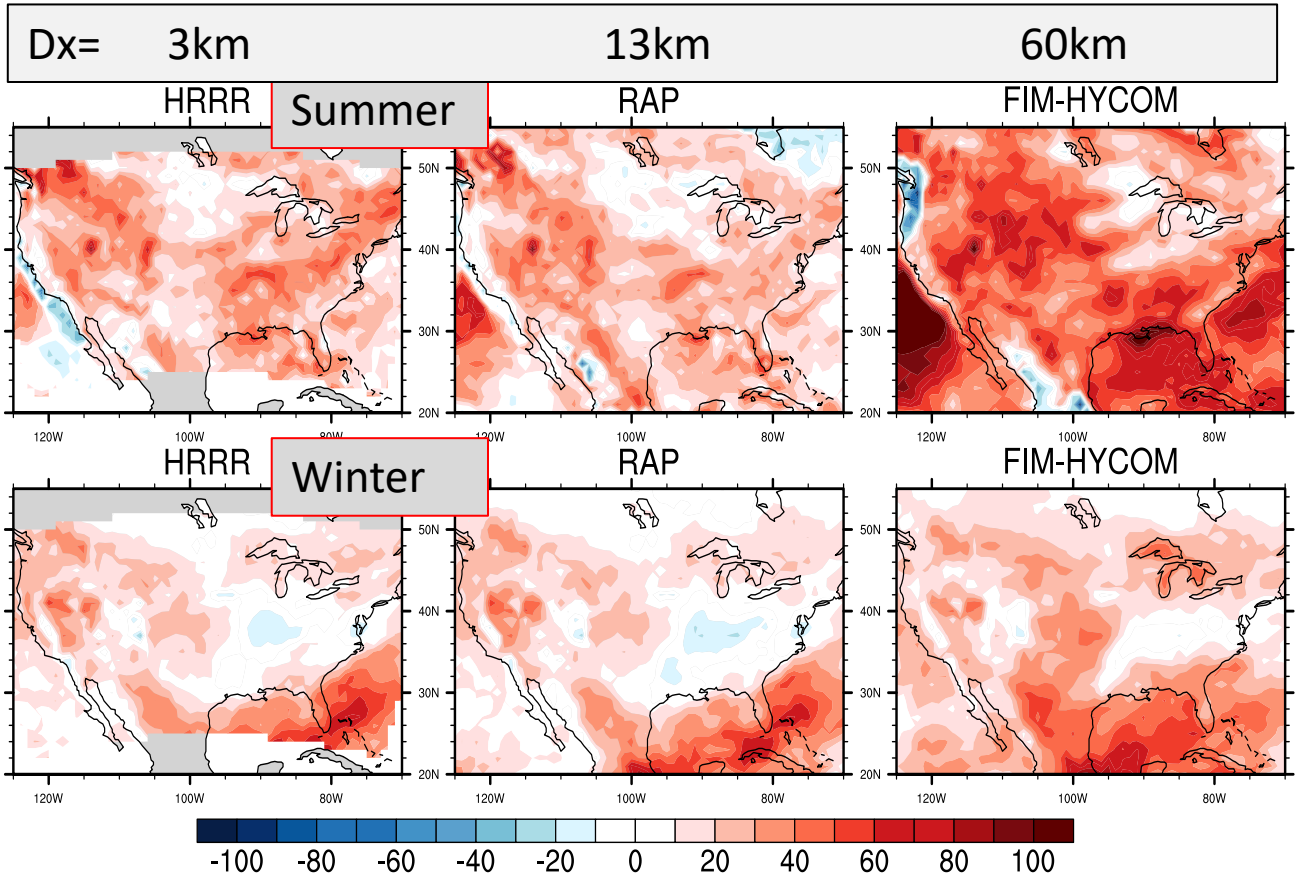
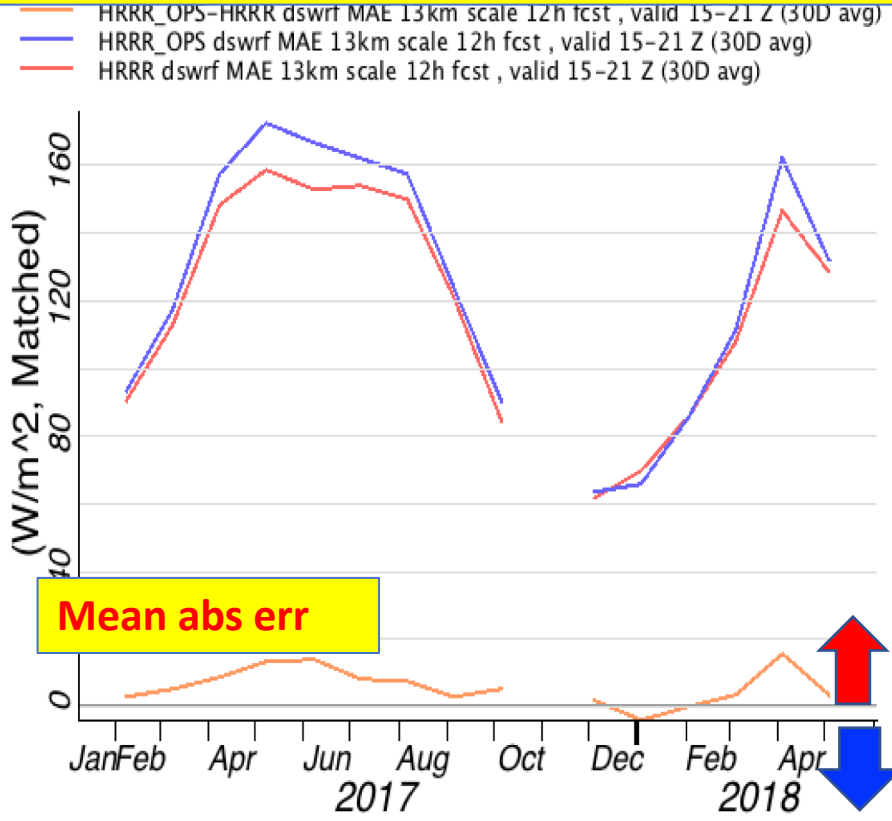
Downward SW radiation error – Forecast minus CERES (W/m^2, NASA sat estimate)



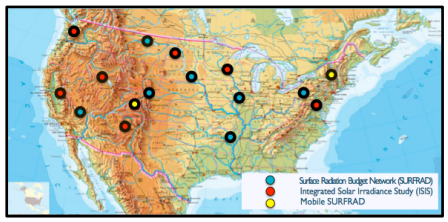
July 2016 / Jan 2017 – ***General problem – excessive downward short-radiation, too little explicit and subgrid clouds***

- RAP – 13km - One-day forecasts over 31 days.
- HRRR – 3km – One-day forecasts over 31 days
- Global FIM/HYCOM – Single 31-day forecast
  - borrows from cumulus physics for RAP (Grell-Freitas convection)
  - Part of NOAA SubX subseasonal experiment

12h HRRR v2/v3 downward SW rad vs. SURFRAD – Mean 15-21z

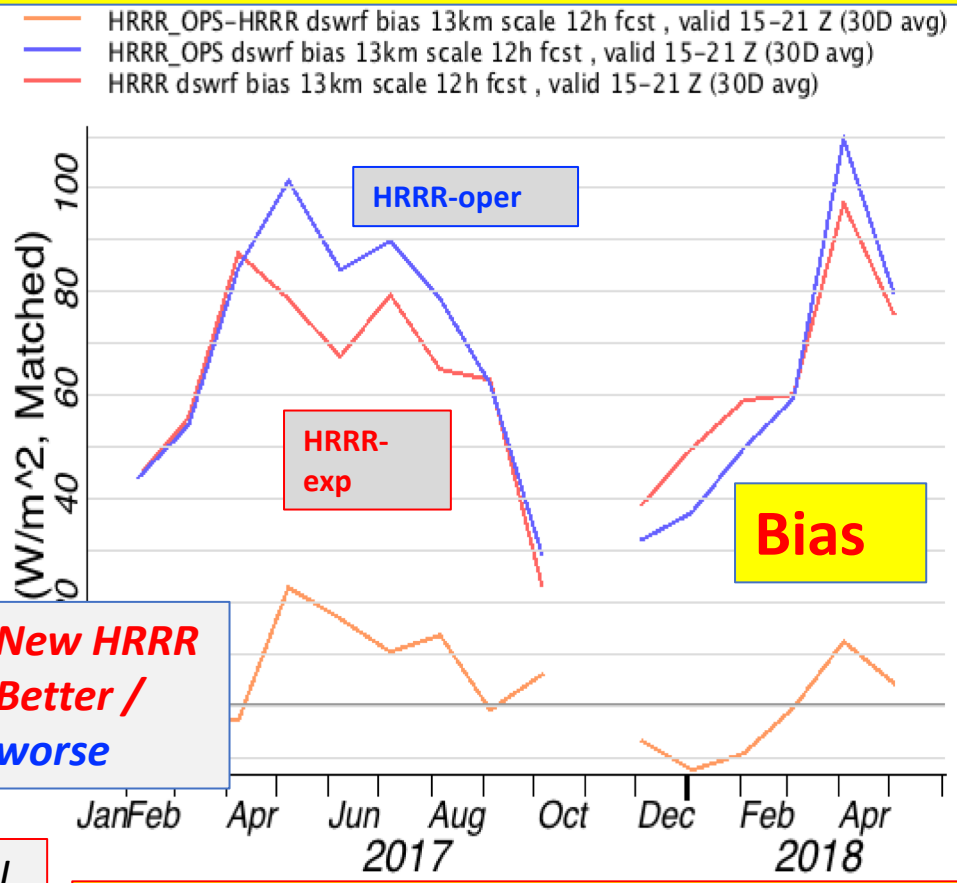


Mean abs err



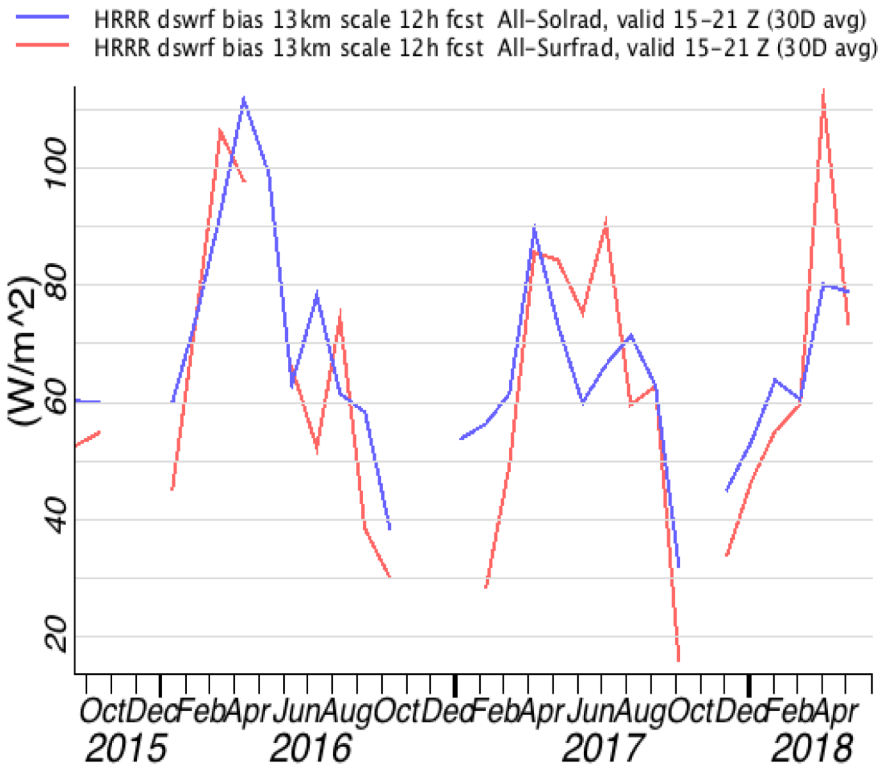
SURFRAD geographical diversity critical for model evaluation

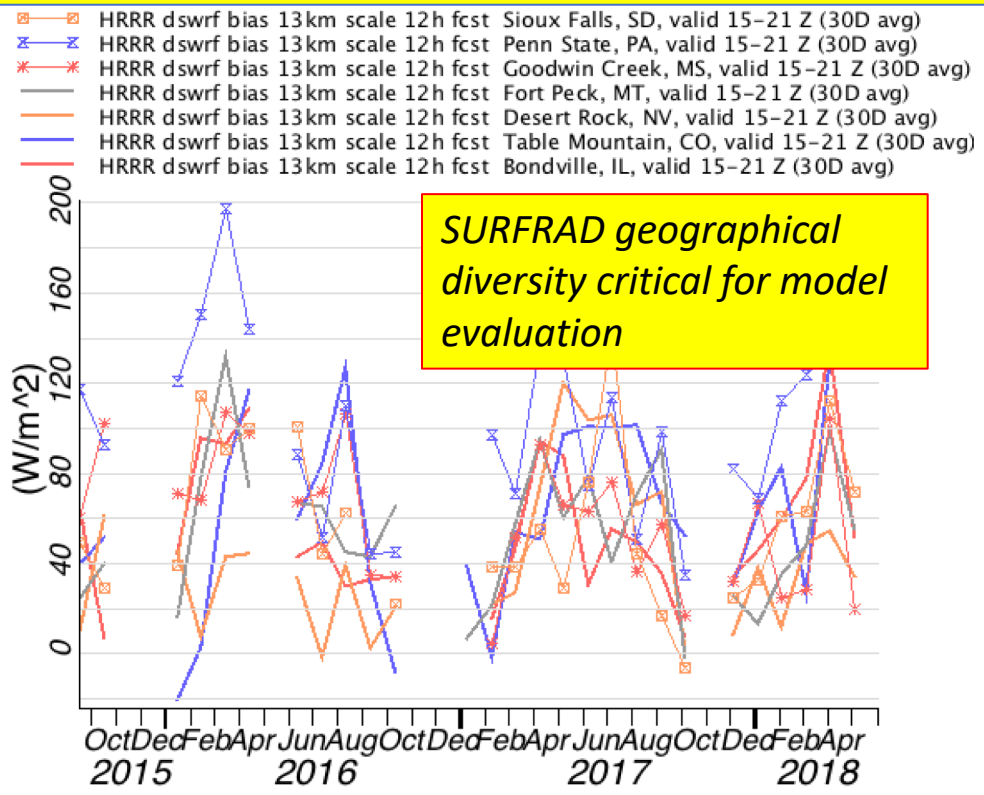
New HRRR Better / worse



May 18 - Better for MAE/bias but much more needed
Sept 18 – (later in this talk). Much better.

12h HRRR Downward SW bias vs. SURF/SolRAD – Mean 15-21z



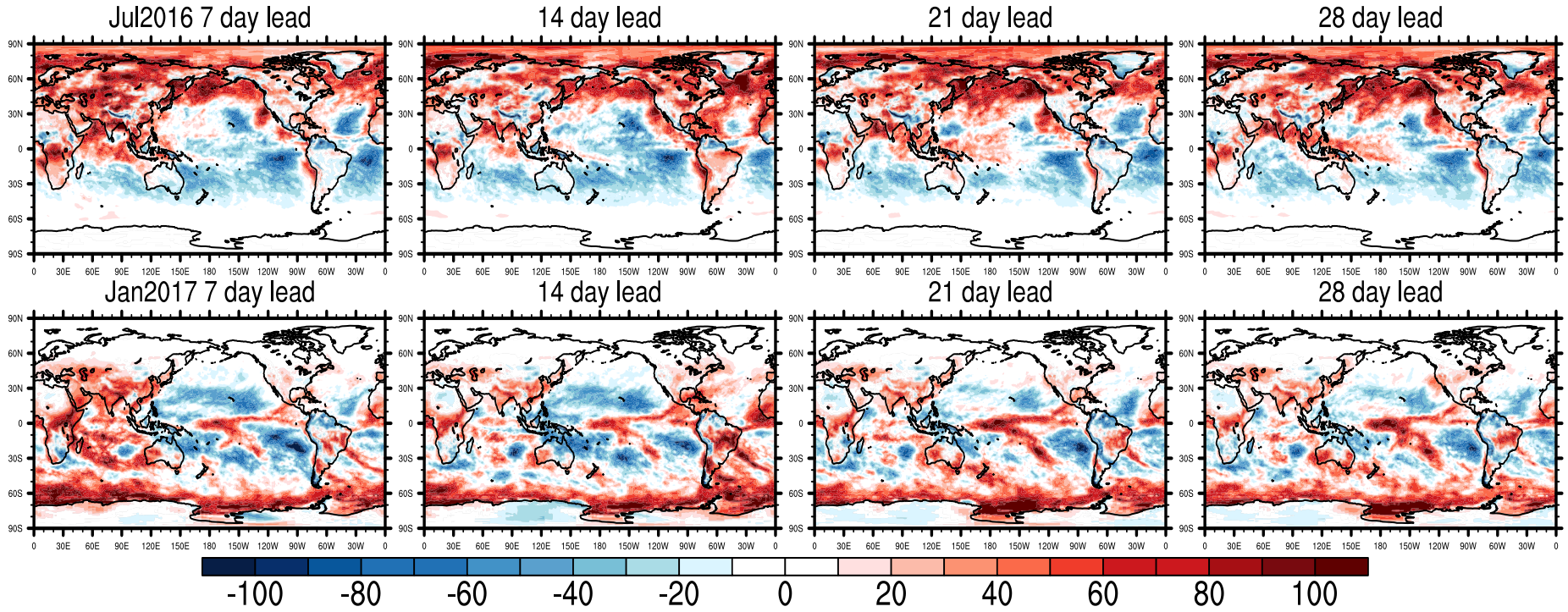


SURFRAD geographical diversity critical for model evaluation

Similar excessive downward SW (HRRR) for SURFRAD vs. SOLRAD obs.

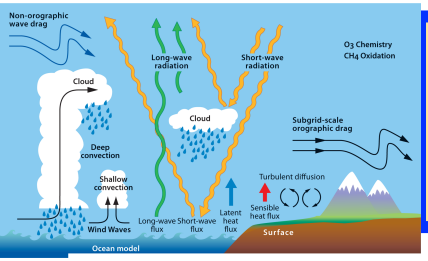
Similar excessive downward SW (HRRR) for different SURFRAD stations

Downward SW radiation - FIM-HYCOM vs. CERES



FIM-HYCOM uses Grell-Freitas deep/shallow convection (same as RAP).

- ***Similar downward SW bias for all 4 weeks.***
- ***Warm season: model too high SW over land, cold ocean stratocu zones, high-latitude ocean.***



Most important for warm bias / too-little cloud For 3km HRRR and 13km RAP hourly models

Model	Run at:	Domain	Grid Points	Grid Spacing	Vertical Levels	Vertical Coordinate	Pressure Top	Boundary Conditions	Initialized
RAP v4	GSD, NCO	North America	953 x 834	13 km	50	Sigma-Isob Hybrid	10 mb	GFS	Hourly (cycled)
HRRR v3	GSD, NCO	CONUS	1799 x 1059	3 km	50	Sigma-Isob Hybrid	20 mb	RAP	Hourly (pre-forecast hour cycle)

Model	Version	Assimilation	Radar DA	Radiation LW/SW	Microphysics	Cumulus Param	Turbulence PBL	Land-sfc scheme
RAP	WRF-ARW v3.8.1+	GSI Hybrid Ensemble to 0.85, cloud/sfc/soil DA	13-km DFI, 20-min LH	RRTMG/ RRTMG	Thompson Aerosol v3.8.1	Grell-Freitas + Shallow	MYNN v3.8.1, EDMF/cl	RUC v3.8.1, 2mT/snow, mosaic
HRRR	WRF-ARW v3.8.1+	GSI Hybrid Ensemble to 0.85, cloud/sfc/soil DA	3-km 15-min LH	RRTMG/ RRTMG	Thompson Aerosol v3.8.1	None	MYNN v3.8.1, EDMF/cl	RUC v3.8.1, 2mT/snow, mosaic

Model	Horiz/Vert Advection	Scalar Advection	Upper-Level Damping	Diffusion Option	6th Order Diffusion	SW Radiation Update	Land Use	MP Tend Limit	Time-Step
RAP	5th/5th	Positive-Definite	w-Rayleigh 0.2	Full (2)	Yes 0.12	20 min	MODIS Seasonal, VIIRS GVF	0.01 K/s	60 s
HRRR	5th/5th	Positive-Definite	w-Rayleigh 0.2	Full (2)	Yes, 0.25 no slope	15 min with SW-dt	MODIS Seasonal, VIIRS GVF	0.07 K/s	20 s

Cloud-rad-4h->4wk - Benjamin 11