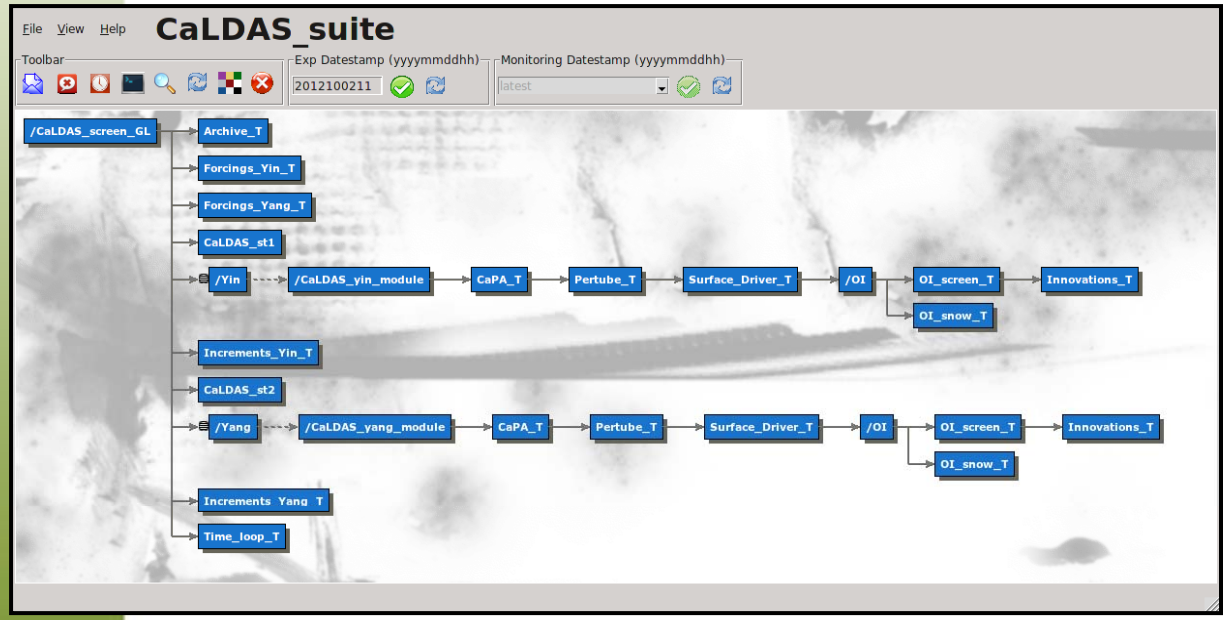
Environment Canada Environnement Canada

Canada

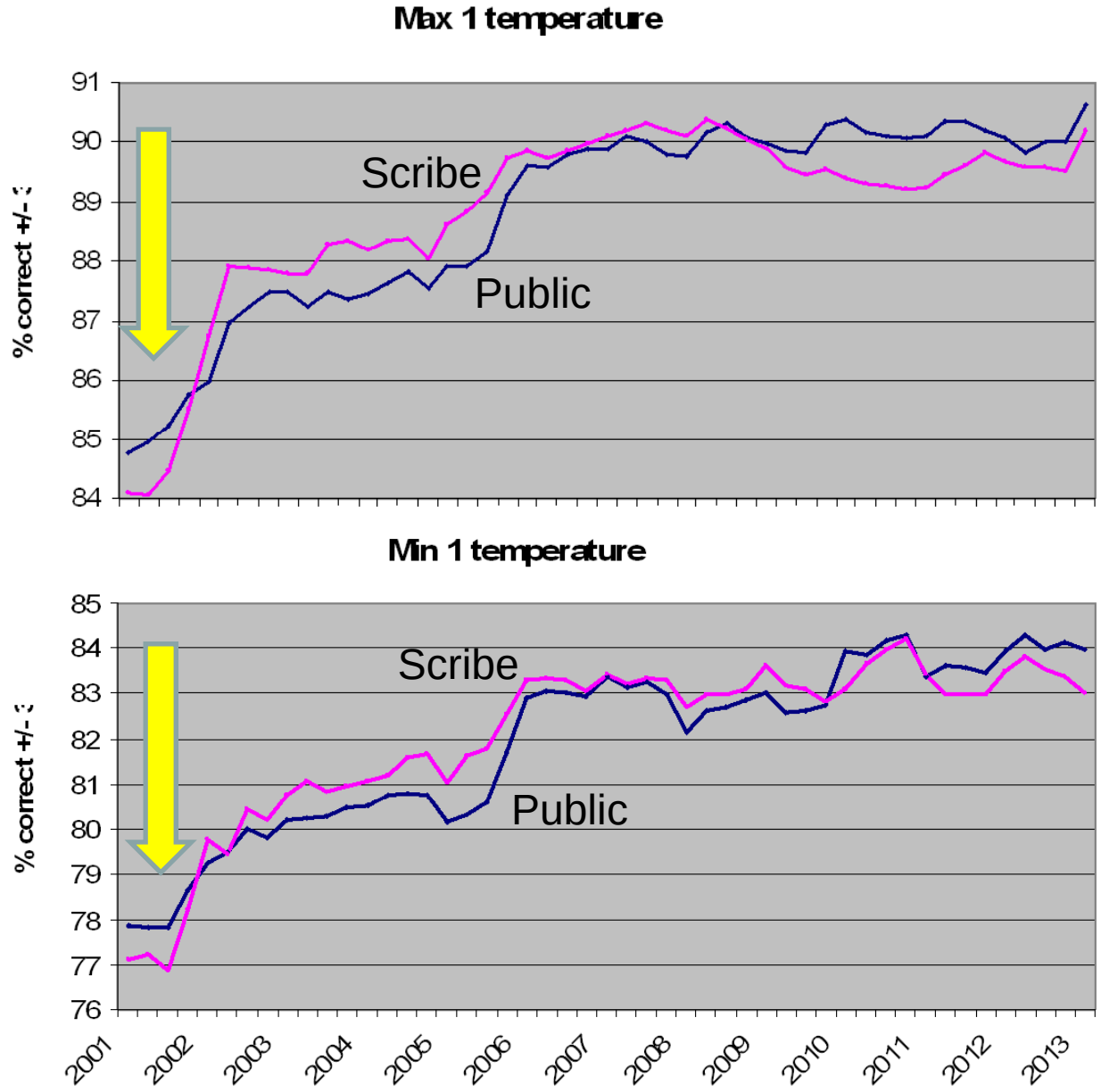
Pour une implémentation en mode expérimental de la version globale du système d'assimilation de surface CaLDAS



Stéphane Bélair
Bernard Bilodeau
Marco Carrera
Dorothée Charpentier
Mario Lépine
+
Nathalie Gauthier
Maria Abrahamowicz
Ervig Lapalme
Marcel Vallée
Sarah Dyck

Séminaire interne, Pré-CPOP, Dorval, le 13 juin 2013

A bit of history… Sept. 11, 2001

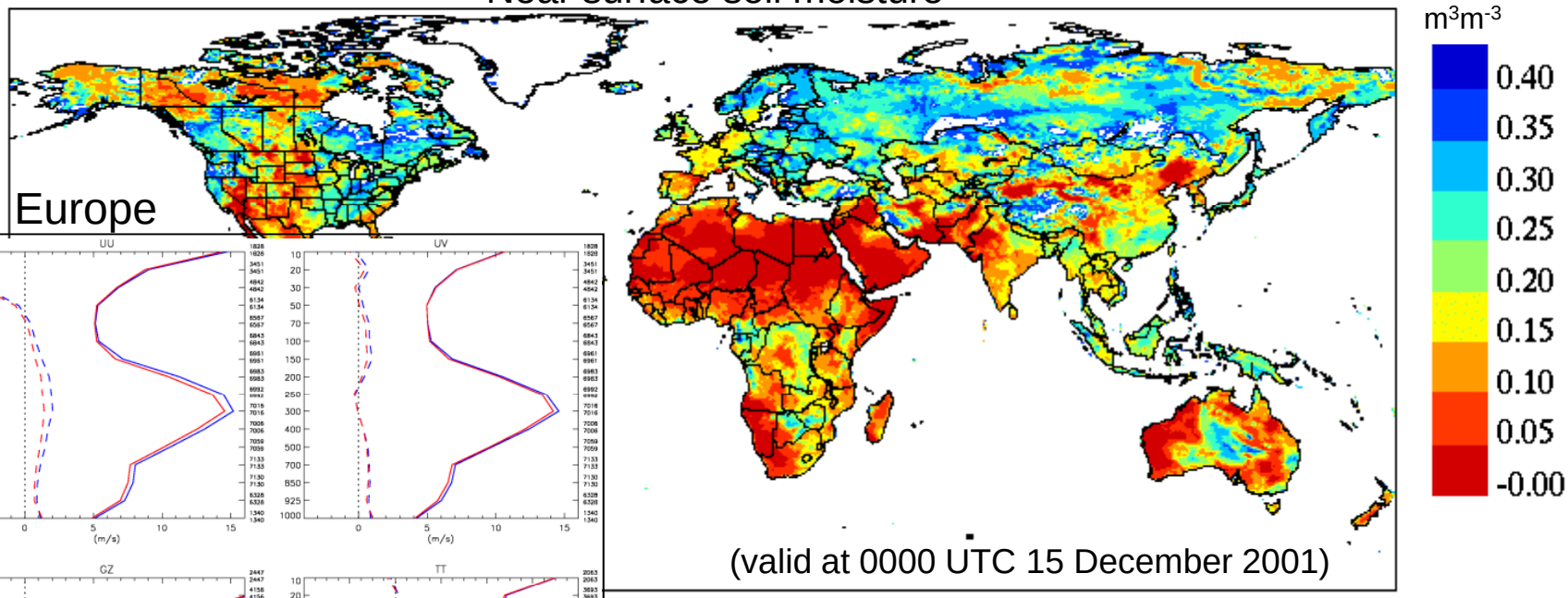


Implementation in the RDPS of ISBA and of the sequential land data assimilation system (OI, screen-level air temperature and relative humidity)

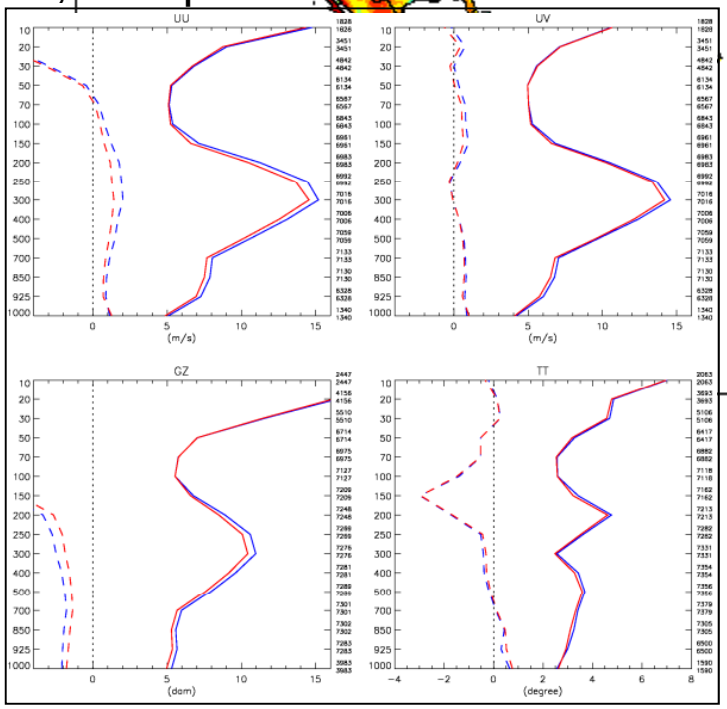
Thanks to Tom Robinson

A bit of history… Oct. 31, 2006

Near surface soil moisture

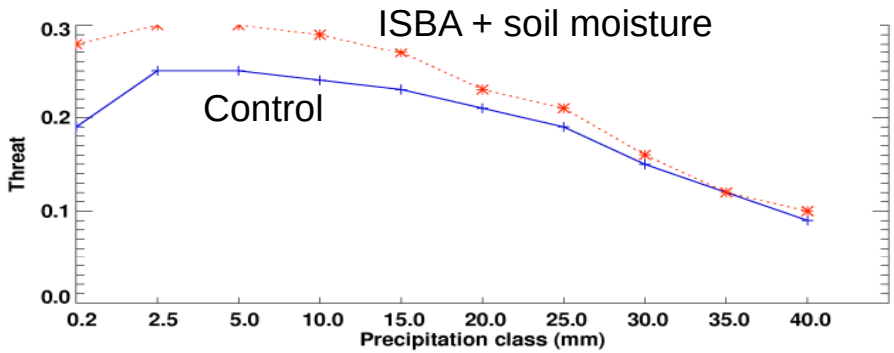


120-h, Europe



Implementation of ISBA and of the sequential land data assimilation system in the GDPS

Precipitation Threat Score (Day 4)- SHEF



Main objective of the presentation

In preparation for a formal proposal at the next CPOP meeting (June 18th) concerning the implementation in experimental mode of the first version of the Global Surface Assimilation System (GSAS 1.0), the main objective of this presentation is to describe the configuration of what will be proposed and present the results supporting the proposal.

The Canada Land Data Assimilation System (CaLDAS)

IN

Ancillary land surface data

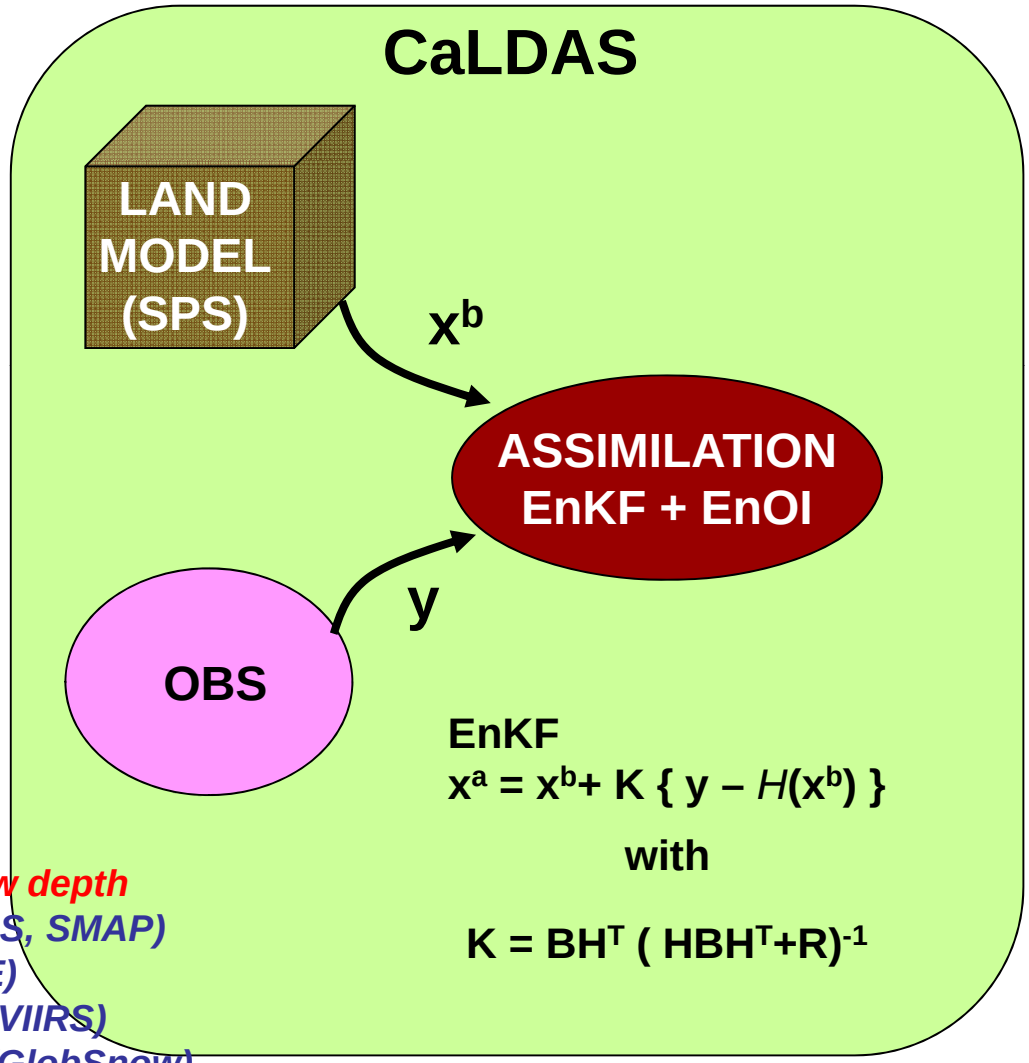
Orography, vegetation, soils, water fraction, ...

Atmospheric forcing

T, q, U, V, Pr, SW, LW

Observations

Screen-level (T, Td)
Surface stations snow depth
L-band passive (SMOS, SMAP)
MW passive (AMSR-E)
****Optical / IR (MODIS, VIIRS)***
Combined products (GlobSnow)



OUT

Analyses of…

Surface Temperature

Soil moisture

Snow depth

Vegetation*

*) not done yet…

The CaLDAS projects

CaLDAS-screen
(GSAS / RSAS 1.0)

- Assimilation of screen-level air temperature and dew point temperature to initialize soil moisture and surface temperature;
- ensemble OI for snow depth (surface obs)

CaLDAS-SMOS/SMAP

- Assimilation of L-band TBs from SMOS (and eventually SMAP) to initialize soil moisture
- Screen-level data used as forcing

(GSAS / RSAS 2.0)

CaLDAS-SNOW

- Assimilation of GlobSnow SWE retrievals and of snow coverage area from MODIS (eventually VIIRS)
- In combination with CaLDAS-SMOS/SMAP

(GSAS / RSAS 3.0)
CaLDAS-Veg

- Vegetation characteristics (LAI, veg) provided by CTEM
- Evaporation conductance obtained from photosynthesis in SVS
- Possible assimilation of MODIS / VIIRS for LAI

Configuration of GSAS 1.0

Ensemble Kalman Filter

24 members

3-h assimilation window

On two Yin-Yang 25-km grids

First guess from the Surface Prediction System (SPS), also known as GEM-Surf in the literature

Only minor changes to land surface modeling (still ISBA)

No changes to geophysical fields

Perturbed atmospheric forcing (precip, TT, SW, and LW)

Ensemble of CaPA precipitation analyses

Observations are OI analyses of T_2m and Td_2m (every 3h) and surface measurements of snow depth

Observation error from dispersion of OIs (for T_2m and Td_2m)

No bias correction.

Control variables are T2 and w2 for the EnKF.

Perturbations to analyses and to observations (except for snow)

The land surface variables provided by CaLDAS

Analyzed mean surface temperature **I0(2)** (ensemble average) ;

Analyzed root-zone soil moisture **I1(2)** (ensemble average) ;

Analyzed snow depth over land **(SD)** (ensemble average) ;

First-guess superficial soil moisture **I1(1)** (ensemble average) ;

First-guess surface temperature **I0(1)** (ensemble average) ;

First-guess soil volumetric ice content **I2** (ensemble average) ;

First-guess water retained in vegetation **I3** (ensemble average) ;

First-guess snow depth over glaciers and sea ice (ens. Average);

First-guess water retained in snowpack **I4** (ensemble average) ;

First-guess snow albedo **I6** (ensemble average) ;

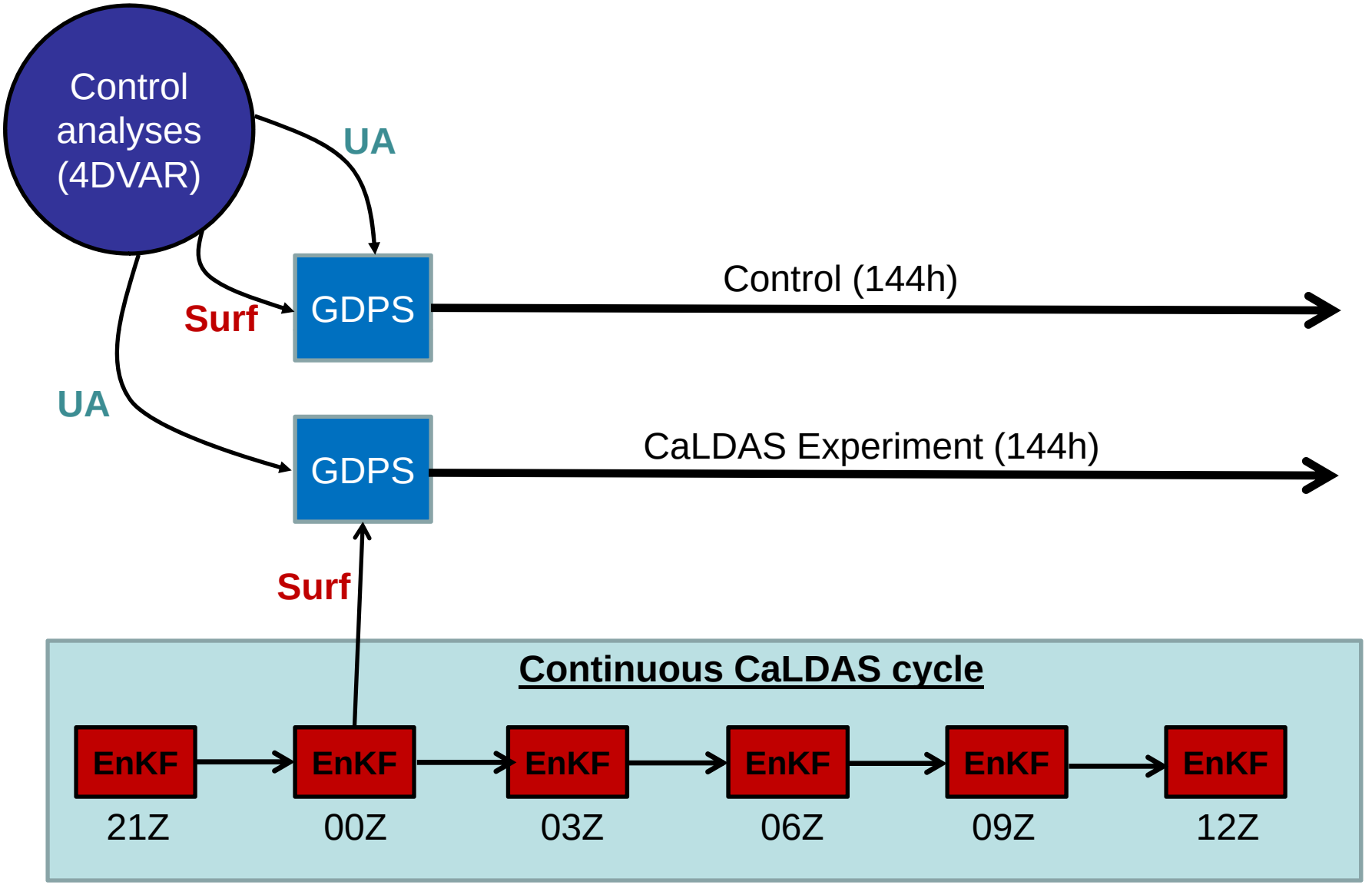
First-guess snow density **DN** (ensemble average) ;

Evaluation

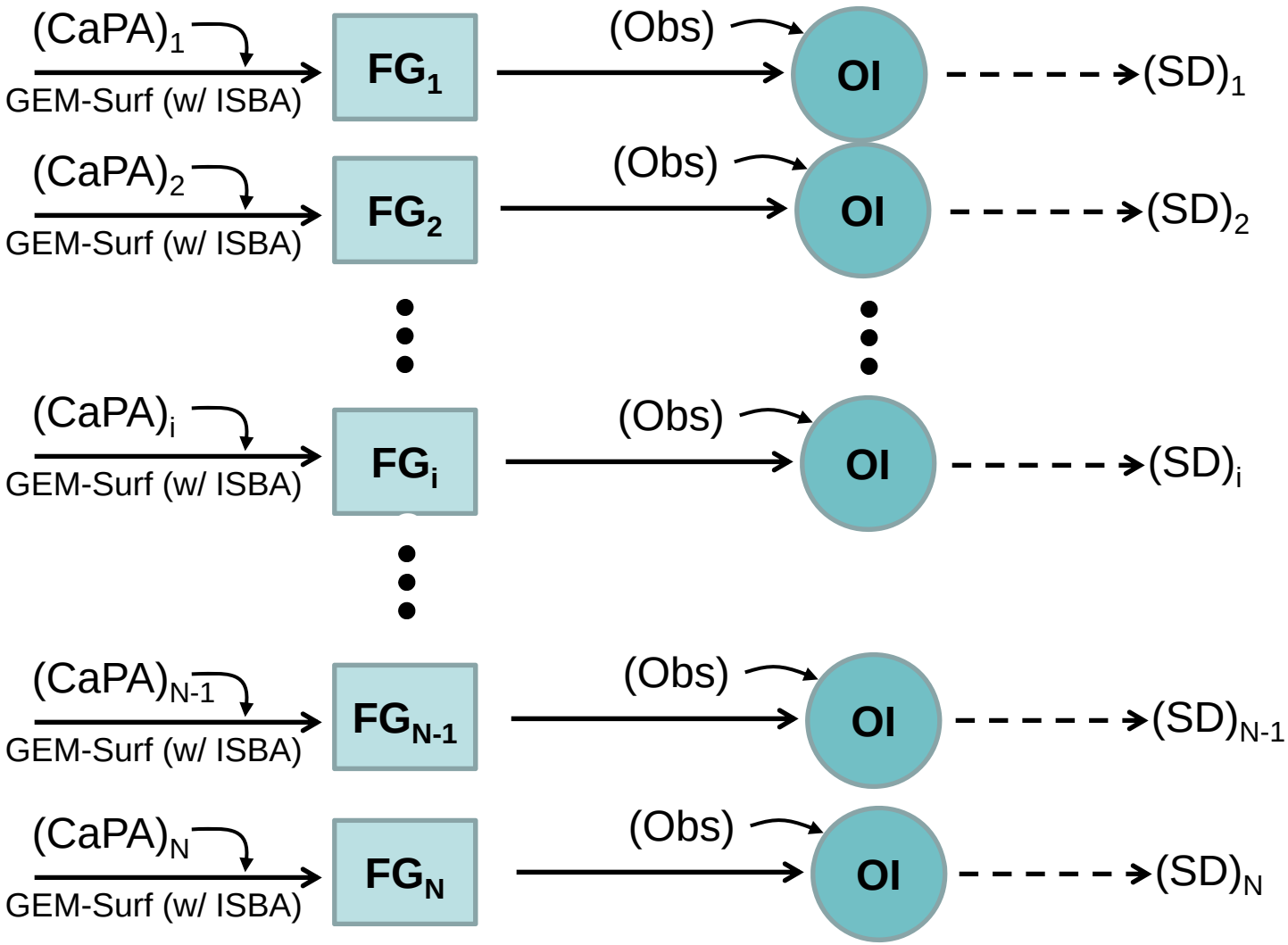
- **Products Evaluated**. Verification of GDPS model forecasts initialized with CaLDAS surface analyses. Forecast impacts will be examined for forecast ranges from 0 – 144h.

  - **Upper-Air Scores** : Bias, RMSE, and STDE for UU, VV, GZ, TT, and ES against WMO upper-air radiosonde stations.
  - **Surface Scores** : Bias, RMSE, and STDE for TT, TD, and UU, VV against surface SYNOP stations.
  - **Precipitation Scores** : Bias, POD, FAR, ETS, and frequency of occurence against SYNOP and SHEF networks over North America. Accumulation periods of 6hrs and 24 hrs.
  - **Cloud Cover Fraction** : Bias, percent correct, frequency of occurrence, and skill scores (e.g., HSS) against observed cloud amounts over North America.

Offline tests (winter and summer 2011)

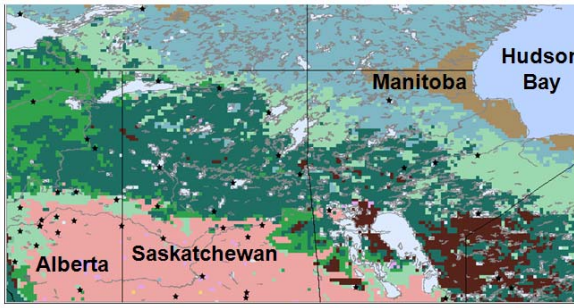


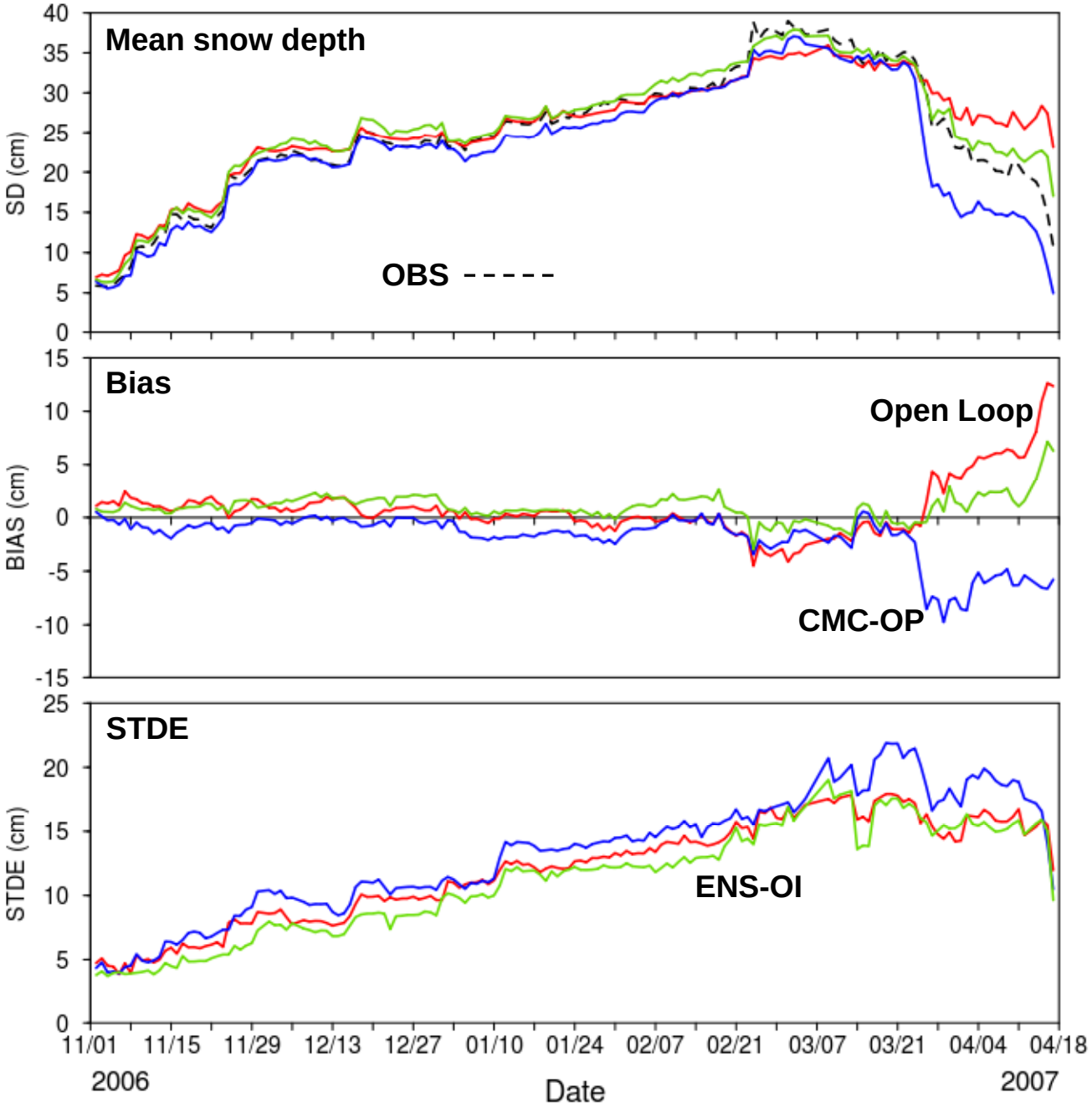
Configuration of GSAS 1.0… the snow part



Individual OIs based on Brasnett (1999)

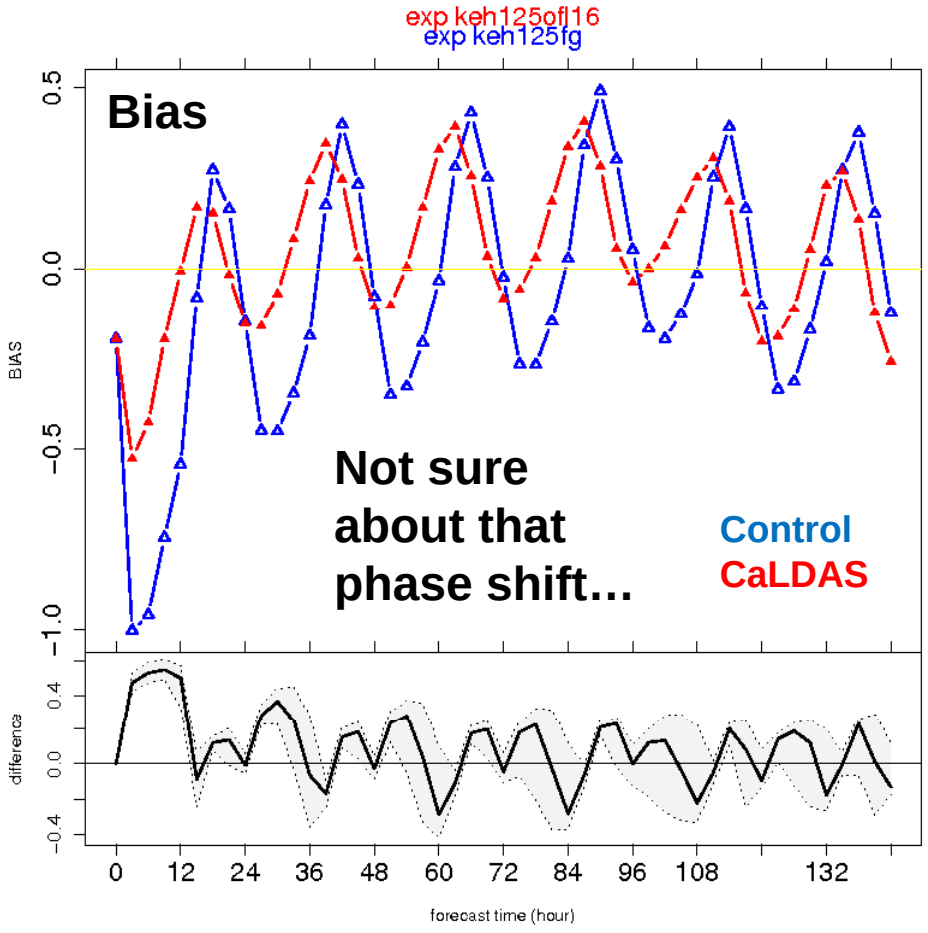
Improved analysis of snow depth

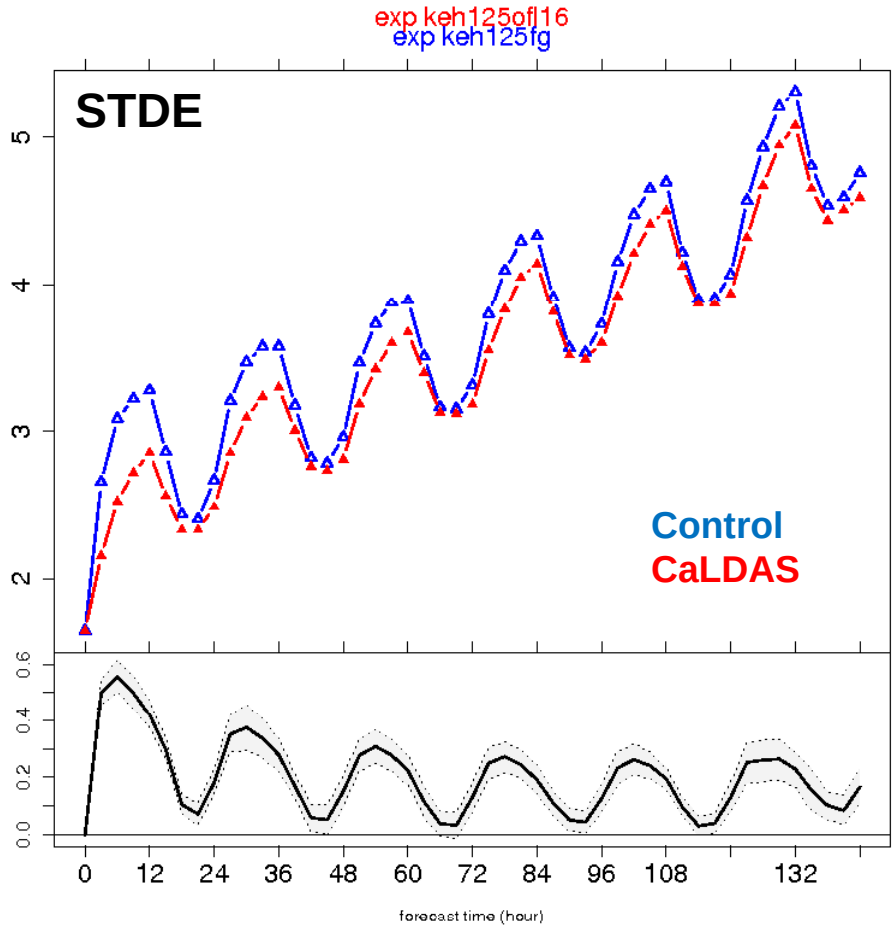




Bélair et al, to be submitted soon

Winter results – 2m temperature (00Z runs – North America)





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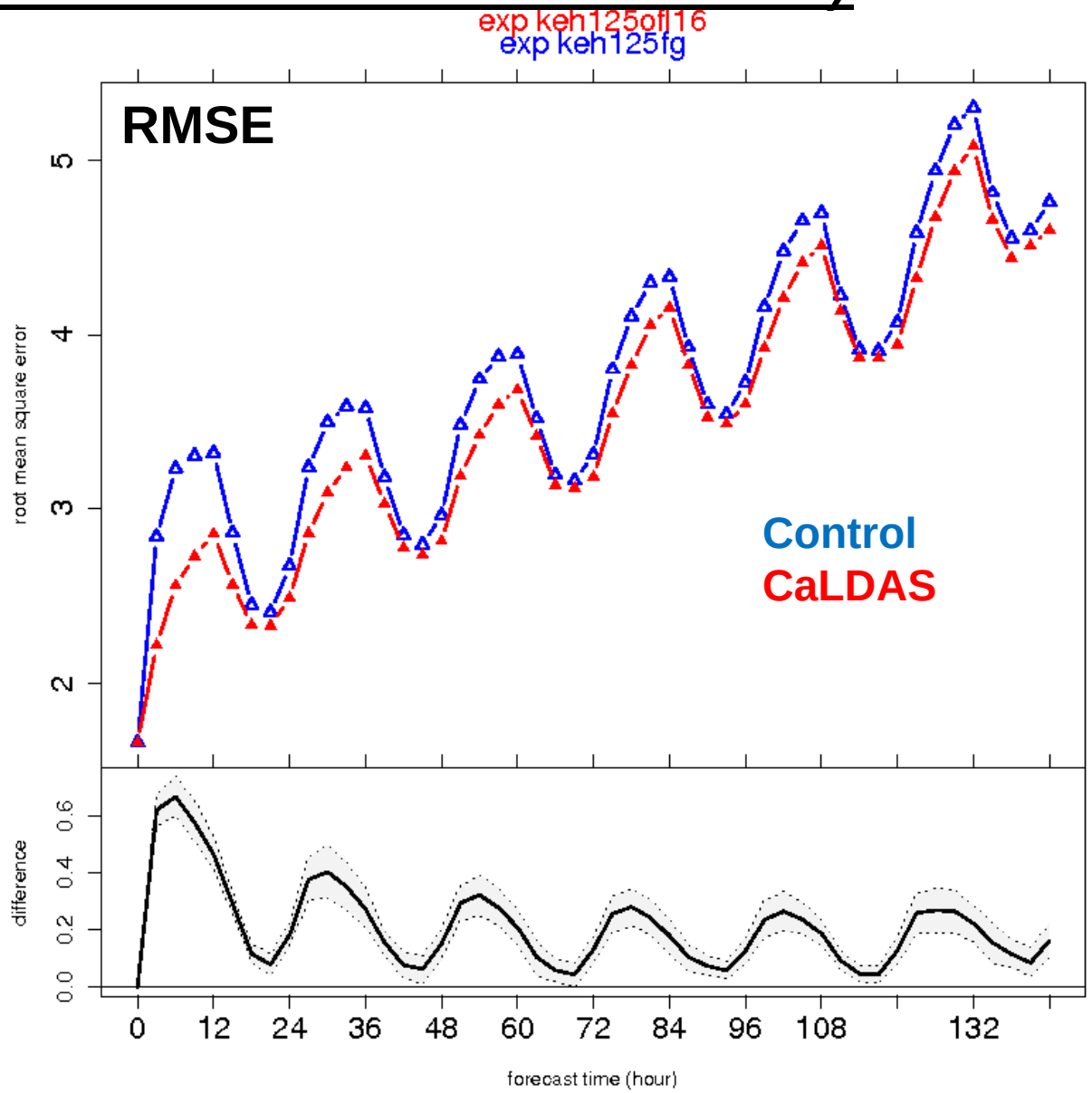
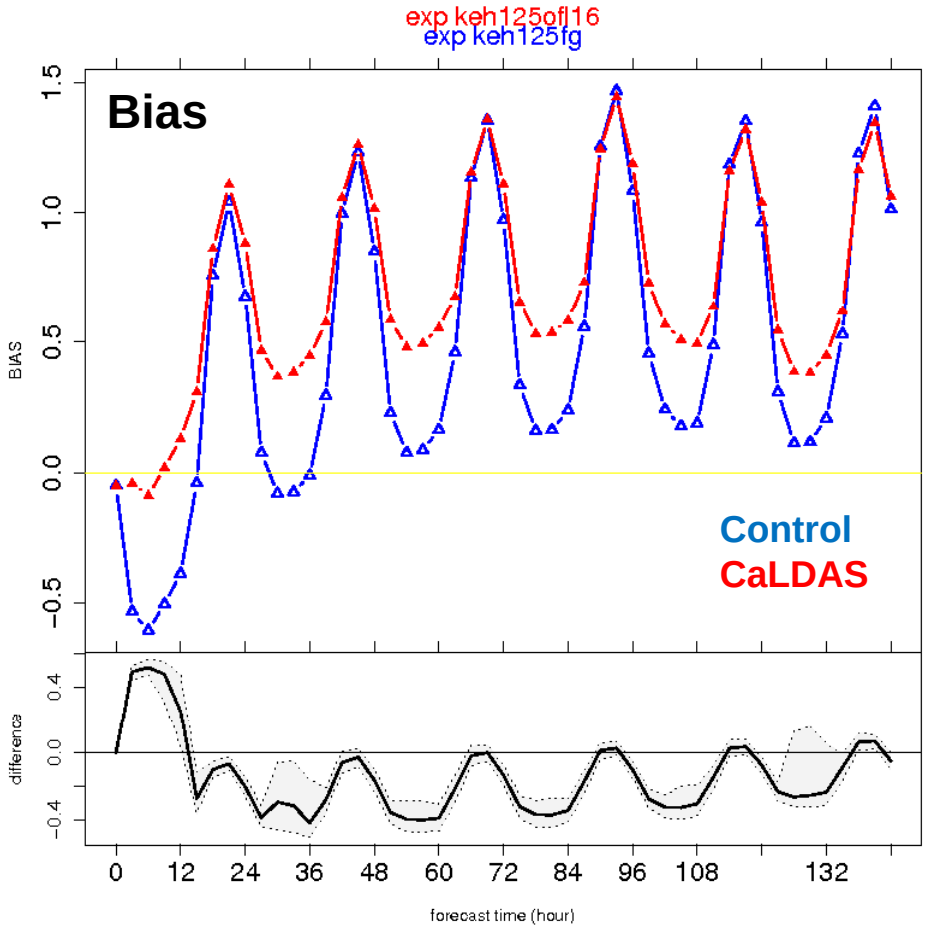
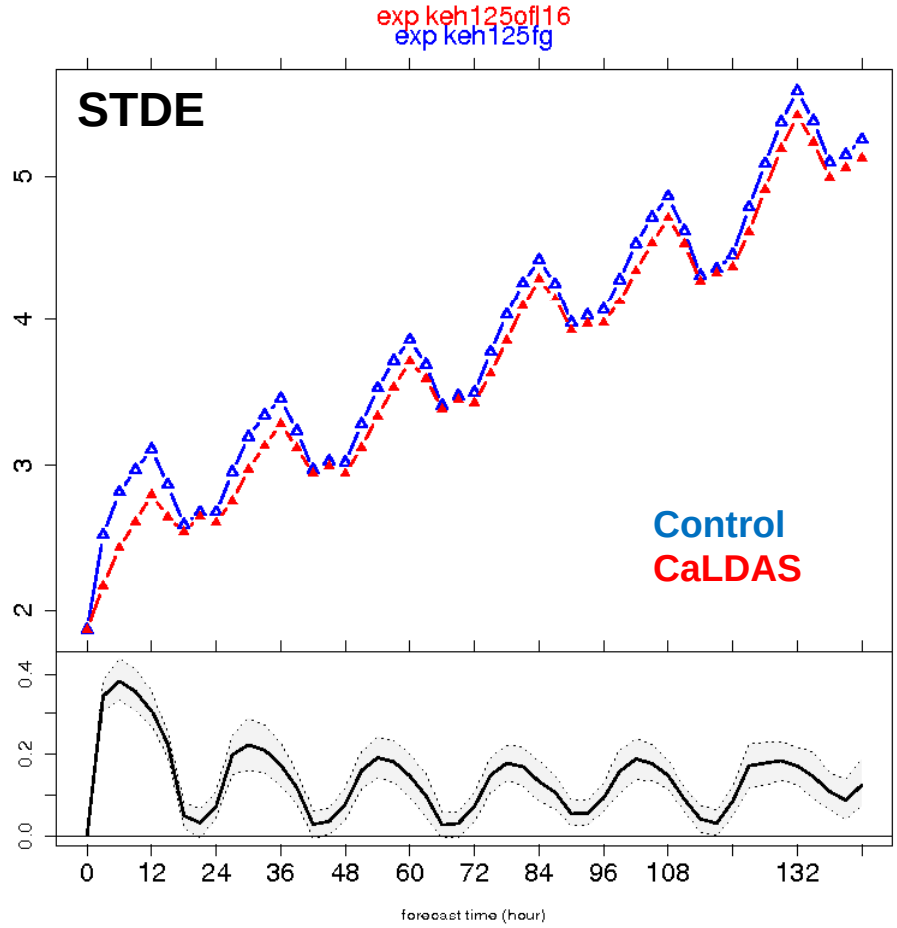
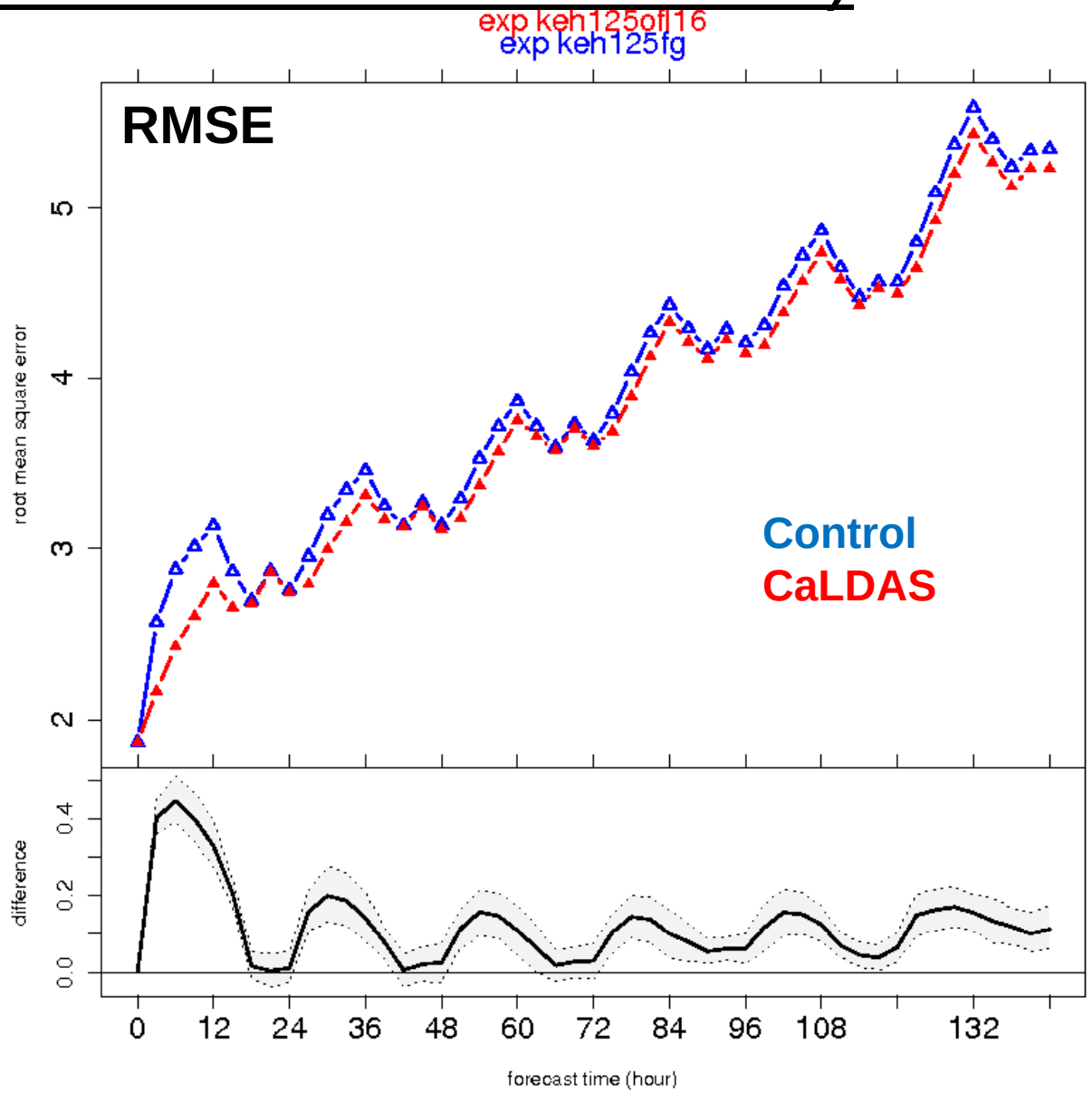


Winter results – 2m dew point temp (00Z runs – North America)

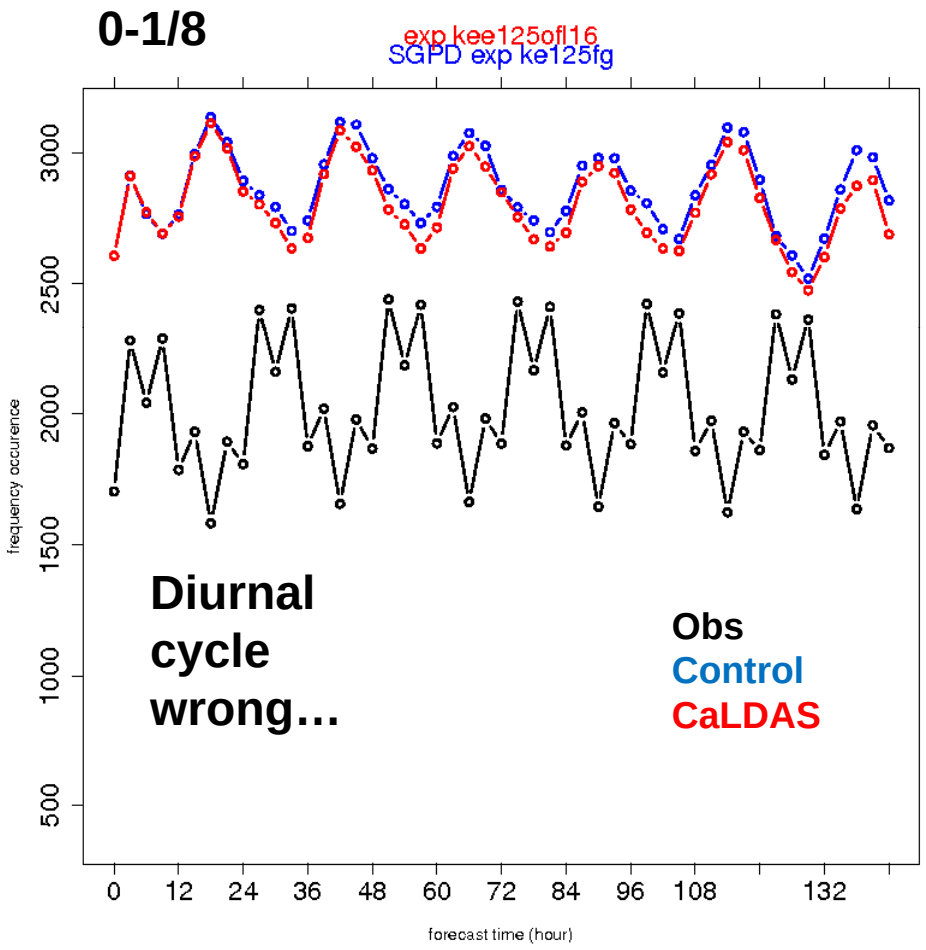


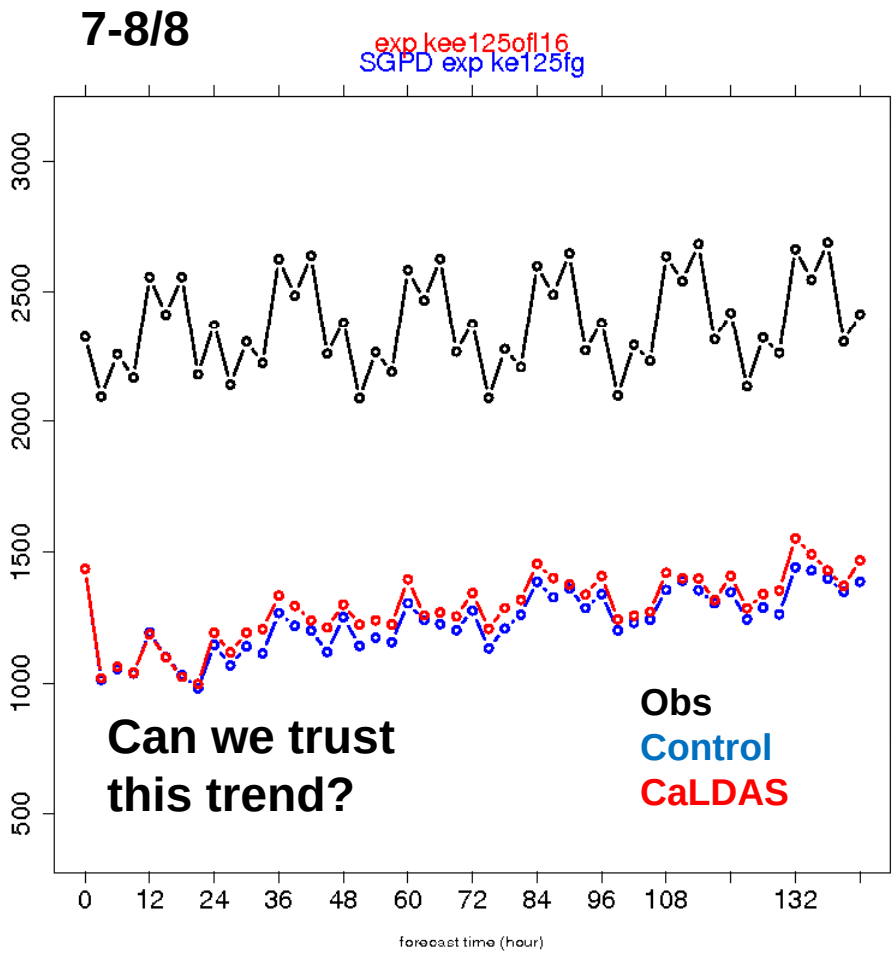


Winter results – 2m dew point temp (00Z runs – North America)



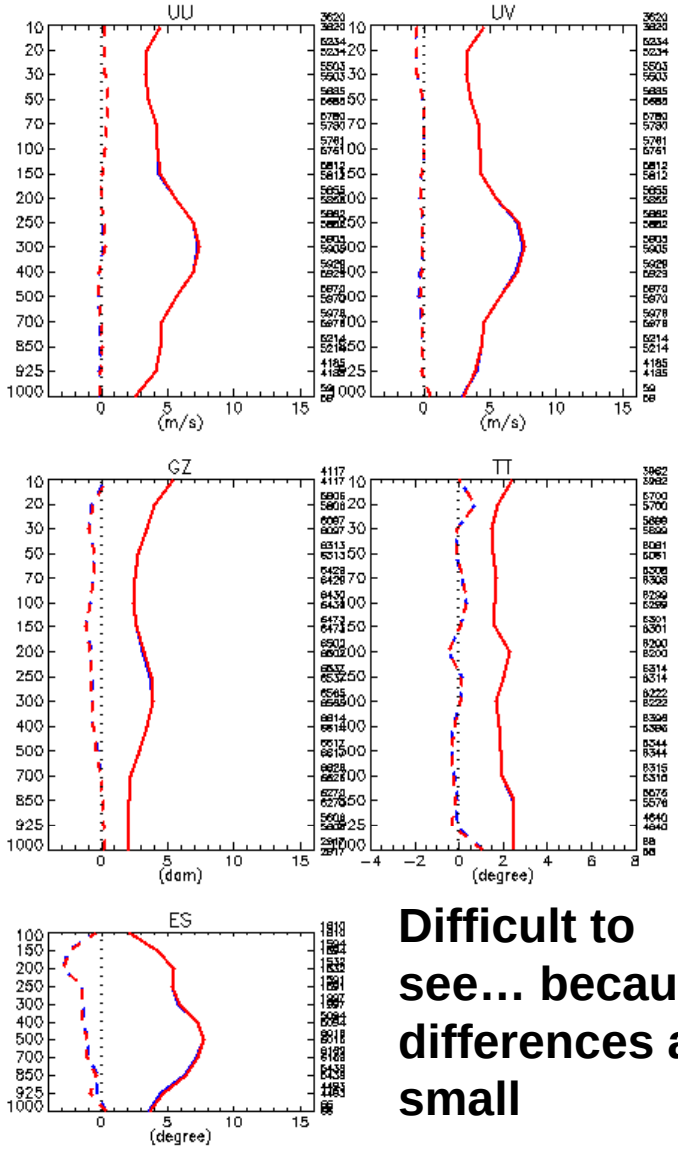
Winter results – Cloud fraction occurrence (00Z runs – North America)





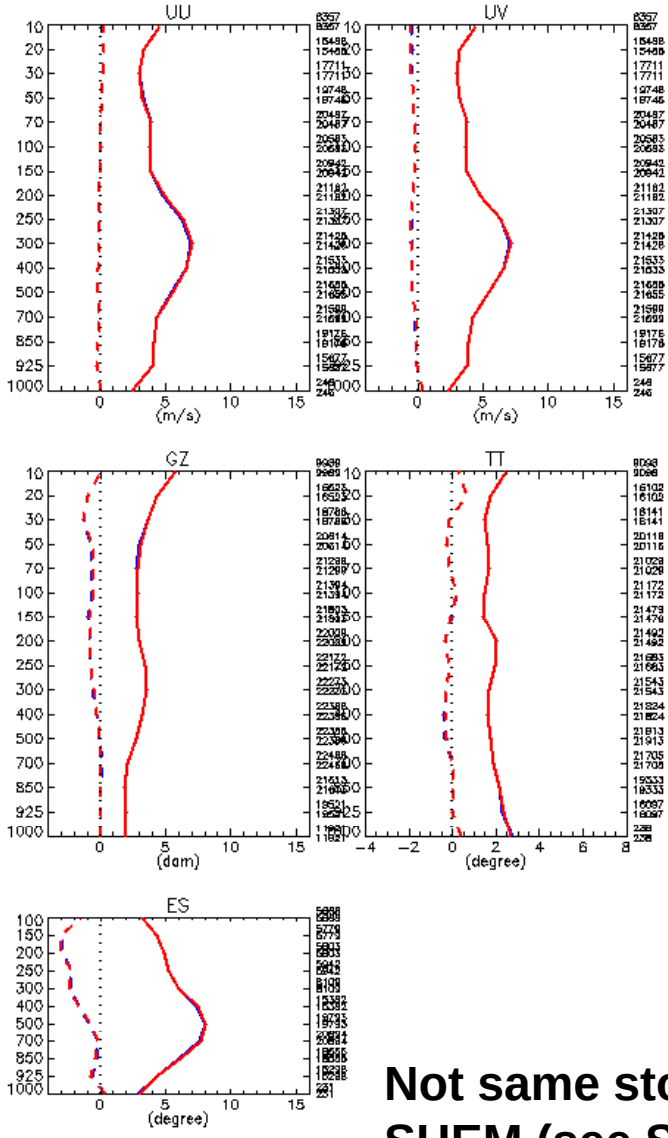
Winter results – Upper air

North America



Difficult to see… because differences are small

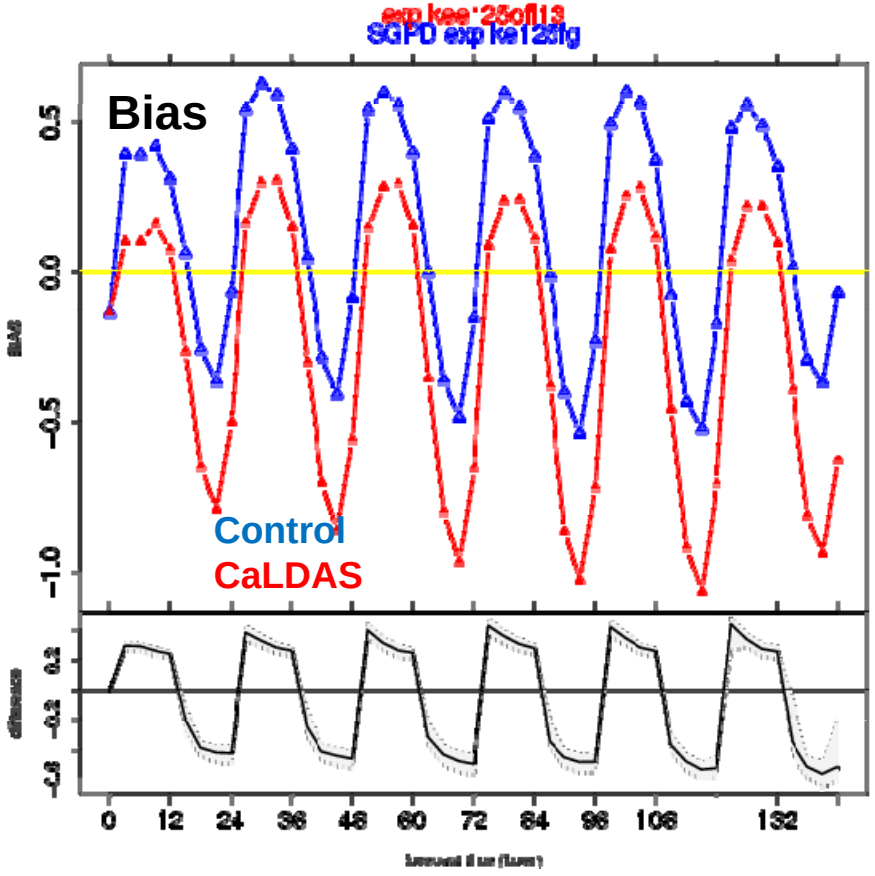
Northern Extra-tropics

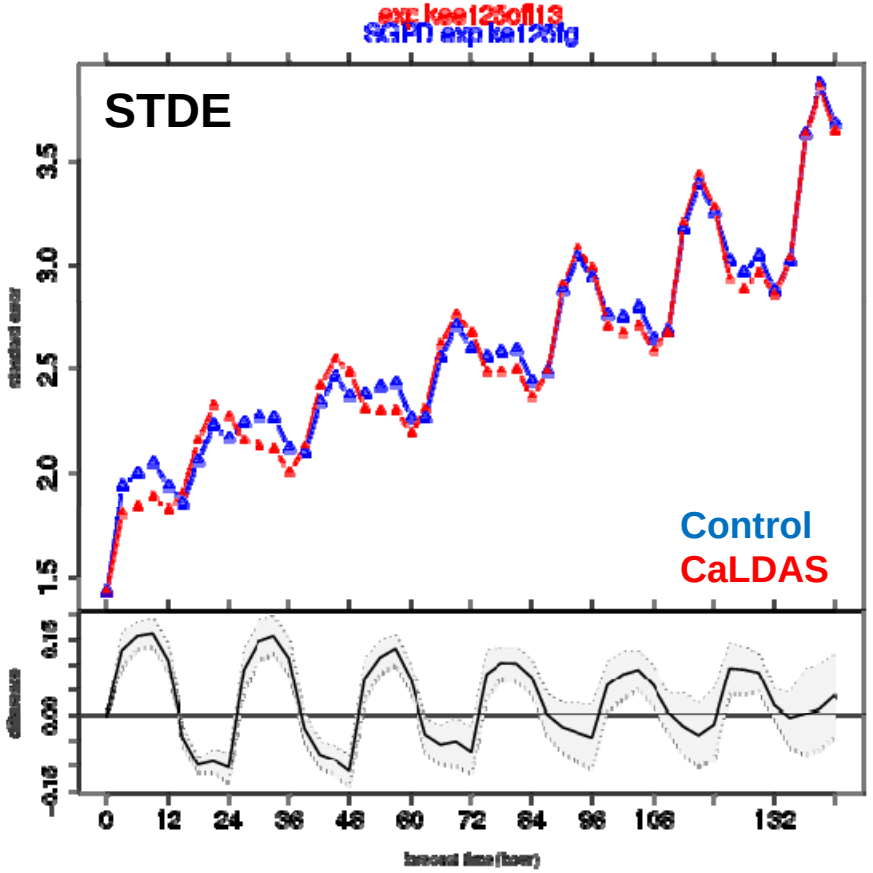


Not same story for SHEM (see Summer results)

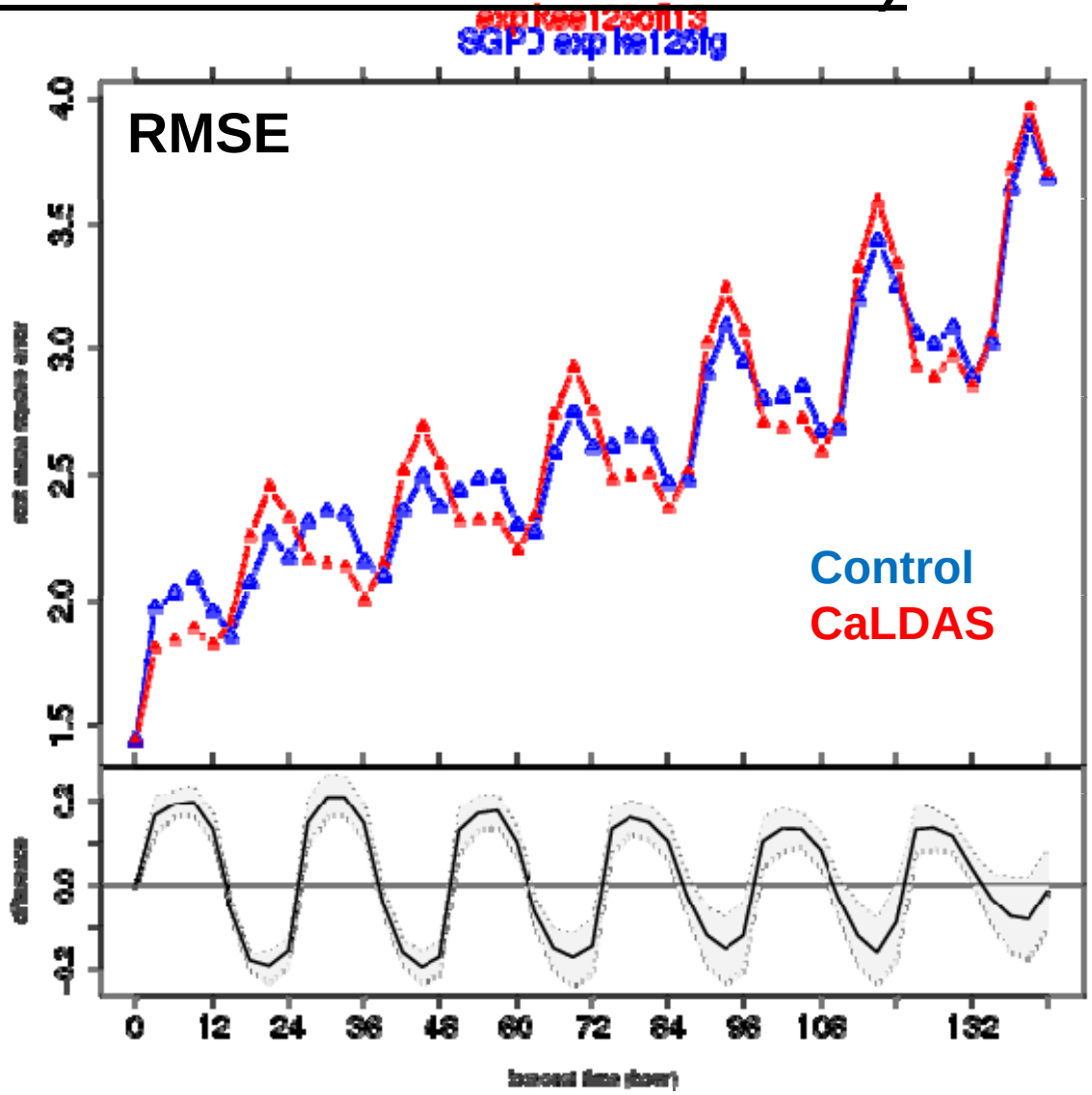
72h forecasts

Summer results – 2m temperature (00Z runs – North America)

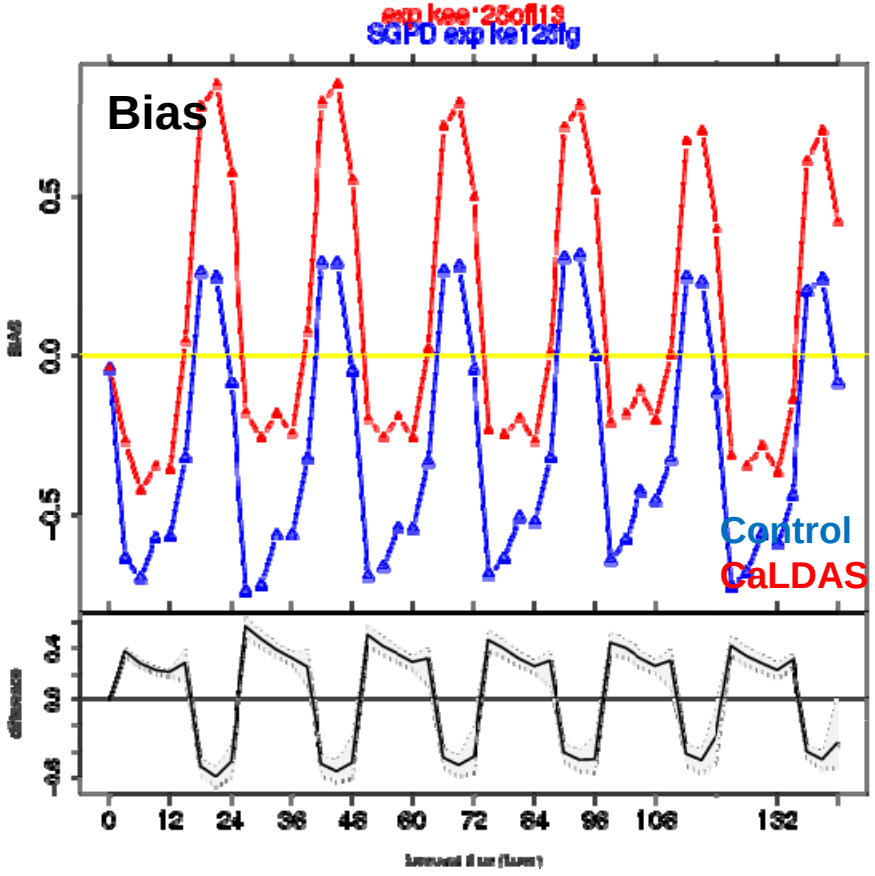


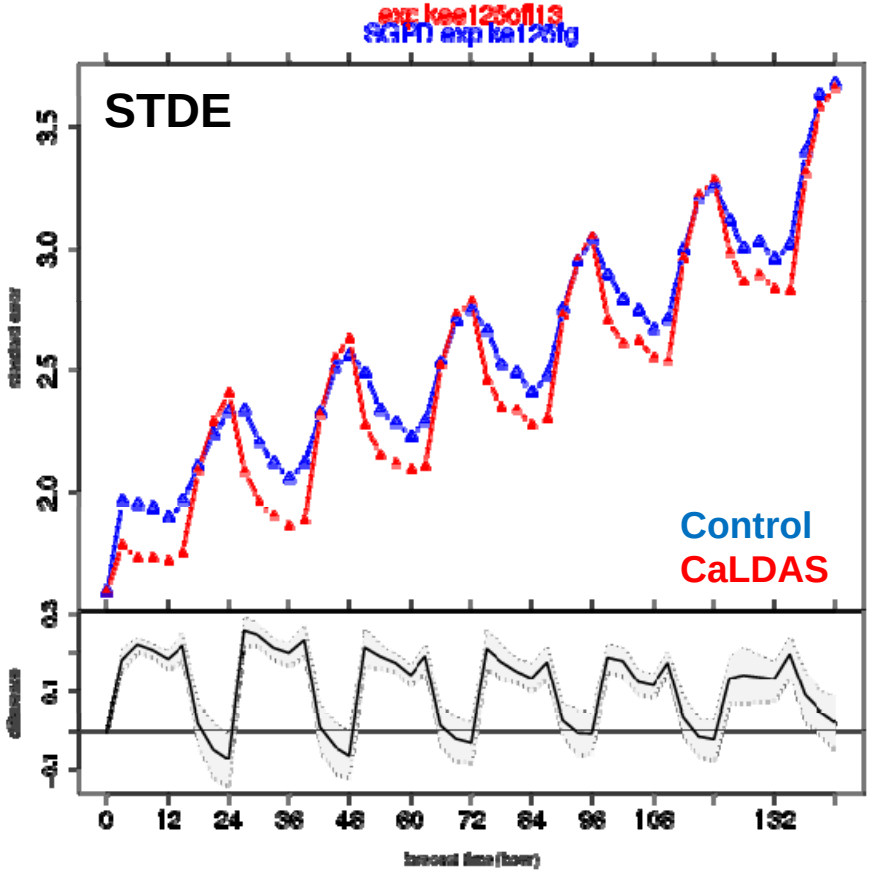


Summer results – 2m temperature (00Z runs – North America)

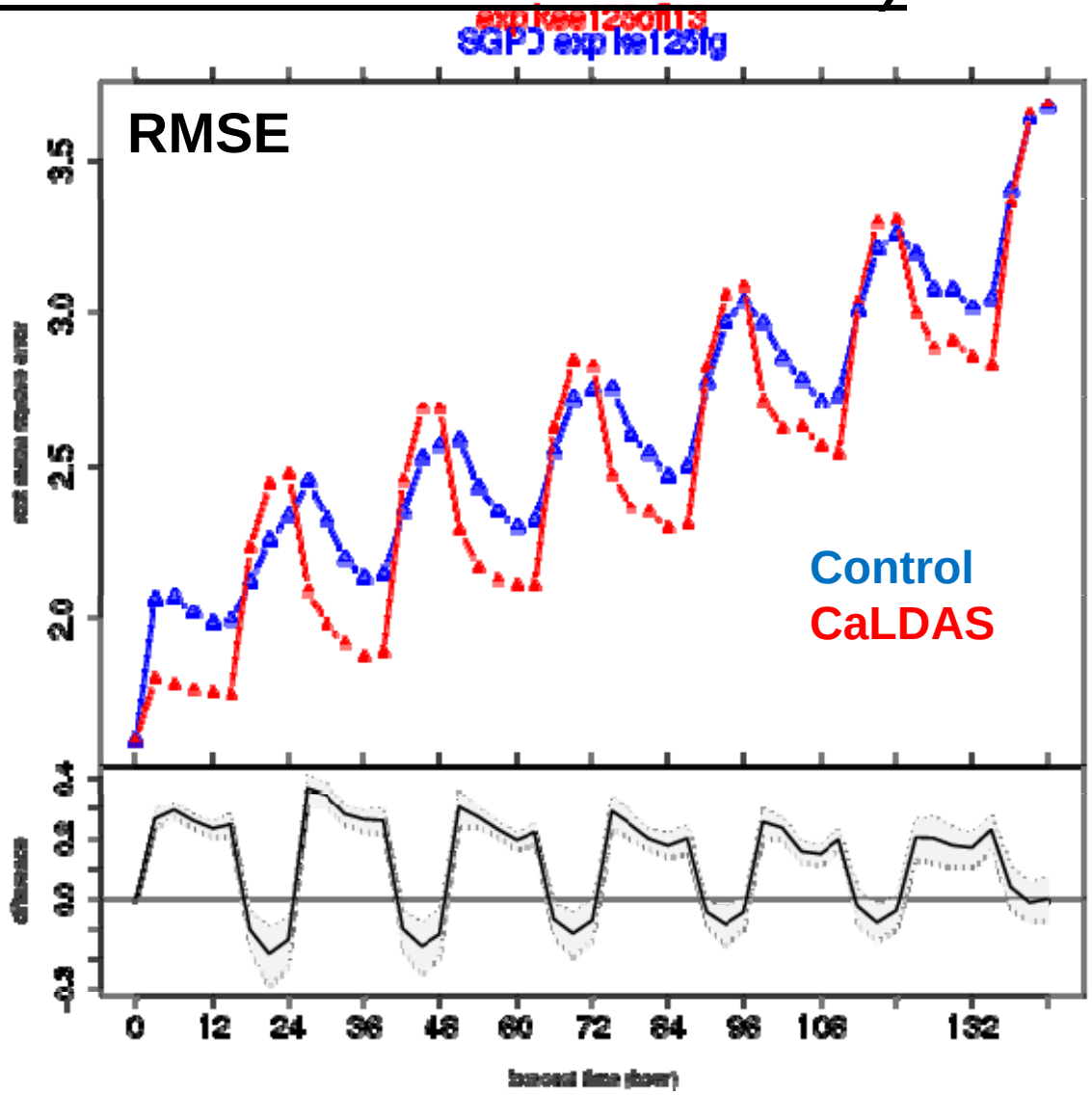


Summer results – 2m dew point temp (00Z runs – North America)

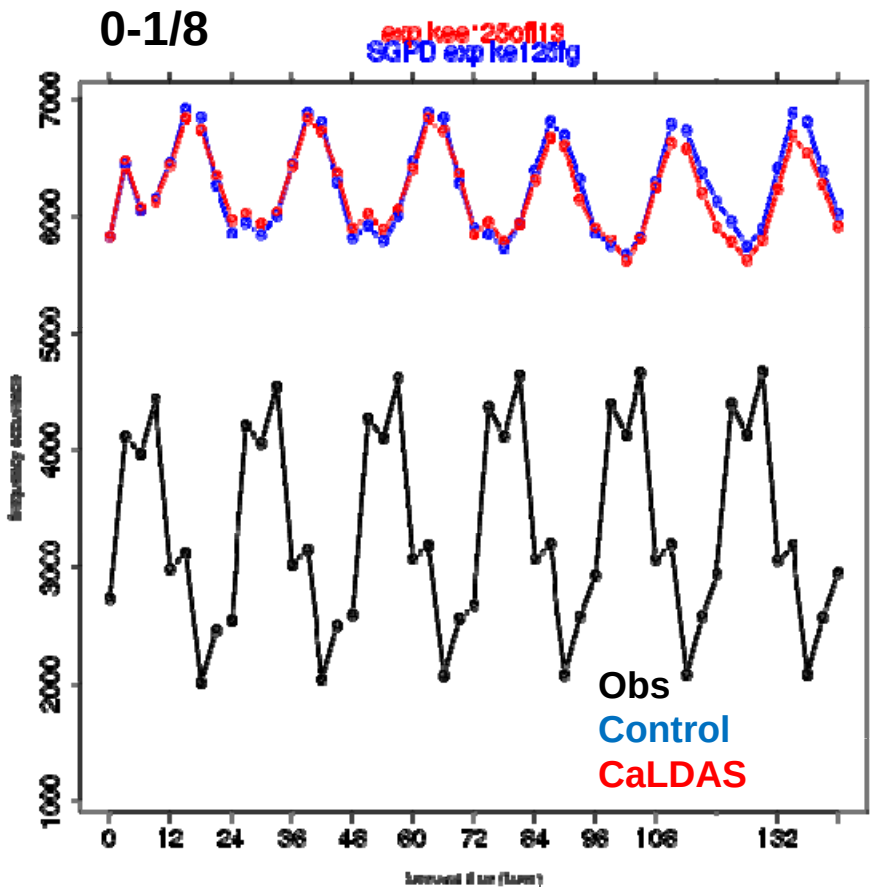


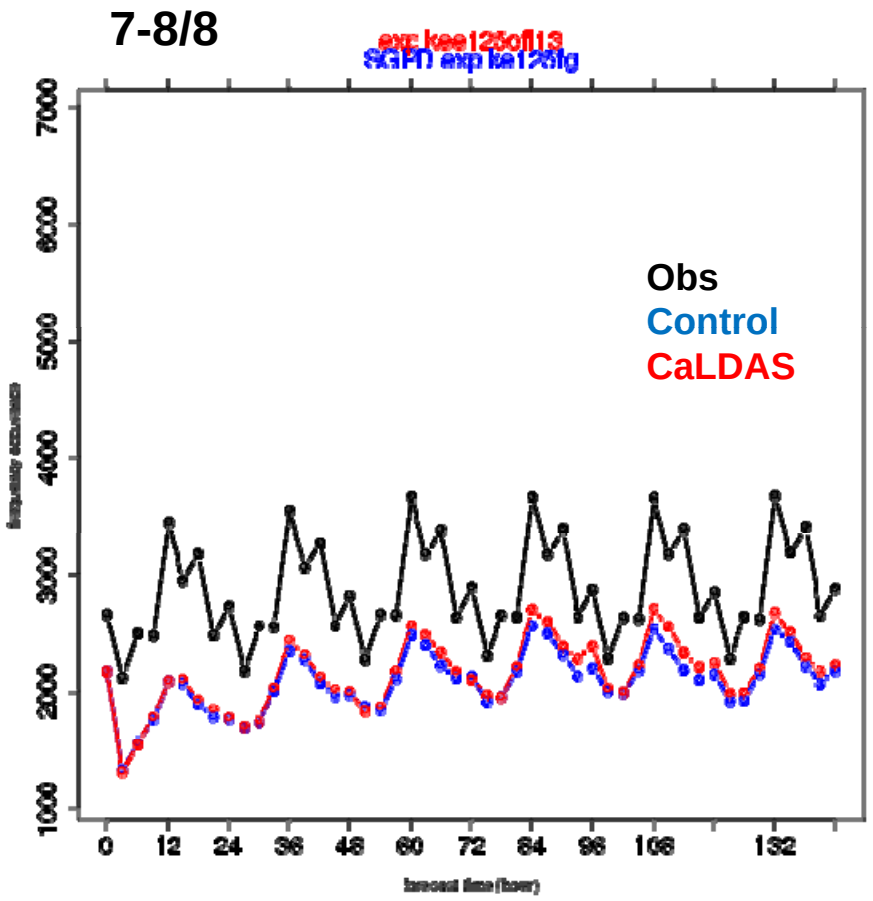


Summer results – 2m dew point temp (00Z runs – North America)

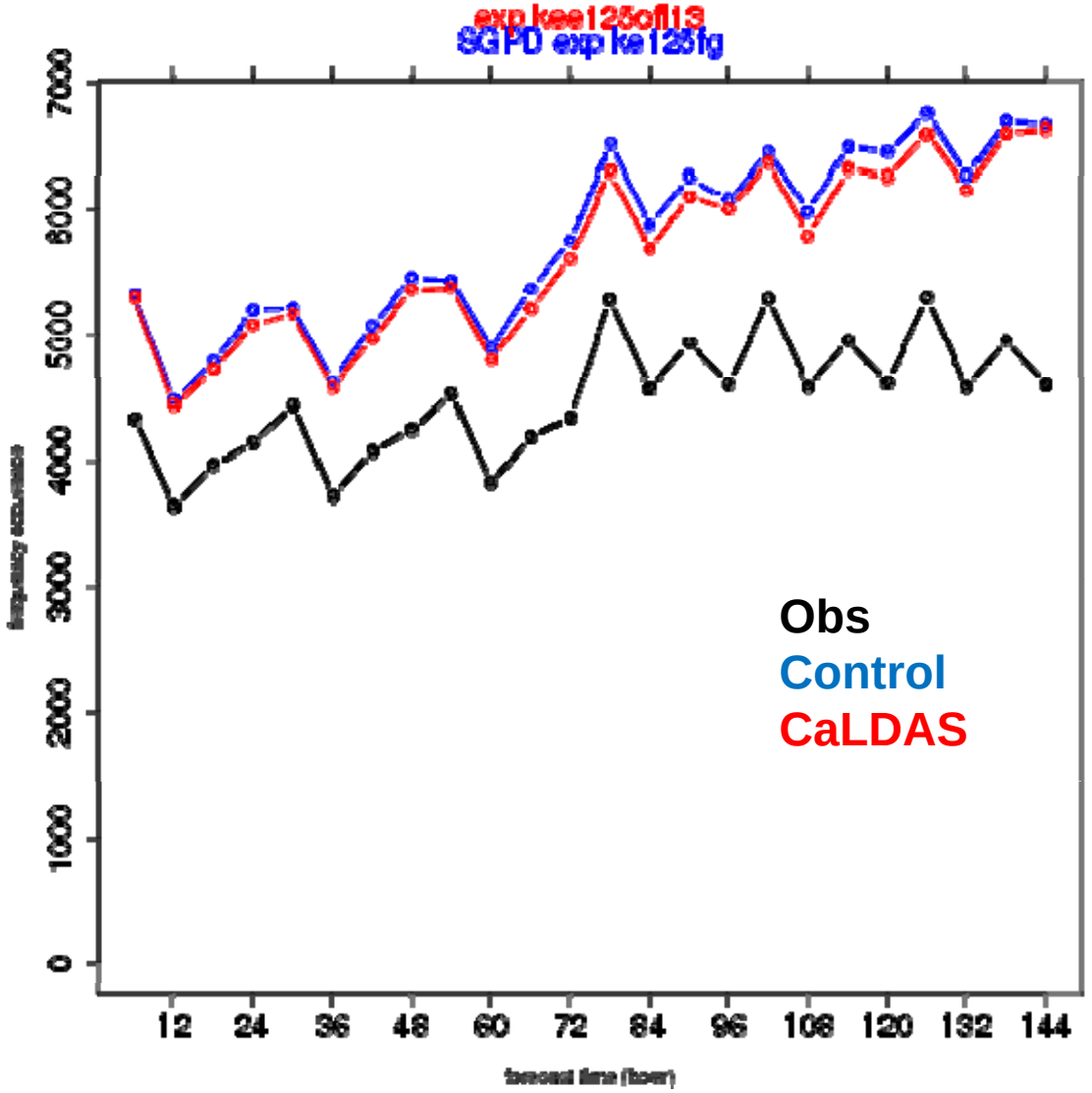


Summer results – Cloud fraction occurrence (00Z runs – North America)





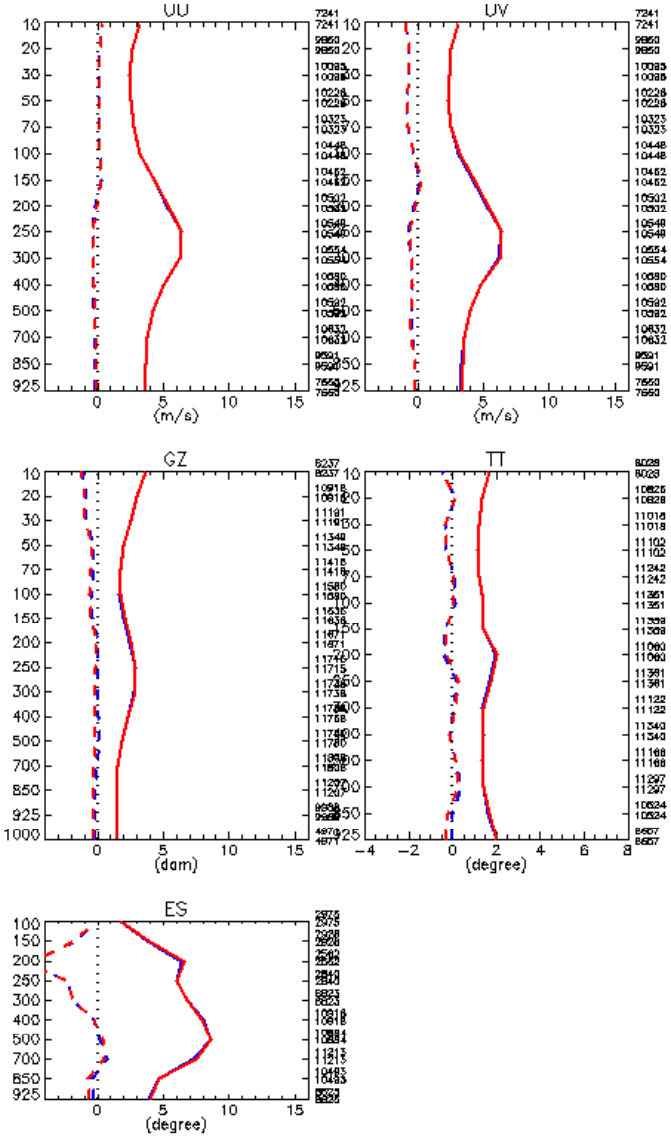
Summer results – Precipitation occurrence (00Z runs – North America)



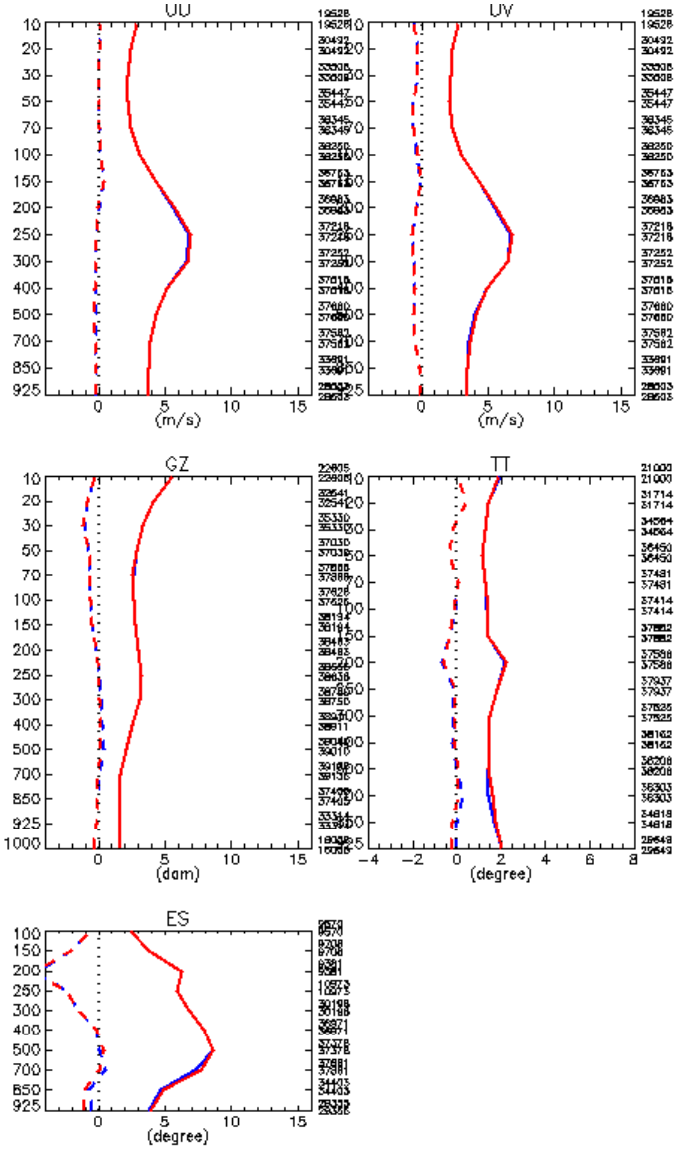
Frequency occurrence of events with 6h precipitation accumulation greater than 0.5 mm

Summer results – Upper air

North America



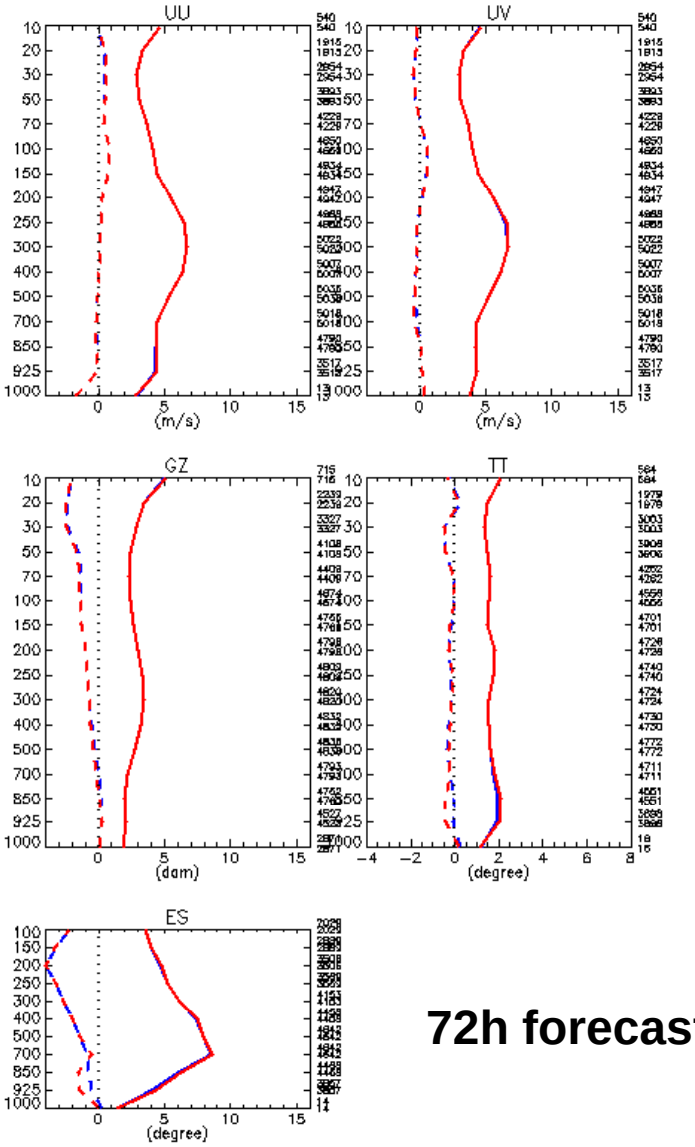
Northern Extra-tropics



72h forecasts

Summer results – Upper air

Southern Extra-tropics



72h forecasts

Summary of objective evaluation

		Winter	Summer
SD			
T2m	***Bias***		
	STDE		
	RMSE		
Td2m	***Bias***		
	STDE		
	RMSE		
Clouds			
Precip			
UA	***NAM***		
	NHEM		
	SHEM		

++	+	-	- -

Expected upgrade before the YECE implementation, including ...

Better constraints on the soil moisture increments at the extremes (mostly at the wilting point) OR increase the dynamical range of ISBA (severely limited right now) – responsible for biases.

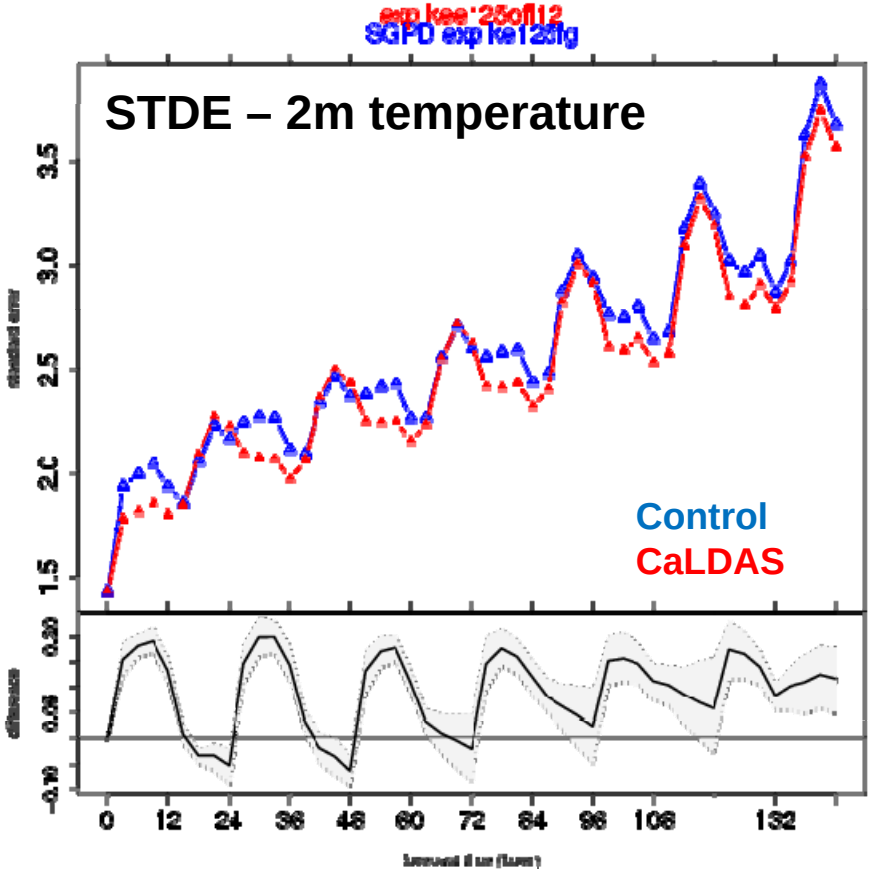
Use version with more realistic perturbations to observations (and wider spread) – will be possible because of reduced biases (first point).

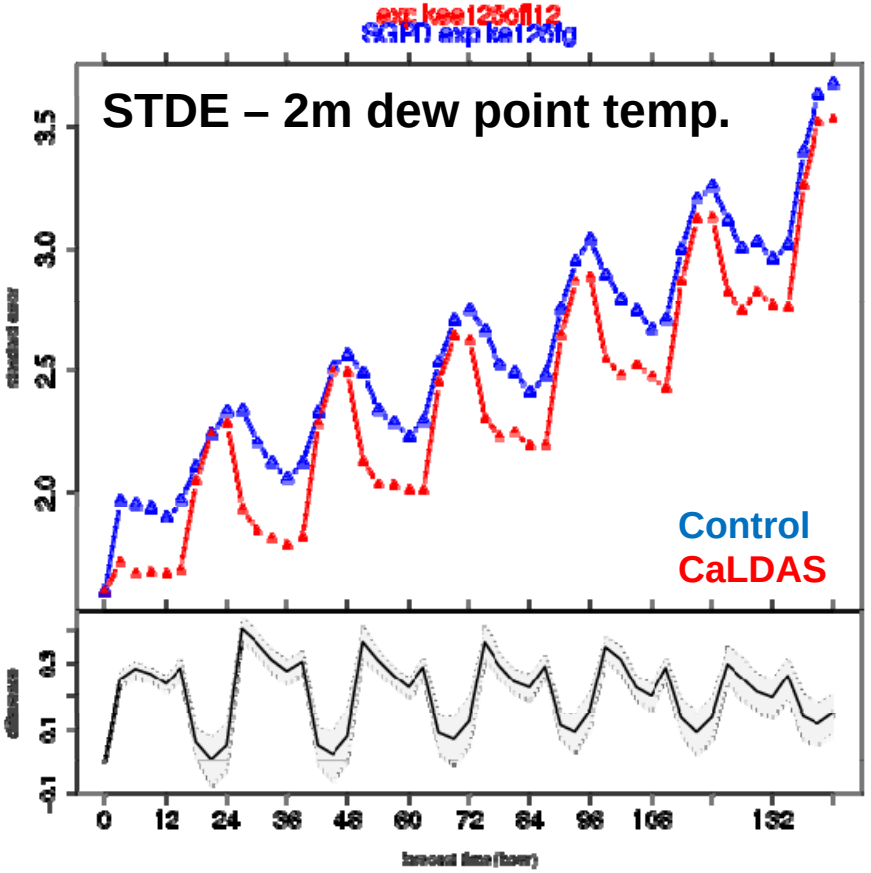
Re-examine how the deterministic analyses are constructed from the ensembles (median, smoothing).

On a 15-km Yin-Yang grid

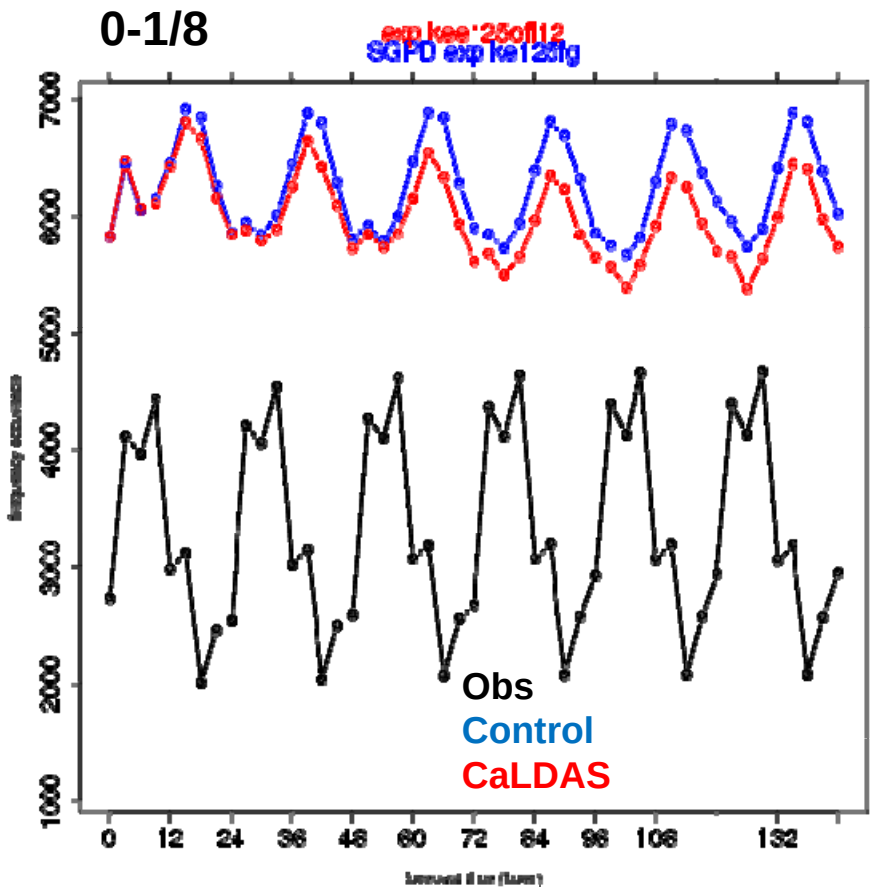
Maybe use a larger ensemble

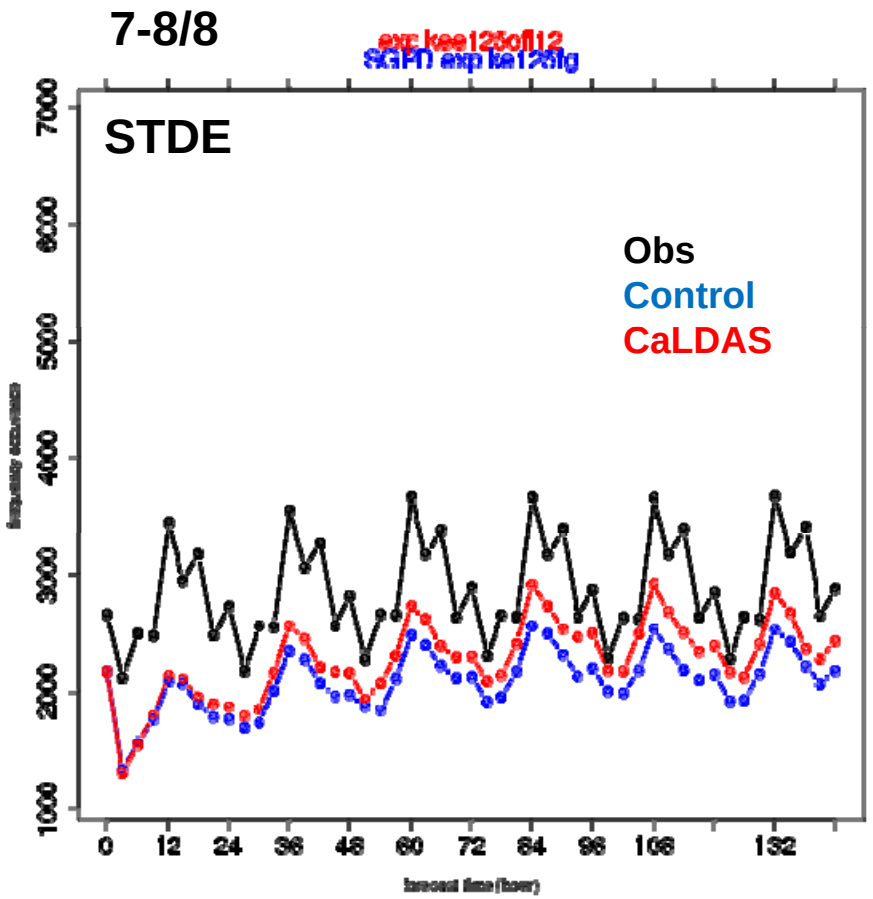
More realistic perturbations on observations – Summer results





More realistic perturbations on observations – Summer results





Why it is a good idea to proceed with the implementation right now

What could be called a "mechanical" implementation…

Spin-up of surface fields (deep soil moisture requires more than a year)

Installation before the next GDPS (YECE), which will feature other technically challenging components, like the EnVAR and the Yin-Yang GEM

Entirely new system (increase level of confidence in its robustness)

The land surface products can be used and evaluated for other applications (e.g., hydrology) and by other departments (e.g., AAFC, NRCan)

What will be proposed at CPOP

It is proposed to implement GSAS 1.0, with the configuration as described in this presentation (offline, YY25km) in experimental mode at CMC-Operations.