Forecast Evaluation and User-Focused Verification

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NCAR

Why forecast verification?

- Monitor performance
- Improve forecasts
- Communicate meaningful information to users
  - Requires identifying users’ information needs

Hence we need approaches that can do all of these things…

Different approaches for

different purposes

different types of forecasts

Tailoring verification approaches

Different types of forecasts

- Forecast “element” characteristics
  - Continuous (e.g., RMSE)
  - Categorical (e.g., Yes/No; POD, FAR)
  - Probabilistic
- Temporal characteristics
  - Time series?
- Spatial attributes
  - Gridded vs. Point
  - Spatial approaches

Different purposes

- Monitoring
  - Use basic easy-to-understand metrics
- Forecast improvement
  - Diagnostic approaches
- Users
  - Diagnostic
  - User-relevant

Identifying users' needs

- Defining events:
  - What elements are needed? Time and space scales?
- What are the important decisions that are made relative to the events?
- What aspects are important?
  - Timing? Spatial location?
  - Intensity?
- How do we measure the “quality of these aspects?

Choices of events and metrics impact model optimization

Example events

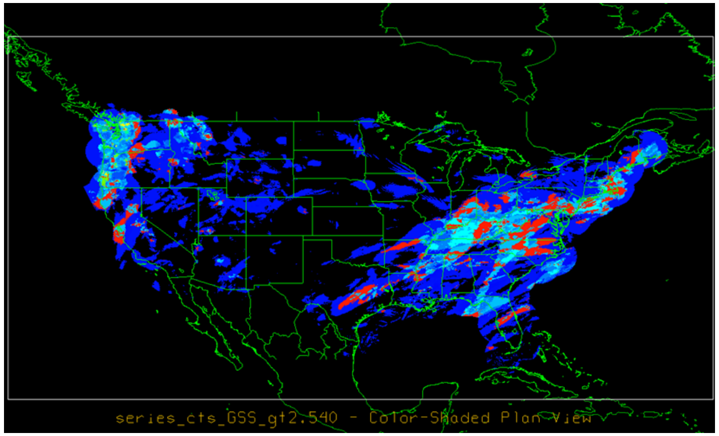
- Decadal ice extent (building ships)
- Spatial extent of ice on a particular date (e.g., Sep 1) (seasonal prediction)
- Ice extent on specific dates and particular locations (ship movements)

Community Tools for Forecast Evaluation

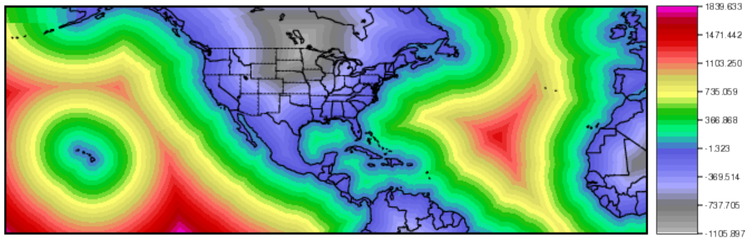
- Traditional and new tools
- Initial version released in 2008
- Includes
  - Traditional approaches
  - Spatial methods (MODE, Scale, Neighborhood)
  - Confidence Intervals
  - Ensemble methods
- Supported to the community
  - More than 2,400 users (50% university)
  - Regular tutorials
  - Email help

MET

Model Evaluation Tools



Spatial distribution of Gilbert Skill Score



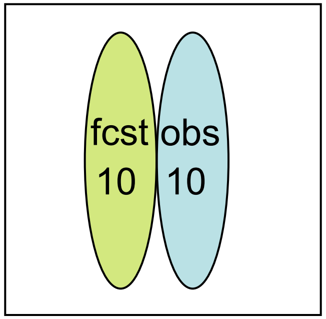
http://www.dtcenter.org/met/users/

Traditional spatial verification

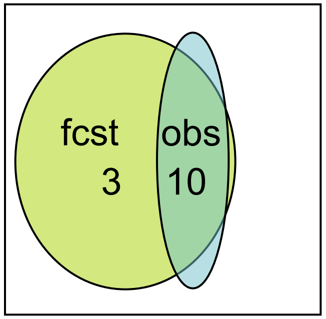
- Requires an exact match between forecasts and observations at every grid point

  □ Problem of "double penalty" - event predicted where it did not occur, no event predicted where it did occur

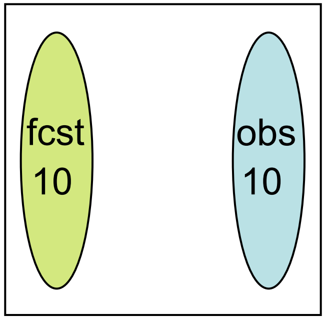
- Traditional scores do not say very much about the source or nature of the errors



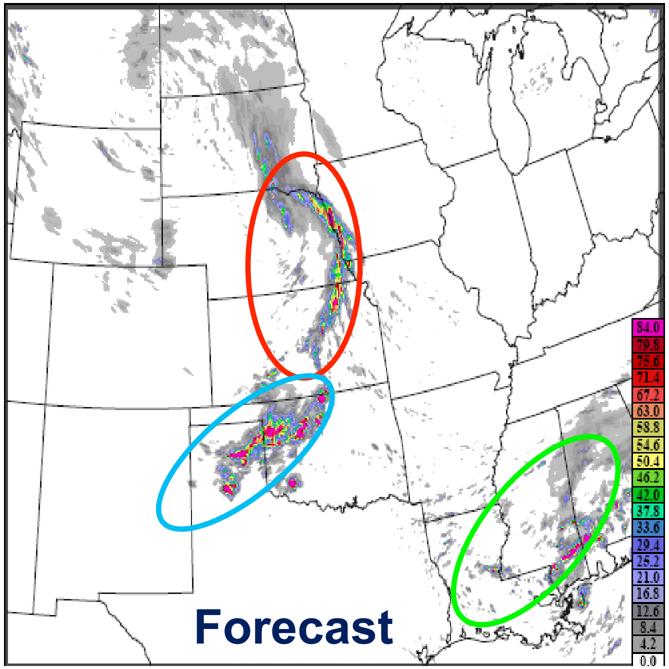
Hi res forecast
RMS ~ 4.7
POD=0, FAR=1
TS=0

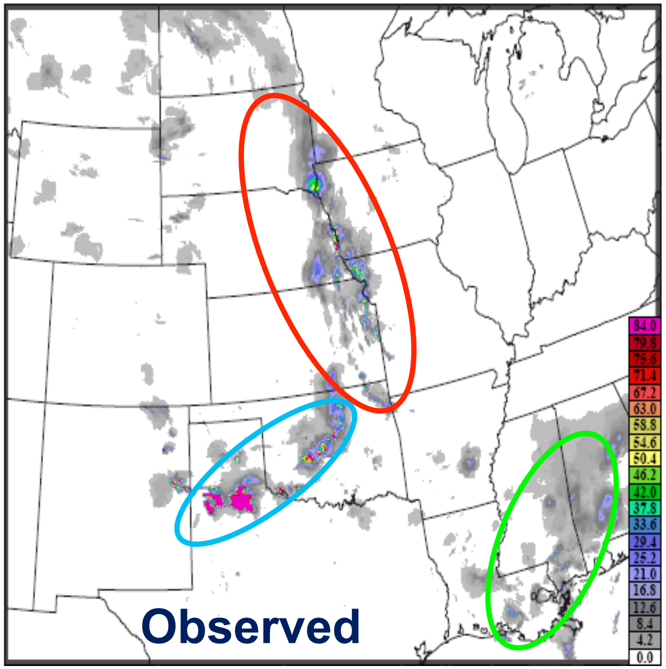


Low res forecast
RMS ~ 2.7
POD~1, FAR~0.7
TS~0.3



Impacts of spatial variability





Grid-to-grid results:
POD = 0.40
FAR = 0.56
CSI = 0.27

(Poor Scores)

- Traditional approaches ignore spatial structure in the forecasts
  - Spatial correlations
- Small errors lead to poor scores (squared errors… smooth forecasts are rewarded)
- Methods for evaluation are not diagnostic
- Spatial methods can identify particular features of interest to evaluate

New Spatial Verification Approaches

Neighborhood

Successive smoothing of forecasts/obs

Gives credit to "close" forecasts

Object- and feature-based

Evaluate attributes of identifiable features

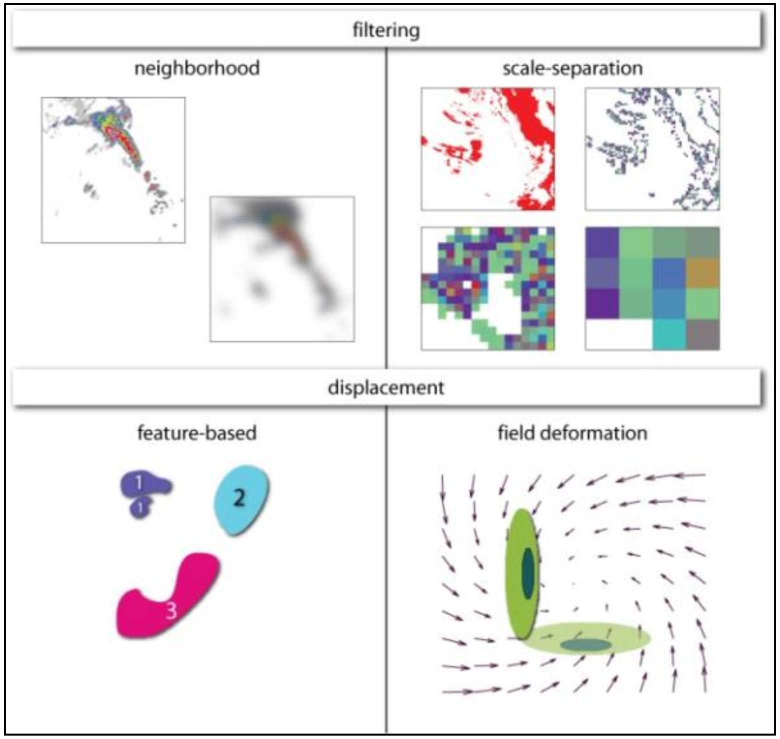
Scale separation

Measure scale-dependent error

Field deformation

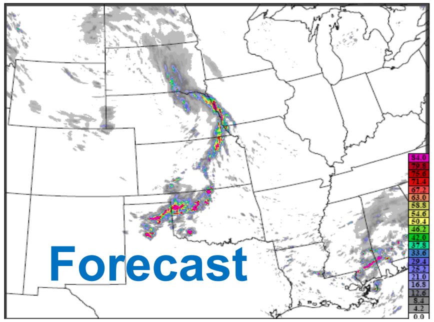
Measure distortion and displacement (phase error) for whole field

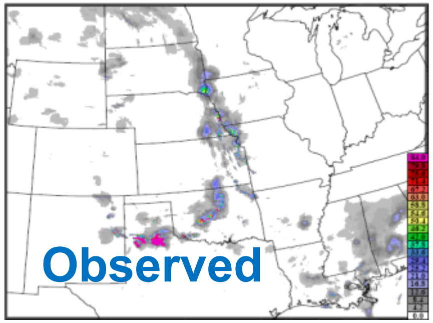
How should the forecast be adjusted to make the best match with the observed field?



http://www.ral.ucar.edu/projects/icp/

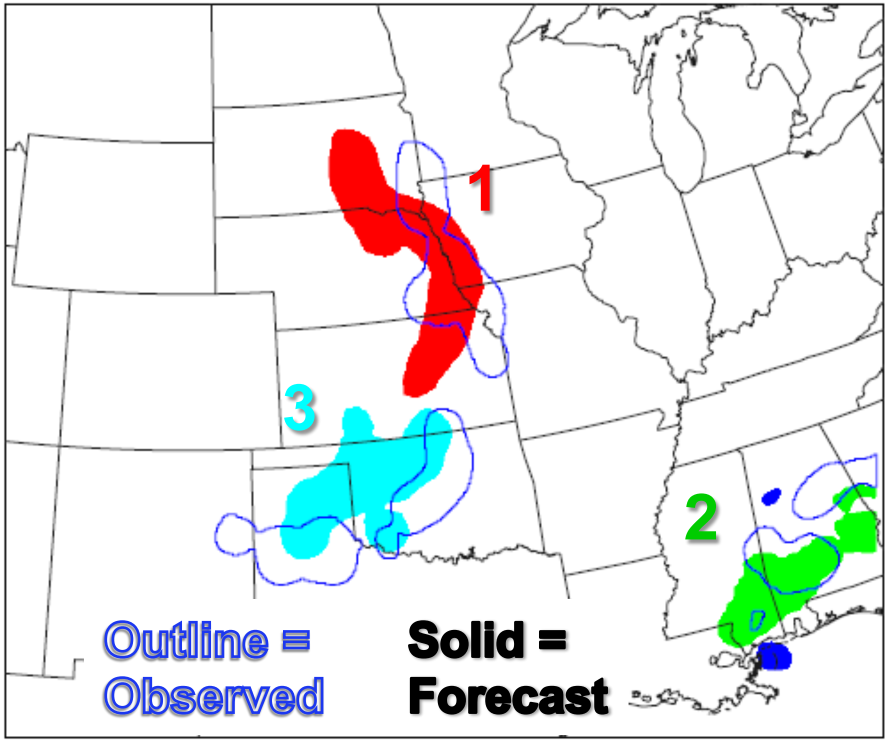
Method for Object-based Diagnostic Evaluation (MODE)





Traditional verification results:

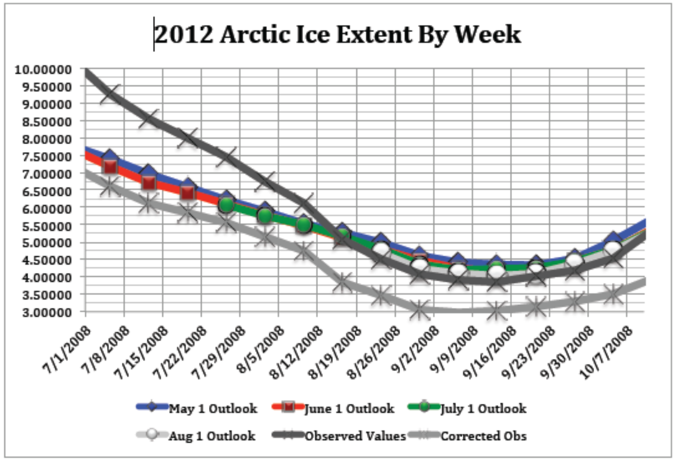
Forecast has very little skill



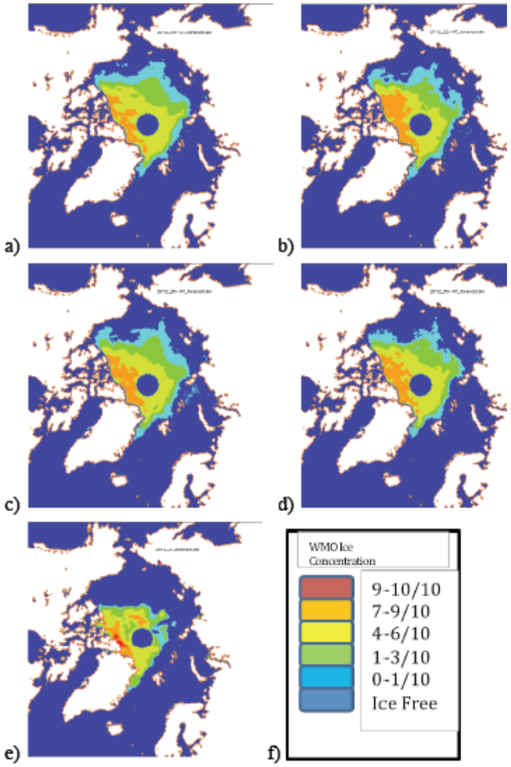
MODE quantitative results:

- Most forecast areas too large
- Forecast areas slightly displaced
- Median and extreme intensities too large
- BUT – overall – forecast is pretty good

Applications to sea-ice and polar prediction problems



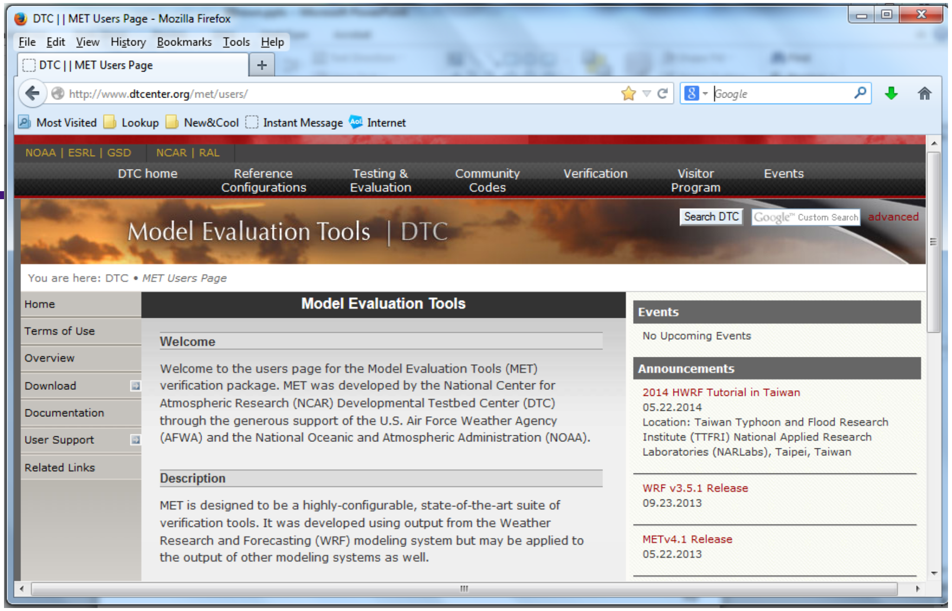
- Many tools exist for evaluation of time series (e.g., in MET)
- New spatial methods may be beneficial for evaluation of sea ice and other polar predictions to provide
  - Diagnostic information
  - More specific information tailored to evaluate meaningful events for users



From Arbetter 2012

Resources

- Model Evaluation Tools
- WMO verification Working Group
  - Connected to WWRP, WGNE, PPP, S2S, HIW
  - web page
- R verification package
- Verification discussion group



You are here: DTC • *MET Users Page*

Model Evaluation Tools

Welcome

Welcome to the users page for the Model Evaluation Tools (MET) verification package. MET was developed by the National Center for Atmospheric Research (NCAR) Developmental Testbed Center (DTC) through the generous support of the U.S. Air Force Weather Agency (AFWA) and the National Oceanic and Atmospheric Administration (NOAA).

Description

MET is designed to be a highly-configurable, state-of-the-art suite of verification tools. It was developed using output from the Weather Research and Forecasting (WRF) modeling system but may be applied to the output of other modeling systems as well.

Events

No Upcoming Events

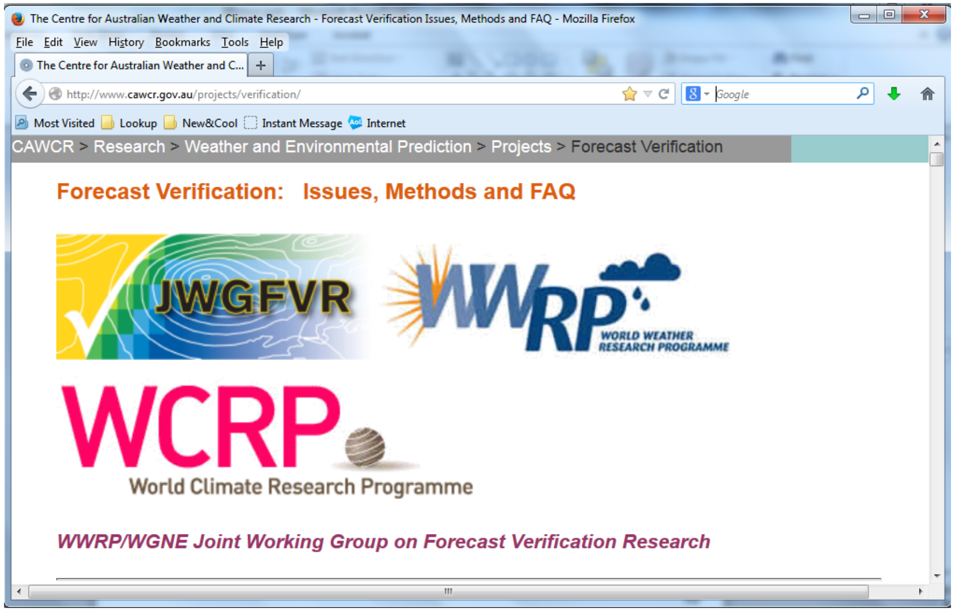
Announcements

2014 HWRF Tutorial in Taiwan
05.22.2014
Location: Taiwan Typhoon and Flood Research Institute (TTFRI) National Applied Research Laboratories (NARLabs), Taipei, Taiwan

WRF v3.5.1 Release
09.23.2013

METv4.1 Release
05.22.2013

http://www.dtcenter.org/met/users/

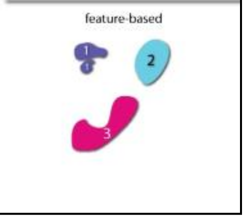

The Centre for Australian Weather and Climate Research - Forecast Verification Issues, Methods and FAQ - Mozilla Firefox
File Edit View History Bookmarks Tools Help
The Centre for Australian Weather and C...
http://www.cawcr.gov.au/projects/verification/
Google
Most Visited
Lookup
New&Cool
Instant Message
Internet
CAWCR > Research > Weather and Environmental Prediction > Projects > Forecast Verification
JWGFVR
WWRP
WORLD WEATHER RESEARCH PROGRAMME
WCRP
World Climate Research Programme

Forecast Verification: Issues, Methods and FAQ

WWRP/WGNE Joint Working Group on Forecast Verification Research

http://www.cawcr.gov.au/projects/verification/

BACK-UP SLIDES

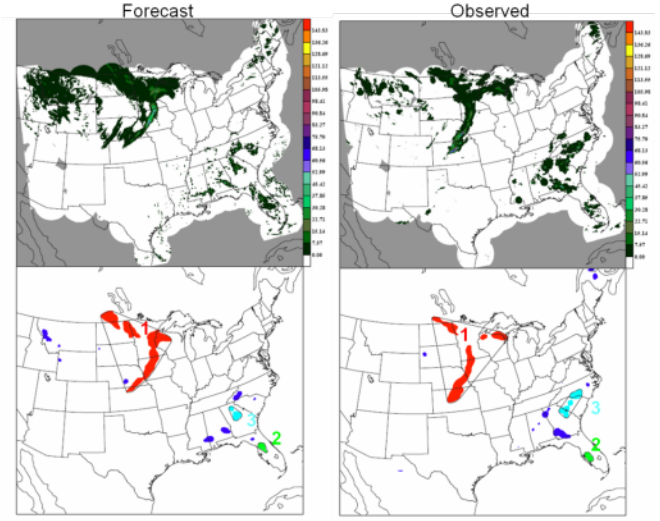


Object/Feature-based

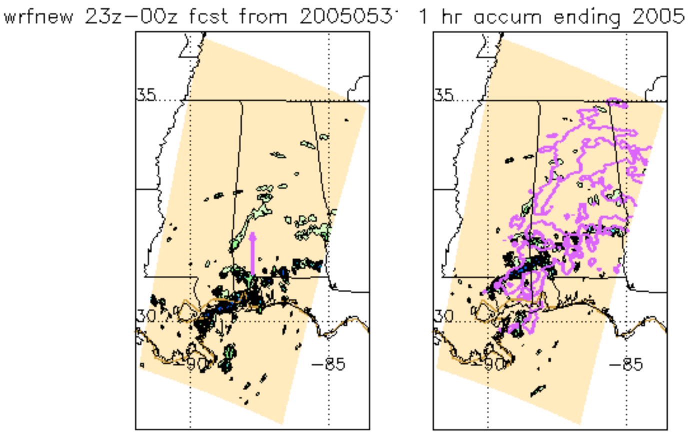
Goals: Measure and compare (user-) relevant features in the forecast and observed fields

Examples:

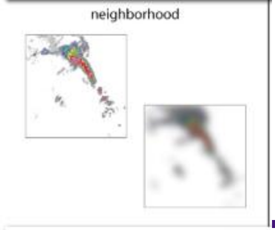
- Contiguous Rain Area (CRA)
- Method for Object-based Diagnostic Evaluation (MODE)
- Procrustes
- Cluster analysis
- Structure Amplitude and Location (SAL)
- Composite
- Gaussian mixtures



MODE example 2008



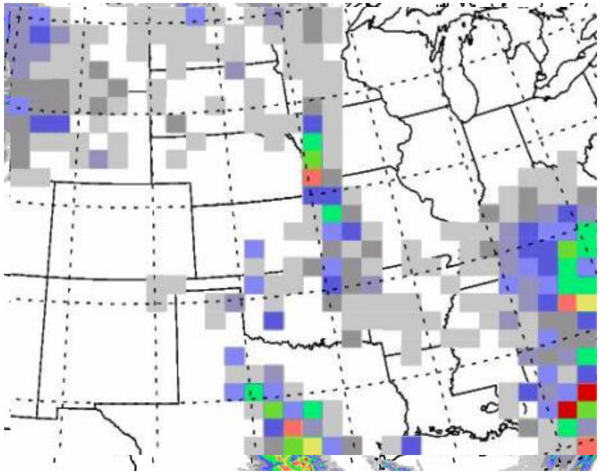
CRA: Ebert and Gallus 2009

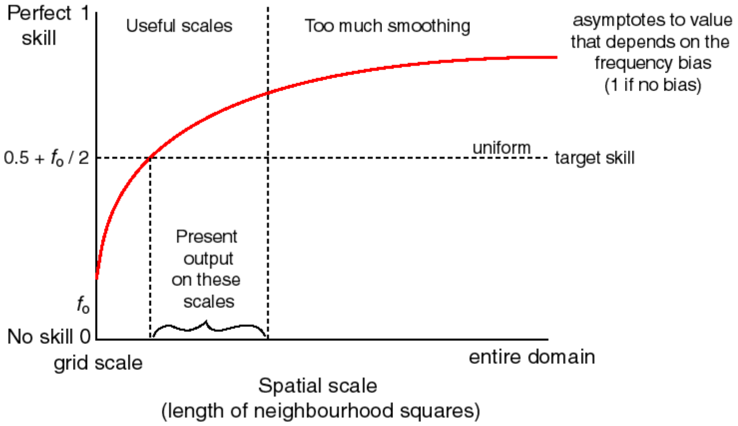


Neighborhood methods

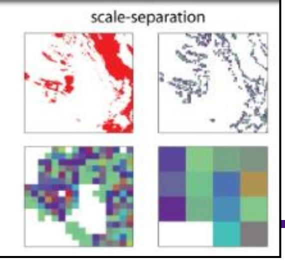
Goal: Examine forecast performance in a region; don’t require exact matches

- Also called “fuzzy” verification
- Example: Upscaling
  - Put observations and/or forecast on coarser grid
  - Calculate traditional metrics
- Provide information about scales where the forecasts have skill
- Examples: Roberts and Lean (2008) – Fractions Skill Score; Ebert (2008); Atger (2001); Marsigli et al. (2006)




Perfect skill 1
Useful scales
Too much smoothing
asymptotes to value that depends on the frequency bias (1 if no bias)
0.5 + f_o / 2
uniform
target skill
Present output on these scales
f_o
No skill 0
grid scale
entire domain
Spatial scale
(length of neighbourhood squares)

From Mittermaier 2008



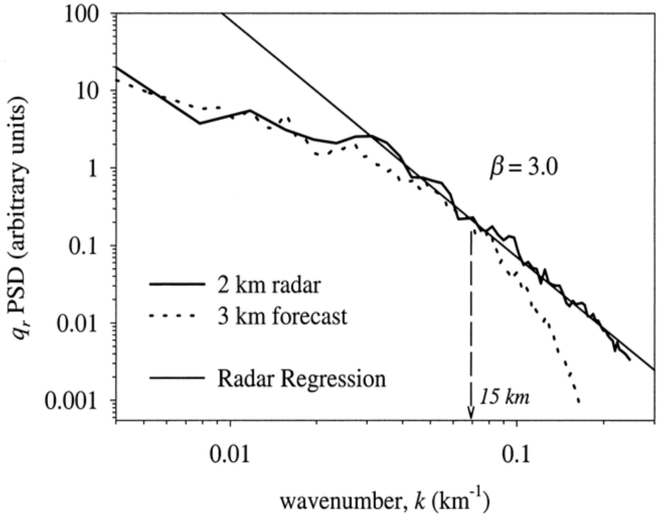
Scale separation methods

- Goal:

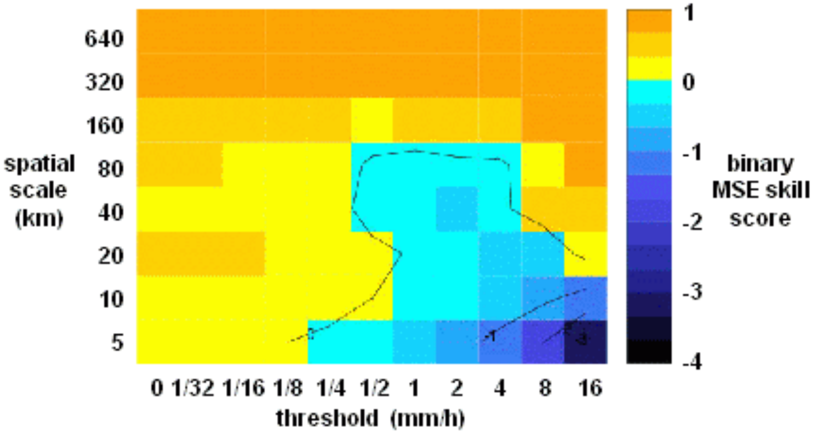
  Examine performance as a function of spatial scale

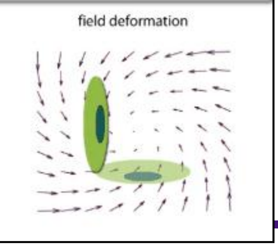
- Examples:
  - Power spectra
    - Does it look real?
    - Harris et al. (2001)
  - Intensity-scale

    Casati et al. (2004)
  - Multi-scale variability (Zapeda-Arce *et al.* 2000; Harris *et al.* 2001; Mittermaier 2006)
  - Variogram (Marzban and Sandgathe 2009)



From Harris et al. 2001



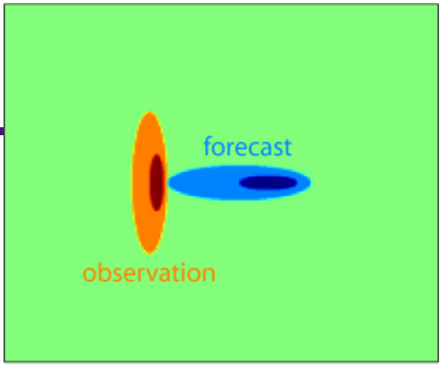


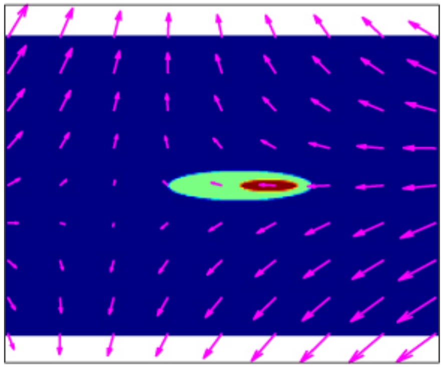
Field deformation

Goal: Examine how much a forecast field needs to be transformed in order to match the observed field

Examples:

- Forecast Quality Index (Venugopal *et al*. 2005)
- Forecast Quality Measure/ Displacement Amplitude Score (Keil and Craig 2007, 2009)
- Image Warping (Gilleland et al. 2009; Lindström *et al.* 2009; Engel 2009)
- Optical Flow (Marzban et al. 2009)





From Keil and Craig 2008