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# **The NCEP Short-Range Ensemble Forecast (SREF) System**

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# Presentation Outline



- History
- Current Status
- Plans for FY10-FY13



# History of the NCEP SREF (2001-2009)



- Apr. 2001: **operational implementation**
- Sept. 2003: 10 to 15 members by adding **5 Eta\_kf** members to increase physics diversity
- Aug. 2004: (1) added more convective schemes to further address **physics diversity**; (2) 63hr to **87hr**; and (3) 48km to **32/40km**
- Dec. 2005: 15 to 21 members by adding **6 WRF members** (2 to 4 models)
- Jun. 2006: 2 to 4 **cycles** and domain expanded to include **Alaska and Hawaii**
- Dec. 2007: **bias correction**



# Upgrades to the SREF system

## (Scheduled Implementation 13 Oct. 2009)



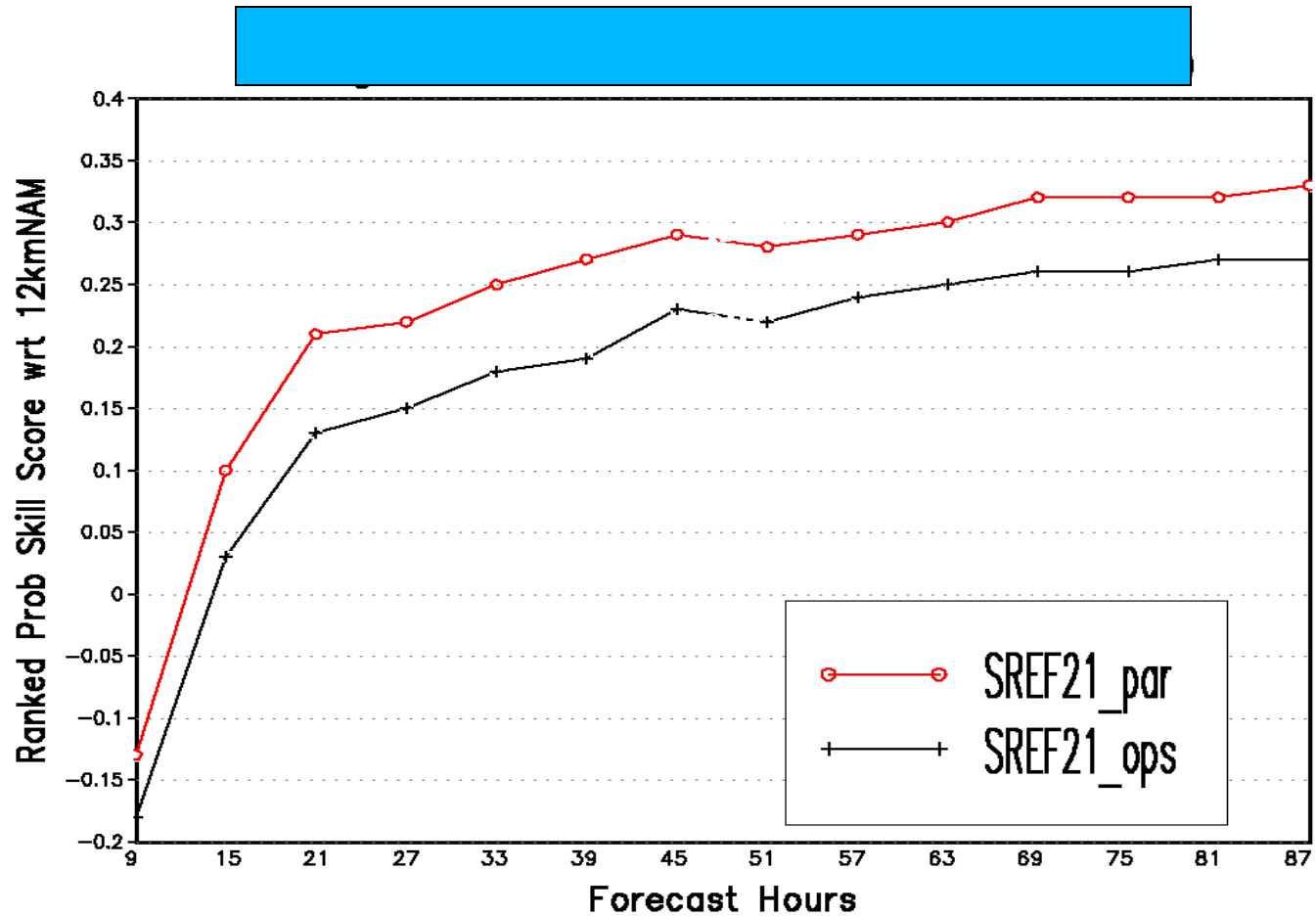
- Upgrade models: **WRF-NMM, WRF-ARW and RSM**
- Increase horizontal resolution:
  - **ARW (45 km to 35 km)**
  - **NMM (40 km to 32 km)**
  - **RSM (45 km to 32 km)**
- Total Membership = 21:
  - **Adding 4 WRF**
  - **Eliminating 4 Eta**
- For the 3 RSM members: replace Zhou cloud with Ferrier
- Use Global Ensemble Transform (ET) perturbations for the 10 WRF members
- Increase output frequency from every 3 hr to hourly for 1st 39hr (for SPC, AWC)
- Add/fix/unify variables in SREF output
  - **wind variance products (for DTRA)**
  - **radar (composite reflectivity + echo top) (for FAA)**
  - **unify PBL height diagnosis with critical Ri (aviation)**
  - **fix cloud base (aviation)**
  - **BUFR broken out into individual station time-series (SPC and WFOs)**
  - **Hurricane track (NHC or TPC)**



# Ranked Probabilistic Skill Score



**CONUS 2 meter temperature  
02 February – 10 August 2009**



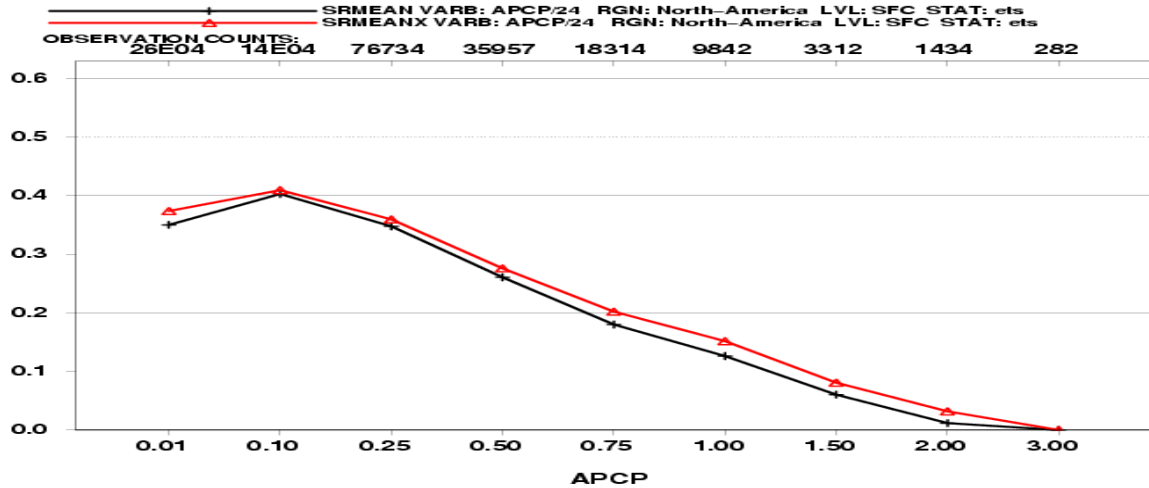
**New SREF is more skillful than the old SREF**



# Warm season 24h Accumulated Precip from EMC parallel (Mar. 12 – Aug. 30, 2009)

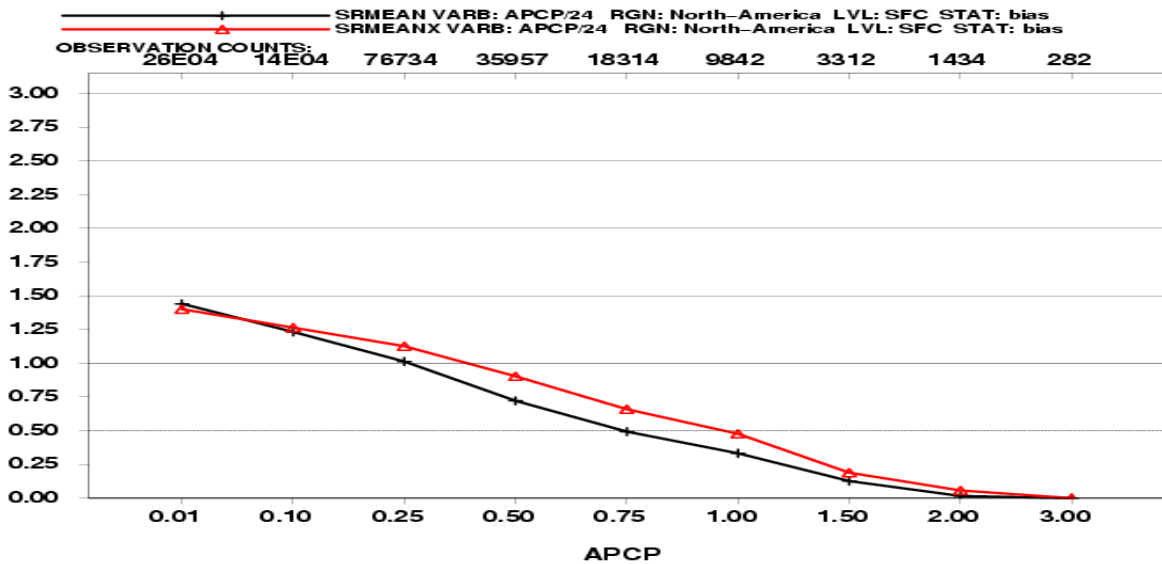


**SFC APCP/24 Equitable-Threat-Score averaged by Threshold  
from 20090312 to 20090830 for 48 Hour Forecasts**



**ETS**

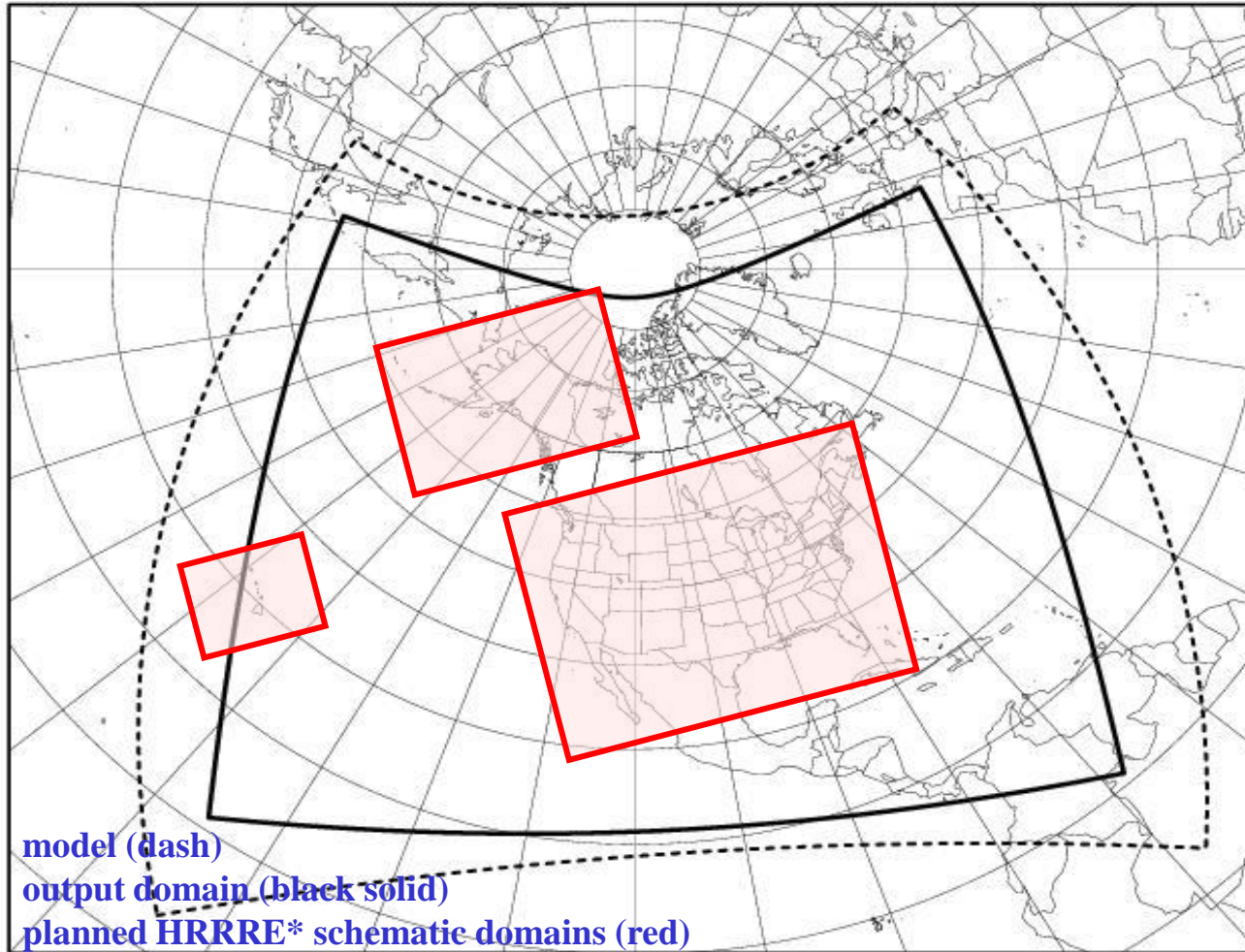
**SFC APCP/24 Bias averaged by Threshold  
from 20090312 to 20090830 for 48 Hour Forecasts**



**BIAS**



# SREF Domains





# SREF Methodology

## IC aspect:

- Multi-analysis (gdas and ndas)
- Perturb ctl anal (bred vector, global ET, regional ET)
- Perturbed LBCs (from global EPS)
- Land surface initial states such as soil moisture and temperature (**tested**)

## Model aspect:

- Multi-model: WRF (NMM, ARW) plus RSM and Eta
- Multi-physics (various convection and cloud schemes)
- Stochastic physics (**tested**)

## Residual Part:

- Post processing including:  
    bias correction  
    downscaling (**tested**)





# SREF Applications

Since the SREF became operational in 2001, its mission has grown to serve:

- **Severe convection forecasts (SPC)**
- **Precipitation forecasts (HPC)**
- **Winter weather (HPC and SPC)**
- **Fire weather (SPC)**
- **Aviation prediction (AWC, EMC and MDL)**
- **Hydrology (Eastern Region RFCs)**
- **Hurricane (EMC, GFDL and NHC)**
- **Others such as Homeland Security (DTRA dispersion modeling) and military (AFWA)**
- **Web products (see the list of the next slide)**



# SREF web products



- **EMC experimental web:**  
<http://www.emc.ncep.noaa.gov/mmb/SREF/SREF.html>
- **NCO operational web:**  
<http://www.nco.ncep.noaa.gov/pmb/nwprod/analysis/>
- **Aviation products web** (by Binbin Zhou): linked at the SREF DEV web
- **SPC convection:** <http://www.spc.noaa.gov/exper/sref/>
- **HPC QPF:** <http://www.hpc.ncep.noaa.gov/wwd/impactgraphics/>
- **WFO** (by Rich Gramm): <http://eyewall.met.psu.edu/>
- **Meteograms** (by Geoff Manikin):  
<http://wwwt.emc.ncep.noaa.gov/mmb/srefmeteograms/sref.html>
- **Cyclone tracks** (by Tim Marchok):  
<http://www.emc.ncep.noaa.gov/gmb/tpm/emchurr/tcgen/>
- **Ensemble variance to drive DTRA dispersion model:**  
[http://www.emc.ncep.noaa.gov/mmb/SREF\\_avia/TEST/web/html/variance.html](http://www.emc.ncep.noaa.gov/mmb/SREF_avia/TEST/web/html/variance.html)

**Need an effort to consolidate the related pages into one run operationally by NCO!**



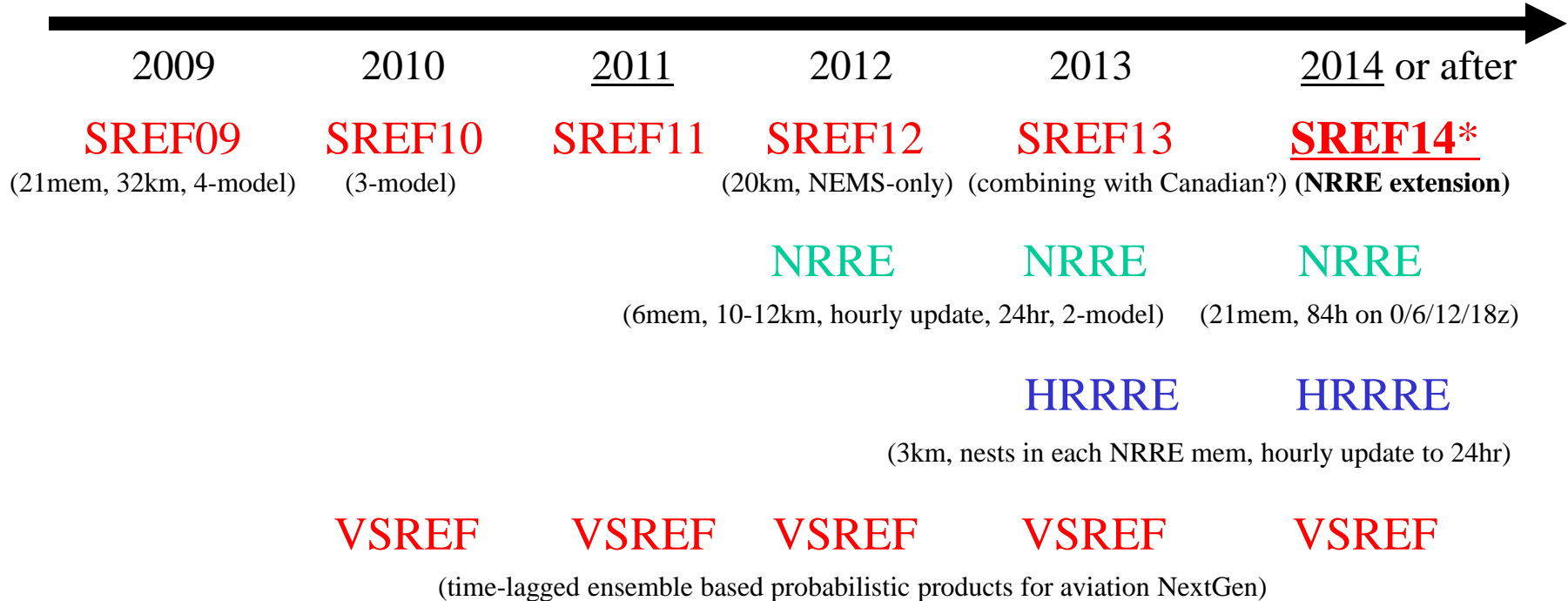
# SREF Data Available to Users



- AWIPS (mean, prob and spread in CONUS, AK and HI grids, **need to add more variables**)
- NOMADS (same as above plus individual members, **need to add Bufr and GEMPAK sounding output**)
- Public ftp site (same as AWIPS plus individual members and bufr)
- NCEP CCS (available to all NCEP service centers)
- 2-year archive (NCEP internal). **We need to push it be archived at NCDC with NOMADS tools for public to access.**
- Through projects (such as data to RFC and CAPS SSEF for the SPC's Spring Experiment)



# SREF Future Plans



- \*NEMS = NOAA Environmental Modeling System (a unified modeling framework)
- \*SREF (32→20km→10/12km, 6-hrly update to 84h for general weather forecasts)
- \*NRRE = NAM Rapid Refresh Ens (10-12km, hrly update to 24h for aviation)
- \*HRRRE = Hi-Res Rapid Refresh Ens. (3km, nested in NRRE, hrly update to 24h for high-impact events for targeted CONUS, AK and HI domains)
- \*VSREF = Very Short-Range Ens Forecast for aviation NextGen prob products



# SREF Future Plans (Cont.)



- **2010:**
  - Downscale of SREF members to 5 or 2.5km using RTMA
  - Addition of more variables to AWIPS
  - Addition of more ensemble products requested by users such as AFWA
- **Others:**
  - Bias correction of precipitation forecasts
  - Reforecasting (need to research the existing OU dataset)
  - Extension to 5 days for hurricane ensemble forecasts (HFIP)
  - Probabilistic streamflow products
  - Couple with air quality and storm surge etc. forecasts
  - 10-minute output frequency to meet wind-energy need



# Thoughts on R2O and O2R: DTC connection

- EMC wanting to have the SREF codes be available to research community via DTC.
- DTC Visiting Scientist Program sending guest scientists to EMC to work directly with the operational codes to test their new methods for potential implementation



# Recommendations

- More computer resource (for higher resolution, reforecasting etc.)
- More personnel (for more frequent system upgrades. Can NOAA THORPEX help?)
- DTC connection (accelerated R2O and O2R)
- All service centers as well as other organizations to contribute to central ensemble product development
- NOMADS data archive (at NCDC) for public to access



# BACKUP SLIDES





# Fall 2009 NCEP SREF System (21 members)



Model	Membershi p	Resolution	Forecast Hours	IC/IC perturbatio n	LBC/LBC perturbatio n	Output Frequency for pgrb files	Output Frequency for bufr soundings
Eta_BMJ	3 (ctl1, n1, p1)	32km	87hr (4 times per day)	ndas/region al BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
Eta_KF	3 (ctl2, n2, p2)	32km	87hr (4 times per day)	ndas/region al BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
RSM_SAS_ Ferrier	3 (ctl1, n1, p1)	32km	87hr (4 times per day)	GFS 3hr fcst/region al BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
RSM_RAS_ Zhao	2 (n2, p2)	32km	87hr (4 times per day)	GFS 3hr fcst/region al BV	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
NMM	5 (ctl, n1, p1, n2, p2)	32km	87hr (4 times per day)	GFS 3hr fcst/global ET	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites
ARW	5 (ctl, n1, p1, n2, p2)	35km	87hr (4 times per day)	GFS 3hr fcst/global ET	GFS/GEFS	1hrly to 39hr, 3hrly afterward	1hrly and breakdown to sites



# Computer Resources Estimation

- **Fall 2009 32km-SREF** (serve as a bench mark system)
  - 1600 CPUs
  - 137.56 GB/cycle
  - 550.24 GB/day
  - 3851.68 GB/week
- **12km-SREF** (doubling vertical res. and  $\frac{1}{2}$  time step)
  - At least 16 times more if no domain, forecast length and membership increase
- **4km-SREF** (plus tripling vertical res. and  $\frac{1}{3}$  time step)
  - At least 144 times more