Verification via Optical Flow

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History

In the past, in this workshop: MVT.
Last year: Optical Flow (OF) for verification.

OF = method for mapping one image (observed field) to another image (forecast field).

Used in machine vision, robotics, image enhancement, moving-target indication, passive navigation, surveillance.

Nowcasting: Bowler, Pierce, and Seed (Jour. Hydrology, 2004)
Verification: Keil and Craig (MWR 2007).

The Math

$$I(x + dx \ , \ y + dy, \ t + dt)$$
$$= I(x, y, t) + \frac{\partial I}{\partial x}dx + \frac{\partial I}{\partial y}dy + \frac{\partial I}{\partial t}dt + ...$$

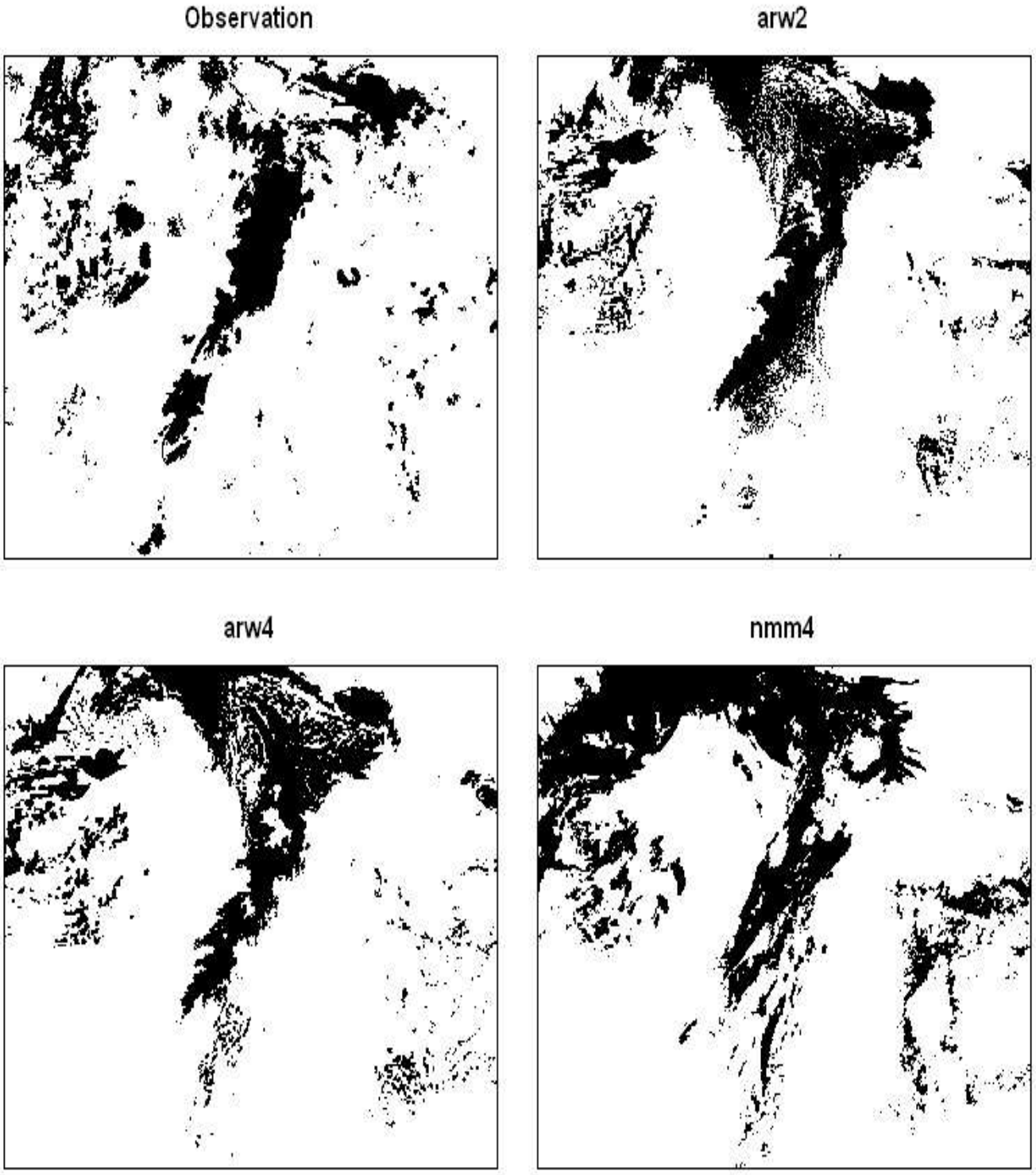
Suppose
$(x, y) \rightarrow (x + dx, y + dy), dt$ later.
$I(x + dx, y + dy, t + dt) = I(x, y, t)$

Then $\quad \frac{\partial I}{\partial x}\, u + \frac{\partial I}{\partial y}\, v = -\frac{\partial I}{\partial t}$

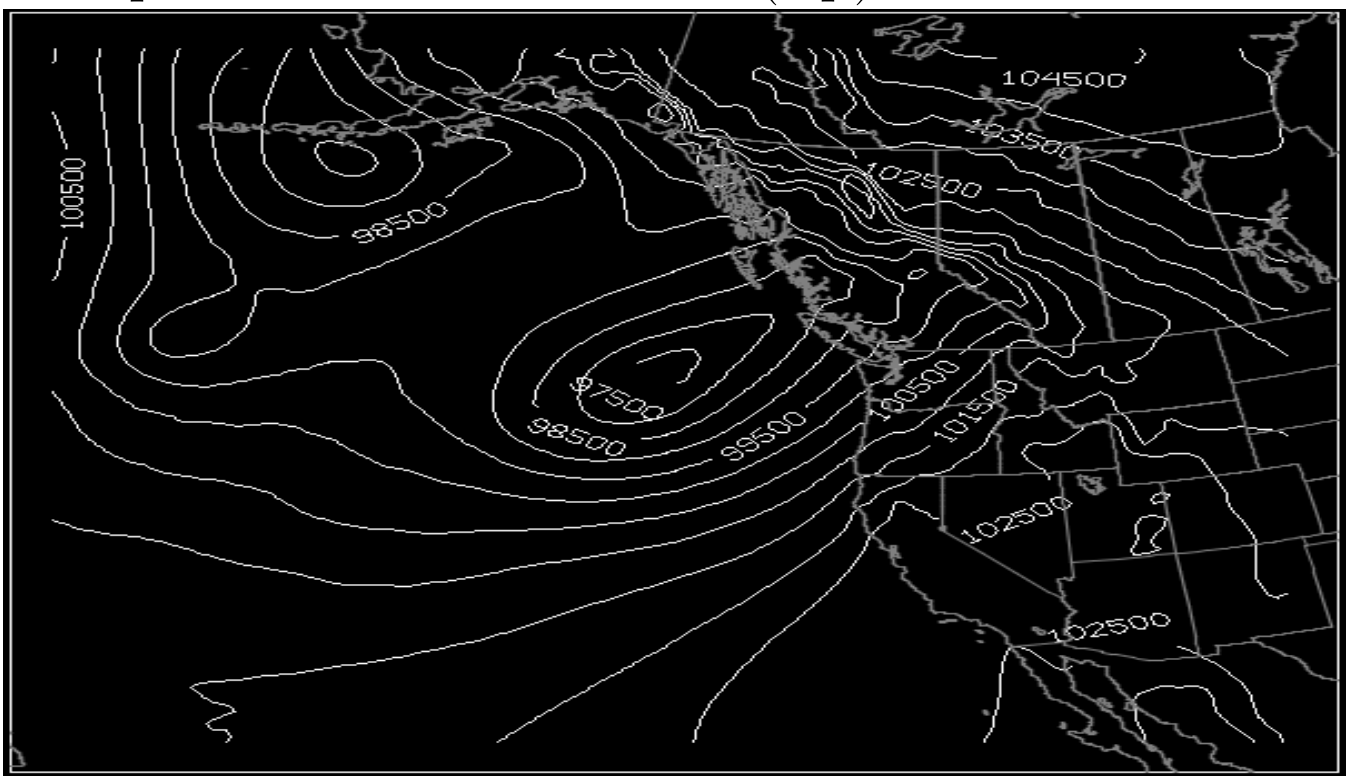
where $\quad u = \frac{\partial x}{\partial t} \qquad v = \frac{\partial y}{\partial t}$

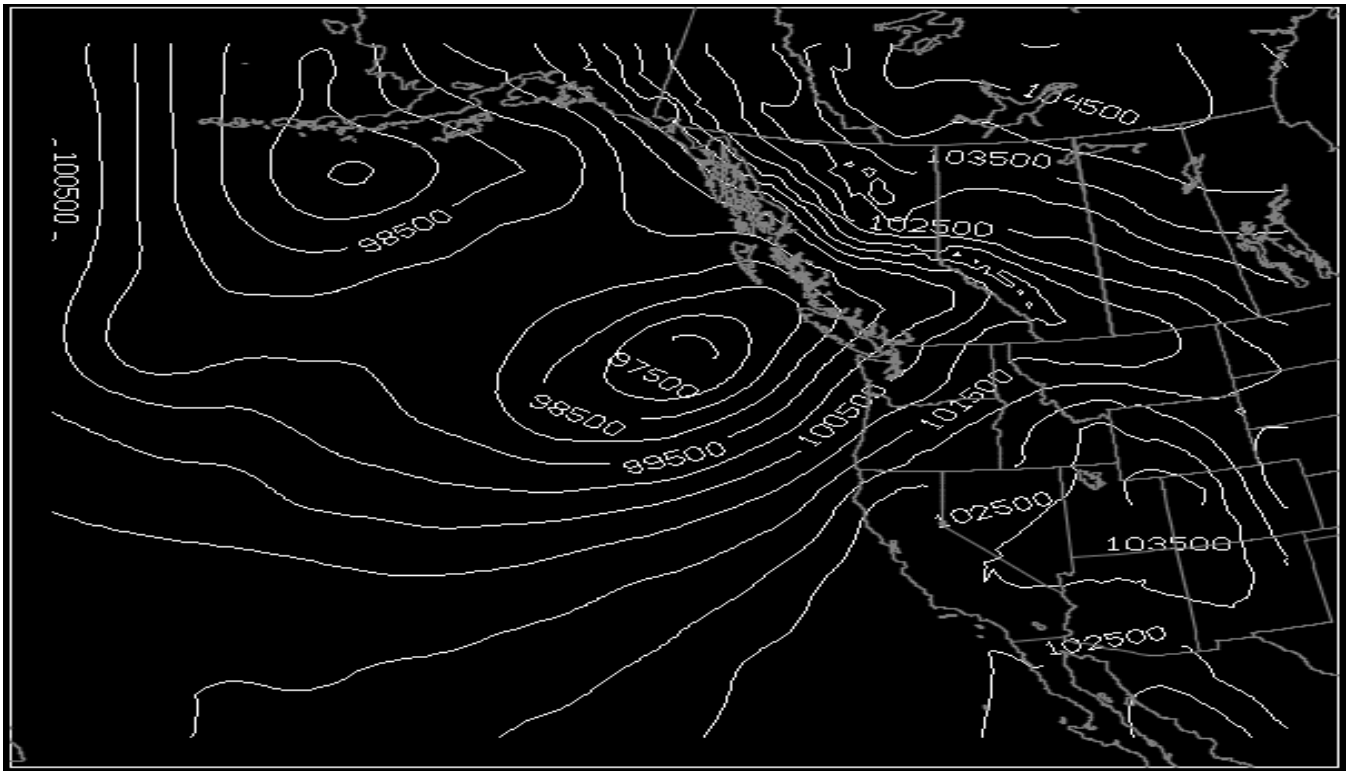
$(u, v) =$ optical flow vector field $=$ unknown.

Comparison of lumpy fields (reflectivity.) is difficult.

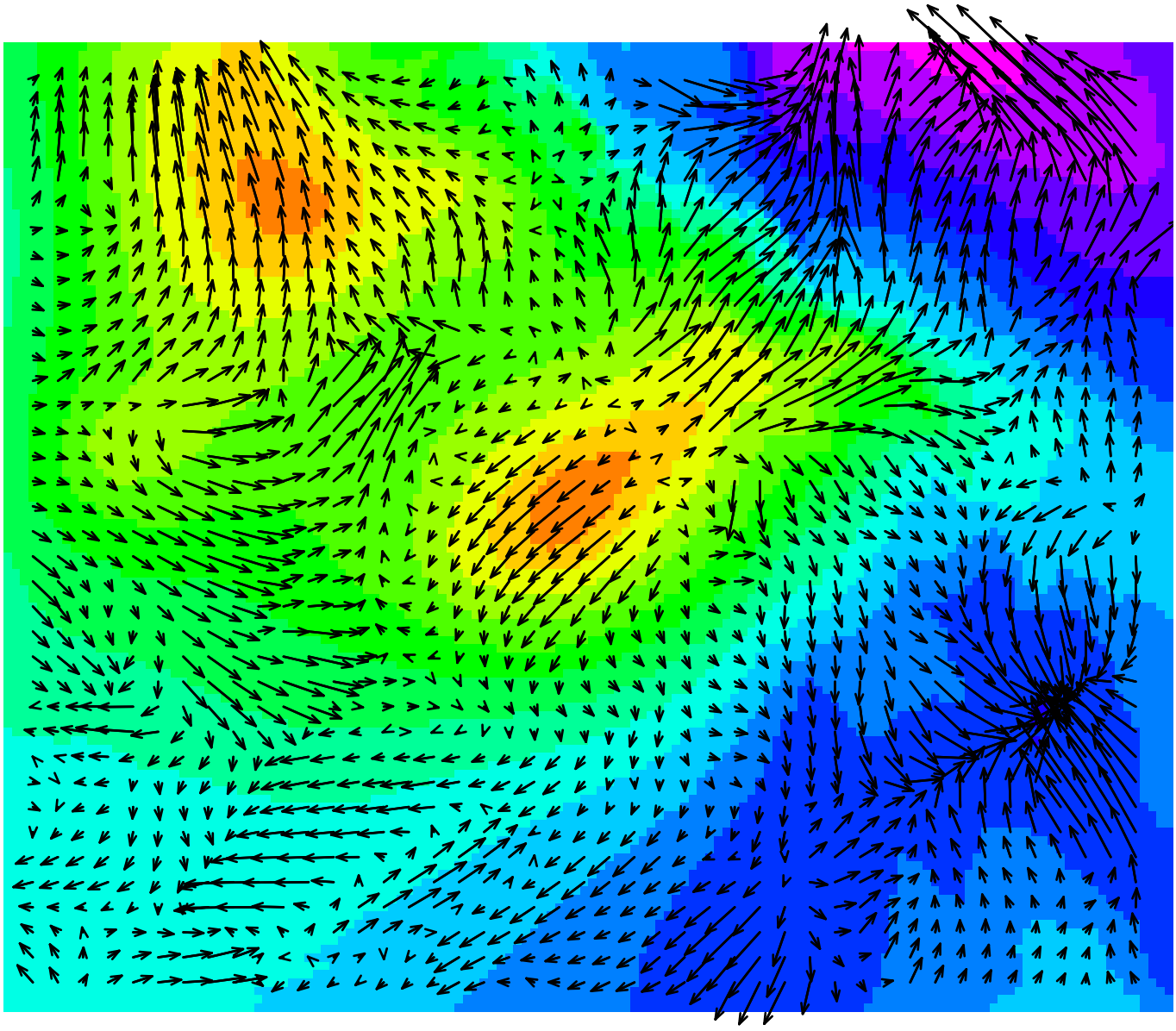


Comparison of smooth fields (slp) is no less difficult!

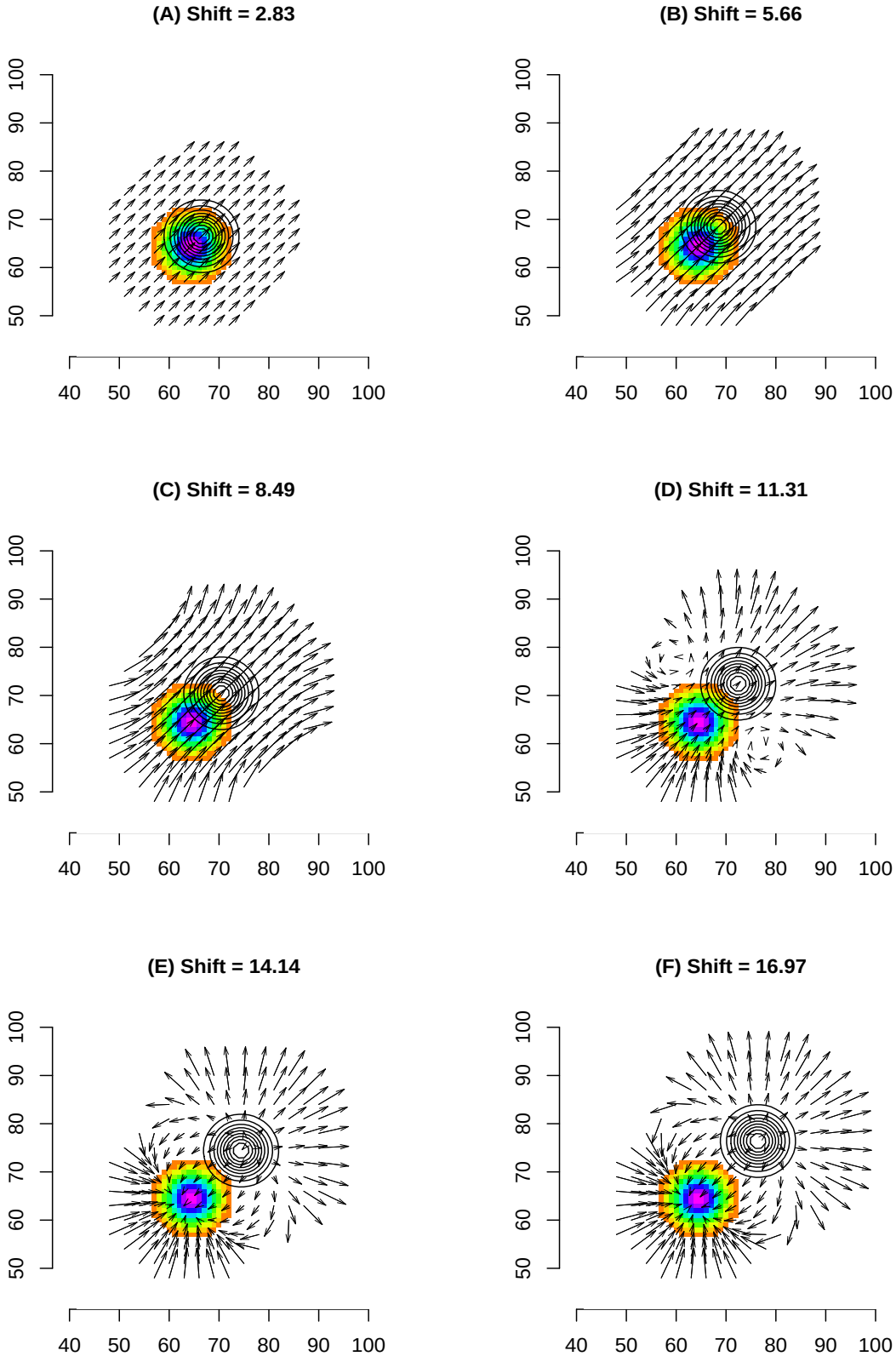




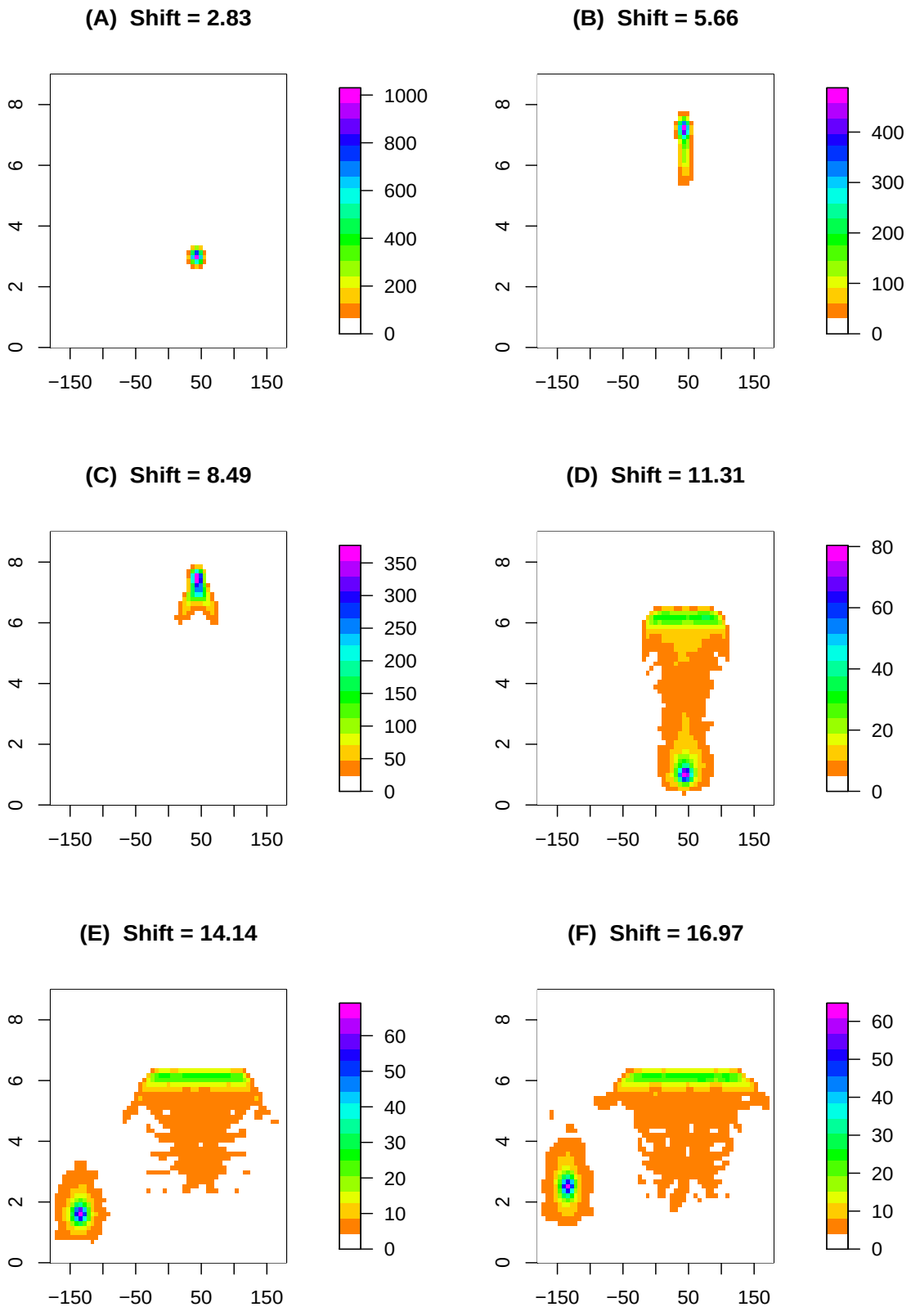
Instead of two hard-to-compare images, OF delivers this:



Confirm that it makes sense:



Joint histograms as summary measures:



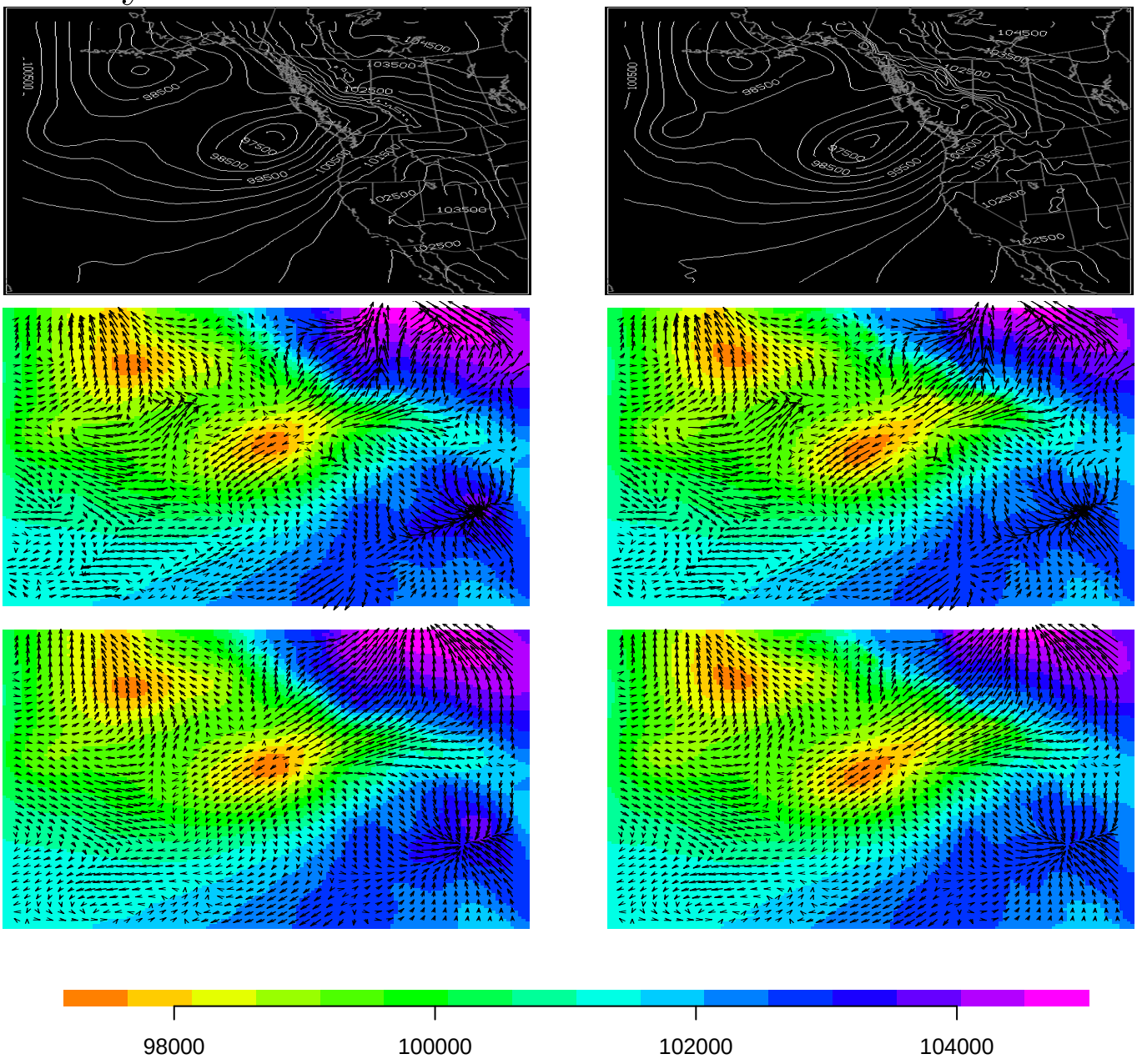
Four case studies: Dec. 4, 2007.

Analysis

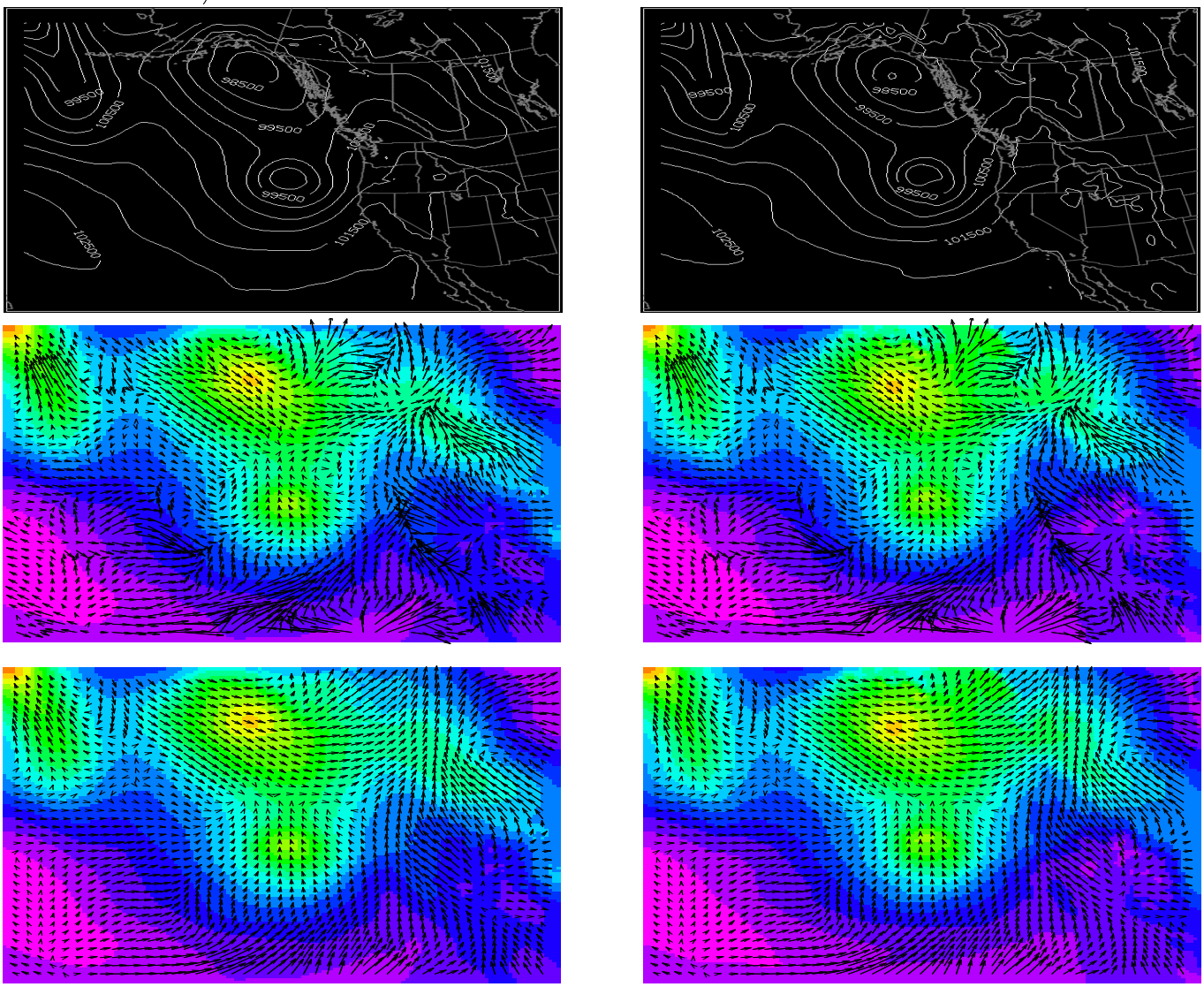
24hr forecast

WSZ=20

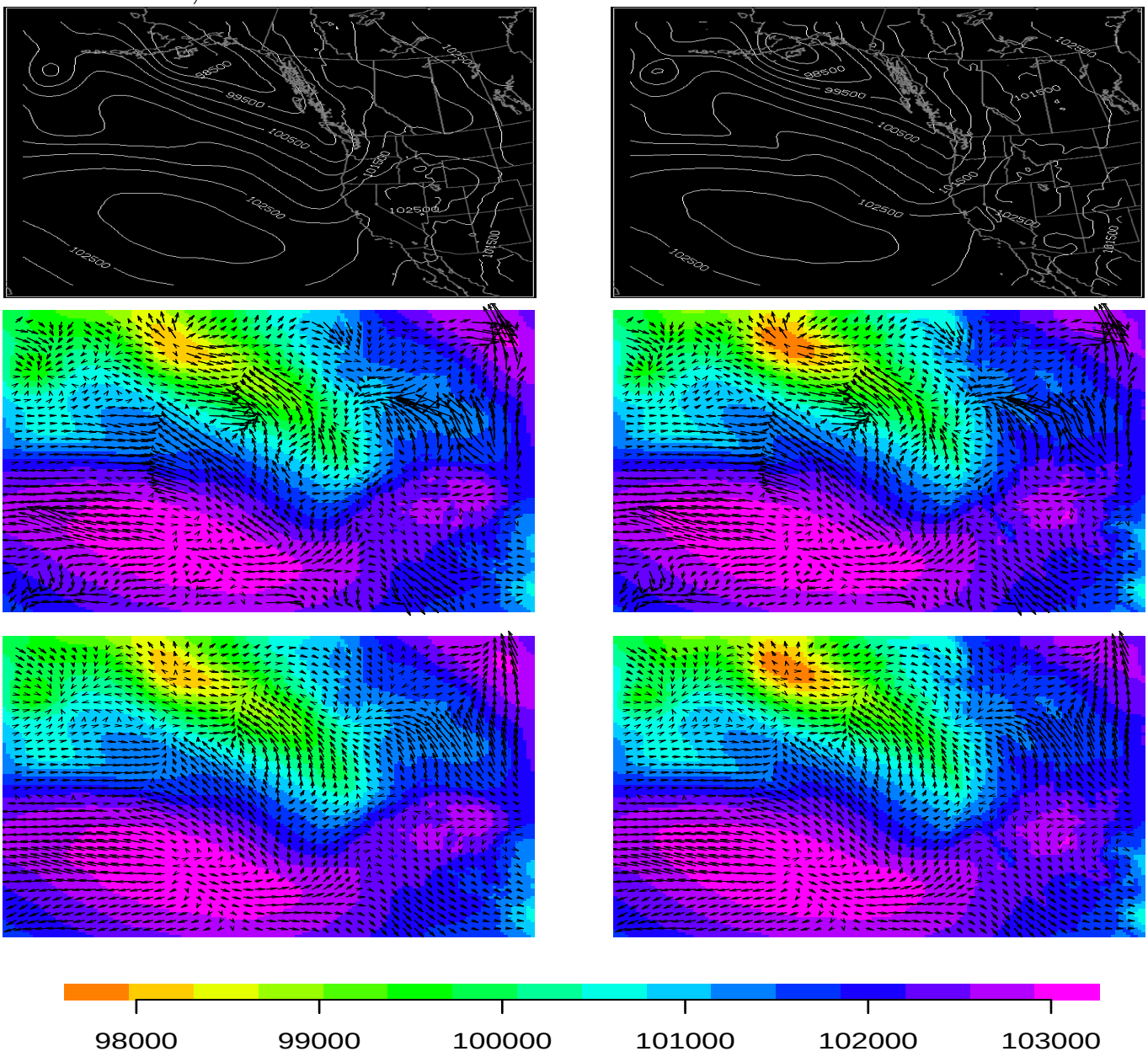
WSZ=40



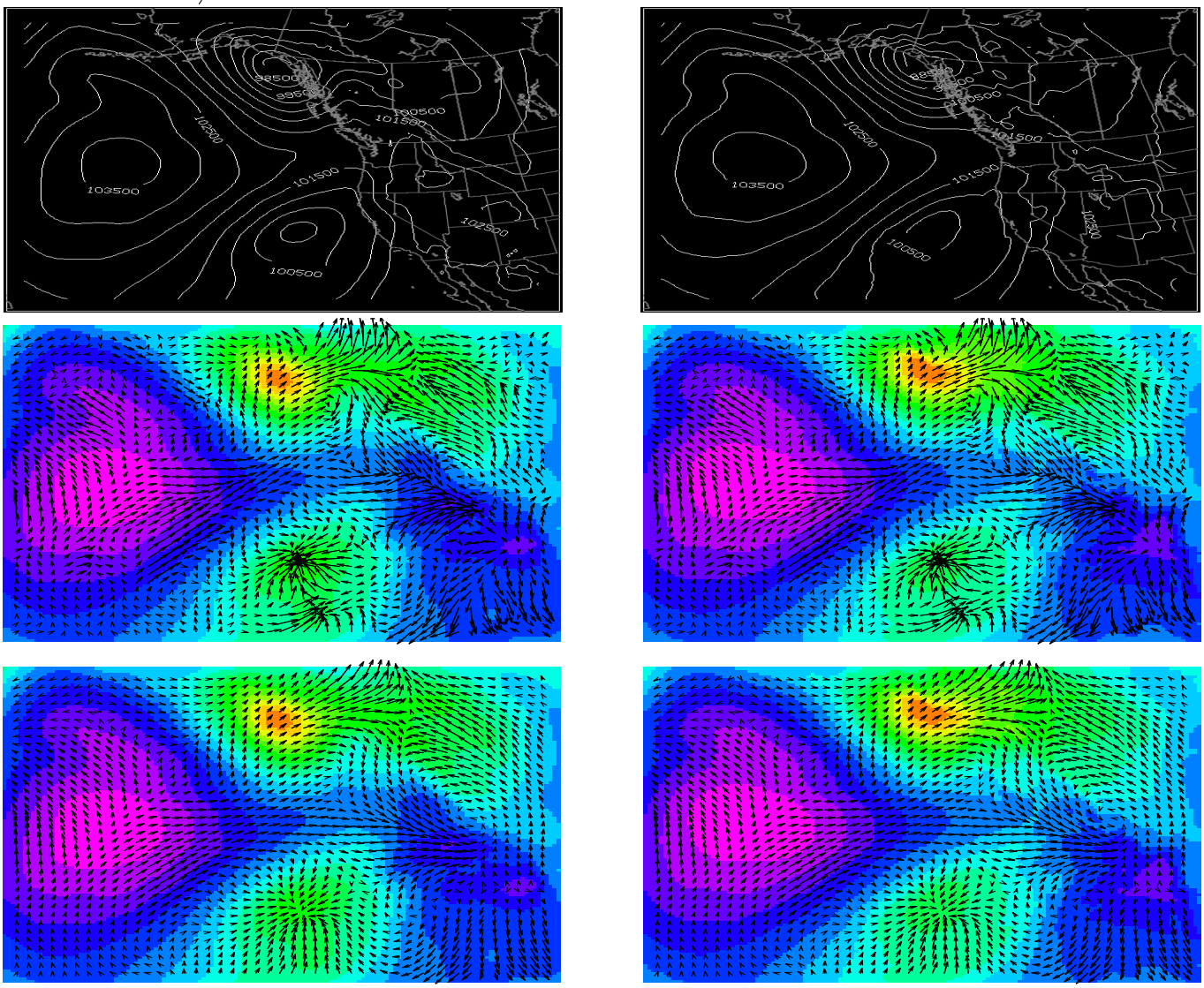
Dec. 18, 2007.



Dec. 28, 2007.



Jan. 26, 2008.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WSZ=40
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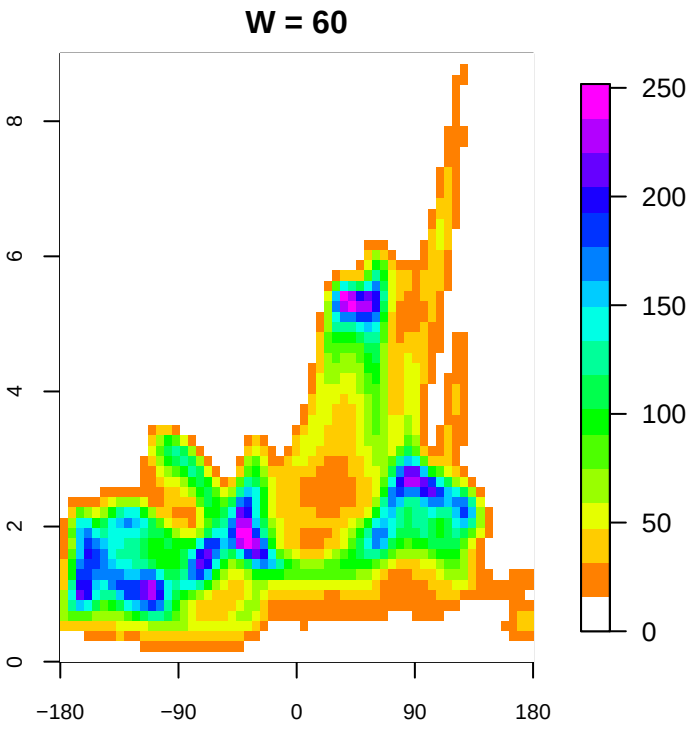
102000
103000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4
6
8
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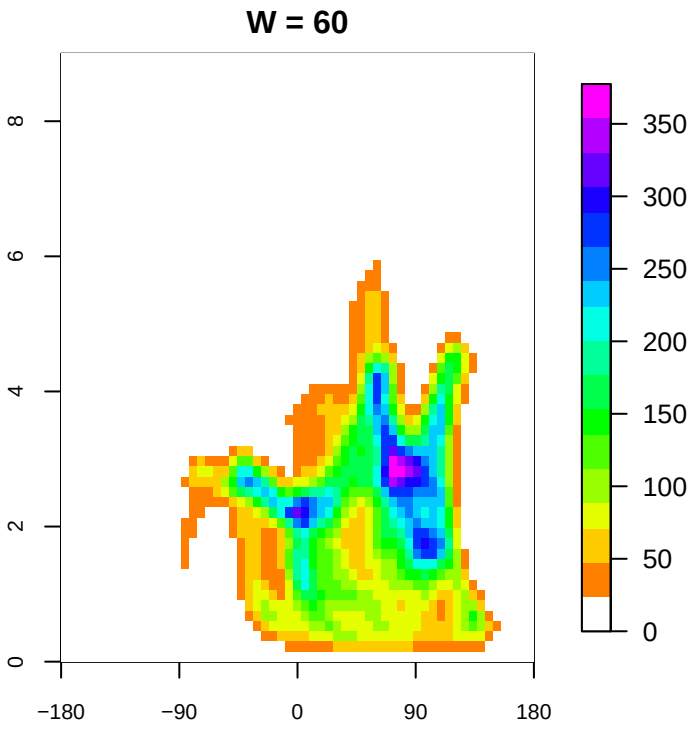
−90
0
90
180
0
50
100
150
200
250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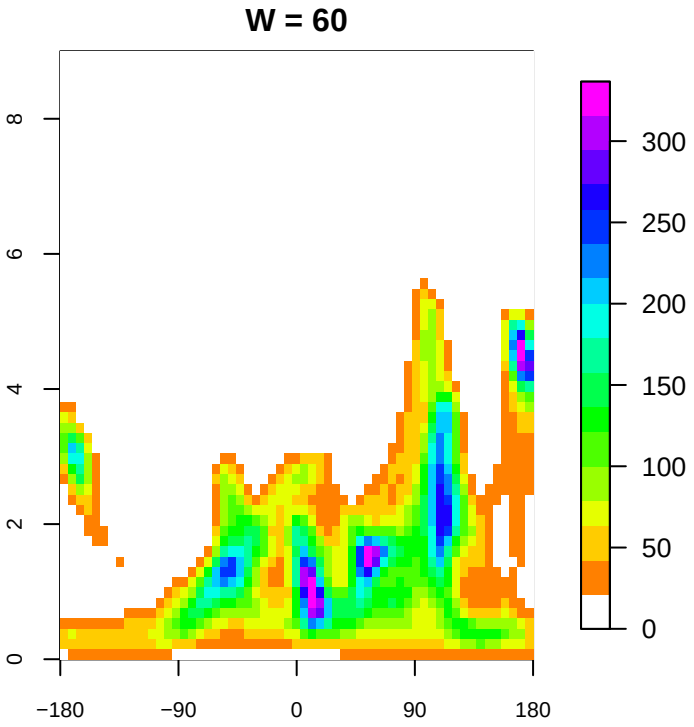
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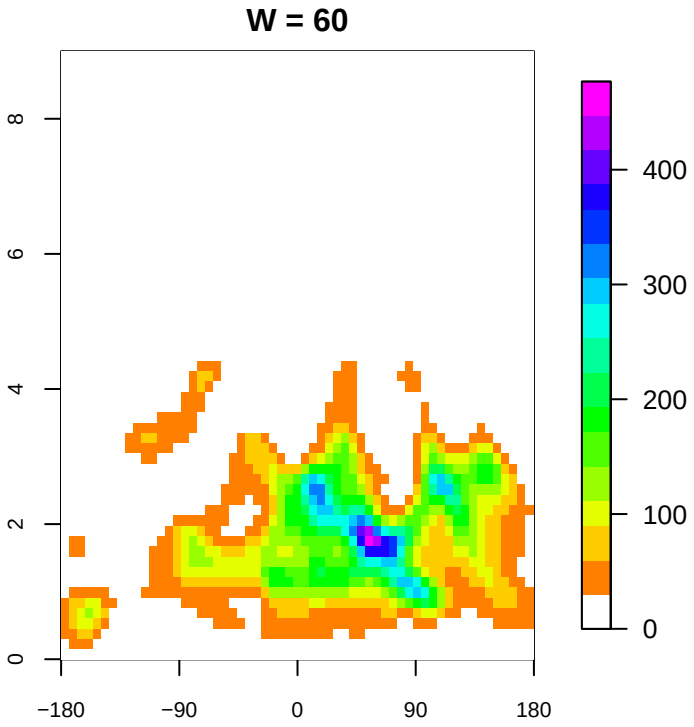
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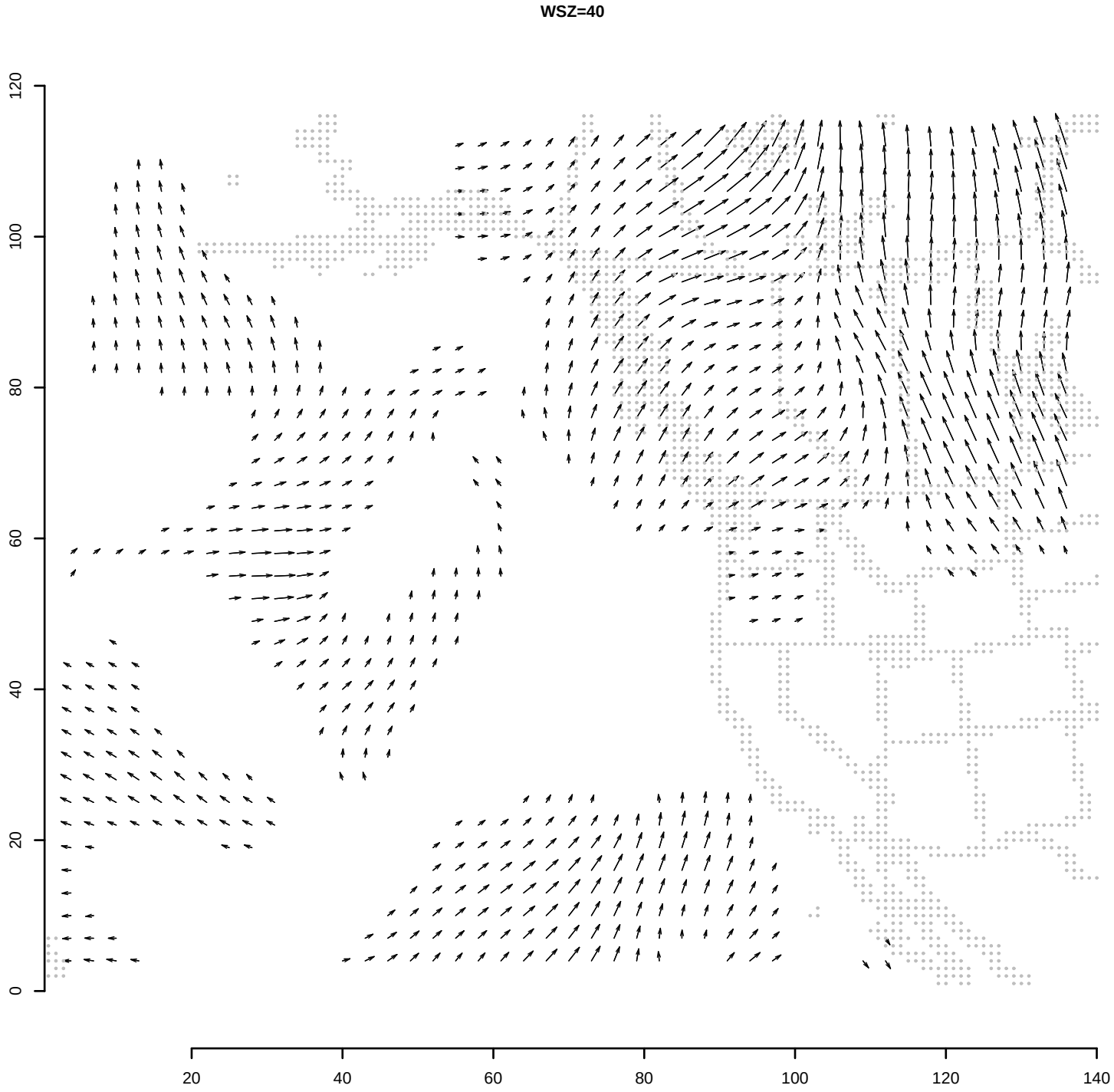
400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120
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40
60
80
100
120
140

In Summary:

Optical flow → visual tool for diagnostic verification.

Summary measures → diagnostic and automatic verification.

Future → doing statistics on lots of dates.

Problems: Discrete fields (e.g., reflectivity).