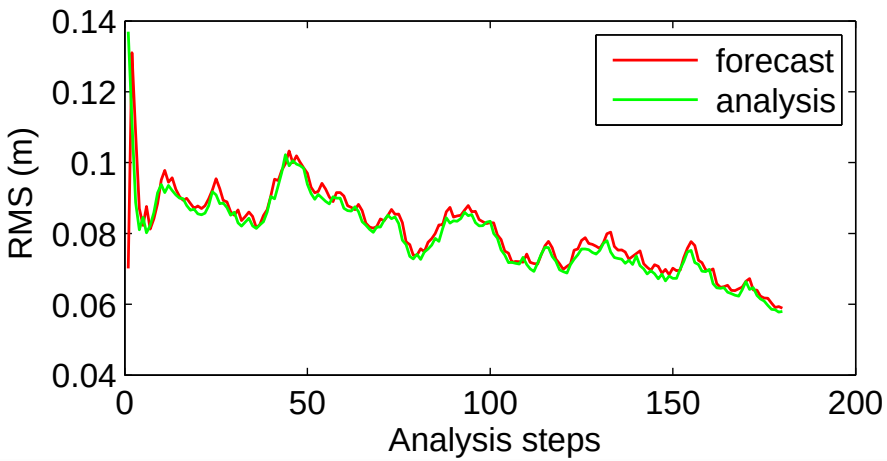


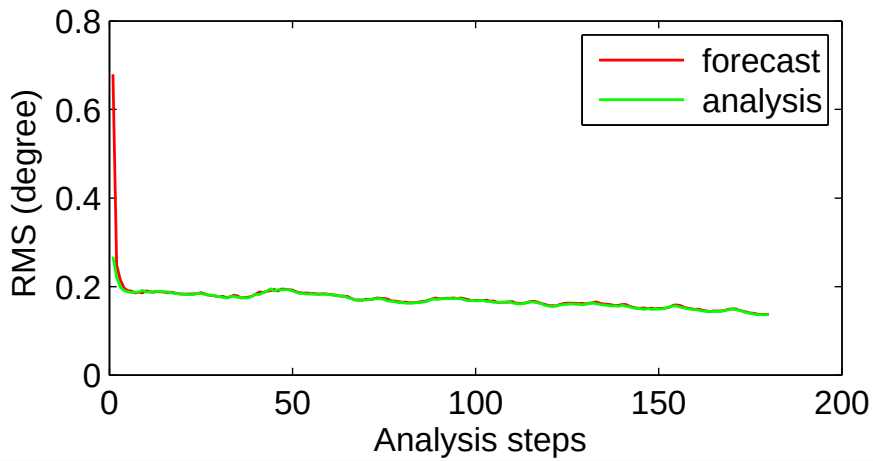




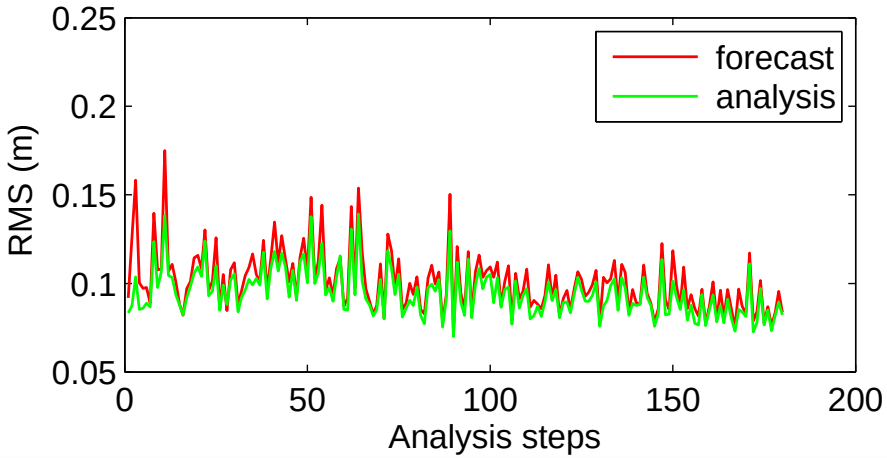
RMS: ensemble mean - truth - observation

- Ensemble mean - truth

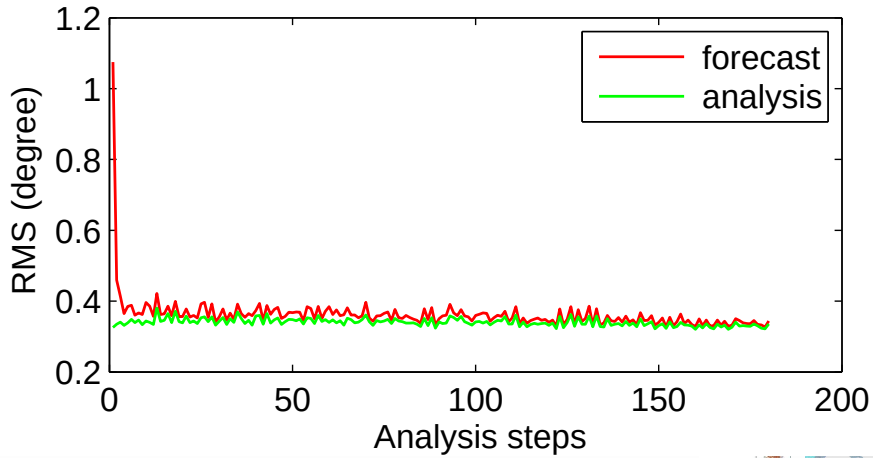




- Ensemble mean - observation

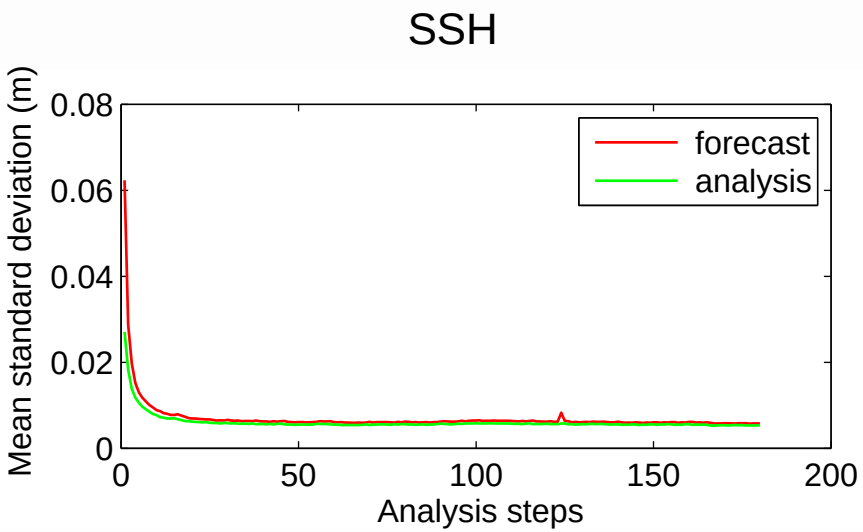


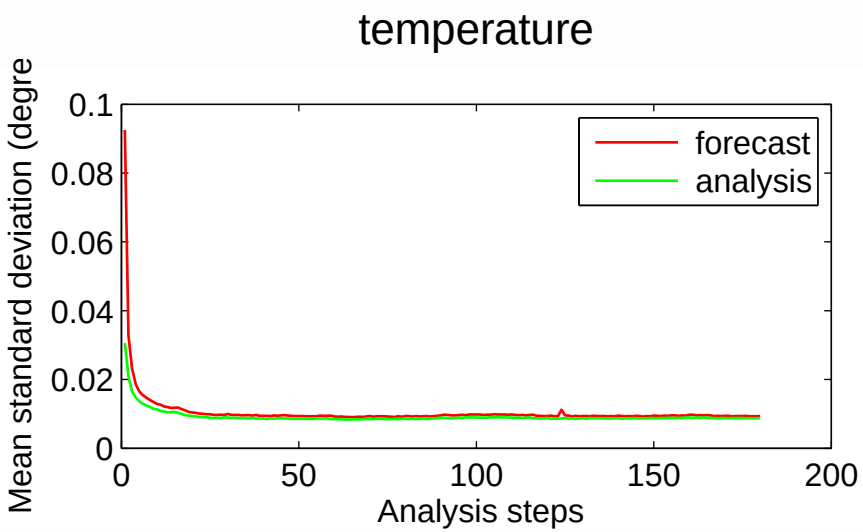
SSH

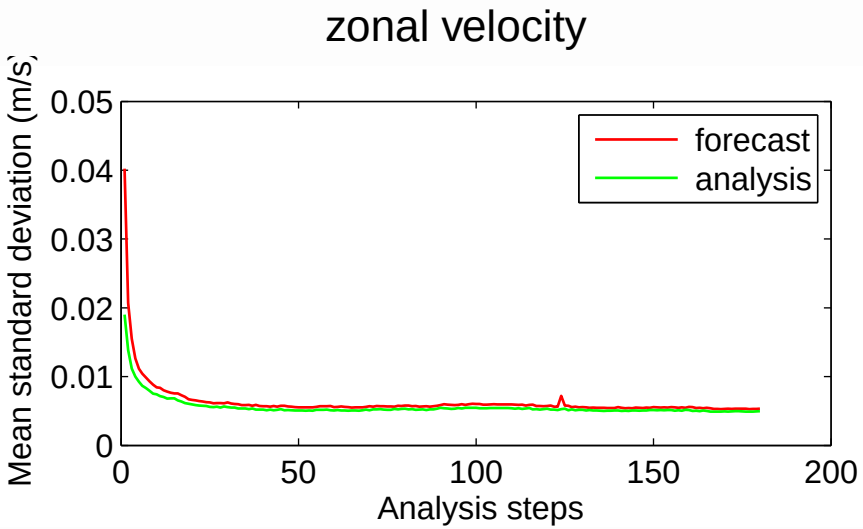


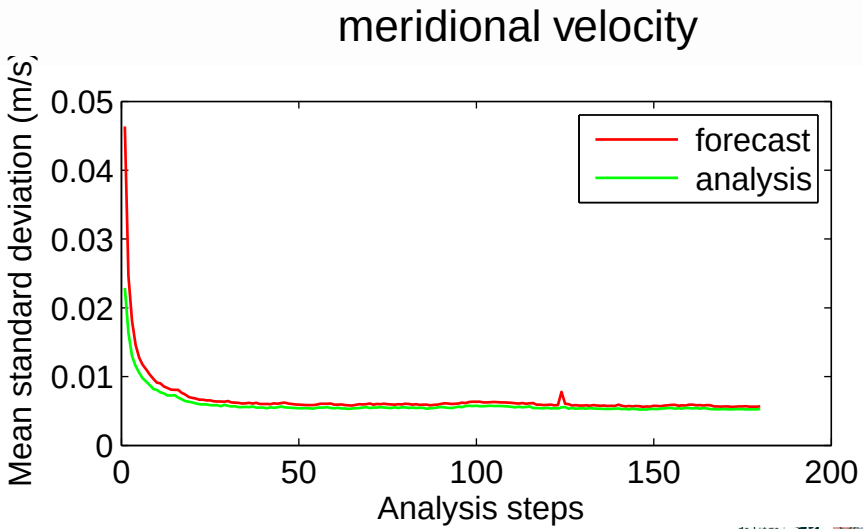
temperature

Ensemble spread



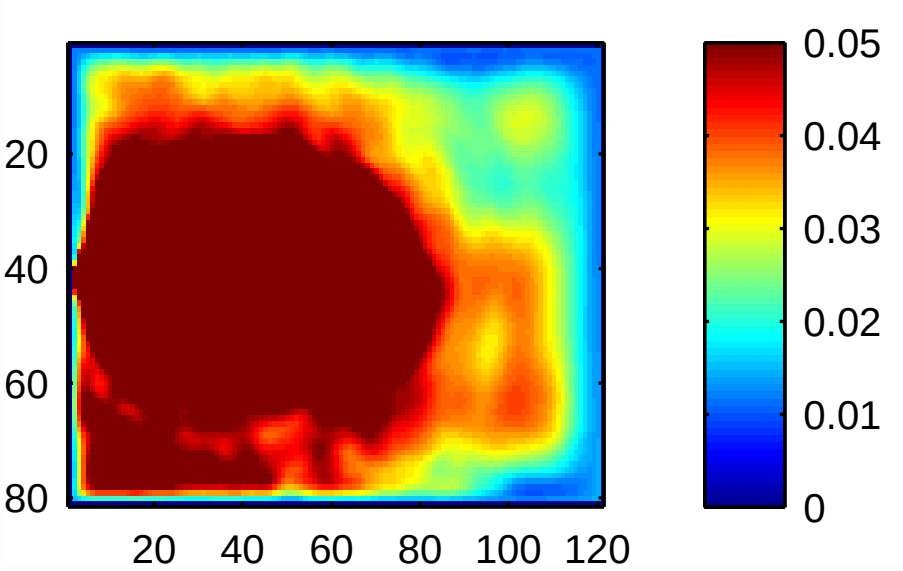




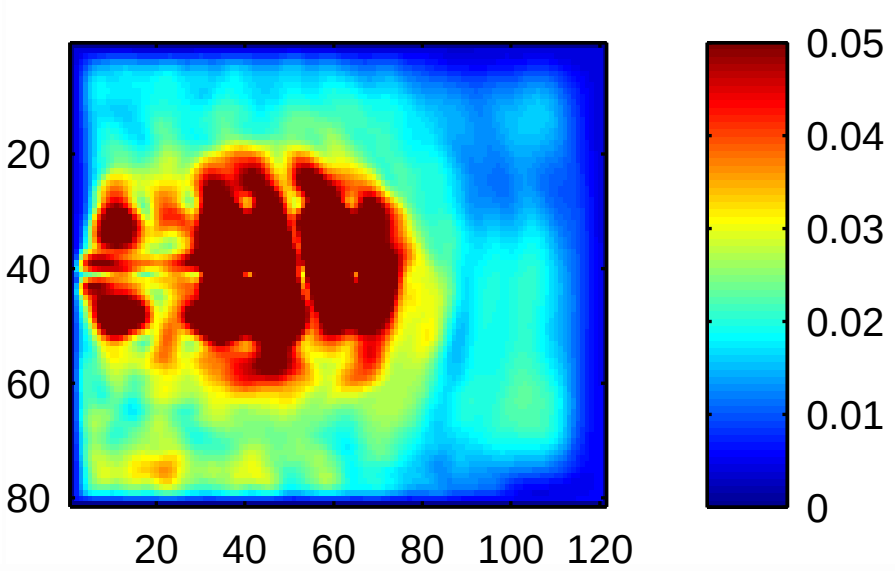


Ensemble spread (SSH)

forecast



analysis



snapshot every 3 steps

Metrics

Scores: reliability & resolution

Which parameters to take?

- RMS and bias of the ensemble mean
- Ensemble standard deviation
- Rank histogram
- Continuous ranked probability score (CRPS)
- ...

Acknowledgments

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