A comparison of adjoint-based forecast sensitivities and singular vectors

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Planning Workshop for the THORPEX Pacific Asian Regional Campaign (T-PARC), Tropical Cyclone Structure (TCS-08) and Other Collaborative Experiments
4-6 December 2007
Princeville Resort, Kauai

Plans for T-PARC in Yonsei Univ.

- Calculation of adjoint-based forecast sensitivities and singular vectors in real-time

- Providing above adaptive observation strategies in real-time for flight plan decision

- Data impact studies using WRF-3DVAR

Typhoon EWINIAR have passed over the Korean peninsula during the 36h period beginning 0000 UTC 09 to 1200 UTC 10 July 2006


Typhoon Track
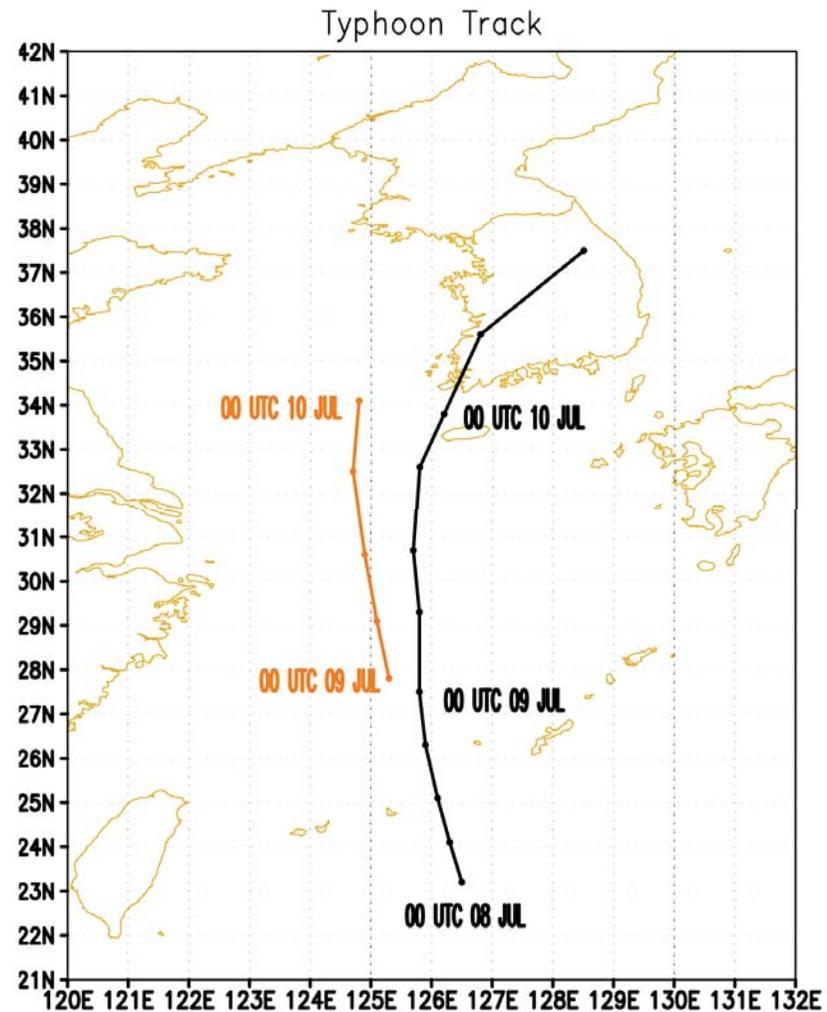
Experimental framework

- MM5 Adjoint Modeling System (Zou et al. 1997)
- 50x50 (80 km) horizontal grid with 20 evenly spaced sigma levels
- Grell scheme, bulk PBL, horizontal & vertical diffusion, dry convective adjustment
- Adjoint sensitivities and singular vectors were calculated for 24 hour MM5 forecast from NCEP analysis at 0000 UTC 09 Jul 2006.
- Response function for adjoint sensitivity: forecast error over the Typhoon center
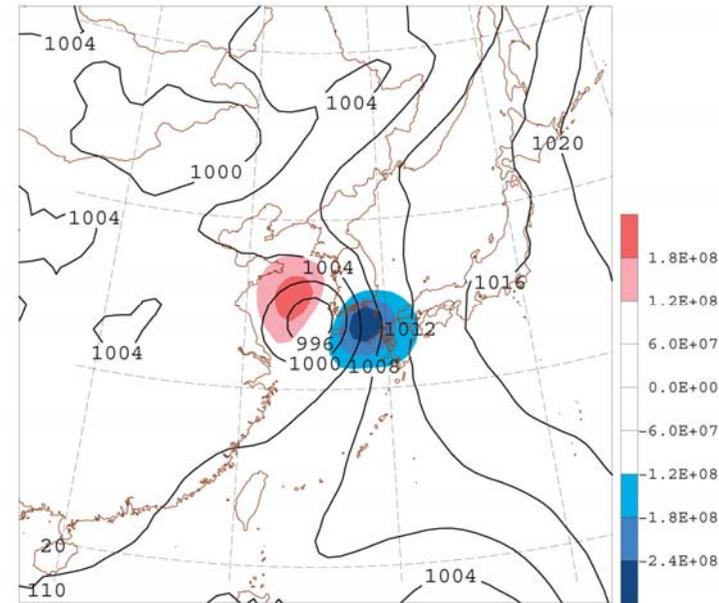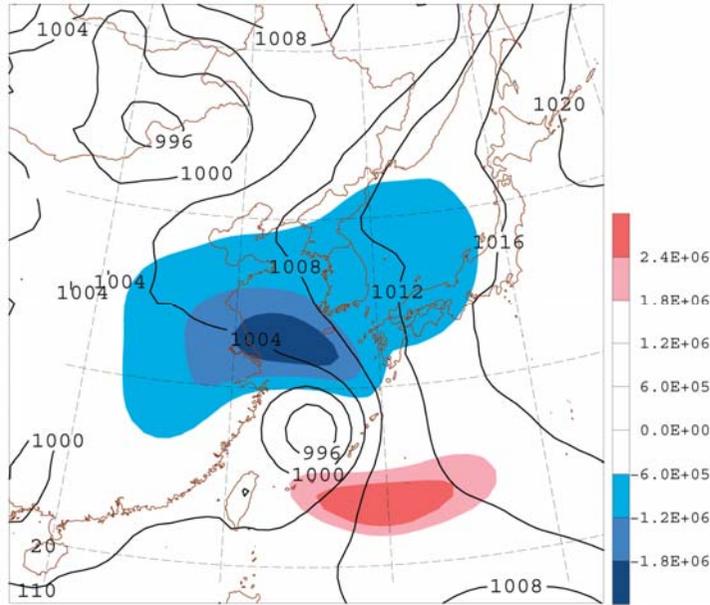
vorticity sensitivity of control (850 hPa)
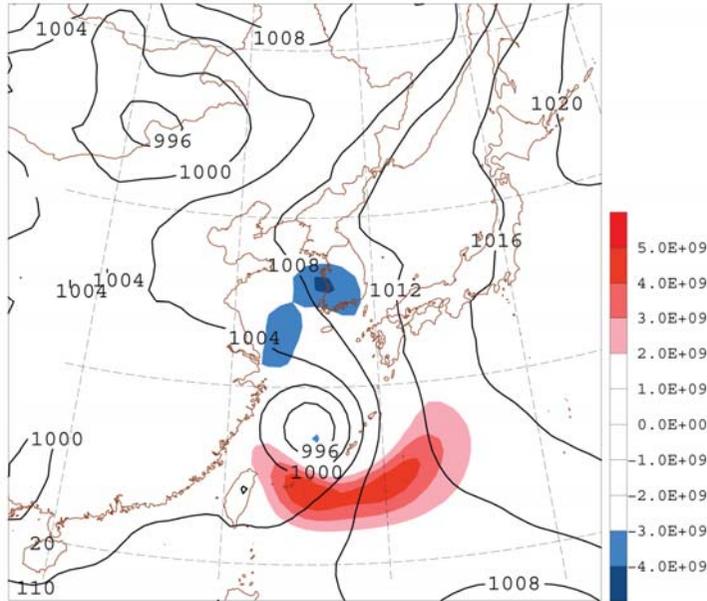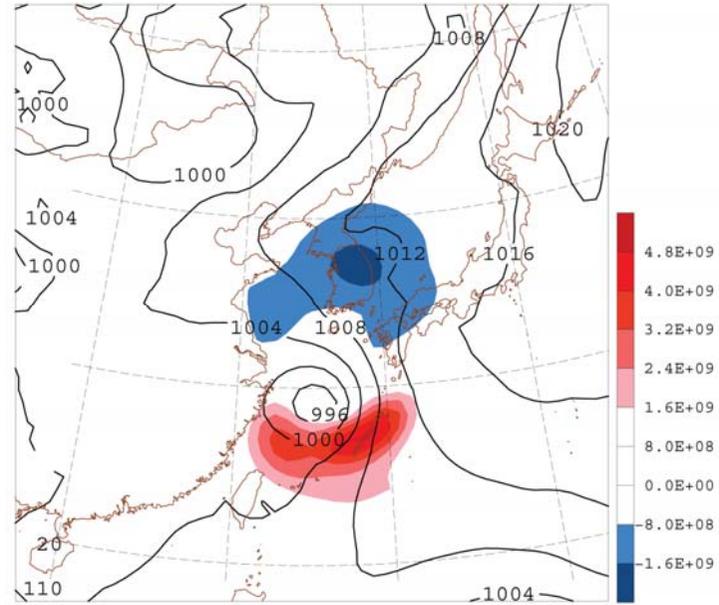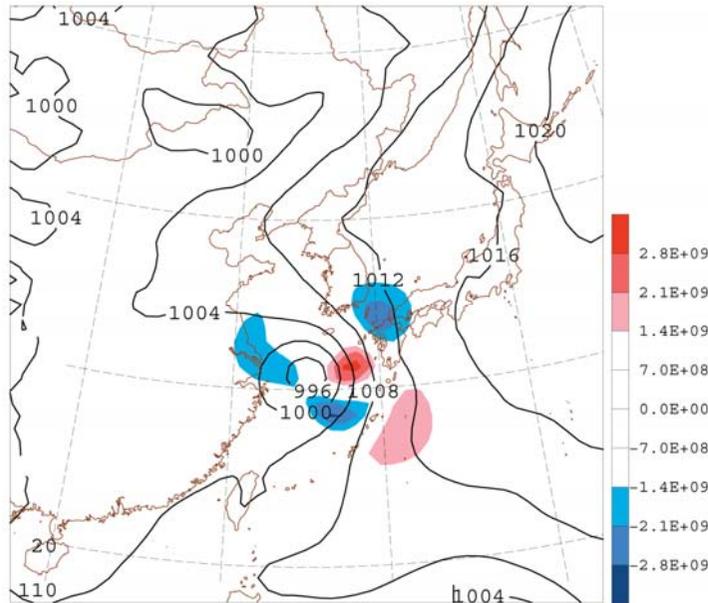
Leading singular vector (850 hPa)
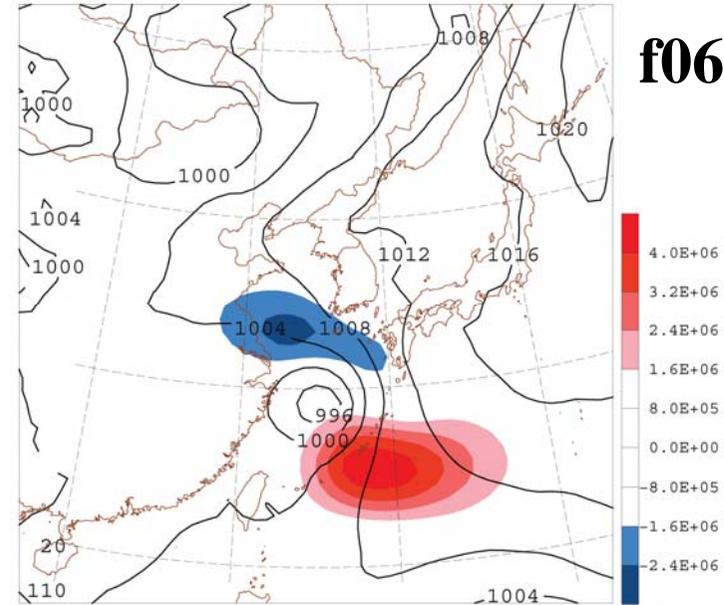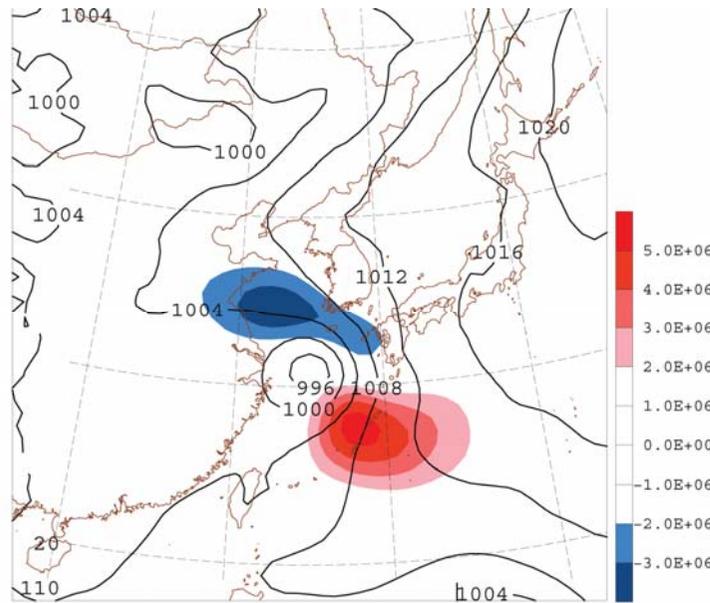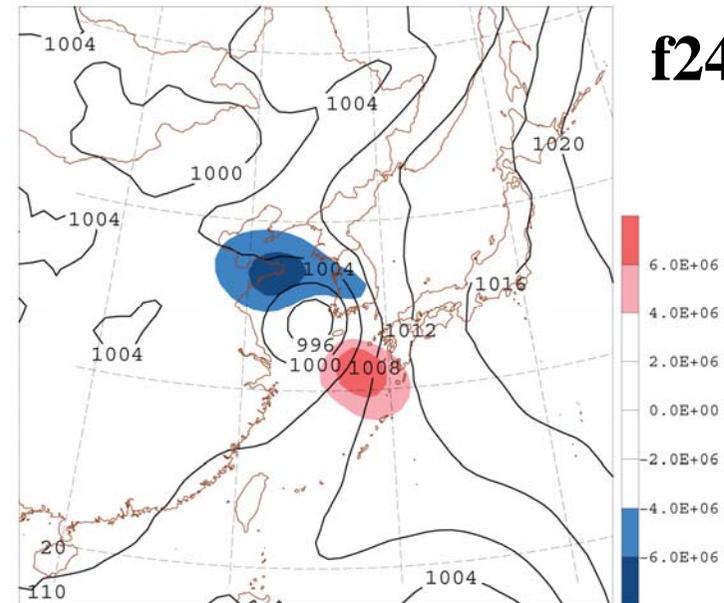
Vertical distributions of energy-weighted adjoint sensitivity
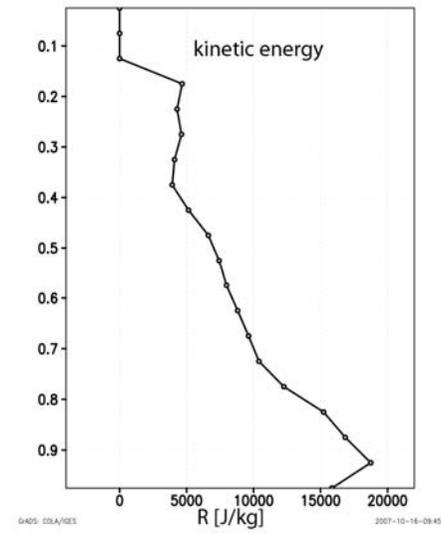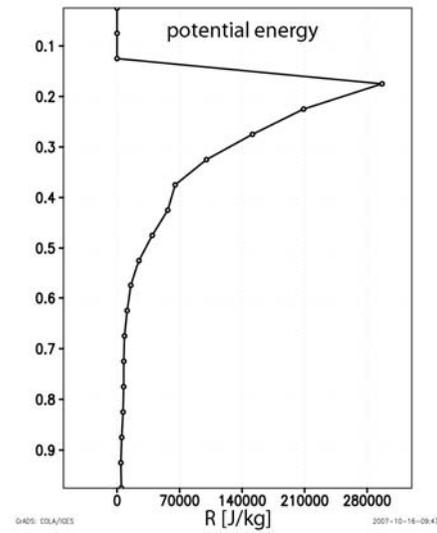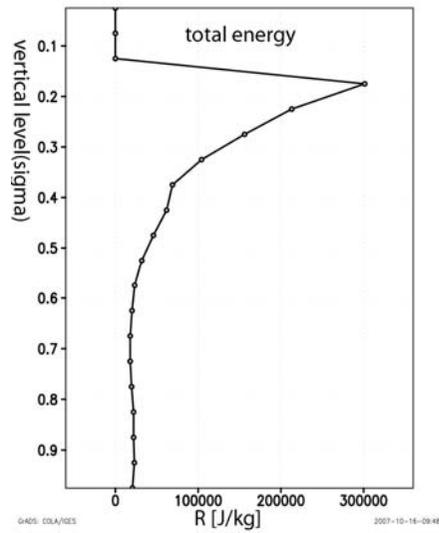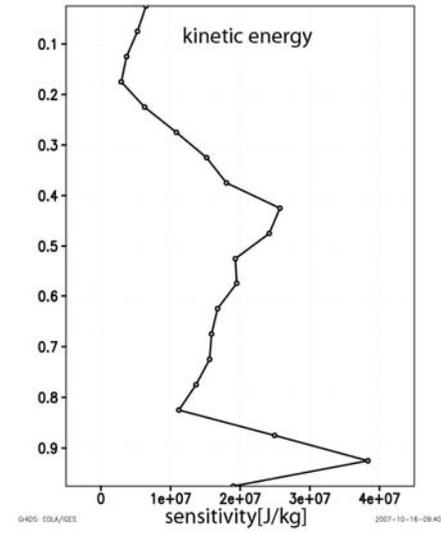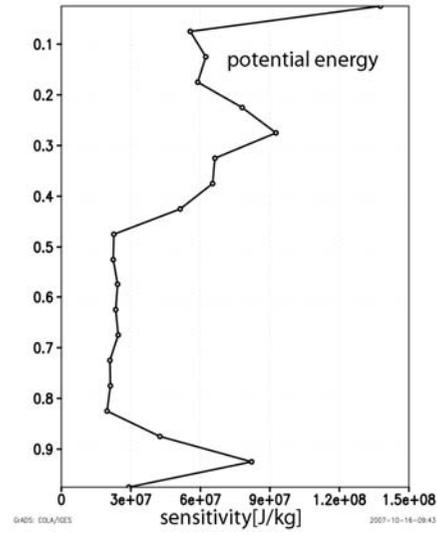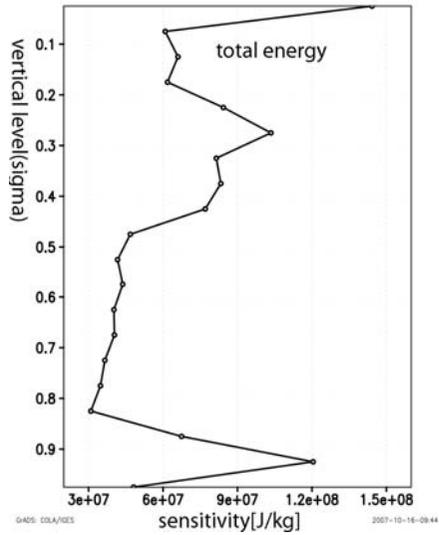
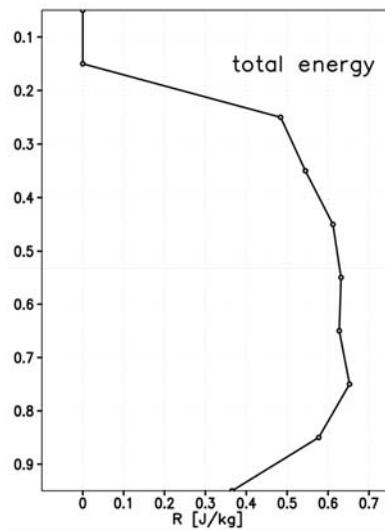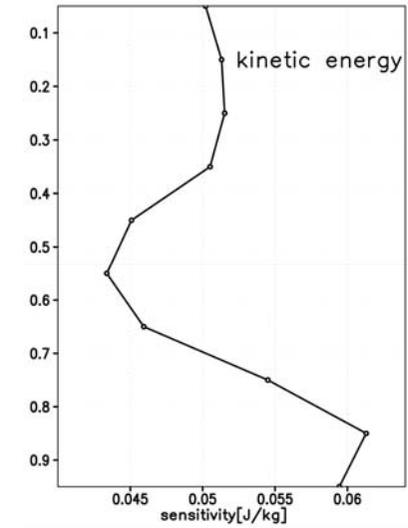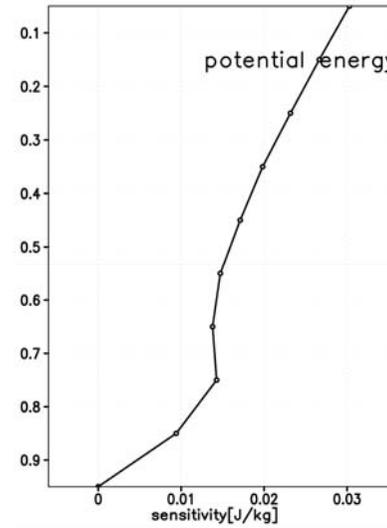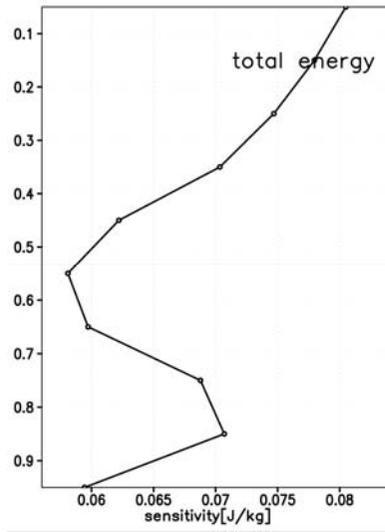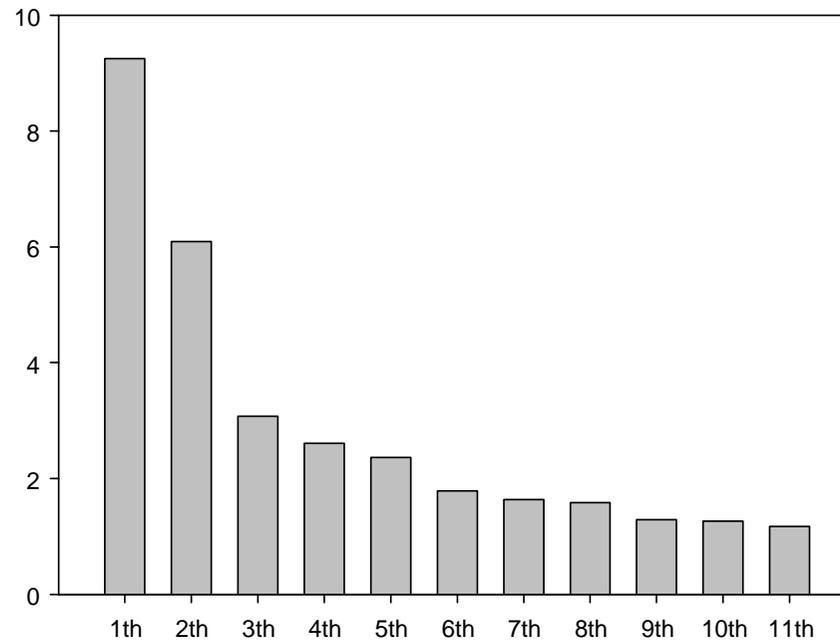# Vertical distributions of energy-weighted singular vector
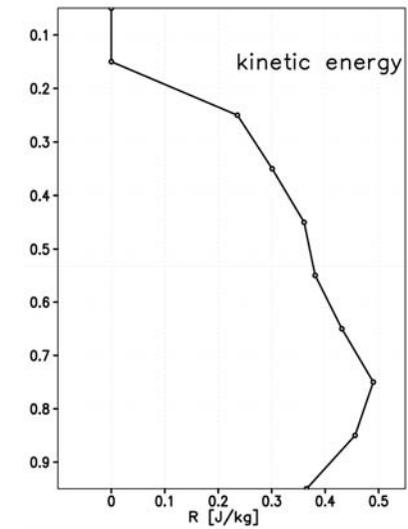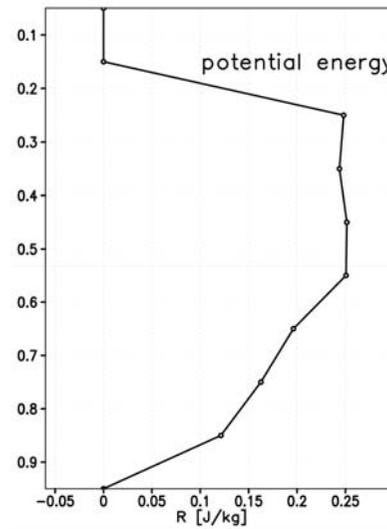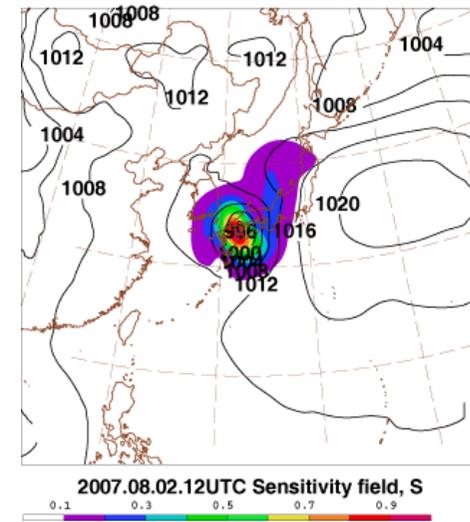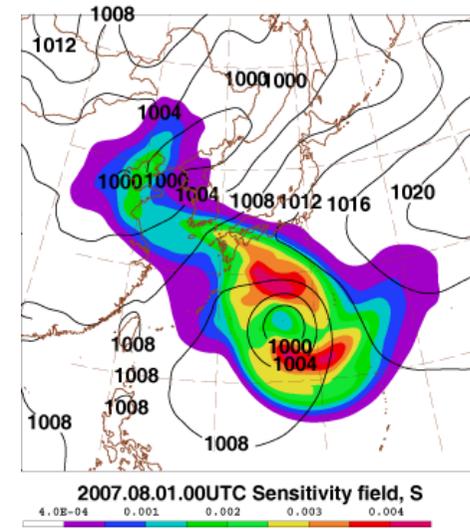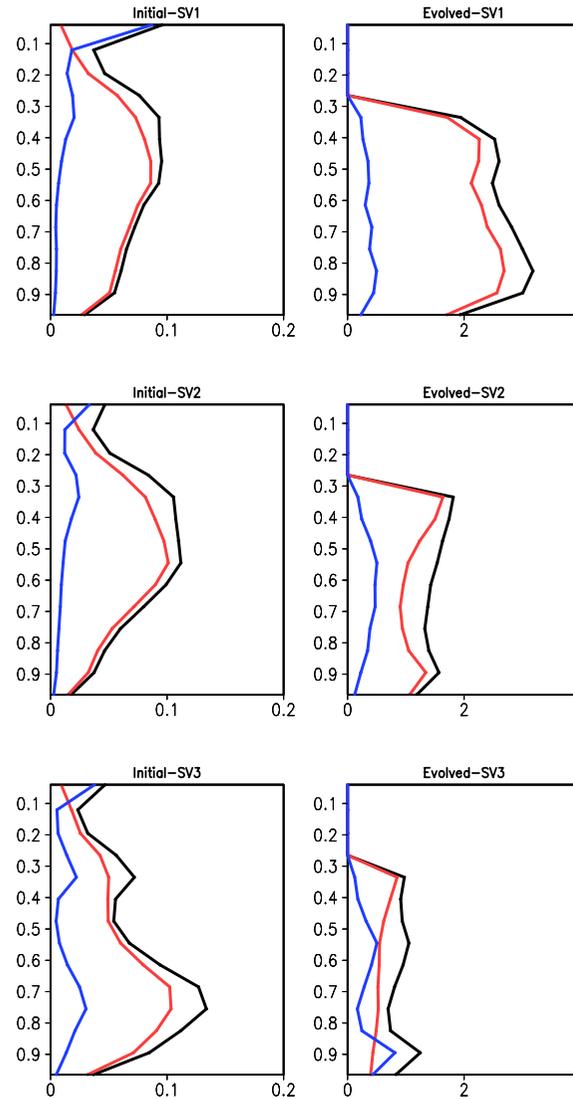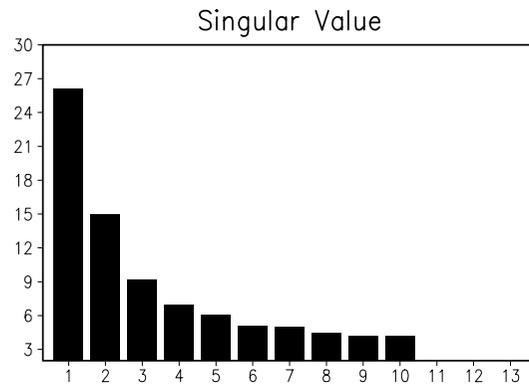
Singular values

singular value

bEXP4

- ✓ 50x50x14 (100km)
- ✓ 36hr opt. time
- ✓ BS(m2c3), TL$AD(m1c1)
- ✓ Dry-TE norm
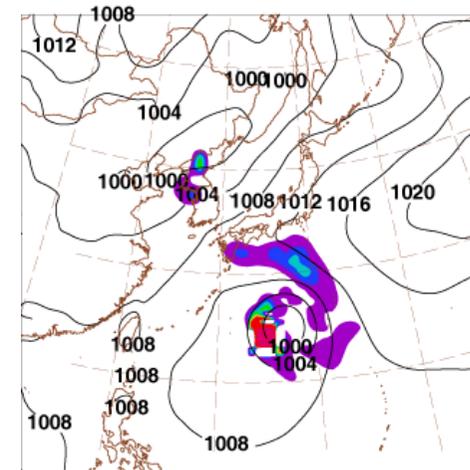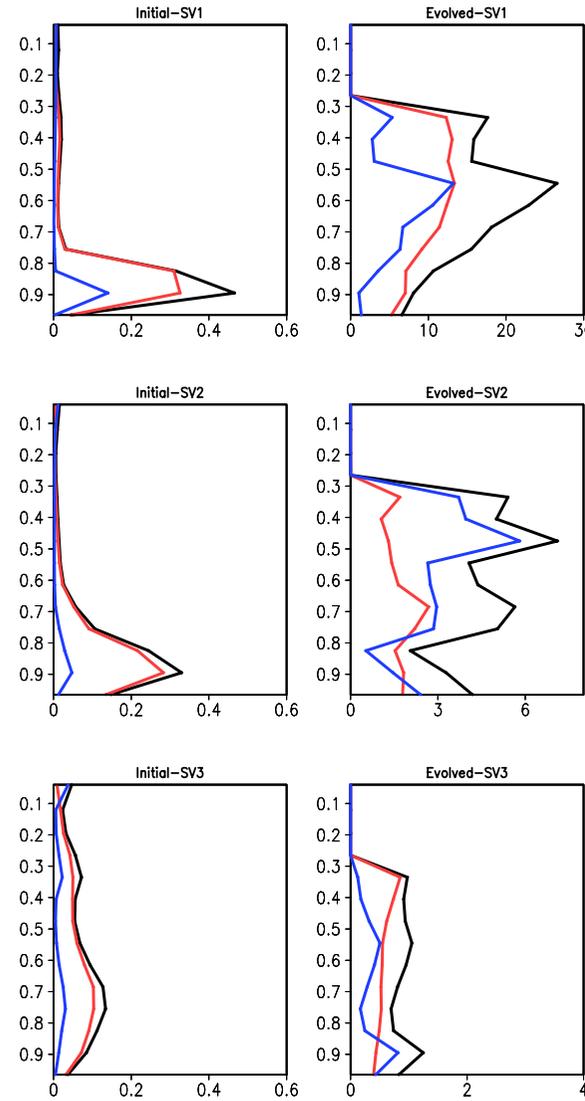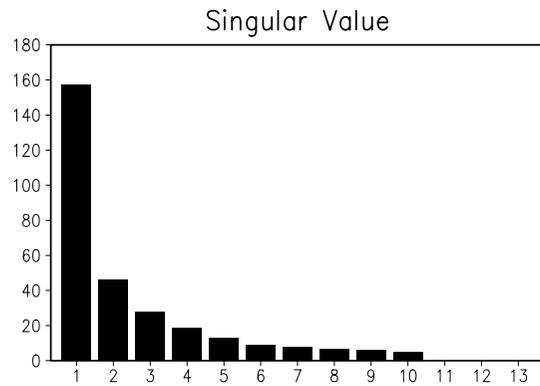
$$R = \iiint_{\sigma,x,y} \frac{1}{2} \left[u'^2 + v'^2 + w'^2 + \left(\frac{g}{\overline{N}\overline{\theta}}\right)^2 \theta'^2 + \left(\frac{1}{\overline{\rho}c_s}\right)^2 p'^2 \right] dx dy d\sigma$$

Singular Value

Initial-SV1 · Evolved-SV1 · Initial-SV2 · Evolved-SV2 · Initial-SV3 · Evolved-SV3

2007.08.01.00UTC Sensitivity field, S

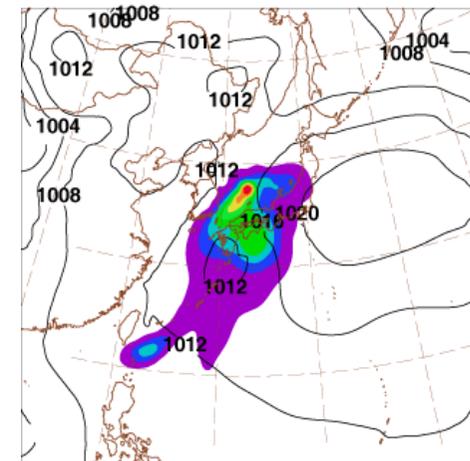2007.08.02.12UTC Sensitivity field, S

bEXP2

- ✓ 50x50x14 (100km)
- ✓ 36hr opt. time
- ✓ BS(m1c3), TL$AD(m1c3)
- ✓ Dry-TE norm

$$R = \iiint\limits_{\sigma,x,y} \frac{1}{2}\left[u'^2 + v'^2 + w'^2 + \left(\frac{g}{\overline{N}\overline{\theta}}\right)^2 \theta'^2 + \left(\frac{1}{\overline{\rho}c_s}\right)^2 p'^2 \right] dxdyd\sigma$$

Singular Value

Initial-SV1 / Evolved-SV1 / Initial-SV2 / Evolved-SV2 / Initial-SV3 / Evolved-SV3

2007.08.01.00UTC Sensitivity field, S

2007.08.02.12UTC Sensitivity field, S